Debug Tool for z/OS

User's Guide

Version 11.1

SC27-3631-02

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Note!

Before using this information and the product it supports, be sure to read the general information under “Notices” on page 511.

This edition applies to Debug Tool for z/OS, Version 11.1 (Program Number 5655-W45) with the PTF for APAR PM44285, which supports the following compilers:

- AD/Cycle C/370 Version 1 Release 2 (Program Number 5688-216)
- C/C++ for MVS/ESA Version 3 (Program Number 5655-121)
- C/C++ feature of OS/390 (Program Number 5647-A01)
- C/C++ feature of z/OS (Program Number 5694-A01)
- OS/VS COBOL, Version 1 Release 2.4 (5740-CB1) - with limitations
- VS COBOL II Version 1 Release 3 and Version 1 Release 4 (Program Numbers 5668-958, 5688-023) - with limitations
- COBOL/370 Version 1 Release 1 (Program Number 5688-197)
- COBOL for MVS & VM Version 1 Release 2 (Program Number 5688-197)
- COBOL for OS/390 & VM Version 2 (Program Number 5648-A25)
- Enterprise COBOL for z/OS and OS/390 Version 3 (Program Number 5655-G53)
- Enterprise COBOL for z/OS Version 4.2 and earlier (Program Number 5655-S71)
- High Level Assembler for MVS & VM & VSE Version 1 Release 4, Version 1 Release 5, and Version 1 Release 6 (Program Number 5696-234)
- OS PL/I Version 2 Release 1, Version 2 Release 2, Version 2 Release 3 (Program Numbers 5668-909, 5668-910) - with limitations
- PL/I for MVS & VM Version 1 Release 1 (Program Number 5688-235)
- VisualAge PL/I for OS/390 Version 2 Release 2 (Program Number 5655-B22)
- Enterprise PL/I for z/OS and OS/390 Version 3 (Program Number 5655-H31)
- Enterprise PL/I for z/OS Version 4.1 (Program Number 5655-W67)

This edition also applies to all subsequent releases and modifications until otherwise indicated in new editions or technical newsletters.

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You can find out more about Debug Tool by visiting the IBM Web site for Debug Tool at: http://www.ibm.com/software/awdtools/debugtool

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About this document

Debug Tool combines the richness of the z/OS® environment with the power of Language Environment® to provide a debugger for programmers to isolate and fix their program bugs and test their applications. Debug Tool gives you the capability of testing programs in batch, using a nonprogrammable terminal in full-screen mode, or using a workstation interface to remotely debug your programs.

Who might use this document

This document is intended for programmers using Debug Tool to debug high-level languages (HLLs) with Language Environment and assembler programs either with or without Language Environment. Throughout this document, the HLLs are referred to as C, C++, COBOL, and PL/I.

Debug Tool runs on the z/OS operating system and supports the following subsystems:

- CICS®
- DB2®
- IMS™
- JES batch
- TSO
- UNIX System Services in remote debug mode or full-screen mode using the Terminal Interface Manager only

To use this document and debug a program written in one of the supported languages, you need to know how to write, compile, and run such a program.

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Using LookAt to look up message explanations

LookAt is an online facility that lets you look up explanations for most of the IBM messages you encounter, as well as for some system abends and codes. Using LookAt to find information is faster than a conventional search because in most cases LookAt goes directly to the message explanation.

You can use LookAt from the following locations to find IBM message explanations for z/OS elements and features, z/VM®, VSE/ESA, and Clusters for AIX® and Linux:

- The Internet. You can access IBM message explanations directly from the LookAt Web site at http://www.ibm.com/eserver/zseries/zos/bkserv/lookat/.
- Your z/OS TSO/E host system. You can install code on your z/OS or z/OS.e systems to access IBM message explanations, using LookAt from a TSO/E command line (for example, TSO/E prompt, ISPF, or z/OS UNIX System Services running OMVS).
- Your Microsoft Windows workstation. You can install code to access IBM message explanations on the *z/OS Collection* (SK3T-4269), using LookAt from a Microsoft Windows command prompt (also known as the DOS command line).
- Your wireless handheld device. You can use the LookAt Mobile Edition with a handheld device that has wireless access and an Internet browser (for example, Internet Explorer for Pocket PCs, Blazer, or Eudora for Palm OS, or Opera for Linux handheld devices). Link to the LookAt Mobile Edition from the LookAt Web site.

You can obtain code to install LookAt on your host system or Microsoft Windows workstation from a disk on your *z/OS Collection* (SK3T-4269), or from the LookAt Web site (click **Download**, and select the platform, release, collection, and location that suit your needs). More information is available in the LOOKAT.ME files available during the download process.

How this document is organized

This document is divided into areas of similar information for easy retrieval of appropriate information. The following list describes how the information is grouped:

- Part 1 groups together introductory information about Debug Tool. The following list describes each chapter:
  - Chapter 1 introduces Debug Tool and describes some of its features.
  - Chapter 2 describes a simple scenario of how to use Debug Tool in full-screen mode, introducing you to some basic commands that you might use frequently.
- Part 2 groups together information about how to prepare programs for debugging. The following list describes each chapter:
  - Chapter 3 describes how to choose compiler options, debugging mode, and runtime options so that you can prepare programs for debugging. It also describes your options for debugging COBOL programs compiled with compilers that are now out-of-service.
  - Chapter 4 describes how to implement the choices you made in chapter 3.
  - Chapter 5 describes how to prepare a LangX COBOL program.
  - Chapter 6 describes how to prepare an assembler program.
  - Chapter 7 describes how to prepare a DB2 program.
  - Chapter 8 describes how to prepare a DB2 stored procedures program.
  - Chapter 9 describes how to prepare a CICS program.

  - Chapter 10 describes how to prepare an IMS program.
  - Chapter 11 describes how to include a call to the TEST runtime option into a program.
- Part 3 groups together information that describes the different methods you can use to start Debug Tool. The following list describes each chapter:
  - Chapter 12 describes how to write the TEST runtime option to indicate how and when you want to start Debug Tool.
  - Chapter 13 describes how to start Debug Tool from Debug Tool Utilities.
  - Chapter 14 describes how to start Debug Tool from a program.
  - Chapter 15 describes how to start Debug Tool in batch mode.
  - Chapter 16 describes how to start Debug Tool for your batch or TSO programs.
  - Chapter 17 describes how to start Debug Tool from CICS programs.
  - Chapter 18 describes how to start Debug Tool in full-screen mode.
  - Chapter 19 describes how to start Debug Tool in full-screen mode using the Terminal Interface Manager. This chapter also describes some tips to starting Debug Tool from a stored procedure.
- Part 4 groups together information about how to debug a program in full-screen mode and provides an example of how to debug a C, COBOL, and PL/I program in full-screen mode. The following list describes each chapter:
  - Chapter 20 provides overview information about full-screen mode.
  - Chapter 21 provides a sample COBOL program to describe how to debug it in full-screen mode.
  - Chapter 22 provides a sample OS/VS COBOL program as representative of non-Language Environment COBOL programs to describe how to debug it in full-screen mode.
  - Chapter 23 provides a sample PL/I program to describe how to debug it in full-screen mode.
  - Chapter 24 provides a sample C program to describe how to debug it in full-screen mode.
  - Chapter 25 provides a sample C++ program to describe how to debug it in full-screen mode.
  - Chapter 26 provides a sample assembler program to describe how to debug it in full-screen mode.
  - Chapter 27 describes how to modify the appearance of a full-screen mode debugging session and save those changes, as well as other settings, into files.
- Part 5 groups together information about how to enter and use Debug Tool commands.
  - Chapter 28 provides information about entering mixed case commands, using DBCS characters, abbreviating commands, entering multiline commands, and entering comments.
  - Chapter 29 describes how to use Debug Tool commands to debug COBOL programs.
  - Chapter 30 describes how to use Debug Tool commands to debug LangX COBOL programs.
  - Chapter 31 describes how to use Debug Tool commands to debug PL/I programs.
  - Chapter 32 describes how to use Debug Tool commands to debug C or C++ programs.

  - Chapter 33 describes how to use Debug Tool commands to debug assembler programs.
  - Chapter 34 describes how to use Debug Tool commands to debug disassembly programs.
- Part 6 groups together information about debugging DB2, DB2 stored procedures, IMS, CICS, ISPF, UNIX System Services, and production-level programs.
  - Chapter 35 describes how to debug a DB2 program.
  - Chapter 36 describes how to debug a DB2 stored procedure.
  - Chapter 37 describes how to debug an IMS program.
  - Chapter 38 describes how to debug a CICS program.
  - Chapter 39 describes how to debug an ISPF program.
  - Chapter 40 describes how to debug a production-level program.
  - Chapter 41 describes how to debug a program running in the UNIX System Services shell.
  - Chapter 42 describes how to debug programs that do not start or run in Language Environment.
- Part 7 groups together information about how to debug programs written in multiple language or running in multiple processes.
  - Chapter 43 describes how to debug a program written in multiple languages.
  - Chapter 44 describes the restrictions when you debug a multithreaded program.
  - Chapter 45 describes how to debug a program that runs across multiple processes and enclaves.
  - Chapter 46 describes how to debug a multiple-enclave interlanguage communication (ILC) application.
  - Chapter 47 describes how to debug programs that are called by Java native methods.
  - Chapter 48 describes how to instruct Debug Tool to handle problems created by program names or the large size of programs.
- Part 8 groups together appendixes. The following list describes each appendix:
  - Appendix A describes the data sets that Debug Tool uses to retrieve and store information.
  - Appendix B describes the process Debug Tool uses to locate source, listing, or side files.
  - Appendix C describes the compiler options you should choose to create programs that can be used by all the Problem Determination Tools, eliminating recompiles when you want to switch tools.
  - Appendix D provides an example that guides you through the process of preparing a sample program and modifying existing setup files by using Debug Tool Utilities.
  - Appendix E provides information about debugging a program in batch mode.
  - Appendix F describes how to use the DTST transaction to display and modify CICS storage.
  - Appendix G describes how to use Load Module Analyzer, a stand-alone program that is shipped with Debug Tool.
  - Appendix H describes how you can use the DTNP transaction, supplied by Debug Tool, to load a new copy of a program into an active CICS region.

– Appendix I describes how to install the IBM Debug Tool DTCN and DTSP Profile Manager plug-in.
– Appendix J describes the resources that are available to help you solve any problems you might encounter with Debug Tool.
– Appendix K describes the features and tools available to people with physical disabilities that help them use Debug Tool and Debug Tool documents.

The last several topics list notices, bibliography, and glossary of terms.

Terms used in this document

Because of differing terminology among the various programming languages supported by Debug Tool, as well as differing terminology between platforms, a group of common terms has been established. The table below lists these terms and their equivalency in each language.

Debug Tool term	C and C++ equivalent	COBOL or LangX COBOL equivalent	PL/I equivalent	assembler
Compile unit	C and C++ source file	Program	• Program • PL/I source file for Enterprise PL/I • A package statement or the name of the main procedure for Enterprise PL/I[1]	CSECT
Block	Function or compound statement	Program, nested program, method or PERFORM group of statements	Block	CSECT
Label	Label	Paragraph name or section name	Label	Label

Notes:

1. The PL/I program must be compiled with and run in one of the following environments:
   - Compiled with Enterprise PL/I for z/OS, Version 3.6 or later, and run with the following versions of Language Environment:
     – Language Environment Version 1.9, or later
     – Language Environment Version 1.6, Version 1.7, or Version 1.8, with the PTF for APAR PK33738 applied
   - Compiled with Enterprise PL/I for z/OS, Version 3.5, with the PTFs for APARs PK35230 and PK35489 applied and run with the following versions of Language Environment:
     – Language Environment Version 1.9, or later
     – Language Environment Version 1.6, Version 1.7, or Version 1.8, with the PTF for APAR PK33738 applied

Debug Tool provides facilities that apply only to programs compiled with specific levels of compilers. Because of this, *Debug Tool User's Guide* uses the following terms:

assembler
Refers to assembler programs with debug information assembled by using the High Level Assembler (HLASM).

COBOL
Refers to the all COBOL compilers supported by Debug Tool except the COBOL compilers described in the term *LangX COBOL*.

disassembly or disassembled
Refers to high-level language programs compiled without debug information or assembler programs without debug information. The debugging support Debug Tool provides for these programs is through the disassembly view.

Enterprise PL/I
Refers to the Enterprise PL/I for z/OS and OS/390® and the VisualAge® PL/I for OS/390 compilers.

LangX COBOL
Refers to any of the following COBOL programs supported through use of the EQALANGX (or IDILANGX) debug file:

- Programs compiled using the IBM OS/VS COBOL compiler.
- Programs compiled using the VS COBOL II compiler with the `NOTEST` compiler option.
- Programs compiled using the Enterprise COBOL compiler with the `NOTEST` compiler option.

As you read through the information in this document, remember that OS/VS COBOL programs are non-Language Environment programs, even though you might have used Language Environment libraries to link and run your program.

VS COBOL II programs are non-Language Environment programs when you link them with the non-Language Environment library. VS COBOL II programs are Language Environment programs when you link them with the Language Environment library.

Enterprise COBOL programs are always Language Environment programs. Note that COBOL DLL's cannot be debugged as LangX COBOL programs.

Read the information regarding non-Language Environment programs for instructions on how to start Debug Tool and debug non-Language Environment COBOL programs, unless information specific to LangX COBOL is provided.

PL/I Refers to all levels of PL/I compilers. Exceptions will be noted in the text that describe which specific PL/I compiler is being referenced.

How to read syntax diagrams

This section describes how to read syntax diagrams. It defines syntax diagram symbols, items that may be contained within the diagrams (keywords, variables, delimiters, operators, fragment references, operands) and provides syntax examples that contain these items.

Syntax diagrams pictorially display the order and parts (options and arguments) that comprise a command statement. They are read from left to right and from top to bottom, following the main path of the horizontal line.

Symbols

The following symbols may be displayed in syntax diagrams:

Symbol	Definition
►►—	Indicates the beginning of the syntax diagram.
—►	Indicates that the syntax diagram is continued to the next line.
►—	Indicates that the syntax is continued from the previous line.
—►◄	Indicates the end of the syntax diagram.

Syntax items

Syntax diagrams contain many different items. Syntax items include:

- Keywords - a command name or any other literal information.
- Variables - variables are italicized, appear in lowercase and represent the name of values you can supply.
- Delimiters - delimiters indicate the start or end of keywords, variables, or operators. For example, a left parenthesis is a delimiter.
- Operators - operators include add (+), subtract (-), multiply (*), divide (/), equal (=), and other mathematical operations that may need to be performed.
- Fragment references - a part of a syntax diagram, separated from the diagram to show greater detail.
- Separators - a separator separates keywords, variables or operators. For example, a comma (,) is a separator.

Keywords, variables, and operators may be displayed as required, optional, or default. Fragments, separators, and delimiters may be displayed as required or optional.

Item type	Definition
Required	Required items are displayed on the main path of the horizontal line.
Optional	Optional items are displayed below the main path of the horizontal line.
Default	Default items are displayed above the main path of the horizontal line.

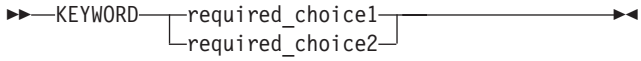
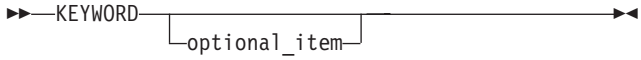
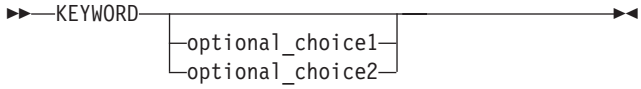
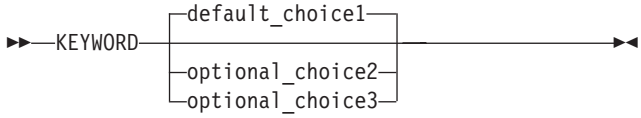
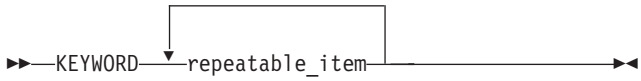
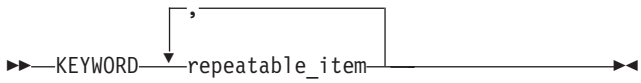
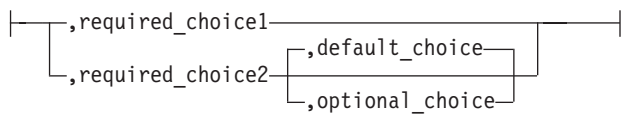
Syntax examples

The following table provides syntax examples.

Table 1. Syntax examples

Item	Syntax example
Required item. Required items appear on the main path of the horizontal line. You must specify these items.	►►—KEYWORD—required_item—►◄

Table 1. Syntax examples (continued)

Item	Syntax example
Required choice. A required choice (two or more items) appears in a vertical stack on the main path of the horizontal line. You must choose one of the items in the stack.	
Optional item. Optional items appear below the main path of the horizontal line.	
Optional choice. An optional choice (two or more items) appears in a vertical stack below the main path of the horizontal line. You may choose one of the items in the stack.	
Default. Default items appear above the main path of the horizontal line. The remaining items (required or optional) appear on (required) or below (optional) the main path of the horizontal line. The following example displays a default with optional items.	
Variable. Variables appear in lowercase italics. They represent names or values.	
Repeatable item. An arrow returning to the left above the main path of the horizontal line indicates an item that can be repeated. A character within the arrow means you must separate repeated items with that character. An arrow returning to the left above a group of repeatable items indicates that one of the items can be selected, or a single item can be repeated.	 
Fragment. The ┤ fragment ├ symbol indicates that a labelled group is described below the main syntax diagram. Syntax is occasionally broken into fragments if the inclusion of the fragment would overly complicate the main syntax diagram.	 **fragment:** 

How to send your comments

Your feedback is important in helping us to provide accurate, high-quality information. If you have comments about this document or any other Debug Tool documentation, contact us in one of these ways:

- Use the Online Readers' Comment Form at www.ibm.com/software/awdtools/rcf/. Be sure to include the name of the document, the publication number of the

document, the version of Debug Tool, and, if applicable, the specific location (for example, page number) of the text that you are commenting on.

- Send your comments by email to comments@us.ibm.com. Be sure to include the name of the book, the part number of the book, the version of Debug Tool, and, if applicable, the specific location of the text you are commenting on (for example, a page number or table number).

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Summary of changes

This section lists the key changes made to Debug Tool for z/OS and the locations in the publications describing these changes.

Changes introduced with the PTF for APAR PM44285

Support for Delay Debug has been introduced. The following changes, if applicable, are marked with revision bars and include the following new options to EQAOPTS :

- DLAYDBG
- DLAYDBGDSN
- DLAYDBGTRC

Note that this support applies only to non-CICS environments.

- Secure communication has been implemented between the z/OS host and a workstation remote debugger over the TCP/IP network.

Changes introduced with the PTF for APAR PM27734

Support for non-Language Environment COBOL has been enhanced. The following changes, if applicable, are marked with revision bars:

- The phrase "non-Language Environment COBOL" has been changed to "LangX COBOL" and the support has been extended.
- LangX COBOL now includes any of the following supported through the use of an EQALANGX file:
  - Programs compiled using the IBM OS/VS COBOL compiler (previously included in non-Language Environment COBOL).
  - Programs compiled using the VS COBOL II compiler with the NOTEST compiler option (previously included in non-Langauge Environment COBOL only when link-edited with a non-Language Environment library).
  - Programs compiled using the Enterprise COBOL compiler with the NOTEST compiler option.

Changes introduced to the -01 edition of the *Debug Tool Customization Guide*

In Debug Tool V11, the Terminal Interface Manager was enhanced to remove the need for a site to set up a separate TN3270E port or to customize a set of terminal LUs. This simplified installation is now documented in “Enabling debugging in full-screen mode using the Terminal Interface Manager” of the *Debug Tool Customization Guide*. For information on customizing a system to support "full-screen mode using a dedicated terminal without Terminal Interface Manager" (specified via the MFI% option in the TEST runtime options string), refer to the *Debug Tool Customization Guide* “Appendix B. Enabling debugging in full-screen mode using a dedicated terminal”. Also, refer to the *Debug Tool Customization Guide* “Appendix B. Enabling debugging in full-screen mode using a dedicated terminal” for information on how the Terminal Interface Manager (specified via the VTAM% option in the TEST runtime options string) was installed in the previous versions of Debug Tool.

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Changes introduced with Debug Tool V11

The following changes, if applicable, are marked with revision bars:

- You can now download a plug-in, called the IBM Debug Tool plug-in for Eclipse, from the IBM website that adds a remote debugger to CICS Explorer®.

  The following changes were made to the topic "Remote debug mode" on page 5:

  – This plug-in was added to the list of products providing supported remote debuggers. This list was also updated to remove remote debuggers in products that are no longer supported.

  – A link to the website with more information about the plug-in and download instructions was added.

  – Cross-references to online topics that help you get started with the remote debuggers have been added.

- A new mode, called explicit debug mode, has been added to help improve performance while debugging large, complex applications by loading debug information for only the compile units that you indicate. To learn more about explicit debug mode, see "Optimizing the debugging of large applications" on page 407.

  A new command, `SET EXPLICITDEBUG`, has been created and several existing commands have been modified. The following list summarizes the changes made to the *Debug Tool Reference and Messages*:

  – A usage note has been added to the `AT ENTRY` command; see "AT ENTRY command".

  – The description of the `LOADDEBUGDATA` command has been modified; see "LOADDEBUGDATA command".

  – A usage note has been added to the `NAMES INCLUDE` command; see "NAMES INCLUDE command".

  – A new option, `EXPLICITDEBUG`, has been added to the `QUERY` command; see "QUERY command".

  – A new usage note has been added to the `SET DISASSEMBLY` command; see "SET DISASSEMBLY command".

  – A description of the `SET EXPLICITDEBUG` command has been added; see "SET EXPLICITDEBUG command".

  – A new usage note has been added to the `SET IGNORELINK` command; see "SET IGNORELINK command".

- Several new panels have been added to the Terminal Interface Manager to help you create the TEST runtime options data set. To learn how to use these panels, see "Creating and managing the TEST runtime options data set" on page 106.

- The Terminal Interface Manager has been enhanced to remove the need for a site to set up a separate TN3270E port or to customize a set of terminal LUs. The topic "Enabling debugging in full-screen mode using the Terminal Interface Manager" of the *Debug Tool Customization Guide* has been updated.

- Debug Tool provides a new plug-in, called the IBM Debug Tool DTCN and DTSP Profile Manager, that adds the **DTCN Profiles** and **DTSP Profile** view to the **Debug** perspective of your Eclipse applications. These views help you manage your DTCN profiles and the TEST runtime options data set (EQAUOPTS) on your z/OS system, respectively.

  Before you can use the **DTCN Profiles** view, the system administrator must do the tasks described in the topic "Adding support for the DTCN Profiles view and APIs" in the *Debug Tool Customization Guide*.

Before you can use the **DTSP Profile** view, the system administrator must do the tasks described in the topic “Adding support for the DTSP Profile view” in the *Debug Tool Customization Guide*.

The following changes were made to the *Debug Tool User's Guide*:

- A brief description of this plug-in was added to the topic “Remote debug mode” on page 5.
- The topic “Creating and managing the TEST runtime options data set” on page 106 was modified to mention the **DTSP Profile** view as another method of updating the TEST runtime options data set. This topic is also available in the *Debug Tool Customization Guide*.
- Installation instructions are in the topic Appendix I, “Installing the IBM Debug Tool DTCN and DTSP Profile Manager plug-in,” on page 497.

- You can now use the Debug Tool Language Environment user exit for DB2 (EQADDCXT) to debug DB2 stored procedures of type SUB invoked by the call_sub function. The following topics in the *Debug Tool User's Guide* were updated to describe how to do this:
  - “Choosing a method or methods for starting Debug Tool” on page 53.
  - Table 11 on page 54.
- An additional method for specifying EQAOPTS options has been added. You can now supply EQAOPTS options at run time by specifying a data set containing EQAOPTS options. Information about the EQAOPTS options has been reorganized and renamed. EQAOPTS options are now called EQAOPTS *commands*. Information about the EQAOPTS commands is located in the following topics:
  - In the *Debug Tool Customization Guide*, information previously found in “Defining EQAOPTS options: checklist and instructions” has been moved to “EQAOPTS commands”. This topic is also included in *Debug Tool Reference and Messages*.
  - A new option, EQAOPTS, has been added to the `QUERY` command; see “QUERY command” in the *Debug Tool Reference and Messages*.
  - The panels for DTCN have been updated to include a field where you can specify the data set name of the EQAOPTS file; see “Creating and storing a DTCN profile” on page 84.
  - A description of the EQAOPTS file has been added to Appendix A, “Data sets used by Debug Tool,” on page 413.
  - A new XML tag (<EQAOPTSFILE>) has been added to the topic “Definition of XML tags” in the *Debug Tool API User's Guide and Reference*.
- Debug Tool now supports accessing the high-order 32 bits of the 64-bit General Purpose Registers (GPRs). In the *Debug Tool Reference and Messages*, the following topics were updated:
  - The following new symbols for the high-order bits were added to the description of the *symbol* element; see “Common syntax elements”: RH0, RH1, RH2, RH3, RH4, RH5, RH6, RH7, RH8, RH9, RH10, RH11, RH12, RH13, RH14, RH15.
  - The description of the “LIST REGISTERS command” has been updated.
  - The description of new variables, %GPRH*n*, has been added to “Debug Tool variables”.
- Debug Tool changed the way it handles nested blocks in C and C++ programs, which enhances performance. In the *Debug Tool Reference and Messages*, usage notes were added to the following topics:
  - “AT ENTRY command”

- "AT EXIT command"
- "AT GLOBAL command"
- "AT PATH command"

The description of the BLOCK parameter of the SET CHANGE command was changed; see "SET CHANGE command". The topic "Changes in behavior of some commands" describes this change in behavior.

- A new window, called the List pop-up window, has been added that displays the results of the LIST *expression* command when the Log window is closed. To learn how the window works, see "List pop-up window" on page 158.
- For PL/I programs, you can now use the PL/I ADDRDATA built-in function and the "=>" operator. In the *Debug Tool User's Guide*, the following changes were made:
  - The tables in "Supported PL/I built-in functions" on page 305 have been updated.
  - The examples in "Accessing PL/I structures" on page 303 have been updated.
- For PL/I programs compiled with Enterprise PL/I for z/OS, Version 4.1 or later, another scenario has been added to "Choosing TEST or NOTEST compiler suboptions for PL/I programs" on page 32 to describe the impact of specifying the GONUMBER(SEPARATE) compiler option.
- For programs compiled with any level of Enterprise PL/I, you can now list a single element of an array of structures. For programs compiled with Enterprise PL/I for z/OS, Version 4.1, you can list a single element of an array of structures in automonitor or use the L prefix command in the Source window to list a single element of an array of structures.

  The following changes were made to the *Debug Tool Reference and Messages*:
  - The description of the "SET AUTOMONITOR command" was updated.
  - The description of the "LIST expression command" was updated.

  In the *Debug Tool User's Guide*, the topic "Accessing PL/I structures" on page 303 was updated.
- For programs compiled with any level of Enterprise PL/I, you can now change the format in which Debug Tool displays an array. By using the new SET LIST BY SUBSCRIPT ON command, you can have Debug Tool display the array as it is stored in memory.

  The description of "SET LIST BY SUBSCRIPT command" was added to the *Debug Tool Reference and Messages*.
- A new keyword, LABELS, was added to the LIST NAMES command where you can list the names of all section and paragraph names in a COBOL or LangX COBOL program, and the names of all instruction labels in an assembler program; see "LIST NAMES command" in the *Debug Tool Reference and Messages*.
- New options, GLOBAL and LOCAL, have been added to the AT CHANGE command so that you can indicate that the command applies to all compile units or only to a specific compile unit.

  In *Debug Tool Reference and Messages*, "AT CHANGE command (full screen mode, line mode, batch mode)" was updated.
- A new option, LOCAL, has been added to the AT LABEL * command so that you can limit the scope of the command to a specific compile unit.

  In *Debug Tool Reference and Messages*, "AT LABEL command" was updated.
- A new option, OCCURRENCE, has been added to the AT GLOBAL command so that you can set a breakpoint that gives Debug Tool control whenever a valid condition occurs or an exception is raised.

In *Debug Tool Reference and Messages*, the topic “AT GLOBAL command” was updated.

- You can now change the subscripts of an array directly in the Monitor window. Instructions have been added to “Replacing a variable in the Monitor window with another variable” on page 192.
- The `CLEAR MONITOR` command has been updated so you can specify a range of monitors to remove from the Monitor window and so you can use the cursor to indicate which monitor to remove from the Monitor window. In the *Debug Tool Reference and Messages*, see “CLEAR command”. In the *Debug Tool User's Guide*, the list of prefix commands in “Entering prefix commands on specific lines or statements” on page 164 has been updated.
- The `QUERY LOCATION` command has been updated so that it displays the former and current value, in hexadecimal format, of a variable when you set a breakpoint on the variable with the `AT CHANGE` command.

  In *Debug Tool Reference and Messages*, “QUERY command” was updated.
- A method for automatically allocating a SAVESETS and SAVEBPS file and enabling the saving and restoring of settings, breakpoints, and monitor specifications has been added.

  If you are not familiar with saving and restoring settings, breakpoints, and monitor specifications, see “Saving and restoring settings, breakpoints, and monitor specifications” on page 184.

  To learn how this new method works and compare it to the previous method, see “Saving and restoring automatically” on page 186.

  Implementing this method requires EQAOPTS commands. If you are not familiar with EQAOPTS commands, see “EQAOPTS commands” in the *Debug Tool Reference and Messages* or *Debug Tool Customization Guide*.

  The descriptions in the *Debug Tool Reference and Messages* for the following commands were updated:

  – A new usage note has been added to the `SET RESTORE` command; see “SET RESTORE command”.

  – A new usage note has been added to the `SET SAVE` command; see “SET SAVE command”.

  The EQAOPTS commands `SAVEBPDSNALLOC` and `SAVESETDSNALLOC` were added and described in “SAVEBPDSNALLOC, SAVESETDSNALLOC” of both the *Debug Tool Reference and Messages* and *Debug Tool Customization Guide*.
- A method for establishing a naming pattern for a log file, creating the log file, and, in a CICS environment, enabling writing to a log file has been added.

  Implementing this method requires EQAOPTS commands. If you are not familiar with EQAOPTS commands, see “EQAOPTS commands” in the *Debug Tool Reference and Messages* or *Debug Tool Customization Guide*. The following EQAOPTS commands were added and descriptions are located in both the *Debug Tool Reference and Messages* and *Debug Tool Customization Guide*:

  – “LOGDSN”

  – “LOGDSNALLOC”

  In the *Debug Tool Reference and Messages*, a new usage note has been added to the `SET LOG` command to explain under which circumstances Debug Tool creates a log file, and the initial setting for the `SET LOG` command; see “SET LOG command”.

  In the *Debug Tool User's Guide*, the following changes were made:

  – To understand the difference between the old method and new method, see “Creating the log file” on page 177.

  - To learn how to start a log file in CICS, see “Restrictions when debugging under CICS” on page 368.
  - The description of the log file has been updated in Appendix A, “Data sets used by Debug Tool,” on page 413.
- A method for establishing a naming pattern for preferences and commands files that Debug Tool can use to find and read those files has been added.

  Implementing this method requires EQAOPTS commands. If you are not familiar with EQAOPTS commands, see “EQAOPTS commands” in the *Debug Tool Reference and Messages* or *Debug Tool Customization Guide*. The following EQAOPTS commands were added and descriptions are located in both the *Debug Tool Reference and Messages* and *Debug Tool Customization Guide*:
  - “COMMANDSDSN”
  - “PREFERENCESDSN”

  A new key word, NULLFILE, was added to the commands_file and preferences_file sections of the TEST runtime options string so you can suppress any system wide settings for the naming patterns. The new key word is described in “Syntax of the TEST run-time option”.

  In the *Debug Tool User's Guide*, the following changes were made:
  - The description of the **Preference File** and **Commands File** fields have been changed in “Description of fields on the DTCN Menu 2 screen” on page 93.
  - Phrases indicating that the preferences or commands file can only be specified through the `TEST` runtime options have been removed throughout the book.
  - To learn when Debug Tool reads preferences and commands files, see “Creating a preferences file” on page 159 and “Creating a commands file” on page 175.
  - A note regarding CICS authorization to read the preferences and commands files was added to “Restrictions when debugging under CICS” on page 368.
  - The description of the preferences and commands files has been updated in Appendix A, “Data sets used by Debug Tool,” on page 413.
- New functions have been added to Debug Tool Utilities to help you more easily start debugging IMS applications running in BTS. In the *Debug Tool User's Guide*, the topic “Debug Tool Utilities” on page 6 has been updated to provide an overview of option 9, IMS BTS Debugging. In the *Debug Tool Customization Guide*, the topic “Customizing IMS BTS Debugging” has been added.
- A new CICS transaction, called DTNP, has been added that can run the NEWCOPY batch command to reload application programs into an active CICS region. This transaction is described in the topic Appendix H, “Running NEWCOPY on programs by using DTNP transaction,” on page 495.
- You can now debug Java native methods and the Language Environment programs they call. To learn how to do this, see Chapter 47, “Debugging programs called by Java native methods,” on page 403 in the *Debug Tool User's Guide*.
- In the *Debug Tool Customization Guide*, all information about customizations required for remote debug mode have been consolidated into one topic called “Adding support for remote debug users”.

  Most of the information in topic “Customizing your z/OS system to give the API access to DTCN profiles” of the *Debug Tool API User's Guide and Reference* has been moved into this new topic and renamed to “Adding support for the DTCN Profiles view and APIs”.

- In the *Debug Tool User's Guide*, some information that was previously in the appendix “Notes on debugging in remote debug mode” has been moved to the online help for the compiled language debugger component of Rational Developer for System z and the IBM Debug Tool plug-in for Eclipse. Information that was previously in the appendix “Running a sample plug-in that uses the API” of the *Debug Tool API User's Guide and Reference* has been moved to the topic Appendix I, “Installing the IBM Debug Tool DTCN and DTSP Profile Manager plug-in,” on page 497.
- Reference cards that were previously in the *Debug Tool Reference and Messages* have been moved to *Debug Tool Reference Summary*. A new reference card specifically for assembler users has been added.

Part 1. Getting started with Debug Tool

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Chapter 1. Debug Tool: overview

Debug Tool helps you test programs and examine, monitor, and control the execution of programs written in assembler, C, C++, COBOL, or PL/I on a z/OS system. Your applications can include other languages; Debug Tool provides a disassembly view that lets you debug, at the machine code level, those portions of your application. However, in the disassembly view, your debugging capabilities are limited. Table 2 and Table 3 on page 4 map out the combinations of compilers and subsystems that Debug Tool supports.

You can use Debug Tool to debug your programs in batch mode, interactively in full-screen mode, or in remote debug mode.

Table 2 maps out the Debug Tool interfaces and compilers or assemblers each interface supports.

Table 2. Debug Tool interface type by compiler or assembler

Compiler or assembler	Batch mode	Full-screen mode	Remote debug mode
OS/VS COBOL, Version 1 Release 2.4 (with limitations) [1]	X	X	
VS COBOL II Version 1 Release 3 and Version 1 Release 4 (with limitations; for programs compiled with the `TEST` compiler option and linked with the Language Environment library.)	X	X	X
VS COBOL II Version 1 Release 3 and Version 1 Release 4 (with limitations; for programs compiled with the `NOTEST` compiler option and linked with a non-Language Environment library.)	X	X	
VS COBOL II Version 1 Release 3 and Version 1 Release 4 (with limitations; for programs compiled with the `NOTEST` compiler option and linked with the Language Environment library.) [1]	X	X	
AD/Cycle® COBOL/370 Version 1 Release 1	X	X	
COBOL for MVS™ & VM	X	X	X
COBOL for OS/390 & VM	X	X	X
Enterprise COBOL for z/OS and OS/390 compiled with the `TEST` compiler option	X	X	X
Enterprise COBOL for z/OS and OS/390 compiled with the `NOTEST` compiler option [1]	X	X	
Enterprise COBOL for z/OS compiled with the `TEST` compiler option	X	X	X
Enterprise COBOL for z/OS compiled with the `NOTEST` compiler option [1]	X	X	
OS PL/I Version 2 Release 1, Version 2 Release 2, and Version 2 Release 3 (with limitations)	X	X	
PL/I for MVS & VM	X	X	
Enterprise PL/I for z/OS and OS/390 compiled with the TEST compiler option	X	X	X
Enterprise PL/I for z/OS compiled with the NOTEST compiler option	X	X	
AD/Cycle C/370™ Version 1 Release 2	X	X	
C/C++ for MVS/ESA Version 3 Release 2	X	X	
C/C++ feature of OS/390 Version 1 Release 3 and earlier	X	X	
C/C++ feature of OS/390 Version 2 Release 10 and later	X	X	X
C/C++ feature of z/OS	X	X	X

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Table 2. Debug Tool interface type by compiler or assembler (continued)

Compiler or assembler	Batch mode	Full-screen mode	Remote debug mode
IBM High Level Assembler (HLASM), Version 1 Release 4, Version 1 Release 5, and Version 1 Release 6	X	X	X

1. See Chapter 5, “Preparing a LangX COBOL program,” on page 67 for information on how to prepare a program of this type.

Table 3 maps out the Debug Tool interfaces and subsystems each interface supports.

Table 3. Debug Tool interface type by subsystem

Subsystem	Batch mode	Full-screen mode	Full-screen mode using the Terminal Interface Manager	Remote debug mode
TSO	X	X	X	X
JES batch	X		X	X
UNIX System Services			X	X
CICS		X[1]		X
DB2	X	X	X	X
DB2 stored procedures			X	X
IMS TM			X	X
IMS batch	X		X	X
IMS BTS		X	X	X
Airline Control System (ALCS)				X[2]

[1] You can use three different ways to debug CICS programs in full-screen mode: single terminal mode, screen control mode, and separate terminal mode.
[2] Only for C and C++ programs.

Refer to the following topics for more information related to the material discussed in this topic.

Related concepts
“Debug Tool interfaces”
Related tasks
Chapter 3, “Planning your debug session,” on page 23
Chapter 20, “Using full-screen mode: overview,” on page 151
Related references
Debug Tool Reference and Messages

Debug Tool interfaces

The terms *full-screen mode*, *batch mode*, and *remote debug mode* identify the types of debugging interfaces that Debug Tool provides.

Batch mode

You can use a Debug Tool commands file to predefine a series of Debug Tool commands to be performed on a running application. Neither terminal input, nor

user interaction is available during batch mode debugging. When commands in the commands file are processed by the debugger, they can produce messages that are written to the Debug Tool log. Log messages are written to a log file for your review at a later time.

The term "batch mode" debugging refers to this debugging method, which is controlled by a predefined script. Note that batch mode debugging is not limited to debugging batch programs. Batch mode can be used with any type of application supported by Debug Tool, including online applications running under CICS, IMS/TM, or TSO.

Full-screen mode

Debug Tool provides an interactive full-screen interface on a 3270 device, with debugging information displayed in three windows:

- A Source window in which to view your program source or listing
- A Log window, which records commands and other interactions between Debug Tool and your program
- A Monitor window in which to monitor changes in your program

You can debug all languages supported by Debug Tool in full-screen mode.

Refer to the following topics for more information related to the material discussed in this topic.

Related tasks
Debug Tool Customization Guide

Full-screen mode using the Terminal Interface Manager

Full-screen mode using the Terminal Interface Manager provides the same interactive full-screen interface that full-screen mode provides and enables you to debug types of programs that you could not debug with full-screen mode. For example, you can debug a COBOL batch job running in MVS/JES, a DB2 Stored Procedure, an IMS transaction running on a IMS MPP region, or an application running in UNIX System Services.

The Terminal Interface Manager (TIM) is a component of Debug Tool that provides communication between the debugger, which controls an application program as it runs, and a terminal session where you interact with the debugger. To use the TIM you connect a 3270 terminal session to the TIM.

The debugger displays on that terminal session in full-screen mode and accepts your commands. You can connect to the TIM from a dedicated 3270 terminal session, for example, a terminal emulator session configured to connect to it. Optionally, you can access the TIM from VTAM session manager software.

Contact your system administrator to determine how to access a terminal session using the TIM on your system.

Remote debug mode

In remote debug mode, the host application starts Debug Tool, which communicates through a TCP/IP connection to a remote debugger on your Windows workstation.

Debug Tool can work with a remote debugger to provide you with the ability to debug host programs, including batch programs, through a graphical user interface (GUI) on the workstation. Debug Tool works with the following remote debuggers:

- IBM Debug Tool plug-in for Eclipse

  To learn more about IBM Debug Tool plug-in for Eclipse, see “CN0D: IBM Debug Tool plug-in for Eclipse” (http://www.ibm.com/support/docview.wss?rs=3138&uid=swg24026610).
- compiled language debugger component of Rational Developer for System z

  To learn how to use the compiled language debugger component of Rational Developer for System z, see “Compiled language debugger” in the online help for Rational® Developer for System z®. (http://publib.boulder.ibm.com/infocenter/ratdevz/v7r5/topic/com.ibm.debug.pdt.doc/topics/cbpovrvw.html)

You can enter some Debug Tool commands through the remote debugger's Debug Console. For a list of Debug Tool commands that you can enter, see “Debug Tool commands supported in remote debug mode” in the *Debug Tool Reference and Messages*.

The IBM Debug Tool DTCN and DTSP Profile Manager plug-in can make it more convenient to work in remote debug mode. The plug-in adds the following views to the **Debug** perspective of the remote debugger:

- The **DTCN Profiles** view, which helps you create and manage DTCN profiles.
- The **DTSP Profile** view, which helps you create and manage the TEST runtime options data set (EQAUOPTS).

To learn how to install and configure these plug-ins, see Appendix I, “Installing the IBM Debug Tool DTCN and DTSP Profile Manager plug-in,” on page 497.

Debug Tool Utilities

Debug Tool Utilities is a set of ISPF panels that give you access to tools that can help you manage your debugging sessions. This topic describes these tools.

Debug Tool Utilities: Job Card

The tool (under option 0, called Job Card) helps you create a JOB card that is used by the tools in **Program Preparation** (option 1), **Debug Tool Setup File** (option 2), and **JCL for Batch Debugging** (option 8).

Debug Tool Utilities: Program Preparation

The set of tools under the **Program Preparation** (option 1) can help you manage all the tasks required to compile or assemble, and link your programs. They can also help you convert older COBOL source code and copybooks to newer versions of COBOL by using COBOL and CICS Command Level Conversion Aid (CCCA). The **Program Preparation** option can be very useful if you do not have an established build process at your site. The following list describes the specific tasks that **Program Preparation** can help you do:

- Run the DB2 precompiler or the CICS translator.
- Set compiler options.
- Specify naming patterns for your data sets.
- Specify input data sets for copy processing.
- Convert, compile, and link-edit your programs in either TSO foreground or MVS batch.
- Convert, compile, and link-edit your high level language programs in either TSO foreground or MVS batch.

- Convert, assemble, and link-edit your assembler programs in either TSO foreground or MVS batch.
- Generate IDILANGX or EQALANGX side files.
- Generate a listing from an IDILANGX, EQALANGX or COBOL SYSDEBUG side file.
- Prepare the following COBOL programs for debugging:
  - Programs written for non-Language Environment COBOL.
  - Programs previously compiled with the CMPR2 compiler option.

  To prepare these programs, you convert the source to the newer COBOL standard and compile it with the newer compilers. After you debug your program, you can do one of the following:
  - Make changes to your non-Language Environment COBOL source and repeat the conversion and compilation every time you want to debug your program.
  - Make changes in the converted source and stop maintaining your non-Language Environment COBOL source.

Debug Tool Utilities: Debug Tool Setup File

Setup files can save you time when you are debugging a program that needs to be restarted multiple times. Setup files store information needed to allocate the necessary files and run a single job-step with Debug Tool either in MVS batch or TSO foreground. You can create several setup files for each program; each setup file can store information about starting and running your program in different circumstances. To create and manage setup files, select Debug Tool Setup File (option 2).

Debug Tool Utilities: Code Coverage

Determining code coverage can help you improve your test cases so they test your program more thoroughly. Debug Tool Utilities provides you with Debug Tool Coverage Utility, a tool to report which code statements have been run by your test cases. Using the report, you can enhance your test cases so they run code statements that were not run previously. Select Code Coverage (option 3) to use this tool.

Debug Tool Utilities: IMS TM Setup

You can create private IMS message regions that you can use to debug test applications and, therefore, not interfere with other regions. For IMSplex users, you can modify the Language Environment runtime parameters table without relinking the applications. The tools that can help you complete these tasks are found under option 4, called IMS TM Setup.

Debug Tool Utilities: Load Module Analyzer

The Debug Tool Load Module Analyzer analyzes MVS load modules or program objects to determine the language translator (compiler or assembler) used to generate the object for each CSECT. The tool that can help you complete this task can be found under option 5, called Load Module Analyzer.

Debug Tool Utilities: Debug Tool User Exit Data Set

This function assists you in preparing a TEST runtime option data set that is used by the Debug Tool Language Environment user exit. The Debug Tool Language Environment user exits use this `TEST` runtime option string to start a debug session.

The tool that can help you complete this task is found under option 6, called Debug Tool User Exit Data Set, in Debug Tool Utilities.

Debug Tool Utilities: Other IBM Problem Determination Tools

This function provides an interface to the IBM File Manager ISPF functions. You can find these tools under option 7, called Other IBM Problem Determination Tools, in Debug Tool Utilities.

Debug Tool Utilities: JCL for Batch Debugging

Modify the JCL for a batch job so that Debug Tool is started when the job is run. The tool that can help you complete this task is found under option 8, called JCL for Batch Debugging, in Debug Tool Utilities.

Debug Tool Utilities: IMS BTS Debugging

The IMS BTS Debugging option helps you run and debug IMS BTS programs by saving, into a set up file, the information needed to create the runtime environment for the program. Debug Tool Utilities uses the information in the set up file to create the appropriate JCL statements, which you can then run in the foreground or submit as a batch job.

Debug Tool Utilities: JCL to Setup File conversion

The JCL to Setup File Conversion option helps you convert a job step, to the Debug Tool set up file format, by presenting the job step list of a job that you can select. You can modify DD information as needed before running it in TSO.

Debug Tool Utilities: Delay Debug profile

The Delay Debug profile function assists you in preparing a data set that contains TEST runtime options, and pattern match arguments. The data set is used by the Debug Tool delay debug mode to find a match of compile unit name. When a match is found, Debug Tool uses the TEST runtime option string to start a debug session. The tool that helps you complete this task is found under option B, called Delay Debug Profile, in Debug Tool Utilities.

Starting Debug Tool Utilities

Debug Tool Utilities can be started in one of the following ways:

- If an option was installed to access the Debug Tool Utilities primary options ISPF panel from an existing panel, then select that option by using instructions from the installer.
- If the Debug Tool data sets were installed into your normal logon procedure, enter the following command from the ISPF Command Shell panel (by default set as option 6):

  ```
  EQASTART common_parameters
  ```

- If Debug Tool was not installed in your ISPF environment, enter this command from the ISPF Command Shell panel (by default set as option 6):

  ```
  EX 'hlq.SEQAEXEC(EQASTART)' 'common_parameters'
  ```

To determine which method to use on your system, contact your system administrator.

The *common_parameters* are optional and specify any of the parameters described in Appendix E of *Debug Tool Coverage Utility User's Guide and Messages*. Multiple options are separated by blanks. Note that if you specify any of these

common_parameters, your settings are remembered by EQASTART and become the default on subsequent starts of EQASTART when you do not specify parameters.

Chapter 2. Debugging a program in full-screen mode: introduction

Full-screen mode is the interface that Debug Tool provides to help you debug programs on a 3270 terminal. This topic describes the following tasks which make up a basic debugging session:

1. "Compiling or assembling your program with the proper compiler options"
2. "Starting Debug Tool" on page 12
3. After you start Debug Tool, you will see the full-screen mode interface. "The Debug Tool full screen interface" on page 13 describes the parts of the interface. Then you can do any of the following tasks:
   - "Stepping through a program" on page 14
   - "Running your program to a specific line" on page 14
   - "Setting a breakpoint" on page 14
   - "Skipping a breakpoint" on page 17
   - "Clearing a breakpoint" on page 18
   - "Displaying the value of a variable" on page 15
   - "Displaying memory through the Memory window" on page 17
   - "Changing the value of a variable" on page 17
   - "Recording and replaying statements" on page 18
4. "Stopping Debug Tool" on page 19

Each topic directs you to other topics that provide more information.

Compiling or assembling your program with the proper compiler options

Each programming language has a comprehensive set of compiler options. It's important to use the correct compiler options to prepare your program for debugging. The following list describes the simplest set of compiler options to use for each programming language:

Compiler options that you can use with C programs
The `TEST` and `DEBUG` compiler options provide suboptions to refine debugging capabilities. Which compiler option and suboptions to choose depends on the version of the C compiler that you are using.

Compiler options that you can use with C++ programs
The `TEST` and `DEBUG` compiler options provide suboptions to refine debugging capabilities. Which compiler option and suboptions to choose depends on the version of the C compiler that you are using.

Compiler options that you can use with COBOL programs
The `TEST` compiler option provides suboptions to refine debugging capabilities. Some suboptions are used only with a specific version of COBOL. This chapter assumes the use of suboptions available to all versions of COBOL.

Compiler options that you can use with LangX COBOL programs
When you compile your OS/VS COBOL program, the following options are required: NOTEST, SOURCE, DMAP, PMAP, VERB, XREF, NOLST, NOBATCH, NOSYMDMP, NOCOUNT.

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When you compile your VS COBOL II program, the following options are required: NOOPTIMIZE, NOTEST, SOURCE, MAP, XREF, and LIST (or OFFSET).

When you compile your Enterprise COBOL program, the following options are required: NOOPTIMIZE, NOTEST, SOURCE, MAP, XREF, and LIST.

Compiler options that you can use with PL/I programs

The TEST compiler option provides suboptions to refine debugging capabilities. Some suboptions are used only with a specific version of PL/I. This chapter assumes the use of suboptions available to all versions of PL/I, except for PL/I for MVS or OS PL/I compilers, which must also specify the SOURCE suboption.

Assembler options that you can use with assembler programs

When you assemble your program, you must specify the ADATA option. Specifying this option generates a SYSADATA file, which the EQALANGX postprocessor needs to create a debug file.

See Chapter 3, “Planning your debug session,” on page 23 for instructions on how to choose the correct combination of compiler options and suboptions to use for your situation.

Starting Debug Tool

There are several methods to start Debug Tool in full-screen mode. Each method is designed to help you start Debug Tool for programs that are compiled with an assortment of compiler options and that run in a variety of runtime environments. Part 3, “Starting Debug Tool,” on page 109 describes each of these methods.

In this topic, we describe the simplest and most direct method to start Debug Tool for a program that runs in Language Environment in TSO. At a TSO READY prompt, enter the following command:

```
CALL 'USERID1.MYLIB(MYPROGRAM)' '/TEST'
```

Place the slash (/) before or after the TEST runtime option, depending on the programming language you are debugging.

The following topics can give you more information about other methods of starting Debug Tool:

- Chapter 13, “Starting Debug Tool from the Debug Tool Utilities,” on page 117
- Chapter 12, “Writing the TEST run-time option string,” on page 111
- “Starting Debug Tool with CEETEST” on page 121
- “Starting Debug Tool with PLITEST” on page 128
- “Starting Debug Tool with the __ctest() function” on page 129
- “Starting Debug Tool for programs that start in Language Environment” on page 135
- Chapter 15, “Starting Debug Tool in batch mode,” on page 131
- “Starting Debug Tool for programs that start outside of Language Environment” on page 137
- “Starting Debug Tool under CICS by using DTCN” on page 142
- “Starting Debug Tool for CICS programs by using CADP” on page 143
- “Starting Debug Tool under CICS by using CEEUOPT” on page 143
- “Starting Debug Tool under CICS by using compiler directives” on page 143
- “Starting a debugging session in full-screen mode using the Terminal Interface Manager or a dedicated terminal” on page 133
- “Starting Debug Tool from DB2 stored procedures” on page 147

The Debug Tool full screen interface

After you start Debug Tool, the Debug Tool screen appears:

```
COBOL    LOCATION: EMPLOOK initialization
Command ===>                                                  Scroll ===> PAGE
MONITOR --+----1----+----2----+----3----+----4----+----5----+----6 LINE: 0 OF 0
****************************** TOP OF MONITOR *******************************
***************************** BOTTOM OF MONITOR *****************************



SOURCE: EMPLOOK --1----+----2----+----3----+----4----+----5----+ LINE: 1 OF 349
       1        ************************************************************  .
       2        *                                                          *  .
       3        *                                                          *  .
       4        ************************************************************  .
       5                                                                      .
       6        ************************************************************  .
       7         IDENTIFICATION DIVISION.                                     .
       8        ************************************************************  .
       9         PROGRAM-ID.    "EMPLOOK".                                    .
LOG 0----+----1----+----2----+----3----+----4----+----5----+----6- LINE: 1 OF 5
******************************** TOP OF LOG *********************************
IBM Debug Tool Version 11 Release 1 Mod 0
11/06/2010 4:11:41 PM
5655-W45: Copyright IBM Corp. 1992, 2010
PF  1:?           2:STEP       3:QUIT       4:LIST       5:FIND      6:AT/CLEAR
PF  7:UP          8:DOWN       9:GO        10:ZOOM      11:ZOOM LOG 12:RETRIEVE
```

The default screen is divided into four sections: the session panel header and three physical windows. The sessional panel header is the top two lines of the screen, which display the header fields and a command line. The header fields describe the programming language and the location in the program. The command line is where you enter Debug Tool commands.

A physical window is the space on the screen dedicated to the display of a specific type of debugging information. The debugging information is organized into the following types, called logical windows:

Monitor window
: Variables and their values, which you can display by entering the `SET AUTOMONITOR ON` and `MONITOR` commands.

Source window
: The source or listing file, which Debug Tool finds or you can specify where to find it.

Log window
: The record of your interactions with Debug Tool and the results of those interactions.

Memory window
: A section of memory, which you can display by entering the `MEMORY` command.

The default screen displays three physical windows, with one assigned the Monitor window, the second assigned the Source window, and the third assigned the Log window. You can swap the Memory window with the Log window.

Refer to the following topics for more information related to the material discussed in this topic.

Related tasks

“Entering commands on the session panel” on page 161
“Navigating through Debug Tool windows” on page 168
“Customizing the layout of physical windows on the session panel” on page 266
Related references
“Debug Tool session panel” on page 151
MEMORY command in *Debug Tool Reference and Messages*
MONITOR command in *Debug Tool Reference and Messages*
SET AUTOMONITOR command in *Debug Tool Reference and Messages*
WINDOW SWAP command in *Debug Tool Reference and Messages*

Stepping through a program

Stepping through a program means that you run a program one line at a time. After each line is run, you can observe changes in program flow and storage. These changes are displayed in the Monitor window, Source window, and Log window. Use the `STEP` command to step through a program.

Refer to the following topics for more information related to the material discussed in this topic.

Related tasks
“Stepping through or running your program” on page 181

Running your program to a specific line

You can run from one point in a program to another point by using one of the following methods:

- Set a breakpoint and use the `GO` command. This command runs your program from the point where it stopped to the breakpoint that you set. Any breakpoints that are encountered cause your program to stop. The `RUN` command is synonymous with the `GO` command.
- Use the `GOTO` command. This command resumes your program at the point that you specify in the command. The code in between is skipped.
- Use the `JUMPTO` command. This command moves the point at which your program resumes running to the statement you specify in the command; however, the program does not resume. The code in between is skipped.
- Use the `RUNTO` command. This command runs your program to the point that you specify in the `RUNTO` command. The `RUNTO` command is helpful when you haven't set a breakpoint at the point you specify in the `RUNTO` command.

Refer to the following topics for more information related to the material discussed in this topic.

Related references
Debug Tool Reference and Messages

Setting a breakpoint

In Debug Tool, breakpoints can indicate a stopping point in your program and a stopping point in time. Breakpoints can also contain activities, such as instructions to run, calculations to perform, and changes to make.

A basic breakpoint indicates a stopping point in your program. For example, to stop on line 100 of your program, enter the following command on the command line:

```
AT 100
```

In the Log window, the message `AT 100 ;` appears. If line 100 is not a valid place to set a breakpoint, the Log window displays a message similar to `Statement 100 is not valid`. The breakpoint is also indicated in the Source window by a reversing of the colors in the prefix area.

Breakpoints do more than just indicate a place to stop. Breakpoints can also contain instructions. For example, the following breakpoint instructs Debug Tool to display the contents of the variable *myvar* when Debug Tool reaches line 100:

```
AT 100 LIST myvar;
```

A breakpoint can contain instructions that alter the flow of the program. For example, the following breakpoint instructs Debug Tool to go to label `newPlace` when it reaches line 100:

```
AT 100 GOTO newPlace ;
```

A breakpoint can contain a condition, which means that Debug Tool stops at the breakpoint only if the condition is met. For example, to stop at line 100 only when the value of *myvar* is greater than 10, enter the following command:

```
AT 100 WHEN myvar > 10;
```

A breakpoint can contain complex instructions. In the following example, when Debug Tool reaches line 100, it alters the contents of the variable *myvar* if the value of the variable *mybool* is true:

```
AT 100 if (mybool == TRUE) myvar = 10 ;
```

The syntax of the complex instruction depends on the program language that you are debugging. The previous example assumes that you are debugging a C program. If you are debugging a COBOL program, the same example is written as follows:

```
AT 100 if mybool = TRUE THEN myvar = 10 ; END-IF ;
```

Refer to the following topics for more information related to the material discussed in this topic.

Related references

Debug Tool Reference and Messages

Displaying the value of a variable

After you are familiar with setting breakpoints and running through your program, you can begin displaying the value of a variable. The value of a variable can be displayed in one of the following ways:

- One-time display (in the Log window) is useful for quickly checking the value of a variable.

  For one-time display, enter the following command on the command line, where *x* is the name of the variable:

  ```
  LIST (x)
  ```

  The Log window shows a message in the following format:

  ```
  LIST ( x ) ;
  x = 10
  ```

  Alternatively, you can enter the `L` prefix command in the prefix area of the Source window. In the following line from the Source window, type in `L2` in the prefix area, then press Enter to display the value of *var2*:

  ```
  200           var1 = var2 + var3;
  ```

Debug Tool creates the command `LIST (var2)`, runs it, then displays the following message in the Log window:

```
LIST ( VAR2 ) ;
VAR2 = 50
```

You can use the `L` prefix command only with programs assembled or compiled with the following assemblers or compilers:

- Enterprise PL/I for z/OS, Version 3.6 or 3.7 with the PTF for APAR PK70606, or later
- Enterprise COBOL (compiled with the TEST compiler option)
- Assembler
- Disassembly

- Continuous display (in the Monitor window) is useful for observing the value of a variable over time.

  For continuous display, enter the following command on the command line, where *x* is the name of the variable:

  ```
  MONITOR LIST ( x )
  ```

  In the Monitor window, a line appears with the name of the variable and the current value of the variable next to it. If the value of the variable is undefined, the variable is not initialized, or the variable does not exist, a message appears underneath the variable name declaring the variable unusable.

  Alternatively, you can enter the `M` prefix command in the prefix area of the Source window. In the following line from the Source window, type in `M3` in the prefix area, then press Enter to add *var3* to the Monitor window:

  ```
  200           var1 = var2 + var3;
  ```

  Debug Tool creates the command `MONITOR LIST (var3)`, runs it, then adds *var3* to the Monitor window.

  You can use the `M` prefix command only with programs assembled or compiled with the following assemblers or compilers:

  - Enterprise PL/I for z/OS, Version 3.6 or 3.7 with the PTF for APAR PK70606, or later
  - Enterprise COBOL (compiled with the TEST compiler option)
  - Assembler
  - Disassembly

- A combination of one-time and continuous display, where the value of variables coded in the current line are displayed, is useful for observing the value of variables when the variables are used.

  For a combination of one-time and continuous display, enter the following command on the command line:

  ```
  SET AUTOMONITOR ON ;
  ```

  After a line of code is run, the Monitor window displays the name and value of each variable on the line of code. The `SET AUTOMONITOR` command can be used only with specific programming languages, as described in *Debug Tool Reference and Messages*.

Refer to the following topics for more information related to the material discussed in this topic.

Related tasks

“Displaying values of C and C++ variables or expressions” on page 310
“Displaying values of COBOL variables” on page 284
“Displaying and monitoring the value of a variable” on page 188

Related references

"Monitor window" on page 155
Description of the MONITOR command in *Debug Tool Reference and Messages*
Description of the SET AUTOMONITOR command in *Debug Tool Reference and Messages*

Displaying memory through the Memory window

Sometimes it is helpful to look at memory directly in a format similar to a dump. You can use the Memory window to view memory in this format.

The Memory window is not displayed in the default screen. To display the Memory window, use the WINDOW SWAP MEMORY LOG command. Debug Tool displays the Memory window in the location of the Log window.

After you display the Memory window, you can navigate through it using the SCROLL DOWN and SCROLL UP commands. You can modify the contents of memory by typing the new values in the hexadecimal data area.

Refer to the following topics for more information related to the material discussed in this topic.

Related tasks
Chapter 27, "Customizing your full-screen session," on page 265
"Displaying the Memory window" on page 173
"Displaying and modifying memory through the Memory window" on page 199
"Scrolling through the physical windows" on page 169
Related references
"Debug Tool session panel" on page 151
WINDOW SWAP command in *Debug Tool Reference and Messages*

Changing the value of a variable

After you see the value of a variable, you might want to change the value. If, for example, the assigned value isn't what you expect, you can change it to the desired value. You can then continue to study the flow of your program, postponing the analysis of why the variable wasn't set correctly.

Changing the value of a variable depends on the programming language that you are debugging. In Debug Tool, the rules and methods for the assignment of values to variables are the same as programming language rules and methods. For example, to assign a value to a C variable, use the C assignment rules and methods:

```
var = 1 ;
```

Refer to the following topics for more information related to the material discussed in this topic.

Related tasks
"Assigning values to C and C++ variables" on page 311
"Assigning values to COBOL variables" on page 283

Skipping a breakpoint

Use the DISABLE command to temporarily disable a breakpoint. Use the ENABLE command to re-enable the breakpoint.

Refer to the following topics for more information related to the material discussed in this topic.

Related references
Description of the DISABLE command in *Debug Tool Reference and Messages*
Description of the ENABLE command in *Debug Tool Reference and Messages*

Clearing a breakpoint

When you no longer require a breakpoint, you can clear it. Clearing it removes any of the instructions associated with that breakpoint. For example, to clear a breakpoint on line 100 of your program, enter the following command on the command line:

```
CLEAR AT 100
```

The Log window displays a line that says `CLEAR AT 100 ;` and the prefix area reverts to its original colors. These changes indicate that the breakpoint at line 100 is gone.

Refer to the following topics for more information related to the material discussed in this topic.

Related references
Description of the CLEAR command in *Debug Tool Reference and Messages*

Recording and replaying statements

You can record and subsequently replay statements that you run. When you replay statements, you can replay them in a forward direction or a backward direction. Table 4 describes the sequence in which statements are replayed when you replay them in a forward direction or a backward direction.

Table 4. The sequence in which statements are replayed.

PLAYBACK FORWARD sequence	PLAYBACK BACKWARD sequence	COBOL Statements
1	9	DISPLAY "CALC Begins."
2	8	MOVE 1 TO BUFFER-PTR.
3	7	PERFORM ACCEPT-INPUT 2 TIMES.
8	2	DISPLAY "CALC Ends."
9	1	GOBACK.
		ACCEPT-INPUT.
4, 6	4, 6	ACCEPT INPUT-RECORD FROM A-INPUT-FILE
5, 7	3, 5	MOVE RECORD-HEADER TO REPROR-HEADER.

To begin recording, enter the following command:

```
PLAYBACK ENABLE
```

Statements that you run after you enter the PLAYBACK ENABLE command are recorded.

To replay the statements that you record:

1. Enter the PLAYBACK START command.
2. To move backward one statement, enter the STEP command.
3. Repeat step 2 as many times as you can to replay another statement.

4. To move forward (from the current statement to the next statement), enter the PLAYBACK FORWARD command.
5. Enter the STEP command to replay another statement.
6. Repeat step 5 as many times as you want to replay another statement.
7. To move backward, enter the PLAYBACK BACKWARD command.

PLAYBACK BACKWARD and PLAYBACK FORWARD change the direction commands like STEP move in.

When you have finished replaying statements, enter the PLAYBACK STOP command. Debug Tool returns you to the point at which you entered the PLAYBACK START command. You can resume normal debugging. Debug Tool continues to record your statements. To replay a new set of statements, begin at step 1 on page 18.

When you finish recording and replaying statements, enter the following command:

```
PLAYBACK DISABLE
```

Debug Tool no longer records any statements and discards information that you recorded. The PLAYBACK START, PLAYBACK FORWARD, PLAYBACK BACKWARD, and PLAYBACK STOP commands are no longer available.

Refer to the following topics for more information related to the material discussed in this topic.

Related references

Description of the PLAYBACK commands in *Debug Tool Reference and Messages*

Stopping Debug Tool

To stop your debug session, do the following steps:

1. Enter the QUIT command.
2. In response to the message to confirm your request to stop your debug session, press "Y" and then press Enter.

Your Debug Tool screen closes.

Refer to *Debug Tool Reference and Messages* for more information about the QQUIT, QUIT ABEND and QUIT DEBUG commands which can stop your debug session.

Refer to the following topics for more information related to the material discussed in this topic.

Related references

Description of the QUIT command in *Debug Tool Reference and Messages*
Description of the QQUIT command in *Debug Tool Reference and Messages*

Part 2. Preparing your program for debugging

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Chapter 3. Planning your debug session

Before you begin debugging, create a plan that can help you make the following choices:

- The compiler or assembler options and suboptions you need to use when you compile or assemble programs.
- The debugging mode (batch, full-screen, full-screen mode using the Terminal Interface Manager, or remote debug mode) that you will use to interact with Debug Tool.
- The method or methods you can use to start Debug Tool.
- If you have older COBOL programs, as listed in the *COBOL and CICS Command Level Conversion Aid for OS/390 & MVS & VM: User's Guide*, how you want to debug them.

To help you create your plan, do the following tasks:

1. Use Table 5 on page 25 to record the compiler options and suboptions that you will use for your programs. The table contains compiler options that can provide the most debugging capability with the smallest program size for a general set of compilers. See "Choosing compiler options for debugging" on page 24 for the following information:
   - The prerequisites required for a compiler option and suboption.
   - Additional tasks that you might need to do to make a compiler option and suboption work at your site.
   - Information about how a compiler option and suboption might affect program size and Debug Tool functionality.
   - If you are using other Problem Determination Tools, information on how to choose compiler options so that you create output that can be used by the other Problem Determination Tools.
2. Use Table 3 on page 4 to record the debugging mode you will use. See "Choosing a debugging mode" on page 48 to learn about prerequisites and tasks you must do to make the debugging mode work.
3. Use Table 11 on page 54 to record the methods you will use to specify `TEST` runtime options. See "Choosing a method or methods for starting Debug Tool" on page 53 to help you determine which method will work best for your programs.
4. If you have older COBOL programs (as listed in the *COBOL and CICS Command Level Conversion Aid for OS/390 & MVS & VM: User's Guide*) that you want to debug, you must decide between the following options:
   - Leave them in their old source and possibly have to debug them as LangX COBOL programs.
   - Convert them to the 1985 COBOL Standard level.

   See "Choosing how to debug old COBOL programs" on page 57 for more information.

After you have completed these tasks, use the information you collected to follow the instructions in Chapter 4, "Updating your processes so you can debug programs with Debug Tool," on page 59.

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Choosing compiler options for debugging

Compiler options affects the size of your load module and the amount of Debug Tool functionality available to you. Debug Tool uses information such as hooks and symbol tables to gain control of a program, run the program statement-by-statement or line-by-line, and display information about your program.

To learn more about how hooks and symbol tables help Debug Tool debug your program, read the following topics:

- “Understanding how hooks work and why you need them” on page 47
- “Understanding what symbol tables do and why saving them elsewhere can make your application smaller” on page 48

To learn more about how the compiler options affect Debug Tool functionality, read the following topics:

- “Choosing TEST or NOTEST compiler suboptions for COBOL programs” on page 27
- “Choosing TEST or NOTEST compiler suboptions for PL/I programs” on page 32
- “Choosing TEST or DEBUG compiler suboptions for C programs” on page 37
- “Choosing DEBUG compiler suboptions for C programs” on page 38
- “Choosing TEST or NOTEST compiler suboptions for C programs” on page 39
- “Choosing DEBUG compiler suboptions for C++ programs” on page 43
- “Choosing TEST or DEBUG compiler suboptions for C++ programs” on page 42
- “Choosing TEST or NOTEST compiler options for C++ programs” on page 44

Table 5. Record the compiler options you need to use in this table. The options you use work with Debug Tool for z/OS, Version 11.1 or later.

Compiler or assembler	Compiler options you will use
OS/VS COBOL, Version 1 Release 2.4 [1]	NOTEST,SOURCE,DMAP,PMAP,VERB,XREF,NOLST,NOBATCH,NOSYMDMP,NOCOUNT ***or*** _____
VS COBOL II Version 1 Release 3 and Version 1 Release 4 (for programs compiled with the TEST compiler option and linked with the Language Environment library.)	TEST ***or*** _____
VS COBOL II Version 1 Release 3 and Version 1 Release 4 (for programs compiled with the NOTEST compiler option and linked with a non-Language Environment library.) [1]	NOTEST,NOOPTIMIZE,SOURCE,MAP,XREF,LIST(or OFFSET) ***or*** _____
VS COBOL II Version 1 Release 3 and Version 1 Release 4 (for programs compiled with the NOTEST compiler option and linked with the Language Environment library.) [1]	NOTEST,NOOPTIMIZE,SOURCE,MAP,XREF,LIST(or OFFSET) ***or*** _____
AD/Cycle COBOL/370 Version 1 Release 1	TEST(ALL,SYM) ***or*** _____
COBOL for MVS & VM	TEST(ALL,SYM) ***or*** _____
COBOL for OS/390 & VM	TEST(NONE,SYM,SEPARATE) ***or*** _____
Enterprise COBOL for z/OS and OS/390, Version 3	TEST(NONE,SYM,SEPARATE) ***or*** _____
Enterprise COBOL for z/OS, Version 4.1 or later compiled with the TEST compiler option	TEST(NOHOOK,SEPARATE,EJPD) ***or*** _____
Enterprise COBOL for z/OS compiled with the NOTEST compiler option [1]	NOTEST,NOOPTIMIZE,SOURCE,MAP,XREF,LIST(or OFFSET) ***or*** _____
OS PL/I Version 2 Release 1, Version 2 Release 2, and Version 2 Release 3	TEST(ALL,SYM) ***or*** _____
PL/I for MVS & VM	TEST(ALL,SYM) ***or*** _____

Table 5. Record the compiler options you need to use in this table. The options you use work with Debug Tool for z/OS, Version 11.1 or later. (continued)

Compiler or assembler	Compiler options you will use
Enterprise PL/I, Version 3.1 through Version 3.3	`TEST(ALL,SYM)` ***or***
Enterprise PL/I, Version 3.4	`TEST(ALL,NOHOOK,SYM)` ***or***
Enterprise PL/I, Version 3.5 or later	`TEST(ALL,NOHOOK,SYM,SEPARATE)` ***or***
Enterprise PL/I, Version 3.7	`TEST(ALL,NOHOOK,SYM,SEPARATE,SOURCE)` ***or***
Enterprise PL/I, Version 3.8 or later	`TEST(ALL,NOHOOK,SYM,SEPARATE)` and `LISTVIEW` ***or***
Enterprise PL/I, Version 4.1 or later	`TEST(ALL,NOHOOK,SYM,SEPARATE)` and `LISTVIEW` and `GONUMBER(SEPARATE)` ***or***
• AD/Cycle C/370 Version 1 Release 1 • C/C++ for MVS/ESA Version 3 Release 1 or later • C++ feature of OS/390 Version 2 Release 6 or later • C++ feature of z/OS, Version 1.5 or earlier	`TEST` ***or***
• C feature of OS/390 Version 2 Release 6 or later • C feature of z/OS, Version 1.5 or earlier	`TEST(HOOK)` ***or***
C/C++ feature of z/OS, Version 1.6 or later	`DEBUG(FORMAT(DWARF))` ***or***
IBM High Level Assembler (HLASM), Version 1 Release 4, Version 1 Release 5, Version 1 Release 6	`ADATA`

1. See Chapter 5, “Preparing a LangX COBOL program,” on page 67 for information on how to prepare a program of this type.

Choosing TEST or NOTEST compiler suboptions for COBOL programs

This topic describes the combination of TEST compiler option and suboptions you need to specify to obtain the desired debugging scenario. This topic assumes you are compiling your COBOL program with Enterprise COBOL for z/OS, Version 3.4, or later; however, the topics provide information about alternatives to use for older versions of the COBOL compiler.

The COBOL compiler provides the `TEST` compiler option and its suboptions to control the following actions:

- The generation and placement of hooks and symbol tables.
- The placement of debug information into the object file or a separate debug file.

The following instructions help you choose the combination of `TEST` compiler suboptions that provide the functionality you need to debug your program:

1. Choose a debugging scenario, keeping in mind your site's resources, from the following list:
   - Scenario A: If you are compiling with Enterprise COBOL for z/OS, Version 4.1 or later, you can get the most Debug Tool functionality and a small program size by using `TEST(NOHOOK,SEPARATE)`. If you need to debug programs that are loaded into protected storage, verify that your site installed the Authorized Debug Facility.

     If you want to compile your program with the `OPT(STD)` or `OPT(FULL)` compiler option, you must also specify the `EJPD` suboption of the `TEST` compiler option to be able to do the following tasks:

     – Use the `GOTO` or `JUMPTO` commands.
     – Modify variables with predictable results.

     When you use the `EJPD` suboption, you might lose some optimization.

     If you are using other Problem Determination Tools, review the information in “Enterprise COBOL for z/OS Version 4 programs” on page 427 to make sure you specify all the compiler options you need to create the files needed by all the Problem Determination Tools.
   - Scenario B: If you are compiling with any of the following compilers, you can get the most Debug Tool functionality and a small program size by using `TEST(NONE,SYM,SEPARATE)`:
     – Enterprise COBOL for z/OS and OS/390, Version 3 Release 2 or later
     – Enterprise COBOL for z/OS and OS/390, Version 3 Release 1 with APAR PQ63235
     – COBOL for OS/390 & VM, Version 2 Release 2
     – COBOL for OS/390 & VM, Version 2 Release 1 with APAR PQ63234.

     If you need to debug programs that are loaded into protected storage, verify that your site installed the Authorized Debug Facility.

     If you want to compile your program with optimization and be able to get the most Debug Tool functionality, you must compile it with one of the following combination of compiler options:

     – `OPT(STD) TEST(NONE,SYM)`
     – `OPT(STD) TEST(NONE,SYM,SEPARATE)`
     – `OPT(FULL) TEST(NONE,SYM)`
     – `OPT(FULL) TEST(NONE,SYM,SEPARATE)`

For these types of programs, you can modify variables, but the results might be unpredictable.

If you are using other Problem Determination Tools, review the information in "Enterprise COBOL for z/OS Version 3 and COBOL for OS/390 and VM programs" on page 431 to make sure you specify all the compiler options you need to create the files needed by all the Problem Determination Tools.

- Scenario C: To get all Debug Tool functionality but have a larger program size and do not want debug information in a separate debug file, compile with one of the following compiler options for the compilers specified:
  - `TEST(HOOK,NOSEPARATE)` with Enterprise COBOL for z/OS, Version 4.1.
  - `TEST(ALL,SYM,NOSEPARATE)` with any of the following compilers:
    - Enterprise COBOL for z/OS and OS/390, Version 3 Release 2 or later
    - Enterprise COBOL for z/OS and OS/390, Version 3 Release 1 with APAR PQ63235
    - COBOL for OS/390 & VM, Version 2 Release 2
    - COBOL for OS/390 & VM, Version 2 Release 1 with APAR PQ40298

  If you are using other Problem Determination Tools, review the information in "Enterprise COBOL for z/OS Version 4 programs" on page 427 or "Enterprise COBOL for z/OS Version 3 and COBOL for OS/390 and VM programs" on page 431 to make sure you specify all the compiler options you need to create the files needed by all the Problem Determination Tools.
- Scenario D: If you are using COBOL for OS/390 & VM, Version 2 Release 1, or earlier, and you want to get all Debug Tool functionality, use `TEST(ALL,SYM)`.

  If you are using other Problem Determination Tools, review the topic that corresponds to the compiler that you are using from the following list to make sure you specify all the compiler options you need to create the files needed by all the Problem Determination Tools:
  - "Enterprise COBOL for z/OS Version 3 and COBOL for OS/390 and VM programs" on page 431
  - "COBOL for MVS and VM programs" on page 434
  - "VS COBOL II programs" on page 438
  - "OS/VS COBOL programs" on page 441
- Scenario E: You can get most of Debug Tool's functionality by compiling with the `NOTEST` compiler option and generating an *EQALANGX* file. This requires that you debug your program in LangX COBOL mode.
- Scenario F: You can get some Debug Tool's functionality by compiling with the `NOTEST` compiler option. This requires that you debug your program in disassembly mode.

  If you are using other Problem Determination Tools, review the topic that corresponds to the compiler that you are using from the following list to make sure you specify all the compiler options you need to create the files needed by all the Problem Determination Tools:
  - "Enterprise COBOL for z/OS Version 4 programs" on page 427
  - "Enterprise COBOL for z/OS Version 3 and COBOL for OS/390 and VM programs" on page 431
  - "COBOL for MVS and VM programs" on page 434
  - "VS COBOL II programs" on page 438
  - "OS/VS COBOL programs" on page 441

2. For COBOL programs using IMS, include the IMS interface module DFSLI000 from the IMS RESLIB library.
3. For scenarios A, B and E, do the following steps:
   a. If you use the Dynamic Debug facility to place hooks into programs that reside in read-only storage, verify with your system administrator that the Authorized Debug facility has been installed and that you are authorized to use it.
   b. After you start Debug Tool, verify that you have not deactivated the Dynamic Debug facility by entering the QUERY DYNDEBUG command.
   c. Verify that the separate debug file is a non-temporary file and is available during the debug session. The listing does not need to be saved.
4. Verify whether you need to do any of the following tasks:
   - If you specify NUMBER with TEST, make sure the sequence fields in your source code all contain numeric characters.
   - You need to specify the SYM suboption of the TEST compiler option to do the following actions:
     – To specify labels (paragraph or section names) as targets of the GOTO command.
     – To reference program variables by name.
     – To access a variable or expression through commands like LIST or DESCRIBE.
     – To use the DATA suboption of the PLAYBACK ENABLE command.

     You need to specify the SYM suboption to do these actions only if you are compiling with any of the following compilers:
     – any release of Enterprise COBOL for z/OS and OS/390, Version 3
     – any release of COBOL for OS/390 & VM, Version 2
   - The TEST compiler option and the DEBUG runtime option are mutually exclusive, with DEBUG taking precedence. If you specify both the WITH DEBUGGING MODE clause in your SOURCE-COMPUTER paragraph and the USE FOR DEBUGGING statement in your code, TEST is deactivated. The TEST compiler option appears in the list of options, but a diagnostic message is issued telling you that because of the conflict, TEST is not in effect.
   - For VS COBOL II programs, if you use the TEST compiler option, you must specify:
     – the SOURCE compiler option. This option is required to generate a listing file and save it at location *userid*.pgmname.list .
     – the RESIDENT compiler option. This option is required by Language Environment to ensure that the necessary Debug Tool routines are loaded dynamically at run time.

     In addition, you must link your program with the Language Environment SCEELKED library and not the VS COBOL II COB2LIB library.

After you have chosen the compiler options and suboptions, see Chapter 3, “Planning your debug session,” on page 23 to determine the next task you must complete.

Refer to the following topics for more information related to the material discussed in this topic.

Related references

Description of the TEST compiler option in *Enterprise COBOL for z/OS Programming Guide*

The following table explains the effects of the NOTEST compiler option, the TEST compiler option, and some of the suboptions of the TEST compiler option on Debug Tool behavior or the availability of features, which are not described in *Enterprise COBOL for z/OS Programming Guide*:

Table 6. Description of the effects that the COBOL NOTEST compiler option and some of the TEST compiler suboptions have on Debug Tool.

Name of compiler option or suboption	**Description of the effect**
NOTEST	• You cannot step through program statements. • You can suspend execution of the program only at the initialization of the main compile unit. • You can include calls to `CEETEST` in your program to allow you to suspend program execution and issue Debug Tool commands. • You cannot examine or use any program variables. • You can list storage and registers. • The source listing produced by the compiler cannot be used; therefore, no listing is available during a debug session. Using the `SET DEFAULT LISTINGS` command can not make a listing available. • Because a statement table is not available, you cannot set any statement breakpoints or use commands such as `GOTO` or `QUERY` location. However, you can still debug your program using the disassembly view. To learn how to use the disassembly view, see Chapter 34, “Debugging a disassembled program,” on page 343.
NONE and NOHOOK	• You can use the `GOTO` or `JUMPTO` commands when you debug a non-optimized program if you compile with one of the following compilers: – Enterprise COBOL for z/OS, Version 4.1 – any release of Enterprise COBOL for z/OS and OS/390, Version 3 – any release of COBOL for OS/390 & VM, Version 2 You can use the `GOTO` or `JUMPTO` command when you debug an optimized program if you compile your program with Enterprise COBOL for z/OS, Version 4.1, and specify the `EJPD` suboption of the `TEST` compiler option. When you specify the `EJPD` suboption, you might lose some optimization. • A call to `CEETEST` can be used at any point to start Debug Tool.

Table 6. Description of the effects that the COBOL NOTEST compiler option and some of the TEST compiler suboptions have on Debug Tool. (continued)

Name of compiler option or suboption	Description of the effect
EJPD	You can modify variables in an optimized program that was compiled with one the following compilers: • Enterprise COBOL for z/OS, Version 4.1 • Enterprise COBOL for z/OS and OS/390, Version 3 Release 2 or later • Enterprise COBOL for z/OS and OS/390, Version 3 Release 1 with APAR PQ63235 installed • COBOL for OS/390 & VM, Version 2 Release 2 • COBOL for OS/390 & VM, Version 2 Release 1 with APAR PQ63234 installed However, results might be unpredictable. To obtain more predictable results, compile your program with Enterprise COBOL for z/OS, Version 4.1, and specify the `EJPD` suboption of the `TEST` compiler option. However, variables that are declared with the VALUE clause to initialize them cannot be modified.
NOSYM	• You cannot reference program variables by name. • You cannot use commands such as `LIST` or `DESCRIBE` to access a variable or expression. • You cannot use commands such as `CALL` variable to branch to another program, or `GOTO` to branch to another label (paragraph or section name). If you are compiling with Enterprise COBOL for z/OS, Version 4.1, the compiler ignores `SYM` or `NOSYM` and always creates a symbol table.
STMT	• The COBOL compiler generates compiled-in hooks for date processing statements only when the `DATEPROC` compiler option is specified. A date processing statement is any statement that references a date field, or any `EVALUATE` or `SEARCH` statement `WHEN` phrase that references a date field. • You can set breakpoints at all statements and step through your program. • Debug Tool cannot gain control at path points unless they are also at statement boundaries. • Branching to all statements and labels using the Debug Tool command `GOTO` is allowed. If you are compiling with Enterprise COBOL for z/OS, Version 4.1, the compiler treats the `STMT` suboption as if it were the `HOOK` suboption, which is equivalent to the `ALL` suboption for any release of Enterprise COBOL for z/OS and OS/390, Version 3, or COBOL for OS/390 & VM, Version 2.

Table 6. Description of the effects that the COBOL NOTEST compiler option and some of the TEST compiler suboptions have on Debug Tool. (continued)

Name of compiler option or suboption	Description of the effect
PATH	• Debug Tool can gain control only at path points and block entry and exit points. If you attempt to step through your program, Debug Tool gains control only at statements that coincide with path points, giving the appearance that not all statements are executed. • A call to `CEETEST` can be used at any point to start Debug Tool. • The Debug Tool command `GOTO` is valid for all statements and labels coinciding with path points. If you are compiling with Enterprise COBOL for z/OS, Version 4.1, the compiler treats the `PATH` suboption as if it were the `HOOK` suboption, which is equivalent to the `ALL` suboption for any release of Enterprise COBOL for z/OS and OS/390, Version 3, or COBOL for OS/390 & VM, Version 2.
BLOCK	• Debug Tool gains control at entry and exit of your program, methods, and nested programs. • Debug Tool can be explicitly started at any point with a call to `CEETEST`. • Issuing a command such as `STEP` causes your program to run until it reaches the next entry or exit point. • `GOTO` can be used to branch to statements that coincide with block entry and exit points. If you are compiling with Enterprise COBOL for z/OS, Version 4.1, the compiler treats the `BLOCK` suboption as if it were the `HOOK` suboption, which is equivalent to the `ALL` suboption for any release of Enterprise COBOL for z/OS and OS/390, Version 3, or COBOL for OS/390 & VM, Version 2.
ALL	• You can set breakpoints at all statements and path points, and step through your program. • Debug Tool can gain control of the program at all statements, path points, date processing statements, labels, and block entry and exit points, allowing you to enter Debug Tool commands. • Branching to statements and labels using the Debug Tool command `GOTO` is allowed. If you are compiling with Enterprise COBOL for z/OS, Version 4.1, the compiler treats the `ALL` suboption as if it were the `HOOK` suboption, which is equivalent to the `ALL` suboption for any release of Enterprise COBOL for z/OS and OS/390, Version 3, or COBOL for OS/390 & VM, Version 2.

Choosing TEST or NOTEST compiler suboptions for PL/I programs

This topic describes the combination of TEST compiler option and suboptions you need to specify to obtain the desired debugging scenario. This topic assumes you are compiling your PL/I program with Enterprise PL/I for z/OS, Version 3.5, or later; however, the topics provide information about alternatives to use for older versions of the PL/I compiler.

The PL/I compiler provides the TEST compiler option and its suboptions to control the following actions:

- The generation and placement of hooks and symbol tables.
- The placement of debug information into the object file or separate debug file.

Debug Tool does not support debugging optimized PL/I programs. Do not use compiler options other than NOOPTIMIZE,

The following instructions help you choose the combination of TEST compiler suboptions that provide the functionality you need to debug your program:

1. Choose a debugging scenario, keeping in mind your site's resources, from the following list:
   - Scenario A: If you are using Enterprise PL/I for z/OS, Version 3.8 or later, and you want to get the most Debug Tool functionality and a small program size, use TEST(ALL,NOHOOK,SYM,SEPARATE) and the LISTVIEW(SOURCE) compiler option. If you need to debug programs that are loaded into protected storage, verify that your site installed the Authorized Debug Facility.

     Consider the following options:

     – If you are using Enterprise PL/I for z/OS, Version 4.1 or later, you can specify the GONUMBER(SEPARATE) compiler option, which can help make the program size smaller. You must install the PTF for APAR PM19445 on Language Environment, Version 1.10 to Version 1.12.

     – You can specify any of the LISTVIEW sub-options (SOURCE, AFTERALL, AFTERCICS, AFTERMACRO, or AFTERSQL), as described in *Enterprise PL/I for z/OS Programming Guide*, to display either the original source or the source after the specified preprocessor.

     – If you are debugging in full-screen mode and you want to debug programs with INCLUDE files that have executable code, specify the LISTVIEW(AFTERMACRO) compiler option and, if you do not specify the MACRO compiler option, specify the PP(MACRO(INCONLY)) compiler option.

     – If you are debugging in remote debug mode and you want to automonitor variables in INCLUDE files, specify the LISTVIEW(AFTERMACRO) compiler option and, if you do not specify the MACRO compiler option, specify the PP(MACRO(INCONLY)) compiler option.

     If you are using other Problem Determination Tools, see “Enterprise PL/I Version 3.5 and Version 3.6 programs” on page 448 to make sure you specify all the compiler options you need to create the files needed by all the Problem Determination Tools.

   - Scenario B: If you are using Enterprise PL/I for z/OS, Version 3.7, and you want to get the most Debug Tool functionality and a small program size, use TEST(ALL,NOHOOK,SYM,SEPARATE,SOURCE). If you need to debug programs that are loaded into protected storage, verify that your site installed the Authorized Debug Facility.

     Consider the following options:

     – You can substitute SOURCE with AFTERALL, AFTERCICS, AFTERMACRO, or AFTERSQL, as described in *Enterprise PL/I for z/OS Programming Guide*.

     – If you are debugging in full-screen mode and you want to debug programs with INCLUDE files that have executable code, specify the TEST(ALL,NOHOOK,SYM,SEPARATE,AFTERMACRO) compiler options and, if you do not specify the MACRO compiler option, specify the PP(MACRO(INCONLY)) compiler option.

– If you are debugging in remote debug mode and you want to automonitor variables in INCLUDE files, specify the TEST(ALL,NOHOOK,SYM,SEPARATE,AFTERMACRO) compiler options and, if you do not specify the MACRO compiler option, specify the PP(MACRO(INCONLY)) compiler option.

If you are using other Problem Determination Tools, see "Enterprise PL/I Version 3.5 and Version 3.6 programs" on page 448 to make sure you specify all the compiler options you need to create the files needed by all the Problem Determination Tools.

- Scenario C: If you are using Enterprise PL/I for z/OS, Version 3.5 or 3.6, and you want to get most Debug Tool functionality and a small program size, use TEST(ALL,NOHOOK,SYM,SEPARATE). If you need to debug programs that are loaded into protected storage, verify that your site installed the Authorized Debug Facility.

  If you are using other Problem Determination Tools, see "Enterprise PL/I Version 3.5 and Version 3.6 programs" on page 448 to make sure you specify all the compiler options you need to create the files needed by all the Problem Determination Tools.
- Scenario D: If you are using Enterprise PL/I for z/OS, Version 3.4, and you want to debug your program without compiled-in hooks, use TEST(ALL,NOHOOK,SYM). If you need to debug programs that are loaded into protected storage, verify that your site installed the Authorized Debug Facility.

  If you are using other Problem Determination Tools, see "Enterprise PL/I Version 3.4 and earlier programs" on page 453 to make sure you specify all the compiler options you need to create the files needed by all the Problem Determination Tools.
- Scenario E: If you are using Enterprise PL/I for z/OS, Version 3.3 or earlier, and you want to get all Debug Tool functionality, use TEST(ALL,SYM).

  If you are using other Problem Determination Tools, see "Enterprise PL/I Version 3.4 and earlier programs" on page 453 or "PL/I for MVS and VM and OS PL/I programs" on page 457 to make sure you specify all the compiler options you need to create the files needed by all the Problem Determination Tools.
- Scenario F: You can get some Debug Tool functionality by compiling with the NOTEST compiler option. This requires that you debug your program in disassembly mode.

  If you are using other Problem Determination Tools, review the topic that corresponds to the compiler that you are using from the following list to make sure you specify all the compiler options you need to create the files needed by all the Problem Determination Tools:
  – "Enterprise PL/I Version 3.5 and Version 3.6 programs" on page 448
  – "Enterprise PL/I Version 3.4 and earlier programs" on page 453
  – "PL/I for MVS and VM and OS PL/I programs" on page 457

2. For scenarios A, B, C, E, and F, do the following steps:
   a. If you use the Dynamic Debug facility to place hooks into programs that reside in read-only storage, verify with your system administrator that the Authorized Debug facility has been installed and that you are authorized to use it.
   b. After you start Debug Tool, verify that you have not deactivated the Dynamic Debug facility by entering the QUERY DYNDEBUG command.
   c. Verify that the separate debug file is a non-temporary file and is available during the debug session.

3. Verify whether you need to do any of the following tasks:
   - When you compile a program, do not associate SYSIN with an in-stream data set (for example //SYSIN DD *) because Debug Tool requires access to a permanent data set for the source of the program you are debugging.
   - If you are compiling a PL/I for MVS & VM or OS PL/I program and to be able to view your listing while debugging in full-screen mode, you must compile the program with the SOURCE compiler option. The SOURCE compiler option is required to generate a listing file. You must direct the listing to a non-temporary file that is available during the debug session. During a debug session, Debug Tool displays the first file it finds named `userid.pgmname.list` in the Source window. In addition, you must link your program with the Language Environment SCEELKED library; do not use the OS PL/I PLIBASE or SIBMBASE library.

     If Debug Tool cannot find the listing at this location, see “Changing which file appears in the Source window” on page 160.

After you have chosen the compiler options and suboptions, see Chapter 3, “Planning your debug session,” on page 23 to determine the next task you must complete.

Table 7. Description of the effects that the PL/I NOTEST compiler option and the TEST compiler suboptions have on Debug Tool.

Name of compiler option or suboption	Description of the effect
NOTEST	Some behaviors or features change when you debug a PL/I program compiled with the NOTEST compiler option. The following list describes these changes: • You can list storage and registers. • You can include calls to PLITEST or CEETEST in your program so you can suspend running your program and issue Debug Tool commands. • You cannot step through program statements. You can suspend running your program only at the initialization of the main compile unit. • You cannot examine or use any program variables. • Because hooks at the statement level are not inserted, you cannot set any statement breakpoints or use commands such as GOTO or QUERY LOCATION. • The source listing produced by the compiler cannot be used; therefore, no listing is available during a debug session. However, you can still debug your program using the disassembly view. To learn how to use the disassembly view, see Chapter 34, “Debugging a disassembled program,” on page 343.
NOHOOK	Some behaviors or features change when you debug a PL/I program compiled with the NOHOOK suboption of the TEST compiler option. The following list describes these changes: • For Debug Tool to generate overlay hooks, one of the suboptions ALL, PATH, STMT or BLOCK must be in effect, but HOOK need not be specified, and NOHOOK would be recommended. • If NOHOOK is specified, ENTRY and EXIT breakpoints are the only PATH breakpoints at which Debug Tool stops.

Table 7. Description of the effects that the PL/I NOTEST compiler option and the TEST compiler suboptions have on Debug Tool. (continued)

Name of compiler option or suboption	Description of the effect
NONE	When you compile a PL/I program with the NONE suboption of the TEST compiler option, you can start Debug Tool at any point in your program by writing a call to PLITEST or CEETEST in your program.
SYM	Some behaviors or features change when you debug a PL/I program compiled with the SYM suboption of the TEST compiler option. The following list describes these changes: • You can reference all program variables by name, which allows you to examine them or use them in expressions and use the DATA parameter of the PLAYBACK ENABLE command. • Enables support for the SET AUTOMONITOR ON command. • Enables the support for labels as GOTO targets.
NOSYM	Some behaviors or features change when you debug a PL/I program compiled with the NOSYM suboption of the TEST compiler option. The following list describes these changes: • You cannot reference program variables by name. • You cannot use commands such as LIST or DESCRIBE to access a variable or expression. • You cannot use commands such as CALL variable to branch to another program, or GOTO to branch to another label (procedure or block name).
BLOCK	Some behaviors or features change when you debug a PL/I program compiled with the BLOCK suboption of the TEST compiler option. The following list describes these changes: • Enables Debug Tool to gain control at block boundaries: block entry and block exit. • When Dynamic Debug is not active and you use the HOOK compiler option, you can gain control only at the entry and exit points of your program and all entry and exit points of internal program blocks. When you enter the STEP command, for example, your program runs until it reaches the next block entry or exit point. • When Dynamic Debug is active, you can set breakpoints at all statements and step through your program. • You cannot gain control at path points unless you also specify PATH. • A call to PLITEST or CEETEST can be used to start Debug Tool at any point in your program. • Hooks are not inserted into an empty ON-unit or an ON-unit consisting of a single GOTO statement.

Table 7. Description of the effects that the PL/I NOTEST compiler option and the TEST compiler suboptions have on Debug Tool. (continued)

Name of compiler option or suboption	Description of the effect
STMT	Some behaviors or features change when you debug a PL/I program compiled with the STMT suboption of the TEST compiler option. The following list describes these changes: • You can set breakpoints at all statements and step through your program. • Debug Tool cannot gain control at path points unless they are also at statement boundaries, unless you also specify PATH. • Branching to all statements and labels using the Debug Tool command GOTO is allowed.
ALL	Some behaviors or features change when you debug a PL/I program compiled with the ALL suboption of the TEST compiler option. The following list describes these changes: • You can set breakpoints at all statements and path points, and STEP through your program. • Debug Tool can gain control of the program at all statements, path points, labels, and block entry and exit points, allowing you to enter Debug Tool commands. • Enables branching to statements and labels using the Debug Tool command GOTO.

Refer to the following topics for more information related to the material discussed in this topic.

Related references

Description of the TEST compiler option in *Enterprise PL/I for z/OS Programming Guide*.

Choosing TEST or DEBUG compiler suboptions for C programs

This topic describes the combination of TEST or DEBUG compiler options and suboptions you need to specify to obtain the desired debugging scenario. This topic assumes you are compiling your C program with z/OS C/C++, Version 1.6, or later; however, the topics provide information about alternatives to use for older versions of the C compiler.

Choosing between TEST and DEBUG compiler options

If you are compiling with z/OS C/C++, Version 1.5 or earlier, you must choose the TEST compiler option.

The C/C++ compiler option DEBUG was introduced with z/OS C/C++ Version 1.5. Debug Tool supports the DEBUG compiler option in z/OS C/C++ Version 1.6 or later. The DEBUG compiler option replaces the TEST compiler option that was available with previous versions of the compiler.

If you are compiling with z/OS C/C++, Version 1.6 or later, choose the DEBUG compiler option and take advantage of the following benefits:

- For C++ programs, you can specify the HOOK(NOBLOCK) compiler option, which can improve debug performance.

- For C and C++ programs, if you specify the FORMAT(DWARF) suboption of the DEBUG compiler option, the load modules are smaller; however, you must save the .dbg file in addition to the source file. Debug Tool needs both of these files to debug your program.
- For C and C++ programs compiled with z/OS XL C/C++, Version 1.10 or later, if you specify the FORMAT(DWARF) suboption of the DEBUG compiler option, the load modules are smaller and you can create .mdbg files with captured source. Debug Tool needs only the .mdbg file to debug your program.

Choosing DEBUG compiler suboptions for C programs

This topic describes the debugging scenarios available, and how to create a particular debugging scenario by choosing the correct DEBUG compiler suboptions.

The C compiler provides the DEBUG compiler option and its suboptions to control the following actions:

- The generation and placement of hooks and symbol tables.
- The placement of debug information into the object file or separate debug file.

Debug Tool does not support debugging optimized C programs. Do not use any OPTIMIZE compiler options other than NOOPTIMIZE or OPTIMIZE(0).

The following instructions help you choose the combination of DEBUG compiler suboptions that provide the functionality you need to debug your program:

1. Choose a debugging scenario, keeping in mind your site's resources, from the following list:
   - Scenario A: To get the most Debug Tool functionality, a smaller program size, and better performance, use one of the following combinations:

     DEBUG(FORMAT(DWARF),HOOK(LINE,NOBLOCK,PATH),SYMBOL,FILE(*file_location*))

     The compiler options are the same whether you use only .dbg files or also use .mdbg files.
   - Scenario B: To get all Debug Tool functionality but have a larger program size and do not want the debug information in a separate file, use the following combination:

     DEBUG(FORMAT(ISD),HOOK(LINE,NOBLOCK,PATH),SYMBOL)
   - Scenario C: You can get some Debug Tool functionality by compiling with the NODEBUG compiler option. This requires that you debug your program in disassembly mode.

   For all scenarios, if you are using other Problem Determination Tools, see “z/OS XL C and C++ programs” on page 461 to make sure you specify all the compiler options you need to create the files needed by all the Problem Determination Tools.
2. For the scenario you selected, verify that you have the following resources:
   - For scenario A, do the following tasks:
     - If you create an .mdbg file, do the following tasks:
       a. Verify that you have applied the following PTFs for the products you are running:
          - For z/OS XL C/C++, Version 1.10: UK50219, UK50245, UK50246, UK50645
          - For z/OS XL C/C++, Version 1.11: UK51669, UK51670, UK51671
          - For z/OS Run-Time Library Extension, Version 1.10, (UTIL, CDA, DBGLD): UK50221, UK50652, UK50220, UK50252

- For z/OS Language Environment, Version 1.10: UK51883
- For z/OS Run-Time Library Extension, Version 1.10, (UTIL, CDA, DBGLD): UK51674, UK51673, UK52065, UK51803

b. Specify YES for the EQAOPTS MDBG command (which requires Debug Tool to search for a .dbg file in a .mdbg file)[1].

c. Verify that the .dbg files are non-temporary files.

d. Create the .mdbg file with captured source by using the -c option for the dbgld command or the CAPSRC option on the CDADBGLD utility.

e. Verify that the .mdbg file is a non-temporary file.

– If you use only .dbg files, verify that the .dbg files are non-temporary files and specify NO for the EQAOPTS MDBG command[2].

- For scenario C, do the following steps:

a. If you are running on z/OS Version 1.6 or Version 1.7, verify that Language Environment PTF for APAR PK12833 is installed.

b. If you use the Dynamic Debug facility to place hooks into programs that reside in read-only storage, verify with your system administrator that the Authorized Debug facility has been installed and that you are authorized to use it.

c. After you start Debug Tool, verify that you have not deactivated the Dynamic Debug facility by entering the QUERY DYNDEBUG command.

3. Verify whether you need to do any of the following tasks:
   - You can specify any combination of the C DEBUG suboptions in any order. The default suboptions are BLOCK, LINE, PATH, and SYMBOL.
   - When you compile a program, do not associate SYSIN with an in-stream data set (for example //SYSIN DD *) because Debug Tool requires access to a permanent data set for the source of the program you are debugging.
   - Debug Tool does not support the LP64 compiler option. You must specify or have in effect the ILP32 compiler option.
   - If you specify the OPTIMIZE compiler option with a level higher than 0, then no hooks are generated for line, block or path points, and no symbol table is generated. Only hooks for function entry and exit points are generated for optimized programs. The TEST compiler option has the same restriction.
   - You cannot call user-defined functions from the command line.

Refer to the following topics for more information related to the material discussed in this topic.

Related references

Description of the DEBUG compiler option in *z/OS XL C/C++ User's Guide*

Choosing TEST or NOTEST compiler suboptions for C programs

This topic describes the debugging scenarios available, and how to create a particular debugging scenario by choosing the correct TEST compiler suboptions.

The C compiler provides the TEST compiler option and its suboptions to control the generation and placement of hooks and symbol tables.

1. In situations where you can specify environment variables, you can set the environment variable EQA_USE_MDBG to YES or NO, which overrides any setting (including the default setting) of the EQAOPTS MDBG command.
2. In situations where you can specify environment variables, you can set the environment variable EQA_USE_MDBG to YES or NO, which overrides any setting (including the default setting) of the EQAOPTS MDBG command.

Debug Tool does not support debugging optimized C programs. Do not use compiler options other than NOOPTIMIZE,

The following instructions help you choose the combination of TEST compiler suboptions that provide the functionality you need to debug your program:

1. Choose a debugging scenario, keeping in mind your site's resources, from the following list:
   - Scenario A: To get all Debug Tool functionality but have a larger program size (compared to using DEBUG(FORMAT(DWARF))), use TEST(ALL,HOOK,SYMBOL).
   - Scenario B: You can get some Debug Tool functionality by compiling with the NOTEST compiler option. This requires that you debug your program in disassembly mode.
   - Scenario C: If you are debugging programs running in ALCS, you must compile with the HOOK suboption of the TEST compiler option.

   For all scenarios, if you are using other Problem Determination Tools, see "z/OS XL C and C++ programs" on page 461 to make sure you specify all the compiler options you need to create the files needed by all the Problem Determination Tools.
2. For scenario B, do the following steps:
   a. If you are running on z/OS Version 1.6 or Version 1.7, verify that Language Environment PTF for APAR PK12833 is installed.
   b. If you use the Dynamic Debug facility to place hooks into programs that reside in read-only storage, verify with your system administrator that the Authorized Debug facility has been installed and that you are authorized to use it.
   c. After you start Debug Tool, verify that you have not deactivated the Dynamic Debug facility by entering the SET DYNDEBUG OFF command.
3. Verify whether you need to do any of the following tasks:
   - When you compile a program, do not associate SYSIN with an in-stream data set (for example //SYSIN DD *) because Debug Tool requires access to a permanent data set for the source of the program you are debugging.
   - If you are using #pragma statements to specify your TEST or NOTEST compiler options, see "Compiling your C program with the #pragma statement" on page 41.
   - The C TEST compiler option implicitly specifies the GONUMBER compiler option, which causes the compiler to generate line number tables that correspond to the input source file. You can explicitly remove this option by specifying NOGONUMBER. When the TEST and NOGONUMBER options are specified together, Debug Tool does not display the current execution line as you step through your code.
   - Programs that are compiled with both the TEST compiler option and either the OPT(1) or OPT(2) compiler option do not have hooks at line, block, and path points, or generate a symbol table, regardless of the TEST suboptions specified. Only hooks for function entry and exit points are generated for optimized programs.
   - You can specify any number of TEST suboptions, including conflicting suboptions (for example, both PATH and NOPATH). The last suboptions that are specified take effect. For example, if you specify TEST(BLOCK, NOBLOCK, BLOCK, NOLINE, LINE), what takes effect is TEST(BLOCK, LINE) because BLOCK and LINE are specified last.
   - No duplicate hooks are generated even if two similar TEST suboptions are specified. For example, if you specify TEST(BLOCK, PATH), the BLOCK

suboption causes the generation of hooks at entry and exit points. The PATH suboption also causes the generation of hooks at entry and exit points. However, only one hook is generated at each entry and exit point.

Table 8. Description of the effects that the C NOTEST compiler option and the TEST compiler suboptions have on Debug Tool.

Name of compiler option or suboption	Description of the effect
NOTEST	The following list explains the effect the NOTEST compiler option will have on how Debug Tool behaves or the availability of features, which are not described in *z/OS XL C/C++ User's Guide*: • You cannot step through program statements. You can suspend execution of the program only at the initialization of the main compile unit. • You cannot examine or use any program variables. • You can list storage and registers. • You cannot use the Debug Tool command GOTO. However, you can still debug your program using the disassembly view. To learn how to use the disassembly view, see Chapter 34, "Debugging a disassembled program," on page 343.
TEST	The following list explains the effect some of the suboptions of the TEST compiler option will have on how Debug Tool behaves or the availability of features, which are not described in *z/OS XL C/C++ User's Guide*: • The maximum number of lines in a single source file cannot exceed 131,072. • The maximum number of include files that have executable statements cannot exceed 1024.
NOSYM	The following list explains the effect the NOSYM suboption of the TEST compiler option will have on how Debug Tool behaves or the availability of features, which are not described in *z/OS XL C/C++ User's Guide*. • You cannot reference program variables by name. • You cannot use commands such as LIST or DESCRIBE to access a variable or expression. • You cannot use commands such as CALL or GOTO to branch to another label (paragraph or section name).

Refer to the following topics for more information related to the material discussed in this topic.

Related references

Description of the TEST compiler option in *z/OS XL C/C++ User's Guide*

Compiling your C program with the #pragma statement

The TEST/NOTEST compiler option can be specified either when you compile your program or directly in your program, using a #pragma.

This #pragma must appear before any executable code in your program.

The following example generates symbol table information, symbol information for nested blocks, and hooks at line numbers:

```
#pragma options (test(SYM,BLOCK,LINE))
```

This is equivalent to TEST(SYM,BLOCK,LINE,PATH).

You can also use a #pragma to specify runtime options.

Rules for the placement of hooks in functions and nested blocks

The following rules apply to the placement of hooks for getting in and out of functions and nested blocks:

- The hook for function entry is placed before any initialization or statements for the function.
- The hook for function exit is placed just before actual function return.
- The hook for nested block entry is placed before any statements or initialization for the block.
- The hook for nested block exit is placed after all statements for the block.

Refer to the following topics for more information related to the material discussed in this topic.

Related references

z/OS XL C/C++ User's Guide

Rules for placement of hooks in statements and path points

The following rules apply to the placement of hooks for statements and path points:

- Label hooks are placed before the code and all other statement or path point hooks for the statement.
- The statement hook is placed before the code and path point hook for the statement.
- A path point hook for a statement is placed before the code for the statement.

Refer to the following topics for more information related to the material discussed in this topic.

Related references

z/OS XL C/C++ User's Guide

Choosing TEST or DEBUG compiler suboptions for C++ programs

This topic describes the combination of TEST or DEBUG compiler options and suboptions you need to specify to obtain the desired debugging scenario. This topic assumes you are compiling your C++ program with z/OS C/C++, Version 1.6, or later; however, the topics provide information about alternatives to use for older versions of the C++ compiler.

Choosing between TEST and DEBUG compiler options

If you are compiling with z/OS C/C++, Version 1.5 or earlier, you must choose the TEST compiler option.

The C/C++ compiler option DEBUG was introduced with z/OS C/C++ Version 1.5. Debug Tool supports the DEBUG compiler option in z/OS C/C++ Version 1.6 or later. The DEBUG compiler option replaces the TEST compiler option that was available with previous versions of the compiler.

If you are compiling with z/OS C/C++, Version 1.6 or later, choose the DEBUG compiler option and take advantage of the following benefits:

- For C++ programs, you can specify the HOOK(NOBLOCK) compiler option, which can improve debug performance.

- For C and C++ programs, if you specify the FORMAT(DWARF) suboption of the DEBUG compiler option, the load modules are smaller; however, you must save the .dbg file in addition to the source file. Debug Tool needs both of these files to debug your program.
- For C and C++ programs compiled with z/OS XL C/C++, Version 1.10 or later, if you specify the FORMAT(DWARF) suboption of the DEBUG compiler option, the load modules are smaller and you can create .mdbg files with captured source. Debug Tool needs only the .mdbg file to debug your program.

Choosing DEBUG compiler suboptions for C++ programs

This topic describes the debugging scenarios available, and how to create a particular debugging scenario by choosing the correct DEBUG compiler suboptions.

The C++ compiler provides the DEBUG compiler option and its suboptions to control the following actions:

- The generation and placement of hooks and symbol tables.
- The placement of debug information into the object file or separate debug file.

Debug Tool does not support debugging optimized C programs. Do not use any OPTIMIZE compiler options other than NOOPTIMIZE or OPTIMIZE(0).

The following instructions help you choose the combination of DEBUG compiler suboptions that provide the functionality you need to debug your program:

1. Choose a debugging scenario, keeping in mind your site's resources, from the following list:
   - Scenario A: To get the most Debug Tool functionality, a smaller program size, and better performance, use one of the following combinations:

     DEBUG(FORMAT(DWARF),HOOK(LINE,NOBLOCK,PATH),SYMBOL,FILE(*file_location*))

     The compiler options are the same whether you use only .dbg files or also use .mdbg files.
   - Scenario B: To get all Debug Tool functionality but have a larger program size and do not want the debug information in a separate file, use the following combination:

     DEBUG(FORMAT(ISD),HOOK(LINE,NOBLOCK,PATH),SYMBOL)
   - Scenario C: You can get some Debug Tool functionality by compiling with the NODEBUG compiler option. This requires that you debug your program in disassembly mode.

   For all scenarios, if you are using other Problem Determination Tools, see “z/OS XL C and C++ programs” on page 461 to make sure you specify all the compiler options you need to create the files needed by all the Problem Determination Tools.
2. For the scenario you selected, verify that you have the following resources:
   - For scenario A, do the following tasks:
     - If you create an .mdbg file, do the following tasks:
       a. Verify that you have applied the following PTFs for the products you are running:
          - For z/OS XL C/C++, Version 1.10: UK50219, UK50245, UK50246, UK50645
          - For z/OS XL C/C++, Version 1.11: UK51669, UK51670, UK51671
          - For z/OS Run-Time Library Extension, Version 1.10, (UTIL, CDA, DBGLD): UK50221, UK50652, UK50220, UK50252

- For z/OS Language Environment, Version 1.10: UK51883
- For z/OS Run-Time Library Extension, Version 1.10, (UTIL, CDA, DBGLD): UK51674, UK51673, UK52065, UK51803

b. Specify YES for the EQAOPTS MDBG command (which requires Debug Tool to search for a .dbg file in a .mdbg file)[3].

c. Verify that the .dbg files are non-temporary files.

d. Create the .mdbg file with captured source by using the -c option for the dbgld command or the CAPSRC option on the CDADBGLD utility.

e. Verify that the .mdbg file is a non-temporary file.

– If you use only .dbg files, verify that the .dbg files are non-temporary files and specify NO for the EQAOPTS MDBG command[4].

- For scenario C, do the following steps:

a. If you are running on z/OS Version 1.6 or Version 1.7, verify that Language Environment PTF for APAR PK12833 is installed.

b. If you use the Dynamic Debug facility to place hooks into programs that reside in read-only storage, verify with your system administrator that you are authorized to do so

c. After you start Debug Tool, verify that you have not deactivated the Dynamic Debug facility by entering the QUERY DYNDEBUG command.

3. Verify whether you need to do any of the following tasks:
   - You can specify any combination of the C++ DEBUG suboptions in any order. The default suboptions are BLOCK, LINE, PATH, and SYM.
   - When you compile a program, do not associate SYSIN with an in-stream data set (for example //SYSIN DD *) because Debug Tool requires access to a permanent data set for the source of the program you are debugging.
   - Debug Tool does not support the LP64 compiler option. You must specify or have in effect the ILP32 compiler option.
   - If you specify the OPTIMIZE compiler option with a level higher than 0, then no hooks are generated for line, block or path points, and no symbol table is generated. Only hooks for function entry and exit points are generated for optimized programs. The TEST compiler option has the same restriction.
   - You can not call user defined functions from the command line.

After you have chosen the compiler options and suboptions, see Chapter 3, “Planning your debug session,” on page 23 to determine the next task you must complete.

Refer to the following topics for more information related to the material discussed in this topic.

Related references

Description of the DEBUG compiler option in *z/OS XL C/C++ User's Guide*

Choosing TEST or NOTEST compiler options for C++ programs

This topic describes the debugging scenarios available, and how to create a particular debugging scenario by choosing the correct TEST compiler suboptions.

3. In situations where you can specify environment variables, you can set the environment variable EQA_USE_MDBG to YES or NO, which overrides any setting (including the default setting) of the EQAOPTS MDBG command.

4. In situations where you can specify environment variables, you can set the environment variable EQA_USE_MDBG to YES or NO, which overrides any setting (including the default setting) of the EQAOPTS MDBG command.

The C++ compiler provides the TEST compiler option and its suboptions to control the generation and placement of hooks and symbol tables.

Debug Tool does not support debugging optimized C++ programs. Do not use compiler options other than NOOPTIMIZE,

The following instructions help you choose the combination of TEST compiler suboptions that provide the functionality you need to debug your program:

1. Choose a debugging scenario, keeping in mind your site's resources, from the following list:
   - Scenario A: To get all Debug Tool functionality but have a larger program size (compared to using DEBUG(FORMAT(DWARF))), use TEST.
   - Scenario B: You can get some Debug Tool functionality by compiling with the NOTEST compiler option. This requires that you debug your program in disassembly mode.
   - Scenario C: If you are debugging programs running in ALCS, you must compile with the HOOK suboption of the TEST compiler option.

   For all scenarios, if you are using other Problem Determination Tools, see “z/OS XL C and C++ programs” on page 461 to make sure you specify all the compiler options you need to create the files needed by all the Problem Determination Tools.
2. Verify whether you need to do any of the following tasks:
   - When you compile a program, do not associate SYSIN with an in-stream data set (for example //SYSIN DD *) because Debug Tool requires access to a permanent data set for the source of the program you are debugging.
   - The C++ TEST compiler option implicitly specifies the GONUMBER compiler option, which causes the compiler to generate line number tables that correspond to the input source file. You can explicitly remove this option by specifying NOGONUMBER. When the TEST and NOGONUMBER options are specified together, Debug Tool does not display the current execution line as you step through your code.
   - Programs that are compiled with both the TEST compiler option and either the OPT(1) or OPT(2) compiler option do not have hooks at line, block, and path points, or generate a symbol table. Only hooks for function entry and exit points are generated for optimized programs.

After you have chosen the compiler options and suboptions, see Chapter 3, “Planning your debug session,” on page 23 to determine the next task you must complete.

Table 9. Description of the effects that the C++ NOTEST and TEST compiler option have on Debug Tool.

Name of compiler option or suboption	Description of the effect
NOTEST	The following list explains the effect of the NOTEST compiler has on Debug Tool behavior, which are not described in *z/OS XL C/C++ User's Guide*: • You cannot step through program statements. You can suspend execution of the program only at the initialization of the main compile unit. • You cannot examine or use any program variables. • You can list storage and registers. • You cannot use the Debug Tool command GOTO. However, you can still debug your program using the disassembly view. To learn how to use the disassembly view, see Chapter 34, "Debugging a disassembled program," on page 343.
TEST	The following list explains the effect the TEST compiler has on Debug Tool behavior, which are not described in *z/OS XL C/C++ User's Guide*: • The maximum number of lines in a single source file cannot exceed 131,072. • The maximum number of include files that have executable statements cannot exceed 1024.

Refer to the following topics for more information related to the material discussed in this topic.

Related references

Description of the TEST compiler option in *z/OS XL C/C++ User's Guide*

Rules for the placement of hooks in functions and nested blocks

The following rules apply to the placement of hooks for functions and nested blocks:

- The hook for function entry is placed before any initialization or statements for the function.
- The hook for function exit is placed just before actual function return.
- The hook for nested block entry is placed before any statements or initialization for the block.
- The hook for nested block exit is placed after all statements for the block.

Refer to the following topics for more information related to the material discussed in this topic.

Related references

z/OS XL C/C++ User's Guide

Rules for the placement of hooks in statements and path points

The following rules apply to the placement of hooks for statements and path points:

- Label hooks are placed before the code and all other statement or path point hooks for the statement.
- The statement hook is placed before the code and path point hook for the statement.
- A path point hook for a statement is placed before the code for the statement.

Refer to the following topics for more information related to the material discussed in this topic.

Related references

z/OS XL C/C++ User's Guide

Understanding how hooks work and why you need them

Hooks enable you to set breakpoints. Hooks are instructions that can be inserted into a program by a compiler at compile time. Hooks can be placed at the entrances and exits of blocks, at statement boundaries, and at points in the program where program flow might change between statement boundaries (called path points). If you compile a program with the TEST compiler option and specify any suboption except NONE or NOHOOK, the compiler inserts hooks into your program.

How the Dynamic Debug facility can help you get maximum performance without hooks

In the following situations, you can compile or create a program without hooks. Then, you can use the Dynamic Debug facility to insert hooks at runtime whenever you set a breakpoint or enter the STEP command:

- Assembler, disassembly, and LangX COBOL programs do not contain hooks.
- If you use Enterprise COBOL for z/OS, Version 4.1, you can compile your programs without hooks by using the TEST(NOHOOK) compiler option.
- If you use one of the following compilers, you can compile your programs without hooks by using the TEST(NONE) compiler option:
  - Enterprise COBOL for z/OS and OS/390, Version 3
  - COBOL for OS/390 & VM, Version 2 Release 2
  - COBOL for OS/390 & VM, Version 2 Release 1, with APAR PQ40298
- If you use the Enterprise PL/I for z/OS, Version 3.4 or later, compiler, you can compile your programs without hooks by using the TEST(NOHOOK) compiler option.

The Dynamic Debug facility can also help improve the performance of Debug Tool while debugging programs compiled with any of the following compilers:

- any COBOL compiler supported by Debug Tool
- any PL/I compiler supported by Debug Tool
- any C/C++ compiler supported by Debug Tool

When you compile with one the following compilers and have the compiler insert hooks, you can enhance the program's performance while you debug it by using the Dynamic Debug facility:

- any COBOL compiler supported by Debug Tool
- any PL/I compiler supported by Debug Tool
- any C/C++ compiler supported by Debug Tool

When you start Debug Tool, the Dynamic Debug facility is activated unless you change the default by using the DYNDEBUG EQAOPTS command. If the DYNDEBUG EQAOPTS command was used to change the default to DYNDEBUG OFF, you can activate it by using the DYNDEBUG ON Debug Tool command. If the Dynamic Debug facility is active, Debug Tool uses the hooks inserted by the compiler, instead of the hooks inserted by the Dynamic Debug facility.

Understanding what symbol tables do and why saving them elsewhere can make your application smaller

The symbol table contains descriptions of variables, their attributes, and their location in storage. Debug Tool uses these descriptions when it references variables. The symbol tables can be stored in the object file of the program or in a separate debug file. You can save symbol tables in a separate debug file if you compile or assemble your programs with one of the following compilers or assembler:

- Enterprise COBOL for z/OS, Version 4.1
- Enterprise COBOL for z/OS and OS/390, Version 3
- COBOL for OS/390 & VM, Version 2 Release 2
- COBOL for OS/390 & VM, Version 2 Release 1 with APAR PQ40298
- OS/VS COBOL Version 1, Release 2.4
- Enterprise PL/I for z/OS, Version 3 Release 5 or later
- High Level Assembler for MVS & VM & VSE, Release 4 or later

Saving symbol tables in a separate debug file can reduce the size of the load module for your program.

For C and C++ programs, debug tables can be saved in a separate debug file (.dbg file) by specifying the `FORMAT(DWARF)` suboption of the `DEBUG` compiler option. Debug Tool supports the `DEBUG` compiler option shipped with z/OS C/C++ Version 1.6 or later.

Choosing a debugging mode

Use the following list to determine which debugging mode to use for your programs:

For TSO programs
: Choose full-screen mode. If you want to use a supported remote debugger, choose remote debug mode.

For JES batch programs
: If you want to interact with your batch program, choose full-screen mode using the Terminal Interface Manager. If you want to interact with your batch program using a supported remote debugger, choose remote debug mode. If you don't want to interact with your batch program, use batch mode and specify commands through a commands file and review results in a log file.

For UNIX System Services programs
: Choose full-screen mode using the Terminal Interface Manager. If you want to use a supported remote debugger, choose remote debug mode.

For CICS programs
: If you want to interact with Debug Tool on a 3270 device, choose full-screen mode and one of the following terminal modes:

  - Single terminal mode: The application program and Debug Tool share the same terminal. Use this terminal mode to debug a transaction that interacts with a 3270 terminal. When you create your CADP or DTCN profile, set the Display Device to the terminal ID that the application program uses.
  - Screen control mode: Debug Tool displays its screens on a terminal running the DTSC transaction.

    If you use screen control mode, the DTSC transaction runs in the same region as your application program on a terminal of your choice, and

displays Debug Tool screens on behalf of the task you are debugging, which might not have its own terminal.

Use screen control mode to debug application programs which are not typically associated with a terminal, and which are running in an MRO environment.

Screen control mode works in the following manner:

1. Enter `DTSC` on the terminal that you want to use to display Debug Tool. This terminal can be connected directly to the region where the application program runs, or connected to the region with CRTE or Transaction Routing. If you use Transaction Routing, you must ensure that DTSC runs in the same region as the application program using it.
2. Set the Display Device in your DTCN or CADP profile to the terminal running the DTSC transaction.
3. Start the application program.
4. Press Enter on the terminal running the DTSC transaction to connect to Debug Tool.

- Separate terminal mode (formerly called *Dual Terminal Mode*): Debug Tool dynamically starts the CDT# transaction on a terminal.

  Use separate terminal mode to debug application programs which are not typically associated with a terminal, and your terminal is connected directly to the region running your application program.

  Separate terminal mode works in the following manner:

  1. Set the Display Device in your DTCN or CADP profile to an available terminal and that terminal can be located by the CICS region running Debug Tool.
  2. Start the application program.

If you want to debug your program with a remote debugger, select remote debug mode. Make note of the TCP/IP address of your remote debugger because you will need it when you update your CADP or DTCN profile.

If you do not use single terminal mode and your program sends a screen to the terminal without the WAIT option, CICS Terminal Control holds that screen until the program runs an `EXEC CICS SEND` or `EXEC CICS RECEIVE` statement.

If you want to debug programs that use Distributed Program Link (DPL), you can select one of the following debugging modes:

- Select remote debug mode and use the remote debugger to debug both the DPL client and DPL server.
- Select full screen mode and use two 3270 terminals, one for the DPL client and one for the DPL server.

  You can connect the 3270 terminal to the DPL server in one of the following ways:

  – Directly to the server region.
  – To the client region. If you choose this option, use one of the following terminal modes:
    - Screen Control Mode with DTSC running on a terminal that is connected to the server with CRTE
    - Separate Terminal Mode with the terminal connected to the client region and configure the server region so that it looks for the terminal in the client region. To configure the server region, see

"Separate terminal mode terminal connects to a TOR and application runs in an AOR" in the *Debug Tool Customization Guide*.

For DB2 programs

Choose full-screen mode using the Terminal Interface Manager. If you want to use a supported remote debugger, choose remote debug mode.

For DB2 Stored Procedures

Choose full-screen mode using the Terminal Interface Manager. If you want to use a supported remote debugger, choose remote debug mode.

For IMS TM programs

Choose full-screen mode using the Terminal Interface Manager. If you want to use a supported remote debugger, choose remote debug mode.

For IMS batch programs

If you want to interact with your IMS batch programs, choose full-screen mode using the Terminal Interface Manager. If you want to interact with your IMS batch programs with a supported remote debugger, choose remote debug mode. If you do not want to interact with your IMS batch program, choose batch mode and specify commands through a commands file and review results in a log file.

For IMS BTS programs

If you want your program and your debugging session to run on a single screen, choose full-screen mode. If you want your BTS data to display on your TSO terminal and your debugging session to display on another terminal, choose full-screen mode using the Terminal Interface Manager. If you want your BTS data to display on your TSO terminal and your debugging session to display on a supported remote debugger, choose remote debug mode.

For ALCS programs

You must choose remote debug mode.

Refer to the following topics for more information related to the material discussed in this topic.

Related references

IMS/VS Batch Terminal Simulator Program Reference and Operations Manual

Debugging in browse mode

When you debug in some production environments, it might be necessary to restrict your ability to change storage contents and execution flow. Debugging in browse mode enables you to debug your programs while restricting your ability to change storage contents and execution flow. Debug Tool uses the RACF® authority of the current user, an EQAOPTS command, or both to determine whether to operate in browse mode.

When you debug in browse mode, you can not do the following actions:

- Modify the contents of memory or registers
- Alter the sequence of program execution

You can use the `QUERY BROWSE MODE` command to determine if browse mode is active.

For information on how to install and control browse mode, see *Debug Tool Customization Guide*.

Browse mode debugging in full screen, line, and batch mode

If you are debugging in full screen, line, or batch mode; browse mode is active; and you enter any of the following commands, Debug Tool displays a message that the command is not permitted in browse mode:

- `ALLOCATE` command
- Assignment command (assembler and disassembly)
- Assignment command (LangX COBOL)
- Assignment command (PL/I)
- `CALL %CECI` command
- `CALL` *`entry_name`* (COBOL)
- `CALL %FM` command
- `CALL %HOGAN` command
- `CLEAR LOG` command
- `COMPUTE` command
- `FREE` command
- `GO BYPASS` command
- `GOTO` command
- `GOTO LABEL` command
- `INPUT` command
- `JUMPTO` command
- `JUMPTO LABEL` command
- `MEMORY` command (Debug Tool displays the Memory window, but you cannot modify anything)
- `MOVE` command
- `QUIT` command
- `QUIT` *`expression`* command
- `QQUIT` command
- `SET INTERCEPT` command
- `SET` command (COBOL)
- `STORAGE` command
- `SYSTEM` command
- `TRIGGER` command
- `TSO` command

If you enter a command with an *expression* or *condition* that might alter any storage, register, or similar data, or the command invokes any user-written function or alters the sequence of execution, Debug Tool displays a message that the command is not permitted in browse mode:

- do/while
- `DO` command (PL/I)
- `EVALUATE` command (COBOL)
- *expression* command (C and C++)
- `for` command (C and C++)
- `%IF` command
- `IF` command
- `LIST` *`expression`* command
- `switch` command

- `while` command

Browse mode debugging in remote debug mode

When you use the remote debugger and browse mode is active, the remote debugger does not allow you to do the following actions:

- JumpTo Location – Source window RMB action
- Change Value – Expression, Variable, and Registers RMB action
- Typing over memory in the Memory window

In addition, the remote debugger enforces following restrictions:

- Change Value – the remote debugger does not allow Registers RMB action and displays an error message
- Terminate Button – the program terminates with an abend (instead, click on Disconnect to continue running the program without the debugger)

Also, the remote debugger does not allow you to enter the following Debug Console commands:

- `JUMPTO` (and `JUMPTO` in the Action field of the Add a Breakpoint window)
- `SET INTERCEPT`
- `QUIT`

If an abend occurs while debugging in remote debug mode and browse mode is active, the remote debugger does not give you any continuation options. You can not continue program execution after the abend occurs.

Controlling browse mode

Browse mode can be controlled (activated or deactivated) by changing RACF access, specifying the EQAOPTS `BROWSE` command, both of these, or neither of these. To control browse mode through RACF access, change your RACF access to the following RACF Facilities:

- For CICS: EQADTOOL.BROWSE.CICS
- For non-CICS: EQADTOOL.BROWSE.MVS

To control browse mode through an EQAOPTS command, specify either ON or OFF for the EQAOPTS `BROWSE` command.

The following table shows how combinations of these control methods (by RACF access or by the EQAOPTS `BROWSE` command) can activate or deactivate browse mode. For instructions using these controls see *Debug Tool Customization Guide*.

Table 10. How different combinations of RACF access and the EQAOPTS BROWSE command activate or deactivate browse mode.

	Setting of the EQAOPTS `BROWSE` command		
Status of RACF access	**Not set (use RACF status)**	**ON**	**OFF**
facility (access) not defined	normal mode (browse mode is not active)	browse mode is active	normal mode
ACCESS=NONE	Cannot use Debug Tool	Cannot use Debug Tool	Cannot use Debug Tool
ACCESS=READ	browse mode is active	browse mode is active	browse mode is active

Table 10. How different combinations of RACF access and the EQAOPTS BROWSE command activate or deactivate browse mode. (continued)

Status of RACF access	Setting of the EQAOPTS BROWSE command		
	Not set (use RACF status)	**ON**	**OFF**
ACCESS=UPDATE (or higher)	normal mode	browse mode is active	normal mode

Choosing a method or methods for starting Debug Tool

Table 11 on page 54 indicates that there are several different methods to start Debug Tool for each type of program. In this topic, you will read about the circumstances in which each applicable method works for each type of program. Then you can select which method would work best for your site. After you complete this topic, you will have selected the methods that work best for your programs.

Table 11. Methods for specifying the TEST runtime options and the subsystems that support these methods.

	Use the EQADBCXT user exit routine	Use the EQADICXT user exit routine	Use the EQADDCXT user exit routine	Use the DFSBXITA user exit	Use the CADP transaction	Use the DTCN transaction	Use the DB2 catalog	From within a program by coding a call to CEETEST, __ctest(), or PLITEST	Through CEEUOPT or CEEROPT	Use the CEEOPTS DD statement in JCL or CEEOPTS allocation in TSO	Use the parameters on the EXEC statement when you start your program	Use the parameters on the RUN statement when you start your program	Use the parameters on the CALL statement when you start your program	Through the EQASET transaction[3]	Through the EQANMDBG program[4]	Use the EQAD3CXT user exit routine
TSO								X	X	X			X		X[4]	
JES batch	X							X	X	X	X				X[4]	X
UNIX System Services								X	X	X						
CICS					X	X		X	X[1]							
DB2								X	X[1]	X		X				
DB2 stored procedures (PROGRAM TYPE=MAIN)			X				X[2]	X	X[1,2]							X
DB2 stored procedures (PROGRAM TYPE=SUB)			X[5]				X	X								
IMS TM		X		X				X	X					X[3]		X
IMS batch	X			X				X	X	X					X[4]	X
IMS BTS	X	X		X				X	X	X					X[4]	X

Notes:

1. You cannot use CEEROPT to specify `TEST` runtime options.
2. The DB2 catalog method always takes precedence over CEEUOPT.
3. This method is only for non-Language Environment assembler programs.
4. This method is only for non-Language Environment programs.
5. This method is only for DB2 stored procedures invoked with the `call_sub` function.

For each subsystem, Table 11 on page 54 shows that you can choose from several different methods of specifying the TEST runtime options. The following list can help you select the method that best applies to your situation, ordered by flexibility and convenience:

For TSO programs

1. For programs that start in Language Environment, specify the TEST runtime options using the CEEOPTS allocation in TSO for the most flexible method of specifying the runtime options.
2. Specify the TEST runtime options using the parameters on the CALL statement if you have a small number of runtime options or need to invoke EQANMDBG for a non-Language Environment program.
3. If you specify the TEST runtime options by coding a call to CEETEST, __ctest(), or PLITEST, you will have to recompile your program every time you want to change the options.

For JES batch programs

1. For programs that start in Language Environment, specify the TEST runtime options using the CEEOPTS DD statement in your JCL for the most flexible method of specifying runtime options.
2. Specify the TEST runtime options using the parameters on the EXEC statement option if you have a small number of runtime options or need to invoke EQANMDBG for a non-Language Environment program.
3. If you specify the TEST runtime options by coding a call to CEETEST, __ctest(), or PLITEST, you will have to recompile your program every time you want to change the options.

For UNIX System Services programs

1. Specify the TEST runtime options by setting the _CEE_RUNOPTS environment variable.
2. If you specify the TEST runtime options by coding a call to CEETEST, __ctest(), or PLITEST, you will have to recompile your program every time you want to change the options.

For CICS programs

1. Specify the TEST runtime options using either the DTCN or CADP transaction to create and store a profile that contains the TEST runtime options.
2. If you specify the TEST runtime options by coding a call to CEETEST, __ctest(), or PLITEST, you will have to recompile your program every time you want to change the options.

For DB2 programs

1. Specify the TEST runtime options using the CEEOPTS DD statement in JCL or CEEOPTS allocation in TSO for the most flexible method of specifying runtime options.
2. Specify the TEST runtime options using the parameters on the RUN statement option if you have a small number of runtime options.
3. If you specify the TEST runtime options by coding a call to CEETEST, __ctest(), or PLITEST, you will have to recompile your program every time you want to change the options.

For DB2 stored procedures that have the PROGRAM TYPE of MAIN

1. Specify the TEST runtime options using the Language Environment EQADDCXT or EQAD3CXT user exit routine. You can run the stored

procedure with your own set of suboptions. Another user can run or debug the stored procedure with a separate set of suboptions. Therefore, multiple users can run or debug the stored procedure at the same time.

2. If the exit routine is not available at your site, specify the TEST runtime options using the DB2 catalog. However, you are limited to specifying one specific set of suboptions, which means that every user that runs or debugs that stored procedure uses the same set of suboptions.

If you implement both methods, the Language Environment exit routine takes precedence over the DB2 catalog.

For DB2 stored procedures that have the PROGRAM TYPE of SUB

- For programs invoked with the call_sub function, specify the TEST runtime options using the Language Environment EQADDCXT exit routine. You can run or debug the DB2 stored procedure with your own set of suboptions, while another user can run or debug the DB2 stored procedure with a separate set of suboptions.

  If the exit routine is not available at your site, specify the TEST runtime options using the DB2 catalog. You are limited to specifying one set of suboptions, which means that every user that runs or debugs that stored procedure uses the same set of suboptions.

  If you implement methods, the Language Environment exit routine takes precedence over the DB2 catalog.
- For programs invoked by any other method, specify the TEST runtime options using the DB2 catalog. You are limited to specifying one set of suboptions, which means that every user that runs or debugs that stored procedure uses the same set of suboptions.

For IMS TM programs

1. Specify the TEST runtime options using the Language Environment EQADICXT or EQAD3CXT user exit routine.
2. If your program is a non-Language Environment program, issue the EQASET transaction to setup your debugging preference.
3. If the EQADICXT or EQAD3CXT user exit routine is not available at your site, specify the TEST runtime options using the DFSBXITA user exit routine.
4. If the EQADICXT, EQAD3CXT, or DFSBXITA user exit routines are not available at your site, specify the TEST runtime options using CEEUOPT or CEEROPT.
5. If none of the previous options are available at your site, specify the TEST runtime options by coding a call to CEETEST, __ctest(), or PLITEST. However, you will have to recompile your program every time you want to change the options.

For IMS batch programs

1. For programs that start in Language Environment, specify the TEST runtime options using the CEEOPTS allocation in JCL because this method can be the most flexible method.
2. Specify the TEST runtime options using the EQADBCXT or EQAD3CXT user exit routine.
3. If your program is a non-Language Environment program, use the EQANMDBG program to start your debugging session.

4. If the EQADBCXT or EQAD3CXT user exit routine is not available at your site, specify the TEST runtime options using the DFSBXITA user exit routine; however, you must specify PROGRAM rather than TRANSACTION.
5. If the EQADBCXT, EQAD3CXT, or DFSBXITA user exit routines are not available at your site, specify the TEST runtime options using CEEUOPT or CEEROPT.
6. If none of the previous options are available at your site, specify the TEST runtime options by coding a call to CEETEST, __ctest(), or PLITEST. However, you will have to recompile your program every time you want to change the options.

For IMS BTS programs

1. For programs that start in Language Environment, specify the TEST runtime options using the CEEOPTS allocation in JCL because this method can be the most flexible method.
2. Specify the TEST runtime options using the EQADICXT or EQAD3CXT user exit routine.
3. If your program is a non-Language Environment program, use the EQANMDBG program to start your debugging session.
4. If the EQADICXT or EQAD3CXT user exit routine is not available at your site, specify the TEST runtime options using the EQADBCXT user exit routine.
5. If the EQADBCXT user exit routine is not available at your site, specify the TEST runtime options using the DFSBXITA user exit routine.
6. If the EQADICXT, EQAD3CXT, EQADBCXT, or DFSBXITA user exit routines are not available at your site, specify the TEST runtime options using CEEUOPT or CEEROPT.
7. If none of the previous options are available at your site, specify the TEST runtime options by coding a call to CEETEST, __ctest(), or PLITEST. However, you will have to recompile your program every time you want to change the options.

After you have identified the method or methods you will use to start Debug Tool, see Chapter 3, “Planning your debug session,” on page 23 to determine the next task you must complete.

Choosing how to debug old COBOL programs

Programs compiled with the OS/VS COBOL compiler can be debugged by doing one of the following:

- Debug them as LangX COBOL programs.
- Convert them to the 1985 COBOL Standard level and compile them with the Enterprise COBOL for z/OS and OS/390 or COBOL for OS/390 & VM compiler. You can use the Load Module Analyzer to identify OS/VS COBOL programs in a load module, then use COBOL and CICS Command Level Conversion Aid (CCCA) to convert the programs.

To convert an OS/VS COBOL program to 1985 COBOL Standard, do the following steps:

1. Identify the OS/VS COBOL programs in your load module by using the Load Module Analyzer. For instructions on using Load Module Analyzer, see Appendix G, “Debug Tool Load Module Analyzer,” on page 487.

2. Convert your OS/VS COBOL source by using COBOL and CICS Command Level Conversion Aid (CCCA). For instructions on using CCCA, see *COBOL and CICS Command Level Conversion Aid for OS/390 & MVS & VM User's Guide*.
3. Compile the new source with either the Enterprise COBOL for z/OS and OS/390 or COBOL for OS/390 & VM.

   You can combine steps 2 and 3 by using the **Convert and Compile** option of Debug Tool Utilities.
4. Debug the object module by using Debug Tool.

After you convert and debug your program, you can do one of the following options:

- Continue to use the OS/VS COBOL compiler. Every time you want to debug your program, you need to do the steps described in this section.
- Use the new source that was produced by the steps described in this section. You can compile the source and debug it without repeating the steps described in this section.

CCCA can use any level of COBOL source program as input, including VS COBOL II, COBOL for MVS & VM, and COBOL for OS/390 & VM programs that were previously compiled with the CMPR2 compiler option.

Chapter 4. Updating your processes so you can debug programs with Debug Tool

After you have completed the tasks in Chapter 3, “Planning your debug session,” on page 23, you can use the information you have collected to update the following processes:

- Your compilation and linking processes so that programs are compiled with the correct compiler options and suboptions and that the required files are saved (for example, the separate debug file).
- Your library or promotion processes so that files containing information that Debug Tool needs to debug your programs are available.
- Your libraries or security systems so that you have access to the files that Debug Tool needs to debug your programs. For example, if you have RACF security measures, you might need to update them so that Debug Tool can access the files it needs.

For more information about how to update these processes, see the following topics:

- “Update your compilation, assembly, and linking process”
- “Update your library and promotion process” on page 64
- “Make the modifications necessary to implement your preferred method of starting Debug Tool” on page 65

Update your compilation, assembly, and linking process

This topic describes the changes you must make to your compilation, assembly, and linking process to implement the choices you made in Chapter 3, “Planning your debug session,” on page 23. If you are familiar with managing JCL and with your site's compilation or assembly process, see “Compiling your program without using Debug Tool Utilities” for instructions on the specific changes you need to make. If your site uses Debug Tool Utilities to manage these processes, see “Compiling your program by using Debug Tool Utilities” on page 61 for instructions on how to use the **Program Preparation** option to update these processes.

Compiling your program without using Debug Tool Utilities

Create or modify JCL so that it includes all the statements you need to compile or assemble your programs, then properly link any libraries. The following list describes the changes you need to make:

- Specify the correct compiler options and suboptions that you chose from Table 5 on page 25.

  For each compiler, there might be additional updates you might need to make so that Debug Tool starts. The following list describes these updates:

  – If you are compiling an Enterprise PL/I program on an HFS file system, see “Compiling a Enterprise PL/I program on an HFS file system” on page 62.

  – If you are compiling a C program on an HFS file system, see “Compiling a C program on an HFS file system” on page 63.

  – If you are compiling a C program with c89 or c++, see “Compiling your C program with c89 or c++” on page 62.

  – If you are compiling a C++ program on an HFS file system, see “Compiling a C++ program on an HFS file system” on page 63.

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- Specify the statements to save the files that Debug Tool needs. Table 12 can help you identify which file you need to save for a particular compiler option. For example, if you are compiling a COBOL program with the SEPARATE suboption of the TEST compiler option, make sure you specify the DD statement with the name of the separate debug file.
- If you are using other Problem Determination Tools, review the topics in Appendix C, "Quick start guide for compiling and assembling programs for use with IBM Problem Determination Tools products," on page 425 that correspond to the compilers or assembler that you are using. Those topics contain instructions on other updates you must make to your compilation, assembler, and linking processes.
- If YES is specified for the EQAOPT MDBG command (which requires Debug Tool to search for a .dbg file in a .mdbg file)[5], verify that the .mdbg file is a non-temporary file and is available during the debug session. Ensure that the .mdbg file was created with captured source by using the -c option for the dbgld command or the CAPSRC option on the CDADBGLD utility.
- For LangX COBOL programs, write JCL that generates the EQALANGX file, as described in "Creating the EQALANGX file for LangX COBOL programs" on page 68.
- For assembler programs, write a SYSADATA DD statement that generates the EQALANGX files, as described in "Creating the EQALANGX file for an assembler program" on page 72.
- For DB2 programs, specify the correct DB2 preprocessor and coprocessor, as described in "Processing SQL statements" on page 75.

Table 12. Files that you need to save when compiling with a particular compiler option or suboption

Programming language	Compiler suboption or assembler option	File you need to save
COBOL		
	SEPARATE	separate debug file
	any other	listing file
	NOTEST	listing file containing pseudo-assembler code
LangX COBOL		
	"Compiling your OS/VS COBOL program" on page 67 "Compiling your VS COBOL II program" on page 68 "Compiling your Enterprise COBOL program" on page 68	EQALANGX
	any other	listing file containing pseudo-assembler code
PL/I		
	SEPARATE	separate debug file
	any other (pre-Enterprise PL/I)	listing file
	any other (Enterprise PL/I)	source file that was used as input to the compiler
	NOTEST	listing file containing pseudo-assembler code
C/C++		

5. In situations where you can specify environment variables, you can set the environment variable EQA_USE_MDBG to YES or NO, which overrides any setting (including the default setting) of the EQAOPTS MDBG command.

Table 12. Files that you need to save when compiling with a particular compiler option or suboption (continued)

Programming language	Compiler suboption or assembler option	File you need to save
	DEBUG(DWARF)	the .dbg file and source file If you are using an .mdbg file that stores the source file, then save that .mdbg file.
	TEST	source file that was used as input to the compiler
	NOTEST	listing file containing pseudo-assembler code
assembler		
	ADATA	EQALANGX
	no debug information saved	listing file containing pseudo-assembler code

After you complete this task, see “Update your library and promotion process” on page 64.

Compiling your program by using Debug Tool Utilities

Debug Tool Utilities provides several utilities than can help you compile your programs and start Debug Tool. The steps described in this topic apply to the following category of compilers and assemblers:

- Enterprise PL/I
- Enterprise COBOL
- C/C++
- Assembler

If you are using Debug Tool Utilities to prepare your program and start Debug Tool, read Appendix D, “Examples: Preparing programs and modifying setup files with Debug Tool Utilities,” on page 471, which describes how to prepare a sample program and start Debug Tool by using Debug Tool Utilities. After you read the sample and understand how to use Debug Tool Utilities, do the following steps:

1. Start Debug Tool Utilities.
2. Type in "1" to select Program Preparation, then press Enter.
3. Type in the number that corresponds to the compiler you want to use, then press Enter.
4. Type in the information about the program you are compiling and select the appropriate options for the CICS and DB2/SQL fields.

   If the program source is a sequential data set and the DB2 precompiler is selected, make sure the DBRMLIB data set field in panel EQAPPC1B, EQAPPC2B, EQAPPC3B, EQAPPC4B, or EQAPPC5B is a partitioned data set with a member name. For example, DEBUG.TEST.DBRMLIB(PROG1).

   Type in the backslash character ("/") in the **Enter / to edit options and data set name patterns** field, then press Enter.
5. Using the information you collected in Table 5 on page 25, fill out the fields with the appropriate values. After you have made all the changes you want to make, press PF3 to save this information and return to the previous panel.
6. Review the choices you made. Press Enter.
7. Verify your selections, then press Enter.

8. After the compilation is done, a panel is displayed. If there were errors in the compilation, review the messages and make any changes. Return to step 1 on page 61 to repeat the compilation.
9. Press PF3 until you return to the Program Preparation panel.
10. In the Program Preparation panel, type in "L", then press Enter.
11. In the Link Edit panel, specify whether you want the link edit to run in the foreground or background. Specify the name of other libraries you need to link to your program. After you are done making all your changes, press Enter.
12. Verify any selections, then press Enter.
13. After the link edit is done, if there were errors in the link edit, review the messages and make any changes. Return to step 1 on page 61 to repeat the process.
14. Press PF3 until you return to the main Debug Tool Utilities panel.

After you complete this task, see “Update your library and promotion process” on page 64.

Compiling a Enterprise PL/I program on an HFS file system

If you are compiling and launching Enterprise PL/I programs on an HFS file system, you must do one of the following:

- Compile and launch the programs from the same location, or
- specify the full path name when you compile the programs.

By default, the Enterprise PL/I compiler stores the relative path and file names in the object file. When you start a debug session, if the source is not in the same location as where the program is launched, Debug Tool does not locate the source. To avoid this problem, specify the full path name for the source when you compile the program. For example, if you execute the following series of commands, Debug Tool does not find the source because it is located in another directory (`/u/myid/mypgm`):

1. Change to the directory where your program resides and compile the program.

```
cd /u/myid/mypgm
pli -g "//TEST.LOAD(HELLO)" hello.pli
```

2. Exit UNIX System Services and return to the TSO READY prompt.
3. Launch the program with the `TEST` run-time option.

```
call TEST.LOAD(HELLO) 'test/'
```

Debug Tool does find the source if you change the compile command to:

```
pli -g "//TEST.LOAD(HELLO)" /u/myid/mypgm/hello.pli
```

The same restriction applies to programs that you compile to run in a CICS environment.

Compiling your C program with c89 or c++

If you build your application using the `c89` or `c++`, do the following steps:

1. Compile your source code as usual, but specify the `–g` option to generate debugging information. The `–g` option is equivalent to the `TEST` compiler option under TSO or MVS batch. For example, to compile the C source file `fred.c` from the `u/mike/app` directory, specify:

```
cd /u/mike/app
c89 –g –o "//PROJ.LOAD(FRED)" fred.c
```

Note: The quotation marks (") in the command line above are required.

2. Set up your TSO environment, as described in "Compiling your program without using Debug Tool Utilities" on page 59 or "Compiling your program by using Debug Tool Utilities" on page 61.
3. Debug the program under TSO by entering the following:

```
FRED TEST ENVAR('PWD=/u/mike/app') / asis
```

Note: The apostrophes (') in the command line above are required. `ENVAR('PWD=/u/mike/app')` sets the environment variable `PWD` to the path from where the source files were compiled. Debug Tool uses this information to determine from where it should read the source files.

If you are creating .mdbg files, capture the source files into the .mdbg file by specify the -c option with the dbgld command, or the CAPSRC option with the CDADBGLD utility. To learn how to use the dbgld command and the CDADBGLD utility, see *z/OS XL C/C++ User's Guide*. Debug Tool needs access to the .mdbg file to debug your program.

Compiling a C program on an HFS file system

If you are compiling and launching programs on an HFS file system, you must do one of the following:

- Compile and launch the programs from the same location.
- Specify the full path name when you compile the programs.

By default, the C compiler stores the relative path and file names of the source files in the object file. When you start a debug session, if the source is not in the same location as where the program is launched, Debug Tool does not find the source. To avoid this problem, specify the full path name of the source when you compile the program. For example, if you execute the following series of commands, Debug Tool does not find the source because it is located in another directory (`/u/myid/mypgm`):

1. Change to the directory where your program resides and compile the program.

```
cd /u/myid/mypgm
c89 -g -o "//TEST.LOAD(HELLO)" hello.c
```

2. Exit UNIX System Services and return to the TSO READY prompt.
3. Launch the program with the `TEST` run-time option.

```
call TEST.LOAD(HELLO) 'test/'
```

Debug Tool finds the source if you change the compile command to:

```
c89 -g -o "//TEST.LOAD(HELLO)" /u/myid/mypgm/hello.c
```

The same restriction applies to programs that you compile to run in a CICS environment.

If you are creating .mdbg files, capture the source files into the .mdbg file by specify the -c option with the dbgld command, or the CAPSRC option with the CDADBGLD utility. To learn how to use the dbgld command and the CDADBGLD utility, see *z/OS XL C/C++ User's Guide*. Debug Tool needs access to the .mdbg file to debug your program.

Compiling a C++ program on an HFS file system

If you are compiling and launching programs on an HFS file system, you must do one of the following:

- Compile and launch the programs from the same location, or
- specify the full path name when you compile the programs.

By default, the C++ compiler stores the relative path and file names of the source files in the object file. When you start a debug session, if the source is not in the same location as where the program is launched, Debug Tool does not locate the source. To avoid this problem, specify the full path name of the source when you compile the program. For example, if you execute the following series of commands, Debug Tool does not find the source because it is located in another directory (`/u/myid/mypgm`):

1. Change to the directory where your program resides and compile the program.
   ```
   cd /u/myid/mypgm
   c++ -g -o "//TEST.LOAD(HELLO)" hello.cpp
   ```
2. Exit UNIX System Services and return to the TSO READY prompt.
3. Launch the program with the `TEST` run-time option.
   ```
   call TEST.LOAD(HELLO) 'test/'
   ```

Debug Tool finds the source if you change the compile command to:

```
c++ -g -o "//TEST.LOAD(HELLO)" /u/myid/mypgm/hello.cpp
```

The same restriction applies to programs that you compile to run in a CICS environment.

If you are creating .mdbg files, capture the source files into the .mdbg file by specify the -c option with the dbgld command, or the CAPSRC option with the CDADBGLD utility. To learn how to use the dbgld command and the CDADBGLD utility, see *z/OS XL C/C++ User's Guide*. Debug Tool needs access to the .mdbg file to debug your program.

Update your library and promotion process

If you use a library to maintain your program and a promotion process to move programs through levels of quality and testing, you might have to update these processes to ensure that Debug Tool can find the files it needs to obtain information about your programs. For example, if your final production level does not have access to the same libraries as your development level, and you want to be able to debug programs that are in the final product level, you might need to update the environment in your final production level so that it can access to the following resources:

- All the data sets required to debug your program, for example, the source file, listing file, separate debug file, or EQALANGX file.
- Access to all the libraries required by your program or Debug Tool.

If you are using other Problem Determination Tools, review the topics in Appendix C, “Quick start guide for compiling and assembling programs for use with IBM Problem Determination Tools products,” on page 425 that correspond to the compilers or assembler that you are using. Those topics give instructions on which files to move through your levels so that the Problem Determination Tools can find the files they need.

If you manage your source code with a library system that requires you specify the `SUBSYS=`*`ssss`* parameter when you allocate a data set, you or your site need to specify the EQAOPTS `SUBSYS` command, which provides the value for *ssss*. You must do this for the following types of programs:

- Enterprise PL/I program that was compiled without the SEPARATE suboption of TEST compiler option
- C/C++ programs

This support is not available for CICS programs. To learn how to specify EQAOPTS commands, see the *Debug Tool Reference and Messages* or the *Debug Tool Customization Guide*.

Make the modifications necessary to implement your preferred method of starting Debug Tool

In this topic, you will use the information you gathered after completing 2 on page 23 and "Choosing a method or methods for starting Debug Tool" on page 53 to write the TEST runtime options string, then save that string in the appropriate location.

You might have to write several different TEST runtime options strings. For example, the TEST runtime options string that you write for your CICS programs might not be the same TEST runtime options string you can use for your IMS programs. For this situation, you might want to use Table 13 to record the string you want to use for each type of program you are debugging.

Table 13. Record the TEST runtime options strings you need for your site

	Test runtime options string (for example, TEST(ALL,,MFI %SYSTEM01.TRMLU001:))
TSO	
JES batch	
UNIX System Services	
CICS	
DB2	
DB2 stored procedures (PROGRAM TYPE=MAIN)	
DB2 stored procedures (PROGRAM TYPE=SUB)	
IMS TM	
IMS batch	
IMS BTS	

If you are not familiar with the format of the TEST runtime option string, see the following topics:

- Description of the TEST runtime option in *Debug Tool Reference and Messages*
- Chapter 12, "Writing the TEST run-time option string," on page 111

After you have written the TEST runtime option strings, you need to save them in the appropriate location. Using the information you recorded in Table 11 on page 54, review the following list, which directs you to the instructions on where and how to save the TEST runtime options strings:

Through the EQADBCXT, EQADICXT, EQADDCXT, or EQAD3CXT user exit routines
See Chapter 11, "Specifying the TEST runtime options through the Language Environment user exit," on page 101.

Through the DFSBXITA user exit routine
See "Setting up the DFSBXITA user exit routine" on page 98.

Using the CADP transaction
See "Creating and storing debugging profiles with CADP" on page 95.

Using the DTCN transaction
See "Creating and storing a DTCN profile" on page 84.

Using the DB2 catalog
See Chapter 8, "Preparing a DB2 stored procedures program," on page 79.

By coding a call to CEETEST, __ctest(), or PLITEST
See one of the following topics:

- "Starting Debug Tool with CEETEST" on page 121
- "Starting Debug Tool with the __ctest() function" on page 129
- "Starting Debug Tool with PLITEST" on page 128

Through CEEUOPT or CEEROPT
See one of the following topics:

- "Starting Debug Tool under CICS by using CEEUOPT" on page 143
- "Linking DB2 programs for debugging" on page 77
- "Starting Debug Tool under IMS by using CEEUOPT or CEEROPT" on page 97

Using the CEEOPTS DD statement in JCL or CEEOPTS allocation in TSO
Use the **JCL for Batch Debugging** option in Debug Tool Utilities.

Using the parms on the EXEC statement when you start your program
When you specify the EXEC statement, include the TEST runtime option as a parameter.

Use the parms on the RUN statement when you start your program
When you specify the RUN statement, include the TEST runtime option as a parameter.

Using the parms on the CALL statement when you start your program
See the example in "Starting Debug Tool" on page 12.

Through the EQASET transaction
See "Running the EQASET transaction for non-Language Environment IMS MPPs" on page 359.

Through the EQANMDBG program
See "Starting Debug Tool for programs that start outside of Language Environment" on page 137.

Chapter 5. Preparing a LangX COBOL program

This chapter describes how to prepare a LangX COBOL program that you can debug with Debug Tool.

The term *LangX COBOL* refers to any of the following programs:

- A program compiled with the IBM OS/VS COBOL compiler.
- A program compiled with the IBM VS COBOL II compiler with the `NOTEST` compiler option.
- A program compiled with the IBM Enterprise COBOL compiler with the `NOTEST` compiler option.

To prepare a LangX COBOL program, you must do the following steps:

1. Compile your program with the IBM OS/VS COBOL, the IBM VS COBOL II, or the IBM Enterprise COBOL compiler using the proper options.
2. Create the EQALANGX file.
3. Link-edit your program.

As you read through the information in this document, remember that OS/VS COBOL programs are non-Language Environment programs, even though you might have used Language Environment libraries to link and run your program.

VS COBOL II programs are non-Language Environment programs when you link them with the non-Language Environment library. VS COBOL II programs are Language Environment programs when you link them with the Language Environment library.

Enterprise COBOL programs are always Language Environment programs. Note that COBOL DLL's cannot be debugged as LangX COBOL programs.

Read the information regarding non-Language Environment programs for instructions on how to start Debug Tool and debug non-Language Environment COBOL programs, unless information specific to LangX COBOL is provided.

Compiling your OS/VS COBOL program

You must compile your OS/VS COBOL program with the IBM OS/VS COBOL compiler and use the following options:

- NOTEST
- SOURCE
- DMAP
- PMAP
- VERB
- XREF
- NOLST
- NOBATCH
- NOSYMDMP
- NOCOUNT

If you are using other Problem Determination Tools (for example, Application Performance Analyzer), you might need to specify additional compiler options. To

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understand how the Problem Determination Tools work together, see Appendix C, “Quick start guide for compiling and assembling programs for use with IBM Problem Determination Tools products,” on page 425. To learn which additional compiler options you might need to specify, see “OS/VS COBOL programs” on page 441.

Compiling your VS COBOL II program

You must compile your VS COBOL II program with the IBM VS COBOL II compiler and use the following options:

- NOTEST
- NOOPTIMIZE
- SOURCE
- MAP
- XREF
- LIST or OFFSET

If you are using other Problem Determination Tools (for example, Application Performance Analyzer), you might need to specify additional compiler options. To understand how the Problem Determination Tools work together, see Appendix C, “Quick start guide for compiling and assembling programs for use with IBM Problem Determination Tools products,” on page 425. To learn which additional compiler options you might need to specify, see “VS COBOL II programs” on page 438.

Compiling your Enterprise COBOL program

You must compile your Enterprise COBOL program with the IBM Enterprise COBOL compiler and use the following options:

- NOTEST
- NOOPTIMIZE
- SOURCE
- MAP
- XREF
- LIST

Creating the EQALANGX file for LangX COBOL programs

To create the EQALANGX file, you use the EQALANGX program. The EQALANGX program shipped as a component of Debug Tool is functionally equivalent to the IDILANGX program shipped as a component of IBM Fault Analyzer. If you have IBM Fault Analyzer installed, you can use the IDILANGX program to create the EQALANGX file, as long as the version of the IDILANGX program is the same as or newer than the EQALANGX program shipped with Debug Tool. To identify the version of the program, do the following steps:

1. Create the EQALANGX file as described in the IBM Fault Analyzer documentation.
2. Look at the first record of the generated EQALANGX file and make a note of the version.
3. Create the EQALANGX file as described in this section.
4. Look at the first record of the generated EQALANGX file.

If you choose to use IDILANGX to create the EQALANGX file, you can skip these instructions. See the IBM Fault Analyzer documentation for instructions on creating the EQALANGX file.

To create the EQALANGX file, do the following steps:

1. Create JCL similar to the following:

```
//XTRACT EXEC PGM=EQALANGX,REGION=32M,
// PARM='(COBOL ERROR LOUD'
//STEPLIB DD DISP=SHR,DSN=hlq.SEQAMOD
//LISTING DD DISP=SHR,DSN=yourid.langxcompiler.listing
//IDILANGX DD DISP=OLD,DSN=yourid.EQALANGX
```

   The following list describes the variables used in this example and the parameters you can use with the EQALANGX program:

   PARM=

   COBOL
   The COBOL parameter indicates that a LangX COBOL module is being processed.

   ERROR
   The ERROR parameter is suggested, but optional. If you specify it, additional information is displayed when an error is detected.

   LOUD
   The LOUD parameter is suggested, but optional. If you specify it, additional informational and statistical messages are displayed.

   64K CREF
   The 64K and CREF parameters are optional. Previously, these options were required.

   The messages displayed by specifying the ERROR and LOUD parameters are Write To Operator or Write To Programmer (WTO or WTP) messages. See the *IBM Fault Analyzer for z/OS User's Guide and Reference* for detailed information about the messages and return codes displayed by the IDILANGX program. The EQALANGX program uses the same messages and return codes.

   hlq.**SEQAMOD**
   The name of the data set containing the Debug Tool load modules. If the Debug Tool load modules are in a system linklib data set, you can omit the following line:

```
//STEPLIB DD DISP=SHR,DSN=hlq.SEQAMOD
```

   yourid.langxcompiler.listing
   The name of the listing data set generated by the IBM OS/VS COBOL, IBM VS COBOL II, or IBM Enterprise COBOL compiler. If this is a partitioned data set, the member name must be specified. For information about the characteristics of this data set, see *IBM OS/VS COBOL Compiler and Library Programmer's Guide*, *VS COBOL II Application Programming Guide for MVS and CMS*, or *Enterprise COBOL for z/OS Programming Guide*.

   yourid.**EQALANGX**
   The name of the data set where the EQALANGX debug file is to be placed. This data set must have variable block record format (RECFM=VB) and a logical record length of 1562 (LRECL=1562).

   Debug Tool searches for the EQALANGX debug file in a partitioned data set with the name *yourid*.EQALANGX and a member name that matches the

name of the program. If you want the member name of the EQALANGX debug file to match the name of the program, you do not need to specify a member name on the DD statement.

2. Submit the JCL and verify that the EQALANGX file is created in the location you specified on the IDILANGX DD statement.

Link-editing your program

You can link-edit your program by using your normal link-edit procedures.

After you link-edit your program, you can run your program and start Debug Tool.

Chapter 6. Preparing an assembler program

This chapter describes how to prepare an assembler program that you can debug with Debug Tool's full capabilities. To prepare an assembler program, you must do the following steps:

1. Assemble your program with the proper options.
2. Create the EQALANGX file.
3. Link-edit your program.

If you use Debug Tool Utilities to prepare your assembler program, you can do steps 1 and 2 in one step.

Before you assemble your program

When you debug an assembler program, you can use most of the Debug Tool commands. There are three differences between debugging an assembler program and debugging programs written in other programming languages supported by Debug Tool:

- After you assemble your program, you must create a debug information file, also called the EQALANGX file. Debug Tool uses this file to obtain information about your assembler program.
- Debug Tool assumes all compile units are written in some high-level language (HLL). You must inform Debug Tool that a compile unit is an assembler compile unit and instruct Debug Tool to load the assembler compile unit's debug information. Do this by entering the LOADDEBUGDATA (or LDD) command.
- Assembler does not have language elements you can use to write expressions. Debug Tool provides assembler-like language elements you can use to write expressions for Debug Tool commands that require an expression. See *Debug Tool Reference and Messages* for a description of the syntax of the assembler-like language.

After you verify that your assembler program meets these requirements, prepare your assembler program by doing the following tasks:

1. "Assembling your program."
2. "Creating the EQALANGX file for an assembler program" on page 72.

"Assembling your program and creating EQALANGX" on page 73 describes how to prepare an assembler program by using Debug Tool Utilities.

Assembling your program

If you assemble your program without using Debug Tool Utilities, you must use the High Level Assembler (HLASM) and specify a SYSADATA DD statement and the ADATA option. This causes the assembler to create a SYSADATA file. The SYSADATA file is required to generate the debug information (the EQALANGX file) used by Debug Tool.

If you are using other Problem Determination Tools, see "Assembler programs" on page 467 to make sure you specify all the assembler options you need to create the files needed by all the Problem Determination Tools.

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Creating the EQALANGX file for an assembler program

To create the EQALANGX file, you use the EQALANGX program. The EQALANGX program shipped as a component of Debug Tool is functionally equivalent to the IDILANGX program shipped as a component of IBM Fault Analyzer. If you have IBM Fault Analyzer installed, you can use the IDILANGX program to create the EQALANGX file, as long as the version of the IDILANGX program is the same as or newer than the EQALANGX program shipped with Debug Tool. To identify the version of the program, do the following steps:

1. Create the EQALANGX file as described in the IBM Fault Analyzer documentation.
2. Look at the first record of the generated EQALANGX file and make a note of the version.
3. Create the EQALANGX file as described in this section.
4. Look at the first record of the generated EQALANGX file.

If you choose to use IDILANGX to create the EQALANGX file, you can skip these instructions. See the IBM Fault Analyzer documentation for instructions on creating the EQALANGX file. To create the EQALANGX files without using Debug Tool Utilities, use JCL similar to the following:

```
//XTRACT EXEC PGM=EQALANGX,REGION=32M,
//  PARM='(ASM ERROR LOUD'
//STEPLIB DD DISP=SHR,DSN=hlq.SEQAMOD
//SYSADATA DD DISP=SHR,DSN=yourid.sysadata
//IDILANGX DD DISP=OLD,DSN=yourid.EQALANGX
```

The following list describes the variables used in this example the parameters you can use with the EQALANGX program:

PARM=

(ASM
Indicates that an assembler module is being processed.

ERROR
This parameter is suggested but optional. If you specify it, additional information is displayed when an error is detected.

LOUD
The LOUD parameter is suggested, but optional. If you specify it, additional informational and statistical messages are displayed.

The messages displayed by specifying the ERROR and LOUD parameters are Write To Operator or Write To Programmer (WTO or WTP) messages. See the *IBM Fault Analyzer for z/OS User's Guide and Reference* for detailed information about the messages and return codes displayed by the IDILANGX program. The EQALANGX program uses the same messages and return codes.

hlq.**SEQAMOD**
The name of the data set containing the Debug Tool load modules. If the Debug Tool load modules are in a system linklib data set, you can omit the following line:

```
//STEPLIB DD DISP=SHR,DSN=hlq.SEQAMOD
```

yourid.sysadata
The name of the data set containing the SYSADATA output from the assembler.

If this is a partitioned data set, the member name must be specified. For information about the characteristics of this data set, see *HLASM Programmer's Guide*.

yourid.**EQALANGX**
The name of the data set where the EQALANGX debug file is to be placed. This data set must have variable block record format (RECFM=VB) and a logical record length of 1562 (LRECL=1562).

Debug Tool searches for the EQALANGX debug file in a partitioned data set with the name *yourid*.EQALANGX and a member name that matches the name of the first CSECT in the assembly. If you want the member name of the EQALANGX debug file to match the first CSECT in the assembly, you do not need to specify a member name on the DD statement. Otherwise, you must specify a member name on the DD statement. In this case, you must use the SET SOURCE command to direct Debug Tool to the member containing the EQALANGX data.

Debug Tool does not support debugging of Private Code (unnamed CSECT). The EQALANGX will issue error messages if an unnamed CSECT is detected in your assembler program.

Assembling your program and creating EQALANGX

You can assemble your program and create the EQALANGX file at the same time by using Debug Tool Utilities. Do the following:

1. Start Debug Tool Utilities. The Debug Tool Utilities panel is displayed.
2. Select option 1, "Program Preparation" . The Debug Tool Program Preparation panel is displayed.
3. Select option 5, "Assemble". The Debug Tool Program Preparation - High Level Assembler panel is displayed. In this panel, specify the name of the source file and the assemble options that are used by High Level Assembler (HLASM) to assemble the program.

   If option 5 is not available, contact your system administrator.
4. Press Enter. The High Level Assembler - Verify Selections panel is displayed. Verify that the information on the panel is correct and then press Enter.
5. If any of the output data sets you specified do not existed, you are asked to verify the options used to create them.
6. If you specified that the processing be completed by batch, the JCL created to run the batch job is displayed. Verify that the JCL is correct, type Submit in the command line, press Enter and then press PF3.
7. After the processing is completed, the High Level Assembler - View Outputs panel is displayed. This panel displays the return code of each process completed and enables you to view, edit, or browse the input and output data sets.

To read more information about a field in any panel, place the cursor in the input field and press PF1. To read more information about a panel, place the cursor anywhere on the panel that is not an input field and press PF1.

After you assemble your program and create the EQALANGX file, you can link-edit your program.

Link-editing your program

You can link-edit your program by using your normal link-edit procedures or you can use Debug Tool Utilities by doing the following:

1. From the `Debug Tool Program Preparation` panel, select option L, "Link Edit". The `Debug Tool Program Preparation - Link Edit` panel is displayed. In this panel, specify the input data sets and link edit options that you need the linker to use.
2. Press Enter. The `Link Edit - Verify Selections` panel is displayed. Verify that the information on the panel is correct and then press Enter.
3. If any of the output data sets you specified do not exist, you are asked to verify the options used to create them. Press Enter after you verify the options.
4. If you specified that the processing be completed by batch, the JCL created to run the batch job is displayed. Verify that the JCL is correct and press PF3.
5. After the processing is completed, the `Link Edit - View Outputs` panel is displayed. This panel displays the return code of each process completed and enables you to view, edit, or browse the input and output data sets.

To read more information about a field in any panel, place the cursor in the input field and press PF1. To read more information about a panel, place the cursor anywhere on the panel that is not an input field and press PF1.

After you link-edit your program, you can run your program and start Debug Tool.

Restrictions for link-editing your assembler program

Debug Tool cannot find the EQALANGX member when you change the name with a CHANGE link statement. For example, the message “EQALANGX debug file cannot be found for PGM1TEST” is displayed when you use the following link statements:

```
CHANGE PGMTEST1(PGM1TEST)
INCLUDE LINKLIB(PGMTEST1)
```

Chapter 7. Preparing a DB2 program

You do not need to use any special coding techniques to debug DB2 programs with Debug Tool.

The following sections describe the tasks you need to do to prepare a DB2 program for debugging:

1. "Processing SQL statements."
2. "Linking DB2 programs for debugging" on page 77.
3. "Binding DB2 programs for debugging" on page 78.

Refer to the following topics for more information related to the material discussed in this topic.

Related references

DB2 UDB for z/OS Application Programming and SQL Guide

Processing SQL statements

You must run your program through the DB2 preprocessor or coprocessor, which processes SQL statements, either before or as part of the compilation. In this section, we describe how and when each compiler uses the DB2 preprocessor or coprocessor. Then you can choose the right method so that you can debug the program with Debug Tool.

- If you are preparing a COBOL program using a compiler earlier than Enterprise COBOL for z/OS and OS/390 Version 2 Release 2 , use the DB2 precompiler. Then compile your program as described in the appropriate section for your programming language.
- If you are preparing a COBOL program using Enterprise COBOL for z/OS and OS/390 Version 2 Release 2 or later, do one of the following tasks:
  - Use the DB2 precompiler. Then compile your program as described in the appropriate section for your programming language.
  - Use the SQL compiler option so that the SQL statements are processed by the DB2 coprocessor during compilation. Save the program listing if you compiled with the `NOSEPARATE` suboption of the `TEST` compiler option or the separate debug file if you compiled with the `SEPARATE` suboption of the `TEST` compiler option.
- If you are preparing a PL/I program using a compiler earlier than Enterprise PL/I for z/OS and OS/390 Version 3 Release 1, use the DB2 precompiler. Then compile your program as described in the appropriate section for your programming language.
- The following table describes your options for specific PL/I compilers.

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If you are using any of the following PL/I compilers:	Choose one of the following tasks:
• Enterprise PL/I for z/OS and OS/390 Version 3 Release 1 through Version 3 Release 4 • Enterprise PL/I for z/OS, Version 3.5 or later, and you do not specify the SEPARATE suboption of the TEST compiler option	• Use the DB2 precompiler. Save the program source files generated by the DB2 precompiler, which Debug Tool uses to debug your program. Then compile your program as described in the appropriate section for your programming language. • Use the PP(SQL:('*option*,...')) compiler option so that the SQL statements are processed by the DB2 coprocessor during compilation. Save the program source file that you used as input to the compiler.

- If you are preparing a program using Enterprise PL/I for z/OS, Version 3.5 or later, and you specify the SEPARATE suboption of the TEST compiler option, do one of the following tasks:
  - Use the DB2 precompiler. Compile the program source files generated by the DB2 precompiler with the appropriate compiler options, as described in “Choosing TEST or NOTEST compiler suboptions for PL/I programs” on page 32, select scenario B. Save the separate debug file created by the compiler.
  - Use the PP(SQL:('*option*,...')) compiler option so that the SQL statements are processed by the DB2 coprocessor during compilation. Save the separate debug file created by the compiler.
- If you are preparing a C or C++ program using a compiler earlier than C/C++ for z/OS Version 1 Release 5, use the DB2 precompiler. Save the program source files generated by the DB2 precompiler, which Debug Tool uses to debug your program. Then compile your program as described in the appropriate section for your programming language.
- If you are preparing a C or C++ program using C/C++ for z/OS Version 1 Release 5 or later, do one of the following tasks:
  - Use the DB2 precompiler. Save the program source files generated by the DB2 precompiler, which Debug Tool uses to debug your program. Then compile your program as described in the appropriate section for your programming language.
  - Specify the SQL compiler option so that the SQL statements are processed by the DB2 coprocessor during compilation. Save the program source file that you used as input to the compiler.
- If you are using an assembler program, first run your program through the DB2 precompiler, then assemble your program using the output of the DB2 precompiler. Generate a EQALANGX file from the assembler output and save the EQALANGX file.

Important: Ensure that your program source, separate debug file, or program listing is stored in a permanent data set that is available to Debug Tool.

To enhance the performance of Debug Tool, use a large block size when you save these files. If you are using COBOL or Enterprise PL/I separate debug files, it is important that you allocate these files with the correct attributes to optimize the performance of Debug Tool. Use the following attributes for the PDS that contains the COBOL or PL/I separate debug file:

- RECFM=FB

- LRECL=1024
- BLKSIZE set so the system determines the optimal size

Refer to the following topics for more information related to the material discussed in this topic.

Related references

DB2 UDB for OS/390 Application Programming and SQL Guide

Linking DB2 programs for debugging

To debug DB2 programs, you must link the output from the compiler into your program load library. You can include the user runtime options module, CEEUOPT, by doing the following:

1. Find the user runtime options program CEEUOPT in the Language Environment SCEESAMP library.
2. Change the NOTEST parameter into the desired TEST parameter. For example:

   ```
   old:  NOTEST=(ALL,*,PROMPT,INSPPREF),
   new:  TEST=(,*,:,*),
   ```

   If you are using remote debug mode, specify the TCPIP suboption, as in the following example:

   ```
   TEST=(,,,TCPIP&&9.24.104.79%8001:*)
   ```

   Note: Double ampersand is required.

   If you are using full-screen mode using a dedicated terminal without Terminal Interface Manager, specify the MFI suboption with a VTAM® LU name, as in the following example:

   ```
   Test=(,,,MFI%TRMLU001)
   ```

   If you are using full-screen mode using the Terminal Interface Manager, specify the VTAM suboption with your user ID, as in the following example:

   ```
   Test=(,,,VTAM%USERABCD)
   ```
3. Assemble the CEEUOPT program and keep the object code.
4. Link-edit the CEEUOPT object code with any program to start Debug Tool.

The modified assembler program, CEEUOPT, is shown below.

```
*/****************************************************************/
*/* LICENSED MATERIALS - PROPERTY OF IBM                         */
*/*                                                              */
*/* 5694-A01                                                     */
*/*                                                              */
*/* (C) COPYRIGHT IBM CORP. 1991, 2001                           */
*/*                                                              */
*/* US GOVERNMENT USERS RESTRICTED RIGHTS - USE,                 */
*/* DUPLICATION OR DISCLOSURE RESTRICTED BY GSA ADP              */
*/* SCHEDULE CONTRACT WITH IBM CORP.                             */
*/*                                                              */
*/* STATUS = HLE7705                                             */
*/****************************************************************/
CEEUOPT  CSECT
CEEUOPT  AMODE ANY
CEEUOPT  RMODE ANY
         CEEXOPT TEST=(,*,:,*)
         END
```

The user runtime options program can be assembled with predefined TEST runtime options to establish defaults for one or more applications. Link-editing an application with this program results in the default options when that application is started.

If your system programmer has not already done so, include all the proper libraries in the SYSLIB concatenation. For example, the ISPLOAD library for ISPLINK calls, and the DB2 DSNLOAD library for the DB2 interface modules (DSN*xxxx*).

Refer to the following topics for more information related to the material discussed in this topic.

Related tasks

Chapter 14, “Starting Debug Tool from a program,” on page 121

Binding DB2 programs for debugging

Before you can run your DB2 program, you must run a DB2 bind in order to bind your program with the relevant DBRM output from the precompiler step. No special requirements are needed for Debug Tool.

Chapter 8. Preparing a DB2 stored procedures program

This topic describes the information you need to collect and the steps you must take to prepare a DB2 stored procedure for debugging with Debug Tool. Debug Tool can debug stored procedures where PROGRAM TYPE is MAIN or SUB; the preparation steps are the same.

Before you begin, verify that you can use the supported debugging modes. Debug Tool can debug stored procedures written in assembler, C, C++, COBOL and Enterprise PL/I in any of the following debugging modes:

- remote debug
- full-screen mode using the Terminal Interface Manager
- batch

Review the topic “Creating a stored procedure” in the *DB2 Application Programming and SQL Guide* to verify that your stored procedure complies with the format and restrictions for external stored procedures. Debug Tool supports debugging only external stored procedures.

To prepare a DB2 stored procedure, do the following steps:

1. Verify that your DB2 system administrator has completed the tasks described in section "Preparing your environment to debug a DB2 stored procedures" of *Debug Tool Customization Guide*. The DB2 system administrator must define the address space where the stored procedure runs, give DB2 programs the appropriate RACF read authorizations, and recycle the address space so that the updates take effect.
2. If you are not familiar with the parameters used to create the DB2 stored procedure you want to debug, you can enter the SELECT statement, as illustrated in the following example, to obtain this information:

   ```
   SELECT PROGRAM_TYPE,STAYRESIDENT,RUNOPTS,LANGUAGE
      FROM SYSIBM.SYSROUTINES
      WHERE NAME='name_of_DB2_stored_procedure';
   ```

3. For stored procedures of program type SUB that are *not* invoked by the `call_sub` function, verify that when your system programmer or DB2 system administrator defines the WLM address space, the value for NUMTCB is set to 1. NUMTCB specifies the maximum number of Task Control Blocks (TCBs) that can run concurrently in a WLM address space. If the stored procedure might run in a TCB other than the one it was started in, you will not able to debug that stored procedure. Setting the value of NUMTCB to 1 ensures that the stored procedure is not run in a different TCB.
4. When you define your stored procedure, verify the following items:
   - Specify the correct value for the LANGUAGE parameter and the PROGRAM TYPE parameter. For C, C++, COBOL or Enterprise PL/I, the PROGRAM TYPE can be either MAIN or SUB. For assembler, the PROGRAM TYPE must be MAIN.
   - For stored procedures of program type SUB that are *not* invoked by the `call_sub` function, determine if other users might run the stored procedure while you are debugging it. If other users might run the stored procedure, you can not debug it.
   - For stored procedures of program type SUB that *are* invoked by the `call_sub` function, review the following options:

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- If you plan to specify the TEST runtime options through the Language Environment EQADDCXT exit routine, specify STAY RESIDENT NO.
- If you plan to specify the TEST runtime options through the DB2 catalog, you can specify either YES or NO for STAY RESIDENT.

5. Compile or assemble your program, as described in Part 2, “Preparing your program for debugging,” on page 21. For Enterprise PL/I programs, also specify the RENT compiler option.
6. Review the following list to determine how to specify the TEST runtime options:
   - For stored procedures of program type MAIN, you can specify the TEST runtime option either through the Language Environment EQADDCXT or EQAD3CXT exit routine, or through the DB2 catalog. If you use both methods, the Language Environment EQADDCXT or EQAD3CXT exit routine take precedence over the DB2 catalog.
   - For stored procedures of program type SUB that *are* invoked by the call_sub function, you can specify the TEST runtime option either through the Language Environment EQADDCXT exit routine or through the DB2 catalog. If you choose to use the Language Environment EQADDCXT exit routine, you must specify the NOTEST runtime option for the RUN OPTIONS parameter when you define the stored procedure.
   - For stored procedures of program type SUB that are *not* invoked by the call_sub function, you can specify the TEST runtime option through the DB2 catalog or from within a program by coding a call to CEETEST, __ctest(), or PLITEST.
7. To specify the TEST runtime options through the Language Environment EQADDCXT or EQAD3CXT exit routine, prepare a copy of the EQADDCXT or EQAD3CXT user exit as described in Chapter 11, “Specifying the TEST runtime options through the Language Environment user exit,” on page 101.

   Remember that if you want to debug an *existing* stored procedure of program type SUB that is invoked by the call_sub function, you must modify the stored procedure so that it uses the NOTEST runtime option for the RUN OPTIONS parameter. The following example shows how to use the ALTER PROCEDURE statement to make this modification:

   ```
   ALTER PROCEDURE name_of_DB2_stored_procedure RUN OPTIONS 'NOTEST';
   ```

8. To specify the TEST runtime options through the DB2 catalog, do the following steps:
   a. If you have not created the stored procedure, write the stored procedure using the CREATE PROCEDURE statement. You can use the following example as a guide:

      ```
      CREATE PROCEDURE SPROC1
         LANGUAGE COBOL
         EXTERNAL NAME SPROC1
         PARAMETER STYLE GENERAL
         WLM ENVIRONMENT WLMENV1
         RUN OPTIONS 'TEST(,,,TCPIP&9.112.27.99%8001:*)'
         PROGRAM TYPE SUB;
      ```

      This example creates a stored procedure for a COBOL program called SPROC1, the program type is SUB, it runs in a WLM address space called WLMENV1, and it is debugged in remote debug mode.

   b. If you need to modify an existing stored procedure, use the ALTER PROCEDURE statement. You can use the following example as a guide:

      The IP address for the remote debugger changed from 9.112.27.99 to 9.112.27.21. To modify the stored procedure, enter the following statement:

```
ALTER PROCEDURE name_of_DB2_stored_procedure
   RUN OPTIONS 'TEST(,,,TCPIP&9.112.27.21%8001:*)';
```

c. Verify that the stored procedure is defined correctly by entering the SELECT statement. For example, you can enter the following SELECT statement:

```
SELECT * FROM SYSIBM.SYSROUTINES;
```

Chapter 9. Preparing a CICS program

To prepare a CICS program for debugging, you must do the following tasks:

1. Complete the program preparation tasks for COBOL, PL/I, C, C++, assembler, or LangX COBOL, as described in the following sections:
   "Choosing TEST or NOTEST compiler suboptions for COBOL programs" on page 27
   "Choosing TEST or NOTEST compiler suboptions for PL/I programs" on page 32
   "Choosing TEST or DEBUG compiler suboptions for C programs" on page 37
   "Choosing TEST or DEBUG compiler suboptions for C++ programs" on page 42
   Chapter 6, "Preparing an assembler program," on page 71
   Chapter 5, "Preparing a LangX COBOL program," on page 67
2. Determine if your site uses CADP or DTCN debugging profiles and verify that your system has been configured to use the chosen debugging profile.
3. Determine if you need to link edit EQADCCXT into your program by reviewing the instructions in "Link-editing EQADCCXT into your program."
4. Do one of the following tasks:
   - If your site is using DTCN debugging profiles, create and store a DTCN debugging profile. Instructions for creating a DTCN debugging profile are in "Creating and storing a DTCN profile" on page 84.
   - If you are using CICS Transaction Server for z/OS Version 2 Release 3 or later and your site uses CADP to manage debugging profiles, create and store a CADP debugging profile. See "Creating and storing debugging profiles with CADP" on page 95 for more information about using CADP.

Link-editing EQADCCXT into your program

Debug Tool provides an Language Environment CEEBXITA assembler exit called EQADCCXT to help you activate, by using the DTCN transaction, a debugging session under CICS. You do not need to use this exit if you are running any of the following options:

- You are running under CICS Transaction Server for z/OS Version 2 Release 3 or later and you use the CADP transaction to define debug profiles.
- You are using the DTCN transaction and you are debugging non-Language Environment Assembler programs.
- You are using the DTCN transaction and you are debugging COBOL programs, or PL/I programs in the following situation:
  - Compiled with Enterprise PL/I for z/OS, Version 3 Release 4 with the PTF for APAR PK03264 applied, or later
  - Running with Language Environment Version 1 Release 6 with the PTF for APAR PK03093 applied, or later

When you use EQADCCXT, be aware of the following conditions:

- If your site does not use an Language Environment assembler exit (CEEBXITA), then link-edit member EQADCCXT, which contains the CSECT CEEBXITA and is in library *hlq*.SEQAMOD, into your main program.

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- If your site uses an existing CEEBXITA, the EQADCCXT exit provided by Debug Tool must be merged with it. The source for EQADCCXT is in *hlq*.SEQASAMP(EQADCCXT). Link the merged exit into your main program.

After you link-edit your program, use the DTCN transaction to create a profile that specifies the combination of resources that you want to debug. See "Creating and storing a DTCN profile."

Creating and storing a DTCN profile

You can create and store DTCN profiles in the following manner:

- By using the DTCN transaction. The rest of the information in these topics describe how to do this.
- By using the sample Eclipse plug-in. To learn how to download, install, and use this sample plug-in, see "Running a sample plug-in that uses the API" in the *Debug Tool API User's Guide and Reference*.

The DTCN transaction stores debugging profiles in a repository. The repository can be either a CICS temporary storage queue or a VSAM file. The following list describes the differences between using a CICS temporary storage queue or a VSAM file:

- If you don't log on to CICS or you log on as the default user, you cannot use a VSAM file. You must use a CICS temporary storage queue.
- If you use a CICS temporary storage queue, the profile will be deleted if the terminal that created the profile has been disconnected or the CICS region is terminated. If you use a VSAM file, the profile will persist through disconnections or CICS region restarts.
- If you use a CICS temporary storage queue, there can be only one profile on a single terminal. If you use a VSAM file, there can be multiple profiles, each created by a different user, on a single terminal.

Debug Tool determines which storage method is used based on the presence of a debugging profile VSAM file. If Debug Tool finds a debugging profile VSAM file allocated to the CICS region, it assumes you are using a VSAM file as the repository. If it doesn't find a debugging profile VSAM file, it assumes you are using a CICS temporary storage queue as the repository. See the *Debug Tool Customization Guide* or contact your system programmer for more information about how the VSAM files are created and managed.

If the repository is a temporary storage queue, each profile is retained in the repository until one of the following events occurs:

- The profile is explicitly deleted by the terminal that entered it.
- DTCN detects that the terminal which created the profile has been disconnected.
- The CICS region is terminated.

If the repository is a VSAM file, each profile is retained until it is explicitly deleted. The DTCN transaction uses the user ID to identify a profile. Therefore, each user ID can have only one profile stored in the VSAM file.

Profiles are either active or inactive. If a profile is active, DTCN tries to match it with a transaction that uses the resources specified in the profile. DTCN does not try to match a transaction with an inactive profile. To make a profile active or inactive, use the **Debug Tool CICS Control - Primary Menu** panel (the main DTCN panel) to

make the profile active or inactive, then save it. If the repository is a VSAM file, when DTCN detects that the terminal is disconnected, it makes the profile inactive.

To create and store a DTCN profile:

1. Log on to a CICS terminal and enter the transaction ID **DTCN**. The DTCN transaction displays the main DTCN screen, Debug Tool CICS Control - Primary Menu, shown below.

```
DTCN              Debug Tool CICS Control - Primary Menu            S07CICPD
                         * VSAM storage method *   1
Select the combination of resources to debug (see Help for more information)
 Terminal Id     ==> 0090
 Transaction Id  ==>
 LoadMod::>CU(s) ==>          ::>               ==>          ::>
                 ==>          ::>               ==>          ::>
                 ==>          ::>               ==>          ::>
                 ==>          ::>               ==>          ::>
 User Id         ==> CICSUSER
 NetName         ==>
 IP Name/Address ==>
Select type and ID of debug display device
 Session Type    ==> MFI                 MFI, TCP
 Port Number     ==>                     TCP Port
 Display Id      ==> 0090

Generated String:  TEST(ALL,'*',PROMPT,'MFI%0090:*')

Repository String: No string currently saved in repository

Profile Status:    No Profile Saved. Press PF4 to save current settings.

PF1=HELP 2=GHELP 3=EXIT 4=SAVE 5=ACT/INACT 6=DEL 7=SHOW 8=ADV 9=OPT 10=CUR TRM
```

   Line **1** displays a message to indicate that DTCN will store the profile in a temporary storage queue or in a VSAM file. Some of the entry fields are filled in with values from one of the following sources:

   - If the temporary storage queue is the type of repository, the fields are filled in with default values that start Debug Tool, in full-screen mode, for tasks running on this terminal.
   - If a VSAM file is the type of repository and a profile exists for the current user, the fields are filled in with data found in that profile. If a VSAM file is the type of repository and a profile does not exist for the current user, the fields are filled in with default values that start Debug Tool, in full-screen mode, for tasks running on this terminal.

   If you do not want to change these fields, you can skip the next two steps and proceed to step 4 on page 86. If you want to change the settings on this panel, continue to the next step.
2. Specify the combination of resources that identify the transaction or program that you want to debug. For more information about these fields, do one of the following tasks:
   - Read “Description of fields on the DTCN Primary Menu screen” on page 88.
   - Place the cursor next to the field and press PF1 to display the online help.
3. Specify the type of debugging session you want to run and the ID of the device that displays the debugging session. For more information about these fields, do one of the following tasks:
   - Read “Description of fields on the DTCN Primary Menu screen” on page 88.
   - Place the cursor next to the field and press PF1 to display the online help.

4. Specify the TEST runtime options, other runtime options, commands file, preferences file, and EQAOPTS file that you want to use for the debugging session by pressing PF9 to display the secondary options menu, which looks like the following example:

```
DTCN              Debug Tool CICS Control - Menu 2              S07CICPD

Select Debug Tool options
Test Option     ==> TEST               Test/Notest
Test Level      ==> ALL                All/Error/None
Commands File   ==> *
Prompt Level    ==> PROMPT
Preference File ==> *

EQAOPTS File    ==>

Any other valid Language Environment options
==>



PF1=HELP 2=GHELP 3=RETURN
```

   Some of the entry fields are filled in with default values that start Debug Tool, in full-screen mode, for tasks running on this terminal. If you do not want to change the defaults, you can skip the rest of this step and proceed to step 5. If you want to change the settings on this panel, continue with this step.
5. Press PF3 to return to the main DTCN panel.
6. If you want to use data passed through COMMAREA or containers to help identify transactions and programs that you want to debug, press PF8. The **Advanced Options** panel is displayed, which looks like the following example:

```
DTCN              Debug Tool CICS Control - Advanced Options         S07CICPD

Select advanced program interruption criteria:

Commarea Offset  ==> 0
Commarea Data    ==>

Container Name   ==>
Container Offset ==> 0
Container Data   ==>

URM Debugging    ==> NO







Default offset and data representation is decimal/character.
See Help for more information.



PF1=HELP 2=GHELP 3=RETURN
```

   You can specify data in the COMMAREA or containers, but not both. You can also use this panel to indicate whether you want to debug user replaceable modules (URMs). For more information about these fields, do one of the following tasks:
   - Read “Description of fields on the DTCN Primary Menu screen” on page 88.
   - Place the cursor next to the field and press PF1 to display the online help.
7. Press PF3 to return to the main DTCN panel.

8. Press PF4 to save the profile. DTCN performs data verification on the data that you entered in the DTCN panel. When DTCN discovers an error, it places the cursor in the erroneous field and displays a message. You can use context-sensitive help (PF1) to find what is wrong with the input.
9. Press PF5 to change the status from active to inactive, or from inactive to active. A profile has three possible states:

   No profile saved
   A profile has not yet been created for this terminal.

   Active The profile is active for pattern matching.

   Inactive
   Pattern matching is skipped for this profile.
10. After you save the profile in the repository, DTCN shows the saved TEST string in the display field Repository String. If you are satisfied with the saved profile, press PF3 to exit DTCN.

Now, any tasks that run in the CICS system and match the resources that you specified in the previous steps will start Debug Tool.

Refer to the following topics for more information related to the material discussed in this topic.

Related tasks
"Displaying a list of active DTCN profiles and managing DTCN profiles"

Related references
"Description of fields on the DTCN Primary Menu screen" on page 88
Description of the DTCD transaction in *Debug Tool Customization Guide*

Displaying a list of active DTCN profiles and managing DTCN profiles

To display all of the active DTCN profiles in the CICS region, do the following steps:

1. If you have not started the DTCN transaction, Log on to a CICS terminal and enter the transaction ID **DTCN**. The DTCN transaction displays the main DTCN screen, Debug Tool CICS Control - Primary Menu.
2. Press PF7. The Debug Tool CICS Control - All Sessions screen displays, shown below.

```
 DTCN              Debug Tool CICS Control - All Sessions             S07CICPD

Overtype "_" with "D" to delete, "A" to activate, "I" to inactivate a profile.

  Owner    Sta Term Tran   User Id    NetName  Applid   Display Id
_ 0090     ACT 0090 TRN1   USER1      0072     S07CICPD 0090

           LoadMod::>CU(s) CIC9060  ::> CS9060          CBLAC?3  ::> *9361
                           ________ ::> ________        ________ ::> ________
                           ________ ::> ________        ________ ::> ________
                           ________ ::> ________        ________ ::> ________
           IP Name/Addr    ____________________________________________________
```

The column titles are defined below:

Owner
The ID of the terminal that created the profile by using DTCN.

Sta Indicates if the profile is active (`ACT`) or inactive (`INA`).

Term The value that was entered on the main DTCN screen in the **Terminal Id** field.

Tran The value that was entered on the main DTCN screen in the **Transaction Id** field.

User Id
The value that was entered on the main DTCN screen in the **User Id** field.

Netname
The value the entered on the main DTCN screen in the **Netname** field.

Applid
The application identifier associated with this profile.

Display Id
Identifies the target destination for Debug Tool information.

LoadMod(s)
The values that were entered on the main DTCN screen in the **LoadMod(s)** field.

CU(s) The values that were entered on the main DTCN screen in the **CU(s)** field.

IP Name/Addr
The value that was entered on the main DTCN screen in the **IP Name/Address** field.

DTCN also reads the Language Environment `NOTEST` option supplied to the CICS region in CEECOPT or CEEROPT. You can supply suboptions, such as the name of a preferences file, with the `NOTEST` option to supply additional defaults to DTCN.

3. To delete a profile, move your cursor to the underscore character (_) that is next to the profile you want to delete. Type in "D" and then press Enter.
4. To make a profile inactive, move your cursor to the underscore character (_) that is next to the profile you want to make inactive. Type in "I" and then press Enter.
5. To make a profile active, move your cursor to the underscore character (_) that is next to the profile you want to make active. Type in "A" and then press Enter.
6. To leave this panel and return to the DTCN primary menu, press PF3.

Refer to the following topics for more information related to the material discussed in this topic.

Related tasks
“Creating and storing a DTCN profile” on page 84

Description of fields on the DTCN Primary Menu screen

This topic describes the fields that are displayed on the DTCN Primary Menu screen.

The following list describes the resources you can specify to help identify the program or transaction that you want to debug:

Terminal Id
Specify the CICS terminal identifier associated with the transaction you want to debug. By default, DTCN sets the ID by one of the following rules:

- If the type of repository is a VSAM file and the current user ID has a saved profile, DTCN fills in the field with the terminal ID that is in the repository. You can change the terminal ID to the ID of the terminal you are currently running on, by placing your cursor on the terminal ID field and then pressing PF10. Press PF4 to save the profile with this new value.
- If the type of repository is a VSAM file and the current user ID does not have a saved profile, the terminal ID field is filled in with the ID of the terminal you are currently running on.
- If the type of repository is a temporary storage queue, the terminal ID field is filled in with the ID of the terminal you are currently running on.
- If the CICS transaction or program that you want to debug is not associated with a specific terminal (for example, the request to start a debug session comes from a browser), make this field blank.

If YES is specified for the EQAOPTS `DTCNFORCETERMID` command, you must specify a terminal identifier. To learn about the EQAOPTS `DTCNFORCETERMID` command, see the topic "EQAOPTS commands" in the *Debug Tool Customization Guide* or *Debug Tool Reference and Messages*.

Transaction Id

Specify the CICS transaction to debug. If you specify a transaction ID without any other resource, Debug Tool is started **every** time any of the following situations occurs:

- You run the transaction.
- The first program run by the transaction is started.
- Any other user runs the transaction.
- Any enabled DFH* module is the first program run by the transaction.

To start Debug Tool at the desired program that the transaction runs, specify the program name in the Program Id(s) field.

If YES is specified for the EQAOPTS `DTCNFORCETRANID` command, you must specify a transaction ID. To learn about the EQAOPTS `DTCNFORCETRANID` command, see the topic "EQAOPTS commands" in the *Debug Tool Customization Guide* or *Debug Tool Reference and Messages*.

LoadMod::>CU(s)

Specify the resource pair or pairs, consisting of a load module name and a compile unit (CU) name that you want to debug. Type in the load module name after the **==>** and the corresponding CU name after the **::>**. You can specify any of the following names:

LoadMod

The name of a load module that you want to debug. The load module must comply with the following requirements:

- For Debug Tool initialization, the load module can be any CICS load module if it is invoked as an Language Environment enclave or over a CICS Link Level. This includes the following types of load modules:
  - The initial load module in a transaction.
  - A load module invoked by CICS LINK or XCTL.
- Any non-Language Environment assembler load module which is loaded through an `EXEC CICS LOAD` command.

CU The name of the compile unit (CU) that you want to debug. The CU must comply with the following requirements:

- Any CICS CU if it is invoked as an Language Environment enclave or over a CICS Link Level. This includes the following types of CUs:
  - The initial CU in a transaction
  - A CU invoked by CICS LINK or XCTL
- Any COBOL CU, even if it is a nested CU or a subprogram within a composite load module, invoked by a static or dynamic CALL.
- Any Enterprise PL/I for z/OS Version 3 Release 4 CU (with the PTF for APAR PK03264 applied), or later, running with Language Environment Version 1 Release 6 (with the PTF for APAR PK03093 applied), or later, even if it is a nested CU or a subprogram within a composite load module, invoked as a static or dynamic CALL.
- Any non-Language Environment assembler CU which is loaded through an `EXEC CICS LOAD` command.

Usage Notes:

- If you specify a LoadMod and leave the corresponding CU field blank, the CU field defaults to an asterisk (*).
- If you specify a CU and leave the corresponding LoadMod field blank, the LoadMod field defaults to an asterisk (*).
- If you leave all LoadMod and CU fields blank and you set the Prompt Level on the “Debug Tool CICS Control - Menu 2” to PROMPT, Debug Tool initializes for the first program invoked.
- If you migrate from a version of Debug Tool prior to Version 10.1, you can obtain the same behavior produced by the **DTCN Program Id** resource by using the **LoadMod::>CU** resource pair and specifying only the CU resource. The LoadMod resource defaults to an asterisk (*).
- You can specify wildcard characters (*) and (?).
- If Debug Tool was started by another program before the `EXEC CICS LOAD` command that starts this non-Language Environment assembler program, you need to enter one of the following commands so that Debug Tool gains control of this program:
  - `LDD`
  - `SET ASSEMBLER ON`
  - `SET DISASSEMBLY ON`
- When you specify a CU for C/C++ and Enterprise PL/I programs (languages that use a fully qualified data set name as the compile unit name), you must specify the correct part of the compile unit name in the CU field. Use the following rules to determine which part of the compile unit name you need to specify:
  - If you are using a PDS or PDSE, you must specify the member name. For example, if the compile unit names are DEV1.TEST.ENTPLI.SOURCE(ABC) and DEV1.TEST.C.SOURCE(XYZ), you must specify ABC and XYZ in the program ID field.
  - If you are using a sequential data set, specify one of the following:
    - The last qualifier of the sequential data set. For example, if the compile unit names are DEV1.TEST.ENTPLI.SOURCE.ABC and DEV1.TEST.C.SOURCE.XYZ, you must specify ABC and XYZ in the program ID field.

- Wildcards. For example, if the compile unit names are DEV1.TEST.ENTPLI.ABC.SOURCE and DEV1.TEST.C.XYZ.SOURCE, you must specify *ABC* and *XYZ* in the program ID field.

– If you compiled your PL/I program with the following compiler and it is running in the following environment, you need to use the package name or the main procedure name:
  - Enterprise PL/I for z/OS, Version 3.5, with the PTFs for APARs PK35230 and PK35489 applied, or Enterprise PL/I for z/OS, Version 3.6 or later
  - Language Environment, Version 1.6 through 1.8 with the PTF for APAR PK33738 applied, or later

- Specifying a CICS program in the LoadMod::>CU field is similar to setting a breakpoint by using the `AT ENTRY` command and Debug Tool stops each time you enter LoadMod::>CU.
- If Debug Tool is already running and it cannot find the separate debug file, then Debug Tool does not stop at the CICS program specified in the LoadMod::>CU field. Use the `AT APPEARANCE` or `AT ENTRY` command to stop at this CICS program.
- If YES is specified for the EQAOPTS `DTCNFORCELOADMODID` command, you must specify a value for the LoadMod field. To learn about the EQAOPTS `DTCNFORCELOADMODID` command, see the topic "EQAOPTS commands" in the *Debug Tool Customization Guide* or *Debug Tool Reference and Messages*.
- If YES is specified for the EQAOPTS `DTCNFORCEPROGID` or `DTCNFORCECUID` commands, you must specify a value for the CU field. To learn about the EQAOPTS `DTCNFORCEPROGID` or `DTCNFORCECUID` commands, see the topic "EQAOPTS commands" in the *Debug Tool Customization Guide* or *Debug Tool Reference and Messages*.

User Id

Specify the user identifier associated with the transaction you want to debug. The following list can help you decide what to enter in this field:

- If the user identifier is the same one that is currently running DTCN, use the default user identifier.
- If the user identifier is different than the one currently running DTCN and you know the user identifier, enter that user identifier.
- If you do not know the user identifier or the transaction is not associated with a user identifier, specify the wild character or blanks.

If YES is specified for the EQAOPTS `DTCNFORCEUSERID` command, you must specify a user identifier. To learn about the EQAOPTS `DTCNFORCEUSERID` command, see the topic "EQAOPTS commands" in the *Debug Tool Customization Guide* or *Debug Tool Reference and Messages*.

NetName

Specify the four character name of a CICS terminal or a CICS system that you want to use to run your debugging session. This name is used by VTAM to identify the CICS terminal or system.

If YES is specified for the EQAOPTS `DTCNFORCENETNAME` command, you must specify a value for the **NetName** field. To learn about the EQAOPTS `DTCNFORCENETNAME` command, see the topic "EQAOPTS commands" in the *Debug Tool Customization Guide* or *Debug Tool Reference and Messages*.

IP Name/Address

The client IP name or IP address that is associated with a CICS application. All IP names are treated as upper case. Wildcards (* and ?) are permitted. Debug Tool is invoked for every task that is started for that client.

If YES is specified for the EQAOPTS `DTCNFORCEIP` command, you must specify an IP address. To learn about the EQAOPTS `DTCNFORCEIP` command, see the topic "EQAOPTS commands" in the *Debug Tool Customization Guide* or *Debug Tool Reference and Messages*.

The following list describes the fields that you can use to indicate which type of debugging session you want to run.

Session Type

Select one of the following options:

MFI Indicates that Debug Tool initializes on a 3270 type of terminal.

TCP Indicates that you want to interact with Debug Tool from your workstation using TCP/IP and a remote debugger.

Port Number

Specifies the TCP/IP port number that is listening for debug sessions on your workstation. By default, the following products use port 8001:

- WebSphere Developer Debugger for zSeries
- Compiled Language Debugger component of WebSphere Developer for zSeries

Display Id

Identifies the target destination for Debug Tool.

If you entered **TCP** in the **Session Type** field, determine the IP address or host name of the workstation that is running the remote debugger. Change the value in the **Display Id** field by doing the following steps:

1. Place your cursor on the **Display Id** field
2. Type in the IP address or host name of the workstation that is running the remote debugger
3. To save the profile with this new value, press PF4.

If you entered **MFI** in the **Session Type** field, DTCN fills in the **Display Id** field according to the following rules:

- If the type of repository is a VSAM file and the current user ID has a saved profile, DTCN fills in the field with the display ID that is in the repository.
- If the type of repository is a VSAM file and the current user ID does not have a saved profile, DTCN fills in the field with the ID of the terminal you are currently running on.
- If the type of repository is a temporary storage queue, DTCN fills in the field with the ID of the terminal you are currently running on.

You can use one of the following terminal modes to display Debug Tool on a 3270 terminal:

- Single terminal mode: Debug Tool and the application program share the same terminal. To use this mode, enter the ID of the terminal being used by your application program or move the cursor to the **Display ID** field and press PF10.

- Screen control mode: Debug Tool displays its screens on a terminal which is running the DTSC transaction. To use this mode, start the DTSC transaction on a terminal and specify that terminal's ID in the **Display ID** field.
- Separate terminal mode: Debug Tool displays its screens on a terminal which is available for use (not associated with any transaction) and can be located by CICS. To use this mode, specify the terminal's ID in the **Display ID** field.

Description of fields on the DTCN Menu 2 screen

The following list describes the fields that you can use to specify the TEST runtime options, other runtime options, commands file, and preferences file that you want to use for the debugging session:

Test Option
TEST/NOTEST specifies the conditions under which Debug Tool assumes control during the initialization of your application.

Test Level
ALL/ERROR/NONE specifies what conditions need to be met for Debug Tool to gain control.

Commands File
A valid fully qualified data set name that specifies the commands file for this run. Do not enclose the name of the data set in quotation marks (") or apostrophes ('). The CICS region must have read authorization to the commands file.

If you leave this field blank and have a value for a default user commands file set through the EQAOPTS COMMANDSDSN command, Debug Tool does the following tasks to find a commands file:

1. Debug Tool constructs the name of a data set from the naming pattern specified in the command.
2. Debug Tool locates the data set.
3. If the data set contains a member with a name that matches the name of the initial load module in the first enclave, it processes that member as a commands file.

If you do not want specify a commands file, and want to prevent Debug Tool from using the file specified by the EQAOPTS COMMANDSDSN command, specify NULLFILE for the commands file.

To learn how to specify the EQAOPTS COMMANDSDSN command, see the topic "EQAOPTS commands" in either the *Debug Tool Customization Guide* or *Debug Tool Reference and Messages*.

Prompt Level
Specifies whether Debug Tool is started at Language Environment initialization.

Preferences File
A valid fully qualified data set name that specifies the preferences file for this run. Do not enclose the name of the data set in quotation marks (") or apostrophes ('). The CICS region must have read authorization to the preferences file.

If you leave this field blank and have a value for a default user preferences file set through the EQAOPTS PREFERENCESDSN command, Debug Tool does the following tasks to find a preferences file:

1. Debug Tool constructs the name of a data set from the naming pattern specified in the command.
2. Debug Tool locates the data set and processes it as a preferences file.

If you do not want to specify a preferences file, and want to prevent Debug Tool from using the file specified by the EQAOPTS PREFERENCESDSN command, specify NULLFILE for the preferences file.

To learn how to specify the EQAOPTS PREFERENCESDSN command, see the topic “EQAOPTS commands” in either the *Debug Tool Customization Guide* or *Debug Tool Reference and Messages*.

EQAOPTS File
A valid fully qualified data set name that specifies the EQAOPTS file for this run. Do not enclose the name of the data set in quotation marks (") or apostrophes ('). The CICS region must have read authorization to the EQAOPTS file.

Any other valid Language Environment Options
You can change any Language Environment option that your site has defined as overrideable except the STACK option. For additional information about Language Environment options, see *z/OS Language Environment Programming Reference* or contact your CICS system programmer.

Description of fields on the DTCN Advanced Options screen

The following list describes the fields that you can use to specify the data passed through COMMAREA or containers that can help identify transactions and programs that you want to debug:

Commarea offset
Specifies the offset of data within a commarea passed to a program on invocation. You can specify the offset in decimal format (for example, 13) or in hexadecimal format (for example, X'D'). If you specify data in hexadecimal format, you must specify an even number of hexadecimal digits.

Commarea data
Specifies the data within a commarea that is passed to a program on invocation. You can specify the data in character format (for example, "ABC") or in hexadecimal format (for example, X'C1C2C3').

Container name
Specifies the name of a container within the current channel passed to a program on invocation. Container names are case sensitive.

Container offset
Specifies the offset of data in the named container passed to a program in the current channel on invocation. You can specify the offset in decimal format (for example, 13) or in hexadecimal format (for example, X'D').

Container data
Specified the data in the named container passed to a program in the current channel on invocation. You can specify the data in character format (for example, "ABC") or in hexadecimal format (for example, X'C1C2C3'). If you specify data in hexadecimal format, you must specify an even number of hexadecimal digits.

URM debugging
Specifies whether you want Debug Tool to include the debugging of URMs as part of the debug session. Choose from the following options:

YES Debug Tool debugs URMs which match normal Debug Tool debugging criteria.

NO Debug Tool excludes URMs form debugging sessions.

Creating and storing debugging profiles with CADP

CADP is an interactive transaction supplied by CICS Transaction Server for z/OS Version 2 Release 3, or later. CADP helps you maintain persistent debugging profiles. These profiles contain a pattern of CICS resource names that identify a task that you want to debug. When CICS programs are started, CICS tries to match the executing resources to find a profile whose resources match those that are specified in a CADP profile. During this pattern matching, CICS selects the best matching profile, which is the one with greatest number of resources that match the active task.

Before using CADP, verify that you have done the following tasks:

- Compiled and linked your program as described in Chapter 9, “Preparing a CICS program,” on page 83.
- Verified that your site uses CADP and that all the tasks required to customize Debug Tool so that it can debug CICS programs described in *Debug Tool Customization Guide* are completed. In particular, verify that the `DEBUGTOOL` system initialization parameter is set to `YES` so that Debug Tool uses the CADP profile repository instead of the DTCN profile repository to find a matching debugging profile.

See *CICS Supplied Transactions* for instructions on how to use the CADP utility transaction. If you are going to debug user-replaceable modules (URMs), specify `ENVAR("INCLUDEURM=YES")` in the **Other Language Environment Options** field.

Refer to the following topics for more information related to the material discussed in this topic.

Related references

CICS Application Programming Guide for a description of debugging profiles.

Starting Debug Tool for non-Language Environment programs under CICS

You can start Debug Tool to debug a program that does not run in the Language Environment run time by using the existing debug profile maintenance transactions `DTCN` and `CADP`. You must use `DTCN` with versions of CICS prior to CICS Transaction Server for z/OS Version 2 Release 3.

To debug CICS non-Language Environment programs, the Debug Tool non-Language Environment Exits must have been previously started.

To debug non-Language Environment assembler programs or non-Language Environment COBOL programs that run under CICS, you must start the required Debug Tool global user exits before you start the programs. Debug Tool provides the following global user exits to help you debug non-Language Environment applications: XPCFTCH, XEIIN, XEIOUT, XPCTA, and XPCHAIR. The exits can be started by using either the DTCX transaction (provided by Debug Tool), or using a PLTPI program that runs during CICS region startup. DTCXXO activates the non-Language Environment Exits for Debug Tool in CICS. DTCXXF inactivates the non-Language Environment Exits for Debug Tool in CICS.

Refer to the following topics for more information related to the material discussed in this topic.

Related tasks

Debug Tool Customization Guide

Passing runtime parameters to Debug Tool for non-Language Environment programs under CICS

When you define your debugging profile using the `DTCN` Options Panel (PF9) or the `CADP` Create/Modify Debugging Profile Panel, you can pass a limited set of runtime options that will take effect during your debugging session when you debug programs that do not run in Language Environment. You can pass the following runtime options:

- `TEST/NOTEST`: must be `TEST`
- `TEST LEVEL`: must be `ALL`
- Commands file
- Prompt Level: must be `PROMPT`
- Preferences file
- You can also specify the following runtime options in a TEST string:
  - `NATLANG`: to specify the National Language used to communicate with Debug Tool
  - `COUNTRY`: to specify a Country Code for Debug Tool
  - `TRAP`: to specify whether Debug Tool is to intercept Abends

Refer to the following topics for more information related to the material discussed in this topic.

Related references

Debug Tool Reference and Messages

Chapter 10. Preparing an IMS program

To prepare an IMS program, do the following tasks:

1. Verify that Chapter 3, “Planning your debug session,” on page 23 and Chapter 4, “Updating your processes so you can debug programs with Debug Tool,” on page 59 have been completed.
2. Contact your system programmer to find out the preferred method for starting Debug Tool and which of the following methods you need to use to specify TEST runtime options:
   - Specifying the TEST runtime options in a data set, which is then extracted by a customized version of the Language Environment user exit routine CEEBXITA. See Chapter 11, “Specifying the TEST runtime options through the Language Environment user exit,” on page 101 for instructions.
   - Specifying the TEST runtime options in a CEEUOPT (application level, which you link-edit to your application program) or CEEROPT module, (region level). See “Starting Debug Tool under IMS by using CEEUOPT or CEEROPT” for instructions.
   - Specifying the TEST runtime options through the EQASET transaction for non-Language Environment assembler programs running in IMS TM. See “Running the EQASET transaction for non-Language Environment IMS MPPs” on page 359 for instructions.
   - “Managing runtime options for IMSplex users by using Debug Tool Utilities” on page 98.

Starting Debug Tool under IMS by using CEEUOPT or CEEROPT

You can specify your TEST runtime options by using CEEUOPT (which is an assembler module that uses the CEEXOPT macro to set application level defaults, and is link-edited into an application program) or CEEROPT (which is an assembler module that uses the CEEXOPT macro to set region level defaults). Every time your application program runs, Debug Tool is started.

To use CEEUOPT to specify your TEST runtime options, do the following steps:

1. Code an assembler program that includes a CEEXOPT macro invocation that specifies your application program's runtime options.
2. Assemble the program.
3. Link-edit the program into your application program by specifying an INCLUDE LibraryDDname(CEEUOPT-member name)
4. Place your application program in the load library used by IMS.

To use CEEROPT to specify your TEST runtime options, do the following steps:

1. Code an assembler program that includes a CEEXOPT macro invocation that specifies your region's runtime options.
2. Assemble the program.
3. Link-edit the program into a load module named CEEROPT by specifying an INCLUDE LibraryDDname(CEEROPT-member name)
4. Place the CEEROPT load module into the load library used by IMS.

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Managing runtime options for IMSplex users by using Debug Tool Utilities

This topic describes how to add, delete, or modify TEST runtime options that are stored in the IMS Language Environment runtime parameter repository. To manage the items in this repository, do the following steps:

1. From the main Debug Tool Utilities panel (EQA@PRIM), type 4 in the Option line and press Enter.
2. In the Manage IMS Programs panel (EQAPRIS), type 1 in the Option line and press Enter.
3. In the Manage LE Runtime Options in IMS panel (EQAPRI), type in the IMSplex ID and optional qualifiers. Debug Tool Utilities uses this information to search through the IMS Language Environment runtime parameter repository and find the entries that most closely match the information you typed in. You can use wild cards (* and %) to increase the chances of a match. After you type in your search criteria, press Enter.
4. In the Edit LE Runtime Options Entries in IMS panel (EQAPRIM), a table displays all the entries found in the IMS Language Environment runtime parameter repository that most closely match your search criteria. You can do the following tasks in this panel:
   - Delete an entry.
   - Add a new entry.
   - Edit an existing entry.
   - Copy an existing entry.

   For more information about a command or field, press PF1 to display a help panel.
5. After you finish making your changes, press PF3 to save your changes and close the panel that is displayed. If necessary, press the PF3 repeatedly to close other panels until you reach the Manage IMS Programs panel (EQAPRIS).

Setting up the DFSBXITA user exit routine

To make the debug session use the options you specified in the Manage LE Runtime Options in IMS function, you must use the DFSBXITA user exit supplied by IMS. This exit contains a copy of the Language Environment CEEBXITA user exit that is customized for IMS. The DFSBXITA user exit either replaces the exit supplied by Language Environment in CEEBINIT, or is placed in your load module.

- To make the user exit available installation-wide, do a replace link edit of the IMS CEEBXITA into the CEEBINIT load module in your system *hlq*.SCEERUN Language Environment runtime library.
- To make the user exit available region-wide, copy the CEEBINIT in your *hlq*.SCEERUN library into a private library, and then do a replace link edit of the IMS CEEBXITA into the CEEBINIT load module in your private library. Then place your private library in the STEPLIB DD concatenation sequence before the system *hlq*.SCEERUN data set in the MPR region startup job.
- To make the user exit available to a specific application, link the IMS CEEBXITA into your load module. The user exit runs only when the application is run.

The following sample JCL describes how to do a replace link edit of the IMS CEEBXITA into a CEEBINIT load module:

```
INCLUDE MYOBJ(CEEBXITA)  1
REPLACE CEEBXITA
INCLUDE SYSLIB(CEEBINIT)
ORDER CEEBINIT MODE AMODE(24),RMODE(24)
ENTRY CEEBINIT
ALIAS CEEBLIBM
NAME CEEBINIT(R)
```

When you assembled the IMS user exit DFSBXITA, if you named the resulting object member DFSBXITA, replace CEEBXITA on line **1** with DFSBXITA.

Chapter 11. Specifying the TEST runtime options through the Language Environment user exit

Debug Tool provides a customized version of the Language Environment user exit (CEEBXITA). The user exit returns a TEST runtime option when called by the Language Environment initialization logic. Debug Tool provides user exits for three different environments. This topic is also described in *Debug Tool Customization Guide* with information specific to system programmers.

The user exit extracts the `TEST` runtime option from a user controlled data set with a name that is constructed from a naming pattern. The naming pattern can include the following tokens:

`&USERID`
Debug Tool replaces the `&USERID` token with the user ID of the current user. Each user can specify an individual `TEST` runtime option when debugging an application. This token is optional.

`&PGMNAME`
Debug Tool replaces the `&PGMNAME` token with the name of the main program (load module). Each program can have its own `TEST` runtime options. This token is optional.

Debug Tool provides the user exit in two forms:

- A load module. The load modules for the three environments are in the *hlq*.SEQAMOD data set. Use this load module if you want the default naming patterns and message display level. The default naming pattern is `&USERID.DBGTOOL.EQAUOPTS` and the default message display level is X'00'.
- Sample assembler user exit that you can edit. The assembler user exits for the three environments are in the *hlq*.SEQASAMP data set. You can also merge this source with an existing version of CEEBXITA. Use this source code if you want naming patterns or message display levels that are different than the default values.

Debug Tool provides the following user exits:

Table 14. Language Environment user exits for various environments

Environment	User exit name
The following types of DB2 stored procedures that run in WLM-established address spaces: • type MAIN[1] • type SUB, invoked by the `call_sub` function[4]	EQADDCXT and EQAD3CXT[5]
IMS TM[2] and BTS[3]	EQADICXT and EQAD3CXT
Batch	EQADBCXT and EQAD3CXT

Notes:

1. EQADDCXT or EQAD3CXT is supported for DB2 version 7 or later. If DB2 RUNOPTS is specified, EQADDCXT or EQAD3CXT takes precedence over DB2 RUNOPTS.
2. For IMS TM, if you do not sign on to the IMS terminal, you might need to run the EQASET transaction with the `TSOID` option. For instructions on how to run the EQASET transaction, see “Debugging Language Environment IMS MPPs without issuing /SIGN ON” on page 360.

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3. For BTS, you need to specify Environment command (./E) with the user ID of the IO PCB. For example, if the user ID is ECSVT2, then the Environment command is `./E USERID=ECSVT2`.
4. Link the user exit into a private copy of the Language Environment module CEEPIPI, not to your application program.
5. EQAD3CXT is used for type MAIN stored procedures only

Each user exit can be used in one of the following ways:

- You can link the user exit into your application program.
- You can link the user exit into a private copy of a Language Environment module (CEEBINIT, CEEPIPI, or both), and then, only for the modules you might debug, place the SCEERUN data set containing this module in front of the system Language Environment modules in CEE.SCEERUN in the load module search path.

To learn about the advantages and disadvantages of each method, see "Comparing the two methods of linking CEEBXITA" on page 104.

To prepare a program to use the Language Environment user exit, do the following tasks:

1. "Editing the source code of CEEBXITA."
2. "Linking the CEEBXITA user exit into your application program" on page 104 or "Linking the CEEBXITA user exit into a private copy of a Language Environment runtime module" on page 105.
3. "Creating and managing the TEST runtime options data set" on page 106.

Editing the source code of CEEBXITA

You can edit the sample assembler user exit that is provided in *hlq*.SEQASAMP to customize the naming patterns or message display level by doing one of the following tasks:

- Use an SMP/E USERMOD to update the copy of the exit in the *hlq*.SEQAMOD data set. The system programmer usually implements USERMODs. Use the following sample USERMODs in *hlq*.SEQASAMP for this task:

User exit name	USERMOD name
EQADDCXT	EQAUMODC
EQADICXT	EQAUMODD
EQADBCXT	EQAUMODB
EQAD3CXT	EQAUMODK

- Create a private load module for the customized exit. Copy the assembler user exit that has the same name as the user exit from *hlq*.SEQASAMP to a local data set. Edit the patterns or message display level. Customize and run the JCL to generate a load module.

Modifying the naming pattern

The naming pattern of the data set that has the `TEST` runtime option is in the form of a sequential data set name. You can optionally specify a `&USERID` token, which Debug Tool substitutes with the user ID of the current user. You can also add a `&PGMNAME` token, which Debug Tool substitutes with the name of the main program (load module). However, if users create and manage the TEST runtime option data

set with the **DTSP Profile** view in the remote debugger, do not specify the &PGMNAME token because the view does not support that token.

In some cases, the first character of a user ID is not valid for a name qualifier. A character can be concatenated before the &USERID token to serve as the prefix character for the user ID. For example, you can prefix the token with the character "P" to form P&USERID, which is a valid name qualifier after the current user ID is substituted for &USERID. For IMS, &USERID token might be substituted with one of the following values:

- IMS user ID, if users sign on to IMS.
- TSO user ID, if users do not sign on to IMS.

The default naming pattern is &USERID.DBGTOOL.EQAUOPTS. This is the pattern that is in the load module provided in *hlq*.SEQAMOD.

The following table shows examples of naming patterns and the corresponding data set names after Debug Tool substitutes the token with a value.

Table 15. Data set naming patterns, values for tokens, and resulting data set names

Naming pattern	User ID	Program name	Name after user ID substitution
&USERID.DBGTOOL.EQAUOPTS	JOHNDOE		JOHNDOE.DBGTOOL.EQAUOPTS
P&USERID.EQAUOPTS	123456		P123456.EQAUOPTS
DT.&USERID.TSTOPT	TESTID		DT.TESTID.TSTOPT
DT.&USERID.&PGMNAME.TSTOPT	TESTID	IVP1	DT.TESTID.IVP1.TSTOPT

To customize the naming pattern of the data set that has TEST runtime option, change the value of the DSNT DC statement in the sample user exit. For example:

```
* Modify the value in DSNT DC field below.
*
* Note: &USERID below has one additional '&', which is an escape
*       character.
*
DSNT_LN         DC  A(DSNT_SIZE)  Length field of naming pattern
DSNT            DC  C'&&USERID.DBGTOOL.EQAUOPTS'
DSNT_SIZE       EQU *-DSNT        Size of data set naming pattern
*
```

Modifying the message display level

You can modify the message display level for CEEBXITA. The following values set WTO message display level:

X'00'
Do not display any messages.

X'01'
Display error and warning messages.

X'02'
Display error, warning, and diagnostic messages.

The default value, which is in the load module in *hlq*.SEQAMOD, is X'00'.

To customize the message display level, change the value of the MSGS_SW DC statement in the sample user exit. For example:

```
* The following switch is to control WTO message display level.
*
*   x'00' - no messages
*   x'01' - error and warning messages
```

```
*   x'02' - error, warning, and diagnostic messages
*
MSGS_SW         DC  X'00'         message level
*
```

Comparing the two methods of linking CEEBXITA

You can link in the user exit CEEBXITA in the following ways:

- Link it into the application program.

  Advantage

  The user exit affects only the application program being debugged. This means you can control when Debug Tool is started for the application program. You might also not need to make any changes to your JCL to start Debug Tool.

  Disadvantage

  You must remember to remove the user exit for production or, if it isn't part of your normal build process, you must remember to relink it to the application program.

- Link it into a private copy of a Language Environment runtime load module (CEEBINIT, CEEPIPI, or both)

  Advantage

  You do not have to change your application program to use the user exit. In addition, you do not have to link edit extra modules into your application program.

  Disadvantage

  You need to take extra steps in preparing and maintaining your runtime environment:

  – Make a private copy of one or more Language Environment runtime routines

  – Only for the modules you might debug, customize your runtime environment to place the private copies in front of the system Language Environment modules in CEE.SCEERUN in the load module search path

  – When you apply maintenance to Language Environment, you might need to relink the routines.

  – When you upgrade to a new version of Language Environment, you must relink the routines.

If you link the user exit into the application program and into a private copy of a Language Environment runtime load module, which is in the load module search path of your application execution, the copy of the user exit in the application load module is used.

Linking the CEEBXITA user exit into your application program

If you choose to link the CEEBXITA user exit into your application program, use the following sample JCL, which links the user exit with the program TESTPGM. If you have customized the user exit and placed it in a private library, replace the data name, (*hlq*.SEQAMOD) of the first SYSLIB DD statement with the data set name that contains the modified user exit load module.

```
//SAMPLELK JOB ,
// MSGCLASS=H,TIME=(,30),MSGLEVEL=(2,0),NOTIFY=&SYSUID,REGION=0M
//*
```

```
//LKED    EXEC PGM=HEWL,REGION=4M,
//             PARM='CALL,XREF,LIST,LET,MAP,RENT'
//SYSLMOD  DD DISP=SHR,DSN=USERID.OUTPUT.LOAD
//SYSPRINT DD DISP=OLD,DSN=USERID.OUTPUT.LINKLIST(TESTPGM)
//SYSUT1   DD  UNIT=SYSDA,SPACE=(1024,(200,20))
//*
//SYSLIB   DD DISP=SHR,DSN=hlq.SEQAMOD
//         DD DISP=SHR,DSN=CEE.SCEELKED
//*
//OBJECT   DD DISP=SHR,DSN=USERID.INPUT.OBJECT
//SYSLIN   DD *
     INCLUDE OBJECT(TESTPGM)
     INCLUDE SYSLIB(EQADICXT)
     NAME TESTPGM(R)
/*
```

Linking the CEEBXITA user exit into a private copy of a Language Environment runtime module

If you choose to customize a private copy of a Language Environment runtime load module, you need to ensure that your private copy of these load modules is placed ahead of your system copy of CEE.SCEERUN in your runtime environment.

The following table shows the Language Environment runtime load module and the user exit needed for each environment.

Table 16. Language Environment runtime module and user exit required for various environments

Environment	User exit name	CEE load module
The following types of DB2 stored procedures that run in WLM-established address spaces: • type MAIN • type SUB, invoked by the `call_sub` function[1]	EQADDCXT or EQAD3CXT[2]	CEEPIPI
IMS TM and BTS	EQADICXT or EQAD3CXT	CEEBINIT
Batch	EQADBCXT or EQAD3CXT	CEEBINIT

Notes:

1. This requires that you install the PTF for APAR PM15192 for Language Environment Version 1.10 to Version 1.12.
2. EQAD3CXT is used for type MAIN stored procedures only.

Edit and run sample *hlq*.SEQASAMP(EQAWLCEE) to create these updated Language Environment runtime modules. This is typically done by the system programmer installing Debug Tool. The sample creates the following load module data sets:

- *hlq*.DB2SP.SCEERUN(CEEPIPI)
- *hlq*.IMSTM.SCEERUN(CEEBINIT)
- *hlq*.BATCH.SCEERUN(CEEBINIT)

When you apply service to Language Environment that affects either of these modules (CEEPIPI or CEEBINIT) or you move to a new level of Language Environment, you need to rebuild your private copy of these modules by running the sample again.

Option 8 of the Debug Tool Utilities ISPF panel, "JCL for Batch Debugging", uses *hlq*.BATCH.SCEERUN if you use Invocation Method E.

Creating and managing the TEST runtime options data set

The TEST runtime options data set is an MVS data set that contains the Language Environment runtime options. The Debug Tool Language Environment user exits (EQADDCXT, EQADICXT, and EQADBCXT) construct the name of this data set based on a naming pattern described in “Modifying the naming pattern” in the *Debug Tool Customization Guide*.

You can create this data set in one of the following ways:

- By using Terminal Interface Manager (TIM), as described in “Creating and managing the TEST runtime options data set by using Terminal Interface Manager (TIM).”
- By using Debug Tool Utilities option 6, "Debug Tool User Exit Data Set", as described in “Creating and managing the TEST runtime options data set by using Debug Tool Utilities” on page 108.
- By using the **DTSP Profile** view. To learn more about this view, see Appendix I, “Installing the IBM Debug Tool DTCN and DTSP Profile Manager plug-in,” on page 497.

Creating and managing the TEST runtime options data set by using Terminal Interface Manager (TIM)

Before you begin, verify that the user ID that you use to log on to Terminal Interface Manager (TIM) has permission to read and write the TEST runtime options data set.

To create the TEST runtime options data set by using Terminal Interface Manager, do the following steps:

1. Log on to Terminal Interface Manager.
2. In the **DEBUG TOOL TERMINAL INTERFACE MANAGER** panel, press PF10.
3. In the *** Specify TEST Run-time Option Data Set *** panel, type in the name of a data set which follows the naming pattern specified by your system administrator, in the **Data Set Name** field. If the data set is not cataloged, type in a volume serial.
4. Press Enter. If Terminal Interface Manager cannot find the data set, it displays the *** Allocate TEST Run-time Option Data Set *** panel. Specify allocation parameters for the data set, then press Enter. Terminal Interface Manager creates the data set.
5. In the *** Edit TEST Run-time Option Data Set *** panel, make the following changes:

   Program name(s)
   Specify the names of up to eight programs you want to debug. You can specify specific names (for example, EMPLAPP), names appended with a wildcard character (*), or just the wildcard character (which means you want to debug all Language Environment programs).

   Test Option
   Specify whether to use `TEST` or `NOTEST` runtime option.

   Test Level
   Specify which TEST level to use: ALL, ERROR, or NONE.

Commands File
If you want to use a commands file, specify the name of a commands file in the format described in the *commands_file_designator* section of the topic "Syntax of the TEST run-time option" in the *Debug Tool Reference and Messages*.

Prompt Level
Specify whether to use `PROMPT` or `NOPROMPT`.

Preferences File
If you want to use a preferences file, specify the name of a preferences file in the format described in the *preferences_file_designator* section of the topic "Syntax of the TEST run-time option" in the *Debug Tool Reference and Messages*.

EQAOPTS File
If you want Debug Tool to run any EQAOPTS commands at run time, specify the name of the EQAOPTS file as a fully-qualified data set name.

Other run-time options
Type in any other Language Environment runtime options.

6. Terminal Interface Manager displays the part of the TEST runtime option that specifies which session type (debugging mode and display information) you want to use under the **Current debug display information** field. To change the session type, do the following steps:
   a. Press PF9.
   b. In the **Change session type** panel, select one of the following options:

      Full-screen mode using the Debug Tool Terminal Interface Manager
      Type in the user ID you will use to log on to Terminal Interface Manager and debug your program in the **User ID** field.

      Remote debug mode
      Type in the IP address in the **Address** field and port number in the **Port** field of the remote debugger's daemon.

   c. (Optional) Press Enter. Terminal Interface Manager accepts the changes and refreshes the panel.
   d. Press PF4. Terminal Interface Manager displays the *** Edit TEST Run-time Option Data Set *** panel and under the **Current debug session type string:** displays one of the following strings:
      - `VTAM%userid`, if you selected **Full-screen mode using the Debug Tool Terminal Interface Manager**.
      - `TCPIP&IP_address%port`, if you selected **Remote debug mode**.
7. Press PF4 to save your changes to the TEST runtime options data set and to return to the main Terminal Interface Manager screen.

Refer to the following topics for more information related to the material discussed in this topic.

- For more information about the values to specify for the Test Option, Test Level, and Prompt Level fields, see the topic "Syntax of the TEST run-time option" in *Debug Tool Reference and Messages*.
- For instructions on creating a commands file or preferences file, see the topics "Creating a commands file" on page 175 or "Creating a preferences file" on page 159.

- For instructions on creating an EQAOPTS file, see the topic “Providing EQAOPTS commands at run time” in the *Debug Tool Reference and Messages* or *Debug Tool Customization Guide*.
- For more information about other Language Environment runtime options, see *Language Environment Programming Reference*, SA22-7562.
- For more information about the values to specify for the **Full-screen mode using the Debug Tool Terminal Interface Manager** field, see “Starting a debugging session in full-screen mode using the Terminal Interface Manager or a dedicated terminal” on page 133.
- For more information about the values to specify for the **Remote debug mode** field, see the online help for the compiled language debugger component of Rational Developer for System z or the IBM Debug Tool plug-in for Eclipse.

Creating and managing the TEST runtime options data set by using Debug Tool Utilities

To create the TEST runtime options data set by using Debug Tool Utilities, do the following steps:

1. Start Debug Tool Utilities and select option 6, "Debug Tool User Exit Data Set".
2. Provide the name of a new or existing data set. Make sure the name matches the naming pattern. If you do not know the naming pattern, ask your system administrator. Remember the following rules:
   - Substitute the `&PGMNAME` token with the name of the program you want to debug. The program must be the main CSECT of the load module in a Language Environment enclave.
   - For IMS, `&USERID` token might be substituted with one of the following values:
     – IMS user ID, if users sign on to IMS.
     – TSO user ID, if users do not sign on to IMS.
3. Fill out the rest of the fields with the TEST runtime options you want to use and the names of up to eight additional programs to debug.
4. For IMS, you can also fill out the IMS Subsystem ID, or IMS Transaction ID field, or both. If provided, the IDs are used as additional filtering criteria.

Part 3. Starting Debug Tool

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Chapter 12. Writing the TEST run-time option string

The instructions in this section apply to programs that run in Language Environment. For programs that do not run in Language Environment, refer to the instructions in “Starting Debug Tool for programs that start outside of Language Environment” on page 137.

This topic describes some of the factors you should consider when you use the TEST runtime option, provides examples, and describes other runtime options you might need to specify. The syntax of the TEST runtime option is described in the topic TEST run-time option in *Debug Tool Reference and Messages*.

To specify how Debug Tool gains control of your application and begins a debug session, you use the TEST run-time option. The simplest form of the TEST option is TEST with no suboptions specified; however, suboptions provide you with more flexibility. There are four types of suboptions available, summarized below.

test_level
: Determines what high-level language conditions raised by your program cause Debug Tool to gain control of your program

commands_file
: Determines which primary commands file is used as the initial source of commands

prompt_level
: Determines whether an initial commands list is unconditionally run during program initialization

preferences_file
: Specifies the session parameter and a file that you can use to specify default settings for your debugging environment, such as customizing the settings on the Debug Tool Profile panel

Special considerations while using the TEST run-time option

When you use the TEST run-time option, there are several implications to consider, which are described in this section.

Defining TEST suboptions in your program

In C, C++ or PL/I, you can define TEST with suboptions using a #pragma runopts or PLIXOPT string, then specify TEST with no suboptions at run time. This causes the suboptions specified in the #pragma runopts or PLIXOPT string to take effect.

You can change the TEST/NOTEST run-time options at any time with the SET TEST command.

Suboptions and NOTEST

Some suboptions are disabled with NOTEST, but are still allowed. This means you can start your program using the NOTEST option and specify suboptions you might want to take effect later in your debug session. The program begins to run without Debug Tool taking control.

To enable the suboptions you specified with NOTEST, start Debug Tool during your program's run time by using a library service call such as CEETEST, PLITEST, or the __ctest() function.

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Implicit breakpoints

If the test level in effect causes Debug Tool to gain control at a condition or at a particular program location, an implicit breakpoint with no associated action is assumed. This occurs even though you have not previously defined a breakpoint for that condition or location using an initial command string or a primary commands file. Control is given to your terminal or to your primary commands file.

Primary commands file and USE file

The primary commands file acts as a surrogate terminal. After it is accessed as a source of commands, it continues to act in this capacity until all commands have been run or the application has ended. This differs from the USE file in that, if a USE file contains a command that returns control to the program (such as `STEP` or `GO`), all subsequent commands are discarded. However, USE files started from within a primary commands file take on the characteristics of the primary commands file and can be run until complete.

The initial command list, whether it consists of a command string included in the run-time options or a primary commands file, can contain a `USE` command to get commands from a secondary file. If started from the primary commands file, a USE file takes on the characteristics of the primary commands file.

Running in batch mode

In batch mode, when the end of your commands file is reached, a `GO` command is run at each request for a command until the program terminates. If another command is requested after program termination, a `QUIT` command is forced.

Starting Debug Tool at different points

If Debug Tool is started during program initialization, it is started before all the instructions in the main prolog are run. At that time, no program blocks are active and references to variables in the main procedure cannot be made, compile units cannot be called, and the `GOTO` command cannot be used. However, references to static variables can be made.

If you enter the `STEP` command at this point, before entering any other commands, both program and Language Environment initialization are completed and you are given access to all variables. You can also enter all valid commands.

If Debug Tool is started while your program is running (for example, by using a `CEETEST` call), it might not be able to find all compile units associated with your application. Compile units located in load modules that are not currently active are not known to Debug Tool, even if they were run prior to Debug Tool's initialization.

For example, suppose load module `mod1` contains compile units `cu1` and `cu2`, both compiled with the `TEST` option. The compile unit `cu1` calls `cux`, contained in load module `mod2`, which returns after it completes processing. The compile unit `cu2` contains a call to the `CEETEST` library service. When the call to `CEETEST` initializes Debug Tool, only `cu1` and `cu2` are known to Debug Tool. Debug Tool does not recognize `cux`.

The initial command string is run only once, when Debug Tool is first initialized in the process.

Commands in the preferences file are run only once, when Debug Tool is first initialized in the process.

Session log

The session log stores the commands entered and the results of the execution of those commands. The session log saves the results of the execution of the commands as comments. This allows you to use the session log as a commands file.

Refer to the following topics for more information related to the material discussed in this topic.

Related tasks

"Link-editing EQADCCXT into your program" on page 83

Related references

Debug Tool Reference and Messages

Precedence of Language Environment run-time options

The Language Environment run-time options have the following order of precedence (from highest to lowest):

1. Installation options in the CEEDOPT file that were specified as nonoverrideable with the NONOVR attribute.
2. Options specified by the Language Environment assembler user exit. In the CICS environment, Debug Tool uses the DTCN transaction and the customized Language Environment user exit `EQADCCXT`, which is link-edited with the application. In the IMS Version 8 environment, IMS retrieves the options that most closely match the options in its Language Environment run-time options table. You can edit this table by using Debug Tool Utilities.
3. Options specified at the invocation of your application, using the `TEST` run-time option, unless accepting run-time options is disabled by Language Environment (`EXECOPS/NOEXECOPS`).
4. Options specified within the source program (with `#pragma` or `PLIXOPT`) or application options specified with CEEUOPT and link-edited with your application.

   If the object module for the source program is input to the linkage editor before the CEEUOPT object module, *then* these options override CEEUOPT defaults. You can force the order in which objects modules are input by using linkage editor control statements.
5. Region-wide CICS or IMS options defined within CEEROPT.
6. Option defaults specified at installation in CEEDOPT.
7. IBM-supplied defaults.

Suboptions are processed in the following order:

1. Commands entered at the command line override any defaults or suboptions specified at run time.
2. Commands run from a preferences file override the command string and any defaults or suboptions specified at run time.
3. Commands from a commands file override default suboptions, suboptions specified at run time, commands in a command string, and commands in a preferences file.

Refer to the following topics for more information related to the material discussed in this topic.

Related references

z/OS Language Environment Programming Guide

Example: TEST run-time options

The following examples of using the TEST run-time option are provided to illustrate run-time options available for your programs. They do not illustrate complete commands. The complete syntax of the TEST run-time option can be found in the *Debug Tool Reference and Messages*.

NOTEST Debug Tool is not started at program initialization. Note that a call to CEETEST, PLITEST, or __ctest() causes Debug Tool to be started during the program's execution.

NOTEST(ALL,MYCMDS,*,*)
Debug Tool is not started at program initialization. Note that a call to CEETEST, PLITEST, or __ctest() causes Debug Tool to be started during the program's execution. After Debug Tool is started, the suboptions specified become effective and the commands in the file allocated to DD name of MYCMDS are processed.

If you specify NOTEST and control has returned from the program in which Debug Tool first became active, you can no longer debug non-Language Environment programs or detect non-Language Environment events.

TEST Specifying TEST with no suboptions causes a check for other possible definitions of the suboption. For example, C and C++ allow default suboptions to be selected at compile time using #pragma runopts. Similarly, PL/I offers the PLIXOPT string. Language Environment provides the macro CEEXOPT. Using this macro, you can specify installation and program-specific defaults.

If no other definitions for the suboptions exist, the IBM-supplied default suboptions are (ALL, *, PROMPT, INSPREF).

TEST(ALL,*,*,*)
Debug Tool is not started initially; however, any condition or an attention in your program causes Debug Tool to be started, as does a call to CEETEST, PLITEST, or __ctest(). Neither a primary commands file nor preferences file is used.

TEST(NONE,,*,*)
Debug Tool is not started initially and begins by running in a "production mode", that is, with minimal effect on the processing of the program. However, Debug Tool can be started using CEETEST, PLITEST, or __ctest().

TEST(ALL,test.scenario,PROMPT,prefer)
Debug Tool is started at the end of environment initialization, but before the main program prolog has completed. The ddname prefer is processed as the preferences file, and subsequent commands are found in data set test.scenario. If all commands in the commands file are processed and you issue a STEP command when prompted, or a STEP command is run in the commands file, the main block completes initialization (that is, its AUTOMATIC storage is obtained and initial values are set). If Debug Tool is reentered later for any reason, it continues to obtain commands from test.scenario repeating this process until end-of-file is reached. At this point, commands are obtained from your terminal.

TEST(ALL,,MFI%F000:)
When running under CICS, Debug Tool displays its screens on terminal ID F000.

TEST(ALL,,MFI%TRMLU001:)
For use with full-screen mode using a dedicated terminal without Terminal

Interface Manager. The VTAM LU TRMLU001 is used for display. This terminal must be known to VTAM and not in session when Debug Tool is started.

TEST(ALL,,,MFI%SYSTEM01.TRMLU001:)
For use in the following situation:

- You are using full-screen mode using a dedicated terminal without Terminal Interface Manager.
- You must specify a network identifier.

The VTAM LU TRMLU001 on network node SYSTEM01 is used for display. This terminal must be known to VTAM and not in session when Debug Tool is started.

TEST(ALL,,,VTAM%USERABCD:)
For use with full-screen mode using the Terminal Interface Manager. The user accessed the Debug Tool Terminal Interface Manager with user id USERABCD.

Remote debug mode
If you are working in remote debug mode, that is, you are debugging your host application from your workstation, the following examples apply:

```
TEST(,,,TCPIP&machine.somewhere.something.com%8001:*)
TEST(,,,TCPIP&9.24.104.79%8001:*)
NOTEST(,,,TCPIP&9.24.111.55%8001:*)
```

Refer to the following topics for more information related to the material discussed in this topic.

Related references
z/OS Language Environment Programming Guide

Specifying additional run-time options with VS COBOL II and PL/I programs

There are two additional run-time options that you might need to specify to debug COBOL and PL/I programs: STORAGE and TRAP(ON).

Specifying the STORAGE run-time option

The STORAGE run-time option controls the initial content of storage when allocated and freed, and the amount of storage that is reserved for the "out-of-storage" condition. When you specify one of the parameters in the STORAGE run-time option, all allocated storage processed by the parameter is initialized to that value. If your program does not have self-initialized variables, you must specify the STORAGE run-time option.

Specifying the TRAP(ON) run-time option

The TRAP(ON) run-time option is used to fully enable the Language Environment condition handler that passes exceptions to the Debug Tool. Along with the TEST option, it **must** be used if you want the Debug Tool to take control automatically when an exception occurs. You must also use the TRAP(ON) run-time option if you want to use the GO BYPASS command and to debug handlers you have written. Using TRAP(OFF) with the Debug Tool causes unpredictable results to occur, including the operating system cancelling your application and Debug Tool when a condition, abend, or interrupt is encountered.

Note: This option replaces the OS PL/I and VS COBOL II STAE/NOSTAE options.

Specifying TEST run-time option with #pragma runopts in C and C++

The TEST run-time option can be specified either when you start your program, or directly in your source by using this #pragma:

```
#pragma runopts (test(suboption,suboption...))
```

This #pragma must appear before the first statement in your source file. For example, if you specified the following in the source:

```
#pragma runopts (notest(all,*,prompt))
```

then entered TEST on the command line, the result would be

```
TEST(ALL,*,PROMPT).
```

TEST overrides the NOTEST option specified in the #pragma and, because TEST does not contain any suboptions of its own, the suboptions ALL, *, and PROMPT remain in effect.

If you link together two or more compile units with differing #pragmas, the options specified with the first compile are honored. With multiple enclaves, the options specified with the first enclave (or compile unit) started *in each new process* are honored.

If you specify options on the command line and in a #pragma, any options entered on the command line override those specified in the #pragma unless you specify NOEXECOPS. Specifying NOEXECOPS, either in a #pragma or with the EXECOPS compiler option, prevents any command line options from taking effect.

Refer to the following topics for more information related to the material discussed in this topic.

Related tasks

z/OS XL C/C++ User's Guide

Chapter 13. Starting Debug Tool from the Debug Tool Utilities

The Debug Tool Setup File option (also called Debug Tool Setup Utilities or DTSU) in Debug Tool Utilities helps you manage setup files which store the following information:

- file allocation statements
- run-time options
- program parameters
- the name of your program

Then you use the setup files to run your program in foreground or batch. The Debug Tool Setup Utility (DTSU) `RUN` command performs the file allocations and then starts the program with the specified options and parameters in the foreground. The DTSU `SUBMIT` command submits a batch job to start the program.

Refer to the following topics for more information related to the material discussed in this topic.

Related tasks

"Creating the setup file"
"Editing an existing setup file"
"Saving your setup file" on page 120
"Starting your program" on page 120

Creating the setup file

You can have several setup files, but you must create them one at a time. To create a setup file, do the following steps:

1. From the **Debug Tool Utilities** panel, select the **Debug Tool Setup File** option.
2. In the `Debug Tool Foreground – Edit Setup File` panel, type the name of the new setup file in the **Setup File Library** or **Other Data Set Name** field. Do not specify a member name if you are creating a sequential data set. If you are creating a setup file for a DB2 program, select the **Initialize New setup file for DB2** field. Press Enter.
3. A panel similar to the ISPF 3.2 "Allocate New Data Set" panel appears when you enter the name of the new set up file in the **Other Data Set Name** field. You can modify the default allocation parameters. Enter the `END` command or press PF3 to continue.
4. The `Edit – Edit Setup File` panel appears. You can enter file allocation statements, run-time options, and program parameters.

Refer to the following topics for more information related to the material discussed in this topic.

Related tasks

"Entering file allocation statements, run-time options, and program parameters" on page 118

Editing an existing setup file

You can have several setup files, but you can edit only one file at a time. To edit an existing setup file, do the following steps:

1. From the `Debug Tool Utilities` panel, select the **Debug Tool Setup File** option.

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2. In the `Debug Tool Foreground – Edit Setup File` panel, type the name of the existing setup file in the **Setup File Library** or **Other Data Set Name** field. Press Enter to continue.
3. The `Edit – Edit Setup File` panel appears. You can modify file allocation statements, run-time options, and program parameters.

Refer to the following topics for more information related to the material discussed in this topic.

Related tasks

"Entering file allocation statements, run-time options, and program parameters"

Copying information into a setup file from an existing JCL

You can enter the `COPY` command to copy an EXEC statement and its associated DD statements from another data set containing JCL.

You can use option `A` to select a step of a job, and convert it to the setup file format.

Entering file allocation statements, run-time options, and program parameters

The top part of the Edit–Setup File panel contains the name of the program (load module) that you want to run and the run-time parameter string. If the setup file is for a DB2 program, the panel also contains fields for the DB2 System identifier and the DB2 plan. The bottom part of the Edit–Setup File panel contains the file allocation statements. This part of the panel is similar to an ISPF edit panel. You can insert new lines, copy (repeat) a line, delete a line, and type over information on a line.

To modify the name of the load module, type the new name in the **Load Module Name** field.

To modify the parameter string:

1. Select the format of the parameter string and whether the program is to start in the Language Environment. Non-Language Environment COBOL programs do not run in Language Environment. If you are debugging a non-Language Environment COBOL program, select the non-Language Environment option.
2. Enter the parameter string in one of the following ways:
   - Type the parameter string in the **Enter / to modify parameters** field.
   - Type a slash ("/") before the **Enter / to modify parameters** field and press Enter. The Debug Tool Foreground - Modify Parameter String panel appears. Define your run-time options and suboptions by doing the following steps:
     a. Define the `TEST` run-time option and its suboptions.
     b. Enter any Language Environment or Debug Tool run-time options and other program parameters.
     c. Press PF3. DTSU creates the parameter string from the options that you specified and puts it in the **Enter / to modify parameters** field.

In the file allocation section of the panel, each line represents an element of a DD name allocation or concatenation. The statements can be modified, copied, deleted, and reordered.

To modify a statement, do one of the following steps:

- Modify the statement directly on the Edit – Edit Setup File panel:
  1. Move your cursor to the statement you want to modify.
  2. Type the new information over the existing information.
  3. Press Enter.
- Modify the statement by using a select command:
  1. Move your cursor to the statement you want to modify.
  2. Type one of the following select commands:
     - SA - Specify allocation information
     - SD - Specify DCB information
     - SS - Specify SMS information
     - SP - Specify protection information
     - SO - Specify sysout information
     - SX - Specify all DD information by column display
     - SZ - Specify all DD information by section display
  3. Press Enter.

To copy a statement, do the following steps:

1. Move your cursor to the **Cmd** field of the statement you want to copy.
2. Type R and press Enter. The statement is copied into a new line immediately following the current line.

To delete a statement, do the following steps:

1. Move your cursor to the **Cmd** field of the statement you want to delete.
2. Type D and press Enter. The statement is deleted.

Debug Tool Utilities does not support reordering the DD names, only the data sets within each concatenation. The DD names are automatically sorted in alphabetical order. To reorder statements in a concatenation, do the following steps:

1. Move your cursor to the sequence number field of a statement you want to move and enter the new sequence number.

To insert a new line, do the following steps:

1. Move your cursor to the **Cmd** field of the line right above the line you want a new statement inserted.
2. Type I and press Enter.
3. Move your cursor to the new line and type in the new information or use one of the Select commands.

The Edit and Browse line commands allow you to modify or view the contents of the data set name specified for DD and SYSIN DD types.

You can use the DDNAME STEPLIB to specify the load module search order.

For additional help, move the cursor to any field and enter the `HELP` command or press PF1.

Refer to the following topics for more information related to the material discussed in this topic.

Related tasks

"Saving your setup file"

Saving your setup file

To save your information, enter the SAVE command. To save your information in a second data set and continue editing in the second data set, enter the SAVE AS command.

To save your setup file and exit the Edit–Edit Setup File panel, enter the END command or press PF3.

To exit the Edit–Edit Setup File panel without saving any changes to your setup file, enter the CANCEL command or press PF12.

Refer to the following topics for more information related to the material discussed in this topic.

Related tasks

"Starting your program"

Starting your program

To perform the allocations and run the program with the specified parameter string, enter the RUN command or press PF4.

To generate JCL from the information in the setup file and then submit to the batch job, enter the SUBMIT command or press PF10.

Chapter 14. Starting Debug Tool from a program

The instructions in this section apply to programs that run in Language Environment. For programs that do not run in Language Environment, refer to the instructions in “Starting Debug Tool for programs that start outside of Language Environment” on page 137.

Debug Tool can also be started directly from within your program using one of the following methods:

- Language Environment provides the callable service `CEETEST` that is started from Language Environment-enabled languages.
- For C or C++ programs, you can use a `__ctest()` function call or include a `#pragma runopts` specification in your program.

  Note: The `__ctest()` function is not supported in CICS.
- For PL/I programs, you can use a call to `PLITEST` or by including a `PLIXOPT` string that specifies the correct `TEST` run-time suboptions to start Debug Tool.

However, you cannot use these methods in DB2 stored procedures with the PROGRAM TYPE of SUB.

If you use these methods to start Debug Tool, you can debug non-Language Environment programs and detect non-Language Environment events only in the enclave in which Debug Tool first appeared and in subsequent enclaves. You cannot debug non-Language Environment programs or detect non-Language Environment events in higher-level enclaves.

To start Debug Tool using these alternatives, you still need to be aware of the `TEST` suboptions specified using `NOTEST`, `CEEUOPT`, or other "indirect" settings.

“Example: using CEETEST to start Debug Tool from C/C++” on page 124
“Example: using CEETEST to start Debug Tool from COBOL” on page 125
“Example: using CEETEST to start Debug Tool from PL/I” on page 126

Related tasks

“Starting Debug Tool with CEETEST”
“Starting Debug Tool with PLITEST” on page 128
“Starting Debug Tool with the __ctest() function” on page 129
“Starting Debug Tool under CICS by using CEEUOPT” on page 143

Refer to the following topics for more information related to the material discussed in this topic.

Related references

“Special considerations while using the TEST run-time option” on page 111

Starting Debug Tool with CEETEST

Using `CEETEST`, you can start Debug Tool from within your program and send it a string of commands. If no command string is specified, or the command string is insufficient, Debug Tool prompts you for commands from your terminal or reads them from the commands file. In addition, you have the option of receiving a feedback code that tells you whether the invocation procedure was successful.

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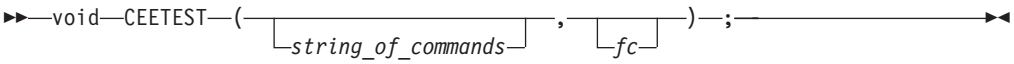
If you don't want to compile your program with hooks, you can use CEETEST calls to start Debug Tool at strategic points in your program. If you decide to use this method, you still need to compile your application so that symbolic information is created.

Using CEETEST when Debug Tool is already initialized results in a reentry that is similar to a breakpoint.

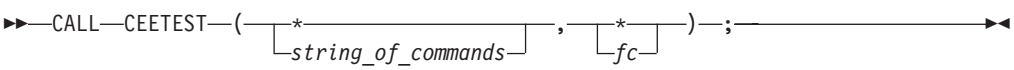
The following diagrams describe the syntax for CEETEST:

For C and C++



For COBOL

For PL/I



string_of_commands (input)
Halfword-length prefixed string containing a Debug Tool command list. The command string *string_of_commands* is optional.

If Debug Tool is available, the commands in the list are passed to the debugger and carried out.

If *string_of_commands* is omitted, Debug Tool prompts for commands in interactive mode.

For Debug Tool, remember to use the continuation character if your command exceeds 72 characters.

The first command in the command string can indicate that you want to start Debug Tool in one of the following debug modes:

- full-screen mode using the Terminal Interface Manager
- remote debug mode

To indicate that you want to start Debug Tool in full-screen mode using a dedicated terminal without Terminal Interface Manager, specify the MFI suboption of the TEST runtime option with the LU name of the dedicated terminal. For example, you can code the following call in your PL/I program:

```
Call CEETEST('MFI%TRMLU001:*;Query Location;Describe CUS;',*);
```

For a COBOL program, you can code the following call:

```
01 PARMS.
05 LEN PIC S9(4) BINARY Value 43.
05 PARM PIC X(43) Value 'MFI%TRMLU001:*;Query Location;Describe CUS;'.

CALL "CEETEST" USING PARMS FC.
```

To indicate that you want to start Debug Tool in full-screen mode using the Terminal Interface Manager, specify the VTAM suboption of the TEST runtime option with the User ID that you supplied to the Terminal Interface Manager. For example, you can code the following call in your PL/I program:

```
Call CEETEST(VTAM%USERABCD:*;Query Location;Describe CUS;,*);
```

In these examples, the suboption `:*` can be replaced with the name of a preferences file. If you started Debug Tool the `TEST` runtime option and specified a preferences file and you specify another preferences file in the `CEETEST` call, the preferences file in the `CEETEST` call replaces the preferences file specified with the `TEST` runtime option.

To indicate that you want to start Debug Tool in remote debug mode, specify the TCPIP suboption of the TEST runtime option with the IP address and port number that the remote debugger is listening to:

For example, you can code the following call in your PL/I program:

```
Call CEETEST('TCPIP&your.company.com%8001:*;',*);
```

These calls must include the trailing semicolon (;).

fc (output)
A 12-byte *feedback* code, optional in some languages, that indicates the result of this service.

CEE000
Severity = 0
Msg_No = Not Applicable
Message = Service completed successfully

CEE2F2
Severity = 3
Msg_No = 2530
Message = A debugger was not available

Note: The CEE2F2 feedback code can also be obtained by MVS/JES batch applications. For example, either the Debug Tool environment was corrupted or the debug event handler could not be loaded.

Language Environment provides a callable service called `CEEDCOD` to help you decode the fields in the feedback code. Requesting the return of the feedback code is recommended.

For C and C++ and COBOL, if Debug Tool was started through `CALL CEETEST`, the `GOTO` command is only allowed after Debug Tool has returned control to your program via `STEP` or `GO`.

Additional notes about starting Debug Tool with CEETEST

C and C++
Include `leawi.h` header file.

COBOL
Include `CEEIGZCT`. `CEEIGZCT` is in the Language Environment SCEESAMP data set.

PL/I Include `CEEIBMAW` and `CEEIBMCT`. `CEEIBMAW` is in the Language Environment SCEESAMP data set.

Batch and CICS nonterminal processes

We strongly recommend that you use feedback codes (fc) when using CEETEST to initiate Debug Tool from a batch process or a CICS nonterminal task; otherwise, results are unpredictable.

"Example: using CEETEST to start Debug Tool from C/C++"
"Example: using CEETEST to start Debug Tool from COBOL" on page 125
"Example: using CEETEST to start Debug Tool from PL/I" on page 126

Related tasks

"Entering multiline commands in full-screen" on page 277

Related references

z/OS Language Environment Programming Guide
Debug Tool Reference and Messages

Example: using CEETEST to start Debug Tool from C/C++

The following examples show how to use the Language Environment callable service CEETEST to start Debug Tool from C or C++ programs.

Example 1

In this example, an empty command string is passed to Debug Tool and a pointer to the Language Environment feedback code is returned. If no other TEST run-time options have been compiled into the program, the call to CEETEST starts Debug Tool with all defaults in effect. After it gains control, Debug Tool prompts you for commands.

```
#include <leawi.h>
#include <string.h>
#include <stdio.h>

int main(void) {
  _VSTRING  commands;
  _FEEDBACK fc;

  strcpy(commands.string, "");
  commands.length = strlen(commands.string);

  CEETEST(&commands, &fc);

}
```

Example 2

In this example, a string of valid Debug Tool commands is passed to Debug Tool and a pointer to Language Environment feedback code is returned. The call to CEETEST starts Debug Tool and the command string is processed. At statement 23, the values of x and y are displayed in the Log, and execution of the program resumes. Barring further interrupts, the behavior at program termination depends on whether you have set AT TERMINATION:

- If you have set AT TERMINATION, Debug Tool regains control and prompts you for commands.
- If you have not set AT TERMINATION, the program terminates.

The command LIST(z) is discarded when the command GO is executed.

Note: If you include a STEP or GO in your command string, all commands after that are not processed. The command string operates like a commands file.

```
#include <leawi.h>
#include <string.h>
#include <stdio.h>
```

```
int main(void) {
  _VSTRING  commands;
  _FEEDBACK fc;

  strcpy(commands.string, "AT LINE 23; {LIST(x); LIST(y);} GO; LIST(z)");
  commands.length = strlen(commands.string);
   .
   .
   .
  CEETEST(&commands, &fc);
   .
   .
   .
}
```

Example 3

In this example, a string of valid Debug Tool commands is passed to Debug Tool and a pointer to the feedback code is returned. If the call to CEETEST fails, an informational message is printed.

If the call to CEETEST succeeds, Debug Tool is started and the command string is processed. At statement 30, the values of x and y are displayed in the Log, and execution of the program resumes. Barring further interrupts, the behavior at program termination depends on whether you have set AT TERMINATION:

- If you have set AT TERMINATION, Debug Tool regains control and prompts you for commands.
- If you have not set AT TERMINATION, the program terminates.

```
#include <leawi.h>
#include <string.h>
#include <stdio.h>

#define SUCCESS "\0\0\0\0"

int main (void) {

   int x,y,z;
   _VSTRING commands;
   _FEEDBACK fc;

   strcpy(commands.string,"AT LINE 30 { LIST(x); LIST(y); } GO;");
   commands.length = strlen(commands.string);
   .
   .
   .
   CEETEST(&commands,&fc);
   .
   .
   .
   if (memcmp(&fc,SUCCESS,4) != 0) {
      printf("CEETEST failed with message number %d\n",fc.tok_msgno);
      return(2999);
   }
}
```

Example: using CEETEST to start Debug Tool from COBOL

The following examples show how to use the Language Environment callable service CEETEST to start Debug Tool from COBOL programs.

Example 1

A command string is passed to Debug Tool at its invocation and the feedback code is returned. After it gains control, Debug Tool becomes active and prompts you for commands or reads them from a commands file.

```
01  FC.
    02  CONDITION-TOKEN-VALUE.
    COPY CEEIGZCT.
        03  CASE-1-CONDITION-ID.
            04  SEVERITY    PIC S9(4) BINARY.
            04  MSG-NO      PIC S9(4) BINARY.
        03  CASE-2-CONDITION-ID
```

```
                REDEFINES CASE-1-CONDITION-ID.
            04  CLASS-CODE  PIC S9(4) BINARY.
            04  CAUSE-CODE  PIC S9(4) BINARY.
        03  CASE-SEV-CTL    PIC X.
        03  FACILITY-ID     PIC XXX.
    02  I-S-INFO            PIC S9(9) BINARY.
77  Debugger                PIC x(7)  Value 'CEETEST'.

01  Parms.
    05  AA                  PIC S9(4) BINARY   Value 14.
    05  BB                  PIC x(14)   Value 'SET SCREEN ON;'.

CALL Debugger USING Parms FC.
```

Example 2

A string of commands is passed to Debug Tool when it is started. After it gains control, Debug Tool sets a breakpoint at statement 23, runs the `LIST` commands and returns control to the program by running the `GO` command. The command string is already defined and assigned to the variable `COMMAND-STRING` by the following declaration in the DATA DIVISION of your program:

```
01 COMMAND-STRING.
   05 AA     PIC 99    Value 60 USAGE IS COMPUTATIONAL.
   05 BB     PIC x(60) Value 'AT STATEMENT 23; LIST (x); LIST (y); GO;'.
```

The result of the call is returned in the feedback code, using a variable defined as:

```
01  FC.
    02  CONDITION-TOKEN-VALUE.
    COPY CEEIGZCT.
        03  CASE-1-CONDITION-ID.
            04  SEVERITY    PIC S9(4) BINARY.
            04  MSG-NO      PIC S9(4) BINARY.
        03  CASE-2-CONDITION-ID
                  REDEFINES CASE-1-CONDITION-ID.
            04  CLASS-CODE  PIC S9(4) BINARY.
            04  CAUSE-CODE  PIC S9(4) BINARY.
        03  CASE-SEV-CTL    PIC X.
        03  FACILITY-ID     PIC XXX.
    02  I-S-INFO            PIC S9(9) BINARY.
```

in the DATA DIVISION of your program. You are not prompted for commands.

```
CALL "CEETEST" USING COMMAND-STRING FC.
```

Example: using CEETEST to start Debug Tool from PL/I

The following examples show how to use the Language Environment callable service `CEETEST` to start Debug Tool from PL/I programs.

Example 1

No command string is passed to Debug Tool at its invocation and no feedback code is returned. After it gains control, Debug Tool becomes active and prompts you for commands or reads them from a commands file.

```
CALL  CEETEST(*,*);    /*  omit arguments   */
```

Example 2

A command string is passed to Debug Tool at its invocation and the feedback code is returned. After it gains control, Debug Tool becomes

active and executes the command string. Barring any further interruptions, the program runs to completion, where Debug Tool prompts for further commands.

```
DCL   ch  char(50)
      init('AT STATEMENT 10 DO; LIST(x); LIST(y); END; GO;');

DCL   1  fb,
         5  Severity  Fixed bin(15),
         5  MsgNo     Fixed bin(15),
         5  flags,
            8  Case   bit(2),
            8  Sev    bit(3),
            8  Ctrl   bit(3),
         5  FacID     Char(3),
         5  I_S_info  Fixed bin(31);


DCL   CEETEST  ENTRY  ( CHAR(*)  VAR  OPTIONAL,
         1   optional ,
           254 real fixed bin(15),     /* MsgSev     */
           254 real fixed bin(15),     /* MSGNUM     */
           254                         /* Flags      */,
             255 bit(2),               /* Flags_Case     */
             255 bit(3),               /* Flags_Severity */
             255 bit(3),               /* Flags_Control  */
           254 char(3),                /* Facility_ID    */
           254 fixed bin(31) )         /* I_S_Info    */
                options(assembler) ;

CALL  CEETEST(ch, fb);
```

Example 3

This example assumes that you use predefined function prototypes and macros by including `CEEIBMAW`, and predefined feedback code constants and macros by including `CEEIBMCT`.

A command string is passed to Debug Tool that sets a breakpoint on every tenth executed statement. Once a breakpoint is reached, Debug Tool displays the current location information and continues the execution. After the `CEETEST` call, the feedback code is checked for proper execution.

Note: The feedback code returned is either CEE000 or CEE2F2. There is no way to check the result of the execution of the command passed.

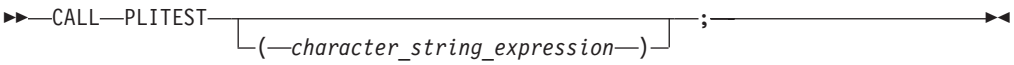
```
%INCLUDE CEEIBMAW;
%INCLUDE CEEIBMCT;
DCL 01 FC FEEDBACK;

/* if CEEIBMCT is NOT included, the following DECLARES need to be
   provided:          ---------- comment start -------------

Declare CEEIBMCT  Character(8) Based;
Declare ADDR      Builtin;
%DCL FBCHECK ENTRY;
%FBCHECK:  PROC( fbtoken, condition ) RETURNS( CHAR );
   DECLARE
      fbtoken    CHAR;
      condition  CHAR;
RETURN('(ADDR('||fbtoken||')->CEEIBMCT = '||condition||')');
%END FBCHECK;
%ACT FBCHECK;
                       ---------- comment end --------------- */

Call CEETEST('AT Every 10 STATEMENT * Do; Q Loc; Go; End;'||
             'List AT;', FC);
```

```
If ¬FBCHECK(FC, CEE000)
   Then Put Skip List('———> ERROR! in CEETEST call', FC.MsgNo);
```

Starting Debug Tool with PLITEST

For PL/I programs, the preferred method of Starting Debug Tool is to use the built-in subroutine PLITEST. It can be used in exactly the same way as CEETEST, except that you do not need to include CEEIBMAW or CEEIBMCT, or perform declarations.

The syntax is:



character_string_expression
Specifies a list of Debug Tool commands. If necessary, this is converted to a fixed-length string.

Notes:

1. If Debug Tool executes a command in a CALL PLITEST command string that causes control to return to the program (GO for example), any commands remaining to be executed in the command string are discarded.
2. If you don't want to compile your program with hooks, you can use CALL PLITEST statements as hooks and insert them at strategic points in your program. If you decide to use this method, you still need to compile your application so that symbolic information is created.

The following examples show how to use PLITEST to start Debug Tool for PL/I.

Example 1

No argument is passed to Debug Tool when it is started. After gaining control, Debug Tool prompts you for commands.

```
CALL PLITEST;
```

Example 2

A string of commands is passed to Debug Tool when it is started. After gaining control, Debug Tool sets a breakpoint at statement 23, and returns control to the program. You are not prompted for commands. In addition, the List Y; command is discarded because of the execution of the GO command.

```
CALL PLITEST('At statement 23 Do; List X; End; Go; List Y;');
```

Example 3

Variable *ch* is declared as a character string and initialized as a string of commands. The string of commands is passed to Debug Tool when it is started. After it runs the commands, Debug Tool prompts you for more commands.

```
DCL  ch   Char(45) Init('At Statement 23 Do; List x; End;');

CALL PLITEST(ch);
```

Starting Debug Tool with the __ctest() function

You can also use the C and C++ library routine __ctest() or ctest() to start Debug Tool. Add:

```
#include <ctest.h>
```

to your program to use the ctest() function.

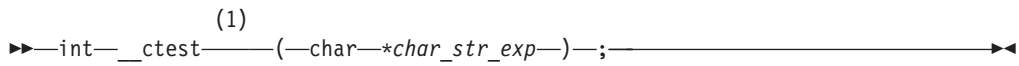
Note: If you do not include ctest.h in your source or if you compile using the option LANGLVL(ANSI), you **must** use __ctest() function. The __ctest() function is not supported in CICS.

When a list of commands is specified with __ctest(), Debug Tool runs the commands in that list. If you specify a null argument, Debug Tool gets commands by reading from the supplied commands file or by prompting you. If control returns to your application before all commands in the command list are run, the remainder of the command list is ignored. Debug Tool will continue reading from the specified commands file or prompt for more input.

If you do not want to compile your program with hooks, you can use __ctest() function calls to start Debug Tool at strategic points in your program. If you decide to use this method, you still need to compile your application so that symbolic information is created.

Using __ctest() when Debug Tool is already initialized results in a reentry that is similar to a breakpoint.

The syntax for this option is:



Notes:

1 The syntax for ctest() and __ctest() is the same.

char_str_exp
Specifies a list of Debug Tool commands.

The following examples show how to use the __ctest() function for C and C++.

Example 1

A null argument is passed to Debug Tool when it is started. After it gains control, Debug Tool prompts you for commands (or reads commands from the primary commands file, if specified).

```
__ctest(NULL);
```

Example 2

A string of commands is passed to Debug Tool when it is started. At statement 23, Debug Tool lists x and y, then returns control to the program. You are not prompted for commands. In this case, the command list z; is never executed because of the execution of the command GO.

```
__ctest("at line 23 {"
        "  list x;"
        "  list y;"
        "}"
        "go;"
        "list z;");
```

Example 3

Variable *ch* is declared as a pointer to character string and initialized as a string of commands. The string of commands is passed to Debug Tool when it is started. After it runs the string of commands, Debug Tool prompts you for more commands.

```
char *ch = "at line 23 list x;";
⋮
__ctest(ch);
```

Example 4

A string of commands is passed to Debug Tool when it is started. After Debug Tool gains control, you are not prompted for commands. Debug Tool runs the commands in the command string and returns control to the program by way of the GO command.

```
#include <stdio.h>
#include <string.h>

char *ch = "at line 23 printf(\"x.y is %d\n\", x.y); go;";
char buffer[35.132];

strcpy(buffer, "at change x.y;");

__ctest(strcat(buffer, ch));
```

Chapter 15. Starting Debug Tool in batch mode

Choose one of the following options to start Debug Tool in batch mode:

- Follow the instructions outlined in this section. This includes modifying your JCL to include the appropriate Debug Tool data sets and TEST runtime options.
- Use the Debug Tool Setup Utility (DTSU). DTSU can generate JCL that includes the appropriate Debug Tool data sets and TEST runtime options, and can submit your batch job. For instructions on how to use DTSU, refer to Chapter 13, "Starting Debug Tool from the Debug Tool Utilities," on page 117.

To start Debug Tool in batch mode without using DTSU, do the following steps:

1. Ensure that you have compiled your program with the TEST compiler option.
2. Modify the JCL that runs your batch program to include the appropriate Debug Tool data sets and to specify the TEST run-time option.
3. Run the modified JCL.

You can interactively debug an MVS batch job by choosing one of the following options:

- In full-screen mode using the Terminal Interface Manager. Follow the instructions in "Starting a debugging session in full-screen mode using the Terminal Interface Manager or a dedicated terminal" on page 133.
- In remote debug mode. Follow the instructions in the topic "Preparing to debug" of the online help for the compiled language debugger component of Rational Developer for System z.

Refer to the following topics for more information related to the material discussed in this topic.

Related tasks

Appendix E, "Notes on debugging in batch mode," on page 477
Chapter 28, "Entering Debug Tool commands," on page 275

Example: JCL that runs Debug Tool in batch mode

Sample JCL for a batch debug session for the COBOL program, EMPLRUN, is provided below. The job card and data set names need to be modified to suit your installation.

```
//DEBUGJCL JOB <appropriate JOB card information>
//* ****************************************************************
//*  JCL to run a batch Debug Tool session
//*    Program EMPLRUN was previously compiled with the COBOL
//*    compiler TEST option
//* ****************************************************************
//STEP1  EXEC PGM=EMPLRUN,
//        PARM='/TEST(,INSPIN,,)'      1
//*
//*  Include the Debug Tool SEQAMOD data set
//*
//STEPLIB     DD DISP=SHR,DSN=userid.TEST.LOAD
//            DD DISP=SHR,DSN=hlq.SEQAMOD
//*
//*  Specify a commands file with DDNAME matching the one
//*    specified in the /TEST runtime option above
//*  This example shows inline data but a data set could be
//*    specified like: //INSPIN  DD DISP=SHR,DSN=userid.TEST.INSPIN
//*
//INSPIN      DD *
```

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```
          STEP;
          AT *
            PERFORM
               QUERY LOCATION;
               GO;
            END-PERFORM;
          GO;
          QUIT;
/*
//*
//*  Specify a log file for the debug session
//*    Log file can be a data set with LRECL >= 42 and <= 256
//*    For COBOL only, use LRECL <= 72 if you are planning to
//*    use the log file as a commands file in subsequent Debug
//*    Tool sessions.  You can specify the log file like:
//*    //INSPLOG   DD DISP=SHR,DSN=userid.TEST.INSPLOG
//*
//INSPLOG     DD SYSOUT=*,DCB=(LRECL=72,RECFM=FB,BLKSIZE=0)
//SYSPRINT    DD SYSOUT=*
//SYSUDUMP    DD DUMMY
//SYSOUT      DD SYSOUT=*
/*
//
```

Modifying the example to debug in full-screen mode

The example in “Example: JCL that runs Debug Tool in batch mode” on page 131 can be modified so that the batch program can be debugged in full-screen mode. Change line **1** to one of the following examples:

- To use full-screen mode using a dedicated terminal without Terminal Interface Manager, use the following statement:

  ```
  //        PARM='/TEST(,INSPIN,,MFI%TRMLU001:)'
  ```

- To use full-screen mode using the Terminal Interface Manager, use the following statement:

  ```
  //        PARM='/TEST(,INSPIN,,VTAM%USERABCD:)'
  ```

Chapter 16. Starting Debug Tool for batch or TSO programs

This section describes how to start Debug Tool to debug programs that run in the following situations:

- Programs that start in Language Environment
- Programs that start outside of Language Environment

Starting a debugging session in full-screen mode using the Terminal Interface Manager or a dedicated terminal

You can debug batch programs interactively by using full-screen mode using the Terminal Interface Manager or full-screen mode using a dedicated terminal without Terminal Interface Manager. Before you start this debugging session, contact your system administrator to verify that your system was customized to support this type of debugging session, and for instructions on how to access a terminal that supports this mode.

You need to decide whether you will use the Debug Tool Terminal Interface Manager. The Debug Tool Terminal Interface Manager enables you to associate a user ID with a specific dedicated terminal, which removes the need to update your runtime parameter string whenever the dedicated terminal LU name changes. This is the recommended method for most users.

To start a debugging session in full-screen mode using the Terminal Interface Manager, do the following steps:

1. Start two terminal emulator sessions in either of the following ways:
   - Two separate emulator windows.
   - If you use IBM Session Manager, you can select two sessions from the IBM Session Manager menu.

   In either case, connect the second emulator session to a terminal that can handle a full-screen mode using the Terminal Interface Manager and that also starts the Terminal Interface Manager.
2. On the first terminal emulator session, log on to TSO.
3. On the second terminal emulator session, provide your TSO user ID and password to the Terminal Interface Manager and press Enter.

   Note: When you provide your user ID and password to the Terminal Interface Manager, you are not logging on TSO. You are only indicating that your user ID is to be associated with this terminal LU.

   A panel similar to the following panel is then displayed on the second terminal emulator session:

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```
                    DEBUG TOOL TERMINAL INTERFACE MANAGER

EQAY001I Terminal TRMLU001 connected for user USER1
EQAY001I Ready for Debug Tool









              PF3=EXIT  PF10=Edit LE options data set  PF12=LOGOFF
```

The terminal is now ready to receive a Debug Tool full-screen mode using the Terminal Interface Manager session.

4. Edit the PARM string of your batch job so that you specify the TEST runtime parameter as follows:

   `TEST(,,,VTAM%userid:*)`

   Place a slash (/) before or after the parameter, depending on our programming language. *userid* is the TSO user ID that you provided to the Terminal Interface Manager.
5. Submit the batch job.
6. On the second terminal emulator session, a full-screen mode debugging session is displayed. Interact with it the same way you would with any other full-screen mode debugging session.
7. After you exit Debug Tool, the second terminal emulator session displays the panel and messages you saw in step 3 on page 133. This indicates that Debug Tool can use this session again. (this will happen each time you exit from Debug Tool).
8. If you want to start another debugging session, return to step 5. If you are finished debugging, you can do one of the following tasks:
   - Close the second terminal emulator session.
   - Exit the Terminal Interface Manager by choosing one of the following options:
     – Press PF12 to display the Terminal Interface Manager logon panel. You can log in with the same ID or a different user ID.
     – Press PF3 to exit the Terminal Interface Manager.

To start a debugging session using a dedicated terminal without the Debug Tool Terminal Interface Manager, do the following steps:

1. Ask your system programmer if you need to specify a VTAM network identifier to communicate with the terminal LU you will use for display. If so, make a note of the network identifier.
2. Start two terminal emulator sessions. Connect the second emulator session to a terminal that can handle a full-screen mode debugging session through a dedicated terminal.

3. On the first terminal emulator session, log on to TSO.
4. On the second terminal emulator session, note the LU name of the terminal. If a session manager is displayed, exit from it.
5. Edit the PARM string of your batch job so that you specify the TEST runtime parameter in one of the following ways:
   - `TEST(,,,MFI%luname:*)`
   - `TEST(,,,MFI%network_identifier.luname:*)`

   Place a slash (/) before or after the parameter, depending on your programming language. *luname* is the VTAM LU name of the second terminal emulator. *network_identifier* is the name of the VTAM network node that contains *luname*.
6. Submit the batch job.
7. On the second terminal emulator session, a full-screen mode debugging session is displayed. Interact with it the same way you would with any other full-screen mode debugging session.
8. After you exit Debug Tool, a USSMSG10 or Telnet Solicitor Logon panel is displayed on the second terminal emulator session.
9. Go back to step 6 if you need to restart the debugging session.

Starting Debug Tool for programs that start in Language Environment

Choose one of the following options to start Debug Tool under MVS in TSO:

- You can follow the instructions outlined in this section. The instructions describe how to allocate all the files you need to start your debug session and how to start your program with the proper parameters.
- Use the Debug Tool Setup Utility (DTSU). DTSU helps you allocate all the files you need to start your debug session, and can start your program or submit your batch job. For instructions on using DTSU, refer to Chapter 13, “Starting Debug Tool from the Debug Tool Utilities,” on page 117.

To start Debug Tool under MVS in TSO without using DTSU, do the following steps:

1. Ensure your program has been compiled with the `TEST` compiler option.
2. Ensure that the Debug Tool SEQAMOD library is in the load module search path.

   Note: High-level qualifiers and load library names are specific to your installation. Ask the person who installed Debug Tool the name of the data set. By default, the name of the data set ends in SEQAMOD. This data set might already be in the linklist or included in your TSO logon procedure, in which case you don't need to do anything to access it.
3. Allocate all other data sets containing files your program needs.
4. Allocate any Debug Tool files that you want to use. For example, if you want a session log file, allocate a data set for the session log file. Do not allocate the session log file to a terminal. For example, do not use `ALLOC FI(INSPLOG) DA(*)`.
5. Start your program with the `TEST` run-time option, specifying the appropriate suboptions, or include a call to `CEETEST`, `PLITEST`, or `__ctest()` in the program's source.

Refer to the following topics for more information related to the material discussed in this topic.

Related tasks

Chapter 12, “Writing the TEST run-time option string,” on page 111

"Starting a debugging session in full-screen mode using the Terminal Interface Manager or a dedicated terminal" on page 133
"Recording your debug session in a log file" on page 176
Chapter 14, "Starting Debug Tool from a program," on page 121
Related references
Debug Tool Reference and Messages
z/OS Language Environment Programming Guide

Example: Allocating Debug Tool load library data set

The following example CLIST fragments show how you might allocate the Debug Tool load library data set (SEQAMOD) if it is not in the linklist or TSO logon procedure:

Example 1:

```
PROC 0 TEST
TSOLIB ACTIVATE DA('hlq.SEQAMOD')
END
```

Example 2:

```
PROC 0 TEST
TSOLIB DEACTIVATE
FREE FILE(SEQAMOD)
ALLOCATE DA('hlq.SEQAMOD') FILE(SEQAMOD) SHR REUSE
TSOLIB ACTIVATE FILE(SEQAMOD)
END
```

If you store either example CLIST in `MYID.CLIST(DTSETUP)`, you can run the CLIST by entering the following command at the TSO READY prompt:

```
EXEC 'MYID.CLIST(DTSETUP)'
```

The CLIST runs and the appropriate Debug Tool data set is allocated.

Example: Allocating Debug Tool files

The following example illustrate how you can use the command line to allocate the preferences and log files, then start the COBOL program `tstscrpt` with the `TEST` run-time option:

```
ALLOCATE FILE(inspprefe) DATASET(setup.pref) REUSE
ALLOCATE FILE(insplog) DATASET(session.log) REUSE
CALL 'USERID1.MYLIB(TSTSCRPT)' '/TEST'
```

The example illustrates that the default Debug Tool run-time suboptions and the default Language Environment run-time options were assumed.

The following example illustrates how you can use a CLIST to define the preferences file (`debug.preferen`) and the log file (`debug.log`), then start the C program `prog1` with the `TEST` run-time option:

```
ALLOC FI(insplog)  DA(debug.log)             REUSE
ALLOC FI(inspprefe) DA(debug.preferen)       REUSE

CALL 'MYID.MYQUAL.LOAD(PROG1)' +
    ' TRAP(ON) TEST(,*,;,inspprefe)/'
```

All the data sets must exist before starting this CLIST.

Starting Debug Tool for programs that start outside of Language Environment

To debug an MVS batch or TSO program that has an initial program that does not run under the control of Language Environment, including non-Language Environment COBOL programs, use the Debug Tool program EQANMDBG to start Debug Tool.

If the initial program does run under the control of Language Environment and subsequent programs run outside the control of Language Environment, you can use the methods described in “Starting Debug Tool for programs that start in Language Environment” on page 135 to debug all the programs.

To start Debug Tool by using EQANMDBG, do one of the following options:

- By using the Debug Tool Setup Utility (DTSU) option 3 to run the programs either under TSO or in MVS batch.
- By modifying the MVS JCL, TSO CLIST or REXX EXEC that you use to start your program, making the following changes:
  - Change the name of the program to be started to EQANMDBG.
  - Make one of the following updates:
    - Change the parameters by adding the name of the program to be debugged and any required Debug Tool run-time parameters. See “Passing parameters to EQANMDBG by using only the PARM string” on page 138 for instructions.
    - Add a EQANMDBG DD statement that provides the name of the program to be debugged and any required Debug Tool run-time parameters. See “Passing parameters to EQANMDBG using only the EQANMDBG DD statement” on page 138 for instructions.
    - Change the parameters by adding the name of the program to be debugged, and add an EQANMDBG DD statement that provides any required Debug Tool run-time parameters. See “Passing parameters to EQANMDBG using the PARM string and EQANMDBG DD statement” on page 139 for instructions.
    - Verify that the Debug Tool SEQAMOD and SEQABMOD libraries are in the load module search path.

Refer to the following topics for more information related to the material discussed in this topic.

Related tasks

Chapter 13, “Starting Debug Tool from the Debug Tool Utilities,” on page 117

Passing parameters to EQANMDBG

When you modify your JCL, CLIST, or REXX EXEC to start EQANMDBG, you pass the following parameters to EQANMDBG:

- The name of the user program to be debugged (required)
- Any of the following run-time options (optional):
  - `TEST` to specify Debug Tool options. For example, you can use suboptions of the `TEST` run-time option to specify the data sets that contain Debug Tool commands and preferences. You can use suboptions to specify whether to use a remote debug mode session or a full-screen mode using the Terminal Interface Manager session.

– NATLANG to specify the national language used to communicate with Debug Tool
– COUNTRY to specify a country code for Debug Tool
– TRAP to specify whether Debug Tool is to intercept abends.

You can specify these parameters in one of following ways:

- "Passing parameters to EQANMDBG by using only the PARM string"
- "Passing parameters to EQANMDBG using only the EQANMDBG DD statement"
- "Passing parameters to EQANMDBG using the PARM string and EQANMDBG DD statement" on page 139

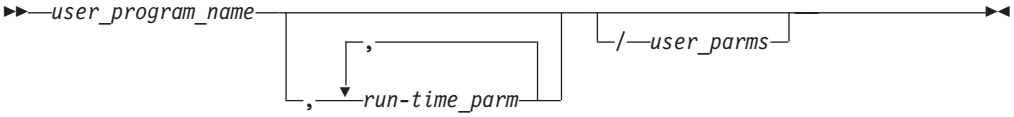
Refer to the following topics for more information related to the material discussed in this topic.

Related references
Debug Tool run-time options (*Debug Tool Reference and Messages*)

Passing parameters to EQANMDBG by using only the PARM string

The easiest way to pass parameters to EQANMDBG is to modify the PARM string to contain the name of the program to be debugged, optionally followed by any of the Debug Tool run-time options and the parameters required by your program.

The syntax for this string is:



The following table compares how a sample JCL statement might look like after you modify the PARM string:

Original sample JCL	Modified sample JCL

`//STEP1 EXEC PGM=MYPROG,PARM='ABC,X(12)'`
`  ...`
`//`
	`//STEP1 EXEC PGM=EQANMDBG,`
	`// PARM='MYPROG,NATLANG(UEN)/ABC,X(12)'`
	`  ...`
	`//`

Passing parameters to EQANMDBG using only the EQANMDBG DD statement

If the user parameter string that you are passing to your program is too long to add the necessary Debug Tool parameters to the PARM string, you can leave the PARM string unchanged and pass all required parameters to Debug Tool by using the EQANMDBG DD statement.

When you add an EQANMDBG DD statement to your JCL or allocate the EQANMDBG file in your TSO session, it can point to a data set with any RECFM (F, V, or U) and any LRECL. The data set must contain one or more lines. If it contains more than one line, all trailing blanks are removed from each line. However, each line is assumed to start in column 1 with any leading blanks considered to be part of the parameter data. Sequence numbers are not supported in this file.

The following table compares original JCL and modified JCL:

Original JCL	Modified JCL

`//STEP1 EXEC PGM=MYPROG,PARM='ABC,X(12)'`
`  ...`
`//`
	`//STEP1 EXEC PGM=EQANMDBG,`
	`// PARM='ABC,X(12)'`
	`//EQANMDBG DD *`
	`MYPROG,`
	`TEST(ALL,INSPIN,,MFI:*),`
	`NATLANG(ENU)`
	`/*`
	`  ...`
	`//`

Passing parameters to EQANMDBG using the PARM string and EQANMDBG DD statement

With this method you can put the name of the user program to be debugged as part of the PARM string, and then specify all other Debug Tool run-time options by using the EQANMDBG DD statement.

This can be desirable if you need to pass the same run-time parameters to several programs, you have room in the PARM string to add the name of the program to be debugged, but you do not have room to add all of the run-time parameters to the PARM string.

When you use this method, you must do the following:

- Include an EQANMDBG DD statement that includes, at a minimum, an asterisk as the first positional parameter to indicate that the user-program name is to be taken from the PARM string.
- Modify the PARM string to include the user-program name followed by a slash at the beginning of the PARM string.

The following table compares original JCL and modified JCL:

Original JCL	Modified JCL

`//STEP1 EXEC PGM=MYPROG,PARM='ABC,X(12)'`
`  ...`
`//`
	`//STEP1 EXEC PGM=EQANMDBG,`
	`// PARM='MYPROG/ABC,X(12)'`
	`//EQANMDBG DD *`
	`*,TEST(ALL,INSPIN,,MFI:*),NATLANG(ENU)`
	`/*`
	`  ...`
	`//`

Example: Modifying JCL that invokes an assembler DB2 program running in a batch TSO environment

The following example shows a portion of JCL that invokes an assembler DB2 program and the modifications you make to this portion of the JCL to start Debug Tool.

Original sample JCL	Modified sample JCL

//RUN EXEC PGM=IKJEFT01,DYNAMNBR=20
//SYSTSIN DD *
 DSN SYSTEM(*DB2_subsystem_id*)
 RUN PROGRAM(MYPGM) PLAN(MYPGM) -
  PARM('*program-parameters*')
 END
/*
// ... other DD statements as needed ...
// ... for TSO and the application ...
	//RUN EXEC PGM=IKJEFT01,DYNAMNBR=20
	//SYSTSIN DD *
	 DSN SYSTEM(*DB2_subsystem_id*)
	 RUN PROGRAM(EQANMDBG) PLAN(MYPGM) -
	  PARM('*program-parameters*')
	 END
	/*
	//EQANMDBG DD *
	MYPGM,TEST(,,,VTAM%*user-id*:)
	/*
	// ... other DD statements as needed ...
	// ... for TSO and the application ...

Chapter 17. Starting Debug Tool under CICS

This topic compares the different methods you can use to start Debug Tool and gives instructions on each method. This topic assumes you have completed the following tasks:

- Ensured that all of the required installation and configuration steps for CICS Transaction Server, Language Environment, and Debug Tool have been completed. For more information, refer to the installation and customization guides for each product.
- Completed all the tasks in the following topics:
  - Chapter 3, “Planning your debug session,” on page 23
  - Chapter 4, “Updating your processes so you can debug programs with Debug Tool,” on page 59
  - Chapter 9, “Preparing a CICS program,” on page 83

Comparison of methods for starting Debug Tool under CICS

There are several different mechanisms available to start Debug Tool under CICS. Each mechanism has a different advantage and are listed below:

- DTCN is a Debug Tool-supplied full-screen CICS transaction that allows you to create a profile that contains a pattern of CICS resource names that identify a task that you want to debug. You can change any Language Environment `TEST` or `NOTEST` runtime option with which your application was originally link-edited. You can also use DTCN to modify other Language Environment runtime options that are not specific to Debug Tool. To learn how to set up profiles with DTCN, see Chapter 9, “Preparing a CICS program,” on page 83.
- CADP is a CICS transaction that enables you to manage debugging profiles. This transaction is available with CICS Transaction Server for z/OS Version 2 Release 3. CADP has the following advantages over DTCN:
  - With CADP, multiple profiles with a single program name can be added from the same display device. There is no limit to the number of profiles supported. With DTCN, a single profile, with up to eight program ids, can be added from a single display device. In either case, the program names can be specified with wild cards.
  - CADP provides the same abilities as DTCN for managing debug profiles for Language Environment applications. CADP can also help manage debug profiles for Java applications, Enterprise Java Beans (EJBs), and CORBA stateless objects.
  - CADP profiles are persistent, and are kept in VSAM files. Persistence means that if the CADP profile was present before a CICS region is restarted, the CADP profile will be present after the CICS region is restarted. For DTCN profiles, if the CICS region that owns the temporary storage queue where the debugging profiles were defined is restarted, the DTCN profiles must be added again after the region is restarted.
  - CADP profiles can be shared across a CICSPLEX.
- Language Environment CEEUOPT module link-edited into your application, containing an appropriate `TEST` option, which tells Language Environment to start Debug Tool every time the application is run.

  This mechanism can be useful during initial testing of new code when you will want to run Debug Tool frequently.

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- A compiler directive within the application, such as `#pragma runopts(test)` (for C and C++) or `CALL CEETEST`.

  These directives can be useful when you need to run multiple debug sessions for a piece of code that is deep inside a multiple enclave or multiple CU application. The application runs without Debug Tool until it encounters the directive, at which time Debug Tool is started at the precise point that you specify. With `CALL CEETEST`, you can even make the invocation of Debug Tool conditional, depending on variables that the application can test.

If your program uses several of these methods, the order of precedence is determined by Language Environment. For more information about the order of precedence for Language Environment run-time options, see *z/OS Language Environment Programming Guide*.

Starting Debug Tool under CICS by using DTCN

If a DTCN profile exists, when a CICS program starts, Debug Tool analyzes the program's resources to see if they match a profile. If Debug Tool finds a match, Debug Tool starts a debugging session for that program. If multiple profiles exist, Debug Tool selects the profile with the greatest number of resources that match the program. If two programs have an equal number of matching resources, Debug Tool selects the older profile.

Before you begin, verify that you prepared your CICS program as instructed in Chapter 9, “Preparing a CICS program,” on page 83.

To start Debug Tool under CICS by using DTCN, do the following steps:

1. If you chose screen control mode, start the DTSC transaction on the terminal you specified in the **Display Id** field.
2. Run your CICS programs. If Debug Tool identifies a task that matches a DTCN profile, Debug Tool starts. If you chose screen control mode, press Enter on the terminal running the DTSC transaction to connect to Debug Tool.

Ending a CICS debugging session that was started by DTCN

After you have finished debugging your program, use DTCN again to turn off your debug profile by pressing PF6 to delete your debug profile and then pressing PF3 to exit. You do not need to remove `EQADCCXT` from the load module; in fact, it's a good idea to leave it there for the next time you want to start Debug Tool.

Example: How Debug Tool chooses a CICS program for debugging

For example, consider the following two profiles:

- First, profile A is saved, specifying resource CU PROG1
- Later, profile B is saved, specifying resource User Id USER1

When PROG1 is run by USER1, profile A is used.

If this situation occurs, an error message is displayed on the system console, suggesting that you should specify additional resources. In the above example, each profile should specify both a User Id and a CU resource.

Refer to the following topics for more information related to the material discussed in this topic.

Related tasks

"Choosing TEST or NOTEST compiler suboptions for COBOL programs" on page 27

Starting Debug Tool for CICS programs by using CADP

Before you begin, verify that you prepared your CICS program as instructed in Chapter 9, "Preparing a CICS program," on page 83.

To start Debug Tool under CICS by using CADP, do the following steps:

1. If you chose screen control mode, start the DTSC transaction on the terminal you specified in the **Display Id** field.
2. Run your CICS programs. If Debug Tool identifies a task that matches a CADP profile, Debug Tool starts. If you chose screen control mode, press Enter on the terminal running the DTSC transaction to connect to Debug Tool.

Refer to the following topics for more information related to the material discussed in this topic.

Related tasks

"Creating and storing debugging profiles with CADP" on page 95

Related references

CICS Supplied Transactions

Starting Debug Tool under CICS by using CEEUOPT

To request that Language Environment start Debug Tool every time the application is run, assemble a CEEUOPT module with an appropriate `TEST` run-time option. It is a good idea to link-edit the CEEUOPT module into a library and just add an `INCLUDE LibraryDDname(CEEUOPT-MemberName)` statement to the link-edit options when you link your application. Once the application program has been placed in the load library (and NEWCOPY'd if required), whenever it is run Debug Tool will be started.

Debug Tool runs in the mode defined in the `TEST` run-time option you supplied, normally Single Terminal mode, although you could provide a primary commands file and a log file and not use a terminal at all.

To start Debug Tool, simply run the application. Don't forget to remove the CEEUOPT containing your `TEST` run-time option when you have finished debugging your program.

Refer to the following topics for more information related to the material discussed in this topic.

Related tasks

Chapter 12, "Writing the TEST run-time option string," on page 111

Starting Debug Tool under CICS by using compiler directives

When compile-directives are processed by your program, Debug Tool will be started in single terminal mode (this method supports only single terminal mode).

Refer to the following topics for more information related to the material discussed in this topic.

Related tasks

"Starting Debug Tool with CEETEST" on page 121

Chapter 18. Starting a full-screen debug session

You can start Debug Tool by using the Language Environment TEST run-time option in one of the following ways:

- Using the Debug Tool Setup Utility (DTSU). DTSU helps you allocate files and can start your program. The methods listed below describe how you manually perform the same tasks.
- For TSO programs that start in Language Environment, start your program with the TEST run-time option as described in “Starting Debug Tool for programs that start in Language Environment” on page 135.
- For MVS batch programs that start in Language Environment, start your Language Environment program with the TEST run-time option and specify the appropriate suboptions, as described in Chapter 15, “Starting Debug Tool in batch mode,” on page 131.
- For MVS batch programs that do not start in Language Environment, start the non-Language Environment Debug Tool (EQANMDBG), and pass your program name and the TEST run-time option. Specify the appropriate suboptions, as described in “Starting Debug Tool for programs that start outside of Language Environment” on page 137.
- For CICS, make sure Debug Tool is installed in your CICS region. Enter DTCN or CADP (in CICS Transaction Server for z/OS Version 2 Release 3 and later) to start the Debug Tool control transaction. Enter the name of the transaction and program that you want to debug and any other criteria, such as terminal id or user id. If you are using DTCN, press PF4 to save the default debugging profile, then press PF3 to exit the DTCN transaction. You are now setup to start your transaction and begin a debugging session.

  If you are using CADP to manage your debugging profiles, make sure that the DEBUGTOOL system initialization parameter is set to YES.
- For CICS transactions that run non-Language Environment assembler programs or non-Language Environment COBOL programs, verify with your system administrator that the Debug Tool CICS global user exits are installed and active. If exits are active and the non-Language Environment assembler or non-Language Environment COBOL programs are defined in a DTCN or CADP debugging profile, Debug Tool will debug the non-Language Environment assembler or non-Language Environment COBOL programs. These programs must be the first program to run at a CICS Link Level (for example, at the start of a task or through a CICS LINK or XCTL request).

Refer to the following topics for more information related to the material discussed in this topic.

Related tasks

Chapter 13, “Starting Debug Tool from the Debug Tool Utilities,” on page 117
“Choosing TEST or DEBUG compiler suboptions for C programs” on page 37
“Choosing TEST or DEBUG compiler suboptions for C++ programs” on page 42
“Choosing TEST or NOTEST compiler suboptions for COBOL programs” on page 27
“Choosing TEST or NOTEST compiler suboptions for PL/I programs” on page 32
“Ending a full-screen debug session” on page 203
“Entering commands on the session panel” on page 161
“Passing parameters to EQANMDBG” on page 137

Related references

“Debug Tool session panel” on page 151

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Chapter 19. Starting Debug Tool in other environments

You can start Debug Tool to debug batch programs from DB2 stored procedures.

Starting Debug Tool from DB2 stored procedures

Before you run the stored procedure, verify that you have completed all the instructions in Chapter 8, “Preparing a DB2 stored procedures program,” on page 79.

To verify that the stored procedure has started, enter the following DB2 Display command, where *xxxx* is the name of the stored procedure:

```
Display Procedure(xxxx)
```

If the stored procedure is not started, enter the following DB2 command:

```
Start procedure(xxxx)
```

If Debug Tool or the remote debugger do not start when the stored procedure calls them, verify that you have correctly specified connection information (for example, the TCP/IP address and port number) in the Language Environment EQADDCXT exit routine or the DB2 catalog.

Refer to the following topics for more information related to the material discussed in this topic.

Related tasks

Chapter 3, “Planning your debug session,” on page 23

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Part 4. Debugging your programs in full-screen mode

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Chapter 20. Using full-screen mode: overview

The topics below describe the Debug Tool full-screen interface, and how to use this interface to perform common debugging tasks.

Debugging your programs in full-screen mode is the easiest way to learn how to use Debug Tool, even if you plan to use batch or line modes later.

The following list describes the maximum screen size supported by Debug Tool for a particular type of terminal:

- In full screen mode, you can use any screen size supported by ISPF.
- In full-screen mode using the Terminal Interface Manager or a CICS terminal, you can use a maximum screen size (number of rows times number of columns) of 10922. If the number of rows times the number of columns is not less than 10923, Debug Tool displays a WTO error message and abends.

Note: The PF key definitions used in these topics are the default settings.

Refer to the following topics for more information related to the material discussed in this topic.

Related tasks

Chapter 18, “Starting a full-screen debug session,” on page 145
“Ending a full-screen debug session” on page 203
“Entering commands on the session panel” on page 161
“Navigating through Debug Tool windows” on page 168
“Recording your debug session in a log file” on page 176
“Setting breakpoints to halt your program at a line” on page 179
“Setting breakpoints in a load module that is not loaded or in a program that is not active” on page 179
“Stepping through or running your program” on page 181
“Displaying and monitoring the value of a variable” on page 188
“Displaying error numbers for messages in the Log window” on page 201
“Displaying a list of compile units known to Debug Tool” on page 201
“Requesting an attention interrupt during interactive sessions” on page 202
Chapter 24, “Debugging a C program in full-screen mode,” on page 233
Chapter 25, “Debugging a C++ program in full-screen mode,” on page 243
Chapter 21, “Debugging a COBOL program in full-screen mode,” on page 205
Chapter 23, “Debugging a PL/I program in full-screen mode,” on page 223

Debug Tool session panel

The Debug Tool session panel contains a header with information about the program you are debugging, a command line, and up to three physical windows. A physical window is the space on the screen dedicated to the display of a specific type of debugging information. The debugging information is organized into the following types, called logical windows:

Monitor window
Variables and their values, which you can display by entering the `SET AUTOMONITOR ON` and `MONITOR` commands.

Source window
The source or listing file, which Debug Tool finds or you can specify where to find it.

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Log window
The record of your interactions with Debug Tool and the results of those interactions.

Memory window
Section of memory, which you can select by entering the MEMORY command.

Each physical window can be assigned only one logical window. The physical window assumes the name of the logical window, so when you enter commands that affect the physical window (for example, the WINDOW SIZE command), you identify the physical window by providing the name of its assigned logical window. Physical windows can be closed (not displayed), but at least one physical window must remain open at any time.

The Debug Tool session panel below shows the default layout which contains three physical windows: one for the Monitor window **1**, a second for the Source window **2**, and the third for the Log window **3**.

```
COBOL    LOCATION: DTAM01 :> 109.1
Command ===>                                                Scroll ===> PAGE
MONITOR -+----1----+----2----+----3----+----4----+----5----+----6- LINE: 1 OF 7
*************************** TOP OF MONITOR ********************************
                                ----+----1----+----2----+----3----+----4----
0001  1 NUM1                     0000000005
0002  2 NUM4                    '1111'          1
0003  3 WK-LONG-FIELD-2          '123456790 223456790 323456790 423456790 5234
0004                             56790 623456790 723456790 8234567890 9234567
0005                             90 023456790 123456790 223456790 323456790 4
0006                             23456790 5234567890 623456790 723456790 8234
SOURCE: DTAM01 ---1----+----2----+----3----+----4----+----5--- LINE: 107 OF 196
     107       *    SINGLE DATAITEM IN A STRUCTURE                          .
     108       *------------------------------------------------------------ .
     109            ADD 1 TO AA-NUM1       2                                 .
     110                                                                      .
     111       *------------------------------------------------------------ .
     112       *    SINGLE DATAITEM IN A STRUCTURE - QUALIFIED                .
LOG 0----+----1----+----2----+----3----+----4----+----5----+---- LINE: 40 OF 43
0040  MONITOR
0041    LIST NUM4 ;
0042  MONITOR                                   3
0043    LIST WK-LONG-FIELD-2 ;
```

Refer to the following topics for more information related to the material discussed in this topic.

Related tasks
“Customizing the layout of physical windows on the session panel” on page 266
Related references
“Session panel header”
“Monitor window” on page 155
“Source window” on page 154
“Log window” on page 156
“Memory window” on page 157

Session panel header

The first few lines of the Debug Tool session panel contain a command line and header fields that display information about the program that you are debugging.

Below is an example header for a C program.

```
 C 1        LOCATION: MYID.SOURCE(TSTPGM1):>248           2
Command ===>  3                                  SCROLL ===> PAGE    4
                          5
```

Below is an example header for a COBOL program.

```
COBOL  1            LOCATION:  XYZPROG::>SUBR:>118    2
Command ===>  3                                  SCROLL ===> PAGE    4
                          5
⋮
```

The header fields are described below.

1 Assemble, C, COBOL, LX COBOL, Disassem, or PL/I

The name of the current programming language. This language is not necessarily the programming language of the code in the Source window. The language that is displayed in this field determines the syntax rules that you must follow for entering commands.

Notes:

1. Debug Tool does not differentiate between C and C++ programs. If there is a C++ program in the Source window, only C is displayed in this field.
2. LX COBOL is used to indicate LangX COBOL.

2 LOCATION

The program unit name and statement where execution is suspended, usually in the form *compile unit:>nnnnnn*.

In the C example above, execution in `MYID.SOURCE(TSTPGM1)` is suspended at line 248.

In the COBOL example above, execution in XYZPROG is suspended at `XYZPROG::>SUBR:>118`, or line 118 of subroutine `SUBR`.

If you are replaying recorded statements, the word "LOCATION" is replaced by `PBK<LOC` or `PBK>LOC`. The < and > symbols indicate whether the recorded statements are being replayed in the backward (<) or forward (>) direction.

If you are using the Enterprise PL/I compiler or the C/C++ compiler, the compile unit name is the entire data set name of the source. If the setting for `LONGCUNAME` is `ON` (the default) to display the CU name in long form, the name might be truncated. If your PL/I program was compiled with the following compiler and running in the following environment, the package statement or the name of the main procedure is displayed.

- Enterprise PL/I for z/OS, Version 3.5, compiler with the PTFs for APARs PK35230 and PK35489 applied, or Enterprise PL/I for z/OS, Version 3.6 or later
- Language Environment, Version 1.6 through 1.8 with the PTF for APAR PK33738 applied, or later

3 COMMAND

The input area for the next Debug Tool command. You can enter any valid Debug Tool command here.

4 SCROLL

The number of lines or columns that you want to scroll when you enter a

SCROLL command without an amount specified. To hide this field, enter the SET SCROLL DISPLAY OFF command. To modify the scroll amount, use the SET DEFAULT SCROLL command.

The value in this field is the operand applied to the SCROLL UP, SCROLL DOWN, SCROLL LEFT, and SCROLL RIGHT scrolling commands. Table 17 lists all the scrolling commands.

Table 17. Scrolling commands

Command	Description
n	Scroll by *n* number of lines.
HALF	Scroll by half a page.
PAGE	Scroll by a full page.
TOP	Scroll to the top of the data.
BOTTOM	Scroll to the bottom of the data.
MAX	Scroll to the limit of the data.
LEFT *x*	Scroll to the left by *x* number of characters.
RIGHT *x*	Scroll to the right by *x* number of characters.
CURSOR	Position of the cursor.
TO *x*	Scroll to line *x*, where *x* is an integer.

5 Message areas
Information and error messages are displayed in the space immediately below the command line.

Source window

```
1 SOURCE: MULTCU ---1----+----2----+----3----+----4----+----5----+ LINE: 70 OF 85
      70        PROCEDURE DIVISION.                                        .
      71       ************************************************************ .
      72       * THIS IS THE MAIN PROGRAM AREA.  This program only displays   .
      73       *         text. 3                                            .
      74       ************************************************************ .

  2   75            DISPLAY "MULTCU COBOL SOURCE STARTED." UPON CONSOLE.      .
      76            MOVE 25 TO PROGRAM-USHORT-BIN.                            .
      77            MOVE -25 TO PROGRAM-SSHORT-BIN.                           . 4
      78            PERFORM TEST-900.                                         .
      79            PERFORM TEST-1000.                                        .
      80            DISPLAY "MULTCU COBOL SOURCE ENDED." UPON CONSOLE.        .
```

The Source window displays the source file or listing. The Source window has four parts, described below.

1 Header area
Identifies the window, shows the compile unit name, and shows the current position in the source or listing.

2 Prefix area
Occupies the left-most eight columns of the Source window. Contains statement numbers or line numbers you can use when referring to the statements in your program. You can use the prefix area to set, display, and remove breakpoints with the prefix commands AT, CLEAR, ENABLE, DISABLE, QUERY, and SHOW.

3 Source display area

Shows the source code (for a C and C++ program), the source listing (for a COBOL, LangX COBOL, or PL/I program), a pseudo assembler listing (for an assembler program), or the disassembly view (for programs without debug information) for the currently qualified program unit. If the current executable statement is in the source display area, it is highlighted.

4 Suffix area

A narrow, variable-width column at the right of the screen that Debug Tool uses to display frequency counts. It is only as wide as the largest count it must display.

The suffix area is optional. To show the suffix area, enter `SET SUFFIX ON`. To hide the suffix area, enter `SET SUFFIX OFF`. You can also set it on or off with the *Source Listing Suffix* field in the Profile Settings panel.

The labeled header line for each window contains a scale and a line counter. If you scroll a window horizontally, the scale also scrolls to indicate the columns displayed in the window. The line counter indicates the line number at the top of a window and the total number of lines in that window. If you scroll a window vertically, the line counter reflects the top line number currently displayed in that window.

Refer to the following topics for more information related to the material discussed in this topic.

Related tasks

"Entering prefix commands on specific lines or statements" on page 164
"Customizing profile settings" on page 269

Monitor window

The Monitor window displays the names and values of variables selected by the `SET AUTOMONITOR` or `MONITOR` commands.

The following diagram shows the default Monitor window and highlights the parts of the Monitor window:

```
COBOL    LOCATION: DTAM01 :> 109.1
Command ===>                                                  Scroll ===> PAGE
MONITOR -+----1----+----2----+----3----+----4----+----5----+----6- LINE: 1 OF 7
******************************** TOP OF MONITOR *******************************
                                  -----+----1----+----2----+- 1 --3----+----4--
0001  1 NUM1                       0000000005
0002  2 NUM4                      '1111'          2
0003  3 WK-LONG-FIELD-2           '123456790 223456790 323456790 423456790 5234
0004      3                        56790 623456790 723456790 8234567890 9234567
0005                               90 023456790 123456790 223456790 323456790 4
0006  4                            23456790 5234567890 623456790 723456790 8234
0007  4 HEX-NUM1                 X'ABCD 1234'
```

1 Monitor value scale, which provides a reference to help you measure the column position in the Monitor value area.

2 Monitor value area, where Debug Tool displays the values of the variables. Debug Tool extends the display to the right up to the full width of the displayable area of the Monitor window.

3 Monitor name area, where Debug Tool displays the names of the variables.

4 Monitor reference number area, where Debug Tool displays the reference number it assigned to a variable.

When you enter the MONITOR LIST, MONITOR QUERY, MONITOR DESCRIBE, and SET AUTOMONITOR commands, Debug Tool displays the output in the Monitor window. If this window is not open, Debug Tool opens it when you enter a MONITOR or SET AUTOMONITOR command.

By default, the Monitor window displays a maximum of 1000 lines. You can change this maximum by using the SET MONITOR LIMIT command. However, monitoring large amounts of data can use large amounts of storage, which might create problems. Verify that there is enough storage available to monitor large data items or data items that contain a large number of elements. To find out the current maximum, enter the QUERY MONITOR LIMIT command.

Refer to the following topics for more information related to the material discussed in this topic.

Related tasks

"Adding variables to the Monitor window" on page 190
"Replacing a variable in the Monitor window with another variable" on page 192
"Adding variables to the Monitor window automatically" on page 192
"Scrolling through the physical windows" on page 169

Related references

"SET MONITOR command" in *Debug Tool Reference and Messages*
"QUERY command" in *Debug Tool Reference and Messages*

Log window

```
LOG 0----+----1----+----2----+----3----+----4----+----5----+----6 LINE: 6 OF 14
0007  MONITOR
0008    LIST PROGRAM-USHORT-BIN ;
0009  MONITOR
0010    LIST PROGRAM-SSHORT-BIN ;
0011  AT 75 ;
0012  AT 77 ;
0013  AT 79 ;
0014  GO ;
```

The Log window records and displays your interactions with Debug Tool.

At the beginning of a debug session, if you have specified any of the following files, the Log window displays messages indicating the beginning and end of any commands issued from these files:

- global preferences file
- preferences file
- commands file

If a global preferences file exists, the data set name of the global preferences file is displayed.

The following commands are not recorded in the Log window.

```
PANEL
FIND
CURSOR
RETRIEVE
SCROLL
WINDOW
IMMEDIATE
```

QUERY prefix command
SHOW prefix command

If SET INTERCEPT ON is in effect for a file, that file's output also appears in the Log window.

You can optionally exclude STEP and GO commands from the log by specifying SET ECHO OFF.

Commands that can be used with IMMEDIATE, such as the SCROLL and WINDOW commands, are excluded from the Log window.

By default, the Log window keeps 1000 lines for display. The default value can be changed by one of the following methods:

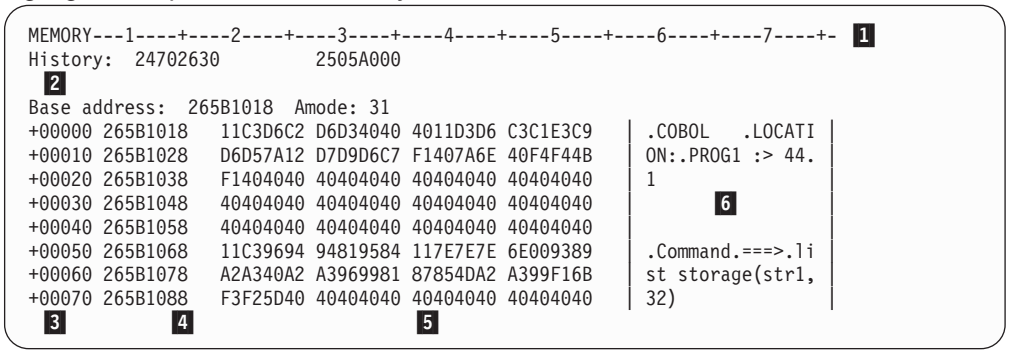
- The system administrator changes it through a global preferences file.
- You can change it through a preferences file.
- You can change it by entering SET LOG KEEP *n*, where *n* is the number of lines you want kept for display

The maximum number of lines is determined by the amount of storage available.

The labeled header line for each window contains a scale and a line counter. If you scroll a window horizontally, the scale also scrolls to indicate the columns displayed in the window. The line counter indicates the line number at the top of a window and the total number of lines in that window. If you scroll a window vertically, the line counter reflects the top line number currently displayed in that window.

Memory window

The Memory window displays the contents of memory. The following figure highlights the parts of the Memory window.



1 Header area
The header area identifies the window and contains a scale.

2 Information area
The information area displays a memory history of up to 8 base addresses. The information area also displays the address mode and up to 8 unique base addresses.

The following sections are collectively known as the memory dump area.

3 Offset column
The offset column displays the offset from the base address of the line of data in memory.

4 Address column
The address column displays the low-order 32 bits of the starting address of the line of data in memory.

5 Hexadecimal data column
The hexadecimal data area displays data in hexadecimal format. Each line displays 16 bytes of memory in four 4 byte groups.

6 Character data column
The character data area displays data in character format. Each line displays 16 bytes of memory.

The maximum number of lines that the Memory window can display is limited to the size of the window. You can use the `SCROLL DOWN` and `SCROLL UP` commands to display additional memory.

Refer to the following topics for more information related to the material discussed in this topic.

Related tasks

"Navigating through the Memory window using the history area" on page 174

Command pop-up window

Debug Tool displays the Command pop-up window as a pop-up window over the Source, Log, and Monitor windows so that you to can more easily enter long or multiline commands. Debug Tool displays the Command pop-up window when any of the following situations occur:

- You enter the `POPUP` command
- You enter an incomplete command on the command line
- You enter a continuation character on the command line
- You type over long text in the Source or Log window

You can control the size of the window by doing any of the following actions:

- When you enter the `POPUP` command, specify the number of lines you want for that particular instance of a Command pop-up window
- If you want the Command pop-up window to display the same number of lines every time you enter the `POPUP` command, specify the number of lines you want with the `SET POPUP` command
- Resize the window by moving the cursor below the last line in the Command pop-up window and then press Enter

After you finish entering commands, press Enter to run the commands and close the window.

List pop-up window

When the Log window is not visible, Debug Tool displays the results of a `LIST` *`expression`* command in the List pop-up window and writes the results to the log. If the expression evaluation fails, Debug Tool displays the List pop-up window with the error message. While the List pop-up window is open, you can not alter the value of a variable. You can scroll up and down in the List pop-up window by entering the `SCROLL UP` and `SCROLL DOWN` commands in the Command line or using the appropriate PF key. The maximum lines of data for the List pop-up window can not exceed 1000 lines. If the result of the expression evaluation exceeds 1000 lines, Debug Tool displays a warning message below the Command line. To close the List pop-up window, do either of the following:

- Press Enter.
- Enter any command except SCROLL UP or SCROLL DOWN in the Command line. Debug Tool closes the window and runs the command.

Creating a preferences file

If you have a preference as to the appearance or behavior of Debug Tool, you can set these options in a preferences file. You can modify the layout of the windows of the session panel, set PF keys to specific actions, or change the colors use in the session panel. “Saving customized settings in a preferences file” on page 271 describes what you can specify in a preferences file and how to make Debug Tool use your preferences file.

If your site has preferences for all users to use, the system administrator can set these preferences in a global preferences file. When Debug Tool starts, it does the following steps:

1. Checks for a global preferences file specified through the EQAOPTS GPFDSN command and runs any commands specified in that file.
2. If you specify a preferences file, Debug Tool looks for that preferences file and runs any commands in that preferences file. A preferences file can be specified through one of the following methods:
   - directly; for example, through the TEST runtime option
   - through the EQAOPTS PREFERENCESDSN command
3. If you specify a commands file, Debug Tool looks for that commands file and runs any commands in that commands file. A commands file can be specified through one of the following methods:
   - Directly, for example, through the TEST runtime option.
   - Through the EQAOPTS COMMANDSDSN command. If that file has a member in it that matches the name of the initial load module in the first enclave, Debug Tool reads that member as a commands file.

Because of the order in which Debug Tool processes these files, any settings that you specify in your preferences and commands files can override settings in the global preferences file. To learn how to specify EQAOPTS commands, see the topic “EQAOPTS commands” in the *Debug Tool Reference and Messages* or *Debug Tool Customization Guide*. To learn about what format to use for the global preferences file, preferences file, and commands file, see Appendix A, “Data sets used by Debug Tool,” on page 413.

Displaying the source

Debug Tool displays your source in the Source Window using a source, listing, or separate debug file, depending on how you prepared your program.

When you start Debug Tool, if your source is not displayed, see “Changing which file appears in the Source window” on page 160 for instructions on how find and display the source.

If there is no debug data, you can display the disassembled code by entering the SET DISASSEMBLY command.

If your programs contain DB2 or CICS code, you might need to use a different file. See Chapter 7, “Preparing a DB2 program,” on page 75 or Chapter 9, “Preparing a CICS program,” on page 83 for more information.

Refer to the following topics for more information related to the material discussed in this topic.

Related tasks

“Choosing TEST or NOTEST compiler suboptions for COBOL programs” on page 27
Chapter 5, “Preparing a LangX COBOL program,” on page 67
“Choosing TEST or NOTEST compiler suboptions for PL/I programs” on page 32
“Choosing TEST or DEBUG compiler suboptions for C programs” on page 37
“Choosing TEST or DEBUG compiler suboptions for C++ programs” on page 42
Chapter 6, “Preparing an assembler program,” on page 71
Chapter 7, “Preparing a DB2 program,” on page 75
Chapter 8, “Preparing a DB2 stored procedures program,” on page 79
Chapter 9, “Preparing a CICS program,” on page 83
Chapter 10, “Preparing an IMS program,” on page 97

Related references

Appendix B, “How does Debug Tool locate source, listing, or separate debug files?,” on page 419
Debug Tool Reference and Messages

Changing which file appears in the Source window

This topic describes several different ways of changing which file appears in the Source window. This topic assumes you already know the name of the source, listing, or separate debug file that you want to display. If you don't know the name of the file, see “Displaying a list of compile units known to Debug Tool” on page 201 for suggestions on how to find the name of a file.

Before you change the file that appears in the Source window, make sure you understand how Debug Tool locates source, listing, and separate debug files by reading Appendix B, “How does Debug Tool locate source, listing, or separate debug files?,” on page 419.

To change which file appears in the Source window, choose one of the following options:

- Type over the name after `SOURCE:`, which is in the Header area of the Source window, with the desired name. The new name must be the name of a compile unit that is known to Debug Tool.
- Use the Source Identification panel to direct Debug Tool to the new files:
  1. With the cursor on the command line, press PF4 (`LIST`).

     In the Source Identification panel, you can associate the source, listing, or separate debug file that show in the Source window with their compile unit.
  2. Type over the **Listing/Source File** field with the new name.
- Use the `SET SOURCE` command. With the cursor on the command line, type `SET SOURCE ON (`*`cuname`*`) `*`new_file_name`*, where *new_file_name* is the new source file. Press Enter.

  If you need to do this repeatedly, you can use the `SET SOURCE ON` commands generated in the Log window. You can save these commands in a file and reissue them with the `USE` command for future invocations of Debug Tool.
- Enter the `PANEL PROFILE` command, which displays the Profile Settings panel. Enter the new file name in the Default Listing PDS name field.
- Use the `SET DEFAULT LISTINGS` command. With the cursor on the command line, type `SET DEFAULT LISTINGS` *`new_file_name`*, where *new_file_name* is the renamed listing or separate debug file. Press Enter.

To point Debug Tool to several renamed files, you can use the SET DEFAULT LISTINGS command and specify the renamed files, separated by commas and enclosed in parenthesis. For example, to point Debug Tool to the files SVTRSAMP.TS99992.MYPROG, PGRSAMP.LLTEST.PROGA, and RRSAMP.CRTEST.PROGR, enter the following command:

```
SET DEFAULT LISTINGS (SVTRSAMP.TS99992.MYPROG, PGRSAMP.LLTEST.PROGA, RRSAMP.CRTEST.PROGR) ;
```

- Use the EQADEBUG DD statement to define the location of the files.
- Code the EQAUEDAT user exit with the location of the files.

For C and C++ programs compiled with the FORMAT(DWARF) and FILE suboptions of the DEBUG compiler option, the information in this topic describes how to specify the location of the *source* file. If you or your site specified YES for the EQAOPTS MDBG command (which requires Debug Tool to search for the .dbg and the source file in a .mdbg file)[6], you cannot specify another location for the source file.

Entering commands on the session panel

You can enter a command or modify what is on the session panel in several areas, as shown in Figure 1 and Figure 2 on page 162.

```
C        LOCATION: MYID.SOURCE(ICFSSCU1) :> 89
Command ===> 1                                        Scroll ===> PAGE 2
MONITOR --+----1----+----2----+----3----+----4----+----5----+----6 LINE: 1 OF 2
****************************** TOP OF MONITOR ******************************
                                ----+----1----+----2----+----3----+----4----
0001  1 VARBL1                   10
0002  2 VARBL2                   20
***************************** BOTTOM OF MONITOR *****************************
SOURCE: ICFSSCU1 - 3 --+----2----+----3----+----4----+----5----+ LINE: 81 OF 96
      81  main()                                                            .
      82  {                                                                 .
      83     int VARBL1 = 10;                                               .
 4    84     int VARBL2 = 20;                                              .
      85     int R = 1;                                                     .
      86                                        5                           .
      87     printf("—— IBFSSCC1 : BEGIN\n");                               .
      88     do {                                                           .
      89        VARBL1++;                                                   .
      90        printf("INSIDE PERFORM\n");                                 .
      91        VARBL2 = VARBL2 - 2;                                        .
      92        R++;                                                        .
LOG  6 --+----1----+----2----+----3----+----4----+----5----+----6 LINE: 7 OF 15
0007  STEP ;
0008  AT 87 ;
0009  MONITOR
0010    LIST VARBL1 ;
0011  MONITOR
0012    LIST VARBL2 ;
0013  GO ;              7
0014  STEP ;
0015  STEP ;
```

Figure 1. Debug Tool session panel displaying the Log window.

6. In situations where you can specify environment variables, you can set the environment variable EQA_USE_MDBG to YES or NO, which overrides any setting (including the default setting) of the EQAOPTS MDBG command.

```
COBOL    LOCATION: PROG1 :> 44.1
Command ===>      1                                          Scroll ===> CSR  2
MONITOR -+----1----+----2----+----3----+----4----+----5----+----6- LINE: 1 OF 2
****************************** TOP OF MONITOR *******************************
                                ----+----1----+----2----+----3----+----4----
0001  1 STR1                    'ONE  '
0002  2 STR3                    'THREE'
***************************** BOTTOM OF MONITOR *****************************
SOURCE: PROG1 - 3 -1----+----2----+----3----+----4----+----5----+ LINE: 43 OF 53
      43            MOVE "ONE" TO STR1. MOVE "TWO" TO STR2. MOVE "THREE" TO S .
      44            MOVE "FOUR" TO STR4. MOVE "FIVE" TO STR5.                 .
      45            PERFORM UNTIL R = 9                                       .
 4    46              MOVE "TOP" TO STR1 MOVE "BEG" TO STR2 MOVE "UP" TO STR3 .
      47              ADD 1 TO VARBL1                                         .
      48              SUBTRACT 2 FROM VARBL2              5                   .
      49              ADD 1 TO R                                              .
      50              MOVE "BOT" TO STR1 MOVE "END" TO STR2 MOVE "DOW" TO STR .
      51            END-PERFORM.                                              .
      52            MOVE "DONE" TO STR1. MOVE "END" TO STR2. MOVE "FIN" TO ST .
      53            STOP RUN.                                                 .
***************************** BOTTOM OF SOURCE ******************************
MEMOR 6 -+----2----+----3----+----4----+----5----+----6----+----7----+----8----+
History: 329D47DA         329D65CC         329D88AB         329D8000
         329D90E8                  8
Base address: 329D90E8 Amode: 31
+00000 329D90E8   D6D5C540 40000000 E3E6D640 40000000    | ONE  ...TWO  ... |
+00010 329D90F8   E3C8D9C5 C5000000 00000000 00000000    | THREE........... |
+00020 329D9108   00000000 00000000 00000000 00000000    | ................ |
+00030 329D9118   00000000 00000000 00000000 00000000    | ................ |
+00040 329D9128   00000000 00000000 00000000 00000000    | ................ |
+00050 329D9138   00000000 00000000 00000000 00000000    | ................ |
+00060 329D9148   00000000 00000000 00000000 00000000    | ................ |
+00070 329D9158   00000000 00000000 00000000 00000000    | ................ |
PF  1:ZOOM MEM   2:STEP       3:QUIT       4:SWAP       5:MEMORY     6:BREAK
PF  7:UP         8:DOWN       9:GO        10:ZOOM SRC  11:ZOOM LOG  12:RETRIEVE
```

Figure 2. Debug Tool session panel displaying the Memory window.

Note: Figure 2 shows PF keys that were redefined. If you want to redefine your PF keys, see “Defining PF keys” on page 265.

1 Command line
You can enter any valid Debug Tool command on the command line.

2 Scroll area
You can redefine the default amount you want to scroll by typing the desired value over the value currently displayed.

3 Compile unit name area
You can change the qualification by typing the desired qualification over the value currently displayed. For example, to change the current qualification from `ICFSSCU1`, as shown in the Source window header, to `ICFSSCU2`, type `ICFSSCU2` over `ICFSSCU1` and press Enter.

4 Prefix area
You can enter only Debug Tool prefix commands in the prefix area, located in the left margin of the Source window.

5 Source window
You can modify any lines in the Source window and place them on the command line.

6 Window id area
You can change your window configuration by typing the name of the window you want to display over the name of the window that is currently being displayed.

7 Log window
You can modify any lines in the log and have Debug Tool place them on the command line.

8 Memory window
You can modify memory or specify a new memory base address. This window is not displayed by default. You must enter the `WINDOW SWAP MEMORY LOG` command, `WINDOW OPEN MEMORY` command, or `WINDOW ZOOM MEMORY` command to display this window.

Refer to the following topics for more information related to the material discussed in this topic.

Related tasks
“Using the session panel command line”
“Issuing system commands” on page 164
“Entering prefix commands on specific lines or statements” on page 164
“Entering multiple commands in the Memory window” on page 165
“Using commands that are sensitive to the cursor position” on page 166
“Using Program Function (PF) keys to enter commands” on page 166
“Retrieving previous commands” on page 167
“Composing commands from lines in the Log and Source windows” on page 167
Related references
“Order in which Debug Tool accepts commands from the session panel”
“Initial PF key settings” on page 166

Order in which Debug Tool accepts commands from the session panel

If you enter commands in more than one valid input area on the session panel and press Enter, the input areas are processed in the following order of precedence.

1. Prefix area
2. Command line
3. Compile unit name area
4. Scroll area
5. Window id area
6. Source/Log window
7. Memory window

Using the session panel command line

You can enter any Debug Tool command in the command field. You can also enter any TSO command by prefixing them with `SYSTEM` or `TSO`. Commands can be up to 48 SBCS characters or 23 DBCS characters in length.

If you need to enter a lengthy command, Debug Tool provides a command continuation character, the SBCS hyphen (-). When the current programming language is C and C++, you can also use the backslash (****) as a continuation character. You can continue requesting additional command lines by entering the continuation characters until you complete your command.

Debug Tool also provides automatic continuation if your command is not complete; for example, if you enter a left brace (**{**) without the matching right brace (**}**). If you need to continue your command, Debug Tool displays the Command pop-up window. You type in the rest of your command and any other commands. Press Enter to run the commands and close the Command pop-up window.

Refer to the following topics for more information related to the material discussed in this topic.

Related tasks
Chapter 28, “Entering Debug Tool commands,” on page 275

Issuing system commands

During your Debug Tool session, you can still access your base operating system using the SYSTEM command. The string following the SYSTEM command is passed on to your operating system. You can communicate with TSO in a TSO environment. For example, if you want to see a TSO catalog listing while in a debugging session, enter `SYSTEM LISTC;`.

When you are entering system commands, you must comply with the following:

- A command is required after the SYSTEM keyword. Do not enter any required parameters. Debug Tool prompts you.
- If you are debugging in batch and need system services, you can include commands and their requisite parameters in a CLIST and substitute the CLIST name in place of the command.
- If you want to enter several TSO commands, you can include them in a USE file, a procedure, or other commands list. Or you can enter:

  ```
  SYSTEM ISPF;
  ```

  This starts ISPF and displays an ISPF panel on your host emulator screen that you can use to issue commands.

For CICS only: The SYSTEM command is not supported.

TSO is a synonym for the SYSTEM command. Truncation of the TSO command is not allowed.

Entering prefix commands on specific lines or statements

You can type certain commands, known as *prefix commands*, in the prefix area of specific lines in the Source or Monitor window so that those commands affect only those lines. For example, you can type the AT command in the prefix area of line 8 in the Source window, press Enter, then Debug Tool sets a statement breakpoint only on line 8.

The following prefix commands can be entered in the prefix area of the Source window:

- AT
- CLEAR
- DISABLE
- ENABLE
- L
- M
- QUERY
- RUNTO
- SHOW

The following prefix commands can be entered in the prefix area of the Monitor window, including the automonitor section:

- HEX
- DEF

- CL
- LIST
- CC...CC (to clear a range of lines)

To enter a prefix command into the Source window, do the following steps:

1. Scroll through the Source window until you see the line or lines of code you want to change.
2. Move your cursor to the prefix area of the line you want to change.
3. Type in the appropriate prefix command.
4. If there are multiple statements or verbs on the line, you can indicate which statement or verb you want to change by typing in a number indicating the relative position of the statement or verb. For example, if there are three statements on the line and you want to set a breakpoint on the third statement, type in a `3` following the `AT` prefix command. The resulting prefix command is `AT 3`.
5. If there are more lines you want to change, return to step 3.
6. Press Enter. Debug Tool runs the commands you typed on the lines you typed them on.

To enter a prefix command into the Monitor window, do the following steps:

1. Scroll through the Monitor window until you see the line or lines you want to change.
2. Move your cursor to the prefix area of the line you want to change.
3. Type in the appropriate prefix command.
4. If there are more lines you want to change, return to step 3.
5. Press Enter. Debug Tool runs the commands you typed on the lines you typed them on.

Refer to the following topics for more information related to the material discussed in this topic.

Related references

SET MONITOR command in *Debug Tool Reference and Messages*
Prefix commands in *Debug Tool Reference and Messages*

Entering multiple commands in the Memory window

You can enter multiple commands and changes into the Memory window. Debug Tool processes the user input line by line, starting at the top of the Memory window, as described in the following list:

1. History entry area. Processing stops at an invalid input, which displays an error message, or after the first "G" or "R" command. The Memory window is refreshed and the remaining commands and changes you typed into the Memory window are ignored.
2. Base address. Processing stops at an invalid input, which displays an error message; after valid input; or after the first "G" command. The Memory window is refreshed and the remaining commands and changes you typed into the Memory window are ignored.
3. Address column. Processing stops at an invalid input, which displays an error message; after valid input; or after the first "G" command. The Memory window is refreshed and the remaining commands and changes you typed into the Memory window are ignored.

4. Hexadecimal data area. Processing stops at an invalid input, which displays an error message; after valid input; or after the first "G" command. Valid changes that Debug Tool encounters before invalid changes or the "G" command are processed. The Memory window is refreshed and the remaining commands or changes you typed into the Memory window are ignored.

Using commands that are sensitive to the cursor position

Certain commands are sensitive to the position of the cursor. These commands, called *cursor-sensitive* commands, include all those that contain the keyword CURSOR (AT CURSOR, DESCRIBE CURSOR, FIND CURSOR, LIST CURSOR, SCROLL...CURSOR, TRIGGER AT CURSOR, WINDOW...CURSOR).

To enter a cursor-sensitive command, type it on the command line, position the cursor at the location in your Source window where you want the command to take effect (for example, at the beginning of a statement or at a verb), and press Enter.

You can also issue cursor-sensitive commands by assigning them to PF keys.

Note: Do not confuse cursor-sensitive commands with the CURSOR command, which returns the cursor to its last saved position.

Refer to the following topics for more information related to the material discussed in this topic.

Related tasks

"Defining PF keys" on page 265

Using Program Function (PF) keys to enter commands

The cursor-sensitive commands, as well as other full-screen tasks, can be issued more quickly by assigning the commands to PF keys. You can issue the WINDOW CLOSE, LIST, CURSOR, SCROLL TO, DESCRIBE ATTRIBUTES, RETRIEVE, FIND, WINDOW SIZE, and the scrolling commands (SCROLL UP, DOWN, LEFT, and RIGHT) this way. Using PF keys makes tasks convenient and easy.

Refer to the following topics for more information related to the material discussed in this topic.

Related tasks

"Defining PF keys" on page 265

"Using commands that are sensitive to the cursor position"

Related references

"Initial PF key settings"

Initial PF key settings

The table below shows the initial PF key settings.

PF key	Label	Definition	Use
PF1	?	?	"Getting online help for Debug Tool command syntax" on page 280
PF2	STEP	STEP	"Stepping through or running your program" on page 181
PF3	QUIT	QUIT	"Ending a full-screen debug session" on page 203
PF4	LIST	LIST	"Displaying a list of compile units known to Debug Tool" on page 201

PF key	Label	Definition	Use
PF4	LIST	`LIST` *variable_name*	"Displaying and monitoring the value of a variable" on page 188
PF5	FIND	`IMMEDIATE FIND`	"Finding a string in a window" on page 171
PF6	AT/CLEAR	`AT TOGGLE CURSOR`	"Setting breakpoints to halt your program at a line" on page 179
PF7	UP	`IMMEDIATE UP`	"Scrolling through the physical windows" on page 169
PF8	DOWN	`IMMEDIATE DOWN`	"Scrolling through the physical windows" on page 169
PF9	GO	`GO`	"Stepping through or running your program" on page 181
PF10	ZOOM	`IMMEDIATE ZOOM`	"Zooming a window to occupy the whole screen" on page 268
PF11	ZOOM LOG	`IMMEDIATE ZOOM LOG`	"Zooming a window to occupy the whole screen" on page 268
PF12	RETRIEVE	`IMMEDIATE RETRIEVE`	"Retrieving previous commands"

Refer to the following topics for more information related to the material discussed in this topic.

Related tasks

"Defining PF keys" on page 265

Retrieving previous commands

To retrieve the last command you entered, press PF12 (`RETRIEVE`). The retrieved command is displayed on the command line. You can make changes to the command, then press Enter to issue it.

To step backwards through previous commands, press PF12 to retrieve each command in sequence. If a retrieved command is too long to fit in the command line, only its last line is displayed.

Refer to the following topics for more information related to the material discussed in this topic.

Related tasks

"Composing commands from lines in the Log and Source windows"

Composing commands from lines in the Log and Source windows

You can use lines in the Log and Source windows to compose new commands.

To compose a command from lines in the Log or Source window, do the following steps:

1. Move the cursor to the desired line.
2. Modify one or more lines that you want to include in the command. For example, delete any comment characters.
3. Press Enter. Debug Tool displays the input line or lines on the command line. If the line or lines do not fit on the command line, Debug Tool displays the Command pop-up window with the command as typed in so far. Any trailing blanks on the last line are removed. If you want to expand the Command pop-up window, place the cursor below it and press Enter.

4. If the command is incomplete, modify the command.
5. Press Enter to run the command.

Refer to the following topics for more information related to the material discussed in this topic.

Related tasks

"Retrieving previous commands" on page 167
Chapter 28, "Entering Debug Tool commands," on page 275

Related references

"COBOL command format" on page 281
"Debug Tool subset of PL/I commands" on page 299
"PL/I language statements" on page 299
"Debug Tool commands that resemble C and C++ commands" on page 309

Opening the Command pop-up window to enter long Debug Tool commands

If you need to enter a command that is longer than the length of the command line, enter the `POPUP` command to open the Command pop-up window and then enter your Debug Tool command.

Debug Tool automatically displays the Command pop-up window in the following situations:

- You enter an incomplete command on the command line.
- You enter a continuation character on the command line.

You can enter the rest of your command in the Command pop-up window.

Navigating through Debug Tool windows

You can navigate in any of the windows using the `CURSOR` command and the scrolling commands: `SCROLL UP`, `DOWN`, `LEFT`, `RIGHT`, `TO`, `NEXT`, `TOP`, and `BOTTOM`. You can also search for character strings using the `FIND` command, which scrolls you automatically to the specified string.

The window acted upon by any of these commands is determined by one of several factors. If you specify a window name (`LOG`, `MEMORY`, `MONITOR`, or `SOURCE`) when entering the command, that window is acted upon. If the command is cursor-oriented, the window containing the cursor is acted upon. If you do not specify a window name and the cursor is not in any of the windows, the window acted upon is determined by the settings of **Default window** and *Default scroll amount* under the Profile Settings panel.

Refer to the following topics for more information related to the material discussed in this topic.

Related tasks

"Moving the cursor between windows" on page 169
"Scrolling through the physical windows" on page 169
"Scrolling to a particular line number" on page 171
"Finding a string in a window" on page 171
"Changing which file appears in the Source window" on page 160
"Displaying the line at which execution halted" on page 173
"Customizing profile settings" on page 269

Moving the cursor between windows

To move the cursor back and forth quickly from the Monitor, Source, or Log window to the command line, use the CURSOR command. This command, and several other cursor-oriented commands, are highly effective when assigned to PF keys. After assigning the CURSOR command to a PF key, move the cursor by pressing that PF key. If the cursor is not on the command line when you issue the CURSOR command, it goes there. To return it to its previous position, press the CURSOR PF key again.

Refer to the following topics for more information related to the material discussed in this topic.

Related tasks

"Defining PF keys" on page 265

Switching between the Memory window and Log window

Debug Tool has four logical windows, but can only display up to three physical windows at a time. You can alternate between the Memory window and the Log window by entering the WINDOW SWAP MEMORY LOG command on the command line. You can navigate through the physical windows by entering scroll commands.

Refer to the following topics for more information related to the material discussed in this topic.

Related tasks

"Scrolling to a particular line number" on page 171
"Scrolling through the physical windows"

Scrolling through the physical windows

You can scroll through the physical windows by using commands or PF keys. Either way, the placement of the cursor plays a key role in determining which physical window is affected by the command.

To scroll through a physical window by using commands, do the following steps:

1. If you are going to scroll left or right through the Monitor value area of the Monitor window, enter the SET MONITOR WRAP OFF command.
2. Type in the scroll command in the command line, but do not press the Enter key. You can enter any of the following scroll commands: SCROLL LEFT, SCROLL RIGHT, SCROLL UP, SCROLL DOWN . You cannot scroll left or right in the Memory window.
3. Move the cursor to the physical window or area of the physical window you want to scroll through. In the Memory window, move the cursor to any section of the memory dump area. In the Monitor window, move the cursor to the Monitor value area to scroll left or right through that area. If you did not enter the SET MONITOR WRAP OFF command, then the scroll command will scroll the entire window.
4. Press Enter.

If you scroll a window or area to the right or left, Debug Tool adjusts the scale in the window or area to indicate the columns displayed in the window. If you scroll a window up or down, the line counter reflects the top line number currently displayed in that window. In the Memory window, if you scroll up or down, all the sections of the memory dump area adjust to display the new information.

You can combine steps 2 on page 169 and 3 on page 169 above by using the command to indicate which physical window you want to scroll through. For example, if you want to scroll up 5 lines in the physical window that is displaying the Monitor window, you enter the command `SCROLL UP 5 MONITOR`.

To scroll through a physical window using PF keys, do the following steps:

1. Move the cursor to the physical window or scrollable area you want to scroll through. A scrollable area includes the memory dump area of the Memory window.
2. Press the PF7 (UP) key to scroll up or the PF8 (DOWN) key to scroll down. The number of lines that you scroll through is determined by the value of the Default scroll amount setting.

If you do not move the cursor to a specific physical window, the default logical window is scrolled. To find out which logical window is the default logical window, enter the `QUERY DEFAULT WINDOW` command.

Refer to the following topics for more information related to the material discussed in this topic.

Related tasks

"Customizing the layout of physical windows on the session panel" on page 266
"Scrolling to a particular line number" on page 171
"Customizing profile settings" on page 269
"Enlarging a physical window"
"Navigating through the Memory window using the history area" on page 174

Related references

QUERY command in *Debug Tool Reference and Messages*
SCROLL command in *Debug Tool Reference and Messages*
SET DEFAULT WINDOW command in *Debug Tool Reference and Messages*

Enlarging a physical window

You can enlarge a physical window to full screen by using the `WINDOW ZOOM` command or a PF key. To enlarge a physical window by using the `WINDOW ZOOM` command, type in `WINDOW ZOOM`, followed by the name of the physical window you want to enlarge, then press Enter. To reduce the physical window back to its original size, enter the `WINDOW ZOOM` command again. For example, if you want to enlarge the physical window that is displaying the Monitor window, enter the command `WINDOW ZOOM`. To reduce the size of that physical window back to its original size, enter the command `WINDOW ZOOM`.

To enlarge a physical window by using a PF key, move the cursor into the physical window that you want to enlarge, then press the PF10 (ZOOM) key. For example, if you want to enlarge the physical window that is displaying the Source window, move your cursor somewhere into the Source window, then press the PF10 (ZOOM) key. To reduce the size of that physical window back to its original size, press the PF10 (ZOOM) key.

Refer to the following topics for more information related to the material discussed in this topic.

Related tasks

"Customizing the layout of physical windows on the session panel" on page 266

Related references

WINDOW command in *Debug Tool Reference and Messages*

Scrolling to a particular line number

To display a particular line at the top of a window, use the POSITION or SCROLL TO command with the line or statement numbers shown in the window prefix areas. Enter POSITION *n* or SCROLL TO *n* (where *n* is a line number) on the command line and press Enter.

For example, to bring line 345 to the top of the window, enter POSITION 345 OR SCROLL TO 345 on the command line. Debug Tool scrolls the selected window vertically so that it displays line 345 at the top of that window.

If you used the LIST AT LINE or LIST AT STATEMENT command to get a list of line or statement breakpoints, then use the POSITION or SCROLL TO command to display one of those breakpoints at the top of the Source window. As an alternate to using the combination of the LIST AT LINE or LIST AT STATEMENT command with the POSITION or SCROLL TO command, you can use the FINDBP command. The FINDBP command works in a manner similar to the FIND command for strings, except that it searches for line, statement, and offset breakpoints.

Finding a string in a window

You can search for strings in the Source, Monitor, or Log window. You can specify where to start the search, to search either forward or backward, and, for the Source window, the columns that are searched. The default window that is searched is the window specified by the SET DEFAULT WINDOW command or the *Default window* entry in your Profile Settings panel. The default direction for searches is forward. For the Source window, the default boundaries for columns are 1 to *, unless you specify a different set of boundaries with the SET FIND BOUNDS command.

To find a string within the default window using the default search direction, do the following steps:

1. Type in the FIND command, specifying the string you want to find. Ensure that the string complies with the rules described “Syntax of a search string” on page 172.
2. Press Enter.

If you want to repeat the previous search, hit the PF5 key.

Refer to the following topics for more information related to the material discussed in this topic.

Related concepts
“How does Debug Tool search for strings?”
Related references
“Syntax of a search string” on page 172

How does Debug Tool search for strings?

The Debug Tool FIND command uses many of the same rules for beginning a search that the ISPF FIND command uses to begin its searches. Debug Tool begins a search in the first position after the cursor location.

If you reach the end, Debug Tool displays a message indicating you have reached the end. Repeat the FIND command by pressing the PF5 key and then the search starts from the top.

If you were searching backwards and you reach the beginning, Debug Tool displays a message indicating you have reached the beginning. Repeat the FIND command by pressing the PF5 key and the search begins from the end.

Syntax of a search string

The string can contains any combination of characters, numbers, and symbols. However, if the string contains any of the following characters, it must be enclosed in quotation marks (") or apostrophes ('):

- spaces
- an asterisk ("*")
- a question mark ("?")
- a semicolon (";")

Use the following rules to determine whether to use quotation marks (") or apostrophes ('):

- If you are debugging a C or C++ program, the string must be enclosed in quotation marks (").
- If you are debugging an assembler, COBOL, LangX COBOL, disassembly, or PL/I program, the string can be enclosed in quotation marks (") or apostrophes (').

Finding the same string in a different window

To find the same string in a different window, type in the command: `FIND * window_name`.

Finding a string in the Monitor value area when SET MONITOR WRAP OFF is in effect

Type the `FIND` command with the string, then place the cursor in the Monitor window. Debug Tool searches the entire Monitor window, including the scrolled data in the Monitor value area, until the string is found or until the end of data is reached.

Finding the same string in a different direction

To find the same string in a different direction, enter the FIND * command with the string and the PREV or NEXT keyword. For example, the following command searches for the string "RecordDate" in the backwards direction:

```
FIND RecordDate PREV ;
```

Specifying the boundaries of a search in the Source window

You can specify that Debug Tool search through a limited number of columns in the Source window, which can be useful when you are searching through a very large source file and some text is organized in specific columns. You can specify the boundaries to use for the current search or for all searches. The column alignment of the source might not match the original source code. The column specifications for the `FIND` command are related to the scale shown in the Source window, not the original source code.

To specify the boundaries for the current search, enter the `FIND` command and specify the search string and the boundaries. For example, to search for "ABC" in columns 7 through 12, enter the following command:

```
FIND "ABC" 7 12;
```

To search for "VAR1" that begins in column 8 or any column after that, enter the following command:

```
FIND "VAR1" 8 *;
```

To search for "VAR1" beginning in column 1, enter the following command:

```
FIND "VAR1" 1;
```

To specify the default boundaries to use for all searches, enter the SET FIND BOUNDS command, specifying the left and right boundaries. After you enter the SET FIND BOUNDS command, every time you enter the FIND command without specifying boundaries, Debug Tool searches for the string you specified only within those boundaries. For example, to specify that you want Debug Tool to always search for text within columns 7 through 52, enter the following command:

```
SET FIND BOUNDS 7 52;
```

Afterward, every time you enter the FIND command without specifying boundaries, Debug Tool searches only within columns 7 through 52. To reset the boundaries to the default setting, which is 1 through *, enter the following command:

```
SET FIND BOUNDS;
```

Refer to the following topics for more information related to the material discussed in this topic.

Related references

"Example: Searching for COBOL paragraph names"

FIND command in *Debug Tool Reference and Messages*

SET FIND BOUNDS command in *Debug Tool Reference and Messages*

QUERY command in *Debug Tool Reference and Messages*

Example: Complex searches

To find a string in the backwards direction in a different window, enter the FIND command with the string, the PREV keyword, and the name of the window. For example, the following command searches for the string "EmployeeName" in the Log window:

```
FIND EmployeeName PREV LOG;
```

Example: Searching for COBOL paragraph names

To find a COBOL paragraph name that begins in column 8, enter the following command:

```
FIND paraa 8;
```

Debug Tool will find only the string that starts in column 8.

To find a reference to a COBOL paragraph name in COBOL's Area B within columns 12 through 72, enter the following command:

```
FIND paraa 12 72;
```

Debug Tool will find only the string that starts and ends within columns 12 to 72.

Displaying the line at which execution halted

After displaying different source files and scrolling, you can go back to the halted execution point by entering the SET QUALIFY RESET command.

Navigating through the Memory window

This topic describes the navigational aids available through the Memory window that are not available through other windows.

Displaying the Memory window

You can display the Memory window by doing one of the following options:

- Entering the WINDOW SWAP MEMORY LOG command. Debug Tool replaces the contents of the physical window that is displaying the Log window with the

Memory window. The Memory window is empty if you did not specify a base address (by using the MEMORY command) or the history area is empty.

- After assigning the Memory window to a physical window, entering the WINDOW OPEN MEMORY command. Debug Tool opens the physical window and displays the contents of the Memory window.
- Customizing the session panel so that the Memory window is displayed in a default physical window instead of the Log window. Use this option if you want the Memory window to display continuously and in place of the Log window.

Refer to the following topics for more information related to the material discussed in this topic.

Related tasks

"Scrolling through the physical windows" on page 169
"Switching between the Memory window and Log window" on page 169
"Displaying memory through the Memory window" on page 17
"Customizing the layout of physical windows on the session panel" on page 266

Related references

"Memory window" on page 157
"Order in which Debug Tool accepts commands from the session panel" on page 163
MEMORY command in *Debug Tool Reference and Messages*

Navigating through the Memory window using the history area

Every time you enter a new MEMORY command or use the G command, the current base address is moved to the right and down in the history area. The history area can hold up to eight base addresses. When the history area is full and you enter a new base address, Debug Tool removes the oldest base address (located at the bottom and right-most part of the history area) from the history area and puts the new base address on the top left. The history area is persistent in a debug session.

To use the history area to navigate through the Memory window, enter the G or g command over an address in the history area, then press Enter. Debug Tool displays the memory dump data starting with the new address. You can clear the history area by entering the CLEAR MEMORY command. You can remove an entry in the history area by typing over the entry with the R or r command.

Refer to the following topics for more information related to the material discussed in this topic.

Related tasks

"Scrolling through the physical windows" on page 169
"Specifying a new base address"

Specifying a new base address

You can use any of the following methods to specify a new base address:

- Enter the MEMORY command on the command line
- If you defined a PF key as the MEMORY command, place the cursor in the Source window under a variable name and press that PF key.
- Type over an existing address in the Memory window in one of the following locations:
  - Information area: Type over the current base address.
  - Memory dump area: Type over an address in the address column.
- Use the G command in the Memory window in one of the following locations:
  - Information area: Enter the G command over an entry in the history area.

– Memory dump area: Enter the G command over an address in the address column or hexadecimal data columns.

  If you enter the G command in the hexadecimal data columns, verify that the address is completely in one column and does not span across columns. For example, in the following screen, the hexadecimal addresses X'329E6470' appears in two locations:

  - In the second row, it spans the first and second column.
  - In the fifth row, it is contained in the third column.

```
MEMORY---1----+----2----+----3----+----4----+----5----+----6----+----7----+-
History:  24702630         2505A000

Base address:  265B1018  Amode: 31
+00000 265B1018   40404040 40404040 40404040 40404040  |                  |
+00010 265B1028   4040329E 64704040 40404040 40404040  |  .. ..           |
+00020 265B1038   40404040 40404040 40404040 40404040  |                  |
+00030 265B1048   40404040 40404040 40404040 40404040  |                  |
+00040 265B1058   40404040 40404040 329E6470 40404040  |          ....    |
+00050 265B1068   40404040 40404040 40404040 40404040  |                  |
+00060 265B1078   40404040 40404040 40404040 40404040  |                  |
+00070 265B1088   40404040 40404040 40404040 40404040  |                  |
```

  If you enter the G command over the second row, first column, Debug Tool tries to set the base address to X'4040329E'. If you enter the G command over the second row, second column, Debug Tool tries to set the base address to X'64704040'. If you want to set the base address to X'329E6470', do one of the following options:

  - Type the G command over the address in the fifth row, third column.
  - Enter X'329E6470' in the Base address field.
  - Type in X'329E6470' in an address column, without spanning two columns, and then press Enter.

Creating a commands file

A commands file is a convenient method of reproducing debug sessions or resuming interrupted sessions. Use one of the following methods to create a commands file:

- Record your debug session in a log file and then use the log file as a commands file. This is the fastest way to create a valid commands file.
- Create a commands file manually. Appendix A, “Data sets used by Debug Tool,” on page 413 describes the requirements for this file and when Debug Tool processes it.

When you create a commands file that might be used in an application program that was created with several different programming languages, you might want to use Debug Tool commands that are *programming language neutral*. The following guidelines can help you write commands that are programming language neutral:

- Write conditions with the %IF command.
- Delimit strings and long compile unit names with quotation marks (").
- Prefix a hexadecimal constant with an **X** or **x**, followed by an apostrophe ('), then suffix the constant with an apostrophe ('). For example, you can write the hexadecimal constant C1C2C3C4 as x'C1C2C3C4'.
- Group commands together with the BEGIN and END commands.
- Check the *Debug Tool Reference and Messages* to determine if a command works with only specific programming languages.

- Type in comments beginning at column 2 and not extending beyond column 72. Begin comments with "/*" and end them with "*/".

For PL/I programs, if your commands file has sequence numbers in columns 73 through 80, you must enter the `SET SEQUENCE ON` command as the first command in the commands file or before you use the commands file. After you enter this command, Debug Tool does not interpret the data in columns 73 through 80 as a command. Later, if you want Debug Tool to interpret the data in columns 73 through 80 as a command, enter the command `SET SEQUENCE OFF`.

For C and C++ programs, if you use commands that reference blocks, the block names can differ if the same program is compiled with either the ISD or DWARF compiler option. If your program is compiled with the ISD compiler option, Debug Tool assigns block names in a sequential manner. If your program is compiled with the DWARF compiler option, Debug Tool assigns block names in a non-sequential manner. Therefore, the names might differ. If you switch compiler options, check the block names in commands you use in your commands file.

At runtime, a commands file can be specified through one of the following methods:

- Directly, for example, through the `TEST` runtime option.
- Through the EQAOPTS `COMMANDSDSN` command. If that file has a member in it that matches the name of the initial load module in the first enclave, Debug Tool reads that member as a commands file.

To learn how to specify EQAOPTS commands, see the topic "EQAOPTS commands" in the *Debug Tool Reference and Messages* or *Debug Tool Customization Guide*. To learn about what format to use for the commands file, see Appendix A, "Data sets used by Debug Tool," on page 413.

Refer to the following topics for more information related to the material discussed in this topic.

Related tasks

"Entering comments in Debug Tool commands" on page 279

Related references

BEGIN command in *Debug Tool Reference and Messages*

%IF command in *Debug Tool Reference and Messages*

Recording your debug session in a log file

Debug Tool can record your commands and their generated output in a session log file. This allows you to record your session and use the file as a reference to help you analyze your session strategy. You can also use the log file as a command input file in a later session by specifying it as your primary commands file. This is a convenient method of reproducing debug sessions or resuming interrupted sessions.

The following appear as comments (preceded by an asterisk {*} in column 7 for COBOL programs, and enclosed in /* */ for C, C++, PL/I and assembler programs):

- All command output
- Commands from `USE` files
- Commands specified on a `__ctest()` function call
- Commands specified on a `CALL CEETEST` statement
- Commands specified on a `CALL PLITEST` statement
- Commands specified in the run-time `TEST` command string suboption
- `QUIT` commands

- Debug Tool messages about the program execution (for example, intercepted console messages and exceptions)

Refer to the following topics for more information related to the material discussed in this topic.

Related tasks

"Creating the log file"

"Saving and restoring settings, breakpoints, and monitor specifications" on page 184

Creating the log file

For debugging sessions in full-screen mode, you can create a log file in one of the following ways:

- Automatically by using the EQAOPTS `LOGDSN` and `LOGDSNALLOC` commands. This method helps new Debug Tool users automatically create a log file. To learn how to specify EQAOPTS commands, see the topic "EQAOPTS commands" in the *Debug Tool Reference and Messages* or *Debug Tool Customization Guide*.

  If you are an existing user that saves settings in a SAVESETS data set, Debug Tool does not create a new log file for you because the SAVESETS data set contains a `SET LOG` command. Debug Tool uses the log file specified in that `SET LOG` command.
- Manually as described in this topic.

For debugging sessions in batch mode, manually create the log file as described in this topic.

To create a permanent log of your debug session, first create a file with the following specifications:

- RECFM(F) or RECFM(FB) and 32<=LRECL<=256
- RECFM(V) or RECFM(VB) and 40<=LRECL<=264

Then, allocate the file to the DD name INSPLOG in the CLIST, JCL, or EXEC you use to run your program.

For COBOL and LangX COBOL only, if you want to subsequently use the session log file as a commands file, make the RECFM FB and the LRECL equal to 72. Debug Tool ignores everything after column 72 for file input during a COBOL debug session.

For CICS only, `SET LOG OFF` is the default. To start the log, you must use the `SET LOG ON file` command. For example, to have the log written to a data set named `TSTPINE.DT.LOG` , issue: `SET LOG ON FILE TSTPINE.DT.LOG;`.

Make sure the default of `SET LOG ON` is still in effect. If you have issued `SET LOG OFF`, output to the log file is suppressed. If Debug Tool is never given control, the log file is not used.

When the default log file (INSPLOG) is accessed during initialization, any existing file with the same name is overwritten. On MVS, if the log file is allocated with disposition of MOD, the log output is appended to the existing file. Entering the `SET LOG ON FILE xxx` command also appends the log output to the existing file.

If a log file was not allocated for your session, you can allocate one with the `SET LOG` command by entering:

```
SET LOG ON FILE logddn;
```

This causes Debug Tool to write the log to the file which is allocated to the DD name LOGDDN.

Note: A sequential file is recommended for a session log since Debug Tool writes to the log file.

At any time during your session, you can stop information from being sent to a log file by entering:

```
SET LOG OFF;
```

To resume use of the log file, enter:

```
SET LOG ON;
```

The log file is active for the entire Debug Tool session.

Debug Tool keeps a log file in the following modes of operation: line mode, full-screen mode, and batch mode.

Recording how many times each source line runs

To record of how many times each line of your code was executed:

1. Use a log file if you want to keep a permanent record of the results. To learn how to create a log file, see “Creating the log file” on page 177.
2. Issue the command:

   ```
   SET FREQUENCY ON;
   ```

   After you have entered the `SET FREQUENCY ON` command, your Source window is updated to show the current frequency count. Remember that this command starts the statistic gathering to display the actual count, so if your application has already executed a section of code, the data for these executed statements will not be available.

   If you want statement counts for the entire program, issue:

   ```
   GO ;
   LIST FREQUENCY * ;
   ```

   which lists the number of times each statement is run. When you quit, the results are written to the Log file. You can issue the `LIST FREQUENCY *` at any time, but it will only display the frequency count for the currently active compile unit.

Refer to the following topics for more information related to the material discussed in this topic.

Related tasks

“Creating the log file” on page 177

Recording the breakpoints encountered

If you are debugging a compile unit that does not support automonitoring, you can use the `SET AUTOMONITOR` command to record the breakpoints encountered in that compile unit. After you enter the `SET AUTOMONITOR ON` command, Debug Tool records the location of each breakpoint that is encountered, as if you entered the `QUERY LOCATION` command.

Setting breakpoints to halt your program at a line

To set or clear a line breakpoint, move the cursor over an executable line in the Source window and press PF6 (AT/CLEAR). You can temporarily turn off the breakpoint with DISABLE and turn it back on with ENABLE.

Refer to the following topics for more information related to the material discussed in this topic.

Related tasks

"Halting on a line in C only if a condition is true" on page 237
"Halting on a line in C++ only if a condition is true" on page 249
"Halting on a COBOL line only if a condition is true" on page 210
"Halting on a PL/I line only if a condition is true" on page 227

Setting breakpoints in a load module that is not loaded or in a program that is not active

You can browse the source or set breakpoints in a load module that has not yet been loaded or in a program that is not yet active by using the following command:

```
SET QUALIFY CU load_spec ::> cu_spec ;
```

In this command, specify the name of the load module and CU in which you wish to set breakpoints. The load module is then implicitly loaded, if necessary, and a CU is created for the specified CU. The source for the specified CU is then displayed in the SOURCE window. You can then set statement breakpoints as desired.

When program execution is resumed because of a command such as GO or STEP, any implicitly loaded modules are deleted, all breakpoints in implicitly created CUs are suspended, and any implicitly created CUs are destroyed. If the CU is later created during normal program execution, the suspended breakpoints are reactivated.

If you use the SET SAVE BPS function to save and restore breakpoints, the breakpoints are saved and restored under the name of the first load module in the active enclave. Therefore, if you use the command SET QUALIFY CU to set breakpoints in programs that execute as part of different enclaves, the breakpoints that you set by using this command are not restored when run in a different enclave.

Controlling how Debug Tool handles warnings about invalid data in comparisons

When Debug Tool processes (evaluates) a conditional expression and the data in one of the operands is invalid, the conditional expression becomes invalid. In this situation, Debug Tool stops and prompts you for a command. You have to enter the GO command to continue running your program. If you want to prevent Debug Tool from prompting you in this situation, enter the SET WARNING OFF command.

A conditional expression can become invalid for several reasons, including the following situations:

- A variable is not initialized and the data in the variable is not valid for the variable's attributes.
- A field has multiple definitions, with each definition having different attributes. While the program is running, the type of data in the field changes. When Debug

Tool evaluates the conditional expression, the data in the variable used in the comparison is not valid for the variable's attributes.

If an exception is raised during the evaluation of a conditional expression and SET WARNING is OFF, Debug Tool still stops, displays a message about the exception, and prompts you to enter a command.

The following example describes what happens when you use a field that has multiple definitions, with each definition having different attributes, as part of a conditional expression:

1. You enter the following command to check the value of WK-TEST-NUM, which is a field with two definitions, one is numeric, the other is string:

   ```
   AT CHANGE WK-TEST-NUM
      BEGIN;
      IF WK-TEST-NUM = 10;
         LIST 'WK-TEST-NUM IS 10';
      ELSE;
         GO;
      END-IF;
      End;
   ```

2. When Debug Tool evaluates the conditional expression WK-TEST-NUM = 10, the type of data in the field WK-TEST-NUM is string. Because the data in the field WK-TEST-NUM is a string and it cannot be compared to 10, the comparison becomes invalid. Debug Tool stops and prompts you to enter a command.
3. You decide you want Debug Tool to continue running the program and stop only when the type of data in the field is numeric and matches the 10.
4. You enter the following command, which adds calls to the SET WARNING OFF and SET WARNING ON commands:

   ```
   AT CHANGE WK-TEST-NUM
      BEGIN;
      SET WARNING OFF;
      IF WK-TEST-NUM = 10;
         LIST 'WK-TEST-NUM IS 10';
      ELSE;
         BEGIN;
         SET WARNING ON;
         GO;
         END;
      END-IF;
      SET WARNING ON;
      END;
   ```

   Now, when the value of the field WK-TEST-NUM is not 10 or it is not a numeric type, Debug Tool evaluates the conditional expression WK-TEST-NUM = 10 as false and runs the GO command. Debug Tool does not stop and prompt you for a command.

In this example, the display of warning messages about the conditional expression (WK-TEST-NUM = 10) was suppressed by entering the SET WARNING OFF command before the conditional expression was evaluated. After the conditional expression was evaluated, the display of warning messages was allowed by entering the SET WARNING ON command.

Carefully consider when you enter the SET WARNING OFF command because you might suppress the display of warning messages that might help you detect other problems in your program.

Stepping through or running your program

By default, when Debug Tool starts, none of your program has run yet (including C++ constructors and static object initialization).

Debug Tool defines a line as one line on the screen, commonly identified by a line number. A statement is a language construct that represents a step in a sequence of actions or a set of declarations. A statement can equal one line, it can span several lines, or there can be several statements on one line. The number of statements that Debug Tool runs when you step through your program depends on where hooks are placed.

To run your program up to the next hook, press PF2 (STEP). If you compiled your program with a combination of any of the following TEST or DEBUG compiler suboptions, STEP performs one statement:

- For C, compile with TEST(ALL) or DEBUG(HOOK(LINE,NOBLOCK,PATH)).
- For C++, compile with TEST or DEBUG(HOOK(LINE,NOBLOCK,PATH)).
- For any release of Enterprise COBOL for z/OS, Version 3, or Enterprise COBOL for z/OS and OS/390, Version 2, compile with one of the following suboptions:
  - TEST(ALL)
  - TEST(NONE) and use the Dynamic Debug facility
- For Enterprise COBOL for z/OS, Version 4.1, compile with one of the following suboptions:
  - TEST(HOOK)
  - TEST(NOHOOK) and use the Dynamic Debug facility
- For any release of Enterprise PL/I for z/OS, compile with TEST(ALL).
- For Enterprise PL/I for z/OS, Version 3.4 or later, compile with TEST(ALL,NOHOOK) and use the Dynamic Debug facility.

To run your program until a breakpoint is reached, the program ends, or a condition is raised, press PF9 (GO).

Note: A condition being raised is determined by the setting of the TEST run-time suboption *test_level*.

The command STEP OVER runs the called function without stepping into it. If you accidentally step into a function when you meant to step over it, issue the STEP RETURN command that steps to the return point (just after the call point).

Refer to the following topics for more information related to the material discussed in this topic.

Related tasks

Chapter 3, “Planning your debug session,” on page 23
Chapter 12, “Writing the TEST run-time option string,” on page 111

Recording and replaying statements

Debug Tool provides a set of commands (the PLAYBACK commands) that helps you record and replay the statements that you run while you debug your program. To record and replay statements, you need to do the following:

1. Record the statements that you run (PLAYBACK ENABLE command). If you specify the DATA parameter or the DATA parameter is defaulted, additional information about your program is recorded.

2. Prepare to replay statements (PLAYBACK START command).
3. Replay the statements that you recorded (STEP or RUNTO command).
4. Change the direction that the statements are replayed (PLAYBACK FORWARD command).
5. Stop replaying statements (PLAYBACK STOP command).
6. Stop recording the statements that you run (PLAYBACK DISABLE command). All data for the compile units specified or implied on the PLAYBACK DISABLE command is discarded.

Each of these steps are described in more detail in the sections that follow.

Recording the statements that you run

The PLAYBACK ENABLE command includes a set of parameters to specify:

- Which compile units to record
- The maximum amount of storage to use to record the statements that you run
- Whether to record the following additional information about your program:
  - The value of variables.
  - The value of registers.
  - Information about the files you use: open, close, last operation performed on the files, how the files were opened.

The PLAYBACK ENABLE command can be used to record the statements that you run for all compile units or for specific compile units. For example, you can record the statements that you run for compile units A, B, and C, where A, B, and C are existing compile units. Later, you can enter the PLAYBACK ENABLE command and specify that you want to record the statements that you run for all compile units. You can use an asterisk (*) to specify all current and future compile units.

The number of statements that Debug Tool can record depends on the following:

- The amount of storage specified or defaulted.
- The number of changes made to the variables.
- The number of changes made to files.

You cannot change the storage value after you have started recording. The more storage that you specify, the more statements that Debug Tool can record. After Debug Tool has filled all the available storage, Debug Tool puts information about the most recent statements over the oldest information. When the DATA parameter is in effect, the available storage fills more quickly.

You can use the DATA parameter with programs compiled with the SYM suboption of the TEST compiler option only if they are compiled with the following compilers:

- Enterprise COBOL for z/OS, Version 4.1[7]
- Enterprise COBOL for z/OS and OS/390, Version 3 Release 2 or later
- Enterprise COBOL for z/OS and OS/390, Version 3 Release 1 with APAR PQ63235
- COBOL for OS/390 & VM, Version 2 with APAR PQ63234

Refer to the following topics for more information related to the material discussed in this topic.

7. With Enterprise COBOL for z/OS, Version 4.1, and the TEST compiler option the symbol tables are always generated.

Related tasks
"Stop the recording"

Preparing to replay the statements that you recorded

The PLAYBACK START command notifies Debug Tool that you want to replay the statements that you recorded. This command suspends normal debugging; all breakpoints are suspended and you cannot use many Debug Tool commands. *Debug Tool Reference and Messages* provides a complete list of which commands you cannot use while you replay statements.

The initial direction is backward.

Replaying the statements that you recorded

To replay the statements that you recorded, enter the STEP or RUNTO command. You can replay the statements you recorded until one of the following conditions is reached:

- If you are replaying in the backward direction, you reach the point where you entered the PLAYBACK ENABLEcommand. If you are replaying in the forward direction, you reach the point where you entered the PLAYBACK START command. command.
- You reach the point where there are no more statements to replay, because you have run out of storage.

You can replay as far forward as the point where you entered the PLAYBACK START command. As you replay statements, you see only the statements that you recorded for those compile units you indicated you wanted to record. While you are replaying steps, you cannot modify variables. If the DATA parameter is in effect, you can access the contents of variables and expressions.

Changing the direction that statements are replayed

To change the direction that statements are replayed, enter the PLAYBACK FOWARD or PLAYBACK BACKWARD command. The initial direction is backward.

Stop the replaying

To stop replaying the statements that you recorded and resume normal debugging, enter the PLAYBACK STOP command. This command resumes normal debugging at the point where you entered the PLAYBACK START command. Debug Tool continues to record the statements that you run.

Stop the recording

To stop recording the statements that you run and collecting additional information about your program, enter the PLAYBACK DISABLE command. This command can be used to stop recording the statements that you run in all or specific compile units. If you stop recording for one or more compile units, the data collected for those compile units is discarded. If you stop recording for all compile units, the PLAYBACK START command is no longer available.

Refer to the following topics for more information related to the material discussed in this topic.

Related references
Debug Tool Reference and Messages

Restrictions on recording and replaying statements

You cannot modify the value of variables or storage while you are replaying statements.

When you replay statements, many Debug Tool commands are unavailable. *Debug Tool Reference and Messages* contains a complete list of all the commands that are not available.

Restrictions on accessing COBOL data

If the DATA parameter is specified or defaulted for a COBOL compile unit that supports this parameter, you can access data defined in the following section of the DATA DIVISION:

- FILE SECTION
- WORKING-STORAGE SECTION
- LOCAL-STORAGE SECTION
- LINKAGE SECTION

You can also access special registers, except for the ADDRESS OF, LENGTH OF, and WHEN-COMPILED special registers. You can also access all the special registers supported by Debug Tool commands.

When you are replaying statements, many Debug Tool commands are available only if the following conditions are met:

- The DATA parameter must be specified or defaulted for the compile unit.
- The compile unit must be compiled with a compiler that supports the DATA parameter.

You can use the QUERY PLAYBACK command to determine the compile units for which the DATA option is in effect.

Debug Tool Reference and Messages contains a complete list of all the commands that can be used when you specify the DATA parameter.

Saving and restoring settings, breakpoints, and monitor specifications

You can save settings, breakpoints, and monitor specifications from one debugging session and then restore them in a subsequent debugging session. You can save the following information:

Settings

The settings for the WINDOW SIZE, WINDOW CLOSE, and SET command, except the for the following settings for the SET command:

- DBCS
- FREQUENCY
- NATIONAL LANGUAGE
- PROGRAMMING LANGUAGE
- FILE operand of the RESTORE SETTINGS switch
- QUALIFY
- SOURCE
- TEST

Breakpoints

All of the breakpoints currently set or suspended in from the current debugging session as well as all LOADDEBUGDATA (LDD) specifications. The following breakpoints are saved:

- APPEARANCE breakpoints
- CALL breakpoints

- DELETE breakpoints
- ENTRY breakpoints
- EXIT breakpoints
- GLOBAL APPEARANCE breakpoints
- GLOBAL CALL breakpoints
- GLOBAL DELETE breakpoints
- GLOBAL ENTRY breakpoints
- GLOBAL EXIT breakpoints
- GLOBAL LABEL breakpoints
- GLOBAL LOAD breakpoints
- GLOBAL STATEMENT breakpoints
- GLOBAL LINE breakpoints
- LABEL breakpoints
- LOAD breakpoints
- OCCURRENCE breakpoints
- STATEMENT breakpoints
- LINE breakpoints
- TERMINATION breakpoints

If a deferred AT ENTRY breakpoint has not been encountered, it is not saved nor restored.

Monitor specifications

All of the monitor and LOADDEBUGDATA (LDD) specifications that are currently in effect.

In most environments, Debug Tool uses specific default data set names to save these items so that it can automatically save and restore these items for you. In these environments, you must automatically restore the settings so that the SET RESTORE BPS AUTO and SET RESTORE MONITORS AUTO commands are in effect during Debug Tool initialization. There are some environments where you have to use the RESTORE command to restore these items manually.

In TSO, CICS (when you log on with your own ID), and UNIX System Services, the following default data set names are used:

- *userid*.DBGTOOL.SAVESETS (a sequential data set) is used to save the settings.
- *userid*.DBGTOOL.SAVEBPS (a PDS or PDSE data set) is used to save the breakpoints, monitor specifications, and LDD specifications.

In non-interactive mode (MVS batch mode without using full-screen mode using the Terminal Interface Manager), you must include an INSPSAFE DD statement to indicate the data set that you want Debug Tool to use to save and restore the settings and an INSPBPM DD statement to indicate the data set that you want Debug Tool to use to save and restore the breakpoints and monitor and LDD specifications.

Use a sequential data set to save and restore the settings. Use a PDS or PDSE to save and restore the breakpoints and monitor and LDD specifications. We recommend that you use a PDSE to avoid having to compress the data set. Debug Tool uses a separate member to store the breakpoints, LDD data, and monitor specifications for each enclave. Debug Tool names the member the name of the initial load module in the enclave. If you want to discard all of the saved

breakpoints, LDD data, and monitor specifications for an enclave, you can delete the corresponding member. However, do not alter the contents of the member.

Saving and restoring automatically

Saving and restoring automatically means that every time you finish a debugging session, Debug Tool saves information about your debugging session. The next time you start a debugging session, Debug Tool restores that information. Setting up automatic saving and restoring requires that you allocate files and enter the appropriate commands that enable this feature. You can do this in one of the following ways:

- You or your site can specify the EQAOPTS `SAVESETDSNALLOC` and `SAVEBPDSNALLOC` commands. These commands can create the files and enter the appropriate commands for you, your group, or your entire site. If you choose this method, you can skip the rest of this topic and follow the instructions in the topic "EQAOPTS commands" in the *Debug Tool Reference and Messages* or *Debug Tool Customization Guide*.
- Run the EQAWSVST job in *hlq*`.SEQASAMP` to create the data set and run the appropriate commands. The disadvantage to this method is that you have to determine if the values for the EQAOPTS `SAVESETDSN` and `SAVEBPDSN` commands have been altered, and then make a similar change to the job.
- You can do the steps described in this topic.

To enable automatic saving and restoring, you must do the following steps:

1. Pre-allocate a sequential data set with the default name where settings will be saved. If you are running in non-interactive mode (MVS batch mode without using full-screen mode using the Terminal Interface Manager), you must include an INSPSAFE DD statement that references this data set.
2. Pre-allocate a PDSE or PDS with the default name where breakpoints, monitor, and LDD specifications will be saved. If you are running in non-interactive mode (MVS batch mode without using full-screen mode using the Terminal Interface Manager), you must include an INSPBPM DD statement that references this data set.
3. Start Debug Tool.
   - If you are running in CICS, you must log on as a user other than the default user and the CICS region must have update authorization to the SAVE SETTINGS and SAVE BPS data sets.
   - If you are running in non-interactive mode (MVS batch mode without using full-screen mode using the Terminal Interface Manager), you must add INSPSAFE and INSPBPM DD statements that reference the data sets you allocated in step 1 and 2.
4. Enable automatic saving and restoring of settings by using the following commands:

   ```
   SET SAVE SETTINGS AUTO;
   SET RESTORE SETTINGS AUTO;
   ```

5. If you want to enable automatic saving and restoring of breakpoints and LDD specifications or monitor and LDD specifications, use the following commands:

   ```
   SET SAVE BPS AUTO;
   SET RESTORE BPS AUTO;
   SET SAVE MONITORS AUTO;
   SET RESTORE MONITORS AUTO;
   ```

   You must do step 4 (enabling automatic saving and restoring of settings) if you want to enable automatic restoring of breakpoints or monitor specifications.
6. Shutdown Debug Tool. Your settings are saved in the corresponding data set.

The next time you start Debug Tool, the settings are automatically restored. If you are debugging the same program, the breakpoints and monitor specifications are also automatically restored.

Disabling the automatic saving and restoring of breakpoints, monitors, and settings

To disable automatic saving of breakpoints and monitors, you must ensure that the following settings are in effect:

- `SET SAVE BPS NOAUTO;`
- `SET SAVE MONITORS NOAUTO;`

To disable automatic saving of settings, you must ensure that the `SET SAVE SETTINGS NOAUTO;` setting is in effect.

To disable automatic restoring of breakpoints and monitors, you must ensure that the following settings are in effect:

- `SET RESTORE BPS NOAUTO;`
- `SET RESTORE MONITORS NOAUTO;`

To disable automatic restoring of settings, you must ensure that the `SET RESTORE SETTINGS NOAUTO;` setting is in effect.

If you disable the automatic saving of any of these values, the last saved data is still present in the appropriate data sets. Therefore, you can restore from these data sets. Be aware that this means you will restore values from the last time the data was *saved* which might not be from the last time you ran Debug Tool.

Restoring manually

Automatic restoring is not supported in the following environments:

- Debugging in CICS without logging-on
- Debugging DB2 stored procedures

You can save and restore breakpoints, monitor, and LDD specifications by doing the following steps:

1. Pre-allocate a sequential data set for saving and restoring of settings.
2. Pre-allocate a PDSE or PDS for saving and restoring breakpoints and monitor specifications.
3. Start Debug Tool.
4. To enable automatic saving of settings, use the following command where *mysetdsn* is the name of the data set that you allocated in step 1:

   ```
   SET SAVE SETTINGS AUTO FILE mysetdsn;
   ```

5. To enable automatic saving of breakpoints and LDD specifications or monitor and LDD specifications, use the following commands, where *mybpdsn* is the name of the data set that you allocated in step 2:

   ```
   SET SAVE BPS AUTO FILE mybpdsn;
   SET SAVE MONITORS AUTO;
   ```

6. Shutdown Debug Tool.

The next time you start Debug Tool in one of these environments, you must use the following commands, in the sequence shown, at the beginning of your Debug Tool session.

```
SET SAVE SETTINGS AUTO FILE mysetdsn;
RESTORE SETTINGS;
SET SAVE BPS AUTO FILE mybpdsn;
RESTORE BPS MONITORS;
```

You can put these commands into a user preferences file.

Performance considerations in multi-enclave environments

Each time information is saved or restored, the following actions must take place:

1. The data set is allocated.
2. The data set is opened.
3. The data set is written or read.
4. The data set is closed.
5. The data set is deallocated.

Because each of these steps requires operating system services, the overall process can require a significant amount of elapsed time.

For saving and restoring settings, this process is done once when Debug Tool is activated and once when Debug Tool terminates. Therefore, unless Debug Tool is repeatedly activated and terminated, the process is not excessively time-consuming. However, for saving and restoring of breakpoints, monitors, or both, this process occurs once on entry to each enclave and once on termination of each enclave.

If your program consists of multiple enclaves or an enclave that is run repeatedly, this process might occur many times. In this case, if performance is a concern, you might want to consider disabling saving and restoring of breakpoints and monitors. If your program runs under CICS with DTCN and saving and restoring of breakpoints and monitors is not enabled (`SET SAVE BPS NOAUTO;`, `SET SAVE MONITORS NOAUTO;`, `SET RESTORE BPS NOAUTO;`, and `SET RESTORE MONITORS NOAUTO;` are in effect), breakpoints are saved and restored from a CICS Temporary Storage Queue which is less time-consuming than the standard method but does not preserve breakpoints across CICS restarts nor does it provide for saving and restoring of monitors.

Displaying and monitoring the value of a variable

Debug Tool can display the value of variables in the following ways:

- One-time display, by using the `LIST` command, the PF4 key, or the `L` prefix command. One-time display displays the value of the variable at the moment you enter the `LIST` command, press the PF4 key, or enter the `L` prefix command. If you step or run through your program, any changes to the value of the variable are not displayed. The `L` and `M` prefix commands are available only when you use the following languages or compilers:
  - Enterprise PL/I for z/OS, Version 3.6 or 3.7 with the PTF for APAR PK70606, or later
  - Enterprise COBOL compiled with the TEST compile option
  - Assembler
  - Disassembly
- Continuous display, called monitoring, by using the `MONITOR LIST` command, the `SET AUTOMONITOR` command, or the `M` prefix command. If you step or run through your program, any changes to the value of the variable are displayed.

Note: Use the command `SET LIST TABULAR` to format the LIST output for arrays and structures in tabular format. See the *Debug Tool Reference and Messages* for more information about this command.

If Debug Tool cannot display the value of a variable in its declared data type, see "How Debug Tool handles characters that cannot be displayed in their declared data type" on page 195.

One-time display of the value of variables

Before you begin, determine if you want to change the format in which information is displayed. Variables that are areas and structures might be easier to read if they are arranged in a tabular format on the screen. To make changes to the format, do one of the following options:

- If you want to change the format of the output for arrays and structures to tabular format when displaying a variable, do the following steps:
  1. Move the cursor to the command line.
  2. Enter the following command: `SET LIST TABULAR ON`
- If you want to change the format of the output for arrays and structures to linear format when displaying a variable, do the following steps:
  1. Move the cursor to the command line.
  2. Enter the following command: `SET LIST TABULAR OFF`
- If you want to format the logged output of arrays and structures when `SET AUTOMONITOR ON LOG` is in effect, do the following steps:
  1. Move the cursor to the command line.
  2. Enter the following command: `SET LIST TABULAR ON`
  3. Enter the following command: `SET AUTOMONITOR ON LOG`

To display the contents of a variable once, do one of the following options:

- By using the PF4 key, do the following steps:
  1. Scroll through the Source window until you find the variable you want to display.
  2. Move your cursor to the variable name.
  3. Press the PF4 (LIST) key. The value of the variable is displayed in the Log window.
- By using the `LIST` command:
  1. Move the cursor to the command line.
  2. Type the following command, substituting your variable name for *variable-name*:

     `LIST` *`variable-name`*`;`
  3. Press Enter. The value of the variable is displayed in the Log window.
- By using the `L` prefix command, do the following steps:
  1. Scroll through the Source window until you find the operand you want to display.
  2. Move your cursor to the prefix area of the line that contains the operand you want to display.
  3. Type in an "L" in the prefix area, then press Enter to display the value of all of the operands on that line. If you want to display the value of a specific operand on that line, do the following steps:

a. If you are debugging a high-level language program, beginning from the left and with the number 1, assign a number to the first occurrence of each variable. For example, in the following line, *rightSide* is 1, *leftSide* is 2, and *bottomSide* is 3:

```
rightSide = (leftSide * leftSide) + (bottomSide * bottomSide);
```

If you are debugging an assembler or disassembly program, beginning from the left and beginning with number 1 assign the each operand of the machine instruction a number.

b. Type in an "L" in the prefix area, followed by the number assigned to the operand that you want to display. If you wanted to display the value of *leftSide* in the previous example, you would enter "L2" in the prefix area.

c. Press Enter. Debug Tool displays the value of *leftSide* in the Log window.

Adding variables to the Monitor window

When you add a variable to the Monitor window, you are *monitoring* the value of that variable. To add a variable to the Monitor window, do one of the following options:

- To use the `MONITOR LIST` command, do the following steps:
  1. Move the cursor to the command line.
  2. Type the following command, substituting your variable name for *variable-name*:

     ```
     MONITOR LIST variable-name;
     ```

  3. Press Enter. Debug Tool assigns the variable a reference number between 1 and 99, adds the variable to the Monitor window (above the automonitor section, if it is displayed), and displays the current value of the variable.

  Every time Debug Tool receives control or every time you enter a Debug Tool command that can affect the display, Debug Tool updates the value of *variable-name* in the Monitor window so that the Monitor window always displays the current value.
- To use the `M` prefix command, do the following steps:
  1. Scroll through the Source window until you find the operand you want to monitor.
  2. Move your cursor to the prefix area of the line that contains the operand you want to monitor.
  3. Type in an "M" in the prefix area, then press Enter to monitor the value of all of the operands on that line. If you want to monitor the value of a specific operand on that line, do the following steps:
     a. If you are debugging a high-level language program, beginning from the left and with number 1, assign a number to the first occurrence of each variable. For example, in the following line, *rightSide* is 1, *leftSide* is 2, and *bottomSide* is 3:

        ```
        rightSide = (leftSide * leftSide) + (bottomSide * bottomSide);
        ```

        If you are debugging an assembler or disassembly program, beginning from the left and beginning with number 1 assign the each operand of the machine instruction a number.

     b. Type in an "M" in the prefix area, followed by the number assigned to the operand that you want to monitor. If you wanted to monitor the value of *leftSide* in the previous example, you would enter "M2" in the prefix area.

     c. Press Enter.

Every time Debug Tool receives control or every time you enter a Debug Tool command that can affect the display, Debug Tool updates the value of *leftSide* in the Monitor window so that the Monitor window always displays the current value.

Refer to the following topics for more information related to the material discussed in this topic.

Related tasks

"Adding variables to the Monitor window automatically" on page 192

Displaying the Working-Storage Section of a COBOL program in the Monitor window

You can add all of the variables in the Working-Storage Section of a COBOL program to the Monitor window by doing the following steps:

1. Move the cursor to the command line.
2. Type in the following command: `MONITOR LIST TITLED WSS;`
3. Press Enter. Debug Tool assigns the WSS entry a reference number between 1 and 99, adds the WSS entry to the Monitor window, and displays the current values of all of the variables in the Working-Storage Section.

Every time Debug Tool receives control or you enter a Debug Tool command that can effect the display, Debug Tool updates the value of each variable in the Monitor window so that Debug Tool always displays the current value.

Because the Working-Storage Section can contain many variables, monitoring the Working-Storage Section can add a substantial amount of overhead and use more storage.

Refer to the following topics for more information related to the material discussed in this topic.

Related tasks

"Modifying variables or storage by typing over an existing value" on page 198

Displaying the data type of a variable in the Monitor window

The command `SET MONITOR DATATYPE ON` displays the data type of the variables displayed in the Monitor window, including those in the automonitor section. The data type is ordinarily the type which was used in the declaration of the variable. The command `SET MONITOR DATATYPE OFF` disables the display of this information.

To display the value and data type of a variable in the Monitor window:

1. Move the cursor to the command line.
2. Enter the following command:

   ```
   SET MONITOR DATATYPE ON;
   ```

3. Enter one of the following commands:
   - `MONITOR LIST` *`variable-name`*`;`

     Substitute the name of your variable name for *variable-name*. Debug Tool adds the variable to the Monitor window and displays the current value and data type of the variable.
   - `SET AUTOMONITOR ON;`

     Debug Tool adds the variable or variables in the current statement to the automonitor section of the Monitor window and displays the current value and data type of the variable or variables.

- `SET AUTOMONITOR ON LOG;`

  Debug Tool adds the variable or variables to the automonitor section of the Monitor window, displays the current value and data type of the variable or variables, and saves that information in the log.

Replacing a variable in the Monitor window with another variable

When you add a variable to the Monitor window, Debug Tool assigns the variable a reference number between 1 and 99. You can use the reference numbers to help you replace a variable in the Monitor window with another variable.

To replace a variable in the Monitor window with another variable, do the following steps:

1. Verify that you know the reference number of the variable in the Monitor window that you want to replace.
2. Move the cursor to the command line.
3. Type the following command, substituting *reference_number* with the reference number of the variable you want to replace and *variable-name* with the name of a new variable:

   `MONITOR` *`reference_number`* `LIST` *`variable-name`*`;`

   You can specify only an existing reference number or a reference number that is one greater than the highest existing reference number.
4. Press Enter. Debug Tool adds the new variable to the Monitor window on the line that displayed the old variable, and displays the current value of that variable.

If you added an element of an array to the Monitor window, you can replace that element with another element of the same array by doing the following steps:

1. Move your cursor to the Monitor window and place it under the subscript you want to change.
2. Type in the new subscript.
3. Press Enter. Debug Tool replaces the old element with the new element, then displays a message confirming the change.

Adding variables to the Monitor window automatically

As you step through a program, you might want to monitor variables that are on each statement as you run each statement. Manually adding variables to the Monitor window (as described in “Adding variables to the Monitor window” on page 190) before you run each statement can be time consuming. Debug Tool can automatically add the variables at each statement, before or after it is run; display the values of those variables, before or after the statement is run; then remove the variables from the Monitor window after you run the statement. To do this, use the `SET AUTOMONITOR ON` command.

Before you begin, make sure you understand how the `SET AUTOMONITOR` command works by reading “How Debug Tool automatically adds variables to the Monitor window” on page 194.

To add variables to the Monitor window automatically, do the following steps:

1. Move the cursor to the command line.
2. Enter one of the following commands:
   - `SET AUTOMONITOR ON;` if you want to display variables at the current statement, before the statement is run.

- `SET AUTOMONITOR ON PREVIOUS;` if you want to display variables at the statement Debug Tool just ran, after the statement was run.
- `SET AUTOMONITOR ON BOTH;` if you want to display variables at the statement Debug Tool just ran, after the statement was run, and the current statement, before the statement is run.

As you step through your program, Debug Tool displays the names and values of the variables in the automonitor section of the window.

3. To stop adding variables to the Monitor window automatically, enter the `SET AUTOMONITOR OFF` command. Debug Tool removes the line `********** AUTOMONITOR **********` and any variables underneath that line.

Refer to the following topics for more information related to the material discussed in this topic.

Related concepts

"How Debug Tool automatically adds variables to the Monitor window" on page 194

Related tasks

"Saving the information in the automonitor section to the log file"

Related references

Description of the `SET AUTOMONITOR` command in *Debug Tool Reference and Messages*.

"Example: How Debug Tool adds variables to the Monitor window automatically" on page 195

Saving the information in the automonitor section to the log file

To save the following information in the log file, enter the `SET AUTOMONITOR ON LOG` command:

- Breakpoint locations
- The names and values of the variables at the breakpoints

The default option is `NOLOG`, which would not save the above information.

Each entry in the log file contains the breakpoint location within the program and the names and values of the variables in the statement. To stop saving this information in the log file and continue updating the automonitor section of the Monitor window, enter the `SET AUTOMONITOR ON NOLOG` command.

Refer to the following topics for more information related to the material discussed in this topic.

Related concepts

"How Debug Tool automatically adds variables to the Monitor window" on page 194

Related tasks

"Adding variables to the Monitor window automatically" on page 192

Related references

Description of the `SET AUTOMONITOR` command in *Debug Tool Reference and Messages*.

"Example: How Debug Tool adds variables to the Monitor window automatically" on page 195

How Debug Tool automatically adds variables to the Monitor window

When you enter the SET AUTOMONITOR ON command, Debug Tool displays the line ********** AUTOMONITOR ********** at the bottom of the list of any monitored variables in the Monitor window, as shown in the following example:

```
COBOL    LOCATION: DTAM01 :> 109.1
Command ===>                                                Scroll ===> PAGE
MONITOR -+----1----+----2----+----3----+----4----+----5----+----6- LINE: 1 OF 7
****************************** TOP OF MONITOR ******************************
                                ----+----1----+----2----+----3----+----4----+

0001  1 NUM1                     0000000005
0002  2 NUM4                    '1111'
0003  3 WK-LONG-FIELD-2         '123456790 223456790 323456790 423456790 523
0004                            456790 623456790 723456790 823456790 9234567
0005                            90 023456790 123456790 223456790 323456790 4
0006                            23456790 523456790 623456790 723456790 82345
0007                            ********** AUTOMONITOR **********
```

The area below this line is called the automonitor section. Each time you enter the STEP command or a breakpoint is encountered, Debug Tool does the following tasks:

1. Removes any variable names and values displayed in the automonitor section.
2. Displays the names and values of the variables of the statement that Debug Tool runs next. The values displayed are values *before* the statement is run.

This behavior displays the value of the variables before Debug Tool runs the statement. If you want to see the value of the variables after Debug Tool runs the statement, you can enter the SET AUTOMONITOR ON PREVIOUS command. Debug Tool displays the line ********** AUTOMONITOR – PREVIOUS *load-name* ::> *cu-name* :> *statement-id* ********** at the bottom of the list of any monitored variables in the Monitor window. Each time you enter the STEP command or a breakpoint is encountered, Debug Tool does the following tasks:

1. Removes any variable names and values displayed in the automonitor section.
2. Displays the names and the values of the variables of the most recent statement that Debug Tool ran. The values displayed are values *after* that statement was run.

If you want to see the value of the variables before *and* after Debug Tool runs the statement, you can enter the SET AUTOMONITOR ON BOTH command. Debug Tool displays the line ********** AUTOMONITOR *load-name* ::> *cu-name* :> *statement-id* ********** at the bottom of the list of any monitored variables in the Monitor window. Below this line, Debug Tool displays the names and values of the variables on the statement that Debug Tool runs next. Then, Debug Tool displays the line ***** Previous Statement *load-name* ::> *cu-name* :> *statement-id* ***** . Below this line, Debug Tool displays the names and values of the variables of the statement that Debug Tool just ran. Each time you enter the STEP command or a breakpoint is encountered, Debug Tool does the following tasks:

1. Removes any variable names and values displayed in the automonitor section.
2. Displays the names and values of the variables of the statement that Debug Tool runs next. The values displayed are values *before* the statement is run.
3. Displays the names and the values of the variables of the statement that Debug Tool just ran. The values displayed are values *after* the statement was run.

Refer to the following topics for more information related to the material discussed in this topic.

Related tasks
"Adding variables to the Monitor window automatically" on page 192

Related references
Description of the SET AUTOMONITOR command in *Debug Tool Reference and Messages*.
"Example: How Debug Tool adds variables to the Monitor window automatically"

Example: How Debug Tool adds variables to the Monitor window automatically

The example in this section assumes that the following two lines of COBOL code are to be run:

```
COMPUTE LOAN-AMOUNT = FUNCTION NUMVAL(LOAN-AMOUNT-IN).  1
COMPUTE INTEREST-RATE = FUNCTION NUMVAL(INTEREST-RATE-IN).
```

Before you run the statement in Line **1** , enter the following command:

```
SET AUTOMONITOR ON ;
```

The name and value of the variables LOAN-AMOUNT and LOAN-AMOUNT-IN are displayed in the automonitor section of the Monitor window. These values are the values of the variables before you run the statement.

Enter the STEP command. Debug Tool removes LOAN-AMOUNT and LOAN-AMOUNT-IN from the automonitor section of the Monitor window and then displays the name and value of the variables INTEREST-RATE and INTEREST-RATE-IN. These values are the values of the variables before you run the statement.

Refer to the following topics for more information related to the material discussed in this topic.

Related concepts
"How Debug Tool automatically adds variables to the Monitor window" on page 194

Related tasks
"Adding variables to the Monitor window automatically" on page 192

Related references
Description of the SET AUTOMONITOR command in *Debug Tool Reference and Messages*.

How Debug Tool handles characters that cannot be displayed in their declared data type

In the Monitor window, Debug Tool uses one of the following characters to indicate that a character cannot be displayed in its declared data type:

- For COBOL and PL/I programs, Debug Tool displays a dot (X'4B').
- For assembler and LangX COBOL programs, Debug Tool displays a quotation mark (").
- For C and C++ programs, Debug Tool displays the character as an escape sequence.

Characters that cannot be displayed in their declared data type can vary from code page to code page, but, in general, these are characters that have no corresponding symbol that can be displayed on a screen.

To be able to modify these characters, you can use the HEX and DEF prefix commands to help you verify which character you are modifying.

Refer to the following topics for more information related to the material discussed in this topic.

Related tasks

"Modifying characters that cannot be displayed in their declared data type"

Modifying characters that cannot be displayed in their declared data type

As described in "How Debug Tool handles characters that cannot be displayed in their declared data type" on page 195, if you want to modify characters that can't be displayed in their declared data type and ensure that the results are what you expected, do the following steps:

1. Move the cursor to the prefix area of the Monitor window, along the line that contains the character you want to modify.
2. Enter the HEX prefix command. Debug Tool changes the character to display in hexadecimal format.
3. Move the cursor to the character.
4. Type in the new *hexadecimal* value and then press Enter. Debug Tool modifies the character and displays the new value in hexadecimal format.
5. If you want to view the character in its declared data type, move the cursor to the prefix area and enter the DEF command.

Refer to the following topics for more information related to the material discussed in this topic.

"Displaying and monitoring the value of a variable" on page 188
"Modifying the value of a COBOL variable" on page 209
"Displaying and modifying the value of LangX COBOL variables or storage" on page 221
"Modifying the value of a PL/I variable" on page 227
"Modifying the value of a C variable" on page 237
"Modifying the value of a C++ variable" on page 248
"Displaying and modifying the value of assembler variables or storage" on page 261

Related references

Prefix commands in *Debug Tool Reference and Messages*

Formatting values in the Monitor window

To monitor the value of the variable in columnar format, enter the SET MONITOR COLUMN ON command. The variable names that are displayed in the Monitor window are aligned to the same column and values are aligned to the same column. Debug Tool displays the Monitor value area scale under the header line for the Monitor window.

To display the value of the monitored variables wrapped in the Monitor window, enter the SET MONITOR WRAP ON command. To display the value of the monitored variables in a scrollable line, enter the SET MONITOR WRAP OFF command after you enter the SET MONITOR COLUMN ON command.

Displaying values in hexadecimal format

You can display the value of a variable in hexadecimal format by entering the LIST %HEX command or defining a PF key with the LIST %HEX command. For PL/I programs, to display the value of a variable in hexadecimal format, use the PL/I built-in function HEX. For more information about the PL/I HEX built-in function, see *Enterprise PL/I for z/OS: Programming Guide*. If you display a PL/I variable in hexadecimal format, you cannot edit the value of the variable by typing over the existing value in the Monitor window.

To display the value of a variable in hexadecimal format, enter one of the following commands, substituting *variable-name* with the name of your variable:

- For PL/I programs: `LIST HEX(variable-name) ;`
- For all other programs: `LIST %HEX(variable-name) ;`

Debug Tool displays the value of the variable *variable-name* in hexadecimal format.

If you defined a PF key with the LIST %HEX command, do the following steps:

1. If the variable is not displayed in the Source window, scroll through your program until the variable you want is displayed in the Source window.
2. Move your cursor to the variable name.
3. Press the PF key to which you defined LIST %HEX command. Debug Tool displays the value of the variable *variable-name* in hexadecimal format.

You cannot define a PF key with the PL/I HEX built-in function.

Monitoring the value of variables in hexadecimal format

You can monitor the value of a variable in either the variable's declared data type or in hexadecimal format. To monitor the value of a variable in its declared data type, follow the instructions described in “Adding variables to the Monitor window” on page 190. If you monitor a PL/I variable in hexadecimal format by using the PL/I HEX built-in function, you cannot edit the value of the variable by typing over the existing value in the Monitor window. Instead of using the PL/I HEX built-in function, us the commands described in this topic.

To monitor the value of a variable or expression in hexadecimal format, do one of the following instructions:

- If the variable is already being monitored, enter the following command:

  `MONITOR n HEX ;`

  Substitute *n* with the number in the monitor list that corresponds to the monitored expression that you would like to display in hexadecimal format.
- If the variable is not being monitored, enter the following command:

  `MONITOR LIST (expression) HEX ;`

  Substitute *expression* with the name of the variable or a complex expression that you want to monitor.

Refer to the following topics for more information related to the material discussed in this topic.

Related tasks

“Entering prefix commands on specific lines or statements” on page 164

Modifying variables or storage by using a command

You can modify the value of a variable or storage by using one of the following commands:

- assignment command for assembler or disassembly
- assignment command for LangX COBOL
- assignment command for PL/I
- COMPUTE command for COBOL
- Expression command for C and C++
- MOVE command for COBOL
- SET command for COBOL
- STORAGE

Each command is described in *Debug Tool Reference and Messages*.

Refer to the following topics for more information related to the material discussed in this topic.

Related tasks

"Displaying values of COBOL variables" on page 284
"Displaying values of C and C++ variables or expressions" on page 310
"Accessing PL/I program variables" on page 302
"Displaying and modifying the value of assembler variables or storage" on page 261

Modifying variables or storage by typing over an existing value

To modify the value of a variable by typing over the existing value in the Monitor window, do the following steps:

1. Move the cursor to the existing value. If the part of value you that want to modify is out of screen, use the SCROLL Monitor value area function (available with the `SET MONITOR WRAP OFF` command) and move the cursor to the position of existing value.
2. Type in the new value. Black vertical bars mark the area where you can type in your new value; you cannot type anything before and including the left vertical bar nor can you type anything including and after the right vertical bar.
3. Press Enter.

   Debug Tool modifies the variable or storage. The command that Debug Tool generated to modify the variable or storage is stored in the log file.

Restrictions for modifying variables in the Monitor window

You can modify the value of a variable by typing over the existing value in the Monitor window, with the following exceptions:

- You cannot type in a value that is larger than the declared type of the variable. For example, if you declare a variable as a string of four character and you try to type in five characters, Debug Tool prevents you from typing in the fifth character.
- If Debug Tool cannot display the entire value in the Monitor window and the setting of `MONITOR WRAP` is `ON`, you cannot modify the value of that variable.
- If you modify a long value and the setting of `MONITOR WRAP` is `OFF`, Debug Tool creates a `STORAGE` command to modify the value. If you are debugging a program that is optimized, the `STORAGE` command might not modify the value.
- You cannot modify the value of Debug Tool variables, except value of registers %GPRn, %FPRn, %EPRn, %LPRn.
- You cannot modify the value of a Debug Tool built-in function.

- You cannot modify the value of a PL/I built-in function.
- You cannot modify a complex expression.

If you type quotation marks (") or apostrophes (') in the Monitor value area, carefully verify that they comply with any applicable quotation rules.

Opening and closing the Monitor window

If the Monitor window is closed before you enter the `SET AUTOMONITOR ON` command, Debug Tool opens the Monitor window and displays the name and value of the variables of statement you run in the automonitor section of the window.

If the Monitor window is open before you enter the `SET AUTOMONITOR OFF` command and you are watching the value of variables not monitored by `SET AUTOMONITOR ON`, the Monitor window remains open.

Displaying and modifying memory through the Memory window

Debug Tool can display sections of memory through the Memory window. You can open the Memory window and have it display a specific section of memory by doing one of the following options:

- Entering the `MEMORY` command and specifying a base address. If the Memory window is already displayed through a physical window, the memory dump area displays memory starting at the base address.

  If the Memory window is not displayed through a physical window, the base address is saved for usage later when the Memory window is displayed through a physical window.

  To display the Memory window through a physical window, use the `WINDOW SWAP MEMORY LOG` command or `PANEL LAYOUT` command.
- Assigning the `MEMORY` command to a PF key. After you assign the `MEMORY` command to a PF key, you can move the cursor to a variable, then press the PF key. If the Memory window is already displayed through a physical window, the memory dump area displays memory starting at the base address. If the Memory window is not displayed through a physical window, the base address is saved for usage later when the Memory window is displayed through a physical window.

  To display the Memory window through a physical window, use the `WINDOW SWAP MEMORY LOG` command or `PANEL LAYOUT` command.

Refer to the following topics for more information related to the material discussed in this topic.

Related tasks

“Scrolling through the physical windows” on page 169
“Switching between the Memory window and Log window” on page 169
“Displaying memory through the Memory window” on page 17
“Customizing the layout of physical windows on the session panel” on page 266

Related references

“Memory window” on page 157
“Order in which Debug Tool accepts commands from the session panel” on page 163
MEMORY command in *Debug Tool Reference and Messages*

Modifying memory through the hexadecimal data area

You can type over the hexadecimal data area with hexadecimal characters (0-9, A-F, a-f). Debug Tool updates the memory with the value you typed in. If you modify

the program instruction area of memory, Debug Tool does not do any STEP commands or stop at any AT breakpoints near the area where you modified memory. In addition, if you try to run the program, the results are unpredictable.

The character data column is the character representation of the data and is only for viewing purposes.

Managing file allocations

You can manage files while you are debugging by using the DESCRIBE ALLOCATIONS, ALLOCATE, and FREE commands. You cannot manage files while debugging CICS programs.

To view a current list of allocated files, enter the DESCRIBE ALLOCATIONS command. The following screen displays the command and sample output:

```
  DESCRIBE ALLOCATIONS ;
*  Current allocations:
*  VOLUME CAT DISP       OPEN DDNAME   DSNAME
*   1 ---  2 - 3 ------  4 - 5 -----  6 ----------------------------------------
*  COD008  *  SHR KEEP     *  EQAZSTEP BCARTER.TEST.LOAD
*  SMS004  *  SHR KEEP                 SHARE.CEE210.SCEERUN
*  COD00B  *  OLD KEEP     *  INSPLOG  BCARTER.DTOOL.LOGV
*  VIO        NEW DELETE      ISPCTL0  SYS02190.T085429.RA000.BCARTER.R0100269
*  COD016  *  SHR KEEP        ISPEXEC  BCARTER.MVS.EXEC
*  IPLB13  *  SHR KEEP                 ISPF.SISPEXEC.VB
*  VIO        NEW DELETE      ISPLST1  SYS02190.T085429.RA000.BCARTER.R0100274
*  IPLB13  *  SHR KEEP     *  ISPMLIB  ISPF.SISPMENU
*  SMS278  *  SHR KEEP                 SHARE.ANALYZ21.SIDIMLIB
*  SHR89A  *  SHR KEEP                 SHARE.ISPMLIB
*  SMS25F  *  SHR KEEP     *  ISPPLIB  SHARE.PROD.ISPPLIB
*  SMS891  *  SHR KEEP                 SHARE.ISPPLIB
*  SMS25F  *  SHR KEEP                 SHARE.ANALYZ21.SIDIPLIB
*  IPLB13  *  SHR KEEP                 ISPF.SISPPENU
*  IPLB13  *  SHR KEEP                 SDSF.SISFPLIB
*  IPLB13  *  SHR KEEP                 SYS1.SBPXPENU
*  COD002  *  OLD KEEP     *  ISPPROF  BCARTER.ISPPROF
*             NEW DELETE      SYSIN    TERMINAL
*             NEW DELETE      SYSOUT   TERMINAL
*             NEW DELETE      SYSPRINT TERMINAL
```

The following list describes each column:

1 VOLUME
The volume serial of the DASD volume that contains the data set.

2 CAT
An asterisk in this column indicates that the data set was located by using the system catalog.

3 DISP
The disposition that is assigned to the data set.

4 OPEN
An asterisk in this column indicates that the file is currently open.

5 DDNAME
DD name for the file.

6 DSNAME
Data set name for a DASD data set:

- DUMMY for a DD DUMMY
- SYSOUT(x) for a SYSOUT data set

- TERMINAL for a file allocated to the terminal
- * for a DD * file

You can allocate files to an existing, cataloged data set by using the ALLOCATE command.

You can free an allocated file by using the FREE command.

By default, the DESCRIBE ALLOCATIONS command lists the files allocated by the current user. You can specify other parameters to list other system allocations, such as the data sets currently allocated to LINK list, LPA list, APF list, system catalogs, Parmlib, and Proclib. The *Debug Tool Reference and Messages* describes the parameters you must specify to list this information.

Displaying error numbers for messages in the Log window

When an error message shows up in the Log window without a message ID, you can have the message ID show up as in:

```
EQA1807E The command element d is ambiguous.
```

Either modify your profile or use the SET MSGID ON command. To modify your profile, use the PANEL PROFILE command and set **Show message ID numbers** to YES by typing over the NO.

Refer to the following topics for more information related to the material discussed in this topic.

Related tasks

"Customizing profile settings" on page 269

Displaying a list of compile units known to Debug Tool

This topics describes what to do if you want to know which compile units are known to Debug Tool. This is helpful if you have forgotten the name of a compile unit or if the source, listing, or separate debug file has been moved or renamed since your program was compiled. Debug Tool can only display a source, listing, or separate debug file associated with known compile units.

To determine which compile units are known to Debug Tool, do one of the following options:

- Enter the LIST NAMES CUS command.
- If you are debugging an assembler or disassembly program, enter the SET DISASSEMBLY ON or SET ASSEMBLER ON command, then enter the LIST NAMES CUS command.

After you run the LIST NAMES CUS command, Debug Tool displays a list of compile units in the Log window. You can use this list to compose a SET QUALIFY CU command by typing in the words "SET QUALIFY CU" over the name of a compile unit. Then press Enter. Debug Tool displays the command constructed from the words that you typed in and the name of the compile unit. Press Enter again to run the command.

For example, after you enter the LIST NAMES CUS command, Debug Tool displays the following lines in the Log window:

```
USERID.MFISTART.C(CALC)
USERID.MFISTART.C(PUSHPOP)
USERID.MFISTART.C(READTOKN)
```

If you type "SET QUALIFY CU" over the last line, then press Enter, Debug Tool composes the following command into the command line: `SET QUALIFY CU "USERID.MFISTART.C(READTOKN)"`. Press Enter and Debug Tool runs the command.

This method saves keystrokes and reduces errors in long commands.

Refer to the following topics for more information related to the material discussed in this topic.

Related tasks

"Changing which file appears in the Source window" on page 160

Requesting an attention interrupt during interactive sessions

During an interactive Debug Tool session, you can request an attention interrupt, if necessary. For example, you can stop what appears to be an unending loop, stop the display of voluminous output at your terminal, or stop the execution of the `STEP` command.

An attention interrupt should not be confused with the `ATTENTION` condition. If you set an `AT OCCURRENCE` or `ON ATTENTION`, the commands associated with that breakpoint are not run at an attention interrupt.

Language Environment `TRAP` and `INTERRUPT` run-time options should both be set to `ON` in order for attention interrupts that are recognized by the host operating system to be also recognized by Language Environment. The *test_level* suboption of the `TEST` run-time option should *not* be set to `NONE`.

An attention interrupt key is not supported in the following environment and debugging modes:

- CICS
- full-screen mode using the Terminal Interface Manager

For MVS only: For C, when using an attention interrupt, use `SET INTERCEPT ON FILE stdout` to intercept messages to the terminal. This is required because messages do not go to the terminal after an attention interrupt.

For the Dynamic Debug facility only: The Dynamic Debug facility supports attention interrupts only for programs that have compiled-in hooks.

The correct key might not be marked ATTN on every keyboard. Often the following keys are used:

- Under TSO: PA1 key
- Under IMS: PA1 key

When you request an *attention interrupt*, control is given to Debug Tool:

- At the next hook if Debug Tool has previously gained control or if you specified either `TEST(ERROR)` or `TEST(ALL)` or have specifically set breakpoints
- At a `__ctest()` or `CEETEST` call
- When an HLL condition is raised in the program, such as `SIGINT` in C

Refer to the following topics for more information related to the material discussed in this topic.

Related tasks

"Starting a debugging session in full-screen mode using the Terminal Interface Manager or a dedicated terminal" on page 133

Related references

z/OS Language Environment Programming Guide

Ending a full-screen debug session

When you have finished debugging your program, you can end your full-screen debug session by using one of the following methods:

Method A

1. Press PF3 (`QUIT`) or enter `QUIT` on the command line.
2. Type Y to confirm your request and press Enter. Your program stops running.

   If you are debugging a CICS non-Language Environment assembler or non-Language Environment COBOL program, `QUIT` ends Debug Tool and the task ends with an ABEND 4038.

Method B

1. Enter the `QQUIT` command. You are not prompted to confirm your request to end your debug session. Your program stops running.

   If you are debugging a CICS non-Language Environment assembler or non-Language Environment COBOL program, `QUIT` ends Debug Tool and the task ends with an ABEND 4038.

Method C

1. Enter the `QUIT DEBUG` or the `QUIT DEBUG TASK` (CICS only) command.
2. Type Y to confirm your request and press Enter. Debug Tool ends and your program continues running.

Refer to the following topics for more information related to the material discussed in this topic.

Related references

Debug Tool Reference and Messages

Chapter 21. Debugging a COBOL program in full-screen mode

The descriptions of basic debugging tasks for COBOL refer to the following COBOL program.

“Example: sample COBOL program for debugging”

Refer to the following topics for more information related to the material discussed in this topic.

Related tasks

Chapter 29, “Debugging COBOL programs,” on page 281
“Halting when certain routines are called in COBOL” on page 208
“Modifying the value of a COBOL variable” on page 209
“Halting on a COBOL line only if a condition is true” on page 210
“Debugging COBOL when only a few parts are compiled with TEST” on page 210
“Capturing COBOL I/O to the system console” on page 211
“Displaying raw storage in COBOL” on page 211
“Getting a COBOL routine traceback” on page 212
“Tracing the run-time path for COBOL code compiled with TEST” on page 212
“Generating a COBOL run-time paragraph trace” on page 213
“Finding unexpected storage overwrite errors in COBOL” on page 214
“Halting before calling an invalid program in COBOL” on page 214

Example: sample COBOL program for debugging

The program below is used in various topics to demonstrate debugging tasks.

This program calls two subprograms to calculate a loan payment amount and the future value of a series of cash flows. It uses several COBOL intrinsic functions.

Main program COBCALC

```
************************************************************
* COBCALC                                                  *
*                                                          *
* A simple program that allows financial functions to      *
* be performed using intrinsic functions.                  *
*                                                          *
************************************************************
 IDENTIFICATION DIVISION.
 PROGRAM-ID. COBCALC.
 ENVIRONMENT DIVISION.
 DATA DIVISION.
 WORKING-STORAGE SECTION.
 01  PARM-1.
     05  CALL-FEEDBACK     PIC XX.
 01  FIELDS.
     05  INPUT-1           PIC X(10).
 01  INPUT-BUFFER-FIELDS.
     05  BUFFER-PTR        PIC 9.
     05  BUFFER-DATA.
         10  FILLER        PIC X(10)  VALUE "LOAN".
         10  FILLER        PIC X(10)  VALUE "PVALUE".
         10  FILLER        PIC X(10)  VALUE "pvalue".
         10  FILLER        PIC X(10)  VALUE "END".
     05  BUFFER-ARRAY    REDEFINES BUFFER-DATA
                         OCCURS 4 TIMES
                           PIC X(10).
```

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```
 PROCEDURE DIVISION.
     DISPLAY "CALC Begins." UPON CONSOLE.
     MOVE 1 TO BUFFER-PTR.
     MOVE SPACES TO INPUT-1.
* Keep processing data until END requested
     PERFORM ACCEPT-INPUT UNTIL INPUT-1 EQUAL TO "END".
* END requested
     DISPLAY "CALC Ends." UPON CONSOLE.
     GOBACK.
* End of program.

*
* Accept input data from buffer
*
 ACCEPT-INPUT.
     MOVE BUFFER-ARRAY (BUFFER-PTR) TO INPUT-1.
     ADD 1 BUFFER-PTR GIVING BUFFER-PTR.
* Allow input data to be in UPPER or lower case
     EVALUATE FUNCTION UPPER-CASE(INPUT-1)     CALC1              WHEN "END"
         MOVE "END" TO INPUT-1
       WHEN "LOAN"
         PERFORM CALCULATE-LOAN
       WHEN "PVALUE"
         PERFORM CALCULATE-VALUE
       WHEN OTHER
         DISPLAY "Invalid input: " INPUT-1
     END-EVALUATE.
*
* Calculate Loan via CALL to subprogram
*
 CALCULATE-LOAN.
     CALL "COBLOAN" USING CALL-FEEDBACK.
     IF CALL-FEEDBACK IS NOT EQUAL "OK" THEN
       DISPLAY "Call to COBLOAN Unsuccessful.".
*
* Calculate Present Value via CALL to subprogram
*
 CALCULATE-VALUE.
     CALL "COBVALU" USING CALL-FEEDBACK.
     IF CALL-FEEDBACK IS NOT EQUAL "OK" THEN
       DISPLAY "Call to COBVALU Unsuccessful.".
```

Subroutine COBLOAN

```
*************************************************************
* COBLOAN                                                   *
*                                                           *
* A simple subprogram that calculates payment amount        *
* for a loan.                                               *
*                                                           *
*************************************************************
 IDENTIFICATION DIVISION.
 PROGRAM-ID. COBLOAN.
 ENVIRONMENT DIVISION.
 DATA DIVISION.
 WORKING-STORAGE SECTION.
 01  FIELDS.
     05  INPUT-1           PIC X(26).
     05  PAYMENT           PIC S9(9)V99 USAGE COMP.
     05  PAYMENT-OUT       PIC $$$$,$$$,$$9.99 USAGE DISPLAY.
     05  LOAN-AMOUNT       PIC S9(7)V99 USAGE COMP.
     05  LOAN-AMOUNT-IN    PIC X(16).
     05  INTEREST-IN       PIC X(5).
     05  INTEREST          PIC S9(3)V99 USAGE COMP.
     05  NO-OF-PERIODS-IN  PIC X(3).
     05  NO-OF-PERIODS     PIC 99 USAGE COMP.
     05  OUTPUT-LINE       PIC X(79).
```

```
 LINKAGE SECTION.
 01  PARM-1.
     05  CALL-FEEDBACK     PIC XX.
 PROCEDURE DIVISION USING PARM-1.
     MOVE "NO" TO CALL-FEEDBACK.
     MOVE "30000 .09 24 " TO INPUT-1.
     UNSTRING INPUT-1 DELIMITED BY ALL " "
       INTO LOAN-AMOUNT-IN INTEREST-IN NO-OF-PERIODS-IN.
* Convert to numeric values
     COMPUTE LOAN-AMOUNT = FUNCTION NUMVAL(LOAN-AMOUNT-IN).
     COMPUTE INTEREST = FUNCTION NUMVAL(INTEREST-IN).
     COMPUTE NO-OF-PERIODS = FUNCTION NUMVAL(NO-OF-PERIODS-IN).
* Calculate annuity amount required
     COMPUTE PAYMENT = LOAN-AMOUNT *
         FUNCTION ANNUITY((INTEREST / 12 ) NO-OF-PERIODS).
* Make it presentable
     MOVE SPACES TO OUTPUT-LINE
     MOVE PAYMENT TO PAYMENT-OUT.
     STRING "COBLOAN:_Repayment_amount_for_a_" NO-OF-PERIODS-IN
            "_month_loan_of_" LOAN-AMOUNT-IN
            "_at_" INTEREST-IN "_interest_is:_"
         DELIMITED BY SPACES
         INTO OUTPUT-LINE.
     INSPECT OUTPUT-LINE REPLACING ALL "_" BY SPACES.
     DISPLAY OUTPUT-LINE PAYMENT-OUT.
     MOVE "OK" TO CALL-FEEDBACK.
     GOBACK.
```

Subroutine COBVALU

```
*************************************************************
* COBVALU                                                   *
*                                                           *
* A simple subprogram that calculates present value         *
* for a series of cash flows.                               *
*                                                           *
*************************************************************
 IDENTIFICATION DIVISION.
 PROGRAM-ID. COBVALU.
 ENVIRONMENT DIVISION.
 DATA DIVISION.
 WORKING-STORAGE SECTION.
 01  CHAR-DATA.
     05  INPUT-1           PIC X(10).
     05  PAYMENT-OUT       PIC $$$$,$$$,$$9.99 USAGE DISPLAY.
     05  INTEREST-IN       PIC X(5).
     05  NO-OF-PERIODS-IN  PIC X(3).
     05  INPUT-BUFFER      PIC X(10) VALUE "5069837544".
     05  BUFFER-ARRAY   REDEFINES INPUT-BUFFER
                        OCCURS 5 TIMES
                           PIC XX.
     05  OUTPUT-LINE       PIC X(79).
 01 NUM-DATA.
     05  PAYMENT           PIC S9(9)V99 USAGE COMP.
     05  INTEREST          PIC S9(3)V99 USAGE COMP.
     05  COUNTER           PIC 99 USAGE COMP.
     05  NO-OF-PERIODS     PIC 99 USAGE COMP.
     05  VALUE-AMOUNT   OCCURS 99 PIC S9(7)V99 COMP.
 LINKAGE SECTION.
 01  PARM-1.
     05  CALL-FEEDBACK  PIC XX.
 PROCEDURE DIVISION USING PARM-1.
     MOVE "NO" TO CALL-FEEDBACK.
     MOVE ".12 5 " TO INPUT-1.
     UNSTRING INPUT-1 DELIMITED BY "," OR ALL " "                VALU1
      INTO INTEREST-IN NO-OF-PERIODS-IN.
* Convert to numeric values
```

```
     COMPUTE INTEREST = FUNCTION NUMVAL(INTEREST-IN).           VALU2
     COMPUTE NO-OF-PERIODS = FUNCTION NUMVAL(NO-OF-PERIODS-IN).
* Get cash flows
     PERFORM GET-AMOUNTS VARYING COUNTER FROM 1 BY 1 UNTIL
       COUNTER IS GREATER THAN NO-OF-PERIODS.
* Calculate present value
     COMPUTE PAYMENT =
         FUNCTION PRESENT-VALUE(INTEREST VALUE-AMOUNT(ALL) ).   VALU3
* Make it presentable
     MOVE PAYMENT TO PAYMENT-OUT.
     STRING "COBVALU:_Present_value_for_rate_of_"
            INTEREST-IN "_given_amounts_"
            BUFFER-ARRAY (1) ",_"
            BUFFER-ARRAY (2) ",_"
            BUFFER-ARRAY (3) ",_"
            BUFFER-ARRAY (4) ",_"
            BUFFER-ARRAY (5) "_is:_"
        DELIMITED BY SPACES
        INTO OUTPUT-LINE.
     INSPECT OUTPUT-LINE REPLACING ALL "_" BY SPACES.
     DISPLAY OUTPUT-LINE PAYMENT-OUT.
     MOVE "OK" TO CALL-FEEDBACK.
     GOBACK.
*
* Get cash flows for each period
*
 GET-AMOUNTS.
     MOVE BUFFER-ARRAY (COUNTER) TO INPUT-1.
     COMPUTE VALUE-AMOUNT (COUNTER) = FUNCTION NUMVAL(INPUT-1).
```

Refer to the following topics for more information related to the material discussed in this topic.

Related tasks

Chapter 21, “Debugging a COBOL program in full-screen mode,” on page 205

Halting when certain routines are called in COBOL

This topic describes how to halt just before or just after a routine is called by using the AT CALL or AT ENTRY commands. The “Example: sample COBOL program for debugging” on page 205 is used to describe these commands.

To use the AT CALL command, you must compile the calling program with the TEST compiler option.

To halt just before COBLOAN is called, enter the following command:

```
AT CALL COBLOAN ;
```

To use the AT ENTRY command, you must compile the called program with the TEST compiler option.

To halt just after COBVALU is called, enter the following command:

```
AT ENTRY COBVALU ;
```

To halt just after COBVALU is called and only when CALL-FEEDBACK equals OK, enter the following command:

```
AT ENTRY COBVALU WHEN CALL-FEEDBACK = "OK" ;
```

Identifying the statement where your COBOL program has stopped

If you have many breakpoints set in your program, enter the following command to have Debug Tool identify your program has been stopped:

```
QUERY LOCATION
```

The Debug Tool Log window displays something similar to the following example:

```
QUERY LOCATION ;
You were prompted because STEP ended.
The program is currently entering block COBVALU.
```

Modifying the value of a COBOL variable

"Example: sample COBOL program for debugging" on page 205

To list the contents of a single variable, move the cursor to an occurrence of the variable name in the Source window and press PF4 (LIST). Remember that Debug Tool starts **after** program initialization but **before** symbolic COBOL variables are initialized, so you cannot view or modify the contents of variables until you have performed a step or run. The value is displayed in the Log window. This is equivalent to entering LIST TITLED *variable* on the command line. Run the COBCALC program to the statement labeled **CALC1**, and enter AT 46 ; GO ; on the Debug Tool command line. Move the cursor over INPUT-1 and press LIST (PF4). The following appears in the Log window:

```
 LIST ( INPUT-1 ) ;
INPUT-1 = 'LOAN      '
```

To modify the value of INPUT-1, enter on the command line:

```
MOVE 'pvalue' to INPUT-1 ;
```

You can enter most COBOL expressions on the command line.

Now step into the call to COBVALU by pressing PF2 (STEP) and step until the statement labeled **VALU2** is reached. To view the attributes of the variable INTEREST, issue the Debug Tool command:

```
DESCRIBE ATTRIBUTES INTEREST ;
```

The result in the Log window is:

```
ATTRIBUTES FOR INTEREST
  ITS LENGTH IS 4
  ITS ADDRESS IS 00011DC8
  02 COBVALU:>INTEREST   S999V99 COMP
```

You can use this action as a simple browser for group items and data hierarchies. For example, you can list all the values of the elementary items for the CHAR-DATA group with the command:

```
LIST CHAR-DATA ;
```

with results in the Log window appearing something like this:

```
 LIST CHAR-DATA ;
02 COBVALU:>INPUT-1  of 01 COBVALU:>CHAR-DATA  = '.12 5     '
Invalid data for 02 COBVALU:>PAYMENT-OUT  of 01 COBVALU:>CHAR-DATA   is found.
02 COBVALU:>INTEREST-IN  of 01 COBVALU:>CHAR-DATA  = '.12  '
02 COBVALU:>NO-OF-PERIODS-IN  of 01 COBVALU:>CHAR-DATA  = '5  '
02 COBVALU:>INPUT-BUFFER  of 01 COBVALU:>CHAR-DATA  = '5069837544'
SUB(1) of 02 COBVALU:>BUFFER-ARRAY  of 01 COBVALU:>CHAR-DATA  = '50'
SUB(2) of 02 COBVALU:>BUFFER-ARRAY  of 01 COBVALU:>CHAR-DATA  = '69'
```

```
SUB(3) of 02 COBVALU:>BUFFER-ARRAY  of 01 COBVALU:>CHAR-DATA  = '83'
SUB(4) of 02 COBVALU:>BUFFER-ARRAY  of 01 COBVALU:>CHAR-DATA  = '75'
SUB(5) of 02 COBVALU:>BUFFER-ARRAY  of 01 COBVALU:>CHAR-DATA  = '44'
```

Note: If you use the LIST command to list the contents of an uninitialized variable, or a variable that contains invalid data, Debug Tool displays INVALID DATA.

Refer to the following topics for more information related to the material discussed in this topic.

Related tasks

"Using COBOL variables with Debug Tool" on page 283

Halting on a COBOL line only if a condition is true

Often a particular part of your program works fine for the first few thousand times, but it fails under certain conditions. You don't want to just set a line breakpoint because you will have to keep entering GO.

"Example: sample COBOL program for debugging" on page 205

For example, in COBVALU you want to stop at the calculation of present value only if the discount rate is less than or equal to -1 (before the exception occurs). First run COBCALC, step into COBVALU, and stop at the statement labeled **VALU1** . To accomplish this, issue these Debug Tool commands at the start of COBCALC:

```
AT 67 ; GO ;
CLEAR AT 67 ; STEP 4 ;
```

Now set the breakpoint like this:

```
AT 44 IF INTEREST > -1 THEN GO ; END-IF ;
```

Line 44 is the statement labeled **VALU3** . The command causes Debug Tool to stop at line 44. If the value of INTEREST is greater than -1, the program continues. The command causes Debug Tool to remain on line 44 only if the value of INTEREST is less than or equal to -1.

To force the discount rate to be negative, enter the Debug Tool command:

```
MOVE '-2 5' TO INPUT-1 ;
```

Run the program by issuing the GO command. Debug Tool halts the program at line 44. Display the contents of INTEREST by issuing the LIST INTEREST command. To view the effect of this breakpoint when the discount rate is positive, begin a new debug session and repeat the Debug Tool commands shown in this section. However, do not issue the MOVE '-2 5' TO INPUT-1 command. The program execution does not stop at line 44 and the program runs to completion.

Debugging COBOL when only a few parts are compiled with TEST

"Example: sample COBOL program for debugging" on page 205

Suppose you want to set a breakpoint at entry to COBVALU. COBVALU has been compiled with TEST but the other programs have not. Debug Tool comes up with an empty Source window. You can use the LIST NAMES CUS command to determine if the COBVALU compile unit is known to Debug Tool and then set the appropriate breakpoint using either the AT APPEARANCE or the AT ENTRY command.

Instead of setting a breakpoint at entry to COBVALU in this example, issue a STEP command when Debug Tool initially displays the empty Source window. Debug Tool runs the program until it reaches the entry for the first routine compiled with TEST, COBVALU in this case.

Refer to the following topics for more information related to the material discussed in this topic.

Related tasks

"Halting when certain routines are called in COBOL" on page 208

Capturing COBOL I/O to the system console

To redirect output normally appearing on the system console to your Debug Tool terminal, enter the following command:

```
SET INTERCEPT ON CONSOLE ;
```

"Example: sample COBOL program for debugging" on page 205

For example, if you run COBCALC and issue the Debug Tool SET INTERCEPT ON CONSOLE command, followed by the STEP 3 command, you will see the following output displayed in the Debug Tool Log window:

```
SET INTERCEPT ON CONSOLE ;
STEP 3 ;
CONSOLE : CALC Begins.
```

The phrase CALC Begins. is displayed by the statement DISPLAY "CALC Begins." UPON CONSOLE in COBCALC.

The SET INTERCEPT ON CONSOLE command not only captures output to the system console, but also allows you to input data from your Debug Tool terminal instead of the system console by using the Debug Tool INPUT command. For example, if the next COBOL statement executed is ACCEPT INPUT-DATA FROM CONSOLE, the following message appears in the Debug Tool Log window:

```
CONSOLE : IGZ0000I AWAITING REPLY.
The program is waiting for input from CONSOLE.
Use the INPUT command to enter 114 characters for the intercepted
fixed-format file.
```

Continue execution by replying to the input request by entering the following Debug Tool command:

```
INPUT some data ;
```

Note: Whenever Debug Tool intercepts system console I/O, and for the duration of the intercept, the display in the Source window is empty and the Location field in the session panel header at the top of the screen shows *Unknown*.

Displaying raw storage in COBOL

You can display the storage for a variable by using the LIST STORAGE command. For example, to display the storage for the first 12 characters of BUFFER-DATA enter:

```
LIST STORAGE(BUFFER-DATA,12)
```

You can also display only a section of the data. For example, to display the storage that starts at offset 4 for a length of 6 characters, enter:

```
LIST STORAGE(BUFFER-DATA,4,6)
```

Refer to the following topics for more information related to the material discussed in this topic.

Related tasks

"Displaying and modifying memory through the Memory window" on page 199

Getting a COBOL routine traceback

Often when you get close to a programming error, you want to know how you got into that situation, and especially what the traceback of calling routines is. To get this information, issue the command:

```
LIST CALLS ;
```

"Example: sample COBOL program for debugging" on page 205

For example, if you run the COBCALC example with the commands:

```
AT APPEARANCE COBVALU AT ENTRY COBVALU;
GO;
GO;
LIST CALLS;
```

the Log window contains something like:

```
 AT APPEARANCE COBVALU
   AT ENTRY COBVALU ;
 GO ;
 GO ;
 LIST CALLS ;
At ENTRY in COBOL program COBVALU.
From LINE 67.1 in COBOL program COBCALC.
```

which shows the traceback of callers.

Tracing the run-time path for COBOL code compiled with TEST

To trace a program showing the entry and exit points without requiring any changes to the program, place the following Debug Tool commands in a file or data set and USE them when Debug Tool initially displays your program. Assuming you have a PDS member, USERID.DT.COMMANDS(COBCALC), that contains the following Debug Tool commands:

```
* Commands in a COBOL USE file must be coded in columns 8-72.
* If necessary, commands can be continued by coding a '-' in
* column 7 of the continuation line.
 01 LEVEL PIC 99 USAGE COMP;
 MOVE 1 TO LEVEL;
 AT ENTRY * PERFORM;
   COMPUTE LEVEL = LEVEL + 1;
   LIST ( "Entry:", LEVEL, %CU);
   GO;
   END-PERFORM;
 AT EXIT * PERFORM;
   LIST ( "Exit:", LEVEL);
   COMPUTE LEVEL = LEVEL - 1;
   GO;
   END-PERFORM;
```

You can use this file as the source of commands to Debug Tool by entering the following command:

```
USE USERID.DT.COMMANDS(COBCALC)
```

If, after executing the USE file, you run COBCALC, the following trace (or similar) is displayed in the Log window:

```
ENTRY:
LEVEL = 00002
%CU = COBCALC
ENTRY:
LEVEL = 00003
%CU = COBLOAN
EXIT:
LEVEL = 00003
ENTRY:
LEVEL = 00003
%CU = COBVALU
EXIT:
LEVEL = 00003
ENTRY:
LEVEL = 00003
%CU = COBVALU
EXIT:
LEVEL = 00003
EXIT:
LEVEL = 00002
```

If you do not want to create the USE file, you can enter the commands through the command line, and the same effect is achieved.

Generating a COBOL run-time paragraph trace

To generate a trace showing the names of paragraphs through which execution has passed, the Debug Tool commands shown in the following example can be used. You can either enter the commands from the Debug Tool command line or place the commands in a file or data set.

“Example: sample COBOL program for debugging” on page 205

Assume you have a PDS member, USERID.DT.COMMANDS(COBCALC2), that contains the following Debug Tool commands.

```
* COMMANDS IN A COBOL USE FILE MUST BE CODED IN COLUMNS 8-72.
* IF NECESSARY, COMMANDS CAN BE CONTINUED BY CODING A '-' IN
* COLUMN 7 OF THE CONTINUATION LINE.
 AT GLOBAL LABEL PERFORM;
   LIST LINES %LINE;
   GO;
 END-PERFORM;
```

When Debug Tool initially displays your program, enter the following command:

```
USE USERID.DT.COMMANDS(COBCALC2)
```

After executing the USE file, you can run COBCALC and the following trace (or similar) is displayed in the Log window:

```
     42       ACCEPT-INPUT.

     59       CALCULATE-LOAN.

     42       ACCEPT-INPUT.

     66       CALCULATE-VALUE.

     64       GET-AMOUNTS.

     64       GET-AMOUNTS.

     64       GET-AMOUNTS.

     64       GET-AMOUNTS.

     64       GET-AMOUNTS.

     42       ACCEPT-INPUT.

     66       CALCULATE-VALUE.

     64       GET-AMOUNTS.

     64       GET-AMOUNTS.

     64       GET-AMOUNTS.

     64       GET-AMOUNTS.

     64       GET-AMOUNTS.

     42       ACCEPT-INPUT.
```

Finding unexpected storage overwrite errors in COBOL

During program run time, some storage might unexpectedly change its value and you want to find out when and where this happened. Consider this example where the program changes more than the caller expects it to change.

```
   05  FIELD-1     OCCURS 2 TIMES
                       PIC X(8).
   05  FIELD-2         PIC X(8).
 PROCEDURE DIVISION.
*                    ( An invalid index value is set )
     MOVE 3 TO PTR.
     MOVE "TOO MUCH" TO FIELD-1( PTR ).
```

Find the address of `FIELD-2` with the command:

```
DESCRIBE ATTRIBUTES FIELD-2
```

Suppose the result is X'0000F559'. To set a breakpoint that watches for a change in storage values starting at that address for the next 8 bytes, issue the command:

```
AT CHANGE %STORAGE(H'0000F559',8)
```

When the program runs, Debug Tool halts if the value in this storage changes.

Halting before calling an invalid program in COBOL

Calling an undefined program is a severe error. If you have developed a main program that calls a subprogram that doesn't exist, you can cause Debug Tool to halt just before such a call. For example, if the subprogram NOTYET doesn't exist, you can set the breakpoint:

```
AT CALL (NOTYET)
```

When Debug Tool stops at this breakpoint, you can bypass the `CALL` by entering the `GO BYPASS` command. This allows you to continue your debug session without raising a condition.

Chapter 22. Debugging a LangX COBOL program in full-screen mode

The descriptions of basic debugging tasks for LangX COBOL refer to the following program.

"Example: sample LangX COBOL program for debugging"

As you read through the information in this document, remember that OS/VS COBOL programs are non-Language Environment programs, even though you might have used Language Environment libraries to link and run your program.

VS COBOL II programs are non-Language Environment programs when you link them with the non-Language Environment library. VS COBOL II programs are Language Environment programs when you link them with the Language Environment library.

Enterprise COBOL programs are always Language Environment programs. Note that COBOL DLL's cannot be debugged as LangX COBOL programs.

Read the information regarding non-Language Environment programs for instructions on how to start Debug Tool and debug non-Language Environment COBOL programs, unless information specific to LangX COBOL is provided.

Example: sample LangX COBOL program for debugging

The program below is used in various topics to demonstrate debugging tasks. It is an OS/VS COBOL program which is being used as a representative of LangX COBOL programs.

To run this sample program, do the following steps:

1. Prepare the sample program as described in Chapter 5, "Preparing a LangX COBOL program," on page 67.
2. Verify that the debug information for this program is located in the COB03O and COB03AO members of the *yourid*.EQALANGX data set.
3. Start Debug Tool as described in "Starting Debug Tool for programs that start outside of Language Environment" on page 137.
4. To load the debug information for this program, enter the following command:

   ```
   LDD (COB03O,COB03AO) ;
   ```

This program is a small example of an OS/VS COBOL program (COB03O) that calls another OS/VS COBOL program (COB03A0).

Load module: COB03O

COB03O

```
******************************************************
*  PROGRAM NAME: COB03O                              *
*                                                    *
*  COMPILED WITH IBM OS/VS COBOL COMPILER            *
******************************************************

 IDENTIFICATION DIVISION.
 PROGRAM-ID. COB03O.
```

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```
*****************************************************************
*                                                               *
* LICENSED MATERIALS - PROPERTY OF IBM                          *
*                                                               *
* 5655-P14: Debug Tool for z/OS                                 *
* (C) Copyright IBM Corp. 2005 All Rights Reserved              *
*                                                               *
* US GOVERNMENT USERS RESTRICTED RIGHTS - USE, DUPLICATION OR   *
* DISCLOSURE RESTRICTED BY GSA ADP SCHEDULE CONTRACT WITH IBM   *
* CORP.                                                         *
*                                                               *
*                                                               *
*****************************************************************
 ENVIRONMENT DIVISION.
 DATA DIVISION.
 WORKING-STORAGE SECTION.

 01  LOAN          PIC 999999.
 01  INTEREST-RATE PIC 99V99.
 01  INTEREST-DUE  PIC 999999.
 01  INTEREST-SAVE PIC 999999.
 01  INTEREST-AFTER-MULTIPLY PIC 999999.
 01  INTEREST-AFTER-DIVIDE PIC 999999.

* DATE THAT WILL RECEIVE INCREMENTED JULIAN-DATE
 01  INC-DATE            PIC 9(7).
* LOOP COUNT TO INCREMENT DATE 1000 TIMES *
 01  LOOPCOUNT           PIC   9999.

* JULIAN DATE
 01  JULIAN-DATE         PIC 9(7).
 01  J-DATE REDEFINES JULIAN-DATE.
     05 J-YEAR           PIC 9(4).
     05 J-DAY            PIC 9(3).
* SAVE DATE
 01  SAVE-DATE           PIC 9(7).

 PROCEDURE DIVISION.

 PROG.
     ACCEPT JULIAN-DATE FROM DAY
     DISPLAY 'JULIAN DATE: ' JULIAN-DATE
     MOVE JULIAN-DATE TO SAVE-DATE

     MOVE 10000    TO LOAN

     CALL 'COB03AO' USING LOAN INTEREST-DUE.

     DISPLAY 'LOAN: ' LOAN
     DISPLAY 'INTEREST-DUE: ' INTEREST-DUE

     STOP RUN.
```

COB03AO

```
*****************************************************
*  PROGRAM NAME: COB03AO                            *
*                                                   *
*  COMPILED WITH IBM OS/VS COBOL COMPILER           *
*****************************************************

 IDENTIFICATION DIVISION.
 PROGRAM-ID. COB03AO.
*****************************************************************
*                                                               *
* LICENSED MATERIALS - PROPERTY OF IBM                          *
*                                                               *
```

```
* 5655-P14: Debug Tool for z/OS                                    *
* (C) Copyright IBM Corp. 2005 All Rights Reserved                 *
*                                                                  *
* US GOVERNMENT USERS RESTRICTED RIGHTS - USE, DUPLICATION OR      *
* DISCLOSURE RESTRICTED BY GSA ADP SCHEDULE CONTRACT WITH IBM      *
* CORP.                                                            *
*                                                                  *
*                                                                  *
********************************************************************
 ENVIRONMENT DIVISION.
 DATA DIVISION.
 WORKING-STORAGE SECTION.
 77  INTEREST-RATE PIC 99V99 VALUE 0.22.
 LINKAGE SECTION.
 01  USING-LIST.
     02 LOANAMT   PIC 999999.
     02 INTEREST  PIC 999999.


 PROCEDURE DIVISION USING USING-LIST.

 PROG.
     COMPUTE INTEREST = LOANAMT * INTEREST-RATE.
     DISPLAY 'INTEREST-RATE: ' INTEREST-RATE.

     GOBACK.
```

Defining a compilation unit as LangX COBOL and loading debug information

Before you can debug a LangX COBOL program, you must define the compilation unit (CU) as a LangX COBOL CU and load the debug data for the CU. This can only be done for a CU that is currently known to Debug Tool as a disassembly CU or for a CU that is not currently known to Debug Tool.

You use the LOADDEBUGDATA command (abbreviated as LDD) to define a disassembly CU as a LangX COBOL CU and to cause the debug data for this CU to be loaded. When you invoke the LDD command, you can specify either a single CU name or a list of CU names enclosed in parenthesis. Each of the names specified must be either:

- the name of a disassembly CU that is currently known to Debug Tool
- a name that does not match the name of a CU currently known to Debug Tool

When the CU name is currently known to Debug Tool, the CU is immediately marked as a LangX COBOL CU and an attempt is made to load the debug as follows:

- If your debug data is in a partitioned data set where the high-level qualifier is the current user ID, the low-level qualifier is EQALANGX, and the member name is the same as the name of the CU that you want to debug no other action is necessary
- If your debug data is in a different partitioned data set than *userid*.EQALANGX but the member name is the same as the name of the CU that you want to debug, enter the following command before or after you enter the LDD command: SET DEFAULT LISTINGS
- If your debug data is in a sequential data set or is a member of a partitioned data set but the member name is different from the CU name, enter the following command before or after the LDD command: SET SOURCE

When the CU name specified on the LDD command is not currently known to Debug Tool, a message is issued and the LDD command is deferred until a CU by that name becomes known (appears). At that time, the CU is automatically created as a LangX COBOL CU and an attempt is made to load the debug data using the default data set name or the current SET DEFAULT LISTINGS specification.

After you have entered an LDD command for a CU, you cannot view the CU as a disassembly CU.

If Debug Tool cannot find the associated debug data after you have entered an LDD command, the CU is a LangX COBOL CU rather than a disassembly CU. You cannot enter another LDD command for this CU. However, you can enter a SET DEFAULT LISTING command or a SET SOURCE command to cause the associated debug data to be loaded from a different data set.

Defining a compilation unit in a different load module as LangX COBOL

You must use the LDD command to identify a CU as a LangX COBOL CU. If the CU is part of a load module that has not yet been loaded when you enter the LDD command, Debug Tool displays a message indicating that the CU was not found and that the running of the LDD command has been deferred. If the CU later appears as a disassembly CU, the LDD command is run at that time.

Refer to the following topics for more information related to the material discussed in this topic.

Related tasks

"Defining a compilation unit as LangX COBOL and loading debug information" on page 219

Halting when certain LangX COBOL programs are called

"Example: sample LangX COBOL program for debugging" on page 217

To halt after the COB03AO routine is called, enter the following command:

```
AT ENTRY COB03AO ;
```

The AT CALL command is not supported for LangX COBOL routines. Do not use the AT CALL command to halt Debug Tool when a LangX COBOL routine is called.

Identifying the statement where your LangX COBOL program has stopped

If you have many breakpoints set in your program and you want to know where your program was halted, you can enter the following command:

```
QUERY LOCATION
```

The Debug Tool Log window displays a message similar to the following message:

```
QUERY LOCATION
You are executing commands in the ENTRY COB03O ::> COB03AO breakpoint.
The program is currently entering block COB03O ::> COB03AO.
```

Displaying and modifying the value of LangX COBOL variables or storage

To display the contents of a single variable, move the cursor to an occurrence of the variable name in the Source window and press PF4 (LIST). The value is displayed in the Log window. This is equivalent to entering the `LIST` *`variable`* command on the command line.

For example, run the COB03O program to the CALL statement by entering `AT 56 ; GO ;` on the Debug Tool command line. Move the cursor over LOAN and press PF4 (LIST). Debug Tool displays the following message in the Log window:

```
LIST ( 'LOAN ')
LOAN = 10000
```

To change the value of LOAN to 100, type `'LOAN' = '100'` in the command line and press Enter.

To view the attributes of variable LOAN, enter the following command:

```
DESCRIBE ATTRIBUTES 'LOAN'
```

Debug Tool displays the following messages in the Log window:

```
ATTRIBUTES for LOAN
   Its address is 0002E500 and its length is 6
   LOAN PIC 999999
```

To step into the call to COB03AO, press PF2 (STEP).

Halting on a line in LangX COBOL only if a condition is true

Often a particular part of your program works fine for the first few thousand times, but it fails under certain conditions. Setting a line breakpoint is inefficient because you will have to repeatedly enter the `GO` command.

“Example: sample LangX COBOL program for debugging” on page 217

In the COB03AO program, to halt Debug Tool when the LOANAMT variable is set to 100, enter the following command:

```
AT 36 DO; IF 'LOANAMT ¬= 100' THEN GO; END;
```

Line 36 is the line COMPUTE INTEREST = LOANAMT * INTEREST-RATE. The command causes Debug Tool to stop at line 36. If the value of LOANAMT is not 100, the program continues. The command causes Debug Tool to stop on line 36 only if the value of LOANAMT is 100.

Debugging LangX COBOL when debug information is only available for a few parts

“Example: sample LangX COBOL program for debugging” on page 217

Suppose you want to set a breakpoint at the entry point to COB03AO program and that debug information is available for COB03AO but not for COB03O. In this circumstance, Debug Tool would display an empty Source window. To display a list of compile units known to Debug Tool, enter the following commands:

```
SET ASSEMBLER ON
LIST NAMES CUS
```

The LIST NAMES CUS command displays a list of all the compile units that are known to Debug Tool. If COB03AO is fetched later on by the application, it might not be known to Debug Tool. Enter the following commands:

```
LDD COB03AO
AT ENTRY COB03AO
GO
```

Getting a LangX COBOL program traceback

Often when you get close to a programming error, you want to know what sequence of calls lead you to the programming error. This sequence is called a traceback or a traceback of callers. To get the traceback information, enter the following command:

```
LIST CALLS
```

“Example: sample LangX COBOL program for debugging” on page 217

For example, if you run the example with the following commands, the Log window displays the traceback of callers:

```
LDD (COB03O,COB03AO) ;
AT ENTRY COB03AO ;
GO ;
LIST CALLS ;
```

The Log window displays information similar to the following:

```
At ENTRY in LangX COBOL program COB03O ::> COB03AO.
From LINE 74 in LangX COBOL program COB03O ::> COB03O.
```

Finding unexpected storage overwrite errors in LangX COBOL

While your program is running, some storage might unexpectedly change its value and you want to find out when and where this happened. Suppose in the example described in “Getting a LangX COBOL program traceback,” the program finds the value of LOAN unexpectedly modified. To set a breakpoint that watches for a change in the value of LOAN, enter the following command:

```
AT CHANGE 'LOAN';
```

When the program runs, Debug Tool stops if the value of LOAN changes.

Chapter 23. Debugging a PL/I program in full-screen mode

The descriptions of basic debugging tasks for PL/I refer to the following PL/I program.

"Example: sample PL/I program for debugging"

Refer to the following topics for more information related to the material discussed in this topic.

Related tasks

Chapter 31, "Debugging PL/I programs," on page 299
"Halting when certain PL/I functions are called" on page 226
"Modifying the value of a PL/I variable" on page 227
"Halting on a PL/I line only if a condition is true" on page 227
"Debugging PL/I when only a few parts are compiled with TEST" on page 228
"Displaying raw storage in PL/I" on page 228
"Getting a PL/I function traceback" on page 228
"Tracing the run-time path for PL/I code compiled with TEST" on page 229
"Finding unexpected storage overwrite errors in PL/I" on page 230
"Halting before calling an undefined program in PL/I" on page 230

Example: sample PL/I program for debugging

The program below is used in various topics to demonstrate debugging tasks.

This program is a simple calculator that reads its input from a character buffer. If integers are read, they are pushed on a stack. If one of the operators (+ - * /) is read, the top two elements are popped off the stack, the operation is performed on them and the result is pushed on the stack. The = operator writes out the value of the top element of the stack to a buffer.

Before running PLICALC, you need to allocate SYSPRINT to the terminal by entering the following command:

```
ALLOC FI(SYSPRINT) DA(*) REUSE
```

Main program PLICALC

```
plicalc: proc options(main);
/*--------------------------------------------------------------------*/
/*                                                                    */
/* A simple calculator that does operations on integers that          */
/* are pushed and popped on a stack                                   */
/*                                                                    */
/*--------------------------------------------------------------------*/
dcl index  builtin;
dcl length builtin;
dcl substr builtin;
/*                                                                    */
dcl 1 stack,
      2 stkptr fixed bin(15,0) init(0),
      2 stknum(50) fixed bin(31,0);
dcl 1 bufin,
      2 bufptr fixed bin(15,0) init(0),
      2 bufchr char (100) varying;
dcl 1 tok char (100) varying;
dcl 1 tstop char(1) init ('s');
dcl 1 ndx fixed bin(15,0);
dcl num      fixed bin(31,0);
dcl i        fixed bin(31,0);
```

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```
dcl push entry external;
dcl pop  entry returns (fixed bin(31,0)) external;
dcl readtok entry returns (char (100) varying) external;
/*-------------------------------------------------------------------*/
/* input  action:                                                    */
/*    2      push 2 on stack                                         */
/*    18     push 18                                                 */
/*    +      pop 2, pop 18, add, push result (20)                    */
/*    =      output value on the top of the stack (20)               */
/*    5      push 5                                                  */
/*    /      pop 5, pop 20, divide, push result (4)                  */
/*    =      output value on the top of the stack (4)                */
/*-------------------------------------------------------------------*/
bufchr = '2 18 + = 5 / =';
do while (tok ^= tstop);
  tok = readtok(bufin);          /* get next 'token' */
  select (tok);
    when (tstop)
      leave;
    when ('+') do;
      num = pop(stack);
      call push(stack,num);      /*  CALC1  statement */
    end;
    when ('-') do;
      num = pop(stack);
      call push(stack,pop(stack)-num);
    end;
    when ('*')
      call push(stack,pop(stack)*pop(stack));
    when ('/') do;
      num = pop(stack);
      call push(stack,pop(stack)/num); /*  CALC2  statement */
    end;
    when ('=') do;
      num = pop(stack);
      put list ('PLICALC: ', num) skip;
      call push(stack,num);
    end;
    otherwise do;/* must be an integer */
      num = atoi(tok);
      call push(stack,num);
    end;
  end;
end;
return;
```

TOK function

```
atoi: procedure(tok) returns (fixed bin(31,0));
/*-------------------------------------------------------------------*/
/*                                                                   */
/* convert character string to number                                */
/* (note: string validated by readtok)                               */
/*                                                                   */
/*-------------------------------------------------------------------*/
  dcl 1 tok char (100) varying;
  dcl 1 num fixed bin (31,0);
  dcl 1 j fixed bin(15,0);
  num = 0;
  do j = 1 to length(tok);
    num = (10 * num) + (index('0123456789',substr(tok,j,1))-1);
  end;
  return (num);
end atoi;
end plicalc;
```

PUSH function

```
push: procedure(stack,num);
/*--------------------------------------------------------------------*/
/*                                                                    */
/* a simple push function for a stack of integers                     */
/*                                                                    */
/*--------------------------------------------------------------------*/
dcl 1 stack connected,
      2 stkptr fixed bin(15,0),
      2 stknum(50) fixed bin(31,0);
dcl num      fixed bin(31,0);
stkptr = stkptr + 1;
stknum(stkptr) = num; /*  PUSH1  statement */
return;
end push;
```

POP function

```
pop: procedure(stack) returns (fixed bin(31,0));
/*--------------------------------------------------------------------*/
/*                                                                    */
/* a simple pop function for a stack of integers                      */
/*                                                                    */
/*--------------------------------------------------------------------*/
dcl 1 stack connected,
      2 stkptr fixed bin(15,0),
      2 stknum(50) fixed bin(31,0);
stkptr = stkptr - 1;
return (stknum(stkptr+1));
end pop;
```

READTOK function

```
readtok: procedure(bufin) returns (char (100) varying);
/*--------------------------------------------------------------------*/
/*                                                                    */
/* a function to read input and tokenize it for a simple calculator */
/*                                                                    */
/* action: get next input char, update index for next call          */
/* return: next input char(s)                                         */
/*--------------------------------------------------------------------*/
dcl length builtin;
dcl substr builtin;
dcl verify builtin;
dcl 1 bufin connected,
      2 bufptr fixed bin(15,0),
      2 bufchr char (100) varying;
dcl 1 tok char (100) varying;
dcl 1 tstop char(1) init ('s');
dcl 1 j fixed bin(15,0);
                                 /* start of processing */
if bufptr > length(bufchr) then do;
  tok = tstop;
  return ( tok );
end;
bufptr = bufptr + 1;
do while (substr(bufchr,bufptr,1) = ' ');
  bufptr = bufptr + 1;
  if bufptr > length(bufchr) then do;
    tok = tstop;
    return ( tok );
  end;
end;
tok = substr(bufchr,bufptr,1); /* get ready to return single char */
select (tok);
  when ('+','-','/','*','=')
    bufptr = bufptr;
  otherwise do;               /* possibly an integer */
    tok = '';
```

```
    do j = bufptr to length(bufchr);
      if verify(substr(bufchr,j,1),'0123456789') ^= 0 then
        leave;
    end;
    if j > bufptr then do;
        j = j - 1;
      tok = substr(bufchr,bufptr,(j-bufptr+1));
      bufptr = j;
    end;
    else
      tok = tstop;
  end;
end;
return (tok);
end readtok;
```

Refer to the following topics for more information related to the material discussed in this topic.

Related tasks

Chapter 23, “Debugging a PL/I program in full-screen mode,” on page 223

Halting when certain PL/I functions are called

This topic describes how to halt just before or just after a routine is called by using the `AT CALL` and `AT ENTRY` commands. The “Example: sample PL/I program for debugging” on page 223 is used to describe these commands.

To use the `AT CALL` command, you must compile the calling program with the `TEST` compiler option.

To halt just before READTOK is called, enter the following command:

```
AT CALL READTOK ;
```

To use the `AT ENTRY` command, you must compile the called program with the `TEST` compiler option.

To halt just after READTOK is called, enter the following command:

```
AT ENTRY READTOK ;
```

To halt just after TOK is called and only when the parameter `tok` equals 2, enter the following command:

```
AT ENTRY TOK WHEN tok='2';
```

Identifying the statement where your PL/I program has stopped

If you have many breakpoints set in your program, enter the following command to have Debug Tool identify where your program has stopped:

```
QUERY LOCATION
```

The Debug Tool Log window displays something similar to the following example:

```
QUERY LOCATION ;
You are executing commands in the ENTRY READTOK breakpoint.
The program is currently entering block READTOK.
```

Modifying the value of a PL/I variable

To list the contents of a single variable, move the cursor to an occurrence of the variable name in the Source window and press PF4 (LIST). The value is displayed in the Log window. This is equivalent to entering LIST TITLED variable on the command line. For example, run the PLICALC program to the statement labeled **CALC1** by entering AT 22 ; GO ; on the Debug Tool command line. Move the cursor over NUM and press PF4 (LIST). The following appears in the Log window:

```
 LIST NUM ;
NUM =             18
```

To modify the value of NUM to 22, type over the NUM = 18 line with NUM = 22, press Enter to put it on the command line, and press Enter again to issue the command.

You can enter most PL/I expressions on the command line.

Now step into the call to PUSH by pressing PF2 (STEP) and step until the statement labeled **PUSH1** is reached. To view the attributes of variable STKNUM, enter the Debug Tool command:

```
DESCRIBE ATTRIBUTES STKNUM;
```

The result in the Log window is:

```
 ATTRIBUTES FOR STKNUM
   ITS ADDRESS IS  0003944C AND ITS LENGTH IS 200
     PUSH : STACK.STKNUM(50)  FIXED BINARY(31,0) REAL PARAMETER
         ITS ADDRESS IS  0003944C AND ITS LENGTH IS 4
```

You can list all the values of the members of the structure pointed to by STACK with the command:

```
LIST STACK;
```

with results in the Log window appearing something like this:

```
 LIST STACK ;
STACK.STKPTR =                2
STACK.STKNUM(1) =             2
STACK.STKNUM(2) =            18
STACK.STKNUM(3) =        233864
   ⋮
STACK.STKNUM(50) =       121604
```

You can change the value of a structure member by issuing the assignment as a command as in the following example:

```
STKNUM(STKPTR) = 33;
```

Halting on a PL/I line only if a condition is true

Often a particular part of your program works fine for the first few thousand times, but it fails under certain conditions. You don't want to just set a line breakpoint because you will have to keep entering GO.

"Example: sample PL/I program for debugging" on page 223

For example, in PLICALC you want to stop at the division selection only if the divisor is 0 (before the exception occurs). Set the breakpoint like this:

```
AT 31 DO; IF NUM ^= 0 THEN GO; END;
```

Line 31 is the statement labeled **CALC2** . The command causes Debug Tool to stop at line 31. If the value of NUM is not 0, the program continues. The command causes Debug Tool to stop on line 31 only if the value of NUM is 0.

Debugging PL/I when only a few parts are compiled with TEST

"Example: sample PL/I program for debugging" on page 223

Suppose you want to set a breakpoint at entry to subroutine PUSH. PUSH has been compiled with TEST, but the other files have not. Debug Tool comes up with an empty Source window. To display the compile units, enter the command:

```
LIST NAMES CUS
```

The LIST NAMES CUS command displays a list of all the compile units that are known to Debug Tool. If PUSH is fetched later on by the application, this compile unit might not be known to Debug Tool. If it is displayed, enter:

```
SET QUALIFY CU PUSH
AT ENTRY PUSH;
GO ;
```

If it is not displayed, set an appearance breakpoint as follows:

```
AT APPEARANCE PUSH ;
GO ;
```

You can also combine the breakpoints as follows:

```
AT APPEARANCE PUSH AT ENTRY PUSH; GO;
```

The only purpose for this appearance breakpoint is to gain control the **first** time a function in the PUSH compile unit is run. When that happens, you can set a breakpoint at entry to PUSH like this:

```
AT ENTRY PUSH;
```

Displaying raw storage in PL/I

You can display the storage for a variable by using the LIST STORAGE command. For example, to display the storage for the first 30 characters of STACK enter:

```
LIST STORAGE(STACK,30)
```

Refer to the following topics for more information related to the material discussed in this topic.

Related tasks

"Displaying and modifying memory through the Memory window" on page 199

Getting a PL/I function traceback

Often when you get close to a programming error, you want to know how you got into that situation, and especially what the traceback of calling functions is. To get this information, issue the command:

```
LIST CALLS ;
```

"Example: sample PL/I program for debugging" on page 223

For example, if you run the PLICALC example with the commands:

```
AT ENTRY READTOK ;
GO ;
LIST CALLS ;
```

the Log window will contain something like:

```
At ENTRY IN PL/I subroutine READTOK.
From LINE 17.1 IN PL/I subroutine PLICALC.
```

which shows the traceback of callers.

Tracing the run-time path for PL/I code compiled with TEST

To trace a program showing the entry and exit points without changing the program, you can enter the commands described in step 2 by using a commands file or by entering the commands individually. To use a commands file, do the following steps:

1. Create a PDS member with a name similar to the following name:
   userid.DT.COMMANDS(PLICALL)
2. Edit the file or data set and add the following Debug Tool commands:

```
SET PROGRAMMING LANGUAGE PLI ;
DCL LVLSTR CHARACTER (50);
DCL LVL FIXED BINARY (15);
LVL = 0;
AT ENTRY *
DO;
LVLSTR = ' ' ;
LVL = LVL + 1 ;
LVLSTR = 'ENTERING >' || %BLOCK;
LIST UNTITLED ( LVLSTR ) ;
GO ;
END;
AT EXIT *
DO;
LVLSTR = 'EXITING < ' || %BLOCK;
LIST UNTITLED ( LVLSTR ) ;
LVL = LVL - 1 ;
GO ;
END;
```

3. Start Debug Tool.
4. Enter the following command:

```
USE DT.COMMANDS(PLICALL)
```

5. Run your program sequence. Debug Tool displays the trace in the Log window.

For example, after you enter the USE command, you run the following program sequence:

```
*PROCESS MACRO,OPT(TIME);
 *PROCESS S STMT TEST(ALL);

 PLICALL: PROC OPTIONS (MAIN);

 DCL PLIXOPT CHAR(60) VAR STATIC EXTERNAL

 INIT('STACK(20K,20K),TEST');

 CALL PLISUB;

 PUT SKIP LIST('DONE WITH PLICALL');

 PLISUB: PROC;
```

```
 DCL PLISUB1 ENTRY ;

 CALL PLISUB1;

 PUT SKIP LIST('DONE WITH PLISUB ');

 END PLISUB;

 PLISUB1: PROC;

 DCL PLISUB2 ENTRY ;

 CALL PLISUB2;

 PUT SKIP LIST('DONE WITH PLISUB1');

 END PLISUB1;

 PLISUB2: PROC;

 PUT SKIP LIST('DONE WITH PLISUB2');
 END PLISUB2;
 END PLICALL;
```

In the Log window, Debug Tool displays a trace similar to the following trace:

```
'ENTERING >PLICALL                                '
'ENTERING >PLISUB                                 '
'ENTERING >PLISUB1                                '
'ENTERING >PLISUB2                                '
'EXITING < PLISUB2                                '
'EXITING < PLISUB1                                '
'EXITING < PLISUB                                 '
'EXITING < PLICALL                                '
```

Finding unexpected storage overwrite errors in PL/I

During program run time, some storage might unexpectedly change its value and you want to find out when and where this happened. Consider the following example where the program changes more than the caller expects it to change.

```
2 FIELD1(2) CHAR(8);
2 FIELD2 CHAR(8);
 CTR = 3;         /* an invalid index value is set */
 FIELD1(CTR) = 'TOO MUCH';
```

Find the address of `FIELD2` with the command:

```
DESCRIBE ATTRIBUTES FIELD2
```

Suppose the result is X'00521D42'. To set a breakpoint that watches for a change in storage values starting at that address for the next 8 bytes, issue the command:

```
AT CHANGE %STORAGE('00521D42'px,8)
```

When the program is run, Debug Tool halts if the value in this storage changes.

Halting before calling an undefined program in PL/I

Calling an undefined program or function is a severe error. To halt just before such a call is run, set this breakpoint:

```
AT CALL 0
```

When Debug Tool stops at this breakpoint, you can bypass the CALL by entering the GO BYPASS command. This allows you to continue your debug session without raising a condition.

Chapter 24. Debugging a C program in full-screen mode

The descriptions of basic debugging tasks for C refer to the following C program.

“Example: sample C program for debugging”

Refer to the following topics for more information related to the material discussed in this topic.

Related tasks

Chapter 32, “Debugging C and C++ programs,” on page 309
“Halting when certain functions are called in C” on page 236
“Modifying the value of a C variable” on page 237
“Halting on a line in C only if a condition is true” on page 237
“Debugging C when only a few parts are compiled with TEST” on page 238
“Capturing C output to stdout” on page 238
“Calling a C function from Debug Tool” on page 239
“Displaying raw storage in C” on page 239
“Debugging a C DLL” on page 239
“Getting a function traceback in C” on page 240
“Tracing the run-time path for C code compiled with TEST” on page 240
“Finding unexpected storage overwrite errors in C” on page 241
“Finding uninitialized storage errors in C” on page 241
“Halting before calling a NULL C function” on page 242

Example: sample C program for debugging

The program below is used in various topics to demonstrate debugging tasks.

This program is a simple calculator that reads its input from a character buffer. If integers are read, they are pushed on a stack. If one of the operators (+ – * /) is read, the top two elements are popped off the stack, the operation is performed on them, and the result is pushed on the stack. The = operator writes out the value of the top element of the stack to a buffer.

CALC.H

```
/*----- FILE CALC.H ------------------------------------------------*/
/*                                                                  */
/* Header file for CALC.C PUSHPOP.C READTOKN.C                      */
/* a simple calculator                                              */
/*------------------------------------------------------------------*/
typedef enum toks {
  T_INTEGER,
  T_PLUS,
  T_TIMES,
  T_MINUS,
  T_DIVIDE,
  T_EQUALS,
  T_STOP
} Token;
Token read_token(char buf[]);
typedef struct int_link  {
  struct int_link * next;
  int i;
} IntLink;
typedef struct int_stack {
```

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```
  IntLink * top;
} IntStack;
extern void  push(IntStack *, int);
extern int pop(IntStack *);
```

CALC.C

```
/*----- FILE CALC.C ------------------------------------------------*/
/*                                                                  */
/* A simple calculator that does operations on integers that        */
/* are pushed and popped on a stack                                 */
/*------------------------------------------------------------------*/
#include <stdio.h>
#include <stdlib.h>
#include "calc.h"
IntStack stack = { 0 };
main()
{
  Token tok;
  char word[100];
  char buf_out[100];
  int num, num2;
  for(;;)
  {
    tok=read_token(word);
    switch(tok)
    {
      case T_STOP:
        break;
      case T_INTEGER:
        num = atoi(word);
        push(&stack,num);     /* CALC1 statement */
        break;
      case T_PLUS:
        push(&stack, pop(&stack)+pop(&stack) );
        break;
      case T_MINUS:
        num = pop(&stack);
        push(&stack, num-pop(&stack));
        break;
      case T_TIMES:
        push(&stack, pop(&stack)*pop(&stack));
        break;
      case T_DIVIDE:
        num2 = pop(&stack);
        num = pop(&stack);
        push(&stack, num/num2);   /* CALC2 statement */
        break;
      case T_EQUALS:
        num = pop(&stack);
        sprintf(buf_out,"= %d ",num);
        push(&stack,num);
        break;
    }
    if (tok==T_STOP)
      break;
  }
  return 0;
}
```

PUSHPOP.C

```
/*----- FILE PUSHPOP.C ---------------------------------------------*/
/*                                                                  */
/* A push and pop function for a stack of integers                  */
/*------------------------------------------------------------------*/
#include <stdlib.h>
#include "calc.h"
```

```
/*--------------------------------------------------------------------*/
/* input:  stk - stack of integers                                    */
/*         num - value to push on the stack                           */
/* action: get a link to hold the pushed value, push link on stack    */
/*                                                                    */
extern void push(IntStack * stk, int num)
{
  IntLink * ptr;
  ptr       = (IntLink *) malloc( sizeof(IntLink));  /* PUSHPOP1  */
  ptr->i    = num;                /* PUSHPOP2  statement */
  ptr->next = stk->top;
  stk->top  = ptr;

}
/*--------------------------------------------------------------------*/
/* return: int value popped from stack                                */
/* action: pops top element from stack and gets return value from it  */
/*--------------------------------------------------------------------*/
extern int pop(IntStack * stk)
{
  IntLink * ptr;
  int num;
  ptr      = stk->top;
  num      = ptr->i;
  stk->top = ptr->next;
  free(ptr);
  return num;
}
```

READTOKN.C

```
/*----- FILE READTOKN.C -----------------------------------------------*/
/*                                                                    */
/* A function to read input and tokenize it for a simple calculator   */
/*--------------------------------------------------------------------*/
#include <ctype.h>
#include <stdio.h>
#include "calc.h"
/*--------------------------------------------------------------------*/
/* action: get next input char, update index for next call            */
/* return: next input char                                            */
/*--------------------------------------------------------------------*/
static char nextchar(void)
{
/*--------------------------------------------------------------------*/
/* input  action:                                                     */
/*    2      push 2 on stack                                          */
/*    18     push 18                                                  */
/*    +      pop 2, pop 18, add, push result (20)                     */
/*    =      output value on the top of the stack (20)                */
/*    5      push 5                                                   */
/*    /      pop 5, pop 20, divide, push result (4)                   */
/*    =      output value on the top of the stack (4)                 */
/*--------------------------------------------------------------------*/
  char * buf_in  = "2 18 + = 5 / = ";
  static int index;     /* starts at 0 */
  char ret;
  ret = buf_in[index];
  ++index;
  return ret;
}
/*--------------------------------------------------------------------*/
/* output: buf - null terminated token                                */
/* return: token type                                                 */
/* action: reads chars through nextchar() and tokenizes them          */
/*--------------------------------------------------------------------*/
Token read_token(char buf[])
```

```
{
  int i;
  char c;
  /* skip leading white space */
  for( c=nextchar();
       isspace(c);
       c=nextchar())
    ;
  buf[0] = c;  /* get ready to return single char e.g."+" */
  buf[1] = 0;
  switch(c)
  {
    case '+' : return T_PLUS;
    case '-' : return T_MINUS;
    case '*' : return T_TIMES;
    case '/' : return T_DIVIDE;
    case '=' : return T_EQUALS;
    default:
      i = 0;
      while (isdigit(c)) {
        buf[i++] = c;
        c = nextchar();
      }
      buf[i] = 0;
      if (i==0)
        return T_STOP;
      else
        return T_INTEGER;
  }
}
```

Refer to the following topics for more information related to the material discussed in this topic.

Related tasks

Chapter 24, “Debugging a C program in full-screen mode,” on page 233

Halting when certain functions are called in C

This topic describes how to halt just before or just after a routine is called by using the AT CALL and AT ENTRY commands. The “Example: sample C program for debugging” on page 233 is used to describe these commands.

To use the AT CALL command, you must compile the calling program with the TEST compiler option.

To halt just before read_token is called, enter the following command:

```
AT CALL read_token ;
```

To use the AT ENTRY command, you must compile the called program with the TEST compiler option.

To halt just after read_token is called, enter the following command:

```
AT ENTRY read_token ;
```

To halt just after push is called and only when *num* equals 16, enter the following command:

```
AT ENTRY push WHEN num=16;
```

Modifying the value of a C variable

To LIST the contents of a single variable, move the cursor to the variable name and press PF4 (LIST). The value is displayed in the Log window. This is equivalent to entering LIST TITLED *variable* on the command line.

"Example: sample C program for debugging" on page 233

Run the CALC program above to the statement labeled **CALC1** , move the cursor over *num* and press PF4 (LIST). The following appears in the Log window:

```
LIST ( num ) ;
num = 2
```

To modify the value of *num* to 22, type over the num = 2 line with num = 22, press Enter to put it on the command line, and press Enter again to issue the command.

You can enter most C expressions on the command line.

Now step into the call to push() by pressing PF2 (STEP) and step until the statement labeled PUSHPOP2 is reached. To view the attributes of variable *ptr*, issue the Debug Tool command:

```
DESCRIBE ATTRIBUTES *ptr;
```

The result in the Log window is similar to the following:

```
ATTRIBUTES for * ptr
Its address is 0BB6E010 and its length is 8
  struct int_link
    struct int_link *next;
    int i;
```

You can use this action to browse structures and unions.

You can list all the values of the members of the structure pointed to by *ptr* with the command:

```
LIST *ptr ;
```

with results in the Log window appearing similar to the following:

```
LIST * ptr ;
(* ptr).next = 0x00000000
(* ptr).i = 0
```

You can change the value of a structure member by issuing the assignment as a command as in the following example:

```
(* ptr).i = 33 ;
```

Halting on a line in C only if a condition is true

Often a particular part of your program works fine for the first few thousand times, but fails afterward because a specific condition is present. Setting a simple line breakpoint is an inefficient way to debug the program because you need to execute the GO command a thousand times to reach the specific condition. You can instruct Debug Tool to continue executing a program until a specific condition is present.

"Example: sample C program for debugging" on page 233

For example, in the main procedure of the program above, you want to stop at T_DIVIDE only if the divisor is 0 (before the exception occurs). Set the breakpoint like this:

```
AT 40 { if(num2 != 0) GO; }
```

Line 40 is the statement labeled **CALC2** . The command causes Debug Tool to stop at line 40. If the value of num2 is not 0, the program continues. You can enter Debug Tool commands to change the value of num2 to a nonzero value.

Debugging C when only a few parts are compiled with TEST

"Example: sample C program for debugging" on page 233

Suppose you want to set a breakpoint at entry to the function push() in the file PUSHPOP.C. PUSHPOP.C has been compiled with TEST but the other files have not. Debug Tool comes up with an empty Source window. To display the compile units, enter the command:

```
LIST NAMES CUS
```

The LIST NAMES CUS command displays a list of all the compile units that are known to Debug Tool. Depending on the compiler you are using, or if "USERID.MFISTART.C(PUSHPOP)" is fetched later on by the application, this compile unit might not be known to Debug Tool. If it is displayed, enter:

```
SET QUALIFY CU "USERID.MFISTART.C(PUSHPOP)"
AT ENTRY push;
GO ;
```

or

```
AT ENTRY "USERID.MFISTART.C(PUSHPOP)":>push
GO;
```

If it is not displayed, set an appearance breakpoint as follows:

```
AT APPEARANCE "USERID.MFISTART.C(PUSHPOP)" ;
GO ;
```

The only purpose for this appearance breakpoint is to gain control the first time a function in the PUSHPOP compile unit is run. When that happens, you can set breakpoints at entry to push():

```
AT ENTRY push;
```

You can also combine the breakpoints as follows:

```
AT APPEARANCE "USERID.MFISTART.C(PUSHPOP)" AT ENTRY push; GO;
```

Capturing C output to stdout

To redirect stdout to the Log window, issue the following command:

```
SET INTERCEPT ON FILE stdout ;
```

With this SET command, you will capture not only stdout from your program, but also from interactive function calls. For example, you can interactively call printf on the command line to display a null-terminated string by entering:

```
printf(sptr);
```

You might find this easier than using LIST STORAGE.

Capturing C input to stdin

To redirect `stdin` input so that you can enter it from the command prompt, do the following steps

1. Enter the following command: `SET INTERCEPT ON FILE stdin ;`
2. When Debug Tool encounters a C statement such as `scanf`, the following message is displayed in the Log window:

```
EQA1290I The program is waiting for input from stdin
EQA1292I Use the INPUT command to enter up to a maximum of 1000
         characters for the intercepted variable-format file.
```

3. Enter the INPUT command to enter the input data.

Refer to the following topics for more information related to the material discussed in this topic.

Related references

Debug Tool Reference and Messages

Calling a C function from Debug Tool

You can start a library function (such as `strlen`) or one of the program functions interactively by calling it on the command line. The functions must comply with the following requirements:

- The functions cannot be in XPLINK applications.
- The functions must have debug information available.

"Example: sample C program for debugging" on page 233

Below, we call `push()` interactively to push one more value on the stack just before a value is popped off.

```
AT CALL pop  ;
GO ;
push(77);
GO ;
```

The calculator produces different results than before because of the additional value pushed on the stack.

Displaying raw storage in C

A `char *` variable *ptr* can point to a piece of storage containing printable characters. To display the first 20 characters enter:

```
LIST STORAGE(*ptr,20)
```

If the string is null terminated, you can also use an interactive function call on the command line, as in:

```
puts(ptr) ;
```

Refer to the following topics for more information related to the material discussed in this topic.

Related tasks

"Displaying and modifying memory through the Memory window" on page 199

Debugging a C DLL

"Example: sample C program for debugging" on page 233

Build PUSHPOP.C as a DLL, exporting `push()` and `pop()`. Build CALC.C and READTOKN.C as the program that imports `push()` and `pop()` from the DLL named PUSHPOP. When the application CALC starts the DLL, PUSHPOP will not be known to Debug Tool. Use the `AT APPEARANCE` breakpoint to gain control in the DLL the first time code in that compile unit appears, as shown in the following example:

```
AT APPEARANCE "USERID.MFISTART.C(PUSHPOP)" ;
GO ;
```

The only purpose of this appearance breakpoint is to gain control the first time a function in the PUSHPOP compile unit is run. When this happens, you can set breakpoints in PUSHPOP.

Getting a function traceback in C

Often when you get close to a programming error, you want to know how you got into that situation, and especially what the traceback of calling functions is. To get this information, issue the command:

```
LIST CALLS ;
```

"Example: sample C program for debugging" on page 233

For example, if you run the CALC example with the commands:

```
AT ENTRY read_token ;
GO ;
LIST CALLS ;
```

the Log window will contain something like:

```
At ENTRY in C function CALC ::> "USERID.MFISTART.C(READTOKN)" :> read_token.
From LINE 18 in C function CALC ::> "USERID.MFISTART.C(CALC)" :> main :> %BLOCK2.
```

which shows the traceback of callers.

Tracing the run-time path for C code compiled with TEST

To trace a program showing the entry and exit points without requiring any changes to the program, place the following Debug Tool commands in a file and `USE` them when Debug Tool initially displays your program. Assuming you have a data set `USERID.DTUSE(TRACE)` that contains the following Debug Tool commands:

```
int indent;
indent = 0;
SET INTERCEPT ON FILE stdout;
AT ENTRY * { \
  ++indent; \
  if (indent < 0) indent = 0; \
  printf("%*.s>%s\n", indent, " ", %block); \
  GO; \
}
AT EXIT * {\
  if (indent < 0) indent = 0; \
  printf("%*.s<%s\n", indent, " ", %block); \
  --indent; \
  GO; \
}
```

You can use this file as the source of commands to Debug Tool by entering the following command:

```
USE USERID.DTUSE(TRACE)
```

The trace of running the program listed below after executing the USE file will be displayed in the Log window.

```
int foo(int i, int j) {
  return i+j;
}
int main(void) {
  return foo(1,2);
}
```

The following trace in the Log window is displayed after running the sample program, with the USE file as a source of input for Debug Tool commands:

```
>main
 >foo
 <foo
<main
```

If you do not want to create the USE file, you can enter the commands through the command line, and the same effect is achieved.

Finding unexpected storage overwrite errors in C

During program run time, some storage might unexpectedly change its value and you want to find out when and where this happens. Consider this example where function `set_i` changes more than the caller expects it to change.

```
struct s { int i; int j;};
struct s a = { 0, 0 };

/* function sets only field i */
void set_i(struct s * p, int k)
{
  p->i = k;
  p->j = k;   /* error, it unexpectedly sets field j also */
}
main() {
  set_i(&a,123);
}
```

Find the address of `a` with the command

```
LIST &(a.j) ;
```

Suppose the result is `0x7042A04`. To set a breakpoint that watches for a change in storage values starting at that address for the next 4 bytes, issue the command:

```
AT CHANGE %STORAGE(0x7042A04,4)
```

When the program is run, Debug Tool will halt if the value in this storage changes.

Finding uninitialized storage errors in C

To help find your uninitialized storage errors, run your program with the Language Environment `TEST` run-time and `STORAGE` options. In the following example:

```
TEST STORAGE(FD,FB,F9)
```

the first subparameter of `STORAGE` is the fill byte for storage allocated from the heap. For example, storage allocated through `malloc()` is filled with the byte 0xFD. If you see this byte repeated through storage, it is likely uninitialized heap storage.

The second subparameter of `STORAGE` is the fill byte for storage allocated from the heap but then freed. For example, storage freed by calling `free()` might be filled

with the byte 0xFB. If you see this byte repeated through storage, it is likely storage that was allocated on the heap, but has been freed.

The third subparameter of STORAGE is the fill byte for auto storage variables in a new stack frame. If you see this byte repeated through storage, it is likely uninitialized auto storage.

The values chosen in the example are odd and large, to maximize early problem detection. For example, if you attempt to branch to an odd address you will get an exception immediately.

"Example: sample C program for debugging" on page 233

As an example of uninitialized heap storage, run program CALC with the STORAGE run-time option as STORAGE(FD,FB,F9) to the line labeled PUSHPOP2 and issue the command:

```
LIST *ptr ;
```

You will see the byte fill for uninitialized heap storage as the following example shows:

```
LIST * ptr ;
(* ptr).next = 0xFDFDFDFD
(* ptr).i = -33686019
```

Halting before calling a NULL C function

Calling an undefined function or calling a function through a function pointer that points to NULL is a severe error. To halt just before such a call is run, set this breakpoint:

```
AT CALL 0
```

When Debug Tool stops at this breakpoint, you can bypass the CALL by entering the GO BYPASS command. This allows you to continue your debug session without raising a condition.

Chapter 25. Debugging a C++ program in full-screen mode

The descriptions of basic debugging tasks for C++ refer to the following C++ program.

"Example: sample C++ program for debugging"

Refer to the following topics for more information related to the material discussed in this topic.

Related tasks

Chapter 32, "Debugging C and C++ programs," on page 309
"Halting when certain functions are called in C++" on page 247
"Modifying the value of a C++ variable" on page 248
"Halting on a line in C++ only if a condition is true" on page 249
"Viewing and modifying data members of the this pointer in C++" on page 249
"Debugging C++ when only a few parts are compiled with TEST" on page 249
"Capturing C++ output to stdout" on page 250
"Calling a C++ function from Debug Tool" on page 251
"Displaying raw storage in C++" on page 251
"Debugging a C++ DLL" on page 251
"Getting a function traceback in C++" on page 252
"Tracing the run-time path for C++ code compiled with TEST" on page 252
"Finding unexpected storage overwrite errors in C++" on page 253
"Finding uninitialized storage errors in C++" on page 253
"Halting before calling a NULL C++ function" on page 254

Example: sample C++ program for debugging

The program below is used in various topics to demonstrate debugging tasks.

This program is a simple calculator that reads its input from a character buffer. If integers are read, they are pushed on a stack. If one of the operators (+ – * /) is read, the top two elements are popped off the stack, the operation is performed on them, and the result is pushed on the stack. The = operator writes out the value of the top element of the stack to a buffer.

CALC.HPP

```
/*----- FILE CALC.HPP -------------------------------------------------*/
/*                                                                     */
/* Header file for CALC.CPP PUSHPOP.CPP READTOKN.CPP                   */
/* a simple calculator                                                 */
/*---------------------------------------------------------------------*/
typedef enum toks {
  T_INTEGER,
  T_PLUS,
  T_TIMES,
  T_MINUS,
  T_DIVIDE,
  T_EQUALS,
  T_STOP
} Token;
extern "C" Token read_token(char buf[]);
class IntLink {
  private:
    int i;
    IntLink * next;
  public:
    IntLink();
```

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```
    ~IntLink();
    int get_i();
    void set_i(int j);
    IntLink * get_next();
    void set_next(IntLink * d);
};
class IntStack {
  private:
    IntLink * top;
  public:
    IntStack();
    ~IntStack();
    void push(int);
    int pop();
};
```

CALC.CPP

```
/*----- FILE CALC.CPP ------------------------------------------------*/
/*                                                                    */
/* A simple calculator that does operations on integers that          */
/* are pushed and popped on a stack                                   */
/*--------------------------------------------------------------------*/
#include <stdio.h>
#include <stdlib.h>
#include "calc.hpp"
IntStack stack;
int main()
{
  Token tok;
  char word[100];
  char buf_out[100];
  int num, num2;
  for(;;)
  {
    tok=read_token(word);
    switch(tok)
    {
      case T_STOP:
        break;
      case T_INTEGER:
        num = atoi(word);
        stack.push(num);      /* CALC1 statement */
        break;
      case T_PLUS:
        stack.push(stack.pop()+stack.pop());
        break;
      case T_MINUS:
        num = stack.pop();
        stack.push(num-stack.pop());
        break;
      case T_TIMES:
        stack.push(stack.pop()*stack.pop() );
        break;
      case T_DIVIDE:
        num2 = stack.pop();
        num = stack.pop();
        stack.push(num/num2);      /* CALC2 statement */
        break;
      case T_EQUALS:
        num = stack.pop();
        sprintf(buf_out,"= %d ",num);
        stack.push(num);
        break;
    }
    if (tok==T_STOP)
```

```
      break;
  }
  return 0;
}
```

PUSHPOP.CPP

```
/*----- FILE: PUSHPOP.CPP ------------------------------------------*/
/*                                                                  */
/* Push and pop functions for a stack of integers                   */
/*------------------------------------------------------------------*/
#include <stdio.h>
#include <stdlib.h>
#include "calc.hpp"
/*------------------------------------------------------------------*/
/* input:  num - value to push on the stack                         */
/* action: get a link to hold the pushed value, push link on stack  */
/*------------------------------------------------------------------*/
void IntStack::push(int num) {
  IntLink * ptr;
  ptr = new IntLink;
  ptr->set_i(num);
  ptr->set_next(top);
  top = ptr;
}
/*------------------------------------------------------------------*/
/* return: int value popped from stack (0 if stack is empty)        */
/* action: pops top element from stack and get return value from it */
/*------------------------------------------------------------------*/
int IntStack::pop() {
  IntLink * ptr;
  int num;
  ptr = top;
  num = ptr->get_i();
  top = ptr->get_next();
  delete ptr;
  return num;
}
IntStack::IntStack() {
  top = 0;
}
IntStack::~IntStack() {
  while(top)
    pop();
}
IntLink::IntLink() {  /* constructor leaves elements unassigned */
}
IntLink::~IntLink() {
}
void IntLink::set_i(int j) {
  i = j;
}
int IntLink::get_i() {
  return i;
}
void IntLink::set_next(IntLink * p) {
  next = p;
}
IntLink * IntLink::get_next() {
  return next;
}
```

READTOKN.CPP

```
/*----- FILE READTOKN.CPP ------------------------------------------*/
/*                                                                  */
/* A function to read input and tokenize it for a simple calculator */
/*------------------------------------------------------------------*/
```

```
#include <ctype.h>
#include <stdio.h>
#include "calc.hpp"
/*--------------------------------------------------------------------*/
/* action: get next input char, update index for next call            */
/* return: next input char                                            */
/*--------------------------------------------------------------------*/
static char nextchar(void)
{
  /*    input  action
   *    -----  ------
   *    2      push 2 on stack
   *    18     push 18
   *    +      pop 2, pop 18, add, push result (20)
   *    =      output value on the top of the stack (20)
   *    5      push 5
   *    /      pop 5, pop 20, divide, push result (4)
   *    =      output value on the top of the stack (4)
   */
  char * buf_in  = "2 18 + = 5 / = ";
  static int index;     /* starts at 0 */
  char ret;
  ret = buf_in[index];
  ++index;
  return ret;
}
/*--------------------------------------------------------------------*/
/* output: buf - null terminated token                                */
/* return: token type                                                 */
/* action: reads chars through nextchar() and tokenizes them          */
/*--------------------------------------------------------------------*/
extern "C"
Token read_token(char buf[])
{
  int i;
  char c;
  /* skip leading white space */
  for( c=nextchar();
       isspace(c);
       c=nextchar())
    ;
  buf[0] = c;  /* get ready to return single char e.g. "+" */
  buf[1] = 0;
  switch(c)
  {
    case '+' : return T_PLUS;
    case '-' : return T_MINUS;
    case '*' : return T_TIMES;
    case '/' : return T_DIVIDE;
    case '=' : return T_EQUALS;
    default:
      i = 0;
      while (isdigit(c)) {
        buf[i++] = c;
        c = nextchar();
      }
      buf[i] = 0;
      if (i==0)
        return T_STOP;
      else
        return T_INTEGER;
  }
}
```

Refer to the following topics for more information related to the material discussed in this topic.

Related tasks
Chapter 25, “Debugging a C++ program in full-screen mode,” on page 243

Halting when certain functions are called in C++

This topic describes how to halt just before or just after a routine is called by using the AT CALL or AT ENTRY commands. The “Example: sample C++ program for debugging” on page 243 is used to describe these commands. Before you use either of these commands, you must do the following tasks:

- To use the AT ENTRY command, you must compile the called program with the TEST compiler option.
- To use the AT CALL command, you must compile the calling program with the TEST compiler option.

When you use either of these commands, include the C++ signature along with the function name.

To facilitate entering the breakpoint, you can display PUSHPOP.CPP in the Source window by typing over the name of the file on the top line of the Source window. This makes PUSHPOP.CPP your currently qualified program. You can then enter the following command:

```
LIST NAMES
```

Debug Tool displays the names of all the blocks and variables for the currently qualified program. Debug Tool displays information similar to the following example in the Log window:

```
There are no session names.
The following names are known in block CALC ::> "USERID.MFISTART.CPP(PUSHPOP)"
IntStack::~IntStack()
IntStack::IntStack()
IntLink::get_i()
IntLink::get_next()
IntLink::~IntLink()
IntLink::set_i(int)
IntLink::set_next(IntLink*)
IntLink::IntLink()
```

Now you can save some keystrokes by inserting the command next to the block name.

To halt just before IntStack::push(int) is called, insert AT CALL next to the function signature and, by pressing Enter, the entire command is placed on the command line. Now, with AT CALL IntStack::push(int) on the command line, you can enter the following command:

```
AT CALL IntStack::push(int)
```

To halt just after IntStack::push(int) is called, enter the following command, which is the same way as the AT CALL command:

```
AT ENTRY IntStack::push(int) ;
```

To halt just after IntStack::push(int) is called and only when *num* equals 16, enter the following command:

```
AT ENTRY IntStack::push(int) WHEN num=16;
```

Modifying the value of a C++ variable

To list the contents of a single variable, move the cursor to the variable name and press PF4 (LIST). The value is displayed in the Log window. This is equivalent to entering LIST TITLED *variable* on the command line.

"Example: sample C++ program for debugging" on page 243

Run the CALC program and step into the first call of function IntStack::push(int) until just after the IntLink has been allocated. Enter the Debug Tool command:

```
LIST TITLED num
```

Debug Tool displays the following in the Log window:

```
LIST TITLED num;
num = 2
```

To modify the value of num to 22, type over the num = 2 line with num = 22, press Enter to put it on the command line, and press Enter again to issue the command.

You can enter most C++ expressions on the command line.

To view the attributes of variable *ptr* in IntStack::push(int), issue the Debug Tool command:

```
DESCRIBE ATTRIBUTES *ptr;
```

The result in the Log window is:

```
ATTRIBUTES for * ptr
Its address is 0BA25EB8 and its length is 8
  class IntLink
    signed int i
    struct IntLink *next
```

So for most classes, structures, and unions, this can act as a browser.

You can list all the values of the data members of the class object pointed to by ptr with the command:

```
LIST *ptr ;
```

with results in the Log window similar to:

```
LIST * ptr ; * ptr.i = 0 * ptr.next = 0x00000000
```

You can change the value of data member of a class object by issuing the assignment as a command, as in this example:

```
(* ptr).i = 33 ;
```

Refer to the following topics for more information related to the material discussed in this topic.

Related tasks

"Using C and C++ variables with Debug Tool" on page 310

Halting on a line in C++ only if a condition is true

Often a particular part of your program works fine for the first few thousand times, but fails under certain conditions. You don't want to set a simple line breakpoint because you will have to keep entering GO.

"Example: sample C++ program for debugging" on page 243

For example, in main you want to stop in T_DIVIDE only if the divisor is 0 (before the exception occurs). Set the breakpoint like this:

```
AT 40 { if(num2 != 0) GO; }
```

Line 40 is the statement labeled **CALC2** . The command causes Debug Tool to stop at line 40. If the value of num is not 0, the program will continue. Debug Tool stops on line 40 only if num2 is 0.

Viewing and modifying data members of the this pointer in C++

If you step into a class method, for example, one for class IntLink, the command:

```
LIST TITLED ;
```

responds with a list that includes this. With the command:

```
DESCRIBE ATTRIBUTES *this ;
```

you will see the types of the data elements pointed to by the this pointer. With the command:

```
LIST *this ;
```

you will list the data member of the object pointed to and see something like:

```
 LIST * this ;
(* this).i = 4
(* this).next =  0x0
```

in the Log window. To modify element i, enter either the command:

```
i = 2001;
```

or, if you have ambiguity (for example, you also have an auto variable named i), enter:

```
(* this).i = 2001 ;
```

Debugging C++ when only a few parts are compiled with TEST

"Example: sample C++ program for debugging" on page 243

Suppose you want to set a breakpoint at entry to function IntStack::push(int) in the file PUSHPOP.CPP. PUSHPOP.CPP has been compiled with TEST but the other files have not. Debug Tool comes up with an empty Source window. To display the compile units, enter the command:

```
LIST NAMES CUS
```

The LIST NAMES CUS command displays a list of all the compile units that are known to Debug Tool.

Depending on the compiler you are using, or if USERID.MFISTART.CPP(PUSHPOP) is fetched later on by the application, this compile unit might or might not be known to Debug Tool, and the PDS member PUSHPOP might or might not be displayed. If it is displayed, enter:

```
SET QUALIFY CU "USERID.MFISTART.CPP(PUSHPOP)"
AT ENTRY IntStack::push(int) ;
GO ;
```

or

```
AT ENTRY "USERID.MFISTART.CPP(PUSHPOP)":>push
GO
```

If it is not displayed, you need to set an appearance breakpoint as follows:

```
AT APPEARANCE "USERID.MFISTART.CPP(PUSHPOP)" ;
GO ;
```

You can also combine the breakpoints as follows:

```
AT APPEARANCE "USERID.MFISTART.CPP(PUSHPOP)" AT ENTRY push; GO;
```

The only purpose of this appearance breakpoint is to gain control the first time a function in the PUSHPOP compile unit is run. When that happens you can, for example, set a breakpoint at entry to IntStack::push(int) as follows:

```
AT ENTRY IntStack::push(int) ;
```

Capturing C++ output to stdout

To redirect stdout to the Log window, issue the following command:

```
SET INTERCEPT ON FILE stdout ;
```

With this SET command, you will not only capture stdout from your program, but also from interactive function calls. For example, you can interactively use cout on the command line to display a null terminated string by entering:

```
cout << sptr ;
```

You might find this easier than using LIST STORAGE.

For CICS only, SET INTERCEPT is not supported.

Capturing C++ input to stdin

To redirect stdin input so that you can enter it from the command prompt, do the following steps

1. Enter the following command: SET INTERCEPT ON FILE stdin ;
2. When Debug Tool encounters a C++ statement such as scanf, the following message is displayed in the Log window:

   ```
   EQA1290I The program is waiting for input from stdin
   EQA1292I Use the INPUT command to enter up to a maximum of 1000
            characters for the intercepted variable-format file.
   ```

3. Enter the INPUT command to enter the input data.

Refer to the following topics for more information related to the material discussed in this topic.

Related references

Debug Tool Reference and Messages

Calling a C++ function from Debug Tool

You can start a library function (such as `strlen`) or one of the programs functions interactively by calling it on the command line. You can also start C linkage functions such as `read_token`. However, you cannot call C++ linkage functions interactively. The functions must comply with the following requirements:

- The functions cannot be in XPLINK applications.
- The functions must have debug information available.

"Example: sample C++ program for debugging" on page 243

In the example below, we call `read_token` interactively.

```
AT CALL read_token;
GO;
read_token(word);
```

The calculator produces different results than before because of the additional token removed from input.

Displaying raw storage in C++

A `char *` variable `ptr` can point to a piece of storage that contains printable characters. To display the first 20 characters, enter;

```
LIST STORAGE(*ptr,20)
```

If the string is null terminated, you can also use an interactive function call on the command line as shown in this example:

```
puts(ptr) ;
```

You can also display storage based on offset. For example, to display 10 bytes at an offset of 2 from location 20CD0, use the following command:

```
LIST STORAGE(0x20CD0,2,10);
```

Refer to the following topics for more information related to the material discussed in this topic.

Related tasks

"Displaying and modifying memory through the Memory window" on page 199

Debugging a C++ DLL

"Example: sample C++ program for debugging" on page 243

Build PUSHPOP.CPP as a DLL, exporting IntStack::push(int) and IntStack::pop(). Build CALC.CPP and READTOKN.CPP as the program that imports IntStack::push(int) and IntStack::pop() from the DLL named PUSHPOP. When the application CALC starts, the DLL PUSHPOP is not known to Debug Tool. Use the `AT APPEARANCE` breakpoint, as shown in the following example, to gain control in the DLL the first time code in that compile unit appears.

```
AT APPEARANCE "USERID.MFISTART.CPP(PUSHPOP)" ;
GO ;
```

The only purpose of this appearance breakpoint is to gain control the first time a function in the PUSHPOP compile unit is run. When this happens, you can set breakpoints in PUSHPOP.

Getting a function traceback in C++

Often when you get close to a programming error, you want to know how you got into that situation, especially what the traceback of calling functions is. To get this information, issue the command:

```
LIST CALLS ;
```

For example, if you run the CALC example with the following commands:

```
AT ENTRY read_token ;
GO ;
LIST CALLS ;
```

the Log window contains something like:

```
At ENTRY in C function "USERID.MFISTART.CPP(READTOKN)" :> read_token.
From LINE 18 in C function "USERID.MFISTART.CPP(CALC)" :> main :> %BLOCK2.
```

which shows the traceback of callers.

Tracing the run-time path for C++ code compiled with TEST

To trace a program showing the entry and exit of that program without requiring any changes to it, place the following Debug Tool commands, shown in the example below, in a file and `USE` them when Debug Tool initially displays your program. Assume you have a data set that contains `USERID.DTUSE(TRACE)` and contains the following Debug Tool commands:

```
int indent;
indent = 0;
SET INTERCEPT ON FILE stdout;
AT ENTRY * { \
  ++indent; \
  if (indent < 0) indent = 0; \
  printf("%*.s>%s\n", indent, " ", %block); \
  GO; \
}
AT EXIT * {\
  if (indent < 0) indent = 0; \
  printf("%*.s<%s\n", indent, " ", %block); \
  --indent; \
  GO; \
}
```

You can use this file as the source of commands to Debug Tool by entering the following command:

```
USE USERID.DTUSE(TRACE)
```

The trace of running the program listed below after executing the USE file is displayed in the Log window:

```
int foo(int i, int j) {
  return i+j;
}
int main(void) {
  return foo(1,2);
}
```

The following trace in the Log window is displayed after running the sample program, using the USE file as a source of input for Debug Tool commands:

```
>main
 >foo(int,int)
 <foo(int,int)
<main
```

If you do not want to create the USE file, you can enter the commands through the command line, and the same effect will be achieved.

Finding unexpected storage overwrite errors in C++

During program run time, some storage might unexpectedly change its value and you would like to find out when and where this happened. Consider this simple example where function `set_i` changes more than the caller expects it to change.

```
struct s { int i; int j;};
struct s a = { 0, 0 };

/* function sets only field i */
void set_i(struct s * p, int k)
{
  p->i = k;
  p->j = k;   /* error, it unexpectedly sets field j also */
}
main() {
  set_i(&a,123);
}
```

Find the address of `a` with the command:

```
LIST &(a.j) ;
```

Suppose the result is `0x7042A04`. To set a breakpoint that watches for a change in storage values, starting at that address for the next 4 bytes, issue the command:

```
AT CHANGE %STORAGE(0x7042A04,4)
```

When the program is run, Debug Tool will halt if the value in this storage changes.

Finding uninitialized storage errors in C++

To help find your uninitialized storage errors, run your program with the Language Environment `TEST` run-time and `STORAGE` options. In the following example:

```
TEST STORAGE(FD,FB,F9)
```

the first subparameter of `STORAGE` is the fill byte for storage allocated from the heap. For example, storage allocated through operator `new` is filled with the byte `0xFD`. If you see this byte repeated throughout storage, it is likely uninitialized heap storage.

The second subparameter of `STORAGE` is the fill byte for storage allocated from the heap but then freed. For example, storage freed by the operator `delete` might be filled with the byte `0xFB`. If you see this byte repeated throughout storage, it is likely storage that was allocated on the heap, but has been freed.

The third subparameter of `STORAGE` is the fill byte for auto storage variables in a new stack frame. If you see this byte repeated throughout storage, you probably have uninitialized auto storage.

The values chosen in the example are odd and large, to maximize early problem detection. For example, if you attempt to branch to an odd address, you will get an exception immediately.

As an example of uninitialized heap storage, run program CALC, with the STORAGE run-time option as STORAGE(FD,FB,F9), to the line labeled PUSHPOP2 and issue the command:

```
LIST *ptr ;
```

You will see the byte fill for uninitialized heap storage as the following example shows:

```
 LIST * ptr ;
(* ptr).next = 0xFDFDFDFD
(* ptr).i = -33686019
```

Refer to the following topics for more information related to the material discussed in this topic.

Related references

z/OS Language Environment Programming Guide

Halting before calling a NULL C++ function

Calling an undefined function or calling a function through a function pointer that points to NULL is a severe error. To halt just before such a call is run, set this breakpoint:

```
AT CALL 0
```

When Debug Tool stops at this breakpoint, you can bypass the call by entering the GO BYPASS command. This command allows you to continue your debug session without raising a condition.

Chapter 26. Debugging an assembler program in full-screen mode

The descriptions of basic debugging tasks for assembler refer to the following assembler program.

"Example: sample assembler program for debugging"

Refer to the following topics for more information related to the material discussed in this topic.

Related tasks

Chapter 33, "Debugging an assembler program," on page 333
"Defining a compilation unit as assembler and loading debug data" on page 258
"Deferred LDDs" on page 259
"Halting when certain assembler routines are called" on page 261
"Displaying and modifying the value of assembler variables or storage" on page 261
"Halting on a line in assembler only if a condition is true" on page 262
"Getting an assembler routine traceback" on page 262
"Finding unexpected storage overwrite errors in assembler" on page 263

Example: sample assembler program for debugging

The program below is used in various topics to demonstrate debugging tasks.

To run this sample program, do the following steps:

1. Verify that the debug file for this assembler program is located in the SUBXMP and DISPARM members of the *yourid*.EQALANGX data set.
2. Start Debug Tool.
3. To load the information in the debug file, enter the following commands:

   ```
   LDD (SUBXMP,DISPARM)
   ```

This program is a small example of an assembler main routine (SUBXMP) that calls an assembler subroutine (DISPARM).

Load module: XMPLOAD

SUBXMP.ASM

```
*************************************************************
*                                                           *
*  NAME: SUBXMP                                            *
*                                                           *
*        A simple main assembler routine that brings up     *
*        Language Environment, calls a subroutine, and      *
*        returns with a return code of 0.                   *
*                                                           *
*************************************************************
SUBXMP   CEEENTRY PPA=XMPPPA,AUTO=WORKSIZE
         USING WORKAREA,R13
* Invoke CEEMOUT to issue the greeting message
         CALL  CEEMOUT,(HELLOMSG,DEST,FBCODE),VL,MF=(E,CALLMOUT)
* No plist to DISPARM, so zero R1. Then call it.
         SLR   R0,R0
         ST    R0,COUNTER
         LA    R0,HELLOMSG
         SR    R01,R01 ssue a message
```

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```
         CALL  DISPARM              CALL1
* Invoke CEEMOUT to issue the farewell message
         CALL  CEEMOUT,(BYEMSG,DEST,FBCODE),VL,MF=(E,CALLMOUT)
* Terminate Language Environment and return to the caller
         CEETERM  RC=0

*        CONSTANTS
HELLOMSG DC    Y(HELLOEND-HELLOSTR)
HELLOSTR DC    C'Hello from the sub example.'
HELLOEND EQU   *

BYEMSG   DC    Y(BYEEND-BYESTART)
BYESTART DC    C'Terminating the sub example.'
BYEEND   EQU   *
DEST     DC    F'2'               Destination is the LE message file
COUNTER  DC    F'-1'

XMPPPA   CEEPPA  ,                Constants describing the code block
*        The Workarea and DSA
WORKAREA DSECT
         ORG   *+CEEDSASZ         Leave space for the DSA fixed part
CALLMOUT CALL  ,(,,),VL,MF=L      3-argument parameter list
FBCODE   DS    3F                 Space for a 12-byte feedback code
         DS    0D
WORKSIZE EQU   *-WORKAREA
         PRINT NOGEN
         CEEDSA  ,                Mapping of the dynamic save area
         CEECAA  ,                Mapping of the common anchor area
R0       EQU   0
R01      EQU   1
R13      EQU   13
         END   SUBXMP             Nominate SUBXMP as the entry point
```

DISPARM.ASM

```
*************************************************************
*                                                           *
*  NAME:  DISPARM                                           *
*                                                           *
*        Shows an assembler subroutine that displays inbound *
*        parameters and returns.                            *
*                                                           *
*************************************************************
DISPARM  CEEENTRY PPA=PARMPPA,AUTO=WORKSIZE,MAIN=NO
         USING WORKAREA,R13
* Invoke CEE3PRM to retrieve the command parameters for us
         SLR   R0,R0
         ST    R0,COUNTER
         CALL  CEE3PRM,(CHARPARM,FBCODE),VL,MF=(E,CALL3PRM)      CALL2
* Check the feedback code from CEE3PRM to see if everything worked.
         CLC   FBCODE(8),CEE000
         BE    GOT_PARM
* Invoke CEEMOUT to issue the error message for us
         CALL  CEEMOUT,(BADFBC,DEST,FBCODE),VL,MF=(E,CALLMOUT)
         B     GO_HOME                Time to go....
GOT_PARM DS    0H
* See if the parm string is blank.
         LA    R1,1
SAVECTR  ST    R1,COUNTER
         CL    R1,=F'5'                   BUMPCTR
         BH    LOOPEND
         LA    R1,1(,R1)
         B     SAVECTR
LOOPEND  DS    0H
         CLC   CHARPARM(80),=CL80' '   Is the parm empty?
         BNE   DISPLAY_PARM            No. Print it out.
* Invoke CEEMOUT to issue the error message for us
```

```
         CALL  CEEMOUT,(NOPARM,DEST,FBCODE),VL,MF=(E,CALLMOUT)
         B     GO_TEST                 Time to go....

DISPLAY_PARM   DS  0H
* Set up the plist to CEEMOUT to display the parm.
         LA    R0,2
         ST    R0,COUNTER
         LA    R02,80        Get the size of the string
         STH   R02,BUFFSIZE  Save it for the len-prefixed string
* Invoke CEEMOUT to display the parm string for us
         CALL  CEEMOUT,(BUFFSIZE,DEST,FBCODE),VL,MF=(E,CALLMOUT)
*        AMODE Testing
GO_TEST  DS  0H
         L     R15,INAMODE24@
         BSM   R14,R15
InAMode24 Equ  *
         LA    R1,DEST
         O     R1,=X'FF000000'
         L     R15,0(,R1)
         LA    R15,2(,R15)
         ST    R15,0(,R1)
         L     R15,INAMODE31@
         BSM   R14,R15
InAMode31 Equ  *
* Return to the caller
GO_HOME  DS    0H
         LA    R0,3
         ST    R0,COUNTER
         CEETERM  RC=0

*        CONSTANTS
DEST     DC    F'2'               Destination is the LE message file
CEE000   DS    3F'0'              Success feedback code
InAMode24@ DC  A(InAMode24)
InAMode31@ DC  A(InAMode31+X'80000000')
BADFBC   DC    Y(BADFBEND-BADFBSTR)
BADFBSTR DC    C'Feedback code from CEE3PRM was nonzero.'
BADFBEND EQU   *
NOPARM   DC    Y(NOPRMEND-NOPRMSTR)
NOPRMSTR DC    C'No user parm was passed to the application.'
NOPRMEND EQU   *
PARMPPA  CEEPPA ,                 Constants describing the code block
* ================================================================
WORKAREA DSECT
         ORG   *+CEEDSASZ         Leave space for the DSA fixed part
CALL3PRM CALL  ,(,),VL,MF=L       2-argument parameter list
CALLMOUT CALL  ,(,,),VL,MF=L      3-argument parameter list
FBCODE   DS    3F                 Space for a 12-byte feedback code
COUNTER  DS    F
BUFFSIZE DS    H                  Halfword prefix for following string
CHARPARM DS    CL255              80-byte buffer
         DS    0D
WORKSIZE EQU   *-WORKAREA
         PRINT NOGEN
         CEEDSA  ,                Mapping of the dynamic save area
         CEECAA  ,                Mapping of the common anchor area
MYDATA   DSECT   ,
MYF      DS      F
R0       EQU   0
R1       EQU   1
R2       EQU   2
R3       EQU   3
R4       EQU   4
R5       EQU   5
R6       EQU   6
R7       EQU   7
R8       EQU   8
```

```
R9       EQU   9
R10      EQU   10
R11      EQU   11
R12      EQU   12
R13      EQU   13
R14      EQU   14
R15      EQU   15
R02      EQU   2
         END
```

Defining a compilation unit as assembler and loading debug data

Before you can debug an assembler program, you must define the compilation unit (CU) as an assembler CU and load the debug data for the CU. This can only be done for a CU that is currently known to Debug Tool as a disassembly CU.

You use the LOADDEBUGDATA command (abbreviated as LDD) to define a disassembly CU as an assembler CU and to cause the debug data for this CU to be loaded. When you run the LDD command, you can specify either a single CU name or a list of CU names enclosed in parenthesis. Each of the names specified must be either:

- the name of a disassembly CU that is currently known to Debug Tool
- a name that does not match the name of a CU currently known to Debug Tool

When the CU name is currently known to Debug Tool, the CU is immediately marked as an assembler CU and an attempt is made to load the debug data as follows:

- If your assembler debug data is in a partitioned data set where the high-level qualifier is the current user ID, the low-level qualifier is EQALANGX, and the member name is the same as the name of the CU that you want to debug no other action is necessary
- If your assembler debug data is in a different partitioned data set than *userid*.EQALANGX but the member name is the same as the name of the CU that you want to debug, enter the following command before or after you enter the LDD command: SET DEFAULT LISTINGS
- If your assembler debug data is in a sequential data set or is a member of a partitioned data set but the member name is different from the CU name, enter the following command before or after the LDD: SET SOURCE

When the CU name specified on the LDD command is not currently known to Debug Tool, a message is issued and the LDD command is deferred until a CU by that name becomes known (appears). At that time, the CU is automatically created as an assembler CU and an attempt is made to load the debug data using the default data set name or the current SET DEFAULT LISTINGS specification.

After you have entered an LDD command for a CU, you cannot view the CU as a disassembly CU.

If Debug Tool cannot find the associated assembler debug data after you have entered an LDD command, the CU is an assembler CU rather than a disassembly CU. You cannot enter another LDD command for this CU. However, you can enter a SET DEFAULT LISTING command or a SET SOURCE command to cause the associated debug data to be loaded from a different data set.

Deferred LDDs

As described in the previous section, you can use the LDD command to identify a CU as an assembler CU before the CU has become known to Debug Tool. This is known as a deferred LDD. In this case, whenever the CU appears, it is immediately marked as an assembler CU and an attempt is made to load the debug data from the default data set name or from the data set currently specified by SET DEFAULT LISTINGS.

If the debug data cannot be found in this way, you must using the SET SOURCE or SET DEFAULT LISTINGS command after the CU appears to cause the debug data to be loaded from the correct data set. You can do this using a command such as:

```
AT APPEARANCE mycu SET SOURCE (mycu) hlq.qual1.dsn
```

Alternatively, you might wait until you have stopped for some other reason after "mycu" has appeared and then use the SET SOURCE or SET DEFAULT LISTING commands to direct Debug Tool to the proper data set.

Re-appearance of an assembler CU

If a CU from which valid assembler debug data has been loaded goes away and then reappears (e.g., the load module is deleted and then reloaded), the CU is immediately marked as an assembler CU and the debug data is reloaded from the data set from which it was successfully loaded originally.

You do not need to (and cannot) issue another LDD for that CU because it is already known as an assembler CU and the debug data has already been loaded.

Multiple compilation units in a single assembly

Debug Tool treats each assembler CSECT as a separate compilation unit (CU). If your assembler source contains more than one CSECT, then the EQALANGX file that you create will contain debug information for all the CSECTs.

In most cases, all of the CSECTs in the assembly will be present in the load module or program object. However, in some cases, one or more of the assemblies might not be present or might be replaced by other CSECTs of the same name. There are, therefore, two ways of loading the debug data for assemblies containing multiple CSECTs:

- When SET LDD ALL is in effect, the debug data for all CSECTs (CUs) in the assembly is loaded as the result of a single LOADDEBUGDATA (LDD) command.
- When SET LDD SINGLE is in effect, a separate LDD command must be issued for each CSECT (CU). This form must be used when one or more of the CSECTs in the assembly are not present in the load module or program object or when one or more of the CSECTs have been replaced by other CSECTs of the same name.

The following sections use an example assembly that generates two CSECTs: MYPROG and MYPROGA. The debug information for both of these CSECTs is in the data set `yourid.EQALANGX(MYPROG)`.

Loading debug data from multiple CSECTs in a single assembly using one LDD command

If SET LDD ALL is in effect, follow the process described in this section. This process is the easiest way to load debug data for assemblies containing multiple CSECTs when all of the CSECTs are present in the load module or program object.

When you enter the command LDD MYPROG, Debug Tool finds and loads the debug data for both MYPROG and MYPROGA. After the debug data is loaded, Debug Tool uses the debug data to create two CUs, one for MYPROG and another for MYPROGA.

Loading debug data from multiple CSECTs in a single assembly using separate LDD commands

If SET LDD SINGLE is in effect, follow the process described in this section.

When you enter the command `LDD MYPROG`, Debug Tool finds and loads the debug information for both MYPROG and MYPROGA. However, because you specified only MYPROG on the `LDD` command and SET LDD SINGLE is in effect, Debug Tool uses only the debug information for MYPROG. Then, if you enter the command `LDD MYPROGA`, Debug Tool does the following steps:

1. If you entered a `SET SOURCE` command before entering the `LDD MYPROG` command, Debug Tool loads the debug data from the data set that you specified with the `SET SOURCE` command.
2. If you did not enter the `SET SOURCE` command or if Debug Tool did not find debug information in step 1, Debug Tool searches through all previously loaded debug information. If Debug Tool finds a name and CSECT length that matches the name and CSECT length of MYPROGA, Debug Tool uses this debug information.

Debugging multiple CSECTs in a single assembly after the debug data is loaded

After you have loaded the debug data for both of the CSECTs in the assembly, you can begin debugging either of the compile units. Although the contents of both CSECTs appear in the source listing, you can only set breakpoints in the compile unit to which you are currently qualified.

When you look at the source listing, all lines contained in a CSECT to which you are not currently qualified have an asterisk immediately before the offset field and following the statement number. If you want to set a line or statement breakpoint on a statement that has this asterisk, you must first qualify to the containing compile unit by using the following command:

```
SET QUALIFY CU compile_unit_name;
```

After you enter this command, the asterisks are removed from the line on which you wanted to set a breakpoint. The absence of the asterisk indicates that you can set a line or statement breakpoint on that line.

You cannot use the `SET QUALIFY` command to qualify to an assembler compile unit until after you have loaded the debug data for that compile unit.

Halting when certain assembler routines are called

This topic describes how to halt just after a routine is called by using the AT ENTRY command. The “Example: sample assembler program for debugging” on page 255 is used to describe these commands.

To halt after the DISPARM routine is called, enter the following command:

```
AT ENTRY DISPARM
```

To halt after the DISPARM routine is called and only when R1 equals 0, enter the following command:

```
AT ENTRY DISPARM WHEN R1=0;
```

The AT CALL command is not supported for assembler routines. Do not use the AT CALL command to stop Debug Tool when an assembler routine is called.

Identifying the statement where your assembler program has stopped

If you have many breakpoints set in your program, you can enter the following command to have Debug Tool identify where your program has stopped:

```
QUERY LOCATION
```

The Debug Tool Log window displays something similar to the following example:

```
QUERY LOCATION
You are executing commands in the ENTRY XMPLOAD ::> DISPARM breakpoint.
The program is currently entering block XMPLOAD ::> DISPARM.
```

Displaying and modifying the value of assembler variables or storage

To list the contents of a single variable, move the cursor to an occurrence of the variable name in the Source window and press PF4 (LIST). The value is displayed in the Log window. This is equivalent to entering LIST *variable* on the command line.

For example, run the SUBXMP program to the statement labeled **CALL1** by entering AT 70 ; GO ; on the Debug Tool command line. Scroll up until you see line 67. Move the cursor over COUNTER and press PF4 (LIST). The following appears in the Log window:

```
LIST ( COUNTER )
COUNTER = 0
```

To modify the value of COUNTER to 1, type over the COUNTER = 0 line with COUNTER = 1, press Enter to put it on the command line, and press Enter again to issue the command.

To list the contents of the 16 bytes of storage 2 bytes past the address contained in register R0, type the command LIST STORAGE(R0->+2,16) on the command line and press Enter. The contents of the specified storage are displayed in the Log window.

```
LIST STORAGE( R0 -> + 2 , 16 )
000C321E  C8859393 96408699 969440A3 888540A2   *Hello from the s*
```

To modify the first two bytes of this storage to X'C182', type the command R0->+2 <2> = X'C182'; on the command line and press Enter to issue the command.

Now step into the call to DISPARM by pressing PF2 (STEP) and step until the line labeled CALL2 is reached. To view the attributes of variable COUNTER, issue the Debug Tool command:

```
DESCRIBE ATTRIBUTES COUNTER
```

The result in the Log window is:

```
ATTRIBUTES for COUNTER
   Its address is  1B0E2150 and its length is 4
   DS F
```

Converting a hexadecimal address to a symbolic address

While you debug an assembler or disassembly program, you might want to determine the symbolic address represented by a hexadecimal address. You can do this by using the `LIST` command with the `%WHERE` built-in function. For example, the following command returns a string indicating the symbolic location of X'1BC5C':

```
LIST %WHERE(X'1BC5C')
```

After you enter the command, Debug Tool displays the following result:

```
PROG1+X'12C'
```

The result indicates that the address X'1BC5C' corresponds to offset X'12C' within CSECT PROG1.

Halting on a line in assembler only if a condition is true

Often a particular part of your program works fine for the first few thousand times, but it fails under certain conditions. Setting a line breakpoint is inefficient because you will have to repeatedly enter the `GO` command.

“Example: sample assembler program for debugging” on page 255

In the DISPARM program, to stop Debug Tool when the `COUNTER` variable is set to 3, enter the following command:

```
AT 78 DO; IF COUNTER ^= 3 THEN GO; END;
```

Line 78 is the line labeled **BUMPCTR** . The command causes Debug Tool to stop at line 78. If the value of COUNTER is not 3, the program continues. The command causes Debug Tool to stop on line 78 only if the value of COUNTER is 3.

Getting an assembler routine traceback

Often when you get close to a programming error, you want to know what sequence of calls lead you to the programming error. This sequence is called traceback or traceback of callers. To get the traceback information, enter the following command:

```
LIST CALLS
```

“Example: sample assembler program for debugging” on page 255

For example, if you run the SUBXMP example with the following commands, the Log window displays the traceback of callers:

```
AT ENTRY DISPARM
GO
LIST CALLS
```

The Log window displays information similar to the following:

```
At ENTRY IN Assembler routine XMPLOAD ::> DISPARM.
From LINE 76.1 IN Assembler routine XMPLOAD ::> SUBXMP.
```

Finding unexpected storage overwrite errors in assembler

While your program is running, some storage might unexpectedly change its value and you want to find out when and where this happened. Consider the following example, where the program finds a value unexpectedly modified:

```
L R0,X'24'(R3)
```

To find the address of the operand being loaded, enter the following command:

```
LIST R3->+X'24'
```

Suppose the result is X'00521D42'. To set a breakpoint that watches for a change in storage values starting at that address and for the next 4 bytes, enter the following command:

```
AT CHANGE %STORAGE(X'00521D42',4)
```

When the program runs, Debug Tool stops if the value in this storage changes.

Chapter 27. Customizing your full-screen session

You have several options for customizing your session. For example, you can resize and rearrange windows, close selected windows, change session parameters, and change session panel colors. This section explains how to customize your session using these options.

The window acted upon as you customize your session is determined by one of several factors. If you specify a window name (for example, `WINDOW OPEN MONITOR` to open the Monitor window), that window is acted upon. If the command is cursor-oriented, such as the `WINDOW SIZE` command, the window containing the cursor is acted upon. If you do not specify a window name and the cursor is not in any of the windows, the window acted upon is determined by the setting of *Default window* under the Profile Settings panel.

Refer to the following topics for more information related to the material discussed in this topic.

Related tasks

Chapter 20, “Using full-screen mode: overview,” on page 151
Chapter 27, “Customizing your full-screen session”
“Defining PF keys”
“Defining a symbol for commands or other strings”
“Customizing the layout of physical windows on the session panel” on page 266
“Customizing session panel colors” on page 268
“Customizing profile settings” on page 269
“Saving customized settings in a preferences file” on page 271

Defining PF keys

To define your PF keys, use the `SET PFKEY` command. For example, to define the PF8 key as `SCROLL DOWN PAGE`, enter the following command:

```
SET PF8 "Down" = SCROLL DOWN PAGE ;
```

Use quotation marks (") for C and C++. You can use either apostrophes (') or quotation marks (") for assembler, COBOL, LangX COBOL, disassembly, and PL/I. The string set apart by the quotation marks or apostrophes (`Down` in this example) is the label that appears next to PF8 when you `SET KEYS ON` and your PF key definitions are displayed at the bottom of your screen.

Refer to the following topics for more information related to the material discussed in this topic.

Related references

“Initial PF key settings” on page 166

Defining a symbol for commands or other strings

You can define a symbol to represent a long character string. For example, if you have a long command that you do not want to retype several times, you can use the `SET EQUATE` command to equate the command to a short symbol. Afterward, Debug Tool treats the symbol as though it were the command. The following examples show various settings for using EQUATEs:

- `SET EQUATE info = "abc, def(h+1)";` Sets the symbol `info` to the string, `"abc, def(h+1)"`.

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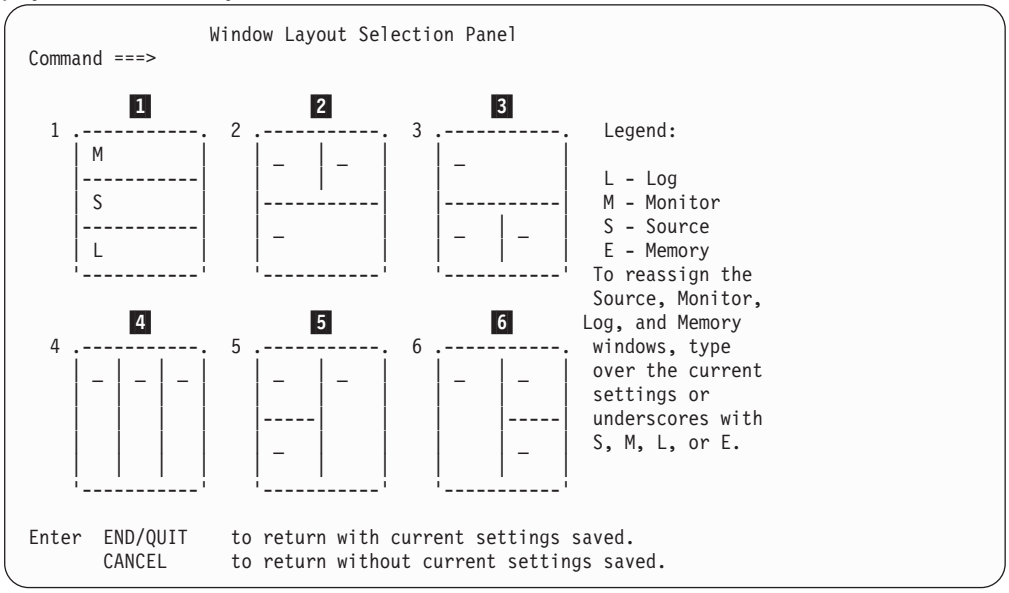
- `CLEAR EQUATE (info);` Disassociates the symbol and the string. This example clears `info`.
- `CLEAR EQUATE;` If you do not specify what symbol to clear, all symbols created by `SET EQUATE` are cleared.

If a symbol created by a `SET EQUATE` command is the same as a keyword or keyword abbreviation in an HLL, the symbol takes precedence. If the symbol is already defined, the new definition replaces the old. Operands of certain commands are for environments other than the standard Debug Tool environment, and are not scanned for symbol substitution.

Customizing the layout of physical windows on the session panel

To change the relative layout of the physical windows, use the `PANEL LAYOUT` command (the `PANEL` keyword is optional). You can display either the Memory window or the Log window in one physical window, but you can not display both windows at the same time in separate physical windows.

The `PANEL LAYOUT` command displays the panel below, showing the six possible physical window layouts.



Initially, the session panel uses the default window layout **1**.

Follow the instructions on the screen, then press the `END` PF key to save your changes and return to the main session panel in the new layout.

Note: You can choose only one of the six layouts. Also, only one of each type of window can be visible at a time on your session panel. For example, you cannot have two Log windows on a panel.

Refer to the following topics for more information related to the material discussed in this topic.

Related tasks

"Opening and closing physical windows" on page 267
"Resizing physical windows" on page 267
"Zooming a window to occupy the whole screen" on page 268
"Saving customized settings in a preferences file" on page 271

Related references
“Debug Tool session panel” on page 151

Opening and closing physical windows

To close a physical window, do one of the following tasks:

- Type the `WINDOW CLOSE` command, move the cursor to the physical window you want to close, then press Enter.
- Enter one of the following commands:
  - `WINDOW CLOSE LOG`
  - `WINDOW CLOSE MONITOR`
  - `WINDOW CLOSE SOURCE`
  - `WINDOW CLOSE MEMORY`
- Assign the `WINDOW CLOSE` command to a PF key. Move the cursor to the physical window you want to close, then press the PF key.

When you close a physical window, the remaining windows occupy the full area of the screen.

To open a physical window, enter one of the following commands:

- `WINDOW OPEN LOG`
- `WINDOW OPEN MONITOR`
- `WINDOW OPEN SOURCE`
- `WINDOW OPEN MEMORY`

If you want to monitor the values of selected variables as they change during your Debug Tool session, you must display the Monitor window in a physical window. If it is not being displayed in a physical window, open a physical window as described above. The Monitor window occupies the available space according to your selected physical window layout.

If you open a physical window and the contents assigned to it are not available, the physical window is empty.

Resizing physical windows

To resize physical windows, do one of the following tasks:

- Type `WINDOW SIZE` on the command line, move the cursor to where you want the physical window boundary, then press Enter. The `WINDOW` keyword is optional.
- Specify the number of rows or columns you want the physical window to contain (as appropriate for the physical window layout) with the `WINDOW SIZE` command. For example, to change the physical window that is displaying the Source window from 10 rows deep to 12 rows deep, enter the following command:

  ```
  WINDOW SIZE 12 SOURCE
  ```
- Assign the `WINDOW SIZE` command to a PF key. Move the cursor to where you want the physical window boundary, then press the PF key.

For the Memory window and the Monitor window, if you make a physical window too narrow to properly display the contents of that window, Debug Tool does not allow you to edit (by typing over) the contents of the window. If this happens, make the physical window wider.

To restore physical window sizes to their default values for the current physical window layout, enter the PANEL LAYOUT RESET command.

Zooming a window to occupy the whole screen

To toggle a window to full screen (temporarily not displaying the others), move the cursor into that window and press PF10 (ZOOM). Press PF10 to toggle back.

PF11 (ZOOM LOG) toggles the Log window in the same way, without the cursor needing to be in the Log window.

Customizing session panel colors

You can change the color and highlighting on your session panel to distinguish the fields on the panel. Consider highlighting such areas as the current line in the Source window, the prefix area, and the statement identifiers where breakpoints have been set.

To change the color, intensity, or highlighting of various fields of the session panel on a color terminal, use the PANEL COLORS command. When you issue this command, the panel shown below appears.

```
                    Color Selection Panel
Command ===>
                       Color    Highlight   Intensity
Title  : field headers  TURQ     NONE        HIGH
         output fields  GREEN    NONE        LOW      Valid Color:
Monitor: contents       TURQ     REVERSE     LOW        White Yellow Blue
         line numbers   TURQ     REVERSE     LOW        Turq Green Pink Red
Source : listing area   WHITE    REVERSE     LOW
         prefix area    TURQ     REVERSE     LOW      Valid Intensity:
         suffix area    YELLOW   REVERSE     LOW        High Low
         current line   RED      REVERSE     HIGH
         breakpoints    GREEN    NONE        LOW      Valid Highlight:
Log    : program output TURQ     NONE        HIGH       None Reverse
         test input     YELLOW   NONE        LOW        Underline Blink
         test output    GREEN    NONE        HIGH
         line numbers   BLUE     REVERSE     HIGH     Color and Highlight
Memory : information    GREEN    NONE        LOW      are valid only with
         offset column  WHITE    NONE        LOW      color terminals.
         address column YELLOW   NONE        LOW
         hex data       GREEN    NONE        LOW
         character data BLUE     NONE        LOW
 Command line           WHITE    NONE        HIGH
 Window headers         GREEN    REVERSE     HIGH
 Tofeof delimiter       BLUE     REVERSE     HIGH
 Search target          RED      NONE        HIGH
Enter  END/QUIT    to return with current settings saved.
       CANCEL      to return without current settings saved.

PF  1:?          2:STEP       3:QUIT       4:LIST       5:FIND       6:AT/CLEAR
PF  7:UP         8:DOWN       9:GO        10:ZOOM      11:ZOOM LOG  12:RETRIEVE
```

Initially, the session panel areas and fields have the default color and attribute values shown above.

The usable color attributes are determined by the type of terminal you are using. If you have a monochrome terminal, you can still use highlighting and intensity attributes to distinguish fields.

To change the color and attribute settings for your Debug Tool session, enter the desired colors or attributes over the existing values of the fields you want to change. The changes you make are saved when you enter QUIT.

You can also change the colors or intensity of selected areas by issuing the equivalent SET COLOR command from the command line. Either specify the fields explicitly, or use the cursor to indicate what you want to change. Changing a color or highlight with the equivalent SET command changes the value on the Color Selection Panel.

Settings remain in effect for the entire debug session.

Refer to the following topics for more information related to the material discussed in this topic.

Related tasks

"Saving customized settings in a preferences file" on page 271

Customizing profile settings

The PANEL PROFILE command displays the Profile Settings Panel, which contains profile settings that affect the way Debug Tool runs. This panel is shown below with the IBM-supplied initial settings.

```
                          Profile Settings Panel
Command ===>

                                Current Setting
                                ---------------
 Change Test Granularity        STATEMENT      (All,Blk,Line,Path,Stmt)
 DBCS characters                NO             (Yes or No)
 Default Listing PDS name
 Default scroll amount          PAGE           (Page,Half,Max,Csr,Data,int)
 Default window                 SOURCE         (Log,Monitor,Source, Memory)
 Execute commands               YES            (Yes or No)
 History                        YES            (Yes or No)
 History size                   100            (nonnegative integer)
 Logging                        YES            (Yes or No)
 Pace of visual trace           2              (steps per second)
 Refresh screen                 NO             (Yes or No)
 Rewrite interval               50             (number of output lines)
 Session log size               1000           (number of retained lines)
 Show log line numbers          YES            (Yes or No)
 Show message ID numbers        NO             (Yes or No)
 Show monitor line numbers      YES            (Yes or No)
 Show scroll field              YES            (Yes or No)
 Show source/listing suffix     YES            (Yes or No)
 Show warning messages          YES            (Yes or No)
 Test level                     ALL            (All,Error,None)
Enter  END/QUIT    to return with current settings saved.
       CANCEL      to return without current settings saved.
```

You can change the settings either by typing your desired values over them, or by issuing the appropriate SET command at the command line or from within a commands file.

The profile parameters, their descriptions, and the equivalent SET commands are as follows:

Change Test Granularity
Specifies the granularity of testing for AT CHANGE. Equivalent to SET CHANGE.

DBCS characters
Controls whether the shift-in or shift-out characters are recognized. Equivalent to SET DBCS.

Default Listing PDS name
If specified, the data set where Debug Tool looks for the source or listing. Equivalent to SET DEFAULT LISTINGS.

Default scroll amount
Specifies the default amount assumed for SCROLL commands where no amount is specified. Equivalent to SET DEFAULT SCROLL.

Default window
Selects the default window acted upon when WINDOW commands are issued with the cursor on the command line. Equivalent to SET DEFAULT WINDOW.

Execute commands
Controls whether commands are executed or just checked for syntax errors. Equivalent to SET EXECUTE.

History
Controls whether a history (an account of each time Debug Tool is entered) is maintained. Equivalent to SET HISTORY.

History size
Controls the size of the Debug Tool history table. Equivalent to SET HISTORY.

Logging
Controls whether a log file is written. Equivalent to SET LOG.

Pace of visual trace
Sets the maximum pace of animated execution. Equivalent to SET PACE.

Refresh screen
Clears the screen before each display. REFRESH is useful when there is another application writing to the screen. Equivalent to SET REFRESH.

Rewrite interval
Defines the number of lines of intercepted output that are written by the application before Debug Tool refreshes the screen. Equivalent to SET REWRITE.

Session log size
The number of session log output lines retained for display. Equivalent to SET LOG.

Show log line numbers
Turns line numbers on or off in the log window. Equivalent to SET LOG NUMBERS.

Show message ID numbers
Controls whether ID numbers are shown in Debug Tool messages. Equivalent to SET MSGID.

Show monitor line numbers
Turns line numbers on or off in the Monitor window. Equivalent to SET MONITOR NUMBERS.

Show scroll field
Controls whether the scroll amount field is shown in the display. Equivalent to SET SCROLL DISPLAY.

Show source/listing suffix
Controls whether the frequency suffix column is displayed in the Source window. Equivalent TO SET SUFFIX.

Show warning messages (C and C++ and PL/I only)
Controls whether warning messages are shown or conditions raised when commands contain evaluation errors. Equivalent to SET WARNING.

Test level
Selects the classes of exceptions to cause automatic entry into Debug Tool. Equivalent to SET TEST.

A field indicating scrolling values is shown only if the screen is not large enough to show all the profile parameters at once. This field is not shown in the example panel above.

You can change the settings of these profile parameters at any time during your session. For example, you can increase the delay that occurs between the execution of each statement when you issue the STEP command by modifying the amount specified in the *Pace of visual trace* field at any time during your session.

To modify the profile settings for your session, enter a new value over the old value in the field you want to change. Equivalent SET commands are issued when you QUIT from the panel.

Entering the equivalent SET command changes the value on the Profile Settings panel as well.

Settings remain in effect for the entire debug session.

Refer to the following topics for more information related to the material discussed in this topic.

Related tasks

"Saving customized settings in a preferences file"

Saving customized settings in a preferences file

You can place a set of commands into a data set, called a preferences file, and then indicate that file should be used by providing its name in the preferences_file suboption of the TEST run-time string. Debug Tool reads these commands at initialization and sets up the session appropriately.

Below is an example preferences file.

```
SET TEST ERROR;
SET DEFAULT SCROLL CSR;
SET HISTORY OFF;
SET MSGID ON;
DESCRIBE CUS;
```

Saving and restoring customizations between Debug Tool sessions

All of the customizations described in Chapter 27, "Customizing your full-screen session," on page 265 can be preserved between Debug Tool sessions by using the save and restore settings feature. See "Recording how many times each source line runs" on page 178 for instructions.

Part 5. Debugging your programs by using Debug Tool commands

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Chapter 28. Entering Debug Tool commands

Debug Tool commands can be issued in three modes: full-screen, line, and batch. Some Debug Tool commands are valid only in certain modes or programming languages. Unless otherwise noted, Debug Tool commands are valid in all modes, and for all supported languages.

For input typed directly at the terminal, input is free-form, optionally starting in column 1.

To separate multiple commands on a line, use a semicolon (;). This terminating semicolon is optional for a single command, or the last command in a sequence of commands.

For input that comes from a commands file or USE file, all of the Debug Tool commands must be terminated with a semicolon, except for the C `block` command.

Refer to the following topics for more information related to the material discussed in this topic.

Related tasks

"Entering commands on the session panel" on page 161
"Abbreviating Debug Tool keywords" on page 276
"Entering multiline commands in full-screen" on page 277
"Entering multiline commands in a commands file" on page 277
"Entering multiline commands without continuation" on page 278
"Using blanks in Debug Tool commands" on page 278
"Entering comments in Debug Tool commands" on page 279
"Using constants in Debug Tool commands" on page 279
"Getting online help for Debug Tool command syntax" on page 280

Related references

Debug Tool Reference and Messages

Using uppercase, lowercase, and DBCS in Debug Tool commands

The character set and case vary with the double-byte character set (DBCS) or the current programming language setting in a Debug Tool session.

DBCS

When the DBCS setting is ON, you can specify DBCS characters in the following portions of all the Debug Tool commands:

- Commentary text
- Character data valid in the current programming language
- Symbolic identifiers such as variable names (for COBOL, this includes session variables), entry names, block names, and so forth (if the names contain DBCS characters in the application program).

When the DBCS setting is OFF, double-byte data is not correctly interpreted or displayed. However, if you use the shift-in and shift-out codes as data instead of DBCS indicators, you should issue `SET DBCS OFF`.

If you are debugging in full-screen mode and your terminal is not DBCS capable, the `SET DBCS ON` command is not available.

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Character case and DBCS in C and C++

For both C and C++, Debug Tool sets the programming language to C. When the current programming language setting is C, the following rules apply:

- All keywords and identifiers must be the correct case. Debug Tool does not convert them to uppercase.
- DBCS characters are allowed only within comments and literals.
- Either trigraphs or the equivalent special characters can be used. Trigraphs are treated as their equivalents at all times. For example, `FIND "??<"` would find not only "??<" but also "{". An exception is that column specifications other than `1 *` are not allowed in `FIND` or `SET FIND BOUNDS` if you search source code and trigraphs are found.
- The vertical bar (|) can be entered for the following C and C++ operations: bitwise or (|), logical or (||), and bitwise assignment or (|=).
- There are alternate code points for the following C and C++ characters: vertical bar (|), left brace ({), right brace (}), left bracket ([), and right bracket (]). Although alternate code points will be accepted as input for the braces and brackets, the primary code points will always be logged.

Character case in COBOL and PL/I

When the current programming language setting is *not* C, commands can generally be either uppercase, lowercase, or mixed. Characters in the range *a* through *z* are automatically converted to uppercase except within comments and quoted literals. Also, in PL/I, only "|" and "¬" can be used as the boolean operators for OR and NOT.

Abbreviating Debug Tool keywords

When you issue the Debug Tool commands, you can truncate most command keywords. You cannot truncate reserved keywords for the different programming languages, system keywords (that is, `SYS`, `SYSTEM`, or `TSO`) or special case keywords such as `BEGIN`, `CALL`, `COMMENT`, `COMPUTE`, `END`, `FILE` (in the `SET INTERCEPT` and `SET LOG` commands), `GOTO`, `INPUT`, `LISTINGS` (in the `SET DEFAULT LISTINGS` command), or `USE`. In addition, `PROCEDURE` can only be abbreviated as `PROC`.

The system keywords, and `COMMENT`, `INPUT`, and `USE` keywords, take precedence over other keywords and identifiers. If one of these keywords is followed by a blank, it is always parsed as the corresponding command. Hence, if you want to assign the value 2 to a variable named *TSO* and the current programming language setting is C, the "=" must be abutted to the reference, as in `"TSO<no space>= 2;"` not `"TSO<space>= 2;"`. If you want to define a procedure named USE, you must enter `"USE<no space>: procedure;"` not `"USE<space>:: procedure;"`.

When you truncate, you need only enter enough characters of the command to distinguish the command from all other valid Debug Tool commands. You should *not* use truncations in a commands file or compile them into programs because they might become ambiguous in a subsequent release. The following shows examples of Debug Tool command truncations:

If you enter the following command...	It will be interpreted as...
`A 3`	`AT 3`
`G`	`GO`
`Q B B`	`QUALIFY BLOCK B`

If you enter the following command...	It will be interpreted as...
Q Q	QUERY QUALIFY
Q	QUIT

If you specify a truncation that is also a variable in your program, the keyword is chosen if this is the only ambiguity. For example, LIST A does not display the value of variable *A*, but executes the LIST AT command, listing your current AT breakpoints. To display the value of *A*, issue LIST (A).

In addition, ambiguous commands that cannot be resolved cause an error message and are not performed. That is, there are two commands that could be interpreted by the truncation specified. For example, D A A; is an ambiguous truncation since it could either be DESCRIBE ATTRIBUTES a; or DISABLE AT APPEARANCE;. Instead, you would have to enter DE A A; if you wanted DESCRIBE ATTRIBUTES a; or DI A A; if you wanted DISABLE AT APPEARANCE;. There are, of course, other variations that would work as well (for example, D ATT A;).

Entering multiline commands in full-screen

If you need to use more than one line to enter a command, you can do one of the following actions:

- Enter a continuation character when you reach the end of the command line.
- Enter the POPUP command before you enter the command.

In either case, Debug Tool displays the Command pop-up window.

When you enter a command in interactive mode, the continuation character must be the last non-blank character in the command line. In the following example, the continuation character is the single-byte character set (SBCS) hyphen (-):

```
LIST (" this is a very very very vvvvvvvvvvvvvvvvvvvvvvvvvvvvvv -
very long string");
```

If you want to end a line with a character that Debug Tool might interpret as a continuation character, follow that character with another valid non-blank character. For example, in C and C++, if you want to enter “i—”, you could enter “(i—)” or “i—;”. When the current programming language setting is C and C++, you can use the backslash character (\).

When Debug Tool is awaiting the continuation of a command in full-screen mode, the Command pop-up window remains open and displays the message “Current command is incomplete, enter more input below”.

Entering multiline commands in a commands file

The rules for line continuation when input comes from a commands file are language-specific:

- When the current programming language setting is C and C++, identifiers, keywords, and literals can be continued from one line to the next if the backslash continuation character is used. The following is an example of the continuation character for C:

  ```
  LIST (" this is a very very very vvvvvvvvvvvvvvvvvvvvvvvvvvvvvv\
  very long string");
  ```

- When the current programming language setting is COBOL, columns 1-6 are ignored by Debug Tool and input can be continued from one line to the next if the

SBCS hyphen (-) is used in column 7 of the next line. Command text must begin in column 8 or later and end in or before column 72.

In literal string continuation, a quotation mark (") or apostrophe (') is required at the end of the continued line. Then, a quotation mark (") or apostrophe (') is required at the beginning of the continuation line. The character following the quotation mark or apostrophe in the continuation line is considered to follow immediately after the last character in the continued line. The following is an example of line continuation for COBOL:

```
123456 LIST (" this is a very very very vvvvvvvvvvvvvvvvvvvvvvv"
123456-"very long string");
```

Continuation is not allowed within a DBCS name or literal string when the current programming language setting is COBOL.

Entering multiline commands without continuation

You can enter the following command parts on separate lines without using the SBCS hyphen (-) continuation character:

- Subcommands and the `END` keyword in the `PROCEDURE` command
- The programming language neutral `BEGIN` command.
- When the current programming language setting is C, statements that are part of a `compound` or `block` statement
- When the current programming language setting is COBOL:
  - `EVALUATE`
    - Subcommands in `WHEN` and `OTHER` clauses
    - `END-EVALUATE` keyword
  - `IF`
    - Subcommands in `THEN` and `ELSE` clauses
    - `END-IF` keyword
  - `PERFORM`
    - Subcommands
    - Subcommands in `UNTIL` clause
    - `END-PERFORM` keyword
- When the current programming language setting is PL/I, the `DO` command is for conditional looping.
- When the current programming language setting is assembler, disassembly, LangX COBOL, or COBOL use the language neutral DO command.

Refer to the following topics for more information related to the material discussed in this topic.

"BEGIN command" in *Debug Tool Reference and Messages*
"DO command (PL/I)" in *Debug Tool Reference and Messages*

Using blanks in Debug Tool commands

Blanks cannot occur within keywords, identifiers, and numeric constants; however, they can occur within character strings. Blanks between keywords, identifiers, or constants are ignored except as delimiters. Blanks are required when no other delimiter exists and ambiguity is possible.

Entering comments in Debug Tool commands

Debug Tool lets you insert descriptive comments into the command stream (except within constants and other comments); however, the comment format depends on the current programming language. The entire line, including comments and delimiter, must not extend beyond column 72.

For C++ only: Comments in the form "//" are not processed by Debug Tool in C++.

- For all supported programming languages, comments can be entered by:
  - Enclosing the text in comment brackets "/*" and "*/". Comments can occur anywhere a blank can occur between keywords, identifiers, and numeric constants. Comments entered in this manner do not appear in the session log.
  - Using the `COMMENT` command to insert commentary text in the session log. Comments entered in this manner cannot contain embedded semicolons.
- When the current programming language setting is COBOL, comments can also be entered by using an asterisk (*) in column 7. This is valid for file input only.
- For assembler and disassembly, comments can also be entered by using an asterisk (*) in column 1.

Comments are most helpful in file input. For example, you can insert comments in a USE file to explain and describe the actions of the commands.

Using constants in Debug Tool commands

Constants are entered as required by the current programming language setting. Most constants defined for each of the supported HLLs are also supported by Debug Tool.

Debug Tool allows the use of hexadecimal addresses in COBOL and PL/I.

The COBOL `H constant` is a fullword address value that can be specified in hex using numeric-hex-literal format (hexadecimal characters only, delimited by either quotation marks (") or apostrophes (') and preceded by `H`). The value is right-justified and padded on the left with zeros.

Note: The `H constant` can only be used where an address or `POINTER` variable can be used. You can use this type of constant with the `SET` command. For example, to assign a hexadecimal value of 124BF to the variable *ptr*, specify:

```
SET ptr TO  H"124BF";
```

The COBOL hexadecimal notation for alphanumeric literals, such as `MOVE X'C1C2C3C4' TO NON-PTR-VAR`, must be used for all other situations where a hexadecimal value is needed.

The PL/I `PX constant` is a hexadecimal value, delimited by apostrophes (') and followed by `PX`. The value is right-justified and can be used in any context in which a pointer value is allowed. For example, to display the contents at a given address in hexadecimal format, specify:

```
LIST STORAGE ('20CD0'PX);
```

Refer to the following topics for more information related to the material discussed in this topic.

Related tasks

"Using constants in COBOL expressions" on page 288
Related references
"C and C++ expressions" on page 313

Getting online help for Debug Tool command syntax

You can get help with Debug Tool command syntax by either pressing PF1 or entering a question mark (?) on the command line. This lists all Debug Tool commands in the Log window.

To get a list of options for a command, enter a partial command followed by a question mark.

For example, in full-screen mode, enter on the command line:

```
?
WINDOW ?
WINDOW CLOSE ?
WINDOW CLOSE SOURCE
```

Now reopen the Source window with:

```
WINDOW OPEN SOURCE
```

to see the results.

The Debug Tool `SYSTEM` and `TSO` commands followed by `?` do not invoke the syntax help; instead the `?` is sent to the host as part of the system command. The `COMMENT` command followed by `?` also does not invoke the syntax help.

Chapter 29. Debugging COBOL programs

Each version of the COBOL compiler provides enhancements that you can use to develop COBOL programs. These enhancements can create different levels of debugging capabilities. The topics below describe how to use these enhancements when you debug your COBOL programs.

"Qualifying variables and changing the point of view in COBOL" on page 289
"Debug Tool evaluation of COBOL expressions" on page 287
Chapter 21, "Debugging a COBOL program in full-screen mode," on page 205
"Using COBOL variables with Debug Tool" on page 283
"Using DBCS characters in COBOL" on page 285
"Using Debug Tool functions with COBOL" on page 289
"Debug Tool commands that resemble COBOL statements"
"%PATHCODE values for COBOL" on page 285
"Debugging VS COBOL II programs" on page 292

Debug Tool commands that resemble COBOL statements

To test COBOL programs, you can write debugging commands that resemble COBOL statements. Debug Tool provides an interpretive subset of COBOL statements that closely resembles or duplicates the syntax and action of the appropriate COBOL statements. You can therefore work with familiar commands and insert into your source code program patches that you developed during your debug session.

The table below shows the interpretive subset of COBOL statements recognized by Debug Tool.

Command	Description
`CALL`	Subroutine call
`COMPUTE`	Computational assignment (including expressions)
Declarations	Declaration of session variables
`EVALUATE`	Multiway switch
`IF`	Conditional execution
`MOVE`	Noncomputational assignment
`PERFORM`	Iterative looping
`SET`	`INDEX` and `POINTER` assignment

This subset of commands is valid only when the current programming language is COBOL.

Related references

Debug Tool Reference and Messages

COBOL command format

When you are entering commands directly at your terminal or workstation, the format is free-form, because you can begin your commands in column 1 and continue long commands using the appropriate method. You can continue on the next line during your Debug Tool session by using an SBCS hyphen (-) as a continuation character.

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However, when you use a file as the source of command input, the format for your commands is similar to the source format for the COBOL compiler. The first six positions are ignored, and an SBCS hyphen in column 7 indicates continuation from the previous line. You must start the command text in column 8 or later, and end it in column 72.

The continuation line (with a hyphen in column 7) optionally has one or more blanks following the hyphen, followed by the continuing characters. In the case of the continuation of a literal string, an additional quotation mark is required. When the token being continued is not a literal string, blanks following the last nonblank character on the previous line are ignored, as are blanks following the hyphen.

When Debug Tool copies commands to the log file, they are formatted according to the rules above so that you can use the log file during subsequent Debug Tool sessions.

Continuation is not allowed within a DBCS name or literal string. This restriction applies to both interactive and commands file input.

Refer to the following topics for more information related to the material discussed in this topic.

Related references

"COBOL compiler options in effect for Debug Tool commands"

"COBOL reserved keywords"

Enterprise COBOL for z/OS Language Reference

COBOL compiler options in effect for Debug Tool commands

While Debug Tool allows you to use many commands that are either similar or equivalent to COBOL commands, Debug Tool does not necessarily interpret these commands according to the compiler options you chose when compiling your program. This is due to the fact that, in the Debug Tool environment, the following settings are in effect:

```
DYNAM
NOCMPR2
NODBCS
NOWORD
NUMPROC(NOPFD)
QUOTE
TRUNC(BIN)
ZWB
```

Related references

Enterprise COBOL for z/OS Language Reference

COBOL reserved keywords

In addition to the subset of COBOL commands you can use while in Debug Tool, there are reserved keywords used and recognized by COBOL that cannot be abbreviated, used as a variable name, or used as any other type of identifier.

Refer to the following topics for more information related to the material discussed in this topic.

Related references

Enterprise COBOL for z/OS Language Reference

Using COBOL variables with Debug Tool

Debug Tool can process all variable types valid in the COBOL language.

In addition to being allowed to assign values to variables and display the values of variables during your session, you can declare session variables to suit your testing needs.

“Example: assigning values to COBOL variables”

Refer to the following topics for more information related to the material discussed in this topic.

Related tasks

“Accessing COBOL variables”

“Assigning values to COBOL variables”

“Displaying values of COBOL variables” on page 284“Declaring session variables in COBOL” on page 287

Accessing COBOL variables

Debug Tool obtains information about a program variable by name, using information that is contained in the symbol table built by the compiler. You make the symbol table available to Debug Tool by compiling with the `TEST` compiler option.

Refer to the following topics for more information related to the material discussed in this topic.

Related tasks

“Choosing TEST or NOTEST compiler suboptions for COBOL programs” on page 27

Assigning values to COBOL variables

Debug Tool provides three COBOL-like commands to use when assigning values to variables: `COMPUTE`, `MOVE`, and `SET`. Debug Tool assigns values according to COBOL rules. See *Debug Tool Reference and Messages* for tables that describe the allowable values for the source and receiver of the `COMPUTE`, `MOVE`, and `SET` commands.

Example: assigning values to COBOL variables

The examples for the `COMPUTE`, `MOVE`, and `SET` commands use the declarations defined in the following COBOL program segment.

```
01  GRP.
    02  ITM-1 OCCURS 3 TIMES INDEXED BY INX1.
        03  ITM-2 PIC 9(3) OCCURS 3 TIMES INDEXED BY INX2.
01  B.
    02  A     PIC 9(10).
01  D.
    02  C     PIC 9(10).
01  F.
    02  E     PIC 9(10)     OCCURS 5 TIMES.
77     AA          PIC X(5)     VALUE 'ABCDE'.
77     BB          PIC X(5).
        88         BB-GOOD-VALUE VALUE 'BBBBB'.
77     XX          PIC 9(9)    COMP.
77     ONE         PIC 99       VALUE 1.
77     TWO         PIC 99       VALUE 2.
77     PTR         POINTER.
```

Assign the value of TRUE to BB-GOOD-VALUE. Only the TRUE value is valid for level-88 receivers. For example:

```
SET BB-GOOD-VALUE TO TRUE;
```

Assign to variable xx the result of the expression (a + e(1))/c * 2.

```
COMPUTE xx =(a + e(1))/c * 2;
```

You can also use table elements in such assignments as shown in the following example:

```
COMPUTE itm-2(1,2)=(a + 1)/e(2);
```

The value assigned to a variable is always assigned to the storage for that variable. In an optimized program, a variable might be temporarily assigned to a register, and a new value assigned to that variable might not alter the value used by the program.

Assign to the program variable c , found in structure d , the value of the program variable a , found in structure b:

```
MOVE a OF b TO c OF d;
```

Note the qualification used in this example.

Assign the value of 123 to the first table element of itm-2:

```
MOVE 123 TO itm-2(1,1);
```

You can also use reference modification to assign values to variables as shown in the following two examples:

```
MOVE aa(2:3)TO bb;
MOVE aa TO bb(1:4);
```

Assign the value 3 to inx1, the index to itm-1:

```
SET inx1 TO 3;
```

Assign the value of inx1 to inx2:

```
SET inx2 TO inx1;
```

Assign the value of an invalid address (nonnumeric 0) to ptr:

```
SET ptr TO NULL;
```

Assign the address of XX to ptr:

```
SET ptr TO ADDRESS OF XX;
```

Assigns the hexadecimal value of X'20000' to the pointer ptr:

```
SET ptr TO H'20000';
```

Displaying values of COBOL variables

To display the values of variables, issue the LIST command. The LIST command causes Debug Tool to log and display the current values (and names, if requested) of variables. For example, if you want to display the variables aa, bb, one, and their respective values at statement 52 of your program, issue the following command:

```
AT 52 LIST TITLED (aa, bb, one); GO;
```

Debug Tool sets a breakpoint at statement 52 (AT), begins execution of the program (GO), stops at statement 52, and displays the variable names (TITLED) and their values.

Put commas between the variables when listing more than one. If you do not want to display the variable names when issuing the LIST command, issue LIST UNTITLED instead of LIST TITLED.

The value displayed for a variable is always the value that was saved in storage for that variable. In an optimized program, a variable can be temporarily assigned to a register, and the value shown for that variable might differ from the value being used by the program.

If you use the LIST command to display a National variable, Debug Tool converts the Unicode data to EBCDIC before displaying it. If the conversion results in characters that cannot be displayed, enter the LIST %HEX() command to display the unconverted Unicode data in hexadecimal format.

Using DBCS characters in COBOL

Programs you run with Debug Tool can contain variables and character strings written using the double-byte character set (DBCS). Debug Tool also allows you to issue commands containing DBCS variables and strings. For example, you can display the value of a DBCS variable (LIST), assign it a new value, monitor it in the Monitor window (MONITOR), or search for it in a window (FIND).

To use DBCS with Debug Tool, enter:

```
SET DBCS ON;
```

If you are debugging in full-screen mode and your terminal is not DBCS capable, the SET DBCS ON is not available.

The DBCS default for COBOL is OFF.

The DBCS syntax and continuation rules you must follow to use DBCS variables in Debug Tool commands are the same as those for the COBOL language.

For COBOL you must type a DBCS literal, such as G, in front of a DBCS value in a Monitor or Data pop-up window if you want to update the value.

Refer to the following topics for more information related to the material discussed in this topic.

Related references

Enterprise COBOL for z/OS Language Reference

%PATHCODE values for COBOL

The table below shows the possible values for the Debug Tool variable %PATHCODE when the current programming language is COBOL.

–1	Debug Tool is not in control as the result of a path or attention situation.
0	Attention function (*not* ATTENTION condition).
1	A block has been entered.
2	A block is about to be exited.

3	Control has reached a label coded in the program (a paragraph name or section name).
4	Control is being transferred as a result of a CALL or INVOKE. The invoked routine's parameters, if any, have been prepared.
5	Control is returning from a CALL or INVOKE. If GPR 15 contains a return code, it has already been stored.
6	Some logic contained by an inline PERFORM is about to be executed. (Out-of-line PERFORM ranges must start with a paragraph or section name, and are identified by %PATHCODE = 3.)
7	The logic following an IF...THEN is about to be executed.
8	The logic following an ELSE is about to be executed.
9	The logic following a WHEN within an EVALUATE is about to be executed.
10	The logic following a WHEN OTHER within an EVALUATE is about to be executed.
11	The logic following a WHEN within a SEARCH is about to be executed.
12	The logic following an AT END within a SEARCH is about to be executed.
13	The logic following the end of one of the following structures is about to be executed: • An IF statement (with or without an ELSE clause) • An EVALUATE or SEARCH • A PERFORM
14	Control is about to return from a declarative procedure such as USE AFTER ERROR. (Declarative procedures must start with section names, and are identified by %PATHCODE = 3.)
15	The logic associated with one of the following phrases is about to be run: • [NOT] ON SIZE ERROR • [NOT] ON EXCEPTION • [NOT] ON OVERFLOW • [NOT] AT END (other than SEARCH AT END) • [NOT] AT END-OF-PAGE • [NOT] INVALID KEY
16	The logic following the end of a statement containing one of the following phrases is about to be run: • [NOT] ON SIZE ERROR • [NOT] ON EXCEPTION • [NOT] ON OVERFLOW • [NOT] AT END (other than SEARCH AT END) • [NOT] AT END-OF-PAGE • [NOT] INVALID KEY.

Note: Values in the range 3–16 can be assigned to %PATHCODE only if your program was compiled with an option supporting path hooks.

Refer to the following topics for more information related to the material discussed in this topic.

Related tasks

“Choosing TEST or NOTEST compiler suboptions for COBOL programs” on page 27

Declaring session variables in COBOL

You might want to declare session variables during your Debug Tool session. The relevant variable assignment commands are similar to their counterparts in the COBOL language. The rules used for forming variable names in COBOL also apply to the declaration of session variables during a Debug Tool session.

The following declarations are for a string variable, a decimal variable, a pointer variable, and a floating-point variable. To declare a string named `description`, enter:

```
77 description      PIC X(25)
```

To declare a variable named `numbers`, enter:

```
77 numbers          PIC 9(4) COMP
```

To declare a pointer variable named `pinkie`, enter:

```
77 pinkie           POINTER
```

To declare a floating-point variable named `shortfp`, enter:

```
77 shortfp          COMP-1
```

Session variables remain in effect for the entire debug session.

Refer to the following topics for more information related to the material discussed in this topic.

Related tasks

"Using session variables across different programming languages" on page 392

Related references

Enterprise COBOL for z/OS Language Reference

Debug Tool evaluation of COBOL expressions

Debug Tool interprets COBOL expressions according to COBOL rules. Some restrictions do apply. For example, the following restrictions apply when arithmetic expressions are specified:

- Floating-point operands are not supported (`COMP-1`, `COMP-2`, external floating point, floating-point literals).
- Only integer exponents are supported.
- Intrinsic functions are not supported.
- Windowed date-field operands are not supported in arithmetic expressions in combination with any other operands.

When arithmetic expressions are used in relation conditions, both comparand attributes are considered. Relation conditions follow the `IF` rules rather than the `EVALUATE` rules.

Only simple relation conditions are supported. Sign conditions, class conditions, condition-name conditions, switch-status conditions, complex conditions, and abbreviated conditions are not supported. When either of the comparands in a relation condition is stated in the form of an arithmetic expression (using operators such as plus and minus), the restriction concerning floating-point operands applies to both comparands. See *Debug Tool Reference and Messages* for a table that

describes the allowable comparisons for the IF command. See the *Enterprise COBOL for z/OS Programming Guide* for a description of the COBOL rules of comparison.

Windowed date fields are not supported in relation conditions.

Refer to the following topics for more information related to the material discussed in this topic.

Related tasks
"Displaying the results of COBOL expression evaluation"
"Using constants in COBOL expressions"
Enterprise COBOL for z/OS Programming Guide
Related references
Debug Tool Reference and Messages

Displaying the results of COBOL expression evaluation

Use the LIST command to display the results of your expressions. For example, to evaluate the expression and displays the result in the Log window, enter:

```
LIST a + (a - 10) + one;
```

You can also use structure elements in expressions. If e is an array, the following two examples are valid:

```
LIST a + e(1) / c * two;
LIST xx / e(two + 3);
```

Conditions for expression evaluation are the same ones that exist for program statements.

Refer to the following topics for more information related to the material discussed in this topic.

Related references
"COBOL compiler options in effect for Debug Tool commands" on page 282
Enterprise COBOL for z/OS Language Reference

Using constants in COBOL expressions

During your Debug Tool session you can use expressions that use string constants as one operand, as well as expressions that include variable names or number constants as single operands. All COBOL string constant types discussed in the *Enterprise COBOL for z/OS Language Reference* are valid in Debug Tool, with the following restrictions:

- The following COBOL figurative constants are supported:
  ZERO, ZEROS, ZEROES
  SPACE, SPACES
  HIGH-VALUE, HIGH-VALUES
  LOW-VALUE, LOW-VALUES
  QUOTE, QUOTES
  NULL, NULLS
  Any of the above preceded by ALL
  Symbolic-character (whether or not preceded by ALL).
- An N literal, which starts with N" or N', is always treated as a national literal.

Additionally, Debug Tool allows the use of a hexadecimal constant that represents an address. This *H-constant* is a fullword value that can be specified in hex using numeric-hex-literal format (hexadecimal characters only, delimited by either

quotation marks (") or apostrophes (') and preceded by H). The value is right-justified and padded on the left with zeros. The following example:

```
LIST STORAGE (H'20cd0');
```

displays the contents at a given address in hexadecimal format. You can use this type of constant with the SET command. The following example:

```
SET ptr TO H'124bf';
```

assigns a hexadecimal value of 124bf to the variable ptr.

Using Debug Tool functions with COBOL

Debug Tool provides certain functions you can use to find out more information about program variables and storage.

Using %HEX with COBOL

You can use the %HEX function with the LIST command to display the hexadecimal value of an operand. For example, to display the external representation of the packed decimal pvar3, defined as PIC 9(9), from 1234 as its hexadecimal (or internal) equivalent, enter:

```
LIST %HEX (pvar3);
```

The Log window displays the hexadecimal string X'000001234'.

Using the %STORAGE function with COBOL

This Debug Tool function allows you to reference storage by address and length. By using the %STORAGE function as the reference when setting a CHANGE breakpoint, you can watch specific areas of storage for changes. For example, to monitor eight bytes of storage at the hex address 22222 for changes, enter:

```
AT CHANGE %STORAGE (H'00022222', 8)
   LIST 'Storage has changed at Hex address 22222'
```

Qualifying variables and changing the point of view in COBOL

Qualification is a method of specifying an object through the use of qualifiers, and changing the point of view from one block to another so you can manipulate data not known to the currently executing block. For example, the assignment MOVE 5 TO x; does not appear to be difficult for Debug Tool to process. However, you might have more than one variable named x. You must tell Debug Tool which variable x to assign the value of five.

You can use qualification to specify to what compile unit or block a particular variable belongs. When Debug Tool is invoked, there is a default qualification established for the currently executing block; it is *implicitly* qualified. Thus, you must explicitly qualify your references to all statement numbers and variable names in any other block. It is necessary to do this when you are testing a compile unit that calls one or more blocks or compile units. You might need to specify what block contains a particular statement number or variable name when issuing commands.

Qualifying variables in COBOL

Qualifiers are combinations of load modules, compile units, blocks, section names, or paragraph names punctuated by a combination of greater-than signs (>), colons, and the COBOL data qualification notation, OF or IN, that precede referenced statement numbers or variable names.

When qualifying objects on a block level, use only the COBOL form of data qualification. If data names are unique, or defined as GLOBAL, they do not need to be qualified to the block level.

The following is a fully qualified object:

```
load_name::>cu_name:>block_name:>object;
```

If required, *load_name* is the name of the load module. It is required only when the program consists of multiple load modules and you want to change the qualification to other than the current load module. *load_name* can also be the Debug Tool variable %LOAD.

If required, *cu_name* is the name of the compile unit. The *cu_name* must be the fully qualified compile unit name. It is required only when you want to change the qualification to other than the currently qualified compile unit. It can be the Debug Tool variable %CU.

If required, *block_name* is the name of the block. The *block_name* is required only when you want to change the qualification to other than the currently qualified block. It can be the Debug Tool variable %BLOCK. If *block_name* is case sensitive, enclose the block name in quotation marks (") or apostrophes ('). If the name is not inside quotation marks or apostrophes, Debug Tool converts the name to upper case.

Below are two similar COBOL programs (blocks).

```
MAIN
⋮
   01  VAR1.
       02  VAR2.
           03  VAR3     PIC XX.
   01  VAR4     PIC  99..

  ***************MOVE commands entered here***************
SUBPROG
⋮
   01  VAR1.
       02  VAR2.
           03  VAR3     PIC XX.
   01  VAR4     PIC  99.
   01  VAR5     PIC  99.

  ***************LIST commands entered here***************
```

You can distinguish between the main and subprog blocks using qualification. If you enter the following MOVE commands when main is the currently executing block:

```
MOVE 8 TO var4;
MOVE 9 TO subprog:>var4;
MOVE 'A' TO var3 OF var2 OF var1;
MOVE 'B' TO subprog:>var3 OF var2 OF var1;
```

and the following LIST commands when subprog is the currently executing block:

```
LIST TITLED var4;
LIST TITLED main:>var4;
LIST TITLED var3 OF var2 OF var1;
LIST TITLED main:>var3 OF var2 OF var1;
```

each LIST command results in the following output (without the commentary) in your Log window:

```
VAR4 = 9;    /*  var4 with no qualification refers to a variable     */
             /*  in the currently executing block (subprog).         */
             /*  Therefore, the LIST command displays the value of 9.*/

MAIN:>VAR4 = 8     /*  var4 is qualified to main.                    */
                   /*  Therefore, the LIST command displays 8,       */
                   /*  the value of the variable declared in main.   */

VAR3 OF VAR2 OF VAR1 = 'B';
               /*  In this example, although the data qualification  */
               /*  of var3 is OF var2 OF var1, the                   */
               /*  program qualification defaults to the currently   */
               /*  executing block and the LIST command displays     */
               /*  'B', the value declared in subprog.               */

VAR3 OF VAR2 OF VAR1 = 'A'
               /*  var3 is again qualified to var2 OF var1           */
               /*  but further qualified to main.                    */
               /*  Therefore, the LIST command displays              */
               /*  'A', the value declared in main.                  */
```

The above method of qualifying variables is necessary for commands files.

Changing the point of view in COBOL

The point of view is usually the currently executing block. You can also get to inaccessible data by changing the point of view using the `SET QUALIFY` command. The `SET` keyword is optional. For example, if the point of view (current execution) is in `main` and you want to issue several commands using variables declared in `subprog`, you can change the point of view by issuing the following:

```
QUALIFY BLOCK subprog;
```

You can then issue commands using the variables declared in `subprog` without using qualifiers. Debug Tool does not see the variables declared in procedure `main`. For example, the following assignment commands are valid with the `subprog` point of view:

```
MOVE 10 TO var5;
```

However, if you want to display the value of a variable in `main` while the point of view is still in `subprog`, you must use a qualifier, as shown in the following example:

```
LIST (main:>var-name);
```

The above method of changing the point of view is necessary for command files.

Considerations when debugging a COBOL class

The block structure of a COBOL class created with Enterprise COBOL for z/OS and OS/390, Version 3 Release 1 or later, is different from the block structure of a COBOL program. The block structure of a COBOL class has the following differences:

- The CLASS is a compile unit.
- The FACTORY paragraph is a block.
- The OBJECT paragraph is a block.
- Each method is a block.

A method belongs to either the FACTORY block or the OBJECT block. A fully qualified block name for a method in the FACTORY paragraph is:

```
class-name:>FACTORY:>method-name
```

A fully qualified block name for a method in the OBJECT paragraph is:

```
class-name:>OBJECT:>method-name
```

When you are at a breakpoint in a method, the currently qualified block is the method. If you enter the LIST TITLED command with no parameters, Debug Tool lists all of the data items associated with the method. To list all of the data items in a FACTORY or OBJECT, do the following steps:

1. Enter the QUALIFY command to set the point of view to the FACTORY or OBJECT.
2. Enter the LIST TITLED command.

For example, to list all of the object instance data items for a class called ACCOUNT, enter the following command:

```
QUALIFY BLOCK ACCOUNT:>OBJECT; LIST TITLED;
```

Debugging VS COBOL II programs

There are limitations to debugging VS COBOL II programs compiled with the TEST compiler option and linked with the Language Environment library. Language Environment callable services, including CEETEST, are not available. However, you must use the Language Environment run time.

Debug Tool does not get control of the program at breakpoints that you set by the following commands:

- AT PATH
- AT CALL
- AT ENTRY
- AT EXIT
- AT LABEL

However, if you set the breakpoint with an AT CALL command that calls a non-VS COBOL II program, Debug Tool does get control of the program. Use the AT ENTRY *, AT EXIT *, AT GLOBAL ENTRY, and AT GLOBAL EXIT commands to set breakpoints that Debug Tool can use to get control of the program.

Breakpoints that you set at entry points and exit statements have no statement associated with them. Therefore, they are triggered only at the compile unit level. When they are triggered, the current view of the listing moves to the top and no statement is highlighted. Breakpoints that you set at entry points and exit statements are ignored by the STEP command.

If you are debugging your VS COBOL II program in remote debug mode, use the same TEST run-time options as for any COBOL program.

Finding the listing of a VS COBOL II program

The VS COBOL II compiler does not place the name of the listing data set in the object (load module). Debug Tool tries to find the listing data set in the following location: userid.CUName.LIST. If the listing is in a PDS, direct Debug Tool to the location of the PDS in one of the following ways:

- In full-screen mode, do one of the following options:
  - Enter the SET DEFAULT LISTINGS command.
  - Enter the SET SOURCE command.

  - Enter the `PANEL PROFILE` command, which displays the Profile Settings panel. Enter the new file name in the Default Listing PDS name field.
  - Enter the command `PANEL LISTINGS` command, which displays the Source Identification Panel. Enter the name of the PDS over the existing name in the Listings/Source File column, then press PF3.
- In remote debug mode, enter the command `SET DEFAULT LISTINGS`.
- Use the EQADEBUG DD statement to define the location of the data set.
- Code the EQAUEDAT user exit with the location of the data set.

For additional information about how you can debug VS COBOL II programs, see *Using CODE/370 with VS COBOL II and OS PL/I*, SC09-1862.

Chapter 30. Debugging a LangX COBOL program

You can use most of the Debug Tool commands to debug LangX COBOL programs that have debug information available. Any exceptions are noted in *Debug Tool Reference and Messages*. Before debugging a LangX COBOL program, prepare your program as described in Chapter 5, “Preparing a LangX COBOL program,” on page 67.

As you read through the information in this document, remember that OS/VS COBOL programs are non-Language Environment programs, even though you might have used Language Environment libraries to link and run your program.

VS COBOL II programs are non-Language Environment programs when you link them with the non-Language Environment library. VS COBOL II programs are Language Environment programs when you link them with the Language Environment library.

Enterprise COBOL programs are always Language Environment programs. Note that COBOL DLL's cannot be debugged as LangX COBOL programs.

Read the information regarding non-Language Environment programs for instructions on how to start Debug Tool and debug non-Language Environment COBOL programs, unless information specific to LangX COBOL is provided.

Loading a LangX COBOL program's debug information

Use the `LOADDEBUGDATA (LDD)` command to indicate to Debug Tool that a compile unit is a LangX COBOL compile unit and to load the debug information associated with that compile unit. The `LDD` command can be used only for compile units that are considered disassembly compile units. In the following example, `mypgm` is the compile unit name of an OS/VS COBOL program: `LDD mypgm`

Debug Tool locates the debug information in a data set with the following name: `yourid.EQALANGX(mypgm)`. If Debug Tool finds this data set, you can begin to debug your LangX COBOL program. If Debug Tool does not find the data set, enter the `SET SOURCE` or `SET DEFAULT LISTINGS` command to indicate to Debug Tool where to find the debug information.

Normally, compile units without debug information are not listed when you enter the `DESCRIBE CUS` or `LIST NAMES CUS` commands. To include these compile units, enter the `SET ASSEMBLER ON` command. The next time you enter the `DESCRIBE CUS` or `LIST NAMES CUS` command, these compile units are listed.

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Debug Tool session panel while debugging a LangX COBOL program

The Debug Tool session panel below shows the information displayed in the Source window while you debug a LangX COBOL program.

```
 1 LX COBOL LOCATION: COB03O initialization
Command ===>                                                  Scroll ===> PAGE
MONITOR --+----1----+----2----+----3----+----4----+----5----+----6 LINE: 0 OF 0
****************************** TOP OF MONITOR *******************************
***************************** BOTTOM OF MONITOR *****************************
SOURCE: COB03O ---1----+----2----+----3----+----4----+----5----+ LINE: 1 OF 111
   2  1     3 *******************************************************         .
        2       *  PROGRAM NAME: COB03O                              *         .
        3       *                                                    *         .
        4       *  COMPILED WITH IBM OS/VS COBOL COMPILER            *         .
        5       *******************************************************         .
        7        IDENTIFICATION DIVISION.                                      .
        8        PROGRAM-ID. COB03O.                                           .
        9       ************************************************************* .
       10       *                                                               .
       11       * LICENSED MATERIALS - PROPERTY OF IBM                          .
       12       *                                                               .
       13       * 5655-P14: Debug Tool for z/OS
       14       * (C) Copyright IBM Corp. 2004 All Rights Reserved
       15       *                                                               .
       16       * US GOVERNMENT USERS RESTRICTED RIGHTS - USE, DUPLICATION OR   .
       17       * DISCLOSURE RESTRICTED BY GSA ADP SCHEDULE CONTRACT WITH IBM   .
       18       * CORP.                                                         .
       19       *                                                               .
       20       *                                                               .
       21       ************************************************************* .
       22        ENVIRONMENT DIVISION.                                         .
       23        DATA DIVISION.                                                .
LOG 0----+----1----+----2----+----3----+----4----+----5----+----6- LINE: 1 OF 7
****************************** TOP OF LOG ********************************
IBM Debug Tool Version 11 Release 1 Mod 0
11/06/2010 4:11:41 PM
5655-W45: Copyright IBM Corp. 1992, 2010
0004 *** Commands file commands follow ***
0005  SET MSGID ON ;
0006  LDD ( COB03O, COB03AO ) ;
0007 EQA1891I *** Commands file commands end ***
***************************** BOTTOM OF LOG ******************************


PF  1:?          2:STEP       3:QUIT       4:LIST       5:FIND       6:AT/CLEAR
PF  7:UP         8:DOWN       9:GO        10:ZOOM      11:ZOOM LOG  12:RETRIEVE
```

The information displayed in the Source window is similar to the listing generated by the COBOL compiler. The Source window displays the following information:

1 LX COBOL
This indicates that the current source program is LangX COBOL.

2 line number
The line number is a number assigned by the EQALANGX program by sequentially numbering the source lines. Use the numbers in this column to set breakpoints and identify statements.

3 source statement
The original source statement.

Restrictions for debugging a LangX COBOL program

When you debug LangX COBOL programs the following general restrictions apply:

- When you compose Debug Tool commands, all expressions must be enclosed in apostrophes (')
- The `AT CALL` command is not supported
- The `AT EXIT` command is not supported
- The `STEP RETURN` command is not supported
- You cannot use the `LIST` command on a level-88 variables.
- You cannot use the assignment statement to alter the contents of a level-88 variable.
- If you enter a `STEP` command when stopped on a statement that returns control to a higher-level program, the `STEP` command acts like a `GO` command.
- The only path-points for the `AT PATH` statement that are supported in a LangX COBOL program are Entry and Label.
- There are behavioral differences between LangX COBOL programs and other COBOL programs. LangX COBOL programs behave more like assembler programs than COBOL programs in many situations. For example, in COBOL, a CU is not known to Debug Tool until it is called, even if it is statically link-edited into the same load module as the calling CU. However, LangX COBOL CU's are all known to Debug Tool when the module is loaded.
- If you are debugging a non-Language Environment VS COBOL II program that uses the CALL statement to invoke a Language Environment program, you cannot stop at or debug the Language Environment program.
- The output of the `DESCRIBE ATTRIBUTES` command might not match the attributes originally coded in the following situations:
  - For packed decimal numbers (COMP-3) the PIC attribute always indicate an odd number of digits. This might be one more digit than was coded in the original PIC.
  - The only non-numeric PIC code that is displayed by Debug Tool is 'X'.
- Under CICS, the initialization of a non-Language Environment COBOL transaction is single-threaded; therefore, when multiple users try to concurrently debug a non-Language Environment COBOL program, the CICS environment initializes one non-Language Environment COBOL transaction at a time. Consider the following example:
  1. Three users start a transaction that runs non-Language Environment COBOL program.
  2. The transaction that started first is initialized first. The other two transactions have to wait until that initialization is completed.
  3. After the initialization of the transaction that started first is done, the transaction that started second is initialized. While this transaction is being initialized, the user of the transaction that started first can run his Debug Tool session and the user of the transaction that started third continues to wait.
  4. After the initialization of the transaction that started second is done, the transaction that started third is initialized. While this transaction is being initialized, the users of the other two transactions can run their Debug Tool sessions.
  5. After the initialization of the transaction that started third is done, all three users can run their Debug Tool sessions, independently, for the same non-Language Environment COBOL program.

%PATHCODE values for LangX COBOL programs

This table shows the possible values for the Debug Tool variable %PATHCODE when the current programming language is LangX COBOL:

%PATHCODE	Entry Type
1	A block has been entered
3	Control has reached a label coded in the program.

Restrictions for debugging non-Language Environment programs

If you specify the TEST run-time option with the NOPROMPT suboption when you start your program, and Debug Tool is subsequently started by CALL CEETEST or the raising of an Language Environment condition, then you can debug both Language Environment and non-Language Environment programs and detect both Language Environment and non-Language Environment events in the enclave that started Debug Tool and in subsequent enclaves. You cannot debug non-Language Environment programs or detect non-Language Environment events in higher-level enclaves. After control has returned from the enclave in which Debug Tool was started, you can no longer debug non-Language Environment programs or detect non-Language Environment events.

Chapter 31. Debugging PL/I programs

The topics below describe how to use Debug Tool to debug your PL/I programs.

Refer to the following topics for more information related to the material discussed in this topic.

Related concepts
“Debug Tool evaluation of PL/I expressions” on page 305
Related tasks
Chapter 23, “Debugging a PL/I program in full-screen mode,” on page 223
Chapter 31, “Debugging PL/I programs”
“Accessing PL/I program variables” on page 302
Related references
“Debug Tool subset of PL/I commands”
“Supported PL/I built-in functions” on page 305

Debug Tool subset of PL/I commands

The table below lists the Debug Tool *interpretive subset* of PL/I commands. This subset is a list of commands recognized by Debug Tool that either closely resemble or duplicate the syntax and action of the corresponding PL/I command. This subset of commands is valid only when the current programming language is PL/I.

Command	Description
`Assignment`	Scalar and vector assignment
`BEGIN`	Composite command grouping
`CALL`	Debug Tool procedure call
`DECLARE` or `DCL`	Declaration of session variables
`DO`	Iterative looping and composite command grouping
`IF`	Conditional execution
`ON`	Define an exception handler
`SELECT`	Conditional execution

PL/I language statements

PL/I statements are entered as Debug Tool *commands*. Debug Tool makes it possible to issue commands in a manner similar to each language.

The following types of Debug Tool commands will support the syntax of the PL/I statements:

Expression
This command evaluates an expression.

Block `BEGIN/END, DO/END, PROCEDURE/END`

These commands provide a means of grouping any number of Debug Tool commands into "one" command.

Conditional
`IF/THEN, SELECT/WHEN/END`

These commands evaluate an expression and control the flow of execution of Debug Tool commands according to the resulting value.

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Declaration
DECLARE or DCL

These commands provide a means for declaring session variables.

Looping
DO/WHILE/UNTIL/END

These commands provide a means to program an iterative or conditional loop as a Debug Tool command.

Transfer of Control
GOTO, ON

These commands provide a means to unconditionally alter the flow of execution of a group of commands.

The table below shows the commands that are new or changed for this release of Debug Tool when the current programming language is PL/I.

Command	Description or changes
ANALYZE	Displays the PL/I style of evaluating an expression, and the precision and scale of the final and intermediate results. Debug Tool does not support this command for Enterprise PL/I programs.
ON	Performs as the AT OCCURRENCE command except it takes PL/I conditions as operands.
BEGIN	BEGIN/END blocks of logic.
DECLARE	Session variables can now include COMPLEX (CPLX), POINTER, BIT, BASED, ALIGNED, UNALIGNED, etc. Arrays can be declared to have upper and lower bounds. Variables can have precisions and scales. You cannot declare arrays and structures when you debug Enterprise PL/I programs.
DO	The three forms of DO are added; one is an extension of C's do. 1. DO; command(s); END; 2. DO WHILE | UNTIL expression; command(s); END; 3. DO reference=specifications; command(s); END;
IF	The IF / ELSE does not require the ENDIF.
SELECT	The SELECT / WHEN / OTHERWISE / END programming structure is added.

%PATHCODE values for PL/I

The table below shows the possible values for the Debug Tool variable %PATHCODE when the current programming language is PL/I.

0	An attention interrupt occurred.
1	A block has been entered.
2	A block is about to be exited.
3	Control has reached a label constant.
4	Control is being sent somewhere else as the result of a CALL or a function reference.
5	Control is returning from a CALL invocation or a function reference. Register 15, if it contains a return code, has not yet been stored.
6	Some logic contained in a complex DO statement is about to be executed.

7	The logic following an IF..THEN is about to be executed.
8	The logic following an ELSE is about to be executed.
9	The logic following a WHEN within a *select-group* is about to be executed.
10	The logic following an OTHERWISE within a *select-group* is about to be executed.

PL/I conditions and condition handling

All PL/I conditions are recognized by Debug Tool. They are used with the AT OCCURRENCE and ON commands.

When an OCCURRENCE breakpoint is triggered, the Debug Tool %CONDITION variable holds the following values:

Triggered condition	%CONDITION value
AREA	AREA
ATTENTION	CEE35J
COND (CC#1)	CONDITION
CONVERSION	CONVERSION
ENDFILE (MF)	ENDFILE
ENDPAGE (MF)	ENDPAGE
ERROR	ERROR
FINISH	CEE066
FOFL	CEE348
KEY (MF)	KEY
NAME (MF)	NAME
OVERFLOW	CEE34C
PENDING (MF)	PENDING
RECORD (MF)	RECORD
SIZE	SIZE
STRG	STRINGRANGE
STRINGSIZE	STRINGSIZE
SUBRG	SUBSCRIPTRANGE
TRANSMIT (MF)	TRANSMIT
UNDEFINEDFILE (MF)	UNDEFINEDFILE
UNDERFLOW	CEE34D
ZERODIVIDE	CEE349

Note: For Enterprise PL/I programs, the following conditions are not supported:

- AT OCCURRENCE file conditions (ENDFILE, ENDPAGE, KEY, NAME, RECORD, TRANSMIT, UNDEFINEDFILE)
- AT OCCURRENCE CONDITION conditions (name)

Note: The Debug Tool condition ALLOCATE raises the ON ALLOCATE condition when a PL/I program encounters an ALLOCATE statement for a controlled variable.

These PL/I language-oriented commands are only a subset of all the commands that are supported by Debug Tool.

Entering commands in PL/I DBCS freeform format

Statements can be entered in PL/I's DBCS freeform. This means that statements can freely use shift codes provided that the statement is not ambiguous.

This will change the description or characteristics of `LIST NAMES` in that:

```
LIST NAMES  db<.c.skk.w>ord
```

will search for

```
<.D.B.C.Skk.W.O.R.D>
```

This will result in different behavior depending upon the language. For example, the following will find `a<kk>b` in C and `<.Akk.b>` in PL/I.

```
LIST NAMES a<kk>*
```

where `<kk>` is shiftout-kanji-shiftin.

Freeform will be added to the parser and will be in effect while the current programming language is PL/I.

Initializing Debug Tool for PL/I programs when TEST(ERROR, ...) run-time option is in effect

With the run-time option, `TEST(ERROR, ...)` only the following can initialize Debug Tool:

- The `ERROR` condition
- Attention recognition
- `CALL PLITEST`
- `CALL CEETEST`

Debug Tool enhancements to LIST STORAGE PL/I command

`LIST STORAGE address` has been enhanced so that the `address` can be a `POINTER`, a `Px` constant, or the `ADDR` built-in function.

PL/I support for Debug Tool session variables

PL/I will support all Debug Tool scalar session variables. In addition, arrays and structures can be declared.

Refer to the following topics for more information related to the material discussed in this topic.

Related tasks

“Using session variables across different programming languages” on page 392

Accessing PL/I program variables

Debug Tool obtains information about a program variable by name using information that is contained in the symbol table built by the compiler. The symbol table is made available to the compiler by compiling with `TEST(SYM)`.

Debug Tool uses the symbol table to obtain information about program variables, controlled variables, automatic variables, and program control constants such as file and entry constants and also CONDITION condition names. Based variables, controlled variables, automatic variables and parameters can be used with Debug Tool only after storage has been allocated for them in the program. An exception to this is DESCRIBE ATTRIBUTES, which can be used to display attributes of a variable.

Variables that are based on any of the following data types must be explicitly qualified when used in expressions:

- an OFFSET variable
- an expression
- a pointer that is either BASED or DEFINED
- a parameter
- a member of either an array or a structure
- an address of a member of either an array or a structure

For example, assume you made the following declaration:

```
DECLARE P1 POINTER;
DECLARE P2 POINTER BASED(P1);
DECLARE DX FIXED BIN(31) BASED(P2);
```

You would not be able to reference the variable directly by name. You can only reference it by specifying either:

```
P2->DX
  or
P1->P2->DX
```

The following types of program variables cannot be used with Debug Tool:

- iSUB defined variables
- Variables defined:
  - On a controlled variable
  - On an array with one or more adjustable bounds
  - With a POSITION attributed that specifies something other than a constant
- Variables that are members of a based structure declared with the REFER options.

Refer to the following topics for more information related to the material discussed in this topic.

Related tasks

"Choosing TEST or NOTEST compiler suboptions for PL/I programs" on page 32

Accessing PL/I structures

The examples in this topic assume the following declaration for a structure called PAYROLL:

```
Declare 1 Payroll(100),
          2 Name,
            4 Last       char(20),
            4 First      char(15),
          2 Hours,
            4 Regular    Fixed Decimal(5,2),
            4 Overtime   Fixed Decimal(5,2);
```

To display the 10th element in the array, enter the following command:

```
LIST PAYROLL(10);
```

Debug Tool displays the following results:

```
LIST PAYROLL ( 10 );
PAYROLL.NAME.LAST(10)='Johnson             '
PAYROLL.NAME.FIRST(10)='Eric                '
PAYROLL.HOURS.REGULAR(10)='40'
PAYROLL.HOURS.OVERTIME(10)='0'
```

To display the first and last name of the 31st element in the array, enter the following command:

```
LIST PAYROLL.NAME(31);
```

Debug Tool displays the following results:

```
LIST PAYROLL.NAME ( 31 );
PAYROLL.NAME.LAST(31)='Rivers              '
PAYROLL.NAME.FIRST(31)='Doug                '
```

To display all the elements of the array by the order of each element in the structure, enter the following command:

```
LIST PAYROLL;
```

Debug Tool displays results similar to the following list, with ellipses (...) used to indicate that additional information has been removed from this list to condense the list:

```
LIST PAYROLL;
PAYROLL.NAME.LAST(1)='Smith               '
PAYROLL.NAME.LAST(2)='Ramirez             '
PAYROLL.NAME.LAST(3)='Patel               '
...
PAYROLL.NAME.LAST(100)='Li                  '
PAYROLL.NAME.FIRST(1)='Jason               '
PAYROLL.NAME.FIRST(2)='Ricardo             '
PAYROLL.NAME.FIRST(3)='Aisha               '
...
PAYROLL.NAME.FIRST(100)='Xian                '
PAYROLL.HOURS.REGULAR(1)='40'
PAYROLL.HOURS.REGULAR(2)='40'
PAYROLL.HOURS.REGULAR(3)='40'
...
PAYROLL.HOURS.REGULAR(100)='40'
PAYROLL.HOURS.OVERTIME(1)='0'
PAYROLL.HOURS.OVERTIME(2)='2'
PAYROLL.HOURS.OVERTIME(3)='3'
...
PAYROLL.HOURS.OVERTIME(100)='0'
```

To display all the elements of the array by the order in which the information is stored in memory, enter the following commands:

```
SET LIST BY SUBSCRIPT ON;
LIST PAYROLL;
```

Debug Tool displays results similar to the following list, with ellipses (...) used to indicate that additional information has been removed from this list to condense the list:

```
LIST PAYROLL;
PAYROLL.NAME.LAST(1)='Smith               '
PAYROLL.NAME.FIRST(1)='Jason                '
PAYROLL.HOURS.REGULAR(1)='40'
PAYROLL.HOURS.OVERTIME(1)='0'
PAYROLL.NAME.LAST(2)='Ramirez             '
PAYROLL.NAME.FIRST(2)='Ricardo             '
```

```
PAYROLL.HOURS.REGULAR(2)='40'
PAYROLL.HOURS.OVERTIME(2)='2'
PAYROLL.NAME.LAST(3)='Patel               '
PAYROLL.NAME.FIRST(3)='Aisha               '
PAYROLL.HOURS.REGULAR(3)='40'
PAYROLL.HOURS.OVERTIME(3)='3'
...
PAYROLL.NAME.LAST(100)='Li                  '
PAYROLL.NAME.FIRST(100)='Xian                '
PAYROLL.HOURS.REGULAR(100)='40'
PAYROLL.HOURS.OVERTIME(100)='0'
```

Debug Tool evaluation of PL/I expressions

When the current programming language is PL/I, expression interpretation is similar to that defined in the PL/I language, except for the PL/I language elements not supported in Debug Tool.

The Debug Tool expression is similar to the PL/I expression. If the source of the command is a variable-length record source (such as your terminal) and if the expression extends across more than one line, a continuation character (an SBCS hyphen) must be specified at the end of all but the last line.

Debug Tool cannot evaluate PL/I expressions until you step past the ENTRY location of the PL/I program.

All PL/I constant types are supported, plus the Debug Tool `PX` constant.

Refer to the following topics for more information related to the material discussed in this topic.

Related references

“Unsupported PL/I language elements” on page 307

Supported PL/I built-in functions

Debug Tool supports the following built-in functions for PL/I for MVS & VM:

ABS	CSTG[2]	LOG1	REAL
ACOS	CURRENTSTORAGE	LOG2	REPEAT
ADDR	DATAFIELD	LOW	SAMEKEY
ALL	DATE	MPSTR	SIN
ALLOCATION	DATETIME	NULL	SIND
ANY	DIM	OFFSET	SINH
ASIN	EMPTY	ONCHAR	SQRT
ATAN	ENTRYADDR	ONCODE	STATUS
ATAND	ERF	ONCOUNT	STORAGE
ATANH	ERFC	ONFILE	STRING
BINARYVALUE	EXP	ONKEY	SUBSTR
BINVALUE[1]	GRAPHIC	ONLOC	SYSNULL
BIT	HBOUND	ONSOURCE	TAN
BOOL	HEX	PLIRETV	TAND
CHAR	HIGH	POINTER	TANH
COMPLETION	IMAG	POINTERADD	TIME
COS	LBOUND	POINTERVALUE	TRANSLATE
COSD	LENGTH	PTRADD[3]	UNSPEC
COSH	LINENO	PTRVALUE[4]	VERIFY
COUNT	LOG		

Notes:

1. Abbreviation for BINARYVALUE
2. Abbreviation for CURRENTSTORAGE
3. Abbreviation for POINTERADD
4. Abbreviation for POINTERVALUE

Debug Tool supports the following built-in functions for Enterprise PL/I:

ACOS
ADDR
ADDRDATA
ALLOCATION[3]
ASIN
ATAN
ATAND
ATANH
BIF_DIM
BINARYVALUE
BINVALUE
COPY[1]
COS
COSD
COSH
COUNT
DATAFIELD
DATE[1]
DATETIME[1]
DIMENSION
ENDFILE
ENTRYADDR[1,2]
ERF
ERFC
EXP
FILEOPEN
GAMMA
HBOUND
HEX
HEXIMAGE
HIGH[1]
IAND
IEOR
IOR
INDEX
INOT
ISRL
ISLL
LBOUND
LENGTH
LINENO
LOG
LOG10
LOG2
LOGGAMMA
LOW[1]
LOWER2
LOWERCASE[1]
MAXLENGTH
NULL
OFFSET
OFFSETADD
OFFSETSUBTRACT
OFFSETDIFF
OFFSETVALUE
ORDINALNAME
ORDINALPRED
ORDINALSUCC
ONCODE
ONCONDCOND
ONCHAR
ONGSOURCE
ONSOURCE
ONCONDID
ONCOUNT
ONFILE
ONKEY
ONLOC
PAGENO
POINTER
PTR
POINTERADD
PTRADD
POINTERSUBTRACT
PTRSUBTRACT
POINTERDIFF
PTRDIFF
POINTERVALUE
PTRVALUE
PLIRETV
RAISE2
REPEAT[1]
SAMEKEY
SEARCH
SEARCHR
SIN
SIND
SINH
SQRT
SUBSTR[1]
SYSNULL
TAN
TAND
TANH
TALLY
TIME[1]
TRANSLATE[1]
UNSPEC[1]
UPPERCASE[1]
VERIFY
VERIFYR

Notes:

1. To use the built-in functions COPY, DATE, DATETIME, ENTRYADDR, HIGH, LOW, LOWERCASE, REPEAT, SUBSTR, TIME, TRANSLATE, UNSPEC, and UPPERCASE, you must apply the Language Environment runtime PTF for APAR PQ94347 if you are running on z/OS Version 1 Release 6.
2. Pseudovariables are not supported for the ENTRYADDR built-in function under Debug Tool.
3. To use the ALLOCATION built-in function, you must apply the Language Environment runtime PTF for APAR PK16316 if you are running on z/OS Version 1 Release 6 or Version 1 Release 7.

Debug Tool does not support the following built-in functions for Enterprise PL/I:

```
ABS
ALL
ANY
BIT
BOOL
CHAR
COMPLETION
CSTG(2)
CURRENTSTORAGE
DEFINE STRUCTURE
EMPTY
GRAPHIC
IMAG
MPSTR
REAL
STATUS
STORAGE
STRING
```

Refer to the following topics for more information related to the material discussed in this topic.

Related tasks

"Using SET WARNING PL/I command with built-in functions"

Using SET WARNING PL/I command with built-in functions

Certain checks are performed when the Debug Tool `SET WARNING` command setting is `ON` and a built-in function (BIF) is evaluated:

- Division by zero
- The remainder (%) operator for a zero value in the second operand
- Array subscript out of bounds for defined arrays
- Bit shifting by a number that is negative or greater than 32
- On a built-in function call for an incorrect number of parameters or for parameter type mismatches
- On a built-in function call for differing linkage calling conventions

These checks are restrictions that can be removed by issuing `SET WARNING OFF`.

Unsupported PL/I language elements

The following list summarizes PL/I functions not available:

- Use of `iSUB`
- Interactive declaration or use of user-defined functions
- All preprocessor directives
- Multiple assignments
- `BY NAME` assignments
- `LIKE` attribute
- `FILE`, `PICTURE`, and `ENTRY` data attributes
- All I/O statements, including `DISPLAY`
- `INIT` attribute
- Structures with the built-in functions `CSTG`, `CURRENTSTORAGE`, and `STORAGE`
- The repetition factor is not supported for string constants
- `GRAPHIC` string constants are not supported for expressions involving other data types
- Declarations cannot be made as sub-commands (for example in a `BEGIN`, `DO`, or `SELECT` command group)

Debugging OS PL/I programs

There are restrictions on how you can debug OS PL/I programs, which are described in *Using CODE/370 with VS COBOL II and OS PL/I*, SC09-1862-01.

The OS PL/I compiler does not place the name of the listing data set in the object (load module). Debug Tool tries to find the listing data set in the following location: `userid.CUName.LIST`. If the listing is in a PDS, direct Debug Tool to the location of the PDS in one of the following ways:

- In full-screen mode, enter the following command:

  ```
  SET DEFAULT LISTINGS my.listing.pds
  ```

- Use the EQADEBUG DD statement to define the location of the data set.
- Code the EQAUEDAT user exit with the location of the data set.

Restrictions while debugging Enterprise PL/I programs

While debugging Enterprise PL/I programs, you cannot use the following commands:

- `ANALYZE`
- `AT ALLOCATE` (of a controlled variable)
- `AT OCCURRENCE` (for file conditions: ENDFILE, ENDPAGE, KEY, NAME, RECORD, TRANSMIT, UNDEFINEDFILE)
- `AT OCCURRENCE CONDITION` conditions (name)
- `GOTO LABEL`

While debugging Enterprise PL/I programs, the following restrictions apply:

- If you are running any version of VisualAge PL/I or Enterprise PL/I Version 3 Release 1 through Version 3 Release 3 programs, you cannot use the `AT LABEL` command.
- If you are running Enterprise PL/I for z/OS, Version 3.4, or later, programs and you comply with the following requirements, you can use the `AT LABEL` command to set breakpoints (except at a label variable):
  - If you are running z/OS Version 1 Release 6, apply the Language Environment PTF for APAR PQ99039.
  - If you are compiling with Enterprise PL/I Version 3 Release 4, apply PTFs for APARs PK00118 and PK00339.
- For expressions, you cannot do either of the following:
  - preface variables with the block, CU, and load module qualification
  - Reference or list at the block entry
- You cannot use some of built-in functions. See “Supported PL/I built-in functions” on page 305 for more information.
- You cannot use the `DECLARE` command to declare arrays, structures, or multiple variables in one line
- The `SET WARNING ON` command has no effect.
- To use the `DESCRIBE ENVIRONMENT` command, you must apply the Language Environment runtime PTF for APAR PQ95664 if you are running z/OS Version 1 Release 6.
- To use the `DESCRIBE ATTRIBUTES` command, you must apply the Language Environment runtime PTF for APAR PK30522 if you are running on z/OS Version 1 Release 6 through Version 1 Release 8.
- Debug Tool does not support debugging of PL/I typed structures. Declaring a variable as TYPE *X*, where *X* comes from a DEFINE STRUCTURE, makes it a typed structure.

Chapter 32. Debugging C and C++ programs

The topics below describe how to use Debug Tool to debug your C and C++ programs.

"Example: referencing variables and setting breakpoints in C and C++ blocks" on page 323

Refer to the following topics for more information related to the material discussed in this topic.

Related concepts

"C and C++ expressions" on page 313
"Debug Tool evaluation of C and C++ expressions" on page 317
"Scope of objects in C and C++" on page 320
"Blocks and block identifiers for C" on page 322
"Blocks and block identifiers for C++" on page 322
"Monitoring storage in C++" on page 330

Related tasks

Chapter 24, "Debugging a C program in full-screen mode," on page 233
Chapter 25, "Debugging a C++ program in full-screen mode," on page 243
"Using C and C++ variables with Debug Tool" on page 310
"Declaring session variables with C and C++" on page 312
"Calling C and C++ functions from Debug Tool" on page 314
"Intercepting files when debugging C and C++ programs" on page 318
"Displaying environmental information for C and C++ programs" on page 324
"Stepping through C++ programs" on page 327
"Setting breakpoints in C++" on page 328
"Examining C++ objects" on page 329
"Qualifying variables in C and C++" on page 325

Related references

"Debug Tool commands that resemble C and C++ commands"
"%PATHCODE values for C and C++" on page 312
"C reserved keywords" on page 315
"C operators and operands" on page 316
"Language Environment conditions and their C and C++ equivalents" on page 316

Debug Tool commands that resemble C and C++ commands

Debug Tool's command language is a subset of C and C++ commands and has the same syntactical requirements. Debug Tool allows you to work in a language you are familiar with so learning a new set of commands is not necessary.

The table below shows the interpretive subset of C and C++ commands recognized by Debug Tool.

Command	Description
block ({})	Composite command grouping
break	Termination of loops or `switch` commands
declarations	Declaration of session variables
do/while	Iterative looping
expression	Any C expression except the conditional (?) operator

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Command	Description
for	Iterative looping
if	Conditional execution
switch	Conditional execution

This subset of commands is valid only when the current programming language is C or C++.

In addition to the subset of C and C++ commands that you can use is a list of reserved keywords used and recognized by C and C++ that you cannot abbreviate, use as variable names, or use as any other type of identifier.

Refer to the following topics for more information related to the material discussed in this topic.

Related references

"C reserved keywords" on page 315

z/OS XL C/C++ Language Reference

Using C and C++ variables with Debug Tool

Debug Tool can process all program variables that are valid in C or C++. You can assign and display the values of variables during your session. You can also declare session variables with the recognized C declarations to suit your testing needs.

Refer to the following topics for more information related to the material discussed in this topic.

Related tasks

"Accessing C and C++ program variables"

"Displaying values of C and C++ variables or expressions"

"Assigning values to C and C++ variables" on page 311

Accessing C and C++ program variables

Debug Tool obtains information about a program variable by name using the symbol table built by the compiler. If you specify `TEST(SYM)` at compile time, the compiler builds a symbol table that allows you to reference any variable in the program.

Note: There are no suboptions for C++. Symbol information is generated by default when the `TEST` compiler option is specified.

Refer to the following topics for more information related to the material discussed in this topic.

Related tasks

"Choosing TEST or DEBUG compiler suboptions for C programs" on page 37

"Choosing TEST or DEBUG compiler suboptions for C++ programs" on page 42

Displaying values of C and C++ variables or expressions

To display the values of variables or expressions, use the `LIST` command. The `LIST` command causes Debug Tool to log and display the current values (and names, if requested) of variables, including the evaluated results of expressions.

Suppose you want to display the program variables `X`, `row[X]`, and `col[X]`, and their values at line 25. If you issue the following command:

```
AT 25 LIST ( X, row[X], col[X] ); GO;
```

Debug Tool sets a breakpoint at line 25 (AT), begins execution of the program (GO), stops at line 25, and displays the variable names and their values.

If you want to see the result of their addition, enter:

```
AT 25 LIST ( X + row[X] + col[X] ); GO;
```

Debug Tool sets a breakpoint at line 25 (AT), begins execution of the program (GO), stops at line 25, and displays the result of the expression.

Put commas between the variables when listing more than one. If you do not want to display the variable names when issuing the LIST command, enter LIST UNTITLED.

You can also list variables with the printf function call as follows:

```
printf ("X=%d, row=%d, col=%d\n", X, row[X], col[X]);
```

The output from printf, however, does not appear in the Log window and is not recorded in the log file unless you SET INTERCEPT ON FILE stdout.

Assigning values to C and C++ variables

To assign a value to a C and C++ variable, you use an assignment expression. Assignment expressions assign a value to the left operand. The left operand must be a modifiable lvalue. An lvalue is an expression representing a data object that can be examined and altered.

C contains two types of assignment operators: simple and compound. A simple assignment operator gives the value of the right operand to the left operand.

Note: Only the assignment operators that work for C will work for C++, that is, there is no support for overloaded operators.

The following example demonstrates how to assign the value of number to the member employee of the structure payroll:

```
payroll.employee = number;
```

Compound assignment operators perform an operation on both operands and give the result of that operation to the left operand. For example, this expression gives the value of index plus 2 to the variable index:

```
index += 2
```

Debug Tool supports all C operators except the tenary operator, as well as any other full C language assignments and function calls to user or C library functions.

Refer to the following topics for more information related to the material discussed in this topic.

Related tasks

“Calling C and C++ functions from Debug Tool” on page 314

%PATHCODE values for C and C++

The table below shows the possible values for the Debug Tool variable %PATHCODE when the current programming language is C and C++.

–1	Debug Tool is not in control as the result of a path or attention situation.
0	Attention function (*not* ATTENTION condition).
1	A block has been entered.
2	A block is about to be exited.
3	Control has reached a user label.
4	Control is being transferred as a result of a function reference. The invoked routine's parameters, if any, have been prepared.
5	Control is returning from a function reference. Any return code contained in register 15 has not yet been stored.
6	Some logic contained by a conditional do/while, for, or while statement is about to be executed. This can be a single or Null statement and not a block statement.
7	The logic following an if(...) is about to be executed.
8	The logic following an else is about to be executed.
9	The logic following a case within an switch is about to be executed.
10	The logic following a default within a switch is about to be executed.
13	The logic following the end of a switch, do, while, if(...), or for is about to be executed.
17	A goto, break, continue, or return is about to be executed.

Values in the range 3–17 can only be assigned to %PATHCODE if your program was compiled with an option supporting path hooks.

Declaring session variables with C and C++

You might want to declare session variables for use during the course of your session. You cannot initialize session variables in declarations. However, you can use an assignment statement or function call to initialize a session variable.

As in C, keywords can be specified in any order. Variable names up to 255 characters in length can be used. Identifiers are case-sensitive, but if you want to use the session variable when the current programming language changes from C to another HLL, the variable must have an uppercase name and compatible attributes.

To declare a hexadecimal floating-point variable called maximum, enter the following C declaration:

```
double maximum;
```

You can only declare scalars, arrays of scalars, structures, and unions in Debug Tool (pointers for the above are allowed as well).

If you declare a session variable with the same name as a programming variable, the session variable hides the programming variable. To reference the programming variable, you must qualify it. For example:

```
main:>x for the program variable x
x for the session variable x
```

Session variables remain in effect for the entire debug session, unless they are cleared using the CLEAR command.

Refer to the following topics for more information related to the material discussed in this topic.

Related tasks

"Using session variables across different programming languages" on page 392
"Qualifying variables and changing the point of view in C and C++" on page 325

C and C++ expressions

Debug Tool allows evaluation of expressions in your test program. All expressions available in C and C++ are also available within Debug Tool except for the conditional expression (? :). That is, all operators such as +, −, %:, and += are fully supported with the exception of the conditional operator.

C and C++ language expressions are arranged in the following groups based on the operators they contain and how you use them:

- Primary expression
- Unary expression
- Binary expression
- Conditional expression
- Assignment expression
- Comma expression
- lvalue
- Constant

An lvalue is an expression representing a data object that can be examined and altered. For a more detailed description of expressions and operators, see the C and C++ Program Guides.

The semantics for C and C++ operators are the same as in a compiled C or C++ program. Operands can be a mixture of constants (integer, floating-point, character, string, and enumeration), C and C++ variables, Debug Tool variables, or session variables declared during a Debug Tool session. Language constants are specified as described in the C and C++ Language Reference publications.

The Debug Tool command DESCRIBE ATTRIBUTES can be used to display the resultant type of an expression, without actually evaluating the expression.

The C and C++ language does not specify the order of evaluation for function call arguments. Consequently, it is possible for an expression to have a different execution sequence in compiled code than within Debug Tool. For example, if you enter the following in an interactive session:

```
int x;
int y;

x = y = 1;

printf ("%d %d %d%" x, y, x=y=0);
```

the results can differ from results produced by the same statements located in a C or C++ program segment. Any expression containing behavior undefined by ANSI standards can produce different results when evaluated by Debug Tool than when evaluated by the compiler.

The following examples show you various ways Debug Tool supports the use of expressions in your programs:

- Debug Tool assigns 12 to `a` (the result of the `printf()`) function call, as in:

```
a = (1,2/3,a++,b++,printf("hello world\n"));
```

- Debug Tool supports structure and array referencing and pointer dereferencing, as in:

```
league[num].team[1].player[1]++;
league[num].team[1].total += 1;
++(*pleague);
```

- Simple and compound assignment is supported, as in:

```
v.x = 3;
a = b = c = d = 0;
*(pointer++) -= 1;
```

- C and C++ language constants in expressions can be used, as in:

```
*pointer_to_long = 3521L = 0x69a1;
float_val = 3e-11 + 6.6E-10;
char_val = '7';
```

- The comma expression can be used, as in:

```
intensity <<= 1, shade * increment, rotate(direction);
alpha = (y>>3, omega % 4);
```

- Debug Tool performs all implicit and explicit C conversions when necessary. Conversion to long double is performed in:

```
long_double_val = unsigned_short_val;
long_double_val = (long double) 3;
```

Refer to the following topics for more information related to the material discussed in this topic.

Related references

"Debug Tool evaluation of C and C++ expressions" on page 317

z/OS XL C/C++ Language Reference

Calling C and C++ functions from Debug Tool

You can perform calls to user and C library functions within Debug Tool, unless your program was compiled with the FORMAT(DWARF) suboption of the DEBUG compiler option.

You can make calls to C library functions at any time. In addition, you can use the C library variables `stdin`, `stdout`, `stderr`, `__amrc`, and `errno` in expressions including function calls.

The library function `ctdli` cannot be called unless it is referenced in a compile unit in the program, either `main` or a function linked to `main`.

Calls to user functions can be made, provided Debug Tool is able to locate an appropriate definition for the function within the symbol information in the user program. These definitions are created when the program is compiled with `TEST(SYM)` for C or `TEST` for C++.

Debug Tool performs parameter conversions and parameter-mismatch checking where possible. Parameter checking is performed if:

- The function is a library function
- A prototype for the function exists in the current compile unit

- Debug Tool is able to locate a prototype for the function in another compile unit, or the function itself was compiled with `TEST(SYM)` for C or with `TEST` for C++.

You can turn off this checking by specifying `SET WARNING OFF`.

Calls can be made to any user functions that have linkage supported by the C or C++ compiler. However, for C++ calls made to any user function, the function must be declared as:

```
extern "C"
```

For example, use this declaration if you want to debug an application signal handler. When a condition occurs, control passes to Debug Tool which then passes control to the signal handler.

Debug Tool attempts linkage checking, and does not perform the function call if it determines there is a linkage mismatch. A linkage mismatch occurs when the target program has one linkage but the source program believes it has a different linkage.

It is important to note the following regarding function calls:

- The evaluation order of function arguments can vary between the C and C++ program and Debug Tool. No discernible difference exists if the evaluation of arguments does not have side effects.
- Debug Tool knows about the function return value, and all the necessary conversions are performed when the return value is used in an expression.
- The functions cannot be in XPLINK applications.
- The functions must have debug information available.

Refer to the following topics for more information related to the material discussed in this topic.

Related tasks

“Choosing TEST or DEBUG compiler suboptions for C programs” on page 37
“Choosing TEST or DEBUG compiler suboptions for C++ programs” on page 42

Related references

z/OS XL C/C++ Language Reference

C reserved keywords

The table below lists all keywords reserved by the C language. When the current programming language is C or C++, these keywords cannot be abbreviated, used as variable names, or used as any other type of identifiers.

`auto`	`else`	`long`	`switch`
`break`	`enum`	`register`	`typedef`
`case`	`extern`	`return`	`union`
`char`	`float`	`short`	`unsigned`
`const`	`for`	`signed`	`void`
`continue`	`goto`	`sizeof`	`volatile`
`default`	`if`	`static`	`while`
`do`	`int`	`struct`	`_Packed`
`double`			

C operators and operands

The table below lists the C language operators in order of precedence and shows the direction of associativity for each operator. The primary operators have the highest precedence. The comma operator has the lowest precedence. Operators in the same group have the same precedence.

Precedence level	Associativity	Operators
Primary	left to right	`() [ ] . –>`
Unary	right to left	`++ -- - + ! ~ & * (typename) sizeof`
Multiplicative	left to right	`* / %`
Additive	left to right	`+ –`
Bitwise shift	left to right	`<< >>`
Relational	left to right	`< > <= >=`
Equality	left to right	`++ !=`
Bitwise logical AND	left to right	`&`
Bitwise exclusive OR	left to right	`^` or `¬`
Bitwise inclusive OR	left to right	`|`
Logical AND	left to right	`&&`
Logical OR	left to right	`||`
Assignment	right to left	`= += –= *= /= <<= >>= %= &= ^= |=`
Comma	left to right	`,`

Language Environment conditions and their C and C++ equivalents

Language Environment condition names (the symbolic feedback codes CEE*xxx*) can be used interchangeably with the equivalent C and C++ conditions listed in the following table. For example, `AT OCCURRENCE CEE341` is equivalent to `AT OCCURRENCE SIGILL`. Raising a `CEE341` condition triggers an `AT OCCURRENCE SIGILL` breakpoint and vice versa.

Language Environment condition	Description	Equivalent C/C++ condition
`CEE341`	Operation exception	`SIGILL`
`CEE342`	Privileged operation exception	`SIGILL`
`CEE343`	Execute exception	`SIGILL`
`CEE344`	Protection exception	`SIGSEGV`
`CEE345`	Addressing exception	`SIGSEGV`
`CEE346`	Specification exception	`SIGILL`
`CEE347`	Data exception	`SIGFPE`
`CEE348`	Fixed point overflow exception	`SIGFPE`
`CEE349`	Fixed point divide exception	`SIGFPE`
`CEE34A`	Decimal overflow exception	`SIGFPE`
`CEE34B`	Decimal divide exception	`SIGFPE`
`CEE34C`	Exponent overflow exception	`SIGFPE`

Language Environment condition	Description	Equivalent C/C++ condition
CEE34D	Exponent underflow exception	SIGFPE
CEE34E	Significance exception	SIGFPE
CEE34F	Floating-point divide exception	SIGFPE

Debug Tool evaluation of C and C++ expressions

Debug Tool interprets most input as a collection of one or more expressions. You can use expressions to alter a program variable or to extend the program by adding expressions at points that are governed by AT breakpoints.

Debug Tool evaluates C and C++ expressions following the rules presented in *z/OS XL C/C++ Language Reference*. The result of an expression is equal to the result that would have been produced if the same expression had been part of your compiled program.

Implicit string concatenation is supported. For example, "abc" "def" is accepted for "abcdef" and treated identically. Concatenation of wide string literals to string literals is not accepted. For example, L"abc"L"def" is valid and equivalent to L"abcdef", but "abc" L"def" is not valid.

Expressions you use during your session are evaluated with the same sensitivity to enablement as are compiled expressions. Conditions that are enabled are the same ones that exist for program statements.

During a Debug Tool session, if the current setting for WARNING is ON, the occurrence in your C or C++ program of any one of the conditions listed below causes the display of a diagnostic message.

- Division by zero
- Remainder (%) operator for a zero value in the second operand
- Array subscript out of bounds for a defined array
- Bit shifting by a number that is either negative or greater than 32
- Incorrect number of parameters, or parameter type mismatches for a function call
- Differing linkage calling conventions for a function call
- Assignment of an integer value to a variable of enumeration data type where the integer value does not correspond to an integer value of one of the enumeration constants of the enumeration data type
- Assignment to an lvalue that has the const attribute
- Attempt to take the address of an object with register storage class
- A signed integer constant not in the range –2**31 to 2**31
- A real constant not having an exponent of 3 or fewer digits
- A float constant not larger than 5.39796053469340278908664699142502496E-79 or smaller than 7.23700557733226221397318656304299 29E+75
- A hex escape sequence that does not contain at least one hexadecimal digit
- An octal escape sequence with an integer value of 256 or greater
- An unsigned integer constant greater than the maximum value of 4294967295.

Refer to the following topics for more information related to the material discussed in this topic.

Related references
"C and C++ expressions" on page 313
z/OS XL C/C++ Language Reference

Intercepting files when debugging C and C++ programs

Several considerations must be kept in mind when using the `SET INTERCEPT` command to intercept files while you are debugging a C application.

For CICS only: `SET INTERCEPT` is not supported for CICS.

For C++, there is no specific support for intercepting IOStreams. IOStreams is implemented using C I/O which implies that:

- If you intercept I/O for a C standard stream, this implicitly intercepts I/O for the corresponding IOStreams' standard stream.
- If you intercept I/O for a file, by name, and define an IOStream object associated with the same file, IOStream I/O to that file will be intercepted.

Note: Although you can intercept IOStreams indirectly via C/370 I/O, the behaviors might be different or undefined in C++.

You can use the following names with the `SET INTERCEPT` command during a debug session:

- `stdout`, `stderr`, and `stdin` (lowercase only)
- any valid `fopen()` file specifier.

The behavior of I/O interception across `system()` call boundaries is global. This implies that the setting of `INTERCEPT ON for xx` in Program A is also in effect for Program B (when Program A `system()` calls to Program B). Correspondingly, setting INTERCEPT OFF for `xx` in Program B turns off interception in Program A when Program B returns to A. This is also true if a file is intercepted in Program B and returns to Program A. This model applies to disk files, memory files, and standard streams.

When a stream is intercepted, it inherits the text/binary attribute specified on the `fopen` statement. The output to and input from the Debug Tool log file behaves like terminal I/O, with the following considerations:

- Intercepted input behaves as though the terminal was opened for record I/O. Intercepted input is truncated if the data is longer than the record size and the truncated data is not available to subsequent reads.
- Intercepted output is not truncated. Data is split across multiple lines.
- Some situations causing an error with the real file might not cause an error when the file is intercepted (for example, truncation errors do not occur). Files expecting specific error conditions do not make good candidates for interception.
- Only sequential I/O can be performed on an intercepted stream, but file positioning functions are tolerated and the real file position is not changed. `fseek`, `rewind`, `ftell`, `fgetpos`, and `fsetpos` do not cause an error, but have no effect.
- The logical record length of an intercepted stream reflects the logical record length of the real file.
- When an unintercepted memory file is opened, the record format is always fixed and the open mode is always binary. These attributes are reflected in the intercepted stream.

- Files opened to the terminal for write are flushed before an input operation occurs from the terminal. This is not supported for intercepted files.

Other characteristics of intercepted files are:

- When an `fclose()` occurs or `INTERCEPT` is set `OFF` for a file that was intercepted, the data is flushed to the session log file before the file is closed or the `SET INTERCEPT OFF` command is processed.
- When an `fopen()` occurs for an intercepted file, an open occurs on the real file before the interception takes effect. If the `fopen()` fails, no interception occurs for that file and any assumptions about the real file, such as the ddname allocation and data set defaults, take effect.
- The behavior of the `ASIS` suboption on the `fopen()` statement is not supported for intercepted files.
- When the `clrmemf()` function is invoked and memory files have been intercepted, the buffers are flushed to the session log file before the files are removed.
- If the `fldata()` function is invoked for an intercepted file, the characteristics of the real file are returned.
- If `stderr` is intercepted, the interception overrides the Language Environment message file (the default destination for `stderr`). A subsequent `SET INTERCEPT OFF` command returns `stderr` to its `MSGFILE` destination.
- If a file is opened with a ddname, interception occurs only if the ddname is specified on the `INTERCEPT` command. Intercepting the underlying file name does not cause interception of the stream.
- User prefix qualifications are included in MVS data set names entered in the `INTERCEPT` command, using the same rules as defined for the `fopen()` function.
- If library functions are invoked when Debug Tool is waiting for input for an intercepted file (for example, if you interactively enter `fwrite(..)` when Debug Tool is waiting for input), subsequent behavior is undefined.
- I/O intercepts remain in effect for the entire debug session, unless you terminate them by selecting `SET INTERCEPT OFF`.

Command line redirection of the standard streams is supported under Debug Tool, as shown below.

1>&2 If `stderr` is the target of the interception command, `stdout` is also intercepted. If `stdout` is the target of the `INTERCEPT` command, `stderr` is not intercepted. When `INTERCEPT` is set `OFF` for `stdout`, the stream is redirected to `stderr`.

2>&1 If `stdout` is the target of the `INTERCEPT` command, `stderr` is also intercepted. If `stderr` is the target of the `INTERCEPT` command, `stdout` is not intercepted. When `INTERCEPT` is set `OFF` for `stderr`, the stream is redirected to `stdout` again.

1>file.name
`stdout` is redirected to **file.name**. For interception of `stdout` to occur, `stdout` or **file.name** can be specified on the interception request. This also applies to **1>>file.name**

2>file.name
`stderr` is redirected to `file.name`. For interception of `stderr` to occur, `stderr` or **file.name** can be specified on the interception request. This also applies to **2>>file.name**

2>&1 1>file.name
`stderr` is redirected to `stdout`, and both are redirected to **file.name**. If

`file.name` is specified on the interception command, both `stderr` and `stdout` are intercepted. If you specify `stderr` or `stdout` on the `INTERCEPT` command, the behavior follows rule 1b above.

1>&2 2>file.name
`stdout` is redirected to `stderr`, and both are redirected to **file.name**. If you specify **file.name** on the `INTERCEPT` command, both `stderr` and `stdout` are intercepted. If you specify `stdout` or `stderr` on the `INTERCEPT` command, the behavior follows rule 1a above.

The same standard stream cannot be redirected twice on the command line. Interception is undefined if this is violated, as shown below.

2>&1 2>file.name
Behavior of `stderr` is undefined.

1>&2 1>file.name
Behavior of `stdout` is undefined.

Refer to the following topics for more information related to the material discussed in this topic.

Related references
z/OS XL C/C++ Programming Guide

Scope of objects in C and C++

An object is *visible* in a block or source file if its data type and declared name are known within the block or source file. The region where an object is visible is referred to as its scope. In Debug Tool, an object can be a variable or function and is also used to refer to line numbers.

Note: The use of an object here is not to be confused with a C++ object. Any reference to C++ will be qualified as such.

In ANSI C, the four kinds of scope are:
Block
File
Function
Function prototype

For C++, in addition to the scopes defined for C, it also has the class scope.

An object has block scope if its declaration is located inside a block. An object with block scope is visible from the point where it is declared to the closing brace (}) that terminates the block.

An object has file scope if its definition appears outside of any block. Such an object is visible from the point where it is declared to the end of the source file. In Debug Tool, if you are qualified to the compilation unit with the file static variables, file static and global variables are always visible.

The only type of object with function scope is a label name.

An object has function prototype scope if its declaration appears within the list of parameters in a function prototype.

A class member has class scope if its declaration is located inside a class.

You cannot reference objects that are visible at function prototype scope, but you can reference ones that are visible at file or block scope if:

- For C variables and functions, the source file was compiled with `TEST(SYM)` and the object was referenced somewhere within the source.
- For C variables declared in a block that is nested in another block, the source file was compiled with `TEST(SYM, BLOCK)`.
- For line numbers, the source file was compiled with `TEST(LINE) GONUMBER`.
- For labels, the source file was compiled with `TEST(SYM, PATH)`. In some cases (for example, when using `GOTO`), labels can be referenced if the source file was compiled with `TEST(SYM, NOPATH)`.

Debug Tool follows the same scoping rules as ANSI, except that it handles objects at file scope differently. An object at file scope can be referenced from within Debug Tool at any point in the source file, not just from the point in the source file where it is declared. Debug Tool session variables always have a higher scope than program variables, and consequently have higher precedence than a program variable with the same name. The program variable can always be accessed through qualification.

In addition, Debug Tool supports the referencing of variables in multiple load modules. Multiple load modules are managed through the C library functions `dllload()`, `dllfree()`, `fetch()`, and `release()`.

"Example: referencing variables and setting breakpoints in C and C++ blocks" on page 323

Related concepts

"Storage classes in C and C++"

Storage classes in C and C++

Debug Tool supports the change and reference of all objects declared with the following storage classes:

```
auto
register
static
extern
```

Session variables declared during the Debug Tool session are also available for reference and change.

An object with `auto` storage class is available for reference or change in Debug Tool, provided the block where it is defined is active. Once a block finishes executing, the `auto` variables within this block are no longer available for change, but can still be examined using `DESCRIBE ATTRIBUTES`.

An object with `register` storage class might be available for reference or change in Debug Tool, provided the variable has not been optimized to a register.

An object with `static` storage class is always available for change or reference in Debug Tool. If it is not located in the currently qualified compile unit, you must specifically qualify it.

An object with `extern` storage class is always available for change or reference in Debug Tool. It might also be possible to reference such a variable in a program

even if it is not defined or referenced from within this source file. This is possible provided Debug Tool can locate another compile unit (compiled with TEST(SYM)) with the appropriate definition.

Blocks and block identifiers for C

It is often necessary to set breakpoints on entry into or exit from a given block or to reference variables that are not immediately visible from the current block. Debug Tool can do this, provided that all blocks are named. It uses the following naming convention:

- The outermost block of a function has the same name as the function.
- For C programs compiled with the ISD compiler option, blocks enclosed in this outermost block are sequentially named: %BLOCK2, %BLOCK3, %BLOCK4, and so on in order of their appearance in the function.
- For C programs compiled with the DWARF compiler option, blocks are named in a non-sequential manner. To determine the names of the blocks, enter the DESCRIBE CU; command.

When these block names are used in the Debug Tool commands, you might need to distinguish between nested blocks in different functions within the same source file. This can be done by naming the blocks in one of two ways:

Short form

function_name:>%BLOCK*zzz*

Long form

function_name:>%BLOCK*xxx* :>%BLOCK*yyy*: ... :>%BLOCK*zzz*

%BLOCK*zzz* is contained in %BLOCK*yyy*, which is contained in %BLOCK*xxx*. The short form is always allowed; it is never necessary to specify the long form.

The currently active block name can be retrieved from the Debug Tool variable %BLOCK. You can display the names of blocks by entering:

```
DESCRIBE CU;
```

Blocks and block identifiers for C++

Block Identifiers tend to be longer for C++ than C because C++ functions can be overloaded. In order to distinguish one function name from the other, each block identifier is like a prototype. For example, a function named shapes(int,int) in C would have a block named shapes; however, in C++ the block would be called shapes(int,int).

You must always refer to a C++ block identifier in its entirety, even if the function is not overloaded. That is, you cannot refer to shapes(int,int) as shapes only.

Note: The block name for main() is always main (without the qualifying parameters after it) even when compiled with C++ because main() has extern **C** linkage.

Since block names can be quite long, it is not unusual to see the name truncated in the LOCATION field on the first line of the screen. If you want to find out where you are, enter:

```
QUERY LOCATION
```

and the name will be shown in its entirety (wrapped) in the session log.

Block identifiers are restricted to a length of 255 characters. Any name longer than 255 characters is truncated.

Example: referencing variables and setting breakpoints in C and C++ blocks

The program below is used as the basis for several examples, described after the program listing.

```
#pragma runopts(EXECOPS)
#include <stdlib.h>

main()
{
      >>> Debug Tool is given <<<
      >>> control here.    <<<
  init();
  sort();
}

short length = 40;
static long *table;

init()
{
  table = malloc(sizeof(long)*length);
   .
   .
}

sort ()
{                                       /* Block sort */
  int i;
  for (i = 0; i < length-1; i++) {      /* If compiled with ISD, Block %BLOCK2; */
                                        /* if compiled with DWARF, Block %BLOCK8 */
    int j;
    for (j = i+1; j < length; j++) {    /* If compiled with ISD, Block %BLOCK3; */
                                        /* if compiled with DWARF, Block %BLOCK13 */
      static int temp;
      temp = table[i];
      table[i] = table[j];
      table[j] = temp;
    }
  }
}
```

Scope and visibility of objects in C and C++ programs

Let's assume the program shown above is compiled with `TEST(SYM)`. When Debug Tool gains control, the file scope variables `length` and `table` are available for change, as in:

```
length = 60;
```

The block scope variables `i`, `j`, and `temp` are not visible in this scope and cannot be directly referenced from within Debug Tool at this time. You can list the line numbers in the current scope by entering:

```
LIST LINE NUMBERS;
```

Now let's assume the program is compiled with `TEST(SYM, NOBLOCK)`. Since the program is explicitly compiled using `NOBLOCK`, Debug Tool will never know about the variables `j` and `temp` because they are defined in a block that is nested in another block. Debug Tool does know about the variable `i` since it is not in a scope that is nested.

Blocks and block identifiers in C and C++ programs

In the program above, the function sort has the following three blocks:

If program is compiled with the ISD compiler option	If program is compiled with the DWARF compiler option
sort	sort
%BLOCK2	%BLOCK8
%BLOCK3	%BLOCK13

The following examples set a breakpoint on entry to the second block of sort:

- If program is compiled with the ISD compiler option: at entry sort:>%BLOCK2;.
- If program is compiled with the DWARF compiler option: at entry sort:>%BLOCK8;.

The following example sets a breakpoint on exit of the first block of main and lists the entries of the sorted table.

```
at exit main {
  for (i = 0; i < length; i++)
    printf("table entry %d is %d\n", i, table[i]);
}
```

The following examples list the variable temp in the third block of sort. This is possible because temp has the static storage class.

- If program is compiled with the ISD compiler option: LIST sort:>%BLOCK3:temp;.
- If program is compiled with the DWARF compiler option: LIST sort:>%BLOCK13:temp;.

Displaying environmental information for C and C++ programs

You can also use the DESCRIBE command to display a list of attributes applicable to the current run-time environment. The type of information displayed varies from language to language.

Issuing DESCRIBE ENVIRONMENT displays a list of open files and conditions being monitored by the run-time environment. For example, if you enter DESCRIBE ENVIRONMENT while debugging a C or C++ program, you might get the following output:

```
Currently open files
    stdout
    sysprint
The following conditions are enabled:
    SIGFPE
    SIGILL
    SIGSEGV
    SIGTERM
    SIGINT
    SIGABRT
    SIGUSR1
    SIGUSR2
    SIGABND
```

Qualifying variables and changing the point of view in C and C++

Qualification is a method of:
- Specifying an object through the use of qualifiers
- Changing the point of view

Qualification is often necessary due to name conflicts, or when a program consists of multiple load modules, compile units, and/or functions.

When program execution is suspended and Debug Tool receives control, the default, or *implicit* qualification is the active block at the point of program suspension. All objects visible to the C or C++ program in this block are also visible to Debug Tool. Such objects can be specified in commands without the use of qualifiers. All others must be specified using *explicit qualification*.

Qualifiers depend, of course, upon the naming convention of the system where you are working.

"Example: using qualification in C" on page 326

Related tasks

"Qualifying variables in C and C++"

"Changing the point of view in C and C++" on page 326

Qualifying variables in C and C++

You can precisely specify an object, provided you know the following:
- Load module or DLL name
- Source file (compilation unit) name
- Block name (must include function prototype for C++ block qualification).

These are known as qualifiers and some, or all, might be required when referencing an object in a command. Qualifiers are separated by a combination of greater than signs (>) and colons and precede the object they qualify. For example, the following is a fully qualified object:

```
load_name::>cu_name:>block_name:>object
```

If required, *load_name* is the name of the load module. It is required only when the program consists of multiple load modules and when you want to change the qualification to other than the current load module. *load_name* is enclosed in quotation marks ("). If it is not, it must be a valid identifier in the C or C++ programming language. *load_name* can also be the Debug Tool variable `%LOAD`.

If required, *CU_NAME* is the name of the compilation unit or source file. The *cu_name* must be the fully qualified source file name or an absolute pathname. It is required only when you want to change the qualification to other than the currently qualified compilation unit. It can be the Debug Tool variable `%CU`. If there appears to be an ambiguity between the compilation unit name, and (for example), a block name, you must enclose the compilation unit name in quotation marks (").

If required, *block_name* is the name of the block. *block_name* can be the Debug Tool variable `%BLOCK`.

"Example: using qualification in C" on page 326

Refer to the following topics for more information related to the material discussed in this topic.

Related concepts
"Blocks and block identifiers for C" on page 322

Changing the point of view in C and C++

To change the point of view from the command line or a commands file, use qualifiers with the SET QUALIFY command. This can be necessary to get to data that is inaccessible from the current point of view, or can simplify debugging when a number of objects are being referenced.

It is possible to change the point of view to another load module or DLL, to another compilation unit, to a nested block, or to a block that is not nested. The SET keyword is optional.

"Example: using qualification in C"

Example: using qualification in C

The examples below use the following program.

```
LOAD MODULE NAME:  MAINMOD
SOURCE FILE  NAME:  MVSID.SORTMAIN.C

short length = 40;
main ()
{
  long *table;
  void (*pf)();

  table = malloc(sizeof(long)*length);
   .
   .
  pf = fetch("SORTMOD");
  (*pf)(table);
   .
   .
  release(pf);
   .
   .
}

LOAD MODULE NAME:  SORTMOD
SOURCE FILE  NAME:  MVSID.SORTSUB.C

short length = 40;
short sn = 3;
void (long table[])
{
  short i;
  for (i = 0; i < length-1; i++) {
    short j;
    for (j = i+1; j < length; j++) {
      float sn = 3.0;
      short temp;
      temp = table[i];
   .
   .
      >>> Debug Tool is given <<<
      >>> control here.    <<<
   .
   .
      table[i] = table[j];
      table[j] = temp;
    }
  }
}
```

When Debug Tool receives control, variables i, j, temp, table, and length can be specified without qualifiers in a command. If variable sn is referenced, Debug Tool

uses the variable that is a `float`. However, the names of the blocks and compile units differ, maintaining compatibility with the operating system.

Qualifying variables in C

- Change the file scope variable `length` defined in the compilation unit MVSID.SORTSUB.C in the load module SORTMOD:

  ```
  "SORTMOD"::>"MVSID.SORTSUB.C":>length = 20;
  ```

- Assume Debug Tool gained control from `main()`. The following changes the variable `length`:

  ```
  %LOAD::>"MVSID.SORTMAIN.C":>length = 20;
  ```

  Because `length` is in the current load module and compilation unit, it can also be changed by:

  ```
  length = 20;
  ```

- Assume Debug Tool gained control as shown in the example program above. You can break whenever the variable `temp` in load module SORTMOD changes in any of the following ways:

  ```
  AT CHANGE temp;
  AT CHANGE %BLOCK3:>temp;
  AT CHANGE sort:%BLOCK3:>temp;
  AT CHANGE %BLOCK:>temp;
  AT CHANGE %CU:>sort:>%BLOCK3:>temp;
  AT CHANGE "MVSID.SORTSUB.C":>sort:>%BLOCK3:>temp;
  AT CHANGE "SORTMOD"::>"MVSID.SORTSUB.C":>sort:>%BLOCK3:>temp;
  ```

  The %BLOCK and %BLOCK3 variables in this example assume the program was compiled with the ISD compiler option. If the example was compiled with the DWARF compiler option, enter the `DESCRIBE PROGRAM` command to determine the correct %BLOCK variables.

Changing the point of view in C

- Qualify to the second nested block in the function `sort()` in `sort`.

  ```
  SET QUALIFY BLOCK %BLOCK2;
  ```

  You can do this in a number of other ways, including:

  ```
  QUALIFY BLOCK sort:>%BLOCK2;
  ```

  Once the point of view changes, Debug Tool has access to objects accessible from this point of view. You can specify these objects in commands without qualifiers, as in:

  ```
  j = 3;
  temp = 4;
  ```

- Qualify to the function `main` in the load module MAINMOD in the compilation unit MVSID.SORTMAIN.C and list the entries of `table`.

  ```
  QUALIFY BLOCK "MAINMOD"::>"MVSID.SORTMAIN.C":>main;
  LIST table[i];
  ```

Stepping through C++ programs

You can step through methods as objects are constructed and destructed. In addition, you can step through static constructors and destructors. These are methods of objects that are executed before and after `main()` respectively.

If you are debugging a program that calls a function that resides in a header file, the cursor moves to the applicable header file. You can then view the function source as you step through it. Once the function returns, debugging continues at the line following the original function call.

You can step around a header file function by issuing the STEP OVER command. This is useful in stepping over Library functions (for example, string functions defined in string.h) that you cannot debug anyway.

Setting breakpoints in C++

The differences between setting breakpoints in C++ and C are described below.

Setting breakpoints in C++ using AT ENTRY/EXIT

AT ENTRY/EXIT sets a breakpoint in the specified block. You can set a breakpoint on methods, methods within nested classes, templates, and overloaded operators. An example is given for each below.

A block identifier can be quite long, especially with templates, nested classes, or class with many levels of inheritance. In fact, it might not even be obvious at first as to the block name for a particular function. To set a breakpoint for these nontrivial blocks can be quite cumbersome. Therefore, it is recommended that you make use of DESCRIBE CU and retrieve the block identifier from the session log.

When you do a DESCRIBE CU, the methods are always shown qualified by their class. If a method is unique, you can set a breakpoint by using just the method name. Otherwise, you must qualify the method with its class name. The following two examples are equivalent:

```
AT ENTRY method()

AT ENTRY classname::method()
```

The following examples are valid:

`AT ENTRY square(int,int)`	'simple' method square
`AT ENTRY shapes::square(int)`	Method square qualified by its class shapes.
`AT EXIT  outer::inner::func()`	Nested classes. Outer and inner are classes. `func()` is within class inner.
`AT EXIT  Stack<int,5>::Stack()`	Templates.
`AT ENTRY Plus::operator++(int)`	Overloaded operator.
`AT ENTRY ::fail()`	Functions defined at file scope must be referenced by the global scope operator ::

The following examples are invalid:

`AT ENTRY shapes`	Where shapes is a class. Cannot set breakpoint on a class. (There is no block identifier for a class.)
`AT ENTRY shapes::square`	Invalid since method square must be followed by its parameter list.
`AT ENTRY shapes:>square(int)`	Invalid since shapes is a class name, not a block name.

Setting breakpoints in C++ using AT CALL

AT CALL gives Debug Tool control when the application code attempts to call the specified entry point. The entry name must be a fully qualified name. That is, the name shown in DESCRIBE CU must be used. Using the example

```
AT ENTRY shapes::square(int)
```

to set a breakpoint on the method square, you must enter:

```
AT CALL shapes::square(int)
```

even if square is uniquely identified.

Refer to the following topics for more information related to the material discussed in this topic.

Related tasks

"Composing commands from lines in the Log and Source windows" on page 167

Examining C++ objects

When displaying an C++ object, only the local member variables are shown. Access types (public, private, protected) are not distinguished among the variables. The member functions are not displayed. If you want to see their attributes, you can display them individually, but not in the context of a class. When displaying a derived class, the base class within it is shown as type class and will not be expanded.

Refer to the following topics for more information related to the material discussed in this topic.

Related tasks

"Example: displaying attributes of C++ objects"

Example: displaying attributes of C++ objects

The examples below use the following definitions.

```
class shape { ... };

class line : public shape {
  member variables of class line...
}

line edge;
```

Displaying object attributes of C++ objects

To describe the attributes of the object `edge`, enter the following command.

```
DESCRIBE ATTRIBUTES edge;
```

The Log window displays the following output.

```
DESCRIBE ATTRIBUTES edge;
ATTRIBUTES for edge
  Its address is yyyyyyyy and its length is xx
  class line
     class shape
     member variables of class shape....
```

Note that the base class is shown as class shape _shape.

Displaying class attributes in C++

To display the attributes of class `shape`, enter the following command.

```
DESCRIBE ATTRIBUTES class shape;
```

The Log window displays the following output.

```
DESCRIBE ATTRIBUTES class shape ;
 ATTRIBUTES for class shape
   const class shape...
```

Displaying static data in C++

If a class contains static data, the static data will be shown as part of the class when displayed. For example:

```
class A {
  int x;
  static int y;
}

A obj;
```

You can also display the static member by referencing it as `A::y` since each object of class A has the same value.

Displaying global data in C++

To avoid ambiguity, variables declared at file scope can be referenced using the global scope operator ::. For example:

```
int x;
class A {
   int x;
   :
   :
   }
}
```

If you are within a member function of A and want to display the value of x at file scope, enter `LIST ::x`. If you do not use ::, entering `LIST x` will display the value of `x` for the current object (i.e., `this–>x`).

Monitoring storage in C++

You might find it useful to monitor registers (general-purpose and floating-point) while stepping through your code and assembly listing by using the `LIST REGISTERS` command. The compiler listing displays the pseudo assembly code, including Debug Tool hooks. You can watch the hooks that you stop on and watch expected changes in register values step by step in accordance with the pseudo assembly instructions between the hooks. You can also modify the value of machine registers while stepping through your code.

You can list the contents of storage in various ways. Using the `LIST REGISTERS` command, you can receive a list of the contents of the General Purpose Registers or the floating-point registers.

You can also monitor the contents of storage by specifying a dump-format display of storage. To accomplish this, use the `LIST STORAGE` command. You can specify the address of the storage that you want to view, as well as the number of bytes.

Example: monitoring and modifying registers and storage in C

The examples below use the following C program to demonstrate how to monitor and modify registers and storage.

```
int dbl(int j)            /* line 1 */
{                         /* line 2 */
  return 2*j;             /* line 3 */
}                         /* line 4 */
int main(void)
{
```

```
  int i;
  i = 10;
  return dbl(i);
}
```

If you compile the program above using the compiler options TEST(ALL),LIST, then your pseudo assembly listing will be similar to the listing shown below.

```
*  int dbl(int j)
           ST    r1,152(,r13)
*  {
           EX    r0,HOOK..PGM-ENTRY
*    return 2*j;
           EX    r0,HOOK..STMT
           L     r15,152(,r13)
           L     r15,0(,r15)
           SLL   r15,1
           B     @5L2
           DC    A@5L2-ep)
           NOPR
 @5L1      DS    0D
*  }
 @5L2      DS    0D
           EX    r0,HOOK..PGM-EXIT
```

To display a continuously updated view of the registers in the Monitor window, enter the following command:

```
MONITOR LIST REGISTERS
```

After a few steps, Debug Tool halts on line 1 (the program entry hook, shown in the listing above). Another STEP takes you to line 3, and halts on the statement hook. The next STEP takes you to line 4, and halts on the program exit hook. As indicated by the pseudo assembly listing, only register 15 has changed during this STEP, and it contains the return value of the function. In the Monitor window, register 15 now has the value 0x00000014 (decimal 20), as expected.

You can change the value from 20 to 8 just before returning from dbl() by issuing the command:

```
%GPR15 = 8 ;
```

Chapter 33. Debugging an assembler program

To debug programs that have been assembled with debug information, you can use most of the Debug Tool commands. Any exceptions are noted in *Debug Tool Reference and Messages*. Before debugging an assembler program, prepare your program as described in Chapter 6, “Preparing an assembler program,” on page 71.

The SET ASSEMBLER and SET DISASSEMBLY commands

The `SET ASSEMBLER ON` and `SET DISASSEMBLY ON` commands enable some of the same functions. However, you must consider which type of CUs that you will be debugging (assembler, disassembly, or both) before deciding which command to use. The following guidelines can help you decide which command to use:

- If you are debugging assembler CUs but no disassembly CUs, you might want to use the `SET ASSEMBLER ON` command. If you need the following functions, use the `SET ASSEMBLER ON` command:
  - Use the `LIST`, `LIST NAMES CUS`, or `DESCRIBE CUS` commands to see the name of disassembly CUs.
  - Use `AT APPEARANCE` to stop Debug Tool when the disassembly CU is loaded.

  If you don't need any of these functions, you don't need to use either command.
- If you are debugging a disassembly CU, you must use the `SET DISASSEMBLY ON` command so that you can see the disassembly view of the disassembly CUs. The `SET DISASSEMBLY ON` command enables the functions enabled by `SET ASSEMBLER ON` and also enables the following functions that are not available through the `SET ASSEMBLER ON` command:
  - View the disassembled listing in the Source window.
  - Use the `STEP INTO` command to enter the disassembly CU.
  - Use the `AT ENTRY *` command to stop at the entry point of disassembly CUs.

If you are debugging an assembler CU and later decide you want to debug a disassembly CU, you can enter the `SET DISASSEMBLY ON` command after you enter the `SET ASSEMBLER ON` command.

Loading an assembler program's debug information

Use the `LOADDEBUGDATA` (or `LDD`) command to indicate to Debug Tool that a compile unit is an assembler compile unit and to load the debug information associated with that compile unit. The `LDD` command can be issued only for compile units which have no debug information and are, therefore, considered disassembly compile units. In the following example, `mypgm` is the compile unit (CSECT) name of an assembler program:

```
LDD mypgm
```

Debug Tool locates the debug information in a data set with the following name: *yourid*`.EQALANGX(mypgm)`. If Debug Tool finds this data set, you can begin to debug your assembler program. Otherwise, enter the `SET SOURCE` or `SET DEFAULT LISTINGS` command to indicate to Debug Tool where to find the debug information. In remote debug mode, the remote debugger prompts you for the data set information when the program is stepped into.

Normally, compile units without debug information are not listed when you enter the `DESCRIBE CUS` or `LIST NAMES CUS` commands. To include these compile units, enter

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the SET ASSEMBLER ON command. The next time you enter the DESCRIBE CUS or LIST NAMES CUS command, these compile units are listed.

Debug Tool session panel while debugging an assembler program

The Debug Tool session panel below shows the information displayed in the Source window while you debug an assembler program.

```
Assemble LOCATION: PUBS :> 34.1
Command ===>                                                                                                  Scroll ===> CSR
MONITOR --+----1----+----2----+----3----+----4----+----5----+----6----+----7----+----8----+----9----+---10----+--- LINE: 0 OF 0
******************************************************* TOP OF MONITOR ********************************************************
****************************************************** BOTTOM OF MONITOR ********************************************************

SOURCE: PUBS +----1----+----2----+----3----+----4----+----5----+----6----+----7----+----8----+----9----+---10-- LINE: 60 OF 513

   1 34 2      3                 *         7                                                                                  .
      34  00000078                OPENIT   EQU   *                                                                          .
      34  00000078               +         OPEN  ((2),INPUT)                                                                 .
      34           4             +         CNOP     0,4                      ALIGN LIST TO FULLWORD                          .
      34  00000078 4510 B080     +         BAL   1,*+8                       LOAD REG1 W/LIST ADDR. @L2A                     .
      35  0000007C               +         DC    A(0)                        OPT BYTE AND DCB ADDR.                          .
      36  00000080 5021 0000     +         ST    2,0(1,0)                    STORE INTO LIST        @L1C.                    .
      37  00000084 9280 1000     +         MVI   0(1),128                    MOVE IN OPTION BYTE                             .
      38  00000088 0A13          +         SVC   19                          ISSUE OPEN SVC                                  .
      39                      5 6         CALL  CEEMOUT,(STRING,DEST,0),VL  Omitted feedback code                           .
      39                         +         SYSSTATE TEST                                            @L3A                     .
      39                         +         CNOP  0,4                                                                         .
LOG 0----+----1----+----2----+----3----+----4----+----5----+----6----+----7----+----8----+----9----+---10----+---1 LINE: 1 OF 9
******************************************************* TOP OF LOG ************************************************************
IBM Debug Tool Version 11 Release 1 Mod 0
11/06/2010 4:11:41 PM
5655-W45: Copyright IBM Corp. 1992, 2010
0004 EQA1872E An error occurred while opening file: INSPPREF. The file may not exist, or is not accessible.
0005  Source or Listing data is not available, or the CU was not compiled with the correct compile options.
0006  LDD PUBS ;
0007  SET DEFAULT SCROLL CSR ;
0008  AT 34 ;
0009  GO ;
******************************************************* BOTTOM OF LOG *********************************************************
PF  1:?          2:STEP       3:QUIT       4:LIST       5:FIND       6:AT/CLEAR
PF  7:UP         8:DOWN       9:GO        10:ZOOM      11:ZOOM LOG  12:RETRIEVE
```

The information displayed in the Source window is similar to the listing generated by the assembler. The Source window displays the following information:

1 statement number

The statement number is a number assigned by the EQALANGX program. Use this column to set breakpoints and identify statements.

The same statement number can sometimes be assigned to more than one line. Comments, labels and macro invocations are assigned the same statement number as the machine instruction that follows these statements. All of these statements have the same offset within the CSECT, which allows you to put the cursor on any of these lines and press PF6 to set a breakpoint. When the statement is reached, the focus is set on the first line within the statement that contains either a macro invocation or a machine instruction.

2 An asterisk in the column preceding the offset indicates that the line is contained in a compile unit to which you are not currently qualified. Before you attempt to set a line or statement breakpoint on that a line, you must enter the SET QUALIFY CU *compile_unit* and specify the name of the containing compile unit for the *compile_unit* parameter.

3 offset

The offset from the start of the CSECT. This column matches the left-most column in the assembler listing.

4 object
The object code for instructions. This column matches the "Object Code" column in the assembler listing. Object code for data fields is not displayed.

5 modified instruction
An "X" in this column indicates an executable instruction that is modified by the program at some point. You cannot set a breakpoint on such an instruction nor can you STEP into such an instruction.

6 macro generated
A "+" in this column indicates that the line is generated by macro expansion. Lines generated by macro expansion appear only in the standard view. These lines are suppressed when the NOMACGEN view is in effect.

7 source statement
The original source statement. This column corresponds to the "Source Statement" column in the assembler listing.

Refer to the following topics for more information related to the material discussed in this topic.

Related references
Debug Tool Reference and Messages

%PATHCODE values for assembler programs

This table shows the possible values for the Debug Tool %PATHCODE variable when the current programming language is Assembler:

%PATHCODE	Entry type	Instruction	Additional requirements or comments
1	A block has been entered.	Any	External symbol whose offset corresponds to an instruction
2	A block is about to be exited.	`BR R14` (07FE)	
		`BALR R14,R15` (05EF)	These instructions are considered an Exit only if this instruction is not followed by an valid instruction.
		`BASR R14,R15` (0DEF)	
		`BASSM R14,R15` (0CEF)	
		`BCR 15,x` (07Fx)	
3	Control has reached a label coded in the program.	Any	Label whose offset corresponds to an instruction.

%PATHCODE	Entry type	Instruction	Additional requirements or comments
4	Control is being transferred as a result of a CALL.	BALR R14,R15 (05EF)	
		BASR R14,R15 (0DEF)	
		BASSM R14,R15 (0CEF)	
		SVC (0A)	
		PC (B218)	
		BAL (45)	Except BAL 1,xxx is not considered a CALL
		BAS (4D)	
		BALR x,y (05)	
		BASR x,y (0D)	
		BASSM x,y (0C)	
		BRAS (A7x5)	
		BRASL (C0x5)	
5	Control is returning from a CALL.	Statement after CALL	If the statement after a CALL is an instruction, it gets an entry here.
6	A conditional branch is about to be executed.	BC x (47x)	x^=15 & X^=0
		BCR x (07x)	x^=15 & X^=0
		BCT (46)	
		BCTR (06)	
		BCTGR (B946)	
		BXH (86)	
		BXHG (EB44)	
		BXLE (87)	
		BXLEG (EB45)	
		BRC x (A7x4)	x^=15 & X^=0
		BRCL (C0x4)	
		BRCT (A7x6)	
		BRCTG (A7x7)	
		BRXH (84)	
		BRXHG (EC44)	
		BRXLE (85)	
		BRXLG (EC45)	

%PATHCODE	Entry type	Instruction	Additional requirements or comments
7	A conditional branch was not executed and control has "fallen-through" to the next instruction.	`Statement after Conditional Branch`	
8	An unconditional branch is about to be executed.	`BC 15,x (47Fx)`	
		`BRC 15,x (A7F4)`	
		`BRCL 15,x (C0F4)`	
		`BSM (0B)`	

Using the STANDARD and NOMACGEN view

The information displayed in the Source window for an assembler program can be viewed in either of two views. The STANDARD view shows all lines in the assembler listing including lines generated through macro expansion. The NOMACGEN view omits lines generated by macro expansion and, therefore, is similar to the assembler listing generated when PRINT NOGEN is in effect.

You can use the following commands to control the view that you see in the Source window for an assembler program:

- SET DEFAULT VIEW is used to indicate the initial view that you see. The setting that is in effect for SET DEFAULT VIEW when you enter the LOADDEBUGDATA (LDD) command for an assembler program determines the initial view for that program.
- QUERY DEFAULT VIEW can be used to see the current setting of SET DEFAULT VIEW.
- QUERY CURRENT VIEW can be used to determine the view in effect for the currently qualified CU.

Debugging non-reentrant assembler

When a load module is marked as non-reentrant and loaded multiple times without a corresponding delete, multiple copies of the load module exist in memory at the same time. Because high level language programs are typically marked as reentrant by default, debugging non-reentrant programs primarily applies to the debugging of assembler programs. The following situations have the special considerations described in the following sections when debugging non-reentrant assembler programs:

- Manipulating breakpoints
- Manipulating local variables

The following descriptions apply only to full screen mode and line mode debugging. There are no corresponding features for supporting debugging of non-reentrant assembler when using the remote debugger.

Manipulating breakpoints in non-reentrant assembler load modules

When you manipulate breakpoints in a compile unit in a non-reentrant load module by using one of the following commands, the command applies to all copies of the compile unit in load modules with the same name:

- AT
- DISABLE AT
- ENABLE AT
- LIST AT
- CLEAR AT
- SET SAVE BPS
- SET RESTORE BPS

Manipulating local variables in non-reentrant assembler load modules

If you want refer to a local variable that is in a compile unit in a non-reentrant load module and multiple copies of that load module exist in memory, you must identify the copy of the compile unit to which you want the command to apply. To identify the copy of the compile unit, you must first obtain an address in the specific compile unit. The following list describes some ways you can obtain an address in a specific compile unit:

- Inspect a variable or register in the calling program for the address of the specific compile unit.
- Enter the QUERY LOCATION command to obtain the address of the specific compile unit.
- Enter the DESCRIBE CU command to see a list of addresses for each compile unit. Then, enter the QUALIFY command with each address until you find the specific compile unit.

After you obtain the address, enter the SET QUALIFY *address*; command, where *address* is an address in the specific compile unit you identified.

Restrictions for debugging an assembler program

When you debug assembler programs the following general restrictions apply:

- Only application programs are supported. No support is provided for debugging system routines, authorized programs, CICS exits, and so on.
- Debugging of Private Code (also known as an unnamed CSECT or blank CSECT) is not supported.
- No support is provided for debugging subtasks. If an ATTACH is run, the debugger always follows the parent task.
- You cannot debug programs that do not use standard linkage conventions for registers 13, 14, and 15 or that use the Linkage Stack. Not using standard linkage conventions or the Linkage Stack can cause the following commands to function incorrectly:
  - LIST CALLS
  - STEP RETURN
  - STEP (when stopped at a return instruction)
  - %EPA
- Debugging of programs that use the MVS XCTL SVC is not supported.
- Debugging of the 64-bit Language Environment-enabled and Language Environment XPLINK programs is not supported.

- CICS does not support 64-bit programs interfacing to CICS services; therefore, Debug Tool does not support debugging of 64-bit programs under CICS.
- Support for binary and decimal floating-point items requires 64-bit hardware and Decimal Floating Point hardware (for decimal floating point support).
- If your current hardware does not support 64-bit instructions or your program is suspended at a point where the 64-bit General Purpose Registers are not available, the 64-bit General Purpose Registers are not available and any reference to symbols for the 64-bit General Purpose Registers are treated as undefined.
- The 64-bit General Purpose Registers are available only in the compile unit in which Debug Tool is stopped at a breakpoint. If you use the `QUALIFY` command to qualify to a compile unit higher in the calling sequence, the 64-bit General Purpose Registers are not accessible.
- When your program is suspended in a compile unit, that compile unit is the only one from which you can access the 64-bit General Purpose Registers. If you use the `QUALIFY` command to qualify to a different compile unit, you can no longer access the 64-bit General Purpose Registers.
- Debugging of programs that use Access Register mode is not supported.
- Debugging of programs that use the IDENTIFY macro or service is not supported.
- You cannot debug programs that were assembled with features that depend on the GOFF option, for example, CSECT names longer than eight characters. If the program can assemble correctly without the GOFF option, then you can debug programs that are assembled with the GOFF option.
- If you are debugging a program that uses ESTAE or ESTAEX, the program behaves as if `TRAP(OFF)` were specified for all Abends while the ESTAE or ESTAEX is active, except program checks. In other words, no condition is seen by Debug Tool. Any Abends except program checks are handled by the ESTAE(X) exit in your program.
- If you are debugging a program that uses SPIE or ESPIE, the program behaves as if `TRAP(OFF)` were specified for all program checks while the SPIE or ESPIE is active, except a program check that might arise from the use of the `CALL` Debug Tool command.
- The debugging of TSO Command Processors is not supported.
- If you start debugging in a non-CICS load module that is not the "top" load module, you cannot continue debugging after that load module returns to its caller. In order to do this, you must invoke Debug Tool using CEEUOPT or some other internal method. You cannot do this by using JCL alone.
- Debugging of assembler or disassembly code requires the use of the Dynamic Debug Facility. Debug Tool does not support the use of the Dynamic Debug Facility to debug code that is not known to the z/OS Contents Supervisor. This can occur in situations similar to the following situations:
  - Debugging load modules loaded by a directed LOAD.
  - Debugging segments of code which have been relocated. For example, a GETMAIN is used to obtain a new piece of storage. Then a section of code is moved into this new piece of storage and control is passed to it for execution.

Restrictions for debugging a Language Environment assembler MAIN program

When you debug a Language Environment-enabled assembler main program, the following restrictions apply:

- If Debug Tool is positioned at the entry point to the assembler main program and you enter a STEP command, the STEP command stops at the instruction that is after the prologue BALR instruction that initializes Language Environment. You cannot step through the portion of the prologue that is before the completion of Language Environment initialization.
- If you set a breakpoint in the prologue before the completion of Language Environment initialization, the breakpoint is accepted. However, Debug Tool does not stop or gain control at this breakpoint.

To debug a Language Environment-conforming assembler MAIN program running under CICS, you must run with CICS Transaction Server, Version 3.1 or later.

Restrictions on setting breakpoints in the prologue of Language Environment assembler programs

The following restrictions apply when you attempt to set explicit or implicit breakpoints in the prologue of a Language Environment assembler program:

- If you try to step across the portion of the prologue code that is between the point where the stack extend routine is called and the LR 13,x instruction that loads the address of the new DSA into register 13, the STEP command stops at the instruction immediately following the LR 13,x instruction.
- If you try to set a breakpoint in the portion of the prologue code between the point where the stack extend routine is called and the LR 13,x instruction that loads the address of the new DSA into register 13, Debug Tool will not set the breakpoint.

Restrictions for debugging non-Language Environment programs

If you specify the TEST run-time option with the NOPROMPT suboption when you start your program and Debug Tool is subsequently started by CALL CEETEST or the raising of an Language Environment condition, you can debug both Language Environment and non-Language Environment programs and detect both Language Environment and non-Language Environment events in the enclave that started Debug Tool and in subsequent enclaves. You cannot debug non-Language Environment programs or detect non-Language Environment events in higher-level enclaves. After control has returned from the enclave in which Debug Tool was started, you can no longer debug non-Language Environment programs or detect non-Language Environment events.

Restrictions for debugging assembler code that uses instructions as data

Debug Tool cannot debug code that uses instructions as data. If your program references one or more instructions as data, the result can be unpredictable, including an abnormal termination (ABEND) of Debug Tool. This is because Debug Tool sometimes replaces instructions with SVCs in order to create breakpoints.

For example, Debug Tool cannot process the following code correctly:

```
Entry1   BRAS  15,0
         NOPR  0
         B     Common
Entry2   BRAS  15,0
         NOPR  4
Common   DS    0H
         IC    15,1(15)
```

In this code, the IC is used to examine the second byte of the NOPR instructions. However, if the NOPR instructions are replaced by an SVC to create a breakpoint, a value that is neither 0 nor 4 might be obtained, which causes unexpected results in the user program.

You can use the following coding techniques can be used to eliminate this problem:

- Method 1: Change the code to reference constants instead of instructions.
- Method 2: Define the referenced instructions by using DC instructions instead of executable instructions.

Using Method 1, you can change the above example to the following code:

```
Entry1   BAL   15,*+L'*+2
         DC    H'0'
         B     Common
Entry2   BAL   15,*+L'*+2
         DC    H'4'
Common   DS    0H
         IC    15,1(15)
```

Using Method 2, you can change the above example to the following code:

```
Entry1   BRAS  15,0
         DC    X'0700'
         B     Common
Entry2   BRAS  15,0
         DC    X'0704'
Common   DS    0H
         IC    15,1(15)
```

Restrictions for debugging self-modifying assembler code

Debug Tool defines two types of self-modifying code: detectable and non-detectable. Detectable self-modifying code is code that either:

- Modifies an instruction via a direct reference to a label on the instruction or on an EQU * or DS 0H immediately preceding the instruction. For example:

  ```
  Inst1    NOP   Label1
           MVI   Inst1+1,X'F0'
  ```

- Uses the EQAMODIN macro instruction to identify the instruction being modified. For example:

  ```
          EQAModIn  Inst1
  Inst1   NOP       Label1
          LA        R3,Inst1
          MVI       0(R3),X'F0'
  ```

Any self-modifying code that does not meet one of these criteria is classified as non-detectable.

Handling of detectable self-modifying assembler code

When Debug Tool identifies detectable, self-modifying code, it indicates the situation in the Source window by putting an "X" in the column immediately before the column indicating a macro-generated instruction. A breakpoint cannot be set on such an instruction nor will STEP stop on such an instruction.

The EQAMODIN macro in shipped in the Debug Tool sample library (*hlq*.SEQASAMP). This macro can be used to make non-detectable, self-modifying code detectable. It generates no executable code. Instead it simply adds information to the SYSADATA file to identify the specified operand as modified. The operand can be specified either as a label name or as "*" to indicate that the immediately following instruction is modified.

Non-detectable self-modifying assembler code

If your program contains non-detectable, self-modifying code that modifies an instruction while the containing compilation unit is being debugged, the result can be unpredictable, including an abnormal termination (ABEND) of Debug Tool. If your program contains self-modifying code that completely replaces an instruction while the containing compilation unit is being debugged and you do not step through the code that modifies the instruction, the result might not be an ABEND. However, Debug Tool might miss a breakpoint on that instruction or display a message indicating an invalid hook address at delete. If you *do* step through the code that modifies the instruction, the instruction that is moved may contain a breakpoint causing a Debug Tool failure when the modified instruction is executed.

The following coding techniques can be used to minimize problems debugging non-detectable, self-modifying code:

- Define instructions to be modified by using DC instructions instead of executable instructions. For example, use the instruction `ModInst DC X'4700',S(Target)` instead of the instruction `BC 0,Target`.

Code that modifies an instruction defined by an instruction op-code	**Code that modifies an instruction defined by a DC**

`ModInst BC  0,Target`
`        ...`
`        MVI ModInst+1,X'F0'`
	`ModInst DC  X'4700',S(Target)`
	`        ...`
	`        MVI ModInst+1,X'F0'`

- Do not modify part of an instruction. Instead, replace an instruction with one that is generated with a DC or marked as modified by use of the EQAMODIN macro. The following table compares coding techniques:

Code that modifies an instruction	**Corresponding code that replaces an instruction with one defined by a DC**

`ModInst  BC 0,Target`
`   ...`
`   MVI ModInst+1,X'F0'`
	`ModInst  BC 0,Target`
	`   ...`
	`   MVC ModInst(4),NewInst`
	`   ...`
	`NewInst DC  X'47F0',S(Target)`

Code that modifies an instruction	**Corresponding code that replaces an instruction marked by EQAMODIN**

`ModInst BC  0,Target`
`        ...`
`        MVI ModInst+1,X'F0'`
	`ModInst BC  0,Target`
	`        ...`
	`        MVC ModInst(4),NewInst`
	`        ...`
	`        EQAMODIN NewInst`
	`NewInst BC  15,Target`

Chapter 34. Debugging a disassembled program

To debug programs that have been compiled or assembled without debug information, you can use the disassembly view. When you use the disassembly view, symbolic information from the original source program (program variables, labels, and other symbolic references to a section of memory) is not available. The DYNDEBUG switch must be ON before you use the disassembly view.

If you are not familiar with the program that you are debugging, we recommend that you have a copy of the listing that was created by the compiler or High Level Assembler (HLASM) available while you debug the program. There are no special assembly or compile requirements that the program must comply with to use the disassembly view.

The SET ASSEMBLER and SET DISASSEMBLY commands

The SET ASSEMBLER ON and SET DISASSEMBLY ON commands enable some of the same functions. However, you must consider which type of CUs that you will be debugging (assembler, disassembly, or both) before deciding which command to use. The following guidelines can help you decide which command to use:

- If you are debugging assembler CUs but no disassembly CUs, you might want to use the SET ASSEMBLER ON command. If you need the following functions, use the SET ASSEMBLER ON command:
  - Use the LIST, LIST NAMES CUS, or DESCRIBE CUS commands to see the name of disassembly CUs.
  - Use AT APPEARANCE to stop Debug Tool when the disassembly CU is loaded.

  If you don't need any of these functions, you don't need to use either command.
- If you are debugging a disassembly CU, you must use the SET DISASSEMBLY ON command so that you can see the disassembly view of the disassembly CUs. The SET DISASSEMBLY ON command enables the functions enabled by SET ASSEMBLER ON and also enables the following functions that are not available through the SET ASSEMBLER ON command:
  - View the disassembled listing in the Source window.
  - Use the STEP INTO command to enter the disassembly CU.
  - Use the AT ENTRY * command to stop at the entry point of disassembly CUs.

If you are debugging an assembler CU and later decide you want to debug a disassembly CU, you can enter the SET DISASSEMBLY ON command after you enter the SET ASSEMBLER ON command.

Capabilities of the disassembly view

When you use the disassembly view, you can do the following tasks:

- Set breakpoints at the start of any assembler instruction.
- Step through the disassembly instructions of your program.
- Display and modify registers.
- Display and modify storage.
- Monitor General Purpose Registers or areas of main storage.
- Switch the debug view.
- Use most Debug Tool commands.

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Starting the disassembly view

To start the disassembly view:

1. Enter the `SET DISASSEMBLY ON` command
2. Open the program that does not contain debug data. Debug Tool then changes the language setting to **Disassem** and the Source window displays the assembler code.

If you enter a program that does contain debug data, the language setting does not change and the Source window does not display disassembly code.

The disassembly view

When you debug a program through the disassembly view, the Source window displays the disassembly instructions. The language area of the Debug Tool screen (upper left corner) displays the word **Disassem**. The Debug Tool screen appears as follows:

```
Disassem LOCATION: MAIN initialization
Command ===>                                                  Scroll ===> PAGE
MONITOR --+----1----+----2----+----3----+----4----+----5----+----6 LINE: 0 OF 0
****************************** TOP OF MONITOR *******************************
****************************** BOTTOM OF MONITOR ****************************



SOURCE: MAIN +----1----+----2----+----3----+----4----+----5----+ LINE: 1 OF 160
      0 1950C770    47F0 F014       BC    15,20(,R15)                        .
   [A]4 1950C774    00C3            ????                                     .
      6 1950C776 [B] C5C5            ????                                     .
      8 1950C778    0000            ????                                     .
      A 1950C77A    0080 [C]        ????                                     .
      C 1950C77C    0000            ????                                     .
      E 1950C77E    00C4            ???? [D]                                 .
     10 1950C780    47F0 F001       BC    15,1(,R15)                         .
     14 1950C784    90EC D00C       STM   R14,R12,12(R13)                    .
     18 1950C788    18BF            LR    R11,R15   [E]                      .
     1A 1950C78A    5820 B130       L     R2,304(,R11)                       .
     1E 1950C78E    58F0 B134       L     R15,308(,R11)                      .
     22 1950C792    05EF            BALR  R14,R15                            .
     24 1950C794    1821            LR    R2,R1                              .
     26 1950C796    58E0 C2F0       L     R14,752(,R12)                      .
     2A 1950C79A    9680 E008       OI    8(R14),128                         .
     2E 1950C79E    05B0            BALR  R11,0                              .
LOG 0----+----1----+----2----+----3----+----4----+----5----+----6- LINE: 1 OF 5
******************************** TOP OF LOG *********************************
IBM Debug Tool Version 11 Release 1 Mod 0
11/06/2010 4:11:41 PM
5655-W45: Copyright IBM Corp. 1992, 2010
0004 EQA1872E An error occurred while opening file: INSPPREF. The file may not
0005          exist, or is not accessible.
0006 SET DISASSEMBLY ON ;
PF  1:?           2:STEP       3:QUIT       4:LIST       5:FIND      6:AT/CLEAR
PF  7:UP          8:DOWN       9:GO        10:ZOOM      11:ZOOM LOG 12:RETRIEVE
```

A Prefix Area
Displays the offset from the start of the CU or CSECT.

B Columns 1-8
Displays the address of the machine instruction in memory.

C Columns 13-26
Displays the machine instruction in memory.

D **Columns 29-32**
Displays the op-code mnemonic or ???? if the op-code is not valid.

E **Columns 35-70**
Displays the disassembled machine instruction.

When you use the disassembly view, the disassembly instructions displayed in the source area are not guaranteed to be accurate because it is not always possible to distinguish data from instructions. Because of the possible inaccuracies, we recommend that you have a copy of the listing that was created by the compiler or by HLASM. Debug Tool keeps the disassembly view as accurate as possible by refreshing the Source window whenever it processes the machine code, for example, after a STEP command.

Performing single-step operations in the disassembly view

Use the STEP command to single-step through your program. In the disassembly view, you step from one disassembly instruction to the next. Debug Tool highlights the instruction that it runs next.

If you try to step back into the program that called your program, set a breakpoint at the instruction to which you return in the calling program. If you try to step over another program, set a breakpoint immediately after the instruction that calls another program. When you try to step out of your program, Debug Tool displays a warning message and lets you set the appropriate breakpoints. Then you can do the step.

Debug Tool refreshes the disassembly view whenever it determines that the disassembly instructions that are displayed are no longer correct. This refresh can happen while you are stepping through your program.

Setting breakpoints in the disassembly view

You can use a special breakpoint when you debug your program through the disassembly view. AT OFFSET sets a breakpoint at the point that is calculated from the start of the entry point address of the CSECT. You can set a breakpoint by entering the AT OFFSET command on the command line or by placing the cursor in the prefix area of the line where you want to set a breakpoint and press the AT function key or type AT in the prefix area.

Debug Tool lets you set breakpoints anywhere within the starting and ending address range of the CU or CSECT provided that the address appears to be a valid op-code and is an even number offset. To avoid setting breakpoints at the wrong offset, we recommend that you verify the offset by referring to a copy of the listing that was created by the compiler or by HLASM.

Restrictions for debugging self-modifying code

Debug Tool cannot debug self-modifying code. If your program contains self-modifying code that modifies an instruction while the containing compilation unit is being debugged, the result can be unpredictable, including an abnormal termination (ABEND) of Debug Tool. If your program contains self-modifying code that completely replaces an instruction while the containing compilation unit is being debugged, the result might not be an ABEND. However, Debug Tool might miss a breakpoint on that instruction or display a message indicating an invalid hook address at delete.

The following coding techniques can be used to minimize problems debugging self-modifying code:

1. Do not modify part of an instruction. Instead, replace an instruction. The following table compares coding techniques:

Coding that modifies an instructions	Coding that replaces an instruction

`ModInst  BC 0,Target`
`...`
`MVI ModInst+1,X'F0'`
	`ModInst  BC 0,Target`
	`...`
	`MVC ModInst(4),NewInst`
	`...`
	`NewInst  BC 15,Target`

2. Define instructions to be modified by using DC instructions instead of executable instructions. For example, use the instruction `ModInst DC X'4700',S(Target)` instead of the instruction `MVC ModInst(4),NewInst`.

Displaying and modifying registers in the disassembly view

You can display the contents of all the registers by using the `LIST REGISTERS` command. To display the contents of an individual register, use the `LIST Rx` command, where `x` is the individual register number. You can also display the contents of an individual register by placing the cursor on the register and pressing the `LIST` function key. The default `LIST` function key is PF4. You can modify the contents of a register by using the assembler assignment statement.

Displaying and modifying storage in the disassembly view

You can display the contents of storage by using the `LIST STORAGE` command. You can modify the contents of storage by using the `STORAGE` command.

You can also use assembler statements to display and modify storage. For example, to set the four bytes located by the address in register 2 to zero, enter the following command:

```
R2-> <4>=0
```

To verify that the four bytes are set to zero, enter the following command:

```
LIST R2->
```

Changing the program displayed in the disassembly view

You can use the `SET QUALIFY` command to change the program that is displayed in the disassembly view. Suppose you are debugging program ABC and you need to set a breakpoint in program BCD.

1. Enter the command `SET QUALIFY CU BCD` on the command line. Debug Tool changes the Source window to display the disassembly instructions for program BCD.
2. Scroll through the Source window until you find the instruction where want to set a breakpoint.
3. To return to program ABC, at the point where the next instruction is to run, issue the `SET QUALIFY RESET` command.

Restrictions for the disassembly view

When you debug a disassembled program, the following restrictions apply:

- Applications that use the Language Environment XPLINK linking convention are not supported.
- The Dynamic Debug facility must be activated before you start debugging through the disassembly view.
- Debugging of assembler or disassembly code requires the use of the Dynamic Debug Facility. Debug Tool does not support the use of the Dynamic Debug Facility to debug code that is not known to the z/OS Contents Supervisor. This can occur in situations similar to the following situations:
  - Debugging load modules loaded by a directed LOAD.
  - Debugging segments of code which have been relocated. For example, a GETMAIN is used to obtain a new piece of storage. Then a section of code is moved into this new piece of storage and control is passed to it for execution.

When you debug a program through the disassembly view, Debug Tool cannot stop the application in any of the following situations:

- The program does not comply with the first three restrictions that are listed above.
- Between the following instructions:
  - After the LE stack extend has been called in the prologue code, and
  - Before R13 has been set with a savearea or DSA address and the backward pointer has been properly set.

The application runs until Debug Tool encounters a valid save area backchain.

Part 6. Debugging in different environments

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Chapter 35. Debugging DB2 programs

While you debug a program containing SQL statements, remember the following behaviors:

- The SQL preprocessor replaces all the SQL statements in the program with host language code. The modified source output from the preprocessor contains the original SQL statements in comment form. For this reason, the source or listing view displayed during a debugging session can look very different from the original source.
- The host language code inserted by the SQL preprocessor starts the SQL access module for your program. You can halt program execution at each call to a SQL module and immediately following each call to a SQL module, but the called modules cannot be debugged.
- A host language SQL coprocessor performs DB2 precompiler functions at compile time and replaces the SQL statements in the program with host language code. However, the generated host language code is not displayed during a debug session; the original source code is displayed.

The topics below describe the steps you need to follow to use Debug Tool to debug your DB2 programs.

- Chapter 7, “Preparing a DB2 program,” on page 75
- “Processing SQL statements” on page 75
- “Linking DB2 programs for debugging” on page 77
- “Binding DB2 programs for debugging” on page 78
- “Debugging DB2 programs in batch mode”
- “Debugging DB2 programs in full-screen mode” on page 352

Refer to the following topics for more information related to the material discussed in this topic.

Related tasks

Chapter 7, “Preparing a DB2 program,” on page 75

DB2 UDB for z/OS Application Programming and SQL Guide

Debugging DB2 programs in batch mode

In order to debug your program with Debug Tool while in batch mode, follow these steps:

1. Make sure the Debug Tool modules are available, either by STEPLIB or through the LINKLIB.
2. Provide all the data set definitions in the form of DD statements (example: Log, Preference, list, and so on).
3. Specify your debug commands in the command input file.
4. Run your program through the TSO batch facility.

Refer to the following topics for more information related to the material discussed in this topic.

Related tasks

Chapter 7, “Preparing a DB2 program,” on page 75

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Debugging DB2 programs in full-screen mode

In full-screen mode, you can decide at debug time what debugging commands you want issued during the test.

Using Debug Tool Setup Utility (DTSU)

The Debug Tool Setup Utility is available through Debug Tool Utilities.

1. Start DTSU by using the TSO command or the ISPF panel option, if available. Contact your system administrator to determine if the ISPF panel option is available.
2. Create a setup file. Remember to select the **Initialize New setup file for DB2** field.
3. Enter appropriate information for all the fields. Remember to enter the proper commands in the **DSN command options** and the **RUN command options** fields.
4. Enter the `RUN` command to run the DB2 program.

Using TSO commands

1. Ensure that either you or your system programmer has allocated all the required data sets through a CLIST or REXX EXEC.
2. Issue the `DSN` command to start DB2.
3. Issue the `RUN` subcommand to execute your program. You can specify the `TEST` runtime option as a parameter on the `RUN` subcommand. The following example starts a COBOL program:

   ```
   RUN PROG(progname) PLAN(planname) LIB('user.library')
       PARMS('/TEST(,*,:,*)')
   ```

   The following example starts a non-Language Environment COBOL program:

   ```
   RUN PROG(EQANMDBG) PLAN(planname) LIB('user.library')
       PARMS('progname,/TEST(,*,:,*)')
   ```

Using TSO/Call Access Facility (CAF)

1. Link-edit the CAF language interface module DSNALI with your program.
2. Ensure that the data sets required by Debug Tool and your program have been allocated through a CLIST or REXX procedure.
3. Enter the `TSO CALL` command `CALL 'user.library(name of your program)'`, to start your program. Include the `TEST` run-time option as a parameter in this command.

In full-screen mode using a dedicated terminal without Terminal Interface Manager

1. Specify the `MFI%LU_name` parameter as part of the `TEST` runtime option.
2. Follow the other requirements for debugging DB2 programs either under TSO or in batch mode.

In full-screen mode using the Terminal Interface Manager

1. Specify the `VTAM%userid` parameter as part of the `TEST` runtime option.
2. Follow the other requirements for debugging DB2 programs either under TSO or in batch mode.

After your program has been initiated, debug your program by issuing the required Debug Tool commands.

Note: If your source does not come up in Debug Tool when you launch it, check that the listing or source file name corresponds to the MVS library name, and that you have at least read access to that MVS library.

Refer to the following topics for more information related to the material discussed in this topic.

Related tasks

Chapter 7, “Preparing a DB2 program,” on page 75

“Starting Debug Tool for programs that start outside of Language Environment” on page 137

Related references

DB2 UDB for z/OS Administration Guide

Chapter 36. Debugging DB2 stored procedures

A DB2 stored procedure is a compiled high-level language (HLL) program that can run SQL statements. Debug Tool can debug any stored procedure written in assembler (if the program type is MAIN), C, C++, COBOL, and PL/I in any of the following debugging modes:

- remote debug mode
- full-screen mode using the Terminal Interface Manager
- batch mode

Before you begin, verify that you have completed all the tasks described in Chapter 8, “Preparing a DB2 stored procedures program,” on page 79. The program resides in an address space that is separate from the calling program. The stored procedure can be called by another application or a tool such as the IBM DB2 Development Center.

Refer to the following topics for more information related to the material discussed in this topic.

Related tasks

Chapter 8, “Preparing a DB2 stored procedures program,” on page 79

“Resolving some common problems while debugging DB2 stored procedures”

Related references

DB2 Application Programming and SQL Guide

Resolving some common problems while debugging DB2 stored procedures

This topic describes the messages you might receive and resolution to the problem described by those messages. This topic covers common problems.

Table 18. Common problems while debugging stored procedures and resolutions to those problems

Error code	Error message	Resolution
`SQLCODE = 471, SQLERRMC = 00E79001`	Stored procedure was stopped.	Start the stored procedure using DB2 Start Procedure command.
`SQLCODE = 471, SQLERRMC = 00E79002`	Stored procedure could not be started because of a scheduling problem.	Try using the DB2 Start Procedure command. If this does not work, contact the DB2 Administrator to raise the dispatching priority of the procedure.
`SQLCODE = 471, SQLERRMC = 00E7900C`	WLM application environment name is not defined or available.	Activate the WLM address space using the MVS `WLM VARY` command, for example: `WLM VARY APPLENV=applenv,RESUME` where *applenv* is the name of the WLM address space.

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Table 18. Common problems while debugging stored procedures and resolutions to those problems (continued)

Error code	Error message	Resolution
SQLCODE = 444, SQLERRMC (none)	Program not found.	Verify that the LOADLIB is in the STEPLIB for the WLM or DB2 address space JCL and has the appropriate RACF Read authorization for other applications to access it.
SQLCODE = 430, SQLERRMC (none)	Abnormal termination in stored procedure	This can occur for many reasons. If the stored procedure abends without calling Debug Tool, analyze the Procedure for any logic errors. If the Procedure runs successfully without Debug Tool, there may a problem with how the stored procedure was compiled and linked. Be sure that the Procedure data set has the proper RACF authorizations. There may be a problem with the address space. Verify that the WLM or DB2 Address Space is correct. If there are any modifications, be sure the region is recycled.

Chapter 37. Debugging IMS programs

This topic describes the following tasks:

- Another method of debugging IMS batch programs interactively.
- What you must know if you want to debug IMS batch programs in batch mode.
- Special steps you must take to debug non-Language Environment IMS MPPs.
- How to create private message regions to test IMS MPPs by using Debug Tool Utilities.

Debugging IMS batch programs interactively by running BTS in TSO foreground

If you want to debug an IMS batch program interactively, you can use full-screen mode using the Terminal Interface Manager or remote debug mode. This topic describes a third option, which is to run BTS in the TSO foreground, by doing the following steps:

1. Define a *dummy* transaction code on the `./T` command to initiate your program
2. Include a *dummy* transaction in the BTS input stream
3. Start BTS in the TSO foreground.

   FSS is the default option when BTS is started in the TSO foreground, and is available only when you are running BTS in the TSO foreground. FSS can only be turned off by specifying TSO=NO on the ./O command. When running in the TSO foreground, all call traces are displayed on your TSO terminal by default. This can be turned off by parameters on either the `./O` or `./T` commands.

Note: If your source (C and C++) or listing (COBOL and PL/I) does not come up in Debug Tool when you launch it, check that the source or listing file name corresponds to the MVS library name, and that you have at least read access to that MVS library.

Debugging IMS batch programs in batch mode

You can use Debug Tool to debug IMS programs in batch mode. The debug commands must be predefined and included in one of the Debug Tool commands files, or in a command string. The command string can be specified as a parameter either in the `TEST` run-time option, or when `CALL CEETEST` or `__ctest` is used. Although batch mode consumes fewer resources, you must know beforehand exactly which debug commands you are going to issue. When you run BTS as a batch job, the batch mode of Debug Tool is the only mode available for use.

For example, you can allocate a data set, `userid.CODE.BTSINPUT` with individual members of test input data for IMS transactions under BTS.

Debugging non-Language Environment IMS MPPs

You can debug IMS message processing programs (MPPs) that do not run in Language Environment by doing the following tasks:

1. Verify that your system is configured correctly and start a new region. See “Verifying configuration and starting a region for non-Language Environment IMS MPPs” on page 358 for instructions.

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2. Choose a debugging interface. See “Choosing an interface and gathering information for non-Language Environment IMS MPPs” for instructions.
3. Run the EQASET transaction, which identifies the debugging interface you chose and enables debugging. See “Running the EQASET transaction for non-Language Environment IMS MPPs” on page 359.
4. Start the IMS transaction that is associated with the program you want to debug.

After you finish debugging your program, you can do one of the following:

- Continue debugging another program.
- Disable debugging and continue running the region for other tasks.
- Disable debugging and shut down the region. If you want to debug an IMS programs, you have to repeat tasks 2 to 4.

Verifying configuration and starting a region for non-Language Environment IMS MPPs

Before you debug an IMS MPP that does not run in Language Environment, do the following steps:

1. Consult with your system administrator and verify that your system has been configured to debug IMS programs that do not run in Language Environment. See the *Debug Tool Customization Guide* for instructions on how to include the APPLFE=EQANIAFE parameter string in the JCL that starts a region and EQANISET.
2. Start an IMS message processing region (MPR) that runs the EQANIAFE application front-end routine whenever a message processing program (MPP) is scheduled.

After you complete these steps, choose a debugging interface as described in “Choosing an interface and gathering information for non-Language Environment IMS MPPs.”

Choosing an interface and gathering information for non-Language Environment IMS MPPs

Choose from one of the following debugging interfaces and gather the indicated information:

- Use full-screen mode using a dedicated terminal without Terminal Interface Manager. Obtain the terminal LU for this terminal. For example, TRMLU001. If you are required to use the VTAM network identifier for the terminal LU, obtain this information from your system programmer.
- Use full-screen mode using the Terminal Interface Manager. Obtain the user ID. For example, USERABCD.
- Use remote debug mode. Obtain the IP address and port number that the remote debugger is listening to.

After you choose a debugging interface, run the EQASET transaction as described in “Running the EQASET transaction for non-Language Environment IMS MPPs” on page 359.

Running the EQASET transaction for non-Language Environment IMS MPPs

Running the EQASET transaction indicates to the EQANIAFE application front-end routine that you want to do one of the following functions:

- Enable a debugging session with the preferences you indicate
- Request information about your existing preferences
- Disable a debugging session

To enable a debugging session, select one of the following options:

- To debug in full-screen mode using a dedicated terminal without Terminal Interface Manager, enter the command `EQASET MFI=terminal_LU_name`. If you are required to specify a VTAM network identifier, enter the command `EQASET MFI=network_identifier.terminal_LU_name`.
- To debug in full-screen mode using the Terminal Interface Manager, enter the command `EQASET VTAM=user_ID`.
- To debug in remote debug mode, enter the command `EQASET TCP=IP_address%port_number`.

After you enter an EQASET command, on the same terminal, start the transaction that is associated with the application program that you want to debug.

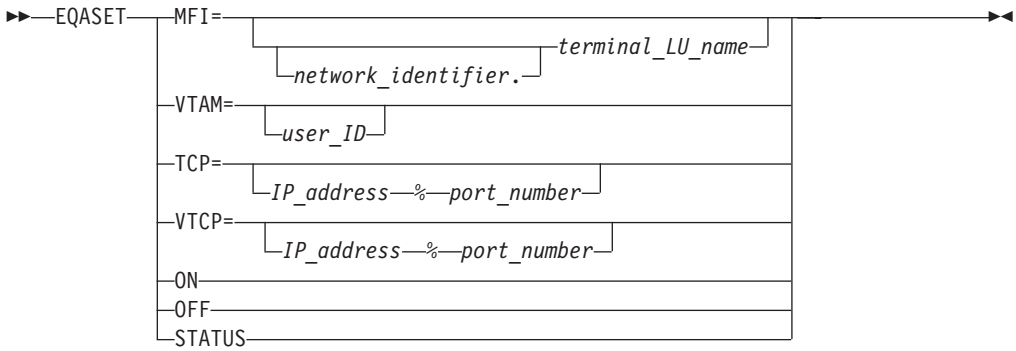
To request information about your existing preferences, enter the command `EQASET STATUS`.

To disable a debugging session, enter the command `EQASET OFF`.

To re-enable a debugging session after using `EQASET OFF`, enter the command `EQASET ON`.

Syntax of the EQASET transaction for non-Language Environment MPPs

The following diagram displays the syntax of the EQASET transaction for non-Language Environment MPPs:



The EQASET transaction manages a separate debugging setting for each user that runs the transaction. Each setting is identified by the user ID that is used to log on to the terminal where the transaction is run. For any user ID, only the last debugging preference (MFI, TCP, VTCP, or VTAM) entered is saved. You can use the STATUS option to see the current debugging preference.

The following TEST runtime option string is constructed with the debugging preference:

`TEST(ALL,INSPIN,,debuggingPreference:*)`

You cannot customize the other runtime options.

MFI=
Use full-screen mode using a dedicated terminal without Terminal Interface Manager. You must specify a dedicated terminal LU name for the debug session. If your site requires that you specify the VTAM network identifier, prefix the name of the VTAM network identifier to the terminal LU name. Without specifying the terminal LU name, debugging is turned off. No space is allowed after the equal sign (=). The preference implies debugging is turned on.

VTAM=
Use full-screen mode using the Terminal Interface Manager. You must specify the user ID that was used to log on to the Terminal Interface Manager. Without specifying the user ID, debugging is turned off. No space is allowed after the equal sign (=). The preference implies debugging is turned on.

TCP= or VTCP=
Use remote debug mode. Specify the TCP/IP address and port number of the workstation where the remote debug daemon is running. Without specifying the IP address and port number, debugging is turned off. No space is allowed after the equal sign (=). The preference implies debugging is turned on. You can specify the TCP/IP address in one of the following formats:

IPv4 You can specify the address as a symbolic address, such as `some.name.com`, or a numeric address, such as 9.112.26.333.

IPv6 You must specify the address as a numeric address, such as 1080:0:FF::0970:1A21. If you use IPv6 format, you must use the TCP= option; you cannot use the VTCP= option.

ON Turn on debugging. This is valid only when a debugging preference (MFI, TCP, VTCP, or VTAM) has been set.

OFF
Turn off debugging.

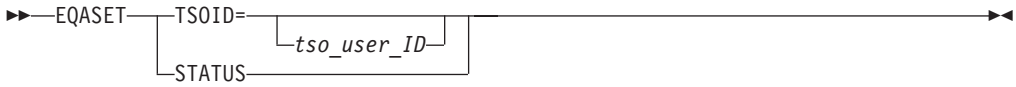
STATUS
Display the current debugging preference. The EQASET transaction displays only the first 25 characters of the IP address.

Debugging Language Environment IMS MPPs without issuing /SIGN ON

The Language Environment user exit for IMS (EQADICXT) constructs the name of an MVS data set that contains the Language Environment runtime options, including the `TEST` runtime option. EQADICXT constructs the name of the MVS data set by assigning values to tokens that represent each qualifier in a data set name; it assigns the *IMS* user ID as the value for the &USERID token. However, if you do not sign on to IMS (by using `/SIGN ON`), the IMS user ID is either the same as the IMS LTERM ID or it is not defined. In either case, EQADICXT cannot locate the MVS data set. To specify that EQADICXT assigns a *TSO* user ID as the value for the &USERID token, run the EQASET transaction specifying the `TSOID` option. For a description of the EQASET transaction with the `TSOID` option, see “Syntax of the EQASET transaction for Language Environment MPPs” on page 361.

Syntax of the EQASET transaction for Language Environment MPPs

The following diagram displays the syntax of the EQASET transaction for Language Environment MPPs:



When you use the EQASET transaction for Language Environment MPPs, it associates the current IMS LTERM ID with the specified TSO user ID. EQADICXT can construct a valid name for the MVS data set using the TSO user ID for the &USERID token.

TSOID=
Identify a TSO user ID to use in place of the &USERID token in the Language Environment user exit. The TSO user ID must match the user ID used to create the data set name, as described in “Creating and managing the TEST runtime options data set” on page 106.

STATUS
Display the current value for `TSOID`.

This option might also display information about debugging preferences for non-Language Environment MPPs.

Creating setup file for your IMS program by using Debug Tool Utilities

You can create setup files for your IMS Batch Messaging Process (BMP) program which describe how to create a custom region and defines the STEPLIB concatenation statements that reference the data sets for your IMS program's load module and the Debug Tool load module. You can also create and customize a setup file to create a private message region that you can use to test your IMS message processing program (MPP). Creating a private message region with class X allows you to test your IMS program run by transaction X and reduce the risk of interfering with other regions being used by other IMS programs.

To create a setup file for your IMS program by using Debug Tool Utilities, do the following steps:

1. Start Debug Tool Utilities. If you do not know how to start Debug Tool Utilities, see “Starting Debug Tool Utilities” on page 8.
2. In the Debug Tool Utilities panel (EQA@PRIM), type 4 in the Option line and press Enter.
3. In the Manage IMS Programs panel (EQAPRIS), type 2 in the Option line and press Enter.
4. In the Create Private Message Regions - Edit Setup File panel (EQAPFORA), type in the information to create a new setup file or edit an existing setup file. Press Enter.

   Create a private message region to customize your application or Debug Tool libraries while you debug your application so that you do not impact other user's activities. Consult your system administrator for authorization and rules regarding the creation of private message regions.

After you specify the setup information required to run your IMS program, you can specify the information needed to create a private message region you can use to test your IMS program or specify how to run a BMP program. To specify this setup information, do the following steps:

5. In the Edit Setup File panel (EQAPFORI), type in the information to start IMS batch processor. Type a forward slash (/) in the field Enter / to modify parameters, then press Enter to modify parameters for the batch processor.
6. In the Parameters for IMS Procedures panel (EQAPRIPM), use one of the following values in the TYPE field to indicate which action you want done:
   - `MSG` to start a private message region.
   - `BMP` to run a BMP program.

   Enter other parameters as needed. Press PF1 for information about the parameters.
7. After you type in the specifications, you can submit your job for processing by pressing PF10.

Placing breakpoints in IMS applications to avoid the appearance of Debug Tool becoming unresponsive

When you debug an IMS application program, the way IMS manages resources might occasionally make Debug Tool appear unresponsive. To avoid this situation, set breakpoints as close as possible to the location that you need to debug or at the GetUnique (GU) call statement. The information in this topic helps you understand how IMS's management of resources might appear to make Debug Tool unresponsive and helps you determine the approximate location to set a breakpoint to avoid this situation.

After you start an IMS transaction, IMS loads and runs the application program associated with that transaction. IMS manages all the messages requested by and returned to that application program, along with all the messages requested by and returned to other application programs running at the same time. IMS uses the processing limit count (PLCT) and other tools to ensure that application programs get the appropriate share of resources. As long as your IMS application program does not exceed the PLCT[8], it continues running and processing messages or waiting for the next message. However, if you are trying to debug the application program, the continued message processing or waiting for messages might make Debug Tool appear unresponsive. To avoid this situation, try one of the following options at the beginning of your debug session, before you begin running the application program (for example, by entering the `GO` command):

- Set a breakpoint as close as possible to the area you want to debug.
- Set a breakpoint at the GU call statement.

Related references

IMS System Definition Reference

8. IMS Quick reschedule allows application programs to process more than the PLCT for each physical schedule. Quick reschedule helps eliminate processing overhead caused by unnecessary rescheduling and reloading of application programs.

Chapter 38. Debugging CICS programs

This topic describes tasks you can do while debugging CICS programs, and describes some restrictions.

Before you can debug your programs under CICS, verify that you have completed the following tasks:

- Ensured that all of the required installation and configuration steps for CICS Transaction Server, Language Environment, and Debug Tool have been completed. For more information, refer to the installation and customization guides for each product.
- Completed all the tasks in the following topics:
  - Chapter 3, “Planning your debug session,” on page 23
  - Chapter 4, “Updating your processes so you can debug programs with Debug Tool,” on page 59
  - Chapter 9, “Preparing a CICS program,” on page 83
  - Chapter 17, “Starting Debug Tool under CICS,” on page 141

Displaying the contents of channels and containers

You can display the contents of CICS channels by using the `DESCRIBE CHANNEL` command and the contents of a container by using the `LIST CONTAINER` command.

The section "Enhanced inter-program data transfer: channels as modern-day COMMAREAs" in the *CICS Application Programming Guide* describes the benefits of containers and channels and how to use them in your programs.

To display a list of containers in the current channel, enter the command `DESCRIBE CHANNEL`. To display a list of containers in another channel, enter the command `DESCRIBE CHANNEL` *`channel_name`*, where *channel_name* is the name of a specific channel. In either case, Debug Tool displays a list similar to the following list:

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```
COBOL    LOCATION: ZCONPRGA :> 274.1
Command ===>                                                  Scroll ===> PAGE
MONITOR -+----1----+----2----+----3----+----4----+----5----+----6- LINE: 1 OF 2
****************************** TOP OF MONITOR *******************************
                                ----+----1----+----2----+----3----+----4----
0001  1 ********** AUTOMONITOR **********
0002    01 DFHC0160               'PrgA-ChanB-ContC'
***************************** BOTTOM OF MONITOR *****************************

SOURCE: ZCONPRGA -1----+----2----+----3----+----4----+----5--- LINE: 272 OF 307
     272       *              FLENGTH(LENGTH OF PrgA-ChanB-XXXXX)             .
     273       *              END-EXEC                                        .
     274            Move 'PrgA-ChanB-ContC' to dfhc0160                       .
     275            Move 'PrgA-CHANB' to dfhc0161                             .
     276            Call 'DFHEI1' using by content x'341670000720000002000000 .
     277       -    '00f0f0f0f5f3404040' by content x'0000' by reference      .
     278            PrgA-ChanB-XXXXX by reference dfhc0160 by content LENGTH  .
     279            PrgA-ChanB-XXXXX by content x'0000' by content x'0000' by .
     280            content x'0000' by content x'0000' by content x'0000' by  .
     281            content x'0000' by content x'0000' by content x'0000' by  .
     282            content x'0000' by content x'0000' by content x'0000' by  .
     283            content x'0000' by content x'0000' by content x'0000' by  .
LOG 0----+----1----+----2----+----3----+----4----+----5----+-- LINE: 147 OF 289
0147  DESCRIBE CHANNEL * ;
0148 CHANNEL                 PrgA-ChanB
0149 CONTAINER NAME                SIZE
0150 ------------------------------------
0151 PrgA-ChanB-ContC                21
0152 PrgA-ChanB-ContB                21
0153 PrgA-ChanB-ContA                21
0154 CHANNEL                 PRGA-CHANA
0155 CONTAINER NAME                SIZE
0156 ------------------------------------
0157 PRGA-CHANA-CONTC                21
PF  1:?          2:STEP       3:QUIT       4:LIST       5:FIND       6:AT/CLEAR
PF  7:UP         8:DOWN       9:GO        10:ZOOM      11:ZOOM LOG  12:RETRIEVE
```

To display the contents of a container in the current channel, enter the command `LIST CONTAINER` *`container_name`*, where *container_name* is the name of a particular channel. To display the contents of a container in another channel, enter the command `LIST CONTAINER` *`channel_name container_name`*, where *channel_name* is the name of another channel. In either case, Debug Tool displays the contents of the container in a format similar to the following diagram:

```
COBOL    LOCATION: ZCONPRGA :> 211.1
Command ===>                                                  Scroll ===> PAGE
MONITOR -+----1----+----2----+----3----+----4----+----5----+----6- LINE: 1 OF 2
****************************** TOP OF MONITOR *******************************
                                ----+----1----+----2----+----3----+----4----
0001  1 ********** AUTOMONITOR **********
0002    01 DFHC0160              'PRGA-CHANA-CONTC'
***************************** BOTTOM OF MONITOR *****************************

SOURCE: ZCONPRGA -1----+----2----+----3----+----4----+----5--- LINE: 209 OF 307
     209       *              FLENGTH(LENGTH OF PrgA-ChanB-ContA)             .
     210       *              END-EXEC                                        .
     211            Move 'PrgA-ChanB-ContA' to dfhc0160                       .
     212            Move 'PrgA-ChanB' to dfhc0161                             .
     213            Call 'DFHEI1' using by content x'341670000720000002000000 .
     214       -    '00f0f0f0f3f5404040' by content x'0000' by reference      .
     215            PrgA-ChanB-ContA by reference dfhc0160 by content LENGTH  .
     216            PrgA-ChanB-ContA by content x'0000' by content x'0000' by .
     217            content x'0000' by content x'0000' by content x'0000' by  .
     218            content x'0000' by content x'0000' by content x'0000' by  .
     219            content x'0000' by content x'0000' by content x'0000' by  .
     220            content x'0000' by content x'0000' by content x'0000' by  .
LOG 0----+----1----+----2----+----3----+----4----+----5----+---- LINE: 15 OF 25
0015  STEP ;
0016  DESCRIBE CHANNEL * ;
0017 CHANNEL                 PRGA-CHANA
0018 CONTAINER NAME                  SIZE
0019 ------------------------------------
0020 PRGA-CHANA-CONTC                  21
0021 PRGA-CHANA-CONTB                  21
0022 PRGA-CHANA-CONTA                  21
0023  LIST CONTAINER PRGA-CHANA PRGA-CHANA-CONTC ;
0024 000C7F78  D7D9C7C1 60C3C8C1 D5C160C3 D6D5E3C3   *PRGA-CHANA-CONTC*
0025 000C7F88  60C4C1E3 C1                           *-DATA           *
PF  1:?          2:STEP       3:QUIT       4:LIST       5:FIND       6:AT/CLEAR
PF  7:UP         8:DOWN       9:GO        10:ZOOM      11:ZOOM LOG  12:RETRIEVE
```

Refer to the following topics for more information related to the material discussed in this topic.

- **Related references**
- DESCRIBE CHANNEL command in *Debug Tool Reference and Messages*
- LIST CONTAINER command in *Debug Tool Reference and Messages*

Controlling pattern-match breakpoints with the DISABLE and ENABLE commands

This topic describes how you can use the DISABLE and ENABLE commands to control pattern-match breakpoints. A *pattern-match* breakpoint is a breakpoint that is identified by the name, or part of the name, of a load module or compile unit specified in a DTCN or CADP profile.

The DISABLE command works with the debugging profile that started the current debugging session to prevent programs from being debugged. When you enter the DISABLE command, you specify the name, or part of the name, of a load module, compile unit, or both, that you do not want to debug. When Debug Tool finds a load module, compile unit, or both, whose name matches the name or part of the name (a pattern) that you specified, Debug Tool does not debug that program. When you enter the ENABLE command, you specify the pattern (the full name or part of a name of a load module, compile unit, or both) that you want to debug. The pattern must match the name of a load module, compile unit, or both, that you specified in a previously entered DISABLE command.

Before you begin, verify that you know which debugging profile started Debug Tool (DTCN or CADP) and the names you specified in the LoadMod::>CU field (for DTCN) or the Program field, Compile Unit field, or both (for CADP).

To use the DISABLE command to prevent Debug Tool from debugging a program, do the following steps:

1. If you don't remember what programs you might have disabled, enter the command LIST DTCN or LIST CADP. This command lists the programs you have already disabled. This step reminds you of the names of load modules, programs, or compile units you already disabled.
2. If you are running with a CADP profile, enter the command DISABLE CADP PROGRAM *program_name* CU *compile_unit_name*. *program_name* is the name of the program, or it matches the pattern of the name of a program, that you specified in the Program field and it is the program that you do not want to debug. *compile_unit_name* is the name of the compile unit, or it matches the pattern of the name of a compile unit, that you specified in the Compile Unit field and it is the compile unit that you do not want to debug. You can specify PROGRAM *program_name*, CU *compile_unit_name*, or both.

   For example, if you have the following circumstances, enter the command DISABLE CADP PROGRAM ABD2 to prevent Debug Tool from debugging the program ABD2:

   - You specified ABD* in the Program field of the profile.
   - You have programs with the name ABD1, ABD2, ABD3, ABD4, and ABD5.
3. If you are running with a DTCN profile, enter the command DISABLE DTCN LOADMOD *load_module_name* CU *compile_unit_name*. *load_module_name* is the name of the load module, or it matches the pattern of the name of a load module, that you specified in the LoadMod field and it is the load module that you do not want to debug. *compile_unit_name* is the name of the compile unit, or it matches the pattern of the name of a compile unit, that you specified in the CU field and it is the compile unit that you do not want to debug. You can specify LOADMOD *load_module_name*, CU *compile_unit_name*, or both.

   For example, if you have the following circumstances, enter the command DISABLE DTCN CU STAR2 to prevent Debug Tool from debugging the compile unit STAR2:

   - You specified STAR* in the CU field of the profile.
   - You have compile units with the names STAR1, STAR2, STAR3, STAR4, and STAR5.

To use the ENABLE command to allow a previously disabled program to be debugged, do the following steps:

1. If you don't remember the exact name of the disabled load module, program, or compile unit, enter the command LIST DTCN or LIST CADP. This command lists the programs you have disabled. Write down the name of the load module, program, or compile unit that you want to debug.
2. If you are running with a CADP profile, enter the command ENABLE CADP PROGRAM *program_name* CU *compile_unit_name*, where *program_name* is the name of the program and *compile_unit_name* is the name of the compile unit that you wrote down from step 1. If you only need to specify a program name, you do not have to type in the CU *compile_unit_name* portion of the command. If you only need to specify a compile unit name, you do not have to type in the PROGRAM *program_name* portion of the command.
3. If you are running with a DTCN profile, enter the command ENABLE DTCN LOADMOD *load_module_name* CU *compile_unit_name*, where *load_module_name* is

the name of the load module and *compile_unit_name* is the name of the compile unit you wrote down from step 1 on page 366. If you only need to specify a load module name, you do not have to type in the `CU` *`compile_unit_name`* portion of the command. If you only need to specify a compile unit name, you do not have to type in the `LOADMOD` *`load_module_name`* portion of the command.

Refer to the following topics for more information related to the material discussed in this topic.

Related references

DISABLE command in *Debug Tool Reference and Messages*
ENABLE command in *Debug Tool Reference and Messages*
LIST CADP or DTCN command in *Debug Tool Reference and Messages*

Preventing Debug Tool from stopping at EXEC CICS RETURN

Debug Tool stops at `EXEC CICS RETURN` and displays the following message:

```
CEE0199W The termination of a thread was signaled due to a STOP statement.
```

To prevent Debug Tool from stopping at every `EXEC CICS RETURN` statement in your application and suppress this message, set the TEST level to ERROR by using the `SET TEST ERROR` command.

Early detection of CICS storage violations

CICS can detect various types of storage violations. The *CICS Problem Determination Guide* describes the types of storage violations that CICS can detect and when CICS detects them automatically. You can request that Debug Tool detect one type of storage violation (whether the storage check zone of a user-storage element has been overlaid). You can make this request at any time.

To instruct Debug Tool to check for storage violations, enter the command `CHKSTGV`. Debug Tool checks the task that you are debugging for storage violations.

You can instruct Debug Tool to check for storage violations more frequently by including the command as part of a breakpoint. For example, the following commands check for a storage violation at each statement in a COBOL program and causes Debug Tool to stop if a violation is detected in the current procedure:

```
AT STATEMENT *
  PERFORM
    CHKSTGV ;
    IF %RC = 0 THEN
      GO ;
    END-IF ;
  END-PERFORM ;
```

If you plan on running a check at every statement, run it on as few statements as possible because the check causes overhead that can affect performance.

Refer to the following topics for more information related to the material discussed in this topic.

Related references

CICS Problem Determination Guide

Saving settings while debugging a pseudo-conversational CICS program

If you change the Debug Tool display settings (for example, color settings) while you debug a pseudo-conversational CICS program, Debug Tool might restore the default settings. To ensure that your changes remain in effect every time your program starts Debug Tool, store your display settings in the preferences file or the commands file.

Saving and restoring breakpoints and monitor specifications for CICS programs

When you set any of the following specifications to AUTO, these specifications are used to control the saving and restoring of breakpoints and LOADDEBUGDATA specifications between Debug Tool settings:

- SAVE BPS
- SAVE MONITORS
- RESTORE BPS
- RESTORE MONITORS

You set switches by using the `SET` command. The SAVE BPS and SAVE MONITORS switches enable the saving of breakpoints and monitor specifications between debugging sessions. The RESTORE BPS and RESTORE MONITORS switches control the restoring of breakpoints and monitor specifications at the start of subsequent debugging sessions. Setting these switches to AUTO enables the automatic saving and restoring of this information. You must also enable the SAVE SETTING AUTO switch so that these settings are in effect at the start of subsequent debugging sessions.

While you run in CICS, consider the following requirements:

- You must log on as a user other than the default user.
- The CICS region must have update authorization to the SAVE SETTINGS and SAVE BPS data sets.

When you activate a DTCN profile for a full-screen debugging session and SAVE BPS, SAVE MONITORS, RESTORE BPS, and RESTORE MONITORS all specify NOAUTO, Debug Tool saves most of the breakpoint and `LOADDEBUGDATA` information for that session into the profile. When the DTCN profile is deleted, the breakpoint and `LOADDEBUGDATA` information is deleted.

See “Performance considerations in multi-enclave environments” on page 188 for information about performance savings and restoring settings, breakpoints, and monitors under CICS.

Refer to the following topics for more information related to the material discussed in this topic.

Related references

Debug Tool Reference and Messages

Restrictions when debugging under CICS

The following restrictions apply when debugging programs with the Debug Tool in a CICS environment.

- You can use CRTE terminals only in single terminal mode and screen control mode. You cannot use them in separate terminal mode.
- The `__ctest()` function with CICS does nothing.
- The CDT# transaction is a Debug Tool service transaction used during separate terminal mode debugging and is not intended for activation by direct terminal input. If CDT# is started via terminal entry, it will return to the caller (no function is performed).
- Applications that issue EXEC CICS POST cannot be debugged in separate terminal mode or screen control mode.
- References to DD names are not supported. All files, including the log file, USE files, and preferences file, must be referred to by their full data set names.
- The commands `TSO`, `SET INTERCEPT`, and `SYSTEM` cannot be used.
- CICS does not support an attention interrupt from the keyboard.
- The CICS region must have read authorization to the preferences and commands files.
- If the EQAOPTS `LOGDSN` command does not specify a naming pattern, Debug Tool does not automatically start the log file. You need to run the `SET LOG ON` *`fileid`* command.

  If the EQAOPTS `LOGDSN` command specifies a naming pattern, Debug Tool automatically starts the log file by running the `SET LOG ON` *`fileid`* command.

  If you are not logged into CICS or are logged in under the default user ID, Debug Tool does not run the EQAOPTS `LOGDSN` command; therefore, Debug Tool does not automatically start a log file.

  The CICS region must have update authorization to the log file.
- Ensure that you allocate a log file big enough to hold all the log output from a debug session, because the log file is truncated after it becomes full. (A warning message is not issued before the log is truncated.)
- Debug Tool disables Omegamon RLIM processing for any CICS task which is being debugged.
- You can start Debug Tool when a non-Language Environment assembler or non-Language Environment COBOL program under CICS starts by defining a debug profile by using CADP or DTCN. But Debug Tool will only start on a CICS Link Level boundary, such as when the first program of the task starts or for the first program to run at a new Link Level. For profiles defined in CADP or DTCN which list a non-Language Environment assembler or non-Language Environment COBOL program name that is dynamically called using EXEC CICS LOAD/CALL, Debug Tool will not start. Non-Language Environment assembler or non-Language Environment COBOL programs that are called in this way are identified by Debug Tool in an already-running debugging session and can be stopped by using a command like `AT APPEARANCE` or `AT ENTRY`. However, they cannot be used to trigger a Debug Tool session initially.

Accessing CICS resources during a debugging session

You can gain access to CICS temporary storage and transient data queues during your debugging session by using the `CALL %CEBR` command. You can do all the functions you can currently do while in the CICS-supplied CEBR transaction. For access to general CICS resources (for example, information about the CICS system you are debugging on or opening and reading a VSAM file) you can use the `CALL %CECI` command. This command gives control to the CICS-supplied CECI transaction. Press PF3 from inside CEBR or CECI to return to the debug session. For more information about CEBR and CECI, see *CICS Supplied Transactions*.

Accessing CICS storage before or after a debugging session

You can uses the DTST transaction to display and modify CICS storage. See Appendix F, “Displaying and modifying CICS storage with DTST,” on page 479 for more information.

Chapter 39. Debugging ISPF applications

You can debug ISPF applications in one of the following ways:

- Starting a separate terminal using full-screen mode using a dedicated terminal without Terminal Interface Manager. When you run your program, specify the `MFI` suboption of the `TEST` runtime option. The `MFI` suboption requires that you specify the VTAM LU name of the separate terminal that you started, as in the following example:

  ```
  TEST(,,MFI%TRMLU001)
  ```

- Starting a separate terminal using full-screen mode using the Terminal Interface Manager. When you run your program, specify the `VTAM` suboption of the `TEST` runtime option. The `VTAM` suboption requires that you specify your user ID, as in the following example:

  ```
  TEST(,,VTAM%USERABCD)
  ```

- Using remote debug mode.
- Using the same emulator session. PA2 refreshes the ISPF application panel and removes residual Debug Tool output from the emulator session. However, if Debug Tool sends output to the emulator session between displays of the ISPF application panels, you need to press PA2 after each ISPF panel display.

The rest of this section assumes that you are debugging ISPF applications using the same emulator session.

When you debug ISPF applications or applications that use line mode input and output, issue the `SET REFRESH ON` command. This command is executed and is displayed in the log output area of the Command/Log window.

Refer to the following topics for more information related to the material discussed in this topic.

Related concepts

"Remote debug mode" on page 5

Related tasks

Chapter 27, "Customizing your full-screen session," on page 265

"Preparing to debug" in the online help for the compiled language debugger component of Rational Developer for System z.

"Preparing to debug" in the online help for the IBM Debug Tool plug-in for Eclipse.

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Chapter 40. Debugging programs in a production environment

Programs in a production environment have any of the following characteristics:

- The programs are compiled without hooks.
- The programs are compiled with the optimization compiler option, usually the `OPT` compiler option.
- The programs are compiled with COBOL compilers that support the `SEPARATE` suboption of the `TEST` compiler option.

This section helps you determine how much of Debug Tool's testing functions you want to continue using after you complete major testing of your application and move into the final tuning phase. Included are discussions of program size and performance considerations; the consequences of removing hooks, the statement table, and the symbol table; and using Debug Tool on optimized programs.

Refer to the following topics for more information related to the material discussed in this topic.

Related tasks

"Fine-tuning your programs for Debug Tool"
"Debugging without hooks, statement tables, and symbol tables" on page 374
"Debugging optimized COBOL programs" on page 376

Fine-tuning your programs for Debug Tool

After initial testing, you might want to consider the following options available to improve performance and reduce size:

- Compile your COBOL programs with optimization compiler options, as described in "Debugging optimized COBOL programs" on page 376. You cannot debug PL/I and C/C++ programs that are optimized.
- Removing the hooks, which can improve the performance of your program.
- Removing the statement and symbol tables, which can reduce the size of your program.

Removing hooks

One option for increasing the performance of your program is to compile with a minimum of hooks or with no hooks.

- For C programs, compiling with the option `TEST(NOLINE,BLOCK,NOPATH)` causes the compiler to insert a minimum number of hooks while still allowing you to perform tasks at block boundaries.
- For COBOL programs, compiling with the following compiler suboptions creates programs that do not have hooks:
  - `TEST(NONE)` for any release of the Enterprise COBOL for z/OS, Version 3, or COBOL OS/390 & VM, Version 2, compiler
  - `TEST(NOHOOK)` for Enterprise COBOL for z/OS, Version 4.1

  Using the Dynamic Debug facility, Debug Tool inserts hooks while debugging the program, allowing you to perform almost any debugging task.

Independent studies show that performance degradation is negligible because of hook-overhead for PL/I programs. Also, in the event you need to request an attention interrupt, Debug Tool is not able to regain control without compiled-in hooks. In such a case you can request an interrupt three times. After the third time,

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Debug Tool is able to stop program execution and prompt you to enter QUIT or GO. If you enter QUIT, your Debug Tool session ends. If you enter GO, control is returned to your application.

Programs compiled with certain suboptions of the TEST compiler option have hooks inserted at compile time. However, if the Dynamic Debug facility is activated (which is the default, unless altered by the DYNDEBUG EQAOPTS command) and the programs are compiled with certain compilers, the compiled-in hooks are replaced with runtime hooks. This replacement is done to improve the performance of Debug Tool. Certain path hook functions are limited when you use the Dynamic Debug facility. To enable these functions, enter the SET DYNDEBUG OFF command, which deactivates the Dynamic Debug facility. See *Debug Tool Reference and Messages* for a description of these commands.

It is a good idea to examine the benefits of maintaining hooks in light of the performance overhead for that particular program.

Removing statement and symbol tables

If you are concerned about the size of your program, you can remove the symbol table, the statement table, or both, after the initial testing period. For C and PL/I programs, compiling with the option TEST(NOSYM) inhibits the creation of symbol tables.

Before you remove them, however, you should consider their advantages. The statement table allows you to display the execution history with statement numbers rather than offsets, and error messages identify statement numbers that are in error. The symbol table enables you to refer to variables and program control constants by name. Therefore, you need to look at the trade-offs between the size of your program and the benefits of having symbol and statement tables.

For programs that are compiled with the following compilers and with the SEPARATE suboption of the TEST compiler option, the symbol tables are saved in a separate debug file. This arrangement lets you to retain the symbol table information and have a smaller program:

- Enterprise COBOL for z/OS, Version 4.1
- Enterprise COBOL for z/OS and OS/390, Version 3
- COBOL for OS/390 & VM, Version 2 Release 2
- COBOL for OS/390 & VM, Version 2 Release 1, with APAR PQ40298
- Enterprise PL/I for z/OS, Version 3.5 or later

For C and C++ programs compiled with the C/C++ compiler of z/OS, Version 1.6 or later, you can compile with the FORMAT(DWARF) suboption of the DEBUG compiler option to save debug information in a separate debug file. This produces a smaller program.

Debugging without hooks, statement tables, and symbol tables

Debug Tool can gain control at program initialization by using the PROMPT suboption of the TEST run-time option. Even when you have removed all hooks and the statement and symbol tables from a production program, Debug Tool receives control when a condition is raised in your program if you specify ALL or ERROR on the TEST run-time option, or when a __ctest(), CEETEST, or PLITEST is executed.

When Debug Tool receives control in this limited environment, it does not know what statement is in error (no statement table), nor can it locate variables (no symbol table). Thus, you must use addresses and interpret hexadecimal data values to examine variables. In this limited environment, you can:

- Determine the block that is in control:

  ```
  list (%LOAD, %CU, %BLOCK);
  or
  list (%LOAD, %PROGRAM, %BLOCK);
  ```

- Determine the address of the error and of the compile unit:

  ```
  list (%ADDRESS, %EPA);  (where %EPA is allowed)
  ```

- Display areas of the program in hexadecimal format. Using your listing, you can find the address of a variable and display the contents of that variable. For example, you can display the contents at address 20058 in a C and C++ program by entering:

  ```
  LIST STORAGE (0x20058);
  ```

  To display the contents at address 20058 in a COBOL or PL/I program, you would enter:

  ```
  LIST STORAGE (X'20058');
  ```

- Display registers:

  ```
  LIST REGISTERS;
  ```

- Display program characteristics:

  ```
  DESCRIBE CU;  (for C)

  DESCRIBE PROGRAM;  (for COBOL)
  ```

- Display the dynamic block chain:

  ```
  LIST CALLS;
  ```

- Request assistance from your operating system:

  ```
  SYSTEM ...;
  ```

- Continue your program processing:

  ```
  GO;
  ```

- End your program processing:

  ```
  QUIT;
  ```

If your program does not contain a statement or symbol table, you can use session variables to make the task of examining values of variables easier.

Even in this limited environment, HLL library routines are still available.

Programs that are compiled with the following combination of compilers and compiler options can have the best performance and smallest module size, while retaining full debugging capabilities:

- Enterprise COBOL for z/OS, Version 4.1, with the `TEST(NOHOOK,SEPARATE)` compiler option.
- Enterprise COBOL for z/OS and OS/390, Version 3, with the `TEST(NONE,SYM,SEPARATE)` compiler option.
- COBOL for OS/390 & VM, Version 2, with the `TEST(NONE,SYM,SEPARATE)` compiler option.
- Enterprise PL/I for z/OS, Version 3.5 or later, with the `TEST(ALL,SYM,NOHOOK,SEPERATE)` compiler option.

Debugging optimized COBOL programs

Before debugging an optimized COBOL program, you must compile it with the correct compiler options. See “Choosing TEST or NOTEST compiler suboptions for COBOL programs” on page 27.

The following list describes the tasks you can do while debugging optimized COBOL programs:

- You can set breakpoints. If the optimizer moves or removes a statement, you can't set a breakpoint at that statement.
- You can display the value of a variable by using the `LIST` or `LIST TITLED` commands. Debug Tool displays the correct value of the variable.
- You can step through programs one statement at a time, or run your program until you encounter a breakpoint.
- You can use the `SET AUTOMONITOR` and `PLAYBACK` commands.
- You can modify variables in an optimized program that was compiled with one the following compilers:
  - Enterprise COBOL for z/OS, Version 4.1
  - Enterprise COBOL for z/OS and OS/390, Version 3 Release 2 or later
  - Enterprise COBOL for z/OS and OS/390, Version 3 Release 1 with APAR PQ63235 installed
  - COBOL for OS/390 & VM, Version 2 Release 2
  - COBOL for OS/390 & VM, Version 2 Release 1 with APAR PQ63234 installed

  However, results might be unpredictable. To obtain more predictable results, compile your program with Enterprise COBOL for z/OS, Version 4.1, and specify the `EJPD` suboption of the `TEST` compiler option. However, variables that are declared with the VALUE clause to initialize them cannot be modified.
- If you are using Enterprise COBOL for z/OS, Version 4.1 and specify the `EJPD` suboption of the `TEST` compiler option, you can use the `JUMPTO` and `GOTO` commands.

The enhancements to the compilers help you create programs that can be debugged in the same way that you debug programs that are not optimized, with the following exceptions

- You cannot change the flow of your program.
- You cannot use the `GOTO` or `JUMPTO` command, unless you are compiling with Enterprise COBOL for z/OS, Version 4.1, and you specify the `EJPD` suboption of the `TEST` compiler option.
- You cannot use the `AT CALL` *`entry_name`* command. Instead, use the `AT CALL *` command.
- If the optimizer discarded a variable, you can refer to the variable only by using the `DESCRIBE ATTRIBUTES` command. If you try to use any other command, Debug Tool displays a message indicating that the variable was discarded by the optimization techniques of the compiler.
- If you use the `AT` command, the following restrictions apply:
  - You cannot specify a line number where all the statements have been removed.
  - You cannot specify a range of line numbers where all the statements have been removed.

– You cannot specify a range of line numbers where the beginning point or ending point specifies a line number where all the statements have been removed.

The Source window does display the variables and statements that the optimizer removed, but you cannot use any Debug Tool commands on those variables or statements. For example, you cannot list the value of a variable removed by the optimizer.

Chapter 41. Debugging UNIX System Services programs

You must debug your UNIX System Services programs in one of the following debugging modes:

- remote debug mode
- full-screen mode using the Terminal Interface Manager

If your program spans more than one process, you must debug it in remote debug mode.

If one or more of the programs you are debugging are in a shared library and you are using dynamic debugging, you need to assign the environment variable `_BPX_PTRACE_ATTACH` a value of `YES`. This enables Debug Tool to set hooks in the shared libraries. Programs that have a `.so` suffix are programs in a shared library. For more information about how to set environment variables, see your UNIX System Services documentation.

Debugging MVS POSIX programs

You can debug MVS POSIX programs, including the following types of programs:

- Programs that store source in HFS
- Programs that use POSIX multithreading
- Programs that use fork/exec
- Programs that use asynchronous signals that are handled by the Language Environment condition handler

To debug MVS POSIX programs in full screen mode or batch mode, the program must run under TSO or MVS batch. If you want to run your program under the UNIX SHELL, you must debug in full-screen mode using the Terminal Interface Manager or remote debug mode. To debug any MVS POSIX program that spans more than one process, you must debug the program in remote debug mode.

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Chapter 42. Debugging non-Language Environment programs

There are several considerations that you must make when you debug programs that do not run under the Language Environment. Some of these are unique to programs that contain no Language Environment routines, others pertain only when the initial program does not execute under control of the Language Environment, and still others apply to all programs that have mixtures of non-Language Environment and Language Environment programs.

Refer to the following topics for more information related to the material discussed in this topic.

Related tasks

Chapter 13, “Starting Debug Tool from the Debug Tool Utilities,” on page 117

Debugging exclusively non-Language Environment programs

When Language Environment is not active, you can debug only assembler, disassembly, or non-Language Environment COBOL programs. Debugging programs written in other languages requires the presence of an active Language Environment.

Debugging MVS batch or TSO non-Language Environment initial programs

If the initial program that is invoked does not run under Language Environment, and you want to begin debugging before Language Environment is initialized, you must use the EQANMDBG program to start both Debug Tool and your user program.

You do not have to use EQANMDBG to initiate a Debug Tool session if the initial user program runs under control of the Language Environment, even if other parts of the program do not run under the Language Environment.

When you use EQANMDBG to debug an assembler program that creates a COBOL reusable runtime environment, Debug Tool is not able to debug any COBOL programs. You can create a COBOL reusable runtime environment in one of the following ways:

- Calling the preinitialization routine ILBOSTP0
- Calling the preinitialization routine IGZERRE
- Specifying the runtime option RTEREUS.

Refer to the following topics for more information related to the material discussed in this topic.

Related references

Chapter 16, “Starting Debug Tool for batch or TSO programs,” on page 133

z/OS Language Environment Debugging Guide

Debugging CICS non-Language Environment assembler or non-Language Environment COBOL initial programs

The non-Language Environment assembler or non-Language Environment COBOL program that you specify in a DTCN or CADP profile that starts a debugging session must be one of the following:

- The first program started for the CICS transaction.

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- The first program that runs for an `EXEC CICS LINK` or `XCTL` statement.

Part 7. Debugging complex applications

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Chapter 43. Debugging multilanguage applications

To support multiple high-level programming languages (HLL), Debug Tool adapts its commands to the HLLs, provides *interpretive subsets* of commands from the various HLLs, and maps common attributes of data types across the languages. It evaluates HLL expressions and handles constants and variables.

The topics below describe how Debug Tool makes it possible for you to debug programs consisting of different languages, structures, conventions, variables, and methods of evaluating expressions.

A general rule to remember is that Debug Tool tries to let the language itself guide how Debug Tool works with it.

Refer to the following topics for more information related to the material discussed in this topic.

Related tasks

"Qualifying variables and changing the point of view" on page 387
"Debugging multilanguage applications" on page 391
"Handling conditions and exceptions in Debug Tool" on page 389

Related references

"Debug Tool evaluation of HLL expressions"
"Debug Tool interpretation of HLL variables and constants" on page 386
"Debug Tool commands that resemble HLL commands" on page 386
"Coexistence with other debuggers" on page 394
"Coexistence with unsupported HLL modules" on page 394

Debug Tool evaluation of HLL expressions

When you enter an expression, Debug Tool records the programming language in effect at that time. When the expression is run, Debug Tool passes it to the language run time in effect when you entered the expression. This run time might be different from the one in effect when the expression is run.

When you enter an expression that will not be run immediately, you should fully qualify all program variables. Qualifying the variables assures that proper context information (such as load module and block) is passed to the language run time when the expression is run. Otherwise, the context might not be the one you intended when you set the breakpoint, and the language run time might not evaluate the expression.

Refer to the following topics for more information related to the material discussed in this topic.

Related references

"Debug Tool evaluation of C and C++ expressions" on page 317
"Debug Tool evaluation of COBOL expressions" on page 287
"Debug Tool evaluation of PL/I expressions" on page 305

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Debug Tool interpretation of HLL variables and constants

Debug Tool supports the use of HLL variables and constants, both as a part of evaluating portions of your test program and in declaring and using session variables.

Three general types of variables supported by Debug Tool are:

- Program variables defined by the HLL compiler's symbol table
- Debug Tool variables denoted by the percent (**%**) sign
- Session variables declared for a given Debug Tool session and existing only for the session

HLL variables

Some variable references require language-specific evaluation, such as pointer referencing or subscript evaluation. Once again, the Debug Tool interprets each case in the manner of the HLL in question. Below is a list of some of the areas where Debug Tool accepts a different form of reference depending on the current programming language:

- Structure qualification
  C and C++ and PL/I: dot (.) qualification, high-level to low-level
  COBOL: `IN` or `OF` keyword, low-level to high-level
- Subscripting
  C and C++: `name [subscript1][subscript2]...`
  COBOL and PL/I: `name(subscript1,subscript2,...)`
- Reference modification
  COBOL `name(left-most-character-position: length)`

HLL constants

You can use both string constants and numeric constants. Debug Tool accepts both types of constants in C and C++, COBOL, and PL/I.

Debug Tool commands that resemble HLL commands

To allow you to use familiar commands while in a debug session, Debug Tool provides an *interpretive subset* of commands for each language. This consists of commands that have the same syntax, whether used with Debug Tool or when writing application programs. You use these commands in Debug Tool as though you were coding in the original language.

Use the `SET PROGRAMMING LANGUAGE` command to set the current programming language to the desired language. The current programming language determines how commands are parsed. If you `SET PROGRAMMING LANGUAGE` to `AUTOMATIC`, every time the current qualification changes to a module in a different language, the current programming language is automatically updated.

The following types of Debug Tool commands have the same syntax (or a subset of it) as the corresponding statements (if defined) in each supported programming language:

Assignment
These commands allow you to assign a value to a variable or reference.

Conditional
These commands evaluate an expression and control the flow of execution of Debug Tool commands according to the resulting value.

Declarations
These commands allow you to declare session variables.

Looping
These commands allow you to program an iterative or logical loop as a Debug Tool command.

Multiway
These commands allow you to program multiway logic in the Debug Tool command language.

In addition, Debug Tool supports special kinds of commands for some languages.

Related references
"Debug Tool commands that resemble C and C++ commands" on page 309
"Debug Tool commands that resemble COBOL statements" on page 281

Qualifying variables and changing the point of view

Each HLL defines a concept of name scoping to allow you, within a single compile unit, to know what data is referenced when a name is used (for example, if you use the same variable name in two different procedures). Similarly, Debug Tool defines the concepts of qualifiers and point of view for the run-time environment to allow you to reference all variables in a program, no matter how many subroutines it contains. The assignment `x = 5` does not appear difficult for Debug Tool to process. However, if you declare `x` in more than one subroutine, the situation is no longer obvious. If `x` is not in the currently executing compile unit, you need a way to tell Debug Tool how to determine the proper `x`.

You also need a way to change the Debug Tool's point of view to allow it to reference variables it cannot currently see (that is, variables that are not within the scope of the currently executing block or compile unit, depending upon the HLL's concept of name scoping).

Refer to the following topics for more information related to the material discussed in this topic.

Related tasks
"Qualifying variables"
"Changing the point of view" on page 389

Qualifying variables

Qualification is a method you can use to specify to what procedure or load module a particular variable belongs. You do this by prefacing the variable with the block, compile unit, and load module (or as many of these labels as are necessary), separating each label with a colon (or double colon following the load module specification) and a greater-than sign (:>), as follows:

load_name::>*cu_name*:>*block_name*:>*object*

This procedure, known as *explicit qualification*, lets Debug Tool know precisely where the variable is.

If required, *load_name* is the load module name. It is required only when the program consists of multiple load modules and when you want to change the qualification to other than the current load module. *load_name* can be the Debug Tool variable `%LOAD`.

If required, *cu_name* is the compile unit name. The *cu_name* is required only when you want to change the qualification to other than the currently qualified compile unit. *cu_name* can be the Debug Tool variable `%CU`.

If required, *block_name* is the program block name. The *block_name* is required only when you want to change the qualification to other than the currently qualified block. *block_name* can be the Debug Tool variable `%BLOCK`.

For PL/I only:

In PL/I, the primary entry name of the external procedure is the same as the compile unit name. When qualifying to the external procedure, the procedure name of the top procedure in a compile unit fully qualifies the block. Specifying both the compile unit and block name results in an error. For example:

```
LM::>PROC1:>variable
```

is valid.

```
LM::>PROC1:>PROC1:>variable
```

is not valid.

For C++ only:

You must specify the full function qualification including formal parameters where they exist. For example:

1. For function (or block) ICCD2263() declared as void ICCD2263(void) within CU "USERID.SOURCE.LISTING(ICCD226)" the correct block specification for C++ would include the parenthesis () as follows:

   ```
   qualify block %load::>"USERID.SOURCE.LISTING(ICCD226)":>ICCD2263()
   ```

2. For CU ICCD0320() declared as int ICCD0320(signed long int SVAR1, signed long int SVAR2) the correct qualification for `AT ENTRY` is:

   ```
   AT ENTRY "USERID.SOURCE.LISTING(ICCD0320)":>ICCD0320(long,long)
   ```

   Use the Debug Tool command `DESCRIBE CUS` to give you the correct `BLOCK` or `CU` qualification needed.

   Use the `LIST NAMES` command to show all polymorphic functions of a given name. For the example above, `LIST NAMES "ICCD0320*"` would list all polymorphic functions called `ICCD0320`.

You do not have to preface variables in the currently executing compile unit. These are already known to Debug Tool; in other words, they are *implicitly* qualified.

In order for attempts at qualifying a variable to work, each block must have a name. Blocks that have not received a name are named by Debug Tool, using the form: `%BLOCK`*nnn*, where *nnn* is a number that relates to the position of the block in the program. To find out the Debug Tool's name for the current block, use the `DESCRIBE PROGRAMS` command.

Refer to the following topics for more information related to the material discussed in this topic.

Related references

"Qualifying variables and changing the point of view in C and C++" on page 325

"Qualifying variables and changing the point of view in COBOL" on page 289

Changing the point of view

The point of view is usually the currently executing block. You can get to inaccessible data by changing the point of view using the SET QUALIFY command with the following operand.

load_name::>*cu_name*:>*block_name*

Each time you update any of the three Debug Tool variables %CU, %PROGRAM, or %BLOCK, all four variables (%CU, %PROGRAM, %LOAD, and %BLOCK) are automatically updated to reflect the new point of view. If you change %LOAD using SET QUALIFY LOAD, only %LOAD is updated to the new point of view. The other three Debug Tool variables remain unchanged. For example, suppose your program is currently suspended at loadx::>cux:>blockx. Also, the load module loadz, containing the compile unit cuz and the block blockz, is known to Debug Tool. The settings currently in effect are:

```
%LOAD = loadx
%CU = cux
%PROGRAM = cux
%BLOCK = blockx
```

If you enter any of the following commands:

```
SET QUALIFY BLOCK blockz;

SET QUALIFY BLOCK cuz:>blockz;

SET QUALIFY BLOCK loadz::>cuz:>blockz;
```

the following settings are in effect:

```
%LOAD = loadz
%CU = cuz
%PROGRAM = cuz
%BLOCK = blockz
```

If you are debugging a program that has multiple enclaves, SET QUALIFY can be used to identify references and statement numbers in any enclave by resetting the point of view to a new block, compile unit, or load module.

Related tasks

Chapter 45, "Debugging across multiple processes and enclaves," on page 397
"Changing the point of view in C and C++" on page 326
"Changing the point of view in COBOL" on page 291

Handling conditions and exceptions in Debug Tool

To suspend program execution just before your application would terminate abnormally, start your application with the following runtime options:

```
TRAP(ON)
TEST(ALL,*,NOPROMPT,*)
```

When a condition is signaled in your application, Debug Tool prompts you and you can then *dynamically* code around the problem. For example, you can initialize a pointer, allocate memory, or change the course of the program with the GOTO command. You can also indicate to Language Environment's condition handler, that you have handled the condition by issuing a GO BYPASS command. Be aware that some of the code that follows the instruction that raised the condition might rely on data that was not properly stored or handled.

When debugging with Debug Tool, you can (depending on your host system) either instruct the debugger to handle program exceptions and conditions, or pass them on to your own exception handler. Programs also have access to Language Environment services to deal with program exceptions and conditions.

Refer to the following topics for more information related to the material discussed in this topic.

Related tasks

"Handling conditions in Debug Tool"

"Handling exceptions within expressions (C and C++ and PL/I only)" on page 391

Handling conditions in Debug Tool

You can use either or both of the two methods during a debugging session to ensure that Debug Tool gains control at the occurrence of HLL conditions.

If you specify `TEST(ALL)` as a run-time option when you begin your debug session, Debug Tool gains control at the occurrence of most conditions.

Note: Debug Tool recognizes all Language Environment conditions that are detected by the Language Environment error handling facility.

You can also direct Debug Tool to respond to the occurrence of conditions by using the `AT OCCURRENCE` command to define breakpoints. These breakpoints halt processing of your program when a condition is raised, after which Debug Tool is given control. It then processes the commands you specified when you defined the breakpoints.

There are several ways a condition can occur, and several ways it can be handled.

When a condition can occur

A condition can occur during your Debug Tool session when:

- A C++ application throws an exception.
- A C and C++ application program executes a `raise` statement.
- A PL/I application program executes a `SIGNAL` statement.
- The Debug Tool command `TRIGGER` is executed.
- Program execution causes a condition to exist. In this case, conditions are not raised at consistency points (the operations causing them can consist of several machine instructions, and consistency points usually occur at the beginnings and ends of statements).
- The setting of `WARNING` is `OFF` (for C and C++ and PL/I).

When a condition occurs

When an HLL condition occurs and you have defined a breakpoint with associated actions, those actions are first performed. What happens next depends on how the actions end.

- Your program's execution can be terminated with a `QUIT` command. If you are debugging a CICS non-Language Environment assembler or non-Language Environment COBOL programs, `QUIT` ends Debug Tool and the task ends with an ABEND 4038.
- Control of your program's execution can be returned to the HLL exception handler, using the `GO` command, so that processing proceeds as if Debug Tool had never been invoked (even if you have perhaps used it to change some variable values, or taken some other action).

- Control of your program's execution can be returned to the program itself, using the `GO BYPASS` command, bypassing any further processing of this exception either by the user program or the environment.
- PL/I allows `GO TO out of block;`, so execution control can be passed to some other point in the program.
- If no circumstances exist explicitly directing the assignment of control, your primary commands file or terminal is queried for another command.

If, after the execution of any defined breakpoint, control returns to your program with a `GO`, the condition is raised again in the program (if possible and still applicable). If you use a `GOTO` to bypass the failing statement, you also bypass your program's error handling facilities.

Refer to the following topics for more information related to the material discussed in this topic.

Related references

"Language Environment conditions and their C and C++ equivalents" on page 316
"PL/I conditions and condition handling" on page 301
z/OS Language Environment Programming Guide
Enterprise COBOL for z/OS Language Reference

Handling exceptions within expressions (C and C++ and PL/I only)

When an exception such as division by zero is detected in a Debug Tool expression, you can use the Debug Tool command `SET WARNING` to control Debug Tool and program response. During an interactive Debug Tool session, such exceptions are sometimes due to typing errors and so are probably not intended to be passed to the program. If you do not want errors in Debug Tool expressions to be passed to your program, use `SET WARNING ON`. Expressions containing such errors are terminated, and a warning message is displayed.

However, you might want to pass an exception to your program, perhaps to test an error recovery procedure. In this case, use `SET WARNING OFF`.

Refer to the following topics for more information related to the material discussed in this topic.

Related tasks

"Using SET WARNING PL/I command with built-in functions" on page 307

Debugging multilanguage applications

Language Environment simplifies the debugging of multilanguage applications by providing a single run-time environment and interlanguage communication (ILC).

When the need to debug a multilanguage application arises, you can find yourself facing one of the following scenarios:

- You need to debug an application written in more than one language, where each language is supported by Language Environment and can be debugged by Debug Tool.
- You need to debug an application written in more than one language, where not all of the languages are supported by Language Environment, nor can they be debugged by Debug Tool.

When writing a multilanguage application, a number of special considerations arise because you must work outside the scope of any single language. The Language Environment initialization process establishes an environment tailored to the set of HLLs constituting the main load module of your application program. This removes the need to make explicit calls to manipulate the environment. Also, termination of the Language Environment environment is accomplished in an orderly fashion, regardless of the mixture of HLLs present in the application.

Refer to the following topics for more information related to the material discussed in this topic.

Related tasks

"Debugging an application fully supported by Language Environment"

"Using session variables across different programming languages"

Debugging an application fully supported by Language Environment

If you are debugging a program written in a combination of languages supported by Language Environment and compiled by supported compilers, very little is required in the way of special actions. Debug Tool normally recognizes a change in programming languages and automatically switches to the correct language when a breakpoint is reached. If desired, you can use the `SET PROGRAMMING LANGUAGE` command to stay in the language you specify; however, you can only access variables defined in the currently set programming language.

When defining session variables you want to access from compile units of different languages, you must define them with compatible attributes.

Refer to the following topics for more information related to the material discussed in this topic.

Related tasks

"Using session variables across different programming languages"

Related references

z/OS Language Environment Programming Guide

Using session variables across different programming languages

While working in one language, you can declare session variables that you can continue to use after calling in a load module of a different language. The table below shows how the attributes of session variables are mapped across programming languages. Session variables with attributes not shown in the table cannot be accessed from other programming languages. (Some attributes supported for C and C++ or PL/I session variables cannot be mapped to other languages; session variables defined with these attributes cannot be accessed outside the defining language. However, all of the supported attributes for COBOL session variables can be mapped to equivalent supported attributes in C and C++ and PL/I, so any session variable that you declare with COBOL can be accessed from C and C++ and PL/I.)

Machine attributes	PL/I attributes	C and C++ attributes	COBOL attributes	Assembler, disassembly, and LangX COBOL attributes
byte	`CHAR(1)`	`unsigned char`	`PICTURE X`	`DS X` or `DS C`
byte string	`CHAR(j)`	`unsigned char[j]`	`PICTURE X(j)`	`DS XLj` or `DS CLj`

Machine attributes	PL/I attributes	C and C++ attributes	COBOL attributes	Assembler, disassembly, and LangX COBOL attributes
halfword	FIXED BIN(15,0)	signed short int	PICTURE S9(j≤4) USAGE BINARY	DS H
fullword	FIXED BIN(31,0)	signed long int	PICTURE S9(4<j≤9) USAGE BINARY	DS F
floating point	FLOAT BIN(21) or FLOAT DEC(6)	float	USAGE COMP-1	DS E
long floating point	FLOAT BIN(53) or FLOAT DEC(16)	double	USAGE COMP-2	DS D
extended floating point	FLOAT BIN(109) or FLOAT DEC(33)	long double	n/a	DS L
fullword pointer	POINTER	*	USAGE POINTER	DS A

Note: When registering session variables in PL/I, the DECIMAL type is always the default. For example, if C declares a float, PL/I registers the variable as a FLOAT DEC(6) rather than a FLOAT BIN(21).

When declaring session variables, remember that C and C++ variable names are case-sensitive. When the current programming language is C and C++, only session variables that are declared with uppercase names can be shared with COBOL or PL/I. When the current programming language is COBOL or PL/I, session variable names in mixed or lowercase are mapped to uppercase. These COBOL or PL/I session variables can be declared or referenced using any mixture of lowercase and uppercase characters and it makes no difference. However, if the session variable is shared with C and C++, within C and C++, it can only be referred to with all uppercase characters (since a variable name composed of the same characters, but with one or more characters in lowercase, is a different variable name in C and C++).

Session variables with incompatible attributes cannot be shared between other programming languages, but they do cause session variables with the same names to be deleted. For example, COBOL has no equivalent to PL/I's FLOAT DEC(33) or C's long double. With the current programming language COBOL, if a session variable X is declared PICTURE S9(4), it will exist when the current programming language setting is PL/I with the attributes FIXED BIN(15,0) and when the current programming language setting is C with the attributes signed short int. If the current programming language setting is changed to PL/I and a session variable X is declared FLOAT DEC(33), the X declared by COBOL will no longer exist. The variable X declared by PL/I will exist when the current programming language setting is C with the attributes long double.

Refer to the following topics for more information related to the material discussed in this topic.

Related references

"Debug Tool interpretation of HLL variables and constants" on page 386

Creating a commands file that can be used across different programming languages

If you want to create a commands file to use across different programming languages, “Creating a commands file” on page 175 describes some guidelines you should follow to ensure that the commands files works correctly.

Coexistence with other debuggers

Coexistence with other debuggers cannot be guaranteed because there can be situations where multiple debuggers might contend for use of storage, facilities, and interfaces that are intended for only one requester.

Refer to the following topics for more information related to the material discussed in this topic.

Related references

“Coexistence with unsupported HLL modules”

Coexistence with unsupported HLL modules

Compile units or program units written in unsupported high- or low-level languages, or in older releases of HLLs, are tolerated. See *Using CODE/370 with VS COBOL II and OS PL/I* for information about two unsupported HLLs that can be used with Debug Tool.

Refer to the following topics for more information related to the material discussed in this topic.

Related references

“Coexistence with other debuggers”

Chapter 44. Debugging multithreading programs

You can run your multithreading programs with Debug Tool when POSIX pthread_create is used to create new threads under Language Environment. When more than one thread is involved in your program, Debug Tool might be started by any or all of them. Because conflicting use of the terminal or log file, for example, could occur if Debug Tool is operating on multiple threads, its use is single-threaded. So, if your program runs as two threads (thread A and thread B) and thread A calls Debug Tool, Debug Tool accepts the request and begins operating on behalf of thread A. If, during that period, thread B calls Debug Tool, the request from thread B is held until the request from thread A is complete (for example, you issued a STEP or GO command). Debug Tool is then released and can accept any pending invocation.

Restrictions when debugging multithreading applications

- Debugging applications that create another thread is constrained because both threads compete for the use of the terminal.
- Only the variables and symbol information for compile units in the thread that is being debugged are accessible.
- The `LIST CALL` command provides a traceback of the compile units only in the current thread.

Refer to the following topics for more information related to the material discussed in this topic.

Related references

z/OS Language Environment Programming Guide

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Chapter 45. Debugging across multiple processes and enclaves

There is a single Debug Tool session across all enclaves in a process. Breakpoints set in one process are restored when the new process begins in the new session.

In full-screen mode or batch mode, you can debug a non-POSIX program that spans more than one process, but Debug Tool can be active in only one process. In remote debug mode, you can debug a POSIX program that spans more than one process. The remote debugger can display each process.

When you are recording the statements that you run, data collection persists across multiple enclaves until you stop recording. When you replay your statements, the data is replayed across the enclave boundaries in the same order as they were recorded.

A commands file continues to execute its series of commands regardless of what level of enclave is entered.

Refer to the following topics for more information related to the material discussed in this topic.

Related tasks

"Starting Debug Tool within an enclave"
"Viewing Debug Tool windows across multiple enclaves"
"Ending a Debug Tool session within multiple enclaves" on page 398
"Using Debug Tool commands within multiple enclaves" on page 398

Starting Debug Tool within an enclave

After an enclave in a process activates Debug Tool, it remains active throughout subsequent enclaves in the process, regardless of whether the run-time options for the enclave specify `TEST` or `NOTEST`. Debug Tool retains the settings specified from the `TEST` run-time option for the enclave that activated it, until you modify them with `SET TEST`. If your Debug Tool session includes more than one process, the settings for `TEST` are reset according to those specified on the `TEST` run-time option of the first enclave that activates Debug Tool in each new process.

If Debug Tool is first activated in a nested enclave of a process, and you step or go back to the parent enclave, you can debug the parent enclave. However, if the parent enclave contains COBOL but the nested enclave does not, Debug Tool is not active for the parent enclave, even upon return from the child enclave.

Upon activation of Debug Tool, the initial commands string, primary commands file, and the preferences file are run. They run only once, and affect the entire Debug Tool session. A new primary commands file cannot be started for a new enclave.

Viewing Debug Tool windows across multiple enclaves

When an enclave starts another enclave, all compile units in the first enclave are hidden. You can change the point of view to a new compile unit (by using the `SET QUALIFY` command) only if that compile unit is in the current enclave.

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Ending a Debug Tool session within multiple enclaves

If you specify the NOPROMPT suboption of the TEST runtime option for the next process on the host, Debug Tool restores the saved breakpoints after it gains control of that next process. However, Debug Tool might gain control of the process after many statements have been run. Therefore, Debug Tool might not run some or all of the following breakpoints:

- STATEMENT/LINE
- ENTRY
- EXIT
- LABEL

If you have not used these breakpoint types, you can specify NOPROMPT.

In a single enclave, QUIT closes Debug Tool. For CICS non-Language Environment programs (assembler or non-Language Environment COBOL), QUIT closes Debug Tool and the task ends with an ABEND 4038, regardless of the link level.

In a nested enclave, however, QUIT causes Debug Tool to signal a severity 3 condition that corresponds to Language Environment message CEE2529S. The system is trying to cleanly terminate all enclaves in the process.

Normally, the condition causes the current enclave to terminate. Then, the same condition will be raised in the parent enclave, which will also terminate. This sequence continues until all enclaves in the process have been terminated. As a result, you will see a CEE2529S message for each enclave that is terminated.

For CICS and MVS only: Depending on Language Environment run-time settings, the application might be terminated with an ABEND 4038. This termination is normal and should be expected.

Using Debug Tool commands within multiple enclaves

Some Debug Tool commands and variables have a specific scope for enclaves and processes. The table below summarizes the behavior of specific Debug Tool commands and variables when you are debugging an application that consists of multiple enclaves.

Debug Tool command	Affects current enclave only	Affects entire Debug Tool session	Comments
%CAAADDRESS	X		
AT GLOBAL		X	
AT TERMINATION		X	
CLEAR AT	X	X	In addition to clearing breakpoints set in the current enclave, CLEAR AT can clear global breakpoints.
CLEAR DECLARE		X	
CLEAR VARIABLES		X	
Declarations		X	Session variables are cleared at the termination of the process in which they were declared.

Debug Tool command	Affects current enclave only	Affects entire Debug Tool session	Comments
DISABLE	X	X	In addition to disabling breakpoints set in the current enclave, DISABLE can disable global breakpoints.
ENABLE	X	X	In addition to enabling breakpoints set in the current enclave, ENABLE can enable global breakpoints.
LIST AT	X	X	In addition to listing breakpoints set in the current enclave, LIST AT can list global breakpoints.
LIST CALLS	X		Applies to all systems except MVS batch and MVS with TSO. Under MVS batch and MVS with TSO, LIST CALLS lists the call chain for the current active thread in the current active enclave. For programs containing interlanguage communication (ILC), routines from previous enclaves are only listed if they are coded in a language that is active in the current enclave. **Note:** Only compile units in the current thread will be listed for PL/I multitasking applications.
LIST EXPRESSION	X		You can only list variables in the currently active thread.
LIST LAST		X	
LIST NAMES CUS		X	Applies to compile unit names. In the Debug Frame window, compile units in parent enclaves are marked as deactivated.
LIST NAMES LABELS	X		You can only list variables in the currently active thread.
LIST NAMES TEST		X	Applies to Debug Tool session variable names.
MONITOR GLOBAL		X	Applies to Global monitors.
PLAYBACK ENABLE		X	The PLAYBACK command that informs Debug Tool to begin the recording session.
PLAYBACK DISABLE		X	The PLAYBACK command that informs Debug Tool to stop the recording session.
PLAYBACK START		X	The PLAYBACK command that suspends execution of the program and indicates to Debug Tool to enter replay mode.
PLAYBACK STOP		X	The PLAYBACK command that terminates replay mode and resumes normal execution of Debug Tool.
PLAYBACK BACKWARD		X	The PLAYBACK command that indicates to Debug Tool to perform STEP and RUNTO commands backward, starting from the current point and going to previous points.
PLAYBACK FORWARD		X	The PLAYBACK command that indicates to Debug Tool to perform STEP and RUNTO commands forward, starting from the current point and going to the next point.
PROCEDURE		X	

Debug Tool command	Affects current enclave only	Affects entire Debug Tool session	Comments
SET AUTOMONITOR[1]	X		Controls the monitoring of data items at the currently executing statement.
SET COUNTRY[1]	X		This setting affects both your application and Debug Tool. At the beginning of an enclave, the settings are those provided by Language Environment or your operating system. For nested enclaves, the parent's settings are restored upon return from a child enclave.
SET EQUATE[1]		X	
SET INTERCEPT[1]		X	For C, intercepted streams or files cannot be part of any C I/O redirection during the execution of a nested enclave. For example, if `stdout` is intercepted in program A, program A cannot then redirect `stdout` to `stderr` when it does a `system()` call to program B. Also, not supported for PL/I.
SET NATIONAL LANGUAGE[1]	X		This setting affects both your application and Debug Tool. At the beginning of an enclave, the settings are those provided by Language Environment or your operating system. For nested enclaves, the parent's settings are restored upon return from a child enclave.
SET PROGRAMMING LANGUAGE[1]	X		Applies only to programming languages in which compile units known in the current enclave are written (a language is "known" the first time it is entered in the application flow).
SET QUALIFY[1]	X		Can only be issued for load modules, compile units, and blocks that are known in the current enclave.
SET TEST[1]		X	
TRIGGER condition[2]	X		Applies to triggered conditions.[2] Conditions can be either an Language Environment symbolic feedback code, or a language-oriented keyword or code, depending on the current programming language setting.
TRIGGER AT	X	X	In addition to triggering breakpoints set in the current enclave, `TRIGGER AT` can trigger global breakpoints.

Notes:

1. `SET` commands other than those listed in this table affect the entire Debug Tool session.
2. If no active condition handler exists for the specified condition, the default condition handler can cause the program to end prematurely.

Chapter 46. Debugging a multiple-enclave interlanguage communication (ILC) application

When you debug a multiple-enclave ILC application with Debug Tool, use the SET PROGRAMMING LANGUAGE to change the current programming language setting. The programming language setting is limited to the languages currently known to Debug Tool (that is, languages contained in the current load module).

Command lists on monitors and breakpoints have an implied programming language setting, which is the language that was in effect when the monitor or breakpoint was established. Therefore, if you change the language setting, errors might result when the monitor is refreshed or the breakpoint is triggered.

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Chapter 47. Debugging programs called by Java native methods

This topic describes how to debug, with Debug Tool, Java native methods and the programs they call that are running in Language Environment. By inserting calls to the Language Environment CWI service CEE3CBTS and callable service CEETEST into your Java native method or program and compiling your methods or programs with the HOOK suboption of the TEST compiler option, you can debug your application. These instructions describe how to insert the calls to CEE3CBTS and CEETEST directly into your method or program.

These instructions assume you understand the following items:

- You understand Java JNI interface.
- You have configured a remote debugger (for example, Rational Developer for System z) to debug the Java native method and the programs it calls. You need to know the IP address and port ID of the remote debugger.
- You can modify the compilation parameters of the Java native method and the programs it calls.

Do the following steps:

1. Review the description of the Language Environment CWI service CEE3CBTS in *Language Environment Vendor Interfaces*. For this situation, specify the following values for the elements in the structure:
   - TCP/IP address, as described in the *Language Environment Vendor Interfaces*
   - Debugger port ID, as described in the *Language Environment Vendor Interfaces*
   - Client Process ID, assign a value of 0
   - Client Thread ID, assign a value of 0
   - Client IP address, assign a value of 0
   - Debug Flow, assign a value of 1
2. Choose which programs that the native method calls to debug. Decide where you want to start and stop debugging.
3. In the Java native method, add a call to CEE3CBTS with the *AttachDebug* function code and assign values to the debug context parameters.
4. In the Java native method or the programs it calls, add a call to CEETEST. CEETEST is the way you start Debug Tool for this situation.
5. In the Java native method, add a call to CEE3CBTS with the *StopDebug* function code to stop the debug session.
6. Modify the compilation parameters of the Java native method so that they compile with the HOOK suboption of the TEST compiler option.
7. Modify the compilation parameters of the programs you chose in step 2 so that they compile with the HOOK suboption of the TEST compiler option.
8. Run the JCL for your programs. Your remote debugging session starts.

After you finish debugging your Java native method and the programs called by the Java native method, remove the modifications done in these steps before moving your application to a production environment.

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Refer to the following topics for more information related to the material discussed in this topic.

Related tasks

"Starting Debug Tool with CEETEST" on page 121
"Choosing TEST or NOTEST compiler suboptions for COBOL programs" on page 27
"Choosing TEST or NOTEST compiler suboptions for PL/I programs" on page 32
"Choosing TEST or DEBUG compiler suboptions for C programs" on page 37
"Choosing TEST or DEBUG compiler suboptions for C++ programs" on page 42

Related references

Language Environment Vendor Interfaces

Chapter 48. Solving problems in complex applications

This section describes some problems you might encounter while you try to debug complex applications and some possible solutions.

Debugging programs loaded from library lookaside (LLA)

Debug Tool obtains information about programs in memory by using binder APIs. The binder APIs must access information stored in the data set containing the load module or program object. In most cases, z/OS can provide Debug Tool the data set name from which the program was loaded so Debug Tool can pass it to the binder APIs. However, z/OS does not have this information for programs loaded from LLA.

When Debug Tool attempts to debug a program loaded from LLA, Debug Tool does the following steps:

- Debug Tool checks for the allocation of DD name EQALOAD and checks that it contains a member name that matches the program that LLA loaded.
- If Debug Tool does not find a program by the specified name in EQALOAD, Debug Tool checks for the allocation of DD name STEPLIB and checks that it contains a member name that matches the program that LLA loaded.
- If Debug Tool does find a program by the specified name in one of the previous steps and the length of this program matches the length of the program in memory, Debug Tool passes the data set name from the corresponding DD statement to the binder APIs to use it to obtain the information.

The following restrictions apply:

- Debug Tool cannot always determine the exact length of the program in memory. In certain situations, the length might be rounded to a multiple of 4K. Therefore, the length checking is not always exact and programs that might appear the same length are not.
- The copy of the program found in DD name EQALOAD or DD name STEPLIB must exactly match the copy in memory. If the program found does not exactly match the copy loaded from LLA (even though the lengths match), unpredictable problems, including abends, might occur.
- If you are running DTSU in foreground, you must use DD name EQALOAD. When a DD name of STEPLIB is specified when DTSU is running in the TSO foreground, DTSU uses a different DD name and, therefore, Debug Tool cannot find STEPLIB.

Debugging user programs that use system prefixed names

Debug Tool assumes that load module and compile unit names that begin with specific prefixes are system components. For example, EQAxxxxx is a Debug Tool module, CEExxxxx is a Language Environment module, and IGZxxxxx is a COBOL module.

Debug Tool does not try to debug load modules or compile units that have these prefixes for the following reasons:

- Debug Tool might perform improper recursions that might result in abnormally endings (ABENDs) or other erroneous behavior.

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- Debug Tool assumes users do not have access to the source for these load modules and library routines.
- Creating debug information for these routines would waste significant amounts of memory and other resources.

If you have named a user load module or compile unit with a prefix that conflicts with one of these system prefixes, you can use the NAMES INCLUDE command and the instructions described in this section to debug this load module or compile unit.

IMPORTANT: Do **not** use the NAMES INCLUDE command to debug system components (for example, Debug Tool, Language Environment, CICS, IMS, or compiler run-time modules). If you attempt to do debug these system components, you might experience unpredictable failures. Only use this command to debug *user* programs that are named with prefixes that Debug Tool recognizes as system components.

Displaying system prefixes

You can display a list of prefixes that Debug Tool recognizes as system prefixes by using the following commands:

```
NAMES DISPLAY ALL EXCLUDED LOADMODS;
NAMES DISPLAY ALL EXCLUDED CUS;
```

These commands display a list of names currently excluded at your request (by using the NAMES EXCLUDE command), followed by a section displaying a list of names excluded by Debug Tool.

Refer to the following topics for more information related to the material discussed in this topic.

Related references

"NAMES command" in *Debug Tool Reference and Messages*

Debugging programs with names similar to system components

If the name of your program begins with one of the prefixes excluded by Debug Tool, use the NAMES INCLUDE command to indicate to Debug Tool that your program is a user load module or compile unit, not a system program.

Refer to the following topics for more information related to the material discussed in this topic.

Related references

"NAMES command" in *Debug Tool Reference and Messages*

Debugging programs containing data-only modules

Some programs contain load modules or compile units that have no executable code. These modules are known as data-only modules. These modules are prevalent in assembler programs. In some situations, Debug Tool might not recognize that these modules contain no executable instructions and attempt to set a breakpoint, which means overlaying the contents of these modules.

In these situations, you can use the NAMES EXCLUDE command to indicate to Debug Tool that these are data-only modules that contain no executable code. Debug Tool will not attempt to set breakpoints in these data-only modules. If the NAMES EXCLUDE

command is used to exclude a module that contains executable instructions, the module might still appear in Debug Tool and Debug Tool might still attempt to set breakpoints in the modules.

Refer to the following topics for more information related to the material discussed in this topic.

Related references

"NAMES command" in *Debug Tool Reference and Messages*

Optimizing the debugging of large applications

Debug Tool was designed is to implicitly load the debug data for any compile units compiled with the TEST or DEBUG compiler option. However, some very large applications can contain a large number of load modules or compile units that you do not need to debug. In some cases, the creation and manipulation of debug data for these load modules or compile units can consume a significant amount of memory, CPU time, and other resources.

You can handle this situation in one of the following ways:

- Change the default behavior so that Debug Tool loads debug data only for modules that you indicate that you want to debug.
- Indicate to Debug Tool that you do not want to debug certain modules.

Using explicit debug mode to load debug data for only specific modules

By default, Debug Tool automatically loads debug data whenever it encounters a high-level language compile unit compiled with the TEST or DEBUG compiler option. In most cases, this is the most convenient mode of operation because you do not have to decide in advance which load modules and compile units you want to debug. However, in some complex applications, manipulating this data might cause a significant performance impact. In this case, you can use explicit debug mode to load debug data only for compile units that you indicate you want to debug.

You enable explicit debug mode by entering the SET EXPLICITDEBUG ON command or by specifying the EQAOPTS EXPLICITDEBUG command. By default, this mode is OFF. In explicit debug mode, (except for cases described below) you must use the LOADDEBUGDATA (LDD) command to cause Debug Tool to load the debug data for the compile units that you want to debug.

In most cases, you can use the SET EXPLICTDEBUG command to enable explicit debug mode; however, in some cases you might need to use the EQAOPTS EXPLICITDEBUG command. Because Debug Tool does not process commands until after it processes the initial load module and all the compile units it contains, if you want Debug Tool to *not* load debug data for compile units in the initial load module, use the EQAOPTS EXPLICITDEBUG command.

When explicit debug mode is active, Debug Tool loads debug data in only the following cases:

- For the compile unit where Debug Tool first became active and the first compile unit in each enclave. In most cases, this is the entry compile unit for the initial load module.
- Whenever Debug Tool loads a load module and you previously entered a LOADDEBUGDATA (LDD) command for that load module and compile unit or when you enter an LDD command for a compile unit in the current load module.

- Whenever Debug Tool processes a load module for any of the following reasons and you previously specified the compile unit on a NAMES INCLUDE CU command:
  - It is the initial load module.
  - When Debug Tool loads a load module that you previously specified on an LDD command.
  - When Debug Tool loads a load module that you previously specified on a NAMES INCLUDE LOADMOD command.
  - It is a load module for which Debug Tool generated an implicit NAMES INCLUDE LOADMOD command.
- For the target of a deferred AT ENTRY which specifies both load module and compile unit names and in which the compile unit name is not a source file name enclosed in quotation marks (").
- For the entry point compile unit of a load module that you specified in an AT LOAD command.
- In CICS, for the load module and compile units you specified in DTCN or the Program and Comp Unit you specified in CADP, unless they contain an asterisk (*).

Debug Tool does not support the SET DISASSEMBLY ON command in explicit debug mode. When explicit debug mode is active, Debug Tool forces SET DISASSEMBLY OFF and you will not be able to set it back to ON while in explicit debug mode.

Excluding specific load modules and compile units

In some cases, you might know that there are certain load modules or compile units that you do not want to debug. In this case, you can improve performance by informing Debug Tool to not load debug data for these load modules or compile units.

You can use the NAMES EXCLUDE command to indicate to Debug Tool that it does not need to maintain debug data for these modules. When you use the NAMES EXCLUDE command to exclude executable modules, there are situations where Debug Tool requires debug data for the excluded modules. The following list, while not comprehensive, describes some of the possible situations:

- The entry point of an enclave.
- The next higher-level compile unit when a STEP RETURN command is executing.
- Compile units that appear in the call chain of a compile unit where Debug Tool has suspended execution.
- The next higher-level compile unit when the user-program has been suspended at an AT EXIT breakpoint.

Also, when you enter a deferred AT ENTRY command, Debug Tool generates an implicit NAMES INCLUDE command for the load module and compile unit that is the target of the deferred AT ENTRY. If these names appear later in the program, Debug Tool will not exclude them even if you specified them in a previous NAMES EXCLUDE command.

In all of the above situations, Debug Tool loads debug data as required and these modules might become known to Debug Tool.

Refer to the following topics for more information related to the material discussed in this topic.

Related references

"NAMES command" in *Debug Tool Reference and Messages*

Displaying current NAMES settings

Use the `NAMES DISPLAY` command to display the current settings of the `NAMES` command.

Refer to the following topics for more information related to the material discussed in this topic.

Related references

"NAMES command" in *Debug Tool Reference and Messages*

Using the EQAOPTS NAMES command to include or exclude the initial load module

You cannot use the `NAMES` command on load modules or compile units that are already known to Debug Tool; therefore, you cannot use the `NAMES` command to indicate to Debug Tool that you want to include or exclude the initial load module or the compile units contained in the initial load module. If you want to do this, you must specify the EQAOPTS `NAMES` command either at run time or through the EQAOPTS load module. To learn how to specify EQAOPTS commands, see the topic “EQAOPTS commands” in the *Debug Tool Reference and Messages* or *Debug Tool Customization Guide*.

Refer to the following topics for more information related to the material discussed in this topic.

Related references

"NAMES command" in *Debug Tool Reference and Messages*

Using delay debug mode to delay starting of a debug session

By default, Debug Tool starts a debug session at the first entry compile unit of the initial load module of an application. However, there are cases where the problem is in some compile unit (for example, `prog1`) inside the application that needs debugging.

Currently, you enter AT ENTRY `prog1` and GO commands when the debug session starts.

However, in some complex applications, it can take some significant time before `prog1` appears. In this case, you can use delay debug mode to delay the starting of the debug session until Debug Tool recognizes `prog1`.

Debug Tool is in the dormant state during the delay debug mode and monitors only a few events. When Debug Tool recognizes `prog1`, Debug Tool comes out of delay debug mode, completes the initialization, and starts the debug session.

You enable delay debug mode by using the DLAYDBG EQAOPTS option. By default, delay debug mode is NO. When delay debug mode is enabled, you need to set two other options:

DLAYDBGDSN

Delay debug profile data set naming pattern.

Delay debug profile contains the program list and TEST runtime option. This profile is used by Debug Tool to match the compile unit name with the names on the program list. If there is a match, Debug Tool comes out of the delay debug mode and uses the TEST runtime to complete the initialization.

DLAYDBGTRC

Delay debug pattern match trace message level.

This message level is used to generate error and information messages for debugging purposes.

Once Debug Tool completes the initialization, the delay debug mode cannot be reactivated.

Usage notes

- The delay debug mode applies to non-CICS environments only.
- The delay debug mode applies to Enterprise COBOL and Enterprise PLI compile units only.
- The main program of the application must be a Language Environment program.
- If the user exit method is used to start Debug Tool at the beginning of the application, the user exit data set should have a '*' as one of the names in the program name list name list, so that the pattern matching always succeeds and the TEST runtime option is returned to Language Environment.

  In addition, the name of the user exit data set must be different from the name of the delay debug profile data set.
- The TEST runtime option in the delay debug profile must have PROMPT in the third sub option, for example, `TEST(ALL,*,PROMPT,*)`.

Refer to the following topics for more information related to the material discussed in this topic.

Related references

Part 8. Appendixes

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Appendix A. Data sets used by Debug Tool

Debug Tool uses the following data sets:

C and C++ source

This data set is used as input to the compiler, and must be kept in a permanent PDS member, sequential file, or HFS file. The data set must be a single file, not a concatenation of files. Debug Tool uses the data set to show you the program as it is executing.

The C and C++ compilers store the name of the source data set inside the load module. Debug Tool uses this data set name to access the source.

This data set might not be the original source; for example, the program might have been preprocessed by the CICS translator. If you use a preprocessor, you must keep the data set input to the compiler in a permanent data set for later use with Debug Tool.

As this data set might be read many times by Debug Tool, we recommend that you do one of the following:

- Define it with the largest block size that your DASD can hold.
- Instruct the system to compute the optimum block size, if your system has that capability.

If you manage your source code with a library system that requires you to specify the `SUBSYS=ssss` parameter when you allocate a data set, you or your site need to specify the EQAOPTS `SUBSYS` command, which provides the value for *ssss*. This support is not available when debugging a program under CICS. To learn how to specify EQAOPTS commands, see the topic "EQAOPTS commands" in the *Debug Tool Reference and Messages* or the *Debug Tool Customization Guide*.

If the following conditions apply to your situation, you do not need access to the source because the .mdbg file has a copy of the source:

- You are compiling with z/OS XL C/C++, Version 1.10 or later.
- You compile your program with the `FORMAT(DWARF)` and `FILE` suboptions of the `DEBUG` compiler option.
- You create an .mdbg file and save (capture) the source with either of the following commands:
  - the dbgld command with the -c option
  - the CDADBGLD command with the CAPSRC option
- You or your site specified YES for the EQAOPTS `MDBG` command[9], which requires Debug Tool to search for the .dbg and source file in a .mdbg file.

COBOL listing

This data set is produced by the compiler and must be kept in a permanent PDS member, sequential file, or HFS file. Debug Tool uses it to show you the program as it is executing.

The COBOL compiler stores the name of the listing data set inside the load module. Debug Tool uses this data set name to access the listing.

Debug Tool does not use the output that is created by the COBOL `LIST` compiler option.

9. In situations where you can specify environment variables, you can set the environment variable EQA_USE_MDBG to YES or NO, which overrides any setting (including the default setting) of the EQAOPTS `MDBG` command.

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COBOL programs that have been compiled with the SEPARATE suboption do not need to save the listing file. Instead, you must save the separate debug file SYSDEBUG.

The VS COBOL II compilers do not store the name of the listing data set. Debug Tool creates a name in the form userid.cuname.LIST and uses that name to find the listing.

Because this data set might be read many times by Debug Tool, we recommend that you do one of the following:

- Define it with the largest block size that your DASD can hold.
- Instruct the system to compute the optimum blocksize, if your system has that capability.

EQALANGX file

Debug Tool uses this data set to obtain debug information about assembler and LangX COBOL source files. It can be a permanent PDS member or sequential file. You must create it before you start Debug Tool. You can create it by using the EQALANGX program. Use the SYSADATA output from the High Level assembler or the listing from the IBM OS/VS COBOL, IBM VS COBOL II, or Enterprise COBOL compiler as input to the EQALANGX program.

PL/I source (Enterprise PL/I only)

This data set is used as input to the compiler, and must be kept in a permanent PDS member, sequential file, or HFS file. Debug Tool uses it to show you the program as it is executing.

The Enterprise PL/I compiler stores the name of the source data set inside the load module. Debug Tool uses this data set name to access the source.

This data set might not be the original source; for example, the program might have been preprocessed by the CICS translator. If you use a preprocessor, you must keep the data set input to the compiler in a permanent data set, for later use with Debug Tool.

Because this data set might be read many times by Debug Tool, we recommend that you do one of the following:

- Define it with the largest block size that your DASD can hold.
- Instruct the system to compute the optimum block size, if your system has that capability.

If you manage your source code with a library system that requires you to specify the SUBSYS=*ssss* parameter when you allocate a data set, you or your site need to specify the EQAOPTS SUBSYS command, which provides the value for *ssss*. This support is not available when debugging a program under CICS. To learn how to specify EQAOPTS commands, see the topic "EQAOPTS commands" in the *Debug Tool Reference and Messages* or the *Debug Tool Customization Guide*.

PL/I listing (all other versions of PL/I compiler)

This data set is produced by the compiler and must be kept in a permanent file. Debug Tool uses it to show you the program as it is executing.

The PL/I compiler does not store the name of the listing data set. Debug Tool looks for the listing in a data set with the name in the form of userid.cuname.LIST.

Debug Tool does not use the output that is created by the PL/I compiler LIST option; performance improves if you specify NOLIST.

Because this data set might be read many times by Debug Tool, we recommend that you do one of the following:

- Define it with the largest block size that your DASD can hold.
- Instruct the system to compute the optimum block size, if your system has that capability.

Separate debug file

This data set is produced by the compiler and it stores information used by Debug Tool. To produce this file, you must compile your program with the following compiler options:

- The `SEPARATE` compiler suboption of the `TEST` compiler option, which is available on the following compilers:
  - Enterprise COBOL for z/OS, Version 4.1
  - Enterprise COBOL for z/OS and OS/390, Version 3
  - COBOL for OS/390 & VM, Version 2 Release 2
  - COBOL for OS/390 & VM, Version 2 Release 1 with APAR PQ40298
  - Enterprise PL/I for z/OS, Version 3.5 or later

  The compiler uses the SYSDEBUG DD statement to name the separate debug file.
- The `FORMAT(DWARF)` suboption of the `DEBUG` compiler option with z/OS C/C++, Version 1.6 or later. The compiler uses one of the following methods to name the separate debug file (also known as a .dbg file):
  - You specify a name with the `FILE` suboption
  - You specify a name with the SYSCDBG DD statement
  - If you do not specify a name, the compiler generates a name as described in *z/OS XL C/C++ User's Guide*.

  The file does not contain source. You must also save the source file.

Save the file in any of the following formats:

- a permanent PDS member
- a sequential file
- for COBOL or PL/I, a HFS file
- for C or C++, a z/OS UNIX System Services file

The compiler stores the data set name of the separate debug file inside the load module. Debug Tool uses this data set name to access the debug information, unless you provide another data set name as described in Appendix B, “How does Debug Tool locate source, listing, or separate debug files?,” on page 419.

Because this data set might be read many times by Debug Tool, do one of the following steps to improve efficiency:

- Define it with the largest block size that your DASD can hold.
- Instruct the system to compute the optimum block size, if your system has that capability.

.mdbg file

The .mdbg file is created by the dbgld command or CDADBGLD utility. It contains all the .dbg files for all the programs in a load module or DLL. Beginning with z/OS XL C/C++, Version 1.10, Debug Tool can obtain information from this file if it also stores (captures) the source files. Create an .mdbg file with captured source by using the dbgld command with the -c option or the CDADBGLD utility with the CAPSRC option.

To learn how to use these commands, see *z/OS XL C/C++ User's Guide*.

Preferences file

This data set contains Debug Tool commands that customize your session. You can use it, for example, to change the default screen colors set by Debug Tool. Store this file in a permanent PDS member or a sequential file.

You can specify a preferences file directly (for example, through the `TEST` runtime option) or through the EQAOPTS `PREFERENCESDSN` command. For instructions, see "Creating a preferences file" on page 159.

A CICS region must have read authorization to the preferences file.

Global preferences file

This is a preferences file generally available to all users. It is specified through the EQAOPTS `GPFDSN` command. To learn how to specify EQAOPTS commands, see the topic "EQAOPTS commands" in the *Debug Tool Reference and Messages* or the *Debug Tool Customization Guide*. If a global preferences file exists, Debug Tool runs the commands in the global preferences file before commands found in the preferences file.

A CICS region must have read authorization to the global preferences file.

Commands file

This data set contains Debug Tool commands that control the debug session. You can use it, for example, to set breakpoints or set up monitors for common variables. Store it in a permanent PDS member or a sequential file.

If you specify a preferences file, Debug Tool runs the commands in the commands file *after* the commands specified in the preferences file.

You can specify a commands file directly (for example, through the `TEST` runtime option) or through the EQAOPTS `COMMANDSDSN` command. If it is specified through the EQAOPTS `COMANDSDSN` command, it must be in a PDS or PDSE and the member name must match the name of the initial load module in the first enclave. For instructions on creating a commands files, see "Creating a commands file" on page 175.

A CICS region must have read authorization to the commands file.

EQAOPTS file

This data set contains EQAOPTS commands that control initial settings and options for the debug session. Store it in a permanent PDS member or a sequential file. To learn how to specify EQAOPTS commands, see the topic "EQAOPTS commands" in the *Debug Tool Reference and Messages* or the *Debug Tool Customization Guide*.

The record format must be either F or FB and the logical record length must be 80.

A CICS region must have read authorization to the EQAOPTS file.

Log file

Debug Tool uses this file to record the progress of the debugging session. Debug Tool stores a copy of the commands you entered along with the results of the execution of commands. The results are stored as comments. This allows you to use the log file as a commands file in subsequent debugging sessions. Store the log file in a permanent PDS member or a

sequential file. Because Debug Tool writes to this data set, store the log file as a sequential file to relieve any contention for this file.

Debug Tool does not use log files in remote debug mode.

The log file specifications need to be one of the following options:

- RECFM(F) or RECFM(FB) and 32<=LRECL<=256
- RECFM(V) or RECFM(VB) and 40<=LRECL<=264

You can specify a log file directly (for example, the INSPLOG DD or the `SET LOG` command) or through the EQAOPTS `LOGDSN` command. For instructions, see "Creating the log file" on page 177.

For DB2 stored procedures, to prevent multiple users from trying to use the same log, do not use the EQAOPTS `LOGDSN` command.

For CICS, review the special circumstances described in "Restrictions when debugging under CICS" on page 368.

Save settings file (SAVESETS)

Debug Tool uses this file to save and restore, between Debug Tool sessions, the settings from the SET command. A sequential file with RECFM of VB and LRECL>=3204 must be used.

The default name for this data set is *userid*`.DBGTOOL.SAVESETS`. However, you can change this default by using the EQAOPTS `SAVESETDSN` command. In non-interactive mode (MVS batch mode without using a full-screen terminal), the DD name used to locate this file is INSPSAFE.

You can not save the settings information in the same file that you save breakpoint and monitor specifications information.

Save settings files are not used for remote debug sessions.

Automatic save and restore of the settings is not supported under CICS if the current user is not logged-in or is logged in under the default user ID. If you are running in CICS, the CICS region must have update authorization to the save settings file.

Save settings files are not supported automatically when debugging DB2 stored procedures.

You or your site can direct Debug Tool to create this file and enable saving and restoring settings through the EQAOPTS `SAVESETDSNALLOC` command. For instructions, see "Saving and restoring settings, breakpoints, and monitor specifications" on page 184.

Save breakpoints and monitor specifications file (SAVEBPS)

Debug Tool uses this file to save and restore, between Debug Tool sessions, the breakpoints, monitor specifications, and LDD specifications. A PDSE or PDS data set with RECFM of VB and LRECL >= 3204 must be used. (We recommend you use a PDSE.)

The default name for this data set is *userid*`.DBGTOOL.SAVEBPS`. However, you can change this default by using EQAOPTS `SAVEBPDSN` command. In non-interactive mode (MVS batch mode without using a full-screen terminal), the DD name used to locate this file is INSPBPM.

You can not save the breakpoint and monitor specifications information in the same file that you save settings information.

Save breakpoints and monitor specifications files are not used for remote debug sessions.

Automatic save and restore of the breakpoints and monitor specifications is not supported under CICS if the current user is not logged-in or is logged in under the default user ID. If you are running in CICS, the CICS region must have update authorization to the save breakpoints and monitor specifications file.

Save breakpoints and monitor specifications files are not supported automatically when debugging DB2 stored procedures.

You or your site can direct Debug Tool to create this file and enable saving and restoring breakpoints and monitor specifications through the EQAOPTS `SAVEBPDSNALLOC` command. For instructions, see “Saving and restoring settings, breakpoints, and monitor specifications” on page 184.

Appendix B. How does Debug Tool locate source, listing, or separate debug files?

Debug Tool obtains information (called debug information) it needs about a compilation unit (CU) by searching through the following sources:

- In some cases, the debug information is stored in the load module. Debug Tool uses this information, along with the source or listing file, to display source code on the screen.
- For COBOL and PL/I CUs compiled with the SEPARATE suboption of the TEST compiler option, Debug Tool uses the information stored in a separate file (called a separate debug file) that contains both the debug information and the information needed to display source code on the screen.
- For C and C++ CUs created and debugged under the following conditions, Debug Tool uses the debug information stored in the .dbg file along with the source file to display code on the screen:
  - Compiled with the FORMAT(DWARF) suboption of the DEBUG compiler option
  - Specified or defaulted to NO for the EQAOPTS MDBG command[10]
- For C and C++ CUs created and debugged under the following conditions, Debug Tool uses debug information and source code stored in the .mdbg file to display source code on the screen:
  - Compiled with the FORMAT(DWARF) suboption of the DEBUG compiler option
  - Compiled with z/OS XL C/C++, Version 1.10 or later
  - Created an .mdbg file with saved (captured) source for the load module or DLL by using the -c option of the dbgld command or CAPSRC option of the CDADBGLD utility.
  - Specified YES for the EQAOPTS MDBG command (which requires Debug Tool to search for .dbg and source files in a .mdbg file)[11]
- For assembler and LangX COBOL CUs, Debug Tool uses the information stored in a separate file (called an EQALANGX file) that contains both the debug information and the information needed to display source code on the screen.

In all of these cases, there is a default data set name associated with each CU, load module, or DLL. The way this default name is generated differs depending on the source language and compiler used. To learn how each compiler generates the default name, see the compiler's programming guide or user's guide.

Debug Tool obtains the source or listing data, separate debug file data, or EQALANGX data from one of the following sources:

- the default data set name
- the SET SOURCE command
- the SET DEFAULT LISTINGS command
- the EQADEBUG DD statement

For C and C++ CUs, Debug Tool obtains the source data and separate debug file data from different sources, depending on how you created the CU and what value

10. In situations where you can specify environment variables, you can set the environment variable EQA_USE_MDBG to YES or NO, which overrides any setting (including the default setting) of the EQAOPTS MDBG command.

11. In situations where you can specify environment variables, you can set the environment variable EQA_USE_MDBG to YES or NO, which overrides any setting (including the default setting) of the EQAOPTS MDBG command.

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you specified for the EQAOPTS MDBG command.[12] For CUs created and debugged under the following conditions, Debug Tool obtains the source data from the source file and separate debug file data from the .dbg file:

- Compiled with the FORMAT(DWARF) suboption of the DEBUG compiler option
- Specified NO for the EQAOPTS MDBG command[13]

Debug Tool obtains the source file from one of the following sources:

- the default data set name
- the SET SOURCE command
- the SET DEFAULT LISTINGS command
- the EQAUEDAT user exit (specifying function code 3)
- The EQADEBUG DD name
- the EQA_SRC_PATH environment variable

Debug Tool obtains the .dbg file from one of the following sources:

- the default data set name
- the SET DEFAULT DBG command
- the EQAUEDAT user exit (specifying function code 35)
- the EQADBG DD name
- the EQA_DBG_PATH environment variable

Note that these lists do show only what can be processed, not the processing order.

For C and C++ CUs created and debugged under the following conditions, Debug Tool obtains the source data and separate debug file data from the .mdbg file:

- Compiled with the FORMAT(DWARF) suboption of the DEBUG compiler option
- Compiled with z/OS XL C/C++, Version 1.10 or later
- Created an .mdbg file with saved (captured) source for the load module or DLL by using the -c option of the dbgld command or CAPSRC option of the CDADBGLD utility.
- Specified YES for the EQAOPTS MDBG command (which requires Debug Tool to search for a .dbg file in a .mdbg file)[14]

Debug Tool obtains the .mdbg file from one of the following sources:

- the default data set name
- the SET MDBG command
- the SET DEFAULT MDBG command
- the EQAUEDAT user exit (specifying function code 37)
- the EQAMDBG DD statement
- the EQA_MDBG_PATH environment variable

For each type of file (source, listing, separate debug file, .dbg, or .mdbg), Debug Tool searches through the sources in different order. The rest of the topics in this chapter describe the order.

---

12. In situations where you can specify environment variables, you can set the environment variable EQA_USE_MDBG to YES or NO, which overrides any setting (including the default setting) of the EQAOPTS MDBG command.
13. In situations where you can specify environment variables, you can set the environment variable EQA_USE_MDBG to YES or NO, which overrides any setting (including the default setting) of the EQAOPTS MDBG command.
14. In situations where you can specify environment variables, you can set the environment variable EQA_USE_MDBG to YES or NO, which overrides any setting (including the default setting) of the EQAOPTS MDBG command.

If you are using the EQAUEDAT user exit in your environment, the name provided in the user exit takes precedence if Debug Tool finds that file.

For .dbg and .mdbg files, Debug Tool does not search for the source until it finds a valid .dbg or .mdbg file.

How does Debug Tool locate source and listing files?

Debug Tool reads the source or listing file for a CU each time it needs to display information about that CU. While you are debugging your CU, the data set from which the file is read can change. Each time Debug Tool needs to read a source or listing file, it searches for the data set in the following order:

1. SET SOURCE command
2. SET DEFAULT LISTINGS command. If the EQAUEDAT user exit is implemented and a EQADEBUG DD statement is not specified, the data set name might be modified by the EQAUEDAT user exit.
3. if present, the EQADEBUG DD statement
4. default data set name. If the EQAUEDAT user exit is implemented and a EQADEBUG DD statement is not specified, the data set name might be modified by the EQAUEDAT user exit.

How does Debug Tool locate COBOL and PL/I separate debug file files?

Debug Tool might read from a COBOL or PL/I separate debug file more than once but it always reads the separate debug file from the same data set. After Debug Tool locates a valid separate debug file, you cannot direct Debug Tool to a different separate debug file. When the CU first appears, Debug Tool looks for the separate debug file in the following order:

1. SET SOURCE command
2. default data set name. If the EQAUEDAT user exit is implemented and a EQADEBUG DD statement is not specified, the data set name might be modified by the EQAUEDAT user exit.
3. SET DEFAULT LISTINGS command. If the EQAUEDAT user exit is implemented and a EQADEBUG DD statement is not specified, the data set name might be modified by the EQAUEDAT user exit.
4. if present, the EQADEBUG DD statement

The SET SOURCE command can be entered only after the CU name appears as a CU and the separate debug file is not found in any of the other locations. The SET DEFAULT LISTINGS command can be entered at any time before the CU name appears as a CU or, if the separate debug file is not found in any of the other possible locations, it can be entered later.

How does Debug Tool locate EQALANGX files

An EQALANGX file, which contains debug information for an assembler or LangX COBOL program, might be read more than once but it is always read from the same data set. After Debug Tool locates a valid EQALANGX file, you cannot direct Debug Tool to a different EQALANGX file. After you enter the LOADDEBUGDATA (LDD) command (which is run immediately or run when the specified CU becomes known to Debug Tool), Debug Tool looks for the EQALANGX file in the following order:

1. SET SOURCE command

2. a previously loaded EQALANGX file that contains a CSECT that matches the name and length of the program
3. default data set name. If the EQAUEDAT user exit is implemented and a EQADEBUG DD statement is not specified, the data set name might be modified by the EQAUEDAT user exit.
4. SET DEFAULT LISTINGS command. If the EQAUEDAT user exit is implemented and a EQADEBUG DD statement is not specified, the data set name might be modified by the EQAUEDAT user exit.
5. the EQADEBUG DD statement

The SET SOURCE command can be entered during any of the following situations:

- Any time after the CU name appears as a disassembly CU.
- If the CU is known when the LDD command is entered but then Debug Tool does not find the EQALANGX file.
- If the CU is not known to Debug Tool when the LDD command is entered and then Debug Tool runs the LDD after the CU becomes known to Debug Tool.

The SET DEFAULT LISTINGS command can be entered any time before you enter the LDD command or, if the EQALANGX file is not found by the LDD command, after you enter the LDD command.

How does Debug Tool locate the C/C++ source file and the .dbg file?

If you compile with the FORMAT(DWARF) and FILE suboptions of the DEBUG compiler option and specify NO for the EQAOPTS MDBG command[15], Debug Tool needs the source file and the .dbg file. The following list describes how Debug Tool searches for those files:

- Debug Tool reads the source files for a CU each time it needs to display the source code. Debug Tool searches for the source file by using the name the compiler saved in the load module or DLL. If you move the source files to a different location, Debug Tool searches for the source file based on the input from the following commands, user exit, or environment variable, in the following order:
  1. In full screen mode, the SET SOURCE command.
  2. In remote debug mode, the EQA_SRC_PATH environment variable or what you enter in the **Change Text File** action from the editor view.
  3. The EQADEBUG DD statement.
  4. The EQAUEDAT user exit, specifying function code 3. If you specify the EQADEBUG DD statement, the EQAUEDAT user exit is not run.
  5. The SET DEFAULT LISTINGS command.
- Debug Tool might read the .dbg file more than once, but it always reads this file from the same data set. After Debug Tool locates this file and validates its contents with the load module being debugged, you cannot redirect Debug Tool to search a different file. Debug Tool searches for the .dbg file by using the name the compiler saved in the load module or DLL. If you move the .dbg file to a different location, Debug Tool searches for the .dbg file based on the input from the following commands, user exit, or environment variable, in the following order:
  1. In remote debug mode, the EQA_DBG_PATH environment variable.

15. In situations where you can specify environment variables, you can set the environment variable EQA_USE_MDBG to YES or NO, which overrides any setting (including the default setting) of the EQAOPTS MDBG command.

2. The EQADBG DD statement.
3. The EQAUEDAT user exit, specifying function code 35. If you specify the EQADBG DD statement, the EQAUEDAT user exit is not run.
4. The SET DEFAULT DBG command.

To learn more about the DEBUG compiler option, the dbgld command, and the CDADBGLD utility, see *z/OS XL C/C++ User's Guide*.

How does Debug Tool locate the C/C++ .mdbg file?

For the following conditions, Debug Tool can obtain debug information and source from a module map (.mdbg) file:

- You do one of the following tasks:
  - You or your site specifies YES for the EQAOPTS MDBG command and, for environments that support environment variables, you do not set the environment variable EQA_USE_MDBG to NO.
  - You or your site specifies or defaults to NO for the EQAOPTS MDBG command but, for environments that support environment variables, you override that option by setting the environment variable EQA_USE_MDBG to YES.
- You compile your programs with z/OS XL C/C++, Version 1.10 or later

You use the dbgld command with the -c option or the CDADBGLD utility with the CAPSRC option to save (capture) the source files, as well as all the .dbg files, belonging to the programs that make up a single load module or DLL into one module map file (.mdbg file). Create an .mdbg file with captured source for any load module or DLL that you want to debug because the .mdbg file makes it easier for you to debug the load module or DLL. For example, if your load module is consists of 10 programs and you do not create a module map file, you would need to keep track of 10 .dbg files and 10 source files. If you create a module map file for that load module, you would need to keep track of just one .mdbg file.

Debug Tool might read the .mdbg file more than once, but it always reads this file from the same data set. After Debug Tool locates this file and validates its contents with the load module being debugged, you cannot redirect Debug Tool to search a different file. Debug Tool searches for the .mdbg file based on the input from the following commands, user exit, or environment variable, in the following order:

1. The EQAUEDAT user exit, specifying function code 37.
2. If you do not write the EQAUEDAT user exit or the user exit cannot find the file, the default data set name, which is *userid*.mdbg(*load_module_or_DLL_name*), or, in UNIX System Services, **./***load_module_or_DLL_name***.**mdbg.

If Debug Tool cannot find the .mdbg file, then it searches for the .mdbg file based on the input from the following commands, DD statement, or environment variable, in the following order:

1. The SET MDBG command
2. The SET DEFAULT MDBG command
3. The EQAMDBG DD statement.
4. The EQA_MDBG_PATH environment variable.

To learn more about the DEBUG compiler option, the dbgld command, and the CDADBGLD utility, see *z/OS XL C/C++ User's Guide*.

Appendix C. Quick start guide for compiling and assembling programs for use with IBM Problem Determination Tools products

This chapter describes the minimal steps required to prepare your programs for use with IBM Problem Determination Tools products. For more detailed information, refer to 'Part 2. Preparing your program for debugging' of the *Debug Tool for z/OS User's Guide*, 'Part 2. Fault Analyzer Installation and Administration' of the *Fault Analyzer for z/OS User's Guide*, or 'Appendix B. Creating side files using CAZLANGX' of the *Application Performance Analyzer for z/OS User's Guide*.

The purpose of this chapter is to provide instructions for a single compile method for organizations that are using some combination of Debug Tool for z/OS, Fault Analyzer for z/OS, and Application Performance Analyzer for z/OS. If your enterprise is only using Debug Tool for z/OS, you can alternatively refer to 'Part 2. Preparing your program for debugging' of the *Debug Tool for z/OS User's Guide*. If your enterprise is only using Fault Analyzer for z/OS, alternatively refer to 'Part 2. Fault Analyzer Installation and Administration' of the *Fault Analyzer for z/OS User's Guide*. If your enterprise is only using Application Performance Analyzer for z/OS, alternatively refer to 'Appendix B. Creating side files using CAZLANGX' of the *Application Performance Analyzer for z/OS User's Guide*.

Debug Tool for z/OS, Fault Analyzer for z/OS and Application Performance Analyzer for z/OS are designed to use load modules and other files produced by IBM compilers. You must compile your programs with certain compiler options so that they produce load modules and files that these products can use.

This chapter uses the term 'source information files' to refer to the types of files that are used by Debug Tool for z/OS, Fault Analyzer for z/OS and Application Performance Analyzer for z/OS. The different kinds of source information files that are the subject of discussion in this chapter include:

- SYSDEBUG files
- LANGX files
- Compiler listings
- DWARF files
- Expanded source files

Be aware that different compilers generate different kinds of source information files. If you use more than one compiler, you might have more than one type of source information library.

When you compile your programs with the compiler options described in this chapter, you can use the load modules and source information files created by the compilers as follows:

- Prepare the module for debugging (if you are using Debug Tool for z/OS). Debug Tool for z/OS lets you work with program statements and variables.

  When a program is compiled with the right options, the module that is produced by the compiler can be debugged and a source information file, which contains program statements, can be produced. When you use Debug Tool for z/OS to debug a program, Debug Tool for z/OS uses the source information file to display the program source statements in the source window.

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Depending on the source language and compiler used, either the load module, source information file, or DWARF file contains information about statements and variables, such as offsets and lengths, and contains information that allows the debugger to locate statements and variables in storage. If you do not compile with the correct compile options, debugging is limited to something called 'disassembly' mode, where machine code is displayed, but no source statements or variables.

- Utilize Fault Analyzer for z/OS to automatically pinpoint the source statement that caused an abend, and can show you the values of variables in your programs at the time of an abend.
- Utilize Application Performance Analyzer for z/OS to show you precisely which program statements are utilizing the most CPU time and wait time, to give you information you need to tune your applications.

Updating your build process

If someone recently installed one or more of the IBM Problem Determination Tools products on your system, the program build processes might not have been updated yet. Updating the build processes is an important and necessary part of implementing the IBM Problem Determination Tools products.

In many organizations, there is clear ownership of these build processes. In other organizations, it might not be obvious who should make the changes. Many organizations use standard compile processes or PROCs that your system administrators maintain and have updated to prepare programs for the IBM Problem Determination Tools products. If this is the case, find out what processes have been made available and how to use them. In other organizations, each developer maintains their own compile JCL or PROCs to compile programs. If this is the case, update your own compile JCL to prepare your programs for the IBM Problem Determination Tools products as described below.

Start by researching what is required for each compiler individually. For example, the changes required for Enterprise COBOL for z/OS, Enterprise PL/I for z/OS, C/C++ and Assembler are all slightly different.

In general, there are three changes that might be needed to compiler JCL to produce programs that can be used by the IBM Problem Determination Tools:

1. Specify compiler options required by the IBM Problem Determination Tools.
2. Code the JCL to produce and save the source information files that the IBM Problem Determination Tools products need. Newer compilers can generate the required source information files directly. Some older compilers require an additional step in the compile job to run a special utility program that produces the needed file.
3. In certain environments, it is advantageous to include a special Debug Tool for z/OS module into the application load module during the link edit step. In most cases this is optional, but it can simplify starting Debug Tool for z/OS for certain types of programs. For certain older compilers running in certain environments, you must include a special module to enable Debug Tool for z/OS.

Updating your promotion process

Typically, when a program is tested, program load modules are promoted through different stages before reaching production. For example, when a new program is compiled for the first time, it might be placed into a test load library. After unit testing is completed, perhaps the compiled program is promoted to a quality

assurance environment. And eventually, it is promoted into production. On your system, you might know these stages by different names, such as:

- Unit test
- System test
- Model office

Consider whether you want the ability to use Debug Tool for z/OS, Fault Analyzer for z/OS and Application Performance Analyzer for z/OS throughout your programs' life cycle. Even if you do not plan to use Debug Tool for z/OS with production programs, Fault Analyzer for z/OS and Application Performance Analyzer for z/OS are very useful in those stages. To enable the IBM Problem Determination Tools products at each stage, update your promotion processes to retain the source information files. Promotions can be accomplished by performing a recompile, a copy, or a move. Perform the same steps with your source information files that you perform with your load modules or object modules. For each load library or object library, you should have a corresponding set of source information libraries. Whenever you promote a load module or object module, you should promote the source information file as well. This ensures that the source information file is available for Fault Analyzer and Application Performance Analyzer, and you can continue to take advantage of the IBM Problem Determination Tools products at all stages of your program's life cycle.

Preparing your programs

Each compiler produces different kinds of source information files, and each of the IBM Problem Determination Tools products reads different kinds of files. It can be time-consuming to research all the different combinations, but for each compiler, there is a suggested method described below. If you use the suggested methods, then your programs will be ready to take full advantage of the IBM Problem Determination Tools products.

- "Enterprise COBOL for z/OS Version 4 programs"
- "Enterprise COBOL for z/OS Version 3 and COBOL for OS/390 and VM programs" on page 431
- "COBOL for MVS and VM programs" on page 434
- "VS COBOL II programs" on page 438
- "OS/VS COBOL programs" on page 441
- "Enterprise PL/I Version 3.7 and later programs" on page 443
- "Enterprise PL/I Version 3.5 and Version 3.6 programs" on page 448
- "Enterprise PL/I Version 3.4 and earlier programs" on page 453
- "PL/I for MVS and VM and OS PL/I programs" on page 457
- "z/OS XL C and C++ programs" on page 461
- "Assembler programs" on page 467

Enterprise COBOL for z/OS Version 4 programs

The following table shows various compiler options that can be used to prepare Enterprise COBOL for z/OS Version 4 programs for use with the IBM Problem Determination Tools products (Debug Tool for z/OS, Fault Analyzer for z/OS and Application Performance Analyzer for z/OS). The methods suggested in the following table indicate if the load module produced is suitable for a production environment. Load modules suitable for a production environments have no significant runtime overhead.

Table 19. Examples of compiler options and source information files supported by IBM Problem Determination Tools products for Enterprise COBOL for z/OS Version 4

Compiler options	Source information file type produced	Is the load module production ready?	Options supported and suggested for Debug Tool for z/OS	Options supported and suggested for Fault Analyzer for z/OS	Options supported and suggested for Application Performance Analyzer for z/OS
TEST(NOHOOK, SEPARATE, EJPD), LIST, MAP, SOURCE, NONUMBER, XREF(SHORT)	SYSDEBUG	Yes	Suggested for production and test		
NOTEST, LIST, MAP, SOURCE, NONUMBER, XREF(SHORT)	Compiler listing	Yes	N/A	Supported	Supported
NOTEST, LIST, MAP, SOURCE, NUMBER, XREF(SHORT)		Yes	N/A	Supported	N/A
LIST, MAP, SOURCE, NONUMBER, XREF(SHORT)	LANGX file	Yes	N/A	Supported	Supported

Note: The highlighted row or rows in the table above indicate the suggested compiler options and source information file types for each product.

Preparing Enterprise COBOL for z/OS Version 4 programs

Perform the following steps for compiling your Enterprise COBOL for z/OS Version 4 programs using the compiler options suggested in Table 19:

1. Create libraries (PDSE is suggested unless PDS is required in your organization) for SYSDEBUG files. Create one or more SYSDEBUG libraries for each environment, such as test, production, and so on.
2. Create a corresponding SYSDEBUG library for each load library. Specify `LRECL=(80 to 1024),RECFM=FB,BLKSIZE=(multiple of lrecl < 32K)`.
3. For all programs in both test and production environments, specify the following compiler options:
   `TEST(NOHOOK,SEPARATE,EJPD),LIST,MAP,SOURCE,NONUMBER,XREF(SHORT)`.

   The `TEST` compiler option is required if you plan to use Debug Tool for z/OS to debug a program. The `TEST` option is optional if you plan to use Fault Analyzer for z/OS or Application Performance Analyzer for z/OS.

   The `SEPARATE` sub-option produces a SYSDEBUG file.

   `NOHOOK` and `SEPARATE` produce a production-ready module that can still be debugged.

   If the `OPT` option is also used, `EJPD` might reduce optimization but enables the debugger's `JUMPTO` and `GOTO` commands. These commands are disabled when `OPT` and `NOEJPD` are both used.
4. When the `TEST` option is not used, save the compiler listing in a file, or use the *xxx*LANGX utility program to create a LANGX file. Equivalent *xxx*LANGX utilities are available in Debug Tool for z/OS as EQALANGX, in Fault Analyzer for z/OS as IDILANGX and in Application Performance Analyzer for z/OS as CAZLANGX.

Fault Analyzer for z/OS and Application Performance Analyzer for z/OS can use compiler listings and LANGX files to provide source-level support.

5. The LIST, MAP, SOURCE, and XREF options are needed only if a compiler listing or a LANGX file will be used to provide source information to Fault Analyzer for z/OS or Application Performance Analyzer for z/OS. If a SYSDEBUG file will be used with these products or if you will not be using Fault Analyzer for z/OS or Application Performance Analyzer for z/OS, the LIST, MAP, SOURCE, and XREF options are optional.
6. The NONUMBER compiler option is needed only if a compiler listing file will be used to provide source information to Application Performance Analyzer for z/OS. If a SYSDEBUG file will be used with Application Performance Analyzer for z/OS, or if you will not be using Application Performance Analyzer for z/OS, the NONUMBER option is optional.
7. Code a SYSDEBUG DD in the JCL of the compiler step:

   ```
   //SYSDEBUG DD DSN= SYSDEBUG.pds(pgmname),DISP=SHR
   ```

   Save the SYSDEBUG file produced by the compiler in the SYSDEBUG library and specify a member name that is equal to the program name of your application program. This is the source information file for Debug Tool for z/OS, Fault Analyzer for z/OS and Application Performance Analyzer for z/OS.
8. Modify the promotion process to promote SYSDEBUG files. When a load module is promoted, for example from test to production, promote the corresponding SYSDEBUG file or files. A promotion can be a recompile, copy, or move. Perform the same steps with the SYSDEBUG file that you perform with the module during promotion.
9. Optionally, include a Debug Tool Language Environment (LE) exit module into the load module during the linkage editor step. This is one way to enable Debug Tool's panel 6 in ISPF, a simple panel-driven method to start the debugger automatically when a program runs, without JCL changes, based on the program name and user ID. Use module EQADBCXT for batch programs (including IMS batch), EQADICXT for IMS/TM programs and EQADDCXT for DB2 stored procedures. Do not include the exit module for CICS programs.

   You can also use module EQAD3CXT for batch programs, IMS/TM, IMS BTS programs, and DB2 type MAIN stored procedures.

Sample JCL for compiling Enterprise COBOL for z/OS Version 4 programs

Below is a JCL example for compiling an Enterprise COBOL for z/OS Version 4 program for use with the IBM Problem Determination Tools products. This is a generic sample, and might not meet all your requirements to generate your modules.

Notice that the TEST compiler option is specified. Code the correct sub-options of the TEST compiler option for the version of the compiler that you are using. You can also code any other compatible compiler options that are required by your programs.

Also notice that a SYSDEBUG DD statement has been coded. This is the source information file that the compiler produces. It refers to a SYSDEBUG library that is a PDS or PDSE. The member name must be the same as the program name.

For Enterprise COBOL for z/OS, these are the only required changes.

However, there is an optional change in the linkage editor step. The example below shows that a special Language Environment exit module is included in the application load module. Although this is not required, it enables the use of Debug Tool panel 6, which makes the debugger easier to start in some environments. If you prefer to use panel 6 to start Debug Tool, this is one way to enable it. If you do not plan to use Debug Tool panel 6, then do not include an exit module.

```
//*     - - -  ADD A JOB CARD ABOVE THIS LINE  - - -
//*
//*  SAMPLE JCL TO PREPARE AN ENTERPRISE COBOL PROGRAM
//*  FOR THE IBM ZSERIES PD TOOLS PRODUCTS:
//*     FAULT ANALYZER, DEBUG TOOL, AND APPLICATION PERF. ANALYZER
//*
//*  NOTES:
//*
//*   COMPILER:
//*    1. A TEST COMPILER PARM IS REQUIRED FOR DEBUG TOOL
//*    2. COMPILER PARM TEST(NOHOOK,SEPARATE,EJPD) HAS ADVANTAGES:
//*         - THE MODULE IS READY FOR DEBUG TOOL
//*         - THE MODULE IS PRODUCTION-READY (NO RUN-TIME OVERHEAD)
//*         - A SYSDEBUG FILE IS CREATED THAT CAN BE USED BY DT,FA,APA
//*    3. COMPILER PARMS LIST,MAP,SOURCE,XREF ARE REQUIRED IF YOU PLAN
//*       TO USE THE COMPILER LISTING WITH FA OR APA, OR XXXLANGX
//*
//*   BINDER (LINKAGE EDITOR):
//*    4. THE INCLUDE FOR MODULE EQAD?CXT IS *OPTIONAL*.  IT IS AN
//*       LE EXIT MODULE THAT CAN BE USED TO START DEBUG TOOL.
//*       UNDERSTAND THE METHODS AVAILABLE FOR STARTING DEBUG TOOL,
//*       AND CHOOSE WHETHER YOU WANT TO USE THE LE EXITS.
//*         IF YOU USE THIS METHOD, LOAD THE CORRECT EXIT MODULE:
//*            EQADBCXT: FOR BATCH PROGRAMS
//*            EQADICXT: FOR ONLINE IMS PROGRAMS
//*            EQADDCXT: FOR DB2 STORED PROCEDURES (OF TYPE MAIN AND SUB)
//*           (for SUB this is supported only for invocations through call_sub)
//*            (DO NOT INCLUDE AN EXIT FOR CICS PROGRAMS)
|//*            YOU CAN ALSO USE MODULE EQAD3CXT FOR BATCH PROGRAMS, ONLINE IMS
|//*            PROGRAMS, AND DB2 TYPE MAIN STORED PROCEDURES.
//*
//*  SET PARMS FOR THIS COMPILE:
//*  ---------------------------
//   SET MEM=SAM1                              PROGRAM NAME
//   SET COBOLLIB='IGY.V4R1.SIGYCOMP'          COBOL COMPILER LOADLIB
//   SET DTLIB='EQAW.SEQAMOD'                  DEBUG TOOL LOADLIB
//   SET LELIB='CEE.SCEELKED'                  LE LINKEDIT LIBRARY
//   SET UNITDEV=SYSALLDA                      UNIT FOR TEMP FILES
//*
//*  ****************************
//*        COMPILE STEP
//*  ****************************
//COMPILE  EXEC PGM=IGYCRCTL,REGION=0M,
//   PARM=('TEST(NOHOOK,SEPARATE,EJPD),LIST,MAP,XREF(SHORT),NONUMBER,SOURCE')
//STEPLIB  DD DISP=SHR,DSN=&COBOLLIB
//SYSIN    DD DISP=SHR,DSN=&SYSUID..ADLAB.SOURCE(&MEM)
//SYSLIB   DD DISP=SHR,DSN=&SYSUID..ADLAB.COPYLIB
//SYSPRINT DD DISP=SHR,DSN=&SYSUID..ADLAB.LISTING(&MEM)
//SYSDEBUG DD DISP=SHR,DSN=&SYSUID..ADLAB.SYSDEBUG(&MEM)
//SYSLIN   DD DISP=(MOD,PASS),DSN=&&LOADSET,UNIT=&UNITDEV,
//            SPACE=(80,(10,10))
//SYSUT1   DD SPACE=(80,(10,10),,,ROUND),UNIT=&UNITDEV
//SYSUT2   DD SPACE=(80,(10,10),,,ROUND),UNIT=&UNITDEV
//SYSUT3   DD SPACE=(80,(10,10),,,ROUND),UNIT=&UNITDEV
//SYSUT4   DD SPACE=(80,(10,10),,,ROUND),UNIT=&UNITDEV
//SYSUT5   DD SPACE=(80,(10,10),,,ROUND),UNIT=&UNITDEV
//SYSUT6   DD SPACE=(80,(10,10),,,ROUND),UNIT=&UNITDEV
//SYSUT7   DD SPACE=(80,(10,10),,,ROUND),UNIT=&UNITDEV
//*
//CBLPRINT  EXEC PGM=IEBGENER,REGION=0M
```

```
//SYSPRINT  DD SYSOUT=*
//SYSUT1    DD DSN=&SYSUID..ADLAB.LISTING(&MEM),DISP=SHR
//SYSUT2    DD SYSOUT=*
//SYSIN     DD DUMMY
//*  ********************************
//*        LINK-EDIT (BINDER) STEP
//*  ********************************
//LKED EXEC PGM=IEWL,REGION=0M,COND=(5,LT,COMPILE),PARM='LIST,XREF'
//SYSLIB   DD DISP=SHR,DSN=&LELIB
//DTLIB    DD DISP=SHR,DSN=&DTLIB
//SYSLMOD  DD DSN=&SYSUID..ADLAB.LOAD(&MEM),DISP=SHR
//SYSLIN   DD DISP=(OLD,DELETE),DSN=&&LOADSET
//*  INCLUDING A DEBUG TOOL LE EXIT (EQADBCXT, EQADDCXT, EQADICXT, OR EQAD3CXT)
//*  IS OPTIONAL.
//*  AN EXIT ENABLES STARTING DEBUG TOOL USING THE USER EXIT DATA SET UTILITY
//*  (ONE OF THE DEBUG TOOL ISPF UTILITIES)
//*  //        DD *
//*   INCLUDE DTLIB(EQADBCXT)
//SYSPRINT DD SYSOUT=*
//SYSUT1   DD UNIT=&UNITDEV,DCB=BLKSIZE=1024,SPACE=(1024,(200,20))
```

Enterprise COBOL for z/OS Version 3 and COBOL for OS/390 and VM programs

The following table shows various compiler options that can be used to prepare Enterprise COBOL for z/OS Version 3 and COBOL for OS/390 and VM programs for use with the IBM Problem Determination Tools products (Debug Tool for z/OS, Fault Analyzer for z/OS and Application Performance Analyzer for z/OS). The methods suggested in the following table indicate if the load module produced is suitable for a production environment. Load modules suitable for a production environments have no significant runtime overhead.

Table 20. Examples of compiler options and source information files supported by IBM Problem Determination tools products for Enterprise COBOL for z/OS Version 3 and COBOL for OS/390 and VM

Compiler options	Source information file type produced	Is the load module production ready?	Options supported and suggested for Debug Tool for z/OS	Options supported and suggested for Fault Analyzer for z/OS	Options supported and suggested for Application Performance Analyzer for z/OS
TEST(NONE, SYM, SEPARATE), LIST, MAP, SOURCE, NONUMBER, XREF(SHORT)	SYSDEBUG	Yes	Suggested for production and test		
NOTEST, LIST, MAP, SOURCE, NONUMBER, NOOPT, XREF(SHORT)	Compiler listing	Yes	N/A	Supported	Supported
NOTEST, LIST, MAP, SOURCE, XREF(SHORT), NUMBER		Yes	N/A	Supported	N/A
LIST, MAP, SOURCE, NONUMBER, XREF(SHORT)	LANGX file	Yes	N/A	Supported	Supported

Note: The highlighted row or rows in the table above indicate the suggested compiler options and source information file types for each product.

Preparing Enterprise COBOL for z/OS Version 3 and COBOL for OS/390 and VM programs

Perform the following steps for compiling your Enterprise COBOL for z/OS Version 3 and COBOL for OS/390 and VM programs using the compiler options suggested in Table 20 on page 431:

1. Create libraries (PDSE is suggested unless PDS is required in your organization) for SYSDEBUG files. Allocate one or more SYSDEBUG libraries for each environment, such as test, production, and so on.
2. Create a corresponding SYSDEBUG library for each load library. Specify `LRECL=(80 to 1024),RECFM=FB,BLKSIZE=(multiple of lrecl < 32K)`.
3. For all programs in both test and production environments, use `TEST(NONE,SYM,SEPARATE),LIST,MAP,SOURCE,NONUMBER,XREF(SHORT)`.

   `TEST` is required by Debug Tool for z/OS.

   The `SEPARATE` sub-option produces a SYSDEBUG file. Specifying `NONE` with `SEPARATE` produces a production-ready module that can still be debugged.

   If `OPTIMIZE` is specified, the debugger `JUMPTO` and `GOTO` commands are disabled. These commands are enabled when `NOOPTIMIZE` is specified.
4. The `LIST`, `MAP`, `SOURCE`, and `XREF` options are needed only if a compiler listing or a LANGX file will be used to provide source information to Fault Analyzer for z/OS or Application Performance Analyzer for z/OS. If a SYSDEBUG file will be used with these products, or if you will not be using Fault Analyzer for z/OS or Application Performance Analyzer for z/OS, the `LIST`, `MAP`, `SOURCE`, and `XREF` options are optional.
5. The `NONUMBER` compiler option is needed only if a compiler listing file will be used to provide source information to Application Performance Analyzer for z/OS. If a SYSDEBUG file will be used with Application Performance Analyzer for z/OS, or if you will not be using Application Performance Analyzer for z/OS, the `NONUMBER` option is optional.
6. Code a SYSDEBUG DD in the JCL of the compiler step.

   ```
   //SYSDEBUG DD DSN= SYSDEBUG.pds(pgmname),DISP=SHR
   ```

   Save the SYSDEBUG file produced by the compiler in the SYSDEBUG library and specify a member name that is equal to the program name of your application program. This is the source information file for Debug Tool for z/OS, Fault Analyzer for z/OS and Application Performance Analyzer for z/OS.
7. Modify the promotion process to promote SYSDEBUG files. When a load module is promoted, for example from test to production, promote the corresponding SYSDEBUG file or files. A promotion can be a recompile, copy, or move. Perform the same steps with the SYSDEBUG file that you perform with the module during promotion.
8. Optionally, include a Debug Tool Language Environment exit module into the load module during the linkage editor step. This is one way to enable Debug Tool's panel 6 in ISPF, a simple panel-driven method to start the debugger automatically when a program runs, without JCL changes, based on the program name and user ID. Use module EQADBCXT for batch programs (including IMS batch), EQADICXT for IMS/TM programs and EQADDCXT for DB2 stored procedures. Do not include the exit module for CICS programs.

   You can also use module EQAD3CXT for batch programs, IMS/TM, IMS BTS programs, and DB2 type MAIN stored procedures.

Sample JCL for compiling Enterprise COBOL for z/OS Version 3 programs

Below is a JCL example for compiling an Enterprise COBOL for z/OS Version 3 program for use with the IBM Problem Determination Tools products. This is a generic sample, and might not meet all your requirements.

Notice that a TEST option is specified. Code the correct sub-option of the TEST compiler option for the version of the compiler that you are using. You can also code any other compatible compiler options that are required by your programs.

Also notice that a SYSDEBUG DD statement has been coded. This is the source information file that the compiler produces. It refers to a SYSDEBUG library that is a PDS or PDSE. The member name must be the same as the program name.

For Enterprise COBOL for z/OS, these are the only required changes.

However, there is an optional change in the linkage editor step. The example below shows that a special Language Environment exit module is included in the application load module. Although this is not required, it enables the use of Debug Tool panel 6, which makes the debugger easier to start in some environments. If you prefer to use panel 6 to start Debug Tool, this is one way to enable it. If you do not plan to use Debug Tool panel 6, then do not include an exit module.

```
//*    - - -  ADD A JOB CARD ABOVE THIS LINE  - - -
//*
//*  SAMPLE JCL TO PREPARE AN ENTERPRISE COBOL PROGRAM
//*  FOR THE IBM ZSERIES PD TOOLS PRODUCTS:
//*     FAULT ANALYZER, DEBUG TOOL, AND APPLICATION PERF. ANALYZER
//*
//*  NOTES:
//*
//*   COMPILER:
//*    1. A TEST COMPILER PARM IS REQUIRED FOR DEBUG TOOL
//*    2. COMPILER PARM TEST(NONE,SYM,SEP) HAS THREE ADVANTAGES:
//*         - THE MODULE IS READY FOR DEBUG TOOL
//*         - THE MODULE IS PRODUCTION-READY (NO RUN-TIME OVERHEAD)
//*         - A SYSDEBUG FILE IS CREATED THAT CAN BE USED BY DT,FA,APA
//*    3. COMPILER PARMS LIST,MAP,SOURCE,XREF ARE REQUIRED IF YOU PLAN
//*       TO USE THE COMPILER LISTING WITH FA OR APA, OR XXXLANGX
//*    4. COMPILER PARM NOOPT IS OPTIONAL.  HOWEVER, THE DEBUG TOOL
//*       COMMANDS JUMPTO AND GOTO WILL NOT BE AVAILABLE IF
//*       THE OPT PARM IS USED
//*
//*   BINDER (LINKAGE EDITOR):
//*    5. THE INCLUDE FOR MODULE EQAD?CXT IS *OPTIONAL*.  IT IS AN
//*       LE EXIT MODULE THAT CAN BE USED TO START DEBUG TOOL.
//*       UNDERSTAND THE METHODS AVAILABLE FOR STARTING DEBUG TOOL,
//*       AND CHOOSE WHETHER YOU WANT TO USE THE LE EXITS.
//*         IF YOU USE THIS METHOD, LOAD THE CORRECT EXIT MODULE:
//*            EQADBCXT: FOR BATCH PROGRAMS
//*            EQADICXT: FOR ONLINE IMS PROGRAMS
//*            EQADDCXT: FOR DB2 STORED PROCEDURES (OF TYPE MAIN AND SUB)
//*           (for SUB this is supported only for invocations through call_sub)
//*            (DO NOT INCLUDE AN EXIT FOR CICS PROGRAMS)
//*            YOU CAN ALSO USE MODULE EQAD3CXT FOR BATCH PROGRAMS, ONLINE IMS
//*            PROGRAMS, DB2 TYPE MAIN STORED PROCEDURES.
//*
//*  SET PARMS FOR THIS COMPILE:
//*  ---------------------------
//   SET MEM=SAM1                              PROGRAM NAME
//   SET COBOLLIB='IGY.V3R4.SIGYCOMP'          COBOL COMPILER LOADLIB
//   SET DTLIB='EQAW.SEQAMOD'                  DEBUG TOOL LOADLIB
//   SET LELIB='CEE.SCEELKED'                  LE LINKEDIT LIBRARY
```

```
//   SET UNITDEV=SYSALLDA                    UNIT FOR TEMP FILES
//*
//*  ***************************
//*        COMPILE STEP
//*  ***************************
//COMPILE  EXEC PGM=IGYCRCTL,REGION=0M,
//   PARM=('TEST(NONE,SYM,SEPARATE),LIST,MAP,SOURCE,NONUMBER,XREF(SHORT)')
//STEPLIB  DD DISP=SHR,DSN=&COBOLLIB
//SYSIN    DD DISP=SHR,DSN=&SYSUID..ADLAB.SOURCE(&MEM)
//SYSLIB   DD DISP=SHR,DSN=&SYSUID..ADLAB.COPYLIB
//SYSPRINT DD DISP=SHR,DSN=&SYSUID..ADLAB.LISTING(&MEM)
//SYSDEBUG DD DISP=SHR,DSN=&SYSUID..ADLAB.SYSDEBUG(&MEM)
//SYSLIN   DD DISP=(MOD,PASS),DSN=&&LOADSET,UNIT=&UNITDEV,
//            SPACE=(80,(10,10))
//SYSUT1   DD SPACE=(80,(10,10),,,ROUND),UNIT=&UNITDEV
//SYSUT2   DD SPACE=(80,(10,10),,,ROUND),UNIT=&UNITDEV
//SYSUT3   DD SPACE=(80,(10,10),,,ROUND),UNIT=&UNITDEV
//SYSUT4   DD SPACE=(80,(10,10),,,ROUND),UNIT=&UNITDEV
//SYSUT5   DD SPACE=(80,(10,10),,,ROUND),UNIT=&UNITDEV
//SYSUT6   DD SPACE=(80,(10,10),,,ROUND),UNIT=&UNITDEV
//SYSUT7   DD SPACE=(80,(10,10),,,ROUND),UNIT=&UNITDEV
//*
//CBLPRINT  EXEC PGM=IEBGENER,REGION=0M
//SYSPRINT  DD SYSOUT=*
//SYSUT1    DD DSN=&SYSUID..ADLAB.LISTING(&MEM),DISP=SHR
//SYSUT2    DD SYSOUT=*
//SYSIN     DD DUMMY
//*  ********************************
//*        LINK-EDIT (BINDER) STEP
//*  ********************************
//LKED EXEC PGM=IEWL,REGION=0M,COND=(5,LT,COMPILE),PARM='LIST,XREF'
//SYSLIB   DD DISP=SHR,DSN=&LELIB
//DTLIB    DD DISP=SHR,DSN=&DTLIB
//SYSLMOD  DD DSN=&SYSUID..ADLAB.LOAD(&MEM),DISP=SHR
//SYSLIN   DD DISP=(OLD,DELETE),DSN=&&LOADSET
//*  INCLUDING A DEBUG TOOL LE EXIT (EQADBCXT, EQADDCXT, EQADICXT OR EQAD3CXT)
//*  IS OPTIONAL.
//*  AN EXIT ENABLES STARTING DEBUG TOOL USING THE USER EXIT DATA SET UTILITY
//*  (ONE OF THE DEBUG TOOL ISPF UTILITIES)
//*  //        DD *
//*   INCLUDE DTLIB(EQADBCXT)
//SYSPRINT DD SYSOUT=*
//SYSUT1   DD UNIT=&UNITDEV,DCB=BLKSIZE=1024,SPACE=(1024,(200,20))
```

COBOL for MVS and VM programs

The following table shows various compiler options that can be used to prepare COBOL for MVS and VM programs for use with the IBM Problem Determination Tools products (Debug Tool for z/OS, Fault Analyzer for z/OS and Application Performance Analyzer for z/OS). The methods suggested in the following table indicate if the load module produced is suitable for a production environment. Load modules suitable for a production environments have no significant run-time overhead.

Table 21. Examples of compiler options and source information files supported by IBM Problem Determination tools products for COBOL for MVS and VM

Compiler options	Source information file type produced	Is the load module production ready?	Options supported and suggested for Debug Tool for z/OS	Options supported and suggested for Fault Analyzer for z/OS	Options supported and suggested for Application Performance Analyzer for z/OS
TEST(ALL, SYM), LIST, MAP, SOURCE, NOOPT, NONUMBER, XREF(SHORT)	Compiler listing	No	Suggested for test. (Using Debug Tool in production for this compiler is not suggested.)		
NOTEST, LIST, MAP, SOURCE, NONUMBER, XREF(SHORT)		Yes	N/A	Suggested for production	
NOTEST, LIST, MAP, SOURCE, NONUMBER, XREF(SHORT)	LANGX file	Yes	N/A	Supported	Supported

Note: The highlighted row or rows in the table above indicate the suggested compiler options and source information file types for each product.

Preparing COBOL for MVS and VM programs

Perform the following steps for compiling your COBOL for MVS and VM programs:

1. Create libraries (PDSE is suggested unless PDS is required in your organization) for compiler listing files. Allocate one or more compiler listing libraries for each environment, such as test and production.
2. Create a corresponding listing library for each load library. Specify `LRECL=133,RECFM=FBA,BLKSIZE=(multiple of lrecl < 32K)`.
3. For all programs, such as batch, CICS, and IMS:
   - In test environments, specify compiler options `TEST(ALL,SYM),NOOPT,LIST,MAP,SOURCE,NONUMBER,XREF(SHORT)` to create a module that can be used with Debug Tool for z/OS, Fault Analyzer for z/OS and Application Performance Analyzer for z/OS.

     `TEST` is required for Debug Tool for z/OS.

     The `ALL` sub-option adds debug hooks, which will add some run-time overhead.

     `SYM` stores symbolics data required by Debug Tool for z/OS into the module, which can make it significantly larger.

     The other options format the compiler listing as required by Debug Tool for z/OS, Fault Analyzer for z/OS, and Application Performance Analyzer for z/OS.
   - In production environments, specify compiler options `NOTEST,LIST,MAP,SOURCE,NONUMBER,XREF(SHORT)` to create a production-ready module that can be used with Fault Analyzer for z/OS and Application Performance Analyzer for z/OS (but not Debug Tool for z/OS). Specify `OPTIMIZE` if preferred.

     `NOTEST` disables source level debugging with Debug Tool , but can provide better performance and smaller module size.

     The other options (except `OPTIMIZE`) format the compiler listing as required by Fault Analyzer for z/OS and Application Performance Analyzer for z/OS.

4. Modify the SYSPRINT DD in the JCL of the compiler step to refer to a file.

   ```
   //SYSPRINT DD DSN= compiler.listing.pds(pgmname),DISP=SHR
   ```

   Save the compiler listing in a file in the compiler listing library and specify a member name that is equal to the program name of your application program. This is the source information file for Debug Tool for z/OS, Fault Analyzer for z/OS and Application Performance Analyzer for z/OS.
5. Modify the promotion process to promote compiler listing files. When a load module is promoted, for example, from test to production, promote the corresponding compiler listing file or files. A promotion can be a recompile, a copy, or a move. Perform the same steps with the compiler listing file that you perform with the module during promotion.
6. Optionally, include a Debug Tool Language Environment exit module into the load module during the linkage editor step. This is one way to enable Debug Tool's panel 6 in ISPF, a simple panel-driven method to start the debugger automatically when a program runs, without JCL changes, based on the program name and user ID. Use module EQADBCXT for batch programs (including IMS batch), EQADICXT for IMS/TM programs and EQADDCXT for DB2 stored procedures. Do not include the exit module for CICS programs.

   You can also use module EQAD3CXT for batch programs, IMS/TM, IMS BTS programs, and DB2 type MAIN stored procedures.

Sample JCL for compiling COBOL for MVS and VM programs

Below is a JCL example for compiling an COBOL for MVS and VM program for use with the IBM Problem Determination Tools products. This is a generic sample, and might not meet all your requirements.

Notice that a `TEST` option is specified. Code the correct sub-options of the `TEST` compiler option for the version of the compiler that you are using. You can also code any other compatible compiler options that are required by your programs.

Also notice that the SYSPRINT DD refers to a permanent file. This is the source information file that the compiler produces. It refers to a listing library that is a PDS or PDSE. The member name must be the same as the program name. For COBOL for MVS and VM, these are the only required changes.

However, there is an optional change in the linkage editor step. The example below shows that a special Language Environment exit module is included in the application load module. Although this is not required, it enables the use of Debug Tool panel 6, which makes the debugger easier to start in some environments. If you prefer to use panel 6 to start Debug Tool, this is one way to enable it. If you do not plan to use Debug Tool panel 6, then do not include an exit module.

```
//*     - - -  ADD A JOB CARD ABOVE THIS LINE  - - -
//*
//*  SAMPLE JCL TO PREPARE A COBOL FOR MVS AND VM PROGRAM
//*  FOR THE IBM ZSERIES PD TOOLS PRODUCTS:
//*     FAULT ANALYZER, DEBUG TOOL, AND APPLICATION PERF. ANALYZER
//*
//*  NOTES:
//*
//*   COMPILER:
//*    1. A TEST COMPILER PARM IS REQUIRED FOR DEBUG TOOL
//*    2. COMPILER PARMS LIST,MAP,SOURCE,XREF ARE REQUIRED IF YOU PLAN
//*       TO USE THE COMPILER LISTING WITH FA OR APA, OR XXXLANGX
//*    3. COMPILER PARM NOOPT IS OPTIONAL.  HOWEVER, THE DEBUG TOOL
//*       COMMANDS JUMPTO AND GOTO WILL NOT BE AVAILABLE IF
//*       THE OPT PARM IS USED
```

```
//*
//*   BINDER (LINKAGE EDITOR):
//*    4. THE INCLUDE FOR MODULE EQAD?CXT IS *OPTIONAL*.  IT IS AN
//*       LE EXIT MODULE THAT CAN BE USED TO START DEBUG TOOL.
//*       UNDERSTAND THE METHODS AVAILABLE FOR STARTING DEBUG TOOL,
//*       AND CHOOSE WHETHER YOU WANT TO USE THE LE EXITS.
//*         IF YOU USE THIS METHOD, LOAD THE CORRECT EXIT MODULE:
//*            EQADBCXT: FOR BATCH PROGRAMS
//*            EQADICXT: FOR ONLINE IMS PROGRAMS
//*            EQADDCXT: FOR DB2 STORED PROCEDURES (OF TYPE MAIN AND SUB)
//*           (for SUB this is supported only for invocations through call_sub)
//*            (DO NOT INCLUDE AN EXIT FOR CICS PROGRAMS)
//*           YOU CAN ALSO USE MODULE EQAD3CXT FOR BATCH PROGRAMS, ONLINE IMS
//*            PROGRAMS, DB2 TYPE MAIN STORED PROCEDURES.
//*
//*  SET PARMS FOR THIS COMPILE:
//*  ---------------------------
//   SET MEM=SAM1                              PROGRAM NAME
//   SET COBOLLIB='IGY.SIGYCOMP'               COBOL COMPILER LOADLIB
//   SET DTLIB='EQAW.SEQAMOD'                  DEBUG TOOL LOADLIB
//   SET LELIB='CEE.SCEELKED'                  LE LINKEDIT LIBRARY
//   SET UNITDEV=SYSALLDA                      UNIT FOR TEMP FILES
//*
//*  ****************************
//*       COMPILE STEP
//*  ****************************
////COMPILE  EXEC PGM=IGYCRCTL,REGION=0M,
//   PARM=(NOTEST,LIST,MAP,SOURCE,NONUMBER,XREF(SHORT)')
//STEPLIB  DD DISP=SHR,DSN=&COBOLLIB
//SYSIN    DD DISP=SHR,DSN=&SYSUID..ADLAB.SOURCE(&MEM)
//SYSLIB   DD DISP=SHR,DSN=&SYSUID..ADLAB.COPYLIB
//SYSPRINT DD DISP=SHR,DSN=&SYSUID..ADLAB.LISTING(&MEM)
//SYSDEBUG DD DISP=SHR,DSN=&SYSUID..ADLAB.SYSDEBUG(&MEM)
//SYSLIN   DD DISP=(MOD,PASS),DSN=&&LOADSET,UNIT=&UNITDEV,
//            SPACE=(80,(10,10))
//SYSUT1   DD SPACE=(80,(10,10),,,ROUND),UNIT=&UNITDEV
//SYSUT2   DD SPACE=(80,(10,10),,,ROUND),UNIT=&UNITDEV
//SYSUT3   DD SPACE=(80,(10,10),,,ROUND),UNIT=&UNITDEV
//SYSUT4   DD SPACE=(80,(10,10),,,ROUND),UNIT=&UNITDEV
//SYSUT5   DD SPACE=(80,(10,10),,,ROUND),UNIT=&UNITDEV
//SYSUT6   DD SPACE=(80,(10,10),,,ROUND),UNIT=&UNITDEV
//SYSUT7   DD SPACE=(80,(10,10),,,ROUND),UNIT=&UNITDEV
//*
//CBLPRINT  EXEC PGM=IEBGENER,REGION=0M
//SYSPRINT  DD SYSOUT=*
//SYSUT1    DD DSN=&SYSUID..ADLAB.LISTING(&MEM),DISP=SHR
//SYSUT2    DD SYSOUT=*
//SYSIN     DD DUMMY
//*  ********************************
//*       LINK-EDIT (BINDER) STEP
//*  ********************************
//LKED EXEC PGM=IEWL,REGION=0M,COND=(5,LT,COMPILE),PARM='LIST,XREF'
//SYSLIB   DD DISP=SHR,DSN=&LELIB
//*** DTLIB    DD DISP=SHR,DSN=&DTLIB
//SYSLMOD  DD DSN=&SYSUID..ADLAB.LOAD(&MEM),DISP=SHR
//SYSLIN   DD DISP=(OLD,DELETE),DSN=&&LOADSET
//*  INCLUDING A DEBUG TOOL LE EXIT (EQADBCXT, EQADDCXT, EQADICXT OR EQAD3CXT)
//*  IS OPTIONAL.
//*  AN EXIT ENABLES STARTING DEBUG TOOL USING THE USER EXIT DATA SET UTILITY
//*  (ONE OF THE DEBUG TOOL ISPF UTILITIES)
//*  //        DD *
//*   INCLUDE DTLIB(EQADBCXT)
//SYSPRINT DD SYSOUT=*
//SYSUT1   DD UNIT=&UNITDEV,DCB=BLKSIZE=1024,SPACE=(1024,(200,20))
```

VS COBOL II programs

If you are currently using the TEST option to compile your programs, consider using NOTEST. Using NOTEST allows you to take advantage of Debug Tool for z/OS functionality that is not available when compiling with the TEST option. Examples of Debug Tool for z/OS functions that are available when compiling with the NOTEST option include the automonitor feature and using AT ENTRY *program name* breakpoints. Compiling with NOTEST also allows you to generate a module that can be debugged but does not incur additional overhead when running without the debugger.

The following table shows various compiler options that can be used to prepare VS COBOL II programs for use with the IBM Problem Determination Tools products (Debug Tool for z/OS, Fault Analyzer for z/OS and Application Performance Analyzer for z/OS). The methods suggested in the following table indicate if the load module produced is suitable for a production environment. Load modules suitable for a production environments have no significant run-time overhead.

Table 22. Examples of compiler options and source information files supported by Problem Determination tools products for VS COBOL II

Compiler options	Source information file type produced	Is the load module production ready?	Options supported and suggested for Debug Tool for z/OS	Options supported and suggested for Fault Analyzer for z/OS	Options supported and suggested for Application Performance Analyzer for z/OS
NOTEST, LIST, MAP, SOURCE, XREF, NONUMBER, NOOFFSET	Compiler listing	Yes	N/A	Supported	Supported
NOTEST, LIST, MAP, SOURCE, XREF, NUMBER		Yes	N/A	Supported	N/A
NOTEST, LIST, MAP, NOOPT, SOURCE, XREF, NONUMBER	LANGX file	Yes	Suggested for production and test		

Note: The highlighted row or rows in the table above indicate the suggested compiler options and source information file types for each product.

Preparing VS COBOL II programs

Perform the following steps for compiling your VS COBOL II programs using the compiler options suggested in Table 22:

1. Allocate libraries (PDSE is suggested unless PDS is required for your organization) for LANGX files. Allocate one or more LANGX libraries for each environment, such as test and production.
2. Create a corresponding LANGX library for each load library. Specify LRECL=1562 or greater,RECFM=VB,BLKSIZE= lrecl+4 to 32k.
3. For all programs, such as batch, CICS, and IMS, in both test and production environments, compile with NOTEST,LIST,MAP,NOOPT,SOURCE,XREF,NONUMBER compiler options.
4. Modify the SYSPRINT DD in the compiler step to refer to a file. It can be either a permanent or temporary file. This will be the input to the *xxx*LANGX utility.

5. Add a step after the compiler step to run the Problem Determination tools *xxx*LANGX utility. This utility program reads the compiler listing and generates a LANGX file. This is the source information file for Debug Tool for z/OS, Fault Analyzer for z/OS and Application Performance Analyzer for z/OS. Save the LANGX file in the LANGX file library and specify a member name that is equal to the program name of your application program. Equivalent *xxx*LANGX utilities are available in Debug Tool for z/OS as EQALANGX, in Fault Analyzer for z/OS as IDILANGX and in Application Performance Analyzer for z/OS as CAZLANGX.
6. If the module is linked with Language Environment services, optionally include a Debug Tool Language Environment exit module into the load module during the linkage editor step. This is one way to enable the Debug Tool panel 6 in ISPF, a simple panel-driven method to start the debugger automatically when a program runs, without JCL changes, based on the program name and user ID. Use module EQADBCXT for batch programs (including IMS batch), EQADICXT for IMS/TM programs and EQADDCXT for DB2 stored procedures. Do not include the exit module for CICS programs or if the module is not linked with Language Environment services (it is linked with COBOL II runtime services).

   You can also use module EQAD3CXT for batch programs, IMS/TM, IMS BTS programs, and DB2 type MAIN stored procedures.
7. Modify the promotion process to promote LANGX files. When a load module is promoted, for example, from test to production, promote the corresponding LANGX file or files. A promotion can be a recompile, copy, or move. Perform the same steps with the LANGX file that you perform with the module during promotion.

Sample JCL for compiling VS COBOL II programs

Below is an example of JCL for compiling a VS COBOL II program for use with IBM Problem Determination Tools products. This is a generic sample, and might not meet all your requirements.

Notice the compiler options used and notice that the compiler listing is passed to an added step that generates a LANGX file. The compiler listing can be stored in a permanent file or can be passed in a temporary file. For VS COBOL II, these are the only required changes.

However, there is an optional change in the linkage editor step. The following example includes a special Language Environment exit module in the application load module. Although this is not required, it enables the use of Debug Tool panel 6, which makes the debugger easier to start in some environments. If you prefer to use panel 6 to start Debug Tool, this is one way to enable it. If you do not plan to use Debug Tool panel 6, then do not include an exit module. Do not include the exit module for CICS programs or if the module is not linked with Language Environment services (it is linked with COBOL II runtime services).

```
//*     - - -  ADD A JOB CARD ABOVE THIS LINE  - - -
//*
//*  SAMPLE JCL TO PREPARE A VS COBOL II PROGRAM
//*  FOR THE IBM ZSERIES PD TOOLS PRODUCTS:
//*     FAULT ANALYZER, DEBUG TOOL, AND APPLICATION PERF. ANALYZER
//*
//*  NOTES:
//*
//*   COMPILER:
//*    1. COMPILER OPTIONS LIST,MAP,SOURCE,XREF ARE REQUIRED IF YOU
//*       PLAN TO USE THE LISTING WITH A PD TOOLS PRODUCT, OR TO
//*       PROCESS THE LISTING WITH AN XXXLANGX UTILITY
//*    2. COMPILER OPTION NOTEST IS SUGGESTED FOR ALL COBOL II
//*       PROGRAMS, EVEN IF IBM DEBUG TOOL FOR Z/OS WILL BE USED
```

```
//*
//*   BINDER (LINKAGE EDITOR):
//*    3. IN THIS EXAMPLE, THE MODULE IS LINKED WITH LANGUAGE
//*       ENVIRONMENT RUNTIME SERVICES. THIS IS CONTROLLED BY THE
//*       LIBRARY OR LIBRARIES SPECIFIED IN THE SYSLIB DD IN THE
//*       BINDER STEP.
//*    4. THE INCLUDE FOR MODULE EQAD?CXT IS *OPTIONAL*.  IT IS AN
//*       LE EXIT MODULE THAT CAN BE USED TO START DEBUG TOOL.
//*       UNDERSTAND THE METHODS AVAILABLE FOR STARTING DEBUG TOOL,
//*       AND CHOOSE WHETHER YOU WANT TO USE THE LE EXITS.
//*         IF YOU USE THIS METHOD, LOAD THE CORRECT EXIT MODULE:
//*            EQADBCXT: FOR BATCH PROGRAMS
//*            EQADICXT: FOR ONLINE IMS PROGRAMS
//*            EQADDCXT: FOR DB2 STORED PROCEDURES (OF TYPE MAIN AND SUB)
//*             (for SUB this is supported only for invocations through call_sub)
//*         (DO NOT INCLUDE AN EXIT FOR CICS PROGRAMS, OR FOR
//*          PROGRAMS LINKED WITH THE COBOL II RUNTIME SERVICES
//*          INSTEAD OF LANGUAGE ENVIRONMENT RUNTIME SERVICES)
|//*          YOU CAN ALSO USE MODULE EQAD3CXT FOR BATCH PROGRAMS, ONLINE IMS
|//*          PROGRAMS, DB2 TYPE MAIN STORED PROCEDURES.
//*
//*  SET OPTIONS FOR THIS COMPILE:
//*  --------------------------
//   SET MEM=SAMII1                          PROGRAM NAME
//   SET COB2COMP='IGY.V1R4M0.COB2COMP'      COBOL II COMPILER LIB
//   SET DTLIB='EQAW.SEQAMOD'                DEBUG TOOL LOADLIB
//   SET LELKED='CEE.SCEELKED'               LE LINK LIBRARY
//   SET LELIB='CEE.SCEERUN'                 LE RUNTIME LIBRARY
//   SET UNITDEV=SYSALLDA                    TEMP DATASET UNIT
//   SET LANGX='EQALANGX'                    XXXLANGX UTILITY PROGRAM
//   SET LANGXLIB='EQAW.SEQAMOD'             LIB FOR XXXLANGX UTILITY
//*
//*  ****************************
//*        COMPILE STEP
//*  ****************************
//COMPILE  EXEC PGM=IGYCRCTL,REGION=4M,
//   PARM=('NOTEST,LIST,MAP,NOOPT,SOURCE,XREF,NONUMBER',
//         'RES,APOST,LIB,DYNAM,NORENT,NOSSRANGE')
//STEPLIB  DD DISP=SHR,DSN=&COB2COMP
//SYSIN    DD DISP=SHR,DSN=&SYSUID..ADLAB.SOURCE(&MEM)
//SYSLIB   DD DISP=SHR,DSN=&SYSUID..ADLAB.COPYLIB
//SYSPRINT DD DISP=SHR,DSN=&SYSUID..ADLAB.LISTING(&MEM)
//SYSLIN   DD DISP=(MOD,PASS),DSN=&&LOADSET,UNIT=&UNITDEV,
//            SPACE=(80,(10,10))
//SYSUT1   DD SPACE=(80,(10,10),,,ROUND),UNIT=&UNITDEV
//SYSUT2   DD SPACE=(80,(10,10),,,ROUND),UNIT=&UNITDEV
//SYSUT3   DD SPACE=(80,(10,10),,,ROUND),UNIT=&UNITDEV
//SYSUT4   DD SPACE=(80,(10,10),,,ROUND),UNIT=&UNITDEV
//SYSUT5   DD SPACE=(80,(10,10),,,ROUND),UNIT=&UNITDEV
//SYSUT6   DD SPACE=(80,(10,10),,,ROUND),UNIT=&UNITDEV
//SYSUT7   DD SPACE=(80,(10,10),,,ROUND),UNIT=&UNITDEV
//*
//CBLPRINT  EXEC PGM=IEBGENER,REGION=0M
//SYSPRINT  DD SYSOUT=*
//SYSUT1    DD DSN=&SYSUID..ADLAB.LISTING(&MEM),DISP=SHR
//SYSUT2    DD SYSOUT=*
//SYSIN     DD DUMMY
//*
//* ********************************
//* STEP TO GENERATE A LANGX FILE
//* ********************************
//LANGX EXEC PGM=&LANGX,REGION=32M,
//   PARM='(COBOL ERROR 64K CREF'
//STEPLIB  DD DISP=SHR,DSN=&LANGXLIB
//         DD DISP=SHR,DSN=&LELIB
//LISTING  DD DSN=&SYSUID..ADLAB.LISTING(&MEM),DISP=SHR
//IDILANGX DD DISP=SHR,DSN=&SYSUID..ADLAB.EQALANGX(&MEM)
```

```
//*
//*  ********************************
//*        LINK-EDIT (BINDER) STEP
//*  ********************************
//LKED EXEC PGM=IEWL,REGION=0M,COND=(5,LT,COMPILE),PARM='LIST,XREF'
//SYSLIB   DD DISP=SHR,DSN=&LELKED
//DTLIB    DD DISP=SHR,DSN=&DTLIB
//SYSLMOD  DD DSN=&SYSUID..ADLAB.LOAD(&MEM),DISP=SHR
//SYSLIN   DD DISP=(OLD,DELETE),DSN=&&LOADSET
| //*  INCLUDING A DEBUG TOOL LE EXIT (EQADBCXT, EQADDCXT, EQADICXT OR EQAD3CXT)
//* IS OPTIONAL
//*  AN EXIT ENABLES STARTING DEBUG TOOL USING THE USER EXIT DATA SET UTILITY
//*  (ONE OF THE DEBUG TOOL ISPF UTILITIES)
//*  //        DD *
//*   INCLUDE DTLIB(EQADBCXT)
//SYSPRINT DD SYSOUT=*
//SYSUT1   DD UNIT=&UNITDEV,DCB=BLKSIZE=1024,SPACE=(1024,(200,20))
```

OS/VS COBOL programs

The following table shows various compiler options that can be used to prepare OS/VS COBOL programs for use with the IBM Problem Determination Tools products (Debug Tool for z/OS, Fault Analyzer for z/OS and Application Performance Analyzer for z/OS). The methods suggested in the following table indicate if the load module produced is suitable for a production environment. Load modules suitable for a production environments have no significant run-time overhead.

Table 23. Examples of compiler options and source information files supported by Problem Determination tools products for OS/VS COBOL

Compiler options	Source information file type produced	Is the load module production ready?	Options supported and suggested for Debug Tool for z/OS	Options supported and suggested for Fault Analyzer for z/OS	Options supported and suggested for Application Performance Analyzer for z/OS
DMAP, NOCLIST, NOLST, PMAP, SOURCE, VERB, XREF(SHORT)	Compiler listing	Yes	N/A	Supported	Supported
(LIST,NOPMAP) or (CLIST,NOPMAP) or (CLIST,PMAP)		Yes	N/A	N/A	N/A
NOBATCH, NOCLIST, NOCOUNT, DMAP, NOLST, PMAP, SOURCE, NOSYMDMP, NOTEST, NOOPT, VERB, XREF(SHORT)	LANGX file	Yes	Suggested for production and test		

Note: The highlighted row or rows in the table above indicate the suggested compiler options and source information file types for each product.

Preparing OS/VS COBOL programs

Perform the following steps for compiling your OS/VS COBOL programs:

1. Allocate libraries (PDSE is suggested unless PDS is required for your organization) for LANGX files. Allocate one or more LANGX libraries for each environment, such as test and production.
2. Create a corresponding LANGX library for each load library. Specify `LRECL=1562 or greater,RECFM=VB,BLKSIZE= lrecl+4 to 32k`.
3. For all programs, such as batch, CICS, and IMS, in both test and production environments, compile with the `NOBATCH, NOCLIST, NOCOUNT, DMAP, NOLST, PMAP, SOURCE, NOSYMDMP, NOTEST, NOOPT, VERB, XREF(SHORT)` compiler options. The module is production-ready and can be debugged using Debug Tool for z/OS.
4. Modify the SYSPRINT DD in the compiler step to refer to a file. It can be either a permanent or temporary file. This will be the input to the *xxx*LANGX utility.
5. Add a step after the compiler step to run the Problem Determination tools *xxx*LANGX utility. This utility program reads the compiler listing and generates a LANGX file, which is the source information file for Debug Tool for z/OS, Fault Analyzer for z/OS and Application Performance Analyzer for z/OS. Save the LANGX file in the LANGX file library, and specify a member name that is equal to the program name of your application program. Equivalent *xxx*LANGX utilities are available in Debug Tool for z/OS as EQALANGX, in Fault Analyzer for z/OS as IDILANGX and in Application Performance Analyzer for z/OS as CAZLANGX.
6. Modify the promotion process to promote LANGX files. When a load module is promoted, for example, from test to production, promote the corresponding LANGX file or files. A promotion can be a recompile, copy, or move. Perform the same steps with the LANGX file that you perform with the module during promotion.

Sample JCL for compiling OS/VS COBOL programs

Below is a JCL example for compiling an OS/VS program for use with the IBM Problem Determination Tools products:

```
//*     - - -  ADD A JOB CARD ABOVE THIS LINE  - - -
//*
//*  SAMPLE JCL TO PREPARE AN OS VS COBOL PROGRAM
//*  FOR THE IBM ZSERIES PD TOOLS PRODUCTS:
//*     FAULT ANALYZER, DEBUG TOOL, AND APPLICATION PERF. ANALYZER
//*
//*  NOTES:
//*
//*   COMPILER:
//*    -  COMPILER PARMS DMAP,NOCLIST,NOLST,PMAP,SOURCE,VERB,XREF
//*       ARE REQUIRED IF YOU PLAN TO USE THE COMPILER LISTING WITH
//*       PD TOOLS AND/OR PROCESS IT WITH XXXLANGX
//*
//*   A STEP THAT PROCESSES THE SYSADATA FILE,
//*   AND CREATES A LANGX FILE IS NEEDED.
//*
//*  SET PARMS FOR THIS COMPILE:
//*  ---------------------------
// SET MEM=SAMOS1                       PROGRAM NAME
// SET OSVSCOMP='IGY.VSCOLIB'           OS VS COBOL COMPILER LIBRARY
// SET LELIB='CEE.SCEELKED'             LE LINKEDIT LIBRARY
// SET UNITDEV=SYSALLDA                 UNIT FOR TEMP FILES
// SET SCEERUN='CEE.SCEERUN'            LANGUAGE ENVIRON SCEERUN LIB
// SET LANGX='EQALANGX'                 XXXLANGX UTILITY PROGRAM
// SET LANGXLIB='EQAW.SEQAMOD'          LIBRARY FOR XXXLANGX UTILITY
//*    NOTE: THE XXXLANGX UTILITY IS AVAILABLE WITH DEBUG TOOL,
//*          FAULT ANALYZER, AND APA WITH DIFFERENT NAMES.  YOU CAN
//*          USE ANY OF THEM... THEY ALL PRODUCE THE SAME RESULTS.
//*      IF YOU HAVE DEBUG TOOL, YOU CAN SET:
//*         LANGX='EQALANGX'  LANGXLIB=(THE DT SEQAMOD LIBRARY)
//*      IF YOU HAVE FAULT ANALYZER YOU CAN SET:
```

```
//*         LANGX='IDILANGX'  LANGXLIB=(THE FA SIDIAUTH LIBRARY)
//*      IF YOU HAVE APA (APP. PERFORMANCE ANALYZER) YOU CAN SET:
//*         LANGX='CAZLANGX'  LANGXLIB=(THE APA SCAZAUTH LIBRARY)
//*
//*  ***************************
//*        COMPILE STEP
//*  ***************************
//COMPILE  EXEC PGM=IKFCBL00,REGION=4M,
//   PARM=('DMAP,NOCLIST,NOLST,NOOPT,SOURCE,VERB,XREF(SHORT)')
//*   FOR DT (CHECK DEFAULTS): NOBATCH,NOCOUNT,PMAP,NOSYMDMP,NOTEST
//STEPLIB  DD DISP=SHR,DSN=&OSVSCOMP
//SYSIN    DD DISP=SHR,DSN=&SYSUID..ADLAB.SOURCE(&MEM)
//SYSLIB   DD DISP=SHR,DSN=&SYSUID..ADLAB.COPYLIB
//SYSPRINT DD DISP=SHR,DSN=&SYSUID..ADLAB.OSVSCOB.LISTING(&MEM)
//SYSLIN   DD DISP=(MOD,PASS),DSN=&&LOADSET,UNIT=&UNITDEV,
//            SPACE=(80,(10,10))
//SYSUT1   DD SPACE=(80,(10,10),,,ROUND),UNIT=&UNITDEV
//SYSUT2   DD SPACE=(80,(10,10),,,ROUND),UNIT=&UNITDEV
//SYSUT3   DD SPACE=(80,(10,10),,,ROUND),UNIT=&UNITDEV
//SYSUT4   DD SPACE=(80,(10,10),,,ROUND),UNIT=&UNITDEV
//SYSUT5   DD SPACE=(80,(10,10),,,ROUND),UNIT=&UNITDEV
//SYSUT6   DD SPACE=(80,(10,10),,,ROUND),UNIT=&UNITDEV
//SYSUT7   DD SPACE=(80,(10,10),,,ROUND),UNIT=&UNITDEV
//*
//CBLPRINT  EXEC PGM=IEBGENER,REGION=0M
//SYSPRINT  DD SYSOUT=*
//SYSUT1    DD DSN=&SYSUID..ADLAB.OSVSCOB.LISTING(&MEM),DISP=SHR
//SYSUT2    DD SYSOUT=*
//SYSIN     DD DUMMY
//*
//*  *********************************
//*     STEP TO GENERATE LANGX FILE
//*  *********************************
//LANGX    EXEC PGM=&LANGX,REGION=32M,
//  PARM='(COBOL ERROR 64K CREF'
//STEPLIB  DD DISP=SHR,DSN=&LANGXLIB
//         DD DISP=SHR,DSN=&SCEERUN
//LISTING  DD DSN=&SYSUID..ADLAB.OSVSCOB.LISTING(&MEM),DISP=SHR
//IDILANGX DD DISP=SHR,DSN=&SYSUID..ADLAB.EQALANGX(&MEM)
//*
//*  *********************************
//*        LINK-EDIT (BINDER) STEP
//*  *********************************
//LKED EXEC PGM=IEWL,REGION=0M,COND=(5,LT,COMPILE),PARM='LIST,XREF'
//SYSLIB   DD DISP=SHR,DSN=&LELIB
//SYSLMOD  DD DSN=&SYSUID..ADLAB.LOAD(&MEM),DISP=SHR
//SYSLIN   DD DISP=(OLD,DELETE),DSN=&&LOADSET
//SYSPRINT DD SYSOUT=*
//SYSUT1   DD UNIT=&UNITDEV,DCB=BLKSIZE=1024,SPACE=(1024,(200,20))
```

Enterprise PL/I Version 3.7 and later programs

The following table shows various compiler options that can be used to prepare Enterprise PL/I Version 3.7 and later programs for use with the IBM Problem Determination Tools products (IBM Debug Tool for z/OS, IBM Fault Analyzer for z/OS and IBM Application Performance Analyzer for z/OS). The methods suggested in the following table indicate if the load module produced is suitable for a production environment. Load modules suitable for production environments have no significant run-time overhead.

Table 24. Examples of compiler options and source information files supported by IBM Problem Determination Tools products for Enterprise PL/I Version 3.7 and later

Compiler options	Source information file type produced	Is the load module production ready?	Options supported and suggested for Debug Tool for z/OS	Options supported and suggested for Fault Analyzer for z/OS	Options supported and suggested for Application Performance Analyzer for z/OS
For Enterprise PL/I Version 3.7: TEST(ALL, SYM, NOHOOK, SEPARATE, SEPNAME, AALL), NOPT, AGGREGATE, ATTRIBUTES (FULL), NOBLKOFF, LIST, MAP, NEST, NONUMBER, OFFSET, OPTIONS, SOURCE, STMT, XREF(FULL) For Enterprise PL/I Version 3.8 and later: TEST(ALL, SYM, NOHOOK, SEPARATE, SEPNAME), LISTVIEW(AALL), NOPT, AGGREGATE, ATTRIBUTES (FULL), NOBLKOFF, LIST, MAP, NEST, NONUMBER, OFFSET, OPTIONS, SOURCE, STMT, XREF(FULL)	SYSDEBUG file used by Debug Tool for z/OS and Fault Analyzer for z/OS. LANGX file used by Application Performance Analyzer for z/OS	Although the module is larger than a module compiled with the NOTEST option, you can use the module in production if needed.	Suggested for test. You can also use these options in a production environment if the increased load module size is not an issue.		
AGGREGATE, ATTRIBUTES (FULL), NOBLKOFF, LIST, MAP, NEST, NOTEST, NONUMBER, OFFSET, OPTIONS, SOURCE, STMT, XREF(FULL)	Compiler listing	Yes	N/A	Supported	N/A
	LANGX file	Yes	N/A	Suggested for production and test	

Note: The highlighted row or rows in the table above indicate the suggested compiler options and source information file types for each product.

Preparing Enterprise PL/I Version 3.7 and later programs

Perform the following steps for compiling your Enterprise PL/I Version 3.7 and later programs:

1. Create a library (PDSE is suggested unless PDS is required for your organization) for SYSDEBUG files. This is only needed in test environments where debugging will be performed using `LRECL=(80 to 1024),RECFM=FB,BLKSIZE=(multiple of lrecl < 32K)`.
2. Allocate one or more LANGX libraries for each environment, such as test and production.
3. Create a corresponding LANGX library for each load library. Specify `LRECL=1562 or greater,RECFM=VB,BLKSIZE= lrecl+4 to 32k`.
4. For all programs, such as batch, CICS, and IMS:
   - In test environments:
     - When using the Enterprise PL/I Version 3.7 compiler:

       For all programs, specify the following compiler options:
       `TEST(ALL,SYM,NOHOOK,SEPARATE,SEPNAME,AALL), NOPT, AGGREGATE, ATTRIBUTES(FULL), NOBLKOFF, LIST, MAP, NEST, NONUMBER, OFFSET, OPTIONS, SOURCE, STMT, XREF(FULL)`.
     - When using the Enterprise PL/I Version 3.8 and later compilers:

       For all programs, specify the following compiler options:
       `TEST(ALL,SYM,NOHOOK,SEPARATE,SEPNAME), LISTVIEW(AALL), NOPT, AGGREGATE, ATTRIBUTES(FULL), NOBLKOFF, LIST, MAP, NEST, NONUMBER, OFFSET, OPTIONS, SOURCE, STMT, XREF(FULL)`.

     `TEST(...)` and `NOPT` are required by Debug Tool.

     The `SEPARATE` sub-option produces a SYSDEBUG file. Save the SYSDEBUG file created by the compiler for IBM Debug Tool for z/OS and optionally, IBM Fault Analyzer for z/OS.

     The `AALL (AFTERALL)` sub-option of `TEST` or `LISTVIEW` stores program source information in the SYSDEBUG file that contains information after the last preprocessor, such as macros and INCLUDEs. This expanded source information is available in the source window of IBM Debug Tool for z/OS while debugging.

     The other options format the compiler listing as required for the *xxx*LANGX utility.

     Consider using the `TEST(ALL,NOHOOK,SEPARATE)` options for best performance and to produce a module that can be debugged. Depending on the policies in your organization, the module can be considered for production.
   - In production environments:
     - When using the Enterprise PL/I Version 3.7 or later compiler:

       For all programs, specify `NOTEST, AGGREGATE, ATTRIBUTES(FULL), NOBLKOFF, LIST, MAP, NEST, NONUMBER, OFFSET, OPTIONS, SOURCE, STMT, XREF(FULL)`.

     `NOTEST` disables Debug Tool, but produces a smaller load module.

     The other options format the compiler listing as required for the *xxx*LANGX utility to produce a production-ready module that can be used with IBM Fault Analyzer for z/OS and IBM Application Performance Analyzer for z/OS (but not IBM Debug Tool for z/OS).
5. When a `TEST(...SEPARATE)` option is used, code a SYSDEBUG DD in the second compiler step as follows:

   ```
   //SYSDEBUG DD DSN= sysdebug.pds(pgmname),DISP=SHR
   ```

This is the source information file for IBM Debug Tool for z/OS, and optionally, IBM Fault Analyzer for z/OS. Save it in the SYSDEBUG library, and specify a member name that is equal to the primary entry point name or CSECT name of your application program.

6. Modify the SYSPRINT DD in the compiler step. This is the compiler listing. Write the listing to either a permanent or temporary file. This is the input to the *xxx*LANGX utility.

   Note: This compiler typically renames CSECTs according to an internal compiler algorithm. Therefore, it is not recommended to store PL/I compiler listings or side files using CSECT names as they might not be found by IBM Application Performance Analyzer for z/OS or IBM Fault Analyzer for z/OS. Instead, use the primary entry point name.

7. Add a step after the compile step to run the *xxx*LANGX utility. This utility reads the compiler listing and generates a LANGX file. This is the source information file for IBM Fault Analyzer for z/OS and IBM Application Performance Analyzer for z/OS. Equivalent *xxx*LANGX utilities are available in IBM Debug Tool for z/OS as EQALANGX, in IBM Fault Analyzer for z/OS as IDILANGX and in IBM Application Performance Analyzer for z/OS as CAZLANGX. Save the LANGX file in the LANGX file library, and specify a member name that is equal to the primary entry point name of your application program.
8. Modify the promotion process to promote LANGX files. When a load module is promoted, for example, from test to production, promote the corresponding LANGX file or files. A promotion can be a recompile, copy, or move. Perform the same steps with the LANGX file that you perform with the module during promotion.
9. If you compile with the TEST option and will promote these modules into production, promote the SYSDEBUG file for your production environment.
10. Optionally, include a Debug Tool Language Environment exit module into the load module during the linkage editor step. This is one way to enable Debug Tool's panel 6 in ISPF, a simple panel-driven method to start the debugger automatically when a program runs, without JCL changes, based on the program name and user ID. Use module EQADBCXT for batch programs (including IMS batch), EQADICXT for IMS/TM programs and EQADDCXT for DB2 stored procedures. Do not include the exit module for CICS programs.

    You can also use module EQAD3CXT for batch programs, IMS/TM, IMS BTS programs, and DB2 type MAIN stored procedures

Sample JCL for compiling Enterprise PL/I for z/OS Version 3.7 or later programs

Below is a JCL example for compiling an Enterprise PL/I for z/OS Version 3.7 or later program for use with the IBM Problem Determination Tools products.

```
//* - - - ADD A JOB CARD ABOVE THIS LINE - - -
//*
//* SAMPLE JCL TO PREPARE AN ENTERPRISE PL/I V3.7 OR LATER
//* PROGRAM FOR THE IBM ZSERIES PD TOOLS PRODUCTS:
//* FAULT ANALYZER, DEBUG TOOL, AND APPLICATION PERF. ANALYZER
//*
//* NOTES:
//*
//* COMPILER:
//* 1. COMPILER PARMS TEST IS REQUIRED FOR DEBUG TOOL
//* 2. COMPILER PARM NOPT IS RECOMMENDED FOR DEBUG TOOL
//* 3. COMPILER PARM:
//*     TEST(ALL,SYM,NOHOOK,SEPARATE,SEPNAME,AALL) (V3.7)
//*     TEST(ALL,SYM,NOHOOK,SEPARATE,SEPNAME),LISTVIEW(AALL), (V3.8+)
//*    IS USED BECAUSE:
```

```
//*    - THE MODULE IS READY FOR DEBUG TOOL
//*    - NOHOOK DOES NOT HAVE RUN-TIME CPU OVERHEAD. HOWEVER, THE
//*      MODULE IS LARGER BECAUSE OF STATEMENT TABLE
//*    - A SYSDEBUG FILE IS CREATED THAT CAN BE USED BY DT,FA,APA
//* 4. COMPILER PARMS AGGREGATE,ATTRIBUTES(FULL),NOBLKOFF,LIST,
//*    MAP,NEST,NONUMBER,OPTIONS,SOURCE,STMT,XREF(FULL) ARE NEEDED
//*    TO PROCESS THE COMPILER LISTING WITH XXXLANGX
//*
//* BINDER (LINKAGE EDITOR):
//* 5. THE INCLUDE FOR MODULE EQAD?CXT IS OPTIONAL. IT IS AN
//*    LE EXIT MODULE THAT CAN BE USED TO START DEBUG TOOL.
//*    UNDERSTAND THE METHODS AVAILABLE FOR STARTING DEBUG TOOL,
//*    AND CHOOSE WHETHER YOU WANT TO USE THE LE EXITS.
//*    IF YOU USE THIS METHOD, LOAD THE CORRECT EXIT MODULE:
//*      EQADBCXT: FOR BATCH PROGRAMS
//*      EQADICXT: FOR ONLINE IMS PROGRAMS
//*      EQADDCXT: FOR DB2 STORED PROCEDURES (OF TYPE MAIN AND SUB)
//*           (for SUB this is supported only for invocations through call_sub)
//*    (DO NOT INCLUDE AN EXIT FOR CICS PROGRAMS)
|//*     YOU CAN ALSO USE MODULE EQAD3CXT FOR BATCH PROGRAMS, ONLINE IMS
|//*          PROGRAMS, DB2 TYPE MAIN STORED PROCEDURES.
//*
//* SET PARMS FOR THIS COMPILE:
//* --------------------------
//  SET MEM=PADSTAT                   PROGRAM NAME
//  SET PLICOMP='IBMZ.V3R7.SIBMZCMP'  PLI COMPILER LOADLIB
//  SET DTLIB='EQAW.SEQAMOD'          DEBUG TOOL LOADLIB
//  SET LEHLQ='CEE'                   LE HIGH LVL QUALIFIER
//  SET UNITDEV=SYSALLDA              UNIT FOR TEMP FILES
//  SET LANGX='EQALANGX'              XXXLANGX UTILITY PROGRAM
//  SET LANGXLIB='EQAW.SEQAMOD'       LIBRARY FOR XXXLANGX UTILITY
//*   NOTE: YOU CAN USE THE XXXLANGX UTILITY SHIPPED WITH DT, FA,
//*         OR APA. THE NAMES ARE DIFFERENT, BUT RESULTS ARE THE SAME.
//*         USE ANY OF THEM... THEY ALL PRODUCE THE SAME RESULTS.
//* IF YOU HAVE:     SET LANGX TO:    SET LANGXLIB TO:
//* DEBUG TOOL       EQALANGX         THE DT SEQAMOD LIBRARY
//* FAULT ANALYZER   IDILANGX         THE FA SIDIAUTH LIBRARY
//* APA              CAZLANGX         THE APA SCAZAUTH LIBRARY
//*
//ALLOCOBJ EXEC PGM=IEFBR14 ALLOC OBJ LIB IF NEEDED
//OBJ DD DSN=&SYSUID..ADLAB.OBJ,SPACE=(CYL,(3,1,15)),
// DSORG=PO,RECFM=FB,LRECL=80,BLKSIZE=8000,DISP=(MOD,CATLG)
//*
//* ************************************
//* COMPILE STEP
//* ************************************
//COMPILE EXEC PGM=IBMZPLI,REGION=0M,
// PARM=('TEST(ALL,SYM,NOHOOK,SEPARATE,SEPNAME,AALL),LIST,MAP,SOURCE,',
// 'XREF(FULL),NOBLKOFF,AGGREGATE,ATTRIBUTES(FULL),NEST,OPTIONS,NOPT,',
// 'STMT,NONUMBER,OFFSET')
//*  Note: The above options are for Enterprise PL/I Version 3.7
//*        For Enterprise PL/I Version 3.8+, change the TEST option
//*        to  TEST(ALL,SYM,NOHOOK,SEPARATE,SEPNAME), and add the
//*        LISTVIEW(AALL) option
//STEPLIB  DD DSN=&PLICOMP,DISP=SHR
//         DD DSN=&LEHLQ..SCEERUN,DISP=SHR
//SYSIN    DD DISP=SHR,DSN=&SYSUID..ADLAB.SOURCE(&MEM)
//SYSLIB   DD DISP=SHR,DSN=&SYSUID..ADLAB.COPYLIB
//SYSPRINT DD DISP=SHR,DSN=&SYSUID..ADLAB.ENTPLI.LISTING(&MEM)
//SYSDEBUG DD DISP=SHR,DSN=&SYSUID..ADLAB.SYSDEBUG(&MEM)
//SYSUT1   DD SPACE=(CYL,(5,2),,CONTIG),DCB=BLKSIZE=1024,UNIT=&UNITDEV
//SYSLIN   DD DSN=&SYSUID..ADLAB.OBJ(&MEM),DISP=SHR
//*
//PLIPRINT EXEC PGM=IEBGENER,REGION=0M
//SYSPRINT DD SYSOUT=*
//SYSUT1   DD DSN=&SYSUID..ADLAB.ENTPLI.LISTING(&MEM),DISP=SHR
//SYSUT2   DD SYSOUT=*
```

```
//SYSIN    DD DUMMY
//*
//* ********************************
//* STEP TO GENERATE LANGX FILE
//* ********************************
//LANGX EXEC PGM=&LANGX,REGION=32M,
// PARM='(PLI ERROR 64K CREF'
//STEPLIB  DD DISP=SHR,DSN=&LANGXLIB
//         DD DISP=SHR,DSN=&LEHLQ..SCEERUN
//LISTING  DD DSN=&SYSUID..ADLAB.ENTPLI.LISTING(&MEM),DISP=SHR
//IDILANGX DD DISP=SHR,DSN=&SYSUID..ADLAB.EQALANGX(&MEM)
//*
//* ********************************
//* LINK-EDIT (BINDER) STEP
//* ********************************
//LINK EXEC PGM=IEWL,PARM=(LET,MAP,LIST),REGION=0M
//SYSLIB   DD DSN=&LEHLQ..SCEELKED,DISP=SHR
//DTLIB    DD DSN=&DTLIB,DISP=SHR
//SYSPRINT DD SYSOUT=*
//SYSLMOD  DD DISP=SHR,DSN=&SYSUID..ADLAB.LOAD(&MEM)
//SYSUT1   DD UNIT=SYSDA,SPACE=(TRK,(10,10))
//SYSLIN   DD DSN=&SYSUID..ADLAB.OBJ(&MEM),DISP=(OLD,PASS)
//*  INCLUDING A DEBUG TOOL LE EXIT (EQADBCXT, EQADDCXT, EQADICXT OR EQAD3CXT)
//* IS OPTIONAL. THE EXIT ENABLES STARTING DEBUG TOOL WITH THE
//* USER EXIT DATA SET UTILITY (ONE OF THE DEBUG TOOL ISPF UTILITIES)
//*
//* //  DD *
//* INCLUDE DTLIB(EQADBCXT)
```

Enterprise PL/I Version 3.5 and Version 3.6 programs

The following table shows various compiler options that can be used to prepare Enterprise PL/I Version 3.5 and Version 3.6 programs for use with the IBM Problem Determination Tools products (IBM Debug Tool for z/OS, IBM Fault Analyzer for z/OS and IBM Application Performance Analyzer for z/OS). The methods suggested in the following table indicate if the load module produced is suitable for a production environment. Load modules suitable for a production environments have no significant run-time overhead.

Table 25. Examples of compiler options and source information files supported by IBM Problem Determination Tools products for Enterprise PL/I Version 3.5 and Version 3.6

Compiler options	Source information file type produced	Is the load module production ready?	Options supported and suggested for Debug Tool for z/OS	Options supported and suggested for Fault Analyzer for z/OS	Options supported and suggested for Application Performance Analyzer for z/OS
Preprocess (1st stage) to expand source, In compile (2nd stage): For Enterprise PL/I Version 3.5: TEST(ALL, SYM, NOHOOK, SEPARATE), NOPT, AGGREGATE, ATTRIBUTES (FULL), NOBLKOFF, LIST, MAP, NEST, NONUMBER, OFFSET, OPTIONS, SOURCE, STMT, XREF(FULL) For Enterprise PL/I Version 3.6: TEST(ALL, SYM, NOHOOK, SEPARATE, SEPNAME), NOPT, AGGREGATE, ATTRIBUTES (FULL), NOBLKOFF, LIST, MAP, NEST, NONUMBER, OFFSET, OPTIONS, SOURCE, STMT, XREF(FULL)	SYSDEBUG file used by Debug Tool for z/OS and Fault Analyzer for z/OS. LANGX file used by Application Performance Analyzer for z/OS	Although the module is larger than a module compiled with the NOTEST option, you can use the module in production if needed.	Suggested for test. You can also use these options in a production environment if the increased load module size is not an issue.		
AGGREGATE, ATTRIBUTES (FULL), NOBLKOFF, LIST, MAP, NEST, NOTEST, NONUMBER, OFFSET, OPTIONS, SOURCE, STMT, XREF(FULL)	Compiler listing	Yes	N/A	Supported	N/A
	LANGX file	Yes	N/A	Suggested for production and test	

Note: The highlighted row or rows in the table above indicate the suggested compiler options and source information file types for each product.

Preparing Enterprise PL/I Version 3.5 and Version 3.6 programs

Perform the following steps for compiling your Enterprise PL/I Version 3.5 and Version 3.6 programs:

1. Create a library (PDSE is suggested unless PDS is required for your organization) for SYSDEBUG files. This is only needed in test environments where debugging will be performed using `LRECL=(80 to 1024),RECFM=FB,BLKSIZE=(multiple of lrecl < 32K)`.
2. Allocate one or more LANGX libraries for each environment, such as test and production.
3. Create a corresponding LANGX library for each load library. Specify `LRECL=1562 or greater,RECFM=VB,BLKSIZE= lrecl+4 to 32k`.
4. Run a two-stage compile. The first stage preprocesses the program, so the IBM Problem Determination Tools products have access to fully expanded source code with INCLUDEs and macros. The second stage compiles the program. For all programs, such as batch, CICS, and IMS:
   - In the first compile stage, in both test and production environments, specify compiler options `MACRO,MDECK,NOCOMPILE,NOSYNTAX,INSOURCE` to expand INCLUDEs and macros. The output SYSPUNCH DD will be the input SYSIN DD to the second compile stage.
   - In the second compile stage, in test environments,
     – When using the Enterprise PL/I Version 3.5 compiler:

       For all programs, specify the following compiler options:
       `TEST(ALL,SYM,NOHOOK,SEPARATE), NOPT, AGGREGATE, ATTRIBUTES(FULL), NOBLKOFF, LIST, MAP, NEST, NONUMBER, OFFSET, OPTIONS, SOURCE, STMT, XREF(FULL).`
     – When using the Enterprise PL/I Version 3.6 compiler:

       For all programs, specify the following compiler options:
       `TEST(ALL,SYM,NOHOOK,SEPARATE,SEPNAME), NOPT, AGGREGATE, ATTRIBUTES(FULL), NOBLKOFF, LIST, MAP, NEST, NONUMBER, OFFSET, OPTIONS, SOURCE, STMT, XREF(FULL).`

     `TEST(...)` and `NOPT` are required by Debug Tool.

     The `SEPARATE` sub-option produces a SYSDEBUG file. Save the SYSDEBUG file created by the compiler for Debug Tool (and optionally, Fault Analyzer).

     The other options format the compiler listing as required for the *xxx*LANGX utility.

     Consider using `TEST(ALL,SYM,NOHOOK,SEPARATE)` for best performance and to produce a module that can be debugged. Depending on the policies in your organization, the module can be considered for production.
   - In the second compile stage, in production environments, specify compiler options `NOTEST, AGGREGATE, ATTRIBUTES(FULL), NOBLKOFF, LIST, MAP, NEST, NONUMBER, OFFSET, OPTIONS, SOURCE, STMT, XREF(FULL).`

     Note: The above options can be used with both the Enterprise PL/I Version 3.5 and Version 3.6 compilers.

   `NOTEST` disables Debug Tool, but produces a smaller load module.

   The other options format the compiler listing as required for the *xxx*LANGX utility to produce a production-ready module that can be used with Fault Analyzer for z/OS and Application Performance Analyzer for z/OS (but not Debug Tool for z/OS).
5. When a `TEST(...SEPARATE)` parm is used, code a SYSDEBUG DD in the second compiler step as follows:

   ```
   //SYSDEBUG DD DSN= sysdebug.pds(pgmname),DISP=SHR
   ```

   This is the source information file for IBM Debug Tool for z/OS, IBM Application Performance Analyzer for z/OS and optionally, IBM Fault Analyzer for z/OS.

Save it in the SYSDEBUG library, and specify a member name that is equal to the primary entry point name or CSECT name of your application program.

6. Modify the SYSPRINT DD in the second compiler stage. This is the compiler listing. Write the listing to either a permanent or temporary file. This is the input to the *xxx*LANGX utility.

   Note: This compiler typically renames CSECTs according to an internal compiler algorithm. Therefore, it is not recommended to store PL/I compiler listings or side files using CSECT names as they might not be found by IBM Application Performance Analyzer for z/OS or IBM Fault Analyzer for z/OS. Instead, use the primary entry point name.

7. Add a step after the compile step to run the *xxx*LANGX utility. This utility reads the compiler listing and generates a LANGX file. This is the source information file for IBM Fault Analyzer for z/OS and IBM Application Performance Analyzer for z/OS. Equivalent *xxx*LANGX utilities are available in IBM Debug Tool for z/OS as EQALANGX, in IBM Fault Analyzer for z/OS as IDILANGX and in IBM Application Performance Analyzer for z/OS as CAZLANGX. Save the LANGX file in the LANGX file library, and specify a member name that is equal to the primary entry point name of your application program.
8. Modify the promotion process to promote LANGX files. When a load module is promoted, for example, from test to production, promote the corresponding LANGX file or files. A promotion can be a recompile, copy, or move. Perform the same steps with the LANGX file that you perform with the module during promotion.
9. If you compile with the TEST option and will promote these modules into production, promote the SYSDEBUG file for your production environment.
10. Optionally, include a Debug Tool Language Environment exit module into the load module during the linkage editor step. This is one way to enable Debug Tool's panel 6 in ISPF, a simple panel-driven method to start the debugger automatically when a program runs, without JCL changes, based on the program name and user ID. Use module EQADBCXT for batch programs (including IMS batch), EQADICXT for IMS/TM programs and EQADDCXT for DB2 stored procedures. Do not include the exit module for CICS programs.

    You can also use module EQAD3CXT for batch programs, IMS/TM, IMS BTS programs, and DB2 type MAIN stored procedures

Sample JCL for compiling Enterprise PL/I Version 3.5 or Version 3.6 programs

Below is a JCL example for compiling an Enterprise PL/I for z/OS Version 3.5 or Version 3.6 program for use with the IBM Problem Determination Tools products.

```
//*     - - -  ADD A JOB CARD ABOVE THIS LINE  - - -
//*
//* SAMPLE JCL TO PREPARE AN ENTERPRISE PL/I V3.5 OR
//* ENTERPRISE PL/I V3.6 PROGRAM FOR THE IBM ZSERIES
//* FOR THE IBM ZSERIES PD TOOLS PRODUCTS:
//* FAULT ANALYZER, DEBUG TOOL, AND APPLICATION PERF. ANALYZER
//*
//* NOTES:
//*
//* COMPILER:
//* 1. A 2-STAGE COMPILE IS PERFORMED. STAGE 1 (PREPROCESS) IS
//*    DONE TO EXPAND INCLUDES AND MACROS IN THE PROGRAM, SO THAT
//*    THE SYSDEBUG FILE CREATED IN STAGE 2 (COMPILE) HAS ALL STMTS.
//* 2. COMPILER PARMS TEST AND NOPT ARE REQUIRED FOR DEBUG TOOL
//* 3. COMPILER PARM TEST(ALL,SYM,NOHOOK,SEP) (V3.5) OR
//*    TEST(ALL,SYM,NOHOOK,SEP,SEPNAME) (V3.6) IS USED BECAUSE:
//*    - THE MODULE IS READY FOR DEBUG TOOL
```

```
//*         - NOHOOK DOES NOT HAVE RUN-TIME CPU OVERHEAD. HOWEVER, THE
//*           MODULE IS LARGER BECAUSE OF STATEMENT TABLE
//*         - A SYSDEBUG FILE IS CREATED THAT CAN BE USED BY DT,FA,APA
//*    4. COMPILER PARMS AGGREGATE,ATTRIBUTES(FULL),NOBLKOFF,LIST,
//*       MAP,NEST,NONUMBER,OPTIONS,SOURCE,STMT,XREF(FULL) ARE NEEDED
//*       TO PROCESS THE COMPILER LISTING WITH XXXLANGX
//*
//*   BINDER (LINKAGE EDITOR):
//*    5. THE INCLUDE FOR MODULE EQAD?CXT IS OPTIONAL.  IT IS AN
//*       LE EXIT MODULE THAT CAN BE USED TO START DEBUG TOOL.
//*       UNDERSTAND THE METHODS AVAILABLE FOR STARTING DEBUG TOOL,
//*       AND CHOOSE WHETHER YOU WANT TO USE THE LE EXITS.
//*         IF YOU USE THIS METHOD, LOAD THE CORRECT EXIT MODULE:
//*            EQADBCXT: FOR BATCH PROGRAMS
//*            EQADICXT: FOR ONLINE IMS PROGRAMS
//*            EQADDCXT: FOR DB2 STORED PROCEDURES (OF TYPE MAIN AND SUB)
//*           (for SUB this is supported only for invocations through call_sub)
//*            (DO NOT INCLUDE AN EXIT FOR CICS PROGRAMS)
//*     YOU CAN ALSO USE MODULE EQAD3CXT FOR BATCH PROGRAMS, ONLINE IMS
//*          PROGRAMS, DB2 TYPE MAIN STORED PROCEDURES.
//*  SET PARMS FOR THIS COMPILE:
//*  --------------------------
//   SET MEM=PADSTAT                      PROGRAM NAME
//   SET PLICOMP='IBMZ.V3R5.SIBMZCMP'     PLI COMPILER LOADLIB
//   SET DTLIB='EQAW.SEQAMOD'             DEBUG TOOL LOADLIB
//   SET LEHLQ='CEE'                      LE HIGH LVL QUALIFIER
//   SET UNITDEV=SYSALLDA                 UNIT FOR TEMP FILES
//   SET LANGX='EQALANGX'                 XXXLANGX UTILITY PROGRAM
//   SET LANGXLIB='EQAW.SEQAMOD'          LIBRARY FOR XXXLANGX UTILITY
//*    NOTE: YOU CAN USE THE XXXLANGX UTILITY SHIPPED WITH DT, FA,
//*          OR APA. THE NAMES ARE DIFFERENT, BUT RESULTS ARE THE SAME
//*          USE ANY OF THEM... THEY ALL PRODUCE THE SAME RESULTS.
//*      IF YOU HAVE:     SET LANGX TO:    SET LANGXLIB TO:
//*      DEBUG TOOL       EQALANGX         THE DT SEQAMOD LIBRARY
//*      FAULT ANALYZER   IDILANGX         THE FA SIDIAUTH LIBRARY
//*      APA              CAZLANGX         THE APA SCAZAUTH LIBRARY
//*
//ALLOCOBJ EXEC PGM=IEFBR14              ALLOC OBJ LIB IF NEEDED
//OBJ   DD DSN=&SYSUID..ADLAB.OBJ,SPACE=(CYL,(3,1,15)),
//  DSORG=PO,RECFM=FB,LRECL=80,BLKSIZE=8000,DISP=(MOD,CATLG)
//*  ************************************
//*     PREPROCESS STEP (COMPILE STAGE 1)
//*  ************************************
//PRECOMP  EXEC PGM=IBMZPLI,REGION=0M,
//   PARM=('MACRO,MDECK,NOCOMPILE,NOSYNTAX,INSOURCE')
//STEPLIB  DD   DSN=&PLICOMP,DISP=SHR
//         DD   DSN=&LEHLQ..SCEERUN,DISP=SHR
//SYSIN    DD   DISP=SHR,DSN=&SYSUID..ADLAB.SOURCE(&MEM)
//SYSLIB   DD   DISP=SHR,DSN=&SYSUID..ADLAB.COPYLIB
//SYSPRINT DD   SYSOUT=*
//SYSUT1   DD   SPACE=(1024,(200,50),,CONTIG,ROUND),DCB=BLKSIZE=1024,
//              UNIT=&UNITDEV
//SYSPUNCH DD DISP=(MOD,PASS),DSN=&&SRC1,UNIT=&UNITDEV,
//            SPACE=(80,(10,10))
//*
//*  ************************************
//* COMPILE STEP (COMPILE STAGE 2)
//* ************************************
//COMPILE EXEC PGM=IBMZPLI,REGION=0M,
// PARM=('TEST(ALL,SYM,NOHOOK,SEPARATE),LIST,MAP,SOURCE,XREF(FULL),',
// 'NOBLKOFF,AGGREGATE,ATTRIBUTES(FULL),NEST,OPTIONS,NOPT,',
// 'STMT,NONUMBER,OFFSET')
//*  Note: The above options are for Enterprise PL/I Version 3.5
//*        For Enterprise PL/I Version 3.6, change the TEST option
//*        to:  TEST(ALL,SYM,NOHOOK,SEPARATE,SEPNAME)
//STEPLIB  DD DSN=&PLICOMP,DISP=SHR
//         DD DSN=&LEHLQ..SCEERUN,DISP=SHR
```

```
//SYSIN    DD DSN=&&SRC1,DISP=(OLD,PASS)
//SYSLIB   DD DISP=SHR,DSN=&SYSUID..ADLAB.COPYLIB
//SYSPRINT DD DISP=SHR,DSN=&SYSUID..ADLAB.ENTPLI.LISTING(&MEM)
//SYSDEBUG DD DISP=SHR,DSN=&SYSUID..ADLAB.SYSDEBUG(&MEM)
//SYSUT1   DD SPACE=(CYL,(5,2),,CONTIG),DCB=BLKSIZE=1024,UNIT=&UNITDEV
//SYSLIN   DD DSN=&SYSUID..ADLAB.OBJ(&MEM),DISP=SHR
//*
//PLIPRINT  EXEC PGM=IEBGENER,REGION=0M
//SYSPRINT  DD SYSOUT=*
//SYSUT1    DD DSN=&SYSUID..ADLAB.ENTPLI.LISTING(&MEM),DISP=SHR
//SYSUT2    DD SYSOUT=*
//SYSIN     DD DUMMY
//*
//*  ********************************
//*     STEP TO GENERATE LANGX FILE
//*  ********************************
//LANGX    EXEC PGM=&LANGX,REGION=32M,
//  PARM='(PLI ERROR 64K CREF'
//STEPLIB  DD DISP=SHR,DSN=&LANGXLIB
//         DD DISP=SHR,DSN=&LEHLQ..SCEERUN
//LISTING  DD DSN=&SYSUID..ADLAB.ENTPLI.LISTING(&MEM),DISP=SHR
//IDILANGX DD DISP=SHR,DSN=&SYSUID..ADLAB.EQALANGX(&MEM)
//*
//* ********************************
//* LINK-EDIT (BINDER) STEP
//* ********************************
//LINK EXEC PGM=IEWL,PARM=(LET,MAP,LIST),REGION=0M
//SYSLIB DD DSN=&LEHLQ..SCEELKED,DISP=SHR
//DTLIB DD DSN=&DTLIB,DISP=SHR
//SYSPRINT DD SYSOUT=*
//SYSLMOD DD DISP=SHR,DSN=&SYSUID..ADLAB.LOAD(&MEM)
//SYSUT1 DD UNIT=SYSDA,SPACE=(TRK,(10,10))
//SYSLIN DD DSN=&SYSUID..ADLAB.OBJ(&MEM),DISP=(OLD,PASS)
//*  INCLUDING A DEBUG TOOL LE EXIT (EQADBCXT, EQADDCXT, EQADICXT OR EQAD3CXT)
//*  IS OPTIONAL.  THE EXIT ENABLES STARTING DEBUG TOOL WITH THE
//*  USER EXIT DATA SET UTILITY (ONE OF THE DEBUG TOOL ISPF UTILITIES)
//*  //        DD *
//*   INCLUDE DTLIB(EQADBCXT)
```

Enterprise PL/I Version 3.4 and earlier programs

The following table shows various compiler options that can be used to prepare Enterprise PL/I Version 3.4 and earlier programs for use with the IBM Problem Determination Tools products (Debug Tool for z/OS, Fault Analyzer for z/OS and Application Performance Analyzer for z/OS). The methods suggested in the following table indicate if the load module produced is suitable for a production environment. Load modules suitable for a production environments have no significant run-time overhead.

Table 26. Examples of compiler options and source information files supported by IBM Problem Determination Tools products for Enterprise PL/I Version 3.4 and earlier

Compiler options	Source information file type produced	Is the load module production ready?	Options supported and suggested for Debug Tool for z/OS	Options supported and suggested for Fault Analyzer for z/OS	Options supported and suggested for Application Performance Analyzer for z/OS
Preprocess (1st stage) to expand source, In compile (2nd stage): TEST(ALL), NOPT, AGGREGATE, ATTRIBUTES (FULL), NOBLKOFF, LIST, MAP, NEST, NONUMBER, OFFSET, OPTIONS, SOURCE, STMT, XREF(FULL))	Expanded source file used by Debug Tool for z/OS, LANGX file used by Fault Analyzer for z/OS and Application Performance Analyzer for z/OS	No	Suggested for test. (Using Debug Tool in production for this compiler is not recommended.)		
AGGREGATE, ATTRIBUTES (FULL), NOBLKOFF, LIST, MAP, NEST, NOTEST, NONUMBER, OFFSET, OPTIONS, SOURCE, STMT, XREF(FULL))	Compiler listing	Yes	N/A	Supported	N/A
	LANGX file	Yes	N/A	Suggested for production and test	

Note: The highlighted row or rows in the table above indicate the suggested compiler options and source information file types for each product.

Preparing Enterprise PL/I Version 3.4 and earlier programs

Perform the following steps for compiling your Enterprise PL/I Version 3.4 and earlier programs:

1. Create a library (PDSE is suggested unless PDS is required for your organization) for expanded source files. This is only needed in test environments where debugging will be performed. The library can be any RECFM / LRECL / BLKSIZE supported as input by the compiler.
2. Allocate libraries (PDSE is suggested unless PDS is required for your organization) for LANGX files. Allocate one or more LANGX libraries for each environment, such as test or production.
3. Create a corresponding LANGX library for each load library. Specify `LRECL=1562 or greater,RECFM=VB,BLKSIZE= lrecl+4 to 32k`.
4. Run a 2–stage compile. The first stage preprocesses the program, so the IBM Problem Determination Tools have access to fully expanded source code with INCLUDEs and macros. The second stage compiles the program.
   - In the first compile stage, in both test and production environments:
     – Specify compiler options `MACRO,MDECK,NOCOMPILE,NOSYNTAX,INSOURCE` to expand INCLUDEs and macros.

- Save the output, the expanded source file, in a permanent file in the expanded source file library and specify *member name* = *program name*. This is the source information file for Debug Tool for z/OS. The output SYSPUNCH DD will be the input SYSIN DD to the second compiler stage.

- In the second compile stage, for all programs, such as batch, CICS, and IMS:
  - In test environments, specify compiler options `TEST(ALL), NOPT, AGGREGATE, ATTRIBUTES(FULL), NOBLKOFF, LIST, MAP, NEST, NONUMBER, OFFSET, OPTIONS, SOURCE, STMT, XREF(FULL)`.

    `TEST(ALL)` and `NOPT` are required by Debug Tool. Debug hooks are inserted, which add some runtime overhead. Symbolic data required by Debug Tool is also stored in the module, which can make it significantly larger.

    The other options format the compiler listing as required for the *xxx*LANGX utility.
  - In production environments, specify compiler options `NOTEST, AGGREGATE, ATTRIBUTES(FULL), NOBLKOFF, LIST, MAP, NEST, NONUMBER, OFFSET, OPTIONS, SOURCE, STMT, XREF(FULL))`.

    `NOTEST` disables Debug Tool, but provides the best performance. This produces a production-ready module that can be used with Fault Analyzer for z/OS and Application Performance Analyzer for z/OS (but not Debug Tool).

    The other options format the compiler listing as required for the *xxx*LANGX utility.

5. Modify the SYSPRINT DD in the second compiler stage. This is the compiler listing. Save the compiler listing to either a permanent or temporary file. This will be the input to the *xxx*LANGX utility.

   Note: This compiler typically renames CSECTs according to an internal compiler algorithm. Therefore, it is not recommended to store PL/I compiler listings or side files using CSECT names as they might not be found by Application Performance Analyzer for z/OS or Fault Analyzer for z/OS. Instead, use the primary entry point name.
6. Add a step after the compiler step to run the *xxx*LANGX utility. The *xxx*LANGX utility reads the compiler listing and generates a LANGX file, which is the source information file for Fault Analyzer for z/OS and Application Performance Analyzer for z/OS. Equivalent *xxx*LANGX utilities are available in Debug Tool for z/OS as EQALANGX, in Fault Analyzer for z/OS as IDILANGX and in Application Performance Analyzer for z/OS as CAZLANGX. Save the LANGX file in the LANGX file library, and specify a member name that is equal to the primary entry point name or CSECT name of your application program.
7. Modify the promotion process to promote LANGX files. When a load module is promoted, for example, from test to production, promote the corresponding LANGX file or files. A promotion can be a recompile, copy, or move. Perform the same steps with the LANGX file that you perform with the module during promotion.
8. Optionally, include a Debug Tool Language Environment exit module into the load module during the linkage editor step. This is one way to enable Debug Tool's panel 6 in ISPF, a simple panel-driven method to start the debugger automatically when a program runs, without JCL changes, based on the program name and user ID. Use module EQADBCXT for batch programs (including IMS batch), EQADICXT for IMS/TM programs and EQADDCXT for DB2 stored procedures. Do not include the exit module for CICS programs.

| You can also use module EQAD3CXT for batch programs, IMS/TM, IMS BTS
| programs, and DB2 type MAIN stored procedures

9. For CICS applications only, if the Debug Tool DTCN transaction will be used to start Debug Tool, link edit the Debug Tool CICS startup exit module EQADCCXT into the application load module to enable Debug Tool in CICS. This is not needed if using the CADP transaction instead of DTCN.

Sample JCL for compiling Enterprise PL/I for z/OS Version 3.4 or earlier programs

Below is a JCL example for compiling an Enterprise PL/I for z/OS Version 3.4 or earlier program for use with the IBM Problem Determination Tools products.

```
//*     - - -  ADD A JOB CARD ABOVE THIS LINE  - - -
//*
//*  SAMPLE JCL TO COMPILE WITH ENTERPRISE PLI V3.4 AND PREVIOUS
//*  FOR THE IBM ZSERIES PD TOOLS PRODUCTS:
//*     FAULT ANALYZER, DEBUG TOOL, AND APPLICATION PERF. ANALYZER
//*
//*  NOTES:
//*
//*   COMPILER:
//*    1. A 2-STAGE COMPILE IS PERFORMED.  STAGE 1 (PREPROCESS) IS
//*       DONE TO EXPAND INCLUDES AND MACROS IN THE PROGRAM, SO THAT
//*       A SOURCE FILE IS CREATED FOR DEBUG TOOL THAT HAS ALL STMTS.
//*    2. COMPILER PARM TEST AND NOPT ARE REQUIRED FOR DEBUG TOOL
//*    3. COMPILER PARMS AGGREGATE,ATTRIBUTES(FULL),NOBLKOFF,LIST,
//*       MAP,NEST,NONUMBER,OPTIONS,SOURCE,STMT,XREF(FULL) ARE NEEDED
//*       TO PROCESS THE COMPILER LISTING WITH XXXLANGX
//*
//*   BINDER (LINKAGE EDITOR):
//*    4. THE INCLUDE FOR MODULE EQAD?CXT IS OPTIONAL.  IT IS AN
//*       LE EXIT MODULE THAT CAN BE USED TO START DEBUG TOOL.
//*       UNDERSTAND THE METHODS AVAILABLE FOR STARTING DEBUG TOOL,
//*       AND CHOOSE WHETHER YOU WANT TO USE THE LE EXITS.
//*         IF YOU USE THIS METHOD, LOAD THE CORRECT EXIT MODULE:
//*            EQADBCXT: FOR BATCH PROGRAMS
//*            EQADICXT: FOR ONLINE IMS PROGRAMS
//*            EQADDCXT: FOR DB2 STORED PROCEDURES (OF TYPE MAIN AND SUB)
//*           (for SUB this is supported only for invocations through call_sub)
//*            (DO NOT INCLUDE AN EXIT FOR CICS PROGRAMS)
| //*     YOU CAN ALSO USE MODULE EQAD3CXT FOR BATCH PROGRAMS, ONLINE IMS
| //*          PROGRAMS, DB2 TYPE MAIN STORED PROCEDURES.
//*
//*  SET PARMS FOR THIS COMPILE:
//*  ---------------------------
//   SET MEM=PTEST                        PROGRAM NAME
//   SET PLICOMP='IBMZ.V3R4.SIBMZCMP'     PLI COMPILER LOADLIB
//   SET DTLIB='EQAW.SEQAMOD'             DEBUG TOOL LOADLIB
//   SET LEHLQ='CEE'                      LE HIGH LVL QUALIFIER
//   SET UNITDEV=SYSALLDA                 UNIT FOR TEMP FILES
//   SET LANGX='EQALANGX'                 XXXLANGX UTILITY PROGRAM
//   SET LANGXLIB='EQAW.SEQAMOD'          LIBRARY FOR XXXLANGX UTILITY
//*    NOTE: YOU CAN USE THE XXXLANGX UTILITY SHIPPED WITH DT, FA,
//*          OR APA. THEY NAMES ARE DIFFERENT, BUT RESULTS ARE THE SAME
//*          USE ANY OF THEM... THEY ALL PRODUCE THE SAME RESULTS.
//*      IF YOU HAVE:     SET LANGX TO:    SET LANGXLIB TO:
//*      DEBUG TOOL       EQALANGX         THE DT SEQAMOD LIBRARY
//*      FAULT ANALYZER   IDILANGX         THE FA SIDIAUTH LIBRARY
//*      APA              CAZLANGX         THE APA SCAZAUTH LIBRARY
//*
//ALLOCOBJ EXEC PGM=IEFBR14              ALLOC OBJ LIB IF NEEDED
//XSOURCE DD DSN=&SYSUID..ADLAB.EXPANDED.SOURCE,SPACE=(CYL,(3,1,15)),
//  DSORG=PO,RECFM=FB,LRECL=80,BLKSIZE=8000,DISP=(MOD,CATLG)
//OBJ   DD DSN=&SYSUID..ADLAB.OBJ,SPACE=(CYL,(3,1,15)),
//  DSORG=PO,RECFM=FB,LRECL=80,BLKSIZE=8000,DISP=(MOD,CATLG)
```

```
//*  ************************************
//*     PREPROCESS STEP (COMPILE STAGE 1)
//*  ************************************
//PRECOMP  EXEC PGM=IBMZPLI,REGION=0M,
//   PARM=('MACRO,MDECK,NOCOMPILE,NOSYNTAX,INSOURCE')
//STEPLIB  DD   DSN=&PLICOMP,DISP=SHR
//         DD   DSN=&LEHLQ..SCEERUN,DISP=SHR
//SYSIN    DD   DISP=SHR,DSN=&SYSUID..ADLAB.SOURCE(&MEM)
//SYSLIB   DD   DISP=SHR,DSN=&SYSUID..ADLAB.COPYLIB
//SYSPRINT DD   SYSOUT=*
//SYSUT1   DD   SPACE=(1024,(200,50),,CONTIG,ROUND),DCB=BLKSIZE=1024,
//              UNIT=&UNITDEV
//SYSPUNCH DD DISP=SHR,DSN=&SYSUID..ADLAB.EXPANDED.SOURCE(&MEM)
//*
//*  ************************************
//*     COMPILE STEP (COMPILE STAGE 2)
//*  ************************************
//COMPILE  EXEC PGM=IBMZPLI,REGION=0M,
// PARM=('TEST(ALL),LIST,MAP,SOURCE,XREF(FULL),',
//       'NOBLKOFF,AGGREGATE, ATTRIBUTES(FULL),NEST,OPTIONS,NOPT,',
//       'STMT,NONUMBER,OFFSET')
//STEPLIB  DD DSN=&PLICOMP,DISP=SHR
//         DD DSN=&LEHLQ..SCEERUN,DISP=SHR
//SYSIN    DD DISP=SHR,DSN=&SYSUID..ADLAB.EXPANDED.SOURCE(&MEM)
//SYSLIB   DD DISP=SHR,DSN=&SYSUID..ADLAB.COPYLIB
//SYSPRINT DD DISP=SHR,DSN=&SYSUID..ADLAB.ENTPLI.LISTING(&MEM)
//SYSUT1   DD SPACE=(CYL,(5,2),,CONTIG),DCB=BLKSIZE=1024,UNIT=&UNITDEV
//SYSLIN   DD DSN=&SYSUID..ADLAB.OBJ(&MEM),DISP=SHR
//*
//PLIPRINT  EXEC PGM=IEBGENER,REGION=0M
//SYSPRINT  DD SYSOUT=*
//SYSUT1    DD DSN=&SYSUID..ADLAB.ENTPLI.LISTING(&MEM),DISP=SHR
//SYSUT2    DD SYSOUT=*
//SYSIN     DD DUMMY
//*
//*  ********************************
//*     STEP TO GENERATE LANGX FILE
//*  ********************************
//LANGX    EXEC PGM=&LANGX,REGION=32M,
//  PARM='(PLI ERROR 64K CREF'
//STEPLIB  DD DISP=SHR,DSN=&LANGXLIB
//         DD DISP=SHR,DSN=&LEHLQ..SCEERUN
//LISTING  DD DSN=&SYSUID..ADLAB.ENTPLI.LISTING(&MEM),DISP=SHR
//IDILANGX DD DISP=SHR,DSN=&SYSUID..ADLAB.EQALANGX(&MEM)
//*
//* ********************************
//* LINK-EDIT (BINDER) STEP
//* ********************************
//LINK EXEC PGM=IEWL,PARM=(LET,MAP,LIST),REGION=0M
//SYSLIB DD DSN=&LEHLQ..SCEELKED,DISP=SHR
//DTLIB DD DSN=&DTLIB,DISP=SHR
//SYSPRINT DD SYSOUT=*
//SYSLMOD DD DISP=SHR,DSN=&SYSUID..ADLAB.LOAD(&MEM)
//SYSUT1 DD UNIT=SYSDA,SPACE=(TRK,(10,10))
//SYSLIN DD DSN=&SYSUID..ADLAB.OBJ(&MEM),DISP=(OLD,PASS)
//*  INCLUDING A DEBUG TOOL LE EXIT (EQADBCXT, EQADDCXT, EQADICXT OR EQAD3CXT)
//*  IS OPTIONAL.  THE EXIT ENABLES STARTING DEBUG TOOL WITH THE
//*  USER EXIT DATA SET UTILITY (ONE OF THE DEBUG TOOL ISPF UTILITIES)
//*  //        DD *
//*   INCLUDE DTLIB(EQADBCXT)
```

PL/I for MVS and VM and OS PL/I programs

The following table shows various compiler options that can be used to prepare Enterprise COBOL for z/OS Version 4 programs for use with the IBM Problem Determination Tools products (Debug Tool for z/OS, Fault Analyzer for z/OS and

Application Performance Analyzer for z/OS). The methods suggested in the following table indicate if the load module produced is suitable for a production environment. Load modules suitable for a production environments have no significant run-time overhead.

For the test environment, you need both the listing and the LANGX file (for Fault Analyzer for z/OS and Application Performance Analyzer for z/OS). In production, only the LANGX file is suggested.

Table 27. Examples of compiler options and source information files supported by IBM Problem Determination Tools products for PL/I for MVS and VM and OS PLI

Compiler options	Source information file type produced	Is the load module production ready?	Options supported and suggested for Debug Tool for z/OS	Options supported and suggested for Fault Analyzer for z/OS	Options supported and suggested for Application Performance Analyzer for z/OS
TEST(ALL), AGGREGATE, ATTRIBUTES (FULL), ESD, LIST, MAP, NEST, NOPT, OPTIONS, SOURCE, STMT, XREF(FULL)	Compiler listing	No	Suggested for test. (Using Debug Tool in production for this compiler is not recommended.)	Supported	Supported
	LANGX file	No	N/A	Supported	N/A
NOTEST, AGGREGATE, ATTRIBUTES (FULL), ESD, LIST, MAP, NEST, OPTIONS, SOURCE, STMT, XREF(FULL)	Compiler listing	Yes	N/A	Supported	Suggested for production and test
	LANGX file	Yes	N/A	Suggested for production and test	N/A

Note: The highlighted row or rows in the table above indicate the suggested compiler options and source information file types for each product.

Preparing PL/I for MVS and VM and OS PL/I programs

Perform the following steps for compiling your PL/I for MVS and VM and OS PL/I programs:

1. Create a library (PDSE is suggested unless PDS is required for your organization) for compiler listing files. This is only needed in test environments where debugging will be performed. Specify `LRECL=125 minimum,RECFM=VBA,BLKSIZE= lrecl+4 to 32k`.
2. Allocate libraries (PDSE is suggested unless PDS is required for your organization) for LANGX files. Allocate one or more LANGX libraries for each environment, such as test and production.
3. Create a corresponding LANGX library for each load library. Specify `LRECL=1562 or greater,RECFM=VB,BLKSIZE= lrecl+4 to 32k`.
4. For all programs, such as batch, CICS, and IMS:
   - In test environments, specify compiler options `TEST(ALL), NOPT, AGGREGATE, ATTRIBUTES(FULL), ESD, LIST, MAP, NEST, OPTIONS, SOURCE, STMT, XREF(FULL)`.

     `TEST(ALL)` and `NOOPT` are required by Debug Tool. `TEST` adds debug hooks, which add some runtime overhead. Symbolic data required by Debug Tool is stored in the module, which can make it significantly larger.

The other options format the compiler listing as required by Debug Tool and by the *xxx*LANGX utility.

- In production environments, specify compiler options `NOTEST, AGGREGATE, ATTRIBUTES(FULL), ESD, LIST, MAP, NEST, OPTIONS, SOURCE, STMT, XREF(FULL)`.

  `NOTEST` disables Debug Tool, but provides the best performance.

  The other options format the compiler listing as required for the *xxx*LANGX utility.

  This produces a production-ready module that can be used with Fault Analyzer for z/OS and Application Performance Analyzer for z/OS but not Debug Tool for z/OS.

5. Modify the SYSPRINT DD in the compiler step. This is the compiler listing. Save this to a permanent file. The compiler listing is the input to the *xxx*LANGX utility and is the source information file for Debug Tool for z/OS

   Note: This compiler typically renames CSECTs according to an internal compiler algorithm. Therefore, it is not recommended to store PL/I compiler listings or side files using CSECT names as they might not be found by Application Performance Analyzer for z/OS or Fault Analyzer for z/OS. Instead, use the primary entry point name.

6. Add a step after the compiler step to run the *xxx*LANGX utility. This utility reads the compiler listing and saves a LANGX file. This is the source information file for Fault Analyzer for z/OS and Application Performance Analyzer for z/OS. Equivalent *xxx*LANGX utilities are available in Debug Tool for z/OS as EQALANGX, in Fault Analyzer for z/OS as IDILANGX and in Application Performance Analyzer for z/OS as CAZLANGX. Save it in the LANGX file library and specify a member name that is equal to the primary entry point name of your application program.
7. Modify the promotion process to promote LANGX files. When a load module is promoted, for example, from test to production, promote the corresponding LANGX file or files. A promotion can be a recompile, copy, or move. Perform the same steps with the LANGX file that you perform with the module during promotion.
8. Optionally, include a Debug Tool Language Environment exit module into the load module during the linkage editor step. This is one way to enable Debug Tool's panel 6 in ISPF, a simple panel-driven method to start the debugger automatically when a program runs, without JCL changes, based on the program name and user ID. Use module EQADBCXT for batch programs (including IMS batch), EQADICXT for IMS/TM programs and EQADDCXT for DB2 stored procedures. Do not include the exit module for CICS programs.

   You can also use module EQAD3CXT for batch programs, IMS/TM, IMS BTS programs, and DB2 type MAIN stored procedures
9. For CICS applications only, if the Debug Tool DTCN transaction will be used to start Debug Tool, link-edit the Debug Tool CICS startup exit module EQADCCXT into the application load module to enable Debug Tool in CICS. This is not needed if using the CADP transaction instead of DTCN.

Sample JCL for compiling PL/I for MVS and VM programs

Below is a JCL example for compiling an PL/I for MVS and VM program for use with the IBM Problem Determination Tools products.

```
//*     - - -  ADD A JOB CARD ABOVE THIS LINE  - - -
//*
//*  SAMPLE JCL TO PREPARE A PLI FOR MVS AND VM PROGRAM
//*  FOR THE IBM ZSERIES PD TOOLS PRODUCTS:
```

```
//*     FAULT ANALYZER, DEBUG TOOL, AND APPLICATION PERF. ANALYZER
//*
//*  NOTES:
//*
//*   COMPILER:
//*    1. COMPILER PARM TEST IS REQUIRED FOR DEBUG TOOL
//*    2. COMPILER PARMS AGGREGATE,ATTRIBUTES(FULL),ESD,LIST,
//*       MAP,NEST,OPTIONS,SOURCE,STMT,XREF(FULL) ARE NEEDED
//*       FOR PD TOOLS TO PROCESS THE COMPILER LISTING
//*
//*   BINDER (LINKAGE EDITOR):
//*    3. THE INCLUDE FOR MODULE EQAD?CXT IS OPTIONAL.  IT IS AN
//*       LE EXIT MODULE THAT CAN BE USED TO START DEBUG TOOL.
//*       UNDERSTAND THE METHODS AVAILABLE FOR STARTING DEBUG TOOL,
//*       AND CHOOSE WHETHER YOU WANT TO USE THE LE EXITS.
//*         IF YOU USE THIS METHOD, LOAD THE CORRECT EXIT MODULE:
//*            EQADBCXT: FOR BATCH PROGRAMS
//*            EQADICXT: FOR ONLINE IMS PROGRAMS
//*            EQADDCXT: FOR DB2 STORED PROCEDURES (OF TYPE MAIN AND SUB)
//*           (for SUB this is supported only for invocations through call_sub)
//*            (DO NOT INCLUDE AN EXIT FOR CICS PROGRAMS)
//*     YOU CAN ALSO USE MODULE EQAD3CXT FOR BATCH PROGRAMS, ONLINE IMS
//*          PROGRAMS, DB2 TYPE MAIN STORED PROCEDURES.
//*  SET PARMS FOR THIS COMPILE:
//*  --------------------------
//   SET MEM=PADSTAT                       PROGRAM NAME
//   SET PLICOMP='IEL.V1R1M1.SIELCOMP'     PLI COMPILER LOADLIB
//   SET DTLIB='EQAW.SEQAMOD'              DEBUG TOOL LOADLIB
//   SET LEHLQ='CEE'                       LE HIGH LVL QUALIFIER
//   SET UNITDEV=SYSALLDA                  UNIT FOR TEMP FILES
//   SET LANGX='EQALANGX'                  XXXLANGX UTILITY PROGRAM
//   SET LANGXLIB='EQAW.SEQAMOD'           LIBRARY FOR XXXLANGX UTILITY
//*    NOTE: YOU CAN USE THE XXXLANGX UTILITY SHIPPED WITH DT, FA,
//*          OR APA. THE NAMES ARE DIFFERENT, BUT RESULTS ARE THE SAME
//*          USE ANY OF THEM... THEY ALL PRODUCE THE SAME RESULTS.
//*      IF YOU HAVE:     SET LANGX TO:    SET LANGXLIB TO:
//*      DEBUG TOOL       EQALANGX         THE DT SEQAMOD LIBRARY
//*      FAULT ANALYZER   IDILANGX         THE FA SIDIAUTH LIBRARY
//*      APA              CAZLANGX         THE APA SCAZAUTH LIBRARY
//*
//ALLOCOBJ EXEC PGM=IEFBR14             ALLOC OBJ LIB IF NEEDED
//OBJ   DD DSN=&SYSUID..ADLAB.OBJ,SPACE=(CYL,(3,1,15)),
//  DSORG=PO,RECFM=FB,LRECL=80,BLKSIZE=8000,DISP=(MOD,CATLG)
//*
//*  ************************************
//*     COMPILE STEP
//*  ************************************
//*
//COMPILE  EXEC PGM=IEL1AA,REGION=6M,
// PARM=('TEST(ALL),NOPT,AGGREGATE,ATTRIBUTES(FULL),ESD,LIST,MAP,',
//       'NEST,OPTIONS,SOURCE,STMT,XREF(FULL)')
//STEPLIB  DD   DSN=&PLICOMP,DISP=SHR
//SYSIN    DD   DISP=SHR,DSN=&SYSUID..ADLAB.SOURCE(&MEM)
//SYSLIB   DD   DISP=SHR,DSN=&SYSUID..ADLAB.COPYLIB
//SYSPRINT DD   DISP=SHR,DSN=&SYSUID..ADLAB.PLIMVS.LISTING(&MEM)
//SYSUT1   DD   SPACE=(CYL,(1,1)),UNIT=SYSDA
//SYSLIN   DD DSN=&SYSUID..ADLAB.OBJ(&MEM),DISP=SHR
//*
//PLIPRINT  EXEC PGM=IEBGENER,REGION=0M
//SYSPRINT  DD SYSOUT=*
//SYSUT1    DD DSN=&SYSUID..ADLAB.PLIMVS.LISTING(&MEM),DISP=SHR
//SYSUT2    DD SYSOUT=*
//SYSIN     DD DUMMY
//*
//*  ********************************
//*     STEP TO GENERATE LANGX FILE
//*  ********************************
```

```
//LANGX    EXEC PGM=&LANGX,REGION=32M,
//  PARM='(PLI ERROR 64K CREF'
//STEPLIB  DD DISP=SHR,DSN=&LANGXLIB
//         DD DISP=SHR,DSN=&LEHLQ..SCEERUN
//LISTING  DD DSN=&SYSUID..ADLAB.PLIMVS.LISTING(&MEM),DISP=SHR
//IDILANGX DD DISP=SHR,DSN=&SYSUID..ADLAB.EQALANGX(&MEM)
//*
//* ********************************
//* LINK-EDIT (BINDER) STEP
//* ********************************
//LINK EXEC PGM=IEWL,PARM=(LET,MAP,LIST),REGION=0M
//SYSLIB DD DSN=&LEHLQ..SCEELKED,DISP=SHR
//DTLIB DD DSN=&DTLIB,DISP=SHR
//SYSPRINT DD SYSOUT=*
//SYSLMOD DD DISP=SHR,DSN=&SYSUID..ADLAB.LOAD(&MEM)
//SYSUT1 DD UNIT=SYSDA,SPACE=(TRK,(10,10))
//SYSLIN DD DSN=&SYSUID..ADLAB.OBJ(&MEM),DISP=(OLD,PASS)
//*  INCLUDING A DEBUG TOOL LE EXIT (EQADBCXT, EQADDCXT, EQADICXT OR EQAD3CXT)
//*  IS OPTIONAL.  THE EXIT ENABLES STARTING DEBUG TOOL WITH THE
//*  USER EXIT DATA SET UTILITY (ONE OF THE DEBUG TOOL ISPF UTILITIES)
//*  //        DD *
//*   INCLUDE DTLIB(EQADBCXT)
```

z/OS XL C and C++ programs

The following table shows various compiler options that can be used to prepare z/OS XL C and C++ programs for use with the IBM Problem Determination Tools products (Debug Tool for z/OS, Fault Analyzer for z/OS and Application Performance Analyzer for z/OS). The methods suggested in the following table indicate if the load module produced is suitable for a production environment. Load modules suitable for a production environments have no significant run-time overhead.

Table 28. Examples of compiler options and source information files supported by IBM Problem Determination Tools products for C++

Compiler options	Output produced	Is the load module production ready?	Options supported and suggested for Debug Tool for z/OS	Options supported and suggested for Fault Analyzer for z/OS	Options supported and suggested for Application Performance Analyzer for z/OS
Preprocess (1st stage) to expand source, In compile (2nd stage): TEST, ATTRIBUTE(FULL), NOIPA, LIST, NESTINC(255), NOOFFSET, NOOPT, SOURCE, XREF	Expanded source file used by Debug Tool for z/OS, compiler listing used by Fault Analyzer for z/OS and Application Performance Analyzer for z/OS	No	Suggested for test. (Using Debug Tool in production for this compiler is not recommended.)	Supported	Supported
	Expanded source file used by Debug Tool for z/OS, LANGX file used by Fault Analyzer for z/OS and Application Performance Analyzer for z/OS	No	Supported	Supported	Supported

Table 28. Examples of compiler options and source information files supported by IBM Problem Determination Tools products for C++ (continued)

Compiler options	Output produced	Is the load module production ready?	Options supported and suggested for Debug Tool for z/OS	Options supported and suggested for Fault Analyzer for z/OS	Options supported and suggested for Application Performance Analyzer for z/OS
NOTEST, ATTRIBUTE(FULL), NOIPA, LIST, NESTINC(255), NOOFFSET, NOOPT, SOURCE, XREF	Compiler listing	Yes	N/A	Suggested for production and test	Suggested for production and test
	LANGX file	Yes	N/A	Supported	Supported
Preprocess (1st stage) to expand source. In compile (2nd stage): DEBUG(FORMAT (DWARF), HOOK(LINE, NOBLOCK, PATH), SYMBOL, FILE(location))	Expanded source file and DWARF file	No	Supported. (Using Debug Tool in production for this compiler is not recommended.)	N/A	N/A

Notes:

1. The highlighted row or rows in the table above indicate the suggested compiler options and source information file types for each product.
2. The FORMAT(DWARF) option is supported for z/OS Version 1.6 and higher.

Table 29. Examples of compiler options and source information files supported by IBM Problem Determination Tools products for C

Compiler options	Output produced	Is the load module production ready?	Options supported and suggested for Debug Tool for z/OS	Options supported and suggested for Fault Analyzer for z/OS	Options supported and suggested for Application Performance Analyzer for z/OS
Preprocess (1st stage) to expand source, In compile (2nd stage): TEST(ALL), AGGREGATE, NOIPA, LIST, NESTINC(255), NOOFFSET, NOOPT, SOURCE, XREF	Expanded source file used by Debug Tool for z/OS, compiler listing used by Fault Analyzer for z/OS and Application Performance Analyzer for z/OS	No	Suggested for test. (Using Debug Tool in production for this compiler is not recommended.)	Supported	Supported
	Expanded source file used by Debug Tool for z/OS, LANGX file used by Fault Analyzer for z/OS and Application Performance Analyzer for z/OS	No	Supported	Supported	Supported

Table 29. Examples of compiler options and source information files supported by IBM Problem Determination Tools products for C (continued)

Compiler options	Output produced	Is the load module production ready?	Options supported and suggested for Debug Tool for z/OS	Options supported and suggested for Fault Analyzer for z/OS	Options supported and suggested for Application Performance Analyzer for z/OS
NOTEST, AGGREGATE, NOIPA, LIST, NESTINC(255), NOOFFSET, NOOPT, SOURCE, XREF	Compiler listing	Yes	N/A	Suggested for production and test	Suggested for production and test
	LANGX file	Yes	N/A	Supported	Supported
Preprocess (1st stage) to expand source. In compile (2nd stage): DEBUG(FORMAT (DWARF), HOOK(LINE, NOBLOCK, PATH), SYMBOL, FILE(location))	Expanded source file and DWARF file	No	Supported. (Using Debug Tool in production for this compiler is not recommended.)	N/A	N/A

Notes:

1. The highlighted row or rows in the table above indicate the suggested compiler options and source information file types for each product.
2. The FORMAT(DWARF) option is supported for z/OS Version 1.6 and higher.

Preparing z/OS XL C and C++ programs

Perform the following steps for compiling your z/OS XL C and C++ programs:

1. Create a library (PDSE is suggested unless PDS is required for your organization) for expanded source files. This is only needed in test environments where debugging will be performed. This can be any RECFM / LRECL / BLKSIZE supported as input by the compiler.
2. Allocate libraries (PDSE is suggested unless PDS is required for your organization) for compiler listing files. Allocate one or more compiler listing libraries for each environment, such as test and production.
3. Create a corresponding listing library for each load library. Specify LRECL=133,RECFM=FBA,BLKSIZE=(multiple of lrecl up to 32k) or LRECL=137 or greater, RECFM=VBA,BLKSIZE= lrecl+4 to 32k.
4. Run a 2-stage compile. The first stage preprocesses the program, so the IBM Problem Determination Tools products have access to fully expanded source code. The second stage compiles the program.
   - In the first compile stage, in both test and production environments:
     - Specify compiler options `PP(COMMENTS,NOLINES)` to expand INCLUDEs and macros. The output is SYSUT10 DD, which is the expanded source file and is the input for the second compiler stage.
     - Modify the SYSUT10 DD to enable Debug Tool, by saving it in a expanded source library and specify a member name that is equal to the primary entry point name or CSECT name of your application program.
   - For all programs, such as batch, CICS, and IMS, for the second compiler stage:

– In test environments:
  - For C++, specify compiler options `TEST, ATTRIBUTE(FULL), NOIPA, LIST, NESTINC(255), NOOFFSET, NOOPT, SOURCE, XREF`.

    `TEST` and `NOOPT` are required by Debug Tool. Debug hooks are inserted, which will adds runtime overhead. Symbolic data required by Debug Tool is stored in the module, which can make it significantly larger.

    The other options format the compiler listing as required by Fault Analyzer for z/OS and Application Performance Analyzer for z/OS.
  - For C, specify compiler options `TEST(ALL), AGGREGATE, NOIPA, LIST, NESTINC(255), NOOFFSET, NOOPT, SOURCE, XREF`.

    `TEST(ALL)` and `NOOPT` are required by Debug Tool. Debug hooks are inserted, which adds runtime overhead. Symbolic data required by Debug Tool is stored in the module, which can make it significantly larger.

    The other options format the compiler listing as required by Fault Analyzer for z/OS and Application Performance Analyzer for z/OS.

– In production environments:
  - For C++, specify compiler options: `NOTEST, ATTRIBUTE(FULL), NOIPA, LIST, NESTINC(255), NOOFFSET, NOOPT, SOURCE, XREF`.
  - For C, specify compiler options: `NOTEST, AGGREGATE, NOIPA, LIST, NESTINC(255), NOOFFSET, NOOPT, SOURCE, XREF`.

  `NOTEST` disables Debug Tool, but provides the best performance. This produces a production-ready module that can be used with Fault Analyzer for z/OS and Application Performance Analyzer for z/OS, but not Debug Tool for z/OS.

  The other options format the compiler listing as required for Fault Analyzer for z/OS and Application Performance Analyzer for z/OS.

5. Modify the SYSCPRT DD in the second compiler stage to refer to a file. This is the compiler listing and is the source information file for Fault Analyzer for z/OS and Application Performance Analyzer for z/OS. Save it in the compiler listing library and specify a member that is equal to the CSECT name of your application program.

   ```
   //SYSCPRT DD DSN=compiler.listing.pds(csect-name),DISP=SHR
   ```

   Note: To enable source support in Fault Analyzer, it is a requirement that CSECTs in C programs are named using:

   ```
   #pragma csect(code, "csect_name")
   ```

   where, if using a PDS(E), *csect_name* matches the compiler listing or LANGX file member name.
6. Modify the promotion process to promote compiler listing files. When a load module is promoted, for example, from test to production, promote the corresponding compiler listing file or files. A promotion can be a recompile, copy, or move. Perform the same steps with the compiler listing file that you perform with the module during promotion.
7. Optionally, include a Debug Tool Language Environment exit module into the load module during the linkage editor step. This is one way to enable Debug Tool's panel 6 in ISPF, a simple panel-driven method to start the debugger automatically when a program runs, without JCL changes, based on the program name and user ID. Use module EQADBCXT for batch programs (including IMS batch), EQADICXT for IMS/TM programs and EQADDCXT for DB2 stored procedures. Do not include the exit module for CICS programs.

You can also use module EQAD3CXT for batch programs, IMS/TM, IMS BTS programs, and DB2 type MAIN stored procedures

8. For CICS applications only: if the Debug Tool DTCN transaction will be used to start Debug Tool, link edit the Debug Tool CICS startup exit module EQADCCXT into the application load module to enable Debug Tool in CICS. This is not needed if using the CADP transaction instead of DTCN.

Sample JCL for compiling z/OS C++ programs

Below is a JCL example for compiling an z/OS C/C++ program for use with the IBM Problem Determination Tools products.

```
//* ADD A JOB CARD HERE
//*
//*
//*  SAMPLE JCL TO PREPARE A Z/OS C PROGRAM PROGRAM
//*  FOR THE IBM ZSERIES PD TOOLS PRODUCTS:
//*     FAULT ANALYZER, DEBUG TOOL, AND APPLICATION PERF. ANALYZER
//*
//*  NOTES:
//*
//*   COMPILER:
//*    1. A 2-STAGE COMPILE IS PERFORMED.  STAGE 1 (PREPROCESS) IS
//*       DONE TO EXPAND INCLUDES AND MACROS IN THE PROGRAM AND TO
//*       PRODUCE AN EXPANDED SOURCE FILE.
//*    2. THE EXPANDED SOURCE FILE IS RETAINED.  IT IS USED BY
//*       DEBUG TOOL.
//*    2. COMPILER PARMS TEST AND NOOPT ARE REQUIRED FOR DEBUG TOOL.
//*    3. COMPILER PARMS AGGREGATE, NOIPA, LIST, NOOFFSET, SOURCE,
//*       AND XREF(FULL) ARE NEEDED TO FORMAT THE COMPILER LISTING
//*       SO THAT IT CAN BE PROCESSED WITH XXXLANGX
//*
//*   A STEP RUNS TO PRODUCE A LANGX FILE FOR FAULT ANALYZER AND APA.
//*    NOTE: YOU CAN USE THE XXXLANGX UTILITY SHIPPED WITH DT, FA,
//*          OR APA. THE NAMES ARE DIFFERENT, BUT THE RESULTS ARE THE SAME.
//*          USE ANY OF THEM... THEY ALL PRODUCE THE SAME RESULTS.
//*      IF YOU HAVE:     THEN EXECUTE MODULE:
//*      DEBUG TOOL       EQALANGX, AND ENSURE THAT THE DT SEQAMOD LIBRARY
//*                         IS AVAILABLE (VIA STEPLIB, JOBLIB, OR LINKLIST)
//*      FAULT ANALYZER   IDILANGX, AND ENSURE THAT THE FA SIDIAUTH LIBRARY
//*                         IS AVAILABLE (VIA STEPLIB, JOBLIB, OR LINKLIST)
//*      APA              CAZLANGX, AND ENSURE THAT THE APA SCAZAUTH LIBRARY
//*                         IS AVAILABLE (VIA STEPLIB, JOBLIB, OR LINKLIST)
//*
//*   BINDER (LINKAGE EDITOR):
//*    1. AN INCLUDE FOR MODULE EQAD?CXT IS OPTIONAL.  IT IS AN
//*       LE EXIT MODULE THAT CAN BE USED TO START DEBUG TOOL.
//*       UNDERSTAND THE METHODS AVAILABLE FOR STARTING DEBUG TOOL,
//*       AND CHOOSE WHETHER YOU WANT TO USE THE LE EXITS.
//*         IF YOU USE THIS METHOD, INCLUDE THE CORRECT EXIT MODULE:
//*            EQADBCXT: FOR BATCH PROGRAMS
//*            EQADICXT: FOR ONLINE IMS PROGRAMS
//*            EQADDCXT: FOR DB2 STORED PROCEDURES (OF TYPE MAIN AND SUB)
//*           (for SUB this is supported only for invocations through call_sub)
//*            (DO NOT INCLUDE AN EXIT FOR CICS PROGRAMS)
//*     YOU CAN ALSO USE MODULE EQAD3CXT FOR BATCH PROGRAMS, ONLINE IMS
//*          PROGRAMS, DB2 TYPE MAIN STORED PROCEDURES.
//*
//*  SET PARMS FOR THIS COMPILE:
//*  --------------------------
//*       CPRFX: THE PREFIX THE C/C++ COMPILE IS INSTALLED UNDER
//*       LEPRFX: THE PREFIX FOR THE LE RUNTIME AND LINK LIBS
//*       DTPRFX: THE PREFIX OF THE DEBUG TOOL SEQAMOD LIBRARY
//*
//    SET CPRFX=CBC
//    SET LEPRFX=CEE
//    SET DTPRFX=EQAW
```

```
//*
//*****************************************************************/
//* CREATE C/C++ COMPILER LISTING SYSPRINT, EXPANDED SOURCE DEBUG,  */
//* AND EQALANGX FILES                                              */
//*****************************************************************/
//ALLOC EXEC PGM=IEFBR14
//LISTING DD DSN=&SYSUID..ADLAB.CLST,
//           DISP=(MOD,CATLG),
//           DCB=(DSORG=PO,RECFM=VBA,LRECL=137,BLKSIZE=0),
//           SPACE=(TRK,(20,20,50)),UNIT=SYSDA
//DBGSRC  DD DSN=&SYSUID..ADLAB.CDBG,
//           DISP=(MOD,CATLG),
//           DCB=(DSORG=PO,RECFM=FB,LRECL=80,BLKSIZE=0),
//           SPACE=(TRK,(20,20,50)),UNIT=SYSDA
//LANGX   DD DSN=&SYSUID..ADLAB.EQALANGX,
//           DISP=(MOD,CATLG),
//           DCB=(DSORG=PO,RECFM=VB,LRECL=1562,BLKSIZE=0),
//           SPACE=(TRK,(40,40,50)),UNIT=SYSDA
//*                                                               *
//*****************************************************************
//*-----------------------------------------------------------------
//*  COMPILE STEP1: GENERATE EXPANDED C/C++ SOURCE FILE IN THE DD
//*                 SYSUT10
//*-----------------------------------------------------------------
//COMP1   EXEC PGM=CCNDRVR,REGION=0M,
// PARM=('PP(COMMENTS,NOLINES)')
//STEPLIB  DD  DSNAME=&LEPRFX..SCEERUN2,DISP=SHR
//         DD  DSNAME=&CPRFX..SCCNCMP,DISP=SHR
//SYSMSGS  DD  DUMMY,DSN=&CPRFX..SCBC3MSG(EDCMSGE),DISP=SHR
//SYSLIB   DD  DSNAME=&LEPRFX..SCEEH.H,DISP=SHR
//         DD  DSNAME=&LEPRFX..SCEEH.SYS.H,DISP=SHR
//         DD  DSNAME=&SYSUID..ADLAB.COPYLIB,DISP=SHR
//SYSPRINT DD  SYSOUT=*
//SYSOUT   DD  SYSOUT=*
//SYSCPRT  DD  SYSOUT=*
//SYSUT1   DD  UNIT=SYSDA,SPACE=(32000,(30,30)),
//   DCB=(RECFM=FB,LRECL=80,BLKSIZE=3200)
//SYSUT5   DD  UNIT=SYSDA,SPACE=(32000,(30,30)),
//   DCB=(RECFM=FB,LRECL=3200,BLKSIZE=12800)
//SYSUT6   DD  UNIT=SYSDA,SPACE=(32000,(30,30)),
//   DCB=(RECFM=FB,LRECL=3200,BLKSIZE=12800)
//SYSUT7   DD  UNIT=SYSDA,SPACE=(32000,(30,30)),
//   DCB=(RECFM=FB,LRECL=3200,BLKSIZE=12800)
//SYSUT8   DD  UNIT=SYSDA,SPACE=(32000,(30,30)),
//   DCB=(RECFM=FB,LRECL=3200,BLKSIZE=12800)
//SYSUT9   DD  UNIT=SYSDA,SPACE=(32000,(30,30)),
//   DCB=(RECFM=VB,LRECL=137,BLKSIZE=882)
//SYSUT10  DD  DISP=SHR,DSN=&SYSUID..ADLAB.CDBG(TMC01A)
//SYSUT14  DD  UNIT=SYSDA,SPACE=(32000,(30,30)),
//             DCB=(RECFM=FB,LRECL=3200,BLKSIZE=12800)
//SYSUT16  DD  UNIT=SYSDA,SPACE=(32000,(30,30)),
//             DCB=(RECFM=FB,LRECL=3200,BLKSIZE=12800)
//SYSUT17  DD  UNIT=SYSDA,SPACE=(32000,(30,30)),
//             DCB=(RECFM=FB,LRECL=3200,BLKSIZE=12800)
//SYSLIN   DD  DUMMY
//SYSIN    DD  DSNAME=&SYSUID..ADLAB.SOURCE(TMC01A),DISP=SHR
//*
//*-----------------------------------------------------------------
//*  COMPILE STEP2: COMPILE THE EXPANDED SOURCE FILE WITH THE DEBUG
//*                 COMPILER OPTION TEST(ALL)
//*-----------------------------------------------------------------
//COMP2   EXEC PGM=CCNDRVR,REGION=0M,
//  PARM=('TEST(ALL), AGGREGATE, NOIPA, LIST, NESTINC(255),',
//    ' NOOFFSET, NOOPT, SOURCE, XREF')
//STEPLIB  DD  DSNAME=&LEPRFX..SCEERUN2,DISP=SHR
//         DD  DSNAME=&CPRFX..SCCNCMP,DISP=SHR
//         DD  DSNAME=&LEPRFX..SCEERUN,DISP=SHR
```

```
//SYSMSGS  DD  DUMMY,DSN=&CPRFX..SCBC3MSG(EDCMSGE),DISP=SHR
//SYSLIB   DD  DSNAME=&LEPRFX..SCEEH.H,DISP=SHR
//         DD  DSNAME=&LEPRFX..SCEEH.SYS.H,DISP=SHR
//SYSCPRT  DD  DISP=SHR,DSN=&SYSUID..ADLAB.CLST(TMC01A)
//SYSOUT   DD  SYSOUT=*
//SYSPRINT DD  SYSOUT=*
//SYSUT1   DD  UNIT=SYSDA,SPACE=(32000,(30,30)),
//   DCB=(RECFM=FB,LRECL=80,BLKSIZE=3200)
//SYSUT5   DD  UNIT=SYSDA,SPACE=(32000,(30,30)),
//   DCB=(RECFM=FB,LRECL=3200,BLKSIZE=12800)
//SYSUT6   DD  UNIT=SYSDA,SPACE=(32000,(30,30)),
//   DCB=(RECFM=FB,LRECL=3200,BLKSIZE=12800)
//SYSUT7   DD  UNIT=SYSDA,SPACE=(32000,(30,30)),
//   DCB=(RECFM=FB,LRECL=3200,BLKSIZE=12800)
//SYSUT8   DD  UNIT=SYSDA,SPACE=(32000,(30,30)),
//   DCB=(RECFM=FB,LRECL=3200,BLKSIZE=12800)
//SYSUT9   DD  UNIT=SYSDA,SPACE=(32000,(30,30)),
//   DCB=(RECFM=VB,LRECL=137,BLKSIZE=882)
//SYSUT10  DD  SYSOUT=*
//SYSUT14  DD  UNIT=SYSDA,SPACE=(32000,(30,30)),
//             DCB=(RECFM=FB,LRECL=3200,BLKSIZE=12800)
//SYSUT16  DD  UNIT=SYSDA,SPACE=(32000,(30,30)),
//             DCB=(RECFM=FB,LRECL=3200,BLKSIZE=12800)
//SYSUT17  DD  UNIT=SYSDA,SPACE=(32000,(30,30)),
//             DCB=(RECFM=FB,LRECL=3200,BLKSIZE=12800)
//SYSLIN   DD DSN=&&TEMOBJ1(TMC01A),DISP=(,PASS),UNIT=SYSDA,
// SPACE=(TRK,(20,20,20)),DCB=(RECFM=FB,BLKSIZE=3120,LRECL=80,DSORG=PO)
//SYSIN    DD  DSNAME=&SYSUID..ADLAB.CDBG(TMC01A),DISP=SHR
//*
//*--------------------------------------------------------------------
//* LINK STEP: LINK THE COMPILED OBJECT DECK
//*--------------------------------------------------------------------
//LKED EXEC PGM=IEWL,PARM=(LET,MAP,LIST)
//SYSLIB DD DSN=&LEPRFX..SCEELKED,DISP=SHR
//SYSPRINT DD SYSOUT=*
//SYSLMOD DD DISP=SHR,DSN=&SYSUID..ADLAB.LOAD
//SYSUT1 DD SPACE=(TRK,(10,10)),UNIT=SYSDA
//OBJECT DD DISP=(OLD,PASS),DSN=&&TEMOBJ1
//* DTLIB DD DSN=&DTPRFX..SEQAMOD,DISP=SHR
//SYSLIN DD *
INCLUDE OBJECT(TMC01A)
ENTRY CEESTART
NAME TMC01(R)
/*
//*  INCLUDING A DEBUG TOOL LE EXIT (EQADBCXT, EQADDCXT, EQADICXT OR EQAD3CXT)
//*  IS OPTIONAL.  THE EXIT ENABLES STARTING DEBUG TOOL WITH THE
//*  USER EXIT DATA SET UTILITY (ONE OF THE DEBUG TOOL ISPF UTILITIES).
//*  AN INCLUDE CAN BE ADDED TO SYSLIN IN THE APPRORIATE SEQUENCE:
//*   INCLUDE DTLIB(EQADBCXT)
//*************************************************************
//* GENERATE THE TMC01A EQALANGX FILE
//*************************************************************
//LANGX1   EXEC PGM=EQALANGX,REGION=32M,
//  PARM='(C ERROR'
//STEPLIB  DD DISP=SHR,DSN=&DTPRFX..SEQAMOD
//            DD DISP=SHR,DSN=&LEPRFX..SCEERUN
//LISTING  DD DSN=&SYSUID..ADLAB.CLST(TMC01A),DISP=SHR
//IDILANGX DD DSN=&SYSUID..ADLAB.EQALANGX(TMC01AX),DISP=(OLD)
```

Assembler programs

The following table shows various assembler options that can be used to prepare programs for use with the IBM Problem Determination Tools products (Debug Tool for z/OS, Fault Analyzer for z/OS and Application Performance Analyzer for z/OS). The methods suggested in the following table indicate if the load module produced

is suitable for a production environment. Load modules suitable for a production environments have no significant run-time overhead.

Table 30. Examples of assembler options and source information files supported by IBM Problem Determination Tools products for Assembler

Assembler options	Source information file type produced	Is the load module production ready?	Options supported and suggested for Debug Tool for z/OS	Options supported and suggested for Fault Analyzer for z/OS	Options supported and suggested for Application Performance Analyzer for z/OS
ADATA	SYSADATA file	Yes	N/A	Supported	Supported
ADATA	LANGX file	Yes	Suggested for production and test		

Note: The highlighted row or rows in the table above indicate the suggested compiler options and source information file types for each product.

Preparing Assembler programs

Perform the following steps for assembling your programs:

1. Allocate libraries (PDSE is suggested unless PDS is required for your organization) for LANGX files. Allocate one or more LANGX libraries for each environment, such as test and production.
2. Create a corresponding LANGX library for each load library. Specify LRECL=1562 or greater,RECFM=VB,BLKSIZE= lrecl+4 to 32k.
3. For all programs, such as batch, CICS, and IMS, in both test and production environments, specify `ADATA`.

   `ADATA` instructs the assembler to produce a SYSADATA file, which contains source and symbolic data about the program. This produces a production-ready module that can be debugged using Debug Tool for z/OS. `ADATA` does not affect the contents of the assembled module.
4. Add a SYSADATA DD in the assembler step. This file is created by the assembler and it can be a permanent or temporary file. Specify `LRECL=8188 or greater,RECFM=VB,BLKSIZE= lrecl+4 to 32k`. This file is the input to the *xxx*LANGX utility.
5. Add a step after the assembler step to run the *xxx*LANGX utility. The *xxx*LANGX utility reads the SYSADATA file and creates a LANGX file. The LANGX file is the source information file for Debug Tool for z/OS, Fault Analyzer for z/OS and Application Performance Analyzer for z/OS. Equivalent *xxx*LANGX utilities are available in Debug Tool for z/OS as EQALANGX, in Fault Analyzer for z/OS as IDILANGX and in Application Performance Analyzer for z/OS as CAZLANGX.
6. Save the LANGX file in the LANGX file library, and specify a member name that is equal to the CSECT name.
7. Modify the promotion process to promote LANGX files. When a load module is promoted, for example, from test to production, promote the corresponding LANGX file or files. A promotion can be a recompile, copy, or move. Perform the same steps with the LANGX file that you perform with the module during promotion.
8. If the assembler program is Language Environment-enabled, optionally include a Debug Tool Language Environment exit module into the load module during the linkage editor step. This is one way to enable Debug Tool's panel 6 in ISPF, a simple panel-driven method to start the debugger automatically when a program runs, without JCL changes, based on the program name and user ID.

Use module EQADBCXT for batch programs (including IMS batch), EQADICXT for IMS/TM programs and EQADDCXT for DB2 stored procedures. Do not include the exit module for CICS programs.

You can also use module EQAD3CXT for batch programs, IMS/TM, IMS BTS programs, and DB2 type MAIN stored procedures

9. For CICS programs only: If the program is a CICS main program, is enabled for Language Environment, and the Debug Tool DTCN transaction will be used to start Debug Tool, then supplied module EQADCCXT must be included in the load module during the linkage editor step.

Sample JCL for assembling a program

Below is a JCL example for assembling a program for use with the IBM Problem Determination Tools products.

```
//*     - - -  ADD A JOB CARD ABOVE THIS LINE  - - -
//*
//*  SAMPLE JCL TO PREPARE AN ASSEMBLER PROGRAM
//*  FOR THE IBM ZSERIES PD TOOLS PRODUCTS:
//*     FAULT ANALYZER, DEBUG TOOL, AND APPLICATION PERF. ANALYZER
//*
//*  NOTES:
//*
//*   ASSEMBLER:
//*    1. AN ADATA PARM IS REQUIRED TO PRODUCE A SYSADATA FILE
//*
//*   A STEP THAT PROCESSES THE SYSADATA FILE,
//*   AND CREATES A LANGX FILE IS NEEDED.
//*
//*   BINDER (LINKAGE EDITOR):
//*    1. AMODE / RMODE CAN BE CODED AS NEEDED BY THE PROGRAM.  THEY ARE
//*       NOT REQUIRED FOR PD TOOLS.
//*
//*  SET PARMS FOR THIS COMPILE:
//*  --------------------------
//   SET MEM=ASAM1                       PROGRAM NAME
//   SET Language EnvironmentHLQ='CEE'    Language Environment HIGH LVL QUALIFIER
//   SET UNITDEV=SYSALLDA                UNIT FOR TEMP FILES
//   SET LANGX='EQALANGX'                XXXLANGX UTILITY PROGRAM
//   SET LANGXLIB='EQAW.SEQAMOD'         LIBRARY FOR XXXLANGX UTILITY
//*    NOTE: YOU CAN USE THE XXXLANGX UTILITY SHIPPED WITH DT, FA,
//*          OR APA. THE NAMES ARE DIFFERENT, BUT RESULTS ARE THE SAME
//*          USE ANY OF THEM... THEY ALL PRODUCE THE SAME RESULTS.
//*      IF YOU HAVE:     SET LANGX TO:    SET LANGXLIB TO:
//*      DEBUG TOOL       EQALANGX         THE DT SEQAMOD LIBRARY
//*      FAULT ANALYZER   IDILANGX         THE FA SIDIAUTH LIBRARY
//*      APA              CAZLANGX         THE APA SCAZAUTH LIBRARY
//*
//*  ********************************
//*      ASSEMBLER STEP
//*  ********************************
//ASM1 EXEC  PGM=ASMA90,COND=(4,LT),REGION=32M,
//      PARM='ADATA,OBJECT'
//SYSIN    DD DISP=SHR,DSN=&SYSUID..ADLAB.SOURCE(&MEM)
//SYSPRINT DD SYSOUT=*
//SYSLIN   DD DISP=SHR,DSN=&SYSUID..ADLAB.OBJ(&MEM)
//SYSADATA DD DISP=SHR,DSN=&SYSUID..ADLAB.SYSADATA(&MEM)
//SYSLIB  DD  DSN=SYS1.MODGEN,DISP=SHR
//        DD  DSN=SYS1.MACLIB,DISP=SHR
//        DD  DSN=&LEHLQ..SCEEMAC,DISP=SHR
//SYSUT1  DD  DISP=(NEW,DELETE),DSN=&&SYSUT1,SPACE=(1700,(900,450)),
//     UNIT=&UNITDEV
//SYSUT2  DD  DISP=(NEW,DELETE),DSN=&&SYSUT2,SPACE=(1700,(600,300)),
//     UNIT=&UNITDEV
//SYSUT3  DD  DISP=(NEW,DELETE),DSN=&&SYSUT3,SPACE=(1700,(600,300)),
//     UNIT=&UNITDEV
```

```
//*
//*  ********************************
//*     STEP TO GENERATE LANGX FILE
//*  ********************************
//LANGX    EXEC PGM=&LANGX,REGION=32M,
//  PARM='(ASM ERROR'
//STEPLIB  DD DISP=SHR,DSN=&LANGXLIB
//         DD DISP=SHR,DSN=&LEHLQ..SCEERUN
//SYSADATA DD DSN=&SYSUID..ADLAB.SYSADATA(&MEM),DISP=SHR
//IDILANGX DD DSN=&SYSUID..ADLAB.EQALANGX(&MEM),DISP=SHR
//*
//*  ********************************
//*        LINK-EDIT (BINDER) STEP
//*  ********************************
//LINK     EXEC PGM=IEWL,PARM='MAP',REGION=0M
//SYSLIB   DD DSN=&LEHLQ..SCEELKED,DISP=SHR
//SYSPRINT DD SYSOUT=*
//SYSLMOD  DD DISP=SHR,DSN=&SYSUID..ADLAB.LOAD(&MEM)
//SYSUT1   DD UNIT=SYSDA,SPACE=(TRK,(10,10))
//SYSLIN   DD DSN=&SYSUID..ADLAB.OBJ(&MEM),DISP=SHR
//         DD *
     MODE AMODE(31),RMODE(24)
     ENTRY ASAM1
//*
```

Appendix D. Examples: Preparing programs and modifying setup files with Debug Tool Utilities

These examples show you how to use Debug Tool Utilities to prepare your programs and how to create, manage, and use a setup file. The examples guide you through the following tasks:

1. Creating personal data sets with the correct attributes.
2. Starting Debug Tool Utilities.
3. Compiling or assembling your program by using Debug Tool Utilities. If you do not use Debug Tool Utilities, you can build your program through your usual methods and resume this example with the next step.
4. Modifying and using a setup file to run your program in the foreground or in batch.

Creating personal data sets

Create the data sets with the names and attributes described below. Allocate 5 tracks for each of the data sets. Partitioned data sets should be specified with 5 blocks for the directory.

Table 31. Names and attributes to use when you create your own data sets.

Data set name	LRECL	BLKSIZE	RECFM	DSORG
prefix.SAMPLE.COBOL	80	*	FB	PO
prefix.SAMPLE.PLI	80	*	FB	PO
prefix.SAMPLE.C	80	*	FB	PO
prefix.SAMPLE.ASM	80	*	FB	PO
prefix.SAMPLE.DTSF	1280	*	VB	PO
* You can use any block size that is valid.				

Copy the following members of the *hlq*.SEQASAMP data set into the personal data sets you just created:

SEQASAMP member name	Your sample data set	Description of member
EQAWPP1	*prefix*.SAMPLE.COBOL(WPP1)	COBOL source code
EQAWPP3	*prefix*.SAMPLE.PLI(WPP3)	PL/I source code
EQAWPP4	*prefix*.SAMPLE.C(WPP4)	C source code
EQAWPP5	*prefix*.SAMPLE.ASM(WPP5)	Assembler source code
EQAWSU1	*prefix*.SAMPLE.DTSF(WSU1)	setup file for EQAWPP1
EQAWSU3	*prefix*.SAMPLE.DTSF(WSU3)	setup file for EQAWPP3
EQAWSU4	*prefix*.SAMPLE.DTSF(WSU4)	setup file for EQAWPP4
EQAWSU5	*prefix*.SAMPLE.DTSF(WSU5)	setup file for EQAWPP5

Starting Debug Tool Utilities

To start Debug Tool Utilities, do one the following options:

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- If Debug Tool Utilities was installed as an option on an existing ISPF panel, then select that option.
- If Debug Tool Utilities data sets were installed as part of your log on procedure, enter the following command from ISPF option 6:

  ```
  EQASTART
  ```

- If Debug Tool Utilities was installed as a separate application, enter the following command from ISPF option 6:

  ```
  EX 'hlq.SEQAEXEC(EQASTART)'
  ```

The Debug Tool Utilities primary panel (EQA@PRIM) is displayed. On the command line, enter the `PANELID` command. This command displays the name of each panel on the upper left corner of the screen. These names are used as navigation aids in the instructions provided in this section. After you complete these examples, you can stop the display of these names by entering the `PANELID` command.

Compiling or assembling your program by using Debug Tool Utilities

To compile your program, do the following steps:

1. In panel EQA@PRIM, select 1. Press Enter.
2. In panel EQAPP, select one of the following option and then press Enter.
   - 1 to compile a COBOL program.
   - 3 to compile a PL/I program
   - 4 to compile a C or C++ program
   - 5 to assemble an assembler program
3. One of the following panels is displayed, depending on the language you selected in step 2:
   - EQAPPC1 for COBOL programs. Enter the following information in the fields indicated:
     - Project = *prefix*
     - Group= `SAMPLE`
     - Type=`COBOL`
     - Member=`WPP1`
   - EQAPPC3 for PL/I programs.
     - Project = *prefix*
     - Group= `SAMPLE`
     - Type=`PLI`
     - Member=`WPP3`
   - EQAPPC4 for C and C++ programs.
     - Project = *prefix*
     - Group= `SAMPLE`
     - Type=`C`
     - Member=`WPP4`
   - EQAPPC5 for assembler programs.
     - Project = *prefix*
     - Group= `SAMPLE`
     - Type=`ASM`
     - Member=`WPP5`

4. If you are preparing an assembler program, enter the location of your CEE library in the Syslib data set Name field. For example: 'CEE.SCEEMAC'
5. Enter '/' to edit options and specify a naming pattern for the output data sets in the field `Data set naming pattern`. Press Enter.
6. One of the following panels is displayed, depending on the language you selected in step 2 on page 472:
   - EQAPPC1A for COBOL programs.
   - EQAPPC3A for PL/I programs.
   - EQAPPC4A for C and C++ programs.
   - EQAPPC5A for assembler programs.

   Look at the panel to review the following information:
   - test compiler options
   - naming patterns for output data sets

   Press PF3 (Exit).
7. One of the following panels is displayed, depending on the language you selected in step 2 on page 472:
   - EQAPPC1 for COBOL programs.
   - EQAPPC3 for PL/I programs.
   - EQAPPC4 for C and C++ programs.
   - EQAPPC5 for assembler programs.

   Select "F" to process these programs in the foreground. Specify "N" for CICS translator and "N" for DB2 precompiler. None of these programs contain CICS or DB2 instructions. Press Enter.
8. One of the following panels is displayed, depending on the language you selected in step 2 on page 472:
   - EQAPPC1B for COBOL programs.
   - EQAPPC3B for PL/I programs.
   - EQAPPC4B for C and C++ programs.
   - EQAPPC5B for assembler programs.

   Make a note of the data set name for Object compilation output. For a COBOL program, the data set name will look similar to the following name: *prefix*`.SAMPLE.OBJECT(WPP1)`. You will use this name when you link your object modules. Press Enter.
9. If panel EQAPPA1 is displayed, press Enter.
10. One of the following panels is displayed, depending on the language you selected in step 2 on page 472:
    - EQAPPC1C for COBOL programs.
    - EQAPPC3C for PL/I programs.
    - EQAPPC4C for C and C++ programs.
    - EQAPPC5C for assembler programs.

    Check for a 0 or 4 return code. Type a "b" in the Listing field. Press Enter.
11. In panel ISRBROBA, browse the file to review the messages. When you are done reviewing the messages, press PF3 (Exit).
12. One of the following panels is displayed, depending on the language you selected in step 2 on page 472:
    - EQAPPC1C for COBOL programs.

- EQAPPC3C for PL/I programs.
- EQAPPC4C for C and C++ programs.
- EQAPPC5C for assembler programs.

Press PF3 (Exit).

13. One of the following panels is displayed, depending on the language you selected in step 2 on page 472:
    - EQAPPC1B for COBOL programs.
    - EQAPPC3B for PL/I programs.
    - EQAPPC4B for C and C++ programs.
    - EQAPPC5B for assembler programs.

    Press PF3 (Exit).
14. One of the following panels is displayed, depending on the language you selected in step 2 on page 472:
    - EQAPPC1 for COBOL programs.
    - EQAPPC3 for PL/I programs.
    - EQAPPC4 for C and C++ programs.
    - EQAPPC5 for assembler programs.

    Press PF3 (Exit).
15. In panel EQAPP, press PF3 (Exit) to return to EQA@PRIM panel.

To link your object modules, do the following steps:

1. In panel EQA@PRIM, select 1. Press Enter.
2. In panel EQAPP, select L. Press Enter.
3. In panel EQAPPCL, specify "F" to process the programs in the foreground. Then, choose one of the following options, depending on the language you selected in step 2 on page 472:
    - For the COBOL program, use the following values for each field: Project = *prefix*, Group= `SAMPLE`, Type=`OBJECT`, Member=`WPP1`
    - For the PL/I program, use the following values for each field: Project = *prefix*, Group= `SAMPLE`, Type=`OBJECT`, Member=`WPP3`
    - For the C program, use the following values for each field: Project = *prefix*, Group= `SAMPLE`, Type=`OBJECT`, Member=`WPP4`
    - For the assembler program, use the following values for each field: Project = *prefix*, Group= `SAMPLE`, Type=`OBJECT`, Member=`WPP5`
4. In panel EQAPPCL, specify the name of the other libraries you need to link to your program. For example, in the field Syslib data set Name, specify the prefix of your CEE library: `'CEE.SCEELKED'`. Press Enter.
5. In panel EQAPPCLB, make a note of the data set name in the Load link-edit output field. You will use this name when you modify a setup file. Press Enter.
6. If panel EQAPPA1 is displayed, press Enter.
7. In panel EQAPPCLC, check for a 0 return code. Type a "V" in the Listing field. Press Enter.
8. In panel ISREDDE2, review the messages. After you review the messages, press PF3 (Exit).
9. In panel EQAPPCLC, press PF3 (Exit).
10. In panel EQAPPCLB, press PF3 (Exit).
11. In panel EQAPPCL, press PF3 (Exit).

12. In panel EQAPP, press PF3 (Exit) to return to EQA@PRIM panel.

Modifying and using a setup file

This example describes how to modify a setup file and then use it to run the examples in the TSO foreground or run the examples in the background by submitting a MVS batch job.

Run the program in foreground

To modify and run the setup file so your program runs in the foreground, do the following steps:

1. In panel EQA@PRIM, select 2. Press Enter.
2. In panel EQAPFOR, select one of the following choices, depending on which language you selected in step 2 on page 472:
   - For the COBOL program, use the following values for each field: Project = *prefix*, Group= SAMPLE, Type=DTSF, Member = WSU1
   - For the PL/I program, use the following values for each field: Project = *prefix*, Group = SAMPLE, Type=DTSF, Member=WSU3
   - For the C program, use the following values for each field: Project = *prefix*, Group= SAMPLE, Type=DTSF, Member=WSU4
   - For the assembler program, use the following values for each field: Project = *prefix*, Group= SAMPLE, Type=DTSF, Member=WSU5

   Press Enter.
3. In panel EQAPFORS, do the following steps:
   a. Replace &LOADDS. with the name of the load data set from step 5 on page 474 of instructions on how to link the object modules.
   b. Replace &EQAPRFX. with the prefix your EQAW (Debug Tool) library.
   c. Replace &CEEPRFX. with the prefix your CEE (Language Environment) library.
   d. Enter "e" in Cmd field next to CMDS DD name. In the window that is displayed, if there is a QUIT ; statement at the end of the data set, remove it. Press PF3 (Exit).
   e. Type "run" in command line. Press Enter.
4. Debug Tool is started and the Debug Tool window is displayed. Enter any valid Debug Tool commands to verify that you can debug the program. Enter "qq" in the command line to stop Debug Tool and close the Debug Tool window.
5. In panel EQAPFORS, check the return code message:
   - For the COBOL program, the return code (RC) is 0.
   - For the PL/I program, the return code (RC) is 1000.
   - For the C program, the return code (RC) is 0.
   - For the assembler program, the return code (RC) is 0.

   Press PF3 (Exit). All the changes made to the setup file are saved.
6. In panel EQAPFOR, press PF3 (Exit) to return to the panel EQA@PRIM.

Run the program in batch

To modify and run the setup file so that the program runs in batch, do the following steps:

1. In panel EQA@PRIM, select 0. Press Enter.
2. In panel EQAPDEF, review the job card information. If there are any changes that need to be made, make them. Press PF3 (Exit).

3. In panel EQA@PRIM, select 2. Press Enter.
4. In panel EQAPFOR, select one of the following choices, depending on which language you selected in step 2 on page 472:
   - For the COBOL program, use the following values for each field: Project = *prefix*, Group = `SAMPLE`, Type = `DTSF`, Member =`WSU1`
   - For the PL/I program, use the following values for each field: Project = *prefix*, Group = `SAMPLE`, Type = `DTSF`, Member =`WSU3`
   - For the C program, use the following values for each field: Project = *prefix*, Group = `SAMPLE`, Type = `DTSF`, Member = `WSU4`
   - For the assembler program, use the following values for each field: Project = *prefix*, Group = `SAMPLE`, Type = `DTSF`, Member = `WSU5`

   Press Enter.
5. If you ran the steps beginning on page 475 (running the program in foreground), you can skip this step. In panel EQAPFORS, do the following steps:
   a. Replace `&LOADDS.` with the name of the load data set from step 5 on page 474 of instructions on how to link the object modules.
   b. Replace `&EQAPRFX.` with the prefix your EQAW (Debug Tool) library.
   c. Replace `&CEEPRFX.` with the prefix your CEE (Language Environment) library.
6. Enter "e" in the Cmd field next to CMDS DD name. If there is not `'QUIT ;'` statement at the end of the data set, then add the statement. Press PF3 (Exit).
7. Type `submit` in command line. Press Enter.
8. In panel ISREDDE2, type `submit` in the command line. Press Enter. Make a note of the job number that is displayed.
9. In panel ISREDDE2, press PF3 (Exit).
10. In panel EQAPFORS, press PF3 (Exit). The changes you made to the setup file are saved.
11. In panel EQAPFOR, press PF3 (Exit) to return to EQA@PRIM panel. locate the job output using the job number recorded. Check for zero return code and the command log output at the end of the job output.

Appendix E. Notes on debugging in batch mode

Debug Tool can run in batch mode, creating a noninteractive session.

In batch mode, Debug Tool receives its input from the primary commands file, the USE file, or the command string specified in the `TEST` run-time option, and writes its normal output to a log file.

Note: You must ensure that you specify a log data set.

Commands that require user interaction, such as `PANEL`, are invalid in batch mode.

You might want to run a Debug Tool session in batch mode if:

- You want to restrict the processor resources used. Batch mode generally uses fewer processor resources than interactive mode.
- You have a program that might tie up your terminal for long periods of time. With batch mode, you can use your terminal for other work while the batch job is running.
- You are debugging an application in its native batch environment, such as MVS/JES or CICS batch.

When Debug Tool is reading commands from a specified data set or file and no more commands are available in that data set or file, it forces a GO command until the end of the program is reached.

When debugging in batch mode, use `QUIT` to end your session.

Refer to the following topics for more information related to the material discussed in this topic.

Related tasks

Chapter 15, “Starting Debug Tool in batch mode,” on page 131

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Appendix F. Displaying and modifying CICS storage with DTST

The DTST transaction enables you to display, scan, and modify CICS storage. It is a BMS transaction and runs on a 3270 terminal.

Starting DTST

This topic describes the methods of starting DTST and gives examples.

Before you begin, if you need to modify storage, verify with your system programmer that you have the authority to modify CICS key storage, USER key storage, or both. "Authorizing DTST transaction to modify storage" in *Debug Tool Customization Guide* describes the steps the system programmer must do to authorize you to modify CICS key storage, USER key storage, or both.

You can start the DTST transaction with or without specifying a base address. A base address can be any of the following items:

- A literal hexadecimal number (for example, 45CB00)
- The name of a program (for example, MYPGM)
- An offset calculation or indirection (for example, 45CB00+40)

You can also specify that DTST take a specific action when it starts. You specify an action with one of the following characters:

- P, which means to page forward or backward.
- S, which means to search through storage until a specific target is found.

“Syntax of the DTST transaction” on page 484 describes all the parameters.

Examples of starting DTST

The following examples illustrate how to enter the DTST command with parameters.

Example: Starting DTST and specifying a literal hexadecimal number

To display storage at address 45CB00, enter the command `DTST 45CB00`.

The base address is 45CB00.

Example: Starting DTST and specifying a program name

To display program storage for program MYPROG, enter the command `DTST P=MYPROG`.

The base address is the address of the program in storage.

Example: Starting DTST and specifying an offset

To display storage at an negative offset of D0 bytes from address 45CB00, enter the command `DTST 45CB00 - D0`.

The result of the calculation (45CB00-D0) is the base address. In this example, the base address is 45CA30.

To display program storage at an positive offset of 28 bytes from the starting address of program MYPROG, enter the command `DTST P=MYPROG+28`.

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If the starting address of program MYPROG is 8492A000, then the result of the calculation (8492A000+28) is the base address (8492A028).

If fullwords generate protection exceptions (for example, in fetch-protected storage), DTST displays question marks in the Storage Key field.

Example: Starting DTST with indirect addressing

To display storage by indirection, use an asterisk (*) to indicate 31-bit addressing or an at sign (@) to indicate 24-bit addressing. DTST uses the fullword at that address as the base address.

If you want to use the fullword at address 45CB00 as the base address, enter the command `DTST 45CB00*`.

You can combine multiple offset or levels of indirection. For example, if you enter the command `DTST 45CB00 + b* + 14** + 14*`, DTST calculates the base address in the following order:

1. Beginning with 45CB00, add B0. The result is 45CBB0.
2. Go to location 45CBB0 to obtain the address at that location. For this example, assume that the address is 29AD00.
3. Add 14 to 29AD00. The result is 29AD14.
4. Go to location 29AD14 to obtain the address at that location. For this example, assume that the address is 1838AD.
5. Go to location 1838AD to obtain the address at that location. For this example, assume that the address is 251936.
6. Add 14 to 251936 to get the result 25194A.
7. Go to location 25194A to obtain the address at that location. For this example, assume that the address is 3920AD. DTST opens the memory window and display the contents of storage beginning at 3920AD.

Example: Starting DTST with the BASE keyword

The BASE keyword can make it easier to write long command lines. The BASE keyword is assigned the value of the base address of the previous DTST command. For example, if you enter the command `DTST 45CB00+10*`, BASE is assigned the value of the result of 45CB00+10*. If you want to use the value of 45CB00+10* in a subsequent command, use the BASE keyword. For example, `DTST BASE+20*`.

Example: Starting DTST with a scan request

You can specify data that you are looking for by adding a scan request to the DTST command. For example, to find the data 'WORKAREA' starting at base address 45CB00, enter the command `DTST 45CB00,S='WORKAREA'`. The scan starts at the base address and continues for 4K bytes. To find the data 'WORKAREA' starting at base address 45CB00 at the beginning of every double word, enter the command `DTST 45CB00,S8='WORKAREA'`. You can specify that the scan be done in a negative direction, which means that addresses are decreasing in value.

Example: Starting DTST with a page number request

You can specify a page you want displayed by adding a page request to the DTST command. For example, to display storage that is 5 pages from the base address 45CB00, enter the command `DTST 45CB00,P=5`. This is equivalent to entering the command `DTST 45CB00`, then pressing the page down keys five times. If you enter the command `DTST 45CB00,P=-5`, it is equivalent to entering the command `DTST 45CB00`, then pressing the page up keys five times.

Modifying storage through the DTST storage window

After you start the DTST transaction, the storage window is displayed. You can modify the contents of storage being displayed in the storage window.

Before you begin, verify with your system programmer that you have the authority to modify CICS key storage, USER key storage, or both. "Authorizing DTST transaction to modify storage" in *Debug Tool Customization Guide* describes the steps the system programmer must do to authorize you to modify CICS key storage, USER key storage, or both.

After you verify that the previous DTST command ran successfully, you can do the following steps to modify storage.

1. Press PF9 to enter modify mode. The command line becomes protected, and columns four through seven become unprotected.
2. Move your cursor to data you want to modify and type in the new data. You can modify several different locations at the same time.
3. Press Enter. DTST verifies that the data you entered is valid. DTST makes all modifications that contain valid data. If any word contains invalid data, the line contains that word is highlighted. You can correct the invalid data, then press Enter to verify the change.
4. Press any function key to end modify mode. However, you can not press any of the following keys:
   - PF10
   - PF11
   - the CLEAR key
   - the Enter key when you have typed in any modifications

Navigating through the DTST storage window

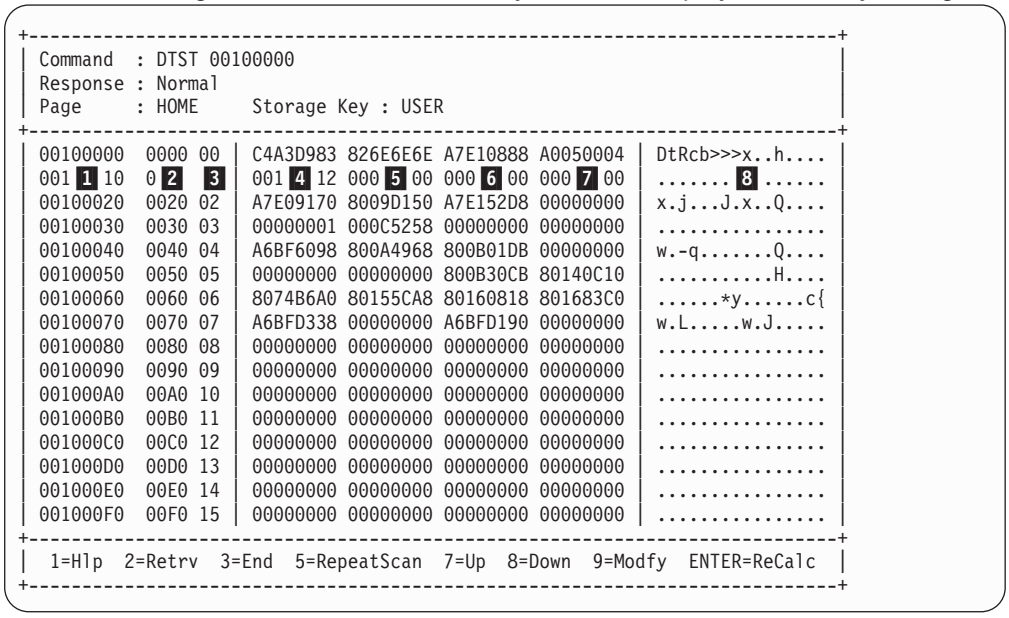
There are several ways to navigate through the DTST storage window.

After you enter the DTST command, do the following steps:

1. Choose one of the following methods to navigate through the window:
   - Use the PF7 or PF8 keys to move up or down a page, respectively.
   - Move your cursor to the command line and enter a new address. All spaces are ignored, except the one after the transaction name (DTST) and any within apostrophes (').
   - Move your cursor over any fullword displayed in column 4 or 6, then press Enter.
2. To close the DTST storage window, press the PF3 key.

DTST storage window

The DTST storage window is the interface you use to display and modify storage.



```
+-------------------------------------------------------------------------------+
| Command  : DTST 00100000                                                      |
| Response : Normal                                                             |
| Page     : HOME     Storage Key : USER                                        |
+-------------------------------------------------------------------------------+
| 00100000  0000 00 | C4A3D983 826E6E6E A7E10888 A0050004 | DtRcb>>>x..h....  |
| 001 1 10  0 2  3  | 001 4 12 000 5 00 000 6 00 000 7 00 | ....... 8 ......  |
| 00100020  0020 02 | A7E09170 8009D150 A7E152D8 00000000 | x.j...J.x..Q....  |
| 00100030  0030 03 | 00000001 000C5258 00000000 00000000 | ................  |
| 00100040  0040 04 | A6BF6098 800A4968 800B01DB 00000000 | w.-q.......Q....  |
| 00100050  0050 05 | 00000000 00000000 800B30CB 80140C10 | ..........H....   |
| 00100060  0060 06 | 8074B6A0 80155CA8 80160818 801683C0 | ......*y......c{  |
| 00100070  0070 07 | A6BFD338 00000000 A6BFD190 00000000 | w.L.....w.J.....  |
| 00100080  0080 08 | 00000000 00000000 00000000 00000000 | ................  |
| 00100090  0090 09 | 00000000 00000000 00000000 00000000 | ................  |
| 001000A0  00A0 10 | 00000000 00000000 00000000 00000000 | ................  |
| 001000B0  00B0 11 | 00000000 00000000 00000000 00000000 | ................  |
| 001000C0  00C0 12 | 00000000 00000000 00000000 00000000 | ................  |
| 001000D0  00D0 13 | 00000000 00000000 00000000 00000000 | ................  |
| 001000E0  00E0 14 | 00000000 00000000 00000000 00000000 | ................  |
| 001000F0  00F0 15 | 00000000 00000000 00000000 00000000 | ................  |
+-------------------------------------------------------------------------------+
|  1=Hlp  2=Retrv  3=End  5=RepeatScan  7=Up  8=Down  9=Modfy  ENTER=ReCalc    |
+-------------------------------------------------------------------------------+
```

The following list describes all the parts of the interface.

Command
The most recent command you entered.

Response
The result of the most recent command you entered. If the command was successful, the word `Normal` is displayed in this field. If the command was unsuccessful, a message indicating the type of error that occurred in the previous command is displayed.

Storage Key
Displays one of the following values:

CICS Indicates that the CICS[hyphen]key storage is displayed.

USER Indicates that the USER[hyphen]key storage is displayed.

KEY*n* Indicates that Key *n* storage is displayed.

???? Indicates that the key is not recognized.

!!!! Indicates that the key was not obtained.

Column 1
Displays the address of storage. The addresses are organized on a word boundary. If you enter an address that is not on a word boundary, the bytes preceding the address, up to the beginning of the word, are padded with blanks.

Column 2
Displays the offset of the address in column 1 from the base address. The offset is displayed in hexadecimal.

Column 3
Displays the line number (0 to 15) in the window. The line number is displayed in decimal.

Columns 4 through 7
Displays the contents of storage in hexadecimal. Each column represents four bytes.

Column 8
Displays the contents of storage contents in EBCDIC.

Some of the following PF keys work only if the previous operation was successful. If the previous operation was successful, the word `Normal` is displayed in the **Response** field.

PF1 (Help)
Displays the help screen. The help screens display command syntax with examples and lists all keywords.

PF2 (Retrieve)
Retrieves the previous command from the command history. DTST stores up to 10 commands in the command history, discarding the older commands to save newer commands.

PF3 (Exit)
Clears the screen and ends the transaction.

PF5 (RepeatScan)
Repeats the scan operation.

PF7 (Up)
Moves one page (256 bytes) back in storage. The base address is not recalculated.

PF8 (Down)
Moves one page (256 bytes) forward in storage. The base address is not recalculated.

PF9 (Modify)
Starts modify mode.

Enter
DTST does one of the following tasks:

- When the cursor is on a fullword, DTST uses that fullword as the base address for the next command.
- Recalculates the base address from the input string, even if it has not changed, then changes the memory window so that the new base address is shown at the top of the screen.

Navigation keys for help screens

DTST provides a number of online help screens. You can access these screens by pressing PF1 on the main screen (when you are not in modify mode), which displays the main help index. You can navigate through the help screens by using the PF keys described in this topic.

PF3
Close the help screen and return to the DTST storage window.

PF7
Display the previous screen.

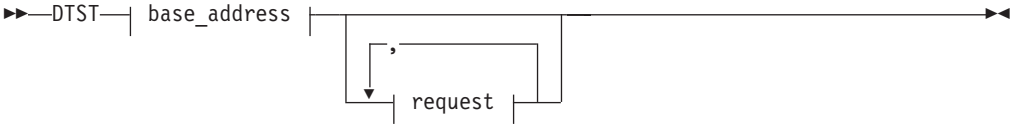
PF8
Display the next screen.

PF10
Display the main help index.

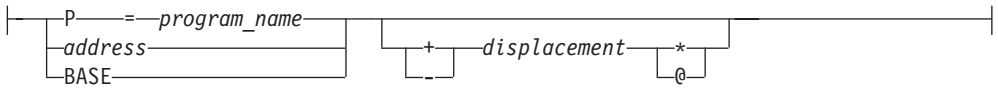
PF11
Display the last help screen.

Syntax of the DTST transaction

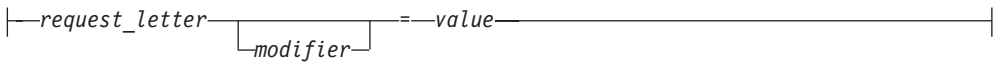
The DTST transaction displays storage in a memory window. You can navigate through the storage area and modify storage.



base_address:



request:



The following list describes the parameters:

address
A one to eight character hexadecimal value.

BASE
The value of the base address of the previously entered DTST command, which ran successfully.

displacement
A one to eight character hexadecimal value.

modifier
Indicates the direction in which to conduct the action. The default is forward, which means an increasing value. For the backward direction, use the negative sign (-).

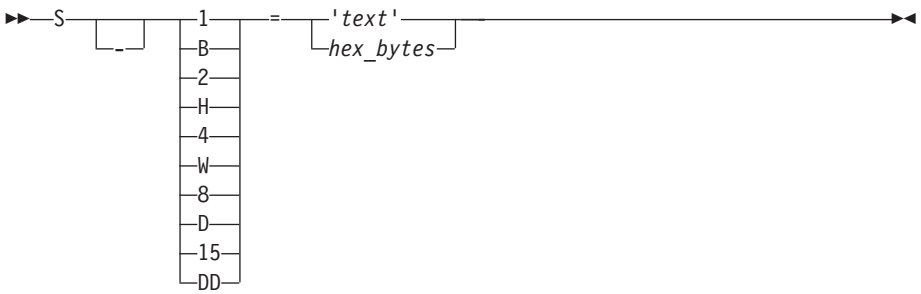
P Indicates that you are specifying the name of a program and you want the starting address of that program to be used as the base address.

program_name
Name of a program.

request_letter
Indicates the action you want DTST to take. The *request_letter* can be one of the following characters:

P Indicates that you want DTST to page up or down.

S Indicates that you want DTST to search through storage and stop when it finds the target. The S request has the following syntax:



value
Hexadecimal or decimal value or a string enclosed in quotation marks (") or apostrophes ('). It is used to indicate the number of pages you want DTST to scroll or the target of a search.

Examples

To indicate that you want to display the fifth page (or screen) of memory after the address x'01000000', enter the command `DTST 01000000,P=5`. This is equivalent to entering `DTST 01000000`, then pressing PF8 five times.

To indicate that you want to find x'00404040' starting at address x'01000000', enter the command `DTST 01000000,S=00404040`.

Appendix G. Debug Tool Load Module Analyzer

The Debug Tool Load Module Analyzer analyzes MVS load modules or program objects to determine the language translator (compiler or assembler) used to generate the object for each CSECT. This program can process all or selected load modules or program objects in a concatenation of PDS or PDSE data sets.

Choosing a method to start Load Module Analyzer

You can start the Load Module Analyzer in one of the following ways:

- Editing sample JCL provided in member EQAZLMA of data set *hlq*.SEQASAMP, then submitting the JCL to run as a batch job.
- By selecting option 5 of Debug Tool Utility ISPF panel.

Starting the Load Module Analyzer by using JCL

To start the Load Module Analyzer by using sample JCL, do the following steps:

1. Make a copy of member EQAZLMA in data set *hlq*.SEQASAMP.
2. Edit that copy, as instructed in the member.
3. Submit the JCL.
4. Review the results.

Starting the Load Module Analyzer by using Debug Tool Utilities

To start the Load Module Analyzer by using Debug Tool Utilities, do the following steps:

1. Start Debug Tool Utilities.
2. Select option 5.
3. Enter the appropriate information into each field on the panel, keeping in mind the following behavior:
   - If you specify that you want a single load module or program object analyzed, Load Module Analyzer is run in the TSO foreground.
   - If you specify that you want an entire PDS or PDSE analyzed, JCL is generated to start Load Module Analyzer in MVS batch. Then, you must submit or save the generated JCL.

Description of the JCL statements to use with Load Module Analyzer

By default, the Load Module Analyzer program processes all members in the PDS or PDSE specified in the EQALIB DD statement. You can use control statements to instruct Load Module Analyzer to process only specific members of the data set concatenation.

Description of DD names used by Load Module Analyzer

Load Module Analyzer uses the following DD names:

EQALIB

Specifies a concatenation of PDS or PDSE data sets containing the load modules or program objects to be analyzed. If the same member is present in more than one of the concatenated data sets, only the first member is processed.

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EQAPRINT
Specifies the output report. It can be in fixed block record format (RECFM=FBA) with a logical record length of 133 or more (LRECL >=133) or in variable block record format (RECFM=VBA) with a logical record length of 137 or more (LRECL >= 137).

EQAIN
Specifies the control statements. If you want only specific load modules or program objects to be processed, use the following syntax:

```
SELECT MEMBER=load_module_name
```

If you want all load modules to be processed, you can omit this DD statement, direct it to DUMMY, or direct it to empty data set. This file must be in fixed block record format (RECFM=FB) with a logical record length of 80 (LRECL=80). Each control statement must be on a separate line. The entries are free-form and you can use blanks before or after each keyword and operator. You can include comments by placing an asterisk in column 1.

EQASYSPF
Specifies a list of system prefixes. This is a list of prefixes of names of CSECTs that you want Load Module Analyzer to recognize as system routines. The list helps limit the amount of output displayed for these prefixes. This file must be in fixed block record format (RECFM=FB) with a logical record length of 80 (LRECL=80). Debug Tool provides data for this file in member EQALMPFX of the table library (SEQATLIB). See “Description of EQASYSPF file format” on page 490 for a description of this file.

EQAPGMNM
Specifies a list of program names corresponding to program IDs found in the load module IDR data. This file must be in fixed block record format (RECFM=FB) with a logical record length of 80 (LRECL=80). Debug Tool provides data for this file in member EQALMPGM of the table library (EQATLIB). See “Description of EQAPGMNM file format” on page 491 for directions on how to add entries to this list.

Description of parameters used by Load Module Analyzer

You can specify parameters by using the PARM= keyword of the EXEC JCL statement. The parameter string passed to this program can consist of any of the following parameters, separated by commas or blanks:

CKVOLFPRS
Lists only CSECTs or entries that use at least one of the Additional Floating-Point Registers 8 through 15. You cannot specify this parameter with the OSVSONLY parameter. If you specify both, the last one specified is used.

COMPOPTS
Lists the compiler options known at run-time for each compile unit. Note, that some compiler options are not known at run time and, in some cases, only certain sub-options of a specific option might be known at run time.

Also, the options known at run time can vary depending on the release and version of each compiler.

This option can be specified with an operand. For example:

```
COMPOPTS=';'
```

In this case, the specified character is used to end each compiler option when it is listed; this makes scanning of the options simpler.

This option applies to the following compilers only:

- Enterprise COBOL
- COBOL for MVS & VM
- VS COBOL II
- Enterprise PL/I
- z/OS XL C/C++

DATEFMT=*dateformat*
Specifies how dates are to be formatted. If a date from the binder CSECT identification record (IDR) data does not appear to be a valid Julian date, it is not reformatted. Use one of the following values:

YYYYMMDD
Sort format: YYYY/MM/DD. (Default)

MMDDYYYY
U.S. standard format: MM/DD/YYYY.

DDMMYYYY
European standard format: DD/MM/YYYY.

LEINFO
Causes the text for each CSECT and external entry point to be inspected for a Language Environment footprint. If one is found, information about the Language Environment entry point name, linkage type, source language, and translation date and time is included in the output for the CSECT or entry. If no Language Environment footprint is found, the prologue code is inspected for known non-Language Environment prologue formats. If one is discovered, the corresponding language is included in the output. Otherwise, "ASSEMBLER" is output.

In addition, for OS/VS COBOL and VS COBOL II, a NON-LEINFO section is included that contains the compile date and time and (for VS COBOL II only) the version of the compiler used.

LESCAN
Causes the actions described under the LEINFO parameter. In addition, the text for each CSECT is scanned looking for "hidden" Language Environment entry points that do not correspond to an external symbol. For example, these might be present for C static functions. If such "hidden" entry points are detected, the same output as described for LEINFO in generated.

LISTLD
Lists all label definition (LD) entries in addition to CSECT names.

LOUD
Specifies that the data read from the EQASYSPF and EQAPGMNM files is displayed in the output listing.

NATLANG=*language_code*
Specifies the national language. Use one of the following values:

ENU
Mixed-case English. (Default)

UEN
Upper-case English.

JPN
Japanese.

KOR
Korean.

OSVSONLY
Specifies that only CSECTs compiled with the OS/VS COBOL compiler are to be displayed in the output. Information about all other CSECTs is suppressed.

You cannot specify this parameter with the CKVOLFPRS parameter. If you specify both, the last one specified is used.

SHOWLIB
Specifies that the include indicator in the EQASYSPF file is to be ignored so that all CSECTs are listed.

SORTBY=*sort_option*
Specifies how to sort the names of the CSECTs in the output. Use one of the following values:

OFFSET
Sort by offset; the order shown in the linkage editor or AMBLIST output. (Default)

NAME
Sorts by CSECT name.

PROGRAM
Sort by the translator program ID.

LANGUAGE
Sorts by the source language and by the translator program ID.

DATE
Sorts by the translation date.

Description of EQASYSPF file format

This file contains a list of system prefixes. When Load Module Analyzer finds a CSECT that has a name prefixed by a name in this list and the entry for that prefix indicates that names beginning with that prefix are not to be included, Load Module Analyzer does not display an individual entry for that CSECT. Instead, a single line is displayed in the output for each prefix found that indicates that one or more CSECTs with the specified prefix was found.

Debug Tool supplies data for this file in member EQALMPFX of the table library (SEQATLIB). If you want to add entries to this file, do one of the following tasks:

- Update the EQALMPFX member in *hlq*.SEQATLIB through the SMP/E USERMOD in *hlq*.SEQASAMP(EQAUMOD3).
- Create a data set containing the new entries. Then, concatenate this data set to the one that ships with Debug Tool.

Each line in this file represents one entry. The entries are free-form; however, each item must be separated from the previous item by one or more blanks. You can include comments by placing an asterisk in column 1. Use the following syntax for each line:

```
prefix   I   L   description
```

prefix
A one to seven character prefix.

I Include indicator. Specify a "1" to indicate that each CSECT beginning with this prefix is to be treated as an ordinary CSECT. Specify a "0" to indicate that CSECTs beginning with this prefix are not to be listed individually.

L Language or system component indicator. Choose from one of the following characters:

B COBOL

N Enterprise COBOL for z/OS, Version 4 or later

V OS/VS COBOL

P PL/I

E Enterprise PL/I

C C/C++

A Assembler

L Language Environment

S CICS

I IMS

2 DB2

M MVS

T TCP/IP

***** Unclassified.

description
A twelve-character description of the component owning the prefix.

Description of EQAPGMNM file format

This file contains a list of program names corresponding to program IDs found in the load module IDR data. These names are used in the output to describe the language translator used to generate the object for the corresponding CSECT.

Debug Tool provides data for this file in member EQALMPGM of the table library (SEQATLIB). If you want to add entries to this file, do one of the following tasks:

- Update the EQALMPRM member in *hlq*.SEQATLIB through the SMP/E USERMOD in *hlq*.SEQASAMP(EQAUMOD4).
- Create a data set containing the new entries. Then, concatenate this data set to the one that ships with Debug Tool.

Each line represents one entry. The entries are free-form. The program number must begin in column 1 and each item must be separated from the previous item by one or more blanks. You can include comments by placing an asterisk in column 1. You cannot use sequence numbers in this file. Use the following syntax for each line:

```
program_name    L   program_description
```

program_name
A seven character program number.

L Language or system component indicator. See “Description of EQASYSPF file format” on page 490 for a list of possible values.

program_description
A description of the program.

Description of program output created by Load Module Analyzer

The output for each load module or program object is displayed in the following order:

- All members of the first EQALIB concatenation with each load module or program object appearing in alphabetical order
- All members of the second EQALIB concatenation that are not duplicates of members in the previous concatenation, with each load module or program object appearing in alphabetical order
- All members of the next EQALIB concatenation that are not duplicates of members in the previous concatenation, with each load module or program object appearing in alphabetical order

Alias names are displayed in the following manner:

- If the primary member name exists, this name is displayed in the output in the order previously described. Before the output of the contents of that member, a list of alias names for the primary member name is given.
- If the primary member name is not present in the data set, the alias is displayed the order previously described.

Description of output contents created by Load Module Analyzer

The following information is included in the output for each CSECT:

- CSECT name
- Segment number (present only for a multi-segment module)
- CSECT offset in load module or segment
- CSECT length in hexadecimal
- Program-ID as contained in the binder IDR data
- Translator (compile or assembly) date
- Program description as supplied for the specified program ID.
- For OS/VS COBOL, PARM=RES or PARM=NORES.
  - PARM=RES indicates that one or more OS/VS COBOL CSECTs in the load module or program object were compiled with the NORES compiler option.
  - PARM=NORES indicates that all OS/VS COBOL CSECTs in the load module or program object were compiled with the NORES compiler option.
- If you specify LEINFO, LESCAN, or CKVOLFPRS:
  - If a Language Environment prologue was detected, information is included in a string identified by `LEINFO=(....` This string contains the Language Environment entry name or an asterisk to indicate that the name is the same as the external symbol, Language Environment linkage type, source language, and translation date, time, and translator version.
  - If no Language Environment prologue was detected, but the prologue appears to be that of a known, non-Language Environment compiler, one of the following is included: C/C++, COBOL, or PL/I.
  - Otherwise, ASSEMBLER is included to indicate that the program is likely to be an assembler program.

Example: Output created by Load Module Analyzer for an OS/VS COBOL load module

The following is a fragment of output that might appear for an OS/VS COBOL load module:

```
1 5655-W45   Debug Tool Version 11 Release 1.2 Load Module Analyzer   2010/11/06    Page   15
                                Load Module  TSCODEL.CICS.TEST.LOAD(CICK512)

 CSECT    Sg   Offset  Length  Program-ID  Trn-Date    Program-Description
 $PRIV000010
                   28     C58   5688216    1996/12/31  AD/Cycle C/370
 $PRIV000011
                  D00    1CD0   5688216    1996/12/31  AD/Cycle C/370
 @@XINIT@        29E0       8   5688216    1996/12/31  AD/Cycle C/370
 @@INIT@         29E8     3D8   5688216    1996/12/31  AD/Cycle C/370
 EQADCRXT        2DC0     240   566896201  1995/05/15  Assembler H Version 1 Release 2, 3, OR 4
 @@C2CBL         3118      10   569623400  1995/08/03  High Level Assembler for MVS & VM & VSE Version 1
 @@FETCH         3138      10   569623400  1995/08/03  High Level Assembler for MVS & VM & VSE Version 1
 MEMSET          3148      10   569623400  1995/08/03  High Level Assembler for MVS & VM & VSE Version 1
 FPRINTF         3158      10   569623400  1995/08/03  High Level Assembler for MVS & VM & VSE Version 1
 CS9403          3168    3518   566895807  1995/08/15  VS COBOL II Version 1 Release 3
 STRLEN          7398      10   569623400  1995/08/03  High Level Assembler for MVS & VM & VSE Version 1
 CEE*                           (Multiple program ID's)
 DFH*                           5668962                Assembler H Version 1 Release 2, 3, OR 4
 EDC*                           5696234                High Level Assembler for MVS & VM & VSE Version 1
 IGZ*                           5668962                Assembler H Version 1 Release 2, 3, OR 4
```

Example: Compiler options output created by Load Module Analyzer

The following is an example of the output that might be generated when `LEINFO` and `COMPOPTS=';'` are in effect:

```
LEINFO=(*,COBOL,V04R02M00 2011/09/12 07:23:06)
COMPOPTS:       ADV;            QUOTE;          ARITH(COMPAT);  NOAWO;          CODEPAGE(1140);
NOCURRENCY;     DATA(31);       NODATEPROC;     DBCS;           NODECK;         NODLL;
NODUMP;         NODYNAM;        NOEXPORTALL;    NOFASTSRT;      INTDATE(ANSI);  NOLIB;
LIST;           NOMAP;          NONAME;         NONUMBER;       NUMPROC(NOPFD); OBJECT;
NOOFFSET;       NOOPTIMIZE;     OUTDD(SYSOUT);  PGMNAME(COMPAT);                RENT;
RMODE(ANY);     SEQUENCE;       SIZE(MAX);      SOURCE;         NOSSRANGE;      NOTERM;
TEST(STMT,PATH,BLOCK,NOSEPARATE);               NOTHREAD;       TRUNC(STD);     NOVBREF;
NOWORD;         YEARWINDOW(1900);               ZWB;
```

Appendix H. Running NEWCOPY on programs by using DTNP transaction

DTNP is a CICS transaction, supplied by Debug Tool, that runs the NEWCOPY batch command which loads a new copy of an application program into an active CICS region.

You can run the transaction in the following ways:

- Enter the transaction name (DTNP). The transaction displays the **Debug Tool - NEWCOPY Program** panel. Enter the name of the application program in the **Program Name** field. To process multiple application programs at once, append the wildcard character (*) to the name. For example, `LYN*` indicates that you want DTNP to process all programs that start with the letters "LYN". Press PF4.
- Enter the transaction name (DTNP), followed by the name of the program. To process multiple application programs at once, append the wildcard character (*) to the name. For example, `LYN*` indicates that you want DTNP to process all programs that start with the letters "LYN".

The transaction displays the results in the **Debug Tool - NEWCOPY Program** panel. If the NEWCOPY action fails, the transaction runs the PHASEIN action, so CICS uses a new copy of the application for all new transaction requests.

Refer to the following topics for more information related to the material discussed in this topic.

Related tasks

Description of the `CEMT SET PROGRAM` command in *CICS Transaction Server for z/OS: Supplied Transactions*, SC34-7004.

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Appendix I. Installing the IBM Debug Tool DTCN and DTSP Profile Manager plug-in

Debug Tool ships the IBM Debug Tool DTCN and DTSP Profile Manager plug-in, which adds the following views to the **Debug** perspective of the remote debugger:

- The **DTCN Profiles** view, which helps you create and manage DTCN profiles on your z/OS system.[16]
- The **DTSP Profile** view, which helps you create and manage the TEST runtime options data set (EQAUOPTS) on your z/OS system.

To install this plug-in, do the following steps:

1. Verify that your system administrator has completed the following tasks described in the *Debug Tool Customization Guide*:
   - "Adding support for the DTCN Profiles view and APIs"
   - "Adding support for the DTSP Profile view"
2. Transfer, in binary format, from your z/OS system to your workstation the following data set:

   hlq.SEQABIN(EQACDPLG)
3. Rename the file to com.ibm.pdt.debugtool.profile_2.0.3.jar.
4. Move that file to the specified directory of any of the following Eclipse-based applications:

   CICS Explorer

   CICS_Explorer_install_directory\dropins

   Eclipse

   Eclipse_install_directory\dropins

   Rational Developer for System z

   C:\Program Files\IBM\SDP\plugins
5. Restart your Eclipse-based application. If you installed a previous version of either plug-in, specify the -clean option when you restart your Eclipse-based application.
6. Specify the settings needed to establish a connection between the **DTCN profiles** view and you z/OS system by doing the following steps:
   a. Click on **Window>Show view>Others...**.
   b. Type in "DTCN" in the text box at the top of the window. Select **DTCN profiles** and click **OK**.
   c. Click on **Window>Preferences**.
   d. Click on **Debug Tool>DTCN (CICS)** in the list.
   e. Fill in all of the following fields:

      Host Name

      TCP/IP name or address of the z/OS system as described in "Defining the CICS TCPIPSERVICE resource" in the *Debug Tool Customization Guide*.

16. Beginning with Rational Developer for System z, Version 7.6.1, you can use CICS debug configurations to manage DTCN profiles. To learn more about CICS debug configurations, see the topic "Debugging CICS applications" in the Rational Developer for System z, Version 7.6.1, information center. If you choose to use CICS debug configurations, you do not need to follow the rest of the instructions in this topic.

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Port Number
Port number of the z/OS system as described in “Defining the CICS TCPIPSERVICE resource” in the *Debug Tool Customization Guide*.

User Id
ID that you use to log on to the CICS system.

Password
Password that you use to log on to the CICS system.

f. Click on **Test Connection**. If you see a message that indicates the test was successful, click on **OK** to close the Preferences window. Otherwise, review the information you entered, correct any mistakes, and retry the connection test. You can also review the trace file (see “Locating the trace file of the DTCN Profiles or DTSP Profile view” on page 499) for diagnostic information that can help identify a mistake.

7. Specify the settings needed to establish a connection between the **DTSP Profile** view and you z/OS system by doing the following steps:
   a. Click on **Window>Show view>Others...**.
   b. Type in "DTSP" in the text box at the top of the window. Select **DTSP Profile** and click **OK**.
   c. Click on **Window>Preferences**.
   d. Click on **Debug Tool>DTSP (non-CICS)** in the list.
   e. Fill in all of the following fields:

      Host Name
      TCP/IP name or address of the z/OS system, which is set by the system administrator according to the instructions in “Installing the server components for IBM Debug Tool DTCN and DTSP Profile Manager” of the *Debug Tool Customization Guide*.

      Port Number
      Port number of the z/OS system, which is set by the system administrator according to the instructions in “Installing the server components for IBM Debug Tool DTCN and DTSP Profile Manager” of the *Debug Tool Customization Guide*.

      User Id
      ID that you use to log on to the z/OS system. The **DTSP Profile** substitutes this ID for the **&userid** token in the **Profile name pattern** field.

      Password
      Password that you use to log on to the z/OS system.

      Profile name pattern
      Specify a naming pattern that matches the default naming pattern set by system administrator according to the instructions in “Modifying the naming pattern” of the *Debug Tool Customization Guide*. The naming pattern must contain the **&userid** token, but not the **&pgmname** token.

   f. Click on **Test Connection**. If you see a message that indicates the test was successful, click on **OK** to close the Preferences window. Otherwise, review the information you entered, correct any mistakes, and retry the connection test. You can also review the trace file (see “Locating the trace file of the DTCN Profiles or DTSP Profile view” on page 499) for diagnostic information that can help identify a mistake.

In the views, you can right click anywhere to see a list of actions available. If you need to change your connection settings, you can right click in any area of the view and select **Preferences**.

Locating the trace file of the DTCN Profiles or DTSP Profile view

When you do actions in the **DTCN Profiles** or **DTSP Profile** view, the views save information about the actions and results of the actions in the following files:

- `.debugtool.dtcn.trace` for **DTCN Profiles** view
- `.debugtool.dtsp.trace` for **DTSP Profile** view

The views save these files in the \.metadata folder of your workspace. (To find the name of the path of your workspace, click on **File>Switch Workspace>Other...** in your Eclipse-based application.) The following topic show an example of what the file might contain after you do a common action and the result of that action.

Example: .debugtool.dtcn.trace file

The following example shows what the file might contain after you send a request to create a profile for Debug Tool for z/OS, Version 10:

```
15 Oct 2009 16:06:11 PDT
Request URI: http://tlba07me.torolab.ibm.com:33000/dtcn/smith02?clientversion=0102
Request method: PUT
<?xml version="1.0"?>
<profile>
<terminalid></terminalid>
<transactionid></transactionid>
<program>
<loadname></loadname>
<pgmname></pgmname>
</program>
<userid>smith02</userid>
<netname></netname>
<clientip></clientip>
<commareaoffset>0</commareaoffset>
<commareadata></commareadata>
<containername></containername>
<containeroffset>0</containeroffset>
<containerdata></containerdata>
<urmdeb>NO</urmdeb>
<activation>ACTIVE</activation>
<trigger>TEST</trigger>
<level>ALL</level>
<sesstype>TCP</sesstype>
<sessaddr>9.30.247.101</sessaddr>
<sessport>8001</sessport>
<commandfile>*</commandfile>
<preferencefile>*</preferencefile>
<otheropts></otheropts>
</profile>
Server response code = 201
Server response msg  = Profile_Created_OK
Server response details = <?xml version="1.0"?><profile><profileversion>0102</prof
ileversion><serviceid>DBGTPROF</serviceid><clientversion>0102</clientversion><serv
erversion>0102</serverversion></profile>
```

The last line of the trace is one line; however, the line is wrapped in this example so that you can see the entire contents of the line.

Examples: .debugtool.dtsp.trace files

The following example shows what the file might contain after you click on **Test Connection** in the **DTSP (non-CICS) Preferences** page:

```
Test Connection button clicked -----
getSocketIO parameters are below.
Host: tlba07me.torolab.ibm.com
Port: 5555
UserId: vikram
Pattern: &userid.dbgtool.eqauoptsStart Service successful. The message was:
 Connected to DebugToolProvider DTSP query response: File exists.
 Connection was successful ---
```

The following example shows what the file might contain after you click on **Finish** in the update wizard:

```
---- DTSP Finish button clicked ----
Profile dataset: vikram2.dbgtool.eqauopts
UEWizard: Read successful.
DT_Update request worked fine. ------
Retrieving Profile -----
GetOtherProfiles: Socket is good -----
GetOtherProfiles: Hashmap contains {otheropts=sto(ff), sessport=8002,
 sessaddr=9.65.111.33, level=ERROR, preferencefile=*, commandfile=*,
 trigger=TEST, sesstype=TCPIP, profiledataset=vikram2.dbgtool.eqauopts}
```

Appendix J. Support resources and problem solving information

This section shows you how to quickly locate information to help answer your questions and solve your problems. If you have to call IBM support, this section provides information that you need to provide to the IBM service representative to help diagnose and resolve the problem.

For a comprehensive multimedia overview of IBM software support resources, see the IBM Education Assistant presentation "IBM Software Support Resources for System z Enterprise Development Tools and Compilers products" at http://publib.boulder.ibm.com/infocenter/ieduasst/stgv1r0/index.jsp?topic=/com.ibm.iea.debugt/debugt/6.1z/TrainingEducation/SupportInfoADTools/player.html.

- "Searching knowledge bases"
- "Getting fixes" on page 502
- "Subscribing to support updates" on page 503
- "Contacting IBM Support" on page 504

Searching knowledge bases

You can search the available knowledge bases to determine whether your problem was already encountered and is already documented.

- "Searching the information center"
- "Searching product support documents"

Searching the information center

You can find this publication and documentation for many other products in the IBM System z Enterprise Development Tools & Compilers information center at http://publib.boulder.ibm.com/infocenter/pdthelp/v1r1/index.jsp. Using the information center, you can search product documentation in a variety of ways. You can search across the documentation for multiple products, search across a subset of the product documentation that you specify, or search a specific set of topics that you specify within a document. Search terms can include exact words or phrases, wild cards, and Boolean operators.

To learn more about how to use the search facility provided in the IBM System z Enterprise Development Tools & Compilers information center, you can view the multimedia presentation at http://publib.boulder.ibm.com/infocenter/pdthelp/v1r1/index.jsp?topic=/com.ibm.help.doc/InfoCenterTour800600.htm.

Searching product support documents

If you need to look beyond the information center to answer your question or resolve your problem, you can use one or more of the following approaches:

- Find the content that you need by using the IBM Support Portal at www.ibm.com/software/support or directly at www.ibm.com/support/entry/portal.

  The IBM Support Portal is a unified, centralized view of all technical support tools and information for all IBM systems, software, and services. The IBM Support Portal lets you access the IBM electronic support portfolio from one place. You can tailor the pages to focus on the information and resources that you need for problem prevention and faster problem resolution.

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Familiarize yourself with the IBM Support Portal by viewing the demo videos at https://www.ibm.com/blogs/SPNA/entry/the_ibm_support_portal_videos?lang=en_us about this tool. These videos introduce you to the IBM Support Portal, explore troubleshooting and other resources, and demonstrate how you can tailor the page by moving, adding, and deleting portlets.

Access a specific IBM Software Support site:

- Application Performance Analyzer for z/OS Support
- Debug Tool for z/OS Support
- Enterprise COBOL for z/OS Support
- Enterprise PL/I for z/OS Support
- Fault Analyzer for z/OS Support
- File Export for z/OS Support
- File Manager for z/OS Support
- WebSphere® Developer Debugger for System z Support
- WebSphere Studio Asset Analyzer for Multiplatforms Support
- Workload Simulator for z/OS and OS/390 Support

- Search for content by using the IBM masthead search. You can use the IBM masthead search by typing your search string into the Search field at the top of any ibm.com® page.
- Search for content by using any external search engine, such as Google, Yahoo, or Bing. If you use an external search engine, your results are more likely to include information that is outside the ibm.com domain. However, sometimes you can find useful problem-solving information about IBM products in newsgroups, forums, and blogs that are not on ibm.com. Include "IBM" and the name of the product in your search if you are looking for information about an IBM product.
- The IBM Support Assistant (also referred to as ISA) is a free local software serviceability workbench that helps you resolve questions and problems with IBM software products. It provides quick access to support-related information. You can use the IBM Support Assistant to help you in the following ways:
  - Search through IBM and non-IBM knowledge and information sources across multiple IBM products to answer a question or solve a problem.
  - Find additional information through product and support pages, customer news groups and forums, skills and training resources and information about troubleshooting and commonly asked questions.

  In addition, you can use the built in Updater facility in IBM Support Assistant to obtain IBM Support Assistant upgrades and new features to add support for additional software products and capabilities as they become available.

  For more information, and to download and start using the IBM Support Assistant for IBM System z Enterprise Development Tools & Compilers products, please visit http://www.ibm.com/support/docview.wss?rs=2300&context=SSFMHB&dc=D600&uid=swg21242707&loc=en_US&cs=UTF-8&lang=en.

  General information about the IBM Support Assistant can be found on the IBM Support Assistant home page at http://www.ibm.com/software/support/isa.

Getting fixes

A product fix might be available to resolve your problem. To determine what fixes and other updates are available, select a link from the following list:

- Latest PTFs for Application Performance Analyzer for z/OS
- Latest PTFs for Debug Tool for z/OS

- Latest PTFs for Fault Analyzer for z/OS
- Latest PTFs for File Export for z/OS
- Latest PTFs for File Manager for z/OS
- Latest PTFs for Optim™ Move for DB2
- Latest PTFs for WebSphere Studio Asset Analyzer for Multiplatforms
- Latest PTFs for Workload Simulator for z/OS and OS/390

When you find a fix that you are interested in, click the name of the fix to read its description and to optionally download the fix.

Subscribe to receive e-mail notifications about fixes and other IBM Support information as described in Subscribing to Support updates..

Subscribing to support updates

To stay informed of important information about the IBM products that you use, you can subscribe to updates. By subscribing to receive updates, you can receive important technical information and updates for specific Support tools and resources. You can subscribe to updates by using the following:

- RSS feeds and social media subscriptions
- My Notifications

RSS feeds and social media subscriptions

For general information about RSS, including steps for getting started and a list of RSS-enabled IBM web pages, visit the IBM Software Support RSS feeds site at http://www.ibm.com/software/support/rss/other/index.html. For information about the RSS feed for the IBM System z Enterprise Development Tools & Compilers information center, refer to the Subscribe to information center updates topic in the information center at http://publib.boulder.ibm.com/infocenter/pdthelp/v1r1/topic/com.ibm.help.doc/subscribe_info.html.

My Notifications

With My Notifications, you can subscribe to Support updates for any IBM product. You can specify that you want to receive daily or weekly email announcements. You can specify what type of information you want to receive (such as publications, hints and tips, product flashes (also known as alerts), downloads, and drivers). My Notifications enables you to customize and categorize the products about which you want to be informed and the delivery methods that best suit your needs.

To subscribe to Support updates, follow the steps below. Additional information is provided at http://www.ibm.com/support/docview.wss?rs=615&uid=swg21172598.

1. Go to the IBM software support site at http://www.ibm.com/software/support.
2. Click the **My Notifications** link in the **Notifications** portlet on the page that is displayed.
3. If you have already registered for **My notifications**, sign in and skip to the next step. If you have not registered, click **register now**. Complete the registration form using your e-mail address as your IBM ID and click **Submit**.
4. In the **My notifications** tool, click the **Subscribe** tab to specify products for which you want to receive e-mail updates.
5. To specify Problem Determination Tools products, click **Other software** and then select the products for which you want to receive e-mail updates, for example, **Debug Tool for z/OS** and **File Manager for z/OS**.

6. To specify a COBOL or PL/I compiler, click **Rational** and then select the products for which you want to receive e-mail updates, for example, **Enterprise COBOL for z/OS**.
7. After selecting all products that are of interest to you, scroll to the bottom of the list and click **Continue**.
8. Determine how you want to save your subscription. You can use the default subscription name or create your own by entering a new name in the **Name** field. It is recommended that you create your own unique subscription name using something easily recognized by you. You can create a new folder by entering a folder name in the **New** field or select an existing folder from the pulldown list. A folder is a container for multiple subscriptions.
9. Specify the types of documents you want and the e-mail notification frequency.
10. Scroll to the bottom of the page and click **Submit**.

To view your current subscriptions and subscription folders, click **My subscriptions**.

If you experience problems with the **My notifications** feature, click the **Feedback** link in the left navigation panel and follow the instructions provided.

Contacting IBM Support

IBM Support provides assistance with product defects, answering FAQs, and performing rediscovery.

After trying to find your answer or solution by using other self-help options such as technotes, you can contact IBM Support. Before contacting IBM Support, your company must have an active IBM maintenance contract, and you must be authorized to submit problems to IBM. For information about the types of available support, see the information below or refer to the Support portfolio topic in the Software Support Handbook at http://www14.software.ibm.com/webapp/set2/sas/f/handbook/offerings.html.

- For IBM distributed software products (including, but not limited to, Tivoli®, Lotus®, and Rational products, as well as DB2 and WebSphere products that run on Windows, or UNIX operating systems), enroll in Passport Advantage® in one of the following ways:

  Online

  Go to the Passport Advantage Web site at http://www.lotus.com/services/passport.nsf/ WebDocs/Passport_Advantage_Home and click **How to Enroll**.

  By phone

  For the phone number to call in your country, go to the Contacts page of the *IBM Software Support Handbook* on the Web at http://www14.software.ibm.com/webapp/set2/sas/f/handbook/contacts.html and click the name of your geographic region.
- For customers with Subscription and Support (S & S) contracts, go to the Software Service Request Web site at http://www.ibm.com/support/servicerequest.
- For customers with IBMLink, CATIA, Linux, S/390®, iSeries®, pSeries®, zSeries®, and other support agreements, go to the IBM Support Line Web site at http://www.ibm.com/services/us/index.wss/so/its/a1000030/dt006.
- For IBM eServer™ software products (including, but not limited to, DB2 and WebSphere products that run in zSeries, pSeries, and iSeries environments), you can purchase a software maintenance agreement by working directly with an IBM

sales representative or an IBM Business Partner. For more information about support for eServer software products, go to the IBM Technical Support Advantage Web site at http://www.ibm.com/servers/eserver/techsupport.html.

If you are not sure what type of software maintenance contract you need, call 1-800-IBMSERV (1-800-426-7378) in the United States. From other countries, go to the Contacts page of the *IBM Software Support Handbook* on the Web at http://www14.software.ibm.com/webapp/set2/sas/f/handbook/contacts.html and click the name of your geographic region for phone numbers of people who provide support for your location.

Complete the following steps to contact IBM Support with a problem:

1. "Define the problem and determine the severity of the problem"
2. "Gather diagnostic information"
3. "Submit the problem to IBM Support" on page 506

To contact IBM Software support, follow these steps:

Define the problem and determine the severity of the problem

Define the problem and determine severity of the problem When describing a problem to IBM, be as specific as possible. Include all relevant background information so that IBM Support can help you solve the problem efficiently.

IBM Support needs you to supply a severity level. Therefore, you need to understand and assess the business impact of the problem that you are reporting. Use the following criteria:

Severity 1
: The problem has a **critical** business impact. You are unable to use the program, resulting in a critical impact on operations. This condition requires an immediate solution.

Severity 2
: The problem has a **significant** business impact. The program is usable, but it is severely limited.

Severity 3
: The problem has **some** business impact. The program is usable, but less significant features (not critical to operations) are unavailable.

Severity 4
: The problem has **minimal** business impact. The problem causes little impact on operations, or a reasonable circumvention to the problem was implemented.

For more information, see the Getting IBM support topic in the Software Support Handbook at http://www14.software.ibm.com/webapp/set2/sas/f/handbook/getsupport.html.

Gather diagnostic information

To save time, if there is a Mustgather document available for the product, refer to the Mustgather document and gather the information specified. Mustgather documents contain specific instructions for submitting your problem to IBM and gathering information needed by the IBM support team to resolve your problem. To determine if there is a Mustgather document for this product, go to the product

support page and search on the term Mustgather. At the time of this publication, the following Mustgather documents are available:

- Mustgather: Read first for problems encountered with Application Performance Analyzer for z/OS: http://www.ibm.com/support/docview.wss?rs=2300 &context=SSFMHB&q1=mustgather&uid=swg21265542&loc=en_US&cs=utf-8 ⟨=en
- Mustgather: Read first for problems encountered with Debug Tool for z/OS: http://www.ibm.com/support/docview.wss?rs=615&context=SSGTSD &q1=mustgather&uid=swg21254711&loc=en_US&cs=utf-8&lang=en
- Mustgather: Read first for problems encountered with Fault Analyzer for z/OS:http://www.ibm.com/support/docview.wss?rs=273&context=SSXJAJ &q1=mustgather&uid=swg21255056&loc=en_US&cs=utf-8&lang=en
- Mustgather: Read first for problems encountered with File Manager for z/OS: http://www.ibm.com/support/docview.wss?rs=274&context=SSXJAV &q1=mustgather&uid=swg21255514&loc=en_US&cs=utf-8&lang=en
- Mustgather: Read first for problems encountered with Enterprise COBOL for z/OS: http://www.ibm.com/support/docview.wss?rs=2231&context=SS6SG3 &q1=mustgather&uid=swg21249990&loc=en_US&cs=utf-8&lang=en
- Mustgather: Read first for problems encountered with Enterprise PL/I for z/OS: http://www.ibm.com/support/docview.wss?rs=619&context=SSY2V3 &q1=mustgather&uid=swg21260496&loc=en_US&cs=utf-8&lang=en

If the product does not have a Mustgather document, please provide answers to the following questions:

- What software versions were you running when the problem occurred?
- Do you have logs, traces, and messages that are related to the problem symptoms? IBM Software Support is likely to ask for this information.
- Can you re-create the problem? If so, what steps were performed to re-create the problem?
- Did you make any changes to the system? For example, did you make changes to the hardware, operating system, networking software, and so on.
- Are you currently using a workaround for the problem? If so, be prepared to explain the workaround when you report the problem.

Submit the problem to IBM Support

You can submit your problem to IBM Support in one of three ways:

Online using the IBM Support Portal

Click **Service request** on the IBM Software Support site at http://www.ibm.com/software/support. On the right side of the Service request page, expand the Product related links section. Click Software support (general) and select ServiceLink/IBMLink to open an Electronic Technical Response (ETR). Enter your information into the appropriate problem submission form.

Online using the Service Request tool

The Service Request tool can be found at http://www.ibm.com/software/support/servicerequest.

By phone

Call 1-800-IBMSERV (1-800-426-7378) in the United States or, from other countries, go to the Contacts page of the *IBM Software Support Handbook* at http://www14.software.ibm.com/webapp/set2/sas/f/handbook/contacts.html and click the name of your geographic region.

If the problem you submit is for a software defect or for missing or inaccurate documentation, IBM Support creates an Authorized Program Analysis Report (APAR). The APAR describes the problem in detail. Whenever possible, IBM Support provides a workaround that you can implement until the APAR is resolved and a fix is delivered. IBM publishes resolved APARs on the IBM Support website daily, so that other users who experience the same problem can benefit from the same resolution.

After a Problem Management Record (PMR) is open, you can submit diagnostic MustGather data to IBM using one of the following methods:

- FTP diagnostic data to IBM. For more information, refer to http://www.ibm.com/support/docview.wss?rs=615&uid=swg21154524.
- If FTP is not possible, e-mail diagnostic data to techsupport@mainz.ibm.com. You must add PMR xxxxx bbb ccc in the subject line of your e-mail. xxxxx is your PMR number, bbb is your branch office, and ccc is your IBM country code. Go to http://itcenter.mainz.de.ibm.com/ecurep/mail/subject.html for more details.

Always update your PMR to indicate that data has been sent. You can update your PMR online or by phone as described above.

Appendix K. Accessibility

Accessibility features help a user who has a physical disability, such as restricted mobility or limited vision, to use software products successfully. The accessibility features in z/OS provide accessibility for Debug Tool.

The major accessibility features in z/OS enable users to:

- Use assistive technology products such as screen readers and screen magnifier software
- Operate specific or equivalent features by using only the keyboard
- Customize display attributes such as color, contrast, and font size

The *IBM System z Enterprise Development Tools & Compilers* Information Center, and its related publications, are accessibility-enabled. The accessibility features of the information center are described at *http://publib.boulder.ibm.com/infocenter/pdthelp/v1r1/topic/com.ibm.help.doc/accessibility_info.html*.

Using assistive technologies

Assistive technology products work with the user interfaces that are found in z/OS. For specific guidance information, consult the documentation for the assistive technology product that you use to access z/OS interfaces.

Keyboard navigation of the user interface

Users can access z/OS user interfaces by using TSO/E or ISPF. Refer to *z/OS TSO/E Primer*, *z/OS TSO/E User's Guide*, and *z/OS ISPF User's Guide Volume 1* for information about accessing TSO/E and ISPF interfaces. These guides describe how to use TSO/E and ISPF, including the use of keyboard shortcuts or function keys (PF keys). Each guide includes the default settings for the PF keys and explains how to modify their functions.

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Softcopy publications

Online publications are distributed on CD-ROMs and can be ordered through your IBM representative. *Debug Tool User's Guide*, *Debug Tool Customization Guide*, and *Debug Tool Reference and Messages* are distributed on the following collection kit:

SK3T-4269

Online publications can also be downloaded from the IBM Web site. Visit the IBM Web site for each product to find online publications for that product.

Glossary

This glossary defines technical terms and abbreviations used in *Debug Tool User's Guide* documentation. If you do not find the term you are looking for, refer to the *IBM Glossary of Computing Terms*, located at the IBM Terminology web site:

`http://www.ibm.com/ibm/terminology`

A

active block. The currently executing block that invokes Debug Tool or any of the blocks in the CALL chain that leads up to this one.

active server. A server that is being used by a remote debug session. Contrast with *inactive server*. See also *server*.

alias . An alternative name for a field used in some high-level programming languages.

animation. The execution of instructions one at a time with a delay between each so that any results of an instruction can be viewed.

attention interrupt. An I/O interrupt caused by a terminal or workstation user pressing an attention key, or its equivalent.

attention key. A function key on terminals or workstations that, when pressed, causes an I/O interrupt in the processing unit.

attribute. A characteristic or trait the user can specify.

Autosave. A choice allowing the user to automatically save work at regular intervals.

B

batch. Pertaining to a predefined series of actions performed with little or no interaction between the user and the system. Contrast with *interactive*.

batch job. A job submitted for batch processing. See *batch*. Contrast with *interactive*.

batch mode. An interface mode for use with the MFI Debug Tool that does not require input from the terminal. See *batch*.

block. In programming languages, a compound statement that coincides with the scope of at least one of the declarations contained within it.

breakpoint. A place in a program, usually specified by a command or a condition, where execution can be interrupted and control given to the user or to Debug Tool.

C

CADP. A CICS-supplied transaction used for managing debugging profiles from a 3270 terminal.

century window (COBOL). The 100-year interval in which COBOL assumes all windowed years lie. The start of the COBOL century window is defined by the COBOL YEARWINDOW compiler option.

command list. A grouping of commands that can be used to govern the startup of Debug Tool, the actions of Debug Tool at breakpoints, and various other debugging actions.

compile. To translate a program written in a high level language into a machine-language program.

compile unit. A sequence of HLL statements that make a portion of a program complete enough to compile correctly. Each HLL product has different rules for what comprises a compile unit.

compiler. A program that translates instructions written in a high level programming language into machine language.

condition. Any synchronous event that might need to be brought to the attention of an executing program or the language routines supporting that program. Conditions fall into two major categories: conditions detected by the hardware or operating system, which result in an interrupt; and conditions defined by the programming language and detected by language-specific generated code or language library code. An example of a hardware condition is division by zero. An example of a software condition is end-of-file. See also *exception*.

conversational. A transaction type that accepts input from the user, performs a task, then returns to get more input from the user.

currently qualified. See *qualification*.

D

data type. A characteristic that determines the kind of value that a field can assume.

data set. The major unit of data storage and retrieval, consisting of a collection of data in one of several

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prescribed arrangements and described by control information to which the system has access.

date field. A COBOL data item that can be any of the following:

- A data item whose data description entry includes a DATE FORMAT clause.
- A value returned by one of the following intrinsic functions:
  DATE-OF-INTEGER
  DATE-TO-YYYYMMDD
  DATEVAL
  DAY-OF-INTEGER
  DAY-TO-YYYYDDD
  YEAR-TO-YYYY
  YEARWINDOW
- The conceptual data items DATE and DAY in the ACCEPT FROM DATE and ACCEPT FROM DAY statements, respectively.
- The result of certain arithmetic operations.

The term date field refers to both *expanded date field* and *windowed date field*. See also *nondate.*.

date processing statement. A COBOL statement that references a date field, or an EVALUATE or SEARCH statement WHEN phrase that references a date field.

DBCS. See *double-byte character set*.

debug. To detect, diagnose, and eliminate errors in programs.

DTCN. Debug Tool Control utility, a CICS transaction that enables the user to identify which CICS programs to debug.

Debug Tool procedure. A sequence of Debug Tool commands delimited by a PROCEDURE and a corresponding END command.

Debug Tool variable. A predefined variable that provides information about the user's program that the user can use during a session. All of the Debug Tool variables begin with %, for example, `%BLOCK` or `%CU`.

debugging profile. Data that specifies a set of application programs which are to be debugged together.

default. A value assumed for an omitted operand in a command. Contrast with *initial setting*.

double-byte character set (DBCS). A set of characters in which each character is represented by two bytes. Languages such as Japanese, which contain more symbols than can be represented by 256 code points, require double-byte character sets. Because each character requires two bytes, the typing, displaying, and printing of DBCS characters requires hardware and programs that support these characters.

dynamic. In programming languages, pertaining to properties that can only be established during the execution of a program; for example, the length of a variable-length data object is dynamic. Contrast with *static*.

dynamic link library (DLL). A file containing executable code and data bound to a program at load time or run time. The code and data in a dynamic link library can be shared by several applications simultaneously. See also *load module*.

E

enclave. An independent collection of routines in Language Environment, one of which is designated as the MAIN program. The enclave contains at least one thread and is roughly analogous to a program or routine. See also *thread*.

entry point. The address or label of the first instruction executed on entering a computer program, routine, or subroutine. A computer program can have a number of different entry points, each perhaps corresponding to a different function or purpose.

exception. An abnormal situation in the execution of a program that typically results in an alteration of its normal flow. See also *condition*.

execute. To cause a program, utility, or other machine function to carry out the instructions contained within. See also *run*.

execution time. See *run time*.

execution-time environment. See *run-time environment*.

expanded date field. A COBOL date field containing an expanded (four-digit) year. See also *date field* and *expanded year*.

expanded year. In COBOL, four digits representing a year, including the century (for example, 1998). Appears in expanded date fields. Compare with *windowed year*.

expression. A group of constants or variables separated by operators that yields a single value. An expression can be arithmetic, relational, logical, or a character string.

eXtra Performance LINKage (XPLINK). A new call linkage between functions that has the potential for a significant performance increase when used in an environment of frequent calls between small functions. XPLINK makes subroutine calls more efficient by removing nonessential instructions from the main path. When all functions are compiled with the XPLINK option, pointers can be used without restriction, which makes it easier to port new applications to z/OS.

F

file. A named set of records stored or processed as a unit. An element included in a container: for example, an MVS member or a partitioned data set. See also *data set*.

frequency count. A count of the number of times statements in the currently qualified program unit have been run.

full-screen mode. An interface mode for use with a nonprogrammable terminal that displays a variety of information about the program you are debugging.

H

high level language (HLL). A programming language such as C, COBOL, or PL/I.

HLL. See *high level language*.

hook. An instruction inserted into a program by a compiler when you specify the TEST compile option. Using a hook, you can set breakpoints to instruct Debug Tool to gain control of the program at selected points during its execution.

I

inactive block. A block that is not currently executing, or is not in the CALL chain leading to the active block. See also *active block*, *block*.

index. A computer storage position or register, the contents of which identify a particular element in a table.

initial setting. A value in effect when the user's Debug Tool session begins. Contrast with *default*.

interactive. Pertaining to a program or system that alternately accepts input and then responds. An interactive system is conversational; that is, a continuous dialog exists between the user and the system. Contrast with *batch*.

I/O . Input/output.

L

Language Environment. An IBM software product that provides a common run-time environment and common run-time services for IBM high level language compilers.

library routine. A routine maintained in a program library.

line mode. An interface mode for use with a nonprogrammable terminal that uses a single command line to accept Debug Tool commands.

line wrap. The function that automatically moves the display of a character string (separated from the rest of a line by a blank) to a new line if it would otherwise overrun the right margin setting.

link-edit. To create a loadable computer program using a linkage editor.

linkage editor. A program that resolves cross-references between separately compiled object modules and then assigns final addresses to create a single relocatable load module.

listing. A printout that lists the source language statements of a program with all preprocessor statements, includes, and macros expanded.

load module. A program in a form suitable for loading into main storage for execution. In this document this term is also used to refer to a Dynamic Load Library (DLL).

logical window. A group of related debugging information (for example, variables) that is formatted so that it can be displayed in a physical window.

M

minor node. In VTAM, a uniquely defined resource within a major node.

multitasking. A mode of operation that provides for concurrent performance, or interleaved execution of two or more tasks.

N

network identifier. In TCP/IP, that part of the IP address that defines a network. The length of the network ID depends on the type of network class (A, B, or C).

nonconversational. A transaction type that accepts input, performs a task, and then ends.

nondate. A COBOL data item that can be any of the following:

- A data item whose date description entry does not include the DATE FORMAT clause
- A literal
- A reference modification of a date field
- The result of certain arithmetic operations that may include date field operands; for example, the difference between two compatible date fields.

The value of a nondate may or may not represent a date.

O

Options. A choice that lets the user customize objects or parts of objects in an application.

offset. The number of measuring units from an arbitrary starting point to some other point.

P

panel. In Debug Tool, an area of the screen used to display a specific type of information.

parameter. Data passed between programs or procedures.

partitioned data set (PDS). A data set in direct access storage that is divided into partitions, called members, each of which can contain a program, part of a program, or data.

path point. A point in the program where control is about to be transferred to another location or a point in the program where control has just been given.

PDS. See *partitioned data set*.

physical window. A section of the screen dedicated to the display of one of the four logical windows: Monitor window, Source window, Log window, or Memory window.

prefix area. The eight columns to the left of the program source or listing containing line numbers. Statement breakpoints can be set in the prefix area.

primary entry point. See *entry point*.

procedure. In a programming language, a block, with or without formal parameters, whose execution is invoked by means of a procedure call. A set of related control statements. For example, an MVS CLIST.

process. The highest level of the Language Environment program management model. It is a collection of resources, both program code and data, and consists of at least one enclave.

Profile. A choice that allows the user to change some characteristics of the working environment, such as the pace of statement execution in the Debug Tool.

program. A sequence of instructions suitable for processing by a computer. Processing can include the use of an assembler, a compiler, an interpreter, or a translator to prepare the program for execution, as well as to execute it.

program unit. See *compile unit*.

program variable. A predefined variable that exists when Debug Tool was invoked.

pseudo-conversational transaction. The result of a technique in CICS called pseudo-conversational processing in which a series of nonconversational transactions gives the appearance (to the user) of a single conversational transaction. See *conversational* and *nonconversational*.

Q

qualification. A method used to specify to what procedure or load module a particular variable name, function name, label, or statement id belongs. The `SET QUALIFY` command changes the current implicit qualification.

R

record. A group of related data, words, or fields treated as a unit, such as one name, address, and telephone number.

record format. The definition of how data is structured in the records contained in a file. The definition includes record name, field names, and field descriptions, such as length and data type. The record formats used in a file are contained in the file description.

reference. In programming languages, a language construct designating a declared language object. A subset of an expression that resolves to an area of storage; that is, a possible target of an assignment statement. It can be any of the following: a variable, an array or array element, or a structure or structure element. Any of the above can be pointer-qualified where applicable.

run. To cause a program, utility, or other machine function to execute. An action that causes a program to begin execution and continue until a run-time exception occurs. If a run-time exception occurs, the user can use Debug Tool to analyze the problem. A choice the user can make to start or resume regular execution of a program.

run time. Any instant when a program is being executed.

run-time environment. A set of resources that are used to support the execution of a program.

run unit. A group of one or more object programs that are run together.

S

SBCS. See *single-byte character set*.

semantic error. An error in the implementation of a program's specifications. The semantics of a program refer to the meaning of a program. Unlike syntax errors, semantic errors (since they are deviations from a

program's specifications) can be detected only at run time. Contrast with *syntax error*.

sequence number. A number that identifies the records within an MVS file.

session variable. A variable the user declares during the Debug Tool session by using Declarations.

single-byte character set (SBCS). A character set in which each character is represented by a one-byte code.

Single Point of Control. The control interface that sends commands to one or more members of an IMSplex and receives command responses.

source. The HLL statements in a file that make up a program.

Source window. A Debug Tool window that contains a display of either the source code or the listing of the program being debugged.

SPOC. See "Single Point of Control."

statement. (1) An instruction in a program or procedure. (2) In programming languages, a language construct that represents a step in a sequence of actions or a set of declarations.

static. In programming languages, pertaining to properties that can be established before execution of a program; for example, the length of a fixed-length variable is static. Contrast with *dynamic*.

step. One statement in a computer routine. To cause a computer to execute one or more statements. A choice the user can make to execute one or more statements in the application being debugged.

storage. A unit into which recorded text can be entered, in which it can be retained, and from which it can be retrieved. The action of placing data into a storage device. A storage device.

subroutine. A sequenced set of instructions or statements that can be used in one or more computer programs at one or more points in a computer program.

suffix area. A variable-sized column to the right of the program source or listing statements, containing frequency counts for the first statement or verb on each line. Debug Tool optionally displays the suffix area in the Source window. See also *prefix area*.

syntactic analysis. An analysis of a program done by a compiler to determine the structure of the program and the construction of its source statements to determine whether it is valid for a given programming language. See also *syntax checker, syntax error*.

syntax. The rules governing the structure of a programming language and the construction of a statement in a programming language.

syntax error. Any deviation from the grammar (rules) of a given programming language appearing when a compiler performs a syntactic analysis of a source program. See also *syntactic analysis*.

T

session variable. See *session variable*.

thread. The basic line of execution within the Language Environment program model. It is dispatched with its own instruction counter and registers by the system. Threads can execute, concurrently with other threads. The thread is where actual code resides. It is synonymous with a CICS transaction or task. See also *enclave*.

thread id. A small positive number assigned by Debug Tool to a Language Environment task.

token. A character string in a specific format that has some defined significance in a programming language.

trigraph. A group of three characters which, taken together, are equivalent to a single special character. For example, ??) and ??(are equivalent to the left (<) and right (>) brackets.

U

utility. A computer program in general support of computer processes; for example, a diagnostic program, a trace program, or a sort program.

V

variable. A name used to represent a data item whose value can be changed while the program is running.

VTAM. See "Virtual Telecommunications Access Method."

Virtual Telecommunications Access Method (VTAM). (1) IBM software that controls communication and the flow of data in an SNA network by providing the SNA application programming interfaces and SNA networking functions. An SNA network includes subarea networking, Advanced Peer-to-Peer Networking (APPN), and High-Performance Routing (HPR). Beginning with Release 5 of the OS/390 operating system, the VTAM for MVS/ESA function was included in Communications Server for OS/390; this function is called Communications Server for OS/390 - SNA Services. (2) An access method commonly used by MVS to communicate with terminals and other communications devices.

W

windowed date field. A COBOL date field containing a windowed (two-digit) year. See also *date field* and *windowed year*.

windowed year. In COBOL, two digits representing a year within a century window (for example, 98). Appears in windowed date fields. See also *century window (COBOL)*.

Compare with *expanded year*.

word wrap. See *line wrap*.

X

XPLINK. See “eXtra Performance LINKage (XPLINK)” on page 516.

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