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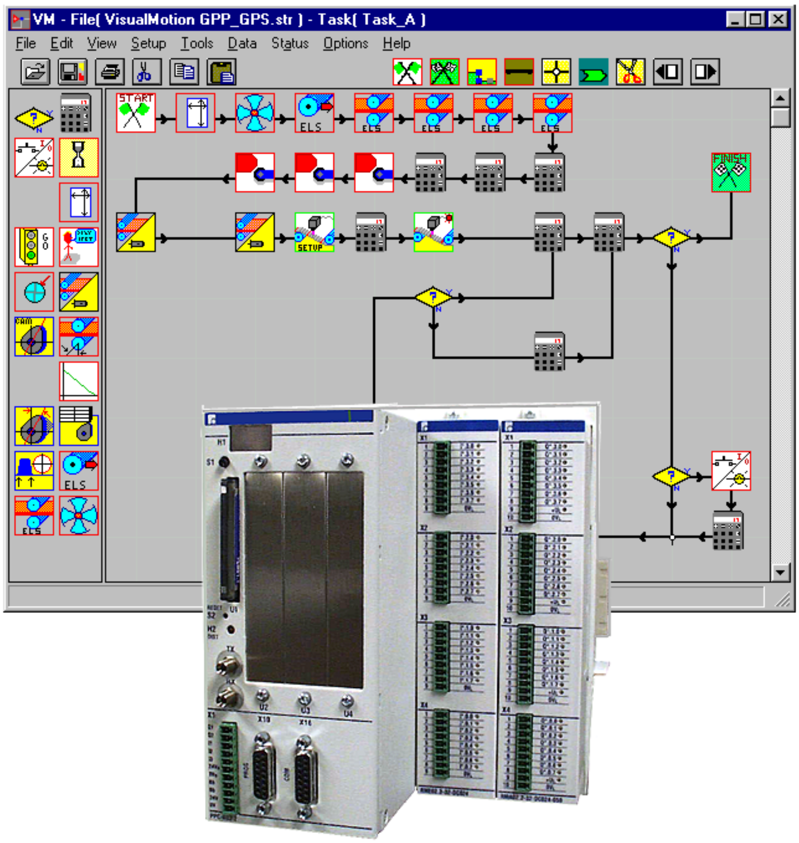

VisualMotion 7 (GPP)
Multi-Axis Motion Control

Application Manual

DOK-VISMOT-VM*-07VRS**-AW02-AE-P

Rexroth
Indramat

Title VisualMotion 7 (GPP)
Multi-Axis Motion Control

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- Document Number: 120-2300-B309-02/AE

Purpose of Documentation This documentation describes…

- The VisualMotion 7 GPP control system which incorporates…
  - the PPC-R control using GPP firmware with non-coordinated, coordinated and electronic line shafting motion capabilities
  - a Windows based programming tool called VisualMotion Toolkit used for the creation of motion programs and system management
  - the control of grouped axes by multiple masters for electronic line shafting applications
  - fieldbus interfaces for Profibus and DeviceNet
  - and overall system functionality

Record of Revisions

Description	Release Date	Notes
01	04/2000	Preliminary Release
02	11/2000	Updated

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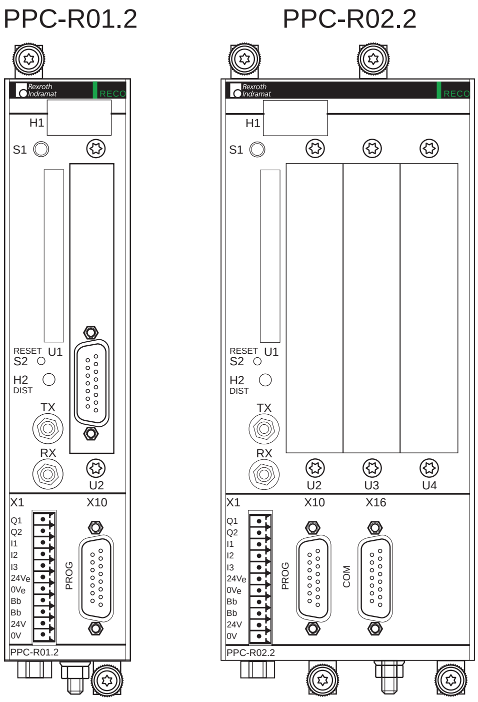
Rexroth Indramat

1 VisualMotion 7.0 Overview

1.1 System Overview

VisualMotion is a programmable multi-axis motion control system capable of controlling up to 32 digital intelligent drives from Rexroth Indramat. The PC software used for motion control management is named VisualMotion Toolkit. The hardware used with VisualMotion 7 GPP firmware is the PPC-R control.



PPCr_front.FH7

Fig. 1-1: PPC-R Motion Control

Note: Although VisualMotion 7 supports the CLC hardware using GPS firmware, this document will focus only on the PPC-R hardware using GPP firmware. For documentation support of CLC hardware using GPS firmware, refer to the following VisualMotion 6.0 documentation:

- VisualMotion GPS 6.0 Reference Manual
  DOK-VISMOT-VM*-06VRS**-FKB1-AE-P
- VisualMotion GPS 6.0 Startup Guide
  DOK-VISMOT-VM*-06VRS**-PR02-AE-P
- VisualMotion GPS 6.0 Troubleshooting Guide
  DOK-VISMOT-VM*-06VRS**-WA02-AE-P

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2 Motion Capabilities

VisualMotion supports three types of motion:

- Non-Coordinated
- Coordinated
- Electronic line Shafting

2.1 Non-Coordinated Motion

Non-coordinated motion is primarily used to control a single independent axis. There are two modes of non-coordinated motion:

- Single axis
- Velocity mode

Single axis

Single axis motion commands within a VisualMotion user program are processed by the control and sent to the digital drive. The user program communicates to the drive the target position (travel distance), the velocity and acceleration. This information is used to develop a velocity profile that is maintained and controlled within the intelligent digital drive. As a result, single axis motion does not require continuous calculation by the control and consumes minimum CPU resources.

Velocity Mode

Velocity mode controls the speed of the axis, with no position control loop. Rexroth Indramat's intelligent digital drives maintain torque and velocity loops internally.

A special form of non-coordinated motion called *ratioed axes* permits linking two axes by relating the number of revolutions of a slave axis to a master axis. For example, a ratio might be required when the positioning axis of a gantry robot has a motor on each side of its supporting track.

2.2 Coordinated Motion

The VisualMotion control defines multi-axis coordinated motion in terms of a path composed of standard straight line and circular geometry segments. Point positions, (x, y, z), are used to establish the start, middle or end of a geometry segment. Two points define a line; three points define a circle. The path combines these standard geometry segments so that the start of the next segment begins at the end of the previous segment. A path, therefore, is nothing more than a collection of connected segments.

Since each segment has an end point specifying speed, acceleration, deceleration and jerk, each segment can have a unique rate profile curve. A special type of segment, called a blend segment, can be used to join two standard geometry segments. Blend segments provide the capability of continuous smooth motion from one standard segment to another without stopping. They reduce calculation cycle time as well as provide a means of optimal path shaping.

A VisualMotion system is capable of calculating a path in any of several different modes:

Constant Speed

Constant Speed mode is always active and tries to maintain a constant speed between any two connecting segments in the path. The system and axes acceleration and deceleration limit this mode. Constant speed is the optimum path motion for applying adhesives or paint, welding and some forms of cutting such as laser or water-jet, etc..

Linear Interpolation

Two points define a coordinated motion straight-line segment. The motion is calculated from the end point of the last segment, or the current position if the system is not in motion, to the new end point.

Circular Interpolation

Three points define a coordinated motion circular segment. Circular motion begins with the end point of the last segment executed, or the current system position if the system is not in motion, moves in a circular arc through an intermediate point, and terminates at the specified endpoint.

Kinematics

In addition to the standard x, y, z kinematics, the control has the capability of executing several forward and inverse kinematic movements by using an application-specific library of kinematic functions.

Kinematics can be developed to customer specifications. Contact Rexroth Indramat's Application Engineering to inquire about applications which could benefit from kinematics.

2.3 Electronic Line Shafting (ELS)

Electronic Line Shafting is used to synchronize one or more slave axes to a master axis. Using GPS firmware, an ELS master can be a real or virtual axis. GPP firmware introduces multiple master functionality. Refer to *Chapter 4, Multiple Master Overview*. Each slave axis can use either velocity, phase or cam synchronization. ELS has the capability to jog each axis synchronously or independently, and to adjust phase offset and velocity while the program is running.

Velocity synchronization

Velocity synchronization relates slave axes to a master in terms of rotational rate. It is used when axis velocities are most critical, as in paper processing operations in which two or more motors act on a single piece of fragile material.

Phase synchronization

Phase synchronization maintains the same relative position among axes, but adjusts the lead or lag of the slaves to the master in terms of degrees. It is used when the positions of axes are most critical. For example, to achieve proper registration in printing operations, the axis controlling the print head may be programmed for a particular phase offset relative to some locating device, such as a proximity switch.

Cam synchronization

Cam synchronization is used when custom position profiles are needed at a slave axis. A cam profile can be executed either in the control (control cam) or in the drives (drive cams).

A cam is an (x, y) table of positions that relate a master axis to a slave. Cams can be stored in the control or in the digital drive. Control cams have more adjustment options and can work with SERCOS drives that do not support the ELS functionality (e.g., SMT or SSE firmware). The same programming commands and utilities are used for both control and drive cams.

The number of control cams that can be active at the same time is limited to 4.

3 VisualMotion Toolkit

3.1 Introduction

VisualMotion Toolkit (VMT) is a Windows-based program used for motion control programming, parametrization, system diagnostics and motion control management. With the use of icon driven instructions, motion control programs are created and downloaded to the control for activation. This chapter presents basic installation procedure and instructions on how to create, download, activate and run a VisualMotion program.

3.2 Installation and Setup

VisualMotion Toolkit is supplied on CD-ROM. VMT is installed with dual language support in English and German. A complete Help System in both English and German is also part of the installation and contain detailed information on the use of VisualMotion along with diagnostics as context sensitive help.

System Requirements

Computer

VisualMotion Toolkit can be installed on any IBM™ PC compatible Pentium computer running…

- Windows95, Windows98, Windows NT 4 or Windows 2000
- 4 Mb of RAM system memory
- Running Windows in enhanced mode is recommended
- Complete dual language (*English and German*) installation including help system requires 19 MB of hard disk space. Additional space is required for user files.

Display

A VGA display is required. A color display allows you to take full advantage of VMT's graphic interface.

Printer

VMT uses the default printer installed on your computer. For optimal resolution, especially when printing icon programs, use a high-resolution (300-dpi) laser or ink jet printer.

Mouse

A serial or bus mouse is required to use VMT’s Icon programming environment.

Serial I/O

VMT can be configured to use the PC's serial port for communication between the Host PC and the PPC-R. An IKB0005 RS-232 serial cable is required between the Host PC and the PPC-R X10 communication port. Hardware handshaking is not used.

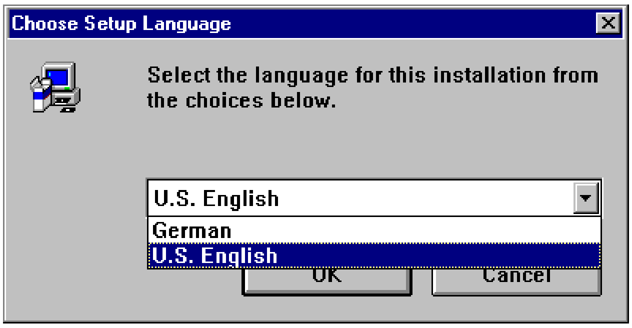
Installing VisualMotion Toolkit 7.0

To install VisualMotion Toolkit in a host computer running under Windows 95/98 or Windows NT4 do the following:

1. Insert the VisualMotion CD to begin. VisualMotion will automatically start.

The install program will prompt you to select the language you wish to use. This option can be changed at any time after installation.

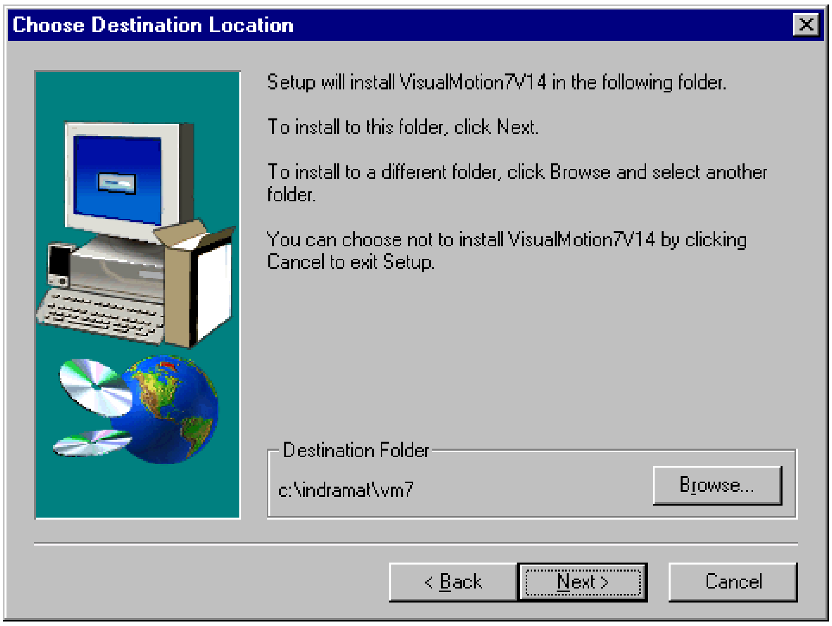
Note: To change the language, select ***Setup* ⇒ *Configuration*** from VisualMotion Toolkit's main menu.



2. Select the language from the drop-down list and click *OK*.

VisualMotion's splash screen will be displayed while an InstallShield® Wizard launches to guide you through the rest of the setup process.

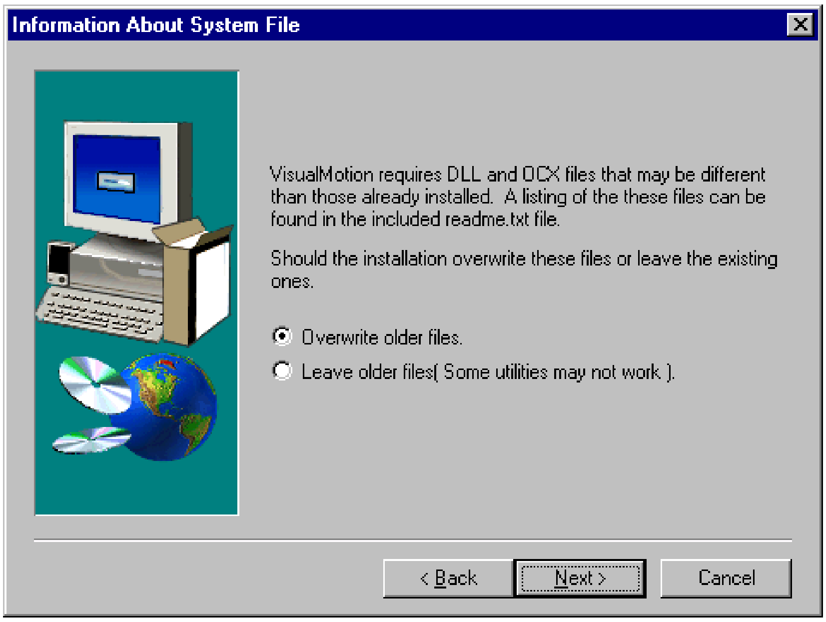
3. When the *Choose Destination Location* screen appears, choose where to install the VisualMotion program on your system. The default directory is *c:\indramat\vm7*.



As part of the installation process, VisualMotion installs certain DLL (Dynamic Link Library) and OCX (OLE Custom ActiveX control) files that are a necessary part of the program. The screen below will ask whether to *Overwrite older files* or *Leave older files*.

Note: The installation of VisualMotion will only install or overwrite DLL and OCX files that are newer than the current system files.

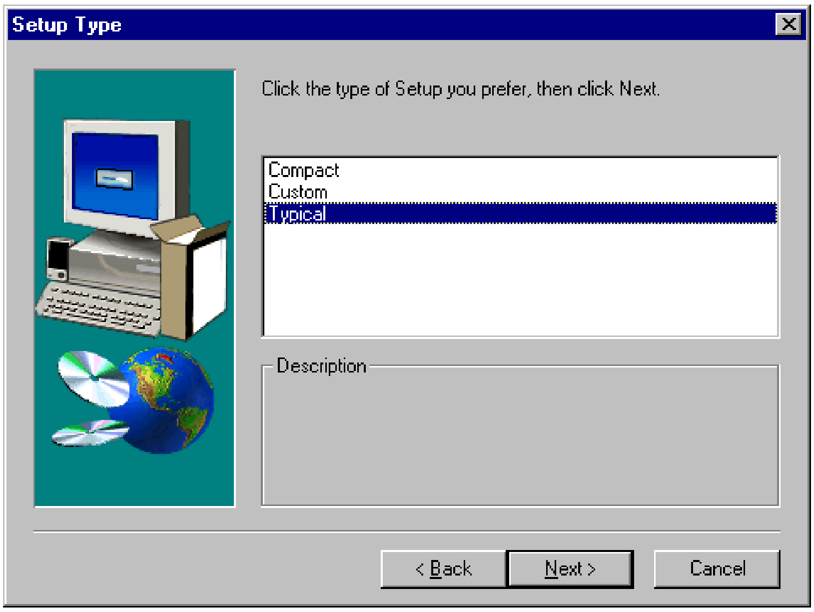
4. Select *Overwrite older files* from the *Information About System File* screen. Without the installation of these files, certain utilities in VisualMotion Toolkit will not work properly.



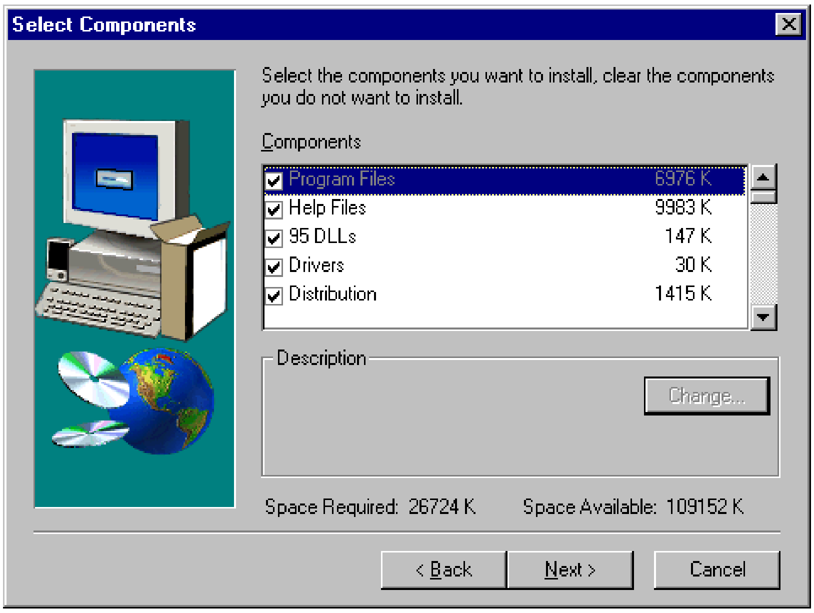
5. The *Setup Type* screen allows you to choose from 3 different installation types. The amount of available hard disk space required is dependent upon the setup type selected. The following table outlines how much hard disk space is required per setup type.

Type of Setup	Description	Required Hard disk Space
Compact	Required files, no help files	7.2 MB
Custom	User-selectable installation	depends on selections 7.2 MB - 19 MB
Typical (English)	Required files and English help files	19 MB
Typical (German)	Required files and German help files	19 MB

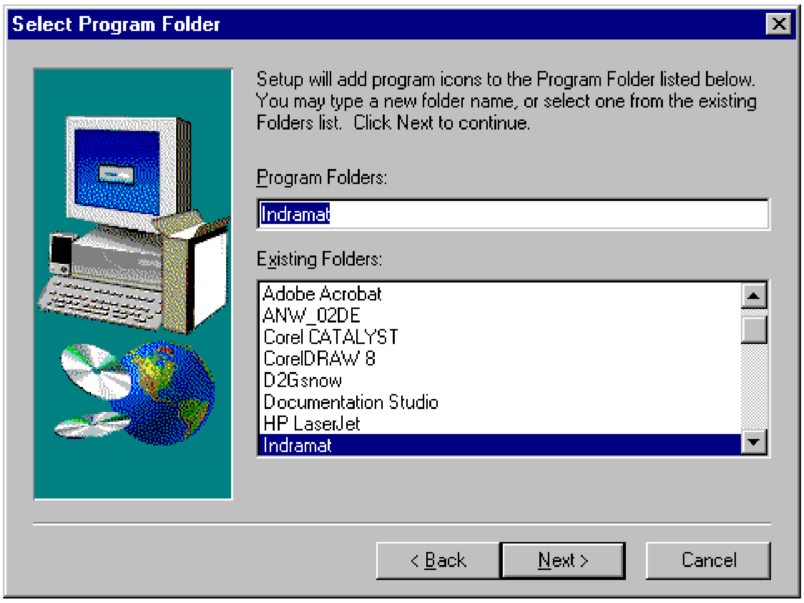
Table 3-1: Setup Types



When Custom is selected, the user has the option to choose all or only those components to install.

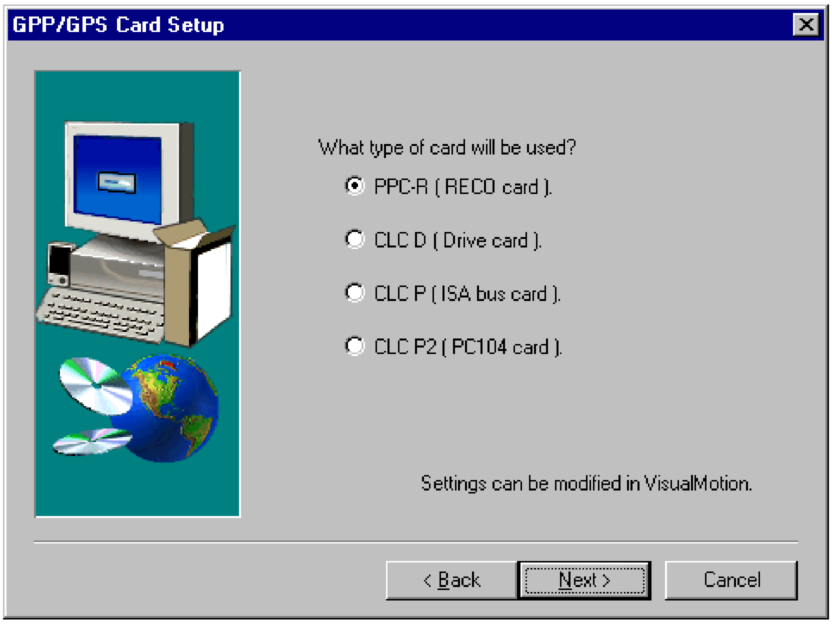


6. Select the folder where you would like to add program icons. Indramat is the default folder.



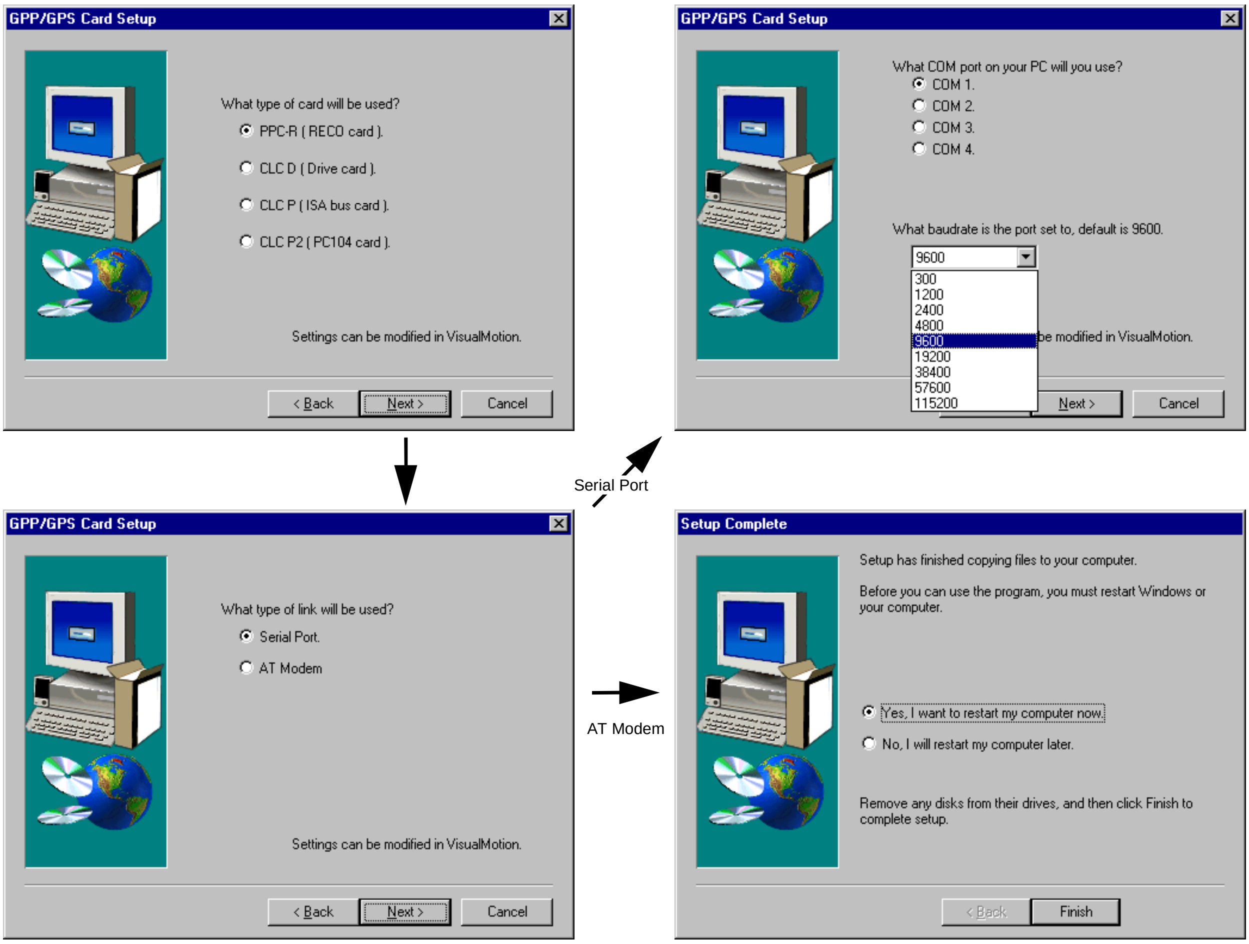
The setup program will show the progress of the installation.

7. The GPP/GPS Card Setup screen will prompt you to select the VisualMotion hardware and settings to be used. The selection of a particular hardware can be modified or changed once VisualMotion Toolkit has been completely installed.



Note: Changes to VisualMotion hardware and settings can be made within VisualMotion Toolkit under menu selection ***Setup*** ⇒ ***Card Selection***.

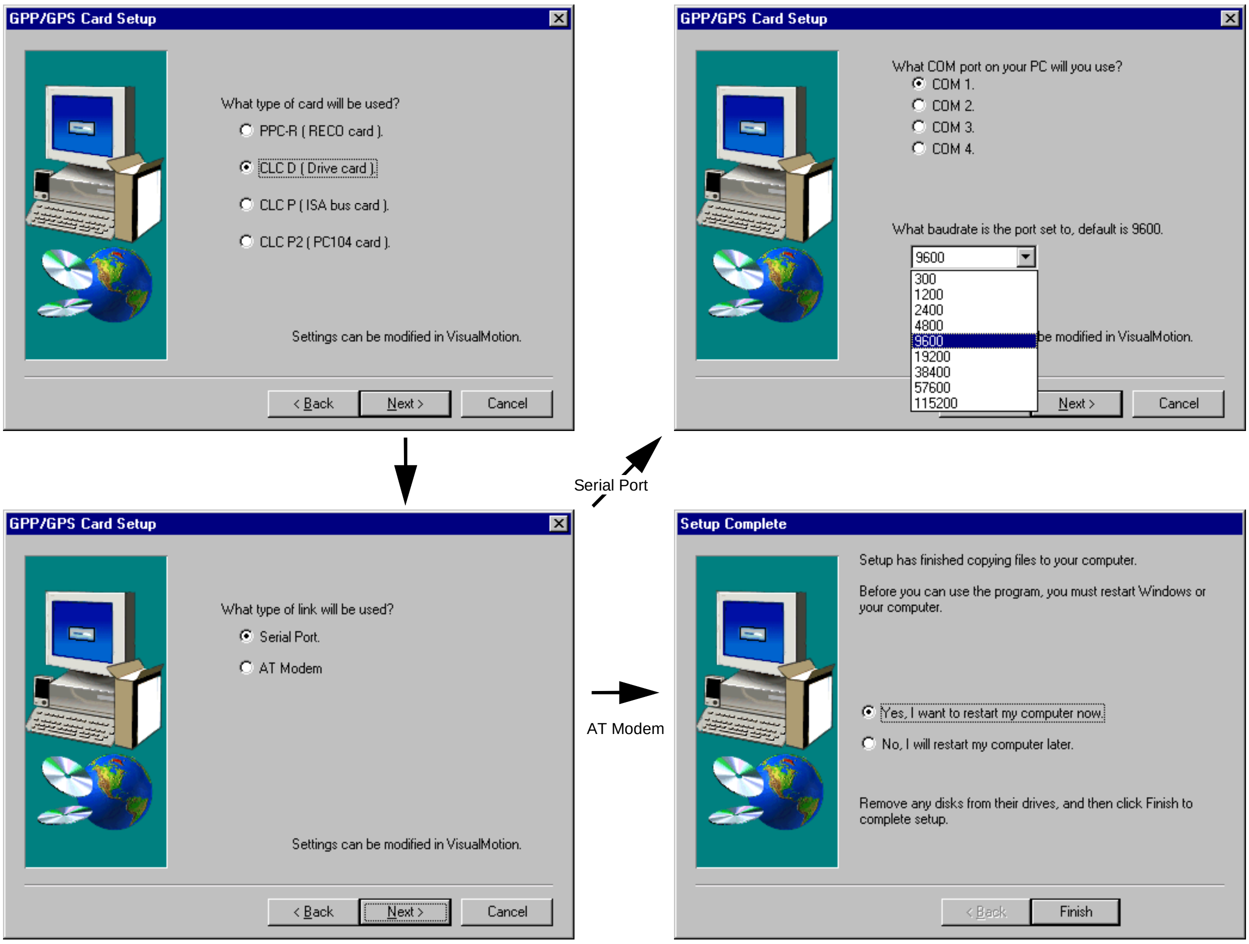
The remaining installation screens vary based on the type of VisualMotion hardware selected. The following figures will illustrate these screens along with any additional information necessary to complete the installation.



If Serial Port is the selected communication link, choose a baudrate to match the PPC-R's X10 com port. This is done by pressing the S1 button on the PPC-R until the set baudrate for X10 is displayed. If the set baudrate on the PPC-R is not know, use 9600 (default).

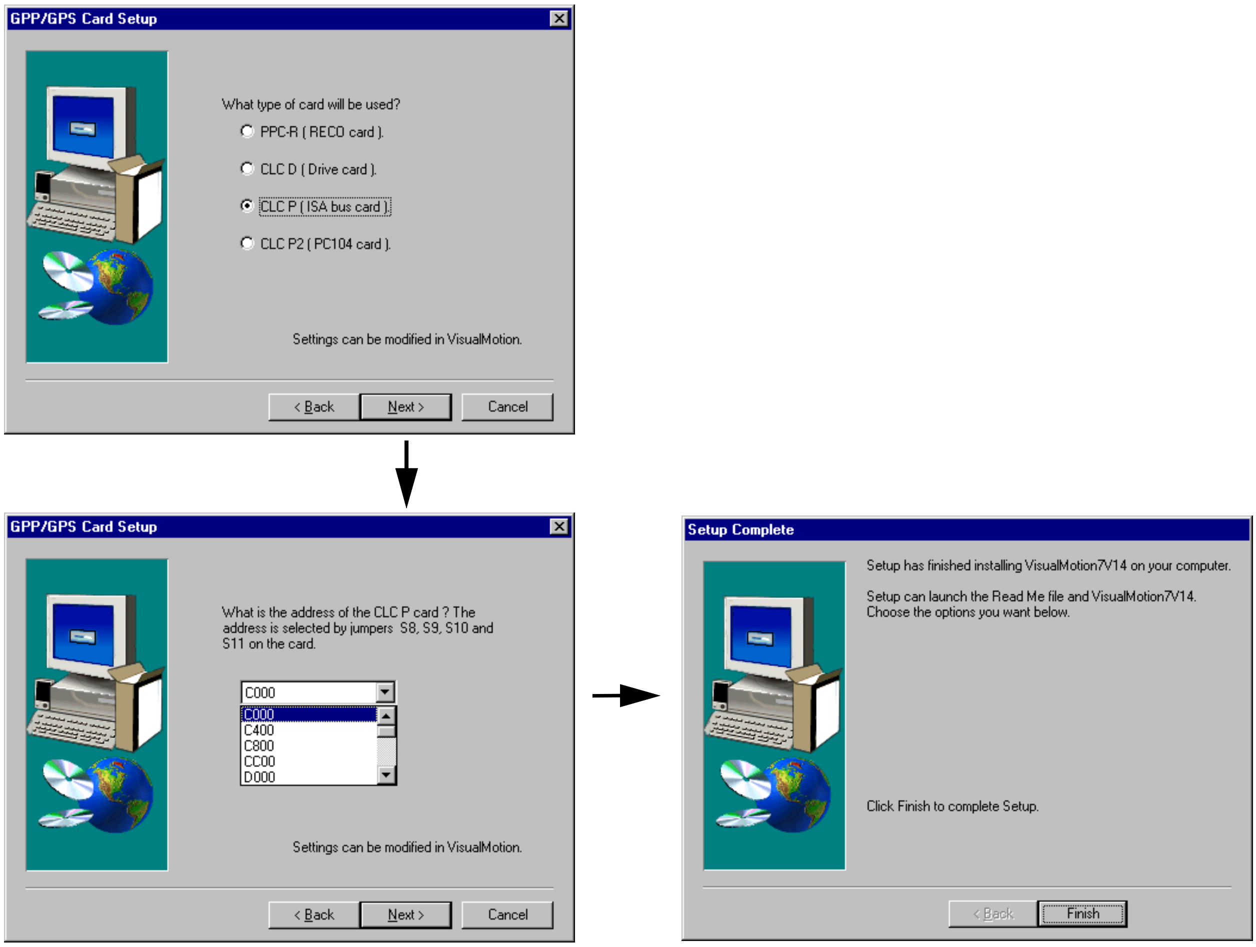
Figure 3-1: PPC-R Installation Screens

Rexroth Indramat



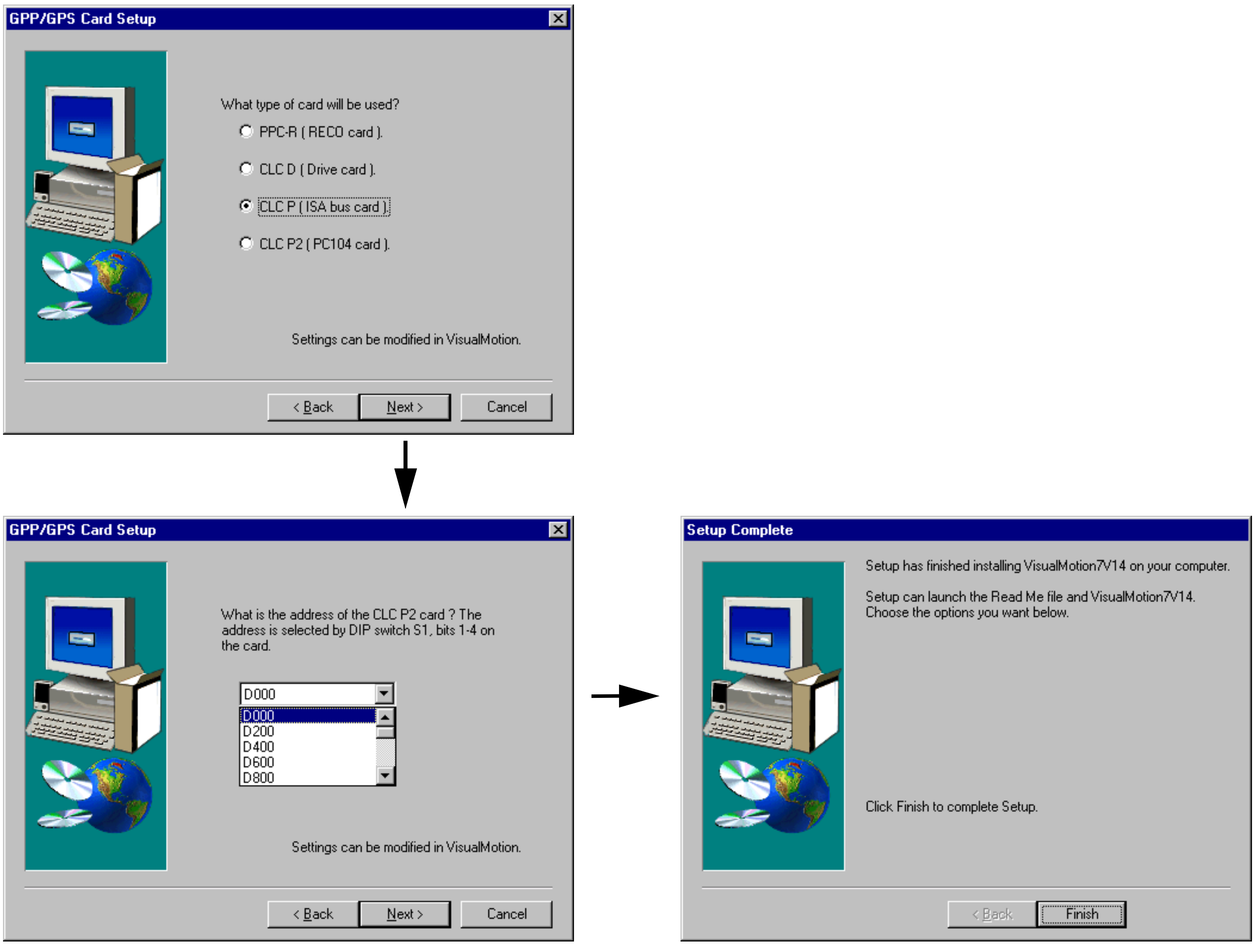
If Serial Port is the selected communication link, choose a baudrate to match the CLC-D com port. If the set baudrate on the CLC-D is not know, use 9600 (default).

Figure 3-2: CLC-D Installation Screens



CLC-P01 address must match the base address selected when the card was installed. Refer to page 2-10 in the VisualMotion GPS 6.0 Startup Guide.

Figure 3-3: CLC-P01 Installation Screens



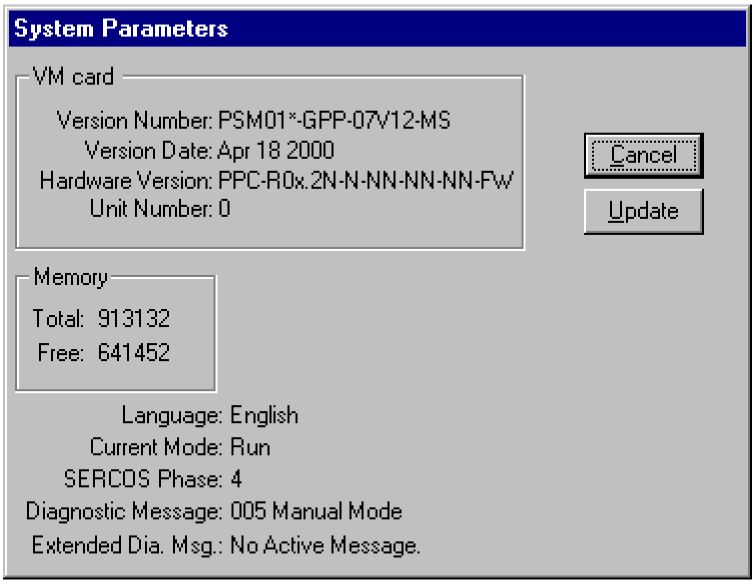
CLC-P02 address must match the base address selected when the card was installed. Refer to page 2-15 in the VisualMotion GPS 6.0 Startup Guide.

Figure 3-4: CLC-P02 Installation Screens

Once VisualMotion Toolkit (VMT) is installed, verify communications by performing the following procedure.

- Start VMT by selecting ***Start*** ⇒ ***Program Files*** ⇒ ***Indramat*** ⇒ ***VisualMotion7***
- Verify that the correct VisualMotion hardware and settings are correct within ***Setup*** ⇒ ***Card Selection***
- Select ***Status*** ⇒ ***System*** from the main menu

If proper communication has been established, the System Parameter screen (shown below) will display the VisualMotion version number along with other messages.



3.3 Create and Download a Program

This section will cover the creation, download and activation of a basic single axis program that is not application specific. Refer to the *VisualMotion Reference Manual* for detailed icon descriptions.

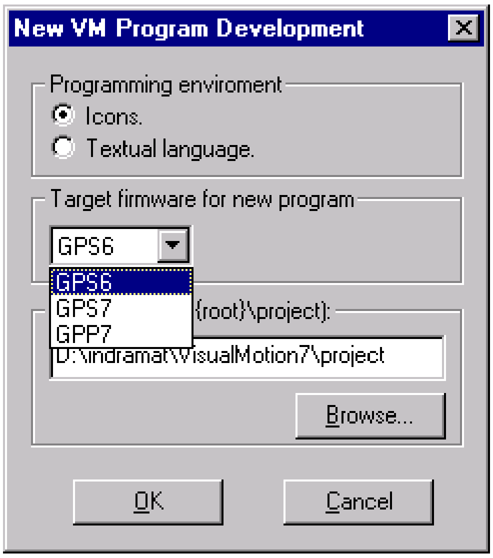
Program Example

1. Start VisualMotion Toolkit (**VMT**) by either double-clicking on a VMT icon shortcut or selecting …

   Start ⇒ Programs ⇒ Indramat ⇒ VisualMotion7

2. From VMT's main menu select ***File*** ⇒ ***New*** and choose ***Icon*** as your programming environment. The target firmware for new program is dependent on the control:

   - GPS for CLC
   - GPP for PPC-R



3. The following series of programming icons will be used in this example. As the icons are placed on the screen, dialog boxes will open and prompt you to enter setup information. A description of the icons along with the setup information required for each dialog box will be provided.

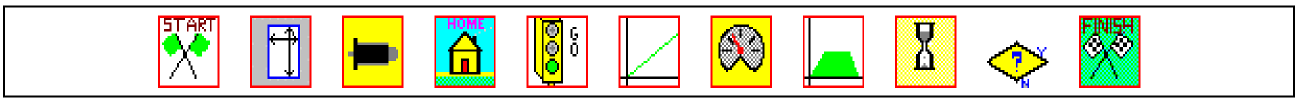
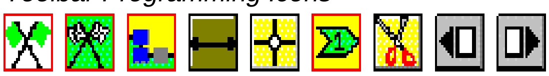


Fig. 3-1: Program Icons

Note: The toolbar programming icons found above the programming area are visible regardless of the Icon palette selected from the *Options* menu. The icons used in this example are found under ***Options*** ⇒ ***Icon Palette 'Single'***.

Toolbar Programming Icons



Start Icon

4. Select and place the **Start** icon from the set of toolbar icons onto the VisualMotion programming area. All VisualMotion *tasks* and *subroutines* must begin with a Start icon.

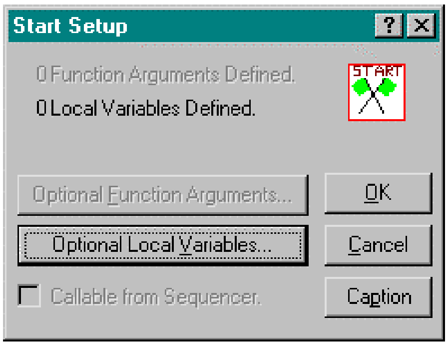
   Task

   A task is a process that the user runs in his machine. VisualMotion can have up to 4 separate processes or tasks running simultaneously in each program. Tasks A-D run simultaneously and are given equal priority (task A is executed first.)

   Subroutine

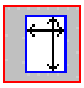
   Subroutines are basically sub-programs that are called by the main program when selected to start. They are used mainly to improve readability as well as simplify the program.

Note: Once an icon is selected, the cursor will change to a crosshair. Move the crosshair onto the programming area and click to place. To make best use of the programming area, begin placing icons in the upper most left-hand corner of the programming area.



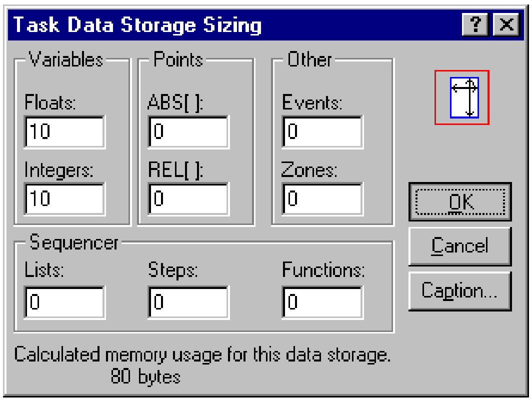
Since this program does not contain any optional function arguments or local variables select OK.

Size Icon

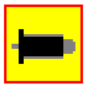


5. Select and place the **Size** icon from the 'Single' Icon Palette to the right of the *Start* icon. This icon determines the number of variables, points, events and zones to be used in the VisualMotion program. It also limits the number of Sequencer Lists, Steps and Functions. Refer to the *VisualMotion Reference Manual* for more information. To maximize memory on the control, place limits on the data storage space.

Note: The default size for both Floats and Integers is 730 and 300 respectively. Reduce this value to 10 for each and click on OK.

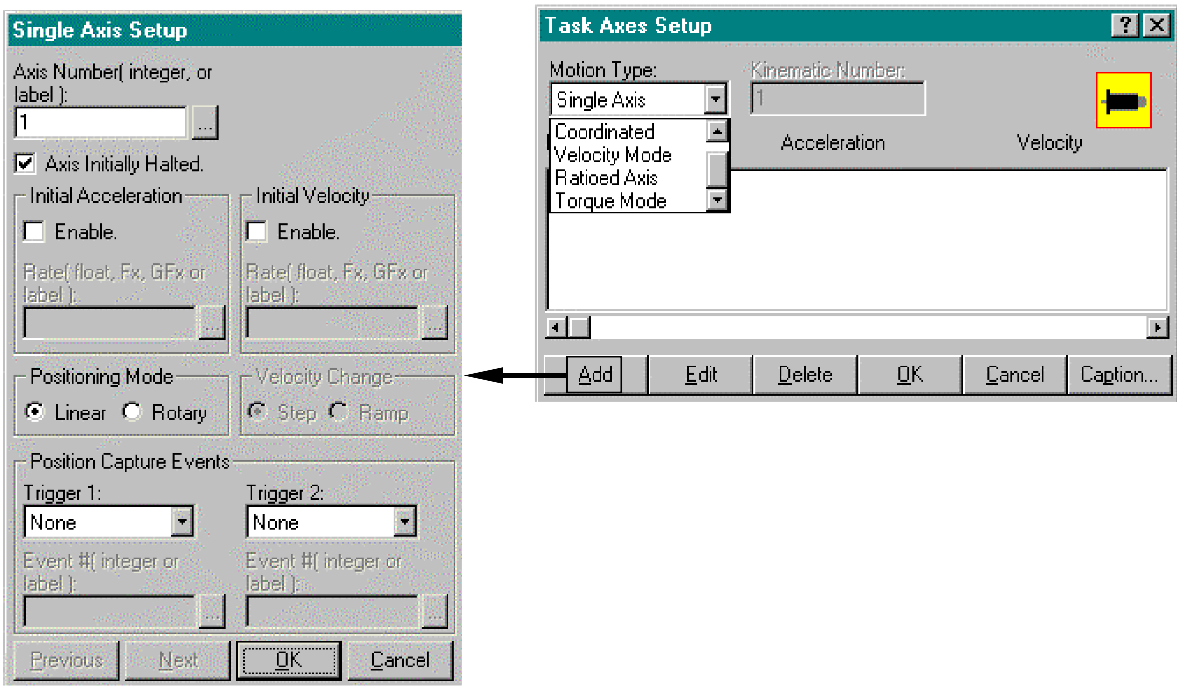


Axis Icon



6. Select and place the ***Axis*** icon to the right of the *Size* icon. This icon configures the primary operation mode for the axis to be used in this Task.
   a. Select *Single Axis* from the Motion Type drop-down menu box.
   b. Click on the *Add* button to setup the axis.
   c. Configure the axis according to the Single Axis Setup window shown below.

   When done, select *OK* and then *Cancel* to close the Single Axis Setup window. If *OK* is selected again; a second axis will be displayed in the *Task Axes Setup* window. Select OK once again to close the *Task Axes Setup* window.



Home Icon

7. Select and place the **Home** icon to the right of the *Axis* icon. This icon executes a drive-controlled homing procedure.

Enter a **1** and select *OK*

Note: Before an axis can be Homed using the *Home* icon, a homing routine must be setup. Refer to the following procedure for details.

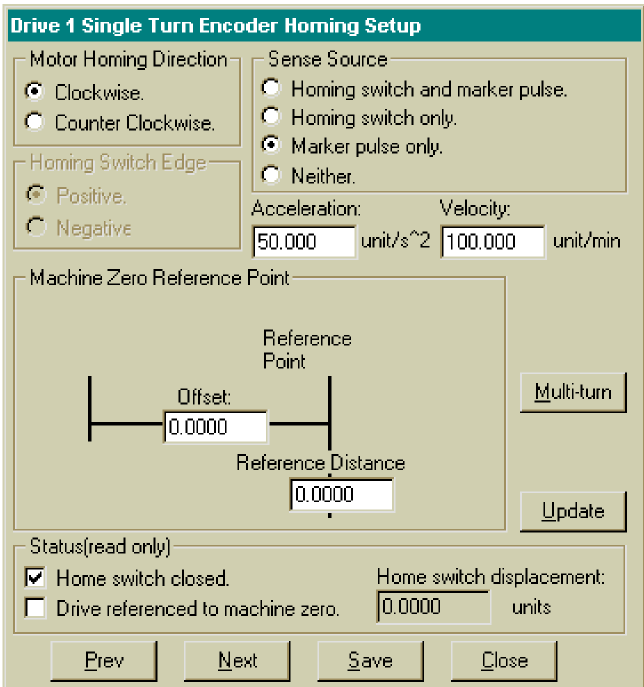
Homing Procedure

Select ***Setup*** ⇒ ***Drives*** from VMT's main menu to open the Drive Parameter Editor window. Now, select ***Parameters*** ⇒ ***Drive Reference*** and VMT will automatically sense the active drive's motor encoder type and launch either the single or multi-turn encoder setup window.

Note: Verify that the motor and drive are properly connected and powered up. Check the serial communication cable between the control and host computer for proper connection.

Drive 1 Single Turn Encoder Homing Setup

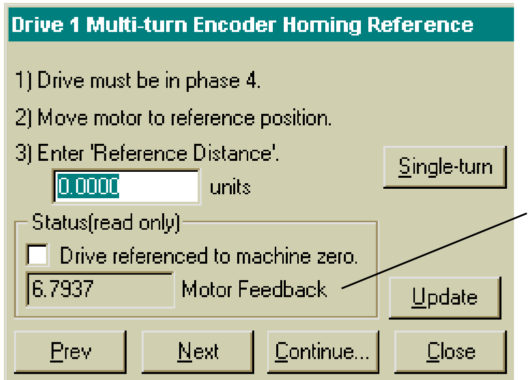
Setup the motor's homing routine according to the window below. The Acceleration and Velocity parameters should be set to a low enough value as to not cause sudden jerk movement. When done, click on *Save* and then *Close* to complete the homing routine for Drive 1.



The homing procedure is an internal function of Rexroth Indramat's intelligent digital drives and requires only that VisualMotion send a home command to the drive. The actual homing procedure performed by the drive is set in drive parameters.

Drive 1 Multi-turn Encoder Homing Reference

If the motor you are using contains an Absolute encoder, the following window will automatically be displayed when ***Parameters*** ⇒ ***Drive Reference*** is selected from the *Drive Parameter Editor* window.

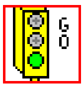


Indicates current motor feedback position.

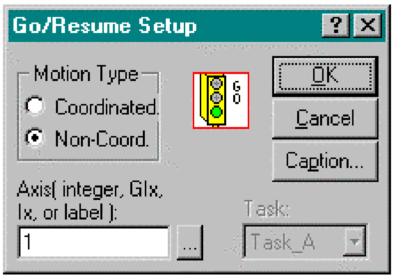
When done, click on *Close* to exit this window. To close the Drive Parameter Editor window and return to the Task programming screen, select ***File*** ⇒ ***Exit***.

The Homing routine for the Home icon is now complete. Refer to chapter 9 for more information regarding the *Drive Parameter Editor*.

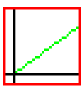
GO Icon



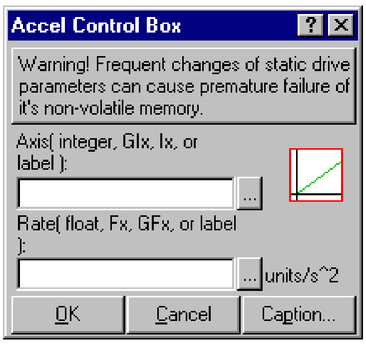
8. Select and place the **GO** icon to the right of the *Home* icon. This icon enables the axis' drive ready signal (RF.)
   a. Enter a **1** in the Axis field to specify which axis to initiate.
   b. Non-Coord. Motion Type should be selected for a single axis.



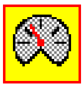
Accel Icon



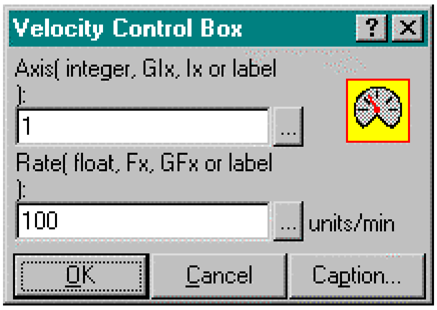
9. Select and place the **Acceleration** icon to the right of the *GO* icon. This icon sets the acceleration rate that will be used in the specified axis.
   a. Enter a **1** to specify the axis.
   b. Enter **15** for the rate of acceleration and click on *OK*.



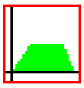
Velocity Icon



10. Select and place the ***Velocity*** icon to the right of the *Accel* icon. This icon sends the velocity rate to the drive that will be used in the move calculation.
    a. Enter a **1** to specify the axis.
    b. Enter **100** for the velocity rate click on *OK.*



MOVE Icon

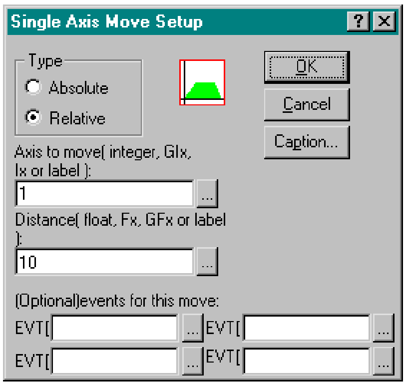


11. Select and place the **MOVE** icon to the right of the velocity icon. This icon sets the distance that will be traveled by the specified axis.
    a. Select **Relative** as the move Type.

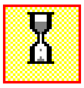
Note: A *Relative* move is an incremental distance that is moved every time the move icon is encountered in the program flow. An *Absolute* move is an exact position that is reached when the move icon is encountered and is not repeated unless the absolute position changes.

---

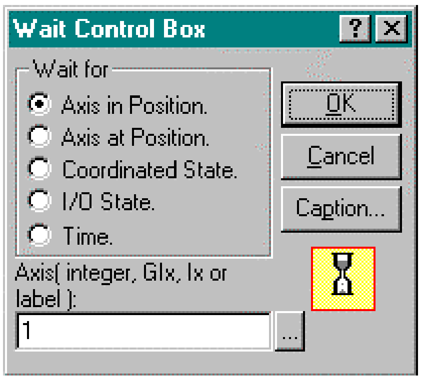
    b. Enter a **1** to specify the axis number.
    c. Enter a distance of **10** and click on *OK.*



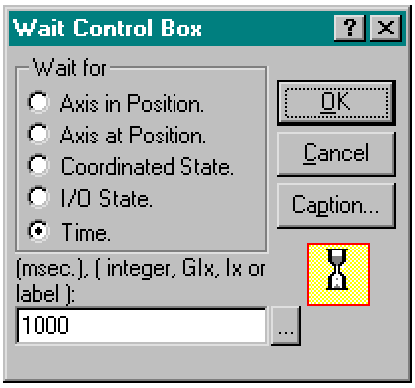
WAIT Icon



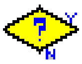
12. Select and place a **WAIT** icon to the right of the *MOVE* icon. The task execution (program flow) will *wait* at this point until the *wait condition* is true. In this case, the task waits until axis 1 is in position.



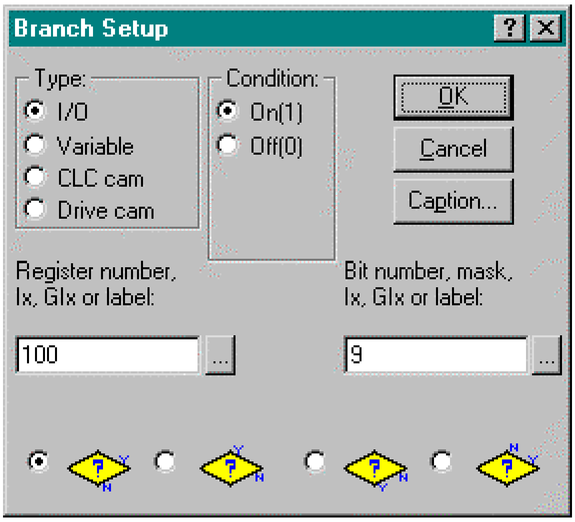
13. Add a second **WAIT** icon below the first and enter a *Time* of 1000 msec. This icon will introduce a pause of 1 sec to the program before proceeding to the next relative move.



Branch Icon



14. Select and place the **Branch** icon to the right of the first *WAIT* icon. This icon re-directs the program flow depending upon a true/false logical value. This creates a loop within the program depending on the value of register 100 bit 9.



Note: The Branch icon will loop back to a specified icon until the branch condition is true. In this example, the *Finish* icon will not be encountered until register 100 bit 9 is on (1.)

Finish Icon

15. Select and place the **Finish** icon to the right of the *Branch* icon. When encountered, the program will end. All *tasks* and *subroutines* must end with the Finish icon.

Line Icon

16. Use the Line icon to connect the icons and show program flow. To connect the icons, click once with the left mouse button on the first icon and then click on the next icon in the program flow. A line will join the icons with an arrow indicating program flow.

Note: If an error is made while connecting two program icons, use the  ***CUT*** icon to remove the created connection line.

Afterwards, re-select the line icon to continue.

The completed program should appear as shown in Fig. 3-2.

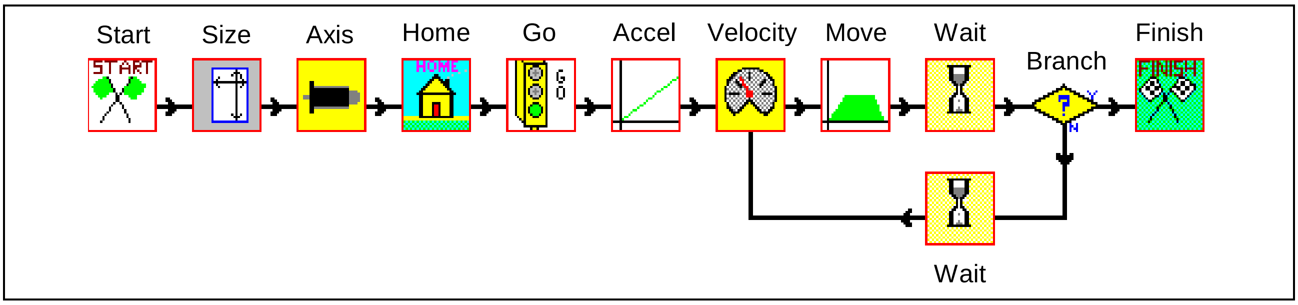


Fig. 3-2: Complete Icon Program

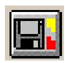
Note: In order to create the loop from the *Branch* icon back to the *Velocity* icon, click on the *Branch* icon first then click on the *Wait* icon. Repeat the step starting with *Wait* icon and finish with the *Velocity* icon.

Save, Compile and Download Program

Save Program

1. To save the program example to a harddrive, select ***File*** ⇒ ***Save As*** and enter the filename "sample.str."

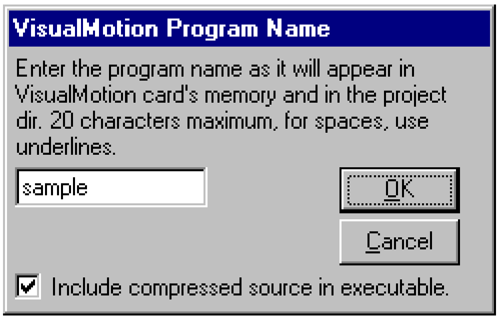
Note: Icon program files are saved with an “*.str” extension at the end of the filename. Refer to Table 3-2 on page 3-26 for other file extensions and their descriptions.

Note: Clicking on the toolbar icon , will automatically cover steps 1-3.

Compile Program

2. Compile the program by selecting ***Compile*** under the ***File*** menu.
   a. The compiler will first check for a complete path from “Start” to “Finish” for each Task and subroutine.
   b. The compiler will then prompt you to enter a name for the program, as it will appear in the control. Use the default name in the text box.

   The compiler will then convert the program to code.



When "*Include compressed source in executable*" is selected, the source ***.str** file is compressed and appended to the ***.exc** file when compiled and download to the control. This allows a customer or service person to upload the ***.str** file from the control.

Current issues when using this feature are:

- Although VisualMotion uses the compress algorithm provided by windows, a large user program may still exceed the per program memory limits of the control.

  CLC max. executable = 108K (GPS-6Vxx/7Vxx)

PPC max. executable = 256K (GPP-7Vxx)

Note: Using this feature can limit the total number of programs that can be concurrently downloaded to the control.

CAUTION

Compressed source program is not password protected.

⇒ Any person knowledgeable about this feature would be able to look at your source program if included.

Retrieving a Compressed Source Program

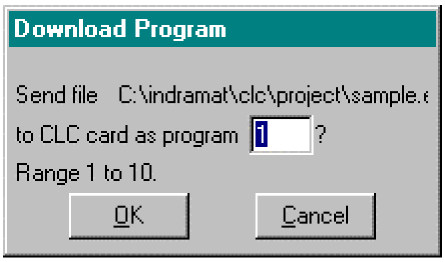
To retrieve a compressed source program, select ***File*** ⇒ ***Open*** and change the ***Files of type:*** to "*Embedded Icon Files(*.exb*.exc)*". Next, save the program to your hard drive and then it will open in VisualMotion.

Click on *OK* and the 2nd compiler information window will appear indicating a successful compile and provide information on the compiled program.

Press *OK* to close the Compiler Information window.

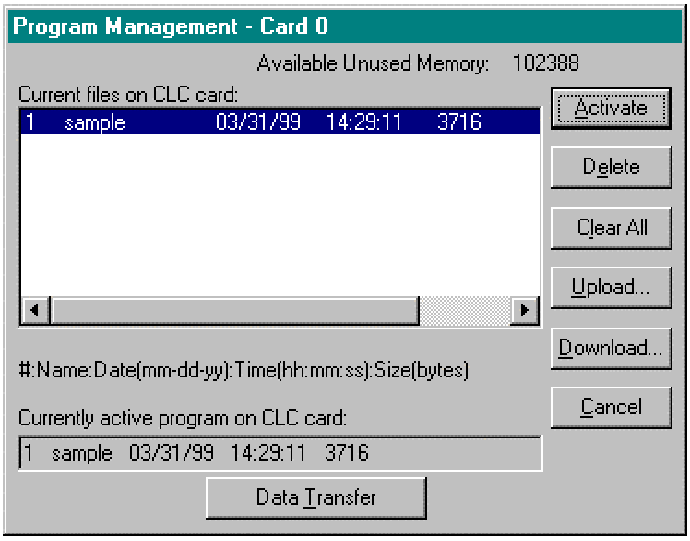
Download Program to the Control

3. Download the program to the control and activate it.
   a. Select ***Program Management*** under the ***File*** menu.
   b. Click on the *Download* button.
   c. Select the program that you just created and click on *Open*. The program will be listed as “sample.exc” under the *Project* folder.
   d. In the Download Program window, enter a program number from 1 to 10 that will be used to identify the VisualMotion program when downloaded to the control.



4. After the download is complete, the program will be automatically highlighted and active in the control if it's the only program. Otherwise, to activate a different program on the control, simply click

and highlight the desired program in the *Current files* field and click on the *Activate* button.



To close the Program Management window, click on *Cancel*.

Program Variables

VisualMotion supports floating-point variables, integer variables and constants. There are three types of program variables:

- Global Variables
- Program Variables
- Local Variables

Global Variables

Global variables, designated GF[#] (Global Float) and GI[#] (Global Integer), are stored in the control's RAM and their values are not retained after power is disconnected. There are 256 global floating points and 256 global integers and they are shared among the programs stored in the control. They can also be used to exchange values between external components of a VisualMotion system that are capable of accessing the global memory area.

Program Variables

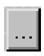
Program variables are designated F[#] and I[#]. The Size icon in VisualMotion determines the number of program variables allocated to a VisualMotion program. Program variables retain their values during power off. The variables can be addressed in a user program by assigning a label to the variable number.

Local Variables

Local or *stack based* variables exist only while in the function (task, subroutine, or event) where they are declared. Local variables are used within a subroutine for local data only. They don't exist outside the subroutine. This type of variable is useful for temporary results within a function or to pass values to a function.

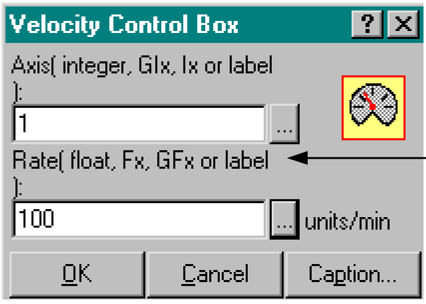
Assigning Labels to Variables

Select ***Labels* ⇒ *User Labels*** under the ***Edit*** menu to assign a label to a variable. A label is simply a name given to a variable, which can help the user identify its function when programming. This can also be done directly within an icon dialog box using the following procedure:

Many programming icons contain a User label button  that opens the User defined Labels window allowing the programmer the ability to create program variables.

Note: Variables can be used to replace numerical values within programming icons. Numerical values within icons that are compiled and downloaded to the control cannot be modified unless changed, re-compiled, downloaded and activated. On the other hand, once compiled and downloaded, variables can be modified within VisualMotion Toolkit by selecting ***Data*** ⇒ ***Variables***. Modified variables are active the next time that specific icon is encountered in the program flow.

Example: Velocity Icon



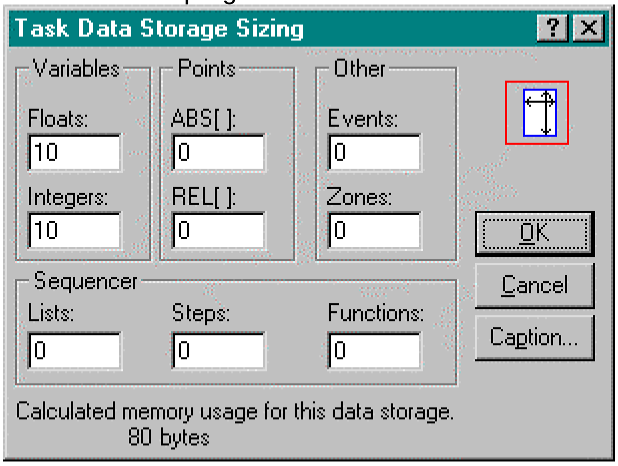
Each icon displays an allowable variable type within the Rate field. In this example, a Rate or velocity can be a float (program or global) or a label.

1. Click on the User label button [...]. The ***User Defined Labels*** window will open.

2. Click the *Add* button to open the ***Add Variable Label*** window.

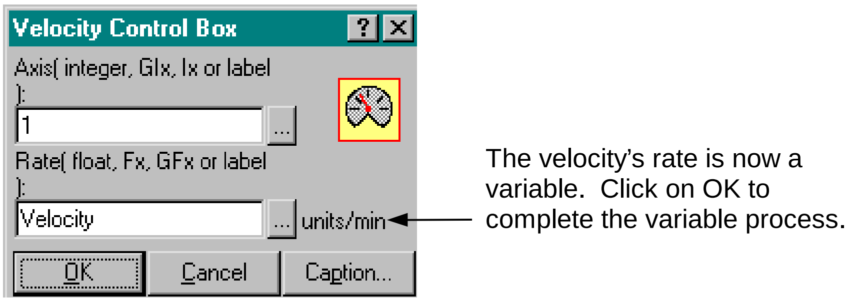
3. Select the ***Type*** of variable to add. Example: constant, floating point or integer.
4. Enter a ***Name*** for the variable.
5. Assign a **1** to the Float (F) label. A second Float variable will receive a 2.

Note: The Size icon determines the number of available variables in a VisualMotion program.



6. Click *Save* to add the variable, then *Close* the *Add Variable Label* window.

7. Highlight the new variable in the *User Defined Labels* window and click *OK*. This will place the new label in the Rate field of the icon's dialog window.



8. Now, use the same procedure to add variables for the **MOVE** icon and the second lower **WAIT** icon.

After all the variables are assigned, Save, Compile and Download the VisualMotion program and activate. To view programmed variables within a VisualMotion program select ***Data*** ⇒ ***Variables***.

Note: When naming a variable, be sure not to use the icon's assigned name in VisualMotion. For example, the *WAIT* icon can be named WAIT_1 but not WAIT.

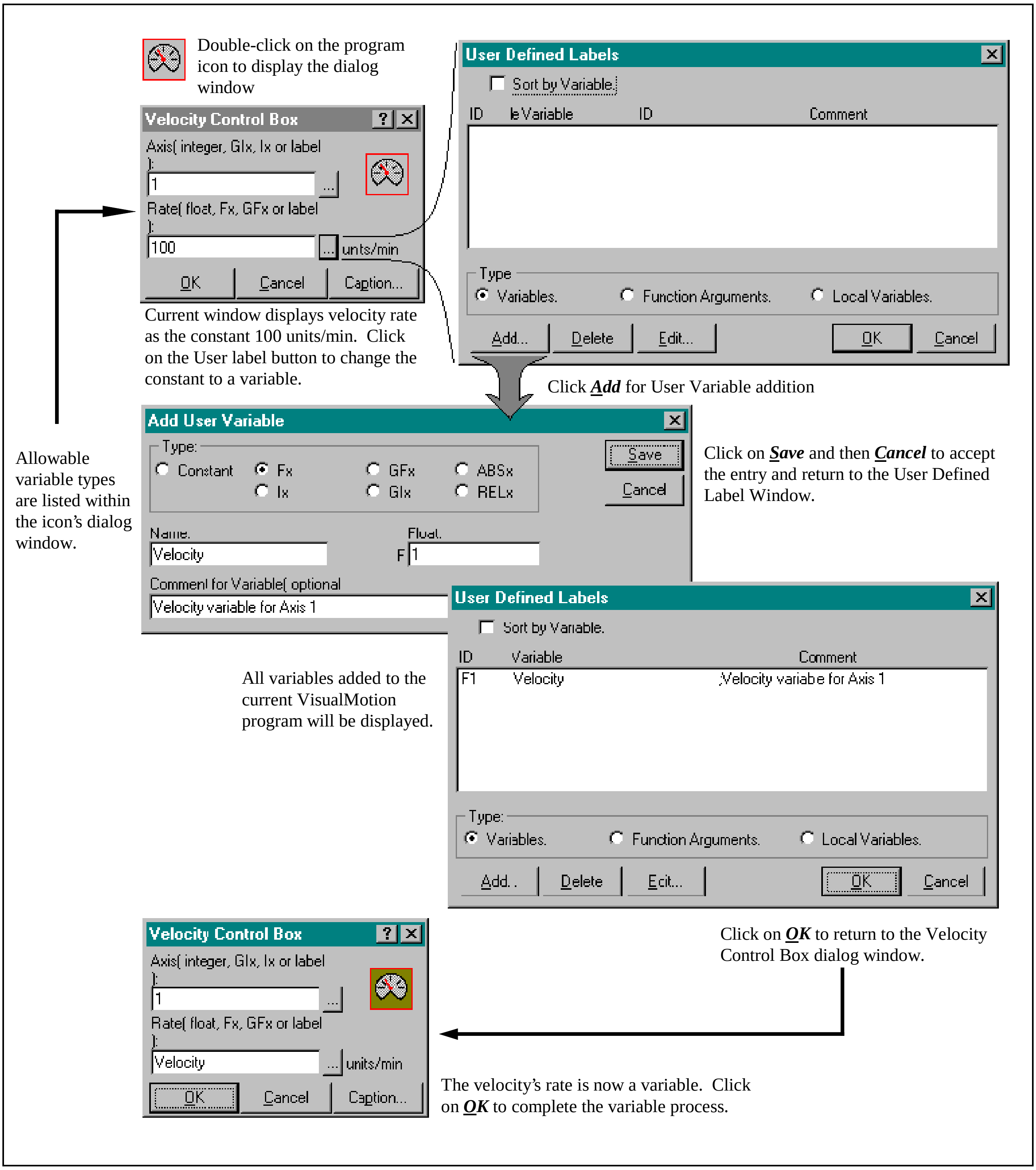


Fig. 3-3: Assigning Variables

Assigning a Value to a Variable

VisualMotion variables are defined by the programmer and are used in programs to enable the user to modify a value in the active VisualMotion program. Modified variables are active the next time the program encounters an icon instruction using that variable. Select ***Data ⇒ Variables*** to view the Active Program, Variable window.

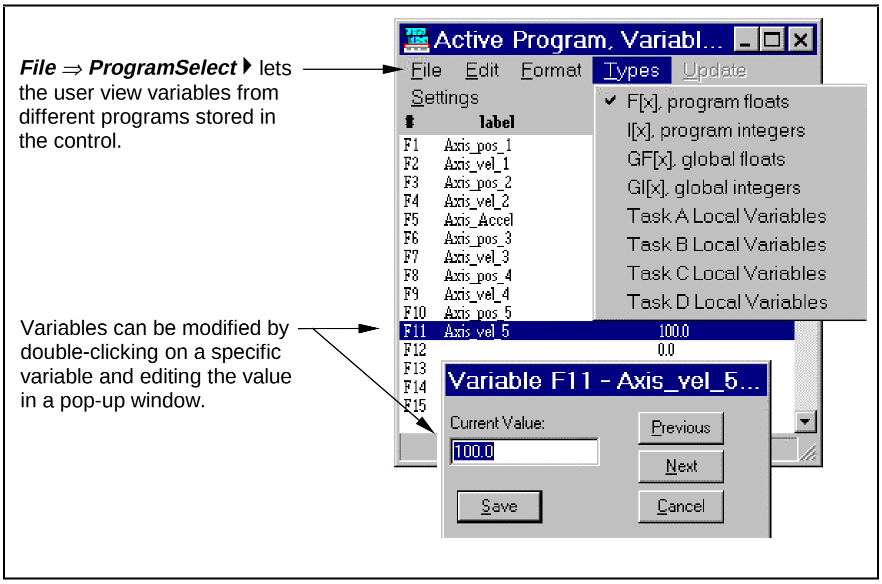


Fig. 3-4: Viewing and Editing Variables

The following variable types are available:

Floating Point Variables (F1-Fx)

A floating-point variable is simply a number containing a decimal point. The number of 32 bit floating point variables is defined in the sizing icon at the beginning of the program and is stored as part of the program.

Integer Variables (I1-Ix)

Integers are signed or unsigned whole numbers, such as 5 or -3. The number of 32 bit Integer variables is defined in the sizing icon at the beginning of the program and is stored as part of the program.

Global Floating Point and Integer Variables (GF1-Gfx;GI1-Gix)

Global variables are available to all programs stored on the control. Global variables are program independent. Multiple programs can write to the same set of global variables.

Task A-D Local Variables

Local variables are created when a task or subroutine starts and are removed when the task or subroutine execution has ended. Arguments can be passed to local variables to allow multiple applications of a common subroutine.

Event functions

Events are basically interrupt driven subroutines. They can be triggered by a variety of methods, such as transition of an input, repeating timer, position trigger, etc..

File Types

Visual Motion uses a number of different file types. Refer to the following chart to identify the file type according to its extension.

Extension	Description
.acc	Text file that ACAM utility converts to a .csv file
.csv	Comma-Separated-Variable type file used to store cam profiles.
.exb	Compiled program file that is uploaded from the control. It is ready to run and contains program data.
.exc	Compiled program file that is downloaded to and executed by the control.
.iom	I/O Mapper files. Text file consisting of Boolean strings.
.lss	Text files where Visual Motion stores register and bit labels used by the .str file.
.lst	Text file that is referred to for registers and bit labels when the registers on the control are viewed.
.map	File used by the “Show Program Flow” function to trace the flow of the program while it is executing.
.pnt	Absolute Point Table
.pos	Text file that PCAM utility converts to a .csv file
.prm	Parameter file in archived format. These files can be transferred to the control.
.str	Graphical icon program file displayed in VisualMotion Toolkit
.tbl	Text file of points created by the control's “Oscilloscope” function.
.var	Old variable file
.vel	Text file that PCAM utility converts to a .csv file
.vtr	New variable file
.mtn	Text language program source file.
.zon	Zone File

Table 3-2: VisualMotion File Extensions

3.4 Program Execution

This section covers program execution, which includes a brief description of the system and task control registers and the I/O Mapper function. Refer to the *VisualMotion Reference Manual* for a more detailed discussion on any of these topics.

Initial Setup Prior to Operation

The following procedure covers the initial setup required to run the program example that was created in Create and Download a Program on page 3-12. The program example should be opened within VisualMotion Toolkit and activated on the control.

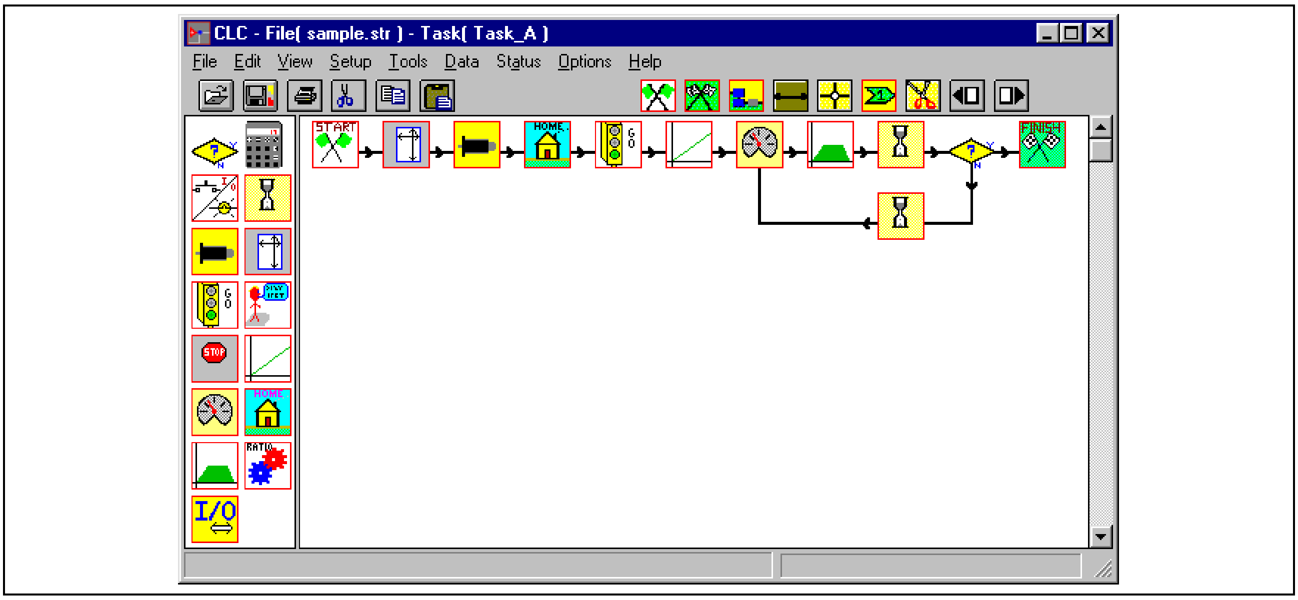
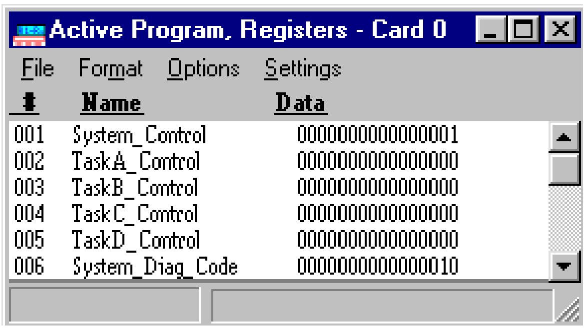


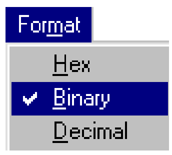
Fig. 3-5: VisualMotion Toolkit Program

Control Registers

Before a VisualMotion program can be activated, key register bits must be set in the System and Task Control registers. Registers 001, *System_Control* and 002, *TaskA_Control* are dedicated as system registers and are used to control program operation. Although the user can modify these registers, we will create an I/O Map using the I/O Mapper function to associate register 100, *User_Inputs_Reg1*, with registers 001 through 005.

VisualMotion registers can be displayed by selecting ***Data*** ⇒ ***Registers*** from VisualMotion Toolkit's (**VMT**) main menu.





Displaying Register bits in Binary Format allows the user to easily view bit states.

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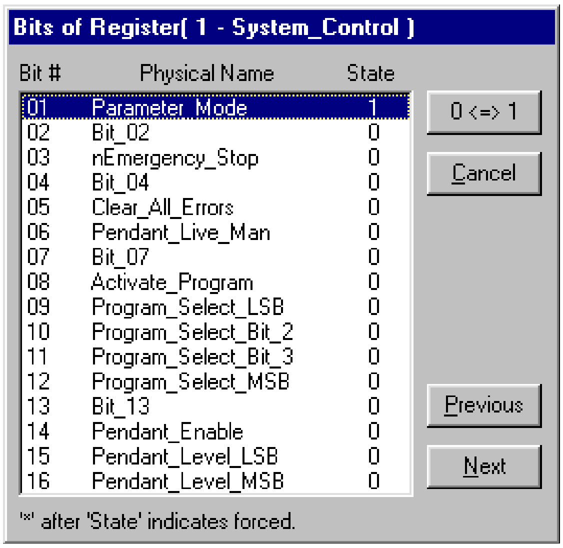
Parameter Mode

Before modifications can be downloaded or updated to the control, the system must be switch to Parameter Mode.

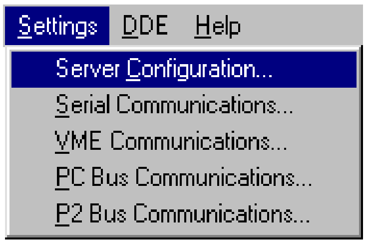
1. Select ***Data*** ⇒ ***Registers*** from VMT's main menu.
2. Double-click on *System_Control* register 001.
3. Click and highlight **Bit #01**, *Parameter_Mode* and select the [0 <=> 1] button to change the **State** of **Bit # 01** from 0 to 1.



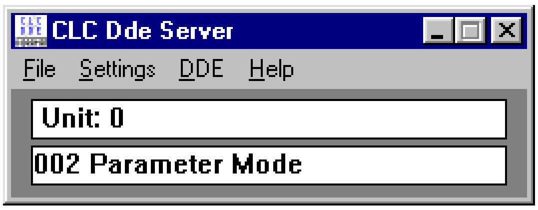
CLC DDE Server

4. The control and drive should now be in Parameter Mode. To confirm the status of the system, use the DDE Server. (Use Alt-Tab to display if already running)

   a. To display control system status on the DDE Server, select ***Settings*** ⇒ ***Server Configuration…*** and set CLC Status Display to **SERIAL_0** and Save.



   b. If Parameter Mode was successful, the DDE Server will display…



   c. Otherwise, the display will read…

Note: If the display status of the DDE Server does not change to Parameter Mode, then register 001 bit 01 is already mapped to another register. If this case, use the following information on the I/O Mapper to correct the situation.

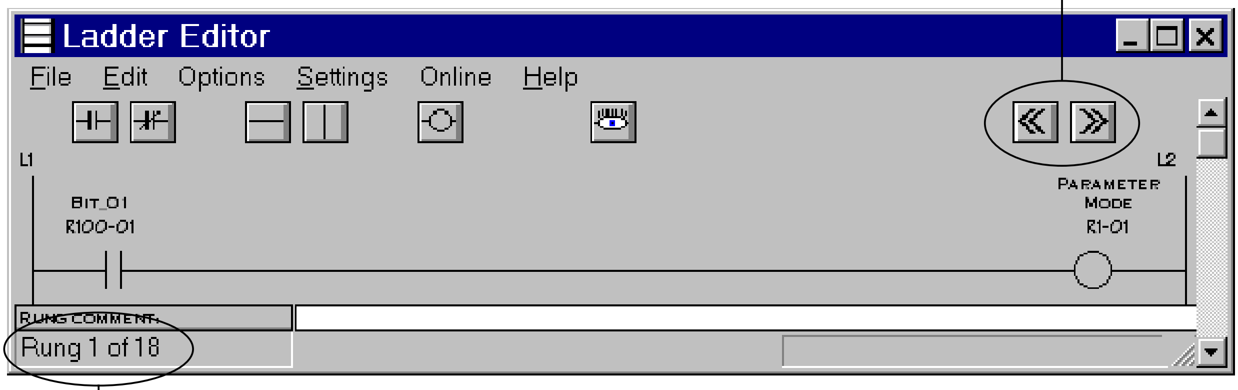
I/O Mapper

The I/O Mapper is a user programmed PLC logic task that automatically starts once the control has successfully completed its power-up sequence. The I/O Mapper is displayed by selecting ***Data ⇒ I/O Mapper***. VisualMotion's I/O Mapper task allows manipulation of I/O register bits that can be programmed using Boolean strings or a ladder logic interface.

Uploading I/O Mapper

Select ***File ⇒ Upload Strings*** to view existing I/O Mapper strings currently in the control.

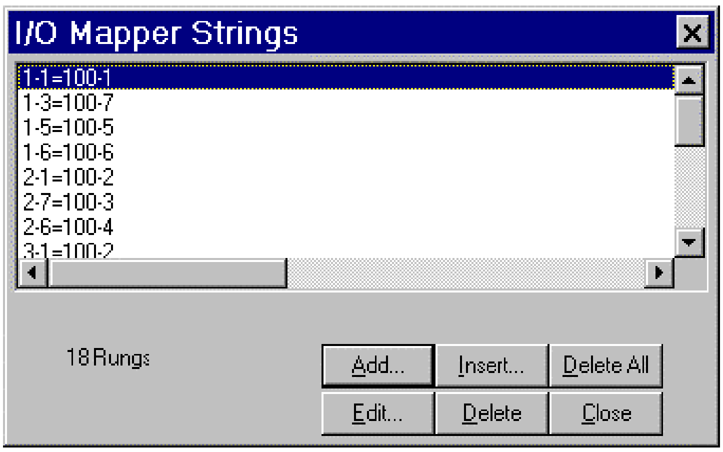
Next/Prev Rung arrows



Only one rung of logic is displayed at a time. To view the next rung, use the next/prev. rung arrows.

Note: If the first rung on the I/O Mapper is blank, then the control does not contain an I/O Mapper program.

To view the I/O Mapper in Boolean equation form, select ***Display Strings*** from the ***Options*** menu.



Considering the above I/O Mapper Strings, register 001 - bit 01 is map to register 100 - bit 01. In this case, the state of register 100 - bit 01 will control the Parameter Mode function of the system.

To switch the system to Parameter Mode…

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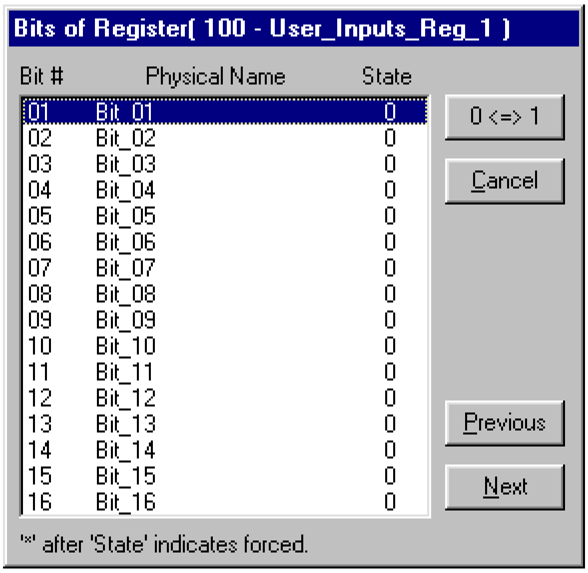
1. Close all I/O Mapper windows and return to VMT’s main window.
2. Select **Data** ⇒ **Registers** to open the Active Program Registers window.
3. Click and hold the scroll bar button and scroll down to register 100.

Note: Register numbers appear at the top of the window as you scroll down or up.

4. Click and highlight **Bit # 01** and select the 0 <=> 1 button to change the **State** of **Bit # 01** from 0 to 1.

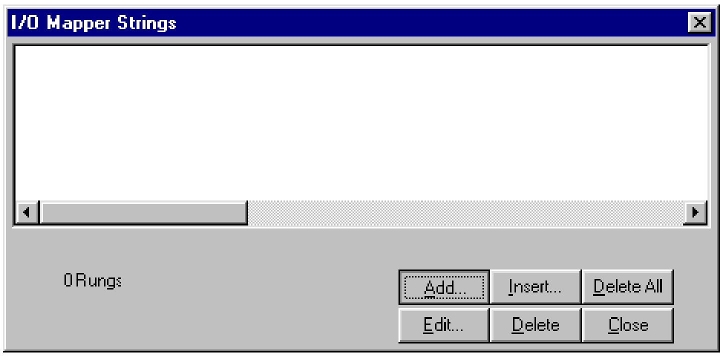


The DDE Server should now display *002 Parameter Mode*.

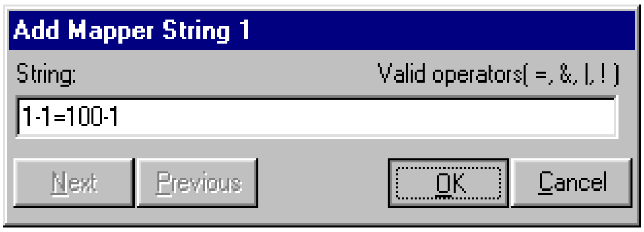
Example I/O Mapper Creation

In this example, Register 001 - bit 01, Parameter Mode, will be mapped equal to the bit state of Register 100 - bit 01.

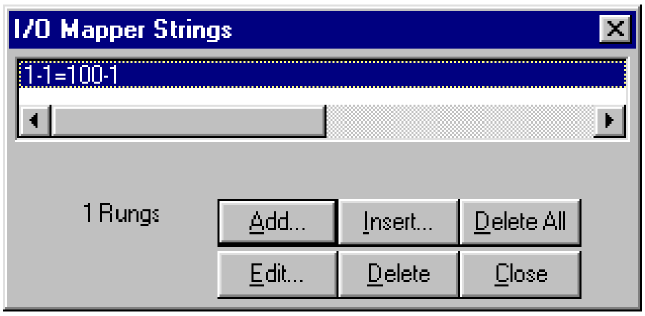
1. Select ***Data*** ⇒ ***I/O Mapper*** to open the Ladder Editor window.
2. From the Ladder Editor window, select ***Options*** ⇒ ***Display Strings***.



3. Click the **Add…** button and enter the following strings.

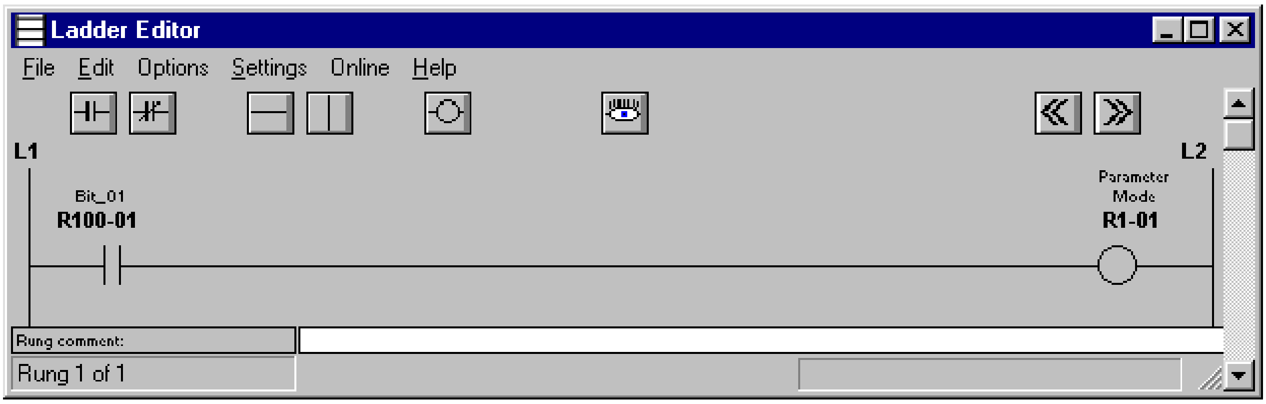


4. Click *OK* and then *Cancel* to close the *Add Mapper String* window.



5. Now click on *Close* to return to the *Ladder Editor* window.

The Ladder Editor window now contains a Rung that illustrates Register **100-01** as an open contact and Register 1-01 as a relay coil. The symbolic relay coil can not be energized (Parameter Mode Active) until the contact **R100-1** is closed. This illustrates the relationship between Register 100 and Register 1.



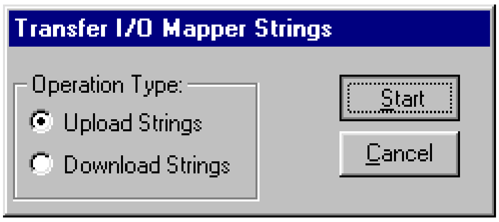
Download I/O Mapper Strings

VisualMotion installs a default I/O Mapper file under the following folder directory: **\\Indramat\vm7\param**

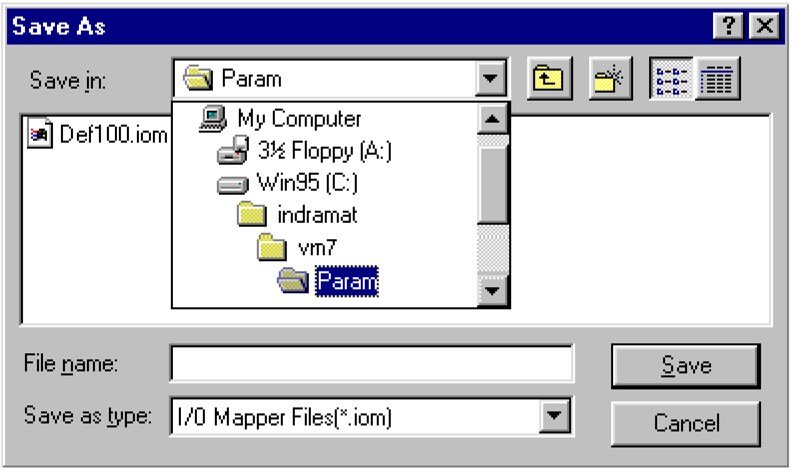
The following I/O Map can either be downloaded using the following procedure or created as described earlier.

Note: The system must be in Parameter Mode before proceeding.

6. From VMT's main menu select ***File ⇒ Transfer I/O Mapper***. Next, click on the Download Strings radio button and the press *Start* to begin downloading the I/O Mapper Strings.



7. Search for the harddrive path below and select the default I/O Mapper file (Def100.iom).



The default I/O Mapper file, *Def100.iom*, is simply a text file that contains the following strings:

Actual strings found in Def100.iom

1-1=100-1	*Parameter Mode*	**4-1=100-2**	*Auto/Manual Mode Task C*
1-3=100-7	*Emergency Stop*	**4-7=100-3**	*Stop Task C*
1-5=100-5	*Clear all Errors*	**4-6=100-4**	*Start Task C*
1-6=100-6	*Pendant Live Man Switch*	**5-1=100-2**	*Auto/Manual Mode Task D*
2-1=100-2	*Auto/Manual Mode Task A*	**5-7=100-3**	*Stop Task D*
2-7=100-3	*Stop Task A*	**5-6=100-4**	*Start Task D*
2-6=100-4	*Start Task A*	**120-1=21-1**	*Parameter Mode*
3-1=100-2	*Auto/Manual Mode Task B*	**120-2=21-5**	*Error Detected*
3-7=100-3	*Stop Task B*		
3-6=100-4	*Start Task B*		

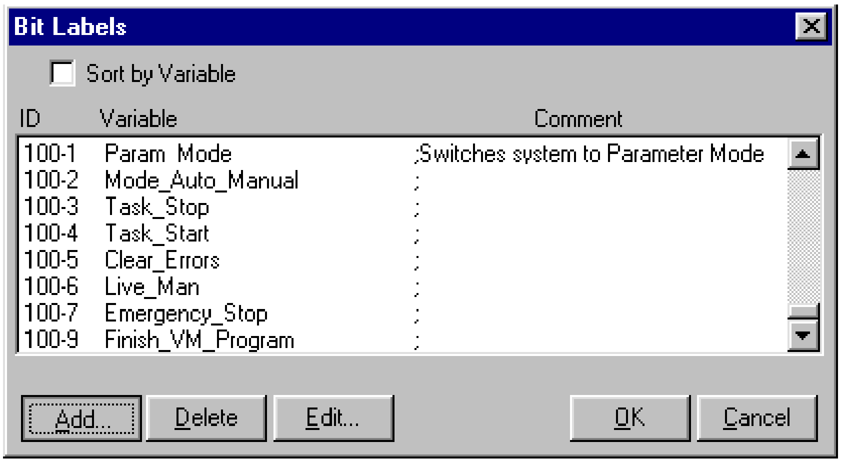
System Status Outputs can be used for external monitoring

String description not found in file

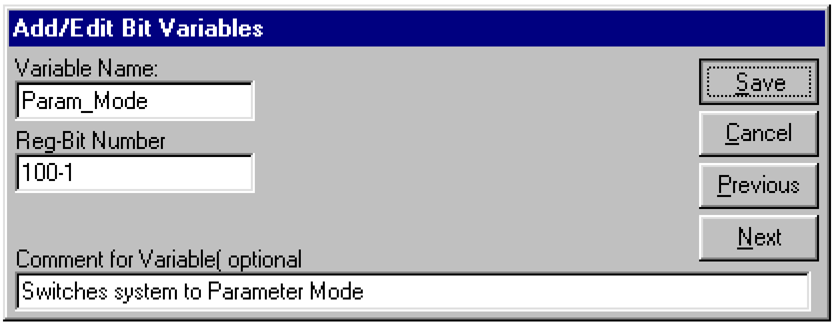
Bit Labels

Bit labels are names given to register bits making them easier to identify and use. Bit label information is saved with each VisualMotion user program file. Once the following labels have been added, the sample program must be saved, compiled, downloaded and activated in the control.

1. Select ***Labels*** ⇒ ***Bit Labels...*** under the Edit menu.



2. Select *Add...* and enter the labels shown above for **Reg.-Bit Number 100-1** to **100-9**.

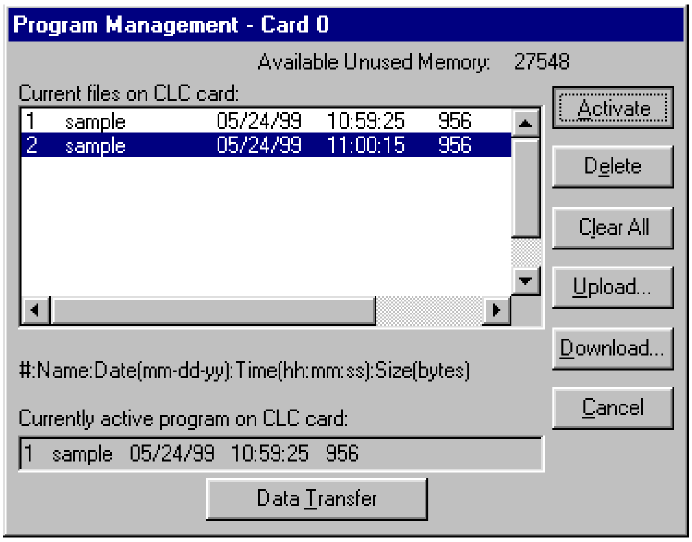


3. After adding the last bit label, click on *Cancel* to close the *Add/Edit Bit Variables* window. Now, click on the *OK* button to close the Bit Labels window.

4. Select ***Save, Compile, Download*** from the ***File*** menu or select the icon from the Toolbar.

5. After the download is complete, select ***File*** ⇒ ***Program Management*** and click on the *Activate* button. To activate a different program, highlight the file and activate.

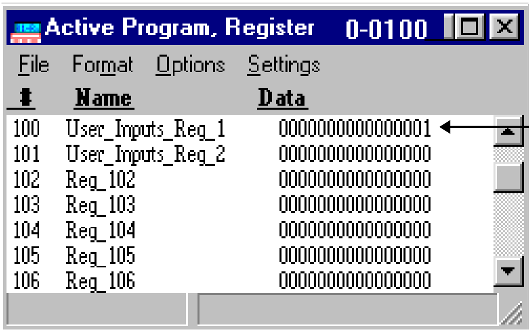
Note: If a program is activated while a different program is currently running, VisualMotion Toolkit will issue an error. Stop all motion before activating a new program.



3.5 Run VisualMotion Program

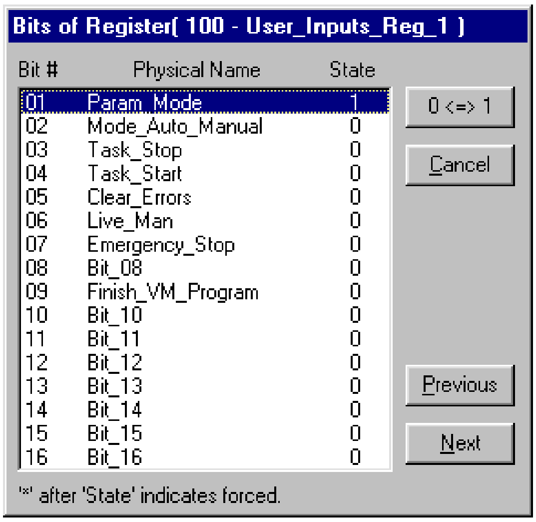
The following procedure covers program execution and operation. Before following this procedure be sure that the initial setup covered in section *Program Execution* on page 3-27 has been completed. The program should be opened within VisualMotion Toolkit and activated in the control.

1. Select ***Data*** ⇒ ***Registers*** from the main menu. Scroll down to register 100 and double-click on it to open.



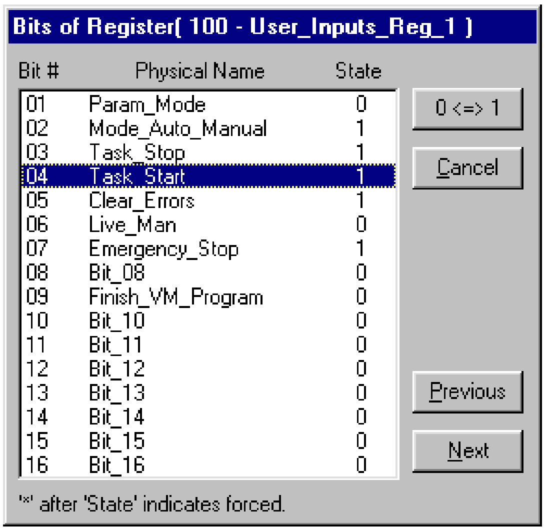
Bit (one) is high indicating that the system is in Parameter Mode.

The bits should now be listed along with their corresponding labels (Physical Name).



2. Change the state of the following bits as listed in the order shown below:

Bit	Label	State
07	Emergency-Stop	0 to 1
01	Param_Mode	1 to 0
05	Clear_Errors	0 to 1
02	Mode_Auto_Manual	0 to 1
03	Task_Stop	0 to 1
04	Task_Start	0 to 1

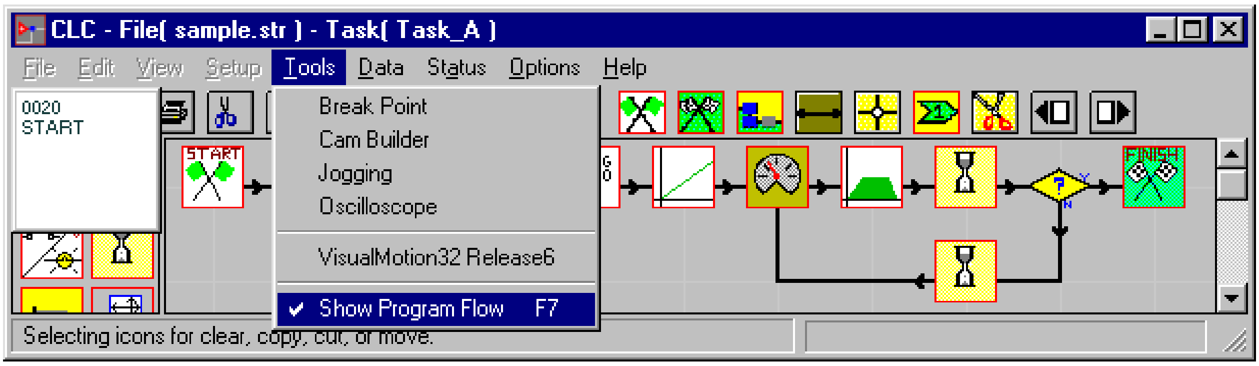


3. The program should now be running with the bits in this state.

Note: If variables were added to the sample program, make sure that they have been assigned a value before starting the program. Refer to *Assigning a Value to a Variable* on page 3-25.

Note: If the program has been started prior to adding values to the variables, the program will not run because all variable values are initially zero. Stop the program by changing the state of bits 3 and 4 from 1 to 0. Once values have been added, reinitialize the program by changing the state of bits 3 and 4 back to 1.

To view which program icon is being processed within VisualMotion Toolkit, select ***Tools*** ⇒ ***Show Program Flow*** or press **F7** on the keyboard to turn the feature on or off.



Rexroth Indramat

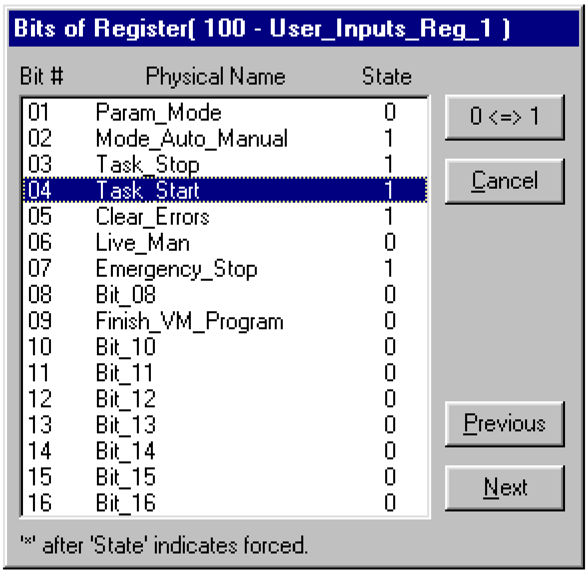
Program Operation

Changing the state (0 <=> 1) of any one of the following bits in Register 100 will stop the program from running.

Bit	Label	State
01	Param_Mode	1
02	Mode_Auto_Manual	0
03	Task_Stop	0
07	Emergency-Stop	0
09	Finish_VM_Program	1

If the program was stopped using bit 100-7, *Emergency Stop,* or from an error, bit 100-5 *Clear_Errors* must be toggled from 1 to 0 to 1 before running again.

To run the program again, toggle bit 100-4 *Task Start* from 1 to 0 to 1 with the other bits in the state shown below:



Note: In order to start the program from the very beginning, toggle bit 100-2, *Mode_Auto_Manual*, from 0 to 1 prior to toggling the *Task_Start* bit.

3.6 Demo Programs

Linear Motion Application Demos

As part of the installation of VisualMotion Toolkit 7, two sample programs are installed along with the application. The programs are both linear motion applications and are called…

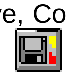
- Position Mode (filename demo_1.str)
- Coordinated Mode (filename demo_2.str)

These programs can be opened in VisualMotion Toolkit by selecting ***File* ⇒ *Sample Programs***. Both application demos automatically setup all the required variables and values. The user simply starts the programs using the appropriate user register and bits.

Setup

Use the following steps to load, compile, download and run each sample program.

1. Start the VisualMotion Toolkit program. From the main menu select ***File* ⇒ *Sample Programs* ⇒ *Position Mode*** or ***Coordinated Mode***

2. The next step will be to Save, Compile and Download the program to the control. Click on the  button. Once the file has been downloaded to the control, select it from the *Program Management* window and click on the “Activate” button.

3. Use the default I/O Mapper (Def100.iom) located in directory ***Indramat/vm7/param.*** Refer to *I/O Mapper* on page 3-29.

4. The run each demo program, select register 100 from ***Data* ⇒ *Registers*** and change the state of the following bits.

Bit	Label	State
07	Emergency-Stop	0 to 1
01	Param_Mode	1 to 0
05	Clear_Errors	0 to 1
02	Mode_Auto_Manual	0 to 1
03	Task_Stop	0 to 1
04	Task_Start	0 to 1
10	Motion start Bit	0 to 1

Refer to *Run VisualMotion Program* on page 3-34 for examples.

VisualMotion Icon Program – Position Mode (Single Axis)

Position Mode (demo_1.str) is a single axis program that when started using register 100, loads and sets up the axis and required variable values. The program then waits for the activation of register 100 bit 10 to begin motion. Once motion begins, values for the variables can be modified by selecting ***Data*** ⇒ ***Variables*** and changing the program variables.

Single Axis Program Variables

The following variables are used in this program and have been assigned a corresponding label:

F1 - Return_Position	I1 - Timer_1 (Return Dwell)
F2 - Forward_Position	I2 - Timer_2 (Forward Dwell)
F3 - Return_Speed	I3 - Part_Counter
F4 - Forward_Speed	
F5 - Accel_Rate	

Note: The dash lines in the following figure are used to simply point the subroutines that are being called out in the program. They are not connection lines in the actual program

To view subroutines in a VisualMotion program select ***View*** ⇒ ***Subroutines*** and select the desired subroutine.

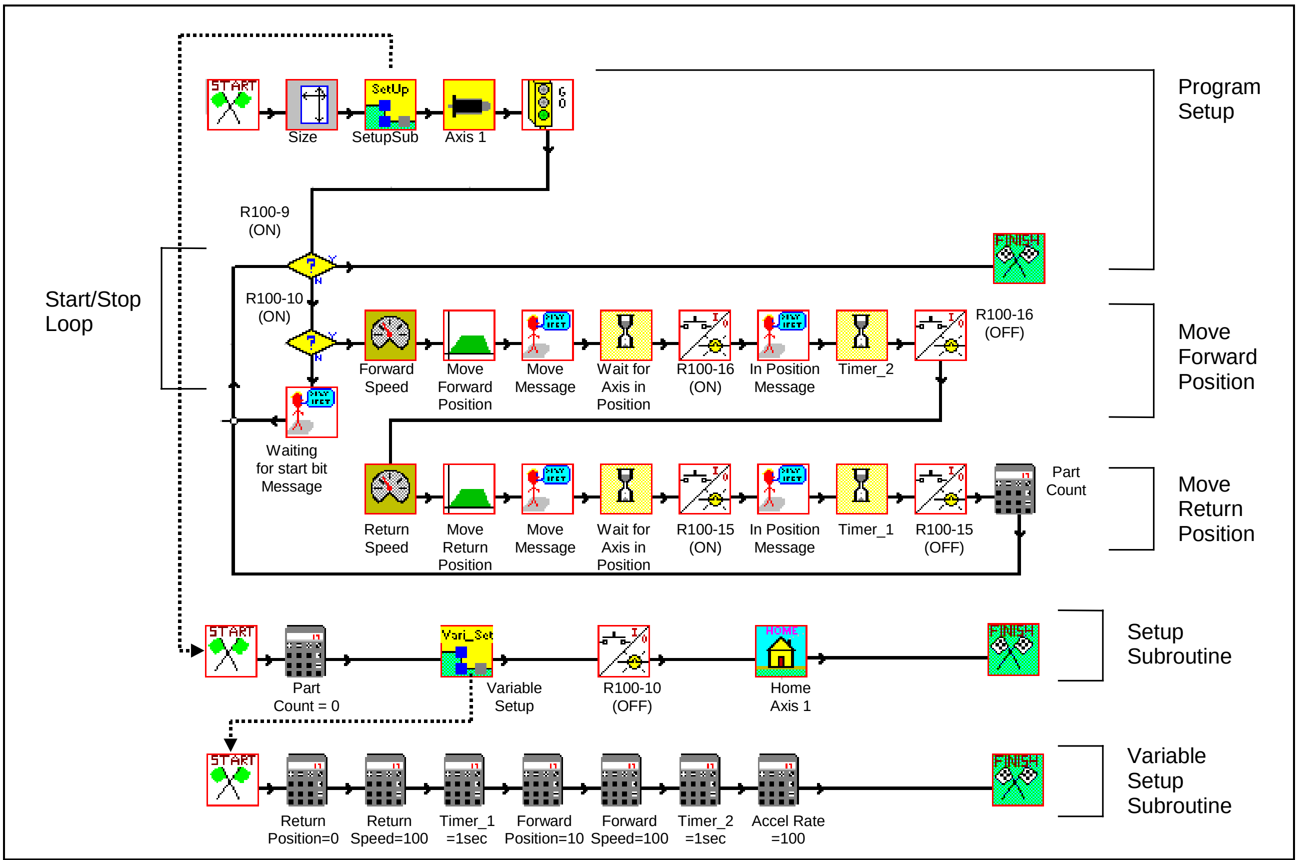


Fig. 3-6: Position Mode Sample Program

Program Setup

The section in Fig. 3-7 starts the program, allocates memory space for variables and sets up axis 1. A setup subroutine is then executed. The Go icon enables axis 1 for non-coordinated motion. The branch icon continues the program if register 100 bit 9 = 0. If the bit is high (1), the program will end.

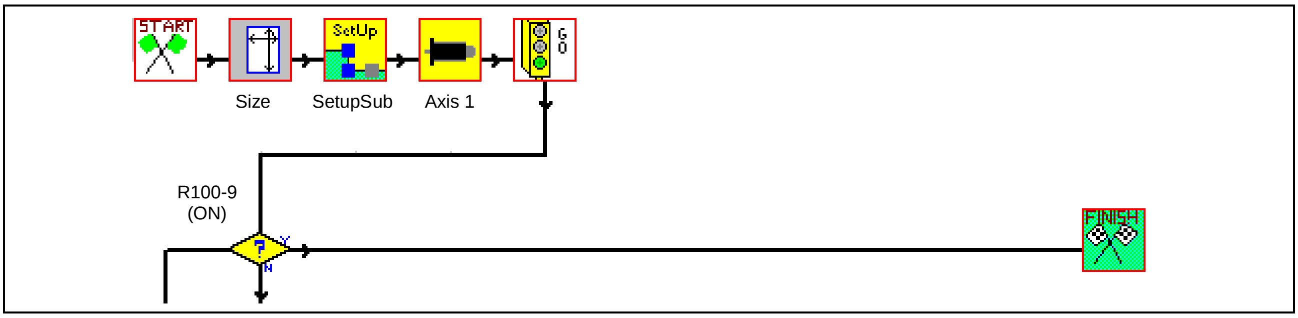


Fig. 3-7: Program Setup

Start / Stop Loop

The section in Fig. 3-8 starts and stops forward and return motion dependent on register 100 bit 10. If bit 10 is off the program will loop through the "Waiting for Start Bit" message icon. If bit 10 is on, the program will continue down to the forward and return move sections. After each cycle the program returns to this branch, adds 1 to the part count and then checks the status of bit 10 again.

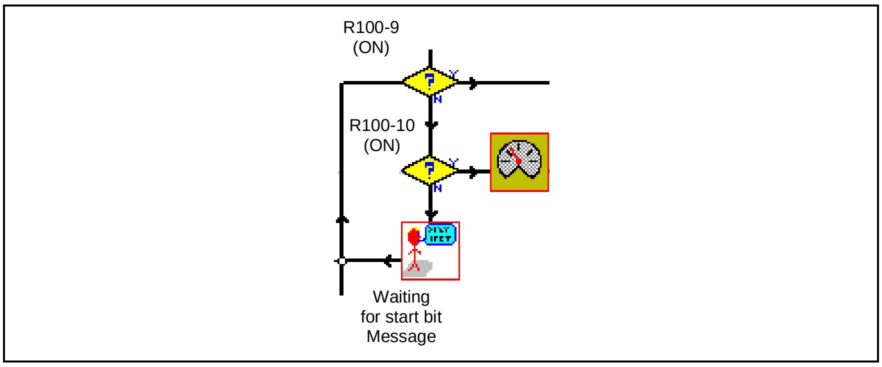


Fig. 3-8: Start / Stop Loop

Move Forward Position

The section in Fig. 3-9 sends the velocity rate value (*Forward_Speed*) and move distance value (*Forward_Position*) to the drive and initiates the forward position move. The message icon sends a "Moving to forward position" status message. The wait icon suspends further program execution until the axis has reached the forward position. Once in the forward position, register 100 bit 16 turns on the "in position" indicator light on the interface. The second wait icon is used to cause the forward dwell (*Timer_2*). After the dwell, register 100 bit 16 is turned off (reset to 0).

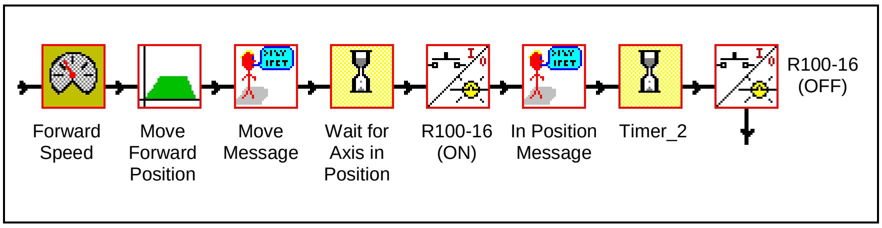


Fig. 3-9: Move Forward Position

Move Return Position

The section in Fig. 3-10 sends the velocity rate value (*Return_Speed*) and move distance value (*Return_Position*) to the drive and initiates the reverse position move. The message icon sends a "Moving to return position" status message. The wait icon suspends further program execution until the axis has reached the reverse position. Once in the return position, register 100 bit 15 turns on the "in position" indicator light on the interface. The second wait icon is used to cause the return dwell (*Timer_1*). After the dwell, register 100 bit 15 is turned off (reset to 0).

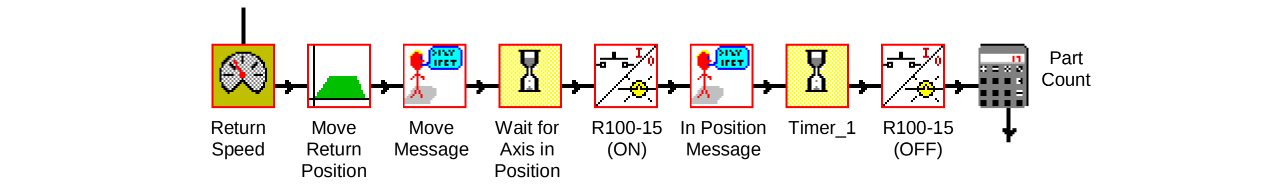


Fig. 3-10: Move Return Position

Setup Subroutine (Counter Reset)

The subroutine in Fig. 3-11 resets the part counter to zero and runs the following Variable Setup subroutine. It moves Axis 1 to its home position. After running the subroutine the program returns back to Task A.

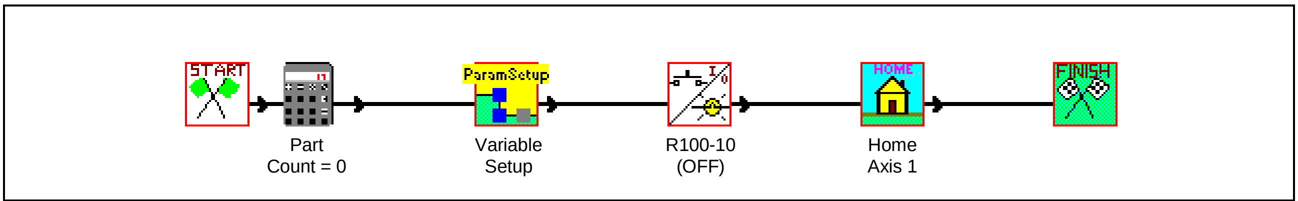


Fig. 3-11: Setup Subroutine (Counter Reset)

Variable Setup Subroutine

The subroutine in Fig. 3-12 sets the variable values for all Floats and Integers. The user can make changes to these variables by selecting ***Data ⇒ Variables***.

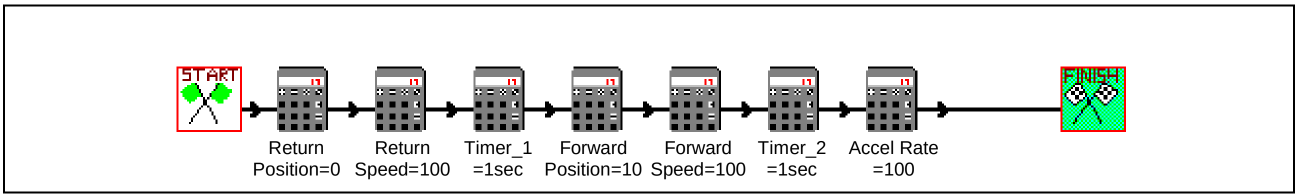


Fig. 3-12: Variable Setup Subroutine

F1 - Return_Position	I1 - Timer_1 (Return Dwell)
F2 - Forward_Position	I2 - Timer_2 (Forward Dwell)
F3 - Return_Speed	I3 - Part_Counter
F4 - Forward_Speed	
F5 - Accel_Rate	

VisualMotion Icon Program - Coordinated Mode

Coordinated Mode (demo_2.str) is a coordinated motion program that is similar to *Position Mode* with the exception of movement type. *Coordinated Mode* uses a series of points within an absolute point table that contains the values required for motion. The starting and ending of *Coordinated Mode* is identical to that of *Position Mode*.

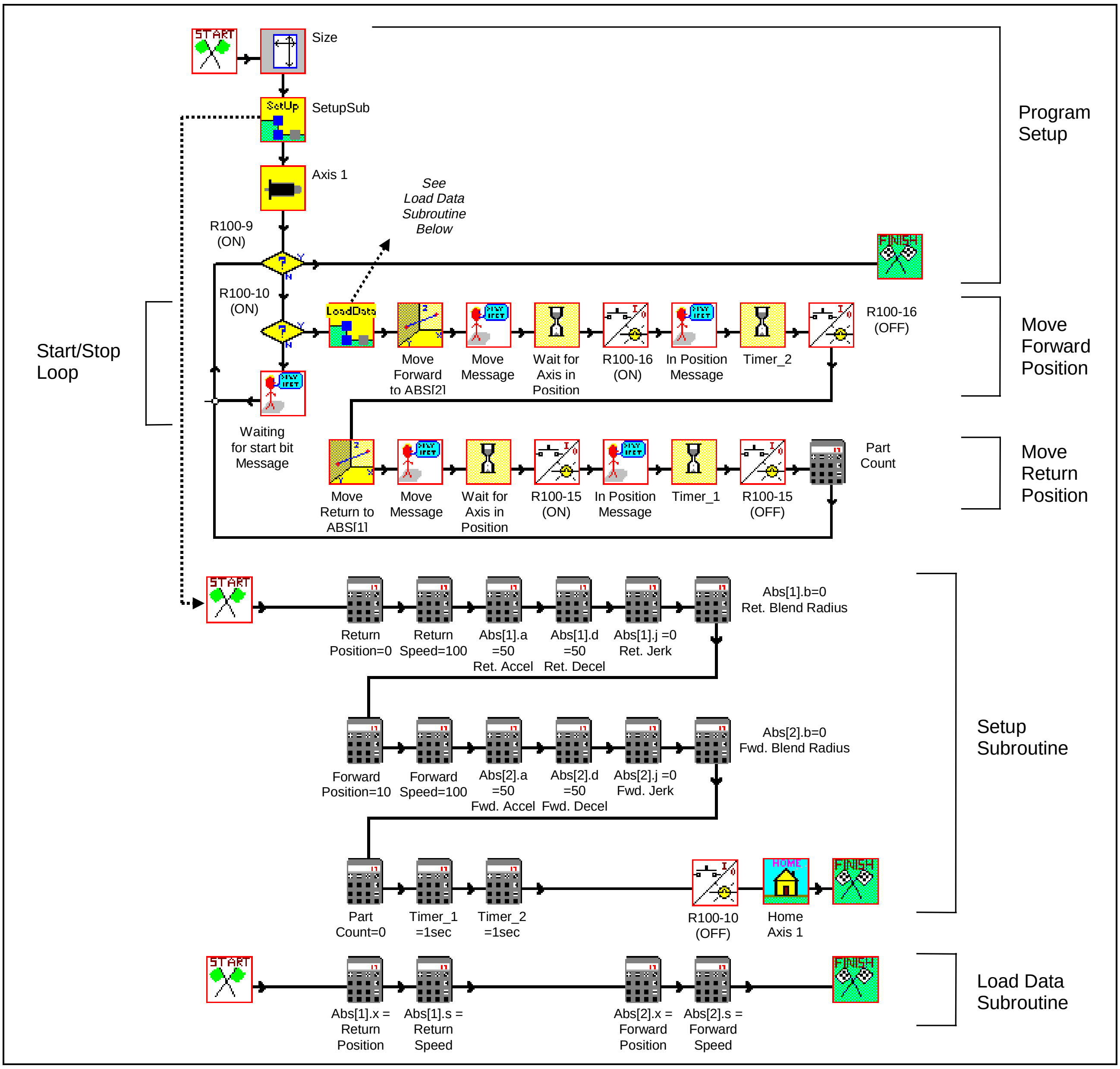


Fig. 3-13: Coordinated Mode Sample Program

Move Forward Position

Coordinated Mode uses coordinated motion. The velocity and move icons used in *Position Mode* have been replaced with a load data subroutine and a path icon. The load data subroutine (refer to Fig. 3-17) assigns values to the absolute point table.

Path Icon

The path icon uses these values to set up coordinated absolute motion. An absolute move begins from the current position (or the endpoint of the previous path segment) and terminates at the absolute point specified. In this case the forward position would be ABS[2]. Speed, acceleration and deceleration values are also provided with each point move.

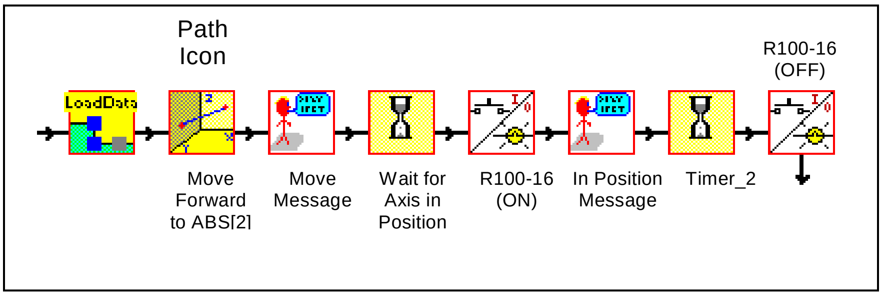
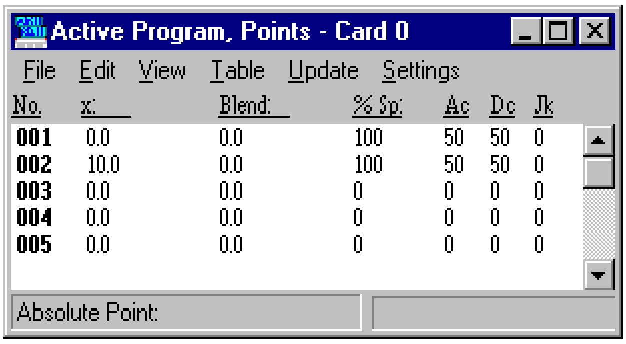


Fig. 3-14: Move Forward Position

The absolute point table can be viewed by selecting ***Data*** ⇒ ***Points***.



No.	x:	Blend:	% Sp:	Ac	Dc	Jk
001	0.0	0.0	100	50	50	0
002	10.0	0.0	100	50	50	0
003	0.0	0.0	0	0	0	0
004	0.0	0.0	0	0	0	0
005	0.0	0.0	0	0	0	0

Fig. 3-15: Absolute Point Table

The return position is ABS[1], so the return move will begin at ABS[2] and then end at ABS [1].

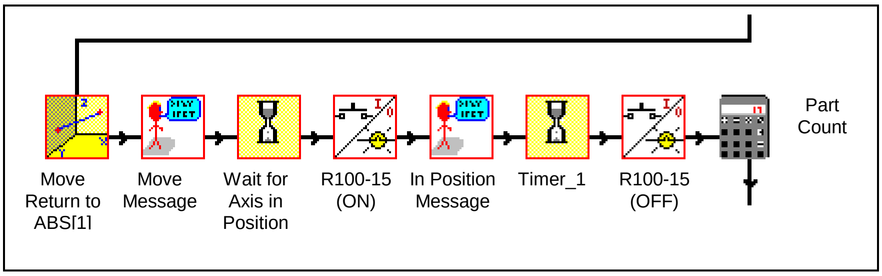


Fig. 3-16: Move Return Position

Load Data Subroutine

The subroutine in Fig. 3-17 associates the variables F1-F4 (Return/Forward Position and Speed) to the absolute point table (Abs[1].x, Abs[2].x, Abs[1].s, Abs[1].x).

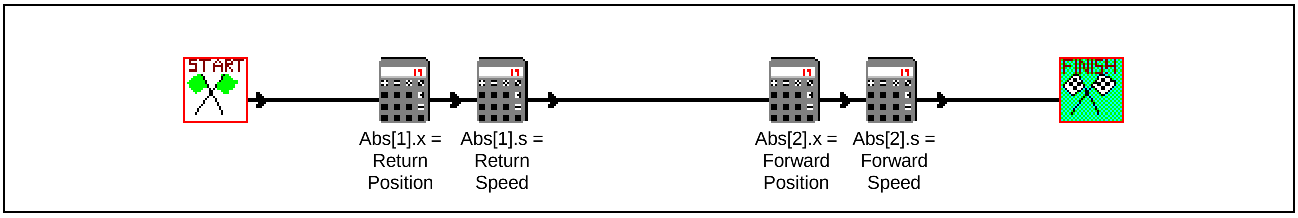


Fig. 3-17: Load Data Subroutine

Variable and Point Table Setup Subroutine

The variable and point table subroutine in Fig. 3-18 assigns values to the associations made within the load data subroutine for Forward/Return Position and Speed. This subroutine also adds values to the absolute point table for axis acceleration (Abs[#].a), deceleration (Abs[#].d), jerk(Abs[#].j, and blend radius (Abs[#].b). In addition, the axis is homed and register 100 bit 10 is turned off.

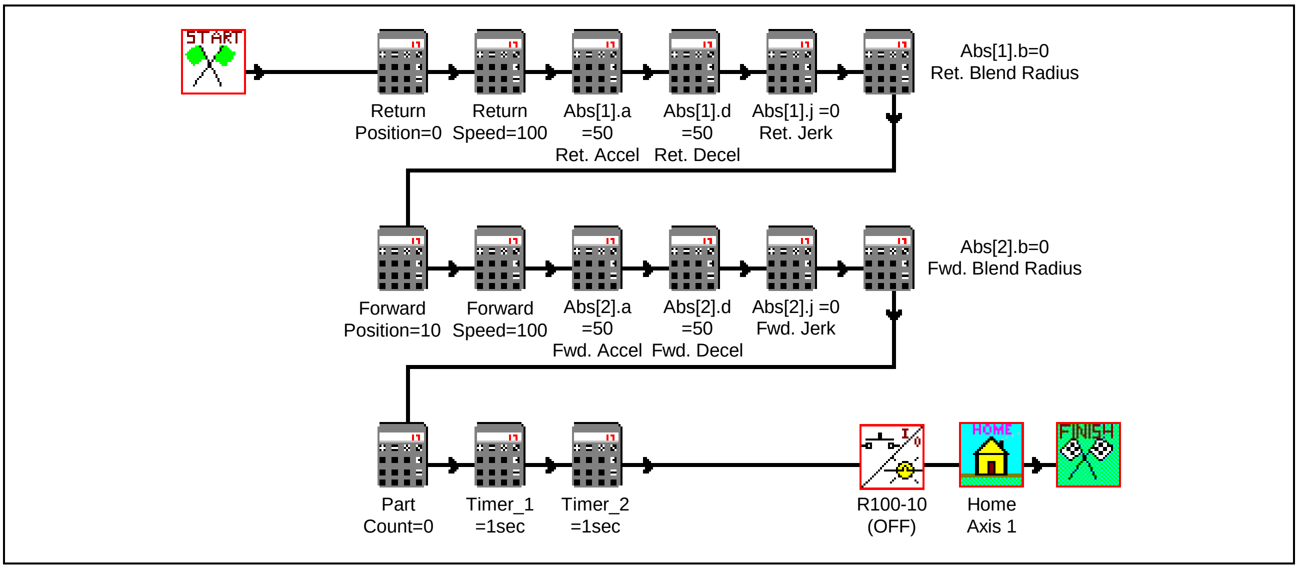


Fig. 3-18: Variable and Point Table Setup Subroutine

4 Multiple Master Overview

4.1 VisualMotion GPP Overview

The Multiple Master functionality of GPP 7 provides the ability of having more than one active master at a time. Electronically synchronized axes can be combined to form Electronic Line Shafting (ELS) Groups. Active masters can control a maximum of eight ELS Groups. Every ELS Group will follow its selected master.

GPP 7 supports six system masters in any combination up to a maximum of the following types:

- 2 Virtual Masters
- 3 Real Masters
- 4 ELS Group Masters

The example configuration in Fig. 4-1 shows 2 Virtual Masters, 2 Real Masters, 1 ELS Group Master (5 masters) and 4 ELS Groups.

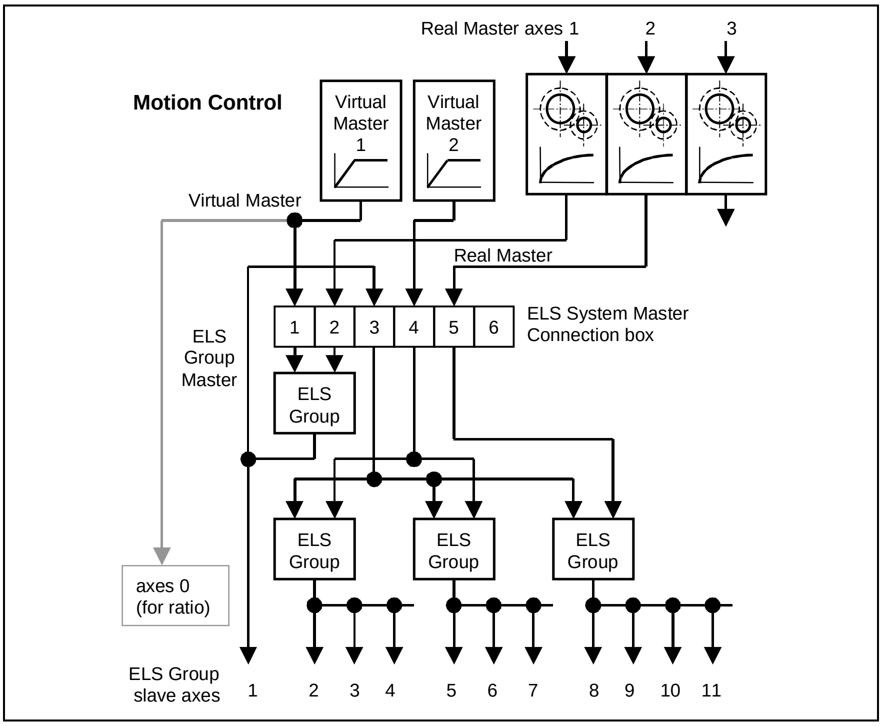


Fig. 4-1: Multiple Master Configuration Example

4.2 Multiple Master Overview

The following overview outlines the main areas of the Multiple Master functionality in GPP firmware.

Virtual Master

Two independent Virtual masters provide positional command signals that are used to drive a group of axes or programmable limit switches. A Virtual Master has two primary modes of operations:

- Velocity Mode
- Position Mode

Refer to chapter 5.2 *Virtual Master* for details.

Real Master

A Real Master is either a primary (motor) or secondary encoder (position feedback) from a drive. Each drive in the system can potentially provide two Real Masters. The raw position value of the Real Master can be filtered and geared by a M/N ratio. A maximum of three Real Masters can be assigned.

ELS Group Master

An ELS Group Master is the output of an ELS Group used as an input master signal, geared by an M/N ratio, to a different ELS Group.

ELS System Master

Virtual Masters, Real Masters and ELS Group Masters can be combined and assigned to one of 6 ELS System Masters. The master signal from each active system master is conditioned (e.g., geared or filtered) and made available for controlling groups of axes. Refer to 5.3 *Electronic line Shafting Master Assignment* for details.

ELS Group

An ELS Group is defined as a set of slave axes that follow the position command signal from one of the 6 System Masters. By using ELS Groups, slave axes are sectionalized into functional groups that can easily control each machine section as an independent process. During operation, an ELS Group can be switch between master signals. Any changes to ELS Group parameters are immediately available to all axes assigned to a group, keeping the machine section precisely synchronized. Refer to 5.4 *ELS Line Shafting Groups* for details.

5 Multiple Master Functionality in VisualMotion 7 (GPP)

5.1 Initialization of VisualMotion's Multiple Master Functionality

The Multiple Master functionality in VisualMotion is initialized and controlled using the registers and program variables of the associated VisualMotion program.

Assigning Registers in VisualMotion

VisualMotion provides 512 registers for controlling and monitoring of the program. Table 5-1 shows a listing of predefined registers.

Register Number	Register Label
1	System Control
2-5	Task A-D Control
6	System Diagnostic Code
7-10	Task Jog Control
11-18	Axis Control 1-8
19	Fieldbus Status
20	Fieldbus Diagnostics
21	System Status
22-25	Task A-D Status
26	Fieldbus Resource Monitor
29	ELS Control
30	ELS Master Status
31-38	Axis Status 1-8
40-87	DEA (4/5/6) I/O (optional setup)
88 and 89	Task A Extend Event Control
90 and 91	Latch and Unlatch
92-94	Mask BTC06 Key Functionality
95-97	BTC06 Teach Pendant Status
98 and 99	BTC06 Teach Pendant Control; Task A-B, C-D
209-232	Axis Control 9-32
309-332	Axis Status 9-32

Table 5-1: PPC Predefined Register Structure

During initialization of both Virtual Masters and ELS Groups, the associated registers should be assigned to a free area of the register block. The assigning of registers is defined in the Virtual Master and ELS Group icons, respectively.

Note: When assigning registers, make sure not to use a register that is already used by the PPC or any other device such as the I/O Mapper, CAM indexer or ELS Group.

Virtual Master and ELS Group Default Registers

To avoid using the same registers, the following register numbers in

Table 5-2 for Virtual Masters and Table 5-3 for ELS Groups can be used as defaults.

Virtual Master	Control Register	Status Register
1	150	180
2	151	181

Table 5-2: Virtual Master Default Registers

ELS Group	Control Register	Status Register
1	152	182
2	153	183
3	154	184
4	155	185
5	156	186
6	157	187
7	158	188
8	159	189

Table 5-3: ELS Group Default Registers

Note: It is strongly recommended that the programmer use default register assignments. This makes documentation and modifications to user programs an easier task over the scope of a project.

Assigning Program Variables

Values that are used by VisualMotion to run the program, such as Virtual Master velocity or acceleration, are stored as program variables.

Program variables are designated as F# for Floats and I# for Integers. The Size icon in VisualMotion determines the number of program variables allocated to the control. Program variables retain their values during power off.

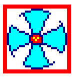
Float Variables (F#)

A variable whose value can be a number containing a decimal point.

Integer Variables (I#)

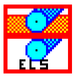
Integers are signed or unsigned whole numbers, such as –3 or 5.

Variable start ID blocks are assigned for Virtual Masters, ELS Masters and ELS Groups within their respective icons. Table 5-4 contains the default start ID blocks for each of the mentioned program variables.



Virtual Master Icon

ELS Master Assignment Icon



ELS Group Icon

Function	Number of Floats	Number of Integers	Float ID Block	Integer ID Block
Virtual Master 1	15	2	F100-F114	I100-I101
Virtual Master 2	15	2	F120-F134	I105-I106
ELS Master Assignment	24	30	F140-F163	I110-I139
ELS Group 1	26	9	F170-F195	I140-I148
ELS Group 2	26	9	F200-F225	I150-I158
ELS Group 3	26	9	F230-F255	I160-I168
ELS Group 4	26	9	F260-F285	I170-I178
ELS Group 5	26	9	F290-F315	I180-I188
ELS Group 6	26	9	F320-F345	I190-I198
ELS Group 7	26	9	F350-F375	I200-I208
ELS Group 8	26	9	F380-F405	I210-I218

Table 5-4: Program Variable Default Start ID Blocks

Assigning Default Labels to Registers and Program Variables

Labels are assigned to program variables in VisualMotion as names to clearly define the value's function. VisualMotion provides default labels and comments for all registers and program variables.

The user can select the default labels and comments by clicking on the *Assign Variable Labels …* button within the Virtual Master, ELS Master Assignment and ELS Group icons. A Dialog window opens allowing the user to add labels and comments to registers and program variables by clicking on the *Add Default Labels* button for the selected data type. Fig. 5-1 shows an example of adding default labels in the dialog window.

Note: Register and variable labels can be modified by selecting ***Edit ⇒ Labels ⇒ User Labels, Register Labels or Bit Labels*** in VisualMotion.

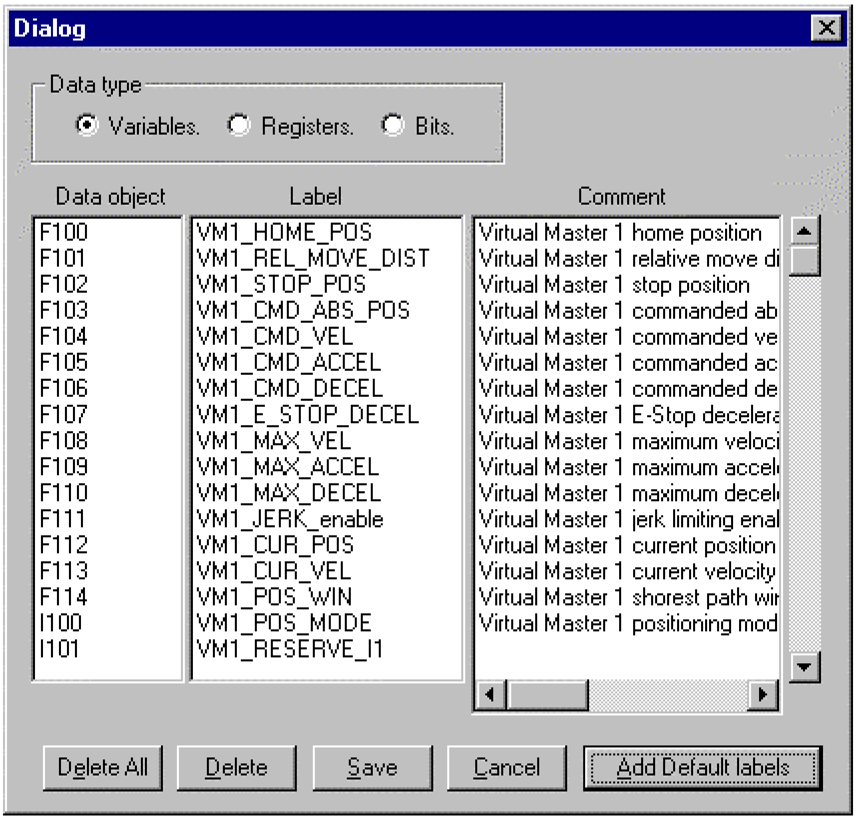


Fig. 5-1: Add Default Labels Example

Virtual Master 1 & 2 Default Register Labels

The default labels for the Virtual Master registers are shown in Table 5-5. The corresponding default bit labels are shown Table 5-6.

Data Object Ttype	Label (20 character limit)	Comment (80 character limit)
Assigned control register number	VM#_CONTROL_REG	Virtual Master # control register
Assigned status register number	VM#_STATUS_REG	Virtual Master # status register

Table 5-5: Virtual Master Default Registers

Default Label Virtual Master 1 & 2 Control Register	**Data Object Virtual Master 1 Control Register-Bit**	**Data Object Virtual Master 2 Control Register-Bit**	**Comment (80 character limit) Virtual Master 1 & 2 Control Register**
VM#_CT_FSTOP	150-1	151-1	VM # control, 0 → 1 triggers fast stop
VM#_CT_HOME	150-2	151-2	VM # control, 0 → 1 loads home position
VM#_CT_GO	150-3	151-3	VM # control, 0=stop, 1=go
VM#_CT_VMODE	150-4	151-4	VM # control, 0=position, 1=velocity mode
VM#_CT_RELMODE	150-5	151-5	VM # control, 0=absolute, 1=relative mode
VM#_CT_RELTRIG	150-6	151-6	VM # control, 0 → 1 triggers relative mode
Default Label Virtual Master 1 & 2 Status Register	**Data Object Virtual Master 1 Status Register-Bit**	**Data Object Virtual Master 2 Status Register-Bit**	**Comment (80 character limit) Virtual Master 1 & 2 Status Register**
VM#_ST_FSTOP	180-1	181-1	VM # status, 1=fast stop active
VM#_ST_HOME	180-2	181-2	VM # status, 1=home complete
VM#_RESERVE3	180-3	181-3	
VM#_ST_VMODE	180-4	181-4	VM # status, 1=velocity mode
VM#_ST_RELMODE	180-5	181-5	VM # status, 1=relative mode
VM#_RESERVE6	180-6	181-6	
VM#_ST_ZEROVEL	180-7	181-7	VM # status, 1=standstill, 0=velocity
VM#_ST_INPOS	180-8	181-8	VM # status, 1=in position
Each # symbol represents an entry for the number of the Virtual Master			

Table 5-6: Virtual Master 1 & 2 Default Register Bits

Virtual Master 1 & 2 Default Program Variable Labels

Default Label Virtual Master 1 & 2 Program Variable	Data Object Virtual Master 1	& 2	Comment (80 character limit) Virtual Master 1 & 2 Program Variable	Default Value	Units	Update Mode
VM#_HOME_POS	F100	F120	Virtual Master # home position	0	Degrees	Phase 4
VM#_REL_MOVE_DIST	F101	F121	Virtual Master # relative move distance	1	Degrees	Phase 4
VM#_STOP_POS	F102	F122	Virtual Master # stop position	0	Degrees	Phase 4
VM#_CMD_ABS_POS	F103	F123	Virtual Master # commanded absolute position	0	Degrees	Phase 4
VM#_CMD_VEL	F104	F124	Virtual Master # commanded velocity	20	RPM	Phase 4
VM#_CMD_ACCEL	F105	F125	Virtual Master # commanded acceleration	100	Rad/sec²	Phase 4
VM#_CMD_DECEL	F106	F126	Virtual Master # commanded deceleration	100	Rad/sec²	Phase 4
VM#_E_STOP_DECEL	F107	F127	Virtual Master # E-Stop deceleration	500	Rad/sec²	Phase 2
VM#_MAX_VEL	F108	F128	Virtual Master # maximum velocity	3200	RPM	Phase 2
VM#_MAX_ACCEL	F109	F129	Virtual Master # maximum acceleration	1000	Rad/sec²	Phase 2
VM#_MAX_DECEL	F110	F130	Virtual Master # maximum deceleration	1000	Rad/sec²	Phase 2
VM#_JERK_ENABLE	F111	F131	Virtual Master # jerk limiting enable	1		Phase 2
VM#_CUR_POS	F112	F132	Virtual Master # current position	0	Degrees	Phase 4
VM#_CUR_VEL	F113	F133	Virtual Master # current velocity	0	RPM	Phase 4
VM#_POS_WIN	F114	F134	Virtual Master # shortest path window	1	Degrees	Phase 2
VM#_POS_MODE	I100	I105	Virtual Master # positioning mode [1.)]	0		Phase 2
VM#_RESERVE_I1	I101	I106				

Each # symbol represents an entry for the number of the Virtual Master
Note 1.) Absolute Position Mode, 0=Positive, 1= Negative, 2= Shortest Path

Table 5-7: Virtual Master 1 & 2 Default Program Variables

ELS Master Assignment Default Program Variable Labels

Default Label ELS Master Assignment Program Variable	Data Object ELS Master Assignment 1	2	3	4	5	6	Comment (80 character limit) ELS Master Assignment Program Variable	Update Mode
ELS_MSTR_FREQ#	F140	F141	F142	F143	F144	F145	ELS Master # filter cutoff frequency	Phase 2
ELS_MSTR_M#	F146	F147	F148	F149	F150	F151	ELS Master # M factor	Phase 2
ELS_MSTR_N#	F152	F153	F154	F155	F156	F157	ELS Master # N factor	Phase 2
ELS_MSTR_RS_FT#	F158	F159	F160	F161	F162	F163	ELS Master # reserve float	Phase 2
ELS_MSTR_A#	I110	I111	I112	I113	I114	I115	ELS Master # ID number	Phase 2
ELS_MSTR_EC#	I116	I117	I118	I119	I120	I121	ELS Master # encoder, Real Master only	Phase 2
ELS_MSTR_FLTR#	I122	I123	I124	I125	I126	I127	ELS Master # filter	Phase 2
ELS_MSTR_TYPE#	I128	I129	I130	I131	I132	I133	ELS Master # type	Phase 2
ELS_MSTR_RSVD#	I134	I135	I136	137	I138	I139	ELS Master reserve integer	Phase 2

Table 5-8: ELS Master Assignment Default Program Variables

ELS Master Variable Definition

ELS_MSTR_FREQ#

Only Real Masters use the filter constant. When a filter (*ELS_MSTR_FLTR#*) is selected for an axis' position feedback, a cutoff frequency for the filter must be entered. The cutoff frequency is the frequency where the signal is reduced by 3dB.

ELS_MSTR_M# and ELS_MSTR_N#

Only Real Masters use the ratio constants (M/N). The output of the master is governed by the equation $y=(M/N)*x$, where x is the feedback value from the real master and y is the master signal used for ELS Groups. All ELS Masters and ELS Groups outputs are modulo 360 degrees.

ELS_MSTR_A#

This variable identifies a valid ID number for a defined master type. For example, when *ELS_MSTR_TYPE#* is set to 3 (Virtual Master) this number must be a 1 or 2. Valid ID numbers are…

- Virtual Master: 1 or 2
- ELS Group Master: 1 - 8
- Real Master: 1 - 3

ELS_MSTR_EC#

When using an encoder device as a Real Master, this variable identifies the source.

- 0 = motor encoder
- 1 = external encoder

ELS_MSTR_FLTR#

This variable identifies the type of filtering to use for the axis position feedback. Valid types are…

- 0 = no filter
- 1 = 1st order low pass
- 2 = 2nd order low pass
- 3 = 3rd order low pass
- 4 = 2nd order Butterworth
- 5 = 3rd order Butterworth
- 6 = 2nd order low pass with velocity feed forward
- 7 = 3rd order low pass with velocity and acceleration feed forward

ELS_MSTR_TYPE#

Available master types are…

- 0 = Real Master
- 1 = ELS Group master
- 2 = External (future development)
- 3 = Virtual Master
- 4 = none

ELS Group 1- 8 Default Register Labels

The default labels for the ELS Group registers are shown in Table 5-9. The corresponding default bit labels are shown in Table 5-10.

Data Object Type	Label (20 character limit)	Comment (80 character limit)
Assigned control register number	G#_CONTROL_REG	Group # control register
Assigned status register number	G#_STATUS_REG	Group # status register

Table 5-9: ELS Group 1- 8 Default Registers

Default Label ELS Group 1-8 Control Register	**Data Object ELS Group Control Register-Bit 1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**Comment (80 character limit) ELS Group 1-8 Control Register**
G#_CT_LOCK_OFF	152-1	153-1	154-1	155-1	156-1	157-1	158-1	159-1	Group # control, 0 → 1 start lock cycle, 1 → 0 start unlock
G#_CT_MSTR_PH	152-2	153-2	154-2	155-2	156-2	157-2	158-2	159-2	Group # control, 0 → 1 triggers master phase adjust
G#_CT_SLV_PH	152-3	153-3	154-3	155-3	156-3	157-3	158-3	159-3	Group # control, 0 → 1 triggers slave phase adjust
G#_CT_MSTR_SEL	152-4	153-4	154-4	155-4	156-4	157-4	158-4	159-4	Group # control, 0=master 1, 1=master 2
G#_CT_VAR_CLK	152-5	153-5	154-5	155-5	156-5	157-5	158-5	159-5	Group # control, 0 → 1 forcing
G#_CT_LOCAL	152-6	153-6	154-6	155-6	156-6	157-6	158-6	159-6	Group # control, 0 → 1 local mode, 1 → 0 selected master
G#_CT_JOG_INC	152-7	153-7	154-7	155-7	156-7	157-7	158-7	159-7	Group # control, 0=continuous jog mode, 1=incremental jog mode
G#_CT_JOG_ABS	152-8	153-8	154-8	155-8	156-8	157-8	158-8	159-8	Group # control, 0=absolute incremental mode, 1=relative incremental mode
G#_CT_JOG_PLUS	152-9	153-9	154-9	155-9	156-9	157-9	158-9	159-9	Group # control, 0 → 1 starts jog mode in positive direction
G#_CT_JOG_MINS	152-10	153-10	154-10	155-10	156-10	157-10	158-10	159-10	Group # control, 0 → 1 starts jog mode in negative direction
Default Label ELS Group 1-8 Status Register	**Data Object ELS Group Status Register-Bit 1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**Comment (80 character limit) ELS Group 1-8 Status Register**
G#_ST_LOCK_ON	182-1	183-1	184-1	185-1	186-1	187-1	188-1	189-1	Group # status, 0=unlocked, 1=locked to master
G#_ST_MSTR_PH	182-2	183-2	184-2	185-2	186-2	187-2	188-2	189-2	Group # status, 1=acknowledges master phase adjust
G#_ST_SLV_PH	182-3	183-3	184-3	185-3	186-3	187-3	188-3	189-3	Group # status, 1=acknowledges slave phase adjust
G#_ST_MSTR_SEL	182-4	183-4	184-4	185-4	186-4	187-4	188-4	189-4	Group # status, 0=master 1, 1=master 2
G#_ST_VAR_ACK	182-5	183-5	184-5	185-5	186-5	187-5	188-5	189-5	Group # status, 1=variables updated
G#_ST_LOCAL	182-6	183-6	184-6	185-6	186-6	187-6	188-6	189-6	Group # status, 1=local mode active
G#_ST_RSVD7	182-7	183-7	184-7	185-7	186-7	187-7	188-7	189-7	
G#_ST_RSVD8	182-8	183-8	184-8	185-8	186-8	187-8	188-8	189-8	
G#_ST_MOTION	182-9	183-9	184-9	185-9	186-9	187-9	188-9	189-9	Group # status, 0=no motion, 1=group is in motion
G#_ST_JOG_POS	182-10	183-10	184-10	185-10	186-10	187-10	188-10	189-10	Group # status, 1=jog is at absolute target
Each # symbol represents an entry for the number of the ELS Group									

Table 5-10: ELS Group 1- 8 Default Register Bits

ELS Group 1- 8 Default Program Variable Labels

Default Label ELS Group 1-8 Program Variable	Data Object ELS Group 1-8 Program Variable 1	2	3	4	5	6	7	8	Comment (80 character limit) ELS Group 1-8 Program Variable	Update Mode
G#_SYNC_ACCEL	F170	F200	F230	F260	F290	F320	F350	F380	Group #, dynamic sync acceleration	Phase 4
G#_SYNC_VEL	F171	F201	F231	F261	F291	F321	F351	F381	Group #, dynamic sync velocity	Phase 4
G#_M1	F172	F202	F232	F262	F292	F322	F352	F382	Group #, M factor	Phase 4 & Forcing
G#_N1	F173	F203	F233	F263	F293	F323	F353	F383	Group #, N factor	Phase 4 & Forcing
G#_REL_M_PH	F174	F204	F234	F264	F294	F324	F354	F384	Group #, relative master phase adjust	Phase 4
G#_REL_S_PH	F175	F205	F235	F265	F295	F325	F355	F385	Group #, relative slave phase adjust	Phase 4
G#_ABS_M_PH	F176	F206	F236	F266	F296	F326	F356	F386	Group #, absolute master phase adjust	Phase 4
G#_ABS_S_PH	F177	F207	F237	F267	F297	F327	F357	F387	Group #, absolute slave phase adjust	Phase 4
G#_H_LOCKON	F178	F208	F238	F268	F298	F328	F358	F388	Group #, H factor lock on cam profile	Phase 4 & Forcing
G#_H_RUN	F179	F209	F239	F269	F299	F329	F359	F389	Group #, H factor 1:1 cam profile	Phase 4 & Forcing
G#_H_LOCKOFF	F180	F210	F240	F270	F300	F330	F360	F390	Group #, H factor lock off cam profile	Phase 4 & Forcing
G#_H_USER	F181	F211	F241	F271	F301	F331	F361	F391	Group #, H factor user cam profile	Phase 4
G#_LOCK_WIN	F182	F212	F242	F272	F302	F332	F362	F392	Group #, shortest path window for dynamic sync. phase correction	Phase 4
G#_STOP_DECEL	F183	F213	F243	F273	F303	F333	F363	F393	Group #, stop ramp deceleration	Phase 4
G#_JOG_ACCEL	F184	F214	F244	F274	F304	F334	F364	F394	Group #, jog acceleration	Phase 4
G#_JOG_VEL	F185	F215	F245	F275	F305	F335	F365	F395	Group #, jog velocity	Phase 4
G#_JOG_INC	F186	F216	F246	F276	F306	F336	F366	F396	Group #, relative position distance (incremental jog)	Phase 4
G#_JOG_ABS	F187	F217	F247	F277	F307	F337	F367	F397	Group #, absolute position target (absolute jog)	Phase 4
G#_JOG_WIN	F188	F218	F248	F278	F308	F338	F368	F398	Group #, shortest path window for absolute jog	Phase 4
G#_LOCKON_OFFSET	F189	F219	F249	F279	F309	F339	F369	F399	Group #, offset added to the output when lock on cam profile is being forced	Phase 4
G#_IN_POS	F190	F220	F250	F280	F310	F340	F370	F400	Group #, input position	Phase 4 & Forcing
G#_IN_VEL	F191	F221	F251	F281	F311	F341	F371	F401	Group #, input velocity (read only)	Phase 4
G#_OUT_POS	F192	F222	F252	F282	F312	F342	F372	F402	Group #, output position (read only)	Phase 4 & Forcing
G#_OUT_VEL	F193	F223	F253	F283	F313	F343	F373	F403	Group #, output velocity (read only)	Phase 4

Table 5-11: ELS Group 1- 8 Default Program Variables (part 1 of 2)

ELS Group 1- 8 Default Program Variable Labels (Cont'd)

Default Label ELS Group 1-8 Program Variable	**Data Object ELS Group 1-8 Program Variable 1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**Comment (80 character limit) ELS Group 1-8 Program Variable**	**Update Mode**
G#_OUT_ACC	F194	F224	F254	F284	F314	F344	F374	F404	Group #, output acceleration (read only)	Phase 4
G#_CAM_INPUT	F195	F225	F255	F285	F315	F345	F375	F405	Group #, group cam profile ID input position	Phase 4 & Forcing
G#_CONFIG	I140	I150	I160	I170	I180	I190	I200	I210	Group #, configuration word	Refer to Fig. 5-2
G#_MSTR1_AXIS	I141	I151	I161	I171	I181	I191	I201	I211	Group #, ELS master ID, number 1	Phase 4
G#_MSTR2_AXIS	I142	I152	I162	I172	I182	I192	I202	I212	Group #, ELS master ID, number 2	Phase 4
G#_ACTIVE_STATE	I143	I153	I163	I173	I183	I193	I203	I213	Group #, active state of state machine for lockon/lockoff	Phase 4 & Forcing
G#_ACTIVE_CAM	I144	I154	I164	I174	I184	I194	I204	I214	Group #, active cam profile table number	Phase 4
G#_LOCKON_CAM	I145	I155	I165	I175	I185	I195	I205	I215	Group #, lock on cam profile table number	Phase 4 & Forcing
G#_RUN_CAM_ID	I146	I156	I166	I176	I186	I196	I206	I216	Group #, 1:1 cam profile table number	Phase 4 & Forcing
G#_LOCKOFF_CAM	I147	I157	I167	I177	I187	I197	I207	I217	Group #, lock off cam profile table number	Phase 4 & Forcing
G#_USER_CAM	I148	I158	I168	I178	I188	I198	I208	I218	Group #, user cam profile table number (state machine disabled)	Phase 4

Table 5-12: ELS Group 1- 8 Default Program Variables (part 2 of 2)

ELS Group Configuration Word

For every ELS Group, an ELS Group configuration word (**G#_CONFIG**) is used to configure all settings for Switching Synchronization, Phase Control and Initialization. These settings are initially configured within VisualMotion Toolkit's ELS Group icon and active once the program is compiled and downloaded to the control. These settings can also be modified by accessing the appropriate integer number and entering an equivalent hexadecimal value for the first 12 bits of the configuration word. Default integer numbers for G#_CONFIG are found in Table 5-12.

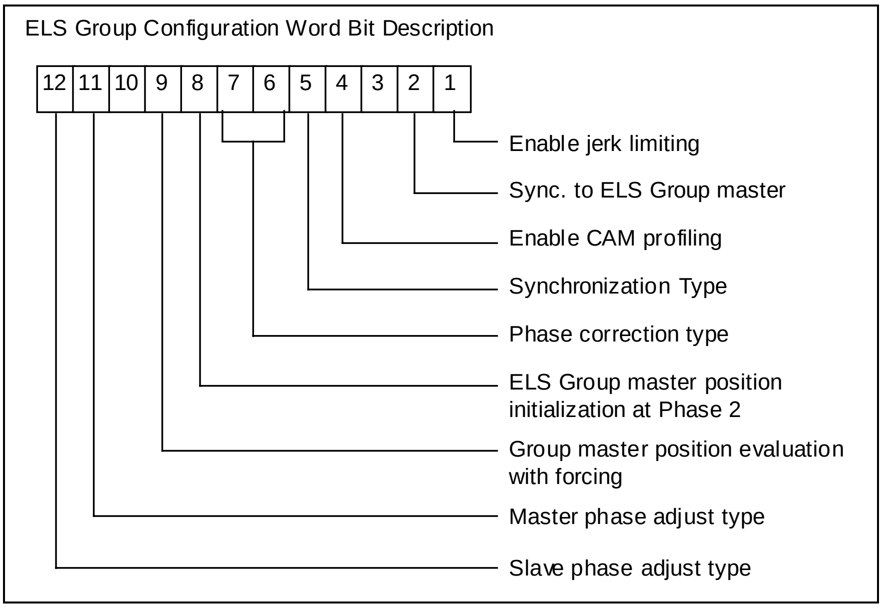


Fig. 5-2: ELS Group Configuration Word Description

**Bit 1:
Enable Jerk Limiting**

This bit is used to enable or disable jerk limiting for the ELS Group master command value.

0 = Disable jerk limiting (***default***)

1 = Enable jerk limiting

(*Updated in Phase 2 & Forcing*)

When enabled, step changes in acceleration are converted into 40ms ramps, independent of the SERCOS clock rate, providing a jerk limiting effect.

**Bit 2:
Sync. to ELS Group Master**

When the control is switched to manual mode, all ELS Groups are switched to local mode. In local mode, each ELS Group can be jogged independently. When switching back to automatic mode, the user can configure bit 2 using the following two options:

0 = Automatically switch back to the ELS Group master and perform a dynamic synchronization if necessary, see bits 5, 6 and 7 (***default***)

1 = Groups will stay in local mode and must be switched manually

(*Updated in Phase 2*)

Bit 4:
Enable CAM Profiling

This bit enables the lock on / lock off CAM profile state. For user CAM profiles to function, disable this feature.

0 = state machine enabled (***default***)

1 = state machine disabled

(*Updated in Phase 2*)

Modifications to the variable G#_H_USER can only be performed when the state machine is disabled. While disabled, the user can select a CAM profile for the ELS Group and modify the G#_H_USER factor. When enabled, the state machine uses as an H factor the values of G#_H_LOCKON, G#_H_LOCKOFF and G#_H_RUN. The G#_H_USER variable displays the current H factor being used for the lock on and lock off cam profiles.

Bit 5:
Synchronization Type

This bit is used to specify the type of synchronization that will be used when switching between ELS Group input masters.

0 = Dynamic synchronization (***default***)

1 = Immediate (*On the Fly when switching to an unused Virtual Master*)

(*Updated in Phase 4*)

When bit 5 is set to 1 and an ELS Group's input master is switched to an unused Virtual Master, this Virtual Master will adapt "On the Fly" to the current ELS Group master's position and velocity.

Bit 6-7:
Phase Correction Type

These bits are used to set the method that will be used for phase corrections during Dynamic Synchronization.

Bit 6	Bit 7	Description
0	0	Shortest path (***default***)
1	0	Positive direction if phase difference is greater than "G#_LOCK_WIN". Otherwise, use shortest path.
0	1	Negative direction if phase difference is greater than "G#_LOCK_WIN". Otherwise, use shortest path.
1	1	No phase correction (*only velocity synchronization is performed*)

(*Updated in Phase 4*)

Bit 8:
ELS Group Master Position Initialization at Phase 2

This bit is used to reinitialize an ELS Groups output master position when the system is switched to Phase 2 (parameter mode) or powered down.

When an ELS Group's M/N or H factor has a value other than 1; for example 0.9, and the ELS Group has been moved, then the group's output master position cannot be calculated using the CAM equation.

The reason for this is as follows:

The control monitors and internally stores the ELS Group's current output position. For example, if after two revolutions of the input master (as illustrated in Fig. 5-3), the system is switched to Phase 2 or loses power; the ELS Group's output master position is stored. The user has the option to restart the ELS Group, to an initial position, by setting bit 8 to 0. This will recalculate the ELS Group's output master position using the CAM equation. Setting bit 8 to 1 allows the ELS Group's output master position to start from the stored position (old values) and continue; using the CAM equation, for consecutive revolutions of the ELS Group's input master.

[(input master * M/N) + master offset]H + slave offset = Group output

Group output position with a 0.9 M/N and no offsets

[(0° * 0.9) + 0°] * 1 + 0° ⇒	0°	;initial position at start
[(0° * 0.9) + 0°] * 1 + 0° ⇒	324°	;after one revolution
[(0° * 0.9) + 0°] * 1 + 0° ⇒	288°	;after second revolution

Fig. 5-3: CAM Equation Example

0 = Initialization with calculated value using the cam equation (***default***)

1 = Use old values

(*Updated in Phase 2 & Forcing*)

Bit 9:
Group Master Position Evaluation with Forcing

This bit is used to initialize an ELS Group's output position when switched to local mode (G#_CT_LOCAL).

0 = Group master positions will be calculated using cam equation (***default***)

1 = Use old values

(*Updated in Phase 2 & Forcing*)

Bit 11:
Master Phase Adjust Type

This bit sets the motion profile type for the active master.

0 = Trapezoidal profile using a velocity profile with dynamic synchronization acceleration/deceleration and additive velocity (***default***)

1 = Immediate – step function

(*Updated in Phase 4*)

Bit 12:
Slave Phase Adjust Type

This bit sets the motion profile type for the all slave axis associated with the ELS Group.

0 = Trapezoidal profile using a velocity profile with dynamic synchronization acceleration/deceleration and additive velocity (***default***)

1 = Immediate – step function

(*Updated in Phase 4*)

Bits 13-32: These bits are not defined in GPP firmware.

ELS Runtime Utility

The ELS Runtime Utility in VisualMotion GPP 7 is a tool designed for modifying default program variables. These are variables that were initialized at compile time for the Virtual Masters icon (Assign Initial Values), ELS Master Assignment icon (including assigned ELS Group Masters). As an example, these variables consist of values for moving, stopping and jogging the Multiple Master components. To open this utility, select ***Data*** ⇒ ***ELS*** from VisualMotion Toolkit's main menu.

Note: A valid GPP program must be active on the control for the ELS Runtime Utility to activate.

The programmer can modify the values initially compiled and downloaded to the GPP for…

- ELS Masters
- ELS Group Masters
- Virtual Masters

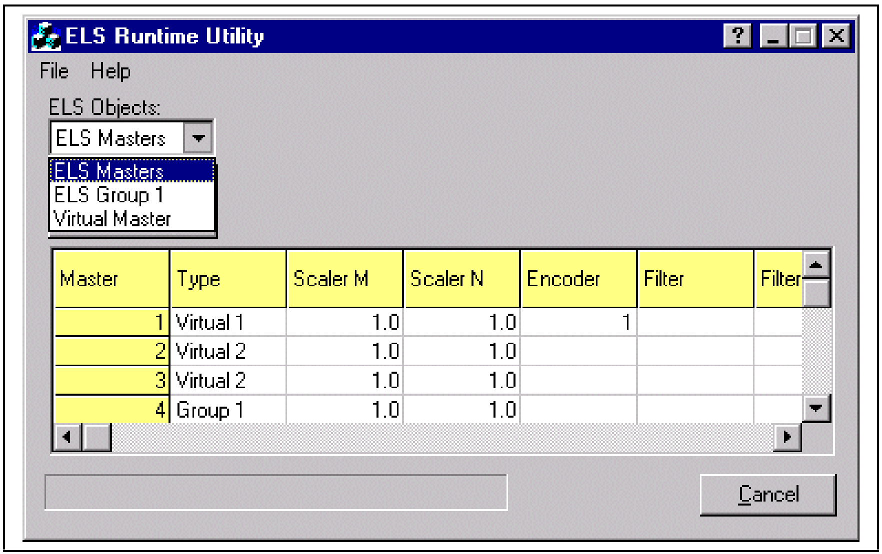


Fig. 5-4: ELS Runtime Utility

Modifying ELS Masters at Runtime

Select *Edit ELS Masters* from the ELS Objects drop-down list and click on the *Edit ELS Masters* button. The Edit ELS Masters window allows the user to modify the types of ELS Masters initially configured at compile time.

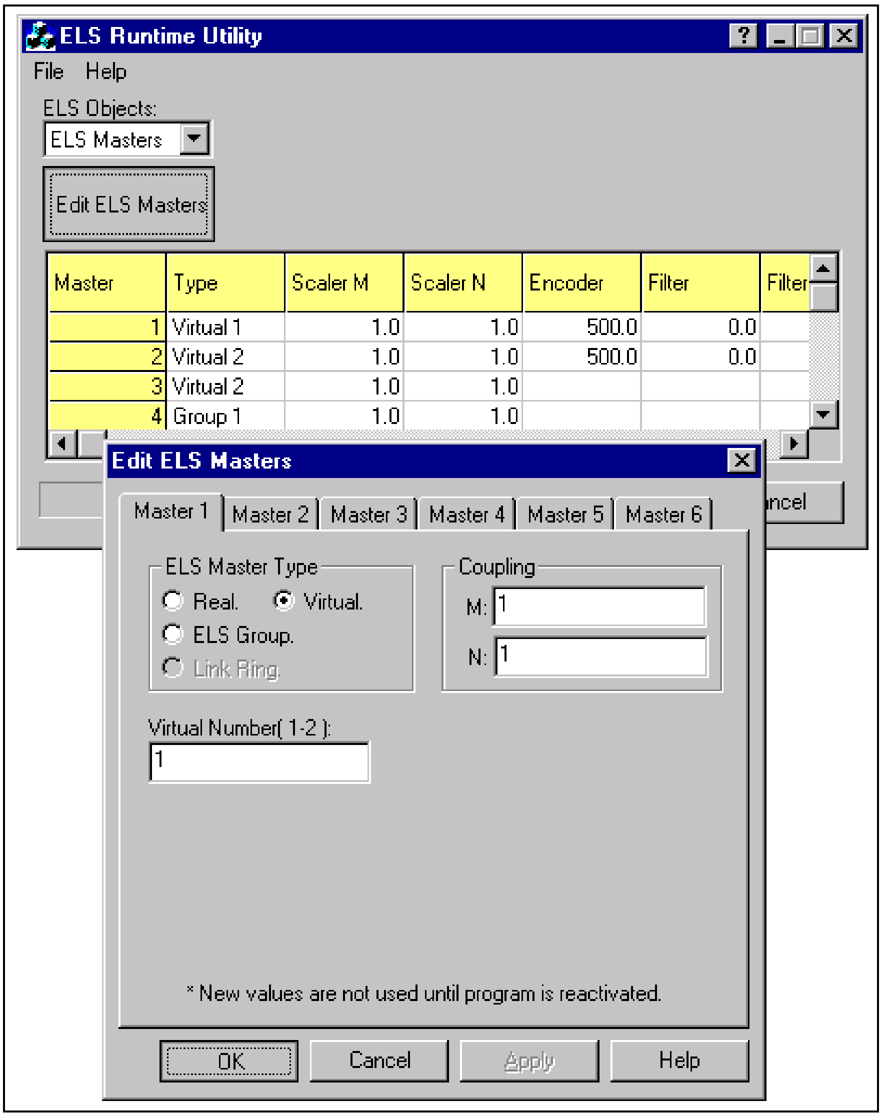


Fig. 5-5: Edit ELS Masters

Changes in the Edit ELS Masters window will modify the types of masters that will be available for configured ELS Groups.

Note: Modifications made to the ELS Masters will be active when the program is restarted. Compile time values in the ELS Master Assignment icon will not be affected. However, variable values can be transferred to another program by using the ***Transfer Variables*** selection under VisualMotion Toolkit's File menu.

Note: Refer to *Table 5-8: ELS Master Assignment Default Program Variables*, to determine what phase the system needs to be in for the variable to be updated.

Modifying ELS Group Masters at Runtime

Selecting ELS Group from the ELS Objects drop-down list and clicking on the Edit ELS Group # Variables button will open the window in Fig. 5-6. From this window, the variables for the ELS Group Master can be modified for functions such as…

- Main (master input, gear ratio, phase adjust, etc.)
- Synchronization
- Initialization controls
- Lock / Unlock Setup
- Stop and Jogging Control and
- Phase types

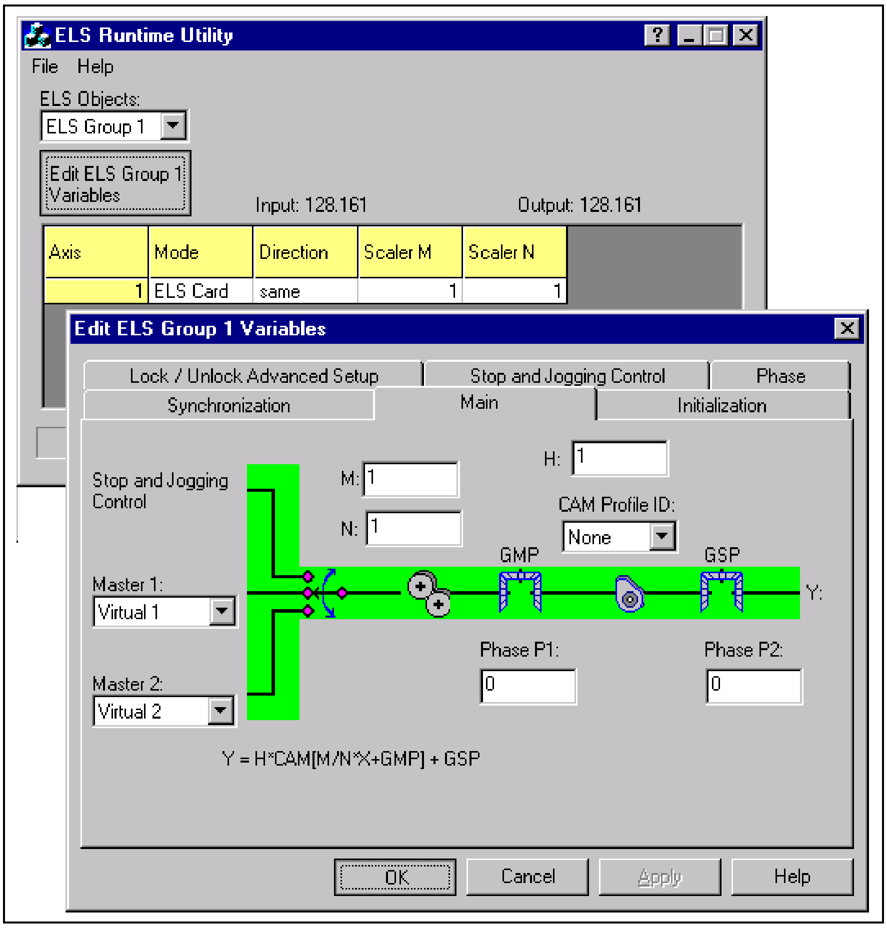


Fig. 5-6: Edit ELS Group # Variables

Note: Refer to *Table 5-12: ELS Group 1- 8 Default Program Variables* to determine what phase the system needs to be in for the variable to be updated.

Modifying Virtual Masters at Runtime

Virtual Master initial values can be modified using the ELS Runtime Utility. For example, changes to the initial Virtual Master velocity value will take effect on the fly. However, changes to the maximum value will not take effect until the system is taken in and out of parameter mode (P2).

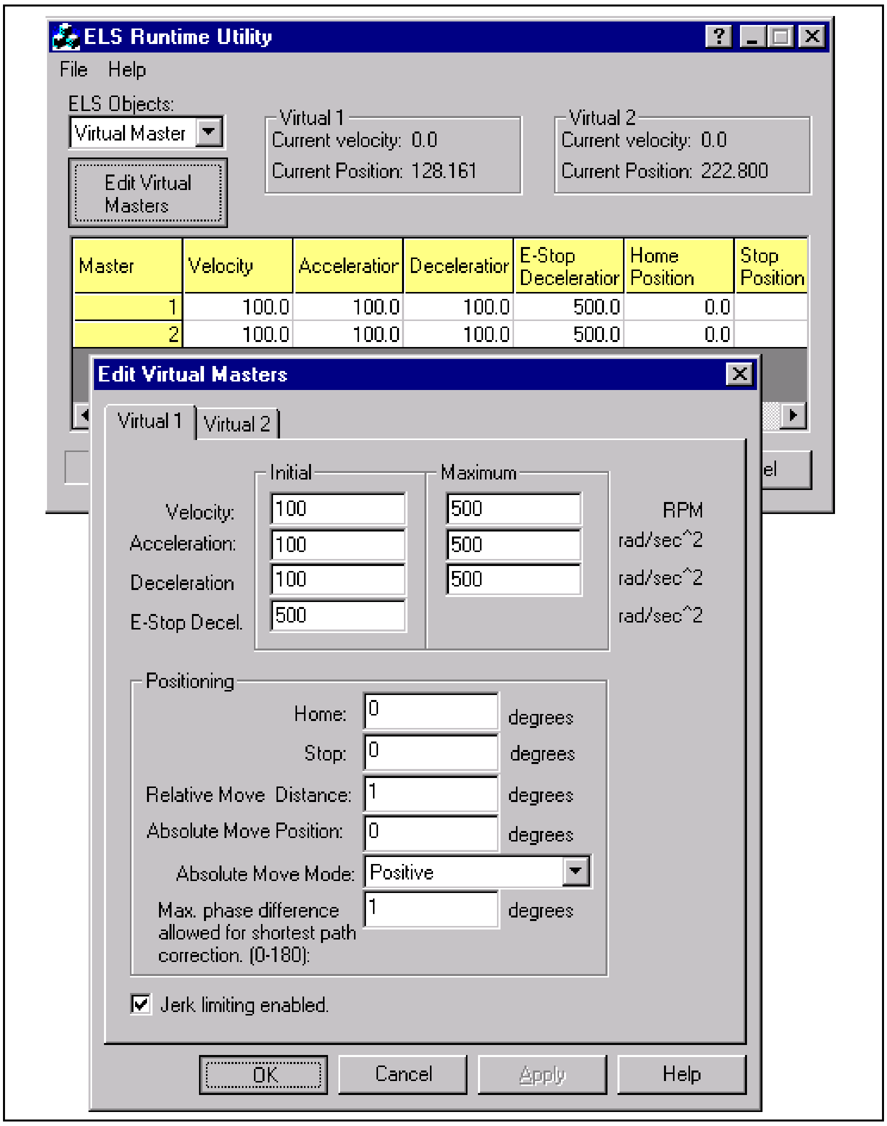
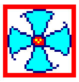


Fig. 5-7: Edit ELS Group # Variables

Note: Refer to *Table 5-7: Virtual Master 1 & 2 Default Program Variables* to determine what phase the system needs to be in for the variable to be updated.

5.2 Virtual Master

GPP 7 supports two Virtual Masters. A Virtual Master is an internal motion engine with an independent set of control parameters. Each Virtual Master can be used independently from each other.



A Virtual Master is controlled by the VisualMotion user program created with VisualMotion Toolkit (VMT,) and/or a PLC using I/O registers and program variables. The initialization of these registers and program variables is defined in the Virtual Master icon. Refer to *Initialization of VisualMotion's Multiple Master Functionality* on page 5-1.

Virtual Master Compile Time Initialization

When the *Assign Initial Values …* button is selected, each Virtual Master contains default initial and maximum values for operating and positioning as shown in Fig. 5-8. These values can be modified before compiling the program or at runtime using the *ELS Runtime* Utility under menu selection ***Data ⇒ ELS***.

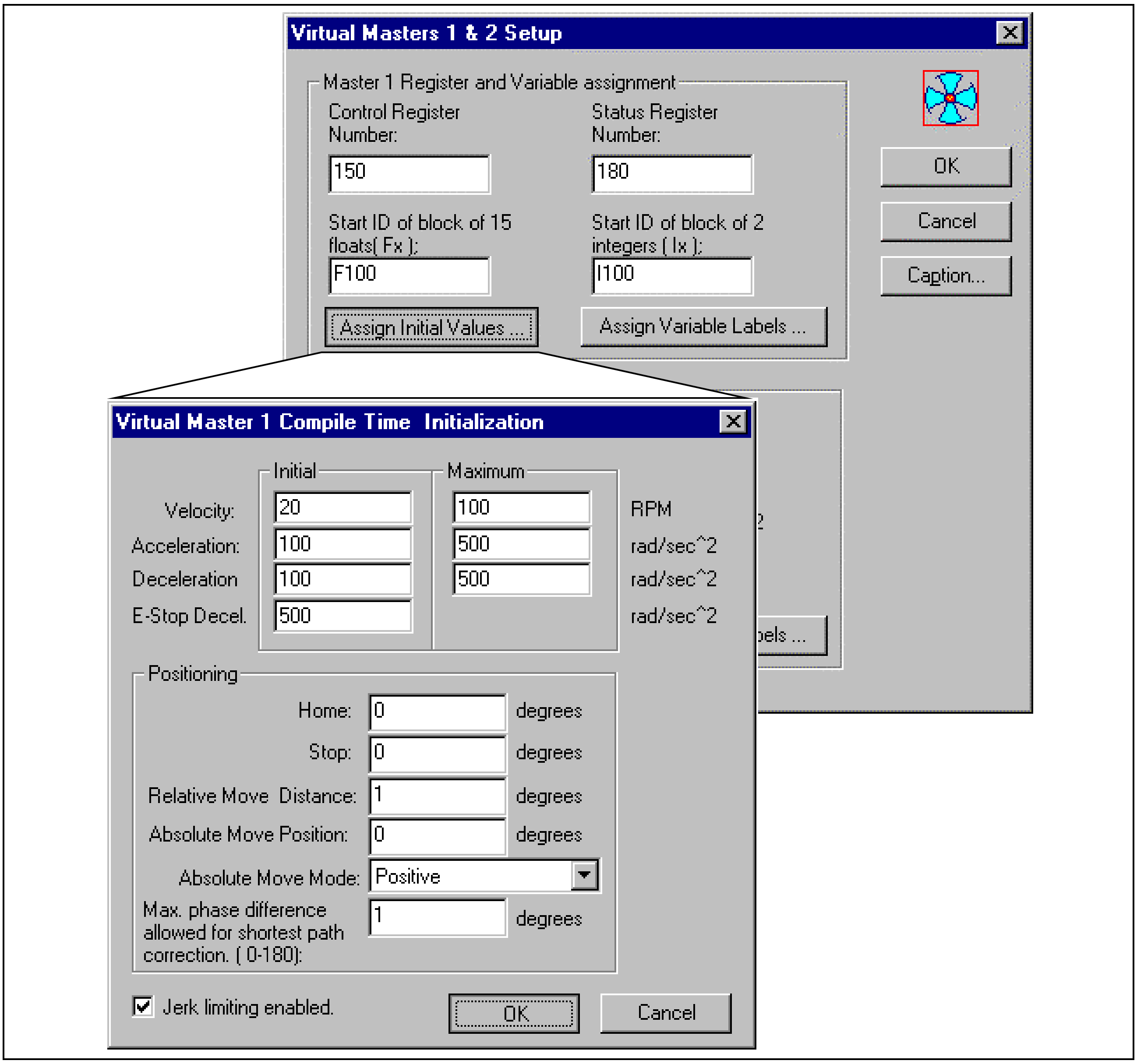


Fig. 5-8: Virtual Master Compile Time Initialization

Virtual Master Modes of Operation

Velocity Mode

In Velocity mode, the Virtual Master moves at its commanded velocity. The rate of change in the commanded velocity (VM#_CMD_VEL) is performed using the defined acceleration/deceleration (VM#_CMD_ACCEL, …DECEL) rate. In this mode, the Virtual Master can be either stopped, decelerating immediately, or at a predetermined stop position between 0 and 360 degrees. To stop the master at a desired stop position may take several revolutions (stop ramp) depending on the current velocity and programmed deceleration.

Note: When a master is in velocity mode, an integrator is engaged providing positional output so that all masters have a uniform signal type (position value with modulo of 360 degrees.)

Position Mode

In Position mode, the Virtual Master moves to a programmed relative or absolute position.

Relative Positioning

Travel distances can be greater than the modulo value for relative positioning moves of the Virtual Master.

Absolute Positioning

The maximum travel distance is +/- 180 degrees (shortest path) or 359.99 degrees (positive or negative direction) with absolute positioning. When the Virtual Master Go bit is high (*VM#_CT_GO*) the absolute target position variable *VM#_CMD_ABS_POS* is used to change the current position of the Virtual Master (*VM#_CUR_POS*). Whenever a new value is written to *VM#_CMD_ABS_POS* the Virtual Master axis will move to the absolute position value contained in *VM#_CMD_ABS_POS*.

5.3 Electronic Line Shafting (ELS) Master Assignment

In the ELS Master Assignment icon, six ELS Masters can be assigned. GPP 7 supports the following three ELS Master types:

- Virtual Master
- Real Master
- ELS Group Master

An ELS Master is associated with a number from 1 to 6. This association creates, using software, an ELS Master connection box that uses the master's signal (commanded position) as an input to an ELS Group. Refer to Fig. 4-1: *Multiple Master Configuration Example* for an illustration of the ELS Master connection box.

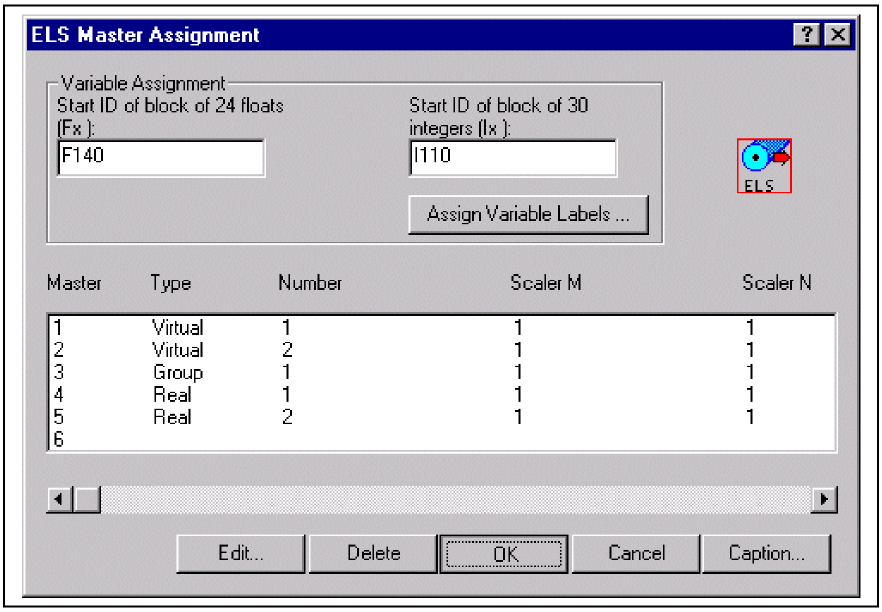


Fig. 5-9: ELS Master Assignment

Cascading ELS Groups

A maximum of four ELS Group Masters can be cascaded to other ELS Groups. When cascading ELS Groups, the lower numbered group's output should become the higher numbered group's input. For example, the output of group 1 is used as the input to group 2 and the output of group 2 is used as the input to group 3. This avoids a delay of one SERCOS cycle between cascading ELS Groups.

Note: An ELS Group Master's output cannot be fed back into the same ELS Group's input.

Note: All motion is associated with task A. Any motion associated with ELS Groups within the VisualMotion program will stop if tasks A stops.

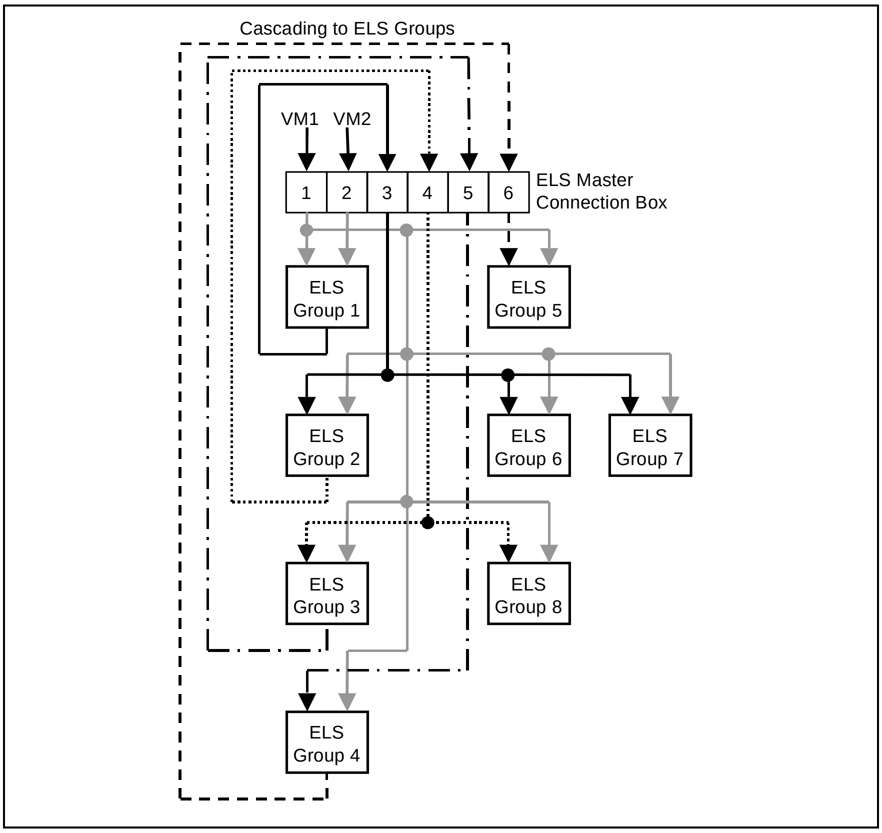
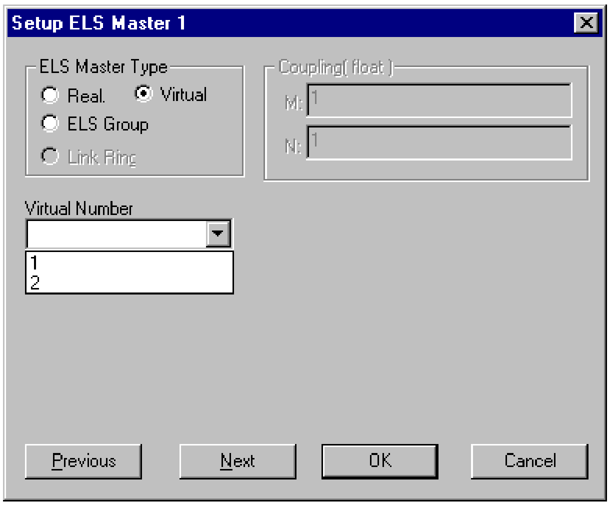


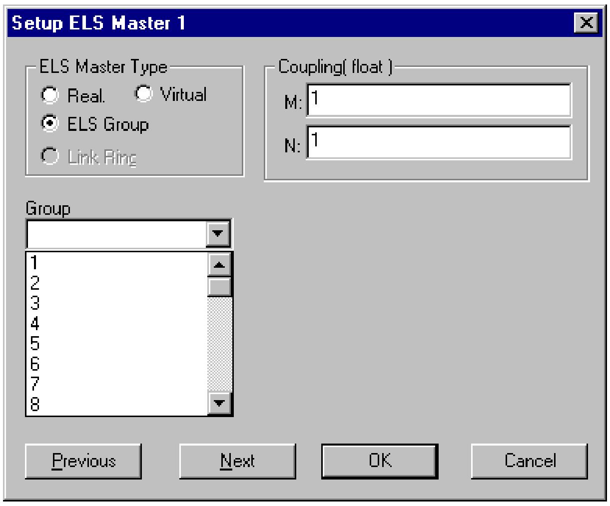
Fig. 5-10: Cascading an ELS Group Master Output

Assigning ELS Master Types

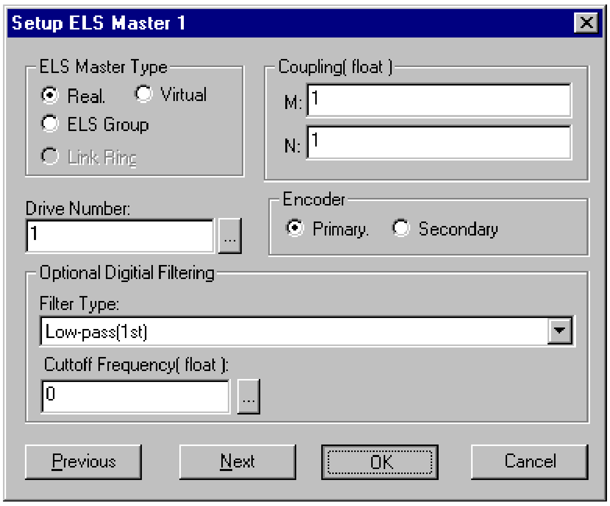
ELS Masters are assigned in the *ELS Master Assignment* icon by selecting a number and clicking on the *Edit…* button



Virtual Masters are initialized using the Virtual Master icon before they are assigned a Virtual Number.



Select the number of the ELS Group that will be used as a master to cascade to other ELS Groups.



Real Masters can be primary encoders that ***are not slaves of an ELS Group*** or secondary encoders. A maximum of three Real Masters can be assigned.

Fig. 5-11: Assigning ELS Master Types

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ELS Master Connection Box (System Masters)

ELS Masters are associated to ELS Groups by means of a software connection box. To view the ELS Master connection box, start VisualMotion Toolkit and…

- Select ***Data* ⇒ *ELS***. This will open the *ELS Runtime Utility* window.
- Select ELS Masters as your ELS object and click on the *Edit ELS Masters* button.

A maximum number of six masters are available in VisualMotion GPP firmware.

Note: An ELS Group output can be linked to one of the connection box numbers. ELS Groups are defined in the ELS Master icon. Up to four ELS Groups can cascade in this manner.

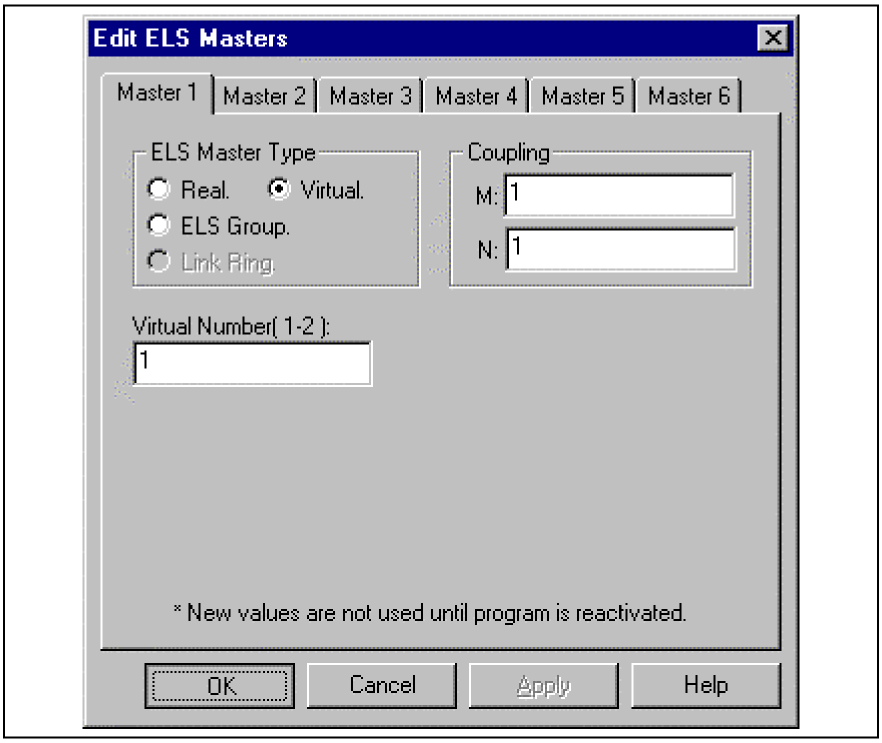
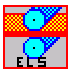


Fig. 5-12: ELS Master Connection Box

5.4 Electronic Line Shafting (ELS) Group



GPP 7 supports a maximum of eight ELS Groups. The initialization of the ELS Group's registers and program variables is defined in the ELS Group Setup icon. Refer to *Initialization of VisualMotion's Multiple Master Functionality* on page 5-1.

An ELS Group's output provides a master position to its assigned ELS Slave axes. ELS Slave axes can only be assigned to an ELS Group at compile time. The ELS Group Master's output position is derived from the currently active group master input. The ELS Group's output signal can be modified using the following features:

- M/N gear ratio
- GMP (Group Master phase offset)
- CAM Profile with/without a Lock On / Lock Off feature using a 3 CAM profile
- GSP (Group Master phase offset)

An ELS Group can only have one active master at any given time determined by the group's control register input bit (G#_CT_MSTR_SEL.) To stop or move a group's master independent from the two input masters, every ELS Group has it's own stop ramp and jog engine. To activate the group internal stop ramp, the group has to be switched into local mode (G#_CT_LOCAL.) When the VisualMotion program's task A is in manual mode, the groups are also switched into local mode. In local mode, after completion of the stop ramp, the group can be jogged with the group jog engine.

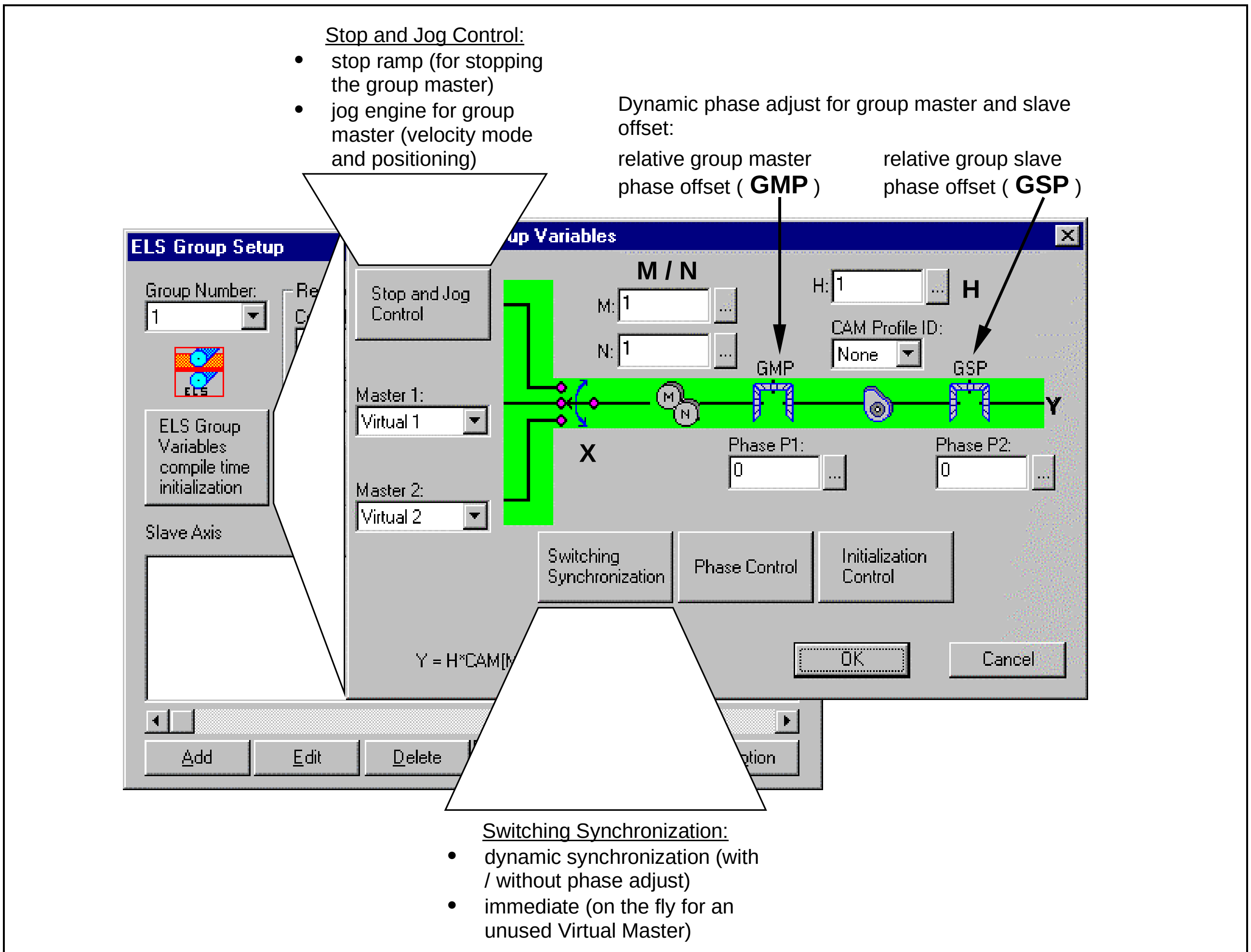


Fig. 5-13: Electronic Line Shafting Group

Rexroth Indramat

The ELS Group's active master input signal "X" is a condition of the equation in Fig. 5-14:

$$Y = H * CAM[M / N * X + GMP] + GSP$$

Fig. 5-14: ELS Group Output Equation

Where CAM[ ] is a control cam profile table or index cam profile, M and N is the current master input / output ratio, H is a cam profile scale factor and GMP and GSP are group master and slave phase adjusts. The signal Y drives the group's slave axes (group master position).

ELS Axis Configuration

ELS Slave axes are assigned to an ELS Group by clicking on the *Add* button and configuring the axis. A maximum of 16 ELS Slave axes (application dependent) can be assigned to an ELS Group. Each ELS axis can be configured with the selections in Fig. 5-15 for…

- Slave Axis number or label
- Synchronization Type
- Slave Direction
- Fine Adjust
- Turns: gear ratio (i.e., When using a gearbox.)

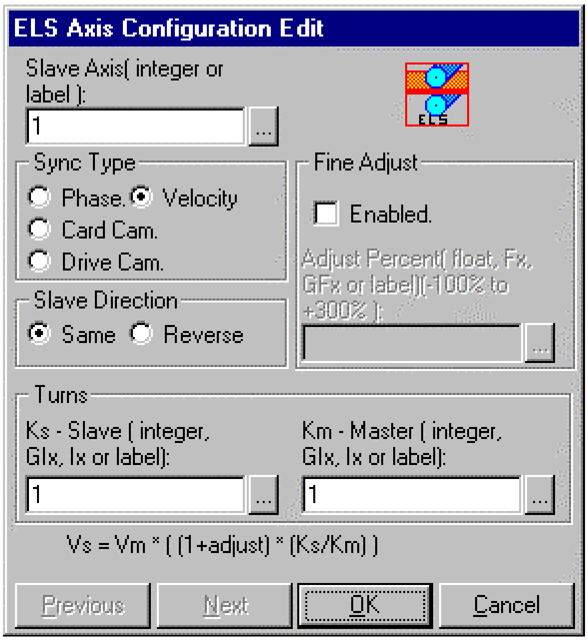


Fig. 5-15: ELS Axis Configuration

Stop and Jog Variables, Compile Time Setup

When an ELS Group is first configured, using the ELS Group icon, default values are supplied for…

- Stop Ramp deceleration
- Jog Controls for continuous, relative or absolute moves

These values are then saved, compiled and downloaded to the control. However, the user can make modifications to any of the values for stop and jogging control using the *ELS Runtime Utility*.

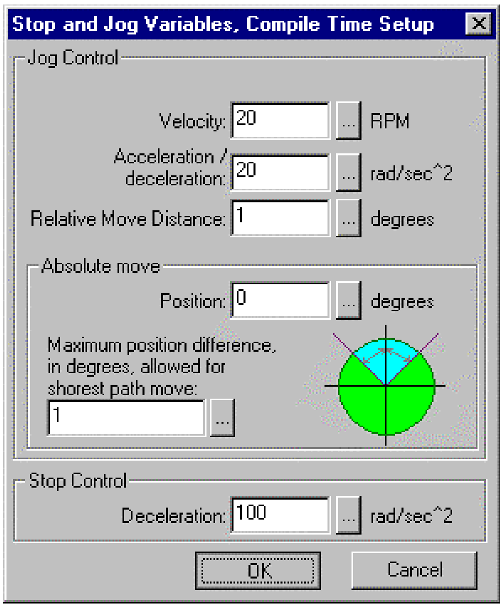


Fig. 5-16: Stop and Jog Variables

Jogging an ELS Group in Local Mode

Before an ELS Group can be jogged, the group must first be switched to local mode by toggling the G#_CT_LOCAL bit. The relative bits for jog controls are shaded within the ELS Group's control register table below.

Bit #	Bit Label	Comment
1	G#_CT_LOCK_OFF	0=lock, 1=starts unlock
2	G#_CT_MSTR_PH	0->1 triggers master phase adjust
3	G#_CT_SLV_PH	0->1 triggers slave phase adjust
4	G#_CT_MSTR_SEL	0=master 1, 1=master 2
5	G#_CT_VAR_CLK	0->1 forcing
6	G#_CT_LOCAL	0->1 switch to local mode (stop ramp / jogging), 1->0 switch from local mode to selected group input master
7	G#_CT_JOG_INC	0=sets continuous jog mode, 1=sets incremental jog mode
8	G#_CT_JOG_ABS	0=sets relative incremental mode, 1=sets absolute mode (then bit 7 will be ignored)
9	G#_CT_JOG_PLUS	0->1 starts jog motion in positive direction
10	G#_CT_JOG_MINS	0->1 starts jog motion in negative direction

Table 5-13: ELS Group Control Register

Setting bit 6 high in the group control register will bring the group velocity to zero using the deceleration rate in “G#_STOP_DECEL” variable. After bit 6 (G#_ST_LOCAL) in the group status register receives an acknowledgement that the group has stopped. The group can be jogged.

The following table describes the interaction of the jog bits. In all cases, jog motion ramps to zero when “G#_CT_JOG_PLUS” and “G#_CT_JOG_MINS” are cleared, or when one of these bits are set and then the other is set.

G#_CT_JOG_INC	G#_CT_JOG_ABS	G#_CT_JOG_PLUS = 0 → 1	G#_CT_JOG_MINS = 0 → 1
0	N/A.	Continuous positive velocity.	Continuous negative velocity
1	0	Moves to positive incremental distance of “G#_JOG_INC “ variable	Moves to negative incremental distance of “G#_JOG_INC “ variable
0	1	Moves to positive incremental distance of “G#_JOG_INC “ variable	Moves to negative incremental distance of “G#_JOG_INC “ variable
1	1	Moves in positive direction ***** to “G#_JOG_ABS” variable position Status bit “G#_ST_JOG_POS” goes high (1) when in position.	Moves in negative direction ***** to “G#_JOG_ABS” variable position Status bit “G#_ST_JOG_POS” goes high (1) when in position.
* shortest path is used if distance is within the “G#_JOG_WIN“ float variable			

Table 5-14: Group Jogging Bit Status

Switching Synchronization between Group Input Masters

Switching between ELS Group input masters 1 and 2 or local mode can be performed using the following methods:

Immediate

The group’s output position and velocity immediately switches, within one SERCOS cycle, between the two masters causing a step or bump in transition. When switching to an inactive Virtual Master, the position and velocity are adjusted “on the fly.”

Dynamic Synchronization with or without Phase Adjust

The velocity and position difference will be compensated for by an internal ramp function synchronizing the transition between masters.

Local Mode

Switching to the group’s local mode will immediately activate the group’s stop ramp. This allows stopping the group‘s output even if both group master inputs are still moving. When the stop ramp has been completed, signaled by the “group local mode active bit,” the group master can be jogged. This allows moving the group master independent from the group master inputs. Deactivation of the local mode will cause dynamic synchronization / immediate switching to the active group input master.

In the following example, ELS Group 1 with master input 1 is designed to synchronize to master input 2 when 2 is selected as the master input of ELS Group 1. In effect, master input 2 acquires the slave axes of ELS Group 1, thus replacing 1.

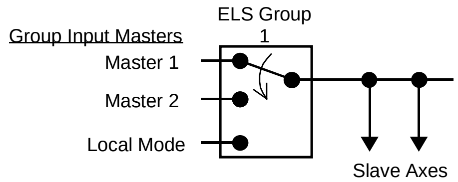


Fig. 5-17: Group Input Master Switching

Synchronization Setup

When the *Switching Synchronization* button is selected, the *Synchronization Setup* window in Fig. 5-18 displays the default values generated by the ELS Group's program variables.

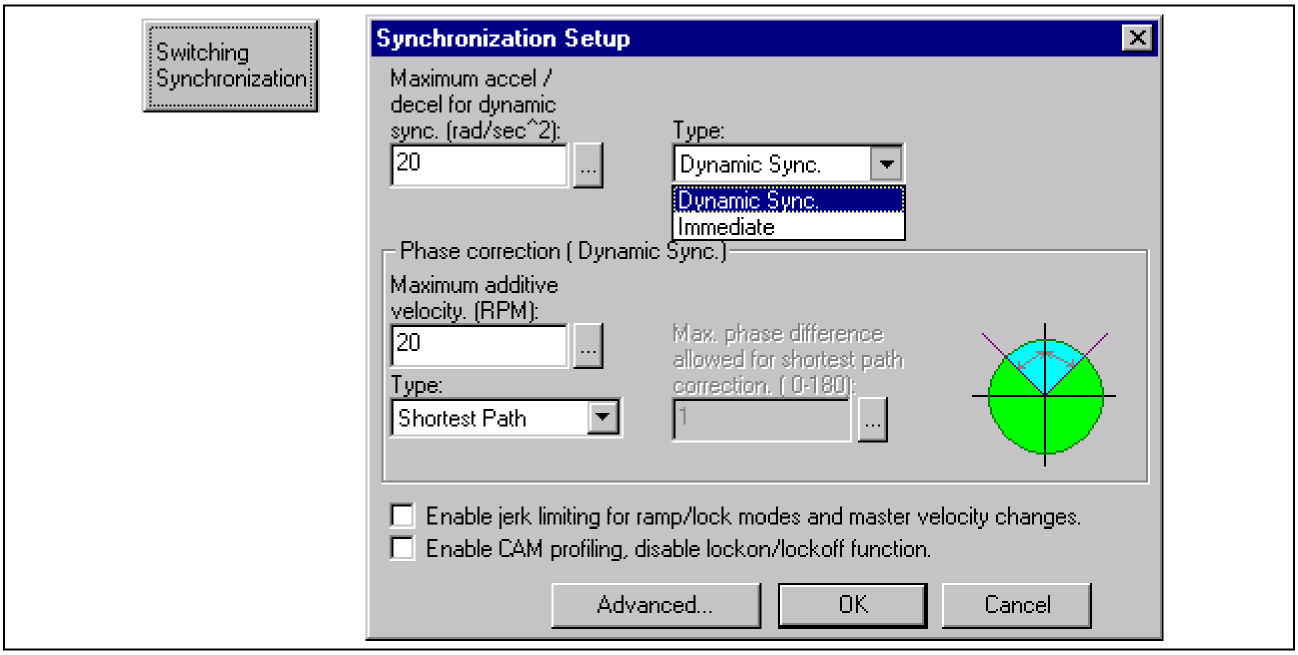


Fig. 5-18: Synchronization Setup

Maximum Acceleration/Deceleration for Dynamic Sync.

This value is the maximum acceleration or deceleration that the ELS Group will use to ramp up to the new master's velocity and perform any phase corrections with a trapezoidal velocity profile.

Note: The maximum acceleration and deceleration value is **only** used for dynamic synchronization.

Type:

This selection determines the method for switching between ELS Group input masters. GPP supports two switching methods as follows:

- Immediate Switching (Refer to page 5-30)
- Dynamic Synchronization (Refer to page 5-32)

Phase Correction

Note: The following phase corrections are **only** available for dynamic synchronization.

Maximum Additive Velocity:

Specifies the maximum increases or decreases in velocity allowed for matching the phase (position) of target master.

Type:

Specifies the direction in which the phase correction will be made. The user can select *shortest path*, *positive*, *negative* or *no phase correction.*

Maximum Phase Difference: "Monitoring Window"

When selecting a positive or negative direction, a value (± 0-180 degrees) is entered which creates a range (monitoring window) around the position of the target master. If any phase errors are within this window, shortest path will be used for the correction.

This allows the user to eliminate large phase corrections depending on the size of the window.

Immediate Switching

This method allows for an immediate transition to a new input master. Switching takes place within one SERCOS cycle without regard to bumpless transitions. When switching between input masters, the group's velocity and position immediately change to match the target master. The bump is caused by the sudden change in velocity and correction of position difference between input masters. The following graph shows a typical immediate switch with a transitional bump.

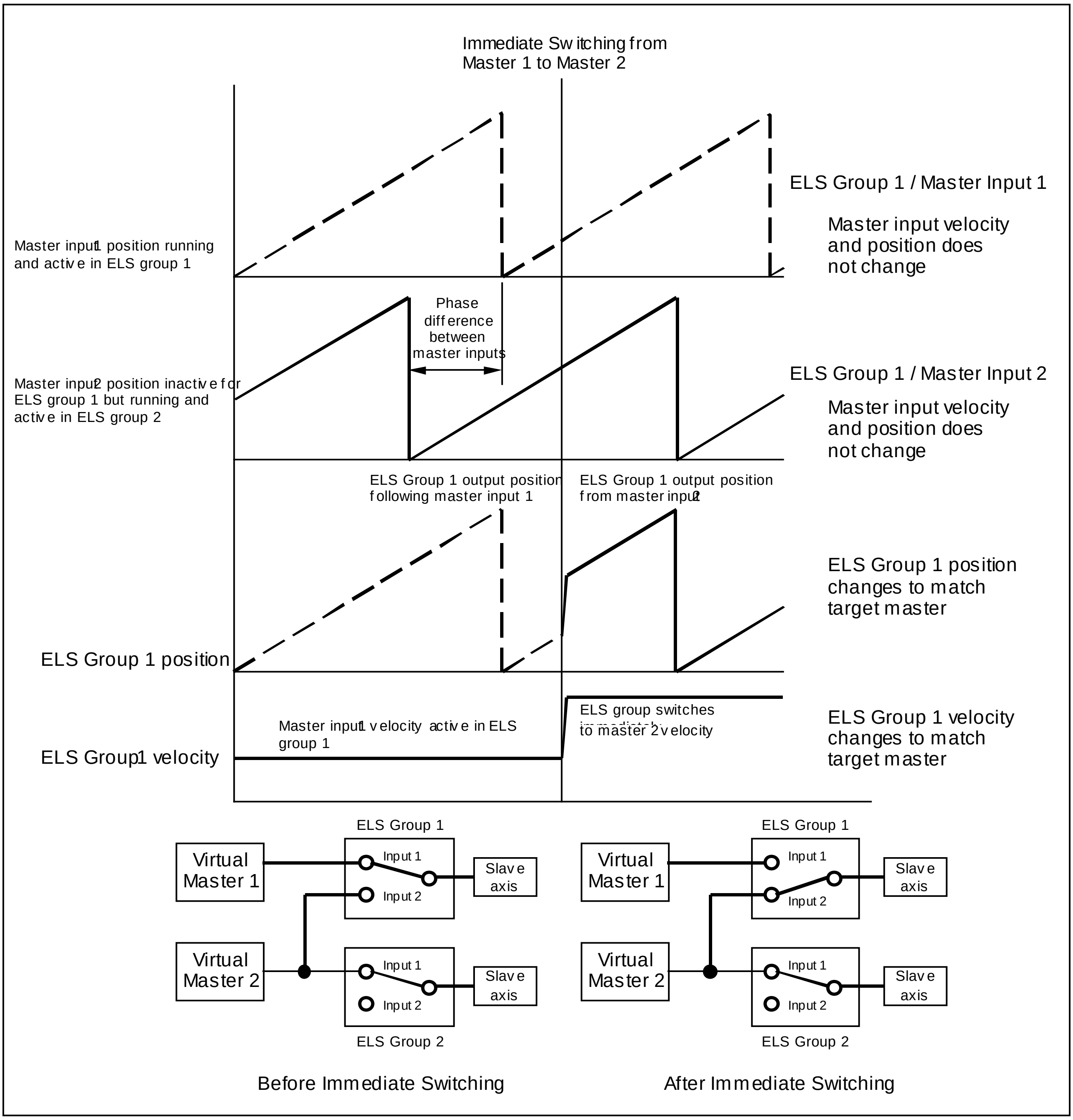


Fig. 5-19: Immediate Switching of ELS Group 1

“On the Fly” Immediate Switching for Running but Inactive Virtual Masters

A special case is switching to a Virtual Master, which is running but not the active master for any other ELS Group. The current master is sampled and it’s position and velocity is measured. These dynamic variables are used to initialize the new Virtual Master's target **on the fly**, allowing for an immediate and bumpless transition.

Note: It is not possible to use this method to synchronize to a Real Master since instantaneous changes in position, velocity, or acceleration would result in a drive fault.

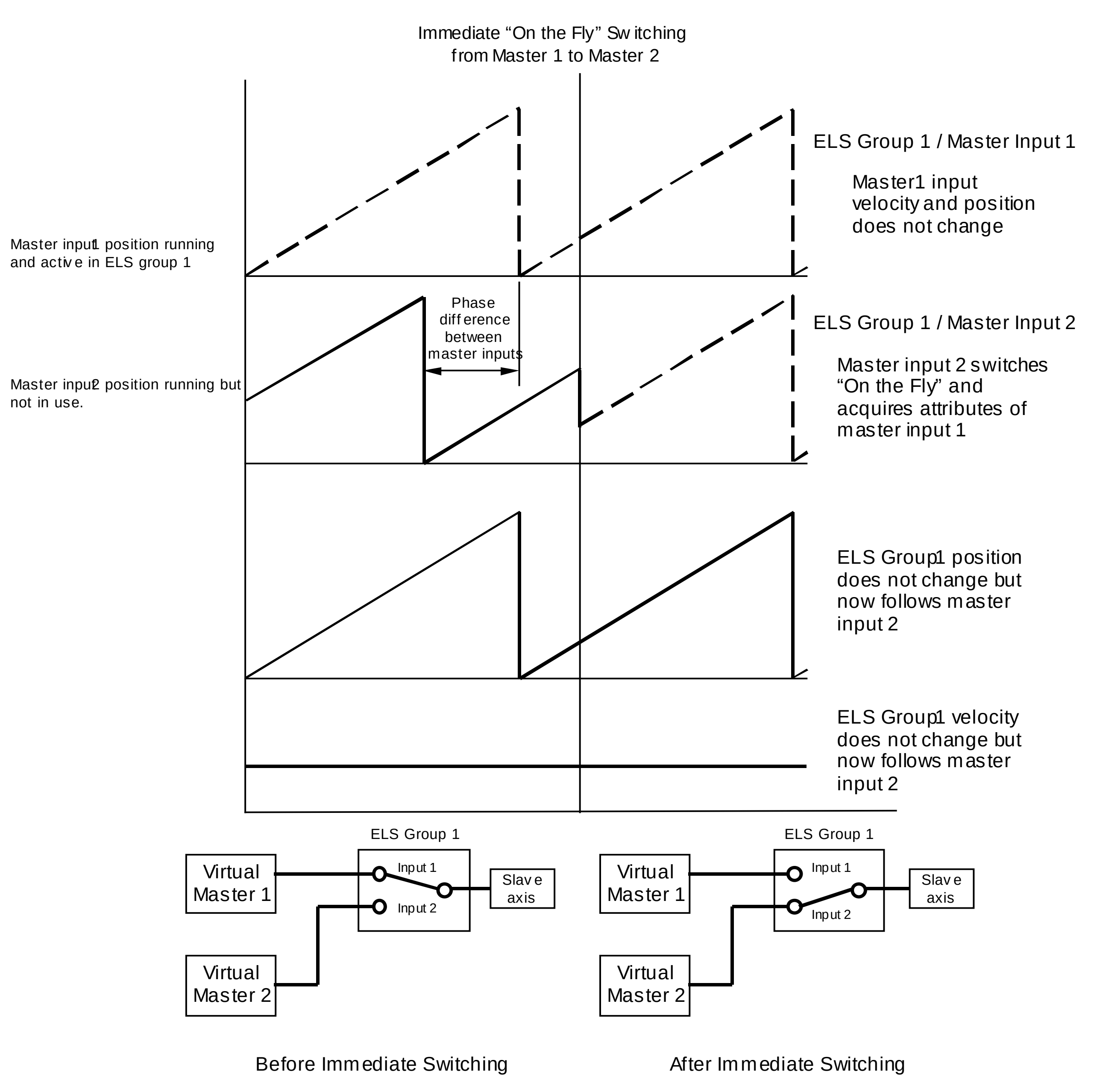


Fig. 5-20: Immediate “On the Fly“ Switching of ELS Group 1

Dynamic Synchronization

Typically, this general-purpose method synchronizes an ELS Group with a real, virtual or ELS Group Master to another real, virtual or ELS Group Master.

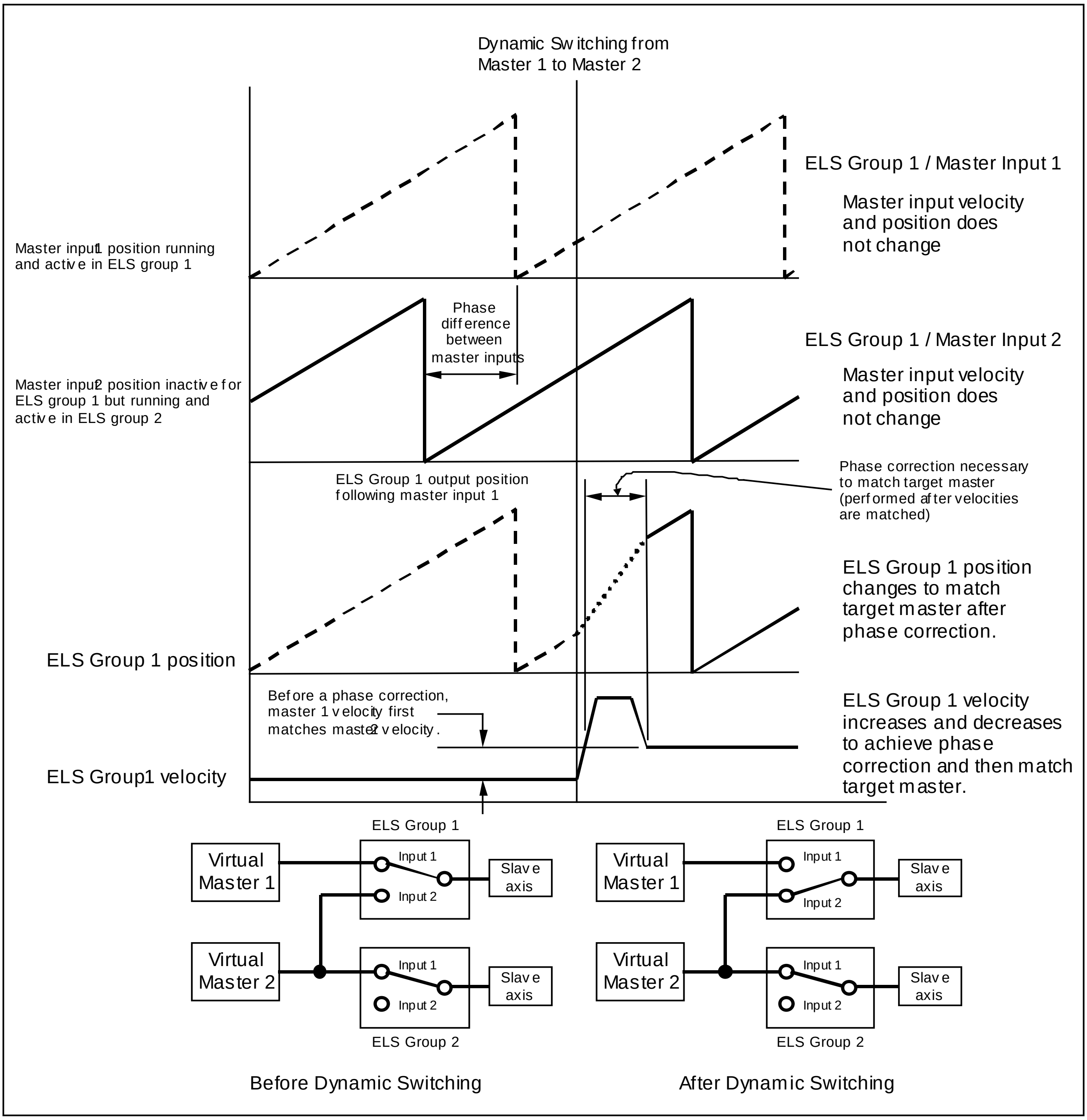


Fig. 5-21: Dynamic Switching of ELS Group 1

Dynamic synchronization allows for a rapid switch to a temporary (internal) velocity mode Virtual Master which then ramps and locks onto the new target master. The temporary master immediately disconnects the group’s connection to the first master and allows for a smooth transition to the next master. Ramping is performed using the ELS Group synchronization's acceleration and velocity rates. These rates are also used for dynamic group master and slave phase corrections.

After ramping (velocity synchronization), a phase adjust compensates for any position error. Once the phase adjust is complete, the ELS Group’s master is switched to the new input master. The temporary, internal master is dissolved after the transition is complete.

Note: Any attempt to switch masters again during dynamic synchronization is ignored, with the exception of switching to local mode (stop ramp.)

Synchronized “Lock On / Lock Off” of ELS Group Master

VisualMotion using GPP firmware incorporates the ability to stop and restart an ELS Group for one or more cycles of the group’s input master. This function is performed using three cam profiles running synchronized with the group’s input master. This synchronization between cam profiles and master input eliminates the need of any phase corrections. This function allows the program to stop a specific group’s process while maintaining other groups running.

The following is an application example of the Lock On / Lock Off feature in GPP firmware. This example monitors the presence of a gap between products in a horizontal wrapper.

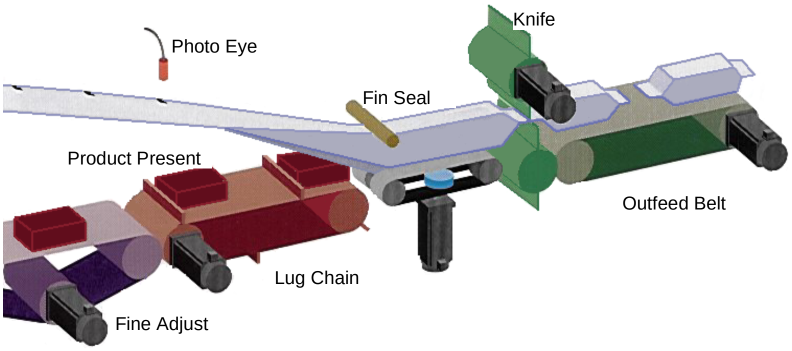


Fig. 5-22: Horizontal Form, Fill and Seal Wrapper

The Lock On / Lock Off feature in GPP is activated by the state condition of bit 1 (G#_CT_LOCK_OFF) in the ELS Group control register.

VisualMotion provides three default cam profiles for the Lock On / Lock Off feature. However, the user can create and download customized cam profiles using the CAM builder function in VisualMotion.

One-to-One Cam Profile “Synchronized to Master”

This cam profile is a one-to-one profile and is normally active and synchronized to the master input *unless* the Lock On / Lock Off feature is *not* active. Under normal operating conditions, this cam profile is active and follows the group’s active master input.

State of Lock On/ Lock Off bit

G#_CT_LOCK_OFF = ***0***

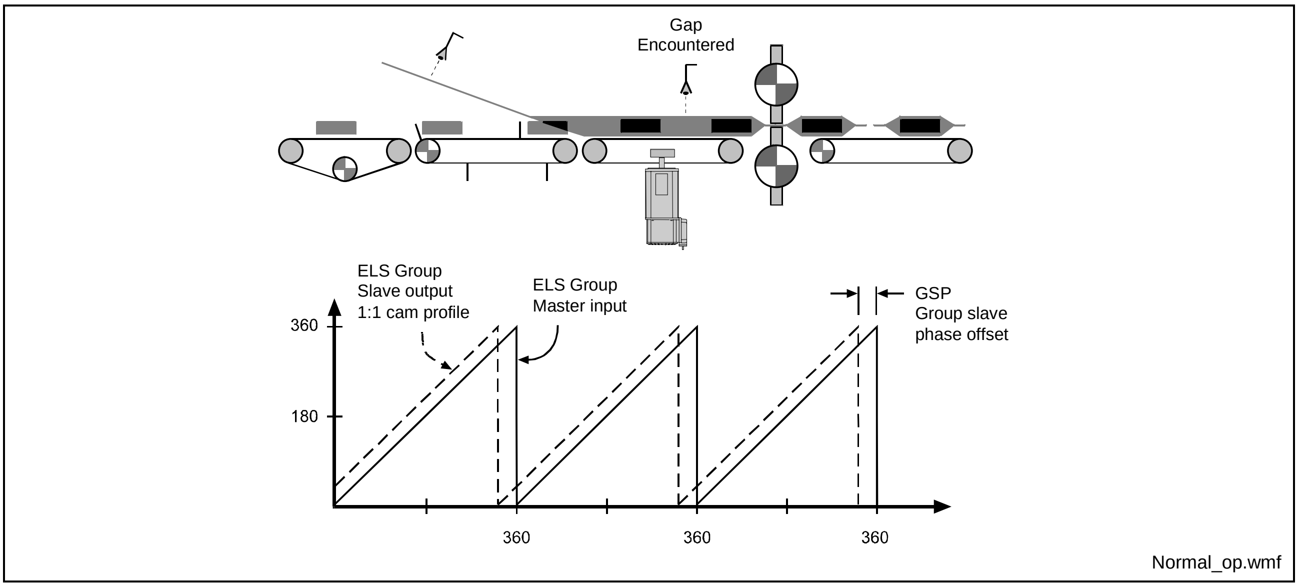


Fig. 5-23: Normal Operation of Wrapper Application

Lock Off The Lock Off cam profile decelerates to a stop over one cycle of the master. After this cycle, the group's velocity is stopped and will not re-start unless the LOCK OFF bit is toggled.

Note: All motion to the ELS Group Master, as well as any cascading groups, will stop.

State of Lock On/ Lock Off bit

G#_CT_LOCK_OFF = **0 to 1**

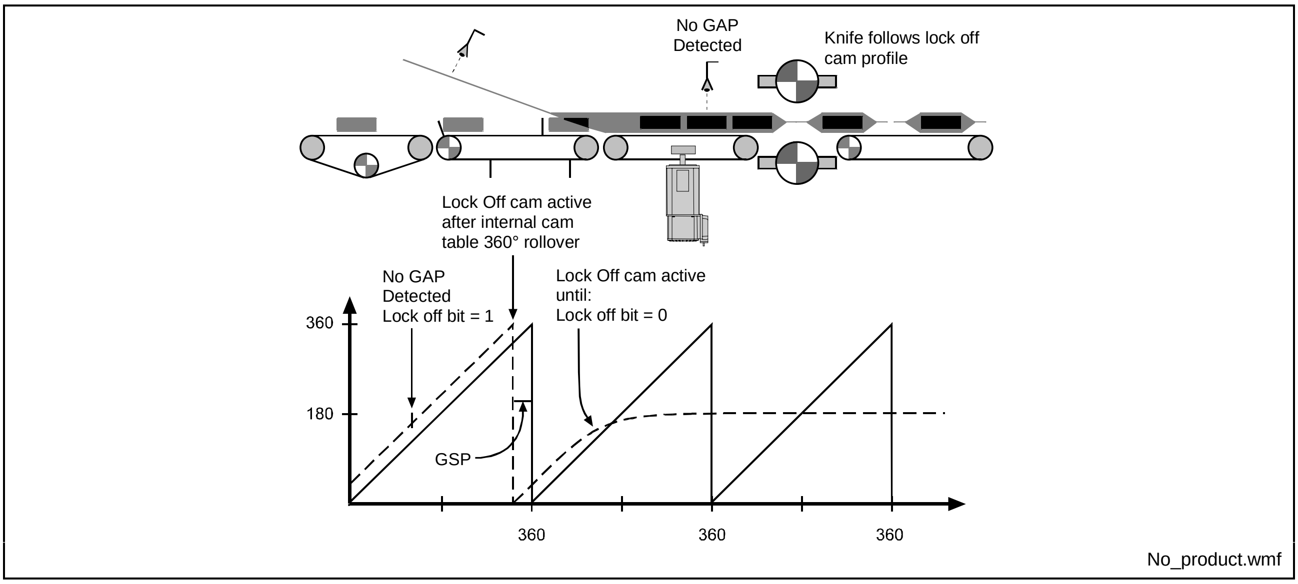


Fig. 5-24: Lock Off Cam Active, *No Product - No Seal*

Lock On The Lock On cam profile is active and accelerates from a stopped position to match the velocity of the master input over one cycle of the master (360 degrees). After this cycle, the velocity of the group matches that of the master.

State of Lock On/ Lock Off bit

G#_CT_LOCK_OFF = ***1 to 0***

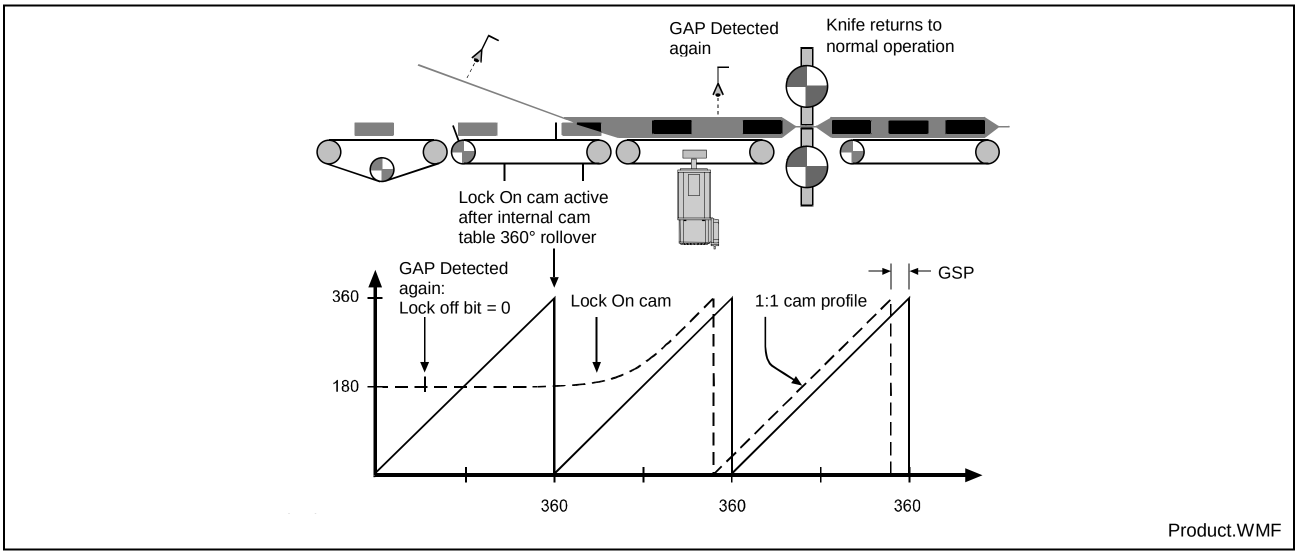


Fig. 5-25: Lock On Cam Active, Product is Present Once Again

6 Profibus Fieldbus Interface

6.1 General Information

Version Note:
Information in this document is based on VisualMotion Toolkit software version 07V14 and PPC-R firmware version GPP07V09.

PPC-R System Description with a Fieldbus

The PPC-R can operate on a serial fieldbus interface (network) by means of a fieldbus expansion card that communicates with the PPC-R via dual-port RAM. The function of the fieldbus card is similar to that of a network card in a PC: it allows communication with other devices on the network.

In Fig. 6-1, a commonly described fieldbus interface is pictured:

- **Fieldbus Master** - PLC fieldbus interface
- **Fieldbus Slave** - PPC-R fieldbus interface

In this document, we will refer to the PLC as the **fieldbus master** and the PPC-R as the **fieldbus slave**.

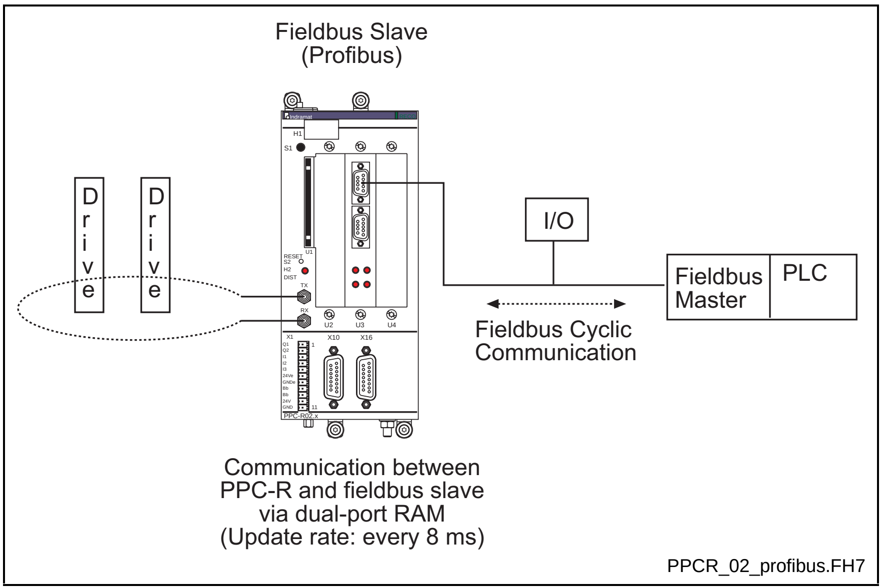


Fig. 6-1: Sample Master/Slave Setup with Fieldbus Card

With the PPC-R, the fieldbus card can be used **only** as a **slave** card in a master/slave setup.

The VisualMotion Fieldbus Mapper

In the VisualMotion software package, the Fieldbus Mapper is a tool used to set up fieldbus configuration and data mapping.

Data Transfer Direction (Output vs. Input)

In the VisualMotion Fieldbus Mapper, output and input are always described with respect to the fieldbus master. The definitions for output and input follow:

output: the communication from the PLC to the PPC-R (i.e. from the fieldbus master to the fieldbus slave).
Synonyms for this type of communication: **send** or **write** data.

input: the communication from the PPC-R to the PLC (i.e. from the fieldbus slave to the fieldbus master).
Synonyms for this type of communication: **receive** or **read** data.

Fieldbus Data Channel Descriptions

The Indramat Profibus fieldbus interface card for the PPC-R supports the cyclic (DP) channel, which is made up of the following two parts:

- ***Real-Time Channel*** (for **single** and **multiplex** channels)
- ***Parameter Channel*** (for systems requiring non-cyclic transmissions)

Cyclic (DP) Channel

Cyclic data is user-defined. It is stored in two ordered lists (C-2600 for input data, C-2601 for output data) and transmitted serially over the bus.

The cyclic data channel is limited to 16 input words and 16 output words. PPC-R data types consume these words in either one-word (or 16-bit) groups for PPC-R registers or two-word (or 32-bit) groups for all other data types.

The PPC-R mapping list is scanned every 8 ms and data is sent and received to/from the fieldbus slave board’s dual port RAM.

The cyclic data channel can be made up of any combination of the following data types:

- Real-Time Channel
  - Single Channel
  - Multiplex Channel
- Parameter Channel

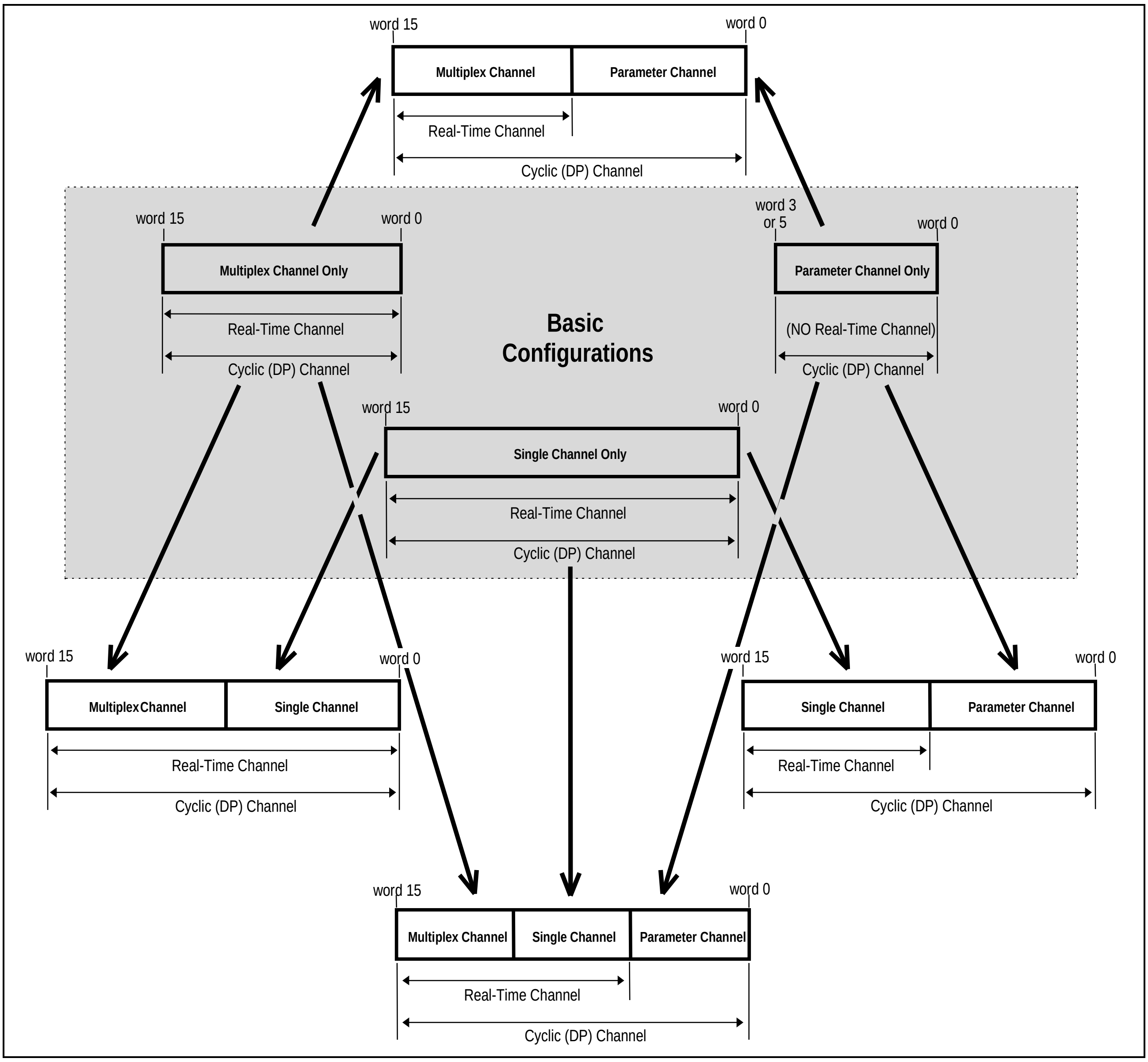


Fig. 6-2: Configuration Options for the Cyclic Data Channel

The Real-Time Channel

In the real-time channel, data is updated cyclically between the fieldbus master and slave. This channel contains two possible data types: **single** and **multiplex**.

Cyclic Data: Types and Sizes

The following table outlines the PPC-R data types that can be transmitted via the cyclic channel and the amount of space (in 16-bit data words) that each data type consumes. Remember that the cyclic channel is limited to 16 data words in each direction (input and output).

Note: The cyclic data mapping lists supports only 16- and 32-bit data of the following types for reading and writing:
- Integer
- Float
- Binary (used in control parameters)
- Hex (used in control parameters)

For all other data types (e.g. diagnostic messages - “strings”), use the Parameter Channel.

PPC-R Data Type	Data Size (in 16-Bit Words)
Register	1
Program Integer (currently active program ONLY *)	2
Program Float (currently active program ONLY *)	2
Global Integer	2
Global Float	2
Card Parameter	2
Axis Parameter	2
Task Parameter	2
Note: Drive parameters "S" or "P" cannot be transmitted cyclically because of the inherent delay of parameter access over the SERCOS service channel. See ***"Parameter Channel."*** However, if a drive parameter is mapped to an Axis Parameter, that Axis parameter could be used in cyclic data (see description of Axis Parameters 180-196 in the **VisualMotion 7 Reference Manual**).	
*** Important Note:** Integers and floats are shown only for the currently active program. Each time you activate a new progam, the fieldbus reads/writes to the newly-activated program.	

Table 6-1: PPC-R Cyclic Data Types and Sizes

Single Data Types

Single data types are mapped directly in the cyclic mapping ordered lists (C-2600, C-2601). The data types are updated every 8 ms via dual-port RAM.

Multiplex Data Types (Cyclic Data Channel)

In some multi-axis applications, 16 words of cyclic data transfer are not sufficient to meet the requirement of the application.

When insufficient data transfer space is available, multiplex data can be set up within the cyclic channel. One multiplex container acts as a placeholder for multiple possible PPC-R data types (all of the same word size). The currently transmitted PPC-R data type is based on an index value placed in a multiplex control or status word attached to the end of the cyclic list. Depending on the index specified by the master, the multiplex channel permits a different set of data within the cyclic channel to be transferred as current real-time data. Multiplex containers can be added to the input and output lists separately and the input and output indexes can be designated separately (in the control and status words).

Note: Using the multiplex channel reduces the maximum number of usable words for storing control data to 15. The 16th word (or last used word, if fewer than 15 words) is used as the multiplex entry control/status word.

Note: Up to 15 multiplex containers can be used. However, a maximum of 180 mapping items can be transmitted in the input or output list. This limitation of mapping objects means that you cannot multiplex all 15 containers with 32 indexes (=480 items).

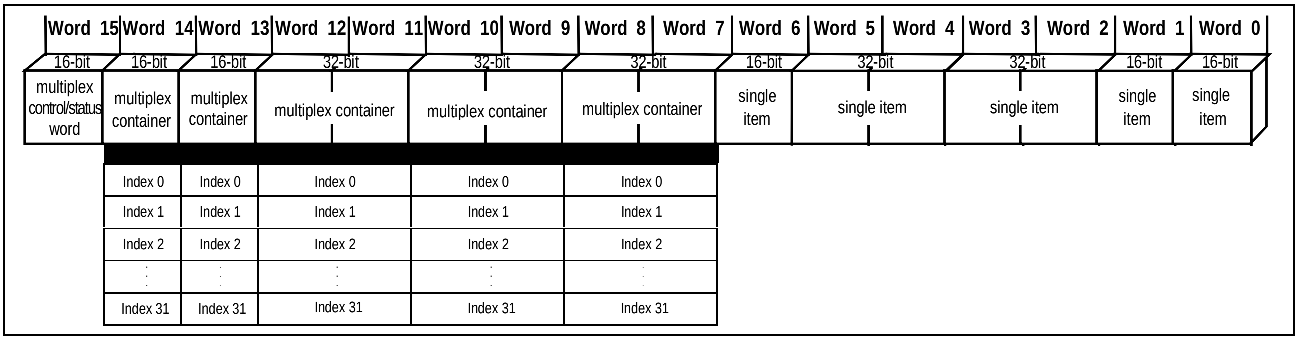


Fig. 6-3: Sample Command (PLC⇒PPC-R) or Response (PPC-R ⇒PLC)

The multiplex control and status words serve to command and acknowledge multiplex data transferred between the fieldbus master and the fieldbus slave. The **control** word is associated with **output** communication (PLC⇒PPC-R). The **status** word is associated with **input** communication (PPC-R⇒PLC). Single data items are not affected by the multiplex control and status words.

Note: For specific information about how the fieldbus master uses the multiplex control and status words, refer to Multiplexing on page 6-22.

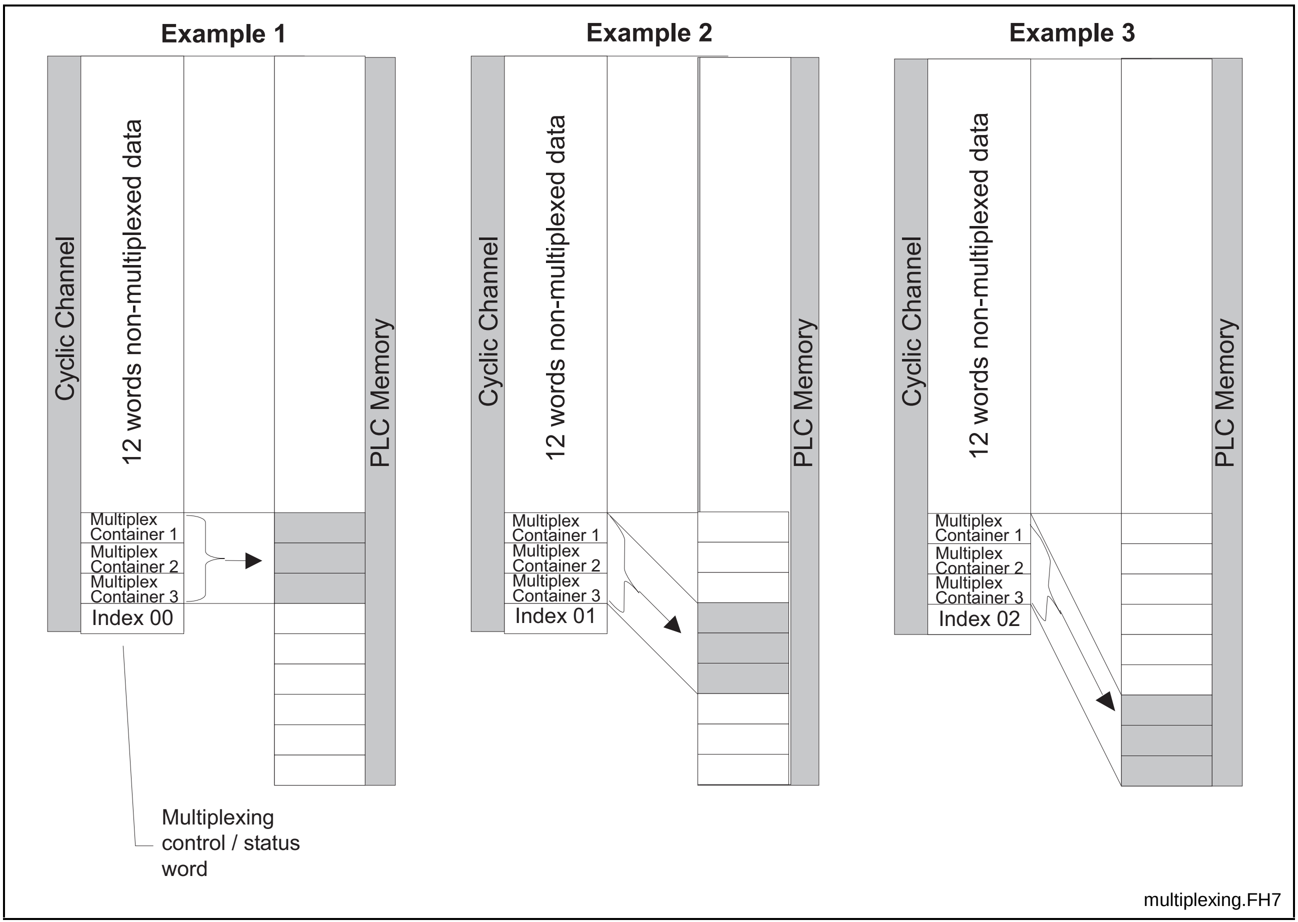


Fig. 6-4: Examples for Reading Data via the Multiplex Channel

Parameter Channel

For Profibus systems using the PPC-R/VisualMotion configuration, a subset of the cyclic (DP) channel can be allocated for non-cyclic communications (e.g. parameterization and extended diagnostic information). This subset of the cyclic channel is called the **Parameter Channel**.

Note: The Parameter Channel is always allocated as the first 4 or 6 words of the Profibus cyclic (DP) channel. The length of the parameter channel plus the length of the real-time channel used to exchange cyclic data represents the entire length of the DP channel (maximum total length: 16 words). Refer to *Fig. 6-2* for DP channel configuration options.

Two messaging formats are available in the Parameter Channel, to allow for a varying degree of implementation, depending on application requirements:

- **Short Format 3**- messaging format that provides direct access to Indramat mapped objects (Registers, Global Floats, Global Integers, Floats, Integers, as well as Card, Axis, Task, and Drive S and P parameters).

Note: List parameters can be accessed using the Data Exchange Object. For further explanation of how this format functions, refer to *Messaging Formats* on page 6-28.

- **VisualMotion ASCII Format**- provided for backward-compatibility with previous VisualMotion versions. For specific information about this format, refer to the *VisualMotion 6.0 Start-Up Guide* (DOK-VISMOT-VM*-06VRS**-PR02-AE-P, Mat. No. 282762).

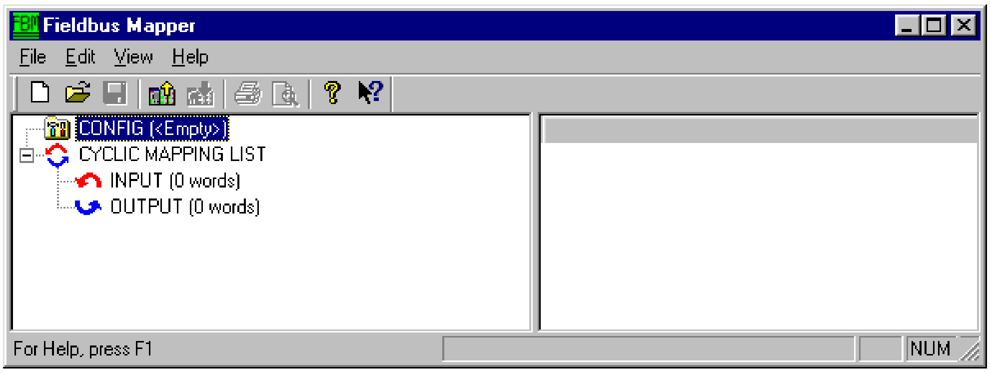
6.2 Fieldbus Mapper Functionality

Initializing the Fieldbus Mapper from VisualMotion 7

1. Open an existing program or create a new program. You must be using PPC-R hardware with GPP firmware to use the Fieldbus Mapper described in this document.

Note: Make sure the VisualMotion system is configured for GPP (in the ***Setup⇒Configuration*** menu item of the main VisualMotion screen).

2. Select ***Data⇒Fieldbus Mapper***. The main Fieldbus Mapper screen appears (refer to *Fig. 6-5*).



FB_Mapper_Main_New.tif

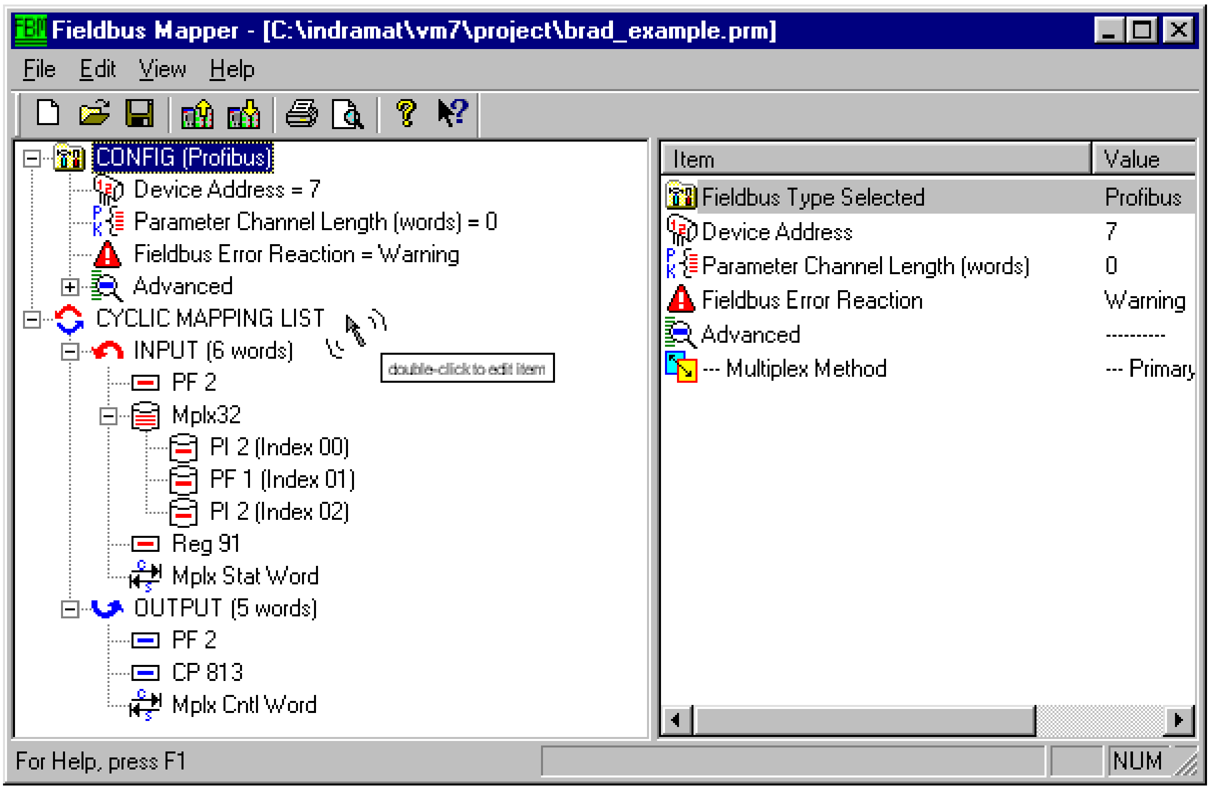
Fig. 6-5: Fieldbus Mapper Main Screen (Blank)

Creating a New Fieldbus Mapper File

1. Click **or** select ***File⇒New***.
   A “setup wizard” goes through three steps:
   - Fieldbus Slave Definition
   - Fieldbus Slave Configuration
   - Cyclic Data Configuration
2. Enter the information requested in the setup screens. For more details on each step, refer to *Fieldbus Slave Definition*, *Fieldbus Slave Configuration*, and *Cyclic Data Configuration* for detailed information about each configuration step.
3. Save the file (automatically has a ***.prm** extension).

Editing an Existing Fieldbus Mapper File

1. Click **or** select ***File⇒Open***.
2. Browse to find the desired file (***.prm** extension).
3. Click *Open*. The main Fieldbus Mapper screen appears, which lists the configuration information. Refer to *Fig. 6-6*.



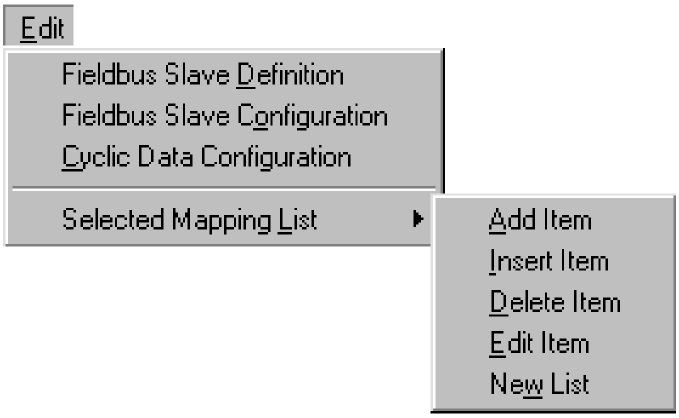
FB_Mapper_Main_PB_Edit.tif

Fig. 6-6: Fieldbus Mapper Main Screen (Complete)

4. From the Fieldbus Mapper main screen, **double-click** on the specific item to be edited. The corresponding setup screen appears.

- Or -

Select the item to edit from the ***Edit*** menu (refer to Fig. 6-7). For more information about each step, refer to *Fieldbus Slave Definition*, *Fieldbus Slave Configuration*, and *Cyclic Data Configuration* for detailed information about each configuration step.



Green and Black Diamond.gif

Fig. 6-7: Fieldbus Mapper Edit Menu

Note: You can also directly add, insert, delete, edit an item, or create a new list by:

- clicking on the item to be edited in the main Fieldbus Mapper screen and selecting the desired function under ***Edit⇒Selected Mapping List***

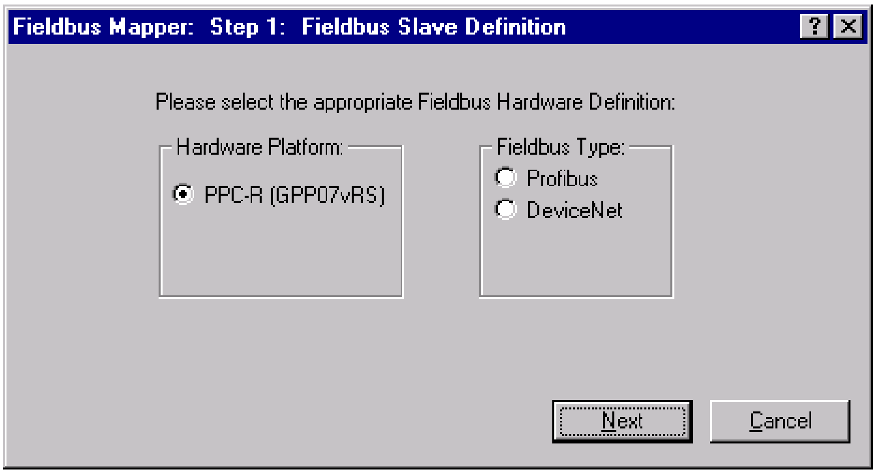
OR

- right-clicking on an item to display a menu of functions

Fieldbus Slave Definition

Only one hardware platform is currently supported in this Fieldbus Mapper: PPC-R (GPP07vRS firmware). If you are using PPC-R hardware with GPS firmware, the previous version of the Fieldbus Mapper initializes.

From the Fieldbus Slave Definition window, select **Profibus** as the Fieldbus Type (refer to *Fig. 6-8*).

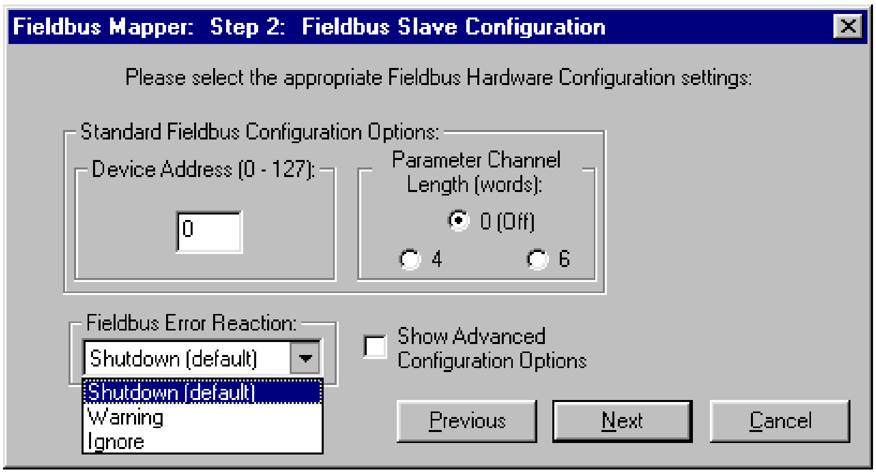


FB_Slave_Def_PB.tif

Fig. 6-8: Fieldbus Slave Definition Window

Fieldbus Slave Configuration

The Profibus Fieldbus Slave Configuration screen is shown in *Fig. 6-9* below.



FB_Slave_Config_PB.tif

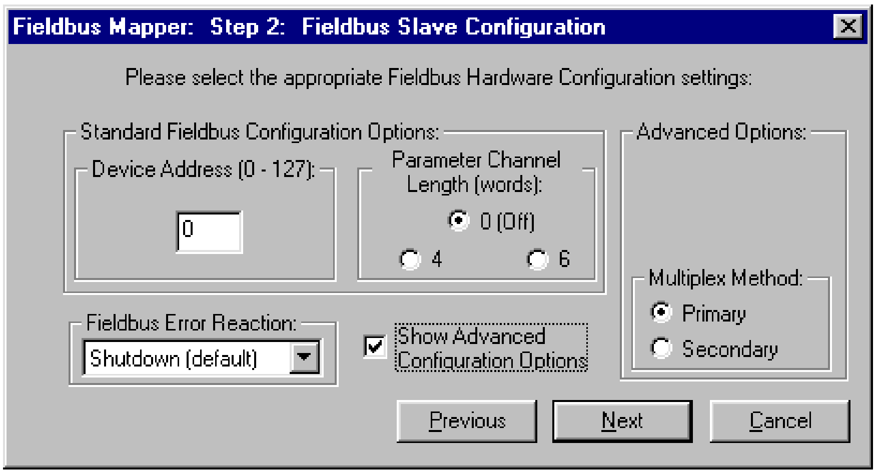
Fig. 6-9: Fieldbus Slave Configuration

Standard Fieldbus Configuration Options:

- **Device Address (0-127):** set to a unique number for the devices on the bus
- **Parameter Channel Length (words):** set to 0 (Off), 4 or 6 words. If 4 or 6 words are selected, these are automatically allocated as the first 4 or 6 words in the Cyclic Data Input and Output Lists.

Fieldbus Error Reaction: Set the Error Reaction to Shutdown (default), Warning or Ignore. Refer to *Fieldbus Error Reaction* on page 6-20 for detailed information about each setting.

Advanced Configuration Options The **"Advanced Options:"** are shown only if the checkbox next to **Show Advanced Configuration Options** is checked (refer to *Fig. 6-10* below). In most cases, the default options should apply.



FB_Slave_Config_PB_Adv.tif

Fig. 6-10: Fieldbus Slave Configuration: Advanced

- **Multiplex Method:** select Primary or Secondary (Primary is the default). Select Secondary only if you have an inconsistent fieldbus master. Refer to *Multiplexing* on page 6-22 for detailed information about each method.

Cyclic Data Configuration

An example of the Cyclic Data Configuration screen is shown in *Fig. 6-11* below. In this screen, four words have been allocated for the Parameter Channel (optional for Profibus fieldbuses only). No data has yet been configured. If you are editing an existing Fieldbus Mapper file, the list will probably contain more items.

First, you must select the Cyclic Input List (from PPC-R to PLC) or the Cyclic Output List (from PLC to PPC-R).

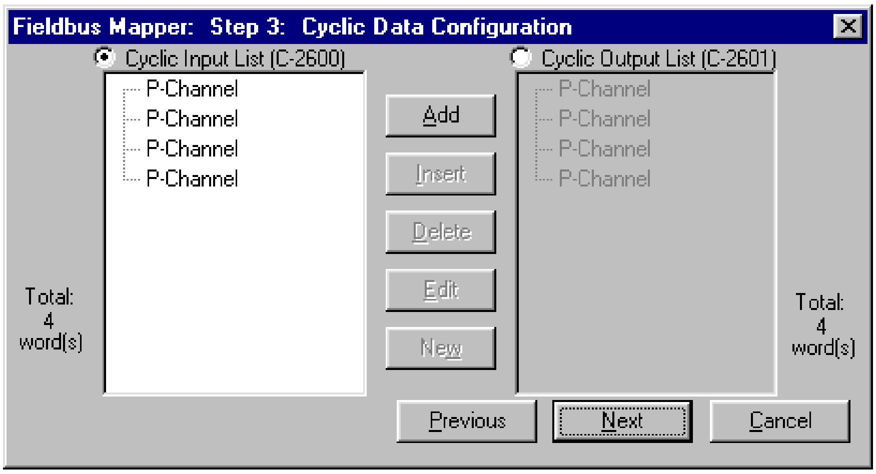


Fig. 6-11: Cyclic Data Configuration—Initial Screen

Adding an Item to the List

1. Select the Cyclic Input List or the Cyclic Output List.
2. Click *Add*. The screen in *Fig. 6-12* below appears. Select the Data Type (for example, Register).

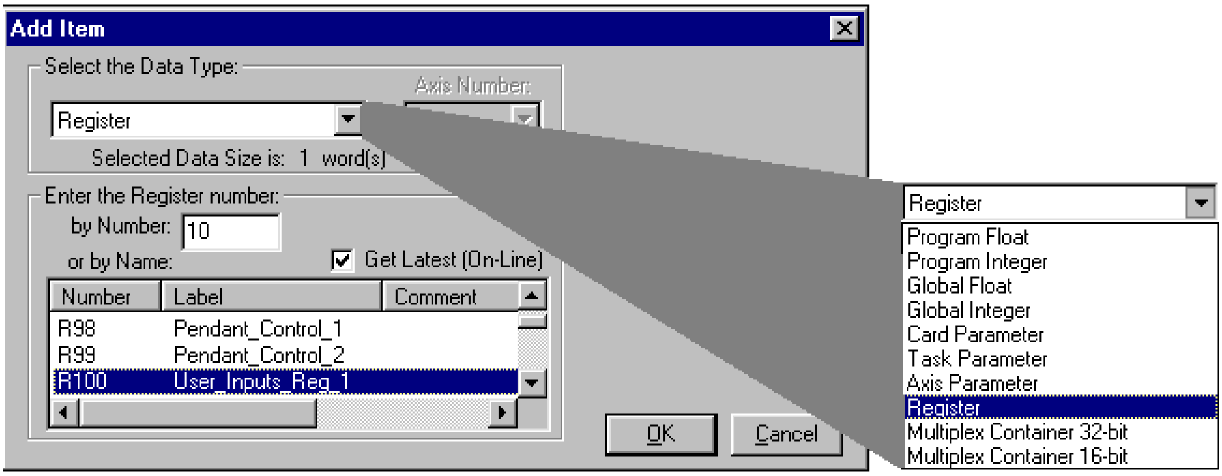


Fig. 6-12: Add Item to Cyclic Data

Note: Registers and 16-bit Multiplex Containers (used only for Registers) require one data word (16 bits), and all other data types require two data words (32 bits) of space.

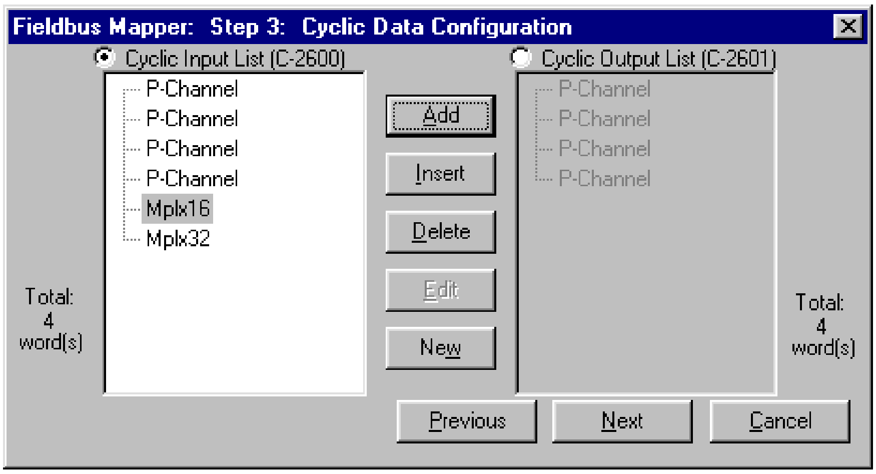
3. Enter the required information (for example Register Number) or select it from the list below. Only the available data types for your designated VisualMotion hardware setup and fieldbus type are listed.

Note: If you check the box next to “Get Latest (On-Line),” the data type label list is updated based on your firmware version and the currently active program.

4. Click *OK* to add the selected item to the list.

Adding Multiplex Containers to the List

1. Select the Cyclic Input List or the Cyclic Output List.
2. Click *Add*.
3. In the “Add Item” screen under “Select the Data Type:” select Multiplex Container 16-bit (for Registers) or Multiplex Container 32-bit (for all other data types).
4. Click OK to add the Multiplex Container to the List. The screen in *Fig. 6-13* below is an example where a 16-bit Multiplex Container and a 32-Bit Multiplex Container have been added.



Cyclic_Data_Mplx.tif

Fig. 6-13: Cyclic Data Configuration, Multiplex Containers

Note: At this point, the Multiplex Containers do not yet contain any items. To add multiplex items, refer to below.

Adding Items to an Empty Multiplex Container

1. In the Cyclic Data Configuration screen, select the multiplex container to which you want to add items.
2. Click *Add*. The screen in *Fig. 6-14* below appears. Because it is unclear whether you would like to add to the list or to the multiplex container, the Fieldbus Mapper is requesting clarification.

Multiplex_Add_Msg.tif

Fig. 6-14: Add Item or Multiplex Item Screen

Note: For subsequent items, highlight any of the indexes within the multiplex container before clicking *Add*, and the Fieldbus Mapper will know you want to add to that container.

3. To add to the selected multiplex container, click *No*. The screen in *Fig. 6-15* below is an example for adding a 32-bit multiplex item.
4. Select the desired item to be added to the multiplex container.

Note: In addition to the data types that can be added to the multiplex list, an empty item called **Multiplex Empty Item** is available to fill a space within the multiplex container, if nothing is to be mapped to a particular index.

5. Click *OK*. The item is automatically placed in the multiplex container as the next unassigned index item (e.g. the first item is index 00, the last is index 31).
6. Repeat for as many items as you want to add to the multiplex container, up to 32 items.

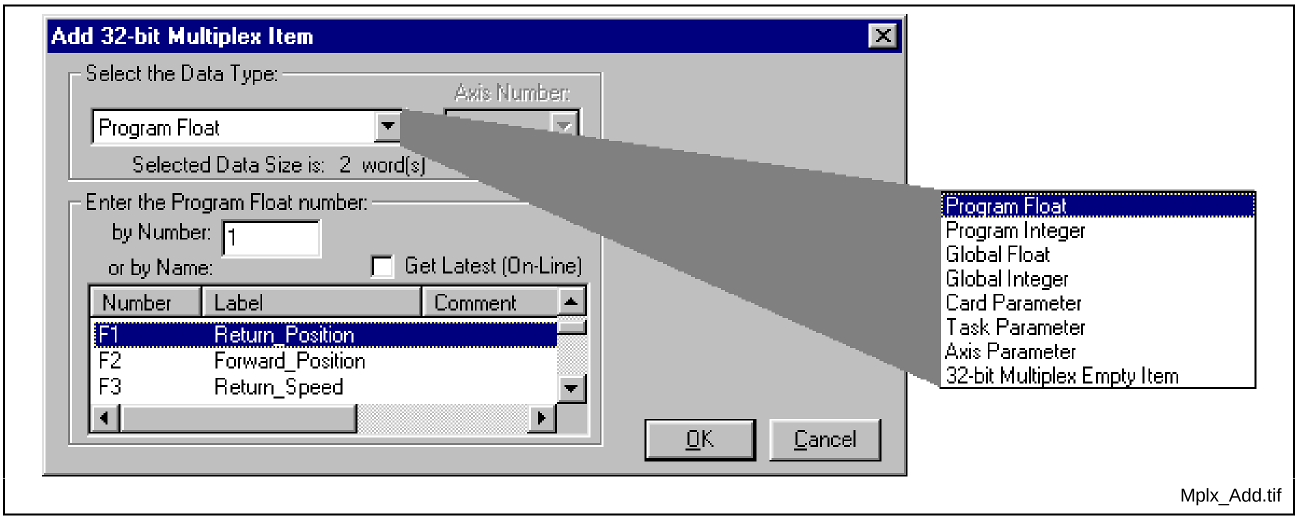


Fig. 6-15: Adding a Multiplex Item to the Container (32-bit example)

Editing the Cyclic Data Lists

To make changes to an existing list, use the following buttons:

Button	Function
Add	Inserts a new item at the end of the list.
Insert	Inserts a new item into the list directly before the selected item.
Delete	Removes the selected item from the list.
Edit	Allows editing of the selected item. (To edit a list item, you may also double-click on it.)
New	Clears up the current list.

Table 6-2: Button Functions in the Cyclic Data Configuration Window

Additional Functions

Several additional functions are now available in the Fieldbus Mapper:

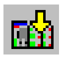
Function	**Icon**	**Menu Selection**
Download the current fieldbus configuration from the PPC-R		File⇒Get Fieldbus Configuration from PPC
Upload the current fieldbus configuration in the Fieldbus Mapper to the PPC-R		File⇒Send Fieldbus Configuration to PPC
Print the current fieldbus configuration data		File⇒Print
Preview the printout of the current fieldbus configuration data		File⇒Print Preview

Table 6-3: Additional Functions

Getting the Fieldbus Configuration from the PPC

After getting the fieldbus configuration from the PPC, the following information is detected by the system and appears in the configuration list:

- Fieldbus Type Found
- Fieldbus FW (Firmware) Version
- GPP Control FW (Firmware) Version

An example is shown in *Fig. 6-16* below.

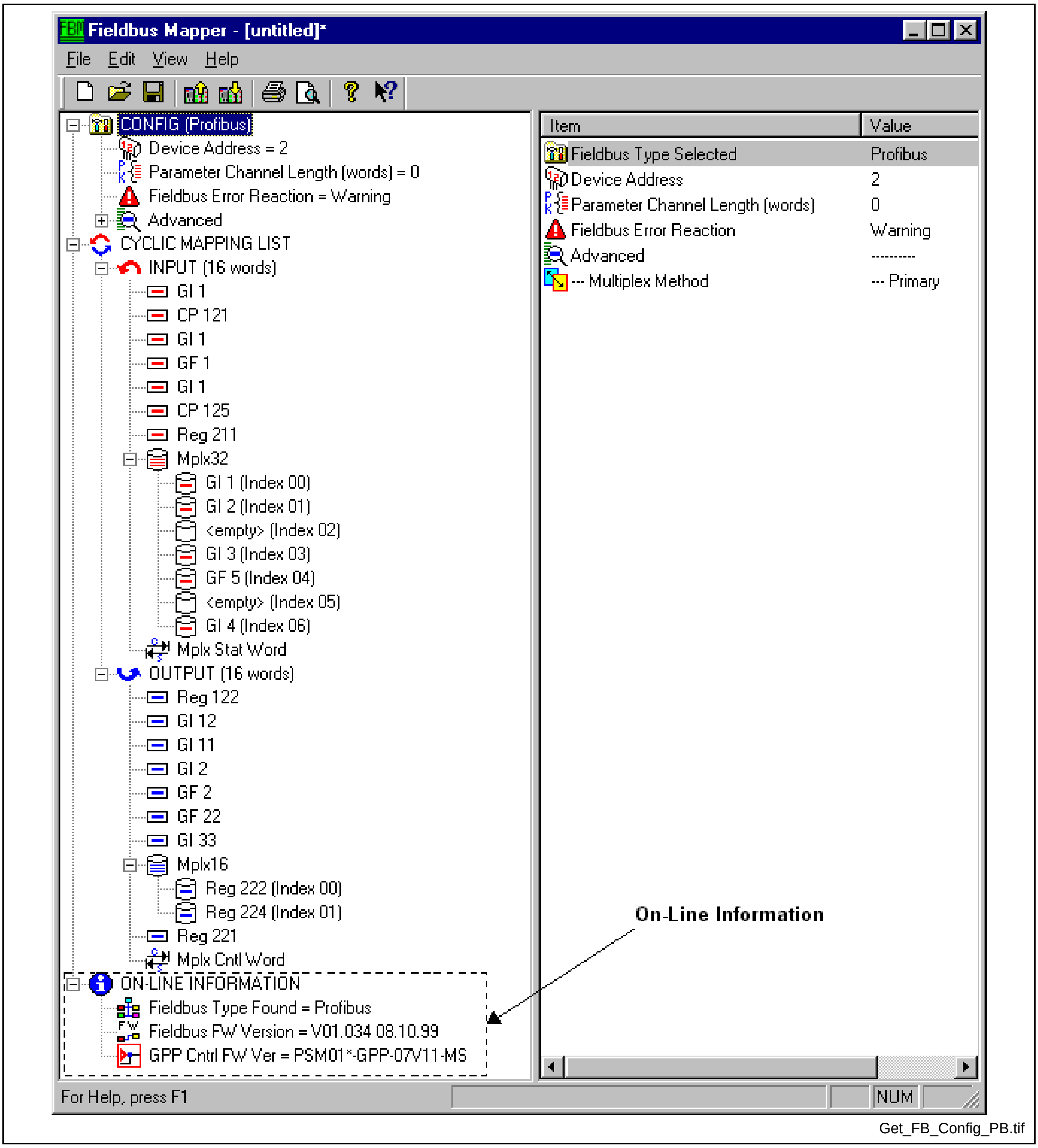


Fig. 6-16: On-Line Fieldbus Configuration Information

6.3 Information for the GPP Programmer

Register 19 Definition (Fieldbus Status)

VisualMotion Register 19 holds the information for "Fieldbus Status." The register information can be referenced in a VisualMotion application program to respond to the status of each bit. The use of these bits is application-dependent.

Table 6-4 below contains the bit assignment for the diagnostic object 5ff2. The assigned bits are labeled with "x" and the bit number in the second row. Unassigned bits are labeled with "---."

16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
---	x15	---	---	---	---	---	---	---	---	---	x5	x4	---	x2	x1

Table 6-4: Bit Assignment for VisualMotion Register 19

Bit Definitions

x1, x2 Status bits for the internal DPR (Dual-Port RAM) communication between the fieldbus slave and the PPC-R:

x1: FB Init. OK , LSB (least significant bit)

x2: FB Init. OK, MSB (most significant bit)

The bit combinations for x1 and x2 are as follows:

Bit 2 (PPC-R)	Bit 1 (Fieldbus)	Description
0	0	A reset has been executed on the DPR, **or** neither the PPC-R nor the fieldbus card have initialized the DPR.
0	1	The DPR is initialized by the fieldbus card, but **not** yet by the PPC-R.
1	0	The DPR initialization is complete. DPR has been initialized by the fieldbus card and PPC-R. Fieldbus to PPC-R communications system is ready.
1	1	Fieldbus to PPC-R communications system is ready.

Table 6-5: Possible Settings for Bits 1 and 2, Status Bits for DPR Communication

x4 Status bit for the active bus capabilities of the fieldbus slaves (FB Slave Ready)

This bit is monitored for the Fieldbus Error Reaction. Whenever this bit goes to 0 after a fieldbus card was initially found by the PPC-R, the selected Error Reaction (system shutdown, error message, or ignore) is initiated. Refer to *Fieldbus Error Reaction* on page 6-20 for an explanation of the Fieldbus Error Reaction setting.

0--> The fieldbus slave is not (yet) ready for data exchange.

1--> The fieldbus slave can actively participate on the bus.

x5 Status bit for the non-cyclic channel (Parameter Channel) (Non-Cyc Ready)

0--> The non-cyclic channel (Parameter Channel) cannot (yet) be used.

1--> The non-cyclic channel (Parameter Channel) is ready for use by the fieldbus master.

x15 Status bit for the cyclic data output (Cyclic Data Valid):

0--> The cyclic data outputs (coming in to the PPC-R) are INVALID.

1--> The cyclic data outputs (coming in to the PPC-R) are VALID. The system looks for this bit to be 1 before allowing data transfer.

Register 20 Definition (Fieldbus Diagnostics)

VisualMotion Register 20 holds the information for "Fieldbus Diagnostics."

Table 6-6 below contains the bit assignment for the diagnostic object 5ff0. The assigned bits are labeled with "x" and the bit number in the second row. Unassigned bits are labeled with "---."

16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
---	x15	x14	x13	---	---	---	---	---	---	---	---	---	---	---	---

Table 6-6: Bit Assignment for VisualMotion Register 20

Bit Definitions

x13 - x15 Identification of the fieldbus interface card (FB Card Found)

The bit combinations for x13, x14 and x15 are as follows:

Bit 15	Bit 14	Bit 13	Fieldbus Type
0	0	0	<NO CARD>
0	0	1	<Not Defined>
0	1	0	Interbus
0	1	1	DeviceNet
1	0	0	Profibus
1	0	1	ControlNet
1	1	0	<Not Defined>
1	1	1	<Not Defined>

Table 6-7: Identification of the Fieldbus Interface

Register 26 Definition (Fieldbus Resource Monitor)

The "Fieldbus Resource Monitor" in register 26 can be used as a method for monitoring the attempts made to process the Cyclic Mapping Lists in parameters C-0-2600 and C-0-2601 across the Dual-port RAM. If after 8 ms, the Cyclic Mapping Lists are not successfully transmitted, a "**miss**" is noted.

Register 26 is divided into the following three counter types:

- Current Miss Counter.
- Peak Miss Counter.
- Fieldbus Timeout Counter.

Table 6-8 below contains the bit assignment for the fieldbus counters. The assigned bits are labeled with an "x" followed by the bit number.

Current Miss Counter				Peak Miss Counter				Fieldbus Time-out Counter							
16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
x16	x15	x14	x13	x12	x11	x10	x9	x8	x7	x6	x5	x4	x3	x2	x1

Table 6-8: Bit Assignment for Fieldbus Resource Monitor (Register 26)

Note: View Register 26 in Hexadecimal format too more easily monitor the fieldbus counters.

Hex display format of register 26

0x0000

Fieldbus Time-out Counter (00-FF)
Increments by one every time 10 cyclic mapping list attempts are missed in 10 attempts.

Peak Miss Counter (0-9)
Displays the peak value of the Current Miss Counter.

Current Miss Counter (0-9)
Displays the count of missed cyclic mapping list attempts out of the last 10 attempts

Note: To view registers in hex, select ***Data*** ⇒ ***Registers*** within VisualMotion Toolkit. If the registers are not currently viewed in hex format, select ***Format*** ⇒ ***Hex*** in the *Active Program, Register* window.

Bit Definitions

x13 - x16 Status bits for the "Current Miss Counter."

An attempt is made to transmit the Cyclic Mapping Lists, C-0-2600, across the Dual-port RAM every 8 ms. For every 10 mapping list update attempts (80 ms), the failed attempts are counted and displayed in these bits (values can range from 0-9). If 10 out of 10 mapping list update attempts are missed, the "Fieldbus Timeout Counter" is incremented by one. This is an indication of a Fieldbus Mapping Timeout Error.

x9 - x12 Status bits for the "Peak Miss Counter."

These bits monitor the "Current Miss Counter's" peak count between a value from 0-9 and hold that value until a larger count is encountered.

x1 - x8 Status bits for the "Fieldbus Timeout Counter."

The count of these bits increments by one every time the "Current Miss Counter" encounters 10 out of 10 missed attempts of the cyclic mapping list update. A count incremented by one represents a Fieldbus Mapping Timeout Error and is processed by GPP according to the selected "Fieldbus Error Reaction" in parameter C-0-2635. Refer to *Fieldbus Error Reaction* below for an explanation of the Fieldbus Error Reaction setting.

Note: The GPP programmer can monitor the "Current Miss Counter" and define a custom error reaction for missed mapping list update attempts less than 10.

Note: The values in register 26 are read/write and can be reset by the user.

Fieldbus Error Reaction

Note: The Fieldbus Error Reaction setting is active only in SERCOS Phase 4. In all other SERCOS phases, it will be inactive.

You can select how you would like the PPC-R system to react in case of a fieldbus error. This reaction can be set in the "Fieldbus Slave Configuration" screen, using the combo box labeled "Fieldbus Error Reaction."

Three options are available for the Error Reaction setting. Depending on the selected setting, the value 0, 1, or 2 is stored in Parameter C-0-2635:

Setting	Value in Parameter C-0-2635
Shutdown	0 (default)
Warning Only	1
Ignore	2

Table 6-9: Parameter C-0-2635 Values for Error Reaction Settings

Fieldbus Mapper Timeout

The Fieldbus Mapper continually scans the system for sufficient resources to process the cyclic data mapping lists (2600 and 2601 lists). If 10 out of 10 attempts of the mapping list updates are missed, the system is considered to have insufficient resources and the selected error reaction is evoked, as follows:

If "Shutdown" (0) is set in Parameter C-0-2635, the following error is generated from the PPC-R card: **520 Fieldbus Mapper Timeout**

If "Warning Only" (1) is set in Parameter C-0-2635, the following error is generated: **209 Fieldbus Mapper Timeout**

If "Ignore" (2) is set in Parameter C-0-2635, the system will update as resources become available, but there is no way to monitor whether or not updates actually occur.

Lost Fieldbus Connection

Register 19, bit 4 indicates the status of the fieldbus. Refer to *Register 19 Definition (Fieldbus Status)* on page 6-17 for more specific bit information. The system monitors this bit and evokes the selected error reaction if the bit is low (0), after a fieldbus card is found. A typical situation that will cause this condition is the disconnection of the fieldbus cable from the fieldbus card.

If "Shutdown Control" (0) is set in Parameter C-0-2635, the following error is generated from the PPC-R (active in SERCOS Phase 4 only): **519 Lost Fieldbus Connection**

If "Warning Only" (1) is set in Parameter C-0-2635, the following error is generated (active in SERCOS Phase 4 only): **208 Lost Fieldbus Connection**

If "Ignore" (2) is set in Parameter C-0-2635, there is no noticeable reaction when Register 19 Bit 4 goes low, unless the GPP application program is customized to evoke a special reaction.

Troubleshooting Tip:

If a fieldbus card is not found on the system, the Error Reaction setting will be ignored. If you have a fieldbus card and the Error Reaction is not responding as expected, the system may not "see" your fieldbus card.

6.4 Information for the PLC Programmer

Important: The fieldbus master's access of the cyclic channel must be consistent over the entire length of the assigned Parameter Channel in order to establish reliable Parameter Channel communications.

*.gsd File

Indramat supplies a *.gsd file containing supporting information for the PPC-R with a Profibus slave configuration. Contact an Indramat technical representative for the location of this file.

Multiplexing

Primary Multiplex Method (for Consistent Masters only)

Important: You should not use the Primary Multiplex Method for a master that is not consistent over the entire cyclic channel. The Secondary Multiplex Method is available for inconsistent masters. Refer to *Secondary Multiplex Method (for Inconsistent Masters)* on page 6-25.

The advantage of the Primary Method is easier handling of input data for consistent masters.

Control Word and Status Word

Control Word

The control word is transferred in the multiplex channel from master to slave. It tells the slave in which index the data is being transferred from master to slave and in which index the data is requested from slave to master.

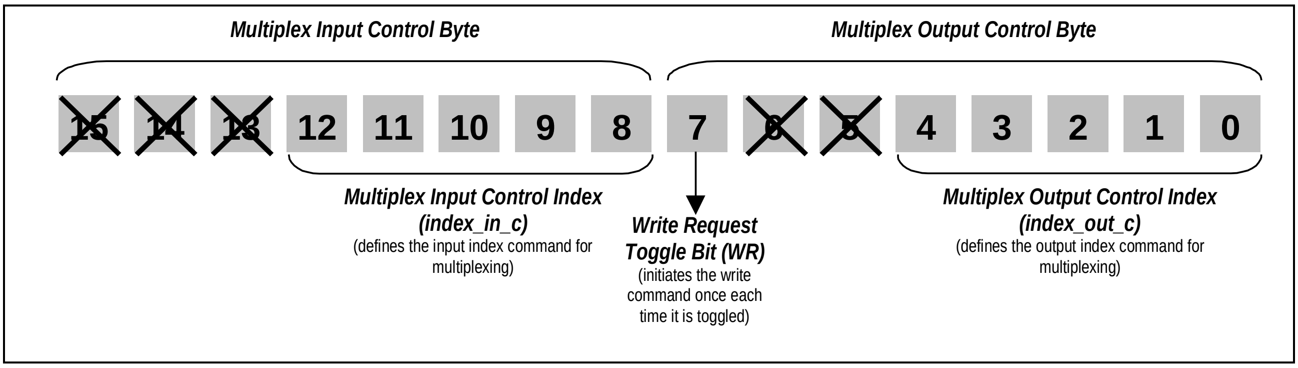


Fig. 6-17: Control Word Definition, Primary Multiplex Method

Index_out_c: tells the slave in which index the data are transferred from master to slave (out = master -> slave, _c = element of control word).

Index_in_c: tells the slave in which index the data is requested from slave to master (in = slave -> master, _c = element of control word).

WR (Write Request): handshake bit (refer to meaning of WR and WA).

Note: Input data via the Multiplex Channel is continually being updated.

Status Word

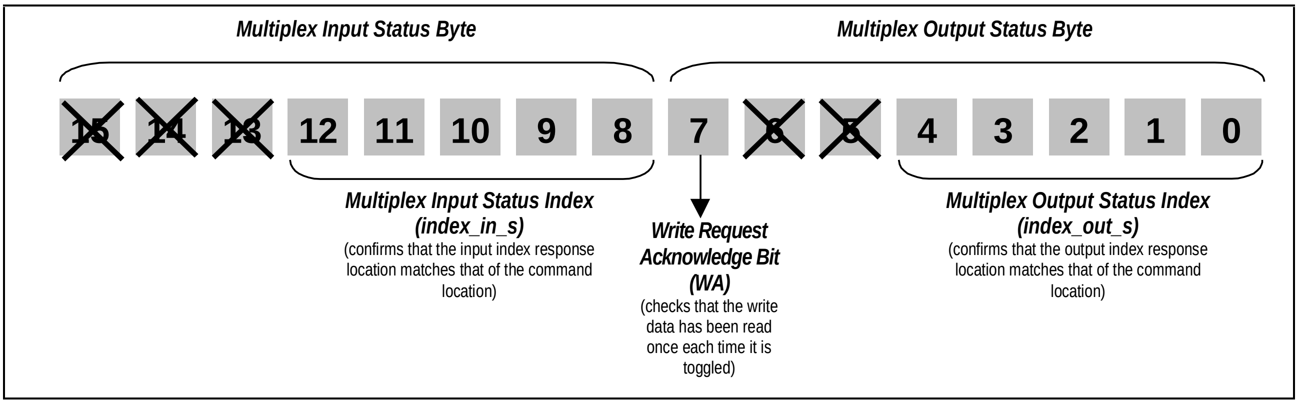


Fig. 6-18: Status Word Definition, Primary Multiplex Method

- **Index_out_s:** acknowledges index written by the master (out = master -> slave, _s = element of status word).
- **Index_in_s:** tells the master which index is transferred from slave to master in the actual process data cycle (in = slave -> master, _s = element of status word).
- **WA (Write Acknowledge):** Handshake bit (refer to meaning of WR and WA).

Handshake Bits WR and WA

WR and WA are handshake bits that allow the controlled writing of data via the multiplex channel. WR and WA control the data transfer for writing data_out (data send from master to slave).

WR == WA:

- tells the master that the slave has received the last multiplex data_out. The master can now send new data_out.
- tells the slave to do nothing, because the master has not yet put new consistent data_out on the bus.

WR! = WA:

- tells the slave to do something, because the master has now put consistent new data_out on bus.
- tells the master to do nothing, because the slave has not yet received the latest multiplex data_out.

Master Communications (Primary Multiplex Method)

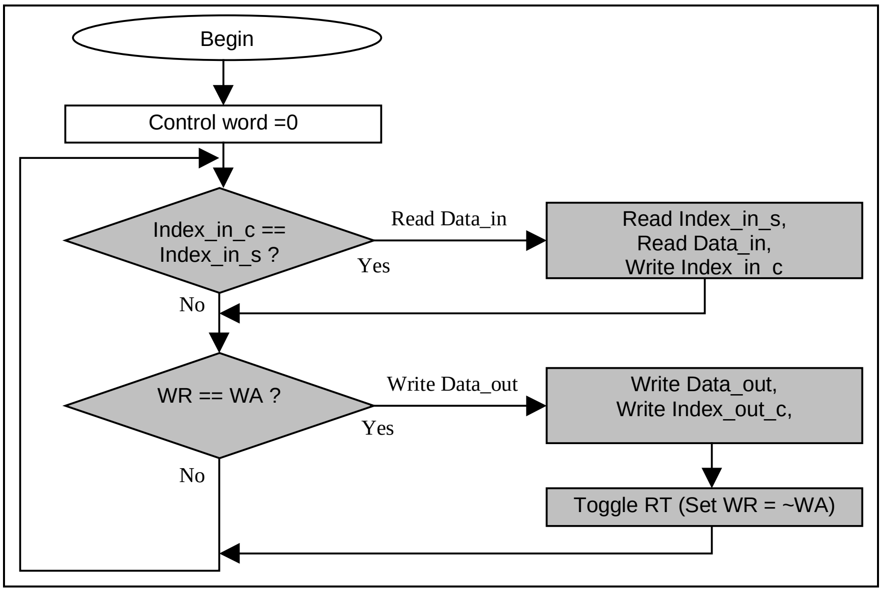


Fig. 6-19: Primary Multiplex Method, Master Communications

Programming Example

To aid in implementing the multiplex function in a PLC program, the following flow chart shows two ways of reading and writing data. Reading and writing can be executed separately, which allows the input data to be updated about 30% faster. The “Read Data” example would be placed at the beginning of a PLC program the “Write Data” example at the end.

Combined reading and writing makes the PLC program simpler, especially when using the same index for both transfer actions.

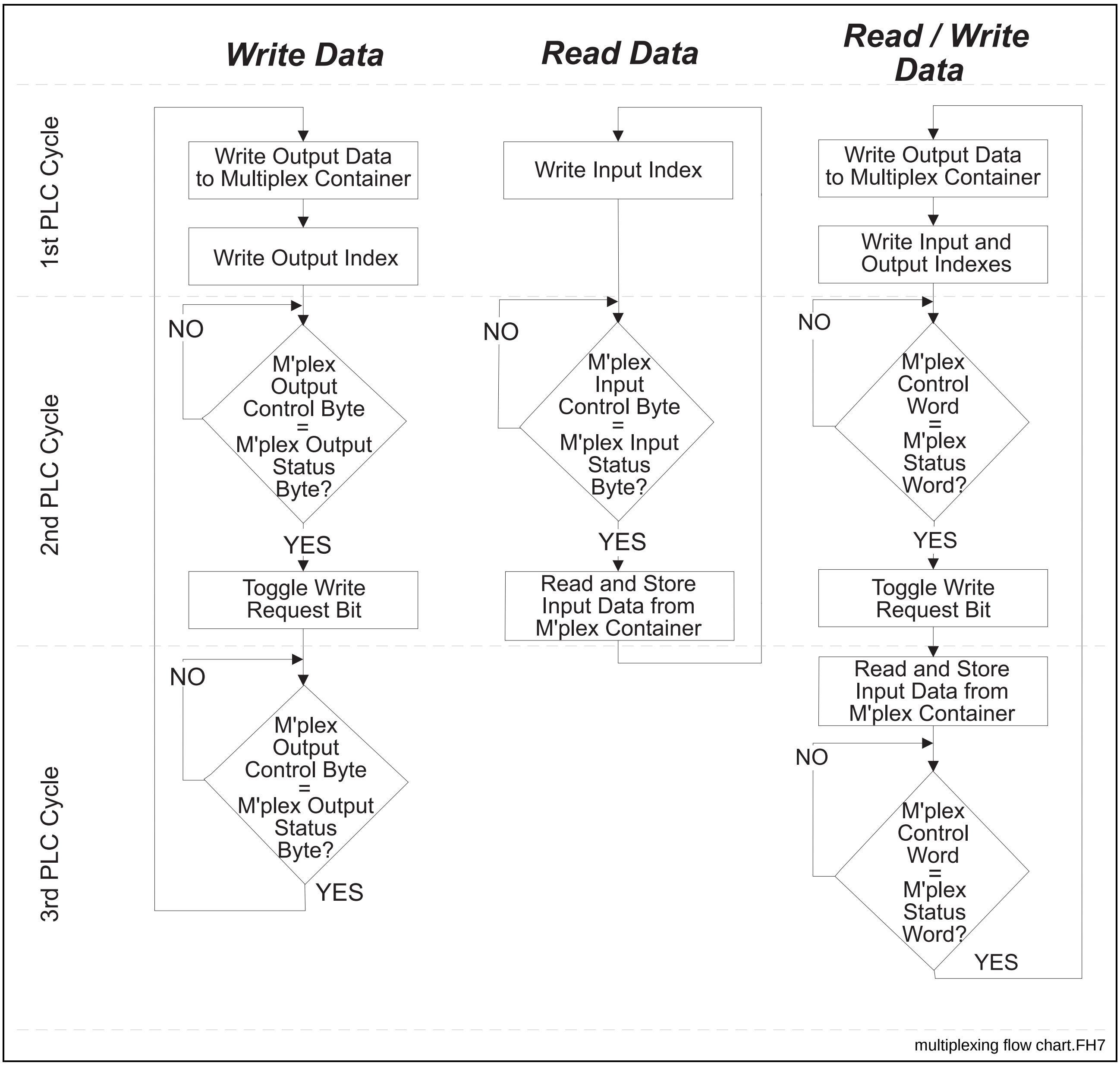


Fig. 6-20: Flow Chart of Multiplex Programming Examples (Primary Method)

Secondary Multiplex Method (for Inconsistent Masters)

Explanation of the Master Consistency Problem

The PPC-R fieldbus slave interfaces can guarantee consistency.

However, some fieldbus masters can only guarantee byte, word or double word consistency. If the master is only word-consistent, it is possible that the master cannot transfer the data and the control word of one multiplex index consistently from the PLC to the fieldbus. Therefore, it is necessary to have a second multiplex method where both input data and output data require the handshake bits to update via the fieldbus.

Note: The meanings of the control and status words are the same as for the Primary Multiplex Method. The only difference is the toggle bits RR and RA, which are used in the Secondary Method.

Fig. 6-21 below illustrates the control word definition for the Secondary Multiplex Method.

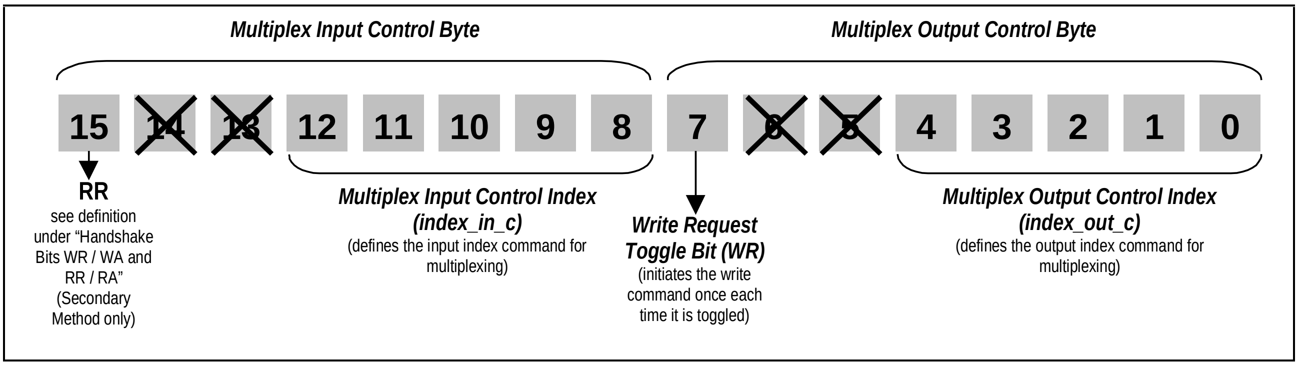


Fig. 6-21: Control Word Definition, Secondary Multiplex Method

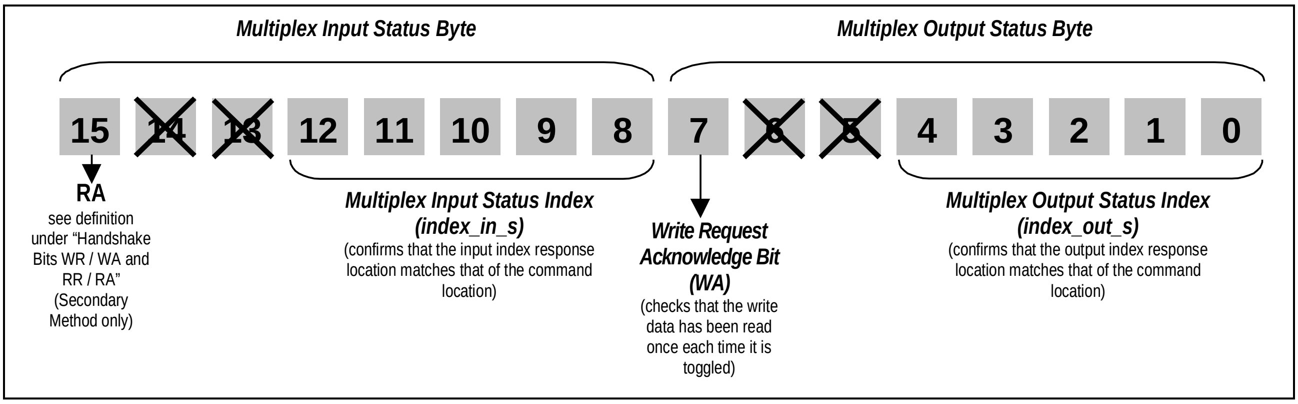


Fig. 6-22: Status Word Definition, Secondary Multiplex Method

The Secondary Multiplex Method has the following features:

- You can transfer a different index from master to slave as from slave to master.
- The handshake bits for both reading and writing of this multiplex channel make the multiplexing possible on inconsistent systems (masters).

Handshake Bits RR and RA

RR (Read Request) and RA (Read Acknowledge) are handshake bits that allow a controlled data transfer and use of the multiplex channel on inconsistent masters. RR and RA control the data transfer for reading data_in (data send from slave to master).

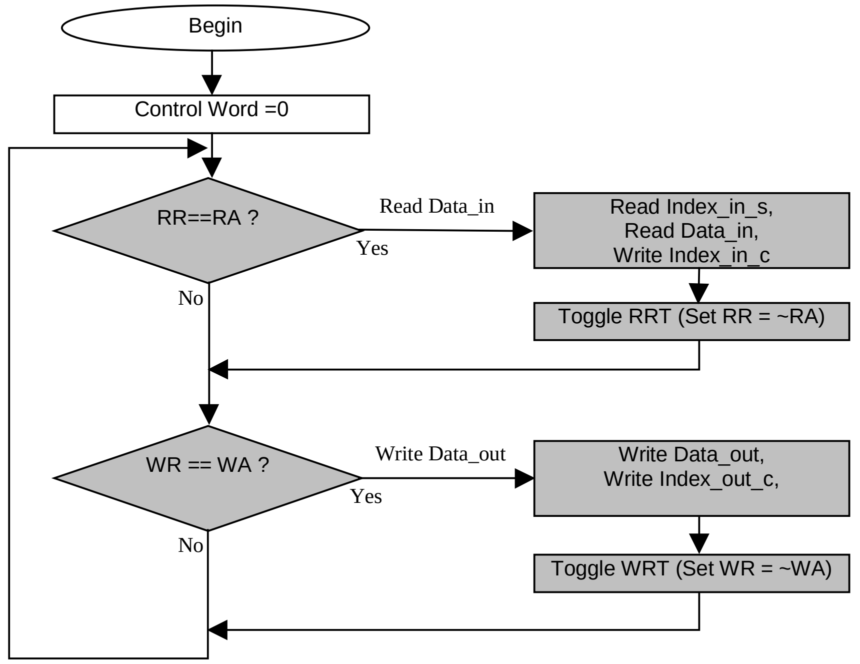
RR == RA:

- tells the master that the slave has sent the requested data_in. The master can now read the data_in and request new data_in.
- tells the slave to do nothing, because the master has not yet put new consistent data on the bus.

RR != RA:

- tells the slave to put new data_in on the bus, because the master requests new data_in.
- tells the master to do nothing, because the slave has not yet put the latest requested multiplex data_in on the bus.

Master Communications (Secondary Multiplex Method)



[*1] there may be different ways to achieve consistency, depending on the master

Fig. 6-23: Secondary Multiplex Method, Master Communications

For some masters, it could be enough to first write data and then the control word. For other masters, you may have to implement a delay time (this time could be different from master to master) before writing WR = ~WA.

Non-Cyclic Data Access via the Parameter Channel

To support the configuration of drives and the access to parameters through the Profibus DP channel, Indramat has established the Parameter Channel.

If the Parameter Channel is used with the PPC-R, the first 4 or 6 data words of the cyclic channel for the slave board must be allocated for non-cyclic transmissions. The remainder of the cyclic channel is called the Real-Time Channel.

Note: The Parameter Channel is always allocated as the first 4 or 6 words of the Profibus cyclic (DP) channel. The length of the Parameter Channel plus the length of the Real-Time Channel used to exchange cyclic data represents the entire length of the channel (maximum total length: 16 words).

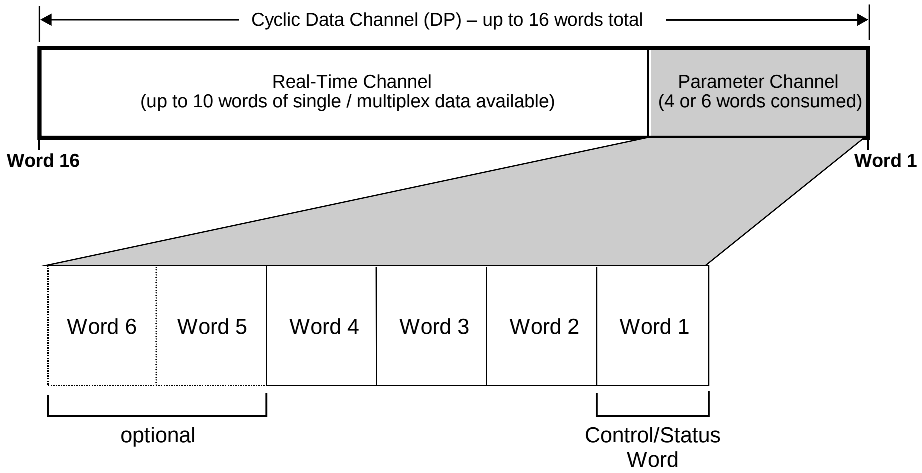


Fig. 6-24: The Parameter Channel inside the Profibus DP Channel

Messaging Formats

Two messaging formats are available in the Parameter Channel:

- **Short Format 3**
- **VisualMotion ASCII Format** - This format is provided for backward-compatibility with VisualMotion 6.0 / GPS firmware. For detailed information, refer to the VisualMotion 6.0 Startup Guide.

Short Format 3: General Explanation

To read or write a VisualMotion data type non-cyclically, a protocol is used inside the Parameter Channel. The protocol requires one word of the Parameter Channel for protocol functions. Thus, depending on the channel length, 3 or 5 data words can be transferred in one cycle. The protocol supports multiple transmissions, but the maximum length of data that can be transferred from or to an object is 128 bytes.

Short Format 3 Data Transfer

The following methods for transferring data are available in Short Format 3:

- Mapped Data
- Data Exchange Objects

Mapped Data

Mapped data is the most powerful feature of the PPC-R non-cyclic fieldbus interface. Through mapped data, the user has access to virtually every PPC-R data type over the fieldbus. It is easy to implement from the PLC side and requires no setup on the PPC-R side.

To access a data type over the fieldbus, it has to be specified by an address that consists of an index and a subindex. The index and subindex for each data type can be calculated by a formula (refer to *Accessing Mapped Data* on page 6-36).

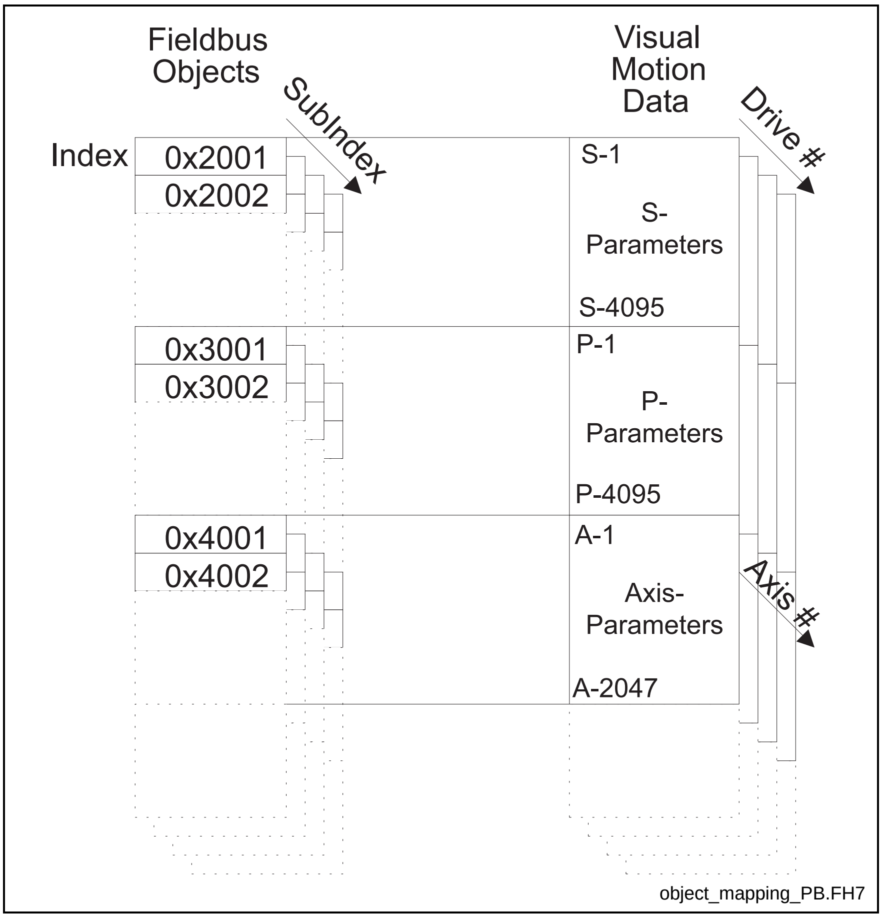


Fig. 6-25: Mapped Data

Mapped data can be used with the following parameters and values:

- S-Parameters (SERCOS Drive S-Parameters)
- P-Parameters (SERCOS Drive P-Parameters)
- A-Parameters (PPC Axis Parameters)
- C-Parameters (PPC C System parameters)
- T-Parameters (PPC Task parameters)

size and format depend on parameter

PF-Values (PPC Program Float data, 32 bit – 2 words, IEEE format)

GI-Values (PPC Global Integer data, 32 bit – 2 words)

GF-Values (PPC Global Float data, 32 bit – 2 words, IEEE format)

PI-Values (PPC Program Integer data, 32 bit – 2 words)

Reg.-Values (PPC Register data, 16 bit – 1 word)

Data Exchange Objects (0x5E70 – 0x5E73) (embedded ASCII Protocol)

User Data Header – Object Index

The index refers to the particular fieldbus slave object that a VisualMotion data type is (automatically) mapped. This object allows for simple, indirect access to VisualMotion data types, and it is combined with the subindex to create a direct relationship to the VisualMotion data types. The available objects can be calculated using the formulas in *Accessing Mapped Data* on page 6-36.

User Data Header – Object SubIndex

The subindex refers to an additional piece of information necessary to obtain direct access to VisualMotion data types. The reference of the subindex depends on the data type in question. For example, the SubIndex refers to the drive number when accessing S and P parameters. However, the subindex refers to the task number when referring to task parameters. The available subindex ranges can be calculated using the formulas in *Accessing Mapped Data* on page 6-36.

Data Exchange Objects

The four data exchange objects 5E70 to 5E73 represent fixed data "containers" of varying lengths that transfer the VisualMotion ASCII Protocol to the PPC-R card. These objects serve as an open-ended possibility to access any VisualMotion data (including cams, diagnostic text, etc.), but more work is required in the master to perform a transmission of this type. Both the VisualMotion ASCII message and the fieldbus transfer message must be formulated.

Table 6-10 lists the available data exchange objects and their sizes.

Data Exchange Object	Data Length (in bytes)
5E70	16
5E71	32
5E72	64
5E73	128

Table 6-10: Length of the Data Exchange Objects

Short Format 3 Parameter Channel (PK) Control and Status Words

PK Control Word

The PK control word is sent from the master to the slave. It is 16 bits wide and the individual bits have the following meanings:

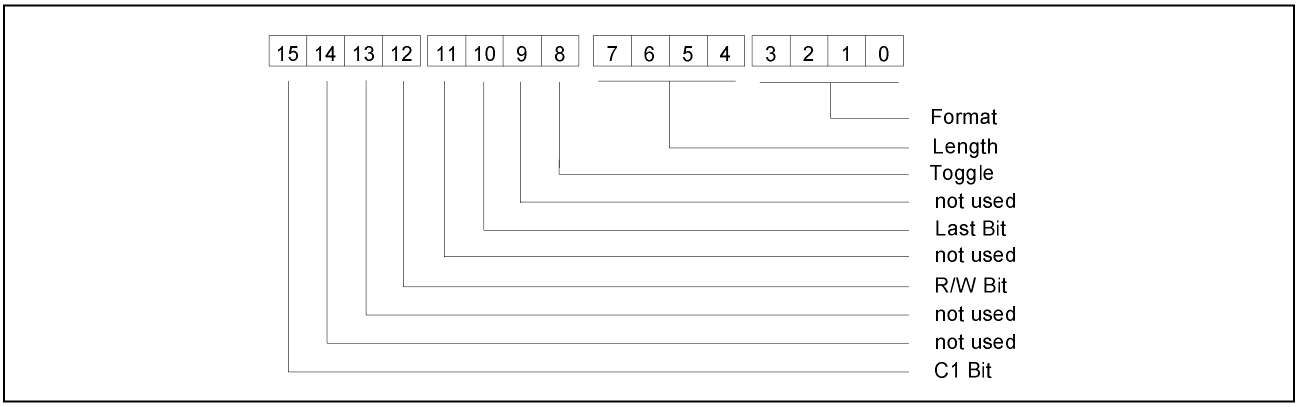


Fig. 6-26: Bits of the PK Control Word

Format: These bits describe the usage and meaning of the following data words in the Parameter Channel. Their value is fixed to 1100_b.

Length: These four bits specify the length of the valid data in bytes, without the control word. The data in the rest of the Parameter Channel is undefined.

Toggle: This bit toggles with every new set of sent data. It is used for a handshake between master and slave. The master is only allowed to toggle this bit when the toggle bit in the status word has the same level as the toggle bit sent in the control word.

L: Last bit. This bit is set when the last fragment of a data block is sent.

R/W: Read/Write; Read = 1, indicates that the master wants to read data.

C1: This bit is used to distinguish between the "old" and "new" handling of the Parameter Channel. For the "new" handling (e.g. Short Format 3), it is fixed to 1

Note: Bits that are not used are set to 0.

PK Status Word

The PK status word is sent as an answer from the slave to the master. The 16 bits have the following meanings:

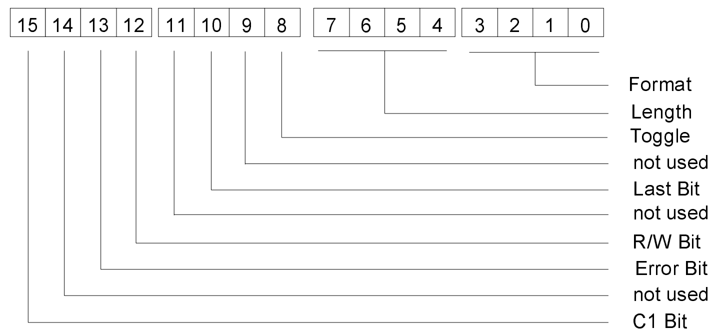


Fig. 6-27: Bits of the PK Status Word

Format: These bits describe the usage and meaning of the following data words in the Parameter Channel. Their value is fixed to 1100_b.

Length: These four bits specify the length of the valid data in bytes, without the status word. The data in the rest of the Parameter Channel is undefined.

Toggle: This bit toggles with every new set of sent data. It is used for a handshake between master and slave. The slave recognizes new data when the toggle bit it receives (control word) is different from the toggle bit in the status word.

L: Last bit. This bit is set when the last fragment of a data block is sent.

R/W: Read/Write Acknowledgement; Read = 1, indicates that the master wants to read data.

Error Bit: This bit indicates an error that occurred within the slave. The reason for the error is coded in the following data.

C1: This bit is used to distinguish between the "old" and "new" handling of the Parameter Channel. For the "new" handling (Short Format 3), it is fixed to 1

Note: Bits that are not used are set to 0.

Short Format 3: Examples

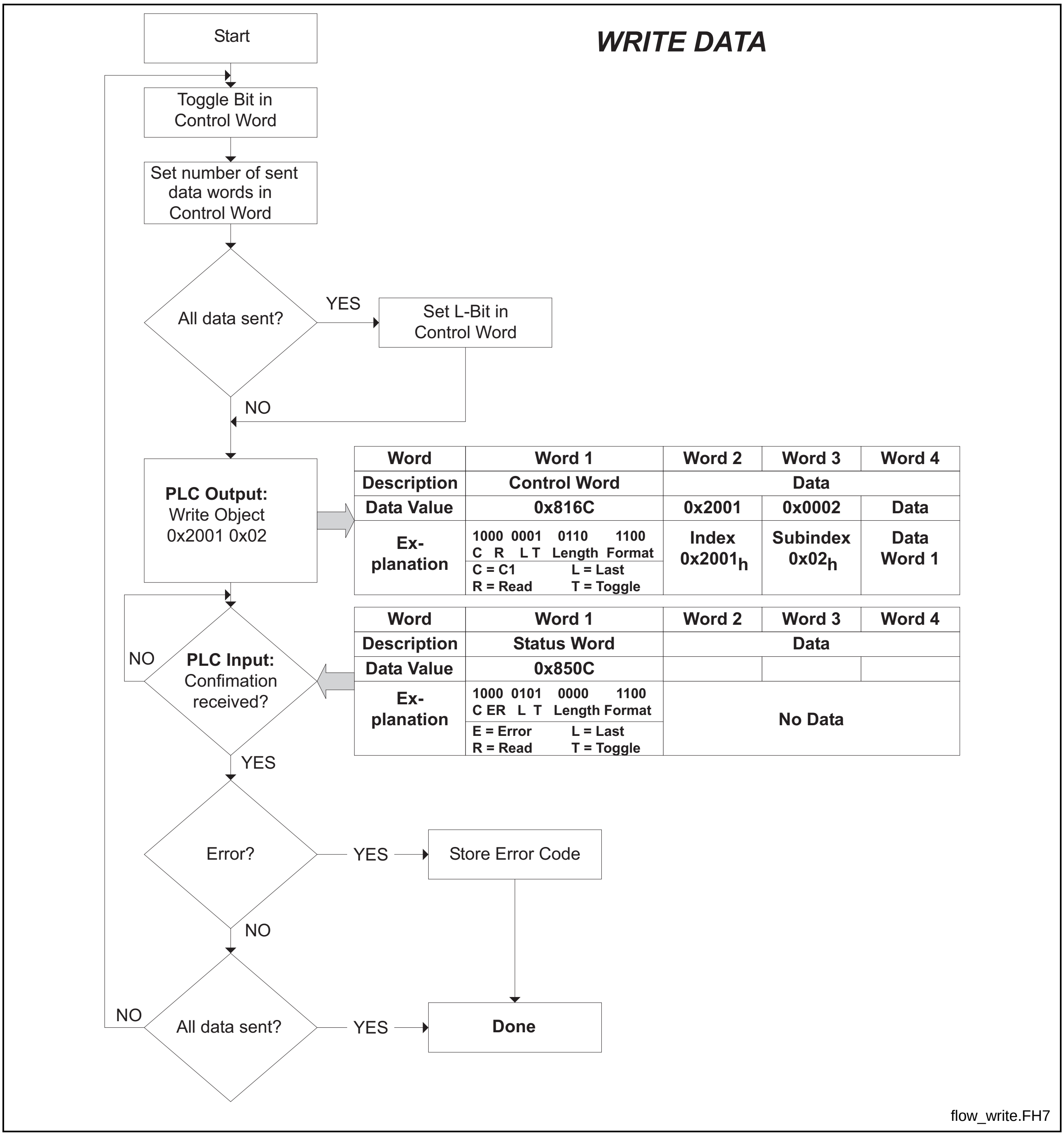
The following examples show how to write and read an object. They display the read and write access of object index 2001_h, subindex 2_h. The matching Visual Motion data according to the chart at the end of this chapter is S-Parameter 1 of Drive 2.

Notes for the following examples:

Note: These flow charts assume a toggle bit value of 0 when starting. The values of the control and status words can change because of different states of toggle bit and last bit.

Note: The master can detect new data comparing its own toggle bit with the toggle bit received from the slave. If they match, new data was received from the slave.

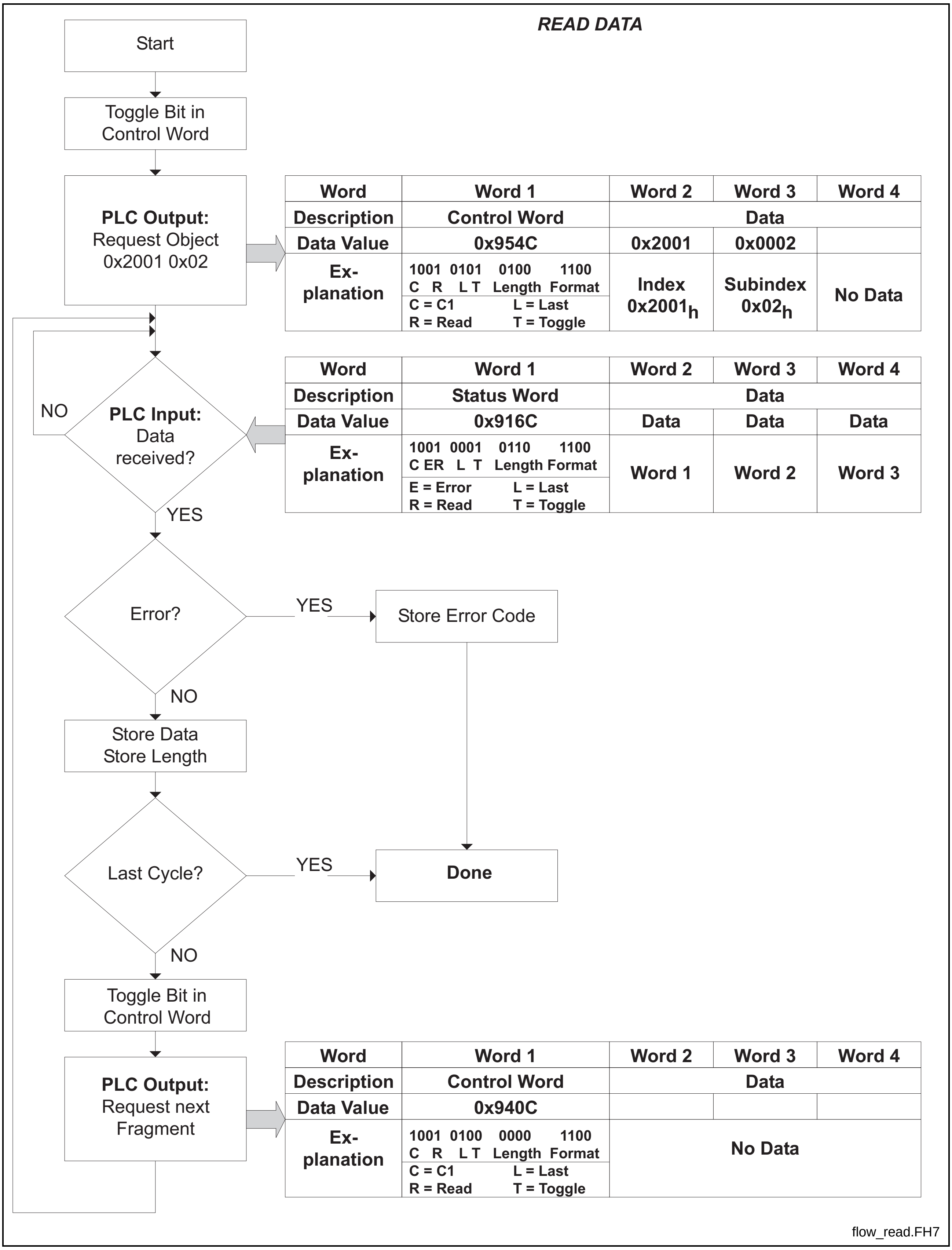
Note: When writing, only the first telegram from the master contains the index and subindex.



Word	Word 1	Word 2	Word 3	Word 4
Description	Control Word	Data		
Data Value	0x816C	0x2001	0x0002	Data
Ex-planation	1000 0001 0110 1100 C R L T Length Format C = C1 L = Last R = Read T = Toggle	Index $0x2001_h$	Subindex $0x02_h$	Data Word 1

Word	Word 1	Word 2	Word 3	Word 4
Description	Status Word	Data		
Data Value	0x850C			
Ex-planation	1000 0101 0000 1100 C ER L T Length Format E = Error L = Last R = Read T = Toggle	No Data		

Fig. 6-28: Write Data Object Example



Word	Word 1	Word 2	Word 3	Word 4
Description	Control Word	Data		
Data Value	0x954C	0x2001	0x0002	
Ex-planation	1001 0101 0100 1100 C R L T Length Format C = C1 L = Last R = Read T = Toggle	Index 0x2001$_h$	Subindex 0x02$_h$	No Data

Word	Word 1	Word 2	Word 3	Word 4
Description	Status Word	Data		
Data Value	0x916C	Data	Data	Data
Ex-planation	1001 0001 0110 1100 C ER L T Length Format E = Error L = Last R = Read T = Toggle	Word 1	Word 2	Word 3

Word	Word 1	Word 2	Word 3	Word 4
Description	Control Word	Data		
Data Value	0x940C			
Ex-planation	1001 0100 0000 1100 C R L T Length Format C = C1 L = Last R = Read T = Toggle	No Data		

Fig. 6-29: Read Data Object Example

Canceling Data Transfer

In some cases, it might be necessary to cancel a data transfer. To request a communication reset, the master sends a cancel telegram to the slave.

Word	Word 1	Word 2	Word 3	Word 4
Description	Control Word	Data		
Data Value	0x810F			
Ex-planation	1000 0001 0000 1111 C ER L T Length Format E = Error L = Last R = Read T = Toggle	No Data		

v

Fig. 6-30: Cancel Telegram

The format byte in the command word is set to F_h. The length byte, the L and the R bits are set to 0.

The slave will set its internal state to expect a new command from the master.

Error Messages

If the transmission fails, the slave will respond with an error message as shown below. The status word value can be different for writing. The error bit in the status word is set and the first word contains a 16-bit error code. The toggle bit has the same state as the corresponding request telegram.

Word	Word 1	Word 2	Word 3	Word 4
Description	Status Word	Data		
Data Value	0xA42C	Error code		
Ex-planation	1011 0100 0010 1100 C ER L T Length Format E = Error L = Last R = Read T = Toggle		No Data	

error.FH7

Fig. 6-31: Error Response from Slave

The error code is two bytes long. The high byte specifies the error class and the low byte contains additional information for the application-specific errors (error class $1F_h$).

Parameter Channel Error Codes (Hi-Byte)

Error No. (Hex)	Error Description
0x1F	Control-specific error. Refer to Low-Byte for additional error information, which is based on VisualMotion Serial Port Diagnostic Codes (in the VisualMotion Troubleshooting Guide).
0x85	Data length too long (here >128 byte).
0x88	An error occurred during the transmission of data between the PPC-R and the fieldbus slave.
0x8B	Format (bits 0-3 of control word) specified is incorrect.
0x8C	The length set in control byte greater than Parameter Channel.
0x8D	Communication not possible. Parameter Channel too short (<2 bytes).
0x90	The format bits (0-3) of the control word were changed while transmitting several data blocks.
0x95	A read command was issued, but the length field was set to !=0.

Table 6-11: Parameter Channel Error Codes

Handling a Data Exchange Object

When mapped objects are not capable of transferring the desired data, a Data Exchange Object can be used.

The same procedures for writing and reading mapped objects via Short Format 3 apply to the Data Exchange Object.

Selecting a Data Exchange Object

Depending on the length of a VisualMotion ASCII message, any of these data exchange objects can be selected.

Note: The entire data length of the data exchange object must always be transmitted even if the VisualMotion ASCII message is shorter.
For example, if you want to transmit an ASCII message of 42 bytes, you must use object 5E72. To avoid a response error from the fieldbus slave, you must append 22 "Null" characters to the end of the ASCII message to complete a data size of 64 bytes.

Note: The checksum for the VisualMotion ASCII protocol is NOT used with the data exchange object. If the checksum is sent as part of the string, it will be ignored, and no checksum will be sent in the VisualMotion ASCII response messages. To ensure data integrity, the fieldbus protocols support a low-level checksum.

Transmission Sequence via a Data Exchange Object

Note: For the data exchange object, two transmission sequences (and two response sequences) are required, to send the read or write message to and then receive the response message from the PPC-R card.

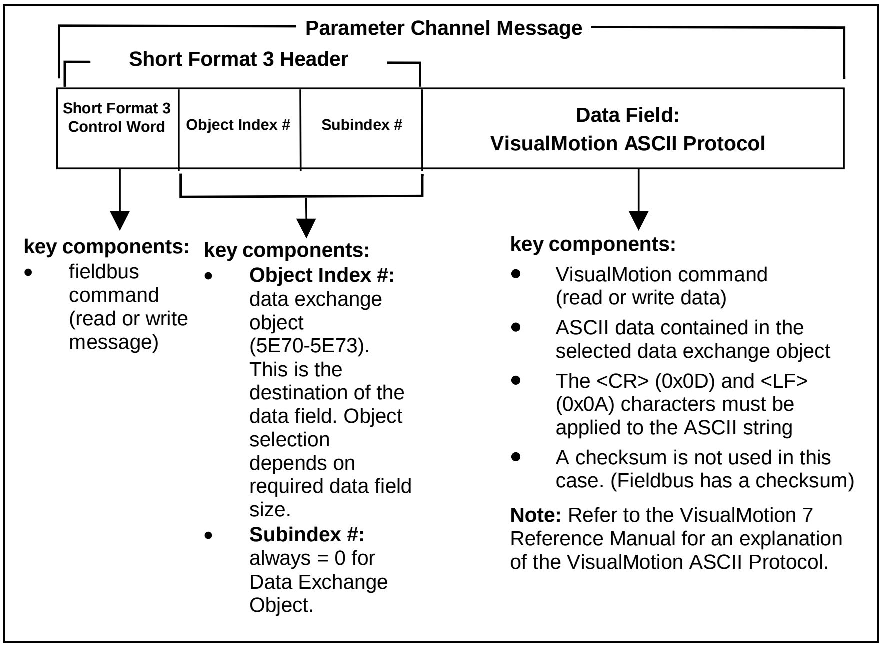


Fig. 6-32: Format of a PK Short Format 3 Message using a Data Exchange Object

The following sequence describes the communication between the fieldbus master (PLC) and the fieldbus slave (PPC-R). For details on reading and writing data in Short Format 3, refer to *Messaging Formats* on page 6-28.

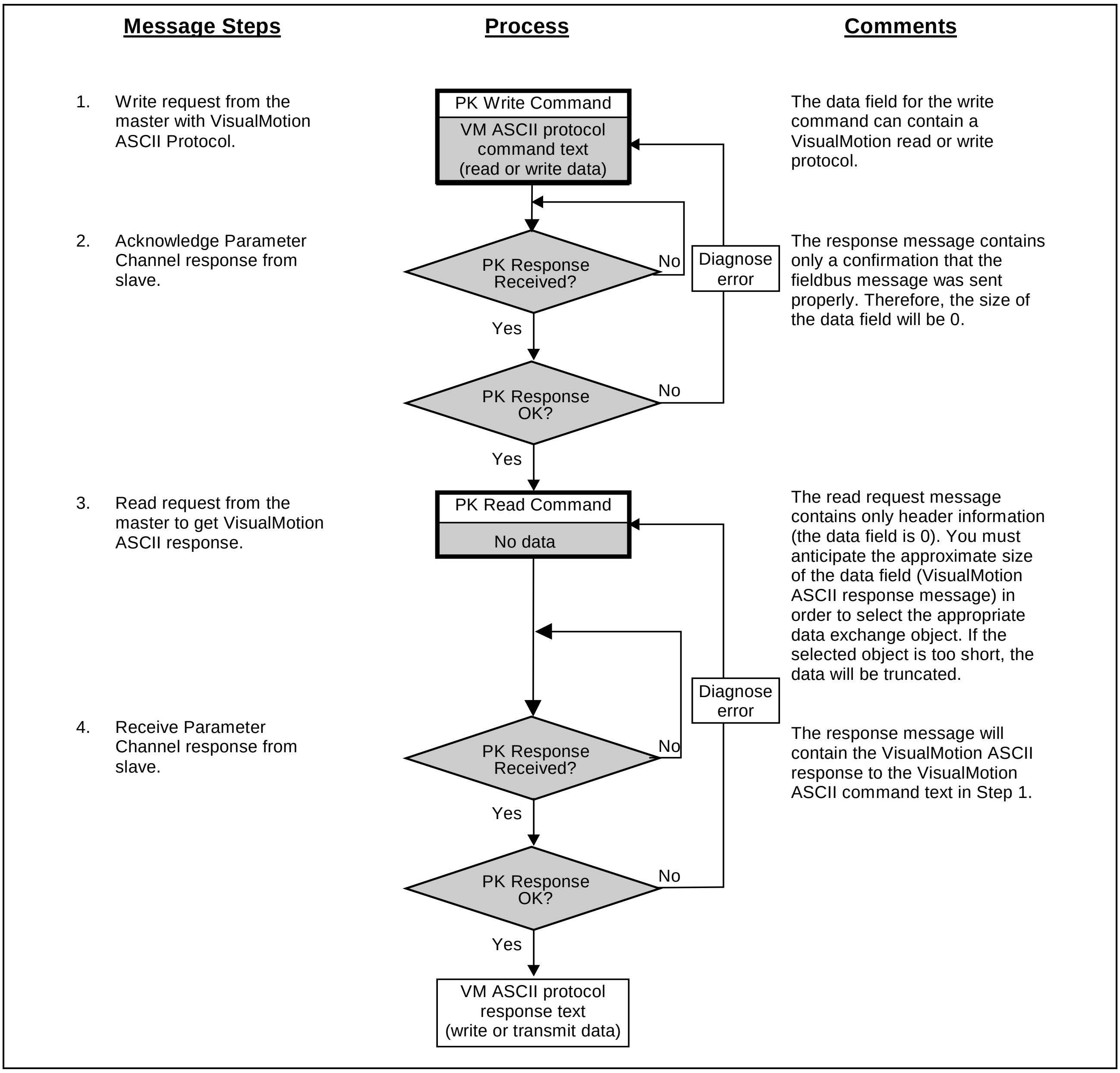


Fig. 6-33: Parameter Channel Short Format 3 Procedure, Using Data Exchange Object

Accessing Mapped Data

Indramat has pre-configured a number of VisualMotion data types to Profibus indexes and subindexes. We call this concept **mapped data**. These data types can be accessed via the Profibus Parameter Channel. The index and subindex for each of these data types can be calculated using the formulas in *Table 6-12* below.

	Object Index #	SubIndex #	Formula
Data Exchange Object	0x5E73	0x00	
	----	----	
	0x5E70	0x00	
<FREE>	0x5E65	0xFF	
	----	----	(with SubIndex)
(349 objects available)	0x5D14	0x01	
Program Integers	0x5D13	0xFF	Index = 0x5D00 + [(Program Integer –1) \ 255]
	----	----	
(Int 1 – Int 5100)	0x5D00	0x01	SubIndex = Program Integer – [(Index – 0x5D00) * 255]
Program Floats	0x5CFF	0xFF	Index = 0x5CEC + [(Program Float –1)] \ 255]
	----	----	
(Float 1 – Float 5100)	0x5CEC	0x01	SubIndex = Program Float – [(Index – 0x5CEC) * 255]
<FREE>	0x5CEB	0xFF	
	----	----	(with SubIndex)
(235 objects available)	0x5C01	0x01	
Global Integers	0x5C00	0xFF	Index = 0x5BF7 + [(Global Integer – 1) \ 255]
	----	----	
(GInt 1 – GInt 2550*)	0x5BF7	0x01	SubIndex = Global Integer – [(Index – 0x5BF7) * 255]
Global Floats	0x5BF6	0xFF	Index = 0x5BED + [(Global Float – 1) \ 255]
	----	----	
(GFloat 1 – Gfloat 2550*)	0x5BED	0x01	SubIndex = Global Float – [(Index – 0x5BED) * 255]
<FREE>	0x5BEC	0xFF	
	----	----	(with SubIndex)
(245 objects available)	0x5AF8	0x01	
Registers	0x5AF7	0xFF	Index = 0x5AEE + [(Register – 1) \ 255]
	----	----	
(Reg. 1 – Reg. 2550**)	0x5AEE	0x01	SubIndex = Register – [(Index – 0x5AEE) * 255]
T-Parameters	0x5AED	0x04	Index = 0x56F1 + T-Parameter
	----	----	
(T-0-0001 – T-0-1020)	0x56F1	0x01	SubIndex = Task Number
<FREE>	0x56F0	0xFF	
	----	----	(with SubIndex)
(GFloat 1 – Gfloat 2550)	0x5600	0x01	
C-Parameters	0x55FF	0x01	Index = 0x4800 + C-Parameter
	----	----	
(C-0-0001 - C-0-3583)	0x4801	0x01	SubIndex = 1
A-Parameters	0x47FF	0x63	Index = 0x4000 + A-Parameter
	----	----	
(A-0-0001 - A-0-2047)	0x4001	0x01	SubIndex = Axis Number
P-Parameters	0x3FFF	0x63	Index = 0x3000 + P-Parameter
	----	----	
(P-0-0001 - P-0-4095)	0x3001	0x01	SubIndex = Drive Number

	Object Index #	SubIndex #	Formula
S-Parameters	0x2FFF	0x63	Index = 0x2000 + S-Parameter
	----	----	
(S-0-0001 - S-0-4095)	0x2001	0x01	SubIndex = Drive Number
<Reserved>	0x1FFF	----	
	----	----	
	0x0000	----	

* current limitation: first 256 global integers/floats.

**current limitation: first 512 registers.

Table 6-12: Formulas for Determining Mapped Objects

Example Lookup Tables for Mapped Objects

Card (C) Parameters

The following is an example lookup table for C-Parameters, when using mapped objects.

Example Look-up Chart for: **C-Parameters** CP 0.Y ==> CP = Card Parameter
Y = Parameter Number

Index

	0x4801	0x4802	0x4803	………….	0x48FF	0x4900	………….	0x55FE	0x55FF
SubIndex = 0x01	CP 0.1	CP 0.2	CP 0.3		CP 0.255	CP 0.256		CP 0.3582	CP 0.3583

Table 6-13: Mapped Object Lookup Table for C-Parameters

Axis(A) Parameters

The following is an example lookup table for A-Parameters, when using mapped objects. The same formula also applies to SERCOS (S) and Task (T) Parameters.

Example Look-up Chart for: **A-Parameters** AP X.Y ==> AP = Axis Parameter
X = Axis Number
Y = Parameter Number

Index

		0x4001	0x4002	0x4003	………… …	0x40FF	0x4100	……………	0x47FE	0x47FF
	0x01	AP 1.1	AP 1.2	AP 1.3		AP 1.255	AP 1.256		AP 1.2046	AP 1.2047
SubIndex =	0x02	AP 2.1	AP 2.2	AP 2.3		AP 2.255	AP 2.256		AP 2.2046	AP 2.2047
	0x03	AP 3.1	AP 3.2	AP 3.3		AP 3.255	AP 3.256		AP 3.2046	AP 3.2047
	:	:	:	:	:	:	:	:	:	:
	:	:	:	:	:	:	:	:	:	:
	0x63	AP 99.1	AP 99.2	AP 99.3		AP 99.255	AP 99.256		AP 99.2046	AP 99.2047

Table 6-14: Mapped Object Lookup Table for A-Parameters

Product-Specific (P) Parameters

The following is an example lookup table for P-Parameters, when using mapped objects.

Example Look-up Chart for: **P-Parameters** PP X.Y ==> PP = SERCOS P-Parameter (set 0 only)
X = Drive Number
Y = Parameter Number

Index = (Class ID && Instance ID for DeviceNet)

		C118, In1	C118, In2	C118, In3	……………	C118, In255	C119, In1	……………	C134, In14	C134, In15
		0x3001	0x3002	0x3003	……………	0x30FF	0x3100	……………	0x3FFE	0x3FFF
	0x01	PP 1.1	PP 1.2	PP 1.3		PP 1.255	PP 1.256		PP 1.4094	PP 1.4095
SubIndex =	0x02	PP 2.1	PP 2.2	PP 2.3		PP 2.255	PP 2.256		PP 2.4094	PP 2.4095
(Attribute ID	0x03	PP 3.1	PP 3.2	PP 3.3		PP 3.255	PP 3.256		PP 3.4094	PP 3.4095
for DNet)	:	:	:	:	:	:	:	:	:	:
	:	:	:	:	:	:	:	:	:	:
	0x63	PP 99.1	PP 99.2	PP 99.3		PP 99.255	PP 99.256		PP 99.4094	PP 99.4095

Table 6-15: Mapped Object Lookup Table for P-Parameters

Integers The following is an example lookup table for Integers, when using mapped objects. The same formula also applies to Floats, Global Integers, Global Floats and Registers.

Example Look-up Chart for:		**VM Program Integers**	PI 0.Y	==>	PI = Program Integer Y = Program Integer Number	
			Index			
		0x5D00	0x5D01	0x5D02	…………..	0x5D13
	0x01	PI 1	PI 256	PI 511		PI 4846
SubIndex =	0x02	PI 2	PI 257	PI 512		PI 4847
	0x03	PI 3	PI 258	PI 513		PI 4848
	:	:	:	:	:	:
	:	:	:	:	:	:
	0xFF	PI 255	PI 510	PI 765		PI 5100

Table 6-16: Mapped Object Lookup Table for Integers

7 DeviceNet Fieldbus Interface

7.1 General Information

Version Note:
Information in this document is based on VisualMotion Toolkit software version 07V14 and PPC-R firmware version GPP07V09.

PPC-R System Description with a Fieldbus

The PPC-R can operate on a serial fieldbus interface (network) by means of a fieldbus expansion card that communicates with the PPC-R via dual-port RAM. The function of the fieldbus card is similar to that of a network card in a PC: it allows communication with other devices on the network.

In Fig. 7-1: Sample Master/Slave Setup with Fieldbus Card below, a commonly described fieldbus interface is pictured:

- **Fieldbus Master** - PLC fieldbus interface
- **Fieldbus Slave** - PPC-R fieldbus interface

In this document, we will refer to the PLC as the **fieldbus master** and the PPC-R as the **fieldbus slave**.

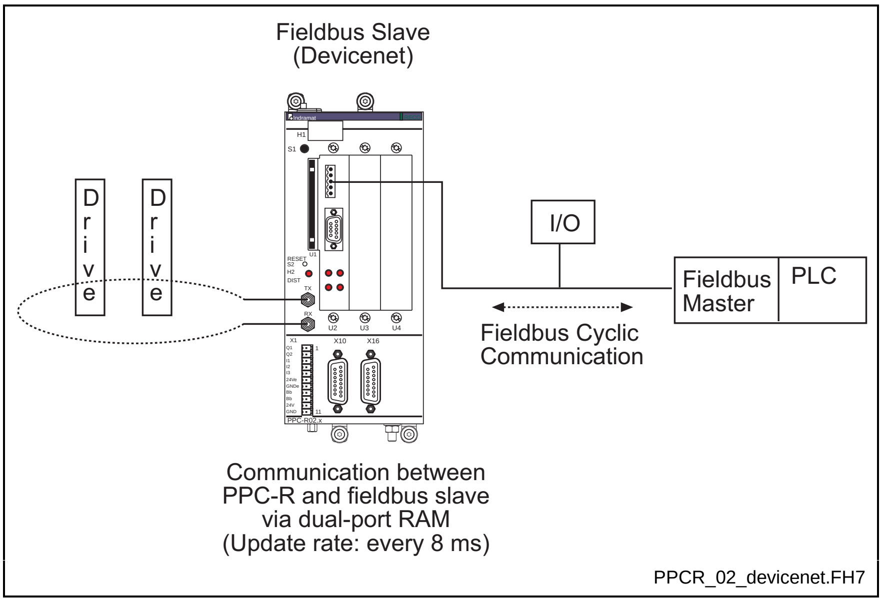


Fig. 7-1: Sample Master/Slave Setup with Fieldbus Card

With the PPC-R, the fieldbus card can be used **only** as a **slave** card in a master/slave setup.

The VisualMotion Fieldbus Mapper

In the VisualMotion software package, the Fieldbus Mapper is a tool used to set up fieldbus configuration and data mapping.

Data Transfer Direction (Output vs. Input)

In the VisualMotion Fieldbus Mapper, output and input are always described with respect to the fieldbus master. The definitions for output and input follow:

output: the communication from the PLC to the PPC-R (i.e. from the fieldbus master to the fieldbus slave).
Synonyms for this type of communication: **send** or **write** data.

input: the communication from the PPC-R to the PLC (i.e. from the fieldbus slave to the fieldbus master).
Synonyms for this type of communication: **receive** or **read** data.

Fieldbus Data Channel Descriptions

The Indramat DeviceNet fieldbus interface card for the PPC-R supports the following message types:

- **Cyclic Channel:** Polled I/O (for single and multiplex channels)
- **Non-Cyclic Channel:** Explicit Messaging

Cyclic (Polled I/O) Channel

Cyclic data is user-defined. It is stored in two ordered lists (C-2600 for input data, C-2601 for output data) and transmitted serially over the bus. In the cyclic channel, data is updated cyclically between the fieldbus master and slave.

The cyclic data channel is limited to 16 input words and 16 output words. PPC-R data types consume these words in either one-word (or 16-bit) groups for PPC-R registers or two-word (or 32-bit) groups for all other data types.

The PPC-R mapping list is scanned every 8 ms and data is sent and received to/from the fieldbus slave board's dual port RAM.

The cyclic data channel can be made up of any combination of the following data types:

- single
- multiplex

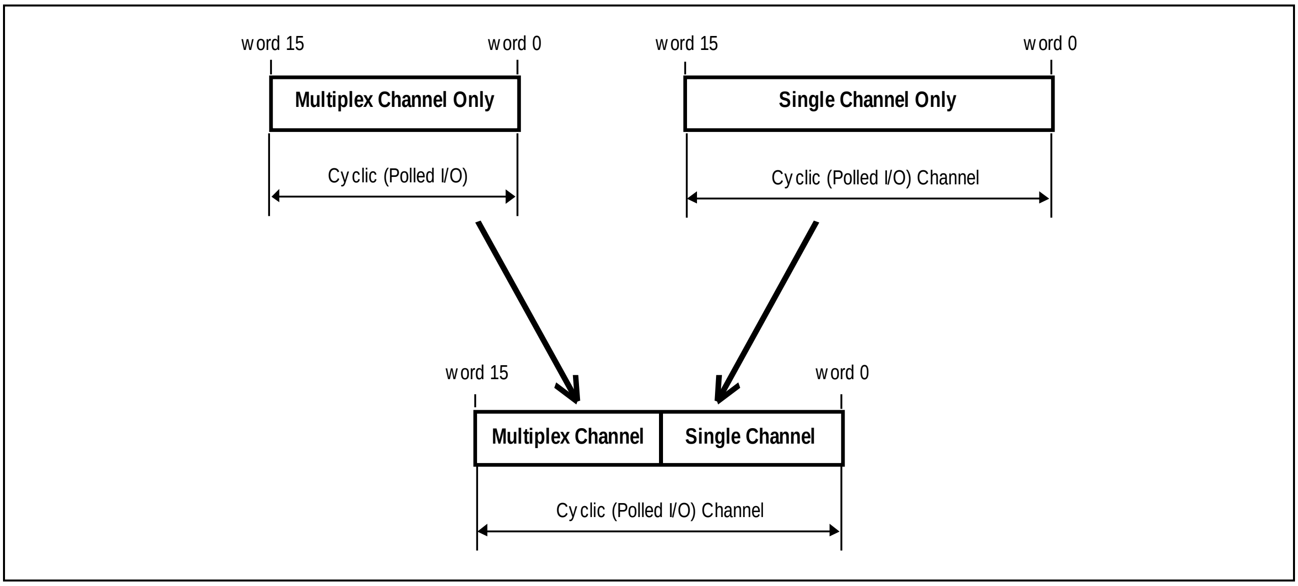


Fig. 7-2: Configuration Options for the Cyclic Data Channel

Cyclic Data: Types and Sizes

The following table outlines the PPC-R data types that can be transmitted via the cyclic channel and the amount of space (in 16-bit data words) that each data type consumes. Remember that the cyclic channel is limited to 16 data words in each direction (input and output).

Note: The cyclic data mapping lists supports only 16- and 32-bit data of the following types for reading and writing:
- Integer
- Float
- Binary (used in PPC-R parameters)
- Hex (used in PPC-R parameters)

For all other data types (e.g. diagnostic messages - “strings”), Explicit Messaging.

PPC-R Data Type	Data Size (in 16-Bit Words)
Register	1
Program Integer (currently active program ONLY *)	2
Program Float (currently active program ONLY *)	2
Global Integer	2
Global Float	2
Card Parameter	2
Axis Parameter	2
Task Parameter	2
Note: Drive parameters "S" or "P" cannot be transmitted cyclically because of the inherent delay of parameter access over the SERCOS service channel. However, if a drive parameter is mapped to an Axis Parameter, that Axis parameter could be used in cyclic data (see description of Axis Parameters 180-196 in the *VisualMotion Reference Manual*).	
*** Important Note:** Integers and floats are shown only for the currently active program. Each time you activate a new progam, the fieldbus reads/writes to the newly-activated program.	

Table 7-1: PPC-R Cyclic Data Types and Sizes

Single Data Types

Single data types are mapped directly in the cyclic mapping ordered lists (C-2600, C-2601). The data types are updated every 8 ms via dual-port RAM.

Multiplex Data Types (Cyclic Data Channel)

In some multi-axis applications, 16 words of cyclic data transfer are not sufficient to meet the requirement of the application.

When insufficient data transfer space is available, multiplex data can be set up within the cyclic channel. One multiplex container acts as a placeholder for multiple possible PPC-R data types (all of the same word size). The currently transmitted PPC-R data type is based on an index value placed in a multiplex control or status word attached to the end of the cyclic list. Depending on the index specified by the master, the multiplex channel permits a different set of data within the cyclic channel to be transferred as current real-time data. Multiplex containers can be added to the input and output lists separately and the input and output indexes can be designated separately (in the control and status words).

Note: Using the multiplex channel reduces the maximum number of usable words for storing PPC-R data to 15. The 16th word (or last used word, if fewer than 15 words) is used as the multiplex entry control/status word.

Note: Up to 15 multiplex containers can be used. However, a maximum of 180 mapping items can be transmitted in the input or output list. This limitation of mapping objects means that you cannot multiplex all 15 containers with 32 indexes (=480 items).

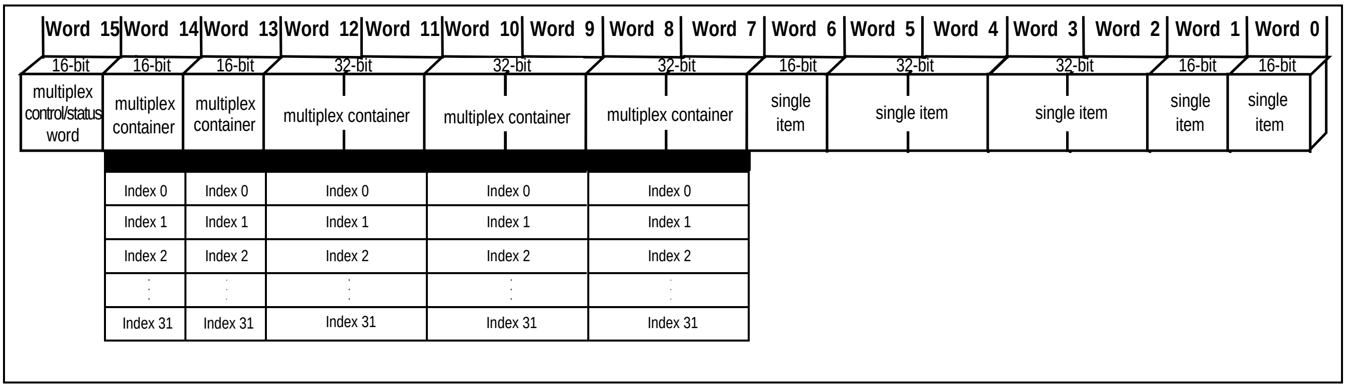


Fig. 7-3: Sample Command (PLC⇒PPC-R) or Response (PPC-R ⇒PLC)

Multiplex Control and Status Words

The multiplex control and status words serve to command and acknowledge multiplex data transferred between the fieldbus master and the fieldbus slave. The **control** word is associated with **output** communication (PLC⇒PPC-R). The **status** word is associated with **input** communication (PPC-R⇒PLC). Single data items are not affected by the multiplex control and status words.

Note: For specific information about how the fieldbus master uses the multiplex control and status words, refer to *Multiplexing* on page 7-19.

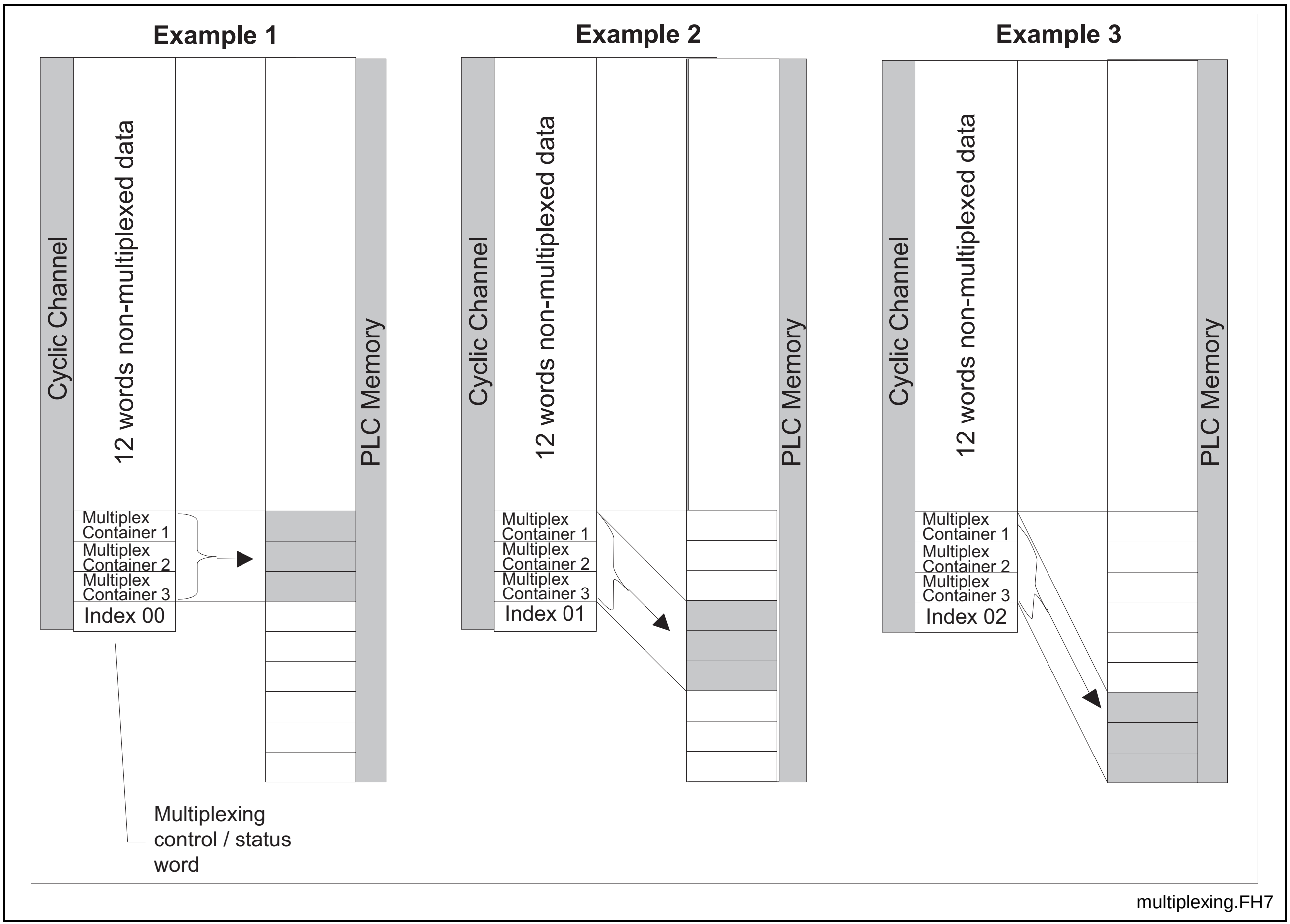


Fig. 7-4: Examples for Reading Data via the Multiplex Channel

Non-Cyclic Channel (Explicit Messaging)

The non-cyclic channel is used for data that needs to be transferred only once or sporadically, such as:

- the transmission of lists
- parametrization of axes or programs
- any non-cyclically mapped data

Instead of being updated during each cycle, non-cyclic data is transferred whenever time is available on the fieldbus. Though any data type can be transferred non-cyclically, diagnostic messages and drive parameters (S and P) **must** be transferred non-cyclically because of the non-cyclic retrieval for drive parameters through SERCOS and the length of the diagnostic messages.

For example: ASCII text in a diagnostic message requires one data word for every two ASCII characters. The non-cyclic channel can transfer only up to 16 data words (or 32 characters) of a diagnostic message at once. This would mean that one diagnostic text message (if 32 characters or more) could consume all the available cyclic data. For this reason, the transfer of diagnostic messages must be made over the non-cyclic (Explicit Messaging) channel; it is not allowed over the real-time channel.

There are two types of non-cyclic data transmissions for the PPC-R/VisualMotion system:

- mapped data (directly to PPC-R data types)
- data exchange object

Non-cyclic data can be accessed via Explicit Messaging support of the Fieldbus master.

Mapped Data

Mapped data is the most powerful feature of the PPC-R non-cyclic fieldbus interface. Through mapped data, the user has access to virtually every PPC-R parameter over the fieldbus. It is easy to implement from the PLC side and requires no setup on the PPC-R side.

Data Exchange Objects

Four data exchange objects Class 100, Instance 1-4, Attribute 100 are available for the transfer of non-cyclic data. These objects represent fixed data "containers" of varying lengths that transfer the VisualMotion ASCII Protocol to the PPC-R card, in the same way that data is transferred using the VisualMotion ASCII Format via an Explicit Message. These objects serve as an open-ended possibility to access any VisualMotion data (including cams, diagnostic text, etc.), but more work is required in the master to perform a transmission of this type. For more specific information about these objects, refer to *Data Exchange Objects* on page 7-28.

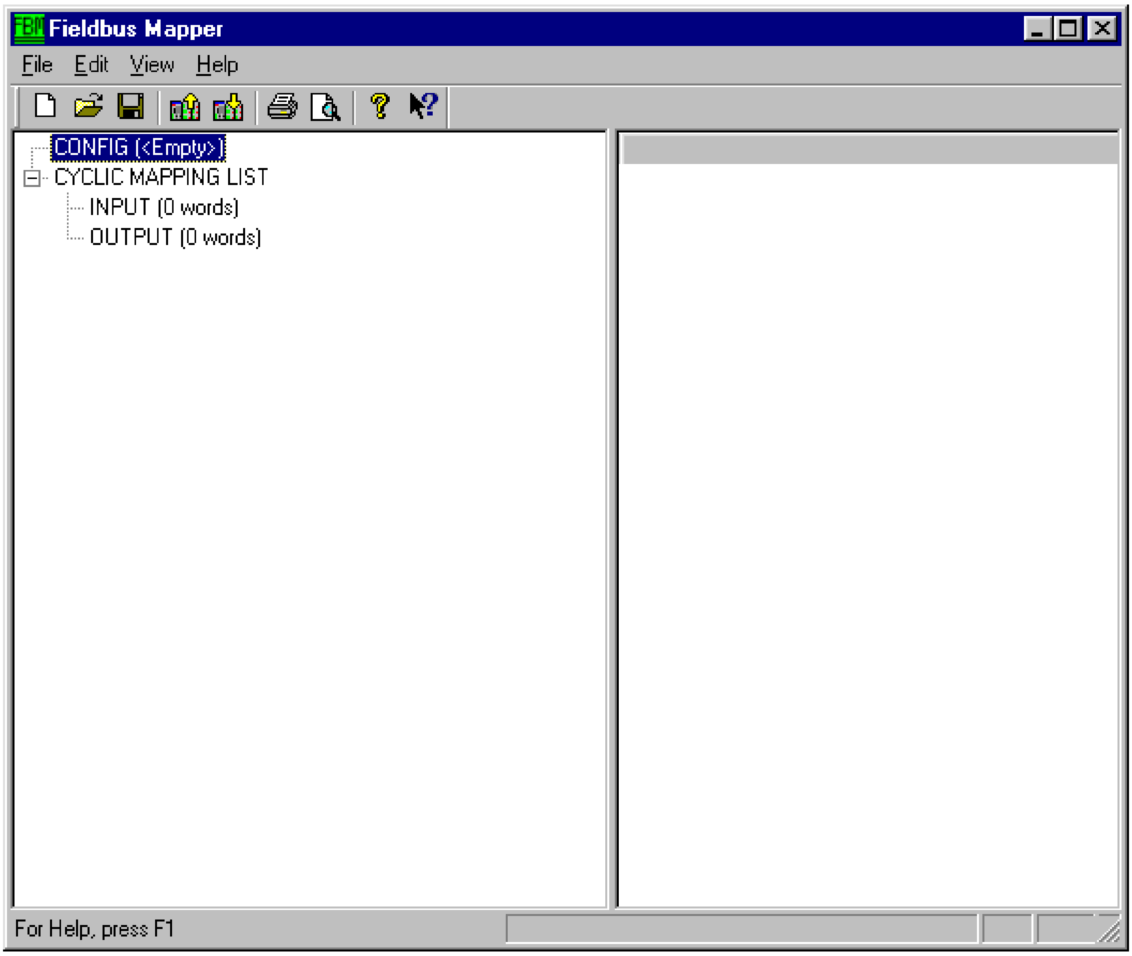
7.2 Fieldbus Mapper Functionality

Initializing the Fieldbus Mapper from VisualMotion 7

1. Open an existing program or create a new program. You must be using PPC-R hardware with GPP firmware to use the Fieldbus Mapper described in this document.

Note: Make sure the VisualMotion system is configured for GPP (in the ***Setup⇒Configuration*** menu item of the main VisualMotion screen).

2. Select ***Data⇒Fieldbus Mapper***. The main Fieldbus Mapper screen appears (refer to *Fig. 7-5* below).



FB_Mapper_Main_New.tif

Fig. 7-5: Fieldbus Mapper Main Screen (Blank)

Creating a New Fieldbus Mapper File

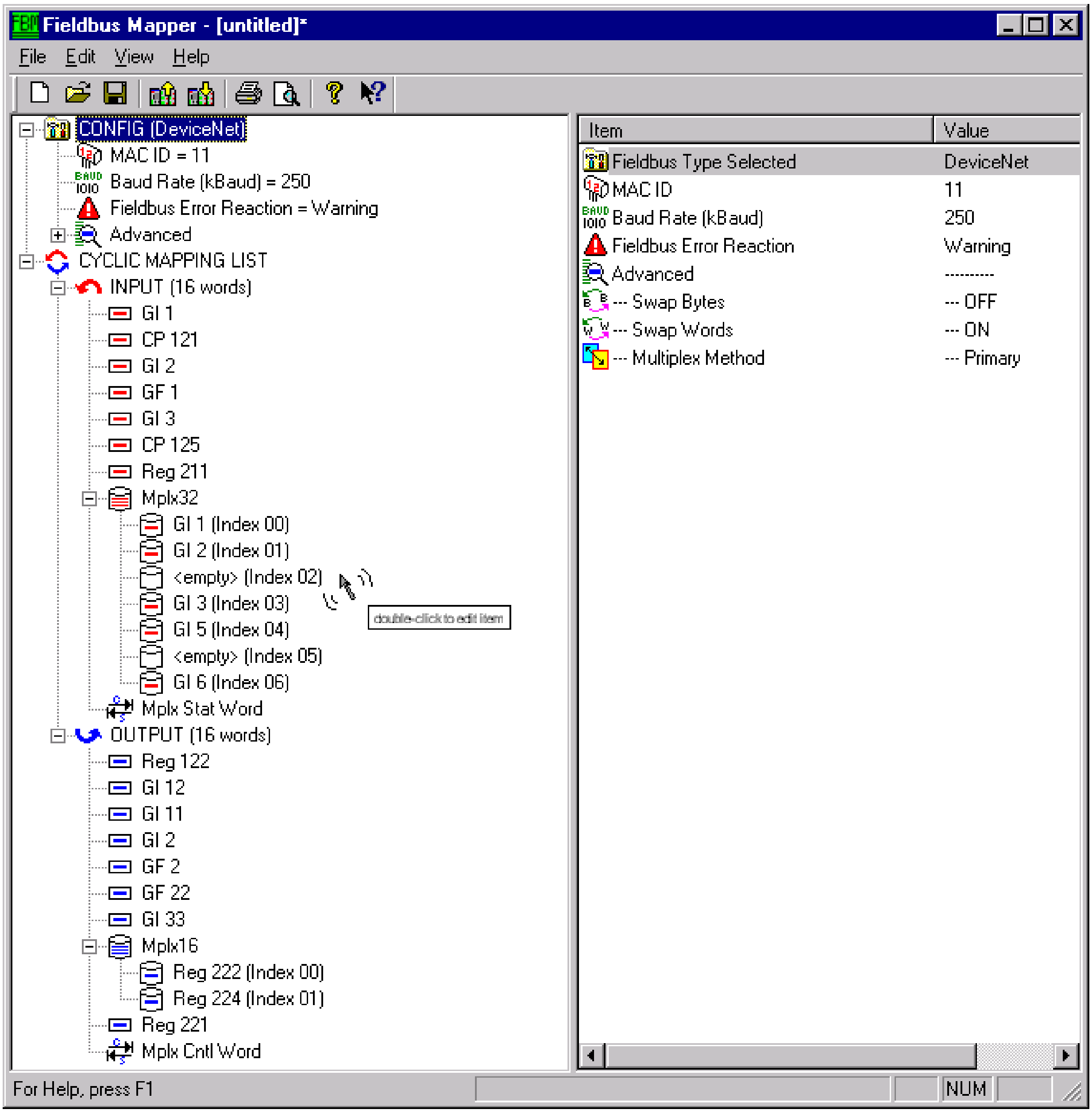
1. Click  **or** select ***File⇒New***.
A “setup wizard” goes through three steps:

- Fieldbus Slave Definition
- Fieldbus Slave Configuration
- Cyclic Data Configuration

2. Enter the information requested in the setup screens. For more details on each step, refer to *Fieldbus Slave Definition*, *Fieldbus Slave Configuration*, and *Cyclic Data Configuration* for detailed information about each configuration step.
3. Save the file (automatically has a **.prm** extension).

Editing an Existing Fieldbus Mapper File

1. Click  or select ***File⇒Open***.
2. Browse to find the desired file (***.prm** extension).
3. Click *Open*. The main Fieldbus Mapper screen appears, which lists the configuration information. Refer to *Fig. 7-6* below.



FB_Mapper_Main_DN_Edit.tif

Fig. 7-6: Fieldbus Mapper Main Screen (Complete)

4. From the Fieldbus Mapper main screen, **double-click** on the specific item to be edited. The corresponding setup screen appears.

- Or -

Select the item to edit from the Edit menu (refer to *Fig. 7-7* below). For more information about each step, refer to *Fieldbus Slave Definition*, *Fieldbus Slave Configuration*, and *Cyclic Data Configuration* for detailed information about each configuration step.

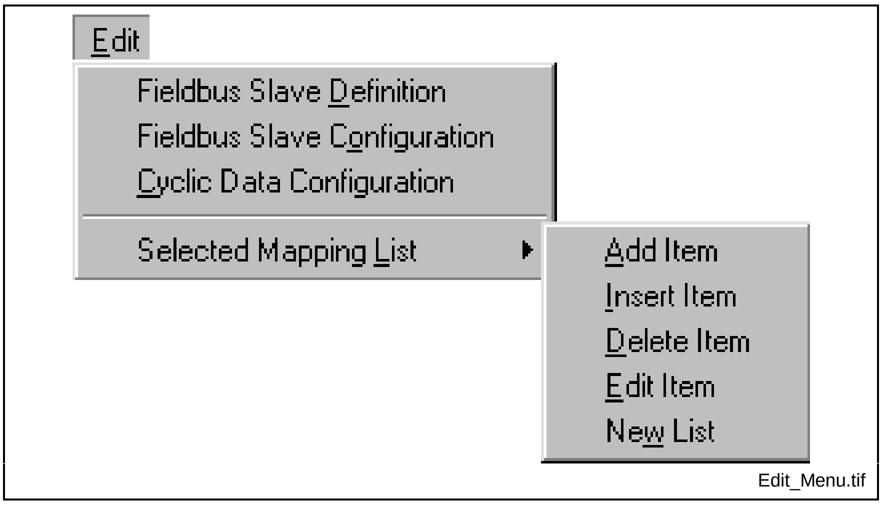


Fig. 7-7: Fieldbus Mapper Edit Menu

Note: You can also directly add, insert, delete, edit an item, or create a new list by:

- clicking on the item to be edited in the main Fieldbus Mapper screen and selecting the desired function under ***Edit⇒Selected Mapping List***

OR

- right-clicking on an item to display a menu of functions

Fieldbus Slave Definition

Only one hardware platform is currently supported in this Fieldbus Mapper: PPC-R (GPP07vRS firmware). If you are using CLC hardware with GPS firmware, the previous version of the Fieldbus Mapper initializes.

From the Fieldbus Slave Definition window, select DeviceNet as the Fieldbus Type (refer to *Fig. 7-8* below).

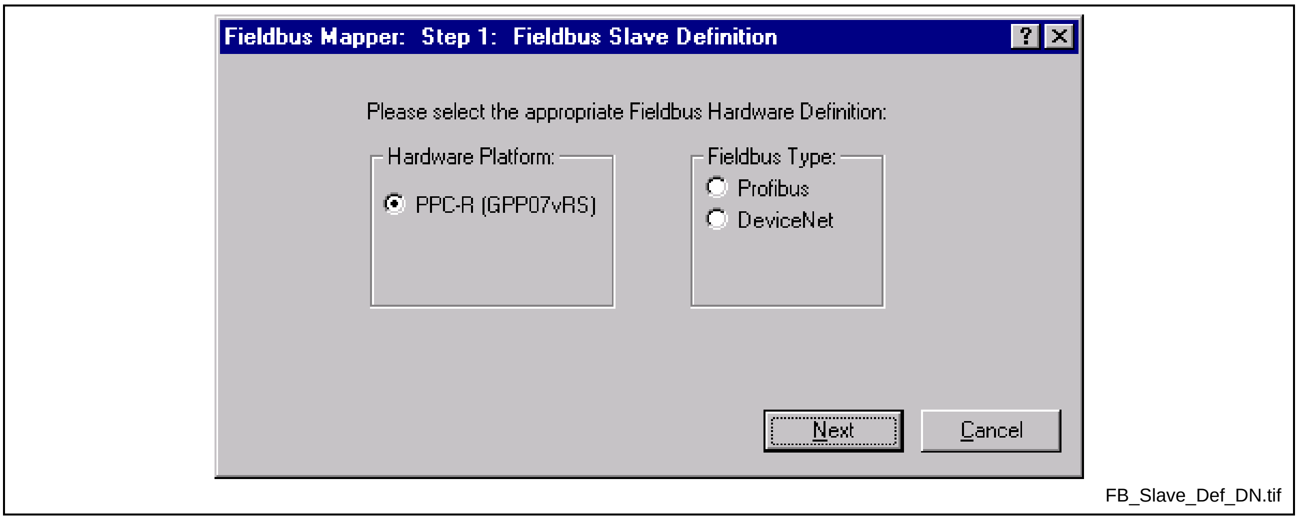
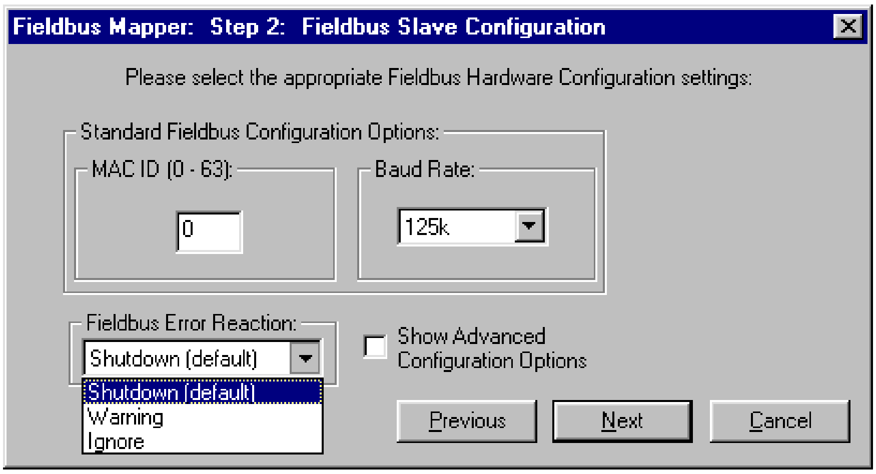


Fig. 7-8: Fieldbus Slave Definition Window

Fieldbus Slave Configuration

The DeviceNet Fieldbus Slave Configuration screen is shown in the figure *Fig. 7-9* below.



FB_Slave_Config_DN.tif

Fig. 7-9: Fieldbus Slave Configuration

Standard Fieldbus Configuration Options

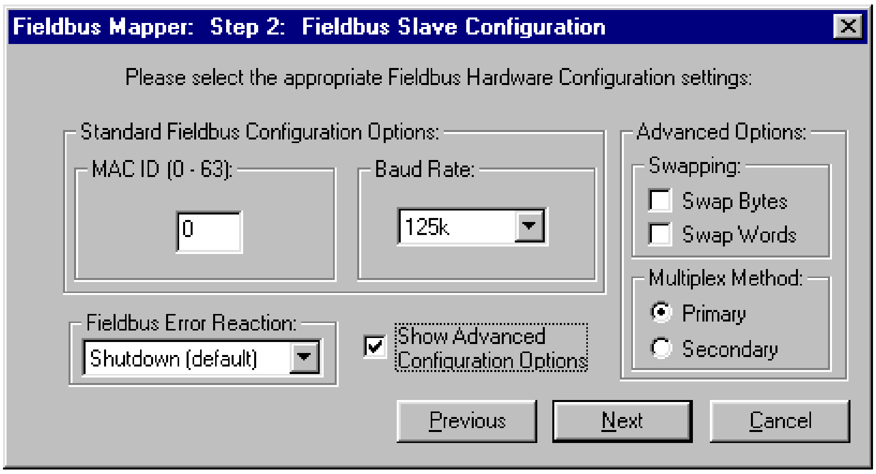
- **MAC ID (0-63):** set to a unique number for this device on the bus.
- **Baud Rate:** set to match that of the other network devices.

Fieldbus Error Reaction

Set the Error Reaction to Shutdown (default), Warning or Ignore. Refer to ***Fieldbus Error Reaction*** on page 7-17 for detailed information about each setting.

Advanced Configuration Options

The *Advanced Options:* are shown only if the checkbox next *to Show Advanced Configuration Options* is checked (refer to *Fig. 7-10* below). In most cases, the default options should apply.



FB_Slave_Config_DN_Adv.tif

Fig. 7-10: Fieldbus Slave Configuration: Advanced

- **Swapping:** If word and byte swapping is required by your PLC, select the checkboxes next to “Swap Bytes” and “Swap Words." Bytes and words are not swapped if the boxes are left unchecked. Refer to *Word and Byte Swapping* on page 7-18.

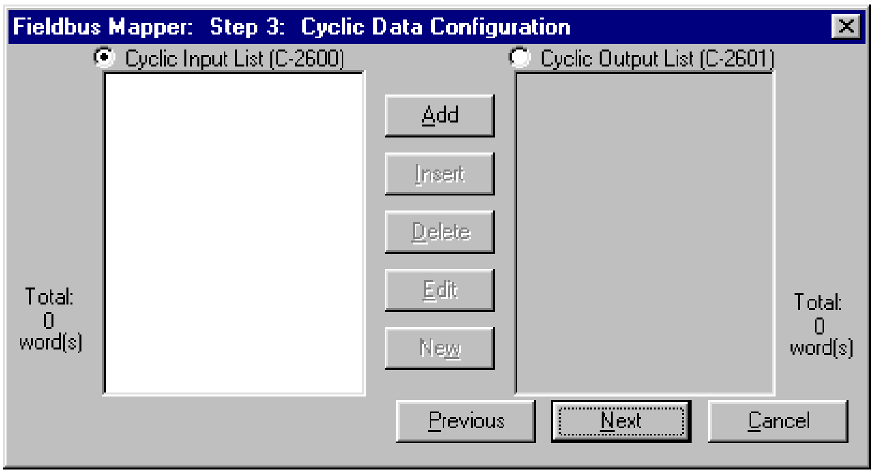
Note: When the Allen-Bradley SDN (DeviceNet Scanner) Module for the SLC-Series PLC is used, both **Swap Bytes** and **Swap Words** can be checked, so the order of resulting data appears correctly.

- **Multiplex Method:** select Primary or Secondary (Primary is the default). Select Secondary only if you have an inconsistent fieldbus master. Refer to *Multiplexing* on page 7-19 for detailed information about each method.

Cyclic Data Configuration

An example of the Cyclic Data Configuration screen is shown in *Fig. 7-11* below. No data has yet been configured. If you are editing an existing Fieldbus Mapper file, the list will probably contain more items.

First, you must select the Cyclic Input List (from PPC-R to PLC) or the Cyclic Output List (from PLC to PPC-R).

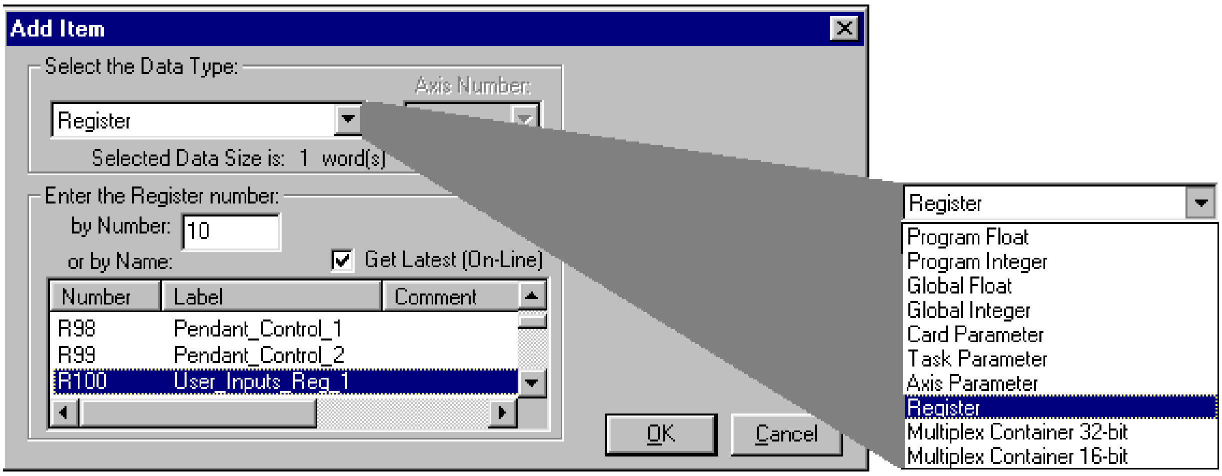


Cyclic_Data_New_DN.tif

Fig. 7-11: Cyclic Data Configuration—Initial Screen

Adding an Item to the List

1. Select the Cyclic Input List or the Cyclic Output List.
2. Click *Add*. The screen in *Fig. 7-12* below appears. Select the Data Type (for example, Register).



Cyclic_Data_Add.tif

Fig. 7-12: Add Item to Cyclic Data

Note: Registers and 16-bit Multiplex Containers (used only for Registers) require one data word (16 bits), and all other data types require two data words (32 bits) of space.

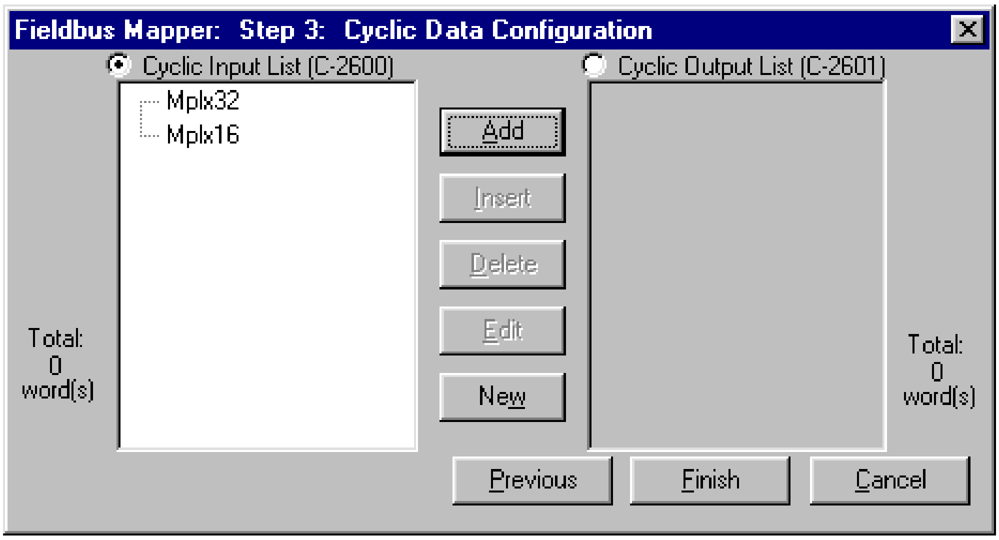
3. Enter the required information (for example Register Number) or select it from the list below. Only the available data types for your designated VisualMotion hardware setup and fieldbus type are listed.

Note: If you check the box next to "Get Latest (On-Line)," the data type label list is updated based on your firmware version and the currently active program.

4. Click *OK* to add the selected item to the list.

Adding Multiplex Containers to the List

1. Select the Cyclic Input List or the Cyclic Output List.
2. Click *Add*.
3. In the *Add Item* screen under *Select the Data Type:* select Multiplex Container 16-bit (for Registers) or Multiplex Container 32-bit (for all other data types).
4. Click *OK* to add the Multiplex Container to the List. The screen in *Fig. 7-13* below is an example where a 16-bit Multiplex Container and a 32-Bit Multiplex Container have been added.



Cyclic_Data_Mplx_DN.tif

Fig. 7-13: Cyclic Data Configuration, Multiplex Containers

Note: At this point, the Multiplex Containers do not yet contain any items. To add multiplex items refer to *Adding Items to an Empty Multiplex Container* below.

Adding Items to an Empty Multiplex Container

1. In the *Cyclic Data Configuration* screen, select the multiplex container to which you want to add items.
2. Click *Add*. The screen in *Fig. 7-14* below appears. Because it is unclear whether you would like to add to the list or to the multiplex container, the Fieldbus Mapper is requesting clarification.

Multiplex_Add_Msg.tif

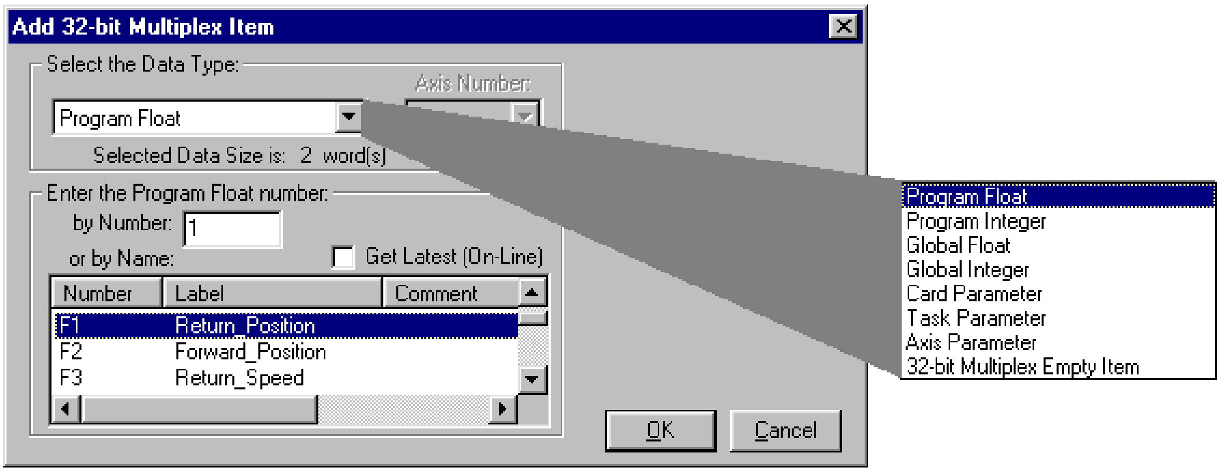
Fig. 7-14: Add Item or Multiplex Item Screen

Note: For subsequent items, highlight any of the indexes within the multiplex container before clicking *Add*, and the Fieldbus Mapper will know you want to add to that container.

3. To add to the selected multiplex container, click *No*. The screen in *Fig. 7-15* below is an example for adding a 32-bit multiplex item.
4. Select the desired item to be added to the multiplex container.

Note: In addition to the data types that can be added to the multiplex list, an empty item called *Multiplex Empty Item* is available to fill a space within the multiplex container, if nothing is to be mapped to a particular index.

5. Click OK. The item is automatically placed in the multiplex container as the next unassigned index item (e.g. the first item is index 00, the last is index 31).
6. Repeat for as many items as you want to add to the multiplex container, up to 32 items.



Mplx_Add.tif

Fig. 7-15: Adding a Multiplex Item to the Container (32-bit example)

Editing the Cyclic Data Lists

To make changes to an existing list, use the following buttons:

Button	Function
Add	Inserts a new item at the end of the list.
Insert	Inserts a new item into the list directly before the selected item.
Delete	Removes the selected item from the list.
Edit	Allows editing of the selected item. (To edit a list item, you may also double-click on it.)
New	Clears up the current list.

Table 7-2: Button Functions in the Cyclic Data Configuration Window

Additional Functions

Several additional functions are now available in the Fieldbus Mapper:

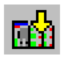
Function	Icon	Menu Selection
Download the current fieldbus configuration from the PPC-R		***File⇒Get Fieldbus Configuration from PPC***
Upload the current fieldbus configuration in the Fieldbus Mapper to the PPC-R		***File⇒Send Fieldbus Configuration to PPC***
Print the current fieldbus configuration data		***File⇒Print***
Preview the printout of the current fieldbus configuration data		***File⇒Print Preview***

Table 7-3: Additional Functions

Getting the Fieldbus Configuration from the PPC

After getting the fieldbus configuration from the PPC, the following information is detected by the system and appears in the configuration list:

- Fieldbus Type Found
- Fieldbus FW (Firmware) Version
- GPP Control FW (Firmware) Version

An example is shown in *Fig. 7-16* below.

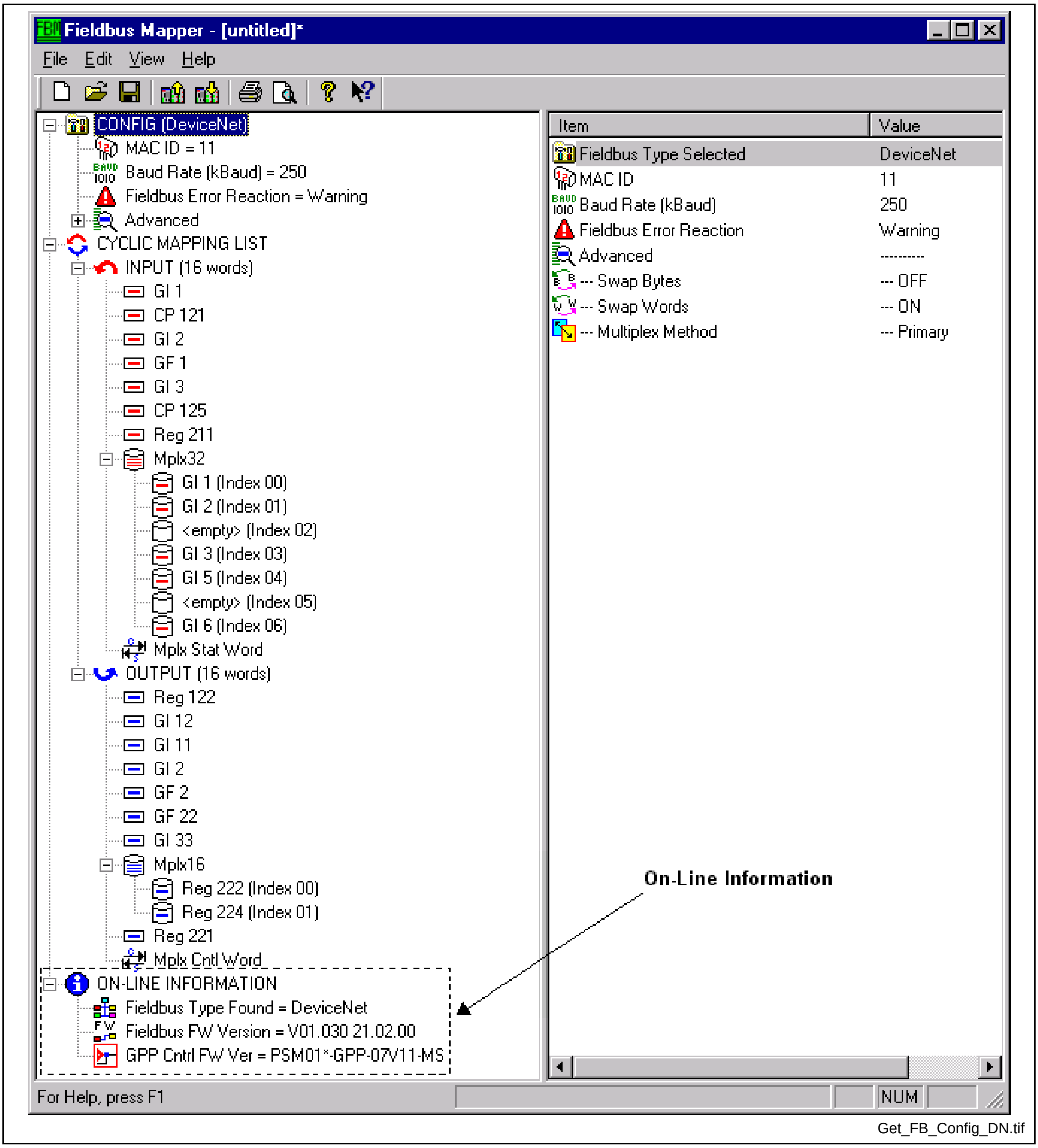


Fig. 7-16: On-Line Fieldbus Configuration Information

7.3 Information for the GPP Programmer

Register 19 Definition (Fieldbus Status)

VisualMotion Register 19 holds the information for "Fieldbus Status." The register information can be referenced in a VisualMotion application program to respond to the status of each bit. The use of these bits is application-dependent.

Table 7-4 below contains the bit assignment for the diagnostic object 5ff2. The assigned bits are labeled with "x" and the bit number in the second row. Unassigned bits are labeled with "---."

16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
---	x15	---	---	---	---	---	---	---	---	---	x5	x4	---	x2	x1

Table 7-4: Bit Assignment for VisualMotion Register 19

Bit Definitions

x1, x2 Status bits for the internal DPR (Dual-Port RAM) communication between the fieldbus slave and the PPC-R:

x1: FB Init OK , LSB (least significant bit)

x2: FB Init OK, MSB (most significant bit)

The bit combinations for x1 and x2 are as follows:

Bit 2 (PPC-R)	Bit 1 (Fieldbus)	Description
0	0	A reset has been executed on the DPR, **or** neither the PPC-R nor the fieldbus card have initialized the DPR.
0	1	The DPR is initialized by the fieldbus card, but **not** yet by the PPC-R.
1	0	The DPR initialization is complete. DPR has been initialized by the fieldbus card and PPC-R. Fieldbus to PPC-R communications system is ready.
1	1	Fieldbus to PPC-R communications system is ready.

Table 7-5: Possible Settings for Bits 1 and 2, Status Bits for DPR Communication

x4 Status bit for the active bus capabilities of the fieldbus slaves (FB Slave Ready)

This bit is monitored for the Fieldbus Error Reaction. Whenever this bit goes to 0 after a fieldbus card was initially found by the PPC-R, the selected Error Reaction (system shutdown, error message, or ignore) is initiated. Refer to *Fieldbus Error Reaction* on page 7-17 for an explanation of the Fieldbus Error Reaction setting.

0--> The fieldbus slave is not (yet) ready for data exchange.

1--> The fieldbus slave can actively participate on the bus.

x5 Status bit for the non-cyclic channel (Explicit Messaging) (Non-Cyc Ready)

0--> The non-cyclic channel (Explicit Messaging) cannot (yet) be used.

1--> The non-cyclic channel (Explicit Messaging) is ready for use by the fieldbus master.

x15 Status bit for the cyclic data output (Cyclic Data Valid):

0--> The cyclic data outputs (coming in to the PPC-R) are INVALID.

1--> The cyclic data outputs (coming in to the PPC-R) are VALID. The system looks for this bit to be 1 before allowing data transfer.

Register 20 Definition (Fieldbus Diagnostics)

VisualMotion Register 20 holds the information for "Fieldbus Diagnostics."

Table 7-6 below contains the bit assignment for the diagnostic object 5ff0. The assigned bits are labeled with "x" and the bit number in the second row. Unassigned bits are labeled with "---."

16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
---	x15	x14	x13	---	---	---	---	---	---	---	---	---	---	---	---

Table 7-6: Bit Assignment for VisualMotion Register 20

Bit Definitions

x13 - x15 Identification of the fieldbus interface card (FB Card Found)

The bit combinations for x13, x14 and x15 are as follows:

Bit 15	Bit 14	Bit 13	Fieldbus Type
0	0	0	<NO CARD>
0	0	1	<Not Defined>
0	1	0	Interbus
0	1	1	DeviceNet
1	0	0	Profibus
1	0	1	CanOpen
1	1	0	<Not Defined>
1	1	1	<Not Defined>

Table 7-7: Identification of the Fieldbus Interface

Register 26 Definition (Fieldbus Resource Monitor)

The "Fieldbus Resource Monitor" in register 26 can be used as a method for monitoring the attempts made to process the Cyclic Mapping Lists in parameters C-0-2600 and C-0-2601 across the Dual-port RAM. If after 8 ms, the Cyclic Mapping Lists are not successfully transmitted, a "**miss**" is noted.

Register 26 is divided into the following three counter types:

- Current Miss Counter.
- Peak Miss Counter.
- Fieldbus Timeout Counter.

Table 7-8 below contains the bit assignment for the fieldbus counters. The assigned bits are labeled with an "x" followed by the bit number.

Current Miss Counter				Peak Miss Counter				Fieldbus Time-out Counter							
16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
x16	x15	x14	x13	x12	x11	x10	x9	x8	x7	x6	x5	x4	x3	x2	x1

Table 7-8: Bit Assignment for Fieldbus Resource Monitor (Register 26)

Note: View register 26 in Hexadecimal format too more easily monitor the fieldbus counters.

Hex display format of register 26

0x0000

Fieldbus Time-out Counter (00-FF)
Increments by one every time 10 cyclic mapping list attempts are missed in 10 attempts.

Peak Miss Counter (0-9)
Displays the peak value of the Current Miss Counter.

Current Miss Counter (0-9)
Displays the count of missed cyclic mapping list attempts out of the last 10 attempts

Note: To view registers in hex, select ***Data* ⇒ *Registers*** within VisualMotion Toolkit. If the registers are not currently viewed in hex format, select ***Format* ⇒ *Hex*** in the *Active Program, Register* window.

Bit Definitions

x13 - x16 Status bits for the "Current Miss Counter."

An attempt is made to transmit the Cyclic Mapping Lists, C-0-2600, across the Dual-port RAM every 8 ms. For every 10 mapping list update attempts (80 ms), the failed attempts are counted and displayed in these bits (values can range from 0-9). If 10 out of 10 mapping list update attempts are missed, the "Fieldbus Timeout Counter" is incremented by one. This is an indication of a Fieldbus Mapping Timeout Error.

x9 - x12 Status bits for the "Peak Miss Counter."

These bits monitor the "Current Miss Counter's" peak count between a value from 0-9 and hold that value until a larger count is encountered.

x1 - x8 Status bits for the "Fieldbus Timeout Counter."

The count of these bits increments by one every time the "Current Miss Counter" encounters 10 out of 10 missed attempts of the cyclic mapping list update. A count incremented by one represents a Fieldbus Mapping Timeout Error and is processed by GPP according to the selected "Fieldbus Error Reaction" in parameter C-0-2635. Refer to *Fieldbus Error Reaction* below for an explanation of the Fieldbus Error Reaction setting.

Note: The GPP programmer can monitor the "Current Miss Counter" and define a custom error reaction for missed mapping list update attempts less than 10.

Note: The values in register 26 are read/write and can be reset by the user.

Fieldbus Error Reaction

Note: The Fieldbus Error Reaction setting is active only in SERCOS Phase 4. In all other SERCOS phases, it will be inactive.

You can select how you would like the PPC-R system to react in case of a fieldbus error. This reaction can be set in the "Fieldbus Slave Configuration" screen, using the combo box labeled "Fieldbus Error Reaction."

Three options are available for the Error Reaction setting. Depending on the selected setting, the value 0, 1, or 2 is stored in Parameter C-0-2635:

Setting	Value in Parameter C-0-2635
Shutdown	0 (default)
Warning Only	1
Ignore	2

Table 7-9: Parameter C-0-2635 Values for Error Reaction Settings

Fieldbus Mapper Timeout

The Fieldbus Mapper continually scans the system for sufficient resources to process the cyclic data mapping lists (2600 and 2601 lists). If 10 out of 10 attempts of the mapping list update are missed, the system is considered to have insufficient resources and the selected error reaction is evoked, as follows:

If "Shutdown" (0) is set in Parameter C-0-2635, the following error is generated from the PPC-R card: **520 Fieldbus Mapper Timeout**

If "Warning Only" (1) is set in Parameter C-0-2635, the following error is generated: **209 Fieldbus Mapper Timeout**

If "Ignore" (2) is set in Parameter C-0-2635, the system will update as resources become available, but there is no way to monitor whether or not updates actually occur.

Lost Fieldbus Connection

Register 19, bit 4 indicates the status of the fieldbus. Refer to *Register 19 Definition (Fieldbus Status)* for more specific bit information. The system monitors this bit and evokes the selected error reaction if the bit is low (0), after a fieldbus card is found. A typical situation that will cause this condition is the disconnection of the fieldbus cable from the fieldbus card.

If "Shutdown" (0) is set in Parameter C-0-2635, the following error is generated from the PPC-R (active in SERCOS Phase 4 only):
519 Lost Fieldbus Connection

If "Warning Only" (1) is set in Parameter C-0-2635, the following error is generated (active in SERCOS Phase 4 only):
208 Lost Fieldbus Connection

If "Ignore" (2) is set in Parameter C-0-2635, there is no noticeable reaction when Register 19 Bit 4 goes low, unless the GPP application program is customized to evoke a special reaction.

Troubleshooting Tip:

If a fieldbus card is not found on the system, the Error Reaction setting will be ignored. If you have a fieldbus card and the Error Reaction is not responding as expected, the system may not "refer to" your fieldbus card.

7.4 Information for the PLC Programmer

*.eds File

Indramat supplies an *.eds file containing supporting information for the PPC-R with a DeviceNet slave configuration. Contact an Indramat technical representative for the location of this file.

Word and Byte Swapping

In the Fieldbus Mapper, it is possible to enable automatic word and byte swapping for DeviceNet fieldbuses (for both input and output), depending on the type of PLC used.

- **32-bit Object Word Swapping** - The setting of this option determines the order in which the two data words in **any 32-bit (double word) cyclic or non-cyclic mapped object** are transmitted. The default setting, "Do not swap words" ("Swap Words" checkbox unchecked under the Advanced Options) causes the words to be transmitted in their usual order: [Word 1], [Word 2]. The "Swap Words" setting ("Swap Words" checkbox checked under the Advanced Options) causes the words to be transmitted in inverted order: [Word 2], [Word 1]. The setting of this option is stored in Card Parameter C-0-2636, bit 0.
- **Explicit Message Byte Swapping** - The setting of this option determines the order in which the bytes of **non-cyclic data >4 bytes long** are transmitted. The default setting, "Do not swap bytes" ("Swap Bytes" checkbox unchecked under the Advanced Options) causes the bytes to be transmitted in their usual order: [Byte 1], [Byte 2], [Byte 3], [Byte 4], [Byte 5], [Byte 6].... The "Swap Bytes" setting ("Swap Bytes" checkbox checked under the Advanced Options) causes each pair of bytes to be transmitted in inverted order: [Byte 2], [Byte 1], [Byte 4], [Byte 3], [Byte 6], [Byte 5].... The setting of this option is stored in Card Parameter C-0-2636, bit 1.

Example: Allen-Bradley SDN Module for SLC-Series PLC

When the Allen-Bradley SDN (DeviceNet Scanner) Module for the SLC-Series PLC is used, both **Swap Words** and **Swap Bytes** can be checked in the Fieldbus Mapper, so the order of resulting data appears correctly.

Multiplexing

Primary Multiplex Method (for Consistent Masters only)

Important: You should not use the Primary Multiplex Method for a master that is not consistent over the entire cyclic channel. The Secondary Multiplex Method is available for inconsistent masters. Refer to *Explanation of the Master Consistency Problem* on page 7-22.

The advantage of the Primary Method is easier handling of input data for consistent masters.

Control Word and Status Word

Control Word

The control word is transferred in the multiplex channel from master to slave. It tells the slave in which index the data is being transferred from master to slave and in which index the data is requested from slave to master.

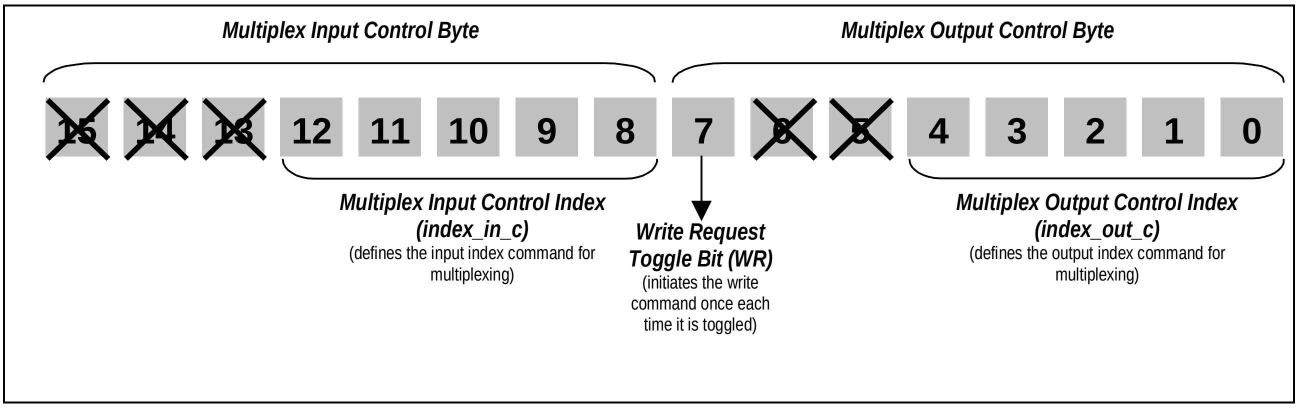


Fig. 7-17: Control Word Definition, Primary Multiplex Method

- **Index_out_c:** tells the slave in which index the data are transferred from master to slave (out = master -> slave, _c = element of control word).
- **Index_in_c:** tells the slave in which index the data is requested from slave to master (in = slave -> master, _c = element of control word).
- **WR (Write Request):** handshake bit (refer to meaning of WR and WA).

Note: Input data via the Multiplex Channel is continually being updated.

Status Word

The status word is transferred in the multiplex channel from slave to master. It acknowledges the written index and the requested index.

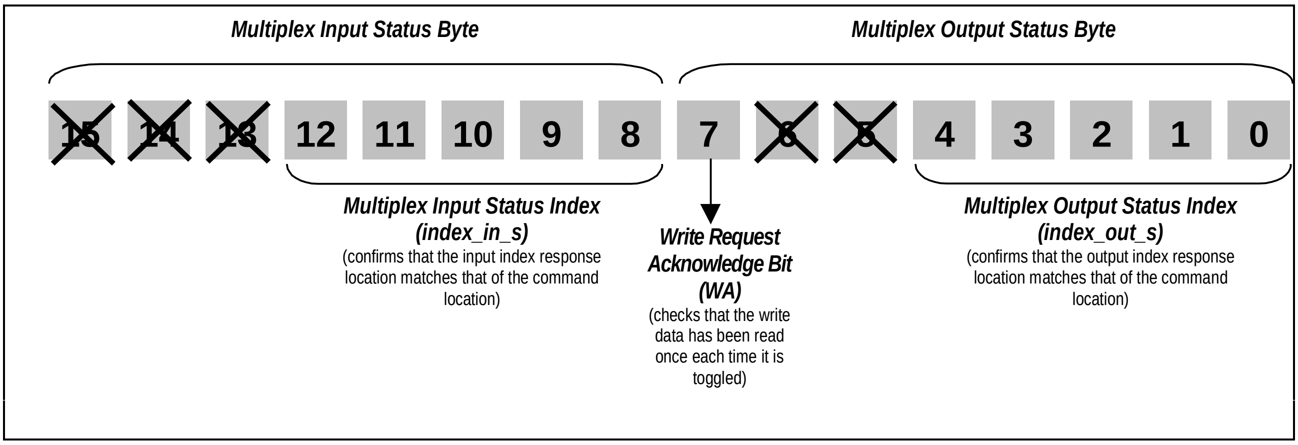


Fig. 7-18: Status Word Definition, Primary Multiplex Method

- **Index_out_s:** acknowledges index written by the master (out = master -> slave, _s = element of status word).
- **Index_in_s:** tells the master which index is transferred from slave to master in the actual process data cycle (in = slave -> master, _s = element of status word).
- **WA (Write Acknowledge):** Handshake bit (refer to meaning of WR and WA).

Handshake Bits WR and WA

WR and WA are handshake bits that allow the controlled writing of data via the multiplex channel. WR and WA control the data transfer for writing data_out (data send from master to slave).

WR == WA:

- tells the master that the slave has received the last multiplex data_out. The master can now send new data_out.
- tells the slave to do nothing, because the master has not yet put new consistent data_out on the bus.

WR! = WA:

- tells the slave to do something, because the master has now put consistent new data_out on bus.
- tells the master to do nothing, because the slave has not yet received the latest multiplex data_out.

Master Communications (Primary Multiplex Method)

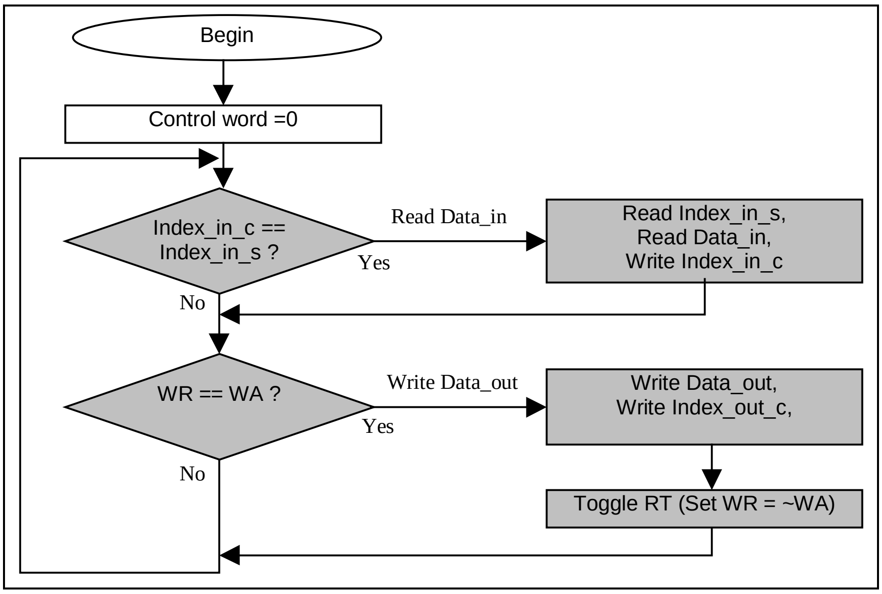


Fig. 7-19: Primary Multiplex Method, Master Communications

Programming Example

To aid in implementing the multiplex function in a PLC program, the following flow chart shows two ways of reading and writing data. Reading and writing can be executed separately, which allows the input data to be updated about 30% faster. The “Read Data” example would be placed at the beginning of a PLC program the “Write Data” example at the end.

Combined reading and writing makes the PLC program simpler, especially when using the same index for both transfer actions.

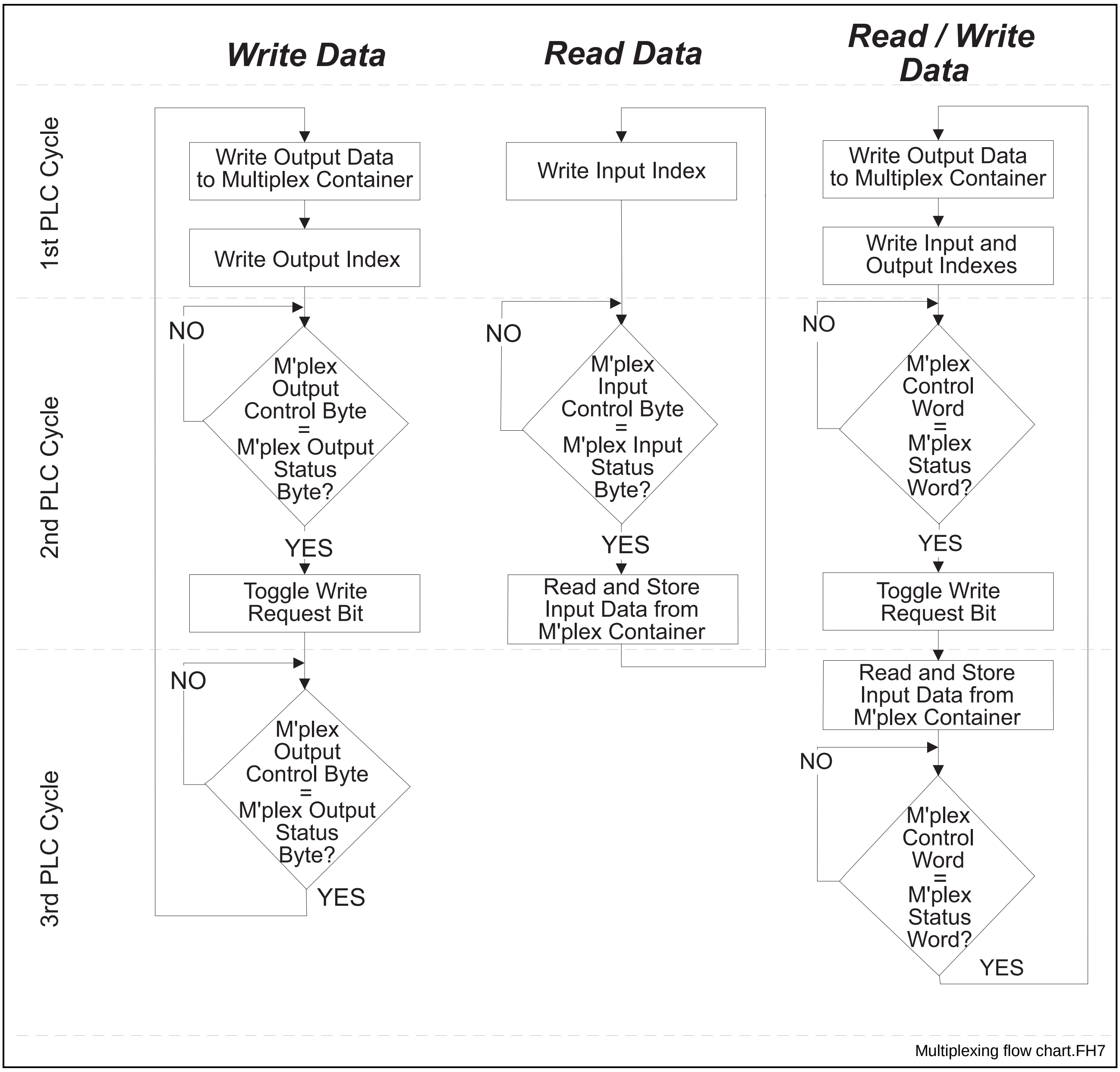


Fig. 7-20: Flow Chart of Multiplex Programming Examples (Primary Method)

Secondary Multiplex Method (for Inconsistent Masters)

Explanation of the Master Consistency Problem

The PPC-R fieldbus slave interfaces can guarantee consistency.

However, some fieldbus masters can only guarantee byte, word or double word consistency. If the master is only word-consistent, it is possible that the master cannot transfer the data and the control word of one multiplex index consistently from the PLC to the fieldbus. Therefore, it is necessary to have a second multiplex method where both input data and output data require the handshake bits to update via the fieldbus.

Note: The meanings of the control and status words are the same as for the Primary Multiplex Method. The only difference is that toggle bits RR and RA are used in the Secondary Method.

Fig. 7-21 and *Fig. 7-22* below illustrate the control and status word definitions for the Secondary Multiplex Method.

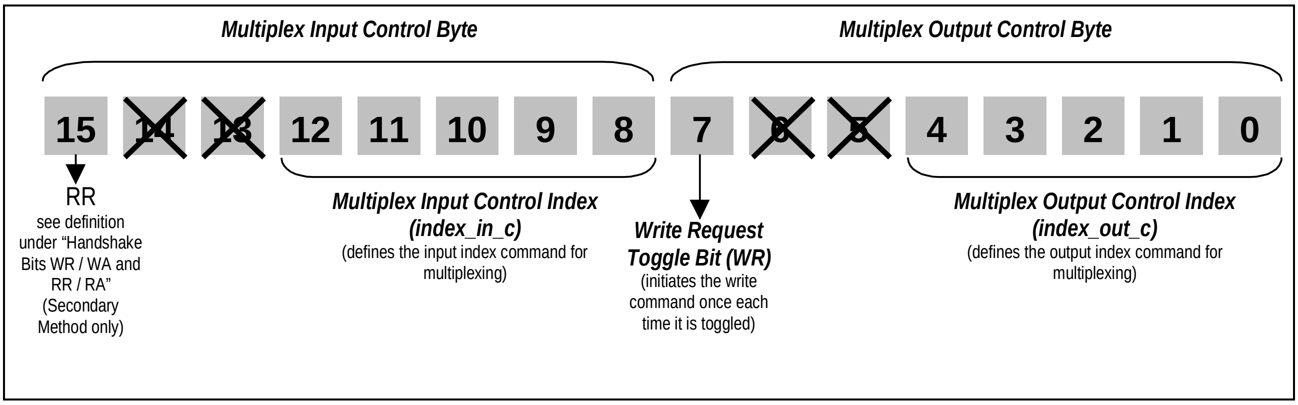


Fig. 7-21: Control Word Definition, Secondary Multiplex Method

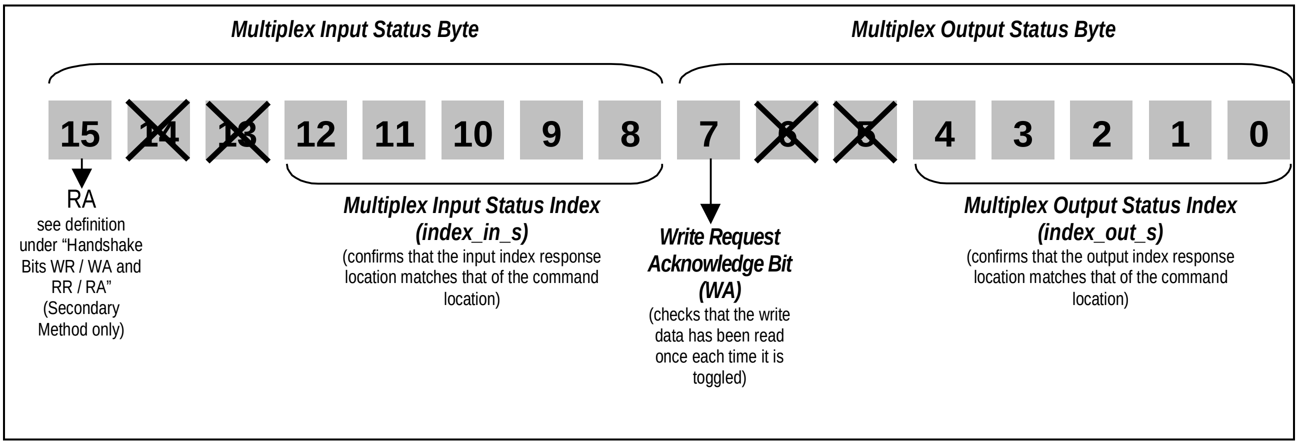


Fig. 7-22: Status Word Definition, Secondary Multiplex Method

The Secondary Multiplex Method has the following features:

- You can transfer a different index from master to slave as from slave to master.
- The handshake bits for both reading and writing of this multiplex channel make the multiplexing possible on inconsistent systems (masters).

Handshake Bits RR and RA

RR (Read Request) and RA (Read Acknowledge) are handshake bits that allow a controlled data transfer and use of the multiplex channel on inconsistent masters. RR and RA control the data transfer for reading data_in (data send from slave to master).

RR == RA:

- tells the master that the slave has sent the requested data_in. The master can now read the data_in and request new data_in.
- tells the slave to do nothing, because the master has not yet put new consistent data on the bus.

RR != RA:

- tells the slave to put new data_in on the bus, because the master requests new data_in.
- tells the master to do nothing, because the slave has not yet put the latest requested multiplex data_in on the bus.

Master Communications (Secondary Multiplex Method)

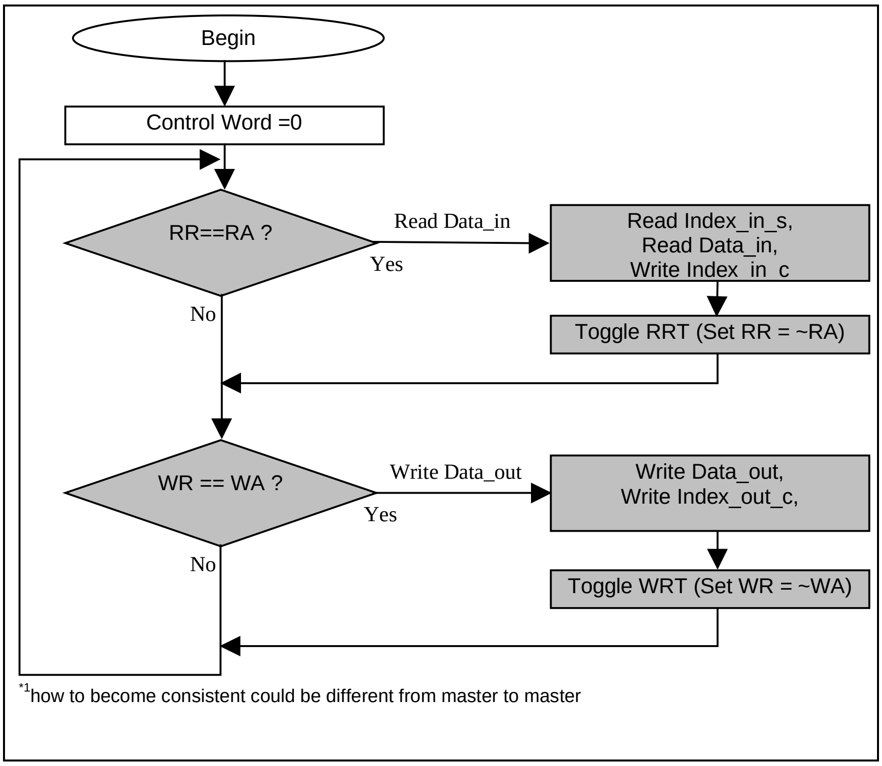


Fig. 7-23: Secondary Multiplex Method, Master Communications

For some masters, it could be enough to first write data and then the control word. For other masters, you may have to implement a delay time (this time could be different from master to master) before writing WR = ~WA.

Non-Cyclic Data (Explicit Messaging)

The following methods for transferring data are available via DeviceNet Explicit Messaging:

- Mapped Data
- Data Exchange Objects

Mapped Data

Mapped data is the most powerful feature of the PPC-R non-cyclic fieldbus interface. Through mapped data, the user has access to virtually every PPC-R parameter over the fieldbus. It is easy to implement from the PLC side and requires no setup on the PPC-R side.

To access a VisualMotion data type over the fieldbus, it has to be specified by an address that consists of a Class, Instance and Attribute. Every data type has a related Class, Instance and Attribute. The Class, Instance and Attribute for each data type can be calculated by a formula (refer to *Example Lookup Tables for Mapped Data* on page 7-34).

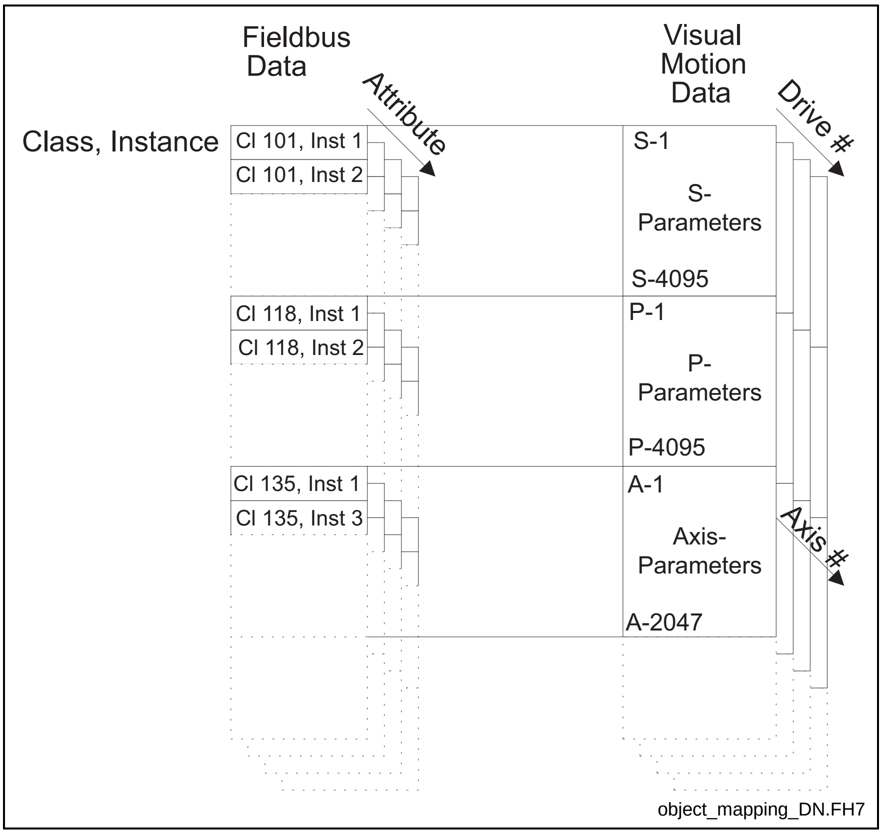


Fig. 7-24: Mapped Data

Mapped data can be used with the following parameters and values:

• S-Parameters (SERCOS Drive S-Parameters) • P-Parameters (SERCOS Drive P-Parameters) • A-Parameters (PPC Axis Parameters) • C-Parameters (PPC C System parameters) • T-Parameters (PPC Task parameters)	size and format depend on parameter

PF-Values (PPC Program Float data, 32 bit – 2 words, IEEE format)

GI-Values (PPC Global Integer data, 32 bit – 2 words)

GF-Values (PPC Global Float data, 32 bit – 2 words, IEEE format)

PI-Values (PPC Program Integer data, 32 bit – 2 words)

Reg.-Values (PPC Register data, 16 bit – 1 word)

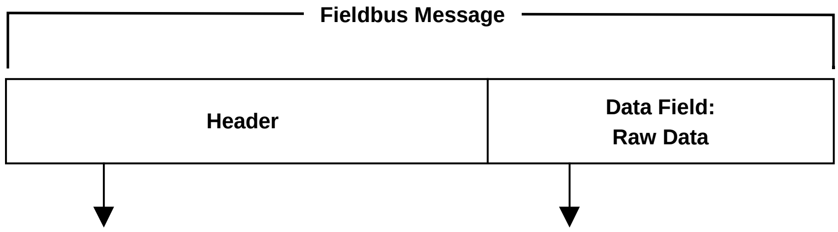
Data Exchange Objects (Class 100, Instance 1-4, Attribute 100)
(embedded ASCII Protocol)

Selecting Mapped Data

To access a data type over the fieldbus, it has to be specified by an address that consists of a Class, Instance and Attribute. Class, Instance and Attribute for each data type can be calculated by a formula (refer to *Accessing Mapped Data* on page 7-32).

Transmission Sequence for Mapped Data

Note: For mapped data, only one transmission (and one response) is required, to send a read or write message to and receive a response from the PPC-R.



key components:

- service code: Read = 0x0E
  Write = 0x10
- mapped data (under ***VisualMotion Mapped Data*** at the end of this section). This is the destination of the data field. Selection of the Class, Instance and Attribute depends on the required VisualMotion.
- Data field size (in bytes)
  minimum = 6 bytes for Class, Instance, Attribute

key components:

- raw data to be transmitted (write message only; unused for read message)

Important: The format of the Fieldbus message header and the method of implementation are dependent on the Fieldbus type and the master (PLC) being used. Refer to your Fieldbus master/PLC documentation for proper transport and formatting of the message header.

Non-Cyclic Mapped Data Write

Message Steps | **Process** | **Comments**

1. Write request from the master with raw data.

The data field for the write request contains the value to be stored in the VisualMotion data.

2. Acknowledge fieldbus response from slave.

The response message contains only a confirmation that the fieldbus message was sent properly. Therefore, the size of the data field will be 0.

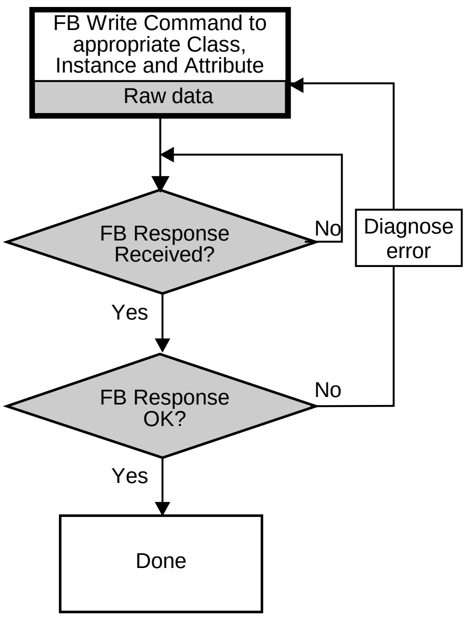


Fig. 7-25: Non-Cyclic Mapped Data Write Process

Example: Write the value -27.43 to Program Float 16 (This is a 32-bit data type, which is mapped to Class 165, Instance 1, and Attribute 16. The Class, Instance and Attribute can be calculated using the formulas under *Accessing Mapped Data* at the end of this chapter.)

1. Write request from the master with raw data.

Header: Write command	**Data Field: VisualMotion raw data**
contains: • Write service code = (0x10) • object number (Class 165, Instance 1, Attribute 16) • data field size (bytes—in this case: 4) + (6 bytes for Class, Inst, Att) = 10 bytes	**contains data (here, shown in decimal format):** `-27.43`

2. After the write request from the master, the PPC-R sends a response message.

Header: Response message	**No data field**
contains: • "Write" message o.k. is denoted by a Response service code of (0x90) • data field size = 0 bytes	

3. If the message response (code in message header) shows o.k., the transaction is complete.

Non-Cyclic Mapped Data Read

Message Steps	**Process**	**Comments**
1. Read request from the master with no data field.		The request message contains only the fieldbus read command and the Class, Instance and Attribute to be read.
2. Acknowledge fieldbus response from slave.		The data field for the response contains the value requested from the slave (PPC-R).
3. Master uses data from fieldbus response.		

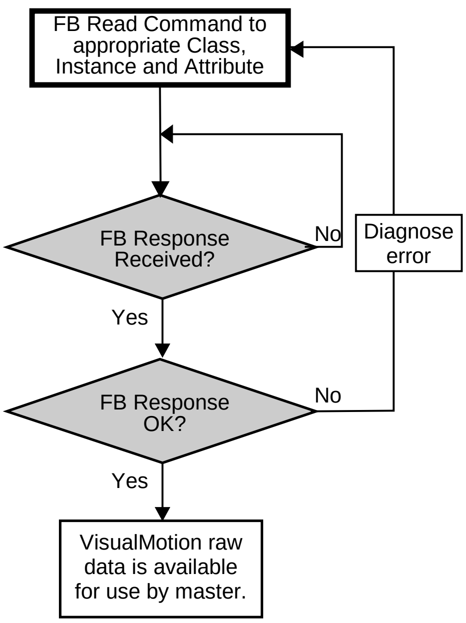


Fig. 7-26: Non-Cyclic Mapped Data Read Process

Example: Read the value contained in Program Integer 8. (This is a 32-bit data type, which is mapped to Class 165, Instance 21, and Attribute 8. The Class, Instance and Attribute can be calculated using the formulas under *Accessing Mapped Data* at the end of this chapter.)

1. Read request from the master.

Header:
Read command

No data field

contains:
- Read service code = (0x0E)
- Class 165, Instance 21, Attribute 8
- data field size = 6 bytes for Class, Inst, Att

2. After the read request from the master, the PPC-R sends a response message.

Header:
Response message

Data Field:
VisualMotion raw data

contains:
- "Read" message o.k. is denoted by a Response service code of (0x8E)
- data field size = 4 bytes

contains data (here, shown in decimal format):
`12345`

If the message response (code in message header) shows o.k., the requested value is attached to the message in the data field. This value is now available for use by the master (PLC).

Data Exchange Objects

The four data exchange objects Class 100, Instance 1-4, Attribute 100 represent fixed data "containers" of varying lengths that transfer the VisualMotion ASCII Protocol to the PPC-R. These objects serve as an open-ended possibility to access any VisualMotion data (including cams, diagnostic text, etc.), but more work is required in the master to perform a transmission of this type. Both the VisualMotion ASCII message and the fieldbus transfer message must be formulated.

Table 7-10 below lists the available data exchange objects and their sizes.

Data Exchange Object	Data Length (in bytes)
Class 100, Instance 1, Attribute 100	16
Class 100, Instance 2, Attribute 100	32
Class 100, Instance 3, Attribute 100	64
Class 100, Instance 4, Attribute 100	128

Table 7-10: Length of the Data Exchange Objects

Selecting a Data Exchange Object

Depending on the length of a VisualMotion ASCII message, any of these data exchange objects can be selected.

Note: The entire data length of the data exchange object must always be transmitted even if the VisualMotion ASCII message is shorter.
For example, if you want to transmit an ASCII message of 42 bytes, you must use Class 100, Instance 3. To avoid a response error from the Fieldbus slave, you must append 22 "Null" characters to the end of the ASCII message to complete a data size of 64 bytes.

Note: The checksum for the VisualMotion ASCII protocol is NOT used with the data exchange object. If the checksum is sent as part of the string, it will be ignored, and no checksum will be sent in the VisualMotion ASCII response messages. To ensure data integrity, the Fieldbus protocols support a low-level checksum.

Transmission Sequence via a Data Exchange Object

Note: For the data exchange object, two transmissions (and two responses) are required, to send the read or write message to and then receive the response message from the PPC-R.

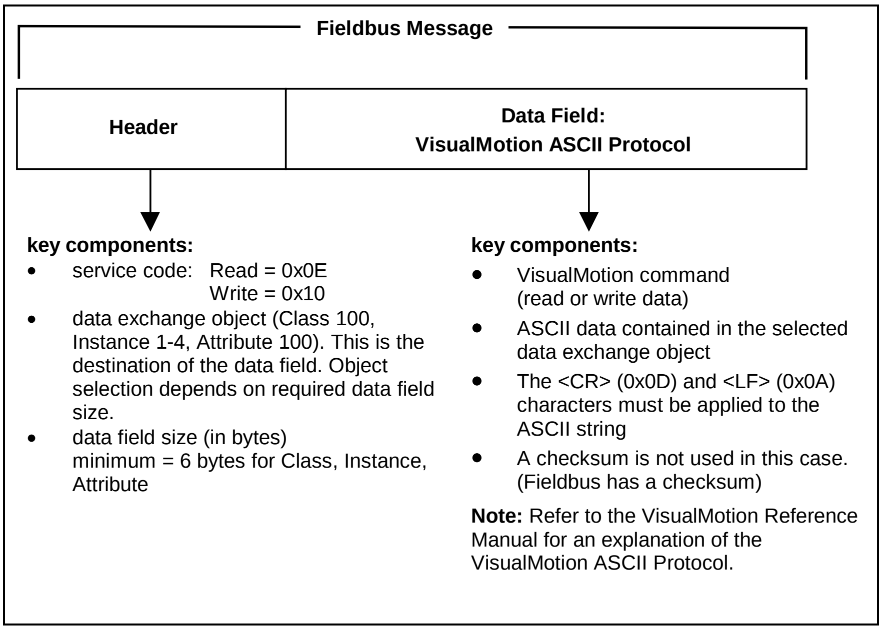


Fig. 7-27: Format of a Non-Cyclic Fieldbus Message using a Data Exchange Object

Important: The format of the fieldbus message header is dependent on the type of master (PLC) being used. Refer to your PLC manufacturer's manual for specific information on this topic.

The following sequence describes the communication between the Fieldbus master (PLC) and the Fieldbus slave (PPC-R):

Message Steps	Comments
1. Write request from the master with VisualMotion ASCII Protocol.	The data field for the write request can contain a VisualMotion read or write protocol.
2. Acknowledge fieldbus response from slave.	The response message contains only a confirmation that the fieldbus message was sent properly. Therefore, the size of the data field will be 0.
3. Read request from the master to get VisualMotion ASCII response.	The read request message contains only header information (the data field is 0). You must anticipate the approximate size of the data field (VisualMotion ASCII response message) in order to select the appropriate data exchange object. If the selected object is too short, the data will be truncated.
4. Receive fieldbus response from slave.	The response message will contain the VisualMotion ASCII response to the VisualMotion ASCII command text in Step 1.

Process

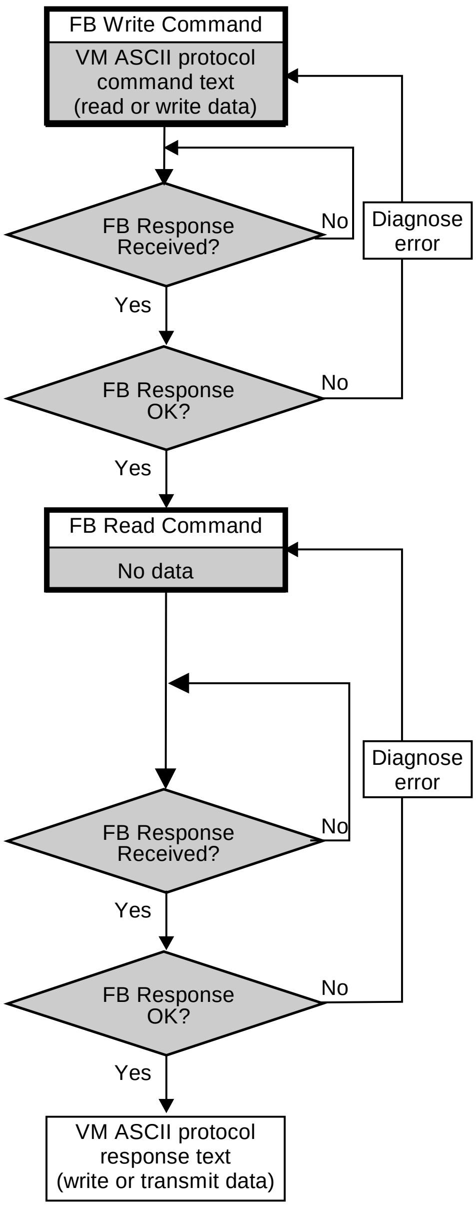


Fig. 7-28: Non-Cyclic (Explicit Messaging) VisualMotion ASCII Communication Process

Example: Read Card Parameter 100 (PPC-R firmware version)

1. Write request from the master with VisualMotion ASCII Protocol.

Header: Write command	Data Field: VisualMotion ASCII Protocol
contains: • Write service code = (0x10) • object number (Class 100, Instance 1, Attribute 100) • data field size (bytes—in this case: 16) + (6 bytes for Class, Inst, Att) = 22 bytes	**contains code:** `>0_CP_1.100\CR\LF\00\00\00`

2. After the first read request from the master, the PPC-R sends a response message.

Header:
Response message

No data field

contains:
- "Write" message o.k. is denoted by a Response service code of (0x90)
- data field size = 0 bytes

3. Read request from the master for the VisualMotion ASCII response message.

Header:
Read command

No data field

contains:
- Read service code = (0x0E)
- object number (Class 100, Instance 3, Attribute 100 —anticipated return data size between 32 and 64 bytes)
- data field size = 6 bytes for Class, Inst, Att

Note: To ensure that all of the data requested in this step is received in step 4 below, a data exchange object of the appropriate size must be selected.
If the selected data exchange object is too small, the data will be truncated.
If the selected data exchange object is too large, efficiency of transmission will be compromised.

4. The PPC-R sends the final response message.

Header:
Response message

Data Field:
VisualMotion ASCII Protocol

contains:
- "Read" message o.k. is denoted by a Response service code of (0x8E)
- data field size = 64 bytes

contains code:
```
>0_CP_1.100_PSM01*-GPP-07V11-
MS\CR\LF\00\00\00\00\00\00\00
\00\00\00\00\00\00\00\00\00\00
\00\00\00\00\00\00\00\00\00\00
\00\00\00\00
```

DeviceNet General Error Codes

Error No. (Hex)	Error Name	Error Description
0x09	Invalid attribute value	Invalid attribute data detected.
0x0E	Attribute not settable	A request to modify a non-modifiable attribute was received.
0x13	Not enough data	The service did not supply enough data to perform the specified operation.
0x14	Attribute not supported	The attribute specified does not exist in the device.
0x15	Too much data	The service supplied more data than was expected.

Error No. (Hex)	Error Name	Error Description
0x16	Object does not exist	The object specified does not exist in the device.
0x1F	Vendor-specific error	A vendor-specific error has been encountered. The Additional Code Field of the Error Response defines the particular error encountered. Use of this General Error Code should only be performed when none of the Error Codes presented in this table or within an Object Class definition accurately reflects the error. Refer to extended error code in the VisualMotion ASCII Error Codes (VisualMotion Reference Manual).

Table 7-11: DeviceNet Error Codes

Accessing Mapped Data

Indramat has pre-configured a number of VisualMotion data types to DeviceNet Class, Instance and Attributes. We call this concept-mapped **data**. These data types can be accessed via DeviceNet Explicit Messaging. The Class, Instance and Attribute for each of these data types can be calculated using the formulas in *Table 7-12* below.

	Class, Instance	Attribute	Formula
Data Exchange Object	Class 166 Instance 137	0	Note: for backwards compatibility, also listed as
	----	----	Class 100, Instance 1 - 4, Attribute 100
	Class 166 Instance 134	0	
<FREE> (349 objects available)	Class 166, Instance 133	255	
	----	----	
	Class 165 Instance 41	1	
Program Integers (Int 1 – Int 5100)	Class 165 Instance 40	255	Class = 165
	----	----	Instance = 21 + [(Program Integer - 1) \ 255]
	Class 165 Instance 21	1	Attribute = Program Integer - [(Instance - 21) * 255)]
Program Floats (Float 1 – Float 5100)	Class 165 Instance 20	255	Class = 165
	----	----	Instance = 1 + [(Program Float - 1) \ 255]
	Class 165, Instance 1	1	Attribute = Program Float - [(Instance - 1) * 255)]

<FREE> (235 objects available)	Class 164, Instance 255	255	
	----	----	
	Class 164, Instance 21	1	
Global Integers (GInt 1 – GInt 2550*)	Class 164, Instance 20	255	Class = 164
	----	----	Instance = 11 + [(Global Integer - 1) \ 255]
	Class 164, Instance 11	1	Attribute = Global Integer - [(Instance - 11) * 255)]
Global Floats	Class 164, Instance 10	255	Class = 164
	----	----	Instance = 1 + [(Global Float - 1) \ 255]

	Class, Instance	Attribute	Formula
(GFloat 1 – Gfloat 2550*)	Class 164, Instance 1	1	Attribute = Global Float - [(Instance - 1) * 255)]
	Class 163, Instance 255	255	
<FREE>	----	----	
(245 objects available)	Class 163, Instance 11	1	
	Class 163, Instance 10	255	Class = 163
Registers	----	----	Instance = 1 + [(Register - 1) \ 255]
(Reg. 1 – Reg. 2550**)	Class 163, Instance 1	1	Attribute = Register - [(Instance - 1) * 255)]
	Class 162, Instance 255	4	Class = 159 + [(T-Parameter - 1) \ 255]
T-Parameters	----	----	Instance = T-Parameter - [(Class - 159) * 255]
(T-0-0001 – T-0-1020)	Class 159, Instance 1	1	Attribute = Task Number
	Class 158, Instance 255	255	
<FREE>	----	----	
(GFloat 1 – Gfloat 2550)	Class 158, Instance 14	1	
	Class 158, Instance 13	1	Class = 144 + [(C-Parameter - 1) \ 255]
C-Parameters	----	----	Instance = C-Parameter - [(Class - 144) * 255]
(C-0-0001 - C-0-3583)	Class 144, Instance 1	1	Attribute = 1 (data)
	Class 143, Instance 7	99	Class = 135 + [(A-Parameter - 1) \ 255]
A-Parameters	----	----	Instance = A-Parameter - [(Class - 135) * 255]
(A-0-0001 - A-0-2047)	Class 135, Instance 1	1	Attribute = Axis Number
	Class 134, Instance 15	99	Class = 118 + [(P-Parameter - 1) \ 255]
P-Parameters	----	----	Instance = P-Parameter - [(Class - 118) * 255]
(P-0-0001 - P-0-4095)	Class 118, Instance 1	1	Attribute = Drive Number
	Class 117, Instance 15	99	Class = 101 + [(S-Parameter - 1) \ 255]
S-Parameters	----	----	Instance = S-Parameter - [(Class - 101) * 255]
(S-0-0001 - S-0-4095)	Class 101, Instance 1	1	Attribute = Drive Number

* current limitation: first 256 global integers/floats.

**current limitation: first 512 registers.

Table 7-12: Formulas for Determining Mapped Objects

Example Lookup Tables for Mapped Data

Card (C) Parameters

The following is an example lookup table for C-Parameters, when using mapped objects.

Example Look-up Chart for: **C-Parameters** CP 0.Y ==> CP = Card Parameter
Y = Parameter Number

		Class 144	Class 144	Class 144	……………	Class 144	Class 145	……………	Class 158	Class 158
		Instance 1	Instance 2	Instance 3	……………	Instance 255	Instance 1	……………	Instance 12	Instance 13
Attribute ID	1	CP 0.1	CP 0.2	CP 0.3		CP 0.255	CP 0.256		CP 0.3582	CP 0.3583

Table 7-13: C-Parameters Lookup Table for Mapped Data Types

Axis(A) Parameters

The following is an example lookup table for A-Parameters, when using mapped objects. The same formula also applies to SERCOS (S) and Task (T) Parameters.

Example Look-up Chart for: **A-Parameters** AP X.Y ==> AP = Axis Parameter
X = Axis Number
Y = Parameter Number

		Class 135	Class 135	Class 135	……………	Class 135	Class 136	……………	Class 143	Class 143
		Instance 1	Instance 2	Instance 3	……………	Instance 255	Instance 1	……………	Instance 6	Instance 7
	1	AP 1.1	AP 1.2	AP 1.3		AP 1.255	AP 1.256		AP 1.2046	AP 1.2047
Attribute ID	2	AP 2.1	AP 2.2	AP 2.3		AP 2.255	AP 2.256		AP 2.2046	AP 2.2047
	3	AP 3.1	AP 3.2	AP 3.3		AP 3.255	AP 3.256		AP 3.2046	AP 3.2047
	:	:	:	:	:	:	:	:	:	:
	:	:	:	:	:	:	:	:	:	:
	99	AP 99.1	AP 99.2	AP 99.3		AP 99.255	AP 99.256		AP 99.2046	AP 99.2047

Table 7-14: A-Parameters Lookup Table for Mapped Data Types

Product-Specific (P) Parameters

The following is an example lookup table for P-Parameters, when using mapped objects.

Example Look-up Chart for: **P-Parameters** PP X.Y ==> PP = SERCOS P-Parameter (set 0 only)
X = Drive Number
Y = Parameter Number

		Class 118 Instance 1	Class 118 Instance 2	Class 118 Instance 3	……………	Class 118 Instance 255	Class 119 Instance 1	……………	Class 134 Instance 14	Class 134 Instance 15
	1	PP 1.1	PP 1.2	PP 1.3		PP 1.255	PP 1.256		PP 1.4094	PP 1.4095
Attribute ID	2	PP 2.1	PP 2.2	PP 2.3		PP 2.255	PP 2.256		PP 2.4094	PP 2.4095
	3	PP 3.1	PP 3.2	PP 3.3		PP 3.255	PP 3.256		PP 3.4094	PP 3.4095
	:	:	:	:	:	:	:	:	:	:
	:	:	:	:	:	:	:	:	:	:
	99	PP 99.1	PP 99.2	PP 99.3		PP 99.255	PP 99.256		PP 99.4094	PP 99.4095

Table 7-15: P-Parameters Lookup Table for Mapped Data Types

Integers

The following is an example lookup table for Integers, when using mapped objects. The same formula also applies to Floats, Global Integers, Global Floats and Registers.

Example Look-up Chart for: **VM Program Integers** PI 0.Y ==> PI = Program Integer
Y = Program Integer Number

		Class 165 Instance 21	Class 165 Instance 22	Class 165 Instance 23	……………	Class 165 Instance 40
	1	PI 1	PI 256	PI 511		PI 4846
Attribute ID =	2	PI 2	PI 257	PI 512		PI 4847
	3	PI 3	PI 258	PI 513		PI 4848
	:	:	:	:	:	:
	:	:	:	:	:	:
	255	PI 255	PI 510	PI 765		PI 5100

Table 7-16: Program Integers Lookup Table for Mapped Data Types

8 Drive Parameter Editor

8.1 Overview

The Drive Parameter Editor shown in Fig. 8-1 can be opened by selecting ***Setup*** ⇒ ***Drives*** or ***Status*** ⇒ ***Drives*** from VisualMotion Toolkit's main menu.

When opened, the Drive Parameter Editor uploads the status information for the first drive found. A graphical representation of the selected drive and motor are automatically displayed and provides information as to the type of drive, drive firmware version and connected motor. The programmed position, velocity and acceleration values from the control are displayed along with the feedback status for the selected drive.

The Drive # box allows selection of another drive by entering a drive number or scrolling with the up/down list buttons. When a different drive is selected, the information on this screen is automatically updated. Since the drive internally generates rate profiles for single axis motion, the programmed acceleration is also displayed. Acceleration is not shown for coordinated motion since the control path planner manages acceleration for coordinated motion.

If applicable within sub-screens of the Drive Parameter Editor window, the **Next** and **Previous** buttons are used to select from multiple drives. These buttons eliminate the need to close the current window displaying drive information and selecting a different drive from the Drive Parameter Editor window.

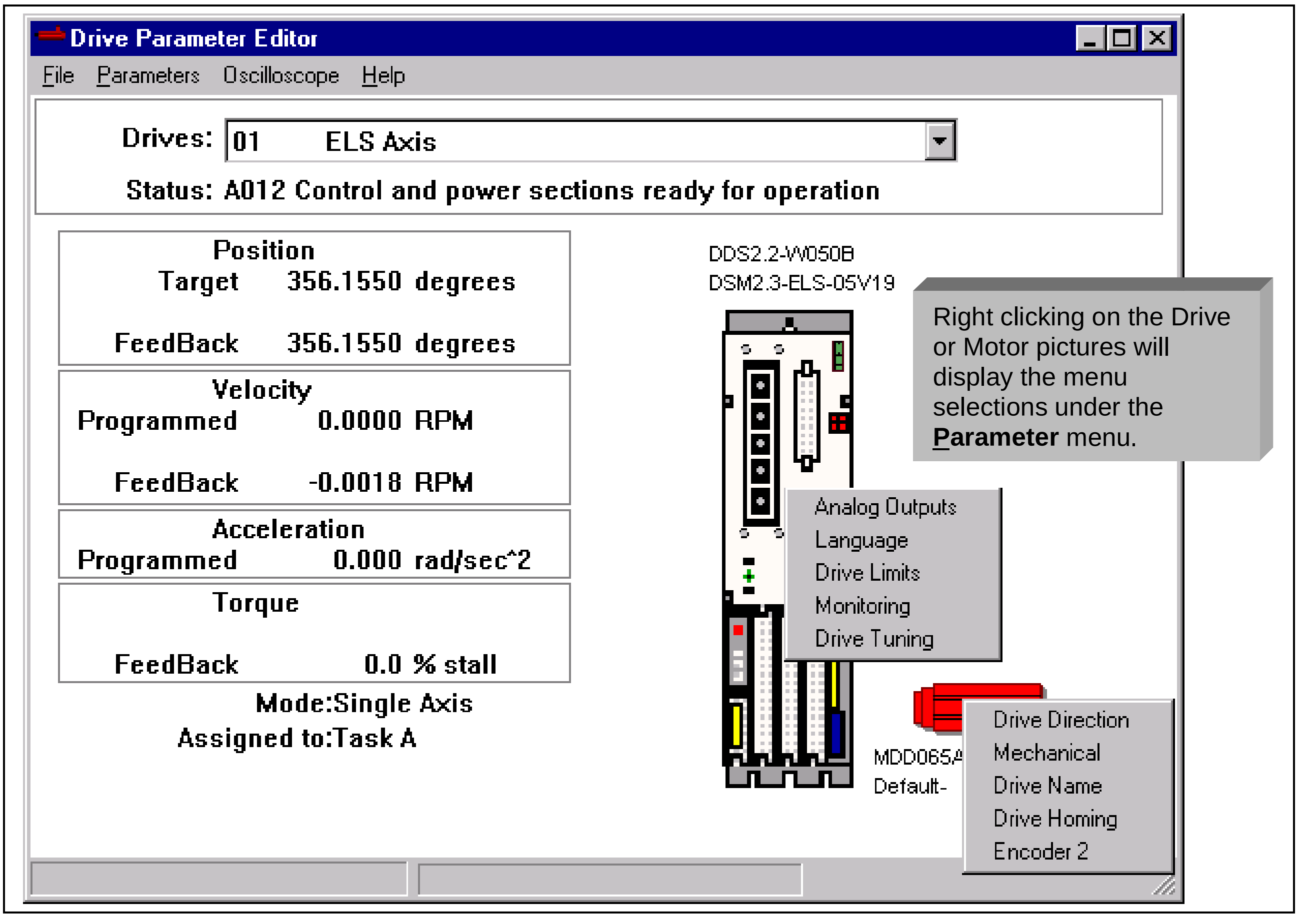


Fig. 8-1: Drive Parameter Editor

8.2 File Menu

Load Default Parameters

The Load Default Parameter selection initiates a command in the drive (P-0-4094, C800 Command Base-parameter load) to load a default set of parameters preconfigured by Indramat for the connected motor/drive combination. All drive parameters are cleared and preset with default (initial) values listed in S-0-0192, IDN-list of backup operation data. These default parameters define the basic state of the drive that permits the drive to be switched to a “ready for operation (bb)” mode. This selection enables the user to return an unstable motor/drive combination to its default settings. The system must be in parameter mode (P2) before making this selection.

When selected, VisualMotion will warn as to the overwriting of drive parameters as shown in Fig. 8-2. Selecting “Yes” will issue the command the drive to load its default parameters.

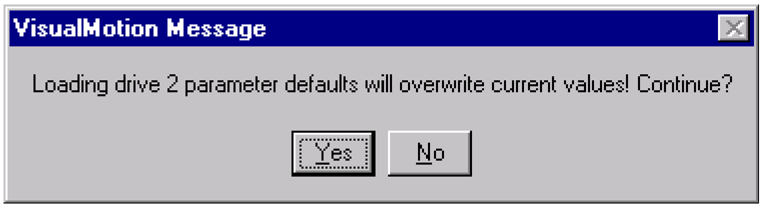


Fig. 8-2: Load Default Parameter Warning

Transfer Parameters

The Drive Parameter Transfer window is used to upload parameters to a file for archiving or viewing. Archived drive parameters can also be downloaded from a file to the control. Downloading of drive parameters requires that the system be switched to parameter mode (P2).

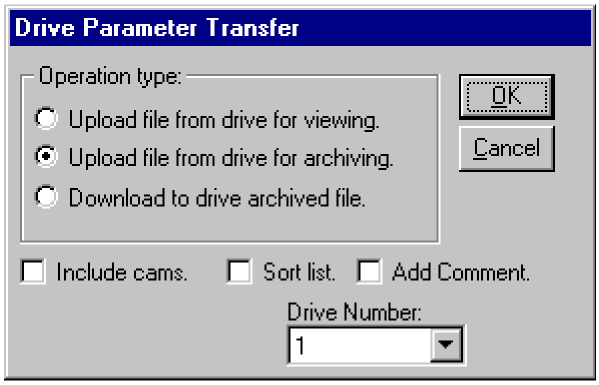


Fig. 8-3: Drive Parameter Transfer

Each drive initially contains a set of default parameters. Once the drive’s parameters are modified for a system, they should be archived and saved to a file for future reference. Select a drive number for the desired operation type. The parameter set for the selected drive connected to the control may be transferred across the SERCOS ring.

Parameters may be uploaded in one of two formats. Uploading for archiving saves the file with a "*.prm" file extension in the **\\Param** directory, with the data in the proper format for downloading to the control. Uploading for viewing saves the file to the same sub-directory as a text file with a "*.txt" extension and may be viewed using Notepad or another

ASCII text editor or file viewer. A text file parameter set uploaded for viewing cannot be downloaded to the control.

8.3 Parameter Menu

The selections under the Parameter menu can be selected by clicking on the Parameter menu and choosing one of the sub-menu items or right clicking on either the drive or motor graphical representation on the main Drive Parameter Editor window.

Analog Outputs

The *Drive n Analog Outputs* window is used to define the signal selection and scaling of the drive's AK1 and AK2 analog outputs. ECODRIVE03, by default, displays the Preset Signals.

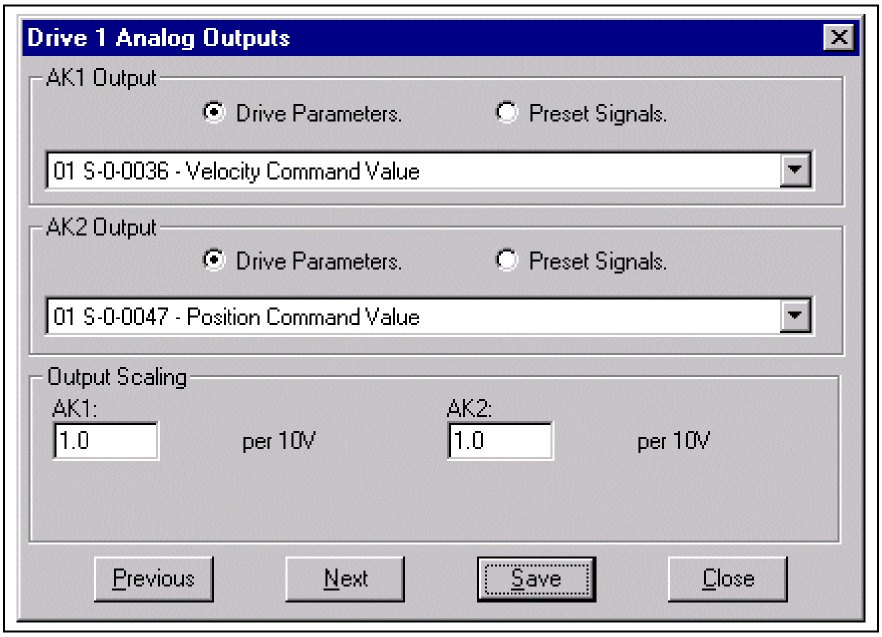


Fig. 8-4: Drive n Analog Output

The selectable AK1 and AK2 analog output signals for DIAX03/04 and ECODRIVE03 are listed in Table 8-1 and Table 8-2 respectively. Individual data boxes allow independent scaling of each output (maximum 10-volt output) to meet the requirements of an external indicator (analog or digital panel meter, etc.)

Preset Signals for AK1 and AK2 Analog Output Signals	**DIAX04**	**ECODRV3**
No output	**X**	**X**
Sine signal from motor encoder	**X**	**X**
Cosine signal from motor encoder	**X**	**X**
Sine signal from external encoder	**X**	**X**
Cosine signal from external encoder	**X**	**X**
Position command value difference between each SERCOS cycle	**X**	**X**
DC bus power	**X**	**X**
Rectified DC bus power	**X**	**X**
Effective current	**X**	**X**
Relative current	**X**	**X**
Thermal loading of power stage (P-0-0141)	**X**	**X**
Motor temperature	**X**	**X**
Magnetism current (Asynchronous Motors)	**X**	**X**
Velocity command at velocity controller	**X**	**X**
Synchronous position command value	**X**	
Synchronous velocity	**X**	
Master axis position fine interpolation	**X**	
Master axis speed in the NC cycle	**X**	

Table 8-1: Preset Signals for AK1 and AK2

Drive Parameters for AK1 and AK2 Analog Output Signals	**DIAX04**	**ECODRV3**
No output	X	X
S-0-0036 – Velocity command value	X	X
S-0-0037 – Additive velocity command value	X	
S-0-0040 – Velocity feedback value	X	X
S-0-0047 – Position command value	X	X
S-0-0048 – Position command value additional	X	X
S-0-0051 – Position feedback value 1 (Ext. feedback)	X	X
S-0-0053 – position feedback value 2 (Ext. feedback)	X	X
S-0-0080 – Torque / Force Command	X	X
S-0-0084 – Torque / Force feedback value	X	X
S-0-0134 – Master control word	X	X
S-0-0135 – Drive status word	X	X
S-0-0182 – Manufacturer Class 3 Diagnostics	X	X
S-0-0189 – Following error	X	X
S-0-0258 – Target position	X	
S-0-0259 – Positioning velocity	X	
S-0-0347 – Speed deviation	X	X
S-0-0383 – Motor temperature	X	X
S-0-0403 – Position feedback value status	X	X
P-0-0052 – Position value feedback 3		X
P-0-0053 – Master drive position		X
P-0-0083 – Gear ratio fine adjust	X	
P-0-0098 – Max. model deviation	X	X
P-0-0141 – Thermal drive load	X	X
P-0-4044 – Braking resistor load		X

Table 8-2: Drive Parameters for AK1 and AK2

After AK1 and AK2 are selected, click on the *Save* button to download the signal selections and scaling factors to the selected drive through the GPP control and across the SERCOS ring. For an explanation of each parameter listed in the tables above, refer to the respective drive manuals.

Drive Direction

The Drive Direction window is used for viewing and setting a drive's directional parameters. These parameters invert the direction of the commands to the drive. For example, a 5-inch move will move 5 inches negative if the Position Command is set to the reverse direction.

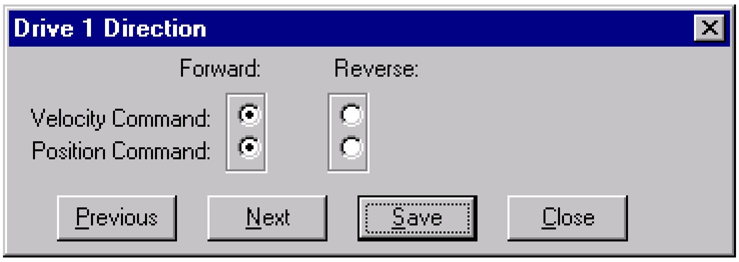


Fig. 8-5: Drive Direction

The drive currently being displayed will be numbered at the top of the window.

To change a drives settings, switch to parameter mode, then select the direction buttons and press the *Save* button. *Refer to the respective drive's documentation for an explanation of parameters S-0-0043 and S-0-0055*.

Drive Name

The Drive Name window is used for naming a drive. The default name is the axis number; however, a custom name can be assigned and saved to any of the drives on the SERCOS ring.

Fig. 8-6: Drive Name

Drive Monitoring

Selecting Drive Monitoring from the Parameters menu opens the Drive Monitoring window and updates the information in Fig. 8-7 for the current drive selected.

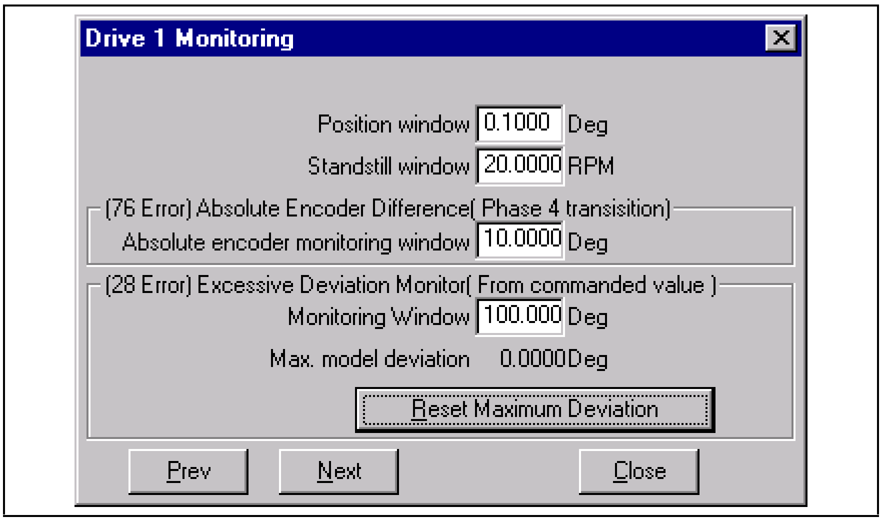


Fig. 8-7: Drive Monitoring

Position window (S-0-0057) sets the tolerance distance used to determine if it's in position.

Standstill window (S-0-0124) sets the velocity to determine if it's at a standstill.

Absolute Encoder Difference (P-0-0097) sets the maximum distance the motor can move when powered down, without causing an error 76 on power up to phase 4.

Monitoring window (S-0-0159) sets the maximum position unit (or percent for some drives) from the command value before the drive issues an error 28.

The current **Maximum Model Deviation** from the command value is displayed in position units (or a percent for some drives). This value can be reset using the *Reset Maximum Deviation* button.

Drive Tuning

Selecting Drive Tuning from the Parameters menu opens the Drive Tuning window for the currently active drive. The adjustments within the Velocity loop are related to a machine's performance. The Current Loop adjustments are set according to the respective motor/drive combination and should not be altered from their initial default setting. If modifications are required, double clicking on any of the boxes in Fig. 8-8 will open a window where values can be changed and saved.

Clicking on the *Load Defaults* button will load default parameter values for all drive loops. The control must be in Parameter Mode. The default values assume a 1:1 ratio of load inertia to motor inertia.

For further information on tuning Indramat drives and tuning parameters, *refer to the respective drive manual.*

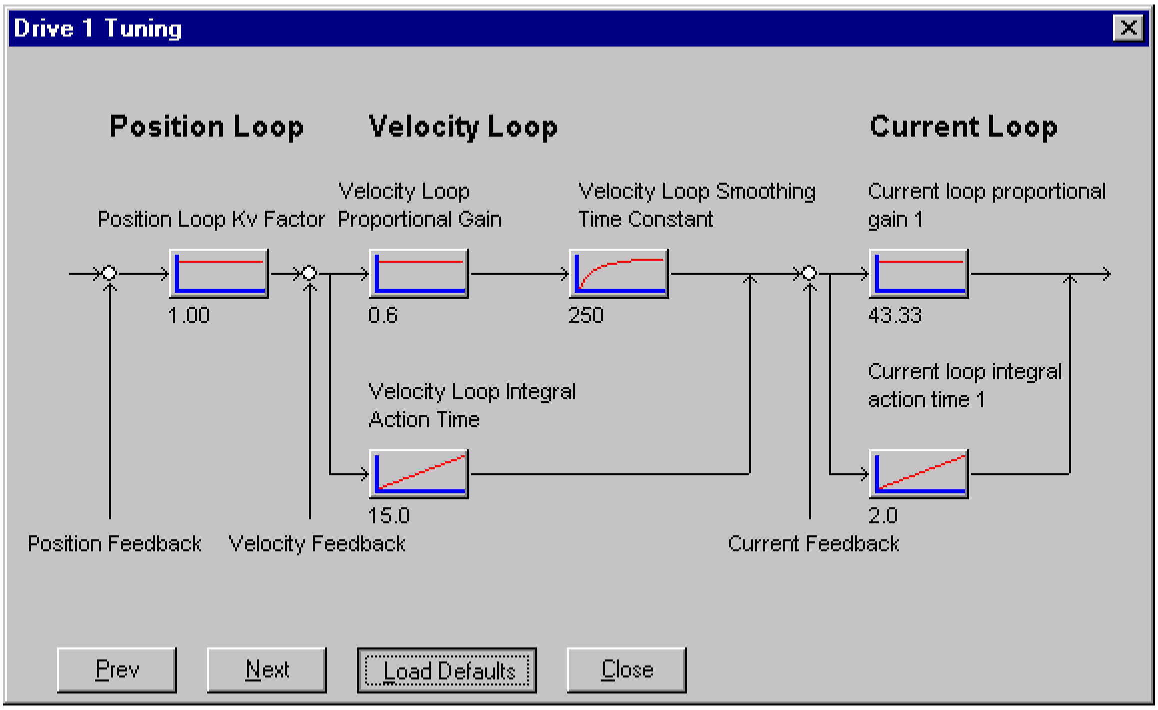


Fig. 8-8: Drive Tuning

Position Loop

The Position Loop **Kv Factor** (SERCOS parameter S-0-0104) data entry box adjusts the proportional gain of the Position Loop. This parameter value may be set from 0 to 655.35.

Velocity Loop

The Velocity Loop **Proportional Gain** data entry box adjusts the gain of the loop feedback path (SERCOS parameter S-0-0100). The gain is initially adjusted by the drive/motor combination for a 1:1 load/motor inertia ratio. This parameter value may be set from 0 to 6553.5

The **Smoothing Time Constant** data box sets a low-pass filter that limits the bandwidth of the feedback loop and reduces digital quantization effects (Indramat parameter P-0-0004). The time constant is set in microseconds, any entry under 250µs switches off filtering.

The Velocity Loop **Integral Action Time** data entry box also sets a low pass filter time constant integrating the velocity loop feedback signal (SERCOS parameter S-0-0101). This parameter is typically used to adjust the loop response time, matching the load to motor and reducing overshoot that may result from a rapid (step) change. This filter has a lower frequency breakpoint than the Smoothing/Roll-off value.

Current Loop

The Current Regulator Proportional Gain (S-0-0106) and Integral Action Time (S-0-0107) adjustments are used for the initial tuning of respective motor/drive combinations. This adjustment should not be changed once it is set for a specific system.

Drive Limits

The Drive n Limitation window is used for enabling and setting hardware and software position limits. Bipolar limit values for each drive can also be modified and saved. Positive and Negative Software **Travel Limits** set floating point values for the drive’s Positive (S-0-0049) and Negative (S-0-0050) parameters. The Travel Limits are not active unless Enabled is checked.

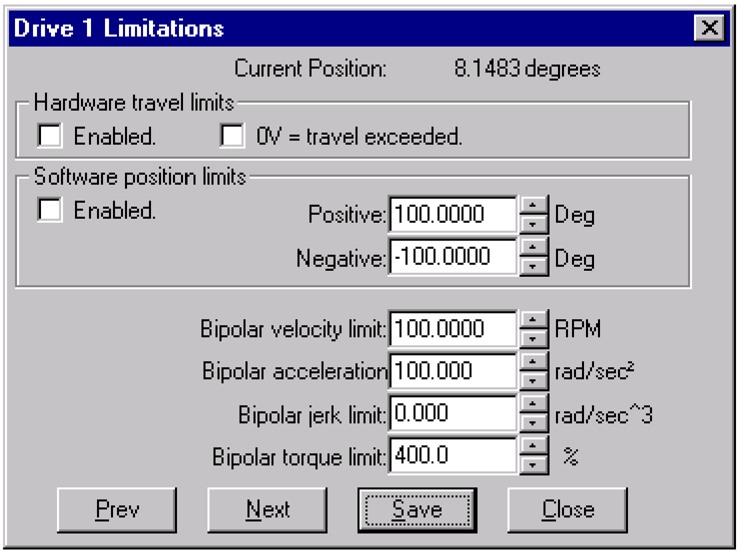


Fig. 8-9: Drive Limits

The **bipolar velocity limit** value (S-0-0091) determines the maximum allowable speed in either direction. If the velocity limit value is exceeded, the drive responds by setting the message "ncommand > nlimit" in Class 3 Diagnostics (IDN S-0-0013).

The **bipolar acceleration** parameter (S-0-0138) reduces the maximum acceleration ability of the drive symmetrically around 0, to the programmed value in both directions.

The **bipolar jerk limit** value (S-0-0349) determines the maximum allowable jerk in either direction.

The **bipolar torque limit** value (S-0-0092) determines the maximum allowable torque in either direction. If the torque limit value is exceeded, the drive sets the message "T > Tlimit" in Class 3 Diagnostics (S-0-0013).

Drive Reference

When the Drive Reference window is opened the drive's feedback type parameter is read and either the single or the multi-turn encoder window is displayed.

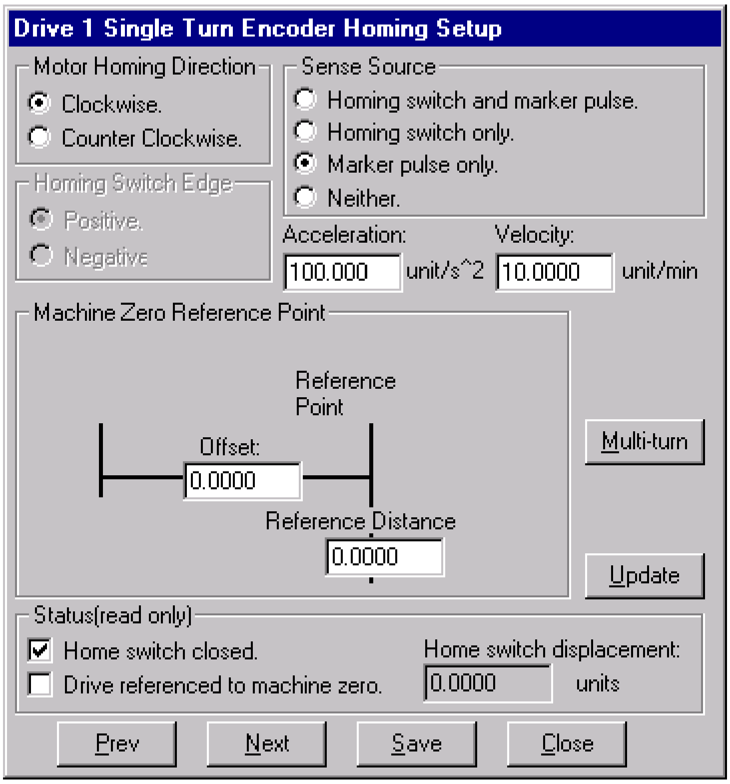


Fig. 8-10: Drive Reference

Homing Direction

The homing direction of the motor is selected in either clockwise or counter-clockwise direction (facing the motor shaft).

Sense Source

The encoder of the motor is considered to be at the home position if the set option is satisfied. The Neither selection disables the homing reference source. An initial acceleration and velocity for homing can also be specified.

Machine Zero Reference Point

In preparation

Status (read only)

In preparation

Multi-turn Encoder

When a drive is selected containing a motor with an absolute encoder, the *Multi-turn Encoder Homing Reference* window in Fig. 8-11 is automatically launched.

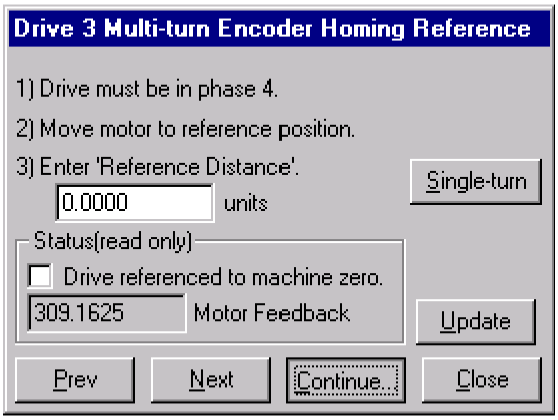


Fig. 8-11: Multi-turn Encoder Homing Reference

This window is used to enter a *Reference Distance* for machine zero. Once this distance is entered, click on the *Continue* button and a message window will open informing you that "*All motion for this axis will be referenced to this new position*". Press *OK* to accept, or *Cancel* to Abort.

After successful completion of this procedure, the checkbox 'Drive referenced to machine zero' will be checked.

Encoder 2

The Encoder 2 setup displays three consecutive windows that are used for configuring an external encoder for each drive in a system. Before an external encoder can be setup, the system must placed in parameter mode. Each drive having an external encoder requiring setup must first be selected from the drop-down list in the Drive Parameter Editor main window.

Note: The three Encoder 2 Setup windows contain a *Next* and *Previous* button for moving between the setup windows and not for selecting the next drive as used in other VisualMotion windows.

Select one the following **Function** types in Fig. 8-12 and click on the *Save* button before proceeding to the next screen. The available function types are as follows:

- Additional load side feedback.
- ELS Master.
- Single load side feedback.
- Measuring wheel.
- Spindle.

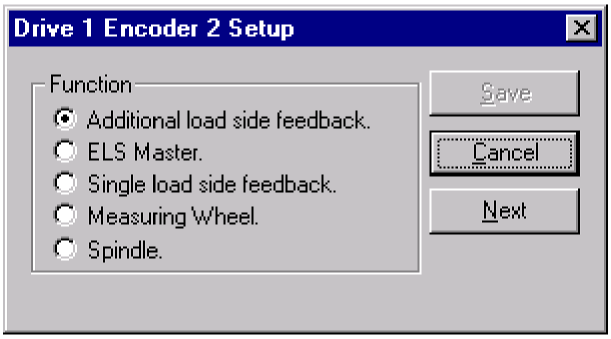


Fig. 8-12: Drive n Encoder 2 Setup

Clicking on the *Next* button will display the second setup window where the Encoder Direction, Application Type and Encoder Type are selected.

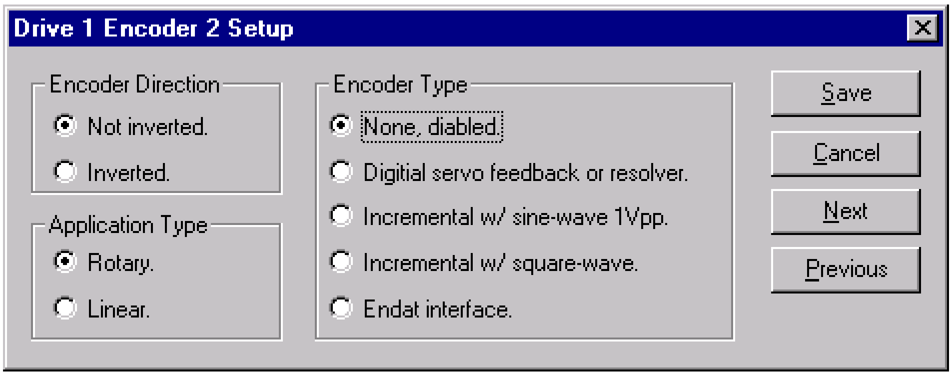


Fig. 8-13: Drive n Encoder 2 Setup (second window)

Encoder Direction sets the rotational direction of the external encoder with no relationship to the motor that is attached to the same drive. The rotational direction is viewed while facing the encoder's shaft.

- ***Not inverted*** is a clockwise rotation.
- ***Inverted*** is a counter clockwise rotation.

Application Type identifies the application as either rotary or linear.

Encoder Type identifies the style of the external encoder being used.

After the selections are made, click on the *Save* button before continuing to the *Next* window. Clicking on the *Previous* button will backup one window.

The last setup window in Fig. 8-14 is used for setting feedback resolution, filter time constant and monitoring window.

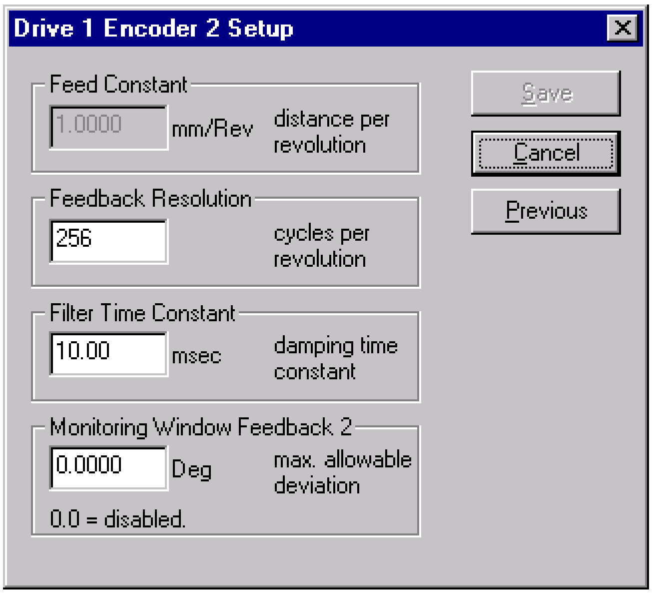


Fig. 8-14: Drive n Encoder 2 Setup (last window)

Encoder 2 used as a measuring wheel

The measuring wheel command is supported by the following drives and firmware versions:

- ECODRIVE03 using SGP-01V13 firmware.
- DIAX03/04 using ELS-05V11 firmware.

Measuring wheel example

Roll feed applications use a drive's primary motor to move sheet material (through the use of motor-driven rollers) off of a larger roll for processing further down the line. Due to slip or lag from the motor-driven rollers, the encoder on the motor is not suitable for measuring material lengths. A secondary (external) encoder can be configured as a measuring wheel to provide a more precise position value from a remote location on the machine. The torque to turn the measuring wheel is minimal, so the slip is negligible.

Note: The measuring wheel must remain in constant contact with the material or the position control loop will not be properly closed. When contact with the material is no longer possible, the position feedback must be switched back to the motor encoder.

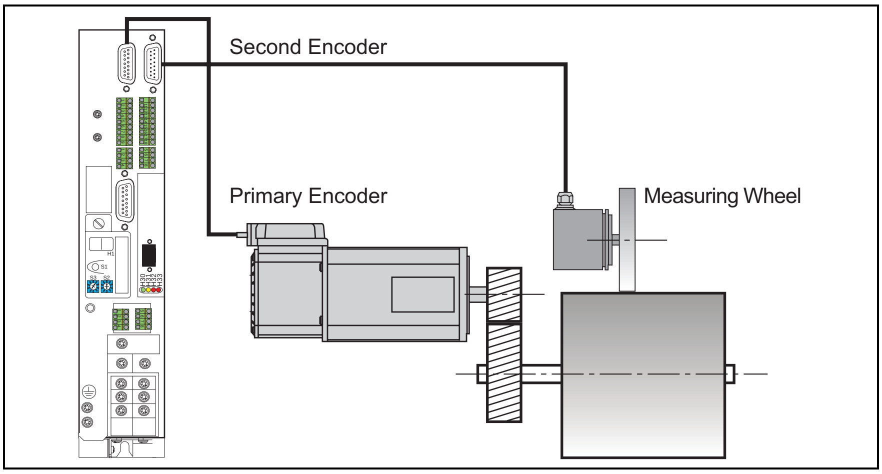


Fig. 8-15: Roll feed using a measuring wheel

Encoder 2 Setup

Using the Encoder 2 setup windows, select Measuring Wheel as a **Function** type in Fig. 8-12 and click on the *Save* button before proceeding to the next window. When Measuring Wheel is selected and saved, a “3” is written to parameter ***P-0-0185, Function of encoder 2***.

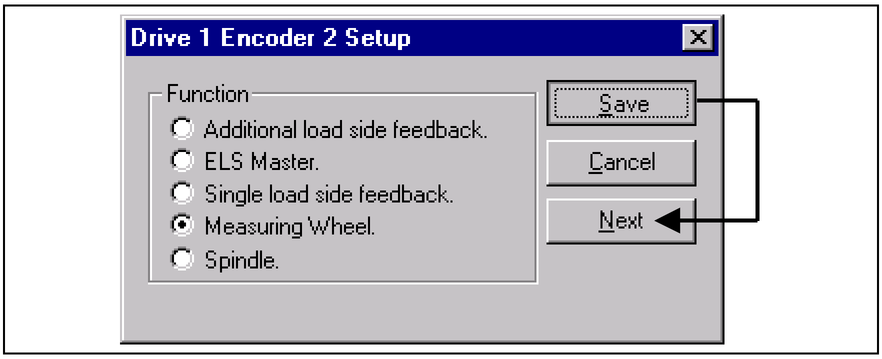


Fig. 8-12: Drive n Encoder 2 Setup

Click on the *Next* button. Select the encoder's direction and type.

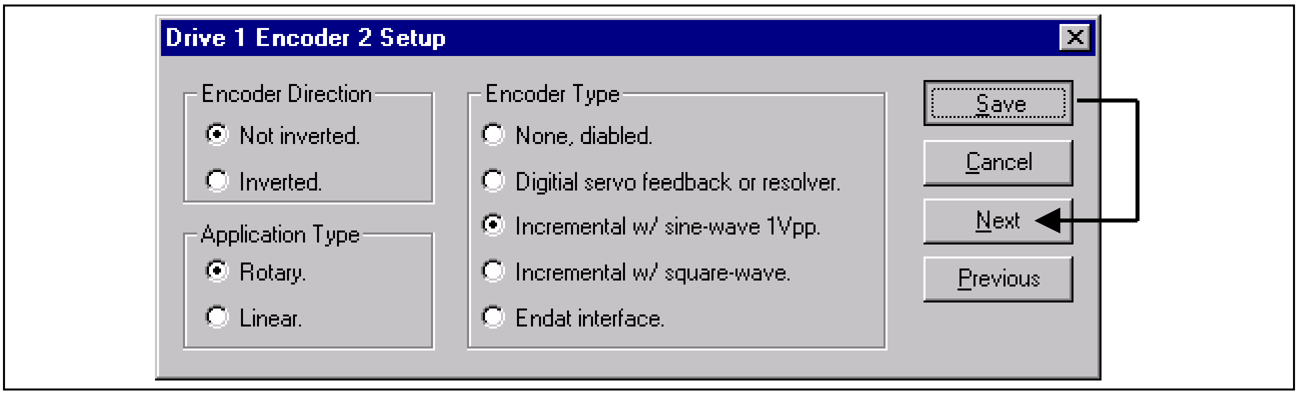


Fig. 8-13: Drive n Encoder 2 Setup (second window)

- **Encoder Direction** sets the rotational direction of the external encoder with no relationship to the motor attached to the same drive. The rotational direction is viewed while facing the encoder’s shaft.
  - ***Not inverted*** is a clockwise rotation.
  - ***Inverted*** is a counter clockwise rotation.

- **Application Type** identifies the application as either rotary or linear.

Note: Application type should be set to rotary. Linear scales have a defined range of movement. For this reason, they are not typically applied to applications that require an infinite range of motion, such as roll feed.

- **Encoder Type** (P-0-0075, Feedback 2 type) identifies the style of the secondary encoder being used.

After the selections are made, click on the *Save* button before continuing to the *Next* window. The last window in the Encoder 2 setup is used to fine-tune the accuracy of the measuring wheel.

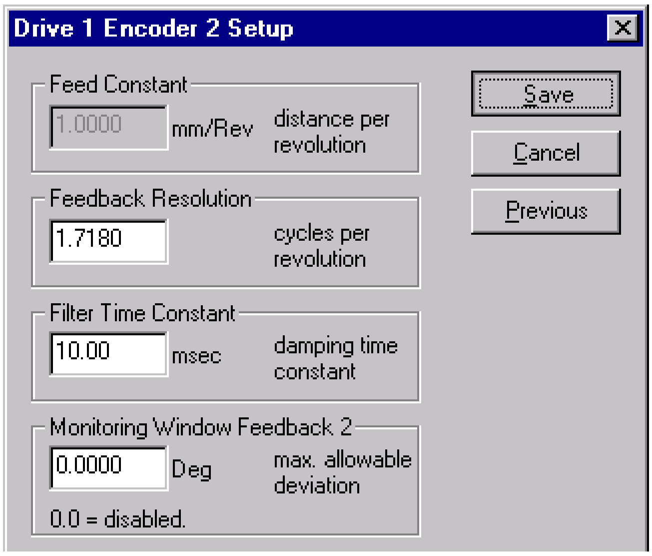


Fig. 8-14: Drive n Encoder 2 Setup (last window)

- **Feed Constant** is grayed out
- **Feedback Resolution** is used to account for diameter difference when coupling to a larger measuring contact wheel. The value entered in this field is the quotient of the equation in the figure below.

$$\frac{\text{Circumference of measuring wheel } (2\Pi r)}{\text{Line counts per revolution of encoder}} = \text{Feedback Resolution}$$

Example:
An encoder with a line counts per rev.
of 256 is coupled to a measuring
wheel with a radius of 70mm

$$\frac{2 * \Pi * 70 \text{ mm}}{256 \text{ counts/rev}} = 1.7180 \text{ mm/rev}$$

Fig. 8-16: Feedback Resolution value

- **Filter Time Constant** is used to filter out negative effects resulting from poor coupling of encoder 2.
- **Monitoring Window Feedback 2** defines the maximum allowable deviation between motor encoder and secondary (measuring wheel) encoder.

Note: When Encoder 2 is used as a measuring wheel, the monitoring window value must be set to 0.0, otherwise an excessive deviation error will be issued.

Activating the Measuring Wheel

Before the measuring wheel can be activated…

- the encoder must be configured as a measuring wheel using VisualMotion's Encoder 2 Setup.
- the material must be in the feed roll and in contact with the material to ensure stability.

Position control is switched from the motor encoder to the measuring wheel by changing the value of parameter ***P-0-0220, D800 Command Measuring wheel Operation Mode,*** as stated in Table 8-3.

Value of Parameter P-0-0220	Description
0	Switches position control from measuring wheel to motor encoder.
3	Switches position control from motor encoder to measuring wheel.

Table 8-3: Parameter P-0-0220 settings

When a value of "3" is entered into P-0-0220, the position control is switched to the measuring wheel. When a value of "0" is entered into P-0-0220, the motor's position feedback is set to the same value as the measuring wheel and position control is switched back to the motor encoder.

Using VisualMotion to Activate Measuring Wheel

Using a VisualMotion program, a parameter transfer icon can be used to change the value of P-0-0220. Add the parameter transfer icon prior to motion in the program flow and setup the Parameter Transfer window in Fig. 8-17 as shown.

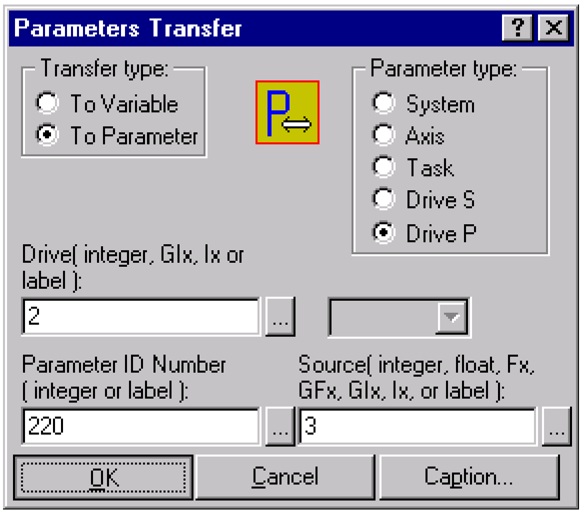


Fig. 8-17: Parameter Transfer

Mechanical

Selecting Mechanical from the Parameters menu opens the *Drive n Mechanicals* window and uploads the current values from the drive. This dialog window allows easy access to several important parameters, which must be set before running any motion programs.

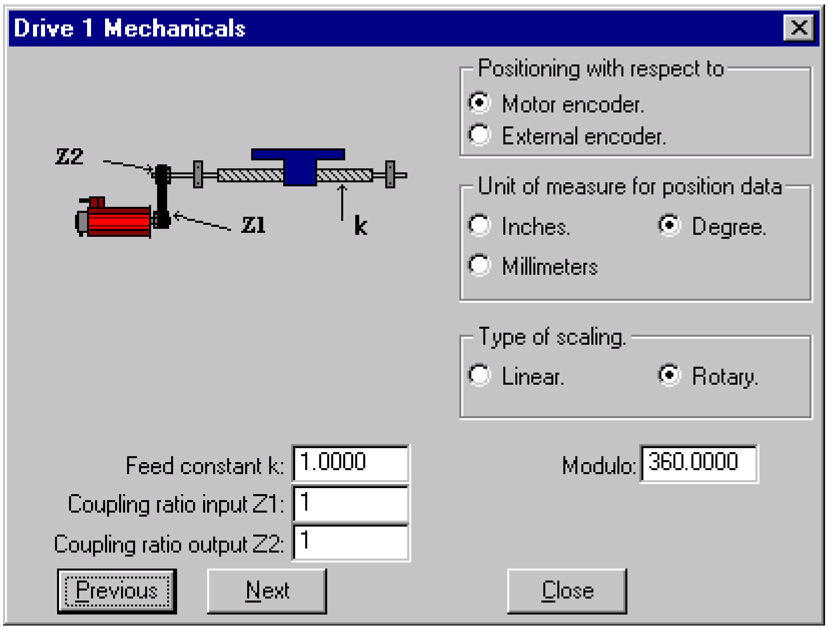


Fig. 8-18: Drive n Mechanicals

Positioning with respect to…

- **Motor encoder** configures the drive to use the motor's encoder to close the position loop and provide cyclic feedback from drive parameter S-0-0051.
- **External encoder** configures the drive to use the connected external encoder to close the position loop and provide cyclic feedback from drive parameter S-0-0053.

The **Units of measure for position data** selection has a choice of inches, millimeters or radians for the system-wide unit of measurement (A-0-0005).

The **Type of scaling** selection can be linear or rotary (A-0-0004 bit 2). When linear is selected, absolute positioning is enabled in the drive. When rotary is selected, position is in degrees, velocity in RPM, and acceleration in radians/sec2.

The **Feed Constant** allows setting the ratio of movement in system units resulting from each revolution of the driven shaft (S-0-00123). For example, a five Threads per Inch ball screw provides 0.200 inch movement per revolution.

Output (Z2) and Input (Z1) Revolutions permit setting the ratio between the motor shaft and driven shaft. Integer values permit preservation of maximum system accuracy with ratios that result in repeating decimals (i.e. 1:3 = 0.333333). These values are set in the drive's Input Revolutions of Load Gear (S-0-0121) and Output Revolutions of Load Gear (S-0-0122) parameters.

The **Modulo** value (S-0-0103) is indicated as a maximum rotational value in which the motor will turn before resetting the position to zero. The default value when operating in modulo mode is 360. (Modulo mode is set in the drive by setting bit 7 of IDN S-0-0076, Scaling Options for Position Data).

Overview

Selecting Overview from the Setup menu opens the Parameter Overview window. This window is used to view and modify existing Control, Drive, Task and Axis parameters. The Parameter Overview window is arranged in a series of tabs. Selecting the Control tab will upload all control system parameters. Selecting the Drive or Axis tabs will display multiple tabs matching the number of drives in the system. Selecting the Task tab will display all 4 VisualMotion Tasks A-D. Menu commands are displayed by selecting a parameter and right-clicking the mouse.

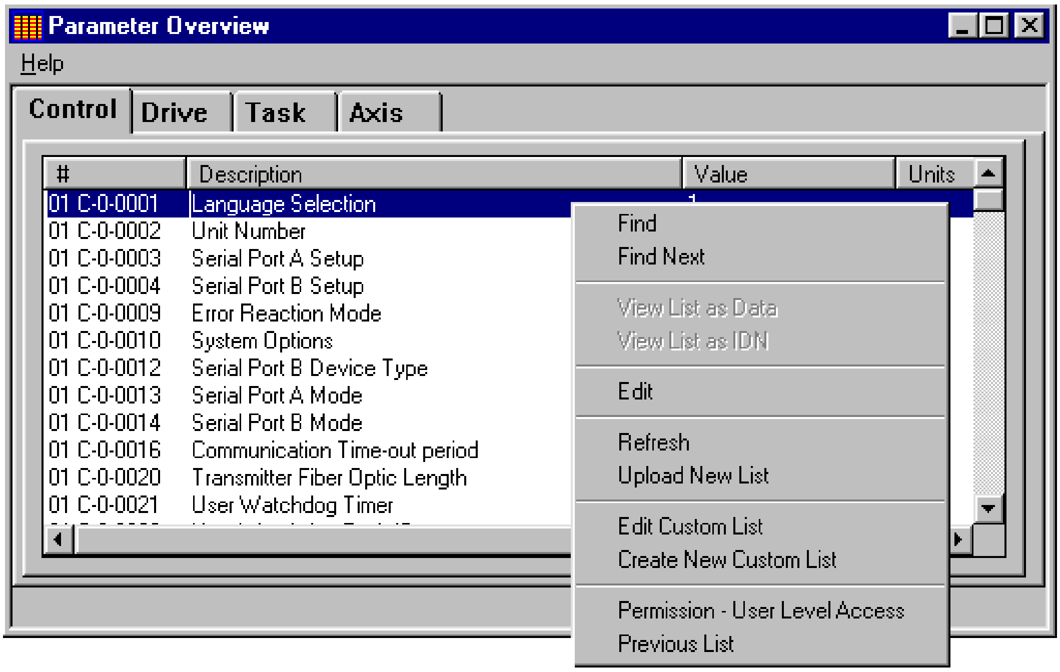


Fig. 8-19: Parameter Overview Screen

After the selected list has been loaded, you may scroll the list by clicking on the list scroll bar's up and down arrowheads, or clicking and dragging the scroll button.

Editing a Parameter

A parameter can be edited by double-clicking the desired parameter from the list, or by right-clicking the mouse and selecting Edit. The Parameter Editor window will open allowing you to change the parameter value and Modify the parameter by downloading it to the control or drive. Context sensitive help can be called out by pressing the F1 key on the keyboard.

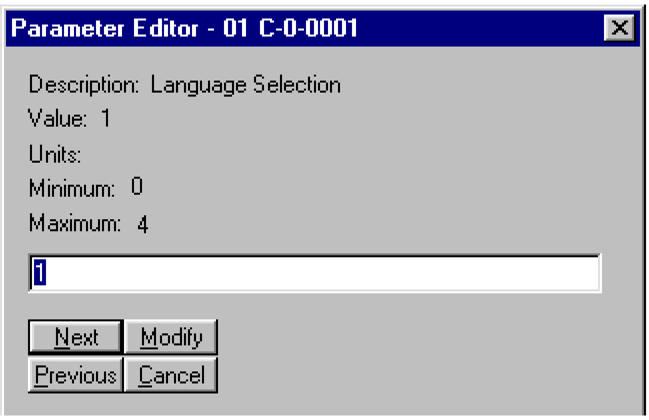


Fig. 8-20: Parameter Editor

Displaying a List

Parameter lists are displayed in red and therefore can be easily found for any set of parameters. To display a list for a Parameter, use the scroll button, click and hold, and locate the desired parameter list. Releasing the scroll button will refresh the current selection and display any parameter list in red. Afterwards, double-click on the desired parameter list and VisualMotion will automatically display the list as either Data or IDN. This can also be accomplished by selecting the parameter list, right-clicking and selecting either ***View List as Data*** or ***View List as IDN***. To return to the main parameter window, select Refresh from the menu selections.

View List as Data

Viewing a parameter list as data will display only the parameter numbers with no other description.

Example: C-0-3000 I/O Mapper Program

1-1=100-1

1-3=100-7

View List as IDN

Viewing a parameter list as IDN (**ID**entification **N**umber) will display the parameters in the same format as the main window.

Example:

01 C-0-001 Language Selection 1

01 C-0-002 Unit Number 0

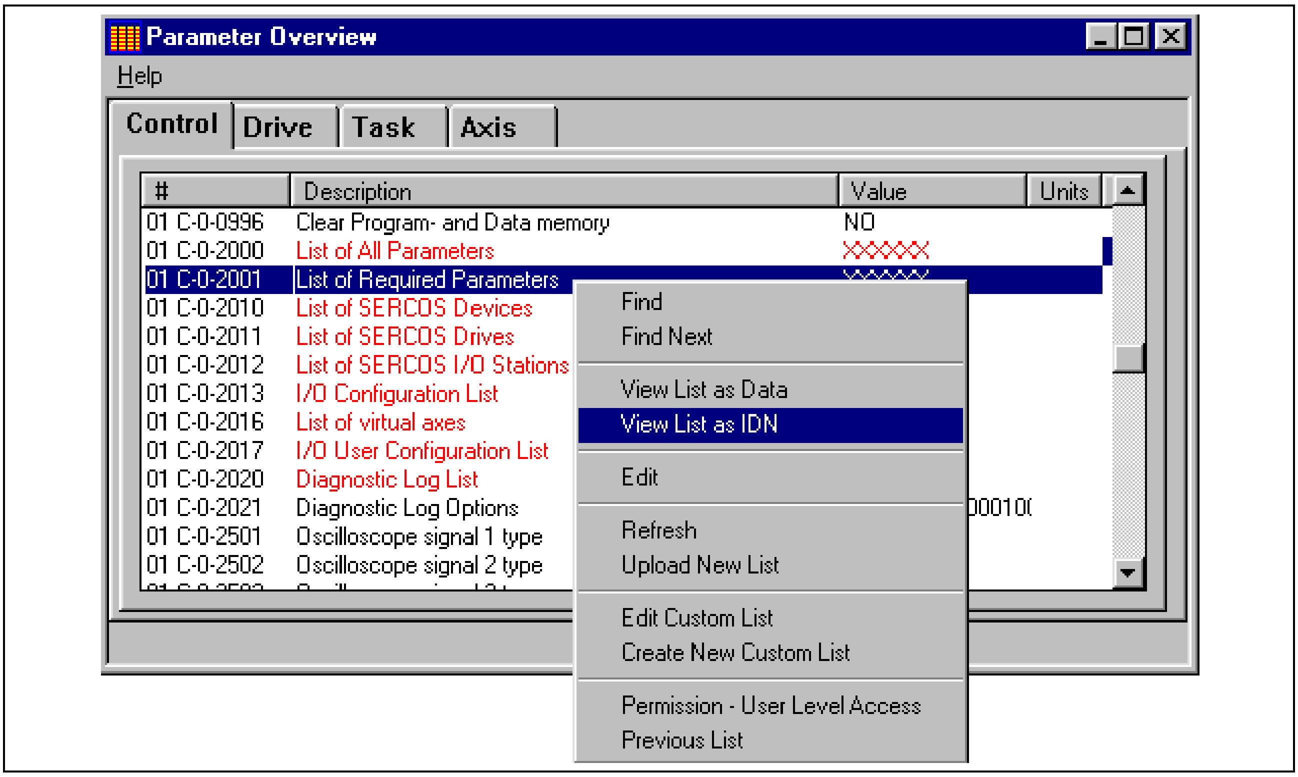


Fig. 8-21: Viewing List

Create a Custom List

In addition to uploading all the parameters of a set (i.e., all drive or task parameters, etc.) you can create a custom set of parameters by right clicking and selecting ***Create New Custom List***.

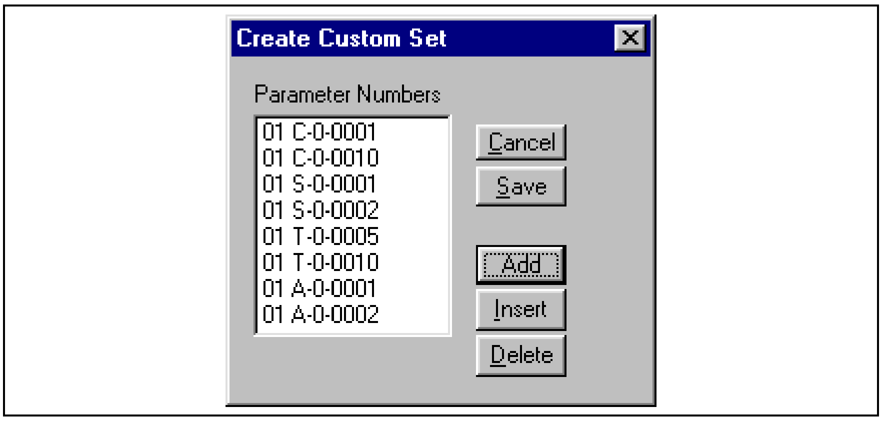


Fig. 8-22: Create Custom Set

The Create Custom Set window remains open and on top, allowing the user to add parameters from any of the four main tabs and selecting the Add button. Only one parameter may be added at a time. Selecting one of the parameters in the custom list, then clicking Delete removes the item from the custom set. Once the set is complete, select the Save button and a second window will open allowing the user to name the custom set and password protect the set. The password entry is required for saving the Custom Set. This password will be used in a future End User Diagnostic Tool currently under development.

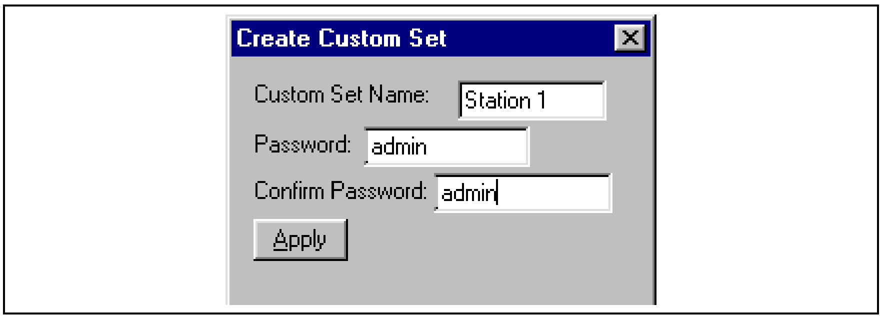


Fig. 8-23: Create Custom Set Password

A new tab will appear in the Parameter Overview main window named Custom with the newly created tab. From here, the user can view and modify any parameters from within any created custom tab.

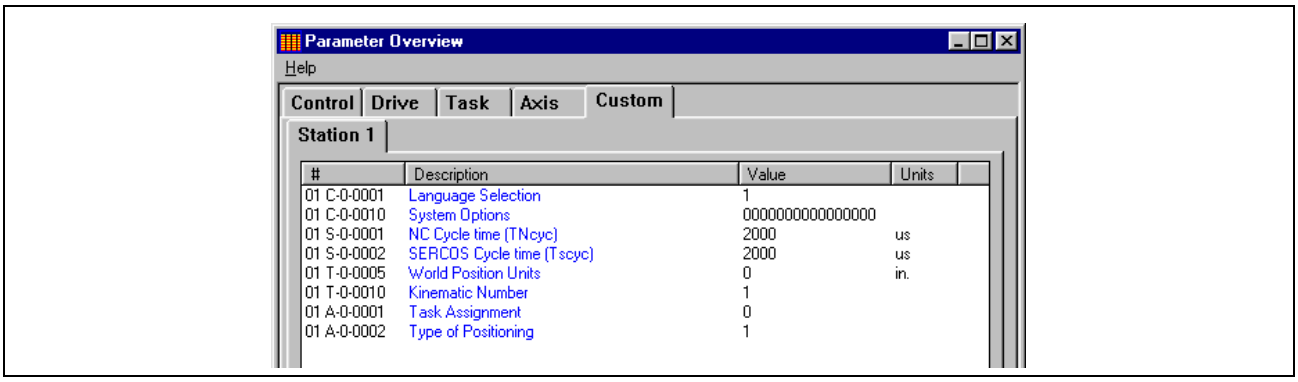


Fig. 8-24: Created Custom Set Tab

Synchronization

Velocity Synchronization

Velocity synchronization is used in printing machines for simple transport feeds. The drive runs with velocity synchronous to the master axis. The track speed at the circumference of the transport feed or the winder is preset by an electronic gear. A gear ratio fine adjust is available for use as a tension control. The gear ratio fine adjustment can be configured as cyclical data, permitting velocity changes at the slave axis while the master axis speed is constant. Velocity can also be changed by modifying the master axis gear parameter.

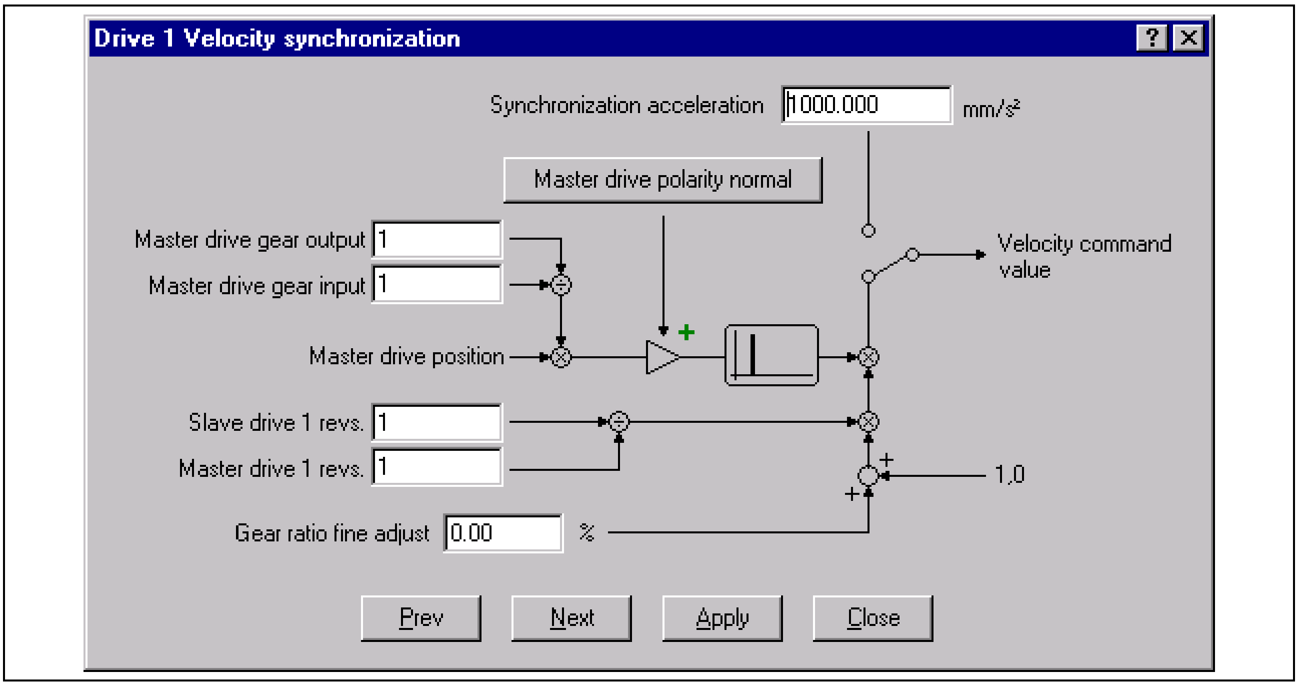


Fig. 8-25: Drive n Velocity Synchronization

Synchronization Acceleration (P-0-0142)

Maximum acceleration or deceleration that is used to dynamically synchronize the slave's output position to that of the master input position (ramp up and lock on). Acceleration and delay is performed with the synchronization acceleration in the second step of dynamic synchronization (ramp up and lock on). This affects device-operating modes with underlying position control. When running an angle offset, the slave drive is accelerated or decelerated with the synchronization acceleration.

Master Drive Polarity (P-0-0108)

This parameter inverts master drive position polarity. This means that an inverted, electronic gearbox can be implemented. Click on the button to change between Master drive polarity normal (positive) and Master drive polarity reversed (negative).

Master Drive Gear Output (P-0-0157)

This parameter together with ***Master Drive Gear Input (P-0-0156***), determine the master drive gear ratio. The output ratio of these two parameters is multiplied with the master drive position before it is sent to the drive. This 16 bit word can be modified in phase 4.

Slave Drive n Revs (S-0-0237)
Master Drive n Revs. (S-0-0236)

The output ratio of these two parameters is multiplied with the master drive position before it is sent to the drive. This is a 32 bit word that can only be modified in phase 2.

Gear Ratio Fine Adjust

The output ratio of the electronic gearbox is changed by this percentage value. This parameter is only active in velocity synchronization mode and is typically used as a tension control.

Phase Synchronization

Phase synchronization is used for machining processes that require an absolute phase synchronization of the drive's output position to the master axis input position (e.g., printing, punching or perforating in printing machines). When this mode is activated, the drive will either accelerate or decelerate to match the master's velocity. Then, dynamic synchronization is performed to match the position of the slave drive to that of the master's position set in the control.

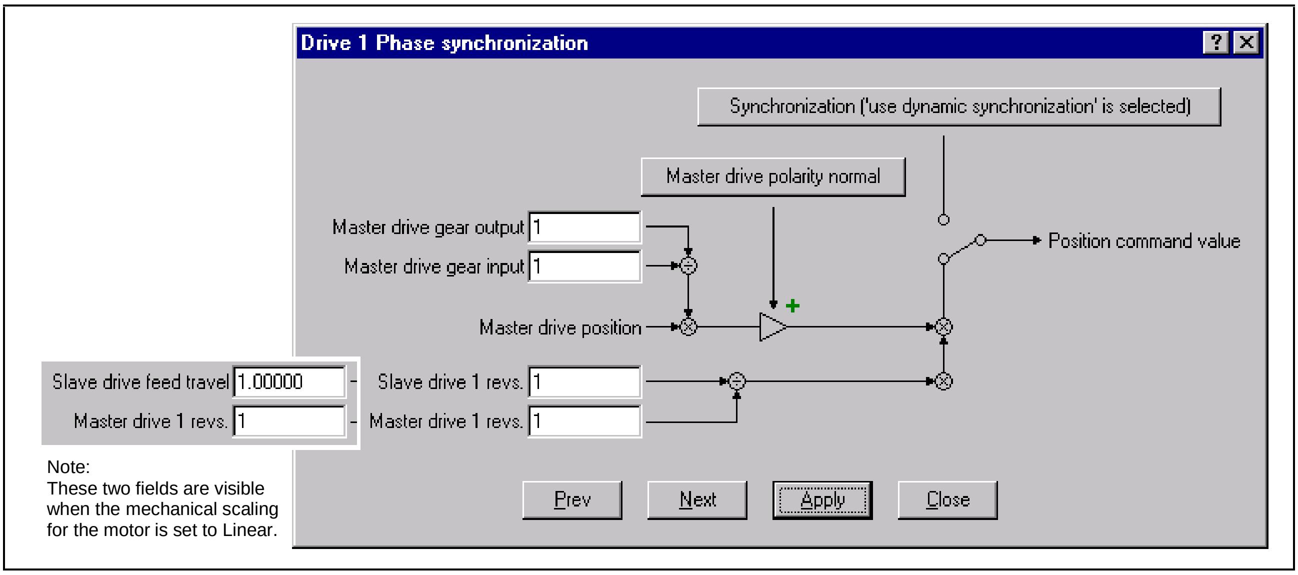


Fig. 8-26: Drive n Phase Synchronization

Master Drive Polarity (P-0-0108)

This parameter inverts master drive position polarity. This means that an inverted, electronic gearbox can be implemented. Click on the button to change between Master drive polarity normal (positive) and Master drive polarity reversed (negative).

Master Drive Gear Output (P-0-0157)

This parameter together with ***Master Drive Gear Input (P-0-0156***) determines the master drive gear ratio. The output ratio of these two parameters is multiplied with the master drive position before it is sent to the drive. This 16 bit word can be modified in phase 4.

Slave Drive n Revs (S-0-0237)
Master Drive n Revs. (S-0-0236)

The output ratio of these two parameters is multiplied with the master drive position before it is sent to the drive. This 32 bit word can only be modified in phase 2.

Slave Drive Feed Travel (P-0-0159)

During linear angle synchronization, the slave axis performs one feed per revolution of the master axis. Parameter P-0-0159, Slave drive feed travel, together with the parameter S-0-0236, Master drive 1 revs., determines the distance to go per revolution of the master axis. This parameter is visible when the mechanical scaling for the motor is set to linear under ***Parameters ⇒ Mechanical***.

The following parameter values are found under the Synchronization window in Fig. 8-27: Synchronization Window and are used to fine adjust the synchronization between the position command value (slave drive output position) to the master drive axis input position.

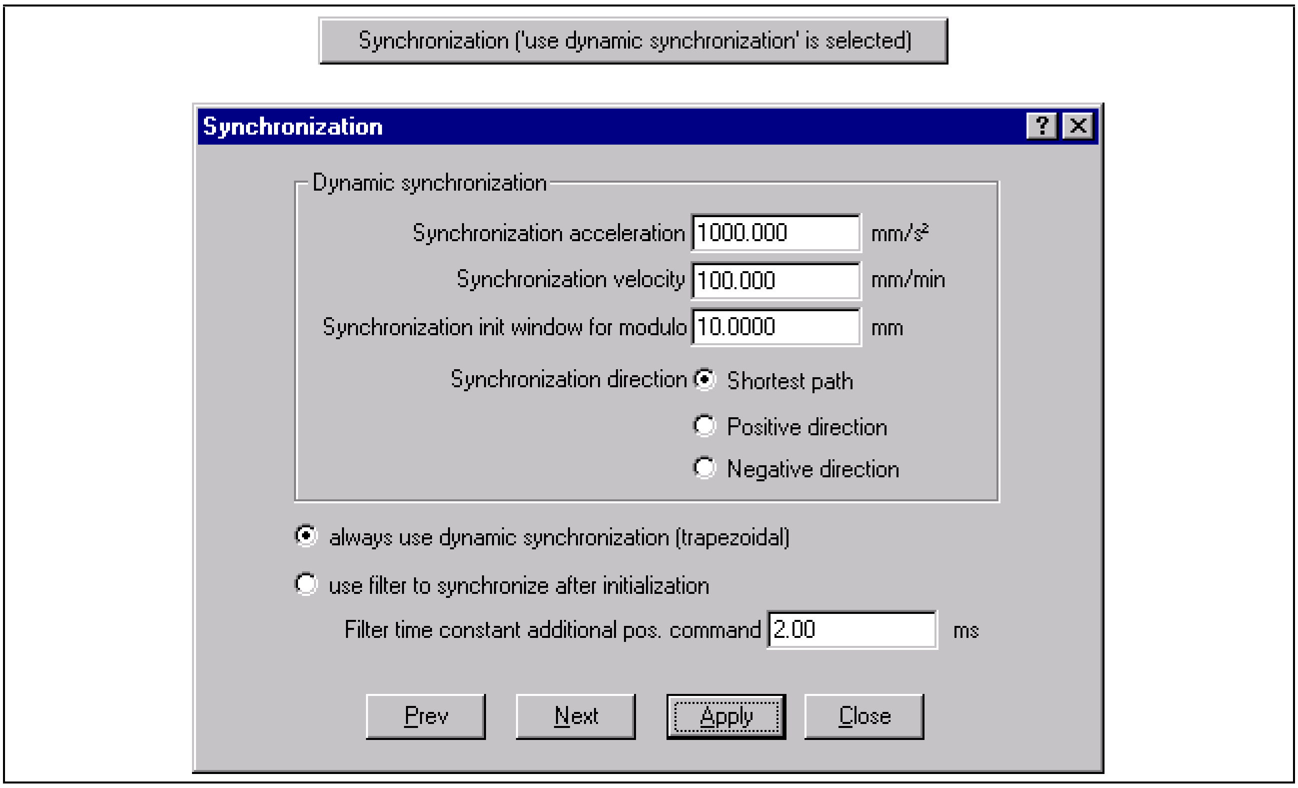


Fig. 8-27: Synchronization Window

Synchronization Acceleration (P-0-0142)

Maximum acceleration or deceleration that is used to dynamically synchronize the slave’s output position to that of the master input position (ramp up and lock on). Acceleration and delay is performed with the synchronization acceleration in the second step of dynamic synchronization (ramp up and lock on). This affects device-operating modes with underlying position control. When running an angle offset, the slave drive is accelerated or decelerated with the synchronization acceleration.

Synchronization Velocity (P-0-0143)

The maximum velocity used for dynamic synchronization.

Synchronization Init Window for Modulo (P-0-0151)

The second step in dynamic synchronization (ramp up and lock on) establishes a path that must be crossed to reach absolute synchronization. If the position difference between slave and master exceeds "synchronization window in modulo format P-0-0151", then the synchronization direction is determined by parameter "synchronization direction" (P-0-0154). If the position difference is greater than that set in P-0-0151, then the selection in P-0-0154 "synchronization direction" is used.

Synchronization Direction (P-0-0154)

Synchronization will be perform in the direction specified by P-0-0154 when the synchronization position difference is greater than P-0-0151. The following direction paths are available:

- Shortest path
- Positive direction
- Negative direction

Synchronization Mode (P-0-0155)

The drive will start the dynamic synchronization automatically after one of the following operating modes is activated:

- phase synchronization
- cam shaft
- pattern transmission

The S-0-0047 Position Command Values, will be generated by the drive until the absolute synchronization (S-0-0047 = XSynch + S-0-0048) is reached. The P-0-0142, Synchronization Acceleration, and P-0-0143, Synchronization Velocity, will be taken into consideration.

The following synchronization modes will then be examined:

Always use dynamic synchronization (trapezoidal)

If synchronization mode 0 is set, a path will be created after every change of the position command value based on the following (phase adjusting) equation:

Path = XSynch + S-0-0048 - S-0-0047

In addition, the path will be taken with regard to the synchronization acceleration and velocity.

Use filter to synchronize after initialization

If synchronization mode 1 is set, parameters P-0-0142 and P-0-0143 will be inoperative after absolute synchronization is reached. The following changes of the S-0-0048, Position Command Value Additional, will then be smoothed through a filter of the first order. The time constant for the filter will be set by parameter P-0-0060, Filter Time Constant Additional Position Command.

Filter Time Constant Additional Position (P-0-0060)

If P-0-0155 is set to "Always use dynamic synchronization (trapezoidal)", then dynamic synchronization will be switched off after absolute synchronization is reached for the first time. Changes to the S-0-0048, additional position command value will be smoothed with a filter of the first order. The time constant of the filter can be set with this parameter.

Electronic Cam Shaft

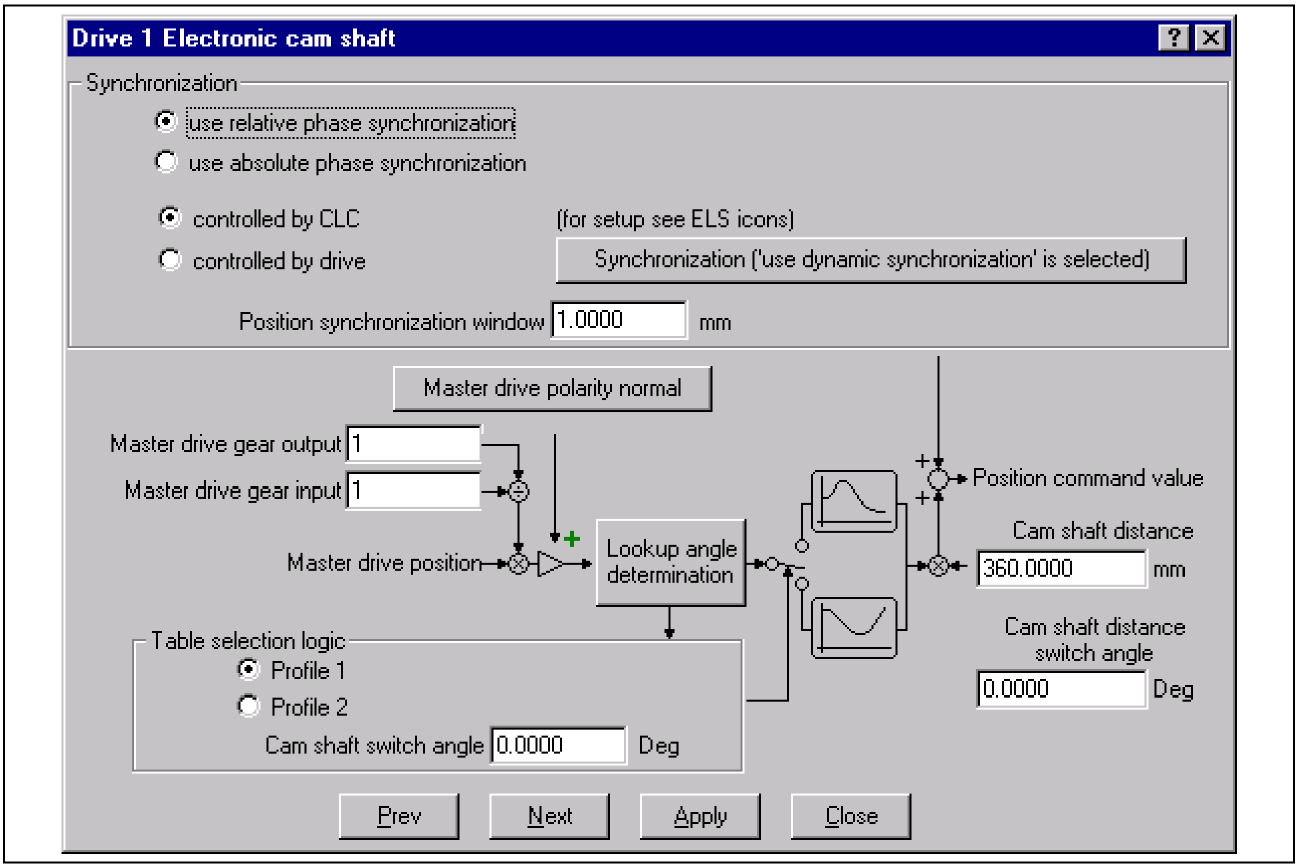


Fig. 8-28: Drive n Electronic Cam Shaft

The selections in the Synchronization area determine the type of phase offset at synchronization, the device that will generate the phase offset and the settings for dynamic synchronization.

Use Relative Phase Synchronization (A-0-0164, Bit 6=0)

When relative phase synchronization is enabled, the master and slave positions are synchronized and the relative phase offset difference is written to parameter P-0-0151.

Use Absolute Phase Synchronization (A-0-0164, Bit 6=1)

When absolute phase synchronization is enabled, the phase offset value in parameter A-0-0151 is used to set a phase offset between the master and salve positions.

Generated by the Control (A-0-0164, Bit 1=0)

When selected, the phase offset is generated by the control.

Generated by the Drive (A-0-0164, Bit 1=1)

When selected, the phase offset is generated by the drive.

Position Synchronization Window (S-0-0228)

If the difference between the position command value and the feedback value is smaller than the synchronization window during the parameterized synchronization operating mode with underlying position control, then bit 8 in the S-0-0182, Manufacturer Class 3 Status will be set.

Refer to Fig. 8-27 for details on dynamic synchronization settings.

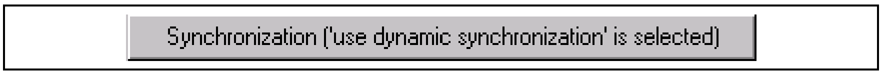


Fig. 8-29: Synchronization for Electronic Cam Shaft

Master Drive Polarity (P-0-0108)

This parameter inverts master drive position polarity. This means that an inverted, electronic gearbox can be implemented. Click on the button to change between Master drive polarity normal (positive) and Master drive polarity reversed (negative).

Master Drive Gear Output (P-0-0157)

This parameter together with ***Master Drive Gear Input (P-0-0156***) determines the master drive gear ratio. The output ratio of these two parameters is multiplied with the master drive position before it is sent to the drive. This 16 bit word can be modified in phase 4.

Slave Drive n Revs (S-0-0237)
Master Drive n Revs. (S-0-0236)

The output ratio of these two parameters is multiplied with the master drive position before it is sent to the drive. This 32 bit word can only be modified in phase 2.

Slave Drive Feed Travel (P-0-0159)

During linear angle synchronization, the slave axis performs one feed per revolution of the master axis. Parameter P-0-0159, Slave drive feed travel, together with the parameter S-0-0236, Master drive 1 revs., determines the distance to go per revolution of the master axis. This parameter is visible when the mechanical scaling for the motor is set to linear under ***Parameters*** ⇒ ***Mechanical***.

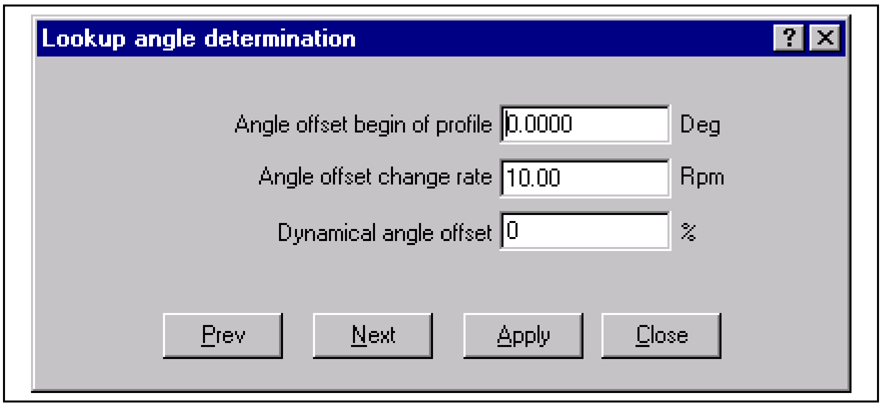


Fig. 8-30: Lookup angle Determination

Angle Offset Begin of Profile (P-0-0061)

The profile (table) will be shifted by this angle in relation to the Master drive position.

The offset is used in the cam shaft or pattern transmission operating modes.(Master Phase Adjust)

Angle Offset Change Rate (P-0-0158)

In Cam shaft or pattern transmission operating modes, P-0-0061 affects the table access angle. To avoid jumps of the table access angle; a new value for P-0-0061 does not immediately become effective. Starting with the current value, a ramp-like approximation of the new value is performed. The approximation is performed along the shortest path. The ramp is set in P-0-0158.

Dynamical Angle Offset (P-0-0085)

This parameter is used to compensate a lag error if the position controller has not set to lag free control. The table access angle is set prematurely and is velocity dependent.

Table Selection Logic Profiles (P-0-0088)

Each drive controller is capable of containing two internal cam tables. This parameter selects which cam table profile to use when the cam shaft switch angle is encountered. Profile 1 relates to the cam table profile in parameter P-0-0072 and profile 2 relates to the cam table profile in parameter P-0-0092.

Cam Shaft Switch Angle (P-0-0094)

If the Master drive position passes this angle in a positive or negative direction, then a switch will be made to the cam-profile table that was pre-selected by parameter P-0-0088, Cam Shaft Control.

Parameter P-0-0089, Cam Shaft Status will be set to the activated cam profile table. When the drive is first initialized, the cam profile set in P-0-0088 will be activated. Parameter P-0-0089 also will be set.

Cam Shaft Distance (P-0-0093)

This parameter determines the factor with which the cam profile will be multiplied.

Cam Shaft Distance Switch Angle (P-0-0144)

A new value for the P-0-0093, Cam Shaft Distance will become active only when the table access angle passes the cam shaft switch angle. The angle for the table access is derived out of the following parameters:

- P-0-0053, Master drive position
- P-0-0061, Angle offset begin of profile
- P-0-0085, Dynamical angle offset
- P-0-0108, Master drive polarity
- P-0-0156, Master drive gear input revolutions
- P-0-0157, Master drive gear output revolutions
- P-0-0158, Angle offset change rate

This works only in a curve pattern disk (Cam profile) operating mode.

8.4 Oscilloscope

The oscilloscope utility is used to capture and display run-time data. The capture can be of the control or on a drive that supports this feature. Selected data is acquired on the drive or control, passed to VisualMotion Toolkit, and displayed on the graphical format. The graphical display and supporting data can be printed, or the data can be saved to a file for later review.

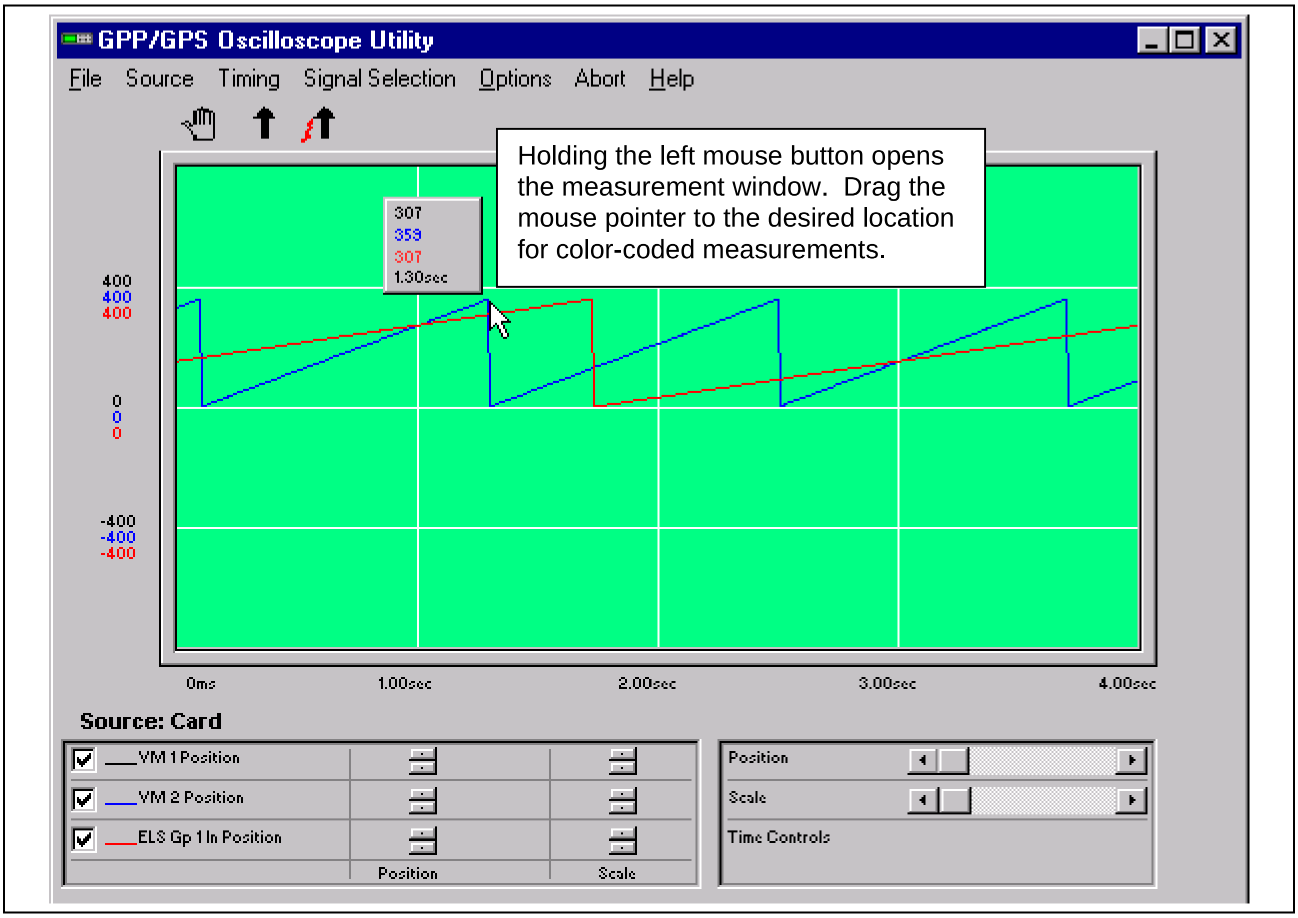


Fig. 8-31: Oscilloscope Utility

File Menu

The File menu is used for retrieving file data, saving data to a file, printing, and exiting the oscilloscope utility.

Open - data from user selected input file is loaded into input data list-box.

Save - data from user selected output is loaded into output data list-box.

Print Output - the oscilloscope graph and its related data table is sent to the printer.

Exit - terminates this utility

Source Menu

Selects the source from which the oscilloscope will gather signal data.

Drive 1 to n - lists of all drives on the SERCOS ring that supports the oscilloscope feature.

Card - when selected, the oscilloscope can then read card variables, parameters and registers.

Timing

The Oscilloscope timing options in Fig. 8-32 are used for setting the ***Sampling Rate*** (How often a trace is captured) and ***Sample Count*** (How many sampling rates are captured). The ***Capture Duration*** field displays the total capture duration that is calculated by multiplying the Sample Count and Sampling Rate. A ***Pretrigger*** can be added and is a percentage of the capture interval.

Note: The pretrigger appears on the oscilloscope screen as a vertical line.

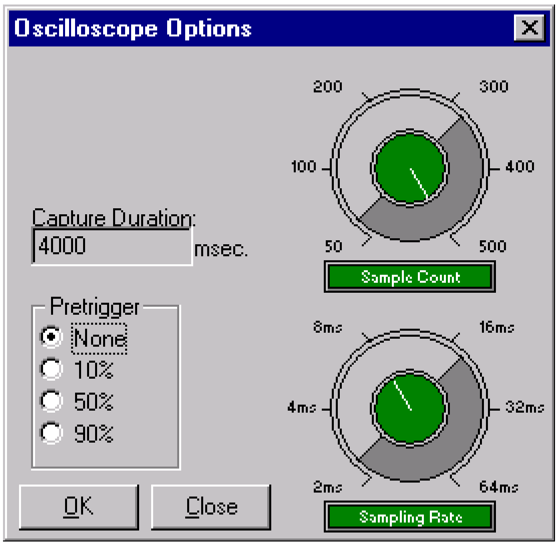


Fig. 8-32: Oscilloscope Options

Signal Selection

The Drive Signal Setup in Fig. 8-33 is available when a drive is selected under the Source menu.

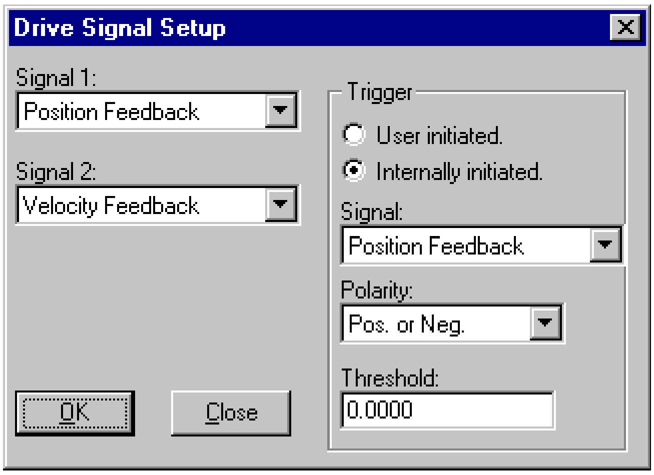


Fig. 8-33: Drive Signal Selection

Two drive signals can be captured and viewed. The following is a listing of the available drive signals.

- Position Feedback.
- Velocity Feedback.
- Velocity Deviation (from commanded value).

- Position Deviation (from commanded value).
- Torque Command Value (required to maintain the commanded Velocity/Position).
- Disabled (Signal 2 only).

The Card Signal Setup in Fig. 8-34 is available when a Card is selected under the Source menu.

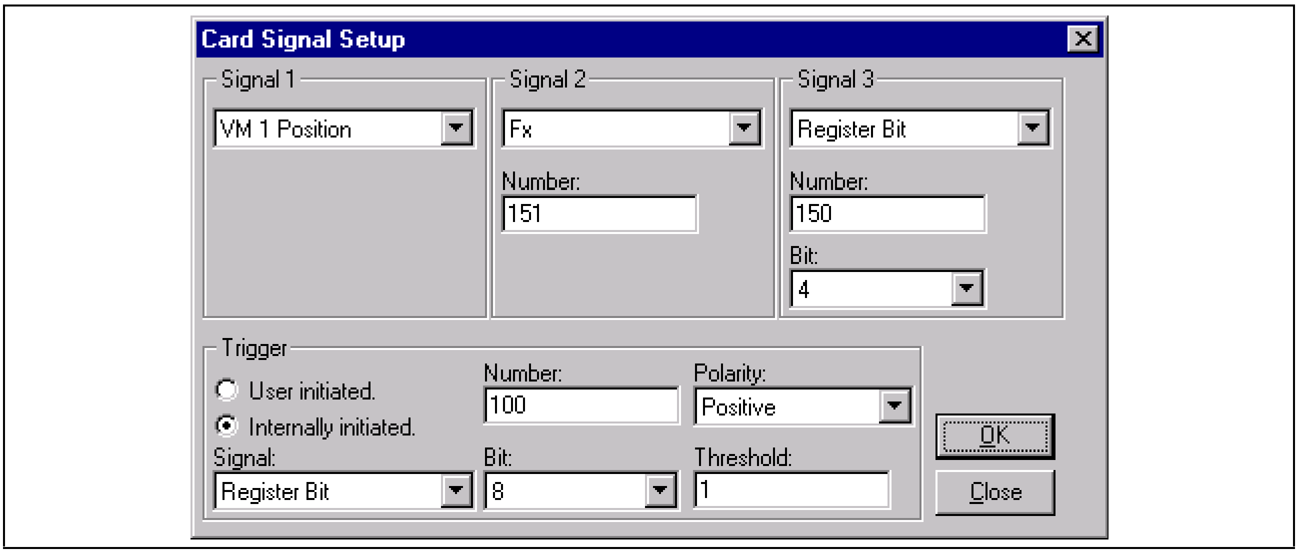


Fig. 8-34: Card Signal Selection

- Program Floats (Fx).
- Program Integer (Ix).
- Global Floats (GFx).
- Global Integers (GIx).
- Axis Parameters of drives on SERCOS ring.
- Register Bit.
- +/- Register (could be used to monitor a register's value).
- Card Param.
- ELS Gp # In Position.**
- ELS Gp # In Velocity.**
- ELS Gp # Out Position.**
- ELS Gp # Out Velocity.**
- ELS Gp # Out Acceleration.**
- VM1 Position (Virtual master signal).
- VM1 Velocity.
- VM2 Position.
- VM2 Velocity.

*Axis parameter must be in cyclic telegram. Use parameter A-0-0185 and A-0-0195 to add other drive parameters to cyclic data.

**The # symbol represents ELS Groups 1-8. This same signal is available for each ELS Group in the system.

For either signal source, the sample acquisition may be **User initiated** or **Internally initiated**.

For **User initiated** captures, data acquisition starts as soon as the capture button  is pressed. This type of start capture is not deterministic. All other fields in the trigger section are grayed out.

For **Internally initiated** captures, the available signals are the same as the signals for Signals 1 – 3. The heading in the trigger fields will change based on the signal selected. The trigger polarity options are on positive edge, negative edge, or both. Signal threshold is the signal level to trigger.

Options menu

From the options menu, a trace's appearance can be changed from *Lines* to *Dots*. When combined with the Time Controls feature on page 8-34, the user can scale (zoom) in to reveal the individual dots that makeup the trace.

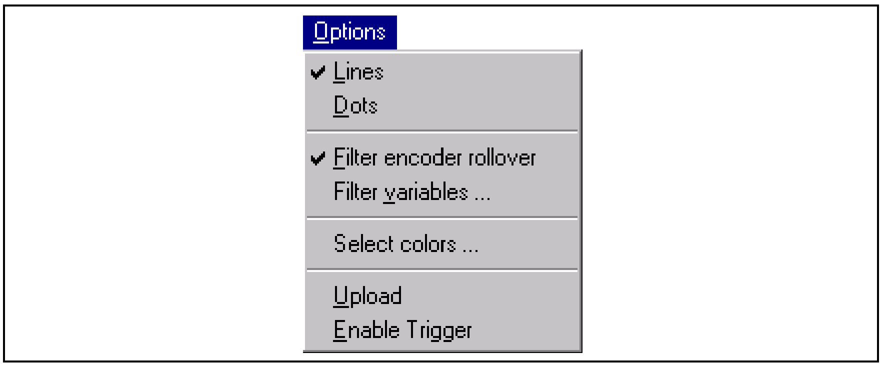


Fig. 8-35: Options Menu

Filter encoder rollover

The position control loop in servo systems is continuously correcting the position of an encoder when at standstill. This continuous correction in position can cause dithering that will be captured by the oscilloscope. When selected, the *Filter encoder rollover* will eliminate any dithering based on the settings of the *Filter variables* … window in Fig. 8-36.

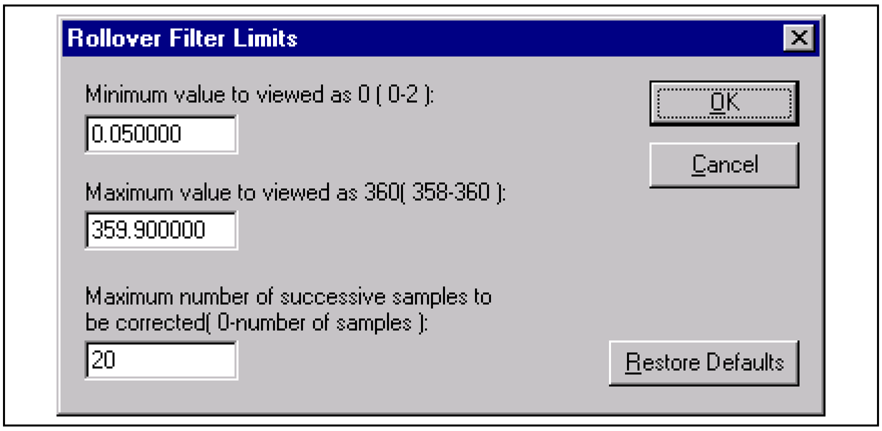


Fig. 8-36: Filter variables

Minimum value to be viewed as 0

A value between 0 and 2 degrees will be used as the filter window for ignoring position dithering. While holding position at 360°, any value between 0 and the minimum value entered will be interpreted as a dither and seen as 360 degrees up to a maximum number of successive samples.

Maximum value to be viewed as 360

A value between 358 and 360 degrees will be used as the filter window for ignoring position dithering. While holding position at 0°, any value between 360 and the maximum value entered will be interpreted as a dither and seen as 0 degrees up to a maximum number of successive samples.

The oscilloscope will immediately capture any position value outside the minimum or maximum filter windows. An example of the filter encoder rollover is shown in Fig. 8-37.

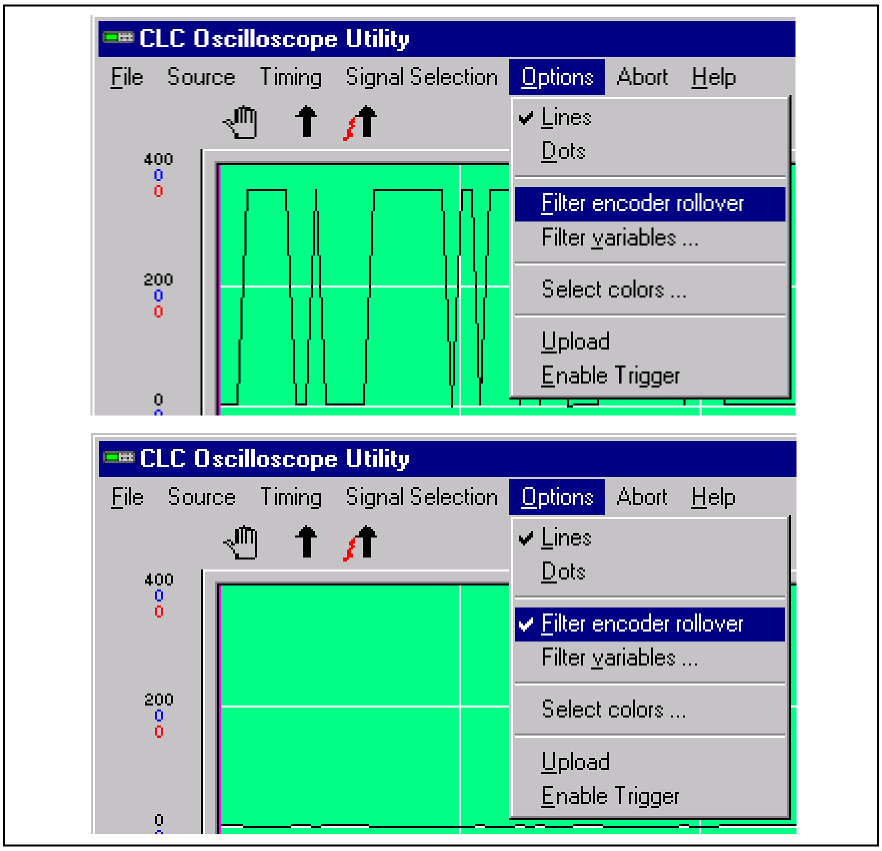


Fig. 8-37: Filter encoder rollover

Select colors…

The three available signal traces are color coded and can be changed for both run time and memory by selecting a color for each trace in the Signal color selection window in Fig. 8-38.

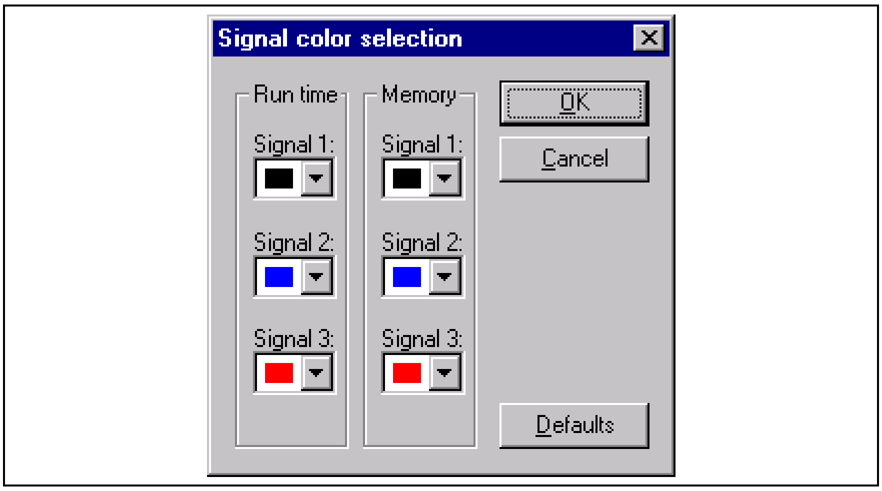


Fig. 8-38: Signal color selection

Abort, Upload and Enable Trigger

The *Abort*, *Upload* and *Enable Trigger* buttons are used to trigger trace captures of configured signals. The *Upload* and *Enable Trigger* functions are also available under the Options menu.

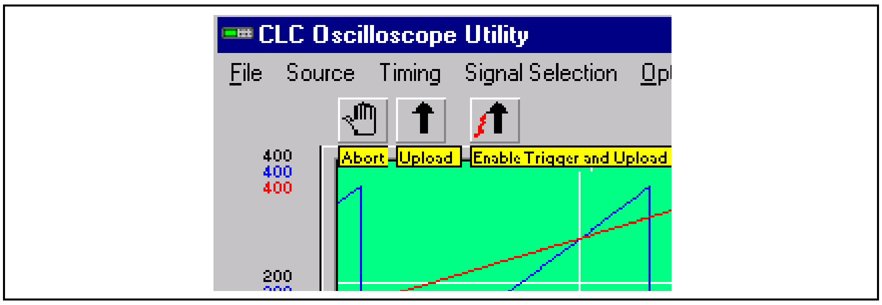


Fig. 8-39: Signal triggering buttons

Oscilloscope memory buttons

Using memory buttons, traces can be stored into memory for viewing and comparing.

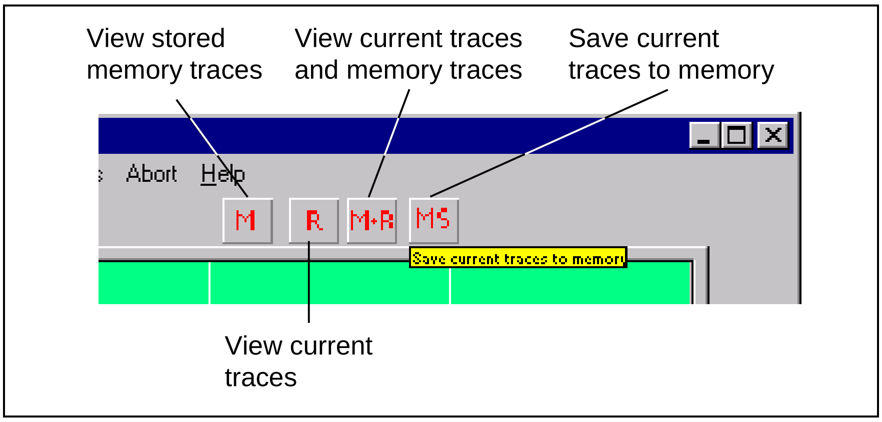


Fig. 8-40: Oscilloscope memory buttons

Manipulating trace signals

When multiple traces are captured at one time, they can be positioned and scaled independently of each other by using the up and down arrows for each trace as shown in Fig. 8-41. The traces can also be turned on or off by clicking on the check boxes to the right of the signal description.

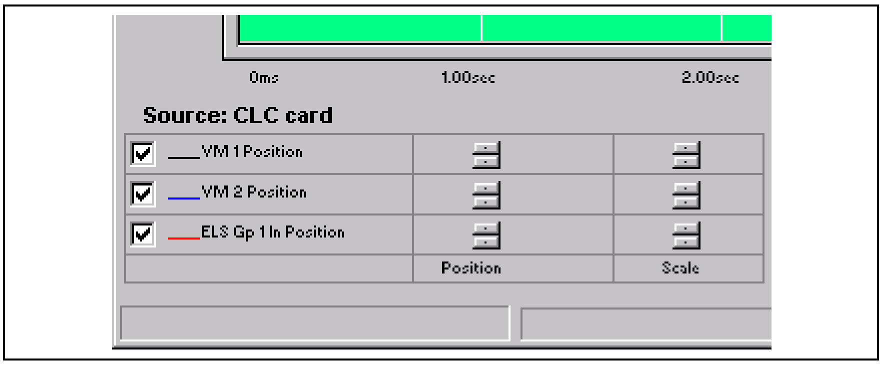


Fig. 8-41: Manipulating trace signal

By positioning the traces above and below each other, the user can more easily distinguish between the signal. Fig. 8-42 shows an example of three traces repositioned for clarity.

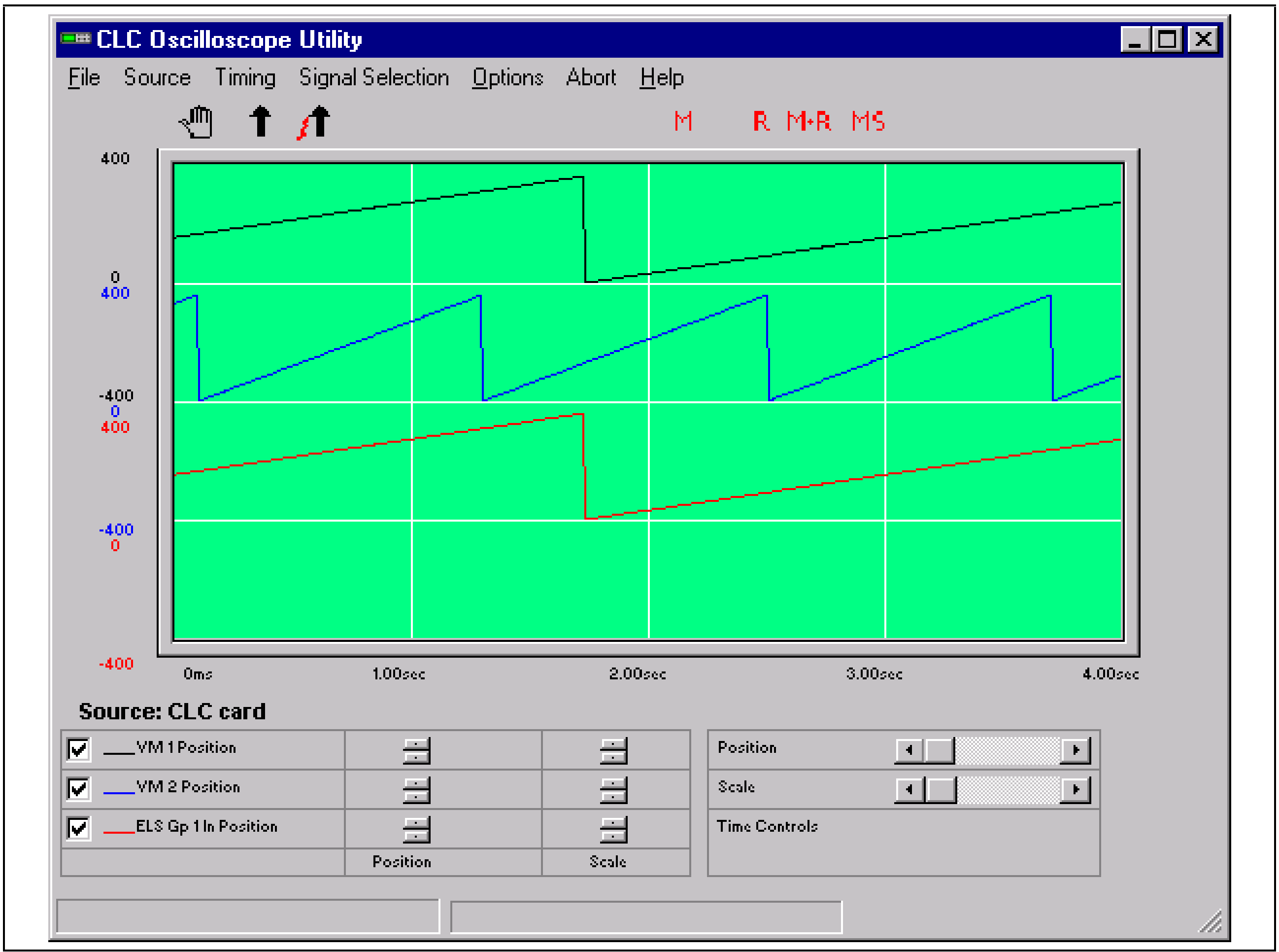


Fig. 8-42: Separated oscilloscope traces

Time Controls

The position and scale functions in Fig. 8-43 are used to more closely analyze a specific area of a captured trace. The scale function acts as a zoom, allowing the user to view smaller sections of a trace, while the position function controls the horizontal scrolling.

Note: The position function only works after using scale.

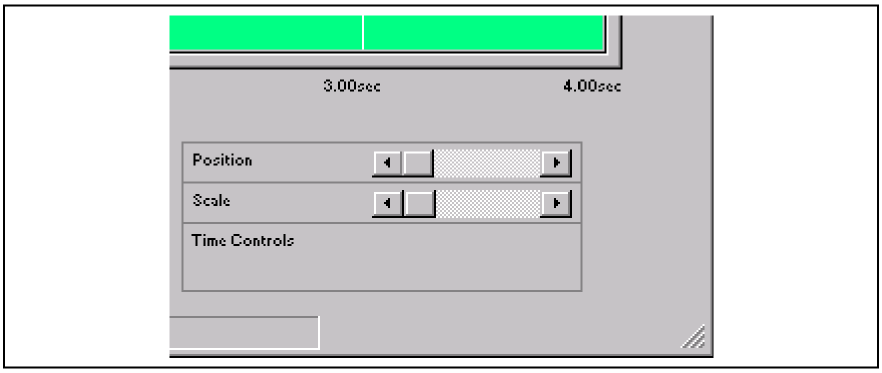


Fig. 8-43: Time Controls

9 Sample Applications

9.1 Coordinated Motion

Pick and Place

The Pick & Place Unit takes the product from the Pick_Up position and transports it to the Place position. In this example, the path corresponds to a movement in a two-dimensional Cartesian coordinate system. Therefore, two servo drives are needed.

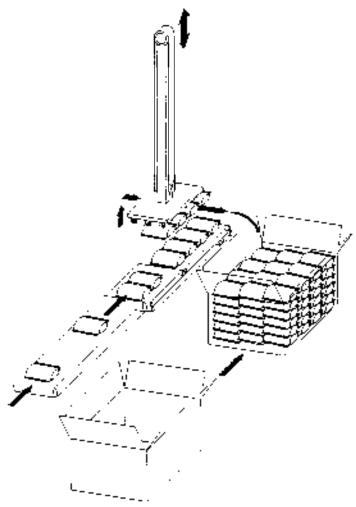


Fig. 9-1: Pick & Place Unit

Path The motion path is composed of 11 points (Cartesian coordinates) taken from the absolute point table. The product will be taken at the Pick_Up position and moved along points P3, P4, P6, P7 and P8 to the Place position P9. Subsequently, the Pick & Place Unit moves back to the Pick_Up position to handle the next product.

At the Place position, four products will always be put side by side in three rows. Accordingly, there are 12 different Place positions that are focused one after another.

Only when a product is detected, does the Pick & Place Unit move to the Pick_Up position. This is accomplished by reading the status of a photo-eye with a digital input to set an Enable_Bit. If the Enable_Bit is low (no product is detected) the Pick & Place Unit moves to a Wait Position (P1) until a product is detected (see Fig. 9-1).

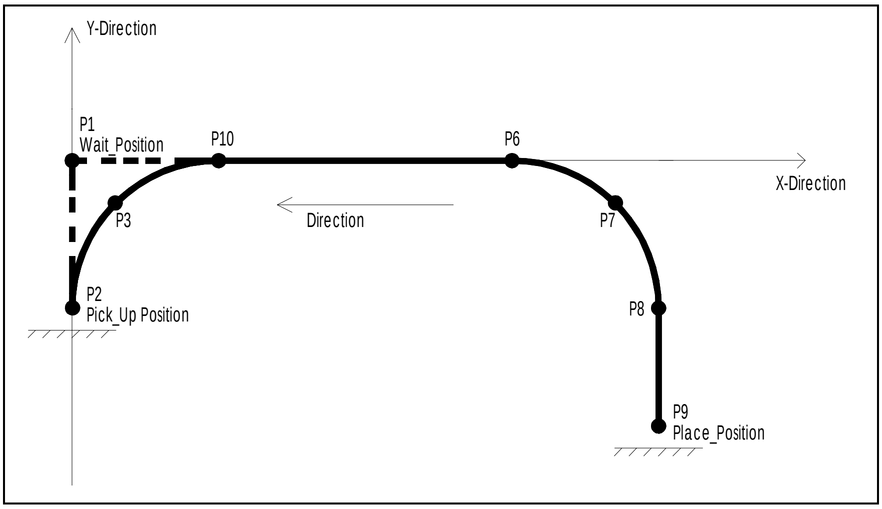


Fig. 9-1: Path to Pick_Up Position

Likewise, the unit is only allowed to move to the Place_Position if the product can be placed. (Palette is present; palette is not filled). If the Enable_Bit is low, the unit moves to the Wait Position P5 (see Fig. 9-2).

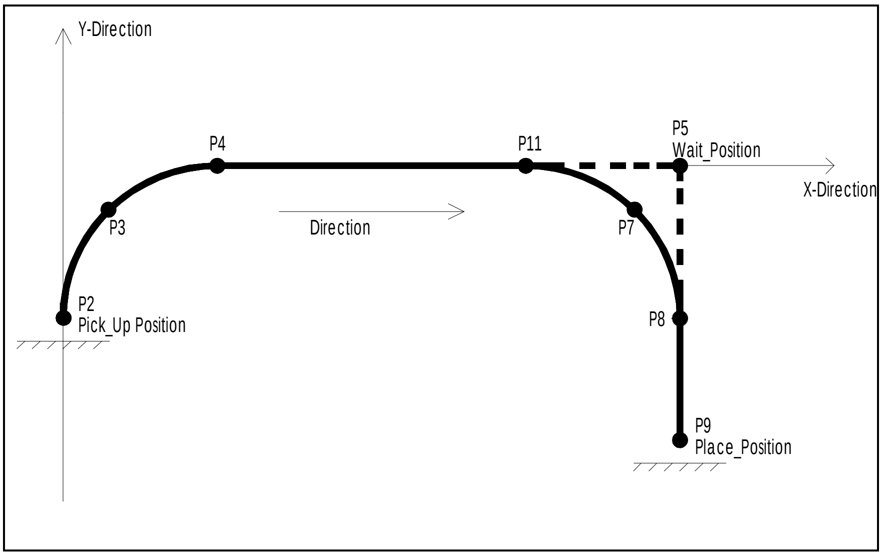


Fig. 9-2: Path to Place_Position

Kinematic

The absolute points defining the path-movement are given in Cartesian coordinates. The control calculates the commanded positions for the different drives using the defined path and the kinematics number. The kinematics number represents a library routine, which identifies the kinematics used for coordinated motion. The default kinematics number is N°1. This kinematics number instructs the system to move in the positive X-direction if the x-axis turns positive. Accordingly, the system moves in the positive Y-direction if the y-axis turns positive.

VisualMotion Program

Task A Program

The Task_A program provides the path movement of the Pick & Place Unit. After a new task starts, the Unit will first be moved up, then directed to point P1. The first cycle starts when a product Pick_Up is enabled.

The complete path is defined by geometric segments (linear and circular segments). The movement can be divided into a movement to the Place_Position and in a movement to the Pick_Up position.

Path to Place Position

1. Circular Segment P2 => P3 => P4
2. Linear Segment P4 => P11
3. Circular Segment P11 => P7 => P8
4. Linear Segment P8 => P9

Path to Pick_Up Position

5. Linear Segment P9 => P8
6. Circular Segment P8 => P7 => P6
7. Linear Segment P6 => P10
8. Circular Segment P10 => P3 => P2

Path Change

During normal operation (product arriving in time, palette moved in time), the Unit moves in a circle to the Pick_Up or Place_Position. If the Enable_Bit is missing, the path has to change to a linear movement to the waiting position. The waiting position is vertical to the Pick_Up or Place_Position.

The path planner continuously monitors the difference between the current system position and the planned position. The distance that the path planner looks ahead of the current position is defined by the Look Ahead Distance in Task Parameter T-0-0023.

The motion path can be changed as long as the look ahead distance is not part of the affected segment. For this reason, the decision for changing the path has to be done early enough.

In the example program, a time based Event is started every 40ms. The Event function evaluates the enable status as soon as a product is picked up (target point = P4) or has been placed (target point = P6).

Procedure to Startup

1. Define all necessary points in the Pick & Place Motion Path. In general, it is advantageous to create the movement using the fewest amounts of segments.
2. Find the necessary factors and parameter settings to achieve the intended velocity profile. This should be done with a fixed path (without path change).

Important Parameters:

- T-0-0020 Maximum Path Speed
- T-0-0021 Maximum Path Acceleration
- T-0-0022 Maximum Path Deceleration
- T-0-0023 Look Ahead Distance
- T-0-0024 Velocity Override
- A-0-0020 Maximum Velocity (Axis)
- A-0-0021 Maximum Acceleration (Axis)

- T-0-0022 Maximum Deceleration (Axis)

Point Table Entries:

- Blend
- Speed
- Acceleration
- Deceleration
- Jerk

3. Extend the program to the designed functionality (with path change). Activate the Event function.

The control defines coordinated motion in terms of a path composed of standard straight lines and circular geometric segments. The path combines these segments so that the start of the next segment begins at the end of the previous segment. The absolute table entry that is used for the end point of a segment contains the rate profile parameters (speed, acceleration, deceleration, jerk) used by the path planner to construct the rate profile for this segment.

Blend segments provide the capability of continuous smooth motion between standard segments without stopping. The common point between two geometric segments (end-point of the previous segment = start point of the next segment) contains the parameter characterizing the blend segment (only the blend radius of this point is important).

Planning and developing proper values for the parameters and points table are crucial to the Pick & Place Unit (how many segments are used to define the path, which distance has to be moved, etc.).

The following registers and variables are used with this demo-program.

Register

Reg.-Bit	Label	Description
100-9	GO_PICK_UP	Enable_Bit to move to the Pick_Up Position (P2)
100-10	GO_PLACE	Enable_Bit to move to the Place_Position (P9)
120-9	AT_PLACE	Product has been placed
120-10	AT_PICK_UP	Product has been picked up
120-13	TO_WAIT_PICK_UP	Go to wait position to pick up the products (P1)
120-14	TO_WAIT_PLACE	Go to wait position to place the products (P5)
120-15	SELECTION_PICK_UP	Decision to move to Pick_Up position is made
120-16	SELECTION_PLACE	Decision to move to Place position is made

Variables

Variables	Label	Description
F1	override	Velocity-Override to change the cycle time. Maximum Value = 100 (100%). Start Value = 30 (30%).
F4	position_X_AXIS	Feedback Position X-Axis
I3	row_y	counter of product rows
I4	column_x	counter of product placed side by side

9.2 Electronic Line Shafting

The Basic Function of Flying Synchronization

For products that require some type of finishing, e.g., labeling, generally require flying synchronization of other axes that are moving simultaneously parallel to a belt. Flying synchronization is typically performed either on a transport belt or in a chain, without stopping either the belt or the chain. The motion sequence of these axes can be broken down as follows:

1. ***Standstill and wait phases*** ⇒ In this phase, a product or label, that is affixed by the arm out of a magazine, is at rest.
2. ***Acceleration phase*** ⇒ This is characterized by synchronization velocity, i.e., accelerating to belt velocity. It is necessary to select your starting position so that upon reaching synchronization velocity, the desired relative position to the product being transported has been reached.
3. ***Synchronous phase*** ⇒ Phase for finishing, filling or gluing on a label.
4. ***Braking phase*** ⇒ The axis is brought to a standstill at the desired stop position.

Depending on the constructive tasks, a return motion to the start position may be needed. It is not the case in this example.

In Fig. 9-3, the significant points of flying synchronization are described in terms of a curve-controlled axis in a flying, print marker-controlled application of labels.

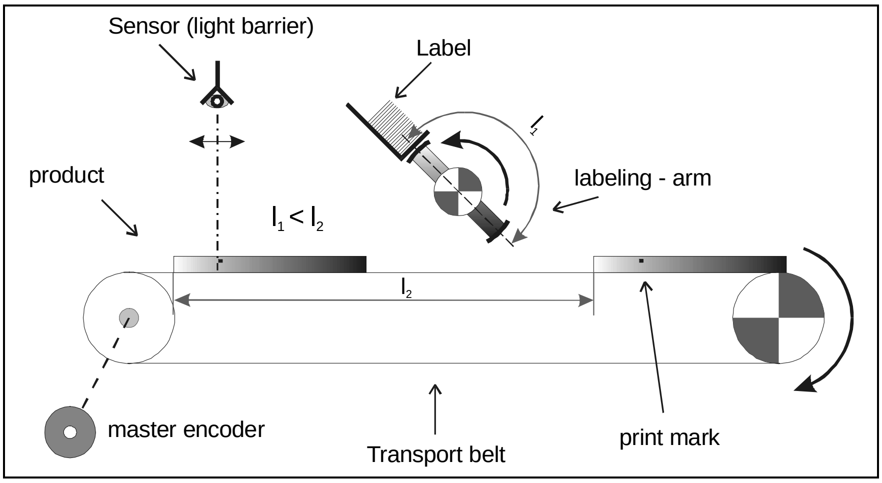


Fig. 9-3: Basic Structure of the Flying Application of Labels

How the Example Application Works

A transport belt is moving a product. A label must be glued to it at pre-defined and specific locations. A rotating arm takes the label from a magazine and applies it to the product in a *flying* fashion. To accomplish this, a sensor detects a print mark on the leading edge of a product or directly elsewhere on the product. In addition, the velocity and the position of the transport belt are monitored. A motor encoder on the transport belt motor or a separate master axis encoder is used for this purpose.

In order to be able to apply the label at the correct position on the product, the arm must start a specific master axis angle in terms of the flank change of the sensor signal.

In the synchronization phase, i.e., that part of the motional phase in which the roll away velocity must equal the transport velocity, the label must be applied. This is followed by a deceleration during which a 180° motion must be performed.

As the application arm conducts a start/stop motion, while the transport belt continuously moves, the minimum clearance to the product needed for functioning (l_2) must be greater than the roll away distance of the arm (l_1). This is also exemplified by the velocity of the transport belt to the application arm. The surface under the velocity curve of the belt (v_{belt}) in Fig. 9-4 must be at least the surface of the velocity curve of the application arm.

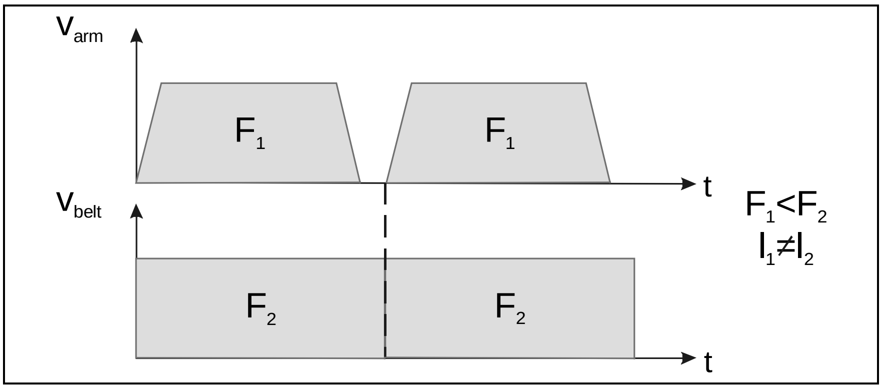


Fig. 9-4: Velocity of the Labeling Arm and Transport Belt

Programming with VisualMotion

Functional Principle

Fig. 9-5 illustrates the marginal conditions.

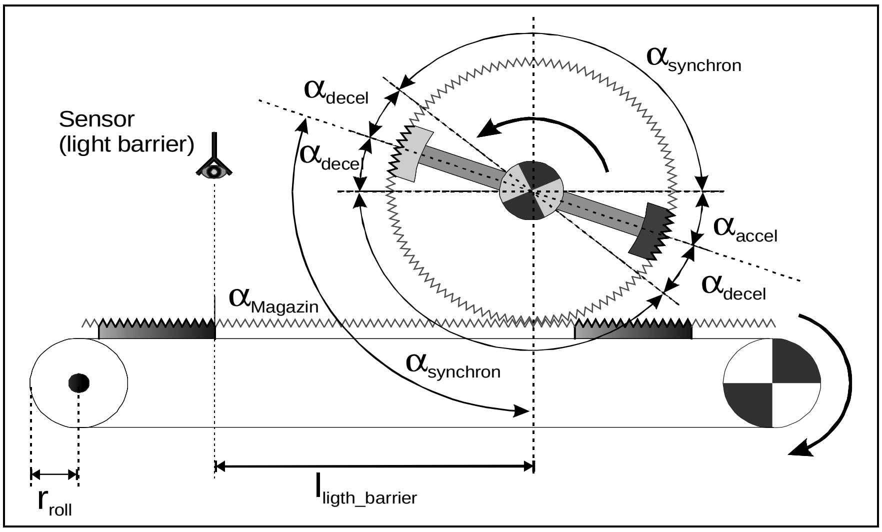


Fig. 9-5: Function Mechanism of the Labeling Machine

A sensor recognizes the product (detection of a print mark or product edge). Afterwards, there is an acceleration of the servo-controlled application arm. At a specific master axis position, this arm must move angle-synchronously to the conveyor belt. In addition to taking into account the synchronous phase for label application (the accel and decel phases of the arm), a minimum amount of time must also be set aside for the removal of the label from the magazine. The diagram in Fig. 9-6 illustrates the relationship between product recognition, angle synchronous turning motion and accel and decel distance. When applying the label, the arm must be angled synchronously to the product. In other words, the teeth must feed (black) into each other, followed by accel or decel before and after. The gray shows that the gear teeth did not grip into each other.

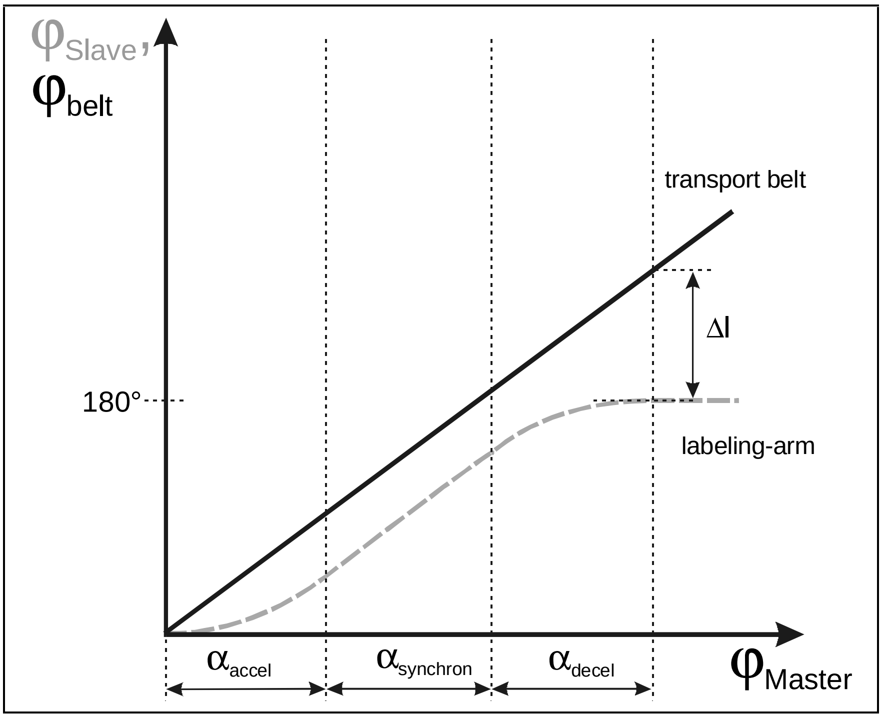


Fig. 9-6: CAM Profile

Upon detection of the sensor signal, the current master axis angle is detected via a rapid input (probe input on the control). Using the given angle difference between the point of arrival of the sensor signal and the start of the arm motion, it is possible to compute the necessary master axis angle shifting (mph).

During the zero crossover of the master axis, the desired motion of the application arm is activated. The motional form is implemented with a CAM, broken down into acceleration, synchronization and decel phase. See Fig. 9-6. In the synchronous phase, the slave axis runs angle synchronous to the belt when applying the label. The CAM must be dimensioned so that the motion is completed by a whole master rotation. The activating of the CAM must take place before modulo overrun of the effective master angle.

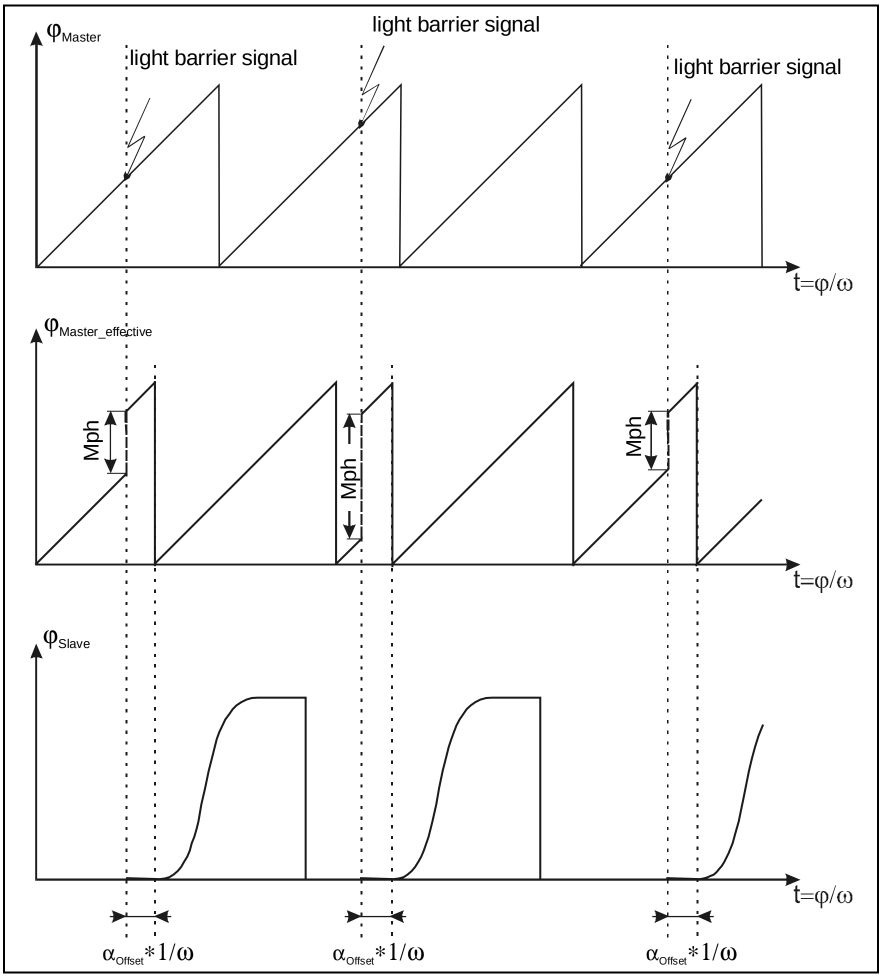


Fig. 9-7: Time Diagram of the Real and Effective Master Encoder Position and Slave Position

The signal of the light barrier arrives; the offset is computed in terms of the master position and the slave axis follows in relationship to the CAM table of the effective master starting from the zero crossovers. Upon reaching the end position, the slave axis is again halted.

Notes on Dimensioning

The angle with which the sensor is minimally moved toward the point of application is computed as shown in Fig. 9-8.

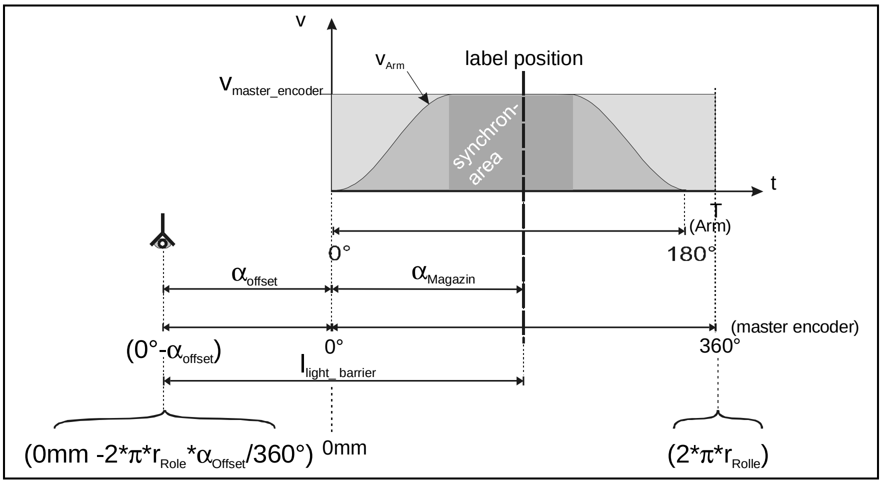


Fig. 9-8: Light Barrier Position

To compute the distance from the light barrier to point of application, the required angle variables are given. With offset angle known, as well as the offset angle and magazine position (relates to midpoint of application position and label magazine) as well as the roll radius of the transport belt, it is possible to determine the distance of $l_{Light\_Barrier}$.

$$l_{Light\_Barrier} = \frac{2 \cdot \pi \cdot r_{Roll}}{360°} \cdot \left(\alpha_{Magazin} + \alpha_{Offset}\right)$$

The offset angle (start angle starting from the motion) depends on the generated CAM (Fig. 9-6).

For the illustrated example, a mounting clearance for the light barrier to the application position is computed in terms of:

$$l_{Light\_Barrier\_Example} = \pi \cdot r_{Roll} \cdot \left(1 + \frac{\alpha_{Offset}}{180°}\right)$$

To compensate computation time, the offset angle must exceed:

$$\alpha_{Offset} > 360° \cdot \frac{t_{Computingtime}}{T}$$

Experience has shown that the hardware and software listed in section 1 require a computation time of at least 20ms. Included in the point computation time are event execution and parameter descriptions (shifting of master angle and change of stroke). If the program contains numerous other events, then include the relevant amount of safety in the computation.

The minimum clearance dimensions of the product are illustrated in Fig. 9-8. The transport belt (master axis) runs the distance Δl during the entire motional phase of the slave axis. To ensure a safe operation, the following minimum distance is required:

$$l_2 > l_1 + \Delta l$$

Due to the condition that stroke (Hub) changes are only active after zero crossover of the master axis, the master must pass the modulo overrun until the next product is detected. A safety reserve should be taken into account here as well.

Implementation with VisualMotion

CAMs can be implemented either in the control (control CAM) or in the drive (ELS, SGP firmware). The desired CAMs are stored in table form. In the control, this table (with the current master axis angle) is used to determine a new position command value for the slave axis (cyclical command value default via SERCOS Interface). Given a drive CAM, the slave axis is given the data on the current master axis angle and the drive determines, using the CAM table, the relevant position command value.

Implementation with Control CAMs (drive-dependent):

At the start of the program, the slave axis is homed; the desired CAM is allocated and synchronized in standstill to the master axis. At the time of start, the stroke (Hub) factor and the linear integral of the CAM equation (L factor) are set to zero. At the start of the master axis, i.e., the transport belt, the slave axis remains rigid at its start position. The master axis position latched in the drive with the help of the light barrier signal now makes it possible to calculate the required angle shift from the CAM - table start. The axis thus has its zero crossover of the master axis angle to the desired start time of the motional phase of the arm.

The stroke (Hub) of the CAM is then set to the desired nominal value whereby the stroke change does not become effective until the zero crossover of the master axis.

When programming, note the function with which the slave position is generated. A command position of a control CAM results from the following equation.

Scmd = H · CAM · [(M / N) · Mcmd + Mph] + L · Mcmd + Sph

Symbol	Unit	Definition	Parameter
Scmd	Grad	Commanded position to Slave	A-0-0163
H	1	CAM scaling term (stroke or Hub)	A-0-0033
CAM [ ]	1	CAM table	C-0-3101 ... C-0-3108
M	1	Multiplying scaling term of the master position	A-0-0032
N	1	Multiplying scaling term of the slave position)	A-0-0031
Mcmd	Grad	Commanded Position of the Master	C-0-0157
Mph	Grad	Master CAM phase adjust	A-0-0151
L	1	Linear scaling term of Master position	A-0-0035
Sph	Grad	Slave CAM phase adjust	A-0-0161

Thus for implementation, only the currently active master is affected. Linear shifting and slave offset are not needed and the added terms (*L· Mcmd+Sph*) are set to zero. The equation reduces to:

Scmd = H · CAM · [(M / N) · Mcmd + Mph]

The master/slave ratio (*M/N*) is generally 1, but it can be used for adjustment purposes. This must be taken into consideration during the offset computations.

The product of the gear ratio and the current master axis position is added to a master offset (*Mph*). This results in the table index that points to the relevant line of the CAM table (*CAM*). With stroke (*H*), the motional width of the working axis can be set.

Note: The scaling factor stroke (Hub) is either 0 or 1 in CAMs

Example

The current real master axis position (*Mcmd*) equals 170 degrees. To receive the signal, the effective master axis encoder *((M/N)· Mcmd+Mph)* should equal 290 degrees (fixed offset angle or offset of 70 degrees). The gear ratio is (1/1). Changes in stroke become effective after the zero crossover of the master. This generates the following equation:

Mph = 360° – offset – latch

The needed master offset equals: 120 Grad.

The difference of command and actual position is added to the master offset (Mph) with the CAM equation. The master axis must be able to turn with 70 degrees until the stroke change is active (zero crossover).

Due to the mechanism, the time the product arrives and the velocity of the master axis are independent of the start of the slave axis.

To stop the slave axis, an event is started which is dependent on the slave position during which the stroke (Hub) is set to zero again (it becomes active after the zero crossover) and the probe is reactivated.

The entire process can be summarized as follows:

The current master axis encoder position is detected by a probe (rapid input). The probe signal starts a high-priority event in the motion program (interrupt program). During this event, the previously introduced computation is performed and allocated to the master offset and the stroke is set to one. The axis starts the motion in terms of the desired offset angle. Upon reaching a set position (e.g., 10% of the stroke) of the slave axis, a second position-dependent event (repeating axis position event) is started. In this event, the stroke (Hub) factor is set to zero and the probe is reactivated. The axis conducts the motion with the motion set by the CAM and then remains motionless at the end position.

Implementation with Drive CAMs:

Implementing this function with the help of a drive CAM is done similarly to the control CAM. The only differences are the scaling factor and the CAM equation used.

Scmd = H · CAM (Mcmd – Mph) + Sph

Symbol	Unit	Definition	Parameter
Scmd	Grad	Commanded position to Slave	S-0-0047
H	1	CAM scaling term (stroke or Hub)	P-0-0093
CAM [ ]	1	CAM table	P-0-0072 & P-0-0092
Mcmd	Grad	Commanded Position of the Master	C-0-0157
Mph	Grad	Master CAM phase adjust	P-0-0061
Sph	Grad	Slave CAM phase adjust	A-0-0151 or P-0-0031

The slave offset is also set to zero. The equation is reduced to the term:

Scmd = H · CAM (Mcmd – Mph)

To determine the master offset, a negative sign is used in the equation.

mph = – 360° + offset + latch

Note: Scaling factor stroke (Hub) with control CAMs is either 0 or a modulo value (e.g., 180 degrees).

Example

The current real master axis encoder position (Mcmd) equals 340 degrees. Upon detection of the signal, the current active master axis encoder (Mcmd+Mph) should equal 290 degrees (offset angle or offset of 70 degrees). Changes in stroke become current after the zero crossover of the active master. Thus, results in a master offset angle of (-360°+70°+340°) 50 degrees.

Note: The scalable transition angle of stroke (Hub) activation in the drive is set to zero degrees (P-0-0094).

The main program sequence, probe event and position-dependent event is identical for both CAM types.

Program Sequence (Summary):

1. Task A (Main Task)
   1.1. Initialization
      1.1.1. Variables
      1.1.2. Set operating mode (ELS – Slave Axis)
      1.1.3. Allocate events [Feedback Capture, Repeating Axis Position]
      1.1.4. Allocate CAMs
      1.1.5. Master Phase Adjust set to zero
      1.1.6. Slave Phase Adjust set to zero
      1.1.7. Activate the feedback capture event and the repeating axis event (allocate to slave axis)
   1.2. Wait in program loop until program ended by setting register 100 bit 16
2. Feedback Capture Event
   2.1. read "latched" position
   2.2. Compute new offset angle
   2.3. Allocate <u>absolute</u> master phase offset
   2.4. Wait until new master phase offset effective (4ms)
   2.5. Activate stroke (Hub) (control CAM - stroke = 1)
3. Repeating Axis Position Event
   3.1. Set stroke (Hub) to zero (control CAM - stroke = 0)
   3.2. Reactivate probe event

An event is a higher priority program part and is processed prior to a main task.

The feedback capture event is started by an external event (e.g., binary light barrier signal). The repeating axis event is activated as soon as the actual value of the axis reaches the programmed starting angle.

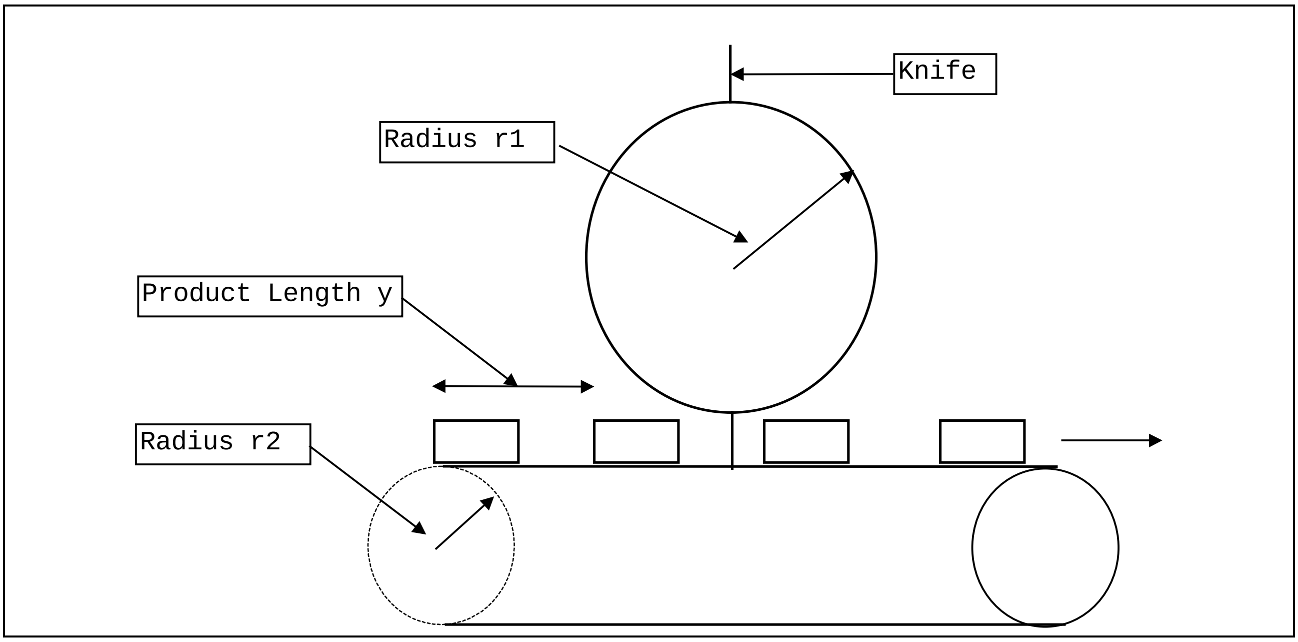
Program Sequence (Summary)

1. Probe signal coming.
2. Feedback capture event is started and processed (offset computed, set and stroke (Hub) set to one).
3. The slave axis conducts motion in terms of the active CAM and relevant offset angle.
4. Given set slave position, the repeating axis event is started. The slave axis is deactivated again and the probe input is reactivated.

9.3 Rotary Cutoff

In this application, a cam profile is designed that drives a two bladed knife used to seal and cut pre-wrapped candy bars on a conveyor belt.

Consider the following drawing:



Rotating Knife Application

In this application, the ELS line master is driving motor r2 directly and motor r1 is the cam axis.

A cam table with a dwell is needed so that during the dwell the knife will match line speed to allow for proper sealing and cutting. The placement of the dwell within the cam will affect the master phase adjust, Mph, needed for centering the cam to the product cycle.

Define Ry to be the number of master revolutions/product cycle.

Then,

Ry = y/(2*π*r2)

To set the cam cycle to the product cycle use M and N.

One cycle of the normalized cam for every product implies:

Ry*(M/N) = 1 revolution

so,

N = Ry

M = 1

For the moment, assume H = 0.

L is set to match distance and speed of the knife during a cycle to that of the product.

The equation for L is as follows:

(2*π*r1)*(Ry)*L = y

L = r2/r1

The distance factor (2*π*r1)*(Ry) is the total distance traveled by the knife in one product cycle. L is used to scale this distance to y, the product length.

Define B to be the number of knife blades, thus B=2, and d to be the distance between knife blade(s).

If y equals d then the distance traveled by the knife in one product cycle is the same as the product length. In this case no cam is needed and H = 0.

If y is not equal d then the knife never hits the product at the right time in the cycle. This is where H comes in and a cam is need.

H is used to scale the cam to make up for any length difference between y and d.

The distance between knife blades is defined by:

d =(2*π*r1)/B

The distance adjustment needed each cycle is given by:

d_adj = d - y

The cam is normalized so it makes one cycle per product cycle, therefore:

B*d*H = d_adj

H = (d - y)/(B*d)

H = (1 - y/d)/B

Note that B*d = 2*π*r1.

H may be zero. When H is zero, the cam profile is not needed and this application can be done without a cam.

H may be negative. This happens when the distance between the blades is smaller than the product length, so that the knife will slow down during the cam cycle then speed up and be at line speed during the dwell. The distance adjustment attributed to the cam is exactly d-y.

H may be too negative. In this case, the cam will slow the knife so much that it actually will reverse direction and travel backwards. This is not acceptable and only happens when the product length is at least twice that of the knife. For this case, L must be set to zero and a cam profile developed that will start from rest, accelerate to match line speed, then decelerate to a stop. The details of this approach are not addressed here.

H may be positive. In this case the distance between the knife blades is larger than a candy bar so the knife will speed up during the cam cycle then slow down and match line speed during the dwell.

H may be too positive. In this case, the amount of distance the cam profile must make up is so large and the line speed may be so high that the acceleration and deceleration rates are not acceptable to the motors.

Phase can be added or subtracted to center the cutting edge of the knife exactly between the candy bars.

For pre-production setup, initialize the ELS master and master phase adjust to zero degrees. Center the cam dwell at zero degrees of the cam. Set the slave phase adjust so that the knife is positioned at its first cut.

During production, use the master phase adjust for registration correction as needed.

10 DDE Server

10.1 Dynamic Data Exchange

The Microsoft Windows™ operating system specifies a method for transferring data between applications called Dynamic Data Exchange (DDE). DDE is a message protocol that developers can use for exchanging data between Windows-based applications. The communication server uses the Dynamic Data Exchange Management library (DDEML) built on top of the DDE protocol. The DDEML provides services that the message-based DDE protocol does not support. Under the DDEML, a client application requests information from a server application, or it sends unsolicited data to the server. The client does this by passing predefined ASCII strings to the server through the DDEML.

Client and server must first establish a common conversation before data can be exchanged. A service name and a topic name define conversations. The DDE server application uses this information for establishing communications. After having established a conversation, the client application can now exchange data by specifying an item name. The item name identifies the specific data to be exchanged.

There are three basic types of data transactions that can be initiated by the client application. A ***request*** transaction is used to obtain data from the server. The server application knows how to obtain the requested information. The second type of transaction is an ***advise link***. After a client application establishes an advise link with a server, it is up to the server to poll the data for changes. If the server finds that the data has changed it will notify the client application. The third type of transaction is a ***poke***. A poke transaction is used to send data for a specific item to the server.

The Dynamic Data Exchange Server

CLC_DDE is a Windows based Dynamic Data Exchange (DDE) Server application that is used to communicate with Indramat's GPS/GPP motion controller. It has been implemented using Windows Dynamic Data Exchange Management Library (DDEML).

Key Features

- Serial connection to the GPS/GPP with support for an RS485 auto switching adapter
- Support for a modem connection to a GPS/GPP (AT protocol)
- VME back plane communications from a XYCOM PC (Requires *XVME984.DLL*)
- VME back plane communications from a GE FANUC Plug & Play PC (Requires *VPCMTK.DLL*)
- Direct PC AT bus communication to a CLC-P card (Requires *control_P.DLL*)
- Direct PC104 bus communication to a CLC-P02 card (Requires control_P2.DLL)
- Connection for editing a control compiled program file off line (Requires *CLC_FILE.DLL*)
- Demonstration connection for testing client applications off line (Requires *DEMO.INI*)
- Access to server parameters and status through DDE
- Supports *Request, Advise* and *Poke* transactions

Dynamic Data Exchange Interface

A Windows™ application, known as a *client,* can pass information between other applications known as *servers* using Dynamic Data Exchange (*DDE*). A client establishes a conversation with a server specifying a *Service* and a *Topic*. Once a conversation has been started, a client may request or send information by specifying an *item*.

Service Name

The control communication server supports two DDE service names. The standard service name is ***CLC_DDE***. This should be used for all connections except when connecting to a control compiled program file. In this case, use ***CLC_FILE***.

Topic Name

When the standard service name is used to exchange control data, the topic name identifies the method of connection to the GPS/GPP and the controller unit number. Valid strings consist of a communication device name and a unit number. Valid device names are ***SERIAL_***, **AT_*MODEM_***, ***XYCOM_***, ***GE_P&P_***, ***DEMO_, ISA_ or PC104_*** and valid card unit numbers are ’0’ to ’F’. Connections that use the CLC_FILE service should specify the VisualMotion program file as the topic name. If the file is not located in the same directory as clc_dde.exe then the complete path should be included. To exchange server data, the service name should be **CLC_DDE** and the topic name should be **SERVER**. This is the only topic that will not support an advise link. See section SERVER Topic Name on page 7-16.

Example:

"SERIAL_0"	Serial connection to a GPS/GPP control designated as unit ’0’
"XYCOM_B"	Xycom PC in VME rack talking to a CLC-V card designated as unit ’B’
"ISA_1"	PC talking over the ISA bus to a CLC-P01 card designated as unit 1
"PC104_0"	PC talking over the PC104 bus to a CLC-P02 card designated as unit 0
"SERVER"	Exchange CLC_DDE server information

Item Name

The item name identifies the specific data to exchange. When exchanging control data, the item name consists of a string that contains the class, subclass and data identifiers of the information for the GPS/GPP controller. The strings follow the ASCII serial protocol. Refer to *Appendix A,* ***Direct ASCII Communications*** for an explanation of these codes. When exchanging server data the item name should consist of the section and entry name from the INI file (clc_dde.ini). The two names must be divided by a pipe (‘|’) character. Not all server data has read/write capabilities.

Example:

"RX 0.10"	Specifies register 10 in hexadecimal format
"TP 2.20"	Specifies task B parameter 20
"CP 1.122"	Specifies card parameter 122
"SERIAL|Baud rate"	Specifies the baud rate to use for serial connections

Note: Serial connections directed at different units will be passed through the VME backplane to the proper unit (CLC-V only). This allows communications with any control_V card in the VME rack with only one serial connection.

10.2 The Communication Servers Main Window

The DDE Server is first launched when a request is made to the GPS/GPP. The DDE Server can be setup to display the VisualMotion control's unit number and current status. In this mode, the DDE Server can act as a diagnostic window for the GPS/GPP system.

The DDE Server can be displayed as an icon on the Start toolbar or as the dialog window in Fig. 10-1.

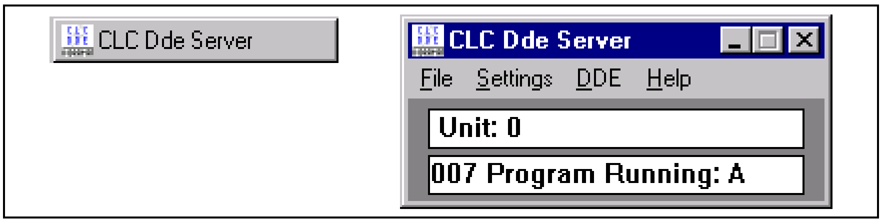


Fig. 10-1: DDE Server

All settings for the DDE Server are made from the menu selections in Fig. 10-2.

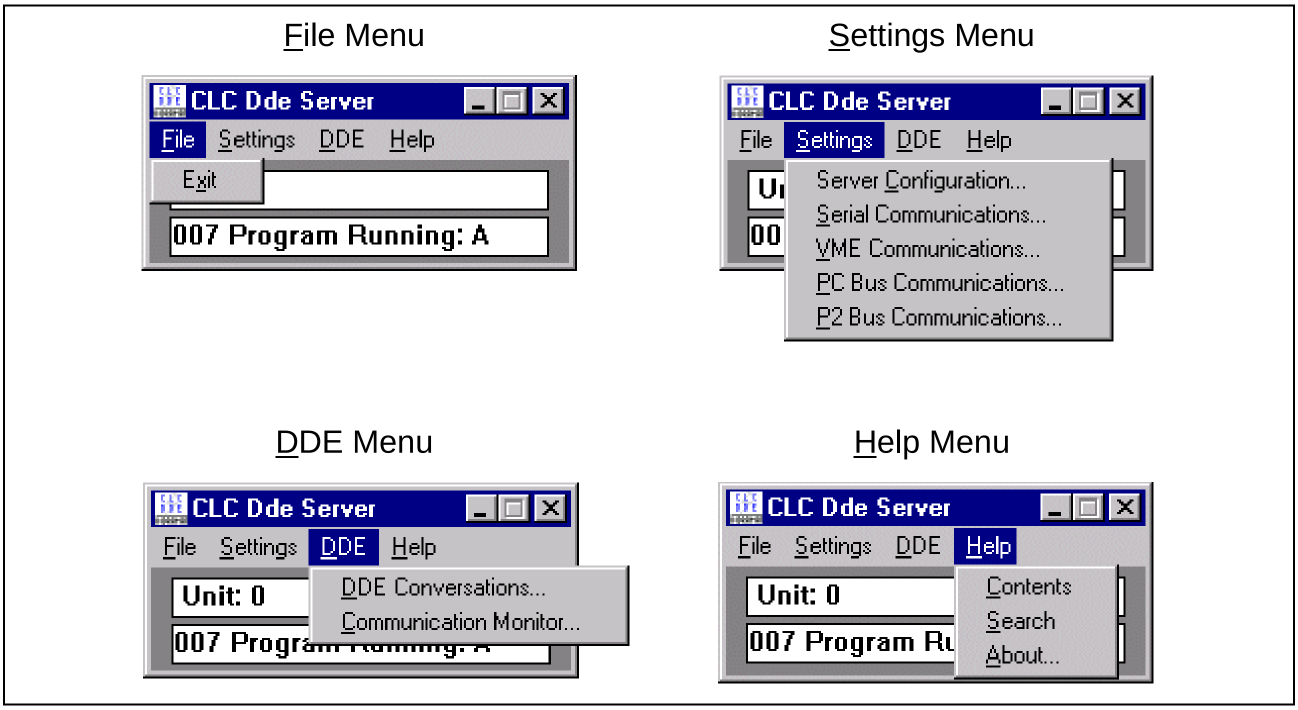


Fig. 10-2: DDE Server Menu Selections

Rexroth Indramat

Settings Menu - Control Server Configuration

The control Server Configuration allows setting of various system parameters as well as providing performance status information.

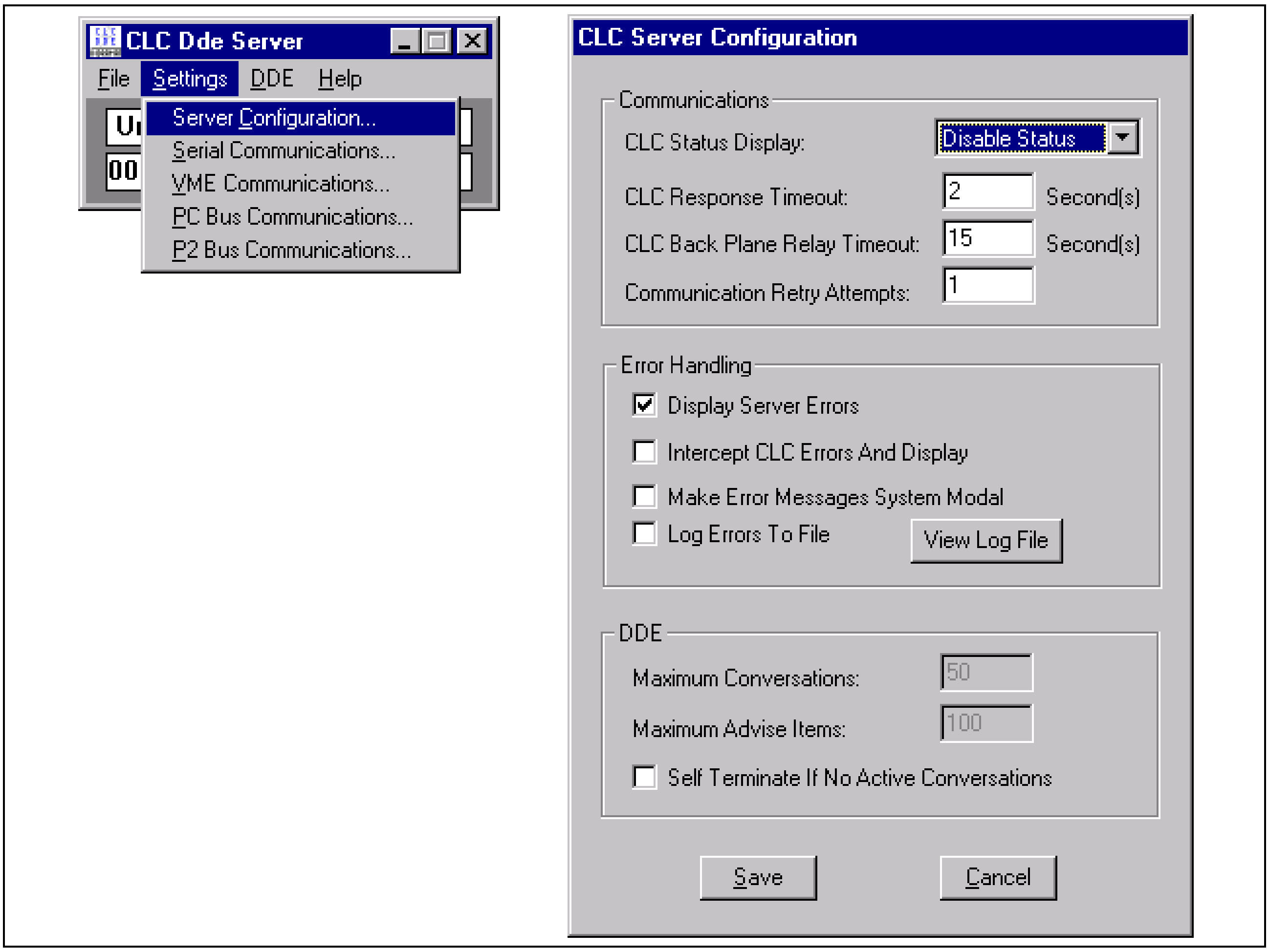


Fig. 10-3: control Server Configuration

Communications

CLC Status Display	Selects the CLC device/unit (i.e. serial_0) combination to be displayed in the status window of the server. The request will be inserted into the standard client advise loop queue. Selecting "Disable Status" can turn off this feature. Disable Status displays "*Status Display is Disabled*" Serial_0 displays current status of system; for example, "*007 Program Running: A*"
CLC Response Time-out	The amount of time in seconds that the server will wait for a completed response from the CLC/GPS/GPP controller before diagnosing a disconnect. The valid range of values is 1-900 seconds.
CLC Back Plane Relay Time-out ***(Not used with GPS/GPP)***	CLC-V control cards have the ability to redirect incoming serial messages over the VME back plane to other CLC-V cards in the same rack. This allows a host to address multiple control cards with one serial connection. These transmissions may require more time than a direct serial link. The relay time-out value is used for these transactions. The valid range of values is 1-900 seconds.
Communication Retry Attempts	The number of times the server will re-send a message before it issues an error. The valid range of values is 0-255 seconds.

Error Handling

Intercept CLC Errors And Display	Checking this box will cause the server to intercept CLC error responses and displayed them in a message box. Request and poke transactions will return a failure to the client application. Advise links will remain active; however, they will return nothing until the error is resolved. The error response will be written to the error log file if that feature is enabled. If this box is not checked the error string will be returned to the client.
Make Error Messages System Modal	Checking this box will cause all server generated message boxes to have system modal attributes. This means that all applications will be suspended until the user responds to the message box. The window can not be forced to the background.
Log Errors To File	Checking this box will cause the server to log all server errors to a file. The current system date and time will be associated with each log entry. As a default this feature is not enabled.
View Log File	Pressing this button will cause the current error log file to be displayed in notepad.

DDE

Maximum Conversations	This is a static display of the maximum number of allowed DDE conversations as specified in the INI file. The server will refuse any DDE connection requests in excess of this value.
Maximum Advise Items	This is a static display of the maximum number of allowed DDE advise links as specified in the INI file. The server will refuse any requests for advise links in excess of this value.
Self Terminate If No Active Conversations	Checking this box will cause the server to close when the last DDE conversation has terminated. This is the default state.

Settings Menu - Serial Communications

The Serial Communications dialog window allows the user to select the serial communication parameters the server will use. When this dialog window is open, all communications are suspended. If changes are made to the configuration, they will take affect when the “Save” button is pressed.

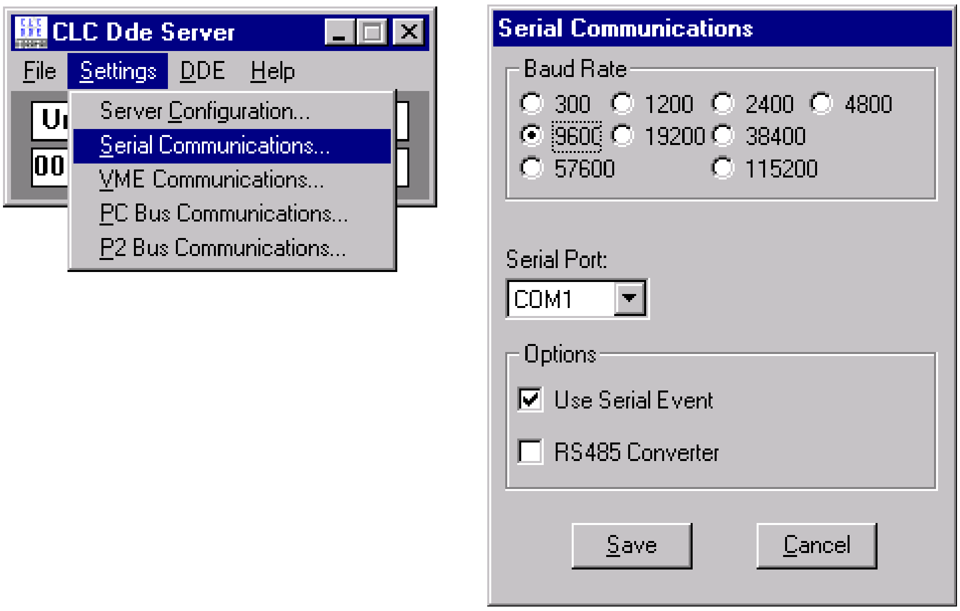


Fig. 10-4: Serial Communications

Baud Rate	Set the baud rate to match the GPS/GPP’s port as displayed in VisualMotion under menu selection ***Setup*** ⇒ ***CLC Serial Ports***.
Serial Port	Select the serial communications port to use on the PC.
Use Serial Event	Checking this box causes Windows to notify the server when a completed message is in the receive queue. This will increase the number of serial messages sent over polling for a response. Slower computers may not be able to utilize this feature.
RS485 Converter	This option should be used when an RS232 to RS485 converter is present. A delay will be inserted between messages, which is equal to at least one character transmission at the selected baud rate. This is necessary to ensure that the CLC card/GPS/GPP controller has had sufficient time in which to turn the RS485 transmitter off and enable the receiver. Please note that the converter must toggle the transmitter and receiver automatically, and disable echo back.

Settings Menu - VME Communications

The VME Communications dialog window allows the user to edit parameters that the server uses when talking over the VME bus using a XYCOM embedded PC. When this dialog window is open, all communications are suspended. If changes are made to the configuration, they will take affect when the "Save" button is pressed. The Dynamic Link Library "XVME984.DLL" must be in the control directory or the Windows™ path.

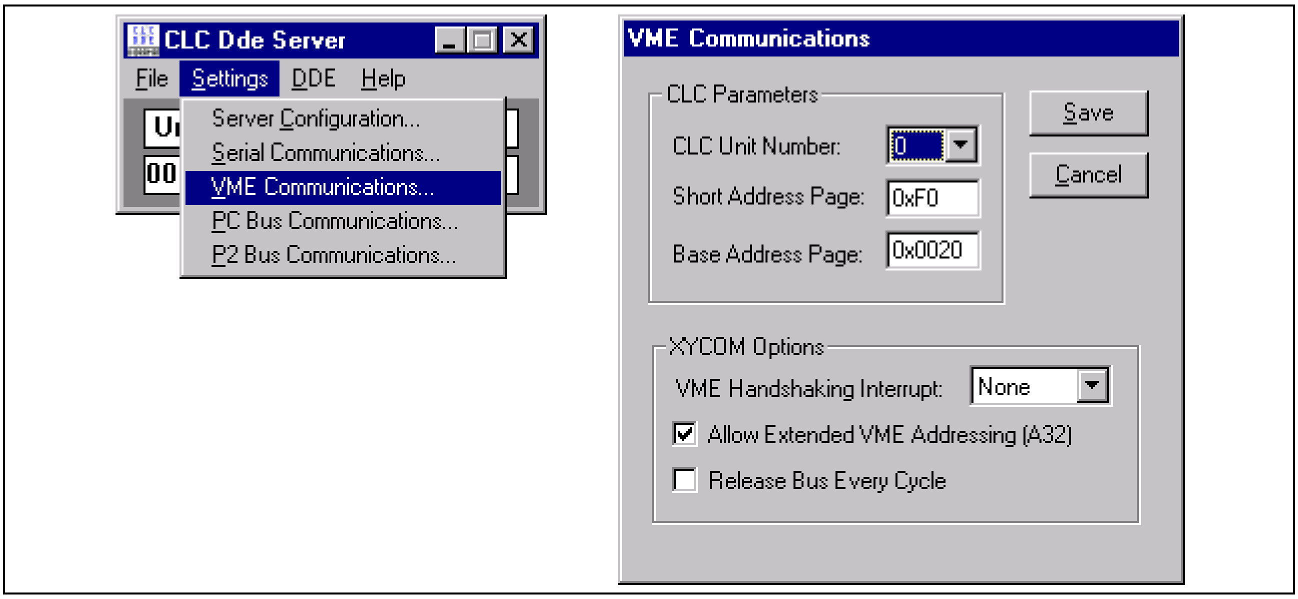


Fig. 10-5: VME Communications

Control Parameters

CLC Unit Number	The CLC unit number for the currently displayed data.
Short Address Page	The address page in short VME memory space where the selected CLC card resides.
Base Address Page	The address page in Standard or Extended memory space where the CLC's shared RAM is located.

Note: The default server settings correspond to the default control card settings and should not need to be altered.

XYCOM Options

VME Handshaking Interrupt	Select the VME interrupt which all CLC-V control cards should use to terminate a communication response. If this option is not used, the server will poll for a communication response every 55 milliseconds. Refer to your XYCOM owner's manual to configure the computers BIOS to acknowledge the selected VME interrupt.
Allow Extended VME Addressing (A32)	Check this box if the XYCOM PC can support A32 addressing.
Release Bus Every Cycle	Check this box if the PC should release the VME bus after every cycle. This will increase communication overhead due to the additional bus arbitration cycles.

Settings Menu - PC Bus Communications

The PC Communications dialog window allows the user to view control status indicators and set communication parameters. When this dialog window is open, all communications are suspended. If changes are made to the configuration, they will take affect when the “Save” button is pressed. The dynamic link library “control_P.DLL” must be in the control directory or the windows path.

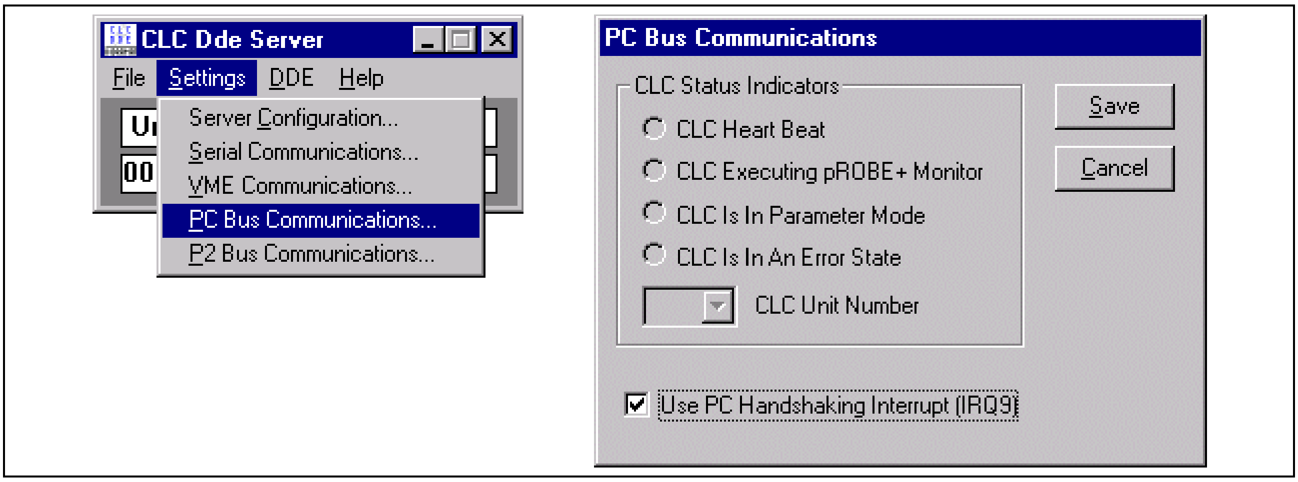


Fig. 10-6: PC Bus Communications

Control Status Indicators

CLC Heart Beat	This indicator will blink indicating that the selected CLC control card is running.
CLC Executing pROBE+Monitor	This indicator will be marked if the selected CLC control card has faulted and is running the pROBE+ monitor.
CLC Is In Parameter Mode	This indicator will be marked when the selected CLC control card is in parameter mode.
CLC Is In An Error State	This indicator will be marked when the selected CLC control card is in an error state. Card parameter 122 will contain the specific error message.
CLC Unit Number	This option selects the card number. This card number must match the settings of hardware switches S8 through S11. To locate a card without knowing the switch settings, use the following procedure: ⇒ Start with card number 0. ⇒ If sounds are active on your PC and 0 is not the correct card number, a sound will be heard. ⇒ Continue this procedure until a sound is not heard. This is an indication that the correct card number has been selected. Once this is established, use the same card number under ***Setup*** ⇒ ***Card*** Selection in VisualMotion Toolkit. Connection method must also be set to PC ISA Bus.
Use PC Handshaking Interrupt (IRQ 9)	When selected, this option will force all CLC-P control cards to terminate communication responses with a PC interrupt (*IRQ 9*). Hardware jumper S5 must be inserted on the CLC-P card for this option to work properly. If this option is not used, the server will poll for a communication response every 55 milliseconds. **Note**: When using the interrupt option on the CLC-P control card, no other hardware devices may use IRQ 9.

Settings Menu - P2 Bus Communications

The P2 Communications dialog window allows the user to view control status indicators and set communication parameters. When this dialog window is open, all communications are suspended. If changes are made to the configuration, they will take affect when the “Save” button is pressed. The dynamic link library “control_P.DLL” must be in the following Windows system directories.

- For Windows 95/98: \WINDOWS\SYSTEM
- For Windows NT: \WINNT\SYSTEM32, also required for Windows NT: control_P2.SYS in directory \WINNT\SYSTEM32\DRIVERS

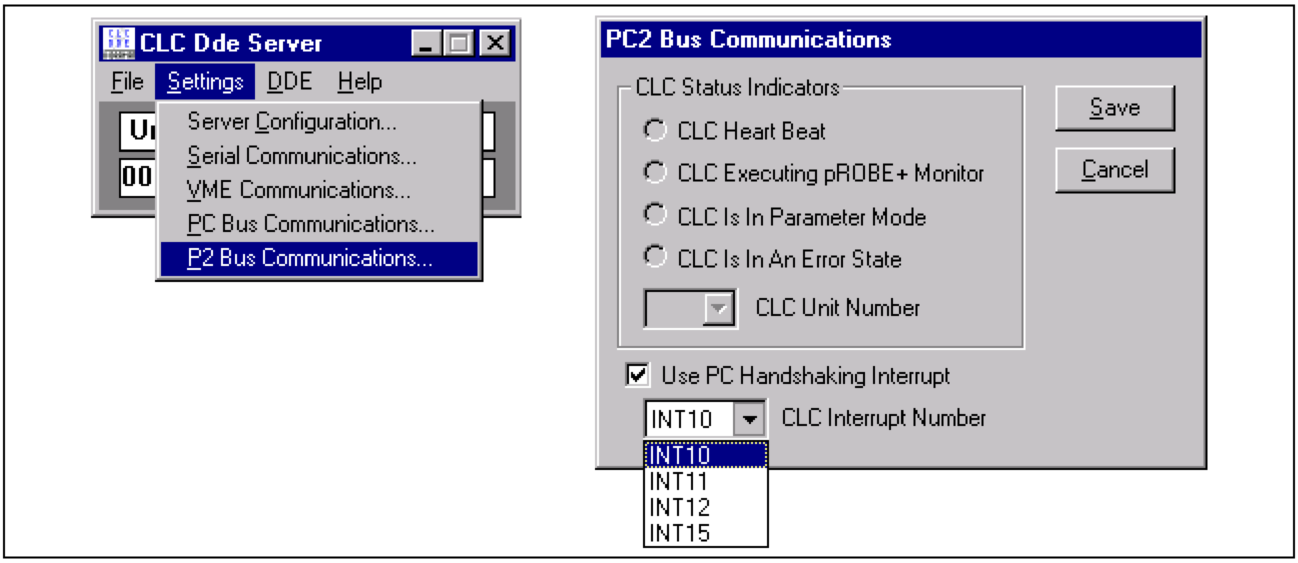


Fig. 10-7: P2 Bus Communications

Control Status Indicators

CLC Heart Beat	This indicator will blink indicating that the selected CLC control card is running.
CLC Executing pROBE+Monitor	This indicator will be marked if the selected CLC control card has faulted and is running the pROBE+ monitor.
CLC Is In Parameter Mode	This indicator will be marked when the selected CLC control card is in parameter mode.
CLC Is In An Error State	This indicator will be marked when the selected CLC control card is in an error state. Card parameter 122 will contain the specific error message.
CLC Unit Number	This option selects the card number. This card number must match the settings of hardware S1 DIP switches 1 through 4. To locate a card without knowing the DIP switch settings use the following procedure: ⇒ Start with card number 0. ⇒ If sounds are active on your PC and 0 is not the correct card number, a sound will be heard. ⇒ Continue this procedure until a sound is not heard. This is an indication that the correct card number has been selected. Once this is established, use the same card number under ***Setup*** ⇒ ***Card*** Selection in VisualMotion Toolkit. Connection method must also be set to PC-104 Bus.
Use PC Handshaking Interrupt 	When selected, this option will force all CLC-P02 control cards to establish communication responses with a PC interrupt selected. Hardware S1 DIP switches 5 through 8 settings must match the interrupt selected for this option to work properly. If this option is not used, the server will poll for a communication response every 55 milliseconds. When selected, this option will increase the handshake response time. **Note**: The default interrupt setting is INT10.

Rexroth Indramat

DDE Conversations

The DDE Conversations dialog window displays the **Conversation, Service and Topic Handles** for all of the current DDE conversations. The **Item Count** column shows the total number of active advise links, request transactions and poke transactions. Double click on a specific conversation entry in order to view the item transaction list. A second method is to select the conversation and then use the “expand” button. This dialog window is useful when creating client applications that talk to the control communications server.

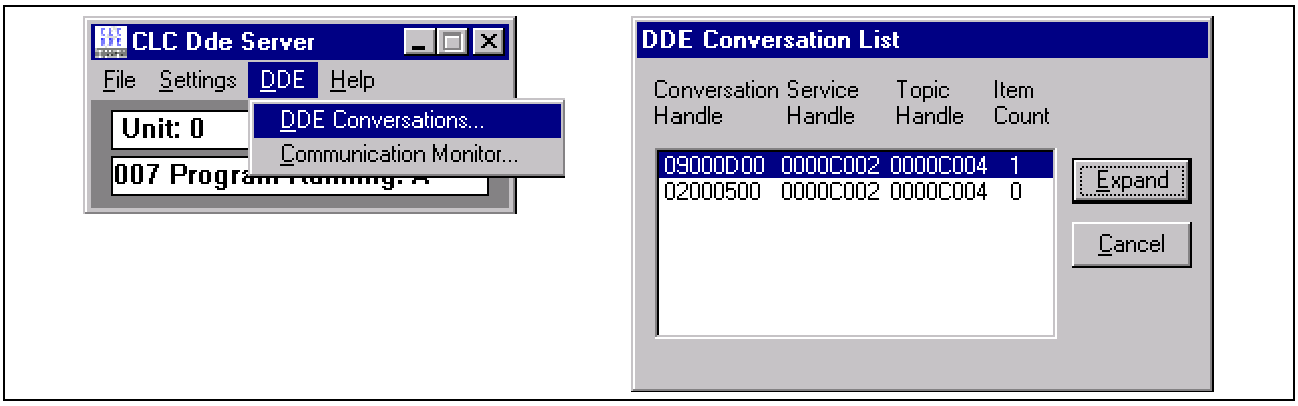


Fig. 10-8: DDE Conversations

DDE Conversation Item Dialog

The DDE Conversation Item dialog window can be used to view the item transaction list for a conversation. The Service name, Topic string, Item string, clipboard Format and Transaction Type are displayed in text format. Use the “Next” and “Previous” buttons to cycle through the current list.

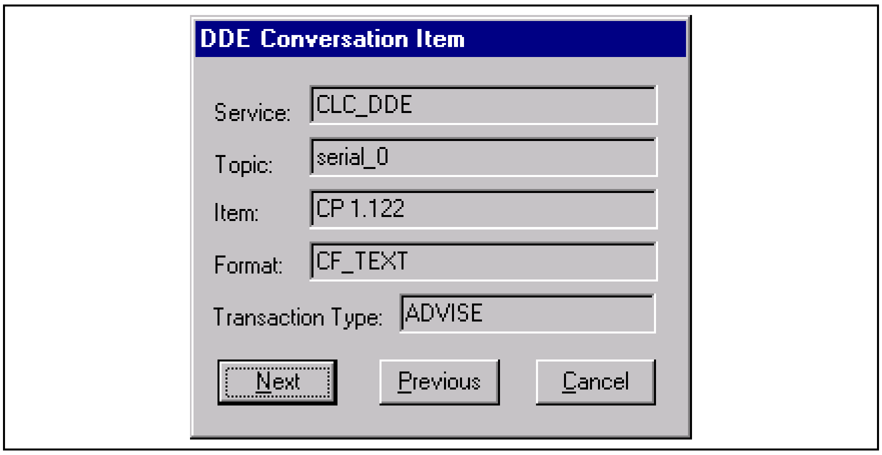


Fig. 10-9: DDE Conversation Item

Communication Monitor

The DDE Communication Monitor displays all of the current DDE conversations. The monitor can display DDE requests and/ or responses depending on the selection made under the *Settings* menu.

The active window builds a communications log of all DDE conversations that occur while the monitor is running. Selecting *Clear* will empty the log. Selecting *Stop* will stop the conversation monitoring and allow users to scroll through the log. The Monitor window can be resized to enlarge the active viewing area.

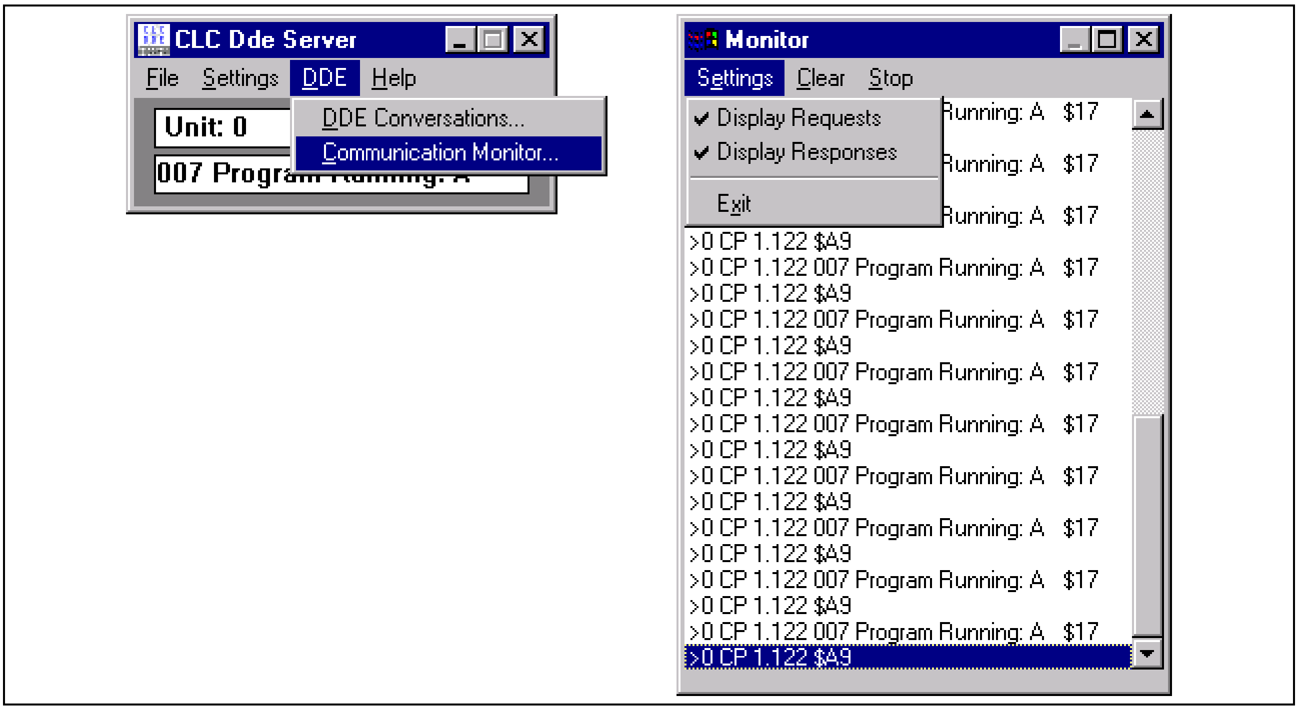


Fig. 10-10: DDE Communication Monitor

10.3 Modem Communication using TAPI Interface

VisualMotion 7 and the DDE Server can communicate with a remote GPS/GPP controller using Windows™ standard Telephony Application Programming Interface (TAPI). Any modem supporting auto-answer, no flow control, and baud rates from 9600 to 38400 can be used for communications.

Before VisualMotion can communicate with a remote GPS/GPP controller connected to a modem, the TAPI interface must be setup in VisualMotion Toolkit and the DDE Server. Select ***Setup*** ⇒ ***Card Selection*** from VisualMotion Toolkit's main menu and specifying the connection method as *AT Modem* from the Card Selection Setup window in Fig. 10-11.

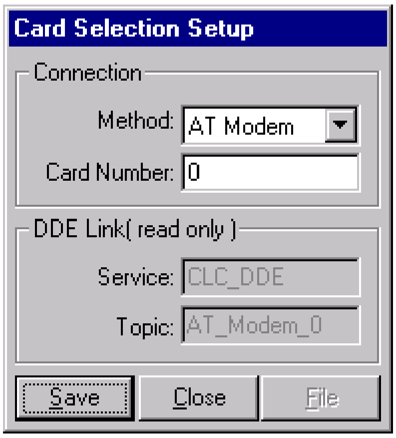


Fig. 10-11: Card Selection Setup

Technical Requirements

The remote modem communicates to the GPS/GPP controller through a serial connection and a null modem adapter. The remote modem dictates the baud rate of the connection. Thus, when the remote modem is set to 9600 baud, the local modem will assume that rate of transmission. The remote modem also must be configured to auto-answer calls with no flow control. The user must determine how to set up the specific remote modem with these parameters. An example setup that utilizes Hayes Accura 336/56K modems and an Indramat IKB0005 serial cable is shown in Fig. 10-12.

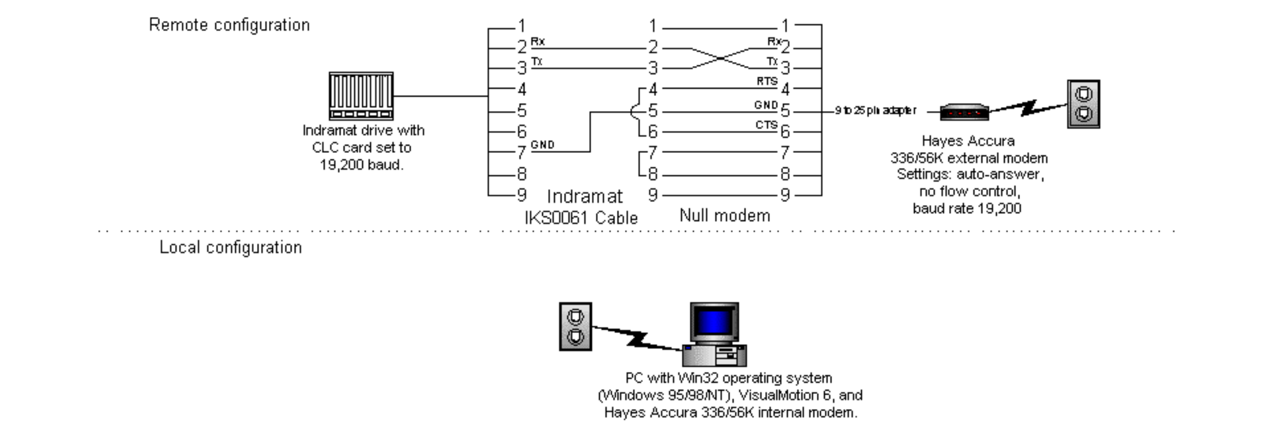


Fig. 10-12: Example Modem Setup

Modem Configuration

Once the AT Modem connection method is setup and saved in VisualMotion Toolkit, the first attempt at communicating with the GPS/GPP, such as ***Status*** ⇒ ***System***, will open the Modem Configuration window in Fig. 10-13. If a configured modem is detected, the *TAPI Line* field will display a Standard Modem. If no modem is detected, VisualMotion will display a "*TAPI line is not usable"* error. Install and/or configure a modem and reinitiate communications before continuing. For a complete listing of modem errors, refer to Table 7-2 on page 7-15.

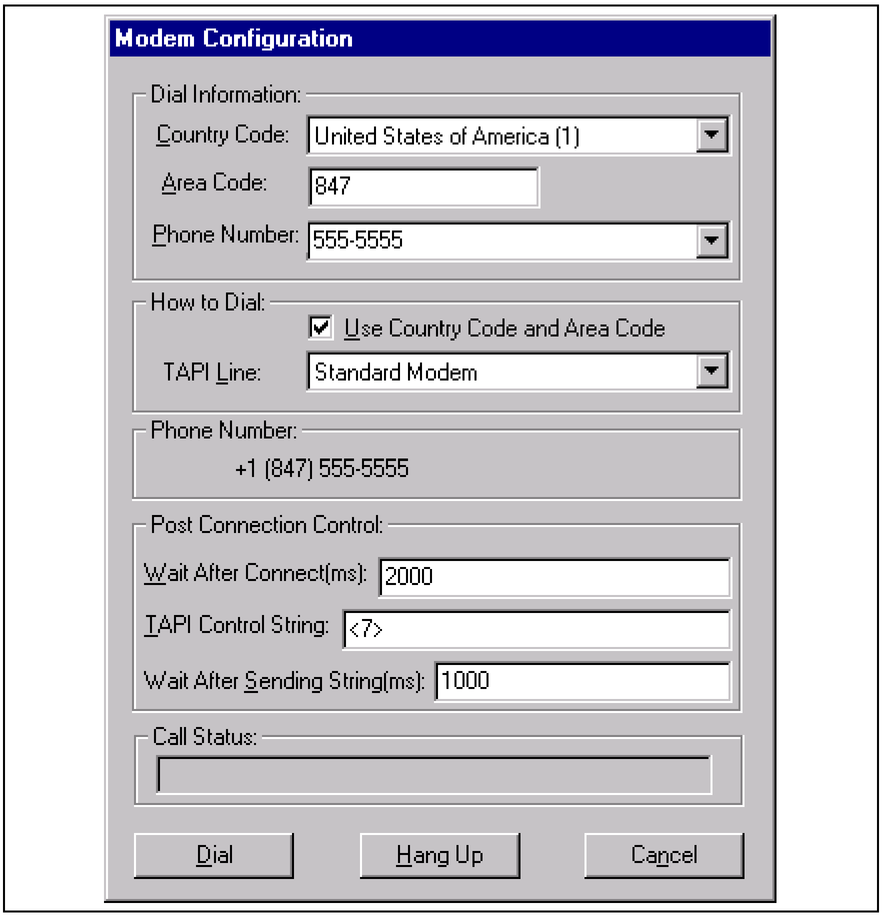


Fig. 10-13: Modem Configuration

The fields in the Modem Configuration window must be setup before actual communications can be established with the remote modem. Select the country and area code of the remote location where the GPS/GPP is setup. Enter the telephone number and *How to Dial* options and click on **Dial** button. Optional Post Connection Control fields are available for entering a timeout value (up to 10,000 ms or 10 seconds) and a control string to be written to the modem once the connection is established. The format of acceptable input control strings for the TAPI Control String fields are listed in Table 7-1. When the modem establishes communications, the Modem Configuration window disappears and VisualMotion 7 is now linked with the remote GPS/GPP controller.

TAPI Control String

The TAPI Control String field allows the user to send commands directly to the modem after a connection has been established. The string can be a mixture of control and ASCII characters. To enter control characters, use the decimal values listed in Table 10-1 surrounded by <> brackets. For example, to send <CTRL Q> followed by a 2, the user would enter <17>2 in the control string field.

ASCII Command	Decimal Equivalent
<CTRL A>	1
<CTRL B>	2
<CTRL C>	3
<CTRL D>	4
<CTRL E>	5
<CTRL F>	6
<CTRL G>	7
<CTRL H>	8
<CTRL I>	9
<CTRL J>	10
<CTRL K>	11
<CTRL L>	12
<CTRL M>	13
<CTRL N>	14
<CTRL O>	15
<CTRL P>	16
<CTRL Q>	17
<CTRL R>	18
<CTRL S>	19
<CTRL T>	20
<CTRL U>	21
<CTRL V>	22
<CTRL W>	23
<CTRL X>	24
<CTRL Y>	25
<CTRL Z>	26
<ESC>	27

Table 10-1: TAPI Control String ASCII Codes

VisualMotion Modem Error Messages

If modem connections cannot be established, VisualMotion will issue various error messages. The following table contains a list of such messages.

Error	Solution
TAPI does not support this line version.	User's version of operating system does not support TAPI 1.4. Cannot use VisualMotion 6 without 32-bit Microsoft operating system.
TAPI line error.	Select a line that can be used for telephony.
TAPI line does not support data modem.	Select another line that supports data modem use.
TAPI line cannot make outbound calls.	Select a line that supports outbound dialing.
TAPI line is already in use.	Select a new line or disconnect the current connection.
TAPI line does not support partial dialing.	Select a line that supports partial dialing.
TAPI line unable to translate phone number.	Re-enter a valid phone number.
TAPI line does not support voice call.	Select a line that supports voice calling.
TAPI line does not support Comm/Data modem class.	Select a line that supports communication and data modem.
TAPI line is not usable.	Selected line is in use or does not support data modem use. Select a line that does not have these restrictions.

Table 10-2: VisualMotion Modem Error Messages

10.4 SERVER Topic Name

The “SERVER” topic name allows a DDE client application access to CLC_DDE’s parameter set and status. The server will accept request and poke transactions. When accessing a parameter the client application should specify the section and entry names from the INI file. The two names must be separated by a pipe character (‘|’). When requesting status information the client should use “STATUS” as the section name (i.e. “STATUS|ErrorState”). RW = Read/Write RO = Read Only

Section: GENERAL

Response_Timeout	RW	1-900 Seconds	Message response time out.
Relay_Timeout	RW	1-900 Seconds	Message time out when using VME pass-through.
Communication_Retry	RW	0-255	Number of times to re-send a message.
Suspend_Polling	RO	0 or 1	If 1 CLC_DDE status polling will be disabled.
Display_control_Errors	RW	0 or 1	If 1 CLC_DDE will intercept & display control Errors.
Log_Errors	RW	0 or 1	If 1 all server errors will be logged to the error file.
Modal_Errors	RW	0 or 1	Displayed errors with the system modal attribute.
Self_Terminate	RW	0 or 1	Close CLC_DDE when last conversation terminates.
Monitor_List_Size	RW	1-500	# of entries in communication monitor window.
Editor	RW	256 Characters	Name & path of text editor to use to display error log.

Section: SERIAL

Baud rate	RO	115200..300	Baud rate for serial connection to control card.
Port	RO	1-4	COM port number to use for serial connection.
Serial_Event	RW	0 or 1	Use serial event option to increase performance.
RS485_Converter	RW	0 or 1	Activate RS485 adapter code.

Section: VME

Sustain_Bus	RW	0 or 1	Release every cycle option for XYCOM PC.
A32_Addressing	RW	0 or 1	Use A32 addressing for XYCOM PC.
VME_IRQ	RO	0-7	Number of VME IRQ to use (0 = disabled).

Section: AT_MODEM	Baud rate	RO	9600..300	Baud rate to use to communicate with the modem.
	Port	RO	1-4	COM port number the modem is on.
	Auto_Connect	RW	0 or 1	Initialize & connect on conversation connection.
	Phone	RW	50 Characters	Phone number to dial.
	Initialize_Script	RW	100 Characters	Script to initialize modem.
	Disconnect_Script	RW	100 Characters	Script to disconnect modem.
	Dial_Prefix	RW	50 Characters	Script to send to modem before telephone number.
	Escape_Sequence	RW	50 Characters	Script to send modem to return to command mode.
Section: PC	PC_IRQ	RO	0 or 1	if 1 use PC interrupt for communications.
Section: P2	PC_IRQ	RO	0 or 1	if 1 use PC interrupt for communications.
Section: DDE	Status	RO	200 Characters	CLC_DDE's status request item.
	Max_Conversations	RO	1-3274	Maximum allowed conversations.
	Max_Advise_Items	RO	1-3500	Maximum allowed advise items.
Section: STATUS	ErrorState	RO	0 or 1	If 1 CLC_DDE is issuing an error.
	ErrorText	RO	256 Characters	Error text message CLC_DDE is displaying.
	RequestState	RO	0 or 1	If 1 CLC_DDE is actively communicating.

10.5 DDE Client Interfaces

The following examples illustrate how to create custom DDE client interfaces for the Control. DDE communication allows certain software applications to read from (*request*), and write to (*poke*) the Control card.

Creating and Customizing a DDE Client Interface in Microsoft Excel™

The following example illustrates how to create a custom DDE client interface for the Control card using Microsoft Excel™ (*Version 5.0 and up*) Other programs that support DDE communication can also be used in a similar fashion. Requested information can be read directly by a spreadsheet, chart or database, while poke transactions allow users to control program execution from within this custom interface.

The example below was created for an ELS/CAM application. The instructions for creating the Control program that corresponds with this spreadsheet can be found in the *Appendix E. Example Programs*. All of the *requested* data in the spreadsheet was read from the Control card with the CAM program running.

DDE Worksheet Functions

A DDE request can be made directly from a *cell* within an Excel™ Worksheet using a formula outlined in Fig. 10-14. The Control_DDE Server should be running before a request is made. Each request is queued in the server and then handled using round robin arbitration. The Excel Worksheet will automatically update the cell as the information becomes available. The response time varies according to how many other applications are running and how many DDE conversations are occurring at the same time. Limit the number of active DDE requests within a worksheet in order to get a faster response time.

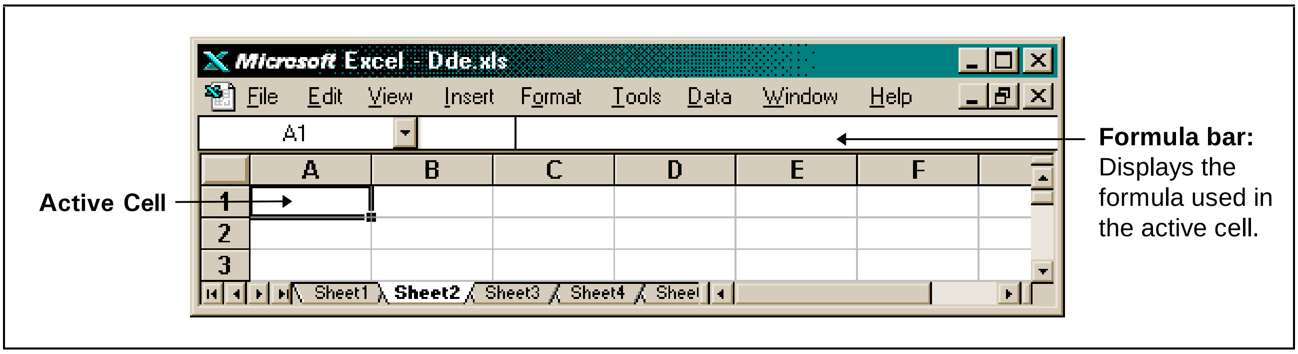


Fig. 10-14: Excel Worksheet

Select a cell and then enter the **DDE Service name**, **Topic name** and **Item name** within the formula bar using the following syntax as an example:

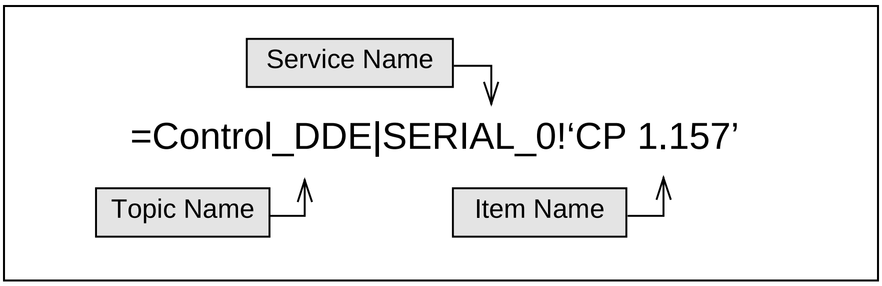
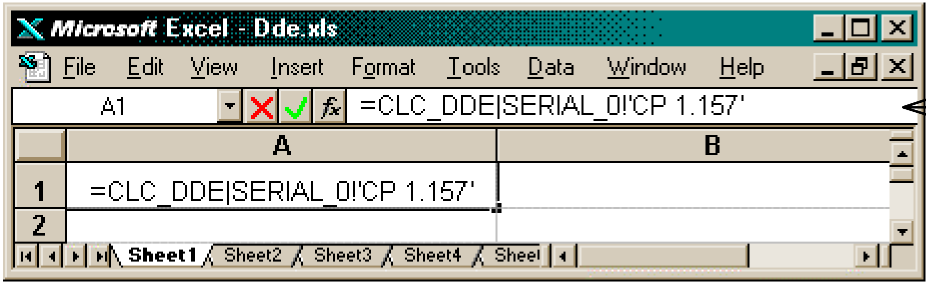


Fig. 10-15: Syntax Example



Formula bar: Displays the formula used in the active cell. To enter/edit formulas, select a cell, type the data and then press ENTER. You can also double-click a cell to edit data directly in the cell.

Fig. 10-16: Example DDE Formula

The **Item name** 'CP 1.157' will read the value of the system or "Card" Parameter C-0-0157 which is the current ELS master position.

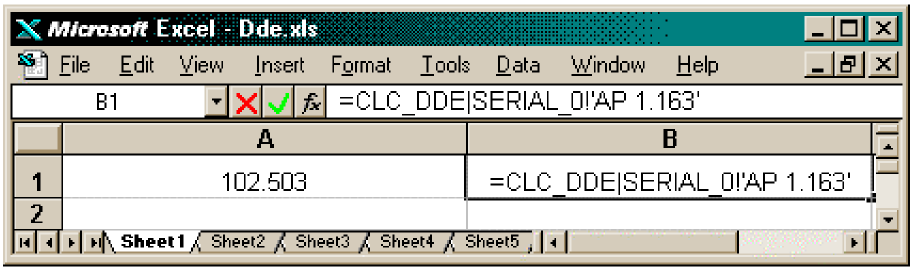


Fig. 10-17: Example DDE Formula Result

The **Item name** 'AP 1.163' will read the value of the Axis Parameter A-0-0163 which is the Control Cam Output Position. **See *Direct ASCII Communications* for the syntax used with other item names.**

A pie chart can be used to graphically illustrate the master and slave positions between 0° and 360°. Enter two formulas in the second row which subtract the ELS Master and Slave Positions from 360° (=360-A1, =360-B1). Select each column and create a pie chart using the Excel *Chart Wizard*. If the Control_DDE Server is active and an ELS program is running the pie charts will rotate to reflect the current ELS positions as they change.

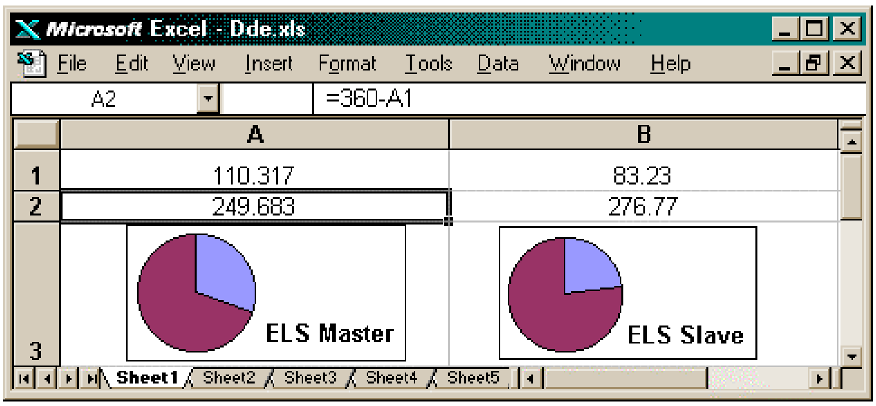


Fig. 10-18: Pie Chart

DDE Functions using Visual Basic® for Excel™

Visual Basic® for Excel™ has its own DDE Functions that can be used in a spreadsheet macro or module. The following Visual Basic® macros illustrate how to use the *DDERequest* and *DDEPoke* functions. The *DDERequest* function is used to read the values of the CAM coefficient and phase offset parameters. The *DDEPoke* function is used to write values to predefined program variables that were added in the spreadsheet. Each variable also has a corresponding **Item name** needed for DDE communication.

The variables listed in column A were predefined in the CAM program to store the CAM coefficients and Phase Adjust values. **Macro 1** requests the current coefficient values from the corresponding Control System (card) and Axis parameters.

Note: *When making a DDERequest from a macro the Service name and Topic name are included in the DDEInitiate function and assigned to a variable (MYControl)*.

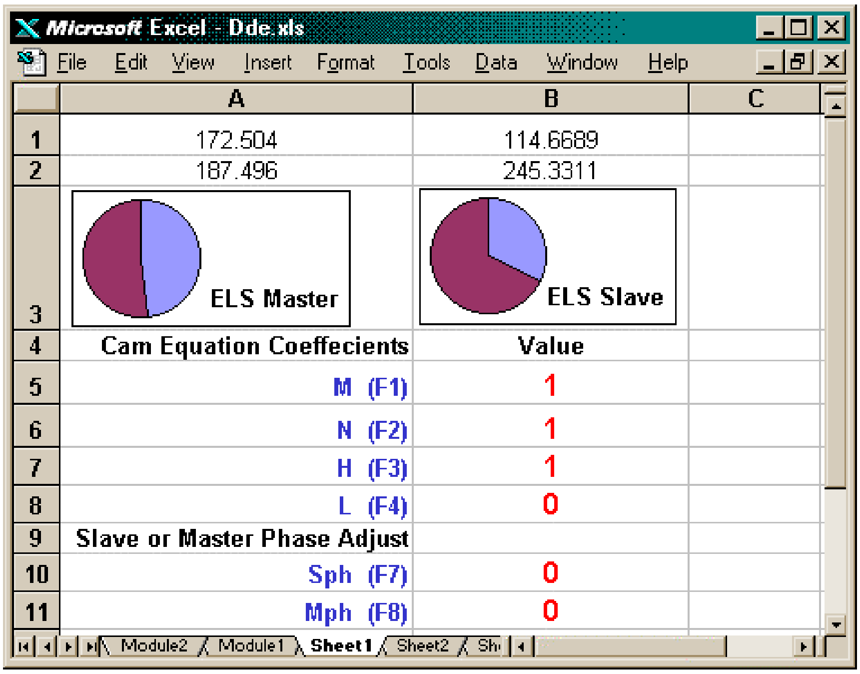


Fig. 10-19: Macro 1

```
Function Request()

MYControl = DDEInitiate("Control_DDE",
"SERIAL_0")

m = Application.DDERequest(MYControl, "AP
1.032")
Worksheets(1).Cells(5, 2).Value = m
n = Application.DDERequest(MYControl, "AP
1.031")
Worksheets(1).Cells(6, 2).Value = n
h = Application.DDERequest(MYControl, "AP
1.033")
Worksheets(1).Cells(7, 2).Value = h
l = Application.DDERequest(MYControl, "AP
1.035")
Worksheets(1).Cells(8, 2).Value = l
sph = Application.DDERequest(MYControl, "AP
1.162")
Worksheets(1).Cells(10, 2).Value = sph
mph = Application.DDERequest(MYControl, "AP
1.151")
Worksheets(1).Cells(11, 2).Value = mph

End Function
```

DDEInitiate ("Service Name", "Topic Name")

A-0-0032 Cam Slave Factor (M)

A-0-0031 Cam Master Factor (N)

A-0-0033 Cam Stretch Factor (H)

A-0-0035 Cam Master Position (L)

A-0-0162 Cam Slave Phase Adjust

A-0-0151 ELS Phase Offset

Additional variables were added to column A to adjust the ELS Master velocity (F5) and the active CAM number (I1). Column C contains the **Item name** that corresponds with each program variable (F1-F8 and I1). The DDEPoke command in **Macro 2** references the worksheet for the DDE **Item name** and value for each variable.

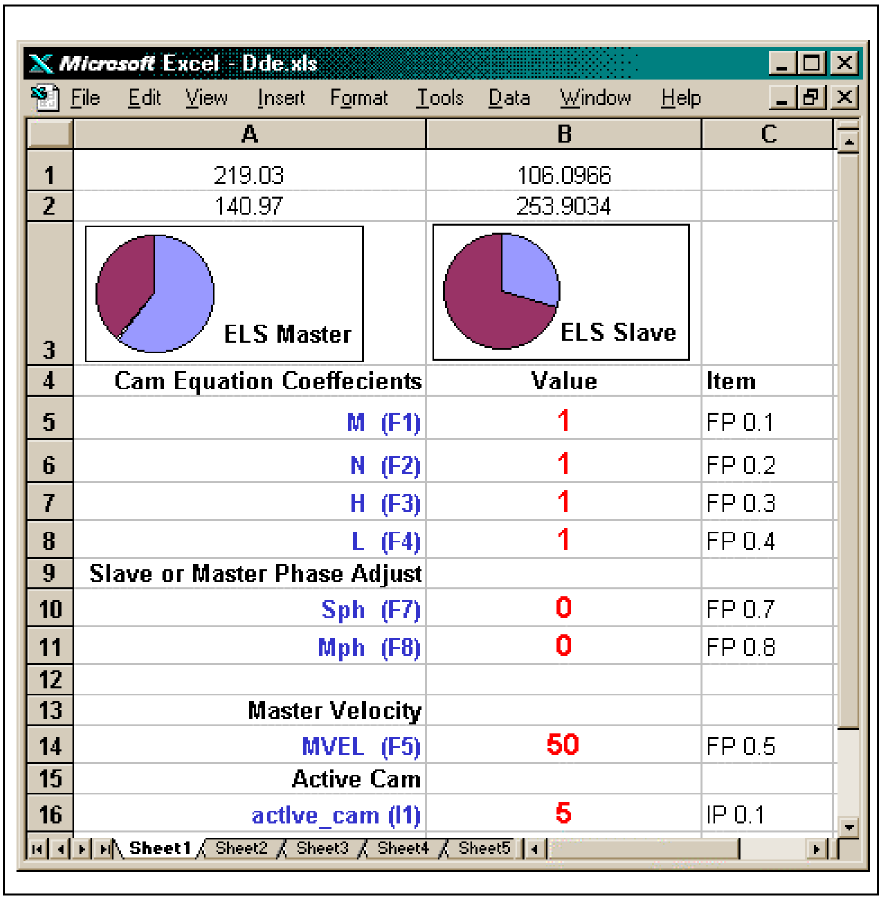


Fig. 10-20: Macro 2

When **Macro 2** is executed the data in the value column will be written or “poked” to the variables defined by the corresponding **Item names**. This allows the user to see how different values will alter the performance of the slave axis with respect to the master. The DDEPoke command uses the following syntax:

Application.DDEPoke *MYControl*, *Item Name*, *Value*

MYControl is defined in the *DDEInitiate* command and includes the DDE **Service name** and **Topic name.**

```
Function Poke()

MYControl = DDEInitiate("Control_DDE", "SERIAL_0")

Application.DDEPoke MYControl, Worksheets(1).Cells(5, 3).Value, Worksheets(1).Cells(5, 2)
Application.DDEPoke MYControl, Worksheets(1).Cells(6, 3).Value, Worksheets(1).Cells(6, 2)
Application.DDEPoke MYControl, Worksheets(1).Cells(7, 3).Value, Worksheets(1).Cells(7, 2)
Application.DDEPoke MYControl, Worksheets(1).Cells(8, 3).Value, Worksheets(1).Cells(8, 2)
Application.DDEPoke MYControl, Worksheets(1).Cells(10, 3).Value, Worksheets(1).Cells(10, 2)
Application.DDEPoke MYControl, Worksheets(1).Cells(11, 3).Value, Worksheets(1).Cells(11, 2)

Application.DDEPoke MYControl, Worksheets(1).Cells(14, 3).Value, Worksheets(1).Cells(14, 2)

Application.DDEPoke MYControl, Worksheets(1).Cells(16, 3).Value, Worksheets(1).Cells(16, 2)

End Function
```

Wonderware

In order for Wonderware to communicate with the Control, a DDE link between the two must be created. The link, or DDE Access, tells Wonderware what Windows application to use (clc_dde.exe server) in order to communicate with the Control. This application must be running in order for Wonderware to communicate with the Control.

1. To establish a DDE link:

Choose DDE Access Names under the Special Menu in Intouch Development. The DDE Access Name Definition window will open

Press the Add button:

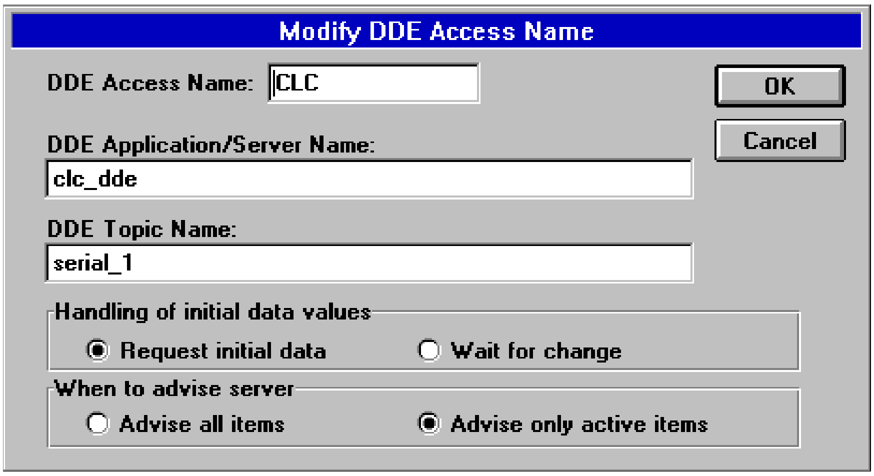


Fig. 10-21: Modify DDE Access Name

DDE Access Name:

The DDE Access Name can be any name you choose.

DDE Application/Server Name:

For the Control, this is the clc_dde server (clc_dde.exe) provided in the Visual Motion toolkit. It is not necessary to use the *.exe* extension. It is good practice, however, to include the path for the clc_dde server in the DOS Path statement and to configure Wonderware to launch the clc_dde server. If Wonderware is in your Windows Start-up group, then the clc_dde server application should also be in that group. Since Windows launches applications in the startup group from left to right, the clc_dde server icon should be to the left of the Intouch icon.

Topic Name:

The topic name will depend upon the method of communication between the computer and the Control. The following items describe the different methods of communication.

Serial Communications

If you are communicating with the Control (D, P, or V) via the computer's serial port, the topic name will be "serial_*x*" where *x* is the Control device number, card parameter C-0002. The default for a CLC-D and CLC-P is device #0. The CLC-V is switch selectable via the Mode switch on the front of the card.

PC Backplane Communications

If you are communicating with the CLC-P via the PC backplane, the topic name will be "isa_*x*" where *x* is the PC address of the card.

VME Backplane Communications

If you are communicating with the CLC-V via the VME backplane, the topic name will be "xycom_*x*" where *x* is the VME card address set by the Mode switch on the front of the CLC-V.

If you are still not sure of the topic name, it can be found in the Control server application after Visual Motion has established communications with the Control. To find the active topic name, open "Server Configuration" under the Settings menu in the clc_dde server application. The topic name is found in the "Control Status Display" box.

Tagnames

To display a Control parameter, variable, etc. in Wonderware, the following type of tagname can be used:

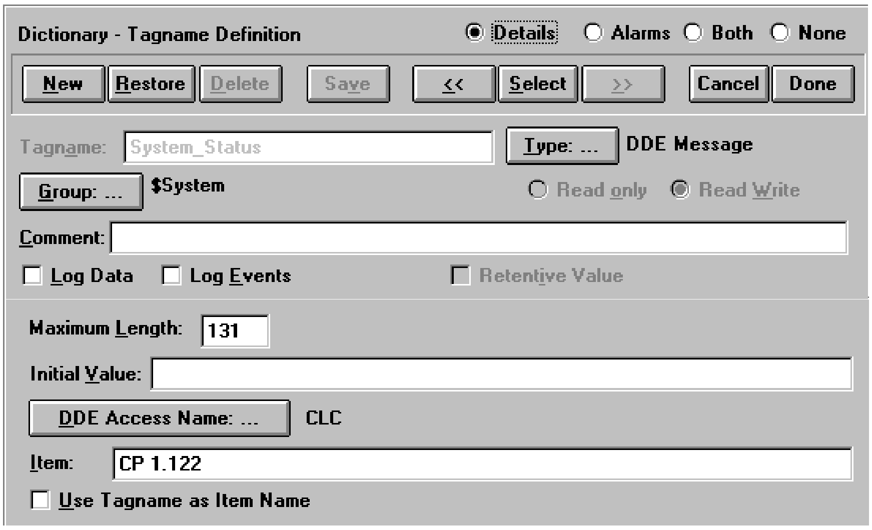


Fig. 10-22: Tagname for Displaying Parameters

The tagname in above is labeled *System_Status*. It is type DDE Message, since it is only displaying the parameter. DDE Access name is “Control”.

The item field requests the parameter or variable to display; for example, the item request C-0-0122, system status is entered in the figure above. Other examples:

Parameters	**Example**	
Card	CP 1.122	C-0-0122 System Status Message
Task	TP 1.123	Task A param. 123, Task Status Message
Drive	DP 2.95	Drive 2, param 95 Drive Status Message
Axis	AP 3.4	Axis 3, param. 4 Axis Options
Variables	**Example**	
Floating Points	FP 0.12	Active Program, float # 12
Integers	IP 1.5	Program #1, integer #5
Global Floats	GF 0.1	Active Program, global float #1
Global Integers	GI 2.2	Program #2, global integer #2

To write to a Control variable, parameter, etc, the following type of tagname can be used:

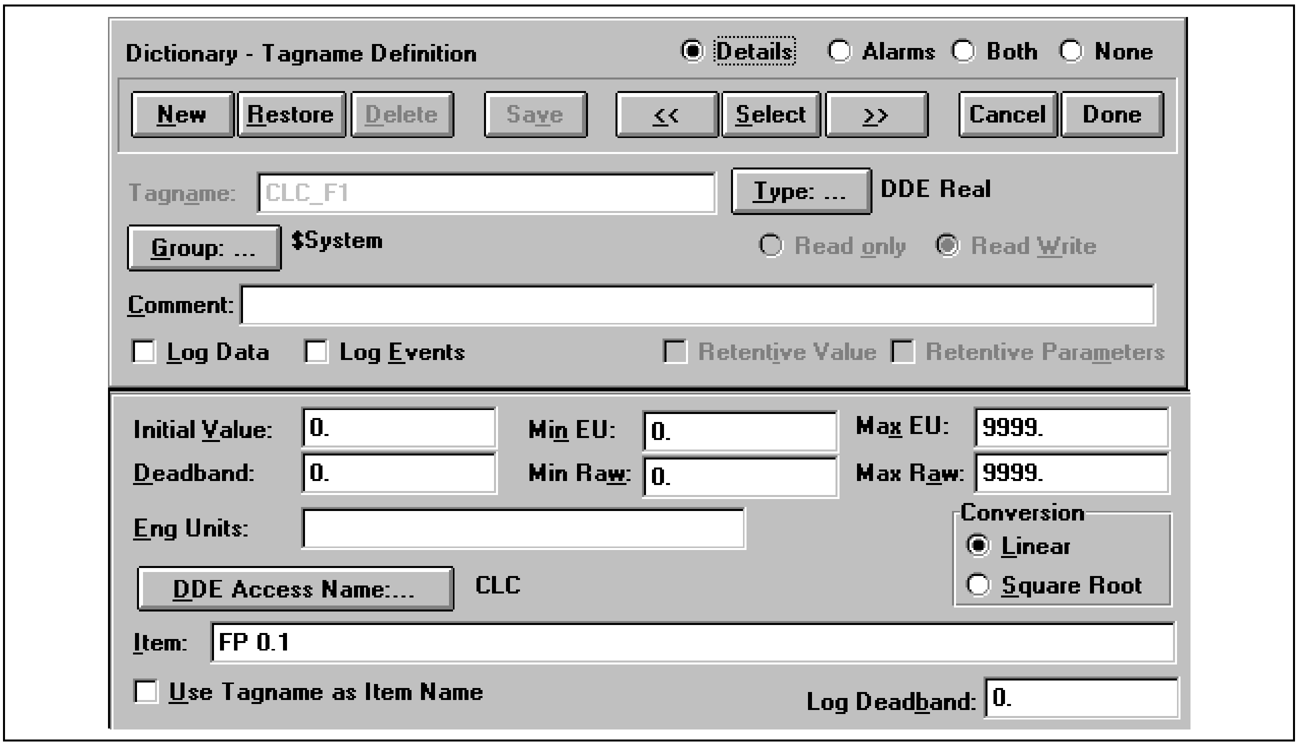


Fig. 10-23: Tagname Definition

The tagname in above makes floating point variable #1 of the active Control program a DDE real variable. The value of FP 0.1 can be changed in Wonderware by changing the value of the tagname, Control_F1.

To change a bit in a Control register:

Configure a tagname as a Type DDE Integer, min EU -99999, min Raw -99999

max EU 99999, max Raw 99999

Tagname Reg_100

Item RD 0.100

The above tagname will write to register 100. To change a specific bit in that register, configure a pushbutton as shown below.

Object type: Button

Button Type: User Input, Discrete

Tagname: Reg_100.00

The above button has two states, on and off. When in the on state, register 100 bit 1 will be set to 1. When in the off state, that bit will be set to 0. To write to bit 2, change the tagname to Reg_100.01, bit 3 = Reg_100.02, bit 4 = Reg_100.03, ... bit 16 = Reg_100.15

11 Program Debugging and Monitoring

11.1 Finding Program Problems

Identifying errors in complex programs can be a difficult and frustrating process. Therefore, understand the application and design a program structure around the application.

Start with simple, basic program blocks. Test the blocks, independently if possible, even if testing requires writing a bit more program just for test purposes. A tested and dependable section of a program allows you to focus on just the potential problem areas. If the program compiles correctly, make sure that the problem lies with the program, not the hardware. If necessary, write short test programs to test individual hardware functions.

Use a program branch and the VisualMotion's message capabilities to insert a message into your program. Shortly stopping the program and checking critical values can tell you where things are going wrong.

Think through the implications of using triggered events. Remember that events and the execution of event functions typically occur asynchronously to program tasks. You cannot always depend on the timing of triggered events. It may be necessary to add additional program code to provide synchronization.

The following Task parameters can also be used to help with program debugging:

- T-0-0130 Current Instruction Pointer
- T-0-0131 Current Instruction
- T-0-0132 Instruction Pointer at Error
- T-0-0133 Composite Instruction Pointer
- T-0-0135 Current Subroutine
- T-0-0136 Stack Variable Data
- T-0-0137 Task Subroutine Breakpoint
- T-0-0138 Sequencer Information
- T-0-0200 Last Active Event Number

If the program does not compile, or compiles with errors, use VisualMotion's "Display Code" selection from the File menu to check that the compiler is generating the instructions you intend. Remember that the compiler doesn't check your program's logic, the compiler can only check for proper syntax and use. VisualMotion's compilers typically provide error or warning dialog windows that refer to line numbers in the displayed code. The following section provides the syntax of the displayed code.

Test Code

A typical example of additional code for testing program functionality is the use of counters. One way to implement a counter would be to change the state of an I/O bit after a distance event has occurred. After each move that is suppose to trigger the event, increment an integer variable called “move_count.” Then, use a branch statement to test whether the I/O bit did in fact change state. If it did, then increment an integer variable called “event_count.” The final value of “event_count” can be compared to “move_count” to see if, in fact, the event occurred once for every move.

11.2 Control Compiler Base Code

Compiling an Icon or Text Language program produces a text file output listing in Control Base Code, using mnemonics and syntax similar to assembly language. The Base Code resulting from the compilation of a program may be viewed using Window's Notepad by selecting "Display Code" from the VisualMotion File menu. Base Code may also be viewed using a compatible ASCII-only text editor.

Base Code is typically used as an aid to debugging when checking a program for logical errors. Base Code files are view-only program listing files. Editing a Base Code file has no effect on a subsequent re-compilation of the program.

The labels in a Base Code listing result from both user-defined labels and the labels that are generated internally by the VisualMotion compiler.

Base Code instruction mnemonics and valid arguments

The following lists the Base Code instruction mnemonics and valid arguments. Instructions requiring more than one argument show the arguments separated by commas. Alternative forms for arguments are shown by enclosing a general form for each argument in square brackets, separated by a vertical bar "|".

ABORT_PATH

ABORT_PATH [task]
Halts coordinated motion in the specified task.

ACCEL

ACCEL [axis | label | Ix | GIx],[rate | label | Fx | Gfx]

Sets the acceleration rate for the specified axis.

AXES

AXES task mode, axis,

Specifies the axes to be assigned to this task and how they will be used. (All axes used in a task must be declared for that task.)

Task mode:

1. for single axis non-coordinated motion.
2. for coordinated axis for multi-axis coordinated motion.
3. for velocity mode, rotation only - no axis positioning.
4. for ratioed slave axis.
5. for ELS mode.
6. for Torque mode.

Axis = a valid identifier for an axis, from 1 to the maximum number of axes

AXES_GROUP

AXES_GROUP task mode, axis, axis, axis, axis, axis, axis

AXIS_EVENT

AXIS_EVENT [axis | label | Ix | GIx], event #1, event #2, event #3, event #4

Enables up to four Repeating Position events for a single-axis, ELS, ratio, or velocity mode axis.

Event # = [an integer Event # | label | Ix | GIx]

AXIS_ATPOSITION

AXIS_ATPOSITION axis, position

where

Axis = drive number

Position = position to wait for

AXIS_WAIT

AXIS_WAIT [axis | label | Ix | Gix]

If the argument is a positive integer representing a valid axis, program execution waits for the axis to be within its preset drive position window. If the argument is -1, program execution waits until all axes in the task are within their position windows. The position window is defined by the drive parameters: Position Window and Zero Velocity. AXIS_WAIT will wait indefinitely if used with velocity mode (axis task mode 3) since positioning is not used.

BNE

BNE label (subroutine or event)

Branches to label if the task's status word is set to "not equal."

BEQ

BEQ label (subroutine or event)

Branches to label if the task's status word is set to "equal."

BGT

BGT label (subroutine or event)

Branches to label if the task's status word is set to "greater than."

BLT

BLT label (subroutine or event)

Branches to label if the task's status word is set to "less than."

BGE

BGE label (subroutine or event)

Branches to label if the task's status word is set to "greater than or equal."

BLE

BLE label (subroutine or event)

Branches to label if the task's status word is set to "less than or equal."

BRA

BRA label (subroutine or event)

Branch to label, always (no matter what)

CALL_FUNC

CALL_FUNC func_offset, ret_pointer, arg_count, arg1_ptr, ... argn_ptr

Calls the function at func_offset with a return pointer and a variable number of arguments.

func_offset	offset in bytes from current program counter to start of function
ret_pointer	pointer to int or float return variable if (0), there is no return value

arg_count	number of arguments passed to the function if (0), there are no arguments there can be between 1 and 5 arguments
arg1_ptr... argn_ptr	pointer to argument passed to function can be int, float, global int, global float, constant int, constant float, local int, local float, absolute or relative point label used as initial value of local variable

CALC

CALC evaluates the equation

CAP_ENABLE

CAP_ENABLE axis, probe, event#

Enables the event on the axis for the probe transition. When the transition occurs, the event triggers.

Axis = from 1 to the maximum number of axes

Probe:
1 = probe 1, 0 --> 1

2 = probe 1, 1 --> 0

3 = probe 2, 0 --> 1

4 = probe 2, 1 --> 0

Event = [event # **|** label **|** Ix **|** GIx]

CAP_SETUP

CAP_SETUP axis, probe

At program activation, the drive is configured to capture feedback position on its probe transition and to include position data in its cyclic telegram data.

Axis = from 1 to the maximum number of axes

Probe:
1 = probe 1, 0 --> 1

2 = probe 1, 1 --> 0

3 = probe 2, 0 --> 1

4 = probe 2, 1 --> 0

CLEAR

CLEAR [Ix | GIx | Fx | GFx | label]

Sets integer or float variable to zero

COMP

COMP [Ix | GIx | Fx | GFx | label], [Ix | GIx | Fx | GFx | label]

Set the task's status word to the logical result of 1st argument minus 2nd argument.

DATA_SIZE

DATA_SIZE I, F, ABS, REL, EVT, ZONE

Sets the amount of memory allocated for each type of data in one of the four program tasks. (The total program requirement is the sum of the DATA_SIZE allocations for each task in the program.)

I = the number of integer variables allocated for this task

F = the number of floating point variables allocated for this task

ABS = the number of absolute point table entries allocated for this task

REL = the number of relative point table entries allocated for this task

EVT = the number of event table entries allocated for this task

ZONE = the number of zone table entries allocated for this task

DEC

DEC *[Ix | GIx | label]*

Subtracts 1 from the specified integer variable

DECEL

DECEL *axis, rate*

Sets the deceleration rate for the axis

Axis = [integer constant | label | Ix | GIx]

Rate = [floating point constant | label | Fx | GFx]

ELS_ADJUST

ELS_ADJUST *axis, offset*

Sets the phase or velocity offset for the ELS axis.

Axis = [integer constant | label | Ix | GIx]

Offset = [floating point constant | label | Fx | GFx]

ELS_ADJUST1

ELS_ADJUST1 axis, offset, type

Axis = [integer constant | label | Ix | GIx]

Offset = [floating point constant | label | Fx | GFx]

Type:

1 = absolute

2 = incremental

3 = continuos +

4 = continuos –

ELS_GROUPM

ELS_GROUPM group number, control register, status register, float block, integer block

where

Group number = 1 to 8

ELS_GROUPS

ELS_GROUPS group number, axis number, motion type

where

Group number = 1 to 8

Axis number = 1 to 32

Motion type:

1 = phase

2 = velocity

3 = card cam

4 = drive cam

ELS_INIT

ELS_INIT ELS type, slave axis, master axis, encoder, sync type

Initializes the relationship between master and slave axes.

ELS type:

1 = Virtual Master

2 = Real Master (daisy-chained)

3 = Real Master (SERCOS)

4 = follow axis feedback

Slave axis = [integer constant | label]

Master axis = [integer constant | label]

Encoder:

1 = primary encoder

2 = secondary encoder

Sync type:

1 = velocity

2 = phase

ELS_MASTER

ELS_MASTER float block, integer block

ELS_MODE

ELS_MODE axis, mode

Sets the mode for the specified ELS axis.

Axis = [integer constant | label | Ix | GIx]

Mode:

1 = single axis

2 = ELS synchronization

ELS_STOP

ELS_STOP

END

Defines the end of the program for the task.

EVENT_DONE

EVENT_DONE event

Marks the specified event status as complete.

Event = [integer constant | Ix |GIx | label]

EVENT_ENABLE

EVENT_ENABLE event

Activates the specified repeating timer event.

Event = [integer constant | Ix | GIx | label]

EVENT_END

Defines the end of an event routine program code.

EVENT_START

Marks the beginning of an event routine program code.

EVENT_WAIT

EVENT_WAIT event

Pauses task execution until the specified active event completes.

Event = [integer constant | Ix | GIx | label]

FUNC_ARG

func_label: FUNC_ARG label, type, <min value>, <max value>

Declares local variables.

func_label	text label of function
Label	text string identifier of local variable
Type	'F'=float, 'I'=integer, "ABS"= ABS point index, "REL"= REL point index
min value	optional minimum value of argument
max value	optional maximum value of argument

FUNC_END

func_label: FUNC_END return value

Indicates the end of a function and optional return value.

Func_label	text label of function
Return value	return argument

FUNC_START

func_label: FUNC_START

Indicates the start of the function named by 'func_label'.

Func_label	text label of function

GET_PARAM

GET_PARAM type, set, ID number, destination

Copies the specified parameter data to the specified integer or floating point variable (the variable type must match the parameter type).

Type:

A = axis

C = system

D = drive

T = task

Set = axis or drive ([integer constant | Ix | label]), or task ID letter

ID number = identifying parameter number (range 1 to 65535)

Destination = destination variable, [Ix | GIx| Fx | GFx | label]

GO

GO axis

Starts continuous motion on the axis. The axis must be configured as non-coordinated or velocity mode.

Axis = [integer constant | Ix | GIx | label]

HOME

HOME axis

Enables motion homing the specified axis. (The homing parameters must have been set in the DDS drive.)

Axis =[integer constant | Ix | GIx | label]

INC

INC [Ix | label]

Adds 1 to the specified integer variable.

LOCAL/VAR

func_label: LOCAL/VAR label, type

Declares local variables.

Func_label	text label of function
Label	text string identifier of local variable
Type	'F'=float, 'I'=integer

MESSAGE

MESSAGE type, message, variable

where

Type:

1 = status

2 = diagnostic

Message = Up to 80 characters

Variable = Fx, Ix, GFx, Gix

MESSAGE_PORT

func_label MESSAGE_PORT target, string, <pointer>

Outputs formatted string to designated port.

Func_label	text label of function
Target	1 = diagnostic message. 2 = status message. 3 = serial host port(Port A). 4 = serial teach pendant port(Port B).
String	Formatted text string to display, formatting types are %d, %f, %x
pointer	Optional single argument - Rx, Fx, Ix, GFx , or GIx

MOVE_JOINT

MOVE_JOINT ABS point

Moves the joint based on an absolute point (six-axis CLC only.)

ABS point = [integer constant | Ix | GIx | label], an entry in the absolute point table

KINEMATIC

KINEMATIC kinematics library number

Selects the set of equations specified by the library number from an optional kinematics library. Used to translate Cartesian coordinates for custom coordinated motion applications such as robotics.

MOVEA_AXIS

MOVEA_AXIS axis, distance, event, event, event, event

Starts single axis absolute motion for the specified axis, and activates the specified events.

Axis = [integer constant | Ix | GIx | label]

Distance = [floating point constant | Fx | GFx | label]

Event = [integer constant | Ix | GIx | label]

MOVER_AXIS

MOVER_AXIS axis, distance, event, event, event, event

Starts single axis relative motion for the specified axis, and activates the specified events. An event is specified by an integer number index into the event table or a label for an integer variable containing the index.

Axis = [integer constant | Ix | GIx | label]

Distance = [floating point constant | Fx | GFx | label]

Event = [integer constant | Ix | GIx | label]

MOVEA_PATH

MOVEA_PATH ABS point

Starts coordinated motion from the current position to the point specified in the absolute point table.

ABS point = [integer constant | Ix | GIx | label]

MOVER_PATH

MOVER_PATH ABS point, REL point

Starts coordinated straight line motion from the current position to the point specified by the vector sum of the absolute and relative points.

ABS point = [integer constant | Ix | GIx | label]

REL point = [integer | Ix | GIx | label]

MOVEA_CIRCLE

MOVEA_CIRCLE ABS point, ABS point

Starts coordinated motion from the current position, through the first specified point, ending at the second specified point.

ABS point = [integer constant | Ix | GIx | label]

MOVER_CIRCLE

MOVER_CIRCLE REL point, REL point, ABS point

Starts coordinated motion from the current position, through the point specified by the vector sum of the ABS point and the first REL point, ending at the point specified by the vector sum of the ABS point and the second REL point.

ABS point = [integer constant | Ix | label]

REL point = [integer constant | Ix | label]

MSG_DIAG

MSG_DIAG ASCII text string

Sets the current diagnostic message to the specified ASCII text string.

MSG_STATUS

MSG_STATUS ASCII text string

Sets the current status message to the specified ASCII text string.

PARAM_BIT

PARAM_BIT type, set, ID number, source, I/O mask

Sets the parameter bit specified by the type, set, ID number and I/O mask to the value in the specified source variable at initialization.

Type:

A = axis

C = system

D = drive

T = [A | B | C | D] (task ID letter)

Set = [integer constant | Ix | GIx | label] for axis or drive; or [A | B | C | D] for task

ID number = [integer constant] for a parameter number in the range 1 to 65535

Source = [integer constant | floating point constant | Ix | GIx | Fx | GFx | label]

I/O mask = specifies 1 to 16 bits in an I/O register

PARAM_INIT

PARAM_INIT type, set, ID number, source

Sets the specified parameter to the value in the specified variable at initialization.

Type:
A = axis

C = system

D = driveT = [A | B | C | D] (task ID letter)

Set = [integer constant | Ix | GIx | label] for axis or drive; or [A | B | C | D] for task

ID number = [integer constant] for a parameter number in the range 1 to 65535

Source = [integer constant | floating point constant | Ix | GIx | Fx | GFx | label]

PID_CONFIG

PID_CONFIG #, type, control_register, status_register, loop_time, set_point_type, set_point, set_point_axis, feedback_type, feedback, feedback_axis, output_type, output, output_axis, control_block

#: PID loop number, range 1-10.

type: PID loop type, currently only 1 is valid.

control_register: label or number of register used for control of this loop.

status_register: label or number of register used for status of this loop

loop_time: update time of this loop, multiples of 8 millisecond.

set_point_type: Type of set point, 1=variable, 3=unsigned register, 4=signed register

set_point: Axis parameter, register, variable, or equivalent label to be used as the set point of this loop.

set_point_axis: For axis parameters, axis number; else 0.

feedback_type: Type of feedback, 1=variable, 2=axis parameter, 3=unsigned register, 4=signed register

feedback: Axis parameter, register, variable, or equivalent label to be used as the feedback of this loop.

feedback_axis: For axis parameters, axis number; else 0.

output_type: Type of output, 1=variable, 2=axis parameter, 3=unsigned register, 4=signed register

output: Axis parameter, register, variable, or equivalent label to be used as the output of this loop.

output_axis: For axis parameters, axis number; else 0.

control_block: First variable in a block of 20 float variables(Fx) to be used for this loop.

See also **VAR_INIT**.

PLS_INIT

PLS_INIT switch number, 0, output register, master type, axis/number, offset

PLS_INIT switch number, element, on position, off position

where

Switch number = 1

Element = 1 to 16

On position = 0 to 360

Off position = 0 to 360

Offset = 0 to 360

Axis/number = drive number if drive based / 1 or 2 if real master

Master type:

1 = ELS

2 = Virtual

3 = Real(1 or 2)

4 = drive based

PLS1_INIT

PLS1_INIT switch number, 0, output register, master type, number, offset, mask register

PLS1_INIT switch number, element, on position, off position, lead time

where

Switch number = 1

Element = 1 to 16

On position = 0 to 360

Off position = 0 to 360

Lead time = 0 to cycle time

Number = ELS Master or ELS Group number

Master type =

5 = ELS Master

6 = ELS Group

POSITION

POSITION task, ABS point

Copies the current position coordinates of the specified task to the specified ABS point table entry. The contents of the point table entry are overwritten.

Task = [A | B | C | D]

ABS point = [integer constant | Ix | GIx | label]

RATIO

RATIO master axis, slave axis, master ratio, slave ratio

Sets the ratio between the specified master and slave axes.

Master axis = [integer constant | Ix | GIx]

Slave axis = [integer constant | Ix | GIx]

Master ratio = [floating point constant | Fx | GFx]

Slave ratio = [floating point constant | Fx | GFx]

READ

READ register, count, target variable

Copies the contents of the specified I/O register(s) to the lower 16 bits of the specified integer variable(s). The upper word of the variable(s) is zero-filled. Only a contiguous block of registers can be moved.

Register = an integer constant specifying the number of the starting source I/O register.

Count = a positive integer constant for the number of register to copy target variable = the starting integer variable table entry for the destination of the data.

RESUME_PATH

RESUME_PATH task

Restarts previously halted coordinated motion in the specified task.

Task = [A | B | C | D]

RETURN

Marks the end of a subroutine's program code, and returns program execution to the calling program.

ROBOT_ORGIN

ROBOT_ORIGIN *point*

where

Point = relative point index to be used as origin

ROBOT_TOOL

ROBOT_TOOL *point*

where

Point = relative point index to be used as tool offset

ROTARY_EVENT

ROTARY_EVENT *type, axis, event1, event2, event3, event4* (GPP)

ROTARY_EVENT *axis, event1, event2, event3, event4* (GPS)

where

Event1 = index of event to trigger

Event2 = index of event to trigger

Event3 = index of event to trigger

Event4 = index of event to trigger

Type = drive number if drive based / ELS Master or ELS Group number

0 = Drive

1 = ELS Master

2 = ELS Group

Axis = drive number if drive based / ELS Master or ELS Group number

SET

SET I/O state, register, I/O mask

Sets the specified register's bits, that are enabled by the I/O mask, to the state specified by I/O state.

I/O state = 16 bit binary word of bits to set in the specified register. 0 = off, 1 = on.

Register = an integer number specifying an I/O register

I/O mask = 16 bit binary word specifying the bits that may be changed. 1 = enabled

SET_PARAM

SET_PARAM type, set, ID number, source

Copies the specified parameter's value to the specified integer or floating point variable. The source variable data type must match the destination parameter data type.

Type:
A = axis

C = system

D = driveT = task

Set = [Ix | GIx | label] for axis or drive; or [A | B | C | D] for task ID letter]

ID number = identifying parameter number, within the range: 1 to 65535

Source = [integer constant | floating point constant | Ix | GIx | Fx | GFx | label]

START

Marks the beginning of a task or subroutine.

STOP

STOP axis

Signals the drive to halt single-axis or velocity mode motion on the specified axis if the argument is a positive integer (1 - 8). If the argument is -1, motion is halted for all single-axis and velocity mode axes in the task. Signaling the drive to halt motion decelerates the axis to zero velocity using the deceleration rate programmed in the appropriate drive parameter.

Axis = [integer constant | Ix |GIx | label]

STOP_PATH

STOP_PATH task

Stops coordinated motion in the specified task.

Task = [A | B | C | D]

TEST

TEST register, I/O mask

Sets the task's status word to the result of a logical AND of the specified register and the I/O mask.

Register = a positive integer constant for a modifiable CONTROL register.

I/O mask = 16 bit binary word.

V_MASTER

V_MASTER number, control register, status register, float block, integer block

where

Number = 1 to 6

VAR_INIT

VAR_INIT ar_start, arg1, arg2, arg3... arg20

var_start: First variable in a block of program variables(Fx, Ix) to be initialized.

arg1- arg20: initializing values.

VEL

VEL axis, rate

Sets the velocity specified by rate in the specified task axis.

Axis = [integer constant | Ix | GIx | label]

Rate = [floating point constant | Fx | GFx | label]

WAIT

WAIT delay

where

Delay = 1 to 32767 msec

WAIT_IO

WAIT_IO register, I/O mask, I/O state

Suspends task execution until the specified I/O conditions are met.

Register = an integer constant for a CONTROL register

I/O mask = identifies 1 to 16 bits in an I/O register

I/O state = 0 --> off; non-zero --> on

WAIT_PATH

WAIT_PATH task, ABS or REL point, condition

Suspends task execution until the specified path planner conditions are met.

Task = [A | B | C | D]

ABS point = [integer constant | Ix | GIx | label], reference to an absolute table entry

REL point = [integer constant | Ix | GIx | label], reference to a relative table entry

Condition:

0 = Ready

1 = Accel

2 = Slew

3 = Blending

4 = Target decel

5 = Controlled stop

6 = Stopped

7 = At target

8 = Done

WRITE

WRITE register, count, source

Copies the data in the specified integer variable(s) to the specified I/O register.

Register = an integer number for the starting destination I/O register.

Count = a positive integer constant for the number of registers to copy.

Source = an integer number for the starting source integer variable table entry.

11.3 Icon Language Warnings and Error Messages

VisualMotion Icon Compiler generates the following warning messages. After receiving a warning message you may continue or exit the compilation.

- Data missing in one or more fields, do you still wish to continue?
- Caution! Changing Modes may halt motion. Continue?
- Caution! Changing Modes may start motion. Continue?
- File does not contain source program!
- Icon workspace at end is not empty. Program parts will be lost, continue anyway?
- Transfer failed!

VisualMotion’s Icon Compiler displays the following error messages:

- More than one connect icon with number %d!
- Function variables must be defined first!
- Data Size icon objects exceed size of non-volatile ram!
- Change to default registers and variables for this number?
- Only one ELS System Master icon allowed per program!
- Only one Virtual Master icon allowed per program!
- Only eight ELS Groups allowed!
- Only ten PIDs allowed!
- Only four CAM Indexers allowed!
- Warning! Frequent changes of static drive parameters can cause premature failure of it's non-volatile memory.
- Valid Entries are '0' or '1'.
- Invalid name!
- Cannot change task or open dialog window while dialog window is open
- Axis undefined or not unique.
- Valid event numbers are 1 to 100.
- Valid axis numbers are 1 to 8.

- Valid number range is 1 - 32767.
- Valid percents are 1 - 100.
- Labels must start with an alpha character!
- Label name already exists!
- Number missing or out of range.
- Selected Icon is not a subroutine or no icon selected!
- Data Field Empty!
- Label type must be defined!
- Task name undefined.
- No filename specified.
- Non-Branch icons have only two output connections.
- Branch icons have only two output connections.
- Point out of range.
- Connection could not be made, try connecting adjacent ---?
- Only connections between icons or adjacent blocks can be ---?
- Finish icon not found or open path!
- Start icon not found or multiple Start icons found!
- Icon program not found!
- Cannot open code file!
- Unknown icon term _______.
- Missing axis selection.
- Open in program flow, at or near highlighted icon, ---?
- Branch Icon has missing connection or one in wrong dire ---?
- No axis selected!
- Time Delay out of range!
- Could not initialize update timer!
- Operation type not selected!
- Drive numbers doesn’t match.
- Should drive number be c ---?
- Can’t open file ________!
- Source or target not selected!
- Valid range ___ - ___
- Valid range ___ - ___
- CONTROL card parameters cannot be changed!
- File syntax other than parameters!
- File of different type parameters!
- CONTROL card is not communicating!
- No selection made!

11.4 Text Language Error Messages

The following are error messages produced by the Visual Motion text compiler. Line numbers refer to code displayed by selecting "Display Code" from the Visual Motion *File menu*. For further information on the format of the code displayed see Control Compiler Base Code.

First Pass Errors

- CONTROL code converter error log file!
- Unable to open source file!
- Line [nnn], Maximum number of terms reached!
- Line [nnn], unknown mnemonic operator - [xxx]
- Line [nnn], unknown, missing or wrong argument - [xxx]
- Line [nnn], missing point argument!
- Line [nnn], missing closing bracket "]"!
- Line [nnn], additional arguments - [xxx...]!
- Line [nnn], point number ’??’ out of range (1-nn)!
- Line [nnn], missing arguments!
- Line [nnn], unknown IF conditional terms - [?] [?]!
- Line [nnn], ELSE or ENDIF without IF term!
- Line [nnn], maximum number of nested IFs exceeded!
- Line [nnn], sequencing error, IF, ELSE, or ENDIF imbalanced
- Line [nnn], missing message text!
- Line [nnn], incompatible circle arguments - [xxx]
- Line [nnn], variable out of range - [variable name]
- Line [nnn], right side of EQU must be a number - [____]!
- Line [nnn], label [label name] not found
- Line [nnn], arguments must be integer or constant!
- Line [nnn], bit number [nn] out of range (1-nn)!
- Line [nnn], register number [nn] out of range (1-nn)!
- Line [nnn], integer variable number [nn] out of range (1-nn)!
- Line [nnn], register number + count exceeds range (1-nn)!
- Line [nnn], axis number [nn] out of range (1-n)!
- Line [nnn], mode number [nn] out of range (0-n)!
- Line [nnn], mark "_____" also defined on line [nn]!
- Mark [_____] on line [nnn] was not referenced in program!
- Mark [_____] used on line [nnn] is not declared!
- Line [nnn], event number [nn] out of range (1-nn)!
- Line [nnn], delay value [n...] out of range (1-n...)!
- Line [nnn], too many arguments!

Second Pass Compiler Errors

Line xx, more than one equal operator.

On line xx, more than one “=” character was found.

Line xx, colon used for other than mark!

A colon was found beyond the first word on line xx.

Line xx, function start found inside of subroutine!

A Start icon was found inside a subroutine on line xx.

Line xx, function end found without function start!

A Finish icon was found without first finding a Start icon on line xx.

Duplicate local argument ’xx’ found in subroutine ’yy’!

Two local arguments with the same name xx were found in subroutine yy.

Subroutine ’xx’ has more than 5 user accessible arguments!

A subroutine can only have 5 arguments passed to it. Subroutine xx has more than 5.

Subroutine ’xx’ has more than 16 local variables/arguments!

A subroutine can only have 16 local or stack variables. Subroutine xx has more than 16.

Line xx, invalid sequencer list index ’xx’!

An error was made while defining a sequencer on base code line xx. One of the sequencer “list_Numbers” is greater than 30 or has been entered out of sequence (0,1,2,3,4,5).

Line xx, invalid sequencer step index ’yy’!

An error was made while defining a sequencer step on base code line xx. One of the sequencer steps “step_Numbers”, yy, is greater than sequencer functions defined in the “DATA/SIZE instruction of the program or has been entered out of sequence (0, 1,2,3,4,5).

Number of sequencer step names exceed sequencer step size!

The number of sequencer steps found is greater than sequencer Steps defined in the “DATA/SIZE instruction of the program.

Number of sequencer names exceed sequencer list size!

The number of sequencer names found is greater than sequencer Lists defined in the “DATA/SIZE instruction of the program.

Line xx, invalid axis number - yy!

An error was found in the PLS/INIT instruction on base code line xx. The “axis” number yy is not valid for the type selected. Valid ranges are:

Type	Range
1or 2	1-2
3 or 4	1-32
5	1-6
6	1-8

Line xx, invalid PLS master type - yy, range 1 – 4.

An error was found in the PLS/INIT instruction on base code line xx. The “type” yy is not a value from 1 to 4.

Line xx, duplicate label ‘yy' or multiple definition of variable!

An error was found in the FUNCTION/ARG instruction or START icon on base code line xx. The label yy was used already.

Line xx, error in number of function arguments - yy!

An error was found in the CALL instruction or SUB icon on base code line xx. The number of arguments yy, passed to the subroutine is different than defined in the function called.

Line xx, index ’yy’ is a float!

An error was found on base code line xx. The index used to a variable is a float (i.e. F[F5]).

Line xx, two names assigned to a sequencer ’yy’!

An error was made while defining a sequencer on base code line xx. A sequencer index ‘yy’ is given two different names.

Line xx, same name assigned to two sequencers ’yy’!

An error was made while defining a sequencer on base code line xx. The same name ‘yy’ is given to two sequencers.

Line xx, invalid cam option type ’yy’!

An error was made while defining the CAM/BUILD instruction on base code line xx. The cam option or type ‘yy’ is outside the range 1-4.

Line xx, end point ’yy’ is less than start point!

An error was made while defining the CAM/BUILD instruction on base code line xx. The point defined as the end_point ‘yy’ is less than the start point.

Line xx, invalid cam wait option - yy, range 0 - 1

An error was made while defining the CAM/BUILD instruction on base code line xx. The wait option ‘yy’ is outside the range 0-1.

Maximum number of messages reached!

The number of messages, status and diagnostic, allowed per program is 500. An attempt to exceed this was found.

Multiple PLS initializations found!

More than one instruction was found to define the same PLS data .

Line xx, invalid message type, range 1 - 2

An error was made in the MESSAGE instruction on base code line xx. The valid range of values are 1-2.

Line xx, invalid cam type ’yy’! 0=CLC, 1=Drive.

An error was made in the CAM/ENGAGE instruction on base code line xx. The value ‘yy’ is invalid, valid range of values is 0-1.

Line xx, ELS slave ’yy’ same as master!

An error was made in the ELS/INIT instruction on base code line xx. The slave axis ‘yy’ is the same as the master axis.

Line xx, invalid PID number ’yy’, range 1 - 10

An error was made in the PID/CONFIGURE instruction on base code line xx. The loop number ‘yy’ is invalid, range is 1-10.

Line xx, invalid PID type ’yy’, range 1 - 1

An error was made in the PID/CONFIGURE instruction on base code line xx. The type ‘yy’ is invalid, the only type available is 1.

Line xx, same PID status and control registers ’yy’

An error was made in the PID/CONFIGURE instruction on base code line xx. The same register number ‘yy’ was used for the control and status, they must be different.

Line xx, invalid PID loop time ’yy’, range 8 - 152

Line xx, PID loop time ’yy’, not multiple of 8

An error was made in the PID/CONFIGURE instruction on base code line xx. Loop times are multiples of 8 ms, from 8 to 152. The value ‘yy’ is not valid.

Line xx, Data initialization ’yy’, exceeds data range

Line xx, variable block ’yy’ exceeds variable allocation!

An error was made in the VAR/INIT instruction on base code line xx. An attempt was made to initial variables beyond their range with ‘yy’. Increase size of variables in DATA/SIZE instruction.

Line xx, Multiple configurations For PID loop yy

An error was made in the PID/CONFIGURE instruction on base code line xx. More than one initialization found for PID ‘yy’.

Line xx, PID control blocks overlapping ‘yy’

An error was made in the PID/CONFIGURE instruction on base code line xx. A float variables control block overlaps another.

Line xx, invalid PID argument ‘yy’

An error was made in the PID/CONFIGURE instruction on base code line xx. Invalid set_point_type, feedback_type, or output_type found ‘yy’, valid range 1-4.

Line xx, zone element ’yy’ missing or entered with spaces!

Line xx, zone element ’yy’ unknown!

An error was defining a zone element instruction on base code line xx. Invalid text found was ‘yy’.

Line xx, Missing open parenthesis!

An error was found in a mathematical expression on base code line xx. A closed parenthesis found without matching open.

Line xx, invalid ELS Group number 'yy', range 1 – 8

An error was made in the ELS_GROUP instruction on base code line xx. Invalid group number found ‘yy’, valid range 1-8.

Line xx, multiple ELS Master instructions found!

A second ELS_MASTER instruction was found on base code line xx. Only one ELS_MASTER instruction is allowed per program.

Line xx, multiple ELS Group ‘yy’ instructions found!

A second ELS_GROUP instruction for group ‘yy’ was found on base code line xx. Only one ELS_GROUP instruction per group is allowed in a program.

Line xx, axis ’yy’ found in multiple ELS Group instructions!

A second ELS_GROUP instruction for axis ‘yy’ was found on base code line xx. An axis can only be assigned to one ELS_GROUP.

Line xx, invalid ELS Master number ’yy’, range 1 - 6

An error was made in the ELS_MASTER instruction on base code line xx. Invalid master number found ‘yy’, valid range 1-6.

Line xx, Valid modes are 0=axis, 1=ELS Master, 2=ELS Group !

An error was made in the ROTARY/EVENT instruction on base code line xx. Valid modes are 0=axis, 1=ELS Master, 2=ELS Group

Line xx, invalid Virtual Master number ’yy’, range 1 - 2

An error was made in the V_MASTER instruction on base code line xx. Master number ‘yy’ is not in the range 1-2.

Line xx, Illegal syntax : syntax ’yy’ is not allow at the moment.

An error was made in the mathematical equation instruction or Calc icon on base code line xx. Syntax ‘yy’ is not allowed in this sequence of terms.

’*xxxx*’ - unresolved mark reference.

The mark '*xxxx*' was used as a destination in a branch or subroutine call, but was not found in the code. Check for possible spelling error or missing subroutine.

Line *xx*, all probe types zero or not unique!

The probe arguments are both zero or are the same.

Line *xx*, argument ’*yyyy*’ out of range!

The argument *’yyyy’* is out of range, check syntax in manual.

Line *xx*, axes missing or not unique!

In a AXES_GROUP command for ratioed axis, the slave axis argument is zero or is the same as the master axis.

Line *xx*, axis number ’*yyyy*’ out of range (*wwww*, *xxxx, 1-zzzz*).

The axis number or label '*yyyy*' has not been resolved to a valid number. The numbers '*wwww*', '*xxxx*', and range 1 to '*zzzz*' are valid axis numbers.

Line *xx*, bit number ’*yyyy*’ out of range (1-16)!

On line '*xx*', the string '*yyyy*' is evaluated to number outside of the valid range for register bits.

Line *xx*, 'compare' arguments must be floats, integers, or constants!

Compare arguments must be Fx, GFx, GIx, Ix or equivalent labels or constants. Compares are derived from "IF" statements in textual language programs or "BRANCH" icons in GUI programs.

Line *xx*, event element ’*yyyy*’ missing or entered with spaces!

On line 'xx', the compiler has not found a "]" in the event string 'yyyy'. It uses this to position to the start of the event element. The event element { s, t, d, a, f, m }must follow immediately.

Line *xx*, event element ’*yyyy*’ unknown!

The event element '*yyyy’* was not found in the event element table, check manual for exact syntax.

Line *xx*, event EVT[].*yy* data is not changeable in program

Line *xx*, event function '*yyyy*' not found in program!

The event function 'yyyy' was not found in the program. Check spelling and capitalization.

Line *xx*, event message '*yyyy*' must start with quotes!

The compiler is expecting a quote to start the ASCII string for the event message, but did not find it.

Line *xx*, event number '*yyyy*' out of range!

On line '*xx*', the string '*yyyy*' was evaluated to be out of the range for events defined for this program. Events and other variables are declared in the "DATA/SIZE" command in a textual language program or by the "SIZE" icon in GUI programs.

Line *xx*, float number '*yyyy*' conversion error!

The string 'yyyy' for conversion to a float was determined to contain one of the following errors:

No numeric characters.

More than one exponent symbol 'E' ('e').

More than two sign symbols'.

More than one decimal point.

Alpha characters other than 'E' ('e').

Line *xx*, hex number '*yyyy*' conversion error!

On line '*xx*', the string '*yyyy*' is greater than 10 characters long or contains non-hexadecimal characters. Valid strings start with 0x and contain ASCII characters 0-9, A-F or a-f (0x1BF8).

Line *xx*, integer number '*yyyy*' conversion error!

The string 'yyyy' for conversion to an integer was determined to contain one of the following errors:

No numeric characters.

Number of numeric characters exceed 10.

The converted number exceeds 0x7FFFFFFF.

Line *xx*, Invalid argument '*yyyy*'!

Line *xx*, Invalid cam number '*yyyy*'! Range 1 to 8.

The CAM number *'yyyy'* was evaluated to be less than one or greater than 8.

Line *xx*, Invalid count or count plus register exceeds range!

The count of registers to be transferred was evaluated to be less than one or when added to the starting register exceeds the maximum register range (512 registers for GPS/GPP).

Line *xx*, Invalid Encoder type '*yyyy*', 1=primary, 2=secondary!

The ELS master encoder type *'yyyy'* was evaluated to be less than one or greater than 2.

Line *xx*, Invalid ELS type '*yyyy*', range 1 to 4!

The ELS type *'yyyy'* was evaluated to be less than one or greater than 4.

Line *xx*, Invalid sync type '*yyyy*', 1=velocity, 2=phase, 3=cam!

The ELS sync type *'yyyy'* was evaluated to be less than one or greater than 3.

Line *xx*, Invalid VME Address '*yyyy*'!

The VME address *'yyyy'* was evaluated to be less than one or greater than 0xFCFEFFFF.

Line *xx*, Invalid VME address width '*yyyy*'!

The address width *'yyyy'* was not found in the table of VME address widths.

{"A16," "A24", "A32"}

Line *xx*, Invalid VME byte order '*yyyy*'!

VME byte order *'yyyy'* must start with 'I' or 'M', 'I' is for Intel order, 'M' is for Motorola. It can be a single character or the name, Intel or Motorola. It is case sensitive, so 'I' and 'M' must be capitalized.

Line *xx*, Invalid VME count '*yyyy*'!

The count of VME objects to transfer *'yyyy'* was evaluated to be less than one or greater than 32767.

Line *xx*, Invalid VME data width '*yyyy*'!

The data width *'yyyy'* was not found in the table of VME bus widths.

{"D32", "D16", "D8"}

Line *xx*, Invalid VME data format '*yyyy*'!

The data format *'yyyy'* was not found in the table of VME data formats.

{"I32", "I16", "I8", "U32", "U16", "U8", "F32", "POINT"}

Line *xx*, Left term '*yyyy*' of equation must not be constant!

A calculation must have a variable(Fx, GFx, GIx, Ix) or changeable table element(ABS[1].x, EVT[3].d, etc.) as its term to the left of the equal sign.

Line *xx*, Maximum number of terms reached.

When parsing the line 'xx', the number of terms exceeded 32. A term is one or more alphanumeric characters followed by a space, comma or other non-alphanumeric character. This error usually only occurs in message statements with many short words. Try a message with fewer words.

Line *xx*, Maximum size (20) of term exceeded!

While parsing line *'xx'* for arguments a string of more than 20 characters was encountered. Arguments and argument labels are limited to 20 characters. Check label length and use of commas between arguments.

Line *xx*, Message exceeds 80 characters!

The number of characters used in the message exceeds 80 characters. This count includes spaces.

Line *xx*, missing argument(s)!

One or more additional arguments were expected.

Line *xx*, missing beginning quotes of message!

On line ’xx’, quotes were expected to denote the start of the message. Diagnostic, status and event messages are specified within quotes in textual language programs. Also, use quotes when using the "CALC" icon to set an event message.

Line *xx*, missing closing bracket ’]’!

The closing bracket used to denote the end of the index of a data structure was not found.

Line *xx*, missing closing curly brace ’}’!

The closing brace used to denote the end of initialization data for a data structure was not found. Other causes are extra arguments or the wrong character.

Line *xx*, missing closing quotes of message!

On line ’xx’, quotes were expected to denote the end of the message. Diagnostic, status and event messages are specified within quotes in textual language programs. Also, use quotes when using the "CALC" icon to set an event message.

Line *xx*, missing mark name!

The argument of branch command does not start with an alpha character. Check for missing or misspelled argument.

Line *xx*, Parameter <type> must be ’A’, ’C’, ’D’ or ’T’

The parameter class was not found to be ’A’, ’C’, ’D’, ’T’, or equivalent label. Check for missing or misspelled argument.

Line *xx*, point element ’*yyyy*’ missing or entered with spaces!

On line ’xx’, the compiler has not found a "]." in the point string ’yyyy’. It uses this to position to the start of the point element. The point element {x, y, z, b, s, a, d, j, e1, e2, e3, e4, r, p, ya, el} must follow immediately.

Line *xx*, point element ’*yyyy*’ unknown!

The point element ’*yyyy’* was not found in the point element table, check manual for exact syntax.

Line *xx*, register number ’*yyyy*’ out of range (1-*zzzz*)!

The register number ’*yyyy*’ is less than one or greater than the maximum register ’*zzzz*’.

Line *xx*, table or array index out of range ’*yyyy*’!

The table or array index ’*yyyy*’ is less than one or greater than number declared by DATA/SIZE command or by the default declaration.

Line *xx*, table or array label index out of range ’*yyyy*’!

The table or array index label ’*yyyy*’ is evaluated to be less than one or greater than number declared by DATA/SIZE command or by the default declaration.

Line *xx*, Task must be 'A', 'B', 'C' or 'D'!

The compiler is expecting a task argument (A, B, C, or D) and has not found it. This may result from a missing argument or arguments out of sequence.

Line *xx*, too many arguments!

More terms than expected were found following the command. Check for extra arguments, extra commas or terms with spaces in them.

Line *xx*, unknown mnemonic operator - '*yyyy*'!

On line '*xx*', the string '*yyyy*' is assumed to be a command, but was not found in the list of valid commands. This error is most often generated from textual language programs when the command is misspelled or from incorrect syntax.

Line *xx*, unknown or out of range variable '*yyyy*'!

On line '*xx*', the string '*yyyy*' is not of the type expected. Check for argument type(float where integer should be used, etc.) , or for missing or misspelled arguments.

Line *xx*, unresolved index '*yyyy*'!

The index '*yyyy*' could not be resolved, check for missing or misspelled label. Labels are case sensitive and cannot contain spaces.

Line *xx*, unresolved index label '*yyyy*'!

The index label '*yyyy*' could not be resolved to an integer or integer variable, check for missing or misspelled label. Labels are case sensitive and cannot contain spaces.

Line *xx*, unsupported data transfer! VME bus width '*yyyy*', VME format '*zzzz*', local

The selected VME data transfer is not supported in this product. Check VME format and local format for possible erroneous selection.

Line *xx*, Unsupported structure transfer!

The data structures equated to each other are not of the same type. The data structure transfers supported are: Point to Point, Event to Event, and Zone to Zone.

Line *xx*, Valid modes are 1=single axis, 2=ELS synchronized!

The second argument of the "ELS/MODE" command is missing or out of range. This can also be generated if the first argument is invalid and appears as two or more arguments to the compiler.

Line *xx*, variable table '*yyyy*' index unknown!

The closing bracket is missing or other delimiters found in the index term of a variable or register with index format.

Mark table filled - *yyyy*, reduce number of subroutine calls.

The total number of marks used exceeds the table space provided. Marks are the location tags of the start of tasks, event functions and subroutines, or, the destination of a branch or Goto. Try to optimize your program to reduce the number of branches. If the problem persist, contact your Rexroth Indramat representative.

Upon successful completion of the compile, the number of marks and labels used are displayed in the completion window.

No main task (A, B, C, or D) found!

After compiling the program, no marks were found for Task_A, Task_B, Task_C, or Task_D. One or more of these tasks marks must be used. If it’s a textual language program, check spelling and the underscore. The marks for the main tasks are case insensitive.

Sequencing error in output file!

While computing byte offsets for branches and subroutine calls, an unknown command op-code was encountered. This error can occur in a corrupted Windows memory system or a compiler bug. Try rebooting your computer and compiling again. If the problem persist, contact your Rexroth Indramat representative.

Size of program exceeds compiler space!

The compiler has 48k of space available for program development, this error is outputted when that space is filled. Variables and tables are not included in this space. Try reworking your program to fit it in the space.

Unable to allocate memory for compiler!

The 2nd pass compiler uses a large block of memory (48K) allocated from the Windows operating system to build the program. When Windows fails to allocate this memory, this error is outputted. Try closing other applications or rebooting Windows to free needed memory.

Unable to open source file.

This error is issued on failing to open the file "CLCCODE.TXT.” Some possible causes are:

File "CLCCODE.TXT" is not in the "\CLC" directory. This file is created by compiling a textual or icon program.

The maximum number of file is already open. DOS file "CONFIG.SYS" configures the maximum number of files.

The file is already open and cannot be shared.

Write to file error!

This error is outputted when the number of bytes sent to the output file doesn't match the number of bytes written in the output file. Check for available hard drive disk space or write protection on the output file (\\indramat\vm7\project*.exc).

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Rexroth Indramat

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