**HP-41 Focal User Code Compiler**

**&**

**Barcode Creation**

**&**

**Decompiler**

**Version 1.0**

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Prerequisits

The Focal compiler and decompiler run in a .Net 4.0 environment. The .Net 4.0 or higher runtime package needs to be installed first. .Net 4.0 is supported by Windows XP and all newer Windows operating systems.

Focal Compiler

The HP-41 Focal User Code Compiler transforms focal user code from text form to the binary raw file format or to barcodes. The compiler reads in an ASCII source file and outputs a .raw binary file. In case of barcodes JPG files are created.

Strong error checking is done during the compilation. In addition to the original HP-41 the compiler adds some features like comments and constants to structure the source file and to make it more readable and maintainable.

Source File Structure

The compiler accepts any valid HP-41 command plus parameters. Additionally the compiler recognizes the commands of some common plug-in modules and translates them to the appropriate XROM codes. Please refer to appendix A and B for more details.

The compiler is line oriented. A source code line follows the following rule set:

1. Strings must always be quoted with a double quote (“)
2. Comments always start with a semicolon.
3. Structure of a source line
4. A source line may be empty to structure the source code
5. A source line may only contain a comment
6. A source line may contain a compile directive
7. Otherwise a source line contains a focal statement
8. A valid focal statement is one of the following 5 cases. Each one may be followed by a comment:
9. A number
10. A string
11. An append string which in turn is a string prefixed by the single character ‘>’
12. A valid HP-41 command plus it’s parameters
13. A valid XRom command

Example

define MyVariable 01  
define FirstLoopLabel 2  
define LoopCounter 100  
define ReadyMsg “READY”  
define NowMsg “ NOW”  
  
LBL “START” ;the program starts here  
LoopCounter  
STO MyVariable  
LBL FirstLoopLabel  
DSE MyVariable  
GTO FirstLoopLabel  
ReadyMsg  
>NowMsg ;append  
AVIEW  
RTN

Directives

## define

The define directive creates a constant, which is the association of a letter, number or text with that constant. After the constant is defined, the compiler substitutes the constant for each occurrence of the constant in the source file. **define** may occur everywhere in the source code, the constant can be used from that point of definition.

Syntax

define constant number

define constant letter

define constant text

Example

define MyConst 12  
define MyLabel “Foo”  
define MyStack Y  
  
LBL MyLabel  
RCL MyConst  
STO ind MyStack

XROM Codes

The compiler recognizes the commands of some common plug-in modules and translates them to the appropriate XROM codes. The list of known XROM codes can be extended by the user by adding entries to the file XRomCodes.txt. The file must be located next to the FocalComp.exe. Please refer to appendix A and B for more details.

Command Line

The compiler takes only one parameter as input: the source file to compile. The compiler replaces the extension of the given source file with the extension .raw and creates that new file. In case the raw file already exists the file is deleted. For barcodes the compiler creates one JPG file per page. The page number is appended to the filename.

Command:

FocalComp <options> <filename>

Options:

-raw: compile into a .raw file

-barcode: compile and create JPG files that contain the barcodes

Focal Decompiler

The HP-41 Focal Decompiler decompiles raw files into human readable HP-41 Focal statements. The result is written into an ASCII text file.

XROM Codes

The decompiler recognizes the commands of some common plug-in modules and translates them to the appropriate XROM codes. The list of known XROM codes can be extended by the user by adding entries to the file XRomCodes.txt. The file must be located next to the FocalDecomp.exe. Please refer to appendix A and B for more details.

Command Line

The decompiler takes as input the raw file to decompile and optional the name of the output file. If no output filename is specified the decompiler replaces the extension of the given input filename with the extension .txt

FocalDecomp <filename> [<output filename>]

**Appendix A**

## Parameter

Some of the HP-41 commands require one or more parameters. The following table lists the basic parameters including their value range:

|  |  |
| --- | --- |
| Register | integer value 0-101 |
| Stack | single letter (case insensitive):  x, y , z, t, l, m, n, o, p, q, r, d, e |
| Local\_Number\_Label | integer value 0-99 |
| Local\_Letter\_Label | single letter (case-sensitive) without quotes: A-J, a-e |
| Global\_Label | quoted text (e.g. “TRIANGLE”) |
| Single\_Digit | Integer value 0-9 |
| indirect | the keyword ‘ind’ without quotes |
| Flag | integer value 0-55 |
| XRom\_Module | integer value 0-31 |
| XRom\_Function | Integer value 0-63 |
| Comma | the character ‘,’ without quotes |

## Floating Point Numbers

Floating point values may not contain blanks; the exponent follows the mantissa without blanks. The exponent is introduced by the letter ‘e’.

A valid floating point value is -1234.56e-78.

The comiler also supports the special short float syntax. A float may only consist of an exponent like E56 (which is the short form of 1E56).

## Parameter Type Groups

All HP-41 commands are grouped into 7 groups. The commands within each group have the same parameter structure and requirements. The following table lists the command types and their parameter options:

|  |  |
| --- | --- |
| Type 1 | no parameters required |
| Type 2 | one the following parameter:  Register Stack indirect Register  indirect Stack |
| Type 3 | one the following parameters:  Single\_Digit  indirect Register  indirect Stack |
| Type 4 | one the following parameters:  Flag  indirect Register  indirect Stack |
| Type 5 | one the following parameters:  Local\_Number\_Label Local\_Label  Global\_Label |
| Type 6 | one the following parameters:  Local\_Number\_Label Local\_Label  Global\_Label  indirect Register  indirect Stack |
| Type 7 | 3 parameters in the following order:  XRom\_Module  Comma  XRom\_Function |

## Commands

Commands Type 1

NULL

+

-

\*

/

X<Y?

X>Y?

X<=Y?

S+

S-

HMS+

HMS-

MOD

%

%CH

P-R

R-P

LN

X^2

SQRT

Y^X

CHS

E^X

LOG

10^X

E^X-1

SIN

COS

TAN

ASIN

ACOS

ATAN

DEC

1/X

ABS

FACT

X#0?

X>0?

LN1+X

X<0?

X=0?

INT

FRC

D-R

R-D

HMS

HR

RND

OCT

CLS

X<>Y

PI

CLST

R^

RDN

LASTX

CLX

X=Y?

X#Y?

SIGN

X<=0?

MEAN

SDEV

AVIEW

CLD

DEG

RAD

GRAD

ENTER

ENTER^

STOP

RTN

BEEP

CLA

ASHF

PSE

CLRG

AOFF

AON

OFF

PROMPT

ADV

Commands Type 2

RCL

STO

ST+

ST-

ST\*

ST/

ISG

DSE

VIEW

SREG

ASTO

ARCL

x<>

Commands Type 3

FIX

SCI

ENG

TONE

Commands Type 4

SF

CF

FS?C

FC?C

FS?

FC?

Command Type 5

LBL

Commands Type 6

GTO

XEQ

Command Type 7

XROM

**Appendix B**

File format of XRomCodes.txt

The file is line oriented. Each line contains one out of the following list:

* a blank line
* a comment
* an XRom definition

A comment starts with a semicolon “;”.

An XRom definition line has the following syntax:

<function name>, <rom#>, <function#> [;<comment>]

The function name optionally can be enclosed by quotes (“), the comment is optional. A valid XRom definition are:

"test1", 12, 42 ;a comment

test2, 13, 43 ;a comment

**Appendix C**

The following functions of ROMs are known to the compiler and the compiler creates the appropriate XROM codes.

Extended I/O

-X\_MASS\_1A

COPYFL

DIRX

FLLENG

FLTYPE

MCOPY

MCOPYPV

MVERIFY

-X\_EXT\_FCN

ALENGIO

ANUNDEL

ATOXL

ATOXR

ATOXX

XTOAL

XTOAR

X<>FIO

YTOAX

-X\_CTRL\_FNS

AID

CLRDEV

CLRLOOP

DEVL

DEVT

FINDAID

ID

INAC

INACL

INAE

INAN

INXB

INP

LOCK

NLOOP

NOTREM

OUTAC

OUTACL

OUTAE

OUTAN

OUTXB

OUTP

POLL

POLLD

POLLE

POLLUNC

RCLSEL

SRQ?

STAT

XFER

XFERC

XREFCL

XFERE

XFERN

-ADV\_CTL\_FN

ADROFF

ADRON

DDL

DDT

LAD

SEND

TAD

UNL

UNT

EXT-Functions

-EXT\_FCN\_1B

ALENG

ANUM

APPCHR

APPREC

ARCLREC

AROT

ATOX

CLFL

CLKEYS

CRFLAS

CRFLD

DELCHR

DELREC

EMDIR

FLSIZE

GETAS

GETKEY

GETP

GETR

GETREC

GETRX

GETSUB

GETX

INSCHR

INSREC

PASN

PCLPS

POSA

POSFL

PSIZE

PURFL

RCLFLAG

RCLPT

RCLPTA

REGMOVE

REGSWAP

SAVEAS

SAVEP

SAVER

SAVERX

SAVEX

SEEKPT

SEEKPTA

SIZE?

STOFLAG

X<>F

XTOA

-CX EXT-Functions

ASROOM

CLRGX

ED

EMDIRX

EMROOM

GETKEYX

RESZFL

SREG?

X=NN?

X#NN?

X<NN?

X<=NN?

X>NN?

X>=NN?

Time

-TIME 2C

ADATE

ALMCAT

ALMNOW

ATIME

ATIME24

CLK12

CLK24

CLKT

CLKTD

CLOCK

CORRECT

DATE

DATE+

DDAYS

DMY

DOW

MDY

RCLAF

RCLSW

RUNSW

SETAF

SETDATE

SETIME

SETSW

STOPSW

SW

T+X

TIME

XYZALM

-CX TIME

CLALMA

CLALMX

CLRALMS

RCLALM

SWPT

HP-IL Mass storage functions

CREATE

DIR

PURGE

READA

READK

READP

READR

READRX

READS

READSUB

RENAME

SEC

SEEKR

UNSEC

VERIFY

WRTA

WRTK

WRTP

WRTPV

WRTR

WRTRX

WRTS

ZERO

HP-IL Control Functions

AUTOIO

FINDIO

INA

IND

INSTAT

LISTEN

LOCAL

MANIO

OUTA

PWRDN

PWRUP

REMOTE

SELECT

STOPIO

TRIGGER

Wand

WNDDTA

WNDDTX

WNDLNK

WNDSUB

WNDSCN

WNDTST

-HP 41Z

W^1/Z

W^Z

X^1/Z

X^Z

Z+

Z-

Z\*

Z/

Z^1/X

Z^2

Z^3

Z^X

Z=0?

Z=I?

Z=W?

Z=WR?

Z#0?

Z#W?

ZACOS

ZALOG

ZASIN

ZATAN

ZCOS

ZEXP

ZHACOS

ZHASIN

ZHATAN

ZHCOS

ZHSIN

ZHTAN

ZIMAG?

ZIN?

ZINT?

ZINV

ZLN

ZLOG

ZNEG

ZOUT?

ZPI\*

ZREAL?

ZRND

ZSIN

ZSQRT

ZTAN

ZUNIT?

-ZSTACK

CLZ

CLZST

LASTZ

ZAVIEW

ZENTER^

Z<>

Z<>ST

ZTRP

Z<>W

ZIMAG^

ZRCL

ZRDN

ZREAL^

ZRPL^

ZRUP

ZSTO

ZVIEW

^IM/AG

1/Z

e^Z

EIZ/IZ

NXTACS

NXTASN

NXTATN

NXTLN

NXTRTN

SQRTZ

Z\*I

ZCHSX

ZGEU

ZK?YN

ZKBRD

ZST+

ZST-

ZST\*

ZST/

ZWLOG

-ZVECTOR

POLAR

RECT

ZARG

ZCONJ

ZMOD

ZNORM

ZPOL

ZREC

ZSIGN

ZWANG

ZWCROSS

ZWDET

ZWDIST

ZWDOT

ZWLINE

-HL ZMATH

ZAWL

ZBS#

ZCI

ZCRT

ZEI

ZERF

ZGAMMA

ZHCI

ZHGF

ZHSI

ZIBS

ZJBS

ZKBS

ZLI2

ZLIN

ZLNG

ZLRCH

ZPROOT

ZPSI

ZQRT

ZSHK1

ZSHK2

ZSI

ZSOLVE

ZWL

ZYBS

ZZETA

-SNDMTH 2x2

2^X-1

S1/N

SDGT

SN^X

AINT

ATAN2

BS>D

CBRT

CEIL

CHSYX

CROOT

CVIETA

D>BS

D>H

E3/E+

FLOOR

GMSLVR

GEU

H>D

HMS\*

HMS/

LOGYX

MKEYS

P>R

QREM

QROOT

QROUT

R>P

R>S

S>R

STLINE

T>BS

VMANT

X^3

X=1?

X=YR?

X>=0?

X>=Y?

Y^1/X

Y^^X

YX^

-FRC

D>F

F+

F-

F\*

F/

FRC?

INT?

-HYP

HACOS

HASIN

HATAN

HCOS

HSIN

HTAN

-RCL

AIRCL

RCL^

RCL+

RCL-

RCL\*

RCL/

-HL MATH

1/GMF

SFL

SFL$

SFL#

BETA

CHBAP

CI

DHT

EI

ENX

ERF

FFOUR

FINTG

FLOOP

FROOT

GAMMA

HCI

HGF+

HSI

IBS

ICBT

ICGM

IERF

IGMMA

JBS

KBS

LINX

LNGM

LOBACH

PSI

PSIN

SI

SJBS

SYBS

TAYLOR

WL0

YBS

ZETA

ZETAX

ZOUT

-PB/STs

%T

CORR

COV

CRVF

CURVE

EVEN?

GCD

LCM

LR

LRY

NCR

NPR

ODD?

PDF

PFCT

PRIME?

RAND

RGMAX

RGSORT

SEEDT

ST<>S

STSORT