free42: Programs For Functions

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Contents

1 Metadata

The home for this HTML file is: `https://richmit.github.io/hp42/pgmforfun.html`
A PDF version of this file may be found here: `https://richmit.github.io/hp42/pgmforfun.pdf`
Files related to this document may be found on github: `https://github.com/richmit/hp42`
Directory contents:

`src`	-	The org-mode file that generated this HTML document
`src_42s`	-	Ready to convert source listings for 42s code in this document
`docs`	-	This html document
`bin`	-	Importable RAW program files

2 Introduction

Plots Sums $\sum_{n=1}^{15} \frac{1}{n^2}$ Products $\prod_{n=1}^{15} \frac{1}{n^2}$ Integrals $\int_1^{15} \frac{1}{x^2}\,dx$ Roots

This is a collection of programs that work with `MVAR`-type programs (equations). I was inspired to do this when the `PGMENU` function was added to free42.

2.1 Functionality & the Main Menu

2.2 Notes Regarding Some Individual Programs

2.2.1 `FEVL`: Evaluating the current equation

I frequently use `VARMENU` to repeatedly evaluate a formula, with different input values. Functionally that means typing in the value, and then hitting the variable button twice. That's not super efficient when repeatedly changing the same variable. That's where this little function comes in!

MSTR	LBL	Menu	Description
SPT	FSPT	SPT	Interactive application for computing Sums, Products, and Tables
LBL 99	FPLT	PLOT	Interactive application for plotting a function (DM42 Specific)
COMP:SOLVE	FSLV	COMP:SOLVE	Solve EqP for EqV in [LLIM, ULIM]
COMP:INTG	FINT	COMP:INTG	Integrate EqP for EqV in [LLIM, ULIM]
COMP:SUM	FSUM	COMP:SUM	Sum EqP for values of EqV from LLIM to ULIM stepping by STEP
COMP:PROD	FPRD	COMP:PROD	Product EqP for values of EqV from LLIM to ULIM stepping by STEP
COMP:EVAL	FEVL	COMP:EVAL	Evaluate EqV on X
COMP:□□□□		COMP:□□□□	
COMP:PICF	LBL 96	COMP:PICF	Interactive application to select and describe an MVAR program
COMP:□□□□		COMP:□□□□	
COMP:□□□□		COMP:□□□□	
COMP:INDP	LBL 97	COMP:INDP	Store/Recall current value of "X"
COMP:□□□□		COMP:□□□□	
COMP:EVAL	FEVL	COMP:EVAL	Evaluate EqV on X
WRAP:PICF	LBL 96	WRAP:PICF	Interactive application to select and describe an MVAR program
WRAP:□□□□		WRAP:□□□□	
WRAP:SFUN	LBL 98	WRAP:FUN	Store/Recall Current wrapped simple function
WRAP:X	LBL 97	WRAP:X	Store/Recall current value of "X"
WRAP:□□□□		WRAP:□□□□	
WRAP:SEVAL	SFWRP	WRAP:SFWRP	Evaluate currently wrapped simple function
PICF	LBL 96	PICF	Interactive application to select and describe an MVAR program
FVARM		FVARM	MVAR program with all the global variables for these apps

2.2.2 PICF: Selecting a MVAR program

This little function is at the center of all the tools on this page. It queries for an MVAR program, lets you set constants, pick an independent variable, and describe the number of returns from the function. See the section Organizing Principles for more about the global variables used to house this data.

2.2.3 SFWRP: Wrap a simple function

This MVAR program allows one to wrap a simple function for use with tools that need an MVAR program. For example, if you have a program for SECH you can use this program to wrap SECH allowing you to use the built in solver & integrator or programs like FPLT.

To use this program simply put the name of the simple function into the variable WFUN. Note you can do that in the FUN button on the last page of the main menu.

2.2.4 FSLV & FINT: Apply the built in SOLVE & INTG tools to the current EqP

These are handy little functions that allow one to apply the built in solver and integration capabilities of the 42s to the program currently active function.

2.2.5 FPRD & FSUM: Non-interactive Sums & Products

These programs are well suited for use by other programs. They print no status, and are significantly faster than the interactive tool FSPT. Note that they do not support the LN transform capability of FSPT.

2.3 Organizing Principles

All the top level programs use PICF to collect information about the MVAR program to be used. The collected information is housed in three global variables:

Variable	Contents
EqP	Name of MVAR program
EqV	Name of independent variable
EqD	Number of returns from MVAR program

Depending on what we are doing with the MVAR program, we may need to know something about the independent variable too. For example when summing function values we need to know lower and upper ranges over which to sum, and a step size by which to increment the variable. We use a consistent set of global variables based upon names used by built in tools:

Variable	Contents
LLIM	Lower limit of independent variable
ULIM	Upper limit of independent variable
STEP	A step size

If a second variable is used, then similar variables are used; however, we have no precedent for what to name them. So I have decided to use the following:

Variable	Contents
YMIN	Lower limit of second or dependent variable
YMAX	Upper limit of second or dependent variable
YSTP	A step size for a second or dependent variable

If an accuracy is required, then we use the variable ACC.

3 FMENU: Main menu for all apps

3.1 Menu Code

```
(MJR-generate-42-menu-code "FMENU" 0 tbl 0 1 'stay 'up #'MJR-custom-gen-lab #'MJR-custom-gen-sub)
```

```
@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@      (FMENU)
@@@@ DSC: Auto-generated menu program
LBL "FMENU"
LBL 01             @@@@ Page 1 of menu FMENU
CLMENU
"SPT"
KEY 1 XEQ "FSPT"
XEQ 99
KEY 2 XEQ "FPLT"
"COMP"
KEY 3 GTO 02
"WRAP"
KEY 4 GTO 03
"PICF"
KEY 5 XEQ 96
"FVARM"
KEY 6 XEQ "FVARM"
KEY 9 GTO 00
MENU
STOP
GTO 01
LBL 02             @@@@ Page 1 of menu COMP
CLMENU
"SOLVE"
KEY 1 XEQ "FSLV"
"INTG"
KEY 2 XEQ "FINT"
"SUM"
KEY 3 XEQ "FSUM"
"PROD"
KEY 4 XEQ "FPRD"
"EVAL"
KEY 5 XEQ "FEVL"
KEY 7 GTO 04
KEY 8 GTO 04
KEY 9 GTO 01
MENU
STOP
GTO 02
LBL 04             @@@@ Page 2 of menu COMP
CLMENU
"PICF"
KEY 1 XEQ 96
"INDP"
KEY 4 XEQ 97
"EVAL"
KEY 6 XEQ "FEVL"
KEY 7 GTO 02
KEY 8 GTO 02
KEY 9 GTO 01
MENU
STOP
GTO 04
LBL 03             @@@@ Page 1 of menu WRAP
CLMENU
"PICF"
KEY 1 XEQ 96
"SFUN"
KEY 3 XEQ 98
"X"
KEY 4 XEQ 97
"SEVAL"
KEY 6 XEQ "SFWRP"
KEY 9 GTO 01
MENU
STOP
GTO 03
LBL 00 @@@@ Application Exit
EXITALL
RTN
@@@@ Free labels start at: 5
```

3.2 Functions

```
@@@@ LBL: 80-87, 97-98

@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@         (PICF)
@@@@ DSC: Pick an MVAR function and variable
@@@@ IN:  X: integer
@@@@ FAQ: If X=0, then EqD is set to 1.  Otherwise the user is prompted.
@@@@ UPD: 2021-02-24
@@@@ GBL: EqP  -- Name of selected function
@@@@ GBL: EqV -- Name of selected variable
@@@@ GBL: EqD -- Return count
@@@@ BUG: Variable menu works like solver, not like integrator.  Can't fix that...
@@@@ REQ: REQ:free42>=3.0
LBL "PICF"
FUNC 10
L4STK
CLV "EqP"
CLV "EqV"
CLV "EqD"
X≠0?
GTO 87
1
STO "EqD"
LBL 87
EXITALL
PGMMENU
"Pick Function"
AVIEW
STOP
ASTO "EqP"
EXITALL
VARMENU IND "EqP"
"Set Var; "
├"Pick Free Var"
AVIEW
STOP
ASTO "EqV"
EXITALL
SF 25
RCL "EqD"
FS?C 25
GTO 86
"Select Return"
├" Count"
AVIEW
CLMENU
"1"
KEY 1 XEQ 82
"2"
KEY 2 XEQ 83
"3"
KEY 3 XEQ 84
"4"
KEY 4 XEQ 85
MENU
STOP
EXITALL
STO "EqD"
LBL 86
"F: "
ARCL "EqP"
├"("
ARCL "EqV"
├"):→"
ARCL "EqD"
AVIEW
RTN
LBL 82
1
RTN
LBL 83
2
RTN
LBL 84
3
```

```
RTN
LBL 85
4
RTN

@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@
@@@@ DSC: Run PICF with a 1 value for X -- so return count is queried
LBL 96 @NM@ IPICF
FUNC 00
1
XEQ "PICF"
RTN

@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@        (FPRD)
@@@@ DSC: Product of a function evaluated at regular intervals over a range
@@@@ OUT: X: The product
@@@@ FAQ: No error checking is done on LLIM, ULIM, STEP, EqV, or EqP
@@@@ FAQ: Faster than product in FSPT
@@@@ FAQ: EqD is ignored -- only last function value is summed
@@@@ UPD: 2021-04-06
@@@@ REQ: REQ:free42>=3.0
LBL "FPRD"
FUNC 01
1
LSTO "_PROD"
@@@@ Step through independent variable values and do product
RCL "LLIM"
STO IND "EqV"
LBL 80
@@@@ Evaluate function
SF 25
XEQ IND "EqP"
FC?C 25
RTNERR 2
STO× "_PROD"
@@@@ Increment independent variable
RCL "STEP"
RCL+ IND "EqV"
STO IND "EqV"
RCL "ULIM"
X≥Y?
GTO 80
@@@@ All done, put Prd on stack
RCL "_PROD"
RTN

@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@        (FSUM)
@@@@ DSC: Sum a function evaluated at regular intervals over a range
@@@@ OUT: X: The sum
@@@@ FAQ: No error checking is done on LLIM, ULIM, STEP, EqV, or EqP
@@@@ FAQ: Faster than sum in FSPT
@@@@ FAQ: EqD is ignored -- only last function value is summed
@@@@ UPD: 2021-04-06
@@@@ REQ: REQ:free42>=3.0
LBL "FSUM"
FUNC 01
0
LSTO "_SUM"
@@@@ Step through independent variable values and do sum
RCL "LLIM"
STO IND "EqV"
LBL 81
@@@@ Evaluate function
SF 25
XEQ IND "EqP"
FC?C 25
RTNERR 2
STO+ "_SUM"
@@@@ Increment independent variable
RCL "STEP"
RCL+ IND "EqV"
STO IND "EqV"
RCL "ULIM"
X≥Y?
GTO 81
@@@@ All done, put Sum on stack
```

```
RCL "_SUM"
RTN

@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@        (FSLV)
@@@@ DSC: Use SOLVE to find a root for EqV in EqP on [LLIM, ULIM]
@@@@ OUT: T: Code indicating solver exit reason
@@@@         0 Found a root
@@@@         1 Sign Reversal
@@@@         2 Extremum
@@@@         3 Bad Guess or Guesses
@@@@         3 Constant?
@@@@ OUT: Z: EqP evaluated at X
@@@@ OUT: Y: Previous best guess
@@@@ OUT: X: Final best guess -- a root if we are lucky
@@@@ FAQ: No error checking is done on LLIM, ULIM, STEP, EqV, or EqP
@@@@ FAQ: Faster than product in FSPT
@@@@ FAQ: EqD is ignored -- only last function value is summed
@@@@ GBL: EqP, EqV, LLIM, ULIM
@@@@ UPD: 2021-04-06
@@@@ REQ: REQ:free42>=3.0
LBL "FSLV"
FUNC 04
PGMSLV IND "EqP"
RCL "LLIM"
STO IND "EqV"
RCL "ULIM"
SOLVE IND "EqV"
RTN

@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@        (FINT)
@@@@ DSC: Use INTEG to find a root for EqV in EqP on [LLIM, ULIM]
@@@@ OUT: X: The integral
@@@@ FAQ: No error checking is done on ACC, LLIM, ULIM, STEP, EqV, or EqP
@@@@ FAQ: EqD is ignored -- only last function value is summed
@@@@ GBL: EqP, EqV, LLIM, ULIM, ACC
@@@@ UPD: 2021-04-06
@@@@ REQ: REQ:free42>=3.0
LBL "FINT"
FUNC 03
PGMINT IND "EqP"
INTEG IND "EqV"
RTN

@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@        (FEVL)
@@@@ DSC: Evaluate EqP at X
@@@@ OUT: X: EqP(x)
@@@@ FAQ: No error checking is done on EqV or EqP
@@@@ GBL: EqP, EqV
@@@@ UPD: 2021-04-09
@@@@ REQ: REQ:free42>=3.0
LBL "FEVL"
STO IND "EqV"
XEQ IND "EqP"
RTN

@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@        (FVARM)
@@@@ DSC: MVAR Program with all the global vartiables used by the F* programs
@@@@ GBL: EqP, EqV, EqD, ACC, WFUN, LLIM, ULIM, STEP, YMIN, YMAX, & YSTP
@@@@ UPD: 2021-04-06
LBL "FVARM"
MVAR "LLIM"
MVAR "ULIM"
MVAR "STEP"
MVAR "YMIN"
MVAR "YMAX"
MVAR "YSTP"
MVAR "EqP"
MVAR "EqV"
MVAR "EqD"
MVAR "ACC"
MVAR "WFUN"
RTN

@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@        (SFWRP)
@@@@ DSC: Wrap a simple function inside an =MVAR= program
LBL "SFWRP"
```

```
MVAR "WFUN"
MVAR "X"
RCL "X"
XEQ IND "WFUN"
RTN

@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@
@@@@ Store/Recall variable "WFUN"
LBL 98
FS? 64
RCL "WFUN"
STO "WFUN"
RTN

@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@
@@@@ Store/Recall variable "X"
LBL 97
FS? 64
RCL "X"
STO "X"
RTN

@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@
@@@@ LBL for FPLT menu
LBL 99
CLA
SF 25
RCL "GrMod"
FC?C 25
RTNNO
"PLOT"
RTNYES

@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@
END
```

4 FSPT: Interactive Sums, Products, & Tables

Create function tables and computes sums & products. Works much like the built in integration application.

The LOG button transforms the function results by taking the natural logarithm – for example this allows us to compute very large products by summing the logarithms.

The IND button stores the independent variable value in the table.

When not provided, the values for LLIM, STEP, & EqD default to 1.

Note: Using [SHIFT] before [LLIM], [ULIM], and [STEP] menu keys will recall the current value to the stack instead of setting the value.

```
@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@      (FSPT)
@@@@ DSC: Sums, Products, & Tables
@@@@ IN:  N/A
@@@@ OUT: N/A
@@@@ UPD: 2021-04-03
@@@@ GBL: LLIM -- Lower limit for variable
@@@@ GBL: ULIM -- Upper limit for variable
@@@@ GBL: STEP -- Size of steps to make
@@@@ FLG: 82: Set: log function returns
@@@@ FLG: 83: Set: Store independent variable in table
@@@@ FLG: 84: Set: doing table, Clear: Doing sum or product (see flag 85)
@@@@ FLG: 85: Set: doing sum, Clear; doing product
@@@@ LLB: 00-12,14-24,26-33
@@@@ GLB: FSPT
@@@@ USE: PICF
@@@@ REQ: REQ:free42>=3.0
LBL "FSPT"
CF 82
SF 83
1
XEQ "PICF"
R↓
LBL 01            @@@@ Page 1 of menu PROG_NAME
CLMENU
"LLIM"
KEY 1 XEQ 03
"ULIM"
KEY 2 XEQ 04
"STEP"
KEY 3 XEQ 05
"∑"
```

```
KEY 4 XEQ 06
"π"
KEY 5 XEQ 07
"□"
KEY 6 XEQ 08
KEY 7 GTO 02
KEY 8 GTO 02
KEY 9 GTO 00
MENU
STOP
GTO 01
LBL 02            @@@@ Page 2 of menu PROG_NAME
CLMENU
"EQ"
KEY 1 XEQ 09
FS? 82
"LN•"
FC? 82
"LN"
KEY 2 XEQ 10
FS? 83
"IND•"
FC? 83
"IND"
KEY 3 XEQ 11
KEY 7 GTO 01
KEY 8 GTO 01
KEY 9 GTO 00
MENU
STOP
GTO 02
LBL 00
EXITALL
RTN
LBL 03               @@@@ Action for menu key LLIM
FS? 64
RCL "LLIM"
STO "LLIM"
"LLIM: "
ARCL ST X
AVIEW
RTN
LBL 04               @@@@ Action for menu key ULIM
FS? 64
RCL "ULIM"
STO "ULIM"
"ULIM: "
ARCL ST X
AVIEW
RTN
LBL 05               @@@@ Action for menu key STEP
FS? 64
RCL "STEP"
STO "STEP"
"STEP: "
ARCL ST X
AVIEW
RTN
LBL 06               @@@@ Action for menu key Σ
CF 84                @@@@ 84 clear -> not a table
SF 85                @@@@ 85 set   -> sum
GTO 20
RTN
LBL 07               @@@@ Action for menu key π
CF 84                @@@@ 84 clear -> not a table
CF 85                @@@@ 85 clear   -> product
GTO 20
RTN
LBL 08               @@@@ Action for menu key □
SF 84                @@@@ 84 set ->  table
GTO 20
RTN
LBL 09               @@@@ Action for menu key EQ
1
XEQ "PICF"
R↓
```

```
RTN
LBL 10               @@@@ Action for menu key LN
FS?C 82
RTN
SF 82
RTN
LBL 11               @@@@ Action for menu key IND
FS?C 83
RTN
SF 83
RTN
LBL 20  @@@@ Guts of the sum, product, table code
@@@@ Default LLIM & STEP to 1 if unset
1
SF 25
RCL "LLIM"
FC?C 25
STO "LLIM"
SF 25
RCL "STEP"
FC?C 25
STO "STEP"
@@@@ Check for bad LLIM, ULIM, & STEP.
RCL "LLIM"
RCL "ULIM"
X>Y?
GTO 12
"ERR: LLIM ⩾"
⊢" ULIM"
AVIEW
RTN
LBL 12
RCL "STEP"
X>0?
GTO 14
"ERR: STEP ⩽ 0"
AVIEW
RTN
LBL 14
RCL "EqD"
X>0?
GTO 15
"ERR: EqD ⩽ 0"
AVIEW
RTN
LBL 15
4
X⩾Y?
GTO 16
"ERR: EqD > 4"
AVIEW
RTN
LBL 16
@@@@ Init before loop
FS? 84          @@@@ 84 set -> table
GTO 21          @@@@ 84 clear -> (85 set -> sum , 85 clear -> product)
GTO 22
LBL 22
@@@@ Sum or Product
FS? 85
0
FC? 85
1
LSTO "_SOP"
GTO 23
LBL 21
@@@@ Table
1
ENTER
ENTER
RCL "EqD"
FS? 83
+
NEWMAT
LSTO "_TMAT"
R↓    @@@@ Drop matrix off stack to save RAM
```

```
INDEX "_TMAT"
GROW
LBL 23
@@@@ Step through independent variable values and do sum, product, or table
RCL "LLIM"
STO IND "EqV"
LBL 24
@@@@ Print progress
CLA
ARCL "EqV"
⊢"="
ARCL IND "EqV"
AVIEW
FC? 84
GTO 32
@@@@  Doing a table: Setup CTR for loop later
RCL "EqD"
LSTO "_CTR"
@@@@  Doing a table:  Store independent variable if FS? 83
FC? 83
GTO 32
RCL IND "EqV"
STOEL
J+
LBL 32
@@@@ Evaluate function
SF 25
XEQ IND "EqP"
FS?C 25
GTO 17
"ERR: Func Eval"
AVIEW
RTN
LBL 17
@@@@ Do thing for sum, product, or table
FS? 84
GTO 26
GTO 27
LBL 27
@@@@ Sum or Product
FC? 82
GTO 29
SF 25
LN
FS?C 25
GTO 29
"ERR: Bad Log"
AVIEW
LBL 29
FS? 85
STO+ "_SOP"
FC? 85
STO× "_SOP"
GTO 28
LBL 26
@@@@ Table
LBL 30
FC? 82
GTO 31
SF 25
LN
FS?C 25
GTO 31
"ERR: Bad Log"
AVIEW
LBL 31
STOEL
J+
R↓
DSE "_CTR"
GTO 30
LBL 28
@@@@ Increment independent variable
RCL "STEP"
RCL IND "EqV"
+
```

```
STO IND "EqV"
RCL "ULIM"
X⩾Y?
GTO 24
@@@@ All done.  Report Results
FS? 84          @@@@ 84 set -> table
GTO 33          @@@@ 84 clear -> (85 set -> sum , 85 clear -> product)
GTO 19
LBL 19
@@@@ Sum or Product
FS? 85
"SUM: "
FC? 85
"PROD: "
RCL "_SOP"
GTO 18
LBL 33
@@@@ Table
CLA
RCL "_TMAT"
LBL 18
ARCL ST X
AVIEW
RTN
END
```

5 FPLT: Interactive Plotting

Features:

- Designed for high resolution mode of DM42
- Dots are connected
- Interactive zoom-box
- Optional autoscale of y-axis
- Control over axis and grid line drawing
- Quick access to solver and integration from plot
- Factor zoom
- Default window
- Minimal & efficient interface
- Integrated with other tools on this page – solver & integration

5.1 User Interface

5.1.1 Main Menu

Menu	Description
EQ	Setup Equation
XRNG	Set X range (X: max Y: min). MAGIC
YRNG	Set Y range (X: max Y: min). MAGIC
GRID	Set grid width (X: Y-width Y: X-width). MAGIC
COMP	Computations (solve & integrate)
PLOT	Draw plot

Magic:

- `XRNG` set to [0, 0]: Sets range to default [-10, 10].
- `XRNG` reversed limits: Automatically detected and swapped
- `XRNG` set to [M, M]: Zooms range by a factor of M.
- `YRNG` set to [0, 0]: Sets range to default [-6, 6]
- `YRNG` reversed limits: Automatically detected and swapped
- `YRNG` set to [M, M]: Zooms range by a factor of M.
- `GRID` set to 0: If one of the grid widths is zero, then no grids are drawn for that axis
- `GRID` set to a negative value: No axis or grid marks will be drawn for that axis
- `GRID`: If grid lines are closer than 10 pixels, then grids are suppressed.

For a graph with default settings: [0] [ENTER] [XRNG] [YRNG] [GRID] [PLOT]

5.2 Computational Menu

This menu is for doing computations on the current equation based on the current plot range or last zoom box region.

Menu	Description
ROOT	Find a root in plot range
INTG	Integrate over plot range with ACC equal to the area of a pixel
EVAL	Evaluate the function
□□□□	-
□□□□	-
R<>B	Swap plot range with last zoom box range

5.2.1 Graphics Display

Key	Action
[2]	Adjust bottom side of zoom box
[4]	Adjust left side of zoom box
[8]	Adjust top side of zoom box
[6]	Adjust right side of zoom box
[ENTER]	Zoom to box & Redraw
[X<>Y]	Auto-scale Y & Redraw. Zoombox is used for x-range
[+]	Set zoom box adjustment speed to fast
[-]	Set zoom box adjustment speed to slow
[*]	Zoom out 2x (multiply ranges by 2)
[/]	Zoom in 2x (divide ranges by 2)
[←]	Exit to main menu. Note: saves the zoom box range.
[.]	Toggle connected dots in graph

5.3 Code

```
@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@          (FPLT)
@@@@ DSC: Plot a MVAR function
@@@@ GBL: EqP, EqV, LLIM, ULIM, STEP, YMIN, YMAX, YSTP
@@@@ GBL: ZLLIM, ZULIM -- zoom box limits.
@@@@ FAQ: STEP & YSTP are used for grids
@@@@ FLG: 03: PREF: Set: draw dots only;  Clear: connect dots
@@@@ FLG: 04: PREF: Set: Use GrMod 2; Clear Use GrMod 3
@@@@ FLG: 05: PREF: Reserved
@@@@ FLG: 82: TEMP: Used for max/min computation
@@@@ FLG: 83: TEMP: Used for automatic autoscale redraw
@@@@ FLG: 84: TEMP: Reserved
@@@@ FRE: LBL: 79-99
@@@@ REQ: REQ:free42>=3.0
@@@@ UPD: 2021-04-09

LBL "FPLT"
FC? 04
3
FS? 04
2
STO "GrMod"
R↓
131
STO "ResX"
R↓
16
STO "ResY"
R↓
XEQ 74
LBL 01                @@@@ Page 1 of menu FPLT
CF 83                 @@@@ Turn off auto yscale redraw
CLMENU
"EQ"
KEY 1 XEQ 02
"XRNG"
KEY 2 XEQ 03
"YRNG"
KEY 3 XEQ 04
"GRID"
KEY 4 XEQ 05
"COMP"
KEY 5 XEQ 06
"PLOT"
KEY 6 XEQ 07
KEY 9 GTO 00
MENU
STOP
```

```
GTO 01
LBL 00               @@@@ Application Exit
EXITALL
RTN
LBL 02               @@@@ Action for menu key EQ
0
XEQ "PICF"
RTN
LBL 03               @@@@ Action for menu key XRNG
FUNC 00
FS? 64
GTO 10               @@@@ For shift we just display settings
X≠Y?
GTO 24
X=0?
GTO 26
@@@@ Code for LLIM=ULIM≠0
RCL "ULIM"
RCL- "LLIM"
2
÷
×
RCL "ULIM"
RCL+ "LLIM"
2
÷
RCL ST X
RCL ST Z
-
STO "LLIM"
R↓
+
STO "ULIM"
GTO 10
LBL 26
@@@@ Code for LLIM=ULIM=0
CLV "LLIM"
CLV "ULIM"
XEQ 74
GTO 10
LBL 24
@@@@ Code for LLIM≠ULIM
STO "ULIM"
X<>Y
STO "LLIM"
X<>Y
LBL 10
"XMIN: "
RCL "LLIM"
ARCL ST X
⊢"[LF]XMAX: "
RCL "ULIM"
ARCL ST X
AVIEW
RTN
LBL 04               @@@@ Action for menu key YRNG
FUNC 00
FS? 64
GTO 50               @@@@ For shift we just display settings
X≠Y?
GTO 22
X=0?
GTO 23
@@@@ Code for YMIN=YMAX≠0
RCL "YMAX"
RCL- "YMIN"
2
÷
×
RCL "YMAX"
RCL+ "YMIN"
2
÷
RCL ST X
RCL ST Z
-
```

```
STO "YMIN"
R↓
+
STO "YMAX"
GTO 50
LBL 23
@@@@ Code for YMIN=YMAX=0
CLV "YMIN"
CLV "YMAX"
XEQ 74
GTO 50
LBL 22
@@@@ Code for YMIN≠YMAX
STO "YMAX"
X<>Y
STO "YMIN"
X<>Y
LBL 50
"YMIN: "
RCL "YMIN"
ARCL ST X
⊢"[LF]YMAX: "
RCL "YMAX"
ARCL ST X
AVIEW
RTN
LBL 05              @@@@ Action for menu key GRID
FUNC 00
FS? 64
GTO 49              @@@@ For shift we just display settings
STO "YSTP"
X<>Y
STO "STEP"
LBL 49
"XSTP: "
RCL "STEP"
ARCL ST X
⊢"[LF]YSTP: "
RCL "YSTP"
ARCL ST X
AVIEW
RTN
LBL 06              @@@@ Action for menu key COMP
LBL 30              @@@@ menu COMP
CLMENU
"ROOT"
KEY 1 XEQ 32
"INTG"
KEY 2 XEQ 33
"EVAL"
KEY 3 XEQ 34
@@@@ "RSV1"
@@@@ KEY 4 XEQ 35
@@@@ "RSV2"
@@@@ KEY 5 XEQ 36
"R<>B"
KEY 6 XEQ 37
KEY 9 GTO 31
MENU
STOP
GTO 30
LBL 31              @@@@ Menu Exit
RTN
LBL 32              @@@@ Action for menu key FSLV
FUNC 04
XEQ "FSLV"
RTN
LBL 33              @@@@ Action for menu key FINT
FUNC 01
RCL "ULIM"
RCL- "LLIM"
RCL÷ "ResX"
RCL "YMAX"
RCL- "YMIN"
RCL÷ "ResY"
×
```

```
XEQ "FINT"
RTN
LBL 34               @@@@ Action for menu key RSV0
XEQ "FEVL"
@@@@ RSV0
RTN
LBL 35               @@@@ Action for menu key RSV1
@@@@ RSV1
RTN
LBL 36               @@@@ Action for menu key RSV2
@@@@ RSV2
RTN
LBL 37               @@@@ Action for menu key RANGE <> BOX swap
XEQ 39
RTN
RCL "GrMod"
LBL 07               @@@@ Action for menu key PLOT
@@@@ Set AGRAPH flags to OR
CF 34
CF 35
@@@@ Just in case an important var is not set
XEQ 74
SF 25
RCL "EqV"
FC?C 25
GTO 76
R↓
SF 25
RCL "EqP"
FC?C 25
GTO 76
R↓
GTO 77  @@ All good
LBL 76
"ERR: Pick An"
⊢" EQ First!"
AVIEW
RTN
LBL 77
@@@@ Set YWID
RCL "YMAX"
RCL- "YMIN"
1
RCL "ResY"
-
÷
STO "YWID"
@@@@ Set YWID
RCL "ULIM"
RCL- "LLIM"
RCL "ResX"
1
-
÷
STO "XWID"
@@@@ Draw stuff
CLLCD
CLMENU               @@@@ Only needed on DM42
EXITALL              @@@@ Only needed on DM42
FC? 83
GTO 17
@@@@ Doing an autoscale draw
RCL "ResX"
14
÷
IP
1
-
LSTO "_I"
LBL 15
RCL "ResY"
2
÷                            @@@@ Yctr
9
-
RCL "_I"
```

```
14
×                              @@@@ X coord
"@‘px|˜⊢˜|xp‘@"                 @@@@ Draw up triangle
AGRAPH
"×∫πßffl?⊢?●→π∫×"               @@@@ Draw down triangle
X<>Y
12
+
X<>Y
AGRAPH
DSE "_I"                        @@@@ Loopity doopity do
GTO 15
GTO 20                  @@@@ Jump past axis and grid drawing for autoscale redraw
LBL 17
@@@@ Draw X Axis
RCL "STEP"
X<0?                    @@@@ No axis if negative
GTO 11
0
XEQ 56
XEQ 58
1
-
XEQ 58
2
+
XEQ 58
LBL 11
@@@@ Draw X Grid
RCL "STEP"
X≤0?
GTO 08                  @@@@ no grid when STEP<=0
RCL "XWID"
10
×
X>Y?
GTO 08                  @@@@ no grid when too small
R↓
RCL "ULIM"
RCL÷ "STEP"
IP
RCL× "STEP"
RCL+ "STEP"
RCL "LLIM"
RCL÷ "STEP"
IP
RCL× "STEP"
RCL- "STEP"
LBL 09
ENTER
XEQ 46
XEQ 48
R↓
RCL+ "STEP"
X<Y?
GTO 09
LBL 08
@@@@ Draw Y Axis
RCL "YSTP"
X<0?                    @@@@ No axis if negative
GTO 12
0
XEQ 46
XEQ 48
1
-
XEQ 48
2
+
XEQ 48
LBL 12
@@@@ Draw Y Grid
RCL "YSTP"
X≤0?
GTO 20                  @@@@ no grid when STEP<=0
RCL "YWID"
```

```
-10
×
X>Y?
GTO 20                @@@@ no grid when too small
R↓
RCL "YMAX"
RCL÷ "YSTP"
IP
RCL× "YSTP"
RCL+ "YSTP"
RCL "YMIN"
RCL÷ "YSTP"
IP
RCL× "YSTP"
RCL- "YSTP"
LBL 21
ENTER
XEQ 56
XEQ 58
R↓
RCL+ "YSTP"
X<Y?
GTO 21
LBL 20
@@@@ Set Alpha to our box
"πππ"
@@@@ Plot curve
@@@@ Init YPMAX & YPMIN
SF 82
@@@@ Init LASTY
0
LSTO "_LASTY"
R↓
@@@@ Loop across screen
RCL "ResX"
1000
÷
1
+
LSTO "_XICUR"
LBL 41
RCL "_XICUR"
IP
XEQ 47
STO IND "EqV"
SF 25
XEQ IND "EqP"
FC?C 25
GTO 29
FC? 82
GTO 43
@@@@ Setup YPMIN & YPMAX
LSTO "_YPMAX"
LSTO "_YPMIN"
CF 82
LBL 43
@@@@ Update YPMIN & YPMAX if required.
RCL "_YPMAX"
X<>Y
X>Y?
LSTO "_YPMAX"
RCL "_YPMIN"
X<>Y
X<Y?
LSTO "_YPMIN"
FC? 83
GTO 78
@@@@ Draw autoscale progress bar
RCL "ResY"
2
÷
1
-
RCL "_XICUR"
AGRAPH
R↓
```

```
R↓
GTO 19
LBL 78
@@@@ If y is on screen, then draw it
XEQ 56
XEQ 55
GTO 29
@@@@ DRAW FAT PIXEL
RCL "_XICUR"
XEQ 51              @@@ XICUR YICUR
R↓
@@@@ Do we draw lines?
FS? 03
GTO 19
@@@@ Don't do lines for an autoscale draw
FS? 83
GTO 19
@@@@ Do we have a last point?
RCL "_LASTY"
X=0?
GTO 19
@@@@ Yep & Yep.  We draw a line!
X<>Y
RCL "_XICUR"  @@@@ xi  newy lasty
XEQ 40
LBL 19
@@@@ Save last Y
R↓
LSTO "_LASTY"
GTO 42
LBL 29  @@@@ Bad Y target
0
LSTO "_LASTY"
@@@@ Backend of loop
LBL 42
ISG "_XICUR"
GTO 41
@@@@ Done with graph.
@@@@ Setup zoom box
10
LSTO "_ZSPD"
1
LSTO "_ZBTOP"
LSTO "_ZBLFT"
RCL "ResY"
LSTO "_ZBBOT"
RCL "ResX"
LSTO "_ZBRGT"
@@@@ Do we redraw with autoscale?
FS?C 83
GTO 68
@@@@ graph UI
LBL 16
RCL "_ZSPD"
LSTO "_CTR"
LBL 52
RCL "_ZBRGT"
RCL "_CTR"
+
XEQ 48
DSE "_CTR"
GTO 52
RCL "_ZSPD"
LSTO "_CTR"
LBL 53
RCL "_ZBBOT"
RCL "_CTR"
+
XEQ 58
DSE "_CTR"
GTO 53
RCL "_ZSPD"
LSTO "_CTR"
LBL 54
RCL "_ZBTOP"
RCL "_CTR"
```

```
-
XEQ 58
DSE "_CTR"
GTO 54
RCL "_ZSPD"
LSTO "_CTR"
LBL 59
RCL "_ZBLFT"
RCL "_CTR"
-
XEQ 48
DSE "_CTR"
GTO 59
LBL 44
GETKEY1
13
X=Y?                @@@@ 13 ENTER key
GTO 73
R↓
17
X=Y?                @@@@ 24 Backspace key
GTO 60
R↓
32
X=Y?                @@@@ - speed slow key
GTO 66
R↓
37
X=Y?                @@@@ - speed fast key
GTO 65
R↓
24
X=Y?                @@@@ 24 LEFT key
GTO 61
R↓
26
X=Y?                @@@@ 26 RIGHT key
GTO 62
R↓
20
X=Y?                @@@@ 20 TOP key
GTO 63
R↓
30
X=Y?                @@@@ 30 BOTTOM key
GTO 64
R↓
14
X=Y?                @@@@ 14 autoscale key
GTO 68
R↓
22
X=Y?                @@@@ 22 zoom in key
GTO 67
R↓
35
X=Y?                @@@@ 35 period.  toggle dots/lines
GTO 75
R↓
27
X=Y?                @@@@ 27 zoom out key
GTO 69
GTO 44              @@@@ Nothing matched get another key
LBL 67              @@@@ 22 / zoom
0.5
ENTER
ENTER
XEQ 03
XEQ 04
GTO 07
LBL 69              @@@@ 27 x zoom out
2.0
ENTER
ENTER
XEQ 03
XEQ 04
```

```
GTO 07
LBL 68              @@@@ Autoscale Y
1
RCL "_ZBLFT"
-
ABS
RCL "ResX"
RCL "_ZBRGT"
-
ABS
+
X=0?
GTO 14
@@@@ Zoom box has been set
RCL "_ZBLFT"
XEQ 47
RCL "_ZBRGT"
XEQ 47
STO "ULIM"
X<>Y
STO "LLIM"
SF 83
GTO 07
LBL 14
@@@@ No zoom box
RCL "_YPMAX"
-5
RCL× "YWID"
+
RCL "_YPMIN"
5
RCL× "YWID"
+
STO "YMIN"
X<>Y
STO "YMAX"
GTO 07
LBL 75              @@@@ 35 toggle dots/lines
FS?C 03
GTO 07
SF 03
GTO 07
LBL 65              @@@@ 37 + set speed fast
10
LSTO "_ZSPD"
GTO 16
LBL 66              @@@@ 32 - set speed slow
1
LSTO "_ZSPD"
GTO 16
LBL 61              @@@@ LEFT REDO
RCL "_ZBRGT"
-2
RCL× "_ZSPD"
+
RCL "_ZSPD"
RCL+ "_ZBLFT"
X<Y?
LSTO "_ZBLFT"
XEQ 47
STO "ZLLIM"
GTO 16
LBL 62              @@@@ RIGHT REDO
RCL "_ZBLFT"
2
RCL× "_ZSPD"
+
RCL "_ZSPD"
+/-
RCL+ "_ZBRGT"
X>Y?
LSTO "_ZBRGT"
XEQ 47
STO "ZULIM"
GTO 16
LBL 63              @@@@ TOP REDO
```

```
RCL "_ZBBOT"
-2
RCL× "_ZSPD"
+                     @@@@ Upper_limit
RCL "_ZSPD"
RCL+ "_ZBTOP"          @@@ New_ZBTOP Lower_limit
X<Y?
LSTO "_ZBTOP"
GTO 16
LBL 64                @@@@ BOT REDO
RCL "_ZBTOP"
2
RCL× "_ZSPD"
+                     @@@@ Lower_limit
RCL "_ZSPD"
+/-
RCL+ "_ZBBOT"          @@@ New_ZBBOT Lower_limit
X>Y?
LSTO "_ZBBOT"
GTO 16
LBL 73
RCL "_ZBTOP"
XEQ 57
RCL "_ZBBOT"
XEQ 57
STO "YMIN"
R↓
STO "YMAX"
RCL "_ZBRGT"
XEQ 47
RCL "_ZBLFT"
XEQ 47
STO "LLIM"
X<>Y
STO "ULIM"
GTO 07
LBL 60
RTN
LBL 40  @@@@ Draw Line
FUNC 00
@@@@ xi newy lasty
LSTO "_XNUE"
R↓              @@@@ yn yo
RCL ST Y        @@@@ yo yn yo
RCL- ST Y       @@@@ yo-yn yn yo
ABS             @@@@ |yo-yn| yn yo
3
X>Y?
RTN @@@@ Pts too close, no line to draw
@@@@ We are drawing a line!
R↓
R↓              @@@@ yn yo
LSTO "_YNUE"
X<>Y
LSTO "_YOLD"     @@@@ yo yn
+
2
÷
IP
LSTO "_YCTR"
@@@@ CTR -> OLD Y
RCL "_XNUE"
1
-
RCL "_YOLD"
RCL "_YCTR"
XEQ 70
@@@@ CTR -> NEW Y
R↓
R↓
R↓
RCL "_XNUE"
RCL "_YNUE"
RCL "_YCTR"
XEQ 70
R↓
```

```
R↓
R↓
RTN
LBL 70          @@@@ Draw Fat, Vertical Line Segment   Ystart Yend X .  Yend already has a fat point drawn.
FUNC 00
X<Y?
GTO 71
@@@@ Line going up
1
STO- ST T
R↓              @@@@ Ystart Yend X-1
1
STO- ST Z
R↓              @@@@ Ystart Yend-1 X-1
3
-               @@@@ Ystart-3 Yend+1 X-1
LBL 72          @@@@ ycur Yend-1 X-1
RCL ST Z        @@@@ X-1 ycur Yend-1 X-1
AGRAPH
R↓              @@@@ ycur Yend-1 X-1
3
-               @@@@ ycur(updated) Yend-1 X-1
X>Y?
GTO 72
RTN
LBL 71
@@@@ Line going down
1
STO- ST T
R↓              @@@@ Ystart Yend X-1
1
STO- ST Z
R↓              @@@@ Ystart Yend-1 X-1
LBL 18          @@@@ Ycur Yend-1 X-1
RCL ST Z        @@@@ X-1 Ycur Yend-1 X-1
AGRAPH
R↓              @@@@ yc yn+1 xn-1
3
+               @@@@ yc yn+1 xn-1
X<Y?
GTO 18
RTN
LBL 51               @@@@ Draw BIG Pix  (assumes Alpha is set)
FUNC 00
1
-
X<>Y
1
-
X<>Y
AGRAPH
RTN
LBL 58               @@@@ HLINE
FUNC 00
XEQ 55
GTO 27
+/-
1
PIXEL
LBL 27
RTN
LBL 48               @@@@ VLINE
FUNC 00
XEQ 45
GTO 28
+/-
1
X<>Y
PIXEL
LBL 28
RTN
LBL 45               @@@@ X Out Of Range
FUNC 00
X≤0?
RTNYES
RCL "ResX"
```

```
X<Y?
RTNYES
RTNNO
LBL 55                @@@@ Y Out Of Range
FUNC 00
X≤0?
RTNYES
RCL "ResY"
X<Y?
RTNYES
RTNNO
LBL 46                @@@@ XR->XI
FUNC 11
RCL- "LLIM"
RCL÷ "XWID"
1
+
RTN
LBL 47                @@@@ XI->XR
FUNC 11
1
-
RCL× "XWID"
RCL+ "LLIM"
RTN
LBL 56                @@@@ YR->YI
FUNC 11
RCL- "YMAX"
RCL÷ "YWID"
1
+
RTN
LBL 57                @@@@ YI->YR
FUNC 11
1
-
RCL× "YWID"
RCL+ "YMAX"
RTN
LBL 39                @@@@ Swap rng & box
FUNC 00
SF 25
RCL "ZLLIM"
FC?C 25
GTO 38
SF 25
RCL "ZULIM"
FC?C 25
GTO 38
SF 25
RCL "LLIM"
FC?C 25
GTO 38
SF 25
RCL "ULIM"
FC?C 25
GTO 38
STO "ZULIM"
R↓
STO "ZLLIM"
R↓
STO "ULIM"
X<>Y
STO "LLIM"
"XMIN: "
ARCL ST X
R↓
⊢"[LF]XMAX: "
ARCL ST X
R↓
AVIEW
RTN
LBL 38
"ERR: Range or "
"⊢ unset"
AVIEW
```

```
RTN
LBL 74   @@@@ Set any unset global variables to defaults
10
SF 25
RCL "ULIM"
FC?C 25
STO "ULIM"
-10
SF 25
RCL "LLIM"
FC?C 25
STO "LLIM"
6
SF 25
RCL "YMAX"
FC?C 25
STO "YMAX"
-6
SF 25
RCL "YMIN"
FC?C 25
STO "YMIN"
0
SF 25
RCL "YSTP"
FC?C 25
STO "YSTP"
0
SF 25
RCL "STEP"
FC?C 25
STO "STEP"
RTN
END
```

6 Test Functions

A few `MVAR` functions to test with

```
@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@      (TFS)
@@@@ DSC: SIGN
LBL "TFS"
MVAR "X"
RCL "X"
1
-
SIGN
5
×
RTN
END

@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@      (TFE)
@@@@ DSC: Exponential
LBL "TFE"
MVAR "X"
RCL "X"
E↑X
RTN
END

@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@      (TFL)
@@@@ DSC: Linear M*X+B
LBL "TFL"
MVAR "X"
MVAR "M"
MVAR "B"
RCL "X"
RCL× "M"
RCL+ "B"
RTN
END

@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@      (TFQ)
@@@@ DSC: A quadratic with zeros at 0 and 1
```

```
LBL "TFQ"
MVAR "X"
RCL "X"
1
-
RCL "X"
×
RTN
END

@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@      (TFC)
@@@@ DSC: A cubic with zeros at -1, 0.9, and 1
LBL "TFC"
MVAR "X"
RCL "X"
1
-
RCL "X"
1
+
×
RCL "X"
.9
-
×
RTN
END

@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@      (TFO)
@@@@ DSC: A function that with increasing frequency approaching zero
LBL "TFO"
MVAR "X"
RCL "X"
ABS
0.001
+
1/X
SIN
RTN
END

@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@      (TFI)
@@@@ DSC: A function that has many undefined regions
@@@@ FAQ: Good test to make sure we don't connect across known discontinuities
LBL "TFI"
MVAR "X"
RCL "X"
2
MOD
IP
1/X
5
×
RTN
END

@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@      (TFM)
@@@@ DSC: A function that has many step discontinuities
LBL "TFM"
MVAR "X"
RCL "X"
2
MOD
IP
.5
-
10
×
RTN
END

@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@      (TFF)
@@@@ DSC: A function flips between 1 and -1 each call
@@@@ FAQ: Worst case performance for connecting dots
LBL "TFF"
MVAR "X"
```

```
5
FS?C 85
RTN
SF 85
-5
RTN
END
```

7 EOF