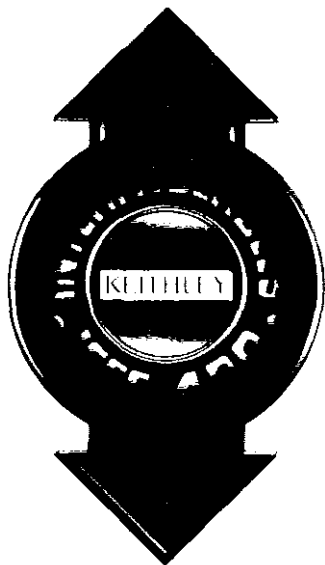


Programming Instructions



Model 192
Programmable DMM

INTRODUCTION

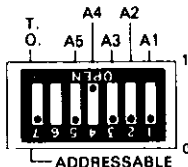
The Keithley 192 Programmable DMM is easily interfaced to common controllers using the IEEE-488 bus. The following programs select the 2V range and obtain a reading on the following controllers:

APPLE II, DEC LSI 11, HP 85, HP 9825A, PET/CBM 2001, TEK 4052, HP 9826, IBM PC.

All other parameters are left in the turn-on state. Other parameters may be programmed by expanding the programming command, entered after "TEST SETUP" appears on the CRT.

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PROGRAM CODES

FRONT PANEL OPERATION

Select range, function and input. Use ZERO to cancel displayed offset. (A separate value is stored for each function.)

FRONT PANEL PROGRAMS

0 CLEAR

Press PRGM 0 to cancel active program (3-7 only).

1 RESOLUTION

Press PRGM 1 to display 6½ digits; press again to return to 5½ digits.

2 FILTER

Press PRGM 2 to turn filter on; press again to turn off.

3 OFFSET/SCALE

Select function and range. Press PRGM 3. Old scale(s) is displayed. Load new number if desired: $-2 \leq s \leq 2$. Press ENT. Old offset(b) is displayed. Load new number if desired. Press ENT. Y is displayed: $Y = sX + b$. Press RECALL to view or change constants.

4 % DEVIATION

Select function and range. Press PRGM 4. Old nominal is displayed. Load a new number if desired. Press ENT. % deviation is displayed. Display reads OFLO at $\pm 200\%$. Press RECALL to view or change nominal.

5 MIN/MAX

Select function and range. Press PRGM 5. After one second delay, minimum and maximum readings are stored. Press RECALL to display minimum reading. Press again to display maximum reading. Press again to resume program.

6 HI/LO/PASS

Select function and range. Press PRGM 6. Old low limit is displayed. Load a new number if desired. Press ENT to start. HI/LO/PASS is displayed. Press RECALL to view or change limits.

7 100 POINT DATA LOGGER

Select function and range. Press PRGM 7. Old interval (r) is displayed:

0 = min.

1 = 0.5sec

2 = 1sec

3 = 5sec

4 = 10sec

5 = 1min.

- 6 = 5min.
- 7 = 10min.
- 8 = 30min.
- 9 = 1hr

Load a new number if desired. Press ENT. Press to start logger. Press RECALL to view the number and data of last data point. Use RECALL to step through data. Use -RECALL to back up. Press 0 ENT to continue logging data.

IEEE-488 PROGRAMMING

FUNCTION:	F0 = DCV
	F1 = ACV
	F2 = k Ω
RANGE:	R0 = Auto
	R1 = 0.2
	R2 = 2
	R3 = 20
	R4 = 200
	R5 = 2000
	R6 = 20M (Ω only)
ZERO:	Z0 = Off
	Z1 = On
TRIGGER:	T0 = Cont. on TALK
	T1 = One Shot on TALK
	T2 = Cont. on GET
	T3 = One Shot on GET
	T4 = Cont. on X
	T5 = One Shot on X
RATE:	S0 = 4msec integration (4 ½ d)
	S1 = Line cycle integration (5 ½ d)
	S2 = Line cycle integration with Filter 1 (5 ½ d)
	S3 = Line cycle integration with Filter 2 (6 ½ d)
	S4 = Line cycle integration with Filter 3 (6 ½ d)
	S5 = 100msec integration (5 ½ d)
	S6 = 100msec integration with Filter 1 (6 ½ d)
	S7 = 100msec integration with Filter 2 (6 ½ d)
	S8 = 100msec integration with Filter 3 (6 ½ d)
DELAY:	W0 = 0
	W1 = 10msec

BUFFER: Q0 = Clear
Q1 = Store 100 readings

MODE: M0 = SRQ Off
M1 = SRQ On

EOI: K0 = Send
K1 = Do not Send

TERMINATOR: Y(LF) = CR LF
Y(CR) = LF CR
Y() = Any ASCII
Y(DEL) = None

X = Execute

UX = Send status bytes. Sequence is:

T F R K Q S M Y Z W

DEFAULT: F0R5Z0T0S2W1Q0K0M0Y(LF)

DATA FORMAT: 16 bytes + terminator

FUNCT.		DISPLAY							EXP.	TERMI-NATOR							
N	D	C	V	+	1	2	3	.	4	5	6	7	E	+	0	CR	LF

N = Normal
Z = Zeroed
O = OFLO

SRQ BYTE: VALUE:

0			0	X	X	X	X
---	--	--	---	---	---	---	---

1 = ERROR
0 = NORMAL
1 = SRQ by 192
0 = SRQ not by 192

ERROR SRQ

0: lddC
1: lddCO
2: CONFLICT
3: NO REMOTE

DATA SRQ

0: Normal
1: Overflow
2: BUFFER FULL

PROGRAMS

The following programs are designed to be a simple aid to the user, and are not intended to suit specific needs. Detailed programming information can be found in the manual.

These programs display one reading at the output of the controller. The program provides an ASCII string variable output of the form:

NDCV + 0.000000E 0 CR LF

The note at the end of each program indicates modifications to provide a numeric variable (A) in exponential form:

APPLE II (APPLE Interface)

The program below obtains one reading from the Model 192 DMM and displays the reading on the APPLE II screen, using an APPLE IEEE-488 interface.

DIRECTIONS

1. Set switches on 192 to addressable mode, primary address 8.
2. Connect 192 to APPLE II and APPLE IEEE-488 interface.
3. Enter the program below using the RETURN key after each line. (Type in line numbers.)
4. Type in RUN and depress RETURN key.
5. The display will read "TEST SETUP".
6. To program 192 to the 2V range and take a reading, type in FOR2X and depress the RETURN key.
7. Display will read NDCV + 0.000000E + 0 for "0" volts in.

PROGRAM

```
10 Z$ = CHR$(26)
20 INPUT "TEST SETUP?";B$

30 PR#3
40 IN#3
50 PRINT "RA"
60 PRINT "WT(";Z$; B$)

70 PRINT "LF1"
80 PRINT "RDH";Z$;:INPUT"
  ";A$
90 PRINT "UT"
100 PR#0
```

COMMENTS

```
To dimension data string.
Enter programming command.
(Example: 2V range = FOR2X.)
Send output to IEEE bus.
Get input from IEEE bus.
Turn remote on.
Output programming command
to 192.
Linefeed on.

Untalk.
Send output to CRT.
```

110	IN#0	Get input from keyboard.
120	PRINT A\$	Display data string.
130	GO TO 20	Repeat

NOTE: If conversion to numeric variable is desired, add the following:

124	A = VAL(MID\$(A\$,5,15))	Convert string to numeric value.
126	PRINT A	

DEC LSI 11

The program below obtains one reading from the Model 192 DMM and displays the reading on the DEC LSI 11 microcomputer CRT terminal. The LSI 11 must be configured with 16k words of RAM and an IBV 11 IEEE interface. The software must be configured with IB software as well as the FORTRAN and the RT 11 operating system.

DIRECTIONS

1. Set switches on 192 to addressable mode, primary address 1.
2. Connect 192 to the IBV II IEEE cable.
3. Enter the program below, using the editor under RT 11 and the name IPHILD.
4. Compile using the fortran compiler as follows: FORTRAN IPHILD
5. Link with the system and IB libraries as follows: LINK IPHILD, IBLIB
6. Type RUN IPHILD and depress the RETURN key.
7. The display will read "ENTER ADDRESS".
8. To program the 192 to the 2V range and take a reading, type in FOR2X and depress RETURN key.
9. Display will read NDCV + 0.000000E + 0 for "0" volts in.

```
PROGRAM IPHILD
INTEGER*2 PRIADR
LOGICAL*1 MSG(80),
INPUT(80)
```

COMMENTS

DO 2 I=1, 10	
CALL IBSTER (I,0)	!Turn off IB errors.
2 CONTINUE	
CALL IBSTER (15, 5)	!Allow 5 error 15's.
CALL IBTMO (120)	!Allow 1 sec. bus timeout.
CALL IBTERM ("10")	!Set LF as terminator.
CALL IBREN	!Turn remote on.
4 TYPE 5	

5	FORMAT (1X,'ENTER ADDRESS', \$) ACCEPT 10,PRIADR	!Input the address 8.
10	FORMAT (214)	
12	TYPE 15	
15	FORMAT (1X,'TEST SETUP', \$) CALL GETSTR (5,MSG, 72) CALL IBSEOI (MSG,-1, PRIADR)	!Prompt for the test setup. !Get the test setup. !Program the 192.
18	I=IBRECV (INPUT,80, PRIADR) INPUT (I+1)=0 CALL PUTSTR (7,INPUT, '0') CALL IBUNT GO TO 12 END	!Get the data from the 192. !Untalk the 192. !Repeat

HP 85

The program below obtains one reading from the Model 192 DMM and displays the reading on the HP 85 CRT screen, using the 82937A GPIB interface and an I/O ROM.

DIRECTIONS

1. Set switches on 192 to the addressable mode, primary address 8.
2. Connect 192 to the HP 82937A IEEE interface.
3. Depress SHIFT SCRATCH and then depress END LINE to erase the previous program.
4. Enter the program below using the END LINE key after each line is typed. (Type in line numbers.)
5. Depress RUN key.
6. The display will read "TEST SETUP".
7. To program the 192 to the 2V range and take a reading, type in FOR2X and depress the END LINE key.
8. Display will read NDCV + 0.000000E + 0 for "0" volts in.

PROGRAM

```
10 REMOTE 708
20 DISP "TEST SETUP"
30 INPUT A$
```

COMMENTS

```
Set to remote.
Prompt for test setup.
```

40	OUTPUT 708; A\$	Program the 192.
50	ENTER 708; B\$	Get the data from the 192.
60	DISP B\$	
70	GO TO 20	Repeat
80	END	

NOTE: If conversion to numeric variable is desired, change line 60 as follows:

60 DISP VAL (B\$(5))

HP 9825A

The program below obtains one reading from the Model 192 DMM and displays the reading on the HP 9825A using a 98034A HPIB interface and a 9872A extended I/O ROM.

DIRECTION

1. Set switches on 192 to addressable mode, primary address 8.
2. Connect 192 to HP 9825A and 98034A HPIB interface.
3. Enter the program below, using the STORE key after each line is typed. Line numbers are automatically assigned by the 9825A.
4. Depress the RUN key.
5. The display will read "TEST SETUP".
6. To program the 192 to the 2V range and take a reading, type in FOR2X and depress the CONT key.
7. Printer will read NDCV + 0.000000E + 0 for "0" volts in.

PROGRAM

```

0 dim A$(20), B$(20)
1 dev "192", 708

2 rem "192"
3 ent "TEST SETUP", A$

4 wrt "192", A$

5 red "192", B$

6 prt B$
7 gto 3

```

COMMENTS

```

To dimension data string.
Define Model 192 channel A
address.
Set to remote.
Enter programming command.
(Example: 2VDC range =
FOR2X.)
Output program command to
Model 192 via IEEE bus.
Read data from Model 192 via
IEEE bus.
Print data on hard copy printer.
Repeat.

```

NOTE: In conversion to numeric variable is desired, omit lines 6 and 7 and substitute:

6	"e" - B\$(13, 13); flt5	Convert to numeric vlaue.
7	prt val(B\$(5))	
8	gto 3	Repeat

PET/CBM 2001

The program below obtains one reading from the Model 192 DMM and displays the reading on the PET/CBM 2001 Series.

DIRECTIONS

1. Set switches on 192 to addressable mode, primary address 8.
2. Connect 192 to PET/CBM 2001 IEEE interface.
3. Enter the program below using the RETURN key after each line.
4. Type RUN and depress the RETURN key.
5. The display will read "TEST SETUP".
6. To program the 192 to the 2V range and take a reading, type in FOR2X and depress the RETURN key.
7. Display will read NDCV + 0.000000E + 0 for "0" volts in.

PROGRAM

```

10 OPEN 6,8
20 INPUT "TEST SETUP";B$

30 PRINT#6,B$
40 INPUT#6,A$

50 IF ST=2 THEN 40
60 PRINT A$
70 GO TO 20

```

COMMENTS

```

Open file 6, primary address 8.
Enter programming command.
(Example: 2V DC range=FOR2X.)

Output to the IEEE bus.
Read data from Model 192 via
IEEE bus.

If time out, input again.
Print data.
Repeat

```

NOTE: If conversion to numeric variable is desired, omit line 60 and type the following:

```

70 A = VAL (MID$(A$,5,16))      Convert string to numeric
                                value.

80 PRINT "A = ";A
90 GO TO 20                      Repeat

```

TEK 4052

The program below obtains one reading from the Model 192 DMM and displays the reading on the TEK 4052 graphics terminal, with a TEK 4051 GPIB interface.

DIRECTIONS

1. Set switches on 192 to the addressable mode, primary address 8.
2. Connect 192 to TEK 4051 IEEE interface.
3. Enter the program below using the RETURN key after each line.
4. Type in RUN.
5. The display will read "TEST SETUP".
6. To program the 192 to the 2V range and take a reading, type in FOR2X and depress the RETURN key.
7. Display will read NDCV + 0.000000E + 0 for "0" volts in.

PROGRAM

```
5 PRINT @ 37, 0: 10,255,13
10 PRINT "TEST SETUP"
20 INPUT A$
30 PRINT @ 8: A$
40 INPUT % 8: B$
50 PRINT B$
60 GO TO 10
```

COMMENTS

Prompt for the test setup.

Program the 192 DMM.

Get the data from the 192 DMM.

Repeat

NOTE: If conversion to numeric value is needed, change lines 40 and 50 to:

```
40 INPUT % 8:A
50 PRINT A
```

HP 9826

The program below obtains one reading from the Model 192 DMM and displays the reading on the HP 9826 screen, using the BASIC ROMs.

DIRECTIONS

1. Using address switches, select primary address 8.
2. Connect 192 to the HP 9826.
3. Enter the program below using the EXECUTE key after each line is typed.
4. Depress the RUN key.
5. The display will read "TEST SETUP".
6. To program the 192 to the 2V range and take a reading, type in FOR2X and depress the END LINE key.
7. Display will read NDCV + 0.000000E + 0 for "0" volts in. (Short Input)

PROGRAM

```
10 REMOTE 708
20 PRINT "TEST SETUP"
```

COMMENTS

Set to remote.

Prompt for test setup.

30	INPUT B\$	
40	OUTPUT 708; B\$	Program the 192.
50	ENTER 708; A\$	Get the data from the 192 DMM.
60	PRINT A\$	
70	GO TO 20	Repeat
80	END	

NOTE: If conversion to numeric variable is needed, change lines 50 and 60 as follows:

```
50 ENTER 708;A
60 PRINT A
```

IBM PERSONAL COMPUTER XT or PC

The following program sends a command string to the Model 192 and displays the reading on the IBM personal computer display. The equipment required for this program is the IBM personal computer XT or PC, the National Instruments GPIB-PC interface and the DOS 2.00 operating system. The GPIB software and hardware must be installed and configured per the National Instruments GPIB-PC instruction manual.

DIRECTIONS

1. Using rear panel switches, set primary address to 8 on the Model 192.
2. Connect the Model 192 to the GPIB-PC interface with power off.
3. Type in the command BASIC on the IBM keyboard to get into the IBM interpretive BASIC language.
4. Type in the command LOAD "DECL" to prepare the system for programming. The LOAD "DECL" command takes up the first five lines of the program. Refer to the program.
5. Type in the following program starting with line 10.
6. Type in RUN to execute the program.
7. The display will read "ENTER COMMAND".
8. To program the 192 to the 2V range and take a reading, type in FOR2X and press the return key.
9. The display will read NDCV + 0.000000E + 0 for "0" volts in.

PROGRAM

```
1 CLEAR, 60000!
2 IBINIT = 60000!
3 BLOAD "bib.m",IBINIT
4 IBSTA% = 0:IBCNT% = 0:
  IBERR % = 0
```

COMMENTS

The first five lines do not have to be typed in. Typing in LOAD "DECL" accomplishes this task.

```

5  CALL IBINIT (IBRD%,
    IBWRT%,IBCMD%,
    IBWAIT%,IBRPP%,
    IBONL%,IBSRC%,
    IBSIC%,IBSRE%,IBRTL%,
    IBRSV%,IBLPE%,
    IBPAD%,IBSAD%,
    IBIST%,IBDMA%,
    IBEOS%,IBTMO%,
    IBEOT%,IBGTS%,
    IBCAC%,IBDIAG%,
    IBSTA%,IBERR%,
    IBCNT%)
10  BD% = 0                Interface board number is 0.
120 RD$ = SPACE$(20)      Reading buffer is 20 characters
130 V% = 0:CALL IBPAD%(BD
    %,V%)                 Primary address of GPIB PC
                             interface is 0.
140 CALL IBSIC%(BD%) '    Interface Clear.
150 V% = 1:CALL IBSRE%(BD
    %,V%)                 Set 192 to remote.
160 CMD$ = "@2" '        MTA LAG #8
170 CALL IBCMD%(BD%,
    CMD$) '               Address 192 to talk.
180 INPUT "ENTER
    COMMAND";C$          Prompt for command.
190 CALL IBWRT%(BD%,C$) ' Program the 192
200 CMD$ = " R" '        MLA LAG #8
210 CALL IBCMD%(BD%,
    CMD$) '               Address 192 to talk.
220 CALL IBRD%(BD%,RD$) ' Get data string.
230 PRINT RD$            Print data string.
240 GO TO 60 '           Repeat
NOTE: For conversion to numeric variable change line 130 to:
130 PRINT VAL(MID$(RD$,5,
    16))

```

HP 9816

The following program sends a command, reads data from the Model 192 and displays the readings on the HP 9816 screen, using BASIC 2.0.

DIRECTIONS

1. Set address switches to primary address 8.
2. Connect the Model 192 to the HP 9816.

3. Enter the program below using the **ENTER** key after each line is typed.
4. Depress the **RUN** key.
5. The display will read "TEST SETUP".
6. To program the Model 192 to the 2V range and read data, type in **FOR2X** and depress the **ENTER** key.
7. The display will read **NDCV + 0.000000E + 0** for "0" volts in.

PROGRAM

COMMENTS

10	REMOTE 708	Set to remote.
20	INPUT "TEST SETUP",A\$	Prompt for test setup.
30	OUTPUT 708; A\$	Program the 192.
40	ENTER 708; B\$	Read the data from the 192.
50	PRINT B\$	
60	GO TO 20	Repeat
70	END	

NOTE: For conversion to numeric variable, change lines 40 and 50 as follows:

40	ENTER 708; A
50	PRINT A

KEITHLEY

Keithley Instruments, Inc.
28775 Aurora Road
Cleveland, Ohio 44139
(216) 248-0400