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OPERATING MANUAL

4000 SERIES
LOW NOISE FOCAL PLANE ARRAY
TEST SYSTEM

PULSE INSTRUMENTS COMPANY
1234 Francisco St.
Torrance, California 90502
Phone: (310) 515 5330
Fax (310)-515-0068

Revision R
August 27, 1993
Software Versions To 3.27

1.0 WARRANTY AND SAFETY INFORMATION

1.1 WARRANTY

Pulse Instruments warrants these products to be free from defects in material and workmanship for a period of one year from date of shipment.

During the warranty period, Pulse Instruments will, at it`s discretion, repair or replace any products or materials returned, freight prepaid, which prove to be defective through normal use.

This warranty does not apply to defects resulting from unauthorized modification, misuse, or neglect. This warranty is in lieu of all other warranties expressed or implied, and Pulse Instruments shall not be liable for any consequential damages resulting from the use of this product.

Pulse Instruments will also not warrant the specifications as listed in this manual if other than Pulse Instruments supplied power supplies are used with this system.

1.2 SAFETY INFORMATION

1.2.1 General

1. The 4001 Control mainframe and the PI-4003 Power Mainframe use a detachable 3-wire power cord for connection to both the power source and to earth ground. These units are to be connected only to a power source outlet that has provision for properly grounding the plug.

2. Do not operate units with covers removed.

3. Service on these instruments should only be performed by authorized Pulse Instruments personnel. Unless permission to service is granted by Pulse Instruments, any service performed on these instruments could void all warranty claims.

1.2.2 Fuses

The PI-4001, PI-4003, and PI-4004 use slow blow fuses designed for general circuit protection. The three fuses are located on the front right-hand side of the mother board in both the PI-4001 Control Mainframe, the PI-4004 Power Mainframe, the PI-4003 Power Mainframe, and the PI-4002 Instrument Mainframe. Be certain that input power is disconnected before checking or replacing the fuses.

2.0 TABLE OF CONTENTS

2.1 TABLE OF CONTENTS

1.0 WARRANTY AND SAFETY INFORMATION 2

1.1 WARRANTY 2

1.2 SAFETY INFORMATION 2

1.2.1 General 2

1.2.2 Fuses 2

2.0 TABLE OF CONTENTS 3

2.1 TABLE OF CONTENTS 3

3.0 SPECIFICATIONS 9

3.1 PI-4001 CONTROL MAINFRAME 9

3.2 PI-4002 INSTRUMENT MAINFRAME 9

3.3 40460 DUAL CHANNEL DRIVER CARD 9

3.4 40465 DUAL CHANNEL TRI-LEVEL DRIVER CARD 11

3.5 40480 HIGH SPEED DRIVER CARD 13

3.6 40490 65 MHZ DRIVER CARD 16

3.7 40740 FOUR CHANNEL, DC BIAS SUPPLY CARD 19

3.8 40750 FOUR CHANNEL LOW NOISE DC BIAS CARD 20

3.9 40752 FOUR CHANNEL LOW NOISE DC BIAS CARD 20

3.10 40753 TWO CHANNEL LOW NOISE DC BIAS CARD 21

3.11 40770 FOUR QUADRANT BIAS SUPPLY 22

3.12 PI-4003 DC POWER MAINFRAME 24

4.0 INSTALLATION 25

4.1 INTRODUCTION 25

4.2 PACKING AND UNPACKING 25

4.3 POWER REQUIREMENTS 25
4.4 COOLING AND VENTILATION 26
4.5 CONFIGURATION 26
4.6 REAR PANEL -- PI-4001 CONTROL MAINFRAME 27
4.6.1 General 27
4.6.2 Remote Operation of the PI-4002 Mainframe ..28
4.7 REAR PANEL -- PI-4002 INSTRUMENT MAINFRAME 29
4.7.1 General 29
4.7.2 Connectors 40480 Driver Card 33
4.7.3 Connectors 40490 65 MHz Driver Card 33
5.0 BASIC DESCRIPTION 35
5.1 GENERAL 35
6.0 CONFIGURATION INFORMATION AND OPTIONS 37
7.0 FRONT PANEL CONTROLS 39
7.1 GENERAL 39
7.1.1 Power On/Off Switch 39
7.1.2 Cursor Controls 39
7.1.3 Home Key 39
7.1.4 Prev Key 39
7.1.5 Next Key 39
7.2 FUNCTION KEYS 39
7.2.1 General 39
7.2.2 Update 39
7.2.3 Line 39
7.2.4 Lock 40
7.3 SOFTKEYS 40

7.3.1 General 40
7.4 DATA KEYS 40
7.4.1 Data Keys 40
7.4.2 Clear Entry 40
7.4.3 Enter 41
8.0 SYSTEM MENUS 42
8.1 90040 NON VOLATILE MEMORY OPTION 42
8.1.1 General 42
8.1.2 Explanation of Softkeys 43
8.2 MAIN MENU 45
8.2.1 General 45
8.2.2 Main Menu Headings 46
8.2.3 Explanation of Softkeys 48
8.2.4 Setting and Using the Prg. Rise and Fall ...49
8.2.5 Voltage and Current Sense 50
8.2.6 Current Sense Measurement Using the DVM 51
8.2.7 Voltage Sense, Main Menu 52
8.2.8 Setting The High Resolution Mode DC Bias ...52
8.2.9 Setting Driver and DC Bias Limits 53
8.2.10 Setting the Programmable Sequence 54
8.2.10.1 Setting the Prog. Screen Sequence 55
8.2.10.2 Setting the Prog. Online Sequence 55
8.2.10.3 Setting the Prog. Disconnect Seq.....56
8.3 WINDOWS IN THE ZOOM MODE 57
8.3.1 40460 Dual Channel Driver Card Window 57
8.3.1.1 Settable Parameters 40460 Driver 57

8.3.1.2 Softkeys 40460 Driver Card Window 59
8.3.2 40465 Tri-Level Driver Card Window 60
8.3.2.1 Settable Parameters 40465 Tri-Level 60
8.3.2.2 Softkeys 40465 Tri-Level Card 62
8.3.2.3 Operation of the 40465 Tri-Level Card ..62
8.3.3 40480 High Speed Driver Card Window 64
8.3.3.1 Settable Parameters 40480 Card 64
8.3.3.2 Softkeys 40480 Driver Card Window 65
8.3.3.3 Mode Functions 40480 Driver Card 66
8.3.4 40490 65 MHz Driver Card Window 67
8.3.4.1 Settable Parameters 40490 Card 67
8.3.4.2 Softkeys 40490 Driver Card Window 68
8.3.4.3 Mode Functions 40490 Driver Card 69
8.3.5 40740 DC Bias Card Window 71
8.3.5.1 Settable Parameters 40740 Bias Card 71
8.3.5.2 Softkeys 40740 DC Bias Card Window 72
8.3.6 40750 Low Noise DC Bias Card Window 72
8.3.6.1 Settable Parameters 40750 Bias Card 73
8.3.6.2 Softkeys 40750 DC Bias Card Window 74
8.3.7 40770 Four Quadrant Bias Supply 74
8.3.7.1 Settable Parameters 40770 Bias Card 76
8.3.7.2 40770 Measuring Current Output 78
8.3.7.3 Softkeys 40770 Four Quadrant Bias 79
8.3.7.4. Main Menu Changes 40770 Bias Card 80
8.3.7.5 40770 Kelvin Connection Diagrams 80

8.4 INTERFACE MENU 82
8.4.1 General 82
8.4.2 Explanation of Softkeys 82
9.0 PROGRAMMING THE 4000 SERIES LOW NOISE TEST SYSTEM 84
9.1 CHANGES IN VERSION 2.00/3.00 SOFTWARE 84
9.2 IEEE-488 GPIB PROGRAMMING 87
9.2.1 General 87
9.3 IEEE-488 COMMANDS 90
9.3.1 Chart of Commands 90
9.3.2 Non Volatile Memory Commands 90
9.3.3 System Commands 91
9.3.4 Mode Commands 94
9.3.5 Label Setting Commands 95
9.3.6 Rise and Fall Time Setting Commands 95
9.3.6.1 Protect and Unprotect Tr and Tf 96
9.3.7 Voltage Setting Commands 97
9.3.8 40465 Tri-Level Driver Card Commands 98
9.3.9 40750 DC Bias Card Commands 101
9.3.10 40770 Four Quadrant Bias Supply Commands .102
9.3.11 40480/40490 Driver Card Commands 105
9.3.12 Voltage and Current Sense Commands 107
9.3.13 Increment/Decrement Commands 109
9.3.14 Inc/Dec Width and Delay Commands 110
9.3.15 Programmable Limits Commands 110
9.3.16 System Dump Commands 112
9.3.17 Prog. the Screen, Online, Disconnect Seq..114

9.3.18 90040 Non-Volatile Memory Option Commands 116
9.3.19 Increasing Download Speed 117
9.4 SAMPLE PROGRAM 118
10.0 RS-232-C PROGRAMMING 126
10.1 GENERAL 126
10.2 RS-232-C PINOUTS 126
10.3 PROGRAMMING INFORMATION 127
10.4 RS-232-C SAMPLE PROGRAM 128
11.0 EPROM REPLACEMENT-PI-4001 CONTROL MAINFRAME 129
11.1 INSTALLING CPU EPROMS 129
11.2 INSTALLING CHARACTER ROMS 131
12.0 ERROR AND WARNING MESSAGES 132
12.1 GENERAL 132
12.2 EXPLANATION OF ERROR AND WARNING MESSAGES 132
12.2.1 Error Messages 132
12.2.2 Warning Messages 136
12.2.3 Card Placement Errors 136
12.2.4 Extended Character Set Labels 137
13.0 Problems and Troubleshooting Guide 138

3.0 SPECIFICATIONS

3.1 PI-4001 CONTROL MAINFRAME

CPU: ..... Intel 80186 Microprocessor.
Compatibility: .... IEEE-488 GPIB, RS-232-C.
Display: ..... 7 inch amber CRT, 80 characters per line.
Power: ..... 110 Vac ± 10%, 5 Amps max. 47/63 Hz.
220 Vac ± 10%, 2.5 Amps max. 47/63 Hz.
Dimensions: ..... 7.0" H x 17.5" W x 19.625" D.
Weight: ..... 15 lbs.
Temperature: ..... 0°C to 50°C.

3.2 PI-4002 INSTRUMENT MAINFRAME

Card Slots: ..... Eight.
DC Input: ..... +31 Vdc, -31 Vdc, +10 Vdc, -10 Vdc.
Dimensions: ..... 7.0" H x 17.5" W x 19.625" D.
Weight: ..... 15 lbs.
Temperature: ..... 0°C to 50°C.
I/V Sense Output: Dual BNC Port isolated from chassis ground.

3.3 40460 DUAL CHANNEL DRIVER CARD

OUTPUT HIGH LEVEL: ..... +20.47 V to -19.48 V into 1 MΩ
manually selectable or programmable.

RESOLUTION: ..... 10 mV or 11 bits, plus sign bit (into 1 MΩ).

ACCURACY: 100 mV of selected value for positive going transition time set to min. and may increase to 125 mV maximum for transition times > minimum value (into 1 MΩ).

OUTPUT LOW LEVEL: ..... -20.47 V to +19.47 V into 1 MΩ
manually selectable or programmable.

RESOLUTION: ..... 10 mV or 11 bits, plus sign bit.

ACCURACY: 100 mV of selected value for negative going transition time set to minimum and may increase to 125 mV maximum for transition times > minimum value (into 1 MΩ).

OUTPUT AMPLITUDE: ..... 1 V TO 20 V maximum into 1 MΩ.

OUTPUT/INPUT CONNECTORS: BNC.

RISE AND FALL TIMES (@ 20 V p-p)

40 ns - 40,000 ns in 3 Ranges.
40 ns - 400 ns 15% ± 5 ns, except tr/tf ± 40 ns.
400 ns - 4,000 ns 5% ± 20 ns.
4,000 ns - 40,000 ns 5% ± 200 ns.

OUTPUT REPETITION RATE
(3 ft. length 50 Ω cable with 100 pf load).

20 V Amplitude 8 MHz max.
15 V Amplitude 10 MHz max.

OUTPUT ABERRATIONS

5% ± 200 mV for output amplitude ≥ 3 V while driving a 3 ft. length of 50 Ω cable terminated in 100 pf//1 MΩ.

OUTPUT POLARITY:..... Normal or inverted output selected by front panel control, IEEE-488 Bus, or RS-232-C Port.

OUTPUT RESISTANCE: .. 50 Ω ± 10%.

OUTPUT NOISE: ..... 1Hz 3.5uV/√Hz, 10Hz 900nV/√Hz, 100Hz 400nV/√ Hz, 1KHz 300nV/√Hz.

CLOCK OUTPUT: .... Rear panel insulated BNC Connector, isolated from chassis ground.

TTL INPUT: ..... Rear panel insulated BNC Connector, optically isolated from clock output, and isolated from chassis ground.

CONTROL INPUTS: .. Control input optically isolated from IEEE-488 Bus and isolated from chassis ground.

CURRENT SENSE OUTPUT: . 3 Ranges: 1mA/V: 2% reading ± 3 uA.
10mA/V: 2% reading ± 30 uA.
25mA/V: 2% reading ± 300 uA.

VOLTAGE SENSE OUTPUT: . 2 Ranges: 2 V: 0.2% reading ± 4 mV.

20 V: 0.2% reading ± 40 mV.

3.4 40465 DUAL CHANNEL TRI-LEVEL DRIVER CARD

HL High Level
LL Low Level
MHL Middle High Level
MLL Middle Low level

Operating Conditions are: HL - LL $\geq$ 2 V
LL + 2 V $\leq$ MHL, MLL $\leq$ HL - 2V
MHL $\geq$ MLL

	1 MOhm Load //100pf	50 Ohms // 100pf
High Level		
Range:	-18.00 V to +20.00 V	-9.0 V to +10 V
Resolution:	10 mV	5 mV
Accuracy:*	0.1% of Prog value ± 100 mV	5% of prog value ± 50 mV
Low Level		
Range:	-20.00 V to +18.00 V	-10 V to +9.0 V
Resolution:	10 mV	5 mV
Accuracy:*	0.1% of Prog value ± 100 mV	5% of prog value ± 50 mV
Middle High Level Middle Low Level		
Range:	-18.00 V to +18.00 V	-9.0V to +9.0 V
Resolution:	10 mV	5 mV
Accuracy:*	0.1% of Prog value ± 100 mV	5% of prog value ± 50 mV

* Accuracy of HL, LL, MHL, MLL may decrease to the following for transition times greater than minimum value:

	0.1% of prog value ± 130 mV	5% of prog value ± 65 mV

In Tri Level Mode:

MHL = MLL = ML
Accuracy of Setting

MHL = MLL	1% of prog value ± 300 mV	5% of prog value ± 50 mV
Output Amplitude:	1 V to 23 V max	0.5 V to 11.5 V max

Output /Input Connectors: BNC

Output (Isolated from chassis ground): 2 Channels

Main Input (All modes of operation): 2 Channels

Delayed Input (with respect to Main
Input for four or Tri-Level Drivers): 2 Channels

Both types of input can be directly connected or optically isolated to the outside world. This feature is selectable per channel via front panel, IEEE-488 bus or RS-232-C Port.

Output Transition Times:

[Measured using 20 Vp-p (HL = 10 V, LL = -10 V) into 1 MOhm]

30 ns to 30 μs in three ranges, with independent control over leading and trailing edge.

30 ns - 300 ns	10% of prog value ± 5 ns
300 ns - 3 μs	5% of prog value ± 30 ns
3 μs to 30 μs	5% of prog value ± 200 ns

Both the rise and fall time must be programmed in the same range. When driving a 50 Ohm load, transition edges may exhibit exponential rather than linear characteristics.

Output Repetition Rate into 1 Mohm

20 V Amplitude:	10 MHz	(Normal Mode)
	5 MHz	(4 Levels or Tri-Level Mode)

Output aberrations

For output amplitude$\geq$ 3 V while driving a 3 ft cable (50 Ohm) terminated in 100pf, in 1 MOhm // 15pf.

Normal Mode: 5% of amplitude ± 200 mV

4 Level or Tri-State Mode: 5% of amplitude ± 350 mV

Output Polarity: Invert/Noninvert, programmable

Output Resistance: 50 Ohms ± 10% or 10 Ohms ± 10%, selectable from front panel, or programmable

Output Noise:	1 Hz	3 μV/$\sqrt{Hz}$
	10 Hz	800 nV/$\sqrt{Hz}$
	100 Hz	400 nV/$\sqrt{Hz}$
	1 kHz	300 nV/$\sqrt{Hz}$

External Source

Direct Input: Input resistance 500 Ohms ± 10%
Input Voltage range 0 to 5 V max

Optically Isolated Input: Input impedance 300 Ohms in series with LED
Input Voltage Range 3 V to 6 V
Jitter in Opto mode 4 ns max

Current Sense Output:		
	1 mA/V	2% reading ± 3 μA
	10 mA/V	2% reading ± 30 μA
	25 mA/V	2.5% reading ± 300 μA

Voltage Sense Output:		
	2 V	0.2% reading ± 4 mV
	20 V	0.2% reading ± 40 mV

3.5 40480 HIGH SPEED DRIVER CARD

Output Characteristics

Output characteristics are measured using a 4ft. length of 50 Ω Cable connecting the output to the specified load.

	1 MOhm load // 15pf	50 Ohm Load
High Level Range:	+20 V to -10 V	+10 V to -5V
Resolution:	10mV	5mV
Accuracy:	0.1% of prog. value ± 100mV	5% of prog. value ± 50mV
Low Level		
Range:	+10 V to -20 V	+5 V to -10 V
Resolution:	10mV	5mV
Accuracy:	0.1% of prog. value ± 100mV	5% of prog. value ± 50mV
Amplitude:	20 V to 2 V	10 V to 1 V
Rise and Fall Times:	5ns Max.	3.5ns Max.
Max. Repetition Rates:	50 MHz	60 MHz
Output Aberrations:	5% of Vo p-p +350mV for Vo p-p > 2V	5% of Vo p-p + 200mV for Vo p-p > 1V

Output Resistance:	Not Measured	50Ω ± 5% for 1V ≤ Vo p-p ≤ 10 V
Output Polarity:	Normal or Inverted	Normal or Inverted

External Source - TTL

Input Resistance: 50 Ω or 500 Ω, DC Coupled, ± 10%

Input Voltage Range: 2 V to 5 V

Minimum Pulse Width: 7ns

Maximum Clock Rate: 60 MHz

External Source - Optically Isolated

Input Impedance: 300 Ω in series with LED

Input Voltage Range: 3V to 6V (3mA to 10mA max)

Minimum Pulse Width: 25ns

Max Clock Rate: 20 MHz.

MODES OF OPERATION

EXT WIDTH, INT WIDTH, INT DELAY/WIDTH AND DOUBLE PULSE

All timing parameters are measured, using the External TTL input with 50 Ohm input impedance and with the output terminated into 50 Ohms.

EXT WIDTH

Output pulse width or pattern controlled by pulse width or pattern of external signal. 8ns minimum output pulse width and 12ns maximum output delay with respect to trigger output.

INT WIDTH

Range: Output pulse width variable from 8ns to 90ms maximum.
Resolution: 1% of Programmed Value maximum or 100ps, whichever is greater.

Accuracy: 5% of programmed value ± 2ns

Jitter: 0.1% of programmed value + 100ps.

Offset Delay: Fixed 21ns ± 3ns with respect to trigger output.

Max. Duty Cycle: Greater than 50%.

INT DELAY/WIDTH

Range: Output delay with respect to trigger output variable from 30ns minimum to 90ms maximum.
Output Pulse Width characteristics identical to those under INT WIDTH

Resolution: 1% of Programmed Value maximum or 200ps, whichever is greater.

Accuracy: 5% of programmed value ± 2ns

Jitter: 0.1% of programmed value + 100ps.

Offset Delay: Fixed 21ns ± 3ns with respect to trigger output.

Max. Duty Cycle: Greater than 50%.

DOUBLE PULSE

Range: Spacing between pulse pair variable from 16.6ns minimum to 90ms maximum.

Resolution: 1% of Programmed Value maximum or 100ps, whichever is greater.

Accuracy: 5% of programmed value ± 2ns

Jitter: 0.1% of programmed value + 100ps.

Offset Delay: Fixed 21ns ± 3ns with respect to trigger output.

Maximum Duty Cycle: Greater than 50%.

TRIGGER OUTPUT

Amplitude: 1 V into 50 Ω minimum.

Minimum Pulse Width: 7ns, TTL input, 25ns Optically isolated input.

Delay: 10ns maximum with respect to TTL input.
65ns maximum with respect to Optically isolated input.

OUTPUT/INPUT CONNECTORS: BNC

CLOCK OUTPUT: .... Rear panel BNC Connector.

TTL INPUT: Rear Panel BNC Connector.

OPTICALLY ISOLATED TTL INPUT: ..... Rear panel BNC Connector, optically isolated from clock output, and isolated from chassis ground.

CONTROL INPUTS: .. Control input optically isolated from IEEE-488 Bus and isolated from chassis ground.

CURRENT SENSE OUTPUT: Not Available.

VOLTAGE SENSE OUTPUT: . 2 Ranges: 20 V: 0.2% reading ± 4 mV.
200 V: 0.2% reading ± 40 mV.

3.6 40490 HIGH SPEED DRIVER CARD

Output Characteristics

Output characteristics are measured using a 4ft. length of 50 Ω Cable connecting the output to the specified load.

	1 MOhm load // 15pf	50 Ohm Load
High Level		
Range:	+20 V to -10 V	+10 V to -5V
Resolution:	10mV	5mV
Accuracy:	0.1% of prog. value ± 100mV	5% of prog. value ± 50mV
Low Level		
Range:	+10 V to -20 V	+5 V to -10 V
Resolution:	10mV	5mV
Accuracy:	0.1% of prog. value ± 100mV	5% of prog. value ± 50mV
Amplitude:	20 V to 2 V	10 V to 1 V
Rise and Fall Times:	5ns Max.	3.5ns Max.
Max. Repetition Rates:	60 MHz	65 MHz
Output Aberrations:	5% of Vo p-p +350mV for Vo p-p > 2V	5% of Vo p-p + 200mV for Vo p-p > 1V

Output Resistance:		50Ω ± 5% for 1V ≤ Vo p-p ≤ 10 V
Output Polarity:	Normal or Inverted	Normal or Inverted

External Source - TTL

Input Resistance: 50 Ω or 500 Ω, DC Coupled, ± 10%

Input Voltage Range: 2.25 to 5 V

Minimum Pulse Width: 7ns

Maximum Clock Rate: 65 MHz

External Source - Optically Isolated

Input Impedance: 300 Ω in series with LED

Input Voltage Range: 3V to 6V (3mA to 10mA max)

Minimum Pulse Width: 25ns

Max Clock Rate: 20 MHz.

Jitter: 0.1% of Pulse Width +3ns

MODES OF OPERATION

EXT WIDTH, INT WIDTH, INT DELAY/WIDTH AND DOUBLE PULSE

All timing parameters are measured, using the External TTL input with 50 Ohm input impedance and with the output terminated into 50 Ohms.

EXT WIDTH

Output pulse width or pattern controlled by pulse width or pattern of external signal. 8ns minimum output pulse width and 12ns maximum output delay with respect to trigger output.

INT WIDTH

Range: Output pulse width variable from 7ns to 100ms maximum, in eight ranges.

Resolution: 1% of Programmed Value maximum or 100ps, whichever is greater.

Accuracy: 5% of programmed value ± 2ns

Jitter: 0.1% of programmed width value + 100ps.

Offset Delay: Fixed 21ns ± 3ns with respect to trigger output.

Max. Duty Cycle: Greater than 50%.

INT DELAY/WIDTH

Range: Output delay with respect to trigger output variable from 30ns minimum to 100ms maximum, in eight ranges. Output Pulse Width characteristics identical to those under INT WIDTH.

Resolution: 1% of Programmed Value maximum or 200ps, whichever is greater.

Accuracy: 5% of programmed value ± 2ns

Jitter: 0.1% of programmed delay value + 100ps.

Offset Delay: Fixed 21ns ± 3ns with respect to trigger output.

Max. Duty Cycle: Greater than 50%.

DOUBLE PULSE

Range: Spacing between pulse pair variable from 15ns minimum to 100ms maximum.

Resolution: 1% of Programmed Value maximum or 100ps, whichever is greater.

Accuracy: 5% of programmed value ± 2ns

Jitter: 0.1% of programmed value + 100ps.

Offset Delay: Fixed 21ns ± 3ns with respect to trigger output.

Maximum Duty Cycle: Greater than 50%.

TRIGGER OUTPUT

Amplitude: 1 V into 50 Ω minimum.

Minimum Pulse Width: 7ns, TTL input, 25ns Optically isolated input.

Delay: 15ns maximum with respect to TTL input.
65ns maximum with respect to Optically isolated input.

OUTPUT/INPUT CONNECTORS: BNC

CLOCK OUTPUT: Rear Panel BNC Connector.

MAIN OUTPUT: Rear Panel BNC Connector.

TTL INPUT: Rear Panel BNC Connector.

MUX OUTPUT: Rear Panel BNC Connector.

OPTICALLY ISOLATED TTL INPUT: Rear panel BNC Connector, optically isolated from clock output, and isolated from chassis ground.

CONTROL INPUTS: .. Control input optically isolated from IEEE-488 Bus and isolated from chassis ground.

CURRENT SENSE OUTPUT: Not Available.

VOLTAGE SENSE OUTPUT: . 2 Ranges: 20 V: 0.2% reading ± 4 mV.
200 V: 0.2% reading ± 40 mV.

3.7 40740 FOUR CHANNEL, BIPOLAR DC BIAS SUPPLY CARD

OUTPUT VOLTAGE:..... +20.47 V, to -20.48 V selectable from front panel control or programmable via IEEE-488 Bus.

RESOLUTION: 10 mV or 11 bits, plus sign bit.

High resolution mode provides 1 mV or 0.5 mV resolution when 2 channels are combined.

ACCURACY: ..... ± 20 mV of selected value (into 1 M Ω).

OUTPUT CURRENT:... ± 25 ma max. for $-20V \leq Vo \leq +20V$.

OUTPUT RESISTANCE: 75 milli-Ohms max. for $Io \leq +25$ mA.

OUTPUT NOISE:.... 1Hz 850nV/√Hz, 10Hz 300nV/√Hz, 100Hz 200nV/√Hz, 1kHz 100nV/√Hz, 10kHz 50nV/√Hz.

CURRENT SENSE: .. 1 mA/V: 0.2% reading ± 1 uA.
10 mA/V: 0.2% reading ± 10 uA.
100 mA/V:0.2% reading ± 100 uA.

VOLTAGE SENSE: 2 V: 0.2% reading ± 0.5 mV.
20 V:0.2% reading ± 5 mV.

3.8 40750 FOUR CHANNEL, BIPOLAR LOW NOISE DC BIAS SUPPLY CARD

OUTPUT VOLTAGE:..... Range 1 -10.24 V to +10.235 V.
Range 2 -20.48 V to +20.47 V.
Range selectable from front panel control or programmable via IEEE-488 Bus.

RESOLUTION: 11 bits plus sign bit. or Range 1, 5 mV.
Range 2, 10 mV.

High Resolution Mode provides 0.5 mV or 0.250 mV resolution when 2 channels are combined.

ACCURACY: ..... ± 20 mV of selected value (into 1 MΩ).

OUTPUT CURRENT:.. ± 25 ma max. for -20 V ≤ Vo ≤ +20 V.

OUTPUT RESISTANCE: 75 milli-Ohms max. for Io ≤ +25 mA.

OUTPUT NOISE:..... Range 1 Range 2

1 Hz	250 nV/√Hz	350 nV/√Hz
10 Hz	75 nV/√Hz	100 nV/√Hz
100 Hz	75 nV/√Hz	75 nV/√Hz
1 KHz	50 nV/√Hz	50 nV/√Hz
10 KHz	50 nV/√Hz	50 nV/√Hz

CURRENT SENSE: .. 1 mA/V: 0.2% reading ± 1 uA.
10 mA/V: 0.2% reading ± 10 uA.
100 mA/V: 0.25% reading ± 100 uA.

VOLTAGE SENSE: 2V: 0.2% reading ± 0.5 mV.
20V: 0.2% reading ± 5 mV.

3.9 40752 FOUR CHANNEL, BIPOLAR LOW NOISE DC BIAS SUPPLY CARD

OUTPUT VOLTAGE:..... Range 1 -10.24 V to +10.235 V.
Range 2 -20.48 V to +20.47 V.
Selectable from front panel control or programmable via IEEE-488 Bus.

RESOLUTION: 11 bits plus sign bit. or Range 1, 5 mV.
Range 2, 10 mV.

High Resolution Mode provides 0.5 mV or 0.250 mV resolution when 2 channels are combined.

ACCURACY: ..... ± 20 mV of selected value (into 1 MΩ).

OUTPUT CURRENT:.. ± 100 mA max. for -20 V ≤ Vo ≤ +20 V.

OUTPUT RESISTANCE: 75 milli-Ohms max. for Io ≤ +25 mA.

OUTPUT NOISE:.....	Range 1	Range 2
1 Hz	300 nV/√Hz	400 nV/√Hz
10 Hz	75 nV/√Hz	100 nV/√Hz
100 Hz	75 nV/√Hz	75 nV/√Hz
1 KHz	50 nV/√Hz	50 nV/√Hz
10 KHz	50 nV/√Hz	50 nV/√Hz

CURRENT SENSE: .. 1 mA/V: 0.2% reading ± 1 uA.
10 mA/V: 0.2% reading ± 10 uA.
100 mA/V: 0.25% reading ± 100 uA.

VOLTAGE SENSE: 2V: 0.2% reading ± 0.5 mV.
20V: 0.2% reading ± 5 mV.

3.10 40753/40755 TWO CHANNEL, BIPOLAR LOW NOISE DC BIAS SUPPLY CARD

OUTPUT VOLTAGE:..... Range 1 -10.24 V to +10.235 V.
Range 2 -20.48 V to +20.47 V.
Selectable from front panel control or programmable via IEEE-488 Bus.

RESOLUTION: 11 bits plus sign bit. or Range 1, 5 mV.
Range 2, 10 mV.

High Resolution Mode provides 0.5 mV or 0.250 mV resolution when 2 channels are combined.

ACCURACY: ..... ± 20 mV of selected value (into 1 MΩ).

OUTPUT CURRENT:.. ± 250 mA max. for -20 V ≤ Vo ≤ +20 V.

OUTPUT RESISTANCE: 75 milli-Ohms max. for Io ≤ +25 mA.

OUTPUT NOISE:.....	Range 1	Range 2
1 Hz	350 nV/√Hz	450 nV/√Hz
10 Hz	75 nV/√Hz	100 nV/√Hz
100 Hz	75 nV/√Hz	75 nV/√Hz
1 KHz	50 nV/√Hz	50 nV/√Hz
10 KHz	50 nV/√Hz	50 nV/√Hz

CURRENT SENSE: .. 1 mA/V: 0.2% reading ± 1 uA.
10 mA/V: 0.2% reading ± 10 uA.
100 mA/V: 0.25% reading ± 100 uA.

VOLTAGE SENSE: 2V: 0.2% reading ± 0.5 mV.
20V: 0.2% reading ± 5 mV.

3.11 40770 FOUR QUADRANT BIAS CARD

VOLTAGE SOURCE (Mode 1)

Vout: ±24.5 Volts

Resolution: 3 mV

Accuracy: 0.1% of program Value ±15mV.

VOLTAGE SOURCE MODE: Current protection

Current protection, Voltage Mode in 7 ranges, 128 steps each range: Accuracy of current protection.

	Range		
200mA	3%	of program value	±300μA
20mA	3%	of program value	±30μA
2mA	3%	of program value	±3μA
200μA	3%	of program value	±300nA
20μA	3%	of program value	±30nA
2μA	3%	of program value	±3nA
200pA	3%	of program value	±20nA

VOLTAGE SOURCE MODE: Current Sense

Range Accuracy:

1 0.4% of reading ±.2mA
2 0.2% of reading ±5uA
3 0.2% of reading ±500nA
4 0.2% of reading ±50nA
5 0.2% of reading ±5nA
6 0.2% of reading ±500pA
7 0.3% of reading ±100pA

VOLTAGE SOURCE MODE: Output Resistance: 75 milliOhms max for output currents <200mA, Voltage Mode, 200mA range.

VOLTAGE SOURCE MODE: Output Noise:

1 Hz, 950 nV/√Hz
10 Hz, 350 nV/√Hz
100 Hz, 250 nV/√Hz
1 kHz, 230 nV/√Hz
10 kHz, 70 nV/√Hz

CURRENT SOURCE (Mode 2)

CURRENT SOURCE MODE: Current Source

Range	Max. Current	Resolution	Accuracy
1	±200mA	25μA	0.2% of programmed value ±100μA, ±5μA x Vo
2	±20mA	2.5μA	0.1% of programmed value ±10μA, ±0.5μA x Vo
3	±2mA	.25μA	0.1% of programmed value ±1μA, ±50nA x Vo
4	±200μA	25nA	0.1% of programmed value ±100nA, ±5nA x Vo
5	±20μA	2.5nA	0.1% of programmed value 10nA, ±0.5nA x Vo
6	±2μA	250pA	0.2% of programmed value ±1nA, ±50pA x Vo
7	±200nA	25pA	0.3% of programmed value ±200pA, ±5pA x Vo

where Vo is Output Voltage.

CURRENT SOURCE MODE: Voltage Protection

2.5 V Range, 128 steps

25 V Range, 128 steps

Accuracy of Voltage Protection on both ranges is 3% of setting ±200mV.

CURRENT SOURCE MODE: Voltage Sense

Two Ranges; 2.5V and 25V

2.5V Range 0.2% of reading value ±2mV (Vo in range of ± 8 V).
25V Range 0.2% of reading value ±20mV.

3.12 PI-4003 DC POWER MAINFRAME

1- +31VDC 10 AMPS
1- -31VDC 10 AMPS
1- +10VDC 10 AMPS
1- -10 VDC 10 AMPS (Not implemented at present, reserved for future applications)

Load Regulation: ± 0.1% (0 to 100% full load).
Line Regulation: 0.2% (20% line change).
Noise and Ripple: 0.1% peak to peak.
Transient Response: less than 50 μsec for 50% load change.
Temperature Coefficient: ± 0.01%/°C maximum.
Stability: ± 0.1% maximum for 24 hours after warm-up.

---

1. Unless otherwise specified, all dynamic measurements are made using a 3 ft. length, 50 Ω coaxial cable transmitted into 15pf/1MΩ (such as the input of a 300MHz oscilloscope).

4.0 INSTALLATION

4.1 INTRODUCTION

This operating manual contains all the information required to install, operate and program the PI-4001/4002/4003/4006 mainframes, and all options and accessories. All information in this manual regarding the PI-4002 Instrument Mainframes is identical for the PI-4006 Front Loading Instrument Mainframes.

The PI-4000 Series Test System is a complex instrument that is capable of performing many tasks. To use this instrument to full advantage, a thorough reading of this manual is required.

4.2 PACKING AND UNPACKING

The PI-4001/4002 Mainframes were shipped to you in a foam filled carton that was designed to withstand normal shipping requirements. Please report any damages to the carrier as soon as possible.

The PI-4001 Control Mainframe was shipped with the following accessories:

1 - Operators Manual
1 - Power Cord
1 - 40090-X PI-Bus Interconnect cable
1 - Set Rack Slides (If unit is Rack Mount Version)

Please contact Pulse Instruments immediately if you find any discrepancies.

***** DO NOT TURN THE POWER ON UNTIL *****
***** YOU HAVE READ THE FOLLOWING: *****

4.3 POWER REQUIREMENTS

The Pulse Instruments Model PI-4001 Control Mainframe and the PI-4003 DC Power Mainframe are designed to operate from either a 120V or 220V power source, depending upon the model shipped from the factory. The label in the bottom rear corner of the back panel above the power receptacle indicates the voltage inputs required for operation of your units.

Please verify that the Voltage indicated is correct for your intended application before connecting power cords to the units, or the units to the power source.

4.4 COOLING AND VENTILATION

To prevent damage or over-heating to your PI-4001/4002/4003, please make certain that there are no obstructions near the unit that would defeat fan operation or air flow vents located around the unit. Adequate air circulation and ventilation are necessary for proper unit operation and instrument life. It is recommended that a space of 1.75 Inches be used between each mainframe for proper ventilation. All instrument and system fan filters should also be cleaned at regular intervals depending upon your operating environment.

4.5 CONFIGURATION

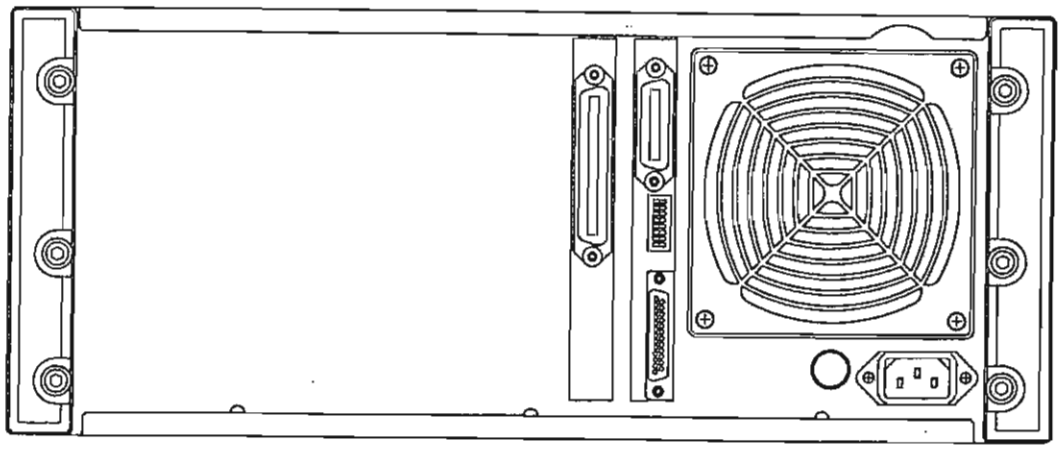
The PI-4001/4002/4003 is normally supplied in rack mount configuration. If you intend to use the unit for bench top applications only, the factory should be notified at the time of ordering, as removal of the rack mount slide brackets require operations from inside the unit.

All printed circuit boards that are supplied as part of your unit were installed at the factory. You may, however, re-arrange the Driver and Bias supply cards to any configuration that you require within the eight output card slots. Resetting the system will bring up the new Card configuration.

Changing Card loctions will affect any software that is written based on previous Card locations.

You can also get the configuration of your system over the IEEE-488 Bus or through the RS-232-C Port with the ID Command. See Section 9.0 Programming the 4000 Series System.

4.6 REAR PANEL -- PI-4001 Control Mainframe



4.6.1 General

The PI-4001 Control Mainframe is programmable through compatibility with the IEEE-488 GPIB and EIA STD RS-232-C for Full Duplex Asynchronous Receiver/ Transmitter operation.

These connectors are located in the control slot labeled B on the right rear of the mainframe. The DIP-Switch between the two connectors is used for setting the IEEE-488 address.

The left control slot contains the connector for the PI-Bus. The ribbon cable that is connected to the PI-Bus connector has been designed to daisy chain all of the PI-4002 Instrument Mainframes in the system to the PI-Bus connection at the rear of the PI-4001 Control Mainframe.

This Bus is optically isolated between the control mainframe and the instrument mainframe to prevent transfer of the digital noise in the PI-4001 Control Mainframe to the Instrument Mainframes. The PI-Bus cable is connected to control slot A on the PI-4002 Instrument Mainframes.

Make certain that the daisy chain cables are pressed firmly in place to make accurate connection. NEVER disconnect the cables by pulling on the cable.

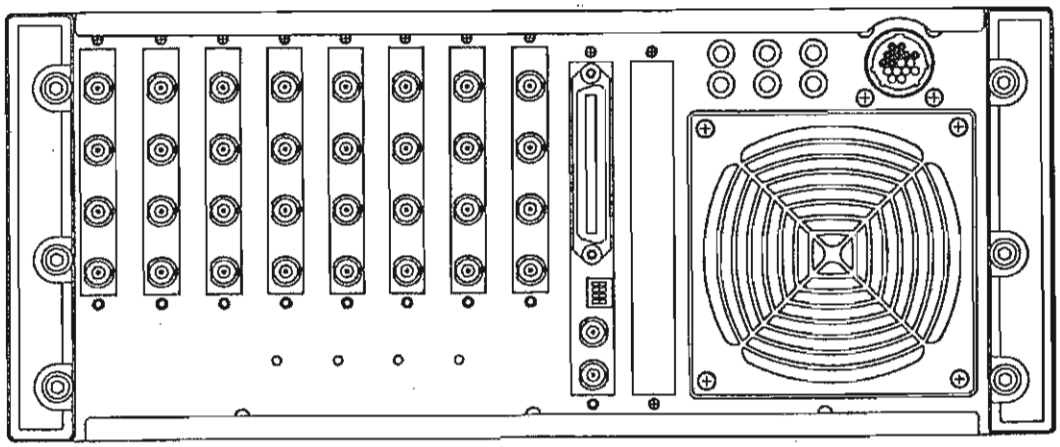
The PI-4001 Control Mainframes have their own internal power supplies and should be connected to your AC power source.

The PI-4002 Instrument Mainframes are to be connected to the DC Power Mainframe (PI-4003) through the power connector on the top right rear corner of each PI-4002 Instrument Mainframe.

4.6.2 Remote Operation of PI-4002 Instrument Mainframe.

The PI-4002 Instrument Mainframe can be placed a maximum of 23 feet from the PI-4001 Control Mainframe. This distance takes into consideration the absolute distance of the length of 40090-X daisy chain cable from the connector mount on the rear of the PI-4001 to the cable connection on the rear of the farthest distance cable connection on the PI-4002 Instrument Mainframe, if there are more than one PI-4002 Instrument Mainframe in the system.

4.7 REAR PANEL -- PI-4002 Instrument Mainframe



4.7.1 General

The following information is a description of the connections to be made on the rear of the PI-4002 Instrument Mainframe. The internal motherboard is floating with respect to the case.

The Instrument Mainframe can be placed in a remote location with respect to the PI-4001 Control Mainframe. See Section 4.6.2

1. The A Control Slot is used for the ribbon connector from the A control slot of the PI-4001 Control Mainframe. This ribbon cable contains the PI-Bus. It is connected in daisy chain fashion to the PI-4002 Instrument Mainframes. The connectors are keyed, and can only be installed in one way. Using a small screwdriver or similar tool, carefully press the wire lock on the top of the connector in place to prevent the cable from working loose if the cable is moved or stressed.

2. The slots labeled from 1 to 8 are for the driver and bias cards. These cards can be installed into any slot and mixed throughout the mainframe. If you intend to re-arrange the cards, turn off power to the system. If you re-arrange the cards, you will have to change any software that has been created, to reference the new slot locations.

3. The DIP-Switch directly below the PI-Bus connector in the A control slot is used for setting the Instrument Mainframe Number. Each mainframe used in the system must be set to a different mainframe number to allow access to the mainframe by the PI-4001 Control Mainframe. The mainframe numbers can be from one to seven. There can be as many as four mainframes controlled from one PI-4001 Control Mainfame.

You will note the Instrument Mainframe numbers on the Location section of the menu headings on the Main Menu. The DIP-Switch is ON, to the right side. The numbers are added in the ON position.

4. The six banana jacks in the upper right corner are the Voltage monitor jacks. These jacks are used for monitoring the system DC voltage that is connected to the DC power connector. These Jacks are not for connection to any other source and are not to be used to draw power from the mainframe.

The outputs from these jacks are as listed:

--- White ... -31 Vdc
--- Blue .... +10 Vdc
--- Red ..... +31 Vdc
--- Black ... Ground
--- Green ... Case
--- Yellow .. -10 Vdc (Not implemented at present, reserved for future applications)

The internal motherboard and the Cards are floating with respect to the case. You may ground the motherboard and cards by connecting a jumper between the Black and Green banana jacks.

HOWEVER, YOU WILL INCREASE SYSTEM NOISE IF THIS IS DONE.

The system DC Voltages should be set using the ADJ pots on the front of the PI-4003 DC Power Mainframe to the following tolerances:

-31 Vdc: In range from -31 Vdc to -33 Vdc.
+31 Vdc: In range from +31 Vdc to +33 Vdc.
+10 Vdc: In range from +9 Vdc to +11 Vdc.
-10 Vdc: Not used at present.

These measurements should be made from the Voltage monitor banana jacks with respect to the black Voltage monitor banana jack, which is power supply ground.

5. The PI-4002 Instrument Mainframes are to be connected to DC Power Supplies through the power connector on the top right rear corner of each PI-4002 Instrument Mainframe, by using the 40093 DC Power Cables. The connectors are keyed and can only be inserted one way. The opposite end of the connector is connected to any of the rear connectors, labeled J1 through J4, on the rear of the PI-4003 DC Power Mainframe. If you are not using the PI-4003 DC Power Mainframe, refer to the pin basing diagram for the DC Power connectors in this section.

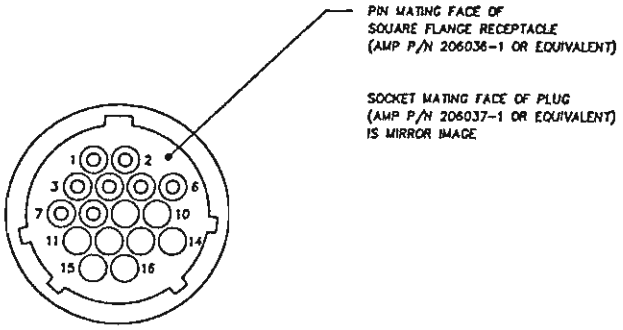
6. The two BNC Connectors directly below the DIP-Switch in control slot A are the sense connectors. The top BNC connector is the "+" or Positive output, and the lower BNC connector is the "-" or Negative output. These outputs are used as the DVM connection for the current and Voltage sense functions of the Driver and DC Bias Cards. There is a polarity shift between Voltage and current measurements on these pins. See Section 8.2.2 for more information regarding this feature.

In systems using more than one PI-4002 Instrument Mainframe, the Sense connectors should be tied together in parallel to allow "muxing" of more than one mainframe into one DVM. The Sense connectors allow use of the Sense function in the same manner as a Scanner; manually, or over the IEEE-488 Bus or RS-232-C Port. The sense connectors on the individual PI-4002 Instrument Mainframes must be connected together in parallel, or Tee'd to allow the muxing feature to operate.

The outer case of the PI-4002 is floating with respect to the internal motherboard, which allows the cards to float with respect to the case. If you require the internal cards to be at the same ground potential as the case, a connection can be made between the green and black banana plugs on the rear of the PI-4002 mainframe. This connection could severely increase the system noise.

The following diagram illustrates the power supply connector wiring on the rear of the PI-4002 Instrument Mainframe.

PIN INSTALLATION TABLE	
PIN NO.	
1	+31 V
2	GND RETURN
3	-31 V
4	GND RETURN
5	+10 V
6	GND RETURN
7	-10 V
8	GND RETURN
9	NO PIN
10	NO PIN
11	NO PIN
12	NO PIN
13	NO PIN
14	NO PIN
15	NO PIN
16	NO PIN



PI-4002 Instrument Mainframe Power Connector Basing -- Rear View

Once the Power Supplies have been connected to the PI-4002 Instrument Mainframes, and the interconnects have been made using the PI-Bus Interconnect Cable, power can be applied to the system.

The power-up sequence is as follows:

1. Turn on the DC Power Supplies, or the PI-4003 DC Power Mainframe.

2. Turn on the PI-4002 Instrument Mainframe.

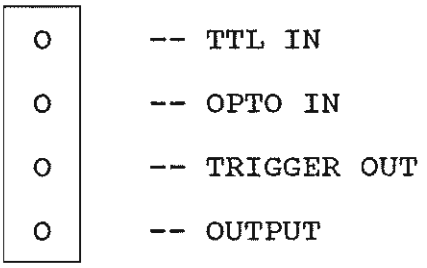
3. Turn on the PI-4001 Control Mainframe.

If the System is not powered up in this sequence, the CRT will display a reset condition, since the PI-4001 will search for the Cards, and will not find them, if the PI-4002 and PI-4003 are not turned on before the PI-4001 Control Mainframe.

Also verify that the each PI-4002 Instrument Mainframe is set to a different mainframe number on the rear dip-switch if you have a problem here.

4.7.2 Connectors on 40480 50 MHZ Driver Card

The BNC connectors on the rear of the 40480 Driver Card are as follows:



TTL IN -- Direct input to the card. Not optically isolated, will allow 50 MHz. Output.

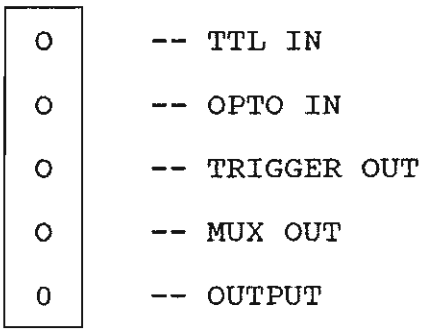
OPTO IN -- Optically isolated input. Will allow maximum 20 MHz output frequency.

TRIGGER OUT -- Trigger supplied for use with oscilloscope or other functions. Also the reference for Internal Width and Delay functions.

OUTPUT -- Output of the Driver Card.

4.7.3 Connectors on 40490 65 MHZ Driver Card

The BNC connectors on the rear of the 40490 Driver Card are as follows:



TTL IN -- Direct input to the card. Not optically isolated, will allow 65 MHz. Output.

OPTO IN -- Optically isolated input. Will allow maximum 20 MHz output frequency.

TRIGGER OUT -- Trigger supplied for use with oscilloscope or other functions; also the reference for Internal Width and Delay functions.

MUX OUT -- Used for connection to Oscilloscope to view the output waveform. Not to be used as a driver output. This output allows you to view the waveform without making connection to the actual driver output or connecting to the device under test.

OUTPUT -- Output of the Driver Card.

5.0 BASIC DESCRIPTION

5.1 General

The 4000 Series Low Noise Test System represents an entirely new approach to the instrumentation manufactured by Pulse Instruments for the testing of Focal Plane Arrays and Charge Coupled Devices.

The system uses a mainframe approach that separates the digital electronics from the bias and drive circuitry, both optically and through the use of separate power sources. This feature provides a very high level of noise immunity.

The power required for the Driver Cards and DC Bias Supply Cards, located in the PI-4002 Instrument Mainframe is supplied by separate power supplies (the PI-4003) that are located physically in the rack, but are not part of the PI-4002 Instrument Mainframes. There is also circuitry within the PI-4002 Instrument Mainframe to detect any loss of input power to the mainframe, and to reset the outputs of the drivers and biases to 0 Volts in the event of loss of power. This feature provides maximum protection to the device under test in case of power failure or loss of any supply input.

The PI-4003 Power Mainframe and the PI-4002 Instrument Mainframes are floating to insure the least possible noise from the power system. The separate mainframe structure will also allow the drivers and bias supplies to be located in close proximity to the device under test, if desired, while the digital electronics can be located in a remote area. There is also protection against transients that could possibly damage the Device Under Test. When the power is turned on or off, the output voltage levels on all drivers and bias supplies are held within the range of ± 3 Volts.

The system will require at least one PI-4001 Control Mainframe, and one PI-4002 Instrument Mainframe, and a source of DC power, such as the PI-4003 Power Mainframe for the PI-4002 Instrument Mainframe.

The PI-4001 Control Mainframe is microprocessor controlled, and contains all the digital circuitry for controlling the drivers, bias supplies, and all other system functions, via an optically isolated bi-directional bus connected to the PI-4002 Instrument Mainframes.

The PI-4001 contains it's own source of power to allow isolation of the PI-4002 Instrument Mainframes from digital noise and noise created over the IEEE-488 Bus or RS-232-C Serial Port. The Control Mainframe can select up to seven PI-4002 Instrument Mainframes and the Driver and Bias Supply Cards used with these mainframes.

The PI-4002 Instrument Mainframe will accept eight plug-in Cards. This allows up to 16 channels of dual channel driver output, or up to 32 channels of bias supply output in a single mainframe. The driver cards and bias supply cards can also be mixed in the instrument mainframe in any desired combination.

The system shares a common bi-directional bus structure in all models of mainframes. This allows flexibility in design and the addition of future modules and options, without the need to redesign the entire package.

The PI-4003 DC Power Mainframe can supply power for 3 PI-4002 Instrument Mainframes.

6.0 CONFIGURATION INFORMATION AND OPTIONS-4000 SERIES LOW NOISE TEST SYSTEM

PI-4001 Control Mainframe...Contains all intelligent control for the system, and the front panel control for manual use.

PI-4002 Instrument Mainframe...Contains eight slots for installation of cards as required for the system, and receives all information from PI-4001 Control Mainframe.

PI-4003 DC Power Mainframe...Supplies DC power for up to 3 PI-4002 Instrument Mainframes.

PI-4006 Front Loading Instrument Mainframe...Contains eight slots for installation of cards as required for the system, and receives all information from PI-4001 Control Mainframe.

40460 Dual Channel Clock Driver Card... Contains two channels of ±20 V., 8MHz. Clock Drivers.

40461 Dual Channel Clock Driver Card... Contains two channels of ±25 V., 8MHz. Clock Drivers. Requires special power supplies.

40465 Dual Channel Tri-Level Clock Driver Card... Contains two channels of ± 20 V., 8MHz. Tri-Level Clock Drivers.

40480 50 MHz. Clock Driver Card...Contains one channel of ±20 V., 50 MHz. Clock Driver. Discontinued, replaced with 40490 Card.

40490 65 MHz. Clock Driver Card...Contains one channel of ±20 V., 65 MHz. Clock Driver.

40740 Four channel Bias Supply Card...Contains four channels of ±20 V., 25ma. DC Bias Supplies. Discontinued, replaced with 40750 Card.

40741 Four channel Bias Supply Card...Contains four channels of ±25 V., 25ma. DC Bias Supplies. Requires special power supplies.

40750 Low Noise Four Channel Bias Supply Card...Contains four channels of ±20 V., 25mA DC Bias Supplies with 250 nV/√Hz Output Noise Levels at 1 Hz.

40751 Low Noise Four Channel Bias Supply Card...Contains four channels of ±25 V., 25mA DC Bias Supplies with 250 nV/√Hz Output Noise Levels at 1 Hz. Requires special power supplies.

40752 Low Noise Four Channel Bias Supply Card...Contains four channels of ±20 V., 100mA DC Bias Supplies with 300 nV/√Hz Output Noise Levels at 1 Hz.

40755 Low Noise Two Channel Bias Supply Card...Contains two channels of ±20 V., 250mA DC Bias Supplies with 400 nV/√Hz Output Noise Levels at 1 Hz.

40770 Four Quadrant Bias Supply... Two channels of ±24.5 VDC, each capable of Force Voltage/Force Current modes. Also allows programmable current limits.

40100 Calibration Kit...

The 40100 Calibration Kit provides the tools to allow calibration of the Voltage settings, and the Voltage and Current Sense functions on all of the Clock Driver and DC Bias Cards supplied with the 4000 system. The kit is complete with software that is MS-DOS compatible that guides you through the set up and calibration of the cards in a simple step by step manner. Also included are the required precision output loads and special connectors, a Card Extender, a calibration manual, and an attractive carrying case. Specify 5.25", or 3.5" disk size at time of order.

System Software Package

The system software allows the set up of all of the functions of the 4000 Test System, over the IEEE-488 Bus. The software runs under Windows 3.1 (or current version) and will function with all personal computers using 80386 or higher versions of microprocessors. The software can be used with the keyboard, or with a two or three button Microsoft compatible mouse.

The software sets up all system and card functions in a menu driven style through the use of the keyboard or Microsoft Compatible Mouse.The software allows all file handling functions such as Save, Load, Dump, etc., and the use of all programmable functions of the 4000 System.

7.0 FRONT PANEL CONTROLS PI-4001 CONTROL MAINFRAME

7.1 General

> NOTE: WORDS WHICH ARE BRACKETED REPRESENT FRONT PANEL KEYS, EG. THE THE PREV KEY IS REPRESENTED BY [PREV]

7.1.1 Power On/Off Switch.....Applies power to the PI-4001 Control Mainframe. Turning off power will remove all contents of the Volatile memory, which will include all present instrument settings.

7.1.2 Cursor Controls.....Allows movement of the cursor up, down, left, or right. Cursor movement on each menu is based on individual menu requirements.

7.1.3 [Home] Key.....Places the cursor on Channel one of the Main Menu. This key is also used to remove the window display from the CRT when the [ZOOM] Softkey is pressed. The [Home] Key when pressed at the same time as the [CE] Key comprises the system reset. The system reset sets all bias and driver output voltages to 0 volts, and places the system in the Off Line Mode.

7.1.4 [PREV] Key.....Allows selection of the last menu or previous display in the menu sequence, or when the [ZOOM] Softkey is pressed, will allow select of the previous Card to be windowed on the CRT.

7.1.5 [NEXT] Key.....Allows selection of the next menu in sequence, or when the [ZOOM] Softkey is pressed, will allow the selection of the next card to be windowed on the CRT.

7.2 FUNCTION KEYS

7.2.1 General

The references to the function keys below will describe their use in this system.

7.2.2 [UPDATE] Key -- Not in use, since the software is now automatically updated.

7.2.3 [LINE] Key -- The [LINE] Key is used to set the Off Line and On Line status of the system. When the system is first turned on, immediately upon power up, the default setting of the outputs is 0 Volts, and the unit is in the Off Line state.

In the Offline state, any changes to any driver or bias output Voltages will not be reflected in the output until the unit is placed in the Online state by toggling the [LINE] Key. The top of the CRT display provides an indication of the current setting of this function.

The Online, Offline Feature is designed to protect the device under test during set up and editing of the output levels.

If you are in the On Line state and go to Off Line, the output Voltages remain the same as they were before you went off line. If you should change the Voltage levels while you are in the Off Line State, going back On Line would now give you the new output levels.

7.2.4 [Lock] or [Disc] Key -- The [Lock] Key is presently being used for the Connect/Disconnect feature. When pressed, this key places the outputs through a small resistance to ground to effectively disconnect the outputs of the system. When in the disconnected mode, the screen display will display disconnect at the Online/Offline location. Pressing this key again will bring the instrument back to the Offline state. Pressing the [Offline] Key will bring the system back to Online.

7.3 SOFTKEYS

7.3.1 General

The function and value of the 6 softkeys are software defined. Each successive menu redefines their use, the softkeys represent approximately 24 different functions. Their location directly below the CRT allows easy coordination with their current value or function, which is displayed on the lower portion of the CRT. Please refer to the menu section for the value and function descriptions of the individual keys.

7.4 DATA KEYS

7.4.1 Data Keys

The data keys enable new parameter values and output data to be entered in decimal, binary, or hexadecimal data entry as required by the function being set.

7.4.2 Clear Entry [CE]

The [CE] key will clear out any information that has been entered by the data keys prior to pressing [ENT]

7.4.3 Enter [ENT]

The [ENT] key assembles all new parameter values and performs the entry of these values into program operation.

8.0 SYSTEM MENUS

8.1 NON VOLATILE STORAGE MENU - 90040 NON-VOLATILE MEMORY OPTION

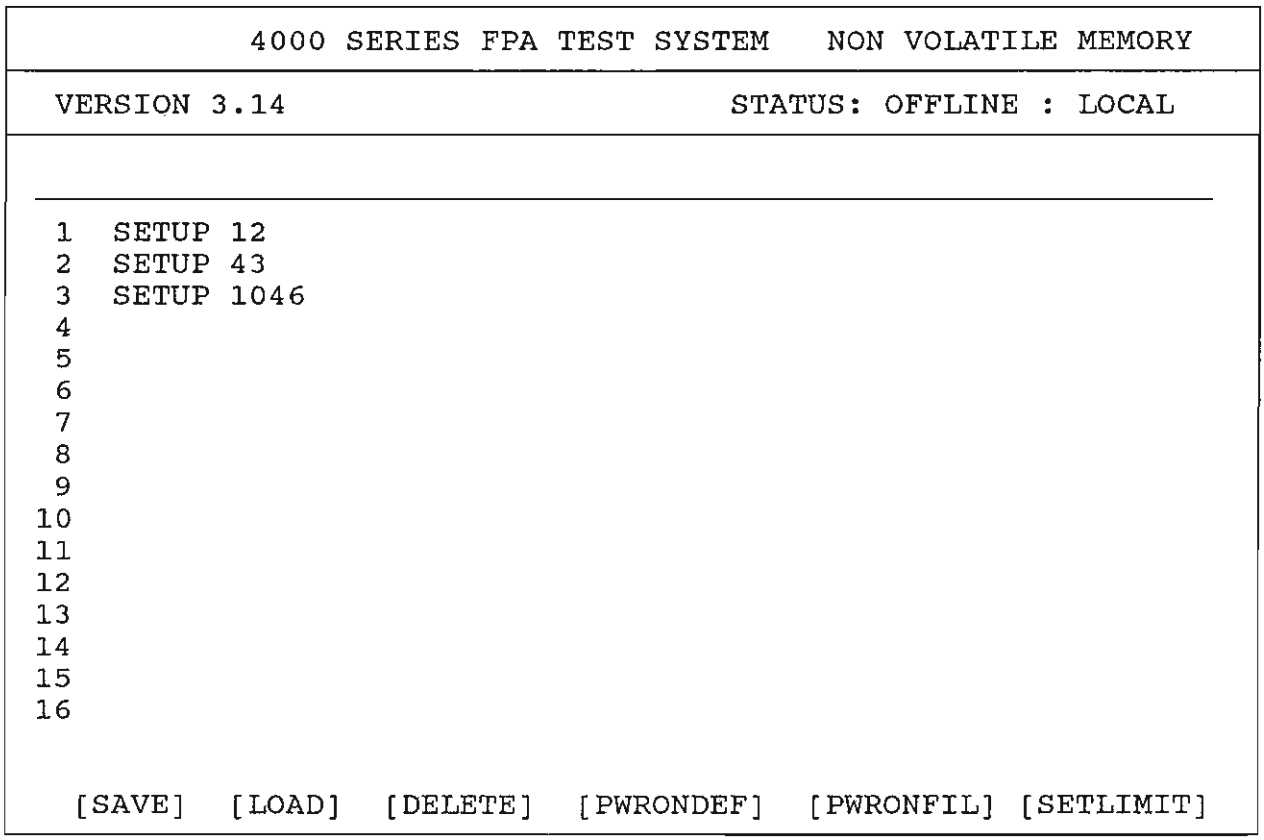


Figure 7. Directory Non-Volatile Memory Option

8.1.1 General

If the 90040 Non-Volatile Memory Option is installed in your PI-4001, You will see the Non Volatile Memory Directory on Power up. If you do not see this Menu, then the option is not installed.

The information shown on the display provides you with the type of file, and the user assigned reference number, for all of the files in non-volatile memory.

The 90040 Non-Volatile Memory Option allows the user to store up to 256K Bytes of instrument set-up within the PI-4001 Control Mainframe for later recall. All functions are available over the IEEE-488 Bus or through the RS-232-C Port, or from the front panel.

64 programs or files can be stored. The files stored contain the Voltage settings of each channel of Driver and DC Bias Card, and also the pre-set maximum Voltage limits that are user settable

for each channel of Driver and DC Bias. The following information will assume that you are familiar with operation and set-up of the 4000 System as described in this Manual.

The devices being used for non volatile storage are battery powered RAMS, which were selected for their fast access times. The RAMS are powered by Lithium batteries that have an expected use life of 10 years.

Each file saved is assigned a reference number by the user. These numbers can be from 1 to 4095. You cannot use the same number for a similar type of file, but the same number can be assigned to files of a different type. The following files can be saved.

1. SETUP -- Selecting this option will let you save the entire setup currently in the instrument. A file built under the SETUP command is a file that contains all of the function settings that were established within the instrument at the time the file was saved, as well as the maximum Voltage limits for each channel of Driver and DC Bias channel in the system. A typical directory entry for a setup would be:

SETUP3

Where: SETUP refers to saving all of the program.
3 is the number assigned by the user to identify the program.

2. PWRON -- This file is identical to the files built under set up, except that this is the power up file. One file can be designated as the file that will automatically be loaded upon power up. The file loads automatically, and applies the Voltage limits to the Drivers and DC Bias Cards that were previously set on the Bias Cards and Driver Cards Limits Setting Menus.

8.1.2 Explanation of Softkeys - Non Volatile Storage

The softkeys are defined as follows:

[SAVE] [LOAD] [DELETE] [PWRONDEF] [PWRONFIL] [SETLIMIT]

[SAVE] - When a program has been established, and is ready to be saved, pressing the [SAVE] softkey will begin the sequence of events to allow the save of the set up currently residing in the instrument.

Once you have pressed the [SAVE] softkey, you are given the message, "Save as File Number:". Enter the identifying number from 1 to 4095 that you select, and press [ENT]. The Message, "file Saved", will appear.

If a file has already been created using the number you have selected, you will be presented with the following options and message, "Overwrite? Confirm (ENT/NEXT = Yes, CE/PREV = No) ?". Pressing [ENT] or [Next] will destroy the old file and Write the new file in it's place. Pressing [CE] or [PREV] will take you out of the function and allow you to choose a new identifying number for the file to be saved.

[LOAD] - Allows the loading of programs that are internally stored. Pressing the [LOAD] softkey will begin the sequence of events that will load the selected internally stored program.

[DELETE] - Programs to be deleted are selected with the Up/Down Cursor controls. IF YOU SELECT A FILE AND PERFORM THE [DELETE] FUNCTION, THERE IS A PERMANENT LOSS OF THIS FILE.

To delete a file, select the file with the Cursor. The message, "Delete File? Confirm (ENT/NEXT = yes, CE/PREV = no)?", will be displayed.

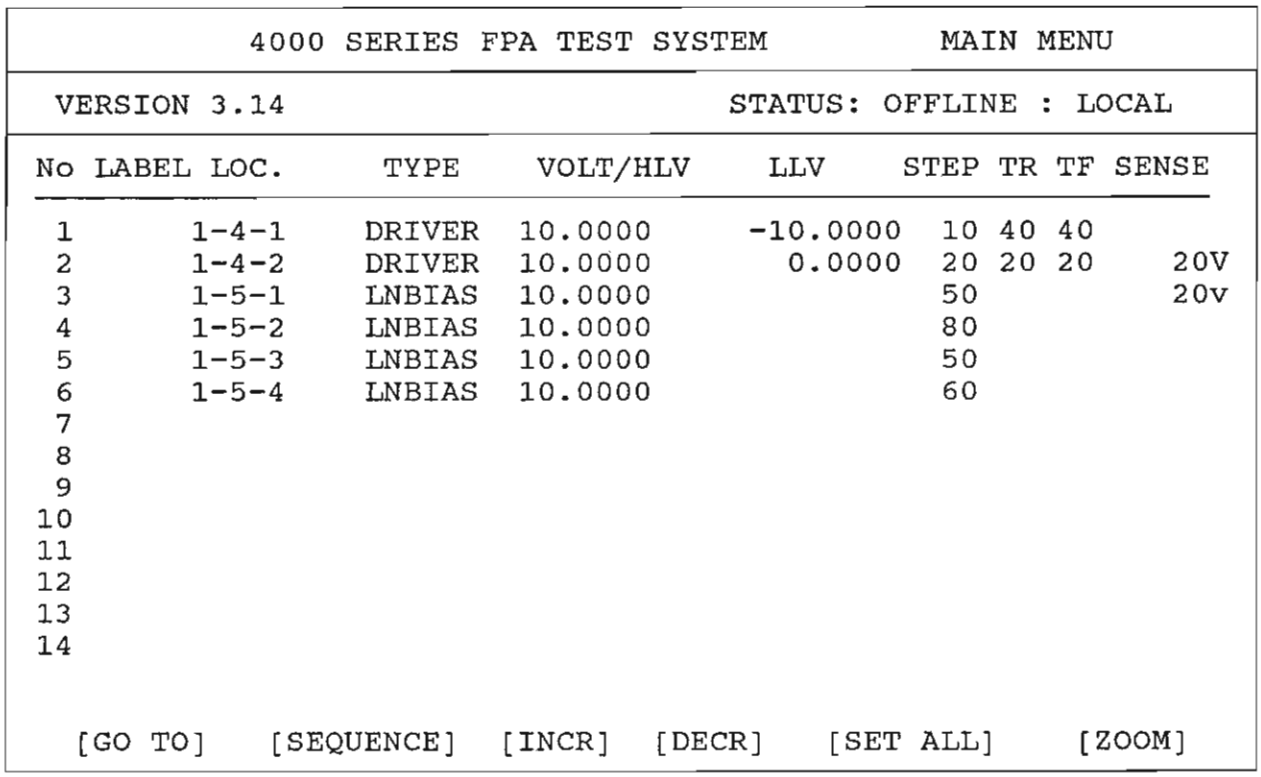
Pressing [ENT] or [NEXT] will destroy the file. Pressing [CE] or [PREV] will take you out of the function without deleting the file.

[PWRONDEF] - Sets the system with all Driver, Bias channels at 0 V output and all programmable Limits for the drivers and biases as established on the Driver/Bias Limits Setting Menu set for maximum output Voltage (-20.48 to +20.47).

Since the system will power up with the program that is set with the [PWRONFIL] softkey, to power up the system in the all 0V output mode, press the [PWRONDEF] softkey to set the instrument to default condition. Then press the [SAVE] softkey and enter the file number when asked, to save the default condition. Now place the cursor on the file that you just saved, and press the [PWRONDEF] softkey to make the default condition the power up file.

[PWRONFIL] - Pressing this softkey places the file at the location of the cursor as the file that is automatically loaded at power up. The Power on file can be changed at any time by selecting another file and pressing the [PWRONFIL] softkey twice; once to remove the present power up file as the default, and once to select the file at the location of the cursor as the power up file.

8.2 MAIN MENU



8.2.1 General

The Main Menu provides you with a data base style listing of all of the Cards that are currently in the system. The cards are presented in the order that they are installed in the PI-4002 Instrument Mainframe, beginning with the lowest mainframe number.

The Main Menu is also the default power up menu, if the system does not have the Non-Volatile Memory Option.

If you prefer the Bias and Driver Cards separated as to type, this can be accomplished by:

1. Install the Cards in the system as you would like them displayed.

2. Set up a new sequence of display with the use of the [SEQUENCE] Softkey, and save the set up as the power on file, or as a file that can be called. See Section 8.1 Non-Volatile Storage Menu.

All references to row in this manual refer to the horizontal data across the CRT that is referring to a particular CHANNEL of output.

All references to column refer to a particular FUNCTION displayed vertically down the display which affects all channels.

The Main Menu is used for setting all Card parameters, either as displayed on the Menu, or through use of the [ZOOM] Softkey to gain access to additional parameters not on the Main Menu display.

To set the Voltage output on a selected channel, using the cursor keys, place the cursor on the channel you want to set and enter the Voltage with the data keys, pressing the [ENT] Key will set the Voltage into the channel.

To RESET the system, simultaneously press the [HOME] and the [CE] Keys. Resetting the system will destroy the contents of volatile memory and place the system in the same condition as power on.

8.2.2 Main Menu Headings

The following information is a description of the Menu Headings and their functions. In many columns you will notice N.A. shown. This represents a non-applicable setting which is applied to all functions that are Voltage dependent when there is a Voltage setting of 0.

1. No. -- Number refers to the numbers of the cards in the order that they found by the software as it polls the mainframes in order. The [GOTO] Softkey when used with this number allows you to call up any channel.

2. LABEL -- The Label indicators are blank if the four character labels have not been programmed over the IEEE-488 Bus or RS-232-C Port. See LABEL in the programming section.
3. LOC. -- Location (Example, 3-1-2). the "3" represents the PI-4002 Instrument Mainframe number and the "1" represents the slot in the mainframe where the card is located. The "2" represents the particular channel on the card. The mainframe number is set by the dip-switch on the rear of each mainframe. The eight slots are numbered from right to left from the rear of the mainframe.

4. TYPE -- Refers to the type of Card in the particular slot; DC bias, clock driver, etc.

5. VOLT/HLV -- VOLT/HLV indicates the Voltage setting of the DC Bias Card that is in the selected location. It also represents the high level Voltage of the total swing of the output Voltage of a Driver Card. The difference between the High Level Voltage and the Low Level Voltage cannot exceed 25 Volts for the 40460 Driver Card, or 20V for the 40480, 40490 or 40465 Driver Card. The HLV or High Level Voltage must always be set above or equal to the LLV or Low Level Voltage.

6. LLV (Volt) -- This represents the Low Level Voltage of the total swing of the output Voltage of a driver. The absolute difference between the High Level Voltage, and the Low Level Voltage cannot exceed 25 Volts for the 40460 Driver Card, or 20V for the 40480, 40490 or 40465 Driver Card. The LLV or Low Level Voltage must always be set below or equal to the High Level Voltage.

7. STEP -- The Step refers to the present incremental setting of the card selected by the cursor. The step is used for setting the current value to be incremented or decremented when setting High Level Voltage, Low Level Voltage, and the Voltage output of the DC Biases. The values of the step function can be from 10mV to 100mV in 10mV increments. These ranges can vary depending upon the type of card accessed.

8. TR (ns) -- The programmable Tr feature allows the setting of the rise times of the individual channel outputs, either by front panel control, or remotely, over the IEEE-488 Bus or RS-232-C Port. Any value within range can be set at the point of the cursor with the data keys and [Ent] Key. The Rise and Fall Times are fixed on the 40480 and 40490 Driver Card. See Section 8.2.4, Setting the programmable Rise and Fall Times.

9. TF (ns) -- The programmable TF feature allows the setting of the fall times of the individual channel outputs either by front panel control, or remotely, over the IEEE-488 Bus or RS-232-C Port. Any value within range can be set at the point of the cursor with the data keys and [Ent] Key. The Rise and Fall Times are fixed on the 40480 and 40490 Driver Cards. See Section 8.2.4, Setting the programmable Rise and Fall Times.

10. SENSE -- The Sense column provides the Voltage or Current range status of each Driver or DC Bias output when the channel Voltage or Current Sense has been set. Current Sense is not available on the 40480 or 40490 Driver Cards. The selection of either Voltage or Current Sense can be made by placing the cursor in the Sense column of the desired card and pressing the [INC] or [DEC] Softkey to toggle the available settings. This feature can also be set in the Zoom Mode.

8.2.3 Explanation of Softkeys

The First Page of softkeys Main Menu are as follows:

[GOTO] [SEQUENCE] [INC] [DEC] [SET ALL] [ZOOM]

[GOTO] -- Allows access to any channel location, and places the selected channel at the top of the CRT screen. [GOTO] XX [ENT], where XX is the No. column on the Main Menu.

[SEQUENCE] -- Allows the programming of the sequence that will be used to apply the outputs to the device under test, or the sequence to remove the outputs from the device under test. Also allows set up of the order of display of the clock drivers and DC biases on the CRT. See Section 8.2.10 Setting the Programmable Sequence.

[INCR] -- Allows incrementing of the Voltage and rise and fall time settings. Voltages can be incremented from 10mv to 100mV in 10mV increments, and rise and fall times can be incremented in steps of 1ns, 10ns, or 100ns. See also High Resolution Mode for additional information on increment settings for bias cards.

[DECR] -- Allows decrementing of the Voltage and rise and fall time settings. Voltages can be decremented from 10mv to 100mV in 10mV increments, and rise and fall times can be decremented in steps of 1ns, 10ns, or 100ns. See also High Resolution Mode for additional information on decrement settings for bias cards.

[SET ALL] -- Allows you to set all of the channels to the same value with one command. This softkey works with HLV, LLV, TR, TF, INVERT, NONINV, DELAY, and WIDTH functions. The softkey sets all the drivers or DC biases to the value at the location of the cursor, when the softkey is pressed. Once you have pressed the key, you will be asked to press the [ENT] key to confirm this function. This will prevent you from accidently resetting all of the values that are programmed in.

[ZOOM] -- Provides a window of additional information on the selected card. Place the cursor on the card desired and press the [ZOOM] softkey. You will be presented with a window on the CRT displaying additional information. While in the window mode you may change the parameters on any displayed function by selecting the appropriate softkey. You may also change parameters on all Drivers or all Biases in the system while in this mode through the use of the [SET ALL] softkey. Once you have entered the window mode, you can change the window information to display other channels by using the [PREV] and [NEXT] softkeys. To remove the window press the [HOME] key.

8.2.4 Setting And Using The Programmable Rise And Fall Time 40460 Driver Card.

The Programmable Rise and Fall time function allows the setting of the individual rise and fall times of the channel outputs throughout the range of 40ns representing a minimum 2ns/V rise time up to 2000ns/V. The ranges are shown below.

Minimum	Maximum	Slew Rate	Inc/Dec Value
Range 1 40ns	400ns	2ns/V	1ns
Range 2 400ns	4000ns	20ns/V	10ns
Range 3 4000ns (4usec)	40000ns (40usec)	200ns/V	100ns

When Any voltage is changed on the 40460 Driver output, the Tr and Tf ranges are automatically re-calculated to display the same slew rate that was being used before the change, unless the current rise or fall time setting is Protected from change. See Section 8.3.1 [TR PROTECT] and [TF PROTECT] Softkeys, for information on protecting the rise and fall time settings.

The rise and fall times must always be set on the same range to prevent the setting of the rise time from affecting the setting of the fall time or vice versa. If an attempt is made to set either the Rise Time or Fall Time ranges incorrectly, there will be no change in the setting, and an " Out of Range" message will be presented.

Since the minimum slew rate of the Driver Card is 2ns/V, the software is designed to look at the Voltage levels between the high and low settings on each driver channel and automatically set the lowest range setting, as the default condition. This is the lowest value, or the value corresponding to a Tr or Tf of 2ns/V, based upon the voltage differential (HLV-LLV). If you have previously set the rise and fall times to the value that you require, the system will default to your pre-set slew rate, if any voltages are changed.

Once the default setting of the Tr/Tf is accomplished, the value of the Tr/Tf can be changed by placing the cursor on the proper channel, and inputting the new setting with the data keys. If you enter an illegal value, the CRT will display the error message: "out of range". This means that the Tr or Tf that you have selected based on the Voltage setting of the channel is out of the range of 2ns/V minimum and 2000ns/V maximum setting.

You can set any value desired based upon the guidelines of the chart above. For example, if you enter a value of HLV 10.000, and an LLV of 0.000, you will note that the default setting of Tr/Tf is 20ns, which is within the 2ns/V minimum setting. If you tried to Decrement this value 1ns to a value of 19ns, you would get an "out of range" error message since the value you were trying to set was 1.9ns/V, or out of minimum range.

The value of the Increment/Decrement Softkeys depends on the range. The chart above shows that the value changes by a factor of 10 times as you increase the range. As you get near the end of any range, you will notice a message that will ask you to select the operating range that you wish to use.

As you approach the end of Range 1, which would be approximately 390ns, the following message will appear: "Select range for 2ns/V or range 2 for 20ns/V (Enter 1 or 2)". You may at that time elect to stay on range 1, that you are using, which allows a maximum of 400ns in 1ns increments, or to change to range 2, which has a range from 400ns to 4000ns in 10ns steps. If you select between these ranges you will notice an overlap of about one step or 10ns, or 100ns depending upon the range.

NOTE: THE RISE AND FALL TIME SETTINGS MUST ALWAYS BE ON THE SAME RANGE AS SHOWN ON THE CHART. For example, you cannot set a rise time of 40ns and a fall time of 4000ns, since these values are not within the same range.

This is also true for access over the IEEE-488 bus or through the RS-232-C Port.

8.2.5 Voltage and Current Sense

The Voltage or Current Sense output on the PI-4002 Instrument Mainframe can be used to measure the load current of the 40460 Driver Card, or the exact Voltage output of either the high or low rail. In the current sense mode, the SENSE column on the Main Menu indicates the channel that is currently being sensed, and whether the Card is set for Current or Voltage sense. You should not have the Current Sense in effect while the Data Generator is running, since you will improperly terminate the output with the Current Sense series resistors.

The Voltage and Current Sense measurements are taken from the I/V Sense Port on the rear of the PI-4002 Instrument Mainframe.

All the I/V Sense ports can be tied together in parallel and multiplexed throughout the system to share a common DVM.

The multiplexed output is available at the dual BNC Output on the rear of the PI-4002 Instrument Mainframe. The output is taken

between the two center pins of the dual BNC Connectors. DO NOT MEASURE OR USE EITHER BNC CENTER PIN TO GROUND AS A METHOD OF MEASUREMENT.

The upper BNC Pin is negative with respect to the lower BNC Pin. Therefore, the upper BNC Pin should be connected to the minus or input low of a DVM with 4 1/2 digit capability, if possible. There is a reversal of polarity between current and Voltage measurements between these pins.

The DVM should be set to the 1 Vdc range. You should use a BNC to Dual Banana adaptor and take the signal only from the center pin portion of the BNC output on both "+" and "-" sense outputs

There should be a load connected to the driver output that is to be measured.

8.2.6 Current Sense Measurement Using the DVM.

The current output is the DVM voltage multiplied by the selected current range.

For example; if the DVM reading was .987 V, and you were on the 25mA/V range, the output current would be 24.675 mA, ie...

(.987 X 0.025)

When taking Current measurements, the sensing Voltage output range on the DVM should not exceed 2.5 Vdc, or the next higher Current Sense range for the channel you want to measure should be selected.

With no signal applied to the Driver input, the Current measurement is the High Rail (HLV) with an inverted output setting, and the Low Rail (LLV) with the output setting in the noninverted mode. The Invert and NonInvert functions can be set for all channels in the system with the [SET ALL] softkey, from any Driver Card in the Zoom Mode window.

1 mA/V	1k Ohms
10 mA/V	100 Ohms
25 mA/V	40 Ohms

Internal Range Resistance values of the 40460/40461 Driver Cards.

The range resistors are not in the direct output path of the Drivers.

The Current Sense Mode is not available on the 40480 or 40490 Driver Cards.

There should be a load connected to the bias supply output that is to be measured. For example: 10k Ohms.

For example; if the DVM reading was .987 V, and you were on the 10mA/V range, the output current would be 9.87 mA.

The internal range resistances for current measurements of the Bias Cards are as follows:

1mA/V	1000 Ohms
10mA/V	100 Ohms
100mA/V	10 Ohms

Internal current range resistance
40740, 40741, and 40750 Bias Cards

8.2.7 Voltage Sense -- Main Menu.

Voltage Sense allows reading of the actual Voltage output of the channel selected at the position of the cursor. The Voltage sense output on the PI-4002 Instrument Mainframe can be used to measure the Voltage output of any driver output on the Driver Status and Set Up Menu. Unless the Current Sense Mode has been selected, the Voltage Sense is always available at the channel of the cursor location. It has no effect on the output signal.

Basically, the Voltage Sense Output is a Voltage divider that takes the output Voltage from the selected channel, and either reads it directly on the 2 V range, for output Voltages below 2 Volts, or divides it by ten on the 20 V range to allow reading of Voltages above 2 Volts. All of the system cards use the 2 V and 20 V ranges, with the exception of the 40480 50 MHz card, which uses the ranges of 20V and 200V.

In the Voltage Sense mode, the SENSE column on the Main Menu indicates the channel that is currently being sensed.

8.2.8 Setting The High Resolution Mode on the DC Bias Cards.

The High Resolution Mode allows adjustment of the Bias Voltage output at the cursor location in the increments listed below for the particular DC Bias Cards in your system.

Card	Low Res.	High Res.	
40740	10 mV	0.5 mV	
40741	12.5 mV	0.625 mV	
40750	10 mV	0.5 mV	High Range ± 20 V Setting
40750	10 mV	0.250 mV	Low Range ± 10 V Setting

NOTE: The High Resolution Mode is achieved by sacrificing one channel of bias output for each channel that is set up to be incremented or decremented in the High Resolution ranges as opposed to the 10 mV default range. The channels involved must be on the same card.
The High Resolution Mode can only be selected for the ODD-numbered channels, since the EVEN-numbered channels are added to the odd-numbered channels to achieve the mode. For example, if you select channel one for high resolution output, then channel two would be sacrificed to allow you to achieve the required resolution.

Whenever an even channel has been sacrificed for the High Resolution mode, the resolution column for that channel will display H-R. This display indicates that the even channel is functioning in conjunction with the odd channel directly above it to set the High Resolution Mode. Do not use the channel labeled H-R as an output channel while in the High Resolution Mode.

The cursor does not access the Resolution Column.

8.2.9 Setting Driver and DC Bias Limits

Each DC Bias Channel and The High and Low Rails of the drivers, can be set for the maximum Voltage limits that you would ever want to see applied to a particular device.

This feature will prevent over-Voltage of the Device Under Test by an accidental over-Voltage of any channel that is connected to the Device Under Test.

Driver Cards Limits Setting allows you to set the High and Low Rails of the Drivers (Upper and Lower Limits), and the maximum Voltage amplitude of the output signal of each channel.

Bias Cards Limits Setting allows you to set the Upper and Lower limits of each DC Bias Channel. For example, you may want the DC Biases to only be adjusted between the range of 9 V (lower limit) and 11 V (upper limit).

8.2.10 Setting the Programmable Sequence

The 4000 System allows you to set the sequence of the application of the Clock Drivers and DC Biases to the device under test in the order or sequence that you require. The sequence can either be set using the Front Panel, the IEEE-488 Bus, or RS-232-C Port.

Upon power up, the 4000 System handles the sequence in the following manner:

Default sequence

Screen -- Ascending mainframe, slot and channel.
Online -- Biases in ascending order, Drivers in descending order.
Disconnect -- Drivers in ascending order, Biases in descending order.

Once the sequence has been established, it can be saved as part of the set up that is stored in Non Volatile Memory if this option is present.

Pressing the [SEQUENCE] softkey on the Main Menu will present you with the options of setting up the Screen Display Sequence, the Online Sequence or the Disconnect Sequence.

The Screen Sequence is the order in which the Clock Drivers and DC Biases will be displayed on the CRT. This is not the Order of the Online Sequence or Disconnect Sequence unless either of these sequences has been set the same as the CRT display.

Selecting the [Online Seq] Softkey will present you with the softkeys that are used to set the sequence in which the outputs are applied to the device under test. Once the sequence is established, the output sequence is applied by pressing the [LINE] key.

Pressing the [DISCON SEQ] softkey will present you with the softkeys that are used to set up the sequence in which the Clock Drivers and DC Biases are removed from the device when the [Lock] or [DISCON] key is pressed. (In some versions of the 4000 System the Disconnect Softkey is labeled [LOCK].

You do not have to set up all of the channels in sequence. If only a few channels are critical, the balance of the channels will be applied in default order. Once you have set up the number of channels that you require, press the [EXIT] softkey on the menu you are using to finish the sequence set up.

8.2.10.1 Setting the Programmable Screen Sequence

When the [SCREEN SEQ] Softkey is pressed, you will be presented with the following Softkeys.

[GO TO] [MOVE] [SWAP] [INSERT] [DELETE] [EXIT]

[GO TO] -- The [GO TO] Softkey is used to select the channel from the No. Column, by pressing the [GO TO] Softkey and the number of the channel you wish displayed.

[MOVE] -- Allows you to Move the channel to the desired location. To Move the channel, place the cursor on the channel, and press the [MOVE] Softkey. You will then be asked for the new location for the channel. Cursor to the new location, press [ENT], and the channel will be moved.

[SWAP] -- Allows you to swap two selected channels.

[INSERT] -- Adds a line (space) at the point of the cursor.

[DELETE] -- Deletes the line (space) at the point of the cursor.

[EXIT] -- Takes you out of the Screen Sequence function.The [EXIT] Softkey will remove you from the function giving you the channels in sequence that you have established, and giving you the default set up for the balance of the channels you have not changed.

8.2.10.2 Setting the Programmable Online Sequence

When the [ONLINE SEQ] Softkey is pressed, you will be presented with the following softkeys.

[GO TO] [MOVE] [SWAP] [ ] [OPPOSITE] [EXIT]

[GO TO] -- The [GO TO] Softkey is used to select the channel from the No. Column, by pressing the [GO TO] Softkey and the number of the channel you wish displayed.

[MOVE] -- Allows you to Move the channel to the desired location. To Move the channel, place the cursor on the channel, and press the [MOVE] Softkey. You will then be asked for the new location for the channel. Cursor to the new location, press [ENT], and the channel will be moved.

[SWAP] -- Allows you to swap two selected channels.

[OPPOSITE] -- Reverses the order of the current settings of the currently programmed Disconnect Sequence and establishes this sequence as the Online Sequence.

[EXIT] -- Takes you out of the Online Sequence function. The [EXIT] Softkey will remove you from the function giving you the channels in sequence that you have established, and giving you the default set up for the balance of the channels you have not changed.

8.2.10.3 Setting the Programmable Disconnect Sequence

When the [DISCON SEQ] Softkey is pressed, you will be presented with the following Softkeys.

[GO TO] [MOVE] [SWAP] [ ] [OPPOSITE] [EXIT]

[GO TO] -- The [GO TO] Softkey is used to select the channel from the No. Column, by pressing the [GO TO] Softkey and the number of the channel you wish displayed.

[MOVE] -- Allows you to Move the channel to the desired location. To Move the channel, place the cursor on the channel, and press the [MOVE] Softkey. You will then be asked for the new location for the channel. Cursor to the new location, press [ENT], and the channel will be moved.

[SWAP] -- Allows you to swap two selected channels.

[OPPOSITE] -- Reverses the order of the current settings of the currently programmed Online Sequence and establishes this sequence as the Disconnect Sequence.

[EXIT] -- Takes you out of the Disconnect Sequence function. The [EXIT] Softkey will remove you from the function giving you the channels in sequence that you have established, and giving you the default set up for the balance of the channels you have not changed.

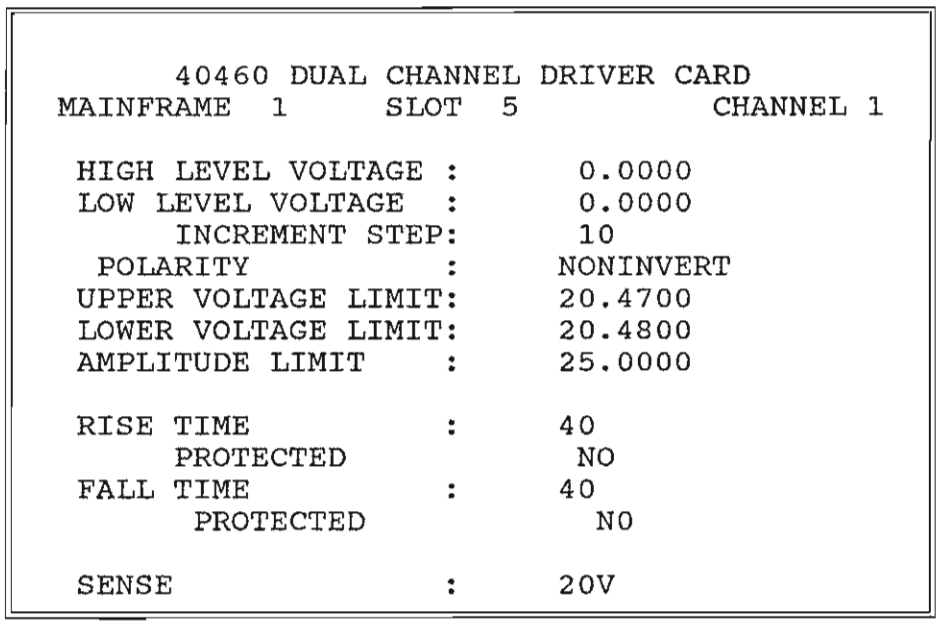
8.3 WINDOWS IN THE ZOOM MODE

The following section explains the window information that is presented for each card when the [ZOOM] softkey is pressed. To use the Zoom Mode, place the cursor on the desired channel row and press the [ZOOM] Softkey. To remove the window press the [HOME] Key.

Any parameter can be changed for all similar cards in the system by using the [SET ALL] Softkey.

The [PREV] and [NEXT] Softkeys can be used to select the channels in sequence as they appear in the Data Base format when the Zoom Mode is not in use.

8.3.1 40460 Dual Channel Driver Card Window



[TR PROTECT] [TF PROTECT] [INCR] [DECR] [SET ALL] [INV/NOINV]

8.3.1.1 Settable Parameters 40460 Dual Channel Driver Card Window

1. High Level Voltage -- Sets the High Rail of the output of the card. The difference between the high level Voltage and the low level Voltage cannot exceed 25 Volts. The HLV or High Level Voltage must always be set above or equal to the LLV or Low Level Voltage.

2. Low Level Voltage -- Sets the Low Rail of the output of the card. The difference between the Low Level Voltage and the

High Level Voltage cannot exceed 25 Volts. The LLV or Low Level Voltage must always be set below or equal to the HLV or High Level Voltage.

3. Increment Step -- Allows setting of the value of the increment step when the [INC] or [DEC] Softkeys are used. The Increment Step can be set from 10 mV to 100 mV in 10 mV increments when used to set the High or Low Level Voltage output.

4. Polarity -- Sets the output to either inverted or noninverted.

5. Upper Voltage Limit -- Allows High Level Voltage of the Driver Card to be set to the maximum Voltage Limits that you would ever want to see applied to a particular device.

6. Lower Voltage Limit -- Allows Low Level Voltage of the Driver Card to be set to the minimum Voltage Limits that you would ever want to see applied to a particular device.

7. Amplitude Limit -- Sets maximum Voltage amplitude that the Driver Card can output. The maximum amplitude for the 40460 Driver Card is 25 V.

8. Rise Time -- Sets the programmable Rise Time. See Section 8.2.4 for information on setting the Programmable Rise and Fall Time.

9. Protected -- Allows you to protect the setting of the Rise Time with changes in the settings of the High and Low Level Rails. In the not protected mode, the rise time will be recalculated to maintain the slew rate that existed before the change in amplitude.

10. Fall Time -- Sets the programmable Fall Time. See Section 8.2.4 for information on setting the Programmable Rise and Fall Time.

11. Protected -- Allows you to protect the setting of the Fall Time with changes in the settings of the High and Low Level Rails. In the Not Protected Mode the Fall Time will be re-calculated to maintain the slew rate that existed before the change in amplitude.

12. Sense -- Toggles the Voltage and Current Sense setting desired for this particular card. You can use the [SET ALL] Softkey while on this parameter to set all of the same type of cards in the system. The Toggled settings for this card are; 20 V, 2 V, 1 mA, 10 mA, and 100 mA.

8.3.1.2 Softkeys 40460 Driver Card Window

[TR PROTECT] -- Toggles the Rise Time Protect feature on and off. The protect feature allows you to change Voltage levels while maintaining the same slew rate, which means that the rise time would change with a change in Voltage.

[TF PROTECT] -- Toggles the Fall Time Protect feature on and off. The protect feature allows you to change Voltage levels while maintaining the same slew rate, which means that the fall time would change with a change in Voltage.

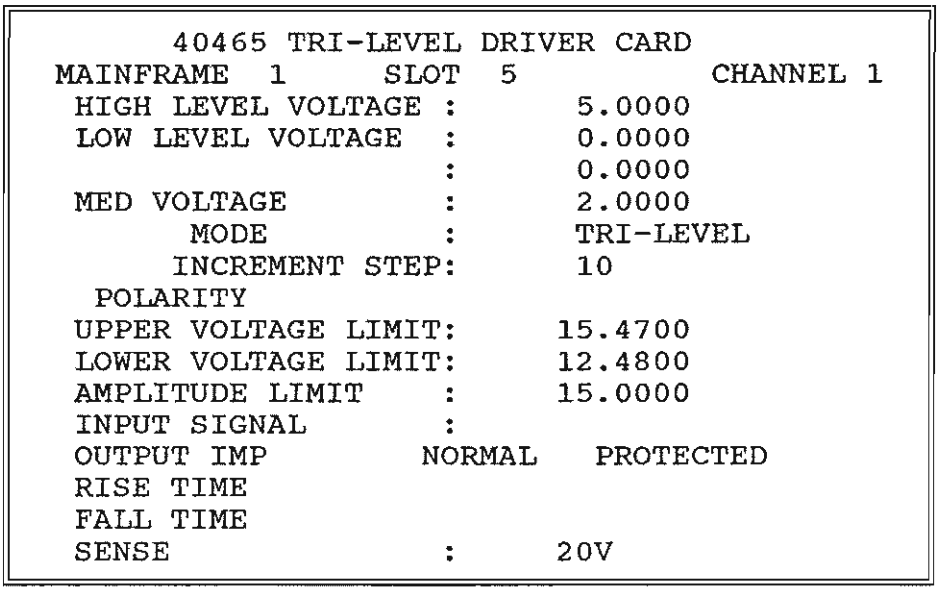
[INCR] -- Toggles the available parameters or values of the function presently at the cursor. Also increments the values of the Voltages and Rise and Fall Times.

[DECR] -- Toggles the available parameters or values of the function presently at the cursor. Also decrements the values of the Voltages and Rise and Fall Times.

[SET ALL] -- Sets all of the channels in the system to the same value as the parameter at the cursor. [SET ALL] will set the parameters for all Drivers, regardless of model number, or all Biases regardless of model number. When the key is pressed you will be asked to verify if you really want this function by pressing [ENT].

[INV/NOINV] -- Toggles the Invert and Non Invert function of the output.

8.3.2 40465 Tri-Level Driver Card Window



[PROTECT] [TOGGLE MODE] [INCR] [DECR] [SET ALL] [INV/NOINV]

8.3.2.1 Settable Parameters 40465 Tri-Level Driver Card Window

1. High Level Voltage -- Sets the High Rail of the output of the card. The difference between the high level Voltage and the low level Voltage cannot exceed 23 Volts. The HLV or High Level Voltage must always be set above or equal to the LLV or Low Level Voltage.

2. Low Level Voltage -- Sets the Low Rail of the output of the card. The difference between the Low Level Voltage and the High Level Voltage cannot exceed 20 Volts. The LLV or Low Level Voltage must always be set below or equal to the HLV or High Level Voltage.

3. MED Level Voltage -- Sets the Middle rail of the output of the card. The difference between the Low Level Voltage and the High Level Voltage cannot exceed 20 Volts. The MHL or Middle High Rail must always be set below HLV by 1 Volt and above the LLV by at least 1 Volt.

4. Mode -- Sets the card mode to be either Two Level, Tri-Level, or Four Level Output.

5. Increment Step -- Allows setting of the value of the increment step when the [INC] or [DEC] Softkeys are used. The Increment Step can be set from 10 mV to 100 mV in 10 mV increments when used to set the High or Low Level Voltage output.

6. Polarity -- Sets the output to either inverted or noninverted.

7. Upper Voltage Limit -- Allows High Level Voltage of the Driver Card to be set to the maximum Voltage Limits that you would ever want to see applied to a particular device.

8. Lower Voltage Limit -- Allows Low Level Voltage of the Driver Card to be set to the minimum Voltage Limits that you would ever want to see applied to a particular device.

9. Amplitude Limit -- Sets maximum Voltage amplitude that the Driver Card can output. The maximum amplitude for the 40465 Driver Card is 23 V.

10. Input Signal -- Selects either the Optically Isolated input, or the not optically isolated input.

11. Output Imp -- Selects the back termination of the driver card to either 50 Ohms or 10 Ohms. In the 10 Ohms back termination function, the Voltage and Current Sense function is not connected. This function must only be used in the 50 Ohm Mode.

12. Rise Time -- Sets the programmable Rise Time. See Section 8.2.4 for information on setting the Programmable Rise and Fall Time.

13. Protected/Normal -- allows you to protect the setting of the Rise Time and Fall Time with changes in the settings of the High and Low Level Rails. In the normal mode, the Rise Time and Fall Time will be recalculated to maintain the slew rate that existed before the change in amplitude.

14. Fall Time -- Sets the programmable Fall Time. See Section 8.2.4 for information on setting the Programmable Rise and Fall Time.

15. Sense -- Toggles the Voltage and Current Sense setting desired for this particular card. You can use the [SET ALL] Softkey while on this parameter to set all of the same type of cards in the system. The Toggled settings for this card are; 20 V, 2 V, 1 mA, 10 mA, and 100 mA.

8.3.2.2 Softkeys 40465 Tri-Level Driver Card Window

[PROTECT] -- Toggles the Rise Time Protect feature on and off. The protect feature allows you to change Voltage levels while maintaining the same slew rate, which means that the rise time would change with a change in Voltage.

[TOGGLE MODE] -- Toggles the selectable features on this menu.

[INCR] -- Toggles the available parameters or values of the function presently at the cursor. Also increments the values of the Voltages and Rise and Fall Times.

[DECR] -- Toggles the available parameters or values of the function presently at the cursor. Also decrements the values of the Voltages and Rise and Fall Times.

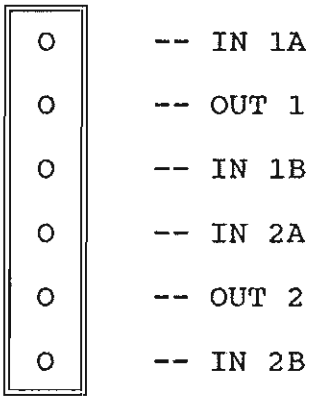
[SET ALL] -- Sets all of the channels in the system to the same value as the parameter at the cursor. [SET ALL] will set the parameters for all Drivers, regardless of model number, or all Biases regardless of model number. When the key is pressed you will be asked to verify if you really want this function by pressing [ENT].

[INV/NOINV] -- Toggles the Invert and Non Invert function of the output.

8.3.2.3 Operation of the 40465 Card in Tri-Level Mode

Obtaining a Tri-Level output from the 40465 Tri-Level Driver Card requires two channels of the PI-5800A Data Generator for each channel on the 40465 Card that is to be used in Tri-Level Mode.

The BNC Connectors on the card are configured as follows:



IN 1A -- Standard Two-level input for channel one from the timing generator or data generator.

OUT 1 -- Driver Output from Channel One (either tri-level or two-level depending upon mode.

IN 1B -- Pulse input for the Tri-Level function.

IN 2A -- Standard Two-level input for channel Two from the timing generator or data generator.

OUT 2 -- Driver Output from Channel Two (either tri-level or two-level depending upon mode.

IN 2B -- Pulse input for the Tri-Level function.

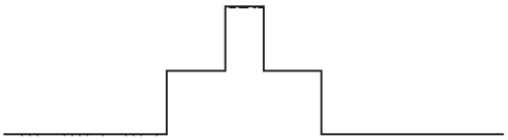
In Two-level operation the card is set in Two-Level Mode by toggling the Mode function in the 40465 Window to Two-level.

The Two-level Mode requires only one input for the selected channel, ie... either a pulse input to channel connector "IN 1A" or "IN 2A" depending upon the channel desired. The card in the Two-Level Mode functions identical to any other driver card such as the 40460 or 40490 Card.

Bi-Level Output



Tri-Level Output



The 40465 Tri-Level Driver Card has two channels, but for clarity the function of channel one is described, which is identical to channel two.

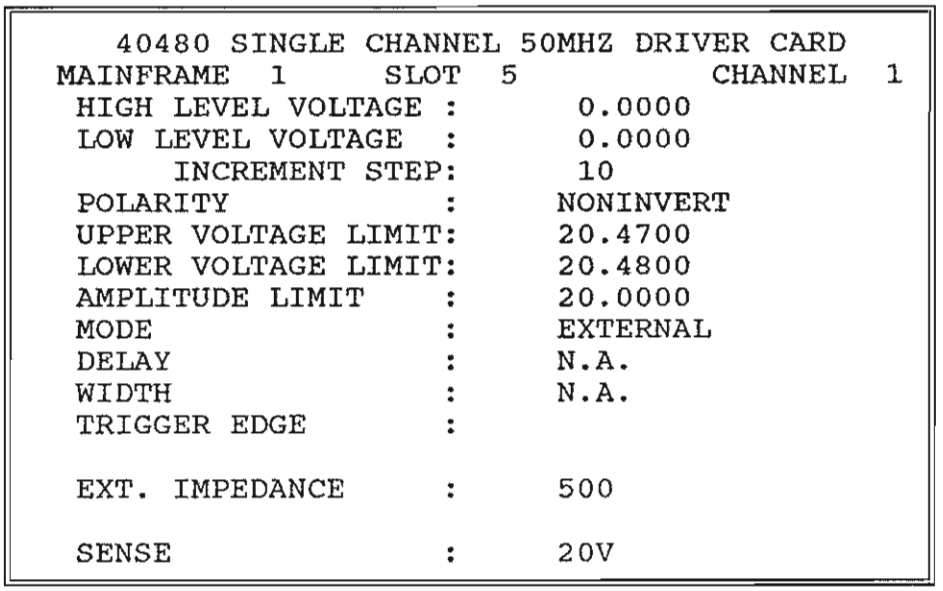
The Tri-Level Mode is set by toggling the Mode function on the 40465 Card Window for the selected channel.

The Tri-level Mode requires two inputs for the selected channel, ie... pulse inputs to channel connectors "IN 1A" and "IN 1B" during the same period.

In the Tri-Level Mode, when no pulse in applied to the "IN 1B" input the output will be Two-Level until receipt of a pulse at input "IN 2B". This will allow typical CCD operations where the

Tri-Level Pulse is needed occur only once during a frame while the remaining clocks are required to be Two Level.

8.3.3 40480 Single Channel 50 MHz Driver Card Window



[TOGGLE MODE] [TGL.TRIGGER] [INCR] [DECR] [SET ALL] [INV/NOINV]

8.3.3.1 Explanation of Settable Parameters 40480 50 MHz Driver Card

1. High Level Voltage -- Sets the High Rail of the output of the card. The difference between the high level Voltage and the low level Voltage cannot exceed 20 Volts. The HLV or High Level Voltage must always be set above or equal to the LLV or Low Level Voltage.

2. Low Level Voltage -- Sets the Low Rail of the output of the card. The difference between the Low Level Voltage and the High Level Voltage cannot exceed 20 Volts. The LLV or Low Level Voltage must always be set below or equal to the HLV or High Level Voltage.

3. Increment Step -- Allows setting of the value of the increment step when the [INC] or [DEC] Softkeys are used. The Increment Step can be set from 10mV to 100mV in 10mV increments when used to set the High or Low Level Voltage output.

4. Polarity -- Sets the output to either inverted or noninverted.

5. Upper Voltage Limit -- Allows High Level Voltage of the Driver Card to be set to the maximum Voltage Limits that you would want to see applied to a particular device.

6. Lower Voltage Limit -- Allows Low Level Voltage of the Driver Card to be set to the minimum Voltage Limits that you would want to see applied to a particular device.

7. Amplitude Limit -- Sets maximum Voltage amplitude that the Driver Card can output. The maximum output amplitude for the 40480 Driver Card is 20 V.

8. Mode -- Displays either the External, Internal Width, Internal Delay/Width, or Double Pulse Mode. See Section 8.3.2.3 for an explanation of these Modes.

9. Delay -- Provides the current setting of the Delay of the channel if the Internal Delay/Width Mode has been selected.

10. Width -- Provides the current setting of the Width of the channel output if either the Internal Width Mode, or the Internal Width/Delay Mode has been selected.

11. Trigger Edge -- Sets the selection of the edge of the input trigger to either the rising or falling edge. This can be set with either the [TGL.TRIGGER] or the [INCR] [DECR] Softkeys.

12. Ext. Impedance -- Selects either 500 Ohms or 50 Ohms input impedance at the TTL Input to match the requirements of your clock source for high speed applications.

13 Sense -- Toggles the Voltage Sense setting desired for this particular card. You can use the [SET ALL] Softkey while on this parameter to set all of the same type of ards in the system. The Toggled settings for this card are; 20V and 200V.

8.3.3.2 Softkeys 40480 Driver Card Window

[TOGGLE MODE] -- Selects either the External, Internal Width, Internal Delay/Width, or Double Pulse Mode. See Section 8.3.3.3 for an explanation of these Modes.

[TGL TRIGGER] -- Selects the Driver Card Trigger output to supply the trigger on either the rising or the falling edge of the signal being supplied to the input of the card. See Section 8.3.3.3 for an explanation of the relationship between the Modes and this trigger function.

[INCR] -- Toggles the available parameters or values of the function presently at the cursor. Also increments the values of the Voltages and Rise and Fall Times.

[DECR] -- Toggles the available parameters or values of the function presently at the cursor. Also decrements the values of the Voltages and Rise and Fall Times.

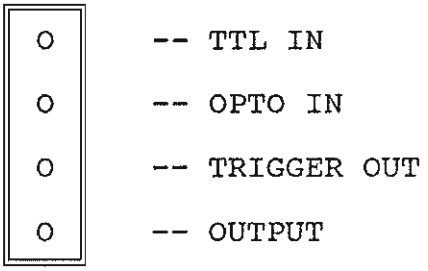
[SET ALL] -- Sets all of the channels in the system to the same value as the parameter at the cursor.

[INV/NOINV] -- Toggles the Invert and Non Invert function of the output.

8.3.3.3 Mode functions for the 40480 50 MHz Driver Card.

The 40480 Driver Card allows you to set internally, the output width and delay of the input signal to the card. This function can be independent of the input signal or directly dependent, depending upon the mode and trigger selected.

The BNC connectors on the rear of the 40480 Driver Card are as follows:



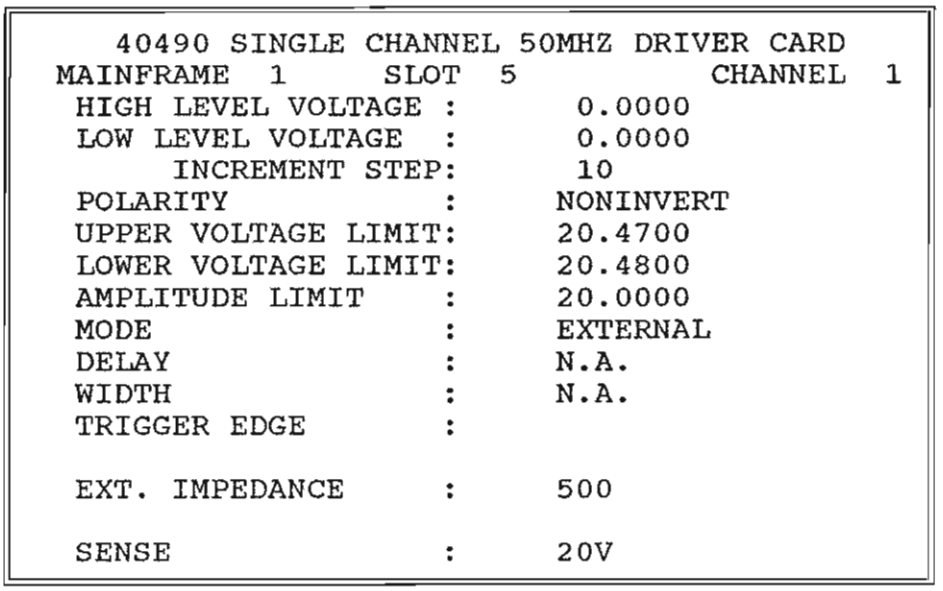
TTL IN -- Direct input to the Card. Not optically isolated, will allow up to 50 MHz Input to the card, producing up to 50 MHz output.

OPTO IN -- Optically isolated input. Will allow maximum 20 MHz input to the Driver Card, and maximum 20 MHz output.

TRIGGER OUT -- Trigger output for use with oscilloscopes or other functions. Also the reference for Internal Width and Delay features.

OUTPUT -- Output of the Driver Card.

8.3.4 40490 Single Channel 65 MHz Driver Card Window



[TOGGLE MODE] [TGL.TRIGGER] [INCR] [DECR] [SET ALL] [INV/NOINV]

8.3.4.1 Explanation of Settable Parameters 40490 65 MHz Driver Card

1. High Level Voltage -- Sets the High Rail of the output of the card. The difference between the high level Voltage and the low level Voltage cannot exceed 20 Volts. The HLV or High Level Voltage must always be set above or equal to the LLV or Low Level Voltage.

2. Low Level Voltage -- Sets the Low Rail of the output of the card. The difference between the Low Level Voltage and the High Level Voltage cannot exceed 20 Volts. The LLV or Low Level Voltage must always be set below or equal to the HLV or High Level Voltage.

3. Increment Step -- Allows setting of the value of the increment step when the [INC] or [DEC] Softkeys are used. The Increment Step can be set from 10mV to 100mV in 10mV increments when used to set the High or Low Level Voltage output.

4. Polarity -- Sets the output to either inverted or noninverted.

5. Upper Voltage Limit -- Allows High Level Voltage of the Driver Card to be set to the maximum Voltage Limits that you would want to see applied to a particular device.

6. Lower Voltage Limit -- Allows Low Level Voltage of the Driver Card to be set to the minimum Voltage Limits that you would want to see applied to a particular device.

7. Amplitude Limit -- Sets maximum Voltage amplitude that the Driver Card can output. The maximum output amplitude for the 40490 Driver Card is 20 V.

8. Mode -- Displays either the External, Internal Width, Internal Delay/Width, or Double Pulse Mode. See Section 8.3.2.3 for an explanation of these Modes.

9. Delay -- Provides the current setting of the Delay of the channel if the Internal Delay/Width Mode has been selected.

10. Width -- Provides the current setting of the Width of the channel output if either the Internal Width Mode, or the Internal Width/Delay Mode has been selected.

11. Trigger Edge -- Sets the selection of the edge of the input trigger to either the rising or falling edge. This can be set with either the [TGL.TRIGGER] or the [INCR] [DECR] Softkeys.

12. Ext. Impedance -- Selects either 500 Ohms or 50 Ohms input impedance at the TTL Input to match the requirements of your clock source for high speed applications.

13 Sense -- Toggles the Voltage Sense setting desired for this particular card. You can use the [SET ALL] Softkey while on this parameter to set all of the same type of cards in the system. The Toggled settings for this card are; 20V and 200V.

8.3.4.2 Softkeys 40490 Driver Card Window

[TOGGLE MODE] -- Selects either the External, Internal Width, Internal Delay/Width, or Double Pulse Mode. See Section 8.3.4.3 for an explanation of these Modes.

[TGL TRIGGER] -- Selects the Driver Card Trigger output to supply the trigger on either the rising or the falling edge of the signal being supplied to the input of the card. See Section 8.3.4.3 for an explanation of the relationship between the Modes and this trigger function.

[INCR] -- Toggles the available parameters or values of the function presently at the cursor. Also increments the values of the Voltages and Rise and Fall Times.

[DECR] -- Toggles the available parameters or values of the function presently at the cursor. Also decrements the values of the Voltages and Rise and Fall Times.

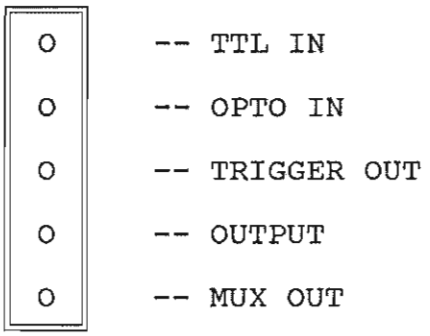
[SET ALL] -- Sets all of the channels in the system to the same value as the parameter at the cursor. You will be asked to confirm this function by pressing the [ENT] key.

[INV/NOINV] -- Toggles the Invert and Non Invert function of the output.

8.3.4.3 Mode functions for the 40490 65 MHz Driver Card.

The 40490 Driver Card allows you to set internally, the output width and delay of the input signal to the card. This function can be independent of the input signal or directly dependent, depending upon the mode and trigger selected.

The BNC connectors on the rear of the 40490 Driver Card are as follows:



TTL IN -- Direct input to the card. Not optically isolated, will allow up to 50 MHz Input to the card, producing up to 50 MHz output.

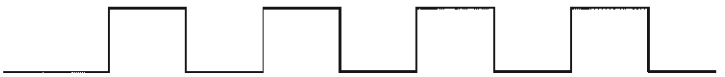
OPTO IN -- Optically isolated input. Will allow maximum 20 MHz input to the Driver Card, and maximum 20 MHz output.

TRIGGER OUT -- Trigger output for use with oscilloscopes or other functions. Also the reference for Internal Width and Delay features.

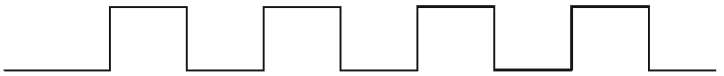
OUTPUT -- Output of the Driver Card.

MUX OUT -- Used for connection to an oscilloscope to view the output waveform. This output is not to be used as a driver output.

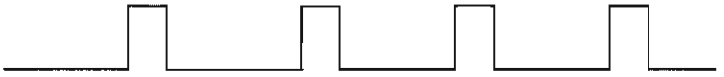
Input Signal



External Mode
(Output Follows
Input Signal)



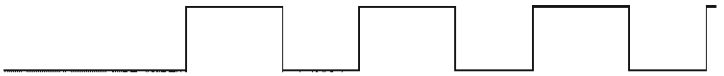
Trigger Out
(Set on Rising or Falling
Edge of Input Signal)



Internal Width Mode
(Rising Edge is
referenced to
Trigger Out)



Internal Delay/Width Mode
(Rising Edge is
referenced to
Trigger Out)



Double Pulse Mode
(Rising Edge is
referenced to
Trigger Out)



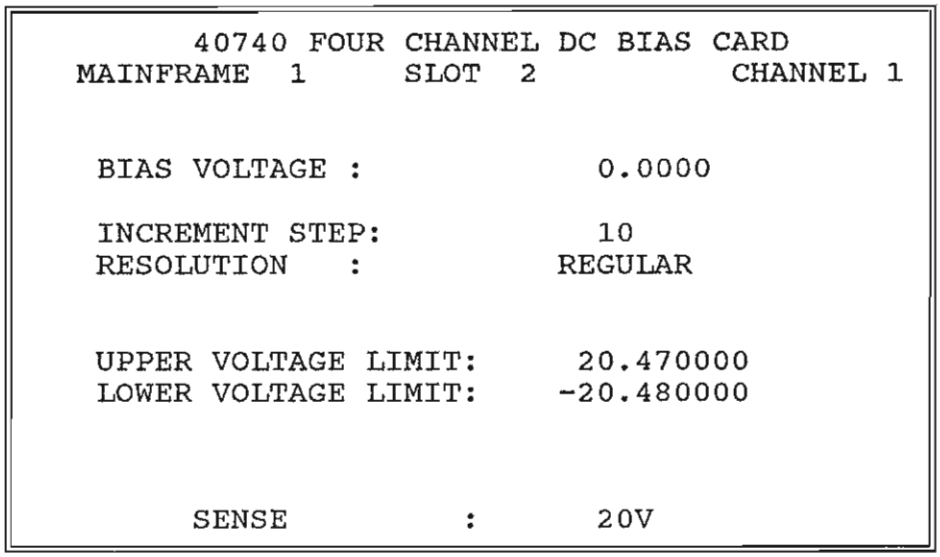
The waveforms above show the relationship of the Input signal to the adjustments that can be made to the output of the 40480 and 40490 Driver Cards.

In the External Mode, the output of the Driver is the same in terms of width and delay as the input signal. The output follows the input.

If any of the two Internal Modes are selected, the output pulse is referenced to the Trigger Out, which can be set to occur on the rising edge of the input signal, or the falling edge of the input signal.

This relationship is shown above by the slight delay of the Trigger Output with respect to the input signal in the diagram above. The diagram shows the trigger to be occurring on the rising edge of the input signal. The Internal Width Mode, is then measured from the Trigger out edge.

8.3.5 40740 Four Channel DC Bias Card Window



[HI/REG RES] [ ] [INCR] [DECR] [SET ALL] [ ]

8.3.5.1 Settable Parameters 40740 DC Bias Card Window

1. Bias Voltage -- Sets the Voltage output of the selected card channel. The Voltage output for the 40740 DC Biases can be set in the range from +20.47 Vdc to -20.48 Vdc.

2. Increment Step -- Allows setting of the value of the increment step when the [INC] or [DEC] Softkeys are used. The Increment Step can be set from 10mV to 100 mV in 10mV increments when used to set the DC Bias Voltage output.

3. Resolution -- Selectable as either High or Regular Resolution with the [HI/REG RES] Softkey. See Section 8.2.8 For information on High Resolution Mode.

4. Upper Voltage Limit -- Allows High Voltage Limit of the Bias Card to be set to the maximum Voltage Limit that you would ever want to see applied to a particular device.

5. Lower Voltage Limit -- Allows Low Voltage Limit of the Bias Card to be set to the minimum Voltage Limit that you would ever want to see applied to a particular device.

6. Sense -- Toggles the Voltage Sense setting desired for this particular card. You can use the [SET ALL] Softkey while on

this parameter to set all of the same type of cards in the system. The Toggled settings for this card are; 20 V, 2 V, 1 mA, 10 mA, and 100 mA.

8.3.5.2 Explanation of Softkeys 40740 DC Bias card

[HI/REG RES] -- Toggles the Resolution of the channel at the cursor between High and Regular Resolution. See Section 8.2.8 High Resolution Mode.

[INCR] -- Toggles the parameters or values of the function presently at the cursor. Also increments the Voltage setting.

[DECR] -- Toggles the parameters or values of the function presently at the cursor. Also decrements the Voltage setting.

[SET ALL] -- Sets all of the channels in the system to the same value as the parameter at the cursor. You will be asked to confirm this function by pressing the [ENT] key.

8.3.6 40750, 40751, 40752, 40753 AND 40755 Low Noise DC Bias Card

```
   40750 FOUR CHANNEL LOW NOISE DC BIAS
MAINFRAME  1     SLOT  2          CHANNEL 1

 BIAS VOLTAGE :            0.0000


 INCREMENT STEP:             10
 RESOLUTION    :           REGULAR

 VOLTAGE RANGE:             HIGH

 NOISE LEVEL   :           REGULAR

 UPPER VOLTAGE LIMIT:     20.475000
 LOWER VOLTAGE LIMIT:    -20.475000

      SENSE          :      20V
```

[HI/REG RES] [LO/REG NOISE] [INCR] [DECR] [SET ALL] [HI/LO RANGE]

8.3.6.1 Explanation of Settable Parameters 40750 Low Noise Bias Card Window

Please note that all information regarding set up and use of the 40750 DC Bias Card is identical for the following DC Bias Cards:

40751 Four Channel Low Noise Bias Card High Voltage (±25V)
40752 Four Channel Low Noise DC Bias Card (100mA Output)
40753 Two Channel Low Noise DC Bias Card (250mA Output)
40755 Four Channel Low Noise DC Bias Card (250mA Output)

1. Bias Voltage -- Sets the Voltage output of the selected card channel.

2. Increment Step -- Allows setting of the value of the Increment Step when the [INC] or [DEC] Softkeys are used. The Increment Step can be set from 10mV to 100mV in 10mV increments when used to set the DC Bias Voltage output.

3. Resolution -- Selectable as either High or Regular Resolution with the [HI/REG RES] Softkey. See Section 8.2.8 For information on High Resolution Mode.

4. Voltage Range -- Displays the current range setting of the card, High or Low. The High Range for this card is from -20.48 Vdc to +20.47 Vdc. The Low Range for this card is from -10.245 Vdc to +10.235 Vdc. This range provides the lowest output noise. See Section 3.0 Specifications for information on the noise differences between these two modes. You can only change ranges when the system is in the Disconnect Mode.

5. Noise Level -- Provides an indication of the current Noise Level Mode of the 40750 cards, either Low Noise Mode or Regular Mode. The Low Noise Mode provides the lowest output noise level, and the regular mode provides 100 msec faster response to changes in Voltage when the Voltage setting is changed.

6. Upper Voltage Limit -- Allows High Voltage Limit of the Bias Card to be set to the maximum Voltage Limit that you would ever want to see applied to a particular device.

5. Lower Voltage Limit -- Allows Low Voltage Limit of the Bias Card to be set to the minimum Voltage Limit that you would ever want to see applied to a particular device.

6. Sense -- Toggles the Voltage Sense setting desired for this particular card. You can use the [SET ALL] Softkey while on this parameter to set all of the same type of cards in the system. The Toggled settings for this card are; 20 V, 2 V, 1 mA, 10 mA, and 100 mA.

8.3.6.2 Softkeys 40750 Low Noise DC Bias Card Window

[HI/REG RES] -- Toggles the selected channel between High Resolution and Regular Resolution. See Section 8.2.8 High Resolution Mode.

[INCR] -- Toggles the available parameters or values of the function presently at the cursor. Also increments the setting of the Voltage.

[DECR] -- Toggles the available parameters or values of the function presently at the cursor. Also decrements the setting of the Voltage.

[SET ALL] -- Sets all of the channels of the same type in the system to the same value as the parameter at the cursor.

[HI/LO RANGE] -- Toggles the High and Low Range Setting of Card. The Voltage output for the 40750 DC Biases can be set anywhere in the range from +20.47 Vdc to -20.48 Vdc, in the High Range Mode and from -10.245 Vdc to +10.235 Vdc in the Low Range Mode. You can only change ranges when the system is in the Disconnect Mode.

8.3.7 40770 Four Quadrant Bias Supply Card

The 40770 Four Quadrant Bias Card, provides two channels of Voltage/Current Source, or DC Bias per card. Each channel can be programmed to function as a variable or constant DC Voltage Source/Current Monitor, or as a variable or constant DC Current Source/Voltage Monitor.

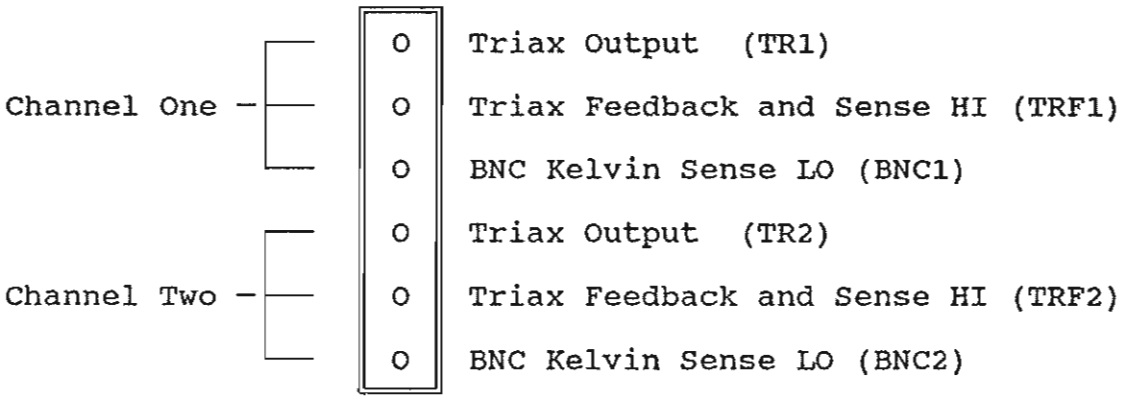
The card allows precise Current Source Mode function with fully programmable current limits in seven ranges to a resolution of 25pA. The card will supply either the Voltage Source or Current Source for measurement of the DC current through Voltage-biased devices, and the DC Voltage across Current-biased devices, for two point measurements, or measurements of semiconductor junctions.

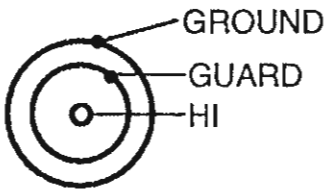
Each channel has 2 triaxial and 1 BNC output connectors. The dual triaxial, single BNC per channel capability allows use of the card in a Kelvin connection with Kelvin Sense through use of the BNC connector for low current sensing.

In the Kelvin configuration, one triaxial connector is used for main output HI and LO (Ground), its inside shield is GUARD. The second triaxial connector allows adjustment of the Voltage Output (HI) and to sense HI at the load, it's inside shield is connected to GUARD. The GUARD is at the same Voltage potential as the output. This prevents leakage between the HI and the LO. Refer to Section 8.3.7.4 for diagrams of these connections.

The output connectors for the 40770 card are defined as follows in the diagram below.

The BNC connector is used to sense LO, when monitoring Voltage in a Kelvin configuration, and provides more accurate Voltage sense on the higher current ranges.





Triaxial Connector Basing

The BNC connector is used to sense LO, when monitoring Voltage in the Kelvin configuration, and provides more accurate Voltage sense on the higher current ranges.

The card can be used in two modes; Voltage Source Mode (also used as a DC Bias in this mode), and the Current Source Mode.

In the Voltage Source Mode (Force Voltage), the Voltage is fixed and the current varies within the range of the current limit setting to keep the Voltage constant. If the current limit is exceeded, the Voltage will drop.

In the Current Source Mode (Force Current), the current is fixed and the Voltage varies within the Voltage Limit setting, based upon changes in the load, to keep the current constant.

NOTE:
When entering Voltages or current values while using this card, you will note that the number that you enter will not be exactly the value displayed. For example, if you enter 10 Volts, you may get 9.9997 Volts.

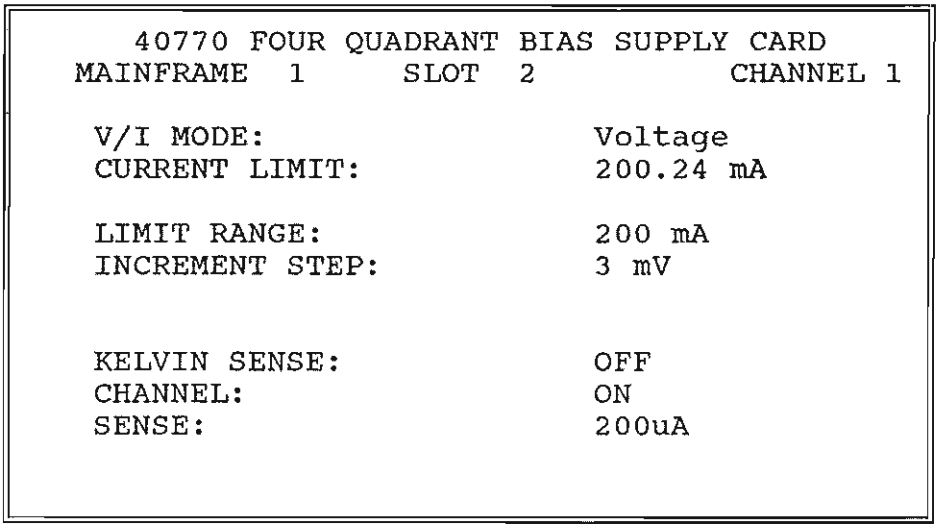
The reason that the value displayed does not match the entered value, is due to the method of calibration. Each range of Voltage and current uses a multi point correction.

When a number is entered, a DAC value is calculated based upon the slope and offset for that range. Since the DAC can only use integer values, a round off takes place. The DAC value is now used to calculate back to a real value using the same slope and offset.

This slope value is more accurate than a fixed value that would be determined by digital to analog converter settings, which are fixed and linear, and do not necessarily track the true card slope, which will not be linear in terms of output Voltage or current tracking.

Since each card is calibrated based upon its individual slope, and the value for the slope is stored on the card in EPROM, the settings from card to card will not agree.

However, the accuracy from card to card will be better than the accuracy that is obtainable by using the conventional method of setting the tracking of the card value by Digital to Analog Converter without taking the slope into account. The slope method provides a higher accuracy setting. Refer to Section 3.11 Specifications, for the accuracies provided.



8.3.7.1 Settable Parameters 40770 Four Quadrant Bias Supply

The following parameters are set in the window after pressing the [ZOOM] softkey. Pressing the [HOME] key in the group of cursor keys will return you to the Main Menu

1. V/I Mode -- Sets the channel in either Voltage Source or Current Source Mode. Selecting the Voltage Source Mode also allows this card to be used as a DC Bias supply.

2. Current Limit -- Sets the current limit of the card based upon the value entered. This value automatically establishes the range based upon it's location within the seven standard current limit ranges available. The seven standard current limit range values are listed in Increment Step, Number 4 in the explanation that follows. Always try to use the lowest possible range, since this will improve the accuracy of the reading by providing more decimal places on the DVM.

3. Limit Range -- The limit range is a value selected within the current limit that cannot be exceeded. For example in the 200 mA current limit, a limit range of 100mA could be set that would limit the output current to 100mA.

4. Increment Step -- allows selection of the step required for incrementing and decrementing the Voltage or Current depending upon the selection of the Voltage Source (Force Voltage) or Current Source (Force Current). The increment is set with the [INCR], [DECR] softkeys. ie... in Current Mode, you increment the Current, In Voltage Mode you increment the Voltage.

The following is a list of the seven standard current limit ranges and their increment step ranges in the Voltage Source Mode. Each range has 128 steps or settings available, and these ranges apply for both positive and negative currents.

Current Limiting Ranges

Range Start	End of Range	Increment Steps on Range
20mA	200mA	128
2mA	20mA	128
200uA	2mA	128
20uA	200uA	128
2uA	20uA	128
200nA	2uA	128
25pA	200nA	128

5. Kelvin Sense -- Indicates if Kelvin Sense function is turned on or off. This is set with the [KELVIN] softkey. The Kelvin Sense function is performed through the connection of the BNC connector that is available in each channel.

6. Channel -- Sets the selected channel in the On or Off condition. This is a protection function, that will allow the channel to be turned off to prevent an over Voltage or over current condition.

7. Sense -- Toggles the Voltage/Current Sense setting desired for this particular Card. You can use the [SET ALL] Softkey while on this parameter to set all of the same type of cards in the system. The Toggled settings for this Card are; 25V, 2.5 V, or whatever current limit setting you select.

To provide the highest possible accuracy of reading, each Voltage Current Sense range uses a DVM range that will allow maximum accuracy for the reading range selected. The Ranges on your DVM are related as follows to the Voltage Current Sense Settings. The polarities as shown on your DVM are correct as shown. See Sections 8.2.6 and 8.2.7 for an explanation of the Voltage and Current Sense functions.

8.3.7.2 Measuring the Current Output in the Voltage Source Mode

The current output is the DVM voltage multiplied by the selected current range.

There should be a load connected to the bias supply output that is to be measured. For example: 1k Ohms.

For example; if the DVM reading was .987 V, and you were on the 20mA/V range, the output current would be 9.87 mA.

ie... 0.987V X 10mA/V = 9.87mA

This calculation gives you the true current. ie...

Reading X M = Real Current

Where: M is the multiplier listed below
Reading is the DVM reading

The internal range resistances for current measurements of the 40770 Four Quadrant Bias Supply Cards are as follows:

Range	Multiplier	Internal Range Resistance
200mA	100mA/V	10 Ohms
20mA	10mA/V	100 Ohms
2mA	1mA/V	1 kOhms
200uA	100uA/V	10 kOhms
20uA	10uA/V	100 kOhms
2uA	1uA/V	1 MOhms
200pA	100pA/V	10MOhms

When taking Current measurements, the sensing Voltage output range on the DVM should not exceed 2.5 Vdc, or the next higher Current Sense range for the channel you want to measure should be selected.

8.3.7.3 Softkeys 40770 Four Quadrant Bias Supply Card

[CH ON/OFF] -- Sets the output of the selected channel to 0 Volts. This function is a protection for the device under test, while a high Voltage or Current setting is present at the output that could possibly endanger the device under test. The channel should always be turned off when changing from Voltage Source to Current Source settings.

[TOGGLE MODE] -- Toggles function of the card from Voltage Source to Current Source Mode.

[INCR] -- Toggles the available parameters or values of the function presently at the cursor. Also increments the setting of the Voltage.

[DECR] -- Toggles the available parameters or values of the function presently at the cursor. Also decrements the setting of the Voltage.

[SET ALL] -- Sets all of the channels of the same type in the system to the same value as the parameter at the cursor.

[KELVIN] -- Sets up the Kelvin Sense Connection. This softkey changes to [LOCAL] when the system is in the REMOTE Mode over the IEEE-488 Bus. Pressing the softkey in the LOCAL Mode will return front panel control.

8.3.7.4 Main Menu Changes with 40770 Four Quadrant Bias Supply

Due to the different parameters that must be displayed with the 40770 Four Quadrant Bias Supply Card, some of the Main Menu column parameter indicators must be changed when the cursor is placed on a card of this type. The Main Menu automatically reverts back to standard display when the cursor is placed on any other type of card. The following page displays the changes in the Main Menu for this card.

The changes are explained in Sections 8.3.7.1 Settable Parameters 40770 Four Quadrant Bias Supply, and Section 8.3.7.3 Softkeys 40770 Four Quadrant Bias Supply Card.

4000 SERIES FPA TEST SYSTEM MAIN MENU

VERSION 3.27 STATUS: OFFLINE: LOCAL

No	LABEL	LOC.	TYPE	V/I	UNITS	STEP	LIM	Range	Sense
1		1-4-1	4QUAD PS	9.0000	V	-10.0000	10	40 40	
2		1-4-2	4QUAD PS	9.0000	V	0.0000	20	20 20	20V
3		1-5-1	LNBIAS	10.0000			50		20v
4		1-5-2	LNBIAS	10.0000			80		
5		1-5-3	LNBIAS	10.0000			50		
6		1-5-4	LNBIAS	10.0000			60		
7									
8									
9									
10									
11									
12									
13									
14									
15									
16									

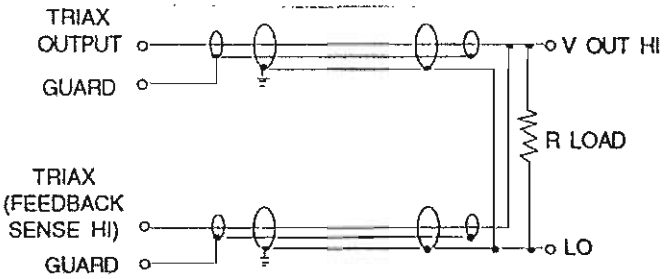
[GO TO] [SEQUENCE] [INCR] [DECR] [SET ALL] [ZOOM]

Main Menu change when cursor is placed on the 40770 Four Quadrant Bias Supply selection.

8.3.7.5 Diagrams of the Kelvin Connections in the Voltage Source Mode for the 40770 Four Quadrant Bias Supply.

The following diagrams show the Kelvin connections and the connections for Kelvin Sense in the Voltage Source Mode for the 40770 Card.

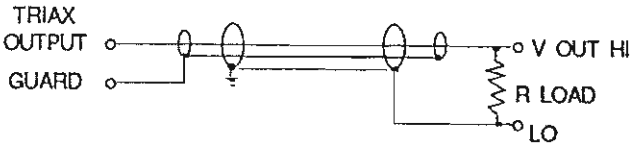
When using this card in the Voltage Source mode, the voltages displayed on the CRT for this card are accurate to approximately 0.1%, not taking into account the cable, cable length, grounding scheme, and actual resistance of the cable used for the Triax Output cable and the Triax (Feedback and Sense HI) Cable.



Recommended Connections for load currents in the range from 2mA to 200mA

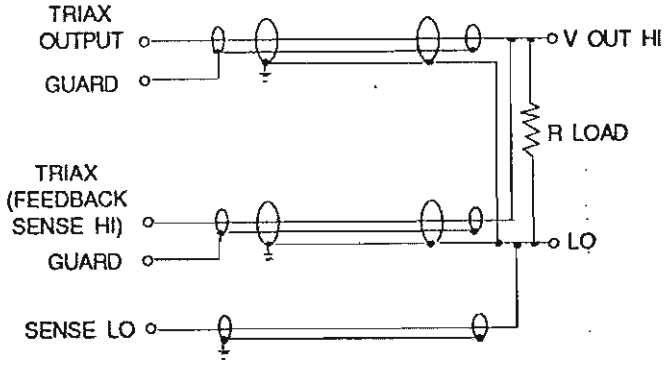
In all the configurations shown, the actual Voltage at the load is fed back through the Triax Feedback and Sense HI Cable, and the card corrects the Voltage to maintain the setting that was programmed on the CRT or over the IEEE-488.

If you are using the card in the Voltage Source Mode strictly for Vout as a DC Bias Card, you only need to connect the upper triax as shown below. This is the configuration for use as a DC Bias Card.



Triax connection for using 40770 card as a DC Bias Card.

If you are using the Voltage Source Mode with lower currents ie... less than 2 mA, the BNC Kelvin Sense Connector should also be used as shown below.



Kelvin Connection showing use of the BNC Kelvin Sense Connection for Low Current operation

8.4 INTERFACE MENU

```
          4000 SERIES FPA TEST SYSTEM    INTERFACE MENU
VERSION 3.20                          STATUS: OFFLINE : LOCAL

       IEEE INTERFACE    :
            IEEE ADDRESS :          7
          SERVICE REQUEST:        OFF
       RS232 INTERFACE   :
            BAUD RATE:           1200
            STOP BITS:              1
            PARITY   :           OFF
  KEYBOARD INTERFACE :
     AUTO REPEAT KEY :             ON

 [SRQ]  [BAUD (↓)]  [BAUD (↑)]  [STOP BITS]  [PARITY] [AUTORPT]
```

8.4.1 General

The Interface Menu provides the status of the IEEE-488 GPIB and RS-232-C functions. In the IEEE-488 portion of the menu, is displayed the IEEE-488 instrument address that is currently set. To change the address, set the new number on the DIP-Switch located on the rear of the PI-4001 Control Mainframe in slot A. Reset the system, by simultaneously pressing [HOME] and [CE], to bring up the new address.

The STATUS display provides a return over the IEEE-488 bus of the On Line and Off Line condition of the unit, as well as any errors pending. See 9.0 IEEE-488 Programming.

8.4.2 Explanation of Softkeys

There is one page of softkeys used with the Interface Menu.

[SRQ] [BAUD (↓)] [BAUD (↑)] [STOP BITS] [PARITY] [AUTO RPT]

Any bus programming errors can be cleared by pressing any key

while on this display. Sending the command STATUS during IEEE-488 or RS-232-C operation will provide you with an indication of any error that is pending. These errors must be cleared to continue operation. See Section 9.2.2 STATUS Command.

[SRQ] -- Toggles the Service Request on and off.

[BAUD RT(↓)] -- Toggles the available Baud Rate settings downward from 19,200 to 110 Baud.

[BAUD (↑)] -- Toggles the available Baud Rate settings upward from 110 Baud to 19,200 Baud.

[STOP BITS] -- Toggles the Stop Bit settings. The Stop Bit setting on the Interface Menu must match the Stop Bit setting of your controller.

[PARITY] -- Toggles the Parity settings. The Parity setting on the Interface Menu must match the Parity setting of your controller.

[AUTO RPT] -- The [AUTO RPT] Softkey allows you to toggle the [INCR] and [DECR] softkeys to select either auto repeat or one setting per press of the softkey.

For example, if Auto On is selected, pressing the [INC] softkey will allow no movement in the setting after the first increment for one-half second. After one-half second, continuing to press the key will store incremental settings at the rate of 15 settings per second that the key is pressed.

The status of this feature is displayed on the CRT at all times on this menu.

9.0 PROGRAMMING THE 4000 SERIES LOW NOISE TEST SYSTEM

9.1 CHANGES IN VERSION 2.XX and 3.XX SOFTWARE

If you are not familiar with programming the 4000 Series System, go directly to section 9.2

If you are familiar with programming the 4000 Series System in software versions before and including 2.00, all your existing software should function properly with the new version 3.00 software. This section will outline the changes in Version 3.00.

The High and Low Resolution functions and the Current and Voltage Sense functions have been modified to ease the programming task.

The following commands have been DELETED, however they have been left in the software to allow your existing software to still function properly. Many of these deleted commands have been left in this manual, so that you may refresh your memory as to their usage. They will be treated in Version 3.00 as follows:

LABEL -- The label that you establish can now be used to access channels in place of the mainframe, slot, channel commands.

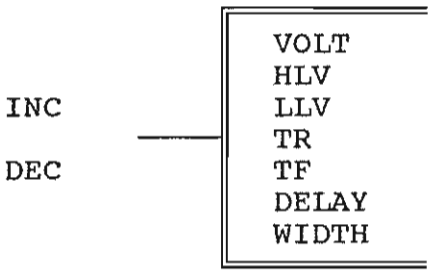
VSENSEOFF -- Now the same as the DESELECT command.
ISENSEOFF -- Now the same as the DESELECT command.
HR10 -- Treated the same as the new HR command.
HR12.5 -- Treated the same as the new HR command.
HR05 -- Treated the same as the new LR command
HR0.625 -- Treated the same as the new LR command.
HR1 -- Treated the same as the new LR command.

RANGE1 -- No longer required. You will get an error if you enter an out of range rise and fall time combination.

RANGE2 -- No longer required. You will get an error if you enter an out of range rise and fall time combination.

RANGE3 -- No longer required. You will get an error if you enter an out of range rise and fall time combination.

CINC, FINC, CDEC, FDEC -- These commands would increment or decrement the last setting of Voltage or Rise and Fall Time. (they can still be used), but have been replaced with:



In the form: INC VOLT or DEC DELAY

In the new structure you can set the ISENSE or VSENSE on any Driver or Bias channel and leave the setting in place, and access the setting with the SELECT command at any time you wish to take a reading. You can also now set ALL ISENSE or VSENSE, which will greatly simplify programming. You can also mix the functions as desired and leave the settings. For example Bias channel 1 could be ISENSE1, Bias Channel 2 could be VSENSE2 etc..

The Voltage and Current sense functions are both turned off with the DESELECT command. This command affects all of the Driver and DC Bias channels in the system, and remains in effect until the receipt of any other Voltage or current setting, or the SELECT command. YOU SHOULD NOT LEAVE DRIVER CARDS IN THE ISENSE MODE WHEN BEING DRIVEN BY THE DATA GENERATOR, SINCE THIS WILL PLACE A SERIES RESISTANCE IN THE OUTPUT AND DEGRADE THE OUTPUT VOLTAGE AND WAVEFORM.

After the DESELECT command has been sent, any VSENSE or ISENSE command sent will turn the sense function back on, but you will not get an output from the sense function until a channel is selected with the SELECT command.

The new commands for the resolution functions are HR (High Resolution) and LR (Low Resolution).

With the 90040 Non-Volatile Memory Option, you can store up to 64 complete instrument set ups, which also include Programmable limits on the Voltage output settings of the Drivers and Biases. These limits as well as complete instrument settings can be placed in a default file that will automatically load the settings and limits upon power up.

The limits can also be programmed over the bus without the presence of the 90040 Non-Volatile Memory Option, but they cannot be saved internally or automatically loaded upon power up. The

Non-Volatile Memory can be fully utilized over the IEEE-488 Bus or through the RS-232-C Port. However, you will not have the Limits Setting Menus, without the option being present.

Version 3.13 adds additional features to the Service Request Function. The second bit of the Service Request is now set when the buffer is full. This allows you to perform other functions, and not tie up the bus with the 4000, until you are ready to read the buffer.

This version also adds the programmable sequencing of the application of the clocks and biases to the device under test.

Version 3.20 adds the requirement to press the [ENT] key when the [SET ALL] softkey is used. It also adds the requirement that the selection of the High or Low Voltage mode on the DC Bias Cards can only be made in the Disconnect Mode.

Version 3.21 -- Adds the 40465 Tri-Level Driver Card.

Version 3.27 -- Adds the 40770 Four Quadrant Bias Supply

9.2 IEEE-488 GPIB PROGRAMMING

9.2.1 General

The PI-4001 Control Mainframe contains the Cards that are necessary for operation of the system over the IEEE-488 Bus, through the use of simple statements. These statements are listed in section 9.2.

During IEEE-488 operation, you can be on any menu in the system.

When in the Remote Mode, during IEEE-488 operation, the [MORE] Softkey becomes [LOCAL] to allow you access to the softkeys and to remove the unit from Remote Mode.

NOTE: TERMINATE ALL COMMAND LINES WITH A <CARRIAGE RETURN>, <LINE FEED>, AND AN EOI. TRANSMISSIONS FROM THE PI-4001 WILL BE TERMINATED SIMILARLY.

Below is an example of a correctly terminated command line. Also note that the SPACES ARE REQUIRED as shown. All command lines are required to be terminated in this manner:

MF 2 SLOT 3 CH 2 HLV 10.5+<CR> <LF>

OR: "MF 2 SLOT 3 CH 2 HLV 10.5"+chr$(13)+chr$(10)

Sample Command Strings

The PI-4001 does not require use of capital letters, but spaces are required.

If the unit goes into remote mode, but appears not to be functioning properly when a command string is sent, send the string: status+chr$(13)+chr$(10)

The status string coming back will provide you with an indication of why the string was not received properly, by giving back an error message, which will be displayed as a number at the status location on the Interface Menu. The error message numbers are explained in Section 12.2.1. THE UNIT WILL NOT RECEIVE PROPERLY IF THERE IS AN ERROR PENDING. IT MUST BE CLEARED BY SENDING THE STATUS COMMAND.

All commands are required to take one of the following two forms to define the channel that is being acted upon:

In form 1, the mainframe, slot, and channel location are accessed with the command.

In form 2, a label assigned to the channel is used instead of the mainframe, slot, channel location sequence.

FORM 1

MAINFRAME num SLOT num CHANNEL num mode value+chr$(13)+chr$(10)

In the form: MF 2 SLOT 6 CH 2 LLV -5.0+chr$(0D)+chr$(0A)

Where:

MF	- Refers to mainframe
NUM	- Is the number of the mainframe or slot or channel you want to access.
SLOT	- Is the slot location within a particular mainframe.
CH	- Is a particular channel within the slot.
Mode	- The function you want to perform, ie... HLV is the mode to set the high voltage level.
VALUE	- Any numerical parameters associated with the mode. ie...5.25 as the high level voltage, if a value is required.
ALL	- Can be used to set all channels at one time. See ALL Command in section 9.2.3 Mode Commands.

NOTE: IN ALL EXAMPLES BELOW THE CARRIAGE RETURN AND LINE FEED WILL NOT BE SHOWN FOR CLARITY.

Once you have established the mainframe number, or the slot number, you can continue sending to the same slot without re-sending the mainframe number, or the slot number, until you require a change in mainframe number or slot number. For example if you are working within the same mainframe, you can send:

slot 5 ch 2 llv -5.5

Once you have established the mainframe reference, you could also continue from here within the same slot with the command:

ch 1 CINC

Once you have accessed a location, you can send up to 2048 characters within the string, ex...

MF 2 slot 3 ch 1 hlv 10.0 LLV -10.2 tr 40 tf 380

FORM 2

The Second form of command structure for the channel being acted upon is as follows:

The label assigned to a particular channel can also be used to program the channel. (See the LABEL command in the programming section for details).

First you must establish the label as representing a particular location with a command referencing the label to a particular channel: ie...

MF 1 SLOT 3 CH 2 Label CLK1

Since you have assigned the label "clk1" to a particular channel, you can now program that channel with the command;

@clk1 HLV 10.00

Note the addition of the @ Sign when the Clk1 label is used as a command.

To change a label or remove the function of the label, use the following commands:

@clk1 Label *

or, MF 1 SLOT 3 CH 2 Label *

or, ALL LABEL *

WHEN INPUTTING DATA FROM THE PI-4001, EOF, IE...END OF FILE (1a HEX), <CARRIAGE RETURN>, <LINE FEED>, AND AN EOI, WILL BE SENT, WHEN THE UNIT HAS COMPLETED SENDING REQUESTED DATA.

THE PI-4001 WILL NOT RESPOND TO ANY PROGRAMMING COMMANDS IF THERE IS AN ERROR PENDING.

9.3 IEEE-488 COMMANDS

9.3.1 Chart of Commands With Page Numbers Where Discussed

STATUS 91
ONLINE 91
OFFLINE ...91
CLEAR 91
DUMPF 112
DUMPV 112
DUMPT 112
REGULAR ...101
LNOISE 101
HLV 97
LLV 97
INV 97
NONINV 97
LABEL 95
ID 113
DUMPLD 113
DUMPLB 113
LOLIMB 111
LOLIMD 111
AMPLIM 111
DELAY (time) NS,US,MS ..106
WIDTH (time) NS,US,MS ..106
INC 109
DEC 109
IMP50 107
IMP500 107
PROTECT ...96
MLV 99
MHLV 100
MLLV 100
FORCEI ... 102
VLIM 103
KELON 103
STEPI 104
DUMPP 103

TR 95
TF 95
VOLT 97
@label name ..95
LABEL * 95
STEP num 109
LR 98
HR 97
ALL 94
ISENSE1 107
ISENSE2 108
ISENSE3 108
DISCON 92
CONNECT 92
DESELECT 92
SETDEFB 112
SETDEFD 111
UPLIMB 111
UPLIMD 110
LRANGE 101
HRANGE 101
SELECT 108
RTRIG 106
FTRIG 107
SRQON 92
SRQOFF 92
UNPROTECT 96
OPTO 100
TTL 100
IMP10 100
DUMPVI 102
CHON 103
KELOFF 103
INC FORCEVI ..104

VSENSE1 ..108
VSENSE2 ..108
VSENSE3 ..108
EXT 105
INTW 106
INTD 106
DP 106
MF 87
SLOT 87
CH 87
NORM 92
; (REM) ..95
SEQ 115
SEQ ONLINE..115
SEQ DISCON..115
SEQ SCREEN..115
DEFAULT...115
OPPOSITE..115
EMPTY 115
END 115
DUMP 115
REGOUT ...105
AUXOUT ...105
TWOLV 98
TRILV 99
FORLV 99
MODEV 102
MODEI 102
FORCEV ...102
ILIM 103
CHOFF 103
STEPV 104
INC VILIM.104

9.3.2 90040 Non-Volatile Memory Option Commands (Page 107)

SAVE num (num is an identification number from 1 to 4096
LOAD num assigned by user to differentiate between saved
DELETE num files)
DIR
DEFAULT
PWRONFILE num

9.3.3 System Commands

The following are system commands that do not require accessing a particular channel and are used in a stand-alone manner.

STATUS -- Sending STATUS provides you with information on On Line/Off Line status, or error messages that may be pending. IF THERE IS AN ERROR PENDING YOU CANNOT LOAD DATA TO THE PI-4001 UNTIL THE ERROR IS CLEARED. THE ERROR IS CLEARED BY SENDING STATUS AND VIEWING THE ERROR INDICATION IN THE STATUS LOCATION ON THE INTERFACE MENU. The error message numbers are explained in Section 12.2.1.

The status buffer can store up to 4 messages. You have not cleared the status buffer of all available messages until you receive an End of File Marker (1A hex).

The order of appearance of the status message sequence is as follows:

-- The On Line/ Off Line status
-- The error number
-- The error message
-- The end of file marker (1A hex)

CLEAR -- Sending the CLEAR command clears all volatile RAM, and sets the PI-4001 Off Line. You will lose all program information, settings, and the programmable limits will return to the default settings when the Clear Command is used. For more information see the SETDEFB and SETDEFD commands. ex... CLEAR

OFFLINE -- When the PI-4001 is in the On Line mode, sending this command places the outputs off line. The offline and online commands stand alone, and no reference to slot is required. ex... offline

ONLINE -- When the PI-4001 is in the Off Line mode, sending this command places the outputs on line. The ONLINE and OFFLINE commands stand alone, and no reference to slot is required. ex... ONLINE

NORM -- Sets default functions back to normal. NORM is a convenience command that resets the slot to normal. Normal for the DC Bias Cards and the Driver Cards is shown below:

Normal Conditions: Driver Card -- NonInv
Sense Off
10 mV Resolution

Normal Conditions: DC Bias Card -- 10 mV Resolution
Sense Off

The command is used as follows, ex... MF 2 SLOT 3 CH 2 NORM

or ALL NORM

DESELECT -- Turns off the Voltage and Current Sense function. This command acts upon all of the channels in the system, and turns off the Voltage and Current Sense function until the receipt of any VSENSE, ISENSE, SELECT command. ex...DESELECT

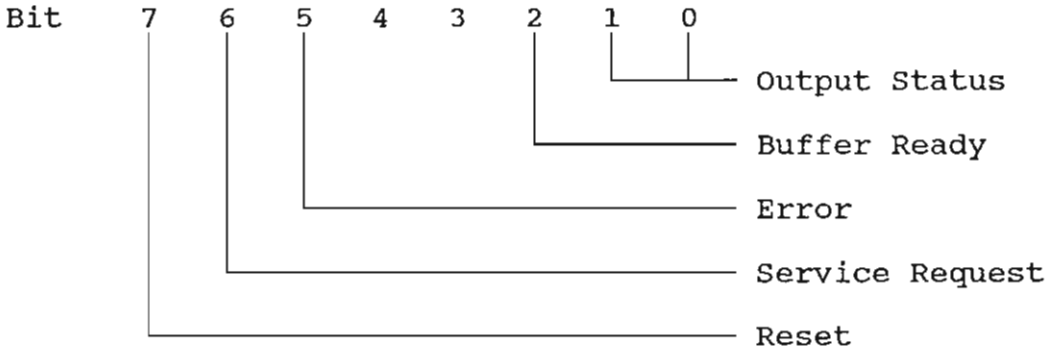
DISCON - Disconnects the outputs of all the channels in the system by first setting all card outputs to 0V and places a small resistance from the outputs to ground to prevent the outputs from coming off 0V. This is also accessible from the front panel by pressing (at present) the [Lock] Key. The CRT display will show Disconnect in the location where Online and Offline are displayed. The disconnect feature is basically for protection of the device under test since it effectively disconnects the device under test from the test system.

CONNECT -- Connects the outputs back directly into the circuit path and sets all outputs to 0V, and places the instrument in the Offline state (all outputs connected in the circuit path with 0V out). Programming output Voltage at this point, and placing the system in the Online state will provide Voltage output to the device under test.

SRQON -- Turns on the Service Request

SRQOFF -- Turns off the Service Request

SERIAL POLL REGISTER/SERVICE REQUEST BYTE



Output Status: 00 - Disconnect
01 - Offline
10 - Online

Buffer Ready: Set with last byte put into Output Buffer, cleared when last byte transmitted.

Service Request: Set when SRQON and any of above reset by Serial Poll.

Error: Set on error, cleared on CLEAR, STATUS, or any key pressed.

9.3.4 MODE COMMANDS

The following commands are the Mode Commands. These commands are slot dependent, ie...You must reference the location in the form:

MAINFRAME NUM SLOT NUM CHANNEL NUM

MF 2 SLOT 4 ch 2 Mode Value

OR: All hlv 10.0 (If you are setting all channels)

ALL -- Sets all of the channels that use the function in the system to the selected setting or function. The mode commands listed below can be used with the ALL command.

TR	HLV	VSENSE1
TF	LLV	VSENSE2
NORM	INV	ISENSE1
VOLT	NONINV	ISENSE2
DUMPV	FINC	ISENSE3
DUMPT	CINC	DUMPLB
DUMPF	FDEC	DUMPLD
RANGE1	CDEC	SETDEFB
RANGE2	LOLIMB	SETDEFD
RANGE3	LOLIMD	UPLIMB
REGULAR	AMPLIM	UPLIMD
LNOISE	LABEL *	EXT
HRANGE	DELAY	INTW
LRANGE	WIDTH	INTD
MODEV	MODEI	DP
FORCEV	FORCEI	DUMPVI
ILIM	VLIM	DUMPP
CHON	CHOFF	KELON
KELOFF	STEPV	STEPI
INC FORCEVI	INC VILIM	

ex... all TR 56
or: all tr 56 tf 56 hlv 5.00 llv -5.023

9.3.5 Label Setting Commands

LABEL -- The LABEL command allows you to place a 4 character identifier on the Main Menu at the Label column and to also use this command to select channels over the IEEE-488 bus or RS-232-C Port. Programming this feature is only available over the IEEE-488 bus or through the RS-232-C port. The channel identifier can be made up of any ASCII characters from A to Z, or from 0 to 9, and the extended character set provided in section 12.3.4. For phi use Chr$(237), or ED Hex. The channel identifier can be a maximum of 4 characters and there must be a space inserted between the command LABEL and the identifier for proper formatting on the CRT screen. For example:

MF 1 SLOT 4 CH 2 label CLK3

@LABEL name -- Once you have established the Label, it can be used in place of the standard Mainframe, slot, Channel designation to select channels to access. In the example above, the label for the channel was designated CLK3. That label can now be used to access the channel as follows:

@clk3 tr 45 tf 45

LABEL * -- Clears the label at the selected channel.

Example: MF 1 Slot 4 CH 2 Label *

or ALL LABEL *

; (REM) -- The Semicolon can be used as a Rem statement in any command line. Once the semicolon is used, the software ignores the information UNTIL THE NEXT RECEIPT OF A CARRIAGE RETURN AND LINE FEED. For example:

@VSS2 VOLT 10.00 ; Set the VSS2 Bias Voltage

9.3.6 Rise and Fall Time Setting Commands

TR --- Sets the programmable rise time at the selected channel, There are 3 ranges listed below that must be used with this mode command depending upon the range required. The Range settings are as shown in the chart on the next page. Both tr and tf must be on the same range.

TF --- Sets the programmable fall time at the selected channel, There are 3 ranges listed below that must be used with this mode command depending upon the range required. The Range settings are as shown on the next page. Both tr and tf must be on the same range.

The Programmable Rise and Fall time option allows the setting of the individual rise and fall times of the Driver channel outputs throughout the range of 40ns representing a minimum 2ns/V rise time all the way up to 2000ns/V. The ranges are as shown below.

Minimum	Maximum	Slew Rate	Inc/Dec Value
Range 1 40ns	400ns	2ns/V	1ns
Range 2 400ns	4000ns	20ns/V	10ns
Range 3 4000ns (4usec)	40000ns (40usec)	200ns/V	100ns

A command example is as follows:

mf 2 slot 4 ch 1 tr 45

In the above command, the setting refers to the lower range, which is from 40ns to 400ns. The value, 45, refers to the present rise time setting of 45ns. The value could be any number between 2ns and 400ns on range 1, depending upon the Voltage difference between HLV and LLV. When setting tr and tf, both must be on the same range. For detailed information on this function refer to section 8.1.3 Setting the Programmable Rise and Fall Time.

Once you have selected the mainframe, slot and channel, you can now increment the rise time in one nanosecond increments, the Range 1 setting, with the command: ch 1 cinc

9.3.6.1 Protect and Unprotect -- Rise and Fall Time Settings

PROTECT -- The protect feature allows you to change Voltage levels while maintaining the same slew rate, which means that the rise time or fall time would change with a change in Voltage.

PROTECT TR
OR PROTECT TF

UNPROTECT -- The unprotect feature allows you to change Voltage levels while not maintaining the slew rate, which means that the rise time or fall time would not change with a change in Voltage.

UNPROTECT TR
OR UNPROTECT TF

9.3.7 Voltage Setting Commands

HLV -- Sets high level voltage mode on the Drivers,

ex... mf 2 slot 3 ch 1 hlv 4.09

LLV -- Sets low level voltage mode on the Drivers,

ex... mf 1 slot 2 ch 2 LLV -5.00

INV -- Inverts the Driver output on the selected channel,

ex... mf 2 slot 3 ch 1 inv

NONINV -- Changes an inverted Driver channel output to true output, ex... mf 3 slot 6 ch 1 noninv

VOLT -- The command, that when used with a value, sets the DC voltage level of the selected bias supply, ex...

mf 4 slot 7 ch 4 volt 10.560

In normal operation the voltage can be set across the bus, in as low as 10mV increments. For voltage adjustments in 0.5 mV or 0.250 mV increments, depending on the Bias Card being used, the HR command is required.

HR -- Sets the High Resolution Mode on the selected odd bias channel, while setting the function of the increment/decrement softkeys as shown below. When HR is set, the DC Bias supply selected can be set in as low as 0.5 mV or 0.250 mV accuracy. Setting the HR mode will provide increment/decrement capability as follows:

finc - 0.5, 0.625, 0.250 mV (depending on Card)
cinc - 0.5, 0.625, 0.250 mV (depending on Card)
fdec - 0.5, 0.625, 0.250 mV (Depending on Card)
cdec - 0.5, 0.625, 0.250 mV (depending on Card)

Bias Card	Low Res.*	High Res.
40740	10/100 mV	0.5 mV
40741	12.5/100 mV	0.625 mV
40750 (Range 2)	10/100 mV	0.5 mV
40750 (Range 1)	5/100 mV	0.250 mV

* Refers to both Fine/Course Increment and Decrement

In Low Resolution Mode (Command - LR) The Fine Increment/Decrement Commands FINC/FDEC will provide the steps shown above for Fine. The Course Increment/Decrement commands CINC/CDEC will always step at 100 mV.

In High Resolution Mode (Command - HR) either FINC/CINC or FDEC/CDEC will produce the High Resolution value for the selected card model. Once the HR Mode is established, the Voltage can be set in the High Resolution settings with the Volts command.

LR -- Sets the Low Resolution Mode on the selected Bias Channel, or All the Bias channels while setting the function of the increment/decrement softkeys as shown below. When LR is set, the DC Bias supply selected can be set in either Fine or Course Increment/Decrement. the LR mode will provide increment/decrement capability as follows (See HR Command for more information):

finc - 0.5, 0.625, 0.250 mV (depending on Card)
cinc - 100 mV (All Cards)
fdec - 0.5, 0.625, 0.250 (Depending on Card)
cdec - 100 mV (All Cards)

For additional information on the High Resolution Mode, see Explanation of Softkeys, Main Menu, and [HR-ON/OFF] softkey.

FINC -- Fine increments the Bias Voltage setting. See LR and HR commands for more information.
ex... mf 2 slot 5 ch 5 finc

CINC -- Coarse increments the Bias Voltage setting. See LR and HR commands for more information.
ex... mf 4 slot 4 ch 4 cinc

FDEC -- Fine decrements the Bias Voltage setting. See LR and HR commands for more information.
ex... mf 2 slot 5 ch 5 fdec

CDEC -- Coarse decrements the Bias Voltage setting. See LR and HR commands for more information.
ex... mf 4 slot 4 ch 4 cdec

9.3.8 40465 Tri Level Driver Card Commands

TWOLV -- Sets the normal driver function from the selected channel on the Card. The two channels on the Card can be set in different modes at the same time. For example, one channel could be in Normal Mode, while the second channel could be set in Tri-Level Mode at the same time. The channels must be set by reference to their channel number. ex...

mf 1 slot 3 ch 2 twolv

All of the 40465 Cards in the system could be set to the same mode by using the ALL command. ex..

All Twolev

TRILV -- Sets the Tri-Level driver function from the selected channel on the Card. The two channels on the Card can be set in different modes at the same time. For example, one channel could be in Normal Mode, while the second channel could be set in Tri-Level Mode at the same time. The channels must be set by reference to their channel number. ex...

mf 1 slot 3 ch 2 trilv

All of the 40465 Cards in the system could be set to the same mode by using the ALL command. ex..

All Trilev

FORLV -- Sets the Four Level driver function from the selected channel on the Card. The two channels on the Card can be set in different modes at the same time. For example, one channel could be in Normal Mode, while the second channel could be set in Four-Level Mode at the same time. The channels must be set by reference to their channel number. ex...

mf 1 slot 3 ch 2 twolv

All of the 40465 Cards in the system could be set to the same mode by using the ALL command. ex..

All FORLV

MLV -- Sets the Middle Voltage Level in the Tri-Level Voltage Mode. The High and Low Rails must be set before the middle rail; the selected channel of the card must have previously been set in the Tri-Level Mode (TRILV). There must also be a one Volt differential between the High to Mid Rails and the Mid to Low Rails.

mf 2 slot 5 ch 1 mlv 5.6

or ALL MLV 5.6

MHLV -- Sets the Middle High Level Voltage in the Four-Level Voltage Mode. The High and Low Rails must be set before the middle rails. The High Level Voltage (HLV) Rail must be at least one volt higher than any of the middle rails, and the Low Level Voltage (LLV) must be set at least one volt lower than any of the middle rails (MHLV, MLLV). The selected channel of the card must have previously been set in the Four-Level Mode (FORLV).

mf 2 slot 5 ch 1 mhlv 7.2

or ALL MHLV 5.5

MLLV -- Sets the Middle Low Level Voltage in the Four-Level Voltage Mode. The High and Low Rails must be set before the middle rails. The High Level Voltage (HLV) Rail must be at least one volt higher than any of the middle rails, and the Low Level Voltage (LLV) must be set at least one volt lower than any of the middle rails (MHLV, MLLV). The selected channel of the card must have previously been set in the Four-Level Mode (FORLV).

mf 2 slot 5 ch 1 MLLV 8.0

or ALL MLLV 5.5

OPTO -- Selects the optically isolated input to the desired channel (TTL Sets the non optically isolated input).

MF 2 slot 5 ch 2 OPTO

or ALL OPTO

TTL -- Selects the non optically isolated input to the desired channel (OPTO Sets the optically isolated input).

MF 2 slot 5 ch 2 TTL

or ALL TTL

IMP10 -- Sets the output impedance of the selected channel to the back terminated 10 Ohm output. In this mode, the Current and Voltage Sense do not function. To change back to a 50 Ohm Output back termination, send the command to turn on the Voltage or Current sense function.

mf 3 slot 6 ch 1 imp10

or ALL IMP10

9.3.9 40750/40751/40752/40753 Low Noise DC Bias Card Commands

All command references in this section to the 40750 Card are also valid for the 40751, 40752, 40753 Cards.

LRANGE -- Sets the 40750 Bias Card selected to Low Range operation from -10.245 to +10.235 V. This function sets the entire Card, so no channel designation is required. ex...

```
mf 1 Slot 2 LRANGE
  or   ALL LRANGE
```

To set the low range, you must be in the Disconnect Mode (DISCON)

HRANGE -- Sets the 40750 Bias Card selected to Low Range operation from -20.48 to +20.47 V. This function sets the entire Card, so that no channel designation is required. ex...

```
mf 1 Slot 2 HRANGE
or      all Hrange
```

To set the High Range function, you must be in the Disconnect Mode (DISCON).

REGULAR -- Sets the noise output mode of the 40750 Card to Regular Mode. This mode does not provide the lower output noise levels of the Low Noise Mode (LNOISE), but improves the response by 100 msec for a 0 to 10 V swing (300 msec). This mode can be set for individual channels, or all channels. ex...

```
mf 2 slot 3 ch 1 regular
   or    all regular
```

LNOISE -- Sets the noise output mode of the 40750 Card to Low Noise Mode. This mode provides lower output noise levels than the Regular Mode (REGULAR), but the response to Voltage changes is 100 msec slower (400 msec), for a 0 to 10 V swing. This mode can be set for individual channels, or all channels. ex...

```
mf 2 slot 3 ch 1 LNOISE
   or    all LNOISE
```

9.3.10 40770 Four Quadrant Bias Supply Commands

The following is a list of commands used with the 40770 Four Quadrant Bias Supply.

MODEV -- Sets the selected channel in the Voltage Source Mode

```
mf 1 slot 1 ch 2 MODEV
or ALL MODEV
```

MODEI -- Sets the selected channel in the Current Source Mode.

```
mf 1 sl 1 ch 1 MODEI
or ALL MODEI
```

FORCEV -- Sets a voltage when the channel is in the Voltage Source Mode.

```
mf 1 sl 2 ch 1 FORCEV 12.5
or ALL FORCEV
```

The range of numbers is -24.5 to 24.5

FORCEI -- Sets a current when the channel is in the Current Source Mode.

```
mf 1 slot 5 ch 1 FORCEI 100.5 mA
or ALL FORCEI
```

The range of FORCEI is from -201.000mA to 201.000mA. There must be a unit that follows the numeric value. If no units are given then nanoAmps are assumed. The units are:

```
mA - milli Amps
uA - micro Amps
nA - nano Amps
```

DUMPVI -- Dumps the Voltage and Current Settings on the selected channel.

```
mf 1 sl 1 ch 1 DUMPVI
or ALL DUMPVI
```

Data returned is in the format needed to set the same value.
ie...mf 1 sl 1 ch 1 forcev 15.23

DUMPP -- Dump Protection will bring back the present Voltage Limit or Current Limit setting, depending on whether the Voltage or Current Source Mode is currently in effect.

```
mf 3 sl 7 ch 1 dumpp
or ALL DUMPP
```

Data returned in the format VLIM 17.5 or ILIM 250 mA

ILIM -- Sets the current limit.

```
mf 2 slot 2 ch 2 ILIM 75 uA
or ALL ILIM 150 nA
```

The range is 0 to 210.00 mA and always positive. There must be a units qualifier after the number or nano Amps are assumed. The unit qualifiers are:

```
mA - milli Amps
uA - micro Amps
nA - nano Amps
```

VLIM -- Sets the Voltage Limit

```
mf 2 slot 2 ch 2 VLIM 75 uA
or ALL VLIM 5.12
```

The range is 0 to 25.500 and always positive

CHON -- Turns on the selected channel.

```
mf 1 sl 5 ch 1 CHON
or ALL CHON
```

CHOFF -- Turns Off the selected channel.

```
mf 1 sl 5 ch 1 CHOFF
or ALL CHOFF
```

KELON -- Turns on the Kelvin Function.

```
mf 1 sl 5 ch 1 KELON
or ALL KELON
```

KELOFF -- Turns off the Kelvin Function.

```
mf 1 sl 5 ch 1 KELOFF
or ALL KELOFF
```

STEPV -- Sets the Increment Step in the Voltage Source Mode

```
mf 1 sl 5 ch 1 STEPV 777
    or ALL STEPV 333
```

The range is from 3 to 999 This number represents milliVolts and no qualifier is expected

STEPI -- Sets the Increment Step in the Current Source Mode.

```
mf 1 sl 5 ch 1 STEPI 25
    or ALL STEPI 97.5
```

The ranges are as follows:
0.25 to 975 for the 2 mA, 2 uA ranges.
2.50 to 9.75 for the 20 mA and 20 uA ranges.
25 to 975 for the 200 mA, 200 uA and 200 nA ranges.

no units are given since the step is based on the range of the FORCEI value. Example if the FORCEI value is 100mA, then the STEPI range is 25 to 975 uA. If the FORCEI value is 20 nA, the STEPI range is 25 to 975 pA. The STEPI units are always one unit down form the FORCEI units.

INC FORCEVI -- Increments for current Force Voltage or Force Voltage Range setting.

```
mf 1 sl 5 ch 2 INC FORCEVI
    ALL INC FORCEVI
```

The value incremented is the current setting of the step function. See STEPI and STEPV commands for this card.

INC VILIM -- Increments the current Voltage or Current Limit setting.

```
mf 1 sl 5 ch 2 INC VILIM
    ALL INC VILIM
```

The value incremented is the current setting of the step function. See ILIM, VLIM, STEPI and STEPV commands for this card.

9.3.11 40480/ 40490 Single Channel Driver Card Commands

All references in this section to the 40480 Card are also valid for the 40490 Card.

The commands listed below are used only with the 40480 and 40490 Driver Card.

DELAY time NS,US,MS
WIDTH time NS,US,MS

IMP50	IMP500
EXT	INTW
INTD	DP
RTRIG	FTRIG

VSENSE3

Since this card is a single channel card, reference to Channel is always Channel 1. The commands can either take the form:

MF 1 Slot 2 ch 1 HLV 5.00 or @clk5 HLV 5.00

If you intend to use the internal width and delay settings care must be taken in selecting the proper mode for their use.

REGOUT -- Used with the 40490 Driver Card to select either normal output or output through the Mux output connector. REGOUT directs the output to the normal Output connector as opposed to the Mux output connector.

AUXOUT Directs the output of the 40490 Card to the Mux output connector as opposed to the normal output connector (REGOUT).

The Modes available are:

Mode	Command
External Input	EXT
Internal Width	INTW
Internal Delay/Width	INTD
Double Pulse	DP

Delay and Width Commands
(Used with INTW and INTD)
DELAY time NS,US,MS
WIDTH time NS,US,MS

EXT - External Input -- If you select External Input (Command EXT), you cannot use the internal width or delay setting function. The output delay and width will be the same as the input signal to the Driver.

INTW - Internal Width -- If you select Internal Width, you can set the Width only of the output of the Driver in the range from 8ns to 80ms, by first establishing the Mode (Command INTW) and then sending the Width setting with the Width setting command. The Mode can be set for all 40480 Cards in the system, or for selected cards.

When the Internal Width Mode command is sent, the Width of the output pulse immediately defaults to minimum setting (8ns) until a command is sent with your required setting. An example is as follows:

MF 2 SLOT 3 CH 1 INTW (Sets Internal Width Mode with default 8ns Width)

MF 2 SLOT 3 CH 1 INTW WIDTH 50 NS (Sets the Internal Width Mode and Sets the Width at 50 nanoseconds.)

or ALL INTW WIDTH 50 ns (Sets all channels to Internal Width Mode at 50 nanoseconds Width.)

Once the Mode has been established, you can change the width as desired. ex...

MF 1 SLOT 2 CH 1 Width 70 ns

INTD - Internal Width/Delay -- This mode is identical in function to the Internal Width mode, with the exception of the addition of delay setting capabilities. The command for this Mode is INTD. The settings for the Width function are in the range from 8ns to 80ms, and the range for the delay function is from 30ns to 80ms.

The commands are used in the same manner as used for the Internal Width Mode. ex...

mf 1 slot 3 ch 1 INTD Delay 50 ns Width 70 ns

The delay and Width can be set independently or together in the same command.

DP -- The Double Pulse Mode will supply a double pulse output from the Driver Card, if this mode is selected. The Width and Delay are both adjustable in this mode. The Double Pulse can be set within the range of 14 ns to 80 ms.

mf 1 slot 3 ch 1 DP Delay 50 ns Width 70 ns

RTRIG -- Sets the Trigger out to occur on the Rising Edge of the Input Signal to the Driver Card. ex...

MF 2 SLOT 4 CH 1 RTRIG

FTRIG -- Sets the Trigger out to occur on the Falling Edge of the Input Signal to the Driver Card.

MF 2 SLOT 4 CH 1 FTRIG

IMP50 -- Selects the 50 Ohms input impedance at the TTL Input to match the requirements of your clock source for high speed applications. ex...

MF 3 SLOT 7 CH 1 IMP50

IMP500 -- Selects the 500 Ohms input impedance at the TTL Input to match the requirements of your clock source for high speed applications. ex...

MF 3 SLOT 6 ch 1 IMP500

9.3.12 Voltage and Current Sense Commands

Any channel can be set with the commands listed in this section to be in any of the 5 ranges at any time. For example a channel 1 Bias could be set for VSENSE2, while a channel 3 Bias could be set for ISENSE3.

The SELECT Command can be sent, at any time, to read the channel output through the Isense/Vsense multiplexed output, and the system will provide whatever reading is set for the particular channel.

Once a channel is set for one of the 5 functions, you do not have to mention the function in the commands again unless you want to change the type of reading you are going to take from the channel. The DESELECT command turns off the sense function.

I Sense Ranges		Driver Cards	DC Bias Cards
ISENSE1	--	1 mA/V	1 mA/V
ISENSE2	--	10 mA/V	10 mA/V
ISENSE3	--	25 mA/V	100 mA/V

ISENSE1 -- Turns on the current sense function for the selected channel. When taking a current measurement or scanning a group of channels, the ISENSE must be turned on, and each channel is selected after setting, with the SELECT command. ex... mf 3 slot 4 ch 2 Isense1

ISENSE2 -- Turns on the current sense function for the selected channel. When taking a current measurement or scanning a group of channels, the ISENSE must be turned on, and each channel is selected after setting, with the SELECT command.
ex... mf 3 slot 5 ch 4 Isense2

ISENSE3 -- Turns on the current sense function for the selected channel. When taking a current measurement or scanning a group of channels, the ISENSE must be turned on, and each channel is selected after setting, with the SELECT command.
ex... mf 3 slot 5 ch 4 Isense3

VSENSE1 -- Turns on the Voltage sense function at the selected channel for the 2V range. When taking a Voltage measurement or scanning a group of channels, the VSENSE1 must be turned on, and each channel is selected after setting, with the SELECT Command.
ex... MF 3 slot 5 ch 2 Vsense1

VSENSE2 -- Turns on the voltage sense function at the selected channel for the 20V range. When taking a voltage measurement or scanning a group of channels, the VSENSE2 must be turned on, and each channel is selected after setting, with the SELECT Command.
ex... MF 3 slot 5 ch 2 Vsense2

VSENSE3 -- Turns on the voltage sense function at the selected channel for the 200V range. This command is used with the 40480 Driver Card only. When taking a voltage measurement or scanning a group of channels, the VSENSE3 must be turned on, and each channel is selected after setting, with the SELECT Command. ex... MF 3 slot 3 CH 1 Vsense3

SELECT -- Allows you to select a preset driver or bias Voltage or current sense function. For example if you had previously set all the DC Bias Channels to the ISENSE3 function, by selecting the required channel and sending the command select you could read the Current on the channel. You can pre-set any driver or bias channel to any Isense or Vsense function and mix them in any way you choose. Sending the SELECT command referenced to a particular channel allows you to take the reading without re-establishing the ISENSE or VSENSE setting again. The DESELECT command turns off the sense function. See 9.3.3 System Commands.

9.3.13 Increment/Decrement Commands

The Increment and Decrement commands can now be referenced to a particular channel or function in the following form:

Increment Commands	Decrement Commands	Cards Used On
STEP num		(All Cards)
INC VOLT	DEC VOLT	(All DC Bias Cards)
INC HLV	DEC HLV	(All Driver Cards)
INC LLV	DEC LLV	(All Driver Cards)
INC TR	DEC TR	(All 40460/40461 Driver Cards)
INC TF	DEC TF	(All 40460/40461 Driver Cards)
INC DELAY	DEC DELAY	(All 40480 Driver Cards)
INC WIDTH	DEC WIDTH	(All 40480 Driver Cards)

The commands VOLTS, HLV, and LLV require the STEP num command to be used to set the range that is to be incremented or decremented for each type of Card. The Steps available for each function are:

Command	Range
Volts	10mV to 100mV in 10mV increments (See also HR Mode)
HLV	10mV to 100mV in 10mV increments
LLV	10mV to 100mV in 10mV increments

The command Step 30 would set the increment and decrement to change in 30 mV Steps. Once this command is sent, it is in use until another STEP num Command is sent. ex...

Step 30 MF 1 SLOT 2 CH 3 INC VOLTS

The Rise and Fall time is used in a similar manner, with the exception that the ranges are changed automatically. See Section 9.3.6. for information on Rise and Fall Time Commands.

Programming the Rise and Fall Time Incremental Commands ex...

MF 1 SLOT 3 CH 2 INC TR

Tr	1ns (Range 1), 10ns (Range 2), 100ns (Range 3)
Tf	1ns (Range 1), 10ns (Range 2), 100ns (Range 3)

9.3.14 Incrementing and Decrementing the Width and Delay

The increment/Decrement ranges for the 40480 and 40490 Cards Width and Delay vary depending upon the value being used. The chart below provides the ranges of Width and Delay and the Increment/Decrement value for each range. The Width or Delay will be incremented based upon the current range value when the command is sent.

MF 1 SLOt 4 CH 1 INC DELAY

Time			Step
14ns	to	1us	100ps
1 us	-	10us	1ns
10us	-	100us	10ns
100us	-	1ms	100ns
1ms	-	10ms	1us
10ms	-	90ms	10us

Chart of Delay and Width Ranges

And Increment/Decrement Step for each range.

9.3.15 Programmable Limits Commands

The programmable limits commands can be used over the IEEE-488 Bus or through the RS-232-C Port even if the 90040 Non-Volatile Memory Option is not installed. In order to save these settings internally after power off, the Non-Volatile Memory Option must be present.

UPLIMD -- Sets the Upper limit of the selected driver channel. This command can be used to reference an individual driver channel, or used to set all of the upper limits of the Drivers in the system. ex...

```
        mf 1 slot 1 ch 1 UPLIMD 10.5
OR      ALL UPLIMD 15.5
```

LOLIMD -- Sets the Lower limit of the selected driver channel. This command can be used to reference an individual driver channel, or used to set all of the lower limits of the Drivers in the system. ex...

```
            mf 1 slot 1 ch 1 LOLIMD -10.5
OR          ALL LOLIMD 0
```

AMPLIM -- Sets the Amplitude Limit of the selected driver channel. This command can be used to reference an individual driver channel, or used to set all of the Amplitude limits of the Drivers in the system. ex...

```
            mf 1 slot 1 ch 1 AMPLIM 5.0
OR          ALL AMPLIM 15.0
```

The maximum amplitude limits of the Driver Cards are as follows:

```
40461 Dual Channel High Voltage Driver -- 30 V
40460 Dual Channel Driver Card         -- 25 V
40465 Tri-Level Driver Card            -- 20 V
40480 Single Channel 50 MHz Driver     -- 20 V
40490 Single Channel 65 MHz Driver     -- 20 V
```

UPLIMB -- Sets the Upper limit of a DC bias channel. This command can be used to reference a DC bias channel, or used to set all of the upper limits of the DC biases in the system. ex...

```
            mf 1 slot 1 ch 1 UPLIMB 10.5
OR          ALL UPLIMB 15
```

LOLIMB -- Sets the Lower limit of the selected DC bias channel. This command can be used to reference a DC bias channel, or to set all of the Lower limits of the DC biases in the system. ex...

```
            mf 1 slot 1 ch 1 LOLIMB 7.55
OR          ALL LOLIMB 5.55
```

SETDEFD -- Sets the default limits of an individual driver channel or all of the drivers in the system. This sets the driver channel or all of the driver channels to maximum to the maximum Voltage output settings for the drivers (Upper Limit +20.47 V, Lower Limit -20.28 V). The CLEAR command will also reset the limits to these default values, as well as setting all driver and bias outputs to 0 V. ex...

```
            MF 1 SLOT 2 CH 1 Setdefd
OR               all Setdefd
```

SETDEFB -- Sets the default limits of an individual DC bias channel or all of the DC biases in the system. This sets the DC bias channel or all of the DC bias channels to maximum to the maximum Voltage output settings for the drivers (Upper Limit +20.47 V, Lower Limit -20.28 V). The CLEAR command will also reset all limits to these default values, as well as setting all driver and bias outputs to 0 V. ex...

```
MF 1 SLOT 2 CH 1 SETDEFB
OR          all setdefb
```

9.3.16 System Dump Commands

DUMPF -- The dumpf command dumps the format of the channels to a file for downloading instrument setups. This command requires use of the slot command for selecting the required slot to be dumped, or use of the all command to dump the format of the instrument.

This command is used in conjunction with the dumpv and dumpt commands, which allow you to download the rise/fall time and voltage setups. The mainframe, slot and channel must be accessed with this command unless the ALL command is used. ex...

```
MF 2 slot 3 ch 2 DUMPF
     or All DUMPF
```

DUMPV -- The DUMPV command dumps the Voltage settings of the channels to a file for downloading instrument setups. This command requires use of the slot command for selecting the slot to be dumped, or use of the ALL command to dump the format of the instrument. This command is used in conjunction with the DUMPF and DUMPT commands, which allow you to download the format and rise/fall time setups. The mainframe, slot and channel must be accessed unless the ALL command is used. ex...

```
mf 3 slot 4 ch 4 dumpf
     or all dumpv
```

DUMPT -- The dumpt command dumps the format of the channels to a file for downloading instrument setups. This command requires use of the slot command for selecting the required slot to be dumped, or use of the ALL command to dump the format of the instrument. This command should be used in conjunction with the DUMPV and DUMPF commands, which allow you to download the format and voltage setups. The mainframe, slot and channel must be accessed unless the ALL command is used.ex...

```
mf 3 slot 4 ch 1 dumpt
     or all dumpt
```

DUMPLD -- This command will dump the limit settings of the Driver Cards. This includes the High Rail (Upper Limits), the Low Rail (Lower Limits), and the Maximum Output Amplitude settings. This dump can be individual channels or all of the driver channels at one time. ex...

```
mf 1 slot 2 ch 2 DUMPLD
   or    ALL DUMPLD
```

DUMPLB -- This command allows you to dump the limit settings of the Bias Cards. This includes the Upper Voltage Limit (Upper Limit) and The lower Voltage Limit (Lower Limit). This command can be used to dump individual channels or all of the Bias channels at one time. ex...

```
MF 2 SLot 6 CH 1 DUMPLB
  or      ALL dumplb
```

UPDATEOFF -- Turns off the update function so that the data being loaded will not be updated to the CRT screen during the loading period. You must however, send the UPDATEON command at the end of the file to update the data on the CRT screen. See Section 9.2.4

UPDATEON -- Turns the update function back on when turned off by the UPDATEOFF command. See 9.3.13 Increasing Download Speed.

The default upon power-up is the UPDATEON command. These commands do not require the ALL command, since they are block commands that automatically affect the entire instrument.

ID -- Sending ID provides you with information on the PI-4001 IEEE-488 address, and driver or bias card locations.

The output buffer provides you with all the card information. You have not cleared the status buffer of all available messages until you receive an End Of File Marker (1A Hex).

The order of appearance of the ID message sequence is as follows:

- - PI-4001 5 (IEEE-488 address)
- - PI-4002
- - MF 1 slot 1 40460 Driver
- - MF 1 slot 2 40740 Bias
- - The End Of File Marker (1A Hex)

9.3.17 PROGRAMMING THE SCREEN, ONLINE, DISCONNECT, SEQUENCE

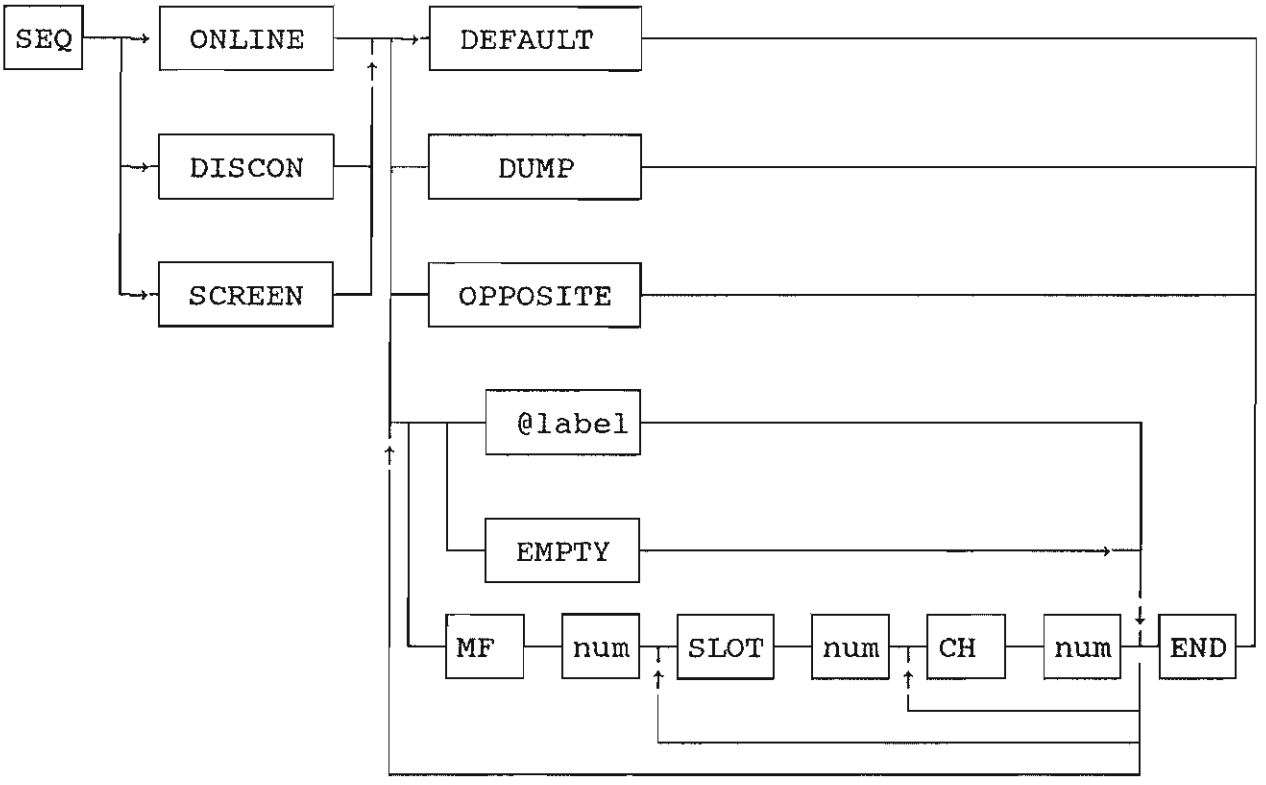
The 4000 Series system allows you to program the sequence of application of the Clock Drivers and Biases as applied to the Output. Using the Screen Sequence, Online Sequence, and Disconnect Sequence Menus, this can be done with the PI-4001 Keyboard, the IEEE-488 Bus, or RS-232-C Port.

This programming applies to both the sequence of application Online of the Clock Drivers and Biases to the device under test, and also to the Disconnect sequence of the Clock Drivers and Biases. The set up can be stored as a file in your computer, or as a file as part of the set up when using the Non Volatile Memory to download program set up. For additional information see Section 8.2.10.

The system will power up in the default sequence as defined below:

DEFAULT sequence is:

SCREEN -- ascending mainframe, slot, and channel order
ONLINE -- biases in ascending order, drivers in descending order
DISCON -- drivers in ascending order, biases in descending order



Bus Commands for programming the Sequence

SEQ -- Command used to start the sequence as in:

SEQ ONLINE (Would begin establishment of an Online Sequence)
SEQ DISCON (Would begin the establishment of a Disconnect Sequence)

ONLINE -- Used in conjunction with SEQ to establish an Online Sequence

DISCON -- Used in conjunction with SEQ to establish a Disconnect Sequence.

SCREEN -- Used in conjunction with SEQ to Establish Sequence of display on the screen

DEFAULT --Used to set the Online or Disconnect sequence back to the Default condition.

DEFAULT sequence is:

SCREEN -- Ascending Mainframe, Slot, and Channel order
ONLINE -- Biases in ascending order, Drivers in descending order
DISCON -- Drivers in ascending order, Biases in descending order

OPPOSITE -- Creates a sequence that is opposite of an established sequence. If an Online sequence has been established, the Command shown below would create the opposite of the Online Sequence as the Disconnect Sequence. Not valid for screen. The command:

SEQ DISCON OPPOSITE

Would disconnect the programmed channels opposite of the programmed Online sequence.

EMPTY -- valid only for SCREEN -- leaves empty line on display. The command would be used in the form:

SCREEN EMPTY

END -- Sets channel sequence according to list. Channels not included in the list remain on the end in unchanged sequence (for SCREEN EMPTY, lines are taken out).

DUMP -- Any of the three sequences can be dumped to your computer with one of the following commands:

SEQ ONLINE DUMP
SEQ SCREEN DUMP
SEQ DISCON DUMP

The following example sets the Online sequence of three Driver Channels.

Assume the three channels to be located in:

```
MF 1 SLOT 2 CH 1
MF 1 SLOT 2 CH 2
MF 2 SLOT 3 CH 1
```

```
SEQ ONLINE MF 1 SLOT 2 CH 2 CH 1 MF 2 SLOT 3 CH 1
```

If the channels were labeled as follows:

```
CLK 1  (Located in MF 1 SLOT 2 CH 1)
CLK 2  (Located in MF 1 SLOT 2 CH 2)
CLK 3  (Located in MF 2 SLOT 3 CH 1)
```

The Online sequence is set up as follows:

```
SEQ ONLINE CLK 2 CLK 1 CLK 3
```

9.3.18 90040 NON-VOLATILE MEMORY OPTION COMMANDS

All of the functions of the 90040 Non-Volatile Memory Option are available over the IEEE-488 Bus and through the RS-232-C Port. The files can be loaded, saved, and deleted with these commands.

DIR -- Provides back to your controller, a directory of all files currently stored in the Non Volatile Memory. ex... DIR

LOAD num -- Loads a complete program as referenced by the number that was assigned when the program was originally saved. ex... LOAD 12

The following command is used to delete files from the 90070 Non-Volatile Memory Option. IF YOU USE THE DELETE COMMAND THE FILES REFERENCED WILL BE PERMANENTLY DESTROYED. ONCE THE COMMAND IS SENT, THE FILE IS LOST.

DELETE num -- Allows Deleting a complete program as referenced by the number that was assigned when the program was originally saved. ex... DELETE 12

SAVE num -- Allows saving a complete program currently in memory as referenced by the number you assign. ex... SAVE 3

PWRONFILE num -- Save the program currently in memory as the default program that is automatically loaded upon power up of the instrument. This saved default program will also include the Voltage limits on the Driver and Bias Cards that are currently in the system. You can also convert any setup file currently in

the Non-Volatile Memory to the Power on File by sending the command PWRONFILE and the number of the file you wish to be the new power on file. For example file 23 could be made the Power ON file with the command PWRONFILE 23. ex... PWRONFILE 23

9.3.19 Increasing Download Speed

When loading data over the IEEE-488 bus or through the RS-232-C port, with the Driver Format and Set Up Menu or Bias Set Up Menu displayed, the PI-4001 updates the CRT screen each time it receives a carriage return (CHR$(13)) and line feed (CHR$(10)).

Since many users write programs that consist of one line statements followed by a carriage return and line feed, the update process upon receipt of the carriage return and line feed can slow the loading process considerably.

There are two ways to avoid this slow down during load:

1. If the instrument is on the Interface Menu during load, the update process will not occur and there is no loss of speed. The Main Menu will be automatically updated the next time it is accessed.

2. If the statements are sent to the PI-4001 as larger strings of data between carriage returns and line feeds you will also speed up the load process. You can combine the data into strings as large as 2048 bytes before a carriage return and line feed are required. Spaces are still required.

9.4 SAMPLE PROGRAM FOR IEEE-488 BUS

The following program was written for the IBM PC using the Ziatech IEEE-488 Card. The program will allow you to save and load files created for the 4000 Test System. A program similar to this for the National IEEE-488 Card is also available on disk from Pulse Instruments. Please consult the factory for details.

```
10 REM ******************************************************
20 REM *                                                    *
30 REM *    PULSE INSTRUMENT GPIB TEST PROGRAM              *
40 REM *     V1.0                                           *
50 REM *                                                    *
60 REM *    THIS PROGRAM WILL DEMONSTRATE HOW TO PROGRAM    *
70 REM *    PI-4000 LOW NOISE FOCAL PLANE ARRAY TEST SYSTEM *
80 REM *    GPIB WITH ZIATECH GPIB CONTROLLER (ZT 14444     *
90 REM *    OR ZT 1488A)                                   *
100 REM ******************************************************
110 REM
120 REM THIS IS TO INITIALIZE THE COMPUTER MEMORY SIZE AND
130 REM ZIATECH GPIB CONTROLLER CARD
140 REM
150 REM DETERMINE COMPUTER MEMORY SIZE FIRST
160 REM
170 REM THIS ROUTINE WILL DETERMINE THE SYSTEM MEMORY SIZE
180 REM AND WILL LOAD THE SUBROUTINE IN A 64K OR LARGER
190 REM SYSTEM
200 REM CLEAR SCREEN
210 CLS
220 REM ASSUME 64K SYSTEM
230 CLEAR ,&H7C00
240 REM
250 REM Get actual memory size from INT 12.
260 REM
270 DATA &H55,&H8B,&HEC,&H8B,&H5E,&H06,&HCD
275 DATA &H12,&H89,&H07,&H5D,&HCA,&H02,&H00
280 REM LOAD TEMPORARY ROUTINE HERE
290 DEF SEG = &H500
300 REM REPEAT UNTIL ALL LOADED
310 FOR I% = 0 TO 13
320 READ J%
330 POKE I%,J%
340 NEXT
350 REM
360 REM INITIALIZE ALL THE ZIATECH CARD VARIABLES
370 REM
380 SUBRT% = 0
390 MEMSIZE% = 0
400 CALL SUBRT%(MEMSIZE%)
410 MEMSIZES$ = STR$(MEMSIZE%)
```

```
420 PRINT USING "&";"Memory size is",MEMSIZES$,"K-Bytes."
430 IF MEMSIZE% < 64 THEN PRINT "Non-sufficient memory":END
440 DEF SEG = &H2500
450 REM
460 REM Load ZT 1488 GPIB and clock routines.
470 REM
480 REM LOAD ZIATECH ZT 1488 ASSEMBLY LANGUAGE GPIB INTERFACE
490 REM
500 BLOAD "BIALL.m", 0
510 REM
520 REM GET ADDRESSES FOR ASSEMBLY LANGUAGE ROUTINES AND EQUATES
530 REM TO OFFSETS IN USER DEFINED SEGMENT.
540 REM
550 GETADR = PEEK(1)*256 + PEEK(0)
560 DIM SUB%(25)
570 FOR I% = 0 TO 24
580 CALL GETADR ( I%, SUB%(I%) )
590 NEXT I%
600 ERSTAT=SUB%(0)
610 INIT=SUB%(1)
620 SENDST=SUB%(2)
630 RECVST=SUB%(3)
640 SRQSTA=SUB%(4)
650 REMOTE=SUB%(5)
660 LOCL=SUB%(6)
670 LOKOUT=SUB%(7)
680 DEVCLR=SUB%(8)
690 TRIG=SUB%(9)
700 TERM=SUB%(10)
710 TIMEDY=SUB%(11)
720 PPOLL=SUB%(12)
730 PPOLLE=SUB%(13)
740 PPOLLU=SUB%(14)
750 PPOLLD=SUB%(15)
760 SPOLL=SUB%(16)
770 SETPRI=SUB%(17)
780 SETSEC=SUB%(18)
790 TEST=SUB%(19)
800 CMD = SUB%(20)
810 XFER = SUB%(21)
820 SENDDM = SUB%(22)
830 RECVDM = SUB%(23)
840 PROLEN = SUB%(24)
850 REM
860 REM GPIB names initialized
870 REM
880 REM load into def seg + prolen
890 REM get addr should be at offset prolen
900 DIM ADDR%(21)
910 GETADR = PROLEN     ' location of clock get address routine
920 FOR I% = 0 TO 12
```

```
930 CALL GETADR ( I%, ADDR%(I%) )
940 NEXT I%
950 REM
960 LODCLK = ADDR%(3)
970 LODLAT = ADDR%(4)
980 RDCLK = ADDR%(5)
990 RDLAT = ADDR%(6)
1000 TIME = ADDR%(7)
1010 SYNCH = ADDR%(8)
1020 SYSTIK = ADDR%(9)
1030 ALARM = ADDR%(10)
1040 INSTAT = ADDR%(11)
1050 REM
1060 REM BASIC NOW INITIALIZED, INITIALIZE COMMON VARIABLES
1070 REM
1080 REM Order of variables in common must agree with order
1090 REM       shown below.
1100 REM
1110 COMMON ERCODE%,RCVLEN%,BASECLK%,BASEPORT%,
     BASEPRI%,BASESEC%,YEAR%
1120 BASECLK% = &H240           ' initialize common
1130 BASEPORT% = &H210
1140 BASEPRI% = &H210
1150 BASESEC% = &H220
1160 YEAR% = &H3838             ' ascii code for 88
1170 REM
1180 REM ON WITH THE USER PROGRAM
1190 REM
1200 DELAY%=3000:CALL TIMEDY(DELAY%)
1210 CALL INIT
1220 REM
1230 REM ******************************************************
1240 REM *                                                    *
1250 REM *  THIS IS A SAMPLE PROGRAM WHICH WILL DEMONSTRATE   *
1260 REM *  HOW TO PROGRAM THE PULSE INSTRUMENTS              *
1270 REM *  PI-4000 LOW NOISE FOCAL PLANE ARRAY TEST SYSTEM   *
1280 REM *                                                    *
1290 REM ******************************************************
1300 REM
1310 REM LINE FEED
1320 REM
1330 LF$ = CHR$(&HA)
1340 REM
1350 REM SET GPIB CONTROLLER TERMINATE AT LINE FEED
1360 REM
1370 CALL TERM(LF$)
1380 REM
1390 REM SET PULSE INSTRUMENT PI-4000 GPIB ADDRESS 7
1400 REM
1410 DEVNO$="7"+" "
1420 REM
```

```
1430 REM THE FOLLOWING FEW LINES DEFINE DRIVER CARD
1440 REM
1450 REM 40460 DRIVER CARD LOCATES MAINFRAME 1 SLOT 1
1460 REM PROGRAM CHANNEL 1 HIGH LEVEL VOLTAGE 10
1470 REM                   LOW LEVEL VOLTAGE -10
1480 REM                   RISE TIME 50 NS
1490 REM                   FALL TIME 60 NS
1500 REM PROGRAM CHANNEL 2 HIGH LEVEL VOLTAGE 5
1510 REM                   LOW LEVEL VOLTAGE -5
1520 REM                   RISE TIME 500 NS
1530 REM                   FALL TIME 600 NS
1540 REM
1560 SENDST$ = "MF 1 SLOT 1 CH 1 HLV 10 LLV -10 TR 50 TF 60"
1570 GOSUB 3500
1580 SENDST$ = "MF 1 SLOT 1 CH 2 HLV 5 LLV -5 TR 500 TF 600"
1590 GOSUB 3500
1600 REM
1610 REM
1620 REM THE FOLLOWING LINES DEFINE BIAS SUPPLY CARD
1630 REM
1640 REM 40740 BIAS SUPPLY CARD LOCATED MAINFRAME 2 SLOT 1
1650 REM CHANNEL 1 PROGRAM 10 VOLT 10mA/V CURRENT SENSE
1660 REM CHANNEL 2 PROGRAM -5 VOLT 1mA/V CURRENT SENSE
1670 REM CHANNEL 3 PROGRAM 5 VOLT AT 0.5 mV RESOLUTION
1680 REM CHANNEL 4 CAN NOT BE PROGRAMMED BECAUSE CHANNEL 3
1690 REM  IS IN HIGH RESOLUTION MODE
1700 REM
1710 SENDST$ = "MF 2 SLOT 1 CH 1 VOLT 10 ISENSE2"
1720 GOSUB 3500
1730 SENDST$ = "MF 2 SLOT 1 CH 2 VOLT -5 ISENSE1"
1740 GOSUB 3500
1750 SENDST$ = "MF 2 SLOT 1 CH 3 VOLT 5 HR"
1760 GOSUB 3500
1770 REM
1780 REM
1790 REM THE FOLLOWING FEW LINES DEFINE
1800 REM LOW NOISE BIAS SUPPLY CARD
1810 REM
1820 REM 40750 LOW NOISE BIAS SUPPLY CARD
1830 REM LOCATES MAINFRAME 2 SLOT 2
1840 REM CHANNEL 1 PROGRAM -10 VOLT 10mA/V CURRENT SENSE
1850 REM CHANNEL 2 PROGRAM 5 VOLT 1mA/V CURRENT SENSE
1860 REM CHANNEL 3 PROGRAM -5 VOLT AT 0.5 mV RESOLUTION
1870 REM CHANNEL 4 CAN NOT BE PROGRAMMED BECAUSE CHANNEL 3
1880 REM           IS IN HIGH RESOLUTION MODE
1890 REM AND SET THE SLOT 2 ALL FOUR CHANNELS
1900 REM AT LOW RANGE (LRANGE) OPERATED AT +10.235 TO -10.24 VOLT
1910 REM AND RESOLUTION WILL BE 5 mV & .25mV
1920 REM AND LOW NOISE MODE
1930 REM
1940 SENDST$ = "MF 2 SLOT 2 CH 1 VOLT -10 LRANGE ISENSE2"
```

```
1950 GOSUB 3500
1960 SENDST$ = "MF 2 SLOT 2 CH 2 VOLT 5 ISENSE1"
1970 GOSUB 3500
1980 SENDST$ = "MF 2 SLOT 2 CH 3 VOLT -5 HR LNOISE"
1990 GOSUB 3500
2000 REM
2010 REM THE NEXT LINE MAKE THE CHANGES ONLINE
2020 REM
2030 SENDST$ = "ONLINE" : GOSUB 3500
2040 REM
2050 REM NEXT FEW LINES WILL DEMONSTRATE HOW TO UPLOAD THE
2060 REM MESSAGES FROM THE INSTRUMENTS TO COMPUTER
2070 REM
2080 REM SENDS - STATUS - TO INSTRUMENT
2090 REM
2100 SENDST$ = "STATUS" : GOSUB 3500
2110 REM
2120 REM INSTRUMENT WILL RESPOND FOUR LINE MESSAGES BACK
2130 REM SUCH AS : STOP (OR RUN) <CR> <LF>
2140 REM            ERROR 0 <CR> <LF>
2150 REM            NO ERROR  <CR> <LF>
2160 REM            1A <CR> <LF> AND EOI
2170 REM
2180 GOSUB 4000 : PRINT RECVST$
2190 GOSUB 4000 : PRINT RECVST$
2200 GOSUB 4000 : PRINT RECVST$
2210 GOSUB 4000 : PRINT RECVST$
2220 REM
2230 REM NEXT FEW LINES WILL DEMONSTRATE HOW TO UPLOAD THE
2240 REM MESSAGES FROM THE INSTRUMENTS TO COMPUTER
2250 REM
2260 REM SENDS -  ALL DUMPV  - TO INSTRUMENT
2270 REM
2280 REM UPLOAD ALL THE VOLTAGE SETTING AT DRIVER & BIAS CARD
2290 REM
2300 SENDST$ = "ALL DUMPV" : GOSUB 3500
2310 REM
2320 REM INSTRUMENT WILL RESPOND MESSAGES BACK
2330 REM IF DRIVER CARD LOCATES AT MAINFRAME 1 SLOT 1
2340 REM AND BIAS SUPPLY CARD LOCATES AT MAINFRAME 2 SLOT 1
2350 REM AND LOW NOISE BIAS SUPPLY CARD LOCATES AT MAINFRAME
2360 REM 2 SLOT 2
2370 REM          MESSAGE WILL BE :
2380 REM                MF 1 SLOT 1 CH 1 HLV 10 LLV -10 <CR> <LF>
2390 REM                MF 1 SLOT 1 CH 2 HLV 5 LLV -5 <CR> <LF>
2400 REM                MF 2 SLOT 1 CH 1 VOLT 10
2410 REM                MF 2 SLOT 1 CH 2 VOLT -5
2420 REM                MF 2 SLOT 1 CH 3 VOLT 5
2430 REM                MF 2 SLOT 2 CH 4 VOLT 0
2440 REM                MF 2 SLOT 1 CH 1 VOLT -10
2450 REM                MF 2 SLOT 1 CH 2 VOLT 5
```

```
2460 REM                MF 2 SLOT 1 CH 3 VOLT -5
2470 REM                MF 2 SLOT 2 CH 4 VOLT 0
2480 REM                1A <CR> <LF> AND EOI
2490 REM
2500 GOSUB 4000 : PRINT RECVST$
2510 GOSUB 4000 : PRINT RECVST$
2520 GOSUB 4000 : PRINT RECVST$
2530 GOSUB 4000 : PRINT RECVST$
2540 GOSUB 4000 : PRINT RECVST$
2550 GOSUB 4000 : PRINT RECVST$
2560 GOSUB 4000 : PRINT RECVST$
2570 GOSUB 4000 : PRINT RECVST$
2580 GOSUB 4000 : PRINT RECVST$
2590 GOSUB 4000 : PRINT RECVST$
2600 GOSUB 4000 : PRINT RECVST$
2610 REM
2620 REM SENDS -  ALL DUMPT  - TO INSTRUMENT
2630 REM
2640 REM UPLOAD ALL THE RISE & FALL TIME SETTING AT DRIVER CARD
2650 REM
2660 SENDST$ = "ALL DUMPT" : GOSUB 3500
2670 REM
2680 REM INSTRUMENT WILL RESPOND MESSAGES BACK
2690 REM          IF DRIVER CARD LOCATES AT MAINFRAME 1 SLOT 1
2700 REM          MESSAGE WILL BE :
2710 REM    MF 1 SLOT 1 CH 1 RANGE1 TR 50 TF 60 <CR> <LF>
2720 REM    MF 1 SLOT 1 CH 2 RANGE2 TR 500 TF 600 <CR> <LF>
2730 REM    1A <CR> <LF> AND EOI
2740 REM
2750 GOSUB 4000 : PRINT RECVST$
2760 GOSUB 4000 : PRINT RECVST$
2770 GOSUB 4000 : PRINT RECVST$
2780 REM
2790 REM SENDS -  ALL DUMPF  - TO INSTRUMENT
2800 REM
2810 REM UPLOAD ALL THE FORMAT SETTING AT DRIVER & BIAS CARD
2820 REM
2830 SENDST$ = "ALL DUMPF" : GOSUB 3500
2840 REM
2850 REM INSTRUMENT WILL RESPOND MESSAGES BACK
2860 REM IF DRIVER CARD LOCATED AT MAINFRAME 1 SLOT 1
2870 REM ,BIAS SUPPLY CARD LOCATED AT MAINFRAME 2 SLOT 1
2880 REM MESSAGE WILL BE :
2890 REM      MF 1 SLOT 1 CH 1 NONINV VSENSE2 <CR> <LF>
2900 REM      MF 1 SLOT 1 CH 2 NONINV VSENSE2 <CR> <LF>
2910 REM      MF 2 SLOT 1 CH 1 LR ISENSE2
2920 REM      MF 2 SLOT 1 CH 2 LR ISENSE1
2930 REM      MF 2 SLOT 1 CH 3 HR VSENSE2
2940 REM      MF 2 SLOT 2 CH 4 HR VSENSE2
2950 REM      MF 2 SLOT 1 CH 1 LR ISENSE2 REGULAR LRANGE
2960 REM      MF 2 SLOT 1 CH 2 LR ISENSE1 REGULAR LRANGE
```

```
2970 REM      MF 2 SLOT 1 CH 3 HR VSENSE2 LNOISE LRANGE
2980 REM      MF 2 SLOT 2 CH 4 HR VSENSE2 REGULAR LRANGE
2990 REM                1A <CR> <LF> AND EOI
3000 REM
3010 GOSUB 4000 : PRINT RECVST$
3020 GOSUB 4000 : PRINT RECVST$
3030 GOSUB 4000 : PRINT RECVST$
3040 GOSUB 4000 : PRINT RECVST$
3050 GOSUB 4000 : PRINT RECVST$
3060 GOSUB 4000 : PRINT RECVST$
3070 GOSUB 4000 : PRINT RECVST$
3080 GOSUB 4000 : PRINT RECVST$
3090 GOSUB 4000 : PRINT RECVST$
3100 GOSUB 4000 : PRINT RECVST$
3110 GOSUB 4000 : PRINT RECVST$
3500 REM
3510 REM OUTPUT A STRING FROM COMPUTER TO PI-4000
3520 REM
3530 REM
3540 REM CONCATENATE THE SENDST STRING WITH <CR> AND <LF>
3550 REM
3560 SENDST$=SENDST$+CHR$(13)+CHR$(10)
3570 REM
3580 REM CALL ZIATECH SEND STRING FUNCTION
3590 REM
3600 CALL SENDST (DEVNO$,SENDST$)
3610 RETURN
4000 REM
4010 REM INPUT A STRING FROM PI-4000 TO THE COMPUTER
4020 REM
4030 REM EMPTY THE RECEIVE STRING
4040 ALLOCATE%=255 : EOL$=CHR$(13)+CHR$(10)
4050 RECVST$=SPACE$(ALLOCATE%)
4060 REM
4070 REM CALL ZIATECH RECEIVE STRING FUNCTION
4080 REM
4090 CALL RECVST (DEVNO$,RECVST$)
4100 POINTER = INSTR(RECVST$,EOL$)
4110 IF POINTER > 0 THEN RECVST$=LEFT$(RECVST$,POINTER-1)
4120 RETURN
5000 REM
5010 REM SAVE THE DATA FROM PI-4000 TO FILE
5020 REM FILE NAME : USER DEFINED
5030 REM
5040 REM OPEN FILE AS OUTPUT
5050 REM
5060 OPEN "O",1,FILE$
5070 REM
5080 REM RECEIVE STRING FROM PI-4000
5090 REM CALL ZIATECH CARD RECVST FUNCTION
5100 REM
```

```
5110 GOSUB 4000
5120 REM
5130 REM COMPARE WITH THE END OF FILE MARKER 1A HEX
5140 REM OR YOU CAN SETUP YOUR GPIB CONTROLLER TERMINATED
5150 REM BY EOI IN ZIATECH CARD IS TERM("@") THEN YOUR
5160 REM CONTROLLER WILL RECEIVE THE WHOLE FILE BACK UNTIL
5170 REM EOI
5180 REM
5190 IF LEFT$(RECVST$, 1) = CHR$(&H1A) THEN 5240
5200 REM
5210 REM SAVE THE STRING INTO THE FILE JUST CREATED
5220 REM
5230 PRINT #1,RECVST$ : GOTO 5070
5240 REM
5250 REM THEN CLOSE THE FILE
5260 REM
5270 CLOSE #1
5280 RETURN
6000 REM
6010 REM DUMP DATA FROM FILE TO PI-4000
6020 REM FILE NAME : USER DEFINED
6030 REM
6040 REM OPEN FILE AS INPUT
6050 REM
6060 OPEN "I",1,FILE$
6070 REM
6080 REM IS IT END OF FILE ?
6090 REM
6100 IF EOF(1) THEN 6190
6110 REM
6120 REM GET DATA STRING THEN SEND IT ACROSS THE GPIB BUS
6130 REM
6140 INPUT #1,SENDST$
6150 REM
6160 REM CALL ZIATECH CARD SENDST FUNCTION
6170 REM
6180 GOSUB 3500 : GOTO 6100
6190 REM
6200 REM THAT'S ALL, CLOSE THE FILE
6210 REM
6220 CLOSE #1 : RETURN
```

10.0 RS-232-C PROGRAMMING

10.1 General

The PI-4001 Control Mainframe is compatible with the EIA STD. RS-232-C standard for full duplex asynchronous receiver/transmitter operation when connected to a controller employing serial binary data interchange.

The information regarding use of this standard is given below. However, we suggest that you refer to the manual on your controller for implementation instructions and information before proceeding.

The commands that are available for use with the RS-232-C standard are identical to all commands that can be used over the IEEE-488 bus.

10.2 RS-232-C PINOUTS

The pins on the RS-232-C connector required for this function are as follows:

Pin 1 - Ground - Case or Shield.
Pin 2 - Receive Data (xmit data connection on controller).
Pin 3 - Transmit Data (receive data connection on controller).
Pin 4 - RTS (Request To Send) input.
Pin 5 - CTS (Clear To Send) output.
Pin 6 - DSR (Data Set Ready) input.
Pin 7 - Ground - Signal.
Pin 20 - DTR (Data Terminal Ready) output.

10.3 PROGRAMMING INFORMATION - RS-232-C

The parameter set-up for the RS-232-C is located on the Interface menu. The softkeys are used to toggle through the available settings until the needed parameters are selected.

The default settings upon power up are:

1200 - Baud Rate
NONE - Parity Rate
8 - Data Rate
1 - Stop Bit

These settings can be changed by pressing the [MORE] softkey to display the second page of softkeys on the Interface Menu, and toggling the appropriate softkeys until the appropriate parameter settings are obtained.

Once you have set up the required RS-232-C parameters and have finished all other programming functions that you require prior to operating the PI-4001 over the RS-232-C link, press the [NEXT] Key and return the Control Mainframe to the Interface Menu display.

All commands that are used on the PI-4001 to operate the instrument over the IEEE-488 Bus are identical to the command requirements through the RS-232-C Port.

NOTE: If the baud rate is set for operation at higher than 2400 bps, the device communications buffer in your controller must be set for more than 1K bytes. For example, when using IBM PC/XT Basic, the command:

```
Basic /C: 1024
```

will set the buffer for 1024 bytes.

The next page contains a sample program for inputting commands from the terminal.

10.4 SAMPLE RS-232-C PROGRAM

Below is a sample program written in BASIC for the IBM PC that demonstrates the programming structure:

```
100 CLS
110 REM       PULSE INSTRUMENTS RS-232-C SAMPLE PROGRAM
120 REM
130 REM use F10 key instead of return key, because it adds a line
      feed
140      KEY OFF : KEY 10 , CHR$(13) + CHR$(10)
150 REM
160 REM set up serial port to 4001 default value
170 REM baud = 1200, no parity, 8 data bits, 1 stop bit and
     control dsr
180      OPEN "com1 : 1200,n,8,1,ds" AS #1
190 REM
200 REM
210 REM  This reads the keyboard, and sends out what ever you
           type
220 REM
230      B$=INKEY$ : IF B$=CHR$(6) THEN RETURN ELSE IF B$<>"" THEN
         PRINT B$;:PRINT#1,B$;
240      IF EOF(1) THEN 230
250 REM
260 REM  this reads the serial port for input and prints data on
         the screen
270 REM
280       A$ = INPUT$(LOC(1),#1)
290       PRINT A$;
300       GOTO 230
```

11.0 EPROM REPLACEMENT IN THE PI-4001 CONTROL MAINFRAME

Installing Version 3.X EPROMS and Video Character ROMS in the PI-4001 Control Mainframe

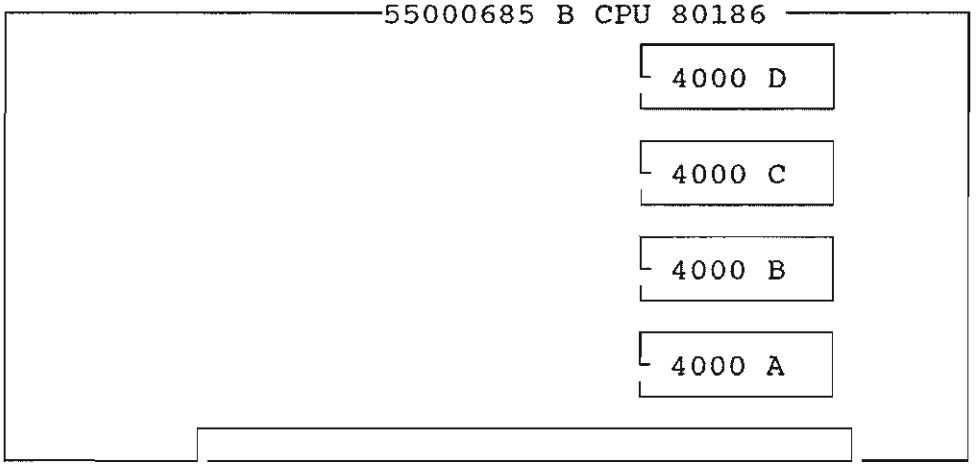
The following procedure explains EPROM replacement in the PI-4001 Control Mainframe. Please note that software improvements will rarely affect your computer program. In the event that a change does affect your program, you will receive detailed information on the modification and where it will affect your program. If you did not receive these instructions, then the version of software that you have received will not effect your programs.

NOTE: IF YOUR INSTRUMENT CONTAINS NON-VOLATILE MEMORY, IT MUST BE DUMPED AND SAVED, SINCE INSTALLATION OF VERSION 3.00 SOFTWARE (AND ABOVE), WILL DESTROY THE CONTENTS OF THE NON-VOLATILE MEMORY WHEN FIRST POWERED UP.. SEE BELOW REINITIALIZING NON-VOLATILE MEMORY.

11.1 INSTALLING CPU EPROMS

1. Remove the 6 screws in the top cover and lift off top cover.

2. The CPU Board that contains the EPROMS is the board directly in front of the fan with the identification markings 55000684 80186 CPU or 55000685 B 80186 CPU. Gently remove the card from it's connector.



EPROM Installation 55000685 CPU PC Card

3. With the board on the bench, component side up, position the board so that the connector pin side is closest to you. The EPROMS at the top right hand side of the board are the devices to be changed.

4. Remove all four Eproms (versions 2.xx) or two Eproms (versions 3.00 to 3.26) and place the four Eproms that you have received in the sockets per the diagram above. The system now requires four Eproms starting with software version 3.27.

The indentation on the Eprom should be to the left when the PC Card is in the correct position with the pins on the PC Card directly in front of you.

5. Verify that all devices are installed in their proper sockets, all pins are seated properly, and that all are firmly pressed down.

6. Reinsert the CPU Board, turn on power and verify proper operation of the unit. If your system contains non-volatile memory, see the information below on reinitializing the non volatile memory.

7. Turn off Power. Install the board retaining screws on the rear of the CPU Board.

8. Install top cover, if character ROMS are not to be installed at this time. If character ROMS are to be installed, continue with the next section.

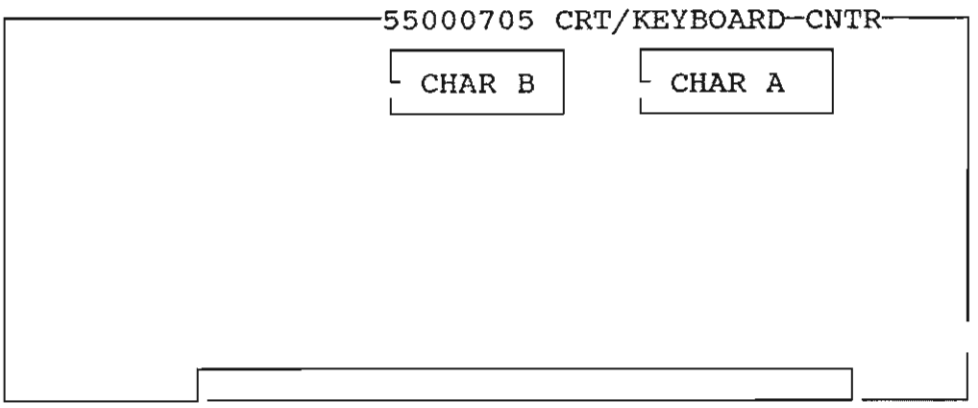
REINITIALIZING NON-VOLATILE MEMORY

1. If your system contains Non-Volatile Memory, the first time you turn on system power you will be presented with the message, "INITIALIZE ALL NON VOLATILE MEMORY" ENT = YES CE = NO.

2. If you press [ENT] the Non-Volatile Memory is Cleared, and you are presented with the message,"Enter Security Code". Upon receipt of this message, Enter the following four characters with the data keys: (XX)

3. The Non-Volatile Memory is now ready to use.

11.2 INSTALLING THE CHARACTER ROMS



55000705 CRT/Keyboard Controller

1. Locate the CRT/Keyboard Controller PC Card Directly behind the CRT.
2. Remove the Card and place on Bench.
3. Remove the two ROMS from the sockets as shown in Figure 1.
4. Install the two ROMS marked Char A and Char B as shown above.
5. Turn on power, and verify operation of the instrument.

12.0 ERROR AND WARNING MESSAGES

12.1 GENERAL

Below is a list of the 4000 System's error messages and warnings. When an error occurs, or a warning is necessary, the message will be displayed on the menu you are presently using. The error message is removed by pressing any key except [ENT].

In the program mode, the errors and warnings are transmitted to the controller in the form of the numbers associated with the error messages specified in the section 12.2 below. Sending STATUS over the bus will return the code corresponding to the messages listed below. All errors must be cleared in this manner before proceeding. THE PI-4001 WILL NOT ACCEPT DATA OVER THE BUS IF THERE IS AN ERROR PENDING. See STATUS command in programming section 9.3.3 System Commands.

12.2 EXPLANATION OF ERROR AND WARNING MESSAGES

12.2.1 ERROR MESSAGES

An error message is a message that can be read from the status buffer on the Interface Menu, under program control. When in Remote Mode, the error message numbers below are displayed on the status line, on the Interface Menu. See section 9.3.3 System Commands, STATUS Command.

0. NO ERROR --

1. OUT OF RANGE --An attempt was made to enter a voltage greater than +20.47 or less than -20.48, or higher than the specifications for the card allow. The Out of Range Error also applies to an attempt to enter an incorrect programmable tr/tf.

2. DIFFERENCE IS MORE THAN ALLOWED -- An attempt was made to enter a driver high and low level voltage that exceeded the maximum allowable 25 volts.

4. UNABLE TO PROTECT TR/TF -- In some instances the Voltage settings may be too high to protect the rise and fall time.

6. CANNOT USE CONTROL CHANNEL -- An attempt was made to use an even numbered bias supply channel that is currently controlling the odd channel above it, in the High Resolution Mode.

7. MAINFRAME, SLOT OR CHANNEL NOT SELECTED -- An attempt was made to enter a command without identifying the location of the PC Card. See section 9.2.1.

8. FUNCTION NOT FOUND -- An attempt was made to access a function that does not exist.

9. SYNTAX ERROR -- Command structure is incorrect. See section 9.1.1 for information on structuring commands. Carriage Returns and Line Feeds are required.

10. WRONG CARD -- An attempt was made to perform a function that does not exist on the card that was accessed.

11. TIME OUT -- RS-232-C handshaking is incorrect, and The PI-4001 has expended the allotted time required to recognize the controller.

12. OVERRUN ERROR -- The data in the receiver buffer register was not read by the CPU before the next character was sent, thereby destroying the previous character.

13. PARITY ERROR -- The Parity set up is incorrect between the controller and the PI-4001. The parity set up in the PI-4001 must match the parity setup of the computer that is transmitting (or receiving).

14. FRAMING ERROR -- Indicates that the received character did not have a valid stop bit. There is not a match between the stop bit set up of the controller and the PI-4001.

15. CAN ONLY LABEL CHANNEL UP TO FOUR CHARACTERS -- An attempt was made to label a channel with more or less than four ASCII characters, the maximum allowed. Remember to add a space between the LABEL command and the four character Label, for CRT formatting.

16. DUPLICATED LABEL --An attempt was made to establish a Label name that is already being used.

17. SELECTED FILE DOES NOT EXIST -- An attempt was made to load a file from the Non-Volatile Memory Option that does not exist. Check file names with the DIR Command.

19. NO ROOM IN NON-VOLATILE MEMORY -- The maximum storage capacity of the Non-Volatile Memory Option is 256k Bytes.

20. NON-VOLATILE MEMORY CHECKSUM ERROR -- There was an error in saving or loading the program just loaded or saved to Non-Volatile Memory. Try the function again.

21. NON VOLATILE MEMORY OPTION DOES NOT EXIST -- An attempt was made to use a command that is reserved for use with the Non-Volatile Memory Option, and that option does not exist in the instrument you are using.

22. FILE NOT SAVED - SETTINGS OUT OF LIMITS -- An attempt was made to save a file into Non-Volatile Memory that contained either Driver or Bias Voltage output settings that are out of the range of the Programmed Limits that are established with this program. The system cannot accept these settings. Either change the limits or change the output voltages to conform with the limits that are set.

23. TR AND TF SET TO THE SAME RANGE -- This is a warning that the values set for the Rise and Fall Time on the selected channel must be on the same range.

24. UNABLE TO PROTECT TR/TF -- When voltages are changed the driver may be unable to maintain the slope because it is out of range of the slew rate of the driver. This message is also displayed when rise and fall time settings are in different ranges.

25. ALL SET -- After each Set All command, you will receive this message back (only on the CRT display).

26. WRONG NUMBER FORMAT -- Incorrect characters were used to enter numbers or expected parameters. ie... letters instead of numerals, two decimal points, negative signs in front of numbers that should not be negative.

27. PARAMETER EXPECTED -- A command has been received that also requires a number value or other parameter and the expected parameter was not included. Such as, sending the Volts command without following with the value or numerical portion of the command.

28. RS-232-C ERROR -- Overrun or frame error. May also happen when you initialize your computer. Generally a problem in the set up.

29. GPIB ERROR -- This is generally a problem with the set up.

30. INPUT BUFFER OVERFLOW -- When your command line is longer than the length of the buffer. ie.. the command line is greater than 6000 characters.

31. OUTPUT BUFFER OVERFLOW -- If you receive this error there is a problem in your system hardware. Please contact the manufacturer.

32. WRONG MAINFRAME, SLOT OR CHANNEL NUMBER -- An attempt was made to access a mainframe, slot, or channel, that the system does not recognize as existing. See section 9.2.1 General. Check that mainframe number is set properly.

35. LABEL NOT FOUND -- An attempt was made to use a label that has not been previously established, or an incorrect spelling of an established label was sent.

37. CONFIGURATION CHANGED -- A warning message that informs you that the PC Card locations in the file loaded from Non-Volatile Memory differs from the present hardware configuration of the system.

38. UNITS MISSING -- No time indication provided after a time reference number. ie... ns, ms, us.

40. FUNCTION NOT ALLOWED -- An attempt was made to use a function or command for the wrong device, ie sending a driver command to a bias PC Card, or sending a command to a PC Card while the PC Card is currently set up in a mode that will not allow action or acceptance of the command. May be also displayed when you turn off a device and the computer does not know that the device is turned off.

41. NON-VOLATILE MEMORY DIRECTORY FULL -- The maximum number of programs that can be stored in the Non-Volatile Memory is 64.

42. SCREEN OVERFLOW ERROR -- This error is created by a failure in the hardware portion of your system. Please report this error to the manufacturer.

43. IMPROPER STATUS CHANGE -- To change status from Disconnect to Online directly without going through Offline.

44. ERROR IN SEQUENCE -- There is an error in the created sequence, an illegal command or improper use of the command.

45. NOT ALLOWED IN CURRENT MODE -- There was an attempt to set a mid level voltage on the 40465 Tri-Level Driver while the driver was in two level mode.

46. RANGE CHANGE ONLY ALLOWED IN DISCONNECT -- An attempt was made to change the range on a 40750/40751/40752/40753 DC Bias PC Card from High Voltage Range to Low Voltage Range or vice versa without the system being in the disconnect state. You will get this error if a range change is attempted while in Online or Offline mode.

12.2.2 WARNING MESSAGES

A warning message is a message that is displayed on the CRT when you are not under program or remote control. Pressing any key except [ENT] will remove the error message.

OUT OF RANGE -- An attempt was made to enter a Voltage greater than +20.47 or less than -20.48, which is the system default, or a Voltage greater than the limits that have been set. The Out of Range Error also applies to an attempt to enter an incorrect programmable tr/tf.

DIFFERENCE IS MORE THAN ALLOWED -- An attempt was made to enter a driver high and low level voltage that exceeded the maximum allowable for the selected Card.

EVEN CHANNEL HAS CONTROL, CHANNEL DATA WILL BE LOST -- This warning message is displayed during setup of the High Resolution function, to warn you that entering the High Resolution Mode will remove from use the even numbered channel below the channel that you are attempting to set in High Resolution Mode.

SELECT RANGE 1 FOR 2ns/V OR RANGE 2 FOR 20ns/V <ENTER 1 OR 2> -- This message informs you that you are nearing the end of the programmable tr/tf range that you have selected on the Driver Status and Setup Menu, and you will have to make a decision to stay on the range that you are using, or go to a higher range that will allow less adjustment resolution.

SELECT RANGE 2 FOR 20NS/V OR RANGE 3 for 200ns/V <ENTER 2 OR 3> -- This message informs you that you are nearing the end of the programmable tr/tf range that you have selected, and you will have to make a decision to stay on the range that you are using, or go to a higher range that will allow less adjustment resolution.

CONTROL CHANNEL CANNOT BE USED -- An attempt was made to use an even numbered bias supply channel that is currently controlling the odd channel above it, in the High Resolution Mode.

12.2.3 How the System Handles Card Placement Errors

When programs are saved in Non Volatile Memory and reloaded back to the system, a check is made to see if the channel information and Card locations that were stored in Non Volatile Memory, agree with the actual Hardware set up of the instrument. The system handles this situation in the following manner.

If the cards that are in the wrong location are of the same type, ie... both bias cards, the message displayed will be "Configuration Changed".

If a card is missing from the system, the message will display "Missing MF1 Slot 5". This is an indication that a card is missing, and the location of the now empty slot.

The Message, "New Card" is displayed if there is a card type now in the system that is not covered in the software.

If there are incorrect cards in the system and misplaced cards in the system the CRT display will be as follows:

1. All correct cards will be shown in default or preprogrammed order.

2. Empty lines are shown in place of missing cards.

3. There will be an additional empty line.

4. All new cards will be displayed in normal mainframe, slot order as they are found in the system.

If any of these situations exist, the errors should be corrected, and the program re-saved correctly.

12.3.4 Using Characters from the Extended Character Set for Labels

The following characters in the extended character set can also be used in the creation of channel labels on the Main Menu Display.

HEX	DECIMAL	CHARACTER	HEX	DECIMAL	CHARACTER
DB-DF	219-223	NOW USED	F0	240	≡
E0	224	α	F1	241	±
E1	225	β	F2	242	≥
E2	226	Γ	F3	243	≤
E3	227	π	F4	244	⌠
E4	228	Σ	F5	245	⌡
E5	229	σ	F6	246	÷
E6	230	μ	F7	247	≈
E7	231	τ	F8	248	°
E8	232	Φ	F9-FF	249-255	NOT USED
E9	233	Θ			
EA	234	Ω			
EB	235	δ			
EC	236	∞			
ED	237	φ			
EE	238	ϵ			
EF	239	∩			

13.0 PROBLEM AND TROUBLESHOOTING GUIDE

The following is a list of the most common problems that are recieved from users of the 4000 System.

1. The PI-4001 Control Mainframe is in Reset when powered up.

1A. System must be powered up in correct sequence. Turn on the PI-4003 DC Power Mainframe or system power supplies, followed by the PI-4002 Mainframes, then turn on the PI-4001 Control Mainframe. Verify that each PI-4002 Instrument mainframe is set to a different mainframe number if there is more than one mainframe in the system. Verify that there is not a Card failure listed on line 22 of the CRT display on the PI-4001 Control Mainframe.

2. Everything appears to be working, but there is no output.

2A. Verify that the system is in the Online Mode. Also press [UPDATE] key on PI-5800A Data Generator to make certain that you are sending out a pattern.

3. The bias noise is higher than it should be (40750, 40751, 40752, 40753, 40755 Cards).

3A. Verify that you are in the Low Voltage Mode if you require less than ± 10.00 V bias level. Also verify that you are in the Low Noise Mode, and not the Regular Mode. Verify that the black and green banana plugs on the rear of the PI-4002 Instrument Mainframe are not tied together.

4. When Powered up the system does not display any Cards on the Main Menu.

4A. Verify that the daisy chain cable (40090-X) is connected properly and inserted all the way in. Verify that the mainframes are each set to a different mainframe number, and that power is applied to the mainframes, and that the PI-4003 DC Power Mainframe is turned on.

5. The system will not recognize a command from the IEEE-488 bus.

5A. The system will appear to "hang" if an error is sent. Read the information in the programming section of the manual on the STATUS Command.

Also verify that the right IEEE-488 number is correctly set on the PI-4001 Control Mainframe. If the IEEE-488 number is changed during operation, you must reset the system (simultaneously pressing [HOME] and [CE]). Verify that the IEEE-488 Cable is installed properly and connected to your controller.

Make certain that the IEEE-488 switch is properly set and reset to verify that the dip switches are in the full on or off position.

If this does not solve the problem, make certain that the power is off and the unit unplugged and verify that the CPU Card and the IEEE-488 Card in the PI-4001 Mainframe are properly seated, and after grounding your hand, reseat the proms on the CPU Card by firmly pressing them in place.

6. One of the Bias Channels appears to be oscillating.

6A. Verify that you are not exceeding the current limit of the bias card you are using. When a bias card is used to draw more current than it is rated for, the unit tries to correct itself. This correction appears as an oscillation on the output. Reduce the current drain, or go to a bias card with a larger current output capability. The 25 mA Bias channel has a safety factor of 25 mA more than the card rating. It is in this range from 25 mA to 50 mA that you will notice the oscillation, as the card attempts to correct for the over current condition.

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