

**Operators Manual
For**

Pulse Instruments

**PI-11000 Instrument Mainframe,
PI-4002B Instrument Mainframe,
PI-4003A DC Power Mainframe,
Low Noise DC Bias Supplies,
Clock Drivers
and
PI-Controller Software**

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1. INTRODUCTION



Figure 1: PI-11008 Instrument Mainframe with 4000 Series Mainframes

PI-11000 is the general model number for the Pulse Instruments line of CompactPCI instrument mainframes. There are models with different slot-counts available, such as the PI-11006 with six slots and the PI-11008 with eight slots.

Each PI-11000 is designed around an x86-based single-board-computer and includes a hard drive, network interface, and an optional IEEE-488 (GPIB) interface. These features enable the PI-11000 to be used as the system controller or a slave instrument in your test setup.

The PI-11000 is programmed, as a standalone instrument, using Pulse Instruments' PI-Controller software operating in Windows 7. This provides a user-friendly interface for programming, editing and controlling the instrument cards. The PI-11000 can also be used as a remote instrument controlled over the IEEE-488 bus by PI-Controller or PI-DATS, or by third-party software running on a remote PC.

The PI-11000 is compatible with the PI-4002B Instrument Mainframe (shown, with the PI-4003A DC Power Mainframe), via USB.

1.1. Before You Get Started

1.1.1. How to Read This Manual

This manual describes operation of instruments from Pulse Instruments containing CompactPCI instrument cards, including clock driver cards, low-noise DC bias cards, and data acquisition cards (including A/D control cards). The primary operating environment is PI-Controller software, although this manual also contains documentation for writing your own control software.

If your instrument mainframe also contains Pulse Instrument pattern generator cards (PI-21000 Clock Generator card and one or more PI-21x0y Pattern cards), then your instrument is also a pattern generator, and will run PI-PAT software in addition to PI-Controller. PI-PAT and PI-Controller will recognize the pattern generator components as a “PI-2005 Pattern Generator,” which has its own command set. The PI-PAT/PI-2005 Operators Manual should be read first, before you continue with this manual.

If your instrument mainframe contains Pulse Instruments data acquisition cards (PI-41000 Digital Acquisition card, PI-3100-USB or PI-3100-USB-M), then these components will be recognized as a PI-3105 Multi-Channel Data Acquisition System. The PI-3105 has a separate command set and operators manual.

This manual should be read before reading the PI-3105 manual.

If you intend to write or use custom software to control the PI-11000, you should read this manual in its entirety to become familiar with the features and controls, before learning to program the instrument.

1.1.2. Packing List

Your PI-11000 Instrument Mainframe was packed with the following items:

- Mainframe
- AC power cable
- CPU card or CompactPCI/PXI Bridge Card installed in the system slot
- One or more Pulse Instruments CompactPCI instruments cards installed in the remaining slots
- One or more Interface cards installed in the remaining slots
 - IEEE-488 interface card
 - PXI/CompactPCI Bridge Card
- Cables for each type of instrument or interface card
- Windows 7 installation CD
- Pulse Instruments software and drivers installation CD
- CD containing device drivers for the single-board computer
- This printed manual (also available in Adobe PDF[®] on the Pulse Instruments software installation CD and on the computer hard drive at C:\Documentation)

Your 4000 Series instrumentation was packed with the following items:

- PI-4003A DC Power Mainframe with AC power cable
- One or more PI-4002B Instrument Mainframes
- One or more Pulse Instruments 4000 Series instrument cards installed in each PI-4002B
- USB cable
- DC power cable
- I/O cables for each type of instrument card

2. HARDWARE

2.1. PI-11000 Front Panel

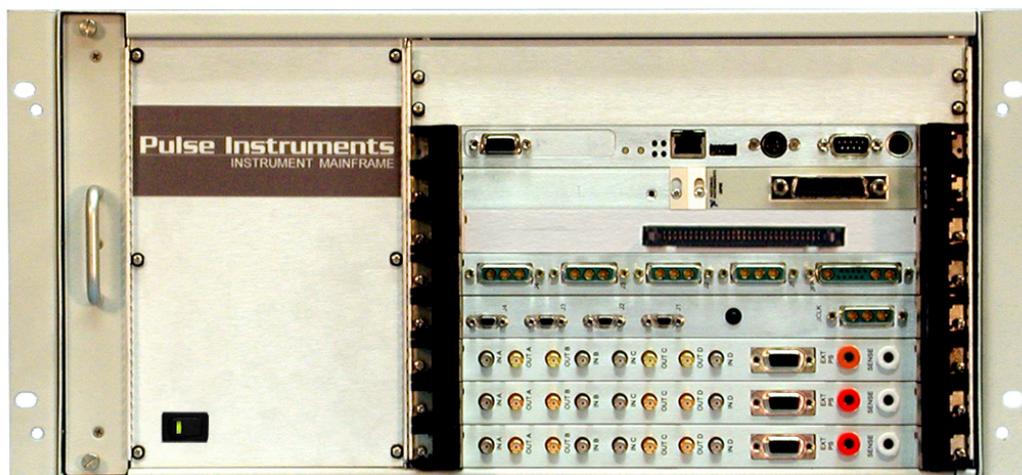


Figure 2: PI-11000 Instrument Mainframe

The PI-11000 Front Panel contains the System Power Switch, the front panels of installed CompactPCI instrument cards, and the optional optical drive.

For information, please see **Section 2.9.2 System Power Switch** or the section for each applicable instrument card.

2.2. CompactPCI Rear Panel

The rear panel has an AC power switch, input voltage selector, power-sequencing connectors, and an AC power socket.

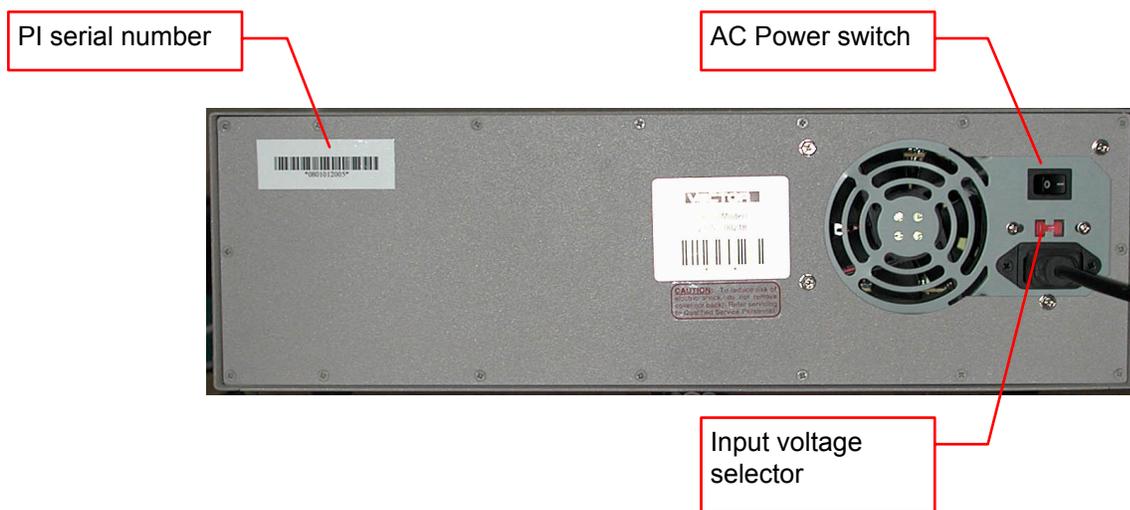


Figure 3: Rear panel of the PI-11006

In the upper left corner is the Pulse Instruments Serial Number of the instrument. Please refer to this number when contacting the factory for service or technical support.

2.3. Mounting

The PI-11000 series is built around a standard 6U CompactPCI chassis, compatible with standard 19" racks. There are several cooling fans in the unit; ensure that the vents are not obstructed when mounting the PI-11000.

When rack-mounting the PI-11000 Pulse Instruments recommends using shelf angles instead of chassis slides. This allows the weight of the instrument to be carried by a support other than the front flanges while minimizing the obstruction to side-to-side airflow.

The PI-4002B and PI-4003A Mainframes can be rack-mounted with the optional slide rails.

WARNING: Due to the weight of the PI-4003A DC Power Mainframe, Pulse Instruments highly recommends that it be mounted at the bottom of the rack to prevent a serious safety hazard. A PI-4003A extended on its slide rails from the top of an equipment rack could cause the rack to tip over, damaging equipment and injuring personnel.

2.4. AC Power

The Pulse Instruments PI-11000 Instrument Mainframe may be configured to accept power from either from a 120 V or 220 V power source (50-60 Hz). The input voltage can be selected by depressing the red voltage slider on the rear panel and moving it so that the desired input voltage is displayed. Insert the provided AC power cable into the power socket on the back of the unit.

PI-4003A DC Power Mainframe is designed to operate either from a 120 V or 220 V power source, depending upon the model shipped from the factory. The label in the bottom rear corner of the back panel above the power cable indicates the voltage input required for operation of your units. Please verify that the voltage indicated is correct for your intended application before connecting the power cord to the unit or to the power source.

Please note that, in fully integrated systems (e.g. System 7700) with factory-provided equipment racks, the internal rack power is typically wired for 120 VAC supply, regardless of the external AC power supply to the rack. An isolation transformer inside the region-specific rack will be configured to provide 120 VAC to the internal instruments.

2.5. PI-4003A Front Panel



Figure 4: Front of PI-4003A

The front panel of the PI-4003A contains the power switch and voltage monitor panel. The system DC voltages on the front of the PI-4003A DC Power Mainframe should read within the following tolerances:

- 31 VDC: From -31 VDC to -33 VDC.
- +31 VDC: From +31 VDC to +33 VDC.
- +10 VDC: From +9 VDC to +11 VDC.
- 10 VDC: Not used at present.

They may be adjusted using the ADJ pots. Precision measurements should be made from the rear panel of a connected PI-4002B. The Voltage Monitor banana jacks should be measured with respect to the black Voltage Monitor banana jack, which is power supply ground.

2.6. PI-4002B Instrument Mainframes

There are three models of instrument mainframe in the PI-4000 Series—the PI-4002B mainframe and the legacy PI-4002/PI-4002A mainframes.

- The PI-4002B-USB is the current model, and it supports all 40xxx and 42xxx instrument cards.
- The PI-4002 is discontinued, but still supported through factory service and software updates. The PI-4002 supports 40xxx-series instrument cards subject to the controller limitations listed below, and it supports selected 42xxx-series instrument cards subject to individual card models' cooling requirements.
- The PI-4002A is built on the same architecture as the PI-4002, but with enhanced cooling. The PI-4002A is shorter internally and **does not** support 40xxx-series instrument cards.
- All models are logically equivalent and present themselves identically to the system software.

Legacy mainframes have two options for the control bus.

- PI-Bus Opto-Isolation Card (header style connector). This is a proprietary control bus used by Pulse Instruments since 1995, implemented over a 60-pin ribbon cable with double-row, 0.1" header style connector. The controller end of the cable can be connected to a PI-4001 Control Mainframe or to older PI-11000 CompactPCI Mainframes or older PI-2005 Pattern Generators equipped with a PI-31001 PI-Bus Interface Card. Newer CompactPCI mainframes no longer support the PI-Bus Interface Card.
- USB Opto-Isolation Card. This newer interface card uses USB to increase flexibility in system configuration. The controller end of the cable can be connected to Windows 7 computer running Pulse Instruments software, including the embedded computers in the PI-11000 and PI-2005.

2.6.1. Control Bus Options

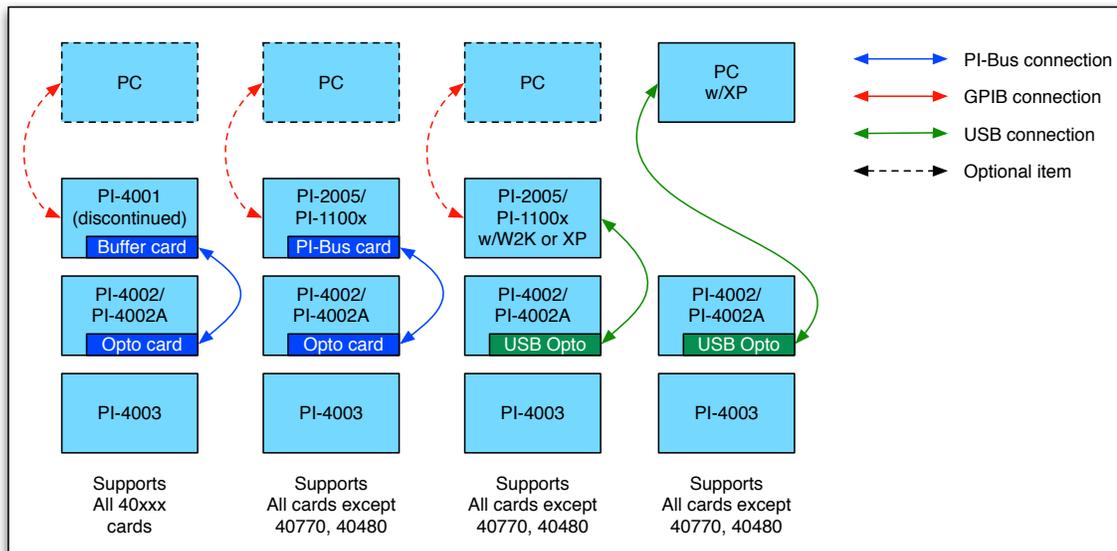


Figure 5: 4000 Series Control Bus Options

The PI-4002x Instrument Mainframes can be controlled in several ways, depending on the configuration:

- An instrument mainframe with a PI-Bus Opto-Isolation card containing **only** 40xxx-numbered cards can be controlled by a PI-4001 Control Mainframe (discontinued, unsupported), **or** by a PI-2005/PI-1100x CompactPCI instrument equipped with a PI-31001 PI-Bus Interface Card.
- An instrument mainframe with a PI-Bus Opto-Isolation card **and** containing any 42xxx-numbered cards can be controlled **only** by a PI-2005/PI-1100x CompactPCI instrument equipped with a PI-Bus Interface Card.
- An instrument mainframe with a USB Opto-Isolation card can be controlled either from a PI-2005/PI-1100x CompactPCI instrument or from a Windows PC.
- A PI-4001 Control Mainframe may be controlled directly from its front panel, or over GPIB from a PC.
- PI-4002/4002A mainframes connected to a PI-2005/PI-1100x CompactPCI instrument via either opto-isolation bus may be controlled directly by software running on the PI-2005/PI-1100x instrument **or** via GPIB by software running on a PC.
- All PI-4002/PI-4002A mainframes within a single system must use the same type of control bus, e.g. either PI-Bus or USB. If a CompactPCI mainframe contains a PI-31001 PI-Bus interface card, any PI-4002/PI-4002A mainframes connected to it via USB will be ignored.

2.7. PI-4002B Front Panel



Figure 6: Front of PI-4002B

The front panel of the PI-4002B contains the DC power switch. The PI-4002B also has front air intake ports that must remain unobstructed.

2.8. PI-4002B Rear Panel Connections



Figure 7: Rear of PI-4002B

The PI-4002B-USB rear panel has the following connectors:

- USB-B plug for connection to a system controller.
- BNC Female connector for Sense output.
- Eight or more banana jacks for voltage monitoring. The number and slot locations for the voltage monitor jacks will vary by product configuration. See Table 1: Voltage Monitor Jacks for details.
- 16 position circular connector for DC power, AMP part number 206037-1. Not all 16 positions will be populated.
 - Pulse Instruments cable part number **40093** may be used to connect the PI-4002B-USB to a PI-4003A DC Power Mainframe.

- Pulse Instruments cable part number **88007001-6** may be used to connect the PI-4002B-USB to a PI-4003A DC Power Mainframe and to an auxiliary power supply.
- If a 3rd-party power supply and cable is used, the customer is responsible for ensuring the correct voltages and pinout. Each wire should be 16 AWG or heavier, and rated to carry at least 150 V at 18 Amps.
- Signal input and output connectors for each installed plugin card. Connector and signal types will vary by card model. See the Pulse Instruments 4000 Series manual for details on each card model.

2.8.1. USB Connection

The PI-4002B-USB is controlled via USB 1.1 from a PC or single-board computer running Pulse Instruments software under Windows XP or Windows 7. The computer must be running PI-PAT, PI-DATS or PI-Controller software or compatible 3rd-party software. See the PI-DATS, PI-PAT, and PI-Controller software manuals for details on operation.

2.8.2. Sense Out

The Sense Out connector may be connected to a high-impedance voltmeter for voltage-sense and current-sense measurements. Output of the Sense connector will be in the range of ± 2.0 V. See the PI-DATS, PI-PAT, and PI-Controller software manuals for details on operation.

2.8.3. Address DIP Switch

The PI-4002B-USB logical address is controlled by the 4-position DIP switch.

In software, all instrument card channels are assigned a unique hardware address, consisting of a Mainframe number (MF), slot number (SLOT), and channel number (CH).

2.8.3.1. Mainframe Numbering

Each PI-4002B-USB Instrument Mainframe is numbered 1 – 15, based on the binary value of a 4-position DIP switch on the controller card of each mainframe. Each PI-4002B-USB mainframe connected to a single controller must have a unique mainframe number. If your system was shipped from the factory with one PI-4002B-USB mainframe, it will be numbered as MF 1. The lowest position on the DIP switch is the LSB of the address, and a bit's value is 1 when the right side of the switch is depressed.

Address 0 is reserved for system use and should not be assigned to a PI-4002B-USB mainframe.

To change a mainframe number, shut down the controller software, unplug the USB cable connecting the mainframe to the controller, and turn off the PI-4002B-USB. Set the desired mainframe number using the DIP switch, then connect the USB cable and turn on the PI-4002B-USB.

2.8.3.2. Slot Numbering

Card slots in a PI-4002B-USB Instrument Mainframe are numbered from right to left, starting at **Slot 1**, when viewed from the back of the unit (looking at the I/O connectors).

2.8.3.3. Channel Numbering

On plugin cards, channels are numbered from top to bottom, starting at **Channel 1**.

2.8.4. DC Power

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

If you are using any of the external voltages (see table below) there are additional connector which should be cabled to your external supplies.

The outer case of the PI-4002 is floating with respect to the internal motherboard, which allows the PC Cards to float with respect to the case. If you require the internal PC 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 may significantly increase system noise.

The banana jacks in “M1” and “M2” slot are the **Voltage Monitor** jacks. These jacks are to be used for monitoring the system DC voltage on a high-impedance voltmeter. These jacks should NOT be connected to any to any other source, and should not be used to draw power from the mainframe. The outputs from these jacks are as listed:

Color	Assignment
Red	+31 VDC
Blue	+11.5 VDC
Black	Ground
White	-31 VDC
Green	Case
Orange	AUX +V _C
Yellow1	+Sense
Yellow2	-Sense

Table 1: Voltage Monitor Jacks

On some legacy PI-4003 models, the -10 VDC rail is converted to +10 VDC. On these mainframes, J1 and J3 are wired in parallel to the first +10 VDC supply, and J2 and J4 are wired in parallel to the second +10 VDC supply. When connecting PI-4002B mainframes to a PI-4003, use J1 and J2 before using J3 and J4.

Some PI-4002B mainframes have additional circuits to carry different voltages for powering selected high-voltage bias cards and low-impedance clock driver cards.

Modified PI-4002/PI-4002A and PI-4003A mainframes use otherwise-unassigned pins to carry the additional voltages, and remain compatible with all standard Pulse Instruments cards. For additional information concerning special power supplies, please contact support@pulseinstruments.com.

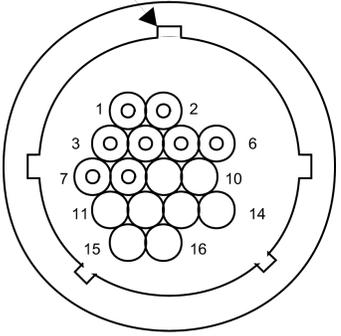
Pin Mating Face of Square Flange Receptacle (AMP P/N 206036-1 or Equivalent)		Pin Assignment Table				
		Pin No.	Color	Assignment	PI-4003 A Pin	Motherboard Pin
		1	Red	+31V	1	7A, 7B
		2	Black	GND	2	
		3	White	-31V	3	13A, 13B
		4	Black	GND	4	
		5	Blue	10V	5	9A, 9B
		6	Black	GND	6	
		7	Yellow	EXT -V _A		12A, 12B
		8	Black	GND		
		9	Orange	EXT +V _A		8A, 8B
		10	Black	GND		
		11	Brown	EXT +V _B		6A, 6B
		12	Black	GND		
		13	Green	EXT -V _B		14A, 14B
		14	Black	GND		
		15	Orange	EXT +V _C		15B
		16	Black	GND		7A, 7B

Figure 8: DC Power Cable Pin Assignments

All fuses are 3AG Slow-blow 5A (Littelfuse 0313005.HXP or equivalent) except for F+11V which is 3AG Slow-blow 8A (Littelfuse 0313008.HXP or equivalent). Fuse holders on the motherboard will be populated only if the unit has been configured by the factory to use the corresponding voltage.

The PI-4002B-USB must be switched off via the front power switch before connecting it to the DC power supply. The DC power supply must also be switched off.

Plugging or unplugging the power cable while the power supply is powered on may permanently damage the PI-4002B-USB and any installed plugin cards and will void the manufacturer's warranty.

The outer case of the PI-4002B-USB is floating with respect to the internal motherboard, which allows the plugin cards to float with respect to the case. If you require the internal PC Cards to be at the same ground potential as the case, a connection can be made between the Green ("Case") and Black ("GND") banana jacks on the rear of the PI-4002B-USB mainframe. This connection may significantly increase system noise.

Card Model	+11.5 V	+31 V	-31 V	-V _A	+V _A	+V _B	-V _B	+V _C
PI-42460 ±18 V Driver	+11.5 V	+31 V	-31 V					
PI-42465 ±18 V Tri-level Driver	+11.5 V	+31 V	-31 V					
PI-42490 High-Speed Driver	+11.5 V	+31 V	-31 V					
PI-42495 Low-Z Driver	+11.5 V			-22 V	+22 V			
PI-42750 ±20 V Bias	+11.5 V	+31 V	-31 V					
PI-42751 ±20 V Bias with current limit	+11.5 V	+31 V	-31 V					
PI-42753 ±25 V Bias	+11.5 V					+35 V	-35 V	

PI-42757 +36 V Bias	+11.5 V	+31 V	-31 V					+46 V
PI-45101 Low-Z Driver	+11.5 V			-22 V	+22 V			

Table 2: DC Power Requirements

Auxiliary DC voltages must be configured in the mainframe by Pulse Instruments, and will be indicated on the front panel decal next to the Status LEDs.

Each PI-4003A DC Power Mainframe can support two PI-4002/PI-4002A Instrument Mainframes. A third PI-4002/PI-4002A Instrument Mainframe may be supported if the total power requirement of all installed cards is less than the rated power output of the PI-4003. Contact Pulse Instruments if you wish to connect more than two Instrument Mainframes to a single DC Power Mainframe.

2.8.5. PI-40460/4046x Dual Channel Clock Driver Card



This is the PI-40460 Dual Channel Clock Driver Card. Each channel has two BNC connectors—one for TTL input and one for clock driver output. The same rear panel is used for the 40461 and 40462 Clock Driver Cards, which are similar, differing only in maximum toggle rate and output amplitude.

2.8.6. PI-40465 Dual Channel Tri-Level Clock Driver Card

This is a diagram of the 40465 Dual Channel Tri-Level Clock Driver card. The BNC Connectors on the rear of the card are as follows:

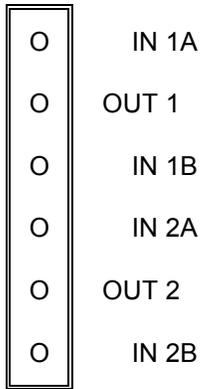


Figure 9: PI-40465 Dual Channel Clock Driver Card

IN 1A — Standard Two-Level input for Channel 1.

OUT 1 — Driver Output from Channel 1.

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

IN 2A — Standard Two-Level input for Channel 2.

OUT 2 — Driver Output from Channel 2.

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

2.8.7. PI-40490 Single-Channel 65 MHz Clock Driver Card

This is a diagram of the 40490 65 MHz Clock Driver card. The BNC Connectors on the rear of the card are as follows:

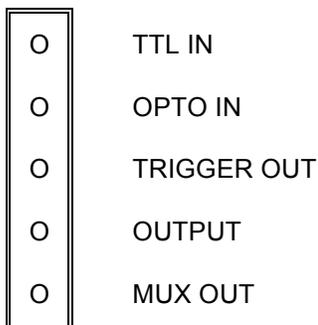


Figure 10: PI-40490 65 MHz Clock Driver Card

TTL IN — Direct input to the Driver Card. Not optically isolated, will allow up to 65 MHz Input, producing up to 65 MHz Output.

OPTO IN — Optically isolated input, will allow up to 20 MHz Input, producing up to 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 — Output to Oscilloscope to view the waveform. This output is not to be used as a driver output.

2.8.8. PI-40740/4075x/4275x Low Noise DC Bias Cards



This is the PI-40750 Four Channel Low Noise DC Bias Card. Each channel has a BNC output connector.

The same rear panel is used for the following card models: 40740, 40752, 40755, 40756, 40757, 40758, 42750, 42751, 42753, and 42757. These cards are all closely related, differing in output voltage, output current, number of channels, and output noise level.

Figure 11: PI-40750 Four Channel Low Noise DC Bias Card

2.8.9. PI-42460 Dual Channel Clock Driver Card



This is the rear panel of the 42460 Dual Channel Clock Driver card. The SMA Connectors are as follows:

Opto In 1 — Optically isolated input, will allow up to 20 MHz Input, producing up to 20 MHz Output.

Driver Out 1 — Driver Output from Channel 1.

TTL In 1 — Direct input to the Driver Card. Not optically isolated, will allow up to 45 MHz Input, producing up to 45 MHz Output.

Opto In 2 — Optically isolated input, will allow up to 20 MHz Input, producing up to 20 MHz Output.

Driver Out 2 — Driver Output from Channel 2.

TTL In 2 — Direct input to the Driver Card. Not optically isolated, will allow up to 45 MHz Input, producing up to 45 MHz Output.

2.8.10. PI-42465 Dual Channel Clock Driver Card



This is the rear panel of the PI-42465 Tri-Level Clock Driver card. The SMA Connectors are as follows:

OPTO IN — Optically isolated input, supporting up to 20 MHz Input, producing up to 20 MHz Output.

OUTPUT — Driver Output.

TTL In 1 — Direct input to the Driver Card. Not optically isolated, will allow up to 45 MHz Input, producing up to 45 MHz Output.

TRILEVEL OPTO IN — Optically isolated input, supporting up to 20 MHz Input, producing up to 20 MHz Output.

TRILEVEL TTL IN — Direct input to the Driver Card. Not optically isolated, will allow up to 45 MHz Input, producing up to 45 MHz Output.

2.8.11. PI-42490 Dual Channel Clock Driver Card



This is the rear panel of the PI-42490 Dual Channel Clock Driver card. The SMA Connectors are as follows:

OPTO IN1 — Optically isolated input, will allow up to 20 MHz Input, producing up to 20 MHz Output.

OUTPUT1 — Driver Output from Channel 1.

TTL IN1 — Direct input to the Driver Card. Not optically isolated, will allow up to 100 MHz Input, producing up to 100 MHz Output.

OPTO IN2 — Optically isolated input, will allow up to 20 MHz Input, producing up to 20 MHz Output.

OUTPUT2 — Driver Output from Channel 2.

TTL IN2 — Direct input to the Driver Card. Not optically isolated, will allow up to 100 MHz Input, producing up to 100 MHz Output.

2.8.12. PI-42495 4-Circuit, Low Impedance Clock Driver Card



This is the rear panel of the PI-42495 4-Circuit, Single Channel, Low-Impedance Clock Driver card. The SMA Connectors are as follows:

OUT 1 — 50 Ohm Output 1.

OUT 2 — 50 Ohm Output 2.

IN — Direct input to the Driver Card. Not optically isolated, will allow up to 70 MHz Input, producing up to 70 MHz Output.

OUT 3 — 50 Ohm Output 3.

OUT 4 — 50 Ohm Output 4.

All four output circuits share a common timing input and a common set programmable V_{HI} and V_{LO} voltages. The four circuits can be used:

- Independently as four 50 Ohm driver channels
- Cabled in groups of two as two 25 Ohm driver channels
- Cabled together as a single 12.5 Ohm driver channel

2.8.13. 45101 16-Circuit, Low Impedance Clock Driver Card



This is the rear panel of the PI-45101 16-Circuit, 2 Channel Low-Impedance Clock Driver card. The Micro-D Connectors on the rear of the card are as follows:

OUT A1 — 50 Ohm Outputs A1-1, A1-2, A1-3, and A1-4.

OUT A2 — 50 Ohm Outputs A2-1, A2-2, A2-3, and A2-4.

IN 1-2 — Direct inputs to the Driver Card. Not optically isolated.

OUT B1 — 50 Ohm Outputs B1-1, B1-2, B1-3, and B1-4.

OUT B2 — 50 Ohm Outputs B2-1, B2-2, B2-3, and B2-4.

The eight “A” output circuits share a common driver input and can be used:

- Independently as eight 50 Ohm driver channels
- Cabled in groups of two as four 25 Ohm driver channels
- Cabled in groups of four as two 12.5 Ohm driver channels
- Cabled together as a single 6.25 Ohm driver channel

The output voltage will follow the input voltage, plus or minus the greater of 1% or 100 mV. The output rise/fall times will follow the input rise/fall times plus or minus 10% for $T_R/T_F > 30$ ns @ 20 V_{PP} into < 20 pf. Output rise/fall times for large capacitances will be dominated by transmission line effects, determined in part by the number of channels commoned together.

The “B” outputs have the same structure, but with a different driver input channel.

2.9. Power-Up, Power-Down Sequence

Each PI-11000 CompactPCI instrument mainframe is equipped with two power switches, one on the front panel, and one on the rear panel. The rear panel switch controls AC power to the mainframe. The front panel switch is the System Power switch and controls power sequencing when two or more CompactPCI mainframes are bridged together with the optional PI-31002/PI-31002SF CompactPCI Bridge Cards and power sequencing cable(s).

2.9.1 AC Power Switch

Once your system has been installed in your rack, the AC power switches on all mainframes should ordinarily remain in the “on” position. You should turn this switch off only to move the system or to change the master/slave sequencing (see below).

Before turning on the AC Power Switch, ensure that all System Power switches are turned off, and that all necessary power-sequencing cables have been properly connected. When each AC power switch is turned on, the LED in the corresponding System Power switch will blink.

To turn off AC power to a mainframe, ensure that the System Power has been turned off, and then turn off each AC power switch.

2.9.2 System Power Switch

The System Power switch on each PI-11000 mainframe has an LED to indicate the power status:

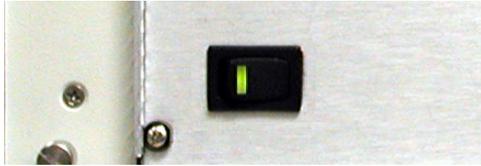


Figure 12: System Power switch

- **Off**—If the LED is off, this indicates that the AC power is off
- **Master Standby**—A rapidly blinking LED indicates that AC power is on, that System Power is off, and that this is the Master mainframe in the power sequence. CompactPCI cards can be safely inserted or removed when the mainframe is in standby mode.
- **Slave Standby**—A slowly blinking LED indicates that AC power is on, that System Power is off, and that this is a Slave mainframe in the power sequence. CompactPCI cards can be safely inserted or removed when the mainframe is in standby mode.
- **On**—If the LED is glowing solid, this indicates that System Power is on.

Before turning on the system, ensure that the AC power switches on all bridged mainframes are on, and that their System Power LEDs are be blinking. Turn on a Pulse Instruments CompactPCI system using the System Power switch on the Master mainframe. If you are using a single (non-bridged) PI-11000, then there is only one mainframe, and it is the master.

If you are using two or more bridged PI-11000 mainframes with power sequencing, only the System Power switch on the master mainframe can turn on the system. The System Power switches on slave mainframes are ignored, and cannot be used to turn those mainframes on or off independently.

NOTE—To prevent against inadvertent powering-on if power sequencing cables are removed, the System Power switches on all slave mainframes should be kept in the “off” position.

NOTE—Do NOT use the AC power switch to turn off any mainframe in a bridged system until the entire system has been turned off from the master mainframe’s System Power switch.

When the System Power switch is turned on at the master mainframe, slave mainframes will turn on in the proper order (e.g. each mainframe will wait until all of its slaves are turned on before it will turn on).

To turn off a Pulse Instruments CompactPCI system, use the System Power switch on the master mainframe. The master and slave mainframes will then power down in the correct order.

WARNING: Do not power up the unit until all proper signal connections have been made. In particular, each PI-2110x Pattern Card must be connected to the PI-21000 Clock Generator Card before power up, otherwise the system will not boot properly or will lock up after booting. If the CLK input cable is connected to the Pattern Card after power up, the system should be rebooted.

2.9.3 Powering Up 4000 Series Instruments

If you are connecting your PI-11000 Instrument Mainframe to a PI-4002B Instrument Mainframe via USB, you must power on the 4000 Series instruments before launching the software on the PI-11000. If the 4000 Series mainframes are not powered up before the software launches, instrument cards may not be recognized by the system.

Once the power supply has been turned on, turn on the PI-4002B-USB using the front panel power switch. The green Status LEDs will light up to indicate the presence of each supplied voltage:



Figure 13: Power Switch and Status LEDs

The software should be shut down before turning off the 4000 Series mainframes.

2.10. Removing/Inserting Instrument Cards

2.10.1. CompactPCI Instrument Cards

Pulse Instruments CompactPCI cards are **not** Hot-Swap compliant. Always turn off power to a CompactPCI mainframe before inserting or removing a Pulse Instruments CompactPCI instrument card.

To remove a CompactPCI card from the mainframe, remove any installed retaining screws, then push the black ejector handles outward until the card slides out approximately ½". Once the card has released from the backplane, pull the black ejector handles straight out of the mainframe until the card slides free. Do not pull on cables or signal connectors to remove instrument cards.

If you are removing a 3U card (for example, the National Instruments IEEE-488 Interface Card), there may be only one ejector handle. The other end of the card is secured by a retaining screw, which will have to be removed first

To insert a CompactPCI card, gently slide it into the mainframe slot until the rear connector has made contact with the backplane, and the ejector handles touch the mainframe. In some cases, especially with 3U cards, it may be necessary to visually align the rear connectors with the backplane during insertion, to prevent misalignment and damage to the pins.

Push the ejector handles inward until the card is fully seated in the mainframe slot. In some cases it may help to remove or partially loosen adjacent cards. If you are inserting a 3U card (for example, the National Instruments IEEE-488 Interface Card), there may be only one ejector handle. The other end of the card should be secured with a retaining screw.

Be sure to properly power down the mainframe before removing or inserting a card, unless the card is Hot-Swap compliant. Pulse Instrument cards are **NOT** Hot-Swap compliant.

2.10.2. 3rd-Party Instrument Cards and Mainframes

The Pulse Instruments PI-11000 Instrument Mainframe has been designed to provide a compact, rugged, low-noise environment for the Pulse Instruments CompactPCI series of Clock Driver and DC Bias cards. The mainframe been designed to decrease output noise and to increase the available power on the –12 V supply.

Although Pulse Instruments CompactPCI cards can be used in other, third-party CompactPCI mainframes, the user should ensure that the mainframe supplies enough ±12 V power for all installed cards. Output noise performance may also suffer if the third-party mainframe has not been designed for low-noise performance.

Third party CompactPCI and PXI cards may be used in a Pulse Instruments CompactPCI Instrument Mainframe, though operation of such cards is not supported or guaranteed by Pulse Instruments.

2.10.3. 4000 Series Instrument Cards

Pulse Instruments 4000 Series instruments cards are **not** hot-swappable. Always turn off power to the PI-4002B-USB mainframe and disconnect the DC power cable before inserting or removing instrument cards. In most cases it is not necessary to remove the mainframe from the rack, but it is usually desirable to slide the mainframe out on its rail slides until it locks into place.

Before removing or installing instrument cards in the PI-4002B-USB, first remove all signal input and output cables from the card. Then remove the top cover by removing 20 machine screws from around the perimeter of the top panel:

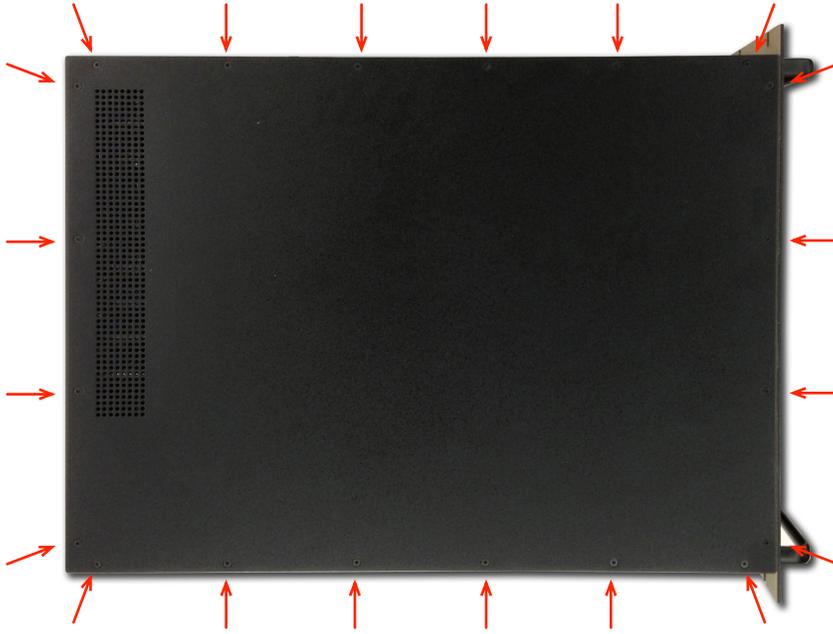


Figure 14: Screw Locations For Top Cover

Once the top cover has been removed, remove 4 machine screws from the rear panel:



Figure 15: Screw Locations For Internal Bracket

Then remove the gold-colored bracket:

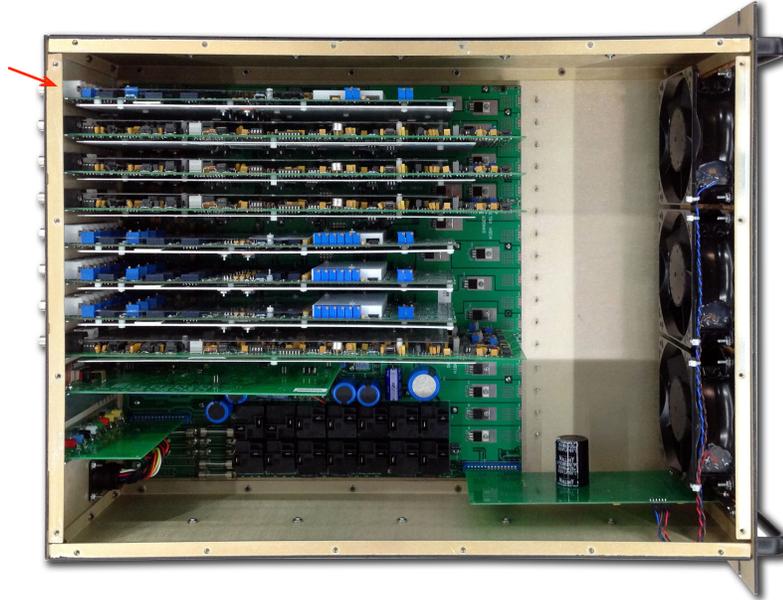


Figure 16: Gold-Colored Bracket

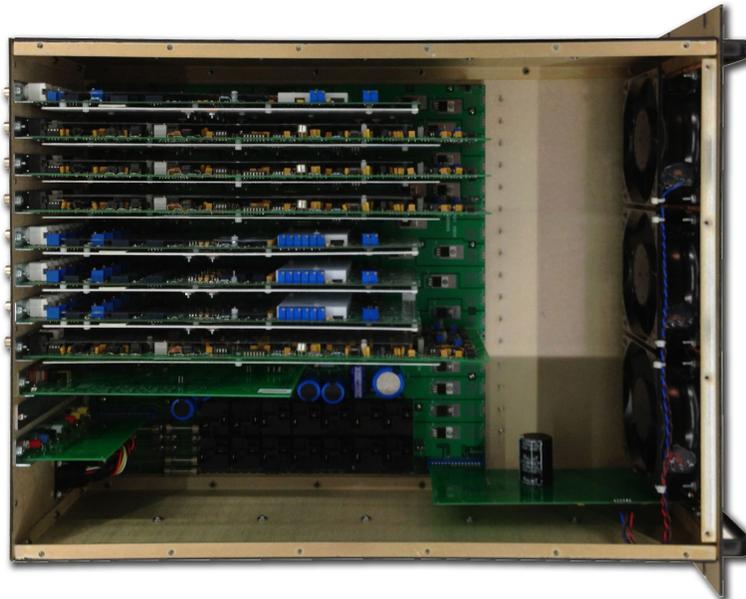


Figure 17: Bracket Removed

Once the bracket has been removed, instrument cards may be removed.

To remove an instrument card from a PI-4002B-USB, remove the retaining screw from the top of the card's rear flange:



Figure 18: Screw Location for Plugin Cards

then pull the card straight up. Cards may be gripped by their printed-circuit boards or by their coaxial connectors, but care should be taken not to grip any of the components on the board.

To install a card, reverse the above procedures, ensuring that the fingers at the bottom of the card are fully and evenly seated in the card socket.

2.11 CompactPCI Bridge Configuration

If you have only one CompactPCI Instrument Mainframe in your system, you may safely ignore this section. 4000 Series mainframes are not CompactPCI mainframes.

2.11.1 CompactPCI Bridging Overview

You will not ordinarily need to reconfigure the master/slave relationship in a Pulse Instruments CompactPCI system. This section is provided for reference only.

CompactPCI mainframes may be “bridged” together to increase the number of available instrument slots in a single system. In a bridged system, a single CPU may control all cards installed in all mainframe as though they were installed in the same mainframe. Bus connections between bridged mainframes are handled at a very low level and are transparent to the end user.

Connections between mainframes are hierarchical, with “master” mainframes controlling “slave” mainframes. CompactPCI mainframes can be “daisy-chained” with a slave having slaves of its own. There should be one CPU in a bridged system, and it should be installed in the system slot of the mainframe at the top level of the hierarchy.

In a bridged CompactPCI system, power **must** be applied to slave mainframes before it is applied to the master mainframe in order for the system controller to recognize and enumerate all the instrument cards.

The master/slave relationship is defined by the placement of PI-31002x CompactPCI bridge cards, and the power sequencing is controlled by circuitry and cabling in PI-11000 mainframes. Both sets of hardware must be configured in the same hierarchical relationship for bridging to operate properly.

2.11.2 CompactPCI Bridge Cards

Pulse Instruments uses several different CompactPCI Bridge cards depending on the application.

2.11.2.1 Model PI-31002SF Bridge Cards (Serial Copper Cabling)

PI-31002SF bridge cards are based on StarFabric transceivers. They are universal, and any card can be used as either a master or a slave, depending on the slot in which it resides. Changing the master/slave role of a StarFabric card requires reprogramming of several registers on the card using a StarFabric boot disk and firmware update utility. Please contact support@pulseinstruments.com if you need to change the master/slave role of a StarFabric card.

PI-31002SF cards have two sets of ports, and one master can control two slaves, either in a “star” or a “daisy-chain” configuration. Only two slaves can be daisy-chained from a single master. Configurations requiring more than 2 slave mainframes will require an additional pair of bridge cards.

A bridge master card can reside in any peripheral slot in a master mainframe. The master card sends and receives PCI bus traffic to and from its slave mainframe, and is responsible for handling buffering and contention between the two busses.

The slave card **must** be installed in the system slot of the slave mainframe. It receives and sends PCI bus traffic from/to its master card and controls the PCI bus of the mainframe into which it is installed.

2.11.2.1.1 Model PI-31002PMC Bridge Cards (Serial Copper Cabling)

PI-31002PMC bridge cards are based on StarFabric transceivers and are logically equivalent to PI-31002SF cards, but implemented in a PMC form factor, permitting them to be installed directly on compatible CPU boards to conserve peripheral slots. A PI-31002PMC must be a master, and it can control two PI-31002SF slave cards.

2.11.2.2 Bridge Cabling

Master and slave cards in a bridge set are connected by flat copper ribbon cables, twisted-pair copper cable, or by optical fiber, depending on the card set specified. Parallel copper bridge card cables have identical connectors on both ends, and the connectors are keyed to ensure proper insertion.

Serial copper cables for StarFabric-based bridge cards are based on Category 5e Shielded Twisted Pair (STP) cabling, and are used in pairs. The Tx port of the Master card should be cabled to the Rx port of the Slave card, and vice-versa. When using bundled cabling between two PI-31002SF cards, note that proper connector order requires a “twist” within the cable bundle at one end, e.g. left connector from one card to right connector on the other. When connecting a PI-31002PMC card to a PI-31002SF card, the cabling should be “straight,” e.g. left to left and right to right. When connected properly the StarFabric ports’ LEDs should remain illuminated after bootup. If they are dark or flashing, the cables are not connected properly.

StarFabric bus negotiation and enumeration occurs at PCI reset (normally during the early boot sequence). Therefore any change or correction in bus cabling will require a reboot in order to be recognized.

2.11.3 Power Sequencing Overview

Because a slave mainframe’s CompactPCI bus must be fully enumerated before its master can initialize, bridged systems must be powered up in the correct sequence. Each slave must be fully powered up before its master is powered up. Power-sequencing circuits in Pulse Instruments PI-11000 mainframes ensure that power is applied properly.

To designate a mainframe as a slave for power-sequencing purposes, connect the supplied ribbon cable from the “To Slave” connector of the master mainframe to the “From Master” connector on the slave mainframe. The cable ends are interchangeable, and the connectors are keyed to ensure correct insertion.

To daisy chain an additional slave mainframe, repeat the process. A PI-11000 can be a master and/or a slave, depending on how the cables are connected. Ensure that the power-sequencing cabling matches the hierarchical order defined by the CompactPCI bridge cards.



Figure 19: Power Sequencing Connections

When the System Power switch is turned on at the master mainframe, power-on requests are sent down the chain until the end of the slave hierarchy is reached. Each slave then powers up and sends a power-on-acknowledgement to its master, which then powers up and sends acknowledgement to **its** master, and so on, until all mainframes have powered up.

Please note that the master/slave relationships defined by the placement of the CompactPCI bridge card sets must match **exactly** the master/slave relationships defined by the power sequencing cables, except as described below.

If the CompactPCI busses are bridged in a “star” fashion, e.g. Mainframes B and C both bridged directly to Mainframe A, then the power sequencing cables may be configured either as A-B-C or as A-C-B. It is important only that all of a mainframe’s slaves be fully powered up and enumerated before it is powered up.

2.11.4 Bridging With 3rd-Party CompactPCI Mainframes

Although it is not supported by Pulse Instruments, the PI-11000 can be bridged with CompactPCI mainframes from other vendors. Setup of the bridge cards is identical, but 3rd-party mainframes will lack the power sequencing circuitry of the PI-11000.

If you must configure a system with a mix of Pulse Instruments and 3rd-party mainframes, remove all power sequencing cables and apply power to each mainframe manually. Power should still be applied to each Pulse Instruments mainframe with the System Power switch.

2.12. Mainframe, Slot and Channel Numbering

In software, all instrument card channels are assigned a unique hardware address, consisting of a Mainframe number (MF), slot number (SLOT), and channel number (CH). Channel mnemonics (PI-Controller) and channel Labels (GPIB) can be assigned on top of these hardware addresses.

2.12.1. Mainframe Numbering

All CompactPCI mainframes connected by a CompactPCI bridge cable (see **Section 2.11 CompactPCI Bridge Configuration**), whether they are PI-11000 Instrument Mainframes or PI-2005 Pattern Generators, are a single logical unit designated as Mainframe 0.

PI-4002B Instrument Mainframes and instrument cards are numbered as described in **Section 2.8.3. Address DIP Switch**.

PI-4003A DC Power Mainframes are not logically addressed and, therefore, have no mainframe number.

2.12.2. Slot Numbering

The card slots in a CompactPCI master mainframe are numbered starting with the Controller (CPU card) at **Slot 0**. The first peripheral slot will be **Slot 1**. If mainframes have been bridged together, card slots in the first slave will be logically numbered starting with the Controller (bridge card) at **Slot 16** and the first peripheral slot at **Slot 17**. The controller slot in a second slave will be numbered as **Slot 32**, and so on. Peripheral cards can be installed in any order, but reordering cards may require you to update the hardware configuration file in PI-Controller. Please **Section 4. Hardware Configuration** for more details.

Card slots in a PI-4002B Instrument Mainframe are numbered from right to left, starting at **Slot 1**, when viewed from the back of the unit (looking at the I/O connectors).

2.12.3. Channel Numbering

On CompactPCI instrument cards, channels are numbered, from left to right, starting with **Channel 1**. Although the front panels of each card may be labeled alphabetically (e.g. A, B, C or D), the channel assignments for software purposes are always numeric.

On 4000 Series Instrument cards, channels are numbered from top to bottom, starting at **Channel 1**.

2.13. Front Panel Connections

2.13.1. The CPU board

The CPU card is a 6U, CompactPCI x86-based SBC with the following features:

- Dual-core or Quad-Core CPU, 2.0 GHz or greater
- 2 GB – 4 GB RAM
- On-board video controller with VGA or DVI ports
- Interrupt and Reset buttons
- On-board Gigabit Ethernet port(s) with status LEDs
- One or more Universal Serial Bus (USB) 2.0 ports
- One or more serial ports (external or internal)
- DVD-RW drive (optional)

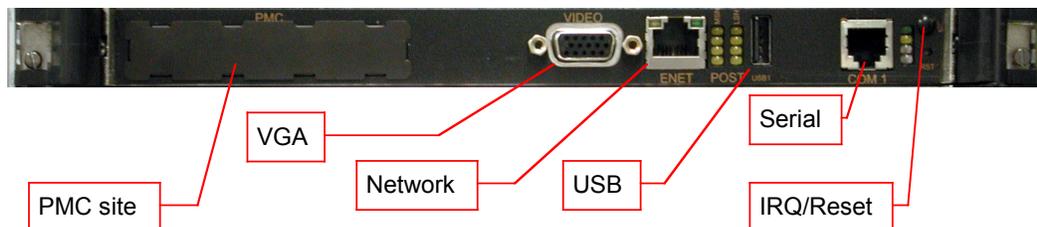


Figure 20: CPU Card (GMS c165 shown)

Your CPU card may appear slightly differently than the model shown above, based on currently-available CPU cards.

The PI-11000 can be controlled Locally, via a user-supplied monitor, keyboard and mouse, or Remotely, via the optional IEEE-488 interface. If the PI-11000 is being controlled Remotely, connection of the monitor, keyboard and mouse is optional.

PI-11000 mainframes running Windows 7 or higher will behave like standard desktop PCs with respect to any external USB devices. USB is fully supported, as are standard mass-storage devices and input devices.

2.13.2 PI-41702/PI-41703 Four Channel Low Noise DC Bias Card



Figure 21: PI-41702 Four Channel Low Noise DC Bias Card

This is the PI-41702 Four Channel Low Noise DC Bias Card. Each channel has an SMA output connector.

The 'D' type connector allows for the introduction of external laboratory-type power supplies to reduce the noise further. To change from using the internal power supplies to external power supplies requires the user to reposition jumpers on the card. Please see **Section 2.14.2 External Power Supply Connector** (below) for the 'D' connector pin assignment.

Sense banana jacks allow for remote measurement of the voltage and current levels. See **Section 2.15. Voltage and Current Sensing** for details regarding this feature.

2.13.3 PI-41401 Four Channel Clock Driver Card



Figure 22: PI-41401 Four Channel Clock Driver Card

This is the PI-41401 Four Channel Clock Driver Card. Each channel has two SMA connectors—one for TTL input and one for output.

The 'D' type connector allows for the introduction of external laboratory-type power supplies to reduce the noise further. To change from using the internal power supplies to external power supplies requires the user to reposition jumpers on the card. Please see **Section 2.14.2 External Power Supply Connector** (below) for the 'D' connector pin assignment.

Sense banana jacks allow for remote measurement of the voltage and current levels. See **Section 2.15. Voltage and Current Sensing** for details regarding this feature.

2.13.4 GPIB Card



Figure 23: Front Panel of PI-31000 GPIB card (National Instruments PXI-GPIB)

This is the optional PXI-GPIB National Instruments Card, and it is used to communicate with the instrument over the IEEE-488 bus. Your GPIB interface card may also be supplied as a PMC module, installed directly on the CPU card or on a PMC carrier board. PMC GPIB interfaces operate identically with PXI-GPIB cards, but use a different cable (supplied with the board) to adapt the Micro-D connector on the card to standard GPIB cables.

All the required drivers have been installed, and the original installation program has been copied to the hard drive in the C:\DRIVERS directory. If installed, the IEEE-488 interface on your PI-11000 may be configured to operate either as an instrument or as a system controller. For more information, please see **Section 6.2.1. Configuring the GPIB Interface**.

2.13.5 CompactPCI Bridge Set (Optional)



Figure 24: Front Panel of PI-31002SF CompactPCI Bridge Card

This is the optional PI-31002 CompactPCI Bridge set. Two of these cards, a Master and a Slave, are required to bridge two PI-11000 Instrument Mainframes. Please see **Section 2.11 CompactPCI Bridge Configuration** for important information regarding bridged systems.

2.14 External Power Supply

2.14.1 External Power Supply Jumpers

If you wish to use an external power supply to reduce output noise on a CompactPCI instrument card, three jumpers on the card must be moved. These jumpers are located between the 'D' connector and the orange banana jack, as shown below. By default, the jumpers are set to use the internal power supply.

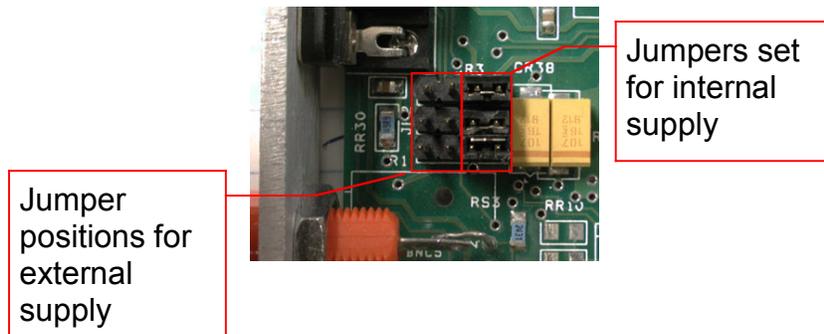


Figure 25: Power Supply Selection Jumpers

2.14.2 External Power Supply Connector

An external power supply can be connected to Pulse Instruments CompactPCI Clock Driver and DC Bias cards using a standard 'D'-type connector. The pin assignments are shown below, as viewed from the front of the card.

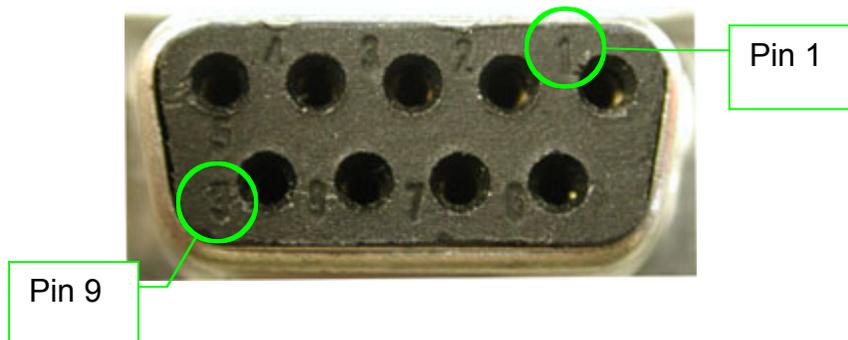


Figure 26: External Power Supply Connector

Pin(s)	Assignment
1	External +12 V
2	External -12 V
3	External +5 V
4,5,8 and 9	No connection
6,7	Ground

Table 3: External Power Supply Connector

Although connections are provided for ± 12 V and for +5 V, only the ± 12 V supplies will affect output noise. Do not apply any voltages to the connector other than those specified in the table above, as they may damage the card and void your warranty.

2.15. Voltage and Current Sensing

Pulse Instruments Clock Driver and DC Bias cards have “sense” circuitry for determining the actual voltage or current being supplied to the DUT. The sense jacks require the use of a user-supplied voltmeter (DVM).

For CompactPCI instrument cards, the sense is available from banana jacks at the front of each card. For 4000 Series instrument cards, the sense is muxed to a single set of BNCs on each 4002 Instrument Mainframe.

Each card can sense voltage or current in several ranges (selectable in software). To use the sense feature, connect the sense banana jacks to your DVM, and then use the DVM reading to compute the voltage or current being supplied to the DUT.

The voltage-sense or current-sense mode for each channel in the test system can be set independently, as can the sensing range for each channel.

Because there is a single set of sense circuitry for multiple output channels on each card, the desired channel must be selected in software before the reading is taken. This can be accomplished via the use of the Sense mnemonic in PI-Controller or via use of the GPIB command **SELECT**. The GPIB **DESELECT** command can be used to turn off all sense ports.

Sense ports for multiple CompactPCI cards and/or PI-4002/PI-4002A Instrument Mainframes can be connected in parallel to a single DVM, as only one channel in a system can be “selected” at any one time. Use the sense selection feature (or the SELECT/DESELECT GPIB commands) to switch among and measure each desired channel in your test system.

2.15.1 Voltage Sense Example

If a DC Bias channel is programmed for 5.62 V, the voltage sense feature can be used to measure the voltage actually delivered to the DUT. To make the measurement, connect a DVM to the sense connector. If the output voltage is positive, then the left banana jack (closest to the External Power Supply connector) is positive for voltage sensing. On a 4002 Instrument Mainframe, the top BNC is positive.

Use the channel’s mnemonic in PI-Controller or the GPIB **VSENSE** command from your system controller to set the sense range to VSENSE1 (-8.192 V - +8.188 V), then use the Sense mnemonic or the GPIB **SELECT** command to switch the sense port to the desired channel.

The reading on the DVM will reflect the actual voltage at the output port of the DC Bias card, and will be a function of the voltage achieved at the DUT. The ratio between the voltage at the output port and the voltage at the DUT is a function of your test system or test fixture setup, and can easily be characterized by the user before making test measurements.

For maximum accuracy, set your DVM to the smallest range that will accommodate the anticipated voltage from the sense port.

2.15.2 Current Sense Example

The current sense feature can be used to measure the current being drawn by the DUT. To make the measurement, connect a DVM to the sense connector. If the output current is positive, then the left banana jack (closest to the External Power Supply connector) represents the negative floating measurement point for current sensing. On a PI-4002/PI-4002A Instrument Mainframe, the BNC polarities are reversed for current sensing.

For example, if a bias channel is programmed for 3.6 V across an estimated 50 Ω load, the estimated current draw will be 72 mA. Use the channel's mnemonic in PI-Controller or the GPIB **ISENSE** command to set the current sense range to 100 mA/Volt, then use the Sense mnemonic or the GPIB **SELECT** command to switch the sense port to the desired channel.

In this range, each 1 Volt measured at the DVM will represent 100 mA being drawn by the DUT. If the DVM reads 0.72 V, then the DUT is drawing 72 mA. The current sense is measured using a series resistor at the output port of the DC Bias card, and will not reflect any current leakage or series resistance that occurs between the output port and the DUT pin.

The numerical sense range must be greater than or equal to the sensed current (e.g. use the 10 mA/Volt range to measure current of ≤ 10 mA), and will result in a voltage at the sense port in the range of ± 1 V. For maximum accuracy, set your DVM to the smallest range that will accommodate the resulting voltage from the sense port.

Current sense calculations from DVM readings outside of ± 1 V are not meaningful, except for the 40755 card, which will output meaningful voltages of ± 2.5 V. If your current-sense setup results in DVM voltages outside that range, use a higher sensing range to scale down the measured voltage.

2.15.3 Range and Accuracy for External Voltage and Current Sense

	External Sense Port Range and Accuracy	
	Voltage Sense	Current Sense
40750/40752 4 Ch. DC Bias	2 ranges <ul style="list-style-type: none"> • 1 V/V: 0.2% ± 0.5 mV • 10 V/V: 0.2% ± 5 mV 	3 ranges <ul style="list-style-type: none"> • 1 mA/V: 0.2% ± 1 μA • 10 mA/V: 0.2% ± 10 μA • 100 mA/V: 0.25% ± 100 μA
40755 2 Ch. DC Bias	2 ranges <ul style="list-style-type: none"> • 1 V/V V: 0.2% ± 0.5 mV • 10 V/V V: 0.2% ± 5 mV 	3 ranges <ul style="list-style-type: none"> • 1 mA/V: 0.2% ± 1 μA • 10 mA/V: 0.2% ± 10 μA • 100 mA/V: 0.25% ± 100 μA
41702 4 Ch. DC Bias	-8.192 V to 8.188 V 0.2% ± 5 mV	3 ranges <ul style="list-style-type: none"> • 1 mA/V: 0.3% ± 2 μA • 10 mA/V: 0.3% ± 20 μA • 100 mA/V: 0.3% ± 200 μA
41703 4 Ch. DC Bias	-8.192 V to 8.188 V 0.2% ± 5 mV	3 ranges <ul style="list-style-type: none"> • 2 mA/V: 0.3% ± 4 μA • 20 mA/V: 0.3% ± 40 μA

	External Sense Port Range and Accuracy	
	Voltage Sense	Current Sense
		<ul style="list-style-type: none"> 200 mA/V: 0.3% ± 400 µA
42750 4 Ch. DC Bias 42755 2 Ch. DC Bias	2 ranges <ul style="list-style-type: none"> 1 V/V: 0.25% ±3 mV 10 V/V: 0.25% ±6 mV 	3 ranges <ul style="list-style-type: none"> 1 mA/V: 0.25% ±1 µA 10 mA/V: 0.25% ±10 µA 100 mA/V: 0.25% ±120 µA
4046x 2 Ch. Clock Driver	2 ranges <ul style="list-style-type: none"> 1 V/V V: 0.2% ±4 mV 10 V/V V: 0.2% ±40 mV 	3 ranges <ul style="list-style-type: none"> 1 mA/V: 2% ±3 µA 10 mA/V: 2% ±30 µA 25 mA/V: 2% ±300 µA
40465 2 Ch. Clock Driver	2 ranges <ul style="list-style-type: none"> 1 V/V V: 0.2% ±4 mV 10 V/V V: 0.2% ±40 mV 	3 ranges <ul style="list-style-type: none"> 1 mA/V: 2% ±3 µA 10 mA/V: 2% ±30 µA 25 mA/V: 2% ±300 µA
40490 65 MHz Clock Driver	2 ranges <ul style="list-style-type: none"> 10 V/VV: 0.2% ±4 mV ±200 V: 0.2% ±40 mV 	N/A
42460 2 Ch. Clock Driver	2 ranges <ul style="list-style-type: none"> 1 V/V V: 0.2% ±4 mV 10 V/V V: 0.2% ±40 mV 	3 ranges <ul style="list-style-type: none"> 1 mA/V: 2% ±3 µA 10 mA/V: 2% ±30 µA 25 mA/V: 2% ±300 µA
42490 2 Ch. Clock Driver	2 ranges <ul style="list-style-type: none"> 1 V/V V: 0.2% ±4 mV 10 V/V V: 0.2% ±40 mV 	3 ranges <ul style="list-style-type: none"> 1 mA/V: 2% ±3 µA 10 mA/V: 2% ±30 µA 100mA/V: 2.5% ±300 µA
41401 4 Ch. Clock Driver	-5 V to 8 V 0.5% ± 20 mV	3 ranges <ul style="list-style-type: none"> 1 mA/V: 1% ± 20 µA 10 mA/V: 1% ± 200 µA 21.1 mA/V: 1% ± 300 µA

The PI-42495 and PI-45101 cards do not have a Sense feature.

2.15.4 Internal Voltage/Current Sense

In addition to the external sense ports, some Pulse Instruments CompactPCI Clock Driver and DC Bias cards also have an internal sense A/D converter that can be read directly in software. This voltage reading is available on the screen after every **Write** in each supported channel's PI-Controller mnemonic in PI-Controller.

The internal analog-to-digital converter (ADC) is not a high-precision device, and the internal sense measurement should be used only as a ranging estimate or as a threshold measurement (to test for shorts, e.g.). You should always use the external sense ports for precision measurements.

The internal ADC reading is polarity- and units-corrected in software, but you must set the appropriate sensing range and select the appropriate channel before reading the internal ADC.

2.15.5 Range and Accuracy for Internal ADC Sense

	Internal ADC Sense Range and Accuracy	
	Voltage Sense	Current Sense
41702 4 Ch. DC Bias	200 mV to 8.188 V 2% ± 50 mV	3 ranges <ul style="list-style-type: none"> 100 mA/V: 5% ± 2 mA 10 mA/V: 5% ± 200 µA

		<ul style="list-style-type: none"> 1 mA/V: 5% ± 20 μA
41401 4 Ch. Clock Driver	±1 V to ±8.188 V <ul style="list-style-type: none"> (Not spec'd <1 V) 2% ± 50 mV	N/A

Table 4: Internal ADC Sense by Card Model

2.15.6 Clock Driver Voltage and Current Sensing

The sense feature on Pulse Instruments Clock Driver cards operates identically to that on the DC Bias cards, but the measurement is most accurate when the clock output is quiescent.

To use the sense feature on a Clock Driver channel, set the timing pattern to input a fixed level to the driver input, or else set the clock driver amplitude to its minimum value.

The PI-41401 has a minimum allowable amplitude of 0 V (within the operating accuracy of the internal DACs), allowing for more accurate sense measurements, even with clock duty cycles other than 50%.

3. SOFTWARE OVERVIEW

PI-Controller is a software program written for users of Pulse Instruments CompactPCI Series and PI-4000 Series test instrumentation. PI-Controller is built around a menu-operated, object-oriented architecture that provides a flexible low maintenance software environment for the specification and real-time control processes associated with testing infrared and visible imagers.

PI-Controller easily configures any test setup and controls hardware to facilitate any needs. PI-Controller allows the operator to define and save control settings for various hardware devices.

When installed on a Pulse Instruments CompactPCI Instrument Mainframe, PI-Controller communicates with CompactPCI instruments cards over the PCI bus. PI-Controller can also be used to control instrument cards in PI-4002B Instrument Mainframes via USB.

When installed on an external computer, such as a desktop PC, PI-Controller communicates with the PI-11000 Instrument Mainframe (and any connected PI-4002B mainframes) over the IEEE-488 (GPIB) bus.

PI-Controller is closely related to another Pulse Instruments products, PI-DATS. PI-DATS provides all the functionality of PI-Controller as well as a generic GPIB driver. PI-DATS also has the ability to set up and run test plans automatically. Please contact Pulse Instruments if you wish to purchase an upgrade to your software.

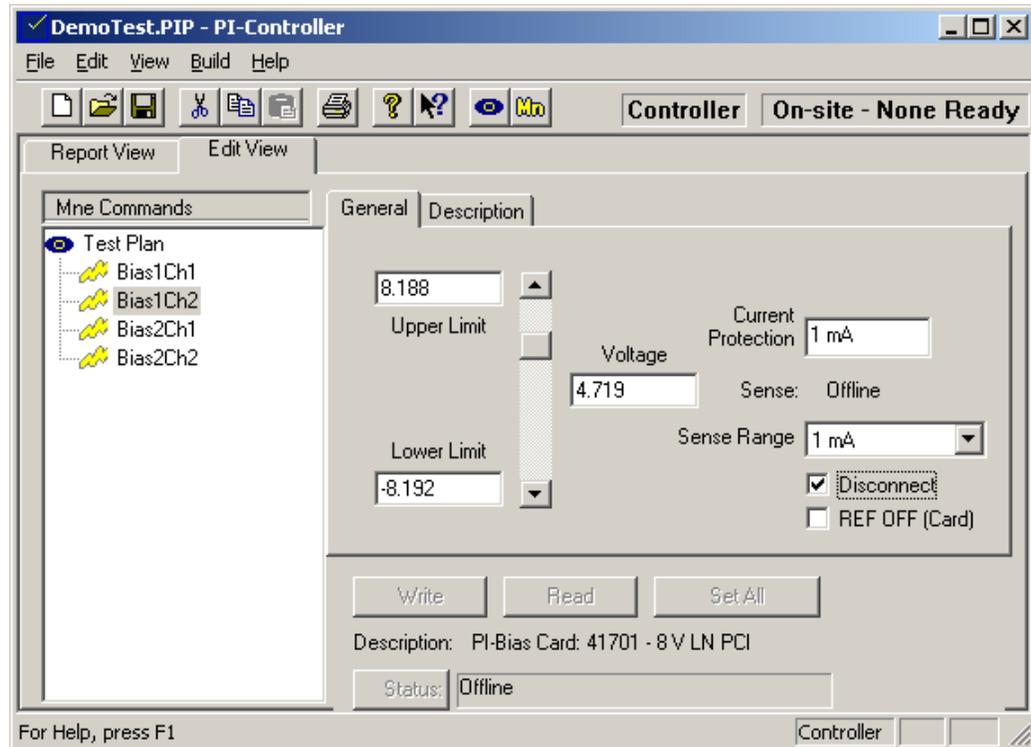


Figure 27: PI-Controller Main Window

Launch PI-Controller by double-clicking the PI-Controller icon on the Windows desktop. PI-Controller will open an untitled .PIP (Pulse Instrument Part) file.

3.1. Configuration

The PI-Controller control software, PI-PAT, Windows 7 and network drivers have been preloaded onto the internal hard drive. If you have ordered the optional IEEE-488 interface, those drivers have also been pre-installed. All software has been provided in its original format, and the video, network, and GPIB drivers have been copied to the hard drive in the directory C:\DRIVERS.

3.1.1. Local vs. Remote Operation

The PI-11000 can be controlled locally via PI-Controller, or remotely from another computer, over the IEEE-488 bus. In Pulse Instruments' terminology, "Local" always refers to the PI-11000, regardless of where the operator is sitting. "Hardware" refers to the instrument cards in the local PI-11000.

In "Local" mode, PI-Controller runs on the single-board-computer inside the PI-11000. It stores files on the local hard drive and writes directly to the registers in hardware.

In "Remote" mode, PI-Controller runs on a remote PC and communicates with the PI-11000 over the IEEE-488 bus. If your system was ordered with the optional IEEE-488 interface, the default address is 14, and it is configured by default as a remote instrument, but it can also be used in Local mode with a user-supplied monitor, keyboard and mouse.

By default, your Pulse Instruments CompactPCI instrument mainframe was configured to launch **PI-PAT** at startup. In addition to being the pattern editing and control software for the Pulse Instruments Pattern Generator cards, PI-PAT also provides the GPIB communications layer to Pulse Instruments CompactPCI clock driver and DC Bias cards. PI-PAT must be running on the Local instrument in order for Pulse Instruments clock driver and DC Bias cards to respond to GPIB commands.

If you are controlling your PI-11000 over GPIB from a remote PC, you cannot run PI-Controller simultaneously on the Local instrument. Furthermore, if you launch PI-Controller locally, it will temporarily disable the GPIB communications layer by putting PI-PAT in **Local Only** mode. If you need to re-enable GPIB communication to the instrument, simply quit PI-Controller, then quit and re-launch PI-PAT.

You can change the GPIB address of your PI-11000 using either the PI-PAT interface or the GPIB **SETGPIBADDR** command.

If installed, the IEEE-488 interface on your PI-11000 may be configured to operate either as an instrument or as a system controller. For more information, please see **Section 6.2.1. Configuring the GPIB Interface**.

3.1.2. Controlling 4000 Series Instrument Cards

4000 Series Instrument Cards are controlled from a PI-11000 Instrument Mainframe via USB. The PI-11000 can be controlled by PI-Controller either locally or remotely, as described above.

Instrument cards in the 4002 Instrument Mainframe are controlled in much the same manner as the CompactPCI Instrument Cards in the PI-11000 Instrument Mainframe, except for the mainframe number and the features specific to each card.

3.1.3. Windows Logon

This section pertains to the networking function included with the PI-11000, and can be safely ignored if the user does not intend to connect the instrument to a network.

The single-board computer in your PI-11000 has a built-in Ethernet port, and the embedded Windows 7 operating system can join your network as a full-fledged network client.

The Windows 7 “auto logon” function has been enabled so that the user does not have to logon to the computer every time it starts up. By default, the auto-logon feature logs the user into the local machine only, with local Administrator privileges.

If you plan to connect the PI-11000 to your company network or to the Internet, consult your network administrator for the appropriate network settings and permissions. This may also require you to modify or disable the Windows 7 automatic logon features in order to comply with your company’s specific network configuration and security policies. See the following Microsoft Knowledge Base articles for details on modifying or bypassing the auto-logon settings.

<http://support.microsoft.com/support/kb/articles/Q114/6/15.asp>

<http://support.microsoft.com/support/kb/articles/Q97/5/97.asp>

Your PI-11000 has been configured with the following Windows account information:

- Computer name: PI11000_<serial>
- Username: Administrator
- Password: password
- Workgroup: WORKGROUP

where “<serial>” is the 10-digit serial number of your PI-11000.

3.2. Operating Concepts And Menu Items

3.2.1. Mnemonic Label

PI-Controller and PI-DATS use the concept of instrument “mnemonics” to represent hardware devices and test plan objects (PI-DATS only). Each object under user control is represented by a graphical icon and a user-assigned mnemonic name (collectively referred to as a “mnemonic” throughout this manual). This allows the user to refer to an instrument by a recognizable mnemonic instead of by its generic description or location. For example, a DC bias channel can be assigned the name **V_{CC}** instead of “Mainframe 1, slot 2, channel 2, ±8 V DC Bias.” Examples:

Mnemonic	Function or Instrument Module
VCC	Channel 1 of 41702 DC Bias card in CompactPCI
Phi1A	Channel 1 of 41401 Clock Driver card in CompactPCI
PhiLB	Channel 2 of 40460 Clock Driver card in 4002
RESULT1	Non-hardware component for managing measured data.

Mnemonics may be renamed by the user at any time. Mnemonic labels are unique within the scope of each PIP file.

Mnemonics for a given function or instrument module can appear several times in a test plan, either with the same label, or with different labels. When running a test plan (available only in PI-DATS), different instances of a given instrument mnemonic can represent different states of the hardware in the test plan sequence.

In the standard PI-Controller mode, multiple instances of a mnemonic can be used to switch among frequently used settings for a single mnemonic. You can create multiple instances of a mnemonic either by using the **Copy/Paste** functions or by using the **Mnemonic Selection** dialog box to add the item repeatedly.

3.2.2. .PIP File (Pulse Instruments Part file)

This is the basic file that PI-Controller creates and uses. PIP is the file extension. When **New** is selected from the File menu, a new PIP file is created (Untitled.PIP). When **Save** is selected from the File menu or when PI-Controller is exited and **Save Changes** is specified, the PIP file is saved to disk. The PIP file contains all mnemonics with their configurations and all hardware components with their connections and attributes.

PIP files can be read or modified by anyone else who also has PI-Controller on their computer.

3.3. Adding Mnemonics

To enable control of a Pulse Instruments hardware device, you must add the channel or card from the **Mnemonic Selection** window. Clicking the **Mnemonics** button  displays a list of available mnemonics. Select the  symbol to view the multiple mnemonic choices of an instrument type:

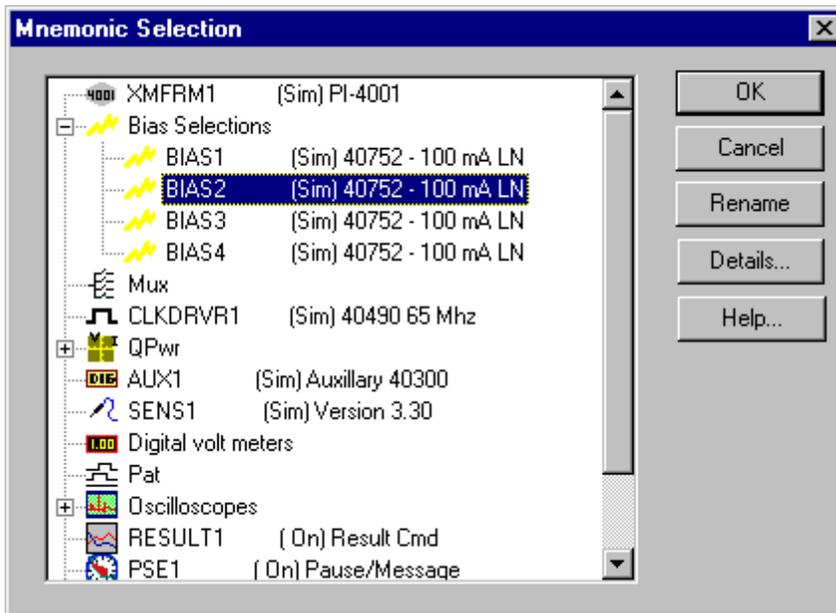


Figure 28: Mnemonic Selection Dialog Box

Add a mnemonic by clicking on its name and then clicking the **OK** button. You can add multiple items by holding the **Ctrl** key as you click, or by holding down the **Shift** key and typing the up and down arrow keys.

If a mnemonic does not appear in the **Mnemonic Selection** dialog box, then the software module for that Instrument or function is not installed on your system. If a mnemonic does appear, but the **OK** button is grayed (not selectable), then the instrument needs to be added to the hardware configuration. (See **Section 4. Hardware Configuration**).

You do not need to add mnemonics for instrument cards or channels that you do not wish to control at this time. Mnemonics can be added at any time.

3.3.1. (Sim) or (On)

These symbols represent the current hardware state. **(Sim)** or Simulation means that there will be no hardware commands sent. **(On)** means that the Instrument is On-Line, and that hardware commands will be sent.

3.3.2. Rename

By default, each mnemonic is assigned a name that describes its model number and mainframe-slot-channel location, e.g. **41701-1-02-1**. The Rename button allows you to give your instrument channels names that are meaningful in your application, such as **VCC**, **VDD** or **PhiLA**.

The new name will be used each time an instance of this mnemonic is inserted into your test plan. Existing mnemonics will not be renamed.

You can also rename any instance of a mnemonic in your test plan by single-clicking on its name in the Main Window.

Mnemonic names are specific to each test plan, and new test plans are created with the default names.

3.3.3. Details

Press this button to display more details about the selected type of Instrument or Function, including its physical slot and channel number.

3.4. Basic Hardware Control

Once the desired mnemonics have been added, you can then use the PI-Controller window to edit the device settings and write those settings to hardware.

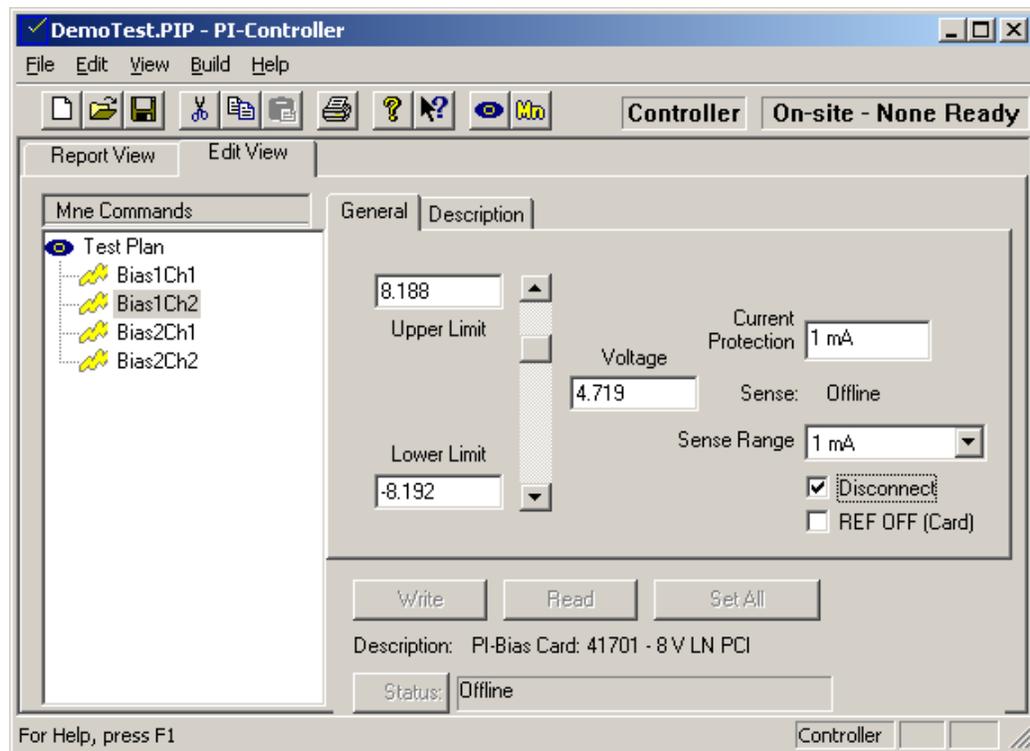


Figure 29: PI-Controller With Bias Mnemonic Selected

To adjust the settings for a device click its mnemonic, input the desired settings via the graphical controls, and then write the changes to hardware. For example, to change the output voltage for Bias1Ch2 to 5.5 V, click on its mnemonic, use the scroll bar control or type **5.5** in the **Voltage** edit box, then click **Write** to make the change at the output.

You can also click **Set All** to write the displayed settings to all the channels of similar cards simultaneously.

To write settings to several cards, you can highlight multiple channels of similar cards by holding down the **Ctrl** key as you click the mnemonics, or by using the **Shift** key and the up/down arrow keys simultaneously. When several mnemonics are selected, the **Write** button changes to **Write Selected** to indicate that the displayed values will be written to all selected channels.

3.4.1. Text Coloring

Throughout PI-Controller, settable parameters will change color to reflect the state of synchronization with the hardware.

- Gray text—signifies that values are valid and consistent with the current state of the hardware
- Blue text—signifies that values are valid, but not consistent with the current state of the hardware. These values will not be written to hardware until the Write button is clicked, and these values will not be reflected at the instrument outputs until the instrument is set to Online.
- Red text—signifies that the values are invalid, either because they are outside of the hardware's operating limits or because they are outside of the user-programmed limits. Invalid values cannot be written to hardware

3.4.1.1. Device Protection Features

Pulse Instruments stimulus instruments have multiple features to assist the operator in protecting the device-under-test (DUT). These features are the runmodes (**Online**, **Offline** and **Disconnect**), the programmable limits and ranges, and the programmable sequences.

3.4.1.1.1. Online, Offline, and Disconnect Modes

The PI-11000 Instrument Mainframe and PI-4002/PI-4002A Instrument Mainframe have three runmodes, **Online**, **Offline**, and **Disconnect**. To prevent inadvertent changing of voltages or signals to the DUT, programmed settings are only changed at the outputs of the instrument when the instrument is **Online**. When the instrument is **Offline**, programmed changes are stored, but the outputs are not changed until the instrument is put back **Online**.

Furthermore, changes made in the PI-Controller windows are not stored until the user clicks the **Write** button.

The **Disconnect** state is an additional device protection feature. When the instrument is put into **Disconnect** mode, the PI-11000 effectively disconnects all outputs from the DUT. This is implemented in different ways, depending on the card model:

- For 4046x and 40490 clock driver cards and 4075x DC bias cards (PI-4000 Series), the outputs are grounded through a small resistor.
- For the 4246x clock driver cards (PI-4000) and 4140x clock driver cards (CompactPCI), the outputs are tri-stated.
- For the 4170x DC bias cards (CompactPCI), the outputs are grounded through a small resistor.

When the PI-11000 or PI-4001 is in **Disconnect**, a DUT can safely be attached to or removed from the test fixture assuming, of course, that no other instruments in your system are actively supplying voltages.

The **Online/Offline/Disconnect** mode is controlled from the **XMFRM** (Mainframe) mnemonic, described below.

When controlling the PI-11000 or PI-4001 from a remote PC via a custom GPIB application, use the **ONLINE**, **OFFLINE**, **CONNECT** and **DISCON** commands to control the runmode.

3.4.1.1.2. Programmable Limits

Use the programmable limits feature in PI-Controller to prevent the DUT from incorrect biasing or clocking. Clock Driver channels have programmable limits for the high- and low-levels and for the maximum allowable amplitude. DC Bias channels have programmable upper and lower limits, and some DC Bias channels offer programmable current limits as well.

Programmable limits can also be set with GPIB commands, such as **UPLIMB**, **LOLIMB**, **ILIM**, **UPLIMD**, **LOLIMD**, and **AMPLIM**.

3.4.1.1.3. Current Sense Range

In addition to specifying the range in which current can be sensed, this setting also acts as a basic form of current protection. The table below shows the approximate peak current supplied by each channel in each Current Sense Range:

	Current Sense Range for DC Bias Cards		
	1 mA/V	10 mA/V	100 mA/V
PI-41700/PI-41701	1.1 mA	11 mA	110 mA
PI-41702	8.2 mA	82 mA	110 mA

	Current Sense Range for Clock Driver Cards		
	1 mA/V	10 mA/V	21.32 mA/V
PI-41401	8.2 mA	50 mA static, 65 mA dynamic	50 mA static, 65 mA dynamic

Table 5: Current Limits and Sense Range By Card Model

Current sensing is not supported on the PI-40490 Clock Driver Card.

Please note that this form of current protection is not a calibrated or specified value. Furthermore, the high-range, maximum current values indicated for the Clock Driver cards represent the operating limits of the driver devices. These values should not be exceeded or sustained or the driver may be permanently damaged.

All cards are set to the minimum sense range (1 mA) at power-up. If you need to supply or drive more current to your device, you must first set a higher current sense range.

3.4.1.1.4. Signal Sequencing

In addition to programming each channel from PI-Controller in the desired order, you can also control the sequence in which signals are applied to the DUT by using the GPIB command **SEQ**.

By default, when the instrument is placed into **Online** mode, programmed settings are applied to each channel in the following order: DC Bias Supplies in ascending order by channel number, and then by slot number; Clock Drivers in descending order by channel number and then by slot number.

Conversely, when the instrument is placed in **Disconnect** mode, channel outputs are disconnected from the DUT in the reverse order: Clock Drivers in ascending order by channel number, and then by slot number; DC Bias Supplies in descending order by channel number, and then by slot number.

If you are controlling your PI-11000 or PI-4001 mainframe from a remote PC, you can alter the order of the **Online** and **Disconnect** sequencing by using the **SEQ** commands.

The **SEQ** command is not yet available within PI-Controller. Channels are always disconnected and placed online in their default order. Application of voltages can be sequenced by the order in which mnemonics are placed in the application window (PI-DATS only), or the order in which individual channels are programmed using the **Write** button.

3.4.1.2. Common Controls



Figure 30: Common controls

3.4.1.2.1. Write/Write Selected

Click **Write** to store the displayed settings for the selected mnemonic(s). If the PI-11000 or PI-4001 is in **Online** mode, the changes will be reflected at the channel outputs and the internally sensed voltage will appear in the status bar. If the PI-11000 is in **Offline** mode, the **Write** button will be disabled and changes will not be effective until it is placed **Online**.

3.4.1.2.2. Read

Click **Read** to poll the hardware and update the screen to reflect the current settings. The currently programmed values will appear in the status bar.

3.4.1.2.3. Set All

Click **Set All** to set all like cards to the state as defined on this screen. Note that the test plan settings for other channels' mnemonics will not be changed; only the state of the hardware will be changed. Mnemonics can be set to match the state of the hardware by selecting them and clicking **Read**.

3.4.1.2.4. Status

Requests the error status of the Control Mainframe. The status bar can display various types of information:

- Pending errors that must be cleared by clicking Status
- The internal ADC reading
- The currently programmed voltage setting
- Online/Offline/Disconnect status of the PI-11000 or PI-4001
- Simulated status of PI-Controller

The status bar is updated after every read or write operation.

3.5. Pat (Pattern Generator) Mnemonic

If you have Pattern Generator cards installed in your PI-11000 or a Pulse Instruments Pattern Generator (PI-2005 or PI-5800) connected via GPIB, you can perform basic hardware control via PI-Controller's **Pat** mnemonic. Editing of Pattern Files must be performed in PI-PAT. Please see the **PI-2005 Operators Manual** for instructions on programming Pattern Generator instruments and cards using **PI-PAT**.

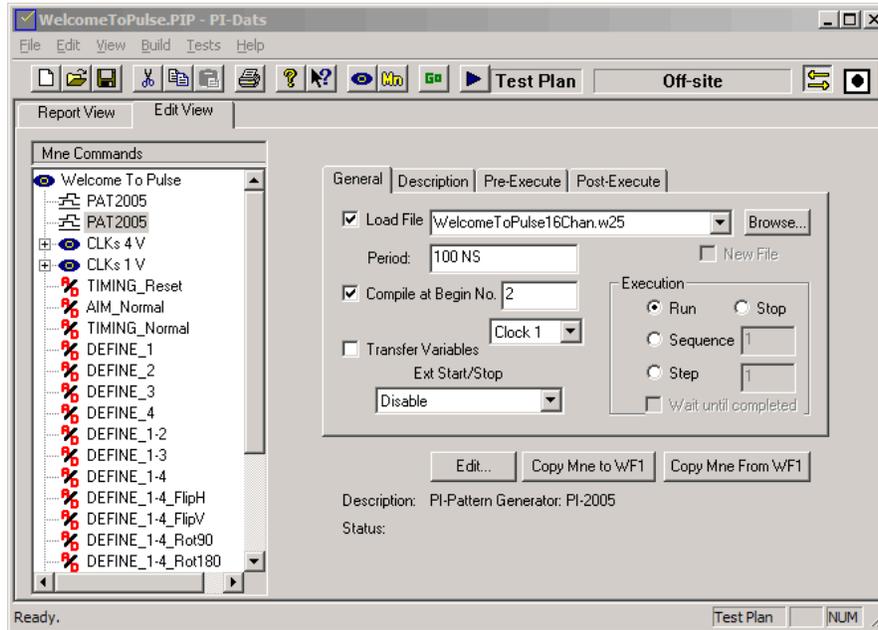


Figure 31: Pat (Pattern Generator) Mnemonic

To load an existing PI-PAT file (.w25 or .w58), click the **Select Pattern File** button and locate a PI-PAT file from your hard drive, then click the **Load File** checkbox.

Once a pattern file has been specified, you can then set a clock **Period** and a program Begin number to **Compile** and run by using the appropriate input boxes and checkboxes.

Finally, choose the runmode (i.e. **Run**, **Stop**, **Step** or **Sequence**) radio button and click **Write** to perform the selected actions.

Once you have loaded a file and compiled a program, you do not need to perform these actions every time you change a setting. For example, if you wish to change only the clock period, or if you wish only to Stop program execution, you can uncheck the **Load File** and **Compile** checkboxes to prevent these actions from being repeated unnecessarily every time you click **Write**.

The **Pat** mnemonic is not affected by the **Online/Offline/Disconnect** state of the **XMFRM** mnemonic, and changes are always made effective when the **Write** button is clicked.

3.5.1. Interaction Between PI-PAT and PI-Controller

PI-Controller and PI-DATS interact with PI-PAT by controlling it via OLE and Windows Automation. When either PI-DATS or PI-Controller launches, it first checks to see if PI-PAT is already running. If so, it establishes an OLE connection. If not, it will launch a hidden copy of PI-PAT and connect to it. A hidden copy of PI-PAT may be revealed either by double-clicking the PI-PAT icon or by clicking the **Edit** button on the Pat mnemonic in Controller mode.

3.6. Clock Driver and DC Bias Card mnemonics

Below are descriptions of each supported Pulse Instruments DC Bias or Clock Driver card model and the settable parameters.

3.6.1. XMFRM (Mainframe) Mnemonic

The **Online/Offline/Disconnect** state and card voltage ranges are controlled by the **XMFRM** (mainframe) mnemonic:

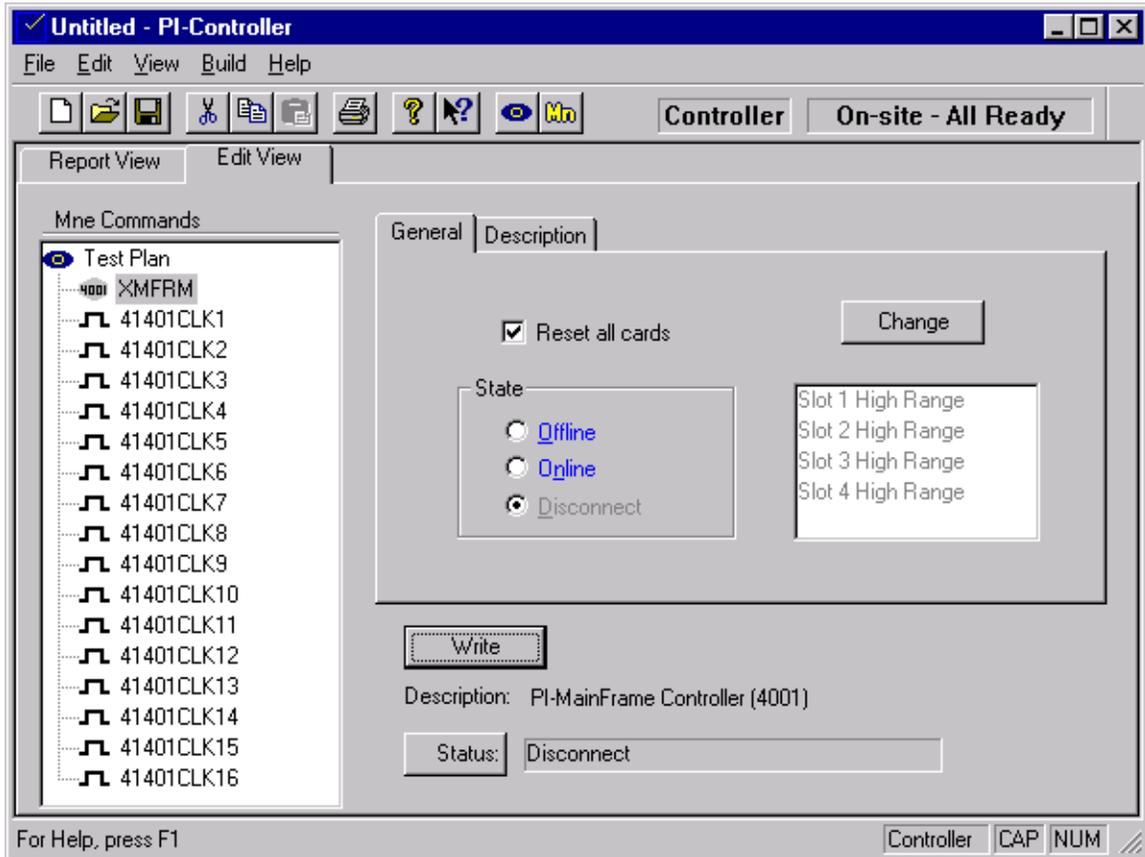


Figure 32: XMFRM (Mainframe) Mnemonic

3.6.1.1. Reset all cards

To reset all cards to the power-up state, check this box and click **Write**.

3.6.1.2. Instrument State

To place the instrument in a desired mode, click the appropriate radio button and then click **Write**. DC Bias and Clock Driver settings will be applied or disconnected based on the default sequence.

3.6.1.3. Voltage Ranges

Selected instruments cards (e.g. PI-41401 Clock Driver Card) may have more than one operating range. To protect against voltage transients, the ranges can only be switched when the instrument is in **Disconnect**. All channels on a given instrument card may be required to be in the same range (depending on card model), but different cards may be in different ranges.

Card Model	Voltage Range		Resolution			
	Hi Range	Lo Range	Hi Range		Low Range	
PI-41401 Clock Driver	-3 to +8 V	-5 to +6 V	64 mV		64 mV	
PI-42750/42755 DC Bias	-20.48 to +20.4775	-10.24 to +10.23875	2.5 mV		1.25 mV	
PI-42753 DC Bias	-25.1 to +25.1	-10.24 to +10.23875	3.125 mV		1.25 mV	
PI-42757 DC Bias	0 to +35.8	0 to +10.23875	2.5 mV		0.625 mV	
			Hi Res	Lo Res	Hi Res	Lo Res
PI-4075x DC Bias	-20.48 to +20.47 V	-10.24 to +10.235 V	0.5 mV	10 mV	0.25 mV	5 mV
PI-40753 DC Bias	-25.00 to +25.00 V	-10.24 to +10.235 V	0.625 mV	12.5 mV	0.25 mV	5 mV

Table 6: Voltage and Resolution By Card Model

To change the range on a card, set the instrument to **Disconnect** by selecting the **Disconnect** radio button and clicking **Write**, then select a card by its slot number and click the **Change** button. Click **Write** again to apply the change. All Range indicators should return to gray to indicate concurrence with the hardware settings. The instrument may now be returned to the **Offline** or **Online** state as desired.

A card or channel's range may not be changed if the programmed voltage levels or limits are outside of the valid values for the new range. To correct this, return the card to its current range setting, place the instrument either in the **Offline** or **Online** state and write the change to hardware, then select each offending mnemonic and make the required changes to voltage settings. Be sure to **Write** each change to hardware, then return to the **Mainframe** mnemonic to change the range.

3.6.2. PI-40740/PI-40750/ PI-40752/PI-40753/PI-40755 DC Bias Cards

This section describes the operation of the PI-40750, PI-40752, PI-40753, and PI-40752 Low-Noise DC Bias cards:

- The PI-40740 provides four channels of ± 20 V DC bias with up to 25 mA of output current per channel.
- The PI-40750 provides four channels of ± 20 V low-noise DC bias with up to 25 mA of output current per channel.
- The PI-40752 provides four channels of ± 20 V low-noise DC bias with up to 100 mA of output current per channel.
- The PI-40753 provides four channels of ± 25 V low-noise DC bias with up to 100 mA of output current per channel.
- The PI-40755 provides two channels of ± 20 V low-noise DC bias with up to 250 mA of output current per channel.

Operation of these cards is identical, with the exception of the number of channels, the typical noise levels, and the maximum output current.

3.6.2.1. Settable Parameters

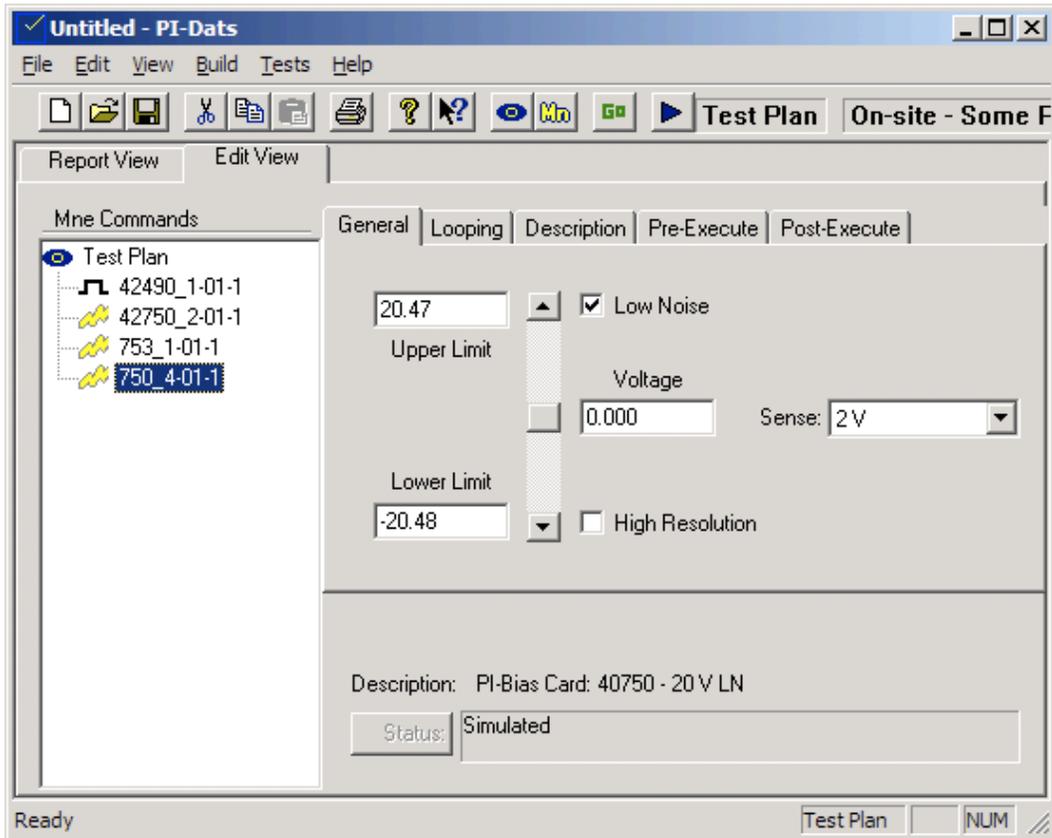


Figure 33: Settable Parameters for PI-4075x DC Bias Card

3.6.2.1.1. Voltage

The Voltage output of the selected channel. The Voltage output on the PI-40750/752/755 DC Bias Card can be set from -20.48 V to $+20.47$ V in High Range or -10.24 V to $+10.235$ V in Low Range using the scroll bar or the text input box.

3.6.2.1.2. Upper Voltage Limit

This limit is the highest allowable value for the Bias Voltage. Use this parameter to protect the device under test. Once this parameter is set, the system will disallow any attempt to set or increment the Bias Voltage to a value higher than this limit. The maximum value for this limit is $+20.47$ V on the PI-40750/752/755 DC Bias Card or $+25.00$ V for the 40753 card.

3.6.2.1.3. Lower Voltage Limit

This limit is the lowest allowable value for the Bias Voltage. Use this parameter to protect the device under test. Once this parameter is set, the system will disallow any attempt to set or decrement the Bias Voltage to a value lower than this limit. The minimum value for this limit is -20.48 V on the PI-40750/752/755 DC Bias Card or -25.00 V for the 40753 card.

3.6.2.1.4. Low Noise

This checkbox selects the noise level for the bias channel. In Low Noise mode (default) a filter circuit significantly reduces output noise, but increases the response time to a programmed change in voltage.

Note: The 40740 card lacks this filter feature and is always in “Regular” mode.

3.6.2.1.5. High Resolution

The programming resolution setting for odd-numbered channels only. When this box is checked, the 40750/752/755 will combine the DAC outputs from two channels to increase the programming resolution of the selected channel to 0.5 mV in High Range and to 0.25 mV in Low Range. Enabling high resolution on an odd-numbered channel will disable the next even-numbered channel on the card.

Note 1: Although the even-numbered “control” channel is disabled, there will still be output of 0 – 200 mV from that channel. The control channel should be physically disconnected from the DUT when high-resolution is enabled.

Note 2: On the 40755 card, High Resolution mode is available on both cards, and no channels are disabled. (The cards are internally wired as channels 1 and 3, but addressed by the operating system as channels 1 and 2).

3.6.2.1.6. Sense Range

Selects the range for voltage and current sensing. Selectable options are **2 V**, **20 V**, **1 mA**, **10 mA**, and **100 mA**. Please see **Section 2.15. Voltage and Current Sensing** for information on use of the Sense feature.

3.6.2.2. Bias Description

This property page describes the type of hardware assigned to this mnemonic. The physical location is also shown.

The screenshot shows a software interface for configuring a PI-Bias Card. It has two tabs: 'General' and 'Description', with 'Description' selected. The 'Description' tab contains the following fields and controls:

- Description: PI-Bias Card
- Part Number: 40750 - 20 V LN (dropdown menu)
- GPIB Address: 11 (dropdown menu)
- MainFrame: 1 (dropdown menu)
- Slot: 1 (dropdown menu)
- Channel: 2 (dropdown menu)
- Buttons: Write, Read, Set All
- Description: PI-Bias Card: 40750 - 20 V LN
- Status: Simulated

Figure 34: Description property page for PI-4075x Four Channel DC Bias Card

3.6.3. PI-41702/41703 DC Bias Cards

This section describes the operation of the PI-41702 and PI-41703 Low Noise Four Channel DC Bias cards.

The PI-41702 provides four channels of ± 8 V DC bias with up to 100 mA of output current per channel. The PI-41702 offers very low output noise, making it suitable for noise-critical applications. The PI-41703 provides four channels of ± 8 V DC bias with up to 150 mA of output current per channel, with slightly higher noise levels.

3.6.3.1. Settable Parameters

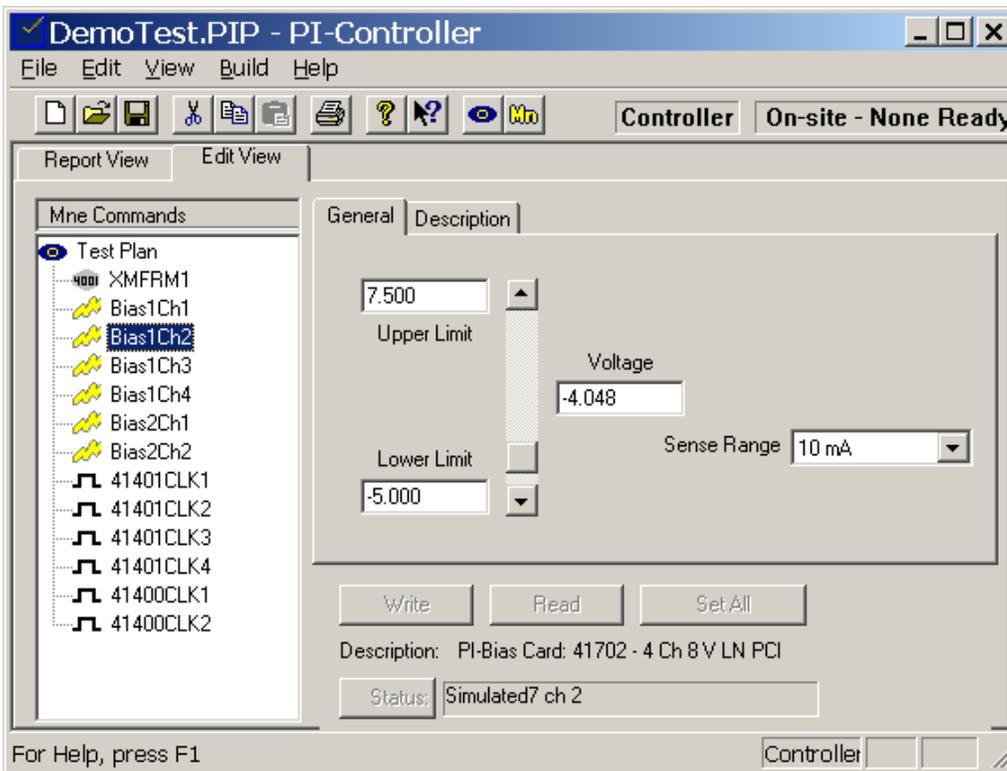


Figure 35: Settable Parameters for PI-41702 Four Channel Low Noise DC Bias Card

3.6.3.1.1. Bias Voltage

The Voltage output of the selected channel. The Voltage output on the PI-41702 and PI-41703 DC Bias Cards can be set from +8.188 V to -8.188 V.

3.6.3.1.2. Upper Voltage Limit

This limit is the highest allowable value for the Bias Voltage. Use this parameter to protect the device under test. Once this parameter is set, the system will disallow any attempt to set or increment the Bias Voltage to a value higher than this limit. The maximum value for this limit is +8.188 V on the PI-41702 and PI-41703 DC Bias Cards.

3.6.3.1.3. Lower Voltage Limit

This limit is the lowest allowable value for the Bias Voltage. Use this parameter to protect the device under test. Once this parameter is set, the system will disallow any attempt to set or decrement the Bias Voltage to a value lower than this limit. The minimum value for this limit is -8.192 V on the PI-41702 and PI-41703 DC Bias Cards.

3.6.3.1.4. Sense Range

Selects the range for voltage and current sensing. Selectable options are **Voltage, 1 mA**, **10 mA**, and **100 mA** for the PI-41702 and **Voltage, 2 mA**, **20 mA**, and **200 mA** for the PI-41703. Please see **Section 2.15. Voltage and Current Sensing** for information on use of the Sense feature.

3.6.3.2. Bias Description

This property page describes the type of hardware assigned to this mnemonic. The physical location is also shown.

The screenshot shows a software interface for configuring a PI-Bias Card. At the top, there are two tabs: 'General' and 'Description', with 'Description' selected. Below the tabs, the text 'Description: PI-Bias Card' is displayed. The main area contains several configuration fields, each with a dropdown arrow: 'Part Number' is set to '41702 - 4 Ch 8 V LN PCI', 'GPIB Address' is 'PCI Bus', 'MainFrame' is '0', 'Slot' is '1', and 'Channel' is '1'. Below these fields are three buttons: 'Write', 'Read', and 'Set All'. At the bottom, there is a 'Status:' label followed by a text box containing 'Offline'. The overall background is a light gray color.

Figure 36: Description property page for PI-41702 Four Channel DC Bias Card

3.6.4. PI-42750/PI-42753/PI-42755/PI-42757 DC Bias Cards

This section describes the operation of the PI-42750 and PI-42755 Low-Noise DC Bias cards:

- The PI-42750 provides four channels of ± 20 V low-noise DC bias with up to 100 mA of output current per channel.
- The PI-42753 provides four channels of ± 25 V low-noise DC bias with up to 100 mA of output current per channel.
- The PI-42755 provides two channels of ± 20 V low-noise DC bias with up to 250 mA of output current per channel.
- The PI-42757 provides four channels of +35.8 V low-noise DC bias with up to 100 mA of output current per channel.

Operation of these cards is similar, with the exception of the number of channels, the minimum resolution, and the maximum output current.

3.6.4.1. Settable Parameters

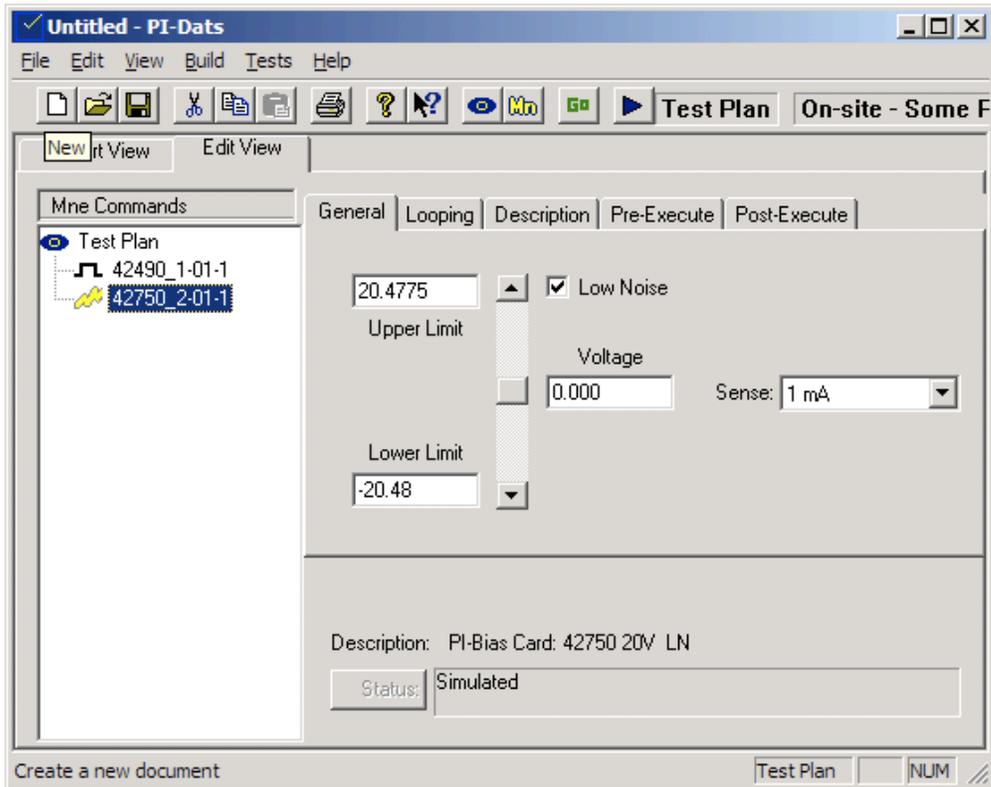


Figure 37: Settable Parameters for PI-4275x DC Bias Card

3.6.4.1.1. Voltage

The Voltage output of the selected channel. The Voltage output can be set using the scroll bar or the text input box. The programmed voltage value must be within the programmed Upper/Lower Voltage Limits (see below) and within the hardware limits listed in Table 6: Voltage and Resolution By Card Model, above.

3.6.4.1.2. Upper Voltage Limit

This limit is the highest allowable value for the Bias Voltage. Use this parameter to protect the device under test. Once this parameter is set, the system will disallow any attempt to set or increment the Bias Voltage to a value higher than this limit.

3.6.4.1.3. Lower Voltage Limit

This limit is the lowest allowable value for the Bias Voltage. Use this parameter to protect the device under test. Once this parameter is set, the system will disallow any attempt to set or decrement the Bias Voltage to a value lower than this limit.

3.6.4.1.4. Low Noise

This checkbox selects the noise level for the bias channel. In Low Noise mode (default) an RC filter circuit significantly reduces output noise, but increases the response time to a programmed change in voltage.

3.6.4.1.5. Sense Range

Selects the range for voltage and current sensing. Selectable options are **2 V**, **20 V**, **1 mA**, **10 mA**, and **100 mA**. Please see **Section 2.15. Voltage and Current Sensing** for information on use of the Sense feature.

3.6.4.2. Bias Description

This property page describes the type of hardware assigned to this mnemonic. The physical location is also shown.

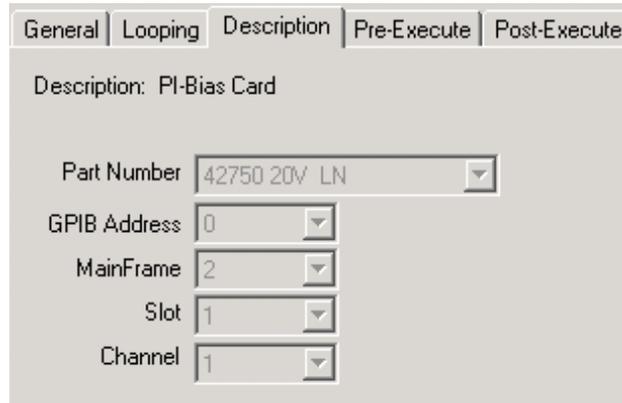


Figure 38: Description property page for PI-4075x Four Channel DC Bias Card

3.6.5. PI-40460 Dual Channel Driver Card

3.6.5.1. Settable Parameters

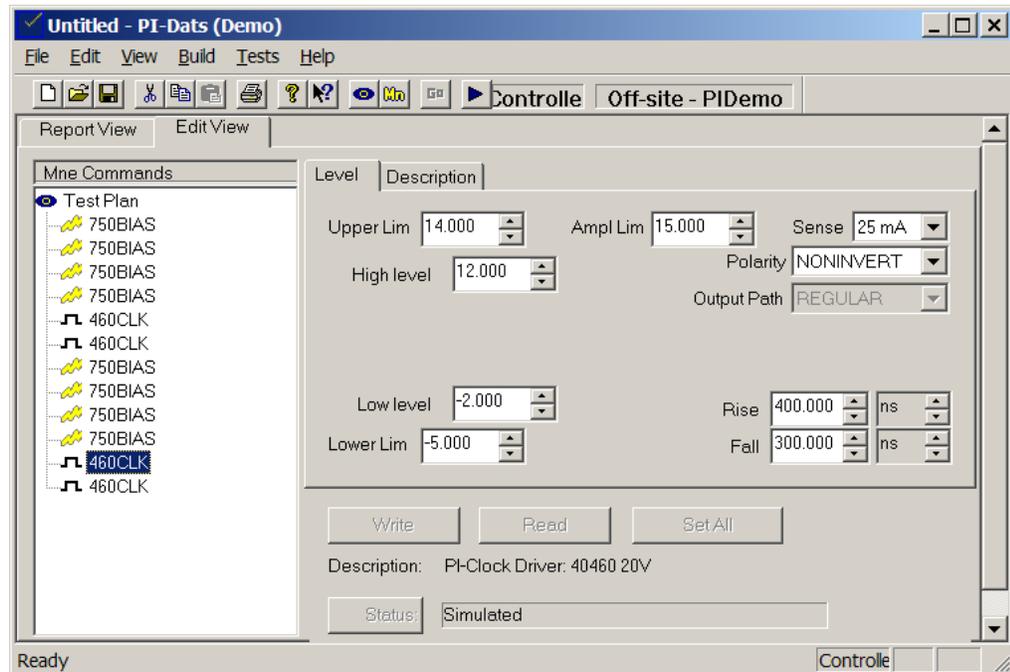


Figure 39: Settable Parameters for PI-4046x Dual Channel Clock Driver Card

3.6.5.1.1. High Level

The high-level voltage output (HLV or “high rail”) of the selected channel. The High Level output on the PI-40460 Dual Channel Clock Driver can be set from +20.47 V to -19.48 V.

3.6.5.1.2. Upper Voltage Limit

This limit is the highest allowable value for the HLV. Use this parameter to protect the device under test. Once this parameter is set, the system will disallow any attempt to set or increment the HLV to a value higher than this limit. The maximum value for this limit is +20.47 V on the PI-40460 Dual Channel Clock Driver Card, and it must be higher than the Lower Voltage Limit.

3.6.5.1.3. Low Level

The low-level voltage output (LLV or “low rail”) of the selected channel. The Low Level output on the PI-40460 Dual Channel Clock Driver can be set from –20.47 V to +19.47 V.

3.6.5.1.4. Lower Voltage Limit

This limit is the lowest allowable value for the LLV. Use this parameter to protect the device under test. Once this parameter is set, the system will disallow any attempt to set or decrement the LLV to a value lower than this limit. The minimum value for this limit is –20.47 V on the PI-40460 Dual Channel Clock Driver Card, and it must be lower than the Upper Voltage Limit.

3.6.5.1.5. Amplitude Limit

This limit is the allowable difference between HLV and LLV. Use this parameter to protect the device under test. Once this parameter is set, the system will disallow any attempt to set or increment/decrement HLV or LLV such that the amplitude exceeds this limit. The allowable range for this limit is 1 V to 20 V on the PI-40460 Dual Channel Clock Driver Card.

3.6.5.1.6. Rise Time

Rise-time is defined as the time between the 10% to 90% points of the pulse amplitude. This transition time is in nanoseconds (ns). The allowable range for this value is from 40 ns to 40,000 ns at 20 V_{PP}, for the PI-40460 Dual Channel Clock Driver Card. The rise and fall time must both be in the same decade range.

3.6.5.1.7. Fall Time

Fall-time is defined as the time between the 90% to 10% points of the pulse amplitude. This transition time is in nanoseconds (ns). The allowable range for this value is from 40 ns to 40,000 ns at 20 V_{PP}, for the PI-40460 Dual Channel Clock Driver Card. The rise and fall time must both be in the same decade range.

3.6.5.1.8. Polarity

The output polarity relative to the input signal. Selectable options are **INVERT** and **NONINVERT**.

3.6.5.1.9. Sense Range

Selects the range for voltage and current sensing. Selectable options are **1 mA**, **10 mA**, and **25 mA**. Please see **Section 2.15. Voltage and Current Sensing** for information on use of the Sense feature.

3.6.5.2. Driver Description

This property page describes the type of hardware assigned to this mnemonic. The physical location is also shown.

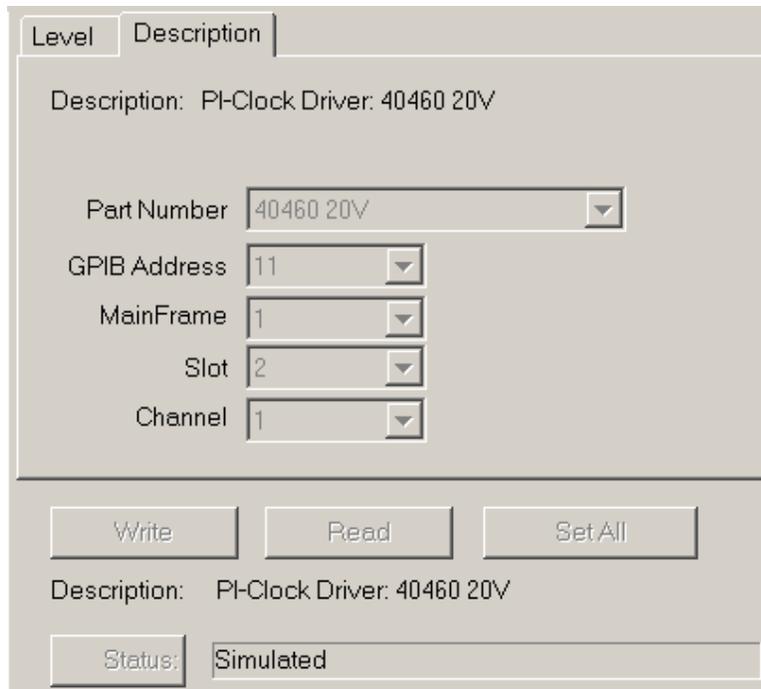


Figure 40: Description property page for PI-40460 Dual Channel Clock Driver Card

3.6.6. PI-40465 Dual Channel Tri-Level Driver Card

3.6.6.1. Settable Parameters

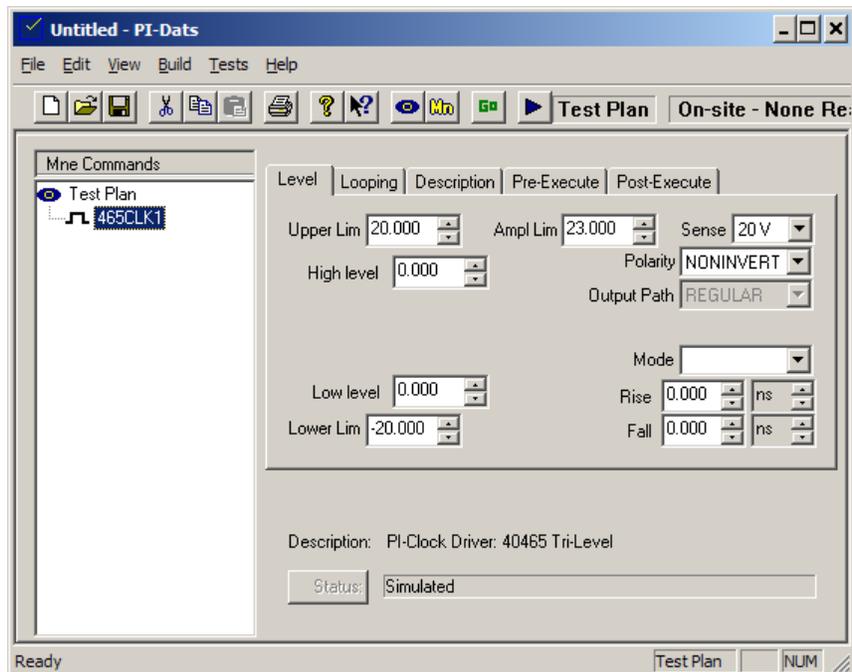


Figure 41: Settable Parameters for PI-40465 Dual Channel Tri-Level Clock Driver

3.6.6.1.1. Description

The 40465 Tri-Level Driver Card can output in Two-Level, Tri-Level, or Four-Level Mode.

In Two-Level Mode, the 40465 behaves like any other two-level driver card, such as the 40460. It requires one input per channel, which should be connected to the A port.

The Tri-Level and Four-Level Modes require two channels of input for each output channel. The diagram below shows the relationship between the inputs at the A and B ports and the output signal.

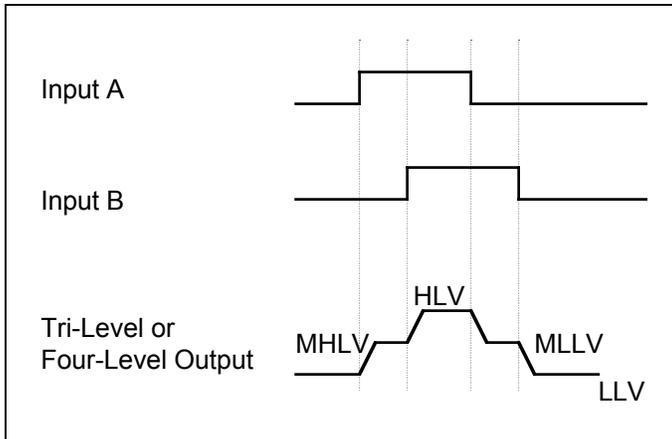


Figure 42: Tri-Level and Four-Level Output From the 40465 Driver Card

In Tri-Level Mode, the MHLV and MLLV are the same value, as specified by the setting of the MLV.

To obtain a Tri-Level or Four-Level output as shown above, you must set up the input signals as shown. The leading edge of the pulse at Input A must precede the leading edge of the pulse at Input B, and the trailing edge of the pulse at Input A must precede the trailing edge of the pulse at Input B. Each “step” in the waveform must be at least 1 V. If any of these conditions is violated you will not be able to control the rise and fall times.

The output signal in Tri-Level and Four-Level Mode will exhibit the same slew rate as if the instrument were set to Two-Level Mode. For example, if the total voltage swing between the HLTV and LLV were 20.00 V and the programmable rise time were 100 ns, the resulting slew rate would be 5 ns/V. In Tri-Level or Four Level Mode, the slew rate remains the same. The total rise time from LLV to HLTV depends, of course, on the pattern at the Input Ports.

Operating parameters that are common with the 4046x cards will not be repeated in the following sections.

3.6.6.1.2. Mode

The output mode of the Driver. The Mode can be set to Two-Level, Tri-Level, or Four-Level.

3.6.6.1.3. Med High Level Voltage

(Four-Level Mode only) The Middle High Rail of the output. The difference between the High Level Voltage and the Med High Level Voltage must be at least 1 V, as must the difference between the Med High Level Voltage and the Low Level Voltage.

3.6.6.1.4. Med (Low) Level Voltage

(Tri-Level or Four-Level Modes only) The Middle Rail of the Tri-Level output or the Middle Low Rail of the Four-Level output. The difference between the High Level Voltage and the Med Low Level Voltage must be at least 1 V, as must the difference between the Med Low Level Voltage and the Low Level Voltage.

3.6.7. PI-40490 65 MHz Clock Driver Card

3.6.7.1. Settable Parameters

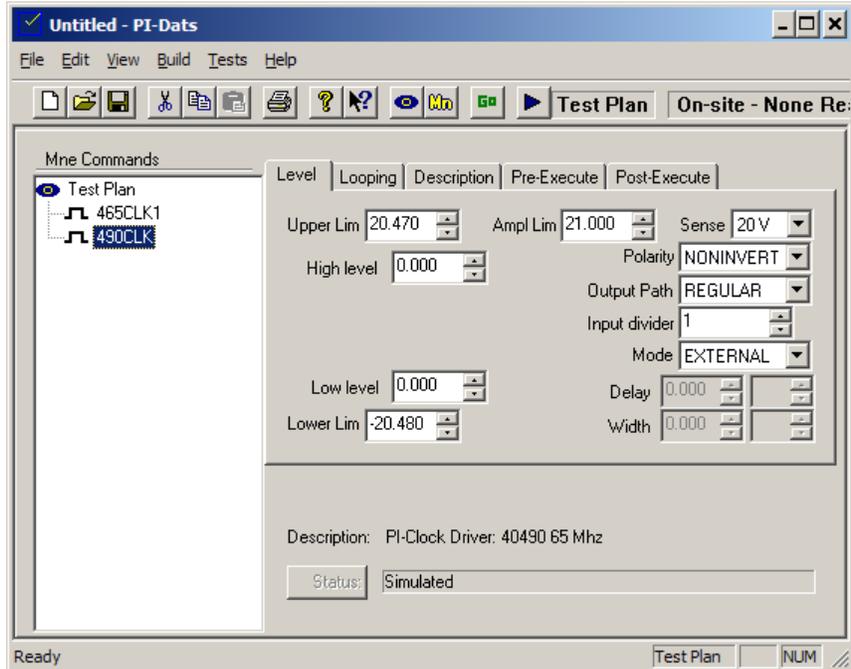


Figure 43: Settable Parameters for PI-40490 65 MHz Clock Driver Card

3.6.7.1.1. Description

There are two output signals and four output modes available on the 40490 Driver Card. The relationship of each output mode to the input signal is shown below.

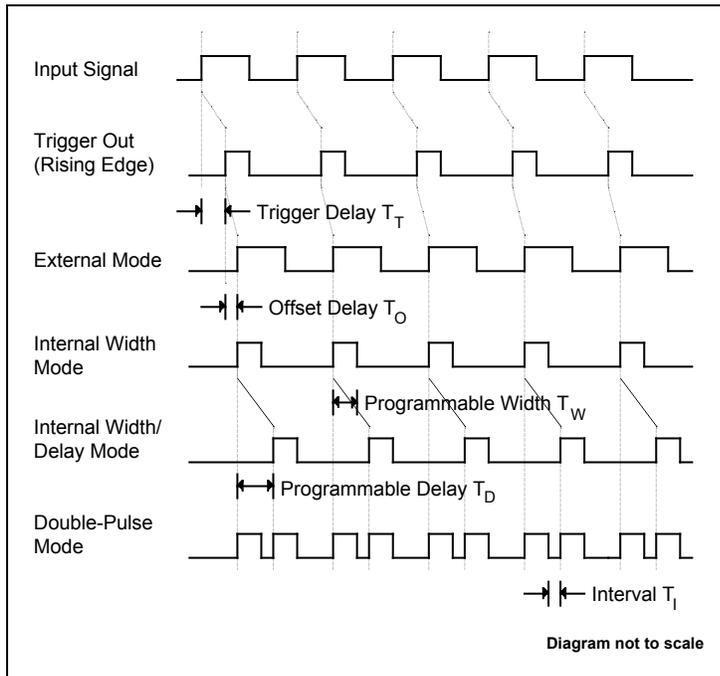


Figure 44 40490 Output Waveforms (Rising edge trigger, non-inverted output)

The first waveform in the diagram above represents the input signal. The second waveform represents the Trigger Out signal. The Trigger Out signal can be programmed to occur on either a rising edge or falling edge of the input signal. In this example, the Trigger Out is occurring on the rising edge of the input signal. There is a slight delay, T_T , between the edge of the input signal and the Trigger Out signal. The duration of T_T is 10 ns maximum with respect to an input at the TTL (non optically-isolated) port and 65 ns maximum with respect to an input at the Optically-Isolated port.

The next four waveforms represent the four output modes available on the 40490 Driver card. In all four modes, there is an additional delay, T_O relative to the Trigger Out signal. This delay represents the time it takes for the output signal to propagate through the driver circuitry. The duration of T_O is typically $21 \text{ ns} \pm 3 \text{ ns}$.

In the External Mode, the width of the Output Signal is identical to the width of the Input Signal. In other words, the source of the width is "external." The total delay between the edge of the input pulse and the edge of the output pulse is $T_T + T_O$.

In the Internal Width Mode, the Width, T_W , of the Output Signal can be set internally from 7 ns to 100 ms. As with the External Mode, the total delay between the edge of the input pulse and the edge of the output pulse is $T_T + T_O$.

In the Internal Delay/Width Mode, both the Width and the Delay can be set internally. The Width may be set from 7 ns to 100 ms, and the Delay may be set from 30 ns to 100 ns. The total delay between the leading edges of the input pulse and output pulse is $T_T + T_O + T_D$.

In the Double Pulse Mode, the driver generates two pulses every time it is strobed by the Trigger Out signal. The first pulse occurs as if the Programmable Delay were 0 ns, and the second pulse occurs after the duration of the actual Programmable Delay. The total delay between the edge of the input pulse and the edge of the first output pulse is $T_T + T_O$. The total delay between the edge of the input pulse and the edge of the second output pulse is $T_T + T_O + T_D$. The interval between pulses, T_I , is not a programmed value. Instead, it is the difference between the Delay and Width, or $T_D - T_W$. $T_D - T_W$ must be set such that the interval, T_I , has a minimum width of 15 ns.

The 40490 card has fixed rising and falling edges. Operating parameters that are common with the 4046x cards will not be repeated in the following sections.

3.6.7.1.2. Mode

The output mode. The 40490 can output in External, Internal Width, Internal Delay/Width or Double-Pulse Mode. See the timing diagram above.

3.6.7.1.3. Delay

The Programmable Delay, T_D , in nanoseconds, microseconds, or milliseconds. This may be set from 30 ns to 100 ms.

3.6.7.1.4. Width

The programmable width, T_W , in nanoseconds, microseconds, or milliseconds. This may be set from 7 ns to 100 ms.

3.6.7.1.5. Output Path

The clock output can be routed either to the "regular" clock driver output or to an Auxiliary output for monitoring on an oscilloscope. The Aux output should not be used to drive your device.

3.6.7.1.6. Input Divider

The input circuit can be set to divide the incoming clock by an integer from 1-16, inclusive.

3.6.8. PI-41401 Four Channel Driver Card

3.6.8.1. Settable Parameters

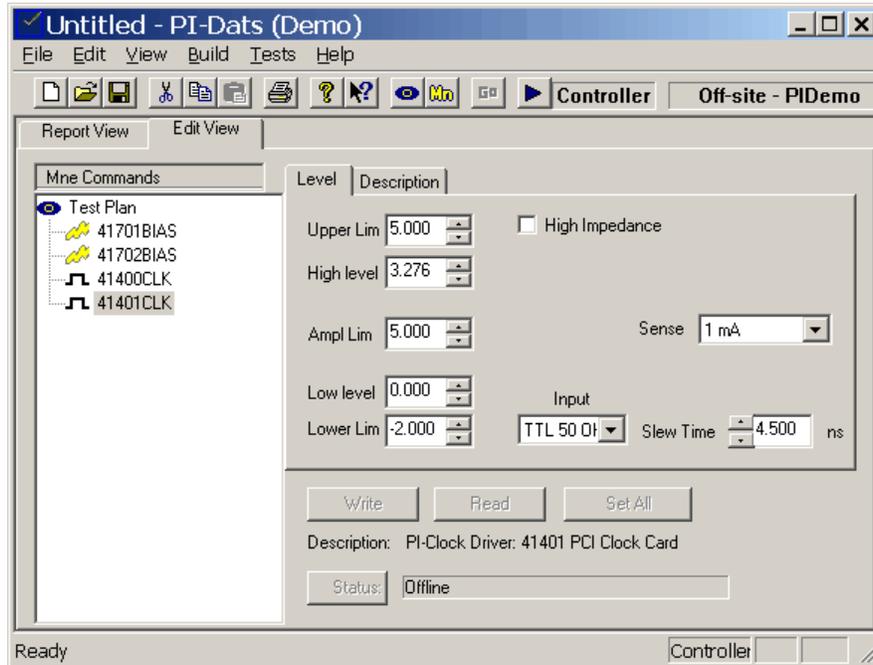


Figure 45: Settable Parameters for PI-41401 Four Channel Clock Driver Card

3.6.8.1.1. High Level

The high-level voltage output (HLV or “high rail”) of the selected channel. The High Level output on the PI-41401 Four Channel Clock Driver can be set from -5.0 V to $+8.0$ V, but the High and Low levels for all four channels on a card must be within one of two ranges, either -5.0 V to $+6.0$ V or -3.0 V to $+8.0$ V.

Driver channels on different cards may be in different ranges. Please see **Section 3.6.1.3. Voltage Ranges** for information on changing ranges.

3.6.8.1.2. Upper Voltage Limit

This limit is the highest allowable value for the HLV. Use this parameter to protect the device under test. Once this parameter is set, the system will disallow any attempt to set or increment the HLV to a value higher than this limit. The maximum value for this limit is $+8.0$ V on the PI-41401 Four Channel Clock Driver Card, and it must be higher than the Lower Voltage Limit.

3.6.8.1.3. Low Level

The low-level voltage output (LLV or “low rail”) of the selected channel. The Low Level output on the PI-41401 Four Channel Clock Driver can be set from -5.0 V to $+8.0$ V, but the High and Low levels for all four channels on each card must be within one of two ranges, either -5.0 V to $+6.0$ V or -3.0 V to $+8.0$ V.

Driver channels on different cards may be in different ranges. Please see **Section 3.6.1.3. Voltage Ranges** for information on changing ranges.

3.6.8.1.4. Lower Voltage Limit

This limit is the lowest allowable value for the LLV. Use this parameter to protect the device under test. Once this parameter is set, the system will disallow any attempt to set or decrement the LLV to a value lower than this limit. The minimum value for this limit is -5.0 V on the PI-41401 Four Channel Clock Driver Card, and it must be lower than the Upper Voltage Limit.

3.6.8.1.5. Amplitude Limit

This limit is the allowable difference between HLV and LLV. Use this parameter to protect the device under test. Once this parameter is set, the system will disallow any attempt to set or decrement HLV or LLV such that the amplitude exceeds this limit. The allowable range for this limit is 0 V to 8.0 V on the PI-41401 Four Channel Clock Driver Card.

3.6.8.1.6. Slew Time

The PI-41401 Four Channel Clock Driver uses a common control for the adjustable rise- and fall-time of each channel. The slew-time is defined as the time between the 10% to 90% points (rising edge) or 90% to 10% points (falling edge) of the pulse amplitude. This transition time is in nanoseconds (ns). The allowable range for this value is from <2 ns to 40 ns, depending on the programmed amplitude, for the PI-41401 Four Channel Clock Driver Card.

At a given amplitude, the lower bound for the rise-time is approximately 0.54 times the numerical amplitude in Volts, and the upper bound is approximately 4.6 times the numerical amplitude in Volts. For example, given a programmed amplitude of 5.0 V, the programmable rise time range is approximately from 2.7 ns to 23.4 ns.

Please note that the slew-time control is intended as a convenience feature, not as a precision adjustment, and actual slew-times may vary significantly from the programmed value, particularly at higher values. Although programmable slew-time behavior is highly repeatable for a given channel, programmable slew-time behavior may exhibit considerable variation across channels. In production environments, the behavior for each channel should be characterized.

3.6.8.1.7. Input

Selects the input source and termination. Selectable options are **TTL 500 Ohms**, and **TTL 50 Ohms**.

3.6.8.1.8. High Impedance

This checkbox tri-states the driver output, allowing the line to be driven high or low by another device or instrument.

3.6.8.1.9. Sense Range

Selects the range for voltage and current sensing. Selectable options are **1 mA**, **10 mA**, and **21.1 mA**. Please see **Section 2.15. Voltage and Current Sensing** for information on use of the Sense feature.

3.6.8.2. Driver Description

This property page describes the type of hardware assigned to this mnemonic. The location is also shown.

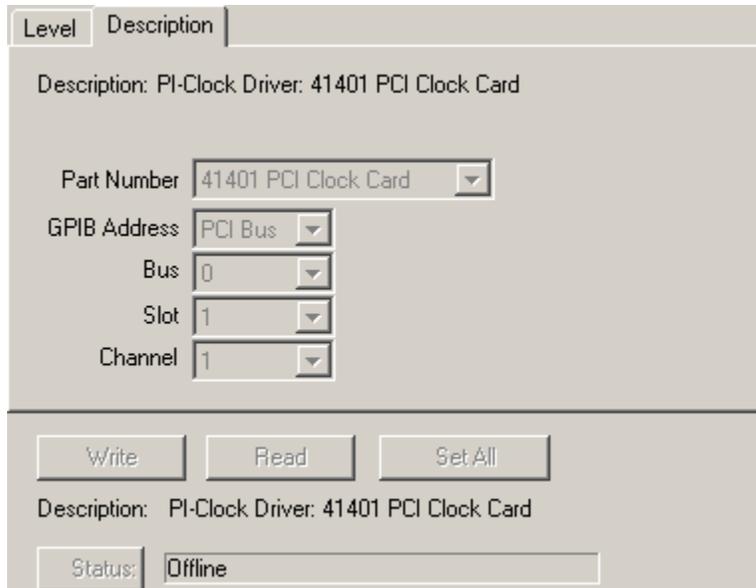


Figure 46: Description property page for PI-41401 Four Channel Clock Driver Card

3.6.9. PI-42460 Dual Channel Driver Card

3.6.9.1. Settable Parameters

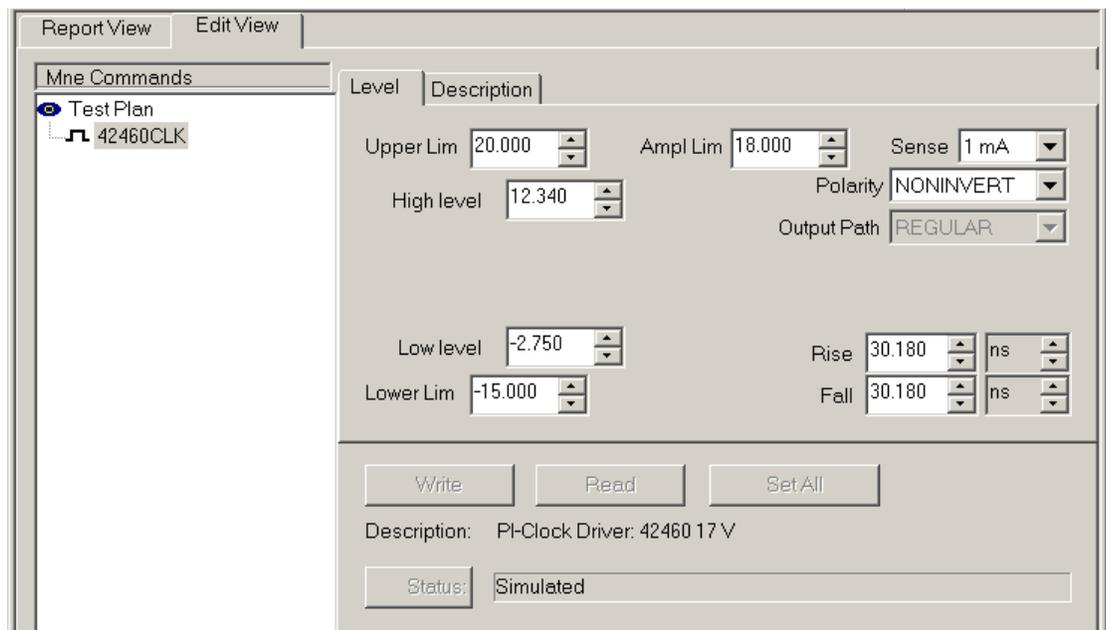


Figure 47: Settable Parameters for PI-42460 Dual Channel Clock Driver Card

3.6.9.1.1. High Level

The high-level voltage output (HLV or “high rail”) of the selected channel. The High Level output on the PI-42460 Dual Channel Clock Driver can be set from +20 V to -18 V.

3.6.9.1.2. Upper Voltage Limit

This limit is the highest allowable value for the HL_V. Use this parameter to protect the device under test. Once this parameter is set, the system will disallow any attempt to set or increment the HL_V to a value higher than this limit. The maximum value for this limit is +20 V on the PI-42460 Dual Channel Clock Driver Card, and it must be higher than the Lower Voltage Limit.

3.6.9.1.3. Low Level

The low-level voltage output (LL_V or “low rail”) of the selected channel. The Low Level output on the PI-42460 Dual Channel Clock Driver can be set from –20 V to +18 V.

3.6.9.1.4. Lower Voltage Limit

This limit is the lowest allowable value for the LL_V. Use this parameter to protect the device under test. Once this parameter is set, the system will disallow any attempt to set or decrement the LL_V to a value lower than this limit. The minimum value for this limit is -20 V on the PI-42460 Dual Channel Clock Driver Card, and it must be lower than the Upper Voltage Limit.

3.6.9.1.5. Amplitude Limit

This limit is the allowable difference between HL_V and LL_V. Use this parameter to protect the device under test. Once this parameter is set, the system will disallow any attempt to set or increment/decrement HL_V or LL_V such that the amplitude exceeds this limit. The allowable range for this limit is 1 V to 20 V on the PI-42460 Dual Channel Clock Driver Card.

3.6.9.1.6. Rise Time

Rise-time is defined as the time between the 10% to 90% points of the pulse amplitude. This transition time is in nanoseconds (ns). The allowable range for this value is from 1 ns/V - 10 ns/V, equivalent to 20 ns - 200 ns at 20 V_{PP}, for the PI-42460 Dual Channel Clock Driver Card. Slower rise-times may be programmed, but no accuracy is specified beyond 10 ns/V, and the programmable precision decreases rapidly at larger values.

3.6.9.1.7. Fall Time

Fall-time is defined as the time between the 90% to 10% points of the pulse amplitude. This transition time is in nanoseconds (ns). The allowable range for this value is from 1 ns/V - 10 ns/V, equivalent to 20 ns - 200 ns at 20 V_{PP}, for the PI-42460 Dual Channel Clock Driver Card. Slower fall-times may be programmed, but no accuracy is specified beyond 10 ns/V, and the programmable precision decreases rapidly at larger values.

3.6.9.1.8. Input

Selects the input source and termination. Selectable options are **Opto**, **TTL 500 Ohms**, and **TTL 50 Ohms**. Note that the **Opto** and **TTL** inputs are on different physical connectors.

3.6.9.1.9. Polarity

The output polarity relative to the input signal. Selectable options are **INVERT** and **NONINVERT**.

3.6.9.1.10. Sense Range

Selects the range for voltage and current sensing. Selectable options are **1 mA**, **10 mA**, and **25 mA**. Please see **Section 2.15. Voltage and Current Sensing** for information on use of the Sense feature.

3.6.9.2. Driver Description

This property page describes the type of hardware assigned to this mnemonic. The physical location is also shown.

Level	Description
Description: PI-Clock Driver: 42460 17 V	

Part Number: 42460 17 V
GPIB Address: 18
MainFrame: 0
Slot: 1
Channel: 1

Figure 48: Description property page for PI-42460 Dual Channel Clock Driver Card

3.6.10. PI-42465 Tri-Level Driver Card

3.6.10.1. Settable Parameters

42465_DriverDiagnostics.PIP - PI-Dats

File Edit View Build Tests Help

Report View Edit View

Mne Commands

- Set Chan Select
- ProgramMux
- VAR_SNAPSHO
- DVM<Setup>
- Vhi DC Level
- 42465_2-05-
- PAUSE
- DVM<Measu
- VAR_SNAPS
- Vlo -DC Level
- Init MHLV
- Init MLLV
- VMidHi DC Level
- 42465_2-05-
- PAUSE
- DVM<Measu
- VAR_SNAPS
- Inc MHLV
- Inc MLLV

Level Looping Description Pre-Execute Post-Execute

Upper Lim 20.47 Ampl Lim 25 Sense 20 V

High level 11.00 Polarity

Med High fMHLV

Med Low fMLLV

Low level -11.00 Input Rise N/A ns

Lower Lim -20.48 TTL500 Fall N/A ns

Mode Four-Level

Description: PI-Clock Driver: 42465 Tri-Level

Status: Simulated

Ready. Test Plan NUM

Figure 49: Settable Parameters for PI-42465 Tri-Level Clock Driver Card

In Two-Level Mode, the 42465 behaves like any other two-level driver card, such as the 42460. It requires one input per channel, which should be connected to the TTL IN or OPTO IN port.

The Tri-Level and Four-Level Modes require two channels of input for each output channel. The diagram below shows the relationship between the inputs at the A and B ports and the output signal.

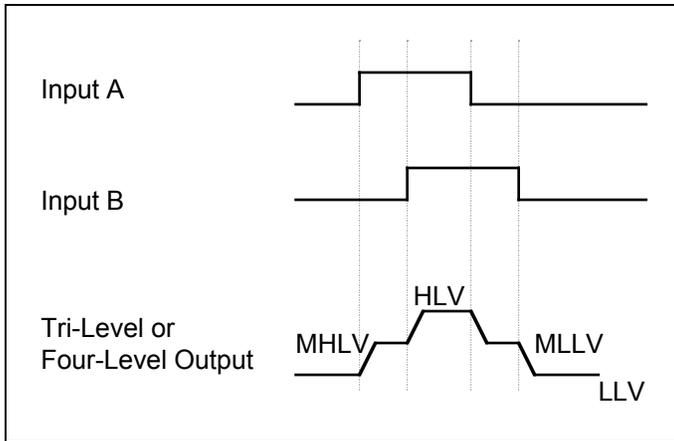


Figure 50: Tri-Level and Four-Level Output From the 42465 Driver Card

In Tri-Level Mode, the MHLV and MLLV are the same value, as specified by the setting of the MLV.

To obtain a Tri-Level or Four-Level output as shown above, you must set up the input signals as shown. The leading edge of the pulse at Input A must precede the leading edge of the pulse at Input B, and the trailing edge of the pulse at Input A must precede the trailing edge of the pulse at Input B. Each “step” in the waveform must be at least 1 V. If any of these conditions is violated you will not be able to control the rise and fall times.

The output signal in Tri-Level and Four-Level Mode will exhibit the same slew rate as if the instrument were set to Two-Level Mode. For example, if the total voltage swing between the HLV and LLV were 20.00 V and the programmable rise time were 100 ns, the resulting slew rate would be 5 ns/V. In Tri-Level or Four Level Mode, the slew rate remains the same. The total rise time from LLV to HLV depends, of course, on the pattern at the Input Ports.

3.6.10.1.1. Upper Voltage Limit

This limit is the highest allowable value for the HLV. Use this parameter to protect the device under test. Once this parameter is set, the system will disallow any attempt to set or increment the HLV to a value higher than this limit. The maximum value for this limit is +20 V on the PI-42465 Clock Driver Card, and it must be higher than the Lower Voltage Limit.

3.6.10.1.2. High Level

The high-level voltage output (HLV or “high rail”) of the driver channel. The High Level output on the PI-42465 Clock Driver can be set from +20 V to -18 V.

3.6.10.1.3. Low Level

The low-level voltage output (LLV or “low rail”) of the selected channel. The Low Level output on the PI-42465 Clock Driver Card can be set from -20 V to +18 V.

3.6.10.1.4. Lower Voltage Limit

This limit is the lowest allowable value for the LLV. Use this parameter to protect the device under test. Once this parameter is set, the system will disallow any attempt to set or decrement the LLV to a value lower than this limit. The minimum value for this limit is -20 V on the PI-42465 Clock Driver Card, and it must be lower than the Upper Voltage Limit.

3.6.10.1.5. Amplitude Limit

This limit is the allowable difference between HLV and LLV. Use this parameter to protect the device under test. Once this parameter is set, the system will disallow any attempt to set or increment/decrement HLV or LLV such that the amplitude exceeds this limit. The allowable range for this limit is 1 V to 20 V on the PI-42465 Clock Driver Card.

3.6.10.1.6. Rise Time

Rise-time is defined as the time between the 10% to 90% points of the pulse amplitude. This transition time is in nanoseconds (ns). The allowable range for this value is from 1 ns/V - 10 ns/V, equivalent to 20 ns - 200 ns at 20 V_{PP}, for the PI-42465 Clock Driver Card. Slower rise-times may be programmed, but no accuracy is specified beyond 10 ns/V, and the programmable precision decreases rapidly at larger values.

3.6.10.1.7. Fall Time

Fall-time is defined as the time between the 90% to 10% points of the pulse amplitude. This transition time is in nanoseconds (ns). The allowable range for this value is from 1 ns/V - 10 ns/V, equivalent to 20 ns - 200 ns at 20 V_{PP}, for the PI-42465 Clock Driver Card. Slower fall-times may be programmed, but no accuracy is specified beyond 10 ns/V, and the programmable precision decreases rapidly at larger values.

3.6.10.1.8. Input

Selects the input source and termination. Selectable options are **Opto**, **TTL 500 Ohms**, and **TTL 50 Ohms**. Note that the **Opto** and **TTL** inputs are on different physical connectors.

3.6.10.1.9. Polarity

The output polarity relative to the input signal. Selectable options are **INVERT** and **NONINVERT**.

3.6.10.1.10. Mode

The output mode of the Driver. The Mode can be set to Two-Level, Tri-Level, or Four-Level.

3.6.10.1.11. Med High Level Voltage

(Four-Level Mode only) The Middle High Rail of the output. The difference between the High Level Voltage and the Med High Level Voltage must be at least 1 V, as must the difference between the Med High Level Voltage and the Low Level Voltage.

3.6.10.1.12. Med (Low) Level Voltage

(Tri-Level or Four-Level Modes only) The Middle Rail of the Tri-Level output or the Middle Low Rail of the Four-Level output. The difference between the High Level Voltage and the Med Low Level Voltage must be at least 1 V, as must the difference between the Med Low Level Voltage and the Low Level Voltage.

3.6.10.1.13. Sense Range

Selects the range for voltage and current sensing. Selectable options are **1 mA**, **10 mA**, and **25 mA**. Please see **Section 2.15. Voltage and Current Sensing** for information on use of the Sense feature.

3.6.10.2. Driver Description

This property page describes the type of hardware assigned to this mnemonic. The physical location is also shown.

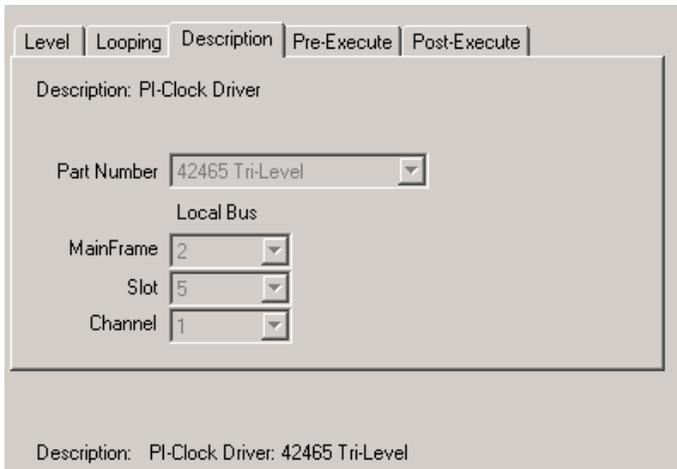


Figure 51: Description property page for PI-42465 Dual Channel Clock Driver Card

3.6.11. PI-42490 Dual Channel Driver Card

3.6.11.1. Settable Parameters

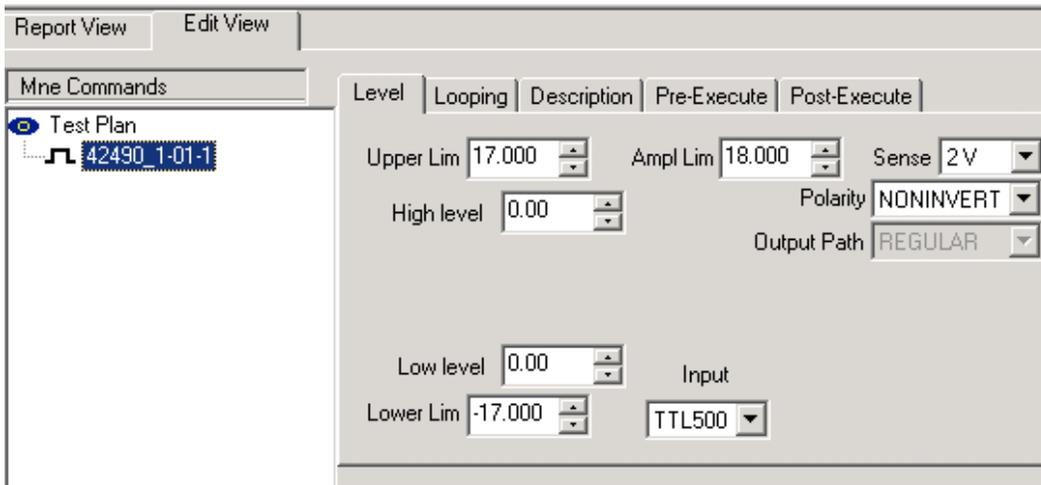


Figure 52: Settable Parameters for PI-42490 Dual Channel Clock Driver Card

3.6.11.1.1. High Level

The high-level voltage output (HLV or “high rail”) of the selected channel. The High Level output on the PI-42490 Dual Channel Clock Driver can be set from +17 V to –7 V.

3.6.11.1.2. Upper Voltage Limit

This limit is the highest allowable value for the HLV. Use this parameter to protect the device under test. Once this parameter is set, the system will disallow any attempt to set or increment the HLV to a value higher than this limit. The maximum value for this limit is +17 V on the PI-42490 Dual Channel Clock Driver Card, and it must be higher than the Lower Voltage Limit.

3.6.11.1.3. Low Level

The low-level voltage output (LLV or “low rail”) of the selected channel. The Low Level output on the PI-42490 Dual Channel Clock Driver can be set from –17 V to +7 V.

3.6.11.1.4. Lower Voltage Limit

This limit is the lowest allowable value for the LLV. Use this parameter to protect the device under test. Once this parameter is set, the system will disallow any attempt to set or decrement the LLV to a value lower than this limit. The minimum value for this limit is -17 V on the PI-42490 Dual Channel Clock Driver Card, and it must be lower than the Upper Voltage Limit.

3.6.11.1.5. Amplitude Limit

This limit is the allowable difference between HLV and LLV. Use this parameter to protect the device under test. Once this parameter is set, the system will disallow any attempt to set or increment/decrement HLV or LLV such that the amplitude exceeds this limit. The allowable range for this limit is 1 V to 18 V on the PI-42490 Dual Channel Clock Driver Card.

3.6.11.1.6. Input

Selects the input source and termination. Selectable options are **Opto**, **TTL 500 Ohms**, and **TTL 50 Ohms**. Note that the **Opto** and **TTL** inputs are on different physical connectors.

3.6.11.1.7. Polarity

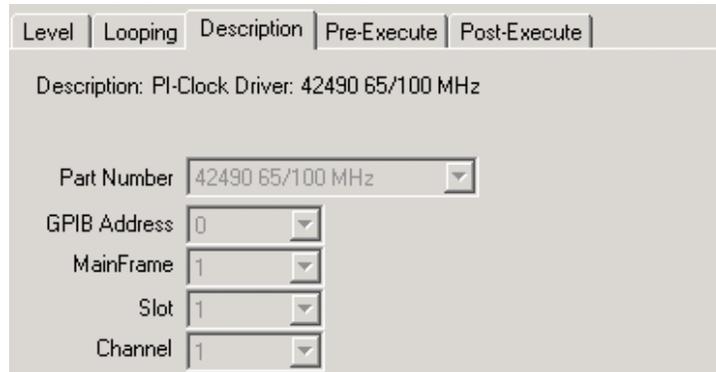
The output polarity relative to the input signal. Selectable options are **INVERT** and **NONINVERT**.

3.6.11.1.8. Sense Range

Selects the range for voltage and current sensing. Selectable options are **1 mA**, **10 mA**, and **100 mA**. Please see **Section 2.15. Voltage and Current Sensing** for information on use of the Sense feature.

3.6.11.2. Driver Description

This property page describes the type of hardware assigned to this mnemonic. The physical location is also shown.



Level	Looping	Description	Pre-Execute	Post-Execute
		Description: PI-Clock Driver: 42490 65/100 MHz		
		Part Number	42490 65/100 MHz	
		GPIB Address	0	
		MainFrame	1	
		Slot	1	
		Channel	1	

Figure 53: Description property page for PI-42490 Dual Channel Clock Driver Card

3.6.12. PI-42495 Low Impedance Driver Card

3.6.12.1. Settable Parameters

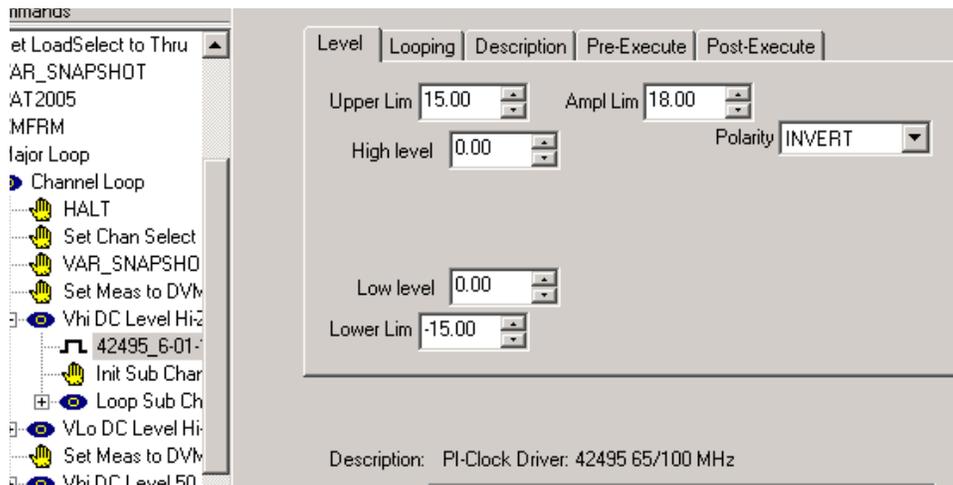


Figure 54: Settable Parameters for PI-42495 Low Impedance Clock Driver Card

The PI-42495 is a four-circuit, single channel, low-impedance driver cards. All four output circuits share a common timing input and a common set programmable V_{HI} and V_{LO} voltages. They are programmed together and appear as a single mnemonic in PI-Controller/PI-DATS. The four circuits can be used:

- Independently as four 50 Ohm driver channels
- Paired as two 25 Ohm driver channels
- Commoned as a single 12.5 Ohm driver channel

3.6.12.1.1. High Level

The high-level voltage output (HLV or “high rail”) of the selected channel. The High Level output on the PI-42495 Clock Driver can be set from +15 V to –7 V.

3.6.12.1.2. Upper Voltage Limit

This limit is the highest allowable value for the HLV. Use this parameter to protect the device under test. Once this parameter is set, the system will disallow any attempt to set or increment the HLV to a value higher than this limit. The maximum value for this limit is +15 V on the PI-42495 Clock Driver, and it must be higher than the Lower Voltage Limit.

3.6.12.1.3. Low Level

The low-level voltage output (LLV or “low rail”) of the selected channel. The Low Level output on the PI-42495 Clock Driver can be set from –15 V to +7 V.

3.6.12.1.4. Lower Voltage Limit

This limit is the lowest allowable value for the LLV. Use this parameter to protect the device under test. Once this parameter is set, the system will disallow any attempt to set or decrement the LLV to a value lower than this limit. The minimum value for this limit is -15 V on the PI-42495 Clock Driver, and it must be lower than the Upper Voltage Limit.

3.6.12.1.5. Amplitude Limit

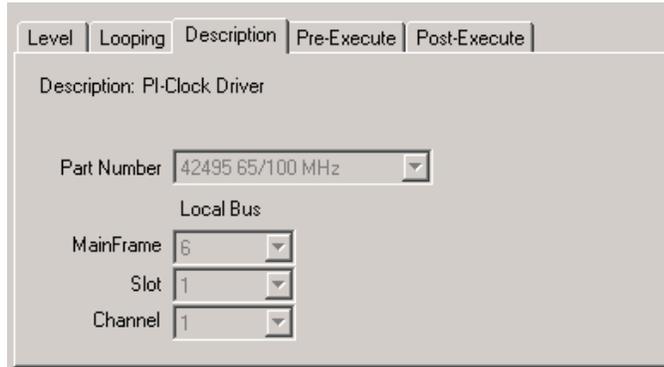
This limit is the allowable difference between HLV and LLV. Use this parameter to protect the device under test. Once this parameter is set, the system will disallow any attempt to set or increment/decrement HLV or LLV such that the amplitude exceeds this limit. The allowable range for this limit is 1 V to 18 V on the PI-42495 Clock Driver.

3.6.12.1.6. Polarity

The output polarity relative to the input signal. Selectable options are **INVERT** and **NONINVERT**.

3.6.12.2. Driver Description

This property page describes the type of hardware assigned to this mnemonic. The physical location is also shown.



The screenshot shows a software interface with five tabs: Level, Looping, Description, Pre-Execute, and Post-Execute. The Description tab is active, displaying the following information:

- Description: PI-Clock Driver
- Part Number: 42495 65/100 MHz (dropdown menu)
- Local Bus
- MainFrame: 6 (dropdown menu)
- Slot: 1 (dropdown menu)
- Channel: 1 (dropdown menu)

Figure 55: Description property page for PI-42495 Low Impedance Clock Driver

3.6.13. PI-45101 Low Impedance Driver Card

The PI-45101 is a 16-circuit, 2-channel low impedance driver card. There are two clock inputs (A and B) and two sets of outputs, each with 8 circuits. The eight “A” output circuits share a common driver input and can be used:

- Independently as eight 50 Ohm driver channels
- Cabled in groups of two as four 25 Ohm driver channels
- Cabled in groups of four as two 12.5 Ohm driver channels
- Cabled together as a single 6.25 Ohm driver channel

The output voltage will follow the input voltage plus or minus the greater of 1% or 100 mV. The output rise/fall times will follow the input rise/fall times plus or minus 10% for $T_R/T_F > 30$ ns @ 20 V_{PP}, < 20 pf. Output rise/fall times into large capacitive loads will be dominated by transmission line effects, determined partly by the number of channels commoned together.

The “B” outputs have the same structure, but with a different driver input channel.

There is no mnemonic for the PI-45101. The only software controls are for Online/Disconnect, described in **Section 3.6.1**. XMFRM (Mainframe) Mnemonic.

3.6.14. Sense Mnemonic

3.6.14.1. Settable Parameters

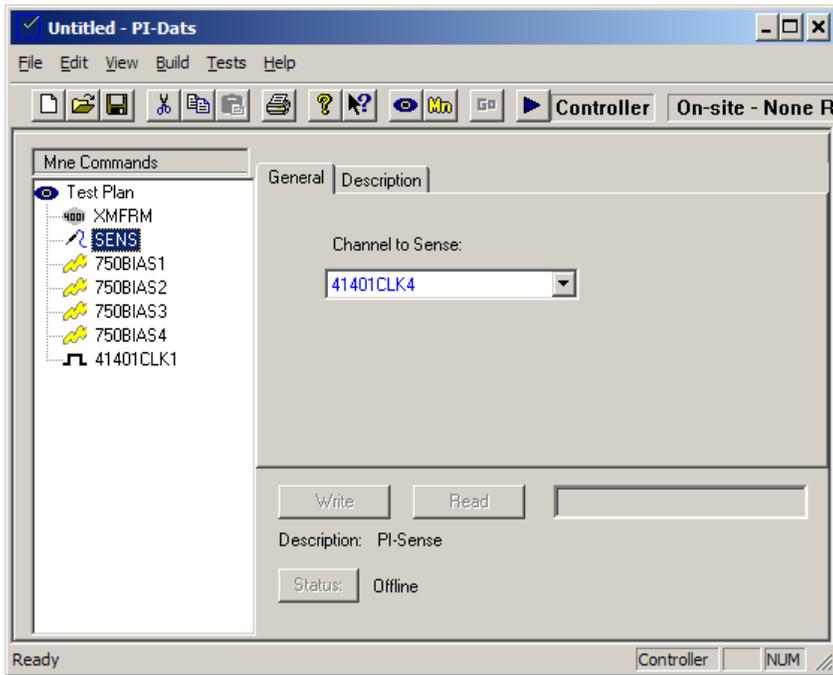


Figure 56: Sense Mnemonic

Use the **Sense** mnemonic's drop menu to switch the sense port to the desired channel. The sense port will not be switched until you click **Write**. The sense type (Voltage or Current) and the sense range must be set using the individual channel controls.

Sense ports for multiple Clock Driver and DC Bias cards can be connected in parallel to a single DVM, as only one channel in a system is "selected" at any one time. Use the sense selection feature to switch among and measure each desired channel in your test system.

4. HARDWARE CONFIGURATION

Your Pulse Instruments CompactPCI mainframe was shipped with a configuration file that reflects the hardware that was installed when it left the factory. If you subsequently add or remove CompactPCI cards, you may need to update the hardware configuration file.

Note that it is not always necessary or desired to update the hardware file to match the actual configuration, as this allows the editing of test settings “offline”, even if all the desired hardware is not available or not currently installed.

To automatically create a hardware file that matches the actual hardware configuration, select the menu item **Edit:Advanced Hardware Configuration**:

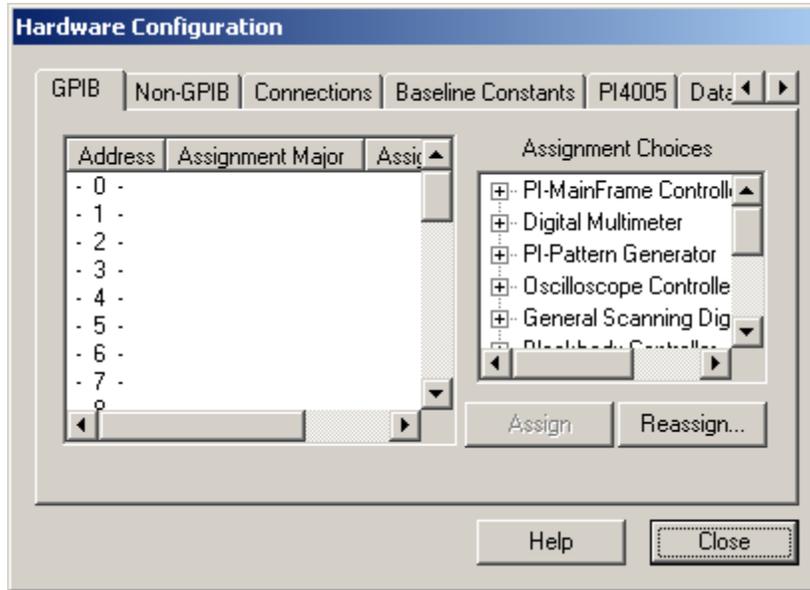


Figure 57: Hardware Configuration Dialog Box

The **Hardware Configuration** dialog box contains settings and controls that are common to PI-Controller and PI-DATS, as well as several types of controls that are not enabled or not meaningful in the context of PI-Controller on a stand-alone instrument. If you wish to upgrade to PI-DATS, please contact Pulse Instruments.

4.1. Automatic Configuration

4.1.1. Configuring PI-Controller in Local Mode

In **Local** mode, the PI-11000 mainframe must be assigned through the Non-GPIB tab:

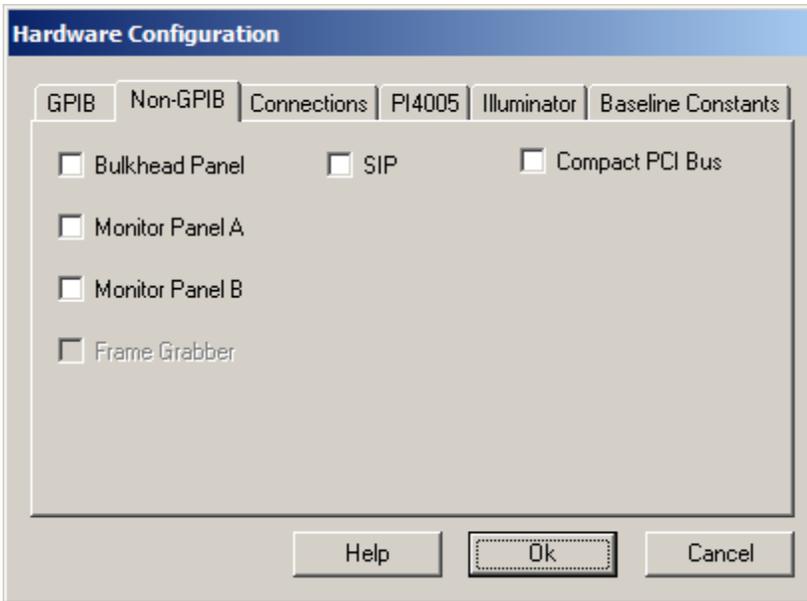


Figure 58: Non-GPIB Tab

Check the **CompactPCI Bus** checkbox to enable DC Bias and Clock Driver cards installed either in the CompactPCI mainframe or in a 4002 Instrument Mainframe connected via the legacy PI-31001 PI-Bus Interface Card.

If you have Pattern Generator cards installed they will be detected by PI-PAT. If a “PI-2005” does not appear in the results after clicking the **Read** button, launch PI-PAT separately and ensure that it is operating in the correct **Local Only** mode.

4.1.2. Configuring PI-Controller in Remote mode

When running PI-Controller from a Remote PC, the PI-11000 must be assigned through the GPIB tab:

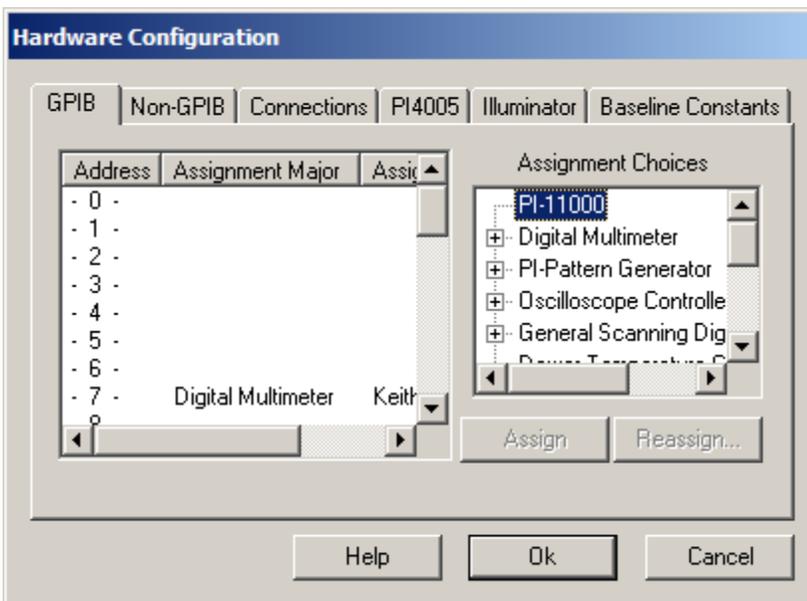


Figure 59: GPIB Tab

To control instrument cards installed in or attached to the PI-11000 Instrument Mainframe or PI-2005 Pattern Generator, click the GPIB address of the PI-11000, select the **CompactPCI** type of Mainframe Controller, and then click **Assign**.

4.1.3. Detecting Cards

Once the mainframe assignment has been made, click on the Connections tab:

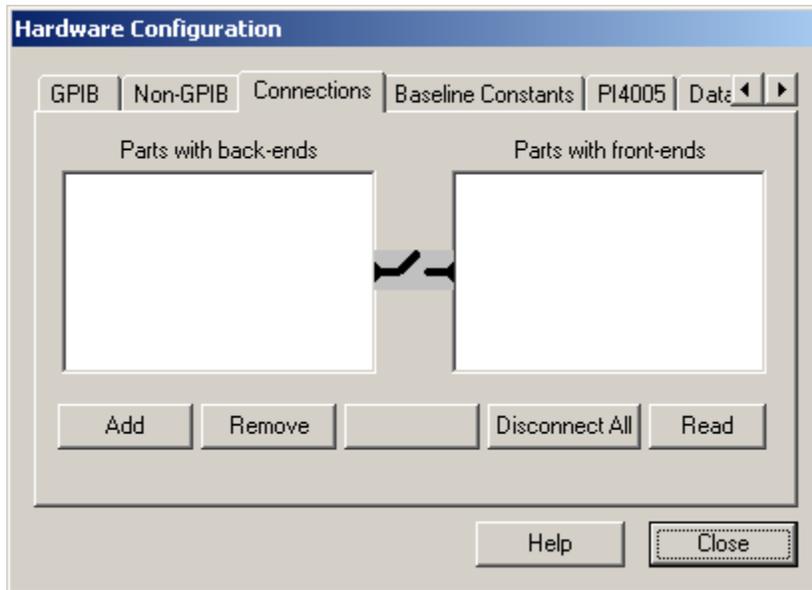


Figure 60: Connections Tab

Clicking the **Read** button will poll the PCI bus or the GPIB for any installed Pulse Instruments cards. Note that clicking the **Read** button will also remove any previous connections to devices that are not currently present in the system.

If clicking the **Read** button on your Remote PC does not properly connect all the devices that are present in the CompactPCI mainframe, please ensure that PI-PAT is running on the local instrument. PI-PAT must be running in order to process incoming GPIB commands.

If your cards are still not detected, verify your hardware connections or else remove and re-seat the cards in the mainframe. Because Pulse Instruments CompactPCI instruments cards are not hot-swap compliant, it is necessary to power-down the unit before removing or inserting a card.

4.2. Manual Configuration

To add a device manually, click the **Add** button to display the **Add Hardware Component** dialog box:

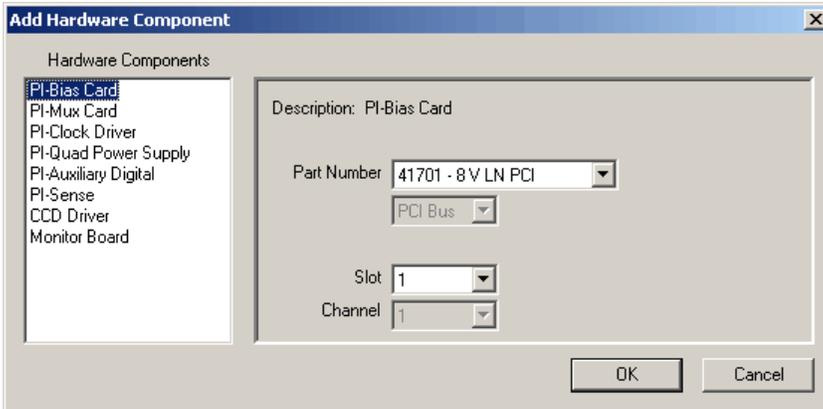


Figure 61: Add Hardware Component Dialog Box

Click on the type of device to add on the left, and then select the specific part number, bus type, and slot before clicking **OK**. Click **Add** to repeat the process until you have added all your devices.

Once you have added devices, either manually or automatically, they will appear in the **Hardware Configuration** dialog box and become available in the mnemonic selection window.

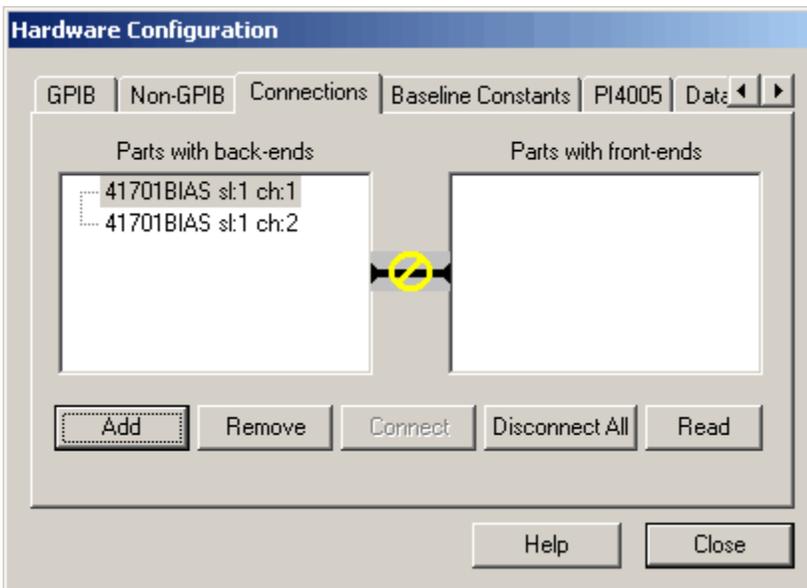


Figure 62: Connections Tab with Devices Added Manually

4.2.1. Off-Line/Simulated Devices

When you have finished specifying or adding devices, click **Close**. If any of the specified devices do not exist in the system, you will receive a **Hardware device not responding** warning:

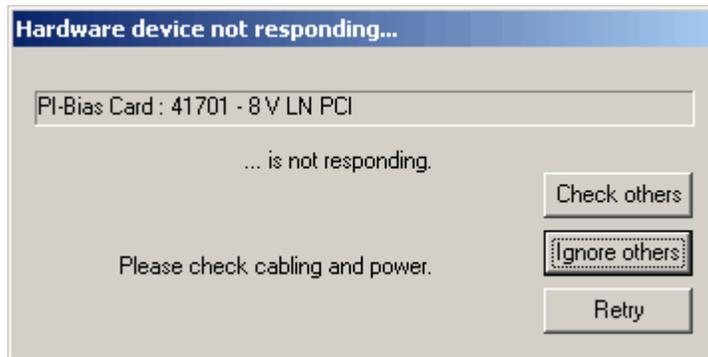


Figure 63: Hardware Not Responding Warning

This is expected behavior if any of the devices you have specified are not currently installed, and you wish to simulate them. Click **Check others** or **Ignore others** if you wish to continue, or click **Retry** to try to connect to the indicated device again.

Once you have completed checking your hardware, any disconnected devices will appear in the **Off-Line list**:

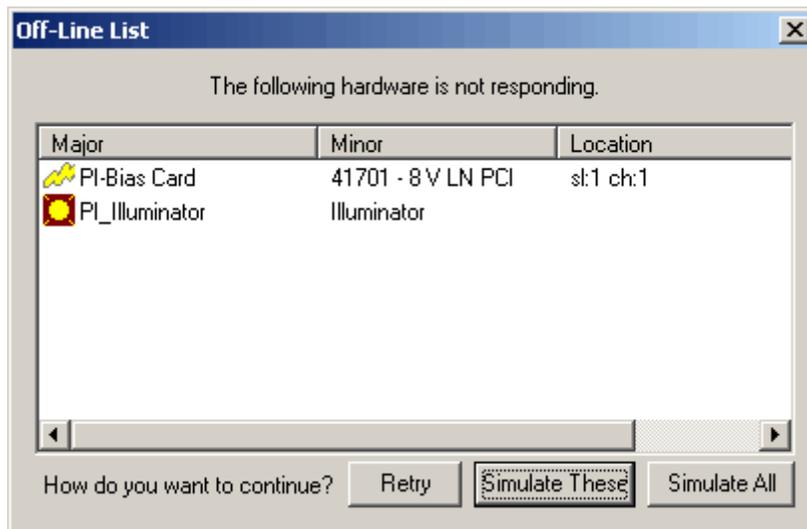


Figure 64: Off-Line Devices List

You can then click **Simulate These** or **Simulate All** to add them to your hardware profile as simulated devices. Connected and simulated devices will then appear in the **Mnemonic Selection** dialog box.

4.3. .HWR File (Pulse Instruments Hardware file)

The hardware files contains the reference information for hardware recognized by PI-Controller. This file is verified whenever PI-Controller is started up or whenever configuration changes are made. The user will not normally need to modify the .hwr files, but for reference purposes they are stored in C:\Program Files\Pulse20

5. MENU ITEMS

5.1. File menu commands

The File menu offers the following commands:

New	Creates a new document.
Open	Opens an existing document.
Save	Saves an opened document using the same file name.
Save As	Saves an opened document to a specified file name.
Diagnostics	Not available in PI-Controller.
Login	Login as another user.
Properties	Displays the details about this PIP file.
Print	Prints a document.
Print Preview	Displays the document on the screen, as it would appear printed.
Print Setup	Selects a printer and printer connection.
Exit	Exits PI-Controller.

5.1.1. New

Use this command to create a new document in PI-Controller.

You can open an existing document with the **Open** command.

Shortcuts

Toolbar: 

Keys: CTRL+N

File New dialog box

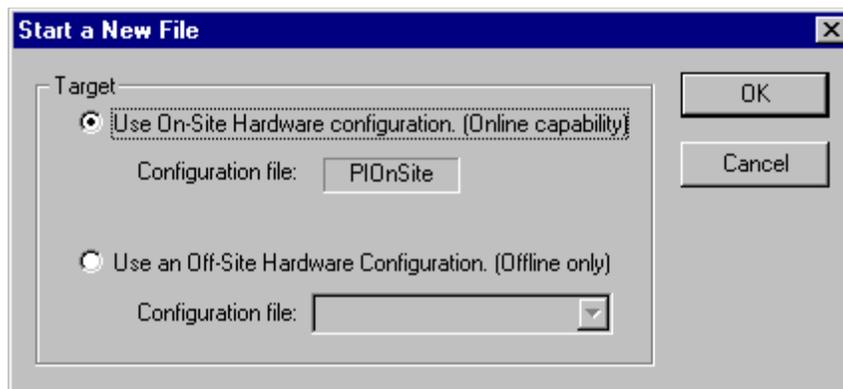


Figure 65: File:New dialog box

Select “**Use On-Site Hardware configuration**” to create a file that is compatible with your hardware. The name of the Configuration file is “PIOnsite.hwr”.

Select “**Use an Off-Site Hardware Configuration**” to create a file that is compatible with an off-site hardware configuration. The Configuration file (.hwr) must exist.

5.1.2. Open command

Use this command to open an existing document in a new window. You can open multiple documents at once. Use the **Window** menu to switch among the multiple open documents.

You can create new documents with the **New** command.

Shortcuts

Toolbar: 

Keys: CTRL+O

5.1.3. Save command

Use this command to save the active document to its current name and directory. When you save a document for the first time, PI-Controller displays the **Save As** dialog box so you can name your document. If you want to change the name and directory of an existing document before you save it, choose the **Save As** command.

Shortcuts

Toolbar: 

Keys: CTRL+S

5.1.4. Save As command

Use this command to save and name the active document. PI-Controller displays the **Save As** dialog box so you can name your document.

To save a document with its existing name and directory, use the **Save** command.

5.1.5. Diagnostics

Not available for PI-Controller.

5.1.6. Login

Login as another user.

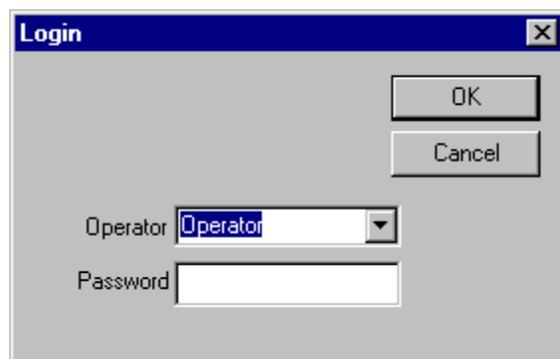


Figure 66: Login dialog box

Enter the name that will appear as “Operator” on reports. Password may not be necessary. Passwords will only be required if PI-Security is enabled.

5.1.7. Properties

Displays the details about this PIP file.

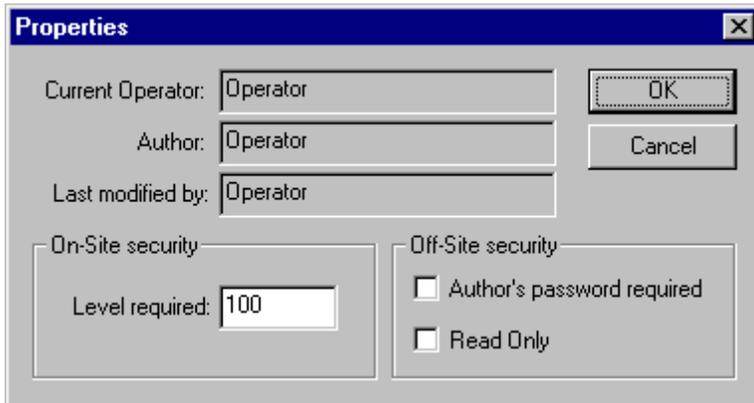


Figure 67: PIP File Properties Dialog Box

The **Current Operator** is the name that is entered on reports.

5.1.8. Exit command

Use this command to end your PI-Controller session. You can also use the **Close** command on the application **Control** menu. PI-Controller prompts you to save documents with unsaved changes.

Shortcuts

Mouse: Click the application's Close button.



Keys: ALT+F4

5.2. Edit menu commands

The Edit menu offers the following commands:

Copy Copies data from the document to the clipboard.

Paste Pastes data from the clipboard into the document.

5.2.1. Copy command

Use this command to copy selected data onto the clipboard. This command is unavailable if there is no data currently selected.

Copying data to the clipboard replaces the contents previously stored there.

Shortcuts

Toolbar:



Keys: CTRL+C

5.2.2. Paste command

Use this command to insert a copy of the clipboard contents at the insertion point. This command is unavailable if the clipboard is empty.

Shortcuts

Toolbar:



Keys: CTRL+V

5.3. View menu commands

The View menu offers the following commands:

- Toolbar** Shows or hides the toolbar.
- Status Bar** Shows or hides the status bar.

5.3.1. Toolbar command

Use this command to display and hide the Toolbar, which includes buttons for some of the most common commands in PI-Controller, such as **File:Open**. A check mark appears next to the menu item when the Toolbar is displayed.

See Toolbar for help on using the toolbar.

Toolbar



The toolbar is displayed across the top of the application window, below the menu bar. The toolbar provides quick mouse access to many tools used in PI-Controller,

To hide or display the Toolbar, choose **Toolbar** from the **View** menu (ALT, V, T).

Click	To
	Open a new document.
	Open an existing document. PI-Controller displays the Open dialog box, in which you can locate and open the desired file.
	Save the active document or template with its current name. If you have not named the document, PI-Controller displays the Save As dialog box.
	Print the active document.
	Remove selected data from the document and stores it on the clipboard.
	Copy the selection to the clipboard.
	Insert the contents of the clipboard at the insertion point.
	Append a new header below the highlighted item. See Append Group Header.
	Append a new Mnemonic below the highlighted item. See Append Mnemonic
	This will initiate a Test Run (PI-DATS only)

Indicator	Meaning
On-site - All Ready	Indicates that all hardware is responding.
On-site - None Ready	Indicates that none of the hardware is responding. All the hardware will be simulated. Check connections and power to the hardware devices.
On-site - Some Ready	Indicates that some of the hardware is responding. The hardware that is not responding will be simulated. Check connections and power to the hardware devices.
On-site - Simulate	The operator has opted to simulate all hardware.
Off-site -	The PIP file loaded does not comply with the hardware attached to your system. All hardware is simulated.

5.3.2. Status Bar command

Use this command to display and hide the Status Bar, which describes the action to be executed by the selected menu item or depressed toolbar button, and keyboard latch state. A check mark appears next to the menu item when the Status Bar is displayed.

Status Bar



The status bar is displayed at the bottom of the PI-Controller window. To display or hide the status bar, use the **Status Bar** command in the **View** menu.

The left area of the status bar describes actions of menu items as you use the arrow keys to navigate through menus. This area similarly shows messages that describe the actions of toolbar buttons as you depress them, before releasing them.

The right areas of the status bar indicate the state of the **Caps Lock** and **Num Lock** keys.

5.4. Help menu commands

The **Help** menu offers the following commands, which provide you assistance with this application:

Help Topics Offers you an index to topics on which you can get help.

About Displays the version number of this application.

5.4.1. Help Topics command

Use this command to display topics of interest related to PI-Controller operation.

Once you open **Help**, you can click the **Contents** button whenever you want to return to the opening screen.

5.4.2. About command

Use this command to display the copyright notice and version number of your copy of PI-Controller.

6. PROGRAMMER'S REFERENCE GUIDE

6.1. Introduction

Previous sections of the PI-11000 Operators Manual are concerned with Local operation of the PI-11000 via Pulse Instruments PI-Controller software. The PI-11000 also can be controlled by 3rd-party software, running either on the embedded CPU card under Windows 7, or on a remote PC running a variety of operating systems.

In either case, the majority of the ASCII command set is identical, with the only difference being setup of the software interface for passing the commands.

If you have purchased the optional IEEE-488 Card, you can operate the PI-11000 with custom software via commands sent over the IEEE-488 bus from a remote PC. The remote PC can run any operating system supported by GPIB, and it can run any application capable of generating ASCII command strings and outputting them over the GPIB interface.

In Pulse Instruments terminology “**Local**” refers to the CompactPCI CPU board or PC directly controlling the hardware via the PCI or USB, and “**Remote**” refers to an external PC controlling the Local CPU or PC via GPIB or TCP/IP, regardless of where the operator is sitting.

Custom applications running on the Local computer must run under Windows 7. Custom control of the PI-11000 on the embedded CPU is accomplished by passing ASCII command strings through one or more DLLs, which you must link to in your application.

Any action or function that can be performed from PI-Controller can also be performed via the ASCII command set. You should already be familiar with using PI-Controller for any of the functions or features you wish before learning to program the instrument.

The following sections of the manual describe the interface and commands used to operate the PI-11000 from your custom application.

The PI-11000 GPIB syntax follows the NI-488.2 standard. There are a few exceptions, where the NI-488 standard is used, in order to ensure backward compatibility with the PI-4001.

We strongly recommend that even programmers familiar with the PI-4001 command set read this section. Although most PI-4001 commands are implemented identically in the PI-11000, there are some differences in syntax.

Your custom application cannot be run simultaneously with PI-Controller on the Local machine, as only one application can link to the DLLs at any one time. It is possible, but not recommended or supported, to run a custom application alongside PI-Controller on a Remote computer, as PI-Controller always assumes that it has sole control of the hardware when it is running.

6.2. Local Operation

6.2.1. Configuring the GPIB Interface

If your PI-11000 Instrument Mainframe was ordered with the optional GPIB interface board (PI-31000), then it is configured by default as a GPIB instrument. Inbound GPIB communication with the PI-11000 is handled by PI-PAT; therefore if PI-PAT is running in Local GPIB mode, it will link to pipci.dll and prevent your application from linking to pipci.dll. To run your custom application, either quit PI-PAT or switch it to Local Only mode. Please see the PI-2005/PI-PAT manual for information on switching modes. If configured from the factory as an instrument, your PI-11000 will automatically launch PI-PAT at startup in Local GPIB mode. To disable this feature, remove the PI-PAT shortcut from C:\WINNT\Profiles\All Users\Start Menu\Programs\Startup or from C:\Windows\Documents and Settings\All Users\Start Menu\Programs\Startup

If you wish to use your optional GPIB interface as a system controller (e.g. to control other equipment, such as a DVM or 'scope), then you must install the standard GPIB driver. When configured as an instrument, the PI-11000 runs a software package called NI-Device, from National Instruments, in order to emulate a standards-compliant GPIB instrument. To run the PI-11000 as a system controller, you must uninstall NI-Device (via the Windows Add/Remove Programs control panel), reboot, and then install the IEEE.488 driver from the C:\Drivers folder.

If you wish to reconfigure the PI-11000 to be an instrument at a later date, you must uninstall the IEEE-488 driver, reboot, and then reinstall NI-Device from the C:\Drivers folder. When reinstalling NI-Device, install only the run-time engine.

When switching GPIB drivers you **must** reboot the system after uninstalling the unwanted driver, **even if the uninstaller does not prompt you do**. Failure to reboot after driver removal may result in failure to load the newly installed driver. If this occurs, uninstall all GPIB drivers, reboot, then reinstall the desired driver.

6.2.2. Linking to pipci.dll or pipciNET.dll

To pass commands to pipci.dll and to receive responses to queries, use two functions exported by pipci.dll, **PIPCCIInputMsg()** and **PIPICIOOutputMsg()**. **PIPCCIInputMsg()** is used to send command strings to the PI-11000, and **PIPICIOOutputMsg()** is used to read strings from the instruments. Any command string valid for GPIB communications is also valid for use with pipci.dll.

The exported function prototypes are as follows:

```
extern "C" __declspec(dllexport) BOOL PIPCCIInputMsg(char
    *pCmd);

extern "C" __declspec(dllexport) BOOL PIPICIOOutputMsg(char
    *pResponse, int nMaxBytes);
```

pipci.dll contains several other exported functions, but they are undocumented, and for Pulse Instruments internal use only.

The following code samples illustrate the preferred method for dynamically linking to pipci.dll, and for passing in a command string:

```
typedef void (BIASCLKINPUTMSG) (char* pMsg);
typedef void (BIASCLKOUTPUTMSG) (char* pMsg, int nMaxLen);
BIASCLKINPUTMSG* m_lpfkBiasClkInputMsg;
BIASCLKOUTPUTMSG* m_lpfkBiasClkOutputMsg;
HINSTANCE m_hBiasClk = NULL;
m_hBiasClk = ::LoadLibrary("pipci.dll");
    if (m_hBiasClk)
    {
        m_lpfkBiasClkInputMsg =
            (BIASCLKINPUTMSG*)GetProcAddress(m_hBiasClk,
            "PIPCCIInputMsg");
        m_lpfkBiasClkOutputMsg =
            (BIASCLKOUTPUTMSG*)GetProcAddress(m_hBiasClk,
            "PIPICIOOutputMsg");
    }
```

For example, to send the STATUS message:

```
CString strCmd(_T("STATUS\r\n"));
(*m_lpfkBiasClkOutputMsg)(strCmd.GetBuffer(20), 20);
```

And to receive a message:

```
char strResponse[512];  
(*m_lpfnBiasClkInputMsg)(strResponse);
```

When finished, the user may call

```
::FreeLibrary(m_hBias);
```

to unload the DLL. Note that all clock drivers and DC bias supplies are reset whenever the DLL is loaded or unloaded.

6.3. Remote IEEE-488 Interface Setup

If your PI-11000 Instrument Mainframe was ordered with the optional GPIB interface board (PI-31000), then it is configured by default as a GPIB instrument. Inbound GPIB communication with the PI-11000 is handled by PI-PAT; therefore PI-PAT must be running, and be in Local GPIB mode, in order to receive any GPIB commands. If configured at the factory as a GPIB instrument, PI-PAT will already be configured to start up automatically, in Local GPIB mode. Please see the PI-2005/PI-PAT manual for information on switching modes.

If your PI-11000 has been re-configured as a system controller, or if you ordered your GPIB interface after your system was delivered, then you may have to install NI-Device. First, use the Windows Add/Remove Programs control panel to uninstall the National Instruments IEEE-488 driver, if present, then install NI-Device from the C:\Drivers folder. When installing NI-Device, install the run-time engine only. Once NI-Device has been installed, PI-PAT can then be run in Local GPIB mode and will handle in-bound GPIB communication.

To run the PI-11000 as a “headless” instrument (e.g. without a monitor, keyboard and mouse), PI-PAT must be configured to start up automatically, in Local GPIB mode. To enable or re-enable this feature, either run the PI-DATS installer and choose the “Local (CompactPCI)” option with the “Automatic PI-PAT startup” box checked, or else create the following shortcut:

```
“C:\Program Files\PULSE20\PI_Pat.exe” /Startup
```

in this directory:

```
C:\WINNT\Profiles\All Users\Start Menu\Programs\Startup
```

or

```
C:\Windows\Documents and Settings\All Users\Start Menu\Programs\Startup
```

By default, each PI-11000 Instrument Mainframe with the optional IEEE-488 interface is configured with an address of 11. To change the GPIB address, please see the PI-2005 Operators Manual.

The PI-3105 GPIB syntax follows the NI-488.2 standard. There are a few exceptions, where the NI-488 standard is used, in order to ensure backward compatibility with the previous Pulse Instruments equipment.

6.4. Input/Output Protocol

6.4.1. Command Strings and File Exchange

6.4.1.1. Input to the PI-11000/PI-4001

Commands sent to the PI-11000 must obey the syntax specified in this document. When describing a command and its syntax, this document will use the following conventions:

All commands recognized by the PI-11000 will be printed in all capital letters.

Example: ALL VOLT 4.667↵

Placeholders for user-supplied values and parameters will be printed in lowercase, boldface, italicized letters or numbers

Example: STEP ***stepval***↵

Strings sent to the PI-11000 need not be in capital letters, but they will be printed here in all capitals for clarity.

All command lines sent to the PI-11000 over GPIB must be terminated with a carriage return and line feed characters (CHR\$(13)+CHR\$(10)). In hexadecimal these character codes are "0D" and "0A." In this document, these two characters will be represented together by a "↵" at the end of each command line. Please note that, although it is displayed as a single character in this manual, both a carriage return and a line feed must be sent. The two examples above are correctly terminated. Commands sent to the DLL via PIPCIInputMsg() do not require termination characters, as the end of the string is used to delimit a valid command. The DLL's parser will allow the termination characters, though, to permit code reuse in your application.

This does not mean that every command must be followed by a line termination. Multiple commands, up to a total of 256 characters, can be sent together on a single command line before a line termination is necessary. For example, the command sequence:

```
SLOT 5 CH 2 UPLIMB 5.00 LOLIMB 1.5 VOLT 4.00↵
```

is a valid command line containing a channel identifier and three commands.

6.4.1.2. Output From the PI-11000

All information sent back from the PI-11000 is in the form of strings with the exception of the outputs from the **ID**, **DUMP** and **STATUS** commands, which are sent as files. GPIB programmers using low-level GPIB routines should use the Receive() function instead of the ibrd() function, especially when reading the output from an ID, DUMP or STATUS command.

Strings are terminated with two characters:

```
0D 0A
```

which are a hexadecimal carriage return and line feed (CHR\$(13)+CHR\$(10)).

Files are terminated with the three-character File Termination Sequence:

```
1A 0D 0A
```

where 1A is a hexadecimal End-of-File character (EOF), 0D is a hexadecimal carriage return and 0A is a hexadecimal line feed.

6.4.2. Errors and the STATUS Command

If the unit does not respond when a command string is sent, you must send the string:

```
STATUS↵
```

The **STATUS** command will clear any pending errors and return a file containing error numbers. THE UNIT WILL NOT RESPOND PROPERLY TO ANY INPUTS IF THERE IS AN ERROR PENDING. THE ERROR MUST BE CLEARED BY SENDING THE STATUS COMMAND.

6.4.2.1. Checking Status of the PI-11000

For commands that return data (such as STATUS and DUMPx commands), a Receive() or call to PIPCIOutputMsg() will begin returning the requested data, one line at a time.

For commands that do not return data (such as VOLT or AMPLIM), a Receive() or call to PIPCIOutputMsg() will return the current online/offline status and any pending errors. This eliminates the need to send the STATUS command after every command has been sent; instead you can simply issue a Receive() after sending each command, and send STATUS to clear an error only if an error is pending.

Please note that consecutive GPIB Receive() commands are permitted with the PI-11000, but consecutive ibrd() commands will result in a time-out.

6.4.3. Specifying Mainframes, Slots and Channels

Many commands that you send to the PI-11000 will require that you specify a mainframe, slot and channel to perform certain functions.

In systems equipped with PI-4002B mainframes, the mainframe number refers to the ID of the PI-4002B Instrument Mainframe, which is set by DIP switches on the rear panel of each PI-4002B. **CompactPCI instrument cards are always in Mainframe 0, even in a bridged system with multiple CompactPCI mainframes.**

The card slots in each CompactPCI mainframe are numbered starting at Slot 1, counting away from the CPU board. If mainframes have been bridged together, instrument card slots in the first slave will be logically numbered starting at Slot 17, and instrument card slots in a second slave will be numbered starting at Slot 33, and so on. (The controller slots in slave chassis will be numbered 16, 32, etc, but these slots are not normally addressable by the user).

Card slots in a PI-4002B Instrument Mainframe are numbered from right to left, starting at Slot 1. Please see **Section 4. Hardware Configuration** for more details.

On each CompactPCI card, channels are numbered, from left to right, starting with Channel 1. Although the front panels of each card may be labeled alphabetically (e.g. A, B, C or D), the channel assignments for command purposes are always numeric.

On each 4000 Series instrument card, channels are numbered from top to bottom, starting at Channel 1.

From a remote computer, the configuration can be read back over the GPIB or from the DLL by issuing the **ID** command.

When issuing a command to the PI-11000, the mainframe, slot and channel designation can be supplied in three different syntaxes.

6.4.3.1. Syntax 1: Numeric Location

The slot and channel position can be specified numerically, for example:

```
MF 0 SLOT 5 CH 2 UPLIMB 8 ↵
```

Whenever a command in this document calls for a channel position (**chpos**) input, substitute an expression of this form. Once you have sent a command with a **chpos**, subsequent commands that affect the same slot and/or channel may be sent without the **MF**, **SLOT**, and **CH** designations. For example, if you had just sent the command used in the example above, you could send the following command:

```
VOLT 5 ↵
```

to set the upper voltage limit for MF 0 SLOT 5 CH 2 to 8 V. Furthermore, since you can send up to 256 characters within one string you could have set both parameters by sending the following line:

```
MF 0 SLOT 5 CH 2 UPLIMB 8 VOLT 5 ↵
```

Consecutive commands on a single command line are separated by a space. If you wish to send a command for a different slot or channel, then you must send another SLOT and CH designation. You need supply on the designations that have changed, so if you have just programmed MF 0 SLOT 5 CH 2, you can program channel 4 on that same card by sending CH 4, followed by a valid command.

6.4.3.2. Syntax 2: Channel Label

The slot and channel designation can also be replaced with a channel's four-character label. In order to use this syntax, the channel must previously have been assigned a label using the **LABEL** command.

Once the label has been assigned, it can be used along with the "@" character to designate a channel. For example, had we first assigned the label "RSET" to Slot 5, Channel 2 using the command:

```
MF 0 SLOT 5 CH 2 LABEL RSET ↵
```

then the last example for Syntax 1 could have been written as:

```
@RSET UPLIMB 8 VOLT 5 ↵
```

As with the Numeric Location syntax, subsequent commands affecting the same channel may be sent without the label. If you wish to send a command for a different slot or channel, then you must send another "@" and label designation or another numeric **MF**, **SLOT**, and **CH** designation.

The use of the **LABEL/@** syntax is useful in automated testing environments, as it allows for rapid development and modification of test plans and without extensive reprogramming. It also allows for hardware reconfiguration with minimal downtime.

6.4.3.3. Syntax 3: ALL

Some commands permit the use of the word **ALL** as a substitute for the *chpos* or channel label indicator. If you precede a command with the word **ALL**, the command will be executed for all channels in the system for which the command applies. For example, the command:

```
ALL UPLIMB 8 ↵
```

will set the upper voltage limit for all bias cards to 8 V. Do *not* use **MF**, **SLOT** or **CH** in conjunction with **ALL**, as **ALL** automatically applies the commands that follow to all supported channels in the system.

The following table shows all the commands that can be used with the **ALL** syntax.

AMPLIM	ISENSE _x	SETDEFD
DESELECT	LLV	SLEW
DUMPLB	LOLIMB	TF
DUMPLD	LOLIMD	TR
DUMPT	LRANGE	TTL50
DUMPV	LRANGED	TTL500
HIZ	MAINOUT	UPLIMB
HLV	MONOUT	UPLIMD
HRANGE	NHIZ	VOLT
HRANGED	NONINV	VSENSE _x
ILIM	OPTO	
INV	SETDEFB	

ALL can be followed by a series of supported commands, e.g.

```
ALL UPLIMB 5 LOLIMB 2 VOLT 3.22 ↵
```

6.4.4. PI-11000 Message Mode

Multiple types of Pulse Instruments card can be installed in the same CompactPCI mainframe, and certain commands, such as **STATUS**, are recognized by more than one type of card. Therefore, the PI-11000 uses “message modes” to determine which commands are intended for which type of card.

A **BIASCLKMSGS** must be sent before a block of commands intended for DC Bias or Clock Driver cards. A **PATMSGS** must be sent before a block of commands intended for Pattern Generator cards.

The **BIASCLKMSGS** command must be sent again if any commands have been subsequently sent to a different type of Pulse Instruments CompactPCI cards (such as Pattern Generator cards, for example).

Please see the following command lines for an example of usage:

```
BIASCLKMSGS ; THESE COMMANDS ARE FOR BIAS/CLK CARDS ↵
ALL LOLIMB -3.00 ↵
ALL UPLIMB 5.00 ↵
MF 0 SLOT 3 CH 2 VOLT -1.80 ↵
MF 0 SLOT 3 CH 1 VOLT 2.3 ↵
CONNECT ↵
ONLINE ↵

PATMSGS ; THESE ARE FOR PATTERN GENERATOR CARDS
COMPILE 1 ↵
SEQUENCE ↵
SEQUENCE ↵
SEQUENCE ↵
SEQUENCE ↵

BIASCLKMSGS ; THERE ARE FOR BIAS/CLK CARDS ↵
OFFLINE ↵
```

6.5. Data Transfer From the PI-11000

To transfer data back from the PI-11000 to your remote PC, you can use one of several methods—GPIB commands, the built-in network interface, or the built-in USB interfaces.

6.5.1. GPIB commands

All channel settings can be read back from the PI-11000 to your system controller using the GPIB “**DUMP**” commands. See **Section 7. Command Reference** for details on using each command.

6.5.2. Network interface

User data, including Pulse Instruments Part files (.PIP) can be also be transferred to and from the instrument using the built-in Ethernet interface. See **Section 3.1.3. Windows Logon** for details on integrating the PI-11000 into your network.

6.5.3. Optical drive

User data can be also be transferred to and from the instrument using the optional optical disk drive. The optical drive can also be used as a bootable device for operating system upgrades or troubleshooting.

6.5.4. External Storage Devices

User data can also be transferred to and from the instrument USB mass storage or other USB storage devices.

6.6. Sample Application/Testing Utility and Source Code (GPIBCom)

Included with your PI-11000 is an unsupported utility, **GPIBCom.exe** for sending and receiving strings from Pulse Instruments equipment or other GPIB-compatible devices. **GPIBCom** can be run Locally, on the CompactPCI CPU board, or Remotely, on a Windows PC with a National Instruments GPIB interface card. When running Locally, GPIBCom communicates either with Pulse Instruments DLLs (**dacq.dll** and **pipci.dll**) via their exposed functions or with Pulse Instruments applications (**PI-PAT**) via Automation. When running Remotely, **GPIBCom** communicates with any instrument that is capable of communicating over GPIB. In each case, this manual will refer to the instrument, DLL or application as the “target.”

Because Pulse Instruments DLLs and applications use the same command set whether run Locally or Remotely, via the Pulse Instruments GUI or a custom application, **GPIBCom** can be used to learn, test, and troubleshoot the hardware and your custom application.

Complete source code for GPIBCom.exe is provided as a MSVC++ (Visual Studio 6) project in the C:\Program Files\Pulse20\CodeSamples directory. Code samples from the project may be copied and used freely in your application.

6.6.1. Local Setup

GPIBCom is located in the C:\Program Files\PULSE20 folder. If you wish to run **GPIBCom** in Local mode, then the executable must remain in this folder, as it links into several Pulse Instruments DLLs that also are in this folder. A shortcut to this executable may be placed anywhere on your hard drive or desktop folder.

Launch **GPIBCom** by double-clicking on its icon or shortcut:

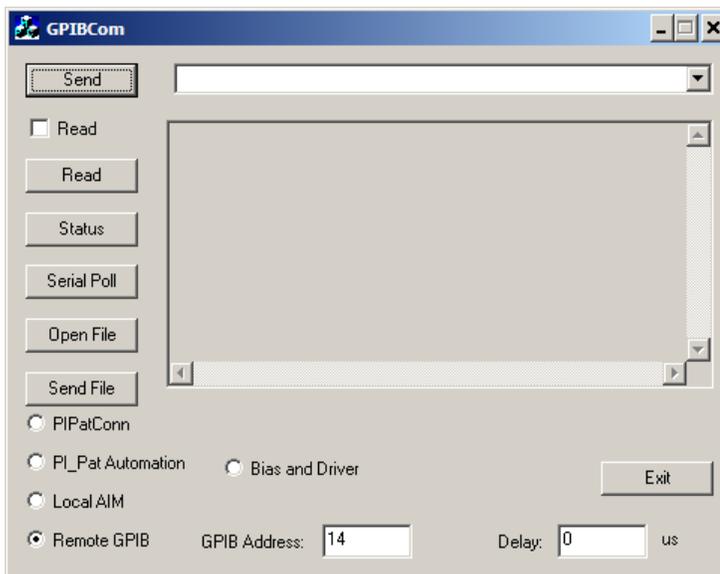


Figure 68: GPIBCom

By default, **GPIBCom** launches in Remote GPIB mode, and is set up to communicate with a GPIB-compatible device. To communicate with Pulse Instruments software on the CompactPCI CPU, click one of the following radio buttons:

- **PI_Pat Automation**—to communicate with **PI-PAT**, which controls the Pattern Generator hardware. If PI-PAT is not running when the first command is sent, PI-PAT will be launched.
- **Pipci.dll**—to communicate with **pipci.dll**, which controls the DC Bias and Clock Driver cards. If PI-PAT is running on the Local CPU, it **must** be in Local Only mode before **GPIBCom** is launched.
- **Dacq.dll**—to communicate with **dacq.dll**, which controls all data acquisition hardware. If PI-PAT is running on the Local CPU, it **must** be in Local Only mode before **GPIBCom** is launched.

Multiple instances of **GPIBCom** may be launched, in different modes, to communicate with different targets. Note that each DLL or application (in the case of PI-PAT) is quit and re-launched when the radio buttons are clicked in a particular instance of **GPIBCom**. Therefore, if you wish to communicate with **PI-PAT** and with **dacq.dll**, for example, it is highly recommended that you launch two instances of **GPIBCom**, rather than switching one instance of **GPIBCom** back and forth between the two modes.

Note that **GPIBCom** will link to **dacq.dll** or **pipci.dll** when used, and therefore will prevent PI-Controller from controlling the relevant hardware. The instance(s) of **GPIBCom** using **dacq.dll** and **pipci.dll** should be quit before launching PI-Controller.

6.6.2. Remote Setup

GPIBCom may be copied from your PI-11000 to any Windows PC equipped with a National Instruments GPIB interface card and drivers. No other drivers or DLLs are required for remote control. In Remote mode, please ensure that the **Remote GPIB** radio button is selected, and that the **GPIB Address** box corresponds to the GPIB address of the device you are controlling.

Multiple instances of **GPIBCom** may be launched to communicate with multiple instruments at different GPIB addresses. To communicate with multiple instrument types within a PI-11000 Instrument Mainframe, use the GPIB Message Mode commands (**PATMSGs**, **BIASCLKMSGs**, and **DACQMSGs**) to switch among different messaging modes.

When communicating with a PI-11000 Instrument Mainframe or PI-2005 Pattern Generator, ensure that **PI-PAT** is running on the Local CPU in Local GPIB mode.

6.6.3. General Operation

GPIBCom can send either single lines of text or entire text files to a target. To send a single string, set up communications per the instructions above, and then type a command in the text entry box next to the **Send** button:

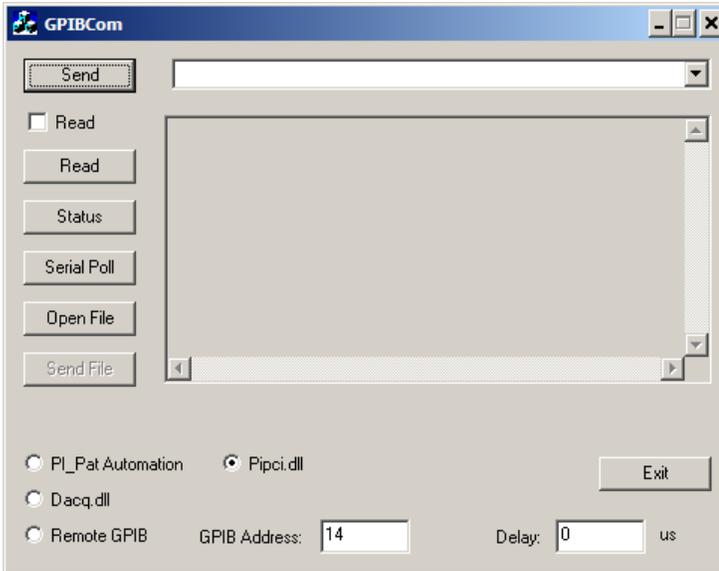


Figure 69: GPIBCom communicating with pipci.dll

Click the **Send** button to send the command. If the **Read** checkbox is checked, **GPIBCom** will immediately query the target for a response. In the case of Pulse Instruments instruments and DLLs, the response will be either an error message, a no-error message, or the response to the query.

Clicking the **Read** button causes **GPIBCom** to query the target for a response.

Clicking the **Status** button is equivalent to sending the string “**STATUS**”, followed by a **Read**.

Clicking **Serial Poll** executes a standard GPIB Serial Poll and displays the result.

GPIBCom can also send the contents of text file, either one line at a time or all at once. To send a file, click the **Open File** button. The text entry box will be disabled, and a standard Windows File Open dialog box will appear, along with option to log responses to another text file. Once you have selected a text file, **GPIBCom** will prompt you for a filename to save query responses to. If the file already exists **GPIBCom** will append strings to the end of it. You can choose not to log strings to a file by clearing the checkbox on the Open File dialog box.

Once the file has opened, the first line of text from the file will appear in the text entry box. Click **Send** to send a single line of text and read the next line into **GPIBCom**. Click **Send File** to send the entire remaining contents of the file to the target. Please note that, when **Send File** is clicked, the file contents are sent via a series of GPIB Send() commands, not `ibwrtfl()`. Once a file has been sent via **Send File**, the line counter resets, and clicking Send File will send the file again, from the beginning of the file.

To cancel sending of a file, click the **Close File** button, and the text entry box will be re-enabled.

7. COMMAND REFERENCE

7.1. Chart of Commands

The following tables show the commands supported by each control mainframe and card model:

7.1.1. System Commands

Command	Short Description	Mainframe Model	
		4001	11000/PC
;(REM)	Comment delimiter	Y	Y
BIASCLKMSGS	Sets Bias/Clk message mode	N/A	Y
CLEAR	Clears instrument	Y	Y
CONNECT	Connects outputs	Y	Y
DELETE	Deletes a saved file from NVM	Y	N/A
DESELECT	Deselects sense	Y	Y
DIR	Lists all saved files in NVM	Y	N/A
DISCON	"Disconnects" output	Y	Y
ID	Returns system info	Y	Y
LOAD	Loads a saved file from NVM	Y	N/A
OFFLINE	Disconnects DACs from registers	Y	Y
ONLINE	Writes registers to DACs	Y	Y
PATMSGS	Sets Pattern message mode	N/A	Y
POWERDOWN	Prepares for power down	N/A	Y
PWRONFILE	Defines a startup-file from NVM	Y	N/A
SAVE	Saves settings as file in NVM	Y	N/A
SEQ...DEFAULT	Defines a ONLINE/DISCON seq.	Y	Y
SEQ...DUMP	Returns a sequence	Y	Y
SEQ...END	Ends a sequence definition	Y	Y
SEQ...OPPOSITE	Defines an ONLINE/DISCON seq.	Y	Y
SETGPIBADDR	Sets GPIB address	N	Y
SRQOFF	Turns service req on	Y	N
SRQON	Turns service req off	Y	N
STATUS	Returns system status and error	Y	Y
UPDATEOFF	Turns off CRT updating	Y	N/A
UPDATEON	Turns on CRT updating	Y	N/A

7.1.2. Card/Channel Commands

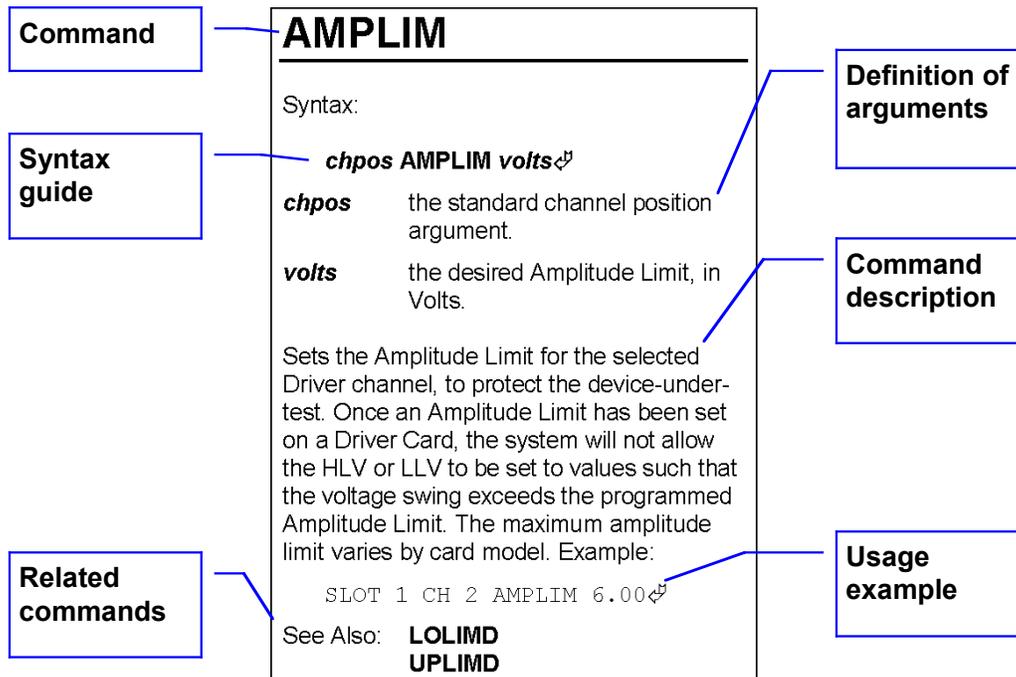
Command	Short Description	Driver Card Model					Bias Card Model				
		4000 Series					CPCI	4000 Series			CPCI
		4046x	40465 42465	40490	42460	42490 42495	41401	40740	4075x	4275x	41702
@	Uses a channel label	Y	Y	Y	Y	Y	Y	Y	Y	Y	
AMPLIM	Sets driver amplitude limit	Y	Y	Y	Y	Y	Y				
AUXOUT	Sets the driver to auxiliary output			Y							
DELAY	Sets the driver internal delay			Y							
DP	Sets the driver to double-pulse mode			Y							
DUMPF	Returns output format and sense range	Y	Y	Y	Y	Y	Y	Y	Y	Y	
DUMPLB	Returns bias limits						Y	Y	Y	Y	
DUMPLD	Returns driver limits	Y	Y	Y	Y	Y	Y				
DUMPP	Returns ILIM or VLIM setting										
DUMPT	Returns TR/TF/SLEW settings	Y	Y		Y		Y				
DUMPV	Returns bias/driver voltages	Y	Y	Y	Y	Y	Y	Y	Y	Y	
EXT	Sets the driver to external width mode			Y							
FTRIG	Sets the driver to falling-trigger mode			Y							
FORLV	Sets 4-level Output		Y								
HIZ	Tri-states driver output					Y					
HLV	Sets driver high rail	Y	Y	Y	Y	Y					
HR	Sets hi-res bias						Y	Y			
HRANGE	Sets bias channel to high range							Y	Y		
HRANGED	Sets driver card to high range					Y					
ILIM	Sets current limit										
IMP10	Select 10-Ohm output impedance		Y								
IMP50	Selects 50-Ohm TTL in			Y							
IMP500	Selects 500-Ohm TTL in			Y							
INC/DEC HLV	Decrements high rail	Y	Y	Y	Y	Y	Y				
INC/DEC LLV	Decrements low rail	Y	Y	Y	Y	Y	Y				
INC/DEC SLEW	Decrements rise/fall-time					Y					
INC/DEC TF	Decrements fall-time	Y	Y		Y						
INC/DEC TR	Decrements rise-time	Y	Y		Y						
INC/DEC VOLT	Decrements bias voltage						Y	Y	Y	Y	
INTD	Sets the driver to internal delay mode			Y							
INTW	Sets the driver to internal width mode			Y							
INV	Inverts driver output	Y	Y	Y	Y	Y					
ISENSE1/2/3	Sets current sense range	Y	Y		Y	Y ¹	Y	Y	Y	Y	
LABEL	Creates a channel label	Y	Y	Y	Y	Y	Y	Y	Y	Y	
LABEL *	Clears a channel label	Y	Y	Y	Y	Y	Y	Y	Y	Y	
LLV	Sets driver low rail	Y	Y	Y	Y	Y	Y				
LNOISE	Sets bias channel to low-noise							Y	Y		
LOLIMB	Sets bias lower limit						Y	Y	Y	Y	
LOLIMD	Sets driver lower limit	Y	Y	Y	Y	Y	Y				
LR	Sets low-res bias						Y	Y			

Command	Short Description	Driver Card Model					Bias Card Model				
		4000 Series					CPCI	4000 Series			CPCI
		4046x	40465 42465	40490	42460	42490 42495	41401	40740	4075x	4275x	41702
LRANGE	Sets bias channel to low range							Y	Y		
LRANGED	Sets driver card to low range					Y					
MAINOUT	Selects main output										
MHLV	Sets the mid-high-level voltage		Y								
MLLV	Sets the mid-low-level voltage		Y								
MLV	Sets the mid-level voltage		Y								
MONOUT	Selects monitor output										
NHIZ	Restores driver output from HIZ					Y					
NONINV	Uninverts driver output	Y	Y	Y	Y	Y					
OPTO	Selects opto input		Y	Y	Y	Y ¹					
REGOUT	Sets the driver to regular output			Y							
REGULAR	Sets bias channel to regular mode							Y	Y		
RTRIG	Sets the driver to rising-trigger mode			Y							
SELECT	Selects sense channel	Y	Y	Y	Y	Y ¹	Y	Y	Y	Y	
SETDEFB	Resets a bias channel						Y	Y	Y	Y	
SETDEFD	Resets a driver channel	Y	Y	Y	Y	Y	Y				
SLEW	Sets common rise/fall-time					Y					
STEP	Sets INC/DEC step	Y	Y	Y	Y	Y	Y	Y	Y	Y	
TF	Sets rise-time	Y	Y		Y						
TR	Sets fall-time	Y	Y		Y						
TRILV	Sets tri-level output		Y								
TTL	Selects TTL in		Y	Y							
TTL50	Selects 50-Ohm TTL in		Y		Y	Y ¹	Y				
TTL500	Selects 500-Ohm TTL in		Y		Y	Y ¹	Y				
TWOLV	Sets two-level output		Y								
UPLIMB	Sets bias upper limit						Y	Y	Y	Y	
UPLIMD	Sets driver lower limit	Y	Y	Y	Y	Y					
VOLT	Sets bias voltage						Y	Y	Y	Y	
VSENSE1/2/3	Sets voltage sense range	Y	Y	Y	Y	Y ¹	Y	Y	Y	Y	
WIDTH	Sets the driver internal width			Y							

1. Excluding PI-42495.

7.2. Command Reference Format

Each entry in the command reference is presented in the following format:



Commands are listed in alphabetical order, and each entry includes a syntax guide, a definition of each argument, a description of what the command does, an example of usage with sample arguments, and a listing of related commands.

; (REM)

Syntax:

; *remarks*

Remarks any text.

Allows the user to insert remarks in any command line. Once the semicolon is received, the PI-11000 will ignore anything between it and the next carriage return and line feed. Example:

```
ALL VOLT 5.0; IGNORE THIS
;IGNORE THIS AS WELL
```

@

Syntax:

@*label command*

label any previously defined label

command any valid command(s)

Once a LABEL command has been issued, @label can be substituted for the standard channel position argument in a line of commands. For example, if slot 2, channel 1 had previously been assigned the label RSET, then the command:

```
@RSET VOLT 5.00
```

would set slot 2, channel 1 to 5 volts.

See Also: **ALL**
CH
LABEL
LABEL *
SLOT

ALL

Syntax:

ALL command ↵

command any valid command

Many commands can be issued to all available driver and bias channels by using ALL in place of the standard channel position argument. See **Section 6.4.3.3. Syntax 3: ALL** for a list of commands that support the ALL syntax.

ALL can only be followed either by a single command or a string of multiple commands separated by spaces.

Example:

```
ALL UPLIMB 5.0 LOLIMB -3.3
↵
```

See Also: **@**
CH
LABEL
LABEL *
MF

AMPLIM

Syntax:

chpos AMPLIM volts ↵

chpos the standard channel position argument.

volts the desired Amplitude Limit, in Volts.

Sets the Amplitude Limit for the selected Driver channel, to protect the device-under-test. Once an Amplitude Limit has been set on a Clock Driver Card, the system will not allow the HLV or LLV to be set to values such that the voltage swing exceeds the programmed Amplitude Limit. The maximum amplitude limit varies by card model.

Example:

```
MF 0 SLOT 1 CH 2 AMPLIM
6.00 ↵
```

See Also: **LOLIMD**
UPLIMD

AUXOUT

Syntax:

chpos1 AUXOUT ↵

Chpos1 is the standard channel position argument, with Channel 1 specified.

Directs the output for the selected channel to the Auxiliary (Muxed) output connector.

See Also: **REGOUT**

BIASCLKMSGSGS

Syntax:

BIASCLKMSGSGS ↵

Multiple types of Pulse Instruments card can be installed in the same CompactPCI mainframe, and certain commands, such as STATUS, are recognized by more than one type of card. Therefore, the PI-11000 uses "message modes" to determine which commands are intended for which type of card.

A BIASCLKMSGSGS must be sent before the initial block of commands intended for DC Bias or clock driver cards..

The BIASCLKMSGSGS command must be sent again if any commands have been subsequently sent to a different type of Pulse Instruments CompactPCI cards (such as Pattern Generator cards), using the command.

If the instrument mainframe is already in Bias/Clock message mode, then BIASCLKMSGSGS is treated as a no-op.

Example:

```
BIASCLKMSGSGS ; THESE COMMANDS ARE
FOR BIAS/CLK CARDS ↵
ALL LOLIMB -3.00 ↵
ALL UPLIMB 5.00 ↵
MF 0 SLOT 3 CH 2 VOLT -1.80 ↵
MF 0 SLOT 3 CH 1 VOLT 2.3 ↵
CONNECT ↵
ONLINE ↵
```

```
PATMSGSGS ; THESE ARE FOR PAT GEN
CARDS
COMPILE 1 ↵
SEQUENCE ↵
```

BIASCLKMSGs ; THERE ARE
FOR BIAS/CLK CARDS ↵
OFFLINE ↵

See Also: **PATMSGs**

CH

Syntax:

MF x SLOT y CH z *command* ↵

x mainframe number of the
desired channel

y slot number of the desired
channel

z desired channel number

command any valid command(s)

CH is part of the standard channel
position (*chpos*) argument that precedes
most commands. Example:

```
MF 0 SLOT 3 CH 2 VOLT -  
1.80 ↵
```

See Also: **@**
ALL
LABEL
LABEL *
MF
SLEW

CLEAR

Syntax:

CLEAR ↵

Clears all settings, and sets the
PI-11000 to the Offline Mode. All
program information, settings, and
programmable limits will return to the
default settings. Example:

```
CLEAR ↵
```

See Also: **SETDEFB**
SETDEFD

CONNECT

Syntax:

CONNECT ↵

Connects the outputs back to the circuit path
with all output voltages to 0 V, and places the
instrument in the Offline state.

To provide voltage output to the device under
test, program output voltages and then send
ONLINE to put the system back Online.

Example:

```
CONNECT ↵
```

See Also: **DISCON**
OFFLINE
ONLINE

DEC

Syntax:

chpos DEC *parameter* ↵

chpos the standard channel position
argument.

parameter is the parameter to be decremented.
Parameter may be VOLT, HLV,
LLV, TR, or TF.

Decrements the specified parameter. For TR,
and TF, the Step Value is determined by the
current value of the parameter. For VOLT, HLV
and LLV, the Step Value must be specified by a
STEP command. Example:

```
MF 0 SLOT 3 CH 2 DEC VOLT ↵
```

The system will not allow a DEC command to
set a voltage or rail below that allowed by the
currently programmed limits for the specified
channel.

See Also: **AMPLIM**
LOLIMB
LOLIMD
STEP
UPLIMD

DELAY...NS

DELAY...US

DELAY...MS

Syntax:

chpos1 DELAY progdelay units

Chpos1 is the standard channel position argument, with Channel 1 specified.

Progdelay is the desired numeric value for the Programmable Delay.

Units is the unit value for the Programmable Delay, either NS, US or MS.

Sets the Programmable Delay for the desired channel. The channel must already have been set to Internal Width/Delay or Double-Pulse Mode. The Programmable Delay may be from 30 ns to 80 ms.

See Also: **DP**
INTD
INTW

DESELECT

Syntax:

DESELECT

Turns off the Voltage and Current Sense functions for all channels in the system.

Example:

DESELECT

See Also: **ISENSE1/2/3**
VSENSE1/2/3

DISCON

Syntax:

DISCON

Protects the device under test by effectively disconnecting the outputs of all the channels in the system.

The DISCON command sets all output voltages to 0 V, and then places all outputs through a small resistance to ground. Example:

DISCON

DISCON places the instrument in Disconnect state.

See Also: **CONNECT**

OFFLINE
ONLINE

DP

Syntax:

chpos1 DP

Chpos1 is the standard channel position argument, with Channel 1 specified.

Sets the selected channel to Double-Pulse Mode. The programmable Width can now be specified with the WIDTH and command. The width of the Double-Pulse can be set from 14 ns to 80 ms. The Delay is fixed at 21 ns \pm 3 ns.

See Also: **DELAY**
EXT
INTD
INTW
WIDTH

DUMPF

Syntax:

chpos DUMPF

chpos the standard channel position argument.

When sent to a driver channel, DUMPF causes the PI-11000 to return the input port/impedance, output formats, sensing range, and output port of the specified channel. Note that not all features are available for all Clock Driver card models. Only arguments relevant to the installed card models will be returned.

When sent to a DC bias channel, DUMPF causes the PI-11000 to return the sensing range.

Example usage:

MF 0 SLOT 3 CH 2 DUMPF

Sample returned string from a PI-41401 Clock Driver channel:

MF 0 SLOT 3 CH 2 TTL500 ISENSE1

Sample returned string from a DC Bias channel

MF 0 SLOT 3 CH 2 ISENSE2 SELECT

DUMPF will also return the SELECT statement for the one channel in the system that is currently selected for sensing.

See Also: **HIZ**
INTD

DUMPLB

Syntax:

chpos DUMPLB

chpos the standard channel position argument.

Dumps the Voltage Limit settings of the selected DC Bias channel. Example:

```
MF 0 SLOT 3 CH 2 DUMPLB
```

Sample output:

```
MF 0 SLOT 3 CH 1 UPLIMB  
8.00 LOLIMB -3.00
```

See Also: **LOLIMB**
TRILV

DUMPLD

Syntax:

chpos DUMPLD

chpos the standard channel position argument.

Dumps the Voltage Limit settings of the selected Driver channel. Example:

```
MF 0 SLOT 3 CH 2 DUMPLD
```

Sample output:

```
MF 0 SLOT 3 CH 1 UPLIMD  
6.00 LOLIMD -2.00 AMPLIM  
6.00
```

See Also: **AMPLIM**
LOLIMD
UPLIMD

DUMPP

Syntax:

chpos DUMPP

chpos the standard channel position argument.

Dumps the ILIM or VLIM settings of the selected DC bias channel. Example:

```
MF 0 SLOT 3 CH 2 DUMPP
```

Sample output:

```
MF 0 SLOT 3 CH 1 ILIM 10 MA
```

See Also: **ILIM**

DUMPT

Syntax:

chpos DUMPT

chpos the standard channel position argument.

Dumps the Rise/Fall Time settings of the selected channel. Example:

```
MF 0 SLOT 3 CH 2 DUMPT
```

Sample output:

```
MF 0 SLOT 3 CH 1 TR 3 TF 2
```

See Also: **SLEW**
TF
TR

DUMPV

Syntax:

chpos DUMPV

chpos the standard channel position argument.

Dumps the Voltage settings and internal DAC reading of the selected channel. Example:

```
MF 0 SLOT 3 CH 2 DUMPV
```

Sample output from a DC Bias channel:

```
MF 0 SLOT 3 CH 1 VOLT 5.625
```

Sample output from a Clock Driver channel:

```
MF 0 SLOT 3 CH 1 HLV 3.625 LLV -  
2.25
```

See Also: **LLV**
HLV
VOLT

EXT

Syntax:

chpos1 EXT ↗

Chpos1 is the standard channel position argument, with Channel 1 specified.

Sets the selected channel to External Input Mode. The programmable Width and Delay features are disabled, and the output width and delay will be the same as those for the input signal.

See Also: **DP**
INTD
INTW

FORLV

Syntax:

chpos FORLV ↗

Chpos is the standard channel position argument.

Sets the specified driver channel to Four-Level function. The two channels on a given Driver Card can be set to different modes at the same time.

See Also: **TRILV**
TWOLV

FTRIG

Syntax:

chpos1 FTRIG ↗

Chpos1 is the standard channel position argument, with Channel 1 specified.

Sets the Trigger Out for the specified channel to occur on the falling edge of the Input Signal to the Driver Card.

See Also: **RTRIG**

HIZ

Syntax:

chpos HIZ ↗

chpos the standard channel position argument.

Sets the specified clock driver channel to HIZ (tri-state) output. Example:

```
MF 0 SLOT 3 CH 2 HIZ ↗
```

Use NHIZ to restore normal output.

See Also: **DUMPF**
INV
NHIZ
NONINV

HLV

Syntax:

chpos HLV voltage ↗

chpos the standard channel position argument.

voltage the desired high-level voltage.

Sets high-level voltage (high rail) for the specified clock driver channel. Example:

```
MF 0 SLOT 3 CH 2 HLV 5.42 ↗
```

The voltage argument cannot be greater than the currently programmed upper limit, and resulting amplitude cannot be greater than the currently programmed amplitude limit for the specified channel.

See Also: **AMPLIM**
DUMPV
LLV
LOLIMD
UPLIMD

HR

Syntax:

chpos HR ↗

chpos the standard channel position argument.

Sets the selected, odd-numbered channel on the selected 4000 Series DC Bias card to High Resolution mode. Note that the next even-numbered channel in sequence is used as the “control” channel, and will be disabled until the selected channel is set back to Low Resolution mode with **LR**.
Example:

```
MF 1 SLOT 3 HR ↵
```

Note 1: the disabled control channel will still output a signal that ranges from 0 – 200 mV as the selected channel is programmed.

Note 2: On the 40755 card, High Resolution mode is available on both cards, and no channels are disabled. (The cards are internally wired as channels 1 and 3, but addressed by the operating system as logical channels 1 and 2).

See Also: **LR**
VOLT

HRANGE

Syntax:

```
chpos HRANGE ↵
```

chpos the standard channel position argument, although the channel designator is optional.

Sets all channels on the selected DC Bias card to High Range. To protect against voltage transients, the system must be in Disconnect mode before HRANGE can be set. HRANGE is the default setting.

Note that all channels on each card must be in the same range, but that different Bias cards can be set to different ranges. For PI-4075x cards, this enables voltage and limit settings from between ±20 V. Example:

```
MF 1 SLOT 3 HRANGE ↵
```

Note that HRANGE will not re-set VOLT, UPLIMB or LOLIMB settings that were changed when LRANGE was set.

See Also: **LOLIMB**
LRANGE
UPLIMB
VOLT

HRANGED

Syntax:

```
chpos HRANGED ↵
```

chpos the standard channel position argument, although the channel designator is optional.

Sets all channels on the selected Clock Driver card to High Voltage Range. Note that all channels on each card must be in the same range, but that different Clock Driver cards can be set to different ranges. For PI-41401 cards, this enables voltage (rail) and limit settings from between -3 V to +8 V. Example:

```
MF 0 SLOT 3 HRANGED ↵
```

Note that HRANGED may cause existing HLV, LLV, UPLIMD and LOLIMD settings to be out of range. New limit settings should be applied before new voltage settings are applied.

See Also: **AMPLIM**
HLV
LLV
LOLIMD
LRANGED
UPLIMD

ID

Syntax:

```
ID ↵
```

Causes the PI-11000 to return a file containing information about the configuration of the system, the IEEE-488 instrument address, the DC bias and clock driver cards currently installed, and the optional features installed.

Example:

```
ID ↵
```

A typical returned ID file looks like the following:

```
PI-11000 ieeeaddr  
MF mfnum
```

SLOT *slotnum* PART NO. *partno*
carddescription

.
.
.

SLOT *slotnum* PART NO. *partno*
carddescription
IEEE-488 AND RS-232-C OPTION
1A 0D 0A

The final bytes are the standard File Termination Sequence.

See Also: **DUMP**

ILIM

Syntax:

chpos* ILIM *amps units ↵

chpos the standard channel position argument.

amps the numeric value of the desired current limit.

units the unit value of the desired current limit, either MA, UA, or NA. If *Units* are omitted, then nA are assumed.

Sets the Current Limit value for the specified DC bias channel. Example:

```
MF 0 SLOT 3 CH 2 ILIM 10  
MA ↵
```

See Also: **DUMPF**

IMP10

Syntax:

***chpos* IMP10** ↵

Chpos is the standard channel position argument.

Sets the selected channel to a 10 Ω back-terminated output. In this mode, the Current and Voltage Sense do not function. To return to a 50 Ω back-terminated output, turn on either the Voltage or Current Sense function.

See Also: **ISENSE**
VSENSE

IMP50

IMP500

Syntax:

***chpos1* IMP50 | IMP500** ↵

Chpos1 is the standard channel position argument, with Channel 1 specified.

Selects the 50 Ω or 500 Ω input impedance at the TTL Input to match the requirements of your clock source for high speed applications.

INC

Syntax:

chpos* INC *parameter ↵

chpos the standard channel position argument.

parameter the parameter to be incremented.
Parameter may be VOLT, HLV, LLV, TR, or TF.

Increments the specified parameter. For TR or TF, the Step Value is determined by the current value of the parameter. For VOLT, HLV and LLV, the Step Value must be specified by a STEP command. Example:

```
MF 0 SLOT 3 CH 2 INC VOLT ↵
```

The system will not allow an INC command to set a voltage or rail above that allowed by the currently programmed limits for the specified channel.

See Also: **AMPLIM**
DEC
LOLIMB
LOLIMD
STEP
UPLIMB
UPLIMD

INTD

Syntax:

***chpos1* INTD** ↵

Chpos1 is the standard channel position argument, with Channel 1 specified.

Sets the selected channel to Internal Width/Delay Mode. The programmable Width and Delay can now be specified with the WIDTH and DELAY commands. Once an INTD command has been received, the Width will default to 8 ns until it is set to another value with the WIDTH command.

See Also: **DELAY**
DP
EXT
INTW
WIDTH

INTW

Syntax:

chpos1 INTW

Chpos1 is the standard channel position argument, with Channel 1 specified.

Sets the selected channel to Internal Width Mode. The programmable Width can now be specified with the WIDTH command. Once an INTW command has been received, the Width will default to 8 ns until it is set to another value with the WIDTH command. The Delay will be the same as the delay for the input signal.

See Also: **DP**
EXT
INTD
WIDTH

INV

Syntax:

chpos INV

chpos the standard channel position argument.

Sets the output format to Inverted for the specified driver channel. Example:

MF 0 SLOT 3 CH 2 INV

See Also: **DUMP**
NONINV

ISENSE1 ISENSE2 ISENSE3

Syntax:

chpos ISENSE_x

chpos the standard channel position argument.

x the Current Sense Range number.

Turns on the Current Sense function for the selected channel and sets it to the specified range. The Current Sense Ranges are shown below:

Range #	Bias Card Range
1	1 mA/V
2	10 mA/V
3	100 mA/V

After the Current Sense function has been turned on with the ISENSE_x command, the channel must be selected with the SELECT command before its current reading will appear at the Sense Port. Example:

MF 0 SLOT 3 CH 2 ISENSE1
SELECT

See Also: **DESELECT**
SELECT
VSENSE

LABEL

Syntax:

chpos LABEL text

chpos the standard channel position argument

text the four character text for the label

Attaches a Label to an output channel. If a channel has a label, then any commands sent to modify it can be sent with the "@" character and the label name in place of the standard channel position argument. For example if the label RSET had been applied to Slot 3 Channel 2 with the command:

```
MF 0 SLOT 3 CH 2 LABEL
RSET ↵
```

Then the subsequent command:

```
@RSET INC VOLT ↵
```

could be used to adjust its parameters. If you wish to change the label assigned to a channel, you must first remove the existing label using the LABEL * command.

See Also: **ALL**
CH
LABEL *
SLOT

LABEL *

Syntax:

```
chpos LABEL text ↵
```

chpos the standard channel position argument

Removes a Label from an output channel. Example:

```
MF 0 SLOT 3 CH 2 LABEL * ↵
```

Subsequent commands for this channel must be preceded by the standard channel position argument.

See Also: **ALL**
CH
LABEL
MF
SLOT

LLV

Syntax:

```
chpos LLV voltage ↵
```

chpos the standard channel position argument.

voltage the desired low-level voltage.

Sets low level voltage (low rail) for the specified clock driver channel. The Voltage argument cannot be less than the currently programmed lower limit, and resulting amplitude cannot be

greater than the currently programmed amplitude limit for the specified channel.

Example:

```
MF 0 SLOT 3 CH 2 LLV -2.20 ↵
```

See Also: **AMPLIM**
HLV
LOLIMD
UPLIMD

LNOISE

Syntax:

```
chpos LNOISE ↵
```

chpos the standard channel position argument.

Sets the selected channel on the selected 4000 Series DC Bias card to Low-Noise mode.

Example:

```
MF 1 SLOT 3 LNOISE ↵
```

Output noise will be lower than if the channel is set to REGULAR mode, but response time to programmed changes will be slower. Different channels on the same card can be set to different noise modes. Note that the default mode is LNOISE.

See Also: **regout**

Syntax:

```
chpos1 REGOUT
```

Chpos1 is the standard channel position argument, with Channel 1 specified.

Directs the output for the selected channel to the Regular (Normal) output connector.

See Also: **AUXOUT**

REGULAR

LOLIMB

Syntax:

```
chpos LOLIMB volts ↵
```

chpos the standard channel position argument.

volts the desired Lower Voltage Limit, in Volts.

Sets the Lower Voltage Limit for the selected Bias channel. Once the Lower Voltage Limit has been set for a DC Bias Channel, the system will not allow a VOLT or DEC VOLT command to bring the Voltage setting for that channel below the Lower Voltage Limit. *Volts* must be in the valid range for the card model, and must be lower than the Upper Voltage Limit. Example:

```
MF 0 SLOT 3 CH 2 LOLIMB -  
7.8 ↵
```

See Also: **DEC**
INC
UPLIMB
VOLT

LOLIMD

Syntax:

chpos* LOLIMD *volts ↵

chpos the standard channel position argument.

volts the desired Lower Voltage Limit, in Volts.

Sets the Lower Voltage Limit for the selected Driver channel. Once the Lower Voltage Limit has been set for a Driver Channel, the system will not allow a LLV or DEC LLV command to bring the Low Level Voltage setting for that channel below the Lower Voltage Limit. *Volts* must be in the valid range for the card model, and must be lower than the Upper Voltage Limit.

Example:

```
MF 0 SLOT 3 CH 2 LOLIMD -  
3.8 ↵
```

See Also: **AMPLIM**
DEC
HLV
INC
LLV
UPLIMD

LR

Syntax:

***chpos* LR** ↵

chpos the standard channel position argument.

Sets the selected, odd-numbered channel on the selected 4000 Series DC Bias card back to Low Resolution (standard) mode. Note that output will be enabled to the next even-numbered channel in sequence (the “control” channel”). The control channel should be physically disconnected from the DUT when using HR mode. Example:

```
MF 1 SLOT 3 LR ↵
```

See Also: **HR**
VOLT

LRANGE

Syntax:

***chpos* LRANGE** ↵

chpos the standard channel position argument, although the channel designator is optional.

Sets all channels on the selected DC Bias card to Low Range. Low Range reduces output noise and increases programming resolution to 5 mV. Note that far greater programming resolution can be achieved with or in combination with High Resolution mode (HR).

To protect against voltage transients, the system must be in Disconnect mode before LRANGE can be set. HRANGE is the default setting.

Note that all channels on each card must be in the same range, but that different Bias cards can be set to different ranges. For PI-4075x cards, this enables voltage and limit settings from between ±10 V. Example:

```
MF 1 SLOT 3 LRANGE ↵
```

Note that LRANGE will force existing VOLT, UPLIMB and LOLIMB settings to within ±10 V.

See Also: **HRANGE**
LOLIMB
UPLIMB
VOLT

LRANGED

Syntax:

chpos LRANGED

chpos the standard channel position argument, although the channel designator is optional.

Sets all channels on the selected Clock Driver card to Low Voltage Range. Note that all channels on each card must be in the same range, but that different Clock Driver cards can be set to different ranges. For PI-41401 cards, this enables voltage (rail) and limit settings from between -5 V to +6 V. Example:

```
MF 0 SLOT 3 LRANGED
```

Note that LRANGED may cause existing HLV, LLV, UPLIMD and LOLIMD settings to be out of range. New limit settings should be applied before new voltage settings are applied.

See Also: **AMPLIM**
HLV
HRANGED
LLV
LOLIMD
UPLIMD

MAINOUT

Syntax:

chpos MAINOUT

chpos the standard channel position argument.

Selects the regular output for the specified driver channel. Example:

```
MF 0 SLOT 3 CH 2 MAINOUT
```

MF

Syntax:

MF x SLOT y CH z command

x mainframe number of the desired channel
y slot number of the desired channel
z desired channel number

command any valid command(s)

MF is part of the standard channel position (chpos) argument that precedes most commands. Example:

```
MF 0 SLOT 3 CH 2 VOLT -1.80
```

See Also: **@**
ALL
CH
LABEL
LABEL *
SLOT

MHLV

Syntax:

chpos MHLV voltage

Chpos is the standard channel position argument.

Voltage is the desired middle-high-level voltage.

Sets the Middle-High-Level Voltage for the specified channel. The channel must be in Four-Level Mode, and the HLV and LLV must already have been set. The minimum difference between the HLV and either MLV must be 1.000V, as must the difference between the LLV and either MLV.

See Also: **HLV**
LLV
MLV
MLLV

MLLV

Syntax:

chpos MLLV voltage

Chpos is the standard channel position argument.

Voltage is the desired middle-low-level voltage.

Sets the Middle-Low-Level Voltage for the specified channel. The channel must be in Four-Level Mode, and the HLV and LLV must already have been set. The minimum difference between the HLV and either MLV must be 1.000V, as must the difference between the LLV and either MLV.

See Also: **HLV**
LLV
MHLV
MLV

MLV

Syntax:

chpos MLV voltage ↗

Chpos is the standard channel position argument.

Voltage is the desired middle-level voltage.

Sets the Middle-Level Voltage for the specified channel. The channel must be in Tri-Level Mode, and the HLV and LLV must already have been set. The minimum difference between the HLV and MLV must be 1.000V, as must the difference between the LLV and MLV.

See Also: **HLV**
LLV
MHLV
MLLV

MONOUT

Syntax:

chpos MONOUT ↗

chpos the standard channel position argument.

Directs the output for the selected channel to the Monitor output connector. Example:

```
MF 0 SLOT 4 CH 2 MONOUT ↗
```

See Also: **MAINOUT**

NHIZ

Syntax:

chpos NHIZ ↗

chpos the standard channel position argument.

Sets the specified clock driver channel to normal (non-tri-stated) output. Example:

```
MF 0 SLOT 3 CH 2 NHIZ ↗
```

See Also: **DUMPF**
HIZ
INV
NONINV

NONINV

Syntax:

chpos NONINV ↗

chpos the standard channel position argument.

Sets the output format for the specified channel to Non-Inverted. Example:

```
MF 0 SLOT 4 CH 2 NONINV ↗
```

See Also: **DUMPF**
INV

OFFLINE

Syntax:

OFFLINE ↗

Places the instrument in the Offline state. Subsequent changes in voltage settings will not be reflected at the output until the instrument is put back Online. Example:

```
OFFLINE ↗
```

OFFLINE can only be issued if the instrument is currently in the Connect state, as DISCON automatically takes the instrument Offline.

See Also: **CONNECT**
DISCON
OFFLINE

ONLINE

Syntax:

ONLINE ↵

Places the instrument in the On-Line state. Changes to voltages settings during the Off-Line state will now be reflected at the output. Example:

ONLINE ↵

ONLINE can only be issued if the unit is currently in the Offline state. If the unit is currently in Disconnect, use CONNECT first, and then ONLINE.

See Also: **CONNECT**
DISCON
OFFLINE

OPTO

Syntax:

chpos OPTO ↵

chpos the standard channel position argument.

Selects the optically isolated input to the desired clock driver channel. Example:

MF 0 SLOT 7 CH 2 OPTO ↵

See Also: **ECL**
TTL
TTL50
TTL500

PATMSGSGS

Syntax:

PATMSGSGS ↵

Multiple types of Pulse Instruments card can be installed in the same CompactPCI mainframe, and certain commands, such as STATUS, are recognized by more than one type of card. Therefore, the PI-11000 uses "message modes" to determine which commands are intended for which type of card.

A PATMSGSGS must be sent before the initial block of commands intended for Pattern Generator cards.

The PATMSGSGS command must be sent again if any commands have been subsequently sent to a different type of Pulse Instruments CompactPCI cards (such as DC Bias or clock driver cards) using the BIASCLKMSGSGS command.

Example:

```
BIASCLKMSGSGS ; THESE COMMANDS ARE
FOR BIAS/CLK CARDS ↵
ALL LOLIMB -3.00 ↵
ALL UPLIMB 5.00 ↵
MF 0 SLOT 3 CH 2 VOLT -1.80 ↵
MF 0 SLOT 3 CH 1 VOLT 2.3 ↵
CONNECT ↵
ONLINE ↵
```

```
PATMSGSGS ; THESE ARE FOR PATTERN
GENERATOR CARDS
COMPILE 1 ↵
SEQUENCE ↵
SEQUENCE ↵
SEQUENCE ↵
```

```
BIASCLKMSGSGS ; THESE ARE FOR
BIAS/CLK CARDS ↵
OFFLINE ↵
```

See Also: **BIASCLKMSGSGS**

POWERDOWN

Syntax: **POWERDOWN** ↵

Causes the PI-11000 to begin the shutdown procedure. The PI-11000 is safe to turn off 30 seconds after the POWERDOWN command has been issued.

The POWERDOWN command is processed by the Pattern Generator command parser, and therefore it must be preceded by the PATMSGSGS command. Example:

```
PATMSGSGS ↵
POWERDOWN ↵
```

See Also: **MONOUT**

REGOUT

Syntax:

***chpos1* REGOUT** ↵

Chpos1 is the standard channel position argument, with Channel 1 specified.

Directs the output for the selected channel to the Regular (Normal) output connector.

See Also: **AUXOUT**

REGULAR

Syntax:

***chpos* REGULAR** ↵

chpos the standard channel position argument.

Sets the selected channel on the selected 4000 Series DC Bias card to Regular mode. Example:

```
MF 1 SLOT 3 REGULAR
```

 ↵

Output noise will be higher than if the channel is set to LNOISE mode, but response time to programmed changes will be faster. Different channels on the same card can be set to different noise modes. Note that the default mode is LNOISE.

See Also: **LNOISE**

RTRIG

Syntax:

***chpos1* RTRIG** ↵

Chpos1 is the standard channel position argument, with Channel 1 specified.

Sets the Trigger Out for the specified channel to occur on the rising edge of the Input Signal to the Driver Card.

See Also: **FTRIG**

SELECT

Syntax:

***chpos* SELECT** ↵

chpos the standard channel position argument.

Causes the Voltage or Current of the desired channel to appear at the Sense Port. The desired channel must have been previously set to Voltage or Current Sense Mode with either the ISENSEx or VSENSEx command. Use the ISENSEx and VSENSEx commands to set up the sensing modes that you wish to use for each channel. Example:

```
MF 0 SLOT 3 CH 2 VSENSE1 SELECT
```

 ↵

Different channels on the same card can be set to different sensing modes and/or sensing ranges. After the channels have been set up, use a series of SELECT command to scan the channels and read the outputs at the Sense Port(s).

See Also: **DESELECT**
ISENSE1/2/3
VSENSE1/2/3

SEQ...DEFAULT

Syntax:

SEQ *sequence* DEFAULT ↵

sequence the type of sequence to define. *Sequence* may be ONLINE or DISCON.

Sets the specified sequence back to the default order. The default order for each type of sequence is as follows:

- ONLINE — Bias Supplies in ascending order by channel number, and then by slot number. Drivers in descending order by channel number and then by slot number.
- DISCON — Drivers in ascending order by channel number, and then by slot number. Bias Supplies in descending order by channel number, and then by slot number.

Example:

```
SEQ ONLINE DEFAULT
```

 ↵

See Also: **SEQ...DUMP**
SEQ...END
SEQ...OPPOSITE

SEQ...DUMP

Syntax:

SEQ sequence DUMP ↵

sequence is the sequence to DUMP.
Sequence can be ONLINE,
SCREEN, or DISCON.

Dumps the On-Line, Screen Display, or
Disconnect Sequence that is currently
set in the system. Example:

SEQ DISCON DUMP ↵

See Also: **SEQ...DEFAULT**
SEQ...END
SEQ...OPPOSITE

SEQ...END

Syntax:

**SEQ sequence *chpos1 chpos2*
chpos3...END** ↵

sequence is the type of sequence to
define. *Sequence* may be
ONLINE or DISCON.

chpos1 *the chpos* of the channel to
place first in this sequence.

chpos2 *the chpos* of the channel to
place second in this
sequence.

chposn *the chpos* of the channel to
place *Nth* in this sequence.

Defines the ONLINE or DISCON
sequence starting with the specified
channels. If the numeric syntax is used
for the channel position arguments, slot
numbers do not need to be repeated
when listing channels from same slot.
For example, if Slot 4 contains a four
channel Driver Card, the following
command sequence:

```
SEQ ONLINE MF 0 SLOT 4 CH 4 CH 3  
CH 2 CH 1 END ↵
```

would define the Online Sequence for the four
channels on that card. A ***chpos*** argument can
also be replaced by a channel's four-character
label.

Not all the channels in the system need to be
assigned in the sequence. Upon receipt of the
END command, the PI-11000 will append all un-
assigned channels to the end of the sequence in
the default order.

See Also: **SEQ...DEFAULT**
SEQ...DUMP
SEQ...OPPOSITE

SEQ...OPPOSITE

Syntax:

SEQ sequence OPPOSITE ↵

sequence is the sequence to define.
Sequence may be ONLINE or
DISCON.

If *Sequence* is ONLINE, creates an On-Line
sequence that is the opposite of the currently
defined Disconnect Sequence. If *Sequence* is
DISCON, creates an Disconnect sequence that
is the opposite of the currently defined On-Line
Sequence.

Example:

SEQ DISCON OPPOSITE ↵

See Also: **SEQ...DEFAULT**
SEQ...DUMP
SEQ...END

SETDEFB

Syntax:

***chpos* SETDEFB** ↵

chpos the standard channel position
argument.

Sets the parameters to their Default values for
the specified Bias Channel. (Upper Limit +8.188
V, Lower Limit -8.188 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.

Example:

```
MF 0 SLOT 3 CH 2 SETDEFB ↵
```

See Also: **CLEAR**
SETDEFD

SETDEFD

Syntax:

```
chpos SETDEFD ↵
```

chpos the standard channel position argument.

Sets the parameters to their Default values for the specified Driver Channel. (Upper Limit maximum value, Lower Limit minimum value). The CLEAR command will also reset the limits to these default values, as well as setting all driver and bias outputs to 0 V.

See Also: **CLEAR**
SETDEFB

SETGPIBADDR

Syntax: **SETGPIBADDR *addr*** ↵

addr is desired new GPIB address for the PI-11000, in the range from 1-30.

Changes the GPIB address of the PI-11000.

The SETGPIBADDR is processed by the Pattern Generator command parser, and therefore it must be preceded by the PATMSGSG command. If subsequent commands are intended for DC bias or clock driver channels, they must be preceded by a BIASCLKMSGSG command.

Note that subsequent communications with the PI-11000 will also require using the new address. Example:

```
PATMSGSG ↵  
SETGPIBADDR 15 ↵
```

See Also: **BIASCLKMSGSG**
PATMSGSG

SLEW

Syntax:

```
chpos SLEW slewtime ↵
```

chpos the standard channel position argument.

slewtime the desired slew time, in nanoseconds.

Sets the programmable slew time for the specified driver channel. Example:

```
MF 0 SLOT 3 CH 2 SLEW 4 ↵
```

See Also: **DUMPT**
TF
TR

SLOT

Syntax:

```
MF x SLOT y CH z command ↵
```

x mainframe number of the desired channel

y slot number of the desired channel

z desired channel number

command any valid command(s)

SLOT is part of the standard channel position (chpos) argument that precedes most commands. Example:

```
MF 0 SLOT 3 CH 2 VOLT -1.80 ↵
```

See Also: **@**
ALL
CH
LABEL
LABEL *
MF

STATUS

Syntax:

STATUS ↵

Causes the PI-11000 to return a Status File containing information on the status of the System. This command also clears any pending errors and returns their corresponding error codes.

Example:

```
STATUS ↵
```

The returned Status File will contain the following information:

```
Online/Offline/Disconnect Status  
Error Message  
1A 0D 0A EOI
```

The final bytes are the standard File Termination Sequence.

If there are any errors pending you will not be able to send data or commands to the PI-11000 until they are cleared with the STATUS command.

See Also: **DUMP**
ID

STEP

Syntax:

```
STEP stepval ↵
```

stepval the desired step value, in mV.

Sets the STEP value for subsequent INC/DEC VOLT, INC/DEC HLV or INC/DEC LLV command. *Stepval* may be from 10 mV to 100 mV in increments of 10 mV.

Once a STEP command is issued, the Step Value remains active until another STEP command is issued. For example, the command sequence:

```
STEP 30 ↵  
MF 0 SLOT 3 CH 1 INC VOLT ↵  
MF 0 SLOT 3 CH 2 INC VOLT ↵  
MF 0 SLOT 4 CH 1 INC VOLT ↵
```

would increment the Voltage setting by 30 mV for each of the specified channels.

See Also: **DEC**
INC

TF

Syntax:

```
chpos TF falltime ↵
```

chpos the standard channel position argument.

falltime the desired fall time, in nanoseconds.

Sets the programmable fall time for the specified driver channel. Example:

```
MF 0 SLOT 3 CH 2 TF 4 ↵
```

See Also: **DUMPT**
TR

TR

Syntax:

```
chpos TR risetime ↵
```

chpos the standard channel position argument.

risetime the desired rise time, in nanoseconds.

Sets the programmable fall time for the specified driver channel. Example:

```
MF 0 SLOT 3 CH 2 TR 3 ↵
```

See Also: **DUMPT**
TF

TRILV

Syntax:

```
chpos TRILV ↵
```

Chpos is the standard channel position argument.

Sets the specified driver channel to Tri-Level function. The two channels on a given Driver Card can be set to different modes at the same time.

See Also: **FORLV**
TWOLV

TTL

TTL50

TTL500

Syntax:

chpos TTL | TTL50 | TTL500 ↗

chpos the standard channel position argument.

Selects the TTL input for the specified driver channel. Selected models may also have a selectable input impedance of 50 or 500 Ω. TTL inputs are not optically isolated. Example:

MF 0 SLOT 3 CH 2 TTL50 ↗

See Also: **OPTO**
ECL

TWOLV

Syntax:

chpos TWOLV ↗

Chpos is the standard channel position argument.

Sets the specified driver channel to normal, two level function. The two channels on a given Driver Card can be set to different modes at the same time.

See Also: **FORLV**
TRILV

UPLIMB

Syntax:

chpos UPLIMB *volts* ↗

chpos the standard channel position argument.

volts the desired Upper Voltage Limit, in Volts.

Sets the Upper Voltage Limit for the selected Bias channel. Once the Upper Voltage Limit has been set for a DC Bias Channel, the system will not allow a VOLT or INC VOLT command to bring the Voltage setting for that channel above the Upper Voltage Limit. *Volts* must be between -8.192 V and +8.188 V, and must be higher than the Lower Voltage Limit. Example:

MF 0 SLOT 3 CH 2 UPLIMB 7.02 ↗

See Also: **INC**
LOLIMB
VOLT

UPLIMD

Syntax:

chpos UPLIMD *volts* ↗

chpos the standard channel position argument.

volts the desired Upper Voltage Limit, in Volts.

Sets the Upper Voltage Limit for the selected Driver channel. Once the Upper Voltage Limit has been set for a Driver Channel, the system will not allow a HLV or INC HLV command to bring the High-Level Voltage setting for that channel above the Upper Voltage Limit. *Volts* must be in the valid range for the specified card model and must be higher than the Lower Voltage Limit. Example:

MF 0 SLOT 3 CH 2 UPLIMD 6.5 ↗

See Also: **AMPLIM**
HLV
INC
LLV
LOLIMD

VOLT

Syntax:

chpos VOLT *voltage* ↗

chpos the standard channel position argument.

voltage the voltage level.

Sets the output level for the specified DC Bias channel.. Example:

MF 0 SLOT 3 CH 2 VOLT -
1.80 ↵

See Also: **DEC**
INC
LOLIMB
UPLIMB

VSENSE1

VSENSE2

VSENSE3

Syntax:

***chpos* VSENSE x** ↵

chpos the standard channel position argument.

x the Voltage Sense Range number.

Turns on the Voltage Sense function for the selected channel. The Voltage Sense Ranges are shown below:

CompactPCI Cards	
Range	Voltage Range
1	-8.192 - +8.188 V
2	N/A
3	N/A

4000 Series Cards	
Range	Voltage Range
VSENSE1	2 V
VSENSE2	20 V
VSENSE3	200 V

Only VSENSE1 is supported on the Pulse Instruments CompactPCI cards. After the Voltage Sense function has been turned on with the VSENSE x command, the channel must be selected with the SELECT command before its Voltage reading will appear at the Sense Port. Example:

MF 0 SLOT 3 CH 2 VSENSE1 ↵
SELECT ↵

See Also: **DESELECT**
ISENSE
SELECT

WIDTH...NS

WIDTH...US

WIDTH...MS

Syntax:

chpos1* WIDTH *progwidth* *units ↵

Chpos1 is the standard channel position argument, with Channel 1 specified.

Progwidth is the desired numeric value for the Programmable Width.

Units is the unit value for the Programmable Width, either NS, US or MS.

Sets the Programmable Width for the desired channel. The channel must already have been set to Internal Width, Internal Width/Delay, or Double-Pulse Mode. The Programmable Width may be from 8 ns to 80 ms.

See Also: **DP**
INTD
INTW

8. TROUBLESHOOTING

DC Bias and Clock Driver Cards		
Symptom	Possible Cause	Solution
No output	Instrument is in Offline or Disconnect mode	Use the XMFRM mnemonic or the ONLINE command to place the instrument Online .
	External DC supply is powered off	Turn on all external supplies
Voltages do not change when programmed	Instrument is in Offline mode.	Use the XMFRM mnemonic or the ONLINE command to place the instrument Online .
Clock driver outputs do not reach programmed amplitude	Current sense may be set to 1 mA range (default), which limits output current	Use the channel mnemonic or the ISENSE command to increase the current sense range, and thus the allowable current.
Clock driver channel has no output	Driver output may be set to Monitor or Mux Out (selected models only)	Use channel mnemonic or MAINOUT command to set output to regular output port.
	Driver input may be set to incorrect port or impedance value	Use channel mnemonic or commands OPTO , TTL50 , or TTL500 to set input to correct port and impedance value.
	Input may not be running	Use Pat mnemonic or START command to start pattern generator cards.
Cannot change bias or driver card voltage range	Mainframe must be in Disconnect before changing ranges	Set Mainframe to Disconnect , change the range, then set Mainframe to Offline or Online .
	Present voltages or limits settings are outside the permitted values for the desired range.	Program valid voltages and limits before changing ranges.
	Certain card models require all channels on a card to be in the same range	Program valid voltages and limits on all channels for the desired card.
DC Bias channels not supplying specified current	Current sense may be set to 1 mA range (default), which limits output current	Use the channel mnemonic or the ISENSE command to increase the current sense range, and thus the allowable current.
Instrument does not recognize GPIB commands for DC Bias and Clock Driver cards	GPIB message mode set to Pattern Generator mode	Send GPIB BIASCLKMSGs command to switch message modes

DC Bias and Clock Driver Cards		
Symptom	Possible Cause	Solution
Instrument does not recognize GPIB commands for Pattern Generator	GPIB message mode set to Bias/Clock Driver mode	Send GPIB PATMSGGS command to switch message modes
Instrument does not recognize any GPIB commands	An error is pending and needs to be cleared	Send STATUS command to clear error
	PI-PAT not running on local instrument. PI-PAT must be running to receive GPIB commands, even if commands are only intended for DC Bias and Clock Driver cards	Start up PI-PAT on local unit. Green LEDs on Pattern Cards will light up when PI-PAT is running.
	Commands sent to wrong address or instrument set to wrong address	Scan the GPIB for available instruments. Send GPIB SETGPIBADDR command if necessary.
PI-Controller does not recognize installed hardware	Hardware has been physically reconfigured	Use the Edit:Advanced Hardware Configuration menu to detect installed hardware.
	Hardware file is corrupt and needs to be rebuilt	Delete the PIOnSite.hwr file from C:\Program Files\Pulse20 and then use the Edit:Advanced Hardware Configuration menu to detect installed hardware.
No output from Sense ports	Sense range not set appropriately	Use channel mnemonic commands ISENSE and VSENSE to set the desired voltage- or current-sense range
	Channel not selected for sensing	Use the Sense mnemonic or the SELECT command to select the channel.
Sensed output is not accurate	Sense range not set appropriately	Use channel mnemonic commands ISENSE and VSENSE to set the voltage- or current-sense range so that the expected sense port output is ± 1 V.
	DVM set to wrong range	Set your DVM to the lowest range that will measure the expected sense port output without overflowing.
Write button is disabled	Instrument is in Offline mode	Use the XMFRM mnemonic to place the instrument Online .

DC Bias and Clock Driver Cards		
Symptom	Possible Cause	Solution
4000 Series instrument cards not recognized	Mainframes powered up in incorrect order	Turn on power in the following sequence: 1) PI-4003A DC Power Mainframe 2) PI-4002B Instrument Mainframes (any order) 3) PI-11000 Instrument Mainframe(s), via System Power Switch
System with 4000 Series instrument cards is in Disconnect, and will not Connect	PI-4002B is in Interrupt because of hardware error	Check all 4000 Series cabling, including PI-Bus Interface Cable.
Cards in Slave mainframe(s) not recognized	CPCI Bridge cards incorrectly installed or cabled	Check that bridge cards are in proper slots for master/slave cards and that cable ordering is correct.
Front panel power switch does nothing	CPCI Slave Mainframes are controlled by the System Power Switch on the Master mainframe	Use System Power switch on Master mainframe or disable power sequencing by removing power sequencing cable.
	Rear-panel AC power switch is in Off position	Turn on rear AC power switch

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