PCB PIEZOTRONICS
AN AMPHENOL COMPANY

Model 481A02

16-channel, line-powered, ICP® sensor signal cond., gain x1, x10, x100, computer/front panel control

Installation and Operating Manual

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Addendum to 481A Series Manual
Normalize Function

The users of the 481A series have been waiting for the ability to provide the signal conditioner with the sensitivity of a particular channel's sensor input (mV/ unit) and have the required gain be calculated by the signal conditioner to normalize the output level. The sensor/ signal conditioner combination would then have sensitivity of 1 Volt/ unit. The value of "unit" is related to a physical property (psi, G's, pounds)

Normalize Output Sensitivity:

The definition of normalized output sensitivity is the calculation of the individual channel's gain, depending on the sensitivity of the sensor attached and the desired output sensitivity. This is simply a function of the desired output sensitivity (in Volts/ unit) divided by the sensor's sensitivity.

$$\text{Gain} = \frac{1 \text{ Volt/ unit}}{\text{Sensitivity (mV/ unit)}}$$

Note: The formula has been simplified for clarity. The difference between the sensor's sensitivity is entered in mV, and the output voltage in Volts is taken out of the equation to insure that the "Gain" is truly a dimensionless number.

Additionally, a feature to improve flexibility allows changing the output level to a value of an integer value between 1 and 10 Volts/ unit (for example - 5 Volts/ unit) instead of simply "normalized" 1 Volt/ unit. The 481A unit has the ability calculate the gain using a known input signal along with the sensor sensitivity, and desired output level. The result of the request impacts the formula:

$$\text{Gain} = \frac{1 \text{ Volt/ unit}}{\text{Sensitivity (mV/ unit)} * \text{Expected Signal (units)}}$$

Since the 481A fine gain options (038 & 038) have a limited gain ranges, 0.1 to 200 and 0.0025 to 200 respectively, some simple error checking has been implemented to insure the limits of the sensor and gain limits of the signal conditioner are not exceeded.

The storage of individual channel gains is already stored in non-volatile memory locations when the memory default option (102) is included in the 481A. The new variables for each channel's sensitivity, normalize output level, and expected input are also stored in non-volatile memory locations. The non-volatile storage will allow previous settings to be maintained after power up or reset. The default values for sensitivity, normalized output value, and expected input will all be defined as 1000mV/unit, 1 Volt/ unit, and 1 unit respectively to simplify calculations. The default settings will be used at power up or reset when the memory default option is not present.

Commands and Syntax:

The 481A series has a defined command set and syntax format that will be followed to provide the necessary error checking and echo format. The 481A manual may be referenced for a detailed discussion of command format and syntax. The normalization command is "N" and will be a channel based command. The command has the format:

N n = xxx.x

Where "n" is the channel number (1 to 16) to be normalized, and xxx.x is the sensor sensitivity in mV/ unit, since most sensitivities are defined in milli-Volts per unit.

For example, an accelerometer has a sensitivity of 11.2 mV/G and is connected to channel 6 would require the command:

N6=11.2

N0 = xx

The normalize command with a channel number equal to "zero" is used to set the output normalization level for the entire rack. The default normalize output value will be 1 Volt/ unit. The limits of " xx" are 1 to 10 Volts.

The echo string for the "N" command is:

1:Ok - command accepted and channel(s) gain has been updated

1 : Calculated Gain out of range, modify expected units

- The combination sensitivity, output level and expected is not within the limits for the gain for a channel(s).

The "N" command also has a read sensitivity command format:

N n ? The echo string will return the information:

"Channel n is xxx.x mV/ unit normalized to 1 Volt/ unit" (default normalize value)

The expected input signal, used in the gain calculation, is entered using the command "E". Since individual channels may experience different input signals, the "E" command is a channels based command. The format is:

E n = yyyy

Again n is the channel number (1 to 16), and yyyy is the expected input value in the same units as the sensor (psi, G's, pounds, etc.). The default value for yyyy is 1 unit for channel until modified.

Reading the expected input value is:

E n ? - Returns the echo string (default normalize value).

"Channel n is xxx.x mV/ unit normalized to 1 Volt/ unit with yyyy units input"

The formula for calculating the gain of each channel is completely defined as:

$$\text{Gain} = \frac{\text{Output Voltage}}{\text{Sensitivity (mV/ unit)} * \text{Expected Signal (units)}}$$

$$A_n = \frac{N_0 \text{ (zero)}}{N_n * E_n}$$

Using the example, sensitivity - 11.2 mV/G, output level – 1 V, and Expected input - 1 G

$$\text{Gain} = \frac{\text{Output Voltage}}{\text{Sensitivity (mV/ unit)} * \text{Expected Signal (units)}}$$

$$A_n = \frac{1}{11.2 \text{ mV/G} * 1 \text{ G}}$$

A6 = 89.3 - option 037 fine gain control
A6 = 89.286 - option 038 expanded fine gain control

Charge Mode Sensors and Normalize Function:

The 481A has the ability accept charge mode sensors using the options 481-082, -086, -087. The charge mode sensor interfaces into an in-line charge amplifier and is selected via a rear panel toggle switch. These options do not allow the user to incorporate the charge sensitivity in the "normalize" gain calculation. The new options 481-282, -286, -287 select the charge, ICP, or voltage mode under the control of the host computer or front panel control. The individual in-line charge amplifier is entered at the factory during final calibration. Whenever the charge mode is selected for a channel and a normalize command is received, the calculation of the gain takes the form:

$$\text{Gain} = \frac{1 \text{ Volt}}{\text{Sensor Sensitivity (pC/ unit)} * \text{Expected Signal (units)} * \text{Charge Sensitivity (mV/pC)}}$$

$$A_n = \frac{N_0 \text{ (zero)}}{N_n * E_n * \text{Fixed at factory}}$$

The voltage mode input implements the "normalize" feature in the same way as the ICP mode. The sensitivity of the voltage input has the same mV/ unit as ICP.

Front Panel Control:

The control of the Normalize function is performed using 3 menu choices. The menu choices are located after the fifth line of menu choices "Lock", "Chrg", and "Fan" The first menu choice is the "Sens" that allows setting and reading of each channel's sensor

sensitivity. The second menu choice is the "Norm" menu, which sets and displays the current output level voltage. Finally, the "Expct" menu choice allows setting and displaying the expected input signal for each channel.

Lock	Chrg	Fan
Sens	Norm	Expct

Upon entry into the "Sens" menu choice, the unit will determine if the option is present and display the input sensitivity of channel number 1. In addition, the input mode is displayed on the top line by either "mV/ unit" for ICP or Voltage input mode or "pC/ unit" for Charge mode.

RK#	Chan	mV/ unit
1	6	11.2

The "Sens" is used similar to the "Gain" menu choice. Reference the front panel control section of the manual to change channel number and adjust the sensitivity of the selected channel. If the sensitivity of the channel will not change, two possibilities exist. First, the desired sensitivity will calculate a gain value that exceeds the legal limit of the 481A. Secondly, the desired change will not calculate to a new gain setting due to resolution of the gain. In either case, use the shift right/ left key to move the cursor to a higher significant digit and attempt a new adjust. If the desired sensitivity is still not capable of being set, move to the "Norm" or "Expct" menu choices and adjust the setting.

Upon entry to the "Norm" menu choice, the unit will determine if the option is present and displays the output voltage level. The up/ down arrow keys are used to adjust the output voltage level by 1-Volt increments. When the upper limit, 10 Volts, or lower limit, 1 Volt, is reached, the value wraps around to the opposite limit. The menu has the format:

RK#	Normalized
1	to 1 Volts

Finally, the "Expct" menu is used to update and monitor the expected input signal for each channel. This menu choice is similar to the "Gain" menu choice in the use of the cursor to adjust the expected input for a given channel. Similar to the "Sens" menu choice, if the expected value does not change, the calculated the gain required for the channel can not be achieved with the channel's values of the sensitivity, output level, and expected value. The suggested means of overcoming the limit is to adjust the output level setting. Upon entry into the menu, the existence of the option is checked and the expected number of "units" is displayed. The menu has the format:

RK#	Chan	units
1	6	1

1-0. INTRODUCTION AND SPECIFICATIONS

1-1. Introduction: Safety Considerations

WARNING 1: *The power supply/signal conditioner should not be opened by anyone other than qualified service personnel.* This product is intended for use by qualified personnel who recognize shock hazards and are familiar with the safety precautions required to avoid injury.

WARNING 2: This equipment is designed with user safety in mind; however, the protection provided by the equipment may be impaired if the equipment is used in a manner not specified by PCB Piezotronics, Inc.

Caution 1: *Cables can kill your equipment.* High voltage electrostatic discharge (ESD) can damage electrical devices. Similar to a capacitor, a cable can hold a charge caused by triboelectric transfer, such as that which occurs in the following:

- Laying on and moving across a rug.
- Any movement through air.
- The action of rolling out a cable.
- Contact to a non-grounded person

The solution for product safety: 1) Connect the cables only with the AC power off. 2) Temporarily "short" the end of the cable before attaching it to any signal input or output.

Caution 2: *ESD considerations should be made prior to performing any internal adjustments on the equipment.* Any piece of electronic equipment is vulnerable to ESD when opened for adjustments. Internal adjustments should therefore be done ONLY at an ESD-safe work area. Many products have ESD protection, but the level of protection may be exceeded by extremely high voltage.

WARNING SYMBOLS AND TERMS

The following symbols and terms may be found on the equipment described in this manual.

This symbol on the unit indicates that the user should refer to the operating instructions located in the manual.

This symbol on the unit indicates that high voltage may be present. Use standard safety precautions to avoid personal contact with this voltage.

This symbol indicates that the test fixture, Model 481A, must be connected to earth ground via the power cord.

The **WARNING** heading used in this manual explains dangers that might result in personal injury or death. Always read the associated information very carefully before performing the indicated procedure.

The **Caution** heading used in this manual explains hazards that could damage the instrument.

EQUIPMENT RATINGS

For complete specifications, please refer to the enclosed Specification Sheet. This equipment operates optimally at +32 to +120°F (0 to +50°C), in an environment having <85% relative humidity. Its line power frequency range is 50/60 Hz. Operation of this unit is limited to environments having an altitude of less than 2 000 meters. The pollution degree for operation of the Model 481A is two (2); overvoltage category is II.

The Model 481A requires 100 to 240 VAC with 1.0 amps to operate. In turn, it supplies 24 VDC, 2 to 20 mA excitation voltage to connected ICP sensors.

This unit get its power via an AC line cord that plugs into the receptacle on the rear panel. Its readout may be monitored by a computer terminal, the connectors for which are also located on the rear panel. This interface is made using RS-232, RS-485 (for PCB proprietary protocol used in rack intercommunication), or IEEE-488 cables. Two D-Sub-9 male connectors are supplied on the rear panel for this purpose. Multiple Model 481A units may be linked using RS-485 or IEEE-488 cables.

A variety of input and output configurations are available on the Model 481A. These are described more fully in Sections 1-3 and 2-14. Signals for sixteen individual channels may be input to the unit through either a single D-Sub-50 female connector, optional individual BNC connectors (16), or optional 10-32 charge mode input connectors (16). Outputs from the unit come in two forms: sixteen BNC outputs are located on the front panel, and a single D-Sub-37 female connector is located on the rear panel.

Two rear panel fuses, located below the switch in the AC receptacle, protect the power line input of the instrument. The fuse type is a T 1.6A, L 250 V. To change the fuse, disconnect the power cord. Find the slot just above the power switch and pull forward to open the door that exposes the fuse racks. Pull out the affected rack and insert a new fuse.

1-2. Model 481A System Description, Basic Configuration

The Model 481A is a basic, line-powered, 16-channel signal conditioning system designed to interface measurement signals to readout or recording devices. The unit also serves to provide excitation power for ICP®-type sensors. It is designed for the customer who desires to completely custom-configure the unit. Model 481A is fully configurable with the many available options listed hereafter. Standard features for the base model include: 12-bit accuracy signal conditioning; unity gain; input fault and overload LED per channel; 16 channels per rack, expandable with optional computer interface; and variable ICP source current, 2 to 20 mA. There are 16 BNC output connectors and illuminator lights on the front panel; the rear panel has power cord and multipin connections (reference fig. 8-1.1 and fig. 8-1.2). Any other features are available as options.

Options

- RS-232 and RS-485 interface (481101)
- Fixed gain: x5 or x10 (481031, 481032)
- Programmable overload threshold level (481020)
- Calibration: external, user-defined selection (481014)
- Calibration: external/internal with amp control (481012)
- Dual independent 16-to-1 output switching (481041)
- Switched output (velocity/displacement) (481061)
- Velocity output every channel (481062)
- RMS-DC conversion (481064)
- IEEE-488 interface (481070)
- External 12-volt operation (481092)
- ICP or voltage sensor input (481084)
- Programmable gain, x1, x10, x100 (481035), with autoranging

- Programmable fine gain, 0.1 to 200 (481037), with auto-ranging
- Expanded programmable fine gain, 0.0025 to 200 (481038), with auto-ranging
- Selectable discharge time constant, 2 or 10 second (481013)
- Fixed low pass filter, several cutoffs available (481050 to 481056)
- Programmable low pass filter (481157) Elliptic
- Programmable low pass filter (481158) Butterworth
- BNC input on rear panel (481080), standard on preconfigured models
- BNC input/output on rear panel (481081)
- BNC output on rear panel for use with 481064 (RMS-DC conversion) option (481085)
- Memory default (481102)
- Selectable ICP® or charge mode sensor input, 0.1 mV/pC (481082)
- Selectable ICP or charge mode sensor input, 1.0 mV/pC (481086)
- Selectable ICP or charge mode sensor input, 10 mV/pC (481087)
- Front panel keypad control/display (option 481103)

NOTE: Throughout this manual, the notation "**Model 481A***" is used to indicate that the section highlighted in the box above refers *conditionally* to that model: the section applies **only** if the unit is so equipped.

1-3. Model 481A System Description, Alternate Configurations

The Model 481A is housed in a standard 19-inch rack chassis. The unit consists of the basic signal conditioner with the standard features listed in Section 1-2. As previously stated, it is designed for the customer who desires to completely custom-configure the unit. Three variations on this unit are also available, tailored in graduated, preconfigured packages of popular options. The features on the preconfigured models range from simple to complex, **and cannot be changed**. If alternate features are desired, the user is advised to build features onto the base model.

Model 481A01 consists of the Model 481A unit having the base model's standard features: 12-bit accuracy signal conditioning; unity gain; input fault and overload LED per channel; 16 channels per rack; and variable ICP source current, 2 to 20 mA. There are 16 BNC output connectors and illuminator lights on the front panel; the rear panel has power cord and multi-pin connections. In addition, it is supplied with 16 BNC inputs on the rear panel.

Model 481A02 consists of the Model 481A unit having the base model's standard features: 12-bit accuracy signal conditioning; unity gain; input fault and overload LED per channel; 16 channels per rack, expandable to 256 channels; and variable ICP source current, 2 to 20 mA; and auto-range capability. There are 16 BNC output connectors and illuminator lights on the front panel; the rear panel has power cord and multi-pin connections. In addition, it is supplied with the following as standard features:

- 16 BNC inputs on the rear panel
- RS-232/RS-485 computer control connections on the rear panel
- Keypad and display on the front panel
- Memory default (internal)
- Programmable gain, x1, x10, x100, with auto-ranging

Model 481A03 consists of the Model 481A unit having the base model's standard features: 12-bit accuracy signal conditioning; unity gain; input fault and overload LED per channel; 16 channels per rack, expandable to 256 channels; variable ICP source current, 2 to 20 mA; and autorange capability. There are 16 BNC output connectors and illuminator lights on the front panel; the rear panel has power cord and multipin connections. In addition, it is supplied with the following as standard features:

- 16 BNC inputs on the rear panel
- RS-232/RS-485 computer control connections on the rear panel

- Keypad and display on the front panel
- Memory default
- Calibration: external/internal with amplitude control
- Programmable overload threshold level
- Programmable fine gain, 0.1 to 200, with auto-ranging
- Programmable low pass filter with enable/disable feature

Multiple Model 481A02 and 481A03 racks (and Model 481A, if so equipped) may be linked by RS-485 or optional IEEE-488 interface to a host computer. By computer command via RS-232, RS-485, or IEEE-488 interface, the user controls the various signal conditioning adjustments, including gain setting, status checking and auto-ranging for each channel, and output switching.

1-3.1 Model 481A ICP® Input/Output Mode, All Models

The Model 481A contains a regulated 24 VDC power supply that provides constant current for 16 individual channels. The rear panel has a 50-pin Dsub connector and 16 BNC connectors for input connections. The front panel contains BNC jacks for output connections. The output connection for each channel is also brought out at the rear panel 37-pin Dsub connector. Sensor signals are decoupled from the typical 9 to 11 VDC bias voltage to produce an AC signal centered around ground. Pin configuration drawings are located in the manual rear, with the Specification Sheet.

1-3.2 RS-232 System Configuration (Models 481A*, 481A02, 481A03)

Figure 1-3.1 shows the system configuration using the RS-232 Serial Interface. The RS-232 terminal is connected to only one unit, since this interface is only one-to-one. The rest of the units are connected in parallel using RS-485 cable (for PCB proprietary protocol used in rack intercommunication). The rear panel contains a 9-pin Dsub connector, with the RS-485 label above the connector on the rear panel. The appropriate cables are supplied for use in multi-node system configurations. See Section 3-6, Model 481A Unit Initialization Procedure for instructions regarding two or more Model 481A units linked by an RS-485 connection.

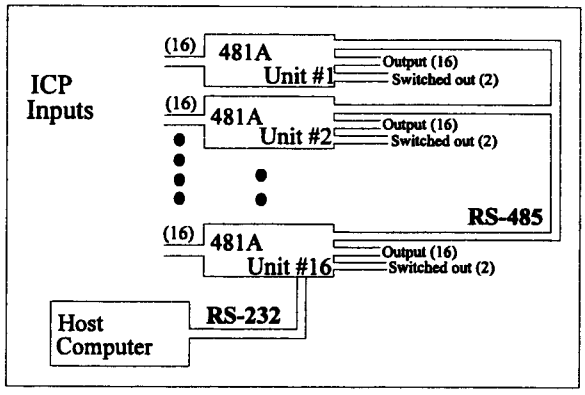


Figure 1-3.1 RS-232 Configuration

1-3.3 IEEE-488 System Configuration (Multi-node)

This section applies to Models 481A02, 481A03 (RS-485), and 481A* (IEEE-488). Figure 1-3.2 shows the possible system configuration using IEEE-488 Serial Interface. The diagram shows that the connections are done in parallel. The host computer's output may be connected to the rear panel of each unit. All cables, except the IEEE-488 cable, are supplied for the use of this possible multi-node system configuration. In the IEEE-488 configuration (option 070), each

rack has an IEEE-488 interface that is set at a unique IEEE-488 device address set by the rear panel rotary switch. The IEEE-488 device address is different from the unit address of the RS-488 interrack communication.. See Section 3-6, Model 481A Unit Initialization Procedure, whenever units are to be set-up using IEEE-488.

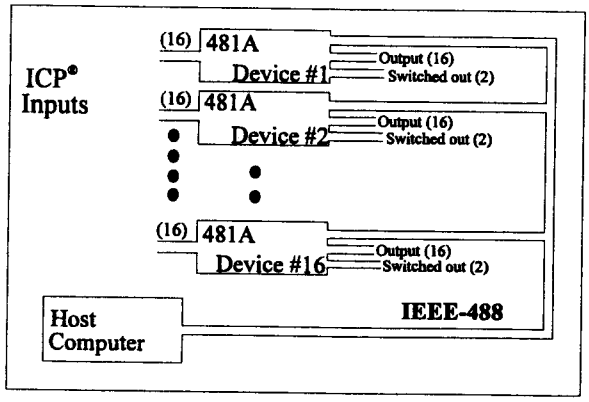


Figure 1-3.2 IEEE-488 Configuration

1-4. Block Diagram

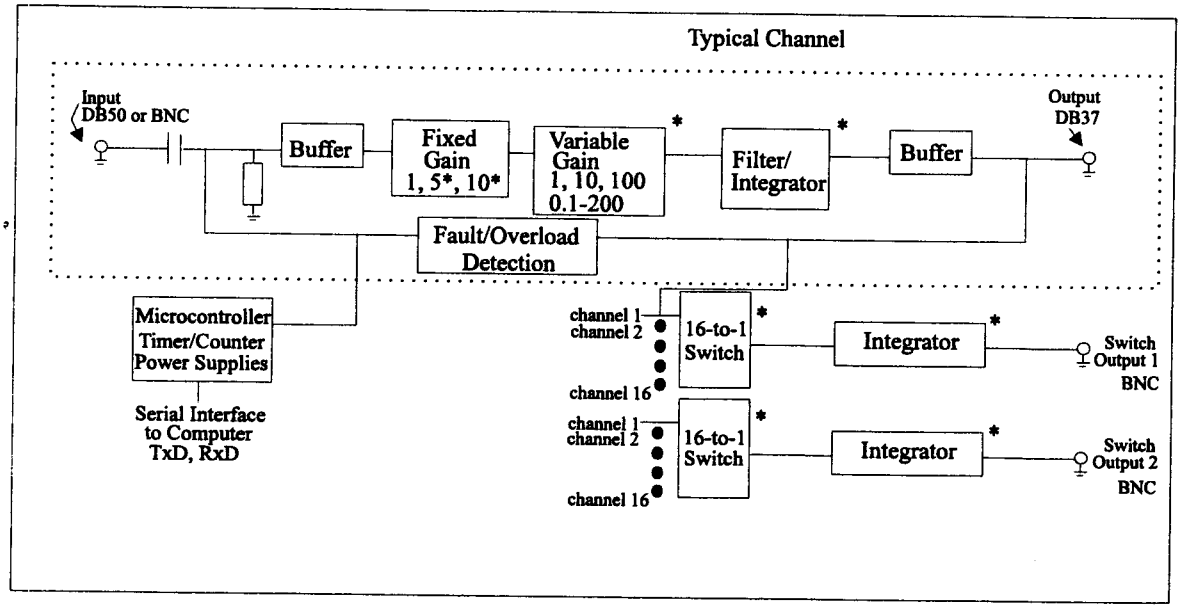


Figure 1-4.1 Typical Block Diagram of Model 481A (options are denoted with an *)

1-5. Specifications

These values may be found on the enclosed Specification Sheet in the rear of the manual.

1-6. Installation

Model 481A mounts in a standard 19-inch equipment rack. See the typical installation drawing in this manual for specific dimensions. The equipment rack should be located in such a way as to allow convenient access to the power outlet for disconnection purposes. Since these units have low power consumption, they can be rack mounted without much space between them, although there should be enough space along the right side to allow the cooling fan to move air. The rear panel contains connectors and a fuse receptacle. Four #10 screws hold the unit to the rack. Once the unit is mounted, the AC power line cord is installed to the unit and to the AC power source.
NOTE: Specific installation is available; contact PCB.

1-7. Operation: Standard AC Line

Plug the three-wire line cord into a 120V/60 Hz or 230V/50 Hz power source and switch the power to ON-AC.

CAUTION: Refer to the rear panel for proper input voltage and currents.

1-7.1. Grounding Techniques

Integrating the Model 481A unit into an application that links the outputs to other test equipment powered by line voltages may lead to errors or loss of signal-to-noise ratio due to ground loops. The evidence of ground loops is easily seen whenever the fundamental frequency (50 or 60 Hz) or a multiple of the fundamental frequency is present in the system when the sensors are "at rest." In order to maintain the operating specification of noise and reduce the effects of line interference, proper grounding techniques should be used. The following procedure may be helpful:

1. Make sure the signal ground lines of all equipment are tied together. The signal grounds of the channels are typically tied together via the case of the input and output BNC (or brought out through the multipin connectors) cable interconnect. The individual channels of the Model 481A have their signal ground line tied together internally at the power supply.

2. Insure that the sensor does not pick up line noise from the body under test. The case of the sensor should be isolated from the body under (ground) using an isolation pad. The isolation pad breaks the loop formed by the signal path of the sensor to the Model 481A and the return (ground) from the Model 481A back to the sensor.

3. Make sure that all equipment signal grounds of the test system are tied to the Earth ground at a single point and the connections linking the equipment ground are made using a wire that can provide very low impedance connection.

1-8. Maintenance and Repair

It is not recommended that the customer attempt repair of the Model 481A in the field. Should trouble occur, contact the factory for assistance. If the unit becomes dusty and dirty, it may be wiped off with a soft cloth.

2-0. THEORY OF OPERATION

2-1. Purpose

The purpose of this section is three-fold:

- To present a short overview of the system application.
- To describe in greater detail the various components and electronic principles that make up a typical channel.
- To describe in greater detail the available options. (See Section 1-2 for a list of options.)

2-2. Sensor Excitation

PCB's trademarked term ICP® refers to a low output impedance voltage mode sensor combining an integrated circuit and a piezoelectric sensing element in a single housing to provide a voltage output. This sensor is powered by a +24 VDC power supply having a constant current, variable from 2 to 20 mA.

Sensor excitation occurs as the constant current of all sixteen channels is set, via the procedure below. Model 481A allows the constant current to be adjusted between 2 and 20 mA to provide the required excitation for most applications. Special situations, such as driving extra-long cables (more than 1000 ft) with high frequency or fast rise time pulses, may require increasing the drive current to 12 mA or higher. See Figure 2-2.1.

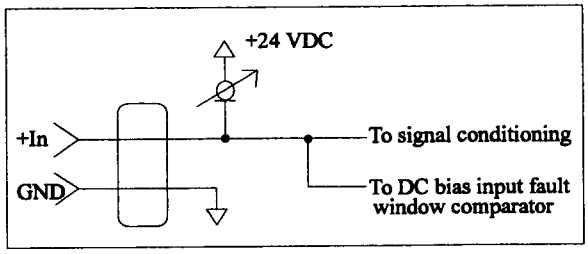


Figure 2-2.1 ICP® Sensor Excitation

When driving fast rise time pulses over long lines, system performance can be optimized by "tuning" the drive current to the line; i.e., by finding the best current setting for the particular test of physical parameters established by the sensor, line length, or pulse rise time. To determine the optimal current setting, experiment with your particular test set-up.

2-2.1 Adjusting ICP® Constant Current

The constant current adjustment is accessable through a recessed potentiometer on right side of the unit near the front. To insure accuracy in constant-current adjustment, make sure all remaining channels have sensors or simulated loads (such as that provided by the Model 401A04 Sensor Circuit, consisting of a unity gain, noninverting, impedance-converting voltage amplifier similar to those found in many ICP sensors.) To set the excitation to the desired value, connect a meter to any input jack and read the constant current directly. All channels are set to the same current reading by this single adjustment. Using a small regular screwdriver, rotate the potentiometer screw to raise or lower the constant current.

2-3. Input Protection

The input section has protection to limit the amplitude of the incoming signal to within +24 volts to ground. Protection for each input consists of two diodes. The maximum allowable input voltage without distortion is ±10 volts, relative to the sensor bias voltage.

NOTE: Connector Option 481084 does not have input protection.

2-4. Input Fault Detection

Model 481A monitors two input fault conditions, "short" and "open," which indicate problems with sensor input. Either case implies that the sensor is NOT functioning properly. An input is **shorted** when it has ground path for the sensor excitation and **open** when the sensor fails to draw the excitation.

Two voltage comparators consist of a window comparator that has two reference voltages (V_{ref}) representing thresholds for "short" and "open." When the sensor's bias voltage (V_{bias}) exceeds the comparator range, the front panel input fault LED lights.

For units having computer control (Option 101), the microcontroller reads input status through the control logic circuitry. The system controller and host read input fault status condition (short or open) through the command set.

NOTE: Red LED implies input fault.

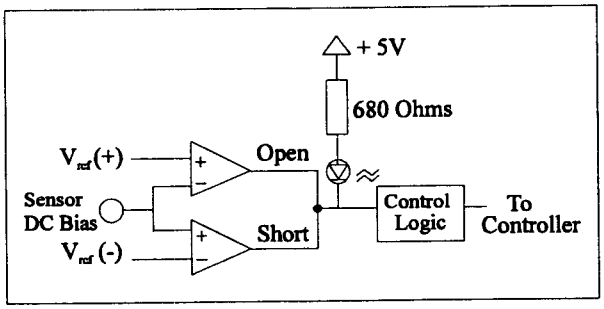


Figure 2-4.1 Input Fault Window Comparator with LED Indicator

2-5. Input Interface

The input signal conditioning for each channel provides two functions: it eliminates the DC bias from the input signal with a 2-second time constant and provides a unity gain buffer with high-input impedance amplifiers. See Figure 2-9.1 for frequency response chart.

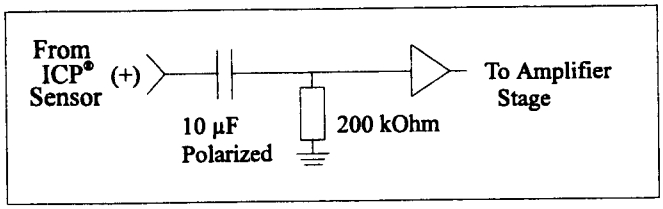


Figure 2-5.1 Input Amplifier Configuration

2-6. Gain

This section applies to the Models 481* and 481A02 only. The Programmable Gain Amplification (PGA) block consists of a decimal gain amplifier. See Figure 2-6.1.

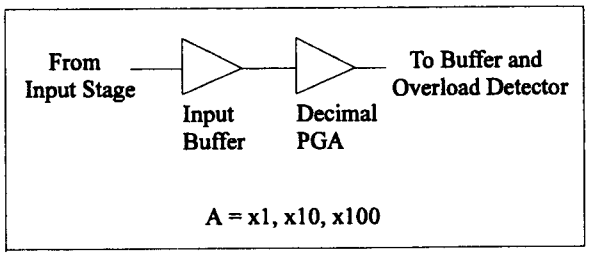


Figure 2-6.1 Selectable Gain Amplifier Configuration (Option 035)

2-6.1 Fixed Gain

This section applies to Model 481A* only. The user may choose, at the time of manufacture, for the optional programmable gain amplifier to be cascaded with a x5 (option 031) or x10 (option 032) to increase the range of gain. The total gain is programmable gain times the fixed value. Therefore, if gain is fixed at x5, the overall gain range is x5, x50, x500. If gain is fixed at x10, the overall gain range is x10, x100, or x1000. NOTE: Options 031 and 032 are not available with either the 037 (0.1 to 200) or 038 (0.0025 to 200) options.

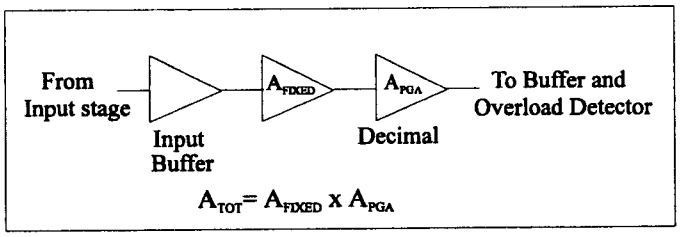


Figure 2-6.2 Fixed (other than x1) Gain Amplifier Configuration

2-6.2 Programmable Fine Gain (Options 481037 and 481038)

This section applies to Model 481A* and 481A03. This feature allows the user to set incremental gains between 0.1 and 200, in 0.1 steps. Option 038 has increased resolution in the number of steps. The steps in option 038 are 0.0025 for gains of less than 10, 0.025 for gains between 10 to 100, and 0.25 for gains between 100 and 200. These options are particularly useful in the standardization of groups of sensors. Consider the following example, wherein the user desires to normalize sensitivities to 1 V/unit for each channel.

Channel	Sensor Sensitivity	Gain Setting of 481A* with 037 Option	Gain Setting of 481A* with 038 Option	Actual Gain Needed
1st Channel	10.10 mV/unit	99.0	99.01	99.01
2nd Channel	101.32 mV/unit	9.9	9.87	9.869
3rd Channel	22.30 mV/unit	44.8	44.850	44.84

These results may be accomplished by using either of two techniques. The user may set the gain via the computer interface command set or the front panel control. (See the command strings in Section 3-10 in the Computer Interface Programming Guide.)

2-7. Overload Detection and Autoranging

2-7.1 Overload

The overload feature uses the same window comparator principle previously discussed. The $+V_{ref}$ is equal to the default overload value of ±10 volts. When the input voltage (Vsignal of Figure 2-7.1) to the window comparator exceeds the reference voltage limits, overload has occurred, and the comparator's output, which is normally "high," becomes "low." This "low" state illuminates the overload LED and triggers the latch of overload detection circuitry. During regular measuring time, the latch holds the occurrence of an overload until the user reads its status through the computer interface

2-7.2 Programmable Overload Detection (Option 481020)

This section applies to Model 481A* and 481A03. The programmable overload sets the reference voltages, both positive and negative. The voltages are equal in amplitude, but opposite in sign. The positive value is used to set the value. The reference voltages are set at 1 to 10 volts in discrete values of 1, 2, 3, ... 8, 9, 10. This allows the Model 481A, via the yellow LED, to warn users that the readout device is receiving a signal exceeding its normal input range.

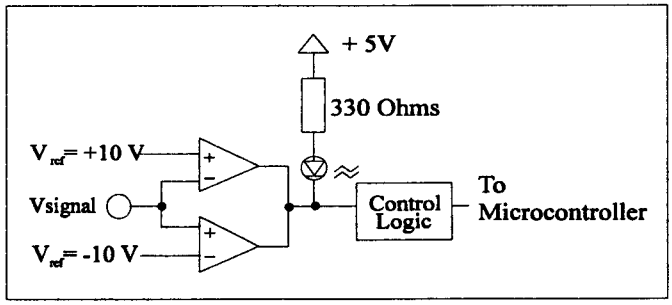


Figure 2-7.1 Autorange/Overload Window Comparator

2-7.3 Autorange

This section applies to Models 481A*, 481A02, and 481A03; it applies to the Model 481A only if equipped with either option 035 (programmable decimal gain) or 037/038 (programmable fine gain). To avoid overload, the Model 481A features autoranging for gain adjustment. It first sets maximum gain on all channels, then decreases the gain setting of any channel on which an overload has occurred. The gain autorange continues until there is no overload with respect to the preset overload threshold level (standard ±10 volts) and sensed signal of the channel. Final gain and overload status interrogation is possible through the command set. The correct procedure for using the autorange feature is as follows:

1. Excite the structure under test.
2. Enable autorange (R = 1).
3. Wait several seconds, until the unit is stabilized.
4. Disable autorange (R = 0).
5. Read the gains of all channels.
6. Begin test run.

2-8. Calibration, External User-Defined Selection (Option 481014)

This section applies to Model 481A* only. The Model 481A includes an input for calibration. The calibration input enables the user to input a signal, common to all channels, through a rear panel BNC. The high pass filter, composed of the resistor-capacitor network, is bypassed. This may be used to test signal characteristics when driving long distances or calibrating phase response of filter options. Calibration input enhances signal integrity throughout the system where the Model 481A is implemented. This is shown in the Figure 2-8.1.

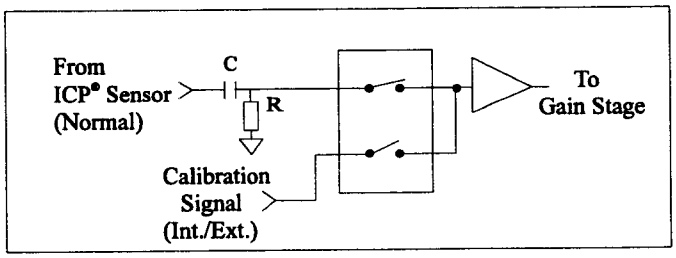


Figure 2-8.1 Normal or Calibration Input Mode

2-8.1 Internal Calibration Source with Amplitude Control (Option 481012)

This section applies to Model 481A* and 481A03. The Model 481A is equipped with a fixed 100 Hz voltage source for calibration, adjustable from 0.1 to 2 volts peak-to-peak and monitored through the output of any channel. The amplitude is controlled via the command set, either through computer interface or the unit's front panel. The features of the external calibration signal (option 014) are included with this option.

2-9. Selectable Discharge Time Constant Coupling (Option 481013)

This section applies to Model 481A* only. The Model 481A contains an optional 10-second or 2-second time constant coupling for filtering off low-frequency signals generated by thermal effects on the sensor mechanism. Refer to Figure 2-9.1 for low-frequency response comparative values. The selection of the discharge time constant is done through computer interface.

DTC (sec)	Frequency (Hz)		
	-5%	-10%	-3dB
1	0.5	0.34	0.16
2	0.25	0.17	0.08
10	0.05	0.03	0.016

Figure 2-9.1 Low-Frequency Response Table

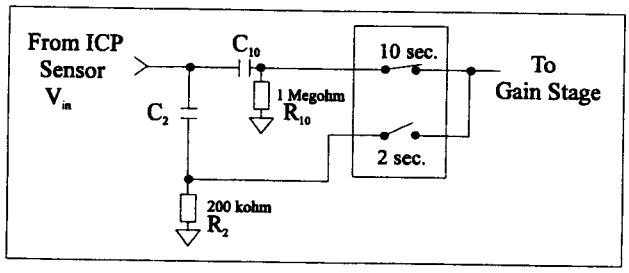


Figure 2-9.2 Selectable Discharge Time Constant

2-10. Switched Output (Option 481041)

This section applies to Model 481A* having computer interface (Option 101) only. For large-scale applications, expensive switching devices are necessary to switch the outputs of a signal conditioner to digitizers. As a system-level solution, the Model 481A eliminates the need for external switching devices with built-in dual independent 16-to-1 switches. See Figure 2-10.1. BNC outputs are located on the rear panel.

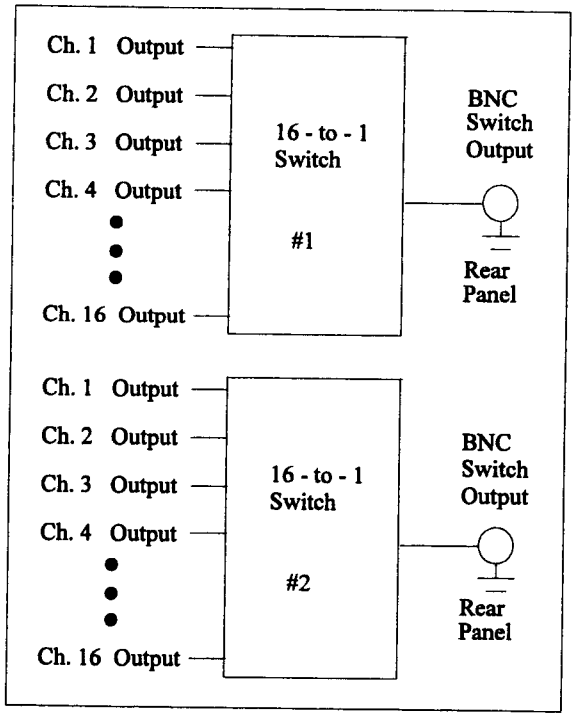


Figure 2-10.1 Switched Output

For every sixteen-channel unit, there are two independent 16-to-1 switched outputs. The outputs of all sixteen channels are switched under the control of the microcontroller.

2-11. Integration to Velocity/ Displacement (Option 481061)

This section applies to Model 481A* having computer interface (Option 101) and switched outputs (Option 041). The switched outputs are used to provide integration on any two channels. The signal of any channel (1 to 16) may be integrated once, to yield Velocity, or twice, to yield Displacement (assuming acceleration input). See Figure 2-11.1. The integration circuitry is designed to handle periodic waveforms (sinusoids) with a low frequency, typically less than 1000 Hz. The integration circuitry is NOT designed to accommodate shock or blast inputs. Refer to the Specification Sheet for sensitivity.

The analog output of the channel has the standard pin-out-of-the-rear panel connector and front panel BNC. The standard output of each analog channel in the 061 scheme is acceleration.

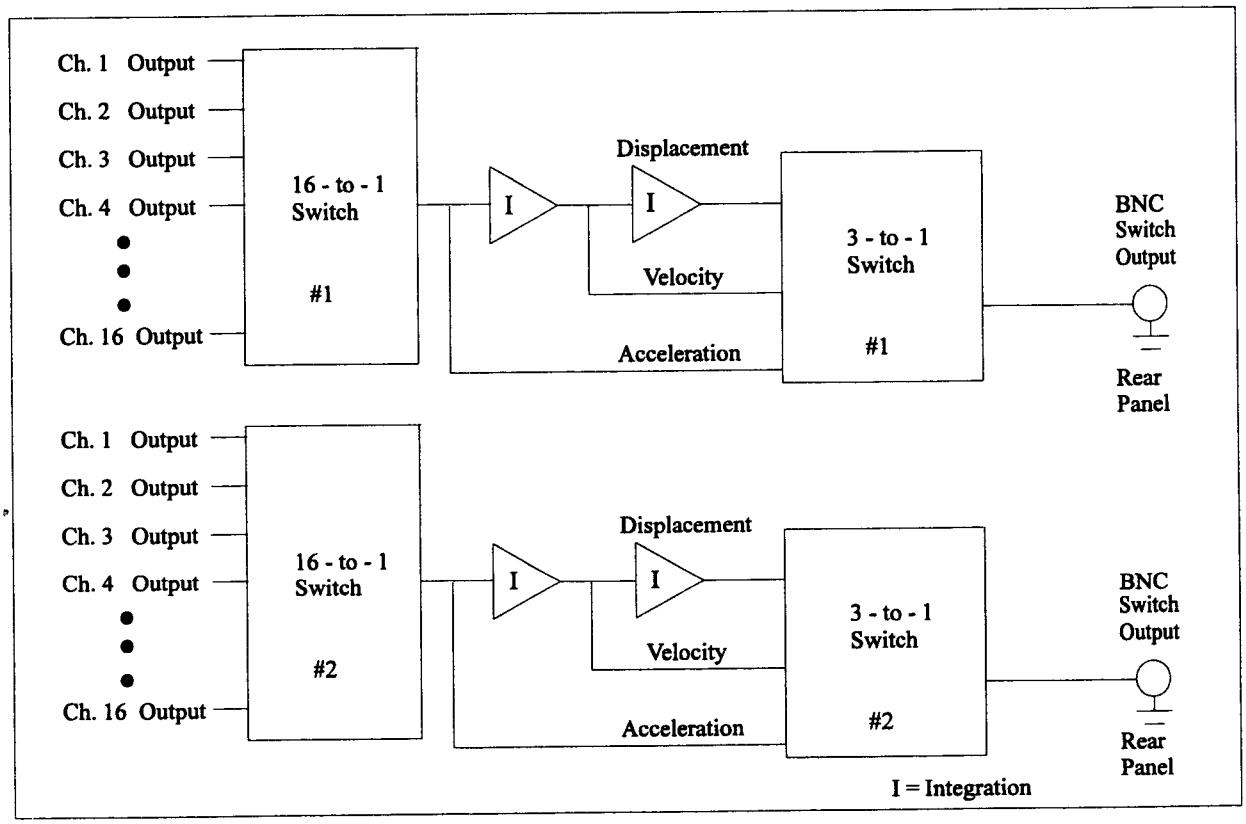


Figure 2-11.1 Integration for Velocity/Displacement

2-11.1 Velocity Output Every Channel (Option 481062 and 481065)

This section applies to Model 481A* only. The plug-in module scheme of the Model 481A is used to implement the single integration function, yielding velocity. The integration of the analog signal is enabled or disabled under user control via either the ENABLE/DISABLE filter command (e.g., X=1 for enable single integration) or the front panel control using the "Intg" menu choice. The enabling or disabling of the integration follows the same scheme as the filter. Specifically, the enable integration feature affects the whole rack (i.e., all channels integrate).

The signal that is output each channel equipped with the 062 option follows the function of the integrator: if enabled, each output is velocity*, and if disabled, the output is acceleration*. The sensitivity of the integration is defined as 100 mV/in/sec for the 062 option. The sensitivity of integration for Option 065 is 100 mV/m/s for S.I. measurements. **The**

output sensitivity is based on a 100 mV/g sensor. If user has a sensor with a sensitivity other than 100 mV/g, the 062 provides 1:1 correlation. The integration is performed after the gain of the Model 481A; therefore, the gain of the channel must be included in the sensitivity of the channel. For example, if the user has a 10 mV/g accelerometer and a gain of x10, channel sensitivity equals 100 mV/g and integration yields 100 mV/in/sec.

The integration may be omitted from any channel if the user wishes to have only the acceleration output. The module for the corresponding channel must be removed and a jumper installed in the socket to short out the module. The modules are located in the middle section (front to back) of the main analog board. The sockets are defined Jx05 (x = the channel number, 1 to 16). The odd-number channels are in the front half, while the even-number channels are located in the rear. The jumper required to omit the integrator is pin 1 to 2. Pin 1 of the socket is the pin closest to the component number of the socket. The jumpers of the odd channels are closest to the right side of the rack, while jumpers for the even channels are located closest to the left side of the rack. The user must document which channels are equipped (or not equipped) with the integrator modules.

*Assuming acceleration input.

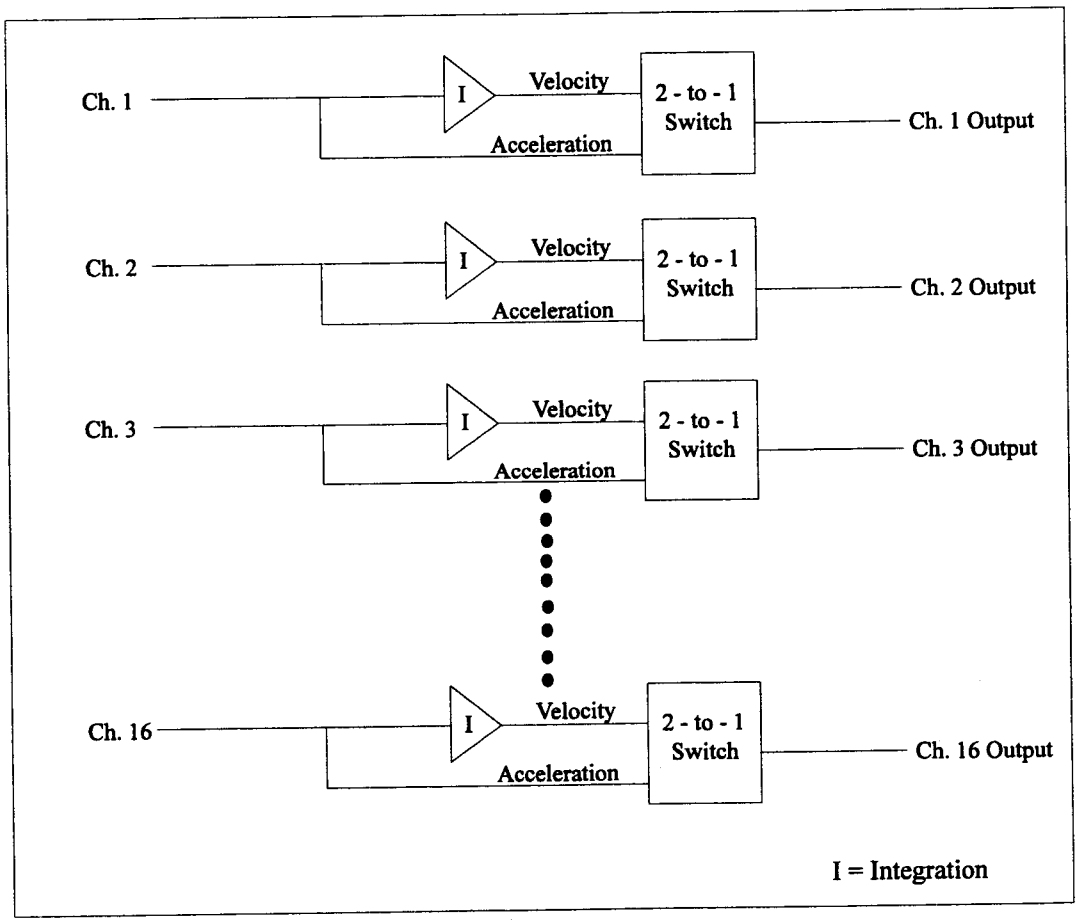


Figure 2-11.2 Velocity Output Every Channel

2-12. Filtering (Options 481050 through 481056)

This section applies to Model 481A* only. The Model 481A has the ability to have a low pass, plug-in filter module installed in any or all channels for the removal of unwanted high-frequency noise. The filter modules are fourth-order

Butterworth low pass (-24 dB/octave). The filters have a master enable/disable control (see Section 3). The cutoff frequency may be selected from the following list:

Option Number	Cutoff Frequency (-3 dB)
481050	2 kHz
481051	10 kHz
481056	20 kHz
481052	100 kHz
481053	150 kHz
481054	200 kHz

The user may also define a specific cutoff frequency that satisfies a specific need using the Option 055. Contact the factory regarding individual requirements. A high pass filter is also available. Refer to Section 2-11.1 for bypassing the filter function. The filter cutoff value may be mixed; contact PCB to discuss this as well.

2-12.1 Programmable Low Pass Filter Elliptic (Option 481057/481157)

This section applies to Model 481A* and 481A03. This package consists of a three-stage filter with pre-anti-alias, a switch capacitor filter and a smoothing filter, all designed for the removal of unwanted high-frequency noise. The filter modules are configured with an eighth-order elliptical rolloff.

The filter is always enabled (Option 057); the widest bandwidth is achieved by setting the cutoff to the maximum setting of 21.4 kHz, which effectively disables the filter. Assuming this 21.4 kHz cutoff setting, signal resolution over a given frequency range is listed below:

Frequency Range (Hz)	Number of Settings	Frequency between settings (Hz) (see NOTE below)
2 to 300	298	2, 3, 4, ... 297, 298, 299
300 to 400	71	301-307, 309-315, 317-321, 323-327, 329, 330, 331, 333, 334, 335, 337, 338, 339, 341, 342, 343, 345, 346, 347, 349, 350, 352, 353, 355, 356, 358, 359, 361, 362, 364, 365, 367, 368, 370, 372, 373, 375, 377, 378, 380, 382, 383, 385, 387, 389, 390, 392, 394, 396, 398, 400
401 to 500	41	401, 403, 405, 407, 409, 411, 413, 415, 417, 419, 421, 423, 425, 428, 430, 432, 434, 436, 438, 441, 443, 445, 448, 450, 452, 455, 457, 460, 462, 465, 467, 470, 472, 475, 478, 480, 483, 486, 489, 491, 494, 497
500 to 598	29	500, 503, 506, 509, 512, 515, 518, 521, 525, 528, 531, 535, 538, 541, 545, 548, 552, 555, 559, 563, 566, 570, 574, 578, 582, 586, 590, 594, 598
602 to 695	20	602, 607, 611, 615, 620, 624, 629, 634, 638, 643, 648, 653, 658, 663, 668, 674, 679, 684, 690, 695
701 to 792	15	702, 707, 713-719, 725, 731, 737, 744, 750, 757, 764, 771, 778, 785, 792
800 to 891	12	800, 807, 815, 823, 831, 839, 847, 856, 864, 873, 882, 891
901 to 995	10	901, 910, 920, 930, 940, 951, 961, 972, 983, 995
1007 to 1097	8	1007, 1019, 1031, 1043, 1056, 1070, 1083, 1097
1111 to 1188	6	1111, 1126, 1141, 1156, 1172, 1188
1205 to 1296	6	1205, 1222, 1240, 1258, 1277, 1296
1316 to 1403	5	1316, 1337, 1358, 1380, 1403
1426 to 1501	4	1426, 1450, 1475, 1501
1528 to 2951	28	1528, 1556, 1585, 1615, 1646, 1678, 1712, 1746, 1783, 1821, 1860, 1902, 1945, 1990, 2038, 2087, 2140, 2194, 2252, 2313, 2377, 2445, 2517, 2593, 2675, 2761, 2853, 2951
3057 to 21 400	25	3057, 3170, 3292, 3424, 3566, 3721, 3890, 4076, 4280, 4505, 4755, 5035, 5350,

		5706, 6114, 6584, 7133, 7781, 8560, 9511, 10 700, 12 228, 14 266, 17 120, 21 400

Units with **Option 157** (Firmware version 4.3 or later) have the ability to enable or disable the programmable filter. Using the "X" command (see section 3) to select filter (EN) or broadband (DIS) response.

Since the filter cannot be bypassed (Option 057), there is always phase shift that is associated with filtering. The exact phase shift is determined by the cutoff frequency selected. The phase matching between channels may be determined by the calibration options (options 012 and 014).

NOTE: Discrete settings can be set to values listed. The actual value set upon executing the SETF command may be read via the GETF command.

2-12.2 Programmable Low Pass Filter Butterworth (Option 481058/481158)

The function of the Butterworth version of the programmable filter is very similar to Option 481057. The key is the switched capacitor filter stage is replaced with a version that provides a Butterworth response, maximum flatness in the passband.

Frequency Range (Hz)	**Number of Settings**	**Frequency between settings (Hz) (see NOTE below)**
2 to 293	291	2, 3, 4, ... 291, 292, 293
294 to 400	66	294-301, 303-308, 310-314, 316, 317, 318, 320-323, 325, 326, 327, 329, 330, 331, 333, 334, 336, 337, 338, 340, 341, 343, 344, 346, 347, 349, 350, 352, 353, 355, 357, 358, 360, 361, 363, 365, 366, 368, 370, 372, 373, 375, 377, 379, 380, 382, 384, 386, 388, 390, 392, 394, 396, 398, 400
402 to 500	40	402, 404, 406, 408, 410, 412, 414, 416, 418, 421, 423, 425, 427, 430, 432, 434, 437, 439, 441, 444, 446, 449, 451, 454, 457, 459, 462, 465, 467, 470, 473, 476, 479, 481, 484, 487, 490, 493, 496, 500
503 to 601	27	503, 506, 509, 512, 516, 519, 522, 526, 529, 533, 536, 540, 544, 547, 551, 555, 559, 563, 567, 571, 575, 579, 583, 588, 592, 597, 601
606 to 701	19	606, 610, 615, 620, 625, 629, 634, 640, 645, 650, 655, 661, 666, 672, 683, 689, 695, 701
707 to 800	14	707, 714, 720, 727, 733, 740, 747, 754, 761, 769, 776, 784, 792, 800
808 to 898	11	808, 816, 824, 833, 842, 851, 860, 869, 879, 888, 898
909 to 1000	9	909, 919, 930, 941, 952, 963, 975, 987, 1000
1012 to 1095	7	1012, 1025, 1038, 1052, 1066, 1081, 1095
1111 to 1194	6	1111, 1126, 1142, 1159, 1176, 1194
1212 to 1290	5	1212, 1230, 1250, 1269, 1290
1311 to 1403	5	1311, 1333, 1355, 1379, 1403
1428 to 1509	4	1428, 1454, 1481, 1509
1538 to 2962	26	1538, 1568, 1600, 1632, 1666, 1702, 1739, 1777, 1818, 1860, 1904, 1951, 2000, 2051, 2105, 2162, 2222, 2285, 2352, 2424, 2500, 2580, 2666, 2758, 2857, 2962
3076 to 20 000	23	3076, 3200, 3333, 3478, 3636, 3809, 4000, 4210, 4444, 4705, 5000, 5333, 5714, 6153, 6666, 7272, 8000, 8888, 10 000, 11 428, 13 333, 16 000, 20 000

Units with Option 158 (Firmware version 4.3 or later) may have the ability to enable or disable the programmable filter. Using the "X" command (see section 3) to select filter (EN) or broadband (DIS) response.

NOTE: Discrete settings can be set to values listed. The actual value set upon executing the SETF command may be read via the GETF command.

2-13. RMS - DC Conversion Every Channel (Option 481064)

This section applies to Model 481A* only. This option converts the input AC signal to an equivalent DC signal to provide a cost-efficient, approximate measure of diagnostic information. Output BNC connectors are located on the unit rear; the option 085 connector configuration is required to accompany the RMS-DC converter.

The effective voltage or current value, when combined with the circuit resistance, determines the average power for a cycle. For example, if the sensed sinusoidal signal is 2 volts peak-to-peak, 1 volt peak, the RMS value may be obtained by multiplying the peak value (1 volt) by 0.707. Maximum output V_{rms} is 5 volts, which corresponds to ±14.2 volts peak-to-peak, 7 volts peak for a sinusoidal signal.

2-14. Connector Configuration (Options 481081, 481082, 481085, 481086, and 481087)

This section applies to Model 481A* only. The front panel BNCs exist solely for monitoring conditioned signal output. Depending on the application, the user may select various input/output configurations on the rear panel. Option 081 provides sixteen BNC inputs for ICP-type sensors and sixteen BNC outputs. Option 085 provides sixteen BNC output jacks on the rear panel to supply DC output from RMS-DC conversion (option 064).

The remaining options deal with selectable ICP® or charge mode sensor input, and they differ only in terms of charge sensitivities. See Section 2-14.1.

2-14.1 Piezoelectric Charge Mode Sensor Input (Options 481082, 481086, and 481087)

This section applies to Model 481A* only. This option allows the user to condition piezoelectric charge signal inputs with considerable temperature, filtering, and gain flexibility. The Model 481A configured for this type of input has sixteen 10-32 inputs to accept charge signals from sixteen individual charge mode sensors (e.g., Series 357). With Option 082, the charge sensitivity is 0.1 mV/pC. With Option 086, the charge sensitivity is 1.0 mV/pC. With Option 087, the charge sensitivity is 10 mV/pC. Consult the Specification Sheet of the Model 481A located in the Appendix of this manual, for details concerning the charge mode input. There are also sixteen BNC jacks that are used to provide input for ICP-type sensors. **Each channel must be selected as either charge mode or ICP mode via the toggle switch beneath the channel. The front panel (red) LED goes out for the channel selected in the charge mode to signify that the internal charge amplifier is functioning properly. In the ICP mode, the LED stays illuminated until a properly functioning ICP sensor is attached.**

2-14.2 Selectable ICP® or Voltage Input Per Channel (Option 481084)

This section applies to Model 481A* only. This option allows the user to select the input mode of each channel. The selection is made via internal jumper settings. These jumpers determine if the ICP excitation is present on the input connector (multipin or BNC option 080 or 081), or if the channel is simply a voltage amplifier. **The ICP excitation must be selected if the channel is to be used to condition the signal of an ICP sensor or charge mode is selected (option 082/086/087).** The factory default is ICP input mode for all channels in the rack. The user must reconfigure the channels to accept a voltage input signal.

The jumpers perform two distinct functions in the set-up of input configuration of the channels. First (Jx03), and most important to the operation of the channel, the excitation is provided to each sensor. The second function of the jumpers (Jx07) is to disable the signal that controls the function of the front panel input fault LED. In the ICP mode, the bias of the sensor is used to control the front LED. The bias voltage is not present in the voltage mode; therefore, the jumpers

are used to disable the function of the bias voltage monitor to force the LED to an off condition, which means the input signal is okay. See Figure 2-14.1.

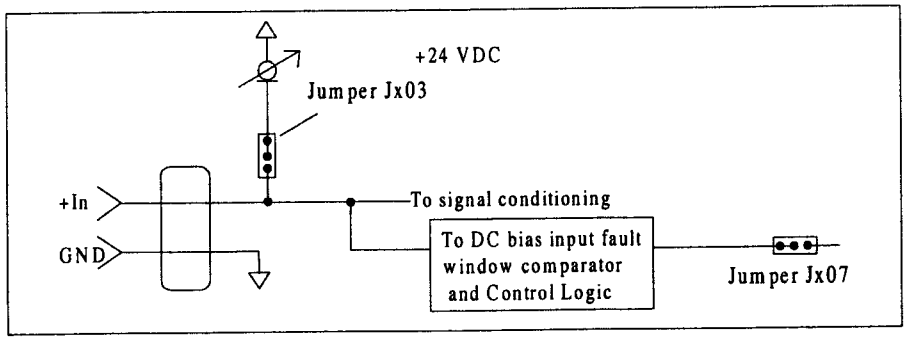


Figure 2-14.1 ICP®/Voltage Jumpers

Jumper Definitions:

The odd-numbered channels (1, 3, 5, ... 15) are located in the front of the unit on the main circuit board. The even channels are located at the rear of the main board. There are two (2) jumpers that are used to define the ICP® or voltage mode for each channel. The jumpers are Jx03 and Jx07 (where "x" is the channel number 1 through 16). The jumpers (Jx03) that control the ICP excitation of the odd-numbered channels are near the front of the unit, while the even-numbered channel jumpers Jx03 are located near the rear of the unit. The location of the Jx07 for control of LED function (all channels) is near the front of the unit. The sketch below details the jumper selections for the even and odd channel in the ICP® and voltage modes. To modify the input configuration between the ICP and voltage mode:

1. Turn off the unit and disconnect the power cord.
2. Remove the top cover by removing the twelve screws.
3. Locate the jumpers associated with the channel(s) affected.
4. Configure the jumper of the channel to the positions in the tables below.

For odd-numbered channels (1, 3, 5, ... 15):

Jx03 ○●●	Jx03 ●●○
Jx07 ●●○	Jx07 ○●●
ICP Input Mode Jumper Definitions	Voltage Input Mode Jumper Definition

For even-numbered channels (2, 4, 6, ... 16):

Jx03 ●●○	Jx03 ○●●
Jx07 ○●●	Jx07 ●●○
ICP Input Mode Jumper Definitions	Voltage Input Mode Jumper Definition

NOTE: ●● implies jumper connection of two pins; ○ implies open connection.

2-15. External 12 VDC Power Supply (Option 481092)

This section applies to Model 481A* only. An optional 12 VDC power supply is available for use with the Model 481A. The external DC power inverter accepts the DC voltage and converts the voltage to an AC line voltage level. The AC output of the power inverter is input directly into the AC input of the Model 481A.

The power supply is supplied with a cigarette-lighter plug for use in 12-volt vehicle systems.

2-16. RS-232 / RS-485 Interface

This section applies to Models 481A*, 481A02, and 481A03. The RS-232 or RS-485 Interface provides serial control of the Model 481A. This may be accomplished through the use of a personal computer, dumb terminal, or handheld controller. The command format is based upon letter representations of the controllable options. The RS-485 option enables the use of multi-rack systems, controlled by a single interface. This serial interface, set-up, and programming are described in Section 3.

2-16.1 Memory Default (Option 481102)

This section applies to Models 481A*, 481A02, and 481A03. This option keeps the programmed configurations stored when the unit is powered down. When the unit is again turned on, all programmable features (e.g., gains, filter status, switched output settings, overload levels, integration level) active at last use are preserved. Each time the setting (configuration) changes, the non-volatile memory is updated.

2-17. IEEE-488 Interface (Option 481070)

This section applies to Model 481A* only. The IEEE-488 interface provides control of the Model 481A through parallel interface. The address is selected using the hexadecimal (0-->F, which corresponds to 0-->15 in decimal) rotary switch located on the rear panel, next to the IEEE-488 connector.

Multiple racks can be connected in two ways: by individual IEEE-488 address (each rack has IEEE-488 interface) or in a master/slave combination (Master has IEEE-488 interface and slave[s] has RS-485), with each rack being at a different unit address. See Section 1-3.

When using IEEE-488, the unit's address does NOT change. The address that was set using the U=m command in IEEE-488, RS-232, or RS-485 remains as the unit address.

2-18. Multirack Interface

This section applies to Models 481A*, 481A02, and 481A03. To expand testing, the Model 481A contains the ability to configure in a multirack system, with up to 16 racks being controlled by a single host computer or dumb terminal. The terminal may use either an RS-232 or IEEE-488 port to control the initial rack, with the others connected through the RS-485 Serial Interface. The rack addresses may be altered and saved through an initial individual software command (see Section 3-10, the command for Set Unit Address).

3-0. COMPUTER INTERFACE PROGRAMMING GUIDE (for units so equipped)

3-1. Introduction

This section applies to Models 481A*, 481A02, and 481A03. Individual commands are subject to feature availability on the particular unit. The RS-232 or RS-485 or IEEE-488 Interface enables the Model 481A to be fully controlled by a computer or handheld controller. With any of these interfaces, this unit is able to become part of a fully automated system.

3-2. IEEE-488 Interface (Option 481070)

This section applies to Model 481A* only. The IEEE-488 Interface provides complete remote control of the Model 481A except for hardware RESET. The interface capability codes for the Model 481A are as follows:

SH1, AH1, T6, TE0, L4, LE0, SR1, RL1, PP0, DC1, C0, E2

These codes are useful for the test system engineer to integrate the IEEE-488 device for testing. These symbols are described by the IEEE Standard 488-1978. EOI (End or Identity) is the control line used to signify the end of transmission. To configure the Model 481A on the IEEE-488 bus, proceed as follows:

1. If the cable is hooked up to any other device, turn the power off on the other device.
2. With system power off, set the IEEE-488 address (1 to 15 [or 1-F in Hex]), using the back panel rotary switch.
3. Connect IEEE-488 cable between the Model 481A rear panel connector and the control interface.
4. Switch on the Model 481A.

3-2.1 RS-232 and RS-485 Interface

This section applies to Models 481A*, 481A02, and 481A03. The RS-232 and RS-485 Interface provide control of the whole rack except for the hardware RESET. The rest of the options described previously are computer-controllable. Other features include:

- A powerful, concise instruction set
- Multinode operation
- Two serial connectors for daisy-chain operation

3-3. RS-232 / RS-485 Host Set-Up

Before any serial interface is used to communicate with the host computer, a specific set-up must be followed. These parameters must be set for the host computer. The full list of parameters are shown below: (EOL = End of Line.)

Parameter	Setting
Transmission Rate	9 600 BPS (bits per second)
Parity	None
Number of data bits	8
Number of stop bits	1
Handshaking	RTS/CTS
Echo	None
Transmit EOL	Carriage Return and Line Feed, <CR><LF>
Receive EOL	Carriage Return and Line Feed, <CR><LF>

3-4. RS-232 Rear Panel Pinout Listing

Number of 9-Pin Connector	Function
1	N.C.
2	TXD
3	RXD
4	N.C.

5	Ground
6	N.C.
7	RTS
8	CTS
9	N.C.

3-5. RS-485 Rear Panel Pinout Listing

Number of 9-Pin Connector	Function
1	N.C.
2	TXD(+)
3	RXD (-)
4	N.C.
5	Ground
6	N.C.
7	N.C.
8	N.C.
9	N.C.

3-6. Model 481A Communication Guidelines

The following are rules ensuring proper functionality of multinode communication.

1) Data transfer from the host terminal to the units must contain an ending delimeter of <CR><LF>.
Example: <CR><LF> -Carriage Return and Line feed. (In ASCII, <CR> is 13; <LF> is 10.)

NOTE: If the unit's serial number is less than 820, leave off the ending delimeter line feed, <LF>.
Example: <CR> -Carriage return. (In ASCII, <CR> is 13.)

2) The number of characters for any command string, from the first character to the <CR>, may not exceed 150 (for firmware versions > 4.0) or 64 (for firmware versions < = 3.9).

3) Spaces are allowed. To write over a typed-in character, a backspace is used. (In ASCII, backspace =8).

4) Global commands (e.g., for all units to perform in a multinode configuration) are sent with an address of "00:", or "0:" . An example is shown to test all front panel LEDs:

Example: 00:L=1 <CR> <LF>

CAUTION: When all units are connected in the multinode system configuration, using the global address with the change-of-unit address command "U" changes all units to the SAME address. If status commands are sent, only units with address #1 respond.

5) In a single transmission, commands may be transmitted only to one specific address. For multiple command transfer, all commands must be separated with a semicolon, ";".

Example: 03:A1=10 ; 03:M1=3 ; 03:M2=6 ; 03:R=1 <CR> <LF>

6) Status request commands, i.e., commands ending with a "?", may only be sent within one transmission.

Example: 02:F? <CR> <LF>

-Reads all the input faults of all channels in Unit 2.

3-7. Model 481A Unit Initialization Procedure

(Each unit must be initialized before first use.)

For Single Unit Set-Up:

1) To begin, plug 9-pin female Dsub connector of given cable into RS-232 port of Model 481A. Plug the other end of the cable into the COM port of the terminal or computer. DO NOT plug any connectors into RS-485 port at this time.

NOTE: This procedure initializes all racks using an RS-232 COM port.

NOTE: The command to change the unit address must be entered via the RS-232 or the GPIB communication ports. If the unit address is changed via the front panel, the new value is lost upon reset or power down.

2) Turn on power to Model 481A. The display should light up to indicate the power is on. The front panel LEDs should flash three times. If this does not occur, press the RESET button, so that the LEDs flash.

3) With the terminal or computer that is set up to transmit data, according to the host set-up discussed in Section 3-3, send the command:

"0:L=1" <CR><LF>

This command flashes the front panel LEDs three times. If this does not occur, press the RESET button again, then repeat the command. If it still does not function properly, check all cable connections and the Host set-up.

4) Now that communication is established, the address must be changed. Change this Model 481A unit to Address 1 by issuing the command:

"0:U=1" <CR><LF>

The system user should note at this time the address of a specific rack. For future use, this unit has Address 1, unless it is changed with the "U" command to a new one.

For Single Unit Set-Up Using IEEE-488 (Model 481A* only):

1) Connect the Model 481A to the host computer through an IEEE-488 cable.

2) Follow steps 2 through 4 on the Single Unit Set-Up procedure above.

For Multinode Operational Unit Set-Up:

1) To initialize the first unit used in a multi-unit system, follow steps 1 through 4 of the previous section, "For Single Unit Set-Up." This initializes the first unit, giving it an address of 1. The user should note at this time that this unit address is 1, and differentiate it from the others.
2) Now that the first unit is initialized, disconnect the serial cable from the rear panel of Unit 1, and plug this female connector into the next unit to be initialized. Follow the same steps as shown in steps 1 through 3 in the previous section, "For Single Unit Set-Up." This attains communication with the Model 481A.

3) Change this particular unit address to 2, or to any address other than 1. This differentiates it from the first unit.

Follow these same guidelines for the other racks to be initialized. The rule to be followed is: Give all racks different addresses, using the "0:U=m" <CR> command, where m is an address from 1 to 16.

NOTE: The unit with address #1 provides the echo strings for global address commands.

3-8. Multinode System Configuration Set-Up

Once all units are initialized with specific individual addresses, the units may be placed in a rack-mount structure, and the interconnecting cables may be inserted according to the following steps:

RS-232 Interface:

RS-232 interface is accomplished using Model 009N03 cables that have a single female connector end and a split other end having one female connector and one male connector. See Figure 3-8.1.

1) Using Cable 1, plug the single female end into the COM port of the host computer.
2) Plug the female connector on the other end of Cable 1 into the RS-232 port of the first unit.
3) Using Cable 2, plug the single female connector into the RS-485 port, also on the first unit.
4) Plug the female connector on the other end of Cable 2 into the RS-485 port of the second unit.
5) To add a third unit, plug the male connector of Cable 2 into the single female connector of Cable 3.
6) Plug the female connector on the other end of Cable 3 into the RS-485 port of the third unit.
7) If still more units are to be added, follow steps 5 and 6, connecting the next unused cable (single female end) into the male connector of the previous cable installed and the female connector on the other end into the next unit's RS-485 port.

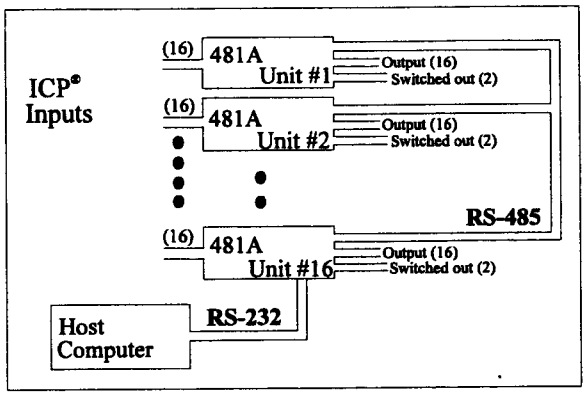


Figure 3-8.1 RS-232 Configuration

RS-485 Interface

RS-485 interface is accomplished using Model 009N03 cables that have a single female connector end and a split other end having one female connector and one male connector. See Figure 3-8.2. This allows a master Model 481A (with keypad and display) to control slave units.

1) Plug the female connector on the other end of Cable 1 into the RS-485 port of the first unit.
2) To add the second unit, plug the male connector of Cable 1 into the single female connector of Cable 2.
3) Plug the female connector on the other end of Cable 2 into the RS-485 port of the second unit.

4) If still more units are to be added, follow steps 3 and 4, connecting the next unused cable (single female end) into the male connector of the previous cable installed and the female connector on the other end into the next unit's RS-485 port.

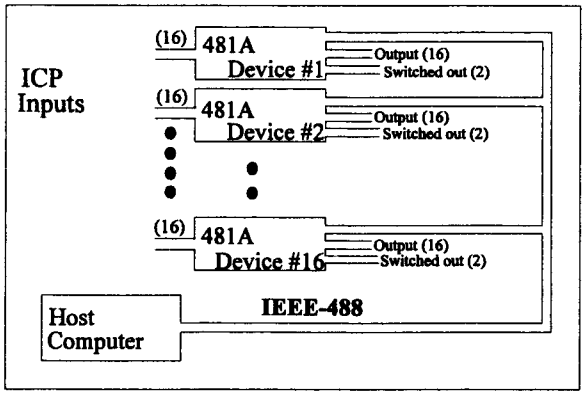


Figure 3-8.2 IEEE-488 Configuration

IEEE-488 Interface **(Model 481A* only):**

IEEE-488 interface is accomplished using an IEEE-488 interface cable. Plug the one connector end into the appropriate receptacle on the host computer and the other end into the IEEE-488 receptacle on the first unit. Tighten the screws on both connectors. To install a second (and subsequent) unit(s), plug a second cable's connector into either the host computer connector or the first unit's connector. Cables may be configured in a daisy chain, or each may originate from the host computer. See Figure 3-7.2.

For All Interface Types:

1) Once all units are connected, turn on power for all Model 481A units. All Model 481A units having computer-control interface should flash the front panel LEDs three times. If this does not occur, reset the unit using the front panel RESET button.

2) Several line feeds, <LF>, may be sent to clear any power on state changes on the serial lines.

3) To test the functionality of the system configuration, send the global command to flash the front panel LEDs three times:

00:L=1 , which is the LED test command.

At this time, all units are ready for all commands and function in the multinode system configuration.

3-9. Command Syntax

The commands included in this unit are based upon an ASCII format. The commands given in the following sections are typed in with no characters preceding nor following them. Each command begins with a single letter or symbol that represents one command, or group of commands with the same meaning. Each may be entered in lower or upper case letters. The letter and its corresponding meaning are shown as:

Letter/Symbol	Meaning
A	Set or read gain
B	Backup configuration, using Banks 1 through 4

C	Enable/disable calibration input
D	Enable 2 or 10 second time constant coupling
F	Read input fault status, all channels
I	Install saved configuration, using Banks 1 through 4
L	Front panel LED enable/disable, test
M	Select or read switcher
O	Read overload condition
R	Enable/disable autoranging
S	Single channel status reading
T	Select variable overload threshold, 1 to 10 volts
U	On-line check: unit number and address
V	Select velocity/displacement output (integrator)
X	Enable/disable filters within each channel
?	Status of last command

3-10. Command Format

Remember: Individual commands are subject to feature availability on the particular unit. Each command is made up of four fields. The fields of each command select the proper setting for the chosen parameter. For example:

Example: 1:A7=10 -The addressed rack #(1:) setting the gain (A) of channel (7) to (=10).

The four fields are shown and described as follows:

<Rack Address:> **<Command Character>** **<Channel Number>** **<Selection>**

1) Rack Address: The unit address for this example is 1. When only one rack is used, its address is set to 1. This field is optional. This simplifies command entry for single unit use.

When using multiple racks, the format is a one- or two-digit rack number, followed by a colon. The addresses may range from 1 to 16, with an address of 0 (zero), representing a command for all racks on the same serial interface RS-485 to perform.

Examples: XX: -Where XX is the unit address.

02: -Precedes a command for Unit Address 2.

00: -Precedes a command for all connected units, e.g., a global command for all units to perform.

NOTE: If rack address "0" is sent, the unit with address #1 responds after the command is completed.

2) Command Character: This is the single character upon which the command format is based. The options for this field are shown in Sections 3 and 4. Each letter and its corresponding meaning are shown in the command set on the following pages.

3) Channel Number: This is the specific channel number to be set by any command. The status channel may be read from, as in reading the gain, or written to, as in setting the output switcher or gain. Some examples are:

Examples: 2:A15? -This reads the gain of Channel 15, of Unit Address 2.

5:S16? -This reads the status of Channel 16, of Unit Address 5.

NOTE: A channel number of 0 affects all channels of addressed units and is legal only for certain commands.

4) Selection: This field is used when setting several parameters. It can set the gain of a channel to a chosen value or select a channel for the output switchers. The gain may be set to 1, 10, or 100. Use of the "equals" character must precede the gain value.

Examples: 1:A5=10 -This sets the gain of Channel 5 to 10, of Unit Address 1.

A11=100 -This sets the gain of Channel 11 to 100, of Unit Address 1, with single unit control.

This field may also be used to disable or enable options by setting 0 or 1, respectively.

Examples: 0:L=1 -Enables and tests the LEDs of all units connected in a multinode configuration.

3:R=1 -Enables autorange of Unit 3.

This command format allows two types of commands. The first is the **directive**-type commands, which tell the unit to perform a specific function. These include setting the gain or switchers, or enabling the filters or autorange. The second type is a **status request**. This command sends a status request command, ending with a "?" , in which the unit sends the particular information back to the host terminal.

The possibility exists to transmit multiple **directive** commands within a single string, ending the total string with a <CR> <LF>. When sending multiple directive commands, a semicolon (;) must separate all distinct commands. The following is an example containing multiple command transmissions in one string:

Example: 2:L=1 ; 2:R=1 ; 2:A3=10 ; 2:M1=4 <CR> <LF>

The previous command performs the following functions on unit Address 2:
-Enables the LEDs with an LED test,
-Enables the autorange option,
-Changes the gain of Channel 3 to 10, and
-Changes the switch to output the signal from Channel 4.

NOTE: Only **directive** commands are allowed to be transmitted within a multiple command string. This is to prevent multiple data transmissions at one time when a multinode system configuration is used.

3-11. Commands

Am=n <CR> <LF> (Models 481A*, 481A02, and 481A03)
SET GAIN: This command sets the programmable gain to any of the possible gain settings. The gain of each channel may be set to x1, x10, or x100 for the 035 option, to any setting within the 0.1 to 200 range for the 037 option, and to 0.0025 to 200 for the 038 option.

m is the channel number; n is the selected gain.

Examples: A2=1 <CR> <LF> -Sets Channel 2 to a gain of 1.
A15=10 <CR> <LF> -Sets Channel 15 to a gain of 10.
Returns: 1:OK <CR><LF>

NOTE: Upon initialization, all channels are set to a gain of 1 (or latest value on a unit equipped with Memory Default, Option 102). Channel number 0 affects all channels.

Am? <CR> <LF> (Models 481A*, 481A02, and 481A03)
READ GAIN: This command reads the gain of any selected channel. These channels must be individually interrogated. The formats are shown in the following example:

Example:	A5? <CR> <LF>	-This reads the gain of Channel 5.
Returns:	1:A5=10 <CR> <LF>	-If the gain is set at 10, on Rack Address 1.

NOTE: Channel number 0 is not allowed for this command in version preceding 4.0. Version 4.0 and later will return all channels in 16 individual echo strings.

NOTE: The "A" command is upper/lower case sensitive. The 038 option REQUIRES lower case "a?" to force the proper return from the unit. The uppercase "A?" only returns one digit after the decimal point if the 037 and 038 options exist in the rack.

B=n <CR> <LF> (Models 481A*, 481A02, and 481A03)
BACKUP CONFIGURATION: The ability to save a preset configuration set-up may save the user time in resetting a particular arrangement for each channel. There are up to four different configurations the user is allowed to set. This saves the gain settings of all channels, switcher outputs, filtering status, calibration, and integrator selections.

n is the number of the specified configuration bank, Banks 1 through 4.

Examples:	B=1 <CR> <LF>	-Saves the present set-up into Bank 1.
	B=4 <CR> <LF>	-Saves the present set-up into Bank 4.
Returns:	1:OK <CR><LF>	

C=n <CR> <LF> (Model 481A* only)
CALIBRATION ENABLE/DISABLE (Option 481014): The calibration input is located on the rear panel of the Model 481A. When the calibration input is enabled, this BNC input accepts an external signal into all channels. This gives the user the ability to check the signal integrity when driving long distances. The ICP® source current may then be altered, if necessary. The calibration signal also allows the user to determine phase matching of filter options (050 through 057). This command does not support the Internal Calibration Source with Amplitude Control (Option 012).

n is 0 or 1, to disable or enable the calibration input signal, respectively.

Examples:	C=0 <CR> <LF>	-Disables the calibration input.
	C=1 <CR> <LF>	-Enables the calibration input.

NOTE: See CALn command for internal calibration signal control.

C? <CR> <LF> (Model 481A* only)
READ CALIBRATION INPUT STATUS (Option 481014): The latest status of the calibration input may be read using this format.

Example:	C? <CR> <LF>	-Reads the latest status of the calibration function.

Returns (option 014):

1:CALIBRATION ON <CR> <LF> , or

1:CALIBRATION OFF <CR> <LF>

Returns (option 012):

1:CALIBRATION INT=.500 <CR><LF> , or

1:CALIBRATION EXT <CR><LF> , or

1:CALIBRATION DISABLE <CR><LF>

D=n <CR> <LF> (Model 481A* only)
2/10 SECOND DISCHARGE TIME CONSTANT COUPLING (Option 481013): With the use of this option, the discharge time constant (DTC) may be selected. The 10-second DTC benefits those sensors with longer time constants.

n is 0 or 1, to enable 10- or 2-second coupling, respectively.

Examples: D=0 <CR> <LF> -Enables 10-second DTC coupling.

D=1 <CR> <LF> -Enables 2-second DTC coupling.

Returns: 1:OK <CR><LF>

D? <CR> <LF> (Model 481A* only)
READ COUPLING STATUS (Option 481013): The present coupling status is read with the use of this status command.

Example: D? <CR> <LF> -Requests the status of the signal coupling.

Returns: 1:10 SECOND DISCHARGE COUPLING <CR> <LF> , or

1: 2 SECOND DISCHARGE COUPLING <CR> <LF> , respectively.

F? <CR> <LF> (Models 481A*, 481A02, and 481A03)
READ INPUT FAULT CONDITIONS: This command reads the condition of the inputs to the unit. Specifically, it reads the status of the sensor bias connected to the respective channel number. Similar to the front panel LED(on), 1 indicates fault, either "short" or "open", and similar to LED (off), a "0" indicates good bias.

This reads the input fault condition of all 16 channels.

Example: F? <CR> <LF> -This reads the input conditions of all 16 channels.

The output of this command is in the format of:

1:IF Ch1-8: 01000001 Ch9-16: 00010101 <CR> <LF>
-Where 0 = normal condition and 1 = an input fault.

This example indicates input faults on Channels 2, 8, 12, 14, and 16, respectively.

I=n <CR> <LF> (Models 481A*, 481A02, and 481A03)

INSTALL CONFIGURATION: This option reads and installs the previously saved configuration. There are up to four possible configurations that may be installed. The configurations are stored in banks, numbering 1 through 4. The configuration installation includes the following options: gain set-up for all channels, filter, switcher, and integrator selections, along with the variable overload setting. The original configurations are saved internally, using the "B=m" command.

n represents the configuration number or bank, 1 through 4.

Example: I=2 <CR> <LF> -Installs Bank #2 of saved configuration status.

Returns: 1:OK <CR><LF>

I? <CR> <LF> (Models 481A*, 481A02, and 481A03)
READ CONFIGURATION BANK: The last bank installed may be recalled with this command. With this status request, the installed bank number (1 through 4) is given.

Example: I? <CR> <LF> -Reads the last bank to be installed.

Returns: 1:INSTALLED BANK #2 <CR> <LF>
-If the last configuration installed was 2.

L=1 <CR> <LF> (Models 481A*, 481A02, and 481A03)
LED TEST: This test command tests the input fault and the overload LEDs. It flashes them three times with a momentary pause between.

Returns: 1:OK <CR><LF>

L=0 <CR> <LF> (Models 481A*, 481A02, and 481A03)
LED DISABLE: This disables (turns off) the input fault and the overload LEDs.

Returns: 1:OK <CR><LF>

L? <CR> <LF> (Models 481A*, 481A02, and 481A03)
LED STATUS: The status of the LEDs is displayed. The output gives:

1:LEDS ENABLED <CR> <LF> , or

1:LEDS DISABLED <CR> <LF>

Mm=n <CR> <LF> (Model 481A* only)
SELECT SWITCHER (Option 481041): The select switcher command updates the output switcher, for which two BNCs are located on the rear panel. Each of the output BNCs handles sixteen channels.

m is the switch number (i.e., m=1 or 2).
n is the channel number, either 1 through 16, or 0 to disable.

NOTE: The switcher associated with m is updated to channel n, while the other switcher is not changed. Also, during the switching time, the respective switcher output is momentarily disabled until the actual switching is done.

Examples: M1=7 <CR> <LF> -Sets Switch 1 to Channel 7 (Switch 2 is unaffected).

M2=0 <CR> <LF> -Disables Switch 2 (Switch 1 is unaffected).

Returns: 1:OK <CR><LF>

Mm? <CR> <LF> (Model 481A* only)
READ SWITCHER (Option 481041): This command reads the current setting of the switcher. This may done using two commands. Either one or both switch outputs may be read at one time.

m is the switch number, i.e., Switch 1 or Switch 2.

Example: M1? <CR> <LF>

Returns: 1:M1=3 <CR> <LF> -If Switch 1 is set to Channel 3.

M? <CR> <LF> (Model 481A* only)
The request of both switch outputs at the same time, separated by a space, may be accomplished with this command.

Example: M? <CR> <LF>

Returns: 1:M1=2 M2=7 <CR> <LF> -If Switch 1 and Switch 2 are set to Channels 2 and 7, respectively.

NOTE: Upon initialization, the two available output switchers are disabled (or are at the most recent setting on units equipped with Memory Default, Option 102.

O? <CR> <LF>(Model 481A* only)
READ OVERLOAD CONDITIONS: This command reads the overload conditions of the signal conditioner. This determines if the signal has exceeded the voltage threshold set in the unit. The unit is capable of handling a ±10 volt swing on the output. Whenever the output exceeds the threshold, the overload condition is latched internally, meaning that when the overload status is read, the data indicates the overloads present since the previous overload status was read. Each time the status is read, the previous latched conditions are cleared.

This returns the overload status of all 16 channels:

Example: O? <CR> <LF> -Reads the overload status of 16 channels.

The output is in the following format:

1: OV Ch1-8: 00100100 Ch9-16: 10010010 <CR> <LF>
-Where 0 = no overload, and 1 = an overload condition.

This indicates an overload on Channels 3, 6, 9, 12, and 15, respectively.

R=n <CR> <LF> (Models 481A*, 481A02, and 481A03)
AUTORANGE ENABLE/DISABLE: This section applies to the Model 481A only if equipped with either option 035 (programmable gain) or 037 (programmable fine gain). The autoranging feature presents an automatic scaling of the

output signal. Along with this command, the programmable gain is implemented to give the largest signal amplitude output. The signals are checked internally; if there is an overload, the channel's gain is stepped down, and checked again. This procedure is followed for all channels, using all gain steps:

n is 0 or 1, which enables or disables the Autorange, respectively.

Example: R=1 <CR> <LF> -Enables the autorange feature.

Returns: 1:OK <CR><LF>

R? <CR> <LF> (Models 481A*, 481A02, and 481A03)
READ AUTORANGE STATUS: This section applies to the Model 481A only if equipped with either option 035 (programmable gain) or 037 (programmable fine gain). The autoranging feature may be enabled, and other commands may be entered during the period it is enabled. The status of the autorange may be read with the use of this command.

Example: R? <CR> <LF> -Reads the status of autoranging.

Returns: 1:AUTORANGE ON <CR> <LF> , or

1:AUTORANGE OFF <CR> <LF> , respectively.

Sm? <CR> <LF> (Models 481A*, 481A02, and 481A03)
READ SINGLE CHANNEL STATUS: When the single status of a specific channel is requested, information on both input fault status and overload status is supplied. In other words, the Read Input Fault Status and Read Overload Status commands are automatically generated to provide a two-fold response.

m is the channel number, 1 through 16.

Example: S3? <CR> <LF> -Asks for the status of Channel 3.

Returns: 1: CH=3 IF=0 OV=1 <CR> <LF> -If Channel 3 has no input fault, but had an overload.

NOTE: Channel number 0 is not allowed for this command.

T=n <CR> <LF> (Model 481A* only)
SELECT OVERLOAD THRESHOLD VOLTAGE (Option 481020): The overloads, upon default, show an overload status when the signal's amplitude increases above ±10 volts, peak-to-peak. This command varies the overload threshold from ±10 volts to an integer value from ±1 volt, and back up to ±10 volts.

n = an integer value from 1 to 10, i.e., 1, 2, 3 ... 10.

Example: T=6 <CR> <LF> -Selects the overload status to trigger at ±6 volts.

Returns: 1:OK <CR><LF>

T? <CR> <LF> (Models 481A* and 481A03)
READ OVERLOAD THRESHOLD VOLTAGE (Option 481020): After the variable overload threshold voltage is set, it may be read at a later time to display the current overload voltage setting.

Example: T? <CR> <LF> -Reads overload voltage setting.

Returns: 1: OVERLOAD VOLTAGE = 6.0V <CR> <LF>
-States that the overload voltage is set at ±6 volts.

U=n <CR> <LF> (Models 481A*, 481A02, and 481A03)
SET UNIT ADDRESS: This command sets the unit address. The unit address is used in multi-rack operations. For single-rack use, the rack number has a post-initialized default address of 1. The rack address is saved in nonvolatile EEPROM each time that it is changed and remains so, even after power is turned off. Upon power-up, the rack address is returned to the last address to which it was changed.

n is the new unit address, which may be 1 through 16.
Example: U=2 <CR> <LF> -Changes rack with Address 1 to Address 2.

Returns: 2:OK <CR><LF>

Example: 3:U=6 <CR> <LF> -Changes rack with Address 3 to Address 6.

Returns: 6:OK <CR><LF>

NOTE: After the unit number is changed, an address field is required with any command to be issued to the unit. Only Unit Address 1 may accept commands without an address.

U? <CR> <LF> (Models 481A*, 481A02, and 481A03)
READ UNIT ADDRESS: This command returns the unit number, along with the rack address. The rack address is used in multi-rack operations. For single-rack use, the rack number has a default address of 1.

Example: U? <CR> <LF>

Returns: 1:481A / Addr=1 <CR> <LF>

This returns the unit number (Model 481A). This is followed by a "/" and the two-digit unit address with an "01" as a default for single-rack use.

Vm? <CR> <LF> (Model 481A* only)
READ STATUS OF INTEGRATION CIRCUITRY (Options 481061, 481062): This command is used to monitor the type and status of the integrating circuitry within the unit. The echo shows the type, either switched output (option 061) or per channel (option 062). The status of the integration is also returned.

m is the switch number (i.e., m = 1 or 2; 0 implies both)

NOTE: If m is omitted, both are returned.

Option 061
Example: V1? <CR><LF>

Returns: 1:V1=VEL -Switched output 1 is outputting a velocity signal of channel-selected "M" command.

Example: V0? <CR><LF>

Returns: 1:V1=ACC V2=DIS - Switched output 1 is outputting an acceleration signal and switched output 2 is providing a displacement signal of channel-selected "M" command.

Option 062
The command syntax remains the same. The echo is determined by the status of the integration. The integration is controlled by the "X" command.

Example: V? <CR><LF>

Returns: 1:Acceleration output <CR><LF>

Example: V1? <CR><LF>

Returns: 1:Velocity output <CR><LF>

Vm=n <CR> <LF> (Model 481A* only)
SELECT VELOCITY OUTPUT (Option 481061): The select velocity output command enables the integrator stage on the two switcher outputs. Each switched output is capable of single or double integration. The single integration is considered a velocity output, with respect to using accelerometers. The double integration outputs a signal representing displacement. These integrators are only on the switched outputs (from the rear panel BNCs). The channel desired to be integrated must be set separately by "M" command.

m is the switch number (i.e., m=1 or 2).
n is the number of integrations: 1 for single integration (velocity); 2 for double integration (displacement).
0 is no integration, implying acceleration output.

NOTE: During the switching time, the respective switcher output is momentarily disabled, until the actual switching is completed.

Examples: V1=1 <CR> <LF> -Sets Switch 1 to velocity output, i.e., single integration performed (Switch 2 output is unaffected)

V1=2 <CR> <LF> -Sets Switch 1 to displacement output, i.e., double integration performed (Switch 2 output is unaffected).

V2=0 <CR> <LF> -No integration is performed on Switch 2 (Switch 1 is unaffected).

Returns: 1:OK <CR><LF>

NOTE: Upon initialization, the two available output switchers are disabled (or are at the most recent setting on units equipped with Memory Default (Option 481102).

X=n <CR> <LF> (Model 481A* only)
FILTER OR INTEGRATOR MODULE PER CHANNEL ENABLE/DISABLE (Options 481050 through 481056, 481062, 481065, and 481157/481158): This command is used to enable or disable the function of the plug-in module when the unit is equipped with the filter/integrator for each channel option. All modules on all channels are affected. Either all filters/integrators are enabled, or all are disabled.

Examples: X=1 <CR> <LF> -Enables all filters/integrators.

X=0 <CR> <LF> -Disables all filters/integrators.

NOTE: This command also controls the Velocity Output per Channel, Option 062/065.

NOTE: See "SETF" command for programmable filter setting (Section 4-6).

X? <CR> <LF> (Models 481A* and 481A03)
READ PLUG-IN MODULE STATUS (Options 481050 through 481056, 481062, 481065, and 481157/481158): Using this command, the status of the filters is shown. The filters are either enabled or disabled. The output format is shown in the following example:

Example: X? <CR> <LF> -Reads filter status.

Returns (options 481050 through 481056):

1:FILTERS ENABLED <CR> <LF> ,or

1:FILTERS DISABLED <CR> <LF> , respectively.

Returns (options 481057/481157 or 481058/481158):

1:FILTERS 1000 Hz <CR> <LF> , if enabled 157/158 or

1:FILTERS DISABLED <CR> <LF> , if enabled 157/158.

NOTE: Actual filter setting returned may differ from user input (SETF)

Returns (option 481062 or 481065)

1:Acceleration output <CR><LF> , or

1:Velocity output <CR><LF> , respectively.

? <CR> <LF> (Models 481A*, 481A02, and 481A03)
STATUS OF LAST COMMAND: This command reads the status of the last command. The status pertains to the command sent previously, not to the present command. The following outputs may be shown with the entering of this command.

Example: ? <CR> <LF> -Requests status of last command.

May return one of the following:

1) 1:OK<CR> <LF>
Represents that the last command was entered in the correct format and was performed properly.

2) 1:Internal Communication Error<CR> <LF>
Internal communication used for control of functions (gain, switch, filter, etc.) has failed.

3) 1:Illegal Command<CR> <LF>

The last command string entered was not recognized as a legal command and was not in the list of commands that are stated for the future.

4) 1:Command Syntax Error<CR> <LF>
The syntax of the previous command had a problem. Check the command desired for the proper spelling, number of parameters required, and termination.

5) 1:Channel Number Out of Range<CR> <LF>
The previous command requires the channel number entered to be within the legal limit of 1 through 16 for discrete channels. The global channel number 0 (zero) may not be allowed for the command.

6) 1:Invalid Rack<CR> <LF>
The rack address of the previous command was out of the legal limit of values. The rack address may be 0 through 16. The global address 0 causes all racks to perform the command.

NOTE: Only the unit with Address #1 responds with an echo string for global commands.

7) 1:Invalid Gain<CR> <LF>
The gain parameter of the previous command was not a legal value. The legal limits for the fine gain control (Option 481037) are 0.1 to 200 and 0.0025 to 200 (Option 481038). The programmable gain of x1, x10, or x100 (times fixed gain) allows only the gain entry of x1 or x10 or x100.

8) 1:Bank Number Out of Range<CR> <LF>
The bank number is equivalent to the switched output number. The desired switched output number of the previous command was not 1 through 4.

9) 1:No Parameters Expected<CR> <LF>
The command syntax of the previous command does not require any additional information besides the command code (letter).

10) 1:One Parameter Expected<CR> <LF>
The command syntax of the previous command requires one parameter to determine the function desired. Check the syntax of the desired command to determine the parameter required and its limits.

11) 1:Too Many Parameters<CR> <LF>
The command syntax of the previous command does not require the number of parameters contained in the command string entered to determine the function desired. Check the syntax of the desired command to determine the correct number of parameters required and the limits of the parameters.

12) 1:Only 0 or 1 Allowed<CR> <LF>
The syntax of the previous command does not allow parameter values other than 0 or 1. The commands that enable or disable function may return this error.

13) 1:Option Not Installed<CR> <LF>
The hardware required to implement this function requested in the previous command is not included in the unit.

14) 1:Overload Threshold Out of Range<CR> <LF>
The parameter for the desired threshold voltage for overload detection entered in the previous command string was not within the legal limits of 1 to 10 volts (peak).

15) 1:Configuration Buffer Empty<CR> <LF>
The desired install configuration of the previous command has not been defined yet and therefore can not be installed. The configuration is not changed.

Addendum to Section 3:

Input/ Output Connector Definitions:

The input connectors are located on the rear panel. The BNC connectors are used to accept ICP and Voltage mode input signals. The ICP excitation will be present on the input BNC only when the ICP mode is selected. The voltage mode input mode allows bipolar, positive and negative (above and below ground) signals. The 10-32 input connectors are dedicated to the Charge mode sensor input. The charge signals are directly input into an in-line charge converter with nominal sensitivity 1.0mV/ pC located inside the 481A30 unit. In all input modes, the signal must be AC type signals.

Command Syntax:

Input Mode Query

Qm? <CR> <LF> (Model 481A* only)
READ STATUS OF INPUT MODE SELECT CIRCUITRY (Options 481-282/ 286/ 287): This command is used to monitor the type and status of the input circuitry for a specific channel within the unit. The echo shows the channel number and input mode function, either ICP, Charge, or Voltage mode.

m is the channel number (i.e., m = 1 through 8 or 16; 0 implies all channels)

Example:	Q1? <CR><LF>	
Returns:	1: CHANNEL 1 CHARGE INPUT	-If channel is Charge mode
or		
Returns:	1: CHANNEL 1 ICP INPUT	-If channel is ICP mode
or		
Returns:	1: CHANNEL 1 ICP INPUT	-If channel is Voltage mode

Qm=n <CR> <LF> (Model 481A* only)
SELECT INPUT MODE FOR SPECIFIC CHANNEL (Option 481182): The select input mode for the "m" channel number. Each channel is capable of selecting ICP, Charge or Voltage input. The ICP and Voltage mode input both use the BNC input connector, and the Charge mode uses the 10-32 input connector.

m is the channel number (i.e., m=1 through 8, or 16).
n is the number of input mode: 0 for ICP input mode, 1 for charge input mode, 2 for voltage input mode.

Examples:	Q1=1 <CR> <LF>	-Sets Channel 1 to Charge mode input
	Q1=2 <CR> <LF>	-Sets Channel 1 to Voltage mode input
	Q2=0 <CR> <LF>	-Sets Channel 2 to ICP mode input.
Returns:	1:OK <CR><LF>	

NOTE: Upon initialization, the input mode of each channel is set to the same status that was in effect prior to power down or reset.

Addendum to Section 3:

Transducer Electronic Data Sheet (TEDS) Interface:

The TEDS sensors attach to the input connectors, either the rear panel BNC or multi-pin (50), the same way a traditional ICP sensor is attached to the 481A. The TEDS interface requires both the option 101 – RS-232 and RS-485 computer interface, and the input mode select option. The input mode select option may be 481-284 – ICP/ Voltage selection, or 481-282/286/287 – ICP, Charge, or Voltage selection. The digital control and input mode select features automatically perform the TEDS read or write function. After the communication with the TEDS sensor is complete the input mode returns to the input mode prior to the communication.

There are five communication functions that may be performed with the TEDS sensors. The simplest functions are a read and write of "raw" TEDS data. These communications send or receive the 32 bytes of program data in the TEDS sensor. The next higher function is read the TEDS data and decode the information to produce a user readable character string. Moving up in complexity, the user may write application specific information to the "user defined address space" in the TEDS sensor; there are 12 bytes dedicated for user input. Finally, the highest function provided by the 481A is to read the TEDS sensor's data and normalize the gain setting for the channel. All the communication with the TEDS sensors has the CRC error checking. The error checking determines the validity of the communication between the sensor and the 481A. In addition, the CRC is used to determine if the "raw" data received from the user is valid. The calculation of the CRC is simply an addition of all data except the first byte. The CRC is the limited to 8 bits (maximum of 256) and must match the first byte transferred to and from the sensor.

The "raw" data commands, are used to send and receive 32 bytes of information along the sensor cabling. The 481A accepts a ASCII character string and converts the 64 characters, input by the user, to a 32 byte string that is sent to the sensor. The reverse is also true; the 32 byte from the sensor are converted to the 64 readable ASCII characters. The conversion of the 64 ASCII characters to 32 bytes is performed by converting each ASCII character to a Hexadecimal (base 16) number and combining pairs of numbers into a single byte that will be sent to the sensor. The inverse process takes the sensor data and splits the bytes into 2 "nibbles" and converts each into an ASCII character. The only ASCII characters that may be entered are numbers 0 through 9, and letters A through F.

The three remaining commands require the TEDS data follow the IEEE 1451.4 template in order to successfully interpret the data returned for the sensor. See attached for a brief overview of the template that the 481A supports. The commands perform a read of the TEDS data and return a detailed character string showing all the data fields each field separated by semicolons (;), write information to the user area of the TEDS data memory, and read the sensor data extract the sensitivity and set the channel's gain. The gain value is determined using the normalize feature. The normalization function is detailed in another section.

Command Syntax:

GTED (Version 4.8 or later)

Get TEDS Sensor data: This command is used to read the TEDS sensor data. The sensor data must follow the IEEE 1451.4 template in order to be properly decoded. The echo string details the channel number and the decoded TEDS data for the channel.

Syntax: GTED [channel] <CR><LF>

channel number is 1 through 8 or 16 depending on unit

Example: GTED C7 <CR><LF>

Returns: 1: Channel 7 Manufacturer PCB;354B33; sn 1066;90.66 mV/(m/s^2); cal date 7/27/1999; F hp 0.000 Hz;phase 0;sens dir Y;meas ID 0;;

Note: the ";;" at the end of the string implies no user area data present in the sensor.

NTED (Version 4.8 or later)

Normalize Gain Setting using TEDS Sensor Sensitivity data: This command is used to read the TEDS sensor data and use the sensitivity information to set the gain of the channel. The sensor data must follow the IEEE 1451.4 template in order to be properly decoded. The echo string details the channel number and the decoded TEDS data for the channel. The actual gain setting must be read using the GETG command.

Syntax: NTED [channel] <CR><LF>

channel number is 1 through 8 or 16 depending on unit

Example: NTED C7 <CR><LF>

Returns: 1: Channel 7 Manufacturer PCB;354B33; sn 1066;90.66 mV/(m/s^2); cal date 7/27/1999; F hp 0.000 Hz;phase 0;sens dir Y;meas ID 0;;

Note: the ";;" at the end of the string implies no user area data present in the sensor.

WTED (Version 4.8 or later)

Write information to TEDS Sensor User Data Area: This command is used to read the TEDS sensor data, and update the user data area with application specific information in the form of ASCII characters. The sensor data must follow the IEEE 1451.4 template in order to be properly decoded. The echo string details the channel number and the decoded TEDS data for the channel along with the new user data area characters

Syntax: WTED [channel] "string <CR><LF>

channel number is 1 through 8 or 16 depending on unit
double quote (") is the delimiter for the start of the string (up to 12 characters)

Example: WTED C7 "loc 246 Y<CR><LF>

Returns: 1: Channel 7 Manufacturer PCB;354B33; sn 1066;90.66 mV/(m/s^2); cal date 7/27/1999; F hp 0.000 Hz;phase 0;sens dir Y;meas ID 0; loc 246 Y;

Note: the user data area has both numbers and letters (upper and lower case).

RTED (Version 4.8 or later)

Get Raw TEDS Sensor data: This command is used to read the TEDS sensor data. The sensor data does not need to follow the IEEE 1451.4 template in order to be properly decoded. The sensor data must have a proper CRC value in order for the 481A to recognize a TEDS sensor is attached to the channel. The echo string details the channel number and the decoded TEDS data for the channel.

Syntax: RTED [channel] <CR><LF>

channel number is 1 through 8 or 16 depending on unit

Example: RTED C1 <CR><LF>

Returns:

1:BB172016204216020000F00818143609880000000000007920363432206 36F6C<CR><LF>

The decoded TEDS data is: 1: Channel 7 Manufacturer PCB;354B33; sn 1066;90.66 mV/(m/s^2); cal date 7/27/1999; F hp 0.000 Hz;phase 0;sens dir Y;meas ID 0; loc 246 Y;

WRTD (Version 4.8 or later)

Write Raw TEDS Sensor data: This command is used to write raw TEDS sensor data. The user data character string does not need to follow the IEEE 1451.4 template in order to be properly executed. The character string going to the sensor must have a proper CRC value in order for the 481A to recognize a TEDS sensor is attached to the channel. The echo string shows the ASCII character string that corresponds to the TEDS data sent to the sensor.

Syntax: WRTD [channel] "BB172016204216020000F00818143609880000000000000 792036343220636F6C<CR><LF>

channel number is 1 through 8 or 16 depending on unit
double quote (") is the delimiter for the start of the string (64 characters)
BB is the CRC error checking value.

Example: RTED C1 <CR><LF>

Returns: 1:BB172016204216020000F00818143609880000000000000 792036343220636F6C<CR><LF>

The decoded TEDS data is: 1: Channel 7 Manufacturer PCB;354B33; sn 1066;90.66 mV/(m/s^2); cal date 7/27/1999; F hp 0.000 Hz;phase 0;sens dir Y;meas ID 0; loc 246 Y;

16) 1:Invalid Integration Setting<CR> <LF>
The integration desired is not supported by the unit. The legal values for the integration parameter are 0, 1, and 2, corresponding to acceleration, velocity, and displacement.

17) 1:Buffer Empty<CR><LF> /* GPIB initialization * /
No commands have been executed since power-up or RESET. The output buffer has not been filled with information related to the execution of a command or condition of a status.

3-12. Factory Defaults for All Units

NOTE: For units equipped with Memory Default, Option 102, the most recent settings are preserved.

Option	Default
A- Variable Gain	All channels set to gain of 1.
I - Install Configuration	No configuration bank installed (i.e., "Installed Bank #0").
L - LED Status	LEDs enabled.
M - Dual Output Switches - 041	Both Switch 1 and Switch 2 disabled.
R - Autorange	Autorange disabled.
T - Variable Threshold of Overload - 020	Set to ±10 volts.
U - Unit Address	Set to the last previously set address.
V - Switched Output (Velocity/Displacement) - 061	No integration performed (both switches disabled).
X - Filter Within Channels - 050 through 056, 062, 157, 158	Filters disabled and velocity output per channel disabled.

4-0. EXPANDED COMMAND SET

This section applies to Models 481A*, 481A02, and 481A03. Individual commands are subject to feature availability on the particular unit. The Model 481A unit also supports the commands of other PCB multichannel devices that have third-party supplier software already written.

4-1. Notes on the ASCII Command Syntax

The following is the expanded format for sending a command to the Model 481A in the ASCII mode:

Mnemonic Group_number Data(n) <CR><LF>

Where:

Mnemonic	=String representation of the command
Group-number	=Channel number, Group or All
Data(n)	=New data byte(s) that are to be sent
CR LF	=End of string delimiter (Carriage Return and Line Feed)

Example:

Calibration On: CAL1 GL <CR><LF>

CAL1	=Mnemonic
GL	=All channels affected
CR LF	=End of string delimiter (Carriage Return and Line Feed)

The Model 481A returns one echo after each command. The echo format depends upon the command executed or error encountered. If the command is a Set-type command, the echo returned is in the following format:

echo :Rack Address:Board_Number Length Condition_Code Check_Sum <CR><LF>

Where:

Rack Address	=In multi-unit configuration, the rack that is echoing the string. (If rack address is 1, its mention in the syntax is optional.)
Board	=Greatest board number that executed the command (always 16)
Length	=Number of fields returned (always 4)
Condition	=Condition code of the command sent (see Section 4-7)
Check_Sum	=ASCII addition of the previous numbers (except rack address)

If the command is a Get-type command (e.g., GETF), the echo format is just the data. If an error is encountered, the echo format follows the Set-type, with the Condition field representing the error encountered.

4-2. Group Definitions

Most commands can be sent to a single channel, group 1, group 2, or all channels. There are commands that cause unit-level changes; choosing a channel selects all channels on that board (e.g., Autorange, Calibration, LED Test, Filter Cutoff. To address channels greater than 16, the user must use the rack address.

Cn	Single channel number from 1 to 16 (0 is not allowed)
G1	Group 1
G2	Group 2
GL	Global broadcast to all channels

4-3. Filter Cutoff Settings (Models 481A* and 481A03)

There are discrete filter settings available, from 2 Hz to 21.4 kHz (Option 057 and 157) and 2 Hz to 20 kHz (Option 058 and 158). The user enters the desired filter setting in Hz, and the Model 481A determines the "n" to provide the filter setting. The next higher cutoff frequency is selected if a nonexistent selection is entered. Default filter cutoff on power-up approximately 1 kHz (995). Filter cutoff follows the equation:

Desired filter cutoff entered in SETF command string (ref 4-6) (f_d):

	For Option 057/157	For Option 058/158	
Master Logic Frequency	8 MHz	8 MHz	(f_m)
Scale Factor	1.07	1.00	(s_f)
Clock to Cutoff Ratio	100	100	(R)

Formula:

$$\text{factual} = \frac{fm}{N} x \frac{sf}{R} \qquad \text{where } N \text{ is an integer}$$

i.e.) $f_d = 2\,500$ Hz (for Option 057/157)

$$\text{Find n} = \frac{fm}{N} x \frac{sf}{R} = \frac{8MHz}{2500Hz} x \frac{1.07}{100}$$

n = 34.24 (make an integer)

N = 34

$$\text{factual} = \frac{fm}{N} x \frac{sf}{R} = \frac{8MHz}{34Hz} x \frac{1.07}{100} = 2518 \text{ Hz}$$

4-4. Gain Settings

See Section 2-6 for a description of gain. If the unit is equipped with programmable fine gain, the gain setting for Option 037 is 0.1 to 200 and for Option 038 is 0.0025 to 200; if the unit has 035 (programmable gain), the setting is x1, x10, x100. *Indicates commands supported by Version 3.0 or later.

4-5. ASCII Command Summary

Command	Functional Descriptions
AUT0 [Cn or GL]	Turn autorange off.
AUT1 [Cn or GL]	Turn autorange on.
CAL0 [Cn or GL]	Turn calibration off.
CAL1 [Cn or GL]	Turn calibration on.
GETC [Group no.]	Get input and overload status (FUTURE).
GETF [Cn or GL]	Get filter setting.
GETG [channel]	Get gain setting.
GGP0	Get all channels without group definition (FUTURE).
GGP1	Get all channels in group 1 (FUTURE).
GGP2	Get all channels in group 2 (FUTURE).
LDC1	Load configuration 1 to all channels (FUTURE).
LDC2	Load configuration 2 to all channels (FUTURE).
LED0 [Group no.]	Turn LEDs off.
LED1 [Group no.]	Initiate LED test.
SETF [Cn or GL] Fn	Set filter cutoff.
SETG [Group no.] An	Set gain value.
SETR	Set the rack address.
SMUX B[Bn] C[Cn]	Select the switching bank and channel.
SRST	Reset the system.
STC1	Store the first configuration (FUTURE).
STC2	Store the second configuration (FUTURE).
STG0 [Channel List]	Set no group definition (FUTURE).
STG1 [Channel List]	Set group 1 definition (FUTURE).
STG2 [Channel List]	Set group 2 definition (FUTURE).
XINS	Sensor installation.
CMD?	Returns if the last command was accepted (FUTURE).
CAL?	Returns status of calibration signal.
IDT?	Returns "PCB 481A" for bus ID.
INP?	Returns the channel(s) that changed input condition.
MUX?	Returns switcher setting from every bank.
OVD?	Returns channel(s) that changed overload status (FUTURE).
*VER?	Returns the current version of the firmware.

4-6. Command Syntax and Descriptions

AUTn (Version 3.0 or later) (Models 481A*, 481A02, and 481A03)
AUTORANGE: Enables or disables the autorange function. Enabling the autorange function automatically adjusts the gain setting of the unit to avoid overload. See Section 2-7.1.

syntax : AUTn [Channel number or Global] <CR><LF>
echo :Rack Address:Board_Number Length Condition_Code Check_Sum <CR><LF>

NOTE: If a channel number is selected, the rack that is addressed autoranges or stops autoranging (all sixteen channels).

n	Function
0	Turn autorange off
1	Turn autorange on

Examples:
Cmd : AUT1 c7 <CR><LF>
echo : 1:16 4 9 29 <CR><LF>

Cmd : AUT0 GL <CR><LF>
echo : 1:16 4 9 29 <CR><LF>

CALn (Version 3.0 or later)
CALIBRATION: Activates or deactivates the calibration mode; also determines the source of the calibration signal as internal or external.

syntax : CALn [Channel number or Global] <CR><LF>
echo :Rack Address:Board_Number Length Condition_Code Check_Sum <CR><LF>

n	Function
0	Turn calibration off
1	Turn calibration on and external
2	Turn calibration on and internal

The syntax of the CAL2 command requires an additional parameter. For the peak voltage, the parameter is preceded by a "V" and must be between 0.0 and 1.0. (See examples below).

Examples:
Cmd : CAL0 C11 <CR><LF>
echo : 1:16 4 9 29 <CR><LF>

Cmd : CAL2 C1 V0.5 <CR><LF>
echo : 1:16 4 9 29 <CR><LF>

GETC (FUTURE)
GET CONDITIONS: Checks the input status and overload conditions of the selected channel or group.

syntax : GETC [group no.] <CR><LF>
echo :Rack Address:Board_Number Length Condition_Code Check_Sum <CR><LF>

where n signifies the number of data pairs (n = 1 to 16)
Data(n)a contains channel number
Data(n)b contains the condition code for data(n)a

Condition	Code
No overload or input fault	0
Input fault (short or open) only	1
Overload only	2
Input fault and overload	3

Example:
Cmd : GETC C2 <CR><LF>
echo : 1:2 0 <CR><LF>

GETF (Version 3.0 or later)
GET FILTER SETTING: Reads the actual filter setting of channels. Due to the discrete nature of the filter setting (Options 057 and 058) the return value may differ from user input value. The filter may also be disabled (Options 157 and 158) (reference "X" command for "Enable/Disable" function).

syntax : GETF [Channel number or Global] <CR><LF>
echo : 1:Data 1 <CR><LF>

Data(n) : filter setting (-3 dB); all channels in Hz

Examples:
Cmd : GETF C5 <CR><LF>
echo : 1:1000 <CR><LF>

Cmd : GETf GL <CR><LF>
echo : 1:200 <CR><LF>

GETG (Version 3.0 or later)
GET GAIN SETTING: Reads the gain setting of a particular channel where the information returned includes channel number and gain.

syntax : GETG [channel] <CR><LF>
echo : 1:Data m Data n <CR><LF>

Data m contains the channel number
Data n contains the gain for data(n)a

Examples:
Cmd : GETG C9 <CR><LF>
echo : 1:9 4.0 <CR><LF>

Cmd : getg c2 <CR><LF>
echo : 1:2 100 <CR><LF>

GGPn (FUTURE)
GET GROUP DEFINITION: Reads the channels associated with a group number.

syntax : GGPn <CR><LF>
echo : 1:Data 1 Data 2 ... Data(m) <CR><LF>

where Data(m) contains all channels (range between 1 and 16) that belong to Group(n)

n	Function
0	Returns channel(s) in no group
1	Returns channel(s) in group 1
2	Returns channel(s) in group 2

Example:
Cmd : GGP1 <CR><LF>
echo : 1:7 11 14 <CR><LF>

LDCn (FUTURE)
LOAD CONFIGURATION: Loads one of the two sets of configurations stored in solid state memory to each channel. It reloads the configuration of hardware determined by stored values (STCn).

syntax : LDCn <CR><LF>
echo:Rack Address:Board_Number Length Condition_Code Check_Sum <CR><LF>

n	Function
0	Load configuration set 1
1	Load configuration set 2

Example:
Cmd : LDC1 <CR><LF>
echo : 1:16 4 9 29 <CR><LF>

LEDn (Version 3.0 or later)
LED CONTROL: Runs LED test/latch LEDs off.

syntax : LEDn [Channel number or Global] <CR><LF>
echo :Rack Address:Board_Number Length Condition_Code Check_Sum <CR><LF>

n	Function
0	Turn LEDs off
1	Run LED test

Example:
Cmd : LED0 c5 <CR><LF>
echo : 1:16 4 9 29 <CR><LF>

SETF (Version 3.0 or later)
SET FILTER: Sets the filter for the selected rack. The programmable will be set to the discrete value closest to the "n" value entered. See the "X" command for "Enable/Disable" function.

NOTE: The programmable filters (Options 157 and 158) must be enabled using "X" command (reference section 3-11) to insure proper filtering (version 4.3 or later)

syntax : SETF [Channel number or Global] Fn <CR><LF>

echo :Rack Address:Board_Number Length Condition_Code Check_Sum <CR><LF>

Fn : filter setting; refer to Sections 2-12.2 and 4-3.

NOTE: When a channel number is selected, all channels in the rack are affected.

Examples:

Cmd : SETF c3 F4 <CR><LF>
echo : 1:16 4 9 29 <CR><LF>

Cmd : SETf GL F90 <CR><LF>
echo : 1:16 4 9 29 <CR><LF>

SETG (Version 3.0 or later)
SET GAIN: Sets the gain for the selected group or channel.

syntax : SETG [channel number or global] <CR><LF>
echo :Rack Address:Board_Number Length Condition_Code Check_Sum <CR><LF>

An : Gain, n = 0.1 to 200 if the unit is equipped with the 037 option; otherwise, n = 1, 10, or 100.

Examples:

Cmd : SETG c10 A2 <CR><LF>
echo : 1:16 4 9 29 <CR><LF>

Cmd : SETG gL A40 <CR><LF>
echo : 1:16 4 9 29 <CR><LF>

SETR (Version 3.0 or later)
SET RACK ADDRESS: Sets the rack address for units used in multirack operation.

syntax : SETR U[n] <CR><LF>
echo :Rack Address:Board_Number Length Condition_Code Check_Sum <CR><LF>

where n signifies unit address 1 to 16

Example:

Cmd : SETR U2 <CR><LF>
echo : 2:16 4 9 29 <CR><LF>

NOTE: Two (2) is the new unit number; future command must use "2:" in the command string.

SMUX (Version 3.0 or later)
SET SWITCHER (Multiplexer): Chooses the channel in the selected switched output bank(s).

syntax : SMUX B[switch no.] C[channel no.] <CR><LF>
echo :Rack Address:Board_Number Length Condition_Code Check_Sum <CR><LF>

switch no. : n = 0 : both affected
: n = 1, 2 : specific switched output number
channel no. : n = 0 : disable the switcher of selected switch numbers
: n > 0 : set switcher to the specific channel within the switch number field

Examples:

Cmd : SMUX B1 C1 <CR><LF>
echo : 1:16 4 9 29 <CR><LF>

Cmd : SMUX B0 c0 <CR><LF>
echo : 1:16 4 9 29 <CR><LF>

SRST (Version 3.0 or later)
SYSTEM RESET: Resets the Model 481A to power-up the default settings and clears all registers and flags. The remote/local status remains unchanged. The input buffer is not cleared; all commands that precede the "?" in the same string are performed. The device clear command is used to ensure that the Model 481A is initialized to the same state each time a (user-defined application) program is run.

The factory default settings are:
Filter = 1 kHz, Gain = 1, Switcher off, No groups assigned

syntax : SRST <CR><LF>
echo :Rack Address:Board_Number Length Condition_Code Check_Sum <CR><LF>

Example:
Cmd : SRST <CR><LF>
echo : 1:16 4 9 29 <CR><LF>

NOTE: Depending on the options (e.g., 481102), the factory default may be different from the actual default.

STCn (FUTURE)
STORE CONFIGURATION: Stores the current configuration of each channel to one of the two nonvolatile memory configurations. Stores Gain, Filter, and Group Definition.

syntax : STCn <CR><LF>
echo :Rack Address:Board_Number Length Condition_Code Check_Sum <CR><LF>

n	Function
1	Store in configuration 1
2	Store in configuration 2

Example:

Cmd : STC1 <CR><LF>
echo : 1:16 4 9 29 <CR><LF>

STGn (FUTURE)
SET GROUP: Defines a group by channel(s). Once defined as a member of a group, the channel responds to either its channel number (Cn), group number (Gn), or a global broadcast (GL).

syntax : STGn [channel list] <CR><LF>
echo :Rack Address:Board_Number Length Condition_Code Check_Sum <CR><LF>

n	Function
0	Set to no group
1	Set to group 1
2	Set to group 2

NOTE: Each channel may be a member of only one group at a time.

channel list: a list of all channels included

i-j -from channel i to j when i<j
i* j* k -channels i, j, and k
i* j-k -channel i and from channel j to k when j<k

Examples:

Cmd : STG1 7*19*24*30 <CR><LF>
echo : 1:16 4 9 29 <CR><LF>

Cmd : STG0 1-32 <CR><LF>
echo : 1:16 4 9 29 <CR><LF>

XINS (Version 3.0 or later)

SENSOR INSTALLATION: Initializes table of input conditions of all channels. This command is used before installing a group of sensors and returns the channel number of the channel that last changed input condition when the command "INP?" is sent.

syntax : XINS <CR><LF>
echo :Rack Address:Board_Number Length Condition_Code Check_Sum <CR><LF>

Example:

Cmd : XINS <CR><LF>
echo : 1:16 4 9 29 <CR><LF>

CMD? (FUTURE)

COMMAND ERROR QUERY: Returns a 1 if the last command was invalid; a 0 if valid.

syntax : CMD? <CR><LF>
echo : 1:n <CR><LF>

n	Function
0	Command syntax was valid
1	Command syntax was invalid

Example:

Cmd : CDM? <CR><LF>
echo : 1:0 <CR><LF>

CAL?

CALIBRATION STATUS QUERY: Returns status of calibration signal.

Example: C? <CR> <LF>

Returns (option 014):

1:CALIBRATION ON <CR> <LF> , or

1:CALIBRATION OFF <CR> <LF>

Returns (option 012):

1:CALIBRATION INT=.500 <CR><LF> , or

1:CALIBRATION EXT <CR><LF> , or

1:CALIBRATION DISABLE <CR><LF>

IDT?
IDENTIFY QUERY: Identifies devices on the bus. The Model 481A responds by returning an eight-character string "PCB 481A," along with the unit address.

syntax : IDT? <CR><LF>
echo : 1:PCB 481A <CR><LF>

Example:
Cmd : IDT? <CR><LF>
echo : 1:PCB 481A <CR><LF>

INP? (Version 3.0 or later)
INPUT CONDITION QUERY: Indicates changes of input conditions (short/open or normal) of any channel. It returns all channel numbers that have changed input status since last query or a "0" if no input status changed.

syntax : INP? <CR><LF>
echo : 1:Channel_list <CR><LF>

Example:
Cmd : INP? <CR><LF>
echo : 1:15 <CR><LF>

MUX? (Version 3.0 or later)
SWITCHER (MULTIPLEXER) CHANNEL(S) QUERY: Returns the channel number of each switched output in the rack. The current channel that is enabled is returned. If switched output does not have a channel enabled, a zero ("0") is returned for that output.

syntax : MUX? <CR><LF>
echo : 1:Data m Data n <CR><LF>
where m is the switched output 1 setting; n is the switched output 2 setting

Example:
Cmd : MUX? <CR><LF>
echo : 1:0 7 <CR><LF>

OVD? (FUTURE)
OVERLOAD QUERY: Indicates whether or not any channel in the rack has had an overload since the last overload query. Overload query returns all channels that have changed overload status since last query, or a 0 if there were no changes in the overload status of any channel.

syntax : OVD? <CR><LF>
echo : 1:Channel_list <CR><LF>

Example:
Cmd : OVD? <CR><LF>
echo : 1:4 <CR><LF>

VER? (Version 3.0 or later)
VERSION QUERY: Returns the current version of the software used by the Model 481A.

syntax : VER? <CR><LF>
echo : 1:Version_String <CR><LF>

where version_string is the current version of the software starting with unit address

Example:
Cmd : VER? <CR><LF>
echo : 1:Version 3.n Software <CR><LF>

4-7. ASCII Condition Code Summary

Code	Error	Explanation
9	No error	Command successfully executed.
100	Internal communication error	Failure of transfer of command string to analog module(s)
101	System RAM test failure	System memory test failure upon power-up
102	Module RAM test failure	Analog module memory test failure upon system initialization
103	Illegal command	Command string not recognized
104	Command syntax error	Command not received in proper format for execution
105	No data	Command does not require additional characters besides mnemonic
106	Command too long	Input string over 150 characters long
107	Channel number out of range	Channel number out of range
109	Gain out of range	Gain input setting less than 0.1 or over 200, or ≠ 1, 10, 100
110	Cutoff frequency out of range	Filter cutoff value less than 2 Hz or over 20 kHz (Option 058/158), 21.4 kHz (Option 057/157)
111	Nonexisting board	Board number out of range for current system size
112	Nonexisting channel	Channel number out of range for current system size
114	Illegal group	Group command not allowed for this command input (Calibration, Autorange, and Set Filter)
115	Bank number out of range	Bank number not legal with present switching configuration and system size
116	Illegal switching configuration	Channel number out of range for current system and switching configuration
117	No parameters expected	Command field only required for command input
118	One parameter expected	Command and group field only required for command input
119	Too many parameters received	Command, group, and data fields only required for command input
120	Configuration undefined	Load configuration attempted that has not been defined previously
121	Input fault buffer error	Buffer not initialized; execute XINS command
127	0 or 1 error	Command support n = 0, 1 only (e.g., Led 1)
128	Multiple channel input	More than 1 channel change since last INP?
129	Option not defined	Hardware for option in command not installed
132	Cal voltage limit	Internal calibration voltage exceeds limits (0.0 to 1.0)

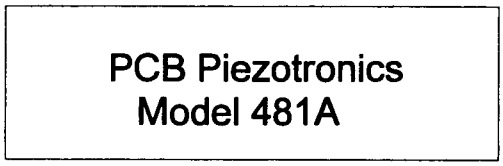
5-0. FRONT PANEL MODULE CONTROL (for units so equipped)

5-1. Introduction

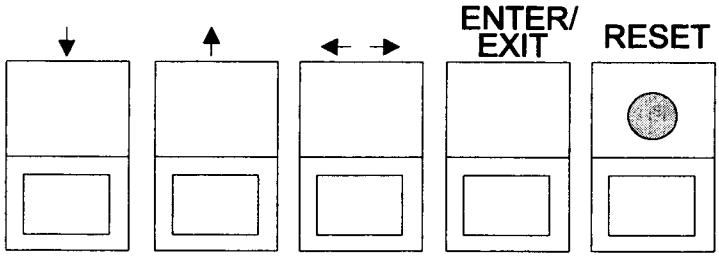
This section applies to Models 481A*, 481A02, and 481A03. Individual commands are subject to feature availability on the particular unit. The Model 481A is equipped with the capability of controlling functions through the front panel module. This module consists of a display and five (5) push buttons. The display shows various menus in which all of the available options are given. The display may scroll through the included options, controlled by the buttons. The menus contain an abbreviated word pertaining to each option. When a specific option is chosen, a submenu appears. It gives the choice(s) of the next selected configuration to the user.

5-2. Front Panel Module Layout

The following illustration shows the front panel module as it appears on the Model 481A.



Directional buttons are shown below, along with explanations of each.



▼ This button manipulates the specific option. The option pointed to by the arrow has a flashing cursor in the first letter of the mnemonic on the display. The next button scrolls DOWN through the rows on the menu. The entire menu consists of five (5) rows of options. This button is used to scroll from the top to the bottom of the menu.

The second function of this button is to vary the submenu selection of the option selected. For example, since there are 16 channels, the gain on each channel may be changed. This button may be used to scroll to the next channel in order to select a new gain. This is shown in the following examples.

▲ This button functions in the same manner as the button just described, but in the opposite direction. It scrolls UP through the rows of the menu, using the flashing cursor to point to the present location. When a submenu is entered, it varies the possible selections of all options and the channel number of the option to be changed.

◄ ► As is shown on the following menus, there are two to three options on each row of the menu. This directs the cursor to traverse the menu horizontally. It passes the cursor over the options shown in the present row, traveling from left to right, and wraps back around to the far left.

ENTER/EXIT: The fourth button controls the entry and exit, to and from the submenus, respectively. When the flashing cursor is on the option selected to be changed, the ENTER/EXIT button is pressed, to pass into the submenu. The submenu shows the necessary information to vary the option as desired.

RESET: The RESET button resets all options back to an initialized configuration. The LCD display shows "PCB Piezotronics," along with the model number, as shown in Section 5-3.

5-3. Unit Initialization

Upon pressing the RESET button, the unit flashes the front panel LEDs three times, and displays the following:

PCB Piezotronics Model 481A

The LED on the RESET button should be on. The unit is initialized, with the factory default configuration as:

Option	Default
Gain	All channels are set to a gain of 1.
Switching	Both Switch 1 and Switch 2 are disabled.
Autorange	Autorange is disabled.
Variable Overload Threshold	Overload threshold is set to ±10 volts.
Calibration Input	Calibration input is disabled.
Integrators	No integration is performed.
Filters for all channels	All filters are disabled.

NOTE: Reference Section 2-16.1 for memory default settings.

5-4. Main Menu Format

With the pressing of any button, the first menu is shown. This shows the first two rows of options, which are:

Gain	Mux	Stat
Leds	Auto	Unit #

The flashing cursor is shown on the "Gain" option initially. The flashing cursor may be moved around the main menu by using the arrow keys. To show the other selections of the main menu, press the down arrow key. This action scrolls vertically the following sections of the menu:

Leds	Auto	Unit #
Ovld	Cal	Coupl

Pressing the down arrow key button once again shows:

Ovld	Cal	Coupl
Intg	Fil	Rack #

Notice how the rows are scrolled up one at a time, replacing the top row with the bottom row each time.

Intg	Fil	Rack #
Lock	Chrg	Local

5-5. Submenu Format and Command Selections

The options within the Model 481A have been shown in the previous sections. They are all able to be varied with the use of the front panel module. The options and their submenus are shown in the following sections.

1) Gain Option:

To enter the submenu for the variable gain option, place the flashing cursor over the word "Gain" in the main menu. This is shown as:

Gain	Switch	Stat
Leds	Auto	Unit #

By pressing the ENTER/EXIT button, the submenu for changing the gain of any channel appears on the display. The submenu pertaining to the "Gain" selection appears as:

RK#	Channel	Gain
01	01	1

Example: To set the gain of Channel 02 to x10
The flashing cursor appears over the channel selection. If the channel selection is to be changed, then the up and down arrow keys may be pressed. This scrolls through the channels (i.e., 01, 02, 03 ... 16). Once the desired channel is selected (02 in this case; see example below) and the gain needs to be changed, press the left or right arrow key, so that the flashing cursor appears over the gain selection.

RK#	Channel	Gain
01	02	1

By pressing the up or down buttons, the gain may be varied, choosing a gain of x1, x10, or x100. In this case, a gain of 10 is selected; see example below. When the gain is changed on the display, the actual gain internal to the unit is changed. In option 037 or 038, if gain does not change, move the cursor to a more significant digit and repeat up/down adjustment of gain.

RK#	Channel	Gain
01	02	10

To set the next channel, press the left arrow key to resume channel control, then press the up or down arrow keys to select a different channel. Continue making selections with the directional keys until all desired channels are set, then press the ENTER/EXIT key to return to the option menu.

2) Switching Option:

The Model 481A has the capability of switching the output of any channel to one of two output BNCs on the rear panel. The switcher option is selected by entering the submenu of the "Mux" mnemonic. This is done by pressing the ENTER/EXIT key when the flashing cursor is on "Mux":

Gain	Mux	Stat
Leds	Auto	Unit #

The sub-menu of the "Mux" selection shows the current output of both switchers. The display shows:

RK#	Multiplexers
01	M1=1 M2=2

The current output of either switcher may be changed by using the up or down keys when the flashing cursor is on the selected switcher. As soon as the switcher channel is altered, the actual output is changed. This display shows that Switch 1 outputs channel 1, while Switch 2 outputs the signal from channel 2. NOTE: If the channel number is equal to 0, no channel's output is selected.

3) Read Channel Status:

The Model 481A contains front panel LEDs to show both the input fault status and the overload status of all channels. The read channel status performs the same function, with one difference: since the overloads are internally latched until the next time they are read, the status ("Stat") option reads the overload condition, both present and recently past. This

benefits the user in allowing the reading of the transient overload, where it would not be able to be seen on the front panel LED. To enter this option, place the flashing cursor over the "Stat" on the display:

Gain	Mux	Stat
Leds	Auto	Unit #

The particular channel may be selected by using the up or down buttons. The input fault or overload status is shown as a "0" if no fault or overload exists, while the presence of a fault or overload shows a "1" in the display. The following figure shows an input fault in Channel 1, with no overload since the last reading.

RK#	Input Status
01	C=1 F=0 O=0

C = Channel number
F = Fault number: 0 = no fault, 1 = input fault
O = Overload condition: 0 = no overload, 1 = overload

4) LED Testing:

The Model 481A shows the status of the input fault and overload for each channel. The testing of the front panel LEDs indicates whether or not they are functioning properly. To test them, place the flashing cursor over the word "Leds" on the display.

Gain	Mux	Stat
Leds	Auto	Unit #

Pressing the ENTER button flashes the LEDs three times and displays:

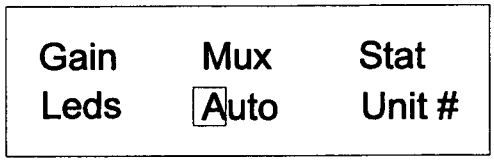
RK#	LED Test
01	ON

While the LEDs flash three times, the LCD shows. The main menu appears once flashing is completed.

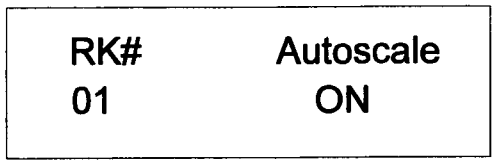
5) Autorange Option:

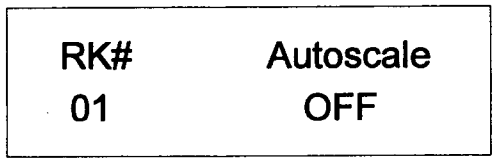
The autoranging feature presents an automatic scaling of the output signal. With this command, the programmable gain is implemented to give the largest signal amplitude output. The signals are checked internally; if there is an overload,

the signal is stepped down by one gain step and checked again. This procedure is followed for all channels, using all gain steps. To use this feature, place the flashing cursor over the word "Auto" on the display.



By pressing the ENTER button, the present status is shown on the display. By pressing the up or down buttons, the "Autoscale" toggles from ON to OFF.



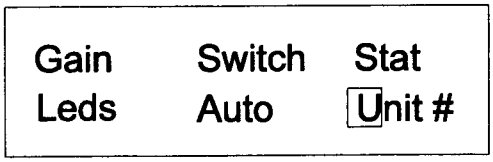


6) Read/Set Unit Number:

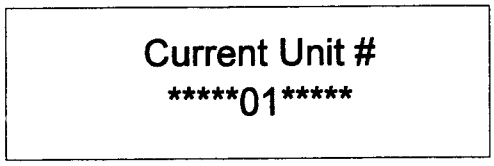
The rack's unit number is displayed and set using the "Unit#" menu selection. The unit number is defined as the address that preceeds the command code in the command string the unit executes (see Section 3-10: Rack Address).The unit address may be altered, using the up and down keys. The altered unit address is lost when the unit is turned off or the reset button is pressed. Consult the command (U - Set Unit Address) for more information. In order to force the unit address to a desired value at power up (after reset), follow the steps outlined in Sections 3-6 and 3-7.

NOTE: When the unit number is the same as the rack number (from "RK#" option), then the front panel module is sending commands to itself (see Section 3 for unit number description).

By moving the cursor to "Unit#" location, the display appears as follows:



Pressing the ENTER button, the submenu (legal unit numbers are 1 through 16) appears as:



7) Variable Overload Threshold:

The overload threshold voltage may be set to the user's specification. This changes the voltage at which the signals overload. The default of the overload voltage is set to trigger at ±10 volts. This may be changed from 1 to 10 volts in increments of 1-volt steps. By moving the cursor upon the "Ovld" location, the display appears as follows:

Leds	Auto	Unit #
Ovld	Cal	Coupl

Pressing the ENTER button, the submenu appears as below. The overload threshold may be altered by using the up or down buttons.

RK#	Ovld. Thresh
01	10 Volts

The threshold voltage shows the positive voltage level. The actual threshold is both positive and negative with equal amplitude.

8) Calibration Options:

The calibration input is located on the rear panel of the Model 481A. When the calibration is enabled, the corresponding signal is applied to all channels. This allows the user to check the signal integrity and channel matching (gain, phase, etc.).

By moving the cursor upon the "Cal" location, the display appears as follows:

Leds	Auto	Unit #
Ovld	Cal	Coupl

Using the ENTER button, the submenu appears as shown in the following diagram. The calibration input may be selected as one of the following combinations by using the up or down buttons: Enabled External, Enabled Internal, or Disabled.

RK#	Calibration
01	En ext

RK#	Calibration
01	En int

RK#	Calibration
01	Disabled

If the unit is equipped with Internal Calibration Source with Amplitude Control (Option 481012), the amplitude is set using the up or down buttons. The change in amplitude (up/down) is approximately 0.05 volts peak. The actual value displayed may differ from .05, 0.1, ... 0.9, 0.95 due to rounding or truncation errors.

RK#	Calibration
01	Int (value) V

9) 10/2 Discharge Time Constant Coupling:

The Model 481A contains an optional 10-second or 2-second time constant coupling (option 481013) for filtering out low-frequency signals generated by thermal effects on the sensor mechanism. The time constant is used to remove the sensor bias voltage (see Section 2.9).

By moving the cursor on the "COUPL" location, the display shows:

Leds	Auto	Unit #
Ovld	Cal	Coupl

When the ENTER button is pressed, the submenu of the coupling option is shown as either 10-second or 2-second. The status may be changed by using the up or down buttons.

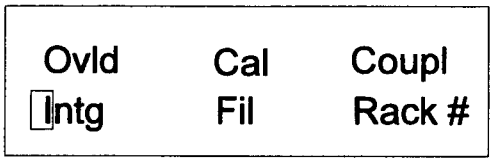
RK#	Coupling
01	is 10 sec

RK#	Coupling
01	is 2 sec

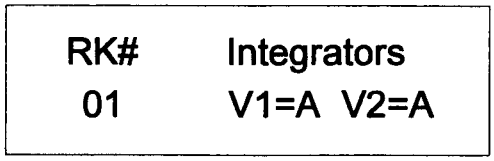
10) Integrator Options:

The Model 481A may have two (2) double integrators on the switched outputs (option 061). Each switcher has a BNC on the rear panel of the unit. The output of each switcher is fed into an integrator, to have the capability of a "velocity" output (single integration), or "displacement" output (double integration) if an accelerometer is used.

By moving the cursor upon the "INTG" location, the display shows:

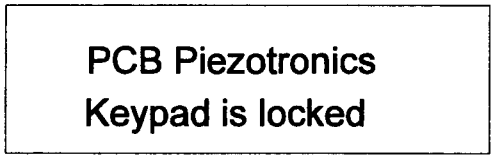


By pressing the ENTER key, the next menu appears as:



The number of integrations performed on each switched output may be changed, first by using the right or left button and placing the cursor on the number associated with the MUX 1 (V1), or on the MUX 2 (V2) output. The up or down buttons may be pressed to vary the number of integrations from A (acceleration) to V (velocity), or to D (displacement). To select the individual channels to be integrated, the ENTER button is pressed, then MUX control menu is used.

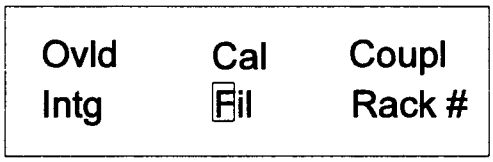
If the unit (Version 3.6 or later) is equipped with integrator per channel, the up and down arrows toggle the function of the integrator to output velocity or acceleration.



NOTE: "ON" implies velocity output each channel.

11) Filter Each Channel Option (Version 3.5 or earlier):

Having a fixed filter or integrator for each channel is an option on the Model 481A. The filters for all channels may be enabled together or disabled together. This option affects all channels simultaneously. By placing the cursor on the word "Fil" on the display, the menu is shown as follows:



By pressing the ENTER button, the submenu indicates the status of the filters:

RK#	Filters
01	OFF

The status of all filters may be changed with the use of the up or down buttons. The display shows "Filters ON" or "Filters OFF."

The programmable filter (Options 057 or 058) affects the FILT submenu by displaying:

RK#	Filter
01	1000 Hz

The cursor shows the position that is changed by the up and down arrow key adjustment. If the cursor is in the thousands place, each up arrow key increases the cutoff by 1000. Use the right arrow key to move the cursor to the desired weighting (place value) position. The cursor wraps around from lowest to highest position when the right arrow key is pressed and the cursor is pointing to the unit's digit. If the filter cutoff does not change, move the cursor to a more significant position and repeat. The actual filter setting is displayed.

NOTE: If the change in the filter cutoff plus the current value exceed the upper or lower frequency limit, the corresponding limit is loaded (e.g., 20 000 Hz plus the up arrow key in any cursor position loads in 2 Hz.)

For Versions 4.3 or later: The filter disable will be executed if the limit is exceeded. The filter will be enabled if continuing to wrap around the limit.

12) Read/Set Rack Number:

Multiple racks may be controlled via the front panel module by using "Rack#." The multi-rack system is set up the same way as described in Section 3-7 of this manual. The rack number corresponds to a rack with unit address that is controlled by the front panel. For example, if an external rack is connected and has a unit address of 3, select the 3 in the Rack# submenu to put the "3:" before the command string sent.

Ovld	Cal	Coupl
Intg	Fil	Rack #

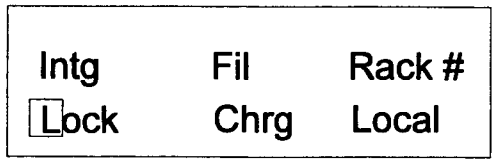
By pressing the ENTER button, the submenu appears as:

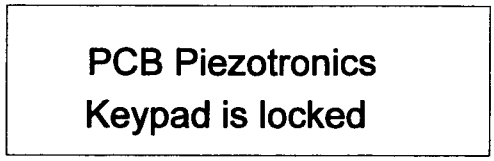
Rack Unit Number
*****01*****

Use the up or down arrow keys to change the rack unit number from 01 to 16. Reference the unit # for more information.

13) Lock:

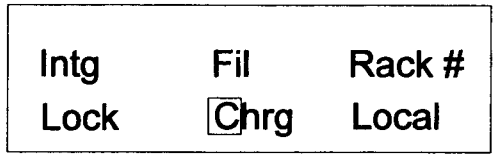
The "Lock" menu choice prohibits the control of the rack through the front panel. If the user selects the "Lock" by pressing the ENTER key, the message "PCB Piezotronics" (top line) and "Keypad is locked" (bottom line) is displayed on the display. The keypad is now disabled and does not work. The RESET button has no means of locking out its function and is still active.





14) Charge:

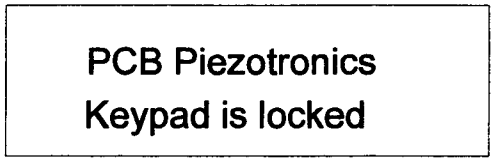
The "Chrg" menu choice is not implemented but is targeted as a control for the future option of ICP® or Charge input (option 082/086/087).

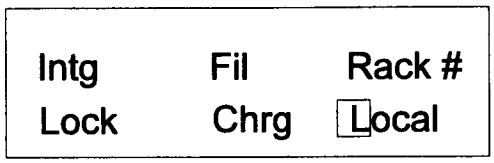


15) Local:

The "Local" menu choice is used to re-enable keypad control of the unit. The user must press the RESET key, and the usual reset function (LEDs flash three times) is performed. Since the reset is a "warm" re-boot, the configuration of the unit is retained after the reset process is completed.

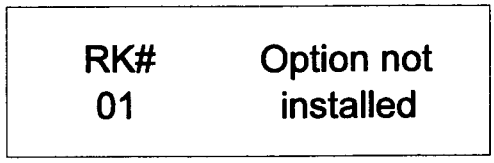
NOTE: The switched output settings are lost. The display does not change (if locked); the top and bottom lines still show "PCB Piezotronics" (top line) and "Keypad is locked" (bottom line). The arrow keys now permit the user to move around the menu choices; however, the ENTER key forces the locked message to reappear. **The user must move the cursor to the :Local: menu choice to restore the front panel control. Once the ENTER key is pressed at the Local position, the locked message does NOT get displayed.** The menu choices are still shown. The standard front panel control is thereby restored.



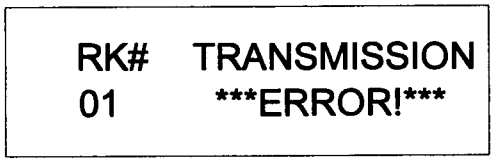


16) User Messages:

For any selected option not actually included in a particular unit, a message is shown on the display. This occurs on the main menu. The cursor is placed over a selected option not included in the model purchased. When the ENTER button is pressed, the following is shown:



If there is any communication error between racks, or if the rack with unit number does not exist, the following message appears:



If this error appears, make sure that the RS-485 cables are connected properly and that the Model 481A with unit address matches the Rack# address of the rack selected to control, using the Rack# menu choice.

Addendum to Section 5.0:

Front Panel Control:

The control of input mode, ICP/ Charge/ Voltage, of each channel is performed using the "Chrg" menu choice. The "Chrg" menu choice is located just below the "Fil" filter control menu choice. The Enter/ Exit key is used to select the menu choice.

Intg	Fil	Rack#
Lock	Chrg	Local

Upon entry into the "Chrg" menu choice, the unit will determine if the option is present and display the input mode of channel number 1. The cursor will point to the channel number 1. The up and down arrow keys are used to change the channel number currently displayed. Using right/left key moves the cursor to the input mode adjust. Again, the up and down keys adjust the input mode selected for the channel. The menu has the form:

RK#	Chan	In mode
1	1	ICP

Or

RK#	Chan	In mode
1	1	Charge

Or

RK#	Chan	In mode
1	1	Voltage

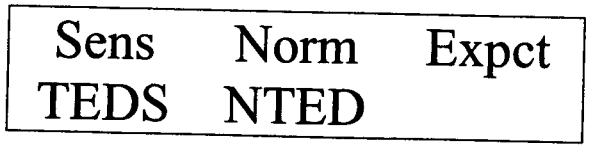
Depending on the mode selected.

The input mode is updated to match the display. Due to settling time requirements, the input fault led may illuminate temporarily while changing modes.

Addendum to Section 5.0:

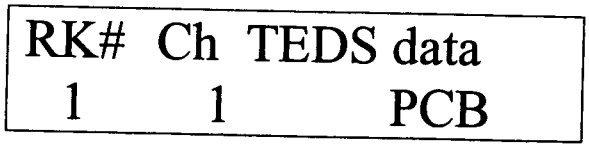
Front Panel Control:

The function of reading TEDS sensor data is performed using the menu choices "TEDS" or "NTED" . The menu choices correspond to the get TEDS data command and the Normalize TEDS data command. The "TEDS" menu choice is located just below the "Sens", Sensitivity menu choice, and "NTED" is located below "Norm", normalize output value menu choice. The Enter/ Exit key is used to select the menu choices.

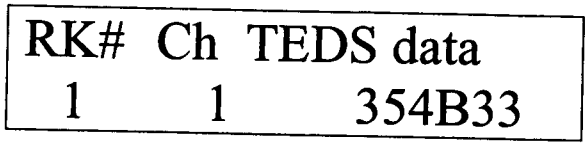


Upon entry into the "TEDS" menu choice, the unit will determine if the option is present and attempt to read the TEDS data of channel number 1. If the option is installed and a TEDS sensor (with IEEE 1451.4 format) is connected to channel 1, the display will show the Manufacturer and the cursor will point to the channel number 1. The up and down arrow keys are used to change the channel number currently displayed. Using right/left key moves the cursor to the TEDS data field. With the cursor pointing at the TEDS data field, the up and down keys step through the decoded TEDS information

The menu has the form:

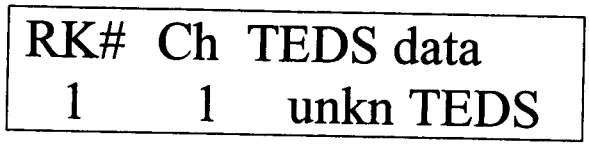


Or



Stepping through the TEDS data, using the up and down arrows, will wrap around to the first field when the last field has been shown.

If the communication with the TEDS sensor is not successful, due to a problem with cabling, non TEDS sensor, or template mismatch, the display will show:



Upon entry into the "NTED" menu choice, the unit will determine if the option is present and attempt to read the TEDS data of channel number 1. If the TEDS option is installed and a TEDS sensor (with IEEE 1451.4 format) is connected to channel 1, the display will show the gain setting for the channel after the normalization has been executed. The cursor points to the channel number 1. The up and down

arrow keys are used to change the channel number currently displayed. Using right/left key or the ENTER/EXIT exits the menu choice.

The menu has the form:

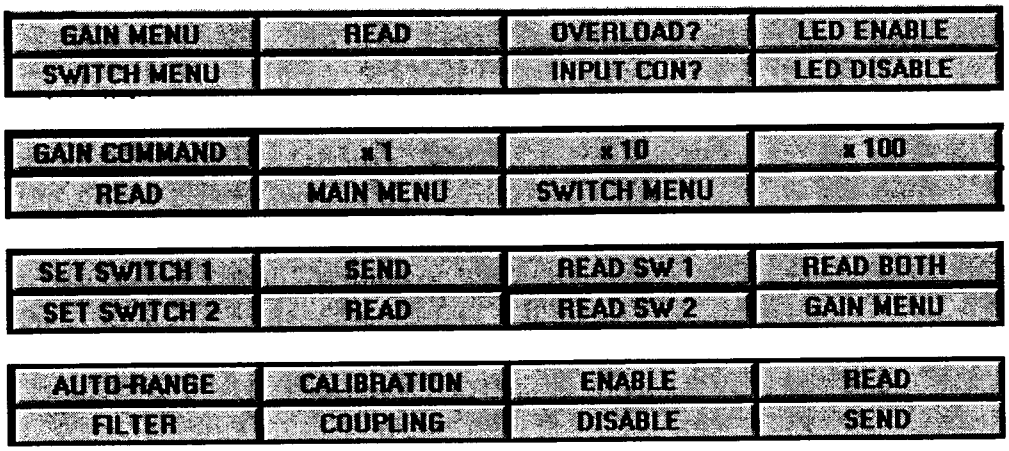
RK#	Ch	TEDS gain
1	1	11.025

If the communication with the TEDS sensor is not successful, due to a problem with cabling, non TEDS sensor, or template mismatch, the display will show:

RK#	Ch	TEDS gain
1	1	unkn TEDS

6.0 SERIES 481A COMPUTER MONITORING USING WINDOWS® 3.0 OPERATING SYSTEM FROM MICROSOFT. (Note: Use Hyper Terminal with Windows® 95.)

6-1. Terminal Emulation Setup Under Windows for Series 481A Signal Conditioners (not supplied—example only for instructional purposes.)



6-2. Description

There are four levels of function keys that are supported in the Windows Terminal Emulation program. **Help** assists the user in developing dedicated sets of function keys that control the Series 481A unit. Creating and storing many configuration files, along with storage of the function keys, allow the user to simplify the Series 481A setup.

The function key levels shown above were developed at PCB to be used as a generic controller of the Series 481A Signal Conditioner. The four levels are a main level, a gain command, a switching level, and a "miscellaneous" level. The levels may be changed either by clicking on the individual level key or by clicking on the desired menu.

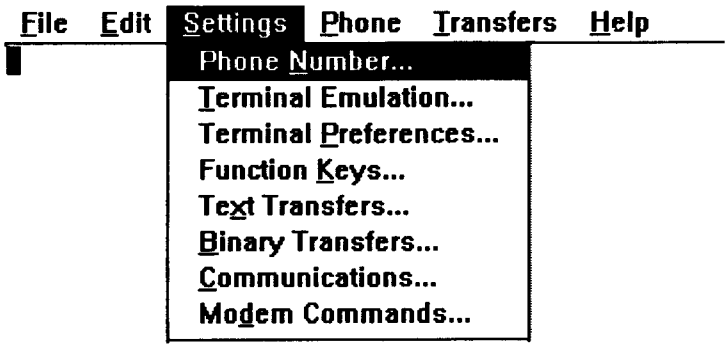
The function keys are labeled such that they describe the function of the string generated by the key. For example, the OVERLOAD? function key reads the status of the overload flag of all channels. The gain command menu is arranged in such a way that the user must first click on GAIN COMMAND, then type the channel number that is desired. After the channel number is specified, the user clicks on either the READ function key, to ascertain the channel's present gain status, or on one of the three gain values (e.g., x10).

The switch menu is used in a similar fashion. The user may read either of the switched outputs or the output of both by selecting the proper function key. If the user wishes to set the switched output to a certain channel, either the SET SWITCH 1 or SET SWITCH 2 must be selected, followed by the typing in of the desired channel number, 1 to 16. Finally, selecting the SEND function key completes the process.

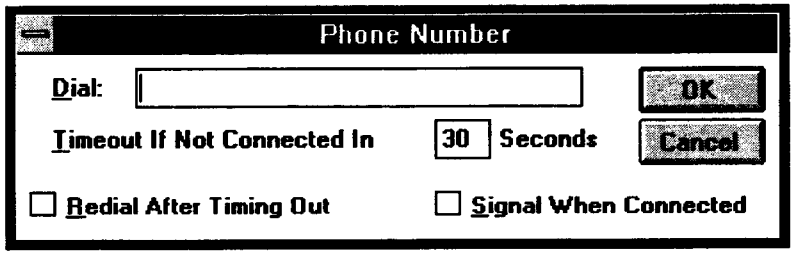
The last menu permits the user to enable or disable four miscellaneous functions: autorange, filter, calibration, and coupling. This is accomplished by first selecting the command in question, then selecting the ENABLE or DISABLE key, and finally, clicking on SEND. The status of the commands may be sought by selecting first the command, then READ. The menu may then be exited by clicking on the level function key.

Once WINDOWS is running, start the terminal emulation by double-clicking on the terminal icon. See below.

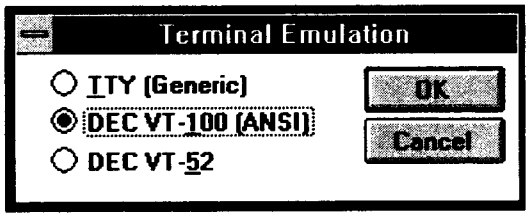
This provokes an error message that states that the COM port is not ready. Simply click CANCEL or OK to clear the screens. Upon receiving the main menu, click on the "Settings" menu choice to list the following sub-topics.



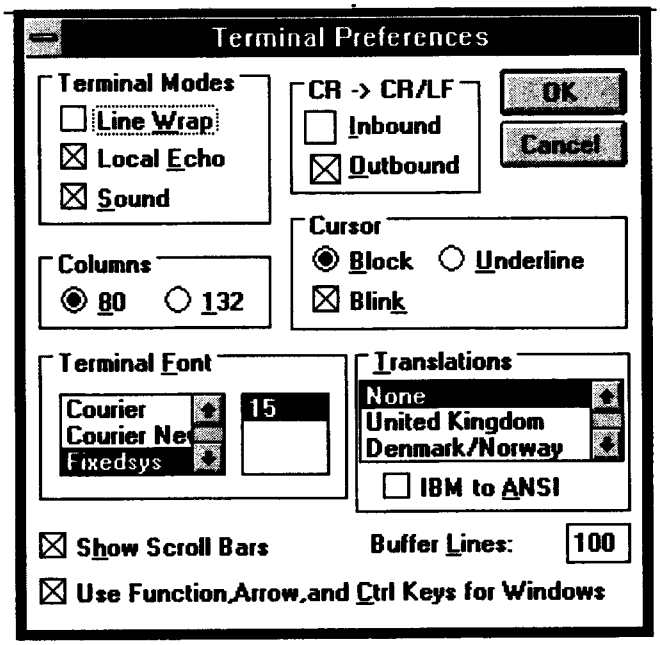
The **Phone Number** is shown only for the purposes of clarity; the Series 481A does NOT require any special selection under this dialogue box. The default is acceptable.



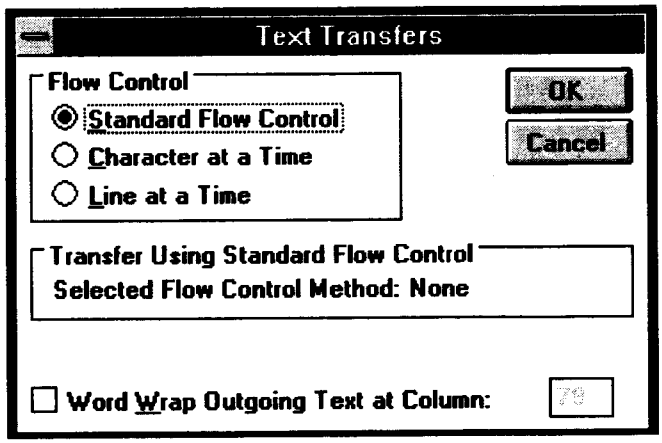
Terminal Emulation is also a default setting, but the user may find it useful to know the setting currently in use; the host may be different than the common PC.



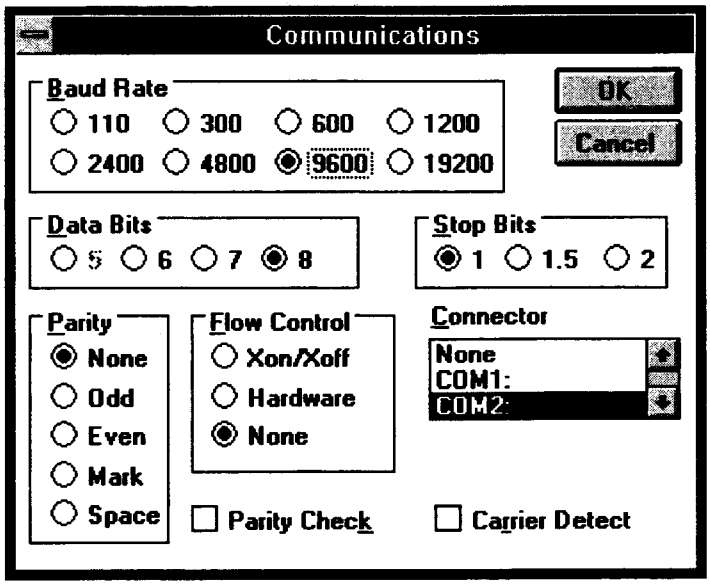
The **Terminal Preferences** dialogue box is one of the critical settings necessary to insure that the command strings are terminated properly. The terminal modes' **Local Echo** is important because it allows the user to see the characters as they are input.



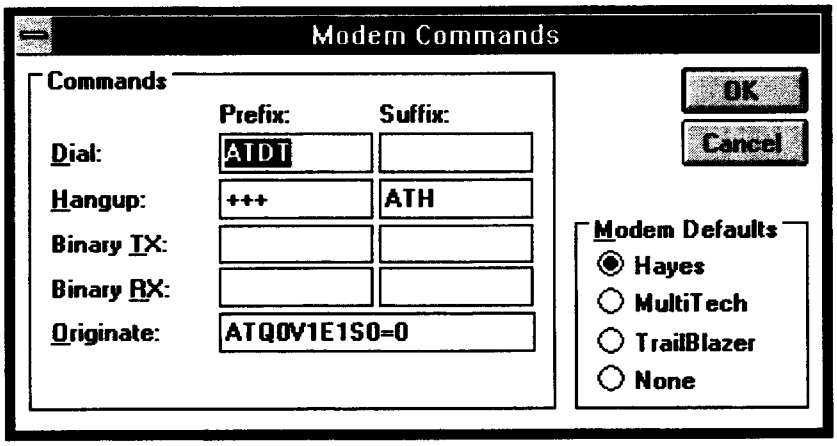
Text Transfers provide the flow control of the characters. The default setting of no flow control is selected here, but **Character at a Time** may be useful to force delays between the characters to allow the Series 481A device to accept a command and execute it before another command is sent by the user.



The **Communications** dialogue box is the most important: it sets up the actual character protocol. The characters must follow this serial format, or the Series 481A does not accept the characters. It is important to note that the **Connector,** the actual communication port of the host PC, must be followed. The COM commonly used during calibration and testing at PCB is COM2, but the user may use port number 1, depending on the system setup (mouse versus no mouse).



The **Modem Commands** dialogue box is also not particularly vital to communications with the Series 481A Signal Conditioners, but it is included here to show the user what is seen on that portion of the menu.

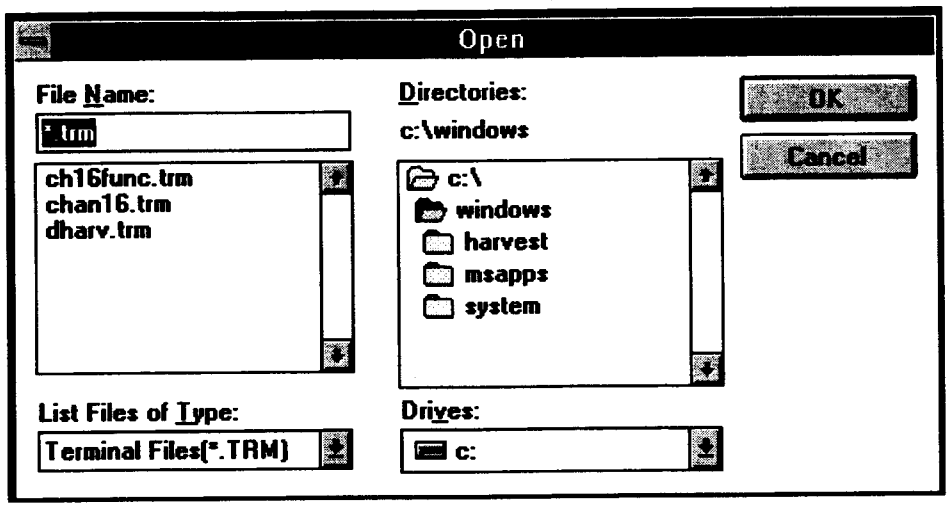


Upon completion of the emulation setup, make sure that the **Caps Lock** is on, as the Series 481A accepts the upper case of the command characters. A good test to insure that the terminal emulator is set properly is to send the following command string:

00:L=1

This command causes the front panel LEDs to flash 3 times. If this is not the response evoked, press **Caps Lock** and repeat the command.

Once the communication is established, go to the **File** menu choice and **Save As:** CHAN16.TRM. This allows the user to immediately recall the Series 481A setup whenever the terminal Emulator is started. The setup is re-installed by going to the **File** menu and choosing **Open**, then clicking on the CHAN16.TRM choice. The proper settings are automatically updated from default or other applications to the desired settings for communication with the Series 481A Signal Conditioner.



6-2.1 Windows 95® Version Using Hyper Terminal:

When using a computer equipped with Windows 95 operating system do the following when communicating with the Model 481A:

(1) Connect the RS-232 connector on the Model 481A to the COM2 (or COM1) port of the computer using the supplied Model 009N03 cable.

(2) Turn on the Model 481A and boot up the computer

(3) Select "Start" then "Programs" then "Accessories" then "Hyperterminal"

(4) Double click on Hyperterminal.Exe

(5) Type in 481A (for name) then select "OK"

Under Phone Number Table select Connect Using "Direct to Com2" (or Com1) and "OK"

(6) Under COM2 (or COM1) Properties - Port Setting Menu Enter
Bits Per Sec - 9600
Data Bits - 8
Parity - None
Stop Bits - 1
Flow Control - Hardware
Select "OK"

(7) Select "File" and "Properties" & "Settings" then pick
Terminal Keys
Emulation VT100
Buffer Lines 500

(8) Pick Ascii Setup
Check (x) Send line ends with line feed
Check (x) Echo typed characters locally
Check (x) Wrap Lines

Select "OK"
Select "OK" again

On blank screen:

Type 0:L=1 and check if the LEDS of the Model 481A flash three times (this means communication has been established. Remember to select "File" and then "Save" configuration (filename 481A).

6-2.2 Sample Commands

Example 1: Insure communication using LEDs as verification: **01:L=1** .

Comments: The LEDs flash three times. Do not send commands until the unit completes the flash, approximately 5 to 6 seconds. It may be advantageous to send the combination of the following commands:

01:L=1;01:U?

The semicolon allows several commands to be entered on the same command line. The U (unit identify) command returns the unit's type and rack address. The benefit of the combination is that it lets the user know exactly when the unit is ready to accept more commands.

Example 2: Interrogate the condition of the input cabling (are all sensors receiving proper excitation?): **01:F?** .

Comments: The unit returns a string with the input condition of each channel encoded as "1", indicating input fault, or "0", indicating normal operation. Individual channel status (including both input and overload conditions) may be requested by using the S (status) command. The returned strings are (assuming all channels are functioning [2, 8, 12, 14, 16 have been corrected]):

1: IF Ch 1-8: 01000001 Ch 9-16: 00010101 <CR>< LF>	for F?
1: CH=3 IF=0 OV=1 <CR><LF>	or S3?

Example 3: Use the autorange feature to set the gains of all channels, as determined by the amplitude of the signal each channel is seeing: **01:R=1** .

Comments: Allow the system to autorange for some time (determined by the application) until the signals stabilize. Disable the autorange feature, 01:R=0 , to lock the gains for the data collection not performed in the Series 481A.

One of the more useful features of the Series 481A is the dual 16-to-1 switched output, used to expand the channel capabilities of spectrum analyzers. The output signal of each channel may be sent through the switched output to a 2- or 4-channel channel analyzer to allow low-speed switching: **01:M1=1;01:M2=9** .

Comments: The signals of Channel 1 and Channel 9 are output through the rear panel BNCs, MUX1 and MUX2, respectively. The data may be collected and analyzed for these channels, and the switched output is updated to other channels (depending on the application) so that all channels in the rack are accessed. The process may be repeated as often as required.

Example 4: Interrogate overload condition: **01:O?** .

Comments: Overload conditions exist when the analog signal is too large for the electronics, whether that involves the Series 481A Signal Conditioners or the acquisition system. If analog signal is continuously too large, the yellow LED appears to be on continuously. If a transient causes an overload, the yellow LED comes on only for a short time. The timing does not matter; any occurrence of an overload during data collection is returned by the O? command. The overload status may explain data exhibiting curious phenomena, a situation that may require that the series setup be modified and the data re-collected.

7-0. MODEL 481A SERIES TROUBLESHOOTING GUIDE

Trouble/Problem	Possible Solution/Cause
Unit does not show any sign of life	-Check fuse- rear panel inside power input module (size/type info). -Check function of reset button on front panel, insure the key is not sticking or rubbing on front panel.
Input Status LED on with sensor connected	-Swap sensor and/or cable with known good to different channel. -Measure input sensor excitation using a voltmeter and ammeter (24V & 4mA). -Check voltage mode input (Option 084) correctly setup both jumpers inside rack properly set. -Does the sensor have low (<1V) or high bias (>22V) in normal operation. -Make sure sensor connected to the proper/desired INPUT connector.
Overload LED on	-If programmable overload (Option 020) included, check setting. -Check gain value, sensed signal times gain value may be too big. -Latch overload option included, read overload status (O?) or RESET if 102 Option included to clear status.
No output signal from channel	-Swap sensor and cables (in/out) to a different channel. -If 084 Option, check for proper input mode ICP or Voltage. -If 082, 086, or 087 check ICP or Charge input mode switch on rear panel. -If 012 or 014 disable calibration mode using proper command string (see manual). -If programmable filtering option included, make sure set high enough to pass signals of interest or disabled for fixed filter options.
Filter setting/response does not match input string or older 584A performance	-Programmable filter sets/echo the closest defined filter setting that is greater than input string – normal -Option 057 is the same for both 584A and 481A, only the echo strings are handled differently.
Front panel keypad does not control the unit	-Unlock keypad – reset unit, mover cursor to "Local" and press ENTER/EXIT. -Make sure the "Rack" is the same as "Unit" number in the sub-menus.
Can't communicate with unit (RS-232 or RS-485)	-Check communication protocol – 8 bits, 9600 bps, 1 start, 1 stop, no parity. -Check provided 009N03 cable and connection to proper communication port. -If the unit number is not equal to "1" the address of the unit MUST be included in the command string. (See Multinode in manual). -Each unit MUST have unique address to allow Multinode (RS-485) operation (See initialization procedure in manual).

Can't communicate with unit (RS-232 or RS-485) (continued)	-The end of string must be a carriage return or a line feed character.
Can't communicate with unit IEEE-488 (Option 070)	-Make sure rear panel rotary switch setting matches IEEE-488 device address selected by the command software. -Check for EOI (end or identify) terminates the command string, asserts with last character.

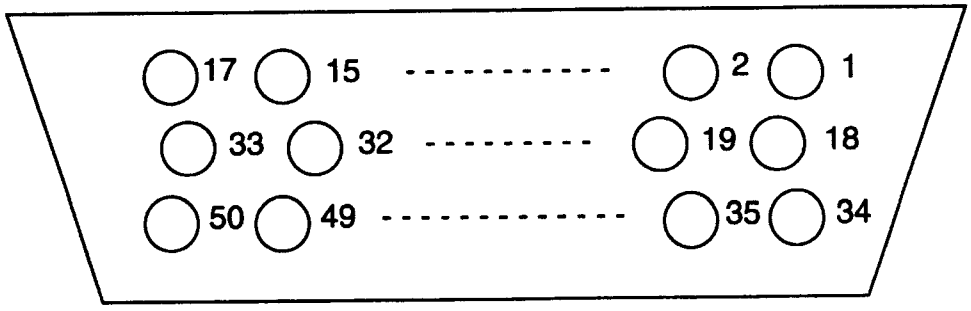
8.0 APPENDIX

Figure 8-1.1 Input Connector-Pin Configuration

Input Connector - Pin Configuration

Rear Connector Pin Number	Channel Number	Description ICP or Direct Voltage	Rear Connector Pin Number	Channel Number	Description ICP or Direct Voltage
1	1	+ IN1	42		
34	1	GND1/NC	26	9	+ IN9
18	1	GND1	10	9	GND9/NC
2	2	GND2	43	9	GND9
35	2	+ IN2	27	10	GND10
19	2	GND2/NC	11	10	+ IN10
3	3	+ IN3	44	10	GND10/NC
36	3	GND3/NC	28	11	+ IN11
20	3	GND3	12	11	GND11/NC
4	4	GND4	45	11	GND11
37	4	+ IN4	29	12	GND12
21	4	GND4/NC	13	12	+ IN12
5	5	+ IN5	46	12	GND12/NC
38	5	GND5/NC	30	13	+ IN13
22	5	GND5	14	13	GND13/NC
6	6	GND6	47	13	GND13
39	6	+ IN6	31	14	GND14
23	6	GND6/NC	15	14	+ IN14
7	7	+ IN7	48	14	GND14/NC
40	7	GND7/NC	32	15	+ IN15
24	7	GND7	16	15	GND15/NC
8	8	GND8	49	15	GND15
41	8	+ IN8	33	16	GND16
25	8	GND8/NC	17	16	+ IN16
9			50	16	GND16/NC

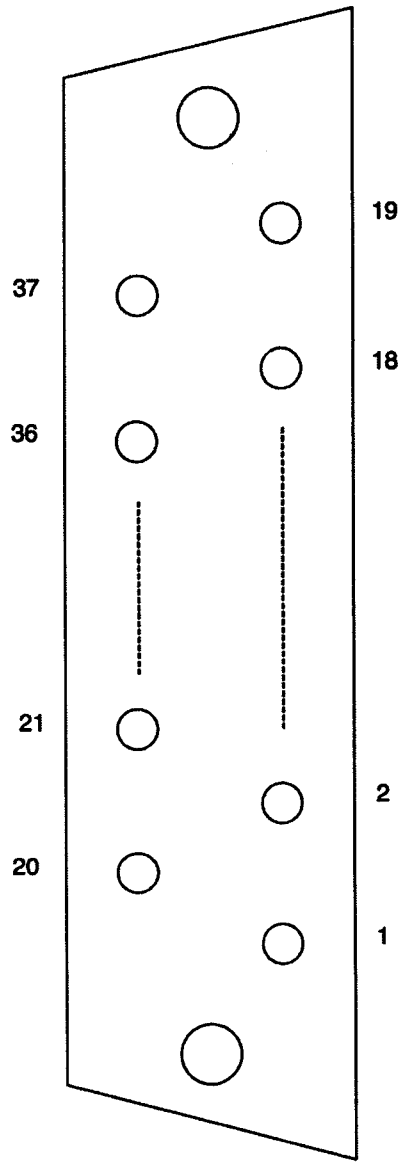
NOTE: NC = no connection. Units equipped with options 481-282, 481-284, 481-286, 481-287, 481-382, 481-386, or 481-387 should not have anything connected to these pins.



Back View of Female Connector (5051)

Figure 8-1.2 Output Pin-Out Configuration

Output Pin-Out Configuration		
Rear Connector Pin #	**Channel Number**	**Description**
1	1	OUT 1
20	1	GND 01
2	2	OUT 2
21	2	GND 02
3	3	OUT 3
22	3	GND 03
4	4	OUT 4
23	4	GND 04
5	5	OUT 5
24	5	GND 05
6	6	OUT 6
25	6	GND 06
7	7	OUT 7
26	7	GND 07
8	8	OUT 8
27	8	GND 08
9		
28		
10	9	OUT 9
29	9	GND 9
11	10	OUT 10
30	10	GND 10
12	11	OUT 11
31	11	GND 11
13	12	OUT 12
32	12	GND 12
14	13	OUT 13
33	13	GND 13
15	14	OUT 14
34	14	GND 14
16	15	OUT 15
35	15	GND 15
17	16	OUT 16
36	16	GND 16
18		
37		
19		



MANUAL NUMBER: 18762
MANUAL REVISION: NR

®Windows is a registered trademark of Microsoft Corporation.

Model Number
481A02

ICP ® SIGNAL CONDITIONER

Revision: K
ECN #: 31504

ELECTRICAL		UNITS	VALUE	
Channels			16	
Display: LED (red) - Bias			Open/Short	
LED (yellow)			Overload	
Sensor Excitation		V/mA	24 ±1/3-20	[1]
Fixed Gain:			x1 (unity)	
Accuracy (at 500 Hz)		%	±1	
Linearity (10-50 kHz)		%	±1	
Frequency Response (-5%)		Hz	0.5 – 100,000	
X100 only		Hz	0.5 – 60,000	[3]
Noise (spectral):	Typical	gain	x1	[5]
	1 Hz	µV√Hz	2.0	
	10 Hz	µV√Hz	0.2	
	100 Hz	µV√Hz	0.2	
	1 kHz	µV√Hz	0.15	
	10 kHz	µV√Hz	0.15	
Broadband Noise 1 Hz-10 kHz (typical)		µV	11.0	
Input Range		V	9.0 (Max.)	
Overload Threshold		Vpk	10 (±0.2)	
Output Range (w/5 kΩ load minimum)		V/mA	10/2.0	
Output DC Offset (maximum)		mV	50	
Output Impedance		ohms	50 (maximum)	
Channel Isolation (minimum)		dB	72	
Power Requirements:		VAC	100-240	
	Maximum	A	0.6	
	Frequency	Hz	47-63	
ENVIRONMENTAL				
Operating Temperature		°F [°C]	32 to 120 [0 to 50]	
Relative Humidity (maximum)		%	85	
PHYSICAL				
Connectors - Signal:	Input (rear)	D-sub-50	1	
	Output (rear)	D-sub-37	1	
	Output (front)	BNC	16	
Connector - Power			IEC 320	
Size (H x W x D):		in	3.5 x 19.0 x 16.25	
		[mm]	[88,8 x 483 x 413]	
Weight (maximum)		lb [kg]	15.0 [6,82]	

CE [4]

All specifications are at room temperature unless otherwise specified

FEATURE LIST					
035 – Programmable Gain					[3]
Gain Accuracy		%	1		
Linearity		%	1		
Gain			x1, x10, x100		
Noise (spectral):	Typical	gain	x1	x10	x100[5]
	1 Hz	µV√Hz	2.0	20.0	200.0
	10 Hz	µV√Hz	0.2	0.6	6.0
	100 Hz	µV√Hz	0.2	0.6	5.0
	1 kHz	µV√Hz	0.15	0.6	5.0
	10 kHz	µV√Hz	0.15	0.6	5.0
Broadband Noise 1 Hz-10 kHz (typical)		µV	11.0	50.0	500
Frequency Response (-5%)		kHz	65	56	40
080 – 16 BNC Inputs Rear Panel					
101 - Digital Control with RS-232/RS-485 Interface					
Connectors		D-sub-9	2		
Baud Rate		bits/sec	9,600		
Start, Data, Stop, Parity			1, 8, 1, No		
Handshaking			RTS/CTS		
RS-485 Devices In System			16		[2]
Cable Length (maximum):	RS-232	ft	50		
Cable Length (maximum):	RS-485 *	ft	200		
Supplied Accessories		cable	009N03		
102 – Memory Default					
103 - Front Panel Control/Display					
Keypad			4		
Reset			1		
Display Dot Matrix		row/col	2/16		

NOTES:
[1] Constant current factory set at 4 mA.
[2] RS-485 interface uses proprietary interconnect of PCB equipment only.
[3] Serial number 253 and greater.
[4] See PCB Declaration of Conformance PA024 for details.
[5] Noise test per A-107-2, using 401A05.

SUPPLIED ACCESSORIES:
Model 017 Power Cable
009N03

Ferrite Bead (part number 100-2973-30)
EE-75 481A Control Software (1 CD ROM)
* Not Tested

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In the interest of constant product improvement, we reserve the right to change specifications without notice.

Drawn: LH	Engineer: CPH	Sales: JJM	Approved: EB	Spec Number:
Date: 10/8/09	Date: 9/16/09	Date: 9/21/09	Date: 9/23/09	8090

PCB PIEZOTRONICS INC
ELECTRONICS DIVISION
3425 Walden Avenue, Depew, NY 14043 *800-828-8840* *Fax (716) 684-0987* *E-Mail: sales@pcb.com*

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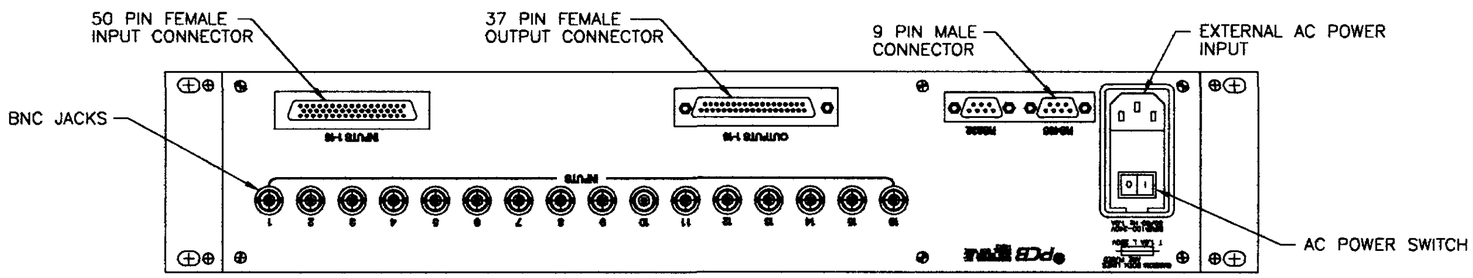
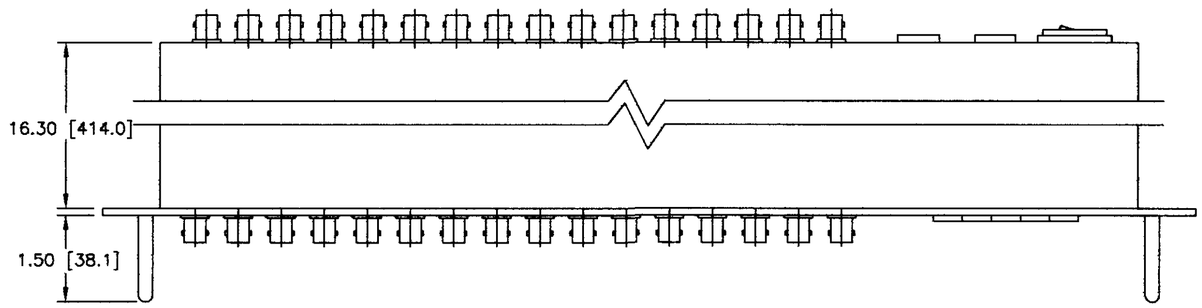
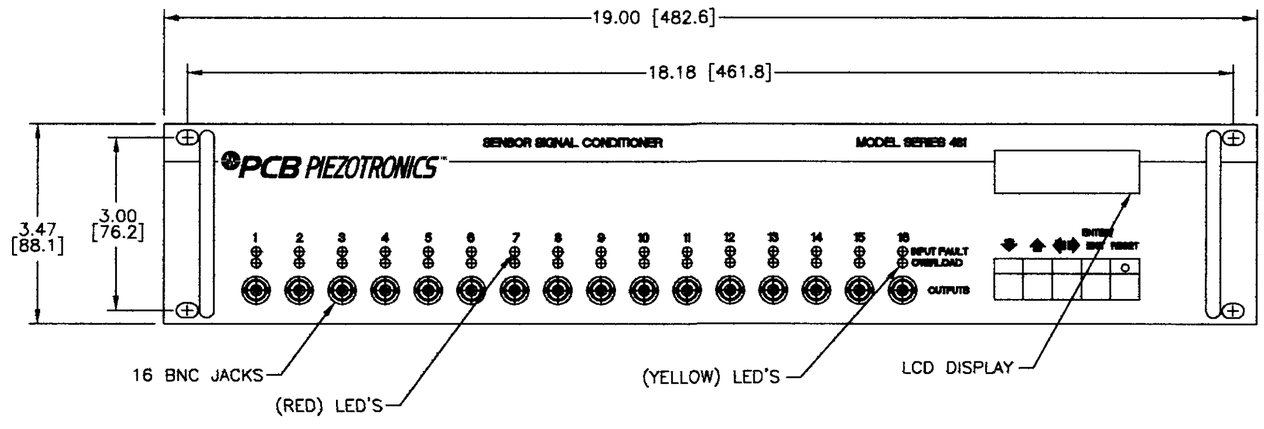
10714

REVISIONS					
ZONE	REV	DESCRIPTION	ECN	DATE	APP'D
	NR	RELEASED TO DRAFTING		3/24/99	KL3/99
	A	UPDATED HANDLES	26003	3/7/07	EB 3/22/07







UNLESS SPECIFIED TOLERANCES	
DIMENSIONS IN INCHES DECIMALS XX ±.03 XXX ±.010 ANGLES ±2 DEGREES	DIMENSIONS IN MILLIMETERS [IN BRACKETS] DECIMALS X ±0.8 XX ±0.25 ANGLES ±2 DEGREES
FILLETS AND RADII .003 – .005	FILLETS AND RADII [0.07 – 0.13]
DD013 REV. C 01/21/03	

DRAWN		3/4/07	MFG		3/27/07
CHK'D	ECB	3/22/07	ENGR		3/26/07
APP'D		3/29/07	SALES		3/4/07

TITLE: OUTLINE DRAWING
MODEL 481A02/481A03
SENSOR SIGNAL CONDITIONER

PCB PIEZOTRONICS INC.
3425 WALDEN AVE. DEPEW, NY 14043
(716) 684-0001 EMAIL: SALES@PCB.COM

CODE IDENT. NO.	DWG. NO.
52681	10714
SCALE: .5X	SHEET 1 OF 1

Repair and Maintenance

PCB guarantees Total Customer Satisfaction through its "Lifetime Warranty Plus" on all Platinum Stock Products sold by PCB and through its limited warranties on all other PCB Stock, Standard and Special products. Due to the sophisticated nature of our sensors and associated instrumentation, **field servicing and repair is not recommended and, if attempted, will void the factory warranty**.

Beyond routine calibration and battery replacements where applicable, our products require no user maintenance. Clean electrical connectors, housings, and mounting surfaces with solutions and techniques that will not harm the material of construction. Observe caution when using liquids near devices that are not hermetically sealed. Such devices should only be wiped with a dampened cloth—never saturated or submerged.

In the event that equipment becomes damaged or ceases to operate, our Application Engineers are here to support your troubleshooting efforts 24 hours a day, 7 days a week. Call or email with model and serial number as well as a brief description of the problem.

Calibration

Routine calibration of sensors and associated instrumentation is necessary to maintain measurement accuracy. We recommend calibrating on an annual basis, after exposure to any extreme environmental influence, or prior to any critical test.

PCB Piezotronics is an ISO-9001 certified company whose calibration services are accredited by A2LA to ISO/IEC 17025, with full traceability to SI through N.I.S.T. In addition to our standard calibration services, we also offer specialized tests, including: sensitivity at elevated or cryogenic temperatures, phase response, extended high or low frequency response, extended range, leak testing, hydrostatic pressure testing, and others. For more information, contact your local PCB Piezotronics distributor, sales representative, or factory customer service representative.

Returning Equipment

If factory repair is required, our representatives will provide you with a Return Material Authorization (RMA) number, which we use to reference any information you have already provided and expedite the repair process. This number should be clearly marked on the outside of all returned package(s) and on any packing list(s) accompanying the shipment.

Contact Information

PCB Piezotronics, Inc.
3425 Walden Ave.
Depew, NY14043 USA
Toll-free: (800) 828-8840
24-hour SensorLine: (716) 684-0001
General inquiries: info@pcb.com
Repair inquiries: rma@pcb.com

For a complete list of distributors, global offices and sales representatives, visit our website, www.pcb.com.

Safety Considerations

This product is intended for use by qualified personnel who recognize shock hazards and are familiar with the precautions required to avoid injury. While our equipment is designed with user safety in mind, the protection provided by the equipment may be impaired if equipment is used in a manner not specified by this manual.

Discontinue use and contact our 24-Hour Sensorline if:

- Assistance is needed to safely operate equipment
- Damage is visible or suspected
- Equipment fails or malfunctions

For complete equipment ratings, refer to the enclosed specification sheet for your product.

Definition of Terms and Symbols

The following symbols may be used in this manual:

DANGER
Indicates an immediate hazardous situation, which, if not avoided, may result in death or serious injury.

CAUTION
Refers to hazards that could damage the instrument.

NOTE
Indicates tips, recommendations and important information. The notes simplify processes and contain additional information on particular operating steps.

The following symbols may be found on the equipment described in this manual:

This symbol on the unit indicates that high voltage may be present. Use standard safety precautions to avoid personal contact with this voltage.

This symbol on the unit indicates that the user should refer to the operating instructions located in the manual.

This symbol indicates safety, earth ground.

PCB- PCB工业监测和测量设备 - 中国RoHS 公布表

PCB Industrial Monitoring and Measuring Equipment - China RoHS Disclosure Table

部件名称 Part Name	有毒和危险品 Toxic and Hazardous Substances or Elements									
Part	铅 (Pb)	水银 (Hg)	镉 (Cd)	六价 铬 (Cr(VI)	多溴化 苯 (PBB)	多溴化二苯 醚 (PBDE)	邻苯二甲酸 二(2-乙基) 己酯 (DEHP)	邻苯二甲丁 基苄酯 (BBP)	邻苯二甲酸 二酸正丁酯 (DBP)	邻苯二甲酸 二异丁酯 (DIBP)
电气外壳 (Electrical Enclosures)	X	O	O	O	O	O	O	O	O	O
紧固件和弹簧 (Fasteners)	X	O	O	O	O	O	O	O	O	O
电缆组件 (Cable Assembly)	X	O	O	O	O	O	O	O	O	O
印刷电路板组装 (PCBAs)	X	O	O	O	O	O	O	O	O	O
机械零件(Mechanical Parts)	O	O	O	O	O	O	O	O	O	O
塑料和橡胶零件 (Plastic & Rubber Parts)	O	O	O	O	O	O	O	O	O	O
金属零件 (Metal Parts)	X	O	O	O	O	O	O	O	O	O

本表格依据 SJ/T 11364 的规定编制

O =表示该有害物质在该部件所有均质材料中的含量均在 GB/T 26572 规定的限量要求以下 (indicates that the content of the toxic and hazardous substance in all the Homogeneous Materials of the part is below the concentration limit requirement as described in GB/T 26572).

X =表示该有害物质至少在该部件的某一均质材料中的含量超出 GB/T 26572 规定的限量要求 (indicates that the content of the toxic and hazardous substance in at least one Homogeneous Material of the part exceeds the concentration limit requirement as described in GB/T 26572).