Operating Manual

Model 161 PE/IEPE Signal Conditioner

Measurement Specialties, Inc.
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Company Overview, Policies and Contact Information

Overview
Measurement Specialties is a global designer and manufacturer of sensors and sensor-based systems and instrumentation which measure pressure/force, position, vibration, temperature, humidity, and fluid properties. Our products are used as embedded devices by original equipment manufacturers (OEMs) or as stand alone sensors for test and measurement to provide critical monitoring, feedback and control input. We are at the heart of many everyday products and provide a vital link to the physical world.

Warranty
Measurement Specialties, Inc. devices are warranted during a period of one year from date of shipment to original purchaser to be free from defects in material and workmanship. The liability of Seller under this warranty is limited to replacing or repairing any instrument or component thereof which is returned by Buyer, at his expense, during such period and which has not been subjected to misuse, neglect, improper installation, repair, alteration, or accident. Seller shall have the right to final determination as to the existence and cause of a defect. In no event shall Seller be liable for collateral or consequential damages. This warrant is in lieu of any other warranty, expressed, implied, or statutory; and no agreement extending or modifying it will be binding upon Seller unless in writing and signed by a duly authorized officer.

Receiving Inspection
Every Measurement Specialties, Inc. device is carefully inspected and is in perfect working condition at the time of shipment. Each device should be checked as soon as it is received. If the unit is damaged in any way, or fails to operate, a claim should immediately be filed with the transportation company.

Service Concerns
If a Measurement Specialties, Inc. instrument requires service, first contact the nearest Measurement Specialties, Inc. representative or distributor. They may be able to solve the problem without returning the unit to the factory. If it is determined that factory service is required, call Customer Service at the regional headquarters for an RMA number before return.

Returns
All units being returned to the factory require an RMA (Return Material Authorization) number before they will be accepted. This number may be obtained by calling Customer Service at the regional headquarters with the following information; model number(s), quantity, serial number(s), and symptoms of the problem, if being returned for service. You must include the original purchase order number if under warranty.

Calibration Services
The Vibration Sensors Group in California and its two manufacturing facilities in China and France now offer factory calibration and test services for Piezoresistive, Variable Capacitance, Piezoelectric and Integrated Electronics Piezoelectric (IEPE, ISOTRON, etc.) accelerometers.

We offer NIST (US), DKD (Germany), COFRAC (France) traceable calibration services on sensitivity at 100 Hz (102 or 120 Hz in Europe). Sensitivity reference frequencies other than 100/102/120 Hz are available upon request. Users of Measurement Specialties accelerometers can expect quick turnaround for full frequency response calibrations from 10 Hz through resonance and for transverse cross-axis sensitivity testing.

<u>We will match sensors to instrumentation purchased.</u>

Calibration of accelerometers not manufactured by Measurement Specialties may take longer depending on availability of test fixtures and the manufacturer's specifications. Environmental

testing over temperature, centrifuge testing and shock calibration are also offered on a case-by-case basis.

Safety Guidelines

Please read the guidelines below before operating this sensitive electronic equipment.

- Avoid expose to rain or humidity.
- Never operate in an explosive or dusty environment
- In no case should the user remove the screws of the apparatus, open it, or modify the interior components of the apparatus.
- Use a soft, dry cloth to clean the surface of the apparatus. Do not use any chemicals such as wax, benzene, alcohol, thinners, insecticide, air freshener, lubricant, detergent or other organic solvent.
- Splashing water on the apparatus can cause electric shock, electric leakage, or fire.

Address all inquiries on operation or applications to your nearest Sales Representative, or to the Vibration Applications Support as follows:

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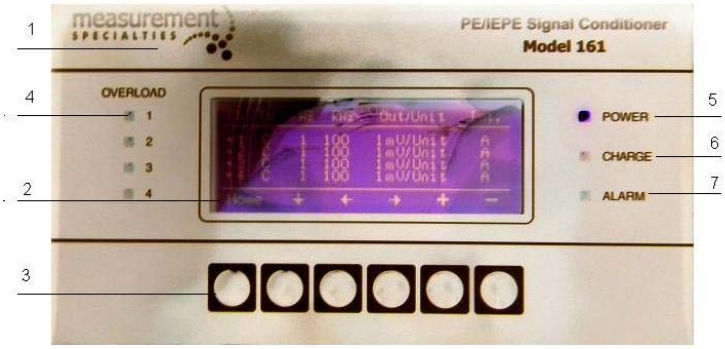
Introduction

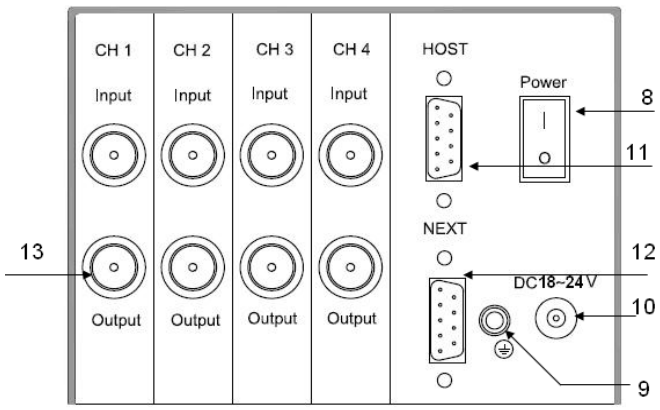
The Model 161 Signal Conditioner is used for conditioning and amplifying PE/IEPE accelerometers. This apparatus can connect with charge accelerometers, IEPE/ICP accelerometers, and TEDS (Transducer Electronic Data Sheet) accelerometers which support IEEE P1451.4. This device contains four signal channels. The front end consists of charge preamplifier, IEPE preamplifier and TEDS read-write circuit. The LCD screen and membrane keys to set up each channel. The Model 161 Signal Conditioner will retain its current settings even if it is switched off. Two groups of parameters can be saved and each group contains parameters of four channels.



Front Panel Display

1. Face plate
2. 192×64 LCD screen
3. Membrane keys on the face plate. The function of the keys is indicated by the symbols, which appear on the screen above each key.
4. Overload indicators. The red LED will be turned on when the associated channel overloads.
5. Power indicator
6. Charging indicator of the battery. Red means battery is currently charging; green means battery is at full capacity (Model 161B only).
7. Alarm indicator warns the battery is depleted (Model 161B only).

Back Panel



8. Power On/Off key.
9. Ground pole
10. DC-socket for connection to an external 18-24V source
11.* RS-232 HOST connector to a PC or DEL 161 Conditioning Amplifier.
12.* RS-232 NEXT connector for connection to MODEL 161 Conditioning Amplifier.
13. Signal condition channel 1 to 4.

* Provided in future updates. Not available at this time.

Key Functions and Symbols

Model 161 Signal Conditioner is operated by pressing the membrane keys on the front panel. The six keys on the front panel allow you to select windows and options, and to specify parameter values. The function of the keys depends on the selected window. The current function will appear on the bottom of the display above each key. Model 161 Signal Conditioner uses highlighted text to indicate the item is selected. The following key symbols are used on the display:

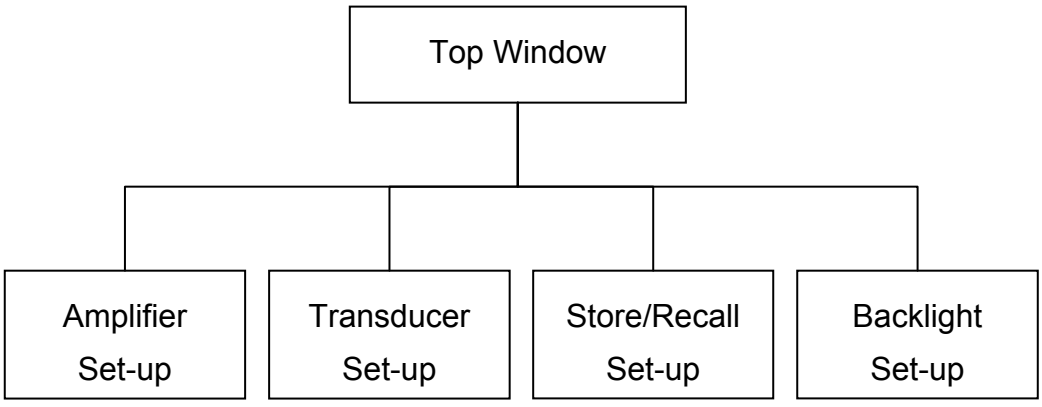
Home	Returns to top window and stays at first item of the top window.
↓	Move cursor down.
↵	Execute.
←	Move cursor left.
→	Move cursor right.
+	Increments the value.
—	Decrements the value.
√	Confirm operation.
×	Operation failed or unselected state.

Power On

Connect the power adaptor which provides 18-24VDC to the DC power port, toggle the power switch, then the power indicator light will be turned on, and the LCD screen displays the current setup of each channel. Allow the signal conditioner to warm up for 10 minutes prior to use. Generally, to avoid ground loop, the Ground plug shouldn't be connected to Ground plugs of other apparatus.

Setup Menu

Model 161 Signal Conditioner uses LCD screen and membrane keys to set up parameters. Each block below denotes a setup window on the LCD screen. The symbols at the bottom of the screen indicate the functions of the corresponding keys.



Top Window

Top Window is the Main Set-up window, which includes Amplifier Set-up, Transducer Set-up, Store/Recall Set-up and Backlight Set-up windows.

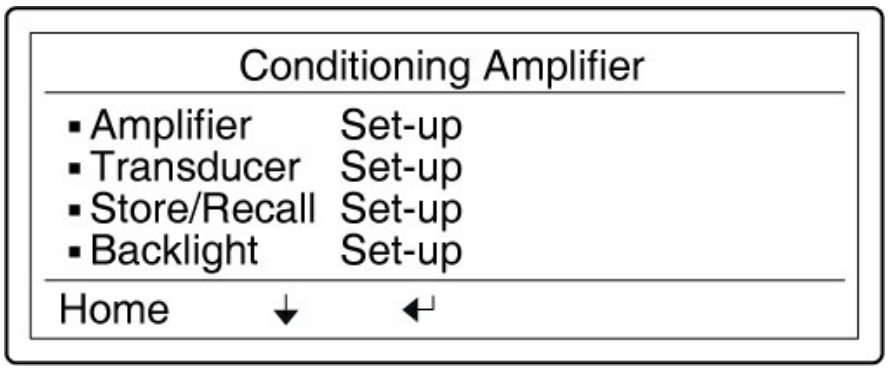


Figure 3-2. Top Window

Use the ↓ key to select a set-up item and press the ↵ key to enter the corresponding set-up window. Press Home key to return to the Main Set-up window.

Amplifier Set-up:
The Amplifier Set-up window is used to set up transducer type of the input, cutoff frequency of high-pass filter and low-pass filter, output sensitivity and output signal type for each individual channel. This window is the default window on the screen when switched on.

Transducer Set-up:
The Transducer Set-up window is used for setting transducer type of the input, transducer sensitivity of the input and the configuration of the TEDS for each individual channel.

Store/Recall Set-up:
The Store/Recall Set-up window is used for saving and retrieving user-defined channel parameters, and restoring to default factory setup.

Backlight Set-up:
The Backlight Set-up window is used for setting up the backlight of the LCD screen.

Amplifier Set-up

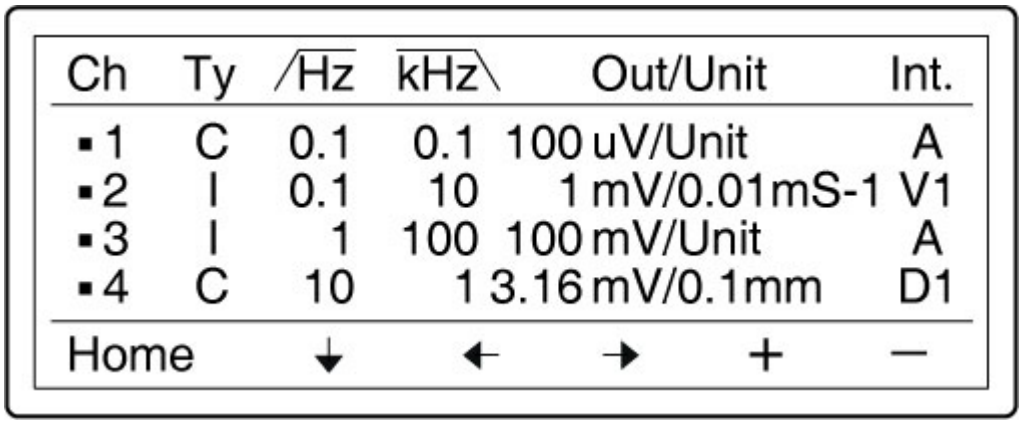


Figure 3-3. Amplifier Set-up window

Ch (1, 2, 3, 4):

Channel number corresponds to the channel 1 to 4 from left to right on the back panel of the Signal Conditioner.

Use ↓ key to select the channel below the currently selected channel and use ← or → key to select the parameter field to the left or right of the currently selected parameter field.

Ty (C, I):

For choosing the transducer type of the input. Two options are available: “C” for charge input and “I” for ICP input. Use ＋or－key to choose the transducer type according to the input signal.

/Hz (0.1, 1, 3, 10):

For choosing the high-pass filter option. Four options 0.1Hz, 1Hz, 3Hz and 10Hz are available. The cut-off frequency is -3dB down of the pass-band. The attenuation curves of the cut-off frequencies are shown below. Use + or – key tp close the cut-off frequency of the high-pass filter for current selected channel.

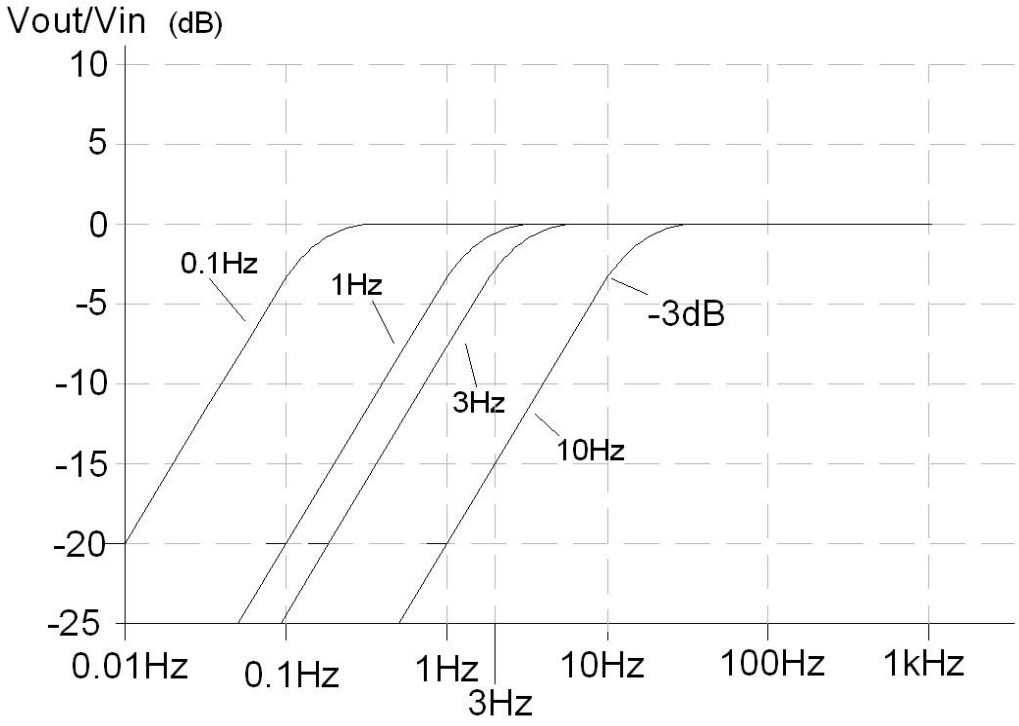


Figure 3-4. Attenuation Curve of the High-pass Filter

kHz\(0.1, 1, 3, 10, 30, 100):

For choosing the low-pass filter option. Six options 100Hz, 1 kHz, 3 kHz, 10 kHz, 30 kHz and 100 kHz are available. The cut-off frequency is -3dB down of the pass-band. The attenuation curves of the cut-off frequencies are shown below.

Use ＋or－key to choose the cut-off frequency of the low-pass filter for current selected channel.

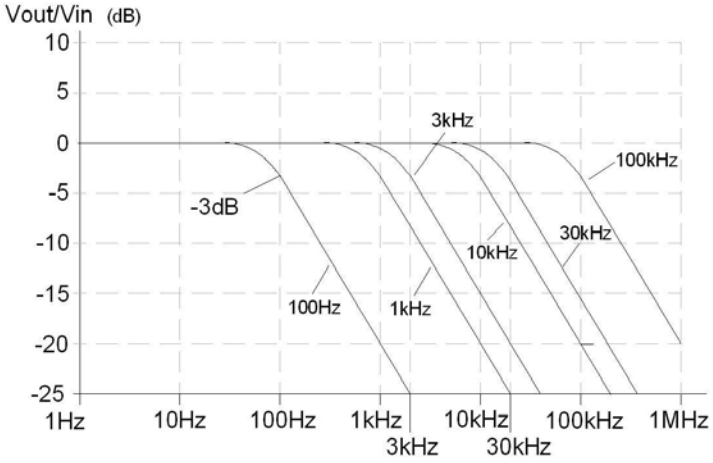


Figure 3-5. Attenuation Curve of the Low-pass Filter

Out/Unit:

For choosing the output sensitivity in 10dB steps with 1mV/Unit at 0dB.

For charge input (C), eleven values from -20dB to 80dB are available: 100uV/Unit, 316uV/Unit……3.16V/Unit and 10V/Unit.

For IEPE input (I), nine values from -20dB to 60dB are available: 100uV/Unit, 316uV/Unit……316mV/Unit and 1V/Unit.

Use ＋or－key to increase or decrease the output sensitivity.
Generally, overloading may occur during the setup of the output sensitivity and the output signal will be saturated. Model 161 Signal Conditioner has overloading LED light on the front panel to indicate signal saturation and ensure that the measurements are valid. When the charge or voltage output of the accelerometers saturate the signal conditioner, the overload occurs and the overload LED is red.

Int. (A,V1,D1,V2,D2):

For choosing the output signal type of each channel. Use＋or－key to select the output signal type. Five options are available: A, V1, D1, V2 and D2. The output signal type and the corresponding output sensitivity unit are showed below:

Int.	Output Signal Type	Output Sensitivity Unit
A	Acceleration signal	V/Unit (Unit:ms^{-2},g)
V1	Velocity signal, integral of acceleration signal	V/0.01mS-1
D1	Displacement signal, double integral of acceleration signal	V/0.1mm
V2	Velocity signal, integral of acceleration signal	V/0.1mS-1
D2	Displacement signal, double integral of acceleration signal	V/1mm

NOTE

When the output signal is integral or double integral signal, the transducer sensitivity should be converted to value in unit of ms-2. For example, when the transducer sensitivity is 52.6pC/g, the user should set transducer sensitivity in Transducer Set-up window in Figure 3-7

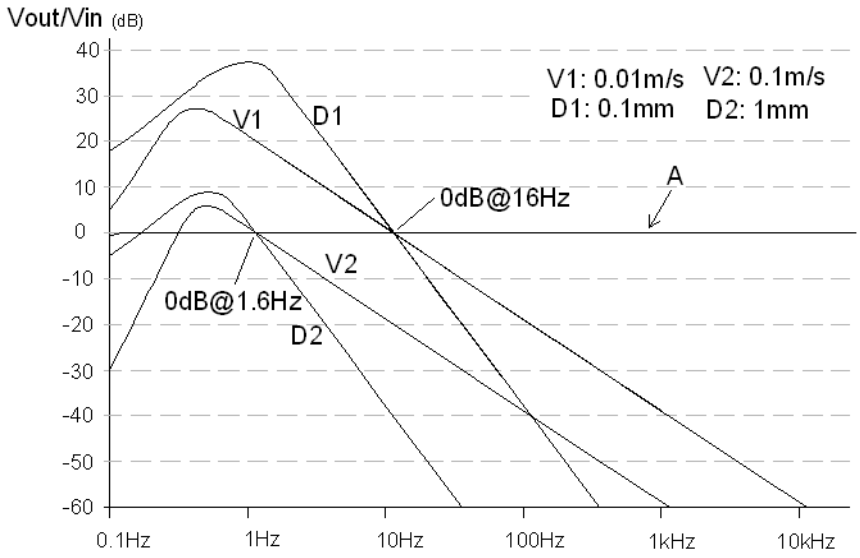


Figure 3-6. Amplitude to Frequency Curve

The velocity and displacement signals are obtained from single integral and double integral of the acceleration signal. Model 161 Signal Conditioner uses piecewise integration to calculate velocity and displacement signals. The V1 and D1 intersect the acceleration line at 16Hz; the available frequency band of V1 is from 10Hz to 10 kHz and the available frequency band of D1 is from 10Hz to 1 kHz. The V2 and D2 intersect the acceleration line at 1.6Hz; the available frequency band of V2 is from 1Hz to 1 kHz and the available frequency band of D2 is from 10Hz to 100Hz.

To better understand the difference between V1/D1 and V2/D2, the block diagram of the integral circuit following a charge amplifier is shown as an example in Figure 3-6 for analysis. Vin is the signal before the integral stage, Vout is the output signal A, V1, V2, D1 or D2. If Vout type is A, Vout/Vin=1,0dB Amplitude of V1/V2/D1/D2 changes with frequency, i.e. V is inversely proportional to ω, D is inversely proportional to ω^2 , ($\omega = 2\pi f$). Therefore, the V and D output signals from the integral stage become smaller when the frequency goes higher, the signal-to-noise ratio is lower as a consequence. To have a better signal-to-noise ratio and obtain wider measurement frequency range, model 161 signal conditioner uses piecewise integration algorithm to compensate signal loss at different frequency bands.
The user should set A as output signal type when he wants to measure acceleration signals; to measure velocity signal within 10Hz to 10 kHz, set output type as V1, because V1 is non-linear below 10Hz and its signal-to-noise ratio deteriorates greatly beyond 10KHz. Similarly, to measure velocity signal within 1Hz to 1 kHz, set output type as V2; to measure displacement signal within 10Hz to 1 kHz, set output type as D1; and to measure displacement signal within 1Hz to 100 Hz, set output type as D2. When the measurement frequency is situated between these measurement bands such as 10Hz, the user should choose V1 or D1 to ensure the measurement precision.

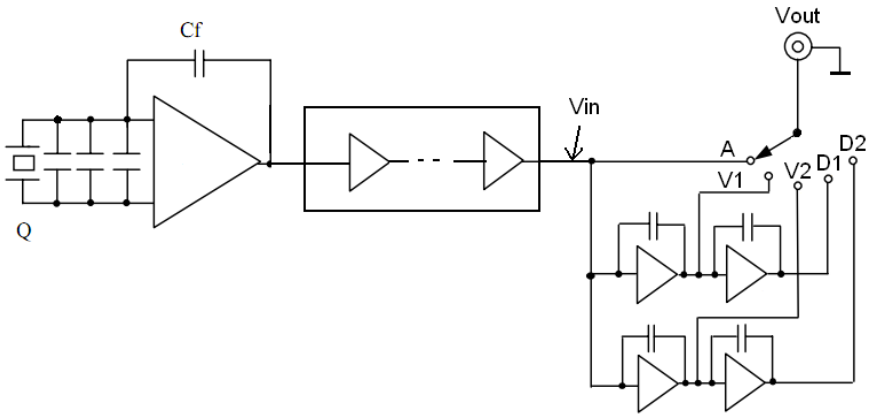


Figure 3-7. Block diagram of integral circuit

Transducer Set-up

Ch	Ty	Sensitivity	Unit	TEDS
▪1	C	001.050	PC/Unit	Set
▪2	I	010.200	mV/Unit	Set
▪3	I	002.010	mV/Unit	Set
▪4	C	005.330	PC/Unit	Set

Home ↓ ← → + —

Figure 3-8. Transducer Set-up Window

Ch (1, 2, 3, 4):

Channel number corresponds to the channel 1 to 4 from left to right on the back panel of the Signal Conditioner.

Use ↓ key to select the channel below the currently selected channel =and use ← or → key to select the parameter field to the left or right of the currently selected parameter field.

Ty (C, I):

For choosing the transducer type of the input. Two options are available: “C” for charge input and “I” for IEPE input.

Use ＋or—key to choose the transducer type according to the input signal.

Sensitivity:

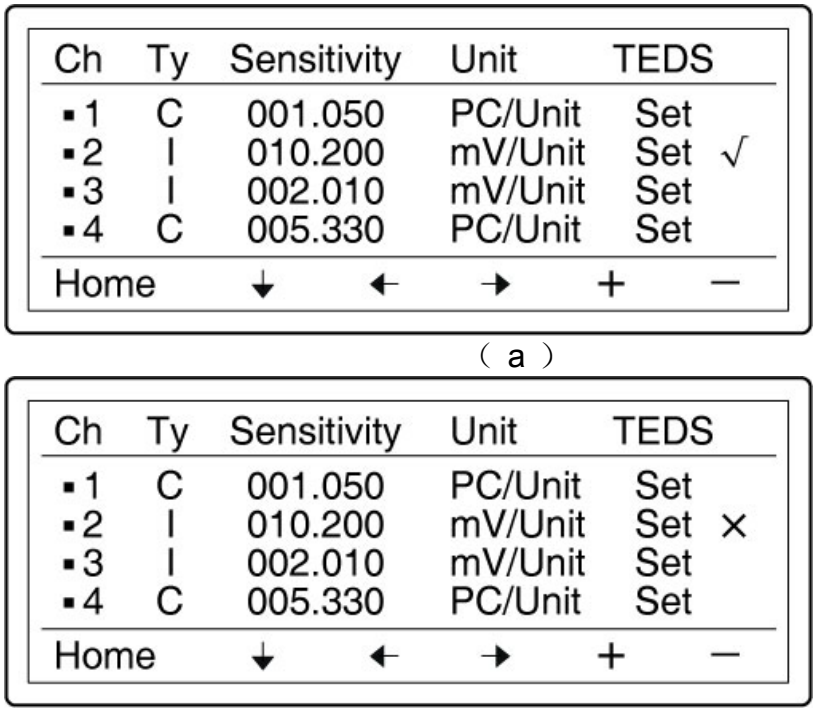
For setting transducer sensitivity. The value range for Charge type transducer is 0.001～999.0 pC/Unit and the value range for IEPE type transducer is 0.01～999.0 mV/Unit. (unit: mS^{-2}, g)

The user should give attention to the sensitivity setting, because the value of sensitivity has only three effective digits. For example, the transducer sensitivity of 9.146mV/Unit should be set as 009.150. Model 161 Signal Conditioner has done the following to ensure three effective digits: (1) when transducer type is set as “C”, the user can set sensitivity on six digits. For example, the

transducer sensitivity of 52.6 pC/Unit is set as 052.600 and the fifth and sixth zero can't be set, namely, ＋and－key are invalid for these two digits. In addition, when you change the first digit as 1, then the fourth digit 6 will be cleared and the value becomes 152.000; (2) when transducer type is set as "I", only five digits are available and the sixth digit is always zero. For example, the transducer sensitivity of 0.181 mV/Unit is set as 000.180 and the sixth digit can't be changed, namely, ＋and－key are invalid for these two digits.

TEDS:

To enable the TEDS transducer: if you connect a TEDS accelerometer that supports IEEE P1451.4 protocol, use ← or → key to select "Set" field, then press＋or－key, Model 161 Signal Conditioner will read the transducer sensitivity, set transducer type as "I" and display "√ " behind "Set" field as showed below. Otherwise, "×" will be displayed when failed.



（ a ）

（ b ）

Figure 3-9. Transducer Set-up Window

Store/Recall Set-up

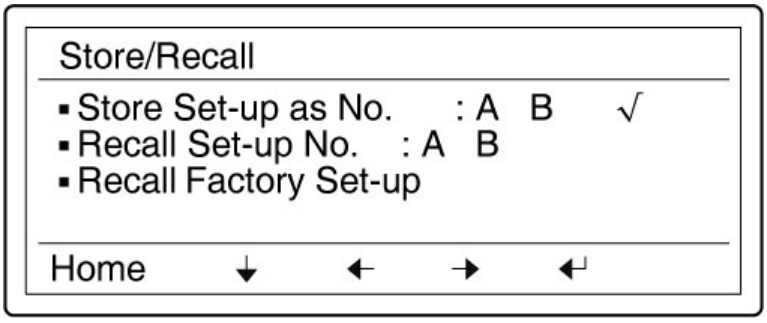


Figure 3-10. Store/Recall Set-up

Store Set-up as No. (A, B):

For saving current parameters of four channels as A or B. First, you should select A or B, then press ↵ key and "√" will appear once when this operation succeeds. Here A and B parameters will not be lost when Signal Conditioner is switched off.

Recall Set-up No. (A, B):
For recalling A or B parameters. The user can retrieve parameters of four channels at once. First, the user need to select A or B, then press ↵ key and "√" will appear once when this operation succeeds.

Recall Factory Set-up:
For restoring the default factory parameters. The user can select this item, then press ↵ key and "√" will appear once when this operation succeeds. All parameters will be changed to the default values as showed below:

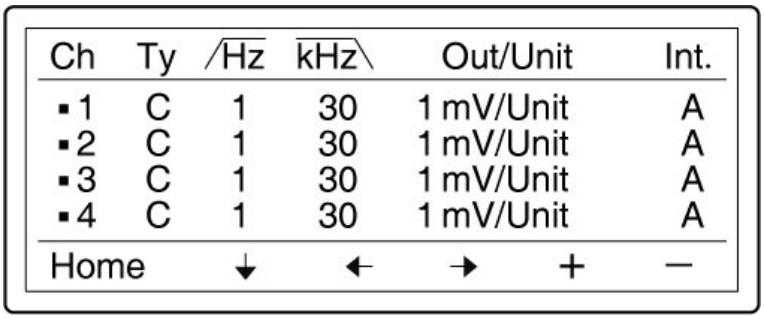


Figure 3-11. Default parameters of Amplifier Set-up

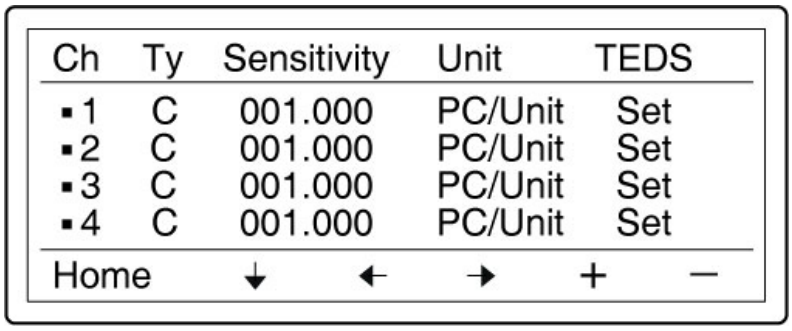


Figure 3-12. Default parameters of Transducer Set-up

Backlight Set-up

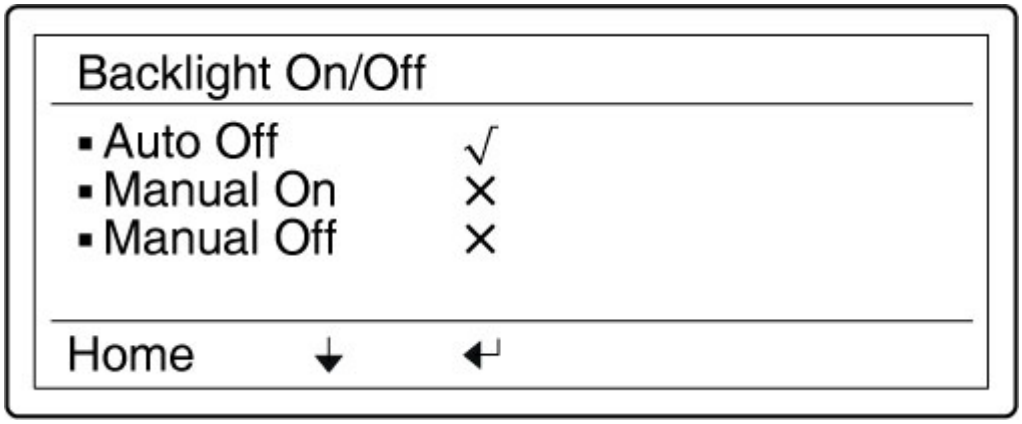


Figure 3-13. Backlight Set-up Window

The Backlight Set-up window is used to modify the backlight mode of the LCD. Three modes are available:
Auto Off mode will be selected when a "√" is displayed on the right. Under this mode, the backlight will switch off and the selected item stops displaying highlighted text after a few

minutes of operation. Pressing any key to turn on backlight and the selected item will resume to high-light text display.

Manual On mode will be selected when a " √ " is displayed on the right. Under this mode, the backlight will be always on and the selected item stops displaying highlighted text after a few minutes of operation. Pressing any key resumes highlighted text.

Manual Off mode will be selected when a " √ " is displayed on the right. Under this mode, the backlight will be off always and the selected item stops displaying highlighted text after a few minutes of operation. Pressing any key resumes highlighted text.

Performance Specifications

INPUT SPECIFICATIONS	
Charge Input	<100,000pC, Single ended, BNC connector
Charge Input Sensitivity Range	0.001pC/unit to 999.0pC/unit (unit: mS^{-2}, g)
Charge, Source Capacitance	<30,000pF
Charge, Source Resistance	>10 Megohms
IEPE Input	<22 Volts (AC+DC components), Single ended, BNC connector
IEPE Input Sensitivity Range	0.01mV/unit to 999.0mV/unit (unit: mS^{-2}, g)
IEPE Current Excitation	4mA
IEPE Compliance Voltage	24 Volts
IEPE Input Impedance	100 Megohms, 30,000pF
OUTPUT SPECIFICATIONS	
AC Voltage	Single ended (referenced to signal ground), short circuit protected, BNC connector
Output Impedance	<100 Ohms

Output Current	35mA max
Linear Output	±10Vpeak
DC Offset	20mV max (10Hz – 100KHz, 10V/unit)
TRANSFER CHARACTERISTICS	
Output Sensitivity Range	Charge: 100µ, 316µ, 1m, 3.16m, 10m, 31.6m, 100m, 316m, 1, 3.16, 10(V/unit)
	IEPE: 100µ, 316µ, 1m, 3.16m, 10m, 31.6m, 100m, 316m, 1(V/unit)
Accuracy	±0.5% of full scale (max), at 1kHz, filters disabled, gain >1
Linearity	±0.1% of full scale, best fit straight line at 1kHz reference
Noise	Measurement Condition: Internal 10KHz lowpass filter is enabled. Charge: 0.062 pC-RMS plus 0.004 pC-RMS per 1000pF of source capacitance referred to input. IEPE: 110uVRMS referred to input. Input shunted with a 249 ohm resistor.
Frequency Response	0.1 Hz to 100 kHz (full power bandwidth), -3db referenced to 1kHz
Low-pass Filter (-3dB)	100Hz, 1kHz, 3kHz, 10kHz, 30kHz, 100kHz
High-pass Filter (-3dB)	0.1Hz, 1Hz, 3Hz, 10Hz
Crosstalk Between Channels	100 db RTI
POWER REQUIREMENTS	
Voltage	18-24VDC from supplier power adaptor
Power dissipation	12W typical
PHYSICAL CHARACTERISTICS	
Weight (w/o power cord)	6.28lbs (2.85kg)
Case Material	Anodized aluminum

Chapter 5 Examples

Acceleration Measurement

Here, channel 1 is used as the measurement channel, set up the output sensitivity according to the measurement requirement. Generally, the voltage of the accelerometer output signal shouldn't be less than 0.05V (peak value).

Example 5-1-1:

The transducer sensitivity of a charge accelerometer is 52.6 pC/g and frequency range is 1Hz to 10000Hz.

On Amplifier Set-up window, the user should set Transducer Type as "C", High-pass Filter as "0.1", Low-pass Filter as "30", Output Sensitivity as "100mV/Unit" and Output Signal Type as "A". On Transducer Set-up window, the user should set the transducer sensitivity as "052.600" pC/Unit.

If the output voltage is 0.13Vrms, then the acceleration value is:

A = 130mVRMS / (100mV/g) = $1.3g_{RMS}$

Example 5-1-2:

The transducer sensitivity of an IEPE accelerometer is 9.506mV/mS^{-2} and frequency range is 1Hz to 5000Hz.

On Amplifier Set-up window, the user should set Transducer Type as "I", High-pass Filter as "0.1", Low-pass Filter as "30", Output Sensitivity as "100mV/Unit" and Output Signal Type as "A". On Transducer Set-up window, the user should set the transducer sensitivity as "009.510" mV/Unit.

If the output voltage is 0.674Vrms, then the acceleration value is:

A = 674mVRMS / (100mV/ms^{-2}) = $6.74mS_{RMS}^{-2}$

Velocity Measurement

Example 5-2-1:

The transducer sensitivity of charge accelerometer is 1500 pC/g and frequency range is 1Hz to 5000Hz.

On Amplifier Set-up window, the user should set Transducer Type as "C", High-pass Filter as "0.1", Low-pass Filter as "30", Output Sensitivity as "316mV/Unit" and Output Signal Type as "A".

On Transducer Set-up window, first, the user should change the sensitivity in unit of mS^{-2}: 1500pC/g = 152.96pC/mS^{-2}(1g=9.8665mS^{-2}), then set the transducer sensitivity as "153.000" pC/Unit.

When the measurement frequency is 100Hz, the user should change Output Signal Type as "V1" on Amplifier Set-up window.

If the output voltage is 0.073Vrms, then the velocity value is:

V=73mVRMS / (316mV/0.01mS-1) = $0.23cmS_{rms}^{-1}$

Displacement Measurement

Example 5-3-1:

Use the same transducer and set all related parameters as Example 5-2-1.

When the measurement frequency is 100Hz, the user should change Output Signal Type as "D1" and change the Output Sensitivity as "100mV/Unit" on Amplifier Set-up window.

If the output voltage is 0.518Vrms, then the displacement value is:

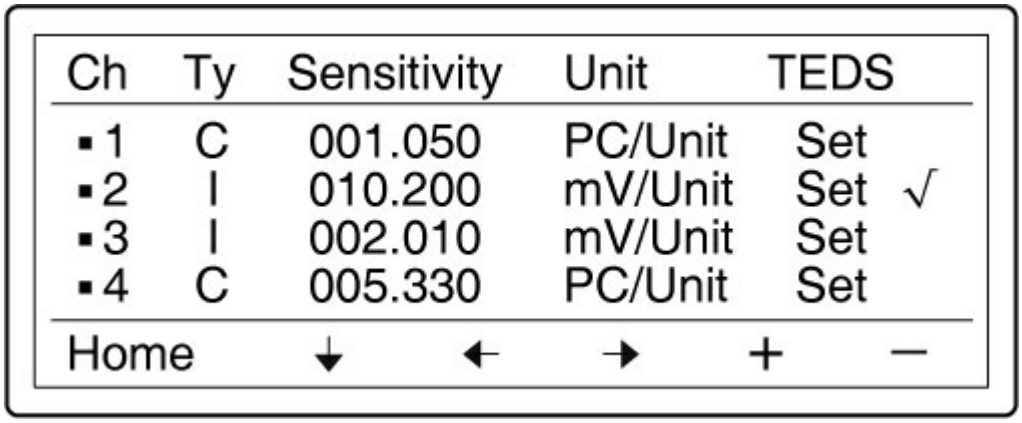
D=518mV/ (100mV/0.1mm)=0.518mm (peak value)

TEDS Transducer Setup

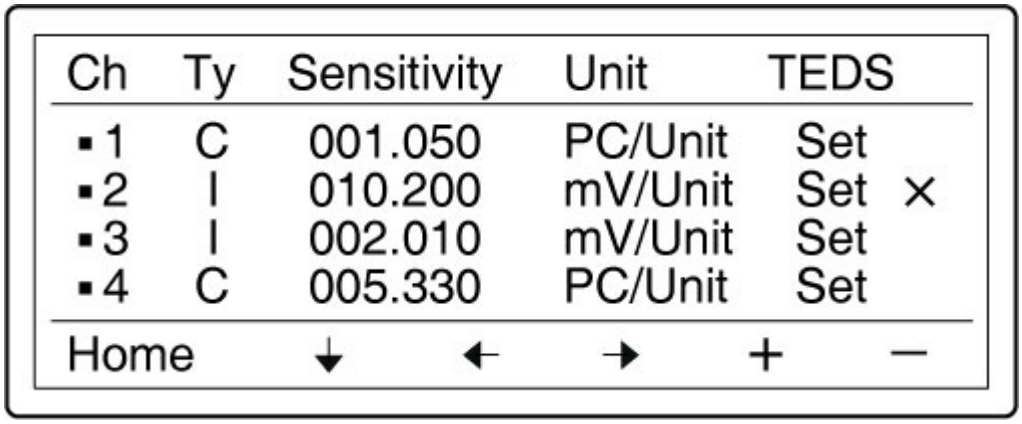
Example 5-4-1:

Model 161 Signal Conditioner is available for TEDS accelerometer that supports IEEE P1451.4 protocol. Here is a TEDS accelerometer with sensitivity of 10.2 mV/mS-2 and frequency range of 1Hz to 5000Hz is used as an example.

First connect the transducer to amplifier and select the Transducer Set-up window. Use ← or → key to select "Set" field, then press＋or－key, Model 161 Signal Conditioner will read the transducer sensitivity, set transducer type as "I" and display "√ " behind "Set" field as showed in Figure 5-1 (a). Otherwise, "×" will be displayed when failed as shown in Figure 5-1 (b).



（ a ）



（ b ）

Figure 5-1. TEDS Set-up Window