IMI SENSORS
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Model 649A01

Loop Powered 4-20 mA Output Reciprocating Machinery Protector (RMP)

Installation and Operating Manual

For assistance with the operation of this product,

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SENSORS AND INSTRUMENTATION FOR MACHINE CONDITION MONITORING

(EX)649AX1-Series Reciprocating Machinery Protector (RMP)

Operating Guide with Enclosed Warranty Information

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Introduction

Reciprocating compressors can develop devastating faults in a short period of time. Mechanical looseness can deteriorate quickly resulting in catastrophic failure of the compressor. In extreme cases, this can happen in a matter of minutes.

Causes of mechanical looseness include:

- Loose or broken bolts
- Loose or cracked rod nuts
- Cracked connecting or piston rod
- Excessive crosshead/slipper clearance
- Excessive clearance in connecting pins

Many of the serious faults associated with reciprocating compressors are characterized by impacting in the compressor. While the peak vibration levels associated with impacting are quite high, they add little energy to the overall vibration level that is usually monitored and trended, thereby allowing the faults to be missed. Additionally, since the time from fault to failure of compressors can be short, periodic monitoring is not generally a good option.

The Reciprocating Machinery Protector (RMP) is a patented smart vibration transmitter that detects impacts and outputs a Reciprocating Fault Index (RFI) signal that indicates the health of the compressor. Using a built-in accelerometer and microprocessor, the RMP detects, weights and quantifies the measured impacts and outputs a 4-20 mA signal proportional to the result. This data can be logged and trended to provide a historical view of condition.

The RMP accommodates two vibration threshold levels and allows different weighting for each, typically with the weighting associated with Threshold 2 being higher as those impacts are more severe. It also allows for peak acceleration trending when measured levels are below either threshold. Traditional impact transmitters essentially only count vibration peaks and therefore often result in missed faults or false trips. Using the multiple thresholds and acceleration trending features, the RMP avoids these problems and outperforms traditional impact transmitters.

Every RMP is factory-programmed. See Page 16 for more information.

The parameters can be field-programmed using an optional USB Programming Kit, as shown on page 8. With the USB Programming Kit, the unit can set in one of two ways:

- Dependent Mode: All parameters automatically calculated based on specified machine speed (RPM).
- Independent Mode: All parameters programmed by the user to tailor the analysis to a particular machine.

The RMP is loop-powered and compatible with most plant monitoring systems such as PLC, DCS, SCADA and Plant Information (PI) systems. When used in conjunction with one of these systems, the RMP provides 24/7 monitoring and protection of critical compressors.

General Features

- USB-programmable (with optional USB Programming Kit as shown on page 6)
- Interfaces with PLC, DCS, SCDA, and other PI systems
- Hermetically-sealed, stainless steel housing for use in harsh environments
- Imbedded piezoelectric accelerometer
- Loop-powered
- 4-20 mA output
- Two vibration threshold levels
- Small footprint, mounts like a sensor
- Programmable features
    - RPM
    - Time window
    - Vibration threshold levels
    - Weighting factors
    - Trending range
- Intrinsically safe versions available (EX prefix)
    - CSA
    - ATEX

Operating Principles

The RMP is a smart vibration transmitter that contains a piezoelectric accelerometer, high speed true peak detector, and a microprocessor. It operates off standard 24 volt loop power and outputs a 4-20 mA signal that is proportional to the Reciprocating Fault Index (RFI). The RFI is a "hybrid" index as defined below.

The RMP looks at data for a period of time equal to the length of the specified Time Window (TW). It detects each peak value (A_P) occurring in the window and compares it against Threshold Level 1 (N_1) and Threshold level 2 (N_2). If none of the peaks exceed Threshold Level 1 or Threshold Level 2, the RMP outputs a $4 - I_L$ mA signal proportional to the maximum peak value seen in the Time Window.

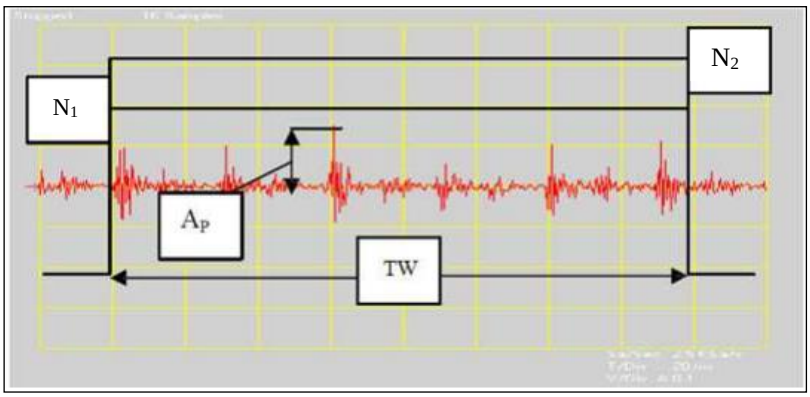


Figure 1 – Vibration Peaks Do Not Exceed Threshold Levels

If at least one peak exceeds Threshold Level 1(N_1) or Threshold Level 2 (N_2), the RMP outputs $I_L - 20$ mA that is proportional to the calculated Reciprocating Fault Index (RFI).

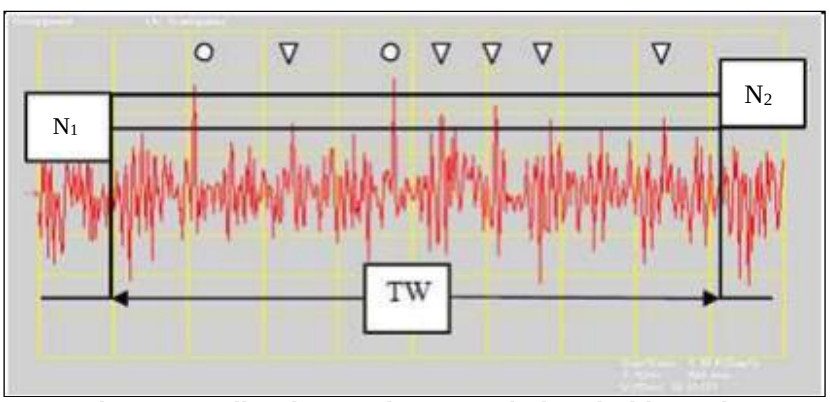


Figure 2 – Vibration Peaks Exceed Threshold Levels

The RFI is computed by:

- Counting the number of peaks that exceed Threshold Level 1 (N_1) and applying Weighting 1 (W_1) to them.
- Counting the number of peaks that exceed Threshold Level 2 (N_2) and applying Weighting 2 (W_2) to them.
- Adding them together along with the maximum value of the trending range current (I_L).

$$I_{OUT} = I_L + W_1 N_1 + W_2 N_2$$

Installation

For full equipment protection, one RMP is typically mounted on each compressor cylinder. The RMP is generally mounted to the crosshead or crosshead slipper (distance piece) with its sensing axis perpendicular to piston rod motion. If the compressor does not have a crosshead, it should be mounted to the crankshaft side of the cylinder.

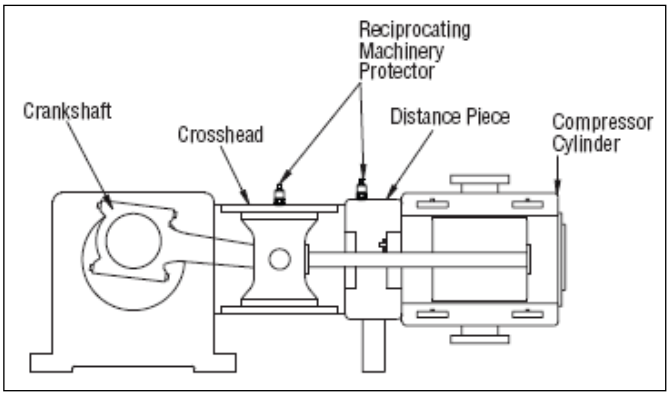


Figure 3 – Recommended Mounting Locations for the Reciprocating Machinery Protector

When choosing a mounting method, consider closely the advantages and disadvantages of each technique. Typical mounting types are stud, direct adhesive, adhesive mounting base and magnetic mounting base. It is highly recommended that the RMP be stud-mounted to the machine. If it is not possible to drill and tap the machine, then epoxy or weld a sensor mounting pad to the machine and stud mount the sensor to the pad. Most RMP models mount using a supplied ¼-28 stud. Some models mount with an integral ¼" NPT stud. It is not recommended to use a magnet for mounting. Magnetic mounting can cause false impacts and result in shutting down a good machine.

For additional information on ¼-28 mounting pads, visit www.pcb.com and type mounting pad into the search box or call IMI for assistance.

Standard Stud Mount Procedure

This mounting technique requires smooth, flat contact surfaces for proper operation and is recommended for permanent and/or secure installations. Stud mounting is also recommended when testing at high frequencies. Note: Do not attempt mounting on curved, rough or uneven surfaces, as the potential for misalignment and limited contact surface may significantly reduce the sensor's upper operating frequency range.

	¼-28 Stud	**¼-28 Captive Screw**
A (in)	0.250	0.250
B (in)	0.350	0.350
Torque (ft-lb)	2 to 5	2 to 5

- Step 1: First, prepare a smooth, flat mounting surface and then drill and tap a mounting hole in the center of this area. A precision-machined mounting surface with a minimum finish of 63 µin (0.0016 mm) is recommended. (If it is not possible to properly prepare the machine surface, consider using an adhesive mounting pad as a possible alternative.) Inspect the area, checking that there are no burrs or other foreign particles interfering with the contact surface.
- Step 2: Wipe clean the mounting surface and spread on a light film of grease, oil or similar coupling fluid prior to installation. Adding a coupling fluid improves vibration transmissibility by filling small voids in the mounting surface and increasing the mounting stiffness. For semi-permanent mounting, substitute epoxy or another type of adhesive.

- Step 3: Hand-tighten the sensor/mounting stud to the machine, and then secure the sensor with a torque wrench to the mounting surface by applying the recommended mounting torque (see enclosed specification data sheet for proper mounting torque). It is important to use a torque wrench during this step. Under-torqueing the sensor may not adequately couple the device; over-torqueing may result in stud failure and possibly permanent damage.

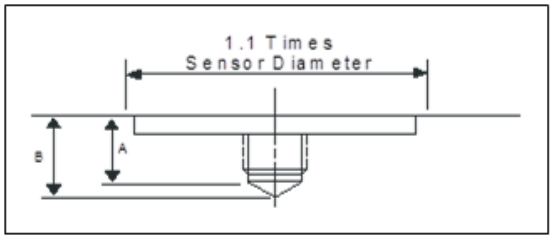


Figure 4 – Mounting Surface Preparation

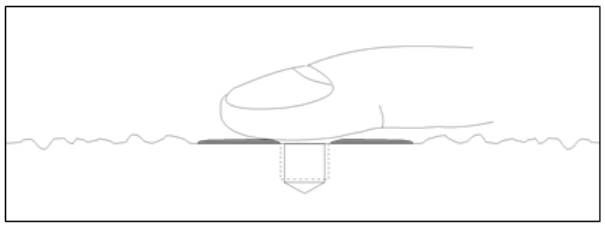


Figure 5 – Mounting Surface Lubrication

Adhesive Stud Mount Procedure

Adhesive mounting is often used for temporary installation or when the machine surface cannot be adequately prepared for stud mounting. Adhesives like hot glue or wax work well for temporary mounts; two-part epoxies and quick-bonding gels provide a more permanent mount.

Note: Adhesively mounted sensors often exhibit a reduction in high-frequency range. Generally, smooth surfaces and stiff adhesives provide the best frequency response. Contact the factory for recommended epoxies.

This method involves attaching a base to the machine surface, then securing the sensor to the base. This allows for easy removal of the accelerometer.

- Step 1: Prepare a smooth, flat mounting surface. A minimum surface finish of 63 µin (0.0016 mm) generally works best.
- Step 2: Stud-mount the sensor to the appropriate adhesive mounting base according to the guidelines set forth in Steps 2 and 3 of the Standard Stud Mount Procedure.
- Step 3: Place a small portion of adhesive on the underside of the mounting base. Firmly press down on the assembly to displace any extra adhesive remaining under the base.

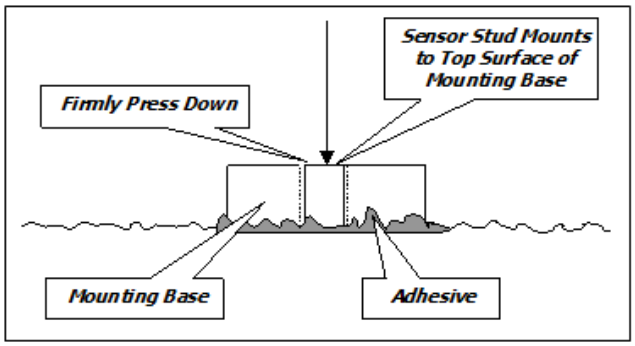


Figure 6 – Adhesive Installation of Mounting Base

Wiring

The RMP operates from a standard 2-wire, 4-20mA loop. If using a loop-powered unit, attach the positive (+) input from the power supply to Pin A on the sensor and the negative (-) input from the power supply to Pin B of the sensor.

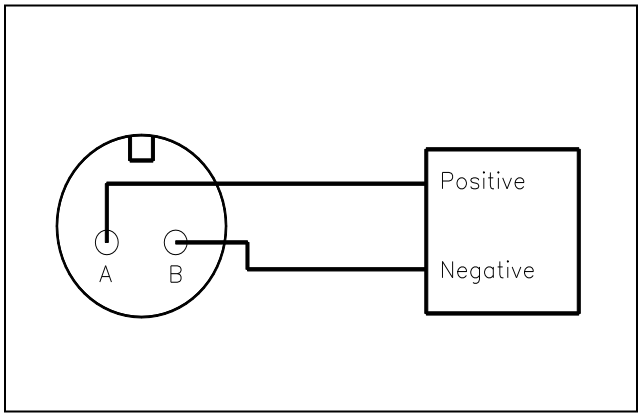


Figure 7– Loop-Powered Wiring

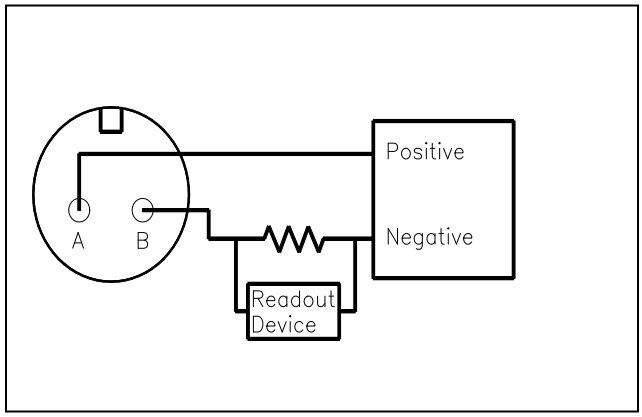


Figure 8 – Loop-Powered Wiring with DC Source

If using a standard DC power supply, install either an ammeter and/or load resistor in line with the output.

The resistor will generate a DC voltage that is proportional to current by:

$$V = IR$$

$$If\ R = 500\ ohms\ and\ I = 6\ mA, then\ V = 3\ VDC$$

Note:

- Resistor value must be less than: (Vsupply – 12) x 50.
- For integral cable sensors: RED wire is positive, BLUE wire is negative.

Programming Software

The RMP can be user-programmed with either of two optional programming kits, Model 600A21 (non-ROHS compliant) or Model 600A35 (ROHS compliant). Both kits include a USB programmer cable/dongle (Model 600A21 kit includes Model 070A89 cable; Model 600A35 kit includes Model 070A103 cable), software (Model EE225) and terminal block/integral cable adapter (Model 042M17). The software can also be downloaded from IMI's website, www.pcb.com. This software must be installed prior to connecting the RMP to the computer using the USB programmer cable. The software includes both the drivers and user interface needed for programming the RMP. During initial installation, you may need administrative rights for the computer in order to install the drivers. Once installed, administrative rights are not required for use.

Figure 9 – Model 600A21/600A35 USB Programmer Kit

Program Installation

Installing the Software and USB Driver: Insert the software CD provided into the CD drive. The software will start the installation automatically if your PC is set to auto-install applications. If not, browse the CD and click on Setup.exe to start the installation process. The default installation directory is C:\PCB\EE225. It is recommended to use the default setting.

The installer will first install the software and then the WinUSB device driver. This device driver is required for the programmer software to communicate with the 070A89 or 070A103 USB programmer cable.

The following screens will be displayed when the installer starts. Click the Next button to proceed from step to step.

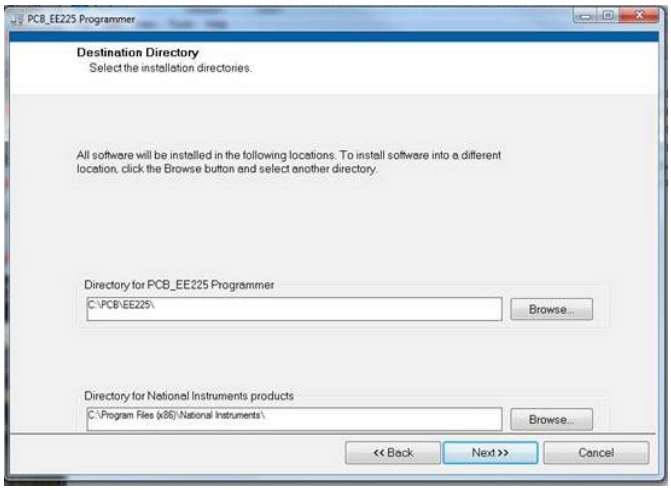


Figure 10 – Install Location Screen

Figure 11 – National Instruments Software License Agreement

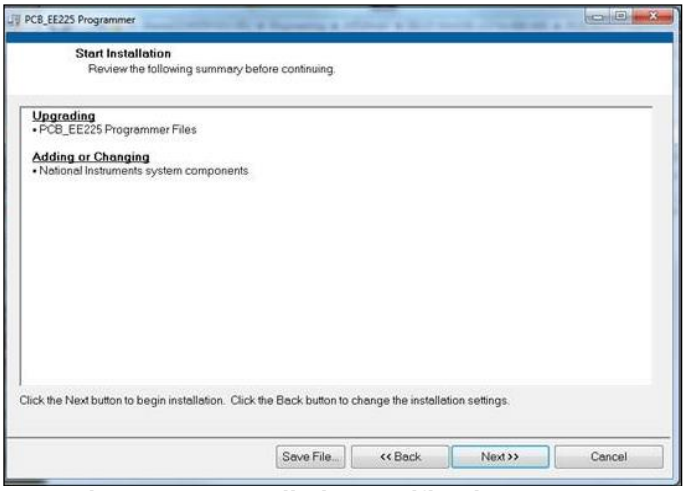


Figure 12 – Installation Verification Screen

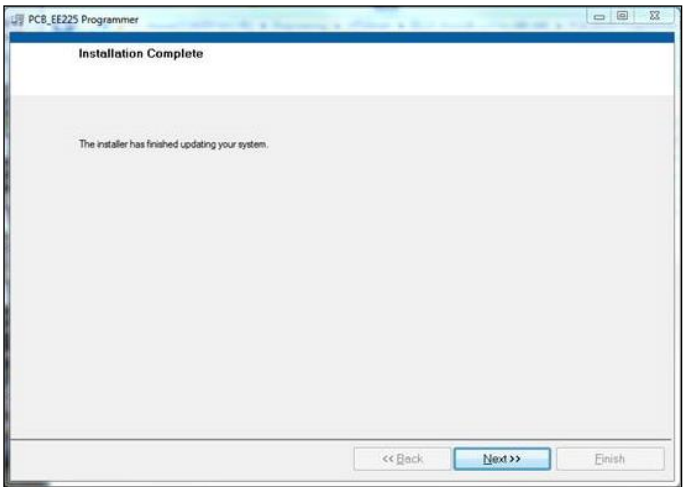


Figure 13 – Installation Complete Screen

After the software completes, the USB driver installer will start automatically. The initial USB installer will look similar to the one below.

Figure 14 – WinUSB Driver Installation Screen

The drivers will now be properly installed and you should get the following screen. Click “Finish”. The software is now ready to use.

Figure 15 – WinUSB Driver Installation Complete Screen

Running the Software

Connect the USB programmer cable to a USB port on the PC and then run the software from the Start | All Programs | PCB EE225 menu item

Initially the screen will appear as in **Error! Reference source not found.** with a yellow bar and status indicating 'Initializing…' followed by the message: "Connecting to USB Dongle…".

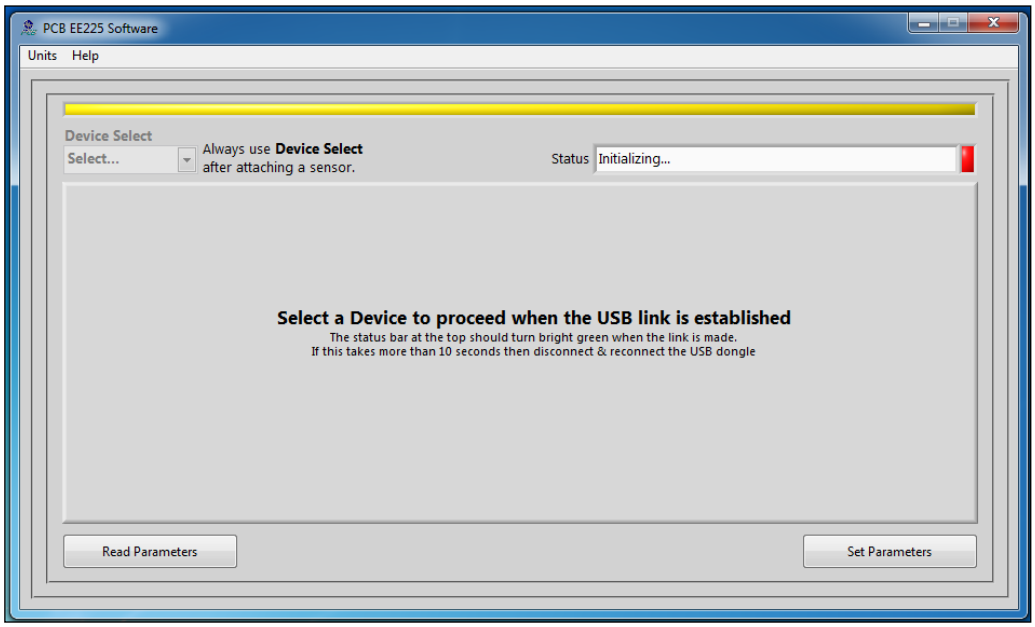


Figure 16 – Software While Connecting to USB Programmer Cable

Once the connection is made the bar at the top of the screen will turn green and the status will indicate "USB Connection Success - Select a device". If the software and USB programmer cable fail to connect, remove and reinsert the USB programmer cable.

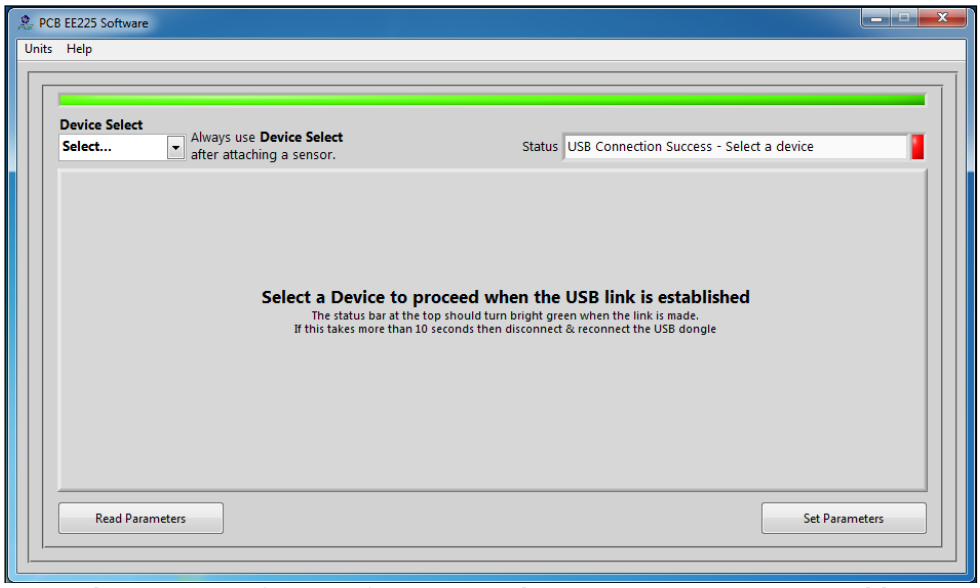


Figure 17 – Software After Connecting to USB Programmer Cable

To select a device, click on the Device Select pull down menu and select the device you'd like to program. In this case, select 649A01.

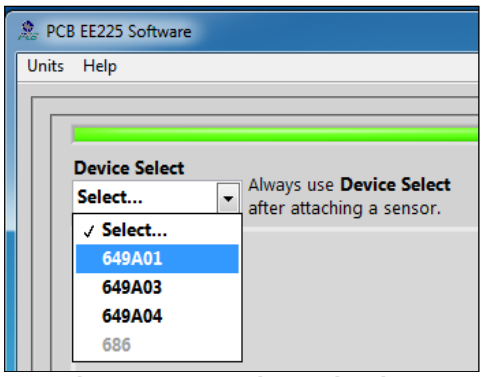


Figure 18 – Device Selection

Once a product is selected, the software will prompt you to confirm connection of the sensor to the PC using the USB programmer cable. Click OK to proceed.

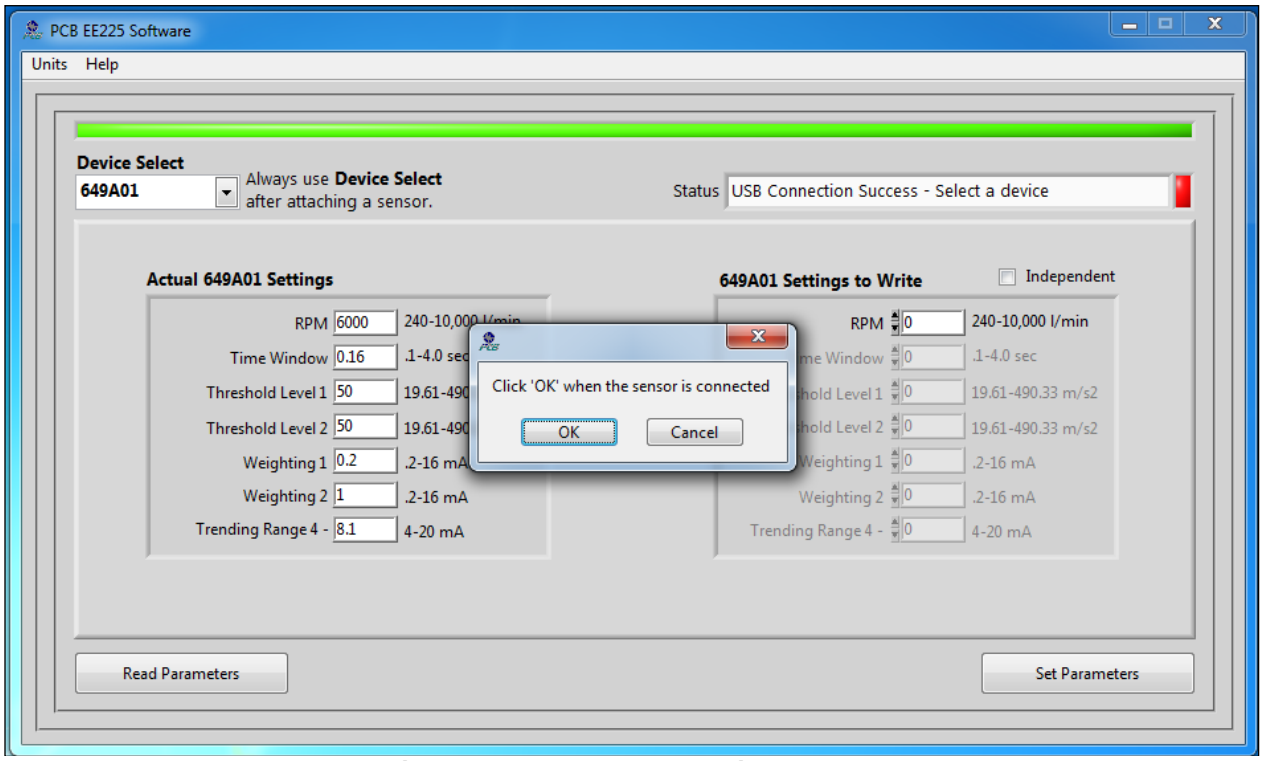


Figure 19 – Sensor Connection Screen

While the software is establishing communication with the sensor, the status will display 'Checking Status…' and the colored indicator box next to the status will alternate between red and yellow. This will take approximately 15 seconds. Once communication is established, the indicator box will turn green and the software will read the sensor's current settings and data. The fields presented in the main body of the screen will be specific to the selected sensor.

Programming Sections

The screen has two sections:

- Actual 649A01 Settings – This section shows the settings currently programed in the sensor.
- 649A01 Settings to Write – This section shows the options for programming the sensor.

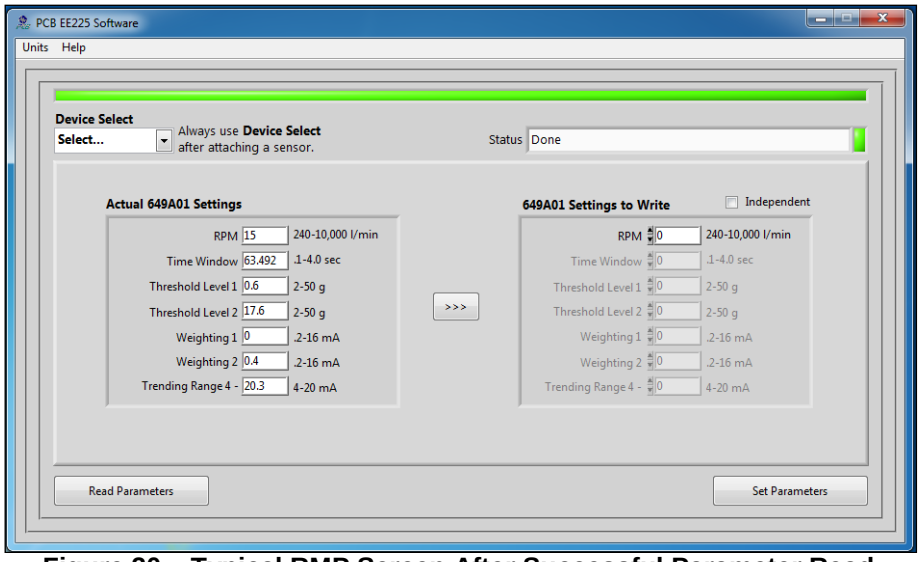


Figure 20 – Typical RMP Screen After Successful Parameter Read

Reading and Writing Parameters

- Reading Parameters - To read the current sensor settings, click the Read Parameters button. This operation takes approximately 45 seconds to complete.
- Transferring Actual Settings to Settings to Write Field - Use the '>>>' button to transfer all Actual Settings to the Settings to Write fields.
- Writing Parameters- Select the appropriate mode and enter any pertinent parameter information. Click the Set Parameters button. This causes the settings to be sent to the sensor and then read back and displayed in the Actual 649A01 Settings.

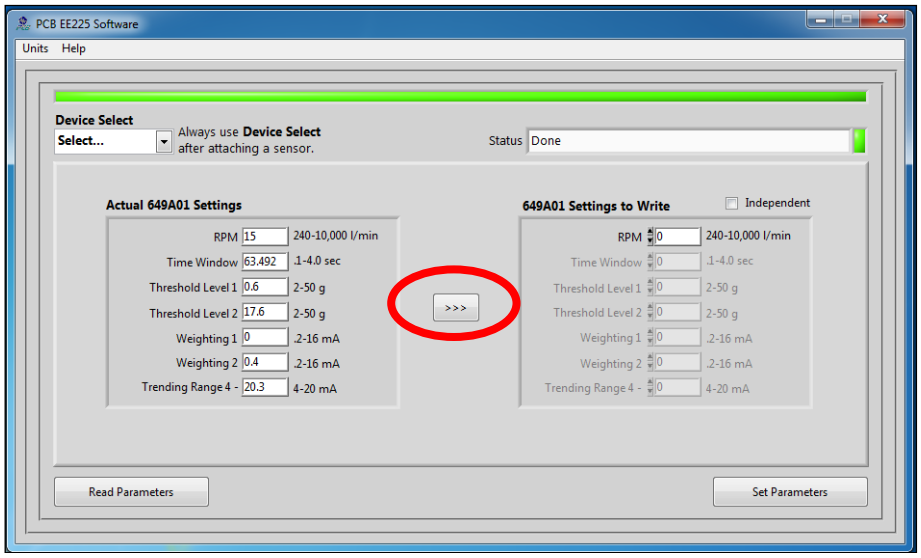


Figure 21 – Transferring Actual Settings to Settings to Write Field

Parameter Options

There are seven parameters (Figure 14) that can be programmed to optimize performance of the RMP. At any point during the programming process, the values can be changed between imperial and metric measurements by clicking the Units dropdown in the top navigation menu and then selecting the appropriate measurement type.

- **Dependent Mode** – If the Independent Mode checkbox is NOT selected, then the parameters will be based on Dependent Mode. When Dependent Mode is used, the user only needs enter the compressor RPM. The remaining six parameters (Time Window, Threshold Level 1, Threshold Level 2, Weighting 1, Weighting 2 and Trending Range) will be automatically calculated based on the compressor rotational speed. Calculation formulas are in table below. The formulas used assume use on reciprocating gas compressor. If RMP is being used on a piston pump or some other type of reciprocating machinery, see the section titled "Using the RMP with Piston Pumps Other Type of Reciprocating Machinery".
- **Independent Mode** – If the Independent Mode checkbox is selected, then the parameters will be based on Independent Mode. When Independent Mode is used the user does NOT enter the RMP of the compressor and instead manually enters values for the Time Window, Threshold Level 1, Threshold Level 2, Weighting 1, Weighting 2 and Trending Range parameters. Value entered for each parameter must be within the software's acceptable range for that parameter. Acceptable ranges are in table below as well as some guidelines for Independent Mode programming.

Parameter	Description	Dependent Mode	Independent Mode	
		Range or Formula	Acceptable Range	Guidelines for Typical Values
RPM	Rotational speed of equipment	240 - 10,000	N/A	N/A
Time Window	Time span (in seconds) during which data is collected for an analysis cycle; based on number of rotations of the shaft.	TW = (60 / RPM) x 16	0.1-4.0 sec	Time span for 12-16 shaft rotations
Threshold Level 1	Cutoff levels (in g of acceleration) above which impacts are counted and weighted. When all vibration is below Threshold Level 1, sensor monitors peak acceleration within trending range.	A_L = RPM / 80	2-50 g 19.61-490.33 m/s^2	2-4 times of baseline acceleration
Threshold Level 2		A_H = RPM / 50	2-50 g 19.61-490.33 m/s^2	1.5-1.6 times of Threshold Level 1
Weighting 1	Factor (in mA of current) applied to impacts that exceed Threshold Level 1.	W_L = 0.1 + (100 / RPM)	0.2-16.0 mA (0.2 mA increments)	Less than Weighting 2 value
Weighting 2	Factor (in mA of current) applied to impacts that exceed Threshold Level 2.	W_H = 0.9 - (100 / RPM)	0.2-16.0 mA (0.2 mA increments)	Greater than Weighting 1 value
Trending Range	Maximum value (in mA of current) dedicated to trending peak acceleration when all impacts are below either threshold level. If impacts exceed either threshold level, trending range current maxes out.	I_L = 8 + (6 x (100/RPM))	4-20 mA	If set at 20 mA, RMP will operate like vibration transmitter.

Examples

Example 1: Connect the RMP to computer with the USB programmer cable. Run the program. Be sure the Independent box is NOT checked and type 780 in the RPM box. Note that all of the other parameters are set automatically. Click Set Parameters to program the RMP with these settings. The RMP will be programmed, the status read, and the screen in Figure 19 displayed.

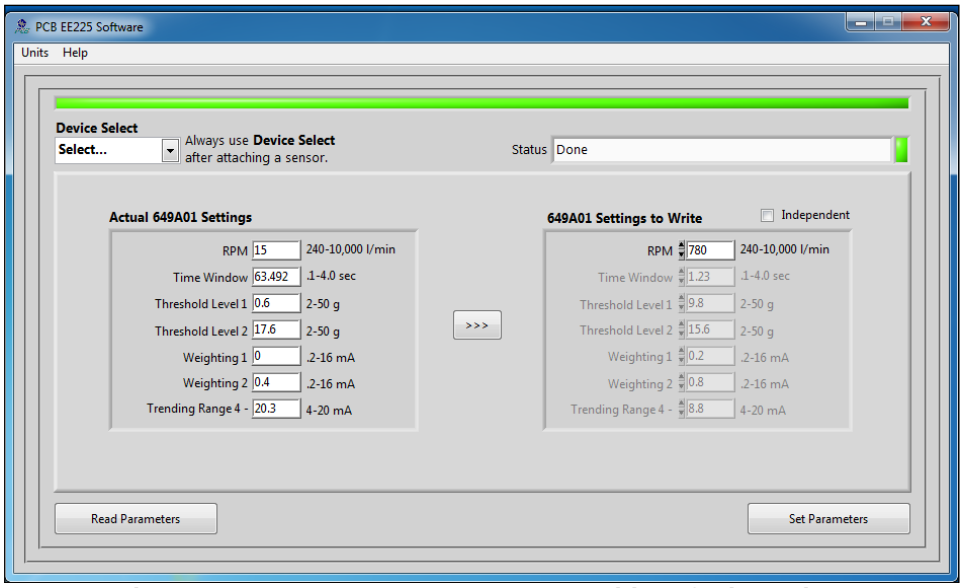


Figure 22 – RMP Programmer Screen with Default Setting

Example 2: Connect the RMP to computer with the USB programmer cable. Run the program. Check the Independent box. Note that the RPM field disappears. Type in the following values: Time Window = 1.2, Threshold Level 1 = 5, Threshold Level 2 = 7, Weighting 1 = 0.6, Weighting 2 = 0.8, and Trending Range = 10. Click Setup to program the RMP with these settings. The RMP will be programmed with the custom setting, the status read, and the screen in Figure 20 below displayed.

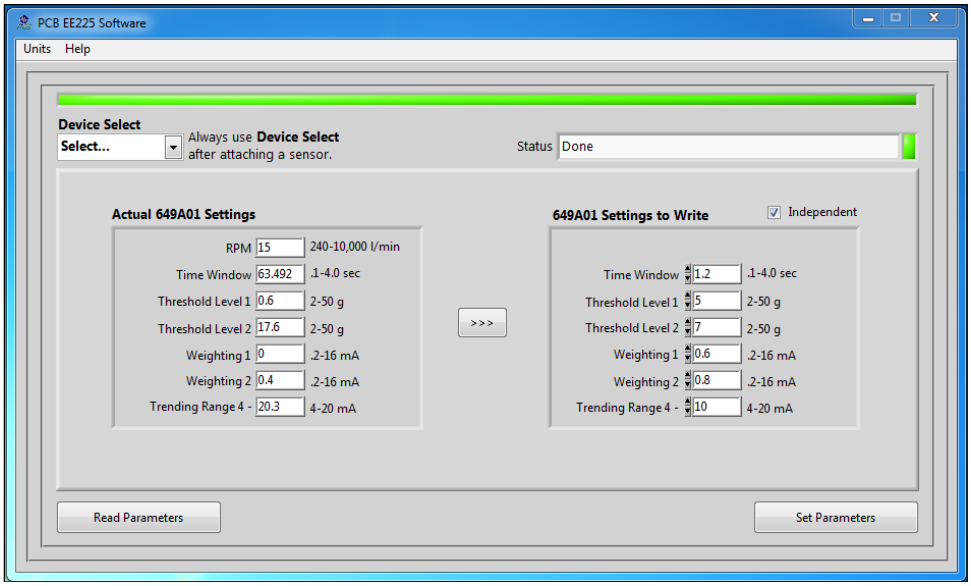


Figure 23 – RMP Programmer Screen with Independent Settings

Determine Baseline Vibration using the RMP

When impacts occur in a machine, peak acceleration rises well above the vibration baseline. The default shock threshold values (Threshold Level 1 & Threshold Level 2) that are automatically inserted in the Programmer Screen based on the specified RPM assume a typical gas compressor with the sensor mounted as recommended in this manual. For some machine types and measurement locations, the default values for Threshold Level 1 and Threshold Level 2 may need to be adjusted. This would be the case if the machinery type or selected measurement location has a higher base vibration than normal.

If you want to measure the baseline peak vibration and do not have appropriate vibration analysis equipment, it can be done using the RMP. To determine the baseline level using the RMP, install the RMP programmed with the following settings and measure the output in mA. This can be done using the same system that will be used for monitoring the RMP.

Threshold Level 1 = 8 g (or 16 g)
Trending Range = 20 mA

Since the RMP outputs a 4-20 mA signal proportional to peak acceleration, 4 mA is zero and each mA over the 4 mA is equal to 0.5g (or 1g) of peak vibration. Example, if Threshold Level 1 is set to 8 g, the Trending Range to 20 mA, and the reading is 12.7 mA, then the actual peak vibration level is (12.7 – 4) x 0.5 = 4.35 g. For more details see “Using the RMP with Piston Pumps Other Types of Reciprocating Machinery”.

Usage with Gas Compressors

Unless otherwise specified, the RMP comes from the factory with default settings for a 1200 RPM reciprocating gas compressor.

- RPM: 1200 RPM
- Time Window: 0.8 sec
- Threshold Level 1: 15 g
- Threshold Level 2: 24 g
- Weighting 1: 0.2 mA
- Weighting 2: 0.8 mA
- Trending Range: 8.5 mA

When field programming a unit in Dependent mode, the default parameters that are automatically inserted in Programmer Screen based on the RPM entry are intended for use with reciprocating gas compressors. If you are using the RMP with a piston pump or any other type of reciprocating machinery, see the section in this manual titled “Using the RMP with Piston Pumps Other Types of Reciprocating Machinery”.

Usage with Piston Pumps and Other Types of Reciprocating Machinery

Although the RMP software has the ability to calculate suggested parameters based on rotational speed for gas compressors, these values may not be appropriate for use when monitoring piston pumps and other types of reciprocating machinery. Due to the nature of their operation, other mechanisms contribute to the maximum acceleration levels seen during normal pump operation. Therefore, it is important to determine what levels exist during normal operation before configuring the software. The following procedure will allow you use the RMP to measure the highest acceleration level occurring during normal operation. Based on this measurement, the RMP parameters can be calculated.

This procedure sets the parameters in the RMP such that 1 mA of incremental output equals 1 g of incremental vibration (i.e., 4 mA = 0 and 20 mA = 16 g pk). The Trending Range is set to 20 mA, which disables the alarm threshold feature of the unit; and thus outputs only the peak acceleration value. Follow these steps to properly set up the unit for this reading.

1. Connect the RMP to the computer using the USB Programmer and run the RMP software.

2. Check the Independent box at the top of the screen. This allows manual configuration of the parameters.

3. Type the following values into the appropriate boxes on the Programmer Screen. When these values have been entered, click the Setup button to download the configuration to the RMP.
   a. Time Window: 1 s
   b. Threshold Level 1: 16 g
   c. Threshold Level 2: 20 g
   d. Weighting 1: 0.2 mA
   e. Weighting 2: 0.8 mA
   f. Trending Range: 20 mA

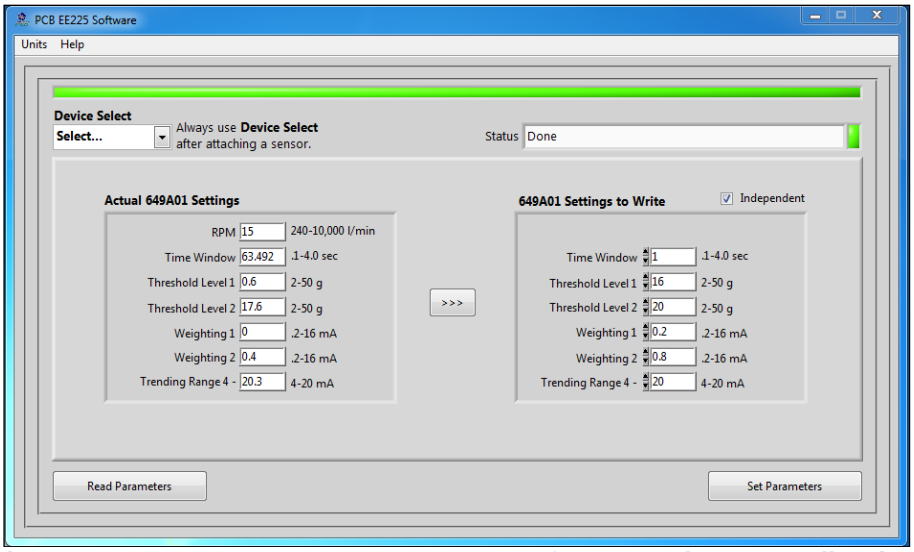


Figure 24 – RMP Programmer Screen Setup for Measuring Base Vibration

4. Disconnect the RMP from the computer and mount it on the pump. Wire it into a PLC or other 4-20 mA compatible system. Optionally, it can be used with a 4-20 mA loop calibrator such as the IMI Model 699A05. Record the output of the RMP in mA. Subtract 4 from that value to get the peak baseline acceleration. For example, if 10 mA is displayed, the peak level is 10 – 4 = 6 g.

5. Based on the peak acceleration level determined in step 4, the RMP can now be programmed appropriately. Disconnect the RMP from the 4-20 mA compatible device, reconnect it to the computer and

run the RMP Software. Use the following guideline to calculate Threshold Level 1 and Threshold Level 2 values.

a. If the peak acceleration value measured in step 4 is less than or equal to 10 g, multiply it by 3 and set the Threshold Level 1 equal to it. Then, multiply the Threshold Level 1 value by 1.6 and set the Threshold Level 2 value equal to it. For example, if the measured peak acceleration in step 4 is 6 g, set Threshold Level 1 to 18 g and Threshold 2 to 28.8 g.
b. If the peak acceleration value determined in step 4 is greater than 10 g, set Threshold Level 1 to 30 g and Threshold Level 2 to 50 g.
c. Set the remaining parameters as follows.
    i. If the peak acceleration value measured in step 4 is less than or equal to 10 g, use the default values that are set automatically by the program based on machine RPM.
    ii. If the peak acceleration value determined in step 4 is greater than 10 g, use the following parameters
        1. Time Window: 1 s
        2. Weighting 1: 0.5 mA
        3. Weighting 2: 0.5 mA
        4. Trending Range 10 mA

6. Using the example of 6 g peak acceleration from step 4, enter the parameters in the Programmer Screen, and click Setup to program the RMP. The following Programmer Screen should be displayed.

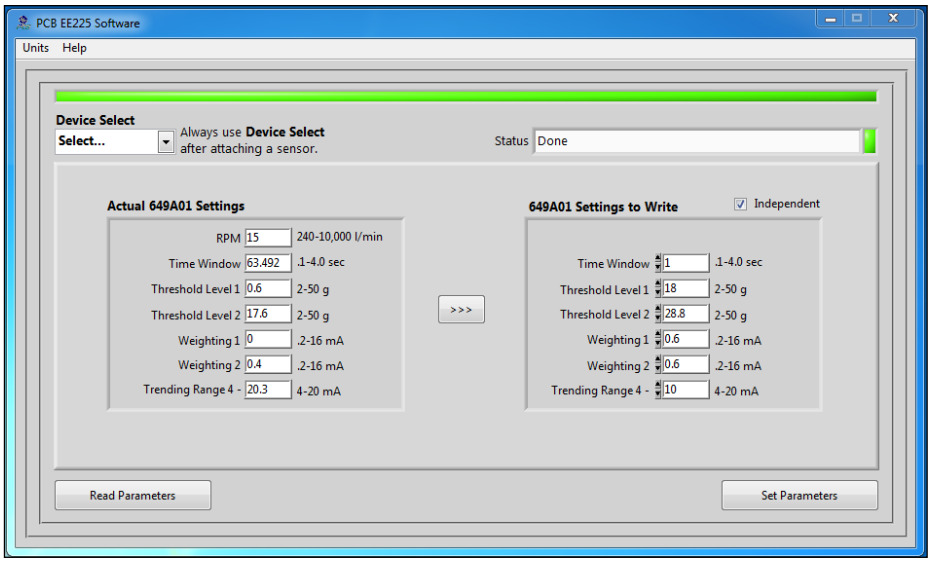


Figure 25 – RMP Programmer Screen for 6 g Peak Acceleration on a Piston Pump

Portable 4-20 mA Loop Calibrator

The loop calibrator (Model 699A05) provides 24V loop power and displays the transmitters electrical current output. This can be used with the sensor for measuring the baseline peak acceleration as described in “Determine Baseline Vibration using the RMP” on page 16. Visit www.pcb.com for more information on the loop calibrator.

Figure 26 – Loop Calibrator

IMI SENSORS
A PCB PIEZOTRONICS DIV.

Cable Ordering Information

Listed below are some of the more popular cables for use with RMPs. For additional information on cable options, visit www.pcb.com and click on the “Cables & Connectors” tab or call IMI for assistance.

IMI Part Number: **052** **BR** **010** **BZ**

Cable Model Series

052	Polyurethane, Shielded, Twisted Pair
048	Armored Polyurethane, Shielded, Twisted Pair

Switch Connector Type

AE	2 socket MIL type with environmental boot
BP	2 socket MIL type high temp with strain relief
BR	2 socket MIL type molded composite
BQ	2 socket MIL type molded composite, right angle

Cable Length

010	10 feet
020	20 feet
030	30 feet
040	40 feet
050	50 feet
XXX	Any length

Cable termination

BZ	Blunt Cut

Warning 1 – ESD sensitivity

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.

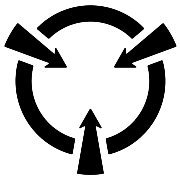
Warning 2 – ESD sensitivity

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 – ESD sensitivity

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, and/or*
- *Contact with a non-grounded person.*



CAUTION
ELECTROSTATIC
DISCHARGE SENSITIVE

The PCB solution for product safety:

- *Connect the cables only with the AC power off.*
- *Temporarily "short" the end of the cable before attaching it to any signal input or output.*

Caution 2 – ESD sensitivity

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.

Warranty

IMI instrumentation is warranted against defective material and workmanship for 1 year unless otherwise expressly specified. Damage to instruments caused by incorrect power or misapplication, is not covered by warranty. *If there are any questions regarding power, intended application, or general usage, please consult with your local sales contact or distributor.* Batteries and other expendable hardware items are not covered by warranty.

Service

Because of the sophisticated nature of IMI instrumentation, field repair is typically **NOT** recommended and may void any warranty. If factory service is required, return the instrumentation according to the "Return Procedure" stated below. *A repair and/or replacement quotation will be provided prior to servicing at no charge.* Before returning the unit, please consult a factory IMI applications engineer concerning the situation as certain problems can often be corrected with simple on-site procedures.

Return procedure

To expedite returned instrumentation, contact a factory IMI applications engineer for a RETURN MATERIAL AUTHORIZATION (RMA) NUMBER. Please have information available such as model and serial number. Also, to insure efficient service, *provide a written description of the symptoms and problems with the equipment to a local sales representative or distributor, or contact IMI if none are located in your area.*

Customers outside the U.S. should consult their local IMI distributor for information on returning equipment. For exceptions, please contact the International Sales department at IMI to request shipping instructions and an RMA. For assistance, please call (716) 684-0003, or fax us at (716) 684-3823. You may also receive assistance via e-mail at **imi@pcb.com** or visit our web site at **www.pcb.com**.

Customer Service

IMI, a division of PCB Piezotronics, guarantees **Total Customer Satisfaction**. If, at any time, for any reason, you are not completely satisfied with any IMI product, IMI will repair, replace, or exchange it at no charge. You may also choose to have your purchase price refunded.

IMI offers to all customers, at no charge, 24-hour phone support. This service makes product or application support available to our customers, day or night, seven days a week. When unforeseen problems or emergency situations arise, call the **IMI Hot Line at (716) 684-0003**, and an application specialist will assist you.

Model Number 649A01	RECIPROCATING MACHINERY PROTECTOR (RMP)	Revision: D ECN #: 56936

Performance	ENGLISH	SI
Output	4-20 mA	4-20 mA
Machinery RPM Range	240 to 10,000 cpm	4 to 166 Hz
Time Window	0.1 to 4.0 sec	0.1 to 4.0 sec
Weighting Factor	0.2 to 16 mA	0.2 to 16 mA
Trending Range Current	4 to 20 mA	4 to 20 mA
Threshold Level	2 to 50 g	2 to 50 g
Environmental		
Temperature Range	-40 to 212 °F	-40 to 100 °C
Storage Temperature Range	-40 to 257 °F	-40 to 125 °C
Electrical		
Excitation Voltage	15 to 30 VDC	15 to 30 VDC
Load Resistance	50(Vs-15) Ohm	50(Vs-15) Ohm
Electrical Isolation	> 10^8 Ohm	> 10^8 Ohm
Physical		
Size (Hex x Height)	1.25 in x 2.60 in	32 mm x 66 mm
Weight	7 oz	198 gm
Mounting Thread	1/4-28 UNF	1/4-28 UNF
Mounting Torque	3 to 5 ft-lb	4 to 7 Nm
Sensing Element	Piezoelectric Accelerometer	Piezoelectric Accelerometer
Housing Material	Stainless Steel	Stainless Steel
Sealing	Welded Hermetic	Welded Hermetic
Electrical Connection Position	Top	Top
Electrical Connections(Pin A)	4-20 mA Pos (+)	4-20 mA Pos (+)
Electrical Connections(Pin B)	4-20 mA Neg (-)	4-20 mA Neg (-)
Overload Limit (Shock)	5,000 g pk	49,050 m/s² pk

OPTIONAL VERSIONS

Optional versions have identical specifications and accessories as listed for the standard model except where noted below. More than one option may be used.

EX - Hazardous Area Approval- contact factory for specific approvals

M - Metric Mount
Supplied Accessory: Model M081A61 Mounting Stud 1/4-28 to M6 X 1 (1)

NOTES:

[1]See PCB Declaration of Conformance PS039 or PS071 for details.
[2]See Model's "Instructions For Use" (IFU) for North American Conformity and Certification Statements.

SUPPLIED ACCESSORIES:

Model 081A41 Mounting stud 1/4-28 socket head set screw brass tip stainless steel 5/8" long (1)

CE
UK CA [1]

Intertek [2]

All specifications are at room temperature unless otherwise specified.
In the interest of constant product improvement, we reserve the right to change specifications without notice.
ICP® is a registered trademark of PCB Piezotronics, Inc.

Entered: ND	Engineer: gs	Sales: JL	Approved: BAM	Spec Number:
Date: 09/08/2026	Date: 09/08/2026	Date: 09/08/2026	Date: 09/08/2026	38166

IMI SENSORS
A PCB PIEZOTRONICS DIV.
3425 Walden Avenue, Depew, NY 14043

Phone: 800-959-4464
Fax: 716-684-3823
E-Mail: imi@pcb.com

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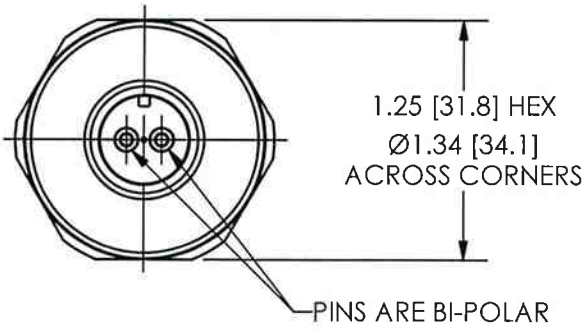
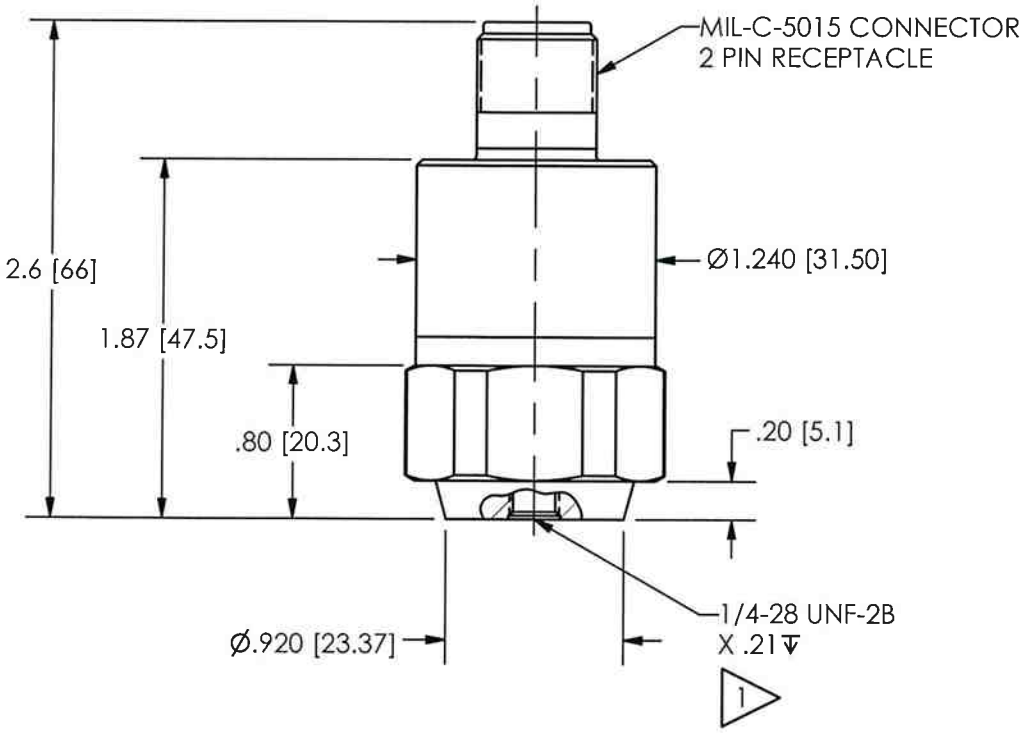
36897

REVISIONS			
REV	DESCRIPTION	ECN	APP'D
NR	RELEASED TO DRAFTING		ECB 8/6/07





1 MODEL 081A40 MOUNTING STUD SUPPLIED AS STANDARD. FOR M PREFIX MODELS (M649A01) MODEL MO81A61 (M6 X 1.0 TO 1/4-28) MOUNTING STUD REPLACES 081A40.

UNLESS OTHERWISE SPECIFIED TOLERANCES ARE:	
DIMENSIONS IN INCHES	DIMENSIONS IN MILLIMETERS [IN BRACKETS]
DECIMALS XX ± .03	DECIMALS X ± 0.8
XXX ± .010	XX ± 0.25
ANGLES ± 2 DEGREES	ANGLES ± 2 DEGREES
FILLETS AND RADII .003 - .005	FILLETS AND RADII [0.07 - 0.13]

DRAWN	MDF	8/6/07	MFG	JB	8/7/07
CHK'D	ECB	8/6/07	ENGR	MJ	8/7/07
APP'D	DMB	8/7/07	SALES	DJ	8-7-07

TITLE
OUTLINE DRAWING
MODEL 649A01
RECIPROCATING MACHINERY PROTECTOR

PCB PIEZOTRONICS INC
3425 WALDEN AVE. DEPEW, NY 14043
(716) 684-0001 E-MAIL: sales@pcb.com

CODE IDENT. NO.	DWG. NO.	
52681	36897	
SCALE: FULL	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).