

## Models 2680M1/2685M1 Airborne Amplifier

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Instruction Manual # (TBD)

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# CONTENTS

01 Products covered . . . . .	3
1.1 Low-pass filters . . . . .	3
02 Product description . . . . .	5
03 Initial inspection . . . . .	6
04 Installation . . . . .	7
04.1 Input Installation . . . . .	7
04.1.1 2680 input cable . . . . .	7
04.1.1.2 Input cable length . . . . .	7
04.1.2 2685 input cable . . . . .	8
04.1.2.1 Input cable length . . . . .	8
04.2 Output connector, 2680, 2685 . . . . .	8
04.3 Powering . . . . .	8
04.4 Signal outputs . . . . .	8
4.4.1 Biased output . . . . .	9
4.4.2 Unbiased output. . . . .	9
4.5 Adjustable gain . . . . .	9
4.5.1 Unsoldering the access screw . . . . .	10
4.5.2 Sealing the access screw . . . . .	10
4.6 How to calculate gain and output level . . . . .	11
4.7 2685 considerations . . . . .	12
4.8 What to look for? . . . . .	13
5.0 Environmental considerations . . . . .	15
5.1 EMC capability . . . . .	15
5.2 Temperature Effects . . . . .	15
5.3 High temperature accelerometers. . . . .	15
6.0 Performance testing . . . . .	16
6.1 Preferred method, 2680 and 2685 . . . . .	16
6.1.1 Hand-held shaker method. . . . .	16
6.1.2 Accelerometer simulator method . . . . .	18
6.1.3 2680 quick test . . . . .	19
6.1.4 2685 quick test . . . . .	20
6.2 2680 Testing without the sensor. . . . .	21
6.3 Final electrical and mechanical installation . . . . .	22
07 Maintenance and calibration. . . . .	24
7.1 Returning the unit . . . . .	24
Appendix A: Cable installation Recommendations . . . . .	25
Appendix B: Why a calibration capacitor? . . . . .	26

## 01 PRODUCTS COVERED

This manual covers the model 2680M1 charge amplifier and the 2685M1 IEPE (ISOTRON®) signal conditioner and applicable accessories. The full model number is printed on the label located on the top of the unit. The below tables describe the numbering system and applicable parameters.

"M" number	Gain range	Input pulse (mV/ pC). 2680 only	Residual noise (mV rms)
M1	0.1 to 1.0	50 000	1.5
M2	0.2 to 2.0	25 000	1.5
M3	0.5 to 5.0	10 000	1.5
M4	1.0 to 10	5000	1.5
M5	2.0 to 20.0	2500	1.5
M6	5.0 to 50.0	1000	1.5
M7	10 to 100	500	2.0

Table 1 "M" number nomenclature for the 2680 and 2685, as indicated.

### 1.1 Low-pass filters

An optional low-pass filter is factory installed in the airborne amplifier if specified on the Purchase Order. Available filters are 2-pole Butterworth filters that provide the unit with a specific frequency response. If an airborne amplifier contains an optional filter, the model number will contain a three-digit suffix (dash number) to indicate the filter's -5% frequency in Hz. The first two digits are significant numbers and the third indicates the numbers of zeroes. As an example, the Model 2680M7-102 Charge Amplifier has a two-pole low-pass filter installed with a flat response from 5Hz (-5%) to 1 kHz (-5%). Tables 2 and 3 provide a list of the various filters by dash number and frequency responses of each.

Lower Cutoff			Upper Cutoff		
Dash number	-10% frequency	-5% frequency	-5% frequency	-3 dB typical	-12 dB typical
None	3 Hz	5 Hz	*20 Hz		
-101	3 Hz	5 Hz	100 Hz	200 Hz	400 Hz
-201	3 Hz	5 Hz	200 Hz	400 Hz	800 Hz
-501	3 Hz	5 Hz	500 Hz	1 kHz	2 kHz
-102	3 Hz	5 Hz	1 kHz	2 kHz	4 kHz
-202	3 Hz	5 Hz	2 kHz	4 kHz	8 kHz
-502	3 Hz	5 Hz	5 kHz	10 kHz	20 kHz
-103	3 Hz	5 Hz	10 kHz	20 kHz	40 kHz
-203	3 Hz	5 Hz	**20 kHz	40 kHz	80 kHz
-402	3 Hz	5 Hz	4 kHz	8 kHz	16 kHz
-250	3 Hz	5 Hz	25 Hz	50 Hz	100 Hz

Table 2: Frequency response based on "dash" number for the model 2680 only

\*10 kHz for M7, \*\*10 kHz for M7

Lower Cutoff			Upper Cutoff		
Dash number	-10% frequency	-5% frequency	-5% frequency	-3 dB typical	-12 dB typical
None	0.7 Hz	3 Hz ±2Hz	20 kHz*		
-101	0.7 Hz	3 Hz ±2Hz	100 Hz	200 Hz	400 Hz
-201	0.7 Hz	3 Hz ±2Hz	200 Hz	400 Hz	800 Hz
-501	0.7 Hz	3 Hz ±2Hz	500 Hz	1 kHz	2 kHz
-102	0.7 Hz	3 Hz ±2Hz	1 kHz	2 kHz	4 kHz
-202	0.7 Hz	3 Hz ±2Hz	2 kHz	4 kHz	8 kHz
-502	0.7 Hz	3 Hz ±2Hz	5 kHz	10 kHz	20 kHz
-103	0.7 Hz	3 Hz ±2Hz	10 kHz	20 kHz	40 kHz
-203	0.7 Hz	3 Hz ±2Hz	20 kHz*	40 kHz	80 kHz
-150	0.7 Hz	3 Hz ±2Hz	15 Hz	30 Hz	60 Hz

Table 3: Frequency response based on "dash" number for the 2685 only.

\*Limit + 5%, -10%

## 02 PRODUCT DESCRIPTION

The Endevco Model 2680 and 2685 Series of Airborne Amplifiers are solid-state airborne devices designed for use with piezoelectric and IEPE transducers. The 2680 and 2685 are essentially identical with the exception of the front-end (see figures 1 and 2). The airborne amplifiers are potted with polyurethane foam and sealed. Units contain a front-end circuit to receive the transducer signal, an optional filter to select the flat frequency response range and a potentiometer to set the desired gain of the amplifier's output.

The 2680's front end has a charge converter and voltage amplifier in the output. The charge amplifier produces an output voltage proportional to the charge at the input, thus minimizing the effect of input cable length. The 2680 is designed to accommodate single-ended charge mode piezoelectric accelerometers and microphones.

The 2685 provides a constant current source and amplifier for an IEPE (ISOTRON) type accelerometer. An IEPE accelerometer has a built-in amplifier that requires a constant current power source. The transducer provides a low impedance voltage output while maintaining a two-wire connection. Both the power and the signal output are carried over the same cable.

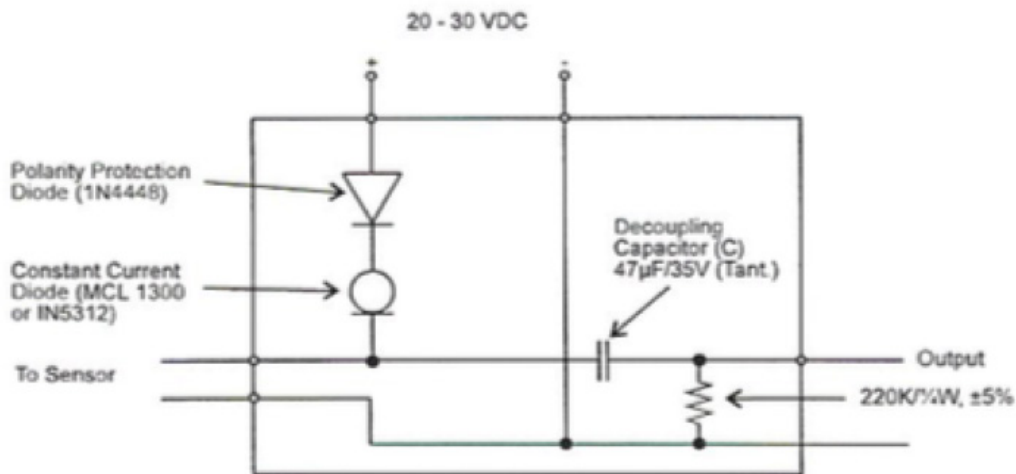


Figure 1: Basic powering circuit similar to the one used in the model 2685

The airborne amplifiers use hybrid microcircuits to achieve small size, low weight, and low power consumption. The case of the airborne amplifier is completely isolated from the circuit and an internal electrostatic shield protects it from stray pickup.

Note that there are no provisions to access TEDS. A TEDS type transducer can be used with the 2685, but the TEDS chip cannot be interrogated via the airborne amplifier. The 2685 does not monitor the transducer's bias excitation voltage. The transducer's bias should not be confused with the biased output available on pin C of the 6-pin connector. Pin 6 should always have a biased output.

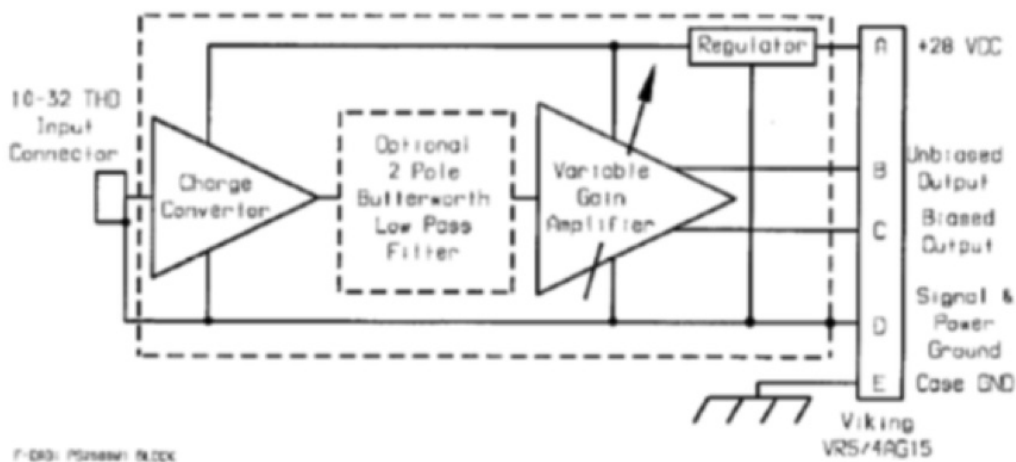


Figure 2: Model 2680 airborne amplifier configured as a charge amplifier.

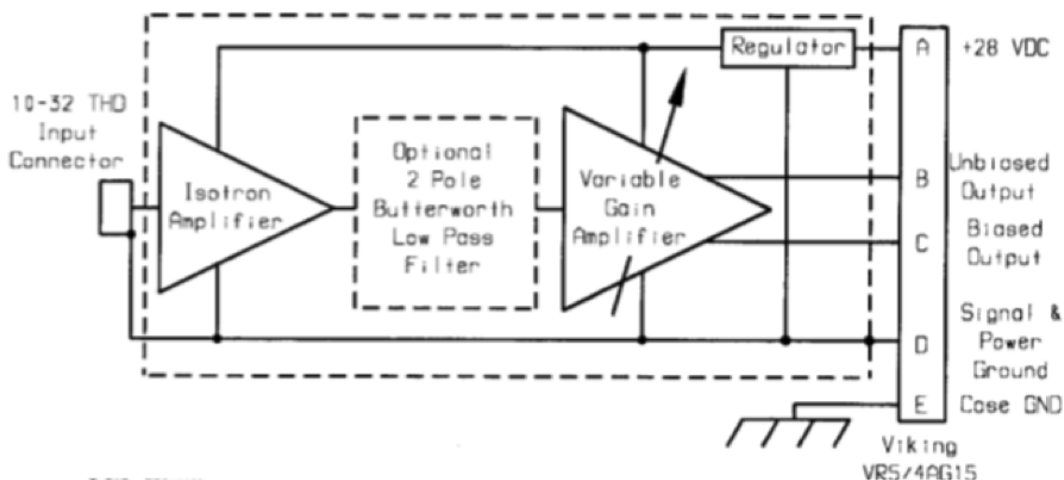


Figure 3: Model 2685 airborne amplifier configured as an IEPE (ISOTRON) current source and voltage amplifier.

### 03 INITIAL INSPECTION

The charge amplifier is packed in a protective bag and packaged in shipping cartons containing shock-absorbent materials to prevent in-transit damage. However, upon receipt of the units, the customer should make an inspection to be certain that no damage has occurred during shipment. Obvious damage should be reported immediately to the carrier.

Inspect the contents of the shipping carton and verify that the applicable accessories listed in Table 4 are included in the shipment with each airborne amplifier.

Should it be necessary to return the amplifier to the factory, follow the instructions in section 7.1 of this manual. It is recommended that an applications engineer be contacted prior to returning the unit since many problems can be resolved via telephone or email.

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## 04 INSTALLATION

The charge amplifier's case is drilled with two holes for mounting the unit to the test specimen. The mounting holes are drilled and counter bored to accommodate a 6-32 cap screw. Since there are some measurement difference between the 2680 and 2685, the user should refer to figures 12 A and 12B for measurement information. The mounting hardware for both airborne amplifier models is listed in Table 4.

Quantity	Description	Endevco part number	Mfg. part number
1	Mating plug	EP38	VP5/4CE6
1	Hood	EP35	VS4/16C5
1	Potting sleeve	EP31	VS4/16C9
1	6-32 ¼" cap screw, CRES	EH535	
1	6-32 ¾" cap screw, CRES	EH293	

Table 4 listing standard accessories' supplied. The mfg. part numbers refer to Viking Electronics.

To minimize noise pickup, the case of the charge amplifier should be grounded to frame ground through the mounting screws, which act as grounding lugs. Frame ground is then connected to circuit ground at some single point to prevent ground loops.

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### 04.1 Input Installation

This section covers the connections between the transducer and the airborne amplifiers.

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#### 04.1.1 2680 input cable

The 2680 airborne amplifier is configured to operate with charge-mode transducers thus the input cable must be low-noise treated. Cable assemblies such as the Endevco 3090C or the premium 3090DV are recommended. The connector on the airborne amplifier is a 10-32 type.

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##### 04.1.1.2 Input cable length

Since the 2680 amplifier supports high impedance charge-mode accelerometers, it is important that the cable be as short as possible. While cable length has no practical effect on sensitivity the high impedance characteristics make the system susceptible to noise pick-up. The model 2680 has an input source capacitance of 10 000 pF, maximum. Thus the capacitance of the accelerometer plus the cable's capacitance must not exceed 10 000pf.

For example, using an Endevco 2276 piezoelectric accelerometer over a distance of 80 feet (24 meters) between the accelerometer and the airborne amplifier. The coaxial cable between the accelerometer and

airborne amplifier has a nominal capacitance of 30 pF/ foot (92 pF/meter):

$$\text{Therefore: } 80 \times 30 = 2400 \text{ pF}$$

2400 pF is well within the capacitance range and will work OK, but there might be some added noise.

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### 04.1.2 2685 input cable

The 2685 is designed to operate with IEPE (ISOTRON) accelerometers, thus low- noise treated cables are unnecessary. Recommended cable assemblies are the Endevco Teflon C-001-AC-001-X or the Endevco silicone C-001-AD-001-X. The connector on the airborne amplifier is a 10-32 type.

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#### 04.1.2.1 Input cable length

The 2685 can support long cables since the accelerometer's used feature a low-impedance voltage output. There is a practical limit of approximately 700 feet (213 meters), which will provide a 10V peak-to-peak output up to 5 kHz. This is based on 30 pF/foot (98 pF/meter), which is a typical capacitance found on many coaxial cables. Shorter cable lengths will permit an increase of the maximum frequency.

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### 04.2 Output connector, 2680, 2685

A 5-pin connector is provided for the output signals, ground and power. The output characteristics and pins are common to both the 2680 and the 2685. The 5-pin connector is a bayonet-locking type. A mating connector is supplied with the amplifier. See figure 1 and 2 for the connector pinout locations.

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### 04.3 Powering

Power is applied to pins A (+) and D (ground) of the five-pin connector. Power should be from a clean DC source of 20 to 32 VDC (28 VDC, nominal). The power input circuit includes reverse polarity protection thus a reversed connection will not damage the airborne amplifier.

The nominal current requirements are per the following table 5:

Model	Description	Current, mA
2680	Units with filters	25
2680	Unfiltered units	20
2685	All versions	30

Table 5

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### 04.4 Signal outputs

Each airborne amplifier has two outputs, biased and/or unbiased. Both outputs are single-ended with one side connected to circuit ground. When both outputs are used simultaneously, the parallel combination of both load resistances must be 10k ohm or greater to meet all specifications.



Maximum output voltage is approximately 0 to 5 v ( $\pm$  v pk) depending on the specific airborne amplifier. The output circuits are short-circuit proof, thus the outputs will withstand an indefinite short without damage.

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#### 4.4.1 Biased output

The biased output is available from pin C (+) and pin D (ground). This output is

direct-coupled with an output impedance of less than 50 ohms. With no input, the airborne amplifier produces +2.5 v dc,  $\pm$ 3% at the output. Output voltage will be approximately  $\pm$  2.5 V pk around this bias level. Clipping will occur slightly above the 0 V level and between +5.0 and +5.3 V.

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#### 4.4.2 Unbiased output

The unbiased output is available between pins B (+) and D (ground). This output is taken from the same source as the biased except a series decoupling capacitor blocks the DC bias only allowing only the AC signal to be available at pin B. With the addition of the series capacitor and bleed resistor in the output, a 0.00 V bias level is established. The unbiased output is linear from 0 to 4.65 V p-p, or 0 to 5.00 V p-p, depending on the specific airborne amplifier used.

Refer to Table 1-2 for further output data on specific airborne amplifiers.

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#### 4.5 Adjustable gain

The airborne amplifier's enclosure contains a removable screw to permit access to a gain potentiometer. The potentiometer enables the user to adjust the gain to any desired setting within the gain range of the amplifier. For example, in an M3 version; the gain range would be 0.5 to 5 per table 1. The gain-access screw is located on the side of the case as shown in figure 4. Remove the access screw using a 5/64" hex wrench with an insulated handle.

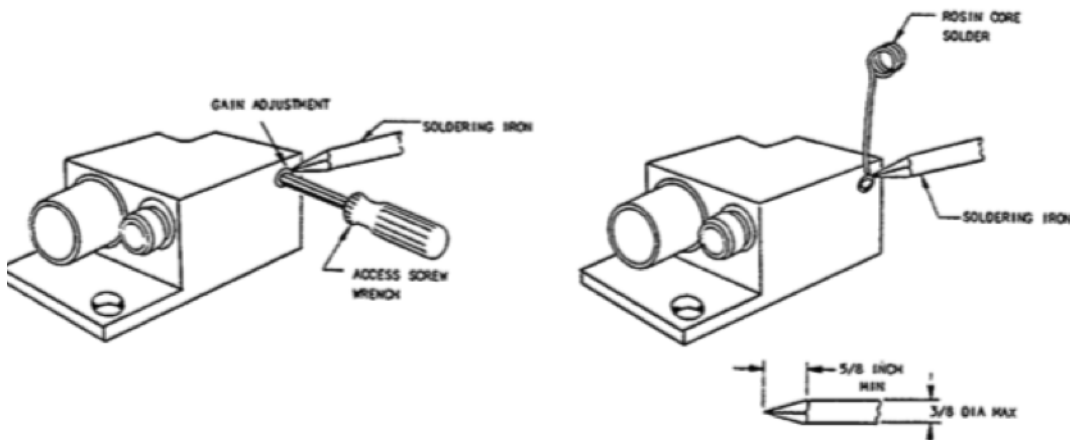


Figure 4 illustrates removal, re-installation and solder sealing of the gain adjustment potentiometer. A 200-watt soldering iron with a narrow tip is recommended.

The gain adjustment is a 12-turn (typical) 500 000-ohm ( $\pm 0.1\%$ ) potentiometer with mechanical stops at the extreme clockwise (cw) and counterclockwise (ccw) positions. Maximum resistance (minimum amplifier gain) is obtained in the extreme cw position. Signals are present at both ends of the potentiometer, but signal changes may not occur during the final two turns. A 1/16" (1.6 mm) flat blade screwdriver is recommended for adjusting the potentiometer.

Airborne amplifiers shipped as a component of an Endevco system consisting of an airborne amplifier with a cable assembly and either an accelerometer or microphone; normally have the gain factory-set to a specific level, and the gain-access screw solder-sealed to the case of the airborne amplifier. The gain-access screw must be sealed to the case with solder (recommended), glyptol or epoxy for it to meet humidity specifications during operation.

Units shipped as single items of equipment have the gain potentiometer set to the maximum rated gain and the gain-access screw temporarily seated in the threaded access hole. Users may adjust the gain to a desired gain setting prior to installation of an airborne amplifier. See table 1 to determine the applicable gain range.

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#### **4.5.1 Unsoldering the access screw**

Should it become necessary to remove the screw from a unit that has been solder sealed, follow the instructions as follows:

- Preheat an oven to 212°F (100°C).
- Place airborne amplifier in the preheated oven for a period of time sufficient for the airborne amplifier to stabilize.
- Insert the 5/64" Allen wrench into the access screw (per figure 4) and place a soldering iron adjacent to the access screw as shown in figure 4.
- Apply ccw torque to the Allen wrench and remove the access screw when solder seal is molten.

#### **CAUTION**

When removing the access screw, care should be exercised to prevent molten solder from entering the airborne amplifier.

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#### **4.5.2 Sealing the access screw**

A new access screw should be used to seal the gain adjust hole. Installing used access hole screws could prevent the airborne amplifier from meeting the humidity specifications. Follow the steps below for installing and sealing the new screw:

- Install a new access screw into the gain adjust hole.
- Preheat oven to 212°F (100°C).

- Place airborne amplifier in the preheated oven for a period of time sufficient for the airborne amplifier to stabilize.
- Remove the airborne amplifier from the oven
- Apply a small amount of rosin core solder (63-37) to the recessed area around the access screw to form a solder seal (see figure 4).

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#### 4.6 How to calculate gain and output level

Any of the methods described in section six may be used. It is necessary to know the following factors:

Accelerometer's sensitivity in mV/g (2685) or pC/g (2680)

Desired full-scale output from the airborne amplifier

Determine the amplifiers peak sensitivity in pC/g or mV/g: (1)

$$As = \frac{Eo}{Fs}$$

Where:  $As$  = Amplifiers charge sensitivity or voltage sensitivity in mV/g.

$Eo$  = Amplifiers peak full-scale output in mV peak

$FS$  = Amplifier's desired peak full-scale output in g peak

The next step is to compute the required gain ( $Aq$ ): (2)

$$Aq = \frac{As}{Sq}$$

Where:  $Sq$  = Sensor's sensitivity in pC/g or mV/g

Make sure that the output signal amplitude is compatible with the readout equipment: (3)

$$As = \frac{Eo}{Fs}$$

$As$  = System sensitivity

Where:  $Eo$  = Output in mV peak

$FS$  = Desired full scale (g peak)

Using one of the signal sources described in section 4, a DMM and/or an oscilloscope, make the necessary adjustment of the potentiometer. The signal source should be set 100Hz.

For example, suppose a system consisting of a charge-mode piezoelectric accelerometer is used to measure  $\pm 50g$  peak, full scale with a 2680 amplifier (which has a 2500 mV full-scale output).

Using the previous equation:

$$A_s = \frac{2500mV}{50g}$$

$$= 50 \text{ mV/g}$$

If the airborne amplifier used is the model 2685, the same equation is used, but the transducers sensitivity is fixed and marked on the transducer and its calibration certificate.

#### 4.7 2685 considerations

This section shows how to determine if the accelerometer's output is compatible with the 2685.

Figure 5 shows a typical transfer function and the effects of the compliance and bias voltage levels. The specified bias level indicated is measured at room temperature and will change as the operating temperature changes. Note that compliance voltage is the supply voltage minus 2-3 Volts due to a voltage drop in the regulator circuit.

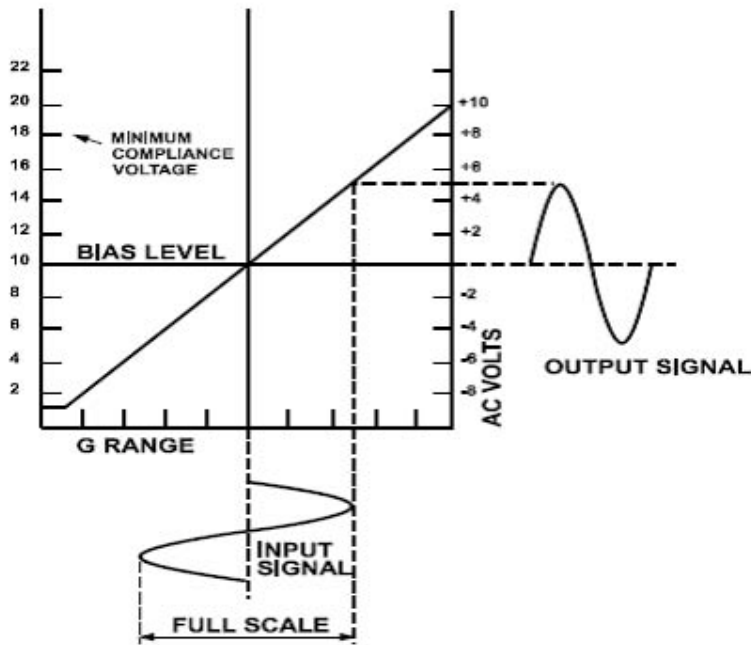


Figure 5 showing the transfer function of a typical IEPE accelerometer.

Use the following equations to determine the maximum full-scale peak output voltage from the IEPE accelerometer.

To determine the maximum positive voltage:

$$F_s = (E_s - 1) - E_b$$

To determine the maximum negative voltage:

$$-F_s = E_b - 2$$

Where:  $F_s$  = Full scale output voltage (peak)

$E_s$  = DC compliance voltage

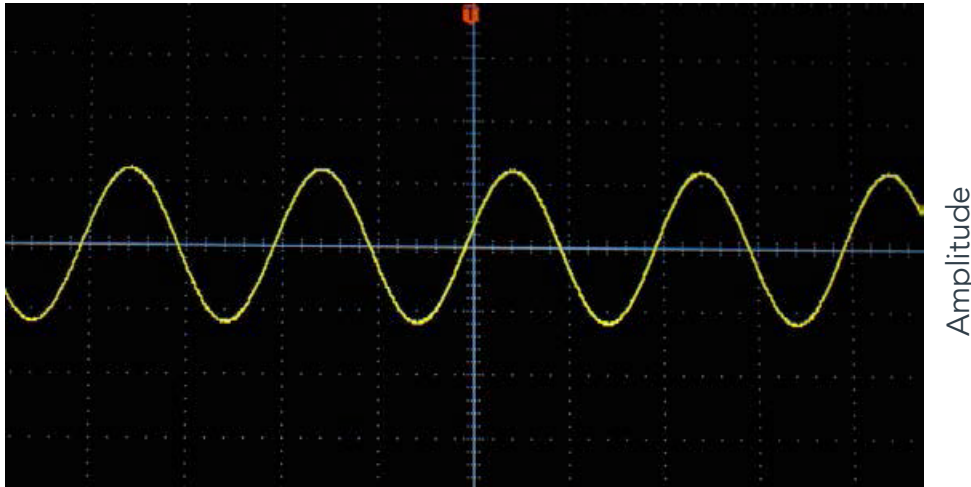
$E_b$  = Bias voltage (from accelerometer calibration certificate)

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## 4.8 What to look for?

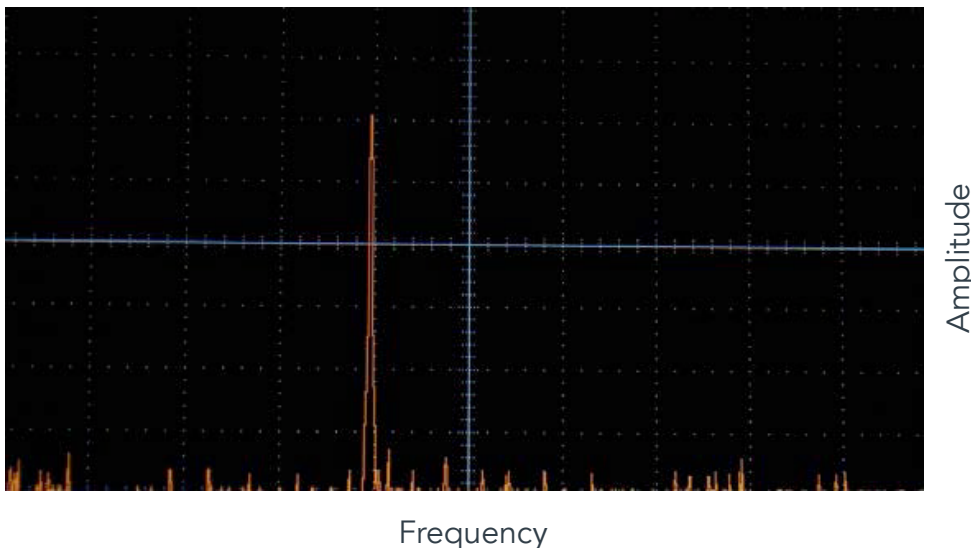
Exercise caution and do not operate too close to the full - scale output. Clipping can occur (Figure 6D) once the signal reaches 0 volts or the maximum voltage and in the region just prior to clipping, the amplitude is non-linear (see figure 5).

An oscilloscope with an FFT function is an excellent tool for checking signals close to the full-scale output. When using the FFT mode, a Hanning window is recommended.



A clean sine wave in the time domain (Figure 6A)

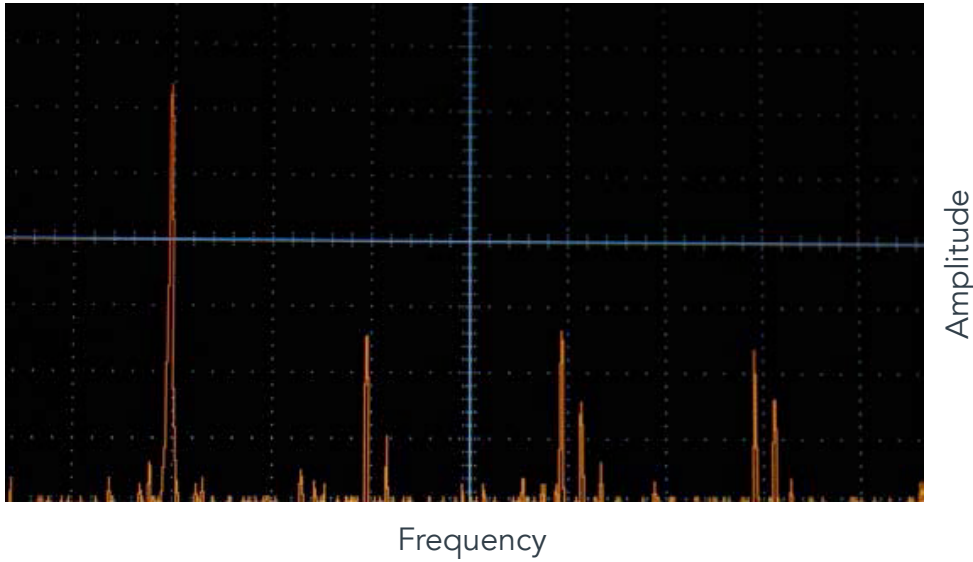
Using the FFT mode on the oscilloscope, view the frequency domain and observe the presence of harmonics. The below image shows the spectrum of an undistorted sine wave. Only a single frequency is present.



(Figure 6B)

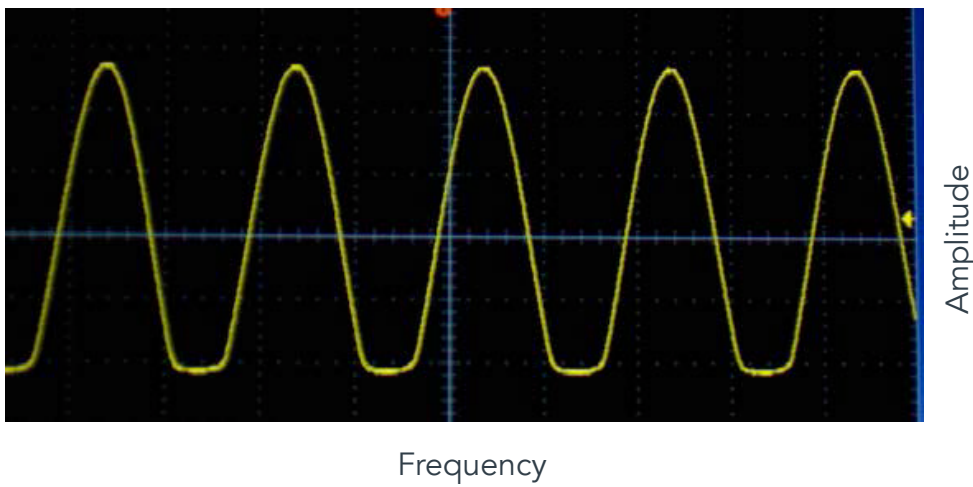
In some cases the time domain display on the oscilloscope can appear as clean as figure 6A, but there may be distortion present that will only be detectable in the frequency domain or on a harmonic distortion analyzer.

Notice the fundamental frequency, on the left, and the presence of harmonics in figure 6C.



(Figure 6C)

Figure 6D is an example of the presence of clipping as seen in the time domain. In this case further analysis using the FFT mode is unnecessary since the problem is obvious.



(Figure 6D)

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## 5.0 ENVIRONMENTAL CONSIDERATIONS

See the applicable product datasheet for applicable environmental specifications and ensure that the airborne amplifiers are operating within these specifications.

The airborne amplifiers are rated to 100% relative humidity and are in compliance with MIL-STD-810D, Method 507.2, procedure III. In order to comply with the specifications, the gain access screw must be solder-sealed. The humidity rating does not include the cable's connectors thus some precautions may be necessary to protect the connectors.

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### 5.1 EMC capability

The airborne amplifiers meet the requirements of MIL-STD-826, CLASS Am. The 2680 is also in compliance with MIL-I-618D; MSFC-SPEC-279, CLASS1; AF/BSA EXHIBIT 62-87.

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### 5.2 Temperature Effects

Airborne amplifiers can be operated over a temperature of -67° F to 212° F (-73° C to 100° C). The gain change over the operating temperature range is illustrated in Figure 7.

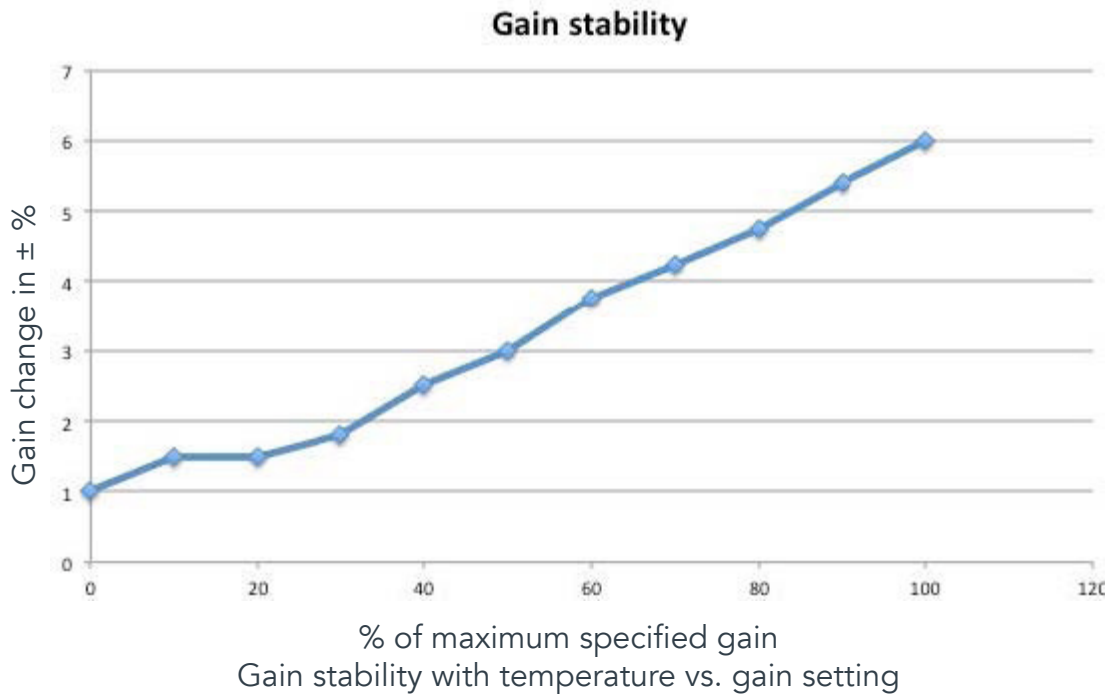


Figure 7: A near linear plot of the temperature effect as a function of gain. Each data point is taken over the operating temperature range.

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### 5.3 High temperature accelerometers

When accelerometers are exposed to high temperature extremes the internal resistance decreases. High temperature accelerometers usually specify resistance at room temperature and at the maximum temperature. The specified source resistance of the 2680 is 3 M  $\Omega$ , minimum.

As an example, let's assume that we are going to use a model 2230 high-temperature accelerometer. The room temperature resistance is  $1\text{G}\ \Omega$  that would work well with the 2680, but the resistance drops to  $100\text{k}\Omega$  when the accelerometer reaches  $900^\circ\text{F}$  ( $482^\circ\text{C}$ ) which is well below the minimum source resistance requirement of the 2680.

In this instance, consider using a 2685 airborne amplifier in conjunction with a 2771C in-line charge converter. The 2771C has a minimum source resistance requirement of  $100\text{k}$ , which will work over the entire temperature range.



Figure 8: Model 2771C in-line charge converter to be installed between the accelerometer and the 2685's input connector.

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## 6.0 PERFORMANCE TESTING

It is sometimes desirable (or required) to test the integrity of a system after installation. This section will provide both a quick test and an in-depth test for both the 2680 and 2685. The quick test might be conducted prior to installation to verify the unit is operational.

The most efficient way to test the performance is described in section 6.1. If these instruments are unavailable, section 6.2 suggests methods where standard laboratory instrumentation can be used to effectively perform the tests. See the appropriate Endevco technical paper for further tests, if required.

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### 6.1 Preferred method, 2680 and 2685

Using one of the Endevco test instruments discussed herein is the easiest and most effective way to conduct a performance test on either of the airborne amplifiers. The two instruments and their applications are discussed below.

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#### 6.1.1 Hand-held shaker method

The Endevco model REF2520/R (figure 9) reference shaker is a highly convenient way to test and confirm the calibration and performance of the accelerometer, cable and amplifier with one simple test. The vibration level is limited to  $1\text{g}$  peak.





Figure 9: A handheld shaker (Endevco REF2520) is ideal for testing system performance.

The shaker provides a one g sine vibration level at selectable frequencies. The accelerometer under test is attached to the top of the shaker.

#### Equipment required:

- 28 volt power supply with an output mA meter
- Oscilloscope
- Digital multimeter

#### Follow the below steps:

1. Apply 28 VDC between pins A (+) and D and confirm that the current is within the specifications in Table 4. Allow about >3 minutes for warm-up.
2. Install a 10k  $\Omega$ , ¼ watt resistor between pins C & D.
3. Attach an oscilloscope to pins C and D.
4. Set the reference shaker frequency to 100Hz.
5. Observe a 100 Hz undistorted sine wave on the oscilloscope. If the oscilloscope is DC coupled a DC bias of 2.50 volts ( $\pm 3\%$ ) should also be observed.

### 6.1.2 Accelerometer simulator method

An accelerometer simulator is also a good source for testing the performance of the 2680 or 2685. In this instance, the accelerometer is absent from the circuit. The Endevco model 4830B (figure 10) is an example of an accelerometer simulator.



Figure 10: Endevco model 4830B hand-held accelerometer simulator with the IEPE and charge output connectors identified.

#### Equipment required:

- 28 volt power supply with an output mA meter
- Digital storage oscilloscope
- Digital multimeter

When using a simulator, follow the below steps:

1. Apply 28 VDC between pins A (+) and D and confirm that the current is within the specifications in Table 4. Allow about >3 minutes for warm-up.
2. Install a 10k  $\Omega$ , ¼ watt resistor between pins C & D.
3. Attach an oscilloscope to pins C and D.
4. Use the charge output for testing the 2680 or the IEPE output for testing the 2685.
5. Set the simulator frequency to 100Hz.
6. Observe a 100 Hz undistorted sine wave on the oscilloscope. If the oscilloscope is DC coupled a DC bias of 2.50 volts ( $\pm 3\%$ ) should be observed.

### 6.1.3 2680 quick test

This section provides a method to perform a quick functional test using common laboratory measurement equipment.

Equipment required:

- 28 volt power supply with an output mA meter
  - Digital storage oscilloscope
  - Digital multimeter
1. Apply 28 Volts between pins A (+) and D. and confirm that the current is within the specifications in table 4.
  2. Connect a 10k  $\Omega$  (minimum) resistor between pins C and D.
  3. With a DMM, measure the DC voltage across the 10k  $\Omega$  resistor. The voltage should read 2.50 VDC  $\pm$ 3%.
  4. Connect a charge-mode piezoelectric accelerometer to the 10-32 input connector using low-noise cable.
  5. Connect an oscilloscope to either/or Pins B and D or C&D. AC coupling is recommended if using pins C&D.
  6. Tap the base of the accelerometer with a wooden pencil, or a plastic screwdriver handle.
  7. Look for an output response on the oscilloscope screen. Figure 11 is an example of a response from a hard strike.
  8. If a suitable response is observed on the oscilloscope, the test is complete.

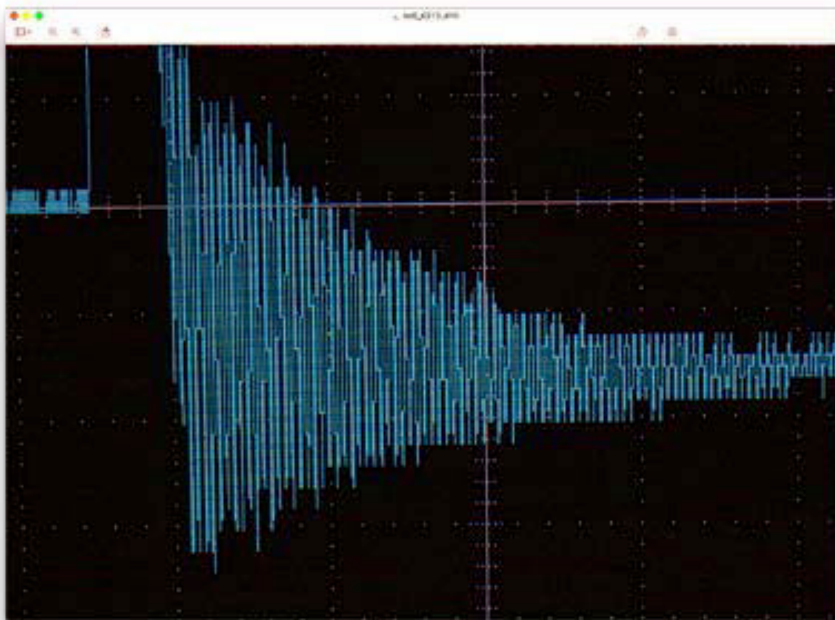


Figure 11: The left side of the trace shows the initial strike followed by the "ring" from the accelerometers resonance. Other patterns are possible from a "good" system.

## 6.14 2685 quick test

Equipment required:

- Digital storage oscilloscope
  - Digital multimeter
  - 28 VDC power supply with an output mA meter
1. Apply 28 Volts between pins A (+) and D. and confirm that the current is within the specifications in table 4.
  2. Connect a 10k  $\Omega$  (minimum) resistor between pins C and D.
  3. With a DMM, measure the DC voltage across the 10k  $\Omega$  resistor. The voltage should read 2.50 VDC  $\pm$ 3%.
  4. Connect an IEPE accelerometer to the 10-32 input connector.
  5. Connect an oscilloscope to either/or Pins B and D or C&D. AC coupling is recommended if using pins C&D.
  6. Tap the base of the accelerometer with a wooden pencil, or a plastic screwdriver handle.
  7. Look for an output response on the oscilloscope screen. Figure 11 is an example of a response from a hard strike.
  8. If a response is observed on the oscilloscope, the test is complete.
  9. Install the accelerometer cable in such a way that the DC voltage can be measured. This is best accomplished using a pair of 10-32 to BNC cables (Endevco 3061) joined by a BNC "T" connector (Amphenol 112461, or equiv.) per figure 5.
  10. Refer to the accelerometer's calibration certificate and note the bias Voltage.
  11. With the power applied (28 VDC), measure the transducer's bias voltage as shown in figure 12. It should read approximately the same as the bias voltage recorded on the calibration certificate. Note that the ambient temperature affects the transducer's bias voltage level. The calibration temperature is recorded on the certificate.

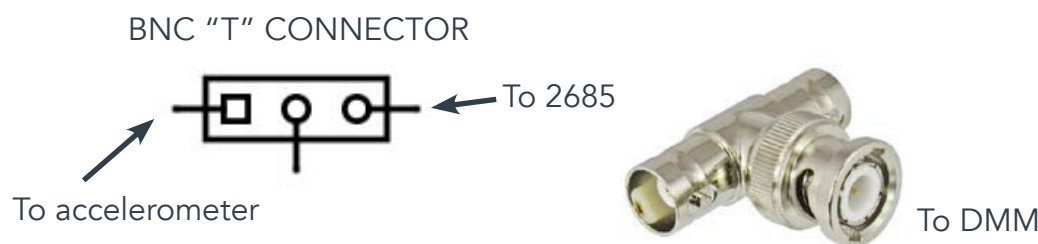


Figure 12: A "T" connector can be used between two BNC to 10-32 cables allowing for the measurement of the bias voltage at the male center of the connector.

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## 6.2 2680 Testing without the sensor

Testing with high accuracy is possible using common laboratory instruments and an Endevco model 2947C Calibration Capacitor. The 2947C is simply a stable, well-shielded 1000pF capacitor that is placed between the signal generator and the 2680 charge amplifier. Its purpose is to convert the signal generators output voltage to a charge (pF) signal. When using a 1000 pF capacitor, charge = volts. The accuracy is dependent on the tolerance of the capacitor and the accuracy of the signal generators output level. The 2947C's internal capacitor is measured and the actual capacitance is marked on the case.



Figure 13 shows an Endevco model 2947C calibration capacitor. The capacitor is housed within a shielded environmentally sealed case. The capacitance is measured and marked on the housing.

### Equipment required:

- Function generator
  - Endevco 2947 Calibration capacitor
  - Oscilloscope
  - Digital multimeter
1. Apply 28 Volts between pins A (+) and D. and confirm that the current is within the specifications in table 4.
  2. Connect a 10k  $\Omega$  (minimum) resistor between pins C and D.
  3. With a DMM, measure the DC voltage across the 10k  $\Omega$  resistor. The voltage should read 2.50 VDC  $\pm$ 3%.
  4. Connect the 2947C to the 10-32 connector and the BNC end to a function generator (see figure 14).
  5. Connect an oscilloscope to either/or Pins B and D or C&D. AC coupling is recommended if using pins C&D.
  6. Set the sine wave frequency to 100 Hz.
  7. Set the amplitude to a level that will produce 10 g.
  8. Look for an output response on the oscilloscope screen. The user should see a pure sine wave with no distortion or clipping. If the oscilloscope has an FFT function, observe the frequency domain response that should be free of harmonics (Figure 4B). Confirm that there are no 50Hz/60 Hz lines present in the spectrum.

9. If a suitable response is observed on the oscilloscope, the test is complete.

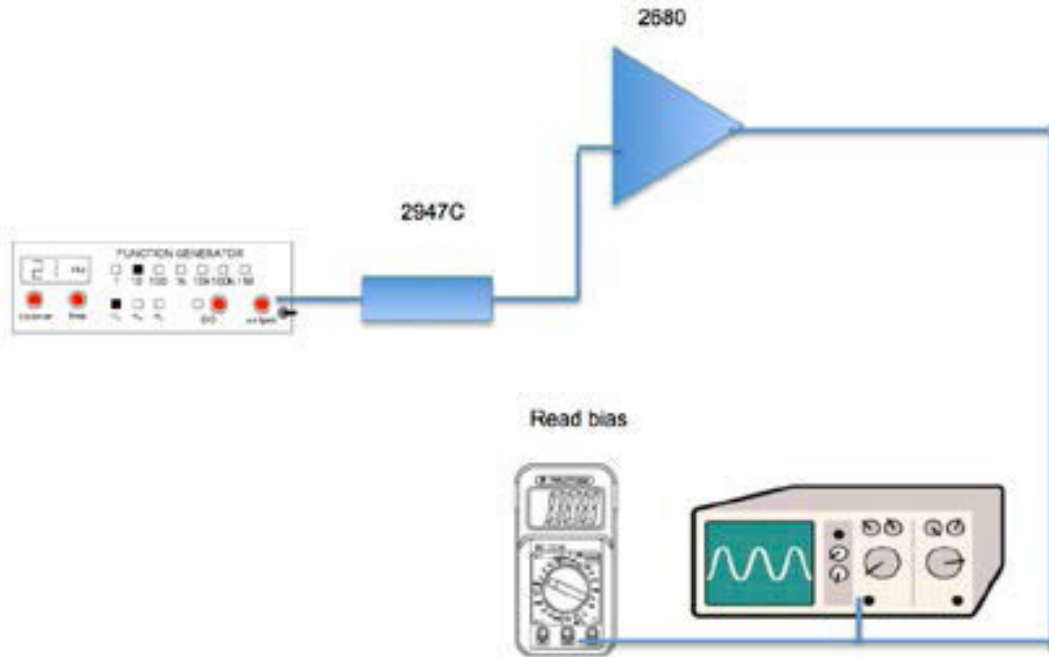


Figure 14: Test set-up using a sine wave voltage signal. The 2947C converts the voltage (mV) signal to a charge signal (pC). The output wave is displayed on the oscilloscope and the bias voltage is read on the DMM.

### 6.3 Final electrical and mechanical installation

Prior to mounting the airborne amplifier, reinstall the potentiometer access screw to approximately 8 in-lbs. (0.6 Nm) and solder-seal the screw per section 3.3. Perform this function once the potentiometer is set to the desired gain.

Once a mounting surface has been determined, drill two holes per the outline drawings. There are some differences between the 2680 and the 2685 so make sure you are following the correct drawing. Drill and tap the holes to accommodate the two 6-32 cap screws. When securing the cap screws, consider the recommended torque for the screw 8 in-lb (0.9 Nm) and the material of the mounting surface.

The accelerometer input cable should be installed with a mounting torque of 1.5 in-lbs. (0.169 Nm), finger tight.

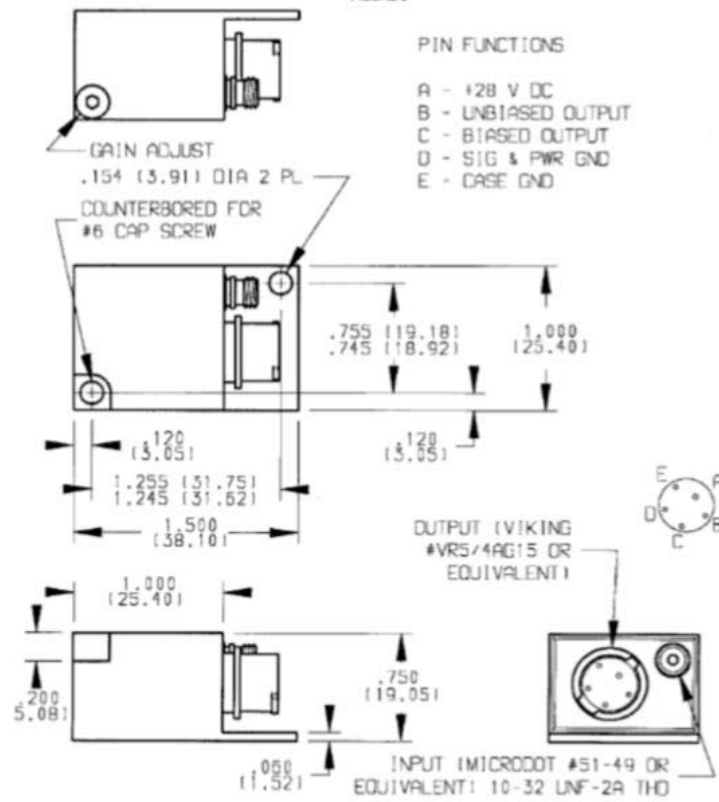


Figure 15A: Outline drawing of the 2680 Charge amplifier.

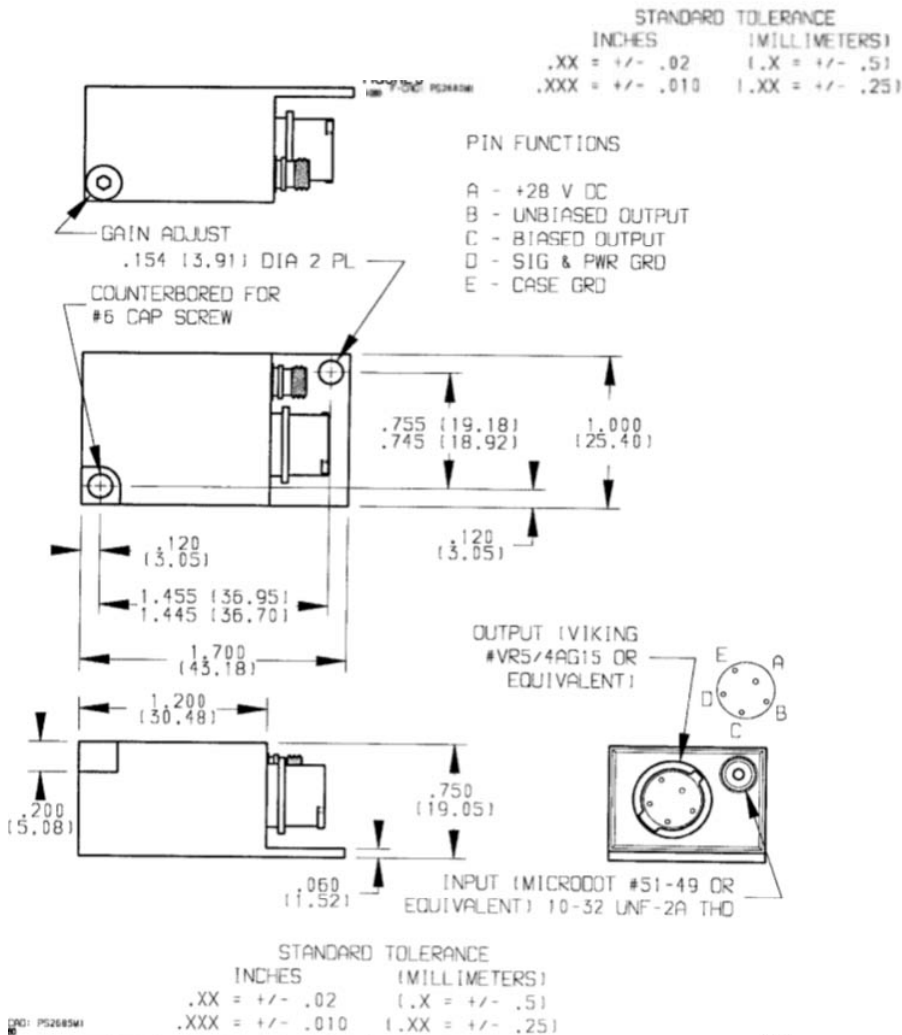


Figure 15B: Outline drawing for the 2685 IEPE (ISOTRON) amplifier.

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## 07 MAINTENANCE AND CALIBRATION

The airborne amplifiers are sealed and potted thus there are no user serviceable parts. Cleaning the connectors is important to maintain noise-free operation. Annual calibration using sources traceable to the National Institute of Standards and Technology (USA) or other recognized standards organizations is recommended.

Below is a list of checks to perform prior to returning the unit or contacting an applications engineer:

- Check the connector wiring making sure that pin A is at the proper polarity. Look for possible shorted pin connections.
- Check for damaged cables on the input and output.
- Using a DMM, measure the DC bias between pins C&D. This should read approximately 4.65 volts DC.
- Measure input current from the power supply. See table 5 for the current values.

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### 7.1 Returning the unit

Prior to returning the unit to the factory, contact the applications engineering department. Let the applications engineer know the results of any of the above tests. If it is necessary to return the unit to the factory, follow the below procedure:

USA: Contact the customer service department, at the factory, and obtain an RMA number. Include the RMA number on the enclosed documentation and the outside of the shipping box. Include a description of the problem encountered and the unit serial number and your contact information.

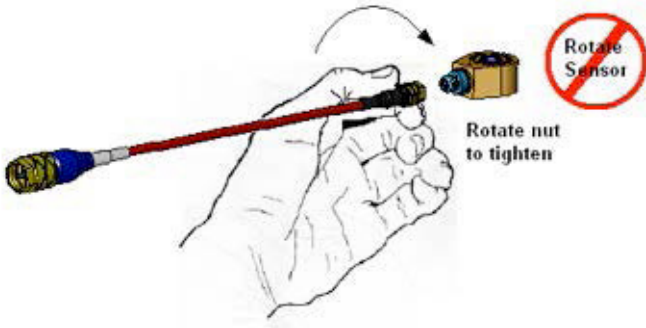
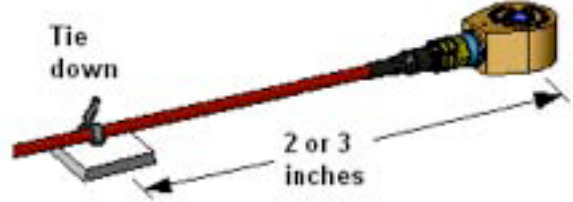
Outside USA: Contact your local representative or distributor and follow their instructions.

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## APPENDIX A: CABLE INSTALLATION RECOMMENDATIONS

The following recommendations are provided to help the users of Endevco cables and assemblies.

1. When attaching a coaxial cable assembly to a transducer or the amplifier, always turn the connector nut onto the transducer. Turning the transducer or amplifier into the cable connector may damage the pin, the cable, or the transducer. Only finger tight to 1.5 in-lbs. (0.169 Nm).
2. Always tie down the cable within 2 or 3 inches of the transducer. Whipping of the cable will generate cable noise, strain the cable unnecessarily at the connector, and cause spurious signals in strain sensitive transducers.
3. When testing in a high humidity environment, curl the cable into a drip loop near the transducer and the airborne amplifier. Any condensation that occurs will then be drawn away from the connector. Apply Dow-Corning Silastic 732RTV adhesive sealant to connector threads and outer joints to prevent moisture from entering the connector.
4. Always be certain that the cable connector is screwed finger tight, or to specifications. Do not lose critical data because of a loose connector
5. When testing in a high humidity environment, curl the cable into a drip loop near the transducer and the airborne amplifier. Any condensation that occurs will then be drawn away from the connector. Apply Dow-Corning Silastic 732RTV adhesive sealant to connector threads and outer joints to prevent moisture from entering the connector.
6. Keep cable connectors and transducer receptacle clean by dipping them in a volatile solvent before use. Freon, acetone, trichloroethane, or similar solvents may be used. Connector contamination caused by ordinary handling can create low impedance paths between signal and ground, increasing noise and affecting the low frequency response of the connected amplifier.
7. If an intermittent signal is encountered and the cable is suspect, check the transducer/cable interface. Flex the cable all along its length, particularly near the connector, and observe the effect on the signal. Check center conductor and cable shield continuity with an ohmmeter.
8. Replace noisy the cable.
9. If you make your own connector-coaxial cable assemblies, cut and strip the cable carefully. When using low-noise cable on the 2680, don't smear the electrically conductive coating across the dielectric.
10. Do not allow cable to be dropped, contaminated, stepped on or otherwise abused. Treat it as carefully as you would treat your transducer.

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## APPENDIX B: WHY A CALIBRATION CAPACITOR?

A calibration capacitor allows for the testing of a charge amplifier without an accelerometer attached to the amplifier's input. Common electronic laboratory test instruments may be used to simulate the input charge signal.

A voltage signal from an audio signal generator is fed into the charge amplifier's input via a 1000pF series capacitor (see figure 14) the voltage signal is thus converted to a charge signal.

The transfer function is:  $Q = EC$

Where:

Q= Charge in picocoulombs (pC)

E= Voltage in volts (V)

C= Capacitance in picofarads (pF)

Since the capacitor is 1000 pF, the transfer function simplifies to  $Q$  (pC) =  $E$  (mV). The charge must be expressed in pC peak if the voltage is expressed in peak units. The calibration reference frequency is 100 Hz, thus this frequency is the recommended input used for this test.

The uncertainty will be that of the signal source and the capacitor. The Endevco 2947C has an uncertainty of  $\pm 1\%$ . Adequate shielding is required for optimum accuracy; the amplifier, being a high impedance device sensitive to ambient noise.