Models 166 and 167 Bridgesensors

Features

- Compact, light and precise at an affordable price
- Digital systems can interpret frequency output with ease
- Digital readouts added with minimum effort
- Ready to use with convenient mounting kit, just add power
- Automatic system isolation input to output

Description

The Model 166 and 167 Bridgesensors are complete transducer or strain gage system signal conditioners. These units contain a power supply regulator for powering the bridge and a differential input instrumentation amplifier. They have a frequency output in addition to the standard analog output. When used with a counter and load cell either unit can form a complete weighing system with minimum parts count. Provision has been made for offsetting the output for system tare weight. The units operate from a standard CALEX ±15 VDC Power Supply or DC/DC Converter.

Models 166 and 167 Simplified Block Diagram

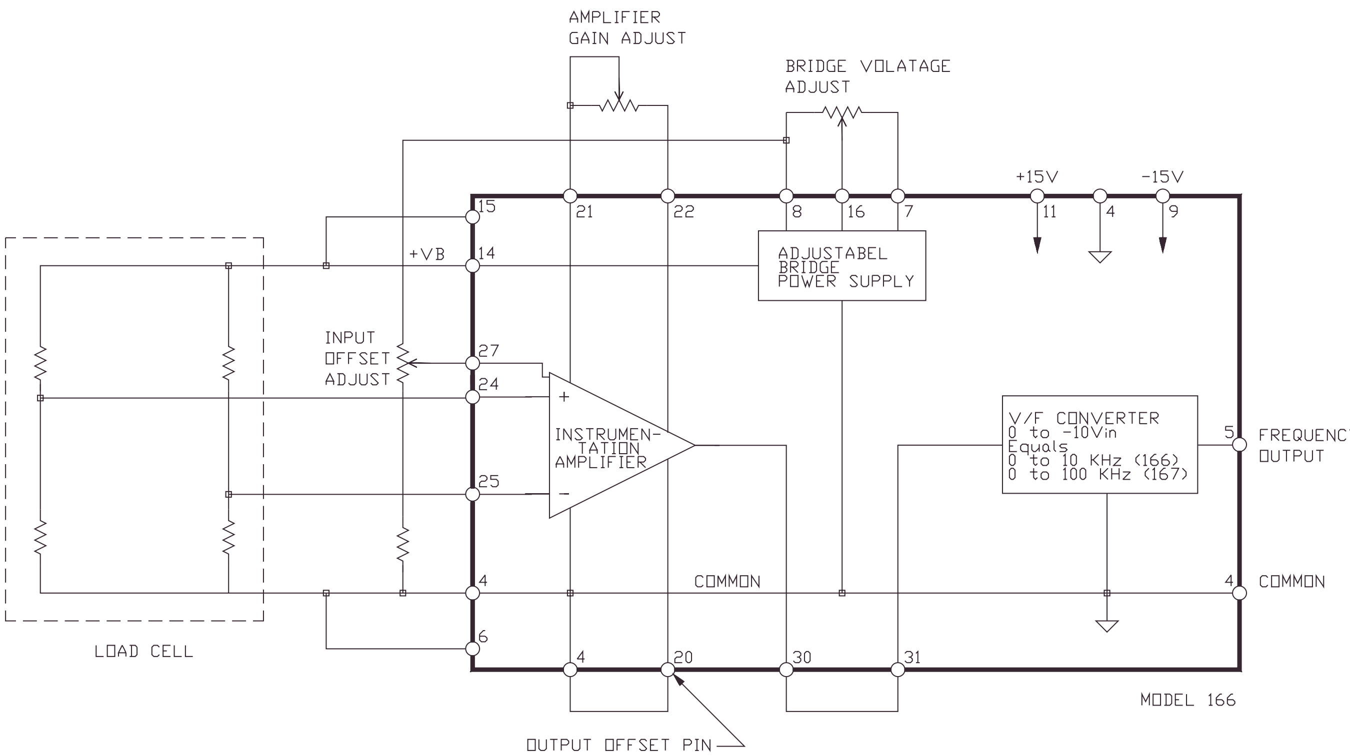


FIGURE 1

Specifications (Typical at +25° rated supply unless otherwise noted.)

Model	166	167
Input Amplifier		
Gain		
Range, Ext. Adj.	10 to 1000	
Equation	G = 10 + 200 kilohm/Rg	
Equation Accuracy	±2%	
Nonlinearity, max.	±0.01%	
Temperature Coefficient	±50 ppm / °C	
Input		
Input Impedence - Diff.	10 megohm	
Input Impedence - CM	500 megohm	
Input Voltage Range, - CM	±6V	
Common Mode Rejection, DC to 60 Hz, G = 100	100 dB typ.	
Input Offsets		
Input Offset Voltage (RTI) @ G = 1000 and +25 °C (Adj. to Zero)	±100 µV	
Vs. Temperature, max.	±0.5 µ V / °C	
Vs. Supply (V_S)	50 µV/V	
Input Bias Current at +25 °C, max.	+250 nA	
Input Difference Current Vs. Temperature, max.	0.1 nA / °C	
Output		
Rated Output - Voltage	±10V	
Rated Current - Output	±5 mA	
Frequency Response		
Bandwidth, -3 dB at G = 100	10 kHz	
Reference Output		
Nominal Value ($+V_R$)	+11.0V to 12.2V	
Temperature Coefficient, max.	±0.01% / °C	
Bridge Supply ($+V_B$)		
Range of Adjustment	+4V to +10V	
Temperature Coefficient	±0.01%/ °C max.	
Output Voltage Noise	1 mVRMS	
Output Current (see Fig. 3)	0 to +100 mA	
Regulation		
Output Voltage Vs. Supply ($\Delta V_B/\Delta V_S$)	1 mV/V	
Regulation, No Load to Full Load	0.01% max.	
V/F Converter		
Input Voltage	0 to -10V	
Input Impedence	100 kilohm	
Output Frequency	0 to 10 kHz	0 to 100 kHz
Temperature Coefficient	±500 ppm	
Direct Output Transistor (Q_1) V_{CEO} V_{EBO} I_C	25 Volts 5 Volts 50 mA	
Isolated Output Transistor (Q_2) V_{CEO} V_{EBO}	30V 7V	N.A. N.A.
Maximum Power Dissipation	150 mW	N.A.
Pulse Width at Collector of Q_1	80 µS typ.	8 µS typ.
General Specification		
Supply Voltage (Rated Specs)	±15V	
Supply Voltage Range	±14 to ±16V	
Quiescent Current Drain	+30 mA and -10 mA	
Environment		
Temperature Range	0 °C to +70 °C	
Size (inches)	2" x 2" x 0.6"	

Bridge Power Supply

The bridge power supply is an adjustable regulated supply specifically designed to drive load cell bridges from 120 to 350 ohms. A curve of maximum output current versus output voltage is shown in Figure 3. The voltage is adjusted by means of an external potentiometer.

Voltage stability is excellent and is derived from a zener reference with a 0.002%/°C temperature coefficient. The power supply uses a series pass regulator together with a frequency stabilized op-amp to provide a ripple free and well regulated voltage source to drive the load cell.

Power supply sense lines are provided on the module so that remote sensing may be used. They can be used to compensate for the voltage drop in long leads to the transducer or to add an external current booster without degrading regulation.

Instrumentation Amplifier

The instrumentation amplifier section of the Models 166/167 is a true differential, high input impedance, low drift amplifier. The design is optimized to perform well with low impedance sources such as a load cell. The drift of the amplifier offset voltage is less than 0.5µV/°C which is the type of performance needed for a strain gage load cell amplifier. For example, with a bridge supply voltage of 10 Volts, a 2 mV/Volt load cell has an output of 20 mV full scale. Amplifier drift of 0.5 µV/°C thus represents an error of 0.0025%/°C of full scale.

Common mode range is ±6 Volts which is adequate when using a 10 Volt bridge supply. Amplifier output is brought out separately for use with or without the voltage to frequency converter. It is also possible to offset the amplifier output from an external low impedance source.

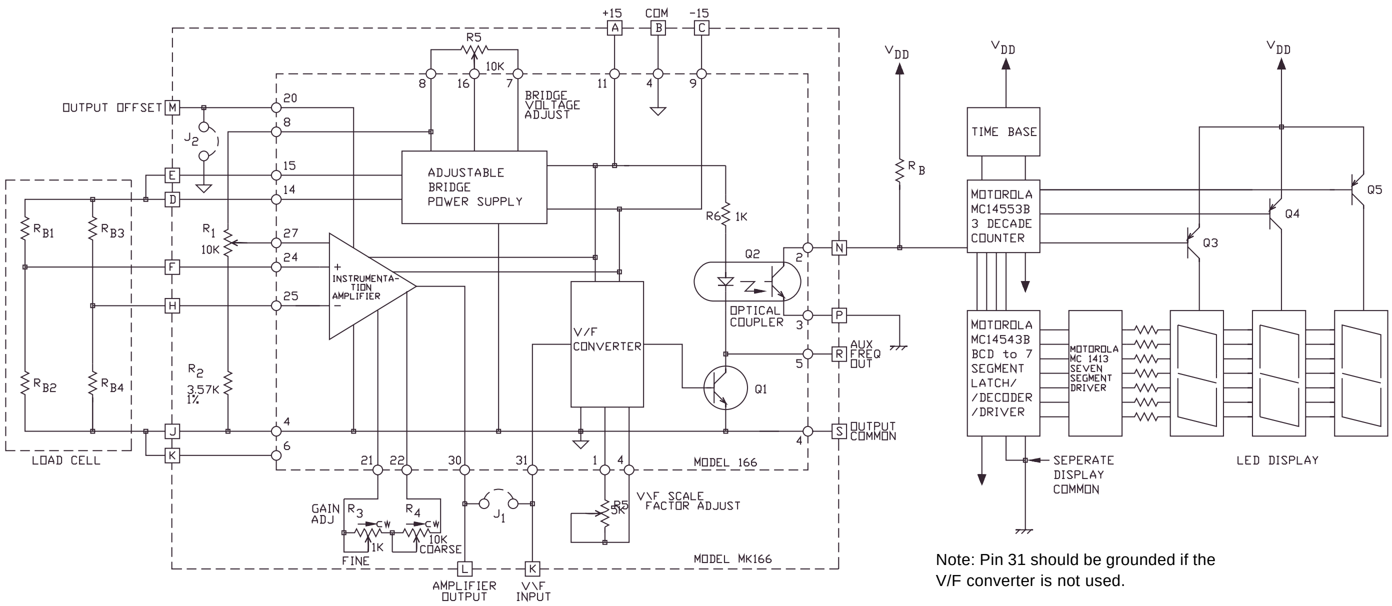
Voltage to Frequency Converter

The Models 166 and 167 employ an advanced integrated circuit to provide a frequency output proportional to the output voltage of the instrumentation amplifier. Although designed for use with the internal instrumentation amplifier, the V/F converter will accept any DC input voltage of from 0 to -10 VDC. Output frequency varies linearly with the input voltage from 0 to 10 kHz or 100 kHz as appropriate. The linearity of the converter is ±0.05% of full scale over the operating range.

Output pulses on the Model 166 are available either as a direct pulse of amplitude +14 Volts or in the form of an optically isolated transistor switch that can be used with a separate power supply for complete system isolation. The Model 167 does not have optical isolation.

Mounting Kit

A convenient PC Card Mounting Kit is available that allows either Bridgesensor to be plugged into a standard 15 pin printed circuit connector. The Model 166/7 Mounting Kit accepts either the Model 166 or Model 167. It includes the necessary potentiometers to adjust the amplifier input offset, the amplifier gain, and the bridge supply voltage. Several test points are provided to assist in calibration or trouble shooting. When ordered with a mounting kit the Model 166 or Model 167 will be delivered mounted on the MK166/7 P.C. card and the potentiometers will be adjusted for zero input offset, an amplifier



Note: Pin 31 should be grounded if the V/F converter is not used.

FIGURE 2. Typical Weighing Application

gain of approximately 500, and a bridge supply voltage of 10 Volts. A 15 pin mating connector is included. A circuit diagram of the MK 166/7 is shown in Figure 7.

Application Information

Figure 2 illustrates a typical weighing application. The load cell signal is amplified and converted to frequency by Models 166 or 167. Scaling is set by changing the amplifier gain or by the V/F scale factor adjustment. These two adjustments allow the user to treat the amplifier and the V/F converter independently if desired. In Figure 2, the amplifier gain would be set so that -10 volts output would represent full scale, 1000 pounds for example. The V/F scale factor would be set for full scale output of 10 kHz or 100 kHz. If a 0.1 second time base were selected for the Model 166 and a 0.01 second for the Model 167 then a load of 999 pounds would be displayed as 999. Stability of the system depends on the load cell stability, the amplifier drift stability, the V/F drift stability and the accuracy of the time base. For better resolution, the display could be expanded to six digits by doubling the counter and digit circuits and by increasing the time base to one second and 0.1 second respectively. For the ultimate in time base accuracy and stability, a crystal clock could be used to generate the time base.

Overall accuracy depends on calibration and the amplifier gain control can be used to provide a system calibration adjustment. System error is the root sum square (RSS) of the various error contributions. If the following errors with respect to the full scale are assumed,

Load Cell	±0.005%/°C (3 mV/V cell)
Amplifier	±0.002%/°C
V/F Converter	±0.01%/°C
Time Base	±0.001%/°C (crystal clock)

Then the theoretical overall error is .011%FS/°C.

Gain

Amplifier gain is set with one external resistor. The MK166/7 mounting kit provides two potentiometers in series for a fine and coarse gain adjustment. There is also a place on the PC card to install a single fixed resistor in place of the potentiometers. The gain equation is $G = 10 + 200\ k\Omega/Rg$ where Rg is the external gain resistor. To illustrate, a gain of 500 would require an Rg of 408 ohms. The accuracy of the gain equation is ±2%. If it is necessary to set the gain very accurately, the best procedure would be to calibrate the amplifier against a known voltage standard.

Bridge Power Supply

The bridge power supply voltage is adjusted with a single 10k potentiometer. To reduce internal heating which could cause undesired amplifier drift, the load current should be kept within the limits indicated in Figure 3. The MK166/7 includes an adjustment potentiometer on the PC card. It is also possible to remotely adjust the bridge supply voltage by applying a positive reference voltage to pin 16 of the 166 or 167 modules. The output voltage will follow the reference voltage, that is, +8 Volts applied to pin 16 will produce a +8 Volt bridge supply voltage.

The + and - sense lines can be used to provide load regulation at the load. If it is necessary to drive more than one or two load cells, the sense lines in combination with a separate power supply and transistor will allow the same regulation and stability but with more output. For example, consider a typical case where four 120 ohm load cells were to be operated in parallel. Current required is 334 mA at 10 Volts. Figure 4 shows how to connect the Models 166/167 to solve this problem.

Input Offset

The external adjustment circuit shown in Figures 1 and 2 will allow the amplifier input offset to be changed over a range of approximately ±2 mV referred to the input. The primary purpose is to adjust the internal amplifier offset to zero; it is not intended to compensate for an unbalanced load cell bridge. When the Model 166 or 167 is purchased on an MK166/7 mounting kit, the offset potentiometer is factory set for minimum offset. If it is necessary to adjust input offset, first short the two inputs to common (pins F, H and J) and then adjust the input offset potentiometer until the amplifier output voltage is minimum (zero volts).

If it is necessary to use this adjustment to compensate for an unbalanced load cell bridge, it can be done, but it should be remembered that in so doing, the amplifier offset drift with temperature will be degraded.

Output Offset

The output of the instrumentation amplifier can be intentionally offset from zero by applying a voltage to pin 20 of the module. It should be noted that the offset introduced by this means is not amplified by the gain, while input offset is. The output can be offset to allow for tare weight compensation. For example, if the container weighs 50 pounds when using a load cell of 1000 pound range, the output of the amplifier may be offset to +0.5 Volt. The weight of the container will then cause the amplifier output to go to zero volts and as load is added the amplifier output will increase in the negative direction causing the V/F converter to operate. In order to minimize the effect of degrading the common mode rejection ratio, the voltage applied to pin 20 should come from a low impedance source such as the output of an operational amplifier.

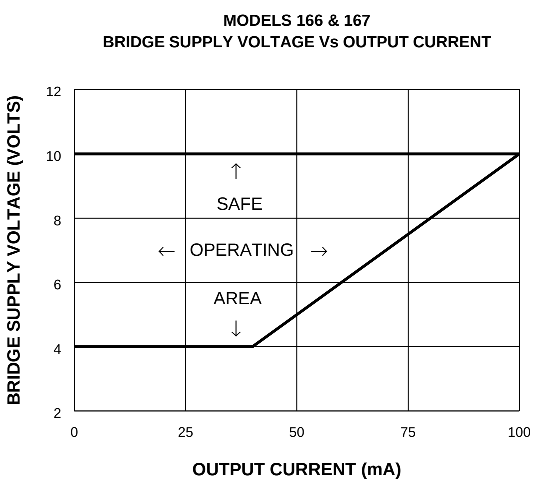


FIGURE 3. Bridge Output Current

V/F Scale Factor Adjust

To set the V/F scale factor, connect an external resistance from pin 1 of the module to common. The value of the resistance is approximately 3 kohms. Calibration is performed by applying -10.000Volts to pin 31 and then adjusting the external resistor until the output frequency is 10.000 kHz or 100.00kHz as appropriate. When the Model 166/7 is purchased with a mounting kit, MK166/7, a multiturn potentiometer is provided for this purpose on the MK166/7. It is factory set for a scale factor of 1 kHz or 10 kHz per volt. The temperature coefficient of the mounting kit pot is ±100 ppm/°C. If better temperature stability is required, the scale factor pot should be replaced with a precision, temperature stable resistor.

Scaling adjustment is done by changing the amplifier gain or by the V/F scale factor adjustment. These two adjustments allow the user to treat the amplifier and the V/F converter independently if desired. In Figure 2, the amplifier gain would be set so that -10 Volts output would represent full scale, 1000 pounds for example. The V/F scale factor would be set for full scale output of 10 kHz or 100 kHz. If a 0.1 second time base were selected for the Model 166 and 0.01 second for the Model 167 then a load of 999 pounds would be displayed as 999.

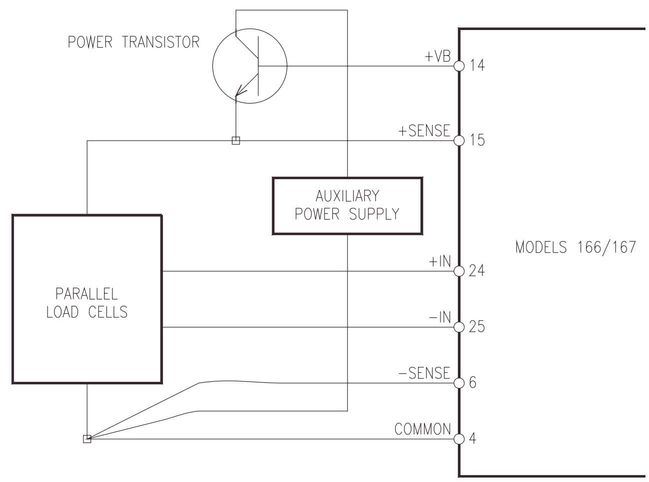


FIGURE 4. Using an External Current Booster

V/F Converter Output

Model 166 provides for auxiliary output or optically isolated output. The auxiliary output is taken between the collector of Q_1 and common. Q_1 can sink 50 mA. When used as a source, the auxiliary output can supply a 10 volt pulse into a 3k load resistor.

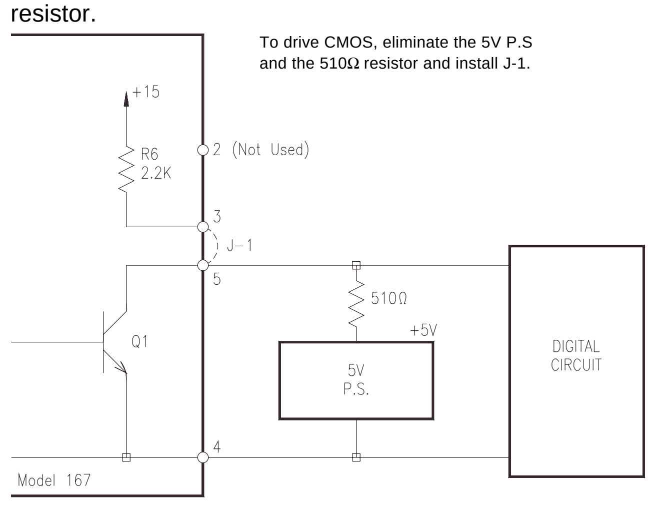


FIGURE 5. Model 167 Output Circuit

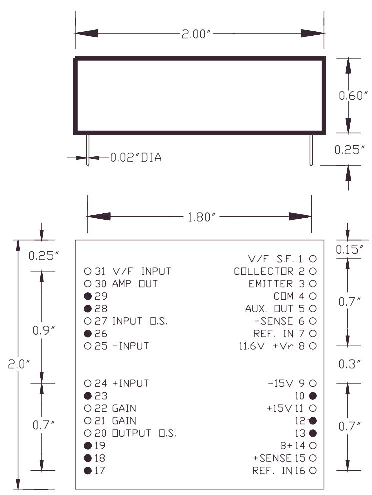
Maximum current through the LED portion of the optical coupler is 13 mA, which results in a minimum phototransistor current of 2 mA. If the phototransistor is used to switch 5 Volts, then its collector resistor should be limited to approximately 1 kohm.

The Model 167 output circuit provides for sinking 50 mA, sourcing 2 mA into 5k or for using a separate collector supply. For example, if TTL digital circuitry is to be driven by the Model 167, the external jumper between pin 3 and 5 can be left out. Then a separate 5 Volt source can be connected to the collector of Q_1 through pin 5 and a load resistor. Figure 5 shows a typical application.

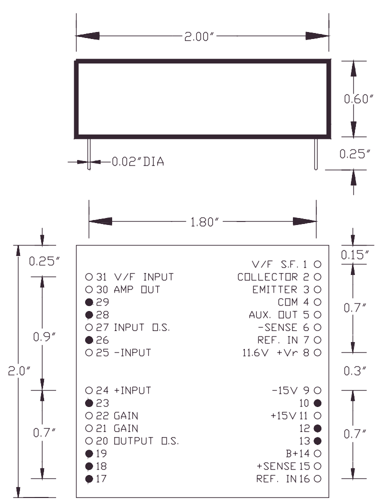
Amplifier Frequency Response

The amplifier bandwidth is 10 kHz at a gain of 100. The rolloff response curve is 20 dB per decade so the 3 dB down frequency can be predicted by knowing the gain setting. For example, at a gain setting of 1000, bw = 1 kHz, and at 10, bw = 100 kHz. It is sometimes desirable to intentionally limit the amplifier frequency response in order to minimize the effect of high frequency noise. The input stage of the V/F converter is an active integrator with a time constant of about 0.5 ms (Model 166), it therefore does not require a bandwidth limit. However, if the amplifier output is also to be monitored by an external device such as a scope or recorder then the user may wish to use additional filtering. This can be done by connecting a simple RC network or an active filter between the monitoring device and the amplifier output. Capacitors should not be connected directly across the amplifier output since this may cause instability.

Mechanical Specifications



MODEL 166
Shaded pins not installed. Shown for position only.



MODEL 167
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FIGURE 6. Outline Dimensions

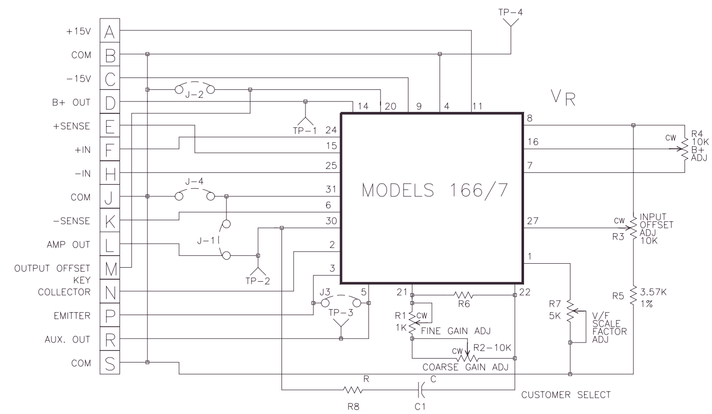

FIGURE 7. MK 166/7 Mounting Kit Schematic

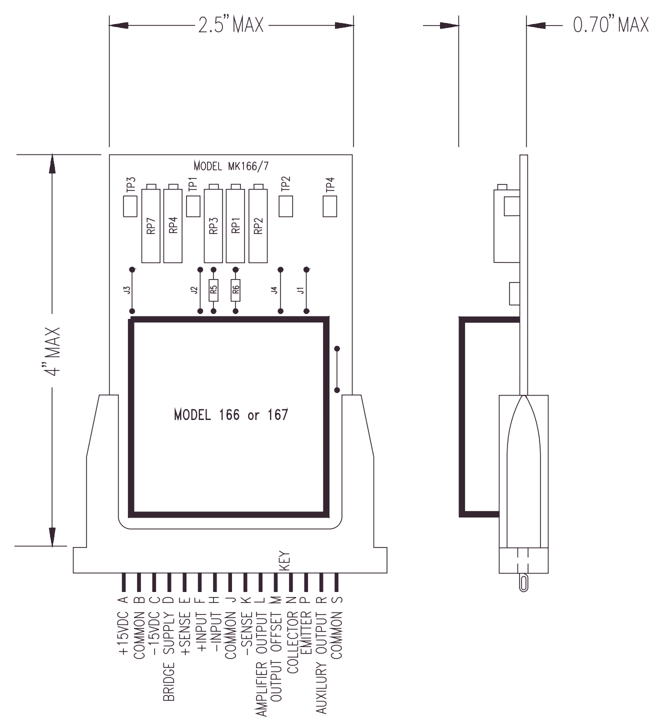

FIGURE 8. MK 166/7 Mounting Kit Dimensions