# M1070 ATTENUATOR/AMPLIFIER

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# M1070 ATTENUATOR/AMPLIFIER

## 1 Description

The M1070 is a general purpose attenuator/low-gain amplifier module for operation with high level sensors such as DC/DC LVDTs, servo accelerometers, etc. and signals generally in the 25mV to 100V range. (For high voltage measurements a special attenuator plug is available, see documentation on C104 High Voltage Connector.)

Features include high input impedance, low noise and drift, with input protection up to 125V differential.

## 2 Front Panel Controls

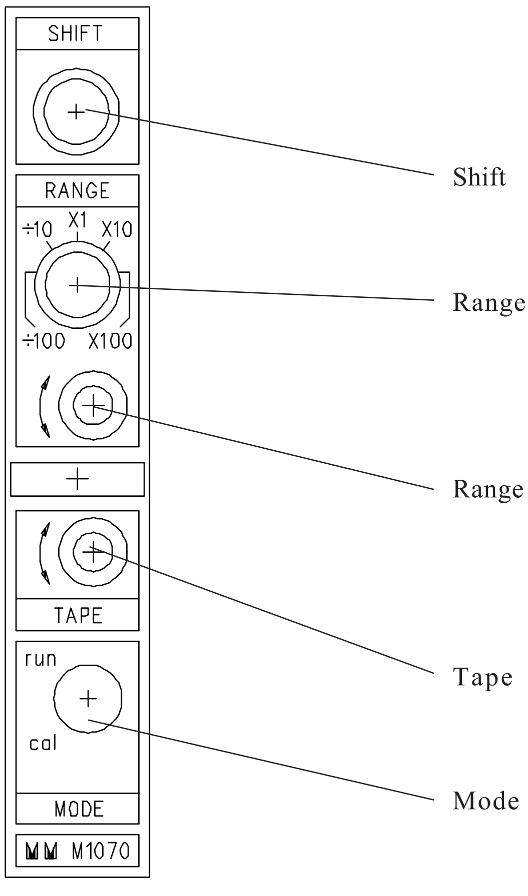


*Figure 1 M1070 Front Panel*

## 2.1 Shift

This is a 22-turn potentiometer which acts as a back-off or input offset control enabling the output to be shifted over plus and minus full scale.

## 2.2 Range

The gain/attenuation range of the amplifier is set by two controls, coarse and fine, which cover the range; divide by 100 to multiplied by 100.

### Coarse Gain

The coarse control is a 5-position rotary switch calibrated directly in gain, the actual sensitivity obtained being a function of the galvanometer type:

| Indicated Range | Typical Input Voltage for 5cm deflection | |
|---|---|---|
| | Max. (fine gain fully counter-clockwise) | Min. (fine gain fully clockwise) |
| “100 | * | 75V |
| “10 | 75V | 7.5V |
| x1 | 7.5V | 750mV |
| x10 | 750mV | 75mV |
| x100 | 75mV | 7.5mV |

* see section 5

### Fine Gain

The Fine Gain control is a 15-turn potentiometer which interpolates the gain steps so that the gain is continuously variable over the switched range.

## 2.3 Tape

A separate amplifier is incorporated to give a buffered voltage output from the unit to drive oscilloscopes, tape recorders, etc. via the Voltage Output connector located on the cabinet rear panel. This is adjustable by means of a 15-turn potentiometer on the module front panel up to ±2V DC.

## 2.4 Mode

A toggle switch enables the amplifier to be used easily in the Operational or the Calibration mode.

In the Operation (RUN) position the amplifier input terminals are directly connected to the transducer via pins 4 and 5 on the Signal Input Connector (see section 8).

In the Calibration (CAL) position the input is connected to a DC calibration voltage derived from the recorder or signal conditioning cabinet being used.

# 3 Internal controls

## 3.1 Bridge Completion

The amplifier may be used with resistive bridge networks in the 1, 2 or 4 arm mode. In the 1 or 2 arm mode, bridge completion is achieved by connecting dummy arms within the amplifier by means of an internal switch (SW2).

The switch is a 6-pole 2-position type, of which poles 1, 2 and 3 are concerned with bridge conditioning, as follows:

**Full Bridge:** In this case the bridge is completed within the transducer, therefore poles 1, 2 and 3 should be in the Open or OFF position.

**Half Bridge:** Poles 1 and 2 are ON, bringing in two 499 ohm dummy arms (R1 and R2). Pole 3 remains Open.

**Quarter Bridge:** Poles 1, 2 and 3 are ON. Note that closing Pole 3 brings in R3, which is normally 120 ohms. If the resistance of the single external bridge arm is different from this value R3 must be changed to match it. (See Typical Input Circuits)

## 3.2 Low Noise Operation

To minimise output noise at high gains a low pass filter can be switched in by closing Poles 4 and 5 of SW2. This, however, has the effect of reducing the bandwidth to approximately 150Hz.

## 3.3 Ground Reference

In applications where the signal source has no connection to ground, (e.g. battery operated systems), it may be desirable to connect the Input LO of the amplifier to ground internally for best noise performance. Pole 6 of SW2 gives this connection when switched to the ON position.

 

# 4 Sensor Excitation

## 4.1 Transducer Supply

The 3 - 12V DC transducer supply (M1015) appears on pins 1 and 2 of the amplifier. These are connected (via R1 and R2) to pins 3 and 4, which in turn are connected to pins 1 and 2 on the 7-pin Signal Input Connector at the rear of the instrument. Thus the transducer cannot be energised unless there is an amplifier present in that particular channel. Note that the amplifier is normally supplied with R1 and R2 replaced by wire links so that the full supply (3 - 12V DC as selected by the Bridge Volts switch) appears across the transducer. However, if a reduced supply is required on a particular channel these may be replaced by resistors of the appropriate value to act as droppers in the supply lines.

For example: With 10V excitation selected, a particular strain gauge is required to be energised with 2.5V.

Bridge resistance = 120 ohms

Bridge excitation = 2.5V

Volt drop required = 7.5V

Therefore:

R1 + R2 = (120x7.5)/2.5 = 360 ohms

So R1 and R2 are 180 ohms each.

Provision is also made to route out the amplifier power supply rails by selection of links (B) on the board. These connect the +12V rail to pin 3, the 0V rail to pin 9 and the -12V rail to pin 4. These in turn are connected to the Signal Input connector on pins 1, 6 and 2 respectively.

Amplifiers supplied from the factory with this connection are designated M1070/S11 and are marked with two brown dots on the handle.

## 4.2 Zero Balance Range

Bridge balance is set by a 22-turn potentiometer which has a nominal range of ±20mV at the input (±4000 microstrain for 10V bridge excitation). For transducers with a very large residual imbalance the range of this control may be increased by the adjustment of R10.

# 5 High Voltage Operation

A special connector, type C104, with a built-in balanced attenuator can be used to extend the input range up to 250V r.m.s. (See documentation on C104 High Voltage Connector).

# 6 Specification

| | |
|---|---|
| Input Configuration: | Low Gain Differential |
| Input Impedance: | 220 Kohm Differential |
| Input Mode: | 1) Resistive bridge in 1, 2 or 4 arm connection with internal bridge completion.<br>2) Medium/high level signals generally. |
| Input Range: | Up to 500 mV (approx.) |
| Maximum Input: | 125V D.C. (up to 250V r.m.s with adaptor type C104) |
| Noise: | Less than 20 microvolts r.m.s.(r.t.i.). |
| Drift: | Less than 20 microvolts/°C (r.t.i.). |
| Bandwidth: | D.C. - 10KHz. |
| Gain: | “100 - x100 in 5 switched steps with interpolate control. |
| Output (Voltage): | Up to ±10V DC |
| Output impedance (Voltage): | 0.5 ohms |
| Output (Current) | ±10mA into 120 ohms |
| Output Impedance (Current): | 250 ohms |
| Package: | Standard M1000 series module |

# 7 Typical Input Circuits

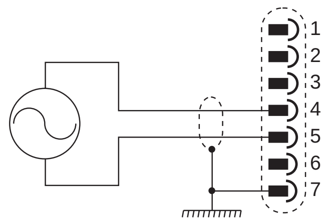


*Figure 2 Analogue Signals*

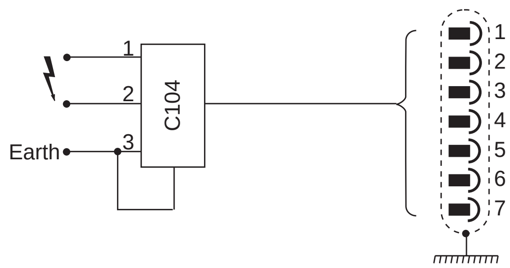


*Figure 3 High Voltage*

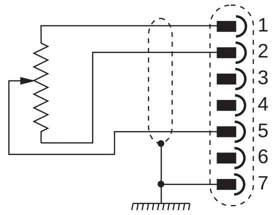


*Figure 4 Potentiometric*

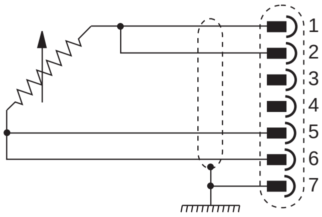


*Figure 5 Resistance Thermometer*

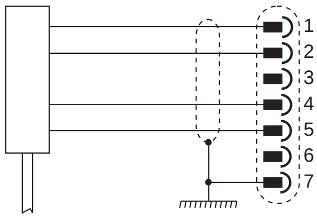


*Figure 6 DC/DC LVDT*

# 8 Calibration

A true calibration of any system can only be achieved by applying a known physical stimulus to the sensor, for example, if the sensor is a pressure transducer, by the use of a deadweight tester, or, in the case of a load cell, by applying known weights, etc. The M1016 calibrator works by removing the output connections from the transducer and injecting a known DC voltage into the amplifier input which corresponds to the signal produced by the transducer for a given stimulus, this being determined by reference to the manufacturers test certificate for that transducer.

Confusion is sometimes caused during the calibration procedure due to the apparent zero shift produced by the different operating modes. It is important for the user to understand why this may occur and how to correct for it. There are basically three zero modes to consider:

a) The galvanometer zero - That is, the true mechanical zero when no current is flowing through the coil. The best way to determine this is to switch the supply to the amplifier off and then the galvanometer may be rotated so that the spot is focused at the point on the chart where the zero for that particular channel is required. The Galvo. On/Off switch is used for this purpose.

b) The amplifier zero - The M1060 module has a variable zero, which is controlled by the potentiometer marked Zero. In practice the amplifier zero should be made coincident with the galvanometer zero by the use of this control. Switch the mode switch on the amplifier to Cal and the Ch. No./Cal switch on the recorder to Ch. No. The meter should now read 0.00V. Adjust using the Zero potentiometer.

c) The sensor zero - Virtually all sensors, except some self-generating types, have a residual zero offset, that is an output which is present when no physical stimulus is applied by the system under test. This may be due to the sensor itself, e.g. mis-match between strain gauges in a Wheatstone bridge, or to physical effects. e.g. an accelerometer would have an output equivalent to 1g in the vertical plane, an absolute pressure transducer would have an output equivalent to ambient barometric pressure, etc. or a combination of both these conditions. This offset can be nulled by the amplifier zero control, as in b) above.

There are two further considerations regarding the zero condition:

d) If a sensor is calibrated in the laboratory and then taken out and mounted on the system under test there may be a difference in the zero due to a change in the temperature or mounting stresses, etc., and this should simply be nulled off as in b) above, the calibration is normally unaffected.

e) When the amplifier is switched from Run to Cal mode there may be a zero shift due to a change in the input conditions. This can be nulled as before without any effect on the calibration.

## 8.1 Calibration Procedure

A typical calibration procedure for one channel would be as follows:

**Example**

It is required to calibrate the recorder for a 1.000 volts input to give 10cm deflection on the galvanometer and 2.00 volts on the Tape output.

Preset the controls as follows:

| | |
|---|---|
| **M1070 Front Panel Controls** | |
| Shift Potentiometer | * |
| Range Switch | x 10 |
| Fine Gain | Fully Counter-clockwise |
| Tape Control | Fully Counter-clockwise |
| Mode Switch | Cal |
| **6-Pole DIP switch** | |
| 1 Half Bridge | OFF |
| 2 Half Bridge | OFF |
| 3 Quarter Bridge | OFF |
| 4 150 Hz low pass filter | OFF |
| 5 150 Hz low pass filter | OFF |
| 6 Ground Input Lo | OFF |
| **Monitor Unit Controls** | |
| Monitor Range Switch | 1.999 |
| Monitor Ch. No./Cal switch | Cal |
| Galvo. On/Off switch | OFF |
| Channel | N |
| Bridge Voltage | * |
| Bridge On/Off | OFF |
| Calibrate +/OFF/- | + |
| Calibrate Fine | * |
| Calibrate Range | 1V |

* Not Important

N Corresponds to channel being calibrated

**Note:** On the M12-150A the Galvo. On/Off switch is fitted inside the Signal Conditioning access hatch on top of the instrument. This feature is not fitted to M1000-6.

Some versions of the M1070 have a higher gain than others and in this case the range switch should be in the X1 position to give the correct gain for the example.

1) Use the Calibrate FINE potentiometer to set the Cal voltage to 1.000 volts on the monitor.

2) Recorders only - Use the galvanometer tool to rotate the galvanometer to align the spot to position 11 on the viewing scale.

**Note:** If all channels are not in use it is preferable to use the centre channels for the best optical fidelity, e.g. Channels 3 through to 7.)

3) Set the Galvo. ON/OFF switch to ON. (This switch provides power to the amplifiers.)
Set the Calibrate +/OFF/- switch to OFF
Set the Monitor CH. No./CAL switch to CH. No.
Set the Monitor 1.999/19.99 switch to 19.99

4) Adjust the SHIFT potentiometer on the amplifier to give 0.00V on the monitor. Observe the galvo, it should correspond to the position set in 2), i.e. 11. If there is a discrepancy recheck the procedure, as either the amplifier is faulty or there has been a wrong setting.

5) Set the Calibrate +/OFF/- switch to +. For recorders use the FINE gain control on the amplifier to set the galvo. spot to position 1, i.e. a deflection of 10cm from 11.

6) Use the TAPE potentiometer on the amplifier to set the monitor voltage to 2.00 volts. At this stage, the system has been calibrated for a sensitivity of 10cm/volt on the recorder and 2.00 volts/volt on the voltage output.

7) Set the Calibrate +/OFF/- swtich to OFF. If there has been a change from the original setting of 11 on the chart scale or 0.00V on the monitor repeat the above procedure from the original preset values in order to fine tune the system.

8) Set the RUN/CAL switch on the amplifier to RUN. The recorder will now read directly the voltage at the input connector scaled as in 7).

If the galvo. spot is off scale, turn the range switch on the amplifier to x 1. This will reduce the original setting by a factor of 10, thus indicating the input voltage as calibrated x 10.