M1060 HIGH GAIN AMPLIFIER

CONTENTS

M1060 HIGH GAIN AMPLIFIER

1 Description

M1060 is a high gain differential-input DC amplifier primarily intended for operation with strain gauges in 1, 2 or 4 external arm mode, load cells, pressure transducers and similar low-level sensors.

Features include high input impedance, low noise and drift, full input protection up to 30V differential, wide dynamic range and galvanometer protection by output current-limiting.

2 Front Panel Controls

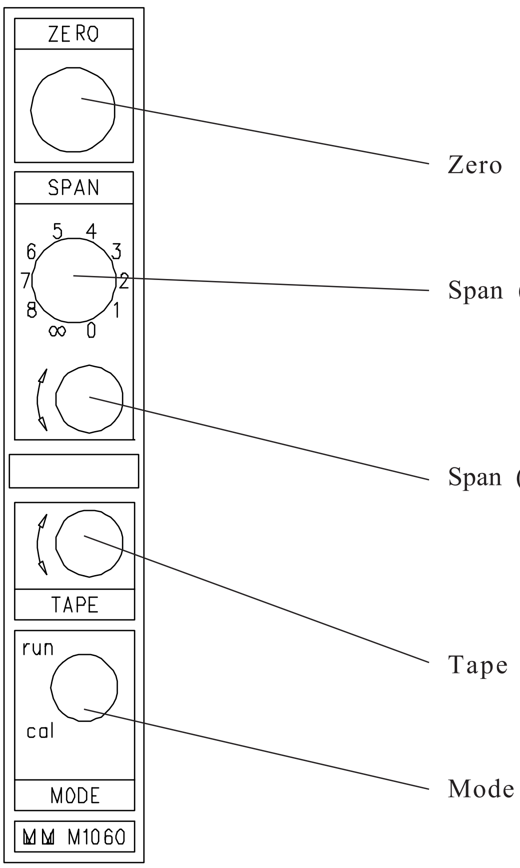

Figure 1 M1060 Front Panel

2.1 Zero

This is a 22-turn potentiometer which functions as a bridge balance or input offset control. Its range is approximately ±20mV at the input terminals (±4000 microstrain at 10V bridge excitation). However, the range can be modified by internal adjustment, (see section 4.2).

2.2 Span

The amplifier span (gain) is set by two controls, coarse and fine, which cover the approximate range 20 to 5000:1.

Coarse Gain

The Coarse Gain control is a 10-position rotary switch calibrated such that in each successive position the gain is halved. The gain settings are as follows:

Position	Gain (approx.)	Typical input for a 5cm deflection	
		Min. (V)	Max. (V).
0	5000	0.4	0.7
1	2500	0.7	1.5
2	1250	1.5	3
3	625	3	6
4	312	6	11
5	156	11	22
6	78	22	45
7	39	45	90
8	20	90	175
00	0.5	N/A	N/A

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 bridge 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. The dummy bridge arms should be switched in according to the input configuration, 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 position.

Half Bridge: Poles 1 and 2 are Closed, bringing in the two 499 ohm dummy arms (R25 and R26). Pole 3 remains Open.

Quarter Bridge: Poles 1, 2 and 3 are Closed. Note that closing Pole 3 brings in R27, which is normally 120 ohms. If the resistance of the single external bridge arm is different from this value R27 must be changed to match it. (See also 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.

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 reverse the excitation polarity by means of links, (A or B), on the board, or of course this may also be achieved by reversing pins 1 and 2 on the Signal Input connector.

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 Voltage Output Range

The amplifier has a separate buffered voltage output which appears on the Voltage Output socket on the rear of the instrument. The nominal output level with a 10cm deflection on the galvanometer can be adjusted by means of the potentiometer marked Tape up to ±2V DC.

6 Specification

Input Configuration:	High Gain Differential
Input Impedance:	1 Megohm Differential
Input Mode:	1) Resistive bridge in 1, 2 or 4 arm connection with internal bridge completion. 2) Low level signals generally.
Input Range:	Up to 500 mV (approx.)
Maximum Input:	30V D.C.
Common Mode Rejection:	90dB (D.C. to 60 Hz)
Noise:	Less than 5 microvolts r.m.s.(r.t.i.) at max. gain.
Drift:	Less than 2 microvolts/°C (r.t.i.) at max. gain.
Bandwidth:	D.C. - 5KHz.
Gain:	20 - 5,000 in 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

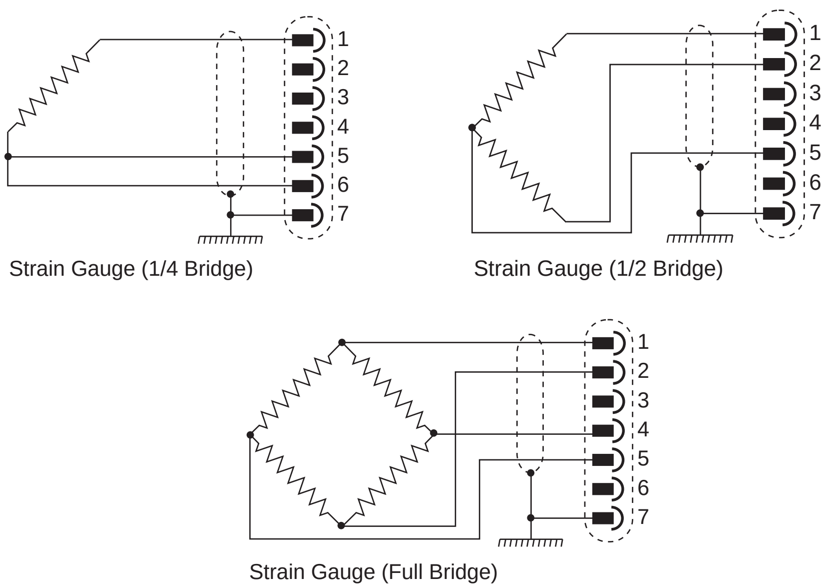

Figure 2 Strain Gauge

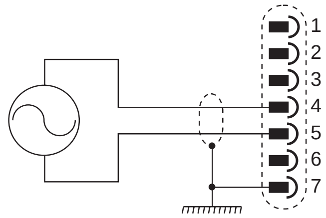

Figure 3 Analogue Signals

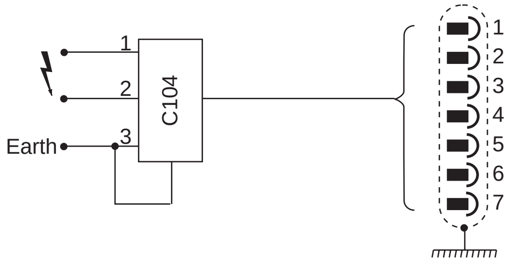

Figure 4 High Voltage

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.

Mode Switch (Amplifier)

This is usually a 2-pole changeover switch connected to the amplifier input terminals.

- In the Operation (RUN) position the amplifier input is connected directly to the signal source (usually a transducer) via pins 4 and 5 on the Signal Input connector at the rear of the instrument.
- In the Calibration (CAL) position the input is connected to a calibration voltage derived from the recorder or signal conditioning cabinet.
- There are some versions of the M1060 module which are fitted with other types of calibration facility (e.g. Shunt cal.). If in doubt consult the Company.

8.1 Calibration Procedure

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

Take a pressure transducer with a nominal output of 40mV for full scale pressure with 10V excitation (typical for an unbonded strain gauge type). However, it is unlikely that any particular transducer would have an output of exactly 40mV, more likely it would be somewhere within ±10% of this value. So, we look at the manufacturers calibration certificate supplied with the transducer and see that this is a 75 PSI unit which has an output of +38.68mV at 75 PSI if energised with a 10V DC supply.

Note: If energised by a different supply the output is normally pro-rata but the temperature coefficient is sometimes degraded.

The transducer has a zero imbalance (i.e. an output when no pressure is applied) of -2.97mV. Therefore the total output change for 75 PSI applied is the sum of these two (because the zero imbalance happens to be negative):

38.68 + 2.97 = 41.65mV.

It would be sensible if we made 75 PSI equivalent to 7.5cm excursion on the chart so that in analysis the pressure is read direct from the grid lines (1cm = 10PSI). Thus the calibration figure would be:

41.65 x (10/7.5) = 55.5mV for 10cm deflection.

Preset the controls as follows:

M1060 Front Panel Controls

Zero Balance Potentiometer	*
Range Switch :	6
Fine Gain	Fully Counter-clockwise
Tape Control	Fully Counter-clockwise
Run/Cal Switch	Cal

DIP Switch

1	Half Bridge	OFF
2	Half Bridge	OFF
3	Quarter Bridge	OFF
4	Low Pass Filter	OFF
5	Low Pass Filter	OFF
6	Not Used	OFF

Monitor Unit Controls

Monitor Range Switch	19.99
Monitor Ch. No./Cal Switch	Cal
Galvo. On/Off	OFF
Channel	N
Bridge Voltage (as required for transducer)	10V
Bridge On/Off	OFF
Calibrate +/OFF/-	+
Calibrate Fine	*
Calibrate Range	10V

* Not Important

N Corresponding 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.

1) Using the Calibrate FINE potentiometer set the voltage on the Monitor to 5.55V.

2) Turn Calibrate RANGE to 100mV. There will now be 55.5mV on the mainframe calibration bus.

3) 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.

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

5) Adjust the ZERO balance potentiometer on the amplifier to give 0.00V on the monitor. Observe the galvo. spot, it should correspond to the position set in 3) i.e. 11. If there is a discrepancy, recheck, as either the amplifier is faulty or there has been a wrong setting.

6) Calibrate +/OFF/- switch to +.

   Adjust the spot deflection to 10cm. i.e. position 1 on the viewing scale using the FINE gain control on the amplifier. If 10cm cannot be achieved turn the RANGE switch one position clockwise to increase the gain by 2, then reduce the FINE gain to re-adjust to 10cm.

7) Using the TAPE potentiometer on the amplifier, set the monitor voltage to a suitable value, e.g. 2.00V. At this stage the system has been calibrated for a sensitivity of 1cm/10 PSI on the recorder and a voltage output of 200mV per 10 PSI.

8) Calibrate +/OFF/- switch to OFF.

   If there has been a change from the original settings of 11 on the graticule or 0.00V on the monitor repeat the above procedure from the original preset values in order to fine tune the system.

9) RUN/CAL switch on the amplifier to RUN.

   Use the ZERO balance potentiometer to set 0.000V on the monitor. The galvanometer spot should still correspond to position 11 on the viewing scale.

10) Bridge ON/OFF switch to ON

    The zero will almost certainly move due to residual offset. Use the Zero control to position the spot to the original zero position, i.e. 11 on the graticule.

11) The system is now fully calibrated and ready for use. If a different position is

preferred for the galvo. mechanical zero, set the Galvo. ON/OFF switch to the OFF position before moving the galvo. Return the switch to ON after the galvo. has been set.

12) If, after step 10), the galvo. or voltmeter are completely off scale note the position of the range switch and temporarily reduce the gain of the amplifier by turning the range switch counter-clockwise one or two positions to find the spot and then re-balance. If it still cannot be re-balanced there must be a fault in the bridge circuit, all four arms of the bridge should be checked at the free connector.