DESCRIPTION

The Model 380G Adjustable Gain Module provides an output current that is directly or, if desired, inversely proportional to a standard 1 to 5 Vdc input.

It incorporates an adjustable gain amplifier that can multiply the input signal by a factor of 0.1 to 100. An input bias trimpot is used to shift the input signal to zero base and to provide a reference signal of up to +5 Volts if required. The output signal is available in either the 4 to 20 mA or the 10 to 50 mA current range, selected by wire jumper J1. The output bias trimpot re-establishes the needed 4 or 10 mA base of the output signal.

The Module is designed to be plugged into a Model 380 Series Card Cage Enclosure equipped with a common power supply (see Service Instruction SD3801).

The input and output of the Module are referenced to one common which is also the power supply common serving all other plug-in modules in the card cage.

Current input signals are accommodated by placing precision resistors across the input terminals in the card cage enclosure. This permits removal of the Module without interrupting the input current loop.

The following calibration equations define the input/output relationships of this Module.

\[ I_O = \frac{G_O}{R_O} (V_A - b_A) + K_O \text{ \hspace{1cm} DIRECT ACTING MODE} \]

\[ I_O = \frac{G_O}{R_O} (b_A - V_A) + K_O \text{ \hspace{1cm} REVERSE ACTING MODE} \]

Where, \( I_O \) = Output Current, 4 to 20 mA or 10 to 50 mA
\( G_O \) = Gain, adjustable 0.1 to 100.
\( R_O \) = Voltage/Current Transfer Constant
\( V_A \) = Input Voltage, 1 to 5 Vdc
\( b_A \) = Input Bias, 0 to 5 Vdc
\( K_O \) = Output Bias, 0 to 20 mA or 0 to 50 mA

SPECIFICATIONS

INPUT (\( V_A \))

Range: 1 to +5 Volts
Impedance: 5 Megohms (min.)
Overload (Without Damage): \( \pm 24 \) Volts (max.)

ADJUSTMENTS

Input Bias (\( b_A \)): Range: 0 to +5 Volts
(Gain (\( G_O \)): 3 Ranges:

<table>
<thead>
<tr>
<th>J2 Position</th>
<th>Gain Range (22 turn trimpot, R9)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>0.1 to 1.0</td>
</tr>
<tr>
<td>B</td>
<td>1.0 to 10</td>
</tr>
<tr>
<td>C</td>
<td>10 to 100</td>
</tr>
</tbody>
</table>

OUTPUT (\( I_O \))

Field Selectable Range

<table>
<thead>
<tr>
<th>Field</th>
<th>Permissible Load</th>
</tr>
</thead>
<tbody>
<tr>
<td>AC Powered Enclosures</td>
<td>24 Vdc Powered Enclosures</td>
</tr>
<tr>
<td>4 to 20 mA</td>
<td>0 to 900 Ohms</td>
</tr>
<tr>
<td>10 to 50 mA</td>
<td>0 to 360 Ohms</td>
</tr>
</tbody>
</table>

Load Effect: Less than \( \pm 0.1\% \) within the allowable load range.

Current Limiting: Output will not exceed 150\% of full scale when input is overdriven.

VOLTAGE TO CURRENT TRANSFER CONSTANT

\( R_O K \): 0.250 (for 16 mA output span)
0.100 (for 40 mA output span)

ACCURACY: \( \pm 0.25\% \) of output span; test limit \( \pm 0.1\% \) typical.

REPEATABILITY: \( \pm 0.15\% \) of output span; test limit \( \pm 0.1\% \) typical.

RESPONSE TIME: 150 mSec to reach 98\% of output span (typical)

OPERATING TEMP: 32 to 122°F (0 to 50°C)

TEMP. EFFECT: Input/Output transfer function changes less than \( \pm 0.008\%/°F \)

ELECTRICAL ISOLATION: NONE. The negative input terminal is common with the negative output terminal and the negative bus of the card cage power supply.

MOORE PRODUCTS CO., Spring House, Pa. 19477

SERVICE INSTRUCTIONS
ADJUSTABLE GAIN MODULE
MODEL 380G

SD380G
Issue: 2
Date: 6/81
INSTALLATION

The Adjustable Gain Module must be installed in a Model Series 380 Card Cage Enclosure. It can be plugged into any of the slots in the enclosure. Refer to customer drawing for the designated slot or assign a convenient slot for it.

The safety keys of the designated slot in the card cage enclosure must be set before the module can be plugged in. Service Instruction SD3801 identifies these safety keys and gives the procedure for setting them. The positions of the keys for the Adjustable Gain Module are as follows:

Left Key: V (Vertical)
Right Key: V (Vertical)

The input and output connections are made to the terminal strips provided at the front or the rear of the card cage enclosure (depending on model). Each terminal strip is identified with a number that matches a corresponding slot number. Refer to the Connection Diagram (Figure 1) in this Instruction and to Service Instruction SD3801.

WARNING

Ensure that power is OFF on all wires being connected.

To convert a current signal to a voltage signal, select an appropriate conditioning resistor listed below and connect it across the required input or output terminals.

<table>
<thead>
<tr>
<th>Current Signal</th>
<th>Conditioning Resistor (to obtain 1 to 5 Volts)</th>
<th>MPCo. Part No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 to 5 mA</td>
<td>1000 Ohms ± 0.1%</td>
<td>15037-228</td>
</tr>
<tr>
<td>4 to 20 mA</td>
<td>250 Ohms ± 0.1%</td>
<td>15037-229</td>
</tr>
<tr>
<td>10 to 50 mA</td>
<td>100 Ohms ± 0.1%</td>
<td>15037-230</td>
</tr>
</tbody>
</table>

NOTE

All plug-in modules in the card cage share the same SIGNAL COMMON bus line due to their common power supply. Be careful when connecting various signal lines to avoid possible ground loops or shorts.

CALIBRATION

GENERAL

The Adjustable Gain Module is normally shipped factory calibrated for a specific customer application. Such a module requires no additional adjustment and can be put immediately into service. It is accompanied by a calibration drawing containing the required hook-up diagram and the calibration equation. The data given in the calibration equation is needed for future calibration checks.

Modules ordered without a specific application request, must be calibrated by the user.

Before any module can be calibrated, it is necessary to develop a calibration equation that will prescribe the operating parameters of the module. The needed calibration data is described in the REQUIRED DATA section.

To assure continued accuracy, it is recommended to check the calibration after the first 30 days of opera-

TERMINAL STRIP ON SERIES 380 RACK ENCLOSURES.

<table>
<thead>
<tr>
<th></th>
<th>INPUT (Note 1 &amp; 2)</th>
<th>OUTPUT R₁ (Note 3)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>NC</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>NC</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>NC</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>NC</td>
<td></td>
</tr>
</tbody>
</table>

NOTES:
1. 1.5V dc signals are standard inputs. For process current inputs, refer to Service Instruction, SD3801 for proper input conditioning resistors.
2. The negative input terminal is common with the cage DC power supply.
3. See output specifications for load limits.

FIGURE 1 Connection Diagram

Ion and then at regular intervals dictated by the severity of the operating environment or whenever an inaccuracy is suspected. Use the following procedure to perform periodic calibration checks or to calibrate the Module for a new application. Figure 2 shows the location of all jumper wires and trimpots.

REQUIRED DATA

To properly calibrate the Module, the following information must be obtained from the calibration equation.

1. Operating Mode (Direct or Reverse Acting)
2. Gain Level (G₀)
3. Voltage to Current Transfer Constant (R₀)
4. Output Bias (R₂)
5. Input Bias (bᵢ)

The required operating mode is revealed by the form of the calibration equation. If the calibration equation appears in the form of the first equation given in the DESCRIPTION section, then a DIRECT ACTING operating mode is required. A calibration equation in the form of the second equation indicates a REVERSE ACTING operating mode requirement.

The GAIN level (G₀) appears in the calibration equation directly. It may be any whole number and/or fraction ranging from 0.1 to 100. This is equivalent to a proportional band range of 1 to 1000%.

Gain (G₀) = 100/Proportional Band

The voltage to current transfer constant (R₀) determines the output current span.

<table>
<thead>
<tr>
<th>R₀</th>
<th>I₀ Span</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.25</td>
<td>16 mA</td>
</tr>
<tr>
<td>0.10</td>
<td>40 mA</td>
</tr>
</tbody>
</table>
INPUT/OUTPUT
J3/J4 JUMPERS*

DIRECT
J3 POINT X
J4 POINT Y

REVERSE
J3 POINT Y
J4 POINT X

* FIELD CHANGEABLE

INPUT BIAS ADJUST

GAIN RANGE | J2*
0.1 TO 1.0 | POINT A
1.0 TO 10 | POINT B
10 TO 100 | POINT C

* FIELD CHANGEABLE

GAIN ADJUST

OUTPUT BIAS ADJUST

OUTPUT RANGE JUMPER*
4-20mA | J1 OUT
10-50mA | J1 IN

*NOTE: JUMPER IS LOCATED ON FOIL SIDE OF PCB BOARD.

FIGURE 2 P.C. Board
For standard output current ranges, the above indicated spans are typically offset by the output bias ($I_O$) of 4 mA or 10 mA to produce 4 to 20 mA or 10 to 50 mA ranges, respectively. The input bias ($I_B$) is also shown in the calibration equation directly. It is normally used to zero base the standard 1 to +5 Volt input to the 0 to +4 Volt range before feeding this signal through the adjustable gain amplifier.

**REQUIRED EQUIPMENT**

The following equipment is required to properly check and calibrate the Adjustable Gain Module:

1. **Model Series 380 Card Cage Enclosure with power supply.**
2. **Adjustable Signal Source.**
   The following devices may serve as signal sources:
   a. Voltage Source — typically 0 to 5 Vdc.
   b. Current Source — typically 0 to 50 mA dc.
   c. Transmitter — adjustable over required range.
   These devices must be adjustable to an accuracy of 0.1%.
3. **Digital Output Meter**
   The following devices may serve this purpose:
   a. Digital Voltmeter
      Range: 0 to 5 Vdc
      Input Impedance: 1 Megohm (minimum)
   b. Digital Milliammeter
      Range: 0 to 50 mAdc
      Insertion Resistance: 200 Ohms (maximum)
   Both devices must have an overall accuracy of 0.1% or better.
4. **Digital Voltmeter**
   Range: 0 to 5000 Vdc
   Input impedance: 1 Megohm (minimum)
   Accuracy: ± 0.005%
5. **Conditioning Resistors**
   Required number of appropriate value to convert current signals to voltage where necessary. See INSTALLATION section for available values.

**PRELIMINARY ADJUSTMENTS**

Obtain all the required calibration data listed and described in the REQUIRED DATA section. Refer to Figure 2 for the location of the various jumper plugs and test jacks.

1. Determine the required output current range ($I_O$).
   If necessary, reposition range jumper J1 located on the foil side of the Module.
2. Determine the required gain ($G_O$). Place the gain range jumper plug J2 into the appropriate jack (A, B, or C) located on the component side of the P.C. Board.
3. Determine the required operating mode and place jumper plugs J3 and J4 into the appropriate jacks (X and Y) as shown in Figure 2.
4. Plug the Module into the specified or a convenient slot in the card cage, turn on the power supply, and let it warm up for five minutes.

**PROCEDURE**

1. Obtain all the required data and equipment as listed and discussed in the correspondingly titled previous sections.
2. Perform all the steps listed in the PRELIMINARY ADJUSTMENTS section.
3. Connect the adjustable signal source to input terminals 1 (+) and 2 (−) on the card cage as shown in Figure 1, Connection Diagram.

**NOTE**

Use appropriate conditioning resistors if it is necessary to convert current signals to voltage. See the INSTALLATION section for a list of available parts.
4. Set the adjustable signal source to the required input bias ($I_B$) level.
5. Connect the Digital Voltmeter to test jacks TP+ and TP− at the front of the Module.
6. Adjust INPUT BIAS trimpot (R9) for 0 Volts (±1 mV) across test jacks TP+ and TP−.
7. Connect the output measuring device to output terminals 4 (+) and 5 (−) on the card cage as shown in Figure 1, Connection Diagram.
8. Adjust OUTPUT BIAS trimpot (R28) for a reading of the required $I_O$ level on the output measuring device (Typically, 4 mA or 10 mA).
9. Use one of the following two procedures to adjust the gain ($G_O$) to the required level:
   a. **Required Gain ($G_O$) = 1 or less.**
      With this requirement, set the signal source to 5.000 Vdc. Calculate the expected output level ($I_O$) by inserting this and other specified data into the appropriate calibration equation given in the DESCRIPTION section.
      Adjust the GAIN trimpot (R8) to read the expected output level ($I_O$) on the output measuring device.
      Repeat steps 4, 6, 8 and 9a as required.
   b. **Required Gain ($G_O$) = 1 or more.**
      With this requirement, it is necessary to calculate the calibration signal level ($V_A$) that will produce exactly a full scale output. The calculation is initiated by plugging the required data into one of the following two equations:

      \[ V_A = \frac{R_O (I_{omax}) - K_O}{G_O} + b_A \]  
      for DIRECT ACTING MODE

      OR

      \[ V_A = b_A - \frac{R_O (I_{omax}) - K_O}{G_O} \]  
      for REVERSE ACTING MODE
Note that in all applications using the standard output spans of 16 or 40 mA, the expression \( R_0 \left( I_{O \text{ (max) }} - I_O \right) \) is equal to 4.000.

A typical computation of \( V_A \) for an application using a standard output span, operating in the reverse acting mode, and specifying \( G_O = 1 \) and \( b_A = 5.000 \), will appear as

\[
V_A = 5.000 - \frac{4.000}{1} = 1.000 \text{V}
\]

Set the signal source to the calculated calibration signal level (\( V_A \)).

Adjust the GAIN trim pot (R8) to read full scale output (\( I_{O \text{ (max) }} \)) on the output measuring device (typically 20 or 50 mA).

10. Repeat steps 4, 6, 8 and 9 as required.

This completes the calibration procedure.

MAINTENANCE

GENERAL

Required maintenance for this Module should consist of periodic cleaning, visual inspection, and calibration checks. The severity of the environment in which the Module is located will determine the required frequency of maintenance.

CLEANING

The Module should be cleaned as often as operating conditions require. The accumulation of dust and dirt on components prevents efficient heat dissipation which can cause overheating and component breakdown.

Blow off accumulated dust and dirt with dry, low velocity air. Any dust or dirt that remains should be removed with a soft brush or cloth dampened with a mild detergent and water solution. Cotton-tipped swabs are useful for cleaning in narrow spaces.

CAUTION

Avoid the use of chemical agents which may damage plastic components or protective coatings.

VISUAL INSPECTION

The Module should be inspected occasionally for defects such as loose or broken connections, damaged circuit board, and heat-damaged components.

The corrective action for most visible defects is obvious. However, if a heat-damaged component is found, the cause of overheating must be corrected to prevent a recurrence of the damage.

CAUTION

Exceeding the specified ambient temperature limits can adversely affect performance and may cause damage.

TROUBLESHOOTING

If the Module does not operate properly when initially installed, check the terminal strip wiring. Most problems in new installations can be traced to wiring mistakes. Also, verify that the equipment associated with the input and output circuits is functioning and is properly calibrated.

If the trouble is traced to the Module, remove the Module and give it a full bench check. A complete schematic of the Module is given in Figure 3.

A Part No. 15376-27 Card Extender can be ordered. It extends the Module beyond the front edge of the card cage enclosure, providing easy access to both sides of the Module's circuit board.

IMPORTANT

Warranty repair and replacement requires the Module to be returned to Moore Products Co., Spring House, Pa. 19477. The warranty is null and void if repair is attempted at any other location.

RECOMMENDED SPARES

There are no recommended spare parts for the Adjustable Gain Module.

One spare module is recommended for every 1 to 10 in service.