DESCRIPTION

The Model 3800 Square Root Extractor Module provides a process current output signal that is proportional to the square root of its input signal. Its normal input range is 1 to 5 Volts. A range of 0 to 4 Volts can be selected by removing jumper J1. Its normal output range is 4 to 20 mA. A 10 to 50 mA output can be obtained by installing jumper J2.

The following expression defines the input to output relationship of this module.

\[ I_o = \frac{G_o \sqrt{V_A - B_A}}{R_o} + K_o \]

Where, \( I_o \) = Output in mA (selectable by J2)
\( G_o \) = Adjustable Output Span (2 ± 10%)
\( V_A \) = Input in Volts
\( B_A \) = Adjustable Input Bias (selectable by J1)
\( K_o \) = Adjustable Output Bias
   For 4 mA output - Without J2
   For 10 mA output - With J2
\( R_o \) = Voltage to Current Transfer Constant
   For 20 mA output = 0.250
   For 50 mA output = 0.100

Refer to the SPECIFICATIONS section for the exact adjustment parameters and operating limitations.

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

SPECIFICATIONS

INPUT

Range (Max.) .................. 0 to + 5 Volts
Input Bias (bA) ................. W J1, 0 ± 2V; WO J1, 1 ± 2V (Adj.)
Overload ........................ ± 30 Volts (Maximum)
Impedance ...................... 1 Megohm (Minimum)

OUTPUT

Permissible Load

<table>
<thead>
<tr>
<th>Selectable Range</th>
<th>AC Powered Enclosures</th>
<th>24V dc Powered Enclosures</th>
</tr>
</thead>
<tbody>
<tr>
<td>4 to 20 mA</td>
<td>0 to 900 Ohms</td>
<td>0 to 700 Ohms</td>
</tr>
<tr>
<td>10 to 50 mA</td>
<td>0 to 360 Ohms</td>
<td>0 to 280 Ohms</td>
</tr>
</tbody>
</table>

Output Bias (K_o) .................. Adjustable ± 5% of output current

Output Span (G_o) .................. Factor 2 adjustable ± 10% as defined by the input/output expression under DESCRIPTION.
Load Effect ...................... Less than 0.1% within permissible load range.
Current Limiting ................. Output will not exceed 150% of full scale when input is overdriven.
CONFORMITY ...................... ± 0.1% for 10% to 100% of input span
   ± 0.15% for 1% to 10% of input span
OPERATING TEMP.................. 32 to 122°F (0 to 50°C)
RESPONSE TIME .................. Less than 300 mSec. to reach 98% of output span.

INITIAL ADJUSTMENTS

Standard modules shipped from the factory accommodate 1 to 5V dc inputs and provide 4 to 20 mA outputs. These ranges can be changed in the field by means of wire jumpers followed by complete calibration.

To check or to change the range settings refer to the following table.

<table>
<thead>
<tr>
<th>Input Range</th>
<th>Range Jumper Wire</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 to 4 Volts</td>
<td>J1 Removed</td>
</tr>
<tr>
<td>* 1 to 5 Volts</td>
<td>J1 Installed</td>
</tr>
<tr>
<td>* 4 to 20 mA</td>
<td>J2 Removed</td>
</tr>
<tr>
<td>10 to 50 mA</td>
<td>J2 Installed</td>
</tr>
</tbody>
</table>

* Standard range set at the factory.

Both range jumpers (J1 and J2) are located on the foil side of the PC board as shown in Figure 1.

INSTALLATION

The Square Root Extractor 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 drawings for the designated slot or assign a convenient slot for it.

WARNING

Ensure that all power (supply and signal) to the enclosure is off before setting the safety keys.
### Input Range Jumper

<table>
<thead>
<tr>
<th>Range</th>
<th>Jumper Placement</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-4V</td>
<td>J1 OUT</td>
</tr>
<tr>
<td>1-5V</td>
<td>J1 IN</td>
</tr>
</tbody>
</table>

### Output Range Jumper

<table>
<thead>
<tr>
<th>Range</th>
<th>Jumper Placement</th>
</tr>
</thead>
<tbody>
<tr>
<td>4-20mA</td>
<td>J2 OUT</td>
</tr>
<tr>
<td>10-50mA</td>
<td>J2 IN</td>
</tr>
</tbody>
</table>

**Note:** Jumper J1 & J2 are located on foil side of PC board.
The safety keys of the assigned slot in the card cage enclosure must be set before the module is plugged in. Service Instruction SD3801 identifies these safety keys and gives the procedure for setting them. The positions of the keys for the Square Root Extractor 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 2) in this Instruction and to Service Instruction SD3801.

**WARNING**

Ensure that all power on all wires to be connected is off.

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 (mA)</th>
<th>Conditioning Resistor (Ohms)</th>
<th>Part No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 to 5</td>
<td>1000 ± 1%</td>
<td>15037-226</td>
</tr>
<tr>
<td>4 to 20</td>
<td>250 ± 1%</td>
<td>15037-229</td>
</tr>
<tr>
<td>10 to 50</td>
<td>100 ± 1%</td>
<td>15037-230</td>
</tr>
</tbody>
</table>

When connecting several conditioning resistors in series in a current loop, make sure the total loop resistance does not exceed the permissible load resistance of the source. Also, watch out for inadvertently connecting several resistors in parallel.

**NOTE**

All the 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**

The Square Root Extractor Module is normally shipped calibrated for a 1 to 5V dc input and a 4 to 20 mA output.

To assure continued accuracy, it is recommended to check its calibration after the first 30 days of operation and then at 6 month intervals thereafter.

Use the following procedure to perform periodic calibration checks or to change the input and/or output range of the module. Figure 1 shows the location of all jumper wires and trimpots.

1. Refer to the INITIAL ADJUSTMENTS section to check the input and output range settings. Change the appropriate jumper wire if a different range is required.
2. Plug the module into the card cage.
3. Obtain an adjustable input signal source. It can be any of the following or similar devices:

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**TERMINAL STRIPS ON SERIES 360 CARD CAGE ENCLOSURES**

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**TABLE 2 Connection Diagram**

1. **15 V DC SIGNALS ARE STANDARD INPUTS. FOR PROCESS CURRENT INPUTS, REFER TO SERVICE INSTRUCTION SD3801 FOR PROPER INPUT CONDITIONING RESISTORS AND THE NEGATIVE OUTPUT TERMINAL.**
2. **THE NEGATIVE INPUT TERMINAL IS COMMON WITH THE CAGE DC POWER SUPPLY.**
3. **SEE OUTPUT SPECIFICATIONS FOR LOAD LIMITS.**

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**FIGURE 2 Connection Diagram**

- **a)** Voltage Source — typically 0 to 5V dc
- **b)** Current Source — typically 0 to 20 mA
- **c)** Transmitter — adjustable over required range

These devices must be adjustable to an accuracy of 0.1% or better.

4. Connect the signal source to the input terminals of the card cage enclosure as shown in Figure 2. If the signal source is a current, use an appropriate conditioning resistor as discussed in the INSTALLATION section.

5. Obtain an output measuring device. It must also be capable of measuring the required current or voltage to an accuracy of 0.1% or better.

6. Connect the output measuring device to the output terminals of the card cage as shown in Figure 2. Refer to the SPECIFICATIONS section for output load limitations. Use an appropriate conditioning resistor if a voltage measuring device is utilized.

7. Set the signal source to its “zero” value. For a 1 to 5V dc input, the “zero” value is 1.000 ± 0.001V dc.

8. Rotate the OUTPUT BIAS trimpot (R51) clockwise until a change in output occurs.
9. Rotate the INPUT BIAS trimpot (R52) counterclockwise until the output stops decreasing.
10. Adjust the OUTPUT BIAS trimpot (R51) until the output “zero” value is obtained. For a 4 to 20 mA output, the “zero” value is 4.000 ± 0.004 mA.
11. Set the signal source to its "zero" value plus 1% of input span. For a 1 to 5 V dc input, this value is 1.040 ± 0.001 V dc.

12. Adjust the INPUT BIAS trimpot (R52) to obtain a corresponding output signal (I₁).
   To calculate this output signal, use the equation that defines the input/output relationship.
   For 4 to 20 mA output range,
   \[ I₁ \approx \frac{2 \sqrt{1.040 - 1}}{0.250} + 4 \text{ mA} \]
   \[ I₁ = 5.6 \text{ mA} \]

13. Set the signal source to its "100%" value. For a 1 to 5 V dc input, the "100%" value is 5.000 ± 0.001 V dc.

14. Adjust the SPAN trimpot (R50) to obtain a corresponding "100%" (full scale) output signal. For a 4 to 20 mA output, this value is 20.00 ± 0.02 mA.

15. Repeat steps 11 through 14 several times until no further adjustments are required. There is some interaction between the Input Bias and Span controls.

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. 15378-27 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 Square Root Extractor Module.

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