GENERAL

The Model 380H1 Lead/Lag Compensator introduces a lead and/or lag into the control circuit. It is especially useful in feed forward control systems requiring dynamic response compensation. Lead and lag times range from 2 seconds to 3600 seconds. They are divided into seven ranges with potentiometer control for essentially infinite time constant resolution.

This module is designed to operate on voltage input signals. Current input signals may be used when precision resistors are placed across the input terminals. This also permits the removal of the module without interrupting the current loop.

The following formula describes the input/output relationship of the Lead/Lag Compensator Module.

\[ I_o (S) = \frac{G_o V_a}{R_o} \left[ \frac{1 + ST_1}{1 + ST_2} \right] \pm R_o \]

- \( S \) = Complex variable of Laplace Transform
- \( I_o \) = Output current
- \( G_o \) = Output span (±20%)
- \( V_a \) = Input voltage (referenced to common)
- \( R_o \) = Output zero (±12%)
- \( R_o \) = Voltage to current transfer constant
- \( T_1 \) = Lead time constant (2-3600 seconds)
- \( T_2 \) = Lag time constant (2-3600 seconds)

SPECIFICATIONS

Input \((V_a)\)

1-5V dc

Input Impedance

1 meg Ohm min.

Output \((I_o)\)

4-20mA into 1000 Ohm load (max) (900 Ohms for 24V dc powered rack)
10-50mA into 400 Ohm load (max) (360 Ohms for 24V dc powered rack)

Load Effect

Less than 0.1%

MOORE PRODUCTS CO., Spring House, Pa. 19477
Output Span Range \((G_o)\) ±20% of input span

Output Zero Range \((K_o)\) ±12% of input zero

Lead Rate Gain 20 db

Lead Response Time 1/2 of selected lead time

Repeatability 0.1% of span

Voltage to Current Transfer Constant \((R_o)\) 4-20mA output - 250 Ohms
10-50mA output - 100 Ohms

INSTALLATION

Using the card cage enclosure instructions as a reference (Service Instruction, SD3801), set the keys as follows:

Left Key: V (vertical)
Right Key: V (vertical)

If the lead/lag module is factory calibrated, insert the module into the proper slot in the card cage enclosure. If it is not factory calibrated, refer to the CALIBRATION section of this instruction. The module accepts 1-5V dc input signals, if current input signals are to be used, refer to the card cage enclosure instructions, SD3801, for details on input signal conditioning resistors.

CALIBRATION

PREPARATION

Determine if the unit will be used as a lead transmitter, a lag transmitter, or as a combination lead and lag transmitter. If the unit is to be operated as a lead or lag only, then only the associated time constant need be adjusted. If it is to be operated in the lead and lag mode, both time constants must be adjusted.

Determine which output range is required in your application, 4-20 or 10-50mA. A jumper wire located on the foil side of the circuit board determines the output range.

Output 4-20mA: J6 out
Output 10-20mA: J6 in

The following adjustment procedures assume normal proportional operation. Jumpers J1, and J2 installed and Jumpers J3, J4 and J5 not installed. For inverse operation, refer to the Inverse Operation procedure.

ADJUSTMENT PROCEDURES

Time Constant Ranges

The lead and lag time range switches have the following ranges.

<table>
<thead>
<tr>
<th>Switch Position</th>
<th>Time Range (seconds)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2 - 6</td>
</tr>
<tr>
<td>2</td>
<td>6 - 18</td>
</tr>
<tr>
<td>3</td>
<td>18 - 60</td>
</tr>
<tr>
<td>4</td>
<td>54 - 175</td>
</tr>
<tr>
<td>5</td>
<td>162 - 530</td>
</tr>
<tr>
<td>6</td>
<td>400-1280</td>
</tr>
<tr>
<td>7</td>
<td>1130-3680</td>
</tr>
</tbody>
</table>
Lead Time Adjustment

1. If the desired lead time is known, the TC adjustment pot can be set for within 10% of desired time by the following calculation.

\[ N = \frac{60T - 191.7X}{X - 10T} \]

where \( N \) = number of turns on pot \( \text{CCW} \) from full \( \text{CW} \) position.

\( T \) = desired time.

\( X \) = lowest time for range selected (from chart above)

set pot accordingly.

2. Set mode switch as follows: Position 2 "on" (lead "on")

Position 1 "off" (lag "off")

3. Set lead time position 1 "on".

4. Apply 1.000V dc \( \pm 0.004 \) input signal and wait one minute for output to settle, adjust output "zero" for 4mA (or 10mA).

5. Apply 5.000 \( \pm 0.001 \)V dc and wait one minute, adjust output "span" for 20mA (or 50mA).

6. Repeat steps 4 and 5 until output values correspond.

7. Lead time verification: Apply 1.000 \( \pm 0.001 \)V dc at input and wait one minute for output to settle.

8. Select the desired lead time range, switch off position 1 (unless this range is used).

9. Step the input voltage from 1.000V dc to 1.400 \( \pm 0.001 \)V dc and monitor output. Record the peak output current. The output should decay to a value of

\[ I_0 = (3.68) \ (I_{OP} - I_Z - I_F) + I_Z + I_F \]

in one tenth of the desired lead time.

where \( I_{OP} \) = peak output current, full scale \( I_0 \) \( \pm 15\% \)

\( I_Z \) = zero value of output current.

\( I_F \) = final value of output current.

i.e. With a 10% input step from the zero value, the output will go immediately to 10 times the input step and decay to 36.8% of final value in one tenth of the lead time.

10. If the decay time is acceptable, proceed. If not, reset lead time position 1 "on", set output at 1.000V dc, and adjust time trim pot to add (CW) or subtract (CCW) time as required. Repeat steps 8 and 9 as required.
Lag Time Adjustment

1. If the desired lag time is known, the same procedure outlined in Step 1 of Lead Time Adjustment can be used to set the lag TC adjustment pot.

2. Set MODE switch as follows: Position 1 "on" (lag "on")
   Position 2 "off" (lead "off")

3. Set lag time position 1 "on".

4. Set lead time position 1 "on".

5. Apply 1.000 ±.001V dc input signal and wait one minute for output to settle, adjust output "zero" for 4mA (or 10mA) output current.

6. Apply 5.000 ±.001V dc, wait one minute, and adjust output "span" for 20mA (or 50mA) output current.

7. Repeat steps 5 and 6 until output values correspond.

8. Lag time verifications apply 1.000 ±.001V dc at input, wait one minute for output to settle.

9. Select the desired lead time range, switch "off" position 1 (unless this range is used).

10. Step the input voltage from 1.000V dc to 5.000 ±.001V dc and monitor output. The output should rise to 63.2% of the final value at the desired lag time.

   To shorten set-up time of the longer time constants, the output can be monitored at one tenth of the lag time. At this point the output current should be:

   \[ I_0 = (0.95)(I_{f.s.} - I_z) + I_z \]

   \[ I_{f.s.} = \text{full scale current} \]

   i.e. With a 1-5V dc input step, the output will rise to 9.5% of full scale output current in one tenth of the lag time.

11. If the lag time is acceptable, proceed. If not, reset lag position 1 on - set output to 1.000V dc, and adjust lag trim pot to add or subtract time as required. Repeat steps 9 and 10 as required.

   NOTE: In lag only mode lead time must be position 1.

Lead and Lag Operation

1. Perform procedures shown under Lead Time Adjustment and Lag Time Adjustment to set desired lead and lag times.

2. Set "mode" switch as follows: Position "1" "on" (lag "on")
   Position "2" "on" (lead "on")

3. Set each lead and lag time range switches - position 1 "on". Perform steps 4, 5 and 6 of the Lead Time Adjustment.

4. Set lead and lag time to their proper ranges as determined in Step 1. Unit is now set for lead/lag operation.
Inverse Operation

1. Install Jumpers J3, J4, and J5. Remove or cut Jumpers J1, and J2.

2. Time constant set up procedures are the same except as follows:

   Lead Adj. Step - 4  Substitute 5,000 ±.001V dc input for
   Lag Adj. Step - 5  1,000 ±.001V dc.
   Lead Adj. Step - 5  Substitute 1,000 ±.001V dc input for
   Lag Adj. Step - 6  5,000 ±.001V dc.
   Lead Adj. Step - 7  Substitute 5,000 ±.001V dc input for
   Lag Adj. Step - 8  1,000 ±.001V dc.
   Lead Adj. Step - 9  Substitute "Step the input from 5,000V dc
to 4,600 ±.001V dc" for "Step the input from 1,000V dc to 1,400" .001Vdc.
   Lag Adj. Step - 10 Substitute "Step the input from 5,000V dc
to 1,000V dc" for "Step the input from 1,000V dc to 5,000V dc".

MAINTENANCE

These instruments are solid state and require no maintenance on a regular basis, except for annual cleaning, blowing out dirt, and verifying calibration. If your transmitter is not operating properly, we suggest removing it and giving it a full bench check-out. We find most problems are in the field wiring or other circuits, not in the transmitter. If the problem is traced to the unit itself, conventional electronic troubleshooting methods suffice.

Terminal strip on Series 380
rack enclosures.

1  + INPUT (Note 1 & 2)
2  -
3  NC
4  +
5  NC
6  OUTPUT
    R_L (Note 3)
7  NC
8  NC
9  NC

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.

CONNECTION DIAGRAM
OPERATION NOTES:
1. FOR LEAD ONLY, SET SWITCHES AS
   FOLLOWS: 5-1 OFF, 6-1 OFF, 6-2 OFF, 6-3 SET DESIRED TIME CONSTANT.
2. FOR LOW-BACK, SET SWITCHES AS
   FOLLOWS: 5-1 OFF, 6-1 OFF, 6-2 OFF, 6-3 SET DESIRED TIME CONSTANT.
3. FOR BOTH LEAD AND LOW OPERATION
   SET SWITCHES AS FOLLOWS: 5-1 OFF, 6-1 OFF, 6-2 OFF, 6-3 SET DESIRED
   ‘LEAD TIME CONSTANT’, 5-2 SET DESIRED ‘LAG TIME CONSTANT’.
4. SEE INSTRUCTIONS FOR TIME
   CONSTANT SET-UP PROCEDURE.