A40-SM2 Series Amplifier

Controlled Start-Up
• Fixes the modulation voltage and inducer state for a predetermined time after receiving EST input.

Inducer State
• Energizes/de-energizes on board SPDT relay setting inducer in low/high speed position.

Temperature Modulation
• Controls discharge air temperature by modulating Maxitrol E valve and setting relay states. Set point is selected with on board or remote temperature dial.

Minimum Input Limits
• Limits minimum VDC to E Valve when non-modulated section stages are operating.

Controlled Transition of Stage
• Adjustable timer used to delay transition of one relay stage to another. Eliminates or reduces unnecessary stage changes.

DESCRIPTION
The Series MX4010 discharge air temperature control system is for use with split manifold atmospheric indirect fired heaters. The split manifold operates as two independent manifold sections sharing a single inducer.

The controller senses and maintains a constant discharge air temperature by modulating one section of the manifold and staging the non-modulated section.

The Series MX4010 controller is used with the E42, E52, and E62 Series modulators. Typical applications achieve a turndown of approximately 10:1 during continuous operation.

SYSTEM FEATURES

A40-SM2 Series Amplifier

Controlled Start-Up
• Fixes the modulation voltage and inducer state for a predetermined time after receiving EST input.

Inducer State
• Energizes/de-energizes on board SPDT relay setting inducer in low/high speed position.

Temperature Modulation
• Controls discharge air temperature by modulating Maxitrol E valve and setting relay states. Set point is selected with on board or remote temperature dial.

Minimum Input Limits
• Limits minimum VDC to E Valve when non-modulated section stages are operating.

Controlled Transition of Stage
• Adjustable timer used to delay transition of one relay stage to another. Eliminates or reduces unnecessary stage changes.

Minimum Temperature Rise
• Heater is cycled on-off at minimum rate to control a lower than continuous temperature rise.

Air Flow Switch (AFS)
• A Model only: Limits maximum modulation VDC and disables Relay 3 if 24 VDC AFS input is not present for a time greater than 3 seconds.

SYSTEM COMPONENTS

A40-SM2 Series Amplifier
E42, E52, and E62 Series modulating gas valves
TD114+ Remote Temperature Selector (optional)
TS194Q/MT1 Discharge air temperature sensor/mixing tube

Acronyms

AFS  Air Flow Switch
DAS  Discharge Air Sensor
E  EXA Series Modulating Valve
EST  Electronic Start Trigger
NC  Normally Closed
NO  Normally Open
RTS  Remote Temperature Selector
SPST  Single Pole Single Throw
SPDT  Single Pole Double Throw

© 2019 Maxitrol Company, All Rights Reserved
**SPECIFICATIONS**

**Dimensions:**
Amplifier: 8.5" L x 3.25" W x 2" H  
Temp Dial: 2.62" W x 3" H x 1.75" D  
Mixing Tube Enclosure: 4.19" W x 4.19" H x 1.88" D  
[Tube Lengths: 9", 12", 23"]  
**NOTE:** Dimensions are to be used only as an aid in designing clearance. Actual production dimensions may vary from those shown.

**Ambient Temperature Limits**
Operating: -40° F to 150° F (-40° C to 66° C)  
RH: 95% non-condensing

**Mounting**
Snap Track, multipoise

**Power Supply**
24 VAC +10-15% (50/60 Hz), Class II Transformer  
20 VA - Rating for Maxitrol electronics and modulating gas valve only  
Half-Wave Rectified  
**NOTE:** Polarity is specified - Transformer can be externally grounded

**External Wiring**
Gauge: 18-22 AWG, copper only – meets application temperature rating  
Connection: 1/4" male spade .032 thk

**Relays: 1, 2, 3, 4**
A: When relay common voltage input is externally supplied (dry contact), the voltage should not exceed 24 VAC, VDC nominal  
B: When relay common 24 VAC input is internally supplied, the circuit load through shunt jumper J1, J2, or J3 should not exceed 1A  
Rated load: 2A Max. @ 24 VAC (Resistive load)  
Max switching capacity: 50 VA (Resistive load)

**Discharge Air Temperature Sensor (DAS)**
TS194Q  
1000Ω PRTD

**DAS Mixing Tube**
MT1 or MT2 Series

**Discharge Air Temperature Selector**
TD114+ Remote Temperature Selector or on-board dial interface

**Temperature Ranges:**
40° to 90° F (4° to 32° C)  
80° to 130° F (26° to 54° C)  
120° to 170° F (49° to 76° C)  
160° to 210° F (71° to 99° C)

**EXA Modulating Gas Valve**
Power: 24 VAC, VDC  
Rated load: 0.3 A max  
Control Voltage: 0 - 10 VDC (Polarity Sensitive)  
100kΩ Input Impedence

**Performance**

**Relay 1 - Inducer**
Trigger Voltage  
2 - 5 VDC nominal (modulation voltage)

Span (Total)  
0.1 - 0.4 VDC

**Relay 2 & 3 - Stage Transition**

Delay Time  
60 - 360 seconds

**Relay 4 - Thermostat Interrupt (Min. Temp Rise)**
Trigger Voltage [Descending]  
0.05 - 0.10 VDC nominal output  
Span (De-energize) [Ascending]  
0.05 - 0.10 VDC above trigger voltage  
Timer  
5 - 55 seconds

**IMPORTANT:**
The MX40 Series is a discharge air temperature control, not a safety limit or safety control. A separate safety and/or limit control must be used when required by the application.
SPECIFICATIONS

EST Input
24 VAC continuous source (must share common with 24 VAC power)

NOTE: Commonly tied to gas valve 24 VAC input

Start-up Timer
5 - 55 seconds

Start-up Modulator Voltage
1 - 10 VDC

Minimum Voltage - Stage 3 & 4
0.5 - 5 VDC

AFS Fault Maximum Modulation Voltage (A suffix only)
2 - 10 VDC

NOTE: Shunt Jumper (J4) To Disable Feature

Reliability/Durability
100% duty cycle

Sensitivity Adjustment
The sensitivity control will allow the user to control the response of the system. Caution should be exercised in the use of this adjustment. Under normal usage the pointer should be located at approximately 2 o’clock.

If hunting is encountered (rapid oscillation), rotating the sensitivity adjustment counter-clockwise will dampen the oscillation – stabilizing the flame.

DO NOT adjust unless necessary, decreasing the sensitivity will increase the temperature “DROOP” of the system.

SHUNT JUMPER AND DIP SWITCH SETTINGS

Table 1: SW1 DIP Switch Settings

<table>
<thead>
<tr>
<th>SW</th>
<th>40-90 °F</th>
<th>80-130 °F</th>
<th>120-170 °F</th>
<th>160-210 °F</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>OFF</td>
<td>ON</td>
<td>OFF</td>
<td>OFF</td>
</tr>
<tr>
<td>2</td>
<td>OFF</td>
<td>OFF</td>
<td>ON</td>
<td>OFF</td>
</tr>
<tr>
<td>3</td>
<td>OFF</td>
<td>OFF</td>
<td>OFF</td>
<td>ON</td>
</tr>
<tr>
<td>4</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

On-Board Dial | Remote Dial

Table 2: Shunt Jumper Settings

<table>
<thead>
<tr>
<th>J1</th>
<th>Connects T2 to T5</th>
</tr>
</thead>
<tbody>
<tr>
<td>J2</td>
<td>Connects T2 to T8</td>
</tr>
<tr>
<td>J3</td>
<td>Connects T9 to T10</td>
</tr>
<tr>
<td>J4</td>
<td>Connects T2 to T18</td>
</tr>
</tbody>
</table>

24 VAC - shunt jumper installed
0 VAC - shunt jumper not installed

Figure 2: Shunt Jumper
### Figure 3: A40-SM2 Trimpot, LED, Dip Switch and Shunt Jumper Locations

<table>
<thead>
<tr>
<th>Setting</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1</strong> Start Time</td>
<td></td>
</tr>
<tr>
<td><strong>2</strong> Start Voltage</td>
<td></td>
</tr>
<tr>
<td><strong>3</strong> AFS Limit (“A” Suffix)</td>
<td></td>
</tr>
<tr>
<td><strong>4</strong> Stage 3, 4 Min VDC</td>
<td></td>
</tr>
<tr>
<td><strong>5</strong> Relay 4 Timer</td>
<td></td>
</tr>
<tr>
<td><strong>6</strong> Stage 3, 4 Time Delay</td>
<td></td>
</tr>
<tr>
<td><strong>7</strong> Relay 1 Trigger</td>
<td></td>
</tr>
<tr>
<td><strong>8</strong> Relay 1 Deadband</td>
<td></td>
</tr>
<tr>
<td><strong>9</strong> Sensitivity</td>
<td></td>
</tr>
<tr>
<td><strong>10</strong> Integral Temperature Dial</td>
<td></td>
</tr>
</tbody>
</table>

**NOTE:** Turn trimpot clockwise to increase, counter-clockwise to decrease
## PCB CONNECTIONS

<table>
<thead>
<tr>
<th>No</th>
<th>PCB Label</th>
<th>Description</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>COM</td>
<td>COM</td>
<td>Power Common</td>
<td>Internally connected to T1</td>
</tr>
<tr>
<td>T1</td>
<td></td>
<td>Power Common</td>
<td>Polarity Sensitive</td>
</tr>
<tr>
<td>T2</td>
<td>24 VAC</td>
<td>Power Input</td>
<td></td>
</tr>
<tr>
<td>T3</td>
<td>EXA</td>
<td>0-10 VDC</td>
<td>Modulation Voltage - Polarity Sensitive</td>
</tr>
<tr>
<td>T4</td>
<td>R1</td>
<td>Relay 1 - SPDT</td>
<td>24 VAC - internal (J1)</td>
</tr>
<tr>
<td>T5</td>
<td>R2</td>
<td>Relay 2 - NO</td>
<td>24 VAC - internal (J2)</td>
</tr>
<tr>
<td>T6</td>
<td>R3</td>
<td>Relay 3 - NO</td>
<td>24 VAC - internal (J3)</td>
</tr>
<tr>
<td>T7</td>
<td>R4</td>
<td>Relay 4 - NC</td>
<td>Thermostat Interrupt (Min temp rise mode)</td>
</tr>
<tr>
<td>T8</td>
<td>SENSOR</td>
<td>Discharge Air Sensor</td>
<td>TS194Q DAS</td>
</tr>
<tr>
<td>T9</td>
<td>DIAL</td>
<td>Remote Temp Selector</td>
<td>TD114+ Series RTS</td>
</tr>
<tr>
<td>T10</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>T11</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>T12</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>T13</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>T14</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>T15</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>T16</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>T17</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>T18</td>
<td>AFS</td>
<td>Air Flow Switch</td>
<td>24 VAC input (A model), shares COM ground</td>
</tr>
<tr>
<td>T19</td>
<td>EST</td>
<td>Start Trigger</td>
<td>24 VAC - Start trigger, shares COM ground</td>
</tr>
</tbody>
</table>

## LED STATUS INDICATORS

<table>
<thead>
<tr>
<th>Status</th>
<th>PCB Label</th>
<th>Color</th>
</tr>
</thead>
<tbody>
<tr>
<td>Main Power</td>
<td>PWR</td>
<td>Blue</td>
</tr>
<tr>
<td>Start Up/Modulating</td>
<td>MOD</td>
<td>Green</td>
</tr>
<tr>
<td>Relay #1 Energized</td>
<td>R1</td>
<td>Red</td>
</tr>
<tr>
<td>Relay #2 Energized</td>
<td>R2</td>
<td>Red</td>
</tr>
<tr>
<td>Relay #3 Energized</td>
<td>R3</td>
<td>Red</td>
</tr>
<tr>
<td>Relay #4 Timer/Energized</td>
<td>T/R4</td>
<td>Red</td>
</tr>
<tr>
<td>AFS (&quot;A&quot; Suffix)</td>
<td>AFS</td>
<td>Green</td>
</tr>
<tr>
<td>Stage Transition Timer</td>
<td>STT</td>
<td>Yellow</td>
</tr>
</tbody>
</table>
OPERATION

Call For Heat (IDLE) Mode
- Thermostat relay is energized (completes W input)
- A40-SM2 is powered with 24 VAC
- E Valve is powered with 24 VAC
- Inducer relay (R1) is de-energized, inducer operates in high speed
- Thermostat Interrupt relay (R2) is de-energized
LED: PWR, AFS (A Model)

Burner Start Up Mode
EST receives 24 VAC input from the ignition control gas valve (MV) circuit
- Timer Starts and modulation voltage is fixed
- Inducer Relay remains de-energized, inducer operates in the high speed state
  NOTE: The system remains in this mode throughout Start up Timer duration
LED: PWR, MOD (Flashes), AFS (A Model)

Operational Mode
- Start up Timer expires
- Set point temperature relative to sensed discharge air temperature determines modulation VDC and mode
- Relays are energized or de-energized based on modulation voltage and stage timing in order to control set-point temperature
LED: PWR, MOD, R1, R2, R3 when energized
  AFS (A Model)

Minimum Temperature Rise Mode (Stage 0)
The heater can be cycled (on and off) to control a temperature rise lower than the minimum continuous temperature rise. Cycling is typically controlled by adding the NC Relay #4 into the burner control thermostat input circuit (W or TH).

Modulation voltage drops to ~0 VDC:
- Result: Relay #4 timer starts, T/R4 LED flashes

Modulation voltage gradually increases before timer expires:
- Result: Timer resets

Modulation voltage remains at 0 VDC long enough for timer to expire:
- Result: Relay #4 is energized

Energizing Relay #4 opens the thermostat circuit causing the heater to shutdown.
Shutdown removes the 24 VAC EST input and the system defaults to the “Call for Heat” mode or remains off if thermostat input is not present.

### Table 3:

<table>
<thead>
<tr>
<th>Stage</th>
<th>EXA Modulation Voltage</th>
<th>R</th>
<th>Mode</th>
<th>% of total (Approx)**</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0 VDC</td>
<td>R4 energized</td>
<td>Heater #1 OFF</td>
<td>&lt;10%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>R1, R2, R3 de-energized</td>
<td></td>
<td></td>
</tr>
<tr>
<td>I</td>
<td>&gt;0-4.5* VDC</td>
<td>R1 energized</td>
<td>Heater #1 ON Inducer-Low</td>
<td>10-30%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>R2, R3 de-energized</td>
<td>Heater #2 OFF</td>
<td></td>
</tr>
<tr>
<td>II</td>
<td>4.5*-10 VDC</td>
<td>R1, R2, R3, R4 de-energized</td>
<td>Heater #1 ON Inducer-High</td>
<td>30-50%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Heater #2 OFF</td>
<td></td>
</tr>
<tr>
<td>III</td>
<td>2*-10 VDC</td>
<td>R2 energized</td>
<td>Heater #1 ON Inducer-High</td>
<td>50-80%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>R1, R3, R4 de-energized</td>
<td>Heater #2 ON Stage-Low</td>
<td></td>
</tr>
<tr>
<td>IV</td>
<td>2*-10 VDC</td>
<td>R2, R3 energized</td>
<td>Heater #1 ON Inducer-High</td>
<td>80-100%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>R1, R4 de-energized</td>
<td>Heater #2 ON Stage-High</td>
<td></td>
</tr>
</tbody>
</table>

*Adjustable VDC setting
**Percentages are approximations

| Table 3: | | | | | | |
|----------|----------|----------|----------|----------|----------|
| Stage    | EXA Modulation Voltage | R | Mode | % of total (Approx)** |
| 0        | 0 VDC      | R4 energized | Heater #1 OFF | <10% |
|          |            | R1, R2, R3 de-energized |               |      |
| I        | >0-4.5* VDC| R1 energized | Heater #1 ON Inducer-Low | 10-30% |
|          |            | R2, R3 de-energized | Heater #2 OFF |      |
| II       | 4.5*-10 VDC| R1, R2, R3, R4 de-energized | Heater #1 ON Inducer-High | 30-50% |
|          |            | | Heater #2 OFF |      |
| III      | 2*-10 VDC  | R2 energized | Heater #1 ON Inducer-High | 50-80% |
|          |            | R1, R3, R4 de-energized | Heater #2 ON Stage-Low |      |
| IV       | 2*-10 VDC  | R2, R3 energized | Heater #1 ON Inducer-High | 80-100% |
|          |            | R1, R4 de-energized | Heater #2 ON Stage-High |      |

*Adjustable VDC setting
**Percentages are approximations
OPERATION

OPERATION: (see Table 3, page 7)

Stage I Minimum to 30% of total rating
  • Modulation Voltage: 0-4.5 VDC
  • Modulated section is operational
  • Inducer operates in low speed
  LED: PWR, MOD, R1, AFS (Model A)

Stage II 30%-50% of total rating
  • Modulation Voltage: 4.5-10 VDC
  • Modulating section is operational
  • Inducer operates in high-speed
  LED: PWR, MOD, AFS (Model A)

Stage II to Stage III Transition
  • Modulation voltage remains at 10 VDC for preset time with no relays energized
  LED: STT*

Stage III 50% to 80% of total rating
  • Modulation Voltage: 2** - 10 VDC
  • Modulating section is operational
  • Relay 2 is energized and 24 VAC output voltage is supplied to non-modulated section start up relay
  • Non-modulated section is operational (low stage)
  LED: PWR, MOD, R2, AFS (Model A)

Stage III to Stage II Transition
  • Modulation voltage remains at adjusted low VDC for preset time with Relay 2 energized
  LED: STT*

Stage III to Stage IV Transition
  • Modulation voltage remains at 10 VDC for a preset time with Relay 2 energized
  LED: STT*

Stage IV 80% to 100% of total rating
  • Modulation Voltage: 2** - 10 VDC.
  • Modulating section is operational
  • Relay 3 is energized and 24 VAC output is supplied to the non-modulated 2 stage gas valve’s high input
  • Non-modulated section is operational (high stage)
  LED: PWR, R2, R3, MOD, AFS (Model A)

Stage IV to Stage III Transition
  • Modulation voltage remains at adjusted low VDC for preset time with Relay 3 energized
  LED: STT*

AFS (A Suffix Only) Models

- Operating Condition #1
  Relay 1 is energized and 24 VAC input is present or not present.
  Result: Normal operation of Stage I.

- Operating Condition #2
  Relay 1 is de-energized and 24 VAC input is present.
  Result: Normal operation of all stages.

- Operating Condition #3
  Relay 1 is de-energized and 24 VAC input is not present for duration greater than 3 seconds.
  Result:
  - AFS Fault.
  - VDC output to valve is limited to user-selected voltage.
  - Relay 2 dependent on operating state when fault occurs.
  - VDC output remains limited, even if the 24 VAC AFS signal is re-established, until reset.

- Resetting AFS Fault
  Perform one of the following:
  - Cycle main power
  - Cycle EST input
  - Energize Relay 1

AFS Fault Override: Shunt Jumper J4

AFS LED
- Lit when 24 VAC input is present or Shunt Jumper J4 is shunted.

* In addition to current stage LED’s

** Adjustable Min VDC