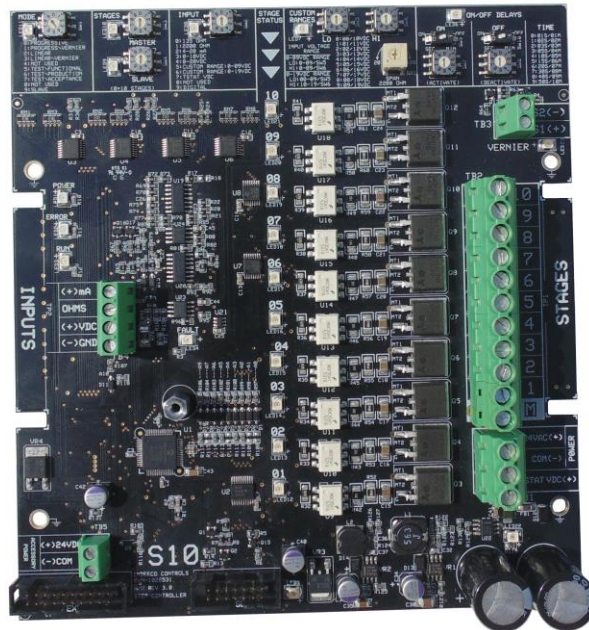




Owner's Manual

S10 SERIES

ELECTRONIC STEP CONTROLLER WITH VERNIER CONTROL



This manual covers installation, setup, operation and troubleshooting. Read carefully before attempting to install, operate or service the S10 Series Step Controller.

IMPORTANT INSTRUCTIONS

SAVE THESE INSTRUCTIONS FOR FUTURE REFERENCE



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GENERAL DESCRIPTION / SPECIFICATIONS

GENERAL DESCRIPTION:

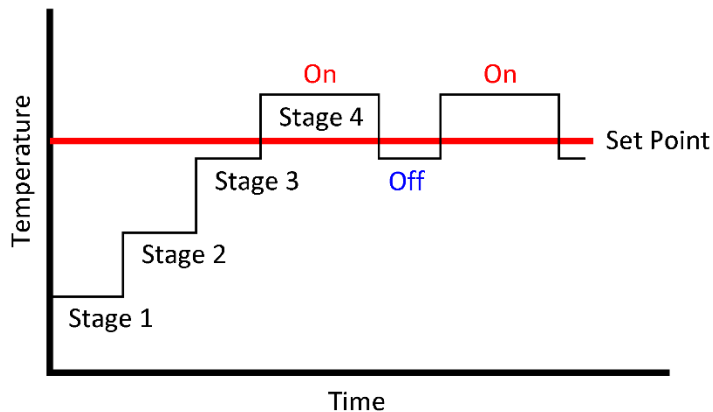
The S10 Series step controller is a microcomputer-based stage controller designed to provide low cost precision control for multi-stage applications. Common applications are HVAC duct heaters, industrial process air heaters, circulation heaters and boilers.

- Low voltage 24 VAC microcomputer-based stage controller
- Capable of controlling 24, 120 or 240 VAC loads
- 10 stage controller with a pulsed 12 VDC vernier stage rated at 100 mA.
- Up to 20 stages of control when using two units wired in a master & slave configuration
- 24 VDC power supply rated at 200 mA is available for an external sensor.

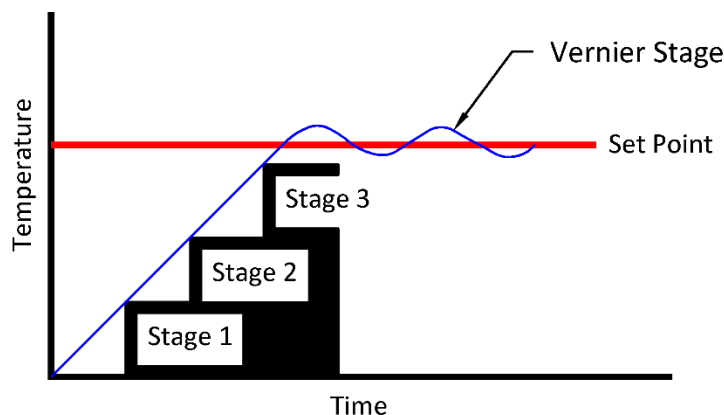
VERNIER OPERATION:

The S10 Series step controller supports a 12 VDC pulsed vernier stage to operate a slave SCR/SSR controller. This will result in more precise temperature control than is otherwise possible with a standard on-off step controller. The slave SCR/SSR power controller provides proportional control (0-100% load) between the switching of the step controller stages.:

Sequence Control without Vernier:



Sequence Control with Vernier:



GENERAL DESCRIPTION / SPECIFICATIONS

FEATURES AND BENEFITS:

Micro-computer based control	Accuracy and reliability
Support for a wide selection of input signals	Adjustable switches to support 5 predefined signals and DC voltage ranges anywhere between 0-20 VDC
Adjustable inter-stage delays	Field adjustable switches to support independent stage on and off delays
External power supply	24VDC power supplied to support external sensors
Fail Safe	Unit cycles down to full OFF if input leads are open, reversed or shorted.
Diagnostic capabilities	11 LED status lights provide detailed status information for troubleshooting.
Functional Test mode	Built in test mode for quick troubleshooting

SPECIFICATIONS:

UL Recognized: File E52105, Guide XAPX2/8

Operating & Storage: -22°F to 185°F (-30°C to 85°C) *

Relay Outputs: 240 VAC ±10%, 90VA max
 208 VAC ±10%, 90VA max
 120 VAC ±10%, 90VA max
 24 VAC ±10%, 24VA max
 Relay Wire Range: 10-24 AWG

Power Supply: 24 VAC ±10% ; 50/60 Hz
 10.5 VA max - Base 10 stage operation with Vernier output.
 11.3 VA max – Additional power required for 24 VDC accessory outputs.
 Power Supply Wire Range: 10-24 AWG

Input Signal: Impedance:
 Equal to or Greater than 10KΩ for VDC inputs
 250Ω for mA inputs
 Input Signal Wire Range: 14-30 AWG

Auxiliary VDC Output: 24 VDC ±10%, 200 mA max. ; Wire Range 14-30 AWG

Vernier Output: 12 VDC pulsed, 100 mA max. ; Wire Range 14-30 AWG

* Maximum operating temperature of to 167°F (75°C) when supplied in enclosure (204 & 205 product code) with class 2 transformer.

HOW TO ORDER

Typical Model Designation (Progressive Enabled):

205 - S10 - M10 -I -A 21
 I II III IV V VI

Typical Model Designation (Progressive Disabled):

201 - S10 - M10
 I II III

I - Product Code:

- 201 - Open board w/ mounting plate (Flange Mounting)
- 202 - Open board w/ standoffs
- 204 – Enclosure w/ holes for LEDs in cover. (Contact factory if REACH or RoHS required on enclosure)
- 205 - Enclosure w/ holes for LEDs and set point adjuster in cover. (Contact factory if REACH or RoHS required on enclosure.)

II - Basic Model: S10

III - Control Stages: M10

IV- Control Type:

- I = Progressive option enabled
- Blank= Progressive option disabled. Fixed for linear control regardless of switch settings

V – Supply Voltage (Used for product codes 201, 204 & 205 units only):

Code	Supply Voltage	Notes
A	24 Vac	
B	120/208/240 Vac	Supplied with 120/208/240 to 24 Vac transformer.

VI – Temperature Range for set point adjuster (Used for product code 205 units only):

Code	Range	Code	Range	Code	Range
21	0-100°F	41	50-150°F	43	50-180°F
47	100-210°F	51	120-250°F	55	150-250°F

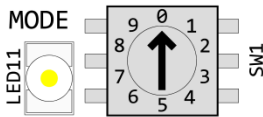
For use with 2200 ohm input signal and a Series 310 Thermistor Sensor.

Slave Cable: 1028815

Cable is 36" long to make the master to slave connection. Contact factory if different length cable is desired.

SETUP INSTRUCTIONS

MODE CONFIGURATION:



MODE

LED11

SW1

- 0: PROGRESSIVE
- 1: PROGRESS\VERNIER
- 2: LINEAR
- 3: LINEAR\VERNIER
- 4: NOT USED
- 5: TEST\FUNCTIONAL
- 6: TEST PRODUCTION
- 7: TEST\ACCEPTANCE
- 8: NOT USED
- 9: SLAVE

The MODE selection dial is used to configure the controller for the desired operation type.



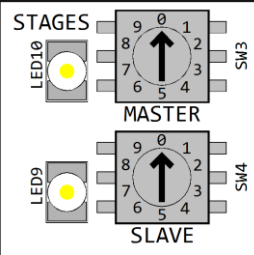
CAUTION:

- Disconnect all power before changing any controller settings.
- If progressive operational mode is used, ensure that the end-use product still complies with all relevant safety standards and regulations. Some manufactured products require linear operation to ensure proper operation of safety controls.
- For a master/slave application, connect the Vernier output to the master step controller.

Switch SW1:

Setting	Label	Description
0	Progressive *	The first stage ON will also be the first stage OFF (FIFO). This operational mode is used to achieve more even wear on the switching devices. For example: 1,2,3 ON then 1,2 OFF then 4, 5 ON then 3 OFF.
1	Progressive/Vernier *	This setting is used when progressive operational mode is desired along with the use of a slave SCR for Vernier control.
2	Linear	The first stage ON will be the last stage OFF (LIFO). For example: 1,2,3,4,5 ON then 5,4,3,2,1 OFF.
3	Linear/Vernier	This setting is used when linear operational mode is desired along with the use of a slave SCR for Vernier control.
4	Not Used	
5	Test Functional	See test definition described in the section 'TROUBLESHOOTING'.
6	Test Production	This is a factory setting used during production and is disabled before shipment to field.
7	Test Acceptance	This is a factory setting used during production and is disabled before shipment to field.
8	Not Used	
9	Slave	This setting is used for all slave step controllers. The mode of operation is controlled by the setting of the master.

STAGE CONFIGURATION:



STAGES

LED10

SW3

MASTER

LED9

SW4

SLAVE

(0=10 STAGE)

(20 stage setup shown)

The STAGE selection dial is used to configure the proper number of stages.



CAUTION:

- Disconnect all power before changing any controller settings.
- For a master/slave controller application, the stage setting on the slave controller is disabled and control is determined by the settings on the master.

Switch SW3 – Master Stages:

- Set the master stages to a value between 1 and 10.
- When a slave controller is used, always set the master stage value to 0 (ie. 10)


Switch SW4 – Slave Stages:

- The slave stage setup is not used if a slave controller is not wired to the master.
- Set the slave stages to the desired value between 1 and 10.

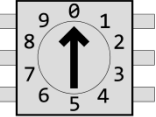
SETUP INSTRUCTIONS - Continued

INPUT CONFIGURATION:

INPUT



LED8



SW2

0: 135 OHM
 1: 2200 OHMS
 2: 4-20 mA
 3: 0-10 VDC
 4: 0-20 VDC
 5: CUSTOM RANGE: 0-09VDC
 6: CUSTOM RANGE: 0-19VDC
 7: TSTAT VDC
 8: NOT USED
 9: DIGITAL

The INPUT selection dial is used to configure the controller for the desired input control signal.



CAUTION:

- Disconnect all power before changing any controller settings.
- For a master/slave application, the input type is determined by the setting on the master controller.
- Wire the control signal to the master unit only.

Switch SW2:

Setting	Label	Notes
0	135 ohm	0-135 ohm linear range
1	2200 ohm	User adjustable 20-400 ohm span with 2200 ohm midpoint. See section '2200 Ohm - Span Setting' for setup description.
2	4-20 mA	
3	0-10 VDC	
4	0-20 VDC	
5*	Custom Range: 0-9VDC	See section 'Custom Range Configuration' for further settings. Maximum range 0-9 VDC.
6*	Custom Range: 0-19VDC	See section 'Custom Range Configuration' for further settings. Maximum range 0-19 VDC. .
7	TSTAT VDC	Used for 3-wire external devices with a 0-10 VDC input signal. See sections 'Input Signal Control Wiring' and 'Auxiliary VDC Power Supply Wiring'.
8	Not Used	
9	Digital	This setting is used in conjunction with other auxiliary boards designed to interpret digital signal protocols. Contact factory for further information.

* See the section 'CUSTOM RANGE CONFIGURATION' when using input settings 5 or 6.

Input Signal Tolerances:

SW2 Setting	Nominal	Low Range Limit	High Range Limit
0	135 ohm	0	145
1	2200 ohm	1900	2500
2	4-20 mA	3	21.5
3	0-10 VDC	0	10.5
4	0-20 VDC	0	21
5	Custom: 0-9VDC	**	***
6	Custom: 0-19VDC	**	***
7	TSTAT VDC	0	10.5


Tolerance of +10% / -5% on range limit indications.

- Input signals above or below the Range Limits will result in an error condition. The controller will continue to operate, but an error light will indicate the out of range condition.
 - See the section 'TROUBLESHOOTING' for error indication light definitions.
- ** Lower range limit for custom VDC setting is the user set value minus 1.0 VDC. For range settings below 2.0 VDC, there is no lower range limit.
- *** Upper range limit for custom VDC settings is the user set value plus 1.0 VDC.

SETUP INSTRUCTIONS – Continued

CUSTOM RANGE CONFIGURATION:

CUSTOM RANGES



LED7

INPUT VOLTAGE RANGE

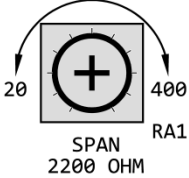
0-09VDC RANGE
LO: 0-09/SW5
HI: 0-09/SW6

0-19VDC RANGE
LO: 00-09/SW5
HI: 10-19/SW6

LO

0:00/10VDC
1:01/11VDC
2:02/12VDC
3:03/13VDC
4:04/14VDC
5:05/15VDC
6:06/16VDC
7:07/17VDC
8:08/18VDC
9:09/19VDC

HI



SPAN
2200 OHM

The CUSTOM RANGE CONFIGURATION selection dials are used to:

1. Set a custom VDC input signal range between 0 & 19 VDC.
2. Adjust the upper & lower range limits for 2200 ohm signals.



CAUTION:

- Disconnect all power before changing any controller settings.
- Configure and wire the control signal to the master unit only.
- Custom VDC scan range must be greater than 1 VDC.

CUSTOM VDC RANGE SETTINGS:

The INPUT CONFIGURATION switch must be set to 5 or 6 to activate these setting adjustments.

VDC Signal for 0% Load (LO-SW5):

Setting	Low Range Input VDC
0	0
1	1
2	2
3	3
4	4
5	5
6	6
7	7
8	8
9	9

VDC Signal for 100% Load (HI-SW6):

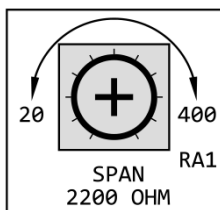
Setting	High Range Input VDC	
	Input Configuration=5	Input Configuration= 6
0	0	10
1	1	11
2	2	12
3	3	13
4	4	14
5	5	15
6	6	16
7	7	17
8	8	18
9	9	19

Example: To configure the controller for a 3-16VDC input signal, set the following switches:

Switch	Description	Setting
SW2	Input Configuration	6
SW5	LO Custom Range	3
SW6	HI Custom Range	6

2200 OHM – SPAN SETTING:

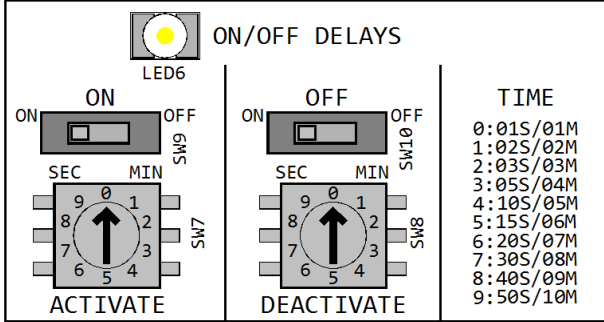
The INPUT CONFIGURATION switch must be set to 1 to activate the span adjustment setting.



Potentiometer RA1 is used for setting the span for 2200 ohm inputs. The span can be adjusted from 20 ohms (fully counter-clockwise) to 400 ohms (fully clockwise).

SETUP INSTRUCTIONS - Continued

ON/OFF DELAY CONFIGURATION:



The ON/OFF DELAY configurations are used to set the time delays for both activating and deactivating stages.



CAUTION:

- Disconnect all power before changing any controller settings.

Toggle switches SW9 & SW10 set the scale to be used by the selector switches as seconds or minutes. See the table below for delay times:

Selector Switches SW7 & SW8:

Setting	Time Delay - Seconds	Time Delay - Minutes
0	1	1
1	2	2
2	3	3
3	5	4
4	10	5
5	15	6
6	20	7
7	30	8
8	40	9
9	50	10

Example: To set an ON delay of 30 seconds and an OFF delay of 60 seconds, set the following switches:

Switch	Description	Setting
SW9	Activate Delay Units	ON (ie. Seconds)
SW7	Activate Delay Time	7
SW10	Deactivate Delay Units	OFF (ie. Minutes)
SW8	Deactivate Delay Time	0

WIRING INSTRUCTIONS

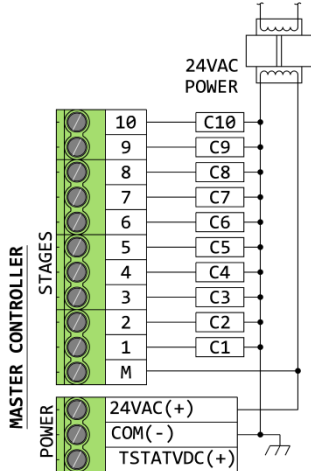
Master to Slave Connection:

A 36" factory supplied ribbon cable is required for the connection of a slave unit to a master unit. Contact factory if different length cable is desired. Cable should be installed such that the red stripe is close to the expansion connector.

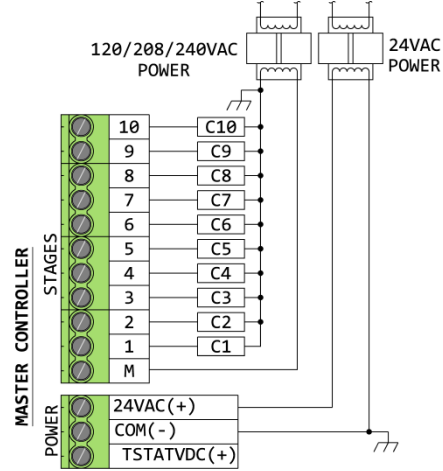
24 VAC Power & Relay Output Wiring:

Use a properly fused Class 1 or Class 2 CSA or UL Recognized transformer to supply 24 VAC board power.

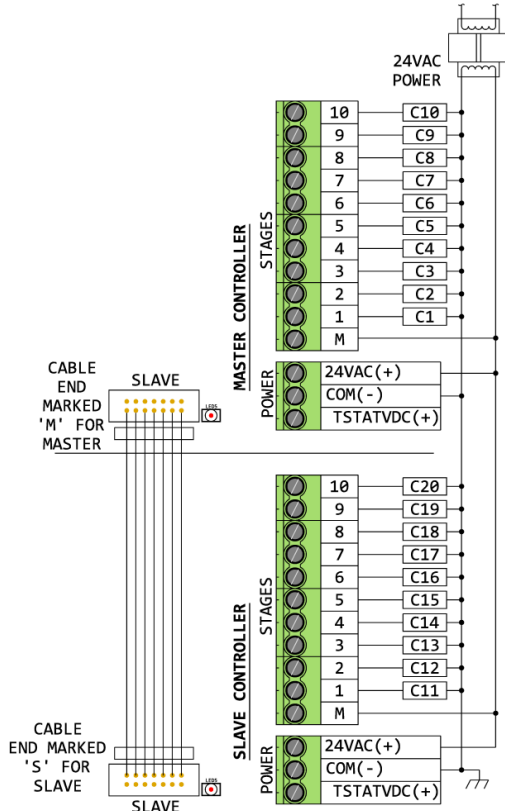
Master Controller with 24 VAC Relay Coils:



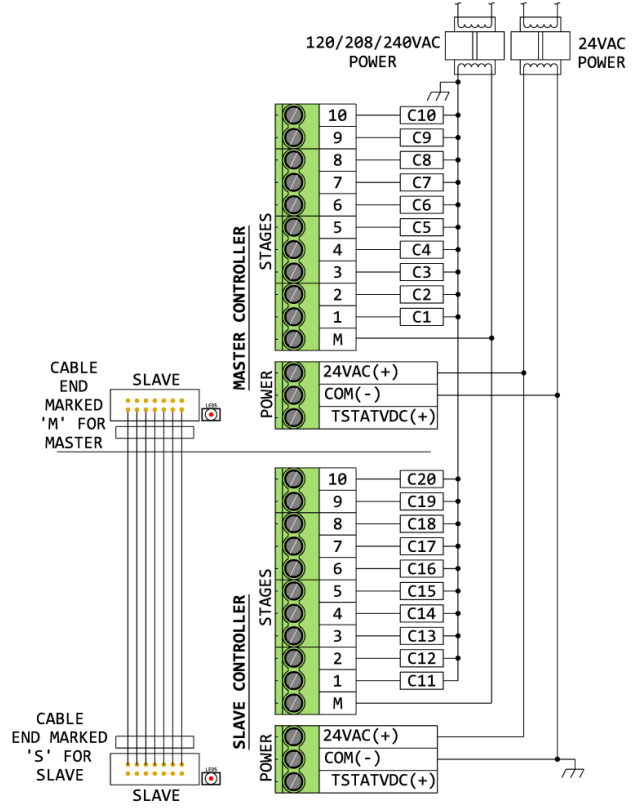
Master Controller with 120/208/240 VAC Relay Coils:



Master & Slave Controller with 24 VAC Relay Coils:



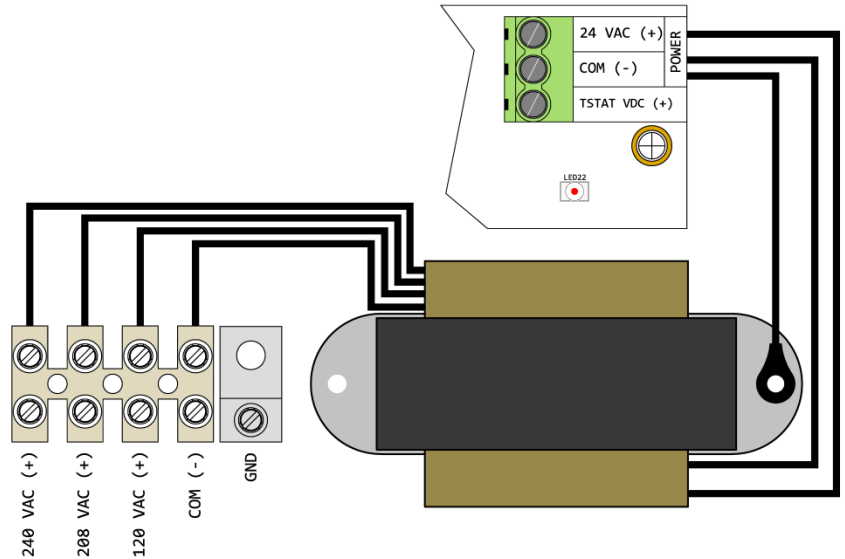
Master & Slave Controller with 120/208/240 VAC Relay Coils:



WIRING INSTRUCTIONS - CONTINUED

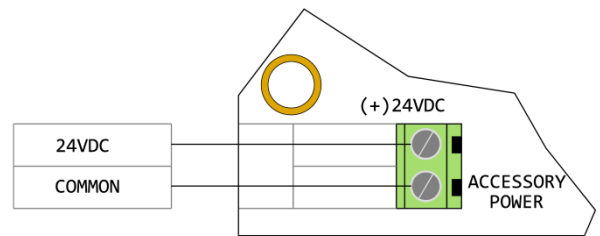
120/208/240 VAC Power Connections:

(Product codes 201, 204 & 205 only)
 A transformer & terminal block are provided for 120, 208 and/or 240 VAC supply connections.

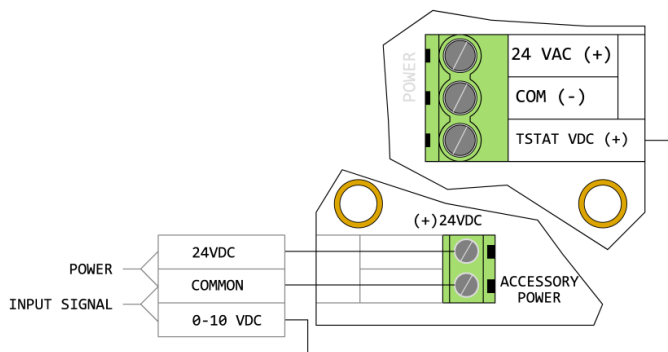


Auxiliary VDC Power Supply Wiring:

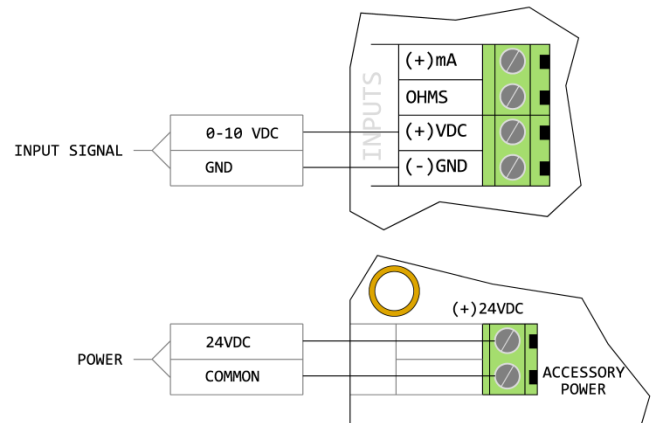
- Rating: 24 VDC \pm 10%, 200 mA max ; Wire Range: 14-30 AWG
- Controller power consumption is increased by up to 11.3 VA for VDC auxiliary power usage.
- Accessory power supply for use with external thermostats or controllers.
- The auxiliary VDC output wiring is considered low-voltage, low energy and may be wired with Class 2 wiring where wet contact is not likely.
- Proper separation of circuits shall be maintained in the end-use equipment.
- See section 'Input Signal Control Wiring' for 3-wire VAC signal device connections.



2-Wire Power Supply



3-Wire Signal Device
(0-10 VDC)

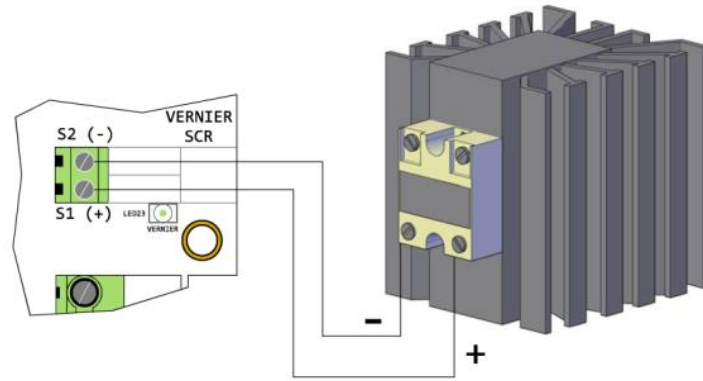


4-Wire Signal Device
(Any supported input signal)

WIRING INSTRUCTIONS - CONTINUED

Vernier Stage Wiring:

- Rating: 12VDC pulsed, 100 mA max; Wire Range: 14-30 AWG.
- The green Vernier light (LED23) on the master unit will cycle at a rate proportional to the Vernier output.
- A single slave SCR is shown. Multiple slaves can be wired together in parallel or series up a max output of 100 mA.



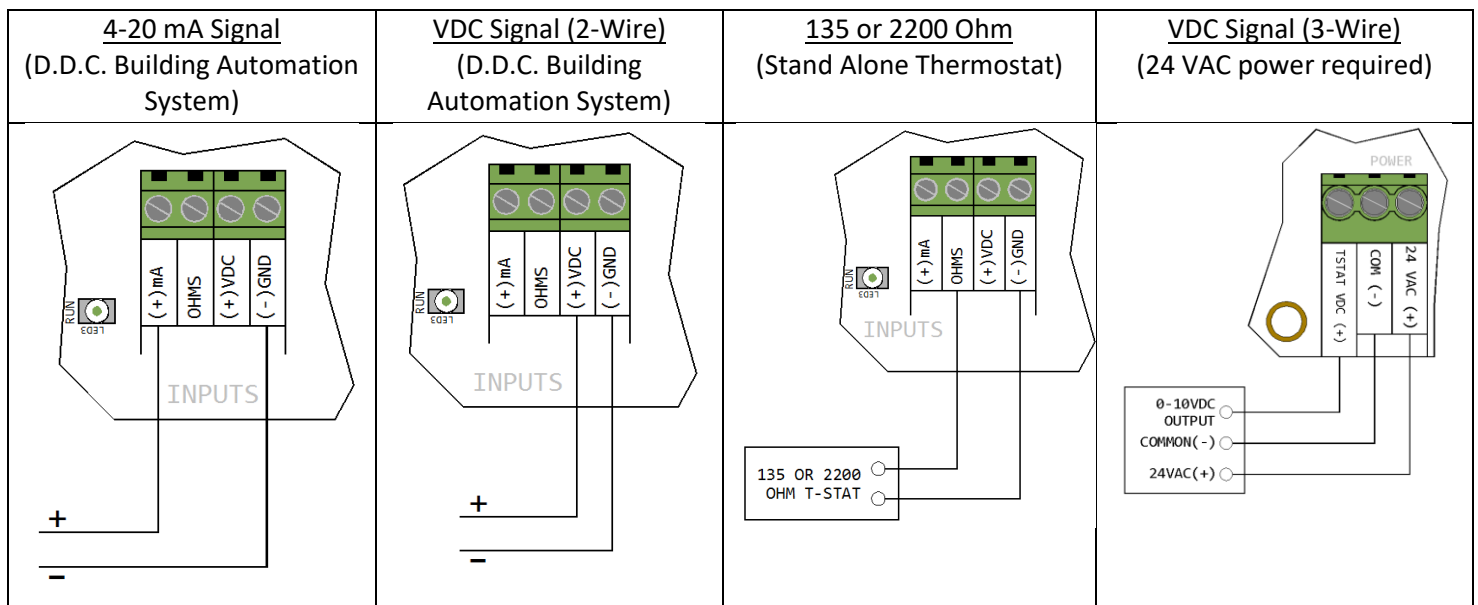
Input Signal Control Wiring:



CAUTION:

- Disconnect all power before changing any controller settings.
- Not maintaining the polarity of connections for the 0-10 VDC stand-alone thermostat could damage the remote thermostat. The 0-10 VDC output wiring terminal is referenced to common for proper operation of the thermostat.

- Input Signal Wire Range: 14-30 AWG.
- Impedance: 250Ω (mA), 10KΩ (VDC)
- The input signal control wiring is considered low-voltage, low energy and may be wired with Class 2 wiring where wet contact is not likely. Proper separation of circuits shall be maintained in the end-use equipment.

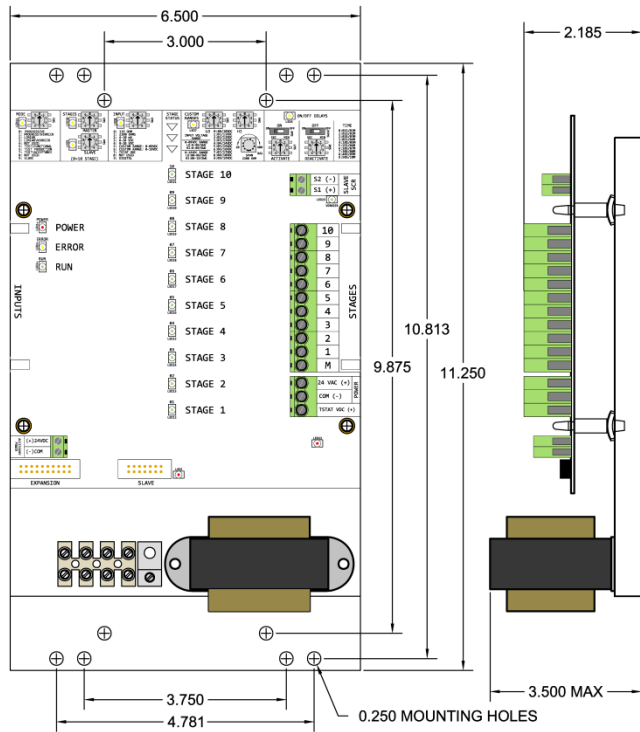


DIMENSIONS & INSTALLATION

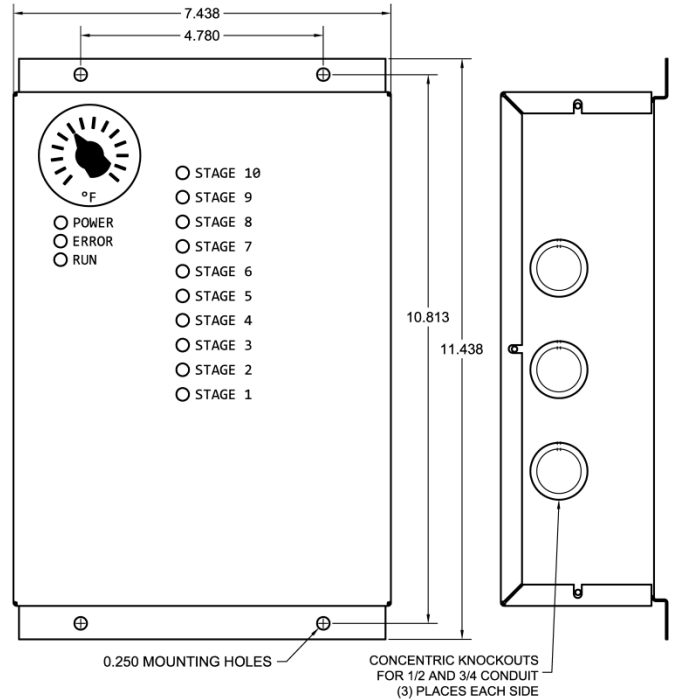
Units may be mounted in any position on a wall or inside a panel. Maximum mounting distance between a master and a slave is 10 feet.

201 SERIES – Metal Mounting Plate

(Transformer & terminal block shown below are only provided for supply voltage codes 'B', 'C' & 'D').

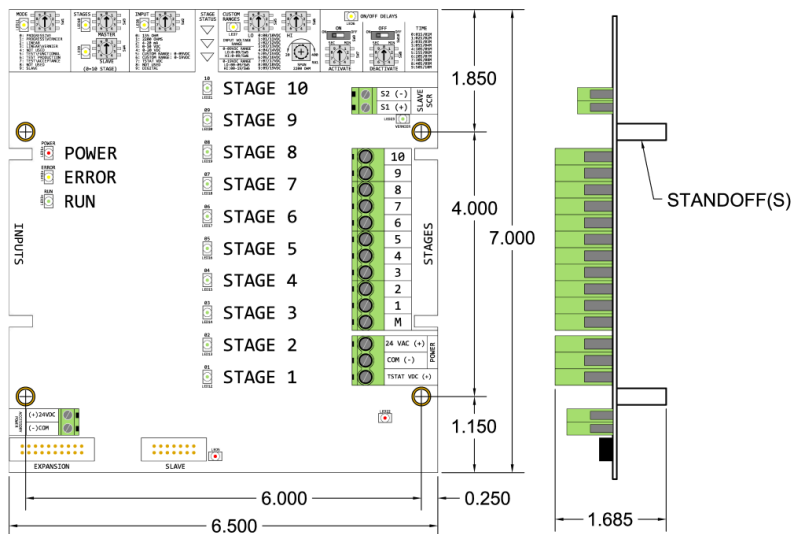


204/205 SERIES – Nema 1 Enclosure



202 SERIES – Nylon Standoffs

(0.187" Diameter mounting holes)



TROUBLESHOOTING

FUNCTIONAL TEST DESCRIPTION:

The functional test mode can be used to verify board operation, stage settings and input signal. This mode will bypass both the inter-stage delay settings and input signal in order to sequence the stages according to the current status of the STAGE settings. The test sequence will also validate the input signal.

When the board is powered on in the functional test mode, the following sequence of events will take place:

1. The following LEDs will illuminate on power up and remain on during the cycling up and down of the stages:

LED			Master Unit	Slave Unit
Description	Number	Color		
Power	LED 1	Red	On	On
Error	LED 2	Yellow	On	On
Run	LED 3	Green	On	On
Fault	LED 4	Yellow	On	Off
Slave	LED 5	Green	On	On
Setup Lights	LED 6 thru LED 11	Yellow	On	Off
DC Power	LED 22	Red	On	On
Vernier	LED 23	Green	On	Off

2. The stage LED lights will cycle on and then off in a linear fashion (first on, last off) according the number of stages currently set. Both the inter-stage delay settings and input signal are bypassed during this test.
3. After the stage cycling is complete, the controller will perform a test to verify the input signal. All lights except the DC Power (LED 22) will turn off and one of the following lights will blink to conclude the functional test:

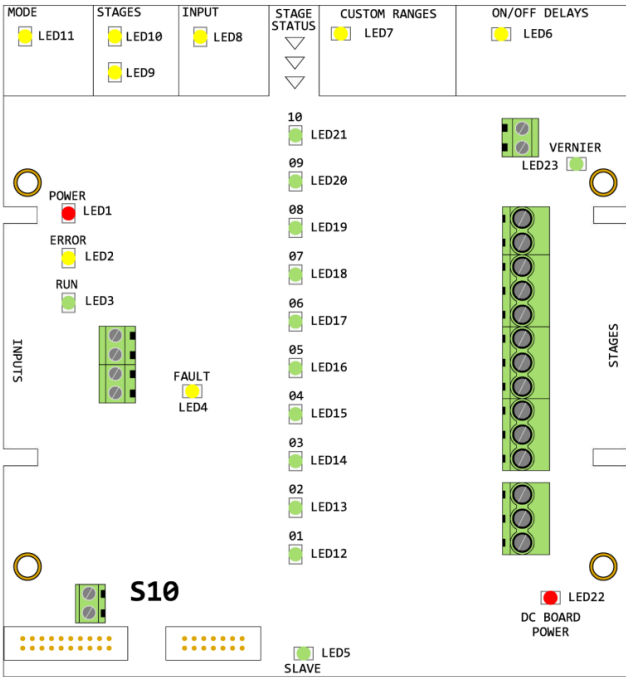
LED			Description of input test result if LED is illuminated
Description	Number	Color	
Power	LED 1	Red	Reversed polarity (mA or VDC)
Error	LED 2	Yellow	No input signal detected or signal detected is out of range *
Run	LED 3	Green	No issues. Valid input signal detected.

* Tolerance of +10% / -5% on range limit indications.

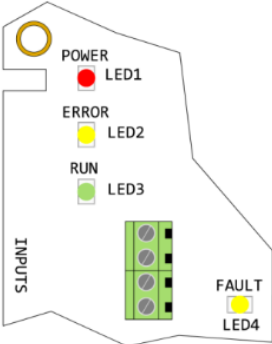
4. After test is complete, power down controller and set the appropriate 'Mode' setting. Controller is ready to put into service. If the light sequence shown is not as expected based on the current setup parameters, please verify settings and contact factory for assistance.

TROUBLESHOOTING - CONTINUED

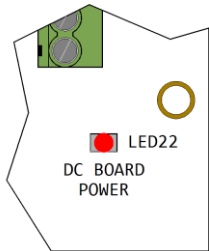
STATUS LIGHT LOCATIONS:



Main Board Status Lights



DC Board Power Light



Notes:

1. The green Vernier light (LED23) on the master will cycle at a rate proportional to the Vernier output.
2. The green Run light (LED3) indicates that the controller is operational.
3. The Slave light (LED5) on the master will only illuminate when a slave controller is detected.
4. Numbers in colored boxes in the table below indicate the number of light blinks.

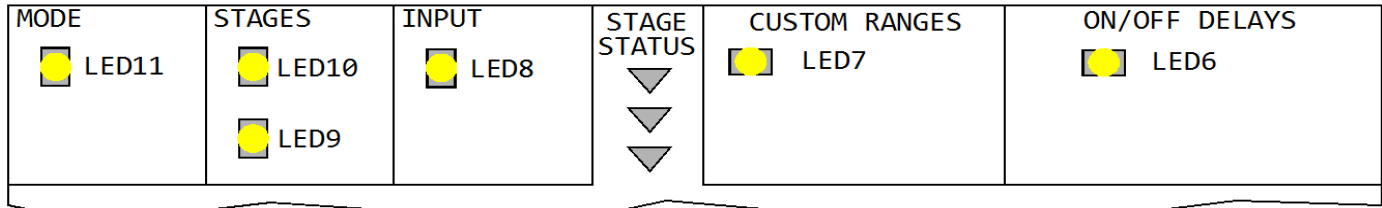
OVERALL MASTER BOARD STATUS:

Case	DC Power	Logic Power	Error	Run	Fault	Slave	Description	Resolution
	LED22	LED1	LED2	LED3	LED4	LED5		
1							No 24 Vac power source or internal board 35 VDC power	Check 24 VAC power source.
2							24 or 12 or 5 VDC power supply malfunction.	Contact Factory.
3			2				Board error on startup.	See section 'DETAILED STATUS INDICATORS' for more
4							Controller at setpoint and monitoring input signal for	Normal Operation (3)
5				1			Controller responding to a change in setpoint.	Normal Operation (3)
6			3				Board error during operation.	See section 'DETAILED STATUS INDICATORS' for more
7			2	2			Slave board communication error at startup.	Verify master to slave connection and cycle power.
8			3	2			Slave board communication error during operation.	Verify master to slave connection and cycle power.
9							Micro-processor error.	Cycle Power.
10					1	1	'MODE' set to 'SLAVE' on master board.	Correct 'MODE' setting.

TROUBLESHOOTING - CONTINUED

DETAILED STATUS INDICATORS:

Configuration Error Lights:



Numbers in colored boxes in the table above indicate the number of light blinks.

Case	Mode Setup	Master Stage	Slave Stage	Input	Custom Range	HI/LO Delays	Description	Resolution
	LED11	LED10	LED9	LED8	LED7	LED6		
1	1						Invalid MODE configuration setting.	Correct MODE configuration selection.
2		1					Slave controller detected. Master stages not set to 10.	Correct Master STAGE configuration selection.
3			1				A Slave controller is not detected. Slave stages not set to 0.	Verify Slave connection or set Slave stage to 0 on Master.
4				1			Invalid INPUT configuration setting.	Correct INPUT configuration setting.
5a				1			Without Error Light (LED2): Input signal out of range. Board will still function either full on or full off.	Verify wiring, connections and signal source.
5b				1			With Error Light (LED2): Open circuit. for ohmic input.	
6				2			(*) Polarity reversed for selected input.	Verify wiring.
7					1		Overall custom range setting is less than 2 VDC.	Verify Lo and HI range configuration settings.
8	1						Progressive Mode selected, but disabled in software for controller.	Set mode to Linear or contact factory for proper controller.

(*) Input polarity reversal (VDC & mA Inputs):

- If detected during controller startup, the S10 prevents operation until the input polarity is corrected.