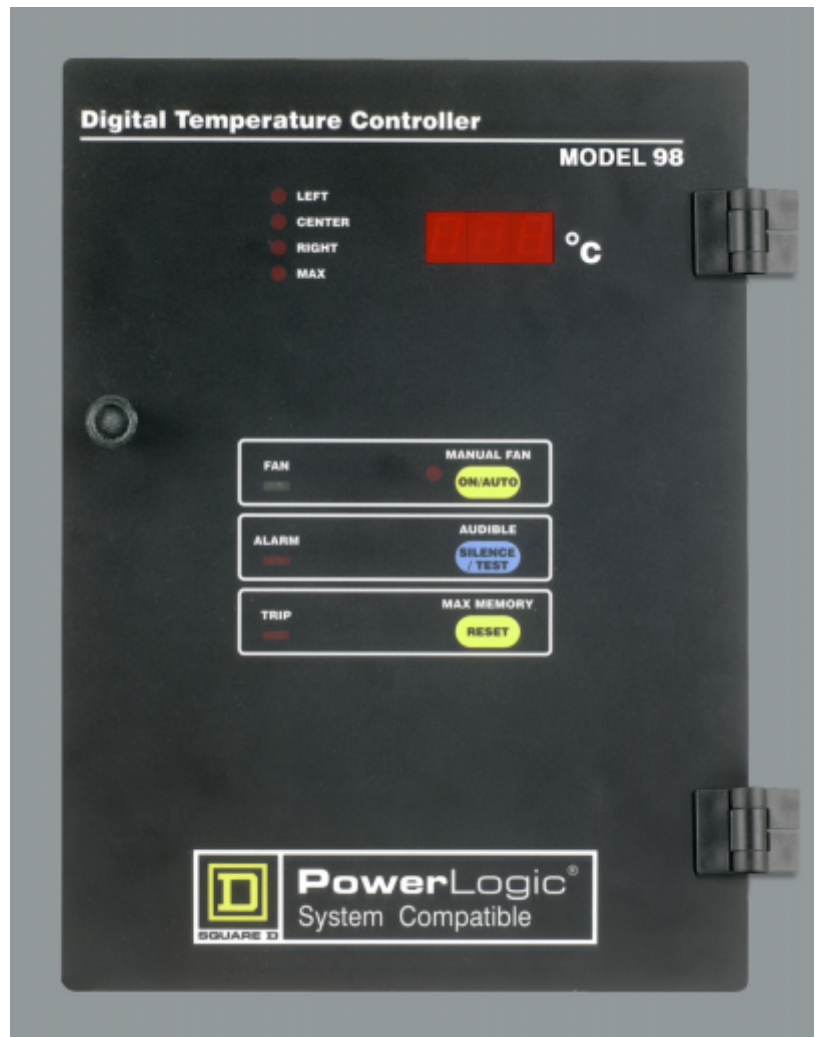


Instruction Bulletin

MODEL 98

Digital Temperature Controller
For Medium Voltage Transformers
Class 7300, 7400

Retain for future use.



SQUARE D

NOTICE

Read these instructions carefully and look at the equipment to become familiar with the device before trying to install, operate, or maintain it. The following special messages may appear throughout this bulletin or on the equipment to warn of potential hazards or to call attention to information that clarifies or simplifies a procedure.



The addition of either symbol to a “Danger” or “Warning” safety label indicates that an electrical hazard exists which will result in personal injury if the instructions are not followed.



This is the safety alert symbol. It is used to alert you to potential personal injury hazards. Obey all safety messages that follow this symbol to avoid possible injury or death.

▲ DANGER

DANGER indicates an imminently hazardous situation which, if not avoided, **will result** in death or serious injury.

▲ WARNING

WARNING indicates a potentially hazardous situation which, if not avoided, **can result** in death or serious injury.

▲ CAUTION

CAUTION indicates a potentially hazardous situation which, if not avoided, **can result** in minor or moderate injury.

CAUTION

CAUTION, used without the safety alert symbol, indicates a potentially hazardous situation which, if not avoided, **can result** in property damage.

NOTE: Provides additional information to clarify or simplify a procedure.

PLEASE NOTE

Electrical equipment should be serviced only by qualified personnel. No responsibility is assumed by Schneider Electric for any consequences arising out of the use of this material.

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WARRANTY

WARRANTY TO CUSTOMERS PURCHASING THROUGH AUTHORIZED SQUARE D DISTRIBUTORS AND CUSTOMERS PURCHASING DIRECTLY FROM SQUARE D.

Square D warrants equipment manufactured by it to be free from defects in materials and workmanship for eighteen (18) months from date of invoice from Square D or its authorized sales channels. If within the applicable warranty period purchaser discovers such item was not as warranted and promptly notifies Square D in writing, Square D shall repair or replace the items or refund the purchase price, at Square D's option. This warranty shall not apply (a) to equipment not manufactured by Square D, (b) to equipment which shall have been repaired or altered by others than Square D, (c) to equipment which shall have been subjected to negligence, accident, or damage by circumstances beyond Square D's control, or to improper operation, maintenance or storage, or to other than normal use or service. With respect to equipment sold but not manufactured by Square D, the warranty obligations of Square D shall in all respects conform and be limited to the warranty actually extended to Square D by its supplier. **The foregoing warranties do not cover reimbursement for labor, transportation, removal, installation, or other expenses which may be incurred in connection with repair or replacement.**

Except as may be expressly provided in an authorized writing by Square D, Square D shall not be subject to any other obligations or liabilities whatsoever with respect to equipment manufactured by Square D or services rendered by Square D.

THE FOREGOING WARRANTIES ARE EXCLUSIVE AND IN LIEU OF ALL OTHER EXPRESS AND IMPLIED WARRANTIES EXCEPT WARRANTIES OF TITLE, INCLUDING BUT NOT LIMITED TO IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE.

SECTION 1—INTRODUCTION

The MODEL 98 Digital Temperature Controller can continuously monitor up to three thermocouples in the windings of a dry type transformer. Based on winding temperatures, the controller has the capability to perform the following functions.

- The controller can display the current winding temperature of each winding and illuminate corresponding LEDs on the controller face that identify which winding temperature is being displayed. It also stores and displays the highest winding temperature, identifying which winding caused that high temperature.
- The controller can operate relays that activate the fans or blowers, sound the high temperature alarm, or actuate a high temperature trip. The controller compares the highest of the three winding temperatures to temperature set points that are stored in the controller's memory. These set points can be reviewed from the controller or through the POWERLOGIC® System Manager Software (SMS-3000).
- The controller can interface as part of a complete POWERLOGIC power monitoring and control system manufactured by Square D. The controller can transfer real-time information to the POWERLOGIC system about the winding temperatures, status of the relays, and the temperature set points contained with the controller's memory. Once in the POWERLOGIC system, the information can be used in tables, graphs, and reports.
- At any time, you can test the controller to check its operation. However, the controller continuously performs internal checks and will display error codes if a problem with its operation is detected.

Below, Table 1 shows at a glance the outputs from the controller. For details about the functionality of the controller, see "Section 4—Operation" on page 13.

Table 1: Controller Outputs

Data	Reading	Action
Current Temperature	Left Phase	Displays temperature and lights up the corresponding LED
	Center Phase	
	Right Phase	
	Maximum Stored	Displays temperature and illuminates corresponding winding LED and MAX LED.
Relay Set Points and Status	Fan	Activates fans or blowers and lights up the fan LED.
	Alarm	Sounds the alarm buzzer and lights up the alarm LED.
	Trip	Actuates a relay and lights up the trip LED.

This instruction bulletin is not an application guide for the MODEL 98 controller or a substitute for adequate training in safe working procedures for this and related electrical equipment. Installation of this electrical equipment may require special licenses or training. Consult applicable national, industry, and local codes for specific requirements that may apply.

The successful operation of this device depends on various factors such as installation, service conditions, and maintenance. Unless designed for other specific applications, this device should be installed on a transformer that is operating under the conditions as specified in ANSI/IEEE C57.12.01.

NOTE: If additional information is needed that is not covered by this instruction bulletin, contact the nearest SquareD Sales Office or Square D Field Services at 1-800-634-2003.

SECTION 2— SAFETY PRECAUTIONS

DANGER

HAZARD OF ELECTRIC SHOCK, BURN, OR EXPLOSION

- Read and understand this entire instruction bulletin before operating or maintaining the MODEL 98 Digital Temperature Controller. Also read and understand the bulletin that ships with the transformer before installing, operating, or maintaining a dry type transformer. Follow all applicable local and national codes.
- The controller is designed to be operated and maintained while the transformer is energized. However, many parts of the transformer operate at high voltages. **DO NOT TOUCH** the transformer parts. Use only electrically insulated tools and clothing, and protective gear when working around electrical equipment.
- Disconnect all power and verify the transformer is de-energized before servicing the transformer. Operation of a primary protective device may be evidence of a faulted transformer. Do not re-energize the transformer until the cause of operation of the primary protective device is found and corrected.
- Do not rely on visual indications such as switch position or fuse removal for determining a de-energized condition. Always assume that a terminal is energized unless it is checked with a properly rated meter to ensure the terminal is de-energized and grounded.

Failure to observe any of these precautions will result in death or serious injury.

SECTION 3—INSTALLATION

The MODEL 98 controller is installed on the transformer at the factory when the transformer is ordered with a forced air cooling package, provisions for future air cooling (package without fans), or provisions for transformer monitoring only.

NOTE: Any disassembly and reassembly of the enclosure or any other part of the transformer will be the sole responsibility of the owner and may void the warranty. Square D Company Field services is available to ensure a factory-authorized installation of the controller.

The MODEL 98 controller is factory-installed in an insulated control box that allows you to access the controller without de-energizing the transformer. Do not energize the transformer if the insulated box has been removed or tampered with.

The insulated box provides additional safety for the user and shields the controller from free flowing air currents, such as those caused when the fans turn on. Moving air could cause the controller to report incorrect readings.

If the controller has been purchased separately and has not been factory-installed, consult the Square D Medium Voltage Transformer facility for recommended installation instructions.

Connections

The type of connection required depends on the use of the controller:

- **Power connections.** If the controller is factory-installed without self-contained power, then a connection is required for control power. All other wiring is completed at the Square D transformer facility.
- **Remote monitoring connections.** If the controller is being used with a remote display and remote alarm, the controller must be wired for this use.
- **POWERLOGIC® system connections.** If the controller is part of a POWERLOGIC power monitoring and control system, the controller must be connected to the system.

DANGER

HAZARD OF ELECTRIC SHOCK, BURN, OR EXPLOSION

- Review "SECTION 2— Safety Precautions" on page 6 before making any connections.
- Ensure all personnel, tools, controller wiring, and other work material or equipment are cleared from the transformer and the control box before turning ON power to the controller.

Failure to observe these precautions will result in death or serious injury.

Connecting to the Power Source

To connect the controller to the 120 or 240 Vac power source, connect TB3-3 to neutral and TB3-4 to line. Connect earth ground to TB2-11 (see Figure 1). See Table 2 on page 10 for the proper jumper settings

⚠ CAUTION
HAZARD OF EQUIPMENT DAMAGE. Ensure power selection jumpers are set properly. Failure to observe this instruction can result in injury or equipment damage.

This also connects power to fan control relay #1. If dual fans or blowers are provided, TB3-7 and TB3-8 are prewired for power to fan control relay #2.

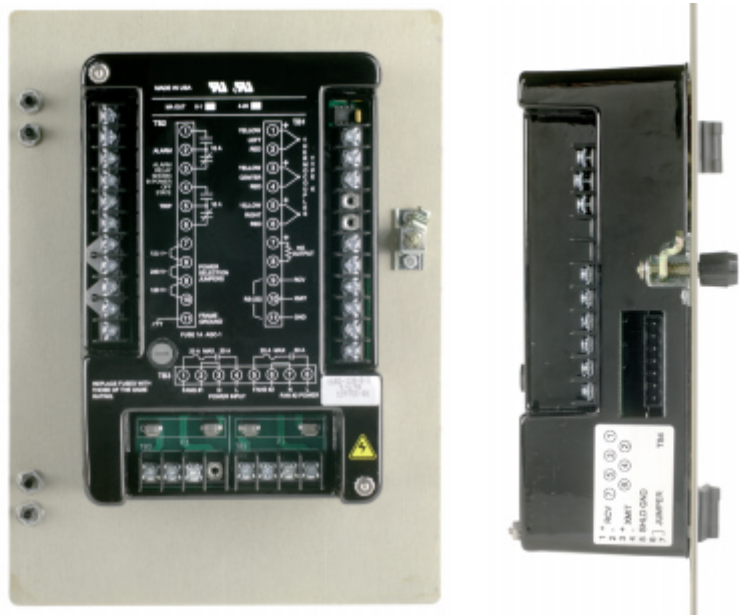


Figure 1: Power Source

⚠ CAUTION
HAZARD OF EQUIPMENT DAMAGE. Before applying power, make sure that all personal and equipment are clear of the blowers or fans. Failure to observe this instruction can result in injury or equipment damage.

When the controller is powered on, the fans or blowers turn ON, then OFF after approximately one minute. This can be used as an initial test to ensure all fans or blowers are operating.

A one ampere fuse protects the controller. If the fuse blows, check the power selection jumpers to ensure that they are set to match the power input voltage.

Do not replace and re-energize the controller until the situation is corrected. If you determine that the controller is properly connected, ensure that all power is off, replace the one-ampere rated fuse and re-energized the controller. If the situation cannot be corrected, contact Customer Service at the Square D Medium Voltage Transformer facility by calling (704) 283-7411. All other connections are prewired at the transformer facility. Table 2 on page 10 has been included as a reference to show the prewired connections.

Wiring Diagram

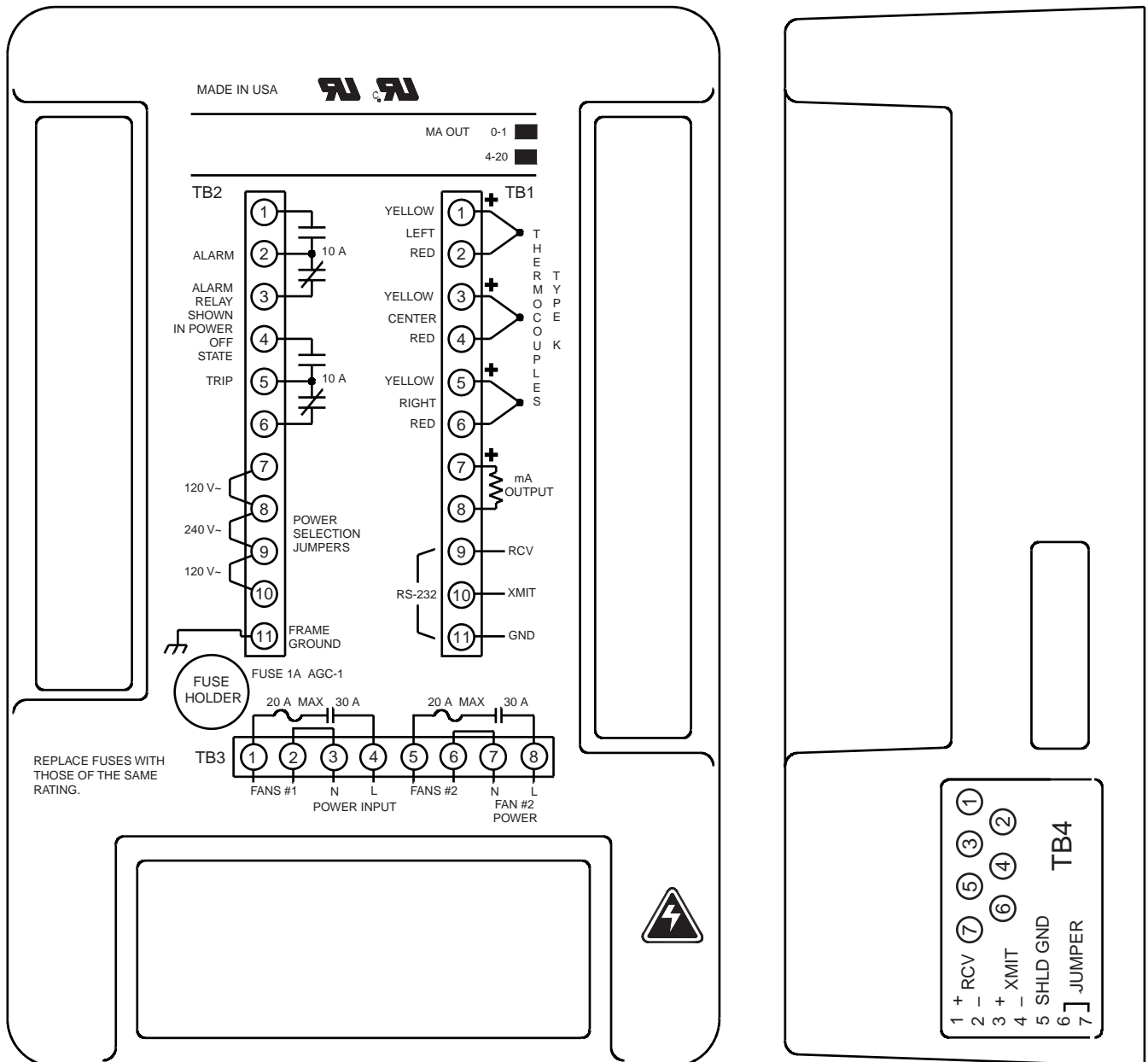


Figure 2: Wiring Diagram

⚠ CAUTION

HAZARD OF EQUIPMENT DAMAGE

The transformer may not operate as designed if the fan, alarm, or trip settings are changed. Only an authorized Square D Company representative can make set point changes to the controller. If changes to the factory settings are needed, contact the After Shipment Customer Service at the Square D Medium Voltage Transformer facility.

Failure to observe this instruction can result in injury or equipment damage.

Table 2: Factory Prewired Connections

Connection Type	Controller Terminal	Item	Connection Information
Thermocouples	TB1-1 to TB1-2	Thermocouple sensor #1	Type K thermocouples are standard. The yellow lead is connected to the positive terminal (1, 3 or 5) and the red lead is connected to the negative terminal (2, 4 or 6).
	TB1-3 to TB1-4	Thermocouple sensor #2	
	TB1-5 to TB1-6	Thermocouple sensor #3	
mA Output	TB1-7, 8	Milliampere output current loop	Provides a current proportional to the present highest temperature. TB1-7 is the positive terminal.
RS-232 Link	TB1-9	Data going to the controller	The controller is shipped from the factory completely programmed and ready for operation. However, in unique operating situations or conditions the controller may require alternate programming. An RS-232 data link is provided for setting up the programmable parameters of the controller. If additional information or changes to the set points are required, contact After Shipment Customer Service at the Square D Medium Voltage Transformer facility by calling (704) 283-7411. While the set points are programmable, only an authorized Square D representative has access to change typical setup parameters.
	TB1-10	Data coming from the controller	
	TB1-11	Ground connection for the data link	
Power Source Connection	TB2-7 to 8 TB2-9 to 10	120 Vac voltage Jumper TB2-7 to 8 and jumper TB2-9 to 10	The controller may be damaged if wired improperly. It is designed to operate on a 120 Vac or a 240 Vac system, but not both. Make sure the power source voltage matches the voltage selection jumpers. Jumpers between terminals are required for proper connection.
	TB2-8 to 9	240 Vac voltage Jumper TB2-8 and 9	
Relay Contacts	TB3-1, 2	Fan #1—Contacts are internally connected to the power source through a fuse internal to the controller	The controller has two circuits for controlling the fans or blowers. Each circuit is protected by its own fuse and controlled by a separate relay with a SPST Form A contact. The contact is open when no power is applied to the unit. The alarm and trip relay contacts are SPDT Form C. The alarm relay is normally energized and changes state when power is lost. The trip relay is normally de-energized and does not change state when power is lost.
	TB3-5, 6 TB3-7, 8	Fan #2—Controls the fans or blowers through a fuse connected to TB3-5,6. Fan #2 circuit is electrically separate from the Fan #1 circuit and is powered from TB3-7, 8	
	TB2-1, 2, 3	Alarm—SPDT (Form C) contacts at TB2-1,2,3 indicate an alarm condition. This relay is usually set to be energized in the normal state so that the loss of control power will cause an alarm	
	TB2-4, 5, 6	Trip—SPDT (Form C) contacts at TB2-4,5,6 indicate that the temperature being monitored has reached the trip state. This relay is usually set to be de-energized in the off state	

Connecting to Remote Current Loop Output

The temperature controller provides a milliampere analog signal for use with remote meter or SCADA systems. Access this output on TB1 terminals 7 and 8. See the back cover of the controller for the type of output (0–1 or 4–20 mA).

Communications Wiring

The MODEL 98 controller is equipped with a RS-485 communication port. The RS-485 standard allows you to daisy chain up to 32 devices on a single communications link.

The controller can be connected to communication ports on one of the following:

- Personal computer with SY/LINK® card or POWERLOGIC Ethernet Gateway
- POWERLOGIC Network Interface Module
- SY/MAX programmable controller
- Other host devices with a POWERLOGIC compatible port

For a more detailed explanation of the system configurations described above, refer to Chapter 3 of Square D Instruction Bulletin No. 3020IM9301R10/97.

To daisy chain the MODEL 98 with other POWERLOGIC compatible devices, use a communications cable containing two twisted-shielded pairs (Belden 8723 or equivalent). See Table 3 on page 12, of this bulletin for the RS-485 terminal block connector designations. To avoid communication problems, do not position the MODEL 98 as the last device on a chain.

Connecting to the POWERLOGIC System

The MODEL 98 controller is designed to interface with the POWERLOGIC power monitoring and control system from Square D, using either MODBUS® or SY/MAX protocols. All communication setup functions that are normally performed at the controller can be performed remotely via a PC with System Manager Software (SMS). After the MODEL 98 Device Type disk is installed, SMS-3000 software provides basic support for the controller, allowing for logging/alarms, historical trending, and standard tables of data to be displayed and saved remotely.

The MODEL 98 Device Type install program can be obtained by:

- Downloading it from the POWERLOGIC.com Website
- Requesting a 3.5" floppy disk copy by calling Customer Service at the Square D Medium Voltage Transformer facility at (704) 283-7411.

SMS version 3.02a users can consult the Basic Support Setup and Operation section of the SMS Users Manual or Help System to learn how to add a device to the system. SMS version 3.1 users can learn how to add a device to the system by going to the Working With Devices section of the SMS Help System. The MODEL 98 Device Type install is only available for those systems using SMS version 3.02a or greater.

Protocols are not interchangeable, therefore the protocol of your network must match the protocol of the controller. If the controller is not operating, the protocol may have been incorrectly specified. Refer to the following section "MODBUS and SY/MAX Protocol" for instructions on how to setup the communication protocol. For further assistance, contact the nearest Square D Sales Office or Square D Field Services at 1-800-634-2003.

MODBUS and SY/MAX Protocol

A seven-terminal connector on the side of the controller (Figure 3) provides a 4-wire RS-485 connection. To make an RS-485 connection, plug in the connector from the controller. The jumper on terminals 6 and 7 causes the microprocessor to use the data from the RS-485 connector and disables the RS232 connection on the rear terminals

To set the baud rate for the RS-485 connection, see “Communications Setup” on page 15.

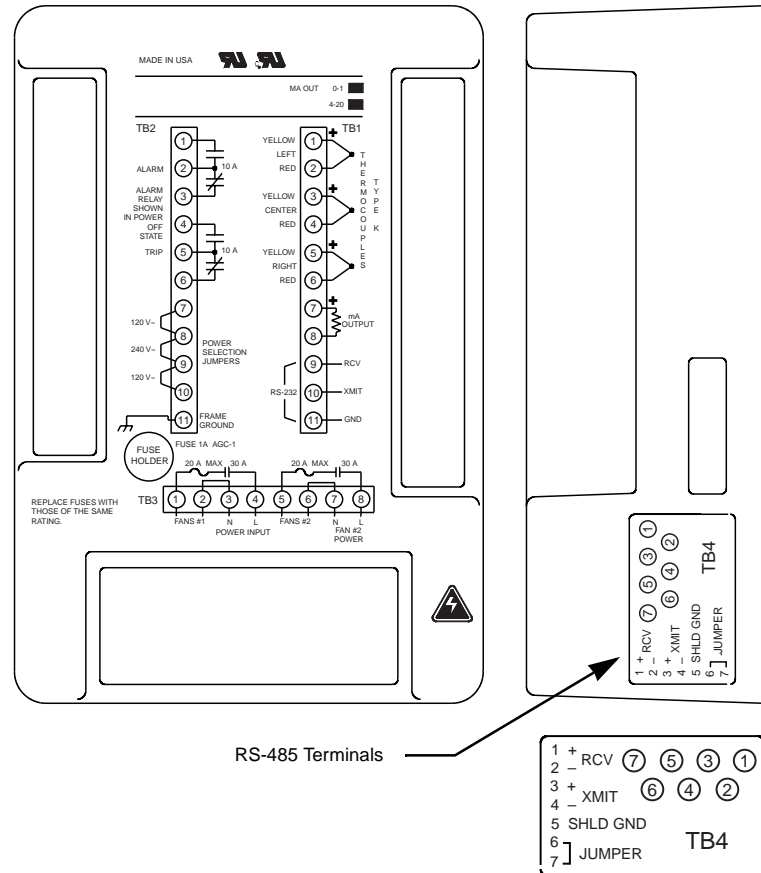


Figure 3: RS-485 Link

Table 3 shows the RS-485 terminals block connector designations.

Table 3: Terminal Connector Designations

Terminal Number	Designation
1	Receive +
2	Receive -
3	Transmit +
4	Transmit -
5	Shield ground
6 and 7	Must be jumpered together, they are at logic 0 volts

SECTION 4—OPERATION

Output Relay Status LEDs— FAN, ALARM, and TRIP

Three LEDs indicate the status of the output relays:

- Yellow (FAN) illuminates when the fan relay is activated. This is triggered when the transformer temperature is above the temperature set point of the fan relay.
- Red (ALARM) indicates that the alarm relay is in the alarm state when the alarm temperature set point is exceeded.
- Red (TRIP) indicates that the trip relay is in the trip state when the maximum temperature set point is exceeded. The trip relay provides a contact that can be used to take the transformer off line.

The front of the MODEL 98 controller displays transformer temperature data, communicates the state of the outputs, and allows you to review set points. Also, you can control the fans, alarm buzzer, and reset the maximum temperature setting.

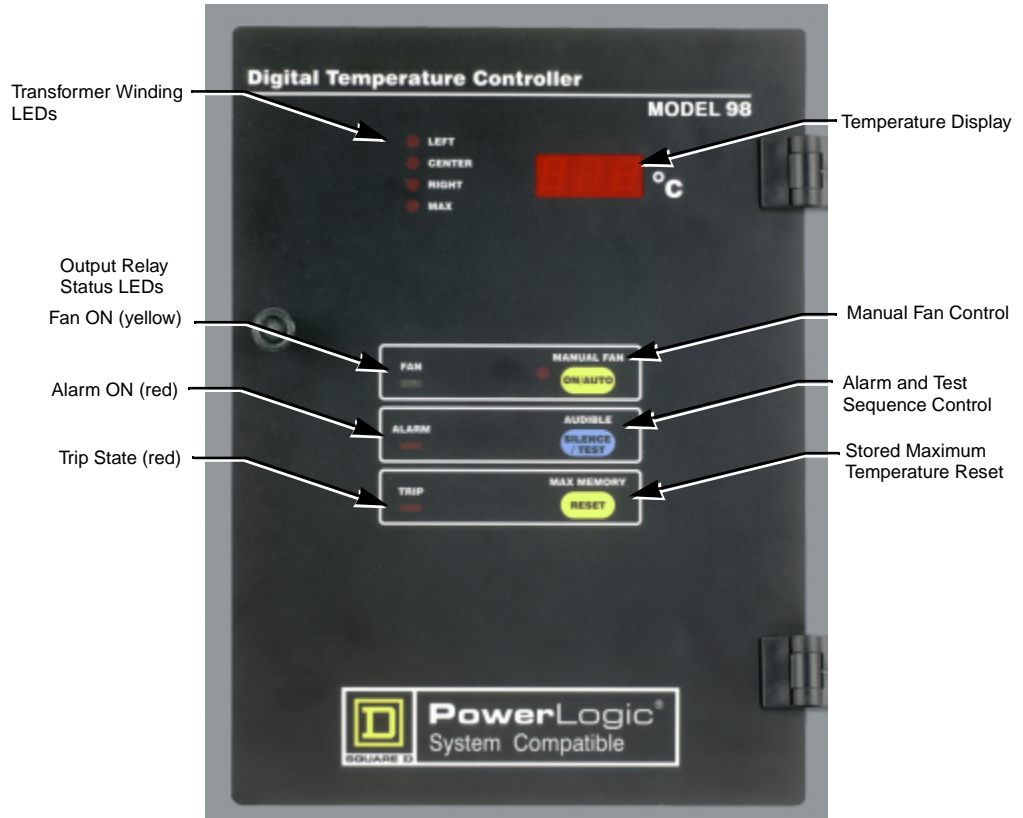


Figure 4: Front Panel Detail

Temperature Display

The temperature display and the transformer winding LEDs work together to communicate the temperature of each winding. Depending on the application, the factory sets the controller to sample the temperatures in one, two, or all three windings.

The maximum temperature reached by any of the windings is also stored in the controller's memory. When the maximum temperature is displayed, two LEDs illuminate. The lighted MAX LED indicates that the display is showing the maximum stored temperature, while the LEFT, CENTER, or RIGHT LED illuminates at the same time to identify the winding that caused the maximum reading. The maximum temperature can be reset at any time, see "Resetting the Maximum Stored Temperature" on page 14.

During normal operation, the controller continuously displays in sequence the winding temperatures and the maximum stored temperature while illuminating the corresponding LED. Each reading from the thermocouples is displayed for approximately two seconds, then the controller automatically steps to the next reading. See "Thermocouples and the Temperature Display" on page 17 for technical details about the temperature readings.

Manually Controlling the Fans or Blowers

The Manual Fan ON/AUTO button forces the fans to turn on whenever you press the ON/AUTO button to manually activate the fan relay. Also, the red LED on the Manual Fan button illuminates to show that the manual fan ON function is active. The fans stay ON until you press the button again to return to the auto mode. Use the Manual Fan feature anytime to verify that the fan relay and fans or blowers are operating properly.

When the Manual Fan button is activated and illuminated *and* the temperature is above the set point that activates the fans, pressing the ON/AUTO button releases the manual fan ON function and returns to the auto mode. The red LED turns off, but in this case the fans remain on. Thus, when the fans have been activated automatically by a temperature above the fan set point, the ON/AUTO button cannot turn the fans OFF.

Silencing the Alarm

An internal buzzer sounds each time the alarm is activated. To silence the buzzer, press SILENCE/TEST. The buzzer remains off until a new alarm occurs. Silencing the alarm does not eliminate the problem that caused the alarm. Promptly find and correct the situation that caused the alarm.

If the alarm is ON but nothing on the control is illuminated, check the fuse located in the round fuse holder on the back cover. The fuse is a 1/4 x 1 in (5 x 20 mm) 250 V, 1 A.

Reviewing Set Points

When the buzzer is not sounding, you can press the SILENCE/TEST button to start a TEST sequence to verify that the controller is operating properly and to review the set points. The test sequence performs the following checks at two second intervals:

1. Displays the fan ON temperature setting and illuminates the fan LED.
2. Displays the alarm temperature setting, illuminates the alarm LED, and sounds the alarm buzzer.
3. Displays the trip temperature setting and illuminates the trip LED.
4. Displays the ambient temperature inside the controller.
5. Displays 888 on the temperature display and illuminates the corresponding temperature source LEDs (LEFT, CENTER, RIGHT, and MAX), and illuminates the Manual Fan LED.

Resetting the Maximum Stored Temperature

Press the Max Memory RESET button to clear the memory of the maximum stored temperature. This causes the current, highest winding temperature to become the stored maximum temperature.

Communications Setup

The communications setup of the MODEL 98 controller can be changed from the front panel by performing the following procedure:

1. Press and hold all three buttons until the unit stops cycling through the readings (approximately 3 seconds).

The controller displays the current baud rate.

Table 4: Baud Rates

Display	Bits per Second
12	1200
24	2400
48	4800
96	9600
192	19,200

Pressing the Audible (middle) button will step the display **up** through the above choices. Pushing the Max Memory (bottom) button will step the display **down** through the above choices

2. When the desired baud rate is displayed, press the Manual Fan (top) button.

The display shows the current parity setting:

Table 5: Parity Settings

Display	Description
PE	Even Parity (Standard)
PO	Odd Parity
P--	No parity

3. When the desired parity is displayed, press the Manual Fan (top) button. The display shows the current Stop-Bit setting.

If parity is Even or Odd the display will show S1 and cannot be changed.

If No Parity has been selected then the number of stop bits can be set to 1 or 2 (S1 or S2). S1 is used if the unit is communicating through a modem, otherwise S2 is standard.

4. When the desired Stop Bit is displayed, press the Manual Fan (top) button. The display shows the current protocol setting:

Table 6: Stop Bit Settings

Display	Protocol
Sy	SY/MAX
nb	MODBUS

5. When the desired protocol is displayed, press the Manual Fan (top) button. The display shows the current address setting.

Pressing the Audible (middle) button will step the display **up** through the addresses. Pushing the Max Memory (bottom) button will step the display **down** through the addresses. Note legal addresses in SY/MAX mode are 1-199. Legal addresses in MODBUS mode are 1-255.

6. Press the Manual Fan (top) button to return the controller to normal operation and save the settings. If you do not press a button for 30 seconds, the unit will automatically return to normal operation and the communications setup will be unchanged.

Controller Error Codes

During normal operation the controller is constantly checking itself for proper operation. If a problem is detected, the controller displays one of the error codes described in Table 7.

Table 7: Error Codes

Display	Reason	Description	Corrective Action
---	Failed Thermocouple or Reversed Connection	Shows “---” on the display when that particular sensor temperature should be displayed. Shows which sensor is malfunctioning. The system activates the alarm, turns ON the fans, and continues to function using the remaining input channels. If the controller detects an open-circuited thermocouple, the alarm sounds and the faulty channel is displayed. A failed thermocouple does not cause a trip. This display also indicates a reversed thermocouple connection when the thermocouple is 30 °C below the terminal block temperature.	1. Make sure the thermocouples are wired according to the wiring diagram on page 9. 2. Inspect the thermocouples for possible damage. If damaged, repair or replace.
E11	Failed A/D Converter	Shows “E11” on all channels, turns ON the fan relay, and activates the alarm.	
E22	Failed Terminal Block Temperature Sensor	Shows “E22” on all channels, sets ambient temperature at 30 °C, activates the alarm, turns ON the fans, and continues to operate using 30 °C ambient temperature.	1. Disconnect power to the controller.
E33	Failed EEROM after initial start up	Shows “E33” on all channels, continues to operate, activates the alarm and turns ON the fan relay.	2. Remove the hinges and disconnect the wiring.
	Failed EEROM at power up	Shows “E33” on all channels, turns ON the fan relay, activates the alarm.	3. Obtain a Returned Material Authorization and return the controller to the Square D Medium Voltage Transformer Facility.
Blank	Failed Display Driver	Blank temperature, nothing is shown in digital display. The controller continues to operate, activates the alarm, and turns ON the fan relay.	

SECTION 5—MAINTENANCE

Inspect the controller regularly during normal transformer inspection. The frequency of inspection depends on operating conditions. If the controller is installed in a Square D transformer that is operating in usual service conditions as defined in ANSI/IEEE C57.12.01, an inspection every five years may be sufficient. However, for unusual locations where the air is contaminated with particles such as dust or chemical fumes, the transformer and controller should be inspected every three months or sooner. After the first few inspections, determine a more definite schedule based on the existing conditions. Perform the following procedures for maintenance.

NOTE: If any problem is found during maintenance, contact the nearest SquareD Sales Office or Square D Field Services at 1-800-634-2003.

⚠ DANGER

HAZARD OF ELECTRIC SHOCK, BURN, OR EXPLOSION

- Before performing this procedure, review “SECTION 2—Safety Precautions” on page 6.
- Before servicing the controller, turn OFF power to the controller.

Failure to observe these precautions will result in death or serious injury.

Testing the Fans or Blowers

The controller has an automatic fan exerciser that turns the fans ON for a short time at preset intervals. However, during a scheduled inspection of the transformer, turn the blowers or fans ON to confirm that they are working properly. To turn the fans ON manually, press the Manual Fan ON/AUTO button. The fans will remain ON until you press the Manual Fan ON/AUTO button again.

Testing the Controller

The TEST button enables you to test the LED displays on the controller to check that the LED lights are working properly. This test should be performed during maintenance. To start the test sequence, press the Audible Alarm SILENCE/TEST button. The display shows the stored set points and the internal temperature of the controller. The controller also tests the digital display, all the LEDs, and the alarm buzzer. For details about what the controller does during the test sequence, see “Reviewing Set Points” on page 14.

SECTION 6—SPECIFICATIONS

Typical controller specifications have been included for reference.

Table 8: Factory Set Points

Rated Average Transformer Temperature Rise*	Relay Set Points					
	Blowers or Fans		Alarm		Emergency Shutdown	
	ON	OFF	ON	OFF	Dry Type Transformers	Cast-Coil Transformers
80°C	110 °C	100 °C	125 °C	123 °C	220 °C	185 °C
115°C	145°C	135 °C	160 °C	158 °C	220 °C	185 °C
150°C	180°C	170 °C	195 °C	193 °C	220 °C	—

* Based on NEMA and ANSI Standards of 30 °C average and 40 °C maximum ambient for any 24-hour period below 3300ft (990 m) altitude.

Thermocouples and the Temperature Display

The digital temperature displayed is always the total temperature of ambient plus approximate hot spot temperatures, not the average temperature rise. For example, a transformer is rated 150 °C average temperature rise when carrying rated full load in a 20 °C ambient temperature. The thermocouple sensors are installed near the theoretical hot spot of the coils. NEMA and ANSI standards permit a 30 °C maximum differential between average and hot spot temperatures. Therefore, the digital display would indicate approximately 20 °C + 30 C + 150 °C = 200 °C total. Note that the alarm would operate at this point to warn that the transformer is approaching the maximum temperature limit of the insulation system.

Table 9: Performance Specifications

Performance Measurement	Specification
Input Power	120/240 Vac, ±15%, 50/60 Hz
Range	0–250 °C
Display Resolution	1°C High resolution mode (increments)
Accuracy	±0.8% ± one count under normal conditions
	±2% ±one count under extreme conditions: Ambient temperature colder than –10 °C
Memory Retention	40 years (with power off)
Relay Ratings	Fans (each relay) 20 A at 120/240 Vac 1 hp at 120 Vac, 2 hp at 240 Vac
	Alarm and Trip 10 A at 120 Vac (resistive) 8 A at 240 Vac (resistive)
Remote Output Current Loop	0–1 mA, 10,000 ¾ maximum, or
	4–20 mA, 500 ¾ maximum
	Accuracy ±1% of full scale reading

Table 10: Mechanical Specifications

Mechanical Measurement	Specification
Front Panel	Front panel graphic overlay 8 in x 11 in (203.2 mm x 279.4mm)
Mounting Panel	Mount through cutout 7.75 in. width x 10.50 in. height (196.9 x 266.7 mm) with four .218 in (5.53 mm) diameter hinge holes
Depth	3.2 in (81.3 mm)
Weight	3 lbs (1.4 kg)
Terminals	Screw terminal; maximum 12-gauge wire

Table 11: Approvals

Approvals	UL per UL 873
	C-UL per CSA 22.2 No. 24-93
	CE per EMC standard No. EN50081-1 and EN50082-2

Table 12: MODEL 98 Register List

Modbus Register Number	Read Registers	Comments	SY/MAX Register Number	Special Symax	
				Register	Returns
40001	Temperature left phase	Normal temp range is 0–255d in low byte.	1	8172	0
40002	Temperature center phase	A value of 8000h indicates invalid data.	2	8173	8176
40003	Temperature right phase		3	8174	1
				8175	0
				8176	0
40004	ETM status	bit 0 = 1 = some other bit is 1 bit 1 = 1 = ON, fan state bit 2 = 1 = ON, alarm state bit 3 = 1 = ON, trip state bit 4 = 1 = ON, buzzer state bit 5 = 1 = ON, manual fan state	4	8177	0
				8178	0
				8179	0
				8180	0
				8181	0
				8182	0
40005	Maximum stored temperature	Normal temperature range is 0–255d in low byte.	5	8183	0
40006	Phase with maximum stored temperature	bit 0 is always a 1 bit 1 = 1 indicates maximum stored temp was left phase bit 2 = 1 indicates maximum stored temp was center phase bit 3 = 1 indicates maximum stored temp was right phase	6	8184	0
				8185	0
				8186	4
				8187	0
				8188	15060
40007	Temperature at unit's terminal block	The lo byte indicates temperature at the intrument terminal block in degrees C. Temperatures below zero will show as zero.	7	8189	0
				8190	0
				8191	0
				8192	0
40008	Diagnostic status	bit 0 = 1 = some other bit is 1 bit 1 = 1 = failed A/D converter bit 3 = 1 = failed terminal block temperature sensor bit 4 = 1 = failed EEROM bit 5 = 1 = failed display driver	8		
40009	Phase status	bit 0 = 1 = some other bit is 1 bit 1 = 1 = left phase disabled bit 2 = 1 = center phase disabled bit 3 = 1 = right phase disabled bit 4 = 1 = left phase has failed sensor bit 5 = 1 = center phase has failed sensor bit 6 = 1 = right phase has failed sensor bit 7 = 1 = fan exerciser is disabled	9		
40010	Fan setpoint		10		
40011	Alarm setpoint		11		
40012	Trip setpoint	Setpoint and deadband are 8 bit data in the low order byte.	12		
40013	Fan deadband		13		
40014	Alarm deadband		14		
40015	Trip deadband		15		
40016	Fan exercise interval	1 to 720 hours (up to 30 Days)	16		
40017	Fan exercise run time	1 to 120 minutes	17		
40018	Time since last ran exercise	1 to 720 hours (up to 30 Days)	18		
40019	Firmware version		19		
48188	Device I.D.	15060d (15060–15069 reserved for ETM)	8188		
Write Registers					
40050	Set manual fan function ON/OFF	0001 turns the Fan ON. 0000 sets the fan to AUTO.	50		
40051	Reset maximum stored temperature	0001 sets the maximum temp stored to current max temp.	51		
40052	Reset unit	0001 resets the unit.	52		
40053	Buzzer control	0001 turns the buzzer ON. 0000 turns the buzzer OFF.	53		

SEM Revised 2/4/99 (added #9 to SY/MAX column)

MODEL 98 Digital Temperature Controller For Medium Voltage Transformers

Square D Company
1809 Airport Road
Monroe, NC 2811 USA
1-888-SquareD (1-888-778-2733)
www.squared.com

Electrical equipment should be serviced only by qualified electrical maintenance personnel. No responsibility is assumed by Square D for any consequences arising out of the use of this material.

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