

# tekmar® - Data Brochure

## Difference Setpoint Control 156

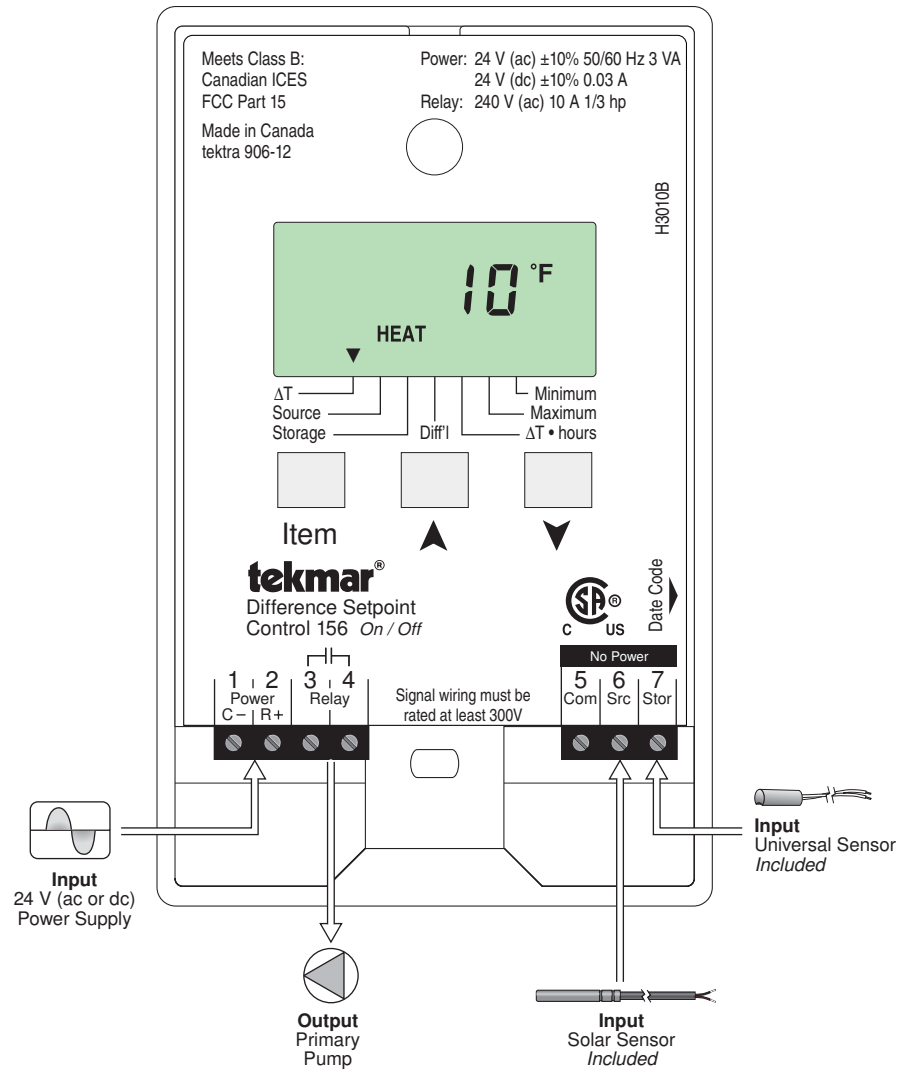
**D156**

06/10

The Difference Setpoint Control 156 is designed to operate an on/off pump to transfer heat from a heat source to a storage tank. The control operates based on a setpoint temperature difference ( $\Delta T$ ). The relay turns on when the  $\Delta T$  rises above the setpoint and turns off when the  $\Delta T$  falls below the setpoint less the differential. The Source Minimum and Storage Maximum settings turn off the relay when heat transfer is no longer desirable. Potential applications include using solar collectors or a wood boiler as a heat source.

### Additional functions include:

- 24 V (ac) OR 24 V (dc) power supply
- Monitor Minimum & Maximum temperatures for Source & Storage
- Displays number of running hours of the relay
- Displays  $\Delta T \cdot$  hours to perform energy calculation
- CSA and UL certified for use in the USA and Canada
- **NEW Solar Sensor 085 immersion type sensor included!**



## How to Use the Data Brochure

This brochure is organized into three main sections.

They are: 1) Sequence of Operation, 2) Installation, and 3) Display Menu.

The Display Menu section of this brochure describes the various items that are adjusted and displayed by the control. The control functions of each adjustable item are described in the Sequence of Operation.

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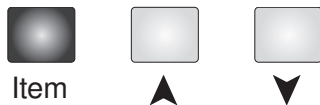
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## User Interface

The 156 uses a Liquid Crystal Display (LCD) as the method of supplying information. Use the LCD in order to set up and monitor the operation of your system. The 156 has three push buttons (Item,  $\blacktriangle$ ,  $\blacktriangledown$ ) for selecting, viewing, and adjusting settings. When programming the control, record settings in the PRGM menu table which is found in the second half of this brochure.

### Item

The selected item will be displayed using a pointer in the display. To view the next available item, press and release the Item button. Once you have reached the last available item, pressing and releasing the **Item** button will return the display to the first item.



### Adjust

To make an adjustment to a setting in the control, press and hold simultaneously for 1 second all three (3) buttons. The display will then show the word PRGM on the left side of the screen. Then select the desired item using the **Item** button. Finally, use the  $\blacktriangle$  or  $\blacktriangledown$  button to make the adjustment.



### View Current Setpoints

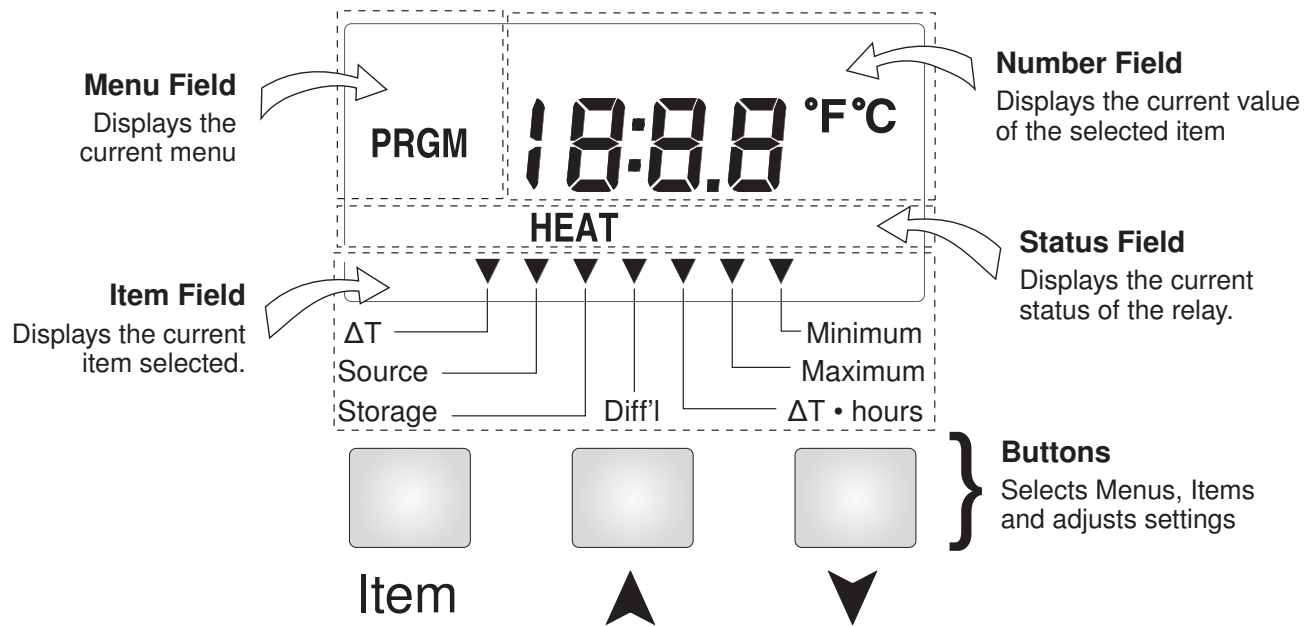
While viewing temperatures, a quick and easy way to view current setpoints is to press and hold either the **Item**,  $\blacktriangle$ , or  $\blacktriangledown$  button.

Press and hold the **Item** button to view the current  $\Delta T$  Setpoint.

Press and hold the  $\blacktriangle$  button to view the current Minimum Source Setpoint.

Press and hold the  $\blacktriangledown$  button to view the current Maximum Storage Setpoint.

## Display



## Symbol Description

▼	<b>POINTER</b> Displays the control operation as indicated by the text.	°F°C	°F, °C Units of measurement
<b>HEAT</b>	<b>HEAT RELAY</b> Displays when the HEAT relay is closed.	<b>PRGM</b>	<b>PROGRAM MENU</b> Program the control settings.

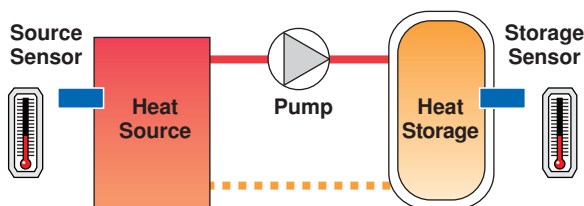
## Sequence of Operation

### Powering Up the Control

When the Difference Setpoint Control 156 is powered up, all segments are displayed in the LCD for 2 seconds, and then the type number is displayed for 2 seconds. Next,

the software version is displayed for 2 seconds. Finally, the control enters into the normal operating mode and by default the LCD displays the current  $\Delta T$  temperature.

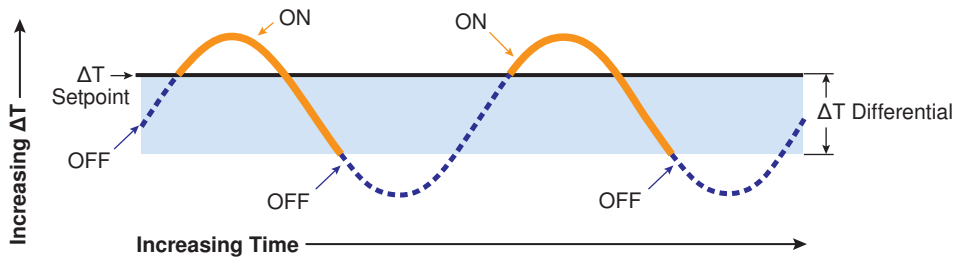
### Setpoint Operation



The Difference Setpoint Control 156 has two control points; heat source and storage. The heat source could be a solar collector or wood boiler while the heat storage is typically a storage tank. The control is looking at the temperature difference ( $\Delta T$ ) between the source and storage to determine when to close the relay and start the heat transfer. The setpoint operation that follows will explain the on and off points of the relay.

## ΔT SETPOINT

The control measures the difference between the source and the storage temperatures ( $\Delta T$ ). When the measured  $\Delta T$  is greater than the  $\Delta T$  setpoint, the relay is turned on to transfer heat from the source to the storage. If the  $\Delta T$  drops below the  $\Delta T$  Setpoint less the  $\Delta T$  Differential, the relay is turned off.



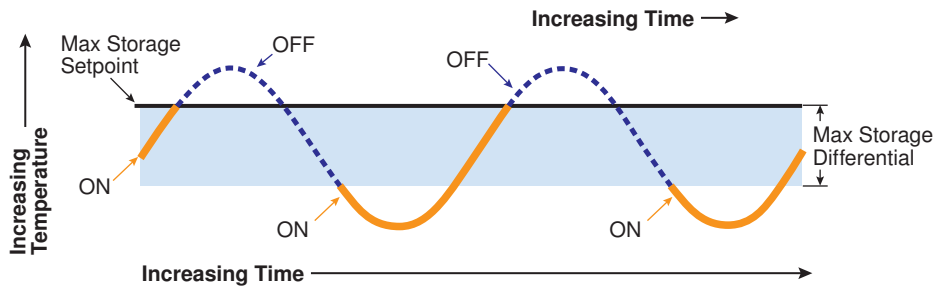
Relay operation showing the turn on and turn off points with respect to the  $\Delta T$  Setpoint and  $\Delta T$  Differential.

Typical Settings	$\Delta T$ Setpoint	Differential
With a heat exchanger	15 to 25 °F (8 to 14 °C)	10 to 15 °F
Without a heat exchanger	13 to 21 °F (7 to 12 °C)	(6 to 8 °C)

## MAXIMUM STORAGE SETPOINT

If the measured storage temperature rises above the Maximum Storage Setpoint, the relay is turned off. The relay remains off until the storage temperature drops below the Maximum Storage Setpoint less the Maximum Storage Differential.

The Maximum Storage Setpoint stops the transfer of heat when the storage temperature rises above the Maximum Storage Setpoint, which prevents the storage tank from over heating. Turning off the relay allows heat to be drawn out of the tank to satisfy any heating loads without heat being returned to the tank from the heat source, thus lowering the tank temperature.

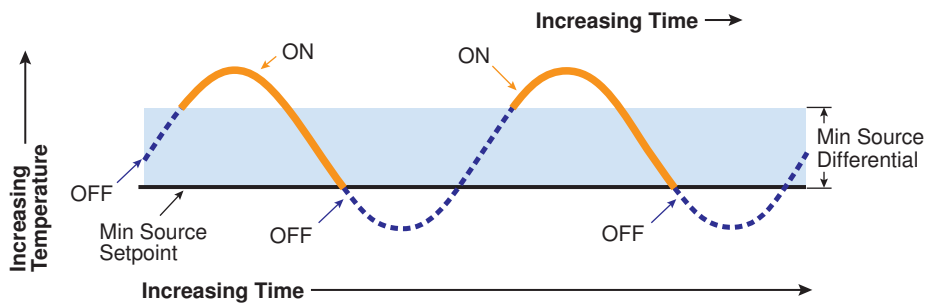


Relay operation showing the turn on and turn off points with respect to the Max Storage Setpoint and Differential.

## MINIMUM SOURCE SETPOINT

If the measured source temperature drops below the Minimum Source Setpoint, the relay is turned off. The relay remains off until the source temperature rises above the Minimum Source Setpoint plus the Minimum Source Differential.

The Source Minimum Setpoint does not provide freeze protection; it only stops the transfer of heat when the source temperature falls below the Minimum Source Setpoint. The heat source is still susceptible to freezing. Turning off the relay allows the heat source to gain heat by stopping the heat transfer to the storage tank.



Relay operation showing the turn on and turn off points with respect to the Min Source Setpoint and Differential.

## Using ΔT•hours to Calculate Heat Transfer

To estimate the total amount of heat the system has transferred from the heat source to the storage tank use the equation:

$$\text{Total Heat Transferred} = \frac{\text{Flow Rate}}{\text{Flow Rate}} \times \frac{\Delta T \cdot \text{hours}}{\Delta T \cdot \text{hours}} \times \frac{K}{K} = \text{BTU}$$

Where:

- Flow Rate is that produced by the pump in US Gallons per minute
- ΔT•hours is the temperature difference between the source and storage multiplied by the amount of time heat transfer is taking place (time the pump runs). This variable is calculated for you by the control since the ΔT is not constant.
- K is a constant calculated by multiplying the fluid property specific heat (BTU/lbm °F) by density (lbm/USGal) by 60 (min/hr). For example, water has a specific heat of 1 BTU/lbm °F and a density of 8.33 lbm/USGal. Therefore the value of K in this case is 1 x 8.33 x 60 = 500.

The value of K depends on the percent volume of glycol added to the heat transfer fluid. Select an appropriate K value from table 1.

Ethylene Glycol Solution			Propylene Glycol Solution		
% by Volume	Freezing Point	K @ 120°F (49°C)	% by Weight	Freezing Point	K @ 120°F (49°C)
0	32°F (0°C)	493	0	32 (0°C)	493
10	23°F (-5°C)	482	10	26 (-3°C)	492
20	14°F (-10°C)	472	20	18 (-8°C)	489
30	2°F (-17°C)	460	30	7 (-14°C)	477
40	-13°F (-25°C)	446	40	-8 (-22°C)	466
50	-36°F (-38°C)	429	50	-29 (-34°C)	446
60	-70°F (-57°C)	411	60	-55 (-48°C)	425

Table 1: K values at 120°F (49°C) for different heat transfer solutions based on % glycol. K increases with temperature.

Note: BTU = British Thermal Unit, lbm = Pound Mass, USGal = US gallon

## Temperature Monitoring

The 156 will monitor the minimum and maximum Source and Storage temperatures. These items are available in the Default menu and may be reset by pressing and holding the ▲ and ▼ buttons simultaneously for 1 second.

'Clr' (clear) will then be displayed followed by the value being reset to the current sensor temperature. Use this feature to determine system performance or for troubleshooting.

## Installation

### Caution

Improper installation and operation of this control could result in damage to the equipment and possibly even personal injury. It is your responsibility to ensure that this control is safely installed according to all applicable codes

and standards. This electronic control is not intended for use as a primary limit control. Other controls that are intended and certified as safety limits must be placed into the control circuit.

### Step One — Getting Ready

Check the contents of this package. If any of the contents listed are missing or damaged, please contact your wholesaler or tekmar sales representative for assistance.

Type 156 includes: One Difference Setpoint Control 156, One Solar Sensor 085, One Universal Sensor 071, Data Brochures D156, D085, D070, D001, Application Brochure A156.

**Note:** Carefully read the details of the Sequence of Operation to ensure that you have chosen the proper control for your application.

## Step Two — Mounting

The control is mounted in accordance with the instructions in the Data Brochure D 001.

## Step Three — Rough-in Wiring

The wiring terminates in the two wiring chambers on the control. Determine whether the low voltage wiring enters the wiring chamber through the back or the bottom of the control. The wiring is roughed-in prior to installation of the control (see Brochure D 001). Standard 18 AWG solid wire is recommended for all low voltage wiring, and multi-strand 16 AWG wire is recommended for 120 V (ac) wiring.

**Power must not be applied to any of the wires during the rough-in wiring stage.**

- Install the Source Sensor 085 and Storage Sensor 071 according to the instructions in the Data Brochures D085 and D070, and run the wiring back to the control.
- Run wires from the 24 V (ac or dc) power to the control. Use a clean power source to ensure proper operation.

## Step Four — Testing the Wiring

The following tests are to be performed using standard testing practices and procedures, and should only be carried out by properly trained and experienced persons.

A good quality electrical test meter, capable of reading from at least 0 - 300 V (ac) and at least 0 - 2,000,000 Ohms, is essential to properly test the wiring and sensors.

### Test the Sensors

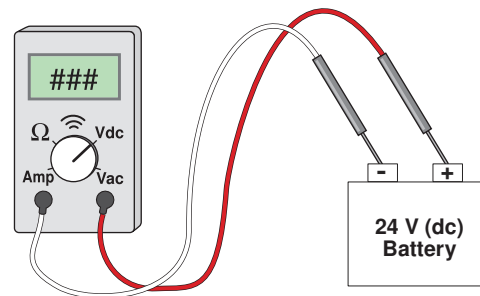
In order to test the sensors, the actual temperature at each sensor location must be measured. A good quality digital thermometer with a surface temperature probe is recommended for ease of use and accuracy. Where a digital thermometer is not available, a spare sensor can be strapped alongside the one to be tested, and the readings compared. Test the sensors according to the instructions in the Data Brochures D085 and D070.

### Test the Power Supply

Make sure exposed wires and bare terminals are not in contact with other wires or grounded surfaces.

If a 24 V (ac) transformer is used, make sure the voltmeter is set to AC. Turn on the power and measure the voltage across the 24 V (ac) power supply. The reading should be between 22 and 26 V (ac).

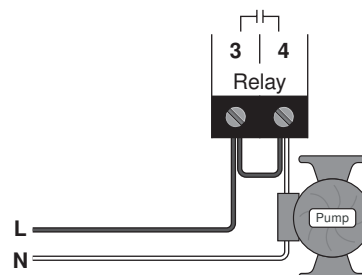
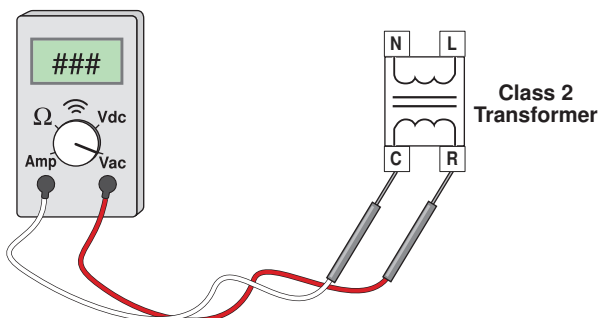
If a DC power source is used, make sure the voltmeter is set to DC. Turn on the power and measure the voltage across the 24 V (dc) power supply. The reading should be between 20 and 28 V (dc).



### Test the Outputs

#### Relay (terminals 3 & 4)

Make sure the power to the pump circuit is off and install a jumper between terminals 3 & 4. When the pump circuit is powered up, the pump should turn on. If the pump fails to operate check the wiring between the terminals and the pump and refer to any installation or troubleshooting information supplied with the pump. If the pump operates correctly, disconnect the power and remove the jumper.



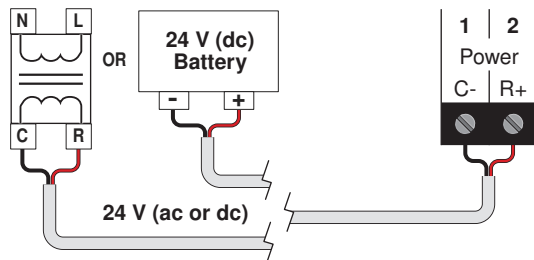
## Step Five — Electrical Connections to the Control

The installer should test to confirm that no voltage is present at any of the wires.

### Powered Input Connections

#### 24 V (ac) or 24 V (dc) Power

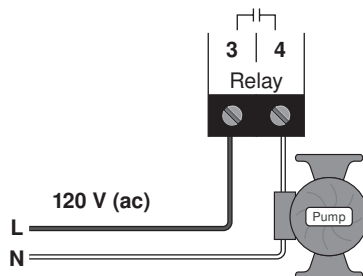
Connect the 24 V (ac) power supply to the Power C- and Power R+ terminals (1 and 2). If using a 24 V (dc) power supply, connect the positive terminal on the DC source to R+ (terminal 2) and the negative terminal to the C- (terminal 1) on the 156. This connection provides power to the microprocessor and display of the control.



### Output Connections

#### Relay Contact

The Relay terminals (3 and 4) are an isolated output in the 156. There is no power available on these terminals from the control. These terminals are to be used as a switch to either make or break the pump circuit. When the 156 requires the pump to run, it closes the contact between terminals 3 and 4.



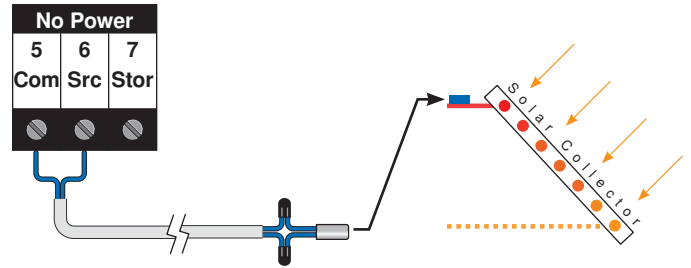
### Sensors and Un-powered Input Connections

**Do not apply power to these terminals as this will damage the control.**

#### Source Sensor

Connect the two wires from the Source Sensor 085 to the Com and Src terminals (5 and 6). The Source Sensor is used by the 156 to measure the Source temperature.

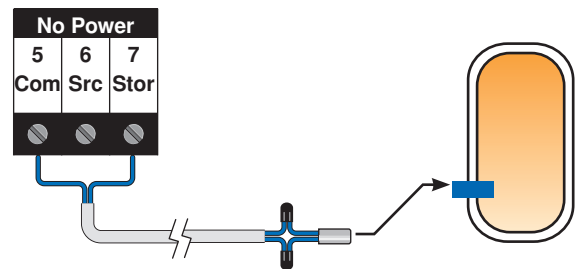
Insert the Solar Sensor 085 into a temperature well, or alternatively strap the Solar Sensor 085 on the outlet pipe close to the heat source with a stainless steel clamp.



#### Storage Sensor

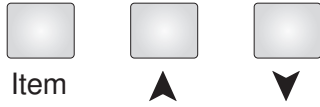
Connect the two wires from the Storage Sensor 071 to the Com and Stor terminals (5 and 7). The Storage Sensor is used by the 156 to measure the Storage temperature.

Insert the sensor in a well near the bottom of the tank.



# Display Menus

## Default Menu (1 of 2)



Use the Item button to view items in this menu. Some items can be cleared by pressing the Up and Down buttons simultaneously.

DEFAULT MENU

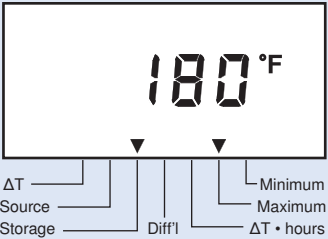
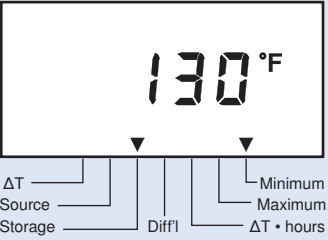
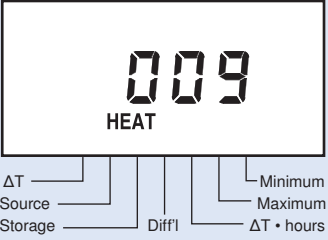
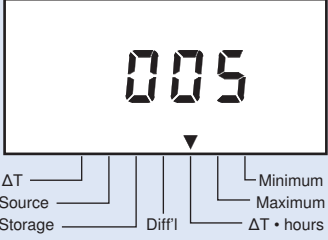
Item Field	Range	Description
	0 to 284 °F (0 to 158 °C)	<b>ΔT TEMPERATURE</b> Current temperature difference between the source and storage sensors. This is also the default display for the control. HEAT is displayed if the relay is closed.
	-76 to 284 °F (-60 to 140 °C)	<b>SOURCE TEMPERATURE</b> Current source temperature as measured by the source sensor. HEAT is displayed if the relay is closed.
	-76 to 284 °F (-60 to 140 °C)	<b>STORAGE TEMPERATURE</b> Current storage temperature as measured by the storage sensor. HEAT is displayed if the relay is closed.
	-76 to 284 °F (-60 to 140 °C)	<b>MAXIMUM SOURCE TEMPERATURE</b> Maximum source temperature since this item was last cleared. To clear, press and hold the up and down buttons for 1 second.
	-76 to 284 °F (-60 to 140 °C)	<b>MINIMUM SOURCE TEMPERATURE</b> Minimum source temperature since this item was last cleared. To clear, press and hold the up and down buttons for 1 second.

Continued on next page.



## Default Menu (2 of 2)

DEFAULT MENU

Item Field	Range	Description
	-76 to 284°F (-60 to 140°C)	<b>MAXIMUM STORAGE TEMPERATURE</b> Maximum storage temperature since this item was last cleared. To clear, press and hold the up and down buttons for 1 second.
	-76 to 284°F (-60 to 140°C)	<b>MINIMUM STORAGE TEMPERATURE</b> Minimum storage temperature since this item was last cleared. To clear, press and hold the up and down buttons for 1 second.
	0 to 999,999 hr	<b>RELAY RUNNING HOURS</b> Number of Relay running hours since this item was last cleared. The control will display the first 3 digits of the number followed by the last 3 digits and then a pause.
	0 to 999,999	<b>ΔT HOURS</b> The ΔT•hours item is used for the energy transfer calculation. The control will display the first 3 digits of the number followed by the last 3 digits. When the control is displaying the hundreds place, '°F or °C' is also shown.

• After the last item, the control returns to the first item in the menu.

## Program Menu (1 of 2)



Item



Press and hold all three buttons simultaneously to enter the Program menu. Use the Up or Down arrows to adjust each setting and the Item button to switch between items.

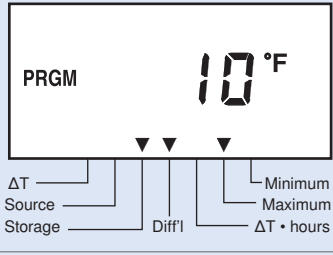
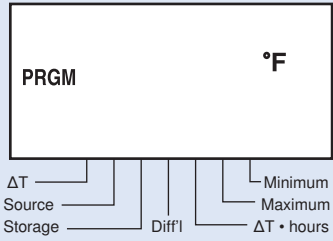
PROGRAM MENU

Item Field	Range	Description	Actual Setting
	2 to 90°F (1 to 50°C) Default = 10°F (6°C)	<b>ΔT SETPOINT</b> The relay operates to transfer heat from the source to the storage in order to maintain the ΔT setpoint.	
	2 to 45°F (1 to 25°C) Default = 5°F (3°C)	<b>ΔT DIFFERENTIAL</b> This differential setting is used to prevent short cycling of the pump when the ΔT is near the ΔT setpoint.	
	-22 to 185°F (-30 to 85°C) Default = 40°F (4°C)	<b>SOURCE MINIMUM SETPOINT</b> If the Source temperature drops below this setpoint, the relay is turned off.	
	2 to 45°F (1 to 25°C) Default = 10°F (6°C)	<b>SOURCE MINIMUM DIFFERENTIAL</b> This differential setting is used to prevent short cycling of the pump when the Source temperature is near the Minimum Source Setpoint.	
	-4 to 248°F (-20 to 120°C) Default = 180°F (82°C)	<b>STORAGE MAXIMUM SETPOINT</b> If the Storage temperature rises above this setpoint the Relay is turned off.	

Continued on next page.

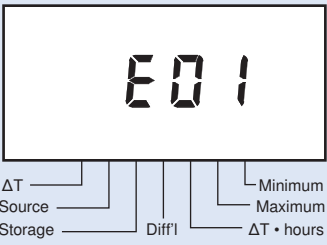
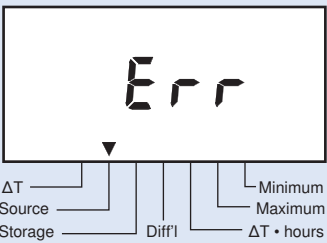
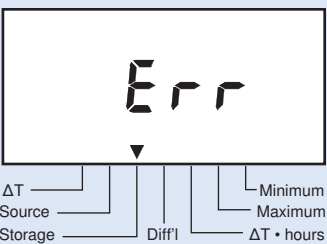
## Program Menu (2 of 2)

PROGRAM MENU

Item Field	Range	Description	Actual Setting
	2 to 45°F (1 to 25°C) Default = 10°F (6°C)	<b>STORAGE MAXIMUM DIFFERENTIAL</b> This differential setting is used to prevent short cycling of the pump when the Storage temperature is near the Maximum Storage Setpoint.	
	°F, °C Default = °F	<b>UNITS</b> The units of measure that all of the temperatures are to be displayed in the control.	

- After the last item, the control returns to the first item in the menu.

## Error Messages

	<b>EEPROM READ ERROR</b> The control was unable to read a piece of information from its EEPROM. This error can be caused by a noisy power source. The control will load the factory defaults and stop operation until all the settings are verified. To clear, view all items in the PRGM menu.
	<b>SOURCE SENSOR ERROR</b> The control is no longer able to read the Source Sensor due to an open or short circuit. Locate and repair the problem as described in the Data Brochure D085. The pump will remain off until the error is cleared.
	<b>STORAGE SENSOR ERROR</b> The control is no longer able to read the Storage Sensor due to an open or short circuit. Locate and repair the problem as described in the Data Brochure D070. The pump will remain off until the error is cleared.

## Technical Data

### Difference Setpoint Control 156 On/Off

Literature	— D 156, A 156, D 001, D 070, D 085
Control	— Microprocessor control; This is <b>not a safety (limit) control</b>
Packaged weight	— 0.78 lb. (355 g) — Enclosure C, White PVC Plastic
Dimensions	— 4-3/4" H x 2-7/8" W x 7/8" D (120 x 74 x 22 mm)
Approvals	— CSA C US, CSA 22.2 N°24 and UL 873, meets class B: ICES & FCC Part 15
Ambient conditions	— Indoor use only, -20 to 120°F (-30 to 50°C), < 90% RH non-condensing
Power supply	— 24 V (ac) ±10%, 50/60 Hz, 3 VA — 24 V (dc) ±10% 0.03 A
Relay	— 240 V (ac) 10 A 1/3 hp
Sensors included:	— NTC thermistor, 10 kΩ @ 77°F (25°C ±0.2°C) β=3892 — 1 of Solar Sensor 085 — 1 of Universal Sensor 071

## Limited Warranty and Product Return Procedure

**Limited Warranty** *The liability of tekmar under this warranty is limited. The Purchaser, by taking receipt of any tekmar product ("Product"), acknowledges the terms of the Limited Warranty in effect at the time of such Product sale and acknowledges that it has read and understands same.*

The tekmar Limited Warranty to the Purchaser on the Products sold hereunder is a manufacturer's pass-through warranty which the Purchaser is authorized to pass through to its customers. Under the Limited Warranty, each tekmar Product is warranted against defects in workmanship and materials if the Product is installed and used in compliance with tekmar's instructions, ordinary wear and tear excepted. The pass-through warranty period is for a period of twenty-four (24) months from the production date if the Product is not installed during that period, or twelve (12) months from the documented date of installation if installed within twenty-four (24) months from the production date.

The liability of tekmar under the Limited Warranty shall be limited to, at tekmar's sole discretion: the cost of parts and labor provided by tekmar to repair defects in materials and/or workmanship of the defective product; or to the exchange of the defective product for a warranty replacement product; or to the granting of credit limited to the original cost of the defective product, and such repair, exchange or credit shall be the sole remedy available from tekmar, and, without limiting the foregoing in any way, tekmar is not responsible, in contract, tort or strict product liability, for any other losses, costs, expenses, inconveniences, or damages, whether direct, indirect, special, secondary, incidental or consequential, arising from ownership or use of the product, or from defects in workmanship or materials, including any liability for fundamental breach of contract.

The pass-through Limited Warranty applies only to those defective Products returned to tekmar during the warranty period. This Limited Warranty does not cover the cost of the parts or labor to remove or transport the defective Product, or to reinstall the repaired or replacement Product, all such costs and expenses being subject to Purchaser's agreement and warranty with its customers.

Any representations or warranties about the Products made by Purchaser to its customers which are different from or in excess of the tekmar Limited Warranty are the Purchaser's sole responsibility and obligation. Purchaser shall indemnify and hold tekmar harmless from and against any and all claims, liabilities and damages of any kind or nature which arise out of or are related to any such representations or warranties by Purchaser to its customers.

The pass-through Limited Warranty does not apply if the returned Product has been damaged by negligence by persons other than tekmar, accident, fire, Act of God, abuse or misuse; or has been damaged by modifications, alterations or attachments made subsequent to purchase which have not been authorized by tekmar; or if the Product was not installed in compliance with tekmar's instructions and/or the local codes and ordinances; or if due to defective installation of the Product; or if the Product was not used in compliance with tekmar's instructions.

THIS WARRANTY IS IN LIEU OF ALL OTHER WARRANTIES, EXPRESS OR IMPLIED, WHICH THE GOVERNING LAW ALLOWS PARTIES TO CONTRACTUALLY EXCLUDE, INCLUDING, WITHOUT LIMITATION, IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE, DURABILITY OR DESCRIPTION OF THE PRODUCT, ITS NON-INFRINGEMENT OF ANY RELEVANT PATENTS OR TRADEMARKS, AND ITS COMPLIANCE WITH OR NON-VIOLATION OF ANY APPLICABLE ENVIRONMENTAL, HEALTH OR SAFETY LEGISLATION; THE TERM OF ANY OTHER WARRANTY NOT HEREBY CONTRACTUALLY EXCLUDED IS LIMITED SUCH THAT IT SHALL NOT EXTEND BEYOND TWENTY-FOUR (24) MONTHS FROM THE PRODUCTION DATE, TO THE EXTENT THAT SUCH LIMITATION IS ALLOWED BY THE GOVERNING LAW.

**Product Warranty Return Procedure** All Products that are believed to have defects in workmanship or materials must be returned, together with a written description of the defect, to the tekmar Representative assigned to the territory in which such Product is located. If tekmar receives an inquiry from someone other than a tekmar Representative, including an inquiry from Purchaser (if not a tekmar Representative) or Purchaser's customers, regarding a potential warranty claim, tekmar's sole obligation shall be to provide the address and other contact information regarding the appropriate Representative.



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