

# tekmar® - Data Brochure

## Mixing Control 354

**D 354**

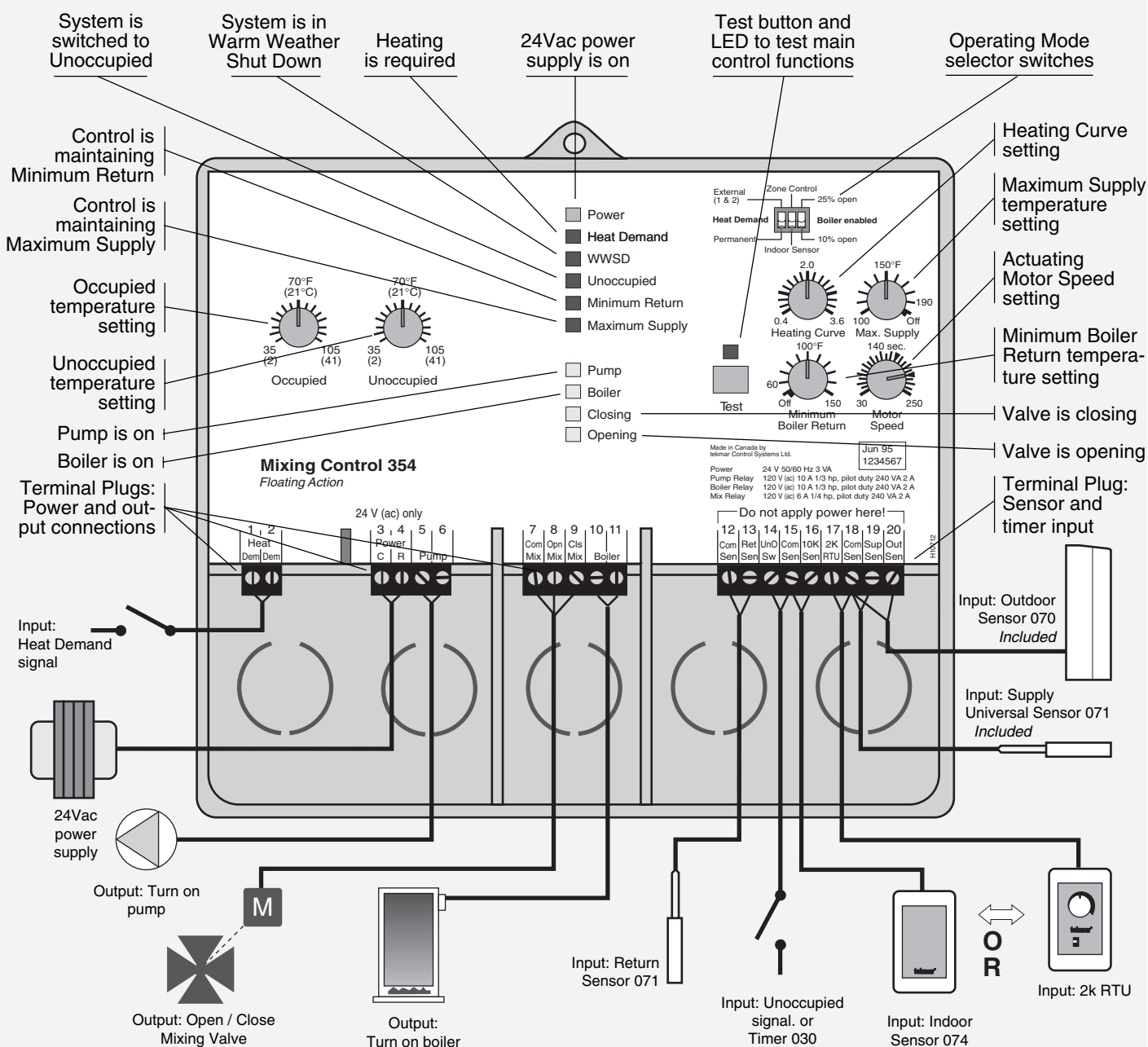
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The tekmar Mixing Control 354 is a microprocessor-based control with a floating action output intended to operate a mixing valve. This valve regulates the supply water temperature to a heating system based on the outdoor air temperature, and optionally, the indoor air temperature. The pump is shut down and the valve is closed when there is no Heat Demand signal or when the outdoor temperature is warm enough so that the system no longer requires heat (WWSD). The pump runs continuously when a zone control is selected. Maximum supply temperature and minimum boiler return temperature can be constrained for protection of system components.

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## Outdoor Reset Strategy

### Correct setting and shifting of the Heating Curve... the key to More Comfort and Energy Savings.

#### Heating Curve

As outdoor temperatures get colder, heat losses from a building increase, requiring the addition of more heat to prevent the indoor air temperature from also getting colder. This tekmar reset control measures the outdoor temperature and as the outdoor temperature gets colder, it balances the heat loss by making the heating supply water hotter.

The Heating Curve is used to calculate exactly how hot to make the supply water at different outdoor temperatures, and illustrates the Reset Ratio. (the number of degrees the supply water temperature is raised for each degree the outdoor temperature falls.)

#### Setting the Heating Curve

Two examples of how the Heating Curve works (see illustration)

—With a 2.4 Curve, the supply water temperature is raised 2.4 degrees for every degree of outdoor temperature drop.

If: WWSD point = 70°F and Outdoor temperature = 30°F, then supply temperature = 166°F

—With a 0.6 Curve, the supply water temperature is raised 0.6 degrees for every degree of outdoor temperature drop.

If: WWSD point = 70°F and Outdoor temperature = 30°F, then supply temperature = 94°F

- If the Heating Curve selected is too low; the heating system will not be able to raise the supply temperature high enough to keep the room temperature warm during colder weather.
- If the Heating Curve selected is too high; too much heat is delivered and the building will overheat during colder weather.

#### Warm Weather Shut Down (WWSD)

At warm outdoor temperatures, the indoor space of a building gains heat from the outdoors; additional heat is not required, and if the heating system is running (even on standby), enough excess heat can be produced to overheat the building, causing discomfort and wasting valuable energy.

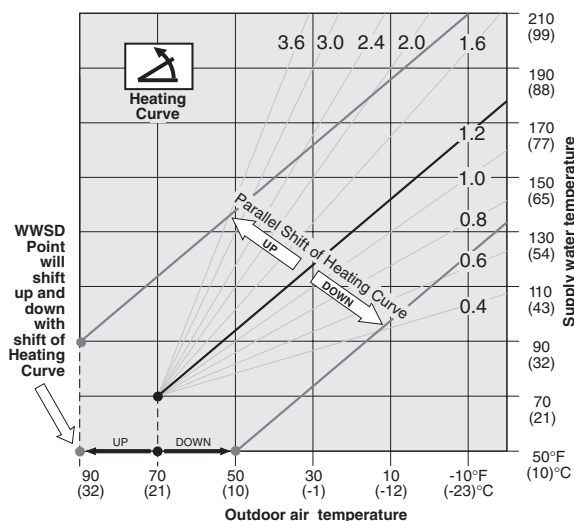
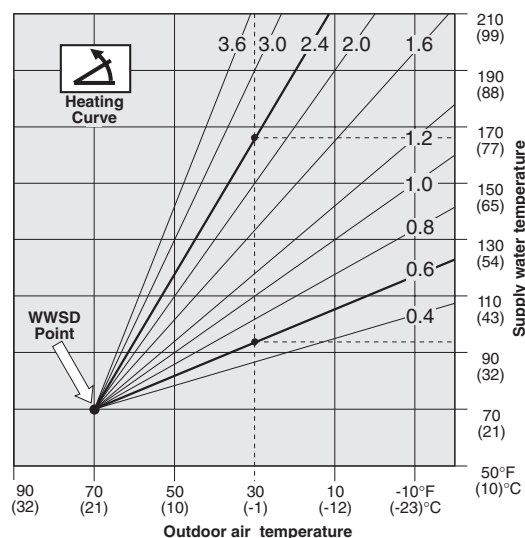
This control closes the mixing valve and turns off the pump, when the outdoor temperature is above the WWSD point.

As outdoor temperatures get colder, there comes a point where the heat gain turns into heat loss; the heat loss causes the indoor temperature to fall below the comfort level, and the heating system must be turned on to start delivering heat.

To provide heat to the building, this control turns on the pump and opens the mixing valve, delivering heat at the low output required by the Heating Curve near the WWSD point. If the outdoor temperature rises above the WWSD point, the control shuts the system off again, and because the system was operating at a low heat output level, overheating and temperature swings in mild weather are avoided.

When the system is operating near the WWSD point and the building is too cold; the WWSD point should be raised.

When the system is operating near the WWSD point and the building is too warm; the WWSD point should be lowered.



#### Shifting the Heating Curve

(a) Manually, at the control:

The Occupied and Unoccupied dials on this control can shift the WWSD point up or down from 35 to 105°F (2 to 41°C).

(b) Automatically, using room temperature feedback:

In addition to a Supply Sensor and an Outdoor Sensor, this control can use a tekmar RTU, Zone Control or Indoor Sensor to provide room temperature feedback for added comfort and system flexibility.

The control still calculates a desired supply temperature based on the Heating Curve setting and the outdoor temperature.

If the air temperature in the room is too cold, the control will shift the heating curve (and WWSD point) *up*, which raises the supply temperature until the room warms up again.

If the air temperature in the room is too warm, the control will shift the heating curve (and WWSD point) *down*, which lowers the supply temperature until the room cools down.

A very cool room temperature can shift the curve far enough up to bring the control out of WWSD at warm outdoor temperatures. A very warm room temperature can shift the curve far enough down to put the control into WWSD at cool outdoor temperatures.

Refer to the tekmar Essays E 001 and E 002 for more detailed information regarding control strategy and integration of control functions.

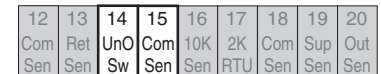
## Sequence of Operation

When the Mixing Control 354 is powered-up, the "Power" light will come on and the control will turn on all LED's for five seconds. If no errors are detected, the control closes the mixing valve for the time set on the Motor Speed dial (this is the last step of the test program, see page 11). Once the mixing valve is closed, the control enters the operating mode. Once in operating mode, the control uses:

- an Outdoor Sensor 070 to continually monitor the outdoor temperature.
- an Universal Sensor 071 to continually monitor the system supply water temperature.
- *Option*, an Universal Sensor 071 to continually monitor the boiler return water temperature.
- *Option*, Indoor temperature can be monitored through the use of;
  - (a) - a tekmar 2K RTU or Indoor Sensor 074 (switch selector switch to "Indoor Sensor" position) **or**;
  - (b) - a tekmar Zone Control (switch selector switch to "Zone Control" position)
- While monitoring all of these temperatures, the control recognizes the following temperature conditions and inputs and will respond as described. During operation, the lights of the control will indicate operational status as illustrated.

### Unoccupied mode

Connect (short circuit) terminals *UnO Sw* — *Com Sen* (14 and 15) together.

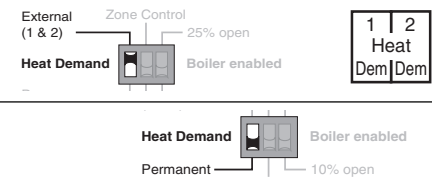


### Heat Demand signal

- (a) - switch the Heat demand switch to the "External (1 & 2)" position, and supply a **24Vac** signal to terminals *Heat Dem* — *Heat Dem* (1 and 2),

**OR**

- (b) - switch the the Heat demand switch to the "Permanent" position.

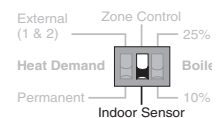


### Occupied/Unoccupied dial function

The control will monitor the outdoor and supply temperatures. The Occupied and Unoccupied dial settings become the WWSD point. When the outdoor temperature is warmer than the setting of the Occupied dial, the control enters WWSD. When switched into Unoccupied mode, the "Unoccupied" light will come on, and the control will operate at the temperature of the Unoccupied dial setting.

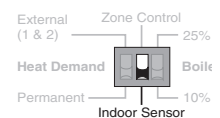
### Indoor Sensor 074 function *Selector switch = Indoor Sensor*

The control will monitor the indoor, outdoor and supply temperatures, and shift the Heating Curve (and the WWSD point) up or down to fine adjust the system supply water temperature whenever the room temperature is different than the setting of the Occupied dial. When switched into Unoccupied mode, the "Unoccupied" light will come on, and the control will operate at the temperature of the Unoccupied dial setting.



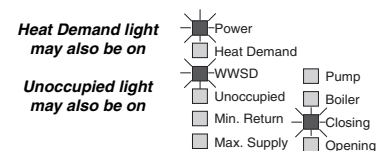
### 2K RTU function *Selector switch = Indoor Sensor*

The control will monitor the indoor, outdoor and supply temperatures, and shift the Heating Curve (and the WWSD point) up or down to fine adjust the system supply water temperature whenever the room temperature is different than the setting of the RTU dial. The Occupied and Unoccupied dials are not functional, and a setback RTU must be used if Unoccupied schedules are desired.



### WWSD function

When WWSD occurs, the "WWSD" and "Closing" lights will come on, the mixing valve will close and the boiler and pump will shut down. The control will continue to monitor the outdoor and supply temperatures. Whenever 3 days pass, the mixing valve will be run open and closed and then the pump will be cycled on for 15 seconds to help prevent seizing.

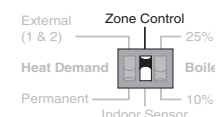


### Valve and Pump Exercising

Exercising of the valve and pump is done to ensure long life of these components. Every three days the control checks to see if the valve has been operated to the fully open and close positions. If the valve has been operated to these positions, the control continues normal operation. If not, the control will open the valve to the fully open position and then return the valve to its previous position. If the valve has not been closed in the last three days, the valve will also cycle fully closed and then return to its operating location.

### tekmar Zone Control function *Selector switch = Zone Control*

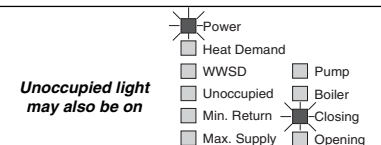
The control will monitor the indoor temperatures of all zones, as well as the outdoor and supply temperatures, and shift the Heating Curve (and the WWSD point) up or down to fine adjust the system supply water temperature for whichever zone requires the hottest supply water. The pump relay is continuously on when Zone Control is selected except during the valve and pump exercising period. The Occupied and Unoccupied dials are not functional.



### Outdoor temperature cold enough to require heating

#### Occupied/Unoccupied dial, no Heat demand signal

When the outdoor temperature is colder than the WWSD point, the control will leave WWSD. Whenever the control leaves WWSD, the "WWSD" light will go out and the control will continue to monitor the outdoor and supply temperatures, but no further control action will take place until there is a heat demand signal.



## Outdoor temperature cold enough to require heating (cont.)

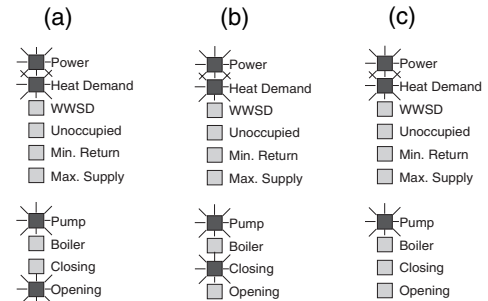
### With Heat demand signal

The "Heat Demand" light will come on, the control will switch on the pump, and calculate the desired supply temperature based on the requirements of the Heating Curve.

The control will operate the actuating motor which positions the mixing valve to deliver the correct supply temperature.

When positioning the mixing valve, the control uses the following control actions;

- (a) - Open the valve. The "Opening" light will come on and the control will power the valve towards the fully open position.
- (b) - Close the valve. The "Closing" light will come on and the control will power the valve towards the fully closed position.
- (c) - No valve movement. "Opening" and "Closing" lights are both off and the valve remains in a fixed position.



**Boiler light may also be on**  
**Min. Return light may also be on**  
**Max. Supply light may also be on**  
**Unoccupied light may also be on**

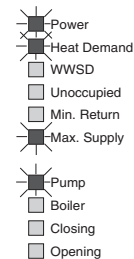
### Maximum Supply temperature operation

To provide a measure of protection to system components that may be damaged by excessive heat, (eg. some types of plastic hydronic radiant floor tubing) this control has a setting for Maximum Supply temperature. Maximum supply can be turned off by rotating the dial fully clockwise.

When the supply temperature gets close to the setting on the Max. Supply dial, the Max Supply light will come on and the control will begin closing the valve, in order to reduce the temperature before it overshoots. The control will operate the valve to maintain the temperature slightly below the Maximum.

The control may operate for a long time at the Maximum supply temperature if :

- (a) - it is coming out of a deep setback or just starting up from a cold start.
- (b) - an RTU (or Occupied dial when Indoor Sensor 074 is used) is turned up suddenly.
- (c) - the maximum setting is too low for system design conditions.



**Opening or Closing light may also be on**  
**Boiler light may also be on**  
**Unoccupied light may also be on**

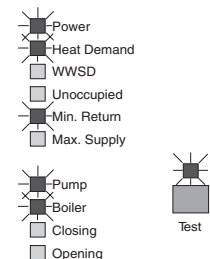
### Minimum Boiler Return temperature operation

To provide a measure of protection to boilers that may be damaged by low return water temperatures, this control has a setting for Minimum Boiler Return temperature.

When the boiler return temperature gets close to the setting on the Minimum Boiler Return dial, the "Min Return" light will come on and the control will begin closing the valve in order to raise the boiler return temperature before it undershoots. The control will operate the valve to maintain the boiler return temperature slightly warmer than the Minimum Boiler Return temperature setting.

The control may operate for a long time at the Minimum Return temperature if:

- (a) - it is coming out of a deep setback or just starting up from a cold start.
- (b) - an RTU (or Occupied dial when Indoor Sensor 074 is used) is turned up suddenly.
- (c) - the minimum setting is too high for system design conditions.



**Opening or Closing light may also be on**  
**Unoccupied light may also be on**

### Notes on operation of Minimum Return and Maximum Supply functions

At times, the control may be trying to control both the Maximum Supply and Minimum Return temperatures (ie. when leaving a deep setback). When this occurs, the control is programmed to give priority to the Minimum Boiler Return function, and only the "Min. Return" light will be displayed.

When the control is in WWSD, the "Min. Return" and "Max. Supply" lights will not be displayed.

When using a Return Sensor for Minimum Boiler Return protection, it is essential that there always be water flow past the boiler return sensor whenever there is a heat demand. See Brochure A 354.

### Caution:

The tekmar Mixing Control 354 is an operating control and is not certified or intended for use as a primary safety device. Under normal operating conditions, the control will provide excellent protection against excessive supply temperatures and low boiler return temperatures, however, if failsafe protection against either of these conditions is essential then separate certified safety limit devices should be employed.

## Installation

### Caution

Improper installation and operation of this control could result in damage to 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.

### Step One ■■■■■ Getting ready ■■■■■

Check the contents of this package. If any of the contents listed are missing or damaged, please refer to the Limited Warranty and Product Return Procedure on the back of this brochure and contact your wholesaler or tekmar sales agent for assistance.

Type 354 includes:

- One Control 354 • One Outdoor Sensor 070 • One Supply Sensor 071
- One Data Brochure D 354 • One Data Brochure D 001 • Application Brochures A 354

Other information available: • Essay E 001 • Essay E 002

Read brochures A 354 and select the correct Application for your job.

### Note:

Carefully read the details of the Application, and the Sequence of Operation sections in all applicable brochures to ensure that you have chosen the proper control and understand its functions within the operational requirements of your system. Some applications feature boiler return protection and require ordering an additional Universal Sensor 071.

### Step Two ■■■■■ Mounting of the base ■■■■■

The control should be removed from its base by pressing down on the release clip in the wiring chamber and sliding upwards on the control. The base is then mounted in accordance with the instructions in the Data Brochure D 001.

### Step Three ■■■■■ Rough-in Wiring ■■■■■

All electrical wiring terminates in the control base wiring chamber. It has standard 7/8" (22mm) knock-outs that will accept common wiring hardware and conduit fittings. Before breaking out the knock-outs, check the wiring diagram and select those sections of the chamber with common voltages, since the safety dividers will later prevent wiring from crossing between sections.

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

- Install the Outdoor Sensor 070, and the Supply Sensor 071 according to the instructions in the Data Brochure D 001 and run the wiring back to the control.

*Option:* A Universal Sensor 071 can be installed to provide Minimum Boiler Return protection. See Brochures A 354.

*Option:* An Indoor Sensor 074, RTU or Zone control can also be connected. See individual sensor instructions.

- Install the wiring from the other system components (Boiler, Pump, Actuating Motor, Heat Demand circuit) to the base.
- Install a 24Vac Class II transformer with a minimum 12VA rating close to the control, and run the wiring from the transformer to the base. *A Class II transformer must be used. Do not connect any of the transformer terminals to ground, as damage to the control may result.*

### Step Four ■■■■■ Electrical connection to the control ■■■■■

#### Power and output connections

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

- Install the control into the base, sliding it down until it snaps into place.
- All electrical connections are made directly to the plug terminals.
- Connect the 24Vac power supply from the secondary side of a 24Vac class II transformer to terminals *Power C*—*Power R* (3 and 4). *Do not connect either of the transformer terminals to ground.*

#### Maximum 24 Volts

3	4	5	6
Power			
C	R		Pump

- Connect the Pump circuit to terminals *Pump* (5 and 6). These terminals lead to a 10 amp dry relay contact which closes when the control requires pump operation.

*Note:* The type 354 is approved for low voltage only (Maximum 24Vac). The pump should be switched through an isolation relay approved for the line voltages required to operate the pump.

3	4	5	6
Power			
C	R		Pump

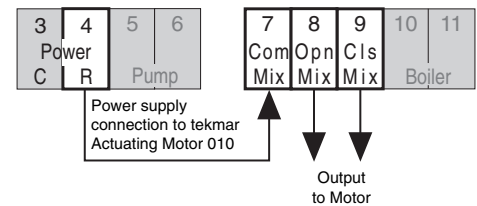
- Connect the boiler circuit to terminals *Boiler* (10 and 11). These terminals lead to a 10 amp dry relay contact which closes when the control requires boiler operation. Boilers with a 24Vac control circuit can be switched directly through the control. If higher voltages are used, an isolation relay should be added.

7	8	9	10	11
Com	Opn	Cls		
Mix	Mix	Mix		Boiler



- Connect the power supply for the actuating motor to terminal *Com Mix* (7). If a tekmar Actuating motor 010 is used, a 24Vac 12VA power supply for the control is adequate for operating the motor. Install a jumper wire between terminal *Power R* (4) and *Com Mix* (7).
- Connect the wire from the OPEN circuit of the actuating motor to the terminal *Opn Mix* (8) of the control. This terminal leads to a 10 amp relay contact which closes to bring power from terminal *Com Mix* (7) to open the valve.
- Connect the wire from the CLOSE terminal of the actuating motor to the terminal *Cls Mix* (9) of the control. This terminal leads to a 10 amp relay contact which closes to bring power from terminal *Com Mix* (7) to close the valve.

#### Maximum 24 Volts



#### Powered input connections

If a 24Vac external heat demand signal is used, (zone valve end switches, etc.) connect the wiring from the Heat Demand circuit to terminals *Heat Dem* — *Heat Dem* (1 and 2). When 24Vac is applied to these terminals, the control will respond to a "call for heat" from the system.

#### Maximum 24 Volts



#### Sensor and unpowered input connections

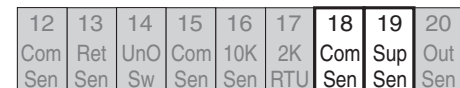
**Power should never be applied to these terminals. Damage to the control will result.**

Connect the two wires from the Outdoor Sensor 070 to terminals *Com Sen* — *Out Sen* (18 and 20).

#### Do not apply power here!



Connect the two wires from the Supply Sensor 071 to terminals *Com Sen* — *Sup Sen* (18 and 19).



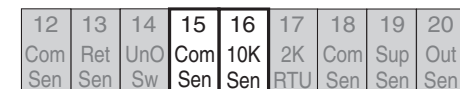
*Option: Boiler Return temperature sensor: (Ordered separately)*

Connect the two wires from the Universal Sensor 071 to terminals *Com Sen* — *Ret Sen* (12 and 13).



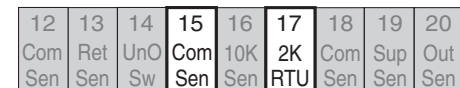
*Option: Indoor temperature feedback sensor. (One option only)*

- (1) Connect the two wires from the Indoor Sensor 074 or the tekmar 10K Zone Control to terminals *Com Sen* — *10K Sen* (15 and 16).



**OR**

- (2) Connect the two wires from the tekmar 2K RTU to terminals *Com Sen* — *2K RTU* (15 and 17).

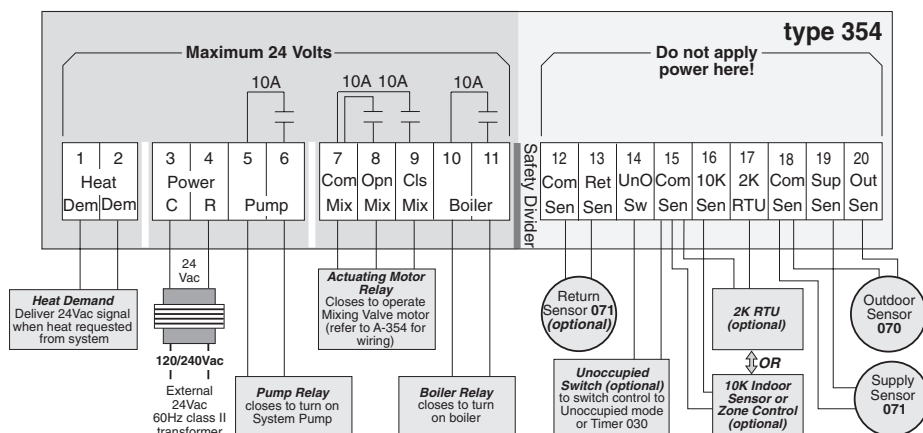


*Option: Occupied/Unoccupied switch input.*

Connect the two wires from the Occupied/Unoccupied dry contact switch (timer, relay, etc.) to terminals *UnO Sen* — *Com Sen* (14 and 15).



**Electrical connections to the terminal plugs of the type 354 control. Control relays are shown in "power down" condition.**



**Note: This is not a wiring diagram.**

**For a detailed wiring schematic of your specific application, refer to the Application Brochure A 354.**

## Step Five ■ Testing the wiring ■

### Caution

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

Before applying power to the control for testing, each terminal plug must be unplugged from its header on the control. Pull straight down to unplug.

A good quality electrical test meter, capable of reading from at least 0 — 200 Volts AC, and at least 0 — 1,000,000 Ohms, is essential to properly test this control.

### Test the sensors

These test must be made *before* turning on the power supply, and with the terminals unplugged. The sensors are to be tested according to the instructions in brochure D 001. If a tekmar RTU or Zone Control is used, check the applicable data brochure for the product used.

### Test the power supply

Make sure exposed wiring or bare terminals are not in contact with any other wires or grounded surfaces. Turn on the power to the transformer and use an AC voltmeter to measure the voltage between terminals *C* — *R* (3 and 4). Between 22 and 26 Volts AC should be measured at these terminals.

### Test the powered inputs

If an external Heat Demand signal is used, power up the Heat Demand circuit and supply a Heat Demand signal to the control. Use an AC voltmeter to measure the voltage between terminals *Heat Dem* — *Heat Dem* (1 and 2). Between 22 and 26 Volts AC should be measured at these terminals.

### Test the outputs

If a Pump circuit is connected to the *Pump* (5 and 6) terminals, make sure power to the circuit is off and install a jumper in the terminal plug between terminals 5 and 6. When the circuit is powered-up, the pump should operate. If it does not come on, check the circuit wiring for errors and ensure that it is powered up and the voltage is correct. Check the devices in the circuit (pump, switching relay, etc.) for faults. If the pump operates properly when the circuit is powered up disconnect the power, remove the jumper and proceed to the next step.

**Note: When a Return Sensor 071 is used, the boiler loop pump must operate with the pump. See Brochures A 354.**

If you are using the control to operate the boiler, make sure power to the boiler circuit is off and install a jumper in the terminal plug between the *Boiler* (10 and 11) terminals. When the circuit is powered-up, the boiler should operate. If it does not come on, check the circuit wiring for errors and ensure that it is powered up and the voltage is correct. Check the devices in the circuit (limits, flow switches, etc.) for faults. If the boiler operates properly when the circuit is powered up, disconnect the power, remove the jumper and proceed to the next step.

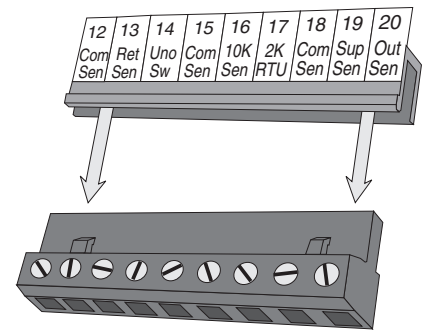
Make sure power to the Actuating Motor circuit is off and install a jumper in the terminal plug between the *Com Mix* — *Opn Mix* (7 and 8) terminals. When the circuit is powered-up, the valve should open. If it does not open, check the circuit wiring for errors and ensure that it is powered up and the voltage is correct. Check the valve to make sure it is not jammed or already fully open. If the valve closes instead of opens, reverse the motor OPEN and CLOSE wiring. If the valve operates properly when the circuit is powered up, disconnect the power, remove the jumper and install it in the terminal plug between the *Com Mix* — *Cls Mix* (7 and 9) terminals. When the circuit is powered-up, the valve should close. If it does not close, check the circuit wiring and valve operation as described above. Disconnect the power, remove the jumper and proceed to the next step.

### Connect the control

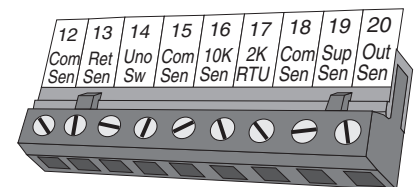
- Turn the power off and make sure all test jumpers have been removed from the plugs.
- Connect the plugs to the control by carefully aligning them with their respective headers and pushing them upwards into the headers. The plugs should snap firmly into place.
- The control is now ready for set-up and operation.

### Caution

The tekmar Mixing Control 354 is an operating control and is not certified or intended for use as a safety device. Under no circumstances should safety limit devices be left disconnected after installation of this control. The installer shall check all applicable code requirements and obtain necessary inspections to ensure that the installation is in compliance with those requirements.



Terminal plug disconnected from its header on the control



Terminal plug pushed into its header on the control

## Settings

### Step Six Essential control settings

To obtain the best operation from a reset control, it is important to measure the system supply temperature as accurately as possible. Whenever the control receives a heat demand signal, the system pump must be operated to maintain continuous water flow across the supply temperature sensor. Whenever the control uses a boiler return sensor, the boiler pump must also be operated to maintain continuous water flow across the boiler return sensor.

For specific application details refer to Brochures A 354.

A more detailed technical description of the effect of control settings on overall system operation is described in the tekmar Essay, E 002.

#### Heating Curve

As outdoor temperatures drop, heat losses from a space become greater and the heating system supply water temperature must be raised to maintain a constant room temperature. The heating curve value describes how many degrees the supply water temperature is raised for a one degree drop in outdoor temperature. The supply temperature starts to increase when the outdoor temperature falls below the WWSD point. To calculate the correct setting for the heating curve, use the following formula.

$$\text{Heating Curve} = \frac{\text{design supply temperature} - \text{room temperature}}{\text{room temperature} - \text{design outdoor temperature}}$$

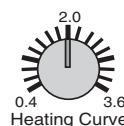
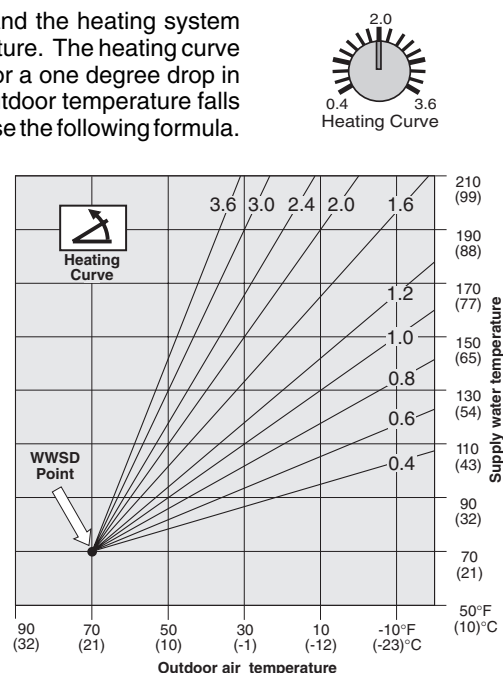
For example:

- Design outdoor temperature = 5°F (-15°C)
- Room temperature = 70°F (21°C)
- Design supply temperature = 160°F (71°C)

$$\text{Heating curve} = \frac{160^{\circ}\text{F} - 70^{\circ}\text{F}}{70^{\circ}\text{F} - 5^{\circ}\text{F}} = \frac{90^{\circ}\text{F}}{65^{\circ}\text{F}} = 1.4$$

For more information regarding the Heating Curve, refer to page 2 of this brochure. If the actual designed supply water temperature for a system is unknown, a trial setting can be calculated using these typical supply temperatures:

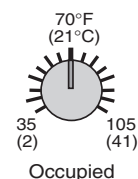
- Fan coils ... 180° to 210°F (82° to 99°C)
- Baseboard convectors ... 160° to 190°F (71° to 88°C)
- Hydronic radiant floors ... 100° to 130°F (38° to 54°C).



#### Occupied temperature

When there is no room temperature feedback to the control, the Occupied dial setting determines the starting point of the heating curve (WWSD point) and the heating curve setting will reset the water temperature as described in the Heating Curve instructions above.

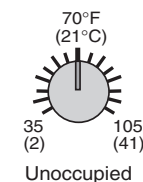
When an Indoor Sensor 074 is connected to the control, the Occupied dial setting becomes the actual controlled temperature of the room. This valuable feature allows the control to compensate for an incorrectly set heating curve or for unexpected internal heat gains or losses. If the room temperature is too high or too low, the indoor sensor allows the heating curve to be shifted up or down accordingly. When a tekmar Zone Control or RTU (Room Temperature Unit) is connected to the control, the RTU setting becomes the controlled temperature and the Occupied dial becomes inactive.



#### Unoccupied temperature

The Unoccupied dial operates in the same way as the Occupied dial, but at a different temperature.

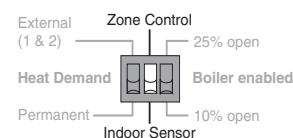
When the terminals *UnO Sw* — *Com Sen* (14 and 15) are shorted out, the control switches from operating at the Occupied dial setting to operating at the Unoccupied dial setting. When a tekmar Zone Control or RTU (Room Temperature Unit) is connected to the control, the RTU setting becomes the controlled temperature and the Occupied/Unoccupied dials become inactive, making it necessary to control Unoccupied temperatures at each individual zone.



#### Zone Control/Indoor Sensor switch

Set this selector switch to the "Indoor Sensor" position when a tekmar Indoor Sensor 074 or a tekmar RTU is connected. The control will receive room temperature feedback from the room that has the Sensor or RTU.

Set the switch to the "Zone Control" position when a tekmar Zone control is connected, the control receives information from the Zone Control that allows the heating curve to be shifted so the supply water temperature is hot enough to satisfy the requirements of the zone with the highest heat demand.

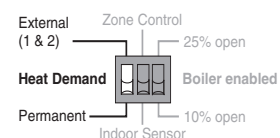




## Heat Demand switch

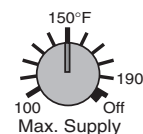
When the heating system uses zone valve end switches or some other means of delivering an external heat demand signal to terminals *Heat Dem* — *Heat Dem* (1 and 2), set this switch to "External (1 & 2)" and the control will only be able to operate the mixing valve when it receives a 24Vac signal from the heat demand circuit.

If an external heat demand signal is not used, set the switch to "Permanent" and the control will be enabled all the time.



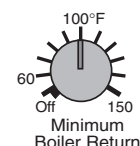
## Maximum Supply temperature

This setting determines the maximum allowable supply temperature to be delivered to the system. When the supply temperature gets too hot, the mixing valve closes until the temperature is stabilized at the maximum. To get the fastest system heat up times, this setting should be set as high as allowable. Refer to page 4 for more details on maximum supply operation and requirements.



## Minimum Boiler Return temperature

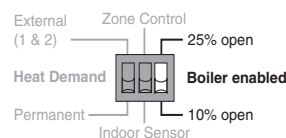
When a Return Sensor 071 is connected to the control, and the dial is turned up from "Off", this setting determines the minimum allowable boiler return temperature. When the return temperature becomes too cold, the mixing valve is closed until the temperature is stabilized at the minimum. To get the fastest system heat up times, this setting should be set as low as allowable. Refer to page 4 for more details on minimum boiler return operation and requirements.



## Boiler Enable switch

The position of this switch determines at which valve position the control will fire the boiler under normal conditions. If there is a Return Sensor 071 installed and the boiler return temperature is too cold, the control will override this setting in order to raise the water temperature more quickly.

- At the "10% open" position, the control will not fire the boiler until the valve has opened at least 10%, and will turn the boiler off when the valve closes to 0% open. This setting would normally be chosen for high mass boilers (cast iron, steel fire tube, etc.), or systems with a large thermal mass in the loop between the boiler and the mixing valve.
- At the "25% open" position, the control will not fire the boiler until the valve has opened at least 25%, and will turn the boiler off when the valve closes to 15% open. This setting would normally be chosen for low mass boilers (copper fin tube, low mass cast iron, etc.), and systems with low thermal mass in the loop between the boiler and the mixing valve.

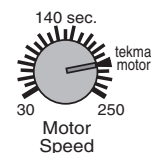


## Note:

**Some heating systems combine high input, low mass boilers with very little thermal mass in the loop between the boiler and mixing valve. In some extreme cases, erratic boiler action (short cycling and tripping of high limits) may result from this type of system even at the "25% open" position. To prevent this type of operation it may be necessary to add thermal mass to the system by installing a storage tank or making the loop larger.**

## Motor Speed

The control determines the position of the mixing valve by timing the actuating motor, and comparing the elapsed time of open signal against the elapsed time of close signal. Selecting the correct Motor Speed setting is essential for proper valve and boiler operation. The tekmar Actuating Motor 010 takes 210 seconds to move from the fully closed to the fully open position and the Motor Speed dial on the control is labeled with a mark indicating the correct position.



If you are using a different make of actuating motor and you know its opening time, set the Motor Speed dial to match. If you are unsure of the exact opening time, complete the following procedure:

- (1) Set the Motor Speed dial to the longest (fully clockwise) position.
- (2) Power up the control and let it run the actuating motor/mixing valve to the fully closed position.
- (3) When the test light turns off, push the test button.
- (4) Observe the motor as it is driven open by the test routine. When the motor reaches its fully open position by stopping against its end switch, turn the Motor Speed dial down just until the control cycles through to the next step in the test routine.
- (5) The Motor speed dial is now calibrated to the motor. Let the control cycle through to the end of the test routine.

## Testing the Control Functions

### Test button

With the settings made and the terminal plugs firmly seated, power up the control. The control will do the last step of the following test routine. It is advisable to re-check the power supply voltage while the control is powered and operating.

The control can be made to cycle through the test routine whenever the Test button is pushed. The test can be halted at certain times during the test by pushing the button a second time. For details of the test routine, refer to the test routine description starting on the next page.



## Indicator lights

There are eleven LEDs on the front of the control that will aid in testing and troubleshooting. During normal operation, these lights indicate the following functions:

Power light on	• the 24Vac power supply has been connected and the control is energized.
Heat Demand light on	• the control is receiving an external heat demand signal at terminals <i>Heat Dem</i> — <i>Heat Dem</i> (1 and 2) or the heat demand selector switch is in the "Permanent" position or a 10K Zone causes a Heat Demand.
Control WWSD light on	• the control has calculated that the outdoor temperature is warm enough to not require heat.
Unoccupied light on	• the terminals <i>Uno Sw</i> — <i>Com Sen</i> (14 and 15) are shorted together, switching the control into Unoccupied (setback) mode.
Min. Return light on	• the control is operating the mixing valve to satisfy the minimum boiler return requirement.
Max. Supply light on	• the control is operating the mixing valve to prevent maximum supply temperature overshoot.
Pump light on	• the pump relay is on, closing the contacts between the <i>Pump</i> (5 and 6) terminals.
Boiler light on	• the boiler relay is on, closing the contacts between the <i>Boiler</i> (10 and 11) terminals.
Closing light on	• the close relay is on, closing the contacts between the <i>Com Mix</i> — <i>Cls Mix</i> (7 and 9) terminals.
Opening light on	• the open relay is on, closing the contacts between the <i>Com Mix</i> — <i>Opn Mix</i> (7 and 8) terminals.
Test light on	• the control is going through the programmed test routine

## Step Seven Operational test of control functions - Test button

The Mixing Control 354 has a Test button which can be used to test all of the main control functions at any time. When the Test button is pushed, the control automatically runs through the following test procedure. If a fault in a sensor occurs, the lights will flash an error message and the test routine will be exited until the fault is located and corrected. The error messages are listed on page 11.

### All red status lights on

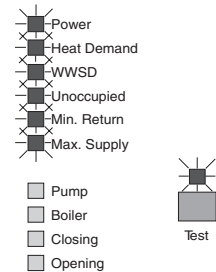
On power-up, and at the start of each test routine, all of the red status lights are switched on for approximately 5 seconds.

The control searches for sensor faults and, if no faults are found, proceeds to the next step.

If a sensor fault occurs, the control suspends the test routine and indicates the fault by flashing some of the lights in an error message. These error messages are listed on page 11.

When the test button is pushed, one or two of the yellow operation lights may also be on, but these lights have no effect and no significance during the test routine.

*Note: Whenever the control exits the test routine, there is a 3 second delay before the control will be able to re-enter. Pushing the test button during this 3 seconds will have no effect.*

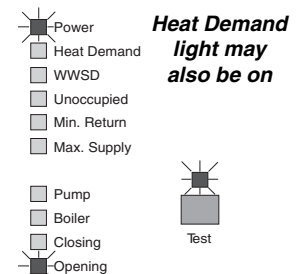


### Power light on — Test light on — Opening light on

The control turns on the open relay for the time span set on the Motor Speed dial. (See motor speed calibration procedure on page 9.)

If the Test Button is pushed once during the time the valve is driving open, the "Test" light will flash and the control will be held in a pause mode for 5 minutes, after which time it will automatically exit the test routine and return to normal operating mode. During the 5 minute pause, the valve will continue to drive open until it reaches the fully open position.

Pushing the Test button during the 5 minute pause will allow the control to resume the test routine at the next step.

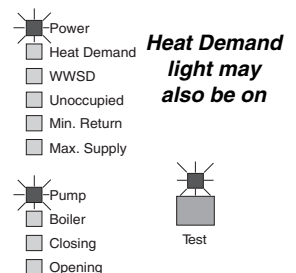


### Power light on — Test light on — Pump Light on

The opening relay is turned off and the control turns on the pump for 10 seconds and cycles to the next step.

During the 10 seconds, if there is a heat demand signal, and the Test button is pressed once, the test routine will be halted and the pump will remain on. The "Test" light will flash, and the control will be held in a pause mode for 5 minutes, after which time it will automatically exit the test routine and cycle into normal operating mode.

Pushing the Test button during the 5 minute pause will allow the control to resume the test routine at the next step.



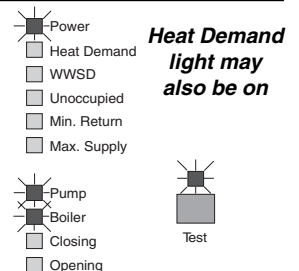
### Power light on — Test light on — Pump Light on — Boiler light on

The pump is running; the control turns on the boiler for 10 seconds.

During the 10 seconds, if there is a heat demand signal, and the Test button is pressed, the test routine will be halted and the pump and boiler will remain on.

The "Test" light will flash, and the control will be held in a pause mode for 5 minutes, after which time it will automatically exit the test routine and cycle into normal operating mode.

Pushing the Test button during the 5 minute pause will allow the control to resume the test routine at the next step.

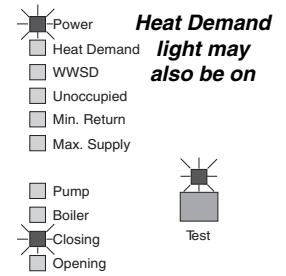


**Power light on — Test light on — Closing light on**

The control turns off the boiler and pump and turns on the close relay for the time span set on the Motor Speed dial.

If the Test Button is pushed once during the time the valve is driving closed, the "Test" light will flash, and the control will be held in a pause mode for 5 minutes, after which time it will automatically exit the test routine and cycle into normal operating mode. During the 5 minute pause, the valve will continue to drive to the fully closed position.

Pushing the Test button during the 5 minute pause will allow the control to resume the test routine at the next step, which is back to normal operating mode.



**Power light on — Test light off**

The control has exited the test routine, entered operating mode and will function according to the sequence of operation described on pages 3 and 4. *One or more of the indicator lights may be on.* Refer to page 3 and 4 for a description of the possible indicator light combinations under normal operating conditions.

## Step Eight Troubleshooting

As in any troubleshooting procedure, it is important to isolate a problem as much as possible before proceeding. The Error Messages and Test button greatly simplify troubleshooting of the type 354. When the control is flashing an Error Message, identify the fault from the look-up table on the bottom of this page and then follow standard testing procedures to confirm the problem. If you suspect a wiring fault, return to steps four and five and carefully check all external wiring and wiring connections.

Notes:

- If the Outdoor Sensor develops either a short circuit or an open circuit, the control is programmed to calculate the outdoor temperature at -8°F (-22°C), and control the supply temperature accordingly.
- If there is an Outdoor Sensor failure, the control will only allow the valve to operate as high as the supply maximum setting.
- If the Supply Sensor develops either a short circuit or an open circuit, the control is programmed to fully close the mixing valve to help prevent overheating.

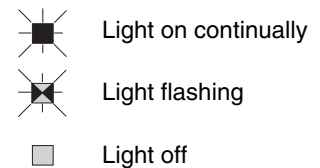
**After any repair has been completed, press the test button to confirm that correct operation has been restored.**

## Step Nine Before you leave

- Install the wiring cover over the wiring chamber and secure it to the base with the two screws provided. Place the front cover on the control to cover the setting dials and snap it into place. Install a lock if security is required.
- Place this brochure, and all other brochures relating to the installation, in the protective plastic bag supplied with the control. Place the bag in a conspicuous location near the control for future reference.
- It is important to explain the operation and maintenance of this control and of the system to the end user and anyone else who may be operating the system.

## Error Messages

Whenever a fault is detected in any of the sensors, the indicator lights will flash in specific ways, indicating the location of the problem. The following look-up table describes each error condition and shows the flashing light sequence that results. After repairing the problem, press the test button to cycle the control through the test routine. This will confirm that the fault has been repaired and that correct control action has been restored. For detailed Sensor testing instructions see Data Brochure D 001.

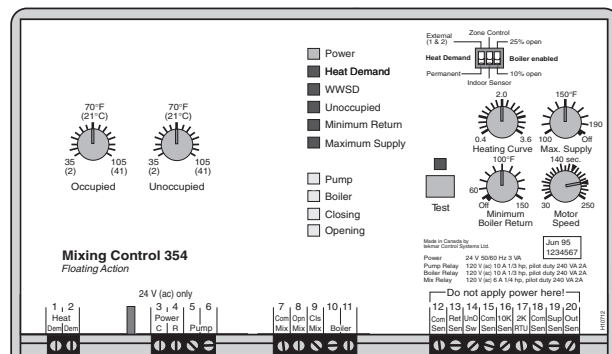


<b>Indoor Sensor short circuit</b> <ul style="list-style-type: none"> <li>Power (flashing)</li> <li>Heat Demand (flashing)</li> <li>WWSD (flashing)</li> <li>Unoccupied (flashing)</li> <li>Min. Return (flashing)</li> <li>Max. Supply (flashing)</li> <li>Pump (off)</li> <li>Boiler (off)</li> <li>Closing (off)</li> <li>Opening (off)</li> </ul>	<b>Supply Sensor short circuit (see troubleshooting notes)</b> <ul style="list-style-type: none"> <li>Power (flashing)</li> <li>Heat Demand (flashing)</li> <li>WWSD (flashing)</li> <li>Unoccupied (flashing)</li> <li>Min. Return (flashing)</li> <li>Max. Supply (flashing)</li> <li>Pump (off)</li> <li>Boiler (off)</li> <li>Closing (off)</li> <li>Opening (off)</li> </ul>	<b>Outdoor Sensor short circuit (see troubleshooting notes)</b> <ul style="list-style-type: none"> <li>Power (flashing)</li> <li>Heat Demand (flashing)</li> <li>WWSD (flashing)</li> <li>Unoccupied (flashing)</li> <li>Min. Return (flashing)</li> <li>Max. Supply (flashing)</li> <li>Pump (off)</li> <li>Boiler (off)</li> <li>Closing (off)</li> <li>Opening (off)</li> </ul>	<b>Boiler Return Sensor short circuit (see troubleshooting notes)</b> <ul style="list-style-type: none"> <li>Power (flashing)</li> <li>Heat Demand (flashing)</li> <li>WWSD (flashing)</li> <li>Unoccupied (flashing)</li> <li>Min. Return (flashing)</li> <li>Max. Supply (flashing)</li> <li>Pump (off)</li> <li>Boiler (off)</li> <li>Closing (off)</li> <li>Opening (off)</li> </ul>
<b>RTU short circuit</b> <ul style="list-style-type: none"> <li>Power (flashing)</li> <li>Heat Demand (flashing)</li> <li>WWSD (flashing)</li> <li>Unoccupied (flashing)</li> <li>Min. Return (flashing)</li> <li>Max. Supply (flashing)</li> <li>Pump (off)</li> <li>Boiler (off)</li> <li>Closing (off)</li> <li>Opening (off)</li> </ul>	<b>Supply Sensor open circuit (see troubleshooting notes)</b> <ul style="list-style-type: none"> <li>Power (flashing)</li> <li>Heat Demand (flashing)</li> <li>WWSD (flashing)</li> <li>Unoccupied (flashing)</li> <li>Min. Return (flashing)</li> <li>Max. Supply (flashing)</li> <li>Pump (off)</li> <li>Boiler (off)</li> <li>Closing (off)</li> <li>Opening (off)</li> </ul>	<b>Outdoor Sensor open circuit (see troubleshooting notes)</b> <ul style="list-style-type: none"> <li>Power (flashing)</li> <li>Heat Demand (flashing)</li> <li>WWSD (flashing)</li> <li>Unoccupied (flashing)</li> <li>Min. Return (flashing)</li> <li>Max. Supply (flashing)</li> <li>Pump (off)</li> <li>Boiler (off)</li> <li>Closing (off)</li> <li>Opening (off)</li> </ul>	<b>Boiler Return Sensor open circuit (see troubleshooting notes)</b> <ul style="list-style-type: none"> <li>Power (flashing)</li> <li>Heat Demand (flashing)</li> <li>WWSD (flashing)</li> <li>Unoccupied (flashing)</li> <li>Min. Return (flashing)</li> <li>Max. Supply (flashing)</li> <li>Pump (off)</li> <li>Boiler (off)</li> <li>Closing (off)</li> <li>Opening (off)</li> </ul>

## Technical Data

### Mixing Control 354 Floating

Literature	— D 354, A 354, D 001, D 070, Essays
Control	— Microprocessor control; This is <b>not a safety (limit) control</b> .
Packaged weight	— 2.8 lb. (1300 g), Enclosure A, PVC plastic
Dimensions	— 6-5/8" H x 7-9/16" W x 2-13/16" D (170 x 193 x 72 mm)
Approvals	— Meets DOC regulations for EMI/RFI.
Ambient conditions	— Indoor use only, 30 to 120°F (0 to 50°C), < 95% RH non-condensing.
Power supply	— Class 2, 24 V (ac) ±10% 50/60 Hz 3 VA
Mix Relays	— 120 V (ac) 6 A 1/4 hp, pilot duty 240 VA 2 A
Other Relays	— 120 V (ac) 10 A 1/3 hp, pilot duty 240 VA 2 A
Sensors	— NTC thermistor, 10 kΩ @ 77°F (25°C ±0.2°C) β=3892
included:	Outdoor Sensor 070 and Universal Sensor 071.
optional:	Universal Sensor 071, and Indoor Sensor 076 or 2k RTU
Occupied	— 35 to 105°F (2 to 41°C)
Unoccupied	— 35 to 105°F (2 to 41°C)
Heating Curve	— 0.4 to 3.6
Max. Supply	— 100 to 190°F, Off (38 to 88°C, Off)
Minimum Boiler Return	— Off, 60 to 150°F (Off, 16 to 66°C)
Motor Speed	— 30 to 250 seconds



The installer must ensure that this control and its wiring are isolated and / or shielded from strong sources of electromagnetic noise. Conversely, this electronic control does not exceed the Class B limits for radio noise emissions from digital apparatus as set out in the Radio Interference Regulations of the Canadian Department of Communications. If this equipment does cause interference, the user is encouraged to try to correct the interference by reorienting the receiving antenna and / or relocating the receiver with respect to this equipment.

Le présent numérique n'émette pas de bruits radioélectriques dépassant les limites applicables aux appareils numériques de Classe B prescrites dans le règlement sur le brouillage radioélectriques édicté par le Ministère des Communications du Canada.

**Caution** Nonmetallic enclosure does not provide grounding between conduit connections. Use grounding type bushings and jumper wires.

**Attention** Un boîtier non métallique n'assure pas la continuité électrique des conduits. Utiliser des manchons ou des fils de accord spécialement conçus pour la mise à la terre.

## Limited Warranty and Product Return Procedure

**Limited Warranty** The liability of tekmar Control Systems Ltd. and tekmar Control Systems, Inc. ("tekmar") under this warranty is limited. Please read and understand the conditions appearing herein.

tekmar warrants each tekmar product against defects in workmanship and materials, when the product is installed and used in compliance with tekmar's instructions. The 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, but in any event the warranty period shall not extend beyond thirty-six (36) months from the production date. During the warranty period, tekmar will, at its discretion, either repair at no charge, exchange or give credit for the defective product, provided the product is returned to tekmar.

The liability of tekmar shall be limited to the cost of parts and labour provided by tekmar to correct defects in materials and / or work-manship or to the exchange of the defective product for a replacement product or to the granting of credit limited to the original cost of the product, at tekmar's discretion, and such repair, exchange or credit shall be deemed to be the sole remedy available from tekmar. This warranty does not cover the cost of the parts or labour to remove or to transport the defective product, or to reinstall the repaired or replacement product. Returned products that are not defective are not covered by this warranty.

This warranty does not apply if the product has been damaged by accident, abuse, misuse, negligence, fire, Act of God, 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 the local codes and ordinances, or if due to defective installation of the product.

The warranty applicable to a product is as set out in the statement of warranty policy (the "Warranty") above, receipt of which is hereby acknowledged. The liability of tekmar is limited to those obligations identified in the warranty as obligations of tekmar. The warranty is understood to be in substitution for any loss, costs or damages for which tekmar might otherwise be liable at law or in equity and in particular, in lieu of any liability for fundamental breach of contract.

tekmar disclaims any responsibility for losses, expenses, inconveniences, or any special, indirect, secondary, incidental or consequential damages arising from ownership or use of any items subject to any claim hereunder, regardless of whether such claim is stated in contract, tort or strict product liability.

This warranty is in lieu of all other warranties, express or implied, including, without limitation, warranties of merchantability, 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. No implied warranties shall extend beyond twenty-four (24) months from the production date.

Some states or provinces do not allow limitations on how long an implied warranty lasts, so the above limitation may not apply to you. This warranty gives you specific legal rights, and you may also have other rights which vary from state to state or province to province.

**Product Return Procedures** 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 for that territory. If the address of the representative is not known, please request it from tekmar at the telephone number listed below.

**In North America:** tekmar Control Systems Ltd., Canada  
tekmar Control Systems, Inc., U.S.A.  
Head Office: 4611 - 23rd Street  
Vernon, B.C. Canada V1T 4K7  
Tel. (604) 545-7749 Fax. (604) 545-0650