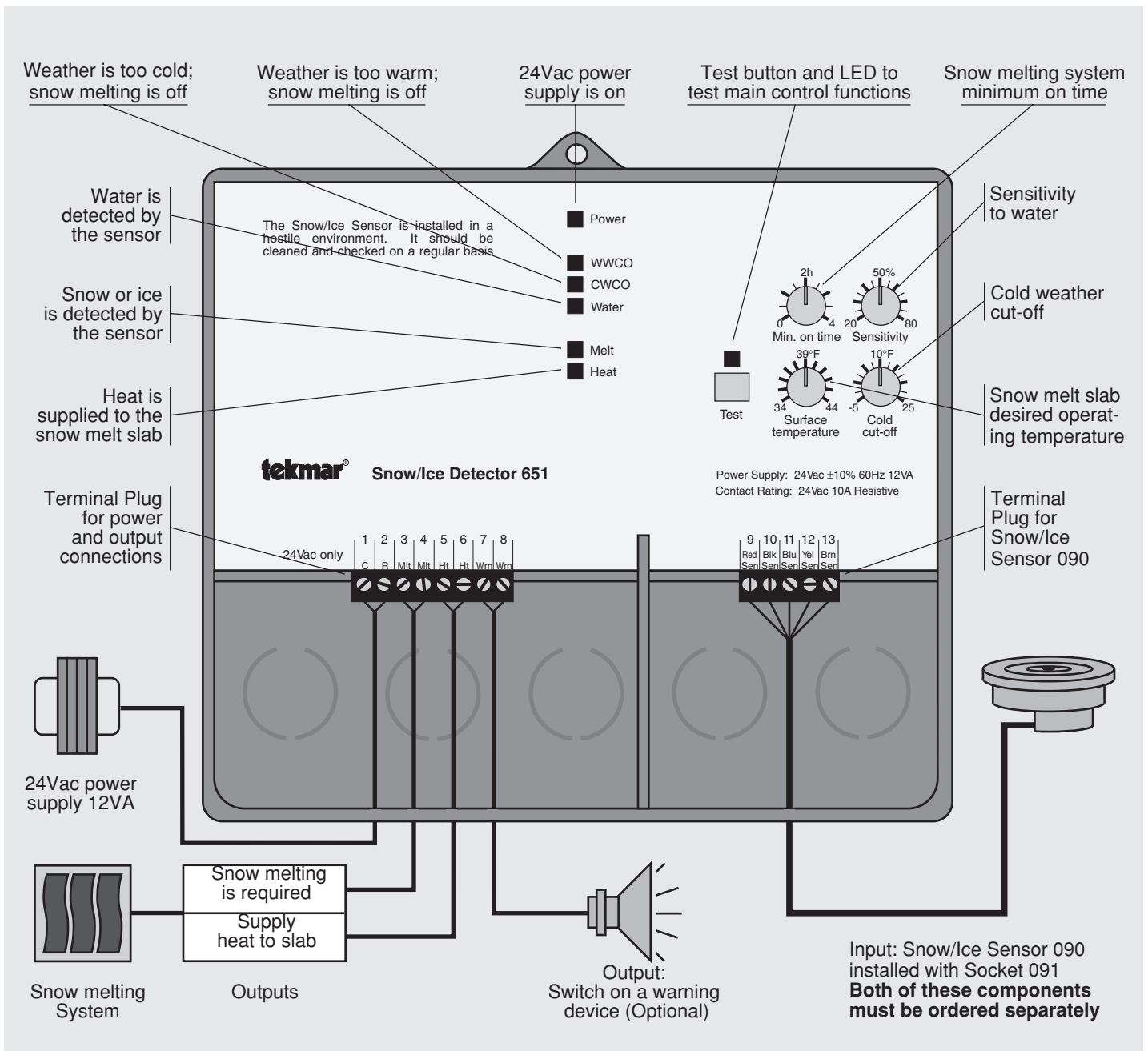


The tekmar Snow/Ice Detector 651 is a microprocessor-based control which activates and controls a snow melting system. This control is not designed as a simple detection device and will not operate properly in an unheated slab.

The in-ground sensor that must be used with this control is Snow/Ice Sensor 090. When specific selected surface temperature and moisture conditions occur, the control activates a MELT contact to signal the presence of snow or ice to an operator or other snow melting control device, or to initiate start-up of a snow melt system. The control also cycles a HEAT contact to operate a heat supply device (e.g. boiler, electric cables, pump, valve, etc.) in order to control the temperature of the snow melt slab. If a power outage or fault in the sensor occurs during freezing weather, the control activates a WARNING contact. Settings are made for snow melting system minimum on time, water detection sensitivity, slab temperature setpoint and cold weather cut-off.



## Technical Data

### Technical Specifications

Dimension (h x w x d)	— 6-5/8" x 7-9/16" x 2-13/16" (170 x 193 x 72mm)
Weight	— 2.2 lbs (1.0 Kg)
Ambient	— 30 to 160°F (0 to 70°C), < 95% RH non-condensing
Power supply	— 24Vac ± 10%, 60Hz, 12VA class II transformer
Relay capacity	— SPST, 24Vac, 10 Amps resistive
Sensor	— Snow/Ice Sensor 090, Socket 091, accurate with up to 500 feet (150m) 18AWG cable
Control accuracy	— ± 0.2°F (± 0.1°C)

### Features

6 Indicator lights	— POWER, WWCO, CWCO, WATER, MELT, HEAT
MELT output	— isolated SPST dry relay contacts close when snow/ice melting is required
HEAT output	— isolated SPST dry relay contacts close to operate the heat source
WARNING output	— isolated SPST dry relay contacts close when an error is detected
Test button	— pre-programmed test run for the Snow/Ice Sensor
Error message display	— sensor faults are indicated by flashing light codes

### Settings

Minimum snow melt on time	— 0 to 4 hrs
Water detection sensitivity	— 20 to 80%
Slab surface temperature setpoint	— 34 to 44°F (1.1 to 6.7°C)
Cold weather cut-off	— -5 to 25°F (-20 to -4°C)

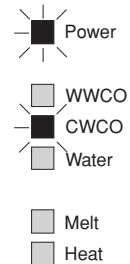
## Sequence of Operation

When the Snow/Ice Detector 651 is powered-up, it cycles through an automatic test routine described in detail on pages 6 and 7 of this brochure. When the test routine is completed and no errors are detected, the control exits the test routine and enters the operating mode.

Once in operating mode, the control uses the Snow/Ice Sensor 090 to continually monitor the actual surface temperature of the snow melt slab. While monitoring this temperature, the control recognizes the following three temperature conditions and responds accordingly. During operation, the lights of the control will indicate operational status as illustrated.

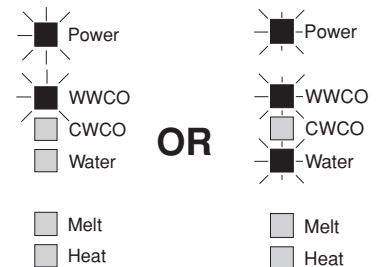
### Slab surface temperature too cold

- If the slab surface temperature becomes colder than the Cold weather cut-off setting, the "CWCO" light will come on, the snow melting system will be kept off and the Snow/Ice Sensor 090 heater will not be energized.



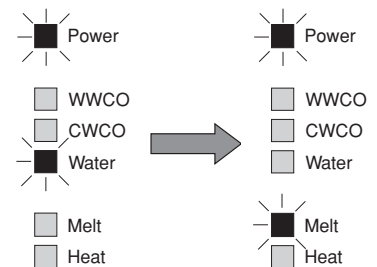
### Slab surface temperature too warm

- If the slab surface temperature is warmer than the Surface temperature setting, the "WWCO" light will turn on and the control will continue to monitor slab actual temperature and check for the presence of water. If water is present at this time, the "Water" light will turn on but the control will not respond in any other way. When the slab surface temperature drops below the Surface temperature setting within 4 hours of water having been detected, the control will switch into the melting mode as described below.



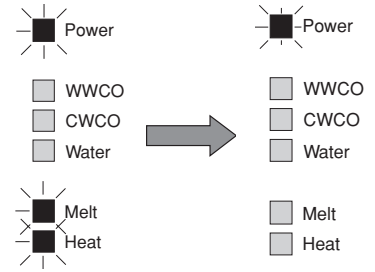
### Slab surface temperature at snow/ice forming temperatures

- When the slab surface temperature is between the Surface temperature and Cold weather cut-off settings, the "WWCO" light will turn off and the Snow/Ice Sensor 090 will be heated.
- The control will continually check for the presence of water. If water is detected at this time, the "Water" light will come on.
- If water continues to be detected at these snow/ice forming temperatures for at least 10 seconds, the MELT relay will switch on and enable the melting system or separate melting system control. The "Melt" light will turn on and the "Water" light will turn off.



### When snow/ice is detected

- The MELT relay will stay on for at least the set minimum on time.
- The HEAT relay will turn the heat supply device on when the slab temperature is lower than the Surface temperature setting. The HEAT relay will be cycled to maintain the set surface temperature and the "Heat" light will cycle on and off with the relay.
- When at least the minimum on time has passed, the slab is up to temperature, and no water is detected, the "Melt" light and the MELT relay will both turn off. The "WWCO" light may come on for a short time, shutting off when the slab cools back down. The control will continue to test for snow/ice with the "Power" light on.



### When in melting mode

- If the slab does not come up to its operating temperature within 4 hours, an error signal will be generated and the WARNING relay contacts will close while the control continues to try to melt the snow. This error signal can only be cleared by pressing the Test button or restarting the control. The fault that kept the slab from coming up to temperature should then be located.
- When the minimum on time has elapsed and the slab surface is up to operating temperature, the control will again test for water.
- If water is detected, the control will stay in MELT mode, continue to cycle the HEAT relay, and maintain the slab surface temperature.
- If water is not detected for 40 seconds, the MELT relay and HEAT relay will turn off and the control will return to monitoring the slab surface temperature. The snow melt system will then be off, or in an idle mode if it is equipped with a separate control having an idle option.
- If at any time there are lights flashing, or if the WARNING relay is tripped, see the Error Message List on page 8. This list will explain the error message light sequence.

## 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 651 includes:

- One electronic control, type 651
- One Data Brochure D 651
- One Data Brochure D 001
- One Application Brochure A 651

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

Read Brochure A 651 and select the correct Application for your job.

### Note

**This control must be installed with the Snow/Ice Sensor 090 and the Socket 091. These components are not included with type 651 and must be ordered separately.** It is important to have all necessary components on hand and to go through step one of the installation procedure with each component before you start to install the system. 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 you understand its functions within the operational requirements of your system.

## 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 all 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 Snow/Ice Sensor 090 according to the instructions in Data Brochure D 090, and run the wiring back to the base.
- Install the wiring from the other system components 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 the control is grounded to the sensor and damage to the control may result.

## Step Four

### Electrical connection to the control

#### Power and output connections

- The power supply should be disconnected at this stage, and the installer should test to confirm that no voltage is present at any of the wires.
- Install the control back 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 C — R (1 and 2). Do not connect either of the transformer terminals to ground, or damage to the control could result.

1	2	3	4	5	6	7	8
C	R	Mlt	Mlt	Ht	Ht	Wrn	Wrn

Max. 24 Volts

- Connect the circuit of the melting system to terminals Mlt — Mlt (3 and 4). These terminals lead to a 10 amp resistive dry relay contact inside the control which closes when the control detects the presence of snow or ice. The most common devices to be turned on (enabled) by the type 651 are pumps, heating devices or other tekmar controls.

1	2	3	4	5	6	7	8
C	R	Mlt	Mlt	Ht	Ht	Wrn	Wrn

Max. 24 Volts

*Note:* If the tekmar Hydronic Snow/Ice Melting Control type 217 needs to be enabled, connect terminals Mlt — Mlt (3 and 4) of the type 651 to terminals 10 (En) and 13 (Cs) of the type 217. (See A 651-2, A 651-3)

- Connect the circuit of the device that delivers heat to the snow melting slab, (electric cables, pump, boiler, etc.) to terminals Ht — Ht (5 and 6). These terminals lead to a 10 amp resistive dry relay contact inside the control which closes when the control determines that the slab needs heat.

1	2	3	4	5	6	7	8
C	R	Mlt	Mlt	Ht	Ht	Wrn	Wrn

Max. 24 Volts

- If desired, connect a warning device to terminals Wrn — Wrn (7 and 8). These terminals lead to a 10 amp resistive dry relay contact inside the control which closes when there is a power failure or a Snow/Ice Sensor failure during freezing weather.

1	2	3	4	5	6	7	8
C	R	Mlt	Mlt	Ht	Ht	Wrn	Wrn

Max. 24 Volts

#### Caution

**The tekmar Snow/Ice Detector type 651 is an operating control. It is not certified as a safety device. If safety considerations are critical, a separate alarm system must be installed**

#### Sensor connections

This control is designed for use with the tekmar Snow/Ice Sensor 090 only. See Data Brochure D 090 for the installation instructions regarding Snow/Ice Sensor 090 and the Socket 091, which is also required.

The cable supplied with the sensor is 65 ft (20m) long, but can be extended up to a total overall length of 500 ft (150m). If extension becomes necessary, splices should be properly soldered and waterproofed, and be protected in an accessible, waterproof junction box. Minimum wire size of 18 AWG is required for extensions.

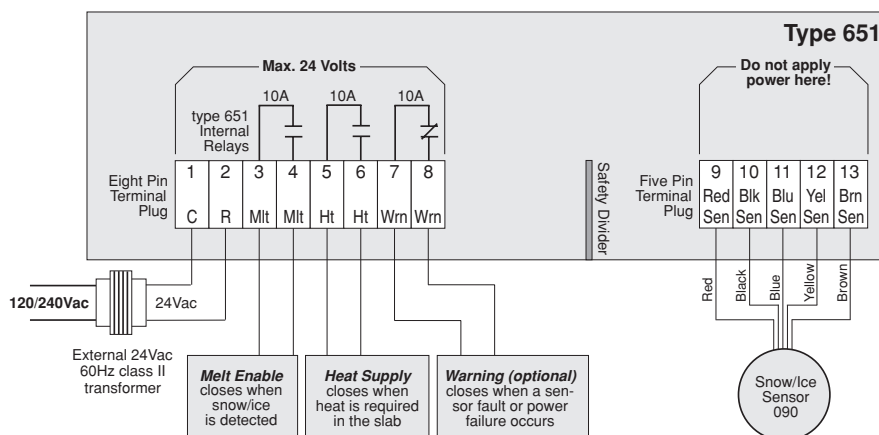
- Connect the red wire from the sensor cable to terminal Red — Sen (9)
- Connect the black wire from the sensor cable to terminal Blk — Sen (10)
- Connect the blue wire from the sensor cable to terminal Blue — Sen (11)
- Connect the yellow wire from the sensor cable to terminal Yel — Sen (12)
- Connect the brown wire from the sensor cable to terminal Brn — Sen (13)

For sensor testing instructions, see Brochure D 090 (included with Sensor 090)

9	10	11	12	13
Red Sen	Blk Sen	Blu Sen	Yel Sen	Brn Sen

Do not apply power here!

### Control relays are shown in the power down condition



Electrical connections to the terminal plugs of Snow/Ice Detector 651

## Step Five

### Testing the wiring

#### Caution

- These tests are to be performed using standard testing practices and procedures and should only be carried out by a properly trained and experienced technician.
- 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 sensor

- This test must be made *before* turning on the power supply, and with the terminals unplugged. Test the Snow/Ice Sensor according to the instructions in brochure D 090.

#### Test the power supply

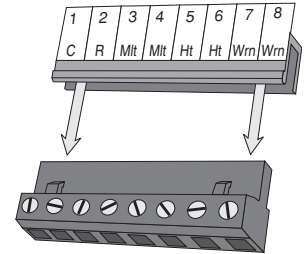
- Make sure exposed wiring or bare terminals are not in contact with any other wires or grounded surfaces. Turn on the power to the transformer. While using an AC voltmeter, between 22 and 26 Volts AC should be measured across terminals C — R (1 and 2).

#### Test the Outputs

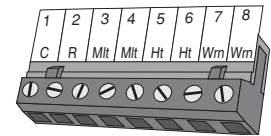
- Devices connected to terminals 3 and 4, 5 and 6, or 7 and 8, must be less than 28Vac. **At no time** should voltages in excess of 28Vac be measured at these terminals.
- If a device is connected to the Mlt — Mlt (3 and 4) terminals; make sure power to the device is off and install a jumper in the terminal plug between terminals 3 and 4. When the device is powered-up, it should operate. If it does not come on, check the wiring from the terminal plug to the device, and refer to any installation or trouble shooting information supplied with the device. If the device is operating properly, disconnect the power and remove the jumper.
- Repeat this procedure for the heat supply device connected to the Ht — Ht (5 and 6) terminals, and for the warning device connected to the Wrn — Wrn (7 and 8) terminals.

#### 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. The plugs should snap firmly into the headers.



Terminal plug disconnected from its header on the control



Terminal plug pushed into its header on the control

## Settings

### Step Six

#### Essential control settings

##### Slab surface temperature

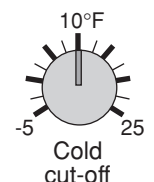
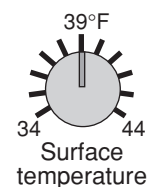
Two conditions must exist before the MELT relay will be switched on. The sensor must detect moisture, and the slab surface temperature must be lower than the setting of the Surface temperature dial, but warmer than the setting of the Cold cut-off dial. The Surface temperature dial is adjustable from 34 to 44°F (1 to 7°C). A typical trial setting would be 36°F (2°C).

This setting will vary in different areas, depending on local weather conditions. Heavy snowfall can load a slab at temperatures well above freezing, so in heavy snowfall areas this setting could be quite high on the scale. In some areas, ice formation causes more problems than snow loading, and the setting could be set toward the lower end of the scale, since ice will typically form only on surfaces that are closer to freezing.

##### Cold weather cut-off

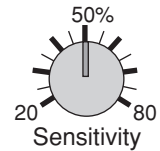
When the slab temperature falls below the Cold weather cut-off setting, the Snow/Ice Detector will not switch the snow melting equipment on. This dial is adjustable from -5 to 25°F (-20 to -4°C).

The setting of this dial is dependant on local conditions, and on the capacity of the snow melt system. In most localities, snow melting is not desired at the lower temperatures, since snow becomes dry, light and less slippery, and melting becomes less economical.



## Water detection sensitivity

The sensitivity of the Snow/Ice Sensor to water is selected by the Water Sensitivity adjustment dial. As snow becomes contaminated with dirt, and as the sensor surface itself becomes dirty, the control may indicate the presence of water all the time. If this condition occurs, clean the surface of the sensor, and/or turn down the sensitivity setting. If the snow and rain in your area is very clean, the sensitivity setting may need to be increased before the control will detect it. A typical trial setting is from 50 to 65%.

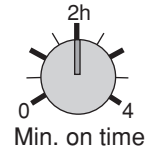


### Note

**The Snow/Ice Sensor is installed in a hostile environment and it should be checked on a regular basis. It can be cleaned with a wire brush when necessary. After cleaning, check operation by pressing the test button to cycle the control through the test routine.**

## Snow melting system minimum on time

The control switches on the MELT relay when a snow/ice condition is detected. The relay will be kept on for at least the time duration set on the minimum on time adjustment dial, or if it takes longer, for the length of time it takes to heat the slab to the surface temperature selected. This setting prevents short cycling due to fluctuating water or temperature conditions. A typical trial setting is 1 hour.



## Test button

When the Test button is pushed, the control cycles through a self test routine. The test can be halted during the output testing by pushing the button a second time. For details of the test routine, refer to the test routine description starting on this page.



## Testing the Control Functions

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

### Indicator lights

There are seven 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.
- WWCO light on** • the slab surface temperature is higher than the slab surface temperature setting on the control.
- CWCO light on** • the slab surface temperature is lower than the cold weather cut-off temperature setting on the control.
- Water light on** • the snow/ice sensor is detecting the presence of water.
- Melt light on** • the MELT relay is energized, the melting system should be in operation.
- Heat light on** • the HEAT relay is energized, the heat supply device should be delivering heat to the slab.
- Test light on** • the control is going through the programmed test routine.

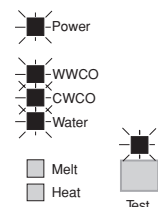
## Step Seven

### Operational test of control functions - Test button

The Snow/Ice Detector 651 has a Test button which can be used to test all of the main control functions at any time. When the control is initially powered-up, or when the Test button is pushed, the control automatically runs through the following test procedure. If a fault in the sensor or in the snow melt system occurs, the lights will flash an error message, the WARNING relay contacts will close, and the test routine will be suspended until the fault is located and corrected. The error messages are listed on page 8.

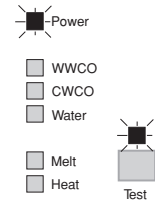
### Red lights on

On power-up, the "Power" light is switched on. Each time the control is powered-up, and at the start of each test routine, the control also switches the "Test" light and the three other red lights on for approximately 5 seconds. During this time the control searches for sensor faults and, if no faults are found, proceeds to the next step. If a sensor fault occurs, the control exits the test routine, closes the WARNING relay contacts, and indicates the fault by flashing some of the lights in an error message. These error messages are listed on page 8.



Power light on — Test light on

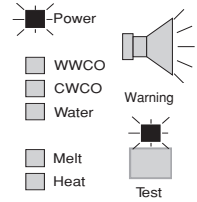
The control turns on the internal heater of the Snow/Ice Sensor 090 and looks for a 3°F (1.7°C) heat rise to occur in the centre of the sensor in less than 40 seconds. If the control does not sense a rise in temperature because of a defective heater, a disconnected red wire or reversed yellow and brown wires, it will exit the test routine, close the WARNING relay contacts and flash the lights in an error message. If the centre of the sensor is hotter than 120°F (49°C) due to fast repeated use of the test button, frequent power up cycles or very hot ambient conditions, the control will skip this part of the test routine.



Power light on — Test light on — Warning on

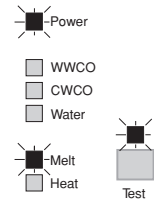
The test routine can be halted at this, or any of the following steps by pushing the Test button once. The "Test" light will flash, and the control will be held in a pause mode for 5 minutes, after which time it will automatically exit the test routine. Pushing the Test button during the 5 minute pause will allow the control to resume the test routine at the next step.

When the control successfully completes all sensor tests, it closes the WARNING relay contacts. If the external warning device does not come on, the wiring from the control should be checked and the warning device examined for possible faults.



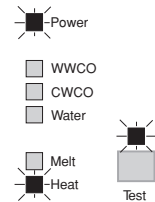
Power light on — Test light on — Melt light on

After 10 seconds, the Warning turns off and the "Melt" light turns on. The MELT relay is energized, and its contacts close for 10 seconds, turning on the melting system. If the melting system does not come on, the wiring from the control should be checked and the melting system examined for possible faults.



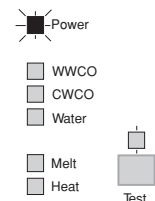
Power light on — Test light on — Heat light on

After 10 seconds, the Melt light turns off and the "Heat" light turns on. The HEAT relay is energized, and its contacts close for 10 seconds, turning on the slab heat supply device. If the slab heat supply device does not come on, the wiring from the control should be checked and the heat supply device examined for possible faults.



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 2 and 3. One or more of the other indicator lights may also be on. Refer to page 2 and 3 for a description of the indicator lights under 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 651. When the control is flashing an Error Message, identify the fault 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. After any repair has been completed, press the test button to allow the control to cycle through the test routine. This will allow you 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 maintainance 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 the sensor or the slab heating system, the indicator lights will flash in specific ways to indicate the problem. The following list 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 Snow/Ice Sensor 090 testing instructions see Data Brochure D 090.

<p><b>Sensor: heater response too slow or Red wire open circuit or Yellow and Brown wires reversed</b></p>	<p><b>Sensor: Yellow wire, Black wire or all wires open circuit</b></p>	<p><b>Sensor: Yellow wire short circuit to Black wire</b></p>	<p><b>Sensor: Brown wire open circuit</b></p>
<p><b>Sensor: Brown wire short circuit to Black wire</b></p>	<p><b>Sensor: Blue wire open circuit</b></p>	<p><b>Sensor: Surface is dirty or water is contaminated, see cleaning instructions or; Blue wire short circuit to Black wire</b></p>	<p><b>Slab heating system malfunction</b></p>

If the red wire short circuits to the black wire, the power supply becomes shorted out and the control will continually cycle through the start of the test routine. This fault should be repaired immediately or damage to the power supply could result.

## Limited Warranty and Product Return Procedure

**Limited Warranty:** tekmar warrants to the original purchaser each tekmar product against defects in workmanship and materials when the product is installed and used in compliance with tekmar's instructions. This limited warranty covers the cost of parts and labour provided by tekmar to correct defects in materials and/or workmanship. Returned products that are fully operational are not considered a warranty case. tekmar also does not cover parts or labour to remove, transport or reinstall a defective product. tekmar will not be liable for any damage other than repair or replacement of the defective part or parts and such repair or replacement shall be deemed to be the sole remedy from tekmar. This warranty shall not apply to any defects caused or repairs required as a result of unreasonable or negligent use, neglect, accident, improper installation, or unauthorised repair or alterations. In case of defect, malfunction or failure to conform to warranty, tekmar will, for a warranty period of 24 months from the date of invoice to the original purchaser or 12 months from the date of installation of the product, whichever occurs first, repair, exchange or give credit for the defective product. Any express or implied warranty which the purchaser may have, including merchantability and fitness for a particular purpose, shall not extend beyond 24 months from the date of invoice or 12 months from the date of installation of the product, whichever occurs first.

**Replacements:** tekmar can send replacement products if requested. All replacements are invoiced. Any possible credit for the replacement will only be issued once the replaced product has been returned to tekmar.

**Product Return Procedure:** Products that are believed to have failed must be returned to tekmar Control Systems Ltd. 4611-23rd Street, Vernon B.C. Canada V1T 4K7 when agreed to by tekmar. The installer or other qualified service person must, at the owners expense, determine which component has failed. The product must be returned complete with

all of its components (sensors, base, etc.) Products must be returned together with the proof of purchase to the original purchaser who then returns the product to tekmar after receiving a Return Goods Authorisation (RGA) number from tekmar.

Please include the following information with the product: The full address of the original purchaser, the RGA number and a description of the problem.

From the U.S.A., in order to avoid customs charges, products must be returned via US Post with the package clearly marked with the RGA number, product type and the statement "Canadian Product returned for repair". For shipping purposes the product can be valued at one half list price.

- 1) If returned during the warranty period and the product is defective, tekmar will issue full credit for the returned product less cost of missing parts.
- 2) If returned during the warranty period and the product is fully operational, tekmar will return the product to the original purchaser for a testing cost of \$30.00 plus postage.
- 3) If returned during the warranty period and the product is not damaged and is fully operational, tekmar can take back the product for a return charge of 40% of the product's net value. This request has to be specified otherwise the product will be returned with a testing cost of \$30.00 plus postage.
- 4) If returned after the warranty period and the product needs repair, tekmar will repair and return the product. Repair and postage costs will be invoiced. tekmar's repair costs are calculated at \$30.00 / hour plus the cost of parts. If the repair costs will be more than \$60.00 a repair estimate will be sent to the original purchaser.

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