CONDUCTIVE CONCRETE SNOWMELT SYSTEM

OPERATIONS AND MAINTENANCE MANUAL

PART I HEATING OPERATIONS

Operating period: October 20 – March 31

Conductive Concrete Snowmelt System

Conductive concrete is a concrete mixture containing electrically conductive materials to enable conduction of electricity. Steel angle iron embedded in the conductive concrete are used for electrodes, which are connected to a power source. When energized, conductive concrete is the heating element generating heat for snowmelt and deicing. The applied voltage is limited to 48V AC. The electrical components required for conductive concrete heating includes electric wires, cables, transformers, equipment cabinets and terminations. Conduits, pull boxes and junction boxes are often required for establishing connection from the steel angle iron to the electrical cabinets. A snowmelt power controller, with an aerial snow sensor and a pavement temperature and moisture sensors, is also required to turn on the power to the conductive concrete heating system when the weather conditions favor wintry precipitation to take place. The controller also turns the power off when sensors indicate that heating is no longer needed.

For safe operations, the conductive concrete snow melt system is designed in accordance with the U.S. Patent No.10,385,519: Systems and Methods for Construction of Electrically Conductive Concrete Slab with protection from Current Leakage. A conductive concrete pavement is "encapsulated" by a polymer sheet and a foam board underneath the slab, along with a durable polymer sealant to cover any exposed surfaces. The electrical safety of conductive concrete heating has been verified by extensive lab testing as well as by a third-party electrical testing entity, to meet the 5 mA GFCI tolerance stipulated by the National Electrical Code (NEC/NFPA 2020).

Conductive concrete heating is very energy efficient utilizing low voltage AC. To maintain adequate snow melting rate, however, it is desirable to preheat conductive concrete. Without preheating, it will take longer for conductive concrete to reach temperatures above 32F. It will

take even longer during heavy precipitation or if snow has already accumulated on the concrete. For snowmelt operations below 10F, preheating is a requirement. Most commercial snowmelt controllers do not provide preheating functions. To achieve preheating, a snowmelt controller needs to be supplemented with a management system to initiate the heating functions remotely. For instance, a web app can be developed by an integrator for mobile devices. Control will be communicated via fiber-optic cable or a wireless mesh network.

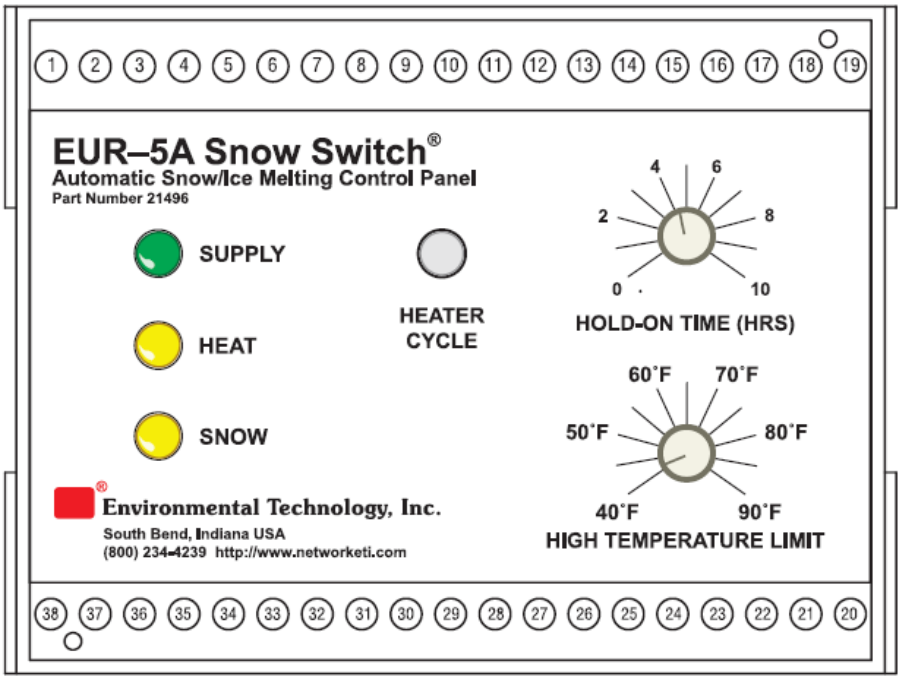
The EUR-5A Snow/ice Melt Controller

The EUR-5A controller by ETI is used for power control of the conductive concrete snow melt system installed at the KCATA's Bus Rapid Transit bus stations. The controller comes with a Model SIT-6E pavement mounted temperature/moisture sensor, a Model CIT-1 aerial snow sensor, and a high Temperature Limit Sensor. The SIT-6E sensor has a 'Hold-on' time selectable from 0 to 6 hours. The High Temperature Limit Sensor is housed inside the SIT-6E pavement sensor, which is selectable from 40 to 90F at the controller. The controller will stop heating when the high temperature limit is reached. The EUR-5A controller also has a Hold-on timer, selectable from 0 to 10 hours. The hold-on time will provide the pavement heating and drying functions.

The hold-on time for the controller should be set at 10 hours and SIT-6E sensor at 6 hours. The high temperature limit should be set at 55F. The preheating time needs to be adjusted according to the ambient temperature. Continuously preheating for 10~20 hours may be required prior to a snowstorm for extremely cold temperature (e.g., subzero to single digit F).

Manual Operation Sequence

If a supplemental snow melt management system is not available for remotely monitoring and controlling the EUR-5A controller, it is desirable to preheat the concrete manually before wintry precipitation begins. EUR-5A controller provides a manual pre-heating function by pressing the "Heater Cycle" pushbutton. It is a good practice to start preheating the concrete 8 hours prior to anticipated snowfall or winter precipitation. The front panel of EUR-5A is shown below.



The manual preheating operation sequence is given as follows:

1. Set the Hold-On time dial on the front panel to 10 hours to allow ample preheating before the storm.
2. Set the High Temperature Limit to 55F. Note that if the High Temperature Limit is reached before the 10 hours, EUR-5A will stop preheating and switch to auto mode, waiting for wintry precipitation.
3. Depress the Heater Cycle button on the front panel for approximately 5 seconds, until the Yellow Heat indicator light is on. From this point on, the controller is in Manual mode and the Hold-On time starts. If longer preheating than 10 hours is desired, the manual preheating steps will need to be repeated.
4. Both the CIT-1 aerial snow sensor and the SIT-6E pavement temperature/moisture sensor serve the same function to turn the heat on, if the pavement temperature drops below 38F AND moisture is detected. When EUR-5A is in auto or Stand-By mode, it awaits signal from either sensor to call for heat.
5. When one of the sensors calls for heating, EUR-5A controller will engage heating and start the 'Hold-On' Timer.
6. If the pavement temperature from the High Temperature Limit Sensor exceeds the high temperature limit, the EUR-5A controller will suspend heating and the timer, and switch to Stand-By.

Operation Sequence of the Supplemental Management System

A supplemental management system shall be developed based on the EUR-5A manual and the datasheets of the associated sensors. **The operating sequence recommended by the developer need to be inserted here:**

1. KCATA personnel will initiate the heating sequence via the software, when a snowstorm is in the forecast.
2. The software sends the manual override "on" signal to connect terminals 10 and 11. This forces the heaters to be on continuously. EUR-5A controllers will start preheating the concrete without checking the High Temperature Limit, until the software sends the manual override "off" signal to connect terminals 10 and 12 to turn off the heating. This would require pavement temperature info to limit heating.
3. The pavement will cool off to a temperature below 38F, and the SIT-6E sensor will call for heating if moisture is detected by the SIT-6E pavement sensor or snow is detected by the CIT-1 aerial snow sensor.
4. When the sensors call for heating, EUR-5A controller will engage heating and start the 'Hold-On' Timer.
5. If the pavement temperature from the Temperature Limit Sensor exceeds the high temperature limit, the EUR-5A controller will stop heating and the timer and switch to stand-by.
7. The pavement will cool off to a temperature below 38F, and SIT-6E pavement sensor will call for heating until the Hold-On Timer has expired.
8. If the high pavement temperature limit is not reached, heat will be on until the Hold-On Timer expires.

PART II SYSTEMS MAINTENANCE

Inspections before the Winter Season

1. Inspect all the exposed electrical components of the conductive concrete snow melt system for physical damage. These items include the electrical wiring and cables coming out of stub-ups and leading to the cabinets, pull-boxes and junction boxes, aerial icing sensors, pavement temperature/moisture sensors. Clean contents of the cabinets with compressed air as needed.
2. For the inside of cabinets, check for blown fuses and tripped circuit breakers.
3. Check for damage to the Tuffseal® sealant for chips and scrapes. Tuffseal® sealant is

expected to have a 10-year service life. If repair is necessary, use rollers to reapply three coats of Tuffseal® sealant on damaged areas. Check for integrity of the Flexseal® on the anchors of the benches, TVM's, and waste receptacles. Reapply as necessary. Damages to the conductive concrete can be patched with high- strength, non-shrink grout paste.

4. Inspect railings, anchors and supports for structural integrity.
5. Power up each cabinet for approximately 30 minutes under ambient temperature lower than 45F, to verify the functionality of circuit breakers and transformers in the cabinet. Use a handheld current sensor to measure current drawn at each transformer. Spot check stray voltage level (lower than 5V) at railings and anchor bolts locations. Use a small metal plate on Tuffseal®-coated conductive concrete to simulate contact. A 1,000-Ohm resistor shall be used in parallel with a voltmeter for stray voltage measurements.

Special Maintenance Requirements for the EUR-5A Controller

1. KCATA Facility should maintain a binder of laminated hard copies of all the manuals and datasheets of the EUR-5A controller, the SIT-6E pavement mounted temperature/moisture sensor, the CIT-1 aerial snow sensor, the high Temperature Limit Sensor, and the remote snowmelt management system for reference. The ETI's website provides a good source of information regarding their EUR-5A controller and sensors: www.networketi.com. A KCATA's electrician should be able to troubleshoot the system should issues arise during deicing operations. ETI's tech support: Max Allen, at mallen@networketi.com or by phone at 269-944-6155.
2. For the EUR-5A controller to function properly, it is essential to make sure the "moisture grid" in the aerial sensor and the pavement temperature/moisture sensor be free of debris mixed with ice/snow particles. The gunk will significantly reduce the sensitivity of the sensors and has accounted for 90% of the cases where the controller did not function properly. Use a 3M Scotchbrite Pad with warm soapy water to clean the moisture grids on the sensor faces thoroughly before operations. ETI has a maintenance PDF "8 simple steps for maintaining snow ice melting system", which should be observed to ensure good working condition of the sensors. https://networketi.com/8-simple-steps-for-maintaining-your-eti-snow-ice-melt-system-for-winter/ This maintenance manual should also be placed in the O&M Manual binder.