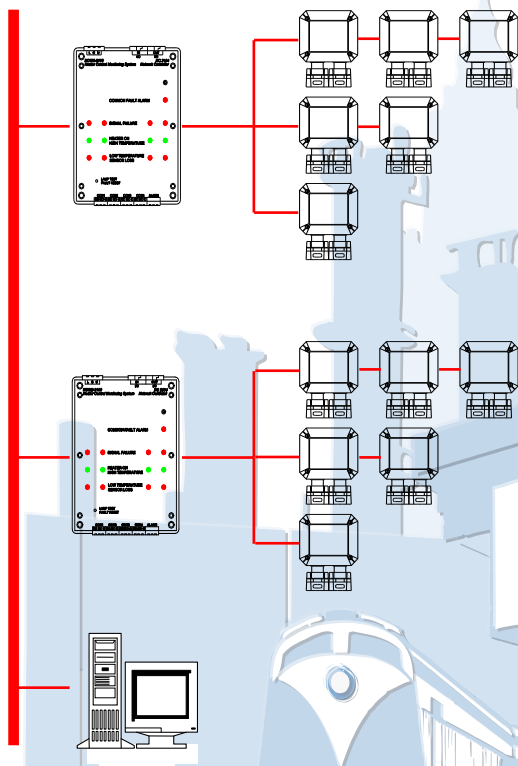
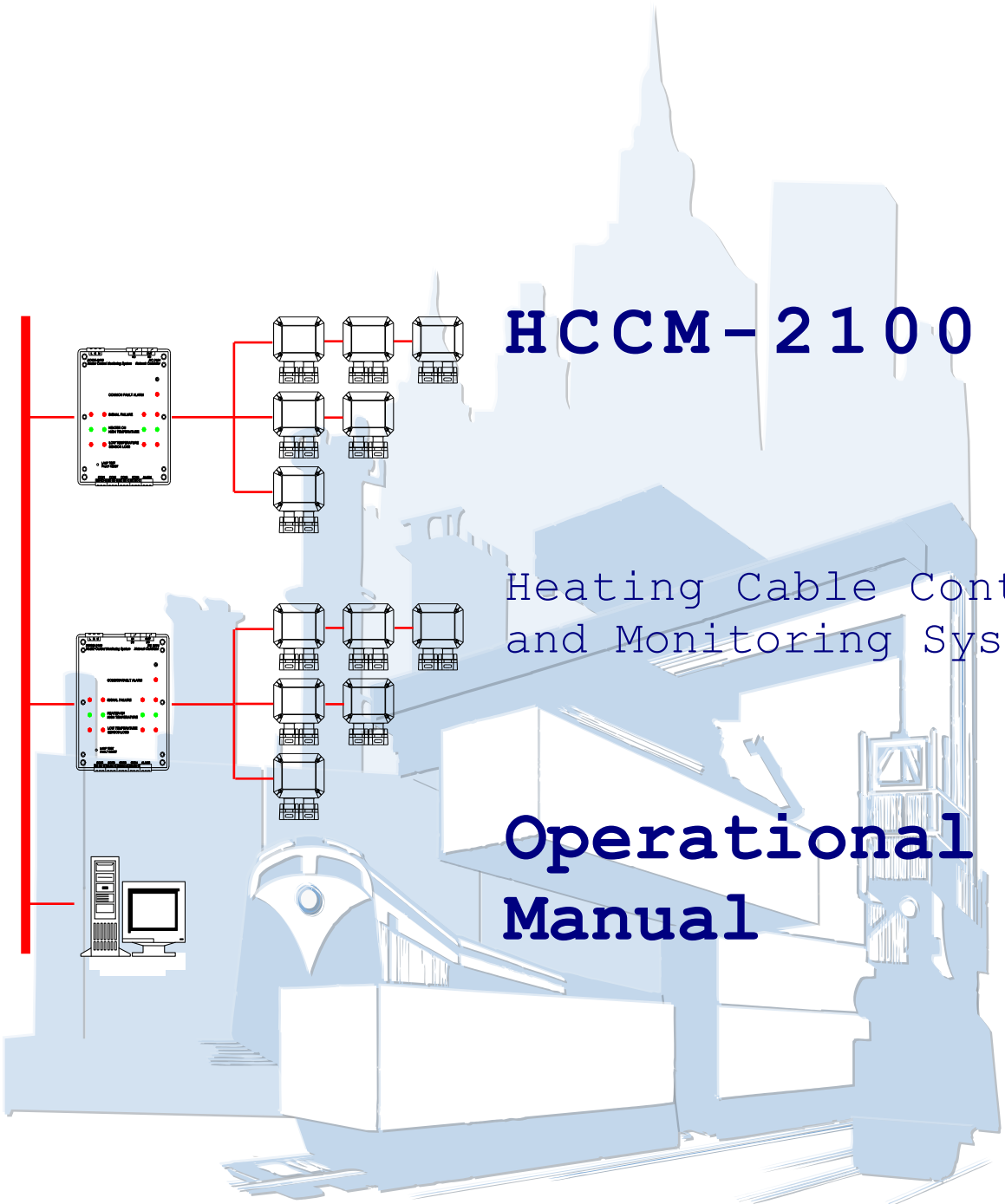




innovative technologies for the 21st century



# HCCM-2100

Heating Cable Control  
and Monitoring System

# Operational Manual

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**OVERVIEW**

**Introduction to HCCM-2100**

HCCM-2100, Heating Cable Control and Monitoring System utilize electrical heat tracing as a platform to provide comprehensive protection and early warning of failure and vandalism for critical piping applications. HCCM-2100 utilizes power line communication to provide full monitoring and control functions without dedicated communication wiring (Figure 1). Communication occurs over the heat trace cables and the interconnecting power wiring.

HCCM-2100 provides Distributed Temperature Sensing and Heating Cable Control and Monitoring. Pipe temperatures are monitored and heater cables are controlled to maintain the pipe temperature setpoint(s). The integrity of the heater cables, connections, power wiring, and temperature sensor is monitored. Alarms are provided for low pipe temperature (below control setpoint).

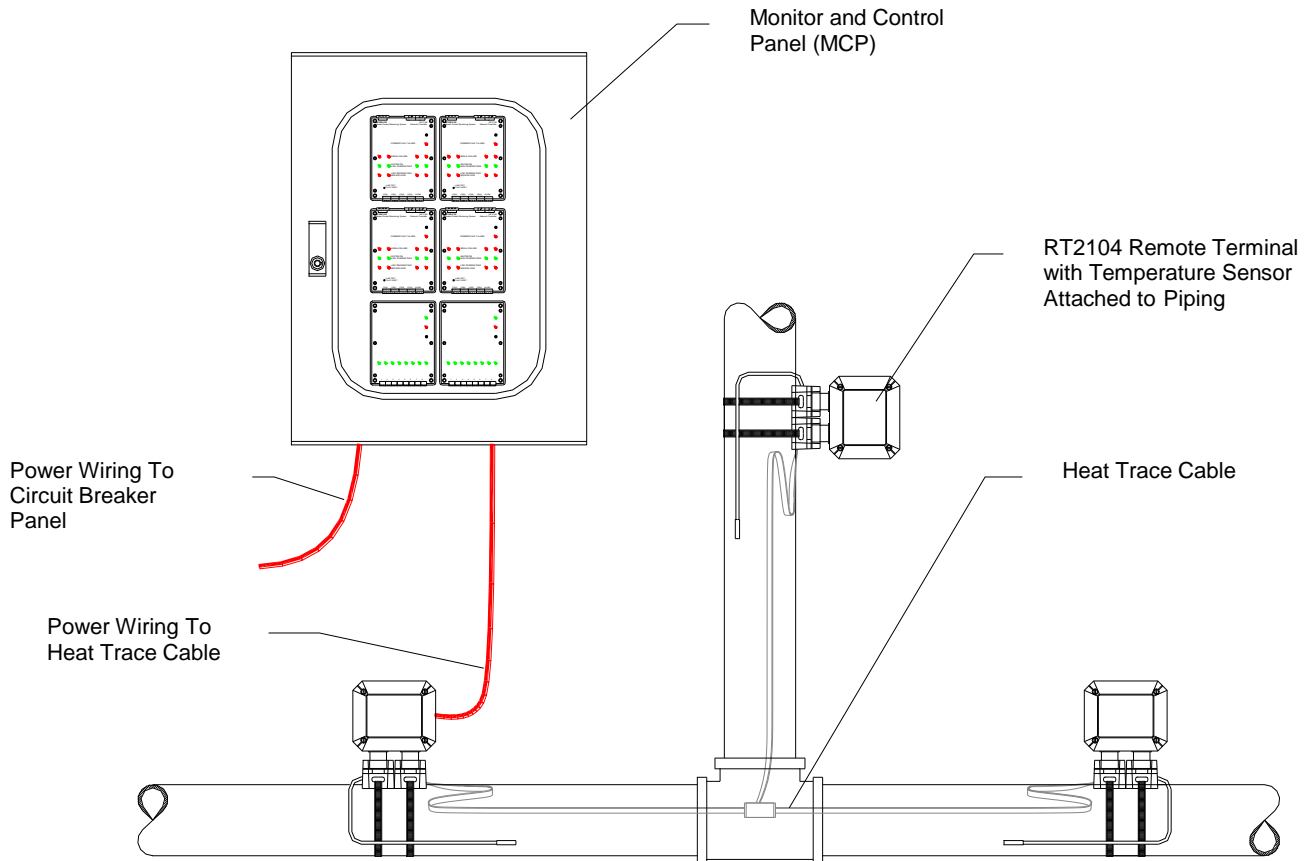


Figure 1. Power Line Communication of the HCCM-2100 (208V, 3 wire system shown)

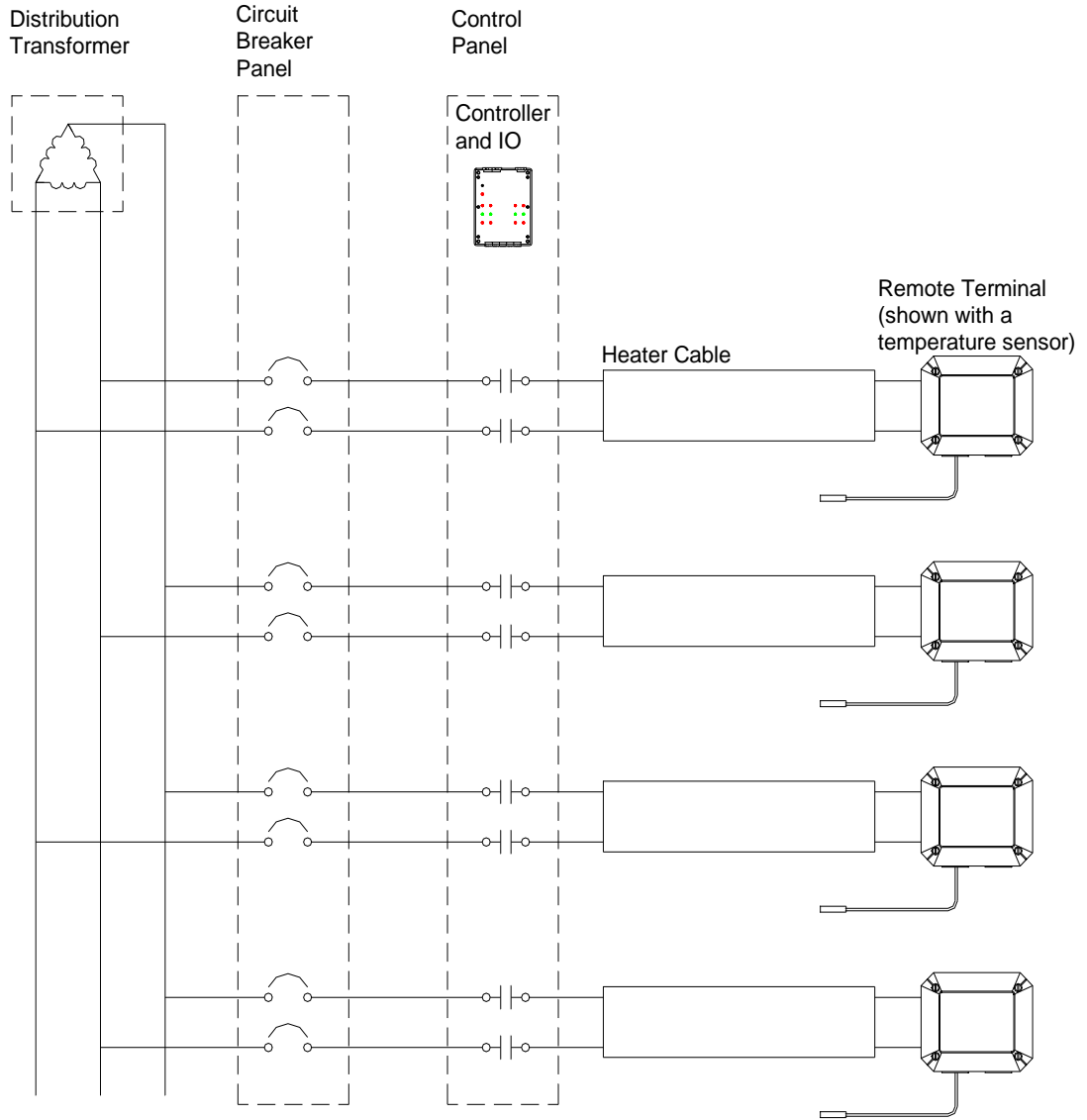


Figure 2. System Overview

### Communication Technology

The HCCM-2100 System uses spread-spectrum communication technology to provide noise and interference free operation over the power lines.

Temperature, sensor integrity, leak, and valve position information are sent digitally from remote terminals to a central monitor and control panel *over the heating cable and electrical distribution system wiring.*

INTECH 21 communication method eliminates filtering and isolation devices required by other systems, in electrically noisy applications found at Transit, Industrial, and large Commercial applications. The system operates on the same electrical network as other electrical and electronic devices without disturbance to those systems.

The HCCM-2100 System is designed to operate at voltages from 120V to 230V, single and three-phase power. The HCCM-2100 System is immune to voltage spikes and can withstand megger insulation tests of up to 5,000 Volts.

## System Architecture

The HCCM-2100 System can be configured as a star or bus network using heating cable and/or power wiring as the communication media as shown in Figure 4. The system is comprised of NC-2104 Network Controllers and RT-2104 Remote Terminals.

Each NC-2104 unit can simultaneously communicate with multiple remote terminals in order to monitor and control multiple heat-tracing circuits. Each sensor on the system represents an indication and control "zone" on the network controller.

Configured as a token ring network, multiple network controllers can be interconnected via power line, fiber-optic or twisted shielded cable to meet application requirements. Each remote terminal is uniquely addressed to a specific network controller. The system supports simultaneous communication between multiple network controllers their respective remote terminals.

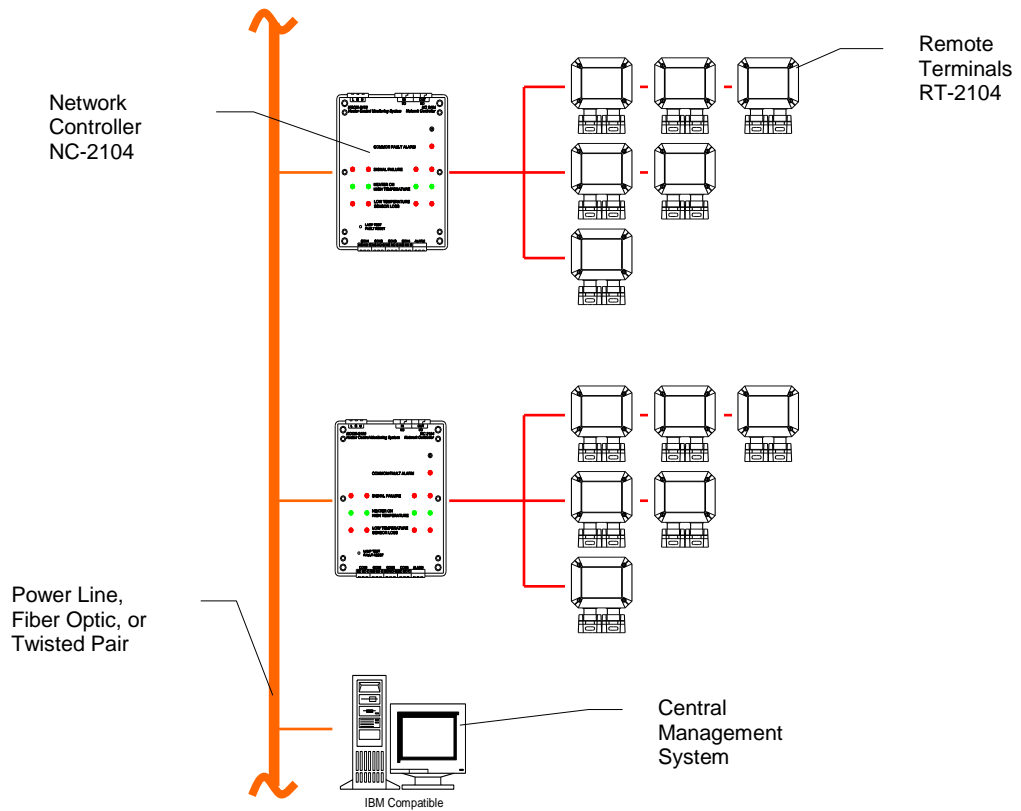


Figure 3. System Architecture

# Operation

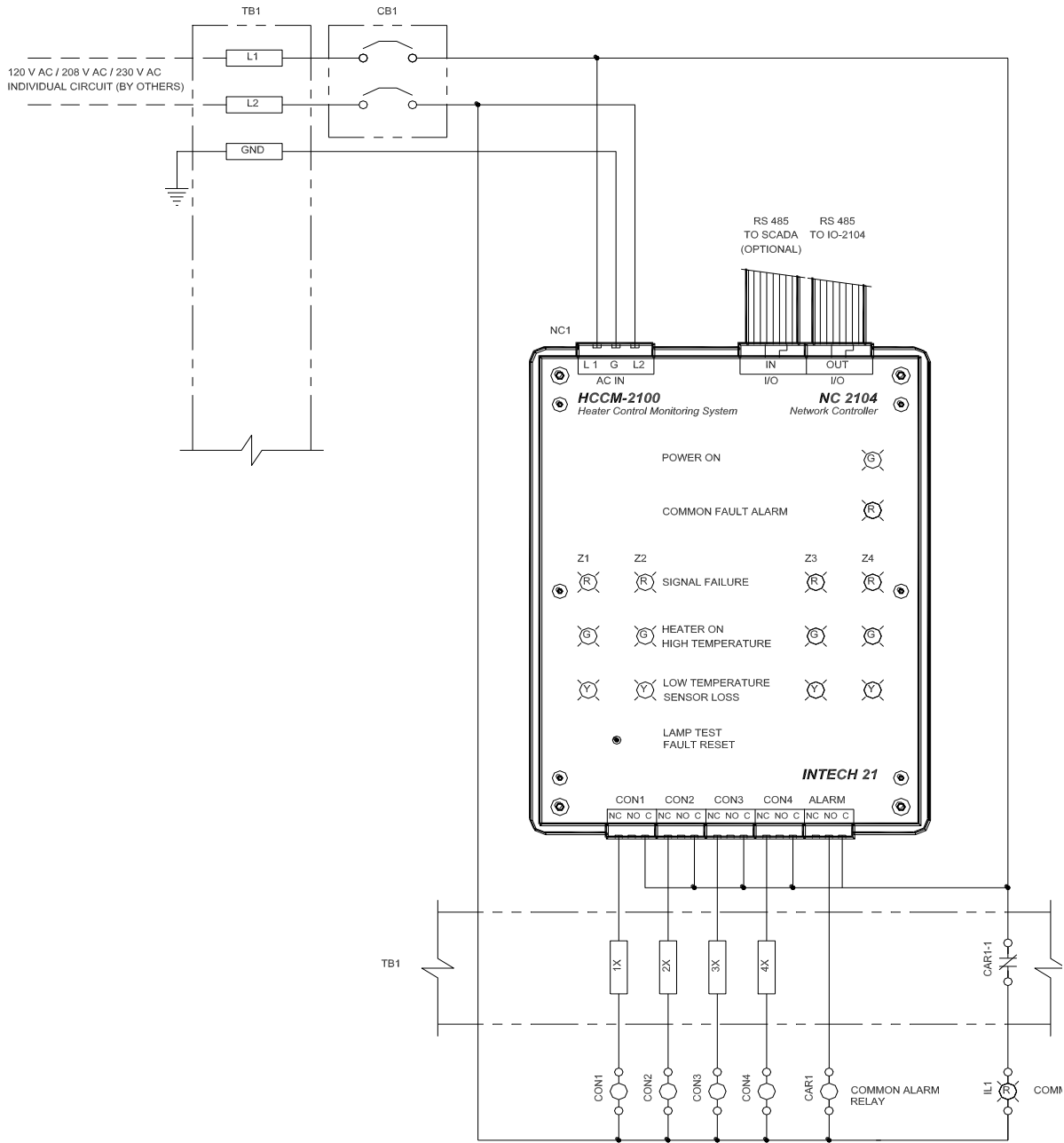


Figure 4. Typical Schematic

HCCM-2100 monitors individual process (i.e. pipe) temperatures at the end of each heating circuit where the available voltage to power the heater cable is lowest (due to voltage drop). For long or critical

pipelines it may be desired to monitor pipe temperatures at multiple locations along a pipe and the piping dead-legs. The integrity of each heating cable circuit including the heating cable, power wiring and all connections are independently monitored from every transmitter location.

HCCM-2100 monitors individual process (i.e. pipe) temperatures at the

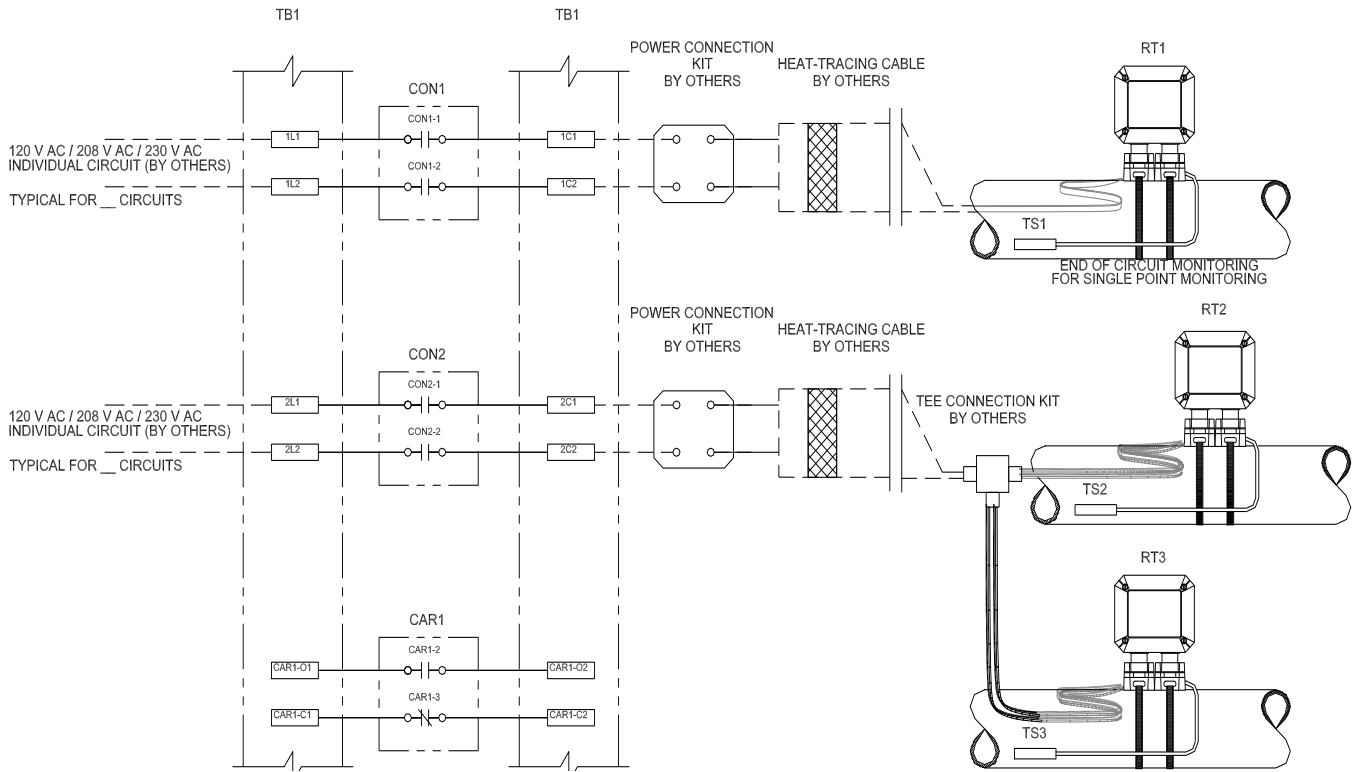


Figure 5. Typical Schematic (continued from previous page)

end of each heating circuit where the available voltage to power the heater cable is lowest (due to voltage drop). For long or critical pipelines it may be desired to monitor pipe temperatures at multiple locations along a pipe and the piping dead-legs. The integrity of each heating cable circuit including the heating cable, power wiring and all connections are independently monitored from every transmitter location.

The process temperature is monitored by the use of a resistive temperature sensor connected to a RT-2104 Remote Terminal. The RT-2104 continuously transmits the temperature values to the NC-2104 Network Control unit. Each sensor connected to the system represents one “zone” of indication and control in the NC-2104. The NC-2104 turns each individual heat-tracing circuit on or off, based on the temperature settings in order to maintain the control setpoint of each particular zone. A dedicated LED indicating the activation of each zone’s control relay is provided.



In addition to the control setpoint, each zone has a low and high temperature alarm setpoint. If this setpoint is reached, a discrete low temperature LED for that zone is illuminated, and an alarm relay is energized. The same LED provides indication of sensor failure or damage by blinking and energizing an alarm relay.

The HCCM-2100 system monitors the integrity for the entire system, cables, wiring and monitoring components, and includes comprehensive self-diagnostic routines to insure that all of the system components are operational. In the event of any alarm or component failure, the system will turn the heater on insuring fail-safe protection of the fluid piping. A dedicated LED for each zone indicates loss of communication due to either electronic, heater cable, or power wiring damage or failure.

In conventional heat-tracing systems where thermostats and indirect current sensing are used for monitoring and control, a failure of one of the system components may be undetected. The HCCM-2100 system remains active all year long, periodically checking the entire system operation even during periods where heat tracing is not required. HCCM-2100 will alarm and notify maintenance personnel of problems when they occur, long before the heating season begins.

### ***Timing Procedure***

Upon initiation the HCCM-2100 System stays energized for a maximum of five minutes to run self-diagnostics of the entire heat tracing system, including the heating cable, power wiring, field connections and splices, remote terminals, temperature sensors, and associated components of the control and monitoring system.

Following the first five minutes on, the system turns off for not less than five minutes. When the system turns back on the NC-2104 calculates the rate of temperature change and the length of time the system can be safely turned off.

The length of the off period is maximized automatically, based on the process temperature, control setpoint, and rate of the temperature change, but never exceeds three hours.

System Integration

Intech 21 provides industrial grade, UL approved HCCM-2100 components and systems for use on critical heat tracing applications.

Any alarm condition results in the zone being energized for continuous communication between associated RT-2104 and NC-2104 units until the condition is remedied.

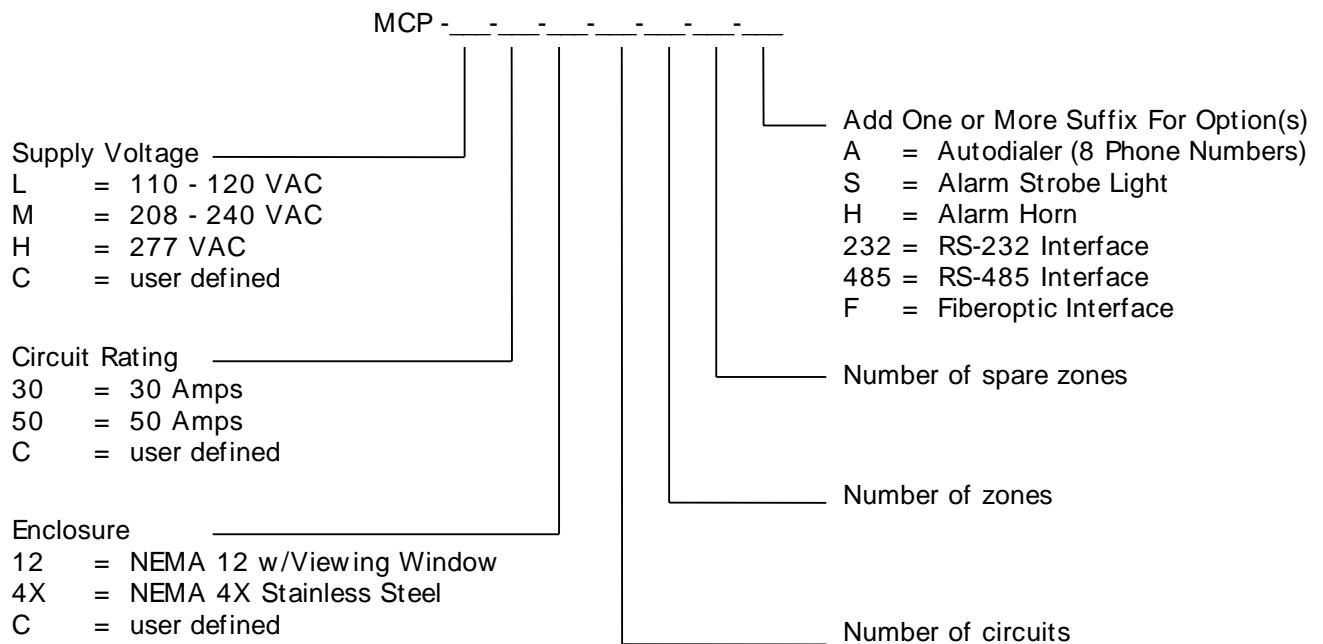


## System Selector

Standard Monitor and Control Panel (MCP) enclosures are rated NEMA 12 and include viewing window for LED's, and remote alarm contacts. NEMA 4X stainless steel enclosures, alarm strobe light, and/or alarm siren, and auto-dialer are available as standard MCP options.

Standard panels have the same number of heat trace control contactors as zones of temperature sensing.

**An RS-485 output is provided as standard for central system interface of all system operating parameters. RS-232 and fiber-optic interfaces are available as standard options.**

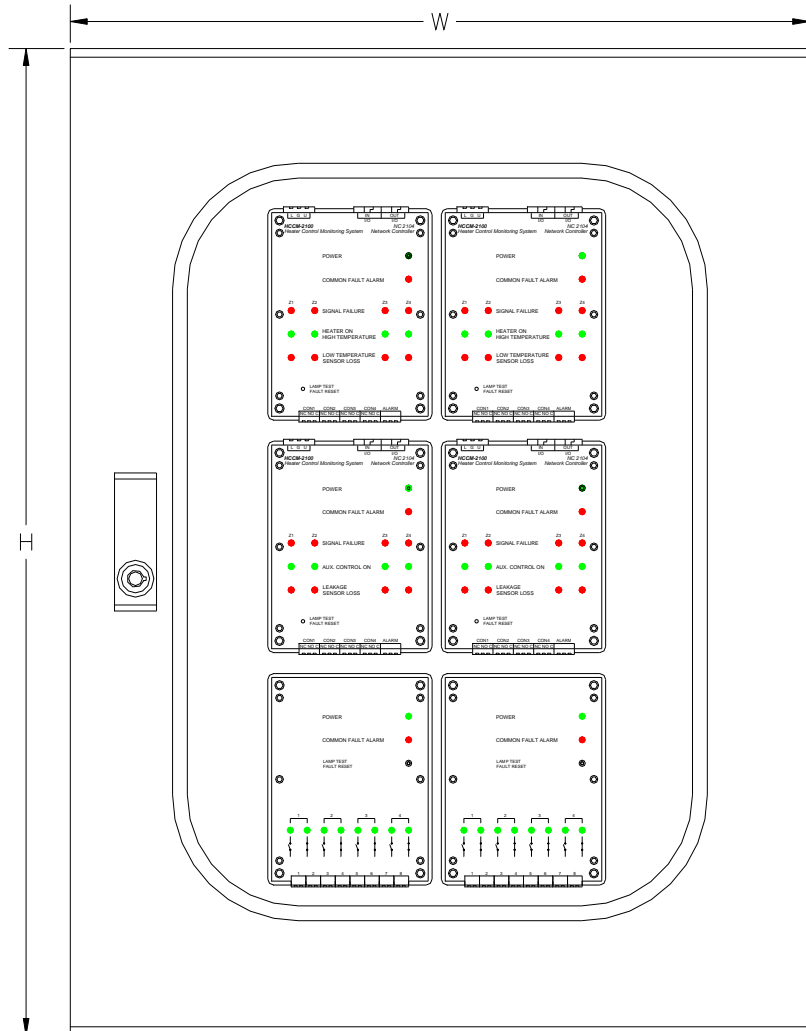


## System Components

*Control Systems are sized for specific number of zones and circuits.*

*Control System shown is an eighteen circuits, eighteen zones system. A dedicated contactor switches each heating circuit.*

*Control Systems are available in a variety of configurations to provide various enclosure options, branch circuit protection, audible annunciation, etc.*



### **MCP Monitoring and Control System**

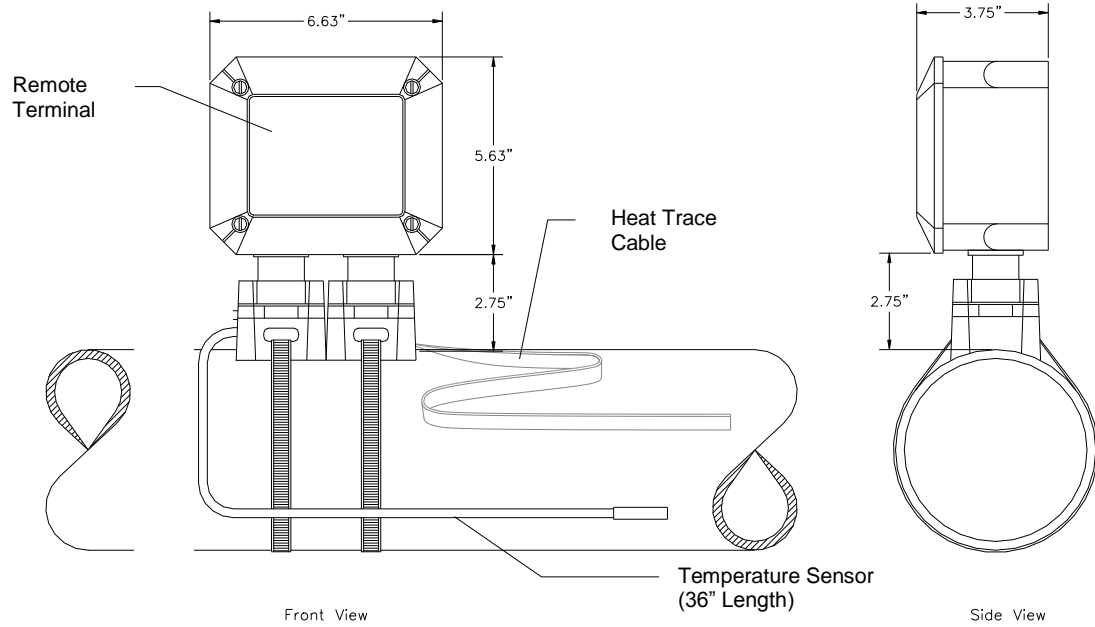
#### **Description**

The complete HCCM-2100 system control panel consists of enclosure, system circuit breaker, necessary NC-2104 and IO-2104 units, contactors, relays, and terminal blocks.

#### **Specifications**

Standard Enclosure: NEMA 12 (with viewing window), Optional Enclosure: NEMA 4X Stainless Steel  
 Standard Contactors: DP, 600 V AC max., 30 FLA, 50 FLA, @ 277 V AC  
 Standard Terminals: 30 A, 10 AWG.

**RT-2104 Remote Terminal**



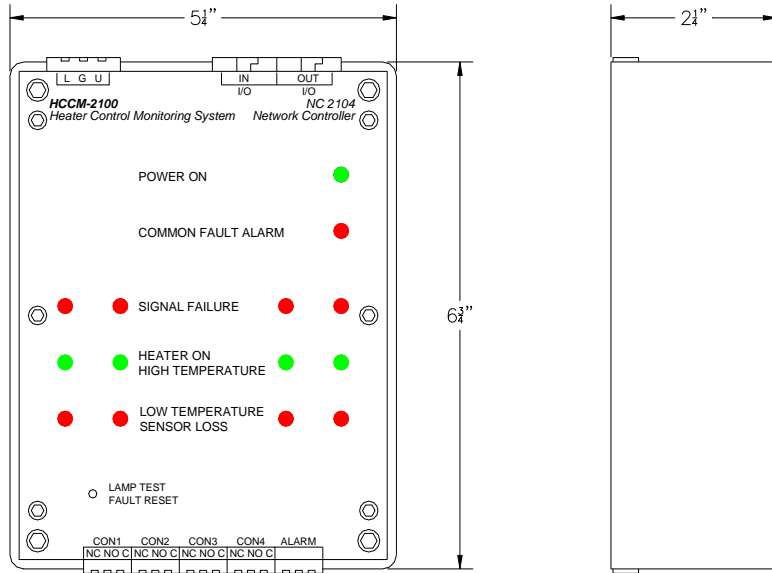
**Description**

The RT-2104 Remote communicates pipe temperature, and system integrity status to the NC-2104. The RT-2104 is connected to the heat trace cable with the cable manufacturer's UL/FM Approved splice kit. The RT-2104 Remote Terminals are provided in a NEMA-4X enclosure.

**Specifications**

Power Input:	5W
Input Power:	110/220-277 V AC, 50/60 Hz
Ambient:	-25°C to 55°C (-13°F to 131°F)
Storage:	-35°C to 85°C (-31°F to 185°F)
Humidity:	0% to 95% (Non-condensing)
Temp Sensor Input:	Resistive temperature sensor
Leakage Sensor:	Resistive conductivity sensor
Mounting:	Pipe or Wall
Approvals:	UL for US and Canada

**NC-2104 Network Controller**



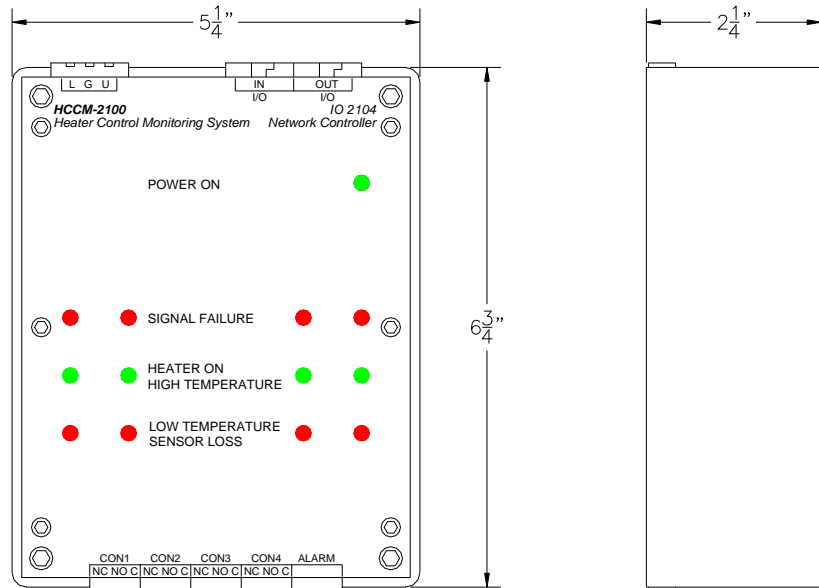
**Description**

The NC-2104 is a microprocessor-based network controller. Each Network Controller can monitor and control up to four heating circuits by itself, and up to thirty-two (32) heating circuits with addition of the IO-2104 Input/Output Modules.

**Specifications**

Power Input: 5W  
 Input Power: 110/220-277 V AC, 50/60 Hz  
 Ambient: -25°C to 55°C (-13°F to 131°F)  
 Storage: -35°C to 85°C (-31°F to 185°F)  
 Humidity: 0% to 95% (Non-condensing)  
 Control Output: (4) Dry SPDT, 10 A @ 250 V AC  
 Alarm Output: (1) Dry SPDT, 10 A @ 250 V AC  
 Approvals: UL for US and Canada

**IO-2104 Expansion Unit**



**Description**

The IO-2104 Expansion Units are microprocessor-based system expansion devices that allow up to 28 additional zones of monitoring and control to be added to the NC-2104.

**Specifications**

Power Input: 5W  
 Input Power: 110/220-277 V AC, 50/60 Hz  
 Ambient: -25°C to 55°C (-13°F to 131°F)  
 Storage: -35°C to 85°C (-31°F to 185°F)  
 Humidity: 0% to 95% (Non-condensing)  
 Control Output: (4) Dry SPDT, 10 A @ 250 V AC  
 Approvals: UL for US and Canada



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Engineering Specifications

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Customized CSI format engineering are available through your local INTECH 21 representative, and at our website [www.intech21.com](http://www.intech21.com).

The following sample specification can be used for reference.

**Scope**

Furnish and install \_\_\_ Heating Cable Control and Monitoring Systems (HCCM-2100™) as manufactured by Intech 21, Inc. Glen Cove, NY.

Each HCCM-2100™ System shall be provided to control and monitor \_\_\_ individual heating zones (total number of branches), and \_\_\_ individual heating circuits (total number of feeders).

**Standards and Codes**

Applicable sections of the following codes and standards shall apply to these specifications. The latest edition date of a code or standard in force at the time of installation shall apply.

Institute of Electrical and Electronics Engineers (IEEE)

National Electrical Manufacturers Association (NEMA)

National Electrical Code (NEC)

**System Function**

Each heater cable shall be individually controlled by an end of line temperature sensing device. The thermocouples or RTDs shall be located on each pipe at the furthest end of each heating circuit from the power connection point, and also at the intermediate locations, as shown on the Contract Drawings.

Failure of a temperature sensor shall be indicated at the system monitor panel identifying the heating circuit zone number, and also initiate the common alarm local indication and remote output.

Mechanical thermostats shall not be accepted as equal. Individual temperature controllers requiring additional wiring to the temperature sensors shall not be accepted as equal.

Each heater cable including all tees shall be directly monitored for continuity of all heater cable bus wires by use of an end of line remote terminal. Indirect cable monitoring by current and / or ground fault shall not be accepted as equal to the direct end of line bus wire continuity monitoring.

The addressable system shall be capable of identifying the continuity status of each leg individually. All monitoring and temperature sensing shall be provided without additional wiring other than power supply to the heater cable. The use of any additional noise filtering and / or isolation equipment for the system shall not be acceptable.

**Description of Operation**

The control system shall energize each heater cable when the pipe temperature drops to \_\_\_ degrees F. The system shall indicate an alarm condition when the pipe temperature drops to \_\_\_ degrees F with

the heater energized. The system shall de-energize the cable when the pipe temperature reaches \_\_\_ Deg F. The control system shall be fail-safe. A failure of the temperature sensor shall result in energizing the heater cable, and initiating the alarm.

All heat tracing shall be controlled by a common panel assembly, as indicated on contract drawing. Each heat-traced pipeline shall have a separate control group installed within a common enclosure. The monitor panel shall be a microprocessor based control system interfaced with the heater cable contactors. The use of the electromechanical components for the supervisory functions shall not be considered equal to the system specified.

The monitor panel shall be located as indicated on the Contract Drawings. The panel shall operate at \_\_\_ VAC. The enclosures shall be provided with a laminated system guide that shall define which monitor channel refers to each pipe location.

Upon initiation the system shall stay energized for a maximum of five minutes to run self-diagnostic of the entire heat tracing system, including the heating cable, power wiring, field connections and splices, end of line remote terminals, temperature sensors, and associated components of the control and monitoring system. Based on the temperature of the pipe, the system shall determine the rate of the temperature drop, and initiate temperature monitoring procedure to energize the cable at the temperature set point. The timing of the monitoring procedure shall be self-adjustable between, and shall automatically vary based on the pipe temperature.

### ***System Indicators and Alarms***

The system shall be capable of monitoring the cable integrity and temperature of the pipe, and perform self-diagnostics over 24-hour period, throughout the entire year. The cable integrity checking shall provide for energy conserving operation of the heating cable.

Each panel shall have LED indication for:

- AC Power on.
- Common alarm. (System Fault)

Each heater cable or branch shall have discrete LED indication of:

- Continuity status.
- Continuity fault.
- Ground fault
- Heater on.
- Temperature Sensor Status.
- Low temperature.
- Temperature sensor failure.

The system shall provide common alarm NEMA 4X (red) alarm light on the face of the control enclosure and dry contact output to the central

management system. The system shall have provisions for future communication interface.

### ***Sequence of Ground Fault Detection***

a) Ground Fault shall be detected when more than 200mA AC current is leaking to ground for more than 300 msec. When Ground Fault is detected in the circuit the circuit contactor shall be turned OFF for 10sec and the alarm indicator light for the circuit shall be ON. But no common alarm and alarm signal to the digitizer shall be generated at this stage. The circuit shall be turned back ON after 10 sec.

b) When the circuit is turned back on for the first time, after the first ground fault detection and there is no subsequent ground fault detected, the system shall return to normal operation. If ground fault is detected again for the second time, the circuit contactor shall be turned OFF for 10sec. The alarm indicator light for the circuit shall be ON. But no common alarm and alarm signal to the digitizer shall be generated at this stage. The circuit shall be turned back ON after 10sec.

c) When the circuit is turned back on for the second time, after the second ground fault detection and no ground fault is detected again, the system shall return to normal operation. If ground fault is detected again for the second time, the circuit contactor shall be turned OFF for 10sec. The alarm indicator light for the circuit shall be ON. But no common alarm and alarm signal to the digitizer shall be generated at this stage. The circuit shall be turned back ON after 10sec.

d) When the circuit is turned back on for the third time, after the third ground fault detection and no ground fault is detected again, the system shall return to normal operation. If ground fault is detected again for the third time, the circuit contactor shall be turned OFF permanently (or until reset) and Common Alarm signal for the panel shall be on and alarm signal (contact closure) shall be generated to the digitizer.

e) After eliminating the cause of the circuit leakage current to ground a reset signal shall be applied to the system and the system shall return to normal operation.

### ***Control Panel***

All enclosures shall be NEMA type \_\_\_ with back panel, reversible hinge and latchless access. The enclosure shall have a laminated as-built wiring diagram furnished and installed by the Contractor. The enclosure shall be grounded to the nearest structural steel.

The terminal blocks shall have a \_\_\_ Amps ratings and hardware for panel mounting. Jumpers shall be provided where required. No. \_\_\_ wire shall be used for circuit interconnections and shall be provided with suitable identification.

Contactors shall be rated for \_\_\_ A inductive load, as indicated on contract drawing.

### ***Field Tests***

Wiring shall be installed so that when completed, the system will be free from shorts, crosses or grounds. All electrical feeders and other wire and cable prior to being connected as requested by the Engineer shall be subject to an insulation resistance test using a "megger" with

the D.C. voltages indicated below applied between the connected system and ground. The monitored heating cable circuits shall be tested with the remote terminal units connected during the insulation resistance tests using a “megger” at 2500 Volts DC.

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*All of the above information, including illustrations, is believed to be reliable. Users, however, should independently evaluate the suitability of each product for their application. INTECH 21 makes no warranties as to the accuracy or completeness of the information, and disclaims any liability regarding its use. The INTECH 21 only obligations are those in the Standard Terms and Conditions of Sale for this product, and in no case will INTECH 21 be liable for any incidental, indirect, or consequential damages arising from the sale, resale, use, or misuse of the product. Specifications are subject to change without notice. In addition, INTECH 21 reserves the right to make changes in materials or processing without notice.*

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# Troubleshooting and Maintenance Manual

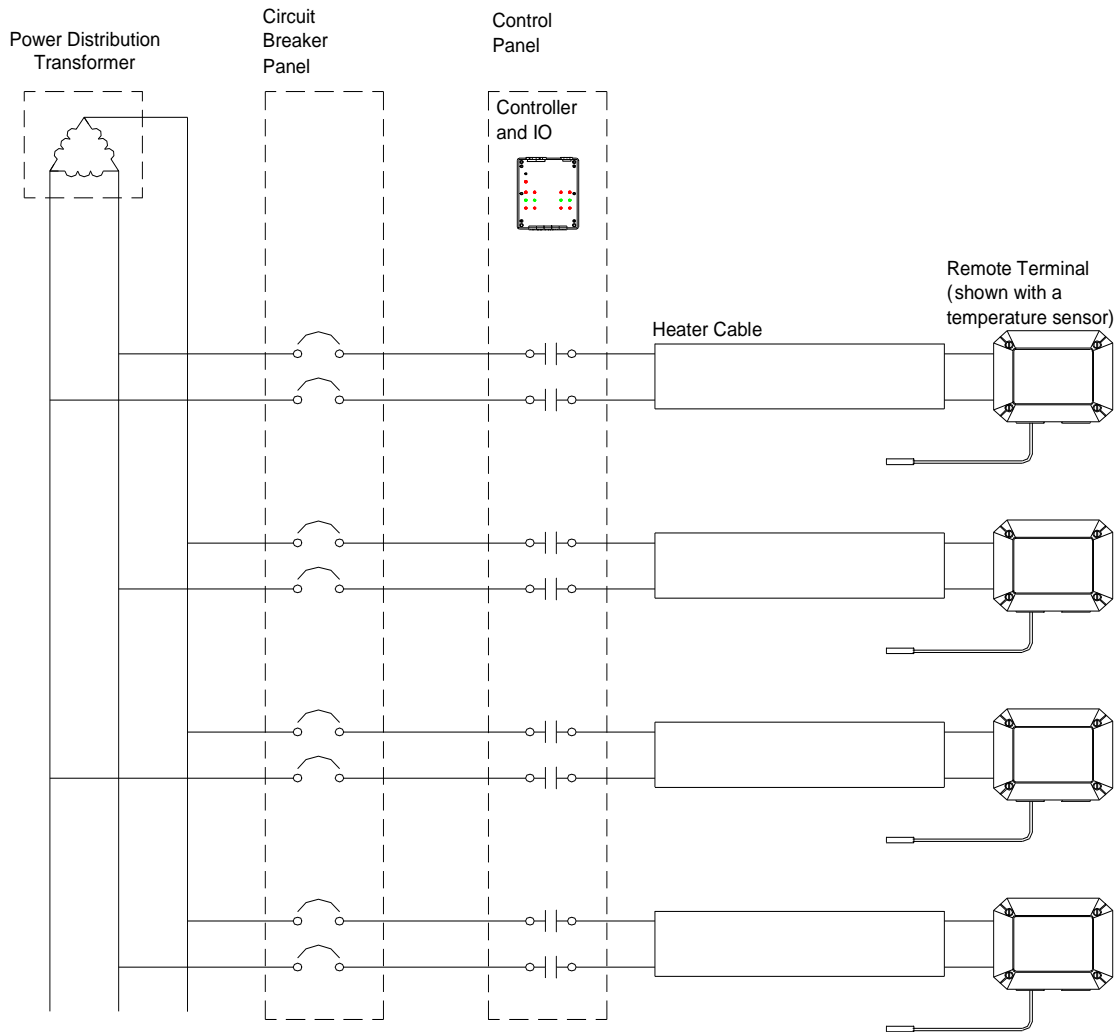
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## Overview

### Introduction to HCCM-2100

HCCM-2100, Heating Cable Control and Monitoring System utilizes electrical heat tracing as a platform to provide comprehensive protection and early warning of failure and vandalism for critical piping applications. HCCM-2100 utilizes power line communication to provide full monitoring and control functions without dedicated communication wiring. A simplified diagram of a typical three wire HCCM-2100 system is shown below.



## Installation

### ***Unpacking the Components***

A typical HCCM-2100 consists of Remote Terminals and a Local Control Panel. Remote Terminals and Local Control Panel are shipped in individual cartons.

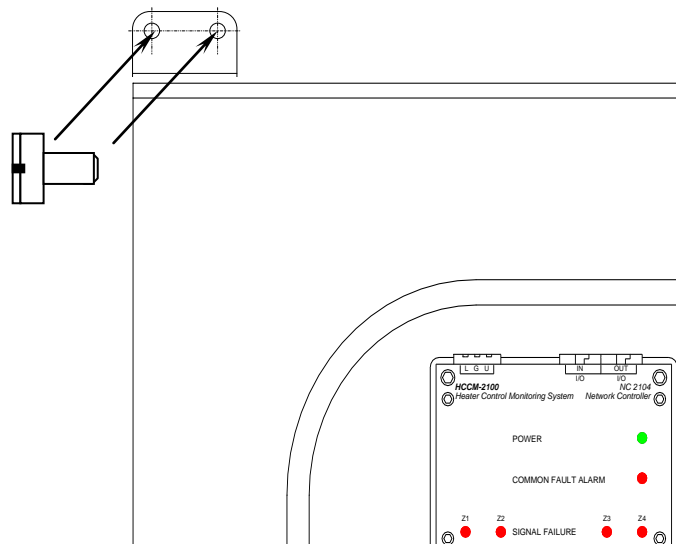
The Local Control Panel includes Network Controller(s); Input/Output Module(s) for systems larger than four zones; and associated power switching relays and contactors. The Local Control Panel carton contains the panel itself, wiring diagram, and is identified by a specific project name and addressing markings.

Inspect the shipping materials carefully for any signs of damage, and notify the shipping carrier if you find any signs of improper handling.

Remove Local Control Panel and Remote Terminals from their packing and carefully inspect all of the components. Report any damage to the shipping carrier.

### ***Local Control Panel Installation***

Install Local Control Panel on a wall using screws (see illustration below) rated for the weight indicated on the packing slip.



### ***Wiring the Local Control Panel***

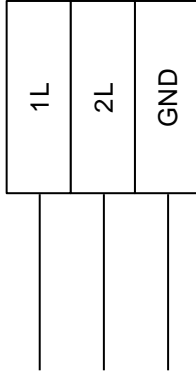
Comply with the National Electrical Code and local code requirements.

Disconnect and lock out all power circuits before working on the panel.

Use bottom of the Local Control Panel to bring the conduits and wiring from circuit breaker power panel, and to individual heater circuits.

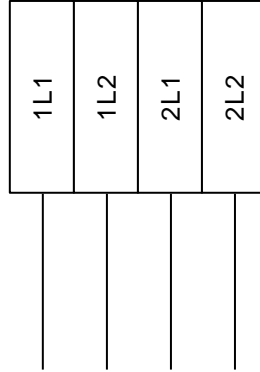
### Local Control Panel Terminal Block

The following terminal block designations are standard on all HCCM-2100 systems. Also, refer to individual wiring diagram supplied with the panel.



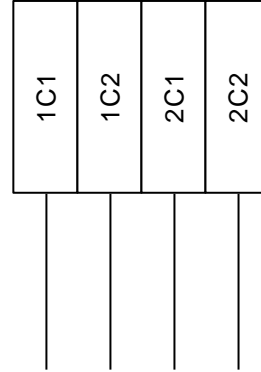
From Individual Control Logic Circuit Breaker  
1. See supplied wiring diagram for circuit breaker size

- 120V
  - 1L Hot
  - 2L Neutral
  - GND Ground
- 208 -230 V
  - 1L Hot 1
  - 2L Hot 2
  - GND Ground
- 277 V
  - 1L Hot 1
  - 2L Neutral
  - GND Ground



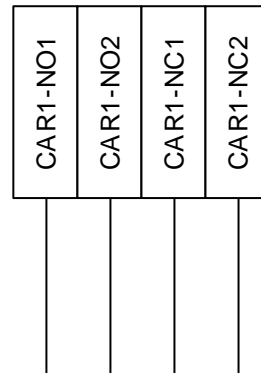
From Individual Heater Cable Circuit Breakers  
1. See supplied wiring diagram for circuit breaker size)  
2. 1L\_ - circuit 1; 2L\_ - circuit 2, etc.)

- 120V
  - \_L1 Hot
  - \_L2 Neutral
- 208 -230 V
  - \_L1 Hot 1
  - \_L2 Hot 2
- 277 V
  - \_L1 Hot
  - \_L2 Neutral



To Individual Heater Circuits  
1. 1C\_ - circuit 1;  
2C\_ - circuit 2, etc.)

- 120V
  - \_C1 Hot
  - \_C2 Neutral
- 208 -230 V
  - \_C1 Hot 1
  - \_C2 Hot 2
- 277 V
  - \_C1 Hot
  - \_C2 Neutral



Common Alarm Relay Output

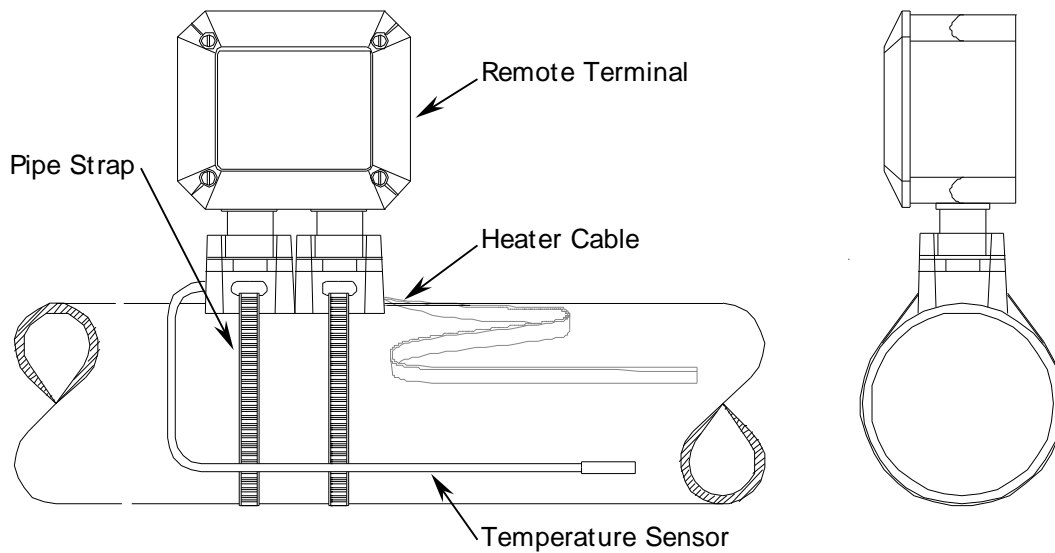
- Normally Open Dry Contact  
CAR1-NO1; CAR1-NO2
- Normally Closed Dry Contact  
CAR1-NC1; CAR1-NC2



### **Remote Terminal Installation**

Remote Terminals can be provided in a variety of enclosures. Installation detail below represents a typical mounting of a Remote Terminal. Remote Terminals are supplied with a three-foot length of a make and model heater cable used in the installation. Refer to the heater cable manufacturer instructions on heater cable splicing.

1. Disconnect and lock out all power circuits before working on the Remote Terminals.
2. Install Temperature Sensor on the lower part of the pipe, horizontally opposing the heater cable. Thoroughly clean a small spot on the pipe. Use heat conductive cement to affix the temperature sensor to the pipe.



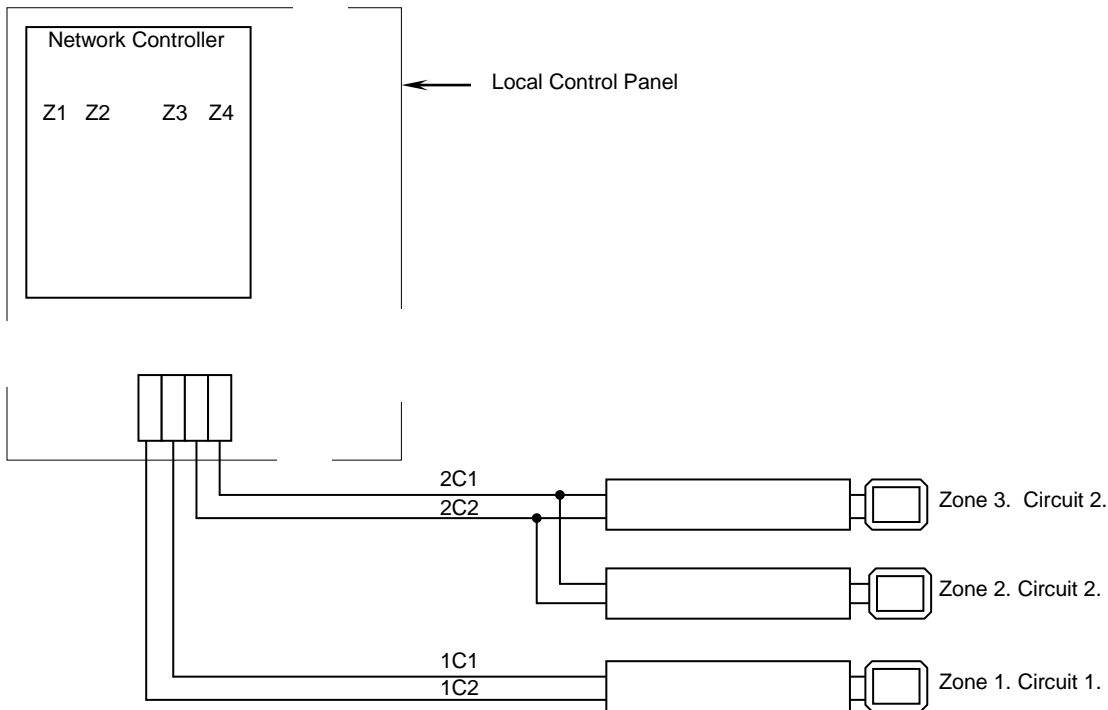
## HCCM-2100 Addressing Procedure

### General

The Local Control Panel is supplied with Network Controller(s) and Input/Output Module(s) already addressed. The identification on the panel indicates the Network Controller (NC) ID.

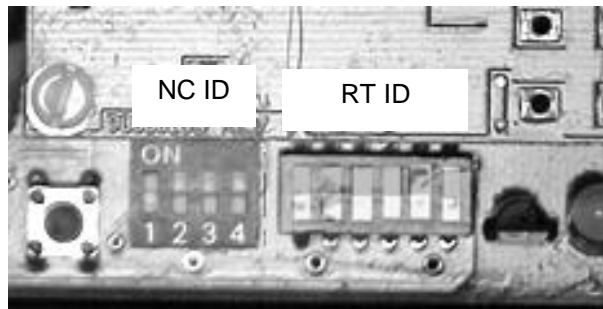
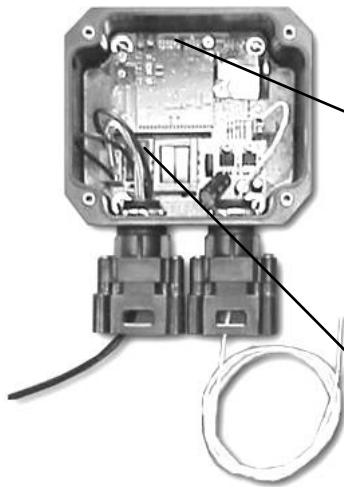
Remote Terminals are addressed after the installation.

1. Install all the Remote Terminals as described earlier in this manual.
2. Mark the ends of the heat tracing cable circuits as they are connected to the Local Control Panel. For example, heat tracing cable circuit connected to 1C1 and 1C2 is marked "Circuit 1", heat tracing cable circuit connected to 2C1 and 2C2 is marked "Circuit 2", and so on.
3. In the event of branched heat tracing cable circuits, identify all Remote Terminals connected to the same circuit with the same circuit number.
4. Identify Remote Terminals by Zone numbers, corresponding to the zone numbers in the Local Control Panel, whether they are installed on branched or individual heat tracing cable circuits.



### **Addressing Procedure**

1. Disconnect and lock out all power circuits before working on the Remote Terminals.
2. Note the Network Controller (NC) ID identified on the Local Control Panel.
3. Remove the Remote Terminal cover to expose the printed circuit board and the addressing dip switches.
4. Set the NC ID dip switch as indicated noted from the Local Control Panel.
5. Set the Remote Terminal dip switch as per Zone markings made earlier (see Table 2).
6. Set the Voltage Selector Switch to proper voltage (115V or 230V). For 208, 230 and 277V systems use 230V setting.
7. Close the cover and tighten the screws on the Remote Terminal.
8. Mark the weatherproof label (provided on the Remote Terminal cover) as per settings made with permanent marker.



Network Controller and Remote Terminal ID dip switches



Voltage Selector Switch

### Dip Switch Addressing

Table 1. Network Controller (NC) ID.



Dip Switch Position				NC ID
Pos1	Pos2	Pos3	Pos4	
down	down	down	down	0
up	down	down	down	1
down	up	down	down	2
up	up	down	down	3
down	down	up	down	4
up	down	up	down	5
down	up	up	down	6
up	up	up	down	7
down	down	down	up	8
up	down	down	up	9
down	up	down	up	10
up	up	down	up	11
down	down	up	up	12
up	down	up	up	13
down	up	up	up	14
up	up	up	up	15

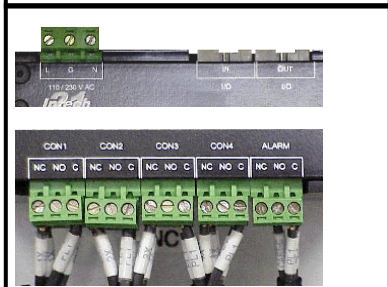
Table 2. Remote Terminal (RT) ID.



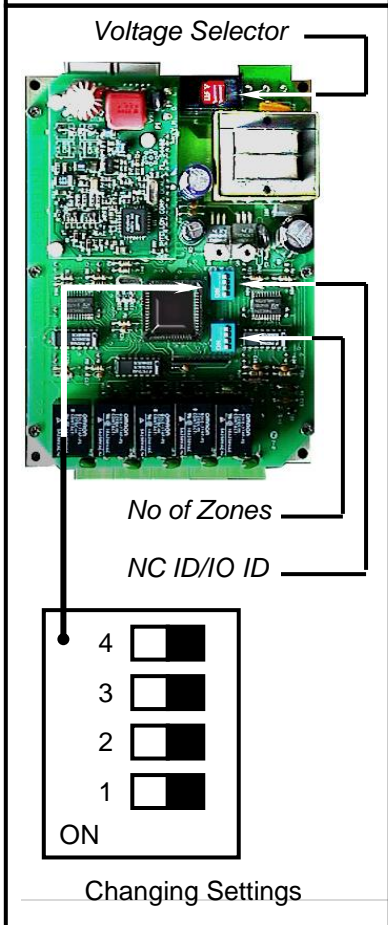
Dip Switch Position				RT ID	Zone No.
Pos1	Pos2	Pos3	Pos4		
down	down	down	down	0	1
down	up	down	down	1	2
down	down	up	down	2	3
down	up	up	down	3	4
down	down	down	up	4	5
down	up	down	up	5	6
down	down	up	up	6	7
down	up	up	up	7	8
up	down	down	down	8	9
up	up	down	down	9	10
up	down	up	down	10	11
up	up	up	down	11	12
up	down	down	up	12	13
up	up	down	up	13	14
up	down	up	up	14	15
up	up	up	up	15	16



Removing the Faceplate



Removing Wiring



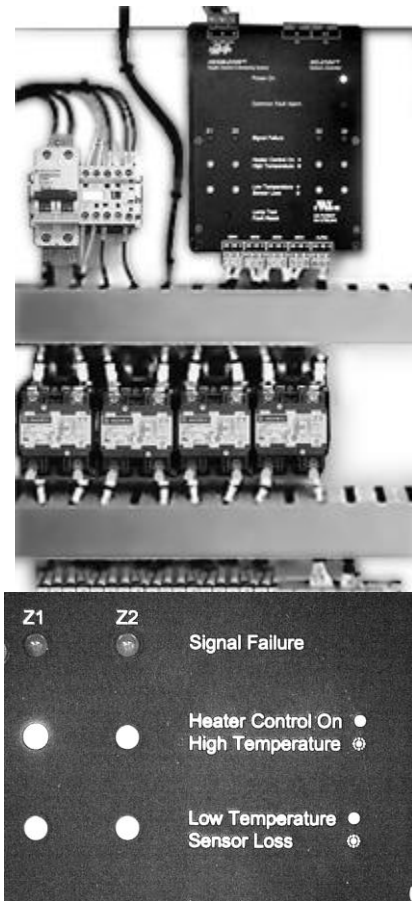
Changing Settings

### Adding Zones

1. Disconnect and lock out all power circuits before working on the Local Control Panel components.
2. Install and properly address additional Remote Terminal(s) as per instructions, and Tables 1 and 2.

NC-2104 Network Controllers and IO-2104 Input / Output Modules contain dip switches for setting up the number of zones (Remote Terminal addresses) that will be monitored. When the Local Control Panel is ordered with spare zone(s) capability, the necessary Network Controller(s), Input Output Module(s) and associated switching contactors are furnished pre-wired to handle these spare zones. The Network Controller(s) and Input Output Module(s) are preset at the factory to handle the actual number of zones (Remote Terminals) that are furnished with the specific order. Monitored zones are marked on a Network Controller as Z1 through Z4; and on Input Output Modules as Z5 through Z8, Z9 through Z12, etc.

3. Determine the appropriate Network Controller or Input Output Module, which will indicate and control additional zone(s).
4. Disconnect all wiring connections by unplugging the Network Controller or Input Output Module terminals, and remove the faceplate and the printed circuit board.
5. Remove the appropriate Network Controller's or Input Output Module's faceplate and the printed circuit board by removing four corner screws.
6. The "No of Zones" dip switch has 4 positions. Each position represents an active zone. Place appropriate dip switch position(s) into ON state to activate additional zone(s).
7. Place the faceplate and the circuit board back. Fasten the four corner screws.
8. Reconnect all wiring connections by plugging the Network Controller or Input Output Module terminals back into original places.



## Operation

Check heater cable insulation integrity using megger as per heater cable manufacturer recommendations prior to energizing the Local Control Panel.

### ***Energizing the Local Control Panel***

1. Turn the Control Logic Circuit Breaker on. The Network Controller and Input / Output Modules (if any) green Power On Light(s) will illuminate.
2. Wait 10 seconds for Network Controller to initialize.
3. Red Signal Failure Lights will illuminate to indicate no communications between Network Controller and Remote Terminals.
4. Turn, one by one, individual heat tracing cable circuit's breakers on. The Signal Failure Alarms for each zone should disappear, as the circuit breakers for these zones are turned on.
5. If the system is turned on during extreme cold weather, amber Low Temperature Lights will illuminate. As the heater cable warms up the pipe, the Low Temperature Alarm should disappear.
6. The Low Temperature Alarm is doubled with Sensor Loss (temperature sensor) Alarm. If the temperature sensor is not connected to the Remote Terminal, Sensor Loss Light will blink rapidly.
7. Green Heater Control On Light is doubled with High Temperature Alarm (if set at factory per customer specifications). Should the high temperature alarm set point be reached, the High Temperature Alarm Light will blink rapidly.

## Troubleshooting

The common alarm is initiated during any monitored alarm condition.

Each monitored zone has identical alarms and indicators. Any of the above alarms will result in turning the heater cable on, providing a fail-safe operation. The alarms and indicators definition and description for each zone is as follows:

Indicator	Color / Mode	Applies to	Function
Power On	Green / Steady	NC-2100 IO-2100	Unit is powered.
Common Alarm	Red / Steady	NC-2100	Any alarm(s), for any zone is indicated. Remote alarm contacts (SPDT) change state.
Signal Failure	Red / Steady	NC-2100 IO-2100	<ol style="list-style-type: none"> <li>1. Power to the zone has been turned off externally.</li> <li>2. Heating Cable failed.</li> <li>3. Remote Terminal RT-2100 failed or has been damaged.</li> <li>4. Power feed (cable and/or connections) have been damaged.</li> <li>5. Contactor contacts or coil failure.</li> </ol>
Heater On	Green / Steady	NC-2100 IO-2100	Heating cable is powered.
High Temperature	Green/ Blinking	NC-2100 IO-2100	<p>High Temperature Set Point has been reached. Possible causes:</p> <ol style="list-style-type: none"> <li>1. Heating cable is oversized for the application.</li> <li>2. Liquid temperature in the pipe is higher then the design criteria.</li> </ol>
Low Temperature	Amber / Steady	NC-2100 IO-2100	<p>Heating cable is powered and monitored temperature dropped to the low temperature alarm setpoint. Possible causes:</p> <ol style="list-style-type: none"> <li>1. Insulation on the pipe or heated vessel has failed.</li> <li>2. Heating cable is off the pipe or heated vessel.</li> <li>3. Temperature sensor is not attached.</li> <li>4. Insufficient heater cable output for operating parameters, pipe and insulation size.</li> </ol>
Sensor Loss	Amber / Blinking	NC-2100 IO-2100	Resistive temperature detector connected to the Remote Terminal RT-2100 has failed or has been damaged.
Lamp Test Fault Reset	Button	NC-2100	Tests all indicators and resets the Network Controller's NC-2100 temperature control cycle.