NGC-40 Bridge

Modbus Overview

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1. NGC-40 Overview

This document will describe the connections and procedures necessary to communicate with the nVent RAYCHEM NGC-40-BRIDGE via Modbus. Detailed information about each Modbus register for the nVent RAYCHEM NGC-40-BRIDGE, NGC-40-HTC, NGC-40-HTC3, NGC-40-IO and NGC-40-SAFETY LIMITER (**hereafter referred to as BRIDGE, HTC, HTC3, IO and LIMITER respectively**) and referred to as CAN Devices collectively.

The nVent RAYCHEM NGC-40 is a multipoint electronic control, monitoring and power distribution system with a unique single-point controller architecture for heat-tracing used in process temperature maintenance and freeze protection applications. By taking advantage of innovative modular packaging techniques, the RAYCHEM NGC-40 system provides configuration and component flexibility so that it may be optimized for a customer's specific needs.

The RAYCHEM NGC-40 uses a single control module per heat-tracing circuit for maximum reliability. The RAYCHEM NGC-40 control system can be powered between 100 to 240 Vac, while Electro-Mechanical Relays (EMRs) or Solid-State Relays (SSRs) allow circuit switching up to 60 A at 600 Vac with single- or three-phase power.

The RAYCHEM NGC-40 control modules include ground-fault detection and protection and eliminate the need for external GF circuit breakers, thus reducing the overall cost of the Heat Management System. The control modules also guarantee precise single phase and three-phase line current measurements.
Up to eight (8) Resistance Temperature Detectors (RTDs) can be used for each heat-tracing circuit allowing a variety of temperature control, monitoring, and alarming configurations.

The NGC-40 System accommodates RTD inputs from a variety of sources. In addition to hardwiring an RTD directly into a Heat Trace Control module, RTDs can be wired to Input/Output modules
(IO Module) within the panel or Remote Monitoring Modules (RMM2*) in the field and assigned to heat tracing circuits through software. This means that a RAYCHEM NGC- 40 system can be optimized for the specific needs of an application or customer. Each IO module accepts up to four additional RTD inputs. Each RMM2* module installed in the field can accept up to 8 RTDs. 16 RMM2* Modules can be daisy
chained together via RS-485 for a total of 128 (8x16) RTDs. Since multiple RMM2*s can be networked over a single cable to the RAYCHEM NGC-40, the cost of RTD field wiring will be significantly reduced.
The RAYCHEM NGC-40 system supports multiple communications ports, allowing serial interfaces (RS-485 and RS-232) and network connections (Ethernet) to be used with external devices. All communications with the NGC-40 panel are accomplished through the NGC-40-BRIDGE module which
acts as the central router for the system, connecting the panel's control modules, IO modules, nVent RAYCHEM Touch 1500 touch screen and Remote Monitoring Modules (RMM2*), as well as upstream devices. Communications to devices external to the NGC- 40 panel are done using the Modbus® protocol over Ethernet, RS-485 or RS-232. The RAYCHEM NGC-40 system provides both alarm outputs and digital inputs. The alarm output can be used to control an external annunciator. The digital input is programmable and may be used for various functions such as forcing outputs on and off or generating alarms, making the system more flexible to match each customer's specific needs. Systems can be configured for nonhazardous and hazardous locations.

NGC-40-BRIDGE

The NGC-40-BRIDGE module provides the interface between a panel's internal CAN-based network and upstream devices. Multiple communications ports are supported, allowing serial and Ethernet connections to be used with external devices.

NGC-40-HTC / NGC-40-HTC3

The NGC-40-HTC (for single-phase heaters) and NGC-40-HTC3 (for 3-phase heaters) modules are used to control either a solid-state relay or contactor within the NGC-40 control and monitoring system. This module also has one alarm output and one digital input. The alarm output can be used to control an external annunciator. The digital input is programmable and may be used for various functions such as forcing outputs on and off. Other features of this module include ground-fault and line current sensing for both HTC and HTC3. The front panel of the HTC module has LED indicators for various status conditions. The front panel also provides a ground-fault and heater test button.

NGC-40-IO

The NGC-40-IO provides up to four additional RTD inputs. These additional RTD inputs can be assigned to any NGC-40-HTC/HTC3. The NGC-40-IO also has one digital input and one alarm relay; each is programmable.

NGC-40-SAFETY TEMPERATURE LIMITER

The NGC-40-SLIM module is used as safety temperature limiter within the NGC-40 control and monitoring system. The module has one output for the contactor, one alarm output and one digital input. The alarm output can be used to control an external annunciator. The digital input can be used for resetting the limiter remotely. The module has 3 temperature inputs which can be used all in case of a three phase heat-tracing system. The limiter is equipped as smart limiter where the current measurements are done in the associated controller. The front panel of the SLIM module has LED indicators for various status conditions. The front panel also provides “Set Config”, “Trip Reset” and “Alarm Reset” buttons.

1.1 Example NGC-40 System

Some sections of this document that describe specific registers and how to read data for individual NGC-40 controllers will use the Example NGC-40 System as shown below. The numbers below the controllers are the individual CAN ID.

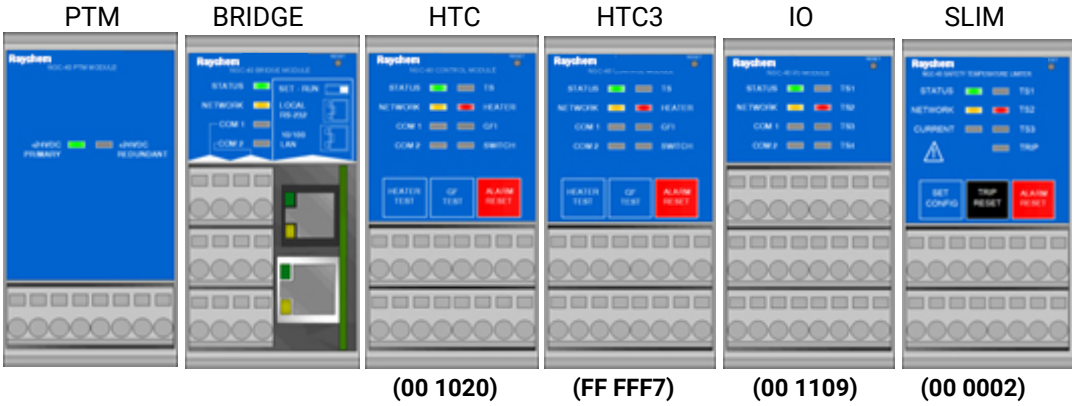

Figure 1 - Sample NGC-40 System

2. Legal

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3. Modbus Protocols

The NGC-40-BRIDGE uses the Modbus protocol on all communication ports. Modbus is a serial communications protocol published by Modicon in 1979, and is used to establish Master-Slave communication between intelligent devices. It is widely used for industrial applications, and has become the de facto industry standard.

For a detailed description of the Modbus protocol refer Modbus.org website.

http://www.modbus.org/

MODBUS Protocol Specification
http://www.modbus.org/docs/Modbus_Application_Protocol_V1_1b.pdf

MODBUS TCP/IP
http://www.modbus.org/docs/Modbus_Messaging_Implementation_Guide_V1_0b.pdf

3.1 Data Addresses

Data addresses in Modbus messages are referenced to zero. The first register will be address “0”.

The NGC-40 Modbus Maps also use zero referenced addresses, so the number given to the left of a register is the same address used to access it.

IMPORTANT: *Some programs used to communicate via Modbus protocols, such as ModScan32, do not use zero referenced addressing. In these cases the user must add a 1 to the Modbus Address. Care must be taken to ensure the correct addressing is being used.*

3.2 Modbus Functions

The following Modbus functions are supported by the BRIDGE:

Data Type Reference	Data Type	Comments
1	Read Coil Status	Reads the ON/OFF status of discrete outputs in the slave.
2	Read Input Status	Reads the ON/OFF status of discrete inputs in the slave.
3	Read Holding Registers	Reads the binary contents of holding registers in the slave.
4	Read Input Registers	Reads the binary contents of input registers in the slave.
5	Force Single Coil	Forces a single coil to either ON or OFF.
6	Preset Single Register	Presets a value into a single holding register
15	Force Multiple Coils (Outputs)	Forces each coil in a sequence of coils to either ON or OFF.
16	Preset Multiple Registers	Presets values into a sequence of holding registers.

3.3 Group writes

Some sections of the NGC-40 Modbus Map are restricted to group writes only (Function 16 – Preset Multiple Registers). This is done to avoid conflicting settings or to restrict access to safety-sensitive areas of the Modbus Map. Registers that must be written as a group are designated with a grey field as shown below:

HTC3 Temperature Source Setup

Modbus Address	Function Code	Description	Comments	Default
80	3,6,16	Temperature Source 1 Mode	Unsigned integer 0 = Not Used 1 = Local 2 = Remote 3 = CAN Network	1=Local
81	3,6,16	Temperature Source 1 Local Setup	Unsigned integer Temperature Input Number (1 = first sensor)	1
82	3,6,16	Temperature Source 1 Local Setup	Unsigned integer Not Used - Must write 0.	0
83	3,6,16	Temperature Source 1 Local Setup	Unsigned integer Not Used - Must write 0.	0
84	3,6,16	Temperature Source 1 Remote Setup Gateway Modbus Address / Gateway Port Number	Unsigned integer MSB = Gateway Modbus Address - Range : 1 to 247 LSB = Gateway Port Number that RMM is connected to - Range : 1 to 4	MSB = 0, LSB = 0
85	3,6,16	Temperature Source 1 Remote Setup RMM Modbus Address / RMM Input Number	Unsigned integer MSB = RMM Modbus Address - Range : 1 to 247 LSB = RMM Input Number - Range : 1 to 8	MSB = 0, LSB = 0
86	3,6,16	Temperature Source 1 Remote Setup	Unsigned integer Not Used - Must write 0.	0
87	3,6,16	Temperature Source 1 CAN Network Setup CAN Network Device ID (MSW)	Unsigned integer CAN Device ID	0
88	3,6,16	Temperature Source 1 CAN Network Setup CAN Network Device ID (LSW)		
89	3,6,16	Temperature Source 1 CAN Network Setup Temperature Input Number	Unsigned integer Temperature Input Number Range: 1 to 4	0
90	3,6,16	Temperature Source 1 Configuration	Unsigned integer 0 = For Monitoring Purposes Only, Not Used for Control, High Limit Cut-out Disabled 1 = Used for Control, High Limit Cut-out Disabled 2 = Not Used for Control, High Limit Cut-out Enabled 3 = Used for Control, High Limit Cut-out Enabled	1 = Used for Control, High Limit Cut-out Disabled

Registers 80-89 **MUST** be written together as a group. Register 90 can be included in that group or written to individually.

Attempts to write to a “Group Write” register individually will result in an Exception Error.

3.4 Modbus Exception Error Codes

The following diagnostic codes/exception error codes are supported by the BRIDGE:

Code Dec/Hex	Name	Meaning	Comment
1/1	Illegal Function	The function code received in the query is not an allowable action for the server (or slave). This may be because the function code is only applicable to newer devices, and was not implemented in the unit selected.	Standard Modbus
2/2	Illegal Data Address	The data address received in the query is not an allowable address for the server (or slave). More specifically, the combination of reference number and transfer length is invalid. For a controller with 100 registers, a request with offset 96 and a length of 4 would succeed, a request with offset 96 and a length of 5 will generate exception 2.	Standard Modbus
3/3	Illegal Data Value	A value contained in the query data field is not an allowable value for the server (or slave). This indicates a fault in the structure of the remainder of a complex request, such as that the implied length is incorrect. It specifically does NOT mean that a data item submitted for storage in a register has a value outside the expectation of the application program, since the MODBUS protocol is unaware of the significance of any particular value of any particular register.	Standard Modbus
4/4	Slave Device Failure	An unrecoverable error occurred while the server (or slave) was attempting to perform the requested action.	Standard Modbus
5/5	Acknowledge	Specialized use in conjunction with programming commands. The server (or slave) has accepted the request and is processing it, but a long duration of time will be required to do so. This response is returned to prevent a timeout error from occurring in the client (or master). The client (or master) can next issue a Poll Program Complete message to determine if processing is completed.	Standard Modbus
6/6	Slave Device Busy	Specialized use in conjunction with programming commands. The server (or slave) is engaged in processing a long duration program command. The client (or master) should retransmit the message later when the server (or slave) is free.	Standard Modbus
7/7			Standard Modbus
8/8	Memory Parity Error	Not used	Standard Modbus, Not used
9/9	Not used	Not used	Not used
10/A	Gateway	Specialized use in conjunction with Gateways (or Bridge),	Standard

	Path Unavailable	indicates that the Gateway (or Bridge) was unable to allocate an internal communication path from the input port to the output port for processing the request. Usually means that the Gateway (or Bridge) is misconfigured or overloaded.	Modbus
11/B	Gateway Target Device Failed To Respond	Specialized use in conjunction with Gateways (or Bridge), indicates that no response was obtained from the target device, Usually means that the device is not present on the network.	Standard Modbus
12/C	Not used	Not used	Not used
13/D	Not used	Not used	Not used
14/E	Not used	Not used	Not used
15/F	Not used	Not used	Not used
16/10	Slave Device Communication Failure	Indicates that a slave device connected to the Gateway or Bridge is not responding and is in a communication failed state.	Gateway and NGC40 Bridge
17/11	Illegal Data Storage Value	A data item submitted for storage in a register has a value outside acceptable limits.	Gateway and NGC40 Bridge
18/12	Can Message Failure	A CAN message received by the Bridge contained a fail code.	NGC40 Bridge
19/13	Can Message Queue Full	The CAN Message queue in the Bridge is full, try again later.	NGC40 Bridge
20/14	Parameter Lock	An attempt was made to write a "Factory Lock" protected parameter. Must use "Factory Unlock" command.	NGC40 Bridge

4. Connecting a Modbus Master Device

4.1 Default Communications settings, SET/RUN switch

If the current communication parameters of the NGC-40-BRIDGE are not known, a slide switch is provided on the front of the module to allow the user to force the RS-232 (COM 3) communications port into a known state, as shown in the table below. To make any changes to the BRIDGE communication settings, a Modbus Master device must be connected to the RS-232 (COM3) port.

COM3 Parameters	SET/Configuration Mode
Modbus Address	1
Protocol	RTU
Data Rate	9600 baud
Data Bits	8
Stop Bits	2
Parity	None
Tx Delay	0 ms

While in the SET mode, modifications to the communication parameters will be saved but will not take effect until the Configurations Switch is moved to the RUN mode. The parameters of the two RS-485 ports (COM 1 and COM 2), and Ethernet port, are not affected by the position of the Configuration Switch.

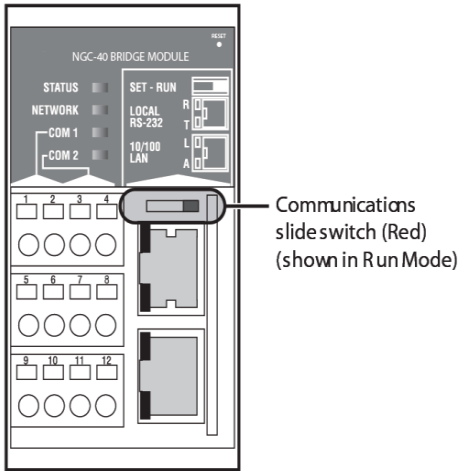

Figure 2 - SET/RUN Slide Switch

4.2 Ethernet

The Ethernet port can be used to connect multiple BRIDGE modules to a host computer by connecting to the user's LAN system.

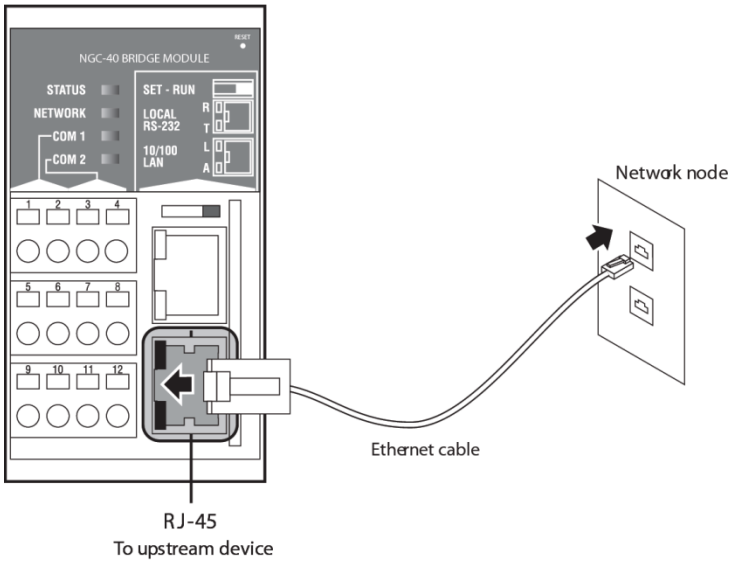

Figure 3 - Ethernet Connection

4.3 RS-485 (COM1 / COM2)

Use the RS-485 port when multiple BRIDGE modules are to be connected to a host computer or the connection is longer than 50 feet, but shorter than 4,000 feet. If longer than 4,000 feet, a repeater may be required. An RS-485 to RS-232 converter may be required to make the connection to a PC.

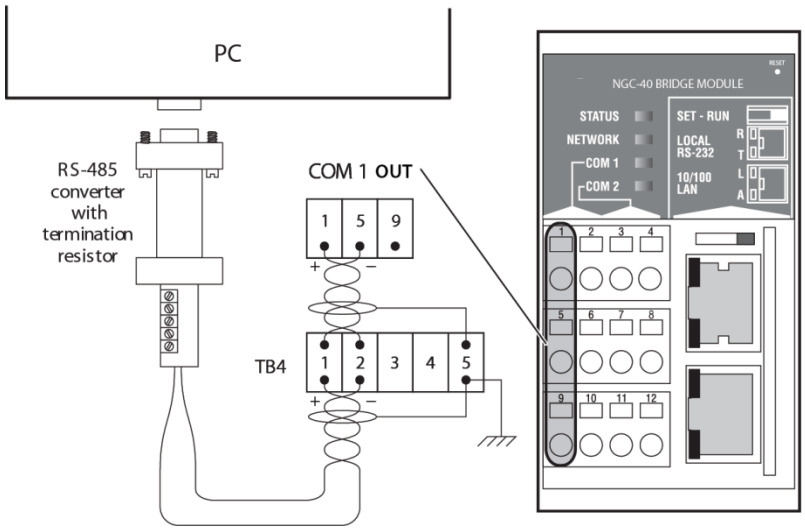

Figure 4 - RS-485 Connection

4.4 COM3 (RS-232)

The RS-232- port can be used as a direct connection to a single PC located within 50 feet of the panel. For an RS-232 connection, a 3 foot long RJ-11 to 9 pin female D-connector (NGC part number 10332-005) has been provided with the NGC-40 panel. Plug the RJ-11 connector into the RS-232 connector on the NGC-40-BRIDGE and the other end into the 9-pin connector on a computer.

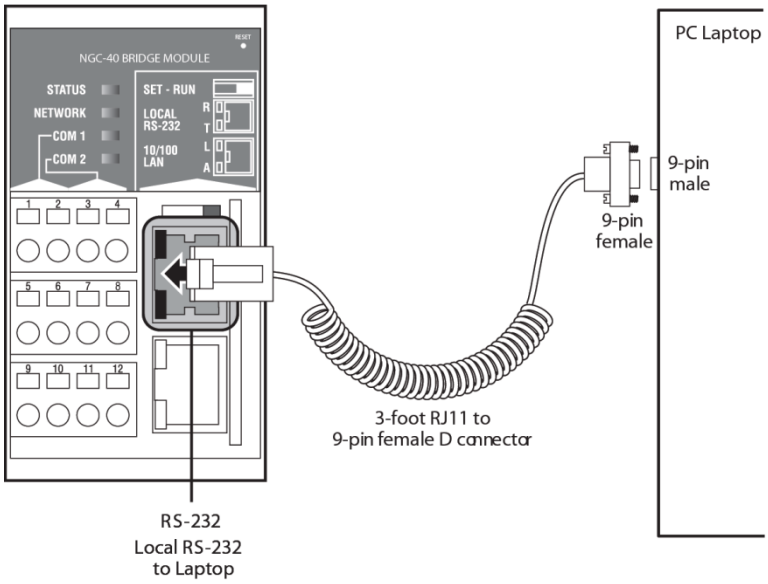

Figure 5 - RS-232 Connection

5. NGC-40-BRIDGE Overview

5.1 Database Synchronization/Global Alarm Status Flags

The BRIDGE communicates to the installed devices over the CAN network and uses synchronization flags to signal important changes on all communication ports. These flags should be continuously scanned to detect changes.

Modbus Address	Function Code	Description	Comments
80	1,5,15	Bridge Database Modified Flag	Write 1 to clear flag, write 0 has no effect
81	1,5,15	Bridge Device List Modified Flag	Write 1 to clear flag, write 0 has no effect
82	1,5,15	Bridge Alarm State Change Flag	Write 1 to clear flag, write 0 has no effect
87	1,5,15	CAN Device Database Modified Flag	Write 1 to clear flag, write 0 has no effect
88	1,5,15	CAN Device Alarm State Change Flag	Write 1 to clear flag, write 0 has no effect
89	1,5,15	CAN Device Communication Fail Flag	Write 1 to clear flag, write 0 has no effect
92	1,5,15	RMM2 Device List Modified Flag	Write 1 to clear flag, write 0 has no effect
93	1,5,15	RMM2 Device Communication Fail Change Flag	Write 1 to clear flag, write 0 has no effect

IMPORTANT: *Changes that occur without any user input, such as alarms and maintenance data, will set the Database Synchronization/Global Alarm Status Flag for all ports.*

Example 1:
A Modbus Master is connected to COM1 (MM1) and a Modbus Master is connected to COM2 (MM2). MM1 changes the Control Temperature Setpoint for an HTC3. MM2 will see that the CAN DEVICE DATABASE MODIFIED FLAG is set. MM1 will not see the flag.

Example 2:
A Modbus Master is connected to COM1 (MM1) and a Modbus Master is connected to COM2 (MM2). An HTC HIGH CONTROL TEMPERATURE ALARM is triggered. Both MM1 and MM2 will see the CAN DEVICE ALARM STATE CHANGE FLAG is set.

The following flow chart illustrates the steps necessary to scan for and react to changes to the database or global alarm status.

Database Synchronization/Global Alarm Status

Bridge Data Modified flag is for data pertaining directly to the BRIDGE, such as Communications registers.

This flag is set when a CAN Device is installed or removed. See Section 5.3 Installing/Removing CAN Devices

This flag shows if either of the 2 BRIDGE specific alarms are set.

The CAN Device Synchronization Flags will be set when information changes relating to any of the installed devices. For each flag there is a section of the Modbus Map to show exactly which device, or devices, has data that has been changed. First scan that Modbus section, note which devices need action, then take appropriate action. After, clear both the Database Synchronization/Global Alarm Status Flag and the Device Specific Flag.

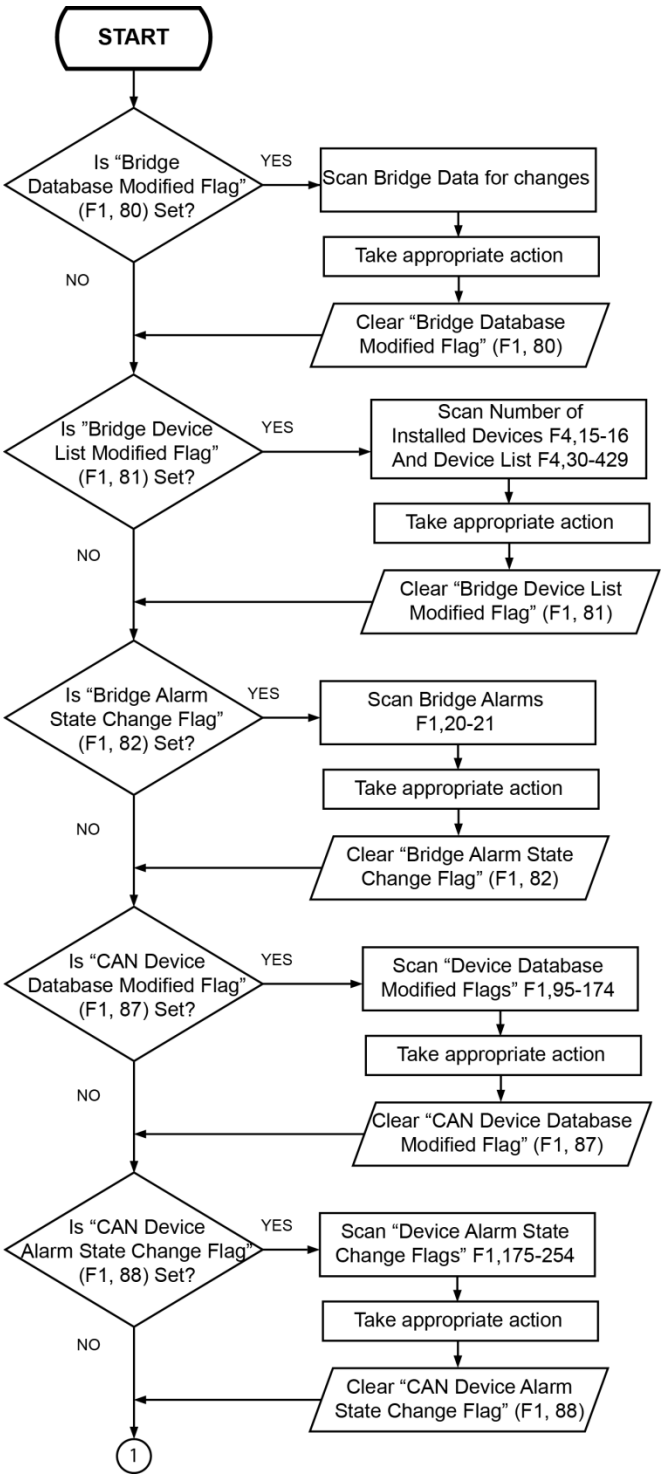

Figure 6 - Database Synchronization Flowchart pg 1

RMM2 Device List Modified flag will be set when an RRM2 device is manually installed or removed, and must be cleared after. See section 5.6 Adding/Deleting RMM2 Devices

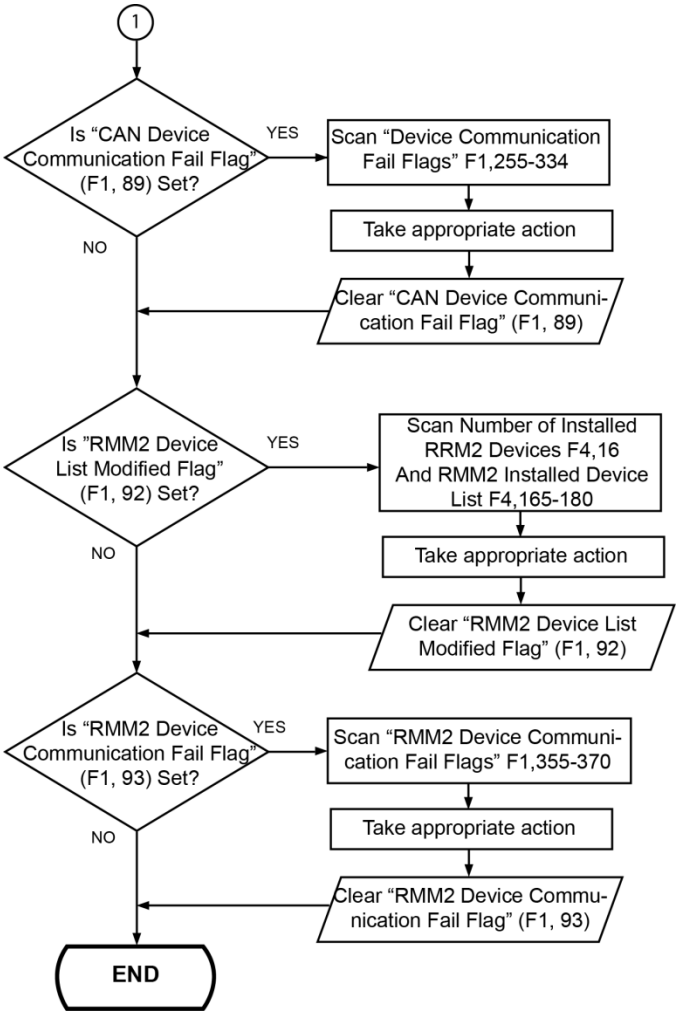

Figure 7 - Database Synchronization Flowchart pg 2

5.1.1 Bridge Database Modified Flag

This flag is set if data pertaining directly to the BRIDGE is changed, this includes communications settings, BRIDGE tag etc.

Modbus Address	Function Code	Description	Comments
80	1,5,15	Bridge Database Modified Flag	Write 1 to clear flag, write 0 has no effect

5.1.2 Bridge Device List Modified Flag

This flag is set for all communication ports when a CAN device is automatically installed (by physically connecting it to the CAN network), and only on the communication ports NOT used to remove the device.

See

Modbus Address	Function Code	Description	Comments
81	1,5,15	Bridge Device List Modified Flag	Write 1 to clear flag, write 0 has no effect

also: 5.4 Installed Device List (CAN Devices)

5.1.3 Bridge Alarm State Change Flag

This flag will be set on all communication ports if either of the two BRIDGE alarms are set, and only on the communication ports NOT used to clear the alarms.

Modbus Address	Function Code	Description	Comments
82	1,5,15	Bridge Alarm State Change Flag	Write 1 to clear flag, write 0 has no effect

5.1.4 CAN Device Database Modified Flag

The CAN Device Database Modified flag will be set if any CAN Device data has been modified. This includes setpoints, temperature sources, tags, maintenance data etc.

To

Modbus Address	Function Code	Description	Comments
87	1,5,15	CAN Device Database Modified Flag	Write 1 to clear flag, write 0 has no effect

see which installed device or devices have modified data see: 6.4 Bridge Device Database Modified Flags
See also: 5.5 Accessing CAN Device Data

5.1.5 CAN Device Alarm State Change Flag

This flag will be set on all communication ports if a new alarm appears or an active alarm is reset.

To

Modbus Address	Function Code	Description	Comments
88	1,5,15	CAN Device Alarm State Change Flag	Write 1 to clear flag, write 0 has no effect

see which installed device or devices have new alarm information see: 6.5 Bridge Device Alarm State Change Flags

5.1.6 CAN Device Communication Fail Flag

This flag is set when the BRIDGE cannot communicate with an installed CAN Device.

To

Modbus Address	Function Code	Description	Comments
89	1,5,15	CAN Device Communication Fail Flag	Write 1 to clear flag, write 0 has no effect

see which installed device or devices have a communication failure see: 6.6 Bridge Device Communication Fail Flag (CAN Devices)

5.1.7 RMM2 Device List Modified Flag

This flag will be set if an RMM2 device is added, but only on the communication ports not used to manually add the RMM2 Device.

See

Modbus Address	Function Code	Description	Comments
92	1,5,15	RMM2 Device List Modified Flag	Write 1 to clear flag, write 0 has no effect

also: 6.13 Install RMM2 Device

5.1.8 RMM2 Device Communication Fail Flag

This flag is set if the BRIDGE cannot communicate with an installed RMM2 device.

To

Modbus Address	Function Code	Description	Comments
93	1,5,15	RMM2 Device Communication Fail Change Flag	Write 1 to clear flag, write 0 has no effect

see which RMM2 devices or devices are in communication failure see: 6.7 Bridge RMM2 Device Communication Failure Flags

5.2 Device Types

These are the Device Type codes as used in the Function 4 “General Information” sections of the Modbus Map.

Type Code	Device
210	NGC-40-HTC
220	NGC-40-HTC3
230	NGC-40-LIMITER
240	NGC-40-IO

5.3 Installing/Removing CAN Devices

The following section will step through the Installation/Removal process for a CAN Device.

5.3.1 Automatic Installation of a CAN Device

To automatically install a CAN Device to the network, simply connect it to the BRIDGE, or insert it anywhere in the chain of devices. The new controller will appear in the Installed Device List in the first empty slot.

See: 5.4 Installed Device List (CAN Devices)

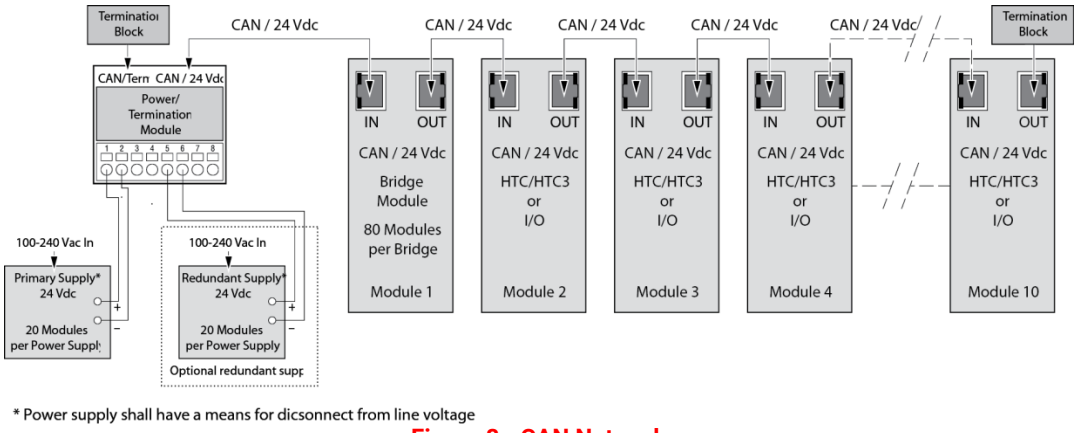

Figure 8 - CAN Network

5.3.2 Removing an Installed CAN Device

To remove an installed device, the Modbus Master must write to all 4 registers of this section using Modbus Function Code 16 (see 3.3 Group writes).

This will leave a blank slot in the Device List. Any new CAN Device connected to the CAN Network will be installed in this blank slot.

IMPORTANT: *If a device is removed following this procedure and is not physically removed from the CAN Network it will be automatically re-added to the Installed Device List. Ensure devices are disconnected from the CAN Network before removing them from the Device List.*

Modbus Address	Function Code	Description	Comments
130	3,6,16	CAN Network Device ID	CAN Network Device ID MSW
131	3,6,16	CAN Network Device ID	CAN Network Device ID LSW
132	3,6,16	Type	Device Type Supported Device Types are: 210 - NGC40 HTC 220 - NGC40 3PH HTC 230 - NGC40 Limiter 240 - NGC40 I/O 250 - NGC40 Power Supply
133	3,6,16	Command	Maintenance Command. 0 = Not Used 1 = Delete 2 = Identify

5.4 Installed Device List (CAN Devices)

The current system configuration can be accessed through the Installed Device List registers which begin at address 30. The NGC-40-BRIDGE supports a maximum of 80 installed devices.

Installed Device List
Modbus Function Code: 4
Modbus Start Address: 30
Modbus Block Size: 5
Number of Blocks: 80

Modbus Address	Function Code	Description	Comments
30	4	CAN Network Device ID (MSW)	CAN Network Device ID
31	4	CAN Network Device ID (LSW)	
32	4	Device Type	Type Code
33	4	Device Alarm Count	Unsigned integer
34	4	Device Subtype	Unsigned integer
429			

For our Example NGC-40 System these registers will appear as below:

INSTALLED DEVICE LIST						
Device Number	**Modbus Address**	**Function Code**	**Value in Hexadecimal**	**Value in Decimal**	**Comments /Example**	
Device 1	30	4	0000		CAN Network Device ID	**HTC**
	31	4	1020			
	32	4	00D2	210	HTC	
	33	4	0001		1 alarm	
	34	4	0001			
Device 2	35	4	00FF		CAN Network Device ID	**HTC3**
	36	4	FFF7			
	37	4	00DC	220	HTC3	
	38	4	0005		5 alarms	
	39	4	0001			
Device 3	40	4	0000		CAN Network Device ID	**IO**
	41	4	1109			
	42	4	00F0	240	IO	
	43	4	0002		2 alarms	
	44	4	0002			
Device 4	45	4	0000		CAN Network Device ID	**LIMITER**
	46	4	0002			
	47	4	00E6	230	LIMITER	
	48	4	000F		15 alarms	
	49	4	0002			
Device 5	50	4	0000			**Nothing Installed**
	51	4	0000			
	52	4	0000			
	53	4	0000			
	54	4	0000			

5.5 Accessing CAN Device Data

Device Data for each installed controller can be accessed through the NGC-40-BRIDGE Modbus Map, starting at address 1000. **Each NGC-40 Controller is allocated 750 registers for each supported Modbus Function Code (1,5,15, 2, 3,6,16, 4)**. To monitor or modify any HTC data, that HTC must first be "Added" to the BRIDGE. Once added, its position (device number) in the BRIDGE's list must be determined. Once the device number is found, apply that number as an offset to the Modbus Address.

Example:

An IO with CAN ID 001109 was found to be device 3. To view the "Temperature Sensor 1 Failure Alarm" located at address 2, Function 1:

Absolute address = Modbus address + Device offset address
Absolute Address = 2 + 1000+[(Device Number-1)*750] = 2500
Absolute Address = 2502, Function 1

Installed Device List (30-429 Function 4)

Device Number	Device Info	Block Size
1	30 34	5
2	35 39	5
3	**40** **44**	**5**
4	45 49	5
5	50 54	5
…		
80	425 429	5

Device Data (1000-60999 For all supported Modbus Functions)

Device Number	Device Data	Block Size	
1	1000 1749	750	Data for HTC 001020 will appear here.
2	1750 2499	750	Data for HTC3 FFFFF7 will appear here.
3	**2500** **3249**	**750**	**Data for IO 001109 will appear here**
4	3250 3999	750	Data for LIMITER 000002 will appear here.
5	4000 4749	750	
…			
80	60250 60999	750	

5.6 Adding/Deleting RMM2 Devices

To add an RMM2 Device, write RMM2 RTU address to any of the “RMM2 Device x RTU Address” registers below.

If the RTU address is within range (32 – 48), and no duplicate RTU addresses are detected, RMM2 installation is complete.

To remove an RMM2 write 0 to the “RMM2 Device x RTU Address”.

Modbus Address	Function Code	Description	Comments
165	3,6,16	RMM2 Device 1 RTU Address	Unsigned Integer Range: 32 – 48 Write 0 to remove RMM2
166	3,6,16	RMM2 Device 2 RTU Address	Unsigned Integer Range: 32 – 48 Write 0 to remove RMM2
167	3,6,16	RMM2 Device 3 RTU Address	Unsigned Integer Range: 32 – 48 Write 0 to remove RMM2
168	3,6,16	RMM2 Device 4 RTU Address	Unsigned Integer Range: 32 – 48 Write 0 to remove RMM2
169	3,6,16	RMM2 Device 5 RTU Address	Unsigned Integer Range: 32 – 48 Write 0 to remove RMM2
170	3,6,16	RMM2 Device 6 RTU Address	Unsigned Integer Range: 32 – 48 Write 0 to remove RMM2
171	3,6,16	RMM2 Device 7 RTU Address	Unsigned Integer Range: 32 – 48 Write 0 to remove RMM2
172	3,6,16	RMM2 Device 8 RTU Address	Unsigned Integer Range: 32 – 48 Write 0 to remove RMM2
173	3,6,16	RMM2 Device 9 RTU Address	Unsigned Integer Range: 32 – 48 Write 0 to remove RMM2
174	3,6,16	RMM2 Device 10 RTU Address	Unsigned Integer Range: 32 – 48 Write 0 to remove RMM2
175	3,6,16	RMM2 Device 11 RTU Address	Unsigned Integer Range: 32 – 48 Write 0 to remove RMM2
176	3,6,16	RMM2 Device 12 RTU Address	Unsigned Integer Range: 32 – 48 Write 0 to remove RMM2
177	3,6,16	RMM2 Device 13 RTU Address	Unsigned Integer Range: 32 – 48 Write 0 to remove RMM2
178	3,6,16	RMM2 Device 14 RTU Address	Unsigned Integer Range: 32 – 48 Write 0 to remove RMM2

See

179	3,6,16	RMM2 Device 15 RTU Address	Unsigned Integer Range: 32 – 48 Write 0 to remove RMM2
180	3,6,16	RMM2 Device 16 RTU Address	Unsigned Integer Range: 32 – 48 Write 0 to remove RMM2

also: 6.13 Install RMM2 Device

5.7 Accessing RMM2 Device Data

Each Installed RMM2 Device has 8 temperature registers. To find the registers for RMM2 Device x use the following formula:

Function 4, 61000 + ((x-1) * 8)

For RRM2 Device 4: 61000 + ((4-1) * 8)
61000 + (24)
61024

Modbus Address	Function Code	Description	Comments
61000	4	RMM2 Device 1 RTD 1 Temperature	Signed Integer in DegC Range: -100 to +900 DegC Open RTD = 1000 Low Res RTD = 1001 High Res RTD = 1002 Invalid Value = 2000 Communications Failure = 2001
61001		RMM2 Device 1 RTD 2 Temperature	
61002		RMM2 Device 1 RTD 3 Temperature	
61003		RMM2 Device 1 RTD 4 Temperature	
61004		RMM2 Device 1 RTD 5 Temperature	
61005		RMM2 Device 1 RTD 6 Temperature	
61006		RMM2 Device 1 RTD 7 Temperature	
61007		RMM2 Device 1 RTD 8 Temperature	
61008 – 61015	4	RMM2 Device 2 RTD 1-8 Temperature	
61016 – 61023	4	RMM2 Device 3 RTD 1-8 Temperature	
61024 – 61031	4	RMM2 Device 4 RTD 1-8 Temperature	

5.8 Load Shedding

Control modules may be put into a load shedding control mode only after receiving a load shed command issued from a Modbus Master. This mode overrides temperature control and forces the output of the control module off until reset by the Modbus Master.

The Modbus Master will issue a load shedding broadcast command to the control modules at least once every minute. If the HTC has Load Shedding Enabled and does not receive this broadcast in the BROADCAST TIMEOUT period, a LOAD SHED SOURCE FAILURE ALARM will be tripped. An HTC can be assigned to 1 or more of 16 zones. The broadcast sent from the Modbus Master will specify which zones are to be turned off or load shed. If the HTC is a member of the specified zones it will turn the output off.

If a load shedding command is received, the control module will continue to hold its output off, until one of the following three conditions occurs:

1. The Modbus Master that initiated load shedding issues a load shedding command that will terminate load shedding mode.

2. Communications are interrupted between the control module and the Modbus Master (as in the case of a damaged communications wire or loss of power to the Modbus Master). Approximately 30 seconds after communications ceases, the control module will return to normal operation.

3. Fail safe operation begins. If the LOAD SHEDDING FAIL SAFE parameter is enabled and the control temperature drops below the CONTROL TEMPERATURE LOW ALARM the output will go on.

   IMPORTANT: *The control module will return to normal operation if communications between the Modbus Master and the control module are disrupted in any way. This will return temperature control to the control module.*

   The control module does not perform a periodic auto-cycle test while in load shedding mode.

   If the LOAD SHEDDING FAIL SAFE parameter is enabled, then the CONTROL TEMPERATURE LOW ALARM must be enabled. The CONTROL TEMPERATURE LOW ALARM temperature must be less than the CONTROL SETPOINT temperature, otherwise the control module will not go into load shedding mode.

6. Modbus Registers for NGC-40-BRIDGE

The NGC-40-BRIDGE module provides the interface between a panel's internal CAN-based network and upstream devices. Multiple communications ports are supported, allowing serial and Ethernet connections to be used with external devices.

6.1 Bridge Alarm Status

The NGC-40 system uses alarms to indicate fault conditions and out-of-range temperatures. Most alarms can be disabled (masked) and set to be latching or non-latching to accommodate specific applications. An active alarm shows a "1" in the alarm register, and can be reset by writing a 1 to that register as long as the alarm condition no longer exists.

Modbus Address	Function Code	Description	Comments
20	1,5,15	Device Reset	Alarm status: 0 = Normal, 1 = Alarm Writing a 1 resets the alarm, writing 0 has no effect
21	1,5,15	Configuration Lost	Alarm status: 0 = Normal, 1 = Alarm Writing a 1 resets the alarm, writing 0 has no effect

Device Reset Alarm

The DEVICE RESET ALARM is used to indicate:

1) Power to the NGC-40-BRIDGE has been interrupted and subsequently restored.
2) A transient has caused the NGC-40-BRIDGE's software to restart.
3) An internal condition has caused the NGC-40-BRIDGE's software to restart.

Configuration Lost Alarm

The CONFIGURATION LOST ALARM indicates that the controller has detected a failure in its database. The database was rebuilt and defaults values are being used.

6.2 Bridge Alarm Mask

The Alarm Mask registers match 1:1 to the Alarm Status registers at Function 1, address 20. A 1 designates an enabled alarm, a 0 is a disabled alarm. Not all alarms can be disabled. Refer to the full Modbus Map located in the Appendices for detailed information on each Alarm Mask.

Modbus Address	Function Code	Description	Comments	Default
50	1,5,15	Device Reset	Alarm mask: 0 = Disabled, 1 = Enabled	Enabled
51	1,5,15	Configuration Lost	Alarm mask: 1 = Enabled (Can not be disabled)	Enabled

6.3 Bridge Database Synchronization/ Global Alarm Status

The DATABASE SYNCHRONIZATION/GLOBAL ALARM STATUS flags are used to signal changes to alarm status or data within one of the installed devices. For more information see section 5.1 Database Synchronization/Global Alarm Status Flags.

Modbus Address	Function Code	Description	Comments
80	1,5,15	Bridge Database Modified Flag	Write 1 to clear flag, write 0 has no effect
81	1,5,15	Bridge Device List Modified Flag	Write 1 to clear flag, write 0 has no effect
82	1,5,15	Bridge Alarm State Change Flag	Write 1 to clear flag, write 0 has no effect
87	1,5,15	CAN Device Database Modified Flag	Write 1 to clear flag, write 0 has no effect
88	1,5,15	CAN Device Alarm State Change Flag	Write 1 to clear flag, write 0 has no effect
89	1,5,15	CAN Device Communication Fail Flag	Write 1 to clear flag, write 0 has no effect
92	1,5,15	RMM2 Device List Modified Flag	Write 1 to clear flag, write 0 has no effect
93	1,5,15	RMM2 Device Communication Fail Change Flag	Write 1 to clear flag, write 0 has no effect

6.4 Bridge Device Database Modified Flags

When the CAN DEVICE DATABASE MODIFIED FLAG (Function 1, Address 87) is set the DEVICE DATABASE MODIFIED FLAGS will signal which device, or devices, have modifications to their data.

Modbus Address	Function Code	Description	Comments
95	1,5,15	Device 1 Database Modified Flag	Write 1 to clear flag, write 0 has no effect
96	1,5,15	Device 2 Database Modified Flag	Write 1 to clear flag, write 0 has no effect
…	…	…	…
173	1,5,15	Device 79 Database Modified Flag	Write 1 to clear flag, write 0 has no effect
174	1,5,15	Device 80 Database Modified Flag	Write 1 to clear flag, write 0 has no effect

6.5 Bridge Device Alarm State Change Flags

When the CAN DEVICE ALARM STATE CHANGE FLAG (Function 1, Address 88) is set the DEVICE ALARM STATE CHANGE FLAG will signal which device, or devices, have a change in alarm state. This could mean either a new alarm or a cleared alarm.

Modbus Address	Function Code	Description	Comments
175	1,5,15	Device 1 Alarm State Change Flag	Write 1 to clear flag, write 0 has no effect
176	1,5,15	Device 2 Alarm State Change Flag	Write 1 to clear flag, write 0 has no effect
…	…	…	…
253	1,5,15	Device 79 Alarm State Change Flag	Write 1 to clear flag, write 0 has no effect
254	1,5,15	Device 80 Alarm State Change Flag	Write 1 to clear flag, write 0 has no effect

6.6 Bridge Device Communication Fail Flag (CAN Devices)

When the CAN DEVICE COMMUNICATION FAIL FLAG (Function 1, Address 89) is set the DEVICE COMMUNICATION FAIL FLAG will signal which device, or devices, are in or have recovered from communication failure.

Modbus Address	Function Code	Description	Comments
255	1	Device 1 Communication Fail Flag	Write 1 to clear flag, write 0 has no effect
256	1	Device 2 Communication Fail Flag	Write 1 to clear flag, write 0 has no effect
…	…	…	…
333	1	Device 79 Communication Fail Flag	Write 1 to clear flag, write 0 has no effect
334	1	Device 80 Communication Fail Flag	Write 1 to clear flag, write 0 has no effect

6.7 Bridge RMM2 Device Communication Failure Flags

When the RMM2 DEVICE COMMUNICATION FAIL CHANGE FLAG (Function 1, Address 93) is set the DEVICE COMMUNICATION FAIL FLAG will signal which device, or devices, are in or have recovered from communication failure.

Modbus Address	Function Code	Description	Comments
355	1,5,15	RMM2 Device 1 Communication Fail Flag	Write 1 to clear flag, write 0 has no effect
356	1,5,15	RMM2 Device 2 Communication Fail Flag	Write 1 to clear flag, write 0 has no effect
…	…	…	…
369	1,5,15	RMM2 Device 15 Communication Fail Flag	Write 1 to clear flag, write 0 has no effect
370	1,5,15	RMM2 Device 16 Communication Fail Flag	Write 1 to clear flag, write 0 has no effect

6.8 Bridge Setup Parameters

Writing a 1 to the LOAD USER CONFIGURATION DEFAULTS will reset all parameters to the default state as shown in the Modbus Map under the “Default” column. This action does not affect calibration.

Modbus Address	Function Code	Description	Comments
335	1,5,15	Load User Configuration Defaults	Write 1 to load user configuration defaults, writing zero is ignored. Reads return 0

6.9 Bridge General Information, Tag

A 40 character TAG may be assigned to a BRIDGE to allow it to be easily associated with a control panel, location, or area.

Modbus Address	Function Code	Description	Comments	Default
0	3,6,16	Bridge Tag 0	NGC40 Bridge Tag No validity checking is done on the character.	DEFAULT-TAG
…	…	…		
39	3,6,16	Bridge Tag 39		

6.10 Bridge Communication Port Information

This section contains all the Communications Parameters for each Communication Port. If the Communication Parameters are unknown, a connection may be made through RS232 (COM2) with the Run/Set switch in SET Mode as detailed in Section 4.1 Default Communications settings, SET/RUN switch.

Modbus Address	Function Code	Description	Comments	Default
60	3,6,16	Master Port	Unsigned integer 0 = None 1 = COM1 2 = COM2	0 = None Currently used only when RMM2 device is connected
61	3,6,16	Reserved		
62	3,6,16	Reserved		
63	3,6,16	Com 1 - Modbus Address	Unsigned integer Range: 1 - 247	1
64	3,6,16	Com 1 - Baud Rate (MSW)	300, 600, 1200, 2400, 4800, 9600, 19200, 38400, 57600, 115200	9600
65	3,6,16	Com 1 - Baud Rate (LSW)		
66	3,6,16	Com 1 - Parity	0 = No, 1 = Odd, 2 = Even	0
67	3,6,16	Com 1 - Data Bits	7 or 8	8
68	3,6,16	Com 1 - Stop Bits	1 = 1 Stop bit, 2 = 2 Stop bit	2
69	3,6,16	Com 1 - Tx Delay	Number of milliseconds Range: 0 - 5000mS	0
70	3,6,16	Com 1 - Protocol	1 = Modbus	1
71	3,6,16	Com 1 - Frame Type	1 = Modbus RTU, 2 = Modbus ASCII	1
72	3,6,16	Com 2 - Modbus Address	Unsigned integer Range: 1 - 247	1
73	3,6,16	Com 2 - Baud Rate (MSW)	300, 600, 1200, 2400, 4800, 9600, 19200, 38400, 57600, 115200	9600
74	3,6,16	Com 2 - Baud Rate (LSW)		
75	3,6,16	Com 2 - Parity	0 = No, 1 = Odd, 2 = Even	0
76	3,6,16	Com 2 - Data Bits	7 or 8	8
77	3,6,16	Com 2 - Stop Bits	1 = 1 Stop bit, 2 = 2 Stop bit	2
78	3,6,16	Com 2 - Tx Delay	Number of milliseconds Range: 0 - 5000mS	0
79	3,6,16	Com 2 - Protocol	1 = Modbus	1
80	3,6,16	Com 2 - Frame Type	1 = Modbus RTU, 2 = Modbus ASCII	1
81	3,6,16	Com 3 - Modbus Address	Unsigned integer Range: 1 - 247	1
82	3,6,16	Com 3 - Baud Rate (MSW)	300, 600, 1200, 2400, 4800, 9600, 19200, 38400, 57600, 115200	9600
83	3,6,16	Com 3 - Baud Rate (LSW)		
84	3,6,16	Com 3 - Parity	0 = No, 1 = Odd, 2 = Even	0
85	3,6,16	Com 3 - Data Bits	7 or 8	8
86	3,6,16	Com 3 - Stop Bits	1 = 1 Stop bit, 2 = 2 Stop bit	2
87	3,6,16	Com 3 - Tx Delay	Number of milliseconds	0

			Range: 0 - 5000mS	
88	3,6,16	Com 3 - Protocol	1 = Modbus	1
89	3,6,16	Com 3 - Frame Type	1 = Modbus RTU, 2 = Modbus ASCII	1
90	3,6,16	Reserved		
91	3,6,16	Reserved		
92	3,6,16	Reserved		
93	3,6,16	Reserved		
94	3,6,16	Reserved		
95	3,6,16	Ethernet Port - Modbus Address	Unsigned integer Range: 1 - 247	1
96	3,6,16	Reserved		
97	3,6,16	Ethernet Port - Modbus Timeout	Modbus Timeout in seconds Range : 0 - 600	60
98	3,6,16	Ethernet Port - IP Address	IP Address (MSW)	192.168.1.100
99	3,6,16	Ethernet Port - IP Address	IP Address (LSW)	
100	3,6,16	Ethernet Port - Netmask	Netmask (MSW)	255.255.255.0
101	3,6,16	Ethernet Port - Netmask	Netmask (LSW)	

6.11 Bridge Device Maintenance

The Device Maintenance is used to delete an Installed Device (Command=1), or to send an Identify command to a specific Installed Device which causes it to flash the LED's in sequence for easy identification (Command=2). All registers in the section must be written to with a group write.

Modbus Address	Function Code	Description	Comments
130	3,6,16	CAN Network Device ID	CAN Network Device ID MSW
131	3,6,16	CAN Network Device ID	CAN Network Device ID LSW
132	3,6,16	Type	Device Type Supported Device Types are: 210 - NGC40 HTC 220 - NGC40 3PH HTC 230 - NGC40 Limiter 240 - NGC40 I/O
133	3,6,16	Command	Maintenance Command. 0 = Not Used 1 = Delete 2 = Identify

6.12 Bridge, General Information

These are read-only registers that provide some basic information about the Bridge module currently connected.

Modbus Address	Function Code	Description	Comments
0	4	Device Type	NGC40 Bridge = 200
1	4	Bridge Firmware Version (Major)	NGC40 Bridge Firmware Version - Major Range: 0 – 255
2	4	Bridge Firmware Version (Minor)	NGC40 Bridge Firmware Version - Minor Range: 0 – 255
3	4	Bridge Firmware Version (Build)	NGC40 Bridge Firmware Version - Build Range: 0 – 255
4	4	Manufactured Year	YYYY
5	4	Manufactured Month	1 - 12
6	4	Manufactured Day	1 - 31
7	4	Serial Number (MSW)	NGC-40 Bridge Serial Number
8	4	Serial Number (LSW)	

Device Type

Indicates the device type of the module.

Firmware Version (Major, Minor, Build)

Indicates the revision level of the firmware programmed into the controller, “major.minor.build”.

Manufactured Year, Month, Day

Indicates the date on which the device was manufactured.

Serial Number

The unique serial number for this device.

6.13 Install RMM2 Device

To install an RMM2 write the Modbus address into any available slot. To remove/uninstall write a 0.

Modbus Address	Function Code	Description	Comments
165	3,6,16	RMM2 Device 1 RTU Address	Unsigned Integer Range: 32 – 48 Write 0 to remove RMM2
166	3,6,16	RMM2 Device 2 RTU Address	Unsigned Integer Range: 32 – 48 Write 0 to remove RMM2
167	3,6,16	RMM2 Device 3 RTU Address	Unsigned Integer Range: 32 – 48 Write 0 to remove RMM2
168	3,6,16	RMM2 Device 4 RTU Address	Unsigned Integer Range: 32 – 48 Write 0 to remove RMM2
169	3,6,16	RMM2 Device 5 RTU Address	Unsigned Integer Range: 32 – 48 Write 0 to remove RMM2
170	3,6,16	RMM2 Device 6 RTU Address	Unsigned Integer Range: 32 – 48 Write 0 to remove RMM2
171	3,6,16	RMM2 Device 7 RTU Address	Unsigned Integer Range: 32 – 48 Write 0 to remove RMM2
172	3,6,16	RMM2 Device 8 RTU Address	Unsigned Integer Range: 32 – 48 Write 0 to remove RMM2
173	3,6,16	RMM2 Device 9 RTU Address	Unsigned Integer Range: 32 – 48 Write 0 to remove RMM2
174	3,6,16	RMM2 Device 10 RTU Address	Unsigned Integer Range: 32 – 48 Write 0 to remove RMM2
175	3,6,16	RMM2 Device 11 RTU Address	Unsigned Integer Range: 32 – 48 Write 0 to remove RMM2
176	3,6,16	RMM2 Device 12 RTU Address	Unsigned Integer Range: 32 – 48 Write 0 to remove RMM2
177	3,6,16	RMM2 Device 13 RTU Address	Unsigned Integer Range: 32 – 48 Write 0 to remove RMM2
178	3,6,16	RMM2 Device 14 RTU Address	Unsigned Integer Range: 32 – 48 Write 0 to remove RMM2
179	3,6,16	RMM2 Device 15 RTU Address	Unsigned Integer Range: 32 – 48 Write 0 to remove RMM2
180	3,6,16	RMM2 Device 16 RTU Address	Unsigned Integer Range: 32 – 48 Write 0 to remove RMM2

6.14 Bridge Status, Installed Devices

These registers show the number of controllers currently installed and monitored by the Bridge.

Modbus Address	Function Code	Description	Comments
15	4	Number of installed devices	Unsigned integer
16	4	Number of installed RMM2 devices	Unsigned integer

Number of Installed Devices

This register shows the number of Installed CAN Devices that the BRIDGE is currently monitoring.

Number of Installed RMM2 Devices

This register shows the number of Installed RMM2 Devices that the Bridge is currently monitoring.

7. Modbus Registers for NGC-40-HTC

The NGC-40-HTC (for single-phase heaters) module is used to control either a solid-state relay or contactor within the NGC-40 control and monitoring system. This module also has one alarm output and one digital input. The alarm output can be used to control an external annunciator. The digital input is programmable and may be used for various functions such as forcing outputs on and off. Other features of this module include ground-fault and line current sensing. The front panel of the HTC module has LED indicators for various status conditions. The front panel also provides a ground-fault and heater test button.

7.1 HTC Alarm Status

The NGC-40 system uses alarms to indicate fault conditions and out-of-range temperatures. Most alarms can be disabled (masked) and set to be latching or non-latching to accommodate specific applications. An active alarm shows a "1" in the alarm register, and can be reset by writing a 1 to that register as long as the alarm condition no longer exists.

7.1.1 HTC Control Temperature Alarms

These alarms are associated with the Control Temperature.

IMPORTANT: *These alarms can be user selectable to be Latching or Non-Latching. If set to Non-Latching, the controller will automatically clear the alarm when the condition no longer exists. If set to Latching the alarm must be cleared by the user.*

If your application is subject to periodic situations where cold or hot product is part of the process, it may be appropriate to configure the HTC for non-latching temperature alarms to avoid nuisance alarms. If it is important to be aware of any temperature alarm conditions that may have existed in a pipe, then the HTC should be configured for latching temperature alarms.

Modbus Address	Function Code	Description	Comments
1	1,5,15	Control Temperature High	Alarm Status: 0 = Normal, 1 = Alarm Writing a 1 resets the alarm, writing 0 has no effect
2	1,5,15	Control Temperature Low	Alarm Status: 0 = Normal, 1 = Alarm Writing a 1 resets the alarm, writing 0 has no effect
38	1,5,15	Control Temperature Failure	Alarm Status: 0 = Normal, 1 = Alarm Writing a 1 resets the alarm, writing 0 has no effect

Control Temperature Failure

The CONTROL TEMPERATURE FAILURE ALARM indicates a failure of one or more of the temperature sources designated as "Use for Control". See "Temperature Source Setup".

Control Temperature High

This alarm will appear when the CONTROL TEMPERATURE exceeds the CONTROL TEMPERATURE HIGH ALARM SETPOINT.

Control Temperature Low

This alarm will appear when the temperature decreases below the CONTROL TEMPERATURE LOW ALARM SETPOINT.

7.1.2 HTC Local Temperature Sensor Alarms

These alarms are associated with the Local Temperature Sensor.

Modbus Address	Function Code	Description	Comments
3	1,5,15	Local Temperature Sensor Failure	Alarm Status: 0 = Normal, 1 = Alarm Writing a 1 resets the alarm, writing 0 has no effect
4	1,5,15	Local Temperature Sensor High	Alarm Status: 0 = Normal, 1 = Alarm Writing a 1 resets the alarm, writing 0 has no effect
5	1,5,15	Local Temperature Sensor Low	Alarm Status: 0 = Normal, 1 = Alarm Writing a 1 resets the alarm, writing 0 has no effect

Local Temperature Sensor Failure

This alarm will appear when a failure of the temperature sensor connected directly to the NGC-40-HTC is detected. Both open and shorted sensors are detected and alarmed by the HTC.

Local Temperature Sensor High

This alarm will appear if the LOCAL TEMPERATURE SENSOR TEMPERATURE measured by the controller exceeds the LOCAL TEMPERATURE SENSOR HIGH ALARM SETPOINT.

Local Temperature Sensor Low

This alarm will appear if the LOCAL TEMPERATURE SENSOR TEMPERATURE measured by the controller decreases below the Local Temperature Sensor Low Alarm Setpoint.

7.1.3 HTC Temperature Source Failure Alarms

These alarms are associated with the Remote Temperature Sources.

This

Modbus Address	Function Code	Description	Comments
6	1,5,15	Temperature Source 1 Failure	Alarm Status: 0 = Normal, 1 = Alarm Writing a 1 resets the alarm, writing 0 has no effect
7	1,5,15	Temperature Source 2 Failure	Alarm Status: 0 = Normal, 1 = Alarm Writing a 1 resets the alarm, writing 0 has no effect
8	1,5,15	Temperature Source 3 Failure	Alarm Status: 0 = Normal, 1 = Alarm Writing a 1 resets the alarm, writing 0 has no effect
9	1,5,15	Temperature Source 4 Failure	Alarm Status: 0 = Normal, 1 = Alarm Writing a 1 resets the alarm, writing 0 has no effect
10	1,5,15	Temperature Source 5 Failure	Alarm Status: 0 = Normal, 1 = Alarm Writing a 1 resets the alarm, writing 0 has no effect
11	1,5,15	Temperature Source 6 Failure	Alarm Status: 0 = Normal, 1 = Alarm Writing a 1 resets the alarm, writing 0 has no effect
12	1,5,15	Temperature Source 7 Failure	Alarm Status: 0 = Normal, 1 = Alarm Writing a 1 resets the alarm, writing 0 has no effect
13	1,5,15	Temperature Source 8 Failure	Alarm Status: 0 = Normal, 1 = Alarm Writing a 1 resets the alarm, writing 0 has no effect

is a series of specific alarms that will occur when the HTC fails to obtain a valid temperature from any of the 8 Temperature Sources. This alarm can have a different meaning depending on the setup of the TEMPERATURE SOURCE MODE.

Temperature Source Mode	Alarm Description
Local	Temperature Source Failure Alarm will appear when a failure of the temperature sensor connected directly to the NGC-40-HTC is detected.
Remote	Temperature Source Failure Alarm will appear when the NGC-40-HTC fails to receive a valid temperature from the “Remote” temperature device within the interval defined by the parameter Broadcast Timeout. It will also appear if the Remote Temperature Source has an RTD Failure. See 7.8.4 HTC Temperature Source Setup for further details.
CAN Network	Temperature Source Failure Alarm will appear when the NGC-40-HTC fails to receive a valid temperature from a module connected to the CAN network within the interval defined by the parameter Broadcast Timeout.

7.1.4 HTC Line Current Alarms

These alarms are associated with the Line Current.

Modbus Address	Function Code	Description	Comments
14	1,5,15	High Line Current	Alarm Status: 0 = Normal, 1 = Alarm Writing a 1 resets the alarm, writing 0 has no effect
15	1,5,15	Low Line Current	Alarm Status: 0 = Normal, 1 = Alarm Writing a 1 resets the alarm, writing 0 has no effect
22	1,5,15	Line Over Current Trip	Alarm Status: 0 = Normal, 1 = Alarm Writing a 1 resets the alarm, writing 0 has no effect

High Line Current

Alarms current levels which are higher than the HIGH LINE CURRENT ALARM SETPOINT.

IMPORTANT: As the HTC automatically protects itself from overload, it would not normally be necessary to enable this alarm. It can be used effectively to guard against accidental paralleling of heating circuits. In-rush, or cold start currents typically associated with self- regulating cables may cause nuisance HIGH LINE CURRENT ALARMS. If this is undesirable this alarm should be disabled.

Low Line Current

Alarms current levels which are lower than the LOW LINE CURRENT ALARM SETPOINT. Monitoring for lower than expected current levels may be an effective means of continuity monitoring. See also HIGH TRACING RESISTANCE ALARM.

IMPORTANT: *To minimize nuisance LOW LINE CURRENT ALARMS, the HTC must detect a current level less than the LOW LINE CURRENT ALARM setpoint for a period longer than approximately 20 consecutive seconds.*

For series type heating cables, adjusting the LOW LINE CURRENT ALARM to 50% of full load current will properly alarm a problem and reduce nuisance alarms due to voltage dips Parallel heaters have unpredictable currents. Typically the Low Current Setting is set to 0.3-1.0A to reduce nuisance alarms. *The low current setting as a percentage of full load current will vary depending on the facility and its power system.*

Over Current Trip

The over current trip feature is always enabled when using an SSR output switch and is used to provide protection for the output switch. The OVER CURRENT TRIP ALARM will only inform the user of an excessively high current condition and that the output switch has been latched off. During a high current condition, the controller attempts to soft start a heating cable by a technique involving measured in-rush current and the SWITCH CURRENT RATING. If the controller is unable to start the cable, it will eventually trip its output switch off and will not retry or pulse its output switch again. At this point the OVERCURRENT TRIP ALARM is latched on.

IMPORTANT: *The controller is NOT a safety cutout or an over current protective device as defined by the National and Canadian Electrical Codes (NEC & CEC). A protective device such as a circuit breaker or fuse must be included as part of a proper design and be selected in accordance with the requirements defined in the National Electrical Code (NEC) and/or the Canadian Electrical Code (CEC).*

The controller cannot protect the SSR from short circuits or excessive over current conditions. Always ensure that the power is off prior to performing any maintenance or troubleshooting of the heating circuit. Verify that no damage has occurred to the cable or the controller prior to re-energizing the circuit.

It is recommended that this alarm be left enabled since an over current trip condition would normally represent a serious problem. Note that this is a factory set alarm value and disabling the alarm does not disable the overcurrent trip function. In some applications the use of self-regulating cable will produce very high in-rush currents during cold startup. These currents may exceed the over current trip limit and the controller will not be able to soft start the trace circuit. If this condition persists please contact your nearest sales office for recommendations and solutions to this problem.

7.1.5 HTC Ground Fault Current Alarms

These alarms are associated with the Ground Fault Current.

Modbus Address	Function Code	Description	Comments
16	1,5,15	High Ground Fault Current	Alarm Status: 0 = Normal, 1 = Alarm Writing a 1 resets the alarm, writing 0 has no effect
17	1,5,15	Ground Fault Trip	Alarm Status: 0 = Normal, 1 = Alarm Writing a 1 resets the alarm, writing 0 has no effect
18	1,5,15	GFI Current Transformer Failure	Alarm Status: 0 = Normal, 1 = Alarm Writing a 1 resets the alarm, writing 0 has no effect

High Ground Fault Current

Alarms ground fault current levels which are higher than the HIGH GF CURRENT ALARM SETPOINT.

Ground Fault Trip

This alarm is activated when the ground fault leakage current exceeds the GROUND FAULT TRIP CURRENT SETPOINT. Exceeding this limit will result in the output switch being latched off.

IMPORTANT: *National Electrical Codes may require that all legs of non-neutral based power sources be opened upon detection of a Ground Fault. Multi-pole switch configurations should be used on non-neutral based power systems. Check the requirements with your local Electrical Authority.*

When the GROUND FAULT TRIP ALARM is disabled, ground fault tripping is disabled as well.

GFI Current Transformer Failure

The HTC continuously tests the GFI current transformer to ensure that it is fully functional. The GFI CURRENT TRANSFORMER FAILURE ALARM is activated if a transformer failure is detected.

7.1.6 HTC Tracing Resistance Alarms

These alarms are associated with the Tracing Resistance.

Modbus Address	Function Code	Description	Comments
20	1,5,15	High Tracing Resistance	Alarm Status: 0 = Normal, 1 = Alarm Writing a 1 resets the alarm, writing 0 has no effect
21	1,5,15	Low Tracing Resistance	Alarm Status: 0 = Normal, 1 = Alarm Writing a 1 resets the alarm, writing 0 has no effect

High Tracing Resistance

Alarm is activated when the heater resistance level increases above the NOMINAL RESISTANCE setting by more than the selected amount.

The HIGH TRACING RESISTANCE ALARM may be used to indicate an open or a high resistance connection or, when using constant wattage parallel cables, may indicate the failure of one or more heating zones. It may also be used to monitor a failed series-type cable or connection in 3-phase applications.

Low Tracing Resistance

Alarms at heater resistance levels which are below the NOMINAL RESISTANCE setting.

IMPORTANT: *This feature can be used effectively to guard against accidental paralleling of heating circuits. Care must be taken when using this alarm feature with heating cables that exhibit a variable resistance with temperature. Low resistance alarming may not be practical when the load has an increasing resistance with temperature (such as self-regulating cables).*

7.1.7 HTC Switch Failure Alarm

The purpose of the SWITCH FAILURE ALARM is to indicate that an output switch failure has occurred. The controller determines that if the output switch is turned off and there is load current present, then the output switch has failed closed and the alarm is latched on.

Modbus Address	Function Code	Description	Comments
23	1,5,15	Switch Failure	Alarm Status: 0 = Normal, 1 = Alarm Writing a 1 resets the alarm, writing 0 has no effect

IMPORTANT: *The SWITCH FAILURE ALARM SHOULD ALWAYS BE ENABLED. A high temperature condition as a result of a failed circuit can only be caused if the output switch fails closed. When an output switch fails closed, the controller cannot turn the tracer power off, therefore no protection features are available (ground fault trip, power limiting, etc.). If a SWITCH FAILURE ALARM is detected, the unit should be serviced immediately.*

7.1.8 HTC Device Reset Alarm

The DEVICE RESET ALARM is used to indicate:

1) Power to the HTC has been interrupted and subsequently restored.
2) A transient has caused the HTC's program to restart.
3) An internal condition has caused the HTC's program to restart.

Modbus Address	Function Code	Description	Comments
24	1,5,15	Device Reset	Alarm Status: 0 = Normal, 1 = Alarm Writing a 1 resets the alarm, writing 0 has no effect

IMPORTANT: *Normally the DEVICE RESET ALARM is left disabled since powering the controller off and on for maintenance or trouble-shooting would require the user to reset this alarm every time.*

7.1.9 HTC Limiting Alarms

These alarms are associated with the Current and Power Limit settings.

Modbus Address	Function Code	Description	Comments
25	1,5,15	Output Limiting	Alarm Status: 0 = Normal, 1 = Alarm Writing a 1 resets the alarm, writing 0 has no effect
26	1,5,15	Circuit Breaker Limiting	Alarm Status: 0 = Normal, 1 = Alarm Writing a 1 resets the alarm, writing 0 has no effect
34	1,5,15	Switch Limiting	Alarm Status: 0 = Normal, 1 = Alarm Writing a 1 resets the alarm, writing 0 has no effect

Output Limiting

This alarm indicates that the HTC is limiting the average amount of current/power that is applied to the trace circuit as defined by the MAXIMUM CURRENT LIMIT / MAXIMUM POWER LIMIT setting. The OUTPUT LIMIT MODE setting determines if this is a power-limiting or current-limiting alarm.

Circuit Breaker Limiting

The circuit breaker limiting feature is always enabled when using an SSR output switch and is intended to prevent the circuit breaker immediately upstream of the controller from tripping during a temporary over current condition. Enabling this alarm will only inform the user that circuit breaker limiting is currently active.

IMPORTANT: *This alarm may be considered an advisory alarm. If the measured current exceeds the level that would cause the upstream circuit breaker to release, the HTC will begin to switch the SSR ON and OFF rapidly to limit the average current to an acceptable level.*

Switch Limiting

This alarm will only inform the user that switch limiting is currently active and an excessively high current condition is present. The HTC will pulse its output switch for a small interval and read the resulting current. If the measured current exceeds the SWITCH CURRENT RATING setting, then the duty-cycle of its output switch will be varied so that an average current not exceeding the SWITCH CURRENT RATING setting is maintained.

IMPORTANT: *This alarm should normally be left enabled. Currents in this range cannot be considered normal and should be investigated.*

7.1.10 HTC Contactor Cycle Count Alarm

CONTACTOR CYCLE COUNT ALARM is activated if the number of on/off transitions of an EMR reaches or exceeds the CONTACTOR CYCLE COUNT ALARM LIMIT SETPOINT. This serves as a method to perform preventative maintenance on the EMR before a failure is likely to occur.

Modbus Address	Function Code	Description	Comments
27	1,5,15	Contactor Cycle Count	Alarm Status: 0 = Normal, 1 = Alarm Writing a 1 resets the alarm, writing 0 has no effect

7.1.11 HTC Digital Input Alarms

These alarms are associated with the Digital Input.

Modbus Address	Function Code	Description	Comments
28	1,5,15	Digital Input Local/Remote	Alarm Status: 0 = Normal, 1 = Alarm Writing a 1 resets the alarm, writing 0 has no effect
29	1,5,15	Digital Input Local Source Failure	Alarm Status: 0 = Normal, 1 = Alarm Writing a 1 resets the alarm, writing 0 has no effect

Digital Input Local/Remote

This alarm will activate when a state change at the Digital Input terminals is detected by the HTC. The DIGITAL INPUT LOCAL/REMOTE CONFIGURATION must be set to any of the following options.

1. Alarm when Digital Input Local/Remote Closed
2. Alarm when Digital Input Local/Remote Open

This alarm can be user selectable to be Latching or Non-Latching. If set to Non-Latching, the controller will automatically clear the alarm when the condition no longer exists. If set to Latching the alarm must be cleared by the user.

Digital Input Remote Source Failure

This alarm will occur when the HTC fails to receive a valid message from a remote NGC-40 module within the time interval defined by the parameter BROADCAST TIMEOUT.

The DIGITAL INPUT LOCAL/REMOTE SOURCE parameter must be set to CAN NETWORK I/O. See Section 7.10.2 HTC Digital Input Settings.

7.1.12 HTC Data Lost Alarms

These alarms indicate memory problems.

User

Modbus Address	Function Code	Description	Comments
30	1,5,15	User Configuration Data Lost	Alarm Status: 0 = Normal, 1 = Alarm Writing a 1 resets the alarm, writing 0 has no effect
31	1,5,15	Factory Configuration Data Lost	Alarm Status: 0 = Normal, 1 = Alarm Writing a 1 resets the alarm, writing 0 has no effect

Configuration Data Lost

The USER CONFIGURATION DATA LOST alarm indicates that the controller has either detected a failure in its non-volatile memory, or the user has performed a LOAD USER DEFAULTS command. This alarm indicates that the user configuration data has been reset to default values.

IMPORTANT: *The User Configuration Data Lost alarm cannot be disabled. If the user configuration data has not been intentionally reset (i.e. using the LOAD USER DEFAULTS command) this alarm may indicate a problem with the HTC, and may require a return to the factory for repair.*

Factory Configuration Data Lost

The FACTORY CONFIGURATION DATA LOST ALARM indicates that the controller has detected a failure in its non-volatile memory and the factory configuration data has been lost. The HTC will rebuild the database and return factory configuration data to default values.

IMPORTANT: *The FACTORY CONFIGURATION DATA LOST ALARM cannot be disabled. This memory stores some of the controller's configuration and calibration settings and the alarm will only be generated if the HTC software cannot bypass the failed area of its memory. This indicates an internal problem and the HTC should be replaced or returned to the factory for repair.*

7.1.13 HTC Load Shed Source Failure Alarm

This alarm will occur when the HTC fails to receive a valid message from a remote device providing Load Shed information within the time interval defined by the parameter BROADCAST TIMEOUT.

Modbus Address	Function Code	Description	Comments
32	1,5,15	Load Shed Source Failure	Alarm Status: 0 = Normal, 1 = Alarm Writing a 1 resets the alarm, writing 0 has no effect

7.1.14 HTC High Limit Cutout Alarm

This alarm will activate when the reading from any one of the 8 Temperature Sources exceeds the HIGH LIMIT CUTOUT SETPOINT. The TEMPERATURE SOURCE X CONFIGURATION must be using any one of the following options:

A. Not Used for Control, High Limit Cut-out Enabled
B. Used for Control, High Limit Cut-out Enabled

Modbus Address	Function Code	Description	Comments
33	1,5,15	High Limit Cutout	Alarm Status: 0 = Normal, 1 = Alarm Writing a 1 resets the alarm, writing 0 has no effect

7.1.15 HTC Heater Time Alarm

The HTC tracks the accumulated “on” time of the heat trace cable and will generate an alarm if this “on” time exceeds the HEATER TIME SETPOINT.

Modbus Address	Function Code	Description	Comments
35	1,5,15	Heater Time	Alarm Status: 0 = Normal, 1 = Alarm Writing a 1 resets the alarm, writing 0 has no effect

7.1.16 HTC Limiter Alarms

These alarms are associated with the installed LIMITER, if one is installed.

Modbus Address	Function Code	Description	Comments
36	1,5,15	Limiter Tripped	Alarm Status: 0 = Normal, 1 = Alarm Writing a 1 resets the alarm, writing 0 has no effect
37	1,5,15	Limiter Communication Failure	Alarm Status: 0 = Normal, 1 = Alarm Writing a 1 resets the alarm, writing 0 has no effect

Limiter Tripped

If any of the Limiter Temperature Readings exceeds the LIMITER SETPOINT TEMPERATURE the LIMITER TRIPPED ALARM will be set. This alarm is only active if there is a Limiter installed. See: 7.11 HTC Limiter Parameters

Limiter Communication Failure

If there is a communication failure between the HTC and the installed Limiter this alarm will be set. This alarm is only active when there is a Limiter installed.

7.2 HTC Alarm Masks

The Alarm Mask registers match 1:1 to the Alarm Status registers at Function 1, address 1. A 1 designates an enabled alarm, a 0 is a disabled alarm. Not all alarms can be disabled. Refer to the full Modbus Map located in the Appendices for detailed information on each Alarm Mask.

Modbus Address	Function Code	Description	Comments	Default
51	1,5,15	Control Temperature High	Alarm Mask: 0 = Disabled, 1 = Enabled	Disabled
…	…	….	…	…
87	1,5,15	Limiter Communication Failure	Alarm Mask: 0 = Disabled, 1 = Enabled	Enabled

7.3 HTC Alarm Latching

The Alarm Latching registers match 1:1 with the Alarm registers starting at Function 1,Address 1. Some alarms are user selectable to be Latching or Non-Latching. If set to Non-Latching, the controller will automatically clear the alarm when the condition no longer exists. If set to Latching the alarm must be cleared by the user.

Modbus Address	Function Code	Description	Comments	Default
101	1,5,15	Control Temperature High	0 = Latching, 1 = Non-Latching	Non-Latching
…	…	….	…	…
138	1,5,15	Control Temperature Failure	0 = Latching, 1 = Non-Latching	Latching

7.4 HTC Controller Setup Parameters

The Controller Setup Parameters include Load Shedding settings and the LOAD USER CONFIGURATION DEFAULTS command.

7.4.1 HTC Load Shedding

A Load Shed command from the Modbus Master overrides temperature control and forces the output of the control module off until reset by the Modbus Master. The following registers define whether Load Shedding is enabled on the control module, and which “zones” it belongs to.

Modbus Address	Function Code	Description	Comments	Default
155	1,5,15	Load Shedding Enabled	0 = No, 1 = Yes	No
156	1,5,15	Load Shedding Fail-safe Enabled	0 = No, 1 = Yes	No
157	1,5,15	Zone 1 Load Shedding Enabled	0 = Not Enabled, 1 = HTC is a member of Zone 1	Not Enabled
158	1,5,15	Zone 2 Load Shedding Enabled	0 = Not Enabled, 1 = HTC is a member of Zone 2	Not Enabled
159	1,5,15	Zone 3 Load Shedding Enabled	0 = Not Enabled, 1 = HTC is a member of Zone 3	Not Enabled
160	1,5,15	Zone 4 Load Shedding Enabled	0 = Not Enabled, 1 = HTC is a member of Zone 4	Not Enabled
161	1,5,15	Zone 5 Load Shedding Enabled	0 = Not Enabled, 1 = HTC is a member of Zone 5	Not Enabled
162	1,5,15	Zone 6 Load Shedding Enabled	0 = Not Enabled, 1 = HTC is a member of Zone 6	Not Enabled
163	1,5,15	Zone 7 Load Shedding Enabled	0 = Not Enabled, 1 = HTC is a member of Zone 7	Not Enabled
164	1,5,15	Zone 8 Load Shedding Enabled	0 = Not Enabled, 1 = HTC is a member of Zone 8	Not Enabled
165	1,5,15	Zone 9 Load Shedding Enabled	0 = Not Enabled, 1 = HTC is a member of Zone 9	Not Enabled
166	1,5,15	Zone 10 Load Shedding Enabled	0 = Not Enabled, 1 = HTC is a member of Zone 10	Not Enabled
167	1,5,15	Zone 11 Load Shedding Enabled	0 = Not Enabled, 1 = HTC is a member of Zone 11	Not Enabled
168	1,5,15	Zone 12 Load Shedding Enabled	0 = Not Enabled, 1 = HTC is a member of Zone 12	Not Enabled
169	1,5,15	Zone 13 Load Shedding Enabled	0 = Not Enabled, 1 = HTC is a member of Zone 13	Not Enabled
170	1,5,15	Zone 14 Load Shedding Enabled	0 = Not Enabled, 1 = HTC is a member of Zone 14	Not Enabled
171	1,5,15	Zone 15 Load Shedding Enabled	0 = Not Enabled, 1 = HTC is a member of Zone 15	Not Enabled

Load Shedding Enabled

This enables/disables load shedding on the controller.

Load Shedding Fail-safe Enabled

When Fail-safe is Enabled, and load shedding is currently active, if the CONTROL TEMPERATURE falls below the LOW CONTROL TEMPERATURE ALARM SETPOINT, the controller overrides the load shedding command and turns the output back on until the temperature rises above the low control temperature setpoint.

IMPORTANT: *Load shedding failsafe is always disabled for ambient control modes.*

Zone 1 to 16 Load Shedding Enabled

Configures the HTC for load shedding zones. There are 16 zones in the HTC controller. The HTC can be configured to be a member of any combination of these 16 zones. If the HTC receives a command to load shed on zone X, the HTC will begin load shedding only if the ZONE X LOAD SHEDDING ENABLED register is set to '1', otherwise no load shedding will occur.

7.4.2 HTC Load User Configuration Defaults

Resets all of the user default settings. The HTC will restore all values listed as "default" in the Modbus Map.

Modbus Address	Function Code	Description	Comments
173	1,5,15	Load User Configuration Defaults	Write 1 to load user configuration defaults, writing 0 is ignored Reads return 0

7.5 HTC Reset Maintenance Information

Writing a 1 to these write-only registers will clear the associated Highest/Lowest Recorded Value register in the Maintenance Information Function 4 section.

Modbus Address	Function Code	Description	Comments
185	5,15	Reset Control Max/Min Temperatures	Writing a 1 resets parameter, writing 0 has no effect
186	5,15	Reset Local Max/Min Temperatures	Writing a 1 resets parameter, writing 0 has no effect
187	5,15	Reset Power Accumulator	Writing a 1 resets parameter, writing 0 has no effect
188	5,15	Reset Highest Instantaneous Line Current Ever Measured	Writing a 1 resets parameter, writing 0 has no effect
189	5,15	Reset Highest Instantaneous Ground Fault Current Ever Measured	Writing a 1 resets parameter, writing 0 has no effect
190	5,15	Reset Contactor Cycle Count	Writing a 1 resets parameter, writing 0 has no effect
191	5,15	Reset Number of Hours In Use	Writing a 1 resets parameter, writing 0 has no effect
192	5,15	Reset Heater Timer	Writing a 1 resets parameter, writing 0 has no effect

Reset Control Max/Min Temperatures
Reset Local Max/Min Temperatures

Resets values for the the maximum and minimum temperatures seen by the HTC3.

Reset Power Accumulator

Resets the value for the total power consumed by the trace circuit.

Reset Highest Instantaneous Line Current Ever Measured

Resets the value for the highest line current detected by the HTC.

Reset Highest Instantaneous Ground Fault Current Ever Measured

Resets the value for highest ground fault current detected by the HTC.

Reset Contactor Cycle Count

Resets the value for the total number of on/off cycles the EMR has been activated.

Reset Number of Hours In Use

Resets the value for the total number of hours that the HTC has been powered up.

Reset Heater Timer

Resets the value for the total number of hours the tracing has been turned on for.

7.6 HTC Controller Status

These read-only registers show the status of the Alarm Output Relay.

Raw

Modbus Address	Function Code	Description	Comments
0	2	Raw Digital Input Local/Remote	0 = Open or 3.3V-24V 1 = Shorted (0V)
1	2	Raw Alarm Output	0 = No Alarm state 1 = Alarm state
2	2	Raw SSR Output	0 = Off, 1 = On
3	2	Raw Contactor Output	0 = Off, 1 = On

Digital Input Local/Remote

Shows the state of the Digital Input; 0 for open and 1 for shorted.

Raw Alarm Output

Shows the state of the Alarm Output; 0 for no alarm and 1 for in alarm state.

Raw SSR Output

Shows the state of the SSR Output; 0 for off and 1 for on.

Raw Contactor Output

Shows the state of the Contactor Output; 0 for off and 1 for on.

7.7 HTC Control Parameters

The Control Parameters define the SWITCH CONTROL MODE and system settings used to control power to the heat trace cable.

Modbus Address	Function Code	Description	Comments	Default
0	3,6,16	Control Temperature Setpoint	Signed integer in 10ths of Degree C Range: -80.0DegC to 700.0DegC	10.0DegC (100)
1	3,6,16	Switch Control Mode	Unsigned integer 0 = PROPORTIONAL (SSR) 1 = ON/OFF EMR 2 = ON/OFF SSR 3 = PASC EMR 4 = PASC SSR 5 = ALWAYS ON 6 = ALWAYS OFF	1 = ON/OFF EMR
2	3,6,16	Deadband	Signed integer in 10ths of Degree C Range: 1.0DegC (10) to 50.0DegC (500)	3.0DegC (30)
3	3,6,16	Proportional Band	Signed integer in 10ths of Degree C Range: 1.0DegC (10) to 50.0DegC (500)	2.0DegC (20)
4	3,6,16	Reserved		
5	3,6,16	PASC Min Ambient Temp	Unsigned integer in 10ths of Degree C Range: -73.0DegC to 51.0DegC (510)	-40DegC
6	3,6,16	PASC Min Pipe Size	Unsigned integer 0= 1.3 cm 1= 2.5 cm 2= >= 5.1 cm	1.3cm
7	3,6,16	PASC Power Adjust	Unsigned integer Range: 10-200%	100%

Control Temperature Set point

The CONTROL TEMPERATURE SETPOINT temperature is the value at which the Heat Trace Controller maintains the circuit temperature using one of the SWITCH CONTROL MODES. The CONTROL TEMPERATURE SETPOINT temperature is compared to the CONTROL TEMPERATURE. A decision is then made to turn on or turn off the output to control power to the heat trace cable.

This allows selection of the type of algorithm to be used by the HTC to maintain the Control Setpoint temperature. There are five different control algorithms available.

Options: = PROPORTIONAL (SSR)
ON/OFF EMR
ON/OFF SSR
PASC EMR
PASC SSR
ALWAYS ON
ALWAYS OFF

Default: On/Off EMR

Proportional (SSR) on the HTC is implemented as follows:

When using SSRs to directly control the power applied to a trace circuit, the output may be switched on/off very rapidly. The controller implements proportional temperature control on a cycle by cycle basis (50 or 60 Hz power line cycle). This algorithm monitors the temperature of the heating circuit and compares it to the CONTROL TEMPERATURE SETPOINT. If the temperature of the control sensor is at or below the CONTROL TEMPERATURE SETPOINT, then power is applied to the trace with a duty cycle of 100% -- the controller output is full on. If the temperature sensed by the control sensor is equal to or greater than the CONTROL TEMPERATURE SETPOINT + the Proportional Band setting, then the controller output will have a duty cycle of 0% -- the output will be off. The temperature of the control sensor is constantly monitored and the output duty cycle is adjusted proportionally according to where the temperature falls within the 0% - 100% band.

Proportional Control Temperature Band

Control Sensor Temperature	Duty Cycle
Setpoint+proportional band	0%
Setpoint+proportional band/2	50%
Setpoint	100%

ON/OFF EMR and ON/OFF SSR control on the HTC is implemented as follows:

When using the HTC in an application where the controller is used to open and close an EMR, proportional control cannot be used. In these cases a On/Off control algorithm is used. The output duty cycle is not controlled, instead the output is either fully on or completely off. The user can set the DEADBAND value. The controller monitors the temperature of the trace circuit and compares it to the CONTROL TEMPERATURE SETPOINT as in the proportional control. If the control sensor temperature is above the CONTROL TEMPERATURE SETPOINT by more than the DEADBAND value, the output is turned off. If the control sensor temperature falls below the CONTROL TEMPERATURE SETPOINT the output is turned on. This is a very simple control algorithm but it works very effectively in heat trace applications where the temperature of a traced system changes relatively slowly.

Deadband Temperature Band

Control Sensor Temperature	Output State
Setpoint+deadband	Off
Setpoint	On

When the control sensor temperature is within the deadband, the output does not change its state. Also, when using ON/OFF EMR control an EMR is not allowed to toggle faster than every 2 seconds. If an AC alarm with an alarm filter time greater than 0 is detected, the EMR will not toggle until the alarm filter time has expired.

PASC EMR and PASC SSR control on the HTC is implemented as follows:

PASC takes advantage of the fact that the heat loss from a pipe is proportional to the temperature difference between the pipe and the ambient air. This is true regardless of heater type, insulation type, or pipe size. Once the heat tracing and insulation on a pipe has been designed to balance heat input with heat loss and maintain a particular temperature, the main variable in controlling the pipe temperature becomes the ambient air temperature. The HTC has a control algorithm that uses the measured ambient temperature, desired maintain temperature, minimum ambient temperature assumption used during design, and size of the smallest pipe diameter to calculate how long the heater should be on or off to maintain a near-constant pipe temperature.

ALWAYS ON

The relay output is switched on, power is applied to the heater, the relay output is left on. Alarms are still active.

ALWAYS OFF

The relay output is switched off, power is removed from the heater, the relay output is left off. Alarms are still active.

Deadband

The controller monitors the temperature of the heating circuit and compares it to the CONTROL TEMPERATURE. If the CONTROL TEMPERATURE is above the CONTROL TEMPERATURE SETPOINT by more than the DEADBAND value, the output is turned off. If the CONTROL TEMPERATURE falls below the CONTROL TEMPERATURE SETPOINT the output is turned on.

Proportional Band

The controller monitors the temperature of the heating circuit and compares it to the CONTROL TEMPERATURE SETPOINT. If the CONTROL TEMPERATURE is at or below the CONTROL TEMPERATURE SETPOINT the power is applied to the trace with a duty cycle of 100% -- the controller output is full on. If the CONTROL TEMPERATURE is equal to or greater than the CONTROL TEMPERATURE SETPOINT + PROPORTIONAL BAND setting, then the controller output will have a duty cycle of 0% -- the output will be off. The temperature of the control sensor is constantly monitored and the output duty cycle is adjusted proportionally according to where the temperature falls within the 0% - 100% band.

Proportional Control Temperature Band

Control Sensor Temperature	Duty Cycle
Setpoint + proportional band	0%
Setpoint + proportional band / 2	50%
Setpoint	100%

For use with the three proportional control modes only.

IMPORTANT: *When using Series-type, Constant wattage, or Self-regulating tracers in an ambient temperature control application, significant energy savings may be realized by setting the PROPORTIONAL BAND to match the expected range of operating ambient temperatures. Heat trace design is normally done assuming worst-case conditions, where 100% of the design output power is required to maintain the desired minimum temperature. When the ambient temperature is above the design minimum, but some heat is still required, adjusting the PROPORTIONAL BAND width accordingly will allow only the amount of power required by the application to be consumed, while maintaining the minimum required temperature.*

PASC Min Ambient Temp

The PASC MIN AMBIENT TEMP is the “lowest ambient temperature” that was used when the heat-tracing system was designed. The entered value should agree with the value used by the design engineer to ensure that the heat tracing system was sized correctly.

PASC Min Pipe Size

PASC MIN. PIPE SIZE is the diameter of the smallest heat-traced pipe in the group controlled by this circuit. Small diameter pipes heat up and cool down more rapidly than larger diameter pipe, therefore, the PASC duty cycle is calculated over a shorter time base. Larger diameter pipes heat and cool less rapidly, so the on/off periods for the heater system can be stretched over a longer period. If EMRs are being used to control the heater circuit, the longer time base reduces the number of EMR on/off cycles and extends the EMR life.

PASC Power Adjust

This allows the PASC control to be adjusted when the heating cable output is greater than the design assumption, or if the pipe insulation proves to be more efficient than assumed. Pipe temperature may run higher or lower than desired if the heating cable has a different output than required to offset the heat loss. The PASC POWER ADJUST parameter enables a reduction or an increase in the heat-tracing effective power by entering a value less or greater than 100%.

IMPORTANT: *If improperly used, the PASC POWER ADJUST parameter can cause the piping to get too cold or too hot. If unsure, leave at 100%. Do not change this value unless an engineer calculates the temperature impact on the system and determines that it is safe to do so. Be particularly cautious if the loop has more than one diameter of pipe or type of heat tracing. Contact a nVent representative for assistance with this factor.*

7.7.1 HTC Output Limit Mode

Two Output Limit modes are available to limit the average power or current that is applied to the heating cable. The controller measures the voltage and/or current of the tracing circuit and will vary its output switch to limit the amount of power or current applied to the trace. To the set the limit value see MAXIMUM POWER SET POINT, or MAXIMUM CURRENT LIMIT settings.

Modbus Address	Function Code	Description	Comments	Default
8	3,6,16	Output Limit Mode	Unsigned integer 0 = Disable Limiting 1 = Power Limiting 2 = Current Limiting	0 = Disable

7.7.2 HTC Test Tracing

The TEST TRACING feature provides an easy method of temporarily overriding the temperature control, without having to modify the CONTROL TEMPERATURE SETPOINT or any other configuration parameter. The function will force the output switch on for the specified interval. After the test time has expired, the HTC will automatically revert back to normal operation.

Modbus Address	Function Code	Description	Comments	Default
9	3,6,16	Test Tracing	Length of time the controller should hold its output on for unsigned integer seconds Range: 0 - Cancel Test Tracing 1 to 300 seconds	

IMPORTANT: *This feature only overrides temperature control, it does not override other control parameters such as power limiting.*

7.8 HTC Temperature Setup

The Temperature Setup registers define Minimum and Maximum limits and other settings for all Temperature Sources.

7.8.1 HTC Control Mode Parameters

These registers define how the Control Temperature is calculated and what the controller will do if the Control Temperature sensors fail.

Modbus Address	Function Code	Description	Comments	Default
20	3,6,16	Temperature Control Mode	Unsigned integer 0 = N/A 1 = Average 2 = Lowest	2 = Lowest
21	3,6,16	Temperature Fail Mode	Unsigned integer 0 = Fail Off 1 = Fail On 2 = Fixed % 3 = Last %	0 = Fail Off
22	3,6,16	Temperature Fail Mode Percentage	Unsigned integer Range: 1 - 99 %	50%

Temperature Control Mode

The TEMPERATURE CONTROL MODE allows the selection of one of two possible Temperature control modes for the controller.

With a Temperature Control Mode of AVERAGE or LOWEST the controller will take the Average or Lowest temperature reading from all configured Temperature Sources and cycle the heater ON or OFF to maintain the CONTROL TEMPERATURE SETPOINT. If either Temperature Source should fail, the controller will transfer control to the remaining “good” Temperature Source and generate the appropriate TEMPERATURE SOURCE FAILURE ALARM (assuming that the alarm is enabled). If all Temperature Sources fail, the controller will turn the heater OFF or ON as determined by the TEMPERATURE FAIL MODE setting.

Temperature Fail Mode

This parameter determines whether the HTC turns the output switch ON, OFF, Fixed %, or Last % if all configured Temperature sensors which are set to “Used For Control” fail to provide a valid temperature. Fixed % will take the value entered in the TEMPERATURE FAIL MODE PERCENTAGE registers, while Last % will use the last calculated duty cycle values (Proportional Modes only).

Temperature Fail Mode Percentage

When Fixed % is chosen for a TEMPERATURE FAIL MODE, this parameter is used set the output duty cycle.

7.8.2 HTC Control Temperature Alarm Setpoints

These registers define the Minimum and Maximum limits for the Control Temperature. If these limits are exceeded an alarm will be set.

Modbus Address	Function Code	Description	Comments	Default
23	3,6,16	Control Temperature High Alarm Setpoint	Signed integer in 10ths of Degree C Range: -80.0DegC to 700.0DegC (7000)	100.0DegC (1000)
24	3,6,16	Control Temperature Low Alarm Setpoint	Signed integer in 10ths of Degree C Range: -80.0DegC to 700.0DegC (7000)	5.0DegC (50)
25	3,6,16	Control Temperature High Alarm Filter	Unsigned integer in seconds Range : 0 to 59940 seconds	0
26	3,6,16	Control Temperature Low Alarm Filter	Unsigned integer in seconds Range : 0 to 59940 seconds	0

Control Temperature High Alarm Setpoint

If the HTC computes a CONTROL TEMPERATURE above this threshold, it generates a CONTROL TEMPERATURE HIGH ALARM, assuming the alarm is enabled.

Control Temperature Low Alarm Setpoint

If the HTC computes a Control Temperature below this threshold, it generates a Control Temperature Low Alarm, assuming the alarm is enabled.

Control Temperature High Alarm Filter

The CONTROL TEMPERATURE HIGH ALARM FILTER will prevent CONTROL TEMPERATURE HIGH ALARM from being indicated until the corresponding alarm condition has existed for the duration of the CONTROL TEMPERATURE HIGH ALARM FILTER time.

IMPORTANT: *If an alarm condition appears and then disappears before the alarm filter time has expired, the filter timer is reset and the alarm condition must exist again for the entire alarm filter time before the corresponding alarm will be indicated.*

If the user resets an alarm while the alarm condition is still exists, then the alarm will not be indicated again until the entire alarm filter time has expired.

Control Temperature Low Alarm Filter

The CONTROL TEMPERATURE LOW ALARM FILTER will prevent CONTROL TEMPERATURE LOW ALARM from being indicated until the corresponding alarm condition has existed for the duration of the CONTROL TEMPERATURE LOW ALARM FILTER time.

7.8.3 HTC Local Temperature Sensor Settings and Setpoints

These registers define the Minimum and Maximum limits for the Local Temperature Sensor. If these limits are exceeded an alarm will be set.

Modbus Address	Function Code	Description	Comments	Default
27	3,6,16	Local Temperature Sensor Tag 0	NGC40-HTC Local RTD Tag No validity checking is done on the character.	"NGC40-HTC-RTD1-" followed by the device CAN ID
…	…	…		
66	3,6,16	Local Temperature Sensor Tag 39		
67	3,6,16	Local Temperature Sensor Type	Unsigned integer 0 = Not Used 1 = 3 wire 100 Ohm Platinum 2 = 2 wire 100 Ohm nickel iron 3 = 2 wire 100 Ohm nickel	1 = 3 wire 100 Ohm Platinum
68	3,6,16	Local RTD Lead Resistance	Unsigned integer in 100ths of Ohms Range: 0 to 20.00Ω (for nickel iron only)	0
69	3,6,16	Local Temperature Sensor High Alarm Setpoint	Signed integer in 10ths of Degree C Range: -80.0DegC to 700.0DegC (7000)	100.0DegC
70	3,6,16	Local Temperature Sensor Low Alarm Setpoint	Signed integer in 10ths of Degree C Range: -80.0DegC to 700.0DegC (7000)	5.0DegC
71	3,6,16	Local Temperature Sensor High Alarm Filter	Unsigned integer in seconds Range : 0 to 59940 seconds	0
72	3,6,16	Local Temperature Sensor Low Alarm Filter	Unsigned integer in seconds Range : 0 to 59940 seconds	0
73	3,6,16	High Limit Cutout Setpoint	Signed integer in 10ths of Degree C Range: -80.0DegC to 700.0DegC (7000)	700.0DegC (7000)

Local Temperature Sensor Tag

A 40 character tag may be assigned to the Local RTD connected directly to the HTC to allow it to be easily associated with a control panel, location, or area.

Local Temperature Sensor Type

This parameter specifies the type of RTD that is connected to directly to the HTC.

IMPORTANT: *If a 2 wire 100 Ω Nickel Iron (NI-FE) RTD is selected then the LOCAL RTD LEAD RESISTANCE must be entered manually.*

Local RTD Lead Resistance

This parameter specifies the lead resistance of a 2 wire Nickel Iron RTD connected directly to the HTC. (For NI-FE RTDs only)

Local Temperature Sensor High Alarm Setpoint

If the local RTD connected directly to the HTC reads a temperature above this threshold, it generates a LOCAL TEMPERATURE SENSOR HIGH ALARM, assuming the alarm is enabled.

Local Temperature Sensor Low Alarm Setpoint

If the local RTD connected directly to the HTC reads a temperature below this threshold, it generates a LOCAL TEMPERATURE SENSOR LOW ALARM, assuming the alarm is enabled.

Local Temperature Sensor High Alarm Filter

The Local TEMPERATURE SENSOR HIGH ALARM FILTER will prevent LOCAL TEMPERATURE SENSOR HIGH ALARM FROM being indicated until the corresponding alarm condition has existed for the duration of the LOCAL TEMPERATURE SENSOR HIGH ALARM FILTER time.

IMPORTANT: *If an alarm condition appears and then disappears before the alarm filter time has expired, the filter timer is reset and the alarm condition must exist again for the entire alarm filter time before the corresponding alarm will be indicated.*

If the user resets an alarm while the alarm condition is still exists, then the alarm will not be indicated again until the entire alarm filter time has expired.

Local Temperature Sensor Low Alarm Filter

The LOCAL TEMPERATURE SENSOR LOW ALARM FILTER will prevent LOCAL TEMPERATURE SENSOR LOW ALARM from being indicated until the corresponding alarm condition has existed for the duration of the LOCAL TEMPERATURE SENSOR HIGH ALARM FILTER time.

High Limit Cutout Setpoint

This parameter defines the HIGH LIMIT CUTOUT SETPOINT for each of the 8 Temperature Sources where the Temperature Source configuration includes HIGH LIMIT CUTOUT ENABLED.

This feature will override the CONTROL TEMPERATURE SETPOINT temperature and force the controller output OFF if any one of the 8 Temperature Sources temperature exceeds the High Limit Cut-Out temperature setting.

IMPORTANT: *The high limit cutout feature overrides an auto-cycle test. A pending auto-cycle will be initiated immediately after the sensed high temperature drops below the HIGH LIMIT CUTOUT SETPOINT.*

If a TEMPERATURE SOURCE FAILURE ALARM occurs and the high limit cutout feature is enabled, the switch output will latch OFF regardless of the TEMPERATURE CONTROL MODE setting or the TEMPERATURE FAIL MODE setting.

7.8.4 HTC Temperature Source Setup

These registers define the source and setup for Temperature Sources 1-8.

Modbus Address	Function Code	Description	Comments	Default
85	3,6,16	Temperature Source 1 Mode	Unsigned integer 0 = Not Used 1 = Local 2 = Remote 3 = CAN Network	1=Local
86	3,6,16	Temperature Source 1 Local Setup	Unsigned integer Temperature Input Number (1 = first sensor)	1
87	3,6,16	Temperature Source 1 Local Setup	Unsigned integer Not Used - Must write 0.	0
88	3,6,16	Temperature Source 1 Local Setup	Unsigned integer Not Used - Must write 0.	0
89	3,6,16	Temperature Source 1 Remote Setup Gateway Modbus Address / Gateway Port Number	Unsigned integer MSB = Gateway Modbus Address - Range : 1 to 247 LSB = Gateway Port Number that RMM is connected to - Range : 1 to 4	MSB = 0, LSB = 0
90	3,6,16	Temperature Source 1 Remote Setup RMM Modbus Address / RMM Input Number	Unsigned integer MSB = RMM Modbus Address - Range : 1 to 247 LSB = RMM Input Number - Range : 1 to 8	MSB = 0, LSB = 0
91	3,6,16	Temperature Source 1 Remote Setup	Unsigned integer Not Used - Must write 0.	0
92	3,6,16	Temperature Source 1 CAN Network Setup CAN Network Device ID (MSW)	Unsigned integer CAN Device ID	0
93	3,6,16	Temperature Source 1 CAN Network Setup CAN Network Device ID (LSW)		
94	3,6,16	Temperature Source 1 CAN Network Setup Temperature Input	Unsigned integer Temperature Input Number Range: 1 to 4	0

		Number		
95	3,6,16	Temperature Source 1 Configuration	Unsigned integer 0 = For Monitoring Purposes Only, Not Used for Control, High Limit Cut-out Disabled 1 = Used for Control, High Limit Cut-out Disabled 2 = Not Used for Control, High Limit Cut-out Enabled 3 = Used for Control, High Limit Cut-out Enabled	1 = Used for Control, High Limit Cut-out Disabled

IMPORTANT: *Function 3, addresses 85-94 must be written as a group. There are 8 temperature sources, see Appendix B: HTC Modbus Map for complete Modbus listing.*

Temperature Source 1 to 8 Mode

The HTC supports 8 Temperature Sources. Each source may be configured to obtain its temperature from the Local RTD connected directly to the HTC, an RTD connected to a Remote device connected to the RS-485 network located outside of the panel, or from one of the NGC-40 modules (NGC-40-HTC, NGC-40-HTC3, NGC-40-IO) within the panel.

Temperature Source 1 to 8 Local Setup

If the Temperature Source Mode is set to LOCAL, this parameter defines the specific RTD connected to the HTC. Since the current version of the NGC-40-HTC supports only one local RTD connected directly the RTD input, this parameter can only be set to 1.

Temperature Source 1 to 8 Remote Setup
Gateway Modbus Address / Gateway Port Number

If the Temperature Source Mode is set to REMOTE, this parameter defines specifics of the device connected to the RS-485 network that will be providing RTD temperature information

Temperature Source 1 to 8 CAN Network Setup
CAN Network Device ID

If the Temperature Source Mode is set to CAN Network, this parameter defines specifics of the module connected to the NGC-40-BRIDGE that will be providing RTD temperature information. The module may be NGC-40-HTC, NGC-40-HTC3, NGC-40-IO.

Temperature Source 1 to 8 Configuration

0 = For Monitoring Purposes Only, Not Used for Control, High Limit Cut-out Disabled
1 = Used for Control, High Limit Cut-out Disabled
2 = Not Used for Control, High Limit Cut-out Enabled
3 = Used for Control, High Limit Cut-out Enabled

When enabled (Configuration = 2 or 3), the TS 1 HIGH LIMIT CUTOUT feature will override the CONTROL TEMPERATURE SETPOINT and force the controller output off if the TS 1 reading exceeds the HIGH LIMIT CUTOUT temperature setting. This is a non-latching condition, so once the TS 1 reading drops below the HIGH LIMIT CUTOUT TEMPERATURE setting, the controller will resume normal operation. If the Temperature Source is set as USED FOR CONTROL (Configuration = 1 or 3) then the Temperature Reading will be used to calculate the CONTROL TEMPERATURE. If not, it is reported and monitored for alarms, but not used for Control calculations.

IMPORTANT: *The TS 1 HIGH LIMIT CUTOUT feature overrides an auto-cycle test. A pending auto-cycle will be initiated immediately after the TS 1 temperature drops below the HIGH LIMIT CUTOUT temperature setting.*

If a TS 1 FAILURE ALARM occurs and the TS 1 HIGH LIMIT CUTOUT feature is enabled, the switch output will latch off regardless of the CONTROL MODE setting or the TEMPERATURE FAIL MODE setting.

7.9 HTC AC Analog Parameters

The AC Analog Parameters include Line Current, Ground Fault Current, Tracing Resistance and Limiting settings.

IMPORTANT: *If an alarm condition appears and then disappears before the alarm filter time has expired, the filter timer is reset and the alarm condition must exist again for the entire alarm filter time before the corresponding alarm will be indicated.*

If the user resets an alarm while the alarm condition is still exists, then the alarm will not be indicated again until the entire alarm filter time has expired.

7.9.1 Line Current Alarms

These registers define the Minimum and Maximum limits for the Line Current. If these limits are exceeded an alarm will be set.

High Line Current Alarm Filter

Modbus Address	Function Code	Description	Comments	Default
245	3,6,16	High Line Current Alarm Filter	Unsigned integer Range: 0 to 12 seconds	0
246	3,6,16	Low Line Current Alarm Filter	Unsigned integer Range: 0 to 12 seconds	0
247	3,6,16	High Line Current Alarm Setpoint	Unsigned integer in 100ths of Amps Range: 0.30A (30) to 60.00A (6000)	30.00A (3000)
248	3,6,16	Low Line Current Alarm Setpoint	Unsigned integer in 100ths of Amps Range: 0.30A (30) to 60.00A (6000)	1.00A (100)

Low Line Current Alarm Filter

The HIGH LINE CURRENT ALARM FILTER will prevent HIGH LOAD CURRENT ALARMS from being indicated until a high current condition has existed for the duration of the HIGH CURRENT ALARM FILTER time.

Low Line Current Alarm Filter

The LOW LINE CURRENT ALARM FILTER will prevent LOW LINE CURRENT ALARMS from being indicated until a low current condition has existed for the duration of the LOW LINE CURRENT ALARM FILTER time.

High Line Current Alarm Setpoint

If the output current is above the HIGH LINE CURRENT ALARM SETPOINT, the HTC generates a HIGH LINE CURRENT ALARM.

Low Line Current Alarm Setpoint

If the output current is below the LOW LINE CURRENT ALARM SETPOINT, the HTC generates a LOW LINE CURRENT ALARM.

7.9.2 HTC Ground Fault Current Alarms

These registers define the Minimum and Maximum limits for the Ground Fault Current. If these limits are exceeded an alarm will be set.

Modbus Address	Function Code	Description	Comments	Default
249	3,6,16	High GF Current Alarm Filter	Unsigned integer Range: 0 to 12 seconds	0
250	3,6,16	High GF Current Alarm Setpoint	Unsigned integer in 10ths of mAmps Range: 10.0mA (100) to 250.0mA (2500)	20.0mA (200)
251	3,6,16	Ground Fault Trip Current Setpoint	Unsigned integer in 10ths of mAmps Range: 10.0mA (100) to 250.0mA (2500)	30.0mA (300)

High GF Current Alarm Filter

The HIGH GF CURRENT ALARM FILTER will prevent HIGH GF CURRENT ALARMS from being indicated until a high GF current condition has existed for the duration of the HIGH GFI ALARM FILTER time.

High GF Current Alarm Setpoint

If the ground fault current measured by the HTC exceeds the HIGH GF CURRENT ALARM SETPOINT, a HIGH GF CURRENT ALARM is generated.

Ground Fault Trip Current Setpoint

This value sets the upper limit of allowable ground fault leakage current. Exceeding this limit will result in the output switch being latched off and the GROUND FAULT TRIP ALARM activated to indicate a ground fault condition.

CAUTION: IN ORDER TO IMPLEMENT A GROUND FAULT TRIP FUNCTION, ALL NON-GROUNDED POWER CONDUCTORS MUST BE OPENED UPON DETECTION OF A GROUND FAULT CONDITION.

IMPORTANT: *National Electrical Codes may require that all legs of non-neutral based power sources be opened upon detection of a Ground Fault. Multi-pole switch configurations should be used on non-neutral based power systems. Check the requirements with your local Electrical Authority.*

7.9.3 HTC Tracing Resistance Alarms

These registers define the Minimum and Maximum limits for the Tracing Resistance. If these limits are exceeded an alarm will be set.

High

Modbus Address	Function Code	Description	Comments	Default
252	3,6,16	High Tracing Resistance Alarm Filter	Unsigned integer Range: 0 to 12 seconds	0
253	3,6,16	Low Tracing Resistance Alarm Filter	Unsigned integer Range: 0 to 12 seconds	0
254	3,6,16	High Tracing Resistance Deviation	Unsigned integer Range: 1% to 250%	50%
255	3,6,16	Low Tracing Resistance Deviation	Unsigned integer Range: 1% to 100%	50%
256	3,6,16	Nominal Tracing Resistance (MSW)	Unsigned integer in 100ths of Ohms Range: 0.8 Ohms (80) to 2500.00 Ohms (250000)	6.00 Ohms (600)
257	3,6,16	Nominal Tracing Resistance (LSW)		

Tracing Resistance Alarm Filter

The HIGH TRACING RESISTANCE ALARM FILTER will prevent HIGH RESISTANCE ALARMS from being indicated until a high resistance condition has existed for the duration of the HIGH RESISTANCE ALARM FILTER time.

Low Tracing Resistance Alarm Filter

The LOW TRACING RESISTANCE ALARM FILTER will prevent LOW RESISTANCE ALARMS from being indicated until a low resistance condition has existed for the duration of the LOW RESISTANCE ALARM FILTER time.

High Tracing Resistance Deviation

Alarms heater resistance levels which have increased from the NOMINAL RESISTANCE setting by more than the HIGH TRACING RESISTANCE DEVIATION setting. The HIGH RESISTANCE ALARM may be used to indicate an open or a high resistance connection or, when using constant wattage parallel cables, may indicate the failure of one or more heating zones. It may also be used to monitor a failed series-type cable or connection in 3-phase applications while minimizing nuisance alarms created by voltage fluctuations.

IMPORTANT: *Care must be taken when using this alarm feature with heating cables that exhibit a variable resistance with temperature. High resistance alarming may not be as effective if the load has a decreasing resistance with temperature.*

HIGH RESISTANCE ALARMS will only be generated if the output switch is on.

Low Tracing Resistance Deviation

Alarms heater resistance levels which have decreased from the NOMINAL RESISTANCE setting by more than the Low Tracing Resistance Deviation setting.

Nominal Tracing Resistance

This parameter defines the nominal expected heater resistance. A value must be entered by the user to allow the HIGH and LOW TRACING RESISTANCE ALARMS to be used. Once the controller and the heating cable have been installed, the following procedure should be used to determine the NOMINAL RESISTANCE setting:

- Adjust the CONTROL SETPOINT temperature to turn on the output switch.
- Allow the load to come up to design temperature and its power consumption to stabilize.
- Monitor the RESISTANCE reading and record its value. Return the CONTROL TEMPERATURE SETPOINT temperature to its proper setting.
- Enter the recorded resistance value as the NOMINAL RESISTANCE setting.

IMPORTANT: *The setup procedure outlined above may have to be repeated a number of times to arrive at a correct NOMINAL RESISTANCE setting. This value will be affected by the heating cable temperature, which in turn is affected by ambient temperature, insulation level, a full or empty pipe or vessel, etc.*

7.9.4 HTC Current and Power Limiting Settings

These registers define some Current Ratings, and Current and Power Limits. If these limits are exceeded an alarm will be set.

Modbus Address	Function Code	Description	Comments	Default
260	3,6,16	Circuit Breaker Type	Unsigned integer 0 = NEMA 1 = Type B 2 = Type C 3 = Type D	0 = NEMA
261	3,6,16	Circuit Breaker Current Rating	Unsigned integer in 100ths of Amps Range: 0.30A (30) to 60.00A (6000)	30.00A
262	3,6,16	SSR Rating	Unsigned integer in 100ths of Amps Range: 0.30A (30) to 60.00A (6000)	30.00A (3000)
268	3,6,16	Voltage	Unsigned integer in 10ths of Volts Fixed voltage Range: 80.0V to 700.0V	120.0V
269	3,6,16	Frequency	Unsigned integer in Hertz Fixed frequency Range: 45Hz to 65Hz	60Hz

270	3,6,16	Maximum Power Set point (MSW)	Unsigned integer in Watts Range: 3 W (3) to 42000 W (42000)	42000W
271	3,6,16	Maximum Power Set point (LSW)		
272	3,6,16	Maximum Current Limit	Unsigned integer in 100ths of Amps Range: 0.30A (30) to 60.00A (6000)	60.00A (6000)

Circuit Breaker Type

Selects the circuit breaker curve to be used when performing circuit breaker current limiting. Each type of breaker has a different allowance for brief over-currents and this parameter must be selected to match the breaker used in the application.

Circuit Breaker Current Rating

The CIRCUIT BREAKER CURRENT RATING setting helps prevent in-rush induced nuisance tripping of the circuit breaker immediately upstream of the controller. The HTC evaluates the square of the current related to time (I^2T) and adjusts the output duty cycle accordingly, limiting the amount of current to an acceptable level.

IMPORTANT: *This feature SHOULD NOT be used to reduce the size of a circuit breaker or increase the maximum heating cable length. It can prevent nuisance trips due to incorrect design or factors prevalent outside those considered by the design.*

Switch (SSR) Current Rating

The SWITCH CURRENT RATING setting defines the current rating of the output switch. It is used by the controller to limit the maximum average current that will be allowed to flow to the load before it begins to adjust the output duty cycle, limiting the amount of current to an acceptable level.

Fixed Voltage

The current version of the NGC-40-HTC does not monitor the line voltage. This parameter specifies the voltage value that the HTC should use when reporting the trace voltage, and calculating trace resistance and trace power.

Fixed Frequency

The current version on the NGC-40-HTC does not monitor the line frequency. This parameter specifies the line frequency value that the HTC should use for calculating timing for proportional SSR control.

Maximum Power Setpoint

This user selectable level limits the maximum amount of power applied to a heat trace circuit. This is an average power calculated by the controller using the average current and the FIXED VOLTAGE setting. The HTC switches the output on and off rapidly to limit the average current to an appropriate level. The MAXIMUM POWER level may be adjusted to eliminate step-down transformers, lower the effective output wattage of a cable, or implement energy management of the heat trace circuit.

IMPORTANT: *This function may be set within reasonable limits for the particular tracer being powered. The effective resolution of the setting is limited to 1/30th of the calculated full on power.*

Do not set the MAXIMUM POWER Setpoint below full output for applications that do not require control of power.

Maximum Current Limit

This user selectable level limits the maximum amount of current applied to a heat trace circuit. This is an average current calculated by the controller. The HTC switches the output on and off rapidly to limit the average current to an appropriate level.

7.10 HTC Controller Setup Parameters

These registers define some additional settings relating directly to the HTC.

7.10.1 HTC Controller Tag

A 40 character TAG may be assigned to a HTC to allow it to be easily associated with a control panel, location, or area.

Modbus Address	Function Code	Description	Comments	Default
285	3,6,16	HTC Tag 0	NGC40-HTC Tag No validity checking is done on the character.	"NGC40-HTC-" followed by the device CAN ID
…	…	…		
324	3,6,16	HTC Tag 39		

7.10.2 HTC Digital Input Settings

These settings are associated with the Digital Input.

Modbus Address	Function Code	Description	Comments	Default
325	3,6,16	Digital Input Local/Remote Source	Unsigned integer 0 = Not Used 1 = Local (HTC) 2 = CAN Network I/O	1 = Local
326	3,6,16	Digital Input Local Source CAN ID (MSW)	Unsigned integer Used only if Digital Input Local/Remote is CAN Network I/O	0
327	3,6,16	Digital Input Local Source CAN ID (LSW)		
328	3,6,16	Digital Input Local/Remote Configuration	Unsigned integer 0 = Not Used 1 = Alarm when Digital Input Local/Remote Closed 2 = Alarm when Digital Input Local/Remote Open 3 = Force Off when Digital Input Local/Remote Closed 4 = Force Off when Digital Input Local/Remote Open 5 = Force On when Digital Input Local/Remote Closed 6 = Force On when Digital Input Local/Remote Open	0 = Not Used

Digital Input Local/Remote Source

The HTC supports a Digital Input that may come from one of two sources. The first being the Local Digital Input on the HTC module, the second from a (remote) NGC-40 module (NGC-40-HTC, NGC-40-HTC3, NGC-40-IO) located within the panel.

Digital Input Local/Remote Source CAN ID

If the chosen DIGITAL INPUT LOCAL / REMOTE SOURCE is Remote this parameter must match the Module ID of the NGC-40 module with the desired Digital Input.

Digital Input Local/Remote Configuration

This parameter defines the function of the Digital Input.

7.10.3 HTC Auto-Cycle Interval

AUTO-CYCLE INTERVAL is the number of hours between successive heating circuit integrity tests. This feature turns on the heat tracing for a ten second period every AUTO-CYCLE INTERVAL. The Auto-Cycle test can help detect problems with the heating system during a time when the system would normally be turned off.

Modbus Address	Function Code	Description	Comments	Default
329	3,6,16	Auto-Cycle Interval	Unsigned integer hours Range: 0 = Disabled 1 to 750 hours.	0 = Disabled

IMPORTANT: *If an AC ALARM becomes active during an auto-cycle, but the AUTO-CYCLE INTERVAL expires prior to the corresponding ALARM FILTER time, then auto-cycling will continue until the ALARM FILTER time has elapsed.*

For the earliest possible alarming of heating circuit problems the AUTO-CYCLE INTERVAL should be set to a small value.

7.10.4 HTC Contactor Cycle Count Alarm Setpoint

This parameter sets the limit of on/off transitions an EMR needs to reach or exceed before a CONTACTOR COUNT ALARM becomes active. This serves as a method to perform preventative maintenance on the EMR before a failure is likely to occur.

Modbus Address	Function Code	Description	Comments	Default
330	3,6,16	Contactor Cycle Count Alarm Limit Setpoint (MSW)	Unsigned integer Range: 0 to 999999	100000
331	3,6,16	Contactor Cycle Count Alarm Limit Setpoint (LSW)		

IMPORTANT: *Writing a '0' to this parameter is for testing and will produce a CONTACTOR CYCLE COUNT ALARM for any Contactor Cycle Count, any time this alarm is enabled.*

7.10.5 HTC Alarm Output Settings

These registers define the Alarm Output settings.

Modbus Address	Function Code	Description	Comments	Default
332	3,6,16	Alarm Output Mode	Unsigned integer 0 = Normal Operation 1 = Toggle 2 = Flash	0 = Normal Operation
333	3,6,16	Alarm Output Toggle Time	Unsigned integer in seconds Range: 1 to 240	60 seconds

Alarm Output Mode

Programs the alarm output relay for flashing, toggling, or normal output in case of an alarm condition. Under normal setting the alarm output is active when alarm conditions exist, inactive when no alarm conditions exist. Toggle setting is the same as normal operation, except every new alarm that occurs the alarm relay goes inactive the 'alarm output toggle time', then goes active again.

IMPORTANT: *If the alarm output is used to drive a pilot light, it is recommended that flash be selected to enable flashing operation. When the output is also configured for normally closed operation, the pilot light will be on steady for normal operation, flash in case of alarm and be extinguished due to a bulb failure or loss of power.*

If multiple alarm outputs from different controllers are wired in series (i.e.: multi-point panels), set this parameter to normal operation.

Alarm Output Toggle Time

When the ALARM OUTPUT MODE is set to ""toggle", this setting determines how long the alarm relay toggles inactive before returning to the active state when a new alarm occurs.

7.10.6 HTC Broadcast Timeout

This defines the Timeout Period for Broadcast messages. After this time has elapsed without a broadcast, Failure or Communication Alarms will be activated. The BROADCAST TIMEOUT is used for Load Shedding commands, RMM Temperatures, Remote Temperature Sources, and data from other controllers including the LIMITER.

Modbus Address	Function Code	Description	Comments	Default
334	3,6,16	Broadcast Timeout (Load Shed/Temperature Source/Digital Input Local Source Failure)	Unsigned integer Range: 1 - 10 minutes	1 minute

7.10.7 HTC Heater Time Setpoint

After the number of hours defined by the HEATER TIME SETPOINT has elapsed, the HEATER TIME ALARM is activated.

Modbus Address	Function Code	Description	Comments	Default
335	3,6,16	Heater Time Setpoint (MSW)	Unsigned integer in hours Range: 1-999999	100,000 hours
336	3,6,16	Heater Time Setpoint (LSW)		

7.11 HTC Limiter Parameters

To install a LIMITER that will monitor and safety-limit the output of the HTC, write the LIMITER CAN ID into these registers. A setting of zero means there is no LIMITER installed.

Modbus Address	Function Code	Description	Comments	Default
480	3,6,16	Limiter CAN ID MSW		
481	3,6,16	Limiter CAN ID LSW		

7.12 HTC General Information

These read-only registers give some basic information about the HTC.

Modbus Address	Function Code	Description	Comments
0	4	Device Type	NGC40 HTC Device Type 210 = NGC40 HTC Rev A
1	4	Firmware Version	NGC40 HTC Firmware Version - Major 0 - 255
2	4	Firmware Version	NGC40 HTC Firmware Version - Minor 0 - 255
3	4	Firmware Version	NGC40 HTC Firmware Version - Build 0 - 255
4	4	Manufactured Year	Format : YYYY
5	4	Manufactured Month	Range : 1 - 12
6	4	Manufactured Day	Range : 1 - 31
7	4	Serial Number (MSW)	NGC-40 HTC Serial Number
8	4	Serial Number (LSW)	
9	4	Device Subtype	

Device Type

Indicates the DEVICE TYPE of the module.

Firmware Version (Major, Minor, Build)

Indicates the revision level of the firmware programmed into the controller, “major.minor.build”.

Manufactured Year, Month, Day

Indicates the date on which the device was manufactured.

Serial Number

The unique SERIAL NUMBER for this device.

7.13 HTC Range Information

The Range Information section shows the hard-coded maximum and minimum allowable user-configurable settings, viewable over Modbus for reference purposes only.

Modbus Address	Function Code	Description	Comments
15	4	Local Temperature Sensor Range Maximum	Signed integer in 10ths of Degree C Defines range for set points (including alarm set points) 700.0DegC (7000)
16	4	Local Temperature Sensor Range Minimum	Signed integer in 10ths of Degree C Defines range for set points (including alarm set points) -80.0DegC(-800)
17	4	Current Range Maximum	Unsigned integer in 100ths of Amps Defines range for set points (including alarm set points) 60.0A(6000)
18	4	Current Range Minimum	Unsigned integer in 100ths of Amps Defines range for set points (including alarm set points) 0.30A(30)
19	4	GFI Range Maximum	Unsigned integer in 10ths of mAmps Defines range for set points (including alarm set point) 250.0mA(2500)
20	4	GFI Range Minimum	Unsigned integer in 10ths of mAmps Defines range for set points (including alarm set point) 10.0mA(100)
21	4	Maximum Power Set point Range Maximum (MSW)	Unsigned integer in Watts Defines range for set points (including alarm set points) 42000 W (42000)
22	4	Maximum Power Set point Range Maximum (LSW)	
23	4	Maximum Power Set point Range Minimum (MSW)	Unsigned integer in Watts Defines range for set points (including alarm set points) 3 W (3)
24	4	Maximum Power Set point Range Minimum (LSW)	
25	4	Nominal Tracing Resistance Range Maximum (MSW)	Unsigned integer in 100ths of Ohms Defines range for set points (including alarm set points) 2500.00Ohms(250000)
26	4	Nominal Tracing	

		Resistance Range Maximum (LSW)	
27	4	Nominal Tracing Resistance Range Minimum (MSW)	Unsigned integer in 100ths of Ohms Defines range for set points (including alarm set points) 0.8 Ohms.
28	4	Nominal Tracing Resistance Range Minimum (LSW)	

7.14 HTC Dynamic Output Status

These registers show the status and on/off time of the Electro-Mechanical Relay (EMR) or Solid-State Relay (SSR).

Modbus Address	Function Code	Description	Comments
40	4	Control Output Duty Cycle	0 - 100% 0 = Full Off, 100 = Full On
41	4	PASC on count	seconds
42	4	PASC off count	seconds
43	4	PASC next switch action	seconds
44	4	Output state	0=off, 1 = on
45	4	Tracing Control Status	Only reports the highest priority if more than one condition exists. Lowest Priority 0 = normal temperature control 1 =Digital Input Local/Remote - force off 2 = auto-cycle in progress 3 = load shedding active 4 = load shedding in fail safe mode (not active in a TS fail off or an output override force off condition) 5 = Digital Input Local/Remote - force on 6 = TS high limit cutout active 7 = contactor no toggle for 0.8 sec 8 = overcurrent trip 9 = ground fault trip 10 = Factory Configuration Data Lost- forced off. 11 = start-up delay active 12 = forced off Highest Priority

Control Output Duty Cycle

0 – 100%
The duty cycle is the percentage of a full cycle that the output is on. 0 = Full Off, 100 = Full On.

PASC on count

The number of seconds of on-time during the currently calculated PASC cycle.

PASC off count

The number of seconds of off-time during the currently calculated PASC cycle.

PASC next switch action

The number of seconds until the next switch-state change.

Output state

The current state of the trace switch.

Tracing Control Status

Gives the state of the Tracing Control Output. If more than one condition exists the highest priority is the one reported.

7.15 HTC Analog Readings

The read-only Analog Readings registers show all the measured parameters.

7.15.1 HTC Temperature Readings

These registers show the measured temperature on all installed temperature sources.

Modbus Address	Function Code	Description	Comments
50	4	Control Temperature	Signed integer in 10ths of Degree C Control Temp Failure = +3000.0DegC (30000)
51	4	Temperature Source 1 Temperature	Signed integer in 10ths of Degree C TS Failure = +3000.0DegC (30000) TS Not Used = +3200.0DegC (32000)
52	4	Temperature Source 2 Temperature	Signed integer in 10ths of Degree C TS Failure = +3000.0DegC (30000) TS Not Used = +3200.0DegC (32000)
53	4	Temperature Source 3 Temperature	Signed integer in 10ths of Degree C TS Failure = +3000.0DegC (30000) TS Not Used = +3200.0DegC (32000)
54	4	Temperature Source 4 Temperature	Signed integer in 10ths of Degree C TS Failure = +3000.0DegC (30000) TS Not Used = +3200.0DegC (32000)
55	4	Temperature Source 5 Temperature	Signed integer in 10ths of Degree C TS Failure = +3000.0DegC (30000) TS Not Used = +3200.0DegC (32000)
56	4	Temperature Source 6 Temperature	Signed integer in 10ths of Degree C TS Failure = +3000.0DegC (30000) TS Not Used = +3200.0DegC (32000)
57	4	Temperature Source 7 Temperature	Signed integer in 10ths of Degree C TS Failure = +3000.0DegC (30000) TS Not Used = +3200.0DegC (32000)
58	4	Temperature Source 8 Temperature	Signed integer in 10ths of Degree C TS Failure = +3000.0DegC (30000) TS Not Used = +3200.0DegC (32000)
59	4	Ambient Temperature	Signed integer in 10ths of Degree C TS Failure = +3000.0DegC (30000)
60	4	Local Temperature Sensor Temperature	Signed integer in 10ths of Degree C TS Failure = +3000.0DegC (30000) TS Not Used = +3200.0DegC (32000)

Control Temperature

This is the temperature that the controller uses to determine whether its output switch should be on or off. It is derived from a combination of the 8 configurable temperature sources, using the lowest/average of all temperature sensors selected as USED FOR CONTROL.

Temperature Source 1 to 8 Temperature

This temperature is the value of the 8 configurable temperature sources.

Ambient Temperature

The temperature reading of the on-board temperature sensor. This is for reference only and is not normally displayed to the user.

Local Temperature Sensor Temperature

This is the temperature of the local RTD.

7.15.2 HTC Line Current and Ground Fault Current Readings

These read-only registers show the measured and calculated Line Currents as well as Ground Fault Current and Power Consumption.

Modbus Address	Function Code	Description	Comments
61	4	Effective Line Current	Unsigned integer in 100ths of Amps This is the effective current (equals full Line Current multiplied by the output duty cycle).
62	4	Instantaneous Line Current	Unsigned integer in 100ths of Amps
63	4	Instantaneous Ground Fault Current	Unsigned integer in 10ths of mAmps
64	4	Voltage	Unsigned integer in 10ths of Volts Currently this is not a monitoring value. This register value is entered in AC Analog Parameters function 3, register 268
65	4	Frequency	Unsigned integer in Hertz Currently this is not a monitoring value. This register value is entered in AC Analog Parameters function 3, register 269
66	4	Power Consumption (MSW)	Unsigned integer in Watts
67	4	Power Consumption (LSW)	
68	4	Tracing Resistance (MSW)	Unsigned integer in 100ths of Ohms Open Circuit = 8000.00Ohms (800000)
69	4	Tracing Resistance (LSW)	
76	4	Last On Effective Line Current	Unsigned integer in 100ths of Amps This is the effective current (equals full Line Current

			multiplied by the output duty cycle).
77	4	Last On Line Current	Unsigned integer in 100ths of Amps This is the instantaneous current (equals full Line Current).
78	4	Last On Control Temperature	Signed integer in 10ths of Degree C
79	4	Last On Ground Fault Current	Unsigned integer in 10ths of mAmps

Effective Line Current

This is the effective current (equals full Line Current multiplied by the output duty cycle). For example if the full-on current is 10A and the duty cycle is 36%, the effective line current is 10A x 36% = 3.6A.

Instantaneous Line Current

The INSTANTANEOUS LINE CURRENT reading indicates the current in Amps being drawn by the heating cable, without regard for the duty cycle being applied.

Instantaneous Ground Fault Current

If the controller detects any leakage current in the output circuit, it will indicate the level in milliamps.

Fixed Voltage

This value must be set to the trace voltage. The present version of htc/htc3 does not measure this parameter.

Fixed Frequency

This value must be set to the frequency of the trace power. The present version of htc/htc3 does not measure this parameter.

Power Consumption

Load power provides an indication of the average power being consumed by the heat trace cable.

IMPORTANT: *The controller calculates load power by multiplying the fixed voltage reading by the INSTANTANEOUS LINE CURRENT reading.*

Tracing Resistance

Tracing resistance in Ohms. Resistance is calculated using the fixed voltage reading divided by the instantaneous current reading to yield a load resistance in ohms. If the controller's output switch is on, but no current is present, the TRACING RESISTANCE will read "open circuit".

IMPORTANT: *If the controller's output switch is off, the TRACING RESISTANCE will always display the last resistance which was calculated while the output switch was on.*

7.16 HTC Latched Alarm Values

The Latched Alarm registers hold the value of each parameter that caused an alarm trip. If there is no alarm, the register holds the “Invalid Alarm Value” shown in the Comments column.

Modbus Address	Function Code	Description	Comments
90	4	Control Temperature High Alarm Value	Signed integer in 10ths of Degree C Invalid Alarm Value = +3000.0DegC (30000)
91	4	Control Temperature Low Alarm Value	Signed integer in 10ths of Degree C Invalid Alarm Value = +3000.0DegC (30000)
92	4	Local Temperature Sensor High Alarm Value	Signed integer in 10ths of Degree C Invalid Alarm Value = +3000.0DegC (30000)
93	4	Local Temperature Sensor Low Alarm Value	Signed integer in 10ths of Degree C Invalid Alarm Value = +3000.0DegC (30000)
94	4	High Line Current Alarm Value	Unsigned integer in 100ths of Amps Invalid Alarm Value = 650.00A (65000)
95	4	Low Line Current Alarm Value	Unsigned integer in 100ths of Amps Invalid Alarm Value = 650.00A (65000)
96	4	High GF Current Alarm Value	Unsigned integer in 10ths of mAmps Invalid Alarm Value = 6500.0mA (65000)
97	4	GF Current Trip Alarm Value	Unsigned integer in 10ths of mAmps Invalid Alarm Value = 6500.0mA (65000)
98	4	High Tracing Resistance Alarm Value (MSW)	Unsigned integer in 100ths of Ohms Open Circuit = 8000.00 Ohms (800000) Invalid Alarm Value = 9000.00 Ohms (900000)
99	4	High Tracing Resistance Alarm Value (LSW)	
100	4	Low Tracing Resistance Alarm Value (MSW)	Unsigned integer in 100ths of Ohms Invalid Alarm Value = 9000.00 Ohms (900000)
101	4	Low Tracing Resistance Alarm Value (LSW)	

7.17 HTC Maintenance Information

These registers indicate the maximum and minimum temperatures ever recorded by the HTC since the last time the values were reset. It may be useful to log the maximum/minimum temperatures ever experienced on a particular trace circuit for the purposes of trouble shooting or gathering data for future design criteria. The temperature values are written to the controller's non-volatile memory once every
24 hours or whenever any maintenance data is reset by the user. Max/min temperatures are recorded for the local RTD and Control Temperatures.

IMPORTANT: *Can only be reset (cleared) by the operator.*

Modbus Address	Function Code	Description	Comments
120	4	Maximum Control Temperature	Signed integer in 10ths of Degree C Invalid Value = -3000.0DegC (35536)
121	4	Minimum Control Temperature	Signed integer in 10ths of Degree C Invalid Value = +3000.0DegC (30000)
122	4	Local Temperature Sensor Maximum Temperature	Signed integer in 10ths of Degree C Invalid Value = +3000.0DegC (30000)
123	4	Local Temperature Sensor Minimum Temperature	Signed integer in 10ths of Degree C Invalid Value = +3000.0DegC (30000)
124	4	Power Accumulator (MSW)	Unsigned integer in 10ths kW-hr
125	4	Power Accumulator (LSW)	
126	4	Highest Instantaneous Line Current Ever Measured	Unsigned integer in 100ths of Amps
127	4	Highest Instantaneous Ground Fault Ever Measured	Unsigned integer in 10ths of mAmps
128	4	Contactor Cycle Count (MSW)	Unsigned integer Number of off-on transitions
129	4	Contactor Cycle Count (LSW)	
130	4	Number of Hours In Use (MSW)	Unsigned integer
131	4	Number of Hours In Use (LSW)	
132	4	Number of Hours Since Last Reset	Unsigned integer
133	4	Heater Time (MSW)	Unsigned integer in hours
134	4	Heater Time (LSW)	
135	4	Test Tracing Time Count	Unsigned integer seconds Remaining time during which the controller should hold its input on

Power Accumulator

This feature indicates the total power consumption of the trace circuit since the last time the POWER ACCUMULATOR was reset. It may be useful to log the amount of power consumed on a particular trace circuit for the purposes of energy management or gathering of data for future design criteria. The value of this accumulator is written to the controller's non-volatile memory once every 24 hours or whenever any maintenance data is reset by the user.

Highest Instantaneous Line Current Ever Measured

This feature indicates the highest instantaneous load current measured since the last time the PEAK LINE CURRENT was reset. This value is written to the controller's non-volatile memory once every 24 hours or whenever any maintenance data is reset by the user.

Highest Instantaneous Ground Fault Ever Measured

This feature indicates the highest instantaneous ground fault current measured since the last time the PEAK GROUND FAULT CURRENT was reset. This current value is written to the controller's non-volatile memory once every 24 hours or whenever any maintenance data is reset by the user.

Contactor Cycle Count

This feature indicates the total number of on/off transitions an EMR has done since the last time the CONTACTOR CYCLE COUNTER was reset. This serves as a method to do preventative maintenance on the EMR according to the manufacturer's specifications. This count value is written to the controller's non-volatile memory once every 24 hours or whenever any maintenance data is reset by the user.

IMPORTANT: *Once the CONTACTOR CYCLE COUNTER reaches 999,999,999 it will stop counting.*

The CONTACTOR CYCLE COUNTER is only indicated if the SWITCH CONTROL MODE is set to either ON/Off EMR, or PASC EMR.

Number of Hours In Use

The purpose of this feature is to indicate the total hours of use of the controller since its initial operation. It may be useful to log the amount of time a particular controller has been in operation for the purposes of maintenance planning or reliability testing. The value of this accumulator is written to the controller's non-volatile memory once every 24 hours or whenever any maintenance data is reset by the user.

Number of Hours Since Last Reset

This feature indicates the total hours of use of the controller since the last reset. It may be useful to log the amount of time a particular controller has been in operation since the last time the controller's power was cycled for trouble-shooting purposes.

Heater Time

Represents the number of hours that the trace has spent energized.

7.18 HTC Limiter Reading

If there is a LIMITER installed this register will hold the current temperature reading from that LIMITER. If there is no LIMITER installed it will read 3200.

Modbus Address	Function Code	Description	Comments
480	4	Limiter Temperature	Signed Integer in Degree C Reading is the greatest of the enabled Limiter RTDs Invalid value = +3000 DegC (3000) Not in use = +3200 DegC (3200)

8. Modbus Registers for NGC-40-HTC3

The NGC-40-HTC3 (for 3-phase heaters) modules are used to control either a solid-state relay or contactor within the NGC-40 control and monitoring system. This module also has one alarm output and one digital input. The alarm output can be used to control an external annunciator. The digital input is programmable and may be used for various functions such as forcing outputs on and off. Other features of this module include ground-fault and line current sensing. The front panel of the HTC3 module has LED indicators for various status conditions. The front panel also provides a ground-fault and heater test button.

8.1 HTC3 Alarm Status

The NGC-40 system uses alarms to indicate fault conditions and out-of-range temperatures. Most alarms can be disabled (masked) and set to be latching or non-latching to accommodate specific applications. An active alarm shows a "1" in the alarm register, and can be reset by writing a 1 to that register as long as the alarm condition no longer exists.

8.1.1 HTC3 Control Temperature Alarms

These alarms are associated with the Control Temperature.

IMPORTANT: *These alarms can be user selectable to be Latching or Non-Latching. If set to Non-Latching, the controller will automatically clear the alarm when the condition no longer exists. If set to Latching the alarm must be cleared by the user.*

If your application is subject to periodic situations where cold or hot product is part of the process, it may be appropriate to configure the HTC for non-latching temperature alarms to avoid nuisance alarms. If it is important to be aware of any temperature alarm conditions that may have existed in a pipe, then the HTC should be configured for latching temperature alarms.

Modbus Address	Function Code	Description	Comments
1	1,5,15	Control Temperature High	Alarm Status: 0 = Normal, 1 = Alarm Writing a 1 resets the alarm, writing 0 has no effect
2	1,5,15	Control Temperature Low	Alarm Status: 0 = Normal, 1 = Alarm Writing a 1 resets the alarm, writing 0 has no effect
58	1,5,15	Control Temperature Failure	Alarm Status: 0 = Normal, 1 = Alarm Writing a 1 resets the alarm, writing 0 has no effect

Control Temperature High

This alarm will appear when the Control Temperature exceeds the CONTROL TEMPERATURE HIGH ALARM SETPOINT.

Control Temperature Low

This alarm will appear when the temperature decreases below the CONTROL TEMPERATURE LOW ALARM SETPOINT.

Control Temperature Failure

The CONTROL TEMPERATURE FAILURE ALARM indicates a failure of one or more of the temperature sources designated as “Use for Control”. See “Temperature Source Setup”.

8.1.2 HTC3 Local Temperature Sensor Alarms

These alarms are associated with the Local Temperature Sensor.

Modbus Address	Function Code	Description	Comments
3	1,5,15	Local Temperature Sensor Failure	Alarm Status: 0 = Normal, 1 = Alarm Writing a 1 resets the alarm, writing 0 has no effect
4	1,5,15	Local Temperature Sensor High	Alarm Status: 0 = Normal, 1 = Alarm Writing a 1 resets the alarm, writing 0 has no effect
5	1,5,15	Local Temperature Sensor Low	Alarm Status: 0 = Normal, 1 = Alarm Writing a 1 resets the alarm, writing 0 has no effect

Local Temperature Sensor Failure

This alarm will appear when a failure of the temperature sensor connected directly to the NGC-40-HTC is detected. Both open and shorted sensors are detected and alarmed by the HTC.

Local Temperature Sensor High

This alarm will appear if the Local Temperature Sensor value measured by the controller exceeds the LOCAL TEMPERATURE SENSOR HIGH ALARM SETPOINT.

Local Temperature Sensor Low

This alarm will appear if the Local Temperature Sensor value measured by the controller decreases below the LOCAL TEMPERATURE SENSOR LOW ALARM SETPOINT.

8.1.3 HTC3 Temperature Source Failure Alarms

These alarms are associated with the Remote Temperature Sources.

This

Modbus Address	Function Code	Description	Comments
6	1,5,15	Temperature Source 1 Failure	Alarm Status: 0 = Normal, 1 = Alarm Writing a 1 resets the alarm, writing 0 has no effect
7	1,5,15	Temperature Source 2 Failure	Alarm Status: 0 = Normal, 1 = Alarm Writing a 1 resets the alarm, writing 0 has no effect
8	1,5,15	Temperature Source 3 Failure	Alarm Status: 0 = Normal, 1 = Alarm Writing a 1 resets the alarm, writing 0 has no effect
9	1,5,15	Temperature Source 4 Failure	Alarm Status: 0 = Normal, 1 = Alarm Writing a 1 resets the alarm, writing 0 has no effect
10	1,5,15	Temperature Source 5 Failure	Alarm Status: 0 = Normal, 1 = Alarm Writing a 1 resets the alarm, writing 0 has no effect
11	1,5,15	Temperature Source 6 Failure	Alarm Status: 0 = Normal, 1 = Alarm Writing a 1 resets the alarm, writing 0 has no effect
12	1,5,15	Temperature Source 7 Failure	Alarm Status: 0 = Normal, 1 = Alarm Writing a 1 resets the alarm, writing 0 has no effect
13	1,5,15	Temperature Source 8 Failure	Alarm Status: 0 = Normal, 1 = Alarm Writing a 1 resets the alarm, writing 0 has no effect

is a series of specific alarms that will occur when the HTC fails to obtain a valid temperature from any of the 8 Temperature Sources. This alarm will be generated when the HTC fails to receive a temperature from the configured Local, CAN or Remote device (HTC, HTC3, IO, RMM) within the BROADCAST TIMEOUT INTERVAL. It will also appear if the Remote Temperature Source has an RTD Failure.

8.1.4 HTC3 Line Current Alarms

These alarms are associated with the Line Current.

Modbus Address	Function Code	Description	Comments
14	1,5,15	High Line Current L1	Alarm Status: 0 = Normal, 1 = Alarm Writing a 1 resets the alarm, writing 0 has no effect
15	1,5,15	High Line Current L2	Alarm Status: 0 = Normal, 1 = Alarm Writing a 1 resets the alarm, writing 0 has no effect
16	1,5,15	High Line Current L3	Alarm Status: 0 = Normal, 1 = Alarm Writing a 1 resets the alarm, writing 0 has no effect
17	1,5,15	Low Line Current L1	Alarm Status: 0 = Normal, 1 = Alarm Writing a 1 resets the alarm, writing 0 has no effect
18	1,5,15	Low Line Current L2	Alarm Status: 0 = Normal, 1 = Alarm Writing a 1 resets the alarm, writing 0 has no effect
19	1,5,15	Low Line Current L3	Alarm Status: 0 = Normal, 1 = Alarm Writing a 1 resets the alarm, writing 0 has no effect
29	1,5,15	Line Over-current Trip L1	Alarm Status: 0 = Normal, 1 = Alarm Writing a 1 resets the alarm, writing 0 has no effect
30	1,5,15	Line Over-current Trip L2	Alarm Status: 0 = Normal, 1 = Alarm Writing a 1 resets the alarm, writing 0 has no effect
31	1,5,15	Line Over-current Trip L3	Alarm Status: 0 = Normal, 1 = Alarm Writing a 1 resets the alarm, writing 0 has no effect

High Line Current L1, L2, L3

Alarms on current levels which are higher than the High Line Current Alarm Setpoint L1, L2, L3.

IMPORTANT: *As the HTC automatically protects itself from overload, it would not normally be necessary to enable this alarm. It can be used effectively to guard against accidental paralleling of heating circuits. In-rush, or cold start currents typically associated with self- regulating cables may cause nuisance HIGH CURRENT ALARMS. If this is undesirable this alarm should be disabled.*

Low Line Current L1, L2, L3

Alarms on current levels which are lower than the Low Line Current Alarm Setpoint L1, L2, L3. Monitoring for lower than expected current levels may be an effective means of continuity monitoring. See also HIGH TRACING RESISTANCE ALARM.

IMPORTANT: *To minimize nuisance LOW CURRENT ALARMS, the HTC must detect a current level less than the LOW CURRENT ALARM setpoint for a period longer than approximately 20 consecutive seconds.*
For series type heating cables, adjusting the LOW LINE CURRENT ALARM to 50% of full load current will properly alarm a problem and reduce nuisance alarms due to voltage dips. Parallel heaters should be adjusted to a level as close as possible to full load current but lower than the current at worst case voltage. The low current setting as a percentage of full load current will vary depending on the facility and its power system.

Over Current Trip L1, L2, L3

The over current trip feature is always enabled when using an SSR output switch and is used to provide protection for the output switch. The OVER CURRENT TRIP L1, L2, L3 ALARM will only inform the user of an excessively high current condition and that the output switch has been latched off. During a high current condition, the controller attempts to soft start a heating cable by a technique involving measured in-rush current and the Switch Current Rating. If the controller is unable to start the cable, it will eventually trip its output switch off and will not retry or pulse its output switch again. At this point the OVERCURRENT TRIP ALARM is latched on.

IMPORTANT: *The controller is NOT a safety cutout or an over current protective device as defined by the National and Canadian Electrical Codes (NEC & CEC). A protective device such as a circuit breaker or fuse must be included as part of a proper design and be selected in accordance with the requirements defined in the National Electrical Code (NEC) and/or the Canadian Electrical Code (CEC).*

The controller cannot protect the SSR from short circuits or excessive over current conditions. Always ensure that the power is off prior to performing any maintenance or troubleshooting of the heating circuit. Verify that no damage has occurred to the cable or the controller prior to re-energizing the circuit.

It is recommended that this alarm be left enabled since an over current trip condition would normally represent a serious problem. NOTE that this is a factory set alarm value and disabling the alarm does not disable the overcurrent trip function. In some applications the use of self-regulating cable will produce very high in-rush currents during cold startup. These currents may exceed the over current trip limit and the controller will not be able to soft start the trace circuit. If this condition persists please contact your nearest sales office for recommendations and solutions to this problem.

8.1.5 HTC3 Ground Fault Current Alarms

These alarms are associated with the Ground Fault Current.

Modbus Address	Function Code	Description	Comments
32	1,5,15	High Ground Fault Current	Alarm Status: 0 = Normal, 1 = Alarm Writing a 1 resets the alarm, writing 0 has no effect
33	1,5,15	Ground Fault Trip	Alarm Status: 0 = Normal, 1 = Alarm Writing a 1 resets the alarm, writing 0 has no effect
34	1,5,15	GFI Current Transformer Failure	Alarm Status: 0 = Normal, 1 = Alarm Writing a 1 resets the alarm, writing 0 has no effect

High Ground Fault Current

Alarms ground fault current levels which are higher than the HIGH GF CURRENT ALARM SETPOINT.

Ground Fault Trip

This alarm is activated when the ground fault leakage current exceeds the GROUND FAULT TRIP CURRENT SETPOINT. Exceeding this limit will result in the output switch being latched off.

IMPORTANT: *National Electrical Codes may require that all legs of non-neutral based power sources be opened upon detection of a Ground Fault. Multi-pole switch configurations should be used on non-neutral based power systems. Check the requirements with your local Electrical Authority.*

When the Ground Fault Trip alarm is disabled, ground fault tripping is disabled as well.

GFI Current Transformer Failure

The HTC continuously tests the GFI current transformer to ensure that it is fully functional. The GFI CURRENT TRANSFORMER FAILURE ALARM is activated if a transformer failure is detected.

8.1.6 HTC3 Tracing Resistance Alarms

These alarms are associated with the Tracing Resistance.

Modbus Address	Function Code	Description	Comments
23	1,5,15	High Tracing Resistance L1	Alarm Status: 0 = Normal, 1 = Alarm Writing a 1 resets the alarm, writing 0 has no effect
24	1,5,15	High Tracing Resistance L2	Alarm Status: 0 = Normal, 1 = Alarm Writing a 1 resets the alarm, writing 0 has no effect
25	1,5,15	High Tracing Resistance L3	Alarm Status: 0 = Normal, 1 = Alarm Writing a 1 resets the alarm, writing 0 has no effect
26	1,5,15	Low Tracing Resistance L1	Alarm Status: 0 = Normal, 1 = Alarm Writing a 1 resets the alarm, writing 0 has no effect
27	1,5,15	Low Tracing Resistance L2	Alarm Status: 0 = Normal, 1 = Alarm Writing a 1 resets the alarm, writing 0 has no effect
28	1,5,15	Low Tracing Resistance L3	Alarm Status: 0 = Normal, 1 = Alarm Writing a 1 resets the alarm, writing 0 has no effect

High Tracing Resistance L1, L2, L3

Alarm is activated when the heater resistance level increases above the NOMINAL RESISTANCE setting by more than the selected amount.
The HIGH TRACING RESISTANCE ALARM L1, L2, L3 may be used to indicate an open or a high resistance connection or, when using constant wattage parallel cables, may indicate the failure of one or more heating zones. It may also be used to monitor a failed series-type cable or connection in 3-phase applications.

Low Tracing Resistance L1, L2, L3

Alarms on heater resistance levels which are below the NOMINAL RESISTANCE L1, L2, L3 setting.

IMPORTANT: *This feature would not normally be enabled. It can be used effectively to guard against accidental paralleling of heating circuits. Care must be taken when using this alarm feature with heating cables that exhibit a variable resistance with temperature. Low resistance alarming may not be practical when the load has an increasing resistance with temperature (such as self-regulating cables).*

8.1.7 HTC3 Switch Failure Alarms

The purpose of the SWITCH FAILURE ALARM L1, L2, L3 is to indicate that an output switch failure has occurred. The controller determines that if the output switch is turned off and there is load current present, then the output switch has failed closed and the alarm is latched on.

Modbus Address	Function Code	Description	Comments
35	1,5,15	Switch Failure L1	Alarm Status: 0 = Normal, 1 = Alarm Writing a 1 resets the alarm, writing 0 has no effect
36	1,5,15	Switch Failure L2	Alarm Status: 0 = Normal, 1 = Alarm Writing a 1 resets the alarm, writing 0 has no effect
37	1,5,15	Switch Failure L3	Alarm Status: 0 = Normal, 1 = Alarm Writing a 1 resets the alarm, writing 0 has no effect

IMPORTANT: *The SWITCH FAILURE ALARM L1, L2, L3 should always be enabled. A high temperature condition as a result of a failed circuit can only be caused if the output switch fails closed. When an output switch fails closed, the controller cannot turn the tracer power off, therefore no protection features are available (ground fault trip, power limiting, etc.). If a SWITCH FAILURE ALARM L1, L2, L3 is detected, the unit should be serviced immediately.*

8.1.8 HTC3 Device Reset Alarm

The DEVICE RESET ALARM is used to indicate:

1) Power to the HTC3 has been interrupted and subsequently restored.
2) A transient has caused the HTC3's program to restart.
3) An internal condition has caused the HTC's program to restart.

Modbus Address	Function Code	Description	Comments
38	1,5,15	Device Reset	Alarm Status: 0 = Normal, 1 = Alarm Writing a 1 resets the alarm, writing 0 has no effect

IMPORTANT: *Normally the DEVICE RESET ALARM is left disabled since powering the controller off and on for maintenance or trouble-shooting would require the user to reset this alarm every time.*

8.1.9 HTC3 Limiting Alarms

These alarms are associated with the Current and Power Limit settings.

Modbus Address	Function Code	Description	Comments
39	1,5,15	Output Limiting L1	Alarm Status: 0 = Normal, 1 = Alarm Writing a 1 resets the alarm, writing 0 has no effect
40	1,5,15	Output Limiting L2	Alarm Status: 0 = Normal, 1 = Alarm Writing a 1 resets the alarm, writing 0 has no effect
41	1,5,15	Output Limiting L3	Alarm Status: 0 = Normal, 1 = Alarm Writing a 1 resets the alarm, writing 0 has no effect
42	1,5,15	Circuit Breaker Limiting L1	Alarm Status: 0 = Normal, 1 = Alarm Writing a 1 resets the alarm, writing 0 has no effect
43	1,5,15	Circuit Breaker Limiting L2	Alarm Status: 0 = Normal, 1 = Alarm Writing a 1 resets the alarm, writing 0 has no effect
44	1,5,15	Circuit Breaker Limiting L3	Alarm Status: 0 = Normal, 1 = Alarm Writing a 1 resets the alarm, writing 0 has no effect
52	1,5,15	Switch Limiting L1	Alarm Status: 0 = Normal, 1 = Alarm Writing a 1 resets the alarm, writing 0 has no effect
53	1,5,15	Switch Limiting L2	Alarm Status: 0 = Normal, 1 = Alarm Writing a 1 resets the alarm, writing 0 has no effect
54	1,5,15	Switch Limiting L3	Alarm Status: 0 = Normal, 1 = Alarm Writing a 1 resets the alarm, writing 0 has no effect

Output Limiting L1, L2, L3

This alarm indicates that the HTC3 is limiting the average amount of current/power that is applied to the trace circuit as defined by the MAXIMUM CURRENT LIMIT L1, L2, L3/ MAXIMUM POWER LIMIT L1, L2, L3 setting. The OUTPUT LIMIT MODE setting determines if this is a power-limiting or current-limiting alarm.

Circuit Breaker Limiting L1, L2, L3

The circuit breaker limiting feature is always enabled when using an SSR output switch and is intended to prevent the circuit breaker immediately upstream of the controller from tripping during a temporary over current condition. Enabling this alarm will only inform the user that circuit breaker limiting is currently active.

IMPORTANT: *This alarm may be considered an advisory alarm. If the measured current exceeds the level that would cause the upstream circuit breaker to release, the HTC3 will begin to switch the SSR ON and OFF rapidly to limit the average current to an acceptable level.*

Switch Limiting L1, L2, L3

This alarm will only inform the user that switch limiting is currently active and an excessively high current condition is present. The HTC3 will pulse its output switch for a small interval and read the resulting current. If the measured current exceeds the SWITCH CURRENT RATING L1, L2, L3 setting, then the duty-cycle of its output switch will be varied so that an average current not exceeding the SWITCH CURRENT RATING L1, L2, L3 setting is maintained.

IMPORTANT: *This alarm should normally be left enabled. Currents in this range cannot be considered normal and should be investigated.*

8.1.10 HTC3 Contactor Cycle Count Alarm

CONTACTOR CYCLE COUNT alarm is activated if the number of off-to-on transitions of an EMR reaches or exceeds the CONTACTOR CYCLE COUNT ALARM LIMIT SETPOINT. This serves as a method to perform preventative maintenance on the EMR before a failure is likely to occur.

Modbus Address	Function Code	Description	Comments
45	1,5,15	Contactor Cycle Count	Alarm Status: 0 = Normal, 1 = Alarm Writing a 1 resets the alarm, writing 0 has no effect

8.1.11 HTC3 Digital Input Alarms

These alarms are associated with the Digital Input.

Modbus Address	Function Code	Description	Comments
46	1,5,15	Digital Input Local/Remote	Alarm Status: 0 = Normal, 1 = Alarm Writing a 1 resets the alarm, writing 0 has no effect
47	1,5,15	Digital Input Local Source Failure	Alarm Status: 0 = Normal, 1 = Alarm Writing a 1 resets the alarm, writing 0 has no effect

Digital Input Local/Remote

This alarm will activate when a state change at the Digital Input terminals is detected by the HTC. The DIGITAL INPUT LOCAL/REMOTE CONFIGURATION (Function 3,Address 378) must be set to any of the following options.

1. Alarm when Digital Input Local/Remote Closed
2. Alarm when Digital Input Local/Remote Open

This alarm can be user selectable to be Latching or Non-Latching. If set to Non-Latching, the controller will automatically clear the alarm when the condition no longer exists. If set to Latching the alarm must be cleared by the user.

Digital Input Remote Source Failure

This alarm will occur when the HTC fails to receive a valid message from a remote NGC-40 module within the time interval defined by the parameter BROADCAST TIMEOUT.

The DIGITAL INPUT LOCAL/REMOTE SOURCE parameter must be set CAN NETWORK I/O.

8.1.12 HTC3 Data Lost Alarms

These alarms indicate memory problems.

User

Modbus Address	Function Code	Description	Comments
48	1,5,15	User Configuration Data Lost	Alarm Status: 0 = Normal, 1 = Alarm Writing a 1 resets the alarm, writing 0 has no effect
49	1,5,15	Factory Configuration Data Lost	Alarm Status: 0 = Normal, 1 = Alarm Writing a 1 resets the alarm, writing 0 has no effect

Configuration Data Lost

The USER CONFIGURATION DATA LOST ALARM indicates that the controller has either detected a failure in its non-volatile memory, or the user has performed a LOAD USER DEFAULTS command. This alarm indicates that the user configuration data has been reset to default values.

IMPORTANT: *The USER CONFIGURATION DATA LOST ALARM can not be disabled. If the user configuration data has not been intentionally reset (i.e. using the LOAD USER DEFAULTS command) this alarm may indicate a problem with the HTC, and may require a return to the factory for repair.*

Factory Configuration Data Lost

The FACTORY CONFIGURATION DATA LOST alarm indicates that the controller has detected a failure in its non-volatile memory and the factory configuration data has been lost. The HTC will rebuild the database and return factory configuration data to default values.

IMPORTANT: *The FACTORY CONFIGURATION DATA LOST can not be disabled. This memory stores some of the controller's configuration and calibration settings and the alarm will only be generated if the HTC software cannot bypass the failed area of its memory. This indicates an internal problem and the HTC should be replaced or returned to the factory for repair.*

8.1.13 HTC3 Load Shed Source Failure Alarm

This alarm will occur when the HTC fails to receive a valid message from a remote device providing Load Shed information within the time interval defined by the parameter BROADCAST TIMEOUT.

Modbus Address	Function Code	Description	Comments
50	1,5,15	Load Shed Source Failure	Alarm Status: 0 = Normal, 1 = Alarm Writing a 1 resets the alarm, writing 0 has no effect

8.1.14 HTC3 High Limit Cutout Alarm

This alarm will activate when the reading from any one of the 8 Temperature Sources exceeds the HIGH LIMIT CUTOUT SETPOINT. The TEMPERATURE SOURCE X CONFIGURATION must be using any one of the following options:

1. Not Used for Control, High Limit Cut-out Enabled
2. Used for Control, High Limit Cut-out Enabled

Modbus Address	Function Code	Description	Comments
51	1,5,15	High Limit Cutout	Alarm Status: 0 = Normal, 1 = Alarm Writing a 1 resets the alarm, writing 0 has no effect

8.1.15 HTC3 Heater Time Alarm

The HTC tracks the accumulated “on” time of the heat trace cable and will generate an alarm if this “on” time exceeds the HEATER TIME SETPOINT.

Modbus Address	Function Code	Description	Comments
55	1,5,15	Heater Time	Alarm Status: 0 = Normal, 1 = Alarm Writing a 1 resets the alarm, writing 0 has no effect

8.1.16 HTC3 Limiter Alarms

Modbus Address	Function Code	Description	Comments
56	1,5,15	Limiter Tripped	Alarm Status: 0 = Normal, 1 = Alarm Writing a 1 resets the alarm, writing 0 has no effect
57	1,5,15	Limiter Communication Failure	Alarm Status: 0 = Normal, 1 = Alarm Writing a 1 resets the alarm, writing 0 has no effect

Limiter Tripped

If any of the Limiter Temperature Readings exceeds the LIMITER SETPOINT TEMPERATURE the LIMITER TRIPPED ALARM will be set. This alarm is only active if there is a Limiter installed.
See: 8.11 HTC3 Limiter Parameters

Limiter Communication Failure

If there is a communication failure between the HTC and the installed Limiter this alarm will be set. This alarm is only active when there is a Limiter installed.

8.2 HTC3 Alarm Masks

The Alarm Mask registers match 1:1 to the Alarm Status registers at Function 1, address 1. A 1 designates an enabled alarm, a 0 is a disabled alarm. Not all alarms can be disabled. Refer to the full Modbus Map located in the Appendices for detailed information on each Alarm Mask.

Modbus Address	Function Code	Description	Comments	Default
71	1,5,15	Control Temperature High	Alarm Mask: 0 = Disabled, 1 = Enabled	Disabled
…	…	….	…	…
127	1,5,15	Limiter Communication Failure	Alarm Mask: 0 = Disabled, 1 = Enabled	Enabled

8.3 HTC3 Alarm Latching

The Alarm Latching registers match 1:1 with the Alarm registers starting at Function 1, Address 1. Some alarms are user selectable to be Latching or Non-Latching. If set to Non-Latching, the controller will automatically clear the alarm when the condition no longer exists. If set to Latching the alarm must be cleared by the user.

Modbus Address	Function Code	Description	Comments	Default
141	1,5,15	Control Temperature High	0 = Latching, 1 = Non-Latching	Non-Latching
…	…	….	…	…
198	1,5,15	Control Temperature Failure	0 = Latching, 1 = Non-Latching	Latching

8.4 HTC3 Controller Setup Parameters

The Controller Setup Parameters include Load Shedding settings and the LOAD USER CONFIGURATION DEFAULTS command.

8.4.1 HTC3 Load Shedding

A Load Shed command from the Modbus Master overrides temperature control and forces the output of the control module off until reset by the Modbus Master. The following registers define whether Load Shedding is enabled on the control module, and which “zones” it belongs to.

Load

Modbus Address	Function Code	Description	Comments	Default
215	1,5,15	Load Shedding Enabled	0 = No, 1 = Yes	No
216	1,5,15	Load Shedding Fail-safe Enabled	0 = No, 1 = Yes	No
217	1,5,15	Zone 1 Load Shedding Enabled	0 = Not Enabled, 1 = HTC is a member of Zone 1	Not Enabled
218	1,5,15	Zone 2 Load Shedding Enabled	0 = Not Enabled, 1 = HTC is a member of Zone 2	Not Enabled
219	1,5,15	Zone 3 Load Shedding Enabled	0 = Not Enabled, 1 = HTC is a member of Zone 3	Not Enabled
220	1,5,15	Zone 4 Load Shedding Enabled	0 = Not Enabled, 1 = HTC is a member of Zone 4	Not Enabled
221	1,5,15	Zone 5 Load Shedding Enabled	0 = Not Enabled, 1 = HTC is a member of Zone 5	Not Enabled
222	1,5,15	Zone 6 Load Shedding Enabled	0 = Not Enabled, 1 = HTC is a member of Zone 6	Not Enabled
223	1,5,15	Zone 7 Load Shedding Enabled	0 = Not Enabled, 1 = HTC is a member of Zone 7	Not Enabled
224	1,5,15	Zone 8 Load Shedding Enabled	0 = Not Enabled, 1 = HTC is a member of Zone 8	Not Enabled
225	1,5,15	Zone 9 Load Shedding Enabled	0 = Not Enabled, 1 = HTC is a member of Zone 9	Not Enabled
226	1,5,15	Zone 10 Load Shedding Enabled	0 = Not Enabled, 1 = HTC is a member of Zone 10	Not Enabled
227	1,5,15	Zone 11 Load Shedding Enabled	0 = Not Enabled, 1 = HTC is a member of Zone 11	Not Enabled
228	1,5,15	Zone 12 Load Shedding Enabled	0 = Not Enabled, 1 = HTC is a member of Zone 12	Not Enabled
229	1,5,15	Zone 13 Load Shedding Enabled	0 = Not Enabled, 1 = HTC is a member of Zone 13	Not Enabled
230	1,5,15	Zone 14 Load Shedding Enabled	0 = Not Enabled, 1 = HTC is a member of Zone 14	Not Enabled
231	1,5,15	Zone 15 Load Shedding Enabled	0 = Not Enabled, 1 = HTC is a member of Zone 15	Not Enabled

Shedding Enabled

This enables/disables load shedding on the controller.

Load Shedding Fail-safe Enabled

When Fail-safe is Enabled, and when load shedding is currently active, if the control temperature falls below the low control temperature alarm setpoint, the controller overrides the load shedding command and turns the output back on until the temperature rises above the low control temperature setpoint.

IMPORTANT: *Load shedding failsafe is always disabled for ambient control modes.*

Zone 1 to 16 Load Shedding Enabled

Configures the HTC for load shedding zones. There are 16 zones in the HTC controller. The HTC can be configured to be a member of any combination of these 16 zones. If the HTC receives a command to load shed on zone X, the HTC will begin load shedding only if the Zone X Load Shedding Enabled register is set to '1', otherwise no load shedding will occur.

8.4.2 HTC3 Load User Configuration Defaults

Resets all of the user default settings. The HTC3 will restore all values listed as "default" in the Modbus Map.

Modbus Address	Function Code	Description	Comments
233	1,5,15	Load User Configuration Defaults	Write 1 to load user configuration defaults, writing 0 is ignored Reads return 0

8.5 HTC3 Reset Maintenance Information

Writing a 1 to these write-only registers will clear the associated Highest/Lowest Recorded Value register in the Maintenance Information Function 4 section.

Modbus Address	Function Code	Description	Comments
245	5,15	Reset Control Max/Min Temperatures	Writing a 1 resets parameter, writing 0 has no effect
246	5,15	Reset Local Max/Min Temperatures	Writing a 1 resets parameter, writing 0 has no effect
247	5,15	Reset Power Accumulator	Writing a 1 resets parameter, writing 0 has no effect
248	5,15	Reset Highest Instantaneous Line Current Ever Measured	Writing a 1 resets parameter, writing 0 has no effect
249	5,15	Reset Highest Instantaneous Ground Fault Current Ever Measured	Writing a 1 resets parameter, writing 0 has no effect
250	5,15	Reset Contactor Cycle Count	Writing a 1 resets parameter, writing 0 has no effect
251	5,15	Reset Number of Hours In Use	Writing a 1 resets parameter, writing 0 has no effect
252	5,15	Reset Heater Timer	Writing a 1 resets parameter, writing 0 has no effect

Reset Control Max/Min Temperatures
Reset Local Max/Min Temperatures

Resets the maximum and minimum temperatures ever seen by the HTC3.

Reset Power Accumulator

Resets the power consumed by the trace circuit.

Reset Highest Instantaneous Line Current Ever Measured

Resets the highest line current ever detected by the HTC.

Reset Highest Instantaneous Ground Fault Current Ever Measured

Resets the highest ground fault current ever detected by the HTC.

Reset Contactor Cycle Count

Zeroes the total number of times the EMR has been activated.

Reset Number of Hours In Use

Zeroes the total number of hours that the HTC has ever been powered up.

Reset Heater Timer

Resets the total number of hours the tracing has been turned on for.

8.6 HTC3 Controller Status

These read-only registers show the status of the Alarm Output Relay.

Raw

Modbus Address	Function Code	Description	Comments
0	2	Raw Digital Input Local/Remote	0 = Open or 3.3V-24V 1 = Shorted (0V)
1	2	Raw Alarm Output	0 = No Alarm state 1 = Alarm state
2	2	Raw SSR Output	0 = Off, 1 = On
3	2	Raw Contactor Output	0 = Off, 1 = On

Digital Input Local/Remote

Shows the state of the Digital Input, 0 for open and 1 for shorted.

Raw Alarm Output

Shows the state of the Alarm Output, 0 for no alarm and 1 for in alarm state.

Raw SSR Output

Shows the state of the SSR Output, 0 for off and 1 for on.

Raw Contactor Output

Shows the state of the Contactor Output, 0 for off and 1 for on.

8.7 HTC3 Control Parameters

The Control Parameters define the SWITCH CONTROL MODE and system settings used to control power to the heat trace cable.

Modbus Address	Function Code	Description	Comments	Default
0	3,6,16	Control Temperature Set point	Signed integer in 10ths of Degree C Range: -80.0DegC to 700.0DegC	10.0DegC (100)
1	3,6,16	Switch Control Mode	Unsigned integer 0 = PROPORTIONAL (SSR) 1 = ON/OFF EMR 2 = ON/OFF SSR 3 = PASC EMR 4 = PASC SSR 5 = ALWAYS ON 6 = ALWAYS OFF	1 = ON/OFF EMR
2	3,6,16	Deadband	Signed integer in 10ths of Degree C Range: 1.0DegC (10) to 50.0DegC (500)	3.0DegC (30)
3	3,6,16	Proportional Band	Signed integer in 10ths of Degree C Range: 1.0DegC (10) to 50.0DegC (500)	2.0DegC (20)
4	3,6,16	Reserved		
5	3,6,16	PASC Min Ambient Temp	Unsigned integer in 10ths of Degree C Range: -73.0DegC to 51.0DegC (510)	-40DegC
6	3,6,16	PASC Min Pipe Size	Unsigned integer 0= 1.3 cm 1= 2.5 cm 2= >= 5.1 cm	1.3cm
7	3,6,16	PASC Power Adjust	Unsigned integer Range: 10-200%	100%

Control Temperature Set point

The CONTROL TEMPERATURE SETPOINT temperature is the value at which the Heat Trace Controller maintains the circuit temperature using one of the Switch Control Modes. The CONTROL TEMPERATURE SETPOINT temperature is compared to the Control Temperature. A decision is then made to turn on or turn off the output to control power to the heat trace cable.

This allows selection of the type of algorithm to be used by the HTC to maintain the Control Setpoint temperature. There are five different control algorithms available.

Options: = PROPORTIONAL (SSR)
ON/OFF EMR
ON/OFF SSR
PASC EMR
PASC SSR
ALWAYS ON
ALWAYS OFF

Default: On/Off EMR

Proportional (SSR) on the HTC is implemented as follows:

When using SSRs to directly control the power applied to a trace circuit, the output may be switched on/off very rapidly. The controller implements proportional temperature control on a cycle by cycle basis (50 or 60 Hz power line cycle). This algorithm monitors the temperature of the heating circuit and compares it to the CONTROL SETPOINT temperature. If the temperature of the control sensor is at or below the CONTROL SETPOINT temperature, then power is applied to the trace with a duty cycle of 100% -- the controller output is full on. If the temperature sensed by the control sensor is equal to or greater than the CONTROL SETPOINT temperature + the PROPORTIONAL BAND setting, then the controller output will have a duty cycle of 0% -- the output will be off. The temperature of the control sensor is constantly monitored and the output duty cycle is adjusted proportionally according to where the temperature falls within the 0% - 100% band.

Proportional Control Temperature Band

Control Sensor Temperature	Duty Cycle
Setpoint+proportional band	0%
Setpoint+proportional band/2	50%
Setpoint	100%

ON/OFF EMR - ON/OFF SSR control on the HTC is implemented as follows:

When using the HTC in an application where the controller is used to open and close an EMR, proportional control cannot be used. In these cases a On/Off control algorithm is used. The output duty cycle is not controlled, instead the output is either fully on or completely off. The user can set the DEADBAND value. The controller monitors the temperature of the trace circuit and compares it to the CONTROL SETPOINT temperature as in the proportional control. If the control sensor temperature is above the CONTROL SETPOINT temperature by more than the DEADBAND value, the output is turned off. If the control sensor temperature falls below the CONTROL SETPOINT temperature the output is turned on. This is a very simple control algorithm but it works very effectively in heat trace applications where the temperature of a traced system changes relatively slowly.

Deadband Temperature Band

Control Sensor Temperature	Output State
Setpoint+deadband	Off
Setpoint	On

When the control sensor temperature is within the deadband, the output does not change its state. Also, when using ON/OFF EMR control an EMR is not allowed to toggle faster than every 2 seconds. If an AC alarm with an alarm filter time greater than 0 is detected, the EMR will not toggle until the alarm filter time has expired.

PASC EMR – PASC SSR control on the HTC is implemented as follows:

PASC takes advantage of the fact that the heat loss from a pipe is proportional to the temperature difference between the pipe and the ambient air. This is true regardless of heater type, insulation type, or pipe size. Once the heat tracing and insulation on a pipe has been designed to balance heat input with heat loss and maintain a particular temperature, the main variable in controlling the pipe temperature becomes the ambient air temperature. The HTC has a control algorithm that uses the measured ambient temperature, desired maintain temperature, minimum ambient temperature assumption used during design, and size of the smallest pipe diameter to calculate how long the heater should be on or off to maintain a near-constant pipe temperature.

ALWAYS ON

The relay output is switched on, power is applied to the heater, the relay output is left on. Alarms are still active.

ALWAYS OFF

The relay output is switched off, power is removed from the heater, the relay output is left off. Alarms are still active.

Deadband

The controller monitors the temperature of the heating circuit and compares it to the CONTROL TEMPERATURE. If the control temperature is above the CONTROL TEMPERATURE SETPOINT by more than the DEADBAND value, the output is turned off. If the control temperature falls below the CONTROL TEMPERATURE SETPOINT the output is turned on.

Proportional Band

The controller monitors the temperature of the heating circuit and compares it to the CONTROL Temperature SETPOINT. If the Control Temperature is at or below the CONTROL Temperature SETPOINT the power is applied to the trace with a duty cycle of 100% -- the controller output is full on. If the CONTROL Temperature is equal to or greater than the CONTROL SETPOINT temperature + the PROPORTIONAL BAND setting, then the controller output will have a duty cycle of 0% -- the output will be off. The temperature of the control sensor is constantly monitored and the output duty cycle is adjusted proportionally according to where the temperature falls within the 0% - 100% band.

Proportional Control Temperature Band

Control Sensor Temperature	Duty Cycle
Setpoint + proportional band	0%
Setpoint + proportional band / 2	50%
Setpoint	100%

For use with the three proportional control modes only.

IMPORTANT: *When using Series-type, Constant wattage, or Self-regulating tracers in an ambient temperature control application, significant energy savings may be realized by setting the PROPORTIONAL BAND to match the expected range of operating ambient temperatures. Tracer design is normally done assuming worst-case conditions, where 100% of the design output power is required to maintain the desired minimum temperature. When the ambient temperature is above the design minimum, but some heat is still required, adjusting the PROPORTIONAL BAND width accordingly will allow only the amount of power required by the application to be consumed, while maintaining the minimum required temperature.*

PASC Min Ambient Temp

The PASC Min Ambient Temp is the "lowest ambient temperature" that was used when the heat-tracing system was designed. The entered value should agree with the value used by the design engineer to ensure that the heat tracing system was sized correctly.

PASC Min Pipe Size

Min. Pipe Size is the diameter of the smallest heat-traced pipe in the group controlled by this circuit. Small diameter pipes heat up and cool down more rapidly than larger diameter pipe, therefore, the PASC duty cycle is calculated over a shorter time base. Larger diameter pipes heat and cool less rapidly, so the on/off periods for the heater system can be stretched over a longer period. If EMRs are being used to control the heater circuit, the longer time base reduces the number of EMR on/off cycles and extends the EMR life.

PASC Power Adjust

This allows the PASC control to be adjusted when the heating cable output is greater than the design assumption, or if the pipe insulation proves to be more efficient than assumed. Pipe temperature may run higher or lower than desired if the heating cable has a different output than required to offset the heat loss. The Power Adjust parameter enables a reduction or an increase in the heat-tracing effective power by entering a value less or greater than 100%.

IMPORTANT: *If improperly used, the Power Adjust parameter can cause the piping to get too cold or too hot. If unsure, leave at 100%. Do not change this value unless an engineer calculates the temperature impact on the system and determines that it is safe to do so. Be particularly cautious if the loop has more than one diameter of pipe or type of heat tracing. Contact a nVent representative for assistance with this factor.*

8.7.1 HTC3 Output Limit Mode

Two Output Limit modes are available to limit the average power or current that is applied to the heating cable. The controller measures the voltage and/or current of the tracing circuit and will vary its output switch to limit the amount of power or current applied to the trace. To the set the limit value see MAXIMUM POWER SET POINT, or MAXIMUM CURRENT Limit settings.

Modbus Address	Function Code	Description	Comments	Default
8	3,6,16	Output Limit Mode	Unsigned integer 0 = Disable Limiting 1 = Power Limiting 2 = Current Limiting	0 = Disable

8.7.2 HTC3 Test Tracing

The TEST TRACING feature provides an easy method of temporarily overriding the temperature control, without having to modify the CONTROL TEMPERATURE SETPOINT or any other configuration parameter. The function will force the output switch on for the specified interval. After the test time has expired, the HTC will automatically revert back to normal operation.

Modbus Address	Function Code	Description	Comments	Default
9	3,6,16	Test Tracing	Length of time the controller should hold its output on for unsigned integer seconds Range: 0 - Cancel Test Tracing 1 to 300 seconds	

IMPORTANT: *This feature only overrides temperature control, it does not override other control parameters such as power limiting.*

8.8 HTC3 Temperature Setup

The Temperature Setup registers define Minimum and Maximum limits and other settings for all Temperature Sources.

8.8.1 HTC3 Control Mode Parameters

These registers define how the Control Temperature is calculated and what the controller will do if the Control Temperature sensors fail.

Modbus Address	Function Code	Description	Comments	Default
15	3,6,16	Temperature Control Mode	Unsigned integer 0 = N/A 1 = Average 2 = Lowest	2 = Lowest
16	3,6,16	Temperature Fail Mode	Unsigned integer 0 = Fail Off 1 = Fail On 2 = Fixed % 3 = Last %	0 = Fail Off
17	3,6,16	Temperature Fail Mode Percentage	Unsigned integer Range: 1 - 99 %	50%

Temperature Control Mode

The Temperature CONTROL MODE allows the selection of one of two possible Temperature control modes for the controller.

With a TS CONTROL MODE of AVERAGE or LOWEST the controller will take the average or LOWEST temperature reading from all configured Temperature Sources and cycle the heater ON or OFF to maintain the CONTROL TEMPERATURE SETPOINT temperature. If either Temperature Source should fail, the controller will transfer control to the remaining “good” Temperature Source and generate the appropriate Temperature Source FAILURE ALARM (assuming that the alarm is enabled). If all Temperature Sources fail, the controller will turn the heater OFF or ON as determined by the Temperature FAIL MODE setting.

Temperature Fail Mode

This parameter determines whether the HTC turns the output switch ON, OFF, Fixed %, or Last % if all configured Temperature sensors which are set to Used For Control fail to provide a valid temperature.
Fixed % will take the value entered in the TEMPERATURE FAIL MODE PERCENTAGE registers, while Last % will use the last calculated duty cycle values (Proportional Modes only).

Temperature Fail Mode Percentage

When Last % is chosen for a TEMPERATURE FAIL MODE, this parameter is used set the output duty cycle.

8.8.2 HTC3 Control Temperature Alarm Setpoints

These registers define the Minimum and Maximum limits for the Control Temperature. If these limits are exceeded an alarm will be set.

Modbus Address	Function Code	Description	Comments	Default
18	3,6,16	Control Temperature High Alarm Setpoint	Signed integer in 10ths of Degree C Range: -80.0DegC to 700.0DegC (7000)	100.0DegC (1000)
19	3,6,16	Control Temperature Low Alarm Setpoint	Signed integer in 10ths of Degree C Range: -80.0DegC to 700.0DegC (7000)	5.0DegC (50)
20	3,6,16	Control Temperature High Alarm Filter	Unsigned integer in seconds Range : 0 to 59940 seconds	0
21	3,6,16	Control Temperature Low Alarm Filter	Unsigned integer in seconds Range : 0 to 59940 seconds	0

Control Temperature High Alarm Setpoint

If the HTC computes a Control Temperature above this threshold, it generates a CONTROL TEMPERATURE HIGH ALARM, assuming the alarm is enabled.

Control Temperature Low Alarm Setpoint

If the HTC computes a Control Temperature below this threshold, it generates a CONTROL TEMPERATURE LOW ALARM, assuming the alarm is enabled.

Control Temperature High Alarm Filter

The CONTROL TEMPERATURE HIGH ALARM FILTER will prevent CONTROL TEMPERATURE HIGH ALARM from being indicated until the corresponding alarm condition has existed for the duration of the CONTROL TEMPERATURE HIGH ALARM FILTER time.

IMPORTANT: *If an alarm condition appears and then disappears before the alarm filter time has expired, the filter timer is reset and the alarm condition must exist again for the entire alarm filter time before the corresponding alarm will be indicated.*

If the user resets an alarm while the alarm condition is still exists, then the alarm will not be indicated again until the entire alarm filter time has expired.

Control Temperature Low Alarm Filter

The CONTROL TEMPERATURE LOW ALARM FILTER will prevent CONTROL TEMPERATURE LOW ALARM from being indicated until the corresponding alarm condition has existed for the duration of the CONTROL TEMPERATURE LOW ALARM FILTER time.

8.8.3 HTC3 Local Temperature Sensor Settings

These registers define the Minimum and Maximum limits for the Local Temperature Sensor. If these limits are exceeded an alarm will be set.

Modbus Address	Function Code	Description	Comments	Default
22	3,6,16	Local Temperature Sensor Tag 0	NGC40-HTC Local RTD Tag No validity checking is done on the character.	"NGC40-HTC-RTD1-" followed by the device CAN ID
…	…	…		
61	3,6,16	Local Temperature Sensor Tag 39		
62	3,6,16	Local Temperature Sensor Type	Unsigned integer 0 = Not Used 1 = 3 wire 100 Ohm Platinum 2 = 2 wire 100 Ohm nickel iron 3 = 2 wire 100 Ohm nickel	1 = 3 wire 100 Ohm Platinum
63	3,6,16	Local RTD Lead Resistance	Unsigned integer in 100ths of Ohms Range: 0 to 20.00Ω (for nickel iron only)	0
64	3,6,16	Local Temperature Sensor High Alarm Setpoint	Signed integer in 10ths of Degree C Range: -80.0DegC to 700.0DegC (7000)	100.0DegC
65	3,6,16	Local Temperature Sensor Low Alarm Setpoint	Signed integer in 10ths of Degree C Range: -80.0DegC to 700.0DegC (7000)	5.0DegC
66	3,6,16	Local Temperature Sensor High Alarm Filter	Unsigned integer in seconds Range : 0 to 59940 seconds	0
67	3,6,16	Local Temperature Sensor Low Alarm Filter	Unsigned integer in seconds Range : 0 to 59940 seconds	0
68	3,6,16	High Limit Cutout Setpoint	Signed integer in 10ths of Degree C Range: -80.0DegC to 700.0DegC (7000)	700.0DegC (7000)

Local Temperature Sensor Tag

A 40 character tag may be assigned to the Local RTD connected directly to the HTC to allow it to be easily associated with a control panel, location, or area.

Local Temperature Sensor Type

This parameter specifies the type of RTD that is connected to directly to the HTC.

IMPORTANT: *If a 2 wire 100 Ω Nickel Iron (NI-FE) RTD is selected then the Local RTD LEAD RESISTANCE must be entered manually.*

Local RTD Lead Resistance

This parameter specifies the lead resistance of a 2 wire Nickel Iron RTD connected directly to the HTC. (For NI-FE RTDs only)

Local Temperature Sensor High Alarm Setpoint

If the local RTD connected directly to the HTC reads a temperature above this threshold, it generates a LOCAL TEMPERATURE SENSOR HIGH ALARM, assuming the alarm is enabled.

Local Temperature Sensor Low Alarm Setpoint

If the local RTD connected directly to the HTC reads a temperature below this threshold, it generates a LOCAL TEMPERATURE SENSOR LOW ALARM, assuming the alarm is enabled.

Local Temperature Sensor High Alarm Filter

The LOCAL TEMPERATURE SENSOR HIGH ALARM FILTER will prevent Local TEMPERATURE SENSOR HIGH ALARM from being indicated until the corresponding alarm condition has existed for the duration of the LOCAL TEMPERATURE SENSOR HIGH ALARM FILTER time.

IMPORTANT: *If an alarm condition appears and then disappears before the alarm filter time has expired, the filter timer is reset and the alarm condition must exist again for the entire alarm filter time before the corresponding alarm will be indicated.*

If the user resets an alarm while the alarm condition is still exists, then the alarm will not be indicated again until the entire alarm filter time has expired.

Local Temperature Sensor Low Alarm Filter

The Local TEMPERATURE SENSOR LOW ALARM FILTER will prevent LOCAL TEMPERATURE SENSOR LOW ALARM from being indicated until the corresponding alarm condition has existed for the duration of the LOCAL TEMPERATURE SENSOR HIGH ALARM FILTER time.

High Limit Cutout Setpoint

This parameter defines the High Limit Cutout Setpoint for each of the 8 Temperature Sources where the Temperature Source configuration includes High Limit Cut-out Enabled.

This feature will override the CONTROL TEMPERATURE SETPOINT temperature and force the controller output off if any one of the 8 Temperature Sources temperature exceeds the High Limit Cut-Out temperature setting.

IMPORTANT: *The HIGH LIMIT CUTOUT feature overrides an auto-cycle test. A pending auto-cycle will be initiated immediately after the Temperature Source x temperature drops below the HIGH LIMIT CUTOUT SETPOINT.*

If a Temperature Source Failure occurs and the High Limit Cutout feature is enabled, the switch output will latch off regardless of the Temperature CONTROL MODE setting or the Temperature FAIL MODE setting.

8.8.4 HTC3 Temperature Source Setup

These registers define the source and setup for Temperature Sources 1-8.

Modbus Address	Function Code	Description	Comments	Default
80	3,6,16	Temperature Source 1 Mode	Unsigned integer 0 = Not Used 1 = Local 2 = Remote 3 = CAN Network	1=Local
81	3,6,16	Temperature Source 1 Local Setup	Unsigned integer Temperature Input Number (1 = first sensor)	1
82	3,6,16	Temperature Source 1 Local Setup	Unsigned integer Not Used - Must write 0.	0
83	3,6,16	Temperature Source 1 Local Setup	Unsigned integer Not Used - Must write 0.	0
84	3,6,16	Temperature Source 1 Remote Setup Gateway Modbus Address / Gateway Port Number	Unsigned integer MSB = Gateway Modbus Address - Range : 1 to 247 LSB = Gateway Port Number that RMM is connected to - Range : 1 to 4	MSB = 0, LSB = 0
85	3,6,16	Temperature Source 1 Remote Setup RMM Modbus Address / RMM Input Number	Unsigned integer MSB = RMM Modbus Address - Range : 1 to 247 LSB = RMM Input Number - Range : 1 to 8	MSB = 0, LSB = 0
86	3,6,16	Temperature Source 1 Remote Setup	Unsigned integer Not Used - Must write 0.	0
87	3,6,16	Temperature Source 1 CAN Network Setup CAN Network Device ID (MSW)	Unsigned integer CAN Device ID	0
88	3,6,16	Temperature Source 1 CAN Network Setup CAN Network Device ID (LSW)		
89	3,6,16	Temperature Source 1 CAN Network Setup Temperature Input	Unsigned integer Temperature Input Number Range: 1 to 4	0

		Number		
90	3,6,16	Temperature Source 1 Configuration	Unsigned integer 0 = For Monitoring Purposes Only, Not Used for Control, High Limit Cut-out Disabled 1 = Used for Control, High Limit Cut-out Disabled 2 = Not Used for Control, High Limit Cut-out Enabled 3 = Used for Control, High Limit Cut-out Enabled	1 = Used for Control, High Limit Cut-out Disabled

IMPORTANT: *Function 3, addresses 85-94 must be written as a group. There are 8 temperature sources, see Appendix C – HTC3 Modbus Map for complete Modbus listing.*

Temperature Source 1 to 8 Mode

The HTC supports 8 Temperature Sources. Each source may be configured to obtain its temperature from the Local RTD connected directly to the HTC, an RTD connected to a Remote device connected to the RS-485 network located outside of the panel, or from one of the NGC-40 modules (NGC-40-HTC, NGC-40-HTC3, NGC-40-IO) within the panel.

Temperature Source 1 to 8 Local Setup

If the Temperature Source Mode is set to LOCAL, this parameter defines the specific RTD connected to the HTC. Since the current version of the NGC-40-HTC supports only one local RTD connected directly the RTD input, this parameter can only be set to 1.

Temperature Source 1 to 8 Remote Setup
Gateway Modbus Address / Gateway Port Number

If the Temperature Source Mode is set to REMOTE, this parameter defines specifics of the device connected to the RS-485 network that will be providing RTD temperature information

Temperature Source 1 to 8 CAN Network Setup
CAN Network Device ID

If the Temperature Source Mode is set to CAN Network, this parameter defines specifics of the module connected to the NGC-40-BRIDGE that will be providing RTD temperature information. The module may be NGC-40-HTC, NGC-40-HTC3, NGC-40-IO.

Temperature Source 1 to 8 Configuration

When enabled, the TS 1 HIGH LIMIT CUTOUT feature will override the CONTROL SETPOINT temperature and force the controller output off if the TS 1 reading exceeds the HIGH TS 1 ALARM temperature setting. This is a non-latching condition, so once the TS 1 reading drops below the HIGH TS 1 ALARM temperature setting, the controller will resume normal operation.

IMPORTANT: *The TS 1 HIGH LIMIT CUTOUT feature overrides an auto-cycle test. A pending auto-cycle will be initiated immediately after the TS 1 temperature drops below the HIGH TS 1 ALARM temperature setting.*

If a TS 1 failure occurs and the TS 1 HIGH LIMIT CUTOUT feature is enabled, the switch output will latch off regardless of the TS CONTROL MODE setting or the TS FAIL MODE setting.

If the TS 1 HIGH LIMIT CUTOUT feature is enabled, then the HIGH TS 1 ALARM temperature setting can be set, regardless of whether the HIGH TS 1 ALARM is enabled.

8.9 HTC3 AC Analog Parameters

The AC Analog Parameters include Line Current, Ground Fault Current, Tracing Resistance and Limiting settings.

IMPORTANT: *If an alarm condition appears and then disappears before the alarm filter time has expired, the filter timer is reset and the alarm condition must exist again for the entire alarm filter time before the corresponding alarm will be indicated.*

If the user resets an alarm while the alarm condition is still exists, then the alarm will not be indicated again until the entire alarm filter time has expired.

8.9.1 HTC3 Heater Configuration

Selects the topology of the 3-phase heater to enable the controller to properly calculate trace power and trace resistance.

Modbus Address	Function Code	Description	Comments	Default
240	3,6,16	Heater Configuration	Unsigned integer 0 = Single Phase 1 = 3-Phase WYE 2 = 3=Phase DELTA (Used only for reporting trace power and tracing resistance)	1 = 3-Phase WYE

8.9.2 HTC3 Line Current Alarms

These registers define the Minimum and Maximum limits for the Line Current. If these limits are exceeded an alarm will be set.

Modbus Address	Function Code	Description	Comments	Default
247	3,6,16	High Line Current Alarm Filter L1	Unsigned integer Range: 0 to 12 seconds	0
248	3,6,16	High Line Current Alarm Filter L2	Unsigned integer Range: 0 to 12 seconds	0
249	3,6,16	High Line Current Alarm Filter L3	Unsigned integer Range: 0 to 12 seconds	0
250	3,6,16	Low Line Current Alarm Filter L1	Unsigned integer Range: 0 to 12 seconds	0
251	3,6,16	Low Line Current Alarm Filter L2	Unsigned integer Range: 0 to 12 seconds	0
252	3,6,16	Low Line Current Alarm Filter L3	Unsigned integer Range: 0 to 12 seconds	0
253	3,6,16	High Line Current Alarm Setpoint L1	Unsigned integer in 100ths of Amps Range: 0.30A (30) to 60.00A (6000)	30.00A (3000)
254	3,6,16	High Line Current Alarm Setpoint L2	Unsigned integer in 100ths of Amps Range: 0.30A (30) to 60.00A (6000)	30.00A (3000)
255	3,6,16	High Line Current Alarm Setpoint L3	Unsigned integer in 100ths of Amps Range: 0.30A (30) to 60.00A (6000)	30.00A (3000)
256	3,6,16	Low Line Current Alarm Setpoint L1	Unsigned integer in 100ths of Amps Range: 0.30A (30) to 60.00A (6000)	1.00A (100)
257	3,6,16	Low Line Current Alarm Setpoint L2	Unsigned integer in 100ths of Amps Range: 0.30A (30) to 60.00A (60000)	1.00A (100)
258	3,6,16	Low Line Current Alarm Setpoint L3	Unsigned integer in 100ths of Amps Range: 0.30A (30) to 60.00A (60000)	1.00A (100)

High Line Current Alarm Filter L1, L2, L3

The HIGH LINE CURRENT ALARM FILTER L1, L2, L3 will prevent HIGH LOAD CURRENT ALARMS from being indicated until a high current condition has existed for the duration of the HIGH CURRENT ALARM FILTER L1, L2, L3 time.

Low Line Current Alarm Filter L1, L2, L3

The LOW LINE CURRENT ALARM FILTER L1, L2, L3 will prevent LOW LINE CURRENT ALARMS from being indicated until a low current condition has existed for the duration of the LOW CURRENT ALARM FILTER L1, L2, L3 time.

High Line Current Alarm Setpoint L1, L2, L3

If the output current is above the High Line Current Alarm Setpoint, the HTC3 generates a HIGH LINE CURRENT L1, L2, L3 ALARM.

Low Line Current Alarm Setpoint L1, L2, L3

If the output current is below the Low Line Current Alarm Setpoint, the HTC3 generates a LOW LINE CURRENT L1, L2, L3 ALARM.

8.9.3 HTC3 Ground Fault Current Alarms

These registers define the Minimum and Maximum limits for the Ground Fault Current. If these limits are exceeded an alarm will be set.

Modbus Address	Function Code	Description	Comments	Default
244	3,6,16	High GF Current Alarm Filter	Unsigned integer Range: 0 to 12 seconds	0
245	3,6,16	High GF Current Alarm Setpoint	Unsigned integer in 10ths of mAmps Range: 10.0mA (100) to 250.0mA (2500)	20.0mA (200)
246	3,6,16	Ground Fault Trip Current Setpoint	Unsigned integer in 10ths of mAmps Range: 10.0mA (100) to 250.0mA (2500)	30.0mA (300)

High GF Current Alarm Filter

The HIGH GF CURRENT ALARM FILTER will prevent HIGH GF CURRENT ALARMS from being indicated until a high GF current condition has existed for the duration of the HIGH GFI ALARM FILTER time.

High GF Current Alarm Setpoint

If the ground fault current measured by the HTC exceeds the HIGH GF CURRENT ALARM SETPOINT, a HIGH GF CURRENT ALARM is generated.

Ground Fault Trip Current Setpoint

This value sets the upper limit of allowable ground fault leakage current. Exceeding this limit will result in the output switch being latched off and the GROUND FAULT TRIP ALARM activated to indicate a ground fault condition.

CAUTION: IN ORDER TO IMPLEMENT A GROUND FAULT TRIP FUNCTION, ALL NON-GROUNDED POWER CONDUCTORS MUST BE OPENED UPON DETECTION OF A GROUND FAULT CONDITION.

IMPORTANT: *National Electrical Codes may require that all legs of non-neutral based power sources be opened upon detection of a Ground Fault. Multi-pole switch configurations should be used on non-neutral based power systems. Check the requirements with your local Electrical Authority.*

8.9.4 HTC3 Tracing Resistance Alarms

These registers define the Minimum and Maximum limits for the Tracing Resistance. If these limits are exceeded an alarm will be set.

Modbus Address	Function Code	Description	Comments	Default
262	3,6,16	High Tracing Resistance Alarm Filter L1	Unsigned integer Range: 0 to 12 seconds	0
263	3,6,16	High Tracing Resistance Alarm Filter L2	Unsigned integer Range: 0 to 12 seconds	0
264	3,6,16	High Tracing Resistance Alarm Filter L3	Unsigned integer Range: 0 to 12 seconds	0
265	3,6,16	Low Tracing Resistance Alarm Filter L1	Unsigned integer Range: 0 to 12 seconds	0
266	3,6,16	Low Tracing Resistance Alarm Filter L2	Unsigned integer Range: 0 to 12 seconds	0
267	3,6,16	Low Tracing Resistance Alarm Filter L3	Unsigned integer Range: 0 to 12 seconds	0
268	3,6,16	High Tracing Resistance Deviation L1	Unsigned integer Range: 1% to 250%	50%
269	3,6,16	High Tracing Resistance Deviation L2	Unsigned integer Range: 1% to 250%	50%
270	3,6,16	High Tracing Resistance Deviation L3	Unsigned integer Range: 1% to 250%	50%
271	3,6,16	Low Tracing Resistance Deviation L1	Unsigned integer Range: 1% to 100%	50%
272	3,6,16	Low Tracing Resistance Deviation L2	Unsigned integer Range: 1% to 100%	50%
273	3,6,16	Low Tracing Resistance Deviation L3	Unsigned integer Range: 1% to 100%	50%
274	3,6,16	Nominal Tracing Resistance L1 (MSW)	Unsigned integer in 100ths of Ohms Range: 0.8 Ohms (80) to 2500.00 Ohms (250000)	6.00 Ohms (600)
275	3,6,16	Nominal Tracing Resistance L1 (LSW)		
276	3,6,16	Nominal Tracing Resistance L2 (MSW)	Unsigned integer in 100ths of Ohms	6.00 Ohms (600)

High	277	3,6,16	Nominal Tracing Resistance L2 (LSW)	Range: 0.8 Ohms (80) to 2500.00 Ohms (250000)	
	278	3,6,16	Nominal Tracing Resistance L3 (MSW)	Unsigned integer in 100ths of Ohms Range: 0.8 Ohms (80) to 2500.00 Ohms (250000)	6.00 Ohms (600)
	279	3,6,16	Nominal Tracing Resistance L3 (LSW)		

Tracing Resistance Alarm Filter L1, L2, L3

The HIGH TRACING RESISTANCE ALARM FILTER L1, L2, L3 will prevent HIGH RESISTANCE ALARMS from being indicated until a high resistance condition has existed for the duration of the HIGH RESISTANCE ALARM FILTER L1, L2, L3 time.

Low Tracing Resistance Alarm Filter L1, L2, L3

The LOW TRACING RESISTANCE ALARM FILTER L1, L2, L3 will prevent LOW RESISTANCE ALARMS from being indicated until a low resistance condition has existed for the duration of the LOW RESISTANCE ALARM FILTER L1, L2, L3 time.

High Tracing Resistance Deviation L1, L2, L3

Alarms heater resistance levels which have increased from the NOMINAL RESISTANCE L1, L2, L3 setting by more than the HIGH TRACING RESISTANCE DEVIATION L1, L2, L3 setting. The HIGH RESISTANCE ALARM L1, L2, L3 may be used to indicate an open or a high resistance connection or, when using constant wattage parallel cables, may indicate the failure of one or more heating zones. It may also be used to monitor a failed series-type cable or connection in 3-phase applications while minimizing nuisance alarms created by voltage fluctuations.

IMPORTANT: *Care must be taken when using this alarm feature with heating cables that exhibit a variable resistance with temperature. High resistance alarming may not be as effective if the load has a decreasing resistance with temperature.*

HIGH RESISTANCE ALARMS will only be generated if the output switch is on.

Low Tracing Resistance Deviation L1, L2, L3

Alarms heater resistance levels which have decreased from the NOMINAL RESISTANCE L1, L2, L3 setting by more than the LOW TRACING RESISTANCE DEVIATION L1, L2, L3 setting.

Nominal Tracing Resistance L1, L2, L3

This parameter defines the nominal expected heater resistance. A value must be entered by the user to allow the HIGH and LOW TRACING RESISTANCE ALARMS L1, L2, L3 to be used. Once the controller and the heating cable have been installed, the following procedure should be used to determine the NOMINAL RESISTANCE L1, L2, L3 setting:

- Adjust the CONTROL SETPOINT temperature to turn on the output switch.
- Allow the load to come up to design temperature and its power consumption to stabilize.
- Monitor the RESISTANCE reading and record its value. Return the CONTROL TEMPERATURE SETPOINT temperature to its proper setting.
- Enter the recorded resistance value as the NOMINAL RESISTANCE setting.

IMPORTANT: *The setup procedure outlined above may have to be repeated a number of times to arrive at a correct nominal resistance setting. This value will be affected by the heating cable temperature, which in turn is affected by ambient temperature, insulation level, a full or empty pipe or vessel, etc.*

8.9.5 HTC3 Current and Power Limiting Settings

These registers define some Current Ratings, and Current and Power Limits. If these limits are exceeded an alarm will be set.

Modbus Address	Function Code	Description	Comments	Default
241	3,6,16	Circuit Breaker Type	Unsigned integer 0 = NEMA 1 = Type B 2 = Type C 3 = Type D	0 = NEMA
242	3,6,16	Line-Line Voltage	Unsigned integer in 10ths of Volts Fixed voltage Range: 80.0V to 700.0V	120.0V
243	3,6,16	Frequency	Unsigned integer in Hertz Fixed frequency Range: 45Hz to 65Hz	60Hz
280	3,6,16	Maximum Power Limit Set point L1 (MSW)	Unsigned integer in Watts Range: 3 W (3) to 42000 W (42000)	42000W
281	3,6,16	Maximum Power Limit Set point L1 (LSW)		
282	3,6,16	Maximum Power Limit Set point L2 (MSW)	Unsigned integer in Watts Range: 3 W (3) to 42000 W (42000)	42000W
283	3,6,16	Maximum Power Limit Set point L2 (LSW)		
284	3,6,16	Maximum Power Limit Set point L3 (MSW)	Unsigned integer in Watts Range: 3 W (3) to 42000 W (42000)	42000W
285	3,6,16	Maximum Power Limit Set point L3 (LSW)		
286	3,6,16	Circuit Breaker Current Rating L1	Unsigned integer in 100ths of Amps Range: 0.30A (30) to 60.00A (6000)	30.00A
287	3,6,16	Circuit Breaker Current Rating L2	Unsigned integer in 100ths of Amps Range: 0.30A (30) to 60.00A (6000)	30.00A
288	3,6,16	Circuit Breaker Current Rating L3	Unsigned integer in 100ths of Amps Range: 0.30A (30) to 60.00A (6000)	30.00A
289	3,6,16	SSR Rating	Unsigned integer in 100ths of Amps Range: 0.30A (30) to 60.00A (6000)	30.00A (3000)
259	3,6,16	Maximum Line Current Limit Set Point L1	Unsigned integer in 100ths of Amps Range: 0.30A (30) to 60.00A (6000)	60.00A

260	3,6,16	Maximum Line Current Limit Set Point L2	Unsigned integer in 100ths of Amps Range: 0.30A (30) to 60.00A (6000)	60.00A
261	3,6,16	Maximum Line Current Limit Set Point L3	Unsigned integer in 100ths of Amps Range: 0.30A (30) to 60.00A (6000)	60.00A

Circuit Breaker Type

Selects the 'circuit breaker curve' to be used when performing circuit breaker current limiting. Each type of breaker has a different allowance for brief over-currents and this parameter must be selected to match the breaker used in the application.

Fixed Voltage

The current version on the NGC-40-HTC does not monitor the line voltage. This parameter specifies the voltage value that the HTC should use when reporting the trace voltage, and calculating trace resistance and trace power.

Fixed Frequency

The current version on the NGC-40-HTC does not monitor the line frequency. This parameter specifies the line frequency value that the HTC should use for calculating timing for proportional SSR control.

Maximum Power Setpoint L1, L2, L3

This user selectable level limits the maximum amount of power applied to a heat trace circuit. This is an average power calculated by the controller using the average current and the FIXED VOLTAGE setting. The HTC3 switches the output on and off rapidly to limit the average current to an appropriate level. The MAXIMUM POWER level may be adjusted to eliminate step-down transformers, lower the effective output wattage of a cable, or implement energy management of the heat trace circuit.

IMPORTANT: *This function may be set within reasonable limits for the particular tracer being powered. The effective resolution of the setting is limited to 1/30th of the calculated full on power.*

Do not set the MAXIMUM POWER Setpoint below full output for applications that do not require control of power.

Circuit Breaker Current Rating L1, L2, L3

The CIRCUIT BREAKER CURRENT RATING L1, L2, L3 setting helps prevent in-rush induced nuisance tripping of the circuit breaker immediately upstream of the controller. The HTC3 evaluates the square of the current related to time (I^2T) and adjusts the output duty cycle accordingly, limiting the amount of current to an acceptable level.

IMPORTANT: *This feature SHOULD NOT be used to reduce the size of a circuit breaker or increase the maximum heating cable length. It can be quite effective in preventing nuisance trips due to incorrect design or factors prevalent outside those considered by the design.*

Switch (SSR) Current Rating

The SWITCH CURRENT RATING setting defines the current rating of the output switch. It is used by the controller to limit the maximum average current that will be allowed to flow to the load before it begins to adjust the output duty cycle, limiting the amount of current to an acceptable level.

Maximum Current Limit L1, L2, L3

This user selectable level limits the maximum amount of current applied to a heat trace circuit. This is an average current calculated by the controller. The HTC3 switches the output on and off rapidly to limit the average current to an appropriate level.

8.10 HTC3 Controller Setup Parameters

These registers define some additional settings relating directly to the HTC3.

8.10.1 HTC3 Controller Tag

A 40 character TAG may be assigned to an HTC3 to allow it to be easily associated with a control panel, location, or area.

Modbus Address	Function Code	Description	Comments	Default
335	3,6,16	HTC3 Tag 0	NGC40-HTC3 Tag No validity checking is done on the character.	"NGC40-HTC3-" followed by the device CAN ID
…	…	…		
374	3,6,16	HTC3 Tag 39		

8.10.2 HTC3 Digital Input Settings

These settings are associated with the Digital Input.

Modbus Address	Function Code	Description	Comments	Default
375	3,6,16	Digital Input Local/Remote Source	Unsigned integer 0 = Not Used 1 = Local (HTC) 2 = CAN Network I/O	1 = Local
376	3,6,16	Digital Input Local Source CAN ID (MSW)	Unsigned integer Used only if Digital Input Local/Remote is CAN Network I/O	0
377	3,6,16	Digital Input Local Source CAN ID (LSW)		
378	3,6,16	Digital Input Local/Remote Configuration	Unsigned integer 0 = Not Used 1 = Alarm when Digital Input Local/Remote Closed 2 = Alarm when Digital Input Local/Remote Open 3 = Force Off when Digital Input Local/Remote Closed 4 = Force Off when Digital Input Local/Remote Open 5 = Force On when Digital Input Local/Remote Closed	0 = Not Used

			6 = Force On when Digital Input Local/Remote Open	

Digital Input Local/Remote Source

The HTC3supports a Digital Input that may come from one of two sources. The first being the Local Digital Input on the HTC module, the second from a Remote NGC-40 module (NGC-40-HTC, NGC-40-HTC3, NGC-40-IO) located within the panel.

Digital Input Local/Remote Source CAN ID

If the chosen Digital Input Local / Remote Source is Remote this parameter must match the Module ID of the NGC-40 module with the desired Digital Input.

Digital Input Local/Remote Configuration

This parameter defines the function of the Digital Input.

8.10.3 HTC3 Auto-Cycle Interval

AUTO-CYCLE INTERVAL is the number of hours between successive heating circuit integrity tests. This feature turns on the heat tracing for a ten second period every Auto-Cycle Interval. The Auto-Cycle test can help detect problems with the heating system during a time when the system would normally be turned off.

Modbus Address	Function Code	Description	Comments	Default
379	3,6,16	Auto-Cycle Interval	Unsigned integer hours Range: 0 = Disabled 1 to 750 hours.	0 = Disabled

IMPORTANT: *If an AC ALARM becomes active during an auto-cycle, but the AUTO-CYCLE INTERVAL expires prior to the corresponding ALARM FILTER time, then auto-cycling will continue until the ALARM FILTER time has elapsed.*

For the earliest possible alarming of heating circuit problems the AUTO-CYCLE INTERVAL should be set to a small value.

8.10.4 HTC3 Contactor Cycle Count Alarm Setpoint

This parameter sets the limit of off-to-on transitions of an EMR needs to reached or exceeds before a CONTACTOR COUNT ALARM becomes active. This serves as a method to perform preventative maintenance on the EMR before a failure is likely to occur.

Modbus Address	Function Code	Description	Comments	Default
380	3,6,16	Contactor Cycle Count Alarm Limit Setpoint (MSW)	Unsigned integer Range: 0 to 999999	100000
381	3,6,16	Contactor Cycle Count Alarm Limit Setpoint (LSW)		

IMPORTANT: *Writing a '0' to this parameter is for testing and will produce a Contactor Cycle Count Alarm for any Contactor Cycle Count, any time this alarm is enabled.*

8.10.5 HTC3 Alarm Output Settings

These registers are associated with the Alarm Output settings.

Modbus Address	Function Code	Description	Comments	Default
382	3,6,16	Alarm Output Mode	Unsigned integer 0 = Normal Operation 1 = Toggle 2 = Flash	0 = Normal Operation
383	3,6,16	Alarm Output Toggle Time	Unsigned integer in seconds Range: 1 to 240	60 seconds

Alarm Output Mode

Programs the alarm output relay for flashing, toggling, or normal output in case of an alarm condition. Under normal setting the alarm output is active when alarm conditions exist, inactive when no alarm conditions exist. Toggle setting is the same as normal operation, except every new alarm that occurs the alarm relay goes inactive for the ALARM OUTPUT TOGGLE TIME, then goes active again.

IMPORTANT: *If the alarm output is used to drive a pilot light, it is recommended that flash be selected to enable flashing operation. When the output is also configured for normally closed operation, the pilot light will be on steady for normal operation, flash in case of alarm and be extinguished due to a bulb failure or loss of power.*

If multiple alarm outputs from different controllers are wired in series (i.e.: multi-point panels), set this parameter to normal operation.

Alarm Output Toggle Time
When the ALARM OUTPUT MODE is set to ‘”toggle”, this setting determines how long the alarm relay toggles inactive before returning to the active state when a new alarm occurs.

8.10.6 HTC3 Broadcast Timeout

This defines the Timeout Period for Broadcast messages. After this time has elapsed without a broadcast, Failure or Communication Alarms will be activated. The BROADCAST TIMEOUT is used for Load Shedding commands, RMM Temperatures, Remote Temperature Sources, and data from other controllers including the LIMITER.

Modbus Address	Function Code	Description	Comments	Default
384	3,6,16	Broadcast Timeout (Load Shed/Temperature Source/Digital Input Local Source Failure)	Unsigned integer Range: 1 - 10 minutes	1 minute

8.10.7 HTC3 Heater Time Setpoint

After this number of hours of heater on-time has elapsed, a heater time alarm is activated.

Modbus Address	Function Code	Description	Comments	Default
385	3,6,16	Heater Time Setpoint (MSW)	Unsigned integer in hours Range: 1-999999	100,000 hours
386	3,6,16	Heater Time Setpoint (LSW)		

8.11 HTC3 Limiter Parameters

To install a LIMITER that will monitor and safety-limit the output of the HTC3, write the LIMITER CAN ID into these registers. A value of zero means there is no LIMITER installed.

Modbus Address	Function Code	Description	Comments	Default
480	3,6,16	Limiter CAN ID MSW		
481	3,6,16	Limiter CAN ID LSW		

8.12 HTC3 General Information

These read-only registers give some basic information about the HTC3.

Modbus Address	Function Code	Description	Comments
0	4	Device Type	NGC40 HTC Device Type 210 = NGC40 HTC Rev A
1	4	Firmware Version	NGC40 HTC Firmware Version - Major 0 - 255
2	4	Firmware Version	NGC40 HTC Firmware Version - Minor 0 - 255
3	4	Firmware Version	NGC40 HTC Firmware Version - Build 0 - 255
4	4	Manufactured Year	Format : YYYY
5	4	Manufactured Month	Range : 1 - 12
6	4	Manufactured Day	Range : 1 - 31
7	4	Serial Number (MSW)	NGC-40 HTC3 Serial Number
8	4	Serial Number (LSW)	
9	4	Device Subtype	

Device Type

Indicates the device type of the module.

Firmware Version (Major, Minor, Build)

Indicates the revision level of the firmware programmed into the controller, “major.minor.build”.

Manufactured Year, Month, Day

Indicates the date on which the device was manufactured.

Serial Number

The unique serial number for this device.

8.13 HTC3 Range Information

The Range Information section shows the hard-coded maximum and minimum allowable user-configurable settings, viewable over Modbus for reference purposes only.

Modbus Address	Function Code	Description	Comments
15	4	Local Temperature Sensor Range Maximum	Signed integer in 10ths of Degree C Defines range for set points (including alarm set points) 700.0DegC (7000)
16	4	Local Temperature Sensor Range Minimum	Signed integer in 10ths of Degree C Defines range for set points (including alarm set points) -80.0DegC(-800)
17	4	Current Range Maximum	Unsigned integer in 100ths of Amps Defines range for set points (including alarm set points) 60.0A(6000)
18	4	Current Range Minimum	Unsigned integer in 100ths of Amps Defines range for set points (including alarm set points) 0.30A(30)
19	4	GFI Range Maximum	Unsigned integer in 10ths of mAmps Defines range for set points (including alarm set point) 250.0mA(2500)
20	4	GFI Range Minimum	Unsigned integer in 10ths of mAmps Defines range for set points (including alarm set point) 10.0mA(100)
21	4	Maximum Power Set point Range Maximum (MSW)	Unsigned integer in Watts Defines range for set points (including alarm set points) 42000 W (42000)
22	4	Maximum Power Set point Range Maximum (LSW)	
23	4	Maximum Power Set point Range Minimum (MSW)	Unsigned integer in Watts Defines range for set points (including alarm set points) 3 W (3)
24	4	Maximum Power Set point Range	

		Minimum (LSW)	
25	4	Nominal Tracing Resistance Range Maximum (MSW)	Unsigned integer in 100ths of Ohms Defines range for set points (including alarm set points) 2500.00Ohms(250000)
26	4	Nominal Tracing Resistance Range Maximum (LSW)	
27	4	Nominal Tracing Resistance Range Minimum (MSW)	Unsigned integer in 100ths of Ohms Defines range for set points (including alarm set points) 0.8 Ohms.
28	4	Nominal Tracing Resistance Range Minimum (LSW)	

8.14 HTC3 Dynamic Output Status

These registers show the status and on/off time of the Electro-Mechanical Relay (EMR) or Solid-State Relay (SSR).

Modbus Address	Function Code	Description	Comments
55	4	Control Output Duty Cycle	0 - 100% 0 = Full Off, 100 = Full On
56	4	PASC on count	seconds
57	4	PASC off count	seconds
58	4	PASC next switch action	seconds
59	4	Output state	0=off, 1 = on
60	4	Tracing Control Status	Only reports the highest priority if more than one condition exists. Lowest Priority 0 = normal temperature control 1 =Digital Input Local/Remote - force off 2 = auto-cycle in progress 3 = load shedding active 4 = load shedding in fail safe mode (not active in a TS fail off or an output override force off condition) 5 = Digital Input Local/Remote - force on 6 = TS high limit cutout active 7 = contactor no toggle for 0.8 sec 8 = overcurrent trip 9 = ground fault trip 10 = Factory Configuration Data Lost- forced off. 11 = start-up delay active 12 = forced off Highest Priority

Control Output Duty Cycle

0 – 100%

The duty cycle is the percentage of a full cycle that the output is on. 0 = Full Off, 100 = Full On.

PASC on count

The number of seconds of on-time during the currently calculated PASC cycle.

PASC off count

The number of seconds of off-time during the currently calculated PASC cycle.

PASC next switch action

The number of seconds until the next switch-state change.

Output state

The current state of the trace switch

Tracing Control Status

This explains why the output is in the present state.
Only reports the highest priority if more than one condition exists.

8.15 HTC3 Analog Readings

The read-only Analog Readings registers show all the measured parameters.

8.15.1 HTC3 Temperature Readings

These registers show the measured temperature on all installed temperature sources.

Modbus Address	Function Code	Description	Comments
65	4	Control Temperature	Signed integer in 10ths of Degree C Control Temp Failure = +3000.0DegC (30000)
66	4	Temperature Source 1 Temperature	Signed integer in 10ths of Degree C TS Failure = +3000.0DegC (30000) TS Not Used = +3200.0DegC (32000)
67	4	Temperature Source 2 Temperature	Signed integer in 10ths of Degree C TS Failure = +3000.0DegC (30000) TS Not Used = +3200.0DegC (32000)
68	4	Temperature Source 3 Temperature	Signed integer in 10ths of Degree C TS Failure = +3000.0DegC (30000) TS Not Used = +3200.0DegC (32000)
69	4	Temperature Source 4 Temperature	Signed integer in 10ths of Degree C TS Failure = +3000.0DegC (30000) TS Not Used = +3200.0DegC (32000)
70	4	Temperature Source 5 Temperature	Signed integer in 10ths of Degree C TS Failure = +3000.0DegC (30000) TS Not Used = +3200.0DegC (32000)
71	4	Temperature Source 6 Temperature	Signed integer in 10ths of Degree C TS Failure = +3000.0DegC (30000) TS Not Used = +3200.0DegC (32000)
72	4	Temperature Source 7 Temperature	Signed integer in 10ths of Degree C TS Failure = +3000.0DegC (30000) TS Not Used = +3200.0DegC (32000)
73	4	Temperature Source 8 Temperature	Signed integer in 10ths of Degree C TS Failure = +3000.0DegC (30000) TS Not Used = +3200.0DegC (32000)
74	4	Ambient Temperature	Signed integer in 10ths of Degree C TS Failure = +3000.0DegC (30000)
75	4	Local Temperature Sensor Temperature	Signed integer in 10ths of Degree C TS Failure = +3000.0DegC (30000) TS Not Used = +3200.0DegC (32000)

Control Temperature

This is the temperature that the controller uses to determine whether its output switch should be on or off. It is derived from a combination of the 8 configurable temperature sources.

Temperature Source 1 to 8 Temperature

This temperature is the value of the 8 configurable temperature sources.

Ambient Temperature

The temperature reading of the on-board temperature sensor.

Local Temperature Sensor Temperature

This is the temperature of the local RTD.

8.15.2 HTC3 Line Current and Ground Fault Current Readings

These read-only registers show the measured and calculated Line Currents as well as Ground Fault Current and Power Consumption.

Modbus Address	Function Code	Description	Comments
76	4	Effective Line Current L1	Unsigned integer in 100ths of Amps This is the effective current (equals full Line current multiplied by the output duty cycle).
77	4	Effective Line Current L2	Unsigned integer in 100ths of Amps This is the effective current (equals full Line current multiplied by the output duty cycle).
78	4	Effective Line Current L3	Unsigned integer in 100ths of Amps This is the effective current (equals full Line current multiplied by the output duty cycle).
79	4	Instantaneous Line Current L1	Unsigned integer in 100ths of Amps
80	4	Instantaneous Line Current L2	Unsigned integer in 100ths of Amps
81	4	Instantaneous Line Current L3	Unsigned integer in 100ths of Amps
82	4	Instantaneous Ground Fault Current	Unsigned integer in 10ths of mAmps
83	4	Voltage (Line to Line)	Unsigned integer in 10ths of Volts Currently this is not a monitoring value. This register value is entered in AC Analog Parameters function 3, register 268
86	4	Frequency	Unsigned integer in Hertz Currently this is not a monitoring value. This register value is entered in AC Analog Parameters function 3, register 269
87	4	Power Consumption L1 (MSW)	Unsigned integer in Watts
88	4	Power Consumption L1	

		(LSW)	
89	4	Power Consumption L2 (MSW)	Unsigned integer in Watts
90	4	Power Consumption L2 (LSW)	
91	4	Power Consumption L3 (MSW)	Unsigned integer in Watts
92	4	Power Consumption L3 (LSW)	
93	4	Total Power L1, L2, L3 (MSW)	Unsigned integer in Watts Sum of Phases A,B and C
94	4	Total Power L1, L2, L3 (LSW)	
95	4	Tracing Resistance L1 (MSW)	Unsigned integer in 100ths of Ohms Open Circuit = 8000.00Ohms (800000) Estimated resistance based on heater configuration
96	4	Tracing Resistance L1 (LSW)	
97	4	Tracing Resistance L2 (MSW)	Unsigned integer in 100ths of Ohms Open Circuit = 8000.00Ohms (800000) Estimated resistance based on heater configuration
98	4	Tracing Resistance L2 (LSW)	
99	4	Tracing Resistance L3 (MSW)	Unsigned integer in 100ths of Ohms Open Circuit = 8000.00Ohms (800000) Estimated resistance based on heater configuration
100	4	Tracing Resistance L3 (LSW)	

Effective Line Current L1,L2, L3

This is the effective current (equals full LINE CURRENT L1, L2, L3 multiplied by the output duty cycle. For example if the full-on current is 10A and the duty cycle is 36%, the effective line current is 10A x 36% = 3.6A.

Instantaneous Line Current L1,L2, L3

The INSTANTANEOUS LINE CURRENT L1, L2, L3 reading indicates the current in Amps being drawn by the heating cable, without regard for the duty cycle being applied.

Instantaneous Ground Fault Current

If the controller detects any leakage current in the output circuit, it will indicate the level in milliamps.

Fixed Voltage

This value must be set to the trace voltage. The present version of HTC/HTC3 does not measure this parameter.

Fixed Frequency

This value must be set to the frequency of the trace power. The present version of HTC/HTC3 does not measure this parameter.

Power Consumption L1,L2, L3

Load power provides an indication of the average power being consumed by the heat trace cable.

IMPORTANT: *The controller calculates load power by multiplying the fixed voltage reading by the instantaneous current reading.*

Tracing Resistance L1,L2, L3

Tracing resistance in Ohms. Resistance is calculated using the fixed voltage reading divided by the instantaneous current reading to yield a load resistance in ohms. If the controller's output switch is on, but no current is present, the RESISTANCE will read "open circuit", 8000 Ohms.

IMPORTANT: *If the controller's output switch is off, the RESISTANCE will always display the last resistance which was calculated while the output switch was on.*

8.15.3 HTC3 Last On Values

Value of the parameter the last time the trace was energized.

Last

Modbus Address	Function Code	Description	Comments
109	4	Last On Effective Line Current L1	Unsigned integer in 100ths of Amps This is the effective current (equals full Line current multiplied by the output duty cycle).
110	4	Last On Effective Line Current L2	Unsigned integer in 100ths of Amps This is the effective current (equals full Line current multiplied by the output duty cycle).
111	4	Last On Effective Line Current L3	Unsigned integer in 100ths of Amps This is the effective current (equals full Line current multiplied by the output duty cycle).
112	4	Last On Line Current L1	Unsigned integer in 100ths of Amps This is the instantaneous current (equals full Line current).
113	4	Last On Line Current L2	Unsigned integer in 100ths of Amps This is the instantaneous current (equals full Line current).
114	4	Last On Line Current L3	Unsigned integer in 100ths of Amps This is the instantaneous current (equals full Line current).
115	4	Last On Control Temperature	Signed integer in 10ths of Degree C
116	4	Last On Ground Fault Current	Unsigned integer in 10ths of mAmps

On

Effective Line Current L1, L2, L3

This is the effective current (equals full Line Current multiplied by the output duty cycle) in Amps.

Last On Line Current

This is the instantaneous current (equals full Line Current) in Amps.

Last On Control Temperature

Control Temperature

Last On Ground Fault Current

Ground Fault Current in milliamps.

8.16 HTC3 Latched Alarm Values

The Latched Alarm registers hold the value of each parameter that caused an alarm trip. If there is no alarm, the register holds the “Invalid Alarm Value” shown in the Comments column.

Modbus Address	Function Code	Description	Comments
120	4	Control Temperature High Alarm Value	Signed integer in 10ths of Degree C Invalid Alarm Value = +3000.0DegC (30000)
121	4	Control Temperature Low Alarm Value	Signed integer in 10ths of Degree C Invalid Alarm Value = +3000.0DegC (30000)
122	4	Local Temperature Sensor High Alarm Value	Signed integer in 10ths of Degree C Invalid Alarm Value = +3000.0DegC (30000)
123	4	Local Temperature Sensor Low Alarm Value	Signed integer in 10ths of Degree C Invalid Alarm Value = +3000.0DegC (30000)
124	4	High Line Current Alarm Value L1	Unsigned integer in 100ths of Amps Invalid Alarm Value = 650.00A (65000)
125	4	Low Line Current Alarm Value L1	Unsigned integer in 100ths of Amps Invalid Alarm Value = 650.00A (65000)
126	4	High Line Current Alarm Value L2	Unsigned integer in 100ths of Amps Invalid Alarm Value = 650.00A (65000)
127	4	Low Line Current Alarm Value L2	Unsigned integer in 100ths of Amps Invalid Alarm Value = 650.00A (65000)
128	4	High Line Current Alarm Value L3	Unsigned integer in 100ths of Amps Invalid Alarm Value = 650.00A (65000)
129	4	Low Line Current Alarm Value L3	Unsigned integer in 100ths of Amps Invalid Alarm Value = 650.00A (65000)
130	4	High GF Current Alarm Value	Unsigned integer in 10ths of mAmps Invalid Alarm Value = 6500.0mA (65000)
131	4	GF Current Trip Alarm Value	Unsigned integer in 10ths of mAmps Invalid Alarm Value = 6500.0mA (65000)
132	4	High Tracing Resistance Alarm Value L1 (MSW)	Unsigned integer in 100ths of Ohms Open Circuit = 8000.00 Ohms (800000) Invalid Alarm Value = 9000.00 Ohms (900000)
133	4	High Tracing Resistance Alarm Value L1 (LSW)	
134	4	Low Tracing Resistance Alarm Value L1 (MSW)	Unsigned integer in 100ths of Ohms Invalid Alarm Value = 9000.00 Ohms (900000)
135	4	Low Tracing Resistance Alarm Value L1 (LSW)	
136	4	High Tracing Resistance Alarm Value L2 (MSW)	Unsigned integer in 100ths of Ohms Open Circuit = 8000.00 Ohms (800000) Invalid Alarm Value = 9000.00 Ohms (900000)
137	4	High Tracing Resistance Alarm Value L2 (LSW)	
138	4	Low Tracing Resistance Alarm Value L2 (MSW)	Unsigned integer in 100ths of Ohms

139	4	Low Tracing Resistance Alarm Value L2 (LSW)	Invalid Alarm Value = 9000.00 Ohms (900000)
140	4	High Tracing Resistance Alarm Value L3 (MSW)	Unsigned integer in 100ths of Ohms Open Circuit = 8000.00 Ohms (800000) Invalid Alarm Value = 9000.00 Ohms (900000)
141	4	High Tracing Resistance Alarm Value L3 (LSW)	
142	4	Low Tracing Resistance Alarm Value L3 (MSW)	Unsigned integer in 100ths of Ohms Invalid Alarm Value = 9000.00 Ohms (900000)
143	4	Low Tracing Resistance Alarm Value L3 (LSW)	

8.17 HTC3 Maintenance Information

This feature indicates the maximum and minimum temperatures ever recorded by the HTC since the last time the values were reset. It may be useful to log the maximum/minimum temperatures ever experienced on a particular trace circuit for the purposes of trouble shooting or gathering data for future design criteria. The temperature values are written to the controller's non-volatile memory once every 24 hours or whenever any maintenance data is reset by the user. Max/min temperatures are recorded for the local RTD and Control Temperatures.

IMPORTANT: *Can only be reset (cleared) by the operator.*

Modbus Address	Function Code	Description	Comments
	4	Maximum Control Temperature	Signed integer in 10ths of Degree C Invalid Value = -3000.0DegC (35536)
171	4	Minimum Control Temperature	Signed integer in 10ths of Degree C Invalid Value = +3000.0DegC (30000)
172	4	Local Temperature Sensor Maximum Temperature	Signed integer in 10ths of Degree C Invalid Value = +3000.0DegC (30000)
173	4	Local Temperature Sensor Minimum Temperature	Signed integer in 10ths of Degree C Invalid Value = +3000.0DegC (30000)
174	4	Power Accumulator L1 (MSW)	Unsigned integer in 10ths kW-hr
175	4	Power Accumulator L1 (LSW)	
176	4	Power Accumulator L2 (MSW)	Unsigned integer in 10ths kW-hr
177	4	Power Accumulator L2 (LSW)	
178	4	Power Accumulator L3 (MSW)	Unsigned integer in 10ths kW-hr
179	4	Power Accumulator L3 (LSW)	
180	4	Total Power L1, L2, L3(MSW)	Unsigned integer in 10ths kW-hr Sum of Phases A,B and C
181	4	Total Power L1, L2, L3 (LSW)	
182	4	Highest Instantaneous Line Current Ever Measured L1	Unsigned integer in 100ths of Amps
183	4	Highest Instantaneous Line Current Ever Measured L2	Unsigned integer in 100ths of Amps
184	4	Highest Instantaneous Line Current Ever Measured L3	Unsigned integer in 100ths of Amps
185	4	Highest Instantaneous Ground Fault Ever Measured	Unsigned integer in 10ths of mAmps
186	4	Contactor Cycle Count (MSW)	Unsigned integer Number of off-on transitions
187	4	Contactor Cycle Count (LSW)	
188	4	Number of Hours In Use (MSW)	Unsigned integer
189	4	Number of Hours In Use (LSW)	
190	4	Number of Hours Since Last Reset	Unsigned integer
191	4	Heater Time (MSW)	Unsigned integer in Hours
192	4	Heater Time (LSW)	
193	4	Test Tracing Time Count	Unsigned integer seconds Remaining time during which the controller should hold its input on

Power Accumulator

This feature indicates the total power consumption of the trace circuit since the last time the POWER ACCUMULATOR was reset. It may be useful to log the amount of power consumed on a particular trace circuit for the purposes of energy management or gathering of data for future design criteria. The value of this accumulator is written to the controller's non-volatile memory once every 24 hours or whenever any maintenance data is reset by the user.

Highest Instantaneous Line Current Ever Measured

This feature indicates the HIGHEST INSTANTANEOUS LOAD CURRENT measured since the last time the PEAK LINE CURRENT was reset. This value is written to the controller's non-volatile memory once every 24 hours or whenever any maintenance data is reset by the user.

Highest Instantaneous Line Current Ever Measured L1, L2 L3

This feature indicates the HIGHEST INSTANTANEOUS LOAD CURRENT L1, L2, L3 measured since the last time the PEAK LINE CURRENT was reset. This value is written to the controller's non-volatile memory once every 24 hours or whenever any maintenance data is reset by the user.

Highest Instantaneous Ground Fault Ever Measured

This feature indicates the highest instantaneous ground fault current measured since the last time the PEAK GROUND FAULT CURRENT was reset. This current value is written to the controller's non-volatile memory once every 24 hours or whenever any maintenance data is reset by the user.

Contactor Cycle Count

This feature indicates the total number of off-to-on transitions an EMR has done since the last time the CONTACTOR CYCLE COUNTER was reset. This serves as a method to do preventative maintenance on the EMR according to the manufacturer's specifications. This count value is written to the controller's non-volatile memory once every 24 hours or whenever any maintenance data is reset by the user.

IMPORTANT: *Once the CONTACTOR CYCLE COUNTER reaches 999,999,999 it will stop counting.*

The CONTACTOR CYCLE COUNTER is only indicated if the SWITCH CONTROL MODE is set to either ON/Off EMR, or PASC EMR.

Number of Hours In Use

The purpose of this feature is to indicate the total hours of use of the controller since its initial operation. It may be useful to log the amount of time a particular controller has been in operation for the purposes of maintenance planning or reliability testing. The value of this accumulator is written to the controller's non-volatile memory once every 24 hours or whenever any maintenance data is reset by the user.

Number of Hours Since Last Reset

This feature indicates the total hours of use of the controller since the last reset. It may be useful to log the amount of time a particular controller has been in operation since the last time the controller's power was cycled for trouble-shooting purposes.

Heater Time

Represents the number of hours that the trace has spent energized.

8.18 HTC3 Limiter Reading

If there is a LIMITER installed in the HTC3 this register will hold the current temperature reading from that LIMITER. If there is no LIMITER installed it will read 3200.

Modbus Address	Function Code	Description	Comments
480	4	Limiter Temperature	Signed Integer in Degree C Reading is the greatest of the enabled Limiter RTDs Invalid value = +3000 DegC (3000) Not in use = +3200 DegC (3200)

9. Modbus Registers for NGC-40-IO

The NGC-40-IO provides up to four additional RTD inputs. These additional RTD inputs can be assigned to any NGC-40-HTC/HTC3. The NGC-40-IO also has one digital input and one alarm relay; each is programmable.

9.1 IO Alarm Status

The NGC-40 system uses alarms to indicate fault conditions and out-of-range temperatures. Most alarms can be disabled (masked) and set to be latching or non-latching to accommodate specific applications. An active alarm shows a "1" in the alarm register, and can be reset by writing a 1 to that register as long as the alarm condition no longer exists.

9.1.1 IO Temperature Sensor Alarms

These alarms are associated with the local Temperature Sensors.

Modbus Address	Function Code	Description	Comments
0	1,5,15	Temperature Sensor 1 High	Alarm Status: 0 = Normal, 1 = Alarm Writing a 1 resets the alarm, writing 0 has no effect
1	1,5,15	Temperature Sensor 1 Low	Alarm Status: 0 = Normal, 1 = Alarm Writing a 1 resets the alarm, writing 0 has no effect
2	1,5,15	Temperature Sensor 1 Failure	Alarm Status: 0 = Normal, 1 = Alarm Writing a 1 resets the alarm, writing 0 has no effect
3	1,5,15	Temperature Sensor 2 High	Alarm Status: 0 = Normal, 1 = Alarm Writing a 1 resets the alarm, writing 0 has no effect
4	1,5,15	Temperature Sensor 2 Low	Alarm Status: 0 = Normal, 1 = Alarm Writing a 1 resets the alarm, writing 0 has no effect
5	1,5,15	Temperature Sensor 2 Failure	Alarm Status: 0 = Normal, 1 = Alarm Writing a 1 resets the alarm, writing 0 has no effect
6	1,5,15	Temperature Sensor 3 High	Alarm Status: 0 = Normal, 1 = Alarm Writing a 1 resets the alarm, writing 0 has no effect
7	1,5,15	Temperature Sensor 3 Low	Alarm Status: 0 = Normal, 1 = Alarm Writing a 1 resets the alarm, writing 0 has no effect
8	1,5,15	Temperature Sensor 3 Failure	Alarm Status: 0 = Normal, 1 = Alarm Writing a 1 resets the alarm, writing 0 has no effect
9	1,5,15	Temperature Sensor 4 High	Alarm Status: 0 = Normal, 1 = Alarm Writing a 1 resets the alarm, writing 0 has no effect
10	1,5,15	Temperature Sensor 4 Low	Alarm Status: 0 = Normal, 1 = Alarm Writing a 1 resets the alarm, writing 0 has no effect
11	1,5,15	Temperature Sensor 4 Failure	Alarm Status: 0 = Normal, 1 = Alarm Writing a 1 resets the alarm, writing 0 has no effect

Local Temperature Sensor 1 to 4 Failure

This alarm will appear when a failure of the temperature sensor 1- 4 connected directly to the IO is detected. Both open and shorted sensors are detected and alarmed by the IO.

Local Temperature Sensor 1 to 4 High

This alarm will appear if the Local Temperature Sensor 1-4 value measured by the IO exceeds the LOCAL TEMPERATURE SENSOR 1-4 HIGH ALARM SETPOINT.

Local Temperature Sensor 1 to 4 Low

This alarm will appear if the Local Temperature Sensor 1-4 value measured by the IO decreases below the LOCAL TEMPERATURE SENSOR 1-4 LOW ALARM SETPOINT.

9.1.2 IO Alarm Source Failure Alarms

These alarms are associated with the installed Remote Source Temperature Sensors.

Modbus Address	Function Code	Description	Comments
12	1,5,15	Alarm Source 1 Failure	Alarm Status: 0 = Normal, 1 = Alarm Writing a 1 resets the alarm, writing 0 has no effect
13	1,5,15	Alarm Source 2 Failure	Alarm Status: 0 = Normal, 1 = Alarm Writing a 1 resets the alarm, writing 0 has no effect
…	…	…	…
90	1,5,15	Alarm Source 79 Failure	Alarm Status: 0 = Normal, 1 = Alarm Writing a 1 resets the alarm, writing 0 has no effect
91	1,5,15	Alarm Source 80 Failure	Alarm Status: 0 = Normal, 1 = Alarm Writing a 1 resets the alarm, writing 0 has no effect

Alarm Source 1 – 80 Failure

This is a series of specific alarms that will occur when the IO fails to obtain regular alarm status information from any of the 80 configured Alarm Sources.

9.1.3 Other IO Alarms

The Data Lost alarms indicate memory problems.

Modbus Address	Function Code	Description	Comments
92	1,5,15	Device Reset	Alarm Status: 0 = Normal, 1 = Alarm Writing a 1 resets the alarm, writing 0 has no effect
93	1,5,15	Digital Input	Alarm Status: 0 = Normal, 1 = Alarm Writing a 1 resets the alarm, writing 0 has no effect
94	1,5,15	User Configuration Data Lost	Alarm Status: 0 = Normal, 1 = Alarm Writing a 1 resets the alarm, writing 0 has no effect
95	1,5,15	Factory Configuration Data Lost	Alarm Status: 0 = Normal, 1 = Alarm Writing a 1 resets the alarm, writing 0 has no effect

Device Reset

The DEVICE RESET ALARM is used to indicate:

1) Power to the IO has been interrupted and subsequently restored.
2) A transient has caused the IO's program to restart.
3) An internal condition has caused the IO's program to restart.

IMPORTANT: *Normally the DEVICE RESET ALARM is left disabled since powering the controller off and on for maintenance or trouble-shooting would require the user to reset this alarm every time.*

Digital Input

This is a series of specific alarms that will occur when the IO fails to obtain regular alarm status information from any of the 80 configured Alarm Sources.

User Configuration Data Lost

The USER CONFIGURATION DATA LOST alarm indicates that the controller has either detected a failure in its non-volatile memory, or the user has performed a LOAD USER DEFAULTS command. This alarm indicates that the user configuration data has been reset to default values.

IMPORTANT: *The USER CONFIGURATION DATA LOST ALARM cannot be disabled. If the user configuration data has not been intentionally reset (i.e. using the LOAD USER DEFAULTS command) this alarm may indicate a problem with the IO, and may require a return to the factory for repair.*

Factory Configuration Data Lost

The FACTORY CONFIGURATION DATA LOST ALARM indicates that the controller has detected a failure in its non-volatile memory and the factory configuration data has been lost. The IO will rebuild the database and return factory configuration data to default values.

IMPORTANT: *The FACTORY CONFIGURATION DATA LOST ALARM cannot be disabled. This memory stores some of the controller's configuration and calibration settings and the alarm will only be generated if the IO software cannot bypass the failed area of its memory. This indicates an internal problem and the IO should be replaced or returned to the factory for repair.*

9.2 IO Alarm Masks

The Alarm Mask registers match 1:1 to the Alarm Status registers at Function 1, address 0. A 1 designates an enabled alarm, a 0 is a disabled alarm. Not all alarms can be disabled. Refer to the full Modbus Map located in the Appendices for detailed information on each Alarm Mask.

Modbus Address	Function Code	Description	Comments	Default
110	1,5,15	Temperature Sensor 1 High	Alarm Mask: 0 = Disabled, 1 = Enabled	Disabled
…	…	….	…	…
205	1,5,15	Factory Configuration Data Lost	Alarm Mask: 1 = Enabled (Cannot be disabled)	Enabled

9.3 IO Alarm Latching

The Alarm Latching registers match 1:1 with the Alarm registers starting at Function 1, Address 0. Some alarms are user selectable to be Latching or Non-Latching. If set to Non-Latching, the controller will automatically clear the alarm when the condition no longer exists. If set to Latching the alarm must be cleared by the user.

Modbus Address	Function Code	Description	Comments	Default
220	1,5,15	Temperature Sensor 1 High	0 = Latching, 1 = Non-Latching	Non-Latching
…	…	….	…	…
313	1,5,15	Digital Input	0 = Latching, 1 = Non-Latching	Latching

9.4 IO Setup Parameters

The Controller Setup Parameters for the IO only contains the LOAD USER CONFIGURATION DEFAULTS command.

9.4.1 IO Load User Configuration Data Defaults

Resets all the user default settings. The IO will restore all values listed as "default" in the Modbus Map.

Modbus Address	Function Code	Description	Comments
335	1,5,15	Load User Configuration Data Defaults	Write 1 to load user configuration defaults, writing 0 is ignored Reads return 0

9.5 IO Reset Maintenance Parameters

Writing a 1 to these write-only registers will clear the associated Highest/Lowest Recorded Value register in the Maintenance Information Function 4 section.

Modbus Address	Function Code	Description	Comments
345	5,15	Reset Temperature Sensor 1 Max/Min Temperatures	Writing a 1 resets parameter, writing 0 has no effect
346	5,15	Reset Temperature Sensor 2 Max/Min Temperatures	Writing a 1 resets parameter, writing 0 has no effect
347	5,15	Reset Temperature Sensor 3 Max/Min Temperatures	Writing a 1 resets parameter, writing 0 has no effect
348	5,15	Reset Temperature Sensor 4 Max/Min Temperatures	Writing a 1 resets parameter, writing 0 has no effect
349	5,15	Reset Number of Hours In Use	Writing a 1 resets parameter, writing 0 has no effect

IMPORTANT: *These registers are Function 5,15 – write only*

Reset Temperature Sensor 1 to 4 Max/Min Temperatures

Reset the maximum and minimum temperatures ever seen by the IO module.

Reset Number of Hours In Use

Resets the total number of hours the IO has been operating.

9.6 IO Status

These read-only registers show the status of the Alarm Output Relay.

Modbus Address	Function Code	Description	Comments
0	2	Raw Digital Input Local/Remote	0 = open or 3.3V-24V 1 = shorted (0V)
1	2	Raw Alarm Output	0 = No Alarm state (Alarm LED OFF) 1 = Alarm state (Alarm LED ON)

IMPORTANT: *These registers are Function 2 – Read Only*

Raw Digital Input Local/Remote

Shows the state of the Digital Input, 0 for open and 1 for shorted.

Raw Alarm Output

Shows the state of the Alarm Output, 0 for no alarm and 1 for in alarm state.

9.7 IO Setup Parameters

These registers define some additional settings relating directly to the IO.

IO 0-A 40	Modbus Address	Function Code	Description	Comments	Default	Tag 39
	0	3,6,16	IO Tag 0	NGC40-IO Tag No validity checking is done on the character.	"NGC40-IO-" followed by CAN ID	
	…	…	…			
	39	3,6,16	IO Tag 39			
	40	3,6,16	Digital Input Configuration	Unsigned integer 0 = (Not Used) - Normal No Alarm 1 = Alarm when Digital Input Local/Remote Closed 2 = Alarm when Digital Input Local/Remote Open	0 = (Not Used) - Normal No Alarm	
	41	3,6,16	Alarm Output Mode	Unsigned integer 0 = Normal Operation 1 = Toggle 2 = Flash	0 = Normal Operation	
	42	3,6,16	Alarm Output Toggle Time	Unsigned integer in seconds Range: 1 - 240 seconds	60 seconds	

character TAG may be assigned to a IO to allow it to be easily associated with a control panel, location, or area.

Digital Input Configuration

This parameter defines the function of the Digital Input.

Alarm Output Mode

Programs the alarm output relay for flashing, toggling, or normal output in case of an alarm condition.
Under normal setting the alarm output is active when alarm conditions exist, inactive when no alarm conditions exist. Toggle setting is the same as normal operation, except every time a new alarm occurs the alarm relay goes inactive for the “alarm output toggle time” then goes active again.

IMPORTANT: *If the alarm output is used to drive a pilot light, it is recommended that flash be selected to enable flashing operation. When the output is also configured for normally closed operation, the pilot light will be on steady for normal operation, flash in case of alarm and be extinguished due to a bulb failure or loss of power.*

If multiple alarm outputs from different controllers are wired in series (i.e.: multi-point panels), set this parameter to normal operation.

Alarm Output Toggle Time

When the ALARM OUTPUT MODE is set to “toggle”, this setting determines how long the alarm relay toggles inactive before returning to the active state when new alarms occurs.

9.8 IO Temperature Sensor Setup

These registers define some additional settings relating directly to the IO Temperature Sensors.

Modbus Address	Function Code	Description	Comments	Default
60	3,6,16	Temperature Sensor 1 Tag0	NGC40 RTD1 Tag No validity checking is done on the character.	"NGC40-IO-RTD1-" followed by the device CAN ID
…	…	…		
99	3,6,16	Temperature Sensor 1 Tag39		
100	3,6,16	Temperature Sensor 1 Type	Unsigned integer 0 = Not Used 1 = 3 wire 100 Ohm Platinum 2 = 2 wire 100 Ω nickel iron	1 = 3 wire 100 Ohm Platinum
101	3,6,16	Temperature Sensor 1 RTD Lead Resistance	Unsigned integer in 100ths of Ohms Range: 0 to 20.00Ω (for nickel iron only)	0
102	3,6,16	Temperature Sensor 1 High Alarm Setpoint	Signed integer in 10ths of Degree C Range: -80.0DegC to 700.0DegC (7000)	100.0DegC
103	3,6,16	Temperature Sensor 1 Low Alarm Setpoint	Signed integer in 10ths of Degree C Range: -80.0DegC to 700.0DegC (7000)	5.0DegC
104	3,6,16	Temperature Sensor 1 High Alarm Filter	Unsigned integer in seconds Range : 0 to 59940 seconds	0
105	3,6,16	Temperature Sensor 1 Low Alarm Filter	Unsigned integer in seconds Range : 0 to 59940 seconds	0

IMPORTANT: *Only registers for Temperature Sensor 1 are shown. See Appendix D – IO Modbus Map for full listing.*

Local Temperature Sensor 1-4 Tag 0-39

A 40 character tag may be assigned to the Local RTD 1-4 connected directly to the IO to allow it to be easily associated with a control panel, location, or area.

Local Temperature Sensor 1-4 Type

This parameter specifies the type of RTD that is connected to directly to the IO.

IMPORTANT: *If a 2 wire 100 Ω Nickel Iron (NI-FE) RTD is selected then the Local RTD LEAD RESISTANCE must be entered manually.*

Local RTD 1-4 Lead Resistance

This parameter specifies the lead resistance of a 2 wire Nickel Iron RTD connected directly to the IO. (For NI-FE RTDs only)

Local Temperature Sensor 1-4 High Alarm Setpoint

If any of the 4 local RTD's connected directly to the IO reads a temperature above this threshold, it generates a LOCAL TEMPERATURE SENSOR HIGH ALARM, assuming the alarm is enabled.

Local Temperature Sensor 1-4 Low Alarm Setpoint

If the local RTD connected directly to the IO reads a temperature below this threshold, it generates a LOCAL TEMPERATURE SENSOR LOW ALARM, assuming the alarm is enabled.

Local Temperature Sensor 1-4 High Alarm Filter

The Local TEMPERATURE SENSOR HIGH ALARM FILTER will prevent LOCAL TEMPERATURE SENSOR 1-4 HIGH ALARM from being indicated until the corresponding alarm condition has existed for the duration of the LOCAL TEMPERATURE SENSOR 1-4 HIGH ALARM FILTER time.

IMPORTANT: *If an alarm condition appears and then disappears before the alarm filter time has expired, the filter timer is reset and the alarm condition must exist again for the entire alarm filter time before the corresponding alarm will be indicated.*

If the user resets an alarm while the alarm condition is still exists, then the alarm will not be indicated again until the entire alarm filter time has expired.

Local Temperature Sensor 1-4 Low Alarm Filter

The Local TEMPERATURE SENSOR 1-4 LOW ALARM FILTER will prevent LOCAL TEMPERATURE SENSOR 1-4 LOW ALARM from being indicated until the corresponding alarm condition has existed for the duration of the LOCAL TEMPERATURE SENSOR 1-4 HIGH ALARM FILTER time.

IMPORTANT: *If an alarm condition appears and then disappears before the alarm filter time has expired, the filter timer is reset and the alarm condition must exist again for the entire alarm filter time before the corresponding alarm will be indicated.*

If the user resets an alarm while the alarm condition is still exists, then the alarm will not be indicated again until the entire alarm filter time has expired.

9.9 IO Alarm Source Setup

These registers define the CAN ID for all installed Alarm Sources. To install a remote controller, write the CAN ID into an available slot. A value of zero means nothing is installed.

Modbus Address	Function Code	Description	Comments	Default
260	3,6,16	Alarm Source 1 CAN Network Device ID (MSW)	Unsigned integer CAN Network Device ID	0
261	3,6,16	Alarm Source 1 CAN Network Device ID (LSW)		
262	3,6,16	Alarm Source 2 CAN Network Device ID (MSW)	Unsigned integer CAN Network Device ID	0
263	3,6,16	Alarm Source 2 CAN Network Device ID (LSW)		
…	…	…	…	…
418	3,6,16	Alarm Source 80 CAN Network Device ID (MSW)	Unsigned integer CAN Network Device ID	0
419	3,6,16	Alarm Source 80 CAN Network Device ID (LSW)		

IMPORTANT: *Not all 80 Alarm Source CAN Network Device ID registers have been shown. See Appendix D – IO Modbus Map for full listing.*

Each CAN ID MSB and LSB register set must be written with a group write. See section 3.3 Group writes *for more information on group writes.*

9.10 IO General Information

These read-only registers give some basic information about the IO.

Modbus Address	Function Code	Description	Comments
0	4	Device Type	NGC40-IO Device Type 240 = NGC40-IO Rev A
1	4	Firmware Version	NGC40 IO Firmware Version - Major 0 - 255
2	4	Firmware Version	NGC40 IO Firmware Version - Minor 0 - 255
3	4	Firmware Version	NGC40 IO Firmware Version - Build 0 - 255
4	4	Manufactured Year	Format : YYYY
5	4	Manufactured Month	Range : 1 - 12
6	4	Manufactured Day	Range : 1 - 31
7	4	Serial Number (MSW)	NGC-40 IO Serial Number
8	4	Serial Number (LSW)	
9	4	Device Subtype	

Device Type

Indicates the device type of the module.

Firmware Version (Major, Minor, Build)

Indicates the revision level of the firmware programmed into the controller, ‘major.minor.build’.

Manufactured Year, Month, Day

Indicates the date on which the device was manufactured.

Serial Number

The unique serial number for this device.

9.11 IO Range Information

The Range Information section shows the hard-coded maximum and minimum allowable user-configurable settings, viewable over Modbus for reference purposes only.

The

Modbus Address	Function Code	Description	Comments
15	4	Temperature Sensor 1 Range Maximum	Signed Integer in 10ths of Degree C Defines range for set points (including alarm set points)
16	4	Temperature Sensor 1 Range Minimum	Signed Integer in 10ths of Degree C Defines range for set points (including alarm set points)
17	4	Temperature Sensor 2 Range Maximum	Signed Integer in 10ths of Degree C Defines range for set points (including alarm set points)
18	4	Temperature Sensor 2 Range Minimum	Signed Integer in 10ths of Degree C Defines range for set points (including alarm set points)
19	4	Temperature Sensor 3 Range Maximum	Signed Integer in 10ths of Degree C Defines range for set points (including alarm set points)
20	4	Temperature Sensor 3 Range Minimum	Signed Integer in 10ths of Degree C Defines range for set points (including alarm set points)
21	4	Temperature Sensor 4 Range Maximum	Signed Integer in 10ths of Degree C Defines range for set points (including alarm set points)
22	4	Temperature Sensor 4 Range Minimum	Signed Integer in 10ths of Degree C Defines range for set points (including alarm set points)

Range Information section shows the hard-coded maximum and minimum allowable user-configurable settings, viewable over Modbus for reference purposes only.

9.12 IO Analog Readings

The read-only Analog Readings registers show all the measured parameters.

Modbus Address	Function Code	Description	Comments
30	4	Temperature Sensor 1 Temperature	Signed integer in 10ths of Degree C TS Failure = +3000.0DegC (30000) TS Not Used = +3200.0DegC (32000)
31	4	Temperature Sensor 2 Temperature	Signed integer in 10ths of Degree C TS Failure = +3000.0DegC (30000) TS Not Used = +3200.0DegC (32000)
32	4	Temperature Sensor 3 Temperature	Signed integer in 10ths of Degree C TS Failure = +3000.0DegC (30000) TS Not Used = +3200.0DegC (32000)
33	4	Temperature Sensor 4 Temperature	Signed integer in 10ths of Degree C TS Failure = +3000.0DegC (30000) TS Not Used = +3200.0DegC (32000)

Indicates the temperature of the local temperature sensors in 10ths of Degree C.

9.13 IO Latched Alarm Values

The Latched Alarm registers hold the value of each parameter that caused an alarm trip. If there is no alarm, the register holds the “Invalid Alarm Value” shown in the Comments column.

The

Modbus Address	Function Code	Description	Comments
40	4	Temperature Sensor 1 High Alarm Value	Signed integer in 10ths of Degree C Invalid Alarm Value = +3000.0DegC (30000)
41	4	Temperature Sensor 1 Low Alarm Value	Signed integer in 10ths of Degree C Invalid Alarm Value = +3000.0DegC (30000)
42	4	Temperature Sensor 2 High Alarm Value	Signed integer in 10ths of Degree C Invalid Alarm Value = +3000.0DegC (30000)
43	4	Temperature Sensor 2 Low Alarm Value	Signed integer in 10ths of Degree C Invalid Alarm Value = +3000.0DegC (30000)
44	4	Temperature Sensor 3 High Alarm Value	Signed integer in 10ths of Degree C Invalid Alarm Value = +3000.0DegC (30000)
45	4	Temperature Sensor 3 Low Alarm Value	Signed integer in 10ths of Degree C Invalid Alarm Value = +3000.0DegC (30000)
46	4	Temperature Sensor 4 High Alarm Value	Signed integer in 10ths of Degree C Invalid Alarm Value = +3000.0DegC (30000)
47	4	Temperature Sensor 4 Low Alarm Value	Signed integer in 10ths of Degree C Invalid Alarm Value = +3000.0DegC (30000)

Latched Alarm registers hold the value of each parameter that caused an alarm trip. A value of 30000 indicates no alarm state.

9.14 IO Maintenance Information

This feature indicates the maximum and minimum temperatures ever recorded by the HTC since the last time the values were reset. It may be useful to log the maximum/minimum temperatures ever experienced on a particular trace circuit for the purposes of trouble shooting or gathering data for future design criteria. The temperature values are written to the controller's non-volatile memory once every 24 hours or whenever any maintenance data is reset by the user. Max/min temperatures are recorded for the local RTD and Control Temperatures.

IMPORTANT: *Can only be reset (cleared) by the operator.*

Modbus Address	Function Code	Description	Comments
60	4	Temperature Sensor 1 Maximum Temperature	Signed integer in 10ths of Degree C Invalid Value = -3000.0DegC (35536)
61	4	Temperature Sensor 1 Minimum Temperature	Signed integer in 10ths of Degree C Invalid Value = +3000.0DegC (30000)
62	4	Temperature Sensor 2 Maximum Temperature	Signed integer in 10ths of Degree C Invalid Value = -3000.0DegC (35536)
63	4	Temperature Sensor 2 Minimum Temperature	Signed integer in 10ths of Degree C Invalid Value = -3000.0DegC (35536)
64	4	Temperature Sensor 3 Maximum Temperature	Signed integer in 10ths of Degree C Invalid Value = -3000.0DegC (35536)
65	4	Temperature Sensor 3 Minimum Temperature	Signed integer in 10ths of Degree C Invalid Value = -3000.0DegC (35536)
66	4	Temperature Sensor 4 Maximum Temperature	Signed integer in 10ths of Degree C Invalid Value = -3000.0DegC (35536)
67	4	Temperature Sensor 4 Minimum Temperature	Signed integer in 10ths of Degree C Invalid Value = -3000.0DegC (35536)
68	4	Number of Hours In Use (MSW)	Unsigned integer
69	4	Number of Hours In Use (LSW)	
70	4	Number of Hours Since Last Reset	Unsigned integer

Local Temperature Sensor 1 to 4 Minimum Temperature

This feature indicates the maximum and minimum temperatures ever recorded by the IO since the last time the values were reset. It may be useful to log the maximum/minimum temperatures ever experienced on a particular trace circuit for the purposes of trouble shooting or gathering data for future design criteria. The temperature values are written to the controller's non-volatile memory once every 24 hours or whenever any maintenance data is reset by the user.

Number of Hours In Use

The purpose of this feature is to indicate the total hours of use of the controller since its initial operation. It may be useful to log the amount of time a particular controller has been in operation for the purposes of maintenance planning or reliability testing. The value of this accumulator is written to the controller's non-volatile memory once every 24 hours or whenever any maintenance data is reset by the user.

Number of Hours Since Last Reset

This feature indicates the total hours of use of the controller since the last reset. It may be useful to log the amount of time a particular controller has been in operation since the last time the controller's power was cycled for trouble-shooting purposes.

10. Modbus Registers for NGC-40-SAFETY LIMITER

The NGC-40-SLIM module is used as safety temperature limiter within the NGC-40 control and monitoring system. The module has one output for the contactor, one alarm output and one digital input. The alarm output can be used to control an external annunciator. The digital input can be used for resetting the limiter remotely. The module has 3 temperature inputs which can be used all in case of a three phase heat-tracing system. The limiter is equipped as smart limiter where the current measurements are done in the associated controller. The front panel of the SLIM module has LED indicators for various status conditions. The front panel also provides “Set Config”, “Trip Reset” and “Alarm Reset” buttons.

10.1 LIMITER Alarm Status

The NGC-40 system uses alarms to indicate fault conditions and out-of-range temperatures. Most alarms can be disabled (masked) and set to be latching or non-latching to accommodate specific applications. An active alarm shows a “1” in the alarm register, and can be reset by writing a 1 to that register as long as the alarm condition no longer exists.

Modbus Address	Function Code	Description	Comments
0	1,5,15	RTD 1 Failure	Alarm Status: 0 = Normal, 1 = Alarm Writing a 1 resets the alarm, writing 0 has no effect
1	1,5,15	RTD 2 Failure	Alarm Status: 0 = Normal, 1 = Alarm Writing a 1 resets the alarm, writing 0 has no effect
2	1,5,15	RTD 3 Failure	Alarm Status: 0 = Normal, 1 = Alarm Writing a 1 resets the alarm, writing 0 has no effect
3	1,5,15	Device Reset	Alarm Status: 0 = Normal, 1 = Alarm Writing a 1 resets the alarm, writing 0 has no effect
4	1,5,15	Contactor Cycle Count	Alarm Status: 0 = Normal, 1 = Alarm Writing a 1 resets the alarm, writing 0 has no effect
5	1,5,15	Limiter Tripped	Alarm Status: 0 = Normal, 1 = Alarm Writing a 1 resets the alarm, writing 0 has no effect
6	1,5,15	User Configuration Data Lost	Alarm Status: 0 = Normal, 1 = Alarm Writing a 1 resets the alarm, writing 0 has no effect
7	1,5,15	Factory Configuration Data Lost	Alarm Status: 0 = Normal, 1 = Alarm Writing a 1 resets the alarm, writing 0 has no effect
8	1,5,15	HTC Communication Failure	Alarm Status: 0 = Normal, 1 = Alarm Writing a 1 resets the alarm, writing 0 has no effect

RTD1-3 Failure

The RTD1-3 FAILURE ALARMS indicate a failure of the respective temperature source.

Device Reset Alarm

The DEVICE RESET ALARM is used to indicate:

1) Power to the LIMITER has been interrupted and subsequently restored.
2) A transient has caused the LIMITER's program to restart.
3) An internal condition has caused the LIMITER's program to restart.

IMPORTANT: *Normally the DEVICE RESET ALARM is left disabled since powering the controller off and on for maintenance or trouble-shooting would require the user to reset this alarm every time.*

Contactor Cycle Count

CONTACTOR CYCLE COUNT alarm is activated if the number of off-to-on transitions of an EMR reaches or exceeds the CONTACTOR CYCLE COUNT ALARM LIMIT SETPOINT. This serves as a method to perform preventative maintenance on the EMR before a failure is likely to occur.

Limiter Tripped

This alarm indicates that the LIMITER has detected RTD Temperatures above the Trip Setpoint and has switched the output relay to failure mode. This alarm must be reset following the procedure outlined in section

User Configuration Data Lost

The USER CONFIGURATION DATA LOST ALARM indicates that the controller has either detected a failure in its non-volatile memory, or the user has performed a LOAD USER DEFAULTS command. This alarm indicates that the user configuration data has been reset to default values.

IMPORTANT: *The USER CONFIGURATION DATA LOST ALARM can not be disabled. If the user configuration data has not been intentionally reset (i.e. using the LOAD USER DEFAULTS command) this alarm may indicate a problem with the LIMITER, and may require a return to the factory for repair.*

HTC Communication Failure

The HTC COMMUNICATION FAILURE ALARM indicates that the LIMITER has detected a communication failure in an installed controller. If there is no controller installed this alarm will not appear. See Section 10.9 LIMITER Control Parameters.

10.2 LIMITER Alarm Masks

The Alarm Mask registers match 1:1 to the Alarm Status registers at Function 1, address 0. A 1 designates an enabled alarm, a 0 is a disabled alarm. Not all alarms can be disabled. Refer to the full Modbus Map located in the Appendices for detailed information on each Alarm Mask.

Modbus Address	Function Code	Description	Comments	Default
50	1,5,15	RTD 1 Failure	Alarm Mask: 0 = Disabled, 1 = Enabled	Enabled
51	1,5,15	RTD 2 Failure	Alarm Mask: 0 = Disabled, 1 = Enabled	Disabled
52	1,5,15	RTD 3 Failure	Alarm Mask: 0 = Disabled, 1 = Enabled	Disabled
53	1,5,15	Device Reset	Alarm Mask: 0 = Disabled, 1 = Enabled	Disabled
54	1,5,15	Contactor Cycle Count	Alarm Mask: 0 = Disabled, 1 = Enabled	Enabled
55	1,5,15	Limiter Tripped	Alarm Mask: 0 = Disabled, 1 = Enabled	Enabled
56	1,5,15	User Configuration Data Lost	Always 1 = Enabled	Always Enabled
57	1,5,15	Factory Configuration Data Lost	Always 1 = Enabled	Always Enabled
58	1,5,15	HTC Communication Failure	Alarm Mask: 0 = Disabled, 1 = Enabled	Enabled

10.3 LIMITER Alarm Latching

The Alarm Latching registers match 1:1 with the Alarm registers starting at Function 1, Address 0. Some alarms are user selectable to be Latching or Non-Latching. If set to Non-Latching, the controller will automatically clear the alarm when the condition no longer exists. If set to Latching, the alarm must be cleared by the user.

Modbus Address	Function Code	Description	Comments	Default
100	1,5,15	RTD 1 Failure	0 = Latching, 1 = Non-Latching	Latching
101	1,5,15	RTD 2 Failure	0 = Latching, 1 = Non-Latching	Latching
102	1,5,15	RTD 3 Failure	0 = Latching, 1 = Non-Latching	Latching
103	1,5,15	Device Reset	0 = Latching, 1 = Non-Latching	Latching
105	1,5,15	Limiter Tripped	0 = Latching, 1 = Non-Latching	Non-Latching
108	1,5,15	HTC Communication Failure	0 = Latching, 1 = Non-Latching	Latching

10.4 LIMITER Controller Setup Parameters

These registers allow the user to return all parameters to User Defaults as shown in the Modbus Map, and also to enable/disable the optional second and third RTDs.

Load	Modbus Address	Function Code	Description	Comments	Default	User
	155	1,5,15	Load User Configuration Defaults	Write 1 to load user configuration defaults, writing 0 is ignored Reads return 0 **IMPORTANT: THIS DOES NOT CHANGE THE CUTOUT SETPOINT.**		
	156	1,5,15	Temperature Sensor 2 Setup	0= Not Installed 1= Installed **IMPORTANT:** 'Set Config' button must be pushed to enable/disable temperature sensor 2.	Default: Disabled	
	157	1,5,15	Temperature Sensor 3 Setup	0= Not Installed 1= Installed **IMPORTANT:** 'Set Config' button must be pushed to enable/disable temperature sensor 3.	Default: Disabled	

Configuration Defaults

Resets all of the user default settings. The LIMITER will restore all values listed as “default” in the Modbus Map.

Temperature Sensor 2 Setup
Temperature Sensor 3 Setup

These registers allow Temperature Sensors 2 and 3 to be disabled if they are not installed or not needed. Temperature Sensor 1 cannot be disabled.

IMPORTANT: *To write to these safety-sensitive registers the “SET CONFIG” button on the front of the LIMITER module needs to be pressed at the time of writing, or it will return an exception response.*

10.5 LIMITER Reset Maintenance Information

Writing a 1 to these write-only registers will clear the associated Highest/Lowest Recorded Value register in the Maintenance Information Function 4 section.

Reset	Modbus Address	Function Code	Description	Comments	Default	RTD1
	185	5,15	Reset RTD 1 Max/Min Temperatures	Writing a 1 resets parameter, writing 0 has no effect	185	
	186	5,15	Reset RTD 2 Max/Min Temperatures	Writing a 1 resets parameter, writing 0 has no effect	186	
	187	5,15	Reset RTD 3 Max/Min Temperatures	Writing a 1 resets parameter, writing 0 has no effect	187	
	188	5,15	Reset Contactor Cycle Count	Writing a 1 resets parameter, writing 0 has no effect	188	
	189	5,15	Reset Number of Hours In Use	Writing a 1 resets parameter, writing 0 has no effect	189	

Max/Min Temperatures
Reset RTD2 Max/Min Temperatures
Reset RTD3 Max/Min Temperatures

Resets the maximum and minimum temperatures ever seen by the HTC3.

Reset Contactor Cycle Count

Zeroes the total number of times the EMR has been activated.

Reset Number of Hours In Use

Zeroes the total number of hours that the HTC has ever been powered up.

10.6 LIMITER Parameters

These write-only registers indicate the current status of the LIMITER.

Modbus Address	Function Code	Description	Comments
200	5,15	Reset Tripped Limiter	Writing a 1 resets limiter if reset is enabled, writing 0 has no effect
201	5,15	Trip Limiter	Writing a 1 trips limiter, writing 0 has no effect
202	5,15	Limiter Reset Enable	Writing a 1 allows 5 seconds to reset tripped limiter, writing a 0 has no effect. Reads return 1 while trip-resetting is enabled, 0 otherwise.

Reset Tripped Limiter

A tripped LIMITER may be reset by pressing the “Trip Reset” button on the controller, if the failure state (RTD Failure or High Temperature) is resolved.

The other method of resetting is to first write a “1” to the “LIMITER RESET ENABLE registers (Function 5, address 202). This will enable the RESET TRIPPED LIMITER register for 5 seconds, in this time a “1” written to this register will reset the LIMITER TRIPPED ALARM. Writing do this register without first writing a “1” to the LIMITER RESET ENABLE, or if the timer has counted down, will result in an exception response.

Trip Limiter

This feature has not been implemented in the firmware.

Limiter Reset Enable

Enables the LIMITER to be reset by a Modbus command for 5 seconds. See RESET TRIPPED LIMITER above for explanation.

10.7 LIMITER Controller Status, Raw Alarm Output

This register shows the state of the Alarm Output; 0 for no alarm and 1 for in alarm state.

Modbus Address	Function Code	Description	Comments
0	2	Raw Alarm Output	0 = No Alarm state 1 = Alarm state

10.8 LIMITER Status

This section can be used to determine the trip status of the LIMITER.

Modbus Address	Function Code	Description	Comments
480	2	Limiter Tripped	
481	2	Limiter Non-Latching	

Limiter Tripped

Displays the status of the LIMITER. A 1 designates a tripped state and a 0 is normal operation.

Limiter Non-Latching

Indicates the Latching status of the Limiter. When operating as an Intelligent Limiter (with a controller installed in Function 3, Address 1-2) the LIMITER will be non-latching if it does not detect an output current in the installed controller.

10.9 LIMITER Control Parameters

This section is used to configure the LIMITER for use with another controller.

Modbus Address	Function Code	Description	Comments	Default
0	3,6,16	Limiter Cutout Set point	Signed integer in Degree C Range: -80DegC to 700DegC	10DegC (10)
1	3,6,16	Controller CAN ID (MSW)	Unsigned integer Can ID of the controller. The NGC-40 SLIM will receive information from this contoller.	
2	3,6,16	Controller CAN ID (LSW)		

Limiter Cutout Setpoint

If the LIMITER observes an RTD Temperature above this threshold, it generates a LIMITER TRIPPED ALARM and switches the Alarm Output relay to the alarm state.

Controller CAN ID

Writing an HTC/HTC3 CAN ID into these registers will make it the installed controller for the LIMITER. When operating as an Intelligent Limiter (with a controller installed in Function 3, Addresses 1-2) the LIMITER will be non-latching if it does not detect an output current in the installed controller.

10.10 LIMITER Temperature Setup

This section contains only the RTD Tags.

Modbus Address	Function Code	Description	Comments	Default
247	3,6,16	High Line Current Alarm Filter L1	Unsigned integer Range: 0 to 12 seconds	0
248	3,6,16	High Line Current Alarm Filter L2	Unsigned integer Range: 0 to 12 seconds	0
249	3,6,16	High Line Current Alarm Filter L3	Unsigned integer Range: 0 to 12 seconds	0
250	3,6,16	Low Line Current Alarm Filter L1	Unsigned integer Range: 0 to 12 seconds	0
251	3,6,16	Low Line Current Alarm Filter L2	Unsigned integer Range: 0 to 12 seconds	0
252	3,6,16	Low Line Current Alarm Filter L3	Unsigned integer Range: 0 to 12 seconds	0
253	3,6,16	High Line Current Alarm Setpoint L1	Unsigned integer in 100ths of Amps Range: 0.30A (30) to 60.00A (6000)	30.00A (3000)
254	3,6,16	High Line Current Alarm Setpoint L2	Unsigned integer in 100ths of Amps Range: 0.30A (30) to 60.00A (6000)	30.00A (3000)
255	3,6,16	High Line Current Alarm Setpoint L3	Unsigned integer in 100ths of Amps Range: 0.30A (30) to 60.00A (6000)	30.00A (3000)
256	3,6,16	Low Line Current Alarm Setpoint L1	Unsigned integer in 100ths of Amps Range: 0.30A (30) to 60.00A (6000)	1.00A (100)
257	3,6,16	Low Line Current Alarm Setpoint L2	Unsigned integer in 100ths of Amps Range: 0.30A (30) to 60.00A (60000)	1.00A (100)
258	3,6,16	Low Line Current Alarm Setpoint L3	Unsigned integer in 100ths of Amps Range: 0.30A (30) to 60.00A (60000)	1.00A (100)

10.11 LIMITER Controller Setup Parameters

This section contains the SLIM Tag and parameters to configure the Alarm Relay.

10.11.1 LIMITER Tag

A 40 character tag may be assigned to the LIMITER to allow it to be easily associated with a control panel, location, or area.

Modbus Address	Function Code	Description	Comments	Default
240	3,6,16	SLIM Tag 0	NGC40-SLIM Tag	"NGC40-SLIM-" followed by the device CAN ID
241	3,6,16	SLIM Tag 1		
…	…	…		
278	3,6,16	SLIM Tag 38		
279	3,6,16	SLIM Tag 39		

10.11.2 LIMITER Alarm Relay and Contactor Settings

These registers configure the Alarm Relay for various applications.

Modbus Address	Function Code	Description	Comments	Default
283	3,6,16	Alarm Relay Sense	Unsigned integer 0 = Normally Closed (Closed if no alarms) 1 = Normally Open (Open if no alarms) **IMPORTANT:** Relay is always OPEN if SLIM is not powered.	0 = Normally Closed
284	3,6,16	Alarm Output Mode	Unsigned integer 0 = Normal Operation 1 = Toggle 2 = Flash	0 = Normal Operation
285	3,6,16	Alarm Output Toggle Time	Unsigned integer in seconds Range: 1 to 240	60 seconds
286	3,6,16	Broadcast Timeout (Source Failure)	Unsigned integer Range: 1 - 10 minutes	1 minute
287	3,6,16	Contactor Cycle Count Alarm Limit Setpoint (MSW)	Unsigned integer Range: 0 to 999999	100000
288	3,6,16	Contactor Cycle Count Alarm Limit Setpoint (LSW)		

Alarm Relay Sense

This parameter controls the non-alarm state of the output relay, either Normally Closed or Normally Open.

Alarm Output Mode

Programs the alarm output relay for flashing, toggling, or normal output in case of an alarm condition.
Under normal setting the alarm output is active when alarm conditions exist, inactive when no alarm conditions exist. Toggle setting is the same as normal operation, except every new alarm that occurs the alarm relay goes inactive the 'alarm output toggle time', then goes active again.

IMPORTANT: *If the alarm output is used to drive a pilot light, it is recommended that flash be selected to enable flashing operation. When the output is also configured for normally closed operation, the pilot light will be on steady for normal operation, flash in case of alarm and be extinguished due to a bulb failure or loss of power.*

If multiple alarm outputs from different controllers are wired in series (i.e.: multi-point panels), set this parameter to normal operation.

Alarm Output Toggle Time

When the Alarm Output Mode is set to '"toggle", this setting determines how long the alarm relay toggles inactive before returning to the active state when a new alarm occurs.

Broadcast Timeout

This defines the Timeout Period for Broadcast messages. After this time has elapsed without a broadcast, Failure or Communication Alarms will be activated. The BROADCAST TIMEOUT is used for Load Shedding commands, RMM Temperatures, Remote Temperature Sources, and data from other controllers.

Contactor Cycle Count Alarm Limit

This parameter sets the limit of off-to-on transitions of an EMR needs to reached or exceeds before a CONTACTOR COUNT ALARM becomes active. This serves as a method to perform preventative maintenance on the EMR before a failure is likely to occur.

IMPORTANT: *Writing a '0' to this parameter is for testing and will produce a Contactor Cycle Count Alarm for any Contactor Cycle Count, any time this alarm is enabled.*

10.12 LIMITER General Information

This section contains basic information about the controller.

Modbus Address	Function Code	Description	Comments
0	4	Device Type	NGC40 SLIM Device Type 230 = NGC40 SLIM
1	4	Firmware Version	NGC40 SLIM Firmware Version - Major 0 - 255
2	4	Firmware Version	NGC40 SLIM Firmware Version - Minor 0 - 255
3	4	Firmware Version	NGC40 SLIM Firmware Version - Build 0 - 255
4	4	Manufactured Year	Format : YYYY
5	4	Manufactured Month	Range : 1 - 12
6	4	Manufactured Day	Range : 1 - 31
7	4	Serial Number (MSW)	NGC-40 SLIM Serial Number
8	4	Serial Number (LSW)	
9	4	Device Subtype	

Device Type

Indicates the device type of the module.

Firmware Version (Major, Minor, Build)

Purpose: Indicates the revision level of the firmware programmed into the controller, “major.minor.build”.

Manufactured Year, Month, Day

Indicates the date on which the device was manufactured.

Serial Number

The unique serial number for this device.

10.13 LIMITER Range Information

The Range Information section shows the hard-coded maximum and minimum allowable user-configurable settings, viewable over Modbus for reference purposes only.

Modbus Address	Function Code	Description	Comments
15	4	Local Temperature Sensor Range Maximum	Signed integer in Degree C Defines range for set points (including alarm set points) 700DegC (700)
16	4	Local Temperature Sensor Range Minimum	Signed integer in Degree C Defines range for set points (including alarm set points) -80DegC(-80)

10.14 LIMITER Analog Readings

This section contains the temperature readings of the 3 local RTDs. If RTD2 or RTD3 are not installed, the corresponding register will read 3200.

Modbus Address	Function Code	Description	Comments
50	4	RTD 1 Temperature	Signed integer in Degree C TS Failure = +3000DegC (3000) TS Not Used = +3200DegC (3200)
51	4	RTD 2 Temperature	Signed integer in Degree C TS Failure = +3000DegC (3000) TS Not Used = +3200DegC (3200)
52	4	RTD 3 Temperature	Signed integer in Degree C TS Failure = +3000DegC (3000) TS Not Used = +3200DegC (3200)

10.15 LIMITER Maintenance Information

This feature indicates the maximum and minimum temperatures ever recorded by the LIMITER since the last time the values were reset. It may be useful to log the maximum/minimum temperatures ever experienced on a particular trace circuit for the purposes of trouble shooting or gathering data for future design criteria. The temperature values are written to the controller's non-volatile memory once every 24 hours or whenever any maintenance data is reset by the user. Max/min temperatures are recorded for the local RTD Temperatures.

IMPORTANT: *Can only be reset (cleared) by the operator.*

Modbus Address	Function Code	Description	Comments
120	4	Maximum RTD1 Temperature	Signed integer in Degree C Invalid Value = -3000DegC (35536)
121	4	Minimum RTD1Temperature	Signed integer in Degree C Invalid Value = +3000DegC (3000)
122	4	Maximum RTD2 Temperature	Signed integer in Degree C Invalid Value = -3000DegC (35536)
123	4	Minimum RTD2 Temperature	Signed integer in Degree C Invalid Value = +3000DegC (3000)
124	4	Maximum RTD3 Temperature	Signed integer in Degree C Invalid Value = -3000DegC (35536)
125	4	Minimum RTD3 Temperature	Signed integer in Degree C Invalid Value = +3000DegC (3000)
126	4	Number of Hours In Use (MSW)	Unsigned integer
127	4	Number of Hours In Use (LSW)	
128	4	Number of Hours Since Last Reset	Unsigned integer
129	4	Contactor Cycle Count (MSW)	Unsigned integer Number of off-on transitions
130	4	Contactor Cycle Count (LSW)	

Number of Hours In Use

The purpose of this feature is to indicate the total hours of use of the controller since its initial operation. It may be useful to log the amount of time a particular controller has been in operation for the purposes of maintenance planning or reliability testing. The value of this accumulator is written to the controller's non-volatile memory once every 24 hours or whenever any maintenance data is reset by the user.

Number of Hours Since Last Reset

This feature indicates the total hours of use of the controller since the last reset. It may be useful to log the amount of time a particular controller has been in operation since the last time the controller's power was cycled for trouble-shooting purposes.

Contactor Cycle Count

This feature indicates the total number of off-to-on transitions an EMR has done since the last time the CONTACTOR CYCLE COUNTER was reset. This serves as a method to do preventative maintenance on the EMR according to the manufacturer's specifications. This count value is written to the controller's non-volatile memory once every 24 hours or whenever any maintenance data is reset by the user.

IMPORTANT: *Once the CONTACTOR CYCLE COUNTER reaches 999,999,999 it will stop counting.*

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