



**NEXTRON CORPORATION
MASTERTRACE HEAT TRACING CONTROL
COMMUNICATION PROTOCOL
REV. D4**



MasterTrace Communications Modbus Protocol Rev.D4 Contents and Revisions

Date: Jun 22, 2020
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Revision Status		
Revision	Description	Date
D0.0	Original	Sep 12,1997
D0.1	Added Modbus Addresses	Sep 12,1997
D1.0	Addition of module communication serial 1&2 baud rate, module alarm light mode, GF test, alarm contact configuration. Remove module communication setup (0), module communication baud rate setup (1), M-wire check (35), and Reset M-wire check alarm (186).	Sep 14,1997
D2.0	MS1 MKII Functions	Sep 15,1997
	Removed Date, Time, Cable Fault, Product Code, Module Usage	Jan 19,1998
	Update after prototype and changes to D1	Aug 26,1998
	40089 hardcoded to 601	Sep 1,1998
	40030, 40031 added back; 40004, 40045,40110 remove no switch and add user	Feb 4,1999
	40107 Required for heat trace curve (Reserve for factory use)	Feb 4,1999
	40067,40068,40069,40070,40071,40108,40109 added for factory calibration	Feb 4,1999
	Change factory calibration to 40017-40026, 40067-40070	Mar 10,1999
	Manual version deleted, 40071,40108,40109 Spare	Mar 10,1999
	Temperature range bit added 40045 2 nd byte bit-6 and 40110 3 rd byte bit-6	Mar 10,1999
	40071 Reset latched alarm bits	Apr 12,1999
	Add 40040 Chemelex curves and 40045 bit-7	May 26,1999
	Change Module Setting Index Group from 31-43 to 16-43. Add Index 2000-2019 for RTD Sampler. Add Index 16 for calibration data. Add Index 18 for third party data. Reserve Index 66, 68 for future. Add Index 107 (Jan. 27, 2006).	Feb. 14, 2005
D3.0	For MS1 MKII, CM2001, & MS2102, N/A (Not Available) is the only option for SS alarm contact.	June 1,2018
D4.0	Add Index 25 for Number of Ambient Sensing Heaters. Add Index 39 for Ambient Temperature.	June 18,2020

The above revisions have been reviewed and approved for adequacy prior to issue.

_____	_____	
Engineering Manager	Designer	



1. Data Frame Format and Baud Rate

- 1.1. One data frame of an asynchronous transmission to or from a Master Trace module consists of 1 start bit, 8 data bits and 1 stop bit to produce a 10 bit data frame. This is important for transmission through modems at high bit rates (11 bit data frames are not supported by some modems at bit rates of greater than 300 bps).
- 1.2. The MasterTrace supports operation at 600, 1200, 2400, 4800, 9600 baud.

2. MasterTrace Memory Location Index

- 2.1. There are all kinds of variables in MasterTrace control module firmware. They are designed to fulfil various control & monitor tasks. Their values are stored in a variable register (16 bit) array. Each variable has its own unique starting address, called Memory Location Index, in the register array. Different variable occupies different number of variable registers depending on the variable's data length (2 bytes, 4 bytes, 6 bytes, 18 bytes, etc.). Any customer equipment (Master) with Modbus communication protocol can reach these variables by specifying their Memory Location Indexes, which are 2-byte numbers. The Memory Location Index Map is given in Section 6.
- 2.2. The Modbus address is calculated from the memory location index by adding to it the base address plus one. The base address will vary depending on the code. The base address for command code 03, 06 and 16 is 40000 and for 05 is 0.

3. MasterTrace Data Structures

- 3.1. Listed in Section 7 is the data structure used for each variables in the memory map of Modbus protocol. Any customer equipment (Master) with Modbus communication protocol can reach these variables and interpret the values using the data structure given.

4. MasterTrace Supported Functions

The following functions are supported by MasterTrace firmware:

CODE	Address Range	Type	INTERPRETATION
03	40001-50000	Holding Register	Read variable registers
05	1-10000	Output Coil	Reset heater alarm or statistics
06	40001-50000	Holding Register	Store value into one variable register
16	40001-50000	Holding Register	Store values into a group of variable registers

Note 1: Any slave module must have a unique address within 1 - 254. Address 255 is reserved for module commissioning & addressing.

- 4.1. Function code 03 - Read variable registers
 - 4.1.1. Modbus implementation: Read Holding Registers
 - 4.1.2. MasterTrace implementation: Read variable registers
 - 4.1.3. In Modbus, function Read Holding Registers is used to obtain current binary value in one or more holding registers. It assumes that each register is 16 bit register. For the MasterTrace implementation of Modbus, this function is used to obtain value from one variable register or values from a group of variable registers. Only the variable registers with Memory Location Index between 0 (the first index in Module Setup Group) and 164 (the last index in Heater Statistics Group) can be accessed



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by this command. Any attempts to read a variable register with Memory Location Index beyond the above range will result in an error response in return.

- 4.1.4. Master Query: It consists of module address, function code, memory location index of the starting variable register, number of variable registers to be read, CRC error check.
- 4.1.5. Slave Response: It consists of module address, function code, quantity of data bytes to be returned, data value, and CRC error check.
- 4.1.6. Message Format and Example:
Request slave 11 to respond with local heater #1's low temperature alarm level. Suppose heater #1's low temperature alarm level is 10.1 °C. Here are transmission and response messages:

Master Transmission	Bytes	Message Contents (Decimal)
Slave Address	1	11 (message to slave 11)
Function Code	1	3 (command "read variable registers")
Memory Location Index	2	73 (refer to register storing local heater #1's low temperature alarm level)
Number Of Registers	2	1 (a 2-bytes variable)
CRC	2	????

Slave Response	Bytes	Message Contents (Decimal)
Slave Address	1	11 (message from slave 11)
Function Code	1	3 (command "read variable registers")
Quantity Of Data Bytes	1	2 (2 bytes)
Data Value	2	101 (10.1 °C)
CRC	2	????

- 4.2. Function code 05 - Reset heater alarms & statistics
 - 4.2.1. Modbus implementation: Force Single Coil
 - 4.2.2. MasterTrace implementation: Reset heater alarms & statistics
 - 4.2.3. In Modbus, function Force Single Coil is used to force logic coil to a state of ON or OFF. For the MasterTrace implementation of Modbus, this function is used to reset heater alarm or statistics. Once a MasterTrace control module is in use, it keeps monitoring heater alarms and updating heater statistics. Some of the alarms are latched even after the alarm condition is no longer existed. It's up to customers to reset those latched alarms and some statistics. By sending a data value 65280 (FF00 Hex) to any variable register with Memory Location Index between 165 and 186 (Heater Alarm Reset & Statistics Reset Group) the corresponding alarm or statistics will be reset. Sending a data value 0 to any register within the above range is legal but has no effect. Sending a data value other than 65280 and 0 to any register within the range or sending any data to any register beyond the range is illegal and will result in an error response in return.
 - 4.2.4. Master Query: It consists of module address, function code, memory location index of the variable register, data value FF00 Hex, CRC error check.
 - 4.2.5. Slave Response: It consists of module address, function code, memory location index of the variable register, data value FF00 Hex, CRC error check.



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- 4.2.6. Message Format and Example:
Request slave 200 to reset local heater #10's min. temperature. Here are transmission and response messages:

Master Transmission	Bytes	Message Contents (Decimal)
Slave Address	1	200 (message for slave 200)
Function Code	1	5 (command "reset heater alarm & statistics")
Memory Location Index	2	$173 + (10 - 1) * 190$
Data Value	2	65280 (FF00 Hex)
CRC	2	???

Slave Response	Bytes	Message Contents (Decimal)
Slave Address	1	200 (message for slave 200)
Function Code	1	5 (command "reset heater alarm & statistics")
Memory Location Index	2	$173 + (10 - 1) * 190$
Data Value	2	65280 (FF00 Hex)
CRC	2	???

- 4.3. Function code 06 - Store a value into one variable register
- 4.3.1. Modbus implementation: Preset Single Register
- 4.3.2. MasterTrace implementation: Store a value into one variable register
- 4.3.3. In Modbus, function Preset Single Register is used to place a specific binary value into a holding register. For the MasterTrace implementation of Modbus, this function is used to store a value into one variable register with Memory Location Index in Module Setup Group (0 to 30), Module Setting Group (31 to 43) and Heater Setpoints Group (66 to 108). Any attempts to store a value into a variable register beyond that the above range will result in an error response.
- 4.3.4. Master Query: It consists of module address, function code, memory location index of the variable register, data value, CRC error check.
- 4.3.5. Slave Response: It consists of module address, function code, memory location index of the variable register, data value, CRC error check.
- 4.3.6. Message Format and Example:
Request slave 98 to change its local heater #10's heater setpoint to 30 °C. Here are transmission and response messages:

Master Transmission	Bytes	Message Contents (Decimal)
Slave Address	1	98 (message for slave 98)
Function Code	1	6 (command "Store a value into one variable register")
Memory Location Index	2	$72 + (10 - 1) * 190$
Data Value	2	300 (30.0 °C)
CRC	2	???

Slave Response	Bytes	Message Contents (Decimal)
Slave Address	1	98 (message for slave 98)



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Slave Response	Bytes	Message Contents (Decimal)
Function Code	1	6 (command "Store a value into one variable register)
Memory Location Index	2	$72 + (10 - 1) * 190$
Data Value	2	300 (30.0 °C)
CRC	2	???

- 4.4. Function code 16 - Store values into a group of variable registers
- 4.4.1. Modbus implementation: Reset Multiple Registers
- 4.4.2. MasterTrace implementation: Store values into a group Variable registers
- 4.4.3. In Modbus, function Preset Multiple Registers is used to place specific binary values into a series of consecutive holding registers. It assumes that each register is 16 bit register. For the MasterTrace implementation of Modbus, it is the same thing. Using this command, a group of consecutive variable registers can be assigned to their desired values. Only the variable registers with Memory Location Index in Module Setting Group (31 to 43) and Heater Setpoints Group (66 to 108) can be accessed by this command. Any attempts to store values into variable registers with Memory Location Index beyond the above range will result in an error response in return.
- 4.4.4. Master Query: It consists of module address, function code, memory location index of the starting variable register, number of variable registers to be stored, and quantity of data bytes to be stored, data value, CRC error check.
- 4.4.5. Slave Response: It consists of module address, function code, memory location index of the starting variable register, quantity of data bytes stored, and CRC error check.
- 4.4.6. Message Format and Example:
Request slave 11 to set local heater #1's low temperature alarm level to 5 °C and high temperature alarm level to 300 °C. Here are transmission and response messages:

Master Transmission	Bytes	Message Contents (Decimal)
Slave Address	1	11 (message to slave 11)
Function Code	1	16 (command "store values to a group of variable registers")
Memory Location Index	2	73
Number Of Registers	2	2 (2 variable registers)
Quantity Of Data Bytes	1	4 (4 bytes)
Data Value	4	50 (5 °C for low temp alarm level) 3000 (300 °C for high temp alarm level)
CRC	2	???

Slave Response	Bytes	Message Contents (Decimal)
Slave Address	1	11 (message to slave 11)
Function Code	1	16 (command "store values to a group of variable registers")
Memory Location Index	2	73
Number Of Registers	2	2 (2 variable registers)



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Slave Response	Bytes	Message Contents (Decimal)
CRC	2	????

4.5. Module Commissioning & Addressing

- 4.5.1. A MasterTrace module contains a whole set of setpoints and module settings. It also has its assigned module address. Any customer equipment (Master) with Modbus communication protocol can reset all those heater setpoints & module settings to their default values, or read a module's assigned address, or assign a new address to a module. It is called Module Commissioning & Addressing. To avoid any careless errors, only the module which is in listening to new address mode (The ADDRESS ENABLE shorting link is set to the address enable position.) will respond to Module Commissioning & Addressing commands.
- 4.5.2. To perform module commissioning on a MasterTrace module, a Master must use Function 06 to store a value of 0 into the variable register with Memory Location Index 187. To read a module's address, a Master must use Function 03 to read the value stored in the variable register with Memory Location Index 188.
- 4.5.3. To assign a new address to a module's address, a Master must use Function 06 to store a desired address into the variable register with Memory Location Index 189.

Note 1: The slave address of the above module commissioning & addressing commands is fixed to 255.

- 4.5.4. Message Format and Example:
Assign a module to a new address 230. Here are transmission and response messages:

Master Transmission	Bytes	Message Contents (Decimal)
Slave Address	1	255 (always 255)
Function Code	1	6 (command "Store a value into one variable register)
Memory Location Index	2	189 (refer to the register for assigning address)
Data Value	2	230 (new address)
CRC	2	????

Slave Response	Bytes	Message Contents (Decimal)
Slave Address	1	255 (always 255)
Function Code	1	6 (command "Store a value into one variable register)
Memory Location Index	2	189 (refer to the register for assigning address)
Data Value	2	230 (new address)
CRC	2	????

5. MasterTrace Error Responses

- 5.1. If a MasterTrace module receives a transmission in which an error is indicated by the CRC calculation, or by framing, format, overrun, the module will not respond to the transmission. When a MasterTrace module detects an error other than a CRC error, or framing, format, overrun error, a response will be sent to the master. The most significant bit of the



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FUNCTION CODE byte will be set to 1 (i.e., the function code sent from the slave will be equal to the function code sent from the master plus 128). The byte which follows it will be an exception code indicating the type of error that occurred.

5.2. The slave response to an error (other than CRC error) will be:

Slave Response	Bytes	Message Contents (Decimal)
Slave Address	1	????
Function Code	1	????
Exception Code	1	????
CRC	2	????

5.3. The MasterTrace implements the following exception response codes.

5.3.1. 01 - ILLEGAL FUNCTION

The function code transmitted by the master is not one of the functions supported by MasterTrace.

5.3.2. 02 - ILLEGAL MEMORY LOCATION INDEX

The index transmitted by the master is not allowable.

5.3.3. 08 - ILLEGAL ADDRESS ENABLE JUMPER POSITION

The address enable jumper on MasterTrace module is in wrong position.

6. Memory Location Index Map

6.1. Module Setup Group:

Modbus Register	Index Value	Length Bytes	Variable Name
40001	0	2	Module Communication Port Setup (Rev.D0 Only)
40002	1	2	Module Communication Baud Rate Setup (Rev.D0 Only)
40003	2	2	Module Max. Current Rate Setup _{1,4}
40004	3	2	Module Output Switch Type Setup (Factory Setup) _{1,4}
40005	4	2	Module RTD Mode Setup _{1,4}
40006	5	2	Module Number of Phases Setup _{1,4}
40007	6	2	Module Calibration Date ₁
40008	7	18	Module Firmware Version ₃
40017	16	4	Calibration Data First byte – Calibration item 0 for RTD Low 1 for RTD High 2 for Current 3 for GF Current 4 for Voltage 5 for Firmware Type 6 for Calibration Date 7 for I Low 8 for I High 9 for GF Low 10 for GF High Second byte – Heater Number 0 for heater #1



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Modbus Register	Index Value	Length Bytes	Variable Name
			9 for heater #10 Third byte – Calibration Value High Fourth byte – Calibration Value Low
40019	18	7	Third party Data 1st byte – Contact-LED-Relay 0 for Contact 3 1 for Contact 2 2 for Contact 1 3 for Reserved 4 for LED1 5 for LED2 6 for Relay 2 7 for Relay 1 2 nd , 3 rd , 4 th , 5 th , 6 th , 7 th byte – Reserved
40026	25	2	Number of Ambient Sensing Heaters ₆
40027	26	2	Module Max. Ground Fault Current Rate ₁
40028	27	2	Module Communication Baud Rate For Serial Port #1
40029	28	2	Module Communication Baud Rate For Serial Port #2 ₂
40030	29	2	Module Alarm Light Mode
40031	30	2	Module Alarm Contacts
40032	31	2	Module RTD Selection
40033	32	2	Module Energy Cost Per kWh
40034	33	2	Module Stagger Start ₂
40035	34	2	Product Code _{1,3}
40036	35	2	Module Switch Type ₂
40037	36	2	Module Thermocouple Type _{1,2}
40038	37	2	Module Manual Alarm
40039	38	2	Module GF Test
40040	39	2	Ambient Temperature ₆
40041	40	4	Reserved for future
40043	42	4	Reserved for future

- 1. for manufacturer use only
- 2. Not applicable to MS1 MKII or CM2001
- 3. Read Only
- 4. Read Only for MS1 MKII or CM2001
- 5. MS1 MKII Only
- 6. MS5 & MS10 Only

6.2. Module Status & Statistics Group (Read Only):

Modbus Register	Index Value	Length Bytes	Variable Name
40045	44	4	Module Status
40047	46	4	Module Total Running Hours (32 bit floating point data)
40049	48	4	Module Total Running Hours (32 bit unsigned integer)
40051	50	4	Module Total Energy Used (32 bit floating point data)
40053	52	4	Module Total Energy Used (32 bit unsigned integer)
40055	54	4	Module Total Energy Cost (32 bit floating point data)
40057	56	4	Module Total Energy Cost (32 bit unsigned integer)
40059	58	4	Module Total Running Days (32 bit floating point data)



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Modbus Register	Index Value	Length Bytes	Variable Name
40061	60	4	Module Total Running Days (32 bit unsigned integer)
40063	62	4	Module Total Running Days Since Reset (32 bit floating point data) ₂
40065	64	4	Module Total Running Days Since Reset (32 bit unsigned integer) ₂

1. for manufacturer use only
2. Not applicable to MS1 MKII or CM2001

6.3. Heater Setpoints Group:

Modbus Register	Index Value	Length Bytes	Variable Name
40067	66	4	Reserved for future
40069	68	4	Reserved for future
40071	70	2	Reset Latched Alarms
40072	71	2	Heater Enabled
40073	72	2	Heater Setpoint
40074	73	2	Heater Low Temperature Alarm Level
40075	74	2	Heater High Temperature Alarm Level
40076	75	2	Heater Phase A Low Current Alarm Level
40077	76	2	Heater Phase B Low Current Alarm Level ₂
40078	77	2	Heater Phase C Low Current Alarm Level ₂
40079	78	2	Heater Phase A High Current Alarm Level
40080	79	2	Heater Phase A High Current Trip Alarm Level ₂
40081	80	2	Heater Phase B High Current Alarm Level ₂
40082	81	2	Heater Phase B High Current Trip Alarm Level ₂
40083	82	2	Heater Phase C High Current Alarm Level ₂
40084	83	2	Heater Phase C High Current Trip Alarm Level ₂
40085	84	2	Heater Ground Fault Trip Alarm Level
40086	85	2	Heater Ground Fault Alarm Level
40087	86	2	Heater Power Limit Current
40088	87	2	Heater Tracecheck Time
40089	88	2	Heater Set Voltage ₃
40090	89	2	Heater Low Voltage Alarm Level
40091	90	2	Heater Proportional Control
40092	91	2	Heater RTD Failure Action
40093	92	2	Heater Manual Heater
40094	93	18	Heater Name
40103	102	2	Heater Thermostat Override
40104	103	2	Heater Deadband
40105	104	2	Softstart
40106	105	2	Heater High Voltage Alarm Level
40107	106	2	Reserve for Heat Trace Curve Use
40108	107	2	Heater Tracecheck Turn-On Duration Coefficient
40109	108	2	Reserve for future expansion

1. for manufacturer use only
2. Not applicable to MS1 MKII or CM2001
3. Read only for MS1 MKII or CM2001



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6.4. Heater Status & Measured Values Group (Read Only):

Modbus Register	Index Value	Length Bytes	Variable Name
40110	109	4	Heater Status
40112	111	6	Heater Alarm Status
40115	114	2	Heater Temperature
40116	115	2	Heater RTD A temperature
40117	116	2	Heater RTD B temperature
40118	117	2	Heater On Percentage
40119	118	2	Heater Phase A Current
40120	119	2	Heater Phase B Current ²
40121	120	2	Heater Phase C Current ²
40122	121	2	Heater Ground Fault Current
40123	122	2	Heater Voltage
40124	123	2	Heater Pretrip Ground Fault Current
40125	124	2	Heater Phase A Pretrip Current ²
40126	125	2	Heater Phase B Pretrip Current ²
40127	126	2	Heater Phase C Pretrip Current ²
	127-130		Reserved for future expansion

- 1. for manufacturer use only
- 2. Not applicable to MS1 MKII or CM2001

6.5. Heater Statistics Group (Read Only):

Modbus Register	Index Value	Length Bytes	Variable Name
40132	131	2	Heater Max. Temperature
40133	132	2	Heater Min. Temperature
40134	133	2	Heater Phase A Max. Current
40135	134	2	Heater Phase B Max. Current ²
40136	135	2	Heater Phase C Max. Current ²
40137	136	2	Heater Max. Ground Fault Current
40138	137	4	Heater Energy Used Last Day (32 bit floating point data)
40140	139	4	Heater Energy Used Last Day (32 bit unsigned integer)
40142	141	4	Heater Energy Cost Last Day (32 bit floating point data)
40144	143	4	Heater Energy Cost Last Day (32 bit unsigned integer)
40146	145	4	Heater Energy Used (32 bit floating point data)
40148	147	4	Heater Energy Used (32 bit unsigned integer)
40150	149	4	Heater Energy Cost (32 bit floating point data)
40152	151	4	Heater Energy Cost (32 bit unsigned integer)
40154	153	4	Heater Turn On Hours (32 bit floating point data)
40156	155	4	Heater Turn On Hours (32 bit unsigned integer)
40158	157	2	Heater Percentage of Turn On Time
40159	158	4	Heater Turn On Days (32 bit floating point data)
40161	160	4	Heater Turn On Days (32 bit unsigned integer)



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Modbus Register	Index Value	Length Bytes	Variable Name
40163	162	2	Heater Maximum Voltage
40164	163	2	Heater Minimum Voltage

1. for manufacturer use only
2. Not applicable to MS1 MKII or CM2001

6.6. Heater Alarm Reset & Statistics Reset Group:

Modbus Register	Index Value	Length Bytes	Variable Name
165	164	2	Reset Heater Tracecheck Continuity Alarm
166	165	2	Reset Heater Ground Fault Trip Alarm
167	166	2	Reset Heater Tracecheck Ground Fault Alarm
168	167	2	Reset Heater Tracecheck Low Current Alarm
169	168	2	Reset Heater Tracecheck High Current Alarm
170	169	2	Reset Heater Tracecheck Ground Fault Trip Alarm
171	170	2	Reset Heater Tracecheck Switch Shorted Alarm
172	171	2	Reset Heater Statistics
173	172	2	Reset Heater Max. Temperature
174	173	2	Reset Heater Min. Temperature
175	174	2	Reset Heater Phase A Max. Current
176	175	2	Reset Heater Phase B Max. Current ₂
177	176	2	Reset Heater Phase C Max. Current ₂
178	177	2	Reset Heater Max. Ground Fault Current
179	178	2	Reset Heater Energy Used
180	179	2	Reset Heater Energy Cost
181	180	2	Reset Heater Turn On Hours
182	181	2	Reset Heater Phase A High Current Trip Alarm ₂
183	182	2	Reset Heater Phase B High Current Trip Alarm ₂
184	183	2	Reset Heater Phase C High Current Trip Alarm ₂
185	184	2	Reset GF Test Alarm
186	185	2	Reset Heater Max Voltage
187	186	2	Reset Heater Min Voltage

1. for manufacturer use only
2. Not applicable to MS1 MKII or CM2001.

6.7. Module Commissioning & Addressing Group:

Modbus Register	Index Value	Length Bytes	Variable Name
40188	187	2	Module commission
40189	188	2	Test Module address
40190	189	2	Assign Module address

6.8. RTD Sampler Group:

Modbus Register	Index Value	Length Bytes	Variable Name
42001	2000	2	RTD Sampler's module number
42002	2001	40	RTD Sampler's RTD 1-20 temperatures



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Modbus Register	Index Value	Length Bytes	Variable Name
42022	2020	158	Reserved for future

- 6.9. Indices for Multi-point Controllers
Among the above indices, Indices from 71 to 186 are local heater dependable. For example, one MS10 has 10 local heaters. Heater #1's low temperature alarm level has different value from heater #2's. In order to tell the difference, the actual index of a local heater dependable variable is calculated in this formula:

$$I_{\text{actual}} = I_{\text{map}} + (N-1) * 190$$

where I_{actual} is the actual memory location index, I_{map} is the index from the map, N is the local heater number on a module.

- 6.10. Product Identification
Different MasterTrace module has different numbers of local heaters. MS10 has 10, MS5 has 5, MS2 has 2, while MS1 has only 1 local heater. Master device can obtain this information from the variable named Module Status with index 44.

7. Data Structure

- 7.1. Module Setup Group:

Modbus Register	Bytes	Variable Name	Value Range
40001	2	Module Communication Port Setup (Rev.D0 Only)	=0 if only serial port #1 exists =1 if both serial port #1 and #2 exist
40002	2	Module Communication Baud Rate Setup (Rev.D0 Only)	=0 if baud rate is 600 =1 if baud rate is 1200 =2 if baud rate is 2400 =3 if baud rate is 4800 =4 if baud rate is 9600
40003	2	Module Max. Current Rate Setup ₁	= 0 if max current is 30 A ₃ = 1 if max current is 100 A
40004	2	Module Output Switch Type Setup ₁	= 0 if output switch is solid state switch ₃ = 1 if output switch is relay switch = 2 if output switch is set to user defined
40005	2	Module RTD Mode Setup ₁	= 0 if no RTD = 1 if one RTD = 2 if two RTD ₃ = 3 if one thermocouple
40006	2	Module Number of Phases Setup ₁	= 0 if heater is a one phase heater ₃ = 1 if heater is a three phase heater
40007	2	Module Calibration Date ₁	Highest 5 bits store the day value (1-31) Next 4 bits store the month value (1-12) Next 7 bits store the year value (0-99)
40008	18	Module Firmware Version ₄	First 16 bytes are firmware version text string. Last 2 bytes are null terminator.
40017	4	RTDA Temperature Calibration Offset ₁	32-bit floating point data
40019	4	RTDA Temperature Calibration Scale ₁	32-bit floating point data



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Modbus Register	Bytes	Variable Name	Value Range
40021	4	RTDB Temperature Calibration Offset ₁	32-bit floating point data
40023	4	RTDB Temperature Calibration Scale ₁	32-bit floating point data
40025	4	Heater Current Calibration Scale ₁	32-bit floating point data
40026	2	Number of Ambient Sensing Heaters	= 0 if number of ambient sensing heaters is 0 = 1 if number of ambient sensing heaters is 1 = 2 if number of ambient sensing heaters is 2 = 3 if number of ambient sensing heaters is 3 = 4 if number of ambient sensing heaters is 4 = 5 if number of ambient sensing heaters is 5 = 6 if number of ambient sensing heaters is 6 = 7 if number of ambient sensing heaters is 7 = 8 if number of ambient sensing heaters is 8 = 9 if number of ambient sensing heaters is 9 = 10 if number of ambient sensing heaters is 10 = 11 if number of ambient sensing heaters is Master 1 = 12 if number of ambient sensing heaters is Master 2 = 13 if number of ambient sensing heaters is Master 3 = 14 if number of ambient sensing heaters is Master 4 = 15 if number of ambient sensing heaters is Master 5 = 16 if number of ambient sensing heaters is Master 6 = 17 if number of ambient sensing heaters is Master 7 = 18 if number of ambient sensing heaters is Master 8 = 19 if number of ambient sensing heaters is Master 9 = 20 if number of ambient sensing heaters is Master 10 = 21 if number of ambient sensing heaters is Remote 1 = 22 if number of ambient sensing heaters is Remote 2 = 23 if number of ambient sensing heaters is Remote 3 = 24 if number of ambient sensing heaters is Remote 4 = 25 if number of ambient sensing heaters is Remote 5 = 26 if number of ambient sensing heaters is Remote 6



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Modbus Register	Bytes	Variable Name	Value Range
			= 27 if number of ambient sensing heaters is Remote 7 = 28 if number of ambient sensing heaters is Remote 8 = 29 if number of ambient sensing heaters is Remote 9 = 30 if number of ambient sensing heaters is Remote 10
40027	2	Module Max. Ground Fault Current Rate	= 0 if max ground fault current is 3A = 1 if max ground fault current is 1A ₃
40028	2	Module Baud Rate for Serial Port #1	=0 if baud rate is 600 =1 if baud rate is 1200 =2 if baud rate is 2400 =3 if baud rate is 4800 =4 if baud rate is 9600 =5 if baud rate is 19200 (not supported)
40029	2	Module Baud Rate for Serial Port #2 ₂	=0 if baud rate is 600 =1 if baud rate is 1200 =2 if baud rate is 2400 =3 if baud rate is 4800 =4 if baud rate is 9600 =5 if baud rate is 19200 (not supported)
40030	2	Module Alarm Light Mode	=0 if On when there is an alarm =1 if Off when there is an alarm =2 if flash when there is an alarm otherwise off =3 if flash when there is an alarm otherwise on
40031	2	Module Alarm Contacts	=0 if MECH = NO and SS = NO =1 if MECH = NO and SS = NC =2 if MECH = NC and SS = NO =3 if MECH = NC and SS = NC NC = contact close when no alarm NO = contact open when no alarm • For MS1 MKII, CM2001, & MS2102, SS = N/A (Not Available).

1. for manufacturer use only
2. Not applicable to MS1 MKII or CM2001
3. Hardcode setting for MS1 MKII or CM2001
4. Read Only

7.2. Module Setting Group:

Modbus Register	Bytes	Variable Name	Value Range
40032	2	Module RTD Selection	=0 if RTD A is used, RTD B for backup =1 if two RTD's average is used =2 if the higher reading of two RTDs is used =3 if the lower reading of two RTDs is used =4 if RTD B is used for high temp cutoff =5 if only RTD A's reading is used
40033	2	Module Energy Cost Per kWh	1-50 (in unit of Cent)



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Modbus Register	Bytes	Variable Name	Value Range
40034	2	Module Stagger Start ²	= 0 if stagger start is off = 1 if stagger start is on
40035	2	Product Code ⁴	=1 if module is MS1 type =2 if module is MS2 type =3 if module is MS5 type =4 if module is MS10 type =5 if module is MS1 MKII type ³
40036	2	Module Switch Type ²	=0 if output switch is solid state switch =1 if output switch is relay switch
40037	2	Module Thermocouple Type ²	= 0 if J type thermocouple is used = 1 if K type thermocouple is used
40038	2	Module Manual Alarm	=0 if manual alarm is disabled =x if manual alarm is on for x hours (1<=x<=24) =25 if manual alarm is on continuously
40039	2	Module Ground Fault Test	=0 if GF test is disabled =x if GF test is on for x hours (1<=x<=24) =25 if GF test is to start when store key is pressed
40040	2	Ambient Temperature	(in unit of tenth of degree Celsius) =x if ambient temperature is x/10 degree Celsius (-500<=x<=5000) =-501 if ambient RTD is short =5001 if ambient RTD is open
40041	4	Heat Trace Curve Slope (For User Define Curve)	32-bit Floating Point Format Watt/Ft-°F
40043	4	Heat Trace Curve Offset (For User Define Curve)	32-bit Floating Point Format Watt/Ft

1. for manufacturer use only
2. Not applicable to MS1 MKII or CM2001
3. Hardcode setting for MS1 MKII or CM2001
4. Read Only
5. MS1 MKII Only



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7.3. Module Status Group (Read Only):

Modbus Register	Bytes	Variable Name	Values
40045	4	Module Status	<p>First Byte: b1-b0:output switch type ² 00: solid-state 01: relay b2:number of phase 0: one phase ³ 1: three phase b4-b3:RTD mode 00: no RTD 01: one RTD 02: two RTD ³ 03: one thermocouple b5:max current 0: 30A ³ 1: 100A b6:alarm present bit 0: no alarms 1: alarms present b7:max GF current 0: 3A 1: 1A ³</p> <p>Second Byte: b3-b0:number of heaters 0001: MS1 or MS1 MKII ³ 0010: MS2 0101: MS5 1010: MS10 b5-b4:output switch type (factory) 00: solid-state ³ 01 relay 10 output switch is set to user defined b6:Temperature Measurement Range 0: -50°C to +350°C 1: -50°C to +500°C b7:Firmware Type³ 0: CM2001 1: MS1 MKII</p> <p>Third Byte: b0:TraceCheck Heater On Duration Coefficient 0: no, 1: yes b1:Heater Copy 0: no, 1: yes b7-b2: not used</p> <p>Fourth Byte: Not used</p>

1. for manufacturer use only
 2. Not applicable to MS1 MKII or CM2001
 3. Hardcode setting for MS1 MKII or CM2001



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7.4. Module Statistics Group (Read Only):

Modbus Register	Bytes	Variable Name & Units
40047	4	Module Total Running Hours (32 bit floating point data, in Hours)
40049	4	Module Total Running Hours (32 bit unsigned integer, in 1/10 Hours)
40051	4	Module Total Energy Used (32 bit floating point data, in KWh)
40053	4	Module Total Energy Used (32 bit unsigned integer, in KWh)
40055	4	Module Total Energy Cost (32 bit floating point data, in Cents)
40057	4	Module Total Energy Cost (32 bit unsigned integer, in Cents)
40059	4	Module Total Running Days (32 bit floating point data, in Days)
40061	4	Module Total Running Days (32 bit unsigned integer, in Days)
40063	4	Module Total Running Days Since Reset (32 bit floating point data, in Days) ₂
40065	4	Module Total Running Days Since Reset (32 bit unsigned integer, in Days) ₂

1. for manufacturer use only
2. Not applicable to MS1 MKII or CM2001

7.5. Heater Setpoints Group:

Modbus Register	Bytes	Variable Name	Value Range
40067	4	Ground Fault Calibration Scale ₁	32-bit floating point value
40069	4	Voltage Calibration Scale ₁	32-bit floating point value
40071	2	Reset Latched Alarms ₅	First Byte: b0: low voltage alarm bit b1: high voltage alarm bit b2: continuity check fail b3: not used b4: not used b5: not used b6: not used b7: all alarms Second Byte: b0: low temperature alarm bit b1: high temperature alarm bit b2: low current alarm b3: high current alarm b4: ground fault alarm b5: RTD A failure b6: RTD B failure b7: switch failure
40072	2	Heater Enabled	=0 if heater is disabled =1 if heater is enabled
40073	2	Heater Setpoint	=X if set to X/10 degree C (0<=X<=5000) =5010 if set to "Off" =5020 if set to "None"
40074	2	Heater Low Temperature Alarm Level	=X if set to X/10 degree C (-500<=X<=5000) =5010 if set to "Off"



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40075	2	Heater High Temperature Alarm Level	=X if set to X/10 degree C (0<=X<=5000) =5010 if set to "Off"
40076	2	Heater Phase A Low Current Alarm Level	For 30 A Rating =X if set to X/100 A (0<=X<=3000) =10050 if set to "Off" For 100 A Rating =X if set to X/100 A (0<=X<=10000) =10050 if set to "Off"
40077	2	Heater Phase B Low Current Alarm Level ₂	For 30 A Rating =X if set to X/100 A (0<=X<=3000) =10050 if set to "Off" For 100 A Rating =X if set to X/100 A (0<=X<=10000) =10050 if set to "Off"
40078	2	Heater Phase C Low Current Alarm Level ₂	For 30 A Rating =X if set to X/100 A (0<=X<=3000) =10050 if set to "Off" For 100 A Rating =X if set to X/100 A (0<=X<=10000) =10050 if set to "Off"
40079	2	Heater Phase A High Current Alarm Level	For 30 A Rating =X if set to X/100 A (0<=X<=3000) =10050 if set to "Off" For 100 A Rating =X if set to X/100 A (0<=X<=10000) =10050 if set to "Off"
40080	2	Heater Phase A High Current Trip Alarm Level ₂	For 30 A Rating =X if set to X/100 A (0<=X<=3000) =10050 if set to "Off" For 100 A Rating =X if set to X/100 A (0<=X<=10000) =10050 if set to "Off"
40081	2	Heater Phase B High Current Alarm Level ₂	For 30 A Rating =X if set to X/100 A (0<=X<=3000) =10050 if set to "Off" For 100 A Rating =X if set to X/100 A (0<=X<=10000) =10050 if set to "Off"
40082	2	Heater Phase B High Current Trip Alarm Level ₂	For 30 A Rating =X if set to X/100 A (0<=X<=3000) =10050 if set to "Off" For 100 A Rating =X if set to X/100 A (0<=X<=10000) =10050 if set to "Off"
40083	2	Heater Phase C High Current Alarm Level ₂	For 30 A Rating =X if set to X/100 A (0<=X<=3000) =10050 if set to "Off" For 100 A Rating =X if set to X/100 A (0<=X<=10000) =10050 if set to "Off"



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40084	2	Heater Phase C High Current Trip Alarm Level ₂	For 30 A Rating =X if set to X/100 A (0<=X<=3000) =10050 if set to "Off" For 100 A Rating =X if set to X/100 A (0<=X<=10000) =10050 if set to "Off"
40085	2	Heater Ground Fault Trip Alarm Level	=X if set to X mA (10<=X<=1000) =1005 if set to "Off"
40086	2	Heater Ground Fault Alarm Level	=X if set to X mA (10<=X<=1000) =1005 if set to "Off"
40087	2	Heater Power Limit Current	For 30 A Rating =X if set to X/100 A (0<=X<=3000) =10050 if set to "Off" For 100 A Rating =X if set to X/100 A (0<=X<=10000) =10050 if set to "Off"
40088	2	Heater Tracecheck Time	= X if set to X hours (1<=X<=24) =25 if Tracecheck is "Off"
40089	2	Heater Set Voltage	=X if set to X Volts (100<=X<=600) =601 if heater voltage is measured ₃
40090	2	Heater Low Voltage Alarm Level	=X if set to X Volts (85<=X<=300) =301 if set to "Off"
40091	2	Heater Proportional Control	= 0 if it is disabled = 1 if it is enabled
40092	2	Heater RTD Failure Action	= 0 if heater turns Off = 1 if heater turns On
40093	2	Heater Manual Heater	B4-b0 =0 if manual heater is disabled =1 to 24 if manual heater is on for set hours =25 if heater on continuously b5 and b6 are not used
40094	18	Heater Name	First 16 bytes are heater name text string. Last 2 bytes are null terminator.
40103	2	Heater Thermostat (Master) Override	=0 if it is Off =1 if it is On
40104	2	Heater Deadband	= X if set to X/10 degree C (0<=X<=500)
40105	2	Softstart	=X if set to X seconds (10<=X<=999s) =1000 if off
40106	2	Heater High Voltage Level	=X if set to X Volts (100<=X<=300) =301 if set to "Off"
40107	2	Heat Trace Curve	Reserve for factory use
40108-40109	4	Reserve for future expansion	

1. for manufacturer use only
2. Not applicable to MS1 MKII or CM2001
3. Hardcode setting for MS1 MKII or CM2001
4. Read Only
5. MS1 MKII Only



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7.6. Heater Status Group (Read Only):

Modbus Register	Bytes	Variable Name	Values
40110	4	Heater Status	<p>First Byte: b0:heater alarm present bit b1:heater enabled bit b2:heater setpoint on (not Off or None) bit b3:heater on bit b4>manual heater on/off bit b5:tracecheck on/off bit b6:module alarm present bit b7:not used</p> <p>Second Byte: b1-b0:output switch type₂ 00: solid-state 01: relay b2:number of phase 0: one phase₃ 1: three phase b4-b3:RTD mode 00: no RTD 01: one RTD 02: two RTD 03: one thermocouple b5:max current 0: 30A₃ 1: 100A b6: max GF current rate 0: 3A 1: 1A₃ b7: not used</p> <p>Third Byte: b3-b0:number of heaters 0001: MS1 or MS1 MKII₃ 0010: MS2 0101: MS5 1010: MS10 b5-b4:Output Switch Type (Factory) 00: solid-state₃ 01 relay 10 user defined</p> <p style="background-color: #e0e0e0;">b6: Temperature Measurement Range 0: -50°C to +350°C 1: -50°C to +500°C</p> <p>b7:TraceCheck Heater On Duration Coefficient 0: no, 1: yes</p> <p>Fourth Byte: b0: Heater Copy 0: no, 1: yes b7-b1: Not used</p>



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Modbus Register	Bytes	Variable Name	Values
40112	6	Heater Alarm Status	<p>First Byte: b0: low temp alarm b1: high temp alarm b2: phase A low current b3: phase A high current b4: phase B low current₂ b5: phase B high current₂ b6: phase C low current₂ b7: phase C high current₂</p> <p>Second Byte: b0: ground fault trip alarm b1: ground fault alarm b2: RTD A failure alarm b3: RTD B failure alarm b4: RTD A short alarm b5: RTD A open alarm b6: RTD B short alarm b7: RTD B open alarm</p> <p>Third Byte: b0: output SCR failure alarm b1: Tracecheck ground fault alarm b2: Tracecheck low current alarm b3: Tracecheck high current alarm b4: Tracecheck ground fault trip alarm b5: Tracecheck output SCR failure alarm b6: cable fault alarm₂ b7: low voltage alarm</p> <p>Fourth Byte: b0: high voltage alarm b1: phase A high current trip alarm b2: phase B high current trip alarm₂ b3: phase C high current trip alarm₂ b4: GF test alarm b5: self check fail b6: continuity check fail b7: Tracecheck continuity</p> <p>Fifth Byte: Not Used Sixth Byte: Not Used</p>

- 1. for manufacturer use only
- 2. Not applicable to MS1 MKII or CM2001
- 3. Hardcode setting for MS1 MKII or CM2001
- 4. Read Only

7.7. Heater Measured Values Group (Read Only):

Modbus Register	Bytes	Variable Name	Units
40115	2	Heater Temperature	(in unit of tenth of degree Celsius)
40116	2	Heater RTD A temperature	(in unit of tenth of degree Celsius)
40117	2	Heater RTD B temperature	(in unit of tenth of degree Celsius)
40118	2	Heater On Percentage	(in unit %)



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40119	2	Heater Phase A Current	(in unit of 10mA)
40120	2	Heater Phase B Current ₂	(in unit of 10mA)
40121	2	Heater Phase C Current ₂	(in unit of 10mA)
40122	2	Heater Ground Fault Current	(in unit of 1mA)
40123	2	Heater Voltage	(in unit of Volts)
40124	2	Heater Pretrip Ground Fault Current	(in unit of 1mA)
40125	2	Heater Phase A Pretrip Current ₂	(in unit of 10mA)
40126	2	Heater Phase B Pretrip Current ₂	(in unit of 10mA)
40127	2	Heater Phase C Pretrip Current ₂	(in unit of 10mA)
40128-40131		Reserved for future expansion	

1. for manufacturer use only
2. Not applicable to MS1 MKII or CM2001

7.8. Heater Statistics Group (Read Only):

Modbus Register	Bytes	Variable Name	Units
40132	2	Heater Max. Temperature	(in unit of 0.1 °C)
40133	2	Heater Min. Temperature	(in unit of 0.1 °C)
40134	2	Heater Phase A Max. Current	(in unit of 10mA)
40135	2	Heater Phase B Max. Current ₂	(in unit of 10mA)
40136	2	Heater Phase C Max. Current ₂	(in unit of 10mA)
40137	2	Heater Max. Ground Fault Current	(in unit of 1mA)
40138	4	Heater Energy Used Last Day (32 bit floating point data)	(in unit of KWh)
40140	4	Heater Energy Used Last Day (32 bit unsigned integer)	(in unit of KWh)
40142	4	Heater Energy Cost Last Day (32 bit floating point data)	(in unit of Cents)
40144	4	Heater Energy Cost Last Day (32 bit unsigned integer)	(in unit of Cents)
40146	4	Heater Energy Used (32 bit floating point data)	(in unit of KWh)
40148	4	Heater Energy Used (32 bit unsigned integer)	(in unit of KWh)
40150	4	Heater Energy Cost (32 bit floating point data)	(in unit of Cents)
40152	4	Heater Energy Cost (32 bit unsigned integer)	(in unit of Cents)
40154	4	Heater Turn On Hours (32 bit floating point data)	(in unit of Hours)
40156	4	Heater Turn On Hours (32 bit unsigned integer)	(in unit of Hours)
40158	2	Heater Percentage of Turn On Time	(in unit of %)
40159	4	Heater Turn On Days (32 bit floating point data)	(in unit of Days)
40161	4	Heater Turn On Days (32 bit unsigned integer)	(in unit of Days)
40163	2	Maximum Voltage	(in unit volts)
40164	2	Minimum Voltage	(in unit volts)

1. for manufacturer use only
2. Not applicable to MS1 MKII or CM2001

7.9. Heater Alarm Reset & Statistics Reset Group:

Modbus Register	Bytes	Variable Name
165	2	Reset Heater Tracecheck Continuity Alarm
166	2	Reset Heater Ground Fault Trip Alarm
167	2	Reset Heater Tracecheck Ground Fault Alarm
168	2	Reset Heater Tracecheck Low Current Alarm



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169	2	Reset Heater Tracecheck High Current Alarm
170	2	Reset Heater Tracecheck Ground Fault Trip Alarm
171	2	Reset Heater Tracecheck Output SCR Failure Alarm
172	2	Reset Heater Statistics
173	2	Reset Heater Max. Temperature
174	2	Reset Heater Min. Temperature
175	2	Reset Heater Phase A Max. Current
176	2	Reset Heater Phase B Max. Current ₂
177	2	Reset Heater Phase C Max. Current ₂
178	2	Reset Heater Max. Ground Fault Current
179	2	Reset Heater Energy Used
180	2	Reset Heater Energy Cost
181	2	Reset Heater Turn On Hours
182	2	Reset Heater Phase A High Current Trip Alarm ₂
183	2	Reset Heater Phase B High Current Trip Alarm ₂
184	2	Reset Heater Phase C High Current Trip Alarm ₂
185	2	Reset Heater GF Test Alarm
186	2	Reset Heater Max Voltage
187	2	Reset Heater Min Voltage

- 1. for manufacturer use only
- 2. Not applicable to MS1 MKII or CM2001

7.10. Module Commissioning & Addressing Group:

Modbus Register	Bytes	Variable Name
40188	2	Module commission
40189	2	Test Module address
40190	2	Assign Module address