Tutorial on TTDM-PLUS and TTSIM System Integration using Modbus

There are two ways that system integrators can access leak detection information using the Modbus interface: either through the TTDM-PLUS or with the interface on the individual TTSIM units.

Modbus Interface to the TTDM-PLUS

A TTDM-PLUS is often installed when the owner of the system wishes to have a stand-alone wall mounted user interface that will provide leak detection information independent of the Building Management System (BMS). All of the set-up options and display options of the TraceTek system are available through the TTDM-PLUS User Interface panel. There is a 4 x 20 character LCD display and a number of push buttons for input and output. However, in many installations, the owner of the system would like to have access to the TraceTek leak detection system made available to the BMS system as well as locally displayed on the TTDM-PLUS user interface. To meet this requirement, the TTDM-PLUS has a serial data port and all internal data is made available using the Modbus protocol.

RS232 or RS485

The system integrator can select which type of interface is used by operating the toggle switch at the bottom of the User Interface circuit board. In the RS 232 position, the DB-9 connector on the side of the User Interface circuit board is active as a standard RS232 DTE device (similar to a modem or serial printer connection). The terminal block, J13 on the motherboard is also set up as a RS232 serial port and it is wired in parallel with the DB-9 connector. For permanent installations, the J13 terminal block should be used.

When the toggle switch is placed in the RS 485 position, the J13 terminal block is set up for RS 485 connections. When operating as an RS-485 device, the J13 terminal block can be connected to a two wire RS-485 communications circuit. The TTDM-PLUS acts as a slave device with the BMS system acting as the master. The network address for the TTDM-PLUS is set using the menu and buttons on the front panel (MENU | TTDM NETWORK | RS485 ADDRESS) Password is 00010. The range of addresses is 01 Hex to 20 Hex. Default is 01 Hex. Baud rate can also be set in the same TTDM Network menu. The BMS host can use either Modbus ASCII or Modbus RTU data format. The TTDM-PLUS will recognize the format and respond automatically in the appropriate format.

TTDM-PLUS as a data concentrator

When a TTDM-PLUS is used to manage a network of TTSIM units, the TTDM-PLUS has a dual role: It remains a slave to the BMS, but it acts as a master to its own network of TTSIM devices. Communications to the SIM network is made via an RS485, two-wire network terminated at terminal block J10. Internal communications to the SIM network is always at 9600 baud and a proprietary protocol (based on OPTO-22) is used. The system integrator has no direct access to this communication stream. Instead, the TTDM-PLUS continuously collects, evaluates and stores the data from the SIM network in a database internal to the TTDM-PLUS. This data base is evaluated by the TTDM-PLUS to update the 4x20 LCD display, sound audible alarms, open or close alarm relays and turn status LED's off or on.

In addition to data collection and display functions to support its local operation, the TTDM-PLUS is programmed to respond to external data requests (from the BMS) made through the J13 host port. The full contents of the TTDM-PLUS database are accessible to the BMS through the J13 host port.

There is far more data access than the average system integrator will ever need. But for completeness the entire data register map is documented in Attachment 1.

Who makes the call: BMS or TTDM-PLUS?

All of the data from the TTSIM's is available in the TTDM-PLUS database. The recommended detection / location strategy is for the BMS is to access the SIM data from the TTDM's data base and make an independent evaluation of the data in order to determine if a leak has been detected and if so where it can be found. Simultaneously the TTDM-PLUS will be making it's own evaluation of the data and will generate an alarm indications, locations etc. if the conditions meet it's own criteria. This strategy provides two independent looks at the same data. In most cases the results will be the same because the difference between a dry sensor cable and a wet sensor cable is very distinctive and the location calculation is quite straightforward. (See the following section)

In some installations it may be important to the owner for the TTDM-PLUS to make the initial leak detection determination and for the BMS system to report a leak only after the TTDM-PLUS has made the initial call. This type of arrangement is possible but somewhat more complex and it is documented in the section entitled Access to data already interpreted by the TTDM-PLUS

Access to TTSIM data through the TTDM-PLUS data base

There are five key data values for each TTSIM:

- Location Resistance
- Detection Resistance
- Detection Current
- Cable Resistance Loop RG
- Cable Resistance Loop YB

The interpretation of these values is as follows:

Location Resistance - This value gives the location of the leak in ohms. The data is provided as a 16 bit binary value in RTU mode or as 4 ASCII characters in the range 0 to F if Modbus ASCII is being used. Convert the data to a decimal value, then to get distance in meters divide by 12.8. To get distance in feet, divide the data 4. *It is important to note the TTSIM will try to generate a location value even when there is no real leak present on the sensor cable. Before the calculated location has any value, you must evaluate Detection Resistance and Detection Current*

Detection Resistance - This value gives the resistance through the leak in kilo ohms. The data is provided as a 16 bit binary value in RTU mode or as 4 ASCII characters in the range 0 to F if Modbus ASCII is being used. First convert the date to a decimal value then evaluate. When a TTDM-PLUS is set to NORMAL sensitivity, a leak is declared when the value for Detection resistance falls below 19 kilo ohms. The leak is considered to be cleared when the resistance rises above 38 kilo ohms. A clean and dry cable will report a very large value for Detection Resistance, usually above 100 kilo ohms and often above 65000. In order to detect smaller leaks (more sensitive) the detection threshold can be set to a higher number. For instance a 25 k ohm threshold setting will mean that a smaller puddle of water will be declared as a leak than the default value of 19 k ohm. Be careful, if you set the threshold too low, even a very wet cable may not ever get a low enough resistance through the leak to be detected. The default value of 19 k ohm is a good starting point and a value of 13 k ohms is about the lowest practical limit.

Detection Current - This value gives the current through the leak in micro amps. The data is provided as a 16 bit binary value in RTU mode or as 4 ASCII characters in the range 0 to F if Modbus ASCII is being used. First convert the date to a decimal value then evaluate. When a cable begins to get contaminated with low levels of moisture or dirt, the detection current starts to rise. For a clean and dry cable the Detection Current will be zero. The level of Detection Current is a measure of how much contamination is building up on the cable. The TTDM-PLUS uses a threshold of 50 micro amps to determine when to turn on the contamination LED, sound an alert

signal and activate the service needed relay. To make a BMS system more sensitive to contamination, lower the threshold. To decrease sensitivity to contamination, raise the threshold above 50. To ignore contamination current entirely set the threshold above 250. *Hardware current limiters on the TTSIM analog circuitry prevent the leakage current from reaching this level even with a very wet or dirty cable.*

Cable Resistance Loop RG and Cable Resistance Loop YB - These values gives the resistance along the length of the cable in ohms. The data is provided as a 16 bit binary value in RTU mode or as 4 ASCII characters in the range 0 to F if Modbus ASCII is being used. First convert the date to a decimal value then evaluate. The standard resistance for all TraceTek sensor cables is 4 ohms per foot (about 12.8 ohms per meter). Therefore, a cable that is 100 meters in length will have a loop resistance of 1280 ohms. The RG Loop and the YB loop are two parallel wire loops that make up the sensor cable. Measuring and comparing these two loops can monitor the integrity of the sensor cable. Neither of these two measurements is critical to detecting a leak or locating a leak. However, the two measurements should be about equal and proportional to the cable length. The TTDM-PLUS monitors these two values and if either of the loops moves to an unexpected high value, a loop break alarm is generated. If both loops go to a high value, a cable break alarm is reported. Minor disagreement in the values of the two measurements is reported as a loop imbalance. Generally the two loop measurements should agree within 10%. A major imbalance indicates damage to the cable or ground loop problems that need to be addressed. Very high values indicate cable damage (or open connectors) that will prevent the system from detecting or locating a leak at all. If a break is detected an alarm must be generated.

The data for each SIM channel is stored in the TTDM-PLUS data base in five contiguous Modbus addresses. For instance the data for SIM channel 1 and 2 (and the general formula for all channels) is as follows:

	CH01	CH02	For SIM n
Location Resistance	30118	30134	(n-1)*16 +30118
Detection Resistance	30119	30135	(n-1)*16 +30119
Detection Current	30120	30136	(n-1)*16 +30120
Cable Resistance Loop RG	30121	30137	(n-1)*16 +30121
Cable Resistance Loop YB	30122	30138	(n-1)*16 +30123

For example to obtain the location resistance from SIM 15 attached to a TTDM-PLUS with network address 09. Use the Modbus device address 09 and register address 30342. Remember that the result returned to the BMS will be a 4 digit hexadecimal value.

Access to data already interpreted by the TTDM-PLUS

Should the system integrator choose to let the TTDM-PLUS do the primary data interpretation, then another strategy can be used to bring the data into the BMS. Since all events are recorded into the event history table, the BMS can monitor the event counter for any change, and then when a new event is detected, the most recent event can be interpreted from a look-up table.

The event counter is located in register 30017. The actual event table can store the most recent 1024 events (7 data registers per event) so the event count must be indexed to 1024 event blocks using the modulo operator (%). For instance if the event count is 10, the 7 register block of data for event 10 will start in the 10^{th} group of 7 registers (10 %1024 = 10). If the event total has reached 1034 the data for event 1034 will also be found in the 10^{th} group of 7 registers (1034 %1024 = 10).

So the BMS sequence would be to continuously check the event total in register 30017, then if a new event has occurred, an index is calculated using the formula:

(((Event Count % 1024)-1) * 7) + 30357 (Also noted in Attachment 1)

Once the starting address for a block of 7 registers is calculated the data returned is as follows:

Event Type
Module Address
Module Sub-address (not used)
Event Time Stamp (high byte-hours, low byte-minutes)
Event Date Stamp (high byte-month, low byte-day)
Event Date Stamp (low byte-year)
Event Data (i.e. loc)

Event Type can be decoded as follows (Also noted in Attachment 1)

1	Leak	17	Cable Restored
2	New Leak	18	SI H/W Recovered
3	Re-Alarm	19	SI Comm Recovered
4	Service Req'd	20	SIM Normal
5	Cable Break	21	System Normal
6	YB Loop Break	22	Memory Cleared
7	RG Loop Break	23	RTC/RAM Error
8	Loop Imbalance	24	Re-Alarm X Hours
9	SI H/W Error	25	Alarm Silenced
10	SI Comm Error	33	Feet
11	System Restart	34	Meters
12	System Power Down	35	Zones
13	Leak relay Reset	36	ft
14	Parameter Change	194	Ω
15	Leak Cleared		
16	Service Cleared		

For instance if a leak was detected at 35 meters on SIM Channel 3 at 1435 on 23 February 2002 and just prior to the leak detection there were 54 events in the event history, then the following data would be available.

Event count in Register 30017 goes from 54 to 55 BMS is triggered by increment in event counter.

The modulo operation is invoked to generate the event index of 55 (55 % 1024 = 55)

Starting address for block of seven registers is calculated using formula above as:

(55-1) *7 + 30357 = 30735

Therefore the following registers and data contents can be accessed:

30735	Event Type	0001	(Leak)
30736	Module Address	0003	(Leak was on SIM Channel 3)
30737	Sub Address (not used)		
30738	Time (high byte hours, low byte minutes)	2023	(High byte converts to 20 and low byte is 23)
30739	Month/Day (high byte month low byte day)	0217	(High byte converts to 02 and low byte is 17)
30740	Year	0002	
30741	Data	0035	(location is 35 meters)

Since the type of event will determine the meaning of the data register, several different event handlers must be developed in the BMS code. For this reason, direct access to the SIM data (see proceeding section) is usually a more straight forward choice for the system integrator and is the recommended method

Modbus Interface to the TTSIM-1

In some installations, the owner will choose to have the TTSIM's connected directly to the BMS without the benefit of a TTDM-PLUS Alarm Panel. Since the individual TTSIM units are relatively low in cost, it is often possible to install more SIM's with shorter sections of sensor cable where ever they are need around the building or industrial facility.

The serial data connection to the TTSIM is only made via two-wire RS 485 at 9600 baud. There is no internal provision to switch baud rate.

The TTSIM automatically responds to these 4 protocols: Modbus ASCII, Modbus RTU, Opto-22, and Johnson Controls Metasys. Most system integrators will use one of the two Modbus standards. Metasys formatted data is very efficient, but only of value with Johnson Controls BMS systems. The Opto-22 implementation is a very specific and limited set of registers designed for efficient communication between a TTDM-PLUS and TTSIM-1 units

Access to data and interpretation of the returned values:

Each SIM has its own set of Modbus data registers as fully described in Attachment 2. However, most system integrators will need to access only these 5 registers:

- Location Resistance
- Detection Resistance
- Detection Current
- Cable Resistance Loop RG
- Cable Resistance Loop YB

The interpretation of these values is as follows:

Location Resistance - This value gives the location of the leak in ohms. The data is provided as a 16 bit binary value in RTU mode or as 4 ASCII characters in the range 0 to F if Modbus ASCII is

being used. Convert the data to a decimal value, then to get distance in meters divide by 12.8. To get distance in feet, divide the data 4. *It is important to note the TTSIM will try to generate a location value even when there is no real leak present on the sensor cable. Before the calculated location has any value, you must evaluate Detection Resistance and Detection Current*

Detection Resistance - This value gives the resistance through the leak in kilo ohms. The data is provided as a 16 bit binary value in RTU mode or as 4 ASCII characters in the range 0 to F if Modbus ASCII is being used. First convert the date to a decimal value then evaluate. When a TTDM-PLUS is set to NORMAL sensitivity, a leak is declared when the value for Detection resistance falls below 19 kilo ohms. The leak is considered to be cleared when the resistance rises above 38 kilo ohms. A clean and dry cable will report a very large value for Detection Resistance, usually above 100 kilo ohms and often above 65000. In order to detect smaller leaks (more sensitive) the detection threshold can be set to a higher number. For instance a 25 k ohm threshold setting will mean that a smaller puddle of water will be declared as a leak than the default value of 19 k ohm. Be careful, if you set the threshold too low, even a very wet cable may not ever get a low enough resistance through the leak to be detected. The default value of 19 k ohm is a good starting point and a value of 13 k ohms is about the lowest practical limit.

Detection Current - This value gives the current through the leak in micro amps. The data is provided as a 16 bit binary value in RTU mode or as 4 ASCII characters in the range 0 to F if Modbus ASCII is being used. First convert the date to a decimal value then evaluate. When a cable begins to get contaminated with low levels of moisture or dirt, the detection current starts to rise. For a clean and dry cable the Detection Current will be zero. The level of Detection Current is a measure of how much contamination is building up on the cable. The TTDM-PLUS uses a threshold of 50 micro amps to determine when to turn on the contamination LED, sound an alert signal and activate the service needed relay. To make a BMS system more sensitive to contamination, lower the threshold. To decrease sensitivity to contamination, raise the threshold above 50. To ignore contamination current entirely set the threshold above 250. *Hardware current limiters on the TTSIM analog circuitry prevent the leakage current from reaching this level even with a very wet or dirty cable.*

Cable Resistance Loop RG and Cable Resistance Loop YB - These values gives the resistance along the length of the cable in ohms. The data is provided as a 16 bit binary value in RTU mode or as 4 ASCII characters in the range 0 to F if Modbus ASCII is being used. First convert the date to a decimal value then evaluate. The standard resistance for all TraceTek sensor cables is 4 ohms per foot (about 12.8 ohms per meter). Therefore, a cable that is 100 meters in length will have a loop resistance of 1280 ohms. The RG Loop and the YB loop are two parallel wire loops that make up the sensor cable. Measuring and comparing these two loops can monitor the integrity of the sensor cable. Neither of these two measurements is critical to detecting a leak or locating a leak. However, the two measurements should be about equal and proportional to the cable length. The TTDM-PLUS monitors these two values and if either of the loops moves to an unexpected high value, a loop break alarm is generated. If both loops go to a high value, a cable break alarm is reported. Minor disagreement in the values of the two measurements is reported as a loop imbalance. Generally the two loop measurements should agree within 10%. A major imbalance indicates damage to the cable or ground loop problems that need to be addressed. Very high values indicate cable damage (or open connectors) that will prevent the system from detecting or locating a leak at all. If a break is detected an alarm must be generated.

The addresses for these 5 registers is as follows:

Location Resistance	30002
Detection Resistance	30003
Detection Current	30004
Cable Resistance Loop RG	30005
Cable Resistance Loop YB	30006

Address Assignment Note (Also see TTSIM Installation and Operation Instructions)

The device address must be unique for each SIM on an RS 485 network. Each TTSIM ships from the factors with a default address of 199 (decimal) programmed into register 40011. The device address can be changed by storing any value from 001 to 250 into register 40011. The TTDM-PLUS panel has menu features to make SIM address changes a simple operation, but the system integrator can use any software utility (E.g. Modscan) capable of generating a Modbus write command to change this value. There is a hardware provision (jumper posts and shorting clip) on the TTSIM circuit board that allows the SIM address to be temporarily forced to zero. Typically, a network of SIM's will be connected to the RS 485 network and powered with all addresses still set to the factory default of 199. Then, one by one they will be forced to address 00. While temporarily at address 00, a new, unique address value will be written to register 40011, then the jumper clip is removed and that individual SIM unit assumes it's new network address. The process is repeated for each SIM until all are communicating with the BMS as uniquely identified network devices.

Summary Table for SIM data interpretation:

Sensor / Cable Type	Normal Conditions	Leak Detected	Sensor Contamination
TT1000/ TT3000 water or water based fluids	**30003 > 1000 K Ohms 30004 < 5 micro amps**	**30003 < 19 K Ohms 30004 > 200 micro amps**	**30003 < 1000K Ohms 30004 > 50 micro amps**
TT5000 / TT5001 fuels or solvents	**30003 > 1000 K Ohms 30004 < 5 micro amps**	**30003 < 5 K ohms 30004 > 200 micro amps**	**Usually not applicable, Values similar to TT1000/TT3000 may indicate water intrusion**
Float Switch or other norm ally open contact device	**30003 > 1000 K Ohms 30004 < 5 micro amps**	**30003 < 1 K ohms 30004 > 200 micro amps**	**N/A**

Calculating Leak Location: For sensor cables (TT1000, TT3000, TT5000, and TT5001) the value reported in register **30002** is the resistance measurement between the TT-SIM module and the leak. For feet: divide corrected value from register 30002 by 4. For meters: divide the corrected value from register 30002 by 12.8

Title **Modbus Communications Specification for TTDM-PLUS**

By Ken McCoy, Keith Walberg

This document outlines the Modbus ASCII/RTU communication specification for the External Communication Port on the TTDM-PLUS.
These two Modbus protocols are available in V2.00+

- RS485 implementation is two-wire. Set toggle switch on bottom of TTDM-PLUS UI board to RS485. Baud Rate and Network Address are set in TTDM Network Menu. Connection is made at J13 Host Port Terminal Block on TTDM-PLUS mother board.
- RS232 implementation to be 3 (TX, RX, GND) or 5 (plus RTS/CTS handshaking) wire. Toggle Switch on UI Board must be in the RS232 position. Only one TTDM-PLUS can be connected to the master device. . Connection is made at J13 Host Port Terminal Block on TTDM-PLUS mother board. Or at DB-9 connector on side of UI board

The following are the status codes for the events contained in the event list.

Status and Units Codes List

1	Leak	17	Cable Restored
2	New Leak	18	SI H/W Recovered
3	Re-Alarm	19	SI Comm Recovered
4	Service Req'd	20	SIM Normal
5	Cable Break	21	System Normal
6	YB Loop Break	22	Memory Cleared
7	RG Loop Break	23	RTC/RAM Error
8	Loop Imbalance	24	Re-Alarm X Hours
9	SI H/W Error	25	Alarm Silenced
10	SI Comm Error	33	Feet
11	System Restart	34	Meters
12	System Power Down	35	Zones
13	Leak relay Reset	36	Ft
14	Parameter Change	194	Ω
15	Leak Cleared		
16	Service Cleared		

Modbus Type Coils: Read/Write Digital (0X References): Function 01 to Read, Function 05 to Write, Function 15 to Block Write

Ref. Number	Addr. (Dec)	Addr. (Hex)	Name/Description
			User Interface Functions/Settings
01	0	0000	Init Network (write 1 to do function)
02	1	0001	Update Network (write 1 to do function)
03	2	0002	Clear Events List Memory only (write 1 to do function)
04	3	0003	Restore Defaults (write 1 to do function)
05	4	0004	Modbus Mode (0=ASCII, 1=RTU)
06	5	0005	Auto Reset (1=Yes 0=No)
07	6	0006	Audible Alarm (1=Yes 0=No)
08	7	0007	Alarm Reflash (1=Yes 0=No)

Modbus Type Digital Inputs: Read Only (0X References) : Function 02 to Read

Ref. Number	Addr. (Dec)	Addr. (Hex)	Name/Description
			User Interface /LMM Status Flags
01	0	0000	!Monitor LED
02	1	0001	!Service/LED
03	2	0002	!Leak/LED
04	3	0003	!Trouble/LED

Modbus Type Input Registers (Read Only 3X References) : Function 04 to Read

Ref. Number	Addr. (Dec)	Addr. (Hex)	Name/Description of 16 bit value (4 hex characters)
			User Interface Status
30001	0	0000	Product ID ID = 0-255
30002	1	0001	Major Version Number /Minor Version Number: MV =0-99/ mV = 0-99
30003	2	0002	Version letter cc= ASCII char
30004	3	0003	Rom Checksum
30005	4	0004	Spare
30006	5	0005	Spare
30007	6	0006	Number of Active Nodes
30008	7	0007	Number of Leak Alarms
30009	8	0008	Number of Service Req'd Alarms
30010	9	0009	Number of Cable Breaks
30011	10	000A	Number of Loop Imbalances
30012	11	000B	Number of YB Breaks
30013	12	000C	Number of RG Breaks
30014	13	000D	Number of SI Comm Errors
30015	14	000E	Number of SI H/W Errors
30016	15	000F	Current DAC Value
			Events Data
30017	16	0010	Current/Total Events Number (1-32767)
30018	17	0011	spare
30019	18	0012	Event Pointer - computed index for mapping and flat architecture. This pointer

			is zero based and used for debugging events list access (0-1023)
30020	19	0013	spare
30021	20	0014	Event Type
30022	21	0015	Module Address
30023	22	0016	Module Subaddress (not used)
30024	23	0017	Event Time Stamp (high byte-hours, low byte-minutes)
30025	24	0018	Event Date Stamp (high byte-month, low byte-day)
30026	25	0019	Event Date Stamp (low byte-year)
30027	26	001A	Event Data (i.e. loc)
30028	27	001B	spare
30029	28	001C	spare
30030	29	001D	spare
30031	30	001E	spare
30032	31	001F	spare

			Mapped SIM Analog Inputs/Status
30033	32	0020	AI -0 Status code
30034	33	0021	AI -1 Location Resistance
30035	34	0022	AI -2 Detection Resistance (R S-to-S)
30036	35	0023	AI -3 Detection Current (CURRENT)
30037	36	0024	AI -4 Cable Resistance Loop RG
30038	37	0025	AI -5 Cable Resistance Loop YB
30039	38	0026	spare
30040	39	0027	spare
30041	40	0028	Sim Node Status
30042	41	0029	AI -9 Sensor Version
30043	42	002A	AI -10 Product ID
30044	43	002B	SIM Cable Test Length
30045	44	002C	SIM Leak Location
30046	45	002D	SIM New Leak Resistance
30047	46	002E	SIM Comm Rate
30048	47	002F	SIM Event Code
30049 - 30091	48 - 90	0030 – 005A	LCD Text 4 rows*(20chars + CR)
30092	91	005B	Relays states – that way you can get all front panel info with on read
30093 - 30100	92 - 99	005C - 0063	Unused
			SIM Analog Inputs/Status
30101 - 30116	100 - 115	0064 - 0073	SIM0 - status see Analog Inputs 30033-30048 for format
30117 - 30132	116 - 131	0074 - 0083	SIM1 - status see Analog Inputs 30033-30048 for format
30133 - 30148	132 - 147	0084 - 0093	SIM2 - status see Analog Inputs 30033-30048 for format
30149 - 30164	148 - 163	0094 - 00A3	SIM3- status see Analog Inputs 30033-30048 for format
30165 - 30180	164 - 179	00A4 - 00B3	SIM4 - status see Analog Inputs 30033-30048 for format
30181 - 30196	180 - 195	00B4 - 00C3	SIM5 - status see Analog Inputs 30033-30048 for format
30197 - 30212	196 - 211	00C4 - 00D3	SIM6 - status see Analog Inputs 30033-30048 for format
30213 - 30228	212 - 227	00D4 - 00E3	SIM7 - status see Analog Inputs 30033-30048 for format

30229 - 30244	228 - 243	00E4 - 00F3	SIM8 - status see Analog Inputs 30033-30048 for format
30245 - 30260	244 - 259	00F4 - 0103	SIM9 - status see Analog Inputs 30033-30048 for format
30261 - 30276	260 - 275	0104 - 0113	SIM10 - status see Analog Inputs 30033-30048 for format
30277 - 30292	276 - 291	0114 - 0123	SIM11- status see Analog Inputs 30033-30048 for format
30293 - 30308	292 - 307	0124 - 0133	SIM12 - status see Analog Inputs 30033-30048 for format
30309 - 30324	308 - 323	0134 - 0143	SIM13 - status see Analog Inputs 30033-30048 for format
30325 - 30340	324 - 339	0144 - 0153	SIM14 - status see Analog Inputs 30033-30048 for format
30341 - 30356	340 - 355	0154 - 0163	SIM15 - status see Analog Inputs 30033-30048 for format
30357 - 30372	356 - 371	0164 - 0173	SIM16 - status see Analog Inputs 30033-30048 for format
30373 - 30388	372 - 387	0174 - 0183	SIM17 - status see Analog Inputs 30033-30048 for format
30389 - 30404	388 - 403	0184 - 0193	SIM18 - status see Analog Inputs 30033-30048 for format
30405 - 30420	404 - 419	0194 - 01A3	SIM19 - status see Analog Inputs 30033-30048 for format
30421 - 30436	420 - 435	01A4 - 01B3	SIM20 - status see Analog Inputs 30033-30048 for format
30437 - 30452	436 - 451	01B4 - 01C3	SIM21 - status see Analog Inputs 30033-30048 for format
30453 - 30468	452 - 467	01C4 - 01D3	SIM22 - status see Analog Inputs 30033-30048 for format
30469 - 30484	468 - 483	01D4 - 01E3	SIM23 - status see Analog Inputs 30033-30048 for format
30485 - 30500	484 - 499	01E4 - 01F3	SIM24 - status see Analog Inputs 30033-30048 for format
30501 - 30516	500 - 515	01F4 - 0203	SIM25 - status see Analog Inputs 30033-30048 for format
30517 - 30532	516 - 531	0204 - 0213	SIM26 - status see Analog Inputs 30033-30048 for format
30533 - 30548	532 - 547	0214 - 0223	SIM27 - status see Analog Inputs 30033-30048 for format
30549 - 30564	548 - 563	0224 - 0233	SIM28 - status see Analog Inputs 30033-30048 for format
30565 - 30580	564 - 579	0234 - 0243	SIM29 - status see Analog Inputs 30033-30048 for format
30581 - 30596	580 - 595	0244 - 0253	SIM30 - status see Analog Inputs 30033-30048 for format
30597 - 30612	596 - 611	0254 - 0263	SIM31 - status see Analog Inputs 30033-30048 for format
			Events List -latest 1024 events with 7 items per each event. **Event Entry #** = **(Event # -1) modulo 1024** (the integer remainder after dividing the value by 1024. For example: 5 modulo 1024 =5, 1034 modulo 1024 =10 **Event Entry Starting Address = 30357+(((Event # %1024)-1)*7)**

30357 - 30363	356 -362	0164-016A	Event Entry 1 - see Event Data 30021 - 30027 for format
30364 - 30370	363 -369	016B-0171	Event Entry 2 – see Event Data 30021 - 30027 for format
. .	. .	. .	. .
37511-37517	7510 – 7516	ID56-1D5C	Event Entry1023 - see Event Data 30021 - 30027 for format
37518-37524	7517 – 7523	1D5D-1D63	Event Entry 1024 - see Event Data 30021 - 30027 for format

Modbus Type Holding Registers (Read/Write 40 References) : Function 03 to Read, Function 06 to write or Function 16 to block write

Ref. Number	Addr. (Dec)	Addr. (Hex)	Name/Description of 16 bit value (4 hex characters) TTDM-NMM
			SIM and Events Overlay Pointers
40001	0	0000	Event number of event accessible in Input Registers
40002	1	0001	SIM number of SIM status accessible in Input Registers
40003	2	0002	Spare
			General Setup Parameters
40004	3	0003	Time (high byte-hours, low byte-minutes)
40005	4	0004	Date (high byte-month, low byte-day)
40006	5	0005	Date (low byte-year)
40007	6	0006	Units
40008	7	0007	Language
40009	8	0008	Level 1 Password
40010	9	0009	Level 2 Password
40011	10	000A	Sim Analog Outputs Password
40012	11	000B	Sim 4-20 Value –Sim address used to control 4_20
40013	12	000C	Max 4-20 Value
40014	13	000D	spare
40015	14	000E	Spare
40016	15	000F	TTDM Port Log State – NOTE - all non MODBUS modes, a non-zero value places port in a non Modbus mode until the next valid Modbus message received (mainly used for debug) 0 = No ASCII Data Logging 1 = Log Events to Host 2 = Log SIM communications to Host 4 = Log Time once/sec to Host 8 = Log Front Screen to Host Port
40017	16	0010	Key Input (0-10)
40018	17	0011	Modem Dial String ASCII Characters 1 and 2
40019	18	0012	Modem Dial String ASCII Characters 3 and 4
40020	19	0013	Modem Dial String ASCII Characters 5 and 6
40021	20	0014	Modem Dial String ASCII Characters 7 and 8
40022	21	0015	Modem Dial String ASCII Characters 9 and 10
40023	22	0016	Modem Dial String ASCII Characters 11 and 12
40024	23	0017	Modem Dial String ASCII Characters 13 and 14
			System Operational Setup Parameters
40025	24	0018	ReAlarmDistance

40026	25	0019	ReAlarm Interval
40027	26	001A	Spare
40028	27	001B	Spare
40029	28	001C	Zone Resistance
40030	29	001D	Spare
40031	30	001E	Spare
40032	31	001F	Spare
			Mapped SIM Operational Setup Parameters - for SIM in Reg 40002
40033	32	0020	SIM Barrier Resistance
40034	33	0021	SIM ID String ASCII Character 1 and 2
40035	34	0022	SIM ID String ASCII Character 3 and 4
40036	35	0023	SIM ID String ASCII Character 5 and 6
40037	36	0024	SIM ID String ASCII Character 7 and 8
40038	37	0025	SIM ID String ASCII Character 9 and 10
40039	38	0026	SIM ID String ASCII Character 11 and 12
40040	39	0027	SIM ID String ASCII Character 13 and 14
			Mapped SIM Analog Outputs - for SIM in Reg 40002 (super secret password protected)
40041	40	0028	AO -0 Mode
40042	41	0029	AO -1 Resistance Threshold
40043	42	002A	AO -2 Current Threshold
40044	43	002B	AO -3 Delta Threshold
40045	44	002C	AO -4 R ref
40046	45	002D	AO -5 K Amp
40047	46	002E	AO -6 V ref
40048	47	002F	AO -7 Settle
40049	48	0030	AO -8 Cycle Time
40050	49	0031	AO -9 Polarity Change Cycles
40051	50	0032	AO -10 Unit Address
40052	51	0033	AO -11 Hi Volt Thres
40053	52	0034	AO -12 Misc Parm
40054	53	0035	Sim Sensitivity
40055	54	0036	Sim Service
40056	55	0037	Spare
40057-40100	56-99	0038-0063	Unused

			SIM Analog Outputs
40101 - 40124	100 - 123	0064 - 007B	SIM0 - see Analog Outputs 40033-40056 for format
40125 - 40148	124 - 147	007C- 0093	SIM1 - see Analog Outputs 40033-40056 for format
40149 - 40172	148 - 171	0094 - 00AB	SIM2 - see Analog Outputs 40033-40056 for format
40173 - 40196	172 - 195	00AC- 00C3	SIM3 - see Analog Outputs 40033-40056 for format
40197 - 40220	196 - 219	00C4- 00DB	SIM4 - see Analog Outputs 40033-40056 for format
40221 - 40244	220 - 243	00DC- 00F3	SIM5 - see Analog Outputs 40033-40056 for format
40245- 40268	242 - 267	00F4- 010B	SIM6 - see Analog Outputs 40033-40056 for format
40269 - 40292	268 - 291	010C- 0123	SIM7 - see Analog Outputs 40033-40056 for format
40293 - 40316	292 - 315	0124 - 013B	SIM8 - see Analog Outputs 40033-40056 for format
40317 - 40340	316 - 339	013C- 0153	SIM9 - see Analog Outputs 40033-40056 for format
40341 - 40364	340 - 363	0154 - 016B	SIM10 - see Analog Outputs 40033-40056 for format
40365 - 40388	364 - 387	016C- 0183	SIM11 - see Analog Outputs 40033-40056 for format
40389 - 40412	388 - 411	0184 - 019B	SIM12 - see Analog Outputs 40033-40056 for format
40413 - 40436	412 - 435	019C- 01B3	SIM13 - see Analog Outputs 40033-40056 for format
40437 - 40460	436 - 459	01B4- 01CB	SIM14 - see Analog Outputs 40033-40056 for format
40461 - 40484	460 - 483	01CC- 01E3	SIM15 - see Analog Outputs 40033-40056 for format
40485 - 40508	484 - 507	01E4- 01FB	SIM16 - see Analog Outputs 40033-40056 for format
40509 - 40532	508 - 531	01FC- 0213	SIM17 - see Analog Outputs 40033-40056 for format
40533 - 40556	532 - 555	0214- 022B	SIM18 - see Analog Outputs 40033-40056 for format
40557 - 40580	556 - 579	022C- 0243	SIM19 - see Analog Outputs 40033-40056 for format
40581 - 40604	580 - 603	0244- 025B	SIM20 - see Analog Outputs 40033-40056 for format
40605 - 40628	604 - 627	025C- 0273	SIM21 - see Analog Outputs 40033-40056 for format
40629 - 40652	628 - 651	0274- 028B	SIM22 - see Analog Outputs 40033-40056 for format
40653 - 40676	652 - 675	028C- 02A3	SIM23 - see Analog Outputs 40033-40056 for format
40677 - 40700	676 - 699	02A4- 02BB	SIM24 - see Analog Outputs 40033-40056 for format
40701 -	700 -	02BC-	SIM25 - see Analog Outputs 40033-40056 for format

40724	723	02D3	
40725 - 40748	724 - 747	02D4-02EB	SIM25 - see Analog Outputs 40033-40056 for format
40749 - 40772	748 - 771	02EC-0303	SIM26 - see Analog Outputs 40033-40056 for format
40773 - 40796	772 - 795	0304-031B	SIM27 - see Analog Outputs 40033-40056 for format
40797 - 40820	796 - 819	031C-0333	SIM28 - see Analog Outputs 40033-40056 for format
40821 - 40844	820 - 843	0334-034B	SIM29 - see Analog Outputs 40033-40056 for format
40845 - 40868	844 - 867	034C-0363	SIM30 - see Analog Outputs 40033-40056 for format
40869 - 40892	868 - 891	0364-037B	SIM31 - see Analog Outputs 40033-40056 for format

			SIM Region ID: Address Computed: 45001+ (SIM#* 35) + (Region-1) * 7
45001-45007			SIM 0, Region 1 ID - see SIM ID String 40034-40040
45008-45014			SIM 0, Region 2 ID - see SIM ID String 40034-40040
45015-45021			SIM 0, Region 3 ID - see SIM ID String 40034-40040
45022 45028			SIM 0, Region 4 ID - see SIM ID String 40034-40040
45029-45035			SIM 0, Region 5 ID - see SIM ID String 40034-40040
45036-45042			SIM 1, Region 1 ID - see SIM ID String 40034-40040
45043-45049			SIM 1, Region 2 ID - see SIM ID String 40034-40040
45050-45056			SIM 1, Region 3 ID - see SIM ID String 40034-40040
45057-45063			SIM 1, Region 4 ID - see SIM ID String 40034-40040
45064-45070			SIM 1, Region 5 ID - see SIM ID String 40034-40040
45071-45077			SIM 2, Region 1 ID - see SIM ID String 40034-40040
45078-45084			SIM 2, Region 2 ID - see SIM ID String 40034-40040
45085-45091			SIM 2, Region 3 ID - see SIM ID String 40034-40040
45092 45098			SIM 2, Region 4 ID - see SIM ID String 40034-40040
45099-45105			SIM 2, Region 5 ID - see SIM ID String 40034-40040
45106-45112			SIM 3, Region 1 ID - see SIM ID String 40034-40040
45113-45119			SIM 3, Region 2 ID - see SIM ID String 40034-40040
45120-45126			SIM 3, Region 3 ID - see SIM ID String 40034-40040
45127 45133			SIM 3, Region 4 ID - see SIM ID String 40034-40040
45134-45140			SIM 3, Region 5 ID - see SIM ID String 40034-40040
45141-45147			SIM 4, Region 1 ID - see SIM ID String 40034-40040
45148-45154			SIM 4, Region 2 ID - see SIM ID String 40034-40040
45155-45161			SIM 4, Region 3 ID - see SIM ID String 40034-40040

45162 45168			SIM 4, Region 4 ID - see SIM ID String 40034-40040
45169- 45175			SIM 4, Region 5 ID - see SIM ID String 40034-40040
45176- 45182			SIM 5, Region 1 ID - see SIM ID String 40034-40040
45183- 45189			SIM 5, Region 2 ID - see SIM ID String 40034-40040
45190- 45196			SIM 5, Region 3 ID - see SIM ID String 40034-40040
45197 45203			SIM 5, Region 4 ID - see SIM ID String 40034-40040
45204- 45210			SIM 5, Region 5 ID - see SIM ID String 40034-40040
45211- 45217			SIM 6, Region 1 ID - see SIM ID String 40034-40040
45218- 45224			SIM 6, Region 2 ID - see SIM ID String 40034-40040
45225- 45231			SIM 6, Region 3 ID - see SIM ID String 40034-40040
45232 45238			SIM 6, Region 4 ID - see SIM ID String 40034-40040
45239- 45245			SIM 6, Region 5 ID - see SIM ID String 40034-40040
45246- 45252			SIM 7, Region 1 ID - see SIM ID String 40034-40040
45253- 45259			SIM 7, Region 2 ID - see SIM ID String 40034-40040
45260- 45266			SIM 7, Region 3 ID - see SIM ID String 40034-40040
45267 45273			SIM 7, Region 4 ID - see SIM ID String 40034-40040
45274- 45280			SIM 7, Region 5 ID - see SIM ID String 40034-40040
45281- 45287			SIM 8, Region 1 ID - see SIM ID String 40034-40040
45288- 45294			SIM 8, Region 2 ID - see SIM ID String 40034-40040
45295- 45301			SIM 8, Region 3 ID - see SIM ID String 40034-40040
45302 45308			SIM 8, Region 4 ID - see SIM ID String 40034-40040
45309- 45315			SIM 8, Region 5 ID - see SIM ID String 40034-40040
45316- 45322			SIM 9, Region 1 ID - see SIM ID String 40034-40040
45323- 45329			SIM 9, Region 2 ID - see SIM ID String 40034-40040
45330-			SIM 9, Region 3 ID - see SIM ID String 40034-40040

45336			
45337 45343			SIM 9, Region 4 ID - see SIM ID String 40034-40040
45344- 45350			SIM 9, Region 5 ID - see SIM ID String 40034-40040
45351- 45357			SIM 10, Region 1 ID - see SIM ID String 40034-40040
45358- 45364			SIM 10, Region 2 ID - see SIM ID String 40034-40040
45365- 45371			SIM 10, Region 3 ID - see SIM ID String 40034-40040
45372 45378			SIM 10, Region 4 ID - see SIM ID String 40034-40040
45379- 45385			SIM 10, Region 5 ID - see SIM ID String 40034-40040
45386- 45392			SIM 11, Region 1 ID - see SIM ID String 40034-40040
45393- 45499			SIM 11, Region 2 ID - see SIM ID String 40034-40040
45400- 45406			SIM 11, Region 3 ID - see SIM ID String 40034-40040
45407 45413			SIM 11, Region 4 ID - see SIM ID String 40034-40040
45414- 45420			SIM 11, Region 5 ID - see SIM ID String 40034-40040
45421- 45427			SIM 12, Region 1 ID - see SIM ID String 40034-40040
45428- 45434			SIM 12, Region 2 ID - see SIM ID String 40034-40040
45435- 45441			SIM 12, Region 3 ID - see SIM ID String 40034-40040
45442 45448			SIM 12, Region 4 ID - see SIM ID String 40034-40040
45449- 45455			SIM 12, Region 5 ID - see SIM ID String 40034-40040
45456- 45462			SIM 13, Region 1 ID - see SIM ID String 40034-40040
45463- 45469			SIM 13, Region 2 ID - see SIM ID String 40034-40040
45470- 45476			SIM 13, Region 3 ID - see SIM ID String 40034-40040
45477 45483			SIM 13, Region 4 ID - see SIM ID String 40034-40040
45484- 45490			SIM 13, Region 5 ID - see SIM ID String 40034-40040
45491- 45497			SIM 14, Region 1 ID - see SIM ID String 40034-40040
45498- 45504			SIM 14, Region 2 ID - see SIM ID String 40034-40040

45505-45511			SIM 14, Region 3 ID - see SIM ID String 40034-40040
45512 45518			SIM 14, Region 4 ID - see SIM ID String 40034-40040
45519-45525			SIM 14, Region 5 ID - see SIM ID String 40034-40040
45526-45532			SIM 15, Region 1 ID - see SIM ID String 40034-40040
45533-45539			SIM 15, Region 2 ID - see SIM ID String 40034-40040
45540-45546			SIM 15, Region 3 ID - see SIM ID String 40034-40040
45547 45553			SIM 15, Region 4 ID - see SIM ID String 40034-40040
45554-45560			SIM 15, Region 5 ID - see SIM ID String 40034-40040
45561-45567			SIM 16, Region 1 ID - see SIM ID String 40034-40040
45568-45574			SIM 16, Region 2 ID - see SIM ID String 40034-40040
45575-45581			SIM 16, Region 3 ID - see SIM ID String 40034-40040
45582 45588			SIM 16, Region 4 ID - see SIM ID String 40034-40040
45589-45595			SIM 16, Region 5 ID - see SIM ID String 40034-40040
45596-45602			SIM 17, Region 1 ID - see SIM ID String 40034-40040
45603-45609			SIM 17, Region 2 ID - see SIM ID String 40034-40040
45610-45616			SIM 17, Region 3 ID - see SIM ID String 40034-40040
45617 45623			SIM 17, Region 4 ID - see SIM ID String 40034-40040
45624-45630			SIM 17, Region 5 ID - see SIM ID String 40034-40040
45631-45637			SIM 18, Region 1 ID - see SIM ID String 40034-40040
45638-45644			SIM 18, Region 2 ID - see SIM ID String 40034-40040
45645-45651			SIM 18, Region 3 ID - see SIM ID String 40034-40040
45652 45658			SIM 18, Region 4 ID - see SIM ID String 40034-40040
45659-45665			SIM 18, Region 5 ID - see SIM ID String 40034-40040
45666-45672			SIM 19, Region 1 ID - see SIM ID String 40034-40040
45673-			SIM 19, Region 2 ID - see SIM ID String 40034-40040

45679			
45680-45686			SIM 19, Region 3 ID - see SIM ID String 40034-40040
45687 45693			SIM 19, Region 4 ID - see SIM ID String 40034-40040
45694-45700			SIM 19, Region 5 ID - see SIM ID String 40034-40040
45701-45707			SIM 20, Region 1 ID - see SIM ID String 40034-40040
45708-45714			SIM 20, Region 2 ID - see SIM ID String 40034-40040
45715-45721			SIM 20, Region 3 ID - see SIM ID String 40034-40040
45722 45728			SIM 20, Region 4 ID - see SIM ID String 40034-40040
45729-45735			SIM 20, Region 5 ID - see SIM ID String 40034-40040
45736-45742			SIM 21, Region 1 ID - see SIM ID String 40034-40040
45743-45749			SIM 21, Region 2 ID - see SIM ID String 40034-40040
45750-45756			SIM 21, Region 3 ID - see SIM ID String 40034-40040
45757 45763			SIM 21, Region 4 ID - see SIM ID String 40034-40040
45764-45770			SIM 21, Region 5 ID - see SIM ID String 40034-40040
45771-45777			SIM 22, Region 1 ID - see SIM ID String 40034-40040
45778-45784			SIM 22, Region 2 ID - see SIM ID String 40034-40040
45785-45791			SIM 22, Region 3 ID - see SIM ID String 40034-40040
45792 45798			SIM 22, Region 4 ID - see SIM ID String 40034-40040
45799-45805			SIM 22, Region 5 ID - see SIM ID String 40034-40040
45806-45812			SIM 23, Region 1 ID - see SIM ID String 40034-40040
45813-45819			SIM 23, Region 2 ID - see SIM ID String 40034-40040
45820-45826			SIM 23, Region 3 ID - see SIM ID String 40034-40040
45827 45833			SIM 23, Region 4 ID - see SIM ID String 40034-40040
45834-45840			SIM 23, Region 5 ID - see SIM ID String 40034-40040
45841-45847			SIM 24, Region 1 ID - see SIM ID String 40034-40040

45848-45854			SIM 24, Region 2 ID - see SIM ID String 40034-40040
45855-45861			SIM 24, Region 3 ID - see SIM ID String 40034-40040
45862 45868			SIM 24, Region 4 ID - see SIM ID String 40034-40040
45869-45875			SIM 24, Region 5 ID - see SIM ID String 40034-40040
45876-45882			SIM 25, Region 1 ID - see SIM ID String 40034-40040
45883-45889			SIM 25, Region 2 ID - see SIM ID String 40034-40040
45890-45896			SIM 25, Region 3 ID - see SIM ID String 40034-40040
45897 45903			SIM 25, Region 4 ID - see SIM ID String 40034-40040
45904-45910			SIM 25, Region 5 ID - see SIM ID String 40034-40040
45911-45917			SIM 26, Region 1 ID - see SIM ID String 40034-40040
45918-45924			SIM 26, Region 2 ID - see SIM ID String 40034-40040
45925-45931			SIM 26, Region 3 ID - see SIM ID String 40034-40040
45932 45938			SIM 26, Region 4 ID - see SIM ID String 40034-40040
45939-45945			SIM 26, Region 5 ID - see SIM ID String 40034-40040
45946-45952			SIM 27, Region 1 ID - see SIM ID String 40034-40040
45953-45959			SIM 27, Region 2 ID - see SIM ID String 40034-40040
45960-45966			SIM 27, Region 3 ID - see SIM ID String 40034-40040
45967 45973			SIM 27, Region 4 ID - see SIM ID String 40034-40040
45974-45980			SIM 27, Region 5 ID - see SIM ID String 40034-40040
45981-45987			SIM 28, Region 1 ID - see SIM ID String 40034-40040
45988-45994			SIM 28, Region 2 ID - see SIM ID String 40034-40040
45995-46001			SIM 28, Region 3 ID - see SIM ID String 40034-40040
46002 46008			SIM 28, Region 4 ID - see SIM ID String 40034-40040
46009-46015			SIM 28, Region 5 ID - see SIM ID String 40034-40040
46016-			SIM 29, Region 1 ID - see SIM ID String 40034-40040

46022			
46023-46029			SIM 29, Region 2 ID - see SIM ID String 40034-40040
46030-46036			SIM 29, Region 3 ID - see SIM ID String 40034-40040
46037 46043			SIM 29, Region 4 ID - see SIM ID String 40034-40040
46044-46050			SIM 29, Region 5 ID - see SIM ID String 40034-40040
46051-46057			SIM 30, Region 1 ID - see SIM ID String 40034-40040
46058-46064			SIM 30, Region 2 ID - see SIM ID String 40034-40040
46065-46071			SIM 30, Region 3 ID - see SIM ID String 40034-40040
46072 46078			SIM 30, Region 4 ID - see SIM ID String 40034-40040
46079-46085			SIM 30, Region 5 ID - see SIM ID String 40034-40040
46086-46092			SIM 31, Region 1 ID - see SIM ID String 40034-40040
46093-46099			SIM 31, Region 2 ID - see SIM ID String 40034-40040
46100-46106			SIM 31, Region 3 ID - see SIM ID String 40034-40040
46107 46113			SIM 31, Region 4 ID - see SIM ID String 40034-40040
46114-46120			SIM 31, Region 5 ID - see SIM ID String 40034-40040

			Region Low Limits Address Computed: 47001+ (SIM#* 5) + (Region-1)
47001-47005			SIM 0, Region 1 – 5 Low Limit
47006-47010			SIM 1, Region 1 – 5 Low Limit
47011-47015			SIM 2, Region 1 – 5 Low Limit
47016-47020			SIM 3, Region 1 – 5 Low Limit
47021-47025			SIM 4, Region 1 – 5 Low Limit
47026-47030			SIM 5, Region 1 – 5 Low Limit
47031-47035			SIM 6, Region 1 – 5 Low Limit
47036-47040			SIM 7, Region 1 – 5 Low Limit
47041-47045			SIM 8, Region 1 – 5 Low Limit
47046-47050			SIM 9, Region 1 – 5 Low Limit
47051-47055			SIM 10, Region 1 – 5 Low Limit
47056-47060			SIM 11, Region 1 – 5 Low Limit
47061-47065			SIM 12, Region 1 – 5 Low Limit
47066-47070			SIM 13, Region 1 – 5 Low Limit
47071-47075			SIM 14, Region 1 – 5 Low Limit
47076-47080			SIM 15, Region 1 – 5 Low Limit
47081-47085			SIM 16, Region 1 – 5 Low Limit
47086-47090			SIM 17, Region 1 – 5 Low Limit
47091-47095			SIM 18, Region 1 – 5 Low Limit

47096-47100			SIM 19, Region 1 – 5 Low Limit
47101-47105			SIM 20, Region 1 – 5 Low Limit
47106-47110			SIM 21, Region 1 – 5 Low Limit
47111-47115			SIM 22, Region 1 – 5 Low Limit
47116-47120			SIM 23, Region 1 – 5 Low Limit
47121-47125			SIM 24, Region 1 – 5 Low Limit
47126-47130			SIM 25, Region 1 – 5 Low Limit
47131-47135			SIM 26, Region 1 – 5 Low Limit
47136-47140			SIM 27, Region 1 – 5 Low Limit
47141-47145			SIM 28, Region 1 – 5 Low Limit
47146-47150			SIM 29, Region 1 – 5 Low Limit
47151-47155			SIM 30, Region 1 – 5 Low Limit
47156-47160			SIM 31, Region 1 – 5 Low Limit

			Region High Limits Address Computed: 47201+ (SIM#* 5) + (Region-1)
47201-47205			SIM 0, Region 1 – 5 High Limit
47206-47210			SIM 1, Region 1 – 5 High Limit
47211-47215			SIM 2, Region 1 – 5 High Limit
47216-47220			SIM 3, Region 1 – 5 High Limit
47221-47225			SIM 4, Region 1 – 5 High Limit
47226-47230			SIM 5, Region 1 – 5 High Limit
47231-47235			SIM 6, Region 1 – 5 High Limit
47236-47240			SIM 7, Region 1 – 5 High Limit
47241-47245			SIM 8, Region 1 – 5 High Limit
47246-47250			SIM 9, Region 1 – 5 High Limit
47251-47255			SIM 10, Region 1 – 5 High Limit
47256-47260			SIM 11, Region 1 – 5 High Limit
47261-47265			SIM 12, Region 1 – 5 High Limit
47266-47270			SIM 13, Region 1 – 5 High Limit
47271-47275			SIM 14, Region 1 – 5 High Limit
47276-47280			SIM 15, Region 1 – 5 High Limit
47281-47285			SIM 16, Region 1 – 5 High Limit
47286-47290			SIM 17, Region 1 – 5 High Limit
47291-47295			SIM 18, Region 1 – 5 High Limit

47296-47300			SIM 19, Region 1 – 5 High Limit
47301-47305			SIM 20, Region 1 – 5 High Limit
47306-47310			SIM 21, Region 1 – 5 High Limit
47311-47315			SIM 22, Region 1 – 5 High Limit
47316-47320			SIM 23, Region 1 – 5 High Limit
47321-47325			SIM 24, Region 1 – 5 High Limit
47326-47330			SIM 25, Region 1 – 5 High Limit
47331-47335			SIM 26, Region 1 – 5 High Limit
47336-47340			SIM 27, Region 1 – 5 High Limit
47341-47345			SIM 28, Region 1 – 5 High Limit
47346-47350			SIM 29, Region 1 – 5 High Limit
47351-47355			SIM 30, Region 1 – 5 High Limit
47356-47360			SIM 31, Region 1 – 5 High Limit

Title **Modbus Communications Specification for TTSIM-1**

By Ken McCoy, Keith Walberg

TT-SIM uses two wire, RS-485, full duplex, no hardware handshaking at a rate of 9600 baud. The TT-SIM software is able to distinguish between four different communication protocols and respond automatically in the mode being used by the host system. The three supported protocols are: Modbus-ASCII, Modbus-RTU, Johnson Control Metasys and a proprietary version of Opto22 (automatically invoked when the host is a TTDM-PLUS). System integrators choosing to communicate directly with the TT-SIM are free to use either Modbus ASCII or Modbus RTU using the registers listed in the following tables.

Node addressing: All TT-SIM units are shipped from the factory with address of 199 set in register 40011. New TT-SIM units must be re-addressed to a unique unused address. Simultaneous connection of several units with the same address will cause a communications failure with all of those units. The TT-SIM's can be pre-addressed by the TraceTek distributor using a TTDM-PLUS panel. A TT-SIM can be temporarily forced to 00 by installing Configuration Jumper. (See TTSIM Installation and Operation Instructions.) With this jumper in place the TT-SIM will respond to node address 00 and a new unique address can then be loaded in register 40011 using any software utility capable of writing to a Modbus register (e.g. Modscan). After the configuration jumper is removed the address loaded in 40011 will take precedence.

Note: In the following tables those registers in **bold type** are the most likely registers to be used by system integrators. All registers are documented but many are used only for factory calibration or internal system monitoring.

Table 1. Analog Input Registers

All data fields are returned as 16 bit integer values				
Modbus Register	Name	Description	Units	Range
30001	Status Word	Bit level status flags, (see Table 3.)	None	0-65535
30002	Location Resistance	Location of leak or contamination when detection is above current thresh.	Ohms	0-65535
30003	Detection resistance	Resistance through the leak or contamination	Kohms	0 -65535
30004	Detection Current	Current flowing through leak or contamination	0.1 micro-amps	0-65535
30005	RG Resistance	Loop resistance red to green	Ohms	0-65535
30006	YB Resistance	Loop resistance yellow to black	Ohms	0-65535
30007	ADC Counts1	Adc count of V1 (internal value)	count	0-65535
30008	ADC Counts2	Adc count of V2 (internal value)	count	0-65535
30009	ADC Counts3	Adc count of V3 (internal value)	count	0-65535
30010	F/W version	Firmware version V x.xx	none	0-65535
30011	Product ID	Product ID number	none	0-65535
30012	EEPROM Checksum	Check sum	none	0-65535
30013	Voltage Step Size	Step size in ohms(internal value)	ohms	0-65535

Table 2. Analog Output Registers

All data fields are returned as 16 bit integer				
Modbus Register	Name	Description	Units	Range
40001	SIM Operating Mode	0: normal, 8 normal w/no off time, 64: detect Earth to RG loop, 72 detect Earth to YB loop	None	0 – 4095 [0 default]
40002	High Current Threshold	Leak resistance below which high current mode is automatically selected	Kohms	0 – 4095 [50 default]
40003	Locating Current Threshold	Current above which a location is measured	0.1 micro-amps	0 - 4095 [100 default]
40004	Sensor Delta Threshold	Maximum difference in percent between RG loop resistance and YB loop resistance	percen t	0 – 4095 [10 default]
40005	Rref	Reference resistance minus offset of 6000 (Factory calibration value)	Ohms	0 – 4095 [2250 default]
40006	K	Op Amp Gain correction (Factory calibration value)	none	0 – 4095 [2016 default]
40007	Vref	A/D reference voltage (Factory calibration value_	mVolts	0 – 4095 [2500 default]
40008	Settling Time	Settling time before making A/D measurements	mSec	0 – 255 [50 default]
40009	Cycle Time	Seconds of measurement cycle plus off-time	Sec	0-655 [0 default]
40010	Cycles per Polarity	Number of cycles before alternating polarity	count	0 – 4095 [0 default]
40011	Node Address	RS485 node address	none	0 – 255 [0 default]
40012	High Voltage Threshold	YB loop resistance above which high voltage mode is automatically selected	Ohms x 10	0 –4095 [800 default]
40013 – 40020	Misc. Flags, Gain setting	Calibration and mode controls used during calibration. -RESERVED	none	
40021	EEPROM Check	Checksum for EEPROM	None	varies

Table 3. Status Word Flags (Register 30001)

Data is returned from register 300001 as four hexadecimal digits	
Bit	Description
00	1: detection resistance below high current threshold
01	1: current is above locating current threshold
02	1: open of high resistance in sensor loop(s)
03	1: difference / average of loop resistance > delta threshold
04	1: EEPROM read error
05	1: EEPROM write error
06	1: EEPROM verify error
07	1: EEPROM type X24C01A or equiv. 0: EEPROM type X24C01
08	1: low voltage used 0: high voltage used
09	1: low current used 0: high current used
10	1: measurement cycle in progress 0: off time
11	1: reverse polarity mode 0: normal polarity mode
12	1: ADC calibrate disabled 0: ADC Calibrate enabled
13- 15	Spare (always 0)