TTSIM-1A and TTSIM-2
Interface Specification

Section 1.0

This section describes the Red and Yellow LED On/Off/Blinking scenarios for all Leak and/or Cable Break alarm resetting modes.

Relay Reset Mode	Leak Cleared	Button Pushed (acknowledged)	Led State	Relay State	Location
Auto (Leak arrives)	No	No	On/Blink	On	Initial Location
	No	Yes	On/Solid	Off	Current Location
	Yes	No	Off	Off	Initial Location
	Yes	Yes	Off	Off	No Location
Manual (Leak arrives)	No	No	On/Blink	On	Initial Location
	No	Yes	On/Solid	Off	Current Location
	Yes	No	On/Blink	On	Initial Location
	Yes	Yes	Off	Off	No Location
Safe (Leak arrives)	No	No	On/Blink	On	Initial Location
	No	Yes (1)	On/Solid	On	Current Location
	Yes	No	On/Blink	On	Initial Location
	Yes	Yes	Off	Off	No Location

(1) - Acknowledge is automatically cleared here. LED will stay solid for a while and then start blinking again. Otherwise, if we stay acknowledged, when the Leak/Service clears, the relay will automatically turn off.

Loop imbalance - Yellow LED blinks 2 times every 5 seconds.
EEPROM Error - Yellow LED blinks 3 times every 5 seconds
Service Required - Yellow LED blinks 10 times every 5 seconds

Section 2.0

This section describes the Optopol serial interface

DI registers (Digital Inputs) Error and Condition Flags, also available from AI0; sent as one four digit hexadecimal value after the ">xxM??\r" command. (> = always used as the start of message character, xx = address in two digit hex., ?? = checksum in hex, \r = carriage return).
Unit answers with "Awwww\r" (wwww = status word).

DI Registers (Read only)	Description	Units	Range
DI0: Low Resistance Detected (Use High Isrc)	1: Detection Resistance (AI2) is below the Leak Resistance Threshold, red LED on. 0: high resistance (use Low Isrc in auto. Select), red LED off. When this flag is set and Detection Resistance exceeds this value by 25% the flag is cleared.	none	0/1
DI1: Locating Current Detected	1: Detection Current (AI3) is above the Locating Current Threshold 0: low current (do not locate in normal mode) This blinks the yellow LED 10 times every 5 seconds. When this flag is set and Locating current is 10 less than the Locating Current Threshold, this flag is cleared.	none	0/1
DI2: Sensor Loop Open Error	1: open or high resistance sensor loop (>64K) 0: sensor not open. Yellow LED to blink continuously.	none	0/1
DI3: Sensor Loops Resistance Error	1: difference/ave. of loop resist. > Delta Threshold. 0: sensor OK Yellow LED to blink 2 times every 5 seconds.	none	0/1
DI4: Read EEPROM Err	1: EEPROM Read Error 0: OK Yellow LED to blink 3 times every 5 seconds.	none	0/1
DI5: Write EEPROM Err	1: EEPROM Write Error 0: OK Yellow LED to blink 3 times every 5 seconds.	none	0/1
DI6: Verify EEPROM Err	1: EEPROM Verify Error 0: OK Yellow LED to blink 3 times every 5 seconds.	none	0/1
DI7: EEPROM Type	1: X24C01A or equiv. 0: X24C01	none	0/1
DI8: TTSIM2 Cover Err	1: TTSIM2 Cover Error 0: TTSIM2 Cover OK	none	0/1
DI9: 3 Wire Mode Flag	1: 3 wire mode 0: 4 wire mode	none	0/1
DI10: Measurement Flag	1: set during meas. cycle 0: clear during off-time	none	0/1
DI11: Polarity Mode Flag	1: use red-green (3 wire) 0: use yellow-black (4 wire)	none	0/1
DI12 - Relay State	1: Relay Closed 0: Relay Open	none	0/1
DI13 - Key Press	1: Key Press	none	0/1
DI14 - Alarm Ack.	1: Alarm Acknowledged	none	0/1
DI15 - TTSIM2 Mode	1: TTSIM-2 Mode (cover installed) 0: TTSIM-1A Mode (No Cover)	none	0/1

Section 3.0

This section describes the Modbus serial interface

AI Registers (Analog Inputs): 16 bit integer Data fields offset by 4096 (no offset for Status Word, AI0, or ADC counts, AI6-8); sent as four hexadecimal digits per register; after the ">xxLyyyy??\r" command (yyyy is four digit hex. bitmap of registers requested). Unit answers with "Aaaaabbbbccccdddd....\r" (aaaa,bbbb,.... , are values corresponding to registers requested.)				
Modbus Register	**AI Registers (Read)**	**Description**	**Units**	**Range**
30001	AI0: Status Word	All 16 bits of the DI register (offset by 4096)	None	4096 - 65535
30002	AI1: Location Resistance	Location of leak or contamination, in resistance, when Detection Current is above Current Threshold.	Ohms	4096 - 65535
30003	AI2: Detection Resistance	Voltage between cable loops divided by current	K Ohms	4096 - 65535
30004	AI3: Detection Current	Voltage of Reference resistor divided by Rref	Tenths of micro amps	4096 - 65535
30005	AI4: RG Resistance	Length, in resistance, of Red-Green loop	Ohms	4096 - 65535
30006	AI5: YB Resistance	Length, in resistance, of Yellow-Black loop	Ohms	4096 - 65535
30007	AI6: ADC Counts1	Red Voltage ADC Count	None	0 - 65535
30008	AI7: ADC Counts2	Green Voltage ADC Count	None	0 - 65535
30009	AI8: ADC Counts3	Yellow Voltage ADC Count	None	0 - 65535
30010	AI9: F/W Version	Firmware Version: Vx.xx	None	4096 - 65535
30011	AI10: Product ID	Product ID Number	None	4096 - 65535
30012	AI11: EEPROM Checksum	Checksum of all Holding registers	None	0-65535
30013	AI12: ADC Counts4	Black Voltage ADC Count	None	0 - 65535
30014	AI13: ADC Counts5	V Sense Voltage ADC Count	None	0 - 65535
30015	AI14: ADC Counts6	V Cal Voltage ADC Count	None	0 - 65535
30016	N/A	Solar Location		
30017	N/A	Solar Length		
30018	N/A	Solar Status		
30019	N/A	Display Board Software Version	None	
30020	N/A	Display Board Hardware Version	None	

Modbus Address	**AO Registers (Analog Outputs) Configuration Parameters: 12 bit Integer values (0-4095) send as three Hexadecimal digits per register, read after the ">xxKyyyy??\r" command; or written after the ">xxJyyyyzzzaaabbb...??\r" command. (zzz, aaa, bbb, ..., are values to be written, corresponding to registers indicated by yyyy bitmap). Unit answers a read with "Azzzaaabbb...\r", and a write with "A\r".**			
Holding Registers (R/W)	**AO Registers (Read/Write)**	**Description**	**Units**	**Range [default]**
40001	AO0: SI Operational Mode:	0: normal; 1: Software Relay Reset (write only) 3: 3 Wire Manual Mode (write only) 4: 4 Wire Manual Mode (write only) Note: Always reads 0	none	0-4095 [0]
40002	AO1: Leak Resistance Threshold.	Leak Resistance Threshold when Detection Resistance is below Low Resistance Detected flag DI0 is set.	KOhms	0-4095 [18]
40003	AO2:Locating Current Threshold.	Locating Current Threshold when Detection Current is above a location is measured and Locating Current Detected Flag (DI1) is set	.1 x micro Amps	0-4095 [500]
40004	AO3: Sensor Delta Thres.	Maximum difference allowed in resistance between two loops of cable before an error condition is flagged	percent	10-4095 [10]
40005	AO4: R4 Resistance	In 3 wire mode this value will automatically be set to 3400. In 4 wire Mode this value will automatically be set to 3900. If this value is set to anything but the 3400/3900, that value is always used. This is temporary to figure out proper 3 wire R4 Resistance.	ohms	0 - 4095
40006	AO5: spare	spare		
40007	AO6: Display Units Selected	Display Units selected (0=ft, 1=meters)	None	(0-1) [0]
40008	AO7: Settling Time	Cable settling time before taking AtoD readings (Leak Detection and Location only, Loops fixed at 200ms))	10msec	0-255 [50]
40009	AO8: Loop Ground Time	0-4095: 100ms increments of Loop Ground Time	100 msec	0-4095 [3]
40010	AO9: Sample Length	1-4094: 100 ms increments for sample length (Leak Detection and Location only, Loops fixed at 200ms)	cycles	0-4095 [0]
40011	AO10: Unit Address	RS485 network address: install CFG jumper to force to 0	none	0-255 [0]
40012	AO11. spare			
40013	AO12: Cable Mode	0 = 4 wire mode 1 = 3 wire mode	None	(0-1) [0]

40014	AO13: Gain 1	For Optopoll, Value = Gain 1 * 1000 – 9000 (i.e. 11000 –9000 = 2000) For Modbus, Value = Gain 1 * 1000 (i.e 11000)	.001	Opto (0-4095) Mod (0–10000)
40015	AO14: Gain 2	For Optopoll, Value = Gain 2 * 10,000 (i.e. 2000) For Modbus, Value = Gain 2 * 10,000 (i.e. 2000)	.001	0-4095
40016	AO15: Offset	For Optopoll, Value = Offset + 2000 (i.e. 0+2000 = 2000) For Modbus, Value = Offset (i.e. 0)	None	Opto (0-4095) Mod (-2000-2000)
		Note: Address Mask below is for Opto Addressing, For Modbus Addressing, Add 1 to each address (i.e. Config jumper means that the device will answer to Modbus address 1. If all 16 bits are set to one in register 40017, The device will then respond to addresses 1 – 16		0
40017	N/A	Address Mask 1 – Note: For testing only, If config jumper on, one bit for each SIM Opto address 0-15, Modbus address 1 –16. Bit set means that this SIM will respond to queries if that address. Use for stress testing, demos.		0
40018	N/A	Address Mask 2 – Note: For testing only, If config jumper on, one bit for each SIM Opto address 16-31, Modbus address 17 –32. Bit set means that this SIM will respond to queries if that address. Use for stress testing, demos.		0
40019	N/A	Address Mask 3 – Note: For testing only, If config jumper on, one bit for each SIM Opto address 32-47, Modbus address 33 –48. Bit set means that this SIM will respond to queries if that address. Use for stress testing, demos.		0
40020	N/A	Address Mask 4 – Note: For testing only, If config jumper on, one bit for each SIM Opto address 48-63, Modbus address 49 –64. Bit set means that this SIM will respond to queries if that address. Use for stress testing, demos.		0
40021	N/A	Address Mask 5 – Note: For testing only, If config jumper on, one bit for each SIM Opto address 64-79, Modbus address 65 –80. Bit set means that this SIM will respond to queries if that address. Use for stress testing, demos.		0

40022	N/A	Address Mask 6 – Note: For testing only, If config jumper on, one bit for each SIM Opto address 80-95, Modbus address 81 –96. Bit set means that this SIM will respond to queries if that address. Use for stress testing, demos.		0
40023	N/A	Address Mask 7 – Note: For testing only, If config jumper on, one bit for each SIM Opto address 96-111, Modbus address 97 –112. Bit set means that this SIM will respond to queries if that address. Use for stress testing, demos.		0
40024	N/A	Address Mask 8 – Note: For testing only, If config jumper on, one bit for each SIM Opto address 112-127, Modbus address 113 –128. Bit set means that this SIM will respond to queries if that address. Use for stress testing, demos.		0
40025	N/A	Relay Alarm Mode - Enable Relay output; 0=Leak 1=Leak/Break 2=Leak/Break/Service 3=Force Relay On (test mode, not written to EEPROM) 4=Force Relay Off (test mode, not written to EEPROM)	None	0-4 [0]
40026	N/A	Relay Alarm State - Relay State when in alarm; 0=Relay Off, 1=Relay On	None	0-1 [1]
40027	N/A	Relay Reset - Reset Mode 0=Auto (default) 1=Manual 2=Safe	None	0-2 [0]
40028	N/A	EEPROM Checksum (read only)	None	None
40029	N/A	MetaSys Low Warning Low Word	float	
40030	N/A	MetaSys Low Warning High Word	float	
40031	N/A	MetaSys Low Alarm Low Word	float	
40032	N/A	MetaSys Low Alarm High Word	float	
40033	N/A	MetaSys Power State	int	

Section 4.0

This section describes the I2C interface between the TTSIM-2 and the display.
All blinking of LEDs is done as a 250ms On followed by a 250 ms off period.

Byte 0 - Address (hardware use only)
Byte 1 - Red Led Off time 250 ms increments
Byte 2 - Number Red LED Flashes 250ms On followed by 250 ms Off
(0=Always Off, 255 Always On)
Byte 3 - Yellow Led Off time 250 ms increments
Byte 4 - Number Yellow LED Flashes 250ms On followed by 250 ms Off
(0=Always Off, 255 Always On)
Byte 5 - Green Led Off time 250 ms increments
Byte 6 - Number Green LED Flashes 250ms On followed by 250 ms Off
(0=Always Off, 255 Always On)
Byte 7 - Text Control Byte
Bits (0-3) - delay in 500ms increments before displaying bytes 10,11,12.
0 = Don't display bytes 10,11,12
Bit 7 - Blink Chars 7,8,9 every 500ms ???
Bit 6 - Blink Chars 10,11,12 every 500 ms???
Byte 7 - Char #1 (displayed for XXX ms)
Byte 8 - Char #2 (displayed for XXX ms)
Byte 9 - Char #3 (displayed for XXX ms)
Byte 10 - Char #4
Byte 11 - Char #5
Byte 12 - Char #6
Byte 13 - check sum (XOR of all bytes except address)

Examples:

sum (XOR of all bytes except address)

Section 5.0

This section describes the push button interface between the TTSIM-2 and the display.

Pushing down the pushbutton momentarily will display the initial leak location.
A 3 digit number is then displayed. When no location is displayed, a "---" will be displayed indicating no leak.

Pushing down on the pushbutton continuously for 5 seconds places the TTSIM-2 into setup mode.

The setup mode will go through the following sequence.

1) Hold down pushbutton for 5 seconds

2) Display current units selected by a bar indicator next to units on product label.

3) After each subsequent pushbutton, changed indicator to top or bottom units label.

4) After the proper units mode is selected, hold down push button 2 seconds. Display will now go back to normal mode.