PNEUMERCATOR
Liquid Level Control Systems

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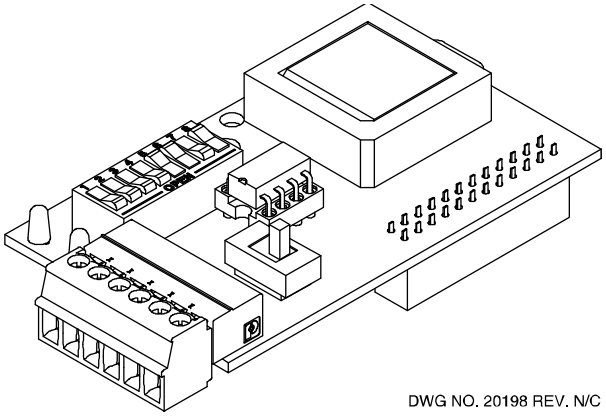
INSTRUCTION MANUAL

MODBUS RTU INTERFACE CARD

FOR

TMS SERIES AND LC2000 SYSTEMS



DWG NO. 20198 REV. N/C

This document describes the installation and setup of any MODBUS RTU RS-485 Interface Card listed on the tables below. Also provided are communications protocol and register mapping used to interface from the TMS/LC2000 console to a host or master computer system supporting MODBUS RTU protocol. Communications is over a half-duplex, single twisted-pair RS-485 cable. Information available from the TMS/LC2000 includes continuous tank data and tank-related alarms, leak/point level sensor statuses and contact closure input statuses. The MODBUS Communications Card includes dipswitches for slave address and baud rate selection and provides LED indicators for transmit and receive activity. See Section 3.0 Product Specifications for details.

P/N	Inputs	Switches
900552-1	One, Non-Isolated	4
900552-10	One, Non-Isolated	8
901050-10	One, Isolated	8
900931-x-4	Four, Isolated	8 (per Input)

P/N	Combo Board Description
900665-x-5	900552-x as Bottom Board
900665-5-x	900552-x as Top Board
900665-5-5	Dual 900552-x
900665-x-R	901050-10 as Bottom Board
900665-R-x	901050-10 as Top Board
900665-R-R	Dual 901050-10

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IMPORTANT! Confirm that the installed TMS console firmware version supports Modbus RTU protocol.

Modbus RTU support is provided with the following TMS console firmware versions:

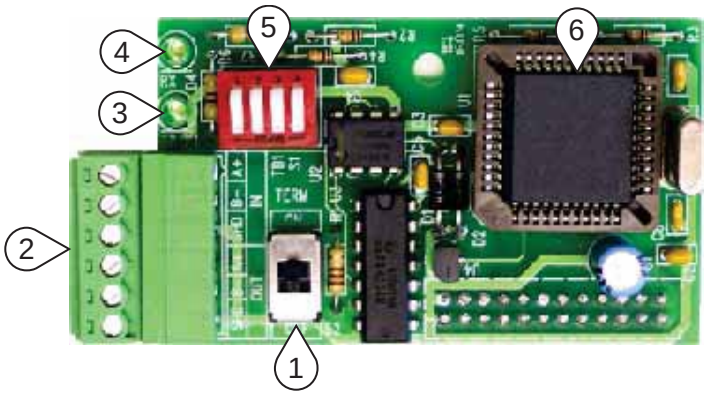
LC2000	ALL		TMS2000W	V4x.00.xx	TMS4000	ALL
TMS1000	V1x.xx.04			V4x.01.xx	TMS4000W	ALL
TMS2000	V2x.99.9A		TMS3000	V3x.99.9A		
	V2x.00.05			V3x.00.05		
	V2x.01.xx			V3x.01.xx		
where "x" denotes "don't care" values						

Please contact Technical Support for an upgrade if you have firmware outside of the above range, or if you have questions about identifying the TMS firmware version in your console.

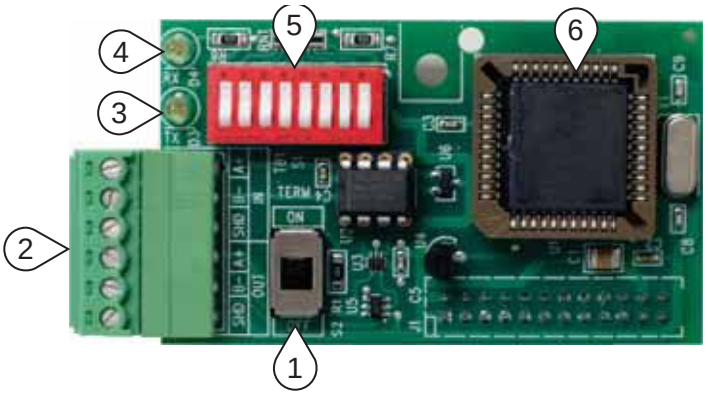
1.0 Installation and Setup

Installation and setup of the Modbus RTU Interface Card requires no programming on the TMS/LC2000 console. Simply select the desired slave address and baud rate and enable line termination resistor if required. No other setup is required.

1. Line Terminator Switch
2. Modbus Line In/Line Out Terminal Connections
3. Slave Transmit LED
4. Slave Receive LED
5. Dip Switches
6. Microprocessor/Firmware (labelled with firmware version in format PMxxxS



900552-1



900552-10

Note: 900552-10 layout comparable to 901050-10 and 900931-x-4

Use Table Set #1, #2, or #3 below corresponding to the number of Dip Switches and Modbus Firmware:

Table #1: 4 Dip Switches, All firmware versions
Table #2: 8 Dip Switches, Firmware range: PM020S – PM030S
Table #3: 8 Dip Switches, Firmware range: PM031S and higher

1.1 Dip Switch Settings

1.1.1 Table Set #1 – (4 Dip Switches)

Slave Device Address	SW #3 Address MSB	SW #2 Address 2SB	SW #1 Address LSB
1*	CLOSED*	CLOSED*	CLOSED*
2	CLOSED	CLOSED	OPEN
3	CLOSED	OPEN	CLOSED
4	CLOSED	OPEN	OPEN
5**	OPEN	CLOSED	CLOSED
6**	OPEN	CLOSED	OPEN
7**	OPEN	OPEN	CLOSED
8**	OPEN	OPEN	OPEN

*Factory defaults
**Valid for firmware version PM008S

Baud Rate	SW #4 Baud Rate Select
9600*	CLOSED*
38400	OPEN

1.1.2 Table Set #2 – (8 Dip Switches, Firmware PM020S-PM030S)

Slave Device Address	SW #6 Address MSB	SW #5 Address 5SB	SW #4 Address 4SB	SW #3 Address 3SB	SW #2 Address 2SB	SW #1 Address LSB
1*	CLOSED*	CLOSED*	CLOSED*	CLOSED*	CLOSED*	CLOSED*
2	CLOSED	CLOSED	CLOSED	CLOSED	CLOSED	OPEN
3	CLOSED	CLOSED	CLOSED	CLOSED	OPEN	CLOSED
4	CLOSED	CLOSED	CLOSED	CLOSED	OPEN	OPEN
5	CLOSED	CLOSED	CLOSED	OPEN	CLOSED	CLOSED
6	CLOSED	CLOSED	CLOSED	OPEN	CLOSED	OPEN
7	CLOSED	CLOSED	CLOSED	OPEN	OPEN	CLOSED
8	CLOSED	CLOSED	CLOSED	OPEN	OPEN	OPEN
9	CLOSED	CLOSED	OPEN	CLOSED	CLOSED	CLOSED
10	CLOSED	CLOSED	OPEN	CLOSED	CLOSED	OPEN
11 thru 62						
63	OPEN	OPEN	OPEN	OPEN	OPEN	CLOSED
64	OPEN	OPEN	OPEN	OPEN	OPEN	OPEN

*Factory defaults

Baud Rate	Baud Rate Select SW #8	SW #7
9600*	CLOSED*	CLOSED*
19200	CLOSED	OPEN
38400	OPEN	CLOSED
NOT USED	OPEN	OPEN

1.1.3 Table Set #3 – (8 Dip Switches, Firmware PM031S and higher)

Slave Device Address	SW #6 Address MSB	SW #5 Address 5SB	SW #4 Address 4SB	SW #3 Address 3SB	SW #2 Address 2SB	SW #1 Address LSB
1*	CLOSED*	CLOSED*	CLOSED*	CLOSED*	CLOSED*	CLOSED*
2	CLOSED	CLOSED	CLOSED	CLOSED	CLOSED	OPEN
3	CLOSED	CLOSED	CLOSED	CLOSED	OPEN	CLOSED
4	CLOSED	CLOSED	CLOSED	CLOSED	OPEN	OPEN
5	CLOSED	CLOSED	CLOSED	OPEN	CLOSED	CLOSED
6	CLOSED	CLOSED	CLOSED	OPEN	CLOSED	OPEN
7	CLOSED	CLOSED	CLOSED	OPEN	OPEN	CLOSED
8	CLOSED	CLOSED	CLOSED	OPEN	OPEN	OPEN
9	CLOSED	CLOSED	OPEN	CLOSED	CLOSED	CLOSED
10	CLOSED	CLOSED	OPEN	CLOSED	CLOSED	OPEN
11 thru 62						
63	OPEN	OPEN	OPEN	OPEN	OPEN	CLOSED
64	OPEN	OPEN	OPEN	OPEN	OPEN	OPEN

*Factory defaults

Baud Rate	Baud Rate Select SW #7
9600*	CLOSED*
38400	OPEN

Data Mapping	Data Mapping Select SW #8
Standard*	CLOSED*
Extended	OPEN

Notes:

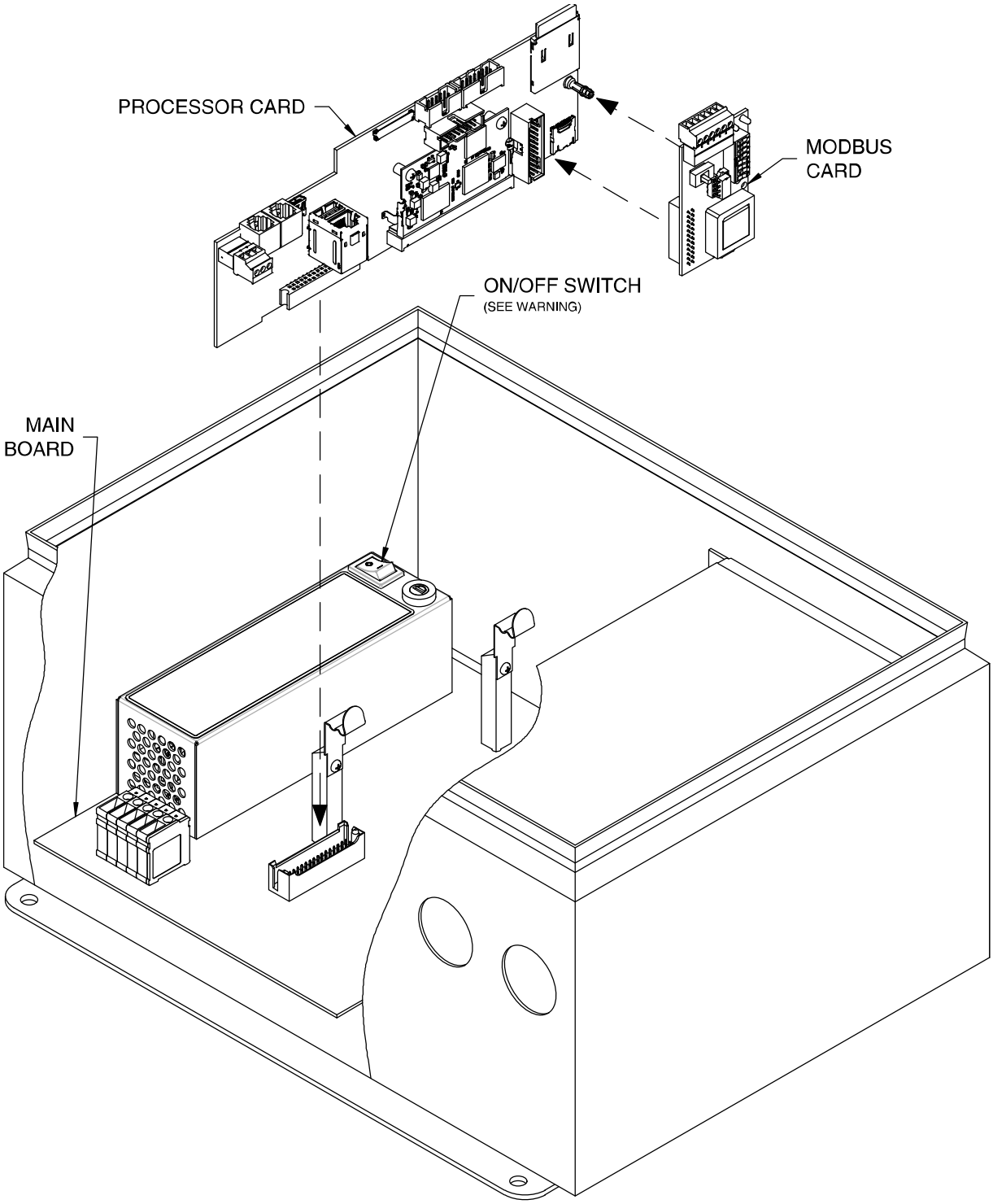
Standard mapping is supported by ALL TMS/LC2000 configurations.

Extended mapping is supported by the TMS4000/TMS4000W equipped with firmware versions V10.053 (Vx0.xx.53) and higher. The extended mapping provides complete support for all Tank Statuses, Tank Channels, and Sensors supported by the TMS4000/TMS4000W. See Section 2.2 for complete details.

1.2 Installation of Single/Dual Input MODBUS Card

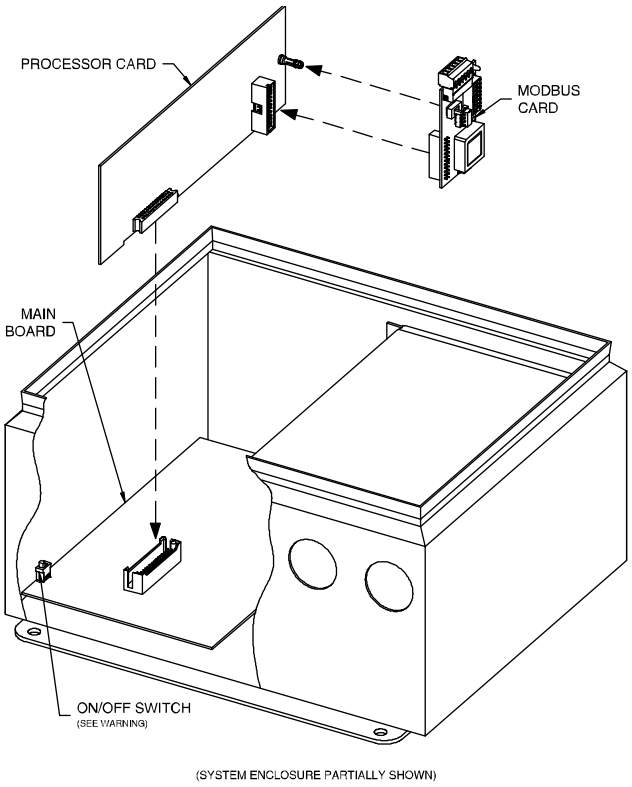
Note: Refer to Drawing 10712 for Installation Instructions for Quad Modbus Card

WARNING! Turn power OFF before installing or removing any circuit cards.



(SYSTEM ENCLOSURE PARTIALLY SHOWN)

DRAWING NO. 20234 REV. N/C



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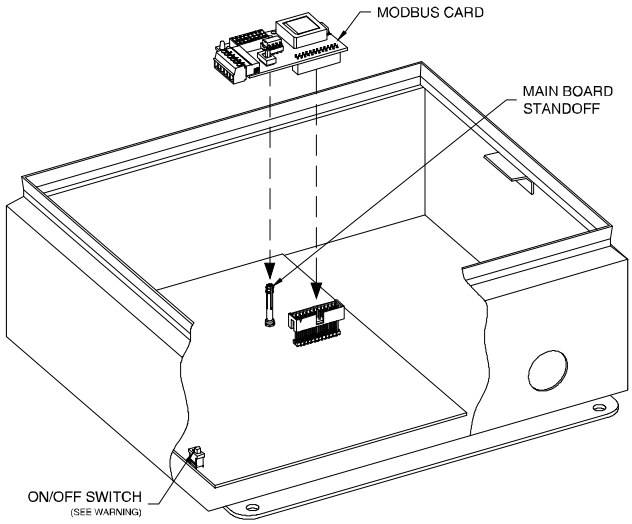
TMS3000



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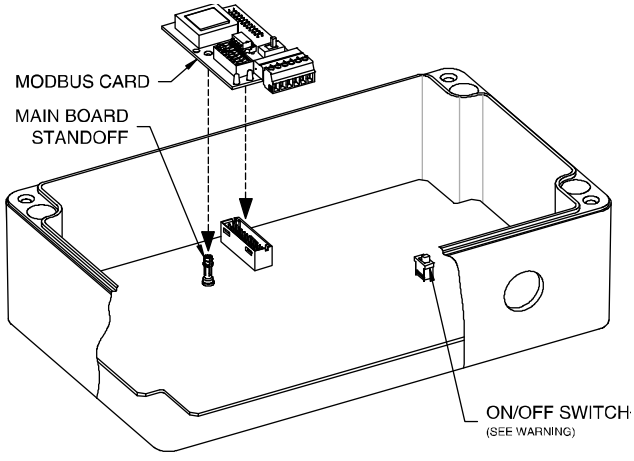
TMS2000(W)/LC2000



DWG NO. 20201 REV. N/C

TMS1000

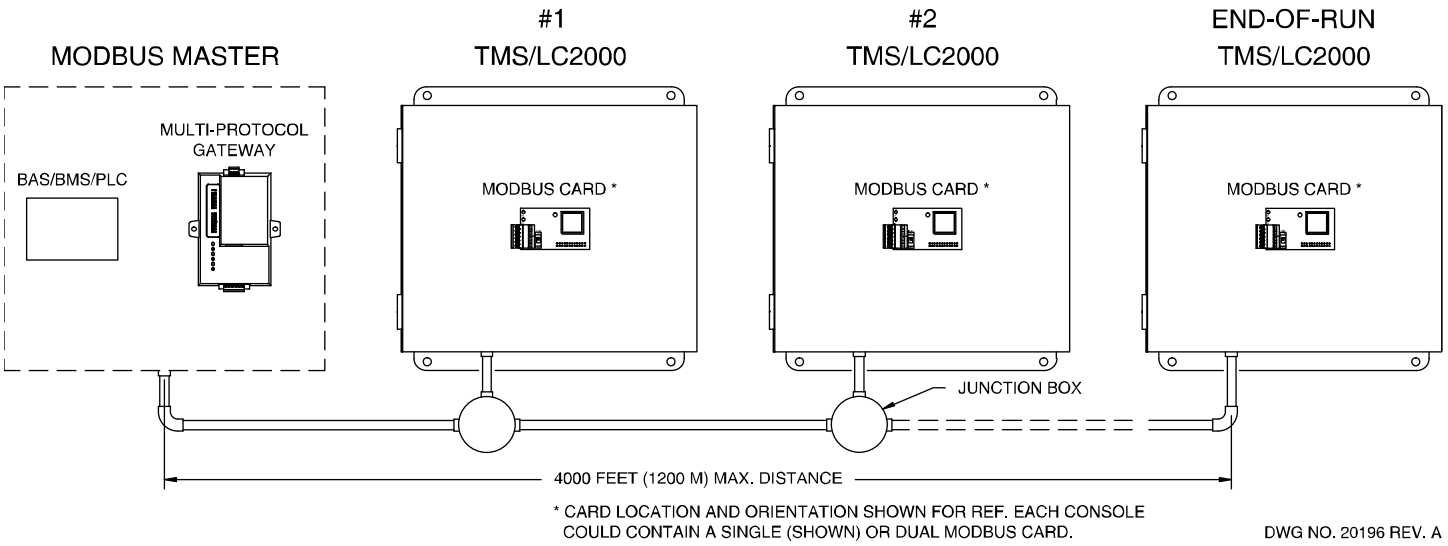
1.3 Terminal Connections

Plug-in terminal block TB1 is provided for connection to the RS-485 Modbus. Note that both input and output terminals are provided to support multi-drop wiring.

OUT			IN		
SHD	B(-)	A(+)	SHD	B(-)	A(+)

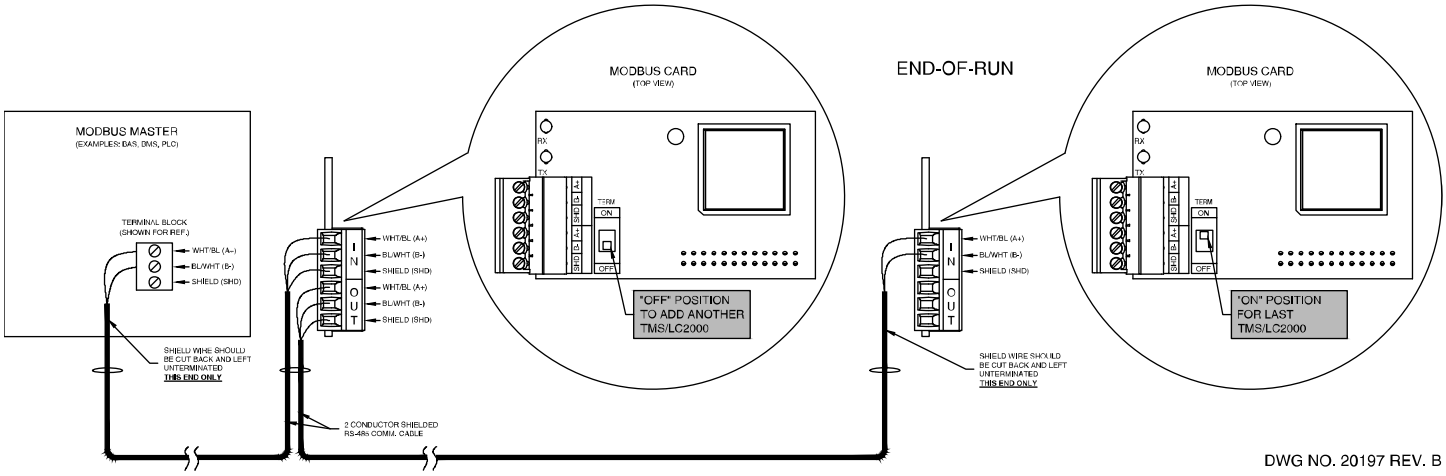
1.3.1 Cabling

Cable type should be twisted pair, shielded, and designated for RS-485 communications having a nominal impedance of 120 ohms. Maximum cable distance supported is 4000' as per below drawing. See 3.0 Product Specifications for example part numbers.



1.3.2 Line Termination Resistor

The RS-485 bus requires that the end-of-run device be terminated with a 120-ohm resistor. This is accomplished by setting the LINE TERMINATION switch to “ON” if the MODBUS Interface Card is the last device on the bus. Otherwise, this switch should be set to “OFF”.



DWG NO. 20197 REV. B

1.4 LED Indicators

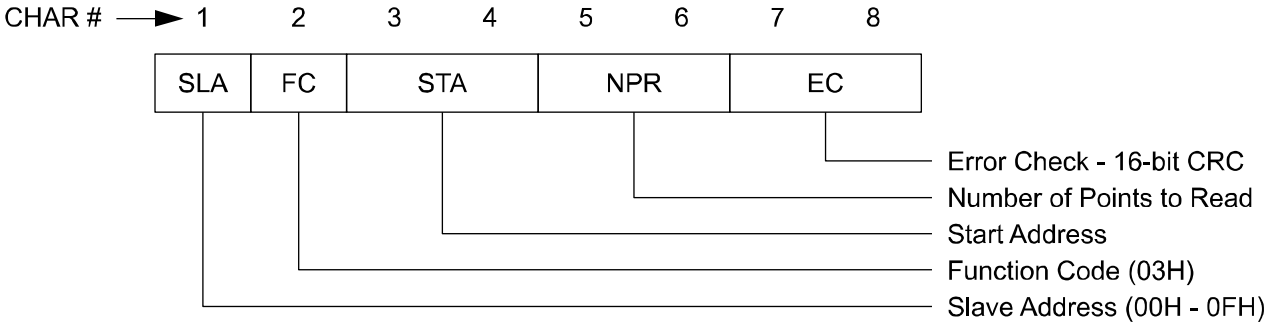
Visual indication of Modbus activity is provided by a SLAVE RECEIVE (RX) and a SLAVE TRANSMIT (TX) LED. Note that SLAVE RECEIVE indicates for all MASTER/HOST transmissions.

2.0 MODBUS Function Format

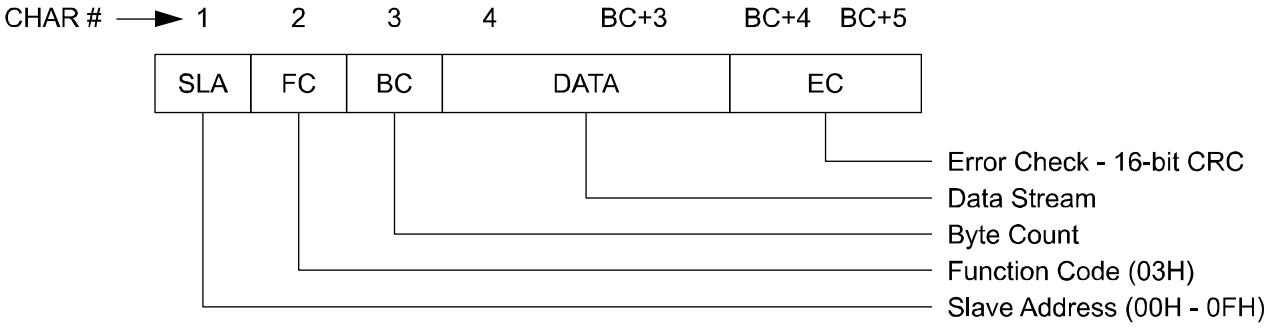
Function Code 3: Read Holding Registers

Note: All Queries are in Hex RTU format

Master to Slave (TMS/LC2000) Query – Read TMS/LC2000 Data



Slave (TMS/LC2000) to Master Response – Read TMS/LC2000 Data



Refer to the appropriate Section for the Data Register Map indicated below:

Standard Mapping (Section 2.1):
All TMS/LC2000 systems supported including LC2000, TMS1000, TMS2000, TMS2000W (wireless), TMS3000, TMS4000, and TMS4000W (wireless).
TMS4000/TMS4000W Note: Support is limited to select Tank Statuses, Tank Channels, and Sensors as supported by the TMS3000. Use Extended Mapping to have access to ALL of the available system data.

Extended Mapping (Section 2.2):
Supported by the TMS4000 and TMS4000W (wireless) that meet the below minimum firmware requirements AND is equipped with Modbus Firmware PM031S or later (See Section 1.1.3 for switch settings):
TMS4000: V30.02.53 or later (TMS4000_10.053 or later)
TMS4000W (wireless): V40.02.53 or later (TMS4000W_10.053 or later)
Note: Provides access to ALL Tank Statuses, Tank Channels, and Sensors.

2.1 TMS/LC2000 Data Register Map – Standard Mapping

Register Address	Data Group
40001	MODBUS Status Register
40002- 40017	Tank 1
40018- 40033	Tank 2
40034- 40049	Tank 3
40050- 40065	Tank 4
40066- 40081	Tank 5
40082- 40097	Tank 6
40098- 40113	Tank 7
40114- 40129	Tank 8
40130- 40145	Tank 9
40146- 40161	Tank 10
40162- 40177	Tank 11
40178- 40193	Tank 12
40194	Sensors 1- 4
40195	Sensors 5 – 8
40196	Sensors 9 – 12
40197	Sensors 13 – 16
40198	Sensors 17 – 20
40199	Sensors 21 – 24
40200	Sensors 25 – 28
40201	Sensors 29 – 32
40202	Sensors 33 – 36
40203	Sensors 37 - 40
40204	Contact Closure 1 – 4
40205	Contact Closure 5 – 8
40206	Contact Closure 9 – 12
40207	Contact Closure 13 - 16

Note: Tank Registers 40002-40193 do not apply to the LC2000.

2.1.1 MODBUS Status Register Detail

The least-significant bit (LSB) of the MODBUS Status Register (MSR) maintains the status of communications between MODBUS and TMS/LC2000 processors. If for any reason communications between these two processors is lost, the MODBUS processor will set the LSB of the MSR to “1”. Additionally, the MODBUS processor will force all tank data to full positive scale except ullage, which will be forced to zero. If communications are normal, the MSR LSB will be set to “0”. The second-significant bit (2SB) of the MSR maintains the status of the TMS tank probe data acquisition process, which is normally scanning tanks on a continuous basis, indicated by the 2SB set to “0”. If an on-site technician is in the process of altering TMS tank or probe configuration data via the TMS front panel, tank data acquisition scanning will be suspended and the 2SB will be set to a “1”. Scanning will resume and the 2SB will set to “0” after the new settings have been saved.

The MSR should be checked occasionally since these statuses indicate that MODBUS register data is not being updated. Typically, the entire MODBUS register set is updated every 0.8 to 1.2 seconds, and the MSR communications status bit is set to “1” after 10 seconds of failed TMS/LC2000 communications. Note that although all unused bits in the MSR are set to zero, they may be used in future firmware versions.

2.1.2 Tank Data Register Detail

Tank Register Start Address “T” = ((N – 1) 16) + 40002, where N = Tank Number 1 thru 12

Note: Tank Data Registers do not apply to the LC2000 since it does not interface with level probes.

Register Description (Starting at Address “T”)	“T” Address Offset	Data Format	Resolution
Tank Status Register (High) **Tank Status Register (Low)**	0 1	See Section 2.1.2.1	N/A
Total Height (High) **Total Height (Low)**	2 3	S + 31 Bits	0.1in/1mm
Gross Volume (High) **Gross Volume (Low)**	4 5	32 Bits	1 GL/1 LT
Net Volume (High) **Net Volume (Low)**	6 7	32 Bits	1 GL/1 LT
% Volume (High) **% Volume (Low)**	8 9	32 Bits	0.1%
Product Temperature (High) **Product Temperature (Low)**	10 11	S + 31 Bits	0.1°F/0.1°C
Water Height (High) **Water Height (Low)**	12 13	S + 31 Bits	0.1in/1mm
Ullage* (High) **Ullage* (Low)**	14 15	32 Bits	1 GL/1 LT
*Ullage is based on 85%, 90%, 95% or 100% of tank capacity, depending on TMS configuration setting “S” denotes sign bit, where 0 = “+”, 1 = “-“. Negative numbers are represented in 2’s compliment form, i.e. –1 = FFFFFFFFh.			

2.1.2.1 Tank Status Register Detail

Use Table #1 or Table #2 below corresponding to the firmware version loaded into the TMS as follows;

Table #1: TMS2000 V2x.99.xx, V2x.00.xx, or V2x.01.01 thru V2x.01.10
TMS2000W V4x.00.xx, or V4x.01.01 thru V4x.01.13 (wireless)
TMS3000 V3x.99.xx, V3x.00.xx, or V3x.01.01 thru V3x.01.10

Table #2: TMS1000 V1x.xx.04 or later
TMS2000 V2x.01.11 or later
TMS2000W V4x.01.14 or later (wireless)
TMS3000 V3x.01.11 or later
TMS4000 V3x.02.01 thru V30.02.49 (TMS4000_10.001 thru TMS4000_10.049)
TMS4000W V4x.02.01 thru V40.02.49 (TMS4000W_10.001 thru TMS4000W_10.049) (wireless)

Where “x” denotes a “don’t care” value

Note: Tank Status Register does not apply to the LC2000.

Table #1		
Bit Pos.	**Status**	
	Wired Systems	**Wireless Systems**
DB0	Delivery in Progress (LSB)	
DB1	Probe Sync Error	Probe Level Error
DB2	Probe Timeout Error	
DB3	In-Tank Leak Test in Progress	N/A
DB4	Pump/Generator Run	
DB5	Ullage Mode LSB (See table below)	
DB6	Ullage Mode MSB (See table below)	
DB7	In-Tank Product Motion (Note: Active LOW)	
DB8	No Monthly Leak Test Warning	N/A
DB9	Product Below Gaugeable Level	
DB10	Theft Alarm	
DB11	Water Setpoint Alarm (HIGH) (2”/51mm)	
DB12	Product Setpoint Alarm #3*/(LOW)** (Under 20%)	
DB13	Product Setpoint Alarm #2*/(HIGH)** (Over 90%)	
DB14	Product Setpoint Alarm #1*/(HIGH HIGH)** (Over 95%)	
DB15	In-Tank Leak Alarm (MSB)	N/A
DB16	N/A	WiS Error
DB17	N/A	WiDAM Timeout Error
DB18	N/A	WiDAM Low Battery Warning
DB19	N/A	Probe Temperature Error
DB20-31	Spare (All zeros)	
All statuses Active HIGH unless otherwise noted		
* Factory defaults for Setpoints are shown in parentheses. Actual TMS settings should be confirmed. ** Factory defaults for 6SP (Vxx.01.xx) are shown. Contact Pneumercator for a firmware upgrade to represent all 6 Product Setpoints in the Status Register		

Ullage %	Ullage Mode MSB	Ullage Mode LSB
85	1	1
90	0	0
95	0	1
100	1	0

Table #2		
Bit Pos.	**Status**	
	Wired Systems	**Wireless Systems**
DB0	Delivery in Progress (LSB)	
DB1	Probe Sync Error	Probe Level Error
DB2	Probe Timeout Error	
DB3	In-Tank Leak Test in Progress	N/A
DB4	Pump/Generator Run	
DB5	Ullage Mode LSB (See table below)	
DB6	Ullage Mode MSB (See table below)	
DB7	In-Tank Product Motion (Note: Active LOW)	
DB8	No Monthly Leak Test Warning	N/A
DB9	Product Below Gaugeable Level	
DB10	Theft Alarm	
DB11	Water Setpoint Alarm HIGH* (2”/51mm)	
DB12	Product Setpoint Alarm LOW* (20%)	
DB13	Product Setpoint Alarm HIGH* (90%)	
DB14	Product Setpoint Alarm HIGH HIGH* (95%)	
DB15	In-Tank Leak Alarm	N/A
DB16	N/A	WiS Error
DB17	N/A	WiDAM Timeout Error
DB18	N/A	WiDAM Low Battery Warning
DB19	N/A	Probe Temperature Error
DB20	Spare	
DB21	Product Setpoint Alarm CRIT LOW* (12%)	
DB22	Product Setpoint Alarm LOW LOW* (15%)	
DB23	Product Setpoint Alarm CRIT HIGH* (98%)	
DB24	Temperature Setpoint Alarm LOW LOW* (25ºF/-4ºC)	
DB25	Temperature Setpoint Alarm LOW* (40ºF/4ºC)	
DB26	Temperature Setpoint Alarm HIGH* (43ºF/6ºC)	
DB27	Temperature Setpoint Alarm HIGH HIGH* (90ºF/32ºC)	
DB28	Water Setpoint Alarm LOW LOW* (TMS4000(W) Only)	
DB29	Water Setpoint Alarm LOW* (TMS4000(W) Only)	
DB30	Water Setpoint Alarm HIGH* (2”/51mm) (TMS4000(W) Only)	
DB31	Water Setpoint Alarm HIGH HIGH* (TMS4000(W) Only) (MSB)	
All statuses Active HIGH unless otherwise noted		
* Factory defaults for Setpoints are shown in parentheses. Actual TMS settings should be confirmed.		

Ullage %	Ullage Mode MSB	Ullage Mode LSB
85	1	1
90	0	0
95	0	1
100	1	0

2.1.3 Sensor Data Register - Sensor Number Detail

Register	DB15-12	DB11-8	DB7-4	DB3-0
40194	4	3	2	Sensor #1
40195	8	7	6	5
40196	12	11	10	9
40197	16	15	14	13
40198	20	19	18	17
40199	24	23	22	21
40200	28	27	26	25
40201	32	31	30	29
40202	36	35	34	33
40203	Sensor #40	39	38	37

2.1.3.1 Sensor Data Register - Status Detail

Status	MSB	3SB	2SB	LSB
Normal	0	0	0	0
Alarm	0	0	0	1
Fault, Short Circuit	0	0	1	0
Fault Open Circuit	0	0	1	1
Product Alarm*	0	1	0	0
Water Alarm*	0	1	0	1
Normal (Dry)*	0	1	1	0
Sensor Fault*	0	1	1	1
Sensor Active	1	0	0	0
Not Enabled	1	1	1	1
*Applies to discriminating liquid hydrocarbon/water leak sensors only				

2.1.4 Contact Closure Data Register - CC Number Detail

Register	DB15-12	DB11-8	DB7-4	DB3-0
40204	4	3	2	1
40205	8	7	6	5
40206	12	11	10	9
40207	16	15	14	13

2.1.4.1 Contact Closure Data Register - Status Detail

Status	MSB	3SB	2SB	LSB
Not Active	0	0	0	0
Active, Relay Control	0	0	0	1
Active, Gate Control	0	0	1	0
Active Alarm	0	0	1	1
Active Acknowledge	0	1	0	0
Not Enabled	1	1	1	1

2.2 TMS4000(W) Data Register Map – Extended Mapping

This section applies to:
TMS4000 V30.02.53 or later (TMS4000_10.053 or later)
TMS4000W V40.02.53 or later (TMS4000W_10.053 or later) (wireless)

Refer to Section 2.1 for unlisted models or firmware versions

Register Address	Data Group
40300	MODBUS Status Register
40301 – 40320	Tank 1
40321 – 40340	Tank 2
40341 – 40360	Tank 3
40361 – 40380	Tank 4
40381 – 40400	Tank 5
40401 – 40420	Tank 6
40421 – 40440	Tank 7
40441 – 40460	Tank 8
40461 – 40480	Tank 9
40481 – 40500	Tank 10
40501 – 40520	Tank 11
40521 – 40540	Tank 12
40541 – 42180	Tanks 13 – 94
42181 – 42200	Tank 95
42201 – 42220	Tank 96
42221	Sensors 1- 4
42222	Sensors 5 – 8
42223	Sensors 9 – 12
42224	Sensors 13 – 16
42225	Sensors 17 – 20
42226	Sensors 21 – 24
42227	Sensors 25 – 28
42228	Sensors 29 – 32
42229	Sensors 33 – 36
42230	Sensors 37 – 40
42231 – 42314	Sensors 41 – 376
42315	Sensors 377 – 380
42316	Sensors 381 – 384
42317	Contact Closure 1 – 4
42318	Contact Closure 5 – 8
42319	Contact Closure 9 – 12
42320	Contact Closure 13 – 16
42321	Contact Closure 17 – 20
42321 – 42330	Contact Closure 21 – 56
42331	Contact Closure 57 – 60
42332	Contact Closure 61 – 64

2.2.1 MODBUS Status Register Detail

The least-significant bit (LSB) of the MODBUS Status Register (MSR) maintains the status of communications between MODBUS and TMS processors. If for any reason communications between these two processors is lost, the MODBUS processor will set the LSB of the MSR to “1”. Additionally, the MODBUS processor will force all tank data to full positive scale except ullage, which will be forced to zero. If communications is normal, the MSR LSB will be set to “0”. The second-significant bit (2SB) of the MSR maintains the status of the TMS tank probe data acquisition process, which is normally scanning tanks on a continuous basis, indicated by the 2SB set to “0”. If an on-site technician is in the process of altering TMS tank or probe configuration data via the TMS front panel, tank data acquisition scanning will be suspended and the 2SB will be set to a “1”. Scanning will resume and the 2SB will set to “0” after the new settings have been saved.

The MSR should be checked occasionally since these statuses indicate that MODBUS register data is not being updated. Typically, the entire MODBUS register set is updated every 0.8 to 1.2 seconds, and the MSR communications status bit is set to “1” after 10 seconds of failed TMS communications. Note that although all unused bits in the MSR are set to zero, they may be used in future firmware versions.

2.2.2 Tank Data Register Detail

Tank Register Start Address “T” = ((N – 1) 20) + 40301, where N = Tank Number 1 thru 96

Register Description (Starting at Address “T”)	“T” Address Offset	Data Format	Resolution
Tank Status Register (High) **Tank Status Register (Low)**	0 1	See Section 2.2.2.1	N/A
Tank Status Register (High) **Tank Status Register (Low)**	2 3	See Section 2.2.2.1	N/A
Total Height (High) **Total Height (Low)**	4 5	S + 31 Bits	0.1in/1mm
Gross Volume (High) **Gross Volume (Low)**	6 7	32 Bits	1 GL/1 LT
Net Volume (High) **Net Volume (Low)**	8 9	32 Bits	1 GL/1 LT
% Volume (High) **% Volume (Low)**	10 11	32 Bits	0.1%
Product Temperature (High) **Product Temperature (Low)**	12 13	S + 31 Bits	0.1°F/0.1°C
Water Height (High) **Water Height (Low)**	14 15	S + 31 Bits	0.1in/1mm
Ullage* (High) **Ullage* (Low)**	16 17	32 Bits	1 GL/1 LT
Spare (High) **Spare (Low)**	18 19	N/A	N/A
*Ullage is based on 85%, 90%, 95% or 100% of tank capacity, depending on TMS configuration setting “S” denotes sign bit, where 0 = “+”, 1 = “-“. Negative numbers are represented in 2’s compliment form, i.e. –1 = FFFFFFFFh.			

2.2.2.1 Tank Status Register Detail

Bit Pos.	Status1
DB0	Delivery in Progress (LSB)
DB1	Inventory Decrease
DB2	Probe Sync Error [1]
DB3	Probe Timeout Error
DB4	In-Tank Leak Test in Progress [1]
DB5	Pump/Generator Run
DB6	Ullage Mode LSB (See table below)
DB7	Ullage Mode MSB (See table below)
DB8	In-Tank Product Motion (Note: Active LOW)
DB9	No Monthly Leak Test Warning [1]
DB10	Product Below Gaugeable Level
DB11	Theft Alarm
DB12	In-Tank Leak Alarm [1]
DB13	In-Tank Leak Test Abort – Del IP [1]
DB14	Product Setpoint Alarm CRIT LOW (12%)
DB15	Product Setpoint Alarm LOW LOW (15%)
DB16	Product Setpoint Alarm LOW (20%)
DB17	Product Setpoint Alarm HIGH (90%)
DB18	Product Setpoint Alarm HIGH HIGH (95%)
DB19	Product Setpoint Alarm CRIT HIGH (98%)
DB20	Water Setpoint Alarm CRIT LOW
DB21	Water Setpoint Alarm LOW LOW
DB22	Water Setpoint Alarm LOW
DB23	Water Setpoint Alarm HIGH (2”/51mm)
DB24	Water Setpoint Alarm HIGH HIGH
DB25	Water Setpoint Alarm CRIT HIGH
DB26	Temperature Setpoint Alarm CRIT LOW
DB27	Temperature Setpoint Alarm LOW LOW
DB28	Temperature Setpoint Alarm LOW
DB29	Temperature Setpoint Alarm HIGH
DB30	Temperature Setpoint Alarm HIGH HIGH
DB31	Temperature Setpoint Alarm CRIT HIGH (MSB)
All statuses Active HIGH unless otherwise noted Default Setpoint values shown in parentheses	
[1] TMS4000 Only [2] TMS4000W Only	

Ullage %	Ullage Mode MSB	Ullage Mode LSB
85	1	1
90	0	0
95	0	1
100	1	0

Bit Pos.	Status2
DB0	Probe Card Not Present [1] (LSB)
DB1	Spare (Zero)
DB2	Spare (Zero)
DB3	Spare (Zero)
DB4	Spare (Zero)
DB5	Spare (Zero)
DB6	Spare (Zero)
DB7	Spare (Zero)
DB8	Spare (Zero)
DB9	Spare (Zero)
DB10	Spare (Zero)
DB11	Spare (Zero)
DB12	Spare (Zero)
DB13	Spare (Zero)
DB14	Spare (Zero)
DB15	Spare (Zero)
DB16	Acquiring Data [2]
DB17	Probe Product Level Error [2]
DB18	Probe Temperature Error [2]
DB19	Probe Water Level Error [2]
DB20	WiS Error [2]
DB21	WiS CTS [2]
DB22	WiS RF [2]
DB23	WiDAM Timeout Error [2]
DB24	WiDAM Low Battery Warning [2]
DB25	Spare (Zero)
DB26	Spare (Zero)
DB27	Spare (Zero)
DB28	Spare (Zero)
DB29	Spare (Zero)
DB30	Spare (Zero)
DB31	Spare (Zero) (MSB)
All statuses Active HIGH unless otherwise noted	
[1] TMS4000 Only [2] TMS4000W Only	

2.2.3 Sensor Data Register - Sensor Number Detail

Register	DB15-12	DB11-8	DB7-4	DB3-0
42221	4	3	2	Sensor #1
42222	8	7	6	5
42223	12	11	10	9
42224	16	15	14	13
42225	20	19	18	17
42226	24	23	22	21
42227	28	27	26	25
42228	32	31	30	29
42229	36	35	34	33
42230	40	39	38	37
42231	44	43	42	41
42232	48	47	46	45
42233	52	51	50	49
42234	56	55	54	53
42235	60	59	58	57
42236	64	63	62	61
42237	68	67	66	65
42238	72	71	70	69
42239	76	75	74	73
42240	Sensor #80	79	78	77
42241 – 42314	Sensors 81 – 376			
42315	380	379	378	Sensor #377
42316	Sensor #384	383	382	381

2.2.3.1 Sensor Data Register - Status Detail

Status	MSB	3SB	2SB	LSB
Normal	0	0	0	0
Alarm	0	0	0	1
Fault, Short Circuit	0	0	1	0
Fault Open Circuit	0	0	1	1
Product Alarm*	0	1	0	0
Water Alarm*	0	1	0	1
Normal (Dry)*	0	1	1	0
Sensor Fault*	0	1	1	1
Sensor Active	1	0	0	0
Not Enabled	1	1	1	1
*Applies to discriminating liquid hydrocarbon/water leak sensors only				

2.2.4 Contact Closure Data Register - CC Number Detail

Register	DB15-12	DB11-8	DB7-4	DB3-0
42317	4	3	2	1
42318	8	7	6	5
42319	12	11	10	9
42320	16	15	14	13
42321	20	19	18	17
42322	24	23	22	21
42323	28	27	26	25
42324	32	31	30	29
42325	36	35	34	33
42326	40	39	38	37
42327	44	43	42	41
42328	48	47	46	45
42329	52	51	50	49
42330	56	55	54	53
42331	60	59	58	57
42332	64	63	62	61

2.2.4.1 Contact Closure Data Register - Status Detail

Status	MSB	3SB	2SB	LSB
Not Active	0	0	0	0
Active, Relay Control	0	0	0	1
Active, Gate Control	0	0	1	0
Active Alarm	0	0	1	1
Active Acknowledge	0	1	0	0
Not Enabled	1	1	1	1

3.0 Product Specifications

Communications Protocol: Modbus RTU

Communications Format: RS-485, Half-Duplex

Connection Type: Plug-In Terminal Block with Wire Entries

Input: Ch. A (+), Ch. B (-), Shield
Output: Ch. A (+), Ch. B (-), Shield

Recommended RS-485 Cable: Belden 9841 (PVC Jacket), 89841 (FEP Teflon Jacket) or similar

Maximum Cable Length: 4000 Feet/1200 Meters total to end of run

LED Indicators: TX (Slave Transmit), RX (Global Receive)

Serial Data Format: Fixed, 1 Start Bit, N-8-1

Baud Rate: 9600 or 38400, Dip Switch Selectable

Slave Address Select: 1 thru 64, Dip Switch Selectable

Maximum Slave Response Time: 400ms

Maximum Number of 16-Bit Registers per READ Command: 64

Maximum Register Update Rate from TMS: 1.2 seconds for Standard Mapping (0.8 seconds typ.)
1.2 – 6.5 seconds for Extended Mapping