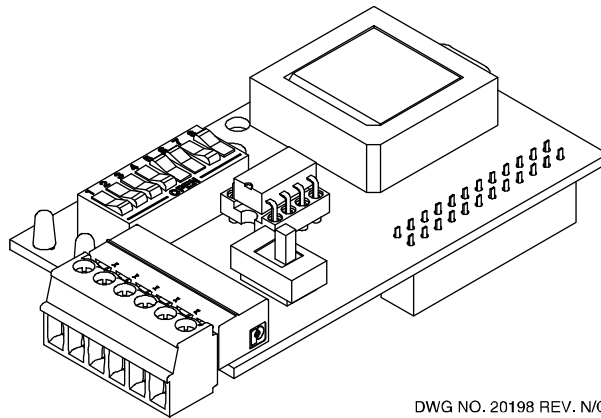


INSTRUCTION MANUAL

MODBUS RTU INTERFACE CARD

FOR

TMS SERIES AND LC2000 SYSTEMS



DWG NO. 20198 REV. N/C

This document describes the installation and setup of the MODBUS RTU RS-485 Interface Card, P/N 900552-x. 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.

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;

Vxx.99.9A or later (wired)
V1x.xx.04 or later
V2x.00.05 or later (wired)
V3x.00.05 or later (wired)

where “x” denotes “don’t care” values

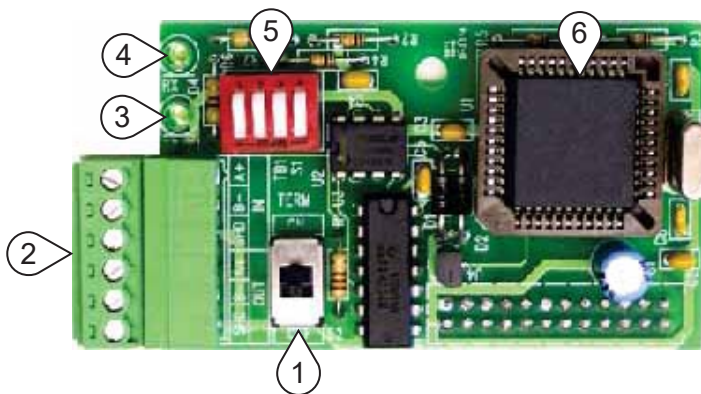
Note: All TMS Vxx.01.xx, LC2000, TMS2000W, TMS4000, and TMS4000W firmware versions support the Modbus RTU Interface Card.

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.

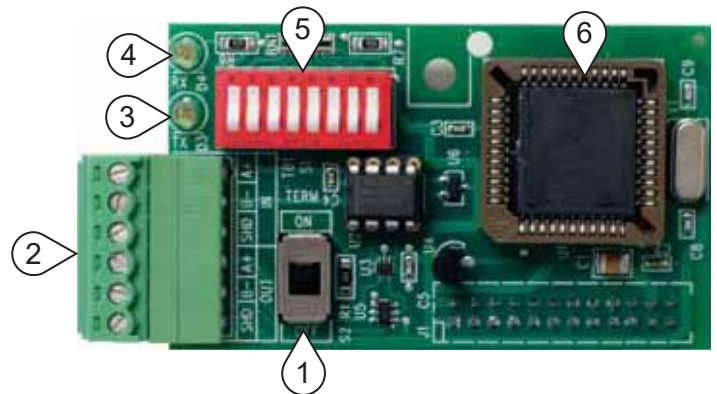
1.0 Installation and Setup

Installation and setup of the 900552 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



Rev. E and earlier



Rev. F and later

Use Table Set #1 or Table Set #2 below corresponding to the revision or number of Dip Switches;

Table #1: Rev. E and earlier, 4 Dip Switches

Table #2: Rev. F and later, 8 Dip Switches

1.1 Dip Switch Settings

1.1.1 Table Set #1 – (Rev. E and earlier, 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 or later

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

1.1.2 Table Set #2 – (Rev. F and later, 8 Dip Switches)

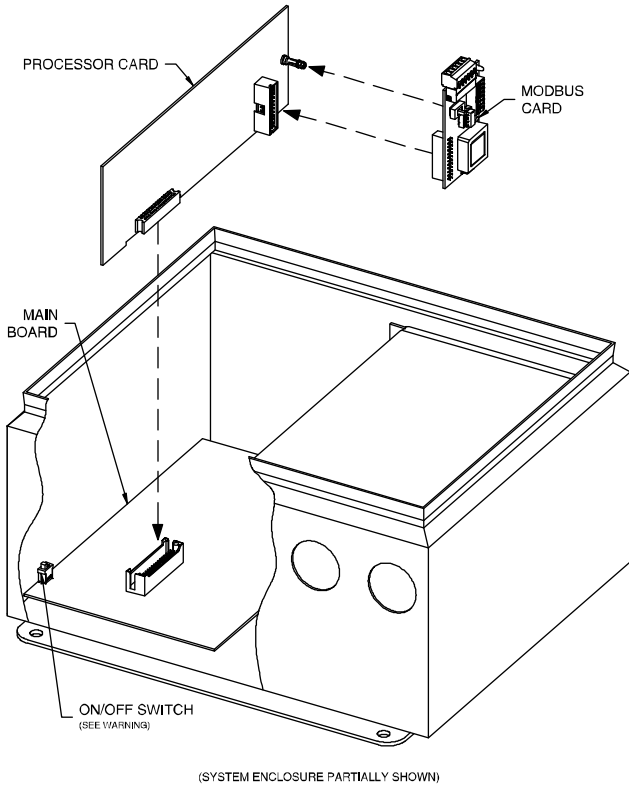
Slave Device Address	SW #6 Address MSB	SW #5 Address 5SB	SW #4 Address 4SB	SW #3 Address 3SB	SW #2 Address 2SB	SW #1 Address LSB
1*	CLOSED*	CLOSED*	CLOSED*	CLOSED*	CLOSED*	CLOSED*
2	CLOSED	CLOSED	CLOSED	CLOSED	CLOSED	OPEN
3	CLOSED	CLOSED	CLOSED	CLOSED	OPEN	CLOSED
4	CLOSED	CLOSED	CLOSED	CLOSED	OPEN	OPEN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

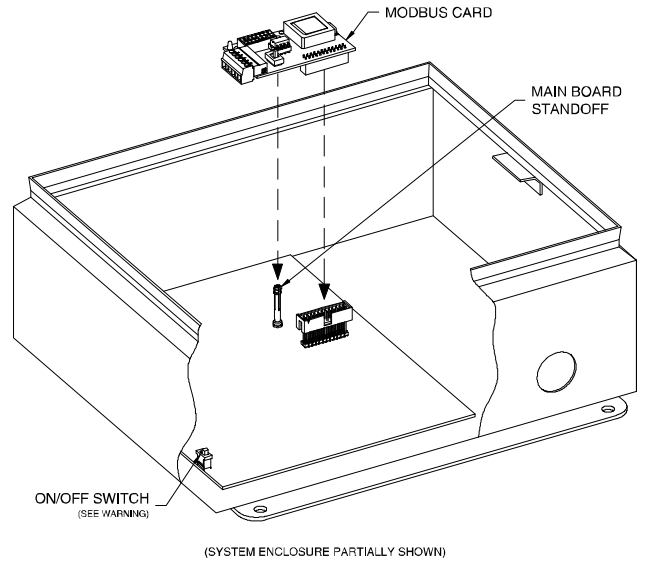
Baud Rate	Baud Rate Select	
	SW #8	SW #7
9600*	CLOSED*	CLOSED*
19200	CLOSED	OPEN
38400	OPEN	CLOSED
NOT USED	OPEN	OPEN

1.2 Installation of MODBUS Card

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



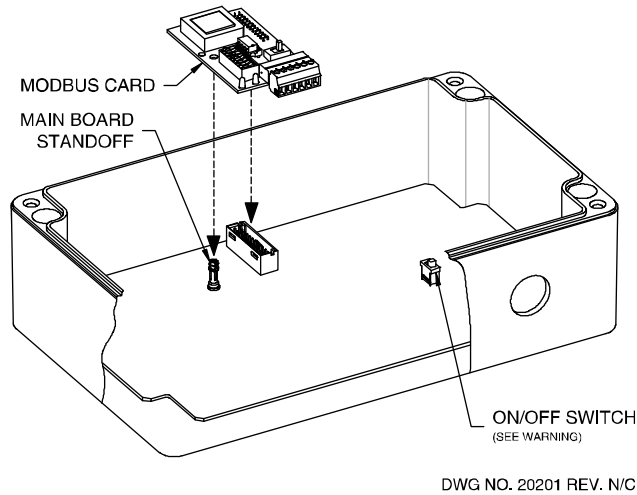
DWG NO. 20200 REV. N/C



DWG NO. 20199 REV. N/C

TMS3000/TMS4000

TMS2000(W)/LC2000



TMS1000

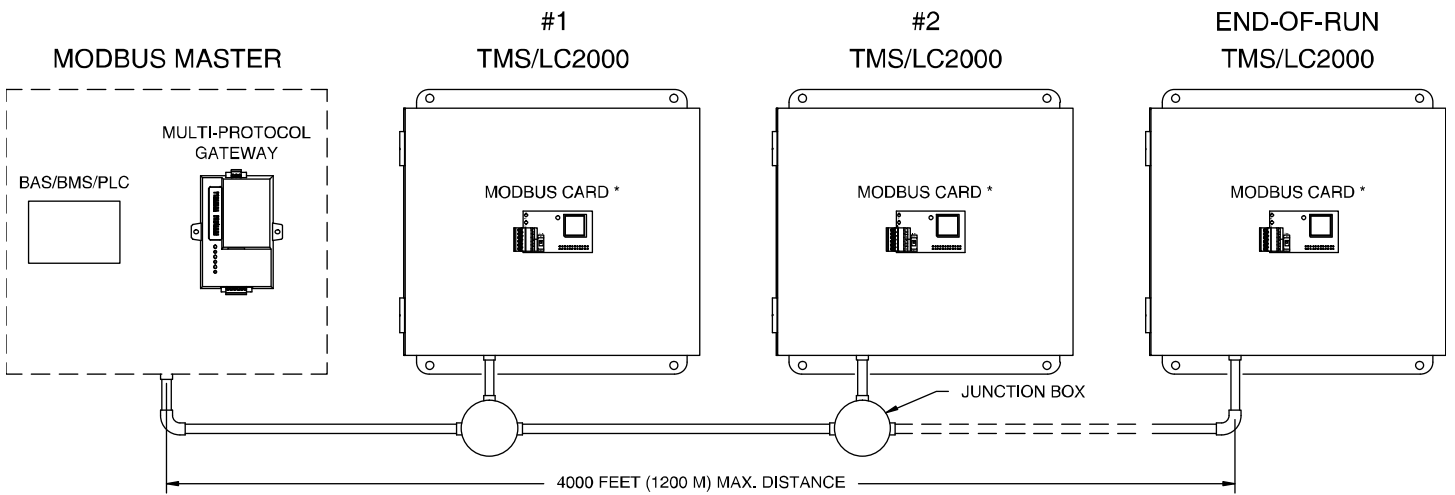
1.3 Terminal Connections

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

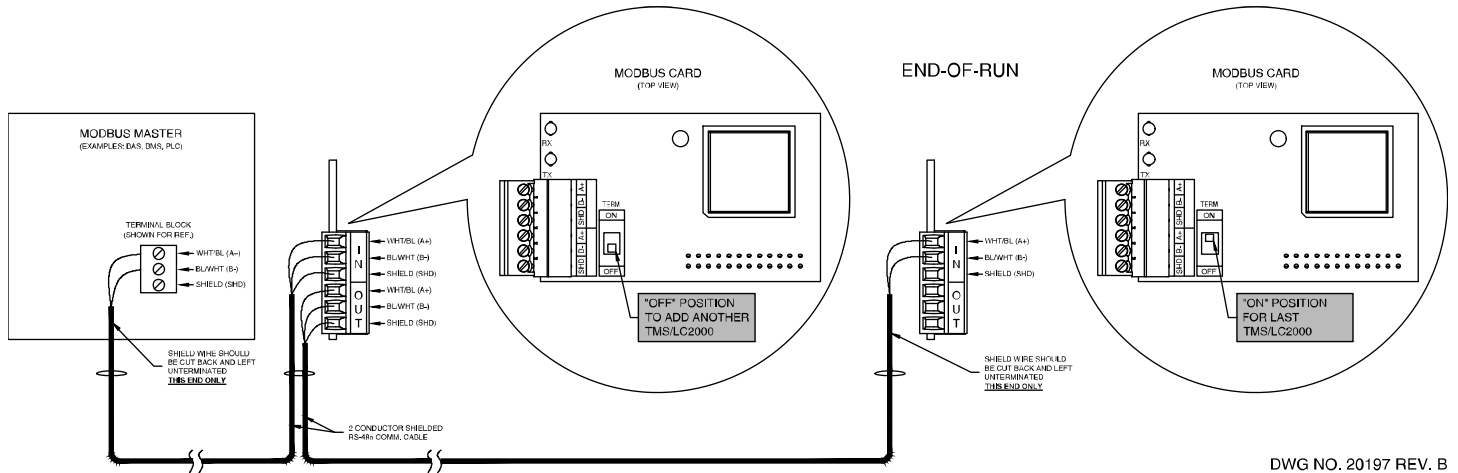
Cable type should be twisted pair, shielded, and designated for RS-485 communications having a nominal impedance of 120 ohms. Maximum cable distance supported is 4000' as per below drawing. See [3.0 Product Specifications](#) for example part numbers.



DWG NO. 20196 REV. A

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”.



1.4 LED Indicators

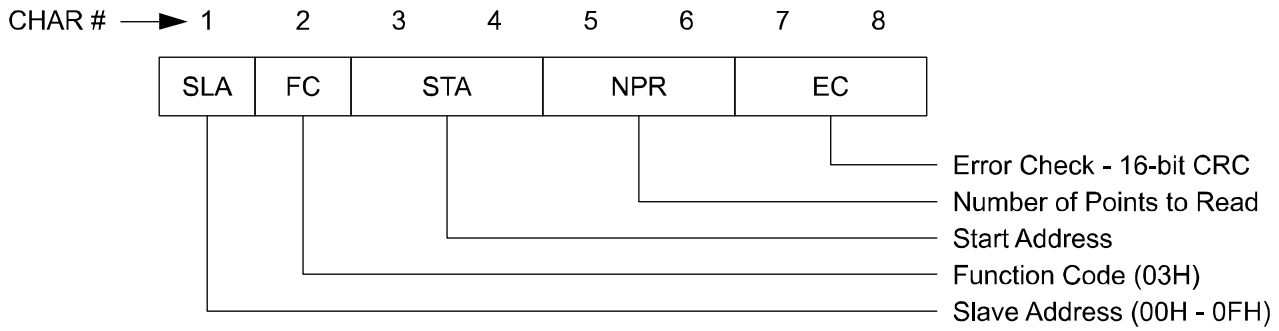
Visual indication of Modbus activity is provided by a SLAVE RECEIVE (RX) and a SLAVE TRANSMIT (TX) LED. Note that SLAVE RECEIVE indicates for all MASTER/HOST transmissions.

2.0 MODBUS Function Format

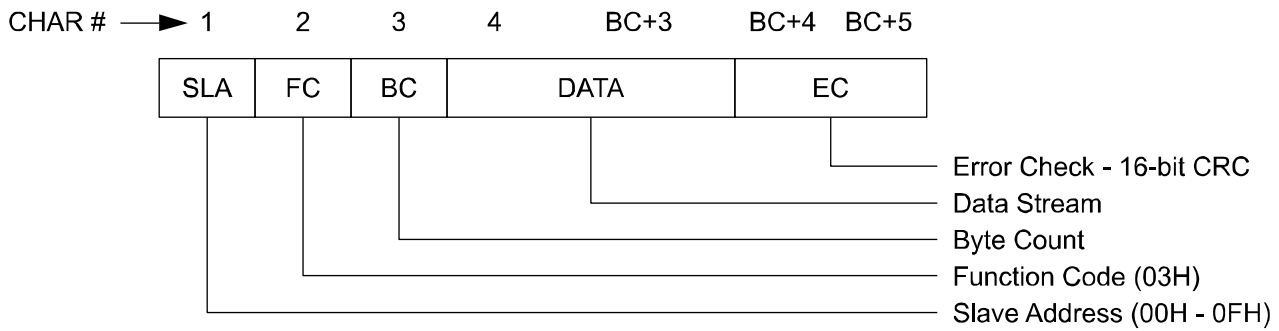
Function Code 3: Read Holding Registers

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



2.1 TMS/LC2000 Data Register Map

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 since it does not interface with level probes.

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 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/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)	0	See Section	N/A
Tank Status Register (Low)	1	2.1.2.1	
Total Height (High)	2	S + 31 Bits	0.1in/1mm
Total Height (Low)	3		
Gross Volume (High)	4	32 Bits	1 GL/1 LT
Gross Volume (Low)	5		
Net Volume (High)	6	32 Bits	1 GL/1 LT
Net Volume (Low)	7		
% Volume (High)	8	32 Bits	0.1%
% Volume (Low)	9		
Product Temperature (High)	10	S + 31 Bits	0.1°F/0.1°C
Product Temperature (Low)	11		
Water Height (High)	12	S + 31 Bits	0.1in/1mm
Water Height (Low)	13		
Ullage* (High)	14	32 Bits	1 GL/1 LT
Ullage* (Low)	15		
*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 (wired)
 TMS3000 V3x.99.xx, V3x.00.xx, or V3x.01.01 thru V3x.01.10 (wired)
 TMS2000W V4x.00.xx, or V4x.01.01 thru V4x.01.13 (wireless)

Table #2: TMS2000 V2x.01.11 or later (wired)
 TMS3000 V3x.01.11 or later (wired)
 TMS2000W V4x.01.14 or later (wireless)
 TMS1000 V1x.xx.04 or later
 TMS4000
 TMS4000W

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

Note: Tank Status Register does not apply to the LC2000 since it does not interface with level probes.

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)	
DB12	Product Setpoint Alarm #3*/(LOW)**	
DB13	Product Setpoint Alarm #2*/(HIGH)**	
DB14	Product Setpoint Alarm #1*/(HIGH HIGH)**	
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		
*Product Setpoint Alarms are programmable for both magnitude and direction. Factory defaults are as follows, but actual TMS settings should be confirmed;		
	Product Setpoint #1	95% High High
	Product Setpoint #2	90% High
	Product Setpoint #3	20% Low

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)	
DB12	Product Setpoint Alarm #3*/(LOW)**	
DB13	Product Setpoint Alarm #2*/(HIGH)**	
DB14	Product Setpoint Alarm #1*/(HIGH HIGH)**	
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	
DB22	Product Setpoint Alarm LOW LOW	
DB23	Product Setpoint Alarm CRIT HIGH	
DB24	Temperature Setpoint Alarm LOW LOW	
DB25	Temperature Setpoint Alarm LOW	
DB26	Temperature Setpoint Alarm HIGH	
DB27	Temperature Setpoint Alarm HIGH HIGH	
DB28	spare	
DB29	spare	
DB30	spare	
DB31	spare (MSB)	
All statuses Active HIGH unless otherwise noted		
TMS Six-Product Setpoint Firmware		
**Product Setpoint Alarms SP1, SP2 and SP3 are assigned as indicated, regardless of TMS programming. These three setpoints in combination with the three product setpoints assigned to DB21-23 provide a total of six product setpoints.		

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

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, 19200, 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 (0.8 seconds typ.)