MODBUS™ RTU

Communications Guide

for use with
MODCELL, MOD 30ML and Commander Products

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OVERVIEW

MODBUS RTU is a non-proprietary serial communications protocol that is widely used in the process control industry. The protocol was developed by Modicon for PLC communications and later released for public use. This protocol is available in all major Human Machine Interface (HMI) software packages and terminals. Many of the major controller and PLC manufacturers also offer MODBUS protocol as a standard or optional protocol in their instrumentation.

The hardware over which MODBUS RTU communications are performed is not defined by the protocol. MODBUS RTU is supported on RS-232, RS-422, RS-485, Ethernet and other electrical standards.

It should be noted that MODBUS RTU, MODBUS ASCII and MODBUS Plus are unique communication formats, and are not compatible with each other. This document will discuss MODBUS RTU only.

HARDWARE REQUIREMENTS

SERIAL INTERFACE CONSIDERATIONS

The Modbus protocol communicates with the instrumentation by means of an industry standard serial interface. This interface may be RS-232, RS-422 or RS-485. Some systems may also support the protocol over other busses or networks, such as Ethernet.

An RS-232 interface allows only two devices to be connected together. RS-422 supports 1 driver and up to 10 receivers on a single network. For bi-directional communications, special tri-state circuitry is provided on the drivers of some instrumentation, allowing 10 driver/receiver pairs. RS-485 supports up to 32 driver/receiver pairs. With special hardware, the RS-422 and RS-485 limits can be expanded to allow as many as 248 devices on a single network. Each device on a network must have a unique address, which may be soft-configured or set with switches. Address zero is reserved for broadcast messages from the host to all slaves. All devices on a network must also be configured with the same parameters, such as baud rate and parity.

In designing the communication architecture, one should consider communications performance when deciding how many devices to connect to a host port. Generally, nearly twice the performance can be achieved by splitting the devices from one port, onto two ports.

CABLE REQUIREMENTS

The type of wire to use is usually specified by the hardware manufacturer and will vary with required length. Wire with twisted pairs and an overall shield is used most often. The shield is tied to earth ground or chassis, and typically at one end only. The shield is not to be used as a signal common or ground. The table below lists typical cable recommendations.

Table 1. Cable Requirements

RS-232	
Up to 15m (50ft)	virtually any standard shielded twisted pair with drain (Beldon 9502 or equivalent)
RS-422 and RS-485	
Up to 6m (20ft)	virtually any standard shielded or twisted pair
Up to 300m (1000ft)	24 AWG twisted pair with overall foil shield with drain wire (Beldon 9841 for 2-wire and 9502 for 4-wire or equiv.)
Up to 1200m (4000ft)	24 AWG twisted pair with foil shield and drain wire on each pair (Beldon 9841 for 2-wire and 9729 for 4-wire or equiv.)

COMMUNICATIONS MODE

Communications can take place in full or half-duplex mode. The communications hardware must be able to support whatever mode the software is using. Half-duplex hardware shares the same lines for transmit and receive, whereas, full-duplex hardware has dedicated transmit and receive lines. MODBUS protocol uses half-duplex communications, regardless of the hardware. Full-duplex hardware is more widely supported by software drivers and devices, than half-duplex.

RS-232 INTERFACE

An RS-232 interface is rated for distances up to 15 meters (50 feet). At least three wires are required for an RS-232 interface. Wires are required for Transmit, Receive and Signal Ground. Some devices support additional wires for communication handshaking. RS-232 hardware is a full-duplex configuration, having separate Transmit and Receive lines.

RS-422 INTERFACE

An RS-422 interface requires at least four wires. Two wires each are used for Transmit and Receive. A fifth wire is usually required for Signal Ground, when connecting non-isolated devices together. Handshaking lines may also be supported by some hardware. This interface is full-duplex, allowing use of the same software drivers as for RS-232. The differential drivers allow for distances up to 1200 meters (4000 feet). The receivers of an RS-422 device are always enabled. For multi-drop operation, drivers must capable of tri-state operation.

RS-485 INTERFACE

An RS-485 interface requires at least two wires. In a two-wire configuration, the same pair of wires is used for Transmit and Receive. The two-wire configuration utilizes half-duplex communications. A four-wire configuration functions much like an RS-422 system, except the Transmit driver circuits are always taken off-line or tri-stated, when not in use. This tri-state feature reduces the load on the network, allowing more devices, without the need of special hardware. A fifth wire is usually required for Signal Ground, when connecting non-isolated devices together. Additional wires for handshaking may also be supported by some hardware. This interface also uses differential drivers, supporting distances up to 1200 meters (4000 feet).

BIAS RESISTORS

RS-422 and RS-485 networks often require bias, or pull-up and pull-down resistors. These resistors are used to stabilize the network. By definition, in a MODBUS RTU network, it is the responsibility of the Master to provide this function. Functionally, any device on the network may provide the bias stabilization. Biasing may also be installed external to the devices, with the appropriate resistors and power supply. If the Master is not the device providing this function, careful consideration must be given to the consequences of that device failing. If the Master is providing this function, and it fails, there would be no communications anyway. In some systems, bias resistors may be installed on two slaves, offering redundant biasing. This feature is available with MOD30ML and Modcell MLP modules (TERM switch). Some systems may function without these stabilizing resistors, but may be more susceptible to communication errors. Though the pull-up and pull-down resistors are the same, the value of these resistors varies from device to device. The actual recommended resistance may be calculated, and varies with the number of devices on the bus. Commander series instruments use 1.8KΩ, while MOD30ML and Modcell use 560Ω. The pull-up resistor is connected from the positive communication line to +5Vdc. The pull-down resistor is connected from the negative communication line to the power supply common.

TERMINATION RESISTORS

Termination resistors are often used to reduce reflections on the network. This problem occurs most with long wires and high baud rates. Due to variations in wire and equipment, whether or not to use these terminators is usually determined by system testing. The general rule is to add them only if needed. The resistors are typically 120Ω, and installed across the Transmit and Receive wire pairs. Normally, one resistor is installed at each end of each pair of wires. For two-wire installations, one resistor would be installed at each end. If bias stabilization resistors are not installed, use of these terminations will probably drown the signal, preventing communications.

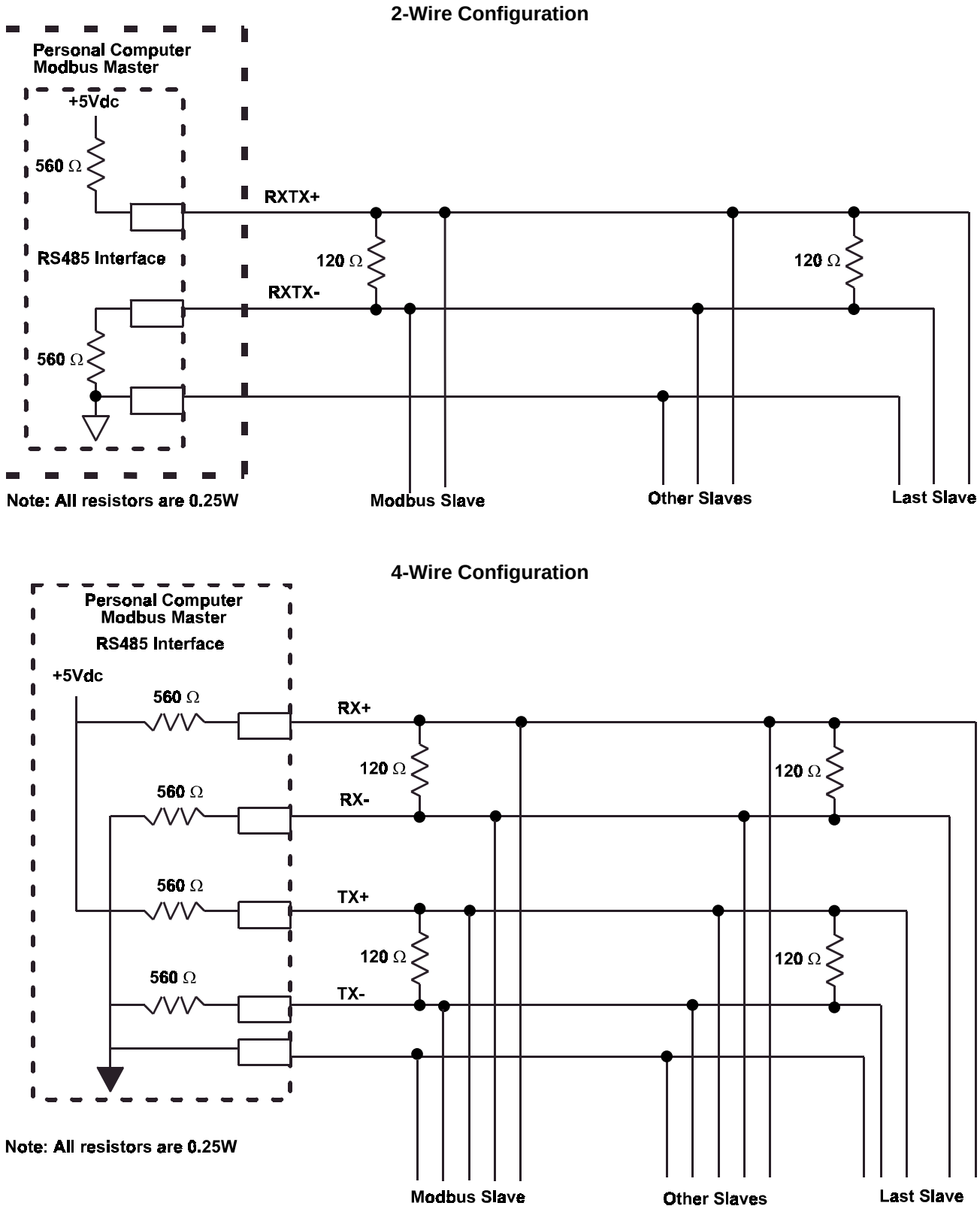


Figure 1. RS-485 Biasing and Termination

SOFTWARE BASICS

MASTER/SLAVE RELATIONSHIP

A MODBUS RTU system consists of a Master and one or more Slave devices. Multiple Masters are not permitted on the same network. The Master is responsible for initiating all communications, therefore, no peer-to-peer capability is supported. With some hardware, it is possible to dynamically switch the device between Master and Slave modes. This capability allows multiple Masters, though not simultaneously. With special hardware, such as Phoenix Digital's MPE Plus, having multiple Masters is possible, though it limits the communications to the basic "Standard" MODBUS commands. Using the MPE Plus will block extended MODBUS communications, including the Application Builder.

MESSAGE RESPONSE TIMES

The MODBUS RTU protocol relies on precise timing for reliable communications. The message structure is such that a 3.5 character or greater pause will be interpreted as the end of a message. The actual time varies with the baud rate. Conversely, most devices require a defined minimum amount of time between messages. Another factor to consider is that each device has its own response time. This response time can be anywhere from a few milliseconds to a few hundred milliseconds. The Host must be configured to allow adequate time for the slowest device to respond.

INSTRUMENT RESPONSE TIMES TO HOST COMMANDS

These times represent the maximum time from when the instrument receives a request from the master, to when it begins to send the response.

Table 2. Instrument Response Times

Device	Max Response Time
C100	250 mSec
C150	250 mSec
C200	250 mSec
C300	180 mSec
C310	160 mSec
C500	125 mSec

Device	Max Response Time
C1900	250 mSec
Modcell MLP	60 mSec *
2050R	100 mSec
MOD30ML	60 mSec *
MR250	125 mSec
PR100	90 mSec

* NOTE: The response times for Modcell MLP and MOD30ML are for read messages. Write messages may take longer. These instruments have a configurable Write Message Timeout parameter.

SOFTWARE DRIVERS

Table 3. Software Drivers

Driver	Description	Use With
1719S	Standard MODBUS Driver	PC-30 and GFW
1733S	Extended MODBUS Driver	PC-30 and GFW
2010S	EMP 16-bit Standard and Extended MODBUS Driver	FIX 5.x for Windows 3.x
2011S	EMP 32-bit Standard and Extended MODBUS Driver	FIX 6.x for Windows 95 and NT
I/O Server	Standard MODBUS	GFW
DDE Server	Standard MODBUS	Wonderware InTouch
OPC Server	Standard and Extended MODBUS	GFW32, FIX Dynamics and other OPC Clients
MODCELL	Enhanced Standard MODBUS	Citect
MODBUS	Standard MODBUS	Citect and others

MODBUS WITH MODCELL MLP AND MOD30ML

STANDARD PROTOCOL

"Standard" MODBUS supports single-register, 16-bit integer values. Modcell and MOD30ML floating-point data may be converted to this format with ML blocks. For maximum resolution, specify an actual engineering-unit range in the ML block. If the engineering range is greater than 65535, a scaled range must be selected. Some standard MODBUS drivers may be capable of reading floating-point data, using a 32-bit two-register format.

The standard MODBUS driver (MB1) for Fix DMACS does not support the floating point format from Modcell MLP and MOD30ML.

The standard MODBUS driver for PC-30 and GFW supports Modcell MLP and MOD30ML floating point signals. A MODBUS I/O Server is also available for GFW, supporting floating-point.

EXTENDED PROTOCOL

Modcell and MOD30ML devices support an extended protocol, in addition to standard MODBUS RTU as a subset. If the Master is capable of utilizing the extended features, additional data types, diagnostics and event information may be obtained. The extended protocol also supports the Status Page in the Application Builder and very fast uploads and downloads. Note that the 2-wire RS-485 module does not support these features.

The Extended MODBUS protocol implemented in Modcell and MOD30ML utilizes a user-defined MODBUS command, and custom drivers are required in the host to support it. Custom drivers supporting this Extended MODBUS protocol are available for PC-30, Genesis for Windows and FIX DMACS. The PC-30/GFW driver supports only Extended MODBUS. The FIX drivers also support standard MODBUS devices, even on the same network as Extended MODBUS devices.

When using Extended MODBUS, special interface files are created when compiling the instrument database. These files provide automatic configuration of host poll records, significantly reducing engineering time. A MIF file is used for FIX software. PC-30 and GFW use a TIF file. With Extended MODBUS, user-friendly alias names are given to points in the Configured List. In the host software, these alias names are used instead of register addresses.

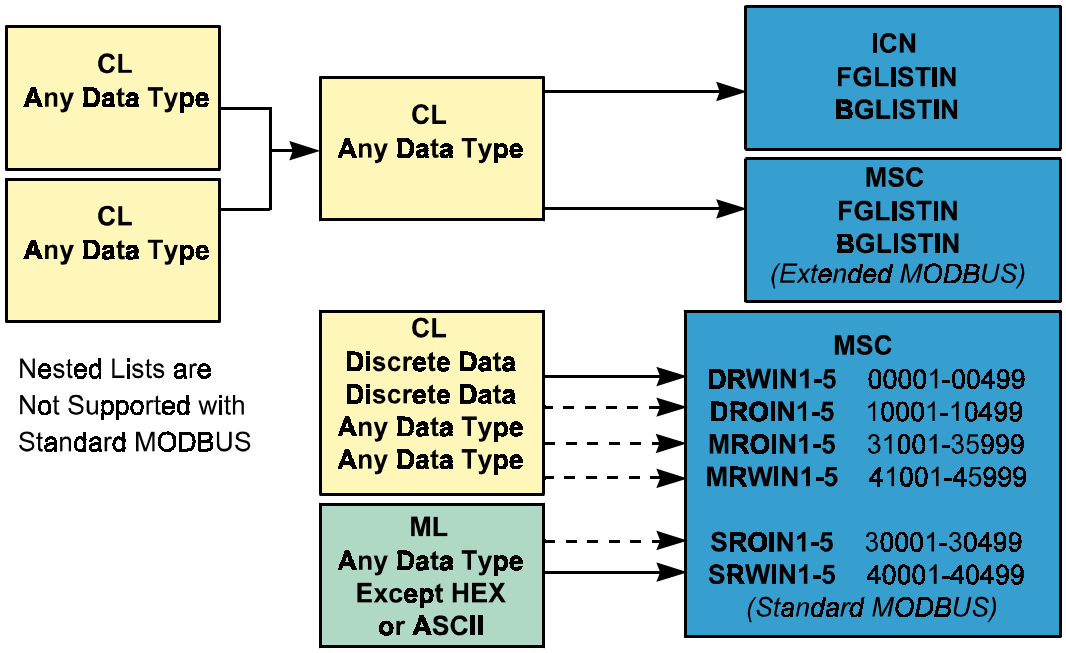
MOD 30ML COMMUNICATION CHANNELS

The built-in communication channel on a MOD30ML can be used with front or rear connection, but not simultaneously. The front connection is RS-232 only, and the rear connection can be either RS-232 or RS-485. Connecting wires to the rear terminations may prevent communications through the front port, even if the rear terminations are not being used. Installing a communication module in slots S9-10 or S10 will disable the built-in channel. A second communication channel can be added by installing a module in slots S7-8 or S8.

USING ML AND CL BLOCKS:

DIRECTING DATA WITH ML AND CL BLOCKS

CL blocks can be connected to MSC blocks, and are usually used for discrete points. A CL block is required for multi-register “standard” MODBUS functions, such as those needed for floating point signals. If a floating point value is placed into an ML block, it is converted to a 16-bit integer value to be sent to the host. If floating point values are placed into a CL, they can be connected to a multi-register input of the MSC block using two registers, or 32 bits. The data format is per ANSI / IEEE Std 754-1985 for Binary Floating-Point Arithmetic. This is the format used by Motorola.



* NOTE: Solid connection lines represent the most commonly used connections.

Figure 2. Extended and Standard MODBUS Lists

BLOCK CONNECTIONS

CL-IN	
ENTRY1	ENTRY2
ENTRY3	ENTRY4
ENTRY5	ENTRY6
ENTRY7	ENTRY8
ENTRY9	ENTRY10
ENTRY11	ENTRY12
ENTRY13	ENTRY14
ENTRY15	ENTRY16
ENTRY17	ENTRY18
ENTRY19	ENTRY20
ENTRY21	ENTRY22
ENTRY23	ENTRY24
ENTRY25	ENTRY26
ENTRY27	ENTRY28
ENTRY29	ENTRY30
ENTRY31	ENTRY32
PREV	NEXT
ESCAPE	

ML-IN	
ENTRY1	ENTRY2
ENTRY3	ENTRY4
ENTRY5	ENTRY6
ENTRY7	ENTRY8
ENTRY9	ENTRY10
ENTRY11	ENTRY12
ENTRY13	ENTRY14
ENTRY15	ENTRY16
ENTRY17	ENTRY18
ENTRY19	ENTRY20
ENTRY21	ENTRY22
ENTRY23	ENTRY24
ENTRY25	ENTRY26
ENTRY27	ENTRY28
ENTRY29	ENTRY30
ENTRY31	ENTRY32
PREV	NEXT
ESCAPE	

CL-OUT	
LISTOUT	BADINP
BLKLEN	COLLECT
COLLQUAL	DISCLEN
LISTSIGN	NDISCLEN
PKDLEN	STATE
UNPKDLEN	VERSION
ESCAPE	

ML-OUT	
LISTOUT	BADINP
BLKLEN	LISTSIGN
STATE	VERSION
ESCAPE	

(Up to 99 Inputs per Block)

MSC-CLIN	
DROIN1	DROIN2
DROIN3	DROIN4
DROIN5	DRWIN1
DRWIN2	DRWIN3
DRWIN4	DRWIN5
FGLISTIN	BGLISTIN
MROIN1	MROIN2
MROIN3	MROIN4
MROIN5	MRWIN1
MRWIN2	MRWIN3
MRWIN4	MRWIN5
ESCAPE	

MSC-MLIN	
SROIN1	SROIN2
SROIN3	SROIN4
SROIN5	SRWIN1
SRWIN2	SRWIN3
SRWIN4	SRWIN5
ESCAPE	

MSC-OUT	
ADDR	BADINP
BAUDRATE	BLKLEN
BOARD	BRKC
BRKS	BRKU
CMD	COMMTYPE
DATABITS	DEFCOMMA
DEFCOMMS	DEFCOMMU
DROLIST1	DROLIST2
DROLIST3	DROLIST4
DROLIST5	DRWLIST1
DRWLIST2	DRWLIST3
DRWLIST4	DRWLIST5
FG	FRAMEC
FRAMES	FRAMEU
INVMSGC	INVMSGS
INVMSGU	MODE
PREV	NEXT
ESCAPE	

Figure 3. Block Connections

USING MODBUS MODULES:

MODULE LOCATION

The sockets in which the module is installed determines its Port number

Table 4. MOD30ML and Modcell MLP Port Numbers

Port Number	MOD30ML	Modcell MLP
1	Built-In, Slots 9-10 or 10	Slots 31-32 or 32
2	Slots 7-8 or 8	Slots 29, 28-28, 30 or 29-30
3	not available	Slots 25-26, 26, 26-27, 27, 27-28 or 28

THE RS-485'S TERM (MASTER/SLAVE) SWITCH

- The master is responsible for stabilizing the bus
- In the YES position the module provides this master function by pulling the comm+ line high and the comm- line low, each through 560Ω resistors
- Some PC cards have these resistors built in, generally only on the receiver. This works fine in 4-wire mode if the transmitter does not tri-state, or in 2-wire mode. 4- wire mode, with a tri-stating transceiver, may require a module to have its switch in the master position, even if its not acting as the master.

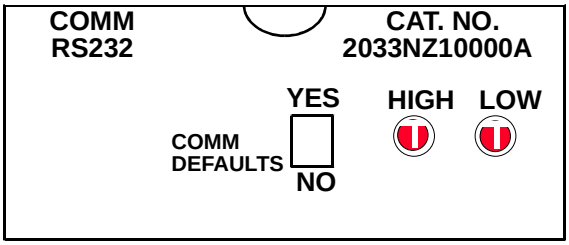
THE COM DEFAULTS SWITCH

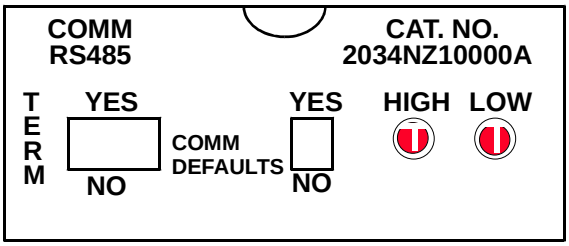
- If the MOD30 ML or Modcell MLP configuration is unknown, setting this switch to th eYES position will allow communications with the unit at 9600 baud, no parity, 8 data bits and 1 stop bit. After downloading the desired parameters, remove power, COM DEFAULTS switch to NO and power up.

THE HIGH AND LOW SWITCHES

- Set the MODBUS Address
- The High switch sets the first hexadecimal digit of the address, and the Low switch sets the second. For example, a switch setting of 13 hex represents a decimal address of 19.

The 2-wire RS-485 module has no switches. It must be configured by the Application Builder software, to change the factory defaults. The factory defaults are 9600 baud, no parity, 8 data bits, one stop bit and a MODBUS address of one. Do not connect an unconfigured module to a network if there is another device on the network with address one.





* NOTE: Address is indicated with the flat side of the switch

Figure 4. Module Switches

MODBUS MASTER

MASTER REQUIREMENTS

MODBUS Master communication requires a few special configuration items.

1. MSC Block - Each MSC block that will be used for MODBUS Master communications must have the Port Functionality set to Master.
2. EX Block for Port Configuration - Each MODBUS Master port requires a specially configured Expression block to define its parameters.
3. EX Block for Communications - Expression blocks are configured to send and receive the actual communication messages. The first 10 inputs are dedicated to configuration and status. The remaining inputs may be used to read or write data. Each block is configured to execute a specific type of MODBUS function. The only relevant factor that limits the number of these blocks is performance.

DATA CONVERSION

Analog data in a newer Commander instruments and the 2050R is stored as a 16-bit signed integer value. Integer values in the Modcell MLP and MOD30ML are unsigned. The decimal point position is also read as a separate value. When reading or writing analog values between these instruments, expression blocks are used to convert from one integer type to the other. The table below indicates the relationship between the two number formats.

Table 5. Integer Conversion - Signed to Unsigned

Signed 16-Bit Number	Unsigned 16-Bit Number
0	0
32767	32767
-32768	32768
-1	65535

SCALER BLOCK

One expression block is required for each slave instrument, for decimal point scaling. The expression is as follows:

if DecPt == 0 then 1.0 else
if DecPt == 1 then 10.0 else
if DecPt == 2 then 100.0 else 1000.0

DecPt is a COUNT input which is read from the slave instrument.
The block's Result is a FLOATING-POINT scaler.

INPUT CONVERT BLOCK

One expression block is required for each analog value read from the slave instrument, for data type conversion. The expression is as follows:

if Input > 32767 then (Input - 65536.0) / Scaler
else Input / Scaler

Input is a COUNT value which is read from the slave instrument.
Scaler is the FLOATING-POINT result of the Scaler block.

OUTPUT CONVERT BLOCK

One expression block is required for each analog value written to the slave instrument, for data type conversion. The expression is as follows:

if (Output * Scaler) > 32767.0 then 32767 else
if (Output * Scaler) < -32768.0 then 32768 else
if Output >= 0 then Output * Scaler else
65536.0 + (Output * Scaler)

Output is the FLOATING-POINT number to be converted to a COUNT, and send to the slave instrument.
Scaler is the FLOATING-POINT result of the Scaler block.

MODBUS WITH COMMANDER SERIES INSTRUMENTS

SCALING ANALOG VALUES

The first Commander instruments to support MODBUS handled scaling of analog values in a different way than later instruments. The C200, C300, C1900 and PR100 use a 12-bit register with a raw range of 0 to 4095. The host must scale the value to obtain the desired engineering unit value.

Newer models, such as the C100, C150, C250, C500 and PR250, place an engineering unit value into one or two 16-bit registers. If two registers are used, the data type is considered a long integer. Values are represented as positive or negative integers without a decimal point. If a decimal point is used in the instrument, additional scaling must be performed at the host.

COMMUNICATIONS CONFIGURATION

The Commander must be configured from the face of the instrument via the Serial Data Communications page. If this page is not accessible, the communications option may not be installed. Some Commanders use a security switch to access the configuration mode. The parameters on this menu group must be set to match host or Modbus Master device. The 3 Line type refers to 2-wire (half-duplex) with a common, where 5 Line is 4-wire (full-duplex) with a common. The number of Start and Data bits are fixed at 1, 8 respectively. The number of Stop Bits is not configurable and can be set to 1 or 2 at the host. Parity can be set to none, odd or even and must match the Host setting. The Ident or Addr entry configures the Modbus Slave address.

CONNECTION WITHIN THE NETWORK

One additional subject that must be addressed, is the electrical stabilization and electrical connection of the RS-485 network. By definition, the Modbus Master device is to supply the pull-up and pull-down resistors to stabilize the network. If the interface device does not have that capability, you may select the "Linked In" jumper setting on the Commander. If the stabilizing is performed at the Commander, and the Commander fails or is removed from the network, all communications may be stopped. Depending on the length of your cable, you may also need termination resistors, which may be installed externally for 3-wire or by a jumper for 5-wire configurations.

HOST CONFIGURATION EXAMPLES

MODBUS WITH FIX AND COMMANDER 150

Either the MB1 or EMP driver may be used, though EMP is recommended. The MODBUS guide uses 1 and 2-digit numbers for addresses. Note that the actual addressing requires a 5-digit number. For digital addresses, use 000xx format, where xx represents the coil address from the instruction book. For analog addresses, use 400xx format, where xx represents the register address from the instruction book.

Table 6. MODBUS with FIX and Commander 150

Poll Record Configuration			
Hardware	MODBUS		
Addressing Type	5-Digit		
Bit Base	0-15		
Data Types	Unsigned - Positive Analog Ranges (up to 9999) Signed - Analog Ranges (between -999 and +9999) Long - Analog Double Register Values (between -9999 and 99999)		
Database Configuration			
Data Type	Database Block	Address Range	Notes
Digital Input	DI	000xx	
Digital Output	DO	000xx	
Digital I/O	DR	000xx	select output enable
Analog Input	AI	400xx	LIN Signal Conditioning
Analog Output	AO	400xx	LIN Signal Conditioning
Analog I/O	AR	400xx	LIN Signal Conditioning

NOTES:

1. Each line of the poll record can have no more than 8 analog or 16 digital addresses.
2. It is acceptable to “read through” undefined addresses.
3. Use a calculation block to scale for proper decimal point position.

MODBUS WITH FIX AND COMMANDER 300

Either the MB1 or EMP driver may be used, though EMP is recommended. The MODBUS guide uses 3-digit numbers for addresses. Note that the actual addressing requires a 5-digit number. For digital addresses, use 00xxx format, where xxx represents the coil address from the instruction book. For analog addresses, use 40xxx format, where xxx represents the register address from the instruction book.

Table 7. MODBUS with FIX and Commander 300

Poll Record Configuration			
Hardware	MODBUS		
Addressing Type	5-Digit		
Bit Base	0-15		
Data Type	Unsigned - Positive Analog Ranges (0 to 4095) Signed - Analog Ranges that go Negative (-2048 to +2047)		
Database Configuration			
Data Type	Database Block	Address Range	Notes
Digital Input	DI	00xxx	
Digital Output	DO	00xxx	
Digital I/O	DR	00xxx	select output enable
Analog Input	AI	40xxx	12BN (positive) or LZ12 (live zero) Signal Conditioning
Analog Output	AO	40xxx	12BN (positive) or LZ12 (live zero) Signal Conditioning
Analog I/O	AR	40xxx	12BN (positive) or LZ12 (live zero) Signal Conditioning

NOTES:

1. Ensure that each line of the poll record contains no more than 8 analogs or 16 digital addresses.
2. It is acceptable to “read through” undefined addresses.

MODBUS WITH INTOUCH AND COMMANDER 300

Below are configuration entries that have been tested with the InTouch Modbus DDE Server and C300.

Table 8. MODBUS with InTouch and Commander 300

Hardware	584/984 PLC
String Variable Style	Full Length
Register Type	Binary
Block I/O Sizes	
Coil Read - 16	Register Read - 8
Coil Write***** - 8	Register Write - 8

* NOTE: The Commander supports only Single-Coil writes (Function Code 05), so Block I/O does not apply. InTouch allows a minimum setting of 8.

In the InTouch Display Configuration Window;

1. Select the desired Value Display Wizard to place a display field into the window
2. Double-click on the display field to configure it
3. Assign a Tagname
4. Check the Allow Input box if you wish to write values from the PC to the Commander
5. Define the Tagname
6. Select DDE Real for analog values
7. Set the Min and Max EU values to match the Commander Display Range
8. Set the Min and Max Raw values to the Response/Entry range specified in the Modbus guide
9. Select DDE Access Name as defined in the I/O Server
10. Specify the Item as a 5-digit Modbus address (i.e. 40051 for Process Variable 1)
11. Coil addresses in the Commander range from 00011 to 00181
12. Register addresses in the Commander range from 40011 to 40230

MODCELL MLP WITH TCP QUICKPANEL

Table 9. Wiring for RS-485 Full Duplex

QuickPanel jr.			Modcell MLP	
TXA	11	————	29-1	Rx+
TXB	15	————	29-2	Rx-
RXA	10	————	30-1	Tx+
RXB	16	————	30-2	Tx-
Frame Ground	1	— Shield		
RTS	4	——┐		
CTS	5	——┘		
CTSB	18	——┐		
DTRB	19	——┘		
CTSA	21	——┐		
DTRA	22	——┘		

PLC & Protocols

SIO/CN1 PLC Modicon Modbus is used when QuickPanel is Master to MLP
Modicon Modbus Slave is used when QuickPanel is slave to MLP
Port Electrical Format: RS-422/485 Full duplex
Baud rate, Data bits, Parity and Stop Bits to match the MLP configuration
Handshake: None
Protocol PLC ID: Modbus address of the MLP

Tags

Analog points are read from the MLP as an integer value (16-bit).
MLP floating-point numbers are not supported by this interface.

Addressing

Registers are referenced as a type and offset. Below are examples for Input Registers and Output (Holding) Registers.

Table 10. TCP QuickPanel Addressing

ML to MSC SROIN1	Modbus Address	QuickPanel Tag
Entry 1	30001	IR001
Entry 2	30002	IR002
ML to MSC SRWIN1		
Entry 1	40001	OR001
Entry 2	40002	OR002

If connecting more than one slave to the QuickPanel, append an underscore and Modbus address to the tag.
Example:

QuickPanel is configured to access PLC ID 1
For MLP at address 2, with the same registers as above, the tags would be IR001_2, IR002_2, OR001_2 and OR002_2.

Scaling

In ML Block, specify actual range for variable, if the number of significant digits is 5 or less. For ranges with more than 7 significant digits, such as 500,000 or 750.000, change the units to allow smaller numbers. For example, instead of 0 to 500,000 CFH, use 0 to 500 KCFH. Also note that the scale factor is for use only with mSec time values. The field is enabled for sources that can support the data type. If your source data is not mSec time, do not change the scale factor from default.

In QuickDesigner, leave Input Low at 0 and High at 65535. The Scale Low and High values should match what is in the Modbus List, unless a decimal is required. If digits to the right of the decimal are needed, multiply the range value by 10 for one place, 100 for two and etc.. For example, if two places are desired to the right of the decimal point with a range of 0 to 10, specify a Scale High of 1000. In display Data Format, specify 2 decimal places.

MOD30ML AND MODCELL MLP REFERENCE TABLES

Table 11. MOD30ML and Modcell Multiloop Processor to Host Device or PC Sample Configuration Entries

MOD30ML or Modcell Multiloop Processor										Host Device or PC						
Signal Source			List													
Data Type	Engineering Range		Type		Entry Number	Modbus List Range		Scale Factor	MSC Connection	Modbus Address	Data Type	Device Range		Engineering Range		Note
	Low	High	CL	ML		Low	High					Low	High	Low	High	
Floating Point	0	100		X	1	0	100		SRWIN1	40001	WORD	0	65535	0	100	
Floating Point	-10	10		X	2	-10	10		SRWIN1	40002	WORD	0	65535	-10	10	
Floating Point	-14	0		X	3	-14	0		SRWIN1	40003	WORD	0	65535	-14	0	
Floating Point	0	80000		X	1	0	8000		SRWIN2	40101	WORD	0	65535	0	8000	10x mult req'd
mSec Time	0	4294967295		X	2	0	65535	1	SRWIN2	40102	WORD	0	65535	0	65535	1 mSec / count
mSec Time	0	4294967295		X	3	0	65535	10	SRWIN2	40103	WORD	0	65535	0	65535	10 mSec / count
mSec Time	0	4294967295		X	4	0	65535	100	SRWIN2	40104	WORD	0	65535	0	65535	100 mSec / count
mSec Time	0	4294967295		X	5	0	65535	1000	SRWIN2	40105	WORD	0	65535	0	65535	1 Sec / count
mSec Time	0	4294967295		X	6	0	65535	10000	SRWIN2	40106	WORD	0	65535	0	65535	10 Sec / count
mSec Time	0	4294967295		X	7	0	65535	100000	SRWIN2	40107	WORD	0	65535	0	65535	100 Sec / count
Discrete	0	1		X	8				SRWIN2	40108	WORD	0	65535	0	1	Bit 1 of 16
Discrete	0	1		X	9				SRWIN2	40109	WORD	0	65535	0	1	Bit 1 of 16
Discrete	0	1	X		1				DRWIN1	00001	BIT	0	1	0	1	Bit 1 of 1
Discrete	0	1	X		2				DRWIN1	00002	BIT	0	1	0	1	Bit 1 of 1
Floating Point	0	100	X		1				MRWIN1	41001	FLOAT	0	100	0	100	
Floating Point	-10	10	X		2				MRWIN1	41003	FLOAT	-10	10	-10	10	
Floating Point	-14	0	X		3				MRWIN1	41005	FLOAT	-14	0	-14	0	
Floating Point	0	80000	X		1				MRWIN2	41101	FLOAT	0	80000	0	80000	

* NOTE: When connections are made from a source that has a variable data type, the Range and Scale Factor fields may be enabled when they do not apply. In this case, leave the default Range of 0 to 65535 and Scale Factor of 1.

Table 12. MODBUS Reference Information for MOD30 ML and Modcell Communications

Code	Function	Action	Data Types	Max Points per Command	Address Range	From	To
01	Read Coil Status	Read one or more consecutive points	Discrete	99	00001-00499	CL	DRWIN1-5
02	Read Input Status	Read one or more consecutive points	Discrete	99	10001-10499	CL	DROIN1-5
03	Read Holding Registers	Read one or more consecutive registers	All except ASCII and HEX - One Register per Point	32	40001-40499	ML	SRWIN1-5
			Any - Uses as many Registers as req'd for Data	125	41001-45999	CL	MRWIN1-5
04	Read Input Registers	Read one or more consecutive registers	All except ASCII and HEX - One Register per Point	32	30001-30499	ML	SROIN1-5
			Any - Uses as many Registers as req'd for Data	125	31001-35999	CL	MROIN1-5
05	Force Single Coil	Write one point	Discrete	1	00001-00499	CL	DRWIN1-5
06	Preset Single Register	Write one register	All except ASCII and HEX - One Register per Point	1	40001-40499	ML	SRWIN1-5
			Any - Uses as many Registers as req'd for Data	1	41001-45999	CL	MRWIN1-5
08	Loopback Test	Return of Query (00)	For Diagnostic Use Only	N/A	N/A	N/A	N/A
15	Force Multiple Coils	Write one or more consecutive points	Discrete	16	00001-00499	CL	DRWIN1-5
16	Preset Multiple Registers	Write one or more consecutive registers	All except ASCII and HEX - One Register per Point	16	40001-40499	ML	SRWIN1-5
			Any - Uses as many Registers as req'd for Data	16	41001-45999	CL	MRWIN1-5
65	Extended Modbus	Read and/or Write any Data Type	Any - Data in buffer, rather than Coils or Registers	Note 6	n/a	CL	FGLISTIN

NOTES:

1. Placing discrete points into Holding or Input Registers uses an entire 16 bit register for one point. This may be more efficient when only a small amount of discrete data is required, along with analog data. If a significant number of discrete points are required, communications and memory efficiency would be improved by placing them into the Coil or Input Status area. Another possibility would be to pack 16 discrete points into a count and store it in an Input or Holding Register. This would be dependent on the host device's ability to accept the packed data format.
2. Date, Floating Point and mSec Time are converted to 16 bit integers when tied to an ML register.
3. It is recommended that no more than the number of points supported per command be put into each Slave ML block. This will prevent the Master device from accessing more than the allowed number of points in a single command. The instrument will not return any data if the maximum number of registers is exceeded or an invalid register is included. Some HMI packages, such as Fix DMACS, allow poll records to be broken into groups to avoid this problem.
4. When using Extended Modbus, group control loop data together in CL blocks for greatest efficiency.
5. Some peripheral equipment that is designed for Modbus communications may not support Extended Modbus (function code 65).
6. The instrument's foreground can hold up to 2400 bytes of data. The number of points that can be handled per command depends on the host software. Connecting the CL block to BGLISTIN may provide increased performance with some host configurations. This is the case when using Database Caching with PC-30 or Genesis for Windows. Without Database Caching enabled, a connection to FGLISTIN is recommended.
7. Each Modbus List block can contain up to 99 points, and each type of connection provides inputs for five lists. This is also true for Configured List blocks for Standard Modbus. When using Extended Modbus, Configured List blocks may be nested, allowing more than 99 points to be connected to FGLISTIN or BGLISTIN.

WIRE CONNECTIONS

Table 13. Wire Connections for RS-232 Devices

PC Serial Port		MOD30ML			Mod cell	RS-232			MOD30ML			Modcell
25-Pin	9-Pin	Port 1		Port 2					Port 1		Port 2	
		BI	9&10	7&8	MLP	Master		Slave	BI	9&10	7&8	MLP
2	3	3	9	13	Hi-1	Tx	⇒	Rx	2	8	12	Hi-2
3	2	2	8	12	Hi-2	Rx	⇐	Tx	3	9	13	Hi-1
7	5	1	10	14	Lo-2	Gnd	⇔	Gnd	1	10	14	Lo-2

Table 14. Wire Connections for RS-485 (4 or 5-Wire) Devices

B&B	Quatech	OPTO-22	MOD30ML			Mod cell	RS-485 (4 or 5-Wire)			MOD30ML			Modcell	
3PXOCC2A	DSP-225	AC 24 AT	Port 1		Port 2					Port 1		Port 2		
3PXCC2A	DS-300	or AC 34	BI	9&10	7&8	MLP	Master		Slave	BI	9&10	7&8	MLP	2050R
2	2	4	3	9	13	Hi-1	Tx+	⇒	Rx+	5	11	15	Lo-1	35
3	7	5	2	8	12	Hi-2	Tx-	⇒	Rx-	4	10	14	Lo-2	34
9	4	8	5	11	15	Lo-1	Rx+	⇐	Tx+	3	9	13	Hi-1	33
1	8	9	4	10	14	Lo-2	Rx-	⇐	Tx-	2	8	12	Hi-2	32
5	3	3	1				Gnd	⇔	Gnd	1				29

B&B	Quatech	OPTO-22	RS-485 (4 or 5-Wire)			Commander							
3PXOCC2A	DSP-225	AC 24 AT						C100					
3PXCC2A	DS-300	or AC 34	Master		Slave	MR250	C1900	C150	C200	C300	C310	C500	PR100
2	2	4	Tx+	⇒	Rx+	7	7	22	7	9	21	34	3
3	7	5	Tx-	⇒	Rx-	8	6	23	6	10	22	35	2
9	4	8	Rx+	⇐	Tx+	3	4	20	4	11	18	32	5
1	8	9	Rx-	⇐	Tx-	2	5	21	5	12	19	33	6
5	3	3	Gnd	⇔	Gnd	12	8	24	Gnd	8	20	36	8

Table 15. Wire Connections for RS-485 (2 or 3-Wire) Devices

B&B	Quatech	OPTO-22	MOD30ML			Mod cell	RS-485 (2 or 3-Wire)			MOD30ML			Modcell	
3PXOCC2A	DSP-225	AC 24 AT	Port 1		Port 2					Port 1		Port 2		
3PXCC2A	DS-300	or AC 34	BI	9&10	7&8	MLP	Master		Slave	BI	9&10	7&8	MLP	2050R
2&9	2&4	4-8	3&5	9&11	13&15	Hi&Lo-1	RxTx+	⇔	RxTx+	3&5	9	13	-1	33&35
3&1	7&8	5-9	2&4	8&10	12&14	Hi&Lo-2	RxTx-	⇔	RxTx-	2&4	8	12	-2	32&34
5	3	3	1				Gnd	⇔	Gnd	1				29

B&B	Quatech	OPTO-22	RS-485 (2 or 3-Wire)			Commander							
3PXOCC2A	DSP-225	AC 24 AT						C100					
3PXCC2A	DS-300	or AC 34	Master		Slave	MR250	C1900	C150	C200	C300	C310	C500	PR100
2&9	2&4	4-8	RxTx+	⇔	RxTx+	3&7	4	22	4			34	
3&1	7&8	5-9	RxTx-	⇔	RxTx-	2&8	5	23	5			35	
5	3	3	Gnd	⇔	Gnd	12	8	24	7			36	

* NOTES: 1. MOD30ML and Modcell do not support MODBUS Master communications with a 2-wire RS-485 module.
2. On Modcell MLP and MOD30ML, 4-wire modules are recommended for all applications, even for 2-wire installations.

⚠ **WARNING** Incorrect wiring can damage communication hardware.

MODBUS MODULE TROUBLESHOOTING WITH MOD30ML AND MODCELL MLP

* NOTE: The extended Modbus communications required for diagnostics and downloading is supported by the 2033N and 2034N modules only. On Modcell, the Identity module firmware must be at least version 4 Logic, version 3 Regulatory, Batch, or Advanced.

1. Remove power from the instrument.
2. Note the switch settings on the Modbus module. Two rotary switches are used to select the address. The address is indicated in hexadecimal, by the flat side of the spindle, with A through F representing 10 through 15.
3. Set the COMM DEFAULTS switch to YES. This will force the module to communicate at 9600 baud, 8 data bits, 1 stop bit and no parity, regardless of the database configuration. Note that these default parameters will be in effect whenever the default database is being executed.
4. If using an RS-485 module, set the TERM switch to NO. This switch provides pull-up and pull-down resistors to stabilize the network. This function is defined by the Modbus specification as the responsibility of the master node, which is the PC in this case. In some cases, it may be necessary to enable this termination, if the PC interface is unable to stabilize the network.
5. Apply power to the equipment.
6. Start the Application Builder software and select the serial port configuration button. Select the serial port that is connected to the instrument and confirm the port settings. The standard Base Addresses are 3F8, 2F8, 3E8 and 2E8 for Com1 through Com4 respectively. If unsure of the address, check the hardware manual for configuration information. Set the Baud Rate to 9600, Data Bits to 8, Parity to None and Stop Bits to 1.
7. Enter the Status display and select the communications setup button. Set the communications type to Extended Modbus. Set the Modbus Address to match the module setting and select the com port to be used. Select OK to close the dialog box. The ICN and Instrument number settings have no effect.
8. Click on the Status line at the bottom of the screen and enter R VERSION. This command will return the version of the instrument. If the instrument responds, confirm that the reported version agrees with the type of instrument that is being tested.
9. If unable to establish communications, disconnect power and remove all analog and communications modules, except for the Modbus module being used. If still unable to communicate, replace the Modbus module. If all previous procedures fail, replace the instrument.

GLOSSARY

The following terms are defined as they relate to this document. The definitions given here may not be the same throughout the industry.

Alias	A meaningful short-hand name given to a data point
Baud	Serial communication data transmission rate
Bit	A binary digit, representing a one or zero
Bus	An electrical circuit over which data is transmitted
Byte	A whole number value represented by eight bits (0 to 255)
CL block	Configured List block
Chassis or Chassis Ground	A connection to an electrically conductive housing or frame of a device. It may or may not be connected to Earth Ground.
Common	The voltage reference point of a circuit. It may or may not be connected to earth ground, though it is generally assumed to be at zero volts, unless otherwise indicated. In floating circuits, the common is sometimes at a relatively high potential. This term is sometimes used interchangeably with the term “Ground”.
CRC	Cyclic Redundancy Check. Complex error checking on a message block.
CTS	ClearToSend hardware handshaking signal. Used with RequestToSend.
Earth or Earth Ground	Global zero voltage reference point. Physical connection is made to the earth through a grounding rod, water pipe or other reliable connection.
Ground	Voltage reference point of a circuit. It may or may not be connected to earth ground, though it is generally assumed to be at zero volts. Sometimes used interchangeably with the term “Common”.
Handshaking	A method of data flow control for serial communications
Hexadecimal or HEX	A number system using a decimal 16 as its base. A single digit number in HEX ranges from 0 to 15, represented by 0 to 9 and A to F.
HMI	Human-Machine Interface (formerly MMI)
Live Zero	Indicates that a numeric range contains both positive and negative numbers
Loopback	A test used for checking functionality of a serial port, utilizing a test plug that connects send, receive and handshaking signals
Long Integer	Analog value consisting of two consecutive 16-bit registers
ML block	MODBUS List block
MLP	MultiLoop Processor (Modcell 2000 Series Controller)
MSC block	MODBUS Serial Communications block
Parity	Simple method of data error checking performed at the byte level. May be user-specified as Odd, Even or None with most equipment and software.

PC	Personal Computer
Receive	Incoming communication signal. (Rx)
RTS	RequestToSend hardware handshaking signal. Used with ClearToSend.
Rx	See Receive
RxA	Usually the negative Receive line. May vary with manufacturer. Also see Receive
RxB	Usually the positive Receive line. May vary with manufacturer. Also see Receive
Signed Integer	Whole number value represented by 16 bits (-32768 to 32767)
Transmit	Outgoing communication signal. (Tx)
Tri-State	The ability of a communications transmitter to turn its circuitry off, reducing the load on the network
Tx	see Transmit
TxA	Usually the negative Transmit line. May vary with manufacturer. Also see Transmit
TxB	Usually the positive Transmit line. May vary with manufacturer. Also see Transmit
Unsigned Integer	Positive whole number value represented by 16 bits (0 to 65535)
Word	A group of 16 bits
Xon/Xoff	Software implementation of data flow control

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