

SERIAL ELECTRO-PNEUMATIC CONTROL BOARD

FUNCTIONAL DESCRIPTION

The Proportion-Air QBT, QBX, QPV, QB3, QB4 and QL3 series devices are available with the Modbus RS232 and RS485 electrical interfaces. This allows them to be controlled by a personal computer or by a master on a Modbus network.

The two electrical interfaces have different capabilities. A Modbus RS232 interface is limited to one master and one slave. A Modbus RS485 interface can have multiple slaves on a bus network. The Proportion-Air Modbus board, internal to the Proportion-Air devices, has passed the Modbus serial protocol test and conforms to the Modbus regular implementation class.

To control a Proportion-Air Modbus slave from a PC, the master emulator from simplymodbus.ca may be used.

This specification assumes that the reader is familiar with the *MODBUS over Serial Line Specification and Implementation Guide* and the *MODBUS APPLICATION PROTOCOL SPECIFICATION* which are available at Modbus.org

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Available with these Models

QBT QPV QB3

QBX QL3 QB4

SPECIFICATIONS

ELECTRICAL

POWER REQUIREMENT	15-24 VDC
SUPPLY CURRENT	Analog Model Current +50 mA
UNIT LOAD	1

SERIAL/DIGITAL

PROTOCOL	Modbus Serial
TRANSMISSION MODES	ASCII, RTU (<i>default</i>)
NODE TYPE	Slave
COMMAND RESOLUTION	16 bits
FEEDBACK RESOLUTION	16 bits
PARITY OPTIONS	No Parity, Even Parity (<i>default</i>)
BAUDRATE OPTIONS	9.6k baud, 19.2k baud (<i>default</i>) 57.6k baud, 115.2k baud

ELECTRICAL INTERFACE

RS232 - Full Duplex

RS485 - Half Duplex, 2 wire (*default*)

ESD Protection $\pm 15kV$ (*HBM*)

Full Fail Safe (*Open/Short*) Rx in RS485

FUNCTION CODES SUPPORTED

- 03 Read Holding Registers
- 08 Diagnostics
- 16 Write Multiple Registers

	Terminal Position	Modbus RS232 Signals	Modbus RS485 Signals
5 Pin Terminal Block	1	Power	Power
	2	Common	Common
	3	TXD	D1
	4	RXD	D0
	5	Shield	Shield

3 RS485 PHYSICAL LAYER

3.1 MULTIPOINT SERIAL BUS INFRASTRUCTURE

The Modbus Board on RS485 is a multipoint system in a two wire configuration. The device allows up to 32 devices on each bus without a repeater. Any combination of drivers and receivers can be used as long as the drivers can be put in a tri-state condition.

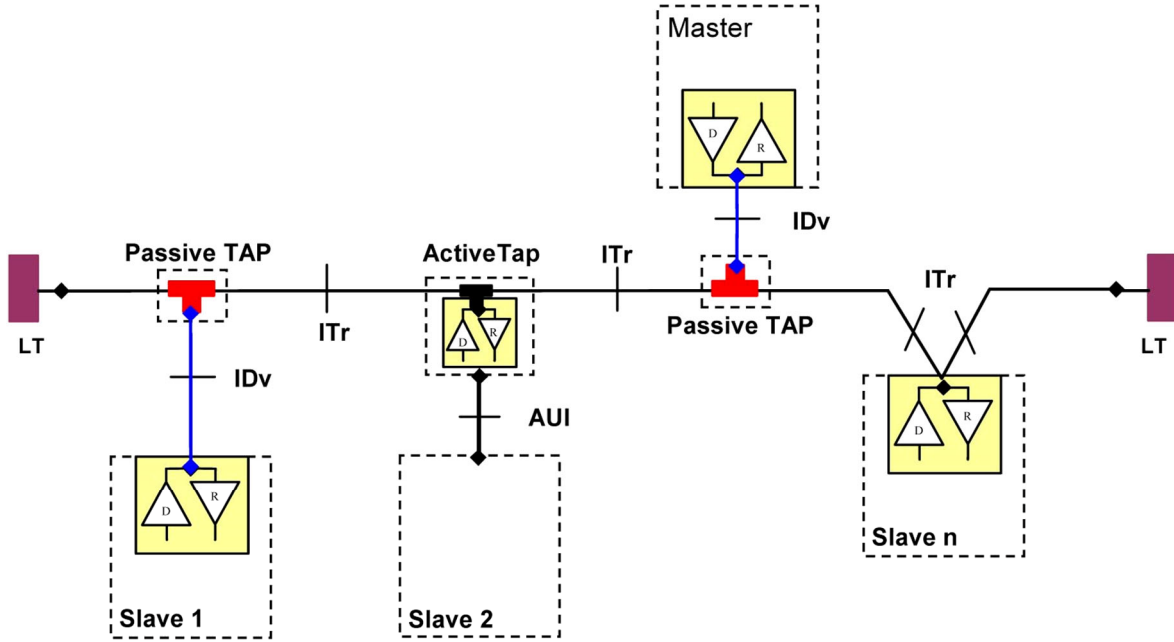


Figure 1: Serial bus infrastructure

TRUNK - Principal Cable

AUI	Attachment Unit Interface - The interface between the device and the Active Tap
IDv	Derivation Interface - The interface between the device and the Passive Tap
ITr	Trunk Interface - The interface with the Trunk
LT	Line Termination - Resistors at both ends of the trunk

At the 115.2k baud rate these devices can operate up to 4000 ft. (1219m). Derivation cables or drop lines for slaves must not be more than 65ft. (20m).

The Modbus Board has “full failsafe” operation so that the receiver output remains in a high state if the inputs are unconnected (floating), shorted together, or if the bus is terminated but not driven.

Proportion-Air devices connect to the trunk through a passive tap.

3.2 TWO-WIRE MODBUS DEFINITION

Proportion-Air products containing the Modbus Board can be used on a RS485 “two-wire” electrical interface.

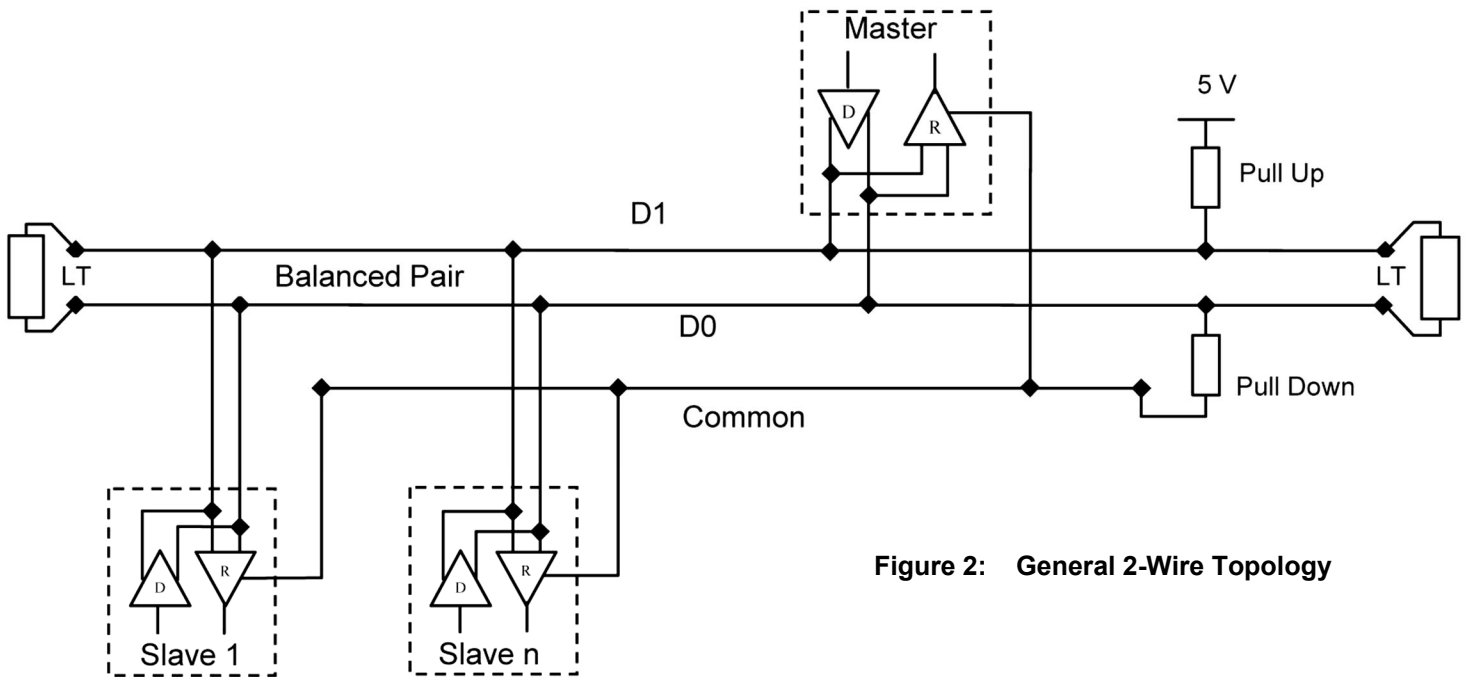


Figure 2: General 2-Wire Topology

Table 1

2W-MODBUS Circuits Definition					
Required Circuits		EIA/TIA-485 name	Description		
On ITr	On IDv				
D1	D1	B/B'	Transceiver terminal 1, V1 Voltage (V1 > V0 for binary 1 [OFF] state)		
D0	D0	A/A'	Transceiver terminal 0, V0 Voltage (V0 > V1 for binary 0 [ON] state)		
Common	Common	C/C'	Signal and optional power supply common		

Notes: A 15 - 24VDC power supply is an optional electric interface.

3.3 LINE TERMINATION

In many RS485 networks, line terminations are necessary to minimize reflections when using high speed baud rates. The Modbus Board does not require line terminations; however, the Modbus specification requires that one line termination be put at each of the two ends of the trunk between the data lines, D0 and D1. Line terminations must not be placed on derivation cables.

The two resistors used for line terminations should match the characteristic impedance of the cable. For example, if the cable impedance is 120-ohms, each of the resistors must be 120-ohms 0.5W.

3.4 LINE POLARIZATION

The Modbus Board transceiver has a "full fail safe" function which assures a high level receiver output in cases when the receiver inputs are unconnected (floating), shorted together, or if the bus is terminated but not driven (i.e., differential voltage drops to nearly zero due to line termination). Line terminations do not disable the fail-safe function on the Modbus board.

Devices on a bus which do not have the fail-safe function must be polarized (or biased) using two additional resistors with the two parallel termination resistors to form a voltage divider network. The details of this biasing network are explained in the *MODBUS over Serial Line Specification and Implementation Guide*.

The Modbus board does not require line polarization; however, it will operate on a bus having line polarization.

The maximum number of devices authorized for a Modbus RS485 bus is reduced from 32 to 28 when polarization is implemented.

3.5 RS485 CONNECTIONS

The Proportion-Air Modbus device connects to a Modbus RS485 network through a derivation cable and a passive tap. Several connector and housing combinations are available for connecting Proportion-Air Modbus devices to the bus. The data and power can be run in the trunk and derivation cable or power can be supplied through a separate cable. There are several factors which determine the connector combinations: the type of environmental protection needed, the distance between the master and the slave(s), the current draw of the slaves on the network, and whether the unit requires and external sensor for second control loop. Three types of connectors are available when data and power are transmitted through the same cable: a 5-pin M12 male receptacle, a 5-pin terminal block and a 6-pin Hirschmann connector. In situations where the power runs in a separate cable, one 4-pin connector is used for power. The following figures and tables describe the connectors and their pin-outs:

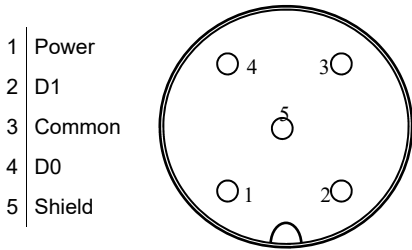


Figure 3: 5-Pin M12 Male Receptacle

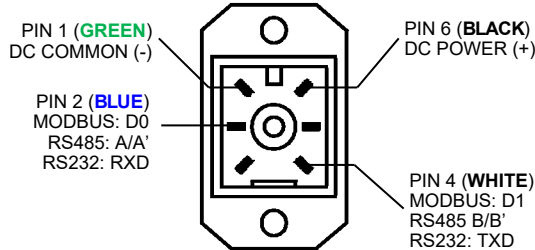
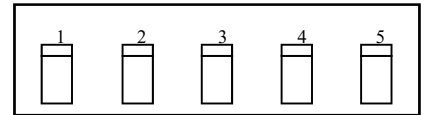


Figure 5: 6-Pin Hirschman Connector
*QB2 must have 3D option for second loop input



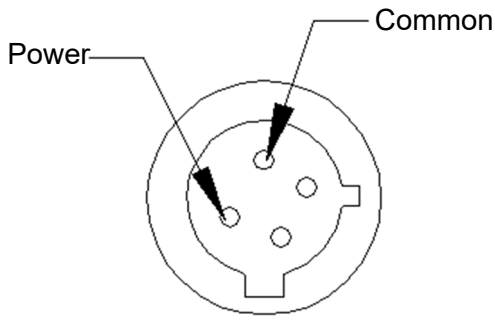
- 1 Power
- 2 Common
- 3 D1
- 4 D0
- 5 Shield

Figure 4: 5-Pin Terminal Block

Table 2: RS485 Pin-outs for M12 Receptacle and Terminal Block

Modbus Name	EIA/TIA-485 Name	Description	M12 Receptacle Pins	Terminal Block Pins
D1	B/B'	Transceiver Terminal 1, V1 Voltage	2	3
D0	A/A'	Transceiver Terminal 0, V0 Voltage	4	4
Common	C/C'	Signal and Power Common	3	2
Power		Power Supply	1	1
Shield			5	5

In the situations where a 5-pin receptacle is used for data only, the following 4-pin receptacle is used to supply power.



SIGNAL	LEAD COLOR
Power	Red/Black
Common	Green

Figure 6: 4-Pin Power Receptacle on Housing

Table 3: Power Cord Color Code

3.5.1 M12 Receptacle and Housing Combinations

The following connection diagrams use the M12 receptacle to connect to the bus.

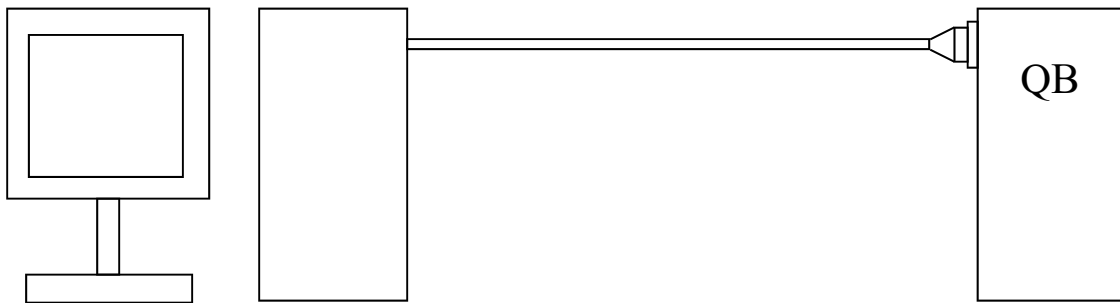


Figure 7: M12 Receptacle - Single Control Loop with Combined Data and Power



Figure 8: M12 Receptacle - Single Control Loop with Separate Power Cable

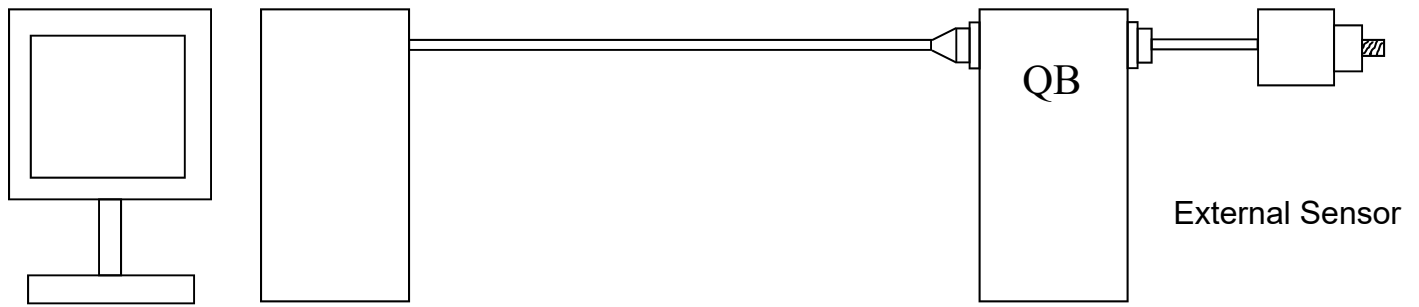


Figure 9: M12 Receptacle - Second Loop with Combined Data and Power Cable



Figure 10: M12 Receptacle - Second Loop with Separate Data and Power Cables

3.5.2 Terminal Block and Housing Combinations

The following connection diagrams use the terminal block to connect to the bus.



Figure 11: Terminal Block - Single Control Loop with Combined Data and Power Cable

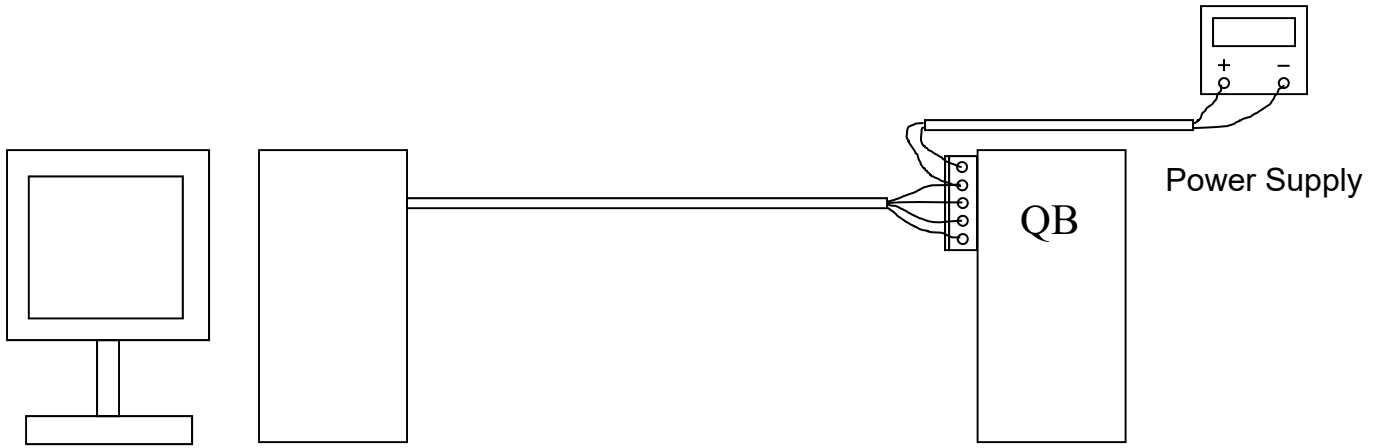


Figure 12: Terminal Block - Single Control Loop with Separate Power Cables



Figure 13: Terminal Block - Second Loop with Combined Data and Power Cables

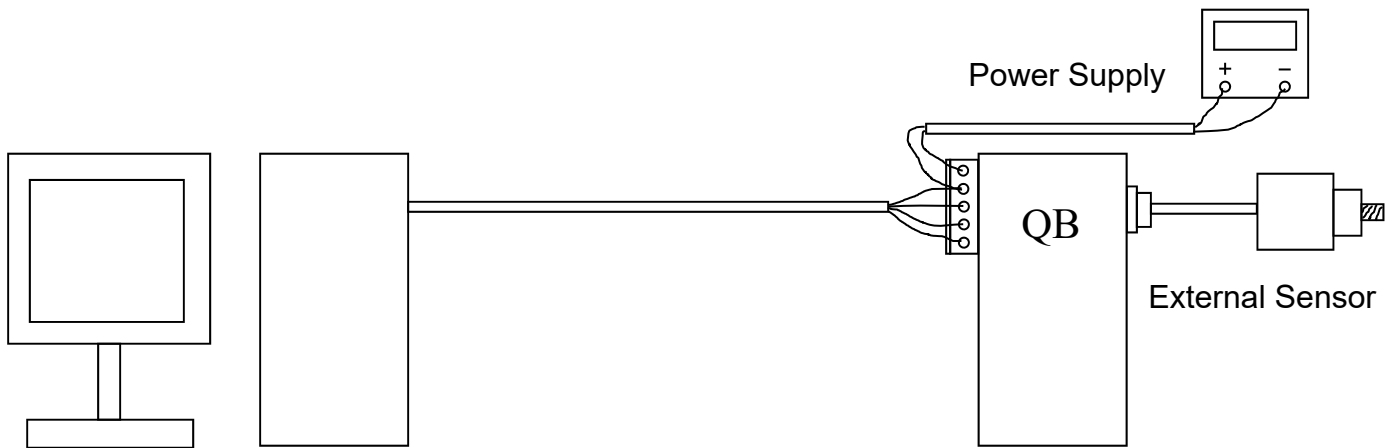


Figure 14: Terminal Block - Second Loop with Separate Data and Power

3.6 RS485 CABLES

The cables should be selected with the following criteria in mind.

- Most RS485 networks use cable with a 120 ohm characteristic impedance, but cables with higher impedances can be used.
- The Modbus specification states that the cable must be shielded, and at one of the cables the shield must be connected to a protective ground.
- Cables with twisted data pairs reduce the noise caused by magnetic coupling.
- A minimum of three conductors are needed: a twisted pair for data and another lead for signal ground. If power is supplied through the same cables as data, a fourth conductor is necessary.
- The Modbus specification states that the wire gauge of the conductors must be large enough to permit the maximum length of the bus (3280 ft. or 1000 m) and that AWG 24 is sufficient for Modbus data.

The following cables conform to EIA RS-485 and are suggested for use in Modbus RS-485 networks:

Belden	
#9842	2 twisted pairs, foil/braid, 120 Ohms, AWG 24
#3106A	1.5 twisted pairs, foil/braid, 120 Ohms, AWG 22
#3107A	2 twisted pairs, foil/brad, 120 Ohms, AWG 22
#3084	Power pair: AWG22
	Data pair: 120 Ohms, AWG24

4 RS232 PHYSICAL LAYER

On an RS232 interface (point-to-point) a single Modbus Board connects to a single PC or PLC. It operates as a DCE on a full-duplex RS232 interface using just three wires. Viewed with reference to the PC, these wires are RXD (receive), TXD (transmit) and Signal Common. The master’s request messages must include the address that was assigned to the slave.

4.1 RS232 CONNECTIONS

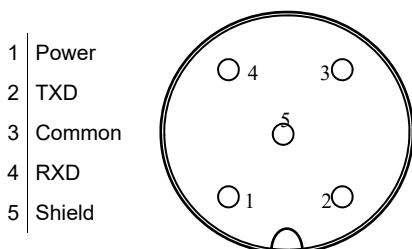


Figure 15: 5-Pin M12 Male Receptacle On Housing

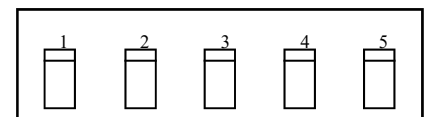


Figure 16: 5-Pin Terminal Block

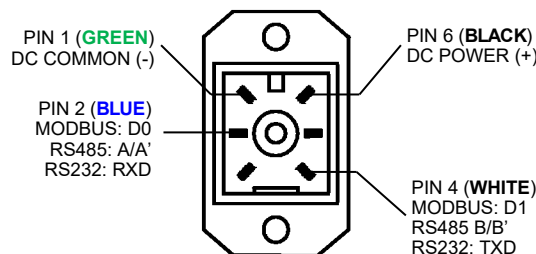


Figure 17: 6-Pin Hirschman Connector
*QB2 must have 3D option for second loop input

Table 4: RS232 Pin-outs for M12 Receptacle and Terminal Block

Master Signals	Proportion-Air Slave	M12 Receptacle Pins	Terminal Block Receptacle Pins
Common	Common	3	2
RXD	RXD	4	4
TXD	TXD	2	3
Power	Power	1	1
Shield	Shield	5	5

Note: The TXD and RXD are with respect to the PC or PLC as a DTE.

The same connection diagrams and receptacles that are used for RS485 in section 3.5 also apply to the RS232 interface.

4.2 RS232 CABLES

The cable length between the slave and the master should be less than 20m (65ft.) according to the Modbus Specification. The cable must be shielded and one end of the cable must be connected to a protective ground. The maximum wire capacitance to ground is 2500pf for a given cable length. The cables in the following list can be used for the RS232 bus. This list is not exhaustive.

*The Proportion-Air device should be treated as a DCE on the RS232 interface.

Belden	
#8102	2 twisted pairs, foil/braid, 100 Ohms, AWG 24
#8162	2 twisted pairs, foil/braid, 100 Ohms, AWG 24

5 MODBUS MESSAGING

5.1 BYTE AND WORD ORDERING

In the registers, data is stored with the high byte first followed by the low byte and the high word first followed by the low word.

5.2 DATA RANGE

The data range for the set point and feedback values is 0x0000 to 0xFFFF. The following are hexadecimal and decimal values for selected points in the data range.

% of Scale	Hexadecimal Value	Decimal Value
0	0x0000	0
10	0x1999	6553
25	0x3FFF	16383
50	0x7FFF	32767
75	0xBFFF	49151
90	0xE665	58982
100	0xFFFF	65535

Table 5: SELECTED POINTS IN DATA RANGE

5.3 FUNCTION CODES SUPPORTED

The Modbus Board supports the following function codes:

Function Code	Maximum Registers Accessible in 1 Message
03 (0x03) Read Holding Registers	16
08 (0x08) Diagnostics	-----
16 (0x10) Write Multiple Registers	16

Function 0x10 supports broadcast messaging.

5.4 DIAGNOSTICS MESSAGES

Under function 08, the following sub functions are supported:

- 00 (0x00) Return Query Data
- 10 (0x0A) Clear Counters
- 11 (0x0B) Return Bus Message Count
- 12 (0x0C) Return Bus Communication Error
- 13 (0x0D) Return Bus Exception Error Count
- 14 (0x0E) Return Slave Message Count
- 15 (0x0F) Return Slave No Response Count
- 18 (0x12) Return Bus Character Overrun Count
- 20 (0x14) Clear Overrun Counter and Flag

For sub-function 10 there is no Diagnostic Register. The counters used for diagnostics are 16 bits wide.

5.5 VISUAL DIAGNOSTICS

For visual diagnostics there are three LEDs labeled “POWER”, “COMMS”, and “ERROR”. Their colors are green, amber, and red respectively. In normal operation all three LEDs will switch ON when the device is initially powered up. The POWER LED will remain ON, but the COMMS and ERROR LEDs will light briefly. If the COMMS and/or the ERROR LED do not light on power up, it indicates that something is wrong with the device firmware.

The amber COMMS LED indicates that the device is transmitting or receiving.

When the red ERROR LED is ON it has only a flashing mode. It flashes whenever any of the sub-function error counters are greater than zero. If it flashes it could indicate the following errors: parity, longitudinal redundancy check (ASCII mode), cyclic redundancy check (RTU mode), character overrun, baud rate for RTU, or less than three characters received. If the device is successfully receiving requests from the master, the ERROR LED can be turned OFF by sending a request with sub-function 10 to clear the error counters.

5.6 EXCEPTION CODES SUPPORTED

The Modbus Board supports the following exception codes:

- 01 Illegal Function
- 02 Illegal Data Address
- 03 Illegal Data Value

5.7 REGISTER LIST

The following tables are the register lists for the Modbus Board codes.

Table 7: Register List for Function Codes 3 and 16

Parameter Name	Register No.	Data Address	Data Type	Range Hexadecimal	Register Access
Server Address	40001	0 (0000H)	Unsigned Int	0001H:00F7H	Read/Write
User Memory	40002	1 (0001H)	2 char ASCII	0000H:FFFFH	“
	40003	2 (0002H)	“	“	“
	40004	3 (0003H)	“	“	“
	40005	4 (0004H)	“	“	“
	40006	5 (0005H)	“	“	“
	40007	6 (0006H)	“	“	“
	40008	7 (0007H)	“	“	“
	40009	8 (0008H)	“	“	“
	40010	9 (0009H)	“	“	“
	40011	10 (000AH)	“	“	“
	40012	11 (000BH)	“	“	“
	40013	12 (000CH)	“	“	“
	40014	13 (000DH)	“	“	“
	40015	14 (000EH)	“	“	“
	40016	15 (000FH)	“	“	“
	40017	16 (0010H)	“	“	“
Serial No.	40018	17 (0011H)	“	“	“
	40019	18 (0012H)	“	“	“
	40020	19 (0013H)	“	“	“
	40021	20 (0014H)	“	“	“
Model No.	40022	21 (0015H)	“	“	“
	40023	22 (0016H)	“	“	“
	40024	23 (0017H)	“	“	“
	40025	24 (0018H)	“	“	“
	40026	25 (0019H)	“	“	“
	40027	26 (001AH)	“	“	“
	40028	27 (001BH)	“	“	“
	40029	28 (001CH)	“	“	“
Firmware Ver.	40030	29 (001DH)	“	“	“
	40031	30 (001EH)	“	“	“
	40032	31 (001FH)	“	“	“
Not Available	40033-40048	21H-30H	--	--	--

Parameter Name	Register No.	Data Address	Data Type	Range: Hexadecimal	Register Access
Monitor	40049	48 (0030H)	Unsigned Int	0000H-FFFFH	Read Only
Command	40050	49 (0031H)	“	“	Read/Write ¹

1. Single Register Write with function code 0x10

5.8 MESSAGE TIMING

In the **unicast** mode the master sends a request to one slave only, and the slave returns a response to the master. If the slave is not functioning properly, it will send a delayed response or it will not send one at all. In order to keep the master from waiting indefinitely for a response from a malfunctioning slave, the master waits a predetermined period called a “Response Time Out” before sending another message. The “Response Time Out” is specific for each combination of slave, function code, and baud rate.

In the **broadcast** mode, the master sends a request to all slaves, but the slaves do not return a response. Before sending its next request, the master must delay a sufficient amount of time to allow the slaves to process the request. The delay is called “Turnaround Delay” and it is specific for each combination of slave, function code, and baud rate.

Keep in mind that the times in the following tables apply only to the serial message capabilities of Proportion-Air devices. Pneumatic responses for the devices will be longer and are application dependent.

Table 9: RTU Response Time Out

Function Code	Maximum Registers Accessed	Baud Rate	Response Time Out
3	16	9.6 kbaud	49 ms
3	16	19.2 kbaud	26 ms
3	16	57.6 kbaud	11 ms
3	16	115.2 kbaud	8 ms
16	16	9.6 kbaud	173 ms
16	16	19.2 kbaud	166 ms
16	16	57.6 kbaud	162 ms
16	16	115.2 kbaud	161 ms

Table 10: ASCII Response Time Out

Function Code	Maximum Registers Accessed	Baud Rate	Response Time Out
3	16	9.6 kbaud	82 ms
3	16	19.2 kbaud	42 ms
3	16	57.6 kbaud	15 ms
3	16	115.2 kbaud	9 ms
16	16	9.6 kbaud	176 ms
16	16	19.2 kbaud	169 ms
16	16	57.6 kbaud	163 ms
16	16	115.2 kbaud	161 ms

Table 11: RTU Turnaround Delay

Function Code	Maximum Registers Accessed	Baud Rate	Response Time Out
16	16	9.6 kbaud	166 ms
16	16	19.2 kbaud	161 ms
16	16	57.6 kbaud	160 ms
16	16	115.2 kbaud	159 ms

Table 12: ASCII Turnaround Delay

Function Code	Maximum Registers Accessed	Baud Rate	Response Time Out
16	16	9.6 kbaud	160 ms
16	16	19.2 kbaud	160 ms
16	16	57.6 kbaud	160 ms
16	16	115.2 kbaud	150 ms

6 DIP SWITCH SETTINGS

The settings on the 6-position DIP switch provide the following choices: slave address, RTU mode, ASCII mode, parity, baud rate, RS232, and RS485. The DIP switch is accessible through an oval access hole on the top of the device. Switch settings do not take effect until after a power down and power up sequence. Refer to Figure 16 and to the following tables for the DIP position settings.

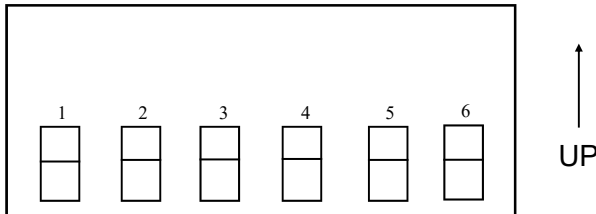


Figure 16: Dip Switch

Table 13: DIP Switch Assignment

Switch Position	Function
1	Slave Address
2	RTU or ASCII
3	Parity Mode
4	Baud Rate MSB
5	Baud Rate LSB
6	RS232 or RS485

Table 14: Slave Address Setting

Mode	DIP Position 1
Default (247)	Up
Stored Value	Down

Table 15: ASCII or RTU Setting

Mode	DIP Position 2
ASCII	Up
RTU	Down

Table 16: Parity Mode

Mode	DIP Position 3
No Parity	Up
Even Parity	Down

Table 17: Baud Rate

Baud Rate	DIP Position 4	DIP Position 5
115,200	Up	Up
57,600	Up	Down
19,200	Down	Up
9,600	Down	Down

Table 18: RS232 or RS485 Interface

Interface	DIP Position 6
RS485	Up
RS232	Down

Switch no.1 controls the Slave Address which has a valid range of 1 to 247. If switch no.1 is in the UP position, the Slave Address defaults to 247. Other slave addresses can be chosen by writing to a nonvolatile register address with a function 16 request using the following procedure:

1. With the device powered down, set position 1 to UP for slave address no. 247
2. Power up the device.
3. With function 16 (0x10), and slave address no. 247, write the desired Slave Address to Register 40001.
4. Power down the unit.
5. Set switch no. 1 to the DOWN position.
6. Then power up the unit after a few seconds.
7. The unit will respond only to the stored Slave Address.

Warning: At the time of the assigning the slave address, it is essential to insure that two devices do not have the same address. If the same address is assigned to more than one slave, it will cause abnormal behavior on the whole serial bus, because the master will not be able to communicate with all the slaves.

With either the RS232 or the RS485 interface, every Proportion-Air device must have a Slave Address recognized by the master.

Switch no. 2 offers the choice of RTU mode or ASCII mode. The switch is UP for ASCII and DOWN for RTU.

Switch no. 3 controls the Parity mode. Even Parity is DOWN and No Parity is UP.

The positions of switch numbers 4 and 5 set the Baud Rate. See table 5 for the four Baud Rate positions.

Switch no. 6 offers the choice of RS232 or RS 485. RS232 is DOWN and RS485 is UP.

The device is shipped from the factory with the following default values:

Table 19: DEFAULT DIP SWITCH SETTINGS

Switch No.	Position	Parameter	Value
1	UP	Slave Address	247
2	DOWN	Transmission Mode	RTU
3	DOWN	Parity	Even
4	DOWN	Baud Rate	19,200
5	UP	Baud Rate	19,200
6	UP	Electrical Interface	RS485, 2-wire

7 TROUBLE SHOOTING

If you have problems communicating with the Proportion-Air device, recheck the wiring connections and the DIP switch settings.

One easily overlooked mistake on a master simulator is to forget to set the Stop bit number to **two** for the No Parity setting.

If you are unsuccessful operating the device on an RS485 interface with an RS232/RS485 converter, switch the device to an RS232 interface to eliminate the added complexity of the RS232/RS485 converter. This will simplify troubleshooting.

The following columns are aides for troubleshooting.

PROBLEMS	POSSIBLE CAUSES
No LED's light up when unit is powered	Power not connected. Power leads not connected correctly.
No slave response to the master's request, but the COMMS LED blinks	The addresses on the slave and master do not match.
No slave response to the master's request, but the COMMS LED blinks and the ERROR LED blinks.	The parity settings are not correct. The baud rate is not correct. One device is set for ASCII and the other is set for RTU.
The slave is sending some valid responses, but the ERROR LED is blinking.	There are occasional errors with the CRC, LRC, parity, character overrun, or less than three bytes received.
Red ERROR LED blinks but no COMMS LED	The baud rate is not correct.

8 ORDERING INFORMATION

Please visit [Proportion-Air.com](https://www.proportionair.com) for ordering information. Or, select these links to go directly to the Proportion-Air product catalog and our How To Order Guide.

Download Product Catalog | <https://www.proportionair.com/literature/brochures/Proportion-Air-Product-Catalog.pdf>

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APPENDIX A: Example Messages

RTU MESSAGES

Function Code 03 - Reading Holding Registers

Purpose	To read the slave address stored in non-volatile memory.
Slave Address	247 (0xF7)
Starting Register	40001
No. of Registers	01
Master Request	[F7] [03] [00] [00] [00] [01] [90] [9C]
Slave Response	[F7] [03] [02] [00] [0A] [F0] [56]

Function Code 08 - Diagnostics

Purpose	Clear diagnostic counters
Slave Address	247 (0xF7)
Sub Function	10(0x000A)
Master Request	[F7] [08] [00] [0A] [00] [00] [D4] [9F]
Slave Response	[F7] [08] [00] [0A] [00] [00] [D4] [9F]

Function Code 16 - Write Multiple Registers

Purpose	Set pressure to 50% of full scale
Slave Address	247 (0xF7)
Starting Register	40050
Register Value	0x7FFF
Master Request	[F7] [10] [00] [31] [00] [01] [02] [7F] [FF] [ED] [A5]
Slave Response	[F7] [10] [00] [31] [00] [01] [44] [90]

ASCII MESSAGES

Function Code 03 – Reading Holding Registers

Purpose	To read the slave address stored in non-volatile memory.
Slave Address	247 (0xF7)
Starting Register	40001
No. of Registers	01
Master Request	:F7 03 00 00 00 01 05 [0D] [0A]
Slave Response	:F7 03 02 00 0A FA [0D] [0A]

Function Code 08 - Diagnostics

Purpose	Clear diagnostic counters
Slave Address	247 (0xF7)
Sub Function	10(0x000A)
Master Request	:F7 08 00 00 00 00 01 [0D] [0A]
Slave Response	:F7 08 00 00 00 00 01 [0D] [0A]

Function Code 16 - Write Multiple Registers

Purpose	Set pressure to 50% of full scale
Slave Address	247 (0xF7)
Starting Register	40050
Register Value	0x7FFF
Master Request	:F7 10 00 31 00 01 02 7F FF 47 [0D] [0A]
Slave Response	[:F7 10 00 31 00 01 C7 [0D] [0A]



Please read all of the following Safety Precautions before installing or operating any Proportion-Air, Inc. equipment or accessories. To confirm safety, be sure to observe 'ISO 4414: Pneumatic Fluid Power - General rules relating to systems' and other safety practices.



Warning

Improper operation could result in serious injury to persons or loss of life!

1. PRODUCT COMPATIBILITY

Proportion-Air, Inc. products and accessories are for use in industrial pneumatic applications with compressed air media. The compatibility of the equipment is the responsibility of the end user. Product performance and safety are the responsibility of the person who determined the compatibility of the system. Also, this person is responsible for continuously reviewing the suitability of the products specified for the system, referencing the latest catalog, installation manual, Safety Precautions and all materials related to the product.

2. EMERGENCY SHUTOFF

Proportion, Inc. products cannot be used as an emergency shutoff. A redundant safety system should be installed in the system to prevent serious injury or loss of life.

3. EXPLOSIVE ATMOSPHERES

Products and equipment should not be used where harmful, corrosive or explosive materials or gases are present. Unless certified, Proportion-Air, Inc. products cannot be used with flammable gases or in hazardous environments.

4. AIR QUALITY

Clean, dry air is not required for Proportion-Air, Inc. products. However, a 40 micron particulate filter is recommended to prevent solid contamination from entering the product.

5. TEMPERATURE

Products should be used with a media and ambient environment inside of the specified temperature range of 32°F to 158°F. Consult factory for expanded temperature ranges.

6. OPERATION

Only trained and certified personnel should operate electronic and pneumatic machinery and equipment. Electronics and pneumatics are very dangerous when handled incorrectly. All industry standard safety guidelines should be observed.

7. SERVICE AND MAINTENANCE

Service and maintenance of machinery and equipment should only be handled by trained and experienced operators. Inspection should only be performed after safety has been confirmed. Ensure all supply pressure has been exhausted and residual energy (compressed gas, springs, gravity, etc.) has been released in the entire system prior to removing equipment for service or maintenance.



Caution

Improper operation could result in serious injury to persons or damages to equipment!

1. PNEUMATIC CONNECTION

All pipes, pneumatic hose and tubing should be free of all contamination, debris and chips prior to installation. Flush pipes with compressed air to remove any loose particles.

2. THREAD SEALANT

To prevent product contamination, thread tape is not recommended. Instead, a non-migrating thread sealant is recommended for installation. Apply sealant a couple threads from the end of the pipe thread to prevent contamination.

3. ELECTRICAL CONNECTION

To prevent electronic damage, all electrical specifications should be reviewed and all electrical connections should be verified prior to operation.

Exemption from Liability

- Proportion-Air, Inc.** is exempted from any damages resulting from any operations not contained within the catalogs and/or instruction manuals and operations outside the range of its product specifications.
- Proportion-Air, Inc.** is exempted from any damage or loss whatsoever caused by malfunctions of its products when combined with other devices or software.
- Proportion-Air, Inc.** and its employees shall be exempted from any damage or loss resulting from earthquakes, fire, third person actions, accidents, intentional or unintentional operator error, product misapplication or irregular operating conditions.
- Proportion-Air, Inc.** and its employees shall be exempted from any damage or loss, either direct or indirect, including consequential damage or loss, claims, proceedings, demands, costs, expenses, judgments, awards, loss of profits or loss of chance and any other liability whatsoever including legal expenses and costs, which may be suffered or incurred, whether in tort (including negligence), contract, breach of statutory duty, equity or otherwise.

Warranty

Proportion-Air, Inc. products are warranted to the original purchaser only against defects in material or workmanship for 18 months from the date of manufacture. The extent of Proportion-Air's liability under this warranty is limited to repair or replacement of the defective unit at Proportion-Air's option. Proportion-Air shall have no liability under this warranty where improper installation or filtration occurred.

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