MOORE INDUSTRIES

March 2013
293-701-01D

I/O Express Peer-to-Host
Distributed Data System **DDS**

DDS *I/O Express Peer-to-Host Distributed Data System*

Contents

(continues)

List of Illustrations and Tables

Peer-to-Host

Introduction

I/O EXPRESS is the name given to the family of modules that make up Moore Industries' Distributed Data System (DDS). The DDS is a group of interface modules that provides a cost-effective communications link between multiple, dispersed points of input, output and control. Modules serve as everything from platforms for two-way communications between control room computers and analog and/or discrete field devices, to multiplexers that squeeze the signals of more than 7,000 points of input and/or output (I/O) over a single, digital Communications Link (Comm Link).

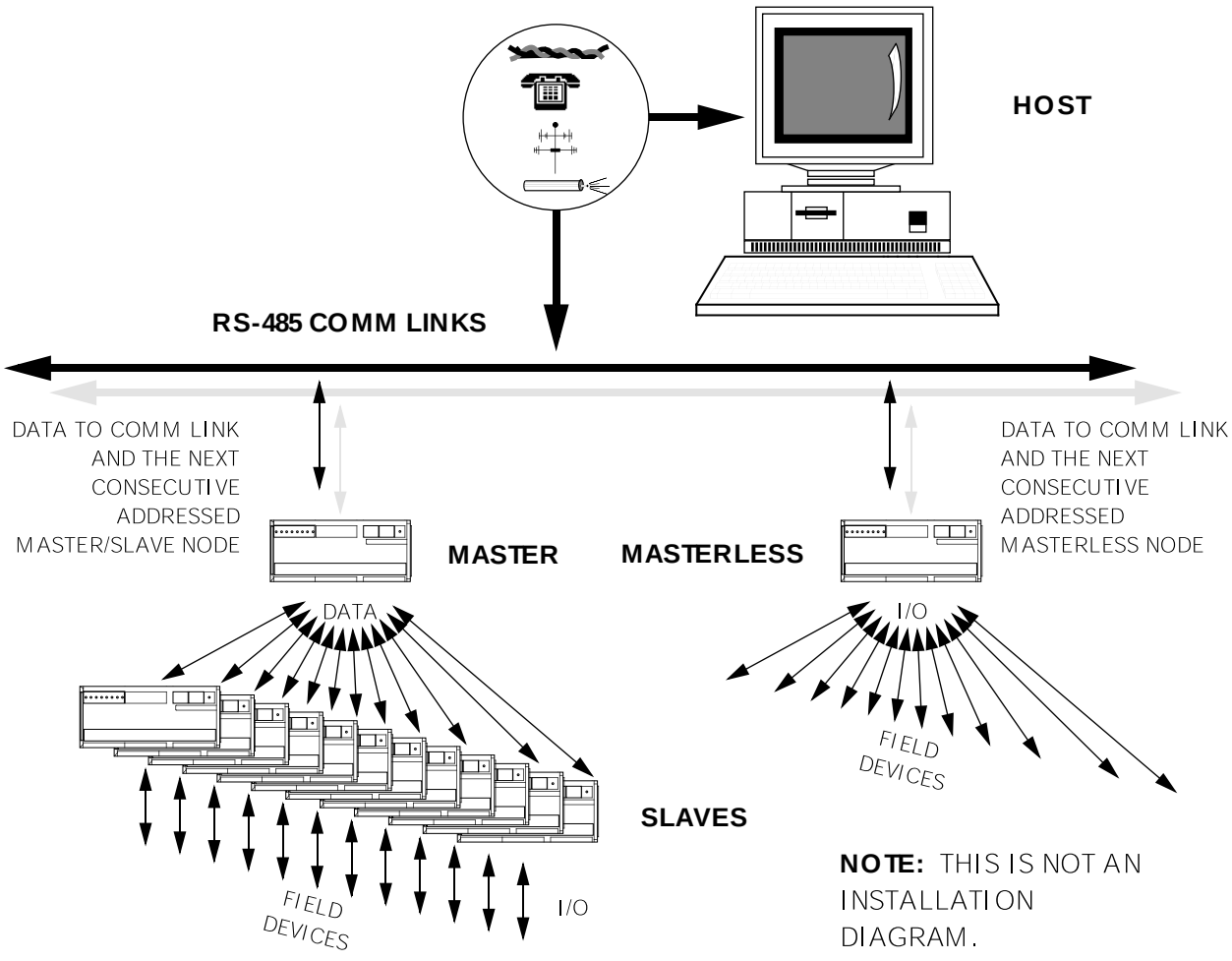
Peer-to-Host vs. Peer-to-Peer Systems

There are two basic types of ***I/O EXPRESS*** systems: Peer-to-Host and Peer-to-Peer. This manual provides information on Peer-to-Host systems. A Peer to Host ***I/O Express*** system relies upon the actions of a Host device to send data and/signals back and forth between points of control and I/O.

Figure 1 shows a general overview of a basic Peer-to-Host ***I/O EXPRESS***. The illustration shows all three types of modules: Masters, Slaves, and Masterless.

Peer-to-Peer systems, which operate without Host control, are covered in a separate manual. Contact the factory, or your local Moore Industries Sales rep-resentative for a copy.

Figure 1. *Understanding the* ***I/O EXPRESS***



The System Host

In this manual, the term "Host" refers to the combination of hardware and software used to communicate MODBUS[1] Remote Terminal Unit (MODBUS RTU) queries to connected ***I/O EXPRESS*** modules over the system Comm Link. Typically, a Host is a personal computer (PC), or some similar type of computer-based controller running distributed control (DCS) or super-visory command and data acquisition (SCADA) software.

Contact the factory for a list of compatible programs.

The Module Types — Masters, Slaves, and Masterless

Master modules multiplex the signals of up to 12 Slave modules. They do not accommodate field I/O signals directly, but combine the signals from all connected Slaves into a single, digital signal that is communicated to the Host over the Comm Link.

Slave modules take input from, and/or provide output to, field devices. They communicate these signals, in digital form, to Master modules, which then send the data over the Comm Link to the system Host.

Masterless modules take input directly from, and/or provide output directly to field devices. They communicate these signals directly to the Host.

Specifications—

Communications

- **Comm Link*** - Half-duplex, digital RS-485 (RS-232 optional) Master-to-Host and Masterless-to-Host. Physical connections may be made over twisted wire pair; fiber optic cabling; dial-up, leased line, or radio modems. Contact the factory, or your Moore Industries Sales representative, for information on Moore Industries' line of communications hardware, including modems, Link-to-Fiber and RS–485-to-RS–232 converters.
- **Protocol*** - MODBUS RTU for Masters-to-Host and Masterless to-Host. Refer to the Operation section of this manual for the valid subset of function codes. A separate, overview section on MODBUS queries is provided as well.
- **Serial Character Format*** - 8 data bits, 1 stop bit, no parity
- **Baud Rate*** - 2400, 4800, 9600, or 19200, user-set. Refer to the Installation section of this manual for instructions.
- **MODBUS Addressing*** - 1-31, user-set. Refer to the Installation section of this manual for instructions.
- **Analog Data Format*** - 12-bit, unsigned integer

* Slave-to-Master communications are simplex, RS-232, using a direct, 1-slave channel-to-1-master channel connection scheme. The protocol and data format is proprietary, and the baud rate is permanently set at the factory to 9600. I/O points multiplexed by Slave modules are monitored and/or controlled by the Host via Master modules only.

1 MODBUS, MODBUS REMOTE TERMINAL UNIT, and MODBUS RTU are products of Modicon, Incorporated.

Specifications—

Modules

Standard ***I/O EXPRESS*** modules accommodate analog inputs and outputs, discrete (digital) inputs and outputs, RTD and thermocouple (T/C) inputs, and relay outputs. The following Specifications listings are organized by I/O type.

The Ordering Information section following these lists, shows how Moore Industries refers to each module type. A brief explanation of Moore Industries' model numbering system is also presented in that section.

Master Modules

Performance	**Scan Rate:** 12 Slave channels updated every 50 to 150 milliseconds, depending upon the I/O configuration of the connected Slave module **Isolation:** 500Vdc between each Comm Link; 500Vdc between either of the Comm Links and Power; and 500Vdc between Comm Links, Power, and Slave modules	**Comm Link (continued)**	**Between Slaves and Masters:** RS-232 direct connection; each Slave to one channel on the Master **Range:** 1.6 km (1 mi) typical, for Master or Masterless modules communicating with the Host at 9600 baud over 20AWG twisted pair; 0.8 km (0.5 mi), typical, at 19.2k baud; 15 m (50 ft) between Slaves and Master modules See NOTE below **Protocol:** MODBUS RTU for Masters and Masterless modules to the Host; Master-Slave communications use a proprietary protocol	**Comm Link (continued)**	**Baud Rate:** User-set between Masters and Host, 2400, 4800, 9600, or 19200; Factory-set between Masters and Slaves, 9600 **Addressing:** User-set with external, wire jumpers 1-31
Comm Link	**Between Masterless modules and Host:** RS-485 multi-drop; two, independent Comm Links continuously maintained			**Power Supply**	11-30Vdc; Load: 2-4 Watts depending upon module type
				Ambient Conditions	**Operating Range:** Ð5¡C to +65¡C (23¡F to 150¡F) **Storage Range:** Ð25¡C to +85¡C (Ð13¡F to 185¡F) **Relative Humidity:** 10-90%, non-condensing
				Controls	External jumpers used to set baud rate and address
				Weight	580g (1.7 lbs)

Analog Input* Modules Ð Slave or Masterless

Performance	**Accuracy:** ±0.15% of span (12-bit resolution) **Scan Rate:** Each channel updated 200 times per sec **Isolation:** 500Vdc between each Comm Link; 500Vdc between either of the Comm Links and Power; and 500Vdc between Comm Links, Power, and input channels; ±7Vdc, (common mode) channel-to-channel **Impedance:** 4-20mA inputs: 250½; Voltage inputs: 1M½ **Common Mode Rejection:** >115dB @ 60Hz	**Comm Link (continued)**	**Between Slaves and Masters:** RS-232 direct connection; each Slave to one channel on the Master **Range:** 1.6 km (1 mi) typical, for Master and Masterless modules communicating with the Host at 9600 baud over 20AWG twisted pair; 0.8 km (0.5 mi), typical, at 19.2k baud; 15 m (50 ft) between Slaves and Master modules See NOTE below **Protocol:** MODBUS RTU for Masters and Masterless modules to the Host; Master-Slave communications use a proprietary protocol	**Comm Link (continued)**	**Baud Rate:** User-set between Masters and Host, 2400, 4800, 9600, or 19200; Factory-set between Masters and Slaves, 9600 **Addressing:** User-set with external, wire jumpers, 1-31
Comm Link	**Between Masterless modules and Host:** RS-485 multi-drop; two, independent Comm Links continuously maintained			**Power Supply**	11-30Vdc; Load: 2-4 Watts depending upon module type
				Ambient Conditions	**Operating Range:** Ð5¡C to +65¡C (23¡F to 150¡F) **Storage Range:** Ð25¡C to +85¡C (Ð13¡F to 185¡F) **Relative Humidity:** 10-90%, non-condensing **Ambient Temperature Effect:** ±0.018% per ¡C
				Controls	External jumpers used to set baud rate and address (Masterless modules only)
				Weight	580g (1.7 lbs)

*Excluding RTD or Thermocouple inputs, which are accommodated by other modules.
Note: Practical system range and throughput may be greater in many applications.

Specifications *(continued from page 3)*

Analog Output Modules Ð Slave or Masterless

Performance

Accuracy: ±0.15% of span (12-bit resolution)
Scan Rate: Each channel updated 100 times per sec
Isolation: 500Vdc between each Comm Link; 500Vdc between Comm Links and Power; 500Vdc between Comm Links and output channels
Drive Capability: 4-20mA units, 700½ maximum
Ripple: 1µA peak-to-peak

Comm Link

Between Masterless modules and Host: RS-485 multi-drop; two, independent Comm Links continuously maintained

Comm Link (continued)

Between Slaves and Masters: RS-232 direct connection; each Slave to one channel on the Master
Range: 1.6 km (1 mi) typical, for Master or Masterless modules communicating with the Host at 9600 baud over 20AWG twisted pair, 0.8 km (0.5 mi), typical at 19.2k baud; 15 m (50 ft) between Slaves and Master modules
See NOTE below
Protocol: MODBUS RTU for Masters and Masterless modules to the Host; Master-Slave communications use a proprietary protocol
Baud Rate: User-set between Masters and Host, 2400, 4800, 9600, or 19200; Factory-set between Masters and Slaves, 9600

Comm Link (continued)

Addressing: User-set with external, wire jumpers, 1-31

Power Supply

11-30Vdc; Load: 2-6 Watts depending on module type

Ambient Conditions

Operating Range: Ð5¡C to +65¡C (23¡F to 150¡F)
Storage Range: Ð25¡C to +85¡C (Ð13¡F to 185¡F)
Relative Humidity: 10 to 90%, non-condensing
Ambient Temperature Effect: ±0.015% per ¡C

Controls

External jumpers used to set baud rate and address (Masterless modules only)

Weight

580g (1.7 lbs)

Digital Input Modules Ð Slave or Masterless

Performance

Scan Rate: Each channel is updated 100 times per sec
Isolation: 500Vdc between each Comm Link; 500Vdc between Comm Links and Power connections; and 500Vdc between Comm Links, Power, and input channels
Impedance:3300½
Maximum Input Voltage: 30Vdc
Threshold: Guaranteed high state above 7V, guaranteed low state under 0.5V

Comm Link

Between Masterless modules and Host: RS-485 multi-drop; two, independent Comm Links continuously maintained

Comm Link (continued)

Between Slaves and Masters: RS-232 direct connection; each Slave to one channel on the Master
Range: 1.6 km (1 mi) typical, for Master or Masterless modules communicating with the Host at 9600 baud over 20AWG twisted pair; 0.8 km (0.5 mi), typical, at 19.2k baud; 15 m (50 ft) between Slaves and Master modules
See NOTE below
Protocol: MODBUS RTU for Masters and Masterless modules to the Host; Master-Slave communications use a proprietary protocol
Baud Rate: User-set between Masters and Host, 2400, 4800, 9600, or 19200; Factory-set between Masters and Slaves, 9600

Comm Link (continued)

Addressing: User-set with external, wire jumpers, 1-31

Power Supply

11-30Vdc; Load: 2-4 Watts depending on module type

Ambient Conditions

Operating Range: Ð5¡C to +65¡C (23¡F to 150¡F)
Storage Range: Ð25¡C to +85¡C (Ð13¡F to 185¡F)
Relative Humidity:10 to 90%, non-condensing

Controls

External jumpers used to set baud rate and address (Masterless modules only)

Weight

580g (1.7 lbs)

Note: Practical system range and throughput may be greater in many applications.

Specifications

Digital Output Modules (Open Collector) Ð Slave or Masterless

Performance

Scan Rate: Each channel updated 100 times per sec
Isolation: 500Vdc between each Comm Link; 500Vdc between Comm Links and Power; 500Vdc between Comm Links and output channels
Output Transistor Rating: Maximum ON Current, 200mA; Maximum OFF Voltage: 40Vdc

Comm Link

Between Masterless modules and Host: RS-485 multi-drop; two, independent Comm Links continuously maintained
Between Slaves and Masters: RS-232 direct connection; each Slave to one channel on the master

Comm Link (continued)

Range: 1.6 km (1 mi) typical, for Master or Masterless modules communicating with the Host at 9600 baud over 20AWG twisted pair; 0.8 km (0.5 mi) typical, at 19.2k baud; 15 m (50 ft) between Slaves and Master modules
See Note below
Protocol: MODBUS RTU for Masters and Masterless modules to the Host; Master-Slave communications use a proprietary protocol
Baud Rate: User-set between Masters and Host, 2400, 4800, 9600, or 19200; factory-set between Masters and Slaves, 9600
Addressing: User-set with external, wire jumpers, 1-31

Power Supply

11-30Vdc; Load: 2-4 Watts depending on module type

Ambient Conditions

Operating Range: Ð5¡C to +65¡C (23¡F to 150¡F)
Storage Range: Ð25¡C to +85¡C (Ð13¡F to 185¡F)
Relative Humidity: 10-90%, non-condensing

Controls

External jumpers used to set baud rate and address (Masterless modules only)

Weight

580g (1.7 lbs)

Relay Output Modules Ð Slave or Masterless

Performance

Scan Rate: Each channel updated 100 times per sec
Isolation: 500Vdc between each Comm Link; 500Vdc between Comm Links and Power; 500Vdc between Comm Links, Power, and output channels; and 250Vdc between output channels

Contacts

8-channle modules are SPDT, rated for 3A at both 24Vdc and 110Vac; 12-channel modules are normally open (NO), SPST, rated for 1A at 24Vdc, and 0.5A at 110Vac

Comm Link

Between Masterless modules and Host: RS-485 multi-drop; two, independent Comm Links continuously maintained

Comm Link (continued)

Between Slaves and Masters: RS-232 direct connection; each Slave to one channel on the Master
Range: 1.6 km (1 mi) typical, for Master or Masterless modules communicating with the Host at 9600 baud over 20AWG twisted pair; 0.8 km (0.5 mi), typical, at 19.2k baud; 15 m (50 ft) between Slaves and Master modules
See NOTE below
Protocol: MODBUS RTU for Masters and Masterless modules to the Host; Master-Slave communications use a proprietary protocol
Baud Rate: User-set between Masters and Host, 2400, 4800, 9600, or 19200; Factory-set between Masters and Slaves, 9600

Comm Link (continued)

Addressing: User-set with external, wire jumpers, 1-31

Power Supply

11-30Vdc; Load: 2-4 Watts depending on module type

Ambient Conditions

Operating Range: Ð5¡C to +65¡C (23¡F to 150¡F)
Storage Range: Ð25¡C to +85¡C (Ð13¡F to 185¡F)
Relative Humidity: 10-90%, non-condensing

Controls

External jumpers used to set baud rate and address (Masterless modules only)

Weight

580g (1.7 lbs)

Note: Practical system range and throughput may be greater in many applicaitons.

(Specifications listings continue)

Specifications *(continued from page 5)*

RTD input Modules Ð Slave or Masterless

Performance
Accuracy: ±0.25% of reading, ±0.25¡C (0.45¡F)
Resolution: ±0.1¡C (0.18¡F)
Scan Rate: Each channel scanned every 1.3 seconds
Isolation: 500Vdc between each Comm Link; 500Vdc between Comm Links and Power; and 500Vdc between Comm Links, Power, and input channels

RTD Type
3-wire, 100 Pt (DIN43760: 1980 and BS1904: 1984 $\alpha = 0.385$)
Range: Ð150¡C to +850¡C (Ð238¡F to 1562¡F)
Linearity: ±0.1¡C (±0.1¡F)
Excitation Current: 1.4mA

Comm Link
Between Masterless modules and Host: RS-485 multi-drop; two, independent Comm Links continuously maintained

Comm Link (continued)
Between Slaves and Masters: RS-232 direct connection; each Slave to one channel on the Master
Range: 1.6 km (1 mi) typical, for Master or Masterless modules communicating with the Host at 9600 baud over 20AWG twisted pair; 0.8 km (0.5 mi), typical, at 19.2k baud; 15 m (50 ft) between Slaves and Master modules
See NOTE below
Protocol: MODBUS RTU for Masters and Masterless modules to the Host; Master-Slave communications use a proprietary protocol
Baud Rate: User-set between Masters and Host, 2400, 4800, 9600, or 19200; Factory-set between Masters and Slaves, 9600

Comm Link (continued)
Addressing: User-set with external, wire jumpers, 1-31

Power Supply
11-30Vdc; Load: 2-4 Watts depending on module type

Ambient Conditions
Operating Range: Ð5¡C to +65¡C (23¡F to 150¡F)
Storage Range: Ð25¡C to +85¡C (Ð13¡F to 185¡F)
Relative Humidity: 10 to 90%, non-condensing
Ambient Temperature Effect: ±0.018% per ¡C

Controls
External jumpers used to set baud rate and address (Masterless modules only)

Weight
580g (1.7 lbs)

Thermocouple Input Modules Ð Slave or Masterless

Performance
Accuracy: ±3¡C (5.4¡F)
Resolution: 0.5¡C (0.9¡F)
Update Rate: Each channel scanned 200 times per sec
Isolation: 500Vdc between each Comm Link; 500Vdc between Comm Links and Power; and 500Vdc between Comm Links, Power, and input channels
Bias Current: 100nA
Input Impedance: >10M
Common Mode Rejection: 110dB @ 60Hz

Thermocouple
Type K with range Ð100¡C to +1372¡C (Ð148¡F to 2502¡F); Type J with range Ð100¡C to +760¡C (Ð148¡F to 1400¡F)
Reference Junction Compensation: ±0.02¡ per degree of shift
Upscale Drive, on open sensor, standard

Comm Link (continued)
Between Masterless modules and Host: RS-485 multi-drop; two independent Comm Links continuously maintained
Between Slaves and Masters: RS-232 direct connection; each Slave to one channel on the Master
Range: 1.6 km (1 mi) typical, for Master of Masterless modules communicating with the Host at 9600 baud over 20AWG twisted pair; 0.8 km (0.5 mi), typical, at 19.2k baud; 15 m (50 ft) between Slaves and Master modules
See NOTE below
Protocol: MODBUS RTU for Masters and Masterless modules to the Host; Master-Slave communications use a proprietary protocol

Comm Link (continued)
Baud Rate: User-set between Masters and Host, 2400, 4800, 9600, or 19200; Factory-set between Masters and Slaves, 9600
Addressing: User-set with external, wire jumpers, 1-31

Power Supply
11-30Vdc; Load: 2-4 Watts depending on module type

Ambient Conditions
Operating Range: Ð5¡C to +65¡C (Ð23¡F to 150¡F)
Storage Range: Ð25¡C to +85¡C (Ð13¡F to 185¡F)
Relative Humidity: 10 to 90%, non-condensing
Ambient Temperature Effect on Amplifier: ±0.02% per ¡C

Controls
External jumpers used to set baud rate and address (Masterless modules only)

Weight
580g (1.7 lbs)

Note: Practical system range and throughput may be greater in many applications.

Throughput

Throughput is defined as the amount of time it takes, data to get from signal input to Host or Host to signal output. Use the following formula:

$$T_1 + T_2 + T_3$$

Where:

T_1 = The period in which an I/O channel is scanned by a Slave or Masterless module:
- 5 milliseconds for an all-analog or T/C input module
- 1.3 seconds for an RTD input module
- 10 milliseconds for analog or discrete (digital) output modules, for discrete (digital) input modules, or for relay output modules

T_2 = (Applies to Master-Slave configuration only. If Masterless T_2 =0) The period in which a Master scans its Slave channels:
- 75 milliseconds, typical, for a Master with 12 discrete (digital) Slave modules
- 200 milliseconds, typical, for a Master with 12 analog Slave modules
- 75-200 milliseconds for Masters scanning a combination of analog and discrete Slave modules

T_3 = The communication time for signals passing between the Master or Masterless module and the Host. Typically, over a twisted pair link set at 9600 baud and reading the entire database of the Master or Masterless module, the time is:
- 50 milliseconds for an all-analog Masterless module
- 30 milliseconds for an all-discrete (digital) Masterless module
- 340 milliseconds for an all-analog Slave Master-Slave node
- 60 milliseconds for an all-discrete (digital) Slave Master-Slave node

Ordering Information

Unit	Module Type	Input/Output Configuration	Power	Options	Housing
DDS	**MH** Master Module, Peer-to-host (31 per system, maximum) **S** Slave Module (12 per Master; 372 per system, maximum in Peer-to-Host) **MLH** Masterless Module, Peer-to-Host (31 persystem, maximum)	**S12** 12 Slave channels (This selection is required with the Master (MH) module) **NOTE:** The following selections are not available with the Master (MH) module. **RT18** 8 RTD Inputs (3-wire, 100½ platinum, -100°C to +700°C) **TJI10** 10 J-type T/C Inputs (-210°C to +760°C, -346°F to +1400°F) **TKI10** 10 K-type T/C Inputs (-270°C to +1372°C, -454°F to +2502°F) **TTI10** 10 T-type T/C Inputs (-270°C to +400°C, -454°F to +752°F) **AI12xx** 12 Analog Inputs (replace **xx** with **20MA** for 4-20mA, with **2V** for 0-2Vdc, **5V** for 0-5Vdc, or with **10V** for 0-10Vdc) **AO820MA** 8 Analog Outputs (4-20mA) **DI21** 21 Discrete Inputs (externally powered, 11-30Vdc) **DO21** 21 Discrete Outputs (open collector 200mA, 40Vdc) **RO8** 8 Relay Outputs (SPDT, rated 3A @ 24Vdc and 110Vac **RO12** 12 Relay Outputs (Normally open SPST, rated 1A @ 24dc and 0.5A @110Vac)	**11-30DC**	Consult factory for information on optional Baud rates and parity settings	**DIN** A.B.S. Nylon housing with removable terminal blocks; mounts on standard Top Hat rail (DIN 46277-3)

I/O EXPRESS Model Numbers

To order additional or replacement modules for your system, specify the following, in order:

Product / Module / I/O Configuration / Power / Options (if installed)[Housing]

- For a Slave accepting 12, 4-20mA inputs:

  DDS / S / AI1220MA / 11-30DC / [DIN]

- For a Master module with radio modem capability:

  DDS / MH / S12 / 11-30DC / -RADIO [DIN]

Installation

Perform the steps for ***I/O EXPRESS*** installation as follows:

1. Configure the baud rate and communications address of each Master and Masterless module to be installed in the application. Use the baud rate of the Host.

IMPORTANT
DO NOT set any baud rate or address jumpers on Slave modules.

2. Connect the Slaves (if any) to their Masters.
3. Physically install each module and wire the Comm Link(s).
4. Connect the appropriate power supply (supplies) and sensors/transmitters/ discrete devices.

Setting Master/Masterless Baud Rate

To set Master and Masterless baud rate, connect wire jumpers between terminals 14, 15 and "C". Table 1 lists the available jumper combinations.

Table 1. *Setting **I/O EXPRESS** Module Baud Rate*

To get this Baud Rate	Connect each terminal to "C"	
	14	15
2400	●	●
4800	●	
9600		
19200		●

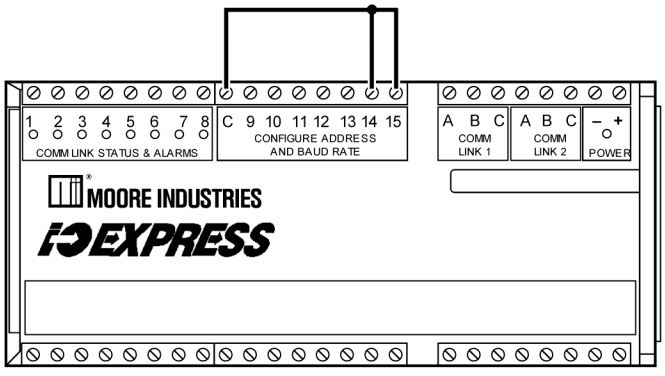
(No jumpers)

IMPORTANT
Set the baud rate the same for all Masters and/or Masterless modules in a system, and make sure that the modules' baud rates match the Host's.

DO NOT set the baud rate jumpers on Slave modules.

Figure 2 illustrates setting 2400 baud.

Figure 2. *Setting **I/O EXPRESS** Module Baud Rate to 2400 (Masters and Masterless Modules ONLY)*

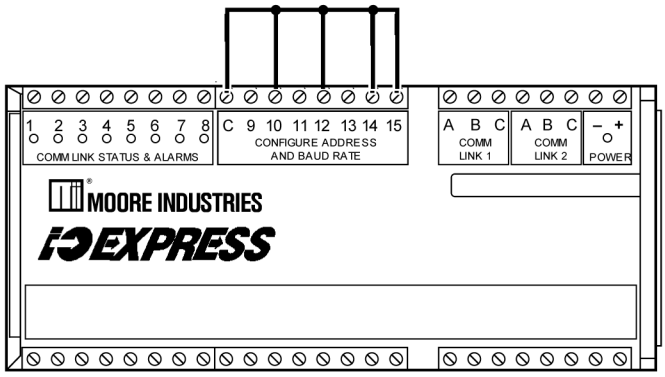


Setting the Masterless/Master Communications Address

As with the baud rate, Master and Masterless modules' addresses are "programmed in" by connecting a particular combination of terminals to the "C" terminal in the "Configure Address and Baud Rate" block on each unit's top panel. Terminals 9 through 13 are set aside for this purpose. Table 2 gives the combinations of jumpers needed to configure each unit with its address. There are 31 available.

For example, figure 3 shows the module from figure 2 with an additional configuration for an address of "21".

Figure 3. *Setting **I/O EXPRESS** Module Address (Masters and Masterless Modules ONLY)*



Redundant Links

Both of the ***I/O EXPRESS*** Comm Links are fully functional during normal system operations. Either can be connected to the Host, or each can be attached to comm ports on separate Hosts for redundant communications. Both Links maintain a database of all system I/O and data during normal operation. If traffic over Link #1 is ever interrupted, all of the data in the system is accessible through Link #2, and vice-versa. Communications may continue without loss of data.

Since Comm Link #1 and Comm Link #2 are redundant in this way, a single Slave can be connected to two Master modules to provide backup of critical I/O. Figure 4 illustrates this type of backup redundancy.

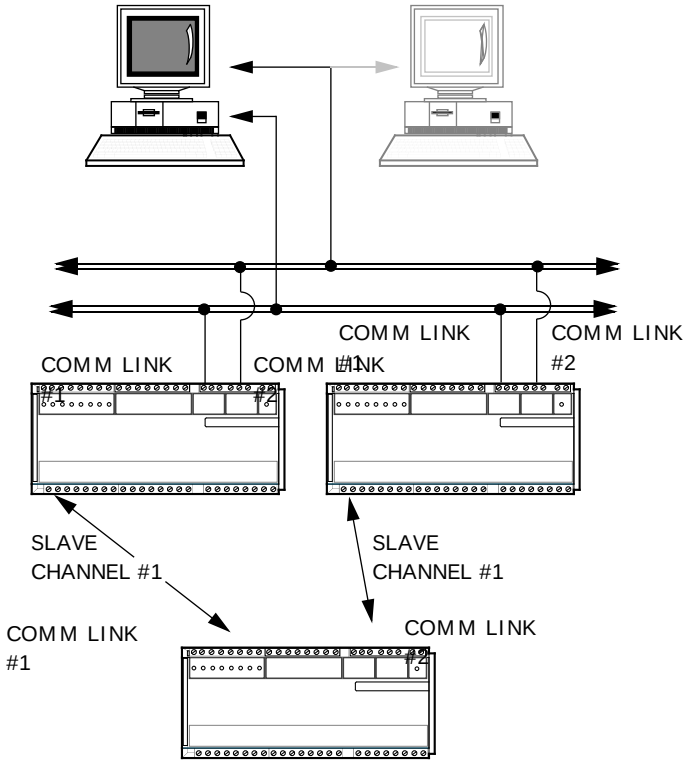
Table 2. *Setting **I/O EXPRESS** Module Address*

To get this address	Connect each of these terminals to "C"				
	9	10	11	12	13
0	DO NOT USE				
1		●	●	●	●
2	●		●	●	●
3			●	●	●
4	●	●		●	●
5		●		●	●
6	●			●	●
7				●	●
8	●	●	●		●
9	●		●		●
10	●		●		●
11			●		●
12	●	●			●
13		●			●
14	●				●
15					●
16	●	●	●	●	
17		●	●	●	
18	●		●	●	
19			●	●	
20	●	●		●	
21		●		●	
22	●			●	
23	●	●	●	●	●
24	●	●	●		
25		●	●		
26	●		●		
27			●		
28	●	●			
29		●			
30	●				
31	Factory-Set Default (no jumpers)				

Important:
DO NOT set the address jumpers on Slave modules

Connecting two Slave modules to the same I/O, and connecting each Slave to two Masters provides excellent backup.

Figure 4. *Using* ***I/O EXPRESS*** *Redundant Hookups*



CONNECT REDUNDANT LINK TO SEPARATE CHANNELS OF ONE MASTER MODULE, OR TO A SEPARATE MASTER MODULE

Mounting the *I/O EXPRESS* on DIN Rail

A compact, DIN-style unit, ***I/O EXPRESS*** modules mount on standard, 35 mm, Top Hat rail (EN50022 or 46277-3). Figure 5 shows the housing dimensions.

To install the ***I/O EXPRESS*** on DIN rail:

1. Locate the mounting clips; two, black, sliding fixtures on the back of the housing. Each is equipped with a locking tab (see Figure 6, inset).
2. Slide each clip downward and while sliding, press the locking tabs inward, until the tabs lock into an open position. A small screwdriver or the point of a pencil works well for pressing the locking tabs in.

   With the tabs locked, the mounting clips will stay up in an open position.
3. Seat the top extrusions of the housing over the upper edge of the Hat rail, and pivot the module around that upper edge of the rail until the mounting clips slide over the bottom edge of the rail.
4. Use a small screwdriver or pencil tip to release the locking tabs by pressing them outward, away from the unit.

To remove the **I/O EXPRESS** from DIN rail, slide a screwdriver into each of the mounting clips. Pull the clips down with the tip of the screwdriver while pivoting the **I/O EXPRESS** and screwdriver handles upward.

Note:

When mounting the I/O Express in multi-tiered applications, allow enough vertical space between rows of units to permit removal of the unit.

Figure 5. *Dimensions of the* ***I/O EXPRESS*** *Housing*

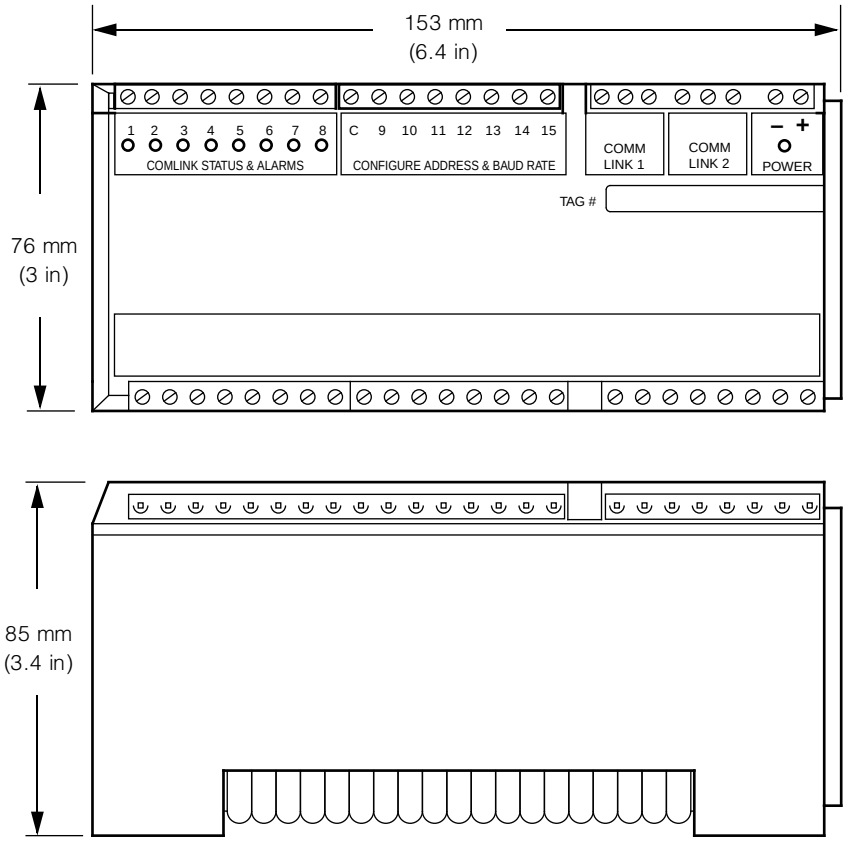
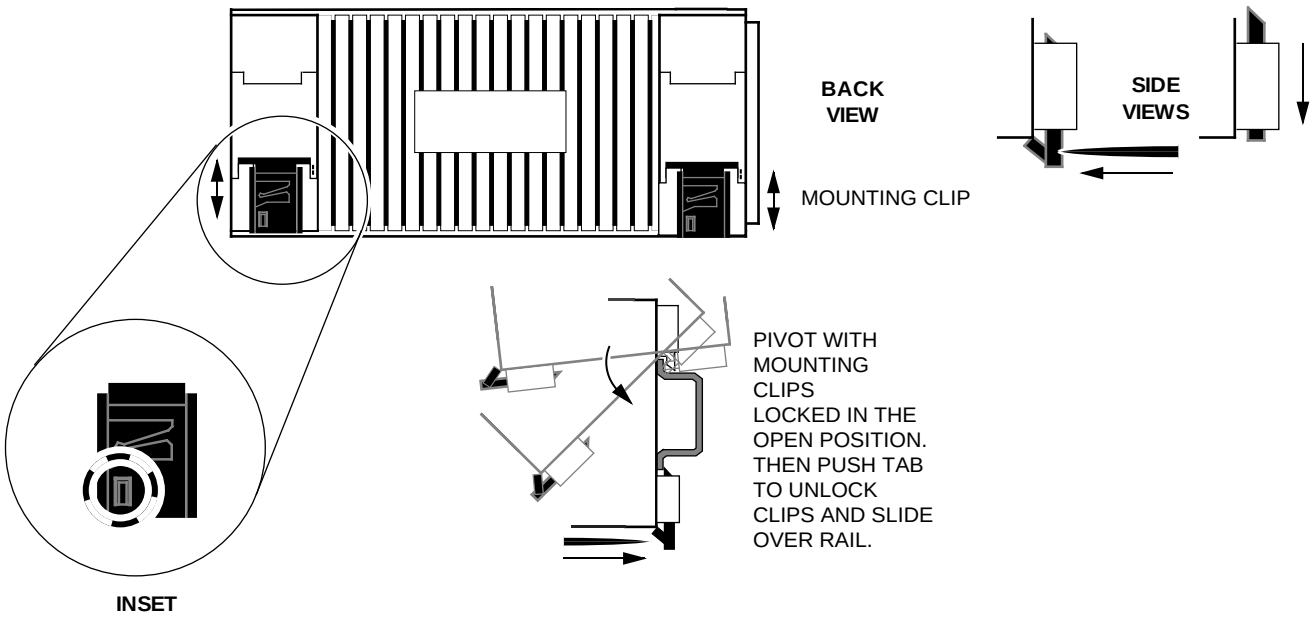


Figure 6. *Installing the* ***I/O EXPRESS*** *– Mounting Clips and Locking Tabs*



Making Electrical and Communications Link Connections

Figure 7 shows how to multi-drop Master and Masterless modules along the Comm Link(s), how to connect Slaves to Masters, and how to connect power to all modules in the system.

Making Connections to Field Instruments — Summary

Note that Figure 7 does not show any field device (I/O) hook-ups to the Masterless and/or Slave modules. The illustrations immediately following Figure 7 provide that information:

- Figure 8 shows how to connect analog inputs
- Figure 9 shows how to connect analog outputs
- Figure 10 shows how to connect 21 discrete inputs
- Figure 11 shows how to connect 21 discrete (open collector) outputs
- Figure 12 shows how to connect 8 relay outputs
- Figure 13 shows how to connect 12 relay outputs
- Figure 14 shows how to connect 8 RTD inputs
- Figure 15 shows how to connect 10 T/C inputs

IMPORTANT:

*Do not attach jumpers or wiring to the "CONFIGURE ADDRESS AND BAUD RATE" terminals of **I/O EXPRESS** Slave modules. The address of each connected Slave is controlled by its Master, and the baud rate for communications between Master and Slave modules is set at the factory (9600 baud).*

Jumpering these terminals will disable communications to the Slave, and cause communications errors, system-wide.

Recommended Ground Wiring Practices

The following ground wiring practices must be followed to ensure proper performance of the ***I/O EXPRESS***:

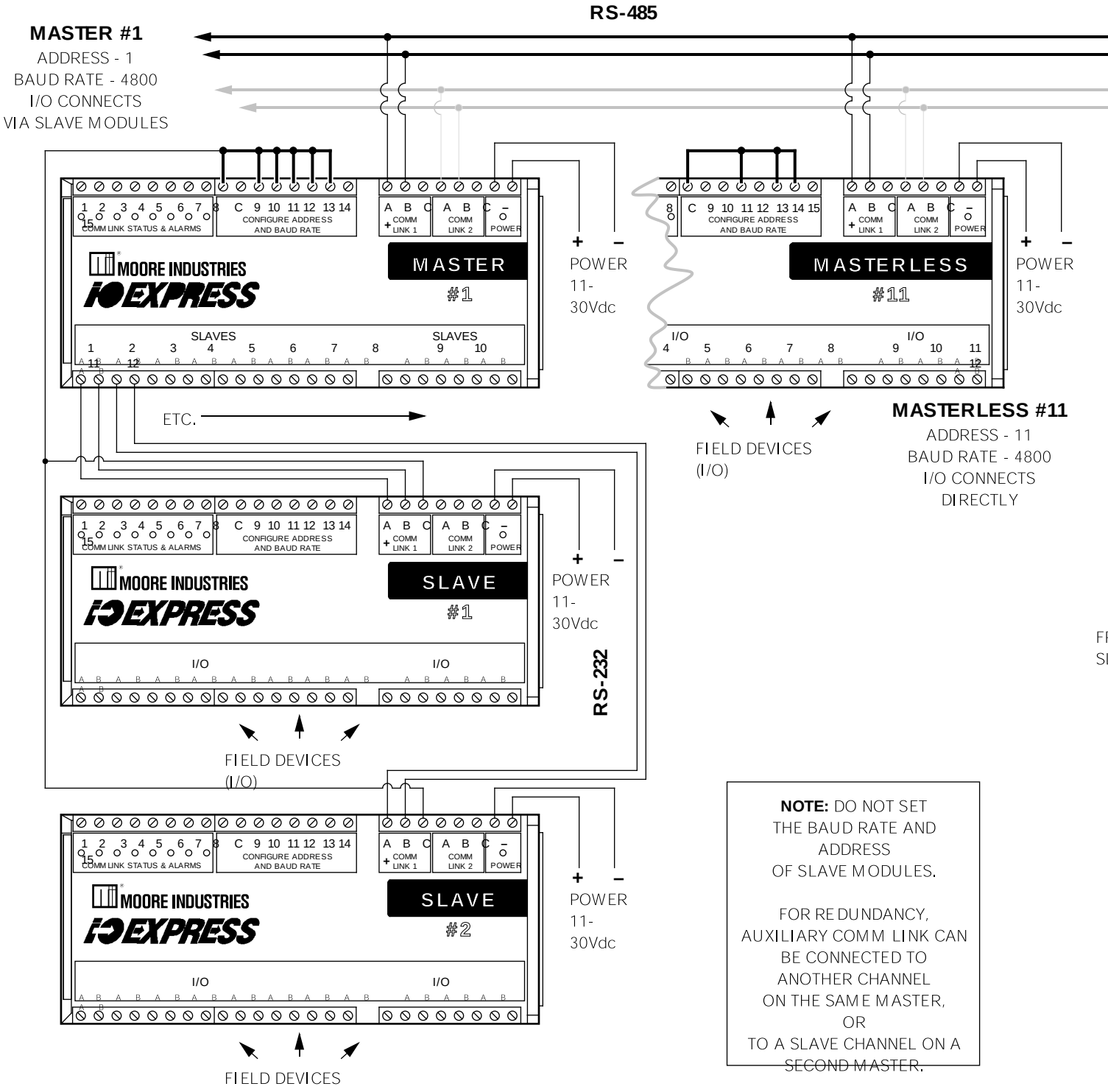
- Where practical, all input signals to, and output signals from, Moore Industries' products should be wired using a shielded, twisted pair technique. Shields are to be connected to an earth or safety ground at one point only.
- RS485 wiring should be shielded, twisted pair. The shield should maintain continuity over the entire link, and be earth grounded at only one location.
- RS232 wiring should be shielded 3-conductor cable. Shields for all links between a Master and its 12 slaves should be left open at the Slave ends, and should be tied together and earth grounded at the Master end.

CE Conformity

Installation of any Moore Industries products that carry the CE certification (Commission Electrotechnique) ***must*** adhere to the guidelines above in order to meet the requirements set forth in applicable EMC (Electromagnetic Compatibility) directives (EN 55011, EN 50082-1, EN 50082-2, etc.)

(This page has been left blank intentionally.)

Figure 7. *Connecting Pairs of* ***I/O EXPRESS*** *Masters (and Masterless Modules), and Slaves to Masters*



Peer-to-Host

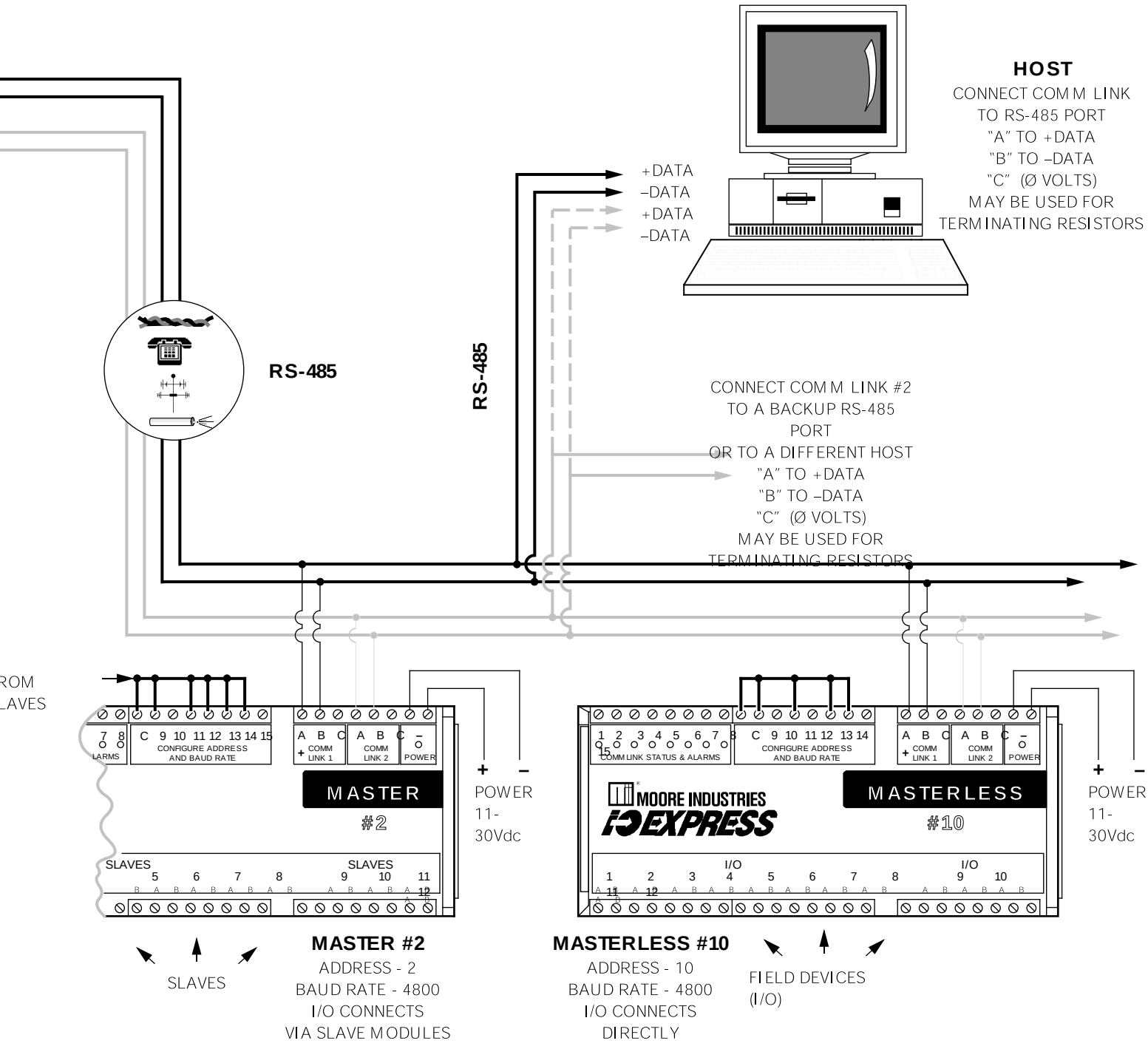

HOST
CONNECT COMM LINK
TO RS-485 PORT
"A" TO +DATA
"B" TO –DATA
"C" (Ø VOLTS)
MAY BE USED FOR
TERMINATING RESISTORS
+DATA
–DATA
+DATA
–DATA
RS-485
RS-485
CONNECT COMM LINK #2
TO A BACKUP RS-485
PORT
OR TO A DIFFERENT HOST
"A" TO +DATA
"B" TO –DATA
"C" (Ø VOLTS)
MAY BE USED FOR
TERMINATING RESISTORS
ROM
LAVES
7 8
ALARMS
C 9 10 11 12 13 14 15
CONFIGURE ADDRESS
AND BAUD RATE
A B C
+ COMM
LINK 1
A B C
COMM
LINK 2
C –
POWER
MASTER
#2
+ –
POWER
11-
30Vdc
SLAVES
5 6 7 8
SLAVES
9 10 11 12
1 2 3 4 5 6 7 8
15
COMM LINK STATUS & ALARMS
C 9 10 11 12 13 14
CONFIGURE ADDRESS
AND BAUD RATE
A B C
+ COMM
LINK 1
A B C
COMM
LINK 2
C –
POWER
MOORE INDUSTRIES
MASTERLESS
#10
+ –
POWER
11-
30Vdc
I/O
1 2 3 4 5 6 7 8
I/O
9 10
11 12
SLAVES
MASTER #2
ADDRESS - 2
BAUD RATE - 4800
I/O CONNECTS
VIA SLAVE MODULES
MASTERLESS #10
ADDRESS - 10
BAUD RATE - 4800
I/O CONNECTS
DIRECTLY
FIELD DEVICES
(I/O)

Figure 8. *Connecting Multiple Analog Inputs to* ***I/O EXPRESS*** *Slaves or Masterless Modules*

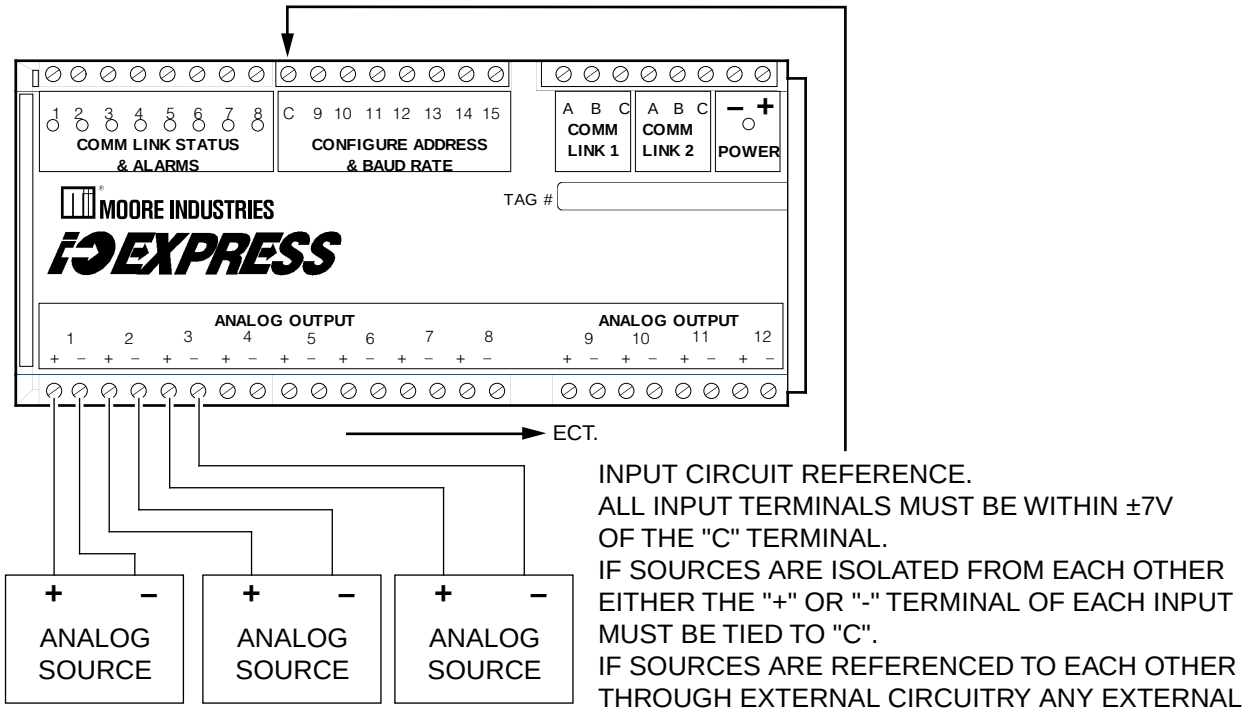
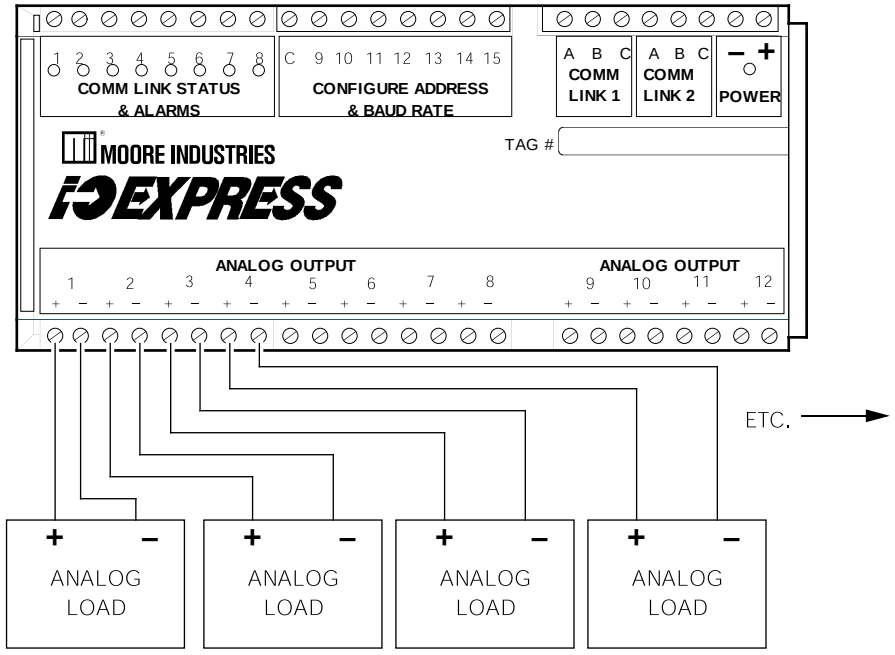
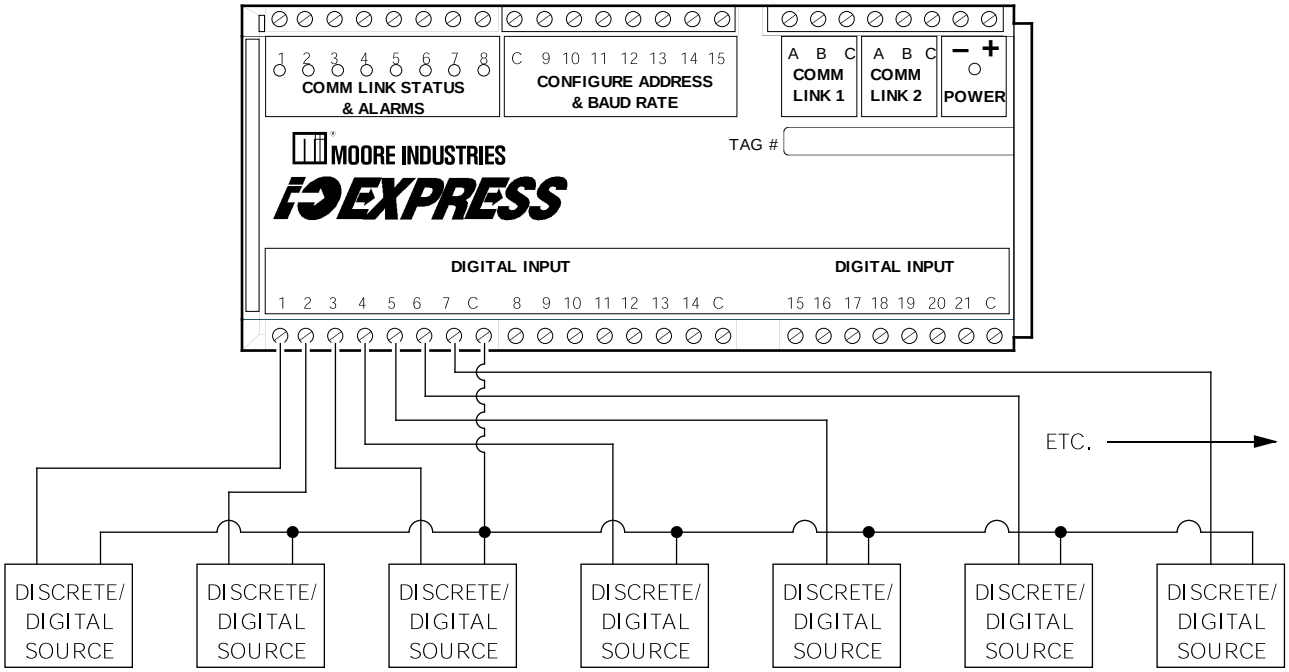


Figure 9. *Connecting Multiple Analog Outputs from* ***I/O EXPRESS*** *Slaves or Masterless Modules to Field Devices*



NOTE: THE "+" TERMINAL OF THIS MODULE PROVIDES THE VARIABLE CURRENT OUTPUT. THE "–" TERMINAL IS TIED, INTERNALLY, TO THE "–" POWER TERMINAL.

Figure 10. *Connecting Multiple, Discrete (Digital) Inputs to* ***I/O EXPRESS*** *Slaves or Masterless Modules*



NOTE: POLARITY OF THE INPUT DEVICES IS IMMATERIAL.

Figure 11. *Connecting Multiple, Discrete (Digital), Open Collector Outputs from* ***I/O EXPRESS*** *Slaves or Masterless Modules to Field Devices*

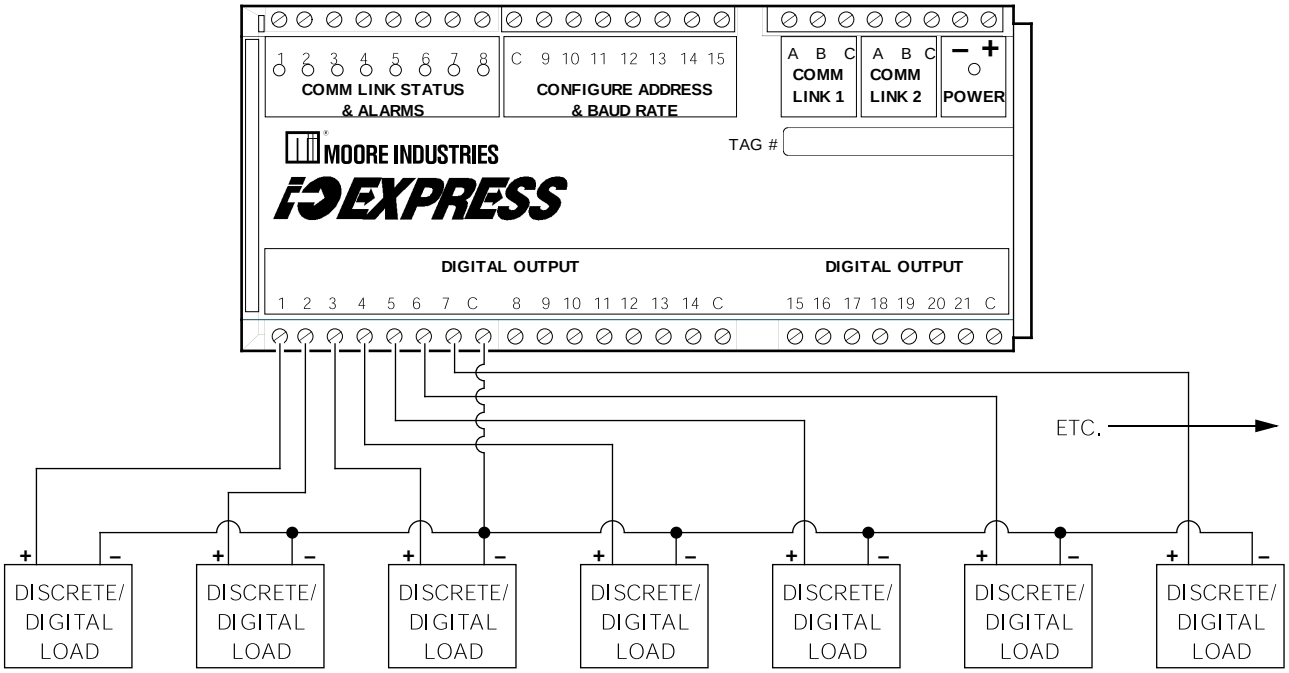


Figure 12. *Connecting 8 Relay Outputs from* ***I/O EXPRESS*** *Slaves or Masterless Modules to Field Devices*

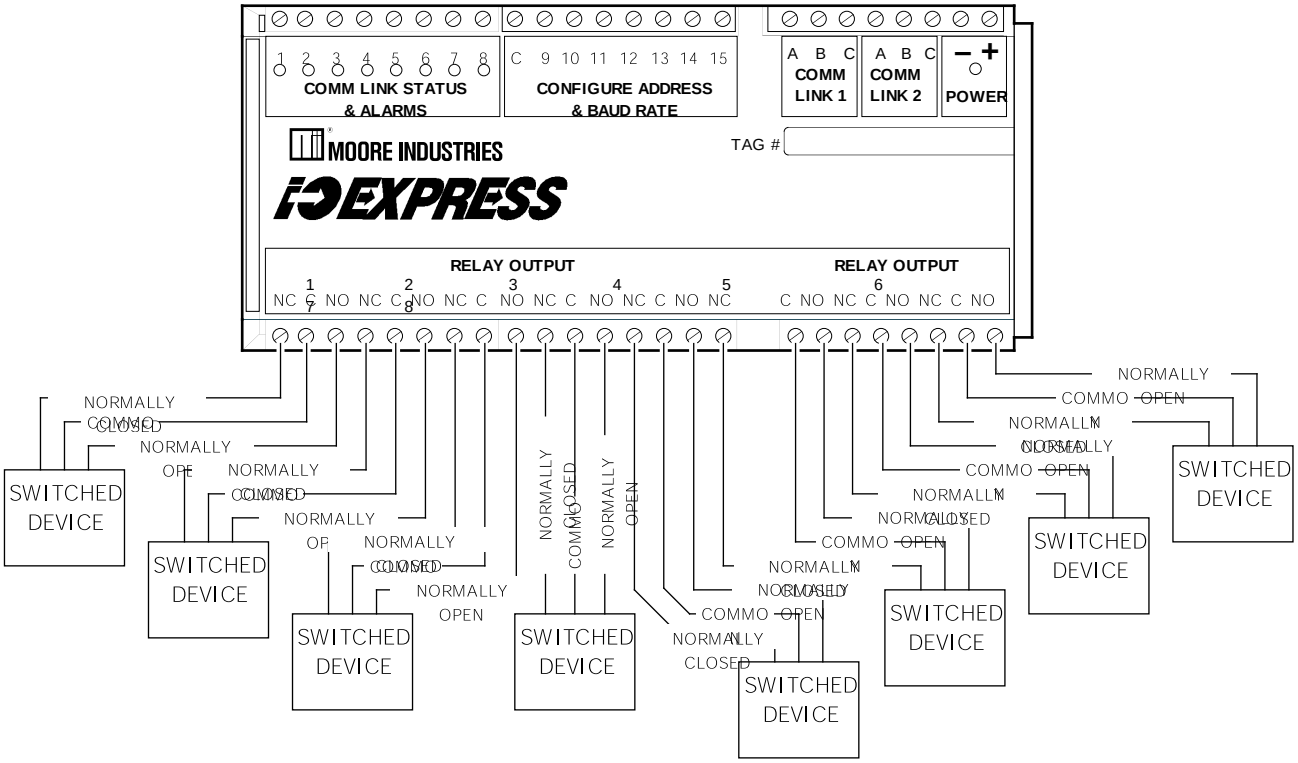


Figure 13. *Connecting 12 Relay Outputs from* ***I/O EXPRESS*** *Slaves or Masterless Modules to Field Devices*

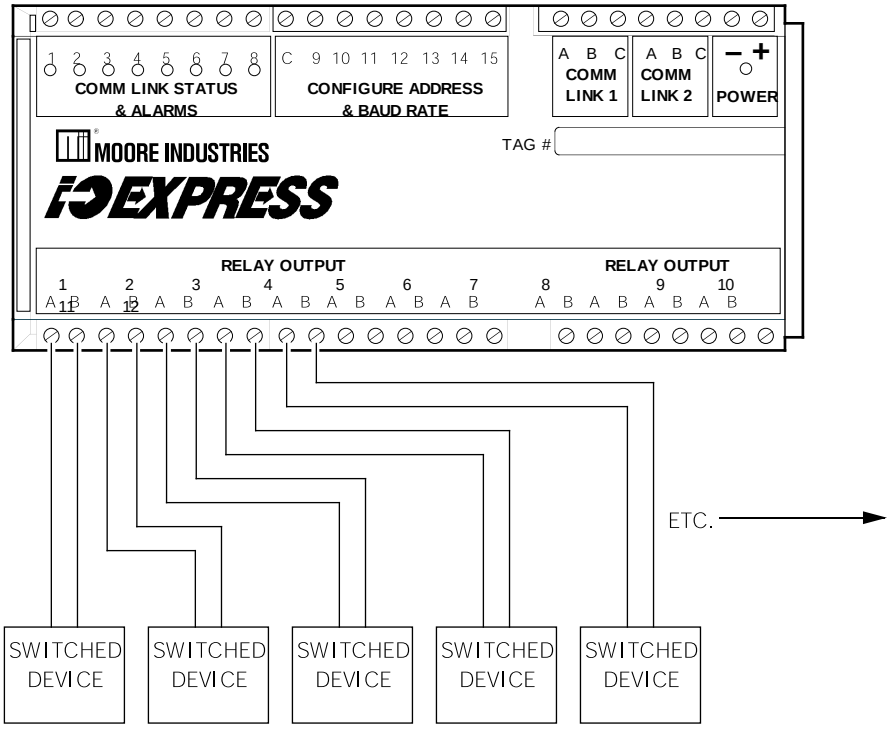


Figure 14. *Connecting 8 RTD Inputs to* ***I/O EXPRESS*** *Slaves or Masterless Modules to Field Devices*

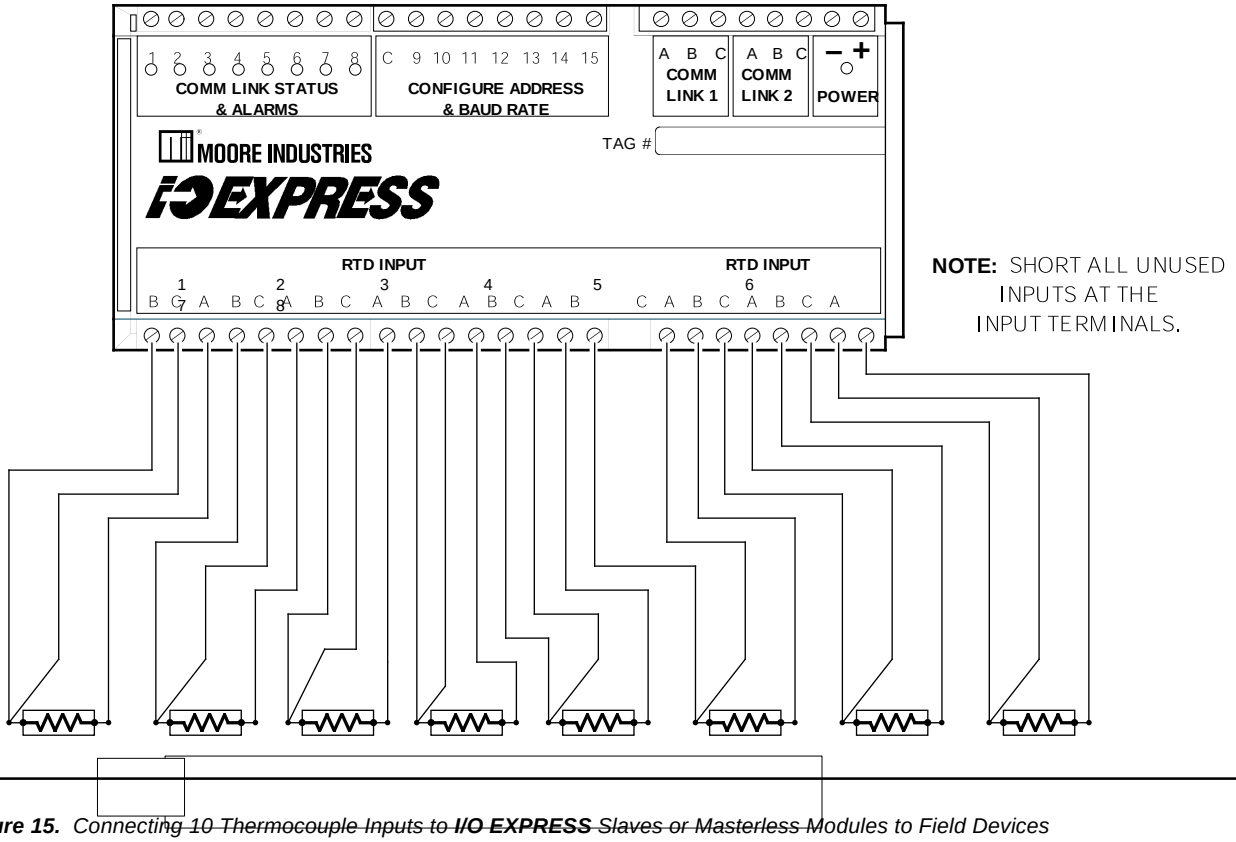
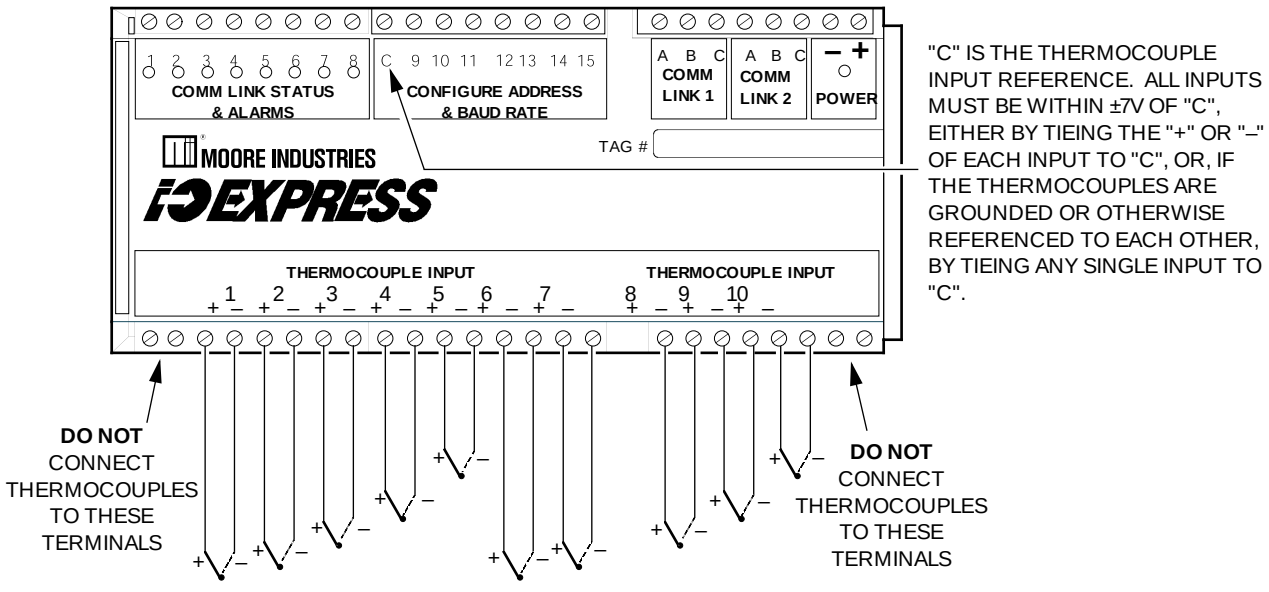


Figure 15. *Connecting 10 Thermocouple Inputs to* ***I/O EXPRESS*** *Slaves or Masterless Modules to Field Devices*



NOTE: TIE ALL UNUSED THERMOCOUPLE INPUTS TO THE "C" TERMINAL OF "CONFIGURE ADDRESS AND BAUD RATE".

Operation

Once connected properly and supplied with the appropriate power, the modules in the ***I/O EXPRESS*** are ready to respond with data or to execute output changes based on the receipt of the MODBUS RTU function codes in properly addressed queries from the Host. To learn more about MODBUS queries, refer to the appendix of this manual.

System operation consists of each ***I/O EXPRESS*** module executing an independent task that constantly refreshes an internal, digital database. The system Host queries individual modules for the contents of these databases using MODBUS queries. Masterless modules are addressed directly. Slave modules are addressed through the Master to which they are connected.

A module's database represents the information on each of its input and/or output channels. Masterless and Slave modules maintain data on the inputs or outputs of field devices, and Master modules maintain the multiplexed, digital data from the Slaves connected to them.

Since the update task is internal and separate from any Host function, all databases are updated continuously during system operation, regardless of whether or not a particular module is queried. This is so that whenever a Master or Masterless module receives a properly addressed MODBUS query from the system Host, the most current data available can be communicated.

MODBUS Implementation

A subset of the available MODBUS RTU function codes is implemented in the ***I/O EXPRESS***. Table 3 lists the available codes. Typically, these codes are incorporated into MODBUS queries by an application running on the Host.

Accessing Masterless Module Data

To communicate with a Masterless module, the appropriate function code must be incorporated in a valid MODBUS RTU query.

Table 3. I/O EXPRESS *Valid MODBUS RTU Function Codes*

MODBUS Function Code	Implementation in the I/O EXPRESS	MODBUS Function Name
01	Read the State (ON/OFF, HI/LO) of the Discrete (Digital) Outputs	Read Coil Status
02	Read the State (ON/OFF, HI/LO) of the Discrete (Digital) Inputs	Read Input Status
03	Read the Level Setting of the Analog Outputs	Read Holding Registers
04	Read the Level Setting of the Analog Inputs	Read Input Registers
05	Change the State of the Discrete (Digital) Outputs	Force Single Coil
06	Change the Level of the Analog Outputs	Preset Single Register
15	Change the State (ON/OFF, HI/LO) of Discrete (Digital) Outputs	Force Multiple Coils
16	Change the Level Setting of the Analog Outputs	Preset Multiple Registers

Accessing Slave Module Data
As it comes in to the Master, data from each Slave is automatically routed to internal areas, or "bins" in the memory of the Master. Bins are further broken down (in memory) into byte addresses according to channel and the type of signal represented, analog or digital.

Commands to change the state or level of Slave module output channels are processed in the same way, starting with the Host, proceeding through the Master to the Slave addressed by the data byte or bytes in the query.

Table 4 lists the byte addresses of Slave module data in a Master. In the table, column "A" lists the Slave numbers (the input channel on the Master), column "B" lists the I/O channels on the Slave module, column "C" lists the addresses for discrete (digital) data, and column "D" lists the addresses for analog data. To access or effect the I/O connected to a Slave, a MODBUS query that includes the data byte address must first be communicated to the Master module, where it is decoded and sent to the appropriate Slave.

Temperature and Analog I/O Data
Data for thermocouple, RTD, and Analog input modules may be accessed by MODBUS function codes 03 or 04. The data is in 16-bit signed integer format.

Thermocouple and RTD data is based on temperature: with 0°C input the host reads 0000; the RTD module gives 10 binary counts per °C and thermocouple modules give 2 counts per °C.

For the 4-20mA input or output modules, the host reads (or writes) 0000 to 4095 for the 4-20mA range. Data goes negative below 4mA and is linear to 3.4mA.

For the voltage input modules, data goes from 0000 to 4095 for the 0 to 100% signal range

Communications Status LEDs and Alarms
There are 8 LEDs in the area of each unit's top panel labeled "Comm Link Status and Alarms". These indicate the status of both the unit's communications to and from the other modules connected on the Comm Link.

Each unit also has 4, open collector transistor outputs tied to the LEDs at terminals 5, 6, 7, and 8. The transistors are common negative at the C terminal of "Configure Address and Baud Rate". These can be used with simple discrete devices to warn of communications faults.

Table 5 summarizes the way the LEDs and outputs work.

NOTE:
Terminals 1 through 6 DO NOT necessarily indicate that either link is "good" or "bad". If they are not pulsing, it may simply mean that there is no communications activity on that particular Comm Link.

Fault Flags
There are twelve fault flags, located at memory addresses 256 through 267 in Master module memory, used to return data on the status of a Master module's Slave channels. Use the 02 MODBUS RTU function code, 'Read Discrete Inputs (Read Input Status)', to find out whether a particular Slave module is on- or off-line.

The 02 code, addressed to the Fault Flag area of memory, returns a 16-bit integer. A binary "0" indicates a good Master-to-Slave link, a "1" indicates that the module at that address is off-line. Disregard the last four (least significant, right-most) bits in the response.

Complete Systems

Moore Industries configures complete, "turn-key" systems using the ***I/O EXPRESS*** and our proven line of premium signal conditioners and transmitters. For more information, or for information on how to use the ***I/O EXPRESS*** in a Peer-to-Peer application, obtain a copy of the Peer-to-Peer Users' Manual from your Moore Industries Sales Representative, or contact the factory.

***Table 4. I/O EXPRESS** Master Module Slave Data Byte Addressing*

A	B	C	D	A	B	C	D	A	B	C	D	A	B	C	D	A	B	C	D	A	B	C	D
1	1	0	0	**3**	1	42	32	**5**	1	84	64	**7**	1	126	96	**9**	1	168	128	**11**	1	210	160
	2	1	1		2	43	33		2	85	65		2	127	97		2	169	129		2	211	161
	3	2	2		3	44	34		3	86	66		3	128	98		3	170	130		3	212	162
	4	3	3		4	45	35		4	87	67		4	129	99		4	171	131		4	213	163
	5	4	4		5	46	36		5	88	68		5	130	100		5	172	132		5	214	164
	6	5	5		6	47	37		6	89	69		6	131	101		6	173	133		6	215	165
	7	6	6		7	48	38		7	90	70		7	132	102		7	174	134		7	216	166
	8	7	7		8	49	39		8	91	71		8	133	103		8	175	135		8	217	167
	9	8	8		9	50	40		9	92	72		9	134	104		9	176	136		9	218	168
	10	9	9		10	51	41		10	93	73		10	135	105		10	177	137		10	219	169
	11	10	10		11	52	42		11	94	74		11	136	106		11	178	138		11	220	170
	12	11	11		12	53	43		12	95	75		12	137	107		12	179	139		12	221	171
	13	12	12		13	54	44		13	96	76		13	138	108		13	180	140		13	222	172
	14	13	13		14	55	45		14	97	77		14	139	109		14	181	141		14	223	173
	15	14	14		15	56	46		15	98	78		15	140	110		15	182	142		15	224	174
	16	15	15		16	57	47		16	99	79		16	141	111		16	183	143		16	225	175
	17	16			17	58			17	100			17	142			17	184			17	226	
	18	17			18	59			18	101			18	143			18	185			18	227	
	19	18			19	60			19	102			19	144			19	186			19	228	
	20	19			20	61			20	103			20	145			20	187			20	229	
	21	20			21	62			21	104			21	146			21	188			21	230	
2	1	21	16	**4**	1	63	48	**6**	1	105	80	**8**	1	147	112	**10**	1	189	144	**12**	1	231	176
	2	22	17		2	64	49		2	106	81		2	148	113		2	190	145		2	232	177
	3	23	18		3	65	50		3	107	82		3	149	114		3	191	146		3	233	178
	4	24	19		4	66	51		4	108	83		4	150	115		4	192	147		4	234	179
	5	25	20		5	67	52		5	109	84		5	151	116		5	193	148		5	235	180
	6	26	21		6	68	53		6	110	85		6	152	117		6	194	149		6	236	181
	7	27	22		7	69	54		7	111	86		7	153	118		7	195	150		7	237	182
	8	28	23		8	70	55		8	112	87		8	154	119		8	196	151		8	238	183
	9	29	24		9	71	56		9	113	88		9	155	120		9	197	152		9	239	184
	10	30	25		10	72	57		10	114	89		10	156	121		10	198	153		10	240	185
	11	31	26		11	73	58		11	115	90		11	157	122		11	199	154		11	241	186
	12	32	27		12	74	59		12	116	91		12	158	123		12	200	155		12	242	187
	13	33	28		13	75	60		13	117	92		13	159	124		13	201	156		13	243	188
	14	34	29		14	76	61		14	118	93		14	160	125		14	202	157		14	244	189
	15	35	30		15	77	62		15	119	94		15	161	126		15	203	158		15	245	190
	16	36	31		16	78	63		16	120	95		16	162	127		16	204	159		16	246	191
	17	37			17	79			17	121			17	163			17	205			17	247	
	18	38			18	80			18	122			18	164			18	206			18	248	
	19	39			19	81			19	123			19	165			19	207			19	249	
	20	40			20	82			20	124			20	166			20	208			20	250	
	21	41			21	83			21	125			21	167			21	209			21	251	

A = SLAVE MODULE
B = SLAVE MODULE
C = DISCRETE (DIGITAL) DATA ADDRESS
D = ANALOG DATA ADDRESS

***Table 5. I/O EXPRESS** Comm Link Status and Alarm Outputs*

Indication	Terminals/LEDs						
	1	2	3	4	5	6	7 & 8
Peer-to-Host activity on Comm Link #1	OFF	OFF	**DO NOT USE**	**DO NOT USE**	PULSING	OFF	7 is OFF 8 is PULSING
Peer-to-Host activity on Comm Link #2	OFF	OFF	**DO NOT USE**	**DO NOT USE**	OFF	PULSING	7 is OFF 8 is PULSING
No Comm Link Activity	OFF	OFF	**DO NOT USE**	**DO NOT USE**	OFF	OFF	7 is ON 8 is OFF

Customer Support

Moore Industries is recognized as the industry leader in delivering top quality to its customers, both in products and services. We perform a battery of stringent quality assurance checks on every unit we ship. If any Moore Industries product fails to perform up to rated specifications, call us for help. Our highly skilled staff of trained technicians and engineers pride themselves on their ability to provide timely, accurate, and practical answers to your process instrumentation questions. Factory phone numbers are on the back cover.

If problems involve a particular DDS module, there are several pieces of information you can gather ***before*** you call the factory that will help our staff to get you answers more efficiently. When you call, please have:

- The model number of the unit in question.
- The serial number of the unit in question.
- The job number (if available)
- The purchase order under which the unit was shipped (if available)

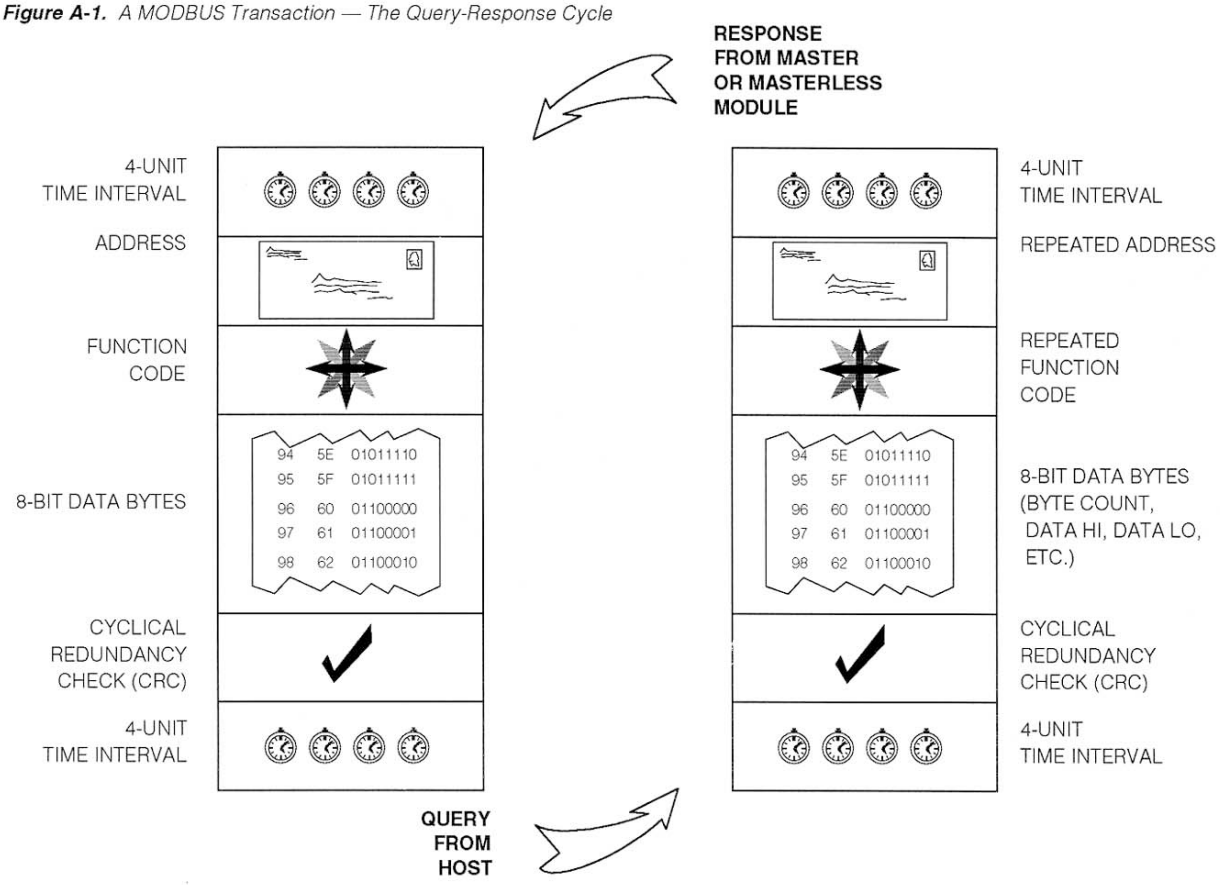
Appendix A – MODBUS Overview

Originally, MODBUS was developed as a protocol, or communications "language" for use by industrial communications equipment (controllers) in sending process data between points of control.

The reliability and relative ease-of-use of MODBUS resulted in its becoming the *de facto* standard in many sectors of the process control industry, adopted by both software developers and hardware manufacturers.

Because ***I/O EXPRESS*** modules "speak" the MODBUS "language" (with a MODBUS RTU "accent"), they are compatible with many popular and powerful DCS and SCADA software packages and equipment. Contact the factory for the most current compatibility list, and/or for information on complete "turn-key" systems, including transmitters, enclosures, wiring, software, installation, and maintenance.

Figure A-1. *A MODBUS Transaction — The Query-Response Cycle*



(From page A-1)

Queries and Responses — the Grammar of MODBUS

The ***I/O EXPRESS*** uses MODBUS RTU transactions to issue commands to field modules and to communicate collected field data from modules to the system Host. A complete transaction consists of a query from a Host and a response from a Master or Masterless module. Figure A-1 illustrates the format of a transaction.

Queries and responses must be "parsed", i.e., framed or formatted according to the rules set forth by the MODBUS protocol. The following list summarizes the basic attributes of the required elements:

- **Time Interval .** All Master and Masterless modules on the ***I/O EXPRESS*** Comm Link "listen" to the transactions being communicated during normal system operations. Whenever the Host institutes a time gap in transaction traffic equivalent to the transmission of at least 3.5 characters (at the baud rate setting), all connected modules begin to "listen" for their address.

- **Address ...** Refer to the Installation section of this manual for instructions on setting Master and/or Masterless modules' addresses. Modules "listen" for their address after the appropriate time interval has been detected on the Comm Link (for an address to be detected, it must be preceded by a time gap of 3.5 characters, minimum). Once a module detects its address, it "listens" for a MODBUS Function code. All modules ignore Function codes, Data Fields, and CRCs not directed to them by the correct address.

- **Function Code** Refer to the Operation section of this manual for a list of the MODBUS Function codes implemented in the ***I/O EXPRESS***. Once a module detects its address, it listens for a 2-digit, MODBUS Function code. This tells the addressed module what to do.

- **Data .....** The Data Field contains any information needed by the addressed module to perform the action specified by the Function code. The length of this field varies according to the type of Function code. The Data Field of a query may contain things such as the starting memory address of Slave data in a Master module, or the logical state (1 or 0) that a particular Masterless discrete output channel is to switch to. The Data Field is explained in greater detail later in this appendix.

- **CRC .....** A 16-bit cyclical redundancy check is always performed, to ensure the correct transmission/receipt of the command.

- **Time Interval .** Every MODBUS query is ended by a gap in transaction traffic of at least 3.5 characters, minimum. This gap may concurrently serve as the gap for the start of another query, in effect allowing a continuous stream of queries separated by time intervals of 3.5 characters.

NOTE:
A MODBUS query, once begun, must be transmitted/received in a continuous stream. If a gap of 1.5 characters is detected during the transmit/receive, the addressed module will abort the query and assume that the next character is an address.

Function Codes and Data Fields

The following section gives brief explanation of the MODBUS RTU Function Codes implemented in the ***I/O EXPRESS***. This information is supplied for reference purposes only. Generally, the operations explained here will be carried out "behind the scenes" by DCS or SCADA software resident on the Host.

Table A-1. *Valid MODBUS RTU Function Codes in the* ***I/O EXPRESS***

MODBUS Function Code	Implementation in the I/O EXPRESS	MODBUS Function Name
01	Read the State (ON/OFF, HI/LO) of the Discrete (Digital) Outputs	Read Coil Status
02	Read the State (ON/OFF, HI/LO) of the Discrete (Digital) Inputs	Read Input Status
03	Read the Level Setting of the Analog Outputs	Read Holding Registers
04	Read the Level Setting of the Analog Inputs	Read Input Registers
05	Change the State of the Discrete (Digital) Outputs	Force Single Coil
06	Change the Level of the Analog Outputs	Preset Single Register
15	Change the State (ON/OFF, HI/LO) of Discrete (Digital) Outputs	Force Multiple Coils
16	Change the Level Setting of the Analog Outputs	Preset Multiple Registers

Table A-1 is a copy of Table 3, from the Operation section of this manual. It lists the ***I/O EXPRESS*** Function Codes and their MODBUS RTU equivalents.

NOTE:
MODBUS RTU differs from MODBUS ASCII and MODBUS+. Make sure you are working with the correct type of MODBUS when executing the following Function Codes in the ***I/O EXPRESS****.*

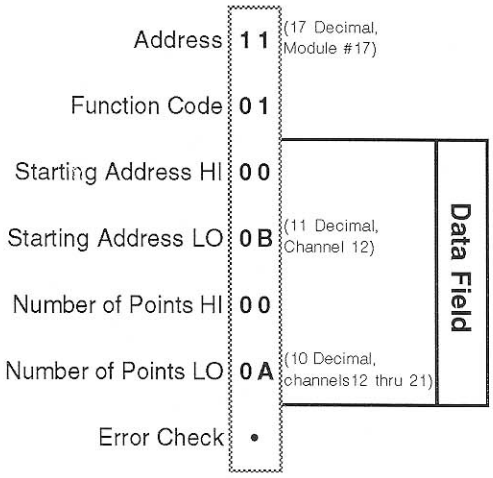
Terminology
Coils are discrete (digital) output channels. Inputs are discrete (digital) input channels. Holding registers are analog output channels. Input registers are analog input channels.

NOTE:
MODBUS RTU data addressing is zero-based, which means that coil (channel) 1 is addressed in a query or response as 0, channel 2 is address as 1, 3 is 2, etc.

Some DCS and SCADA software packages compensate for this, and automatically offset address references. Make sure to check the users' or reference documentation for the package in use in your application.

Function Code 01
Use this MODBUS RTU function to read the **ON/OFF or HI/LO** state of modules configured for **discrete (digital) outputs**.

For example, the query shown below would be used to read coils (discrete output channels) 12 through 21 of a Masterless module with a Comm Link address of 17 (refer to Table 2, in the Installation section of this manual, for instructions on setting module addresses).

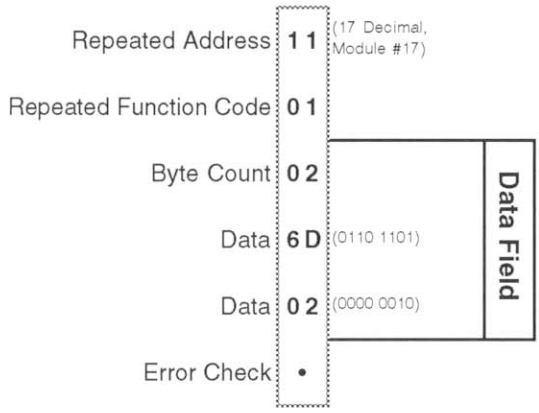


(continues)

(From page A-3)

- The "Starting Address HI" and "Number of Points HI" fields are set to zero when using this function code with ***I/O EXPRESS*** modules.
- In "Starting Address LO", the number 0B Hex (11 Decimal) represents the address for the module's channel 12, incorporating the standard, MODBUS RTU off-set (refer to NOTE on page A3).
- There are 10 points of data available from channels 12 through 21, hence the byte that sets number of points to read is 0A Hex.

A typical response to the preceding query would look like this:



- "1" = ON (HI), "0" = OFF (LO)
- "Byte Count" is calculated by the responding module. It represents the number of 8-bit data bytes that make up a response. In the case of this example, the byte count is 2; one, 8-bit byte and one 4-bit byte with its left over bits set to zero.
- The first byte in the Data Field stands for the first 8 channels addressed by the query. In the example, this is channels 12 through 19.

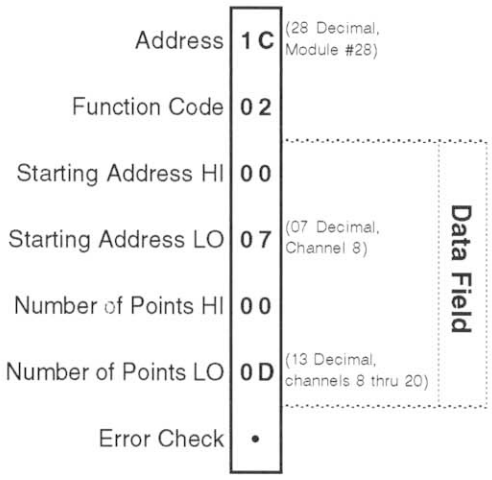
  Reading the response bits left to right, Channel 12 is represented by the last (least significant) bit, or the LSB in the byte. Channel 19 is the most significant bit (MSB).

  Translating the binary equivalent of 6D from the example, then, channel 12 is ON, 13 is OFF, 14 is ON, 15 is ON, 16 is OFF, 17 is ON, 18 is ON, and 19 is OFF.

- The next byte contains the data from channels 20 and 21. In the example response, channel 20 is OFF and channel 21 is ON. The remaining bits in the byte are set to zero.

Function Code 02
Use this MODBUS RTU function to read the **ON/OFF or HI/LO** state of modules configured for **discrete (digital) inputs**.

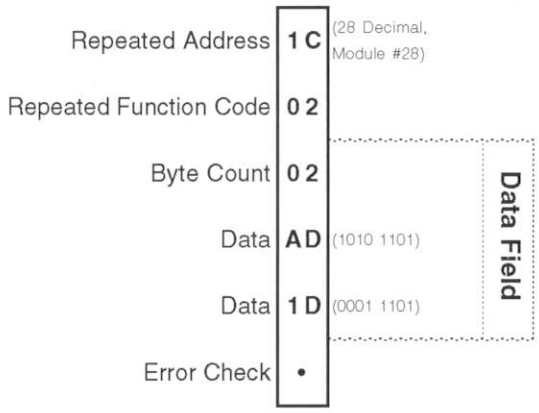
For example, the query shown below would be used to read inputs (discrete input channels) 8 through 20 of a Masterless module with a Comm Link address of 28 (refer to Table 2, in the Installation section of this manual, for instructions on setting module addresses).



- The "Starting Address HI" and "Number of Points HI" fields are set to zero when using this function code with ***I/O EXPRESS*** modules.
- In "Starting Address LO", the number 07 Hex (07 Decimal) represents the address for the module's channel 8, incorporating the standard, MODBUS RTU off-set (refer to NOTE on page A3).

- There are 13 points of data available from channels 8 through 20, hence the byte that sets number of points to read is 0D Hex.

A typical response to the preceding query would look like this:



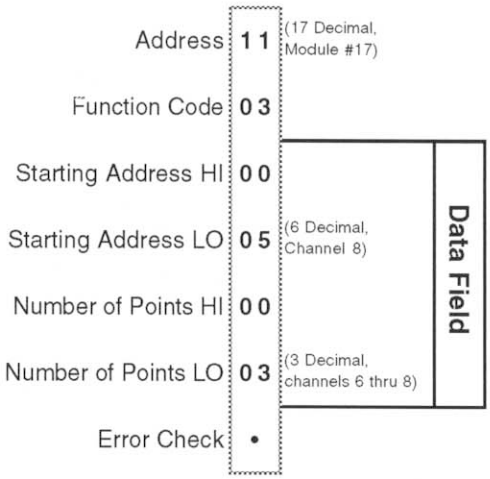
- "1" = ON (HI), "0" = OFF (LO)
- "Byte Count" is calculated by the responding module. It represents the number of 8-bit data bytes that make up a response. In the case of this example, the byte count is 2; one, 8-bit byte and one 4-bit byte with its left over bits set to zero.
- The first byte in the Data Field stands for the first 8 channels addressed by the query. In the example, this is channels 8 through 15.

  Reading left to right, Channel 8 is represented by the last (least significant) bit, or the LSB in the byte, and channel 15 is the most significant bit (MSB).

  Translating the binary equivalent of AD from the example, then, channel 8 is ON, 9 is OFF, 10 is ON, 11 is ON, 12 is OFF, 13 is ON, 14 is OFF, and 15 is ON.
- The next byte contains the data from channels 16 through 20. In the example response, channel 16 is ON, channel 17 is OFF, channel 18 is ON, channel 19 is ON, and channel 20 is ON. The left over bits are set to zero.

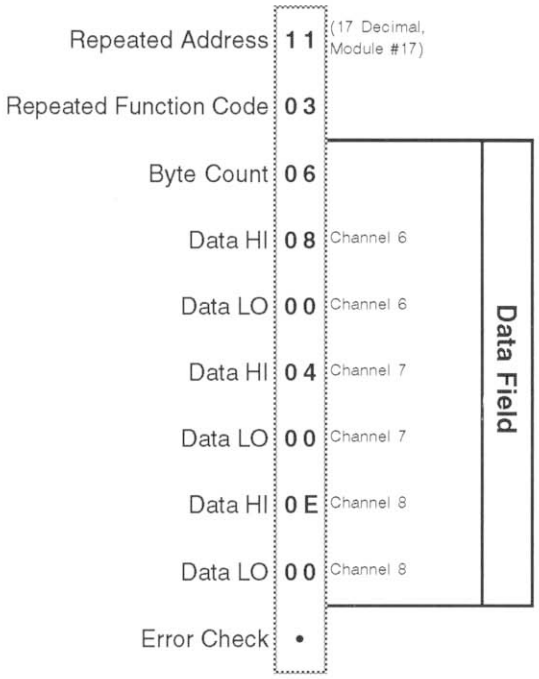
Function Code 03
Use this MODBUS RTU function to read the **level** of modules configured for **analog outputs**.

For example, the query shown below would be used to read level settings for channels 6, 7, and 8 of a 4-20mA output Masterless module with a Comm Link address of 17 (refer to Table 2, in the Installation section of this manual, for instructions on setting module addresses).



- The "Starting Address HI" and "Number of Points HI" fields are set to zero when using this function code with ***I/O EXPRESS*** modules.
- In "Starting Address LO", the number 05 Hex (5 Decimal) represents the address for the module's channel 6, incorporating the standard, MODBUS RTU off-set (refer to NOTE on page A3).
- There are 3 points of data available from channels 6 through 8, hence the byte that sets number of points to read is 03 Hex.

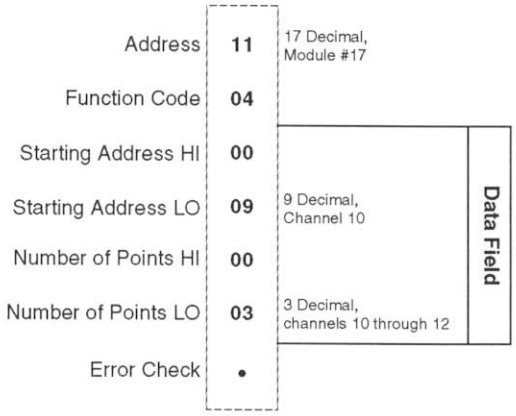
A typical response to the preceding query would look like this:



- Each channel's analog data in the ***I/O EXPRESS*** may be read as 16-bit signed integers.
- "Byte Count" is calculated by the responding module. It represents the number of 8-bit data bytes that make up the response.

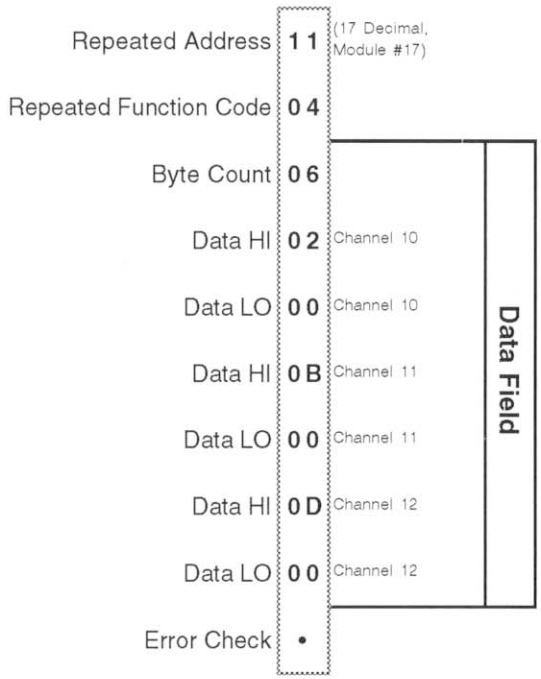
Function Code 04
Use this MODBUS RTU function to read the **level** of modules configured for **analog inputs**.

For example, the query shown below would be used to read the input levels of channels 10, 11, and 12 of a 4-20mA input Masterless module with a Comm Link address of 17 (refer to Table 2, in the Installation section of this manual, for instructions on setting module addresses).



- The "Starting Address HI" and "Number of Points HI" fields are set to zero when using this function code with ***I/O EXPRESS*** modules.
- In "Starting Address LO", the number 09 Hex (9 Decimal) represents the address for the module's channel 10, incorporating the standard, MODBUS RTU off-set (refer to NOTE on page A3).
- There are 3 points of data available from channels 10 through 12, hence the byte that sets number of points to read is 03 Hex.

A typical response to the preceding query would look like this:



- Each channel's analog data in the ***I/O EXPRESS*** may be read as 16-bit signed integers.
- "Byte Count" is calculated by the responding module. It represents the number of 8-bit data bytes that make up the response.

The other MODBUS RTU Function Codes operate in similar fashion. Consult the factory for more information.

Table B-1. *Decimal-to-Hex-to-Binary-to-ASCII Conversion*

D	H	B	A	D	H	B	A	D	H	B	A	D	H	B	A	D	H	B	D	H	B	D	H	B
0	00	0000 0000		41	29	00101001	)	82	52	01010010	R	123	7B	01111011	{	164	A4	10100100	205	CD	11001101	246	F6	11110110
1	01	00000001		42	2A	00101010	*	83	53	01010011	S	124	7C	01111100	|	165	A5	10100101	206	CE	11001110	247	F7	11110111
2	02	00000010		43	2B	00101011	+	84	54	01010100	T	125	7D	01111101	}	166	A6	10100110	207	CF	11001111	248	F8	11111000
3	03	00000011		44	2C	00101100	,	85	55	01010101	U	126	7E	01111110	~	167	A7	10100111	208	D0	11010000	249	F9	11111001
4	04	00000100		45	2D	00101101	-	86	56	01010110	V	127	7F	01111111		168	A8	10101000	209	D1	11010001	250	FA	11111010
5	05	00000101		46	2E	00101110	.	87	57	01010111	W	128	80	10000000		169	A9	10101001	210	D2	11010010	251	FB	11111011
6	06	00000110		47	2F	00101111	/	88	58	01011000	X	129	81	10000001		170	AA	10101010	211	D3	11010011	252	FC	11111100
7	07	00000111		48	30	00110000	0	89	59	01011001	Y	130	82	10000010		171	AB	10101011	212	D4	11010100	253	FD	11111101
8	08	00001000		49	31	00110001	1	90	5A	01011010	Z	131	83	10000011		172	AC	10101100	213	D5	11010101	254	FE	11111110
9	09	00001001		50	32	00110010	2	91	5B	01011011	[	132	84	10000100		173	AD	10101101	214	D6	11010110	255	FF	11111111
10	0A	00001010		51	33	00110011	3	92	5C	01011100	\	133	85	10000101		174	AE	10101110	215	D7	11010111	256	100	100000000
11	0B	00001011		52	34	00110100	4	93	5D	01011101	]	134	86	10000110		175	AF	10101111	216	D8	11011000	257	101	100000001
12	0C	00001100		53	35	00110101	5	94	5E	01011110	^	135	87	10000111		176	B0	10110000	217	D9	11011001	258	102	100000010
13	0D	00001101		54	36	00110110	6	95	5F	01011111	—	136	88	10001000		177	B1	10110001	226	E2	11100010	259	103	100000011
14	0E	00001110		55	37	00110111	7	96	60	01100000	`	137	89	10001001		178	B2	10110010	227	E3	11100011	260	104	100000100
15	0F	00001111		56	38	00111000	8	97	61	01100001	a	138	8A	10001010		179	B3	10110011	228	E4	11100100	261	105	100000101
16	10	00010000		57	39	00111001	9	98	62	01100010	b	139	8B	10001011		180	B4	10110100	229	E5	11100101	etc.	etc.	etc.
17	11	00010001		58	3A	00111010	:	99	63	01100011	c	140	8C	10001100		181	B5	10110101	230	E6	11100110	•	•	•
18	12	00010010		59	3B	00111011	;	100	64	01100100	d	141	8D	10001101		182	B6	10110110	231	E7	11100111	•	•	•
19	13	00010011		60	3C	00111100	<	101	65	01100101	e	142	8E	10001110		183	B7	10110111	232	E8	11101000	•	•	•
20	14	00010100		61	3D	00111101	=	102	66	01100110	f	143	8F	10001111		184	B8	10111000	218	DA	11011010	•	•	•
21	15	00010101		62	3E	00111110	>	103	67	01100111	g	144	90	10010000		185	B9	10111001	219	DB	11011011	•	•	•
22	16	00010110		63	3F	00111111	?	104	68	01101000	h	145	91	10010001		186	BA	10111010	220	DC	11011100	•	•	•
23	17	00010111		64	40	01000000	@	105	69	01101001	i	146	92	10010010		187	BB	10111011	221	DD	11011101	•	•	•
24	18	00011000		65	41	01000001	A	106	6A	01101010	j	147	93	10010011		188	BC	10111100	222	DE	11011110	•	•	•
25	19	00011001		66	42	01000010	B	107	6B	01101011	k	148	94	10010100		189	BD	10111101	223	DF	11011111	•	•	•
26	1A	00011010		67	43	01000011	C	108	6C	01101100	l	149	95	10010101		190	BE	10111110	224	E0	11100000	•	•	•
27	1B	00011011		68	44	01000100	D	109	6D	01101101	m	150	96	10010110		191	BF	10111111	225	E1	11100001	•	•	•
28	1C	00011100		69	45	01000101	E	110	6E	01101110	n	151	97	10010111		192	C0	11000000	233	E9	11101001	•	•	•
29	1D	00011101		70	46	01000110	F	111	6F	01101111	o	152	98	10011000		193	C1	11000001	234	EA	11101010	•	•	•
30	1E	00011110		71	47	01000111	G	112	70	01110000	p	153	99	10011001		194	C2	11000010	235	EB	11101011	•	•	•
31	1F	00011111		72	48	01001000	H	113	71	01110001	q	154	9A	10011010		195	C3	11000011	236	EC	11101100	•	•	•
32	20	00100000		73	49	01001001	I	114	72	01110010	r	155	9B	10011011		196	C4	11000100	237	ED	11101101	•	•	•
33	21	00100001	!	74	4A	01001010	J	115	73	01110011	s	156	9C	10011100		197	C5	11000101	238	EE	11101110	•	•	•
34	22	00100010	"	75	4B	01001011	K	116	74	01110100	t	157	9D	10011101		198	C6	11000110	239	EF	11101111	•	•	•
35	23	00100011	#	76	4C	01001100	L	117	75	01110101	u	158	9E	10011110		199	C7	11000111	240	F0	11110000	4090	0FFA	•
36	24	00100100	$	77	4D	01001101	M	118	76	01110110	v	159	9F	10011111		200	C8	11001000	241	F1	11110001	4091	0FFB	•
37	25	00100101	%	78	4E	01001110	N	119	77	01110111	w	160	A0	10100000		201	C9	11001001	242	F2	11110010	4092	0FFC	•
38	26	00100110	&	79	4F	01001111	O	120	78	01111000	x	161	A1	10100001		202	CA	11001010	243	F3	11110011	4093	0FFD	•
39	27	00100111	'	80	50	01010000	P	121	79	01111001	y	162	A2	10100010		203	CB	11001011	244	F4	11110100	4094	0FFE	•
40	28	00101000	(	81	51	01010001	Q	122	7A	01111010	z	163	A3	10100011		204	CC	11001100	245	F5	11110101	4095	0FFF	•

D = Decimal Number H = Hexadecimal Number B = Binary Number A = ASCII = Unprintable

RETURN PROCEDURES

To return equipment to Moore Industries for repair, follow these four steps:

1. Call Moore Industries and request a Returned Material Authorization (RMA) number.

   Warranty Repair –
   If you are unsure if your unit is still under warranty, we can use the unit's serial number to verify the warranty status for you over the phone. Be sure to include the RMA number on all documentation.

   Non-Warranty Repair –
   If your unit is out of warranty, be prepared to give us a Purchase Order number when you call. In most cases, we will be able to quote you the repair costs at that time. The repair price you are quoted will be a "Not To Exceed" price, which means that the actual repair costs may be less than the quote. Be sure to include the RMA number on all documentation.

2. Provide us with the following documentation:
   a) A note listing the symptoms that indicate the unit needs repair
   b) Complete shipping information for return of the equipment after repair
   c) The name and phone number of the person to contact if questions arise at the factory

3. Use sufficient packing material and carefully pack the equipment in a sturdy shipping container.

4. Ship the equipment to the Moore Industries location nearest you.

The returned equipment will be inspected and tested at the factory. A Moore Industries representative will contact the person designated on your documentation if more information is needed.

The repaired equipment, or its replacement, will be returned to you in accordance with the shipping instructions furnished in your documentation.

The Interface Solution Experts • **www.miinet.com**

MOORE INDUSTRIES

United States • info@miinet.com
Tel: (818) 894-7111 • FAX: (818) 891-2816

Australia • sales@mooreind.com.au
Tel: (02) 8536-7200 • FAX: (02) 9525-7296

Belgium • info@mooreind.be
Tel: 03/448.10.18 • FAX: 03/440.17.97

The Netherlands • sales@mooreind.nl
Tel: (0)344-617971 • FAX: (0)344-615920

China • sales@mooreind.sh.cn
Tel: 86-21-62491499 • FAX: 86-21-62490635

United Kingdom • sales@mooreind.com
Tel: 01293 514488 • FAX: 01293 536852