

# **FACTS** engineering

*Automationdirect.com*<sup>™</sup>

Direct Logic 305

Serial Bridge CPU

F3-OMUX-1

F3-OMUX-2

F3-OMUX-3



Order Number: F3-OMUX-M



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## CHAPTER 1: INTRODUCTION

### Serial Bridge CPU DESCRIPTION

The Serial Bridge CPU™ is a computer digital and analog input/output (I/O) controller. The Bridge CPU communicates to a host computer using the Opto 22 OPTOMUX™ serial communication protocol. The Bridge CPU is the link between the numerous host computer software packages with OPTOMUX drivers and the wide range of analog and digital optically isolated industrial I/O modules available for the **Automationdirect.com** DL305 programmable controller.

### 184 POINT I/O DENSITY

A typical system consists of a **Direct** Logic 305 five, eight or ten slot rack. The Serial Bridge CPU plugs into the first slot of the rack. The module directly controls a mix of up to 136 digital and analog I/O points in a single 19" ten slot rack. Additional digital I/O points can also be controlled by the Serial Bridge CPU with the addition of an expansion rack. See Appendix B for Base Configurations.

### COMMUNICATION NETWORK

Serial Bridge CPUs can be mixed with Opto 22 OPTOMUX brain boards to form a communication network. A Host Computer communicates to the I/O in the network serially using a four wire (plus ground) RS-422/485 multi-drop connection. A total of 16 Serial Bridge CPUs may be used on the same communication network for a maximum of 2944 digital and analog I/O points.

### DISTRIBUTED CONTROL

Bridge CPUs reduce Host Computer overhead by performing various local I/O control functions. Standard OPTOMUX commands enable such functions as Analog Averaging, Peak and Minimum Analog Latching, Timed Digital Outputs, Digital Input Pulse width measurement, digital input state transition latching and digital input counting. For example, any digital input can be configured as a counter with a preset. Bridge CPUs operating at 16 MHz can count 50% duty cycle pulses at a rate of 100 Hz minimum. For a 5 module system the maximum counting rate is 250 Hz.

## SERIAL BRIDGE COMPARED TO OPTO 22 OPTOMUX

### Replace Up To 12 Brain Boards and Mounting Racks

OPTOMUX requires a brain board for every 4, 8, or 16 point mounting rack. Separate brain boards are required for digital and analog I/O racks. Each brain board has a unique OPTOMUX address assigned to it. An OPTOMUX address supports only 16 I/O points.

The Bridge CPU has 12 consecutive OPTOMUX addresses assigned to it and can control a mix of 184 digital and analog I/O. The Serial Bridge CPU uses jumpers to identify I/O modules in the **Direct** Logic 305 rack as either digital or analog. To the host computer, each 16 point digital or analog I/O module slot in the **Direct** Logic 305 appears to be a separate OPTOMUX brain board.

### Automatic Module Type Configuration

Inputs and outputs must be identified for the OPTOMUX brain boards each time there is a power loss.

The Serial Bridge automatically identifies points as inputs or outputs. Although the Bridge CPU will acknowledge the 3 OPTOMUX I/O Configuration Commands, "G-I" they are ignored. The Bridge's response to an I/O configuration, "j", COMMAND represents the physical configuration of I/O modules at that address.

### Built-in Logic and Control Power Supplies

All OPTOMUX boards require an external +5 VDC power supply. Opto22 analog I/O modules require an external  $\pm 15$  VDC power supply.

The Serial Bridge CPU and the Direct Logic 305 I/O modules are powered directly by the DL305 rack. Analog I/O modules use the 24 VDC power supply built into the Direct Logic 305 rack to generate  $\pm 15$  VDC supplies internally. A separate DC power supply is only needed if required to power external field devices. FACTS Engineering 4-20 mA analog output modules source current. Thus an external loop power supply is not required.

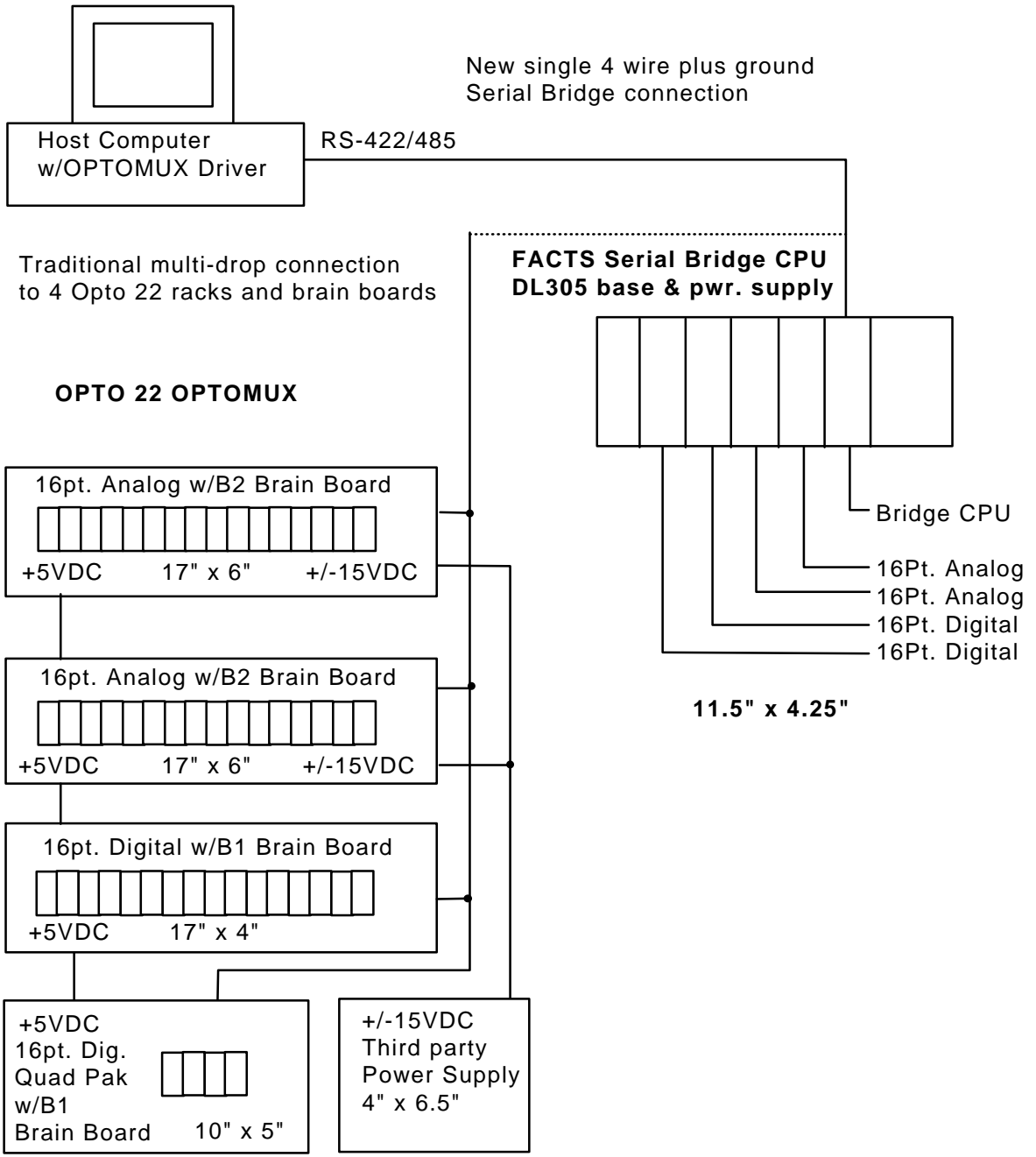
### I/O MODULES NOT SUPPORTED BY THE BRIDGE

Currently the 305 Bridge CPU supports over 36 different Direct Logic 305 I/O modules. The sales catalog contains a complete listing of all available I/O modules. Please call us if you do not find the I/O interface you need for your application.

The only Direct Logic modules which are incompatible with the Bridge CPU are listed below.

D3-HSC	High Speed Counter
D3-04AD	Analog Input, 8-bit, 4 points
D3-02DA	Analog Output, 8-Bit, 2 Points

### Mounting Space Comparison



**TOTAL FOOT PRINT = 342 sq. Inches**

**TOTAL FOOT PRINT = 58 sq. inches**

## **DUAL NETWORK OPERATION APPLICATIONS**

Two optically isolated RS-422/485 serial ports are provided on the Serial Bridge CPU for communication with up to two host computers (model F3-OMUX-2). Since both ports support the OPTOMUX protocol, new applications requiring redundant control or control monitoring are now possible using existing application software. OPTOMUX command responses are the same regardless of the port they were received from.

### **Redundancy for Hazard Tolerance**

Both Serial Bridge CPU communication ports have substantial built in hazard protection. Additional fault tolerance can be realized by using two separate network connections to the host computer. The RS-422/485 connections to the host computer should be optically isolated to maintain the isolation between the communication ports on the Serial Bridge CPU (model F3-OMUX-2). In this configuration the host computer would normally use Port 1 at the highest data rate possible. At some time a network failure occurs due to an uncontrollable outside event such as a power line short or lightning damage. Now the host computer switches to the other network and continues operation using Port 2 of the Serial Bridge CPU. Typically the host computer would drop back to 9600 baud until repairs to the Port 1 network can be made.

### **Distributed Control**

A host computer is connected to Port 1 of the Serial Bridge CPU to perform a given process or machine control function. Another host computer running another process control or data monitoring software package is connected to Port 2 of the Bridge. The control of analog and digital outputs is delegated between the two host computers as appropriate. Unused Serial Bridge output points are delegated between the two hosts for use as status bits and control flags. Both host computers may read the status of all of the external I/O in the system plus the status bits and control flags generated by the other computer. In this manner the I/O of a single Serial Bridge CPU is shared or divided between two different applications.

### **Control Monitoring**

A local host computer is connected to Port 1 of the Serial Bridge CPU to control a local network. A remote computer is connected to Port 2 of the Serial Bridge CPU and other remote Serial Bridge CPUs and OPTOMUX brain boards to form a data gathering and monitoring network. The remote network is connected using a combination of modems, leased-lines, radios and 5 wire RS-422/485 connections.

## CHAPTER 2: INSTALLATION

### BASE INSTALLATION

Direct Logic 305 5-slot and 10-slot racks have configuration jumpers or switches on the back plane which must be set for correct operation (please see Appendix B). For base installation instructions and mounting dimensions please refer to the Direct Logic 305 User Manual.

### BRIDGE CPU SELECTION

There are three Bridge CPU part numbers to select from, F3-OMUX-1, F3-OMUX-2 and F3-OMUX-3.

#### F3-OMUX-1 and F3-OMUX-2

Both the F3-OMUX-1 and F3-OMUX-2 support up to 184 I/O points per CPU. The maximum number of CPUs per network is 16. The first 8 I/O module slots may be used for analog or discrete I/O.

The F3-OMUX-1 is recommended for most applications because it is compatible with both RS-232 and RS-422 communications. This permits program development and trouble-shooting without the need for an RS-232 to RS-422 converter on the host computer. It also provides more flexible I/O configuration than the F3-OMUX-3. If more than 16 CPUs are required on a single network or if modem communication is required then the F3-OMUX-3 is recommended.

The F3-OMUX-2 is recommended for dual network applications such as those described on page 1.4.

#### F3-OMUX-3

The F3-OMUX-3 is optimized for Remote Terminal Unit (RTU) applications and supports both RS-232 and RS-422 communications. It supports up to 184 I/O points per CPU. The maximum number of CPUs per network is 64. If analog modules are used, they are placed consecutively beginning with the first I/O module slot. Up to 7 analog modules may be installed per CPU.

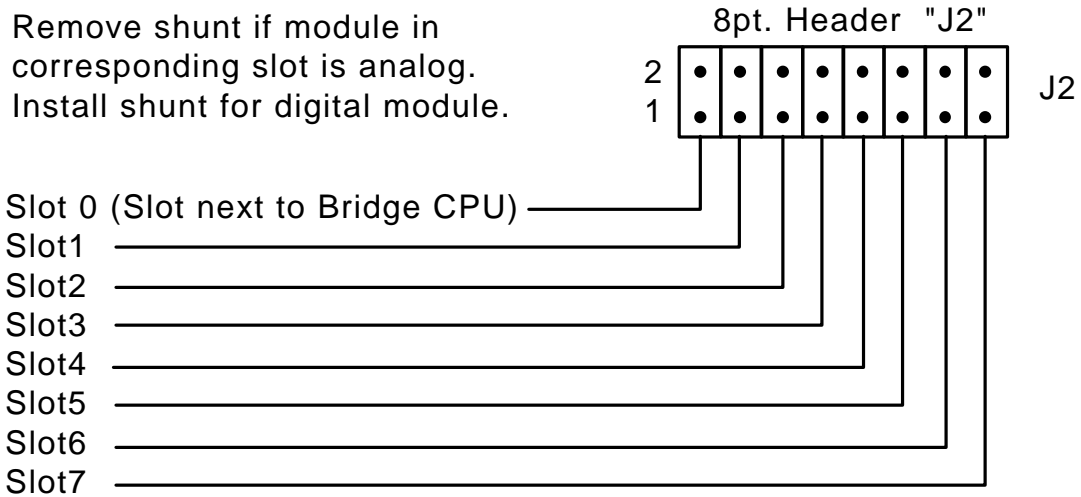
The F3-OMUX-3 provides RS-232 RTS and CTS hardware handshaking lines to enable telephone and radio modem communication networks. A programmable RTS delay is also provided to simplify radio installations.

## CONFIGURATION JUMPERS

Jumper configuration of the F3-OMUX-1 CPU and F3-OMUX-2 CPU is different than the jumper configuration for the F3-OMUX-3 CPU. Jumper configuration for the F3-OMUX-1 and F3-OMUX-2 is described below. The jumper configuration description for the F3-OMUX-3 begins on page 2.4.

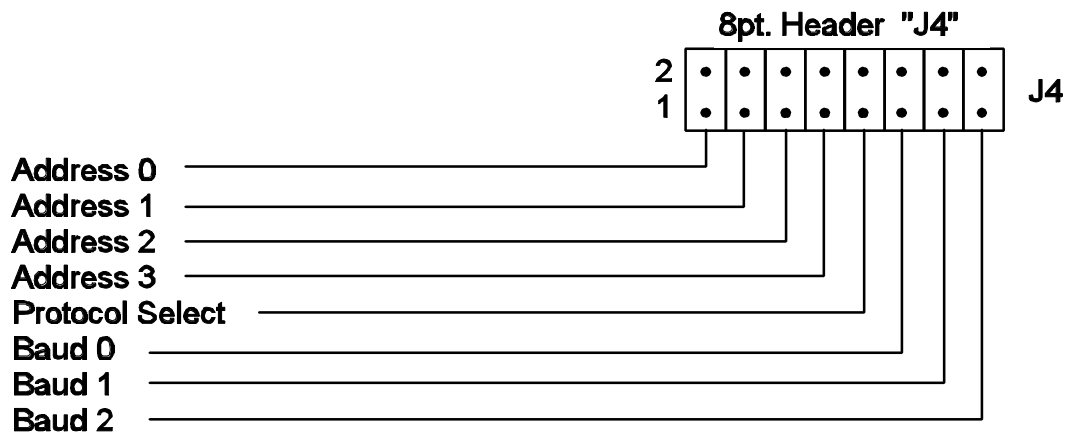
### CONFIGURATION JUMPERS, F3-OMUX-1 and F3-OMUX-2

There are 2 sets of configuration jumpers on the smaller Bridge CPU daughter board. The module is shipped from the factory with shunts on all the jumpers. This configures the module for 38400 baud, all digital I/O, and 12 OPTOMUX addresses 0-11. The jumpers are defined as shown in the following two diagrams.



The last

slot in a ten slot base and all expansion rack slots are 8 point digital slots. Unused slots may be configured for either digital or analog modules with no change in system performance.



## ANALOG/DIGITAL SLOT SELECTION, F3-OMUX-1 and F3-OMUX-2

The first 8 I/O modules slots may be programmed to be either analog or digital using the SLOT 0 to SLOT 7 jumpers on the "J2" header. Remove the shunt if the module in the corresponding slot is analog. Install a shunt if the module is digital. The first I/O module slot next to the CPU is SLOT 0.

NOTE: If a slot is configured as analog but the module is actually digital, the Bridge CPU will return an 'N08' error for any request to that slot.

## ADDRESS SELECTION, F3-OMUX-1 and F3-OMUX-2

There are 16 possible Serial Bridge CPU base addresses. Each Bridge CPU on the same network is assigned a unique base address by positioning the four Address jumpers as shown in the table at the bottom of the page.

The base address becomes the OPTOMUX address for the I/O module in slot 0 (slot next to CPU).

The first 8 DL305 16-point I/O module slots are addressed using 8 consecutive OPTOMUX addresses. The next 7 slots are 8 point module slots which are addressed using 4 more consecutive OPTOMUX address, 1 address for 2 slots.

Example:

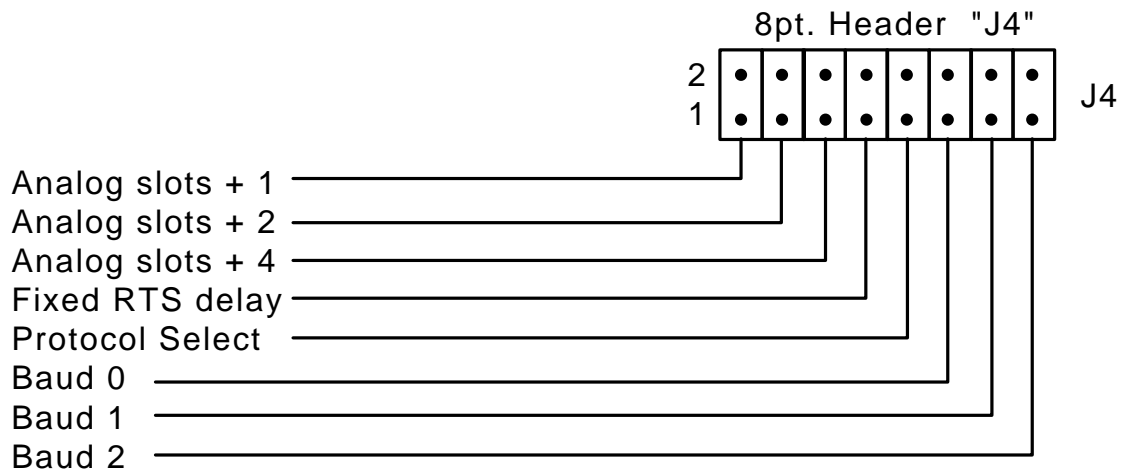
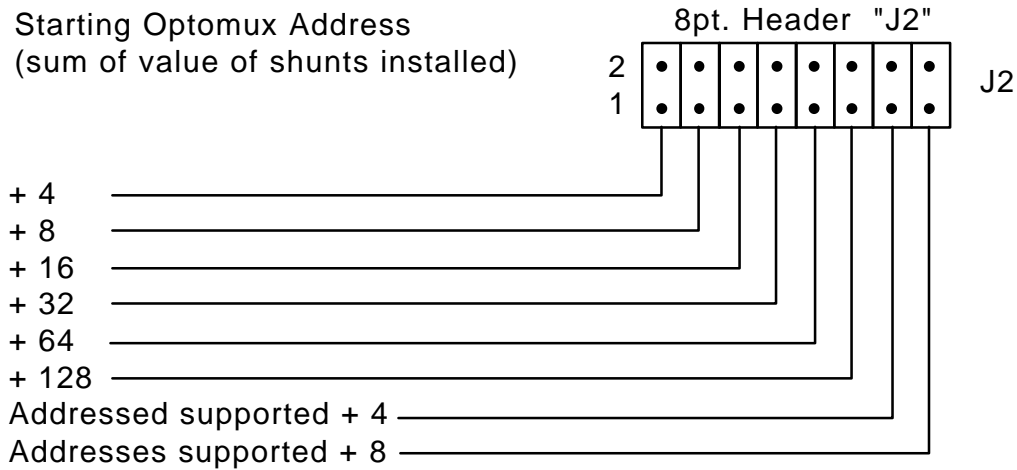
If the base address is 80 then slot 0 would have 16 I/O positions at OPTOMUX address 80, slot 1 would be at address 81 and slot 2 at address 82. Slot 8 and the first module in an expansion base would be at address 88.

Address Jumper	Serial Bridge CPU base address - decimal (hexadecimal)															
	240 (F0)	224 (E0)	208 (D0)	192 (C0)	176 (B0)	160 (A0)	144 (90)	128 (80)	112 (70)	96 (60)	80 (50)	64 (40)	48 (30)	32 (20)	16 (10)	0 (0)
0	G	O	G	O	G	O	G	O	G	O	G	O	G	O	G	O
1	G	G	O	O	G	G	O	O	G	G	O	O	G	G	O	O
2	G	G	G	G	O	O	O	O	G	G	G	G	O	O	O	O
3	G	G	G	G	G	G	G	G	O	O	O	O	O	O	O	O

O indicates jumper installed

### CONFIGURATION JUMPERS, F3-OMUX-3

There are two sets of configuration jumpers on the smaller Bridge CPU daughter board. The module is shipped from the factory with shunts on all the jumpers. This configures the module for 38400 baud, 7 analog I/O slots, and 12 OPTOMUX addresses beginning at address 252. The jumpers are defined as shown in the following two diagrams.



### ADDRESS SELECTION, F3-OMUX-3

There are 64 possible 305 Bridge CPU starting addresses. Use the Starting OPTOMUX Address jumpers +4, +8, +16, +32, +64, +128 to select the CPU starting addresses as shown in the "CPU Starting Address Table" .



### NUMBER OF ADDRESSES SUPPORTED, F3-OMUX-3

Beginning with the programmed starting address, each Bridge CPU supports at least 3 additional consecutive OPTOMUX addresses (4 total). The number of additional consecutive OPTOMUX addresses each CPU supports, either 4 or 8, is selected using two Addresses Supported jumpers (12 OPTOMUX addresses per CPU maximum).

Each Bridge CPU on the same network must be assigned a unique group of consecutive OPTOMUX addresses. If the Starting OPTOMUX Address plus the number of Addresses Supported is greater than the last valid OPTOMUX address (255) then the last address supported is 255.

**CPU Starting Address Table**

For each row in the following table a "O" designates that a shunt should be installed in this position in order to select the starting address shown in the left column.

Starting OPTOMUX address							Starting OPTOMUX address						
	+4	+8	+16	+32	+64	+128		+4	+8	+16	+32	+64	+128
0							128						O
4	O						132	O					O
8		O					136		O				O
12	O	O					140	O	O				O
16			O				144			O			O
20	O		O				148	O		O			O
24		O	O				152		O	O			O
28	O	O	O				156	O	O	O			O
32				O			160				O		O
36	O			O			164	O			O		O
40		O		O			168		O		O		O
44	O	O		O			172	O	O		O		O
48			O	O			176			O	O		O
52	O		O	O			180	O		O	O		O
56		O	O	O			184		O	O	O		O
60	O	O	O	O			188	O	O	O	O		O
64					O		192					O	O
68	O				O		196	O				O	O
72		O			O		200		O			O	O
76	O	O			O		204	O	O			O	O
80			O		O		208			O		O	O
84	O		O		O		212	O		O		O	O
88		O	O		O		216		O	O		O	O
92	O	O	O		O		220	O	O	O		O	O
96				O	O		224				O	O	O
100	O			O	O		228	O			O	O	O
104		O		O	O		232		O		O	O	O
108	O	O		O	O		236	O	O		O	O	O
112			O	O	O		240			O	O	O	O
116	O		O	O	O		244	O		O	O	O	O
120		O	O	O	O		248		O	O	O	O	O
124	O	O	O	O	O		252	O	O	O	O	O	O

### ADDRESSING 8 AND 16 POINT I/O MODULES, F3-OMUX-3

The first 8 I/O module slots are 16 point slots addressed using 8 consecutive OPTOMUX addresses. If these slots are enabled by the Addresses Supported jumpers then each slot will use one 16 point OPTOMUX address even if the module in the slot is only an 8 point module. For example, if the starting address is 80 then the I/O module next to the CPU (slot 2) would have 16 I/O positions at OPTOMUX address 80, slot 3 would be at address 81 and slot 9 at address 87.

The next 7 slots are 8 point module slots which, if enabled, are addressed using 4 more consecutive OPTOMUX address, 1 address for 2 slots. For example, the last slot in the CPU base, slot 10, and the first module in an expansion base would be at address 88.

### ANALOG/DIGITAL SLOT SELECTION, F3-OMUX-3

Consecutive Bridge CPU I/O module slots are jumper selectable for either digital (B1) or analog (B2) OPTOMUX support. Analog modules are installed beginning with the first I/O module slot next to the CPU. The number of analog modules installed is programmed using the three Analog Slots jumpers +1, +2 and +4. Slots not programmed as analog slots are digital slots. If no analog modules are installed then remove the three Analog Slots jumpers. If for example, 5 analog modules are installed then place a jumper on Analog Slots positions +1 and +4 (no jumper on +2).

### FIXED RTS DELAY, F3-OMUX-3

Install the Fixed RTS Delay jumper (factory default) for a 150 msec delay between radio keying (RTS1 goes high) and the start of a response message transmission. Remove the Fixed RTS Delay jumper to enable the CTS1 line to control the RS-232 and RS-422/485 transmitters. If hardware handshaking is not required, remove the Fixed RTS Delay jumper and connect RTS1 to CTS1.

### PROTOCOL SELECT (all models)

Install the Protocol Select jumper (factory default) for standard OPTOMUX compatibility mode. Remove the Protocol Select jumper for Enhanced OPTOMUX operation. Enhanced OPTOMUX replaces the two standard ASCII sum-check bytes with the a four byte ASCII CRC-16 error check as described in Appendix A. This results in superior reliability with an undetected bit error rate near zero.

### BAUD RATE CONFIGURATION (all models)

The Bridge CPU supports baud rates of 300, 1200, 2400, 9600, 19200, 38400, 57600 and 115200. One of the 8 possible baud rates is selected using the 3 Baud jumpers. A "O" in the table designates that a shunt should be installed in this position. A "Q" indicates the shunt should be removed.

	300	57600	1200	2400	115200	9600	19200	38400
Baud 0	Q	O	Q	O	Q	O	Q	O
Baud 1	Q	Q	O	O	Q	Q	O	O
Baud 2	Q	Q	Q	Q	O	O	O	O

### F3-OMUX-2 COMMUNICATION PORT CONNECTIONS

The Serial Bridge CPU is connected to an OPTOMUX network via one of the two 9 pin connectors on the face of the module. Either connector may be used. Both may be used at the same time.

To preserve the isolation between the connectors it is important to note that the signal ground on Port 1 is the same as the 24 VDC common on the Direct Logic 305 rack. The signal ground on Port 2 is the same as the 9 VDC common. This is the terminal labeled "G" on the DL305 rack.

The maximum baud rate supported at Port 2 is 9600. The maximum baud rate which can be used at Port 1 is 115200. Serial port framing is 1 start bit, 8 bit word (8th data bit is ignored), no parity and 1 stop bit. Port 1 is the bottom 9-pin connector.

PORT 1 and PORT 2			
Pin	Symbol	Description	Internal Connections
1	TXD -	From Network -	
2	TXD +	From Network +	
3	GND	Signal Ground	
4	RXD -	From Host -	
5	RXD +	From Host +	
6	RXD -	To Network -	
7	RXD +	To Network +	
8	TXD -	To Host Computer -	
9	TXD +	To Host Computer +	

### Repeat Mode Operation

The Serial Bridge CPU model F3-OMUX-2, can be jumper selected to operate in either the OPTOMUX multi-drop or repeat modes. Factory installed jumpers configure the Serial Bridge CPU for multi-drop mode. The repeat mode is provided for compatibility with first generation OPTOMUX networks and is not recommended for new installations. To reconfigure the module for repeat mode, remove shunts from the jumper locations J22, J23, J24, and J25. Then place shunts on jumper locations J16 and J17. The jumpers are located on the larger mother board. When configured for repeat mode, connections to both ports are required for a single network interface. Use the TO/FROM HOST COMPUTER connections on Port 1 as normal. Then use the TO/FROM HOST COMPUTER connections on Port 2 to re-transmit to the network.

### F3-OMUX-1 and F3-OMUX-3 COMMUNICATION PORT CONNECTIONS

The Serial Bridge CPU is connected to an OPTOMUX network via one of the two 9 pin connectors on the face of the module. Either connector may be used. Both may be used at the same time. The signal ground on both ports is the same as the 9 VDC common. This is the terminal labeled "G" on the DL305 rack. The maximum baud rate supported at Port 2 is 9600. The maximum baud rate which can be used at Port 1 is 115200. Serial port framing is 1 start bit, 8 bit word (8th data bit is ignored), no parity and 1 stop bit.

Port 1 is the bottom 9-pin connector.

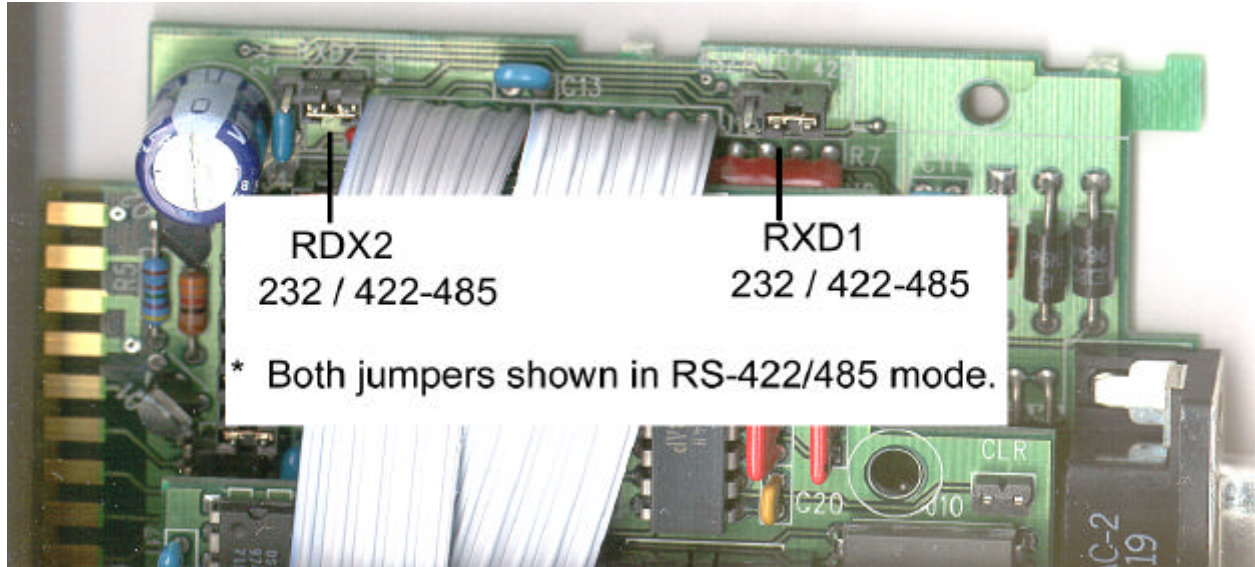
Port 2		
Pin	Symbol	Description
1	RXD2 +	Input High, RS-422
2	TXD2	Output, RS-232
3	RXD2	Input, RS-232
4	+ 5 V.	+5 V. @ 100mA.
5	n/c	No Connection
6	RXD2 -	Input Low, RS-422
7	GND	Signal Ground
8	TXD2 -	Output Low, RS-422
9	TXD2 +	Output High, RS-422

Port 1		
Pin	Symbol	Description
1	RXD1 +	Input High, RS-422
2	TXD1	Output, RS-232
3	RXD1	Input, RS-232
4	RTS1	DTE rdy to xmit, RS-232
5	CTS1	DTE rdy to rxd, RS-232
6	RXD1 -	Input Low, RS-422
7	GND	Signal Ground
8	TXD1 -	Output Low, RS-422
9	TXD1 +	Output High, RS-422

**Note:** When using the Port 1 of the F3-OMUX-3 in RS-422/485 Mode pin 4 and 5 (RTS and CTS) must be jumpered.

## F3-OMUX-1 and F3-OMUX-3 COMMUNICATION PORT RECEIVER CONFIGURATION

Port 1 and Port 2 are independently jumper selectable for RS-232 or RS-422/485 operation. To use the RS-232 receiver on Port 2 or Port 1, place the shunt on the left two pins of RXD2 or RXD1 respectively.



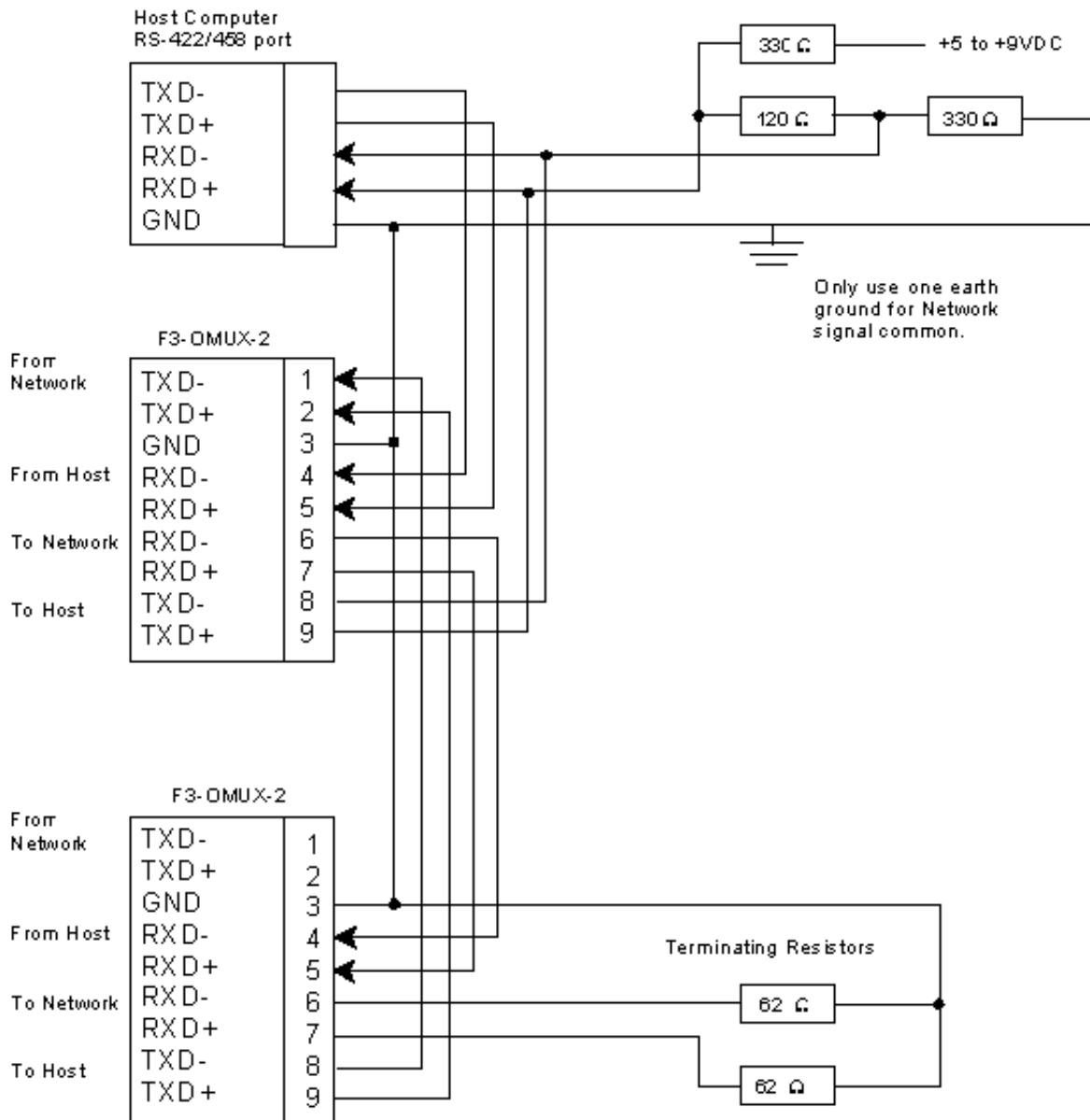
### MODEM CONTROL LINES (F3-OMUX-3 only)

Port 1 supports hardware handshaking using RTS1 and CTS1. When the Bridge CPU has received a valid message and is ready to respond, the RTS1 output line goes high. The Bridge then waits for CTS1 input to go high before transmitting the response. If hardware handshaking is not required then RTS1 should be connected to CTS1.

**Note:** If the Fixed RTS Delay jumper is removed then the RTS/CTS lines must be shorted or appropriately connected.

When a radio or modem does not provide a delayed CTS line then a fixed 150 msec transmitter attack time delay can be provided by installing the "Fixed RTS Delay" jumper on configuration block "J4". When the "Fixed RTS Delay" jumper is installed, the CTS1 input is ignored and the time delay before transmitting a response after RTS1 goes high is fixed at 150 msec.

## Multi-drop Wiring



## Cable Shielding

Shielding improves noise immunity (magnetic field protection). It is important to ground the shield at the host computer end only. Grounding one end only provides the least high frequency signal attenuation and the best rejection of unwanted signals. Grounding both ends of the shield will cause magnetic field induced noised currents to flow through ground. Noise may then appear on the data lines due to transformer like coupling with the shield. If the cable shield must be used as the system ground conductor then placing a 100  $\Omega$  resistor in series with the shield and the ground connection will reduce noise producing ground currents.

## **Connecting Cables and Line Termination**

A dual twisted pair plus ground connection between Bridge CPUs is recommended. Proper termination of the balanced transmission line is required to prevent data errors. A typical AWG 22 solid wire with .060 inch plastic cover, twisted 4.5 times per foot has a characteristic impedance of about 120 . Thus the selection of the two 62 line-to-ground terminating resistors. Line-to-ground termination is preferred to the often shown line-to-line 120 termination. In noisy or long line applications the much better line-to-ground common-mode rejection capability is particularly important. In multi-drop networks, the line must be terminated at the extreme ends only as shown in the two previous diagrams. Addition of intermediate terminations will adversely load the line. If both the transmit and receive ends of the same twisted pair are terminated, double the value of the termination resistors.

## **Floating Data Lines Noise Prevention**

The Bridge CPU and Local Controller receivers incorporate a fail safe feature which guarantees the inputs are inactive when they are open or floating. Receivers will be floating when all transmitters are disabled. Host computer inputs will be floating when there is no Bridge responding. Since not all RS-422/485 receivers incorporate a fail safe feature, it may be necessary to add a pair of network biasing resistors to the host as shown in the diagram on page 2.10. This will pull-up the Bridge's floating transmit line to the RS-422/485 idle state (RXD+ to RXD- > .45 V). An unused RS-232 output (such as RTS) can be set active (high) and then used as the positive voltage source.

## **Point to Point RS-232 Wiring**

The Serial Bridge CPU module F3-OMUX-1, is recommended for point to point RS-232 applications. This module features jumper selectable RS-232 or RS-422/485 ports for direct connection to most host computers.

Connection of a host computer RS-232 port to the F3-OMUX-2 Bridge CPU is accomplished using a FACTS Engineering RS-232/422/485 converter, FA-UNICON. The converter is powered by the Direct Logic 305 base. Network biasing resistors are built into the converter to prevent noise when Bridge transmitters are in their high impedance state.





## CHAPTER 3: OPTOMUX PROTOCOL SUMMARY

### BRIDGE CPU COMMAND SUMMARY

The following summary lists the Bridge CPU commands. Each item in the summary contains the Bridge CPU Command Name, the OPTOMUX Command Character and a brief description of the command. A complete description of these commands is described in the Opto 22 OPTOMUX B1 and B2 Digital and Analog Brain Boards Operations Manual, Part #1927.

Bridge CPU responses strictly adhere to the OPTOMUX 2 pass protocol (4 pass protocol is not supported). There are some minor variations between the OPTOMUX Manual and the operation of a the B1 and B2 brain boards. In these cases the Bridge CPU duplicates the operation of the actual brain boards.

CONFIGURATION	Syntax	Description
POWER UP ACKNOWLEDGE	A	Prevents error code, N00 response @ power up
RESET	B	Sets the bridge CPU to power up status/configuration.
SET DIGITAL WATCHDOG	D(data)	Specify communications timeout and action taken.
SET ANALOG WATCHDOG	D(pts)(data)	Specify communication timeout and action taken.
IDENTIFY MODULE TYPE	F(data)	Identifies a slot as either digital or analog.
ENHANCED WATCHDOG	m(pts)(data)	Specify timeout and resultant state of all outputs.
SET TIME BASE	n(data)	Sets timer resolution in units of 10 milliseconds.
SET MODE	u(data) <sup>1</sup>	Communication timeout occurs when no valid command is received for specified address when data=1.

<sup>1</sup> **Data = 0 is the Opto 22 compatible default. In this mode, any single character or noise on the network will reset the watchdog timer. The default mode should be used with caution.**

**Data = 1 is recommended by FACTS Engineering. In this mode, any slot in the base (that is any Optomux address) may be configured for network or valid address communication monitoring.**

### NEW COMMANDS

IDENTIFY FIRMWARE	z	Returns manufacture and firmware version number.
SET MODE	u [data]	Communication Time-out occurs when no valid command is received for specified address when data = 1.
READ COUNTERS STATUS	v [points]	Returns preset reached for specified counters.
READ/CLR CNT'R STATUS	w [points]	Returns and then clears preset reached status for specified counters.
CLEAR COUNTER STATUS	x [points]	Clears preset reached status for specified counters.
SET COUNTER PRESET	y [pts][data]	Sets counter preset (0-FFFF) for specified counters.

### INPUT/OUTPUT TYPE

DEFINE I/O MODULES	G	The Bridge CPU automatically identifies input and output points. These commands are acknowledged by the Bridge but are otherwise ignored.
DEFINE INPUT MODULES	H	
IDENTIFY I/O TYPE	j	
DEFINE OUTPUT MODULES	I	Identifies 16 points as either inputs or outputs.

### SET/RESET DIGITAL OUTPUTS

SET/RESET OUTPUTS	J [points]	Turn ON or OFF all 16 outputs in a slot.
SET OUTPUTS	K [points]	Turn ON any outputs in a slot.
RESET OUTPUTS	L [points]	Turn OFF any outputs in a slot.
READ I/O STATUS	M	Return ON/OFF status of all 16 I/O in a slot.

### LATCH DIGITAL INPUTS

DEF. LATCHING INPUTS	N [points]	Specify inputs to latch OFF to ON or ON to OFF
DEFINE OFF-ON LATCHES	O [points]	Specify inputs which latch OFF to ON.
DEFINE ON-OFF LATCHES	P [points]	Specify inputs which latch ON to OFF.
READ LATCHED INPUTS	Q	Returns ON status for inputs which have latched.
READ/CLEAR LATCHES	R [points]	Returns ON status for latched inputs and clears them.
CLEAR LATCHED INPUTS	S [points]	Sets specified inputs to their unlatched state.

### DIGITAL INPUT COUNTING

RUN/STOP COUNTERS	T [points]	Starts and stops counting at specified inputs.
RUN COUNTERS	U [points]	Starts counting at specified inputs
STOP COUNTERS	V [points]	Stops counting at specified inputs.
READ ACC. COUNT	W [points]	Returns accumulated count for specified inputs.
READ AND CLEAR COUNT	X [points]	Returns and clears accumulated input count.
CLEAR COUNTERS	Y [points]	Sets accumulated count to zero for specified inputs (X & Y also clear the preset reached status).
READ COUNTERS STATUS	v [points]	Returns preset reached for specified counters.
READ/CLR CNT'R STATUS	w [points]	Returns and then clears preset reached status for specified counters
CLEAR COUNTER STATUS	x [points]	Clears preset reached status for specified
SET COUNTER PRESET	y [pts][data]	Sets counter preset (0-FFFF) for specified counters.

### DIGITAL INPUT PULSE TIMING

DEFINE TIMED INPUTS	a [points]	Time duration of ON or OFF pulses at specified pts.
DEF. INPUTS TIMED ON	b [points]	Time duration of ON pulses at specified inputs.
DEF. INPUTS TIMED OFF	c [points]	Time duration of OFF pulses at specified inputs.
READ TIMING STATUS	d	Returns ON for inputs with pulse timing finished.
READ INPUT TIME DUR.	e [points]	Returns time duration of pulse for specified inputs.
READ/CLEAR TIME DUR.	f [points]	Returns and clears duration for specified inputs.
CLEAR INPUT TIME DUR.	g [points]	Clears time duration of pulse for specified inputs.

### TIMED DIGITAL OUTPUTS

SET ON AND OFF DELAYS	Z [pts], K [data]	Specify ON and OFF delays for specified outputs
SET ON/OFF HOLD TIMES	Z [pts] H, J [data]	Specify ON and OFF hold times for specified outputs.
INITIATE SQUARE WAVE	Z [pts] L, M [data]	Start a continuous square wave for specified outputs.
TURN OFF TIMED OUTPUTS	Z [points] G	Cancel timed outputs for specified output points.
EXTEND EXISTING DELAY	h [points]	Restart or re-trigger an outputs existing time delay.
OUTPUT PULSE TRAIN	i [pts][per][cnt]	Start square wave with a specified period and number of pulses.
START ON PULSE	k [pts][data]	Turns ON specified outputs for specified time.
START OFF PULSE	l [pts][data]	Turns OFF specified outputs for specified time.

### ANALOG READ/WRITE

WRITE OUTPUTS	J [pts][data]	Write 12-bits to analog outputs in a specified slot.
UPDATE OUTPUTS	S [pts][data]	Write different values to one or more analog outputs.
READ OUTPUTS	K [points]	Returns a 12-bit value for specified analog outputs.
READ INPUTS	L [points]	Returns a 12-bit value for specified analog inputs.
READ/AVERAGE INPUTS	M [pts][data]	Returns average analog input for a specified time.
START INPUT AVERAGING	T [pts][data]	Specify inputs to start averaging.
READ AVERAGING STATUS	i	Returns ON for inputs which have completed averaging.
READ INPUT AVERAGE	U [points]	Returns 12-bit average value for specified inputs.

### SAMPLE AND HOLD PEAK AND MINIMUM ANALOG INPUTS

READ MIN. ANALOG INPUT	a [points]	Returns minimum 12-bit value for specified inputs.
READ/CLEAR MIN. INPUT	b [points]	Returns and clears minimum value for specified points.
CLEAR MIN. ANALOG IN	c [points]	Clears minimum 12-bit value for specified inputs.
READ PEAK ANALOG INPUT	d [points]	Returns maximum 12-bit value for specified inputs.
READ/CLEAR PEAK INPUT	e [points]	Returns and clears maximum value for specified pts.
CLEAR PEAK ANALOG IN	f [points]	Clears maximum 12-bit value for specified inputs.

### ANALOG INPUT RANGES

DEF. HIGH/LOW IN LIM.	N [pts][data]	Specify high and low limits for specified analog inputs.
READ IN LIMIT STATUS	O	Returns ON state for inputs which exceeded limits.
READ/CLEAR LIM. STATUS	P [points]	Returns and clears input exceeded limit status.
CLR INPUT LIM. STATUS	Q [points]	Clears status of inputs which have exceeded limits.

### COMMANDS NOT SUPPORTED

The Bridge CPU returns error code "N08" in response to the following unsupported commands.

SET TURN-AROUND DELAY	C	Delay response to command from host.
SET PROTOCOL	E	Selects either the two or four pass protocol. <sup>1</sup>
SET TEMP. PROBE TYPE	k	Initialization for READ TEMPERATURE INPUTS.
READ TEMP. INPUTS	l	Converts analog inputs to temperature.
ANALOG GAIN/OFFSET	g,h,W-Z	Scales analog inputs in engineering units.
ANALOG WAVE FORM	R, V	Start a constant wave form at any analog output.

<sup>1</sup> Bridge CPU supports only 2 pass protocol.

## CHAPTER 4: HOST PROGRAMMING

### ANALOG MODULE ADDRESSING

Addressing of 4 Channel Analog Output Modules, F3-04DA, and 4 channel Analog Input Modules, F3-04ADS, is different than the other analog I/O modules. These modules have discrete channel identification bits whereas the 8 and 16 channel analog input modules use binary coded channel identification.

In the following tables, the first analog point of the Host Channel ID is 1. Some software packages refer to the first analog point as 0. In the tables, the first analog point referred to as Analog Position is 0.

**F3-04DA, F3-04DAS, and F3-04ADS Addressing**

Analog Channel	Host Channel ID	Analog Position	I/O point Mask
1	2	1	0002
2	3	2	0004
3	5	4	0010
4	9	8	0100

**F3-08AD and F3-16AD addressing**

Analog Channel	Host Channel ID	Analog Position	I/O Point Mask
1	1	0	0001
2	2	1	0002
3	3	2	0004
4	4	3	0008
5	5	4	0010
6	6	5	0020
7	7	6	0040
8	8	7	0080
9	9	8	0100
10	10	9	0200
11	11	10	0400
12	12	11	0800
13	13	12	1000
14	14	13	2000
15	15	14	4000
16	16	15	8000



## APPENDIX A: ENHANCED OPTOMUX

Remove the Protocol Select jumper for Enhanced OPTOMUX operation as described in Chapter 2. Enhanced OPTOMUX replaces the two standard ASCII sum-check bytes with the a four byte ASCII CRC- 16 error check. This results in superior reliability with an undetected bit error rate near zero.

The CRC-16 check is calculated on the same portion of the message as standard OPTOMUX. When generating a host command, the beginning of command character, ">", is not included in the CRC-16 calculation. Likewise, the first character of a Bridge CPU response, "A", is not include in the CRC-16 calculation.

### CRC-16 CALCULATION

The CRC-16 error check may be calculated on an OPTOMUX messages using the following procedure:

- 1) Load a 16-bit register with all 1's (often referred to as the initial remainder).
- 2) Exclusive OR the first 8-bit byte with the low order byte of the 16-bit register. The result goes to the 16-bit register.
- 3) Shift the 16-bit register one bit to the right.
  - a) If the bit shifted out to the right is a one, exclusive OR the generating polynomial 1010 0000 0000 0001 with the 16-bit register.
- 4) Repeat step 3 until 8 shifts have been performed.
- 5) Exclusive OR the next 8-bit byte in the message with the 16-bit register.
- 6) Repeat steps 3 through 5 until bytes of the message have been exclusive OR'd with the 16-bit register and then shifted 8 times (per step 3).
- 7) The contents of the 16 bit register is the CRC-16 error check. Swap the bytes in the 16-bit register. Then convert each of the 4 nibbles in the 16-bit register to an ASCII character. Add the four characters to the message, starting with the most significant nibble.
- 8) Finally, a carriage return is added to indicate the end of message.

Examples:

Send a "j" command to slot 2 (first I/O module is slot 0) of a Bridge CPU with a base address (first slots address) of 0.

>02jE480 cr (cr denotes a carriage return character)

A Bridge CPU with a 16 point input module in this slot would respond:

A00001B3F cr

Send a "j" command to slot 4 of a Bridge CPU with a base address of 0.

>04jE720 cr (cr denotes a carriage return character)

A Bridge CPU with a 16 point output module in this slot would respond:

AFFFF472B cr

Send a "L" command to an analog input module in slot 2 (base address is 0).

>02L00082402 cr

The Bridge CPU will return the value of the analog input for channel 4.

A19EF6DB7 cr

Thus the value for channel 4 is  $19EFH - 1000H = 9EFH = 2543$

Send a "M" command to a 16 point digital input module in slot 1.

>01MA46A cr

A Bridge CPU with the first 8 inputs OFF (I inputs) and the second 8 inputs ON (II inputs) would response with the message:

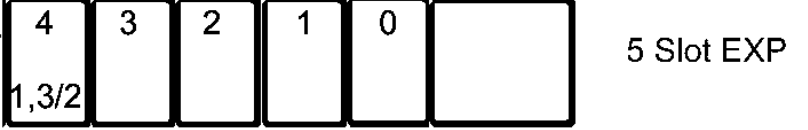
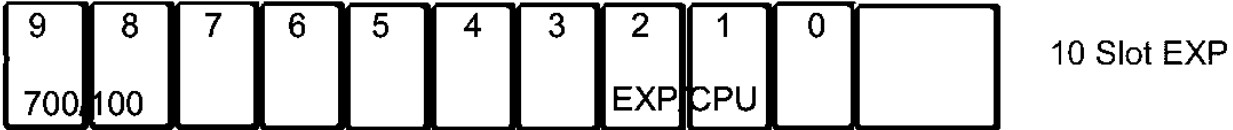
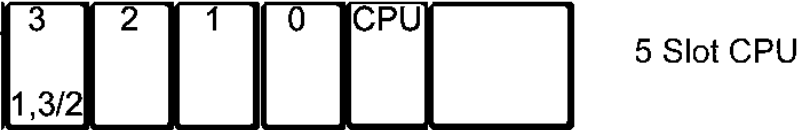
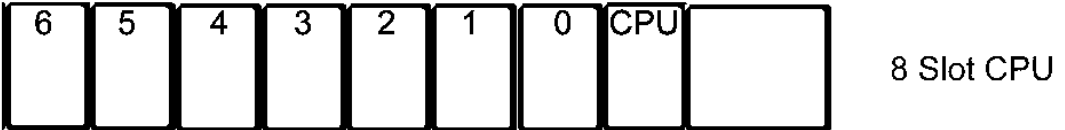
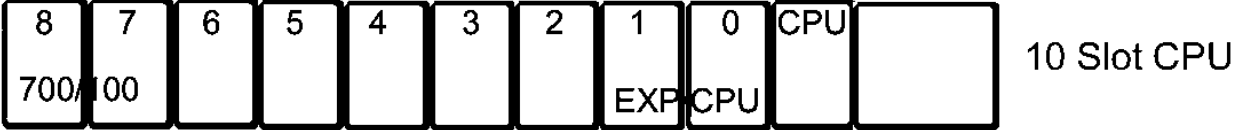
AFF00E0AD cr



# APPENDIX B: BASE CONFIGURATIONS

**BASE SIZES**

Note: Slot 0 is referred to as the first slot available for an I/O module. In a CPU base it is the slot next to the CPU. In an Expansion base it is the slot next to the power supply.



## **VALID BASE COMBINATIONS**

10 Slot CPU Base

8 Slot CPU Base

5 Slot CPU Base

10 Slot CPU Base and a 5 Slot EXP Base

10 Slot CPU Base and a 10 Slot EXP Base

8 Slot CPU Base and a 5 Slot EXP Base

5 Slot CPU Base and a 5 Slot EXP Base

5 Slot CPU Base and two 5 Slot EXP Base

## **JUMPER AND SWITCH LOCATIONS**

### **10 Slot Base**

Jumper Blocks

SW1 -> EXP/CPU - Located between Slot 0 and 1 of a CPU Base

SW2 -> 700/100 - Located between Slot 7 and 8 of a CPU Base

Switches

None

### **8 Slot Base**

Jumper Blocks

None

Switches

None

### **5 Slot Base**

Jumper Blocks

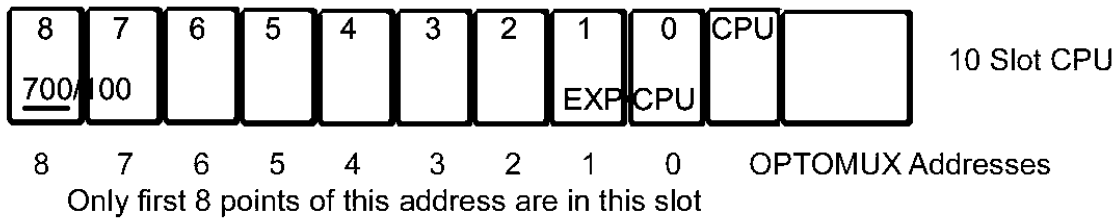
None

Switches

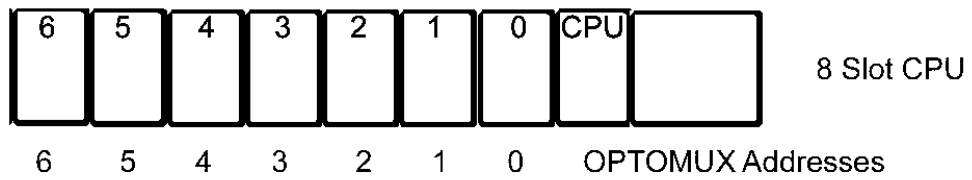
Base 1,3/Base 2 - Located between Slot 2 and 3 of a CPU Base

## BASE ADDRESSING AND JUMPER SETTINGS

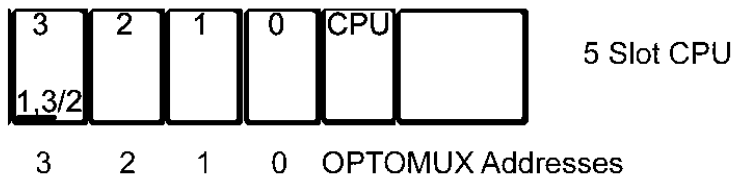
10 Slot CPU base addressing



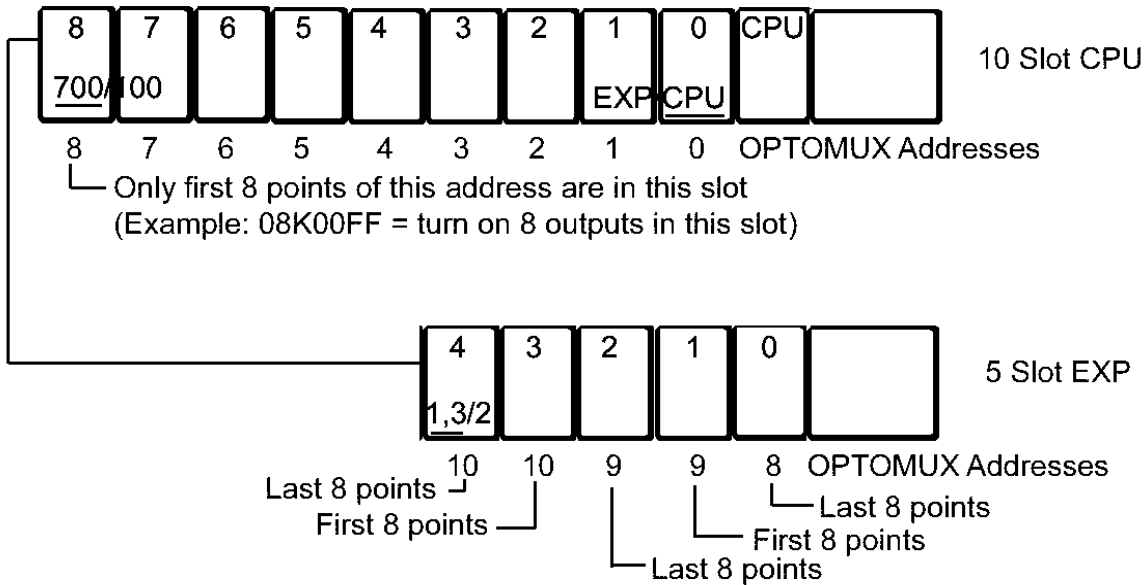
8 Slot CPU base addressing



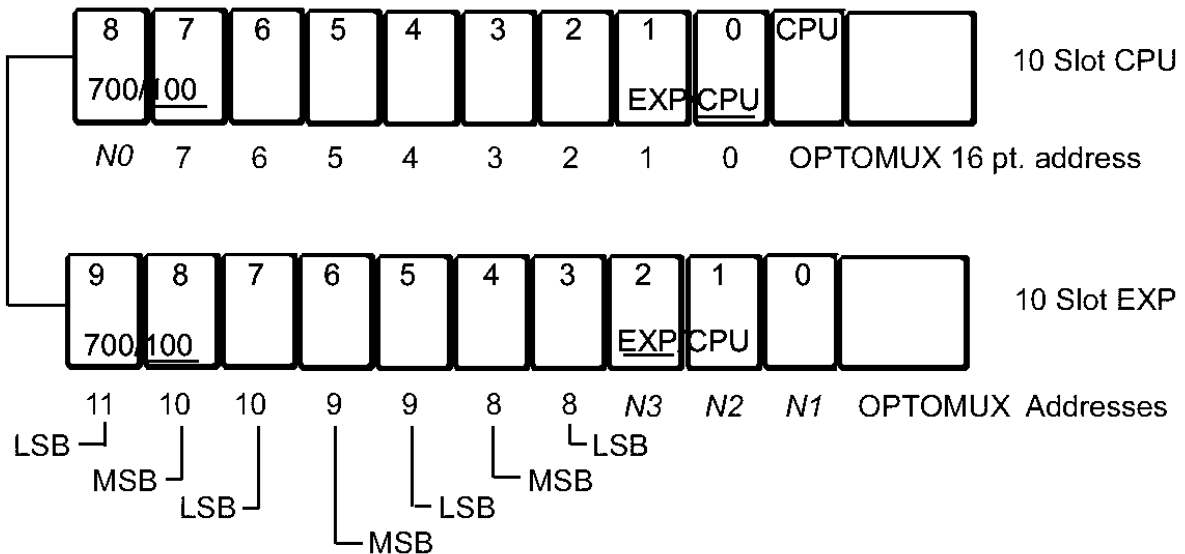
5 Slot CPU base addressing



10 Slot CPU w/5 slot expansion base

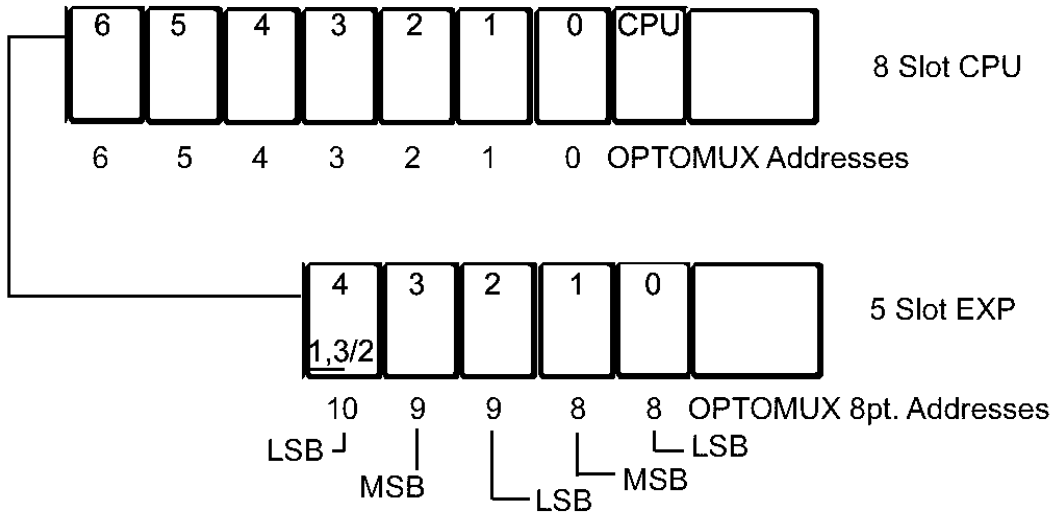


10 Slot CPU w/ 10 Slot expansion base

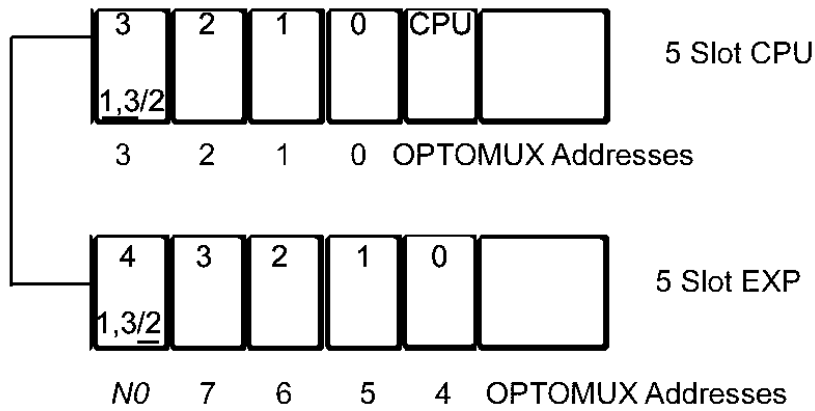


- Notes: N0 same address as MSB 0 (slot 0 must also be 8 pt.)  
 N1 same address as MSB 1 (slot 1 must also be 8 pt.)  
 N2 same address as MSB 2 (slot 2 must also be 8 pt.)  
 N3 same address as MSB 3 (slot 3 must also be 8 pt.)

**8 Slot CPU w/ 5 Slot expansion base**



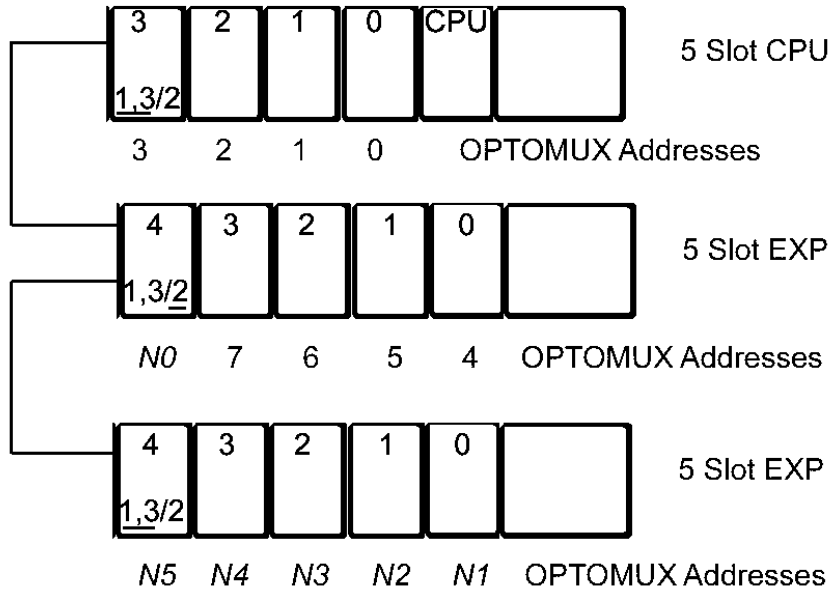
**5 Slot CPU base w/ 5 Slot expansion base**



Notes: If a 16 point module is place in slot 0 then OPTOMUX address *N0* cannot be used.  
*N0* same address as MSB 0 (slot 0 must also be 8 pt.)

### 5 Slot CPU w/ Two 5 slot expansion bases

This configuration is normally used with most of the modules in the system are 8 point modules.



Notes: If a 16 point module is placed in any of the first 8 slots, OPTOMUX addresses 0-7, then the corresponding slots N0 - N7 cannot be used.

- N0 Same address as MSB 0 (slot 0 must also be 8 pt.)
- N1 Same address as MSB 1 (slot 1 must also be 8 pt.)
- N2 Same address as MSB 2 (slot 2 must also be 8 pt.)
- N3 Same address as MSB 3 (slot 3 must also be 8 pt.)
- N4 Same address as MSB 4 (slot 4 must also be 8 pt.)
- N5 Same address as MSB 5 (slot 5 must also be 8 pt.)

## APPENDIX C: SYSTEM THROUGHPUT

The throughput time of an OPTOMUX system is dictated by the capabilities and configuration of the OPTOMUX master, the communication rate, and the number of digital and analog I/O points in the system. If high speed throughput is required for your application, the PAMUX CPU, F3-PMUX, with the parallel interface should be considered.

The OPTOMUX master read inputs and writes outputs by sending OPTOMUX commands. The speed and frequency that each OPTOMUX command is issued through the serial interface is controlled by the OPTOMUX master. The commands will specify some form of the following instructions:

- configure CPU functions
- configure I/O point(s) for a special function
- read digital or analog I/O point(s)
- write digital or analog I/O point(s)

The selected communication rate determines the amount of time required to send a command and to receive a response. The number of characters required in a command or response varies for different commands and for digital and analog data.

The character time can be calculated from the baud rate.

Character Time = (1/Baud) \* Bits Per Character

The elapsed time between the end of a received message and the beginning of the response message is the Bridge CPU Turn Around Response Time. The Turn Around Response Time for all messages is typically less than 1 msec.

Example:

The communication time required to read 16 analog inputs at 9600 baud from address 0 is calculated below.

Character Time = (1/9600) \* 10 = 1.042 milliseconds

Command = >00LFFFF??cr (11 Characters)

Response = A00010002...00090010??cr (68 Characters)

Communication Time = Command Length \* Character Time + Turn Around Response Time + Response Length \* Character Time

Communication Time = (11\*1.042) + 1 + (68\*1.042) = 83.318 msec





## APPENDIX D: I/O UPDATE SPEED

### DESCRIPTION OF OPERATION

The Bridge CPU constantly reads physical inputs and updates internal memory called the input status table. At the same time, the Bridge CPU reads the output status table and updates physical outputs. This operation is called the I/O scan.

When an OPTOMUX command to read discrete or analog inputs is received by the Bridge CPU, the I/O scan is paused and the input values are read out of the input status table. Next the appropriate response message is built and loaded into an interrupt driven serial transmit buffer. The response message is then sent back to the host as the I/O scan is resumed. The time the I/O scan is paused is called the Turn Around Response time. Turn Around Response time for all messages is less than 1 msec.

An OPTOMUX write command to discrete or analog outputs is similar to a read command. Except that when the command is received by the Bridge CPU, the output values are written to the output status table.

The time required to complete a single I/O scan is dependent on the I/O configuration as described below.

### DIGITAL INPUTS

Discrete inputs update the input status table at a rate of 28  $\mu$ sec per point (3.6 msec for 128 points).

### ANALOG INPUTS

Every I/O scan one channel of each analog input module in the Bridge CPU base is updated. The time required by the Bridge CPU to convert, read and update the analog input status table for all 32 channels of eight four channel analog input modules is less than 10 msec. The update time for 64 channels of eight channel input modules is less than 20 msec. The time required to update all the channels on a single multichannel analog input module is 2.4 msec times the number of channels scanned. For minimum update times, analog input modules should be jumped to only scan the channels actually being used.

