



X5DNET01 DEVICENET™ COMMUNICATION OPTION BOARD FOR THE X5 AC DRIVE INSTALLATION MANUAL

DPD00110

Need Help?

This manual answers most installation and startup questions that may arise. However, if you have any problems, please let your first call be to us.

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INSTALLING THE X5DNET01 DeviceNet™ COMMUNICATION OPTION BOARD

INTRODUCTION

The X5 frequency converters can be connected to DeviceNet using an option board, the X5DNET01. The converter can then be controlled, monitored, and programmed from the host system.

DeviceNet is an open network based on Controller Area Network (CAN) standards that is designed to connect low-cost industrial control devices (such as limit switches, photoelectric sensors, motor starters, process sensors, frequency converters, panel displays and operator interfaces) to a network and eliminate expensive hard wiring. The direct connectivity provides improved communication between devices as well as important device-level diagnostics not easily accessible or available through hard-wired I/O interfaces. The DeviceNet model is application independent; it provides the communication services needed by various types of applications.

Many of today's lower-level industrial control devices must retain their low-cost / low resource characteristics even when directly connected to a network. DeviceNet takes this into consideration by defining a specific instance of the model for communications typically seen in a master / slave application. This is referred to as the Predefined Master/Slave Connection Set.

DeviceNet allows the interchangeability of simple devices while making interconnectivity for more complex devices possible. In addition to reading the state of discrete devices, DeviceNet provides the capability to report temperatures, to read the load current in a motor starter, to change the deceleration rate of drives, or to count the number of packages that have passed on a conveyor in the previous hour.

This option also provides two additional control relays, each rated for 115 VAC, 1 amp, or for 230 VAC, 0.5 amp.

NOTE: This network communication interface included with the X5 option is warranted to meet the core specifications for DeviceNet. Many existing software applications are custom-engineered and may contain "brand-specific" communication that will not be supported by the X5 without modification. No guarantee of compatibility with any specific system is made. The user is responsible for any interface software and hardware needed to make an application function.

APPLICABLE DOCUMENTS

This manual is supplied as a supplement to the X5 AC Drive User's Manual (DPD 00089, previously Form 1434).

OPTION KIT CONTENTS

The option kit includes the following materials:

Part Number	Description
25100064C	DeviceNet PC board assembly
32100391	Flexible cable assembly

INSTALLATION PROCEDURES

WARNING

SENSITIVE EQUIPMENT

This assembly contains static-sensitive components. It should be handled only by a static-safe installer, using a grounded wrist strap.

Failure to observe this precaution may cause premature equipment failure.

DANGER

HAZARDOUS VOLTAGE

- Disconnect all power before servicing a drive unit or its components. **WAIT 5 MINUTES** until the DC bus capacitors discharge.
- Ensure that any other power sources that may feed control logic have been disconnected.
- **DO NOT** short across DC bus capacitors or touch unshielded components or terminal strip screw connections with voltage present.
- Install all covers before applying power or starting and stopping the drive.
- The user is responsible for conforming to all applicable code requirements with respect to grounding all equipment.
- Many parts in a drive, including printed circuit boards, operate at line voltage. **DO NOT TOUCH.** Use only electrically-insulated tools.

Before servicing any drive.

- Disconnect all power.
- Place a “DO NOT TURN ON” label on the drive disconnect.
- Lock the disconnect in the open position.

Failure to observe these precautions will cause shock or burn, resulting in severe personal injury or death.

Figure 1 shows the layout of the option board and the location of important components on it.

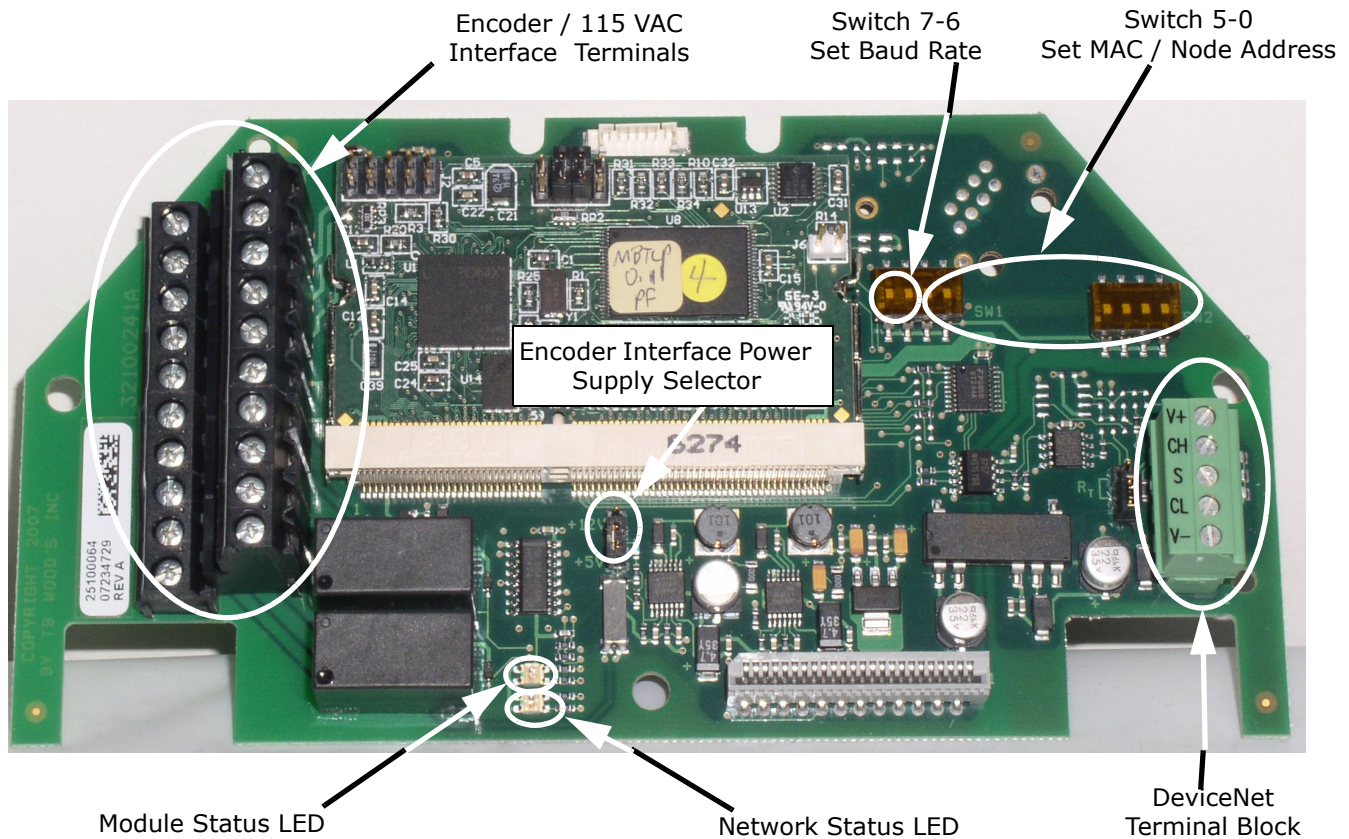


Figure 1: Option board layout

Before you can install the option board, you must first remove the drive cover.

Figure 2 shows the locations of the cover screws. The torque range for the X5 Size 1 cover is 18-26 in/lbs.



Figure 2: Cover assembly and screw locations

The option board is installed just above the control board in all configurations (a Size 1 unit is shown in Figure 3 for reference). The screws labeled “A” must be removed from the X5; those labeled “B” need only to be loosened to accept the board slot.

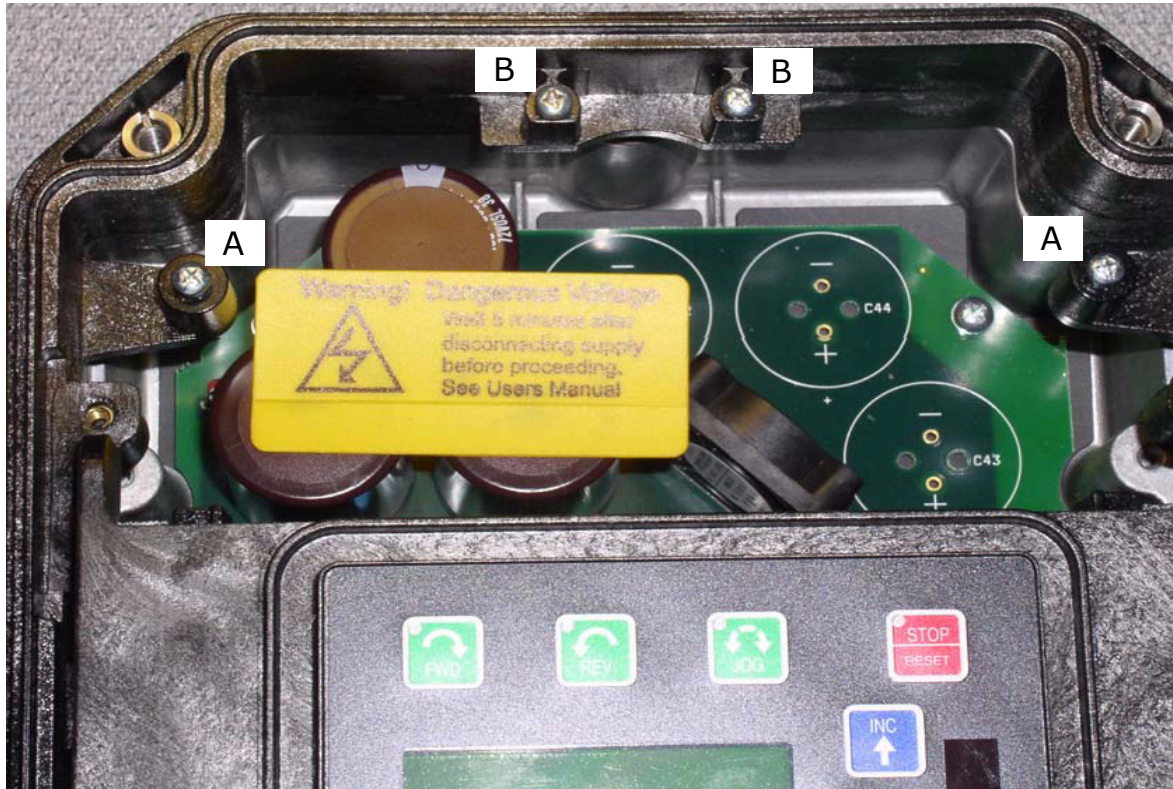


Figure 3: Option board mounting locations

Once the board is in place, tighten the screws to a maximum of 26 in-lbs.

Next, install the flexible circuit to finish the interface to the control board. (Refer to Figure 4.) To install the flexible circuit, first remove the keypad frame (necessary in this size unit). The frame is attached with two screws in opposite corners; the screws thread into fasteners in the plastic assembly. After the flexible circuit is installed, replace these screws, limiting the installation torque to 12 in-lbs..



Figure 4: Flexible circuit interface to control board

115 VAC INTERFACE / RELAY / ENCODER INTERFACE TERMINALS

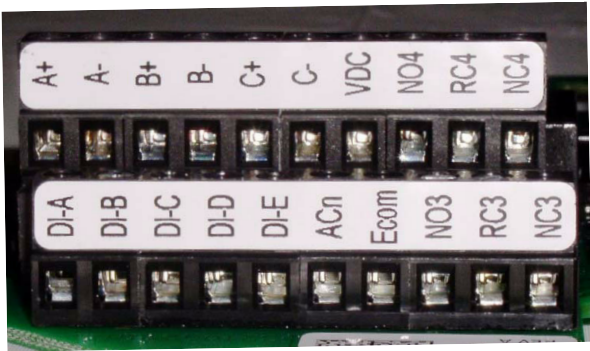


Figure 5: 115 VAC interface / encoder terminals

The option kit includes five 115 VAC inputs, two additional programmable relays, and an encoder interface. The details of the terminals on the board related to the 115 VAC interface and the encoder are shown in Table 1 on page 7:

Table 1: Encoder Interface Terminals

Terminal	Description
----------	-------------

Table 1: Encoder Interface Terminals

DI-A DI-B DI-C DI-D DI-E	<p>115 VAC logic input; connect input to 115 VAC to activate.</p> <p>The programmable functionality of these inputs is controlled by parameters 728, 729, 730, 731, and 732. Each of these inputs can emulate the function of the FWD, REV, R/J, EN, MOL, DI1, DI2, DI3, DI4, or DI5 input terminals on the X5 control board.</p> <p>Refer to the X5 User's Manual for more information (DPD 00089).</p>
ACn	The neutral connection for the 115 VAC control inputs
N03 RC3 NC3	<p>The third auxiliary relay.</p> <p>The function of this relay is set by parameter 709. Functionally, it is capable of each of the features outlined in the X5 user manual under parameters 705-708.</p> <p>Terminal N03 is a normally-open contact; it closes when the relay activates. NC3 is a normally-closed contact; it opens when the relay activates. RC3 is the common terminal associated with both contacts.</p> <p>The ratings of these contacts are 115 VAC, 1 amp; and 230 VAC, 0.5 amp.</p>
N04 RC4 NC4	<p>The fourth auxiliary relay.</p> <p>The function of this relay is set by parameter 710. Functionally, it is capable of each of the features outlined in the X5 user manual under parameters 705-708.</p> <p>Terminal N04 is a normally-open contact; it closes when the relay activates. NC4 is a normally-closed contact; it opens when the relay activates. RC4 is the common terminal associated with both contacts.</p> <p>The ratings of these contacts are 115 VAC, 1 amp; and 230 VAC, 0.5 amp.</p>
A+ A-	Channel A input from the encoder. Compatible with line driver, open collector, or totem pole outputs from an encoder. If it is an open collector or totem pole-type, encoder outputs are used; connect the A- terminal to Ecom.
B+ B-	Channel B input from the encoder. Compatible with line driver, open collector, or totem pole outputs from an encoder. If it is an open collector or totem pole-type, encoder outputs are used; connect the B- terminal to Ecom.
C+ C-	Channel C input from the encoder. Compatible with line driver, open collector, or totem pole outputs from an encoder. If it is an open collector or totem pole-type, encoder outputs are used; connect the C- terminal to Ecom.
VDC	Power supply terminal for use with a customer-supplied encoder. It can be either +12 VDC or +5 VDC based on the position of the encoder interface power supply selector shown in Figure 1 on page 5 . Voltage regulation: +/- 5%; maximum current available is 100 mA.
Ecom	Signal common for the encoder interface

Note that the connections described in [Table 1](#) work only when the encoder has an internal pull-up resistor on the open collector. Alternatively, it might be preferable to pull the + channel high, and attach the open collector to the - channel. For example, if using Channel A, A+ on the option board would be tied to VDC, and A- would be connected to the open collector coming from the encoder. The advantage in this method is that no pull-up/down resistors are needed; if the encoder has an internal pull-up, this does not affect anything.

SPECIFICATIONS FOR ENCODER / 115 VAC INTERFACE

Encoder Interface		115 VAC Interface	
Speed regulation	< 0.1 Hz (1)	On state	90-140 VAC
Input frequency (max.)	100 kHz	Off state	< 10 VAC
Input voltage	10-24 VDC +/- 5%	Input frequency	58-62 Hz
Suggested pull-up resistor	5 VDC	On/off delay	30 ms maximum
	12 VDC		
	24 VDC		
Terminal block wire limitations	12-24 AWG	Terminal block wire limitations	12-24 AWG
(1) PID feedback plus optimal motor turning in SLV mode employed			

SETUP AND USE

The encoder interface is most effective if used in conjunction with the vector mode of operation. Refer to the X5 User's Manual (Chapter 6) for information about using the vector mode. Three additional parameters are provided to calibrate the encoder:

Parameter #	Parameter Name	Range	Default Value
219	Encoder Pulses per Revolution	0-16383	1024
220	Encoder Filter Time	10-1000 ms	20 ms
221	Encoder Speed Protection	0-20.0%	0%

Parameter 219, Encoder Pulses per Revolution, can either be extracted from the encoder nameplate or the data sheet supplied with it. Parameter 220, Encoder Filter Time, is used to filter the encoder signal in the event of noise. Parameter 221 is for limiting the response of the drive, in the event of the loss of encoder signal.

Two other parameters are provided to allow more flexibility in encoder selection, and to improve PID application usage:

Parameter #	Parameter Name	Range	Default Value
223	EncoderType	Quadrature or Single Channel	Quadrature
224	Encoder Range	0-24000 rpm	0 rpm

Parameter 223, Encoder Type, allows the use of either quadrature or single-channel types of encoders.

Parameter 224, Encoder Range, improves PID application flexibility. This parameter should be used in situations where the encoder feedback signal is not always directly proportional to the motor speed, for example, a winder using an encoder mounted on an idler pulley feeding a winding spool. The PID may be attempting to maintain a constant linear speed on the wound media, but as the diameter of the media on the spool changes, the motor turning the spool needs to vary its speed to maintain the linear speed at the idler pulley.

When parameter 224 is set to 0, it is ignored, and the PID calculates the feedback percentage based on parameter 301, Maximum Frequency. When this parameter is set to a non-zero value, the PID uses instead Parameter 224's setting to calculate the feedback percentage.

Encoder feedback works similarly to an analog input as configured in parameters 850 (PID Configure), 851 (PID Feedback), 852 (PID Prop Gain), 853 (PID Int Gain), and 859 (PID Derivative Gain). The "feed forward" options are suggested for setting parameter 850. More specific details on each of the listed parameters can be found in the X5 User's Manual (DPD 00089).

The encoder interface can easily serve as one of the inputs to the X5's Keeper Function (data logging). See the X5 User's Manual for more information.

Both the Vmet and Imet output from the drive can be configured to indicate the status of the encoder. Parameters 700 (Vmet) and 702 (Imet) that relate to the setup and calibration of the Vmet and Imet outputs, both have selections related to the status of the encoder input.

The Program Sequencer function can also key off the encoder's home pulse. To make use of this function, the encoder's home pulse (1 pulse per revolution) must be connected to the C- input of the encoder board.

ENCODER INTERFACE TROUBLESHOOTING

Any problem with the encoder interface will result in an F37 fault. Four advanced fault codes are available to help you determine whether you have an encoder calibration problem, or a defect. For more information on troubleshooting, refer to the Troubleshooting chapter in the X5 User's Manual. For information on setting parameters, see Chapter 7 in the X5 User's Manual.

USING DEVICENET CONNECTIONS

Following are the specifications for DeviceNet connections:

Table 2: DeviceNet Connection Specifications

DeviceNet Connections	Interface	Pluggable connector (5.08 mm)
	Data transfer method	CAN
	Transfer cable	Two-wire twisted shielded cable with two-wire bus power cable and drain
	Isolation	500 VDC
Communications	Baud rate	125, 250 and 500 kbaud
	Product code	0x03 (X5)
	Product type	0x02 (AC Drive)
	Vendor ID	509
	Device Net Other	Network supply voltage: 11 - 25 Vdc Network input current: 28 mA typ., 125 mA inrush (24 Vdc)

Table 3 describes the features and functions of DeviceNet.

Table 3: DeviceNet Features and Functionality

Network size	Up to 64 nodes	
Network length	Selectable end-to-end network distance varies with speed	
	Baud rate	Distance
	125 Kbps	500 m
	250 Kbps	250 m
	500 Kbps	100 m
Data packets	0-8 bytes	
Bus topology	Linear (trunkline / dropline); power and signal on the same network cable	
Bus addressing	Peer-to-peer with Multi-Cast (one to many); Multi-Master and Master / Slave Special case; polled or change of state (exception-based)	
System features	Removal and replacement of devices from the network under power	

PHYSICAL LAYER AND MEDIA

The basic trunkline-dropline topology provides separate twisted pair busses for both signal and power distribution. Thick or thin cable can be used for either trunklines or droplines. End-to-end network distance varies with data rate and cable size.

Devices can be powered directly from the bus and communicate with each other using the same cable. Nodes can be removed from or inserted in the network without powering down the network.

Power taps can be added at any point in the network, which makes redundant power supplies possible. The trunkline current rating is 8 amps. An opto-isolated design option allows externally-powered devices (for example, AC drives, starters, and solenoid valves) to share the same bus cable.

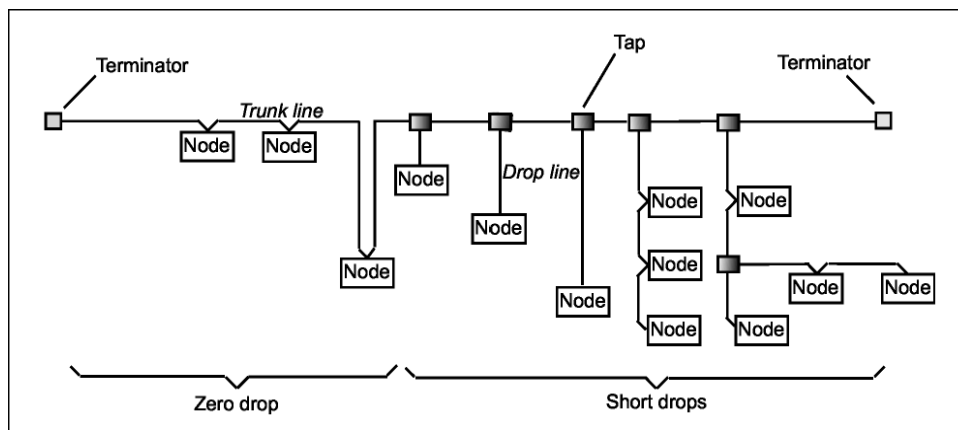


Figure 6: Thick or thin cable can be used for either trunklines or droplines

The X5DNET01 DeviceNet board is connected to the fieldbus through a 5-pin pluggable bus connector. (See [Figure 1 on page 5](#) for the location of the bus connector.) Communication with the control board of the frequency converter takes place through the flexible circuit applied last during the installation process.

DEVICENET TERMINALS

Table 4 describes the DeviceNet terminal assignments:

Table 4: DeviceNet Terminals

Terminal	Description	Signal Reference
1	Communication power supply, ground	V-
2	Communication signal, low	CAN_L
3	Cable shield (bare)	Drain
4	Communication signal, high	CAN_H
5	Communication power supply, +24V	V+

LED INDICATIONS

The DeviceNet Option Board includes two LED status indicators: Network Status and Module Status. See [Figure 1 on page 5](#) for the location of these LEDs on the board. Network status provides information on the network connection status and module status provides information on the DeviceNet module itself. The following tables explain the meaning of the status LEDs:

Table 5: Network Status LED

Network Status LED	If the LED is...	This means...
	OFF	The DeviceNet option is not online. - The device has not completed the Dup_MAC_ID test - If the module status LED is off, the device is not receiving power.
	Green	The DeviceNet option is online, and is allocated to a master.
	Green (flashing)	The DeviceNet option has passed the Dup_MAC-ID test, is online, but is not allocated to a master.
	Red (flashing)	One or more I/O connections are in the timed-out state.
	Red	The DeviceNet option cannot communicate on the network.

Table 6: Module Status LED

Module Status LED	If the LED is...	This means...
	OFF	There is no power applied to the DeviceNet option board.
	Green	The option board is operating normally.
	Green (flashing)	The option board is in Standby state or the device needs commissioning because of a missing, incomplete, or incorrect configuration.
	Red (flashing)	The option board has detected a recoverable fault.
	Red	The option board has detected an unrecoverable fault.

GETTING STARTED USING THE DEVICENET OPTION BOARD

Before using the DeviceNet option board, you must configure the device baud rate and node or MAC address to the desired values, using the DIP switches on the option board. See [Figure 1 on page 5](#) for the location of the two DIP switches; they are spaced somewhat apart from each other. The **leftmost** switch is called **switch 7** and the **rightmost** switch is called **switch 0**. Switches 7 and 6 set the **baud rate**, and switches 5 to 0 set the **node address** (MAC ID).

By default, the baud rate is set to 125K and the node address is zero [0]. Since all new devices are factory-set to node address 0, it is recommended that the address be changed. [Table 7](#) shows the resulting baud rate for all possible combinations of switches 7 and 6:

Table 7: Setting Baud Rates

Baud Rate	Switch 7	Switch 6
125K	0	0
250K	0	1
500K	1	0
500K	1	1

The MAC ID is a 6-bit digital value (ranges from 0-63) controlled by switches 0-5. Switch 5 is the most significant; switch 0 is the least significant.

Note: If power is applied to the option board before the value of the baud rate or MAC ID is changed, power must be cycled before the new settings take effect.

COMMUNICATING WITH DEVICENET

DeviceNet provides two different types of messaging. They are:

- I/O Messaging
- Explicit Messaging

I/O MESSAGING

Input / Output (I/O) polling messages are for time-critical, control-oriented data. The messages are transferred between the devices all the time and are used for continuous control of the frequency converter. They provide a dedicated, special-purpose communication path between a producing application (master) and one or more consuming applications (slaves). They are exchanged across single- or multi-cast connections and typically use high-priority identifiers. I/O polling messages contain no protocol in the 8-byte data field. The meaning of the message is implied by the connection ID (CAN identifier). Before messages are sent using these IDs, both the device sending and receiving them must be configured. The configuration contains the source and destination object attribute addresses for the master and the slave.

The polling message flow is shown in Figure 7.

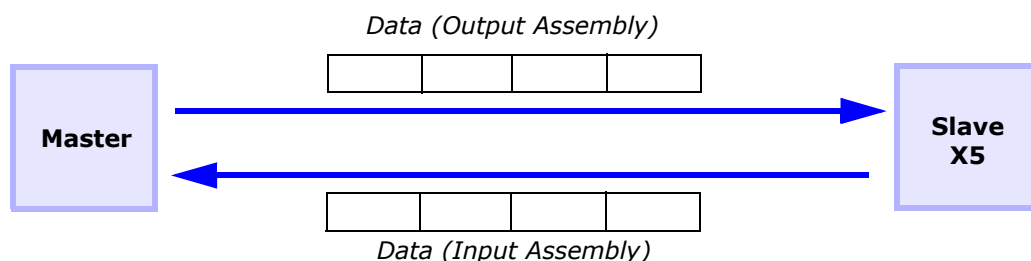


Figure 7: Polling Message Diagram for I/O Messaging

Input and Output Assembly Instances

The following tables outline the supported input and output instances available under the DeviceNet communication link to the X5 unit.

Table 8: Input Instances (Page 1 of 2)

Instance	Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
70	0						Running 1 (Fwd)		Faulted
	1								
	2	Speed Actual (low byte)							
	3	Speed Actual (high byte)							
71 (Default)	0	At Ref	Ref from Net	Ctrl from Net	Ready	Running 2 (Rev)	Running 1 (Fwd)	Warning	Faulted
	1	Drive State							
	2	Speed Actual (low byte)							
	3	Speed Actual (high byte)							
171	0	At Ref	Ref from Net	Ctrl from Net	Ready	Running 2 (Rev)	Running 1 (Fwd)	Warning	Faulted
	1	Drive State							
	2	Speed Actual (low byte)							
	3	Speed Actual (high byte)							
	4	FBus Read1 (low byte)							
	5	FBus Read1 (high byte)							
	6	FBus Read2 (low byte)							
	7	FBus Read2 (high byte)							

Table 8: Input Instances (Page 2 of 2)

Instance	Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
172	0	FBus Read1 (low byte)							
	1	FBus Read1 (high byte)							
	2	FBus Read2 (low byte)							
	3	FBus Read2 (high byte)							
181	0	At Ref	Ref from Net	Ctrl from Net	Ready	Running 2 (Rev)	Running 1 (Fwd)	Warning	Faulted
	1	Drive State							
	2	Speed Actual (low byte)							
	3	Speed Actual (high byte)							
	4	FBus Read1 (low byte)							
	5	FBus Read1 (high byte)							
	6	FBus Read2 (low byte)							
	7	FBus Read2 (high byte)							
	8	FBus Read3 (low byte)							
	9	FBus Read3 (high byte)							
	10	FBus Read4 (low byte)							
	11	FBus Read4 (high byte)							
	12	FBus Read5 (low byte)							
	13	FBus Read5 (high byte)							
182	0	FBus Read1 (low byte)							
	1	FBus Read1 (high byte)							
	2	FBus Read2 (low byte)							
	3	FBus Read2 (high byte)							
	4	FBus Read3 (low byte)							
	5	FBus Read3 (high byte)							
	6	FBus Read4 (low byte)							
	7	FBus Read4 (high byte)							
	8	FBus Read5 (low byte)							
	9	FBus Read5 (high byte)							

Table 9: Output Instances

Instance	Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
20	0						Fault Reset		Run Fwd
	1								
	2	Speed Reference (low byte)							
	3	Speed Reference (high byte)							
21 (De-fault)	0		NetRef	NetCtrl			Fault Reset	Run Rev	Run Fwd
	1								
	2	Speed Reference (low byte)							
	3	Speed Reference (high byte)							
121	0		NetRef	NetCtrl			Fault	Warning	Faulted
	1								
	2	Speed Reference (low byte)							
	3	Speed Reference (high byte)							
	4	FBus Write1 (low byte)							
	5	FBus Write1 (high byte)							
	6	FBus Write2 (low byte)							
	7	FBus Write2 (high byte)							
122	0	FBus Write1 (low byte)							
	1	FBus Write1 (high byte)							
	2	FBus Write2 (low byte)							
	3	FBus Write2 (high byte)							
131	0		NetRef	NetCtrl			Fault Reset	Run Rev	Run Fwd
	1								
	2	Speed Reference (low byte)							
	3	Speed Reference (high byte)							
	4	FBus Write1 (low byte)							
	5	FBus Write1 (high byte)							
	6	FBus Write2 (low byte)							
	7	FBus Write2 (high byte)							
	8	FBus Write3 (low byte)							
	9	FBus Write3 (high byte)							
	10	FBus Write4 (low byte)							
	11	FBus Write4 (high byte)							
	12	FBus Write5 (low byte)							
	13	FBus Write5 (high byte)							
132	0	FBus Write1 (low byte)							
	1	FBus Write1 (high byte)							
	2	FBus Write2 (low byte)							
	3	FBus Write2 (high byte)							
	4	FBus Write3 (low byte)							
	5	FBus Write3 (high byte)							
	6	FBus Write4 (low byte)							
	7	FBus Write4 (high byte)							
	8	FBus Write5 (low byte)							
	9	FBus Write5 (high byte)							

The default active output assembly is 21 and the default input assembly is 71. The active assemblies are configured using class 0x80.

I/O messages 20, 21, 70, and 71 are standard Common Industrial Protocol (CIP) assemblies.

I/O messages 121, 122, 131, 132, 171, 172, 181, and 182 are vendor-specific messages that allow for customized assemblies.

The values of the following parameters indicate which drive parameters are read or written to by the I/O assembly:

Table 10: Parameter Assignments (Parameters 880-894)

Parameter #	Parameter Name	Range	Default
880	FBus Read 1	0-65535	103 (Output Voltage)
881	FBus Read 2		104 (Output Current)
882	FBus Read 3		105 (Drive Load)
883	FBus Read 4		107 (Drive Temp)
884	FBus Read 5		909 (DI Status)
890	FBus Write 1	0-65535	907 (Cntl Word 2)
891	FBus Write 2		402 (Accl Ramp 1)
892	FBus Write 3		403 (Decel Ramp 1)
893	FBus Write 4		920 (SIO Vmet Level)
894	FBus Write 5		921 (SIO Imet Level)

Examples

Examples 1 and 2 on the following pages show how using the FBus Write 2 = Parameter 402 would allow the I/O assembly to set the drive's acceleration rate.

Example 1: Input Assemblies (Page 1 of 2)

Instance	Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
70	0						Running 1 (Fwd)		Faulted
	1								
	2	Speed Actual (low byte)							
	3	Speed Actual (high byte)							
71	0	At Ref	Ref from Net	Ctrl from Net	Ready	Running 2 (Rev)	Running 1 (Fwd)	Warning	Faulted
	1	Drive State							
	2	Speed Actual (low byte)							
	3	Speed Actual (high byte)							
171	0	At Ref	Ref from Net	Ctrl from Net	Ready	Running 2 (Rev)	Running 1 (Fwd)	Warning	Faulted
	1	Drive State							
	2	Speed Actual (low byte)							
	3	Speed Actual (high byte)							
	4	FBus Read1 (low byte)							
	5	FBus Read1 (high byte)							
	6	FBus Read2 (low byte)							
	7	FBus Read2 (high byte)							

Example 1: Input Assemblies (Page 2 of 2)

Instance	Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
172	0	FBus Read1 (low byte)							
	1	FBus Read1 (high byte)							
	2	FBus Read2 (low byte)							
	3	FBus Read2 (high byte)							
181	0	At Ref	Ref from Net	Ctrl from Net	Ready	Running 2 (Rev)	Running 1 (Fwd)	Warning	Faulted
	1	Drive State							
	2	Speed Actual (low byte)							
	3	Speed Actual (high byte)							
	4	FBus Read1 (low byte)							
	5	FBus Read1 (high byte)							
	6	FBus Read2 (low byte)							
	7	FBus Read2 (high byte)							
	8	FBus Read3 (low byte)							
	9	FBus Read3 (high byte)							
	10	FBus Read4 (low byte)							
	11	FBus Read4 (high byte)							
	12	FBus Read5 (low byte)							
	13	FBus Read5 (high byte)							
182	0	FBus Read1 (low byte)							
	1	FBus Read1 (high byte)							
	2	FBus Read2 (low byte)							
	3	FBus Read2 (high byte)							
	4	FBus Read3 (low byte)							
	5	FBus Read3 (high byte)							
	6	FBus Read4 (low byte)							
	7	FBus Read4 (high byte)							
	8	FBus Read5 (low byte)							
	9	FBus Read5 (high byte)							

Example 2: Output Assemblies

Instance	Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
20	0						Fault Reset		Run Fwd
	1								
	2	Speed Reference (low byte)							
	3	Speed Reference (high byte)							
21	0		NetRef	NetCtrl			Fault Reset	Run Rev	Run Fwd
	1								
	2	Speed Reference (low byte)							
	3	Speed Reference (high byte)							
121	0		NetRef	NetCtrl			Fault Reset	Run Rev	Run Fwd
	1								
	2	Speed Reference (low byte)							
	3	Speed Reference (high byte)							
	4	FBus Write1 (low byte)							
	5	FBus Write1 (high byte)							
	6	FBus Write2 (low byte)							
	7	FBus Write2 (high byte)							
122	0	FBus Write1 (low byte)							
	1	FBus Write1 (high byte)							
	2	FBus Write2 (low byte)							
	3	FBus Write2 (high byte)							
131	0		NetRef	NetCtrl			Fault Reset	Run Rev	Run Fwd
	1								
	2	Speed Reference (low byte)							
	3	Speed Reference (high byte)							
	4	FBus Write1 (low byte)							
	5	FBus Write1 (high byte)							
	6	FBus Write2 (low byte)							
	7	FBus Write2 (high byte)							
	8	FBus Write3 (low byte)							
	9	FBus Write3 (high byte)							
	10	FBus Write4 (low byte)							
	11	FBus Write4 (high byte)							
	12	FBus Write5 (low byte)							
	13	FBus Write5 (high byte)							
132	0	FBus Write1 (low byte)							
	1	FBus Write1 (high byte)							
	2	FBus Write2 (low byte)							
	3	FBus Write2 (high byte)							
	4	FBus Write3 (low byte)							
	5	FBus Write3 (high byte)							
	6	FBus Write4 (low byte)							
	7	FBus Write4 (high byte)							
	8	FBus Write5 (low byte)							
	9	FBus Write5 (high byte)							

CONTROL SUPERVISOR BEHAVIOR

The State Transition diagram in Figure 8 provides a graphical description of the states and corresponding state transitions for the control supervisor.

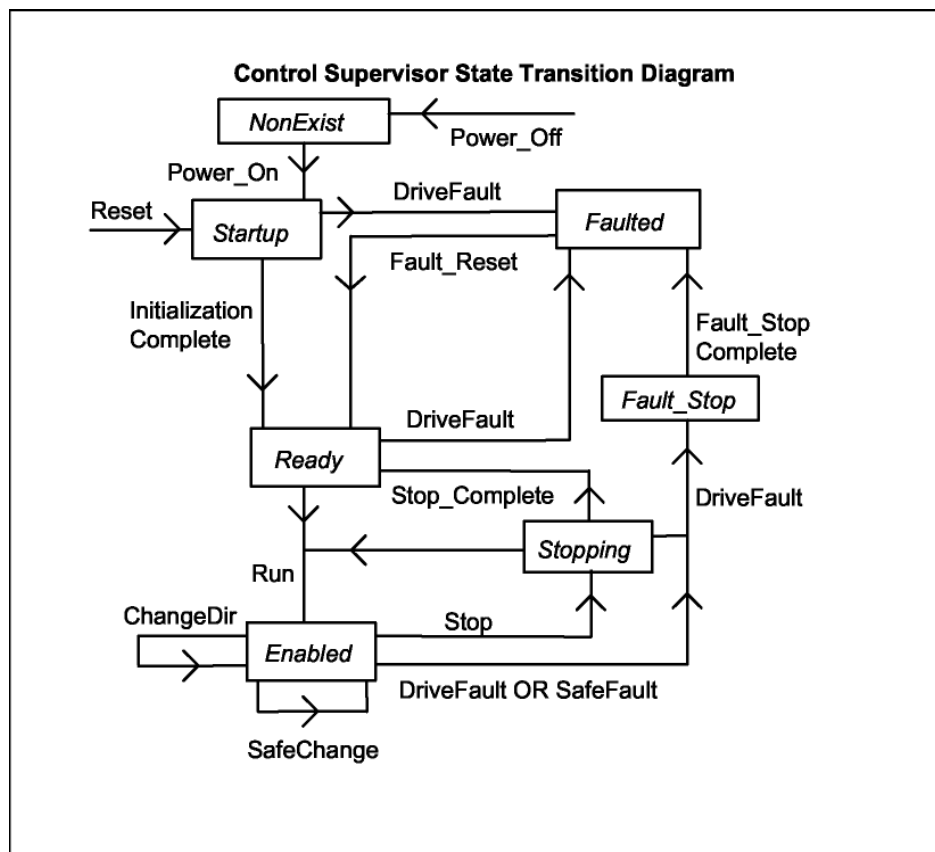


Figure 8: Control Supervisor State Transition Diagram

Table 11 on page 20 explains the state transitions pictured in the flow diagram in Figure 8.

Start Forward, Start Reverse, Change to Forward, Change to Reverse, and Stop (Not Faulted Stop) are static outputs of the control supervisor state machine. They are commands to the drive when CtrlFromNet = 1. When CtrlFromNet = 0, control commands are from another source.

When performing changes to achieve programmed Safe State:

- Run / Stop / Direction can be changed because CtrlFromNet must equal 1 when in the Enabled state.
- Reference in the drive can be changed to Preset Speed only if RefFromNet = 1.

Table 11: Explanation of State Transitions (Page 1 of 2)

Input Conditions								Results	
Old State	CtrlFromNet	Run1 (Fwd)	Run 2 (Rev)	Idle Mode	Fwd Mode	Rev Mode	Event	New State	Action
x	x	x	x	x	x	x	Power_Off	NonExist	
x (except NonExist)	x	x	x	x	x	x	Reset	Startup	Faulted = 0 Ready = 0
									FwdMode = 0 RevMode = 0
									Run1 Var = 0 Run2 Var = 0
NonExist	x	x	x	x	x	x	Power_On	Startup	Faulted = 0 Ready = 0
									FwdMode = 0 RevMode = 0
									Run1 Var = 0 Run2 Var = 0
Startup	x	x	x	x	x	x	Drive Fault	Faulted	Faulted = 1 FaultCode = x
Startup	x	x	x	x	x	x	Initialization Complete	Ready	Ready = 1
Ready	x	x	x	x	x	x	Drive Fault	Faulted	Faulted = 1 FaultCode = x Ready = 0
Ready	1	1	0	0	x	x	Run (Fwd)	Enabled	FwdMode = 1 (Start Forward)
Ready	1	0	1	0	x	x	Run (Rev)	Enabled	RevMode = 1 (Start Reverse)
Enabled	x	x	x	x	x	x	Drive Fault	Fault_Stop	Faulted = 1 FaultCode = x (Initiate Faulted Stop)
									FwdMode = 0 RevMode = 0 Ready = 0
Enabled	1	0	0	x	x	x	Stop	Stopping	(Initiate Stop)
Enabled	1	1	0	0	0	1	ChangeDir (Fwd)	Enabled	FwdMode = 1 RevMode = 0 (Change to Forward)
Enabled	1	0	1	0	1	0	ChangeDir (Rev)	Enabled	FwdMode = 0 RevMode = 1 (Change to Reverse)

Table 11: Explanation of State Transitions (Page 2 of 2)

Input Conditions							Results	
Old State	CtrlFromNet	Run1 (Fwd)	Run 2 (Rev)	Idle Mode	Fwd Mode	Rev Mode	Event	New State Action
Enabled	1	x	x	x	x	x	SafeFault	Faulted = 1 FaultCode = x (Initiate Faulted Stop)
								FwdMode = 0 RevMode = 0 Ready = 0
								Run1 Var = 0 Run2 Var = 0
Enabled	1	x	x	x	x	x	SafeChange	FwdMode = Run1 Var = NOT PresetDir
								RevMode = 0 Run2 Var = PresetDir
								SpeedRef = Preset Speed
								TorqueRef = Preset Torque
Stopping	x	x	x	x	x	x	Drive Fault	Faulted = 1 FaultCode = x (Initiate Faulted Stop)
								Ready = 0
Stopping	1	1	0	0	x	x	Run (Fwd)	Enabled FwdMode = 1 (Start Forward)
Stopping	1	0	1	0	x	x	Run (Rev)	Enabled RevMode = 1 (Start Reverse)
Stopping	x	0	0	x	x	x	Stop_Complete	Ready
Fault_Stopped	x	x	x	x	x	x	Fault_Stop_Complete	Faulted
Faulted	x	x	x	x	x	x	Fault_Reset	Ready Faulted = 0 Ready = 1

EXPLICIT MESSAGING

Explicit Messaging is used in commissioning and configuring the drive via the DeviceNet board. Explicit messages provide multipurpose, point-to-point communication paths between two devices. They provide the typical request / response-oriented network communication used to perform node configuration and problem diagnosis. Explicit messages typically use low-priority identifiers and contain the specific meaning of the message right in the data field. This includes the service to be performed and the specific object attribute address.

LIST OF OBJECT CLASSES

The Communication Interface supports the following object classes:

Table 12: Object Classes

Class	Object
0x01	Identity
0x03	DeviceNet
0x05	DeviceNet Connection
0x28	Motor Data
0x29	Control Supervisor
0x2A	AC/DC Drive
0x65	Parameter
0x80	I/O Configuration

LIST OF DATA TYPES

The attribute list in Table 13 includes information on the data type of each attribute. .

Table 13: Data Types

Data Type Name	Data Type Code	Data Type Description
WORD	1	16-bit word
UINT	2	16-bit unsigned integer
INT	3	16-bit signed integer
BOOL	4	Boolean
SINT	5	Short integer
DINT	6	Double integer
LINT	7	Long integer
USINT	8	Unsigned short integer
UDINT	9	Unsigned double integer
ULINT	10	Unsigned long integer
REAL	11	Single floating-point format (IEEE 754)
LREAL	12	Double floating-point format (IEEE 754)
ITIME	13	Duration (short)
TIME	14	Duration
FTIME	15	Duration (high resolution)
LTIME	16	Duration (long)
DATE	17	Date (see DeviceNet spec)
TIME_OF_DAY	18	Time of day
DATE_AND_TIME	19	Date and time
STRING	20	8-bit-per-character string
STRING2	21	16-bit-per-character string
STRINGN	22	N-bytes-per-character string
SHORT_STRING	23	Short N-byte character string
BYTE	24	8-bit string
DWORD	25	32-bit string
LWORD	26	64-bit string

RESET SERVICE

The X5 unit's identity object (class 0x01) supports only the type 0 reset service. The reset emulates power being cycled to the DeviceNet interface.

FAULT TRACKING

Following is a cross-reference listing of X5 AC drive faults and broadcast DeviceNet faults.

Table 14: Cross-Reference List of X5 and DeviceNet Fault Codes

DeviceNet Fault	X5 Drive Fault	DeviceNet Fault	X5 Drive Fault	DeviceNet Fault	X5 Drive Fault
1000	8	3300	17	6310	2
2110	6	4210	7	6320	30
2120	11	4300	19 / 21	7100	33
2200	3	5112	4	7110	15
2220	18	5120	5	7120	16
2221	20	5200	10	7200	34
2222	28	5210	23	7310	22
2300	9	5300	24 / 29	7500	25
3110	13	5400	27	61441	26
3130	12	5430	31		
3120	14 / 32	6100	1		

Table xx below lists the advanced fault codes for the drive fault (F38) related to the option board. Faults not listed in the table use the drive fault code rather than the DeviceNet defined fault code. For more information on drive faults, see the X5 User's Manual.

The [option board status LEDs](#) are described on [page 12](#) of this manual.

Table 15: Advanced Fault Codes

Advanced Fault Code	Fault	Possible Cause	Corrective Measures
1	Option board loss	Option board is disconnected or damaged	Check option board status LEDs, ribbon cable connection, and cycle power. Replace option board if necessary.
2	Unstable ID during power-up	Option board hardware issues	Cycle power. If problem persists, contact Vacon technical support.
3	Option board changed	Option board was changed during last power-down	If the change was intentional, cycle power.
4	Invalid ID	Option board hardware issues	Cycle power. If problem persists, contact Vacon technical support.
5	Wrong or no daughter card installed	Option DIMM module issues	Cycle power. If problem persists, contact Vacon technical support.
6	Option board software error	Option board software issues	Cycle power. If problem persists, contact Vacon technical support.
7	Option board removed	Option board was removed during last power-down sequence	If the change was intentional, cycle power. Otherwise, follow corrective measures for fault code 1.

APPENDIX: X5 COMMUNICATION INTERFACE OBJECT PROFILES

In the following tables, attributes shown in bold face are stored in the non-volatile part of the drive and maintain their values after a power loss. All other settable attributes will power up at their default values.

Table 16: Identity Object
Class Code 0x01 - Instance Attributes (1)

Attr. No.	Attribute Name	Services	Default, Minimum, Maximum	Data Type	Description
1	Vendor ID	Get_Attribute_Single	509 509 509	2	Identification of each vendor by number
2	Device Type	Get_Attribute_Single	2 2 2	2	Indication of the general type of products
3	Product Code	Get_Attribute_Single	3 3 3	2	This is a code assigned by the vendor to describe the device
4	Revision	Get_Attribute_Single	0x1301 N/A N/A	2	Revision of the item the Identity Object represents
5	Status	Get_Attribute_Single	N/A 0 255	8	Summary status of the device Defined in ODVA DeviceNet specifications
6	Serial Number	Get_Attribute_Single	0 N/A 0xFFFFFFFF	9	Serial number of the device
7	Product Name	Get_Attribute_Single	X5 X5 X5	25	Human-readable identification
8	State	Get_Attribute_Single	N/A 0 5	8	Summary Status of the Device Defined in ODVA DeviceNet specifications: 0 = Nonexistent 1 = Device Self-testing 2 = Standby 3 = Operational 4 = Major Recoverable Fault 5 = Major Unrecoverable Fault

Table 17: DeviceNet Object
Class Code 0x03 - Class Attributes (0)

Attr. No.	Attribute Name	Services	Default, Minimum, Maximum	Data Type	Description
1 0x01	Revision	Get_Attribute_Single	2 2 2	2	Revision of this object

Table 18: Instance Attributes (1)

Attr. No.	Attribute Name	Services	Default, Minimum, Maximum	Data Type	Description
1 0x01	MAC ID	Get_Attribute_Single Set_Attribute_Single	0 0 63	8	Node address
2 0x02	Baud Rate	Get_Attribute_Single Set_Attribute_Single	0 0 2	8	The baud rate of the device: 00 = 125K 01 = 250K 02 = 500K
3 0x03	BOI	Get_Attribute_Single Set_Attribute_Single	0 0 1	4	Bus-Off Interrupt
4 0x04	Bus-Off Counter	Get_Attribute_Single Set_Attribute_Single	0 0 255	8	Number of times CAN went to the bus-off state
5 0x05	Allocation Information	Get_Attribute_Single	N/A N/A N/A	2	Allocation Choice Master's MAC ID Structure of: Byte: Allocation Choice byte Bit 0 = Explicit messaging Bit 1 = Polled I/O USINT Master's MAC ID: 0 - 63 = valid 255 = unallocated
6 0x06	MAC ID Switch Changed	Get_Attribute_Single	0 0 1	4	MAC ID switch setting was changed since power-up
7 0x07	Baud Rate Switch Changed	Get_Attribute_Single	0 0 1	4	Baud rate switch setting was changed since power-up
8 0x08	MAC ID Switch Value	Get_Attribute_Single	0 0 63	8	Actual value of the MAC ID switches (DIP switches 0-5)
9 0x09	Baud Rate Switch Value	Get_Attribute_Single	0 0 3	8	Actual value of the baud rate switches (DIP switches 6-7)

Table 19: Motor Data Object
Class Code 0x28 - Instance Attributes (1)

#	Attribute Name	Services	Default, Minimum, Maximum (1)	Data Type	Description
6 0x06	RatedCurrent[100mA]	Get_Attribute_Single Set_Attribute_Single	360 0 65535	2	Rated Stator Current Units: [100mA]
7 0x07	RatedVoltage[V]	Get_Attribute_Single Set_Attribute_Single	230 100 690	2	Rated Base Voltage Units: [V]
9 0x09	RatedFrequency[Hz]	Get_Attribute_Single Set_Attribute_Single	60 0 400	2	Rated Electrical Frequency Units: [Hz]
12 0x0C	PoleCount	Get_Attribute_Single	2 2 16	2	Number of poles in the motor
15 0x0F	BaseSpeed[RPM]	Get_Attribute_Single Set_Attribute_Single	1760 1 24000	2	Nominal speed at rated frequency from nameplate Units: [RPM]

Table 20: Control Supervisor Object
Class Code 0x29 - Instance Attributes (1) (Page 1 of 2)

Attr. No.	Attribute Name	Services	Default, Minimum, Maximum	Data Type	Description
3 0x03	Run1	Get_Attribute_Single Set_Attribute_Single	0 0 1	4	Run Forward Request
4 0x04	Run2	Get_Attribute_Single Set_Attribute_Single	0 0 1	4	Run Reverse Request
5 0x05	NetCtrl	Get_Attribute_Single Set_Attribute_Single	0 0 1	4	Requests Run/Stop control to be local or from network
6 0x06	State	Get_Attribute_Single	N/A 0 7	8	State of Control Supervisor Instance: 1 = Startup 2 = Not Ready 3 = Ready 4 = Enabled 5 = Stopping 6 = Fault Stop 7 = Faulted
7 0x07	Running1	Get_Attribute_Single	N/A 0 1	4	Running Forward Status: 0 = Other state 1 = Running forward

Table 20: Control Supervisor Object
Class Code 0x29 - Instance Attributes (1) (Page 2 of 2)

8 0x08	Running2	Get_Attribute_Single	N/A 0 1	4	Running Reverse Status: 0 = Other state 1 = Running reverse
9 0x09	Ready	Get_Attribute_Single	N/A 0 1	4	Ready to Accept a Run Event: 0 = Other state 1 = Ready
10 0x0A	Faulted	Get_Attribute_Single	N/A 0 1	4	Fault Occurred: 0 = No faults present 1 = Fault occurred (latched)
12 0x0C	FaultRat	Get_Attribute_Single Set_Attribute_Single	0 0 1	4	Fault Reset Request: 0 = No action 0 -> 1 = Fault reset request 1 = No action
13 0x0D	FaultCode	Get_Attribute_Single	N/A 0 65535	2	If in a faulted state, FaultCode indicates the fault that caused the transition to the faulted state. See Table 14 on page 23.
15 0x0F	CtrlFromNet	Get_Attribute_Single	N/A 0 1	4	Status of Run/Stop control source: 0 = Control is local 1 = Control is from networks

Table 21: AC/DC Drive Object
Class Code 0x2A - Instance Attributes (1) (Page 1 of 2)

Attr. No.	Attribute Name	Services	Default, Minimum, Maximum	Data Type	Description
3 0x03	AtReference	Get_Attribute_Single	N/A 0 1	4	1 = Drive actual at speed reference
4 0x04	NetRef	Get_Attribute_Single Set_Attribute_Single	0 0 1	4	Requests speed reference to be local or from the network: 0 = Set reference to local control 1 = Set reference to DN control Note that the actual status of torque or speed reference is reflected in Attribute 29, RefFromNet.
6 0x06	DriveMode	Get_Attribute_Single	1 1 1	8	1 = Open loop speed (Frequency)
7 0x07	SpeedActual(RPM)	Get_Attribute_Single	N/A 0 10000	3	Actual drive speed (best approximation) Units: RPM
8 0x08	SpeedRef(RPM)	Get_Attribute_Single Set_Attribute_Single	1800 0 12000	3	Speed reference Units: RPM

Table 21: AC/DC Drive Object
Class Code 0x2A - Instance Attributes (1) (Page 2 of 2)

Attr. No.	Attribute Name	Services	Default, Minimum, Maximum	Data Type	Description
9 0x09	CurrentActual(100mA)	Get_Attribute_Single	N/A 0 1000	3	Actual motor phase current Units: 100 mA
17 0x11	OutputVoltage(V)	Get_Attribute_Single	N/A 0 690	3	Output voltage Units: Volts
18 0x12	AccelTime(100ms)	Get_Attribute_Single Set_Attribute_Single	30 1 32000	2	Acceleration time Time from HighSpdLimit Units: 100ms
19 0x13	DecelTime(100ms)	Get_Attribute_Single Set_Attribute_Single	30 1 32000	2	Deceleration time Time from HighSpdLimit to 0 Units: 100ms
20 0x14	LowSpdLimit(RPM)	Get_Attribute_Single Set_Attribute_Single	0 0 12000	2	Minimum speed limit Units: RPM
21 0x15	HighSpdLimit(RPM)	Get_Attribute_Single Set_Attribute_Single	1800 0 12000	2	Minimum speed limit Units: RPM
29 0x1D	RefFromNet	Get_Attribute_Single	N/A 0 1	4	Status of speed reference: 0 = Local speed reference 1 = DeviceNet speed reference

Table 22: Parameter Object
Class Code 0x65 - Instance Attributes (1-999)

Attr. #	Attribute Name	Services	Default, Minimum, Maximum (1)	Data Type	Description
1 0x01	N/A	Get_Attribute_Single Set_Attribute_Single	N/A N/A N/A	2	These instances give direct access to all drive parameters where the instance number corresponds to the parameter number. See the X5 User's Manual (Ch. 7) for detailed information about all drive parameters.

This class is a vendor-specific object that provides direct DeviceNet access to all X5 parameters, including those not defined by DeviceNet. The instance corresponds to the parameter number. For example, if the user wants to set Preset Frequency 1 to 8.2 Hz, the user would issue a SET_ATTRIBUTE_SINGLE request for Class 101 (0x65), instance 303, attribute 1, with a value of 82.

For the full list of drive parameters, see the X5 User's Manual, Chapter 7.

**Table 23: I/O Configuration Object
Class Code 0x80 - Instance Attributes (1)**

Attr. No.	Attribute Name	Services	Default, Minimum, Maximum	Data Type	Description
1 0x01	Input Assembly	Get_Attribute_Single Set_Attribute_Single	71 70 182	8	Sets the input assembly for the I/O connection using the actual assembly number.
2 0x02	Output Assembly	Get_Attribute_Single Set_Attribute_Single	21 20 132	8	Sets the output assembly for the I/O connection using the actual assembly number.
3 0x03	Input Assembly	Get_Attribute_Single Set_Attribute_Single	1 0 5	8	Sets the input assembly for the I/O connection using the assembly offset: 0 = assy 70 1 = assy 71 2 = assy 171 3 = assy 172 4 = assy 181 5 = assy 182
4 0x04	Output Assembly	Get_Attribute_Single Set_Attribute_Single	1 0 5	8	Sets the output assembly for the I/O connection using the assembly offset: 0 = assy 20 1 = assy 21 2 = assy 121 3 = assy 122 4 = assy 131 5 = assy 132

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