User Guide

DeviceNet

UD77/MD25 Option Cards for
Unidrive and MentorII

Part Number: 0447-0034
Issue Number: 1

Safety Information

Persons supervising and performing the electrical installation or maintenance of a Drive and/or an external Option Unit must be suitably qualified and competent in these duties. They should be given the opportunity to study and if necessary to discuss this User Guide before work is started.

The voltages present in the Drive and external Option Units are capable of inflicting a severe electric shock and may be lethal. The Stop function of the Drive does not remove dangerous voltages from the terminals of the Drive and external Option Unit. Mains supplies should be removed before any servicing work is performed.

The installation instructions should be adhered to. Any questions or doubt should be referred to the supplier of the equipment. It is the responsibility of the owner or user to ensure that the installation of the Drive and external Option Unit, and the way in which they are operated and maintained complies with the requirements of the Health and Safety at Work Act in the United Kingdom and applicable legislation and regulations and codes of practice in the UK or elsewhere.

The Drive software may incorporate an optional Auto-start facility. In order to prevent the risk of injury to personnel working on or near the motor or its driven equipment and to prevent potential damage to equipment, users and operators, all necessary precautions must be taken if operating the Drive in this mode.

The Stop and Start inputs of the Drive should not be relied upon to ensure safety of personnel. If a safety hazard could exist from unexpected starting of the Drive, an interlock should be installed to prevent the motor being inadvertently started.

General Information

The manufacturer accepts no liability for any consequences resulting from inappropriate, negligent or incorrect installation or adjustment of the optional operating parameters of the equipment or from mismatching the Drive with the motor.

The contents of this User Guide are believed to be correct at the time of printing. In the interests of a commitment to a policy of continuous development and improvement, the manufacturer reserves the right to change the specification of the product or its performance, or the contents of the User Guide, without notice.

Author:	CT SSPD, PB	
Issue Code:	dnnu1	
Software version:	DPL Toolkit V3.3	
	UD70	System File V2.63
	UD77	Firmware V2.00
	MD25	Firmware V2.00

Contents

1 Introduction

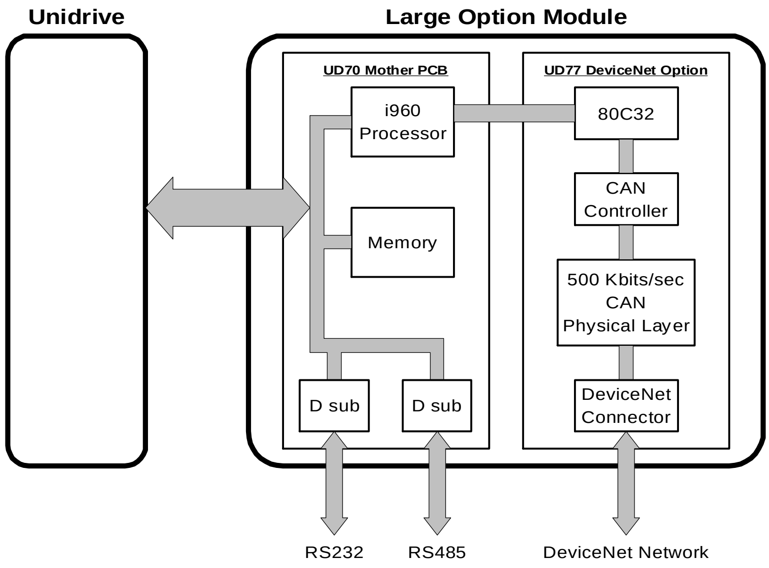
1.1 Using this Guide

Drive parameters are denoted in this manual by "#MM.PP", where MM refers to the menu number, and PP refers to the parameter number within that menu. Please refer to the Unidrive and Mentor II manuals for parameter definitions.

1.2 Unidrive - UD77

The UD77 DeviceNet Interface card for Unidrive is supplied in a Large Option Module. It is an add-on card for the UD70 Applications card. The CAN physical layer is used for DeviceNet, with an 80C32 processor and CAN controller handling all network activity. A Dual-Port RAM interface is used to transfer data between the 80C32 and the UD70.

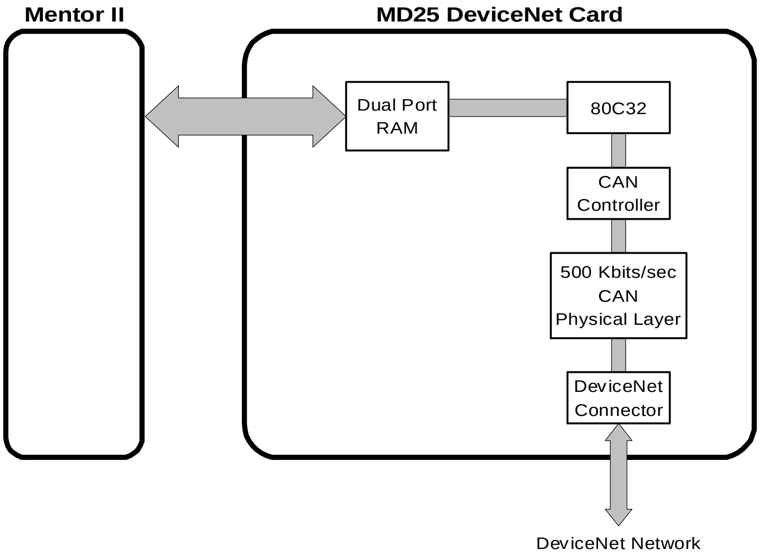
The UD70 retains full functionality, allowing the user to download normal DPL application programs. No program modifications are required to allow existing DPL programs to run. A different UD70 operating system file ("DNET.SYS") is used, and the UD70 has this system file pre-loaded. The UD70 also uses a DPRAM interface to transfer data to and from the Drive.



1.3 Mentor II - MD25

The MD25 DeviceNet Interface card for Mentor II is a single add-on card. It fits onto the 40 pin header on the MDA-2B card on the Mentor II itself. The CAN physical layer is used for DeviceNet, with an 80C32 processor and CAN controller handling all network activity. A dual-port RAM interface is used to transfer data between the 80C32 and the Mentor II.

The MD25 does not have the MD29 hardware, and is unable to run DPL application programs.



1.4 Overview Specification

System	DeviceNet
Vendor Code	257
Data Rate	Up to 500 Kbits/sec
Signalling	CAN
Galvanic Isolation	Yes

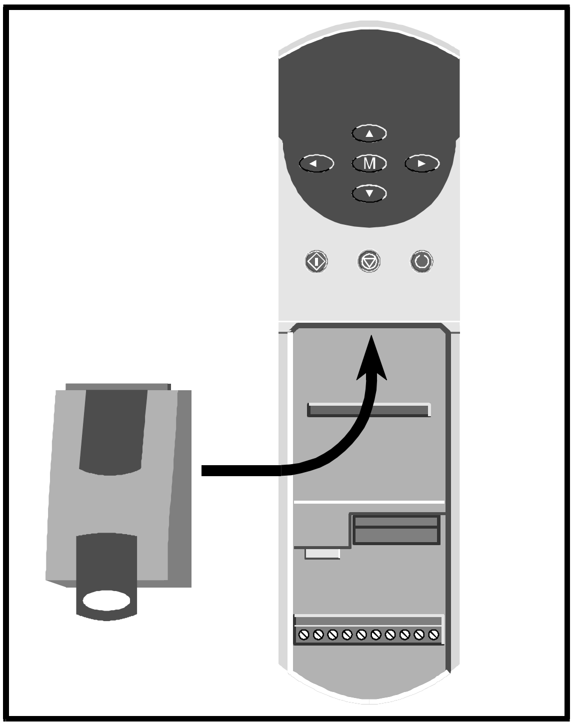
2 Mechanical Installation

IMPORTANT

The Unidrive or Mentor II must be disconnected from the mains supply before installing or removing an option module.

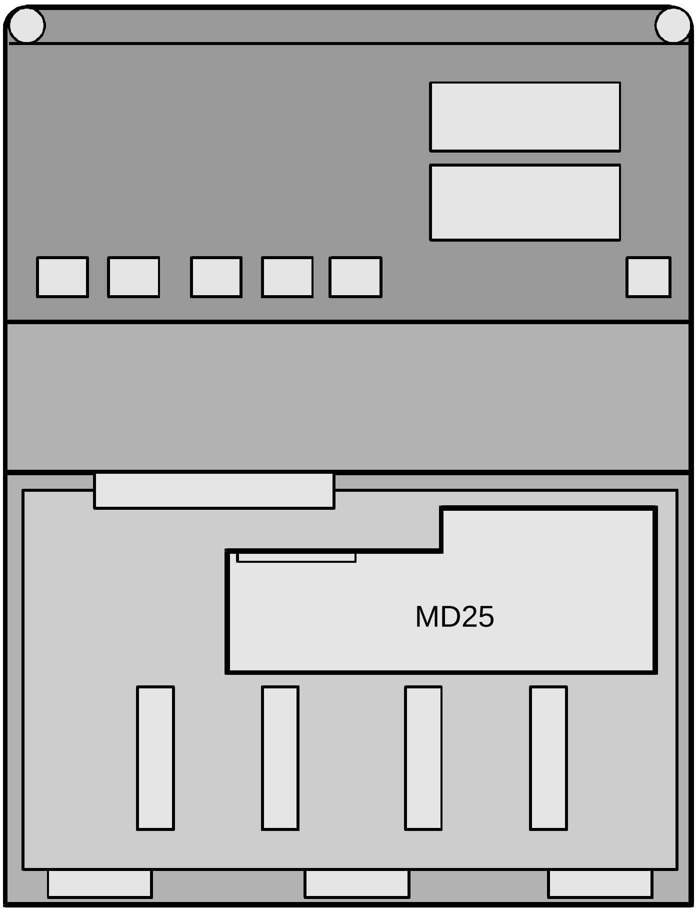
2.1 Unidrive

1. Isolate the Drive from the mains supply and allow 5 minutes for the DC Bus capacitors to discharge.
2. Insert Large Option Module as shown below. Ensure that it is correctly inserted. The module will click firmly into place.
3. To remove the module, pull on the black tab, and the module will disengage from the connector and pull out of the Drive.



2.2 Mentor II

The MD25 is to be located upon a 40-way pin header (PL1) on the MDA2B circuit board, as shown below.



Warning

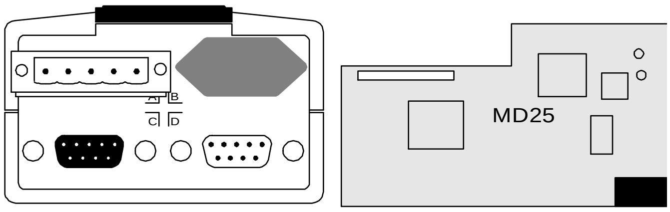
Please take extreme care when locating the board onto this connector - do not force it on. Excessive force may bend and break the pins of the header.

3 Electrical Installation

3.1 DeviceNet Connectors

The UD77 uses a 9-way D-type connector for the DeviceNet connections. A small adapter PCB is provided that plugs into the D-type on the UD77, and provides a standard 5-way DeviceNet terminal for network connections. The MD25 has a single DeviceNet 5-way terminal connector.

The connectors are shown below:



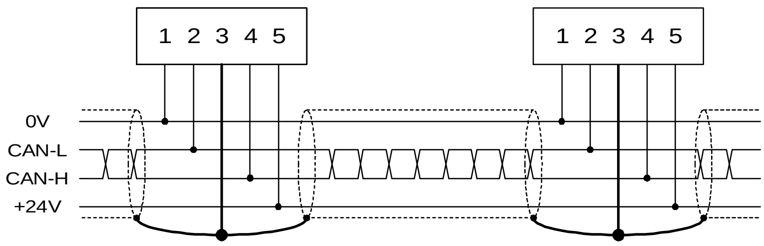
Unidrive Large Option Module

Mentor II DeviceNet Card

The DeviceNet connector provides power and also communications. Cables should be wired according to the following table. (Pin 1 is the left-most pin on the connector.)

Colour	Terminal	Signal	Function
Black	1	0v	Power supply 0V
Blue	2	CAN_L	Data signal low
Bare	3	SHIELD	Shield
White	4	CAN_H	Data signal high
Red	5	VDC	Power Supply

All connections must be connected, as show below:



3.2 Cable Specification

The following 4 core shielded twisted pair cables should be used.

Trunk connections

Characteristic	Minimum value	Nominal Value	Maximum value	Comments
Impedance		120Ω		
Conductor area	1.2 mm^2			
Capacitance			40 pF/m	
Resistance			25 Ω/km	
Line length			100m	@ 500 Kbits/sec
			500m	@ 125 Kbits/sec

Drop connections

Characteristic	Minimum value	Nominal Value	Maximum value	Comments
Impedance		120Ω		
Conductor area	0.5 mm^2			
Capacitance			40pF/m	
Resistance			90 Ω/km	
Line length			6m	Max single drop length
			39m	Max total drop @ 500K
			156m	Max total drop @ 125K

Recommended cable types are Belden 3082A for trunk connections, and Belden 3084A for drop connections.

3.3 Screen

The screen of the cable must be connected to pin 3 of the DeviceNet connector block.

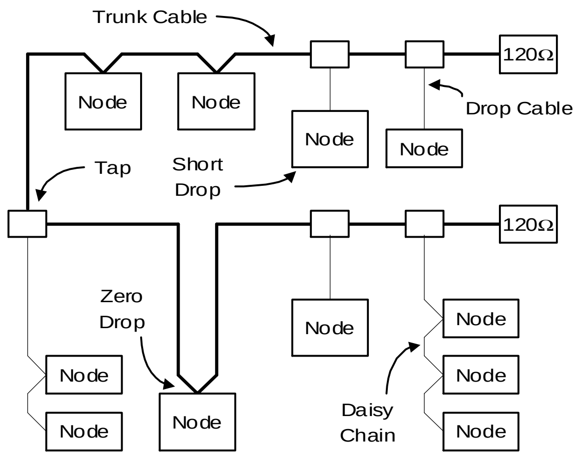
3.4 Termination

The network must be terminated with a 120Ω resistor at each end. The resistor should be connected across the CAN-H and CAN-L lines. Termination resistors are not supplied with either the UD77 or MD25. It is the user's responsibility to ensure correct termination of the network.

3.5 Network limitations

Data Rate (bits/sec)	125K	250K	500K
Max Trunk Distance	500m	250m	100m
Max Drop Length	6m	6m	6m
Cumulative Drop	156m	78m	39m
Number of Nodes	64	64	64

The physical layout of the network also needs to be considered



Trunk Cable — This is the main cable of the network, and all nodes are hung off this cable. Network termination resistors are connected at each end of the trunk cable. The maximum permitted length of the trunk cable depends on the network data rate.

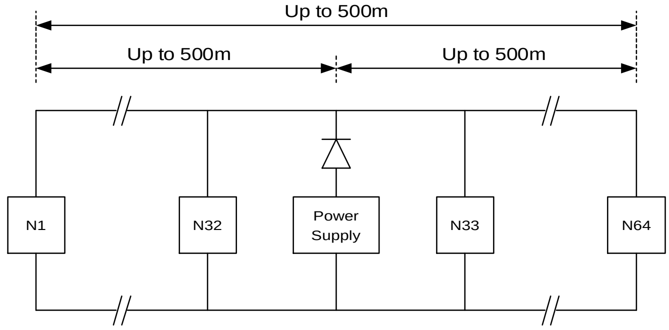
Drop Cable — A drop cable is a branch off the trunk cable with no termination. The maximum length for a drop cable is 6m. A single node can be connected to a drop cable, or several nodes can be daisy-chained , provided the cable length does not exceed 6m. The total length of drop cables on a system is limited, depending on the network data rate being used.

Zero Drop — The main trunk cable is connected directly to the node. This type of connection does not add to the drop cable figure for the system.

3.6 External power supply

UD77 and MD25 are supplied by the Unidrive or Mentor II internal power supplies, but an external +24V power supply is required to power the transceiver circuitry. The +24V is supplied along the red and black cables in the DeviceNet cable, and must be present for a node to communicate with the network.

The typical current drawn from the external +24V supply by the UD77 and MD25 is 5mA per node.



For detailed instructions on determining power supply requirements and configuration, refer to "DeviceNet Installation" from Rockwell Automation, Publication 1485-6.7.1.

3.7 Connecting to the DeviceNet

When making the connection to the DeviceNet the following procedure should be used

1. Switch off the Drive and the network power supply.
2. Ensure that the terminal block is correctly wired.
3. Plug the DeviceNet connector into the UD77 or MD25.
4. Switch on the network power supply, followed by the Drive.

4 Getting Started

4.1 DeviceNet Node Address (MAC-ID)

Set the desired node address in Unidrive parameter #20.05 and Mentor II parameter #14.01, and store the Drive parameters. Node address changes will only take effect when the UD77 or MD25 is next powered up. Valid addresses are between 0 and 63. Each node on the network must have a unique node address or MAC-ID.

When a UD77 or MD25 node is powered up or reset, it will test the network, looking for a node with the same address. If there are no other nodes with the same address, there will be no response. The UD77 or MD25 will repeat the message and if there is still no response, will join the network. If another node on the network has the same address, the UD77 or MD25 will not attempt to join the network.

4.2 Network data rate

Set the desired data rate in Unidrive parameter #20.08 or Mentor II parameter #14.02, and store the Drive parameters. Changes to the data rate will only take effect when the UD77 or MD25 is next powered up. Valid data rates are 0 = 125K, 1 = 250K, and 2 = 500K. All nodes on the network must be set to run at the same data rate.

4.3 Saving Drive Parameters

Changes in the network configuration parameters will not take effect until they have been stored, and the UD77 or MD25 has been reset.

Unidrive

To store changes in Drive parameters in menus 1 to 19, set #MM.00 to 1000 and press the red RESET button on the keypad. To store menu 20 parameters, set #17.19 to 1.

Mentor II

Ensure the Drive is disabled, then set #MM.00 to 1 and press RESET.

4.4 Resetting the DeviceNet Interface

Unidrive

The UD77 DeviceNet interface is reset with a full reset of the UD70. This will occur either when the Drive is reset from a tripped condition, #MM.00 is set to 1070, or #17.19 is set to 1.

Mentor II

A reset switch is provided on the MD25, which will reset the DeviceNet interface without affecting the Drive.

4.5 Trip Action

Connection Timeout

If a polled or cyclic data connection timeout occurs, the UD77 or MD25 will trip the Drive on "tr62", provided the trip is enabled. To enable the trip, set #20.11 or #14.06 to 1, and reset the UD77 or MD25. (Mentor II parameters must be stored to keep the trip enabled at next power-up.)

NOTE:

= on Mentor II, the display will show "- - -", but the trip code given in #10.35 will be 62.

A time-out error can occur if a data line connection is broken, or the external +24V supply is lost. When the connection or power supply is restored, the node will re-join the network, and re-establish the polled or cyclic data connection with the scanner.

Device	Trip Enable Set-up	Action
UD77	#20.11	#10.38 = 62
MD25	#14.06	#10.35 = 62

Bus Off Interrupt

The UD77 or MD25 will automatically trip the Drive on "tr60" if the "Bus Off" condition is detected. "Bus Off" is a lock-out trip condition, and requires a full UD77 or MD25 reset to re-initialise the node. When Unidrive is reset from a trip condition, the UD70 will reset the UD77.

For Mentor II, the only ways to recover from a Bus Off condition are to press the RESET button on the MD25, or cycle the power to the Drive.

NOTE:

On Mentor II, the display will show "- - -", but the trip code given in #10.35 will be 60.

General Errors

A general error can be raised if any scaling parameters used to convert internal Drive values to real units are set to 0.

Drive	Condition	Condition	Comments
Mentor II	Divide by Zero	#10.35 = 61	Check that #3.16 is not set to 0

4.6 Network Interruptions

If a Unidrive or Mentor II trips, then provided it is not due to a network error, the UD77 or MD25 will continue to function, and no network error will be indicated. However, Drive parameters are frozen at their values when the Drive actually tripped, so IN data from read-only parameters will fixed at the value when the trip occurred. Care must be taken if the reference forms part of a closed loop system, as it may be possible for the reference to saturate.

An error may occur when the Unidrive is reset, as this will also reset the UD70. The UD77 may be unable to communicate while the UD70 is re-initialised. Polled or cyclic connections will be re-established once initialisation is complete.

Removing a Drive completely from the system will not affect the operation of the network, but the scanner will indicate that there is an error on the missing node, and connections could not be established. It may be advisable to modify the scan list while the node is out of action.

4.7 Node Status

The Node Status is indicated in #20.09 on Unidrive and #14.03 on Mentor II.

Status	Node Status	Description
Device Operational	1	Device is operating correctly.
Device In Standby Mode	2	On Mentor II, the speed feedback scaling parameter (#3.16) is set 0. This must be set to positive value to allow speed feedback to be scaled correctly.
No +24V Power Supply	5	Device is operating in a normal condition, but no +24V supply has been detected.
Hardware Fault	10	Initialisation routine failed. The device has an unrecoverable fault.

4.8 Network Status

The Network Status is indicated in #20.10 on Unidrive, and #14.04 on Mentor II.

Status	Network Status	Description
Not On-line	1	Device not on-line, or not powered up.
On-line, Not Connected	2	Device on-line, but no connections have been established. The device is not allocated to a master.
On-line, Connected	3	Device on-line and a connection has been established. Device is allocated to a master
Connection Time-out	4	One or more of the I/O connections are in the timed-out state, or a Bus Off error has occurred. No response from the network.
Critical Link Failure	10	Failed communication device. The device has detected an error that has rendered it incapable of communicating on the network.

5 Polled and Cyclic Data

A "polled data" connection transfers data between the scanner and the UD77 or MD25 in both directions. When a polled connection has been established, the scanner will initiate data transfers on a pre-defined timebase, known as the "interscan delay". The timebase is defined as part of the scanner set-up, along with the number of bytes to be transmitted and received.

A "cyclic data" connection only transfers data from the UD77 or MD25 to the PLC. When a cyclic connection has been established, the node will initiate data transfer on a pre-defined timebase, known as the "heartbeat rate". The timebase is defined as part of the node cyclic data connection set-up, along with the number of bytes to be transmitted and received.

NOTE:

"Output data" and "input data" indicates the direction of data as seen by the PLC scanner. At the node, data transfer to the PLC is referred to as "produced data", while data coming from the PLC is "consumed data".

5.1 Polled Interscan Delay

When the scan list is downloaded to the scanner the "interscan delay" must also be set. This determines how often the polled data connections are transmitted over the network. UD77 and MD25 will support interscan delay rates from 5ms to 250ms. The number of bytes transferred in each direction depends on the input and output assembly objects that have been selected.

NOTE:

When DeviceNet Manager uses the EDS file to upload a set of parameters from the Unidrive or Mentor II, the interscan delay determines the time taken to load the listed parameters from the node to the DeviceNet Manager. One parameter is returned to DeviceNet Manager on every second cycle.

5.2 Cyclic Heartbeat Rate

When the cyclic data connection is configured, the "heartbeat rate" must also be set. This determines how often the cyclic data connection is transmitted to the PLC. UD77 and MD25 will support heartbeat rates ranging from 50 milliseconds to 65 seconds. The number of bytes supported by the cyclic data connection depends on the input assembly object that has been selected.

NOTE:

Simultaneous polled and cyclic connections are not supported. The cyclic connection will over-ride the polled connection of both are configured for a single node.

5.3 Message Timing

CAN networks are very fast and efficient, but this efficiency starts to drop off rapidly if the network loading exceeds 35%. Low priority nodes have to wait their turn to win arbitration for the bus, and if high priority nodes re-arbitrate for the bus too quickly, the low priority nodes may never transmit their messages. The network loading must be considered before the interscan delay period is chosen.

If a 6 byte polled data connection is established between the scanner and a node, it will take approximately 200µs to transmit the message at 500 Kbits/sec. The return message will be of similar length, so 400µs is required to complete the data transfer. However, CAN networks should be kept around 35% loading maximum, so the actual time allowed for a single node message should be 400µs / 0.35 = 1.15ms.

In general, the interscan delay time chosen for a 500 Kbits/sec can be calculated approximately as:

At 500 Kbits/sec:

Interscan Delay (in ms) = 1.2ms * number of nodes.

At 250 Kbits/sec:

Interscan Delay (in ms) = 1.2ms * number of nodes * 2

At 125 Kbits/sec:

Interscan Delay (in ms) = 1.2ms * number of nodes * 4

Cyclic messages are transmitted at a very low rate compared to polled data messages. 50ms is the minimum heartbeat rate that can be set. Cyclic messages also have lower priority than polled data messages so provided the heartbeat period is significantly higher than the interscan delay period, cyclic data will have negligible effect on the network loading, and will not unduly interfere with polled data transmissions.

5.4 Output Data

The format of the output data is defined by the "Output Assembly Object". DeviceNet has pre-defined output assembly objects, and objects 20, 21, 22 and 23 are supported. A special Control Techniques output assembly object is also provided, which can be configured to transfer data from the PLC to any R/W Drive parameter. The output assembly object to be used can be configured from DeviceNet Manager by double-clicking on a Unidrive or Mentor II icon in the network window, and selecting the "DeviceNet Config" menu.

Control Techniques Output Assembly Object (Default)

Output Assembly Object 107 - transmits 6 Tx (transmit) bytes from the PLC.

This object allows the user to write to any three parameters within the Drive via a polled data connection. If invalid mapping parameter values are set, the DeviceNet interface will revert to the default values listed below. Changes do not take effect until the UD77 or MD25 has been reset.

Unidrive

Polled Data	Mapping Parameter	Default Mapping Status
OUT Word 1	#20.06	Default map = #90.11, Drive control word
OUT Word 2	#20.01	Default map = #1.21, digital speed reference 1
OUT Word 3	#20.02	Default map = #4.08, torque reference

Mentor II

Polled Data	Mapping Parameter	Default Mapping Status
OUT Word 1	#11.04	Default map = 1940, Drive control word
OUT Word 2	#11.05	Default map = #1.18, digital speed reference 1
OUT Word 3	#11.06	Default map = #4.08, torque reference

Basic Speed Control

Output Assembly Object 20 - transmits 4 Tx (transmit) bytes from the PLC.

Byte	b7	b6	b5	b4	b3	b2	b1	b0
Byte 0						Fault Reset		Run Forward
Byte 1								
Byte 2	Speed Reference (Low byte)							
Byte 3	Speed Reference (High byte)							

Extended Speed Control

Output Assembly Object 21 - transmits 4 Tx (transmit) bytes from the PLC.

Byte	b7	b6	b5	b4	b3	b2	b1	b0
Byte 0		Net Ref	Net Ctrl			Fault Reset	Run Reverse	Run Forward
Byte 1								
Byte 2	Speed Reference (Low byte)							
Byte 3	Speed Reference (High byte)							

Basic Speed and Torque Control

Output Assembly Object 22 - transmits 6 Tx (transmit) bytes from the PLC.

Byte	b7	b6	b5	b4	b3	b2	b1	b0
Byte 0						Fault Reset		Run Forward
Byte 1								
Byte 2	Speed Reference (Low byte)							
Byte 3	Speed Reference (High byte)							
Byte 4	Torque Reference (Low byte)							
Byte 5	Torque Reference (High byte)							

Extended Speed and Torque Control

Output Assembly Object 23 - transmits 6 Tx (transmit) bytes from the PLC.

Byte	b7	b6	b5	b4	b3	b2	b1	b0
Byte 0		Net Ref	Net Ctrl			Fault Reset	Run Reverse	Run Forward
Byte 1								
Byte 2	Speed Reference (Low byte)							
Byte 3	Speed Reference (High byte)							
Byte 4	Torque Reference (Low byte)							
Byte 5	Torque Reference (High byte)							

5.5 32-bit Polled and Cyclic Data Channel (Unidrive only)

A 32 bit data channel can be created for either IN data, OUT data or both, by combining two data words. This allows 32 bit registers (_Pxx%, _Qxx%, _Rxx% and _Sxx%) in the UD70 to be written to and read from by the controlling PLC. (See the User's Guide for the UD70 for more information.)

Using Word 1 and Word 2

The 32 bit channel is automatically configured when the mapping for word 1 (#20.06 or #20.07) is directed to a 32 bit register. These are addressed as #70.xx for _Pxx% registers up to #73.xx for _Sxx% registers. The mapping value for word 2 (#20.01 or #20.03) is disabled if word 1 is directed to or sourced from a 32 bit register. Word 2 will contain the data high word (upper 16 bits of the register) while word 1 will contain the data low word (lower 16 bits of the register).

NOTE:

If word 3 is also directed to or sourced from a 32 bit register, the data will be written to or read from the lower 16 bits of the register.

Using Word 2 and Word 3

If word 1 is directed to or sourced from a 16 bit drive parameter, a 32 bit channel can be created using word 2 and word 3. The destination or source register will be specified in the mapping for word 2, and any mapping for word 3 will be disabled. Word 3 will contain the data high word (upper 16 bits) while word 2 will contain the data low word (lower 16 bits).

5.6 Control Word

The control word is an efficient way of remotely controlling the Drive. Each bit in the control word has a particular function, and provides a method of writing to the bit parameters which control the operation of the Drive (RUN, JOG, DIRECTION, etc.) with a single data word.

Unidrive

The control word on Unidrive is mapped to word 1 (default) by setting #20.06 to 9011. To map to data word 2 or 3, set #20.01 or #20.02 to 9011.

b15	b14	b13	b12	b11	b10	b9	b8
M6	M5	#18.33	M3	M2	M1	M0	#18.32

b7	b6	b5	b4	b3	b2	b1	b0
#18.31	#1.46	#1.45	Trip	#6.32	#6.31	#6.30	#6.15

The bits shown as "Mx" are individual mask bits which allow the corresponding "bx" to be masked. The "Trip" bit will cause a "tr52" trip when set to 1. Parameters #18.31 to #18.33 are general user parameters and do not have mask bits.

NOTE:

If as Mx bit is reset to 0, the bit parameter that it masks will remain at the previous value set.

All direct control of the sequencing bits (#6.30 - #6.32) from digital inputs must be disabled before the control word will can be used. (Set #8.16, #8.19 and #8.21 to another value or 0.) The sequencing bits have the following functions when set to 1.

Parameter	Sequencing bit	PLC Mode (#6.04 = 3)	Wire-proof PLC Mode (#6.04 = 4)
#6.15	Enable	Enable	Enable
#6.30	0	Run	Run Forward
#6.31	1	Jog	Jog
#6.32	2	Reverse	Run Reverse

ENABLE

The display will show "inh" when set at 0, and depends on #6.30 and #6.32 when set to 1. Setting #6.15 to 0 overrides #6.30 and #6.32, and immediately disables the Drive. Motor will coast to rest if it is running when the Drive is disabled.

JOG

The jog bit must be set, along with the appropriate run and direction signals. To reset the Drive using the DeviceNet network, (See Unidrive manual for more information.)

Example Unidrive Control Word Values (PLC Mode)

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0	Value	Action
0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0x0200	Drive disable
0	0	0	1	1	1	1	0	0	0	0	0	0	0	0	1	0x1E01	Enabled + stopped
0	0	0	1	1	1	1	0	0	0	0	0	0	0	1	1	0x1E03	Enabled + run fwd
0	0	0	1	1	1	1	0	0	0	0	0	1	0	1	1	0x1E0B	Enabled + run rev
0	0	0	1	1	1	1	0	0	0	0	0	1	1	1	1	0x1E07	Enabled + jog rev

Example Unidrive Control Word Values (Wire Proof PLC Mode)

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0	Value	Action
0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0x0200	Drive disable
0	0	0	1	1	1	1	0	0	0	0	0	0	0	0	1	0x1E01	Enabled + stopped
0	0	0	1	1	1	1	0	0	0	0	0	0	0	1	1	0x1E03	Enabled + run fwd
0	0	0	1	1	1	1	0	0	0	0	0	1	0	0	1	0x1E09	Enabled + run rev
0	0	0	1	1	1	1	0	0	0	0	0	1	1	0	1	0x1E0C	Enabled + jog rev

Mentor II

The control word on Mentor II can be mapped to any OUT channel by setting the appropriate mapping parameter to 1940.

b15	b14	b13	b12	b11	b10	b9	b8
Valid	#15.31	#15.29	#15.25	Reset	#15.23	#15.22	#15.21

b7	b6	b5	b4	b3	b2	b1	b0
#2.02	#5.17	#4.13	#4.12	#1.13	#1.12	#1.11	#4.10

The VALID bit (b15) must be set to 1 for the Mentor II to accept and implement the message. The RESET bit will reset the Drive from a trip condition. NOTE: the reset sequence on Mentor II takes approximately 3 seconds, and the "Drive Healthy" signal is not returned until the sequence has finished.

Digital input control of the logic functions (#1.11 - #1.13) must be disabled by setting #8.21 to 1. The logic bits have the following functions when set to 1.

Parameter	Function	Description
#1.11	Run Permit	Must be set for the Drive to run.
#1.12	Reverse	Sets the direction of the motor.
#1.13	Inch (Jog)	Selects the inch or jog reference (#1.05).
#5.17	Inhibit	Set to 1 to enable the thyristor bridge firing pulses.

(See Mentor II manual for more information.)

Example Mentor II Control Word Values

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0	Value	Action
1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0x8040	Disabled
1	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0x8082	Run fwd with ramps
1	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0x8006	Run rev, no ramps
1	0	0	0	0	0	0	0	1	0	0	0	1	1	1	0	0x808E	Inch rev with ramps
1	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0x8012	Torque control

Control Word Mapping

Bit	Unidrive - UD77		Mentor II - MD25	
	Parameter	Description	Parameter	Description
0	#6.15	Drive enable	#4.10	Current limit selector
1	#6.30	Sequencing bit 0	#1.11	Reference ON
2	#6.31	Sequencing bit 1	#1.12	Reverse selector
3	#6.32	Sequencing bit 2	#1.13	Inch selector
4	TRIP	Drive Trip (tr52)	#4.12	Torque Mode 0
5	#1.45	Pre-set select 0	#4.13	Torque Mode 1
6	#1.46	Pre-set select 1	#5.17	Inhibit firing
7	#18.31	Application bit	#2.02	Ramp enable
8	#18.32	Application bit	#15.21	Application bit
9	M0	Mask bit 0	#15.22	Application bit
10	M1	Mask bit 1	#15.23	Application bit
11	M2	Mask bit 2	RESET	Set to reset Drive
12	M3	Mask bit 3	#15.25	Application bit
13	#18.33	Application bit	#15.29	Application bit
14	M5	Mask bit 5	#15.31	Application bit
15	M6	Mask bit 6	VALID	VALID bit

The upper bits (b9-b15) of the Unidrive control word are individual mask bits which allow the corresponding bits (b0-b6) to be masked. If M0 (b9) is set, b0 of the control word controls parameter #6.15.

5.7 Mapping Conflicts

When the mapping parameters for the DeviceNet polled data channels are set, care must be taken to ensure that there are no clashes with the mapping of the analogue and digital inputs within the Drive. Neither the UD77 or MD25 will indicate if there is a conflict of mapping parameters. This only applies to analogue and digital inputs, and OUT data on the DeviceNet network.

If a parameter is written to from two different sources, the value of this parameter will depend entirely upon the scan times for the analogue or digital input and the DeviceNet network. Further confusion may be caused due to the update rate of the display. A parameter may appear to be steady at a particular value, but occasionally glitch in the value will be seen. In reality, this value may be changing continuously, leading to erratic Drive behaviour.

Drive Input	**Unidrive Mapping Parameter**	**Mentor II Mapping Parameter**	**Drive Input**	**Unidrive Mapping Parameter**	**Mentor II Mapping Parameter**
Analogue 1	#7.10	#7.11	Digital 2	#8.13	#8.12
Analogue 2	#7.14	#7.12	Digital 3	#8.16	#8.13
Analogue 3	#7.18	#7.13	Digital 4	#8.19	#8.14
Analogue 4		#7.14	Digital 5	#8.21	#8.15
Speed		#7.15	Digital 6	#8.23	#8.16
IN Word 1	#20.06	#11.04	Digital 7		#8.17
IN Word 2	#20.01	#11.05	Digital 8		#8.18
IN Word 3	#20.02	#11.06	Digital 9		#8.19
Digital 1	#8.10		Digital 10		#8.20

To ensure that there are no mapping conflicts, check that each Unidrive mapping parameter and each Mentor II mapping parameter has a different value programmed. Analogue and digital inputs can be de-programmed by setting the value to 0.

With Mentor II, for example, analogue input channel defaults to the torque reference, #4.08. This is also the default for polled data word 3, so either analogue input 4 (#7.14) or polled data channel 3 (#11.06) must be re-mapped before #4.08 can be controlled properly by either source.

5.8 Input Data

The format of the input data is defined by the "input Assembly Object". DeviceNet has pre-defined input assembly objects, and objects 70 and 72 are supported. A special Control Techniques input assembly object is also provided, which can be configured to transfer data from any Drive parameter to the PLC. The input assembly object to be used can be configured from DeviceNet Manager by double-clicking on a Unidrive or Mentor II icon in the network window, and selecting the "DeviceNet Config" menu.

Control Techniques Input Assembly Object (Default)

Input Assembly Object 106 - transmits 6 Rx (receive) bytes to the PLC.

This object allows the user to read from any three parameters within the Drive via a polled data connection. If invalid mapping parameter values are set, the DeviceNet interface will revert to the default values listed below. Changes do not take effect until the UD77 or MD25 has been reset.

Unidrive

Polled Data	Mapping Parameter	Default Mapping Status
IN Word 1	#20.07	Default map = #90.11, Drive status word
IN Word 2	#20.03	Default map = #2.01, post-ramp speed reference
IN Word 3	#20.04	Default map = #4.02, torque-producing current

Mentor II

Polled Data	Mapping Parameter	Default Mapping Status
IN Word 1	#11.01	Default map = 1941, Drive status word
IN Word 2	#11.02	Default map = #2.01, post-ramp speed reference
IN Word 3	#11.03	Default map = #4.02, torque-producing current

Basic Speed Control

Input Assembly Object 70 - transmits 4 Rx (receive) bytes to the PLC.

Byte	b7	b6	b5	b4	b3	b2	b1	b0
Byte 0						Fault Reset		Run Forward
Byte 1								
Byte 2	Speed Feedback (Low byte)							
Byte 3	Speed Feedback (High byte)							

Basic Speed and Torque Control

Input Assembly Object 72 - transmits 6 Rx (receive) bytes to the PLC.

Byte	b7	b6	b5	b4	b3	b2	b1	b0
Byte 0		Net Ref	Net Ctrl			Fault Reset	Run Reverse	Run Forward
Byte 1								
Byte 2	Speed Feedback (Low byte)							
Byte 3	Speed Feedback (High byte)							
Byte 4	Torque Feedback (Low byte)							
Byte 5	Torque Feedback (High byte)							

5.9 Status Word

The status word is an efficient way of remotely monitoring and diagnosing the status of the Drive. Each bit in the status word indicates the status of a particular function of the Drive, e.g. at speed, zero speed, Drive healthy, etc., and provides a quick method of checking the current status of the Drive.

Unidrive

The status word on Unidrive is mapped to word 1 (default) by setting #20.07 to 9011. To map to channel 2 or 3, set #20.03 or #20.04 to 9011.

b15	b14	b13	b12	b11	b10	b9	b8
X	#10.15	#10.14	#10.13	#10.12	#10.11	#10.10	#10.09

b7	b6	b5	b4	b3	b2	b1	b0
#10.08	#10.07	#10.06	#10.05	#10.04	#10.03	#10.02	#10.01

Mentor II

The status word on Unidrive can be mapped to any IN channel by setting the appropriate mapping parameter to 1941.

b15	b14	b13	b12	b11	b10	b9	b8
Error	#15.26	#10.09	0	#10.07	0	#10.05	#10.04

b7	b6	b5	b4	b3	b2	b1	b0
#10.03	#10.02	#10.01	0	#10.13	#4.25	#4.24	#10.12

Status Word Mapping

Bit	Unidrive - UD77		Mentor II - MD25	
	Parameter	**Description**	**Parameter**	**Description**
0	#10.01	Drive healthy	#10.12	Drive healthy
1	#10.02	Drive running	#4.24	Taper threshold 1 exceeded
2	#10.03	Zero speed	#4.25	Taper threshold 2 exceeded
3	#10.04	Running at or below minimum speed	#10.13	I*t Alarm
4	#10.05	Below set speed	0	Not used
5	#10.06	At speed	#10.01	Forward velocity
6	#10.07	Above set speed	#10.02	Reverse Velocity
7	#10.08	Load reached	#10.03	Current limit
8	#10.09	In current limit	#10.04	Bridge 1 enabled
9	#10.10	Regenerating	#10.05	Bridge 2 enabled
10	#10.11	Dynamic brake active	0	Not used
11	#10.12	Dynamic brake alarm	#10.07	At speed
12	#10.13	Direction commanded	0	Not used
13	#10.14	Direction running	#10.09	Zero speed
14	#10.15	Mains Loss	#15.26	Application bit
15	X	Not used	ERROR	Set if there is an error on one of the cyclic channels

6 Explicit Data (Non-Cyclic Data)

An "explicit data" connection allows access to any parameter in the Drive on a non-cyclic basis. Non-cyclic data transfers are must be initiated by the ladder program in the PLC. The scanner will transmit the request over the network, and will set a flag to indicate when data has been returned. The PLC program can subsequently check for any errors during the transmission, and decode the message.

The Control Techniques object (Class 100 or 0x64) provides access to all Drive parameters. All supported pre-defined DeviceNet objects can also be accessed using explicit messaging.

Refer to the Scanner documentation for full details about explicit messaging, and how to implement explicit messaging using the scanner and PLC.

7 Electronic Data Sheets

Electronic Data Sheets are text files that provide DeviceNet Manager with parameter information to allow parameters to be edited via the DeviceNet network. Full sets of parameters can be uploaded from the Drive and stored to disk, or retrieved from disk and downloaded to the Drive. Parameter sets can also be viewed and modified off-line.

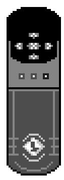
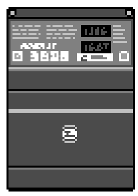
7.1 Generic EDS Files

Generic EDS files are available that support Unidrive fitted with Version 2 and Version 3 software, and configured in open loop, closed loop and servo mode. Generic EDS files for Mentor II fitted with V4.10.xx and V5.01.xx software are also supplied. These files are supplied on the DPL Toolkit V3.3b CD-ROM, and are also available free-of-charge from the Control Techniques web site at "www.controltech.co.uk".

These files contain a basic common selection of the Drive parameters, allowing configuration of speed or torque references, acceleration and deceleration ramps, motor data set-up, digital and analogue I/O configuration parameters, and DeviceNet configuration parameters.

Unidrive Open Loop	G3_OPEN.EDS	G2_OPEN.EDS
Unidrive Closed Loop	G3_CLSD.EDS	G2_CLSD.EDS
Unidrive Servo	G3_SERVO.EDS	G2_SERVO.EDS
Mentor II	G410_M4Q.EDS	G501_M4Q.EDS

Drive bitmaps are also supplied that allow DeviceNet Manager to display a relevant picture on the network diagram.

Unidrive Icon	**Mentor II Icon**
	
UNIDRIVE.BMP	**MENTOR2.BMP**

The EDS files can be installed from within DeviceNet Manager by selecting "**Install EDS Files**" from the Utilities menu. When asked to "**Set Device Bitmap**?", answer "**Yes**", and point to UNIDRIVE.BMP or MENTOR2.BMP.

7.2 Installing EDS Files

To install the generic EDS files, select "**Install EDS Files...**" from the "**Utilities**" menu. Go to the "**G_UNI**" directory, choose "**Select All**", and click on "**OK**". Answer "**Yes**" to set device bitmap, and select "**UNIDRIVE.BMP**". DeviceNet Manager will install the Unidrive generic EDS files to the appropriate locations.

Repeat the above process for the generic Mentor II EDS file, but select the files in "**G_MENTOR**", and choose "**MENTOR2.BMP**" as the bitmap file.

7.3 Unidrive

As Unidrive can operate in three modes, with each mode having a different parameter set, each mode is considered to be a different Drive, and the product code is assigned accordingly.

Product Code

The product code depends on the operating mode of the Drive, and is calculated as:

Product Code = 32 * (#11.31 + 1).

Drive Mode	Product Code
Open Loop	32
Closed Loop	64
Servo	96

Major and Minor Revision Codes

The major and minor revision codes depend on the version of software fitted to the Drive, and are calculated as:

Major Revision = #11.29 / 100

Minor Revision = #11.29 Mod 100

Software Version	Major Revision	Minor Revision
V2.06.00	2	6
V2.10.06	2	10
V3.00.00	3	0

7.4 Mentor II

Product Code

The product code depends on the software fitted to the Drive, and is calculated as:

Product Code = (#11.15 Mod 100) + 1.

Software	Product Code
V4.10.XX	11
V5.01.XX	2

Major and Minor Revision Codes

The major and minor revision codes depend on the version of software fitted to the Drive, and are calculated as:

Major Revision = #11.15 / 100

Minor Revision = #11.15 Mod 100

Software Version	Major Revision	Minor Revision
V4.10.01	4	10
V5.01.00	5	1

7.5 Advanced EDS Files

Advanced EDS files provide access to the complete Drive parameter set for a specific version of software. This also includes parameters for any small option module that may be fitted to the Drive.

DeviceNet Manager requires an accurate list of available Drive parameters, and will not upload parameters if a parameter does not exist. Advanced EDS files must therefore be created using the Advanced EDS File Compiler software from CT SSPD.

The software package uses the UniSoft and MentorSoft databases to generate a full and accurate parameter set, and convert this data to EDS file format. EDS files can therefore be generated for a Unidrive with any combination of Drive operating mode, small option module and software version fitted, and also for a Mentor II with any version of software fitted.

NOTE:

Only 4 Quadrant Mentor II parameter sets are supported. If advanced Mentor II EDS files are installed, they will over-write the existing generic EDS files.

8 Using DeviceNet Manager Software

This section gives only basic getting started instructions on configuring the scanner, mapping data to the PLC, and communicating with a Unidrive and Mentor II. The details given apply to the Allen Bradley SLC500 PLC, fitted with a 1747-SDN DeviceNet Scanner module fitted in slot 1, and using the Allen Bradley PCMCIA DeviceNet card. Configuration routines may differ slightly for other hardware configurations. Consult the relevant Allen Bradley documentation for further details.

8.1 Connecting to the DeviceNet Network

Before DeviceNet Manager can be used to configure the network, an empty project must be created (or an existing project opened). Select "New Project..." from the "File" menu, and give a project name for the overall project, and a network name.

Now that the project has been created, an on-line connection must be set up. Select "**Setup Online Connection**" from the "**Utilities**" menu, and choose the appropriate Driver. Set the data rate as required, and choose an unused node address or MAC-ID. Note that the scanner will default to a data rate of 125 Kbits/sec, and it is generally best to avoid MAC-IDs 0 and 63.

It is recommended that only the scanner and the PC card are initially connected to the network. This allows the scanner to be configured without the risk of other nodes using the same MAC-ID.

8.2 Configuring the Scanner

Before it is possible to configure the scanner, it is necessary to find the default MAC-ID for the scanner. Select "**Mini Who**" from the "**Who**" menu. DeviceNet Manager will scan the whole network, and indicate which MAC-IDs have been assigned to nodes on the network. Only two should be indicated, with one being the address chosen for the PC card, and the other being the current scanner address.

If only the PC card is identified on the grid, check that the scanner is wired correctly, and the +24V supply is present. Click "**Rescan**" to re-check the network for the presence of the scanner. If the scanner still does not appear, close the Mini Who box, and select "**Go Offline**" from the "**Utilities**" menu. Repeat section 8.1, and select a different data rate, until the scanner appears in the Mini Who grid.

Select "**Start Online Build**" from the "**Utilities**" menu, and DeviceNet Manager will build a diagram of the devices connected to the network. This should only include the scanner icon, and the PC card icon.

Scanner MAC-ID

The recommended scanner MAC-ID is 0, as this ensures that messages from the scanner have the highest priority over the network.

To change the MAC-ID, select "**Basic Device Configuration…**" from the "**Utilities**" menu, and set the "**Device Node Address**" to the detected scanner address. Set "**Class**" to 3, "**Instance**" to 1, and "**Attribute**" to 1.

Ensure that "**byte**" is selected, enter the required scanner address in the "**Attribute Data**" window. Click on "Save to Device", and after a few seconds, DeviceNet Manager should indicate that "**Device acknowledged receipt of data**". The scanner will automatically store the new MAC-ID, reset itself, and change to the new address. Subsequent communications with the scanner will be to the new address.

Scanner Data Rate

If the scanner data rate needs to be changed, select "**Basic Device Configuration…**" from the "**Utilities**" menu, and set the "**Device Node Address**" to the assigned scanner address. Set "**Class**" to 3, "**Instance**" to 1, and "**Attribute**" to 2.

Ensure that "**Byte**" is selected, enter a value in "**Attribute Data**" of 0 for 125 Kbps, 1 for 250 Kbps or 2 for 500 Kbps, and click on "**Save to Device**" After a few seconds, DeviceNet Manager should indicate that "**Device acknowledged receipt of data**". The scanner will automatically store the new data rate, reset itself, and change to the new data rate. Subsequent communications with the scanner will require the new data rate.

Select "**Go Offline**" from the "**Utilities**" menu, and re-establish the online connection using the new data rate.

8.3 Building a Network

Once the scanner has been configured, it is STRONGLY recommended that the MAC-ID and data rate for each node are set using the Drive parameters, before connecting each node to the rest of the network.

Automatic Network Build

DeviceNet Manager has a feature that scans every MAC-ID, and builds up a full map of the network. This device map can be saved to disk, and edited as required. If EDS files have been correctly installed, Unidrive and Mentor II nodes will be represented by their relevant icons. If the generic icons appear (plain grey AC or DC motor), then a matching EDS file for the product code and major revision could not be located.

Manual Network Build

This method can be used to build up a network off-line, and stored to disk. To build a network, open a new or existing project. To add a node, double click the appropriate product type (AC or DC Drive) from the Device List on the left side of the screen, then double click on the Control Techniques folder. Click and drag the required Drive to the network screen, and assign a node number.

8.4 Configuring Scanner Data Connections

To define the required scan list of data links between slave nodes and the master scanner, click on a node in the network screen and drag it onto the scanner icon. The node should now be enclosed in a red box. Repeat for as many nodes as necessary. Double click on the scanner icon to configure the scanner, and individual data links.

Scanner Poll Rate

To enable I/O communications, click on the "**I/O Comms**" check box to enable input and output communications. The "**Interscan Delay**" should be entered in milliseconds, and defines how often a polled data connection is transmitted.. Scan rates between 5ms and 250ms are supported.

A slower interscan delay can be used if required, by entering a multiple of the normal interscan delay in the "**Foreground to Bkgd Poll Ratio**" box. These settings must be saved in the scanner module by clicking on "**Save To SDN**".

NOTE:

The PLC must be in the PROGRAM mode to allow parameters to be saved in the scanner.

Scan List

Select "**Edit Scan List**" to see a list of defined data connections. The current scan list can be uploaded from the scanner by selecting "**Load from SDN**". Devices can be added to the scan list by selecting "**Add Devices from Proj**", and dragging a device onto the scanner icon. Select "OK" when complete.

Edit I/O Parameters

To edit the Drive I/O parameters choose "**Edit I/O Parameters**". Set the "**Polled Size**" to 4 or 6 Tx and Rx bytes, depending on the input and output assemblies selected..)

To enable the cyclic data connection, click on the "**Enable**" checkbox, and ensure the "**Cyclic**" button is selected. Set the Tx and Rx data bytes, and enter the "**Heartbeat rate**". Click on the "**Enable**" checkbox to disable the polled data connection. Select "**OK**" when complete.

Strobed and Change of State data are not supported by UD77 and MD25.

Auto Map

Once all the data connections have been defined, they need to be mapped to PLC registers. Click on "**Select All**", then select "**Auto Map**".

For input data, select either "**Discrete Input**" or "**M1 File**", and select "**Discrete Output**" or "**M0 File**" for output data. NOTE: Discrete I/O files only provide 31 data words, while the M0/M1 files allow up to 150 data words.

Select "**Map**", and data words will be assigned to each node. Select "**Datatable Map**" to view see which nodes have been assigned to which data words.

Saving the Scanlist

Now that all data connections have been defined and mapped, the new scanlist must be downloaded to the scanner. Ensure the PLC is in PROG mode, and select "**Save to SDN**".

8.5 Outputs from the PLC

The PLC and scanner register addresses shown below assume that the scanner is fitted in slot 1 on the PLC rack.

Output	**Data**	**Data**															
File	**Word**	**15**	**14**	**13**	**12**	**11**	**10**	**9**	**8**	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**
O:1.0	Word 0	Reserved for Scanner Status															
O:1.1	Word 1	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
O:1.2	Word 2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
O:1.3	Word 3	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
O:1.4	Word 4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
O:1.5	Word 5	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
O:1.6	Word 6	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7
O:1.7	Word 7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7

The table above indicates the node to which each data word will be transferred. The function of each word will depend upon the output assembly object that has been selected at the node.

8.6 Inputs to the PLC

The PLC and scanner register addresses shown below assume that the scanner is fitted in slot 1 on the PLC rack.

Input	Data	Data															
File	**Word**	**15**	**14**	**13**	**12**	**11**	**10**	**9**	**8**	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**
I:1.0	Word 0	Reserved for Scanner Status															
I:1.1	Word 1	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
I:1.2	Word 2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
I:1.3	Word 3	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
I:1.4	Word 4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
I:1.5	Word 5	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
I:1.6	Word 6	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7
I:1.7	Word 7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7

The table above indicates from which node each data word will be received. The function of each word will depend upon the input assembly object that has been selected at the node.

In the above mapping, if node 4 is using input assembly 70, word 4 will return the status word, and word 5 will return the speed feedback.

8.7 Editing Unidrive and Mentor II Parameter Sets

To edit or monitor individual Drive parameters in a particular node, double click on the node icon on the network map. DeviceNet Manager will upload all parameters defined in the appropriate EDS file, and display them on the screen.

To edit a parameter, select it from the list, and click on "**Modify Parameter**". Change the value as necessary, either by typing in a new value, or using the slider bar. Click on "**Save to Device**" to change the value inside the Drive.

If a parameter set has been edited off-line, and stored to disk, this can be loaded into DeviceNet Manager by selecting "**Load from File**", and downloaded to the node by selecting "**Save to Device**".

NOTE:

Selecting "Save to Device" only transfers the new parameter value to the Drive. It does not store the change in the Drive's internal E^2PROM memory.

8.8 Storing Drive Parameters using the EDS File

Unidrive

To store the Drive parameters in the E^2PROM memory, select the "**DeviceNet Config**" from the "**Parameter Group**" list box. Select "**Parameter #MM.00**", set a value of 1000, and "**Save to Device**". Click on "**OK**".

To store the Drive parameters from #01,xx to #19.xx, select "**Drive Reset**" and select the "**Drive Reset**" button. Select "**Save to Device**", and then click on "**OK**". The Drive parameters have now been stored.

To store UD70 parameters #20.xx, #70.xx and #71.xx, select "**UD70 and UD77 Reset**" and select the "**UD70 and UD77 Reset**" button. Select "**Save to Device**", and then click on "**OK**". UD70 non-volatile parameters have now been stored, and the UD70 and UD77 reset.

NOTE:

If the Drive is tripped, the connection to the UD77 may be lost for a few seconds as the UD70 is re-initialised.

Mentor II

To store the Drive parameters in the E^2PROM memory, select the "**DeviceNet Config**" from the "**Parameter Group**" list box. Select "**Parameter #MM.00**", set a value of 1, and "**Save to Device**". Click on "**OK**".

To store the Drive parameters from #01,xx to #16.xx, select "**Drive Reset**" and select the "**Drive Reset**" button. Select "**Save to Device**", and then click on "**OK**". The Drive parameters have now been stored.

9 Diagnostics

9.1 Option Module Code (Unidrive Only)

The identification of the high speed communications option module can be read from #89.01. An integer number will be read back from this parameter.

DeviceNet ID Code = 40.

9.2 Firmware Version

The firmware inside the DeviceNet module controls the information transfer between the UD70 or MD25 and the DeviceNet network. It is strongly advisable to note down what version of firmware is fitted to the DeviceNet interface(s) when contacting Control Techniques for technical support.

Unidrive

The firmware version number installed in the option module can be read from #89.02. The integer value returned by #89.02 should be converted to a hexadecimal value, and this value is in the form xyz. The version number is now in the form Vx.yz.

Example:

If #89.02 = 514, the hex value will be 202, so the firmware version will be V2.02.

Mentor II

The firmware installed on the MD25 can be read from #11.16 in the Mentor II. An integer value will read from the display.

Example:

If a value of 201 is read, the firmware version is V2.01.

9.3 Number of Network Cycles (Unidrive Only)

#20.50 is continuously incremented as data is transferred between the UD70 and UD77. This parameter can be used to monitor the network activity within a DPL program, and rate of change of #20.50 is linked to the scan rate by the following equation:

D#20.50/sec = 3000/interscan in ms

This provides an alternative to using the network connection loss trip, enabled using #20.11. #20.11 trips the Drive instantly, but a DPL program could monitor the state of the network, and bring the Drive to a controlled stop before tripping the Drive.

The following example code shows how to monitor the network from within the DPL program, and trip the Drive when the DeviceNet network is lost.

```
CLOCK {
new_cycles% = #20.50
IF new _cycles% - old_cycles% = 0 THEN #10.38 = 62
old_cycles% = new_cycles%
}
```

9.4 Message Timing

CAN nets are very fast and efficient , but this efficiency starts to drop off rapidly if the network loading exceeds 35%. Low priority nodes have to wait their turn to win arbitration for the bus, and if hi-priority nodes re-arbitratefor the bus too quickly, the low priority nodes may never transmit their messages. The network loading must be considered before the interscan delay period is chosen.

If a 6 byte polled data connection is established between the scanner and a node, it will take approximately 200ms to transmit the message at 500 Kbits/sec. The return message will be of similar length, so 400ms is required to complete the data transfer. However, CAN networks should be kept around 35% loading maximum, so the actual time allowed for a single node message should be 400ms / 0.35 = 1.15ms.

In general, the interscan delay time chosen for a 500 Kbits/sec can be calculated approximately as:

Interscan Delay (in ms) = 1.2 * number of nodes.

If a different data rate is used, the interscan delay period can be scaled accordingly.

Cyclic messages are transmitted at a very low rate compared to polled data messages. 50ms is the minimum heartbeat rate that can be set. Cyclic messages also have lower priority than polled data messages so provided the heartbeat period is significantly higher than the interscan delay period, cyclic data will have negligible effect on the network loading, and will not unduly interfere with polled data transmissions.

9.5 Connection Timeout

A connection timeout occurs if polled or cyclic data is not seen from the network for 4 successive interscan or heartbeat periods. If the trip-enable parameter is set (#20.11 = 1 on Unidrive, #14.06 = 1 on Mentor II) the drive will trip, and produce a trip code of 62.

9.6 Bus Off Interrupt

A Bus Off Interrupt error will be generated if a node develops a fault while transmitting, and does not see the transmitted data on the CAN-H and CAN-L lines being returned to the receive port. This error will automatically trip the Drive with an error code will be 60.

Bus Off is a lock-out condition, and requires a manual reset to re-establish connections to the Drive. On Unidrive press the red RESET button on the keypad to reset the UD77 DeviceNet interface. On Mentor II, use the RESET button on the MD25 to restart the DeviceNet interface. Alternatively, powering down the Drives will cause a complete node reset. Bus Off errors cannot be reset over the DeviceNet network.

9.7 General errors

A general error may be occur if the scaling parameters in the drive are set to zero. This will cause a divide by zero in the firmware, hence it is flagged as an error. The trip code generated will be 61. This is not a lock-out condition, and resetting the drive will allow the network to function correctly. However, pre-defined DeviceNet attributes that return speed in rpm, particularly on Mentor II, may not return valid data. Check #3.16 in the Mentor II is not set to 0.

10 DeviceNet Messaging

The UD77 and MD25 support the Drives profile from the Open DeviceNet Vendors Association (ODVA). The supported device profiles are:

Device	Profile	Device Type	
UD77	AC Drives	2	0x02
MD25	DC Drives	19	0x13

10.1 Object Model

The Object Model used to represent an AC or DC Drive has the following object classes present.

Object Class	Class Code		No of Instances	Effect on behaviour
Identity	1	0x01	1	Supports the device reset service
Message Router	2	0x02	1	Internally routes messages
DeviceNet	3	0x03	1	Configures device attributes
Assembly	4	0x04	10	Defines I/O data format, i.e. parameter mapping
Connection	5	0x05	3	Logical ports in to or out of the Drive
Parameter Group	16	0x10	3	Provides an interface to the AC/DC Drive, Motor Data and Control Supervisor Objects
Motor Data	40	0x28	1	Defines the motor data
Control Supervisor	41	0x29	1	Manages Drive functions, operational states and control
AC/DC Drive	42	0x2A	1	Provides Drive configuration
Control Techniques Group	100	0x64	20 (UD77) 18 (MD25)	Provides an interface to all Drive parameters

10.2 Identity Object Definition

Class code: 1 0x01

The identity object provides device identification information, along with general device information. All attributes are instance 1.

Attribute ID	Access	Name	Data Type	Unidrive	Mentor II
1	RO	Vendor ID	Word	257	257
2	RO	Device Type	Word	2	19
3	RO	Product Code	Word	See below	See below
4	RO	Revision	Word	See below	See below
5	RO	Status	Word	See below	See below
6	RO	Serial Number	Double Word	See below	See below
7	RO	Product Name	Short String	UD77	MD25

The following services are supported:

Service Code	Class	Instance	Service Name
05 (0x05)	No	Yes	Reset
16 (0x10)	No	Yes	Set_Attribute_Single
14 (0x0E)	Yes	Yes	Get_Attribute_Single

Vendor ID

Instance 1 Attribute 1 RO

The Vendor ID is a unique code assigned to each manufacturer of DeviceNet-compatible equipment by the Open DeviceNet Vendors Association. The code for Control Techniques is 257.

Device Type

Instance 1 Attribute 2 RO

The Device Type code indicates which group the product falls under. The UD77 for Unidrive comes under Group 2, “AC Drives”, while the MD25 for Mentor II comes under Group 19, “DC Drives”.

Product Code

Instance 1 Attribute 3 RO

The product code for Unidrive depends on the mode of the Drive. A parameter for product code elaboration is also provided to allow the use of advanced EDS files if required. The product code for Mentor II is derived from the software version fitted to the Drive.

Drive	Returned Value
Unidrive	(32 * (#11.31 + 1)) + #20.12
Mentor II	#11.15 Mod 100

Revision

Instance 1 Attribute 4 RO

The revision code is the combination of the major and minor revision codes, where the major revision code is the low byte, and the minor revision code is the high byte.

Drive	Major Revision	Minor Revision
Unidrive	#11.29 / 100	#11.29 Mod 100
Mentor II	#11.15 / 100	#11.15 Mod 100

Status

Instance 1 Attribute 5 RO

b15	b14	b13	b12	b11	b10	b9	b8
				Major fault (U)	Major fault (R)	Minor fault (U)	Minor fault (R)

b7	b6	b5	b4	b3	b2	b1	b0
					Configured		Owned

R - Recoverable fault

U - Unrecoverable fault

Serial Number

Instance 1 Attribute 6 RO

All Control Techniques DeviceNet interfaces have a unique serial number stored in the non-volatile memory.

Product Name

Instance 1 Attribute 7 RO

The product name is a text string, with UD77 returning "Unidrive DeviceNet Interface", and MD25 returning "Mentor II DeviceNet Interface". This attribute is not accessible using DeviceNet Manager.

10.3 DeviceNet

Class code: 3 0x03

The DeviceNet Object provides the configuration and status of the DeviceNet interface. Network settings for each node, such as the MAC-ID and the data rate can be configured either from the Drive keypad or by using the DeviceNet Manager via the DeviceNet network. All attributes are instance 1.

Attribute ID	Access	Name	Data Type
1	R/W	MAC-ID	Byte
2	R/W	Baud Rate	Byte
3	R/W	Bus Off Interrupt	Byte
4	R/W	Bus Off Counter	Byte
5	RO	Allocation Byte	Byte

The following services are supported:

Service Code	Class	Instance	Service Name
16 (0x10)	No	Yes	Set_Attribute_Single
14 (0x0E)	Yes	Yes	Get_Attribute_Single
75 (0x4B)	No	Yes	Allocate Master/Slave
76 (0x4C)	No	Yes	Release Master/Slave

MAC-ID

Instance 1 Attribute 1 R/W Range: 0 to 63 Type: Byte

Returns the current MAC-ID being used by the node. Valid range is from 0 to 63.

Data Rate

Instance 1 Attribute 2 R/W Range: 0 or 2 Type: Byte

Returns the current data rate set in the node. Valid range is 0 = 125K, 1 = 250K, 2 = 500K.

Bus Off Interrupt

Instance 1 Attribute 3 R/W Range: 0 or 1 Type:: Byte

Bus Off Interrupt (BOI) determines the action if the Bus Off state is encountered. The following values are supported (default value = 0)

Value	Action
0	CAN chip is not reset. Manual reset of the device is required.
1	Device attempts to reset itself. After 10 attempts, an error is raised, and a manual reset is required.

Bus Off Counter

Instance 1 Attribute 4 R/W Range: 0 to 255 Type: Byte

The Bus Off counter counts the number of times the CAN chip went to the "bus off" state. The counter has values of 0 to 255 decimal. The "bus off" counter is reset to zero whenever set regardless of the data value written. The Bus–off Counter is initialised to zero at power–up or device initialisation.

The transmission of a Set_Attribute_Single request to the Bus–off Counter is all that's required to reset the counter.

Allocation Byte

Instance 1 Attribute 5 RO Type: Byte

b7	b6	b5	b4	b3	b2	b1	b0
Reserved	Ack. Suppress.	Cyclic	Change of State	Reserved	Strobed	Polled	Explicit Message

Any bit set to 1 indicates that a request is being made to allocate that particular connection.

10.4 Control Supervisor

Class code: 41 0x29

Manages Drive functions such as start/stop and operational states. All attributes are instance 1.

Attribute ID	Access	Name	Data Type
3	R/W	RunFwd	Byte
4	R/W	RunRev	Byte
5	R/W	NetCtrl	Byte
7	RO	RunningFwd	Byte
8	RO	RunningRev	Byte
9	RO	Ready	Byte
10	RO	Faulted	Byte
12	WO	FaultRst	Byte
13	RO	FaultCode	Word
100	R/W	OutputAssembly	Byte
101	R/W	InputAssembly	Byte
102	R/W	DriveEnable	Byte
103	R/W	ZeroParam	
104	R/W	CyclicAssembly	

The following services are supported:

Service Code	Class	Instance	Service Name
16 (0x10)	No	Yes	Set_Attribute_Single
14 (0x0E)	Yes	Yes	Get_Attribute_Single

RunFwd

Instance 1 Attribute 3 R/W Range: 0 or 1 Type: Byte

Set to 1 to start the Drive, and run forwards. Wire-proof PLC sequencing mode (#6.04 = 4) must be selected on the Unidrive.

Drive	Read	Write (0)	Write (1)
Unidrive	#6.30	Control Word = 0x1C00	Control Word = 0x1C02
Mentor II	#8.34	#8.34 = 0	#8.34 = 1

RunRev

Instance 1 Attribute 4 R/W Range: 0 or 1 Type: Byte

Set to 1 to start the Drive, and run in reverse. Wire-proof PLC sequencing mode (#6.04 = 4) must be selected on the Unidrive.

Drive	Read	Write (0)	Write (1)
Unidrive	#6.32	Control Word = 0x1C00	Control Word = 0x1C08
Mentor II	#8.33	#8.33 = 0	#8.33 = 1

NetCtrl

Instance 1 Attribute 5 R/W Range: 0 to 1 Type: Byte

This attribute writes to #18.31 in the Unidrive. If the control word is being written to using a polled data connection, this parameter will be over-written by bit 7 in the control word.

Drive	Read	Write (0)	Write (1)
Unidrive	#18.31	#18.31 = 0	#18.31 = 1
Mentor II	Not Implemented		

NOTE:

The behaviour must be implemented by the user in DPL on the UD70. DeviceNet simply writes to application parameter #18.31.

RunningFwd

Instance 1 Attribute 7 RO Type: Byte

Read only attribute that indicates that the motor is running forwards when set to 1.

Drive	Read
Unidrive	(#90.11 & 0x2002)==0x2000
Mentor II	#10.01

RunningRev

Instance 1 Attribute 8 RO Type: Byte

Read only attribute that indicates that the motor is running in reverse when set to 1.

Drive	Read
Unidrive	(#90.11 & 0x2002)==0x2002
Mentor II	#10.02

Ready

Instance 1 Attribute 9 RO Type: Byte

Read only attribute that indicates that the Drive is enabled and ready to run.

Drive	Read
Unidrive	#6.15
Mentor II	#8.01

Faulted

Instance 1 Attribute 10 RO Type: Byte

Read only attribute that indicates that the Drive tripped when set to 1. Note that this is the opposite to Drive parameters #10.01 and #10.12, where 1 indicates "Drive healthy".

Drive	Read
Unidrive	!#10.01
Mentor II	!#10.12

FaultRst

Instance 1 Attribute 12 WO Type: Byte

Set to 1 to reset a Drive from a tripped condition. Note that with Unidrive, this will cause a complete reset of the DeviceNet interface.

Drive	Write (1)
Unidrive	#10.38 = 100
Mentor II	#10.35 = 255

FaultCode

Instance 1   Attribute 13   RO   Type: Word

Returns a fault code number, indicating the reason why the Drive tripped. Refer to the Unidrive or Mentor II User's Guides for a full list of fault codes.

Drive	Read
Unidrive	#10.20
Mentor II	#10.25

Under normal operating conditions, the Unidrive and Mentor II will be in the "Drive Healthy" condition, indicating that the Drives are operating with no problems. This condition is indicated by a value of 1 in #10.01 on Unidrive, and #10.12 on Mentor II.

If a Drive trips for any reason, the Drive healthy bit is reset to 0, and a diagnostic code is provided to indicate the reason for the trip. This code is available from #10.20 with Unidrive, or #10.25 from Mentor II.

The table below indicates which trip codes from the Drive have pre-defined DeviceNet fault codes.

Unidrive Fault Code	ODVA Fault Code	Mentor II Fault Code	ODVA Fault Code
3	0x2300	101	0x3134
4	0x7112	103	0x5112
5	0x5100	106	0x3330
10	0x7305	107	0x4310
21	0x4300	109	0x7302
23	0x4110	110	0x7300
26	0x5112	119	0x7301
32	0x3120	120	0x3100
		121	0x2300
		124	0x1000
		125	0x5110
		126	0x3321
		131	0x6200

If the Drive trip code is not on the above list, the ODVA code (0x1000 + Drive trip code) will be returned.

OutputAssembly

Instance 1 Attribute 100 R/W Type: Byte

The output assembly selected determines the format of the data that is transferred from the scanner to the Drive. Four pre-defined DeviceNet output assemblies are supported, and a Control Techniques output assembly is also provided.

Value	Description
20	Basic Speed Control
21	Extended Speed Control
22	Basic Speed and Torque Control
23	Extended Speed and Torque Control
107	User Defined

20 - Basic Speed Control

Byte	b7	b6	b5	b4	b3	b2	b1	b0
Byte 0						Fault Reset		Run Forward
Byte 1								
Byte 2	Speed Reference (Low byte)							
Byte 3	Speed Reference (High byte)							

21 - Extended Speed Control

Byte	b7	b6	b5	b4	b3	b2	b1	b0
Byte 0		Net Ref	Net Ctrl			Fault Reset	Run Reverse	Run Forward
Byte 1								
Byte 2	Speed Reference (Low byte)							
Byte 3	Speed Reference (High byte)							

22 - Basic Speed and Torque Control

Byte	b7	b6	b5	b4	b3	b2	b1	b0
Byte 0						Fault Reset		Run Forward
Byte 1								
Byte 2	Speed Reference (Low byte)							
Byte 3	Speed Reference (High byte)							
Byte 4	Torque Reference (Low byte)							
Byte 5	Torque Reference (High byte)							

23 - Extended Speed and Torque Control

Byte	b7	b6	b5	b4	b3	b2	b1	b0
Byte 0		Net Ref	Net Ctrl			Fault Reset	Run Reverse	Run Forward
Byte 1								
Byte 2	Speed Reference (Low byte)							
Byte 3	Speed Reference (High byte)							
Byte 4	Torque Reference (Low byte)							
Byte 5	Torque Reference (High byte)							

Input Assembly

Instance 1 Attribute 101 R/W Type: Byte

The input assembly selected determines the format of the data that is transferred from the Drive to the PLC. Two pre-defined DeviceNet input assemblies are supported, and a Control Techniques input assembly is also provided.

70 - Basic Speed Control

Byte	b7	b6	b5	b4	b3	b2	b1	b0
Byte 0						Fault Reset		Run Forward
Byte 1								
Byte 2	Speed Feedback (Low byte)							
Byte 3	Speed Feedback (High byte)							

72 - Basic Speed and Torque Control

Byte	b7	b6	b5	b4	b3	b2	b1	b0
Byte 0		Net Ref	Net Ctrl			Fault Reset	Run Reverse	Run Forward
Byte 1								
Byte 2	Speed Feedback (Low byte)							
Byte 3	Speed Feedback (High byte)							
Byte 4	Torque Feedback (Low byte)							
Byte 5	Torque Feedback (High byte)							

DriveEnable

Instance 1   Attribute 102   R/W   Type: Byte

Drive	Read	Write (0)	Write (1)
Unidrive	#6.15	#6.15 = 0	#6.15 = 1
Mentor II	#1.11	#1.11 = 0	#1.11 = 1

ZeroParam

Instance 1   Attribute 103   R/W   Type: Byte

Drive	Read	Write
Unidrive	#0.00	#0.00
Mentor II	#0.00	#0.00

CyclicAssembly

Instance 1   Attribute 104   R/W   Type: Byte

See Attribute 101, Input Assembly.

10.5 AC/DC Drive Object

Class code: 42 0x2A

Models the Drive specific functions, e.g. ramp times, torque control. The pre-defined attributes listed in the table below are supported. All attributes are instance 1.

Attribute ID	Access	Name	Data Type
3	RO	AtReference	Byte
4	R/W	NetRef	Byte
6	R/W	DriveMode	Byte
7	RO	SpeedActual	Word
8	R/W	SpeedRef	Word
11	RO	TorqueActual	Word
12	R/W	TorqueRef (6)	Word

The following services are supported:

Service Code	Class	Instance	Service Name
16 (0x10)	No	Yes	Set_Attribute_Single
14 (0x0E)	Yes	Yes	Get_Attribute_Single

AtReference

Instance 1 Attribute 3 RO Type: Byte

When set to 1, this attribute indicates that the motor is running at the demanded speed.

Drive	Read
Unidrive	#10.06
Mentor II	#10.07

NetRef

Instance 1 Attribute 4 R/W Type: Byte

This attribute selects the source of the speed reference for the Drive. The source can only be changed when the Unidrive or Mentor II is configured in speed control mode.

Drive	Local Reference	Network Reference
Unidrive	NetRef = 0 Local reference provided by analogue reference 1. (#1.14=1)	NetRef = 1 Network reference provided by digital speed reference #1.21. (#1.14 = 3)
Mentor II	NetRef = 0 Local reference provided by digital speed reference 1, #1.17. (#1.14 = 0, #1.15 = 0)	NetRef = 1 Network reference provided by digital speed reference 2, #1.18. (#1.14 = 1, #1.15 = 0)

DriveMode

Instance 1 Attribute 6 RO Type: Byte

The table below lists the modes supported by Unidrive, the Unidrive allows operation in both open loop and closed loop mode using both speed control and torque control. It is not possible to dynamically switch between open loop mode and closed loop mode using DeviceNet, i.e. #11.31 cannot be changed and must be considered as a read-only parameter. If requested a 'Device state conflict' error code 10h should be issued.

Unidrive

DriveMode	Drive Control Mode	Parameter settings
1	Open Loop Speed	#11.31 = 0 AND #4.11 = 0
2	Closed Loop Speed	(#11.31 =1 OR #11.31 = 2) AND #4.11 = 0
3	Torque Control	#4.11 = 0 (#11.31 = X)

Mentor II

DriveMode	Drive Control Mode	Parameter settings
2	Speed Control	#4.12 = 0 AND #4.13 = 0
3	Torque Control with Speed Override	#4.12 = 0 AND #4.13 = 1

SpeedActual

Instance 1 Attribute 7 RO Type: Word

The attribute returns the actual speed of the motor in rpm.

Drive	Read
Unidrive (Open Loop)	#2.01 * 6 / (#5.11+1)
Unidrive (Closed Loop or Servo)	#3.02
Mentor II	#3.03

Note:

For Mentor II, it is assumed that parameter #3.16 has been set up correctly.

SpeedRef

Instance 1 Attribute 8 R/W Type: Word

This attribute provides the speed reference for the Drive, when network reference is selected.

Drive	Read	Write
Unidrive (Open Loop)	rpm = #2.01 * 6 / (#5.11+1)	#1.21 = rpm * (#5.11 + 1) / 6
Unidrive (Closed Loop or Servo)	#3.02	#1.21
Mentor II	rpm = #1.18 * #3.16 / 32000	#1.18 = rpm * 32000 / #3.16

NOTE:

On Mentor II, #3.16 must be set correctly before using this service.

TorqueActual

Instance 1 Attribute 11 RO Type: Word

Returns the motor current being supplied by the Drive.

Drive	Read
Unidrive	#4.02
Mentor II	#5.02

TorqueRef

Instance 1 Attribute 12 R/W Type: Word

Provides the torque reference for the Drive when running in torque control mode. No scaling is applied to #4.08.

Drive	Read	Write
Unidrive	#4.08	#4.08
Mentor II	#4.08	#4.08

10.6 Motor Data Object

Class code: 40 0x28

Serves as a database for the motor parameters. All attributes are instance 1.

Attribute ID	Access	Name	Data Type
3	Set/Get	MotorType	Byte
6	Set/Get	RatedCurrent	Word
7	Set/Get	RatedVoltage	Word

The following services are supported:

Service Code	Class	Instance	Service Name
16 (0x10)	No	Yes	Set_Attribute_Single
14 (0x0E)	Yes	Yes	Get_Attribute_Single

MotorType

Instance 1 Attribute 3 R/W Type: Byte

Defines which types of motor are supported by Unidrive and Mentor II.

Drive	Motor Types Supported
Unidrive Open and Closed Loop	6 - Wound Rotor Induction Motor 7 - Squirrel Cage Induction Motor
Unidrive Servo	9 - Sinusoidal permanent magnet BL Motor 10 - Trapezoidal permanent magnet BL Motor
Mentor II	1 - PM DC Motor 2 - FC DC Motor

RatedCurrent (Unidrive only)

Instance 1 Attribute 6 R/W Type: Word

This attribute specifies or returns the rated current (in amps) for the motor, to an accuracy of 1 decimal place. On size 1 and 2 Unidrive, the second decimal place of current is not accessible via DeviceNet. On size 5 Unidrive, the decimal place is not available inside the Drive, but it must be specified over DeviceNet.

Unidrive #5.07

RatedCurrent (Mentor II only)

Instance 1 Attribute 6 RO Type: Word

This attribute returns the rated current (in amps) for the motor, to an accuracy of 1 decimal place. NOTE: ensure #5.05 and #5.16 are set correctly, and reset the MD25.

#5.16	Current (A * 10)
0	#4.03 * #5.05 / 1600
1	#4.03 * #5.05 / 1600
2	#4.03 * #5.05 / 160

RatedVoltage

Instance 1 Attribute 7 R/W Type: Word

This attribute specifies the rated voltage for the motor.

Drive	Read	Write
Unidrive	#5.09	#5.09
Mentor II	#3.15	#3.15

10.7 Static Assembly Object

Class code: 4 0x04

An assembly object is used to group attributes of other objects together to allow more than one attribute to be sent/received using a single connection. The following standard assembly object instances are to be supported.

Instance	Type	Instance Name
20	Output	Basic Speed Control Output
21	Output	Extended Speed Control Output
22	Output	Speed and Torque Control Output
23	Output	Extended Speed and Torque Control Output
70	Input	Basic Speed Control Input
72	Input	Speed and Torque Control Input
106	Input	Control Techniques Input Assembly Object
107	Output	Control Techniques Output Assembly Object

10.8 Control Techniques Object

Class Code: 100 0x64

This application specific object provides a means to access all parameters within a Control Techniques Drive. Each of the Drive menus is modelled as an instance within this object, each parameter is an attribute of that instance.

When using an explicit connection, each Drive parameter should be accessed as a 16 bit integer, except for menus 70 to 73 on Unidrive. These UD70 internal parameters are 32 bit signed parameters, and will accept or return 4 byte (32 bit) data values.

The table below indicates the number of instances supported and also the number of attributes within each instance.

Instance	Menu	Group Name	Number of Attributes
1	1	Speed Reference	50
2	2	Speed Ramps	41
3	3	Speed Control	30
4	4	Current Control	20
5	5	Motor Control	33
6	6	Sequencing	38
7	7	Analogue I/O	32
8	8	Digital I/O	28
9	9	Logic	33
10	10	Drive Status	42
11	11	Drive Set-up	35
12	12	Programmable Thresholds	17
13	13	Position Control	19
14	14	Process PID Loop	18
15	15	Regen Control	18
16	16	Small Option Module	41
17	17	Large Option Module Set-up	28
18	18	User Menu 1	50
19	19	User Menu 2	50
20	20	Large Option Module	50
70	70	Application Menu	100
71	71	Application Menu	100
72	72	Application Menu	100
73	73	Application Menu	100

Instance	Menu	Group Name	Number of Attributes
1	1	Speed Reference	20
2	2	Speed Ramps	19
3	3	Speed Control	27
4	4	Current Limits	25
5	5	Current Control	26
6	6	Field Control	22
7	7	Analogue I/O	28
8	8	Logic Outputs	34
9	9	Digital I/O	26
10	10	Status Logic	36
11	11	Miscellaneous	24
12	12	Programmable Thresholds	12
13	13	Digital Lock	14
14	14	DeviceNet Configuration	18
15	15	Applications Menu 1	40
16	16	Applications Menu 2	36

If an attempt to access a Drive parameter using this object fails, the codes in the table below will indicate the reason for the failure.

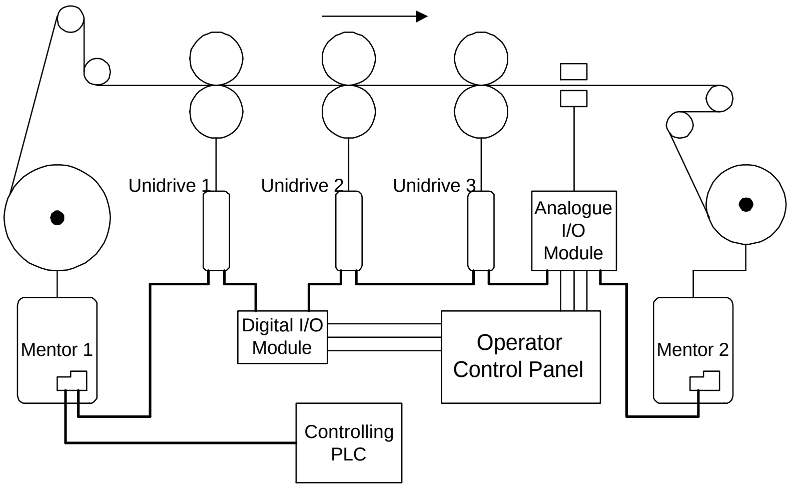
DeviceNet Error Message	DeviceNet Error Code	Reason
Attribute not supported	0x14	Parameter does not exist.
Attribute not settable	0x0E	Parameter is read only.
Attribute not settable	0x0E	Parameter is write only.
Invalid attribute value	0x09	Parameter value out of range.

11 Example Application

11.1 System Overview

Consider a drawing process as shown below. The material is unwound under constant tension, and passed between 3 sets of grip rolls. The material is "drawn" to the required thickness by introducing a ratio between each set of grip rolls. The machine operator has a control panel next to the machine, while the controlling PLC is located some 100m in a another building.

A typical control system is shown, consisting of 2 * Mentor II Drives with tacho feedback and MD25 cards, 3 * Unidrive with encoder feedback and UD70 with DeviceNet interfaces, 1 * digital I/O module, 1 * analogue I/O module and a controlling PLC. The operator panel connects to the digital and analogue I/O modules to both input and display information to and from the PLC. This means that there is no need to run loads of control cables back to the PLC.



Unidrive 3 is the master Drive in the system. This receives the master speed reference from the PLC, and transmits the post-ramp speed reference back to the PLC. The post-ramp speed reference is scaled, and becomes the line speed reference for the Mentor II Drives.

Unidrive 2 is running in digital lock with Unidrive 3. It uses the encoder feedback from Unidrive 3 to generate its own speed reference, and stay locked to it. The draw ratio is calculated by the PLC, and the digital lock ratio is transmitted from the PLC. Unidrive 1 is locked to Unidrive 2, and also receives a digital lock ratio from the PLC.

The Mentor II Drives are running in torque control. Since Coiler software cannot be fitted to the MD25 cards, the Mentor IIs receive only a torque reference, with the Coiler calculations being performed in the PLC itself. The torque reference is changed as diameter changes, to maintain constant tension in the material.

Machine control is implemented using the digital and analogue I/O modules. References are set using potentiometers into the analogue module, and switches into the digital I/O module, and read by the PLC. Displays are controlled in the same manner, with the PLC writing to the digital and analogue I/O modules, and the outputs being displayed using lamps and analogue meters. The draw ratio is read in from 4 thumb wheel switches in BCD format, providing an accuracy of 4 decimal places.

Node	Device	Function
1	Mentor II 1	Unwind Drive, running in Coiler mode torque control.
2	Unidrive 1	Slave Drive running in digital lock with Unidrive 2. Digital lock ratio is passed over network.
3	Digital I/O	Digital inputs to read status of operator panel switches. Outputs are used to control status lamps and displays on operator panel.
4	Unidrive 2	Slave Drive running in digital lock with Unidrive 3 (Master Drive). Digital lock ratio is passed over network.
5	Unidrive 3	Master Drive, running in speed control. Post-ramp reference is used as the line speed reference.
6	Analogue I/O	Analogue inputs to read the material depth transducer feedback signal, line speed, unwind and rewind tension references. Outputs control analogue meters on the operator panel.
7	Mentor II 2	Rewind Drive, running in Coiler mode torque control.

11.2 Input Polled Data

To specify the network requirements, it is necessary to analyse each node, and identify the time critical data for each node. Data channels can then be assigned for each node. This will determine the requirements of the network, and the maximum theoretical performance.

Node	Device	Channel 1	Channel 2	Channel 3	
1	Mentor II 1	Status word	Motor speed	Current feedback	
2	Unidrive 1	Status word	Motor speed	Active current	
3	Digital I/O	Thumb wheel draw ratio	Control panel status		
4	Unidrive 2	Status word	Motor speed	Active current	
5	Unidrive 3	Status word	Line speed reference	Active current	
6	Mentor II 2	Status word	Motor speed	Current feedback	
7	Analogue I/O	Master line speed reference	Material thickness	Unwind tension reference	Rewind tension reference

The IN data words are read from each node to provide information about the actual performance of the line. The motor speed feedback from each Mentor II allows the PLC to calculate the roll diameter relative to the initial reel diameter. The PLC can then calculate the actual roll diameter, allowing the line speed to be ramped up and down automatically as required when rolls need to be replaced.

11.3 Output Polled Data

Node	Device	Channel 1	Channel 2	Channel 3	Channel 4
1	Mentor II 1	Control word	Torque reference		
2	Unidrive 1	Control word	Ratio 2	Maximum torque limit	
3	Digital I/O	Control panel display word	Control panel display word		
4	Unidrive 2	Control word	Ratio 1	Maximum torque limit	
5	Unidrive 3	Control word	Master line speed reference		
6	Mentor II 2	Control word	Torque reference		
7	Analogue I/O	Material depth display	Scaled line speed	Scaled material unwind tension	Scaled material rewind tension

The control words are written to each Drive, thus making it a fully remote controlled system. For safety reasons, the ENABLE terminal on all Drives would have to be hard-wired into an emergency stop circuit. This would ensure that all Drives are disabled instantly if the emergency stop is pressed.

11.4 Network Set-up

The Control Techniques Input and Output objects will be used to utilise the control and status words, so 3 data words are required for each node.

Node	OUT words	IN words	Configuration (inc. message word)
Mentor II 1	2	3	3
Unidrive 1	3	3	3
Digital I/O	2	2	2
Unidrive 2	3	3	3
Unidrive 3	2	3	3
Mentor II 2	2	3	3
Analogue I/O	4	4	4

11.5 Digital I/O

The digital I/O module has 32 inputs and 32 outputs. Utilisation is as follows:

- 4 * 4 inputs draw ratio 1 in BCD format. Provides the overall draw ratio of 0.xxxx.
- 16 inputs inputs for run, jog, enable and emergency stop signals.

The digital outputs are used to control display indication lamps, etc. on the operator's control panel.

11.6 Analogue I/O

The analogue I/O module has 4 input and 4 outputs. Utilisation is as follows:

- 1 input feedback from material thickness transducer
- 1 input master line speed reference
- 2 inputs material tension references for unwind and rewind sections

The analogue outputs are scaled by the PLC to produce real unit readings on analogue meters.

- 1 output material thickness, displayed in mm.
- 1 output actual line speed, displayed in metres/minute.
- 2 outputs material tension, displayed in Newtons.

11.7 Network Timing

If the network is to operate at 500 Kbits/sec with maximum of 33% network loading, then the minimum interscan delay for the Drives alone will be:

Interscan Delay (ms) = 1.2ms * 5 nodes = 6 ms

The analogue and digital I/O blocks will also require a polled data connection. As the digital I/O requires 2 data words and the analogue I/O required 4 data words, they can be considered as 3 words each for network timing purposes.

Hence, Interscan Delay (ms) = 1.2ms * 7 nodes = 8.4 ms

A suitable setting for the interscan delay time would be 10ms.

12 Advanced EDS Files

12.1 Compiling Advanced EDS Files

Run the DEVNET.EXE application program, and compile the required EDS files. Note that the application will indicate the required setting for #20.12 for DeviceNet Manager to use the advanced file. Make a note of where these files are stored on the disk.

Install the EDS files into DeviceNet Manager using the "**INSTALL EDS FILES**" option from the "**UTILITIES**" menu. Advanced EDS files for V4.10.00 or V5.01.00 software for Mentor II will over-write any generic files that have previously been installed.

NOTE:

If a set of advanced EDS files are generated for a particular network, it is strongly advised that this set of files is also stored on a separate floppy disk Drive. If a different PC is used in future to link up to the network, which does not have the necessary files installed, they can be installed easily from the master floppy disk.

12.2 Configuring the Drive

Advanced EDS files are used by setting #20.12 to the appropriate value. A value of 0 in #20.12 means that the generic EDS files will be used. If advanced EDS files are required, this parameter should ideally be set before network configuration begins.

The setting for #20.12 depends on the type of small option module fitted to the Drive, and the software version installed in the Drive.

Codes for the type of small option module fitted to the Drive are given below.

Small Option Module	SOM Code
None Fitted	1
Expanded I/O	2
Second Encoder	3
Resolver	4
SinCos Encoder	5

Software Version codes are as follows:

Unidrive Software Version	Major Revision Code	Software Version Code
V2.03.XX	2	0
V2.06.XX	2	1
V2.10.XX	2	2
V3.00.XX	3	0

The equation for #20.12 is given below. The Advanced EDS File Configuration Code will indicate the required setting for #20.12 when the EDS file is compiled.

Product Elaboration Code = (Software Version Code * 8) + SOM Code

Set #20.12 as indicated. Set #17.19 to 1 to store the menu 20 parameters, and switch off the Drive.

12.3 Configuring the Scanner

If the modified node or nodes were previously listed in the scan list for the scanner, their records must be deleted form the scan list. Remove all relevant scan list records from the scanner, and save the modified list.

NOTE:

It is NOT sufficient to simply modify each record, as the node will now have a different product code, and will not match the product code in the scanner. The scanner will be not be able to open any communications connections with the node.

Re-apply power to all nodes, and perform a full "**On-line Build**". Check that modified nodes find the correct icon, and the description for each node is correct.

Re-configure the data connections to the scanner, re-map the data words to the PLC, and download the new records to the scanner.

12.4 Installing Advanced EDS File Compiler

The Advanced EDS File Compiler is only available on V3.3b CD-ROMs and later.

Using the DPL Toolkit CD-ROM

The CD-ROM will auto-run when inserted into the CD-ROM Drive, and a menu of available applications on the CD-ROM will be displayed. Select the required option from the menu displayed.

If an installation disk is created, run SETUP.EXE and follow the instructions to install the program onto the hard disk of a PC.

Download from the CT Web Site

When an update is downloaded from a web site, it will be in the form of an EXE file. Copy this file to an empty directory on your hard disk. When the file is executed, it will self-extract all the required files for the Advanced EDS File Compiler to the current directory.

To create an installation disk, copy all files (except the downloaded EXE file) to a clean floppy disk. Run SETUP.EXE to install or re-install the program.

To install the program, run SETUP.EXE, and follow the instructions. If a previous version has already been installed, SETUP.EXE can install the new version over the top of the old version. This will not affect any existing custom EDS files that may have already been created.

12.5 Using the Advanced EDS File Compiler

Select "Contents" from the "Help" menu to refer to the help file supplied with the Advanced EDS Files Compiler.

13 Remote Network Configuration

13.1 Using On-Board E2PROM Memory

The UD77 and MD25 both have on-board E^2PROM memory, which stores the DeviceNet parameters. MAC-ID and Data Rate are also stored in this memory, but the stored values are over-written by the Drive parameters. If an invalid value is found in the relevant Drive parameter, the interface will resort to the value in the E^2PROM memory.

To use the node address or data rate setting stored in the E^2PROM memory, set the node address or data rate parameter (#20.05 or #20.08 on Unidrive, #14.01 or #14.02 on Mentor II.) to 64, store the parameters, and cycle the power to the Drive.

Function	Class	Instance	Attribute	Range
Node Address or MAC-ID	3	1	1	0 to 63
Data Rate	3	1	2	0 = 125 Kbits/sec 1 = 250 Kbits/sec 2 = 500 Kbits/sec

14 Quick Reference

14.1 Set-up and Mapping Parameters

Function	Unidrive (Default)	Mentor II (Default)
Node Address (MAC-ID)	#20.05	#14.01
Data Rate	#20.08	#14.02
Network Loss Trip Enable	#20.11	#14.06
Node Status	#20.09	#14.03
Network Status	#20.10	#14.04
IN Word 1 Mapping	#20.07 (Status Word)	#11.01 (Status Word)
IN Word 2 Mapping	#20.03 (#2.01)	#11.02 (#3.02)
IN Word 3 Mapping	#20.04 (#4.02)	#11.03 (#5.01)
OUT Word 1 Mapping	#20.06 (Control Word)	#11.04 (Control Word)
OUT Word 2 Mapping	#20.01 (#1.21)	#11.05 (#1.18)
OUT Word 3 Mapping	#20.02 (#4.08)	#11.06 (#4.08)
Product Code Elaboration	#20.12	

14.2 General Drive Functions

Action	Unidrive	Mentor II
Activate mapping changes	Set #MM.00 to 1070 and press the RESET button	Press the RESET button when the Drive is disabled
Save and activate mapping changes	Set #17.19 to 1	Set #MM.00 to 1 and press RESET
Remote Drive reset	Set #10.38 to 100	Set bit 11 of the control word to 1

14.3 Control Words

	Unidrive - UD77		Mentor II - MD25	
Bit	**Parameter**	**Description**	**Parameter**	**Description**
0	#6.15	Drive enable	#4.10	Current limit selector
1	#6.30	Sequencing bit 0	#1.11	Reference ON
2	#6.31	Sequencing bit 1	#1.12	Reverse selector
3	#6.32	Sequencing bit 2	#1.13	Inch selector
4	TRIP	Drive Trip (tr52)	#4.12	Torque Mode 0
5	#1.45	Preset select 0	#4.13	Torque Mode 1
6	#1.46	Preset select 1	#5.17	Inhibit firing
7	#18.31	Application bit	#2.02	Ramp enable
8	#18.32	Application bit	#15.21	Application bit
9	M0	Mask bit 0	#15.22	Application bit
10	M1	Mask bit 1	#15.23	Application bit
11	M2	Mask bit 2	RESET	Set to reset Drive
12	M3	Mask bit 3	#15.25	Application bit
13	#18.33	Application bit	#15.29	Application bit
14	M5	Mask bit 5	#15.31	Application bit
15	M6	Mask bit 6	VALID	VALID bit

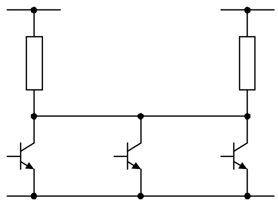
14.4 Status Words

	Unidrive - UD77		Mentor II - MD25	
Bit	**Parameter**	**Description**	**Parameter**	**Description**
0	#10.01	Drive healthy	#10.12	Drive healthy
1	#10.02	Drive running	#4.24	Taper threshold 1 exceeded
2	#10.03	Zero speed	#4.25	Taper threshold 2 exceeded
3	#10.04	Running at or below minimum speed	#10.13	I*t Alarm
4	#10.05	Below set speed	0	Not used
5	#10.06	At speed	#10.01	Forward velocity
6	#10.07	Above set speed	#10.02	Reverse Velocity
7	#10.08	Load reached	#10.03	Current limit
8	#10.09	In current limit	#10.04	Bridge 1 enabled
9	#10.10	Regenerating	#10.05	Bridge 2 enabled
10	#10.11	Dynamic brake active	0	Not used
11	#10.12	Dynamic brake alarm	#10.07	At speed
12	#10.13	Direction commanded	0	Not used
13	#10.14	Direction running	#10.09	Zero speed
14	#10.15	Mains Loss	#15.26	Application bit
15	X	Not used	ERROR	Set if there is an error on one of the cyclic channels

15 Appendix

15.1 CAN Operation

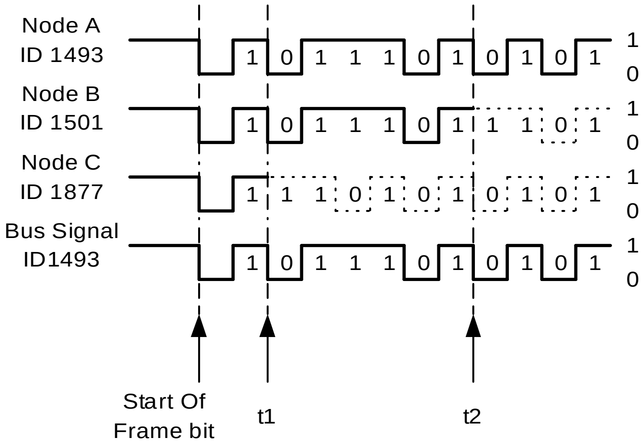
CAN (Controller Area Network) is used as the physical layer for DeviceNet. This uses two signal wires, where the differential voltage between the wires represents logic 1 or logic 0. CAN allows for "peer-to-peer" systems where each node has the ability to take control of the network and transmit data to another node. Since all nodes can transmit over the network, the system must prevent data collisions by implementing a method where only one node is allowed to take control of the bus.



With CAN-based networks, logic 0 on the network is "dominant", while logic 1 is "recessive". The "wired AND" nature of CAN means that when the bus is at logic 1, it is not actually being held at logic 1 by any particular node. Any node can therefore take the bus to logic 0, without damaging any other nodes. Hence the terms "dominant" and recessive.

Non Destructive Bit Arbitration is used to determine which node has control of the network, and therefore prevent "data collisions". (A "data collision" occurs when 2 nodes attempt to transmit, and corrupt each other's message.) Each node on the network is given a unique node address, and this assigns a Message Identifier code to the out-going message.

When a node is transmitting, it is also continuously monitoring the state of the bus. In the example below, all three nodes have messages ready to send out over the network, and are attempting to take control of the network.



After the start of frame bit, each node starts to transmit it message identifier. At time t1, node C transmits a recessive bit (logic 1).. Nodes A and B transmit dominant bits (logic 0), so the bus level goes to logic 0. Node C sees that the data it transmitted is not reflected on the bus data, and therefore other nodes have a higher message priority. It will stop transmitting, and will wait for the the next arbitration cycle before trying again.

Nodes A and B continue to transmit their message IDs, until time t2. At this point, node A goes dominant , but node B is recessive, so node B ceases transmission. After all eleven message identifier bits have been transmitted, only node A is left transmitting, and will proceed to transmit the rest of its message. As can be seen from the ID numbers, node A has the lowest number, and therefore the highest priority. At the next arbitration cycle, node A will not arbitrate for bus access, as it has no message to send. Nodes B and C will arbitrate for the bus, and node B will win, and so on.

15.2 Error Checking

CAN employs several methods of error checking in the low-level protocol.

Cyclic Redundancy Check (CRC)

The CRC safeguards the information in the frame by adding redundant check bits at the transmitting node. At the receiving node, these bits are re-calculated and tested against the received bits. If they do not agree there has been a CRC error, and the data is not passed to the Drive.

Frame Check

This mechanism verifies the structure of the transmitted frame by checking the bit fields against the fixed format and the frame size. Errors detected by frame checks are designated "format errors".

ACK Errors

Frames received are acknowledged by all recipients using positive acknowledgement. If no acknowledgement is received by the transmitter of the message (ACK error) this may mean that there is a transmission error which has been detected only by the recipients, that the ACK field has been corrupted or that there are no receivers.

The CAN protocol also implements two mechanisms for error detection at the bit level.

Monitoring

The ability of the transmitter to detect errors is based on the monitoring of bus signals: each node which transmits also observes the bus level and thus detects differences between the bit sent and the bit received. This permits reliable detection of all global errors and errors local to the transmitter.

Bit Stuffing

The coding of the individual bits is tested at bit level. The bit representation used by CAN is NRZ (non-return-to-zero) coding, which guarantees maximum efficiency in bit coding. The synchronisation edges are generated by means of bit stuffing, i.e. after five consecutive equal bits the sender inserts into the bit stream a stuff bit with the complementary value, which is removed by the receivers. The code check is limited to checking adherence to the stuffing rule.

If one or more errors are discovered by at least one station (any station) using the above mechanisms, the current transmission is aborted by sending an "error flag". This prevents other stations accepting the message and thus ensures the consistency of data throughout the network

After transmission of an erroneous message has been aborted, the sender automatically re-attempts transmission (automatic repeat request). There may again be competition for bus allocation. As a rule, re-transmission will be begin within 23 bit periods after error detection; in special cases the system recovery time is 31 bit periods.

However effective and efficient the method described may be, in the event of a defective station it might lead to all messages (including correct ones) being aborted, thus blocking the bus system if no measures for self-monitoring were taken. The CAN protocol therefore provides a mechanism for distinguishing sporadic errors from permanent errors and localising station failures (fault confinement). This is done by statistical assessment of station error situations with the aim of recognising a station's own defects and possibly entering an operating mode where the rest of the CAN network is not negatively affected. This may go as far as the station switching itself off to prevent messages erroneously recognised as incorrect from being aborted.

15.3 Data Reliability of the CAN Protocol

The introduction of safety-related systems in automobiles brought with it high requirements for the reliability of data transmission. The objective is frequently formulated as not permitting any dangerous situations for the Driver to occur as a result of data exchange throughout the whole life of a vehicle.

This goal is achieved if the reliability of the data is sufficiently high or the residual error probability is sufficiently low. In the context of bus systems data, reliability is understood as the capability to identify data corrupted by transmission faults. The residual error probability is a statistical measure of the impairment of data reliability: it specifies the probability that data will be corrupted and that this corruption will remain undetected. The residual error probability should be so small that on average no corrupted data will go undetected throughout the whole life of a system. Calculation of the residual error probability requires that the errors which occur be classified and that the whole transmission path be described by a model. If we determine the residual error probability of CAN as a function of the bit error probability for message lengths of 80 to 90 bits, for system configurations of five or ten nodes, and with an error rate of 1/1000 (an error in one message in every thousand), then maximum bit error probability is approximately 0.02, in the order of 10^{-13}. Based on this, it is possible to calculate the maximum number of undetectable errors for a given CAN network. For example, if a CAN network operates at a data rate of 1.0 Mbits/sec, at an average bus capacity utilisation of 50 percent, for a total operating life of 4000 hours and with an average message length of 50 bits, then the total number of messages transmitted is $9 * 10^{10}$. The statistical number of undetected transmission errors during the operating life is thus in the order of less than 10^{-2}. Or to put it another way, with an operating time of eight hours per day on 365 days per year and an error rate of 0.7s, one undetected error occurs every thousand years (statistical average).