



## *User Guide*

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# **CTNet**

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UD75

SM-Applications

SM-Applications Plus

MD29AN

Digitax ST

SM-Register

Part Number: 0460-0025-08

Issue Number: 8

## **General Information**

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

The contents of this guide are believed to be correct at the time of printing. In the interests of 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 content of the guide without notice.

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## **Environmental Statement**

Control Techniques is committed to minimising the environmental impacts of its manufacturing operations and of its products throughout their life cycle. To this end, we operate an Environmental Management System (EMS) which is certified to the International Standard ISO 14001. Further information on the EMS, our Environment Policy and other relevant information is available on request, or can be found at [www.greendrives.com](http://www.greendrives.com).

The electronic variable speed drives manufactured by Control Techniques have the potential to save energy and (through increased machine/process efficiency) reduce raw material consumption and scrap throughout their long working lifetime. In typical applications, these positive environmental effects far outweigh the negative impacts of product manufacture and end-of-life disposal.

Nevertheless, when the products eventually reach the end of their useful life, they must not be discarded but should instead be recycled by a specialist recycler of electronic equipment. Recyclers will find the products easy to dismantle into their major component parts for efficient recycling. Many parts snap together and can be separated without the use of tools, while other parts are secured with conventional fasteners. Virtually all parts of the product are suitable for recycling.

Product packaging is of good quality and can be re-used. Large products are packed in wooden crates, while smaller products come in strong cardboard cartons which themselves have a high-recycled fibre content. If not re-used, these containers can be recycled. Polythene, used on the protective film and bags from wrapping product, can be recycled in the same way. Control Techniques' packaging strategy prefers easily recyclable materials of low environmental impact, and regular reviews identify opportunities for improvement.

When preparing to recycle or dispose of any product or packaging, please observe local legislation and best practice.

## **Software Statement**

This Solutions Module (SM) does not have a separate software version. Operation is controlled by the drive software version and module hardware.

## **REACH legislation**

EC Regulation 1907/2006 on the Registration, Evaluation, Authorisation and restriction of Chemicals (REACH) requires the supplier of an article to inform the recipient if it contains more than a specified proportion of any substance which is considered by the European Chemicals Agency (ECHA) to be a Substance of Very High Concern (SVHC) and is therefore listed by them as a candidate for compulsory authorisation.

For current information on how this requirement applies in relation to specific Control Techniques products, please approach your usual contact in the first instance. Control Techniques position statement can be viewed at:

<http://www.controltechniques.com/REACH>

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Issue Number : 8

Hardware : Rev C and Rev D

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# 1 Safety information

## 1.1 Warnings, cautions and notes



A **Warning** contains information, which is essential for avoiding a safety hazard.



A **Caution** contains information, which is necessary for avoiding a risk of damage to the product or other equipment.

**NOTE** A **Note** contains information, which helps to ensure correct operation of the product.

## 1.2 Electrical safety - general warning

The voltages used in the drive can cause severe electrical shock and/or burns, and could be lethal. Extreme care is necessary at all times when working with or adjacent to the drive.

Specific warnings are given at the relevant places in this User Guide.

## 1.3 System design and safety of personnel

The drive is intended as a component for professional incorporation into complete equipment or a system. If installed incorrectly, the drive may present a safety hazard.

The drive uses high voltages and currents, carries a high level of stored electrical energy, and is used to control equipment which can cause injury.

Close attention is required to the electrical installation and the system design to avoid hazards either in normal operation or in the event of equipment malfunction. System design, installation, start up and maintenance must be carried out by personnel who have the necessary training and experience. They must read this safety information and this User Guide carefully.

The STOP and SAFE TORQUE OFF functions of the drive do not isolate dangerous voltages from the output of the drive or from any external option unit. The supply must be disconnected by an approved electrical isolation device before gaining access to the electrical connections.

**With the sole exception of the SAFE TORQUE OFF function on Unidrive SP and Digitax ST, none of the drive functions must be used to ensure safety of personnel, i.e. they must not be used for safety-related functions.**

**NOTE** The SAFE TORQUE OFF function is only available as standard on the Unidrive SP and Digitax ST.

Careful consideration must be given to the functions of the drive which might result in a hazard, either through their intended behavior or through incorrect operation due to a fault. In any application where a malfunction of the drive or its control system could lead to or allow damage, loss or injury, a risk analysis must be carried out, and where necessary, further measures taken to reduce the risk - for example, an over-speed protection device in case of failure of the speed control, or a fail-safe mechanical brake in case of loss of motor braking.

The SAFE TORQUE OFF function has been approved by BGIA as meeting the requirements of the following standards, for the prevention of unexpected starting of the drive:

EN 61800-5-2:2007 SIL 3

EN ISO 13849-1:2006 PL e

EN 954-1:1997 Category 3

The SAFE TORQUE OFF function may be used in a safety-related application. The system designer is responsible for ensuring that the complete system is safe and designed correctly according to the relevant safety standards.

## 1.4 Environmental limits

Instructions in the *Unidrive SP User Guide*, *Commander SK Technical Data Guide*, *Digitax ST User Guide* and *Mentor MP User Guide* regarding transport, storage, installation and use of the drive must be complied with, including the specified environmental limits. Drives must not be subjected to excessive physical force.

## 1.5 Access

Drive access must be restricted to authorized personnel only. Safety regulations which apply at the place of use must be complied with.

## 1.6 Fire protection

The drive enclosure is not classified as a fire enclosure. A separate fire enclosure must be provided.

## 1.7 Compliance with regulations

The installer is responsible for complying with all relevant regulations, such as national wiring regulations, accident prevention regulations and electromagnetic compatibility (EMC) regulations. Particular attention must be given to the cross-sectional areas of conductors, the selection of fuses or other protection, and protective ground (earth) connections.

The *Unidrive SP User Guide*, *Digitax ST User Guide* and *Mentor MP User Guide* contain instructions for achieving compliance with specific EMC standards.

Within the European Union, all machinery in which this product is used must comply with the following directives:

- 2006/42/EC: Safety of machinery.
- 2004/108/EC: Electromagnetic Compatibility.

## 1.8 Motor

Ensure the motor is installed in accordance with the manufacturer's recommendations and that the motor shaft is not exposed.

Standard squirrel cage induction motors are designed for single speed operation. If it is intended to use the capability of the drive to run a motor at speeds above its designed maximum, it is strongly recommended that the manufacturer is consulted first.

Low speeds may cause the motor to overheat because the cooling fan becomes less effective. The motor should be installed with a protection thermistor. If necessary, an electric forced vent fan should be used.

The values of the motor parameters set in the drive affect the protection of the motor. The default values in the drive should not be relied upon.

It is essential that the correct value is entered in the motor rated current parameter, Pr **5.07** (or Pr **0.46** in Unidrive SP, Affinity and Digitax ST, or Pr **0.28 {SE07}** in Mentor MP. This affects the thermal protection of the motor.

## 1.9 Adjusting parameters

Some parameters have a profound effect on the operation of the drive. They must not be altered without careful consideration of the impact on the controlled system. Measures must be taken to prevent unwanted changes due to error or tampering.

## 1.10 Electrical installation

### 1.10.1 Electric shock risk

The voltages present in the following locations can cause severe electric shock and may be lethal:

- AC supply cables and connections
- Output cables and connections
- Many internal parts of the drive, and external option units

Unless otherwise indicated, control terminals are single insulated and must not be touched.

### 1.10.2 Stored charge

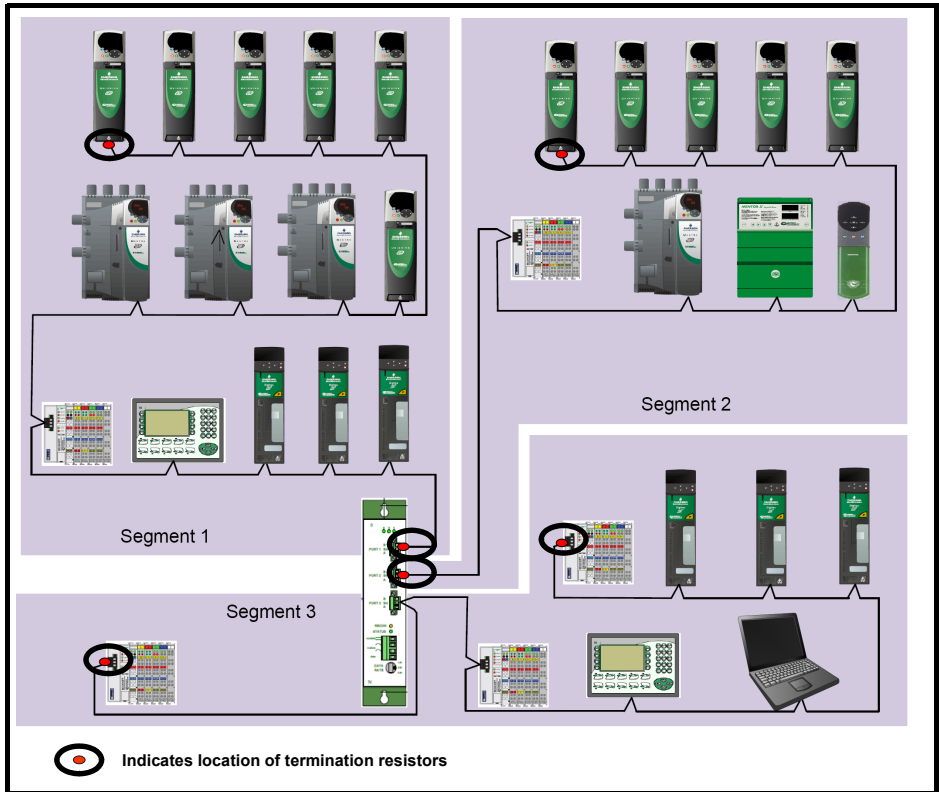
The drive contains capacitors that remain charged to a potentially lethal voltage after the AC supply has been disconnected. If the drive has been energized, the AC supply must be isolated at least ten minutes before work may continue.

## 2 Electrical installation

### 2.1 CNet network overview

A CNet network comprises one or more segments, with multiple segments linked together by a hub. A typical layout of a CNet network is shown in Figure 2-1. Each segment has a termination resistor installed at each end, and each segment meets the limits specified in section 2.3 *CNet segment design* on page 10.

Figure 2-1 Typical CNet network layout





## 2.2 CTNet hardware revision

All new CTNet devices are marked with a hardware revision level. Rev D is the up-to-date hardware revision, but some devices have the intermediate Rev C hardware installed. All Rev C devices will eventually be updated to incorporate the Rev D hardware.

**Table 2-1 CTNet Rev C and Rev D hardware devices**

Device	Reference code	Rev	Revision
Unidrive Classic	UD75	D	80700000005701 (obsolete) Use SM-Applications
Unidrive SP Affinity Digitax ST	SM-Applications	D	82000000011400
	SM-Applications Plus		82000000014000
	SM-Register		82000000015000
Mentor II	MD29AN	D	80100000006201 (obsolete) Use SM-Applications Plus
Mentor MP	SM-Applications Plus	D	V01.03.01 or later
CTNet I/O Coupler	CTNet BK7200 I/O Coupler	C/D	4500-0089
CTIU200	CTNet CTIU SmartStack	C	4500-0088
Hub	CTNet 3 Port Hub,	D	4500-0082
PCI card	CTNet PCI card	D	4500-0085
PCI/PCIX card	CTNet PCI/PCIX Card (replaces 4500-0085)	D	4500-0085-1
PCMCIA card	CTNet PCMCIA Card+MAU	D	4500-0086 (obsolete) Use CTNet USB22 Adaptor
PC ISA card	CTNet ISA Card	D	4500-0084
Hybrid Hub	CTNet 3 Port Hybrid Hub	D	4500-0083
Fiber Optic Repeater	CTNet Fib Optic Repeater	D	4500-0081
CTNet MAU only	CTNet PCMCIA MAU	D	4500-0090
CTNet USB22 Adaptor	USB 22 USB2.0 Adaptor	D	4500-0100

**NOTE**

If a device and revision level is not listed in Table 2-1, refer to section 8 *Legacy CTNet hardware* on page 73.

### 2.2.1 Revision D hardware

CTNet Rev D hardware has been introduced to improve the overall performance of CTNet, and all Rev D devices are marked with the new CTNet conformance logo. Rev D hardware uses an improved output driver stage to give higher voltage pulses, and a higher impedance input stage to reduce the load applied to the network by each node. The overall effect is to increase the number of nodes and/or total length of cable that can be used for a single network segment. The maximum permitted cable length can also be increased by reducing the number of nodes on a segment, and vice versa.

Rev D hardware allows a mathematical model to be applied to a segment design to determine if the combination of nodes and cable length is within the CTNet specifications for the required data rate. The model covers data rates of 5.0 Mbit/s, 2.5 Mbit/s and 1.25 Mbit/s. Table 2-2 below gives some example specifications that can be met with a segment consisting entirely of CTNet Rev D hardware devices.

**Table 2-2 Example segment specifications**

Data rate (Mbit/s)	Total cable length (m)			
	5 nodes	10 nodes	15 nodes	20 nodes
5.0	140	100	75	44
2.5	250	200	150	100
1.25	340	275	200	135

### 2.2.2 Revision C hardware

CTNet Rev C hardware uses identical output driver and input receiver stages as Rev D hardware, but it uses the old CTNet pulse transformer. The lower inductance of the old-style pulse transformer means that fewer Rev C nodes can be connected to a CTNet segment than Rev D devices. Rev C and Rev D devices can be mixed on a network segment without problems, but the higher loading factor of Rev C hardware must be taken in to account when checking the overall design of the CTNet segment (see section 2.3.1 *Segment Load Factor* on page 10 for full details).

## 2.3 CTNet segment design

A CTNet segment has limitations on the number of nodes and total length of cable that can be connected. In general, more nodes means less cable and vice versa, so the arrangement of segment and placement of hubs needs to be carefully considered when designing the network.

The configuration of a CTNet network can be checked by calculating the Segment Load Factor ( $K_{SL}$ ) and Insertion Loss Factor ( $K_{IL}$ ) for each segment. If both  $K_{SL}$  and  $K_{IL}$  are within specifications for ALL segments, the CTNet network will run without problem.

#### NOTE

It is possible that a network configuration that is outside the specified limits may work without any apparent problem. However, Control Techniques will not guarantee reliable operation of a CTNet network if it does not comply with all the specifications listed in this manual. Such a network is also likely to be sensitive to electrical interference.

All devices connected to a segment must be Rev C or Rev D hardware to use the Segment Loss Factor ( $K_{SL}$ ) and Insertion Loss Factor ( $K_{IL}$ ) equations and graphs. All CTNet Rev C and Rev D devices are listed in Table 2-1.

### 2.3.1 Segment Load Factor

The Segment Load Factor determines the maximum number of nodes that can be connected on a single segment of network, irrespective of network length.

#### NOTE

When calculating the Segment Load Factor and Insertion Loss Factors, each connected hub and repeater port must be counted as a node for that segment.

$$K_{SL} = (N_{RevD} \times K_{RevD}) + (N_{RevC} \times K_{RevC})$$

where:

$K_{SL}$  = Segment Load Factor.

$N_{RevD}$  = total number of Rev D devices on the network segment.

$K_{RevD}$  = load factor for a single Rev D device for a given data rate.

$N_{RevC}$  = total number of Rev C devices on the network segment.

$K_{RevC}$  = load factor for a single Rev C device for a given data rate.

The maximum permitted values of  $K_{SL}$  are given in Table 2-3.

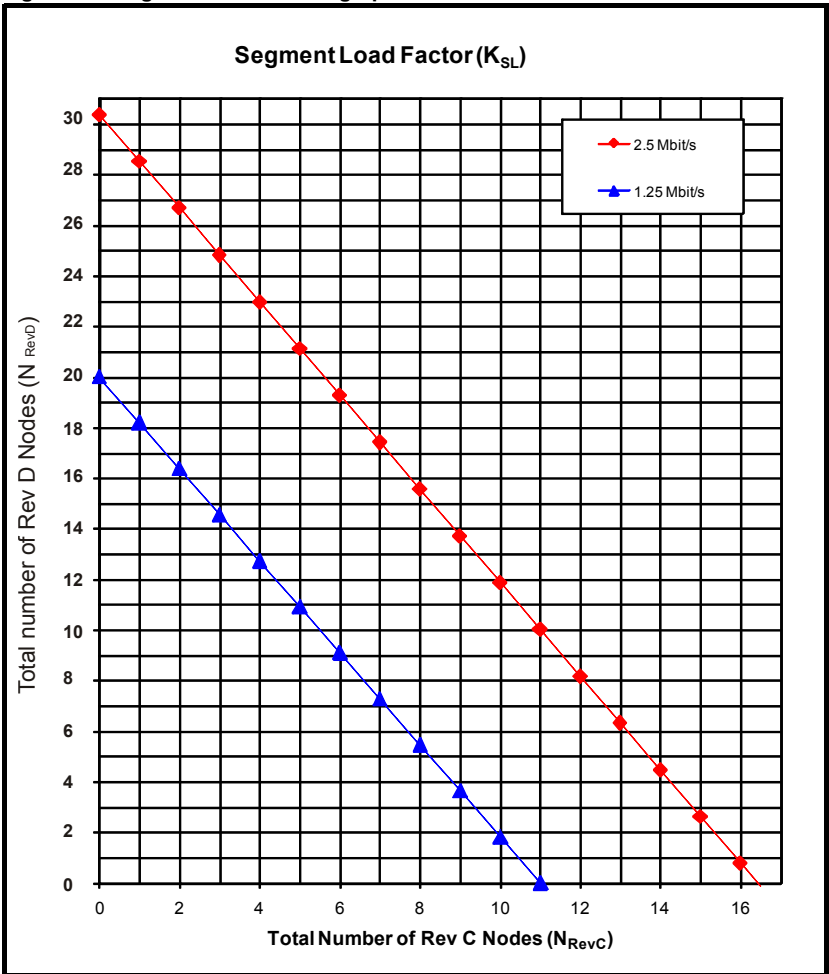
**Table 2-3 Segment Load Factors**

Data Rate (Mbit/s)	Maximum Segment Load Factor ( $K_{SL}$ )	Rev D Device Load Factor ( $K_{RevD}$ )	Rev C Device Load Factor ( $K_{RevC}$ )
1.25	100	5.00	9.09
2.5	100	3.29	6.09
5.0	100	0.53	0.97

To check that the Segment Load Factor ( $K_{SL}$ ) is suitable for a given CTNet segment arrangement:

1. Specify the network data rate.
2. Determine the total number of Rev C ( $N_{RevC}$ ) and Rev D devices. ( $N_{RevD}$ ).
3. Plot the point on the Segment Load Factor Graph (Figure 2-2) where  $N_{RevD}$  and  $N_{RevC}$  intersect.
4. If the point of intersection is above the plotted line for the specified data rate, the Segment Load Factor is too high, and CTNet operation cannot be guaranteed. Split the segment (using a hub) and repeat steps 1 to 3 for each segment.
5. If the point of intersection is on or below the plotted line for the specified data rate, the Segment Load Factor is within the specified limits. Check the Insertion Loss Factor to see if segment arrangement is valid (see section 2.3.2 *Insertion Loss Factor* on page 13).

Figure 2-2 Segment Load Factor graph



**NOTE** At 5.0 Mbit/s, the calculation shows that 188 Rev D or 100 Rev C nodes could be connected to a single segment, but this will be limited by the Insertion Loss Factor (see section 2.3.2 *Insertion Loss Factor* on page 13). As the Segment Load Factor is not a limiting factor at 5.0 Mbit/s, this line is not plotted in Figure 2-2, allowing a clearer scale to be used for the 2.5 Mbit/s and 1.25 Mbit/s data rates.

### 2.3.2 Insertion Loss Factor

The Insertion Loss Factor ( $K_{IL}$ ) determines the maximum length of cable that can be used on a network segment for a given number of nodes. Rev C and Rev D nodes have the same Insertion Loss Factor, so they can be considered to be identical for the purpose of calculating the Insertion Loss Factor.

$$K_{IL} = ((N_{total} - 1) \times K_N) + (L_{total} \times K_C)$$

where

$K_{IL}$  = insertion loss factor.

$N_{total}$  = total number of nodes ( $N_{RevD} + N_{RevC}$ ) on the network segment.

$K_N$  = insertion loss per node for network data rate.

$L_{total}$  = total length of cable (in metres) on the network segment.

$K_C$  = insertion loss per metre of cable for network data rate.

The maximum permitted Insertion Loss values are given in Table 2-4.

**Table 2-4 Insertion Loss values**

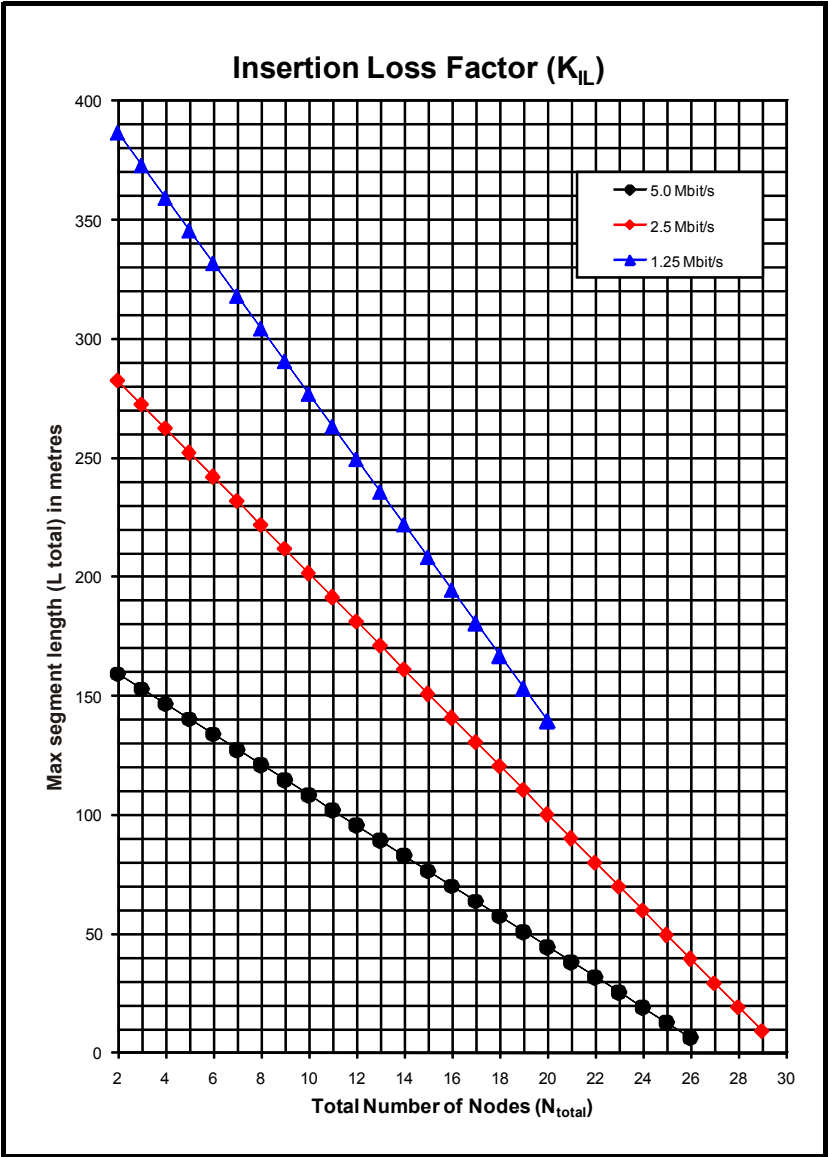
Data rate Mbit/s	Maximum Insertion Loss Factor ( $K_{IL}$ )	Node insertion loss ( $K_N$ )	Cable insertion loss per metre ( $K_C$ )
1.25	1000	34.3	2.50
2.5	1000	34.6	3.42
5.0	1000	38.5	6.04

To calculate the Insertion Loss Factor for a given CTNet segment:

1. Specify the network data rate.
2. Count the total number of nodes ( $N_{total}$ ) on the segment. Hub and repeater ports must be included.
3. Determine the total length of cable ( $L_{total}$ ) on the segment.
4. Plot the point on the Insertion Loss Factor Graph (Figure 2-3) where  $N_{total}$  and  $L_{total}$  intersect.
5. If the point of intersection is above the plotted line for the specified data rate, the Insertion Loss Factor is too high, and correct CTNet operation cannot be guaranteed. The segment will need to be split (using a hub) to bring the Insertion Loss Factor within the specified limits.
6. If the point of intersection is on or below the plotted line for the specified data rate, the Insertion Loss Factor is within the specified limits, and the segment arrangement is acceptable.

**NOTE** Only genuine CTNet cable should be used. Control Techniques cannot guarantee reliable operation if non-branded cable is used. Only genuine CTNet cable carries the CTNet logo and is supplied exclusively by Control Techniques.

Figure 2-3 Insertion Loss Factor graph



### 2.3.3 Propagation Delay Factor

Electrical pulses and light pulses in a glass fibre optic cable take approximately 5ns to travel along 1m of cable, and can take up to 320ns to travel through a hub or repeater. When a node transmits a token, it will wait for a defined period of time (called the Response Time) to see some transmission activity on the network, indicating that another Node has received the token and taken control of the network.

The critical path is the longest possible path (in terms of cable length and number of hubs/repeaters in the path) between any two nodes on the network. If a fibre optic link is used on the CTNet network, the length of the fibre optic link must also be taken into account. The maximum propagation delay experienced on this critical path must be less than the Response Time, or there is a possibility that the Node will start transmitting again **before** the signals from the receiving Node have propagated back through the cable and hubs. Under these circumstances there will be a data collision, i.e. two nodes transmitting at the same time, and network errors will be seen.

In general, the Propagation Delay Factor only becomes a limiting factor when fibre optic links are used to extend the network to lengths that cannot be achieved using copper cable. However, all networks should be checked to ensure that the maximum Propagation Delay Factor is not exceeded.

$$K_{PD} = (64 \times N_{Rep}) + L_{Net}$$

where

$K_{PD}$  = maximum propagation delay factor.

$N_{Rep}$  = total number of hubs/repeaters in the network.

$L_{Net}$  = total length of copper and fibre optic cable (in metres) in the critical path.

The maximum permitted propagation delay factors are given in Table 2-5.

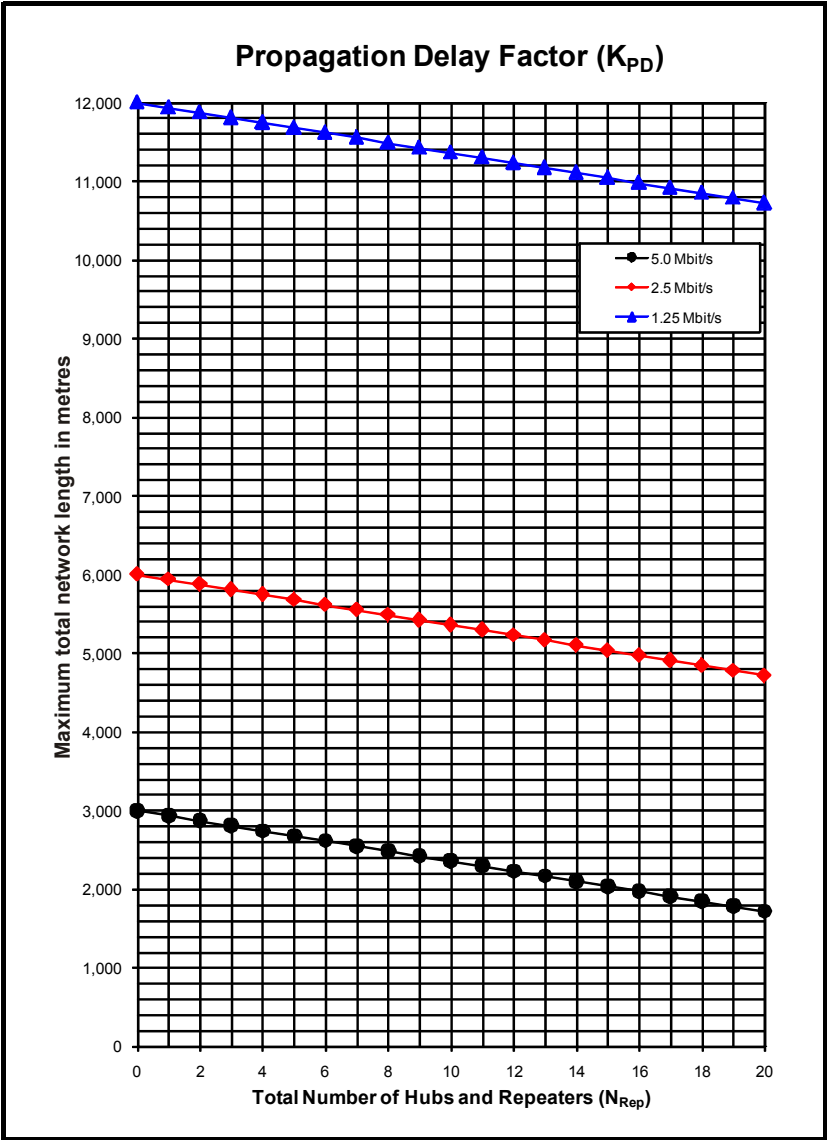
**Table 2-5 Maximum Propagation Delay Factor**

Data rate (Mbit/s)	Maximum Propagation Delay Factor ( $K_{PD}$ )
1.25	12000
2.5	6000
5.0	3000

To calculate the Propagation Delay Factor ( $K_{PD}$ ) for a given CTNet network:

1. Specify the network data rate.
2. Count the total number of hubs and repeaters ( $N_{Rep}$ ) on the network.
3. Determine the total length of copper and fibre optic cable ( $L_{Net}$ ) in the critical path.
4. Plot the point on the Propagation Delay Factor graph (Figure 2-4) where  $N_{Rep}$  and  $L_{Net}$  intersect.
5. If the point of intersection is above the plotted line for the specified data rate, the Propagation Delay Factor is too high, and the CTNet network design is not possible at that data rate.
6. If the point of intersection is on or below the plotted line for the specified data rate, the Propagation Delay Factor is within the specified limits, and the network arrangement will be OK.

Figure 2-4 Propagation Delay Factor graph







## 2.4 CTNet wiring practices

CTNet cable is designed for permanent installation, but repeated connecting and disconnecting of a cable can lead to the copper cores of the CTNet cable breaking. Bootlace ferrules should be used to terminate the end of CTNet cable cores. The ferrule takes the pressure of the clamp mechanism in the CTNet connector, providing superior mechanical strength and resistance to movement. Bootlace ferrules also ensure a good connection within the screw connector.

**NOTE** Only genuine CTNet cable should be used. Control Techniques cannot guarantee reliable operation if non-branded cable is used. Only genuine CTNet cable carries the CTNet logo and is supplied exclusively by Control Techniques.

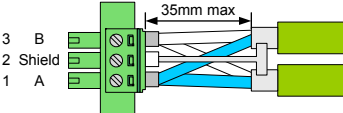
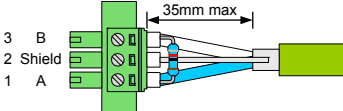
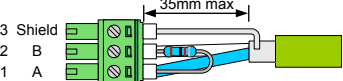
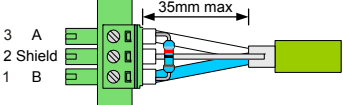
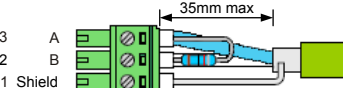
**Table 2-6 Wire termination using bootlace ferrules**

Ferrule type	Diagram	Comment
0.75mm <sup>2</sup> Single Ferrule		A termination resistor can also be crimped into the ferrule to ensure a good electrical connection.
0.75mm <sup>2</sup> Dual Ferrule		No termination resistor required where this connection is used, as it is not at the end of the network.

Do not attempt to put two single ferrule cables into one terminal of a CTNet connector. The plastic surrounds will prevent the ferrules from locating properly in the terminal, and a good electrical connection cannot be guaranteed. Over time, it is possible for two ferrules to become unsettled within a connector, leading to a loose connection. This is unlikely to happen to a tight connection onto a single ferrule.

The force required to tighten the terminal onto two ferrules can exceed the design limits of the connector, and cause distortion of the contact mechanism inside the connector. This leads to a bad connection, as the pin in the plug will not ride down beneath the contact mechanism. Bent pins on the CTNet plug are a sign that the CTNet connector has been over-tightened. Connectors showing this fault should be replaced, and the CTNet plug pins straightened using a pair of pliers.

**Table 2-7 CNet connection methods**

Connection	Comment
 <p>3 B 2 Shield 1 A</p> <p>35mm max</p>	Connections for Unidrive, Unidrive SP, Mentor II and CNet I/O nodes. Network continuity is maintained if the connector is unplugged from the node. Note the shield connection method, further details can be found in Section 2.8.
 <p>3 B 2 Shield 1 A</p> <p>35mm max</p>	Connections for Unidrive, Unidrive SP, Mentor II, PCI/PCIX card, PCMCIA card (revised) and CNet I/O nodes with termination. Network termination is maintained if the connector is unplugged from the node. PCI/PCX part number 4500-0085-1 and PCMCIA part number 4500-0090-1.
 <p>3 Shield 2 B 1 A</p> <p>35mm max</p>	Connection for PCMCIA, PCI, ISA and CNet HMI devices. PCI/PCX part number 4500-0085 and PCMCIA part number 4500-0090.
 <p>3 A 2 Shield 1 B</p> <p>35mm max</p>	Connection for CNet USB22 Adaptor (4500-0100) termination. Network termination is maintained if the connector is unplugged from the adaptor.
 <p>3 A 2 B 1 Shield</p> <p>35mm max</p>	Connection for ARCNET Analyzer (4500-0100) termination. Network termination is maintained if the connector is unplugged from the analyzer.

**NOTE** Termination is only required on the first and last device on a network segment.

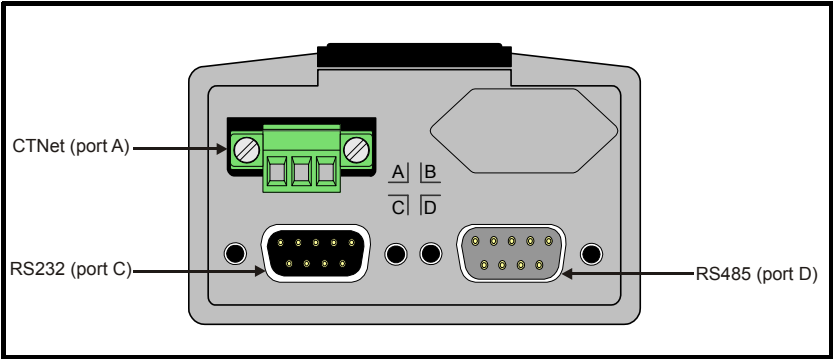
**NOTE** The shield connection does not always appear on pin 2. See Table 2-7 above for connection details.

## 2.5 CNet device connections

### 2.5.1 Unidrive (UD75-CNet)

The UD75-CNet module fits into the large option module slot under the Unidrive keypad. The D-type connectors are the UD70 RS232 programming port (Port C) and the UD70 general purpose RS485 communications port and high speed digital I/O (Port D). CNet connections are made using the 3-pin connector at Port A.

Figure 2-5 UD75-CTNet module



The cable shield should be connected to the CTNet shield pin and also to ground before it reaches the Unidrive as shown in section 2.8 *CTNet shield connections* on page 34.

The UD75-CTNet module does not have an internal CTNet termination resistor installed.

Table 2-8 UD75-CTNet module connections

CTNet (port A)		RS485 (port D)	
Pin	Function	Pin	Function
1	CTNet A	1	RS485 0V isolated
2	CTNet shield	2	RS485 /Tx (TxA)
3	CTNet B	3	RS485 /Rx (RxA)
		4	Digital input 0
		5	Digital input 1
RS232 (port C)		6	RS485 Tx (TxB)
Pin	Function	7	RS485 Rx (RxB)
2	RS232 Rx	8	Digital output 0
3	RS232 Tx	9	Digital 0V
5	Digital 0V		

2.5.2 Unidrive SP (SM-Applications / SM-Applications Plus)

The CTNet module for the Unidrive SP is the SM-Applications module. It can be installed into any one of the three expansion slots available on the Unidrive SP.

SM-Applications and SM-Application Plus can be used to provide CTNet connectivity on Affinity and Digitax ST, with regards to Mentor MP, only SM-Application Plus can be used.

Figure 2-6 SM-Applications

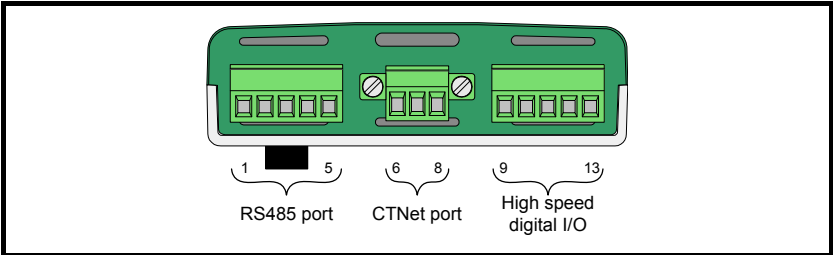


Figure 2-6 above shows the terminal connections of the SM-Applications, the SM-Applications Plus has exactly the same connections. The pin descriptions shown in Table 2-9 (SM-Applications) are identical on the SM-Application Plus.

**NOTE** The SM-Applications and SM-Application Plus do not have an internal termination resistor installed.

The additional terminals are the general purpose RS485 communications port (pins 1 to 5) and the high speed digital I/O terminals (pins 9 to 13).

The cable shield should be connected to the CTNet shield pin, but should also be clamped to ground before it gets to the Unidrive SP. The grounding bracket on the Unidrive SP is provided for this purpose as shown in section 2.8 *CTNet shield connections* on page 34.

**Table 2-9 SM-Applications connections**

RS485	
Pin	Function
1	RS485 isolated 0V
2	RS485 /Rx (RxA)
3	RS485 Rx (RxB)
4	RS485 /Tx (TxA)
5	RS485 Tx (TxB)

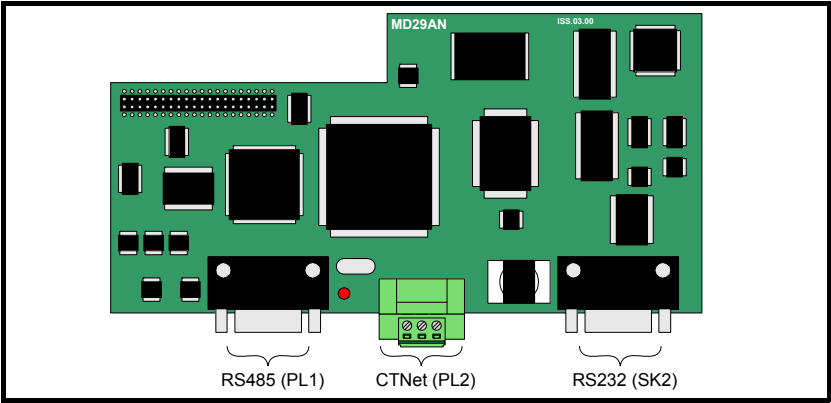
High speed digital I/O	
Pin	Function
9	Digital 0V
10	Digital input 0
11	Digital input 1
12	Digital output 0
13	Digital output 1

CTNet	
Pin	Function
6	CTNet A
7	CTNet shield
8	CTNet B

2.5.3 Mentor II (MD29AN)

The Mentor II CTNet card (MD29AN) fits onto the 40 pin header (PL1) on the MDA2B terminal board of the Mentor II. The D-type connectors are the MD29 RS232 programming port (SK2) and the MD29 general purpose RS485 communications port and high speed digital I/O (PL1). CTNet connections are made using the 3-pin connector (PL2). The MD29AN does not have an internal CTNet termination resistor installed.

Figure 2-7 MD29AN



The cable shield should be connected to the CTNet shield pin, and also clamped to ground before it reaches the Mentor II as shown in section 2.8 *CTNet shield connections* on page 34.

Table 2-10 MD29AN connections

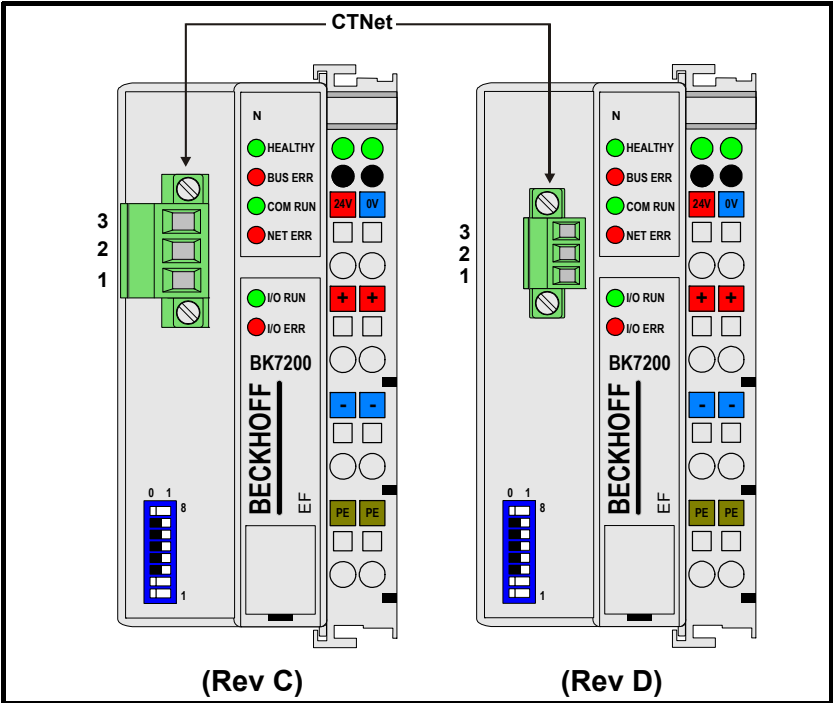
RS485 (PL1)		CTNet (PL2)	
Pin	Function	Pin	Function
1	RS485 0V isolated	1	CTNet A
2	RS485 /Tx (TxA)	2	CTNet shield
3	RS485 /Rx (RxA)	3	CTNet B
4	Digital input 0		
5	Digital input 1		
6	RS485 Tx (TxB)		
7	RS485 Rx (RxB)		
8	Digital output 0		
9	Digital 0V		

RS232 (SK2)	
Pin	Function
2	RS232 Tx
3	RS232 Rx
5	Digital 0V

2.5.4 CTNet I/O coupler (BK7200)

The CTNet I/O coupler allows up to 64 I/O modules to be connected to the CTNet network, with a mixture of digital and analog inputs. Input and output data is transferred between the CTNet I/O coupler and the physical inputs and outputs via the K-Bus serial link between the modules.

Figure 2-8 CTNet I/O couplers



The line of I/O terminals must be terminated with a KL9010 bus end terminal to terminate the K-bus connection. The bus is physically separate from the CTNet.

Table 2-11 CTNet I/O connections

CTNet	
Pin	Function
1	CTNet A
2	CTNet shield
3	CTNet B

Beckhoff Coupler	
Pin	Function
24V	+24V CTNet/K-bus supply
0V	0V CTNet/K-bus supply
+	+24V I/O supply
-	0V I/O supply
PE	Ground

**NOTE** The CTNet connector on the Rev D product is smaller in size than the Rev C version.

The cable shield should be connected to the CTNet shield pin, and should also be clamped to ground before it reaches the CTNet I/O coupler as shown in Section 2.8. The CTNet I/O coupler does not have an internal termination resistor installed.

Figure 2-9 Bekhoff coupler power supply detail

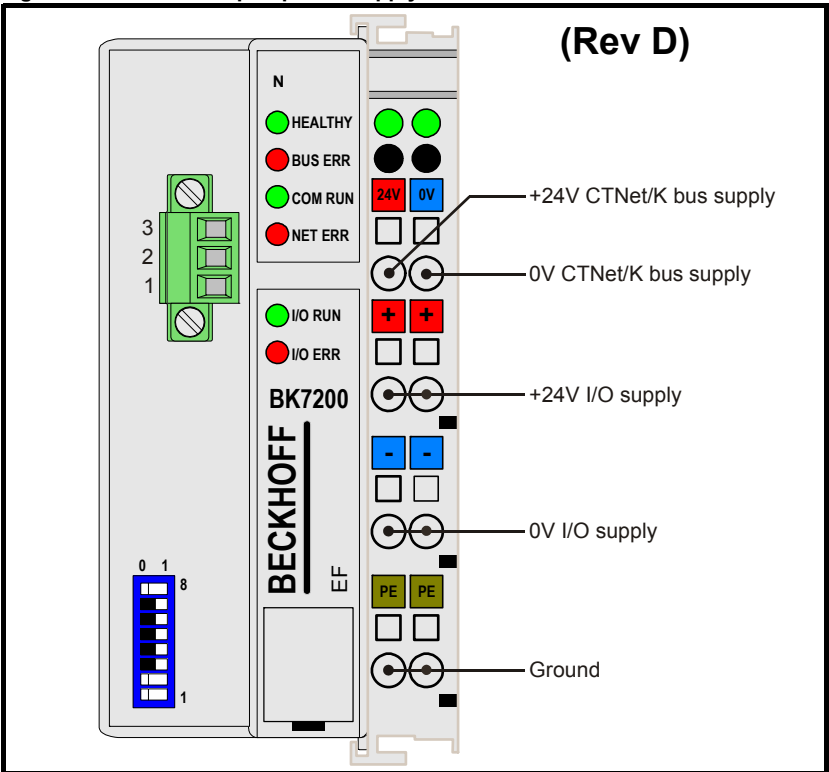


Figure 2-9 details the required power supply connections for both Rev C and Rev D couplers (only the Rev D version is shown here for clarity). Connection is made by pressing the spring loaded tab above each connection, then inserting the required supply cable and then releasing the tab to secure the cable in place.

Table 2-12 Operating specifications

Input voltage	24V DC +/-20%
Continuous current	70mA + (total K-Bus current) /4
Max continuous current	500mA
Starting current	2.5 * continuous current
Operating temperature	0°C to +50°C

Each I/O module will have a specified current consumption which it draws from the K-Bus. If the total continuous current of the CTNet I/O coupler and K-bus exceeds 500mA, a K-bus power supply unit terminal (KL9400) can be used to supply the remainder of the K-bus.

Analog and digital input and output modules are connected to the right hand side of the CTNet I/O coupler. Up to 64 I/O modules can be connected in any combination, subject to the limitations listed in Table 2-13.

**Table 2-13 CTNet I/O coupler input and output limitations**

Terminal group	Max modules	I/O
Digital Input	64	512*
Digital Output	64	512*
Analog Input	50	100
Analog Output	50	100

\* Firmware V1.03.08 must be installed to support 512 digital inputs or outputs.

**NOTE** It is normally recommended that the BK7200 and the I/O use different supplies particularly when the outputs or inputs are used in a noisy environment.

### 2.5.5 CTNet HMI (TIU200)

The CTNet HMI features an operator interface which provides data display, editing and control facilities for a machine via CTNet. All CTNet settings are configured using the TIU Configurator package. The TIU200 must be installed with the CTNet SmartStack module to allow it to communicate over CTNet.

**Figure 2-10 CTNet HMI**

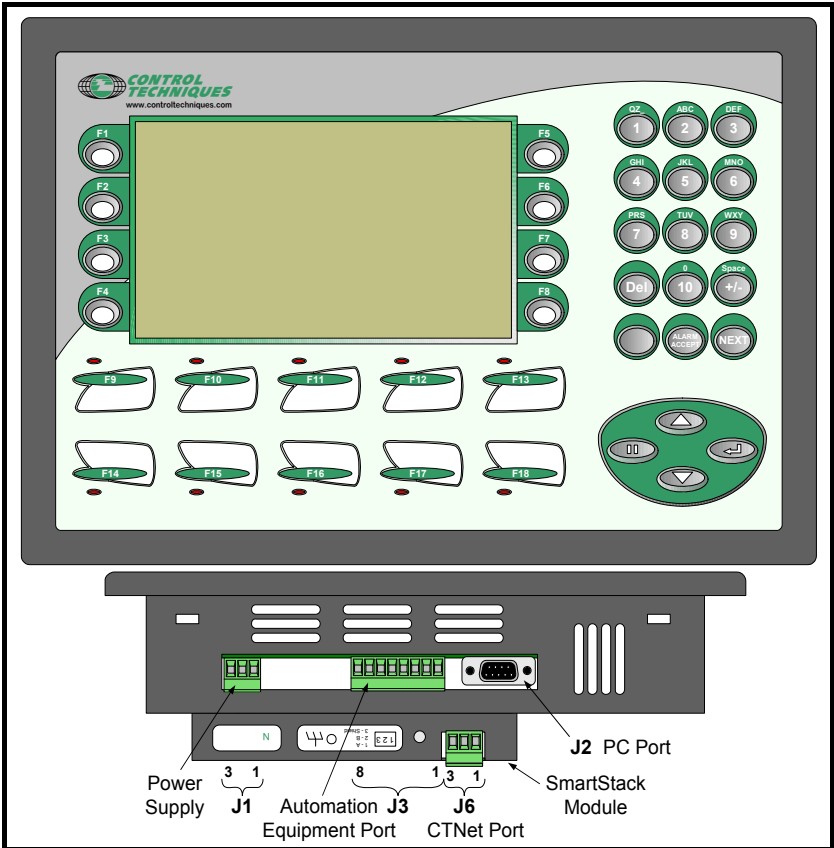
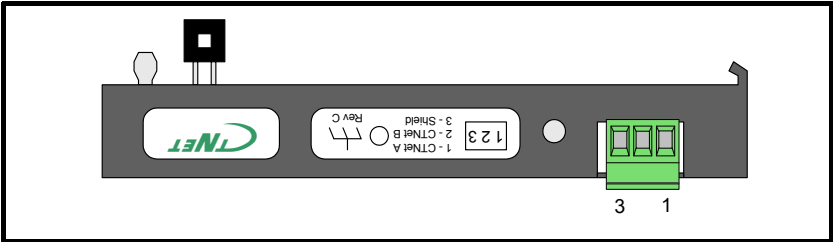




Figure 2-11 SmartStack module



The cable shield should be connected to the CTNet shield pin, and also clamped to ground before it reaches the CTNet HMI (see section 2.8 *CTNet shield connections* on page 34). The pin connections for each connector are shown in Table 2-14. No internal termination resistor is installed.

Table 2-14 CTNet HMI connections

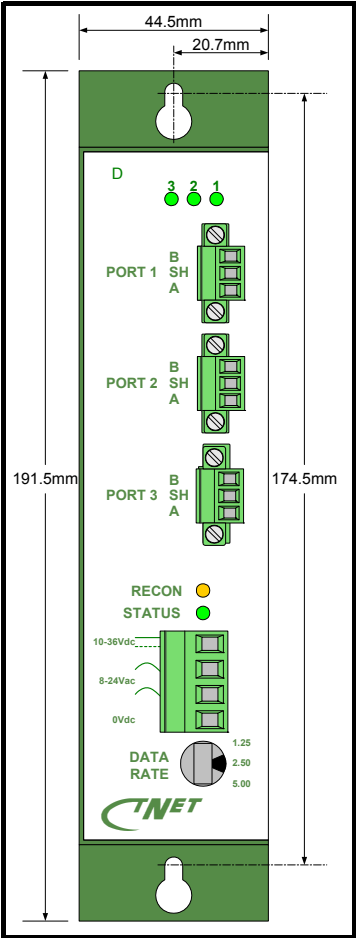
Pin	Function
J1-1	Ground
J1-2	0V Supply
J1-3	+24V Supply
J2-2	Tx
J2-3	Rx
J2-5	0V
J6-1	CTNet A
J6-2	CTNet B
J6-3	CTNet Shield

Pin	Function
J3-1	RS485 Tx+
J3-2	RS485 Tx-
J3-3	RS485 Rx+
J3-4	RS485 Rx-
J3-5	RS232 TxD
J3-6	RS232 GND
J3-7	RS232 RxD
J3-8	Ground

**NOTE** Support for the TIU (previously called CTIU) is now provided by Horner APG (Ireland). Please see [www.horner-apg.com](http://www.horner-apg.com) for contact details.

2.5.6 CTNet hub (AI3-CT)

Figure 2-12 CTNet hub



The CTNet hub is used to link segments together to extend the total length and number of nodes that can be connected to the network. A CTNet hub port must be included as a node for the physical design of each network segment, however this does not count as one of the 255 active nodes permitted on a CTNet network.

Table 2-15 CTNet hub connections

Port 1	
Pin	Function
B	Port 1 CTNet B
SH	Port 1 CTNet shield
A	Port 1 CTNet A

Port 2	
B	Port 2 CTNet B
SH	Port 2 CTNet shield
A	Port 2 CTNet A

Port 3	
B	Port 3 CTNet B
SH	Port 3 CTNet shield
A	Port 3 CTNet A

Hub power supply	
10-36Vd.c.	Positive DC power supply
8-24Va.c.	AC power supply
8-24Va.c.	AC power supply
0Vd.c.	Negative DC power supply

The cable shield should be connected to the CTNet shield pin, and also to ground before it reaches the hub. Refer to section 2.8 *CTNet*

*shield connections* on page 34 for more details.

Table 2-16 Power supply specifications

	DC	AC
Input voltage	10V to 36V	8V to 24V RMS
Input power	4W max	4VA max
Input frequency	N/A	47Hz to 63Hz

Each port has an internal 82Ω termination resistor that can be enabled by fitting jumper link J2 on the internal daughter card for each port. If a port is not connected to a segment, there is no need to fit termination resistors. Extended time-outs are not supported on CTNet. The internal jumper link E1 must be set in the NORM position.

**NOTE** The shield terminals are connected internally to the metal case of the CTNet hub.

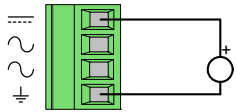
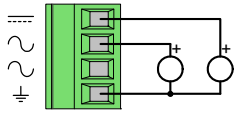
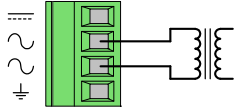
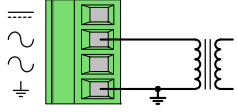
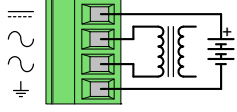
**NOTE** The new CTNet hub do not have termination resistors installed internally, therefore it will necessary to install an 82 resistor across unused ports on the new CTNet hubs. If in doubt measure the resistance of the terminals with the power OFF.

**Table 2-17 CTNet Hub general specification**

Characteristic	Specification
Operating temperature	0°C to +60°C
Storage temperature	-40°C to +85°C
Compliance	ANSI/ATA 878.1
Delay time	320 ns maximum
Unlatch delay time	5.9 $\mu$ s @ 2.5 Mbit/s
Regulatory compliance	CE Mark FCC Part 15 Class A

The CTNet hub, hybrid hub (see section 2.5.10 *CTNet hybrid hub (AI3-485X-CT)* on page 31) and fibre optic repeater (see section 2.5.11 *CTNet fibre optic repeater (AI2-CT/FOG-S7)* on page 32) can be powered from an AC or a DC supply, or a combination of both to ensure continued operation in the event of power supply failure.

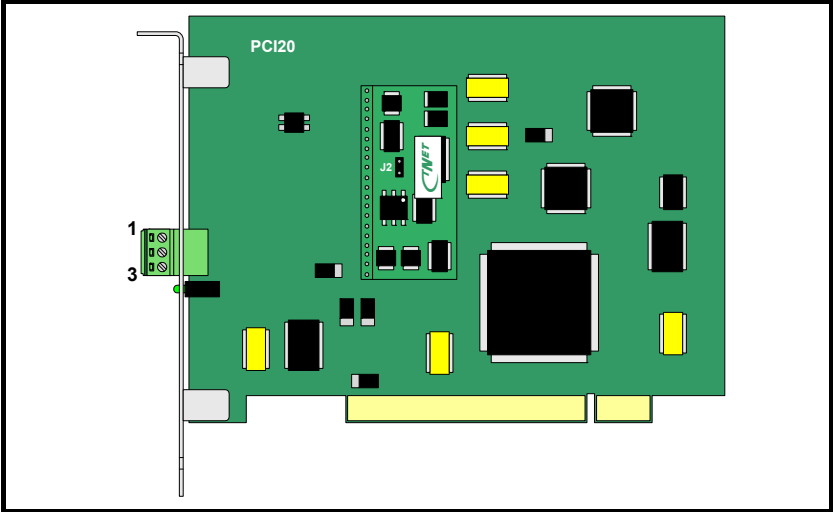
**Table 2-18 CTNet Hub power supply connections**

Power supply	Connections	Description
DC power supply		The power supply input connections are reverse voltage protected.
Redundant DC power supply		Each power supply must be capable of supplying the AI3-CT by itself. Input currents will not necessarily be balanced from the two supplies.
AC power supply		The secondary winding of the transformer must not be grounded.
AC power supply with grounded secondary		For use when the secondary winding of the transformer is grounded.
AC power supply with battery backup		The AC RMS voltage must be higher than the battery voltage to ensure that power is drawn from the AC supply in normal operation. External provision must be made to charge the batteries when AC power is present.

2.5.7 CTNet PCI cards 4500-0085 and 4500-0085-1

Two versions of the PCI card are currently available. The 4500-0085 version is a PCI card for use in a desktop PC, whereas the 4500-0085-1 version supports both PCI and the newer PCIX standard, and is available with screw locks installed.

Figure 2-13 CTNet PCI card (4500-0085)



The cable shield should be connected to both the CTNet shield pin, and also clamped to ground before it reaches the CTNet PCI Card (See section 2.8 *CTNet shield connections* on page 34). A good ground connection cannot be guaranteed if the shield is simply connected to the PCI20-CT card, as the ground connection relies on contact between metallic surfaces within the PC. If any of these surfaces are painted, there may be no ground connection at all.

The card has an internal 82Ω termination resistor that can be enabled by fitting jumper link J2 on the internal daughter card. The internal termination resistor should only be used if the card is connected at the end of a network segment. The two cards have different connector layouts, the newer card has been altered to match the drive connections in order to simplify inter-connection.

Table 2-19 CTNet PCI card connections

Pin	4500-0085	4500-0085-1
1	CTNet A	CTNet A
2	CTNet B	Shield
3	Shield	CTNet B

Table 2-20 CTNet PCI card general specifications

Characteristic	Specification
Operating temperature	0°C to +60°C
Storage temperature	-40°C to +85°C
Dimensions	107mm x 140mm
Compatibility	Compliant with ANSI/ATA 878.1 and PCI bus computers

2.5.8 CTNet PCMCIA card (PCM20H-CT)

The PCM20H-CT kit consists of a PCM20H PCMCIA card and a MAU20H-CT Media Access Unit (MAU) with the CTNet hardware. The PCM20H card can be installed to any PC with a spare PCMCIA slot, allowing an application running on the PC to access data from the nodes connected to the CTNet network. SyPT Pro, CTSoft and the CT OPC Server can all communicate with CTNet via the PCM20H-CT card.

Figure 2-14 CTNet PCMCIA card and MAU types

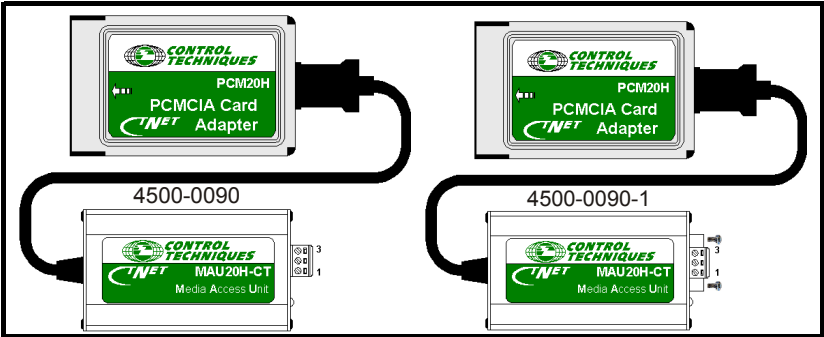


Figure 2-14 shows the two different MAU types. The 4500-0090 is shown on the left and has no retaining screws on the connector. The 4500-0090-1 is shown on the right and has retaining screws on the connector for securing the network cabling. The internal 82Ω termination resistor is disabled by default, and should not be used as there is a risk of damaging the MAU when it is dismantled. The PCM20H-CT card is also generally used for temporary network connections, e.g. using SyPT Pro for system commissioning / start up, and may leave a segment unterminated when disconnected.

Table 2-21 CTNet PCMCIA card connections

Pin	Part Number 4500-0090 Connections	Part Number 4500-0090-01Connections
1	CTNet A	CTNet A
2	CTNet B	Shield
3	Shield	CTNet B

**NOTE** A Contemporary Controls PCM20H card is functionally identical to a PCM20H card with Control Techniques labelling. The CTNet MAU (MAU20H-CT) contains the CTNet hardware, and is different to the Contemporary Controls MAU. The CTNet MAU can be used with a Control Techniques or a Contemporary Controls PCM20H card, and is available as a separate item from Control Techniques to update a PCMCIA kit to Rev D. Part numbers 4500-0090 and 4500-0090-01 have different electrical connections as detailed above.

Table 2-22 CTNet PCMCIA card general specification

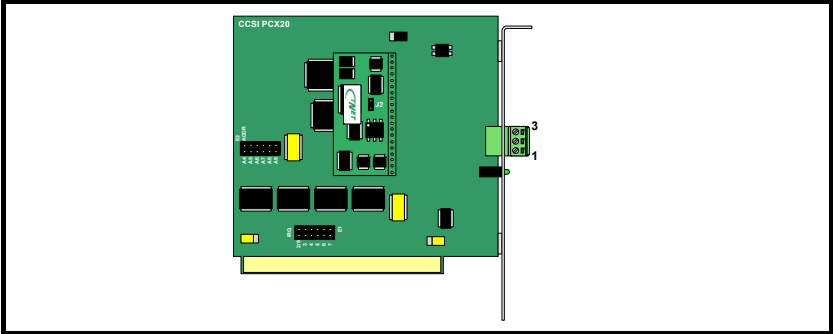
Characteristic	Specification
Operating temperature	0°C to +55°C
Storage temperature	-20°C to +65°C
Dimensions (PCMCIA card)	85mm x 54mm x 5mm
Dimensions (MAU)	81mm x 46mm x 26mm
Dimensions (cable length)	283mm
Compatibility	Compliant with ANSI/ATA 878.1 and PC Card

The PCM20H conforms to release 2.1 of the PC card standard Type II (5.0 mm thick) cards.

2.5.9 CTNet PC ISA card (PCX20-CT)

The PCX20-CT card can be installed to any PC with a spare ISA slot. This allows a PC application program to access data from the nodes connected to the CTNet network. SyPT Pro, CTSoft and CTScope can all communicate with CTNet nodes via the PCX20-CT card.

Figure 2-15 CTNet PC ISA card



The cable shield must be clamped directly to ground before it reaches the PCX20-CT card. A good ground connection cannot be guaranteed if the shield is simply connected to the PCX20-CT card, as the ground connection relies on contact between metallic surfaces. If any of these surfaces are painted, there may be no ground connection at all. The PCX20-CT card has an internal 82Ω termination resistor that can be enabled by fitting jumper link J2 on the internal daughter card.

**NOTE** The termination resistor should only be installed if the PCX20-CT card is connected at the end of a network segment

Table 2-23 CTNet PC ISA card connections

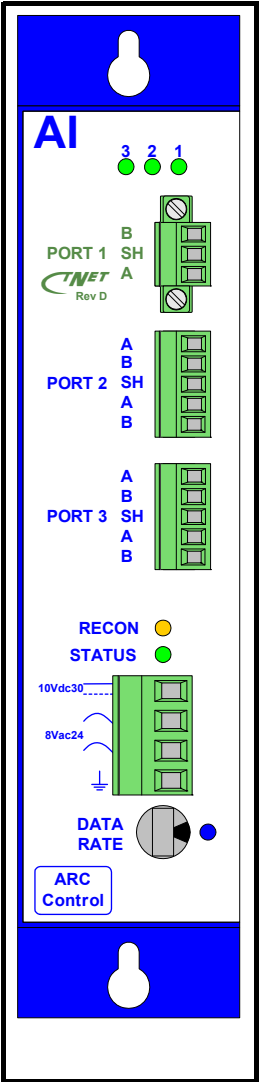
Pin	Connection
1	CTNet A
2	CTNet B
3	Shield

Table 2-24 CTNet PC ISA card general specification

Characteristic	Specification
Operating temperature	0°C to +60°C
Storage temperature	-40°C to +85°C
Dimensions	99mm x 109mm
Compatibility	Compliant with PC/XT/AT computers.

2.5.10 CTNet hybrid hub (AI3-485X-CT)

Figure 2-16 CTNet Hybrid Hub



The CTNet hybrid hub has Rev D hardware installed to port 1, and should only be connected to a network segment consisting entirely of Rev C and Rev D devices. Port 1 must be counted as a node on the segment when calculating the Segment Load, Insertion Loss and Propagation Delay factors.

For power supply connection details, refer to section 2.5.6 *CTNet hub (AI3-CT)* on page 26.

Table 2-25 Hybrid hub connections

Port 1	
Pin	Function
B	CTNet B
SH	CTNet shield
A	CTNet A

Port 2	
Pin	Function
A	CTNet A
B	CTNet B
SH	CTNet shield
A	CTNet A
B	CTNet B

Port 3	
Pin	Function
A	CTNet A
B	CTNet B
SH	CTNet shield
A	CTNet A
B	CTNet B

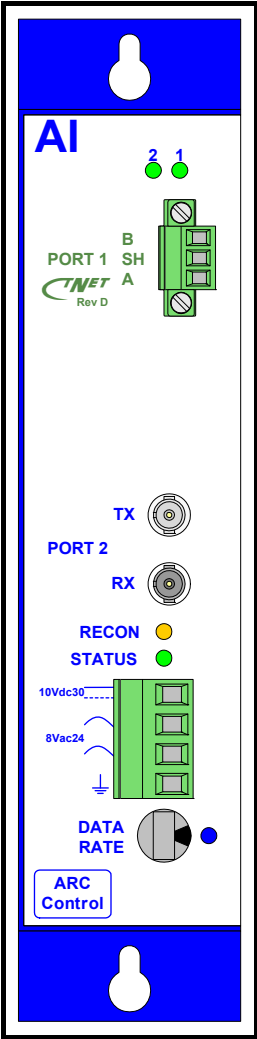
Hub power supply	
Pin	Function
10Vdc30	Positive dc power supply
8Vac24	ac power supply
8Vac24	ac power supply
Ground	Negative dc power supply

Port 2 and port 3 have the older Rev A hardware installed, and should only be connected to a network segment consisting of older CTNet hardware. See section 8 *Legacy CTNet hardware* on page 73 for full details.

All electrical and mechanical specifications for the CTNet hybrid hub are as per the CTNet hub in section 2.5.6 *CTNet hub (AI3-CT)* on page 26. The cable shield should be connected to the CTNet shield pin and also clamped to ground before it reaches the hub. (See section 2.8 *CTNet shield connections* on page 34).

2.5.11 CTNet fibre optic repeater (AI2-CT/FOG-ST)

Figure 2-17 CTNet fibre optic repeater



The CTNet fibre optic repeater has Rev D hardware installed to Port 1, and should only be connected to a network segment consisting entirely of Rev C and Rev D devices. Port 1 must be counted as a node on the segment when calculating the Segment Load, Insertion Loss and Propagation Delay factors.

The fibre optic link uses two glass optical fibre cables in a duplex arrangement, and paired fiber optic cable is available for this purpose. The TX output from a fibre optic repeater should be connected to the RX input at the other end of the fibre. The fibre optic link is invisible to the higher level protocol operation of the CTNet network. A fibre optic link is particularly useful to prevent ground potential equalisation currents from flowing in the shield of the CTNet cable, e.g. between separate buildings, as it provides full electrical isolation between the electrical segments in each building.

Table 2-26 Fibre optic connections

Port 1	
Pin	Function
B	CTNet B
SH	CTNet shield
A	CTNet A

Port 2	
Pin	Function
TX	Optical Output (850nm wavelength)
RX	Optical Input (850nm wavelength only)

Repeater power supply	
Pin	Function
10Vdc30	Positive DC power supply
8Vac24	a.c. power supply
8Vac24	a.c. power supply
Ground	Negative d.c. power supply

All other electrical and mechanical specifications and connections for the CTNet fibre optic repeater are as per the CTNet Hub in section 2.5.6 *CTNet hub (AI3-CT)* on page 26.

The cable shield should be connected to the CTNet Shield pin and also clamped to ground before it reaches the fibre optic repeater (see section 2.8 *CTNet shield connections* on page 34).

Paired multimode glass fibre optic cable must be used, and must be terminated with bayonet style ST connectors. Suitable fibre sizes are 50/125, 62.5/125, and 100/140. The optical power budget is shown in Table 2-27.



Table 2-27 Optical power budget at 25°C

Fibre size µm	Max link loss dB	Max fibre loss dB/km	Max fibre length m
50/125	6.6	4.3	915
62.5/125	10.4	4.3	1825
100/140	15.9	4.0	2740

2.5.12 CTNet USB22 Adaptor (4500-0100)

Figure 2-18 CTNet USB22 USB 2.0 Adaptor

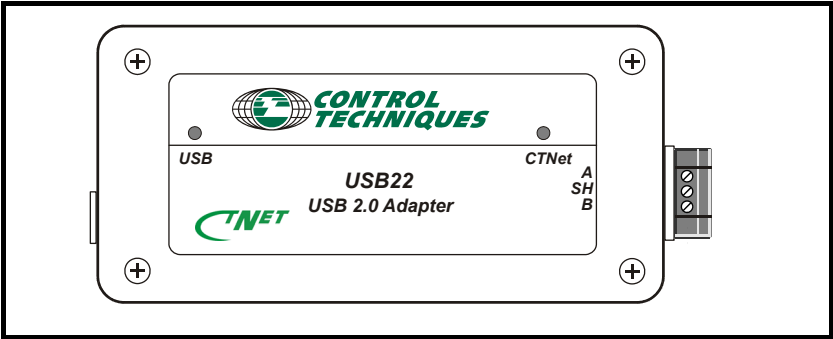


Table 2-28 CTNet USB22 Adaptor connections

Pin	Function
A	CTNet A
SH	CTNet shield
B	CTNet B

This unit replaces the existing CTNet PCMCIA cards and MAUs. While connecting to REV A or REV B, a hybrid hub (4500-0083) should be used. The USB22 unit is supplied with a driver disk and USB cable. CT Comms Server Version 01.05.00 or later is required to use this adaptor and is available for download from CTSupport.com.

2.6 CTNet cable

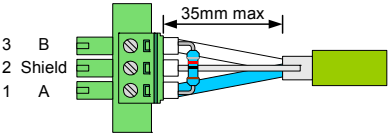
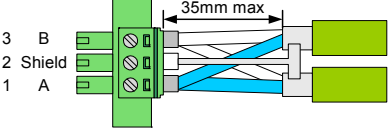
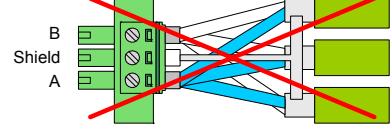
The data cable used in any transmission line system is a fundamental part of the overall system. CTNet has been designed and optimized to operate with customized CTNet cable available from Control Techniques. Control Techniques cannot guarantee reliable CTNet operation if any other type of cable is used.

2.7 CTNet segment termination

- Every CTNet network segment must be terminated at each end of the cable with an 82Ω resistor.
- The cable arrangement must be point-to-point.
- Drop lengths of unterminated cable are not permitted on a CTNet network.
- In applications where a piece of portable equipment contains CTNet nodes, all active lengths of cable must be correctly terminated. This may mean that terminator plugs need to be used in connectors when the equipment is disconnected and moved elsewhere.

**NOTE** Check that the value of the firmware resistor matches the cable impedance.

**Table 2-29 Segment termination rules**

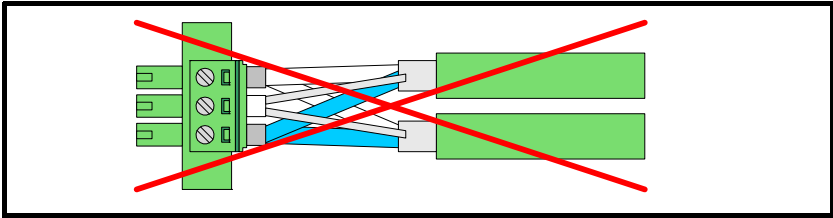
Connection	Termination rule
	1 CTNet cable connected - OK Fit an 82Ω 1% 0.25W termination resistor between the CTNet A and CTNet B data lines.
	2 CTNet cables connected - OK Do not fit a termination resistor.
	3 CTNet cables connected - WRONG! This connection creates an illegal drop length on the network.

Some CTNet devices have internal 82Ω resistors that can be enabled to terminate a segment. However, external resistors are recommended as they provide an easy way to visually determine that each segment is correctly terminated.

## 2.8 CTNet shield connections

The shield of the CTNet cable is the copper braid that surrounds the internal data wires. Shielded cable provides perfect mutual inductance between the shield and internal data cores, meaning that any noise voltages appearing in any conductor are equally induced in the other two conductors. This is known as common mode noise, as the voltage is present on all conductors. The CTNet transformer is extremely effective at rejecting common-mode noise, so the transceivers will only see the true differential signal voltage that they are meant to see. It is very important that the shields of all cables (including motor and encoder cable shields) are connected in accordance with Control Techniques recommendations.

**Figure 2-19 Incorrect CTNet shielding**

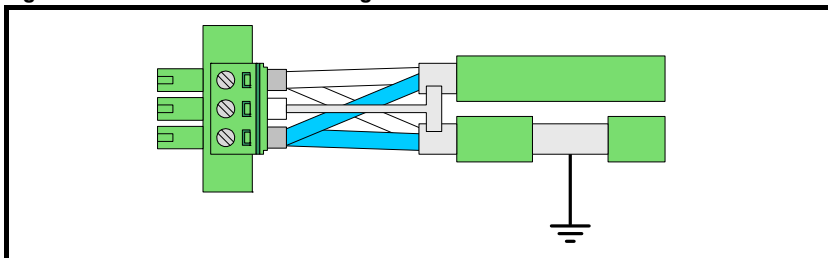


The method used to connect cable shield to a CTNet node or ground is very important. As shown in Figure 2-19, a pigtail connection consists of the shield wires being unwrapped and twisted together to be connected into a terminal, leaving the data cores unshielded.

When a current passes along the shield, it must pass through two pigtails to continue down the shield. Each pigtail has inductance and resistance, so the current will generate a voltage across it.

This voltage does not appear on the data cores as they are not shielded at this point, so a noise voltage will be seen on the data cores relative to the shield. In installations where a number of pigtail connections are utilized, this can lead to significant noise voltage being seen on the data cores.

**Figure 2-20 Correct CTNet shielding**

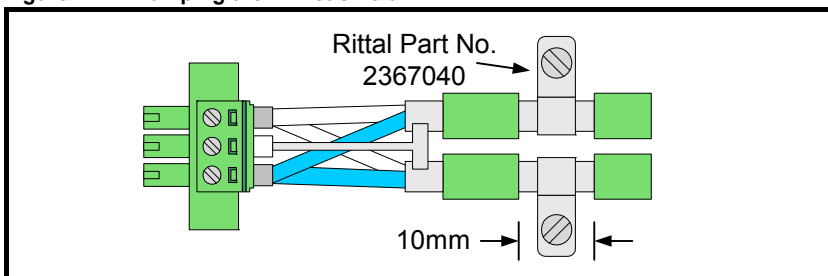


As shown in Figure 2-20, the cable shield should be clamped to ground at least once in each enclosure. Ideally the shield should be grounded at the points where the cable enters or exits the enclosure (see section 2.9.1 *Enclosure entry and exit points* on page 37).

Clamping the shield means that the shield braid is connected to ground without interfering with the actual shielding of the data cores. This provides a low impedance path to ground for any currents flowing in the cable shield, thereby preventing them from entering the CTNet node and causing voltage drops across the pigtail which would otherwise appear as noise to the CTNet transceivers.

Grounding brackets are available for Unidrive SP (supplied as standard) and Unidrive (part number 9500-0040, not supplied as standard). These are ideal for grounding the CTNet cable shield. Grounding brackets are also available for Affinity, Digitax and Mentor MP.

**Figure 2-21 Clamping the CTNet shield**



For CTNet nodes that do not have a convenient grounding bracket, the CTNet cable shield should be clamped to ground as close to each node as possible by removing a section of the green cable insulation close to the CTNet device and clamping the shield to the grounded backplane of the enclosure using a suitable clip as shown in Figure 2-21.

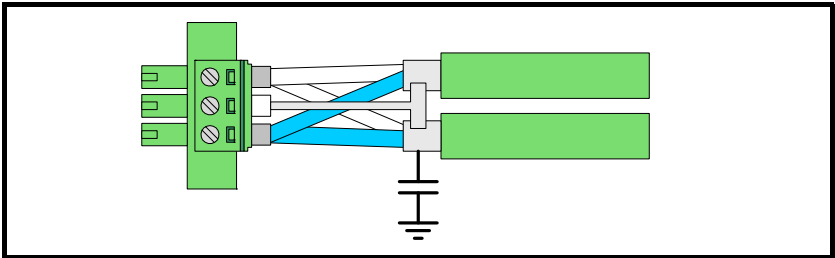
Care should be taken not to damage the cable shield or the data cores in the cable. A suitable grounding clip (part number 2367040) is available from Rittal.

### 2.8.1 Breaking ground loops

If a segment of CTNet network extends over a long distance, i. e. more than 100m, and where the ground points at each end of the segment are at different potentials, a ground loop may be created when the CTNet cable shield is grounded at each end of the segment. This would allow ground potential equalisation currents to flow in the shield of the CTNet cable.

Ground loops can be broken by connecting the cable shield to ground via a Y2 250Vac 1nF capacitor. The capacitor allows high frequency noise currents to pass straight through, but will block any low frequency (50 or 60 Hz) currents.

**Figure 2-22 Shield connections to break ground loops**



**NOTE** The CTNet cable shield must be connected directly to ground at a single location on each segment.

## 2.9 Joining CTNet cables together

When implementing a system, it is often necessary to cut into an existing length of CTNet cable in order to facilitate the design or particular installation requirements.

Typical examples are:

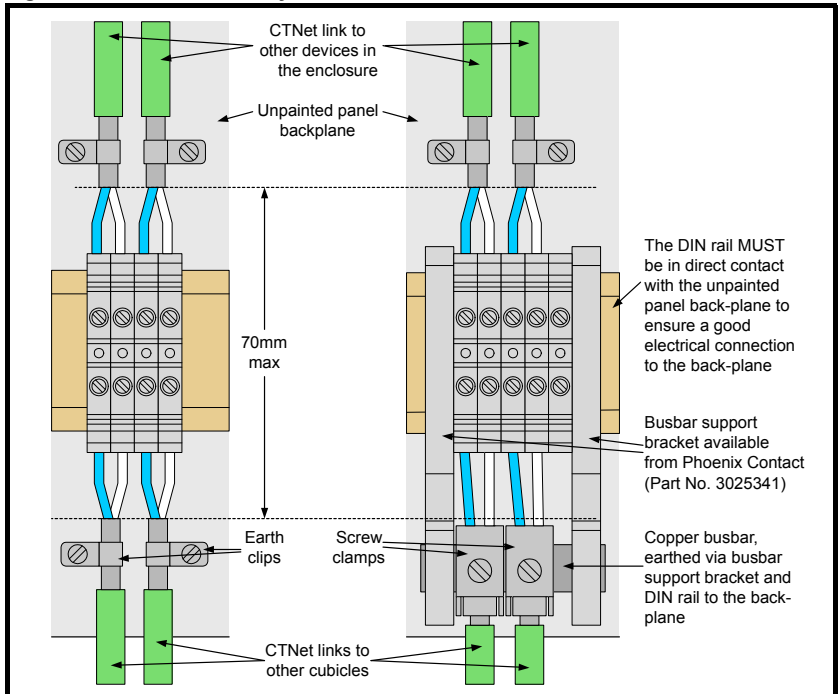
- CTNet panel entry and exit points (see section 2.9.1 *Enclosure entry and exit points* on page 37).
- Using two pieces of CTNet cable to extend a segment length (see section 2.9.2 *Joining two lengths of CTNet cable* on page 38).
- Provide connection points for portable pieces of equipment containing CTNet devices (see section 2.9.3 *Connection points for portable equipment* on page 38).

When the shield around data cables is disturbed, the cable begins to lose its inherent noise immunity, and consequently noise may be induced in the data wires. Attention to detail and the correct use of shield connections around cable break-in points can help to reduce noise to a minimum, and at a level below that which may otherwise cause problems.

## 2.9.1 Enclosure entry and exit points

The shield of each CTNet cable should be grounded to the backplane of the panel at the point where the data cores emerge from the cable. Figure 2-23 below, shows a standard terminal block arrangement with a suitable ground shield clamping clip (as detailed in Figure 2-21) to clamp the shield to the enclosure backplane (Rittal Part No. 2367060).

**Figure 2-23 Enclosure entry / exit connections**



Alternatively screw clamps (Phoenix Contact Part No. 3025163) can be used to clamp the cable to a copper busbar which are grounded via the support brackets (Phoenix Contact Part No. 3025341) and the DIN rail. The data cores are linked using standard connection terminals.

**NOTE** Ensure that the total length of unshielded data cable does not exceed 70mm.

It is preferable to provide convenient connections for the CTNet cable at the enclosure entry and exit points. This allows the system installer (who may not have any previous experience with wiring a CTNet network) to link up with the CTNet network without disturbing the CTNet layout within the enclosure ground shield clips or cable clamps should be supplied with the enclosure, and the person installing the CTNet cable should be made aware of the importance of following the wiring instructions in this User Guide.

### 2.9.2 Joining two lengths of CTNet cable

Multi pole connectors are available that offer electro-magnetic interference shielding when locked. These connectors are ideal for use when breaking a CTNet cable to pass thorough a panel or wall, or for linking lengths of CTNet cable into the network.

Two pins are required for the CTNet A and CTNet B connections, with the shell of the connector being used to link the shields of the cables. The shell is usually clamped to the shield of the CTNet cable, thus ensuring that the data cores remain fully shielded when the connector is locked.

**NOTE** The network segment will be incorrectly terminated while the cables are disconnected.

### 2.9.3 Connection points for portable equipment

Some applications may have an item of portable equipment which needs to be moved to different points on a production line for different products. If this equipment also contains CTNet devices, then it will also require a connection to the CTNet network.

CTNet is particularly suited to this type of system, but the physical wiring layout of the network must be considered for every possible network arrangement.

The preferred method is to design and install the segments required for the fixed devices, and to then consider the requirements for the portable equipment as a secondary issue before linking them to the rest of the network using a CTNet Hub.

The segment must be terminated correctly in all machine configurations, and the segment must meet the specifications described in section 2.3 *CTNet segment design* on page 10. Lengths of cable that are not actually connected to the segment in a particular machine configuration do not need to be terminated.

## 2.10 Other wiring tips

- Wherever possible, do not route CTNet cable close to motor cables. Motor cables carry high frequency currents and an extended parallel run in close proximity with CTNet cable will result in some of this high frequency current being induced into the CTNet cable shield.
- Try to keep the area enclosed by the CTNet cables to a minimum. A large loop coming back to the same starting point will act as an aerial, and the larger the area enclosed by the cable, the more noise will be induced. The enclosed area can be kept to a minimum by running the outward and return cables adjacent to each other. However this may not always be possible, particularly if a segment length is getting close to its maximum, but it will keep any electrical pick-up to a minimum.

## 3 Getting started

If two nodes with the same node address are connected to a CTNet network, they will try to transmit at the same time, and will interfere with each other. Similarly, if a node is configured with a different data rate to the rest of the network, it will not recognise valid messages.

When configuring a CTNet node (and for the reasons stated above), always follow the steps listed below before connecting the node to the CTNet network:

1. Configure the node address. Every node on a CTNet network must have a unique node address.
2. Set the node data rate. Every node on a CTNet network must be configured to operate at the same data rate.
3. Store and activate the new configuration.
4. Connect the node to the network.

### 3.1 Unidrive

The UD75-CTNet module for Unidrive is configured using menu 20 (Pr **20.PP**) parameters. These values are stored in the FLASH memory of the UD70, so the UD75-CTNet will keep any previous configuration when transferred to another Unidrive.

**Table 3-1 UD75-CTNet configuration parameters**

Function	Parameter	Range	Description
Node address	Pr <b>20.01</b>	0 to 255	Valid node address from 1 to 255. Setting the node address to 0 disables the CTNet interface.
Data rate	Pr <b>20.02</b>	0 to 2	0 = 5.0 Mbit/s 1 = 2.5 Mbit/s 2 = 1.25 Mbit/s
Cyclic data rate	Pr <b>20.03</b>	0 to 25099	See section 4.2 <i>Cyclic data rate</i> on page 46.
CTNet status	Pr <b>20.50</b>	-2 to 9999	Indicates the current operating status of the node and CTNet network. See section 6.1.1 <i>Unidrive</i> on page 53.

To store and activate the updated configuration, set Pr **17.19** to 1. This will store the Pr **20.PP** values to the UD70 FLASH memory, and fully reset the UD70 and CTNet interface.

### 3.2 Unidrive SP / Digitax ST / Affinity / Mentor MP

The configuration parameters used to configure the SM-Applications / SM-Applications Plus, depends on which drive expansion slot is used. Configuration parameters are stored in the drives FLASH memory, and can also be stored in the SM-Applications / SM-Applications Plus internal FLASH memory. If the SM-Applications / SM-Applications Plus is installed to a new drive, the previous configuration can be recalled from the internal FLASH memory.

**NOTE** Mentor MP only supports SM-Applications Plus.

**Table 3-2 CTNet configuration parameters (Unidrive SP, Affinity, Mentor MP and Digitax ST)**

Function	Slot 1	Slot 2	Slot 3	Range	Description
Token ring ID	Pr <b>15.22</b>	Pr <b>16.22</b>	Pr <b>17.22</b>	0 to 255	Can be used to identify which token ring the node is connected to. For indication purposes only.
Node address	Pr <b>15.23</b>	Pr <b>16.23</b>	Pr <b>17.23</b>	0 to 255	Valid node address from 1 to 255. Setting the node address to 0 disables the CTNet interface.
Data rate	Pr <b>15.24</b>	Pr <b>16.24</b>	Pr <b>17.24</b>	0 to 2	0 = 5.0 Mbit/s 1 = 2.5 Mbit/s 2 = 1.25 Mbit/s
Cyclic data rate	Pr <b>15.25</b>	Pr <b>16.25</b>	Pr <b>17.25</b>	0 to 9999	See section 4.2 <i>Cyclic data rate</i> on page 46.
CTNet status	Pr <b>15.36</b>	Pr <b>16.36</b>	Pr <b>17.36</b>	-3 to 9999	Indicates the current operating status of the node and CTNet network. See section 6.1.2 <i>SM-Applications / SM-Applications Plus / SM-Register / Digitax ST Plus</i> on page 53.

To store the updated configuration in the drive, set Pr **MM.00** to 1000 and press the red RESET button. When using Mentor MP drives, set Pr **MM.00** to save.

To activate the updated configuration, set Pr **17.19** to reset an SM-Applications module installed in slot 3 (use Pr **15.19** or Pr **16.19** to reset an SM-Applications module installed in slot 1 and slot 2 respectively). When using Digitax ST Indexer, EZMotion or Affinity slot 3 is not available.

### 3.3 Mentor II

The MD29AN for Mentor II is configured using Menu 14 (Pr **14.PP**) and Menu 11 (Pr **11.PP**) parameters. These values are stored in the Mentor II, but NOT in the MD29AN. If an MD29AN is moved to another Mentor II, it will not retain it's previous configuration.

**Table 3-3 MD29AN CTNet configuration parameters**

Function	Parameter	Range	Description
Node address	Pr <b>14.05</b>	0 to 255	Valid node address from 1 to 255. Setting the node address to 0 disables the CTNet interface.
Data rate	Pr <b>11.01</b>	0 to 2	0 = 5.0 Mbit/s 1 = 2.5 Mbit/s 2 = 1.25 Mbit/s
Cyclic data rate	Pr <b>11.02</b>	0 to 1999	See Section 4.2.
CTNet status	Pr <b>16.62</b>	-2 to 9999	Indicates the current operating status of the node and CTNet network. See section 6.1.3 <i>Mentor II</i> on page 53.



To store the updated configuration, set Pr **MM.00** to 1, and press the RESET button on the Mentor II. This will store the Mentor II parameter set.

To activate the changes to the CTNet configuration, set Pr **14.16** to 1 to reset the MD29AN. When the MD29AN has re-initialized, it will reset Pr **14.16** to 0, and the new CTNet configuration will take effect.

### 3.4 CTNet I/O coupler

The CTNet I/O coupler is configured using DIP switches to set the node address and data rate. The DIP switches are only read at power up, so power to the CTNet I/O coupler must be cycled before the new settings will take effect.

**Table 3-4 CTNet I/O coupler configuration settings**

Function	Configuration	Range	Description
Node address	DIP1-DIP6	1 to 64	Valid node address from 1 to 64. See Table 3-5 for DIP switch settings for each node address.
Data rate	DIP7, DIP8	0 to 2	See Table 3-6 for DIP switch settings for each data rate.
Cyclic data rate	N/A	N/A	The CTNet I/O coupler is not capable of generating the CTNet sync message.

**Table 3-5 CTNet I/O coupler node address**

Node address	DIP6-DIP1	Node address	DIP6-DIP1	Node address	DIP6-DIP1	Node address	DIP6-DIP1
1	000000	17	010000	33	100000	49	110000
2	000001	18	010001	34	100001	50	110001
3	000010	19	010010	35	100010	51	110010
4	000011	20	010011	36	100011	52	110011
5	000100	21	010100	37	100100	53	110100
6	000101	22	010101	38	100101	54	110101
7	000110	23	010110	39	100110	55	110110
8	000111	24	010111	40	100111	56	110111
9	001000	25	011000	41	101000	57	111000
10	001001	26	011001	42	101001	58	111001
11	001010	27	011010	43	101010	59	111010
12	001011	28	011011	44	101011	60	111011
13	001100	29	011100	45	101100	61	111100
14	001101	30	011101	46	101101	62	111101
15	001110	31	011110	47	101110	63	111110
16	001111	32	011111	48	101111	64	111111

**Table 3-6 CTNet I/O coupler data rate**

Data rate (Mbit/s)	DIP8-DIP7
5.0	00
2.5	01
1.25	10
Reserved	11

### 3.5 CTNet HMI (TIU200)

The CTNet HMI is configured using the TIU configuration package (typically CBreeze). To configure the CTNet settings proceed as follows:

1. Select **Configure**, **Select Terminal Type** and choose **TIU200**.
2. Select **Configure** and **Communication Settings**.
3. Set **Remote Equipment Manufacturer** to **Control Techniques**.
4. Set **Remote Equipment Model** to **Second proc using CTNet**.
5. Select **Network Mode Enable**.
6. Specify the CTNet node address (1 to 255) in **HMI Network Node**.

The CTNet settings will take effect when the project is downloaded to the CTNet HMI. If **Network Mode Enable** is not selected, the CTNet HMI will only attempt to communicate with the CTNet node address specified in **Global Remote Node ID**.

### 3.6 CTNet Hub

The CTNet Hub does not require a node address, but the correct data rate must be configured using the selector switch. The selector switch is only read at power up, so power to the CTNet Hub must be cycled to make the new setting take effect.

**Table 3-7 CTNet Hub data rate configuration**

Function	Configuration	Range	Description
Data rate	DATA RATE switch	5 to 7	0-4 = reserved 5 = 1.25 Mbit/s 6 = 2.5 Mbit/s 7 = 5.0 Mbit/s

### 3.7 CTNet PC cards

The node address and data rate for the CTNet PC cards are both configured by the CTNetAPI when it goes on-line, and can be specified when the CTNetAPI is installed. These settings can be changed from within all Control Techniques applications that support CTNet, e.g. SyPT Pro, CT Soft, CTNet and OPC Server. Ensure that the correct hardware type is selected when the data rate is specified.

**NOTE**

**Known problem with V1.0.0.0 CTNet driver**

If the PC goes into hibernation or sleep mode, the CTNet card is not powered up when the PC returns to normal operating mode, and a connection error will result when the CTNetAPI attempts to access the card. This problem can be overcome by disabling Hibernation and Sleep modes, or by going to Device Manager and disabling and re-enabling the CTNet card. With a PCMCIA card, temporarily removing the PCMCIA card will have the same effect.

### 3.8 Installing PCI and PCMCIA card drivers

#### 3.8.1 Windows 98, Windows 98SE, Windows ME, Windows 2000, Windows XP

CT PC tools (SyPT Pro, OPC Server, CTSOft, etc). will install and configure the drivers for the CTNet hardware. Windows will automatically assign a base address for the CTNet card, and both the 16-bit and 32-bit CTNetAPIs will detect the assigned base address.

1. Install the CTNet card and boot up the PC.
2. The **Add New Hardware wizard** appears during boot-up, and automatically finds a device driver for a **PCI Network Controller**
3. Follow the wizard, and allow Windows to search for new devices. Specify the location that Windows will search in. De-select **CD-ROM**, select **Floppy disk** and click **Next**. The wizard will find one of the following devices:
  - **PCI20-CT PCI CTNet Card**
  - **PCM20H-CT PCMCIA CTNet Card**
  - **PCM20 PCMCIA CTNet Card**
4. Select the PCI or PCMCIA device as required, complete the wizard.
5. To confirm installation of the CTNet driver, go to **DEVICE MANAGER**. A **CTNet** device category will now be listed.

The operating system will automatically assign a base memory address to the CTNet card. Under Windows 2000 and Windows XP, the CTNetAPI will automatically detect the base address of the CTNet card when the application puts the CTNetAPI on-line. Windows 98, Windows 98SE and Windows ME cannot automatically detect the assigned base address, so it must be specified manually by performing the following additional steps:

6. Double click on the **CTNet** device category and double click on the CTNet device. The **Device Properties** page will appear. Select the **RESOURCES** tab.
7. Two **Input/Output Range** will be listed for the CTNet card. The base address of the CTNet card is the second range in the list, and will cover 16 bytes, e.g. 0x1410 to 0x141F. The first number of this address range (e.g. 0x1410) is the base address that must be specified for the CTNetAPI or CT PC Tools.

**NOTE** If the assigned base address is not listed in the CTNet communication settings, simply type in the assigned base address.

**NOTE** PCI 20 CTNet cards are not supported on Windows7 (64 bit) operating systems.

#### 3.8.2 Windows NT

Control Techniques PC Tools (SyPT Pro, OPC Server, CTSOft, etc). will automatically install and configure the CTNet driver for the CTNet hardware. Windows NT will automatically assign a base address for the CTNet card, and the base address will be detected automatically when the parent PC tool takes the CTNetAPI on-line.

**NOTE** The PCM20-CT and PCM20-H cards are not supported under Windows NT.

If the CT PC tool has installed CTNetAPI V3.00.00 or earlier, the installed CTNet drivers will need to be updated manually. The latest drivers are available from your local Control Techniques Drive Centre.

To update the CTNet drivers:

1. Copy **ctndrv2.sys** and **ctndrvnt.sys** into **c:\winnt\system32\drivers**.
2. Click **Yes** when prompted to replace the existing files.
3. Reboot the PC to ensure the new drivers are loaded.

### 3.8.3 Windows 95

Please refer to section 8.4 *CTNet drivers for Windows 95* on page 75 for information on using CTNet under Windows 95.

## 3.9 Installing the PC ISA card

As the ISA bus is not plug-and-play, Windows cannot automatically assign a base address to the PCX20-CT card. The base address must be configured manually using the jumper links (E1) on the PCX20-CT card, and entered manually when the CTNetAPI or CT application is loaded and configured. Table 3-8 shows the jumper link settings for the required base address.

**Table 3-8 PCX20-CT base address configuration**

Base address	A9	A8	A7	A6	A5	A4
100						
110						
120						
130						
140						
150						
160						
170						
180						
190						
1A0						
1B0						
1C0						
1D0						
1E0						
1F0						
200						
210						
220						
230						
240						
250						
260						
270						
280						
290						
2A0						
2B0						
2C0						
2D0						
2E0						
2F0						
300						
310						
320						
330						
340						
350						
360						
370						
380						
390						
3A0						
3B0						
3C0						
3D0						
3E0						
3F0						

Shaded squares indicate that the jumper link should be installed.

CTNet does not use an interrupt line, so all interrupts should be disabled on the PCX20-CT card. Ensure that none of the E1 links are installed.

## 4 Cyclic data

When a de-centralised control system is used to control a machine or production process, the real-time data about the machine is spread around the nodes on the system. To implement effective control, some of this data must be regularly transferred to other devices to allow the control system to react to changing conditions.

CTNet provides the digital communications link to transfer data between distributed intelligent nodes (Unidrive, Unidrive SP, Mentor II, Affinity, Mentor MP and Digitax ST) running DPL programs.

**Table 4-1 Glossary of terms**

Term	Definition
cyclic data	Method of automatic data transfer between nodes on a CTNet network. Configured during system commissioning / start up.
cyclic data rate	The time period between transmission of the cyclic sync message. Defined as SSFF, where FF = fast cyclic data time (in ms) and SS = ratio of slow data to fast cyclic data.
sync node	The node on the network that coordinates cyclic data transfer by transmitting the sync message at regular intervals.
sync message	The CTNet sync message is used to instruct all other nodes to start transmitting their cyclic data links.
cyclic link	Defines the data registers to be transmitted from a node, the total number of registers to be transmitted, and the registers in the target node where the data is to be written.
fast link	A cyclic link that is transmitted after every sync message.
slow link	A cyclic link that is transited after every SSth sync message, as defined by the synchronization rate.
broadcast link	A cyclic link that is received by all nodes on the network.

### 4.1 What is cyclic data?

Cyclic data is the method of automatic real-time data transfer used on CTNet. During system commissioning / start up, a series of cyclic data links are configured to move data between nodes as required, allowing other devices to respond accordingly.

One node on a CTNet network must be designated as the sync node. When this node transmits the sync message, this is the signal to all other nodes that it is time to re-transmit the configured cyclic data links, thus ensuring that fast changing data is regularly updated in the other nodes on the network.

**Table 4-2 Supported cyclic data features**

Node	Cyclic data	Easy mode	Sync message capable	DPL capable
Unidrive	Yes	Yes	Yes	Yes
Unidrive SP Affinity Digitax ST Mentor MP	Yes	Yes	Yes	Yes
Mentor II	Yes	Yes	Yes	Yes
CTNet I/O	Yes	No	No	No
TIU200	No	No	No	No
PC cards	No	No	No	No

## 4.2 Cyclic data rate

Cyclic data is co-ordinated over the CTNet network by the sync node. The sync rate is specified as SSFF, where FF is the time period (in ms) between cyclic data transfers, and SS is the ratio of slow cyclic transfers to fast cyclic transfers. For example, a setting of 1005 in a Unidrive SP would result in fast cyclic data being transferred every 5ms, and slow cyclic data being transferred every  $10 \times 5\text{ms}$ , i.e. 50ms.

**Table 4-3 Cyclic sync message timebase**

Node	Sync rate parameter	Time base	Comment
Mentor II	Pr 11.02	2.56ms	
Unidrive	Pr 20.03	1.38ms	Switching frequency is 3, 6 or 12 kHz (Pr 5.17 = 0, 2 or 4).
		1.84ms	Switching frequency is 4.5 or 9 kHz (Pr 5.17 = 1 or 3).
Unidrive SP Digitax ST base	Pr 15.25	1ms	SM-Applications / SM-Applications Plus / SM-Register module installed in slot 1.
	Pr 16.25		SM-Applications / SM-Applications Plus / SM-Register module installed in slot 2.
	Pr 17.25		SM-Applications / SM-Applications Plus / SM-Register module installed in slot 3.
Affinity Digitax ST Indexer/ EZMotion	Pr 15.25	1ms	SM-Applications / SM-Applications Plus / SM-Register module installed in slot 1.
	Pr 16.25		SM-Applications / SM-Applications Plus / SM-Register module installed in slot 2.
Mentor MP	Pr 15.25	1ms	SM-Applications Plus / SM-Register module installed in slot 1.
	Pr 16.25		SM-Applications Plus / SM-Register module installed in slot 2.
	Pr 17.25		SM-Applications Plus / SM-Register module installed in slot 3.

When Unidrive or Mentor II are configured to generate the sync message, the internal timebase used to generate the sync message is not 1ms. The actual fast data rate generated will be the next highest multiple of the timebase **above** the specified fast cyclic time. For example, the fast cyclic rate setting of 1005 at 6kHz switching frequency on a Unidrive will actually produce fast cyclic data every 6.9ms, with slow cyclic data every 69ms.

**NOTE**

If the sync node is powered down or disconnected from the CTNet network for any reason, cyclic data transfer will stop. The **AutoSync** function block can be used in the DPL program of all sync-capable nodes to ensure that another node will take over responsibility for the sync message, and cyclic data will continue to be transferred. Refer to section 7.4 *EVENT task trigger on UD70* on page 71 for more details.

## 4.3 Configuring cyclic data links

Cyclic data is configured using the Cyclic Data Editor in the SyPT Pro application, and is incorporated into the DPL program when this is downloaded to the node. Cyclic data links are configured in the source (transmitting) node only, and the following details are specified:

1. Source register
2. Number of consecutive registers
3. Priority (fast or slow)
4. Target node
5. Destination register in target node

When the sync message is received, data is read from the source register(s) and transmitted to the target register(s) in the target node. If multiple registers are transmitted, data is read from and written to consecutive registers following on from the source and target registers. Up to twenty registers can be transmitted on a single cyclic data link.

The total number of data links that can be configured for a source node is ten. This includes both fast and slow cyclic data links, although the cyclic links can be in any combination. There is no limit on the number of cyclic links that can be sent to a single target node; however, the finite processing power of the target node will limit the number of messages that it can handle.

The range of registers that can be used as source and target registers for cyclic data links depends on the source and target node. Table 4-4 shows the range of registers or parameters that can be used as source and target registers for cyclic data links.

**Table 4-4 Cyclic data source and destination registers**

Drive	Device	Source registers	Destination registers	Comment
Unidrive	UD75	_R00%to_R79%	_S00%to_S79%	_R80% to _R99% and _S80% to _S99% are reserved on Unidrive CTNet module
Unidrive SP/ Affinity/ Mentor MP/Digitax ST	SM-Applications/ SM-Applications Plus/ SM-Register	_R00%to_R99%	_S00%to_S99%	
Mentor II	MD29AN	_R00%to_R79%	_S00%to_S79%	_R80% to _R99% and _S80% to _S99% are reserved on CTNet modules
CTNet I/O	BK7200	Pr 1.00 to Pr 1.15	Pr 2.00 to Pr 2.15	Digital inputs and outputs
		Pr 3.00 to Pr 3.99	Pr 4.00 to Pr 4.99	Analog inputs and outputs

Cyclic data links can be edited by the DPL program. Refer to section 7.2 *Editing cyclic data links* on page 70 for further details.

## 4.4 Easy mode cyclic data

A non-DPL method of setting up cyclic data transfer using CTNet is to use the easy mode set-up. Easy mode uses drive parameters to configure data transfer and parameter mapping at each node, and can be configured either from the drive keypad, or via the RS485 port using CTSoft, UniSoft or MentorSoft. Data transfer capabilities are limited, but no DPL code is required.

With easy mode, each node has IN and OUT data slots, similar in concept to analog inputs and outputs. IN data is defined as data coming in to a node, i.e. analog input, while OUT data is transmitted out from the node, i.e. analog output. Unidrive SP, Affinity, Digitax ST and Mentor MP have three IN and three OUT channels, while the Mentor II has two IN and two OUT channels.

**NOTE** The CTNet I/O Coupler does NOT support easy mode cyclic data transfer.

The OUT data channels are configured by specifying the source parameter within the source node, the target node address, and the IN data channels where the data should be written to in the target node. The IN data channels receive data from other nodes on the network, and they only require mapping information to specify the target parameter for the incoming data. The mapping cannot be changed dynamically, as a full reset must be performed to make any changes take effect (see section 3 *Getting started* on page 39).

### 4.4.1 Unidrive

Easy mode cyclic data is configured using menu 20 parameters on Unidrive. The mapping control parameters are shown in Table 4-5.

**Table 4-5 Unidrive easy mode configuration**

Channel	Source/destination parameter	Destination node and channel
IN channel 1	Pr <b>20.10</b> (MMPP)	
IN channel 2	Pr <b>20.11</b> (MMPP)	
IN channel 3	Pr <b>20.12</b> (MMPP)	
OUT channel 1	Pr <b>20.05</b> (MMPP)	Pr <b>20.04</b> (NNNCC)
OUT channel 2	Pr <b>20.07</b> (MMPP)	Pr <b>20.06</b> (NNNCC)
OUT channel 3	Pr <b>20.09</b> (MMPP)	Pr <b>20.08</b> (NNNCC)

The source and destination parameters are entered in the form MMPP, where MM is the menu number and PP is the parameter number. The destination node and channel is entered in the form NNNCC, where NNN is the destination node address, and CC is the IN channel to write to.

If any mapping parameter is set to an invalid value (target parameter is read-only or does not exist), the mapping will revert to 0 when a reset occurs. If a slot is not being used, it can be disabled by setting the mapping to 0.

### 4.4.2 Unidrive SP / Affinity / Digitax ST / Mentor MP

Easy mode cyclic data is configured using channel configuration parameters in the drive. The mapping control parameters are shown in Table 4-6.



**Table 4-6 Easy mode configuration**

Channel	Source/destination parameter MMPP			Destination node and channel NNNCC		
	Slot 1	Slot 2	Slot 3*	Slot 1	Slot 2	Slot 3*
IN channel 1	Pr 15.32	Pr 16.32	Pr 17.32			
IN channel 2	Pr 15.33	Pr 16.33	Pr 17.33			
IN channel 3	Pr 15.34	Pr 16.34	Pr 17.34			
OUT channel 1	Pr 15.27	Pr 16.27	Pr 17.27	Pr 15.26	Pr 16.26	Pr 17.26
OUT channel 2	Pr 15.29	Pr 16.29	Pr 17.29	Pr 15.28	Pr 16.28	Pr 17.28
OUT channel 3	Pr 15.31	Pr 16.31	Pr 17.31	Pr 15.30	Pr 16.30	Pr 17.30

\* Slot 3 is not available on Affinity, Digitax ST Indexer or Digitax ST EZMotion.

The source and destination parameters are entered in the form MMPP, where MM is the menu number and PP is the parameter number. The destination node and channel is entered in the form NNNCC, where NNN is the destination node address, and CC is the IN channel to write to.

For example, to map the value of Pr 1.21 from node 1 (SM-Applications Plus in slot 3) to Pr 1.22 on node 2 (SM-Applications Plus slot 3) on the same CTNet network then;

Easy mode settings for node 1;

Pr 17.27 = 121 (Out channel 1 source, data source)

Pr 17.26 = 201 (Out channel 1 destination; node and channel destination)

Easy mode settings for node 2;

Pr 17.32 = 122 (In channel 1 destination, data destination)

If any mapping parameter is set to an invalid value (target parameter is read-only or does not exist), the mapping will revert to 0 when a reset occurs. If a channel is not being used, it can be disabled by setting the mapping to 0.

#### 4.4.3 Mentor II

Easy mode cyclic data is configured using menu 11 parameters on Mentor II. The mapping control parameters are shown in Table 4-7.

**Table 4-7 Mentor II easy mode configuration**

Channel	Source/destination parameter	Destination node and channel
IN channel 1	Pr 11.07 (MMPP)	
IN channel 2	Pr 11.08 (MMPP)	
OUT channel 1	Pr 11.04 (MMPP)	Pr 11.03 (NNNC)
OUT channel 2	Pr 11.06 (MMPP)	Pr 11.05 (NNNC)

The source and destination parameters are entered in the form MMPP, where MM is the menu number and PP is the parameter number. The destination node and channel is entered in the form NNNC, where NNN is the destination node address, and C is the IN channel to write to.

If any mapping parameter is set to an invalid value (target parameter is read-only or does not exist), the mapping will revert to 0 after which a reset occurs. If a channel is not being used, it can be disabled by setting the mapping to 0.

## 4.5 Mapping conflicts

When the mapping parameters are set, care must be taken to ensure that there are no clashes with the mapping of the analog and digital inputs within the drive. If a parameter is written to by two different sources, the value of this parameter will depend entirely upon the scan times for the analog or digital input and cyclic data timing of CTNet. 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 a glitch in the value will be seen. Internally this value may be continuously changing between the two supplied incoming data values, leading to erratic drive behavior.

**Table 4-8 Analog digital and easy mode input mapping parameters**

Drive input	Mapping parameters		
	Unidrive	Unidrive SP / Digitax ST / Mentor MP	Mentor II
Analog input 1	Pr 7.10	Pr 7.10	Pr 7.11
Analog input 2	Pr 7.14	Pr 7.14	Pr 7.12
Analog input 3	Pr 7.18	Pr 7.18	Pr 7.13
Analog input 4			Pr 7.14
Speed input			Pr 7.15
Easy mode channel 1	Pr 20.10	Pr 15.32, Pr 16.32, Pr 17.32	Pr 11.07
Easy mode channel 2	Pr 20.11	Pr 15.33, Pr 16.33, Pr 17.33	Pr 11.08
Easy mode channel 3	Pr 20.12	Pr 15.34, Pr 16.34, Pr 17.34	
Digital input 1	Pr 8.10	Pr 8.21	
Digital input 2	Pr 8.13	Pr 8.22	Pr 8.12
Digital input 3	Pr 8.16	Pr 8.23	Pr 8.13
Digital input 4	Pr 8.19	Pr 8.24	Pr 8.14
Digital input 5	Pr 8.21	Pr 8.25	Pr 8.15
Digital input 6	Pr 8.23	Pr 8.26	Pr 8.16
Digital input 7			Pr 8.17
Digital input 8			Pr 8.18
Digital input 9			Pr 8.19
Digital input 10			Pr 8.20
Logic output 1	Pr 9.10	Pr 9.10	
Logic output 2	Pr 9.20	Pr 9.20	
Motorized pot output	Pr 9.25	Pr 9.25	
Comparator 1 output	Pr 12.07	Pr 12.07	Pr 12.07
Comparator 2 output	Pr 12.17	Pr 12.27	Pr 12.17
Variable select 1 output		Pr 12.11	
Variable select 2 output		Pr 12.31	
PID output	Pr 14.16	Pr 14.16	

## 5 Non-cyclic data

The non-cyclic data channel allows a node to access any parameter or virtual parameter in any other network node. This function is particularly useful for transmitting infrequent events around the network.

One non-cyclic transaction is serviced by the network controller every 8ms. This limits the number of non-cyclic messages that can be handled by a node to 125 per second. The token-ring architecture of CTNet provides the capability for any node to communicate directly with another node on the network. Nodes that are capable of both sending and receiving non-cyclic messages can communicate with each other at any time.

DPL-capable nodes are able to issue non-cyclic messages to other nodes and respond to non-cyclic messages issued by another node. Source-only nodes, such as TIU200 and PC cards, can issue non-cyclic messages, but they will not respond to non-cyclic messages received from other nodes on the network.

Target-only nodes, such as CTNet I/O, will respond to non-cyclic messages issued from other nodes, but they cannot issue non-cyclic messages as they cannot run DPL programs.

**Table 5-1 Non-cyclic capabilities**

Node	Initiate non-cyclic messages	Respond to non-cyclic messages
UD75	Yes	Yes
SM-Applications SM-Applications Plus SM-Register Digitax ST Plus	Yes	Yes
MD29AN	Yes	Yes
CTNet I/O Coupler (BK7200)	No	Yes
CTNet HMI	Yes	No
PC cards	Yes	No

### 5.1 Non-cyclic message handling

Non-cyclic messages (requests and responses) are transferred into a FIFO non-cyclic buffer as they are received. The buffer can hold five messages, and any subsequent messages received whilst the buffer is full will be lost. The host processor checks the non-cyclic buffer every 8ms, and will process one message if there are messages in the buffer.

A non-cyclic request is a message initiated by a node to read data from or write data to a location within another node. The SyPT Pro watch window uses non-cyclic messages to read data from or write data to parameters and program variables. DPL programs are also downloaded to a node using non-cyclic data.

A non-cyclic response is a message generated in response to a non-cyclic request message received from another node. This can be a response with the data requested, or simply an acknowledgement that a received instruction was executed successfully.

When a non-cyclic request message is issued by the DPL program, it is transferred to the output buffer immediately, and put in the queue for transmission. When the token is next received, provided that there are no cyclic data messages waiting to be transmitted, the message will be sent over the CTNet network.

## 5.2 Non-cyclic message delays

Due to the low priority of non-cyclic messages, the time delay between requesting a parameter from a remote node and receiving a response will depend on the loading of the CTNet network. As the number of nodes increases, the token will be received less often, so the delay between request and response messages being transferred to the output buffer and actual transmission will increase. Similarly, as the network loading due to cyclic data increases, non-cyclic request and response messages may have to wait for several token rotations while higher priority cyclic messages are transmitted.

## 5.3 Reading parameters over CTNet

The **ReadNet** function block is provided in SyPT Pro to allow the DPL program to read parameters from other nodes on the CTNet network. **ReadNet** can be called from any DPL task, and uses minimal resources while waiting for the remote node to respond.

Full details and example DPL code are available in the SyPT Pro help file.

## 5.4 Writing parameters over CTNet

The **WriteNet** function block is provided in SyPT Pro to allow the DPL program to write data to parameters in other nodes on the CTNet network. **WriteNet** can be called from any DPL task, and uses minimal resources while waiting for the remote node to respond.

Full details and example DPL code are available in the SyPT Pro Help File.

## 5.5 Check if node exists

The **CheckNode** function block allows a DPL program to determine whether a target node address is present on the network or not.

Full details and example DPL code are available in the SyPT Pro Help File.

## 5.6 Turbo CTNet Mode

In some applications where large volumes of non-cyclic (usually PC or controller related) traffic is present, priority can be given to non-cyclic messages to improve the performance for non-cyclic messages only.

When this mode is enabled the throughput of Non Cyclic messages will be increased, however this will come at the expense of processor resources for other tasks. Internal testing has shown that this does not normally cause issues, however in circumstances with large amounts of processor utilisation and heavy communications loading this has potential to generate task overruns and potentially will have an impact on inter-option communications throughput.

This setting (as with all other settings for Pr **MM. 44**), should only be changed under the instruction of CT Newtown. This parameter cannot make the processor perform more in the same time frame, but simply prioritizes which task has a higher priority. Thus if the processor has no resources left, then some processes may not have time to complete, causing trips including but not limited to Task.

### NOTE

This mode is available on SM-Applications, SM-Applications Plus, SM-Register and Digitax ST Plus.

## 6 Diagnostics

### 6.1 CTNet status indication

#### 6.1.1 Unidrive

CTNet status is indicated in Pr **20.50** on Unidrive, and is updated once per second. Table 6-1 shows the CTNet network status on Unidrive.

**Table 6-1 Unidrive CTNet status**

Pr <b>20.50</b>	Indication
-2	Initialization failure. The UD70 was unable to configure the CTNet interface. Check that the node address and data rate are set correctly.
-1	A network reconfiguration has been detected.
0	The low-level token ring has been established and is active, but the node is not receiving any CTNet data messages. Indicates that there are no problems with the physical wiring of the CTNet network.
>0	Indicates the number of CTNet messages being processed every second.

The CTNet control software is part of the UD70 system file (UD70NET.SYS) and the system file version can be read from Pr **17.02**.

#### 6.1.2 SM-Applications / SM-Applications Plus / SM-Register / Digitax ST Plus

CTNet status is indicated in Pr **MM.36** where MM is the menu of parameters associated with the slot in which the SM-Applications / SM-Applications Plus module is installed. The status display value is updated once per second. Table 6-2 shows the CTNet network status on the drive.

**Table 6-2 SM-Applications / SM-Applications Plus / SM-Register / Digitax ST Plus CTNet status**

Pr <b>MM.36</b>	Indication
-3	Network reconfiguration issued. The SM-Applications module forced a CTNet network reconfiguration.
-2	Initialization failure. The SM-Applications module was unable to configure the CTNet interface. Check that the node address and data rate are set correctly.
-1	A network reconfiguration has been detected.
0	The low-level token ring has been established and is active, but the node is not receiving any CTNet data messages.
>0	Indicates the number of CTNet messages being processed every second.

#### 6.1.3 Mentor II

CTNet status is indicated in Pr **16.62** in Mentor II, and is updated once per second. Table 6-3 shows the CTNet network status on Mentor II.

**Table 6-3 Mentor II CTNet status**

Pr <b>16.62</b>	Indication
-2	Initialization failure. The MD29AN was unable to configure the CTNet interface. Check that the node address and data rate are set correctly.
-1	A network reconfiguration has been detected during the previous second.
0	The low-level token ring has been established and is active, but the node is not receiving any CTNet data messages.
>0	Indicates the number of CTNet messages being processed every second.

### 6.1.4 CTNet I/O coupler

CTNet status is indicated by the BUS ERR and COM RUN LEDs on the CTNet I/O coupler, and these LEDs are updated once every second. Table 6-4 shows the CTNet network status on the CTNet I/O Coupler.

**Table 6-4 CTNet I/O coupler status**

LED	Color	Indication
OK / HEALTHY	Green	Indicates that the CTNet I/O coupler has powered up and initialized OK.
BUS ERR	Red	A network reconfiguration has been detected during the previous second.
COM RUN	Green	OFF - the low-level token ring has been established and is active, but the node is not receiving any CTNet data messages. ON - indicates that CTNet messages are being received and processed every second.
INIT ERR	Red	Unable to initialise the CTNet interface. Check that the node address and data rate have been configured correctly and is unique on the network.
I/O RUN	Green	Indicates that the K-bus (used to communicate with the I/O modules) has initialized and is running.
I/O ERR	Red	Indicates that there is a problem with the K-bus. Check that the last module is a KL9010 terminator module, all I/O terminals are supported, and all modules are properly installed together.

### 6.1.5 CTNet HMI (TIU)

There is no external CTNet status indication on the CTNet HMI.

### 6.1.6 CTNet Hub

CTNet status is indicated by LEDs on the CTNet Hub. Table 6-5 shows the CTNet network status on CTNet Hub.

**Table 6-5 CTNet Hub status**

LED	Indication
1	Network activity detected on port 1.
2	Network activity detected on port 2.
3	Network activity detected on port 3.
RECON	Network reconfiguration in progress.
STATUS	Indicates the current operating status of the hub. ON = network is active and hub is regenerating signals to the other ports. FLASHING = hub is functioning, but no network activity has been detected.

### 6.1.7 CTNet PCI and ISA cards

CTNet status is indicated by LEDs on the CTNet PCI card. Table 6-6 shows the CTNet network status on CTNet PCI card.

**Table 6-6 CTNet PCI and ISA card status**

LED	Indication
Green	Indicates that the CTNet PCI card is transmitting messages over the CTNet network.
Yellow	Indicates that the CTNet PCI card is being accessed via its I/O address.

### 6.1.8 CTNet PCMCIA card / CTNet USB22 adaptor

CTNet status is indicated by the LED on the CTNet PCI card / CTNet USB22 Adaptor. Table 6-7 shows the CTNet network status on CTNet PCI card / CTNet USB22 Adaptor.

**Table 6-7 CTNet PCMCIA card status**

LEDs	Indication
Green	ON = indicates that the PCMCIA card / CTNet USB22 adaptor is currently active and on-line and is taking part in the token ring. OFF = PCMCIA card / CTNet USB22 Adaptor is off-line.

## 6.2 CTNet configuration errors

Configuration errors are detected as part of the initialization sequence of the CTNet node. During initialization, the node effectively monitors the CTNet network, and if any of the tests fail, the node does not go on-line. This prevents an incorrectly configured node from interfering with the operation of the existing network.

CTNet configuration errors will cause a drive trip when the CTNet interface is initialized. The drive trip code can be viewed through the drive / option module parameters. The location of the trip code is different for each of the drives / modules as shown below.

**Table 6-8 CTNet configuration error trip codes**

Error	Unidrive UD75 tr60-tr64		Mentor II MD29AN A29		SM-Applications SM-Applications Plus SM-Register Digitax ST Plus	
Hardware error (See Section 6.2.1)	Pr <b>10.20</b>	60	Pr <b>10.35</b>	60	Pr <b>MM.50</b>	60
Invalid configuration (See Section 6.2.2)		61		61		61
Data rate mismatch (See Section 6.2.3)		62		62		62
Duplicate node address (See Section 6.2.4)		63		63		63
Illegal cyclic data rate (See Section 6.2.5)		64		64		64

**NOTE**

The x in the error message will indicate the slot number that caused the trip. MM should be replaced by the appropriate menu for the slot, i.e. MM = 15 for slot 1, MM = 16 for slot 2, MM = 17 for slot 3.

### 6.2.1 Hardware error

The internal CTNet hardware could not be correctly initialized. Cycle the power to the device to clear the error. If the fault persists, replace the CTNet module.

### 6.2.2 Invalid configuration

The node address or data rate settings are outside of the permitted range. Valid settings are 0 to 255 for the node address, and 0 to 2 for the data rate.

### 6.2.3 Data rate mismatch

During initialization, the CTNet node will monitor the CTNet network, checking for network activity, and waiting to receive the token from another node. If network activity is detected, but no token is received, the node assumes that the configured data rate is incorrect. The node will continue to attempt to join the token ring by issuing a network reconfiguration once per second. Set the correct data rate and reset the node. When the reset sequence is complete, the node will try again to join the token ring.

### 6.2.4 Duplicate node address

During initialization, the CTNet node will check to see if there is another node already on-line with the specified node address. If not, it will force a network reconfiguration and join the token ring. If another node with the same node address already exists on the token ring, the node will not join the network, preventing any chance of interfering with the existing node.

Set the correct node address, and reset the node (see section 3 *Getting started* on page 39). When the reset sequence is complete, the node will try again to join the token ring.

### 6.2.5 Illegal cyclic data rate

The setting for the cyclic data rate is not valid. Check that the setting for the slow cyclic data rate has not exceeded the maximum for the type of node.

## 6.3 CTNet advanced diagnostics and operation overview

A series of advanced diagnostic registers are available to the DPL program in UD75, MD29AN, SM-Applications, SM-Applications Plus, SM-Register and Digitax ST Plus. This allows the diagnostic values to be transferred to DPL variables or drive parameters for viewing.

The **CTNETDIAGNOSTICS** function provides access to the CTNet diagnostic registers in the DPL program. (Functional Block Library V1.4.0 must be installed to use CTNet diagnostic). All diagnostic registers are returned as output arguments by this **CTNETDIAGNOSTICS**, and these values can be transferred to DPL variables or drive parameters.

**NOTE** On UD75, MD29AN, SM-Applications, SM-Applications Plus, SM-Register and Digitax ST Plus, each diagnostic register also has an alias that can be copied to a DPL variable, e.g. **Messages% = NOFMESSAGES**

Once the diagnostics registers have been transferred to DPL variables, they can be copied to drive parameters to allow the values to be viewed on the drive display.



**Table 6-9 CTNet advanced diagnostic registers**

Diagnostic	CTNETDIAGNOSTIC S argument	Unidrive/Mentor II alias
CTNet messages (See Section 6.3.1)	1	NOFMESSAGES
Cyclic data overruns (See Section 6.3.2)	2	NOFOVERRUNS
Lost message (See Section 6.3.3)	3	NOFLOSTMESSAGES
Message retries (See Section 6.3.4)	4	NOFRETRIES
Network reconfigurations (See Section 6.3.5)	5	NOFRECONS
Excessive NAKs (See Section 6.3.6)	6	NOFEXENAKS
Duplicate sync messages (See Section 6.3.7)	7	NOFDUPSYNCS
My network reconfigurations (See Section 6.3.8)	8	NOFMYRECONS
CTNet non-cyclic messages (See Section 6.3.9)	9	NOFNONCYCLICMESSAGES
Lost routing messages (See Section 6.3.10)	10	Not available. Will always return 0 on UD75, MD29AN, SM-Applications, SM-Applications Plus, SM-Register and Digitax ST Plus

During network initialization, different nodes may be powered up at different times and take longer to go on-line. As the network status is constantly changing during this period, cyclic data overruns, lost messages and/or duplicate sync messages may be registered. However, a CTNet network running under steady conditions with all nodes continuously on-line should not see any change in the number of cyclic data overruns, lost messages or duplicate sync messages.

These diagnostic registers indicate the operational status of the high-level CTNet protocol. CTNet protocol errors do not actually prevent the node from communicating on a network, and do not cause the network to fall over. However, a CTNet network may appear to be operating correctly, but there may be circumstances where problems can appear that may not immediately be obvious.

### 6.3.1 CTNet messages

Argument	1	Range	2147483647 to -2147483648
Variable	Messages%	Reset value	0

**Messages%** is initialized to 0 after reset, and is incremented by one for every CTNet message transmitted or received. Each cyclic data message, cyclic sync message, transmitted broadcast non-cyclic write message and received non-cyclic broadcast message will be counted as one message. All other non-cyclic messages will be counted as two messages, as one transmit message and one receive message will be seen.

**Messages%** will roll-over from 2147483647 to -2147483647 if the node is not reset. This must be allowed for when using this value in a DPL program.

### 6.3.2 Cyclic data overruns and network operation

<b>Argument</b>	2	<b>Range</b>	0 to 65535
<b>Variable</b>	<b>Overruns%</b>	<b>Reset value</b>	0

If a new fast cyclic sync message is received **before** the node has completed the transmission of its fast cyclic data links as triggered by previous fast sync message, this is known as a cyclic data overrun. When this occurs, the node will ignore the new cyclic sync message, and finish transmitting the defined fast links. It will then wait for another fast cyclic sync message to arrive before starting to transmit the fast cyclic data links again. The result is that fast cyclic data will only be transmitted on every other fast sync message, so the update rate in the target node is effectively halved. The same applies to slow cyclic data.

**Overruns%** counts the number of occasions where a cyclic data overrun occurs. This value should not be seen to increase on a correctly configured CTNet system operating under steady network conditions. If cyclic overruns are occurring:

1. Increase / slow down the fast and / or slow cyclic data rate.
2. Convert some fast cyclic data links to slow cyclic data links.

#### NOTE

If **AUTOSYNC** is installed in the DPL program, one cyclic data overrun may be detected when a new node with a lower node address than the current sync node joins the network. The new node will take over as the sync node, and may transmit a new sync message before the expected sync period is complete. Nodes that are still transmitting cyclic data will ignore the new sync message, indicate that a cyclic overrun has occurred, and complete their cyclic data transmissions. When the next sync message is received, cyclic data will continue as normal.

### 6.3.3 Lost messages

<b>Argument</b>	3	<b>Range</b>	0 to 65535
<b>Variable</b>	<b>LostMessages%</b>	<b>Reset value</b>	0

When non-cyclic request and response messages are received from remote nodes, they are transferred to the FIFO non-cyclic message buffer. The buffer is serviced every 8ms on UD75, MD29AN, SM-Applications, SM-Applications Plus, SM-Register and Digitax ST Plus, and all messages held in the buffer at that time will be processed. The buffer can hold six messages.

If a new non-cyclic request or response message is received when the non-cyclic buffer is full, the message will be discarded, and **LostMessages%** will be incremented.

Indicates that messages are being received from the CTNet network faster than the node can process them. When the internal software buffer is full, messages will be lost.

### 6.3.4 Message retries

<b>Argument</b>	4	<b>Range</b>	0 to 65535
<b>Variable</b>	<b>Retries%</b>	<b>Reset value</b>	0

If a target node does not respond to the FBE message (see excessive NAKs, section 6.3.6 *Excessive NAK / network operation* on page 60) or the PAC (data) message when a non-cyclic message is issued, the transmitting node will attempt to send the message five times before abandoning the message. Causes could be that the target node does not exist, or that the message received by the target node was corrupted and the CRC check failed, indicating problems with the network, e.g. noise of bad connections.

**Retries%** will be incremented every time a message transmission fails, so a count of five would be expected for every failed non-cyclic message.

### 6.3.5 Network reconfigurations (network operation)

<b>Argument</b>	5	<b>Range</b>	0 to 65535
<b>Variable</b>	Recons%	<b>Reset value</b>	0

A network reconfiguration is the process by which the nodes on CTNet network generate the token ring arbitration system (see section 6.3.8 *My network reconfigurations* on page 61). No CTNet messages will be transmitted while a network reconfiguration is in progress, but data transfer will automatically restart when the process is complete.

A network reconfiguration sequence consists of three phases:

#### Reconfiguration burst

When a network reconfiguration condition arises in a node, it will transmit the reconfiguration burst onto the network. The idea is to totally corrupt any messages that are present on the network and destroy the token ring. The reconfiguration burst consists of eight pulses and one space, repeated 765 times. This is longer than the longest possible valid message frame, and guarantees that the token ring will be destroyed.

#### Timeout phase

When the Activity Timeout time ( $T_{AC}$ ) has elapsed with no network activity detected, each node will start a pre-defined time-out sequence based on it's node address. The node with the highest address will time out first, and will start transmitting by sending an Invitation To Transmit (ITT or token) message to itself.

#### Reconfiguration phase

After sending a token to itself, the node will transmit a token to the next higher node address, and wait ( $T_{TPFAIL}$ ) for a response (when node address 255 is reached, the node will start again at 1). If no response is detected, the transmitting node will transmit a token to the next highest node address, and so on until a response is seen. The node that responds will now take over and transmit a token to successive higher node addresses until it in turn gets a response, and so on until the token returns to the highest node address.

At this point, every node on the network will know the next highest node address to its own address, token-passing will automatically start, and CTNet messages can be transmitted. The reconfiguration time for a network can be calculated using the following equation:

$$T_{NR} = T_{RB} + T_{AC} + (T_{RTO} \times (255 - N_{Max})) + (T_{TPOK} \times N_{Total}) + (T_{TPFAIL} \times (255 - N_{Total}))$$

where:

$T_{NR}$  = network reconfiguration time.

$T_{RB}$  = reconfiguration burst transmission time.

$T_{AC}$  = network idle time before reconfiguration time-out sequence will begin.

$T_{RTO}$  = reconfiguration timeout delay.

$T_{TPOK}$  = time taken for a successful token pass.

$T_{TPFAIL}$  = time taken for an unsuccessful token pass.

$N_{Total}$  = total number of nodes on the network.

$N_{Max}$  = highest node address.

All timings are shown in microseconds in Table 6-10.

**Table 6-10 Network timings**

Variable	5.0 Mbit/s	2.5 Mbit/s	1.25 Mbit/s
T <sub>RB</sub>	1377	2754	5508
T <sub>AC</sub>	41.2	82.4	164.8
T <sub>RTO</sub>	73	146	292
T <sub>TPOK</sub>	14.1	28.2	56.4
T <sub>TPFAIL</sub>	46.6	93.2	186.4

**Recons%** is incremented by one every time a network reconfiguration is detected, and the network status parameter will indicate -1 for one second.

Network reconfigurations are the most common symptom of a network with major wiring or configuration problems, and identifying the cause of the problem requires a careful and methodical approach, as detailed in section 6.4 *Solving network reconfiguration problems* on page 62. However, network reconfigurations can also be perfectly legitimate events, caused by user code in a CTNet node. See section 6.3.8 *My network reconfigurations* on page 61 for further details.

### 6.3.6 Excessive NAK / network operation

Argument	6	Range	0 to 65535
Variable	LostMessages%	Reset value	0

When a node wishes to transmit a message (cyclic, non-cyclic request or non-cyclic response) to a remote node, it sends the free buffer enquiry (FBE) message to the remote node. If the remote node has an internal buffer available to receive the message, it will respond with the acknowledge (ACK) message. The transmitting node will transmit the data packet (PAC) message, and if the remote node receives the PAC message successfully, it will respond again with the ACK message. This concludes a successful message transmission, and the transmitting node will pass the token to the next node in the token ring.

If the remote node responds with a negative acknowledge (NAK) message (instead of the ACK message) to an FBE message, the transmitting node will abandon attempts to transmit the message, and will pass the token to the next node address on the network. It will attempt to re-send the same message the next time it receives the token.

If a NAK message is received after four attempts to send the message, the node will abandon attempts to send the message, and will increment the **ExeNaks%** register.

Excessive NAK errors occur when the internal hardware buffers are both full. These buffers are serviced by an interrupt routine, so messages must be arriving faster than the processor can transfer them out of the hardware buffers. This condition will only be seen when a target node is being swamped with broadcast messages, or on a network operating at 5.0 Mbit/s where multiple nodes are transmitting to a single node. To prevent excessive NAK errors:

1. Run the network at a slower data rate.
2. Re-design data transfer requirements to reduce the load on the target node.

If a node is being overloaded with non-cyclic messages on a network running at 2.5Mbit/s or 1.25Mbit/s, lost non-cyclic messages will be recorded as lost messages (see section 6.3.3 *Lost messages* on page 58).

### 6.3.7 Duplicate sync messages

Argument	7	Range	0 to 65535
Variable	DupSyncs%	Reset value	0

Cyclic data on a CTNet network should be controlled by a single node on the network. If two or more nodes are configured to generate the sync message, each sync node will detect that another node is generating a sync message, and will increment the **DupSyncs%** register.

Only one node should be configured to generate the sync message. If duplicate sync messages are continuously detected, ensure that another node is not configured to generate the cyclic sync message, and that a DPL program in another node is not trying to enable the sync message using the **SETCTNSYNC** function block.

**NOTE** If **AUTOSYNC** is installed in the DPL program, one duplicate sync message may be detected when a new node i.e. node A with a lower node address than the current sync node (node B), joins the network. Node A will take over as the sync node, and node B will detect the new sync message and register a duplicate sync message. By the time node A transmits another sync message, node B will have disabled sync message generation, no more duplicate sync messages will be registered.

### 6.3.8 My network reconfigurations

Argument	8	Range	0 to 65535
Variable	MyRecons%	Reset value	0

Network reconfigurations are a crucial part of CTNet operation, and may occasionally be seen on a perfectly stable network. It is important to ensure that they are not being caused by user DPL code in UD75, MD29AN, SM-Applications, SM-Applications Plus, SM-Register and Digitax ST Plus or by user code in a PC tool.

There are three conditions under which a network reconfiguration will always be seen and can be accounted for.

1. A new node joining the network at power up.
2. A PC node going on-line.
3. A node re-joining the network after a reset sequence.

It is also possible that a network reconfiguration will occur when a node goes off-line. If the node is in possession of the token when it goes off-line, the token ring is interrupted, and a network reconfiguration will occur to re-establish the token ring. If a node goes off-line when it does not have the token, a network reconfiguration will not occur.

**MyRecons%** is incremented when the node forces a network reconfiguration, allowing the source of the network reconfiguration to be identified. See also section 6.3.5 *Network reconfigurations (network operation)* on page 59 and section 6.4 *Solving network reconfiguration problems* on page 62.

### 6.3.9 CTNet non cyclic messages

Argument	9	Range	0 to 65535
Variable	NonCyclicMessages%	Reset Value	0

**NonCyclicMessages%** is initialized to 0 after reset, and is incremented by one for every CTNet non-cyclic message processed.

### 6.3.10 Lost routing messages (Unidrive SP / Affinity / Digitax ST / Mentor MP)

Argument	10	Range	0 to 65535
Variable	LostRoutingMessages%	Reset Value	0

The drive was unable to route a CT-RTU message from the Unidrive SP RS485 port to the specified network. Either the SM-Applications is not connected to the CTNet network, or the hardware transmit buffers are full.

**LostRoutingMessages%** will be incremented every time a message transmission fails, so a count of five would be expected for every failed non-cyclic message.

## 6.4 Solving network reconfiguration problems

The symptom generally seen on a CTNet network with problems is that network reconfigurations are taking place, either spuriously or continuously. This is indicated by a value of -1 in the status parameter on UD75, MD29AN, SM-Applications, SM-Applications Plus, SM-Register and Digitax ST Plus, the red BUS ERR LED on a CTNet I/O Coupler, and the amber RECON LED on a CTNet Hub. The situation can be made more confusing by the fact that correct data transfer may also be taking place, despite the presence of network reconfigurations.

Status parameter on UD75, MD29AN, SM-Applications, SM-Applications Plus, SM-Register and Digitax ST Plus, the BUS ERR LED on CTNet I/O Couplers and RECON LED on CTNet Hubs are only updated once per second. However, a network reconfiguration will take a maximum of 120ms (see section 6.3.5 *Network reconfigurations (network operation)* on page 59) even at the slowest data rate, so data transfer may be successful for the remainder of each one second interval.

If network reconfigurations appear not to be genuine, refer to section 6.3.8 *My network reconfigurations* on page 61 and check the configuration of each device:

1. Ensure that all nodes on the network have a unique node address.
2. Ensure that all nodes on the network (including hubs) have been configured to run at the correct data rate.
3. All nodes must either be reset or have their power cycled before changes in the configuration take effect (PC nodes must be taken off-line, and will adopt the new settings when they next go on-line).

Any node on a CTNet network can force a network reconfiguration, and every node on the network can detect that a network reconfiguration sequence has occurred. Hence, while the presence of network reconfigurations is easy to detect, this does not actually give any direct indication as to where the problem is occurring on the network.

### 6.4.1 Physical network test

To identify the segment containing the node that is initiating the network reconfigurations:

1. Disconnect all segments from hubs and repeaters. This makes each segment into a separate network with its own token ring system, and allows the integrity of each segment to be checked.
2. Remove all data from the network by disabling cyclic data and all DPL programs. All PC and CTNet HMI nodes should be taken off-line. In this condition, the status parameters on UD75, MD29AN, SM-Applications and SM-Applications Plus should all indicate 0, and the BUS ERR and COM RUN LEDs on the CTNet I/O Coupler should be off.

If network reconfigurations are still occurring on a segment, there is likely to be a problem with the physical wiring on the segment.

3. Disconnect every node from the segment and measure the resistance between the A and B lines. The resistance should be approximately  $41\Omega$ , although this will be slightly higher for longer cable runs due to cable resistance.

**NOTE** Each node must be wired as specified in section 2.4 *CTNet wiring practices* on page 17, otherwise disconnecting the nodes will break the cable continuity, and this test will not be valid.

4. If the resistance measured is in the region of  $82\Omega$ , this indicates that a termination resistor is missing or faulty, or there is a faulty connection on the segment that is breaking cable continuity. In effect, the node will see an unterminated portion of network, and signal reflections may interfere with and corrupt genuine data signals.
5. If the data lines are open circuit, the segment is effectively unterminated. Check that termination resistors are installed, installed correctly, and are the correct value. If necessary, disconnect and measure the termination resistors to ensure that they actually have the resistance value that they are supposed to have.
6. If the resistance measured is less than  $40\Omega$  but not a short circuit, this may indicate that there is an additional termination resistor installed somewhere on the segment. Check that internal termination resistors on CTNet Hubs, Repeaters and PC cards are disabled if external resistors are being used, and remove any external resistors if the internal resistors are enabled.

**NOTE** It is recommended NOT to use the internal termination resistor on PCMCIA cards, as the segment will be left unterminated when the PCMCIA card is disconnected.

7. Reconnect two nodes and check that the segment operates correctly.
8. Add one node at a time until all nodes are re-connected. One network reconfiguration will be seen as each new node is added to the network.
9. If network reconfigurations start to occur when a node is re-connected, this is a good indication that the newly connected node is causing the problems. Disconnect this node from the network again.
10. Continue re-connecting other nodes to the segment. If no further network reconfigurations occur, the node responsible for the network reconfigurations has been identified.
11. Re-connect all segments to the repeaters. Again, if no network reconfigurations occur, the node responsible for the network reconfigurations has been identified. For a system experiencing intermittent recons, it may be a bad connection in the system that is causing the problem. A good way to test this is to move the CTNet cables next to each node in turn, and observe the status of the network. If network reconfigurations occur, check for following faults:
12. Bent pins on the CTNet plug on the device itself. This is an indication that the screw terminals on the CTNet connector have been over-tightened, and the internal contact mechanism has been damaged. Replace the CTNet connector, taking care not to over-tighten the screw terminal.
13. Broken data wires. Repeated plugging and unplugging of the CTNet cable can cause the data wires to break if they do not have adequate strain relief. Bootlace ferrules should be installed (see section 2.4 *CTNet wiring practices* on page 17) to ensure that adequate mechanical strength is provided. In particular, check for a broken wire that may not be obvious, especially in systems where there may be some vibration.

# 6.5 Viewing CTNet signals using an oscilloscope

A dual-channel oscilloscope with MATH function can be used to check the signal on a CTNet segment. Connect CH1 to CTNet A and CH2 to CTNet B, with the ground clips of each probe connected to the screen of the CTNet cable as close to the node as possible. An external termination resistor provides a convenient place to connect to the CTNet A and CTNet B lines without disturbing the network wiring. A typical waveform from a CTNet network running at 2.5 Mbit/s is shown in Figure 6-1 and Figure 6-2.

Figure 6-1 CTNet A and CTNet B signal (Rev D) at 2.5Mbit/s

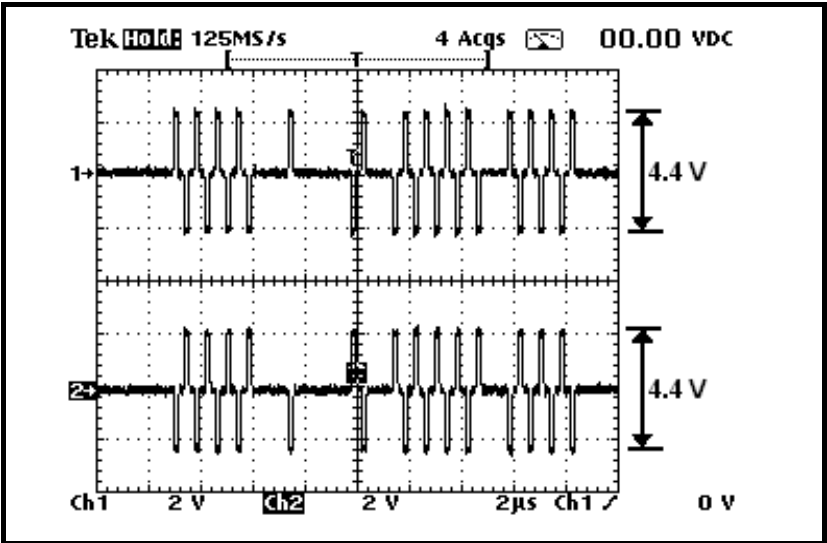
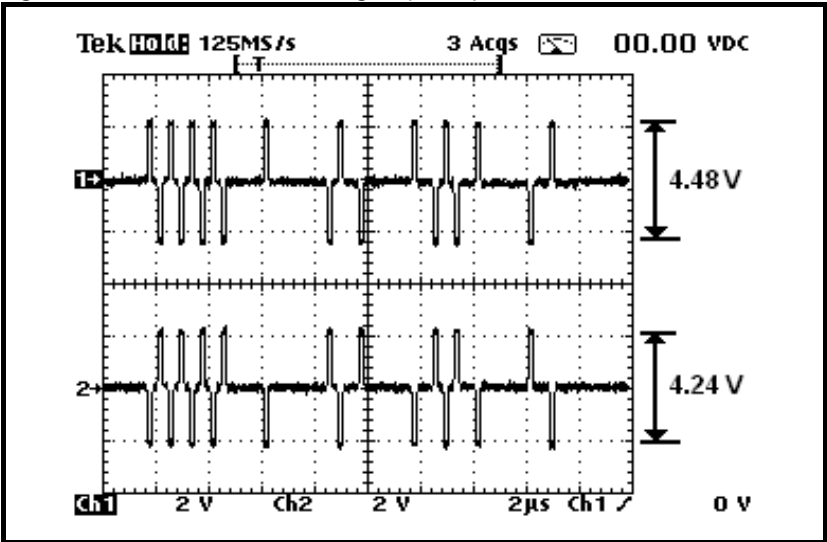


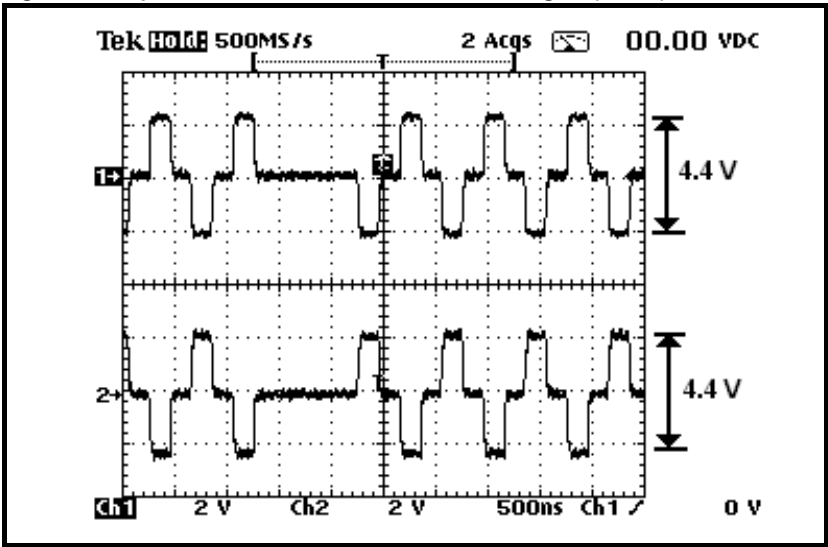
Figure 6-2 CTNet A and CTNet B signal (Rev B) at 2.5Mbit/s



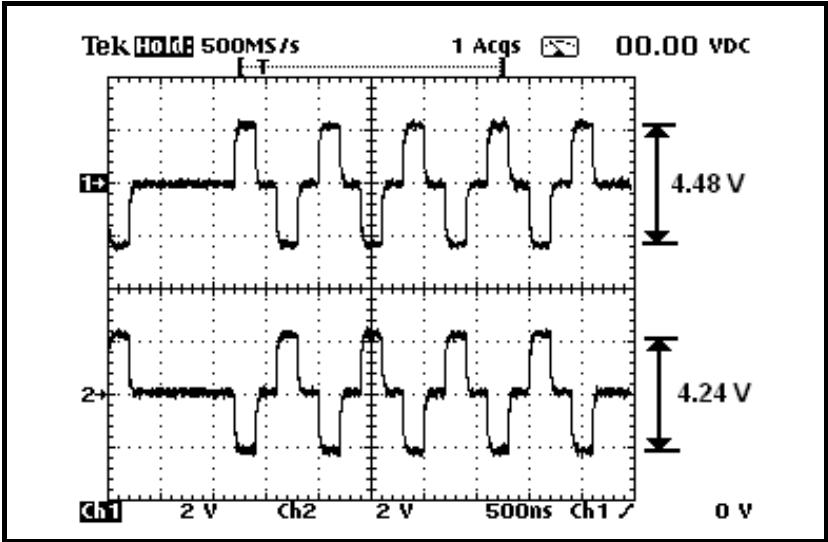


Each channel will show the signal voltage on each data line, relative to the screen. "Logic 1" is indicated by the presence of a 50%-50% mark-space ratio pulse, "logic 0" is indicated by a bit period of silence (see Figure 6-3 and Figure 6-4). Successive pulses are always of opposite polarity.

**Figure 6-3 Expanded view of CTNet A and CTNet B signal (Rev D) at 2.5Mbit/s**



**Figure 6-4 Expanded view of CTNet A and CTNet B signal (Rev B) at 2.5Mbit/s**



It is usual to see some noise on top of the signal pulses, and oscillations of a couple of volts are not uncommon, particularly if the drives are enabled. If the data signals are imprinted onto a 50Hz or 60Hz wave, this may indicate that the screen is not properly earthed on the segment (see Figure 2.8 *CTNet shield connections* on page 34).

The MATH function should be configured to display the difference signal, i.e. CH1 - CH2 or CH2 - CH1. This shows the true differential voltage of the CTNet pulses, and is the voltage seen by the CTNet receiver stage (see Figure 6-5 and Figure 6-6).

**NOTE** It is essential that the scope ground 0V is taken as close to the node as possible, ideally directly on the node's CTNet connector to prevent noise being introduced by the probe.

Figure 6-5 CTNet differential signal (Rev D) at 2.5Mbit/s

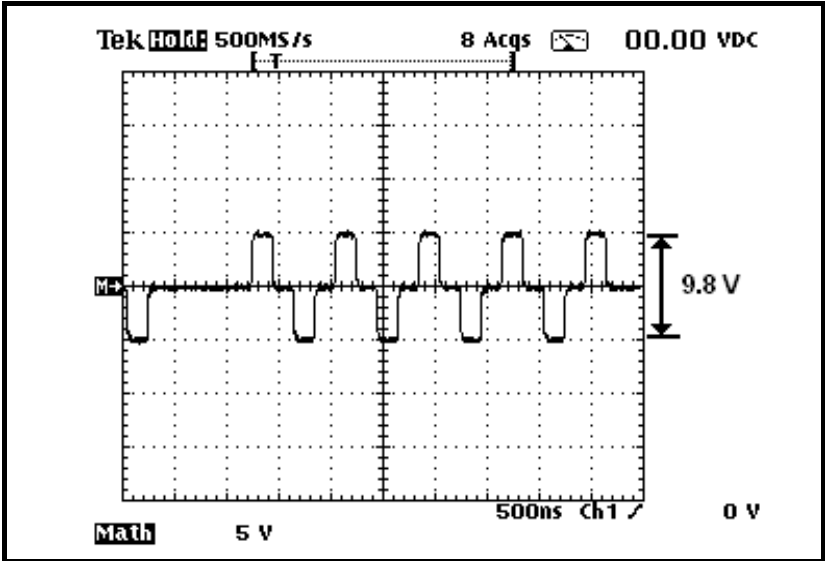
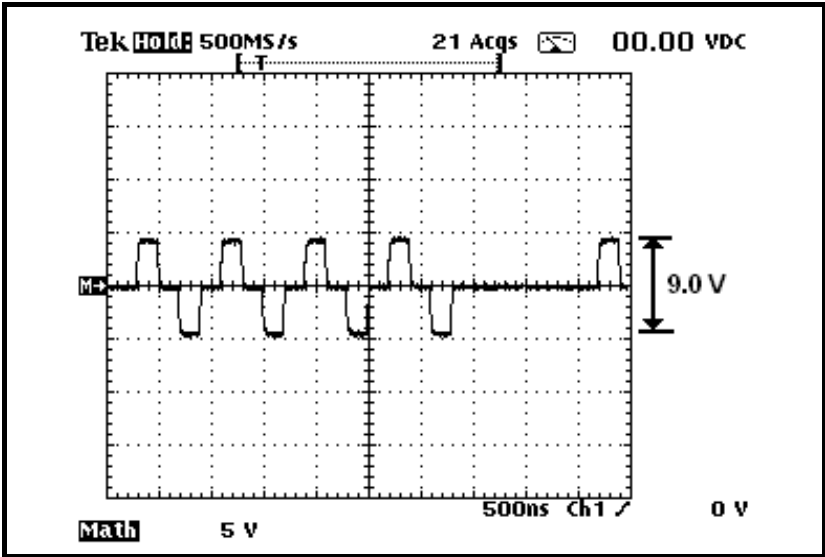


Figure 6-6 CTNet differential signal (Rev B) at 2.5Mbit/s



There should be no noise on this signal. If the signal has excessive noise, this would indicate that there is a wiring error somewhere on the network.

Logic 1 is represented by a single pulse that is high for half of a bit time, with pulses alternating between positive and negative differential voltages. Logic 0 is represented by a space, i.e. no pulse for a whole bit time (see Figure 6-7).

Figure 6-7 Expanded view of CTNet differential signal (Rev D) at 2.5Mbit/s

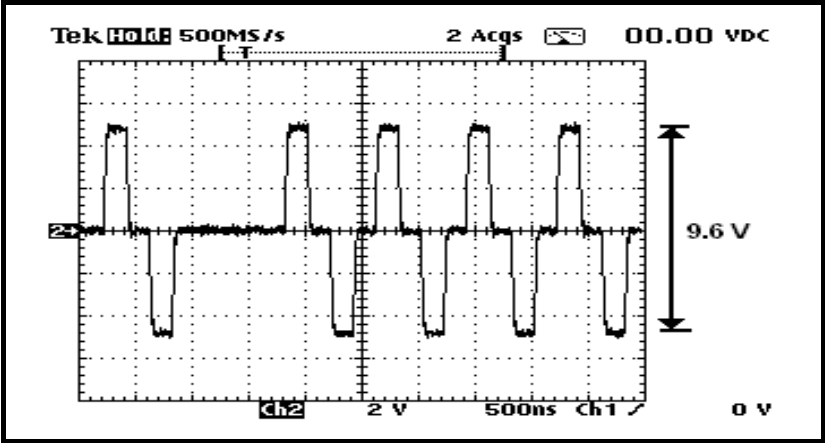
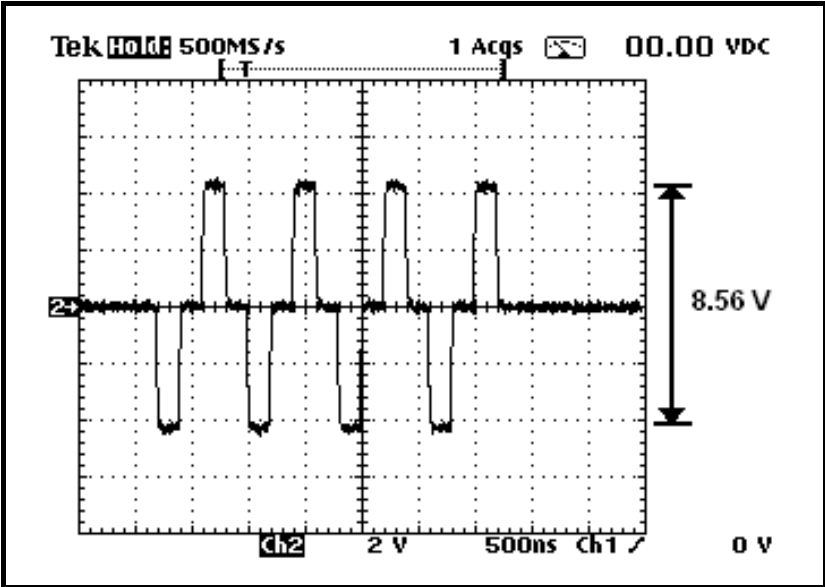


Figure 6-8 Expanded view of CTNet differential signal (Rev B) at 2.5Mbit/s



## 6.6 Overloading a node

CTNet cyclic data messages are handled in an interrupt routine, and have higher priority than DPL program tasks. Consequently, as more and more CTNet messages arrive, the amount of processor time available to run the DPL program tasks is reduced. Although the scheduling of time-base tasks is not affected, the amount of code that can be executed in each task without causing task overrun error is reduced.

### NOTE

Priority of CTNet message handling can be changed in the SM-Applications module to give higher priority to the **POS0** and **POS1** tasks. This will prevent task overrun errors when a node receives a large number of CTNet messages in a short time period (see *CTNet priority level on SM-Applications/SM-Applications Plus/ SM-Register /Digitax ST Plus* on page 72).

SM-Applications, SM-Applications Plus, SM-Register and Digitax ST Plus allow the relative priorities of **POS** interruptions communications, and CTNet Pr **MM.44** should only be used after consideration is given to what other processes in the module will suffer.

### 6.6.1 Continuous overload

Continuous overload occurs when one node is transmitting and receiving a large number of CTNet cyclic data messages. This is particularly common in a system where a CTNet node has been assigned to act as a central point of control for the system, and all other nodes transmit cyclic data to this central node. As the number of processed messages (both transmitted and received) increases, the processor resources available are reduced. If resources get too low, operations such as the Position Controller may have to be switched to a slower timebase, resulting in a significant drop in system response times and overall performance.

Slowing down the rate of cyclic data transfer and re-structuring the cyclic data links will help to reduce the CTNet load on a node. A sensible value should be chosen for fast cyclic data, as there is little point in transmitting a data value every 2 ms if it is only being updated every 10ms in the source node.

Unidrive and Mentor II nodes are capable of processing four messages every millisecond, without any noticeable effect on the available processor resources.

### 6.6.2 Peak overload

Peak overload is usually indicated by a Task Overrun error when there is plenty of processor resource normally available. It occurs when a node receives a burst of messages in quick succession, and the messages arrive quicker than the node can process them.

When the CTNet sync message is transmitted, all nodes with cyclic data links configured will start to transmit their cyclic data when they next receive the token, resulting in the target node receiving a burst of data messages after every sync message. As the cyclic messages are processed, the DPL tasks are blocked, and if blocked for long enough, a DPL Task Overrun error can occur.

Slowing down the fast cyclic data rate has little effect on peak overload problems, as it simply means that the burst of messages arrives less often. This may mean that a DPL Task Overrun error occurs every two days instead of every day, but the fact remains that spurious trips may interrupt the operation of a machine. Resetting the node will allow the system to re-start and maybe continue for another two days before occurring again, and the customer is unlikely to find this situation acceptable.

The network data rate has the greatest effect on peak overload problems, as this affects the time taken to actually transmit a message. Peak overload is most likely to be seen in networks operating at 5.0Mbit/s, as CTNet messages can arrive faster than the node can process them. Broadcast messages also increase the possibility of peak overload problems, as they take less time to transmit than non-broadcast messages.

A good example where overloading a node with messages can occur is when one node is assigned to monitor the network. All other nodes will continuously increment an internal counter, and use cyclic data to transmit the counter value to the monitoring node, to indicate that they are still operating on the network. On a large network, say fifty drives, this can mean that the monitoring node suddenly receives fifty messages in very quick succession, and is unable to process them quickly enough. The effect of the lost messages could indicate to the monitoring node that several drives are not functioning, when this is not actually the case, and in fact all nodes are operating correctly.

The correct way to implement a network monitoring node is to use the **CHECKNODE ( )** command in the **BACKGROUND** task, and use the monitoring node to interrogate each node in turn, and get the operational status of each node. Alternatively, use **ReadNet** to read a parameter from each node.

6.7     **ARCNET Network Analyzer**

ARCNET Network analyzer can capture and decode the messages those controllers use to initiate and control a packet transmission. The analyzer can view all frame types including invitations to transmit (ITT), free buffer enquiry (FBE), acknowledgements (ACK), negative acknowledgements (NAK). It also provides the ability to view ARCNET packets (PAC).

The ARCNET analyzer is available; please contact your distributor or local Drive Centre for more details.

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## 7 Advanced features

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### 7.1 Automatic sync node assignment

If the sync node is configured as described in Section 4.2, cyclic data will be transferred while the sync node is powered up and on-line. However, if the sync node goes off-line for any reason, cyclic data will stop.

In systems where redundancy is required, the transmission of cyclic data must continue to be transmitted if any node (including the sync node) goes off line at any time, or does not join the network when the system is powered up. In either case, it is necessary for the active sync-capable nodes on the network to detect that cyclic data is not being transferred, and for another sync-capable node to take over responsibility for generating the sync message.

The **AUTOSYNC** function block is provided in the Function Block Library in SyPT Pro for this purpose. Including **AUTOSYNC** in the DPL programs of all sync-capable nodes, will guarantee that cyclic data will start at system power-up, and will continue to be transferred provided there is at least one sync-capable node active on the CNet network.

R79%, S79% and one fast cyclic data link must be reserved for use with **AUTOSYNC**, and the Sync Rate configuration parameter (see section 4.2 *Cyclic data rate* on page 46) must be set to 0. Full details about using **AUTOSYNC** in a DPL program and example DPL code are available in the SyPT Pro Help Files.

### 7.2 Editing cyclic data links

Existing cyclic data links can be modified on-the-fly from within the DPL program using the **EDITFASTLINK** and **EDITSLOWLINK** commands. This feature is particularly useful in applications where:

1. Redundancy (using **AUTOSYNC**) is required so that the system will continue to operate if one or more nodes are missing from the network.
2. A production line where different grades or types of finished material require different sections of the production line to communicate with each other. The command works by completely redefining the set-up for the data link within the fast or slow cyclic data structure.

Full details and example DPL code for using **EDITFASTLINK** and **EDITSLOWLINK** are available in the SyPT Pro Help Files.

### 7.3 Enabling and disabling cyclic data links

While cyclic data links cannot be created from within the DPL program, it is possible to enable and disable a cyclic link, provided that it has already been defined in the node. This is done using the **EDITFASTLINK** and **EDITSLOWLINK** commands, with the **NumR%** argument set to 0 to disable the cyclic link (see section 7.2 *Editing cyclic data links* on page 70). The cyclic link can be re-enabled by calling **EDITFASTLINK** or **EDITSLOWLINK** again, with the **NumR%** argument set from 1 to 20 (**AUTOSYNC** uses this feature to enable and disable the cyclic link reserved for its use).

Enabling and disabling cyclic data links can be particularly useful in a system where redundancy is required. Each node must have all the necessary links configured to allow it to operate in all required modes in the system, but cyclic links that are not used in a particular operating mode can be disabled to prevent them from being transmitted. This ensures more efficient utilisation of the available CTNet bandwidth.

**NOTE**

It is not possible to edit the cyclic data link configuration in a CTNet I/O module from the DPL program in another node on the CTNet network.

## 7.4 EVENT task trigger on UD70

The **EVENT** task is a high priority task in the UD70 that can be triggered either by the following methods:

1. Roll-over of the internal timer/counter unit.
2. 0-1 transition of digital input 0.
3. Sync message from the CTNet network.

The **EVENT** task will run once every time the sync message is received from the CTNet network, but it will NOT be triggered if the node is generating the sync message.

**Table 7-1 EVENT task trigger sources**

Pr 17.23	EVENT task trigger source	Description
0	Timer/counter unit	The <b>EVENT</b> task is triggered when the counter rolls over or under, or by digital input 0 on the UD70. Refer to <i>UD70 User Guide</i> for more information.
1	Cyclic sync message	The <b>EVENT</b> task is triggered when the sync message is received from the CTNet network.

**NOTE**

Care must be taken not to put too much code in the **EVENT** task. It has a higher priority than all other UD70 tasks except the **INITIAL** task, so an extended **EVENT** task could easily prevent the **SPEED** task from running, and cause a run-time trip on the UD70.

**NOTE**

This feature is only available with system file V2.07.06 and later.

## 7.5 EVENT task trigger on SM-Applications/SM-Applications Plus/ SM-Register /Digitax ST Plus

The SM-Applications and SM-Applications Plus have four separate **EVENT** tasks. Each task can be triggered by one of the following methods:

1. Execution of the **SCHEDULEEVENT** function block in the DPL program.
2. Sync message from the CTNet network.

The **EVENT** task will run once every time the sync message is received from the CTNet network. Unlike UD70, the specified **EVENT** task will be triggered if the node is generating the sync message.

**Table 7-2 EVENT task trigger sources**

Pr MM.35	Task	Description
0	Disabled	No task will be triggered when the sync message is received
1	EVENT	The <b>EVENT</b> task will be triggered when the sync message is received or transmitted
2	EVENT1	The <b>EVENT1</b> task will be triggered when the sync message is received or transmitted
3	EVENT2	The <b>EVENT2</b> task will be triggered when the sync message is received or transmitted
4	EVENT3	The <b>EVENT3</b> task will be triggered when the sync message is received or transmitted

**NOTE** Care must be taken not to put too much code in an **EVENT** task. They have higher priority than all other SM-Applications tasks except the **INITIAL** task, so an extended **EVENT** task could easily prevent the **POS0** task from running and cause a run-time trip, especially if the **POS0** task is running on a very fast timebase.

## 7.6 CNet priority level on SM-Applications/SM-Applications Plus/ SM-Register /Digitax ST Plus

The priority of CNet message handling can be changed to have a lower priority than the **POS0** and **POS1** tasks. This feature guarantees that the **POS0** and **POS1** tasks will continue to be executed, even if a large number of CNet messages are being received by the SM-Applications / SM-Applications Plus modules.

**Table 7-3 CNet message priority**

Pr 81.44	Task Priority Level		
<b>Access</b>	RW	<b>Range</b>	0 to 255
<b>Default</b>	0	<b>Update Rate</b>	Initialization

The priority levels of different tasks may be changed with this parameter. The parameter is accessed in a bit-wise manner.

Bit	Value	Meaning
0	0	CNet task priority is higher than Pos tasks priority.
	1	CNet task priority is lower than Pos tasks priority. This will reduce the jitter of the POS tasks but could lead to the CNet task being starved.
1	0	Inter-option communication task priority is higher than the POS tasks.
	1	Inter-option communication task priority is lower than the POS tasks.
2	0	Turbo CNet disabled.
	1	Turbo CNet enabled.



## 8 Legacy CTNet hardware

The electrical characteristics can be determined by checking the revision level of the CTNet hardware. Table 8-1 below indicates which hardware level is installed. All nodes on a segment MUST be Rev C or Rev D to use the Segment Loss Factor and Insertion Loss Factor equations and graphs. If a device with older hardware is connected, refer to Section 8.1 for segment limitations regarding number of nodes and length of cable.

**Table 8-1 Legacy CTNet hardware**

Device	Reference code	Hardware Identification	Revision
Unidrive	UD75	UD75A Issue 1 installed	Rev A
		UD75A Issue 3 installed	Rev B
Mentor II	MD29AN	MD29AN Issue 1 and Issue 2	Rev A
		MD29 AN Issue 3 with 5-way connector	Rev B
CTNet I/O	BK7200	Revision level is printed on the plastic cover	Rev B/C
CTNet HMI (CTIU)	CTIU	Part numbers SSP-2050-09000 or 4500-0007	Rev B
Repeater	AI2-485X	Supplied in blue metal case with 5-way CTNet connectors	Rev A
Hub	AI3-485X		Rev A
PC Card	PCI20/5-485X	RJ45 connectors and DIP switches installed	Rev A
PCMCIA	PCM20 with MAU20-485X	Plastic MAU with PCM20 card	Rev A
	PCM20H with MAU20H-485X	Metal MAU with Contemporary Controls labels and PCM20H card	Rev A
ISA card	PCX20/5-485X	RJ45 connectors and DIP switches installed	Rev A

### 8.1 Basic segment limitations

If a network segment has any older CTNet hardware design connected, the Segment Load, Insertion Loss and Propagation Delay factors cannot be applied to the network segment. Refer to Table 8-1 for a list of older types of hardware, and how to identify them. The number of nodes that can be connected to a single network segment is limited by the drive capability of the weakest node on the network.

**Table 8-2 Basic segment limitations (legacy only)**

Device hardware	Maximum nodes	Maximum cable length (m)	
		2.5 Mbit/s	5.0 Mbit/s
Rev A (PC card only)	6	100	50
Rev A	11	100	50
Rev B	15	150	75

**NOTE** The 1.25 Mbit/s or lower data rate must not be used with legacy CTNet hardware.

The worst case segment configuration must be considered when designing the CTNet network. For example, a network of 10 \* Unidrive (Rev B) and 5 \* CTNet I/O (Rev B) nodes can be configured without problem, as the total number of nodes is 15.

However, if a PC card (Rev A) is subsequently connected to configure the network, the PC hardware is now the weakest node on the segment, so the segment is limited to six nodes. The symptom is likely to be continuous or spurious network reconfigurations, as the nodes further away from the PC card will not be able to reliably detect the signals produced by the PC node.

If the node that receives the token from the PC is physically close to the PC node, the signals from the PC node may still be large enough for the receiving node to recognise the token pass. However, when SyPT Pro goes on-line, nodes that are physically further away from the PC may not be detected.

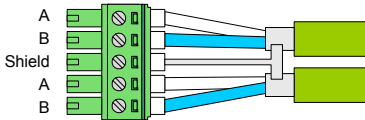
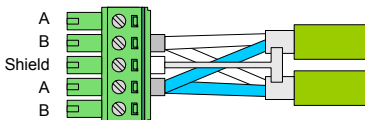
**NOTE** It is possible that a network configuration that is outside the specified limits may work without any apparent problem. Control Techniques will not guarantee reliable CTNet operation for a system that does not comply with the above specifications.

## 8.2 CTNet wiring practices

The basic requirements for the wiring of a CTNet network remain the same, no matter what types of device are connected to a segment, but provided that all specifications listed in section 2.4 *CTNet wiring practices* on page 17, and section 2.6 *CTNet cable* on page 33 to section 2.10 *Other wiring tips* on page 38 are adhered to the network will function correctly.

**NOTE** As a guide, use a minimum of 1m cable between adjacent nodes.

**Table 8-3 5-way connectors**

Connection	Comment
	Easy to wire, but CTNet network continuity is broken if the cable is disconnected from the node.
	Preferred connection method. CTNet network continuity is maintained when the cable is disconnected from the node.

All CTNet networks using legacy hardware should be wired as per recommendations in section 2 *Electrical installation* on page 8. In particular, 82Ω ohm termination resistors should be used on all networks, as this has the single biggest effect when using hubs, repeaters and PC cards are connected to a segment.

**NOTE** The value of the termination resistance must match the cable impedance.

## 8.3 Mixing CTNet hardware

The enhancements made to the CTNet hardware have been designed to significantly increase the number of nodes and maximum cable lengths permitted for a given CTNet segment. This results in higher amplitude driving pulses from each node together with increased input impedance. In addition the voltage thresholds for logic 1 and logic 0 have also been increased.

The Hybrid Hub is available from Control Techniques to allow old and new CTNet segments to be linked together. The Hybrid Hub (see section 2.5.10 *CTNet hybrid hub (A/3-485X-CT)* on page 31) has the older Rev A hardware installed to port 2 and port 3, whereas port 1 has the Rev D hardware installed. This allows existing segments using Rev A or Rev B hardware to be linked to a network consisting of Rev C and Rev D nodes without compromising communications reliability.

**Table 8-4 Hybrid Hub compatibility**

CTNet Hardware revision	CTNet Hardware revision	Comment
Rev A	Rev B	Mix
Rev A	Rev C	Do <b>not</b> mix
Rev C	Rev D	Mix
Rev B	Rev D	Do <b>not</b> mix

## 8.4 CTNet drivers for Windows 95

- Control Techniques CTNet drivers cannot be used under Windows 95.
- Use Contemporary Controls drivers instead.
- CT applications do NOT automatically install the drivers for CTNet hardware.

The following procedures should be followed to ensure that the correct drivers are installed. Please refer to your local Drive Centre for more information regarding drivers for Windows 95.

1. Install the CTNet card and boot up the PC.
2. If the **Add New Hardware wizard** appears during boot-up and asks for a device driver for a **PCI Network Controller** or **Contemporary Control Systems, Inc.-pcm20 Arcnet Adapter**, go to step 11.
3. Click **START**, select **SETTINGS** and click **CONTROL PANEL**.
4. Double click on **SYSTEM** and select the **DEVICE MANAGER** tab.
5. If a **PCI20** or **PCM20** device category is listed, the correct device driver is already installed. Go to step 10.
6. Click **REFRESH**. The wizard will detect a **PCI Network Controller** or **Contemporary Control Systems, Inc.-pcm20 Arcnet Adapter**.
7. Follow the wizard and allow Windows to search for new devices. Select **Display a list of all the drives in a specific location** and click **NEXT** to continue.
8. Specify the location of the file **PCM20.INF** for a PCI card, and **PCM20.INF** for a PCMCIA card. The wizard will find one of the following devices:
  - **Contemporary Controls PCI20/5-485X**
  - **PCM20**
9. Select the listed device, complete the wizard, and return to the **DEVICE MANAGER**. A **PCI** or **PCM** device category will now be listed, depending on the type of card installed. The CTNet driver is now installed.

10. Windows 95 will automatically assign a base memory address to the CTNet card. This base address must be specified for the CTNetAPI or CT application to allow it to access CTNet via the installed CTNet card. To determine the assigned base address, double click on the **PCI** or **PCM** device category and double click on the CTNet device. The **DEVICE PROPERTIES** page will appear. Select the **RESOURCES** tab.
11. Two **Input/Output Range** will be listed for the CTNet card. The base address of the CTNet card is the second range in the list, and will cover 16 bytes, e.g. 0x1410 to 0x141F. The first number of this address range (e.g. 0x1410) is the base address that must be specified for the CTNetAPI or CT PC Tools.

**Address:** This is the unique network identification given to a networked device to allow communication on a network. When a device sends or receives data the address is used to determine the source and the destination of the message.

**Active node:** Active nodes produce an electrical load on the segment, and require a node address to be assigned, as they take part in the token ring bus arbitration system. The maximum number of active nodes that can be connected to a CTNet network is 255 (subject to loading limitations).

**Broadcast link:** A cyclic link that is received by all nodes on the network.

**CTNet:** Control Techniques Network (protocol specified by Control Techniques).

**CTNet I/O Coupler:** CTNet Beckhoff coupler (BK7200).

**Cyclic data:** Method of automatic data transfer between nodes on a CTNet network configured during system commissioning / start up.

**Cyclic Data rate:** The time period between transmission of the cyclic sync message. Defined as SSFF, where FF = fast cyclic data time (in ms) and SS = ratio of slow data to fast cyclic data. SS is in multiples of FF.

**Cyclic link:** Defines the data registers to be transmitted from a node, the total number of registers to be transmitted, and the registers in the target node where the data is to be written. This is configured within SYPT Pro.

**Data rate:** Determines the communication speed of the network, the higher the value the more data can be sent across the network in the same time period.

**Device:** A piece of equipment connected to a network, this may be any type of equipment including repeaters, hubs, masters or slaves. Sometimes called as a node.

**DPL:** Drive Programming Language.

**Easy Mode:** A method of setting up cyclic data transfer on CTNet network using only the drive parameters.

**Earthing:** Describes the electrical safety or shielding / grounding connections for the module.

**Event task:** A way to use a message or change of state to trigger a software routine.

**Fast link:** A cyclic link that is transmitted after every sync message.

**FBE:** Free Buffer Enquiry, use by the transmitting node to ensure the receiving node is ready.

**Grounding:** See Earthing.

**Hub:** Hub links segments together to extend the total length and number of nodes that can be connected to the network.

**Hybrid hub:** A hub with Rev B and Rev D ports.

**IN data:** Data that is returned from a slave device to the CTNet master.

**Insertion Loss factor:** The Insertion Loss Factor ( $K_{IL}$ ) determines the maximum length of cable that can be used on a network segment.

**K-bus:** The data bus used internally on the Beckhoff coupler and terminals.

**Legacy CTNet hardware:** Rev A and Rev B CTNet hardware.

**Network:** One or more segments joined together using hubs to form a single network.

**Node:** A device on the network. This may be either a device such as a drive or part of the network such as a repeater.

**Non-Cyclic Data:** Data that is requested or sent required. This is not sent on a regular basis and generally allows access to any parameter. This is useful for occasional changes or configuration purposes.

**Mapping:** The process of linking data values on the network to parameters within the drive.

**Master:** The controlling device on the network, generally this will include programming features.

**Passive Node:** Passive nodes produce an electrical load on the segment, but do not require a node address to be assigned as they do not take part in the token ring bus arbitration system. They must be included when considering the number of nodes connected to a segment, for example CTNet hub.

**Poll rate:** The rate at which cyclic data is sent and received on the network.

**RECON:** Reconfiguration, indicates a node has joined or left the token ring.

**Repeater:** See Hub.

**Rev A/B/C/D:** The revision of CTNet hardware A, B, C or D.

**Scan rate:** See Poll rate.

**Segment:** Two or more nodes connected to a length of CTNet cable, with an  $82\Omega$  1% 0.25W termination resistor installed at each end. The cable must run from node to node as drop lengths are not permitted on CTNet.

**Segment load factor:** This determines the maximum number of nodes that can be connected on a single segment of network cable.

**Shielding:** A connection to provide additional noise immunity on a network cable.

**Slave:** A slave device will only respond to messages from a master.

**Slow link:** A cyclic link that is transmitted after every SStH sync message, as defined by the synchronization rate.

**Sync Master:** The node on the network that coordinates cyclic data transfer by transmitting the sync message at regular intervals.

**Sync message:** The CTNet sync message is used to instruct all other nodes to start transmitting their cyclic data links.

**Termination:** This is used at both ends of a network segment to prevent reflections and reduce noise.

**Termination resistor:** An  $82\Omega$  1% 0.25W resistor that must be connected between the data lines (A and B) at the end of each segment to prevent pulse reflections. A termination resistor should be installed if there is only one CTNet cable going to a node.

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**0460-0025-08**