CONET Local Area Network

Conet LAN Token Passing Local Area Network.

DATASHEET

CONET FEATURES

- **True Token-passing Local Area Network (Peer to Peer communications) - no master device dependency**
- **High system reliability**
- **Easy "Multi-master" systems.**
- **Switchable data rate enables network to be optimised for the installation - high data rate for high performance and low data rate for low grade cable and/or longer distance.**
- **Transformer isolation 1500V rms at every node yields high noise immunity.**
- **Up to 10km transmission distance.**
- **Defined data formats and standard built-in network services enable total compatibility between different products.**
- **Conet computer interface cards for direct network connection to PC with ISA or PCI buses.**
- **Automatic error detection and retransmission for very secure data communications without false messages.**
- **Up to 127 nodes on one network to keep pace with expanding plant requirements.**

Conet Development

Conet was developed in response to a need from plant operators who wished to bring field data back to the control room or supervisor's office in the most cost effective way. The only solutions that existed were very expensive and beyond the reach of the smaller operator. Thus one of the most important features of Conet is its ability to operate on low cost cabling which, in many instances, is already available as a free pair in a multi-core cable. Conet's design was influenced by the requirements of the Mining industry who required a reliable network to run from surface to the underground levels of the mine often with power cables etc.

Major Uses - two broad categories:

1. Multidrop Telemetry Systems:

Digital and analog signals are transmitted from one or many transmitting stations to one or many receiving stations without the need for a master computer station on the network. The telemetry devices, such as Conet Squeezers, are programmed with built-in software to communicate with each other while Conet itself takes care of error checking and data integrity.

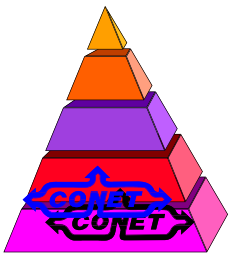
In this category, Conet Squeezer systems may share a network with other intelligent users (e.g. PCs) but operate completely independently.

2. Computer I/O: Data Acquisition

Multiple host computers may communicate with field I/O devices such as PLCs, Remote Terminal Units, Analog and Digital front end systems etc.. This data would typically be used by the computer for monitoring, control, reporting or re-transmission back to other field outputs via the same Conet network.

Product Compatibility

Omniflex has developed a number of intelligent devices which communicate via Conet and has an on-going development program of making Conet compatible with third party vendors of hardware and software. Based on the ISO OSI 7 Layer Model Conet complies



with the Networking Standards making Interface to other products possible.

Conet permits easy communications between any of these different intelligent devices on the same network by making use of a Data Interchange Table (DIT) in memory at each node. This DIT stores all I/O and supervisory/control analog and digital variables in set registers in a block of memory which is accessible from the device itself and from the network. It also contains

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system variables which are unique to the product, such as setpoints, dead-band levels, time delays etc.. All a system programmer needs to know about any device in order to read or write to the DIT is the register number and the format of its contents.

Token Passing Protocol

Conet is a token-passing network. Peer to peer with no master. In order to maintain orderly communications between all the devices, a specially formatted message, known as the 'token', is passed from node to node. The node which has the token at any given time, can transmit messages while it has the token. Once it has done this, it passes the token onto the next highest ID number and so on around the network. If there are only two nodes (IDs), then the token is simply passed back and forth. If there are 20 nodes, then the token is passed from 1 to 20 and back to 1 again. However, Conet is able to re-configure itself if nodes are added or taken off the network at any time by continually searches the network for addresses above the highest node ID. The most efficient operating configuration is to assign node IDs consecutively from 1 to n as minimal time is then wasted looking for non-existent nodes.

Deterministic Network

Conet is a deterministic Network allowing access times to be computed for data through the Network. This information can be read from graphical representation shown in this document.

Network connections

Conet is a bus-style local area network, which means all nodes are simply connected onto the cable at any point along the cable (see sidebar on TOPOLOGIES). A Conet field termination board (Model No: C6169) is used at each node to tee into the main line. Screw terminals are used on the line side for easy wiring and a removable terminal block on the node side allows it to be disconnected from the loop at any time without disrupting communications. Likewise the node can be re-connected without powering down and Conet automatically detects that it has returned and resumes communications with it. The C6169 termination board provides surge suppression for high voltage noise protection, but this is subject to the use of the correct cable for the application.

Data Integrity

Each Conet node is transformer isolated, firstly to block any common mode voltage differentials between nodes which will directly affect data integrity and secondly to provide high electrical noise immunity. This, coupled with a 16-bit CRC (Cyclic Redundancy Checksums) added to every data block, plus automatic error detection and retransmission, ensures very secure data communications. This enables information to be securely transmitted over a distance of up to 10km in noisy electrical environments with an extremely high degree of integrity.

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TYPICAL APPLICATION CATEGORIES

Conet may be used to link up any combination of supported hardware and software for data acquisition and control purposes.

A few typical application categories are

Control and Automation Systems

Using: Maxiflex* stand-alone Remote Terminal Units for analog and digital I/O plus programmability; Integrated with most SCADA systems on the market. Interfacing with third Party devices and communicating with any of the hardware devices on the network.

Process Interface Systems

Maxiflex* systems as front ends to other process control equipment such as DCS systems; Maxiflex* direct analog signal conditioning system(TC,RTD,VC,mV) for high density signal conditioning with full isolation.

Data Acquisition

Maxiflex*, for analog and digital data acquisition; SER-260* Sequential Events Recorder for very fast digiital signal capture.

Critical Event Monitoring

SER260* Sequential Events Recorder for 1 millisecond resolution on all inputs, even in distributed systems. Suitable for predictive maintenance, Statistical and Process Control improvements effecting down-time savings through instantaneous fault analysis. Time stamping at source eliminates errors due to Network Propagation delay so events are collated into true chronological order.

DCS Remote I/O

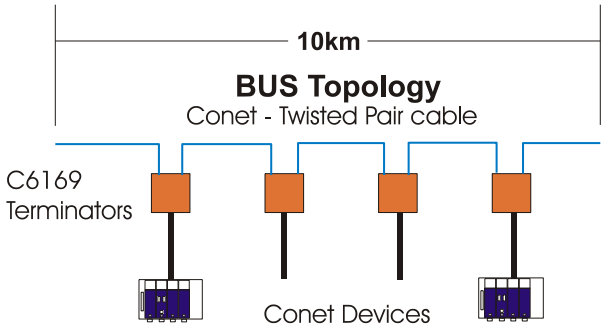
Maxiflex is used by many DCS systems to retrieve data from the Plant using existing plant cabling. Its ability to interface to foreign device protocols make it ideal for example retrieving data from analytical equipment which may be sampling in the field.

CONET NETWORK TOPOLOGIES

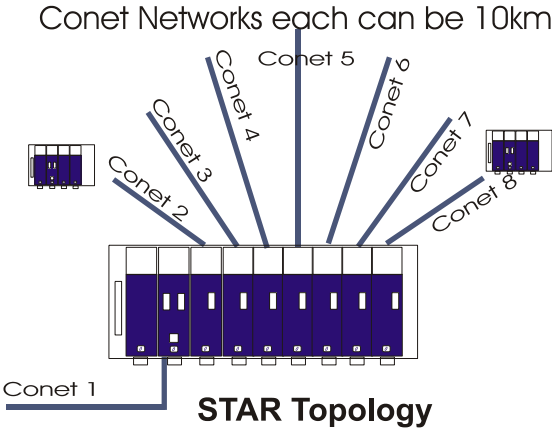
The Flexible Network

The NIM extends the versatility of Conet installations by providing the following benefits:

1. The ability to extend branches off a Conet cable to provide “Star” or “T” configurations, with the only limitation being the longest end to end distance of each network.(i.e. 10km)

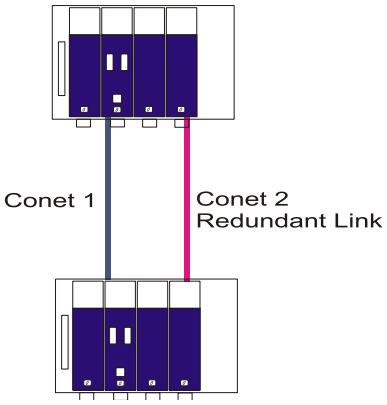


2. The ability to break a Conet network into functionally independent pieces so that a fault in any one section will not affect the operation of any other section.

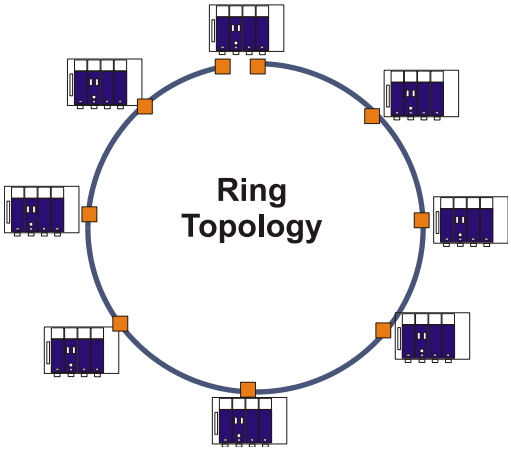


3. The ability to extend the length of a Conet installation when the choice of cable prohibits the full Conet distance from being attained or to extend beyond the 10km limit.
4. The ability to have a redundant Conet link between two nodes

Redundant Link



5. The NIM treats each sector of the network as if it were another Network so a Network made up of a number of smaller Networks as an Intranet will behave as if it were a single network. No data delays are introduced by the NIM The total number of nodes on the enture network is unaffected and each node still has a unique address in global terms.



6.
7. The NIM is a Maxiflex module fitted to a Maxiflex System Base. A variety of NIMs exist to facilitate the connection of other Network devices such as Hart®, Modbus® and many other proprietry protocols.

NETWORK THRU-PUT AND ACCESS TIMES

Thru-put (Figs 1 and 3) is a measure of the efficiency of the network and its abilitty to transmit data relative to the network speed. It is expressed here in kbaud, relative to 62.5kbaud. It can be seen from the graphs that efficiency improves with more nodes connected. Note however, that token "dead-time" (complete scan revolution) increases accordingly.

The sudden drop in thru-put occurs when more than 31 data bytes are transmitted as Conet automatically makes a 'Free Buffer Enquiry' at this point resulting in an increased network overhead.

Typical Data Transmission Times are depicted in Figs 2 and 4. These are the average network scan times when only one node transmits a data packet per token revolution. The actual scan time for any given network, however, is dependent on the following factors:

1. Type of Node device connected
2. Number of Nodes
3. Type of I/O card(s) plugged into the node device
4. Number of I/O at each node
5. Total number of I/O
6. Acknowledgement requests*
7. Free Buffer Enquiries*
8. Application program in Host computer(s)

An assessment of the installation according to the above criteria must be made before thru-put and data transmission times can be calculated using these graphs. Data types and sizes vary with every application.

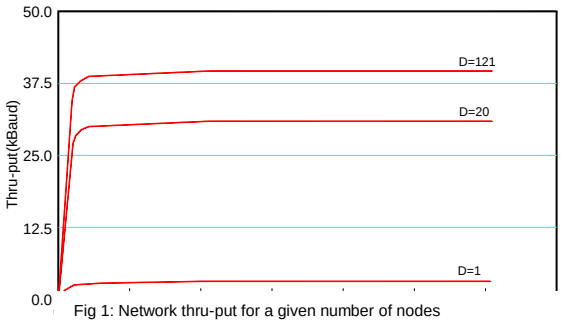


Fig 1: Network thru-put for a given number of nodes

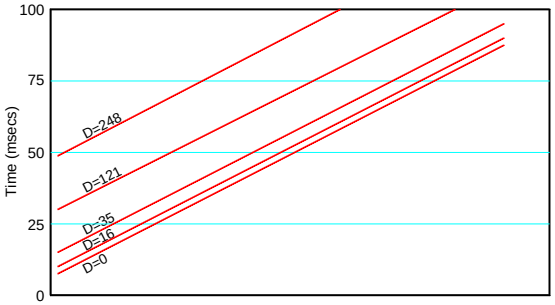


Fig 2: Typical Data Transmission times for a given number of nodes

**See application note no: 98-8902-260-001 for formulae used in calculating network access times.*

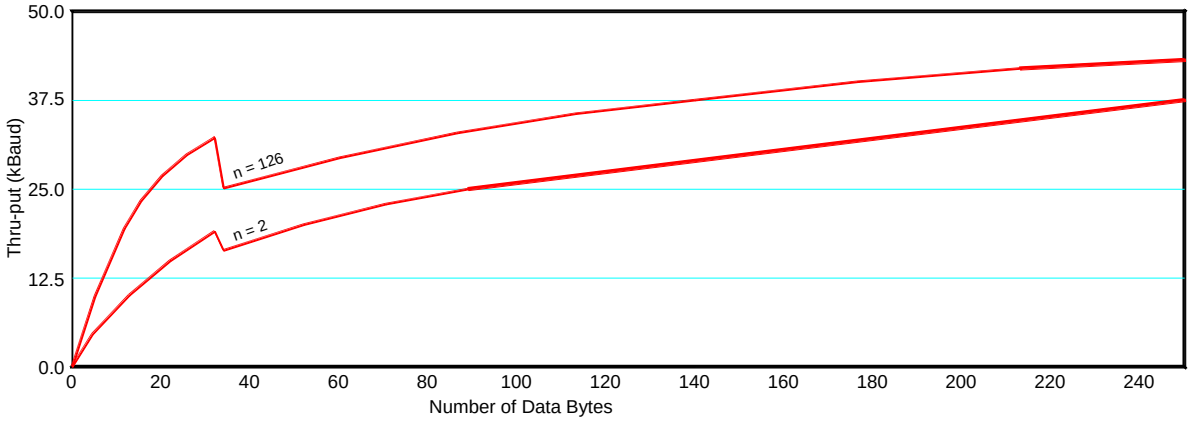


Fig 3: Network thru-put for a given number of data bytes transmitted per node

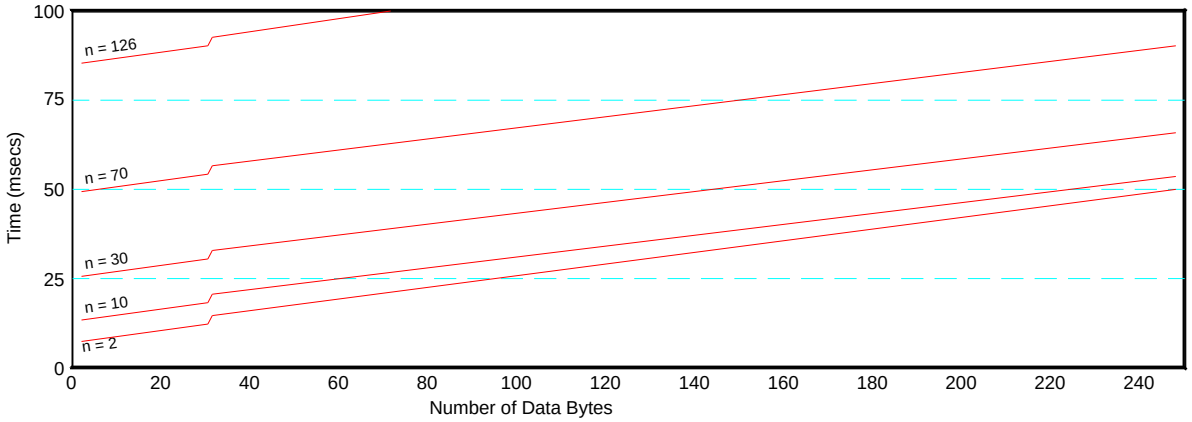


Fig 4 : Typical data transmission times for a given number of data bytes transmitted per node per token revolution

Conet Recommended Installation Practices

1. Use a C6169 Conet Field Termination Board to connect every node to the network. This provides five benefits:

a) High voltage transient suppression via gas discharge devices;

b) Easy loop-through connections via paralleled terminals;

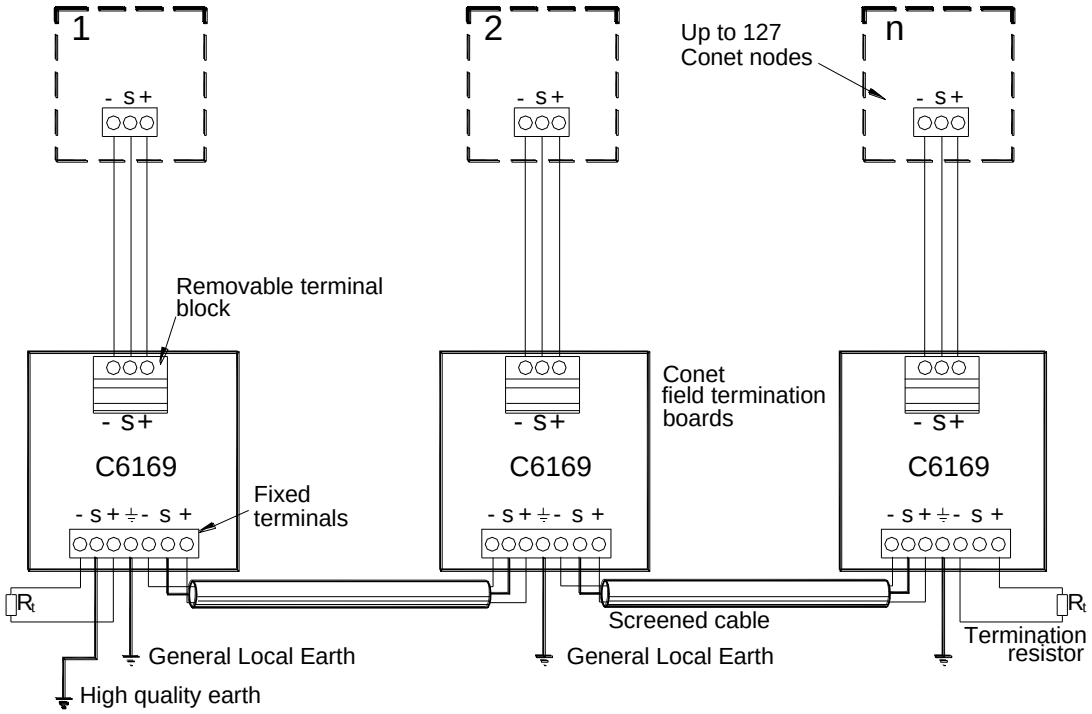
c) Ability to connect and disconnect node via removable terminal block without disturbing network wiring. This can be done while the network is live;

d) Facility to connect a line termination resistor directly into the unused terminals at each end of the line;

e) Facility to connect screen to earth.

2. Connect a line termination resistor at each end of the network. This is usually 100 ohms, 1 Watt, but may be accurately determined using the Conet Line Tester.
3. Ground the Conet screen to a High Quality Earth at only ONE point on the network. This prevents ground loops due to differing potentials around the plant. Each C6169 termination board must be connected to a General Local Earth nearby, to provide a discharge path for the gas discharge devices. (See diagram below).
4. Do NOT suspend the cable high above ground in places where it is especially susceptible to lightning strikes.
5. Avoid running the cable next to high voltage carriers, e.g. 6kV lines as this makes it vulnerable to induced noise.
6. Do NOT tee off the main Conet line more than 20 metres without using the Conet Active Repeater as this may introduce line reflections and error signals.
7. Assign node IDs in ascending order on the network, beginning with ID 1. The physical location of the node does not make any difference, but Conet works most efficiently when there are no gaps in node IDs and they begin at 1.
8. Test the proposed cable for the installation with the Conet Line Tester prior to installing it. This device injects a signal which can be analyzed with an oscilloscope to determine the cable characteristics. Conet is designed to operate on 6V differential voltage but will operate as low as 600mV provided the waveform is not too distorted.
9. Use radio links to aid in commissioning a system which is spread out over a large area. A field telephone may be used with unused pairs in a multi-core cable.

Conet Connection with C6169 Terminator Boards



Connections to the C6169 Termination Boards, showing position of the termination resistors. Note Screen is only ever earthed at one point on the Network.

SPECIFICATIONS

General

Network Type	Token Passing, bus type Local Area Network
System size	up to 127 nodes. Individual products using Conet may impose smaller limitations, depending on volume of I/O.

Data transmission

Type	Manchester encoding
Rate	:62,5k Baud - mode N (Normal) or 7800 Baud - mode S (Slow - use on bad transmission lines)
Signal Level	:6V differential nominal but will operate as low as 600mV if not too distorted.

Data Integrity

Checking	CRC (Cyclic Redundancy Checksum) performed on every data packet
Retries	Automatic error detection and retransmission
Noise rejection	1000Vac rms common mode between node and line without effect on operation.

Protection

Isolation	1000Vac transformer isolation between each node and transmission line. Transformers located at each node.

Required cable characteristics

Type	Twisted pair with outer shield. An additional pair in the cable is useful for communications purposes during commissioning and testing, if radios not available.
Characteristic Impedance	Typically, 100 ohms to frequencies greater than 100kHz. The characteristic impedance should not be less than 50 ohms. Resistance
	The total series loop resistance should not exceed 240 ohms.
Conductor Size	Conductor size of the 2 wires shall be 0,5mm2 (20AWG) or larger in cross sectional area and wire resistance is not to exceed 98 ohms/km (30 ohms/1000ft.) per conductor. See Figure 6 below.
Mutual Capacitance	Mutual pair capacitance between one wire in the pair to the other shall not exceed 60pF per metre (20pF per ft.)
Stray Capacitance	Although it is advantageous to shield the twisted pair, cable capacitance between one wire connected to ground shall not exceed 120pF per meter (40pF/ft.)

Node Connection

Termination Board	Each node must connect to the Conet Network via a Field Termination Board (Model No. C6169). Up to 3 nodes may be connected to the same Field Termination Board, provided they are
	Within 3 metres of each other but it is recommended that one board is used at each node.
Polarity	Polarity insensitive
No of paths	Only a single path may connect any two nodes on the network.
Branches	Any branch off the main line should not exceed 20m unless a suitable impedance tap is used.

Line Termination

Position	Terminate only at each end of transmission line, on C6169 Field Termination Board.
Resistance value	Termination resistors should be equal to the characteristics impedance of the cable (refer to cable manufacturer's specification). Where information is not available, use the Conet Line Tester to determine the cable characteristic impedance. If this is not available, use a 100Ω resistor.
Resistance rating	A 1 watt non-inductive resistor is recommended.

C6169 Field Termination Board

Purpose	One used at each node on network, serving 3 main functions:
1	It provides parallel terminals for easy transmission line loop-through and termination resistor connection
2	It provides convenient removable terminal block to isolate each node without affecting the network; and
3	It provides transient suppression (see spec below) to protect the node instrumentation.
Terminations	:2.5mm2 fixed screw terminals for line terminations.
	:2.5mm2 removable terminal block for connection to node.
Transients	Designed to withstand IEC 255-4 Appendix E Class II Impulse Voltage withstand test (1kV 1.2/50 micro second pulse).

Mechanical C6169 Terminator:

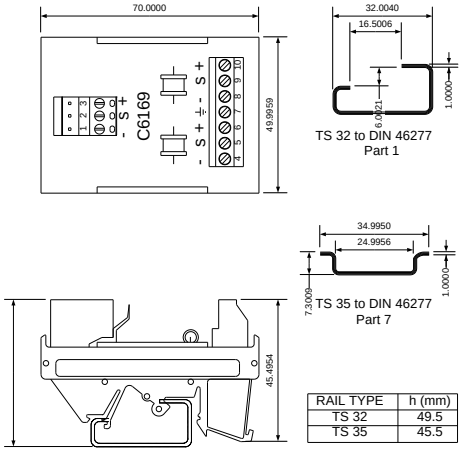


Fig 5: C6169 Field Termination Board General Arrangement

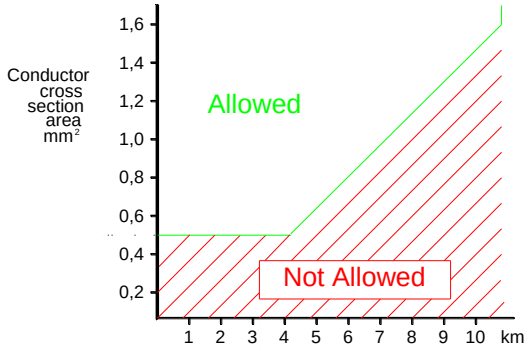


Fig 6: Conet Cable sizing Chart

Ordering Information	
Type	**Conet is an embedded technology in many of the Omniflex Products and is thus available on Conet enabled hardware. Conet is available for different media and applications as shown below:**
Variants	
Conet	For cable networking.
Conet/m	For Radio Networking
Conet/s	For serial links or fiber optic
Conet/p	For program ports
Conet/e	For Ethernet TCP/IP