# Shownet Design

# Training course notes

Strand Lighting

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# Strand Lighting

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# Table of Contents.

# Ethernet in Theatre and Television Section 1


**Ethernet can be considered as a cabling system. It is no more complex than a DMX installation. The only difference is the hardware and that DMX is usually more forgiving if the rules are broken**.

Over many years both television studios and theatres have required an increasing amount of control cables around the building. Starting with simple desks and dimmers, sites also started to install hand held controls, colour changers, remote desks, remote video outputs, reporting dimmers, moving lights and many other options. The cable requirement in a large venue can be overwhelming.

## Dimmer control cable requirements.

From the time of the first thyristor dimmers, back in the late 1950's, there has been a need to install low voltage control cables between lighting control desks and dimmers.

- Pre 1982 Analogue control only.

  Desks and Dimmers used analogue control signals, one wire per dimmer. This is an expensive control method requiring large screened multi-core cables. Long cable runs can result in a voltage drop and lower light levels.

- 1982 Development of D54.

  This Analogue multiplex standard was developed by Strand Lighting using a variation of the Galaxy 1 backup signal. 384 analogue dimmer levels are sent one after another down one control wire with a 0v reference screen.

- 1986 Development of DMX.

  The digital control signal DMX was standardized by the USITT in America. This signal carries 512 dimmer levels in a digital form. The communication uses RS485 protocol and requires a screened twisted pair cable.

- 1990 Revised DMX.

  This is now the industry standard version of the DMX.

## Other control cables

- Colour changer cables.

The original colour wheel used analogue control voltages and required a multi-core cable.

Modern colour scrollers use an RS485 protocol, either DMX or Strand Lighting MRL,  These both require a screened twisted pair data cable.

- Hand Held remote controls.

  Galaxy designers or riggers control uses a two wire digital signal and requires a screened two core cable.

  Lightpalette 90 designers controls use RS485, Impact designers use RS422 and 430 designers use RS232. All of these desks require a cable with two twisted pairs and a screen.

- Remote desks.

  The Galaxy remote desk uses a 20mA current loop which requires a 4 core + screen cable.

  The Lightpalette remote desk uses RS485 protocol and requires a screened twisted pair cable.

- Remote video.

  Standard Analogue Video repeaters for desks like Galaxy and Gemini require three Co-Axial cables.

  Video repeaters for Lightpalette 90 require a screened multi-core cable for EGA video signals.

- Reporting Dimmers

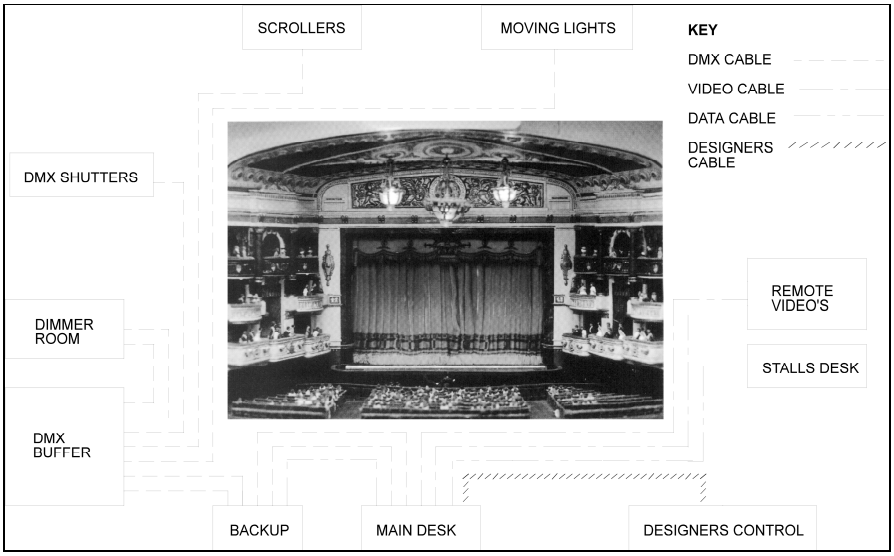
  EC90 dimmers use an RS485 protocol which requires a screened twisted pair.

- Moving lights.

  DMX is the most common protocol for moving lights.

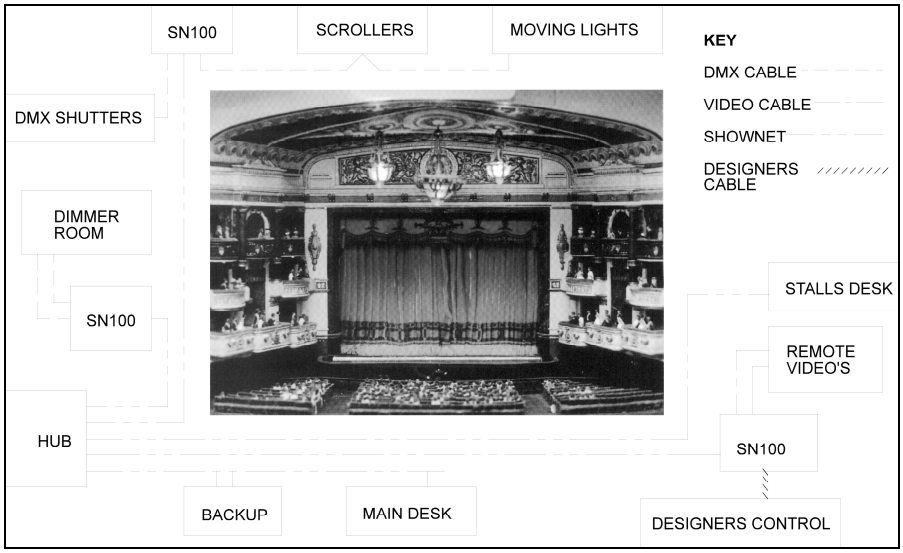
## A traditional cable system.

A large theatre may have any of the items shown below.




## A Shownet cable system.

A typical Shownet installation which provides the same connections as the traditional cable system shown above.





**The Designers Control connection to an SN100 is not available on software version 2.0**

# Local Area Networks. Section 2.

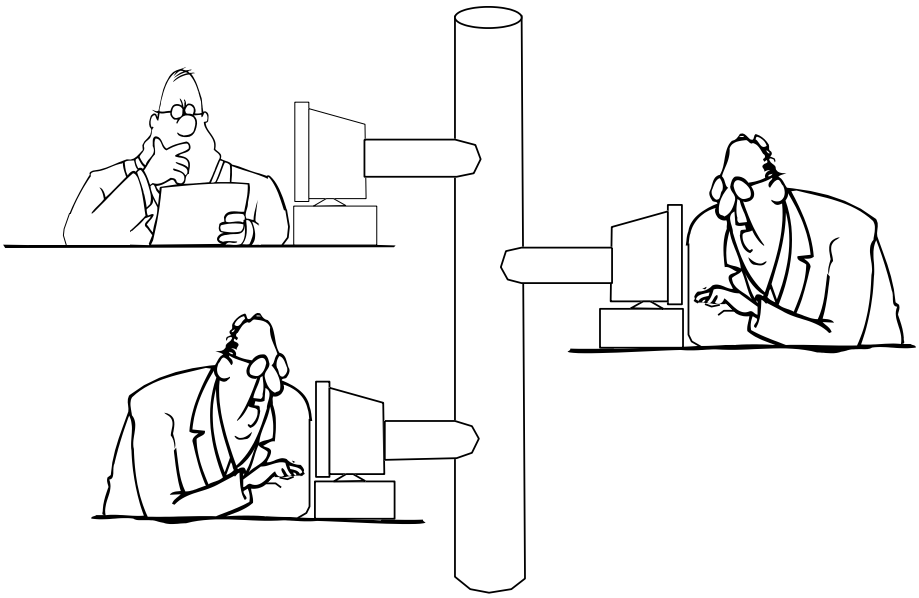
In Section 1 we discussed the advantages in using Ethernet as a cabling system instead of the large numbers of different cables which may be required in a Theatre or Television Studio.


**This chapter looks at how Ethernet works in very simple terms. This information is not necessary in order to design network installations. This information is necessary to understand how to fault find a network installation.**

## How Ethernet works.

One of the best descriptions of Ethernet theory is published in the document "ESTA Recommended Practice for Ethernet Cabling Systems in Entertainment Lighting Applications". The following is a brief synopsis of this description.

Imagine that the Ethernet cable is a pipe and each lighting desk or network node is a person at a portal on this pipe.



From your portal you can hear what is being said at any other portal on the pipe and you can say your own message into the pipe.

You can either shout into the pipe for everyone to hear, or you can start your message by saying who the message is for. The latter case assumes you know that the person is listening.

When the message is for a single person then that person must reply saying the message is either understood or the message was garbled and you should send it again.

If you wish to speak you must first ensure there is no one else talking into the pipe.

If you and another person start to speak at exactly the same time both you and that other person will stop talking. After a pause one person will start to talk again. It is unlikely that both people start talking again at exactly the same time so the message gets through at the second attempt.

The more people there are trying to talk on the pipe the longer each person has to wait for a quiet moment before they can talk. There is also a much higher risk of two people talking at the same time

Since only one person can talk at a time then there has to be a rule about how long each person can talk. A 20 minute monologue would seriously upset everyone else trying to talk.

Finally another group of people, who are all speaking another language, start talking to each other down the same pipe. Both groups are not able to understand each other and ignore messages which they can not understand.

## How the analogy applies.

The pipe in the analogy is the Ethernet cable system.

Each person is a network interface circuit which links the processor in the lighting desk with the cable system. The standard term for a device connected to the network is a NODE.

## The Ethernet “address”.

When a network node wishes to talk to another node it must start by sending start data. To make life simple I will refer to this data as the address. This address carries a lot of information including who the message is to, who it is from, which protocol is being used, details of data compression methods used, how errors are to be handled and much more.

The address is always a fixed length therefore one of the most basic error detection methods is to look for a packet of data shorter than this minimum length.

If a node detects that the data does not have it’s own address the data is ignored and not sent to the processor.

Strand Lighting send some information as “Broadcast”. This means that every node on the network must receive the data. The data is passed to the main processor where the decision to use or not use the data is made.


**The “address” is made up in layers using the OSI model. This information will not help an engineer who is trying to fault find a network. Very expensive network data analysis tools are needed and if a fault is found there is nothing an engineer can do to fix it. Details of the OSI model can be found in any good network book.**

## The Reply.

When a node receives a message which has it's own address then it must send a reply.

The reply consists of the address of the sender followed by an acknowledgement to say everything was received without error, or a message saying the data had an error and the sender should send the data again.

Messages which are sent as "Broadcast" do not require a reply because the network would become filled with answers from every node connected. The node which sent the broadcast message must trust that the data was received correctly. This means there is no error checking.

## Waiting your turn.

Only one node can transmit at a time so every node is waiting for a chance to send when there is a quiet moment.

The decision about who gets to transmit next is made by the network interface circuit. There is a random timer built into every circuit which will wait for a quiet moment then start the clock. If after this random time the network is still quiet then the data is sent. If the random timer on another node is faster then the node must wait for the next quiet moment and start waiting for a different time. Eventually the node will have the fastest timer and will send.

The more nodes there are on the network and the longer each node talks the longer it takes for data to be sent.

## Talking at the same time.

The last section shows that it is rare for two nodes to talk at the same time. The random timers on two nodes must have chosen a time faster than any other node on the network and exactly the same as each other.

Each network interface circuit listens to the data as it is sent and if the data is not the same there must be two nodes transmitting.

The nodes will generate a blocking signal which is recognized by every node as a "Collision" warning. The sending nodes will know they have to try again and the other nodes know that the last frame of data must be ignored.

The usual process of sending data now continues.


**The more nodes there are on the network the higher the risk of collisions. As the number of collisions increase the more often each node has to re-try. This increases the traffic on the network which then increases the risk of more collisions. If the data on the network approaches 50% of the available time there is a risk the network will run unacceptably slowly.**

## Time restrictions

The network restricts the time a single node can transmit by restricting the length of the data.

If a node needs to send a large quantity of data it must be split up into smaller sections. The start data is then used to label each part and make sure the node which receives the data can check that all of the parts have been received and that each part is in the right order.

## Priority.

The analogy does not talk about giving priority to a single person who has urgent information.

This is because Ethernet has no priority system. No matter how important the data the node must wait its turn with every other node.


**Ethernet is totally unsuitable for some forms of data transmission. Voice can be sent over the Ethernet but it must be sent at guaranteed regular intervals so that the receiver hears a voice without gaps. This is impossible when data transfer is based on a random timer.**

**DMX must also be transmitted at regular intervals. This is not as critical as voice because there is a long gap between each repeat of the DMX frame. The network would have to be seriously overloaded before DMX data is delayed by enough to see the effect on stage.**

## Other networks.

If a Strand Lighting ShowNet network is connected to an existing customer's network the data will still be transmitted and received correctly between all Strand devices.

The customer's network will ignore all transmissions from the Shownet and the Shownet will ignore all transmissions from the customer's network.


**Strand Lighting do not recommend the connection of Shownet through another existing network because the amount of network data will increase. If the network traffic is already high the addition of Shownet data may result in poor response speed for both the Strand devices and the customer's own network.**

# Ethernet using 10 Base 2. Section 3.

10 Base 2 Ethernet is often called “Thin Net”.

The term “10 Base” refers to the maximum data transfer rate for the Ethernet system - 10 Mega Bits of data Per Second (10M Bits/Sec)

Do not confuse Mega Bits per Second with Mega Hertz (MHz). All Ethernet cable characteristics are given in MHz. See Section 7 Cable Characteristics.

“2” refers to the maximum transmission distance. This is 200 yards (185 Meters).

## The use of 10 Base 2 in Shownet.


**Strand Lighting do not recommend the use of 10 Base 2 for all connections in a large Shownet installation.**

**Strand Lighting do accept that there are significant cost advantages providing 10 Base 2 is used in an appropriate way.**

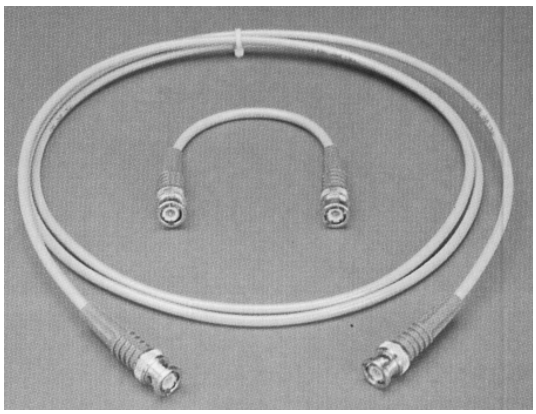
**10 Base 2 should be used for small network installations with no long segments, or to provide connections within small areas which are linked with more reliable cable methods.**

**Any short circuit or fault on a network node is likely to cause total network failure.**

The following chapter covers all sizes of 10 Base 2 installations and all of the rules.

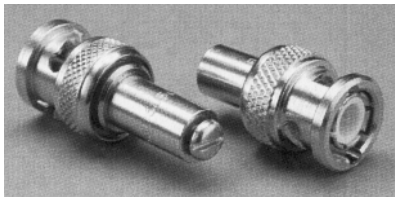
## Hardware.

The cable required is 50 Ohm Co-axial with a BNC connector at each end.

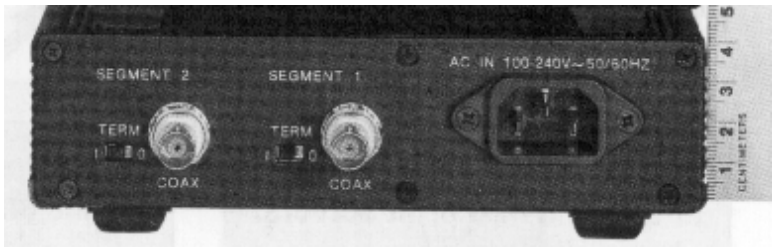


The connection at each network node is via a 50 Ohm T Connector.

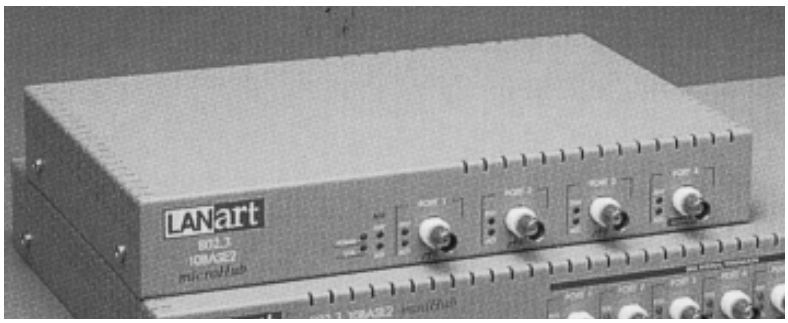
Both ends of the cable must be terminated by fitting a Terminator to the open side of the last T connectors.



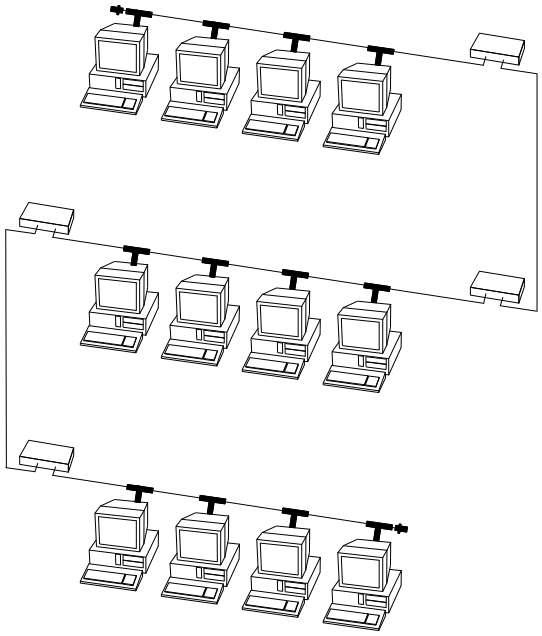
If the cable needs to be extended a repeater is used. The boosted signal can be sent another 185m.




If branches are required a Hub is used. This is a simple repeater with multiple connections.




## Design rules.

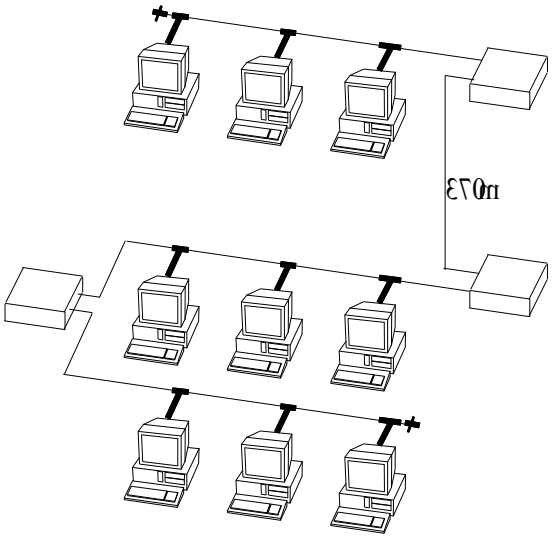


## The 5, 4, 3 rule.

The first three points are quoted in every catalogue and text book however the IEEE standard 802.3 has one additional point.


- **A 10 Base 2 network using simple repeaters may have no more than 5 segments (cable runs of 185m or less).**
- **There can be no more than 4 repeaters on this network.**
- **There can be no more than 3 segments which have nodes attached.**
- Segments which have no nodes attached are called LINK segments in the IEEE standard. If a large network has only two link segments and these are adjacent to each other the repeater between these segments is not required and the cable can be run to twice the usual length (Maximum 370m).

**This final rule only applies to 10 Base 2.**



## The two / four Hub rule.

This rule is probably the most important but is not written down in text books or in the information sheets of network catalogues.

The rule as applied to 10 Base 2.


**This rule applied to hubs and repeaters.**

**If the two populated co-axial segment are linked by a single hub it is classed as a "full" hub. There can be only two full hubs between communicating nodes.**

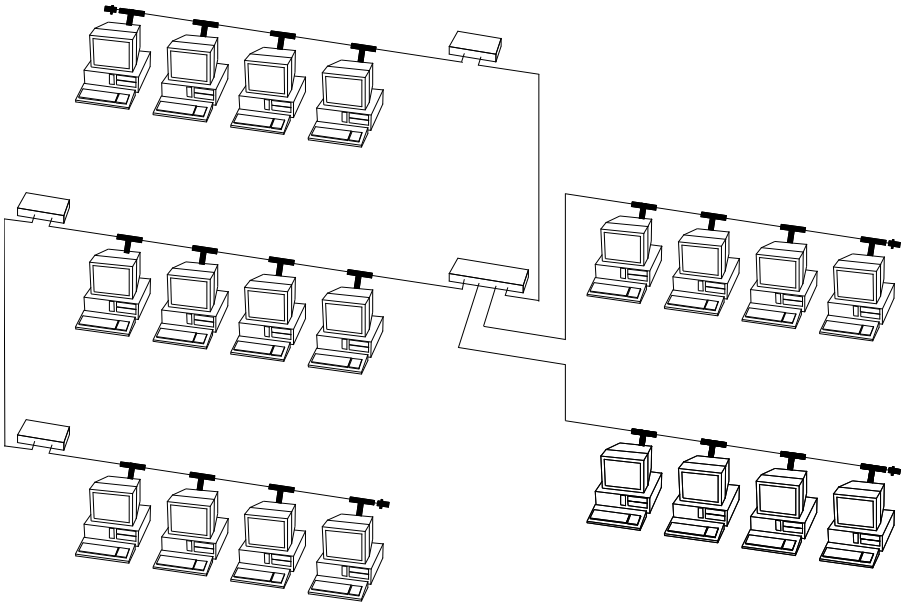
**If two populated co-axial segments are joined by two hubs and there is an unpopulated segment in between. The hubs are classed as "half" hubs. There can be four half hubs between communicating nodes.**

The 5, 4, 3 rule obeys the second part of this rule.

The unpopulated segment between two hubs / repeaters does not have to be co-axial. A twisted pair cable or a fibre optic link can be used instead and still obey this rule.

To transfer to another cable type the hub could be fitted with a transceiver module, a stacking hub could be used with different cable types on each stacked hub, or a converter can be used instead of a repeater.

When hubs are used to expand the network the same rules apply.



## Cable length rule.

Each cable segment must not exceed 185m.

Each cable segment must not be less than ½ m.

## Node connections.

The maximum number of nodes on a segment is 30.

The cable must connect each node in a daisy chain.

Each node must be connected to the Co-axial cable using a 50 Ohm T connector.

There must not be any cable between the T connector and the BNC connector on the network node.

When the network node is at the end of the segment the open end of the T connector must be fitted with a 50 Ohm terminator resistor.

When the segment ends at a repeater or hub there is usually a terminator switch. With the termination switch turned on the cable can be directly connected. There is no need for a terminator or a T connector.

If the hub or repeater is not at the end of the segment the termination must be switched off and the link made with the T connector.

The 10 Base 2 network should be screened to improve noise immunity. This can be done either by using a terminator with an earth connection tag, or using a repeater / hub which has a link to earth the cable screen.

If the screen of the cable is earthed at more than one place on the whole network the screen can cause an earth loop.

> An earth loop is a flow of current down a screen when the earth potential is slightly different at the two places where there are links to earth. This current acts as an aerial and picks up radio noise which interferes with the operation of the network.

Never connect the cable in a loop. This will cause total network failure.

## Network upgrades.

The 10 Base 2 network can not be expanded beyond the limits given above.

To increase the distances and the number of network nodes a repeater or hub should be used to convert to another type of Ethernet cable. Usually 10 Base T using twisted pair cable or 10 Base FL using fibre optic cable.

Co-axial cable is not suitable for upgrade to 100 Base Ethernet. This is the latest technology and can transfer data at 100 Mega Bits per second.

## Problems with 10 Base 2

The most serious problem is total network failure. **Any short circuit or fault on a network node is likely to cause total network failure.**

Almost all other problems on an 10 Base 2 network will affect either :-

a. The distance data can be transmitted.

b. The number of errors on the network.

The distance reduces each time an incorrect piece of hardware is installed or a rule is broken. If a network is small the fault may never be seen until sometime in the future the network is expanded.

The number of errors increases each time an incorrect piece of hardware is installed or a rule is broken. If the amount of traffic on the network is low the equipment will be able to re-send information very quickly and the user will not see the problem. If the amount of traffic is increased by adding more nodes the network may suddenly slow down as it will be unable to handle all the re-send requirements.

## Hardware

50 Ohm co-axial connector used in networks and 75 Ohm Co-axial connectors used in analogue video signals are the same size. Use of the wrong co-axial cable, BNC connections and T connectors can result in more network data errors and a reduction in the maximum length of a segment.


**The most common hardware error is poor quality crimping of the BNC connector onto the Co-axial cable. A single connector can slow down an entire network.**

If professional crimp tools are not available cables with BNC connectors already fitted should be purchased.

## The 5,4,3 rule & two / four hub rule.

If two nodes communicate through more than 2 full hubs / repeaters or 4 half hubs / repeaters the signal quality will suffer and the data may need to be repeated more frequently. This will result in a slower network.

## Cable Length

If the data cable is longer than 185m the signal will degrade to a level where the data may need to be repeated more frequently. This will also result in a slower network

## Node connections

The co-axial cable must be connected in a daisy chain. Adding a spur onto the segment using a T connector will result in serious network problems. The data will be corrupted by reflections from the end of the spur and the additional termination will reduce the strength of the signal.

The termination is the most important hardware aspect of the 10 Base 2 network.


**In addition to a short circuit and a network node failure the other way to guarantee total network failure is to forget the termination resistor at the end of a segment.**

When data arrives at the end of the segment without termination it will reflect back. The network nodes detect two signals on the cable and assume there is a collision so the data is rejected. This happens for every data packet sent and the result is total network failure.

incorrect termination, eg 75 Ohm, will either slow the network performance immediately or when the network is next upgraded.

Earth loops may seriously slow down the operation of the network depending on the amount of current flowing in the screen and the proximity of the cable to sources of radio noise.

## Noise immunity.

This subject is very important and therefore it is not under the heading of 10 Base 2 problems.

**Strand Lighting do not recommend the use of 10 Base 2 for all connections in a large Shownet installation. 10 Base 2 should only be used for small network installations with no long segments, or to provide connections within a small areas**

One reason is the poor noise immunity of 10 Base 2.

In a theatre or television studio there are many more sources of radio noise compared to a typical office building.

Sources of radio noise include

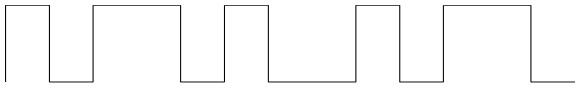
Switched mains (Mains from dimmers to luminares).
Striking Discharge lamps.
Motor controllers (Hoist control)
Radio microphones.

## Collisions.

To understand why 10 Base 2 is susceptible to noise you must understand how the network detects a collision.

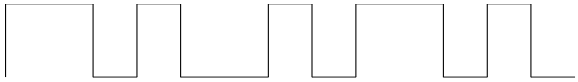
When one node communicates there is a voltage on the network.

Node 1

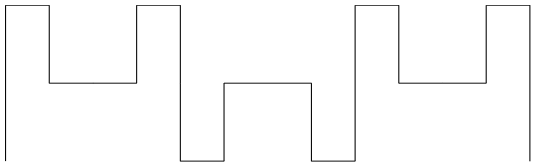


If another node communicates at exactly the same time the signals are added together

Node 2



Combined signal

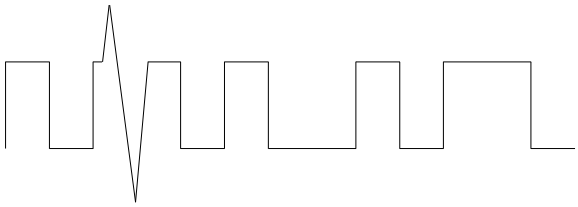


The two transmitting network nodes detect that the voltage on the cable is higher than permitted and generate a jamming signal. This tells every other node to ignore the data.

Any signal which can induce a voltage on the cable so that it exceeds the normal signal voltage will cause a jamming signal.

A single spike from a radio source will cause the network to think a collision has occurred.

Node with noise.



Earthing the screen on the co-axial cable at one point will improve the immunity to noise however there is a risk that the problem will become much worse if a second earth is connected and an earth loop is formed.

To avoid noise problems only use 10 Base 2 in short cable runs between equipment in an area free of EMC radiated noise.

# Ethernet using 10 Base T. Section 4.

10 Base T is sometimes referred to as a UTP Ethernet Network. UTP refers to a cable type and stands for Unshielded Twisted Pair.

This is a misleading description as there are other cable types available. STP - Screened Twisted Pair and FTP - Foil screened Twisted Pair.

The term “10 Base” refers to the maximum data transfer rate for the Ethernet system - 10 Mega data Bits Per Second (10M Bits/Sec)

Do not confuse Mega Bits per Second with Mega Hertz (MHz). All Ethernet cable characteristics are given in MHz. See Section 7 Cable Characteristics.

“T” refers to the twisted cable.

The maximum distance of any cable is exactly 100 Metres.

## The use of 10 Base T in Shownet.

The following section covers all sizes of 10 Base T installations and all of the rules which must be followed.


**Strand Lighting approve of the use of 10 Base T cable for Ethernet connections in part or all of a large Shownet installation.**

**When using 10 Base T Strand Lighting only recommend the use of “Category 5” cable and connections throughout the installation.**

Details of other cable categories and types can be found in Section 7 - Cable characteristics.

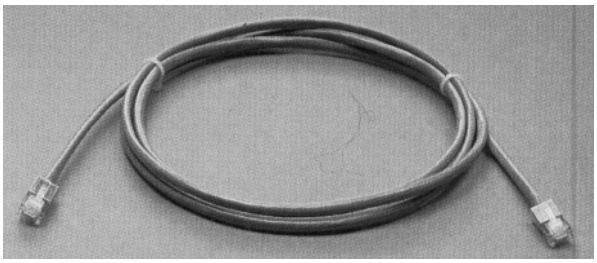

**A cable must be installed for every single network node position. This installation is expensive, both in hardware cost, labour cost and in disruption. It is vital that enough positions are installed when the network is first put in, for any addition of new hardware in the future.**

## Hardware.

The three types of cable UTP, STP and FTP require different types of patch panel however all other hardware is identical.

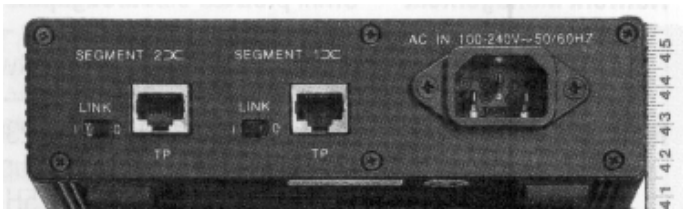
The required cable is Category 5 twisted pair cable. This has four pairs although only two pairs are used in 10 Base T Ethernet. It is terminated by an RJ45 connector on each end.

10 Base T cable.



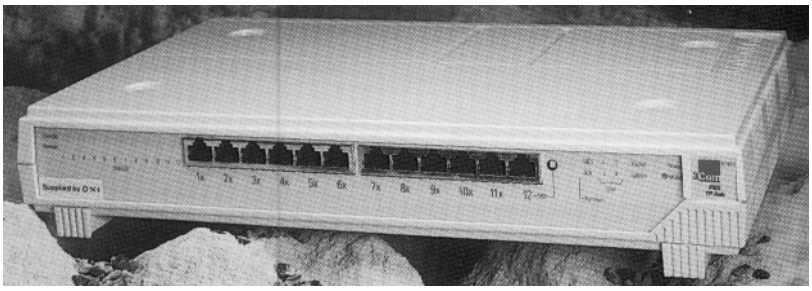

**Two nodes CAN NOT be directly connected using a 10 Base T cable.**

To connect two nodes, or to extend a single cable over the 100m maximum, either a repeater, shown below, or hub must be used.



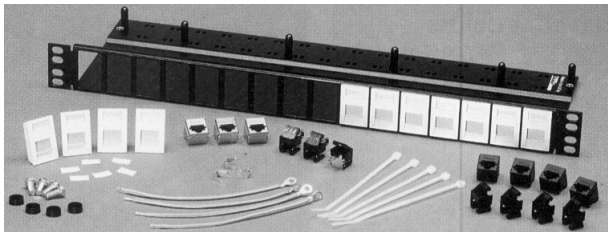

To connect more than two nodes a hub must be used. There are many sizes of hub available ranging from 4 ports to 24. Expansion beyond this is possible.

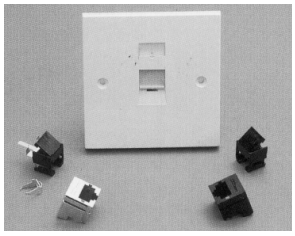
Hubs are also available with many different facilities. This section only covers simple hubs and hubs with a connection which can be used to link from one hub to another.



Wall sockets and patch panels are used on every large installation. Since a single cable must be run to every possible node location these are installed permanently into the building. The network node end has a wall box with an RJ45 connector. The hub end has a patch panel. This allows a small hub to be used and to be patched to only the cables which have nodes attached. If more equipment is installed later the hub can be upgraded.

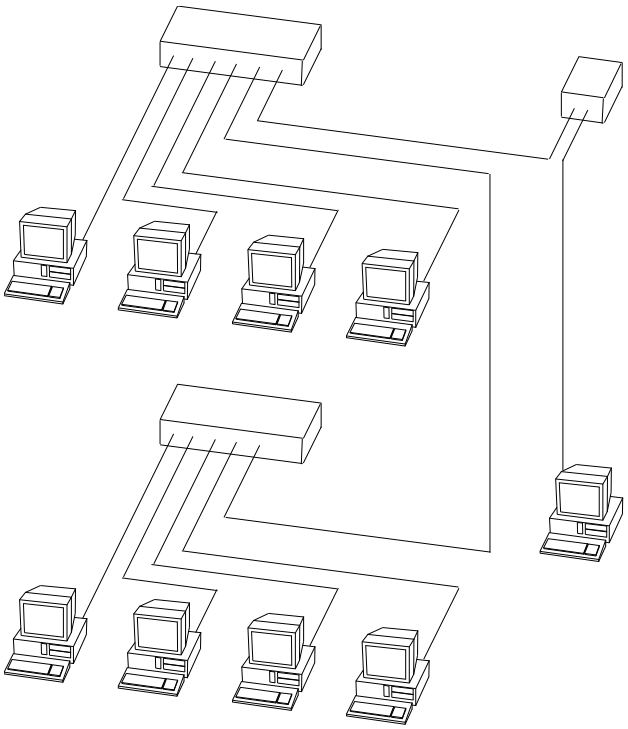
Patch panel. Wall socket.





## Design rules.

Example of a large network installation using only 10 Base T.



The example shows two groups of four computers. Each is connected through a connection on a hub.

The hubs are joined together using a special connector which allows the transmit / receive swap to be removed.

The single computer is over 100m from the top hub and therefore requires a repeater to boost the signal.

The patch panels and wall sockets are not shown.

## The two / four Hub rule.

This rule is probably the most important but is not written down in text books or in the information sheets of network catalogues.

The rule as applied to 10 Base T.


**A twisted pair cable which links a node to a hub is classed as a populated cable. A twisted pair cable which links two hubs can not be connected to a node, and it is therefore is classed as an unpopulated cable. This rule applies to all hubs, repeaters and converters.**

**If two populated twisted pair cable segments are connected to each side of a hub then the hub is classed as a "full hub". There can be only two full hubs between communicating nodes.**

**If two populated twisted pair cable segments are joined by two or more hubs and each hub is linked by an unpopulated cable segment then each hub is classed as "half hub". There can be 4 half hubs between communicating nodes.**

The unpopulated segment between two hubs / repeaters does not have to be a twisted pair. An unpopulated co-axial cable or a fibre optic link can be used instead and still obey this rule.

To transfer to another cable type the hub could be fitted with a transceiver module, a stacking hub could be used with different cable types on each stacked hub, or a converter can be used instead of a repeater.

## Other hub rules.

There must be at least one repeater or hub between nodes.

> The hub is used to swap the transmit twisted pair from one node to the receive twisted pair on the other node. A swap box is not generally recommended but can be used. Details are in Section 6 - Additional hardware.

When two hubs are linked with a twisted pair cable then one hub must have a special connector.

> One connector on the hub has a switch to remove the transmit to receive swap for linking to another hub.

Never allow more than one cable to go between two standard hubs, or connect three hubs in a triangle.

> The two signals will arrive overlapped and the data will be corrupt. It is likely that the network will totally stop. It is only permitted using intelligent hubs with a "Spanning Tree Algorithm". See Section 6 - Additional hardware.

The maximum number of nodes depends on the number of points on the hubs. The hardware does not limit the number of connections.

> Hubs usually have a maximum of 24 connections. Larger hubs can be built using “Stacking Hubs”. Details can be found in Section 6 - Additional hardware.

## Cable length rule.

Each cable segment must not exceed 100m

There is no minimum length of cable.

## Screened cable.

Screened cable is available as STP Screened Twisted Pair or FTP Foil screened Twisted Pair.

Screened cable can only used for the permanent cable runs around a building and is not suitable for patching cables between wall sockets and network nodes, or between patch panels and hubs.

> The screen is not connected to the RJ45 connector and must be earthed at the patch panel. It is vital that the earth is only connected at one end or there will be a risk of an earth loop.

Screened cable is slightly more expensive than unscreened.

## Problems with 10 Base T

The most serious problem for an Ethernet network is total failure. This is not common for 10 Base T installations and there are ways to prevent almost every type of problem.

Almost all problems on a 10 Base T network will affect either :-

a. The distance data can be transmitted.

b. The number of errors on the network.

The distance reduces each time an incorrect piece of hardware is installed or a rule is broken. If a network is small the fault may never be seen until sometime in the future the network is expanded.

The number of errors increases each time an incorrect piece of hardware is installed or a rule is broken. If the amount of traffic on the network is low the equipment will be able to re-send information very quickly and the user will not see a the problem. If the amount of traffic is increased by adding more nodes the network may suddenly slow down as it will be unable to handle all the re-send requirements.

## Hardware and connections.

If two nodes communicate through more than four half hubs the signal will degrade to a level where the network may slow down because of the number of re-tries.

The network connection will not work if two nodes are linked directly with a 10 Base T cable. The transmit will be connected to transmit and receive will be connected to receive. A hub or repeater must be used.

Data can not be transmitted between two standard hubs with a standard cable because the transmit and receive are swapped in the first hub and then swapped back again In the second. The network will operate as if the connection does not exist.

Using two cables to link between two standard hubs, or connecting three standard hubs in a triangle will cause total network failure as data will circulate in never ending loops.

Using the wrong cable standard will reduce the distance the signal will travel and may decrease the signal strength and quality. Only use category 5 cable.

## Short Circuit.

Any short circuit on a network node will not cause total network failure. The hub should isolate the connection from the rest of the network and only one node will be lost.

If a short circuit occurs on a cable between two hubs both hubs will isolate the connection. The remaining nodes on each hub will continue to work.

> For example :-If a Strand Lighting main desk is on one hub and the SN100 operating the dimmers is on another the final effect of a short on the connecting cable will be no different from a total network failure.

## Noise immunity.

10 Base T twisted pair cable is less susceptible to noise than 10 Base 2 however noise can still be a problem.

In a theatre or television studio there are many more sources of radio noise compared to a typical office building.

Sources of radio noise include

> Switched mains (Mains from dimmers to luminares).
> Striking Discharge lamps.
> Motor controllers (Hoist control)
> Radio microphones.

To minimise the EMC in a noisy environment

a. Ensure the cable is run at least ½m away from switching power conductors.

b. Always cross data and power cables at 90 degrees to each other.

c. The insulation on standard Category 5 cable is not rated for installation next to main cables.

## Collisions.

Each 10 Base T node has a transmitter and receiver.

When a node finds a time to transmit it monitors the receive data at the same time. If the receive data is not identical the node assumes that another node decided to transmit at the same time and the node transmits a “Jamming” signal.

The node starts its random timers to try to re-send the data.

The jamming signal is picked up by every node which then ignores the previous piece of corrupt data.

Because the node compares the data out and the data in any noise above a low background level will cause a collision to be detected. Each collision will cause a re-transmit. The network can soon become overloaded with data.

To reduce the risk of noise causing collisions there are different types of category 5 cable. The noise protection is greatly improved by using a screened twisted pair cable.

It is very very difficult to know in advance if the extra protection of a screened cable is needed. The EMC noise along the length of the cable must be assessed.

## Network upgrades.

The 10 Base T network can be expanded by increasing the number of connections from the hub. This can be done by buying a larger hub or by using stacking hubs.

To increase the distances beyond the maximum of 500m a repeater or hub should be used to convert to 10 Base FL. This has a range of 6200m using fibre optic cable.

Category 5 cable is suitable for upgrade to 100 Base TX Ethernet. This is the latest technology and can transfer data at 100 Mega Bits per second using two pairs for transmit and two pairs for receive. The node must be able to support the higher speed and the hubs will also need to be changed.

## Combining 10 Base T and 10 Base 2.

Section 5 will discuss how to combine 10 Base FL with 10 Base T and 10 Base 2.

There are four pieces of hardware which will allow the transfer of data between 10 Base T cable to 10 Base 2 cable.

## The converter.

This has a Coaxial connector and a RJ45 twisted pair connector. The Coaxial connector may have a termination switch so that a T connector and terminator are not required.

The 10 Base T cable can be connected to a single node or to a hub. If the output goes to a hub the rule “Only four half hubs between communicating nodes” must be followed.

## The standard hub.

Many small standard hubs have a number of RJ45 connectors plus one Co-axial connector. There are many different types available and these are quite cheap.

## Hubs with transceiver modules.

Often more expensive hubs have a slot for an additional transceiver module. Modules can be fitted for all type of Ethernet cable :- Fibre optic, Twisted pair, Co-axial, and AUI (for 10 Base 5).

The transceiver module is a standard port and when two hubs are linked using this connector the cable can not be linked to a third hub.

## Stacking hubs.

Each stacking hub is linked using a high speed transceiver module with an AUI connector. The connectors on each part of the stacking hub are linked as if a single hub is in use.

Usually each stacking hub has only one type of connector fitted. To link 10 Base 2 and 10 Base T one stacking hub of each type must be connected.

Stacking hubs are more expensive than standard hubs.

for full details of stacking hubs see Section 6 Additional hardware.

## Rules for combined cable types.

The 10 Base T section of the combined network must comply with all of the rules given earlier in this section.

The 10 Base 2 section of the combined network must comply with all of the rules given in Section 3.

When combined the most critical rule is :- Only two full hubs or four half hubs between any two communicating nodes.

# Ethernet Using 10 Base FL. Section 5.

10 Base FL is a fibre optic protocol. It will carry data down a fibre for up to 2 Km.

It must not be confused with FOIRL which is an older fibre protocol. This has a maximum distance of 1Km and the hardware used is different.

The term “10 Base” refers to the maximum data transfer rate for the Ethernet system - 10 Mega data Bits Per Second (10M Bits/Sec). The FL refers to Fibre Link.


**All Strand Lighting Shownet equipment has either a standard 3COM ELINK III network card fitted or a network interface circuit as part of a Strand Lighting manufactured circuit board.**

**No equipment is fitted with a Fibre connector and the 3COM card can not be replaced by any other type.**

All 10 Base FL connections must be made by using converters from either 10 Base 2 or 10 Base T cables.

## The use of 10 Base FL in Shownet.

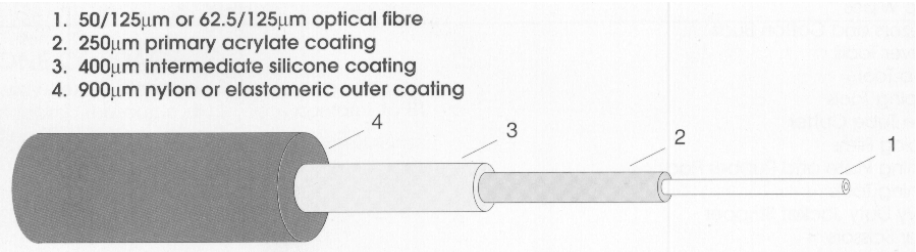
Strand Lighting approve of the use of 10 Base FL in lighting installations

It is totally immune to EMC noise and lightning strike and can be run the long distances around theatres and television studios without repeaters.

The cable and installation costs are very expensive but it provides reliable network connections.

## Hardware.

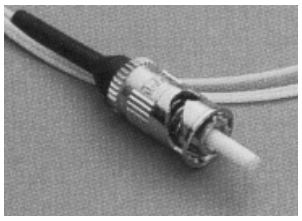
The fibre is normally purchased without connectors. The recommended fibre is 62.5/125. This is a 62.5 micron glass core plus 125 micron cladding.



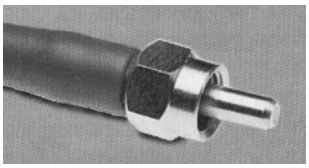

There are several types of connector available.

The two standards are “ST” which resembles a BNC connector and “SMA” which is a screw connector. Both of these are connectors are bonded to the fibre using epoxy adhesive.

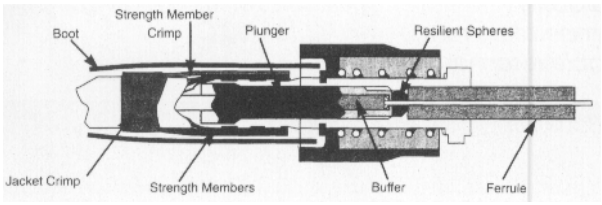
ST connector



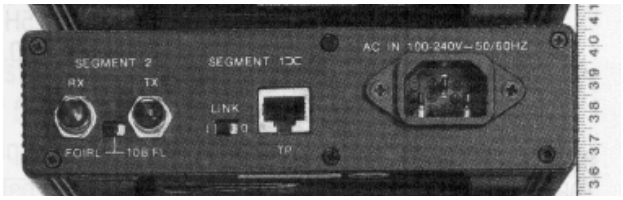
SMA connector



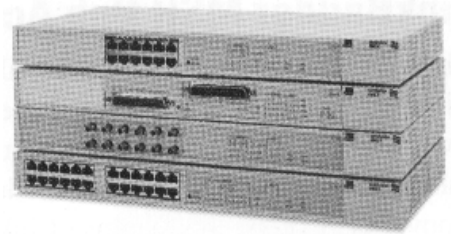
There is also an ST crimp connector manufactured by AMP.




A converter is needed from 10 Base 2 or 10 Base T to 10 Base FL then back again.




A standard hub does not have a 10 Base FL connector. To allow several nodes to be connected a stacking hub or a hub with an optional 10 Base FL adapter must be used. Full details of these hubs in section 6 - Additional hardware.

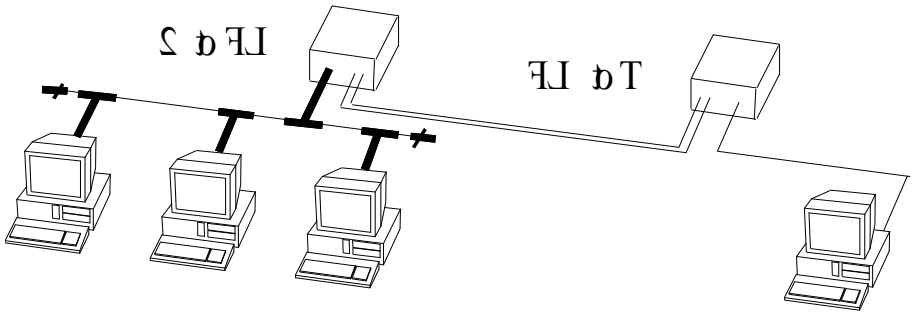


Patch panels do not usually support 10 Base FL connections. It is possible to link fibres which use the SMA style connector but each

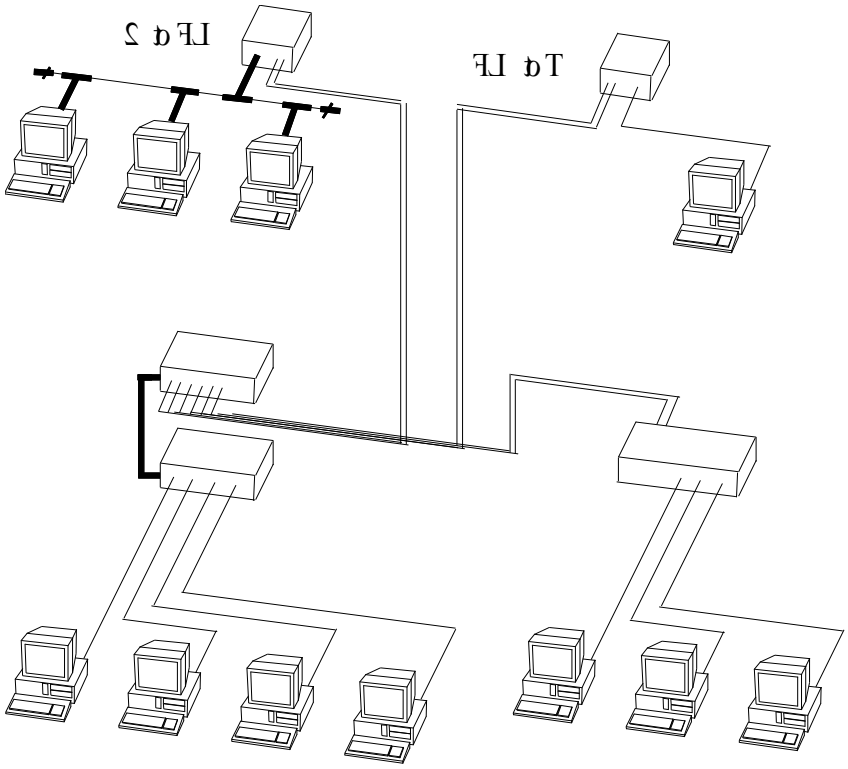
fibre to fibre link could degrade the signal. The fibre is usually connected directly to the hub or converter.

## Design rules.

Example of a small network installation using converters for 10 Base FL and other protocols.



Example of a large network using converters, hubs with optional 10 Base FL transceiver ports and a Stacking hub.



The example shows four areas which are linked by fibre optic cable. The top two boxes are simple converters. The bottom left box is a stacking hub and the bottom right is a hub with an options fibre link.

The patch panels and wall sockets are not used for fibre cables and are not shown for 10 Base T.

## The two / four Hub rule.

This rule is probably the most important but is not written down in text books or in the information sheets of network catalogues.

The rule as applied to 10 Base FL.


**A fibre can not be used to link to a node therefore a twisted pair or co-axial cable which links a node to a hub is classed as a populated cable segment. A fibre optic link between two hubs is classed as an unpopulated cable. This rule applies to all hubs, repeaters and converters.**

**Two populated cable segments are joined together through two or more hubs and each of these hubs is linked by a fibre optic cable. Because the fibre optic cable is classed as an unpopulated cable segment then each hub is classed as "half hub". There can be 4 half hubs between communicating nodes.**

The unpopulated segment between two hubs / repeaters can be fibre optic cable, unpopulated co-axial cable or a twisted pair cable.

To transfer to another cable type the hub could be fitted with a transceiver module, a stacking hub could be used with different cable types on each stacked hub, or a converter can be used instead of a repeater.

## Other hub rules

When stacking hubs are linked using the high speed AUI connection on the back, all the connectors are considered to be on one hub. Data can therefore be sent to more hubs and the 4 half hub rule has not been broken.

If an optional 10 Base 2 connector is fitted on a non stacking hub it is sometimes called the backbone connector. This connection is not running at a higher speed however if the co-axial cable is not populated the 4 x half hub rule applies.

Never allow more than one pair of fibres to go between two hubs, or connect three hubs in a triangle.

> The two signals will arrive overlapped and the data will be corrupt. It is likely that the network will totally stop. It is only permitted using intelligent hubs with a "Spanning Tree Algorithm". See Section 6 - Additional hardware.

## Cable rules.

Each cable segment must not exceed 2000m

There is no minimum length of cable.

Every connection requires two fibre cables. Transmit to receive and receive to transmit.

Cables can be installed in the same trunking as power cables as there is no risk of shorting and no risk from EMC noise.

Cables are available with a variety of different protective coverings and different numbers of cores. Because the cost of running cables is high a pipe can be installed then the fibres are blown through the pipe. Additional fibres can be added later if required.

The quality of the join to the connector and the polished end of the fibre are critical to ensure good data transmission.

## Problems with 10 Base FL

The most serious problem for an Ethernet network is total failure. Because the fibre is usually run to remote areas of a network a break in one fibre will result in a loss of data between areas. This is critical in theatre and television.

> Backup cables can only be run when using an intelligent hub. See "Spanning Tree Algorithm" in Section 6 - Additional hardware.

Cables are quite fragile and require careful handling. Pulling a fibre through a conduit is not recommended.

It is not possible to connect direct to the Shownet nodes.

It is more expensive than other cable types.

Cable repair is possible but requires expensive equipment.

## FDDI fibre links.

The FDDI link is a high speed fibre optic data link used to join hubs around a building.


**FDDI is not Ethernet. It is a totally different type of network and uses different rules. A hub which links to a FDDI backbone contains a basic computer to convert the data to this new protocol.**

The FDDI hubs are very expensive and one is required every time you need to link back to Ethernet.

There are some advantages. The FDDI link can be built in a ring so that a cable break can be resolved by sending data the other way around the loop.

It is unlikely that FDDI will be used in Shownet installations.

## Network upgrades.

The 10 Base FL network can only be expanded by increasing the number of connections from the hub.

Adding more fibres is expensive unless the fibres are blown through an existing fibre pipe.

Fibre optic cables are already able to carry the data for 100 Base Ethernet networks. To upgrade to the higher speed the nodes and the fibre hubs must be upgraded.

# Additional hardware. Section 6.

The following section covers a selection of additional hardware available on Ethernet networks. The section titles includes a brief description of the application if any.

## Standard hubs with transceiver modules
### For adding a single connector of another type.

Many of the larger hubs have an slot somewhere for an optional transceiver module. Modules for all types of cable are available.

These hubs look the same as a standard hub. The case used is often the same.

This module is used to add a single connector to a hub. It is commonly used to add different type of connector to a hub, but the same type of connector could also be fitted.

Section 5 has an example of this type of transceiver being used to add a 10 Base FL link.

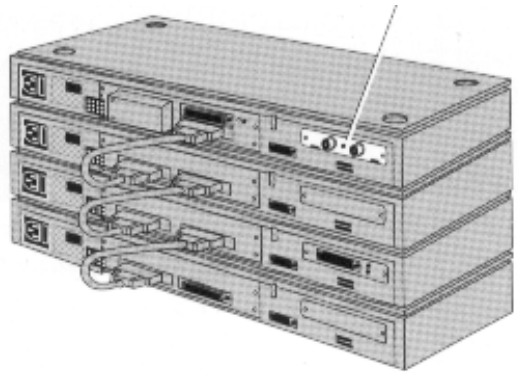
When two nodes communicate through two hubs which are linked using the transceiver modules the data can not be passed through another hub or repeater without breaking the two hub / repeater rule.

## Stacking hubs.
### For ease of expansion or to mix cable types.

Some of this information has already been covered already in sections 4 and 5.

Hubs are available will up to 24 RJ45 (twisted pair) connectors or 4 Co-axial connectors or 6 pairs of fibre connectors. Larger hubs are hard to find.

If there is a chance the customer will one day increase the size of his network then the stacking hub could be a cheaper solution in the long term.



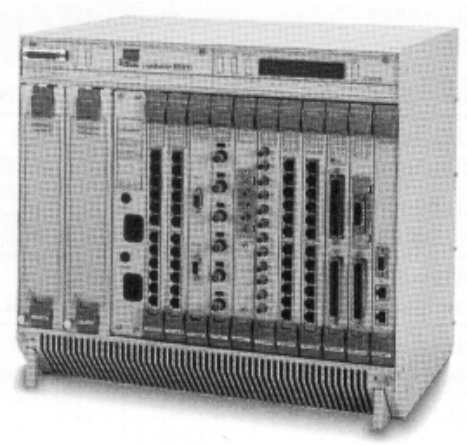
The most important rule says that no more than two full hubs or four half hubs can be used between any two communicating nodes. A hub is classed as a full hub if two populated co-axial cables are joined to two ports. A hub is classed as a half hub if the cable between the hub and another hubs is not populated.

Up to seven stacking hubs can be joined and the combined stack only counts as one hub on the network.

Each hub in the stack can have different cable connectors.

Each hub is linked by a high speed data cable using an AUI connector on the back. The high speed link is terminated on the last hub in the stack..

If the customer needs the facilities which a stacking hub provides when the network is first installed then a second type of stacking hub is available.



The module hub, or multi service hub, is a box with a mains power supply. It has a number module slots in the front. Modules are available with connections for RJ45, Co-axial, Fibre, AUI, or any other cable type which may be required. Blank module cover the unused slots.

The hub can be very easily expanded by adding more modules. The modules are cheaper than more stacking hubs because there is no need for a case or a power supply.

## Backup Cables using a bridge.

The worst possible event for a Shownet network is if the cable linking the control room to the stage, dimmer room or grid is broken.

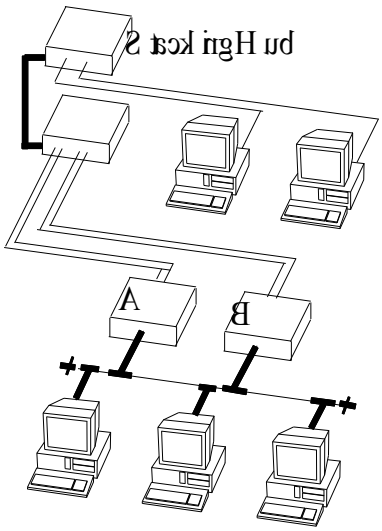
It is forbidden to attach two cables between two hubs because the data will circulate and the network will not work. If two cables are used and one fails then the main cable must be manually switched at both ends for the backup cable.

The only piece of hardware which will allow two cables or more to be connected is a special type of bridge which uses a **"Spanning Tree Algorithm" (STA).**

Many bridges will not quote "Spanning Tree" so look for **IEEE 802.1d Bridging Specification** compliant.

Later in this section we will see that Bridges are expensive and are not usually necessary. This special type is the only one which may be of use in a Shownet installation.

Using a 3COM NET Builder Bridge/Router the equipment is setup as follows.




When the nodes are not using the network Bridge A will communicate with all of the other bridges and one bridge becomes the master. As long as bridge A can communicate with bridge B through both routes, the data will only be passed through bridge A.

If a fault occurs on bridge A, or one of the cables to the bridge is cut, bridge B will detect this and take over the transmission of the data.

The 3COM bridge only supports 10 Base 2 and 10 Base 5 connections.

The DIGITAL DECbridge 90FL supports 10 Base 2 and 10 Base FL. This may be a more useful choice to backup longer cable runs. This bridge is shown in the example above.

The bridge does not count as a hub, converter or repeater because the data is not buffered. Instead it is read into memory and re-transmitted from the other side of the bridge. Data between two communicating nodes can be sent via four half hubs each side of the bridge.

## Passive Hub. For low cost linking two nodes.

This hub is for linking two nodes which are using 10 Base T.

If a standard cable is used directly between two nodes the transmit is connected to transmit and receive to receive.

Making a cable with swapped twisted pairs should not be done because of the risk of using the cable between a node and a hub.

The Two port passive hub consists of two RJ45 connectors and some wires. There is no buffer and the maximum cable length of 100m between the nodes is not increased.

Pin to pin connections.

| Pin | Pin |
|---|---|
| 1 | 3 |
| 2 | 6 |
| 3 | 1 |
| 4 | 7 |
| 5 | 8 |
| 6 | 2 |
| 7 | 4 |
| 8 | 5 |

Two port passive hubs are not available from network manufacturers and must be ordered or made in house. All connectors must be category 5 twisted pair specifications. The network will suffer from a poor quality connector.

Advantages of this passive hub include :-

Low cost.
Unaffected by power failures.

## Lightning Surge Protection.

There are a few companies that provide hardware to protect against lightning.

10 Base T installations usually have a large hub with a patch panel then local wall sockets to each node. Lightning protection patch panels are available to ensure a lightning strike on a cable is not passed to the whole network.

Each node can also be protected using a single node device.

The 10 Base T protective devices are resettable.

Lightning protection is available for 10 Base 2 installations however it is only in the form of fusable links on the co-axial cable which should blow before the worst of the voltages are passed through.

Lightning protection devices are usually very expensive however the total destruction of the network is going to cost a lot more.

In high risk areas lightning protection for the power to the nodes should also be considered.

## Standard Bridges / Routers.

A router is a more advanced type of bridge therefore the description can be applied to both.


**Manufacturers claim that Bridges and Routers will speed up your network. On many types of network this may be true however it is not a useful addition to a Strand Shownet installation.**

## How the bridge works.

A bridge is used to link two parts of a network or to link two different networks.

When the bridge is switched on it listens to the data and learns which nodes are on which side of the bridge. Each network driver chip has a unique network address called the MAC address.

When data is sent from one node to another the bridge knows which side each node is connected to. If the two nodes are on the same side the data is not passed across the bridge. The network on the other side of the bridge has less data and may work faster.

The networks on each side of the bridge are completely independent of each other. If this was not the case one network could not take advantage of the time saving when the other network is talking amongst its own nodes.

When data passes over the bridge the data is read and stored in the memory of the bridge. The bridge then waits for a free time slot on the other network and transmits the data.

Because of the store and transmit operation the bridge does not count as a hub or repeater and there can still be two hubs or repeaters between communicating nodes.

## Why Bridges / Routers are not useful.

There are few advantages in using a bridge for Strand Lighting Shownet because information like DMX data and Video screens are sent as a "Broadcast" message. This means that the destination is every node. The bridge will have to pass all of this data across the bridge every time the data is sent. There are no time savings.

Bridges and routers can also be expensive.

## Switches.

A company may have a high speed file server or a high speed digital phone link (ISDN) to a main frame.

If the high speed server is attached to a standard 10 Base network it will only be using a small amount of the possible processing time talking to the network. Time waiting for network access is wasted.

A typical fast file server would be fitted with a 100 Base network card which will run 10 times faster. This can not be directly connected to a 10 Base network so a switch is used to link the two.

If there are 10 nodes on the 10 Base network each one must wait for a quiet period before it can talk. These 10 nodes can be split into 10 separate 10 Base networks and each one is connected to the switch.

The nodes will now find there is no traffic on their personal network and all will talk at the same time. The Switch will listen and buffer all of the data and send it to the server one at a time using the higher speed link.

The network will operate 10 times faster without the need to upgrade every node to a 100 Base protocol.


**This is not suitable for Strand Lighting Shownet because every node can only talk to another node on its small section of network or to the file server. DMX and Video on Shownet needs to be transmitted between the main desk, the PC backup and every other Shownet node. This is not possible through a switch.**

## Wide Area Networks.

No attempt should be made to connect the Shownet to a wide area network (WAN) except through a dedicated digital phone line. Customers should not attempt to connect to a public digital phone system (ISDN).

The data protocol used by Strand Lighting Shownet is called TCPIP and this is already based on communication down a WAN. Each node has an IP address of 193.195.164.XXX which is registered to Strand Lighting for Internet use.

Before using a public digital phone line a customer must register and receive a unique IP address. The config files should then be changed in every node to use the new IP address.

This section on additional hardware will not cover hardware to attach to Wide Area Networks.

## Network diagnostics and management.

Some hubs can be fitted with a network management module, or a dedicated module can be fitted to a hub stack.

The management module collates data from the whole network. The information is generated using the industry standard format Simple Network Management Protocol (SNMP).

A computer is attached to the management module and the data can be read by any SNMP software.

The software will show the current status of the network and if it is left permanently on the hub a history can be built up and network statistics gathered.

Most management modules can not gather data from the other side of a switch. This is because the other half of the network is running independently. Remote managers can be fitted which gather data and can all be accessed through the main management hub. The industry standard is Remote Monitoring (RMON).

The management module does add to the data on the network but this is not a significant increase.

# Cable Characteristics. Section 7.

This section is intended to give some background information into some of the reasons why Strand Lighting recommend some types of cable over others.


**It is not necessary to understand anything in this section providing the rules for Ethernet design, and the recommendations made by Strand Lighting are followed.**

## Twisted Pair cables.

Twisted pair cables are given different categories.

Category 3 cable is rated to carry 10 M Bits / Second for Ethernet.
Category 4 cable is rated to carry 16 Mbits / Second for Token Ring.
Category 5 cable is rated to carry 100 Mbits / Second for Fast Ethernet.

In addition the length of the cable is defined by the specification used.

The 10 Base T Specification says that any hardware must be designed to ensure that the line driver can send the signal for the required 100m at 10 M Bits / sec down Cat 3, 4 or 5 cable.

The 100 Base TX Specification says that any hardware must be designed to ensure the line driver can send the signal for the required 100m at 100 M Bits / sec down Cat 5 cable only.

Strand Lighting recommend the use of category 5 cable. This is because the network can be upgraded to 100 Base TX if required and also because the quality of the data is better at the end of the category 5 cable.

The reason why the quality of data is better is explained in the next section.

There is no need to know the exact cable characteristics which are required for a category 5 cable.

## Mbits and MHz.

The relation between Mega Bits per second data transfer rates and Mega Hertz is often a cause for concern.

A cable which is capable of carrying 10Mhz may not be able to carry 10 Mega Bits per second data to a satisfactory standard.

Diagram of a 10 MHz waveform

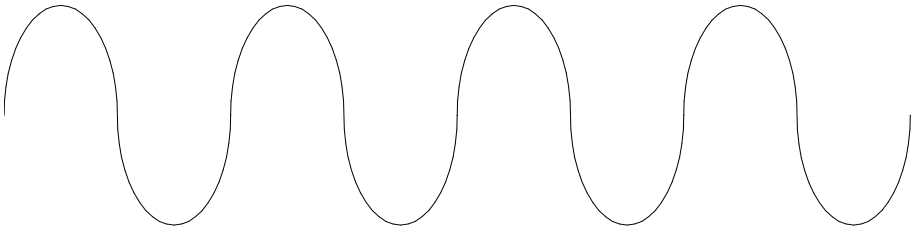
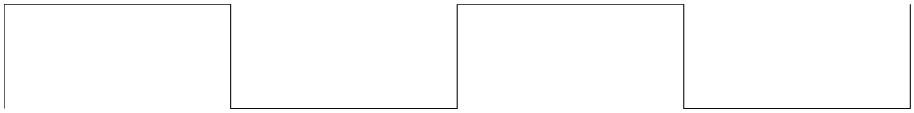


Diagram of a 10 Mega Bits per second waveform - Drawn to the same scale. The data sent is 1 0 10.

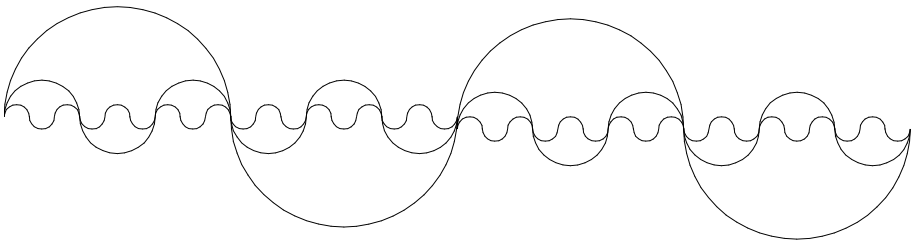


In order to analyse how a square signal will perform down a cable it must be converted into sine waves. The addition of these sine waves making up the square when added. This a procedure called Fourier analysis.

The primary component is a sine wave with a 5 MHz frequency.

Added to this sine wave is another at one third the amplitude and three times the frequency - 15 MHz.

This is still a poor shape so add a sine wave one ninth the amplitude and nine times faster at 45 MHz.



To provide a good quality square wave the cable must be able to carry 45 MHz sine waves.

Category 3 cable is only rated for 10 MHz but can carry data. This is possible because the output of the Ethernet chip is not a true square. It is shaped to help the data reach the other end with the minimum of distortion.

Strand Recommend category 5 cable because there will no distortion of the signal.

## Co-axial cable.

There are two type of co-axial cable available.

Thin Net cable for 10 Base 2 Ethernet and Thick Net cable for 10 Base 5 Ethernet.

10 Base 5 is not used in Shownet.

**Strand Lighting do not recommend the use of 10 Base 2 for all connections in a large Shownet installation. 10 Base 2 should only be used for small network installations with no long segments, or to provide connections within small areas**

The main reason is the poor noise immunity of 10 Base 2. Full details can be found in section 3 “Noise Immunity”.

## Fibre Cable.

There are two types of fibre optic cable.

50/125 mm and 62.5/125 mm.

Both are suitable for 10 Base FL network connections.

Strand Lighting recommend the use of 62.5/125 mm cable as it is rated to 500MHz per Km. This is a better cable to install if the customer is ever going to upgrade to a 100 Base network or faster.

The types of cable describe the dimensions.

62.5 is the class fibre and 125 is the thickness of the cladding.

A typical fibre cable then has a 250 mm primary acrylic coating, a 400 mm silicon coating and a 900 mm nylon or elastomer outer coating.

There are additional coatings depending on the use. These include reinforcing yarn and an outer jacket.

If a multi-core fibre is being used another jacket may enclose all of the cores.

A single fibre cable will have a final outside diameter of only 3mm.

A diagram of a fibre and its coatings can be found in section 5.

# Network testing. Section 8.

If the network is dead or there is a section which is dead then some obvious tests can be made to check the power to the hardware and physical connections.

If the network is going too slowly then there may be a hardware fault or the network design may be incorrect.

To check the network design ask to see the schematic layout of the network and make sure none of the rules in earlier sections have been broken.

## Simple checks.

One of the most simple checks is to ensure there is power on every network node and every hub.

A total failure of all equipment in only one area may be due to a single hub having no power. It is useful to have the network schematic to help isolate the hardware in an affected area.

Also check the physical connections. Make sure none of the cables have been pulled out.

If the network is totally dead disconnect each node one by one. It is possible for a node to fail and fill the network with a continuous noise. This means that none of the other nodes have a chance to talk.

The connector on a node could develop a short circuit if the cable is not made correctly. A 10 Base T hub would isolate this node and allow the rest of the network to continue. A 10 Base 2 network would be stopped by this short.

If the customer has a 10 Base T network make sure the patch leads in the patch panel are linking the hub to the correct cables in the building.

If the customer is using a 10 Base 2 network make sure the termination resistors are fitted, or if the cable ends in a hub, and no T connector is used, make sure the hub has the termination switched on.

If the customer is using 10 Base FL make sure the transmit and receive fibres are swapped between the two hubs.

## Node Configuration.

Another reason why a network may not be working is the configuration of each of the nodes.

Is the network switched on in the console setup screen ?

Have the correct DMX output or input values been entered and do they match the settings in the SN100 or SN102.

Details of these setting can be found in Sections 10 or 11.

The network may also fail if the output protocol is incorrect.

The SN100 and SN102 have 10 Base 2 and 10 Base T connectors. When software version 1.5 is installed the reset TEST button will switch between

the two protocols. Once selected the protocol will remain selected even if the node is switched off.

The 430, 530 and 550 desks have a 3COM network card. It is supplied with a setup disk and the protocol must be set using this disk. This program can only be run under DOS.

There are other card configurations and if these are wrong then the Genius Plus / Lightpalette software will give an error saying the network card could not be initialised.

Details of the 3COM configuration can be found in Appendix A.

## Cable testing.

If all the connections appear OK and the network design is correct but the network is running very slowly then a cable tester can be used to test both the cable and the connectors.

There are many on the market and each tester comes with many different features.

The following list should help you choose a cable tester.

a. Most testers require a test box at each end of a cable. One box to run the tests and the other to terminate the cable. Every cable must be tested from both ends so there is a lot of work involved.

   Some testers are supplied with an intelligent termination box. The termination box contains a duplicate tester and after the main tester has finished the termination box does the same tests from the other end and transmits the results. This is a more expensive option but saves a lot of time.

b. A cable tester must be able to test 10 Base 2 and 10 Base T. The 10 Base T test must be able to test category 5 cable.

c. Most testers only test permanently installed cables. The tester and terminator use high quality patch leads to connect to the patch panel and to the wall socket. There is always a risk that the fault is with the patch lead from the socket to the node.

   There is a new testing standard called TSB 67. This provides rules for testing cable from the hub to the node using all of the customer patch leads. This will identify any bad cables or connectors on patch leads.

d. All cable testers are capable of measuring the length of a cable and the cable characteristics.

   Some cable testers are able to measure the distance to a fault and this can help in finding cable breaks or shorts if a conduit has cut into the cable.

e. Many cable testers can download results into a computer so that a test certificate can be issued. All network installations should be tested by the installer and a test certificate issued for each cable.

## LAN Analysis.

If all of the cable tests do not find the cause of the problem the LAN data may need to be analysed. This is a very expensive option and will usually involve leaving a computer attached to a network for a length of time so that a history of network errors can be built up.

Strand Lighting use a software package called LAN Analyser by Triticom which is a cheap solution at approximately £1000.00 plus the cost of the computer. The disadvantage is that the data can not be viewed whilst gathering data at the same time.

Systems which allow analysis of live data start at about £5,000.00 plus the cost of the computer.

This data will identify how much of the available network time is being used and how many collisions are occurring.

If the network time is low and the collisions are high then it is possible that there is noise on the network causing these collisions.

# Labeling and System Identification. Section 9.

Strand Lighting suggest that network designers follow the recommendations in the ESTA document “Recommended Practice for Ethernet Cabling Systems in Entertainment Lighting Applications”.

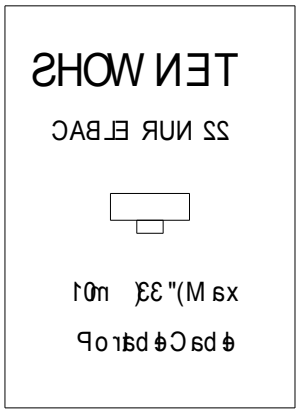
Part 3 of this document covers labeling and identification.

Labeling of all Ethernet lighting system components is vital for a quick repair of a faulty network.

## Wall Plates

Wall plates should have the following markings.

- An indication that the connection is exclusively for Strand Lighting Shownet.
- A unique segment number - (e.g. Cable run 22 )
- An indication of the maximum length of cable between the wall plate and the node.



## Termination Blocks and Hubs.

Permanently installed termination blocks and hubs must have the following markings.

- An indication that the connection is exclusively for Strand Lighting Shownet.
- A unique identifier which shall appear on each hardware component.

## Segment cables.

All segment cables (Co-axial) must have the following markings. Labels must be attached at each termination point.

- An indication that the connection is exclusively for Strand Lighting Shownet.
- The length of the segment cable

# 3 COM Network setup Appendix A

When Networker or PC Backup software is supplied it comes with a 3COM Network card.

3COM Etherlink III 3C509 B - COMBO.

It has a Co-Axial connector for 10 Base 2, an RJ45 connector for 10 Base T and an AUI connector for 10 Base 5.

If it is not setup correctly it will not communicate with the network and it may also cause the console to lock up.

Details of the setup procedure are in networker instruction manual and details of installation are in the 3COM manual.

## Installing the card.

The card should be installed by an experienced PC Engineer or by a Strand Lighting Service Agent. This card is very static sensitive and without anti static precautions the card and the PC motherboard may be damaged.

There are no links to change when fitting the card. A slot on the back of the console is already labeled for the network card.

Remove the blanking plate from the rear of the slot then insert the network card in the extension card slot. Secure the network card using the screw which held the blanking plate.


**Do not fit the network card into the top ISA slot on the left side of the expansion card. Then the console lid is lifted the Co-axial connector is pushed down and may break.**

## Card configuration.

A brand new network card could have any setting in its memory. If the card has Interrupt 11 set then the console will lock up as soon as the Genius Plus or Lightpalette power up screen appears.

This is because of a conflict on interrupt 11 between the network card and the Strand Lighting Control Surface Interface Card.

To configure the network card switch the console on then press F5 on the computer keyboard when the message “Starting MSDOS” appears.

The computer will not run the Genius Plus / Lightpalette software.

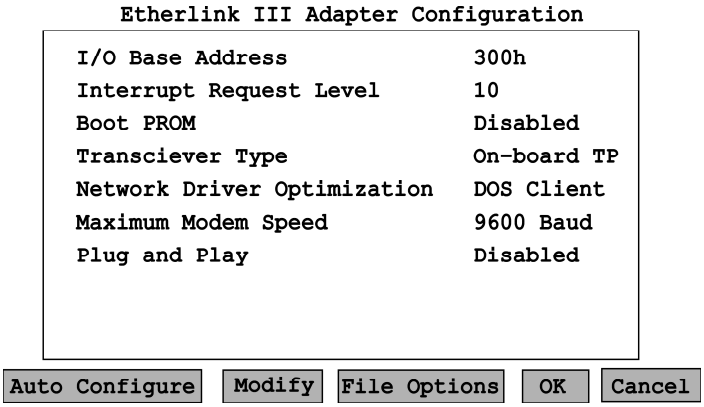
Insert the 3COM setup disk and type the following commands.

A: <enter>
3C5X9CFG <enter>

These commands will start the network card setup program.

Do not run the install program on the floppy disk as this is designed to install network drivers for standard networks like Novell.

The configuration screen.




Use TAB to move the highlight through the option.

If the network card is old it will not have the Plug and Play option. A new network card will have Plug and Play enabled by default.

Go to the Plug and Play option and disable it. Then choose OK. The software will warn you that the computer must be switched off then on before the option will change.

Do not run the tests, go to the file menu and choose exit. Switch off the console then switch on again. Follow the instructions above to return to the configuration screen.

This time make sure the network card is set to I/O address = 300h

The Interrupt must be set to 10.

The Boot PROM must be disabled.

The Transceiver type must not be left at Auto Select as the selection is made when the network card is enabled. At that time there is probably nothing talking on the network so it will guess and may choose the wrong option. Always select On-board Co-axial or On-board TP.


**If the network card is set to 10 Base 2, and the Network is enabled in the console software, the desk will run very very slowly if a terminated network cable is not fitted.**

The Network drive optimization is not used.

The maximum modem speed is also not used.

Select OK then the card will suggest you run the tests. These tests can be run without the network attached.

Finally exit the program. The card is ready for use.

# Bibliography and further reading.

The following books, catalogues and manuals were used as reference material in the production of this manual or as a source of product photographs.

## Standards


Local Area Networks.
IEEE Standard 802.3 - 1993

Local and Metropolitan Area Networks.
IEEE Standard 802.3u Supplement - 1995.

Published by Institute of Electrical and Electronic Engineers Inc,
345 East 47th Street, New York, NY 10017-2394 USA

Commercial Building Telecommunications Cabling Standard.
ANSI / TIA / EIA - 568 - A - 1995

Published by Telecommunications Industry Association
Standards and Technology Department
2500 Wilson Boulevard
Arlington VA 22201

ESTA. Recommended Practices for Ethernet Cabling Systems in Entertainment Lighting Applications.

Published by Entertainment Services and Technology Association.
Copies from Broadway Press, 12 West Thomas Street,
Shelter Island, NY 11964
Copies also available from PLASA.


## Books


Guide to Local Area Networking.

Published by Cabletron Systems Ltd, Network House,
Newbury Business Park, London Road, Newbury, Berks, UK.

Data Communications, Computer Networks and Open Systems.

Author Fred Halsal
Published by Addison-Wesley,
ISBN 0 - 201 - 56506 - 4

## Catalogues.

Black Box Catalogue.

10 Fleming Road, Newbury, Berkshire, RG13 2DE, UK

Pronet Catalogue.

1 Tealgate, Charnham Park, Hungerford, Berkshire, RG17 0YT, UK.

Technocom Catalogue.

70 Buckingham Ave, Slough, SL1 4PN, UK.

Farnell Networking Catalogue.
Farnell - The cable and Wire Book.

Farnell Electronic Components, Canal Road, Leeds, LS12 2TU, UK.

Action Computer supplies.

12 Windmill Lane, Southall, Middlesex, UB2 4QD, UK.

## Manufacturers Data Sheets.

3COM. Buyers Guide and Hub Data Sheets.

Distributors in every country. See Internet http://www.3com.com.
In UK phone :- Bucks 01628 897000. Manchester 0161 873 7717.
Scotland 0131 220 8228.

Digital. Network catalogue and Data Sheets.

Digital Park, Imperial Way, Reading, Berks, RG2 0TE. UK.
Phone 01734 204092.

AMP Data sheets.

AMP, Merrion Avenue, Stanmore, Middlesex, HA7 4RS, UK.
Phone 0181 954 2356.

Fluke. Data sheets.

Distributors in every country.
See Internet http://www.fluke.com/nettools/
in UK Phone :- 01923 240511

Telematic - Lightning and Surge Protection.

Telematic Ltd, Alban Park, Hatfield Road, St Albans, Hertfordshire,
AL4 0XY, UK. Phone :- 01727 833147

## Other documents.

Strand Lighting Networker Manual.
SN100 Data Sheet.
430, 530, 550 Data Sheet.

Strand Lighting Ltd.