Learning notes

Test standard

To certify a cabling installation it is necessary to conform to an accepted standard. This test standard should define the minimum level of performance, method of obtaining measurements and performance requirements for the test tools.

A sub-committee of the TIA Standards committee developed such a standard known as a Telecommunications System Bulletin (TSB-67). TSB-67 is a standard for the performance specification and measurement procedure for post-installation performance testing of UTP cabling systems. (Refer to AS/NZS 3080 *Appendix ZB* for information relating to copper cable testing.)

TSB-67 addresses:

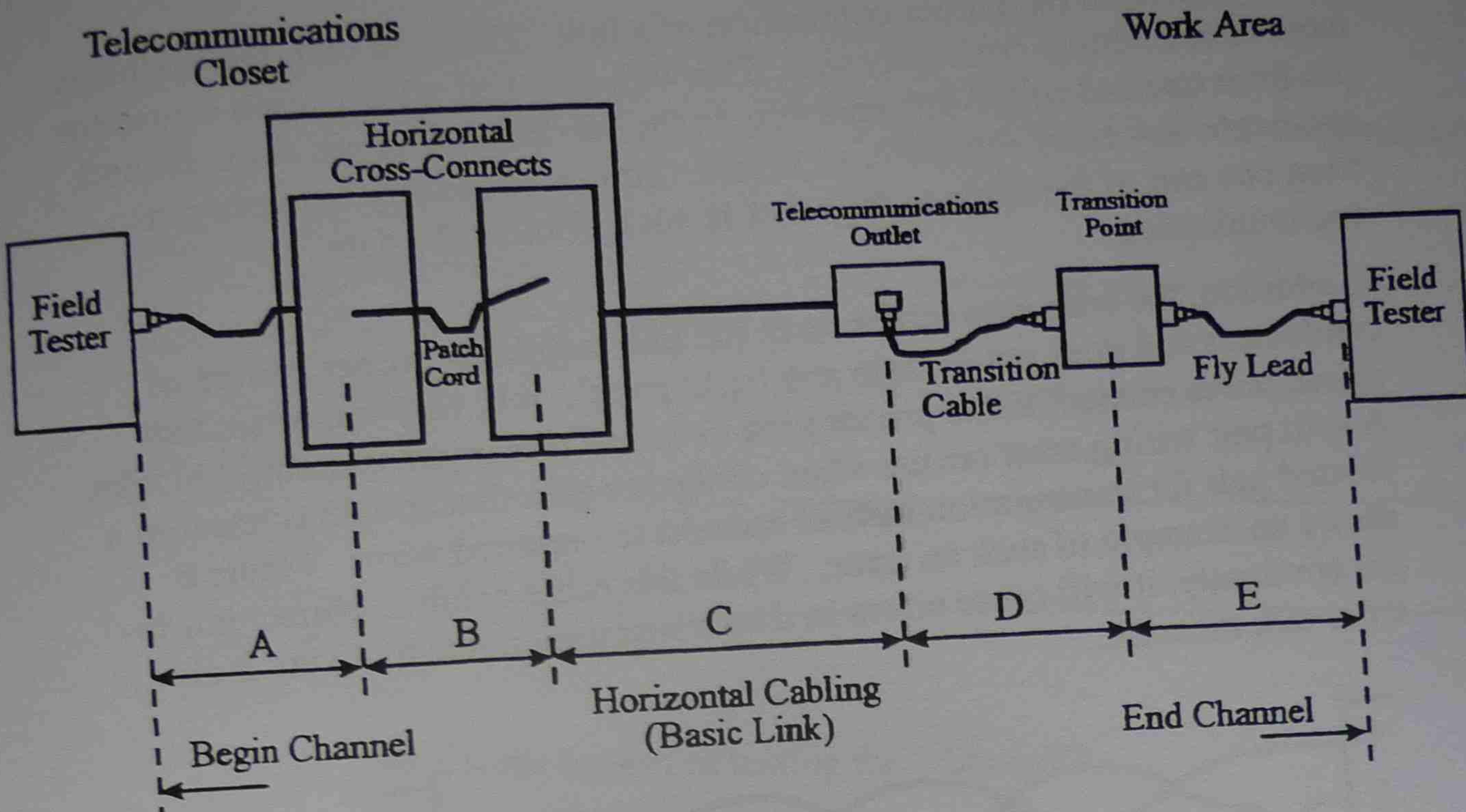
- ❑ specific parameters to test
- ❑ pass or fail limits or criteria for each of these test parameters
- ❑ minimum accuracy and test execution requirements for field test equipment

Parameters to test

TSB-67 contains specifications for the verification of installed UTP cabling links that consist of cables and connecting hardware specified in the TIA-568A standard. The principal test parameters for such a UTP link include:

- ❑ wire map
- ❑ link length
- ❑ attenuation
- ❑ near end crosstalk (NEXT)

In addition to the test parameters to be measured, TSB-67 defines two model link configurations. These configurations are the 'Channel' and the 'Basic Link'.



Key:
A — User Patch Cord
B — 1 or 2 cross connects with a maximum of 2 metre jumper cable
C — Horizontal Cabling
D — Transition cable from telecommunications outlet to in-furniture or under-carpet connection
E — User Patch Cord

Maximum (C + D) of 90 metres
Maximum (A + B + E) of 10 metres

Figure 7 Definition of the channel

Figure 7 shows the channel. The significant feature being the model of the channel defines two transitions at each end, whereas the basic link defines one transition at each end of the link. The channel more likely approximates the link that is of interest to end-users. The end-user wants to verify the performance of the complete cabling link from wiring concentrator or hub to the work-station or network device. This must include the end-users' patch cables but not the test equipment patch cables.

The basic link of Figure 7 consists of the horizontal wiring from the cross-connect to the wall outlet in the work area (segment C) as well as two 2 metre cords for testing equipment. A field tester connects to the basic link using the testing equipment cords.

Wire map

This test affirms the proper connection of a link. The wire map test performs more than a simple continuity test. The wire map test affirms each connector pin from one end of the link connects to the corresponding pin at the far end, and not to any other conductor or shield. Simple continuity between pins from one end of the cable to the other is not sufficient for data communication.

In addition, the wire map test ensures the link maintains proper pairing of conductors and does not contain any 'split pairs'. It is very important that paired wires connect to the proper pins in connectors or cross-connect blocks. A split pair wiring error occurs when connector pins that should connect to a twisted pair for transmission instead connect to unpaired wires. Figure 8 shows an example of such an error. While this cable exhibits correct pin-to-pin continuity, it will cause errors in data transmission due to a very high cross-talk measure.

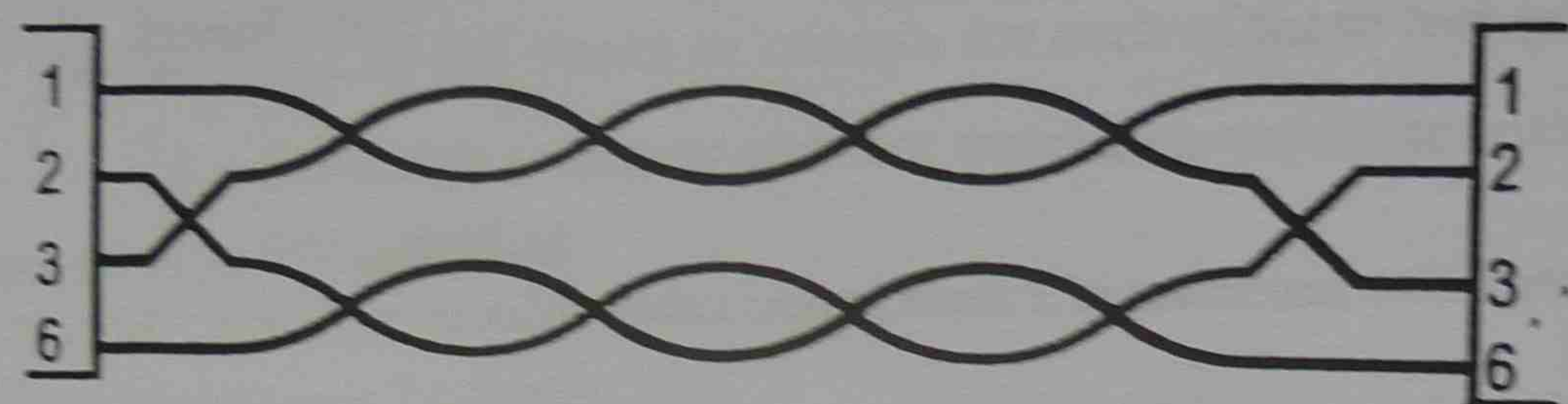


Figure 8 Example of split pair wiring

Link length

It is important to record the length of each link in the administration system. It is possible to estimate the length of a link from the electrical length measurement of the cable. The basis of this measurement is a measurement of the propagation delay of the link and the value of the cable's nominal velocity of propagation (NVP). The NVP expresses the speed with which electrical signals travel in the cable relative to the speed of light in a vacuum. It is possible to calculate the electrical length of the link knowing the NVP of the cable and the time required for a signal to travel the length of the link and back.

The maximum length of a basic link is 90 metres, plus 4 metres for the test equipment patch cords for a total of 94 metres. The total length of a channel must not exceed 100 metres. When measuring channel performance it is imperative to plug the end-user patch cords directly into the field tester. The pass or fail limits defined in TSB-67 add an extra 10% to these link length specifications to acknowledge accurate limitation of the electrical length measurement.

Cable scanners or meters

Cable scanners are high technology devices used to certify LAN cabling. They can perform a large number of tests as well as monitoring of active LANs.

Activation of the scanner's auto test function can perform the following tests on a cable:

- wire map — polarity of wires at connectors both ends
- length
- near end crosstalk
- attenuation
- attenuation to crosstalk ratio (ACR)
- impedance
- capacitance
- loop resistance

The cable scanner will repeat these tests at 100, 200, or 500kHz frequency increments up to a maximum of 100MHz. The scanner will indicate a pass or indicate where the cable has failed. Thorough testing requires checking the cable from both ends. It is possible to do each of the above tests individually to analyse a fault more closely.

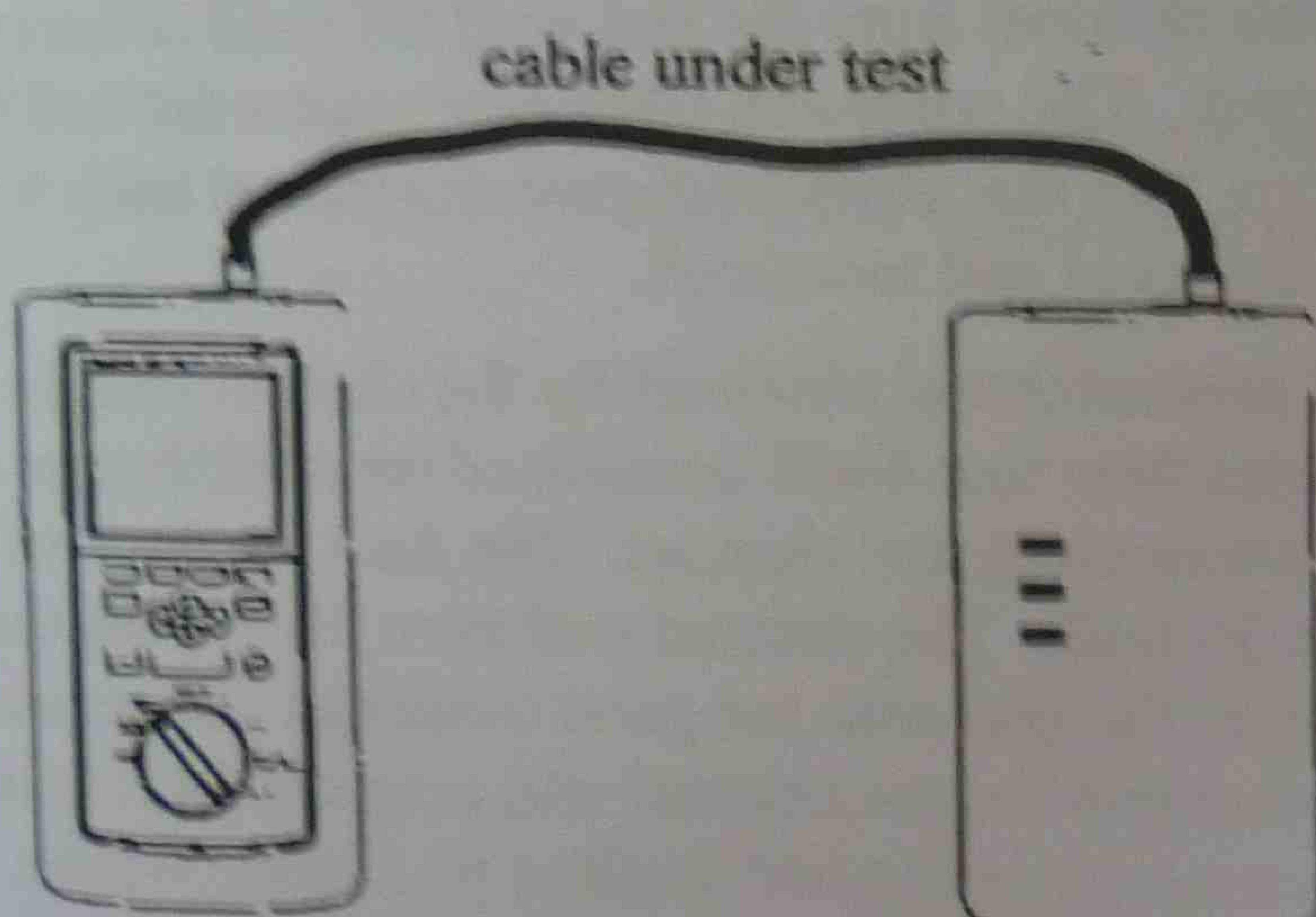


Figure 9 Using a cable scanner

The acceptance levels for each test vary with the different LAN cable requirements. It is possible to program the scanners to suit a particular LAN condition. The scanner can save information obtained in its memory for printing out later. The user receives the information in a report format that provides a permanent hard copy of each individual cable. The category 5 scanners can hold about 500 hundred auto test reports.

Wire map

The cable scanner tests and displays the wire connections between the near and far ends of a cable on all four pairs. If STP cable is used the tester also tests the continuity of the shield. The wire map test detects and reports *opens*, *shorts*, *crossed pairs*, *split pairs* and *reversed pairs*. The tester will display the wire map at completion of the test. Following are sample displays from a Fluke DSP-100 Cable Meter.

Open

Possible causes of open circuits in a cable include:

- ❑ wires connected to wrong pins at connector or terminating modules
- ❑ faulty connections
- ❑ cables routed to the wrong location
- ❑ wires broken by stress at connections
- ❑ damaged connector
- ❑ cuts or breaks in cable

```
Wire Map

RJ45 pin: 1 2 3 4 5 6 7 8 S
          o | | | | | | | o
RJ45 pin: 1 2 3 4 5 6 7 8 S
FAIL
```

This display indicates an open on wire 1. The shield is also open.

Figure 10 Sample wire map showing open circuit

Short

Possible causes of short circuits in a cable include:

- ❑ wires connected to wrong pins at connector or termination modules
- ❑ conductive material caught between pins at a connection
- ❑ damage to cable insulation

```
Wire Map

RJ45 pin: 1 2 3 4 5 6 7 8 S
          s s | | | | | | o
RJ45 pin: 1 2 3 4 5 6 7 8 S
FAIL
```

This display indicates a short between wires 1 and 2.

Figure 11 Sample wire map showing short circuit

Crossed pairs

Possible causes of crossed pairs in a cable include:

- ❑ wires connected to wrong pins at connector or termination modules

```
Wire Map

RJ45 pin: 1 2 3 4 5 6 7 8 S
          x x x | | x | | o
RJ45 pin: 3 6 1 4 5 2 7 8 S
FAIL
```

This display indicates crossed pairs on 1,2 and 3,6.

Figure 12 Sample wire map showing crossed pairs

Split pairs

Possible causes of split pairs in a cable include:

- ❑ wires connected to wrong pins at connector or termination modules

```
Wire Map

RJ45 pin: 1 2 3 4 5 6 7 8 S
          | | | | | | | | o
RJ45 pin: 1 2 3 4 5 6 7 8 S
FAIL
Split Pairs Detected
Pairs 3,6 - 4,5
```

This display indicates split pairs on 3,6 and 4,5.

Figure 13 Sample wire map showing split pairs

Reversed pairs

Possible causes of reversed pairs in a cable include:

- ❑ wires connected to wrong pins at connector or termination modules

```
Wire Map

RJ45 pin: 1 2 3 4 5 6 7 8 S
          x x | | | | | | o
RJ45 pin: 2 1 3 4 5 6 7 8 S
FAIL
```

This display indicates a reversed pair on pair 1,2.

Figure 14 Sample wire map showing reversed pairs

Time domain reflectometer

Quality cable testers include a time domain reflectometer (TDR). The TDR is a measurement technique for determining the length of a cable as well as its characteristic impedance. If a signal travelling through a cable meets an abrupt change in the cable's impedance, some or all of the signal is reflected back to the source. The timing, size and polarity of the reflected signals indicate the location and nature of the impedance discontinuities in the cable.

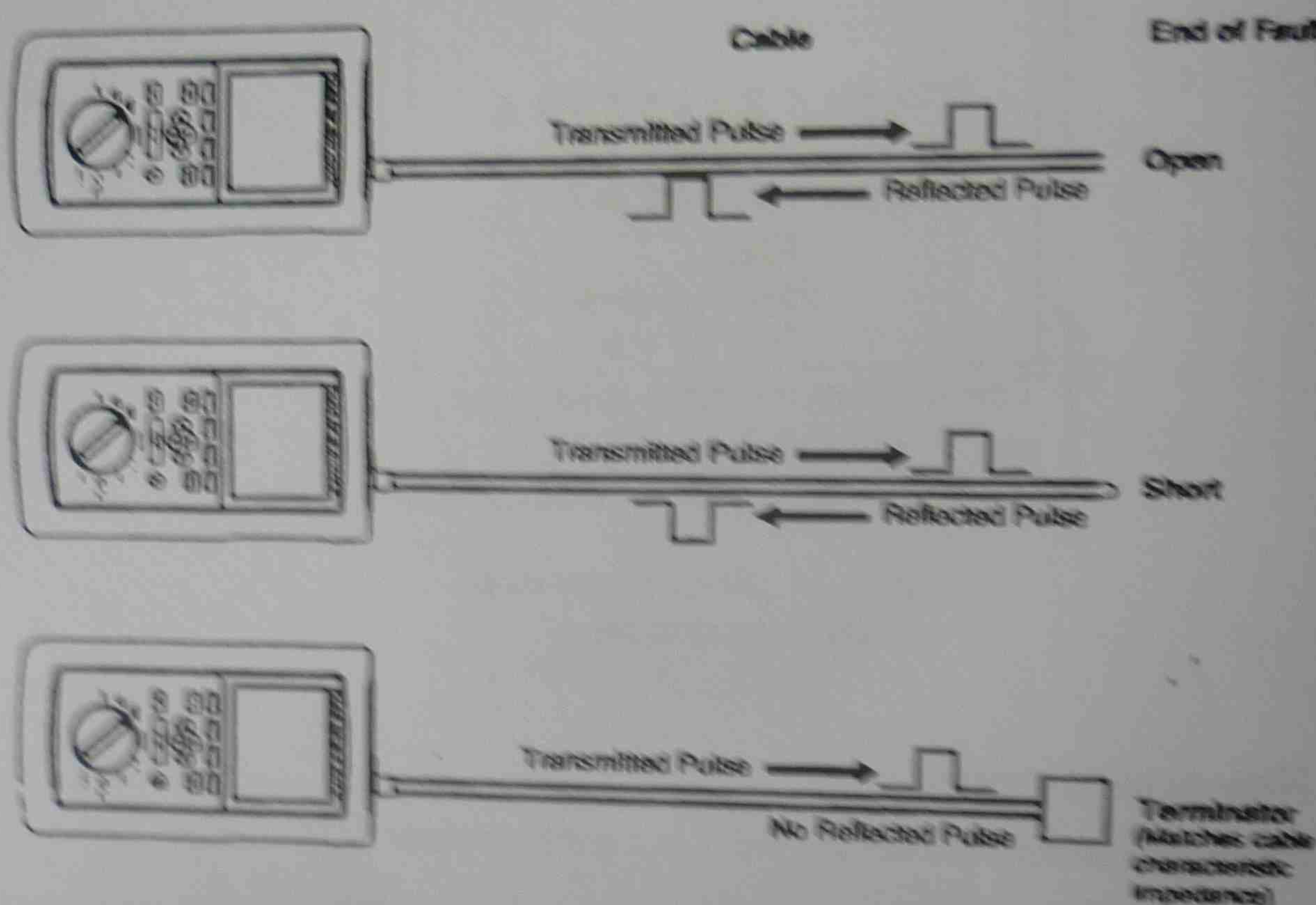
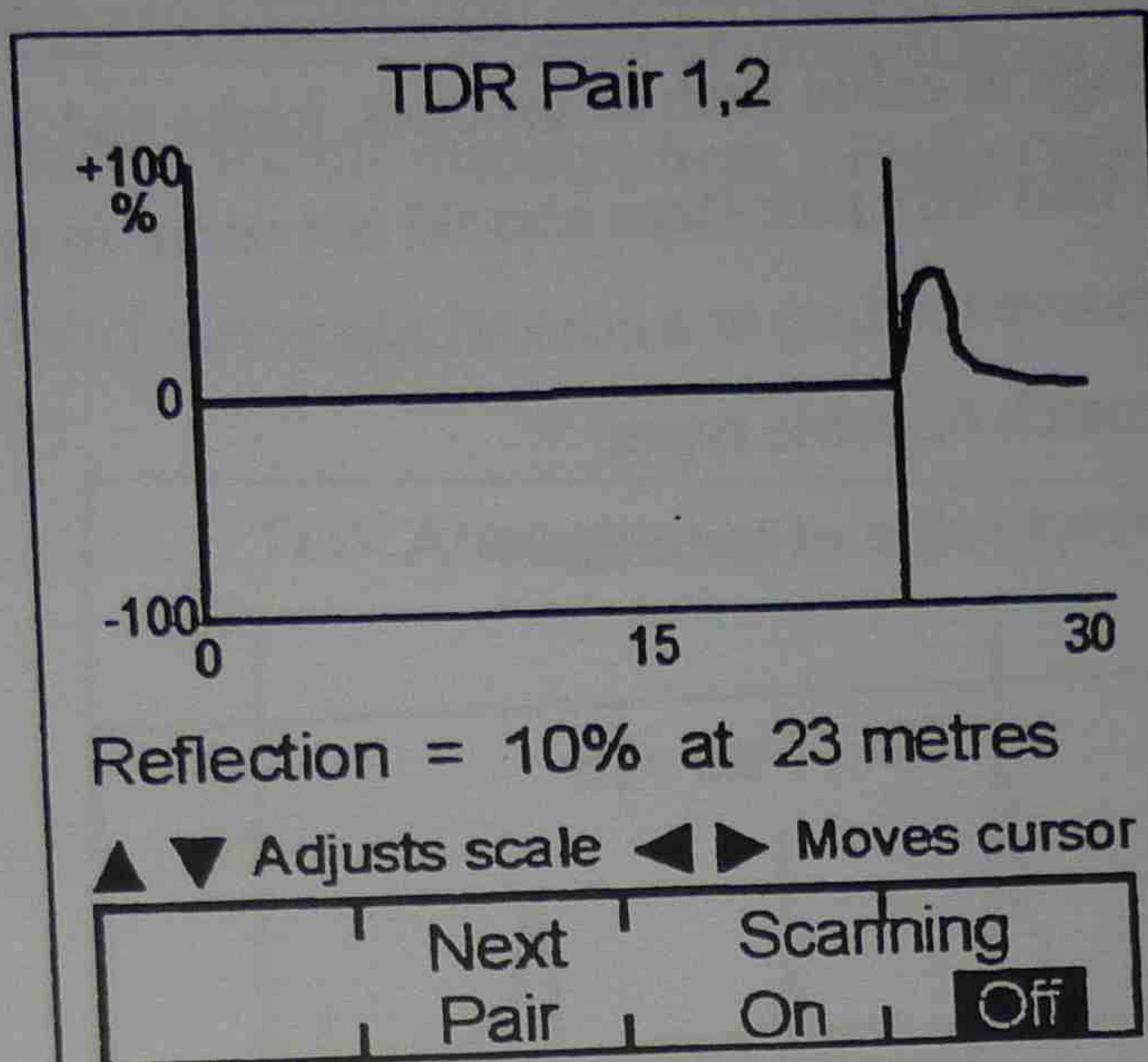


Figure 15 Signals reflected from open, short and terminated cable (picture courtesy of the Fluke Corporation)

Following are sample displays from a Fluke DSP-100 CableMeter.

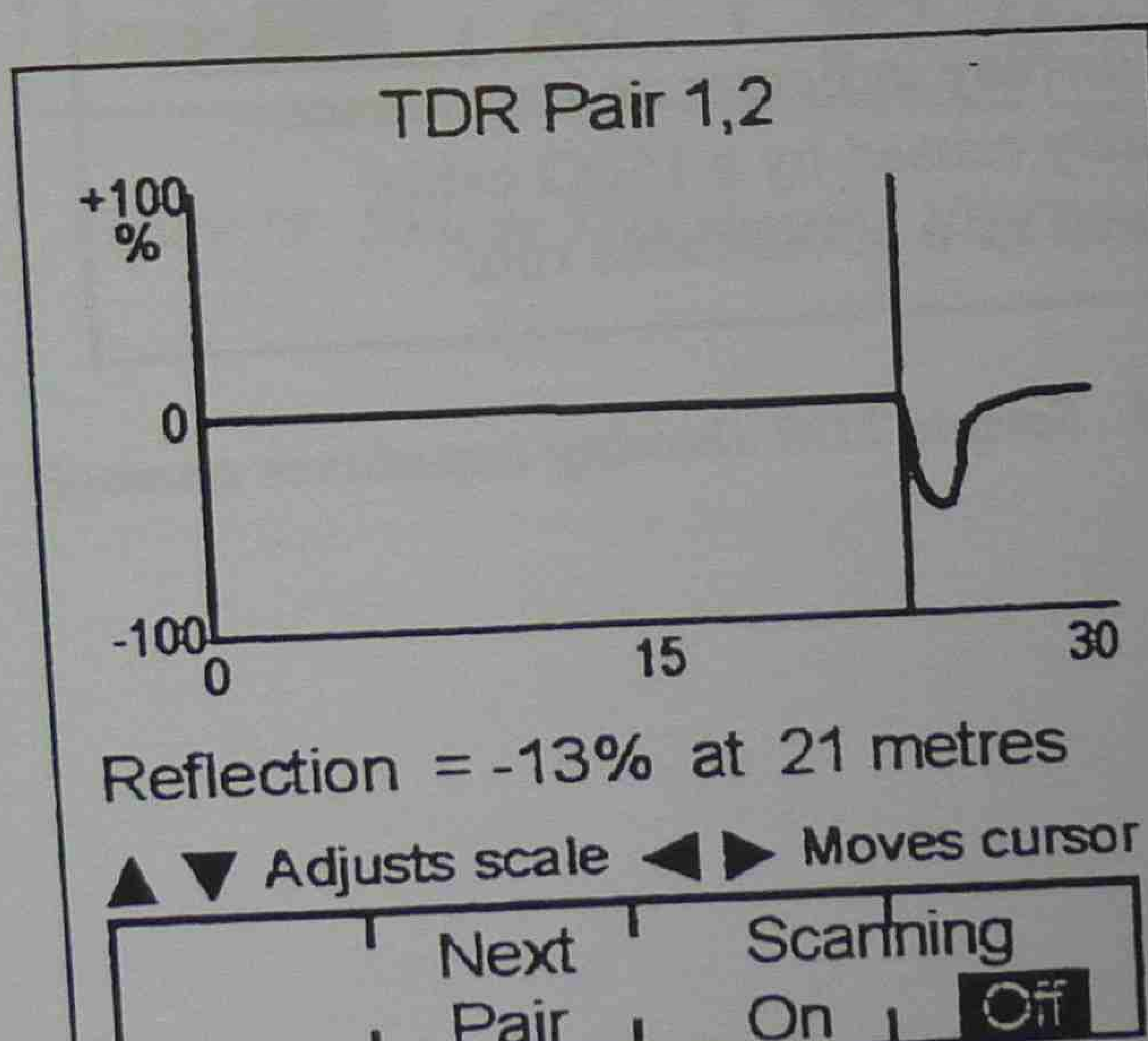
Open circuit



This display indicates an open on pair 1,2.

Figure 16 Sample TDR showing open wire

Short circuit



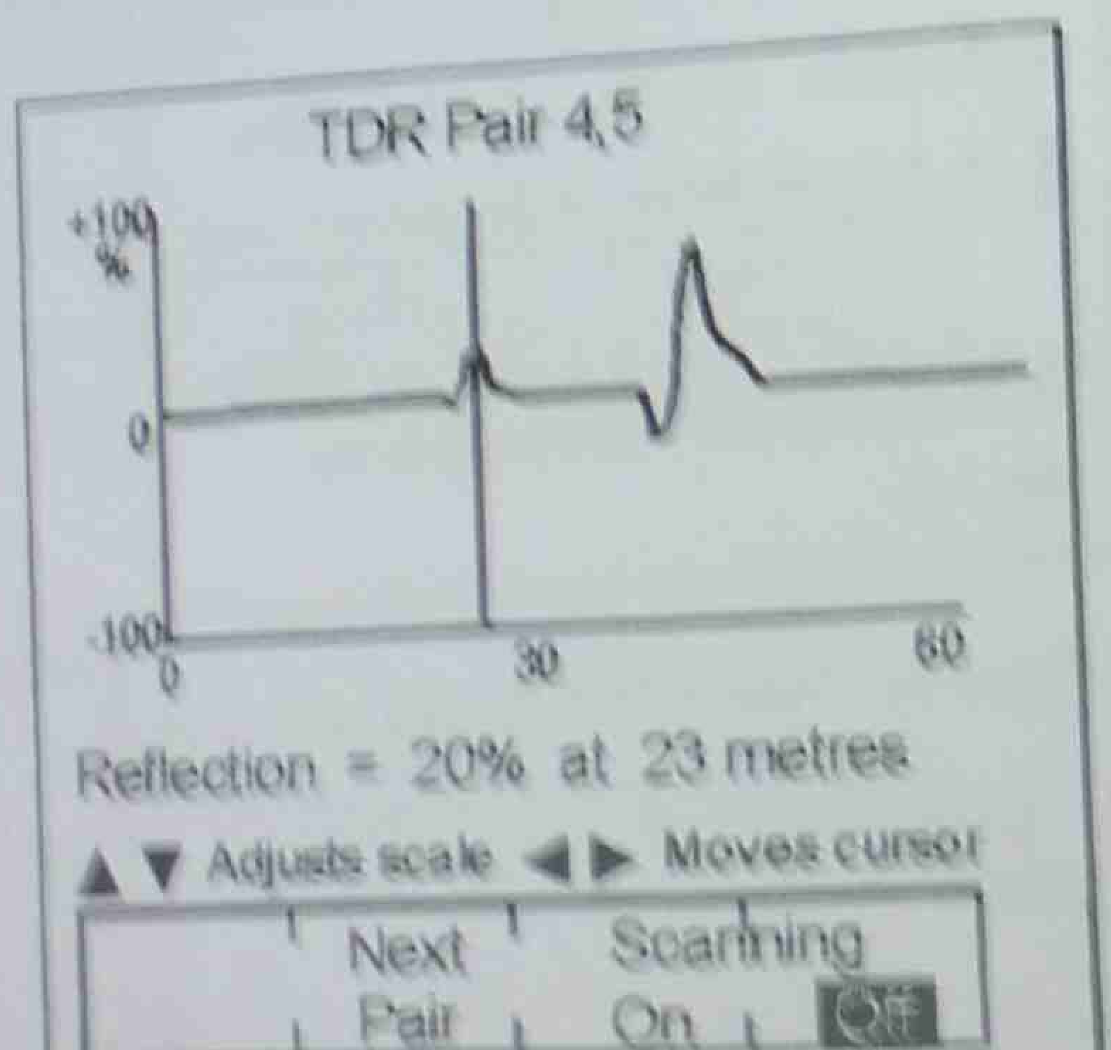
This display indicates a short between wires 1 and 2.

Figure 17 Sample TDR showing shorted wires

Impedance anomaly

Possible causes of reversed pairs in a cable include:

- poor connection between two lengths of cable
- damage to cable such as pinches, kinks and the like
- taps into wire pair (taps should not occur in twisted pair segments)
- excessive loading at a coaxial tap
- mismatch of cable types
- incorrect value of terminator



This display indicates an impedance anomaly caused by a 150Ω cable segment in a 100Ω cable run.

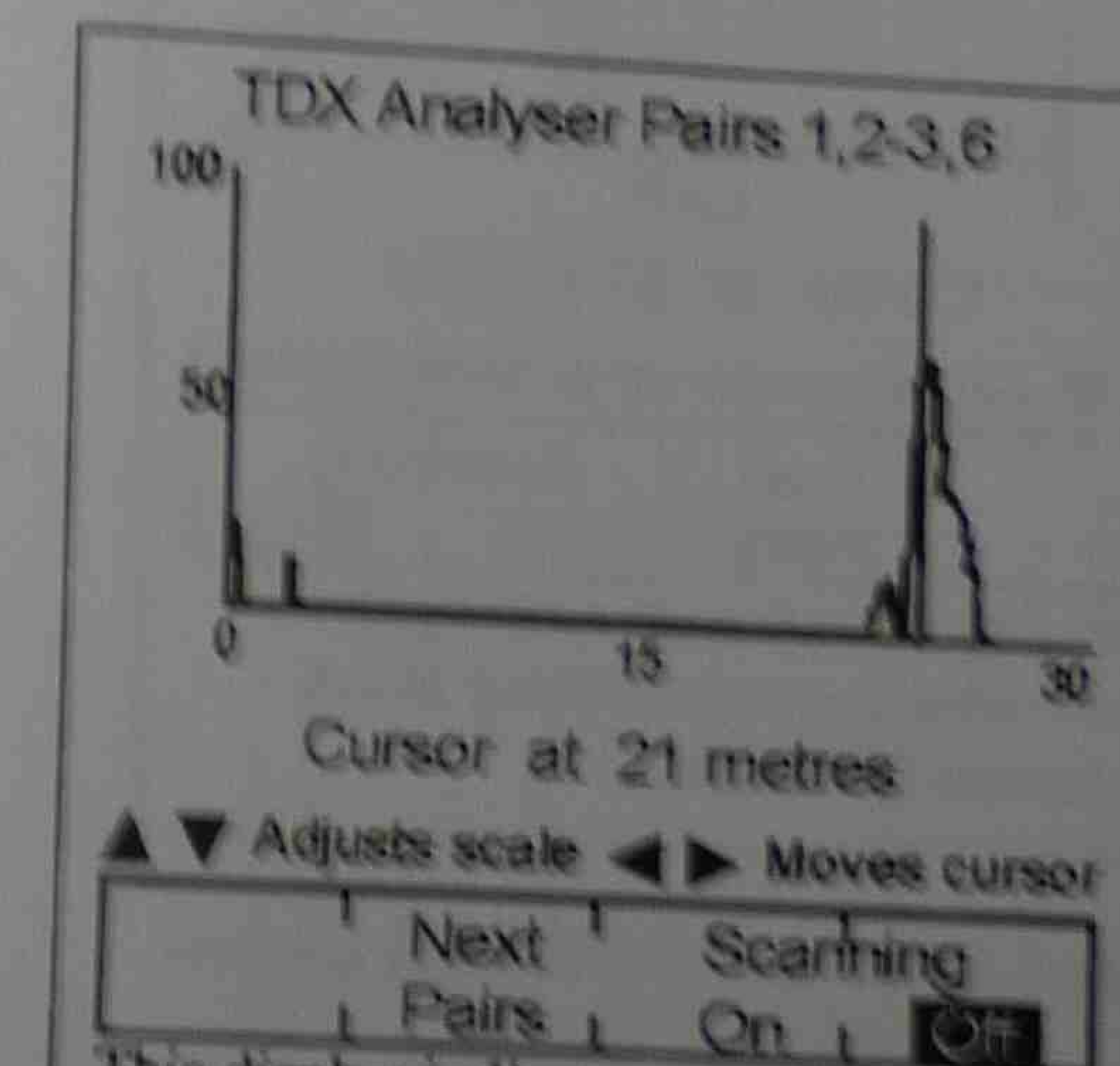
Figure 18 Sample TDR showing impedance anomaly

Time domain crosstalk analyser

The Time Domain Crosstalk (TDX) analyser displays the locations where cross-talk is occurring on the cable. The purpose of the TDX analyser is to assist in the location of sources of cross-talk on the cable.

Following are sample displays from a Fluke DSP-100 CableMeter.

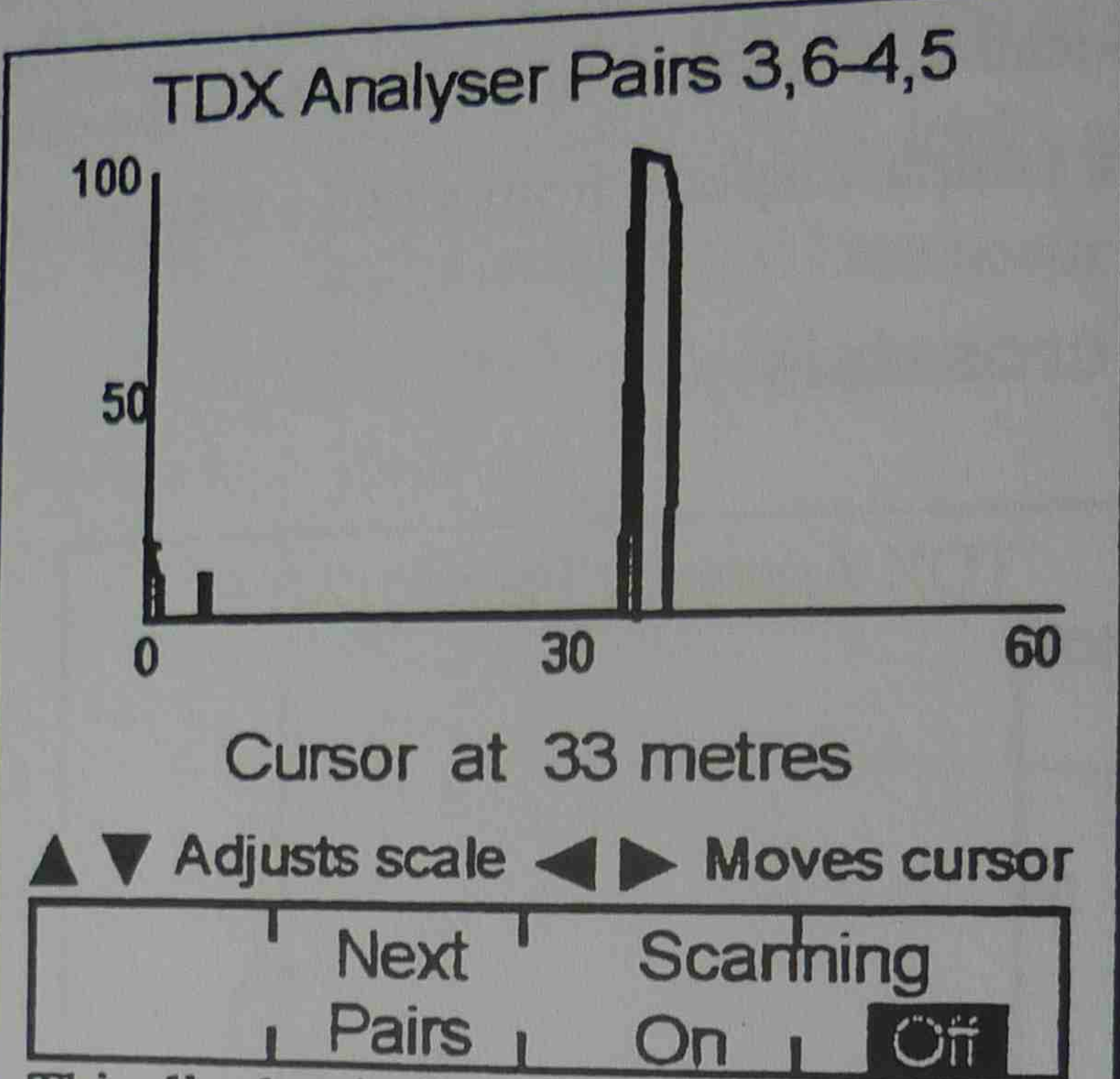
Near end crosstalk



This display indicates excessive untwisting of cable pair at far-end connector.

Figure 19 Sample TDX showing NEXT fail

Split pairs



This display indicates a split pair in a short cable segment starting about 33 metres from tester.

Figure 20 Sample TDX showing split pair

LAN types

Basically there are two types of LAN:

- distributed LAN, where each workstation has its own CPU
- non-distributed, where workstations rely on a mainframe or mini-computer for processing

To make a LAN more cost effective one or more computers are set aside as *'LAN File Servers'*. These machines create a central point on the LAN and control functions such as operator log-on, access to all operating systems (printers, modems and so on). File servers also provide the workstations with file sharing, electronic mailing systems and automatic back-up of files if necessary.

Other LAN devices

repeater

A standard LAN cable segment has a maximum length. Repeaters boost the signal for transmission into an extra segment of cable.

multiport repeater

This is a *'black box'* that acts as an electronic junction box allowing connection of several workstations to one cable. This also serves a signal boosting function.

bridge

This allows sectioning of large LANs and provides joining of remote LANs to create one logical LAN.

router

This provides a path between LANs for selected signals.

brouter

This performs the function of both the bridge and the router.

modem

This converts digital data signals to analogue signals (and vice versa) to enable computers to communicate over telephone lines.

Local area network topologies

Local area networks (LANs) are very popular. There are over 200 different types of LANs from which to choose (counting different protocols).

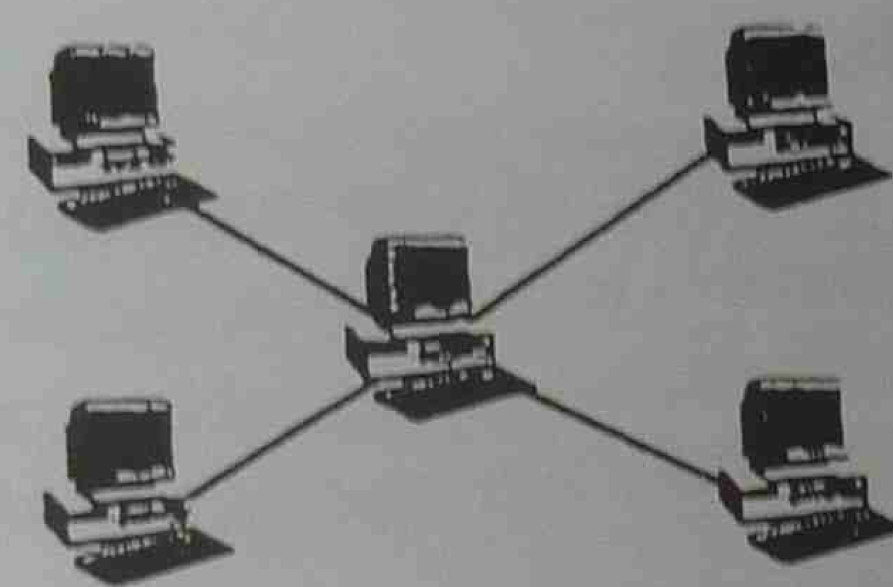
Different hardware providers design their own networks, for example IBM, WANG, XEROX, DEC, INTEL, AT&T, GM. There is no standard software (Protocol) for these networks to use, so hardware providers use their own.

It is possible to interconnect each network in one or more different ways (topology). They also make use of three types of cabling, (twisted pair, coaxial and fibre optic).

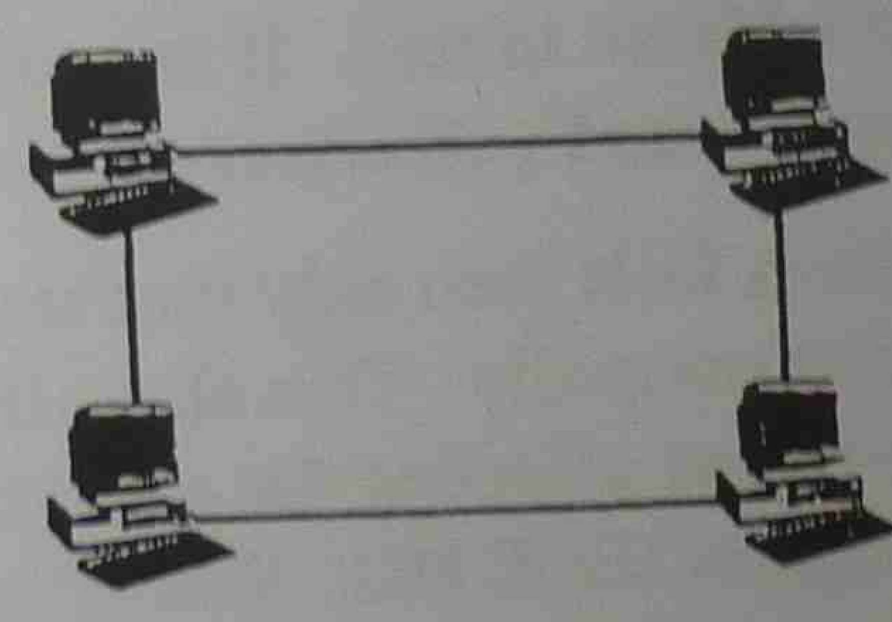
Digital baseband

- Bus

- Star



- Ring



Analogue broadband

- Map or Tree

Bus topology

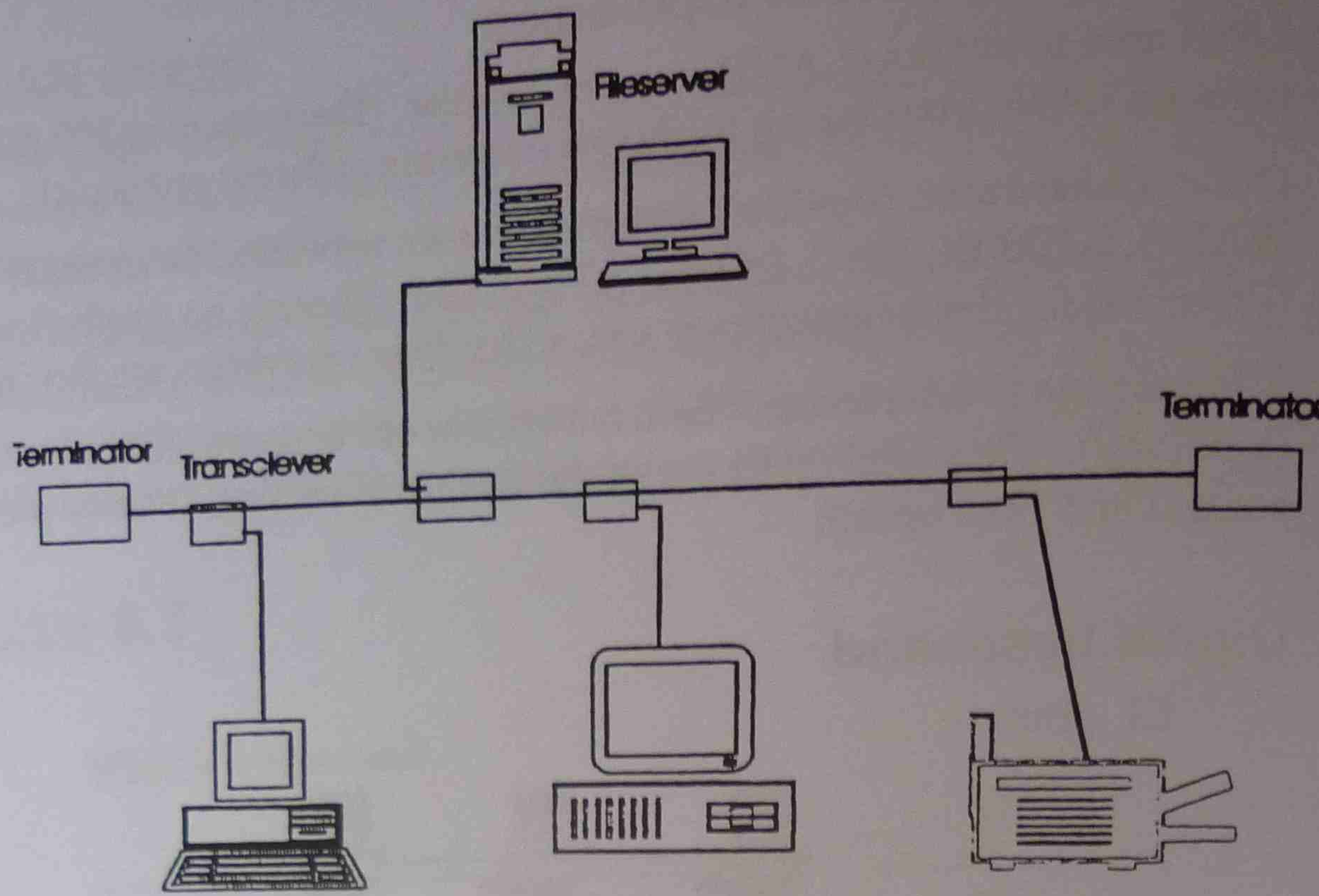


Figure 23 Configuration of the BUS topology

Characteristics

Ethernet is an example of a bus topology LAN. In the bus topology all workstations connect to a single cable (bus). A terminator, matched to the characteristic impedance of the cable, connects to each unused end. This stops reflections of the transmitted signal.

In an Ethernet LAN the bus carries the message from one end of the network to the other. As the message passes along the bus each workstation checks the destination address in turn. If the address matches that of the workstation the information is 'read', otherwise the workstation ignores the information.

If one workstation fails then only that station is affected. The rest of the network operates normally. This also allows the disconnecting of workstations without affecting the network. The industry standard dealing with bus topology is IEEE 802. Workstations attached to the bus must communicate in a coordinated way to ensure only one workstation sends a signal at any one time. The most common monitoring method is carrier sense multiple access with collision detection (CSMA/CD).

Example of bus

Ethernet is a common network using bus topology. Conceptually the Ethernet LAN consists of a single coaxial cable (ether) to which multiple workstations connect. A given Ethernet is limited to a maximum length of 500 metres and a minimum separation of 3 metres between each pair of connectors. Ethernet hardware operates at 10Mb/s although a new version called fast Ethernet operates up to 100Mb/s.

In the Ethernet a sender transmits a modulated carrier wave that travels from the sender toward both ends of the cable. During this time the sender has exclusive use of the ether and other workstations wanting to transmit must wait. An Ethernet network does not have a central controller that tells each workstation when it can use the bus. Instead, all workstations attached to the bus participate in a distributed coordination scheme known as carrier sense multiple access (CSMA). CSMA uses electrical activity on the bus to determine status. The bus does not contain electrical signals when all workstations are idle. A workstation wanting to transmit checks the bus for electrical activity and if all is quiet transmits its signal. This electrical activity on the bus means other workstations must wait for inactivity on the bus before they can transmit.

A problem arises in that if two workstations transmit at the same time the two signals will interfere with each other. In other words the two signals collide. To overcome this the sending workstation monitors the bus and if it detects another signal (other than its own transmission) it immediately stops sending. The workstation will stay idle for a minimum random time and try to send its message again. The random time is an attempt to prevent the same two workstations from accessing the bus at the same time again.

Star topology

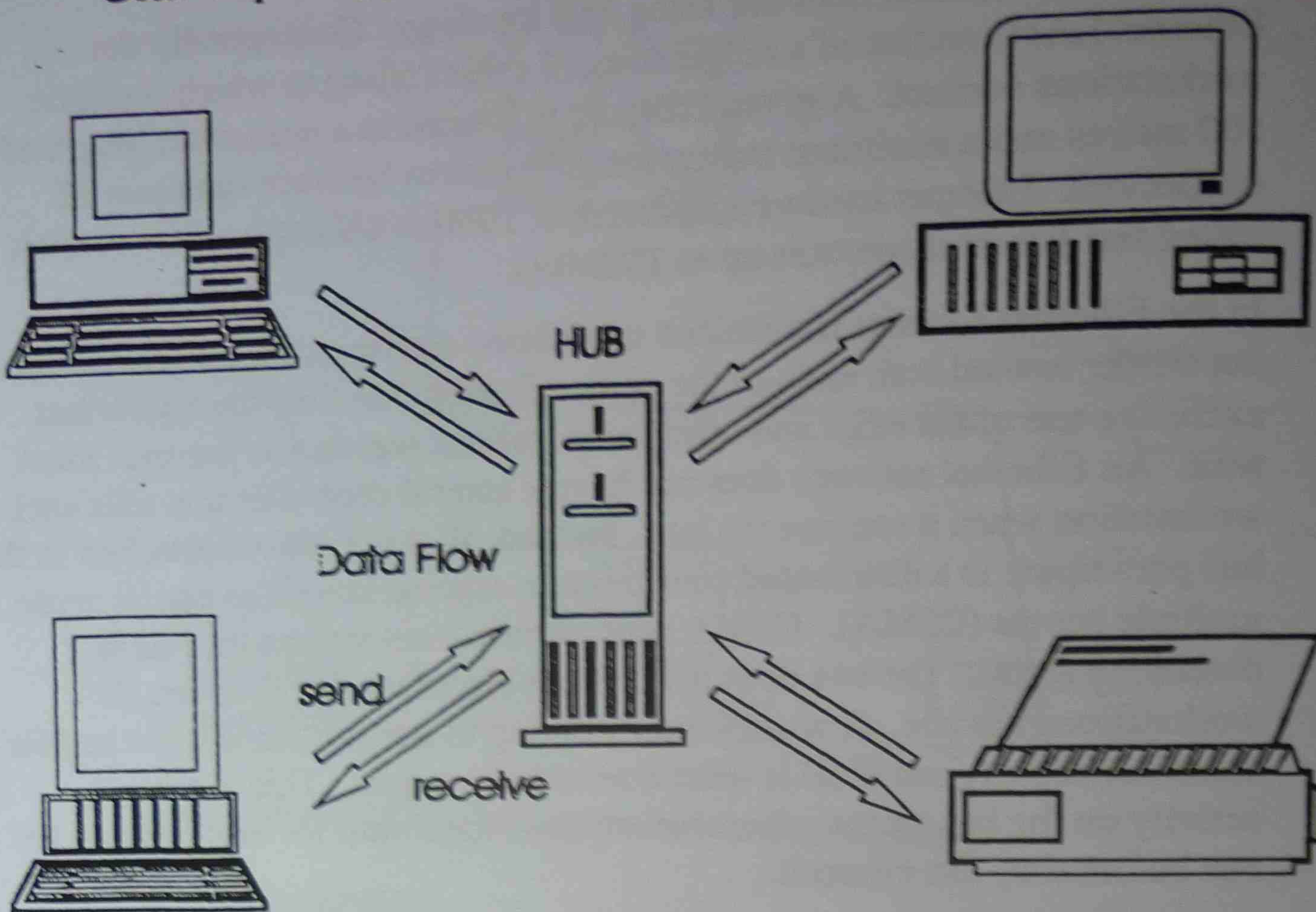


Figure 24 Configuration of the STAR topology

Characteristics

A network is using star topology if all workstations connect to a central point (Figure 24). The centre of a star network is a hub (as the physical shape of the network resembles the spokes in a wheel). A typical hub consists of an electronic device that accepts information from a sending workstation and delivers to the appropriate workstation.

Examples of star

Asynchronous transfer mode (ATM) is a technology that lets several workstations connect to an electronic switch. The ATM switch can operate at a data rate of 155Mb/s

Ring topology

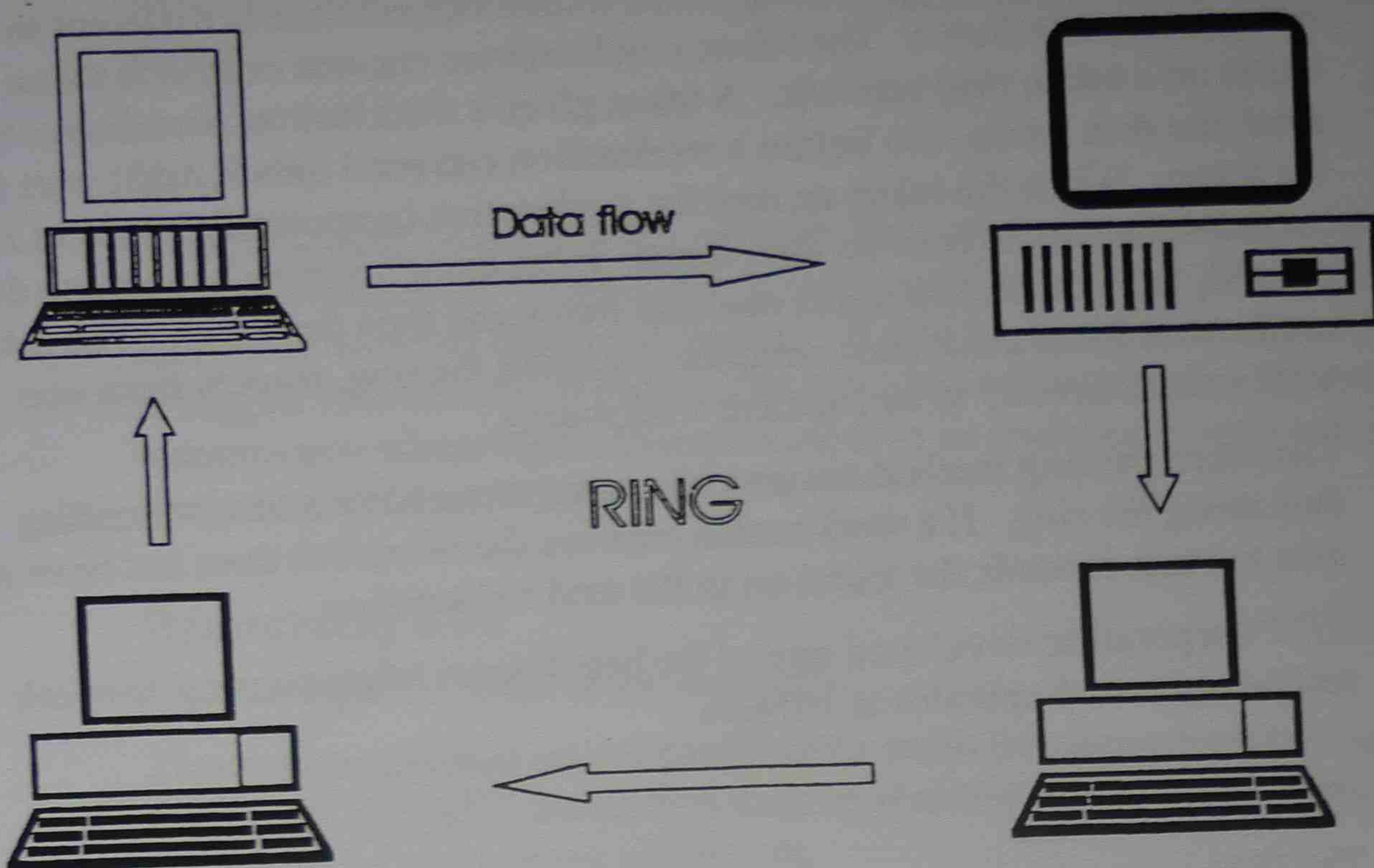


Figure 25 Configuration of the RING topology

Characteristics

In the ring topology the workstations connect in a closed loop. That is a cable connects the first workstation to the second workstation, another cable connects the second workstation to the third, and so on until a cable connects the last workstation to the first. Ring refers to the logical connection between workstations, not the physical orientation. The cable interconnecting two workstations may follow a hallway or rise vertically from one floor to the next.

Example of ring

Most LANs using ring topology use *token passing* as a mechanism for accessing the network. Token ring is the name used to describe the topology. A token ring operates as a single, shared medium. When a workstation needs to send data it must wait for permission before it can access the network. When the sending workstation gets permission it has complete control of the ring. No other transmissions occur at the same time. The sending workstation packages its data into a *frame* which it sends to the next workstation, which sends it to the next workstation and so on, until the frame passes completely around the ring and back to the originator. This allows the originating workstation to compare the received frame with the sent frame and if the two are not the same it can send the frame again. If a frame is for a given workstation, that workstation makes a copy of the frame as it passes around the ring.

The token ring hardware coordinates among all connected workstations to ensure each gets permission in turn. Coordination involves the use of a special reserved message (token). The format of the token is different to that of a normal data frame. The token ring hardware ensures only one token exists on a token ring network. A token gives a workstation permission to send one data frame. So before a workstation can send data it must wait for the token. When the token arrives the workstation temporarily removes it and uses the ring to send its data frame. Even though it may have more data to send, the workstation sends one data frame and then the token. The token, unlike data frames that pass completely around the ring, travels from one workstation directly to an adjacent workstation.

The token passing method ensures all workstations have a turn at sending data along the ring. If a workstation receives the token but does not have any data to send, it sends the token on to the next workstation.

IBM Corporation developed one of the best-known token passing network technologies and operates at 16Mb/s.

IBM token ring

The IBM token ring uses a multiple-station access unit (MAU) to link workstations from a star topology to a ring methodology. Locating MAUs in a wiring closet makes system reconfiguration and maintenance easier. The Multiple station Access Unit has a bypass relay at every port in case the port is not being used.

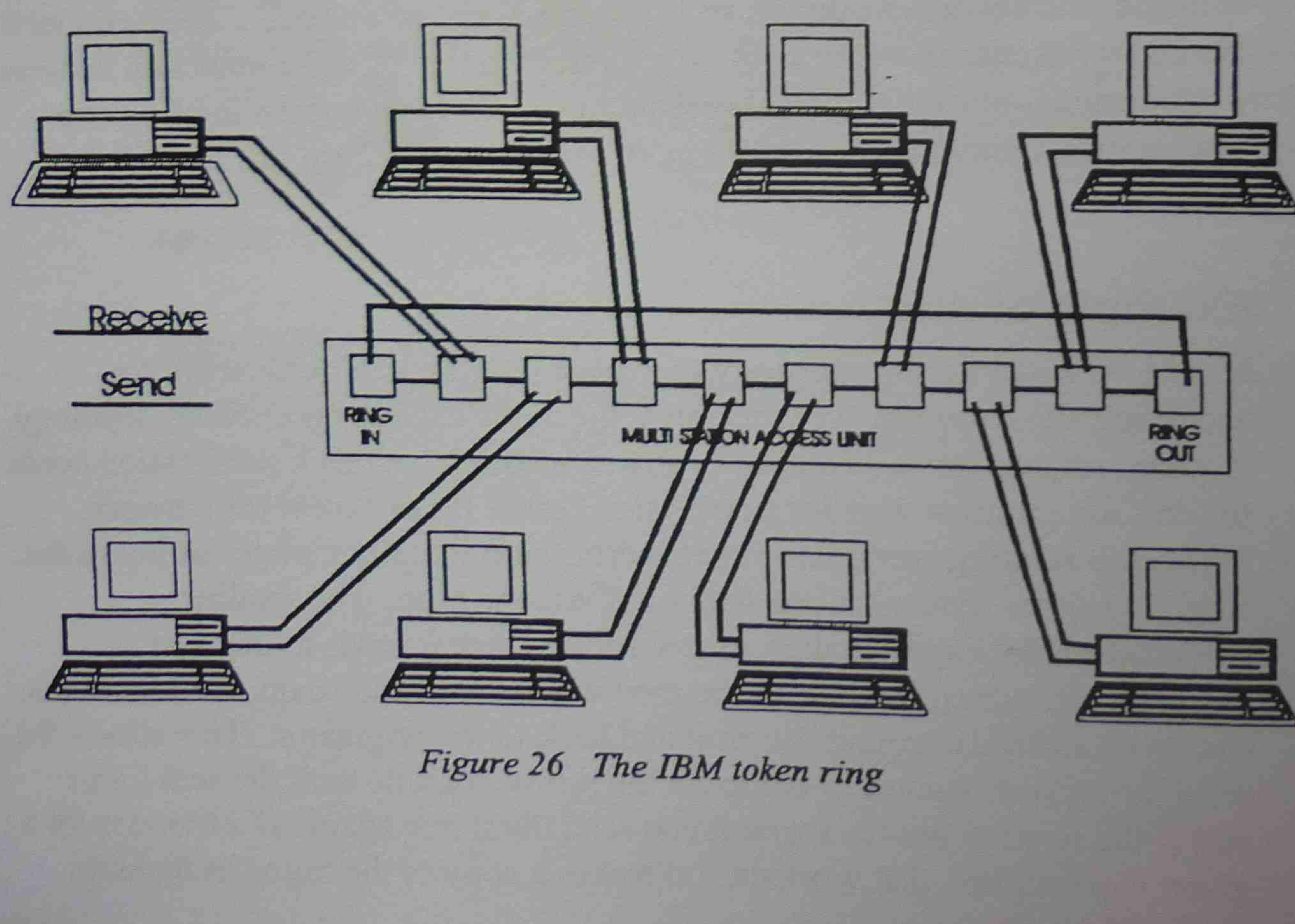


Figure 26 The IBM token ring

Broad band networks

These networks operate by superimposing an analogue signal on a carrier signal.

MAP

General Motors developed this network in an attempt to cut down on $6000 a minute breakdowns. In particular it is designed to satisfy needs of factories, such as networking dissimilar devices. It also has high immunity to EMI, it is rugged and reliable. It operates on a coaxial cable using broadband transmission where signal transmission is in an analogue format using frequency division multiplexing.

Branching tree

'Branching tree' refers to the topology.

This system operates on a network using radio frequency transmission. It makes use of CATV technology such as standard 75 ohm coaxial cable and CATV active and passive equipment.

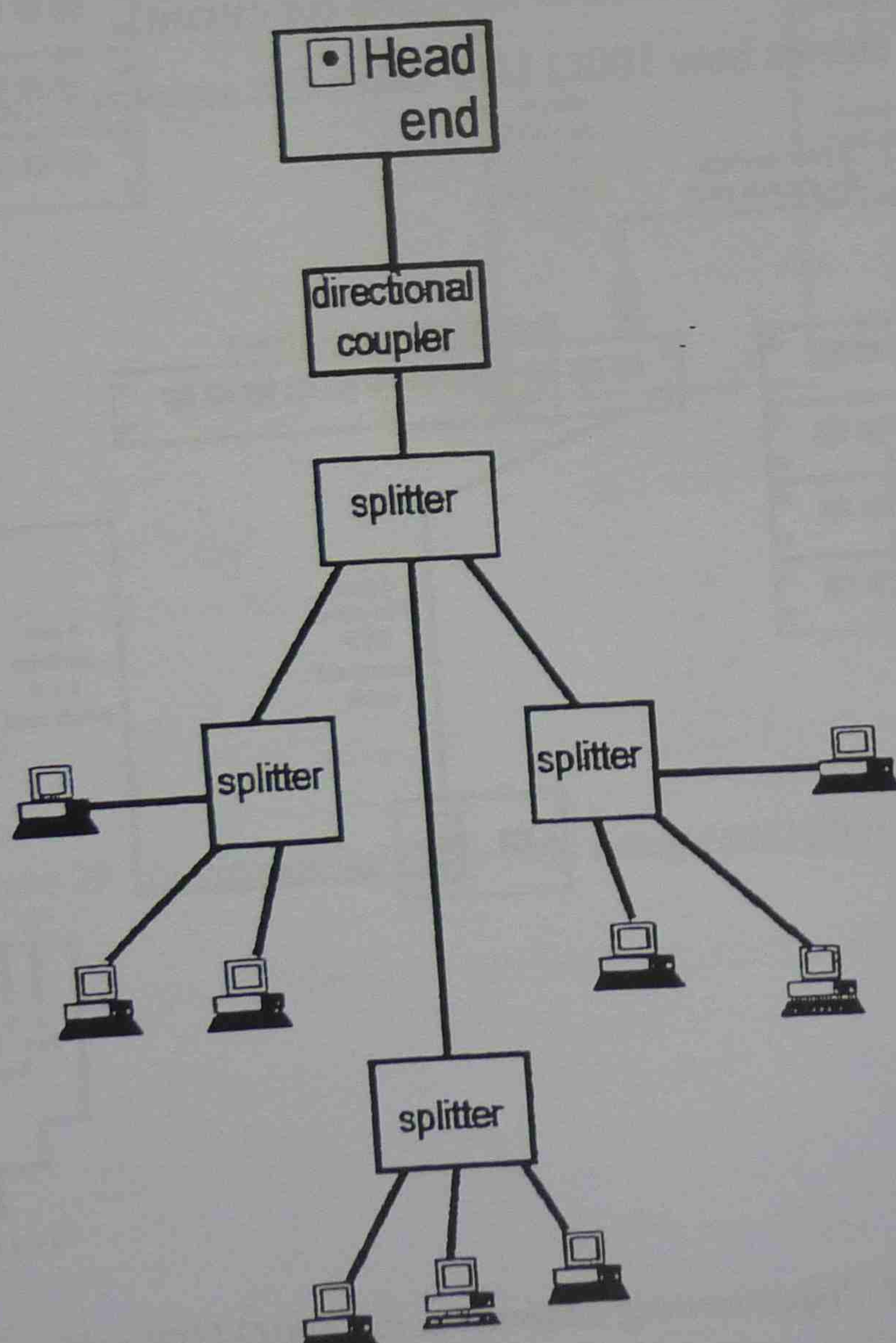


Figure 27 Branching tree

Learning notes

It is important to observe proper work practices when installing horizontal and backbone cabling to ensure initial and continuing performance of the cabling system over its entire life.

This is especially true for higher performance cables, including both copper and optical fibre cabling. High performance copper cables are sensitive to external anomalies. For example, untwisting a pair of copper conductors beyond the maximum specified by AS/NZS 3080 will negatively affect the crosstalk characteristics of the pair or pairs affected. Violating the minimum bend radius requirements also affects the transmission performance characteristics of the cable. As the frequency of transmission increases, the greater the risk an improperly installed cable may affect system performance.

Poor work practices may not be discernible when a network bandwidth is below 16MHz and delivering 10Mb/s (10BASE-T Ethernet). However, this same cable operating in an environment with a network bandwidth greater than 50MHz and delivering 100Mb/s or more, may not operate properly.

Constrictive tie-wraps and over-loading the cable trays can cause bending-loss. Understanding the sensitivity of high-performance cables makes it easy to understand why proper installation is critical.

It is also important to install cabling links to provide labelling and documentation and to allow for the provisioning of colour coding, consistent with the requirements of the Administration section of AS/NZS 3080.

Cabling hardware

Properly installed cabling hardware provides:

- cross-connections as a means to connect various elements of the cabling system and customer equipment using cross-connects, patch cords and equipment cables
- identification of backbone and horizontal cabling sub-systems and administration as described in the Administration section of AS/NZS 3080
- orderly cable management
- the ability to monitor or test cabling and active equipment
- protection against physical damage and ingress of contaminants that may affect continuity
- a termination density that is space efficient, and provides ease of cable management and ongoing administration of the cabling system

Environment

Install cabling hardware only where the temperature is within the range -10° C to +60° C. Protect cabling hardware from physical damage, and from direct exposure to moisture and other corrosive substances.

Although most commercial environments are stable, some industrial environments may experience problems due to:

- air quality measured in terms of particulate (foreign particles) matter in the air
- mechanical compromise (proximity of operating equipment)
- humidity (moisture)
- water (for example a food factory that needs disinfecting of all components within a processing room)

It is important to match the environment to the level of protection the network components require.

Mounting

It is important to securely mount cabling hardware on walls, floors, racks or other stable and accessible surfaces. Telecommunications outlets and connectors should be mounted 350mm to 1 200mm above the finished floor.

For actual outlet mounting height requirements, consult the codes and regulations.

Installation

Install cabling hardware and all other cabling system components to provide minimal signal impairment. This is achievable through proper cable preparation, termination practices, orientation, and mounting in full compliance with manufacturer's guidelines. Furthermore you should install cabling hardware to provide orderly, well-organised cable management.

Areas where there are ongoing changes to the cabling system need ample illumination at the point of termination.

Free-standing equipment racks and cabinets must have enough clearance in accordance with ACA's TS 009. These clearances allow for access to maintain and service equipment and cable dressing space. Multiple racks in series require a single pathway around one end, while multiple racks in parallel can share clearance spaces.

Cable

In addition to meeting the performance requirements in AS/NZS 3080, take care that cables are suitable for the environment in which they are installed. (Temperature must not adversely affect performance beyond the design limits of each link.)

Since fixed cables are used in a wide variety of environments (both indoors and outdoors, air conditioned and non-air conditioned spaces) it is important to choose a cable suited for the environment in which it will be installed.

The maximum cable pulling tensions or minimum bend radii must not exceed manufacturer's specifications.

Using a tension gauge to ensure the maximum pulling tension is not exceeded may be desirable, although this may not be necessary for most horizontal pulls. However it should be considered for inter-building pulls.

For a premises cable installation (intra-building or inter-building) with a total number of pulling angles exceeding 180° use a tension gauge which does not exceed the cable manufacturer's specifications.

Install cables in pathways and spaces that protect from weather and other hazards typical to the environment.

Avoid cable stapling of any recognised media type.

When loose cables are grouped and tied, be careful the cables are not over-tightened.

Do **not** place cables into a cable tray, cabinet, enclosure, or other fixture over a bend delimiter or edge that is beyond the cable manufacturer's maximum bend radii requirements.

Be careful to load the cable trays according to the cable tray manufacturer's instructions. Too many cables in a cable tray may create excessive weight (load) on cables beneath. This may crush them against some sort of edge. Cable trays, cabinets, etc that have carefully designed bend delimiters are also subject to cable set. Cable set may cause *'kinking'* by compression to a cable over time, due to the weight of the cables on top of them in the cable tray. Cable set is caused by improper design of the bend delimiters and/or excessive loading.

Cable support

It is important to install cable support mechanisms (such as hangers, rings, and hooks) in accordance with distances specified in ACA's TS 009. Install all manufactured cable trays according to the cable tray manufacturer's specifications.

Support telecommunications cables with devices designed for this purpose. Installation of these devices should be independent of any other structural component.

It is often seen as convenient to attach cables to present structural components (such as conduit), this poor work practice means:

- The cable could be interrupted by maintenance work done by workers for that structure.
- The support structure may be the distribution network for a service that degrades your cable. (There could be thermal, electrical or moisture hazards.)
- All structural components are placed within the limits of a given load (weight bearing) and attaching cables may violate those load conditions.

Requirements for UTP cables

The parameters used to characterise connector transmission performance are attenuation, NEXT, return loss, and dc resistance. While all of these parameters are sensitive to transmission discontinuity caused by connector terminations, NEXT performance is particularly susceptible to conductor untwisting and other poor installation practices that disturb pair balance and cause impedance variations. As well as signal degradation, improper termination practices may also create loop antenna effects resulting in levels of signal radiation that may exceed regulatory requirements for emissions.

Connector termination

The amount of untwisting in a pair as a result of termination to connecting hardware must be no greater than 13mm for category 5 cables. Maintain wire pair twists as close to the point of mechanical termination as possible for minimal signal impairment.

Untwisted cable pairs should not be re-twisted during installation. The cable manufacturer controls proper pair twisting and incorrect twisting can degrade the performance of cable pairs.

For termination areas requiring frequent access, such as cross-connects used for network moves, and changes, one way to control termination consistency is through the use of connectorised patch cords and patch panels that, in combination, meet appropriate category requirements. Patch cords for moves and changes can reduce performance variations possibly caused by poor or inconsistent field cabling.

Cable sheath removal

It is important to terminate the cable sheath of UTP cables to UTP connecting hardware with no more than 75mm of sheath removed. If installation instructions for proper termination of UTP connecting hardware specify less than 75mm of sheath removed, that must be followed.

To reduce the untwisting of cable pairs, strip back only as much cable sheath as is needed to terminate on the UTP connecting hardware.

Connection scheme

Connect all UTP cabling runs straight through with no transpositions of pairs or conductors. Provide cross-overs, when necessary for certain applications, external to the cabling system.

If equipment cords are used to make connections that are not straight through, they should be clearly marked. To prevent mixing, it is preferable such cords be restricted to the Telecommunications Closet.

Maximum pulling tensions for 4-pair 0.5mm (24 AWG) horizontal UTP cables should not exceed 110 Newtons, to avoid stretching the conductors during installation.

Maximum recommended pulling tension of 4-pair cable described above is a general recommendation only. Comply with the requirements of each cable manufacturer's maximum pulling tension limits.

Cable bend radii

In spaces with UTP terminations, cable bend radii must not be less than four times the cable diameter for 4-pair cable, and must not be less than ten times the cable diameter for multi-pair cables.

Minimum bend radii of UTP cables during installation must not exceed eight times the outer diameter for 4-pair cable, ten times for multi-pair cable.

Avoid twisting of cable during installation.

Throughout all cable installations and all recognised media types, the most severe cable bend radii requirements (those shown above or cable manufacturer's) must be met.

Segregation

It is important to select cable routes carefully to ensure the recommended segregation from LV power cables. AS/NZS 3080 *Appendix ZB* requires segregation of UTP cables from LV power cables as follows:

Circuit rating (kVA)	UTP
≤ 1	300
>1 & ≤ 2	450
>2 & ≤ 5	600
>5	1 500

It is possible to reduce the above distances by using an interposing barrier of earthed metal.

Practical exercise 8.1 Installing horizontal cabling to patch panel

Task

Your task is to install a Category 5 cabling system, using a star topology, in accordance with requirements of AS/NZS 3080.

Background

Installation consists of several two gang telecommunication outlets cabled from a floor distributor via cable tray. The floor distributor is a 12 port (minimum) modular 8 x 8 insulation displacement termination patch panel.

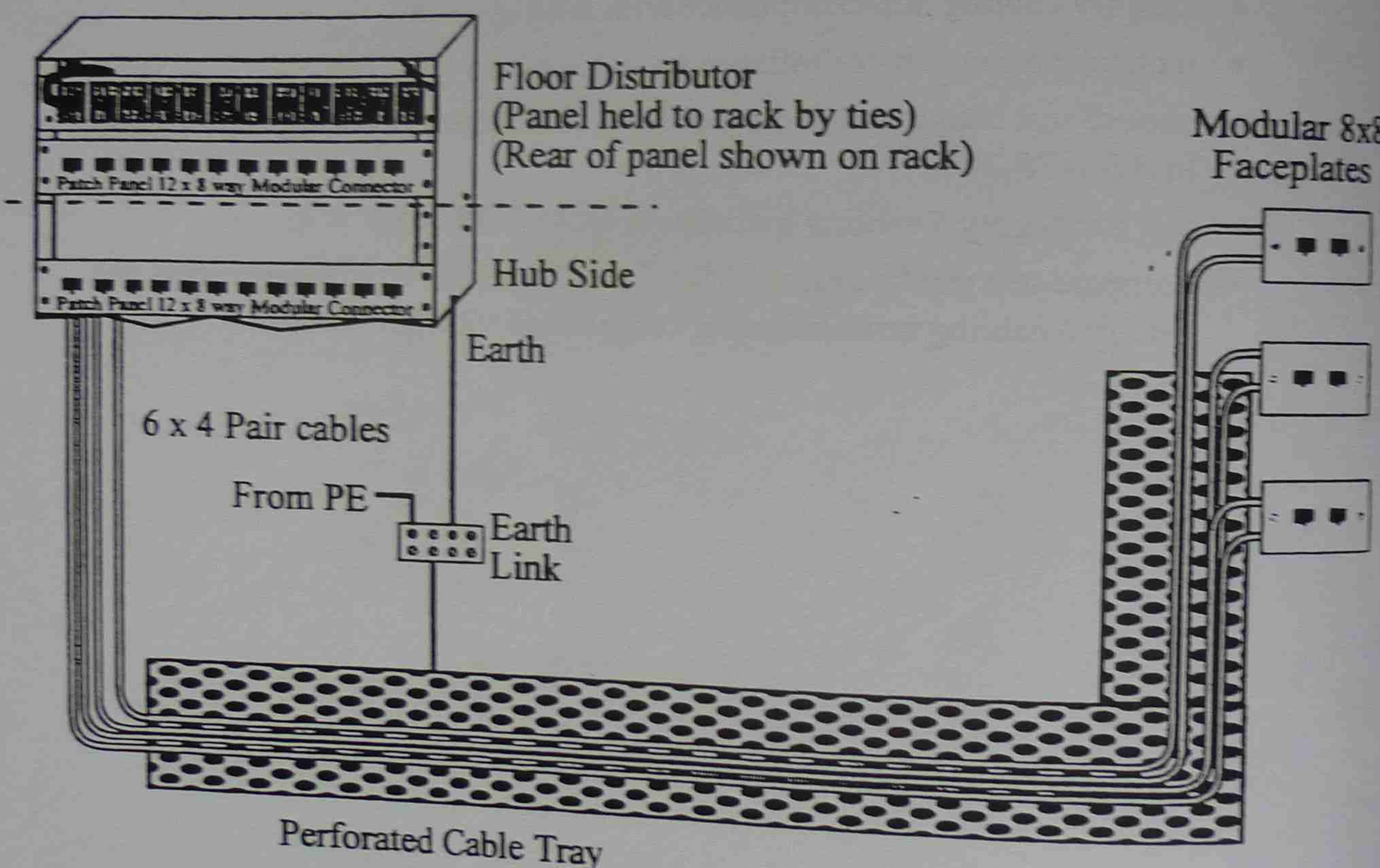


Figure 34 Layout of practical exercise 8.1

Equipment

Use Figure 34 to determine the type and quantity of materials needed (do not include HUB, PABX and the like). Complete the following materials list.

Item No	Item Description	Quantity
1	4 pair Category 5 LAN cable	4 metre
2	4 pair Category 5 patch cable	2 metre
3		
4		
5		
6		
7		
8		
9		
10		
11		
12		

Materials list for practical exercise 8.1

Procedure

1. After your facilitator checks your materials list get the appropriate material from the store.
2. Fix the patch panel, cable tray and faceplate mounting blocks to the work board.
3. Ensure the patch panel and skirting trunking are suitably earthed.
4. Arrange the floor distributor side of the 4 pair cables to the uppermost patch panel so that Outlet 1 to Port 1, Outlet 2 to Port 2 and Outlet 3 to Port 3 and so on.
5. Fix each cable to the rear of the uppermost patch panel so group one is closest to the first termination position. Use a nylon cable tie to secure the cable.
6. Remove about 75mm of sheath from the first 4 pair cable.

7. Install each wire of group one into the appropriate termination of the 8 x 8 modular connector port. Use the colour code shown in Table 3 below as a guide.

   Note: Take care to ensure the untwisted length of wire does not exceed 13mm.

8. Check the wire colour code and position in the modular connector and if this is correct use the *'punch down'* tool to terminate the first four pair of wires.

9. Repeat steps 6 to 8 for the remaining 5 ports. Be careful to maintain each four pair grouping.

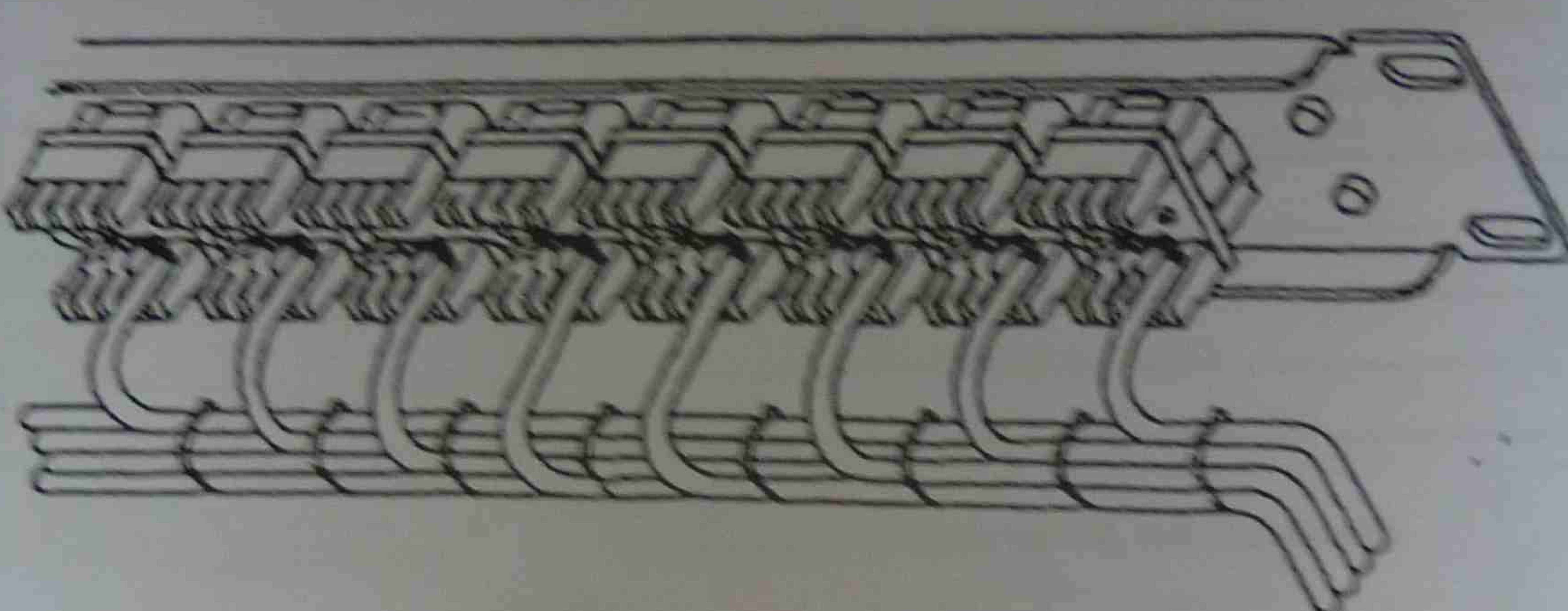


Figure 35 Termination of 4 pair Cat 5 cable at rear of patch panel

Table 3

Pair	*Wire*	*Colour*	*Pin*
1	1	White/blue	5
	2	Blue	4
2	1	White/orange	3
	2	Orange	6
3	1	White/green	1
	2	Green	2
4	1	White/brown	7
	2	Brown	8

Category 5 cable colour code

10. Terminate the other end of the 4 pair cables to the faceplates in a similar way. Use Figure 36 as a guide.

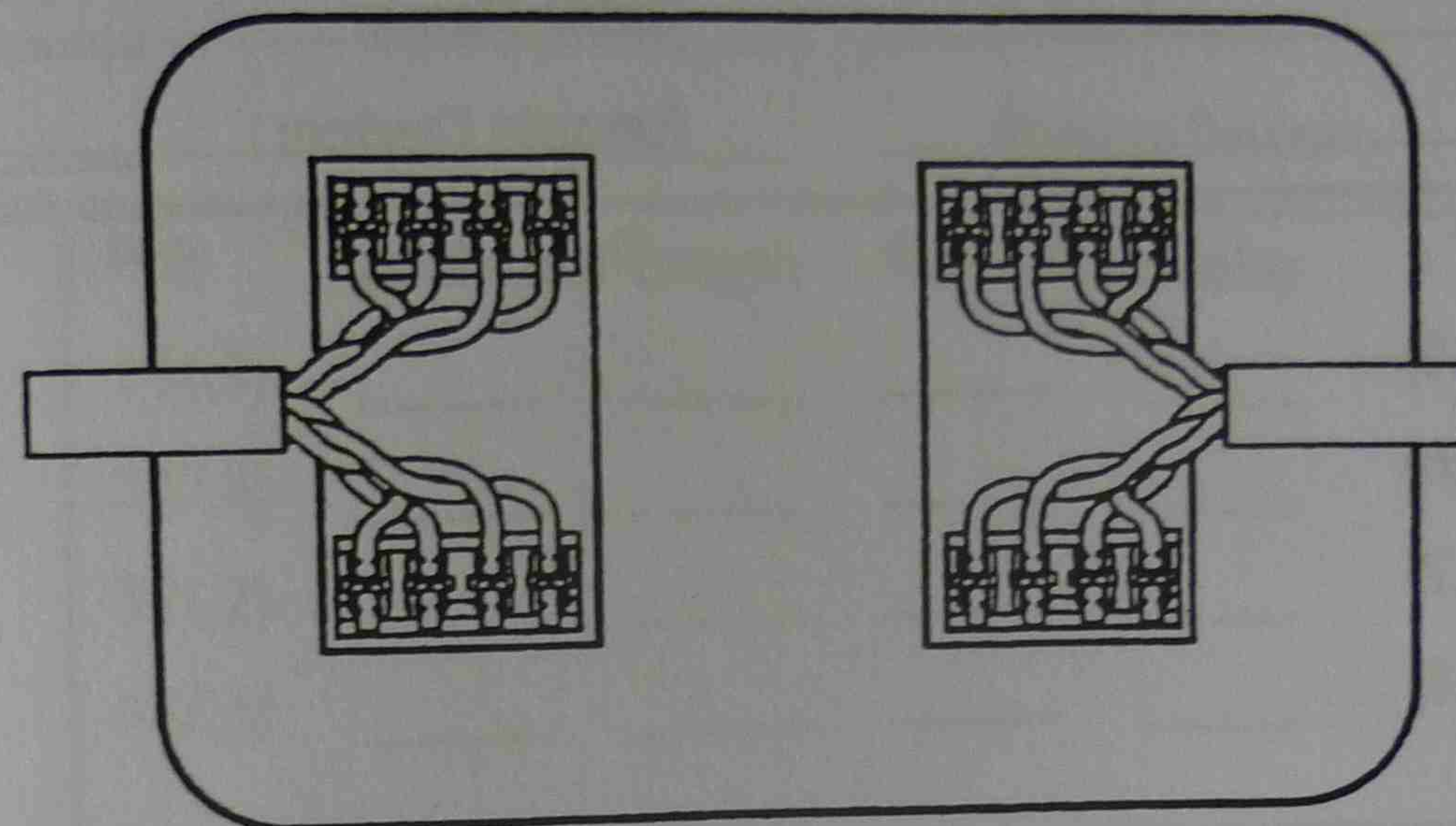


Figure 36 Termination at modular 8 x 8 faceplate

11. Tie the cables together for support after terminating all the cables. It is necessary to support cables running up the back of the patch panel.
12. Use a suitable cable tester to test each Basic Link, following the procedure discussed in Testing. Record your results in the following check list. An auto-generated report from the cable meter (similar to the one on page 84 of this resource manual) is also acceptable.

Test results check list

Cable ID: ____________ Cable Name: ____________

Cable NVP: ____________ Remote Device: ____________

Wire map	
local	remote
1	
2	
3	
4	
5	
6	
7	
8	
SH	

Pair	Length	Prop. delay	Resistance
1 (4,5)			____ ohms
2 (3,6)			____ ohms
3 (1,2)			____ ohms
4 (7,8)			____ ohms

Attenuation	(dB)	Freq (MHz)	Limit (dB)	Margin (dB)
1 (4,5)				
2 (3,6)				
3 (1,2)				
4 (7,8)				

NEXT	Local				Remote			
	(dB)	Freq (MHz)	Limit (dB)	Margin (dB)	(dB)	Freq (MHz)	Limit (dB)	Margin (dB)
1 (4,5) / 2 (3,6)								
2 (3,6) / 3 (1,2)								
4 (7,8) / 3 (1,2)								
4 (7,8) / 1 (4,5)								
1 (4,5) / 3 (1,2)								
4 (7,8) / 2 (3,6)								

ACR	Local		Remote	
	(dB)	Freq (MHz)	(dB)	Freq (MHz)
1 (4,5) / 2 (3,6)				
2 (3,6) / 3 (1,2)				
4 (7,8) / 3 (1,2)				
4 (7,8) / 1 (4,5)				
1 (4,5) / 3 (1,2)				
4 (7,8) / 2 (3,6)				

Practical exercise 9.1 Installing horizontal cabling to 110 wiring block

Background

The 110 wiring block is a Category 5 termination block utilising a quick clip connection. This quick clip connection forms a gas-tight connection that prevents corrosion between the clip and the conductor.

The fixed cabling terminates in the base of the 110 wiring blocks while the cross connects terminate in the top of the connecting block. This method is different to the Krone system where incoming circuits terminate at the top of the wiring module and outgoing circuits originate at the bottom of the module.

Task

Your task is to install a 100 pair floor distributor using the 110 wiring blocks, several telecommunications outlets and associated cabling.

Procedure

1. Secure the mounting blocks, skirting trunking and plastic trunking to the work board using Figure 39 as a guide.
2. Fix one 100 pair 110 wiring block onto the left side of the work board using the necessary tools and hardware. Use Figures 39 and 40 as a guide for positioning the blocks.

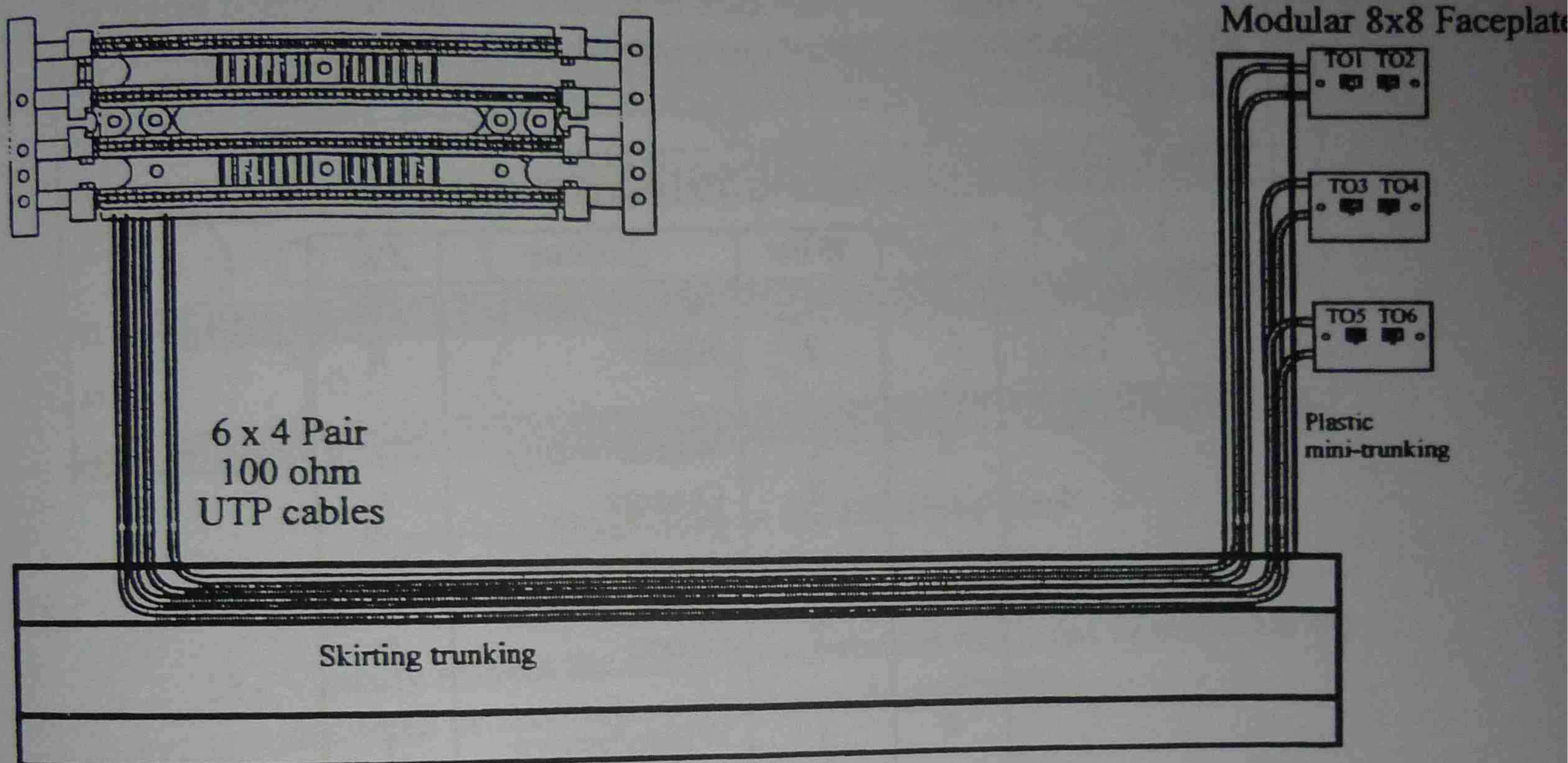


Figure 39 Setting out the work board

3. Ensure secure fixing of the plastic frame to the mounting surface. Use Figure 40 as a guide.

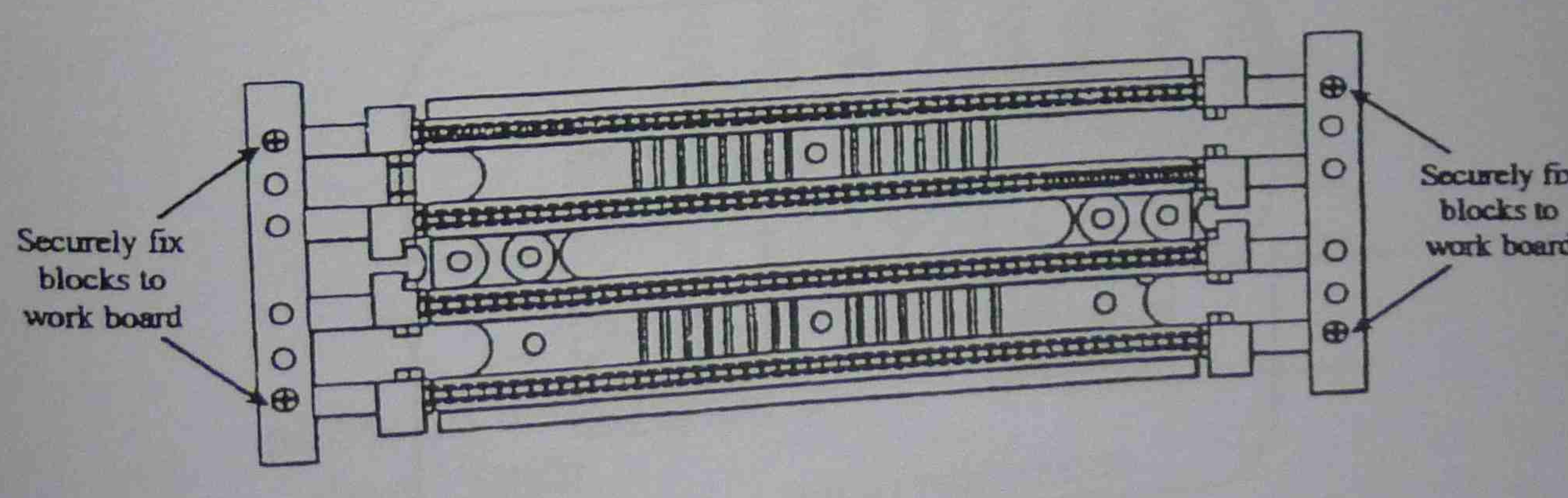


Figure 40 Installing the frame

4. Install two 4 pair Category 5 cables between each mounting block and the 110 Block. Use Figure 39 as a guide.

Terminating at each telecommunications outlet

5. Remove about 75mm of sheath from the first 4 pair cable.
6. Install each wire into the appropriate termination of the 8 x 8 modular connector port. Use Figure 41 and Table 4 as a guide.

Note: Take care to ensure that the untwisted length of wire does not exceed 13mm.

Table 4

Pair	*Wire*	*Colour*	*Pin*
1	1	White/blue	5
	2	Blue	4
2	1	White/orange	3
	2	Orange	6
3	1	White/green	1
	2	Green	2
4	1	White/brown	7
	2	Brown	8

Category 5 cable colour code

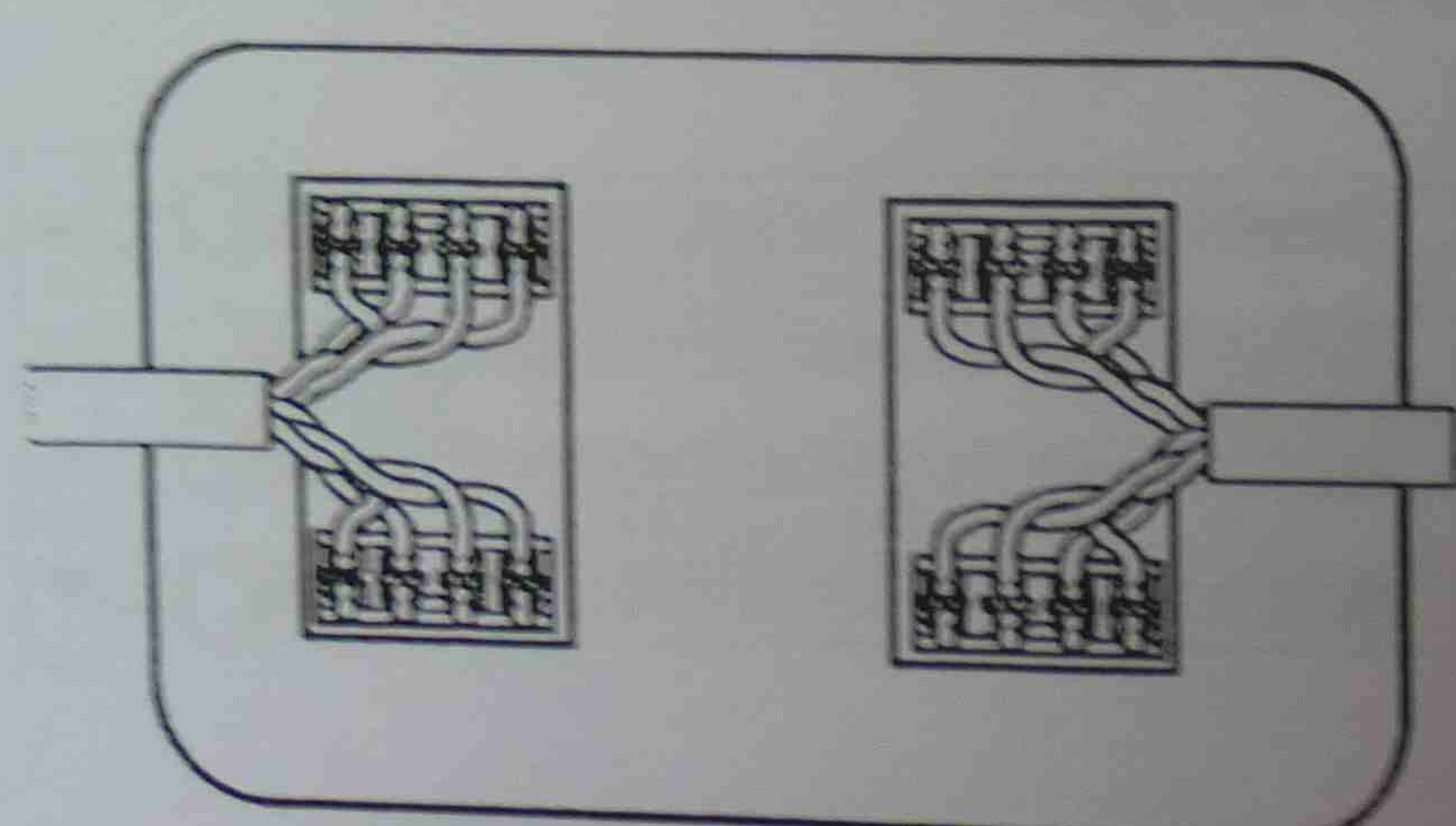


Figure 41 Termination at Modular 8 x 8 faceplate

7. Check the wire colour code and position in the modular connector and if this is correct then use the *'punch down'* tool to terminate the wires.
8. Repeat steps 5 to 7 for the remaining 5 telecommunications outlets.

Terminating at 110 blocks

9. Lace the cables through the correct openings in the 110 wiring blocks.
10. Remove about 75mm of sheath from the first cable.
11. Lace the wires into the appropriate positions in the 110 wiring block. Be careful to ensure the untwisted length does not exceed 13mm. The cable sheath should finish as close as possible to the point of termination. Use Figures 42 and 43 as a guide.

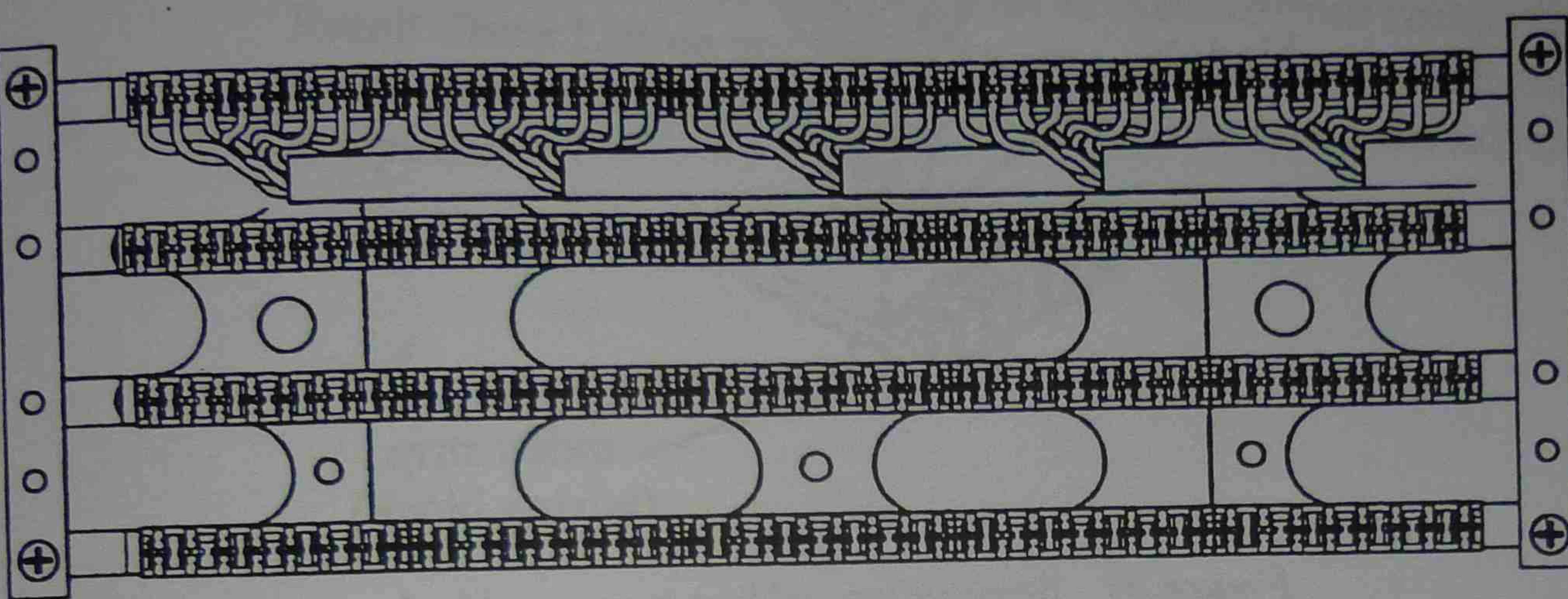


Figure 42 Terminating in the 110 wiring block

12. Visually inspect the cable termination at this point to eliminate any miswires or reversals. Use Figure 43 as a guide.

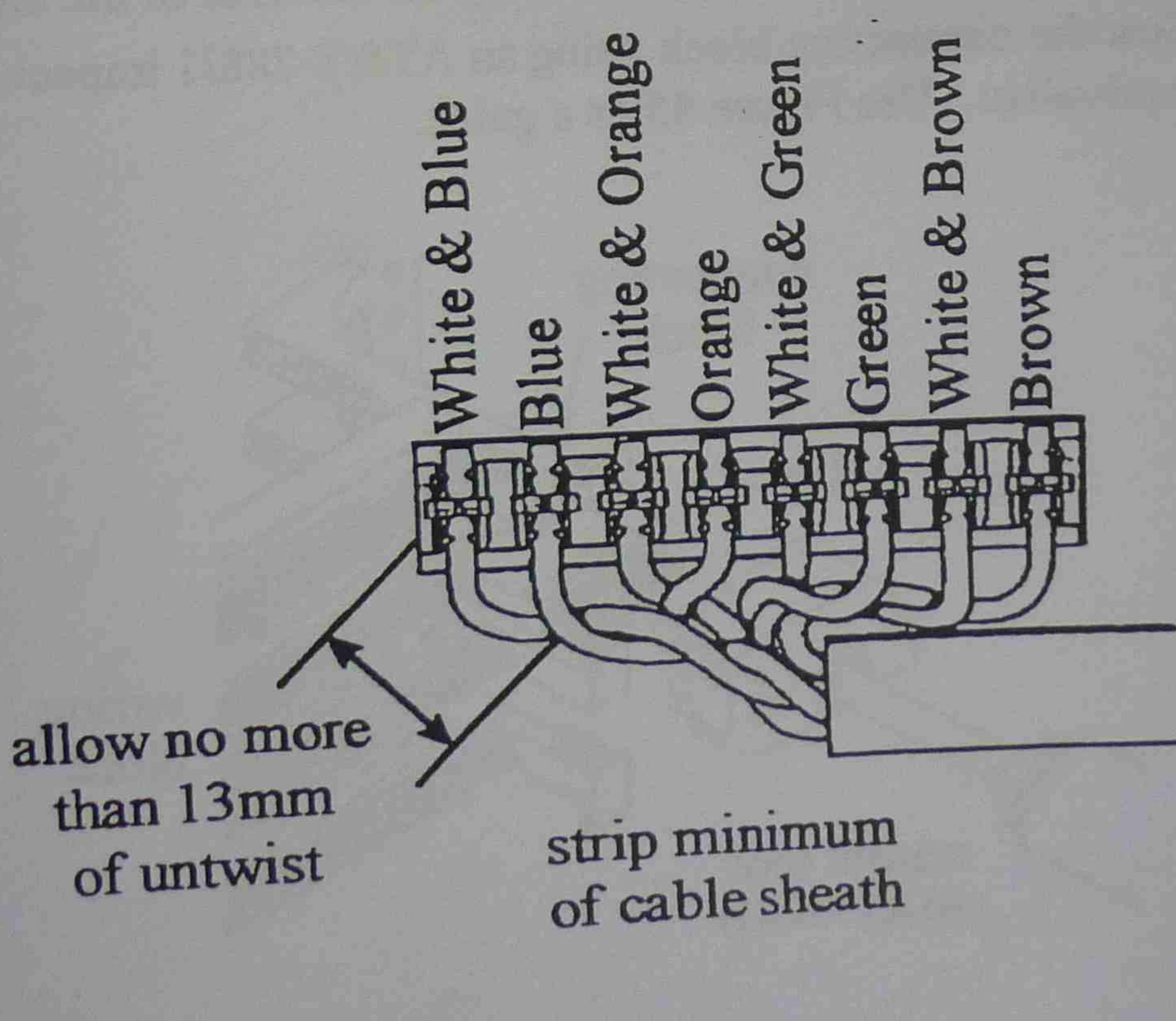


Figure 43 Arrangement of wires in block

13. Seat the conductors ... impact tool or equivalent. Use Figure 44 as a guide.

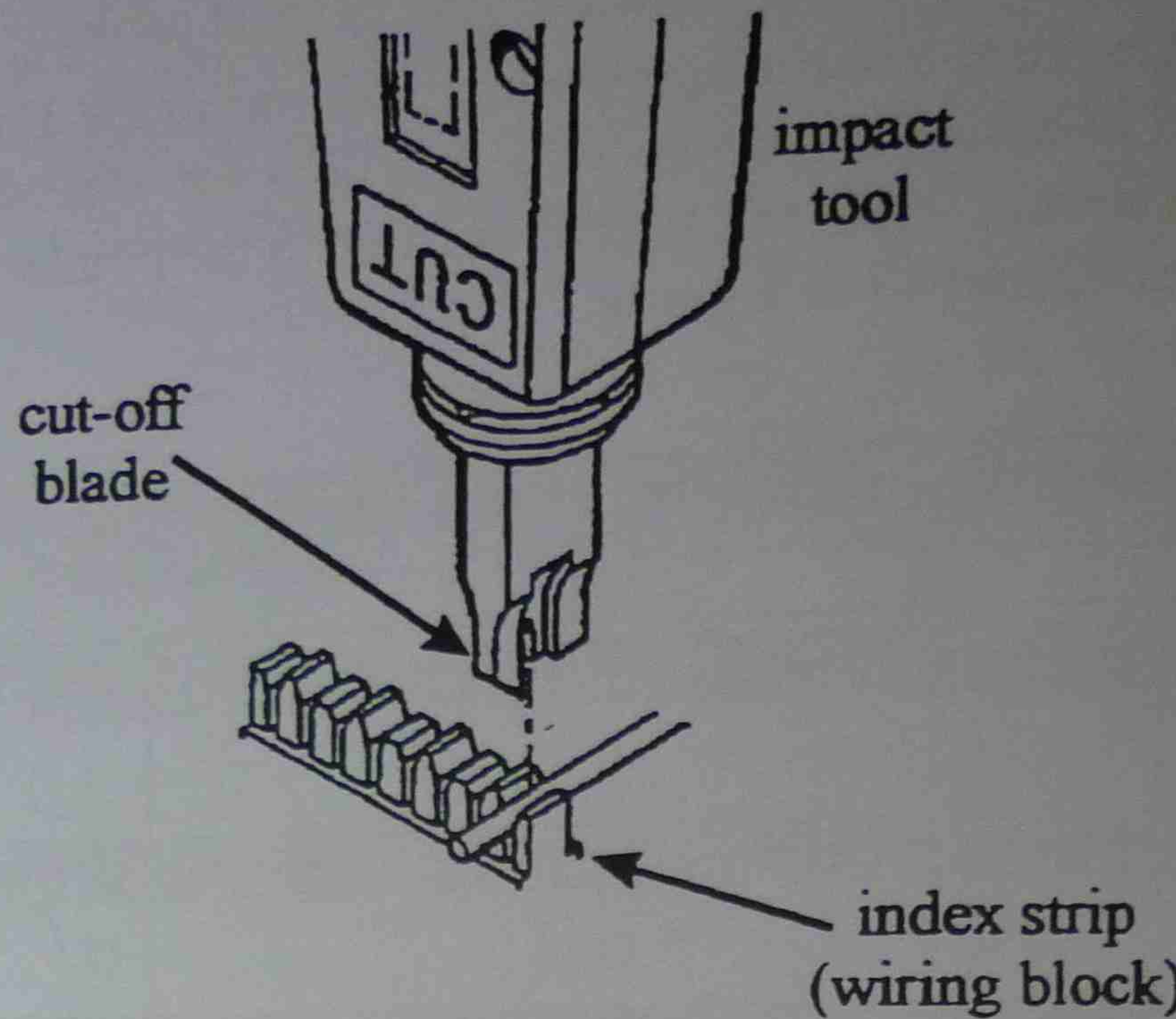


Figure 44 Terminating cabling in wiring block
(picture courtesy of AMP)

14. Visually inspect the cable termination at this point to eliminate any miswires reversals or sheared conductors.
15. Carefully position a 4 pair connecting block (or biscuit) over the wiring base. The blue marking must be to the left side of the block.
16. Seat the connecting block using an AT&T 788J1 impact tool or equivalent. Use Figure 45 as a guide.

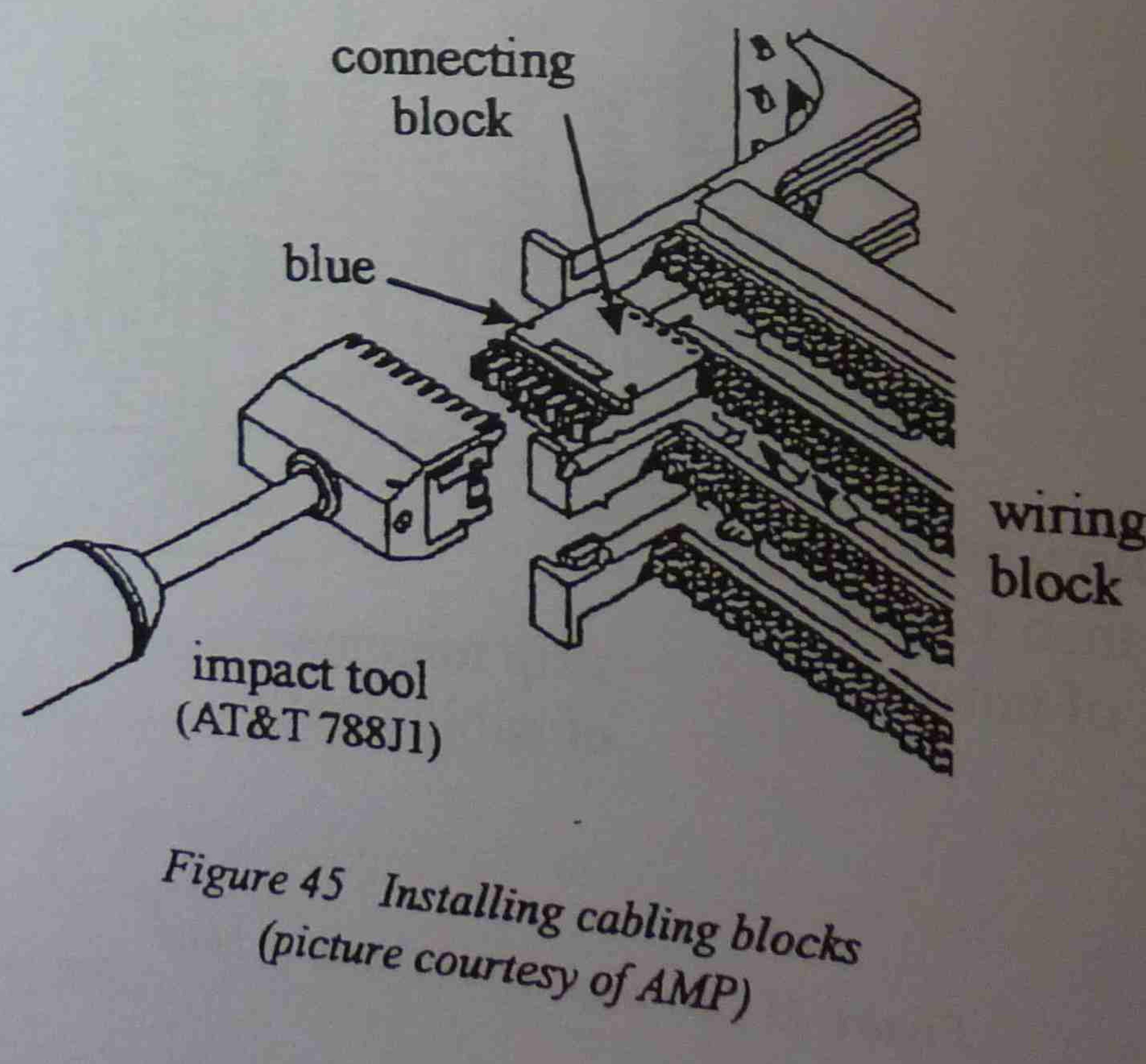


Figure 45 Installing cabling blocks
(picture courtesy of AMP)

17. Label the circuits.
18. Slide the corresponding designation strip into the holder and snap this onto the wiring block.
19. Test the circuit with an appropriate tester for Category 5 compliance.
20. Complete the appropriate administration for the installation using the cabling record on page 142.
21. Use a suitable cable tester to test each Basic Link in accordance with the procedure discussed in Learning Unit 8. Record your results in the Test Result Check List on page 143. An auto-generated report from the cable meter (similar to the one on page 84 of this resource manual) is also acceptable.

Practical exercise 10.1 Installing horizontal cabling to Krone Highband modules

Background

The Krone Highband is a cross-connect system particularly designed for high speed LAN and wide area network (WAN) systems. The highband modules facilitate cross-connecting, patching or patching by exception. The highband patching system utilises Krone's centre port patching which is separate to the wiring termination point.

Task

Your task is to install a 100 pair floor distributor using the Krone Highband termination modules, several telecommunications outlets and associated cabling for a 10BaseT system.

Procedure

1. Secure the skirting trunking to the work board using Figure 46 as a guide.
2. Fix an 11 way Profil frame onto the left side of the work board using the necessary tools and hardware. Use Figure 46 as a guide for positioning the frame.
   - ❑ secure the lower end to the work board first, followed by the upper end.

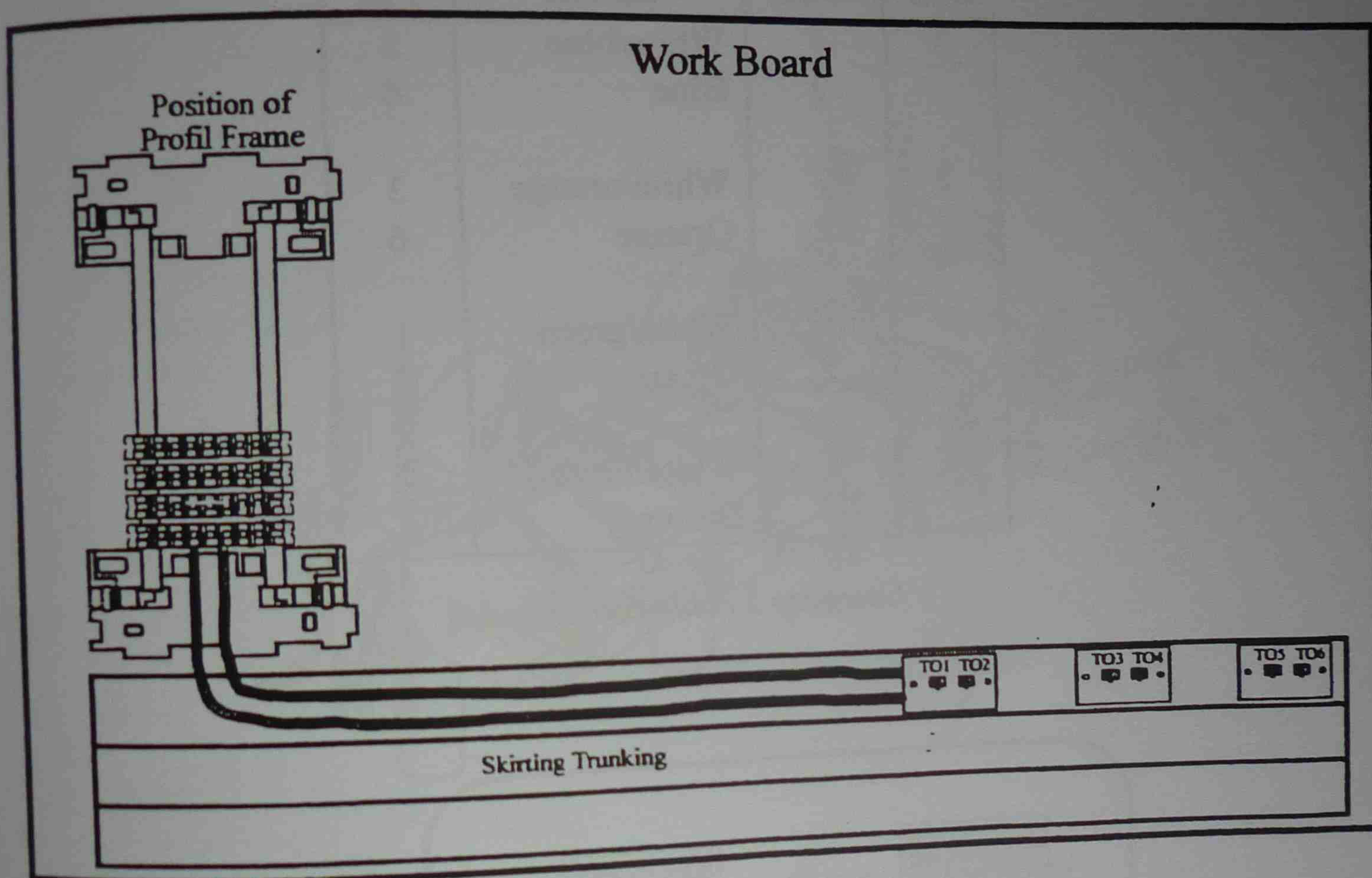


Figure 46 Setting out the work board

3. Ensure secure fixing of the plastic frame to the mounting surface.
4. Position the mounting brackets in the trunking for the telecommunication outlets.
5. Install two 4 pair Category 5 cables between each telecommunication outlet position and the Profil frame. Use Figure 46 as a guide.

Terminating at each telecommunications outlet

6. Remove about 75mm of sheath from the first 4 pair cable.
7. Install each wire into the appropriate termination of the 8 x 8 modular connector port. Use Figure 47 and Table 5 as a guide.

   Note: Take care to ensure that the untwisted length of wire does not exceed 13mm.

Table 5

Pair	*Wire*	*Colour*	*Pin*
1	1	White/blue	5
	2	Blue	4
2	1	White/orange	3
	2	Orange	6
3	1	White/green	1
	2	Green	2
4	1	White/brown	7
	2	Brown	8

Category 5 cable colour code

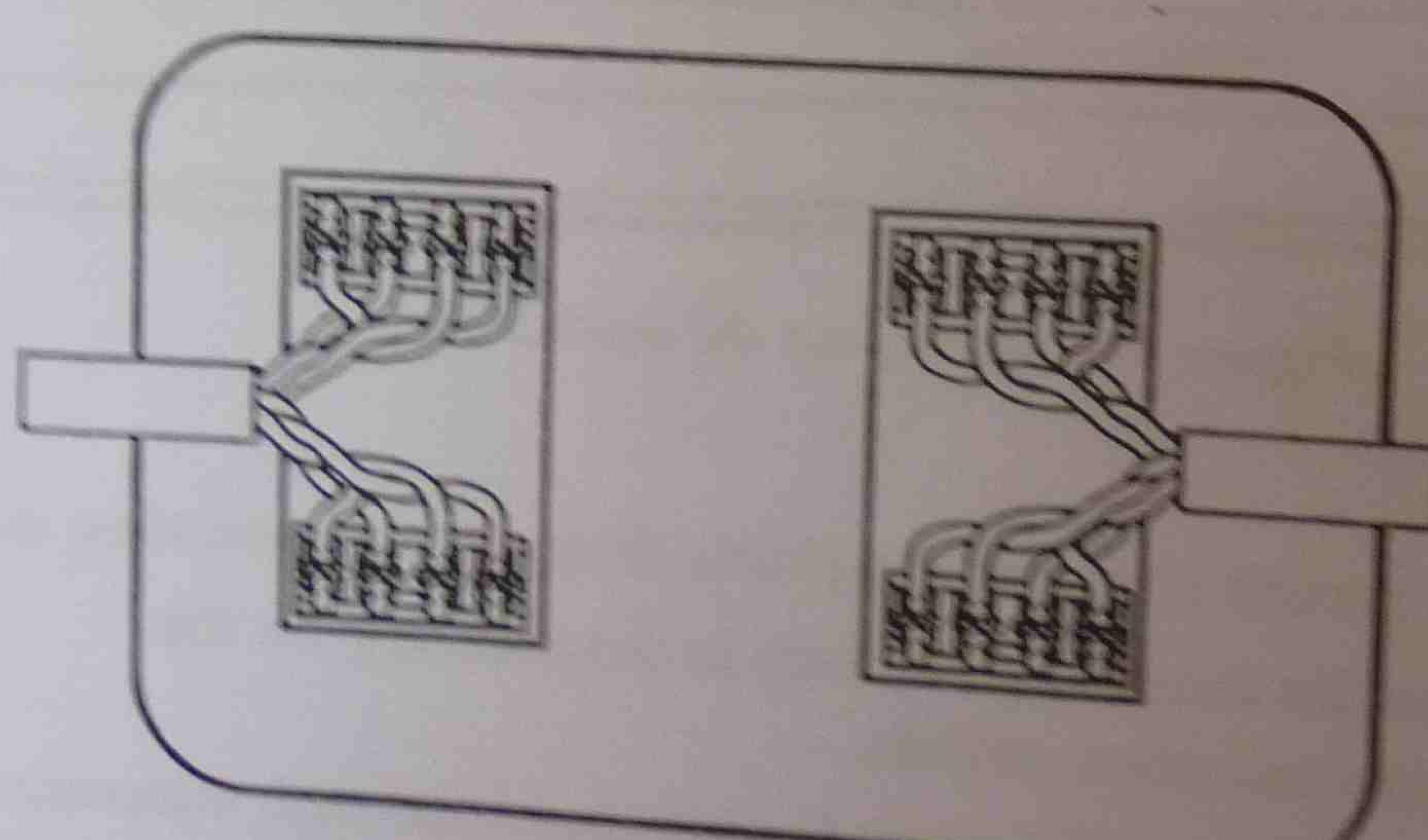


Figure 47 Termination at Modular 8 x 8 faceplate

8. Check the wire colour code and position in the modular connector and if this is correct use the '*punch down*' tool to terminate the wires.
9. Repeat steps 6 to 8 for the remaining

Terminating at Highband modules

10. Lace the cables to the bottom of the Profil frame being careful not to pull the tie too tight. Lace the cables carefully to the termination position at the approximate location of each Highband module.
11. Clip the first (bottom-most) termination module to one of the back-mount rods.
12. Remove about 75mm of sheath from the first cable.
13. Bring the sheath of the first cable to the back of the module considering the minimum bend radius specified by the cable manufacturer and AS/NZS 3080. Use Figure 48 as a guide.

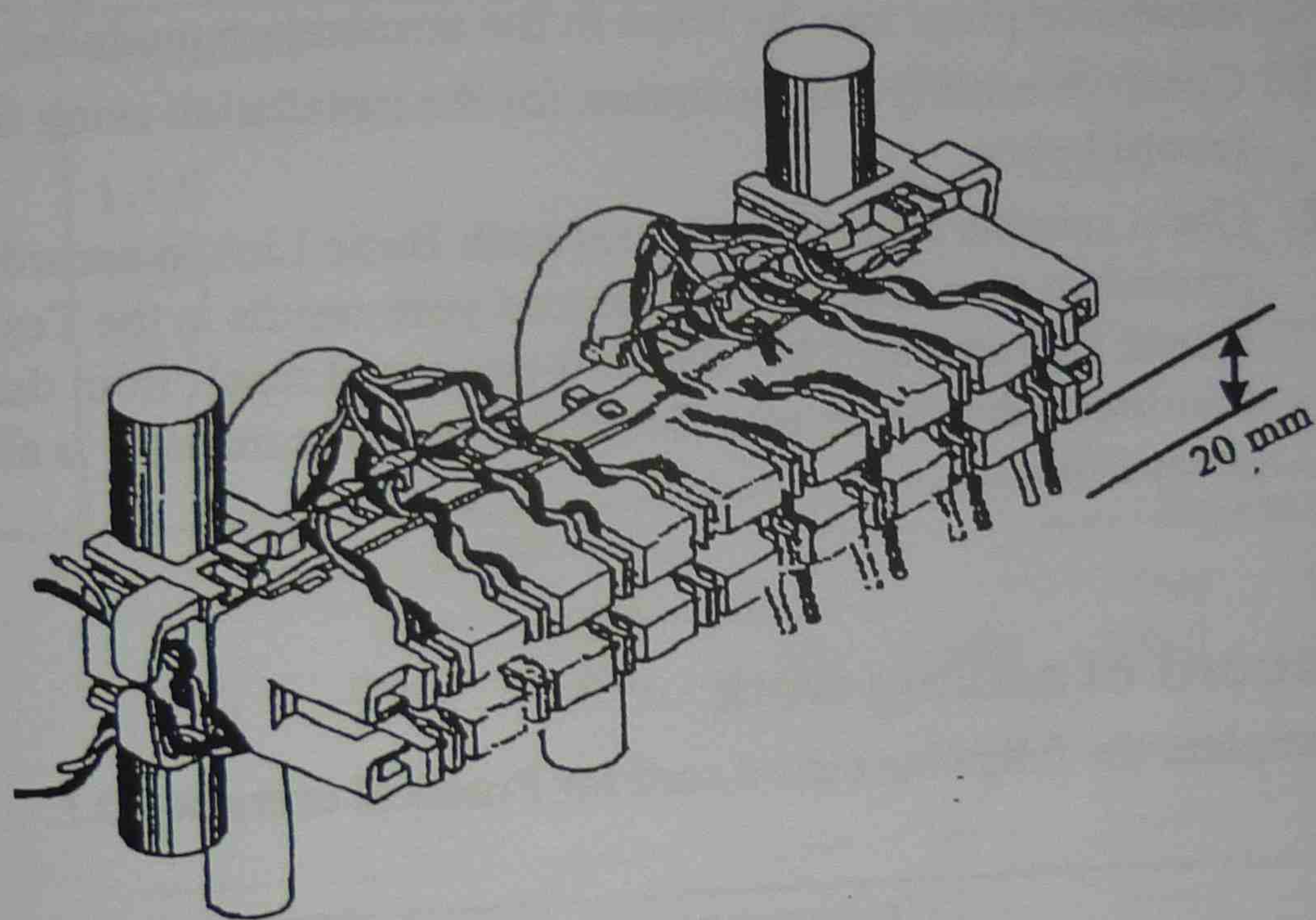


Figure 48 Installing wire pairs into module

14. Fan the wire pairs through the wire guides so that Wire 1 of Pair 1 to the left-most contact slot, Wire 2 of Pair 1 to the adjacent contact slot and so on (see Figure 48). Be certain to maintain the wire pairs up to the termination slots, ensuring there is a minimum of 20mm overhang from the bottom of the module. This will prevent short wire off-cuts fouling the termination area.

Ethernet

Ethernet is a baseband network that has dominated the LAN scene over the years and become an accepted standard. Development of the Ethernet was in 1980 by the combined efforts of Xerox Corporation, Digital Equipment corporation and Intel Corporation. The IEEE 802.3 specification recognises the Ethernet system.

Ethernet's rise in popularity stems from its simplicity. It is easy to set-up, flexible, and readily extendable. Due to its popularity and acceptance as a standard, many manufacturers provide capabilities for connecting their devices to Ethernet. This includes a broad range of devices from mainframes and PCs to mass storage devices. Figures 64 to 66 illustrate examples of small, medium, and large scale Ethernet configurations.

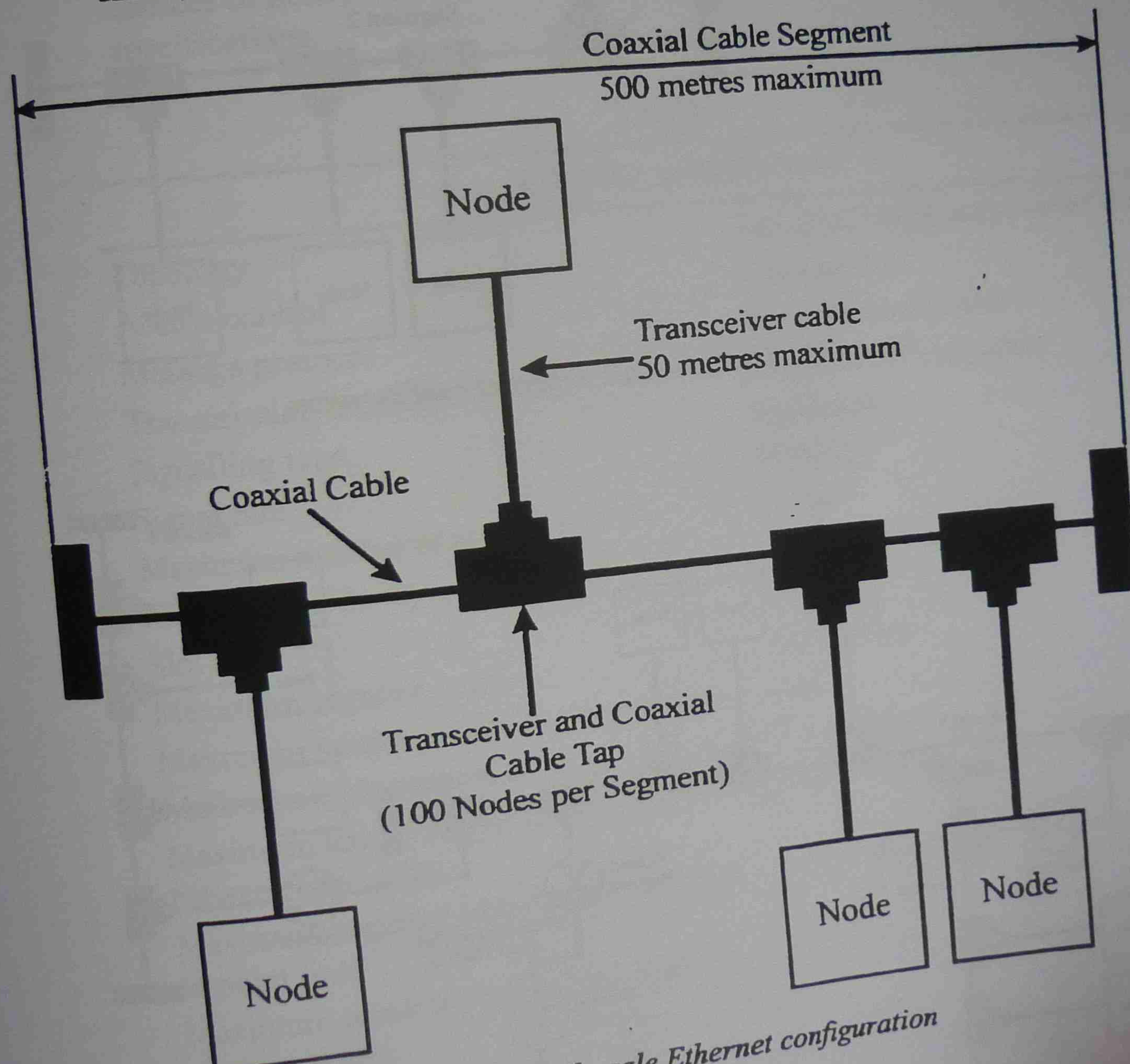


Figure 64 Small-scale Ethernet configuration

Ethernet transceiver

The Ethernet transceiver provides the physical and electrical interface to the Ethernet coaxial cable. Electrical circuits internal to the transceiver are powered via the transceiver cable connected to the Ethernet controller circuit card.

The main blocks in the transceiver are:

- transmitter
- receiver
- collision detector
- dc to dc converter

Figure 67 shows the arrangement of connecting an Ethernet controller card to the Ethernet coaxial cable.

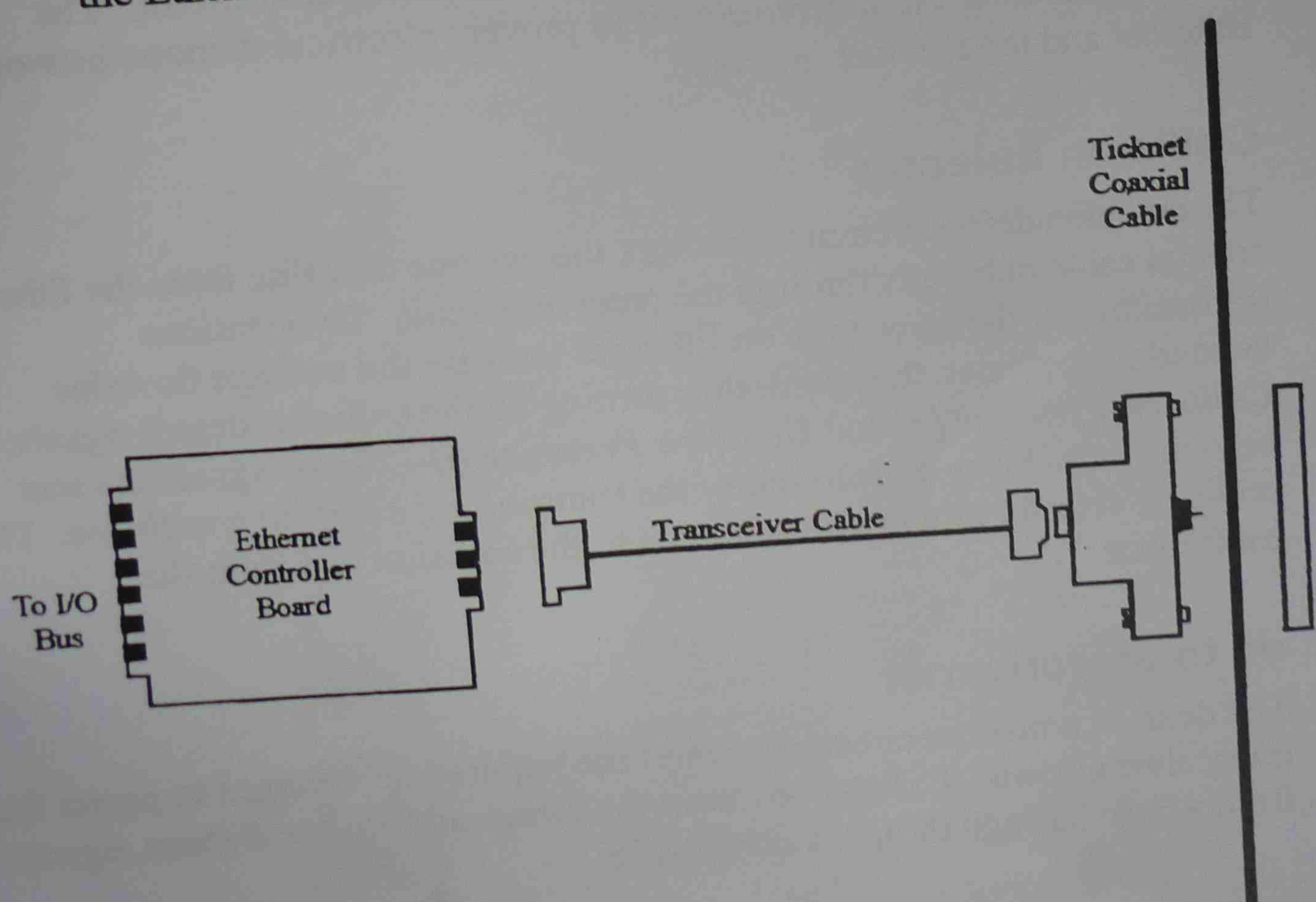


Figure 67 Ethernet controller

Transmitter

The transmitter's primary function is to buffer the signals ***Transmit (+)*** and ***Transmit (-)*** from the transceiver cable and transmit them onto the Ethernet cable. Timing circuits in the transmitter limit the length of time the transmitter may be on. This prevents signals from inadvertently locking in the on condition beyond the maximum packet length. The transmitter also includes a circuit to verify the collision detector circuit is operational during the transmission. The transmitter includes a protective circuit to prevent electrical damage between Ethernet and the transmitter.

Receiver

The receiver section couples the signals from the Ethernet coaxial cable to the receiver buffer circuit. ***Receive (+)*** and ***Receive (-)*** are generated and sent to the transceiver cable pair, provided the signals on the Ethernet cable exceed the average dc threshold for a valid signal. The average dc value of the signal and a collision threshold are sent to the collision detector circuit. The receiver includes a protective circuit to prevent electrical damage between Ethernet and the receiver interface.

Collision detector

The collision detector circuit monitors the average dc value from the Ethernet coaxial cable indirectly through the receiver circuit. Two stations transmitting at the same time on Ethernet increase the average dc value beyond the collision threshold, thus turning on the collision detect signals: ***Collision Presence (+)*** and ***Collision Presence (-)***. These signals are sent onto the transceiver cable to notify the transmitting nodes of a collision. The collision detector circuit also responds to the collision test from the transmitter.

dc to dc converter

The dc to dc converter circuit generates the required dc voltages to power the transceiver circuits. It is sourced from the ***Power*** and ***Power Return*** signals from a node through the transceiver cable.

Thinnet

Thinnet system uses RG-58/U cable having a characteristic impedance of 50 ohms and an attenuation of about 5dB/100 metres @ 100MHz. The maximum distance of this configuration is 185 metres. The topology is the same as for the Thicknet. BNC connectors are the termination medium for this system. BNC 'T' adaptors connect the cable to the nodes.

Figure 68 shows a Thinnet (10 Base2) application. Network devices attach to the bus segment through transceivers (MAUs) much like in Thicknet systems. The transceivers are spaced at 5 metre intervals with a maximum of 30 per cable segment. The BNC connector is the interface for transceivers, splices and terminators. The transceiver tap has either a BNC 'T' or BNC vertical adaptor. It is necessary to place a 'T' in the cable segment when using the vertical adaptor. The out leg of the 'T' then connects to the vertical BNC of the transceiver tap adaptor.

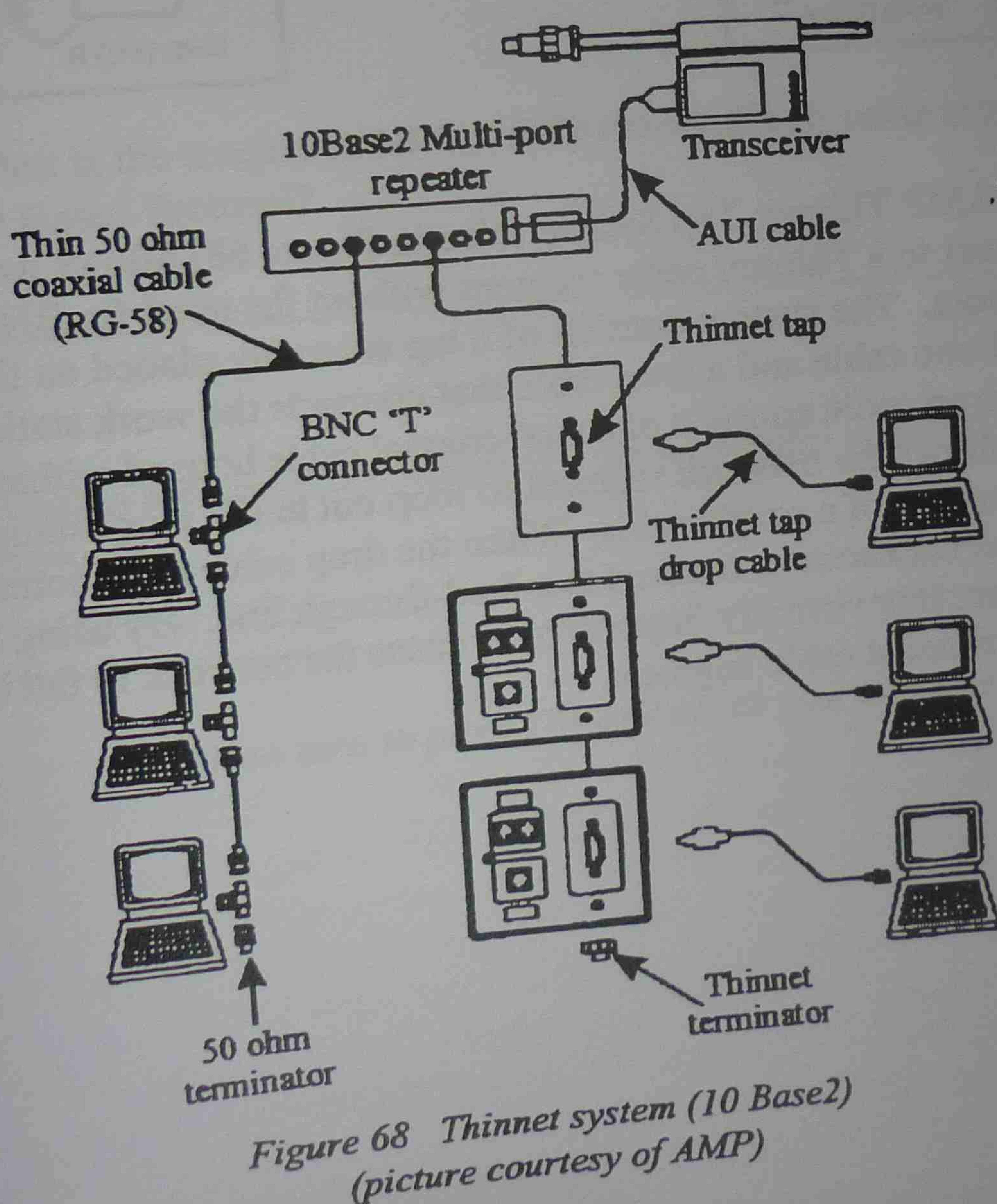


Figure 68 Thinnet system (10 Base2) (picture courtesy of AMP)

Technology has allowed the manufacturing of transceivers small enough to fit on the network interface card inside the work station (see Figure 69). Therefore, most interface cards now provide both an AUI port and a BNC port. The BNC port connects to the internal transceiver allowing the RG-58 backbone to connect directly to the work station with a BNC 'T' connector, eliminating the external transceiver and AUI cable. Multiple segments of 10 Base5 and 10 Base2 may connect as a single network using repeaters. The four-repeater rule and the maximum of five cable segments apply.

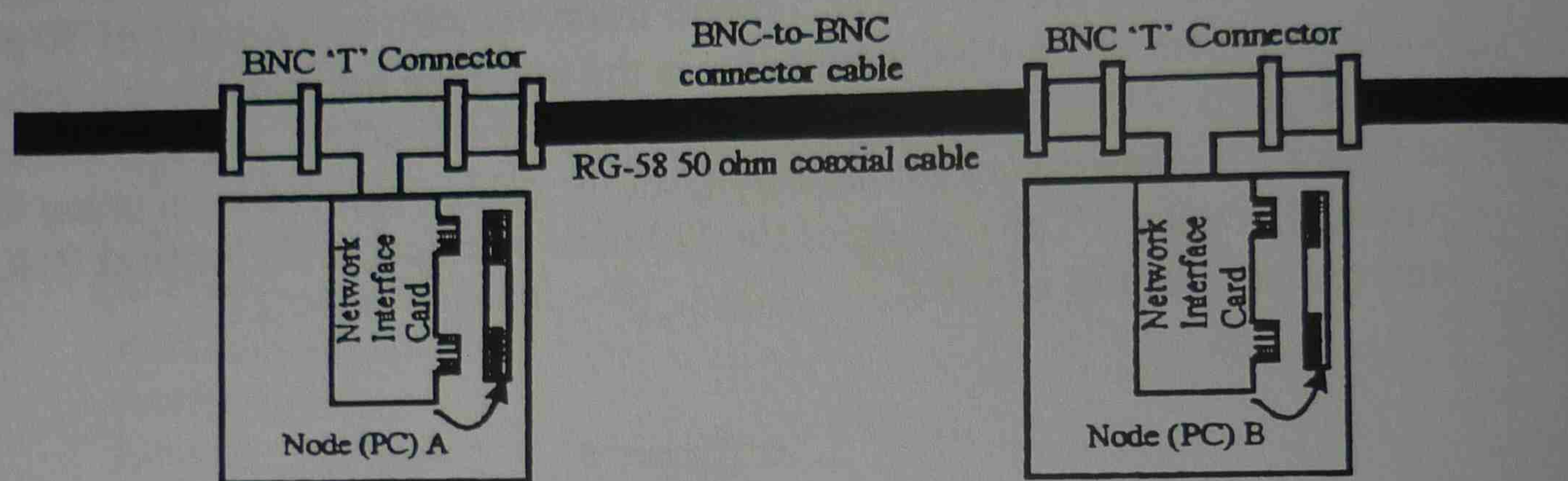


Figure 69 10 Base2 LAN set-up

The AMP Thinnet Tap System (also in Figure 68) allows work stations to connect to a Thinnet cable segment without the need for BNC plugs and 'T' adaptors. The system consists of a tap assembly placed on the RG-58 backbone cable and a drop cable that connects the work station to the tap. The drop cable consists of a dual coaxial cable housed within a single sheath that allows the network segment to loop out to the work station with the appearance of a single cable. When the drop cable is disconnected from the tap the backbone is restored to a feed-through line. By using the Thinnet Tap System, it is virtually impossible to cause the network to fail because of an unterminated cable segment.