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# Econet Installation Guide

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*Econet Installation Guide*



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Within this publication the term 'BBC' is used as an abbreviation for 'British Broadcasting Corporation'.

**WARNING - DANGEROUS VOLTAGES**

**BEFORE WORKING ON ANY OF THE ECONET UNITS  
OR STATIONS ATTACHED TO ECONET WITH A  
COVER REMOVED, SWITCH OFF, DISCONNECT THE  
MAINS PLUG FROM THE SUPPLY AND  
REFER TO THE EQUIPMENT SERVICE MANUALS  
FOR WARNINGS AND CAUTIONS**

**CAUTION - ELECTROSTATIC DAMAGE**

**DO NOT TOUCH COMPONENTS OR CONNECTIONS  
ON THE PRINTED CIRCUIT BOARDS**



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## **About this Guide**

This *Econet Installation Guide* is a guide and reference for the installation of Econet data networks. It takes you through the different types of Econet installation, describes the equipment, gives procedures for physical installation, and, once installed, tells you how to set up the network and install the software to run it.

It will also help you to obtain an overview of an existing network, particularly if you wish to add to or modify your existing equipment and facilities.

The Introduction discusses the basic principles of data networks in general and Econet in particular, introducing the basic components which are common to every Econet network.

Chapter 1 describes the various types of Econet network; the 'one room' network, permanently installed networks of up to 500 metres in length, and larger systems intended for extensive campus operation.

Chapter 2 takes you through the network installation procedures, including electrical tests and fault finding.

Chapter 3 gives more information about large campus networks, made up of several network segments, joined together by 'bridges'.

Chapter 4 tells you how to set up the network ready for use.

Chapter 5 gives an overview of Econet servers.

This guide should be read in conjunction with the user guides supplied with the specific equipment mentioned, as well as other related Econet guides. A bibliography of these guides is included in Appendix E.





# Introduction

The function of any network is to permit programs and data to be passed between computers connected to that network. In order for this to happen certain essential components are required:

- a network cable
- a network clock
- two terminators
- a file server
- network stations (computers)
- connection points for network stations

## 1. Network cable

Programs and data pass along the network cable in the form of electrical signals. The quality of this cable must be high, particularly for extensive networks. Only cable to Acorn's specification should be used. A network built with inferior cable will be less efficient and may cause network faults, which can be hard to trace. Problems caused by sub-standard cable often only manifest themselves when a network has been extended. Suitable cable is described in the chapter *Wiring and testing a network*.

Temporary and short 'one room' networks may be set up by chaining together Acorn 1-metre cables and 'T' pieces.

## 2. The Econet clock

A clock is needed on a network to synchronise the signals passing along the cable. The Econet clock is a small black box connected into the middle of the network cable, and powered from a mains power unit. FileStores have their own clock, which can take the place of the network clock on small networks (see Chapter 1).

## 3. Terminators

When electrical signals are transmitted along a cable, they can be reflected at the ends of the cable. These reflections can interfere with the main signal. To remove these reflections, terminators should be fitted at each end of the

cable. Econet terminators are housed in small plastic boxes and consist of an impedance matching circuit and a solderless connector for the cable. A single 5-pin DIN socket is provided for connection to a network station.

#### **4. File servers**

File servers provide a central storage facility for program and data 'files' for the network. Network users can load data from and save data to the file server. They also run the software utilities which control the network.

#### **5. Network stations**

Network stations, workstations or network terminals, are the names given to the computers attached to the network and sharing network facilities. Nearly all Acorn and BBC computers (since the BBC Model B) can be connected to an Econet network, if fitted with an Econet interface. A list of these is given in Appendix A.

#### **6. Connection points**

Network stations are connected to a permanently-installed Econet cable by means of socket boxes, each one with sockets for two stations. A socket box is similar to a terminator box, except that two 5-pin DIN sockets are provided to serve two stations, in addition to the solderless connections for the distribution cable. Figure 2 in Chapter 1 shows a socket box used in two positions; as an outlet for two Econet stations, or when connected to one station and the clock box at the centre of the network.

Stations are connected to a temporary ('one room') network via DIN 'T' pieces.

# 1. Econet networks

There are a number of ways to implement an Econet network, depending on the size and topology (layout) of the network to be installed. All of these have in common the network components described in the previous chapter.

Econet installations can be classified into three typical types:

- A short 'one room' network
- A permanent, up to 500 metre, network
- An extensive 'campus' network

As the terms imply, the difference between the networks is mainly a matter of size.

This chapter describes the three different types of network. Chapter 2 covers their installation.

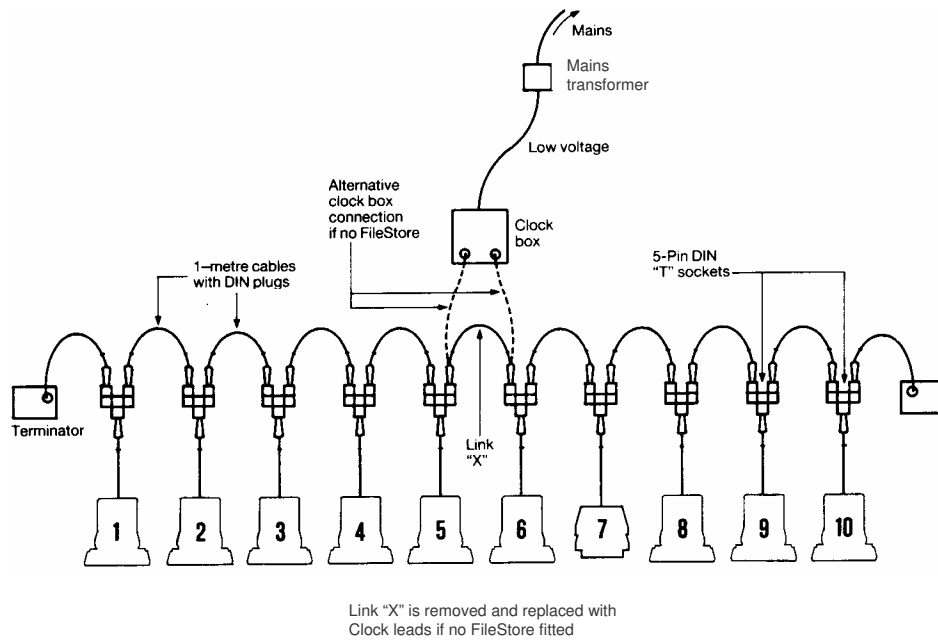
## 1.1 A short 'one room' network

Figure 1 illustrates a 'one room' network.

If your network can be installed so that the total length of the main cable is not greater than 10 metres, the simplest and cheapest implementation is by using a ten station lead set.

This package comprises 10 'T' pieces, each with three 5-pin DIN sockets, and 11 1-metre cables. The 'T' pieces are interconnected as shown in Figure 1, to form the network, the stations being attached to the 'T' pieces with the cables supplied with the Econet interface. You may use all the 'T' pieces and cables to form the network, with one or more stations connected. Both ends of the network must be plugged into a separate terminator box.

Data transmitted across the network requires timing pulses for synchronisation. These are provided either by a clock box, inserted in the centre of the network as shown in the diagram, or alternatively from a FileStore, which generates its own clock and termination, adequate for networks supporting up to ten stations. A FileStore may be connected to any one of the 'T' pieces (shown in Figure 1 at position 7).

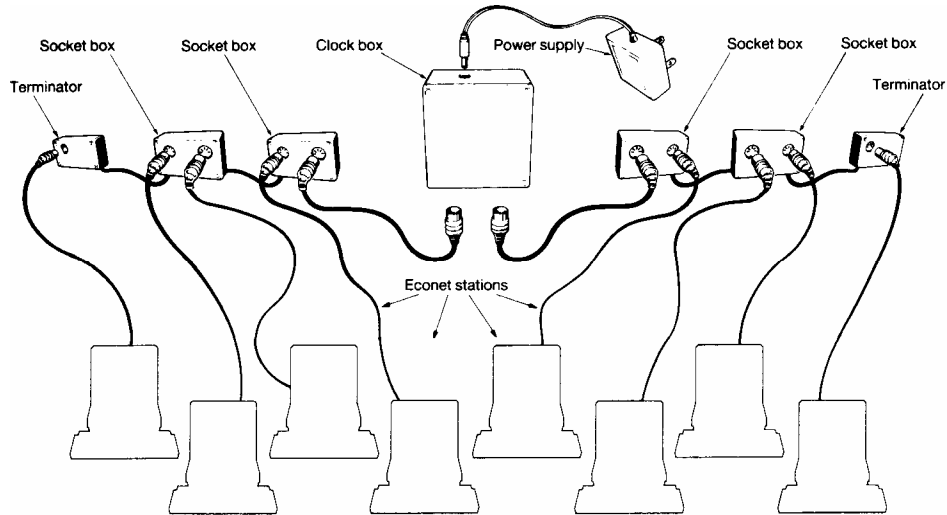


*Figure 1: A short 'one room' network*

The ten station lead set provides a simple method of installing a small local network. However, the reliability of the system is dependent on the integrity of the connection 'T' pieces, which are not intended for multiple make and break operations. If, therefore, your usage of the system requires you to regularly disconnect and re-connect, you should consider a permanent Econet installation, as described in the next section.

## 1.2 Networks up to 500 metres

This is the typical permanent Econet installation, suitable for networks longer than 10 metres, and up to 500 metres in length. Figure 2 shows the network configuration, comprising permanent cabling, socket boxes, terminators and a clock box.



**Figure 2:** Networks up to 500 metres

Up to 253 stations (in the address range 2 to 254), may be connected to one 500m network. Stations for attachment to the network are usually factory set at address 1. It is recommended that this address is reset on installation to a new value in the range 2 to 254, thus avoiding the possibility of an address clash from a new station that has not been reset. Information about address setting is given in Chapter 4.

A terminator box is required at each end of the cable, with a clock box in the middle.

Data transmission across the cable is timed by pulses from the clock box. The normal clock rate is 200kHz, and all clock boxes and FileStores are pre-set to this speed, but other rates may be obtained by re-setting the circuit links inside the clock box. Appendix C tells you how to do this. Lower

clock rates are sometimes required where there are problems with the network transmission line quality; for example where non-recommended cable has been used.

If a FileStore is connected to a network which already has a clock, its internal clock and termination facilities are automatically disabled. The *FileStore Network Manager's Guide* (see the bibliography in Appendix E) describes this facility in more detail.

### 1.3 Large campus networks

Figure 3 shows a typical campus network, which is an extensive network comprising more than one of the 500m network segments described in the previous section.

The 500m network segments are joined to each other by means of 'bridges'.

Econet bridges may be attached to a network either through a socket box, using one station socket, or via a terminator, again using the station socket.

Up to 127 500m network segments may be joined together through bridges to form a campus network. A network segment identity address is assigned to each network segment within the range 1 to 127, and physically set up with links inside the bridge. So, to access a station on a campus network, it is necessary to specify two levels of address, the network segment address (set up in the bridge) and the station address (set up in the station).

More information about campus networks is given in Chapter 3, together with examples of different network topologies.

For some larger networks, there may be a requirement to use long distance links. Appendix B gives more information on advanced network installations of this type.

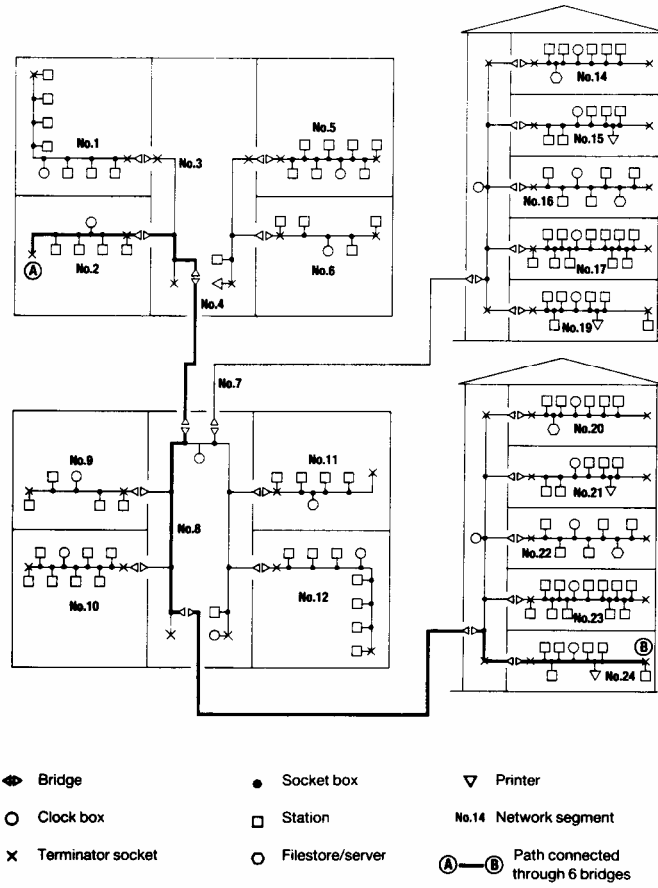


Figure 3: Large campus network





## 2. Wiring and testing a network

This chapter describes how to install different types of Econet network, and lists the parts you will need.

When installing, testing and using any of the circuits, remember that the DIN type connectors fitted, while known to have high reliability in normal use, are not designed to be frequently plugged and unplugged. During the installation, avoid unnecessary making and breaking. If this is unavoidable when using the network, the connectors should be frequently checked.

### 2.1 Short 'one room' networks

#### 2.1.1 Components required

1. **AEH18 10 station lead set**

Comprising:

- 11 1-metre cables terminated at each end with a 5-pin DIN plug
- 10 five-pin DIN 'T' pieces

2. **AEH19 starter kit** (unless your network has a FileStore, *and* less than ten network stations)

Comprising:

- Three socket boxes
- Three 1-metre cables fitted with 5-pin DIN plugs at both ends
- One clock box with power supply and connecting mains lead
- Two terminator boxes
- One cable insertion tool
- *Econet Installation Guide* (this manual)

#### 2.1.2 Installation procedure

The network is simply plugged together, each 'T' piece using two branches to form the network and the other outlet to connect to the station. A typical assembly is shown in Figure 1 in Chapter 1.

When assembling 'one room' networks you can connect together all 10 'T' pieces and 11 cables, or just the number required for the stations in use. It doesn't matter if there are some 'T' pieces without stations.

The clock box is installed as near to the centre of the network as possible and a terminator is connected to each end of the cable. Figure 1 shows how the clock box is inserted into the network by unplugging the middle cable and re-connecting it to one of the clock box sockets, then using an additional cable (supplied with the clock box) to complete the connection.

As mentioned earlier, networks with a FileStore, and ten stations or less, do not need a network clock or terminators.

Stations are attached to the network 'T' pieces by means of the 1 -metre leads supplied with the station Econet interface. If these have gone astray, extra 10 station lead sets can be purchased for this purpose.

## 2.2 Networks up to 500 metres

### 2.2.1 Components required

1. **AEH18 10 station lead set** (only needed if you no longer have the 1-metre leads supplied with the Econet station interface).
2. **AEH19 starter kit** (described above).
3. **AEH21 additional socket kit**, comprising five socket boxes. Each socket box supports two stations, provided that the stations can both be installed within one metre of the socket box. If not, you may need up to one socket box per station. Note that the starter kit has enough sockets to support up to six stations (depending on where you want to locate them).
4. **AEH17 100 metres of network cable**  
The cable used throughout an Econet system consists of two twisted-pair lines with a shield and ground wire. The signal lines are two data lines (D+ and D-) and two clock lines (C+ and C-). There is a single ground wire. The total end-to-end resistance of the installed network should be less than 27 ohms, which will typically permit a main cable length of up to 500m.

Alternative types of cable approved by Acorn are as follows:

Reliance RCC 8064  
Brand Rex CD 84-4-0521  
RS Components 367-921

Approved cable meets the following specification:

Characteristic impedance:	100 ohms + 10%
Mutual capacitance:	less than 66pF per metre
Propagation speed:	greater than 0.5c (where c is the speed of light)

If it is necessary to join lengths of cable, the internal wires should be carefully stripped and soldered. The insulation should be restored either using heat shrinking plastic sleeves or the joint should be housed in a waterproof box.

5. **Recommended tools:** If you have a large number of boxes to install, it is worth considering purchasing professional tools:

- **Cable insertion tool**

The plastic tool supplied with the starter kit is intended only for a small number of operations. A professional, heavy duty tool, which also has an automatic cable trimming feature, can be obtained from RS Components, part number 470-128. This tool also has a wire cutting blade which operates automatically after the insertion has been made. This operation should be disabled when connecting socket boxes. A plastic wedge is supplied with the tool for this purpose.

- **Cable stripping tool**

A special tool is available for stripping a section of the outer insulation of the network cable, without cutting the internal wires, as required when installing socket boxes. The tool is also available from RS Components, part number 547-442. If you use a tool of this type, experiment with the setting of the cutting depth on a piece of spare cable before attempting to strip the main cable.

## 2.2.2 Wiring the network

**Please contact your Acorn supplier if you require help or advice when installing this type of network.**

When wiring large distribution systems, there are several points to consider:

- In all cases, the total length of the main distribution cable should not exceed 500m. Networks extending over distances greater than 500m are described in the section below entitled *Campus networks*, and are implemented by using several 500m networks connected together through 'bridges'.
- The clock should be placed centrally in the network.
- The socket boxes should lie close to the stations.
- It is better to over-estimate rather than under-estimate the amount of cable required.

To make identification of the signal wires easier, a colour coding system is used, as summarised in the table below. Keep an accurate record of the cable installation and colour codes used. Note that some cable manufacturers use identifying colours that are different from this list:

5-pin DIN number		Signal Colour
1	Data+	White/orange
4	Data-	Orange
2	Ground	Copper
5	Clock-	Blue
3	Clock+	White/blue

### 2.2.3 Fitting the clock box

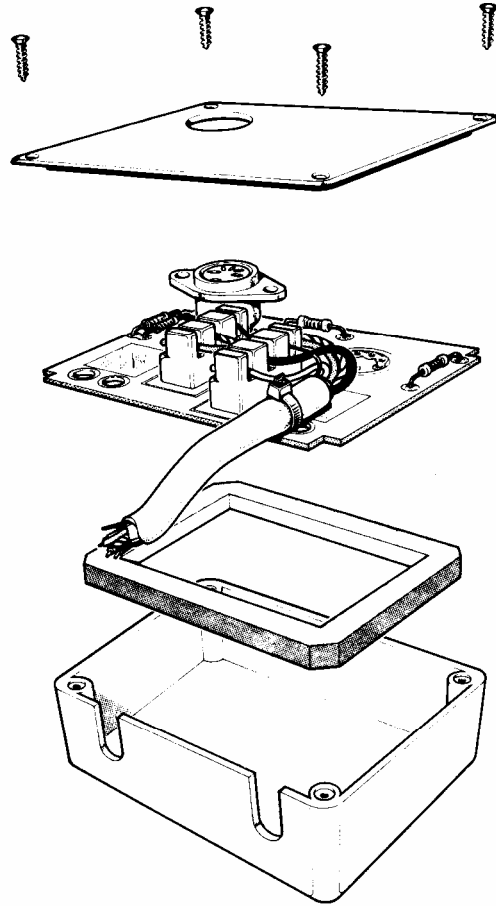
The main Econet distribution cable should be laid out, and cut where the clock box is to be fitted. This should be within 30 metres of its centre - the exact position is not critical. Each of the cut ends should be attached to a socket box (see *Wiring a socket box* below).

The two socket boxes should now be attached to the clock box using the two 1-metre cables with DIN connectors supplied.

The terminator boxes should then be fitted.

### 2.2.4 Wiring the terminator boxes

The terminator boxes should be connected to each end of the cable, using the following method:



**Figure 4:** Wiring a terminator box

1. Strip about 60 millimetres (2.5") of the outer insulator and shielding from the cable. Remove the lid from the terminator box to reveal six white IDCs (insulation displacement connectors). These are marked with the letters E (ground), D+, D-, C- and C+. There is also a cable grip, at the side of the printed circuit board.
2. Lay the colour coded signal wires and the copper ground wire over the appropriate IDC sockets and push them into place using the cable insertion tool. There is no need to strip off the individual wire insulation. Be extremely careful that you use the insertion tool the right way round. If you do not, the connector will break. Locate the correct orientation by experimenting with a spare box, using no wire. Gently push the tool into one of the connectors; if it is the wrong way round, you will feel resistance after the tool has descended about 3 millimetres. Rotate the tool through 180 degrees and try again; it should now go right down to the bottom of the connector with only slight resistance. Note the position of the tool, or mark it so that you will remember.

**Caution: Do not use a screwdriver for inserting cables - only the appropriate tool. If you use a screwdriver, you will not make a good connection and will permanently damage the connectors.**

3. When the wires are in place, fasten the cable to the board using the cable grips and cut off any excess cable protruding from the connectors. Figure 4 shows a correctly wired terminator.
4. When the terminator boxes have been fitted, stations may be connected to them using the 1-metre cables supplied.

## 2.2.5 Wiring a socket box

Fit the socket boxes where the stations are to be sited.

Installing a socket box is very similar to wiring a terminator box, except that the outer insulator and shielding must be stripped without cutting the distribution cables or earth wire. After removing about 60 millimetres (2.5") of the insulator, and any other braid or foil, place the signal and ground wires over the IDC sockets and push them into place with the insertion tool. Again, the cable should be secured to the printed circuit board with the grips.

When the socket boxes have been fitted, stations are connected to them using 1-metre cables with DIN connectors.

## 2.2.6 Testing

Having installed the cable, clock box, terminator boxes and the socket boxes, you can test the wiring. The steps are as follows:

1. Disconnect the clock from the network, so that there are two free DIN plugs. This splits the network so that each half can be tested separately.
2. With an ohmmeter, test the resistance between the two clock lines C+ and C- at the clock box DIN plug and at each socket box. The resistance should be between 110 and 160 ohms if reliable operation is to be ensured.
3. If a high resistance reading is obtained, there is an open circuit between the socket being tested and the terminator box, possibly caused by the data and clock lines being transposed at a socket box. If a very low resistance is obtained (less than 100 ohms), there is a short circuit somewhere between the two lines. If no fault can be found in the cable, the terminator may be faulty.
4. Repeat the test for the D+ and D- lines, but expect a resistance of between 220 and 260 ohms for a healthy cable.

Repeat the whole test sequence on the other half of the network

## 2.3 Campus networks

### 2.3.1 Component requirements

1. **AEH19 starter kit** (described above)
2. **AEH17 100 metres of network cable** (described above)
3. **AEH21 additional socket kit** (described above)
4. **AEH18 10 station lead set** (if required)
5. **AEH20 Bridge**

Comprising:

- Bridge processor
- Two 1-metre cables terminated with a 5-pin DIN plug at either end.

### 2.3.2 Wiring a campus network

Campus-type networks are made up of several 500-metre network segments linked together by bridges. Each 500m segment of the network should be installed as described above.

The bridge unit used to join two segments is attached to a 500m segment through either a terminator or a socket box. Examples of some types of campus networks are shown in Figures 6 and 7.

The interconnection between bridges may be implemented using the standard network cable, socket and terminator boxes. This circuit should normally be regarded as another 500m network segment, obeying the same rules, with a clock box inserted as near to the mid-point as possible. However, there may be some special cases, where, for example, the cable has to cross a road, or where a distance greater than 500m is encountered, which needs special consideration. Some advice on these aspects are given in Appendix B.

### 2.3.3 Levels

The topology of some large networks can create the situation where a signal path could pass through a large number of bridges effectively connected in a long string. The maximum number of bridges in any path between any stations should not exceed seven. Referring to Figure 3, for example, the path shown between (A) and (B) passes through six bridges.

### 2.3.4 Testing

After installing, test each 500m network segment separately by disconnecting at the bridges, following the information given above. Then test the bridge segment in the same manner. This will test the overall wiring of the complete network.

The operation of the bridge is described in the next chapter.



## 3. More on campus networks

Note: only networks with file servers of Level 2 and above may be used with bridges.

### 3.1 The bridge hardware

Externally, a bridge box looks very similar to a second processor or Prestel Adapter; that is, a cream coloured plastic box with the same cross section as a Model B BBC Microcomputer and half the width. On the back panel of the box is a mains lead, a power switch and two 5-pin DIN sockets marked A and B.

The circuitry of the bridge comprises two Econet interfaces, a 2MHz 6502 Processor, 8k of program EPROM and 8k of RAM. The RAM is used as workspace for the bridge software and as a buffer area between the two Econet interfaces.

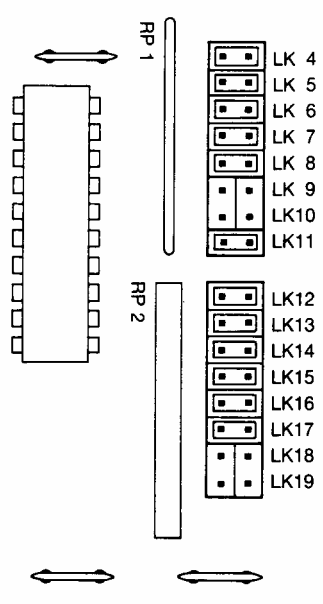
To join two network segments with a bridge, it is first necessary to assign a number to each segment. This may be in the range 1 to 127. Each network segment in the system should have a unique number. You will now need to remove the cover of the bridge.

**DANGER: BEFORE REMOVING THE COVER OF THIS EQUIPMENT, SWITCH OFF AND DISCONNECT THE MAINS PLUG FROM THE SUPPLY.**

Removing the lid of the bridge box reveals two rows of links. These are used to set the network identities.

Figure 5 shows the position of the links on the bridge PCB. The row next to the component marked RP2 controls the identity of the network segment plugged into socket A; the links next to RP1 determine the identity of the network segment plugged into socket B. When the network segment identities have been decided upon, the links may be set in the same way as the station identity in a Model B BBC Microcomputer, as described below.

The most significant bit of the eight-bit network segment identity is at the top of the row, the least significant bit being the bottom link. As the range of legal identity numbers is 1-127, the top link of each row should always



**Figure 5: Bridge address links**

be made, remembering that a made link stands for a '0' in that position and an unmade link stands for a '1'. In order to set up an identity as 1, only the bottom link should be left unmade. The bridge in the diagram has been set up between networks three and six.

Note that all bridges connected to a given network segment should have the network's identity set to the same number. Conversely, no two networks in a system connected by bridges may have the same network identity. Remember to keep a note of the settings; if you forget to do this you will have to remove the bridge box covers and inspect the link settings to find out the addresses you have set!

Once the network identities have been set up on the printed circuit board, the network segments may be joined. This is achieved by attaching the bridge box to network A, exactly as though the bridge box were a normal station, that is, by running a 5-pin DIN to 5-pin DIN lead from a socket or terminator box on the network to a socket marked A on the bridge box.

Repeating for network B completes the joining process.

To activate the bridge, power up. The bridge software detects which networks are in the system and begins its task of looking for messages to pass between the two networks it bridges. Of the 8k of RAM in the bridge, about 4 to 6k is available for the purpose of buffering transactions between the two networks.

You may observe that there is a button on the bottom of the Bridge box. If pressed, it enters test mode. Test mode should not be used while the bridge is connected to Econet, as it creates traffic which will jam the network. For details, please refer to the *Econet Bridge Service Information*.

## 3.2 Typical network layouts

Bridges enable various network layouts, or topologies, to be used that are not normally available to Econet users. The connection between the main network cable and a station is limited to a length of 2 metres. This restricts the network to a single linear layout with short 'spikes' from the socket and terminator boxes. This is often inconvenient, for example when the network has to service several floors of a building, especially when the length limit of 500m is considered.

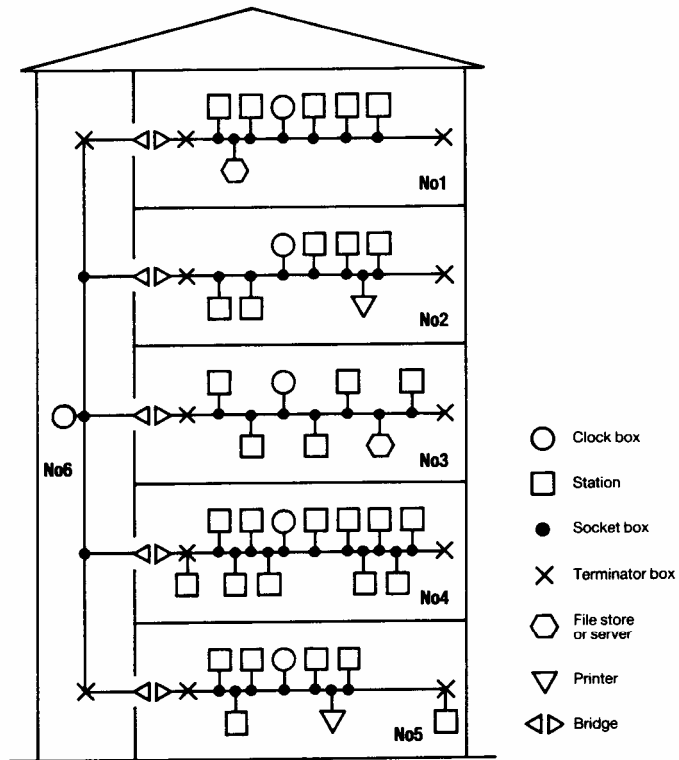
By using networks with one or more bridges, different and more useful topologies may be constructed. This section discusses two examples; an E-type and a Star-type topology.

### 3.2.1 E-type topology

This arrangement is useful when setting up a network on several floors in a building. The idea is to have a single network running up the height of the building, with a bridge on each floor connecting the vertical network to each horizontal floor network. A scheme like this is shown in Figure 6.

In Figure 6, the terminators of network segments 01 to 05 are connected to the terminator or socket boxes of network segment 06 by bridges, as shown.

There is no need for all of the networks in the system to have a file server. In particular, network 01 would probably not have a file server, the cable acting only as a connection between the other three networks.



**Figure 6:** An E type topology

### 3.2.2 Star-type topology

Another common type of network layout is where there is a centralised main network segment with several outlying segments. An example of the need for this is in a school or college where the main network, printer servers and file servers are in the 'computer room' and other rooms, possibly in different buildings, have their own network segments attached to this. Figure 7 illustrates this.

In Figure 7 network segment 03 is the main segment, the others forming branches out from this through the bridges.

It can be seen from Figure 7 that stations on each network segment may reach stations on any other network segment, messages passing through up to two bridges. Of great importance is the fact that no message may reach its destination by more than one route. When connecting networks with bridges, it is vital that there are no duplicating routes (forming loops) between any of the systems. A simple way of detecting loops is to apply the test: If  $n$  network segments are connected by  $n$  or more bridges, there is bound to be a loop, and one or more of the bridges must be removed.

### 3.3 Using a bridged network

The process of logging onto a network with multiple segments is very similar to the usual method. If, say, the file server required is on the 'local' network segment, that is the segment to which the user's station is connected, the sequence is unaltered, as follows:

```
*1 AM 253 PETE
```

where the 253 is the file server number.

To log onto a file server on network number 3, using file server number

251, the command becomes:

```
*1 AM 3.251 PETE
```

with the network number preceding the file server number, separated by a dot. Once the file server has been in use once during a session, its number and the number of the network on which it lives are remembered, and it is possible to log onto it again simply by saying:

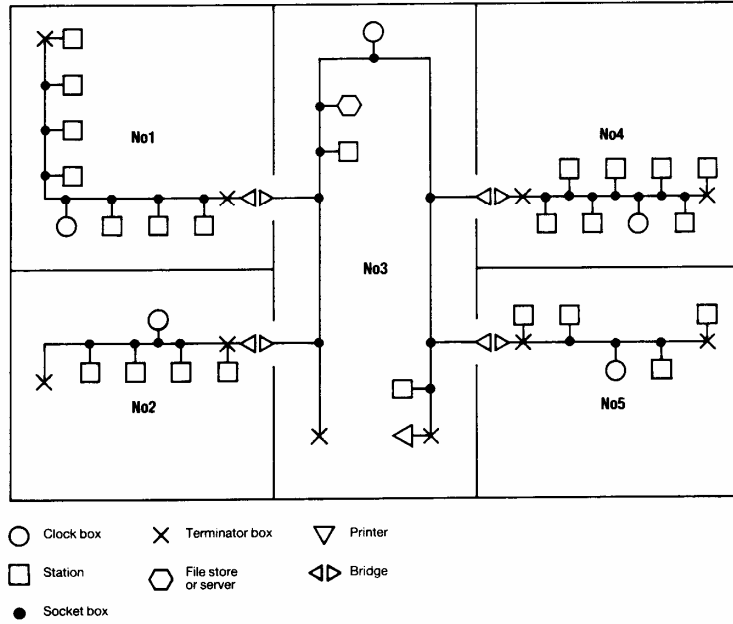


Figure 7: A Star-type topology

\*I AM PETE

If it subsequently becomes necessary to use the local file server again, the local network's number must be given explicitly. The local network is always number zero, so logging on to the local file server again requires:

\*I AM 0.253 PETE

Several other commands require the network number to be specified, such as:

\*NOTIFY, \*REMOTE and \*VIEW.

### **Commands for the Model B BBC micro and Master series**

To notify station 114 on network 17, for example, use the form:

\*NOTIFY 17.114 The memo is on its way

Attempts to view larger screens will cause the station to halt as the screen information cannot be returned through the bridge.

While supervising a transaction between two networks, the bridge holds open a virtual circuit for the duration of a packet. This leads to a slight bandwidth degradation for messages that cross a number of bridges. It should be stressed that this is on a per packet basis and that a significant bandwidth is still available between the individual packets of an operation such as, say, a load, save or catalogue. The bandwidth lost can be calculated as follows:

For a conversation through a single bridge, the circuit is held open for twice the normal duration of the transfer; that is, the time for the full four way handshake to take place. For a two bridge route, the circuit is held open for three network segments so you have a third of the bandwidth. For a three bridge path, four network segments are used, etc.

In practice, though, most of the time taken by a transaction is waiting for the file server to process the command, and no speed difference should be noticed.





## 4. Setting up an Econet system

### 4.1 Introduction

The Model B BBC, Master 128, Master Compact and Archimedes microcomputers can all be used on an Econet network, either separately, or mixed together.

If you are setting up an Econet system for the first time, you will need to activate and test the network. Follow the procedure in the next section.

If you are adding a station to an existing, working Econet system, follow the procedure in Section 4.3, selecting the sub-section for Model B BBC microcomputer stations, Master 128/Compact stations or Archimedes stations.

### 4.2 Procedure

1. Complete the wiring and electrical testing described in Chapter 2
2. Confirm the clock speed is correctly set by the links in the clock box (Please refer to the setting up details given in Appendix C)
3. Connect the clock box in the middle of the network
4. Connect the power supply to the clock box and switch on
5. Connect a station to the network and check the voltages on the data lines at a convenient 5-pin DIN socket. The readings should be:
  - Line D+ (pin 1) to ground (pin 2) 1.8 to 2.2 volts
  - Line D- (pin 4) to ground (pin 2) 2.2 to 2.6 volts
6. If you do not obtain a reading within the ranges given, go back to Chapter 2 and repeat the electrical tests.

#### 4.2.1 Clock speed setting

The speed at which the network operates is set by the links in the clock box. The normal clock frequency, which is pre-set at the factory, is 200kHz. Under special circumstances you may wish to change this, in which case, please refer to Appendix C.

## 4.2.2 Network system fault finding

### No clock

This may be caused by:

- The station not being plugged into the network: replace the lead between the station and its socket box with a known good one.
- The clock box not being plugged into the mains: check the mains socket switch and clock box power switch.
- The clock box not being plugged into the network: check the 5-pin DIN plugs connecting the main cable to the clock box.
- An open circuit or short circuit in the clock lines: repeat the tests detailed in Chapter 2. Remember that any of the 1-metre leads connected to the network may produce a short if faulty.
- The clock box incorrectly set-up: see the setting up information in Appendix C.

If there is still no clock, try connecting a station directly into the clock box by a short 5-pin DIN to 5-pin DIN lead. Try another lead or station if the fault persists. Check the clock setting inside the box. If none of these remedies produces a clock signal, the clock box may be faulty. Consult your supplier.

### Clock distribution faults

If the main network cable is below the specification recommended by Acorn, errors may be caused even if the clock is set correctly and the clock box is fault free.

## 4.2.3 Line jammed faults

This is caused by continuous data signals on the data line preventing any station from using the network and is an indication that the voltages are incorrect or not present.

Carry out the following test sequence:

- Reset all stations on the network, including any file servers, if present. When resetting servers, observe the normal precautions; refer to the relevant file server manual if in any doubt.
- Disconnect all stations from the network.

- Check for faulty terminators, particularly that the voltages are at the correct level (values are given in section 5.2).
- Check for crossed wires.
- Check for a faulty Econet interface in a local station.

At each stage, try to reboot the local station, checking for the error remaining.

#### **4.2.4 Not listening faults**

This occurs when a message sent to a remote station is not accepted. The possible causes are:

- The wrong station identity was given for the remote station.
- The remote station is not plugged into the network or does not have the network software present.
- There is a hardware fault in either the local or remote station.

#### **4.2.5 No reply faults**

These indicate that the remote station received a network request, but has not provided the expected reply within a suitable time. This fault may indicate that the peripheral on the remote station is faulty or not available.

Check that the printer is switched on and is on line. Check that the discs on the file servers are correctly inserted in the drives. Check that any other peripherals are switched on and are in a ready state.

If the fault still occurs, test the peripherals by using them locally. For example, try connecting a printer to a local station.

If these test succeed, it is possible that the user station could not receive incoming messages for some other reason. Try replacing the user's local station and see if the fault persists. If it does, then the installation cables should be checked, performing the tests detailed in Chapter 2. You should also refer to the manuals provided with the server you are trying to use.

## 4.3 Adding a new station to an existing Econet

Adding a new station to the network involves the following steps:

1. Fitting an Econet interface to the new network station (computer)
2. Setting the station number
3. Connecting to Econet network
4. Configuring the station for network use

The details of each step will depend upon the type of station, so the procedure will be described separately for each type.

Each station on the network must have a different station number (in the range 2 to 254) to identify it uniquely. You will probably find it useful to keep a record of the station numbers you have set by using system record sheets, similar to the ones shown in Appendix D.

## 4.4 Setting up a Model B BBC micro station

### 4.4.1 Fitting the Econet interface

The Econet interface for a Model B BBC microcomputer is fitted as a number of separate electronic components, inside the computer, and should only be fitted by a qualified dealer or service centre.

### 4.4.2 Setting the station number

In Model B BBC computers fitted with an Econet interface there is a row of 8 links in the top left hand corner of the board, marked S11. To gain access to these links, the lid of the computer must be removed after unscrewing the four screws marked 'FIX'. Two of the screws are located at the rear of the case and the other two are on the underside of the case at the front.

**WARNING - DANGEROUS VOLTAGES: BEFORE REMOVING THE COVER OF THE COMPUTER, ENSURE THAT THE POWER IS SWITCHED OFF, AND THE MAINS PLUG REMOVED FROM THE SUPPLY.**

The links form an 8-bit binary number representing the computer's station identity. The least significant bit is the link nearest to the rear of the case; the most significant bit is the link nearest to the front of the case (at the bottom in Figure 8). On the BBC Model B+, the links are laid out in the

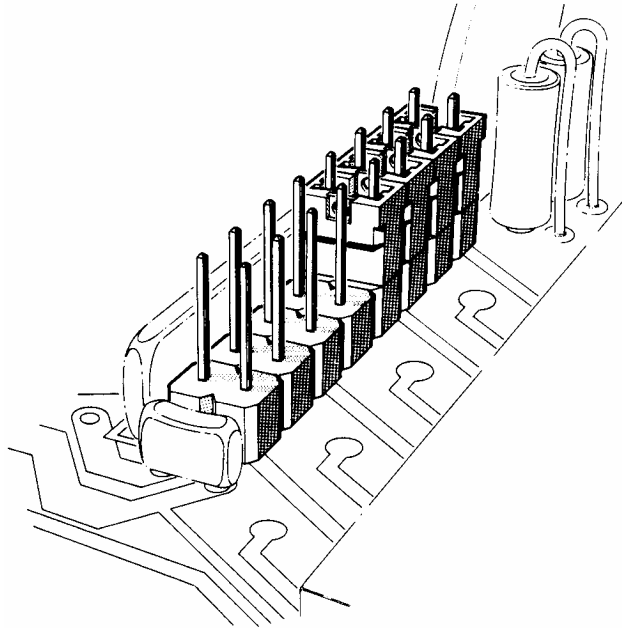


Figure 8: Setting the identity of a BBC micro

opposite sense (that is to say, the most significant bit is the link nearest the rear of the case. If a link is made, the bit is zero; an unmade link implies a 1 bit.

As an example, to obtain the number 240 (128+64+32+16), links 0, 1, 2, and 3 should be made and the rest unmade (counting the rearmost link as number 0). Unused links may be parked by inserting them on only one of the two pins.

#### 4.4.3 Connecting the station to Econet

Connect the station to Econet by plugging the 5-pin DIN connector into a socket box or terminator box. Switch on and attempt to log on at that station. If there are no error messages when you log on, the station has been

set up correctly.

If two stations are set up to the same number, you must disconnect one of them from Econet or turn it off. Change its station number to an unused one before reconnecting or turning it on again.

#### 4.4.4 Configuring the station

##### **Autostart**

It is possible to configure all stations on the network to start up the same way, when SHIFT BREAK is pressed. You set this up using the autostart facility. This works similarly to the autostart at log on, described in the *User Guide*.

For example, you could arrange for every station to start up and display a menu of programs for users to choose from when they press SHIFT BREAK . The programs would be downloaded from the network file server, without the need for users to log on individually.

Whenever a user resets the computer by pressing SHIFT BREAK , the station automatically tries to log on as the user BOOT. The user BOOT can have a directory and !BOOT file like any other user, and this can be set up to contain the starting routine you want the stations to follow.

To set up an autostart that works whenever a user resets a station:

1. Create a main directory and a user called BOOT, if you don't already have one.
2. Create a file called !BOOT in BOOT's main directory. Put in it the commands you want the file server to carry out each time a user resets.
3. Change the autostart setting of BOOT's main directory by typing:

```
*OPT4,<number> RETURN The <number> you type can be  
0,1,2 or 3:
```

- |   |                                                     |
|---|-----------------------------------------------------|
| 0 | switches autostart off                              |
| 1 | makes the file server *LOAD the file !BOOT on reset |
| 2 | Makes it *RUN the file !BOOT on reset               |
| 3 | Makes it *EXEC the file !BOOT on reset              |

If there is no main directory BOOT, the file server will treat \$ as the currently selected directory. The start up option for the user BOOT will be checked. If it is 1,2, or 3, it will look for a file called !BOOT in \$ and try

to \*LOAD, \*RUN or \*EXEC it.

If BOOT's directory has no file !BOOT, or if there's no BOOT directory and \$ has no file !BOOT, users will get the error message `file not found`, or `Bad command`.

#### **Changing station configuration**

You can change the configuration of individual stations by soldering links onto the keyboard. To do this, you first have to remove the lid of the computer.

**WARNING - DANGEROUS VOLTAGES: BEFORE REMOVING THE COVER OF THE COMPUTER, ENSURE THAT THE POWER IS SWITCHED OFF, AND THE MAINS PLUG REMOVED FROM THE SUPPLY.**

Follow this procedure to gain access to the keyboard links:

1. Remove the two screws in the back panel.
2. Remove the two screws on the underside of the computer, near the front, and carefully remove the lid.
3. Remove the keyboard.

Figure 9 shows the keyboard links.

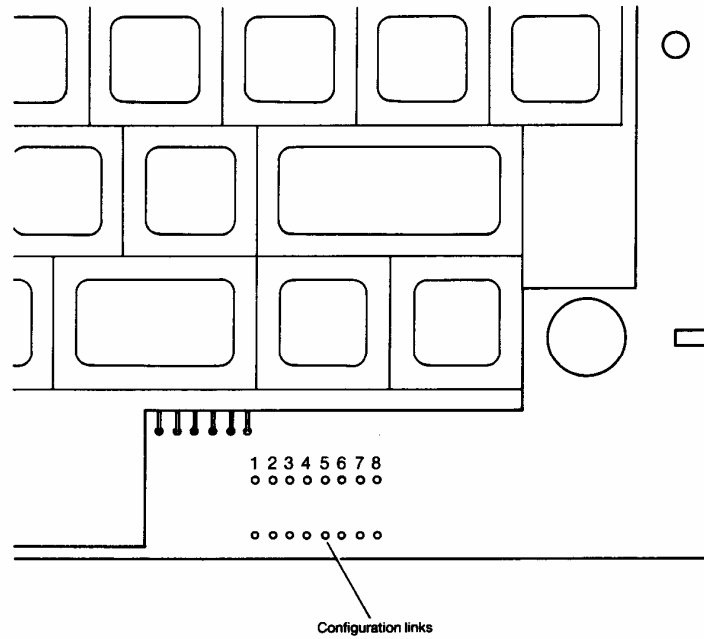
There are two links which you might need to wire up:

- Link 5 - when made, this link causes BREAK to act as SHIFT BREAK and vice-versa.
- Link 1 - when made, this link causes the default filing system at reset to change from DFS to NFS (assuming that the machine contains a DNFS ROM).

## **4.5 Setting up a Master 128 or Compact station**

### **4.5.1 Fitting an Econet interface**

The Econet interface for the Master 128 and Master Compact is supplied as a module that should be fitted inside the computer case. A ROM (Read Only Memory) containing the Econet interface programs is also supplied, which should also be fitted internally. Fitting instructions are supplied with the interface, but if you are not sure how to do this, your supplier will fit these components for you.



**Figure 9: BBC Model B Keyboard links**

#### 4.5.2 Connecting to Econet

Connect the station to Econet, using a lead with a 5 pin DIN connector plugged into a network socket box or terminator box and switch on.

#### 4.5.3 Setting the station number

**Note:** This information will be of interest to users of existing networks. The utilities mentioned are supplied with FileStore E01 and E01S units, and their use is described in the *FileStore Network Manager's Guide*, also supplied with FileStore.

A 5.25" floppy disc is available, reference ADJ2S, from your Acorn dealer. It contains utilities to help you to set the station number.



When you first turn the station on, you will probably get a display that includes the words:

#### **Badly configured station number**

This message is to remind you to set a suitable station number for the new unit. Each station on a network segment must have a different number, to distinguish it from all other stations and FileStore units. To make this easier, keep a record of all station and segment numbers used, using forms similar to the ones in Appendix D.

On the Master 128 and Master Compact computers, the station number is held in non-volatile memory and set up using a utility program stored on the FileStore or fileserver, as follows.

To set the station number:

- Log on as *SYST* at the station
- Type: \*LIB \$.Library1 RETURN to select the correct library
- Type: \* SET ddd RETURN where ddd is the station number you wish to set, in decimal notation
- Reset the station and try to log on

If you have set the station number to the same one as another station or FileStore unit which is connected and turned on, you may get a message such as:

#### **Net error or Not listening**

In this case, disconnect the other station from Econet or turn it off, change its station number to an unused one and reset it, then reconnect or turn on the other station and try to log on again.

The **SET** command is stored in the directory **\$.Library1** on each of the discs supplied with the FileStore. This command is designed to be used only by the Network Manager. You should therefore be careful to ensure that other users are not allowed access to this program, for example by setting the access to LR (see the *FileStore Network Manager's Guide*, Restricted access, Chapter 2).

#### 4.5.4 Setting other station parameters

Most characteristics of network stations are set by users to suit their own preferences, using the **Control Panel** program or \*CONFIGURE command, which are explained in the computer's user guides.

You may need to set the following:

- File server number (\*CONFIGURE FS [ddd] .ddd ) - set to the file server station number; where ddd is the station number and [ddd] is the network segment number, in decimal notation, up to 254.
- Printer server number (\*CONFIGURE PS [ddd.] .ddd ) - set to the printer server station number; where ddd and [ddd] are defined as above.
- Default filing system ROM number (CONFIGURE FILE n) - where n = the default filing system type, as follows:
  - 8 = ANFS
  - 13 = ADFS
  - 9 = DFS (Use the command \*ROMS to determine in which position your filing systems are located.)

CONFIGURE PRINT 4 (network printer)

CONFIGURE BOOT (autoboot with BREAK)

CONFIGURE NO BOOT (autoboot with SHIFT + BREAK)

Certain other characteristics should only be set by the Network Manager. These control how the station's memory is used in network operations (to minimise problems when using programs designed for the Model B BBC computer memory map) and which library the station will use.

To set these options:

1. Log on as **SYST** on the station
2. Type: CHAIN "\$.UTILS.SETSTATION" RETURN

and follow the instructions given on the screen. As a minimum, you should normally select the 'Findlib' option, to make sure that the station selects the correct library when a user logs on.

## 4.6 Setting up an Archimedes station

### 4.6.1 Fitting an Econet interface

The Econet interface for the Archimedes computer is supplied as a module which should be fitted inside the computer case. The ROM (Read Only Memory) which is also supplied, should be discarded, as the programs required are built into the Archimedes. Fitting instructions are supplied with the interface, but if you are not sure how to do it, your supplier will fit it for you.

### 4.6.2 Connecting to Econet

Connect the station to Econet, using a lead with a 5-pin DIN connector plugged into a network socket box or terminator box and switch on.

### 4.6.3 Setting the station number

The Archimedes operating system modules (Econet) include the utility SetStation. This is called from the \* prompt by typing `SETSTATION`.

When you first tam the station on, you will probably get a display that includes the words:

#### **Badly configured station number**

This message is to remind you to set a suitable station number for the new unit. Each station on a network segment must have a different number, to distinguish it from all other stations and FileStore units. To make this easier, keep a record of all station and segment numbers used, using forms similar to the ones in Appendix D.

On the Archimedes computer, the station number is held in non-volatile memory and set up using the utility program mentioned above, as follows:

To set the station number:

- Log on as **SYST** at the station
- Type: `*LIB $ .ArthurLib RETURN` to select the correct library
- Type: `*SETSTATION ddd RETURN` where `ddd` is the station number you wish to set, in decimal notation, in the range 1 to 254
- Reset the station and attempt to log on

If you have set the station number to the same as another station or FileStore which is connected or turned on, you will get a message such as:

**Net error or Not listening or Station name not found**

Disconnect the other station from Econet or turn it off, change its station number to an unused number and reset it, then reconnect or turn on the other station.

The **SETSTATION** command is stored in the library **\$.ArthurLib**. It is designed to be used only by the Network Manager. You should therefore be careful to ensure that other users are not allowed access to this program (see *FileStore Network Manager's Guide*, Restricted access, Chapter 2)

#### 4.6.4 Setting other station parameters

Most characteristics of network stations are set by users to suit their own preferences, by using the **\*CONFIGURE** command, which is explained in the computer's user guides.

You may need to set the following:

- File server number (**\*CONFIGURE FS** ) - set to the file server station number or (disc) tide.
- Printer server number (**\*CONFIGURE PS** ) - set to the file server station number or Econet printer server name.
- Library option (**\*CONFIGURE LIB** ) - set to select the Archimedes library (**\$.ArthurLib** ) automatically.
- **\*CONFIGURE PRINT 4**

See the user guides for details.

## 5. Econet servers

This chapter briefly describes the main characteristics of the file servers, printer servers and FileStores that may be connected to your Econet. This will help you to identify the key elements of your network and check that you have all the relevant manuals and software, especially if you are reviewing a network that has been installed for some time.

The equipment covered is as follows:

- Econet level 1 file server
- Econet level 2 file server
- Econet level 3 file server
- FileStore E01
- FileStore E20
- FileStore E01S
- FileStore E40S
- Printer server.

### 5.1 Level 1 file server

The level 1 file server is a Model B BBC Microcomputer fitted with an Econet interface and a single or dual drive 5.25" floppy disc unit.

The relevant Acorn manuals for this product are:

412,011 issue 1 *Econet level 1 file server Manager's Guide*.

This publication describes the file server installation procedure, testing the server and the workstations on the network, the daily start up procedure, managing the 'names' file and disc management.

412,111 issue 1 *Econet level 1 file server User Guide*.

This publication assumes that the installation has been completed and tested. It describes how to use the file server, name files, display the contents of the disc, and the use of the commands, discs and drives.

The level 1 file server may be connected to Econet through a socket box or a terminator box, in the same manner as a workstation. The network will support any combination of stations, file servers or printer servers, up to a maximum of 254 units.

The level 1 file server is for use with BBC Model B microcomputers only, and provides shared access to files stored on the floppy disc(s).

The level 1 server provides only very rudimentary services, allowing users to save, load and catalogue files. The server does not support any data file access, and will not support Master 128, Master Compact or later network stations. Level 1 servers may still be found in use on some sites, but in most applications they have been replaced by servers which provide a higher level of service.

## 5.2 Level 2 file server

The level 2 file server is a Model B BBC Microcomputer fitted with an Econet interface and a single or dual drive 5.25" floppy disc unit. The microcomputer is connected to a 6502 second processor, housed in a separate box. Alternatively, a Master 128 and Turbo second processor may be used. The level 2 server has a larger command repertoire than the level 1.

The relevant Acorn manuals for this product are:

412,017 issue 1 *Econet level 2 file server Manager's Guide*.

This publication describes the file server installation procedure, testing the server and workstations on the network. It includes the procedure for starting up and closing down the server, the use of the password, assigning user service, creating and deleting user directories and managing the system, discs and drives.

412,018 issue 2 *Econet level 2 and 3 file server User Guide*.

This publication assumes that the installation has been completed and tested. It describes how to use the file server, name files, display the contents of the disc, and the use of commands, discs and drives. It describes the extended command repertoire, printing, communicating with other users and filing systems.

The level 2 file server may be connected to Econet through a socket box or a terminator box, in the same manner as a workstation. The network will

support any combination of workstations, file servers (including level 1), or printer servers, up to a maximum of 254 units.

The level 2 file server provides:

- The same facilities as a level 1 server
- A 6502 second processor for faster processing
- An extended command set.

Extensions to level 1 services:

- Random access to data files
- Use of user names and passwords
- Hierarchical directory structure.

The level 2 server provides a number of extensions beyond the level 1 service. It can provide access to a maximum of 800k of storage on two 5.25" floppy discs. They may still be found in use in many applications, however where access to larger storage devices such as Winchester drives are required, the server may have been upgraded to run level 3 software. Due to the limitations on storage provided by the level 2 server, it is not suitable for use with the Archimedes range of workstations.

### **5.3 Level 3 file server**

The level 3 file server is a Model B BBC Microcomputer fitted with an Econet interface, a single or dual 5.25" floppy drive, a hard disc and a 6502 second processor. Note that the floppy disc drive is only needed to load the file server software. After installation, it may be removed and used elsewhere.

The relevant Acorn manuals for this product are:

427,501 issue 1 *Econet level 3 file server Installation Guide*

This publication describes the installation procedure for a level 3 file server, setting the file server network address, installing the software, assigning hard disc space, updating an existing file server and checking the operation of the network after the installation. There are also some comments on the preparation of the system for users and copying files. An overview of the VIEWDATA system is included.

427,500 issue 1 *Econet level 3 file server Manager's Guide*.

This publication includes the procedure for starting up and closing down the server, the use of the password, assigning user service, creating and deleting user directories and managing the system, discs and drives.

412,018 issue 2 *Econet level 2 & 3 file server User Guide*.

This publication assumes that the installation has been completed and tested. It describes how to use the file server, name files, display the contents of the disc, and the use of commands, discs and drives. It discusses the extended command repertoire, printing, filing systems and communicating with other users.

The level 3 file server may be connected to Econet through a socket box or a terminator box, in the same manner as a workstation. The network will support any combination of workstations, file servers (including level 1 or 2), or printer servers, up to a maximum of 254 units.

The level 3 file server provides the same services as the level 2, described above. The main difference between the two systems is the availability of the hard disc on level 3, which enables stations on the network to store and retrieve files on a shared hard disc drive.

## 5.4 FileStore

FileStores provide shared access to file and printer services in a similar manner to the file servers based on the BBC Model B or Master microcomputer ranges, but are dedicated, purpose-designed file servers, not requiring monitor or keyboard. The items in the range are as follows:

FileStore E01	Controller board with 64k ROM and 64k RAM Two 3.5" floppy drives, each with 0.6 Mbyte of storage.
FileStore E20	This unit is intended to be connected to E01 and contains a 20 Mbyte Winchester hard disc.
FileStore E01S	Similar to E01 except that it is supplied with an expansion socket that allows up to four Winchester hard disc units to be connected.
FileStore E405/E605	These are 40/60 Mbyte Winchester hard disc units. Up to four of these may be connected in 'daisy chain' fashion to an E01S.



The relevant Acorn manual for the products listed above is:

482,000 issue 2 *FileStore Network Manager's Guide*

This publication describes the operation, use and management of a FileStore. Installation information is contained in Appendix A and includes setting up the FileStore, attachment of the additional hard disc units, connection to Econet and the addition of a printer. The appendix also contains information about setting up the system, getting ready for the user and optimising performance.

A FileStore is connected to Econet through a socket box or a terminator box, in the same manner as a workstation. Econet will support any combination of FileStores, file servers or workstations, up to a maximum of 254 units per network.

FileStores include a network clock and termination facility, which is adequate for small networks with up to ten stations.

The FileStore is supplied with formatted floppy discs which contain a number of management and program files. FileStore implements the same user interface and commands used with level 2 and 3 file servers. The services provided are fully compatible with the previous level 3 file server.

## **5.5 Printer server**

A printer server is a Model B BBC Microcomputer Econet station, modified by the addition of a printer control EPROM and, once installed, is available to all users on the Econet network.

The relevant Acorn manual for the product is:

412,014 issue 1 *Econet printer server Manager's Guide*.

This publication describes how to convert a Model B BBC microcomputer, used as an Econet station, to a printer server by the addition of one EPROM. Information is given about setting the station number and printer. Use of the printer server is discussed, together with suggested action in case of problems.



## Appendix A. Specifications

### 5.5.1 Econet network

Type:	CSMA/CD (Carrier Sense Multiple Access with Collision Detection)
Topology:	Bus
Speed:	Baseband 200kbits/second
Maximum single network length:	500m
Maximum number of stations per network:	254
Maximum number of interconnected network segments:	127

### 5.5.2 Network stations

Several different types of network stations can operate over Econet. The list below may be expanded by the use of second processors.

Master Econet terminal	128k RAM, 64k ROM
Master Compact	128k RAM, 64k ROM
Master 128	128k RAM, 128k ROM
Master Turbo	196k RAM, 132k ROM
BBC Model B	32k RAM, 32k ROM
BBC Model B+	64k RAM or 128k RAM 48k ROM
Archimedes	512k to 4 Mbyte RAM 512k ROM
ACW 443	4 Mbyte RAM, 112k ROM

Note: All workstations listed above except the Master Econet terminal and the Acorn Cambridge workstation must be fitted with an Econet interface before they can be used on the network.

### 5.5.3 Fileservers

FileStore E01 (AEH26)	Two 3.5" floppy disc drives Printer interface: parallel Centronics 26-way IDC type Econet interface FileStore expansion bus (for FileStore E20) Automatic Econet clock and termination facility 220-250V 50 Hz AC supply
FileStore E20 (AEH27)	One Winchester drive (20 Mbytes storage) FileStore expansion socket (for connection to FileStore E01) 220-250V 50 Hz AC supply
FileStore E01S (AEH35)	Two 3.5" floppy disc drives Printer interface: parallel Centronics 26 Way Canon D-type Econet interface FileStore expansion bus (takes up to 4 FileStore E405 / E605) Automatic Econet clock and termination facility 220-250V 50 Hz AC supply
FileStore E40S (AEH36)	One Winchester drive (40 Mbytes storage) FileStore expansion bus Drive number select switch 220-250V 50 Hz AC supply
FileStore E60S (AEH37)	One Winchester drive (60 Mbytes storage) FileStore expansion bus Drive number select switch 220-250V 50 Hz AC supply
Level 1 File Server (AES20)	A Model B BBC or Master 128 Computer, with disc and Econet interfaces 40 track disc drive (80 track disc drive sales code AES23) Level 1 Software on disc Provides shared access to files stored on floppy discs Simple file transfer facilities (load, save, catalogue etc).

Specifications

- Level 2 file server (AES21) The following equipment is required:  
Master Turbo with Econet interface, 800k dual disc drive  
or  
Master 128 with Econet interface  
800k dual disc drive  
6502 second processor  
or  
BBC Model B (B+) with Econet interface  
800k dual disc drives  
6502 second processor  
File server software on floppy disc  
*Econet level 2 file server User Guide*  
*Econet level 2 file server Manager's Guide*
- Level 3 file server (AES24) The following equipment is required:  
Master Turbo fitted with Econet interface  
10 Mbyte or 30 Mbyte hard disc drive, 800k dual disc drives  
or  
Master 128 fitted with Econet interface  
10 Mbyte or 30 Mbyte hard disc drive  
800k dual disc drives  
6502 second processor  
or  
BBC Model B (B+) with Econet interface  
10 Mbyte or 30 Mbyte hard disc drive  
800k dual disc drives (only required for installing the network software, backing up files or archiving.)  
6502 second processor  
File server level 3 software on floppy disc  
Viewdata system software on floppy disc  
Battery backed real time clock module fitted with rechargeable battery  
*Econet level 3 file server Initialisation Guide*  
*Econet level 3 file server Manager's Guide*

### 5.5.4 Econet installation kits

Econet Starter kit (AEH19)	Two terminator units One clock unit, frequency selectable Power supply and connecting lead for clock unit Three socket boxes Two 1-metre cables with 5-pin DIN connectors Cable insertion tool <i>Econet Installation Guide</i>
Econet cable (AEH17)	100 metres dual twisted pair Characteristic impedance 100 ohms + 10% Mutual capacitance < 66pF/m Propagation speed > 0.5c (c = speed of light) Connection by solderless IDC sockets, 180 degrees 5-pin DIN
Econet bridge (AEH20)	2 MHz 6502 processor 8k RAM, 8k ROM Two Econet interfaces Self test mode Two 1-metre connecting leads with 5-pin DIN connectors at each end <i>Econet Installation Guide</i>
10 station lead set (AEH18)	10 5-pin DIN 'T' pieces 11 1-metre leads with 5-pin DIN connectors
Econet socket kit (AEH21)	5 socket boxes

## Appendix B. Advanced installations

### 5.6 Introduction

When working on a large network installation, there may be a need to establish links between buildings, across intervening roads or over even greater distances. There are a number of ways of making these links, depending on the distance to be covered and the budget for the project. The following guidelines assume that you want to retain the full functionality of Econet over the link, so that you can log on to network servers, transfer files, and generally use the system in the same way as you would if the file server was right next to you.

The minimum data rate that should be considered for the link is 64000 Baud. Links at lower speeds than this may be suitable for carrying traffic to terminal emulators, but are not suitable for running full Econet protocols. The following sections detail the aspects to be considered when establishing long-distance links of different types.

### 5.7 Links between buildings

**WARNING: All external wiring should be buried below ground level. Wires should not be looped above ground. Cables above ground will be susceptible to electrical interference and may attract electrical discharges. Most wiring regulations forbid the use of overhead cables without appropriate precautions. The detailing of these precautions is beyond the scope of this manual.**

The most flexible method of wiring between buildings is to install pipes or conduits with draw wires. The draw wires can be used to install cable as it is required.

If the distance to be covered is more than a few metres, the link should be set up as a separate network, with a bridge at either end. In this case, the requirement that the clock should be in the middle of the network may be relaxed - the clock should be placed within the building at one end of the link. Line terminators should also be attached at either end in the normal way. If no stations (other than the two bridges) are connected directly to the link, you should find that you can normally obtain reliable operation over distances of up to one kilometre by this method.

## 5.8 Links between sites

Where it is necessary to cross a public road, or other obstacle, it may not be possible to install your own pipe or conduit. In some cases you may find a conduit which already exists which you could use to install the cable.

As an alternative, it may be possible to hire lines from the telephone company or other authority that already has links between the two sites. In this case, you will need two twisted pair cable pairs for each Econet link. British Telecom, for example, may be able to provide such a link in the form of a pair of EPS8 lines. It must be stressed that the lines should link the two sites directly and not go via any public or private exchange or switching system.

Once you have access to the cable, you use one twisted pair circuit to carry the Econet clock signal and one pair to carry the data signals. The circuit provided may then be used to set up a network in the way described above.

As you will not be in a position to guarantee the quality of the cable in the link, you should connect each end to a bridge unit, and not attach any stations directly to the line. The link should be made as short as possible and terminated in the usual way.

## 5.9 Other types of link

Acorn Computers have some experience of linking Econets on remote sites using circuits conforming to the specifications of X21. The circuit speed must be 64000 Baud or above. British Telecom Kilostream, for example, meets this requirement. Such circuits can be used to provide communication over several miles. To link the X21 circuit into the Econet system, two modified Econet bridge units are required. Acorn Customer Support would be happy to advise on the installation of such a system.



## **Appendix C. Clock frequency settings**

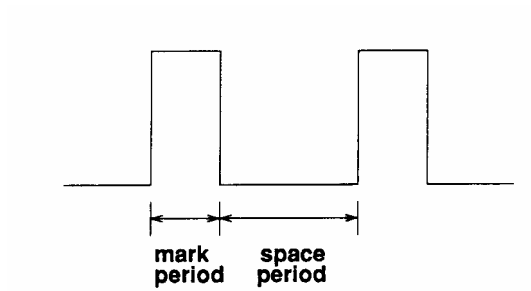
In the past, a number of tables have been published of the network speed settings that should be set in relation to the network length. You may find such tables in some of the publications referenced in this manual. It should be noted that these settings are related to networks on which the clock signal is of a symmetric square wave form. The Clock boxes described in this manual produce an asymmetric wave form as shown in Figure 10. The use of an asymmetric waveform allows the network to be run at maximum speed for all network lengths up to a length of 500m. Operating above this length is not guaranteed, because cable resistance may prevent the correct operation of the collision detection and avoidance procedure. The clock frequency is therefore limited by the speed at which the network station hardware and software can operate. The maximum operating frequency will depend on the mixture of machines that are connected to the network.

THE RECOMMENDED MAXIMUM SPEED OF OPERATION IS 200kHz.

The clock waveform should consist of a 1u second mark pulse and a second space.

Network speeds lower than this may improve reliability in installations where the signal quality is poor due to the age of the installation, the quality of the cable installation or the reliability of the interfaces in the network stations.

Operating above this frequency may be possible for some mixes of station. However, to ensure reliable operation with the widest range of machines, avoid using higher speeds.



*Figure 10: Clock waveform*

Figure 10 shows the Econet clock waveform.

The mark period may be set to  $1\mu\text{s}$  or  $2\mu\text{s}$ , using the selection links shown in Figure 11. The space period is set as a multiple of the mark period. For example, with a mark period of  $2\mu\text{s}$  and a space period of three times the mark, the overall period is  $2\mu\text{s} + 3 \times 2\mu\text{s} = 8\mu\text{s}$ . The network speed is then  $1/8 \mu\text{s}$ , or 125 kHz.

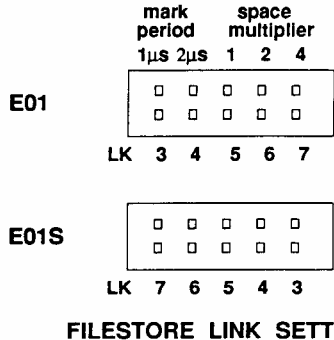
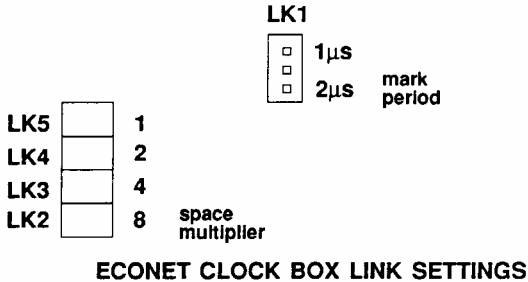


Figure 11: Clock frequency link settings



## Appendix D. Econet Record sheets

<b>FILE SERVERS</b>		
<b>Station No.</b>	<b>Location</b>	<b>Storage Capacity</b>

<b>USER STATIONS</b>			
<b>Station No.</b>	<b>Location</b>	<b>User</b>	<b>Extension No.</b>

<b>PRINTERS</b>				
<b>Name</b>	<b>Location</b>	<b>Printer</b>	<b>Use</b>	<b>Station No.</b>





## Appendix E. Bibliography

Publication number	Title
412,111 issue 1	<i>Econet level 1 file server User Guide</i>
412,018 issue 2	<i>Econet level 2 and 3 file server User Guide</i>
412,019 issue 1	<i>Econet Advanced User Guide</i>
412,011 issue 1	<i>Econet level 1 file server Manager's Guide</i>
412.017 issue 1	<i>Econet level 2 file server Manager's Guide</i>
427,500 issue 1	<i>Econet level 3 file server Manager's Guide</i>
427,501 issue 1	<i>Econet level 3 file server Installation Guide</i>
482,000 issue 1	<i>Econet FileStore Network Manager's Guide</i>
412,014 issue 1	<i>Econet printer server Manager's Guide</i>

These publications are obtainable from approved Acorn dealers, although the older ones may be out of print, and availability will depend on existing stocks.