

**ACORN
COMPUTER**

ECONET

TEST PROCEDURE FOR ACORN APPROVED DEALERS

ECONET TEST PROCEDURE
FOR ACORN APPROVED DEALERS

INCORPORATING OPERATING INSTRUCTIONS FOR THE
ECONET MAINTENANCE AID TEST BOX

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1. INTRODUCTION

This manual describes the test procedures for ECONET systems and includes the operation and use of the ECONET Maintenance Aid (EMA).

The EMA is a portable hardware diagnostic aid for engineers carrying out on-site repairs to ECONET networks. Powered by an internal re-chargeable battery, it is especially useful for fault finding on large networks where moving bulky test equipment is inconvenient. The EMA is intended to be used with a digital multimeter and battery-powered oscilloscope. The resulting test equipment is highly mobile and not dependent on the siting of mains power supply sockets.

The information contained in this manual is aimed at ACORN dealers and service engineers who will be servicing ECONET systems on behalf of ACORN COMPUTERS LIMITED.

This manual should be read in conjunction with the ACORN ECONET **Installation Guide** (ACORN Part No. 0436,101):

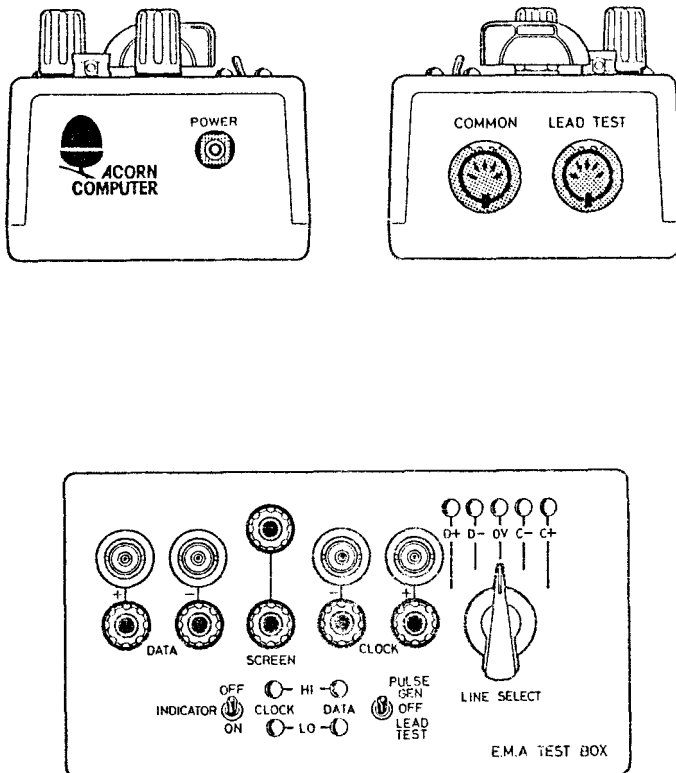


Fig: 1 EMA Test Box

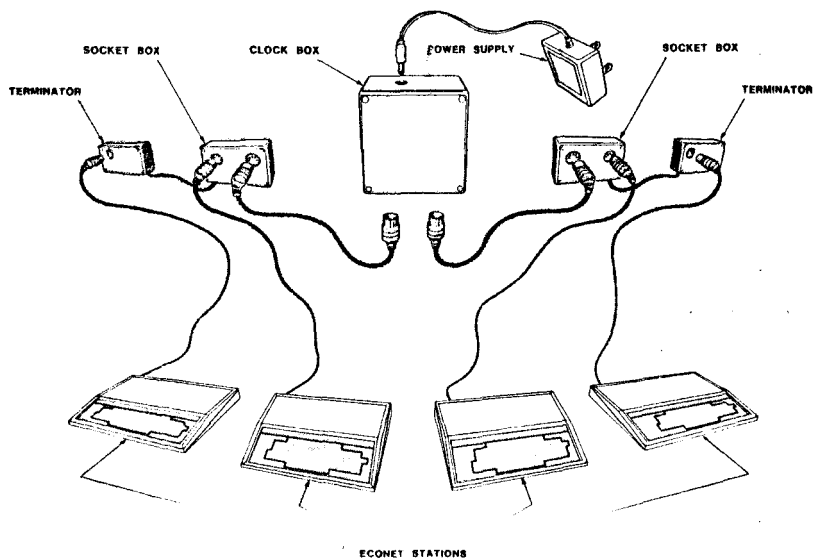


Fig. 2 Typical Permanent ECONET System with four stations

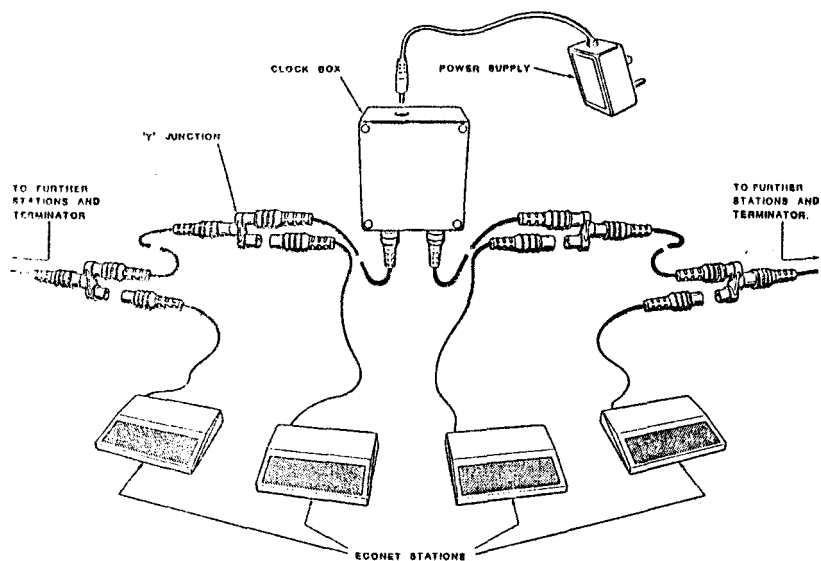


Fig. 3 Typical ECONET system using 10-station lead set (part)

2. THE ECONET SYSTEM

A local area network enabling a number of BBC Microcomputers to be connected together by cable over a total network distance of up to 500 metres.

Figure 2 shows a typical layout with four BBC model BE Microcomputers, configured as ECONET stations, connected to a hard-wired (permanent) system installation. See page 2.

One or more BBC Microcomputers, interfaced with suitable disc systems, may be connected to the system to act as File Servers providing centralised data storage.

Additionally, one or more stations may be connected to printers to provide a shared printer facility for all stations on the network. Designated Printer Servers, these machines are also available for use as a normal user station.

A typical permanent ECONET system comprises:

A Clock Box with Mains Adapter, positioned on or about the centre of the network cable.

2-off Terminator Boxes, one at each end of the ECONET network. These may be self-powered or passive. Self-powered terminators require a mains power supply and are connected to the last socket box on the network by a branch cable. Passive versions are hard wired onto the end of the network and are similar to a socket box but with one socket only.

Socket Boxes, each one capable of servicing two stations. These may be connected to the network cable by one of two methods - either by soldered connections to the sockets or by IDC push-in connectors.

ECONET network cable - twin twisted-pair plus ground, shielded. (See the ECONET Installation Guide for cable specifications).

Branch cables for connecting stations to the network, fitted with a 5-pin DIN 180° plug at each end.

Two or more ECONETS may be linked together by Bridges, thus enabling stations on different networks to communicate with each other. Bridges are self-powered units, connected to each of the two ECONETS by branch cables, as for a normal ECONET station.

Figure 3 shows part of a typical system configured using a 10 station plug-together lead set. Note that in this system the permanent network cable is replaced by 5-pin DIN branch cables; DIN-type 'Y' junctions are used for each station connected to the network instead of socket boxes. See page 2.

3: PRINCIPLE OF EMA OPERATION

The EMA test box includes three test functions:- network monitor, lead tester, and pulse generator.

3.1 Network indicator

This is an extremely useful tool especially when installing networks. The indicator displays the logic state of the Data and Clock lines. The state of the lines is displayed by back-to-back LEDs. The indicator is entirely passive and can be switched out of the Data and Clock lines to avoid interference with reflection or resistance tests.

3.2 Lead Tester

This enables cables to be conveniently tested for shorts, open circuits, or crossed wires. The lead tester checks one wire at a time including the screen connection. The wire under test is selected by a rotary switch. A good connection is indicated by the corresponding LED lighting.

3.3 Pulse generator

This is used to locate an open circuit, short circuit, or a low impedance device connected to the network. The pulse generator is mainly used to locate faults that exist in inaccessible parts of a network - e.g. underground cables, locked rooms, ducting etc. Pulses are placed onto any wire selected by the rotary switch. By observing the nature of any reflections on the network with an oscilloscope it is possible to locate the position and nature of the fault.

4. EQUIPMENT REQUIRED

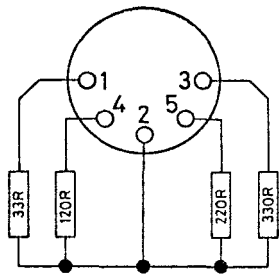
EMA test box

ECONET Mains Adapter (supplied with EMA) - for re-charging internal EMA battery as required.

Multimeter + two leads fitted with 4mm plugs

Battery powered oscilloscope + 2 BNC to BNC leads

DIN plug fitted with resistor network - see Fig.4 below



All resistors $\frac{1}{4}$ Watt

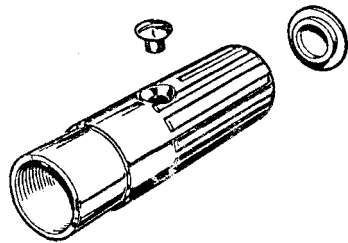
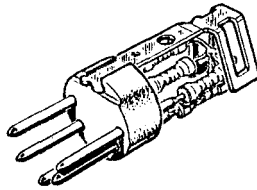


Fig. 4 DIN Plug fitted with resistor network - detail

5. USING THE EMA

5.1 Network indication

To monitor the Data and Clock lines with the Indicator, plug one end of a DIN cable into the socket marked COMMON and the other end into the network; turn the Indicator, switch to ON. When the network is idle, both the Clock LEDs should be on and the Data LEDs should be off. With later Clock2 boxes, if the CLOCK+ LED is brighter than the CLOCK- LED, this indicates that the mark-space ratio of the clock signal is not 1:1. With traffic on the network the Clock LEDs should stay on and both the Data LEDs should pulse on and off. After use it is recommended to disconnect or switch off the Indicator as it will load the network slightly.

5.2 Lead testing

Plug one end of the cable under test into the COMMON socket of the test box and the other end into the LEAD TEST socket. Select the Lead Test function; ensure that the Indicator is switched OFF. Switch the rotary switch through all five positions and ensure that only the corresponding LED lights up. A short will cause more than one LED to light, with an open circuit no LED lights, and crossed wires cause the wrong LED to light.

The Lead Test can also be used to check a Socket Box for continuity. Using two branch cables, known to be good, connect one cable between the EMA COMMON socket and one socket on the Socket Box. Connect the other cable between the second Socket Box socket and the EMA LEAD TEST socket. Proceed as above.

5.3 Network resistance testing

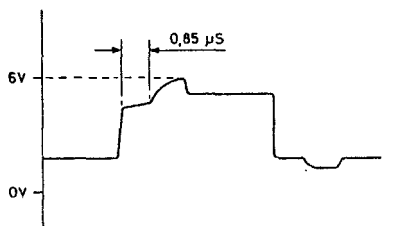
On long networks where it is inconvenient to provide a return path for the Lead Test the network can be checked as follows: Disconnect all stations, the clock and any self-powered terminators from the network.

On networks using the CLOCK2 clockbox, plug one of the DIN plugs formerly connected to the clock into the LEAD TEST socket of the EMA. Plug the DIN plug fitted with resistors into the furthest socket box on that half of the network. Select the Resistance Test function on the multimeter; plug one meter lead into the SCREEN socket of the EMA box and the other lead successively into DATA+, DATA-, CLOCK-, and CLOCK+. Ensure that the resistance measured is within the range 30-90, 100-130, 200-230 and 300-390 Ohms respectively. Repeat for the other half of the network.

On other networks, disconnect as above; plug the resistor plug into one end of the network and a branch cable between the socket lox at the other end of the network and the LEAD TEST socket of the EMA. Proceed as above:

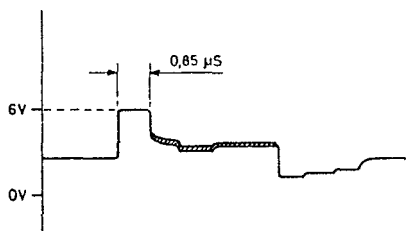
5.4 Reflection testing

To determine the distance to some form of impedance mismatch, unplug the clock box and connect the COMMON socket of the test box to the clock box end of one half of the network. Plug the oscilloscope into any one of the BNC connectors of the EMA box. Select the PULSE GEN function and place the pulses onto the desired wire with the rotary switch. Observe the resulting pulses on the network using the oscilloscope; note that any reflections will be small because of the clamping effect of the line driver in the test box. The most usual fault conditions are open circuit, as shown in Fig: 5, and short circuit, as shown in Fig. 6.



WITH TERMINATOR AT SOURCE
CABLE LENGTH: 84M
OPEN CIRCUIT AT END OF
CABLE

Fig 5. Open circuit - typical oscilloscope trace



WITH TERMINATOR AT SOURCE
SHORT CIRCUIT TO GROUND AT
END OF CABLE
CABLE LENGTH 84M

Fig 6: Short circuit - typical oscilloscope trace

To find the distance from the EMA box to the fault, measure the cycle time of the reflected pulses. This measurement is best made by timing a number of cycles and dividing by the number of cycles. The formula for calculating the distance to the fault is as follows:-

$$\frac{\text{Cable velocity} \times \text{Cycle time}}{2}$$

The factor of two in the expression is to allow for the time there and back. The cable velocity can be found from manufacturers' data (typically 0.66c for ACORN approved cable) or by calibrating a known length of cable.

5.5 Battery recharging

The internal battery of the EMA box may be trickle-charged by connecting it to the 12v AC ECONET Mains Adapter supplied: The battery should be fully re-charged within approximately 8 - 10 hours. The EMA should not be used for testing with the Mains Adapter connected.

6. FAULT DIAGNOSIS

The most common faults that appear on networks are as follows:-

Newly installed network:

- Faulty DIN cables
- Short/open circuit/crossed wires in the network
- Stations not plugged into the network
- Terminators or clock not plugged in and switched on
- Duplicated station number
- Clock speed too fast or too slow
- Bad device connected to network - e.g. cassette socket

In service network:

- Faulty DIN cables
- Faulty station
- Duplicated station number
- Faulty terminators or clock
- Bad device connected to network - e.g. cassette socket
- Bridge fault

A fault on the network is indicated by a message being displayed, e.g.:

Message	Error No.	
NW LISTENING	162	NB Error numbers are not shown as part of the error message, but are invariably used to trap errors in software applications
LINE JAMMED	160	
NET ERROR	161	
NO CLOCK	163	
NO REPLY	165	

These are the most likely to occur in relation to actual network or user station faults. Some of them may also appear as the result of File Server or Printer Server faults.

File Servers and Printer Servers also generate their own error messages in addition to those listed above - for details see the relevant Manager's Guide. Note that these errors are directly related to the File Server or Printer Server and their peripherals - not the network.

The diagnostic flowcharts given in the Appendix should be read in conjunction with the following notes:

6:1 GENERAL NOTES

6.1.1 Two User Stations with the same ID number.

If this is suspected, log off and power-down one of the suspect stations and then attempt to *VIEW the other one from another station. If there are two or more stations with the same number, the numbers must be changed. See 'Setting the User Station Identity' in the Appendix.

6.1.2 Clock Speed

This should be checked on new installations and if the clock function is suspect. To determine whether the clock speed is suitable, refer to page 9 in the ECONET Installation Guide. Note, however, that in some instances the network may appear to function correctly on all but one or two user stations connected towards the centre of the network. When attempting to access another station, the station in question may either 'hang-up', giving no error message, or give the NET ERROR message. This is indicative of an incorrect clock speed - usually too fast (ie the clock signals are out of phase at these stations).

6.1.3 The Network Monitor Utility program supplied on File Server discs can be usefully employed when trying to locate a machine causing LINE JAMMED errors - see page 32 in the ECONET Advanced User Guide. It is also helpful in diagnosing a system which, though operating, appears to be slow and unreliable.

6.1.4 File Servers and Printer Servers

The default station ID number for the File Server is 254 and the number for the Printer Server is 235. If the numbers differ from these, change them as detailed in the Appendix. If there are two or more File Servers or Printer Servers, they should each have different ID numbers, though it is recommended that one File Server is set to the default number 254 and one Printer Server to 235:

6.1.5 Note that a Printer Server which is also being used as a user station cannot print via the network. In practice, this means that printing from the Printer Server is as for a stand-alone machine with local printer, ignoring the presence of the Printer Server software. Note that the software must be re-initialised in order to return to the Printer Server function.

6.2 ERROR MESSAGES

6.2.1 NOT LISTENING - This message may occur when any Network Filing System command is executed, and means either that the machine to which the command is directed is not attached to the network, or is not interested for some reason. For example, trying to save a file on a network without a File Server, or when the File Server program is not running, will produce the NOT LISTENING message.

6.2.2 LINE JAMMED - This message is returned if there is either continuous information on the data lines, or the data lines are tied high or low, preventing other stations from transmitting. This may be due to a fault in another station, the

clock, one (or both) of the terminators, or the network cable, though note that it is possible that external electrical interference may be introduced into the system.

6.2.3 NET ERROR - This message is returned if an error occurs during transmission. It may be due to an unsuitable clock speed for the network, a fault in the terminators or a fault in the network cable.

6.2.4 NO CLOCK - This message is returned if the ECONET interface in the user station cannot detect a valid clock signal. After checking that the user station is plugged into the network, the problem will probably lie in the clock box or in the clock lines of the network cable.

6.2.5 NO REPLY - is returned if the remote station is communicating with the local station and the transfer of data has begun but, for some reason, the remote station is unable to complete the requested task. If the station that is not replying has a peripheral attached, it could be that the peripheral is not connected to the server, not powered up or not initialised.

7: NETWORK FAULTS

When all else has failed and an error persists, the fault most probably lies in the network cabling - either a short circuit, an open circuit or crossed wires. The fault-finding methods employed vary according to the type of network.

7.1 For 10 station plug-together lead sets, proceed as follows:

Break down the network and check each lead and junction using the EMA Lead Test described in section 5.2. Test junctions by inserting them between two known good leads connected to the EMA; transfer the junction-end of one of the leads to the third junction socket to complete the test.

Rebuild the network, replacing any faulty leads or junctions with known good ones. Re-test the network.

7.2 For permanent installations, proceed as follows:

7.2.1 Disconnect all stations from the network socket boxes except one user station.

7.2.2 Connect the EMA COMMON socket to a socket box on the network. Connect an oscilloscope to the BNC CLOCK+ socket on the EMA and check that the clock waveform is as in Fig. 7. The clock speed should also be checked - see section 6.1.2.

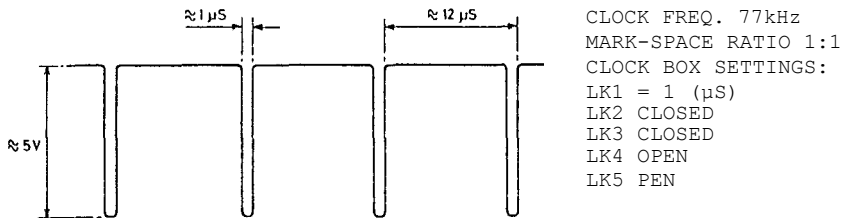


Fig. 7 Typical clock waveform
(at a point on the network close to the clock box)

7.2.3 Repeat this check for the Data lines ensuring the Data waveforms are as in Fig. 8. Traffic can be put onto the network using the following program running on the user station connected to the network:

```
1 ON ERROR
2 *CAT
3 GOTO 2
```

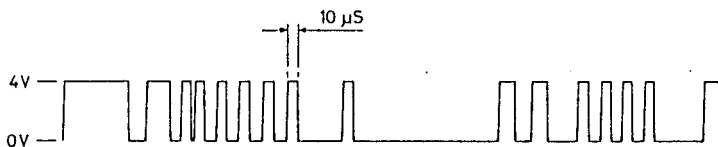


Fig. 8. Typical. Data waveform
(close to the transmitting station)

7.2.4 Check the branch cables on the user station, the clock box, and the terminators (where appropriate) using the EMA Lead Test. Replace any faulty cables and check the waveforms again. Failure to locate the problem indicates a fault in the actual network wiring itself. Remove the clock, two terminators (where appropriate), and the user station.

7.2.5 Connect the resistor DIN plug to one end of the network.

Start at the resistor DIN plug end of the network and make resistance measurements as detailed in section (5.3) on all the network outlet sockets.

An open circuit can be found easily by a sudden increase in resistance when going to the next socket. A short circuit will give a low resistance reading and is located using the ohmmeter on a low range:

MOTE: With a Clock2 box removed, the network is now split into its two halves; check each half in turn, as above

7.2.6 If parts of the network are inaccessible then the fault location can be found using the Reflection Test PULSE GEN function and an oscilloscope as detailed in section 5.4.

7.2.7 NOTE - permanent installations using soldered connections to socket boxes may cause network faults as a result of dry-joints, solder-spikes or insufficient screening, or cable pairs which have been untwisted too far from the soldered connections.

8: STATION FAULTS - BBC MICROCOMPUTER MODELS A & B

If during the preceeding checks you have discovered a faulty station, it may be the case that the machine is incorrectly configured. In the event that you are short of equipment and a replacement machine is not available it may be possible to locate the problem with a visual check. Ensure that the machine is unplugged from the mains supply and the network and remove the lid. Check the following:

8.1 Check that there is, in fact, an ECONET interface in the machine:

8.1.2 Ensure that an NFS or DNFS ROM is fitted.

8.1.3 Check that the top left hand corner of the board is populated, in particular that IC89, the 68B54 ADLC chip, is present.

8.2 Check that link S2 on the left hand edge of the main PCB is cut.

8.3 Locate link S9 which is to be found slightly below and to the left of the words ACORN COMPUTERS. This link should be made if IC78 (located directly below the words ACORN COMPUTERS) is NOT present. The link should be cut if IC78 IS present.

8:4 For the purpose of this section North is taken to mean the back of the machine and South is the front of the machine under the keyboard. Check the following links, although they should have been correctly set during production. The term OPEN means that NO CONNECTION IS MADE across the link. If a compass bearing is indicated it implies a three-pin link running either north to south or east to west. Therefore to set a link NORTH the connector should be placed across the top and middle link of three vertical pins.

The links should be set as follows:

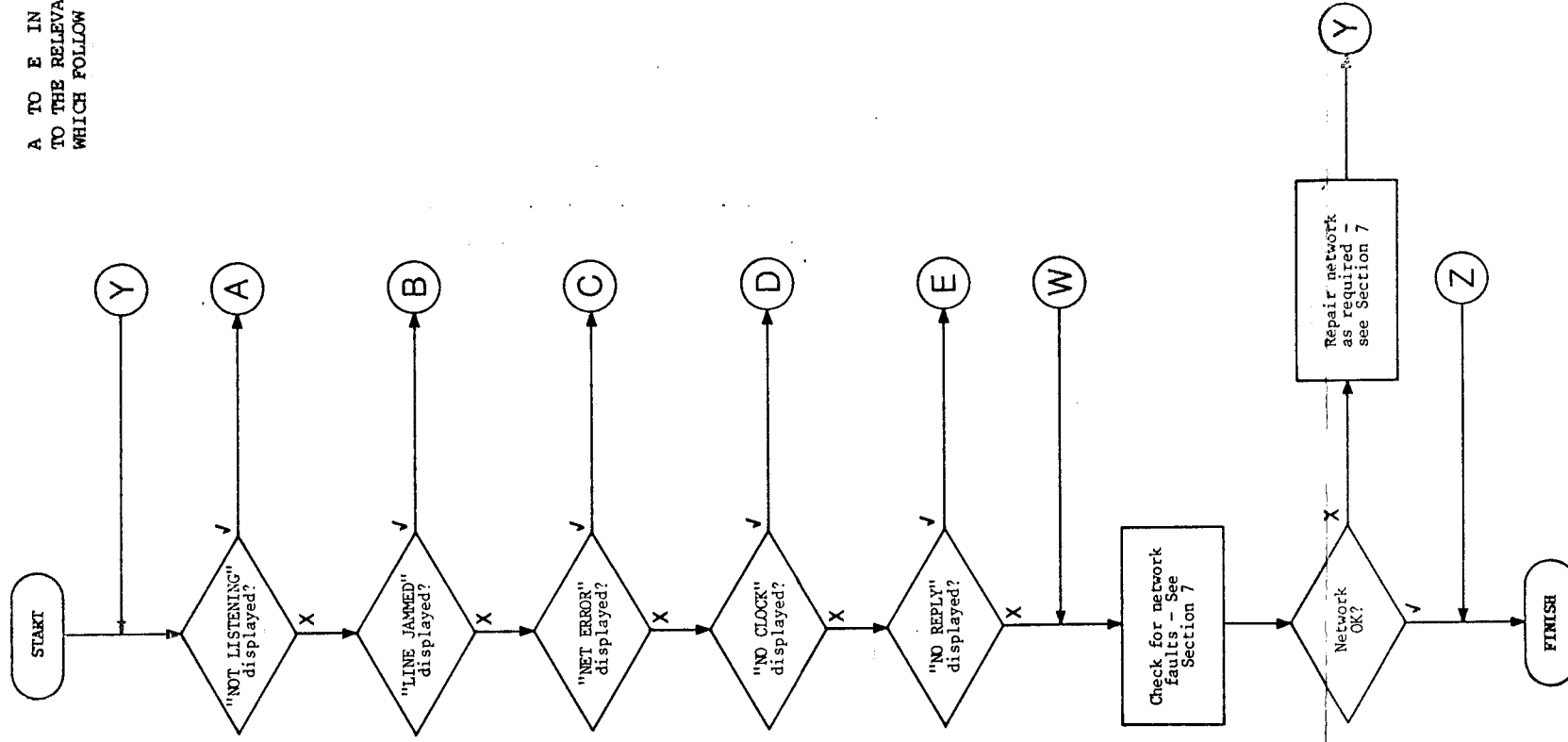
S5	SOUTH
S12	OPEN
S13	OPEN
S18	NORTH
S19	EAST
S20	NORTH
S21	2 x EAST-WEST
S22	NORTH
S32	WEST
S33	WEST

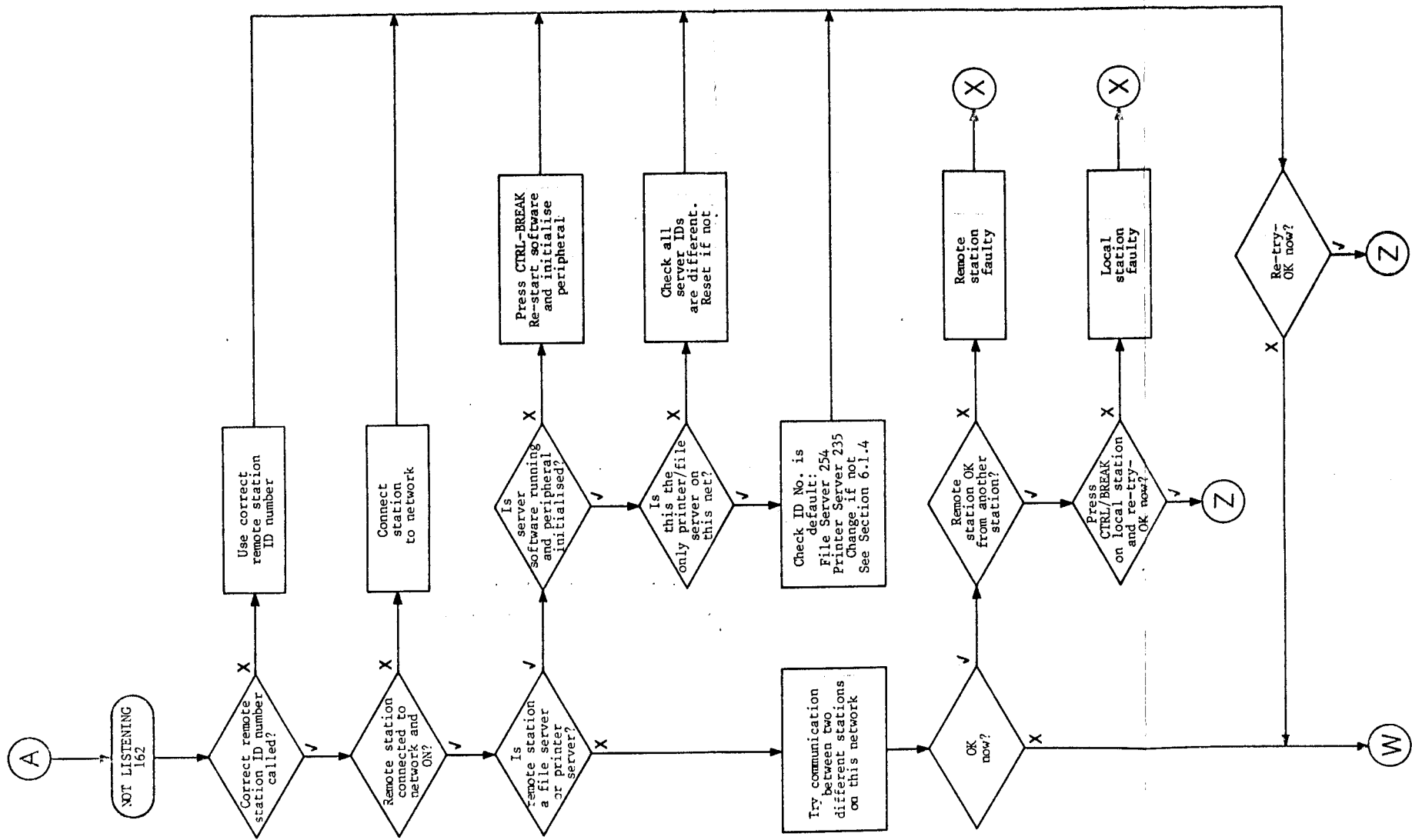
When all the above checks have been completed, the machine should be reassembled and re-tried on the network. If the machine still fails to function correctly it should be returned for repair -see the BBC Microcomputer Service Manual.

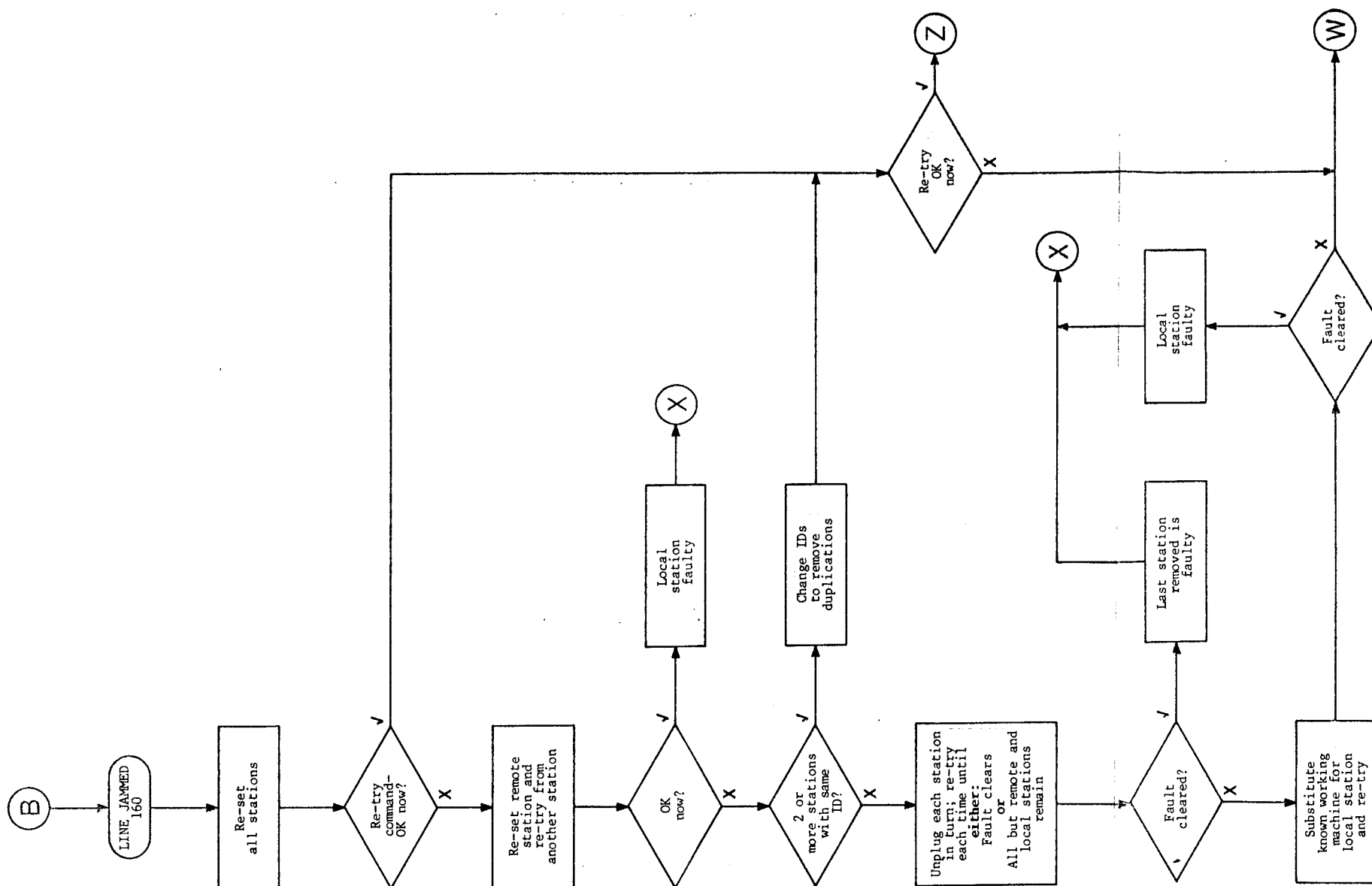
APPENDIX

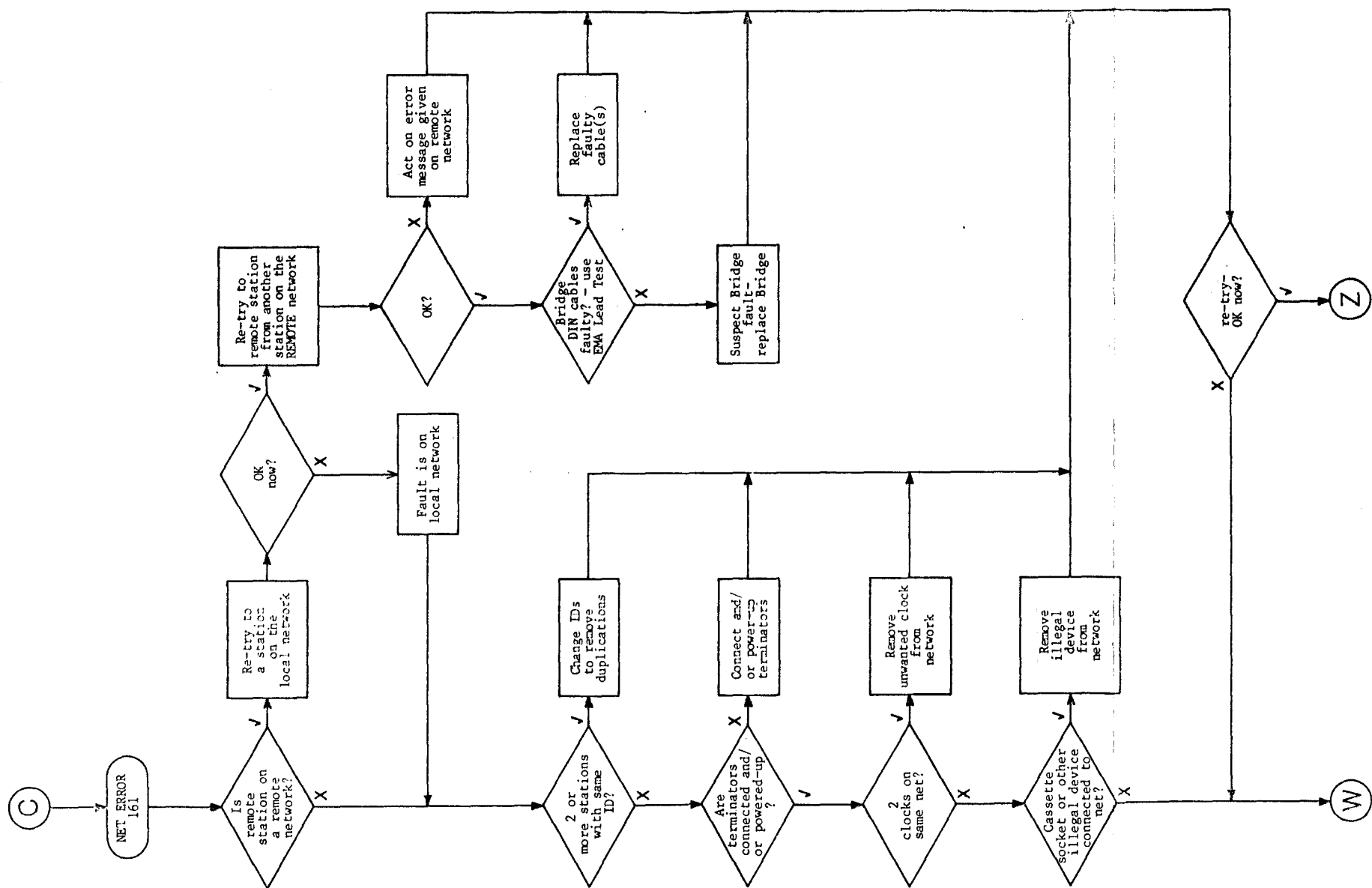
MASTER DIAGNOSTIC FLOWCHART

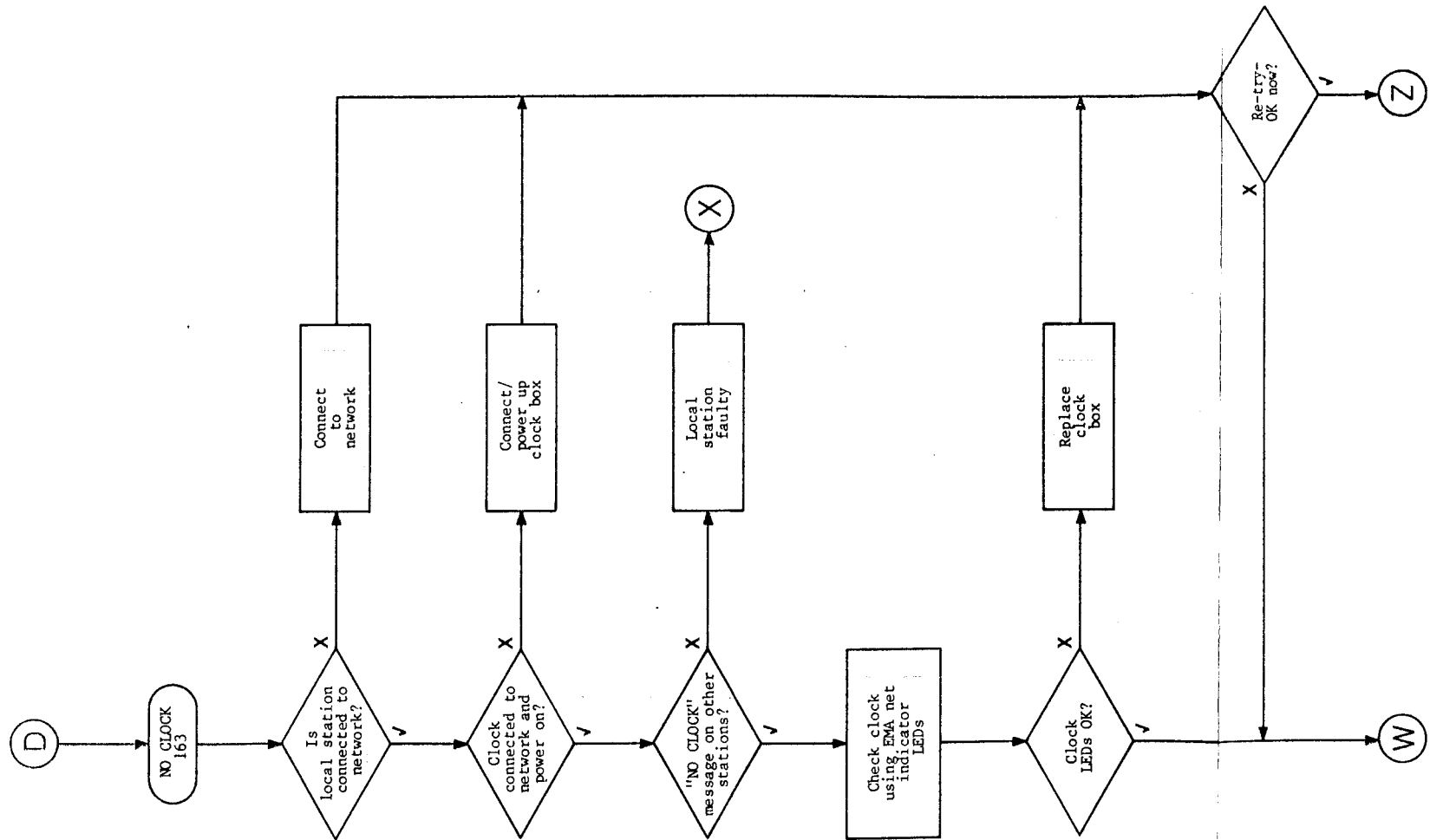
A TO E IN CIRCLES REFER
TO THE RELEVANT FLOWCHARTS
WHICH FOLLOW

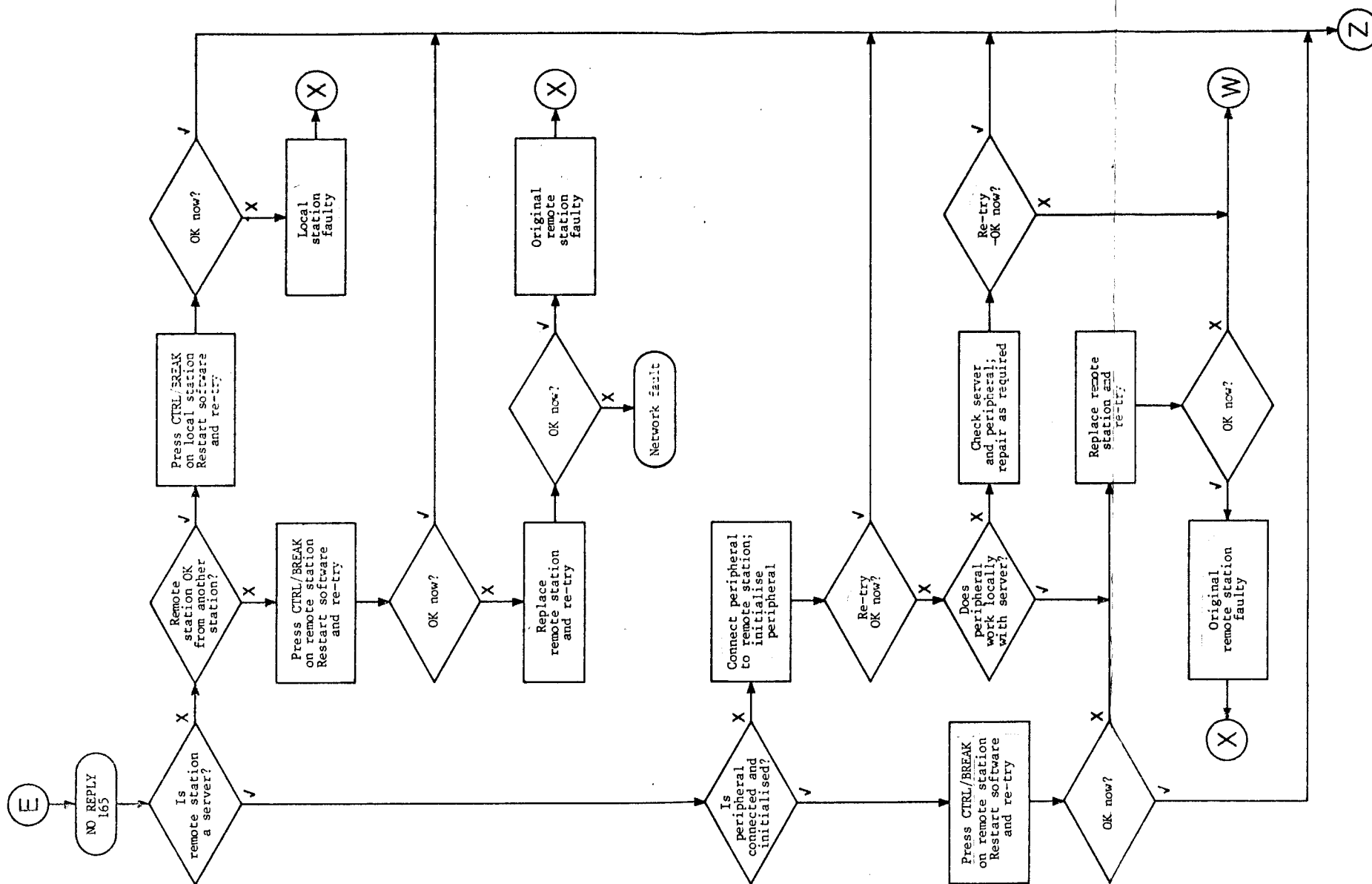


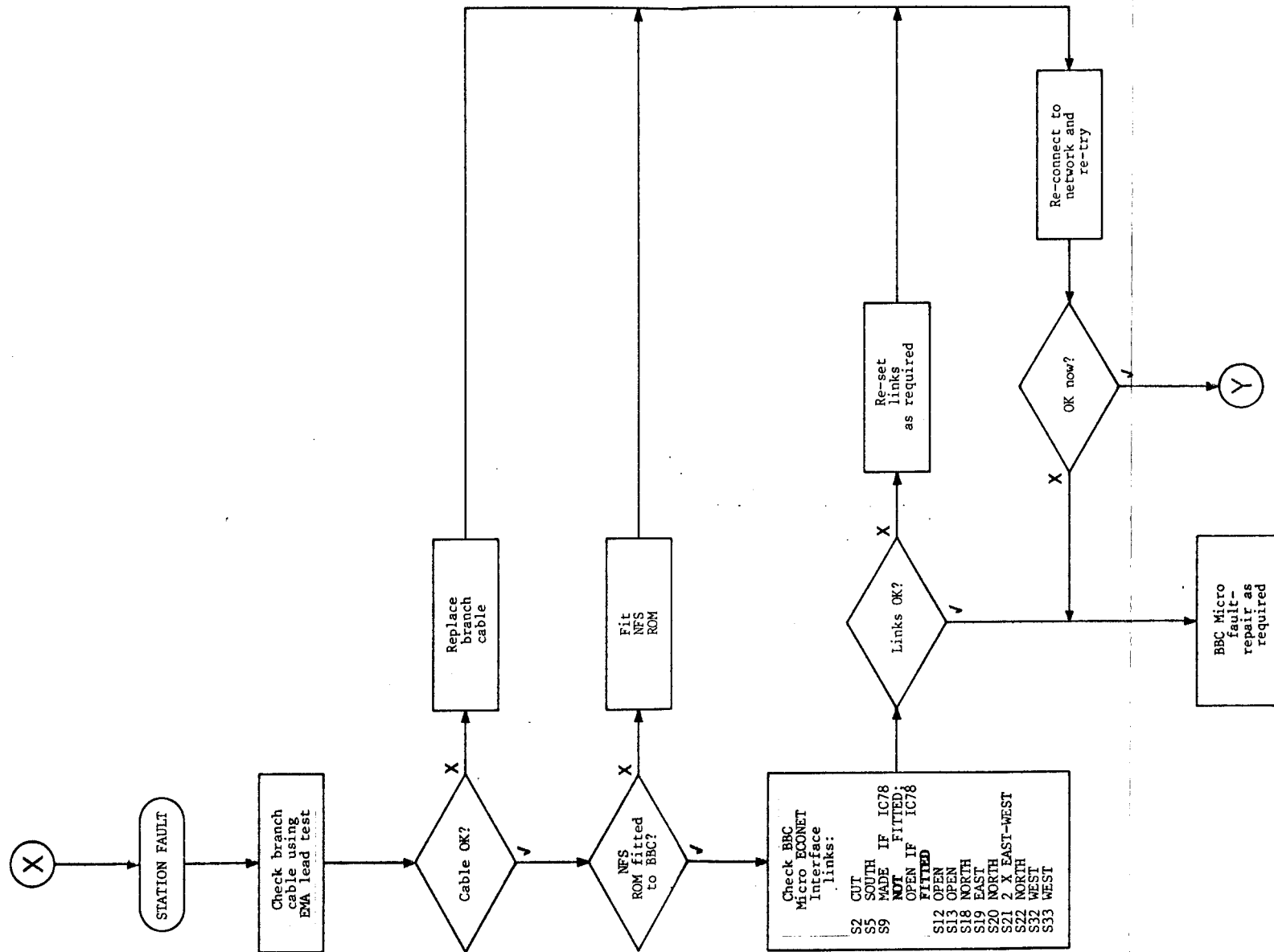


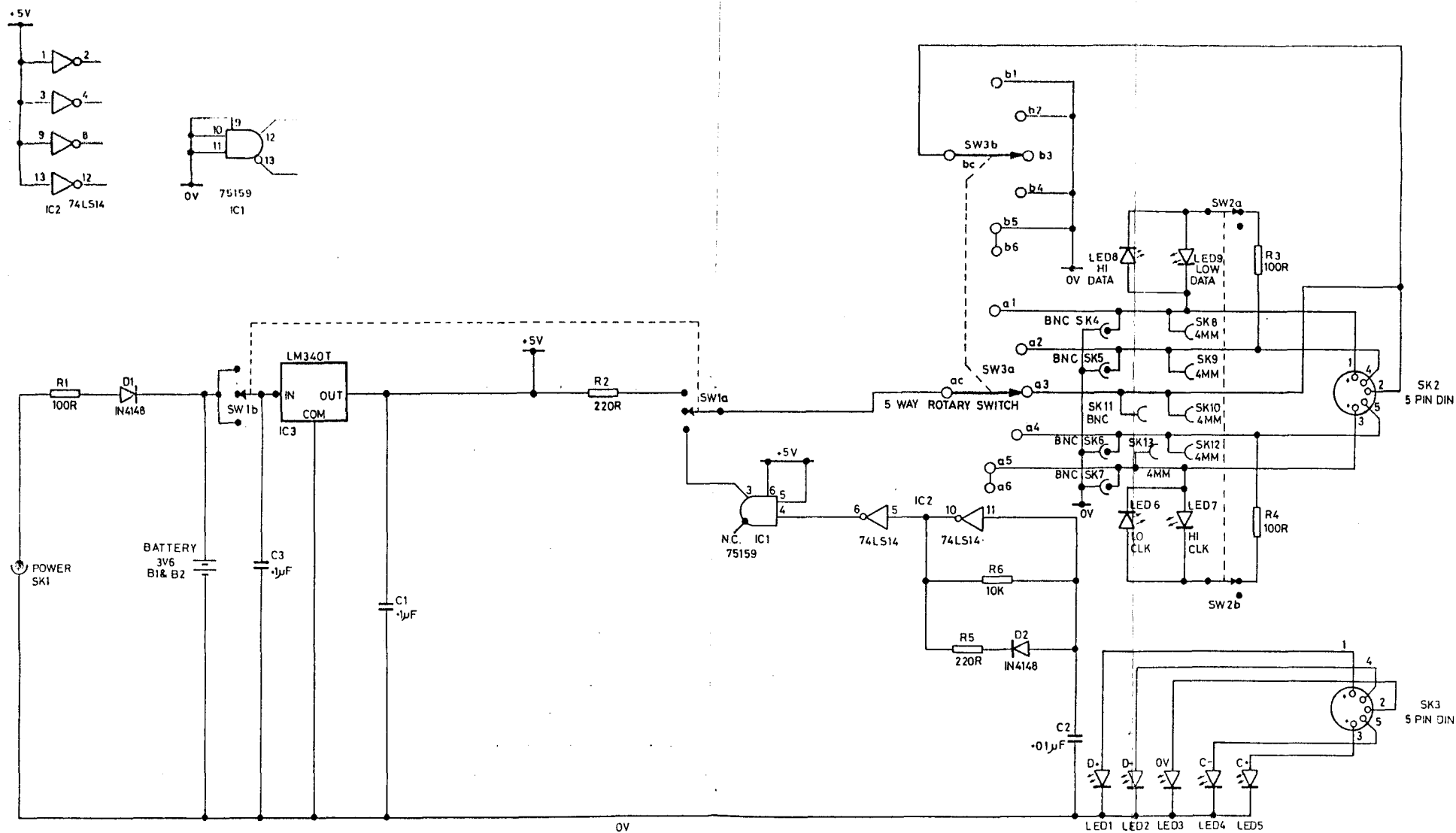












EMA Test Box Circuit Diagram

SETTING THE USER STATION IDENTITY

Throughout this manual, a user station is defined as a BBC Microcomputer model BE or BDE incorporating an ECONET interface. Models A or B may also be fitted with the ECONET interface as an upgrade. All ACORN BUSINESS COMPUTER (ABC) models incorporate ECONET as standard and may be regarded as normal User Stations from an operational viewpoint.

The exact method by which the User Station identity is set depends on whether it is a BBC Microcomputer or an ABC. This appendix describes these differences.

Setting a BBC Microcomputer's Station Identity

In BBC machines fitted with an ECONET interface, there is a row of eight links in the top left-hand corner of the printed circuit board, marked S11. To gain access to these links, disconnect the BBC Microcomputer from the mains supply and remove the lid by unscrewing the four fixing screws; two of these are located at the rear of the case and the other two are on the underside of the case at the front (they may also be identified by the word "FIX").

The links form an 8-bit binary number representing the computer's station identity. The least significant bit is the top link; the most significant bit is the bottom link. If a link is made, the bit is zero; an unmade link implies a one bit. As an example, to obtain station number 240 ($128+64+32+16$), links 0, 1, 2 and 3 should be made and the rest unmade (counting the top link as number 0). This is shown in Fig. 9.

Setting an ABC's Station Identity

To gain access to the ECONET links on an ABC, it is necessary to partially dismantle the processor unit.

THE FOLLOWING MUST BE ONLY BE CARRIED OUT BY AN AUTHORISED DEALER OR ACORN BUSINESS CENTRE - NOT THE CUSTOMER.

WARNING - HIGH VOLTAGE HAZARDS EXIST WITHIN ABCs

ALWAYS UNPLUG THE ABC FROM THE MAINS SUPPLY BEFORE REMOVING THE UPPER CASE: DO NOT WORK ON AN ABC WHICH IS POWERED-UP, WITH THE UPPER CASE REMOVED, UNLESS ESSENTIAL.

HIGH VOLTAGES MAY REMAIN WITHIN THE MONITOR CIRCUITS AND THE ABC PSU FOR SEVERAL HOURS AFTER THE MAINS SUPPLY HAS BEEN DISCONNECTED. OBSERVE ALL SAFETY PRECAUTIONS WHEN WORKING ON AN ABC.

UNDER NO CIRCUMSTANCES SHOULD THE MACHINE BE LEFT UNATTENDED WITH ITS UPPER CASE REMOVED IN THE PRESENCE OF UNQUALIFIED PERSONNEL:

Cable ties are used to secure internal wiring in a safe manner.

Always ensure that any cables disturbed for service are replaced in their original positions and replace any cable ties which have been removed:

The ABC ECONET links are located on the Control PCB, positioned in the lower case of the ABC. To gain access to these links, proceed as follows (see Fig: 10>:

Unplug the ABC from the mains supply:

To remove the upper case assembly, remove the screws and clip covers and undo the two over-centre clips at the rear of the machine, securing the upper case to the lower case at the extreme edges of the rear panel. Lift the rear of the upper case upwards a little and then forwards; ease the screen mask forward to clear the disc drive(s) (where fitted). Now lift the upper case clear of the machine.

The PSU, monitor, disc drives(s) (where fitted) and power distribution board are mounted on a cradle assembly. The cradle is mounted on pivots at the front of the unit and is secured in position by two ¼ turn fasteners at the rear.

Access to the Control PCB is gained by undoing those fasteners (using a coin or large flat-bladed screwdriver) and proceeding as follows:

On TERMINAL and PERSONAL ASSISTANT models only, lift the rear of the cradle assembly upwards until the two stays swing fully open. Assisting the stays just past their fully open position will enable them to "lock" into their support positions. The cradle is now safely supported. Avoid moving the stays whilst the cradle is in its servicing position:

ABCs 100 - 310 are fitted with expansion side-trays, pivoted at their lower edge and secured by 1 turn fasteners. Release these fasteners and lift the side-trays up and then swing them out and down until they rest in the horizontal position. Now lift the cradle assembly as detailed above.

The ECONET links can now be located towards the rear of the Control PCB, adjacent to the Cassette port and labelled S23. Set the station identity as detailed above for the BBC Microcomputer.

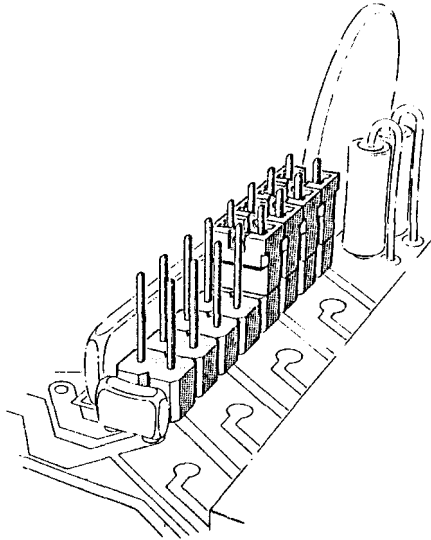


Fig. 9 Setting the station identity of a BBC Microcomputer
(ABC similar)

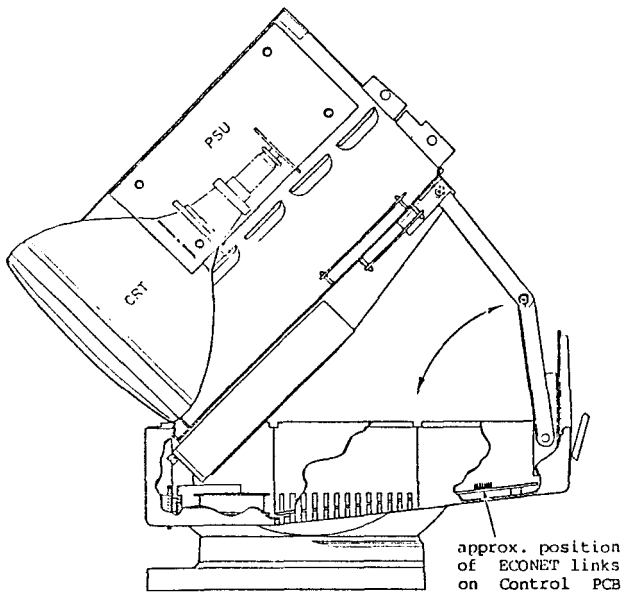


Fig. 10 Side view of an ABC showing cradle in servicing position

