S.E.S. EQUIPMENT

Located at Motherwell & Glasgow Central Signal Boxes

FIRST LINE MANUAL

S.E.S. EQUIPMENT - RECORD OF MODIFICATION

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SECTION 1 - S.E.S. EQUIPMENT

Introduction

The key element of information on train movements is the presence of a particular train at a particular location. This is precisely the information maintained by the train describer memory.

Consequently, the train describer is increasingly finding a use as a data-base for Automatic Train Reporting (ATR), Single Manning Agreement (SMA) equipment, Passenger Information (PIS) and other such systems. Indeed, these are often the justification for the installation of a train describer.

Such systems are here referred to as **CO-SYSTEMS**.

The operating department have been becoming increasingly aware of the opportunities afforded them by the rapid technical advances in the field of Information Technology. This has resulted in an increasing number of co-systems being provided alongside any new TD installations and in a demand for retrospective provision of such facilities on older installations.

Glasgow Central Signalling Centre is equiped with a somewhat elderly GEC-ELLIOT 905 computer-based Train Describer. When this system was installed the only co-system in general use was the Automatic Train Reporting (ATR) system. At that time the ATR was thought of as an extension of the TD rather than as a system in its own right, consequently, there is no distinct ATR system at Central, the data for the ATR network being processed by the TD computer.

The processing power required for the provision of modern co-system facilities is beyond the capacity of the 905. Even if it were not, the pre-existence of standardised co-systems would ensure that the development of such facilities on systems such as Central TD (which is almost life-expired) could not be justified financially. None the less, the strategic importance of Central SC in the ScotRail network made it unacceptable that the antiquity of the TD system should result in the Operating Department having to forgo the advantages of modern technology in the Central SC operations area.

Fortunately an answer aready existed in the form of the ScR Buffer System.

The SES equipment connected to Central TD conswists of two **ScR BUFFER SYSTEMS** (linked to the two computers of the TD installation) and two **ScR ADJACENT BOX SATELLITES** linking the TD to two modern computer-based adjacent Tds (the SCR TD system at Cathcart and the Westinghouse TD system at Paisley).

The Buffer System and Adjacent Box satellite are referred to as the "SES equipment" because they were designed by the **S**ignalling **E**lectronics **S**ection of ScotRail S&T department.

SECTION 2 - ScR Buffer System

Introduction

The current design approach to the use of co-systems with the Scotish Region Train Describer is to maintain the independence of the train describer data-base by transferring the berth data to a second computer over an inter-computer link. This second computer acts as a buffer between the train describer and the co-system.

Since it has the complete berth data at the expenditure of no more processing power than is required to maintain the inter-computer link handshaking, the second computer has most of its processing power still available and free to carry out any protocol conversion and data filtering required by the co-system.

In general, co-systems linked to the TD via the buffer system can be considered as satellites of the buffer computer.

Communication will be via 4 wire full-duplex links with serial interface cards taking responsibility for the protocol interface between the serial link and the buffer computer.

This method makes more efficient use of processing time and allows the data handling routines of the buffer computer to be largrly indepenent of protocol restraints and thus more universal in their applicability.

Each link requires only ne card and a maximum number of links required is unlikely to be such that the buffer computer cannot select the cards directly.

Consequently the buffer computer has no need of a complex routeing system architecture.

Architecture

Buffer system architecture consists of the buffer computer itself, the interface link to the TD computer, and an INTERFACE BUS servicing the number of serial interface cards required.

The interface bus communicates with the computer via a dedicated I/O port. The remaining I/O ports are used to access the bus and to establish the intercomputer link.

At central, the inter-computer link consistsof an I/O port of the buffer computer communicating in parallel with the 905 via a biffer card of the type developed to link the ScR Adjacent Box satellite to the 905.

Depending on the proximity of the c0-system to the TD, modem communication (usually via the telecommunications network) may be used between control card and co-system.

Configuration

Central TD is a dual system using two 905 computers which, although usually task sharing are each capable of controlling the system alone. To conform with general retaionale of the system, and in recognition of the importance, one connected to each of the two TD computers.

The buffer system can support up to three co-systems, one serial communication card on each buffer system interface bus being allocated to each of the co-systems. Each co-system is connected to the buffer system by a single serial link.

To avoid the duplication of the buffer systems giving rise to the transfer of conflicting data between the two TD computers and the co-system, only the buffer computer connected to the "on-line" TD computer communictes with the co-system. This is determined by the buffer computers individually.

Control bits are set by the "Change-over Unit" of the 905 system to determine the on-line TD computer. Each buffer computer reads the condition of the control bits from the highway and adopts the appropriate status.

ASADs are used as the serial communication cards on the interface bus to allow the buffer systems to share spares with the Adjacent Box satellites. The two ASADs allocated to a co-system link communicate with the co-system over a single 4 wire full-duplex link by sharing a common MODEM, the design of the ASAD`s V24 interface circuits being such that the cards can be simply be connected to the MODEM`s V24 circuits in parallel.

SECTION 3 - ADJACENT BOX

Introduction

When the ScR TD is required to communicate with an adjacent box which has existing TD facilities covering the area of the operational interface between the boxes, a serial link using a truncated form of BR SPEC 1810 will be used. This link will be operated over the TD`s Interface Bus in the same way as a satellite system.

If the TD installed at the adjacent box does not use BR 1810, a satellite of ScR TD will normally be provided at the adjacent box to interface that box`s TD to the standard satellite communication link.

This satellite usually consistes of an ASAD card (programmed to translate between the protocol of the link and that of whatever access channel to adjacent box TD is available) and, if necessary, a specially constructed buffer card to provide hardware compatibility.

The ScR TD at Cathcart is required to interface with the computer based Tds at central and Motherwell Scs. Both have GEC-ELLIOT 905 computer-based Tds the design of which pre-dates the adoption of BR 1810. Consequently when the Cathcart TD was designed a ScR Adjacent Box satellite was developed to interface with the 905 TD system.

This consists of an ASAD card and a single, purpose-built support card (known as a 905/ASAD BUFFER card) attached to the Automatic Peripheral Controller (APC) bus of the GEC TD.

Communication between Cathcart and the satellite is via modems over Telecoms lines.

Central is also required to communicate with a Westinghouse TD at Paisley SC. Fortunately, Paisley was designed to use an 1810 protocol which is close enough to the ScR form to allow the use of the ScR Adjacent Box satellite to interface the Central 905 with the Paisley TD.

VOLUME 1

SECTION 4 - CARDS

ASAD Card 85SES4

Introduction

The end product of the Automatic Train-Reporting (**ATR**) system is a record of the time at which a given train passes a predetermined reporting point.

A **REPORTING POINT** is a berth which has been selected to initiate a report when it is occupied or cleared. This selection will be based on the strategic significance of its location - e.g. it may be the berth occupied (or cleared) as a train leaves a station and thus be well placed to indicate whether trains are running to time.

A refinement often included is to programme the system to suppress reports of certain classes of train from certain reporting points. For example, reports to the Passenger Information Office will omit all but class 1 and 2 trains - thus ensuring that the relevant information is not swamped by information on goods movements.

Architecture

ATR architecture is a simpler variation of the TD architecture.

The output devices, known as peripherals, e.g. printer or Visual Display Unit (VDU), are situated remote from the housing of the ATR computer and its support cards, and communicate with the system via modem communication links.

It will be immediately apparent that the control of the peripherals by the ATR computer is analogous to the control of the satellites by the TD computer.

The main function of the ATR is therefore the INTERFACE function.

Consideration of the interface function will show that the architecture of the ATR will consist of the INTERFACE BUS and the ROUTEING SYSTEM, selection of the required peripheral link being via the routeing system and the passage of the data via the interface bus.

The ATR interface function operates exactly as does that of the TD. The cards used are the MR cards (for routeing) and the CONTROL cards (for handling serial communication) and are exactly as used in the TD - with the exception of the communications baud rate which will be selected by wire-wrapped links on each control card to conform with the baud rate of the peripheral at the remote site with which the particular card communicates.

The communications protocol, determined by wire-wrapping on the backplane at the position occupied by the CONTROL card, also differs from that of the TD.

Peripherals

The ATR peripherals will be printers or VDUs, (dependent on whether a permanent record is required), situated at the sites where it has been determined that reports are required. All communication with the peripherals will be by serial data stream.

In most cases the peripheral will only be required to display data transmitted by the ATR and this would require only a 2 wire simplex transmission system. However, occasionally, facilities which allow the operator to interrogate the computer may be required (perhaps to discover the location of a specific train between reporting points). To allow the retrospective provision of this facility, and to maintain a standard hardware configuration for all links, all peripheral links are configured as 4 wire full-duplex links.

Equipment at site will consist of the terminal plus a rack containing a modem, power supply for the modem, and terminations for power and signal distribution to the terminal. If more than one terminal is required at each site these are treated as separate peripherals, however their modems and signal distribution will usually be housed in the same rack. Power distribution will differ for each site (the standard modem rack having only a single power outlet).

Inter-system Link

The link is a serial data link between two ATR systems, each treating the other as a peripheral. The link will operate in full duplex and the interrupts generated by the control cards will be given a high priority. Since the link is between computers (which can handle data at a higher rate than most terminals) the baud rate will be set as high as the transmission system can handle and thus the control card hard-wiring may differ from the other ATR control cards.

The link effectively allows access by one ATR system to the data-base of another. The data from the geographically remote system can then be distributed to the peripheral sites from the local ATR system - saving on trunk line carrier pairs. Since the data is distributed via the local system, it can often utilise a terminal already outputting local data - thus also saving local lines, modems and indeed terminals.

<u>Operation</u>

The ATR print-out consists of the train description entered in a grid with the reporting point name as the X axis and the time as the Y axis. The time is obtained from a "real time" internal clock maintained by the ATR computer.

When the ATR system is reset, either through the initial application of power to the system or through the use of the reset button on the ATR computer, the message "**Please interpose time into CLCK berth**" is sent to the printer on the operating floor.

CLCK is a blind berth in the TD computer provided solely for the purposes of initialising and correcting the ATR clock.

When a four figure number is interposed into the CLCK berth it is transmitted to the ATR computer where it is used to set the time of the clock. The two most significant digits being interpreted as the hour (on a twenty-four hour system), and the two least significant digits as the minutes.

When the message is received the Signalman should use the OCU to enter the current time into CLCK. Until such time as he does so the ATR reports will show ******** as the time.

It should be noted that CLCK only communicates with the ATR when the INTERPOSE key is used. If an attempt is made to interrogate CLCK, the time returned will be **NOT** the current time of the ATR clock, but the last time entered into CLCK.

VOLUME 1

SECTION 5 - FAULT INVESTIGATION

Introduction

It should be stressed at the outset that what follows is largely conjecture. The existing ScR TD systems have proved to be extremely reliable and consequently an empirical base for this section is lacking.

This section has been based on an understanding of the functions and operation of the TD and draws on experience gained commissioning TDs and other systems using similar technology and techniques.

Faults originating in design errors occasionally arose in early systems. Such faults were not of course transferred to "production" systems and early systems have, where practical, been retrospectively converted to production standards.

Since the present document is not a history, care has been taken to ensure that such faults have not biased the contents of this section. If the reader feels that the section does not reflect the pattern of faults on the installation with which he is concerned, and he does not consider that this is due to such historical considerations - or if he encounters faults which have not been conceived by the author, it is important that he communicate this to the Signalling Control UK Glasgow Office in order that any future issue can incorporate his experience.

From time to time a failure may arise which can only be cured by re-setting the computer. The cause of such a failure will be corruption of the computer programme - probably due to a disruption of the 110V power supply to the system. The RESET button is mounted on the front edge of the main processor board - it is **NOT** the toggle switch, which is a programme development aid and should not be touched.

NOTE that the reset has the effect of irretrievably clearing all descriptions from both memory and displays, and should not be used without first informing the Signalman.

Should such failures prove to be a regular occurrence, the Signalling Control UK Glasgow Office should be informed of the circumstances - since such failures can be symptomatic of subtler faults such as a software "bug".

Alarm Indications

The ScR TD has the usual alarms available to the Signalman.

These are:- SYSTEM ALARM OR EQUIPMENT FAULT ALARM (EFA)

TRANSMITTER FAULT ALARM (TFA)

NON-DESCRIBED ALARM (NDA)

RECEIVER CANCEL (RXC)

DESCRIPTION RECEIVED WARNING (DRW)

Of these only EFA and TFA need concern us here - the others being operational alarms rather than fault alarms.

Equipment Fault Alarm

EFA is the main alarm of the system. The computer sends a SYSTEM "OK" message to the OCU on the completion of every programme cycle. If the OCU does not receive this message every five seconds it activates the alarm.

The implication of this alarm is that the main computer has failed. However this is not necessarily the case. The alarm may be sounding due to a fault in either the OCU or the interface link between the OCU and the computer.

To determine whether the computer has indeed failed, check the CONTROL card interfacing the OCU to the computer. If the computer has not failed the transmission of the SYSTEM "OK" will be causing the green LED on the card to flash in a regular manner best described as a "heartbeat".

Among the circumstances which can cause the main computer to fail are programme corruption, power supply failure and a "stuck" interrupt (preventing the computer from returning to the main programme).

If the computer has not failed, or if the alarm cannot be silenced, follow the procedure outlined under SATELLITE FAULTS - OCU.

If the computer has failed check that all power supplies are correct and reset the computer.

If the alarm is still present you are likely to require second line assistance. However if there is no other sign of failure (e.g. STEPPING faults) it is worth changing the CONTROL card (the green LED may have failed!).

If the failure persists then the probable cause is a "stuck" interrupt. Change first the MAIN MR card and then the computer before calling for second line assistance.

Transmitter Fault Alarm

TFA indicates that transmissions to a fringe box have failed. Check with the fringe box Signalman that this is the case (the alarm may be sounding due to a fault in the PANEL satellite), and, if so, test the fringe box link as detailed under COMMUNICATIONS FAULTS.

If the Signalman at the fringe box indicates that transmissions are being received, or if the alarm cannot be silenced, carry out the procedure outlined under SATELLITE FAULTS - PANEL.

<u>Fault Finding Aids</u>

TEST ROUTINE - This is a programme, selected by a toggle switch in the computer swing frame, which continuously outputs the name of each berth to the relevant display. This tests the routeing system and the display function.

STEPPING PANEL - This is a test panel consisting of 16 condition switches and 16 trigger switches connected to a 37 way "D" socket. It can be used to test all steps on a block of two cards, being particularly useful in determining whether a fault lies in the meshing or in the TD hardware.

CARD INDICATIONS - Three of the cards in the system, the CONTROL, MULTIPLEXING, and DEMULTIPLEXING cards, have LEDs mounted on the card edge such that they are visible while the card is operating.

The CONTROL card has three indications:

SD "OK" (green LED) - On whenever the communications IC on the card (the UART) is active, thus indicating that the card is either transmitting or receiving data.

Rx FAULT (yellow LED) - This LED is switched on by the micro-controller to indicate either that an error has been detected in the protocol of a received message or that a fault (e.g. line discontinuity or low signal level) has been detected in the link.

FAULT (red LED) - This LED has no significance in first line fault finding.

Both MULTIPLEXING and DEMULTIPLEXING cards have two indications:

SCAN OK (green LED) - This is on when the computer communicates with the card.

BIT INDICATIONS (14 red LEDs) - On the MULTIPLEXING card these are used to indicate whether the contacts fed into the TD by that card are open or closed. On the DEMULTIPLEXING card they are used to indicate whether the output contacts on the card are open or closed. In both cases, the LED "on" indicates that the contact is closed.

All power supplies used have LEDs indicating that the output voltage is present.

SUBSTITUTION - This is the main first line fault finding aid on the SCR TD. Sufficient spares should be available (including a complete fringe box unit) to allow the technician to quickly and easily identify a faulty unit by replacing it with a unit known to be fault free. **IF THIS METHOD IS TO WORK IT IS IMPORTANT THAT NO FAULTY UNITS ARE KEPT ON SITE AND THAT ALL SUCH UNITS ARE RETURNED IMMEDIATELY FOR REPAIR.**

Introduction

There are three main methods of testing the display system.

(i) THE TEST ROUTINE

On the swing frame in which the main TD computer is mounted, there is a toggle switch. Throwing this switch puts the TD into the test routine.

In this routine the TD will continuously output the external berth name to each display. No berth data is lost during use of this routine and stepping continues.

Restoring the switch will cause the RAM contents (i.e. the descriptions) to be output to the displays.

This routine tests both the routeing system and the display distribution system.

(ii) THE KEYBOARD

Test descriptions can be written into, or removed from, any berth directly from the OCU. This is particularly useful in determining whether a particular display unit is faulty.

(iii) SUBSTITUTION

The degree of standardisation and the construction method used in the TD make it an extremely simple test method either to replace temporarily a suspect card or to change the role in the system of large sections of the TD (e.g. a group of sixteen displays) in order to isolate a fault and aid diagnosis.

(1) FROZEN DISPLAY (i.e. berth holds an old description or remains blank).

The berth contents would not be expected to alter in the test routine. If they do, this means that the description is frozen in RAM rather than the display system - i.e. you are not dealing with a display fault.

Berth contents alter in test routine

Return to the main programme and use the keyboard to interpose a test description to the berth and interrogate the berth.

If the correct description appears when interrogated then the computer is accessing the RAM correctly and is likely to be fault free. Most probably you are dealing with a **stepping** fault - not a display fault.

If the fault continues, and if you are convinced that it is a display fault, call for second line assistance.

Berth contents do not alter in the test routine

You have a display fault. - Substitution is the simplest test method.

First identify the outlet on the distribution unit feeding the display.

Unplug the cable from that outlet, unplug the cable from a working outlet, and temporarily plug the cable from the suspect display into the known working outlet.

If the berth number of the other outlet does not appear on the suspect display when the test routine is running, then either the display unit or the cable is faulty.

Detach the cable from the display and attach a spare display unit.

If the spare unit does not display the berth number the cable should be replaced, if it does, replace the faulty display unit with the spare.

Where the cable and display unit are not at fault the next priority is to clear the distribution unit.

This can done by feeding the group of sixteen displays from the multicore cable carrying another group. If the display remains blank there is a fault in the distribution unit.

The principle of substitution can continue as far as the BSDD card.

Beyond the BSDD card second line assistance will be required.

(2) "CORRUPT" DISPLAYS

This term is applied where the display shows a description whose characters are distorted or unidentifiable.

If a number of berths are affected the data may have been corrupted by a power surge. Switch the distribution box power supply off for a few seconds and then switch it on again. If the fault persists reset the main computer.

If only one berth is affected it is difficult to imagine the source of the distortion being other than in the display unit. Substitution is the easiest method of isolating the fault. Most such faults will be due to faulty display matrices or bad ribbon pressings between the two boards of the display unit.

If the display unit is not the source, first the BSDD card and then the main MR card should be substituted.

Note that reverse connection of the two wires of the serial data pair to a display will **guarantee** a corrupt display. This will not occur in a working system but may be inadvertently introduced in the course of repairs to a display channel.

If the fault persists after replacing the MR card, request second line assistance.

(3) GENERAL DISPLAY FAULTS

General display faults will usually affect the displays in groups of sixteen and its multiples.

Faults of this nature include:-

Faulty display power supply or logic power supply in a distribution unit. (Investigation of general faults should always begin with a check of the power supply voltages.) Distribution Box `B` uses an upgraded version of PK60 Power supply and should **NOT** be interchanged with earlier models.

A cabling discontinuity (e.g. a loose header on the backplane).

Faulty addressing of a BSDD card (change MR card).

Loss of power to the BSDD card.

Loss of SDCK (originates on main MR card).

REMEMBER THAT DISPLAY AND STEPPING ROUTEING SHARE THE SAME HARDWARE.

If steps from the berth with the suspect display operate then the fault is in the distribution system from the display driver (on the BSDD card) outwards.

Introduction

It is important when called to a stepping fault to make absolutely sure of the nature of the fault.

A Signalman reporting a stepping fault usually tends to report his interpretation of the fault: rather as a patient might tend to preempt his doctors diagnosis by complaining of a particular disease.

ALWAYS INVESTIGATE THE SYMPTOMS.

It is particularly important with a new installation to consult the stepping tables. These will have been agreed with senior operating staff and it has been known for signalmen to report a fault when the real problem is that he disagrees with the operating decision.

In the ScR TD, a step takes place when the trigger contact for the step closes (provided the condition contact has remained closed during the preceding 3 seconds).

Every step has a FROM BERTH and a TO BERTH: Identify these for the fault reported using the stepping tables.

Checking a step is particularly easy in the ScR TD - Usually a test panel consisting of 16 condition switches and 16 trigger switches connected to a 37 way "D" socket is provided. This is sufficient to test all steps on a block of two cards.

Identify from the documentation which block the suspect step is allocated to, remove the "D" terminated multicore cable from that block, and plug it into the test block.

Identify the trigger and condition switches involved, close the condition switch and, a few seconds later, close the trigger switch.

If there is no fault within the system the description should move to the TO BERTH.

If for any reason the test panel is not available the test can still be carried out.

Identify the condition and trigger terminals on the block and, with the multicore still connected to the block, connect the condition terminal to the block common with a short length of wire. Then, with a second length of wire, connect the trigger terminal to the block common.

This is equivalent to the two switch closures.

PLEASE NOTE that if repeating the test it is necessary to open the trigger contact for 3 seconds. The validation circuit will not allow a further step until the trigger has cleared.

(1) DESCRIPTION LEAVES FROM BERTH WHEN TRIGGERED - BUT APPEARS IN BERTH OTHER THAN "TO BERTH"

In the computer, a step consists of moving the description from RAM allocated to the FROM BERTH to RAM allocated to the TO BERTH.

The FROM BERTH is determined by the point in the berth scanning programme at which the scan detects that the high order bit of the stepping bus is set (requesting a step).

The TO BERTH ADDRESS is then given by the other bits on the stepping bus. **THIS TYPE OF FAULT IS CAUSED BY THE WRONG ADDRESS appearing on the bus at this point.**

The TO BERTH address for a step is set on the 8 way DIL switch in the validation circuit allocated to that step. The address is placed on the bus when the validation circuit is enabled.

THIS GIVES FOUR POSSIBILITIES

(i) the validation circuit is faulty
(ii) an incorrect validation circuit has been enabled
(iii) there is a fault on the bus
(iv) the switch setting is incorrect for that step

Any fault of type (iv) will be obvious at a glance.

We can discount (iii) if only one step is faulty - since any conceivable fault is likely to affect several steps.

If several steps are affected and no physical damage to the bus is apparent the probable cause is a faulty output buffer on one of the BS cards. Replace each of the cards in turn by the spare and test the affected steps **(remember to change the DIL switch settings each time).**

If the fault can not be traced in this way then either the main computer I/O buffer or the cable connecting it to the stepping bus is likely to be at fault. Replace the main computer with the spare and if the fault persists have the cable investigated by the second line staff.

A fault of type (i) will clear immediately the BS card to which the step is allocated is replaced by the spare **(first ensuring that the DIL switches on the spare card are correctly set).**

Faults of type (ii) can originate either in the system or externally (in the meshing).

If the fault is not present when the stepping is tested using the block test the cause is external. If the fault remains the cause is internal.

(1) (cont.)

<u>Internal</u>

The internal factor in enabling a validation circuit is the presence of the berth select pulse.

Not only do all the steps from a given berth share a berth select line, they are also allocated validation circuits on a single card.

Consequently faults of this nature should respond to changing the BS card.

If the fault persists then a short circuit probably exists between the BS for the affected berth and some other BS line. Change the appropriate BSDD card and if the fault persists have second line staff investigate the berth select wiring.

<u>External</u>

Most steps from a given berth will share a trigger. Therefore faults of this type will usually lie in the CONDITION meshing. Investigate this as you would an interlocking fault.

NOTE: If the description "disappears", this is a fault of this general type with the "clear out" berth number as the **apparent** TO BERTH - since a "clear out" is, for stepping purposes, a step to a blind berth.

(2) DESCRIPTIONS DO NOT STEP OUT OF A GIVEN BERTH.

If the description appears in the TO BERTH, then the step has in fact taken place and the fault is a **display** fault of the **"STUCK" DESCRIPTION** type. In a genuine stepping fault of this type the TO BERTH will remain blank, and, on leaving the TO BERTH, the train will continue to step as a "non-described".

This type of fault can be internal or external - which can be determined by using the block test.

<u>External</u>

First check for the trigger. If the trigger is present when the trigger track is occupied the condition meshing should be investigated.

Remember that both trigger and condition MUST clear after a step otherwise further steps cannot take place. If, for example, the trigger track has failed, steps from that berth will be inhibited.

<u>Internal</u>

There are two possibilities

(i) the validation circuit is not being "primed" by condition and trigger.

(ii) the validation circuit is not responding to selection.

In most cases both will respond to replacing the BS card with the spare.

If not, then (i) implies a fault in the ribbon or pressing between the block and the card.

(ii) implies either a bad wire wrap carrying the berth select pulse or an addressing fault.

If the FROM BERTH display can be altered via the OCU then an addressing fault is unlikely. If not, try changing the BSDD card.

The MR card is a possible though unlikely cause. However, if an addressing fault is traced to this level, then second line test equipment is likely to be required to make further progress.

(3) DESCRIPTION STEPS AT WRONG TIME.

The most likely cause is the trigger arriving at the wrong time.

If the fault occurs with the external trigger disconnected possibilities include another validation circuit responding to the berth select. - However in this case the likelihood is that the step would go to the wrong TO BERTH.

(4) GENERAL STEPPING FAULTS.

NO STEPPING

If no steps occur check the isolation power supply.

If the supply is present change the main MR card. If the fault persists, check the integrity of the bus cabling between the stepping card-frame and the main computer. If no fault is apparent reset the computer and, if the system still will not step, change the main computer card.

A useful point to note is that if the display system is working then most of the addressing can be discounted as the source of the fault.

Check the power supply to the BS cards and the cabling carrying the berth select signals from the BSDD cards to the BS cards. If the fault persists, have second line maintenance check for activity on the bus and the presence of the SCK and LE pulses.

NOTE

Although in general stepping faults can be classed as internal or external, where steps are conditional upon berth occupation it should be borne in mind that certain meshing faults could originate in the MULDEM.

Introduction

The following statement is controversial but true. Don't forget it, it may save a lot of trouble.

THE MOST COMMON CAUSE OF A COMMUNICATION FAULT IS A TRANSMISSION LINE FAULT.

To expand on this a little - even on local communication circuits more faults will be due to faulty connections (e.g. loose or missing links, bad cable presses etc.) than to faulty electronics.

At this point I would like to re-introduce , and hopefully popularise, a test instrument which was common in the recent past but which seems to be becoming increasingly rare in the present "high-tech." atmosphere.

It is cheap, simple, easy to use and highly effective. I refer to a telephone ear piece insert. When attached to the lines by two pieces of wire and two crocodile clips, the ear piece can tell the experienced technician as much as a battery of expensive signal analysing devices.

Obtain an ear piece and listen to the lines of a fully functional link. - With this experience you will be able to listen to a suspect link and determine the following.

(a) Is the modem carrier present?

(b) Is some illegal carrier present?

(c) Is the carrier suffering break-up or being modulated by a corrupting signal?

(d) Is the signal level adequate?

(e) Is the carrier modulated when, and only when, the box transmits?

Using this technique both modem and lines can be tested.

There are three main groups of communication links.

(i) BOX TO BOX
(ii) ATR CHANNELS
(iii) LOCAL SATELLITES

(i) **BOX TO BOX LINKS** (including Fringe Box Links) have the advantage of back-to-back test facilities. This means that the output of the channel can be connected to its input to give a test facility bypassing lines and external systems.

There are usually two points at which the connection can be made:-

(1) at the connector where the lines leave the TD cabinet - here the signal will be an FM carrier (a special back-to-back connector will usually be provided).

(2) on the backplane connector of the relevant control card - here the signal will be V24. **NOTE:** If the connection is made on the backplane then the back-to-back facility does not test the MODEM.

With the back-to-back connection made, preferably as in (1) above, the technician should interpose a test description to the transmitting berth for the link:- The test description should appear in the APPROACH BERTH of the link.

At this point it is probably worthwhile mentioning a type of fault which, although it will have been reported as a communication fault, and may at first glance appear to fall into this category, is in fact most likely to be a satellite fault. This is an early transmission (ET) fault:- The SITE APPENDIX will tell you whether the TD is equipped with ET facilities.

ET allows a description to be transmitted to the fringe box before the train reaches the departure berth at the main box. To do this the computer requires information on certain tracks and signal aspects. This information will be brought into the TD via a local satellite, either the MULDEM (if fitted) or the PANEL satellite.

The system will continue to work back-to-back from the departure berth if the ET facilities are faulty.

If the system works back-to-back any apparent communication fault will lie at the satellite or in the lines or the communication equipment.

If the back-to-back test does not work, have someone repeat the test while you watch the green LED on the control card.

The system will attempt to transmit three times and this can be seen as three bursts of flashing on the LED.

(i) BOX TO BOX LINKS (cont.)

On a correctly functioning link only one burst would be seen since the receiving box would acknowledge the first transmission.

The second and third bursts are an indication that the acknowledgement is not being received:- Listen for the acknowledge transmission on the receive pair. (The intermittent presence of a second, or third, burst is a good indication of "noisy" lines.)

Think about the operation of the control card. It isn't just a serial to parallel convertor - it is also an intelligent buffer.

The significance of this is that a transmission which does not conform to the system protocol will not be passed to the computer - and will therefore not be acknowledged.. However the system protocol is very simple and most of the errors which would cause a message to be rejected would also light the yellow LED on the control card. The control card must also pass valid transmissions to the computer.

To do this it must generate an interrupt on the main MR card and respond to selection by the auxiliary MR card when the interrupt is serviced.

Substitution on the communications links can be utilised on MODEM, CONTROL card, main MR card and the relevant auxiliary MR card.

(ii) ATR CHANNELS

It will not usually be possible to perform any back-to-back tests on an ATR channel - however the ear piece test will still be most useful.

A spare terminal, connected locally, can be used to eliminate suspected line faults. Terminals may be connected directly to the backplane or via a modem. Determine which method is applicable from the site drawings.

If the terminal will not work locally, investigate the functioning of the CONTROL and MR cards as in (i) - remember that when used in the ATR system the CONTROL card does not require its transmissions to be acknowledged and hence transmits once only.

IF SUBSTITUTING CONTROL CARDS ENSURE THAT THE CORRECT BAUD RATE FOR THE TERMINAL HAS BEEN SELECTED.

(iii) LOCAL SATELLITES

A spare satellite, or part thereof, will usually be available for substitution.

If the system will not work with the spare satellite, investigate the functioning of control and MR card as in (i) before following the fault finding procedure for the satellite.

IMPORTANT: When substituting control cards or ASADs ensure that the correct form of transmission is selected (i.e. V24 or current loop) and that the baud rate is correctly set.

When substituting ASADs ensure that the correct programme is fitted and that the card is fully populated for the function required.

KEYBOARD (OCU)

The OCU consists of the KEYBOARD satellite and three display modules.

The LED matrices for the display units are mounted on the keyboard matrix board, and connected by ribbon cable to their main display boards (mounted on a metal plate on the underside of the keyboard).

Each LED matrix is individually mounted in an IC socket and can easily be replaced if faulty. The main display boards are identical to those in the standard DISPLAY MODULES.

The OCU displays are part of the DISPLAY FUNCTION and should be treated as such during fault investigation.

PLEASE NOTE that these displays do not represent geographic locations and do not have berth "names". Consequently they will remain blank during the test routine.

Faults involving the KEYBOARD satellite fall into two categories:-

(a) communication faults between computer and satellite
(b) local faults at the satellite

Communication faults between computer and satellite.

The communication link can be tested by observing the green LED on the CONTROL card.

If the EFA lamp is lit when the "heartbeat" is present, then either there is a discontinuity in the lines or the ASAD card is at fault.

Have an assistant repeatedly push an alpha-numeric key while you observe the LED - you will be able to decide whether the ASAD is transmitting by determining whether there is a change in the rate of flashing of this LED. (Please note that the key must not be held down since if this is done the ASAD will transmit once only.) If a communication fault is suspected, check the ASAD (see ASAD FAULTS below). If the fault continues check the continuity of the link and replace the CONTROL card before calling for second line assistance.

Local faults at the satellite.

If the keyboard is completely inoperative, check the power supplies and then check that the ribbon cable linking the MATRIX board to the ASAD is in place.

If a single key is inoperative, remove the MATRIX card and test the operation of the key with a multimeter.

If a complete row or column is inoperative the fault will be in the ribbon cable or on the ASAD.

KEYBOARD (OCU) (cont.)

Local faults at the satellite. (cont.)

If keys select wrong characters the likely cause is a failure of one of the diodes on the MATRIX card.

If a lamp or buzzer fails to operate the fault will be in the ribbon cable or on the ASAD. Do not overlook the possibility that the lamp or buzzer is itself at fault.

If a lamp or buzzer operates continuously the likelihood is that the FET output driver on the ASAD is damaged. Check the ISOLATION SUPPLY voltage before replacing the ASAD. Do not overlook the possibility that the acknowledge key is inoperative.

ASAD FAULTS - If an ASAD fault is suspected, check the power supply and then test for programme corruption by resetting the ASAD. This is best done by temporarily removing power from the DISTRIBUTION BOX.

If the fault persists replace the ASAD, **FIRST ENSURING THAT THE SPARE CARD IS FULLY POPULATED AND CARRIES THE CORRECT PROGRAMME.**

PANEL

If the PANEL satellite is completely inoperative (which will show when a description arrives from a fringe box without an accompanying DRW) a communication fault should be suspected.

Have one of the fringe boxes transmit to the main box while someone observes the green LED on the CONTROL card allocated to the PANEL satellite.

If the LED flashes as the transmission is made, check the continuity of the link between the card and the panel, and then check the ASAD.

If the fault continues, or if the LED does not flash, replace the CONTROL card before calling for second line assistance.

If a single key is inoperative, generate the alarm the key is intended to acknowledge and simulate its operation on the KLIPPON block. If this does not acknowledge the alarm the fault will be in the ribbon cable or on the ASAD.

If a lamp or buzzer fails to operate, test the component by connecting it to the ISOLATION SUPPLY return at the KLIPPON BLOCK. If the component operates the fault will be in the ribbon cable or on the ASAD.

If a lamp or buzzer operates continuously, the likelihood is that the FET output driver on the ASAD is damaged. Check the ISOLATION SUPPLY voltage before replacing the ASAD. Do not overlook the possibility that the acknowledge key is inoperative.

On some systems, the PANEL satellite transmits to the computer - confirm from the site appendix whether the one you are working on does.

If so, and if one of the transmitted functions is suspect, check that the satellite is transmitting to the computer by simulating the function (e.g. an early transmission contact closure) and observing whether the CONTROL card LED flashes.

ASAD FAULTS - If an ASAD fault is suspected, check the power supply and then test for programme corruption by resetting the ASAD. This is best done by temporarily removing power from the DISTRIBUTION BOX.

If the fault persists replace the ASAD, **FIRST ENSURING THAT THE CARD IS FULLY POPULATED AND CARRIES THE CORRECT PROGRAMME.**

FRINGE BOX UNIT

Before going to the fringe box carry out the tests detailed under COMMUNICATIONS FAULTS - BOX TO BOX LINKS, and satisfy yourself that the fault lies at the fringe box. If you have a spare FRINGE BOX UNIT this can be connected to the link at the Signalling Centre and used in addition to the back-to-back test.

Collect the spares and test equipment you will require:

SPARES:-	1 Fully populated ASAD with fringe box programme. 1 MR card 1 BSDD card 1 MODEM 1 DISPLAY MODULE 1 5V 12A POWER SUPPLY (Appropriate model for unit) 1 5V/+&-12V POWER SUPPLY
TEST EQUIPMENT:-	MULTIMETER TELEPHONE EAR PIECE (see COMMUNICATION FAULTS)

At the fringe box determine the circumstances of failure before testing the unit. (e.g. Did the failure coincide with a lightning strike or power disruption? - This would point to a damaged modem or corrupted programme).

FRINGE BOX UNIT (cont.)

Testing the Unit

Check the power supplies and reset the ASAD. This is best done by temporarily removing power from the FRINGE BOX UNIT.

Operate the unit.

If you can set up a description (but not transmit) the likelihood is that there is a communications fault. If you can not set up, the fault is within the unit.

In either case it is advisable to test the transmission equipment - using the ear piece to test for MODEM and/or line faults. **Remember that the ASAD is part of the transmission equipment.**

If, having changed MODEM and ASAD, you remain convinced of a communications fault - examine the backplane for a loose connector between MODEM and ASAD.

Back-to-Back

The Unit does not have full back-to-back test facilities, however a limited back-to-back test can be made by looping the TX and RX pairs at the Unit.

With the lines disconnected any attempt to transmit will result in the description disappearing from the SET-UP berth and the TFA sounding.

With the lines looped the transmission will be directed to the SET-UP berth (i.e. the description will appear to remain in the SET-UP berth) and the DRW will sound.

If the non-described code (****) is sent a NDA will accompany the DRW - similarly CANC will cause the RxC alarm to sound.

You should now be in a position to decide whether the fault is local to the FRINGE BOX UNIT or in the TRANSMISSION LINK.

FRINGE BOX UNIT (cont.)

Local Faults

The FRINGE BOX UNIT has been designed such that its architecture follows that of the main TD as closely as possible. It can be thought of as a TD with the ASAD as main computer. Consequently most fault investigations at the fringe box can follow the procedures used at the main box.

Displays

The substitution technique should be used. The fringe box does not have a test routine - but it does clear all its displays when the ASAD is reset (which can provide some information about the routeing system).

Only the SET UP berth can be altered from the keyboard, however a suspect display could be connected to the SET UP berth cable and tested.

The board carrying the display matrices can be connected to a different main display board as a further test.

Keyboard

Testing the fringe box keyboard involves similar techniques to testing the OCU keyboard. The differences are as follows:

At the fringe box, EFA is a local facility - the communication link is not involved. An EFA is given if the ASAD computer does not complete its programme cycle within a set time. You will probably only encounter this if the programme is corrupted.

Should EFA continue to sound after resetting the ASAD, suspect a damaged output driver.

Alarms

The fringe box keyboard also handles the TFA and RXC alarms which, at the main box, are the responsibility of the separate PANEL ASAD.

At the fringe box, keyboard faults involving these alarms will be limited to inoperative keys, discontinuities and faulty output drivers (since the alarms are initiated locally and do not involve the communication link directly).

If all alarms fail to sound check that the ISOLATION VOLTAGE (the indication supply) is present.

If the alarms cannot be silenced check the keyboard and the ASAD card.

FRINGE BOX UNIT (cont.)

Other Faults

The unit has one local signalling input - a track contact. This is used to initiate an automatic C/O of the "1st APPROACHING" berth.

If this facility does not work ensure that the ISOLATION SUPPLY is present and that the input is reaching the ASAD before resetting or changing the ASAD.

There is an interesting "fault" associated with this C/O:-

If the main TD computer's memory shows the "1st APPROACHING" berth as occupied it will send any approaching train to "2nd APPROACHING".

Consequently, if the fringe box is reset with a description present in the "1st APPROACHING" berth , "1st APPROACHING" will show clear at the fringe box **although recorded occupied at the main box.**

Any subsequent train will then **appear** to be being sent to the wrong berth.

Therefore, **ALWAYS SEND A MANUAL C/O AFTER RESETTING THE FRINGE BOX.**

MULDEM

The **MUL**tiplexing facility of the MULDEM is used to bring in the extra signalling inputs required to give the TD an EARLY TRANSMISSION (ET) capability.

The **DEM**ultiplexing facility of the MULDEM is used to output berth occupation conditions to the relay meshing used to determine step conditions.

When investigating early transmission faults you will be concerned with the CONTROL card and **MULTIPLEXING** cards of the MULDEM and with the auxiliary MR card used to select the MULDEM cards.

When investigating stepping faults involving steps which are conditional upon the occupation of a berth (e.g. platform shuttle berths), you will be concerned with the CONTROL card and **DEMULTIPLEXING** cards of the MULDEM and with the auxiliary MR card used to select the MULDEM cards. - You will, of course, only investigate these cards after having established that the stepping fault originates in the MESHING.

Early Transmission

The inputs to the MULTIPLEXING cards are connected by ribbon cable to a KLIPPON block situated below those used by the condition and trigger contacts.

If you suspect that a contact used in ET is not reaching the TD computer the drawings should be used to locate the (Red) LED indicating the bit (by BIT NUMBER, WORD and CARD POSITION) and the KLIPPON terminal used (by TERMINAL NUMBER and BLOCK NUMBER).

By shorting the KLIPPON terminal allocated to the bit to the block common, the technician should satisfy himself that the LED lights.

Failing this, the card should be changed. If the bit still does not light the ribbon cable connecting card to terminal is suspect.

If the LED lights but the fault continues then the card is probably not being scanned.

The green LED (SCAN OK) flashes when being serviced by the computer. The rate at which the system operates is such that, under correct operation, this LED will appear to be continuously lit.

If this LED is not lit - change first the CONTROL card and then the MR card.

MULDEM (cont.)

Testing the ET facilities

ET faults will be of one of two types.

(a) ET does not operate from a given berth.
(b) Automatic cancel is not sent when required.

ET does not operate from a given berth

Check with the site appendix to determine the conditions under which the transmission should take place, then place a test description in the berth and simulate the conditions. Satisfy yourself that the MULDEM data is being read (using the procedure outlined above).

If the fault continues call for second line assistance.

Automatic cancel is not sent when required

Place a test description in the berth, simulate the conditions for transmission as in (a), and check with the fringe box Signalman that the description has been received. Restore the route and ensure that the contact representing a clear aspect is no longer being input by the MULDEM.

If the fault continues call for second line assistance.

MULDEM (cont.)

Stepping Faults

The outputs of the DEMULTIPLEXING cards are connected by ribbon cable to a KLIPPON block situated below those used by the condition and trigger contacts.

If you suspect that a contact representing berth occupation is not reaching the meshing, the drawings should be used to locate the (red) LED indicating the bit (by BIT NUMBER, WORD and CARD POSITION) and the KLIPPON terminal used (by TERMINAL NUMBER and BLOCK NUMBER).

When a description is interposed into the berth the LED should light. When the description is cleared from the berth the LED should go out.

If this happens the technician should connect a multimeter between the KLIPPON terminal allocated to the bit and the block common, and satisfy himself that the relay contact on the card is opening and closing as required.

If the contact does not follow the LED, and replacing the card has no effect, the ribbon cable is at fault and should be replaced.

If the relay contact follows the LED then the fault lies with the repeat relay in the MESHING.

When interposing and clearing a description has no effect on the card (and replacing the card makes no difference), check that the SCAN OK LED on the card flashes whenever the description is interposed or cleared.

If not, change first the CONTROL card and then the MR card.

If the fault continues call for second line assistance.

ATR

General

If the ATR system is not functioning, reset the ATR computer whilst observing the green LED on the CONTROL card serving the link to the printer on the operating floor.

If the LED flashes, carry out the procedure outlined under **COMMUNICATION FAULTS - ATR CHANNELS.**

If the LED does not flash, change the CONTROL card followed by the MR card and the ATR computer in turn - repeating the reset test at each stage.

Check for loose connectors on the inter-computer link and the ATR interface bus and, if the system is still inoperative, call for second line assistance.

VOLUME 1

SECTION 6 - SITE APPENDIX

Introduction

Most signalling electronics equipment at Dundee is housed in two cabinets and a desk which are situated in the relay room between the Relay Racks and the Telecommunications equipment. The remaining equipment can be found on the operating floor and at the three fringe boxes.

This manual documents the TD and its ATR Co-system, (including the associated equipment on the operating floor and at the fringe boxes).

The CCTV is entirely independent and is documented separately.

In the relay room

The cabinets contain:- The Train Describer
The ATR Co-system
Camperdown CCTV equipment

The left-hand cabinet contains the ATR, the right-hand the TD and the cabinet beneath the desk contains the CCTV equipment.

On the operating floor

Both DISPLAY DISTRIBUTION BOXES, one which also houses the KEYBOARD and PANEL SATELLITES, can be found inside the Signalman's control panel. The OCU is set into the desk surface of the control panel and the BERTH DISPLAY UNITS are mounted in the mimic diagram. The local ATR PRINTER is located on the supervisor's desk.

At the fringe box

The equipment at each of the three fringe boxes consists of a SATELLITE FRINGE BOX UNIT.

TD Configuration

The Dundee TD is a ScR TD, with berth-conditional stepping and early transmission facilities, supporting a ScR ATR Co-system and the following satellites:-

1 Keyboard (OCU)
1 Panel Interface
3 Fringe Box Units
1 Muldem

As installed (1985) the TD is a 32 berth/112 step describer. To allow for expansion the backplane is wired as a 64 berth/160 step describer - however due to the extenstion of control of Dundee S.B. (1995) to encompass Broughty Ferry the display facilities have been increased to cater for a maximum of 48 berths.

The backplane wiring also allows for 3 additional satellites or 1 additional satellite and 28 bits of muldem expansion. As installed, the muldem allows 28 input bits and 28 output bits - which should be more than adequate for any conceivable expansion at Dundee.

The Muldem is used to:-

(a) bring the signalling conditions used in the early transmission facility into the system, and

(b) output berth occupation to the meshing for use in the berth-conditional stepping.

The three fringe boxes - Taybridge South, Longforgan and Carnoustie, each use a standard Fringe Box Unit of identical configuration. **This allows a fourth unit to be utilised as a common spare.**

The KEYBOARD and PANEL satellites service the OCU and fringe box alarms on the Signalman's Control Panel.

The Train Describer Cabinet

The TD cabinet is a 24U high VERO X SYSTEM case.

Space in the cabinet is allocated as follows (reading from the top front):-

(a) A 3U rack for power supplies and modems.

(b) A 3U drawer unit fitted with a double swing-frame unit - the upper frame carrying the main TD computer and the lower a spare.

The lower space in the upper swing-frame is fitted with a reverse edge connector to which all major I/O wires from the processor are wire wrapped. The shielded and jacketed ribbon cable which connects the processor to the upper card frame mates with this connector.

(c) A 6U card frame carrying the cards for the ROUTING SYSTEM, DISPLAY DRIVE, the INTERFACE BUS and the MULDEM.

(d) A 6U card frame carrying the cards for the STEPPING BUS.

(e) A 6U blanking plate. This space is available for use in any future expansion.

<u>The Train Describer Cabinet</u> (cont.)

<u>Inside the cabinet</u>

Viewed from the rear:

On the right hand side wall of the cabinet a DIN rail is mounted at the level of the power supply rack. This carries the KLIPPON terminals from which the DC power is distributed to the card frames and the computer drawer. The 110V AC supply is terminated in the ATR cabinet.

Mounted centrally on the side wall are the line jack units (LJUs) for the fringe box links. There are five LJUs - the two extra (labelled **TEST** and **BACK-TO-BACK**) are for test purposes.

TEST has a flying lead connected which allows the spare FRINGE BOX UNIT to be connected to the LJU. Any fringe box link can then be tested locally by removing the line plug for that link from its LJU and connecting it to the TEST LJU.

BACK-TO-BACK is a LJU within which the TX pair has been looped to the RX pair. This allows the TD back-to-back test to be carried out on any fringe box link by removing the line plug for that link from its LJU and connecting it to the BACK-TO-BACK LJU.

A panel mounted in the lowest 3U of the side wall carries 37w "D" connectors. From these, paired multicore cables carry the display data to the distribution box in the Signalman's control panel. Also on this panel is a 15w "D" from which the data for the OCU, the PANEL INTERFACE satellite and the ATR printer on the operating floor are carried to the distribution box. This panel is referred to as the **OUTPUT PANEL.**

In the lowest 3U space of the left hand side wall a similar panel carries 37w "D" connectors to which multicore cables carry the stepping and MULDEM inputs from the KLIPPON blocks situated on the rear wall of the relay room. This panel is referred to as the **INPUT PANEL.**

Other features visible from the rear are:-

(a) The jacketed and shielded 64w ribbon cable exiting from a slot in the rear of the computer drawer unit and connected to a horizontal bracket on the upper card frame. - All buses and control signals between the computer and the other cards in the TD system pass along this cable.

(b) The jacketed and shielded 20w ribbon cable exiting from the slot in the rear of the computer drawer unit and passing through a hole in the right-hand wall of the cabinet. This cable carries the inter-computer link between TD and ATR.

(c) The upper edge connector in the unused, extreme right, card position of the LOWER card frame. This is used to distribute the BERTH SELECT signals to the BS cards. A 32w ribbon cable brings these signals to the connector, originating as 2 separate 16w ribbon cables on the BSDD cards of the upper card frame.

The Train Describer cabinet

Inside the cabinet (cont.)

(d) The upper edge connector in the unused, extreme right, card position of the UPPER card frame. This is used in the distribution of buses and control signals. From here a 20w ribbon cable carries the STEPPING bus and SCK to the lower card frame. This cable also brings the ISOLATION supply to the upper card frame for use in the MULDEM.

(e) 2x34w ribbon cables terminating in headers on the lower edge connectors of the BSDD cards and passing to the right of the frame. These carry the display data to the output panel.

(f) 20w ribbon cables terminating in headers on the lower edge connectors of the MULTIPLEXING and DEMULTIPLEXING cards and passing to the LEFT of the frame. These link the MULDEM to the input panel.

(g) 20w ribbon cables terminating in headers on the lower edge connectors of the BS cards and passing to the LEFT of the frame. These carry the stepping inputs from the input panel.

(h) The PCB linking the cards of the INTERFACE bus.

(j) The PCB linking the cards of the STEPPING bus.

(k) The white 4c cables (terminated on headers) connecting the V24 circuits of the CONTROL cards to the MODEM RACK (fringe box links) or OUTPUT PANEL (local satellites).

(l) The white 4c cables connecting the MODEMS to the LJUs.

(m) The DC power cables running to the KLIPPONS from the power supply rack - and from the KLIPPONS to the RINGLOCK connector on the computer drawer and the spade connectors on the DC BUS BARS of the card frames.

ATR Configuration

The Dundee ATR system is a ScR TD Co-system. The co-system computer, as programmed for ATR purposes, controls an interface bus over which it communicates with the ATR peripherals, including an INTER-SYSTEM LINK to EDINBURGH ATR SYSTEM.

The inter-system link is bi-directional, and thus allows data on train movements within the Dundee control area to be output on peripherals connected to the Edinburgh ATR system - and data on train movements within the Edinburgh control area to be output on peripherals connected to the Dundee ATR system.

A single card-frame interface bus - as installed at Dundee - is capable of communicating with 16 ATR peripherals. The modem rack installed at Dundee has space for only 14 modems, however additional modems could be accommodated in the power supply rack if required.

As installed, the ATR backplane is wired for only 8 communication links. Of these, one is allocated to the local printer situated on the operating floor, one to the inter-system link to Edinburgh and the remaining six are available for remote peripherals situated in and around Dundee.

Each link requires a CONTROL card and a MODEM in the ATR cabinet and a MODEM and PERIPHERAL (e.g. printer) at the location where the report is required. In the case of the local printer on the operating floor, the distance involved is such that a modem is not required and a BY-PASS MODULE is fitted in the modem position.

The BAUD RATE of the communication link is selected by wire wrapped links on the CONTROL card. It should be noted that since the inter-system link communicates, not with a peripheral but with a computer, the baud rate of this link has been set considerably higher than that of the others.

The system is, of course, capable of considerable expansion.

This expansion would be in blocks of 8 communication links - each block of 8 links requiring an additional MR card. It will be obvious that expansion of the system as installed to the card-frame maximum of 16 links would be relatively simple.

For expansion beyond 16 links additional card-frames and modem racks would be required. Space is available in the cabinet for expansion to 32 links.

<u>The ATR Cabinet</u>

The ATR cabinet is a 24U high VERO "X SYSTEM" case.

Space in the cabinet is allocated as follows: (reading from the top front)

(a) 3U rack for power supplies only.

(b) A 3U drawer unit fitted with a double swing-frame unit - the upper frame carrying the ATR computer and the lower a spare.

(c) A 6U card frame carrying the cards for the ROUTEING SYSTEM and the INTERFACE BUS.

(d) A 3U rack for modems.

(e) A 3U blanking plate. This space is available for use in any future expansion.

(f) A 6U blanking plate. This space is available for use in any future expansion.

The ATR Cabinet (cont.)

Inside the cabinet

Viewed from the rear:

On the right hand side wall of the cabinet a DIN rail is mounted at the level of the power supply rack. This carries the KLIPPON terminals from which the DC power is distributed to the card frames and the computer drawer.

A second DIN rail is mounted at the bottom of the side wall. This carries the KLIPPON terminals where the 110V AC supply for both cabinets is terminated and fused. (The AC supply is taken from a dedicated 2.5KVA transformer on the power rack on the rear wall of the relay room. The supply is taken through an isolating switch and fuses on the power rack before entering the ATR cubicle).

Mounted centrally on the left-hand side wall are the LJUs for the links to the remote terminals.

Other features visible from the rear are:

(a) The jacketed and shielded 64w ribbon cable exiting from a slot in the rear of the computer drawer unit and connected to a horizontal bracket on the card frame. - All buses and control signals between the computer and the other cards in the ATR system pass along this cable.

(b) The jacketed and shielded 20w ribbon cable exiting from the slot in the rear of the computer drawer unit and passing through a hole in the left-hand wall of the cabinet. This cable carries the inter-computer link between ATR and TD.

(c) The PCB linking the cards of the INTERFACE bus.

(d) The PCB in the two left-hand end positions of the card frame. This carries two 25w type 'D' connectors and two groups of wire wrap terminals. - Each contact of the 'D' connectors is connected via the tracking of the PCB to a corresponding wire wrap terminal.

This PCB is provided to facilitate the wiring of the V24 TX/RX circuits of the control cards to the modem rack. The V24 pins of the CONTROL card edge connectors are wire wrapped to the terminals on the PCB, and a ribbon cable connected via the type 'D' connector carries the signals to the modem rack. Only the lower connector is used by the system as installed - the upper connector being provided to allow for expansion.

The ATR Cabinet (cont.)

Inside the cabinet

Viewed from the rear (cont.):

(e) Two metal brackets in the 4 end positions of the modem rack (positions 66-84).

The right-hand bracket is provided to facilitate the wiring of the V24 TX/RX circuits of the control cards to the modem rack. The V24 terminals of the modems are wired to a 25w type 'D' connector mounted on the bracket. From this a ribbon cable carries the signals to the card frame.

The left-hand bracket is provided to facilitate the wiring of the modem rack to the LJUs. The line terminals of the modems are wired to a 37w type 'D' connector mounted on the bracket. From this an 18pr multicore cable carries the signals to the LJUs.

(f) The small PCB attached to the right-hand side of the modem rack. The +&-12V power supply to the modems is wired via spade connectors on this PCB.

(g) The DC power cables running to the KLIPPONS from the power supply rack - and from the KLIPPONS to the RINGLOCK connector on the computer drawer, the spade connectors on the DC BUS BARS of the card frame, and the small PCB on the modem rack.

On The Operating Floor

Panel Distribution

The two **PANEL DISTRIBUTION BOXES** are mounted in the base of the panel (on the right looking from the front).

On the rear of the Distribution Box `A` box are 32 RINGLOCK connectors, numbered 00 - 31, which are used to distribute data and power to the display modules.

The front of the box carries two 3U EURORACKS.

The top rack contains (reading from left to right as viewed):

(a) A 110V DISTRIBUTION module.

(b) One 5V & +/-12V power supply used by the Keyboard and Panel satellites.

(c) One 5V power supply for the display module logic circuitry.

(d) Two 5V power supplies for the display module LED matrices.

(e) Five POWER DISTRIBUTION MODULES.

The lower rack contains:-

(a) A 6HP plate carrying the IEC socket and fuse holder for the 110V power supply.

(b) A horizontal card frame with 5 card positions. - The Keyboard ASAD is mounted in the lower position and the Panel ASAD in the centre position.

(c) Three SIGNAL DISTRIBUTION modules, labelled PANEL, OCU and SERIAL LINKS.

(d) Two 6HP plates carrying 37w "D" crimp connectors (male). These are used to distribute display data to the RINGLOCK connectors.

On The Operating Floor

Panel Distribution - cont.

On the rear of the Distribution Box `B` box are 16 RINGLOCK connectors, numbered 32 - 47, which are used to distribute data and power to the display modules.

The front of the box carries two 3U EURORACKS.

The top rack contains (reading from left to right as viewed):

(a) A fused 110V IEC inlet panel.

(b) A 110V switch panel

(c) One 5V power supply for the display module logic circuitry.

(d) One 5V power supply for the display module LED matrices.

(e) Blanking Panels

(f) Three POWER DISTRIBUTION MODULES.

On The Operating Floor

Panel Distribution (cont.)

The Modules

110V DISTRIBUTION MODULE

A specially constructed module used to distribute 110V to the power supplies. - A DPST switch (with indicating neon) allows the 110V supply to all 4 power supplies to be controlled from this module.

DC POWER DISTRIBUTION MODULE

Specially constructed modules used to distribute display module power to the RINGLOCK connectors.

SIGNAL DISTRIBUTION MODULES

Specially constructed modules carrying "D" connectors on their frontplates. - Internally a PCB allows the "D" to be connected to the module edge connector via wire wrap posts.

Two of the modules carry a 37w "D". One of these modules is used to connect the Keyboard ASAD to the matrix card (mounted in the OCU), and the other connects the Panel ASAD to the KLIPPON module to which the switches and lamps associated with the fringe box alarms are wired.

The module allocated to the Keyboard (labelled OCU), is fitted with a female "D" and that allocated to the Panel is fitted with a male "D". This ensures that the cables are correctly attached. The wire wrapping within these modules determines the I/O configuration of the satellites.

The KLIPPON module is mounted slightly to the right of the centre-rear of the control panel.

The third SIGNAL DISTRIBUTION module carries two "D" connectors.

A 15w "D" through which the lines, connecting the panel satellites and the operating floor ATR printer to their respective control cards, enter the Distribution Box - and a 9w "D" carrying the lines connecting the printer to the distribution box.

On The Operating Floor (cont.)

OCU

The Operator's Control Unit is mounted in the horizontal surface of the Signalman's panel.

It has the appearance of a flat metal plate bearing five rows of keyswitches and three berth display modules. Handles are mounted proud of the panel on either side of the key switches protecting the keyswitches from side impact and facilitating removal from the control panel.

When removed from the panel the OCU can be seen to consist of a card frame bolted beneath the metal faceplate and a sub-chassis bolted beneath the frame. Three standard main display boards are mounted on the sub-chassis.

The LED matrices for the displays are mounted in IC sockets on the keyboard MATRIX card and connected to the display boards by header-terminated ribbon cables. Faulty display matrices can easily be replaced after access is gained by removing the faceplate.

The three display modules, although mounted and used with the keyboard, are not part of the KEYBOARD satellite system. - They are in fact driven by the display system, in the same way as all the berth displays, and are allocated the first three outlets of the distribution box.

The keyboard proper consists of two cards - the MATRIX card and the ASAD card. At Dundee only the MATRIX card is mounted in the OCU - the ASAD being mounted in the distribution box.

The matrix card plugs into the frame and can be withdrawn after removal of the faceplate. The matrix card is connected to the ASAD card by a ribbon cable which is header terminated on the upper edge connector of the frame. The NDA/EFA buzzer, mounted on the sub-chassis, is connected by plug to the edge connector of the matrix card and can be disabled by withdrawing the plug.

The ATR Printer

The ATR printer on the operating floor is situated on the supervisor's desk. The printer is a TEXAS 703 THERMAL which has a separate power supply. This is mounted beneath the desk.

Data passes to the printer from a CONTROL card in the ATR cabinet via the OUTPUT panel in the TD cubicle and the SERIAL LINKS module in the panel distribution box.

At The Fringe Box

The Fringe Box satellite unit is contained in a 3U total access equipment case. A 3U Eurorack, in which the cards and power supplies are mounted, is fitted in the rear of the case. The front of the case carries the faceplate on which the keyboard and the LED display boards for four berths are mounted.

In the base of the unit are the following "D" type connectors:-

One 9 way female for connection of transmission lines.

One 25 way male for connection of the remote C/O track contact.

One 37 way male and one 37 way female (not used).

Inside the unit, two sub-chassis (each of which carry two of the display units), and two annunciators are bolted to threaded inserts in the base.

The 3 cards used are mounted in the 3U Eurorack using a horizontal mounting kit which has a capacity of 5 cards.

The ASAD card is allocated the lowest position, the MR card the adjacent position and the BSDD card the top position.

The Eurorack also holds:-

The MODEM

One 5V & +/-12V power supply for cards and MODEM

One 5V supply for the display modules *

***WARNING : Due to manufacturer design improvements, power supplies supplied after 1995 have different edge connector allocation and are NOT interchangable with earlier ones.**

A plate carrying an I.E.C. socket and fuse for the 110V supply.

A small P.C.B. mounted on the rear of the rack is connected to the backplane of the BSDD card by ribbon connectors and to the display power supply by spade connectors. This board is used to distribute power and data to the display modules using flying leads connected to the standard ringlock connectors.

The backplane is connected to the keyboard and the "D" connectors in the base by ribbon headers and the annunciators to their drive circuits via bayonet connectors: the keyboard matrix differs from that fitted at the main box in some respects (see main document).

Circuits for line protection are mounted on small Klippon blocks external to the fringe box unit (Carnoustie only).

Early Transmission

All three fringe box links at Dundee are provided with Early Transmission (ET) facilities. These are as follows:-

Longforgan

All classes of train will transmit from D698 berth upon occupation of 556T with D698 aspect clear. Should D698 change to a restrictive aspect after transmission (but prior to D698 stepping to D672) an automatic CANCEL will be transmitted from D698.

Taybridge South

All classes of train will transmit from D718 berth upon occupation of 544T with D718 aspect clear. Should D718 change to a restrictive aspect after transmission (but prior to D718 stepping to D714) an automatic CANCEL will be transmitted from D718.

Carnoustie

To Be Changed
E.T. to Broughty Ferry is somewhat more complicated. Four berths (D763, D765, D943 and D769), in addition to the departure berth, transmit to Broughty Ferry (all codes). Each requires all aspects in the route to be clear from the berth to the limit of Dundee control. In addition, D763 requires occupation of 615T and D765 requires occupation of 614T. In each case if, after transmission (but prior to a step out of the berth), any signal in the route should change to a restrictive aspect, an automatic CANCEL will be transmitted from the transmitting berth.

For fault investigation procedures under E.T. conditions see **FAULT INVESTIGATION**, **SATELLITE FAULTS**, **MULDEM.**

VOLUME 1

SECTION 7 - GLOSSARY AND INDEX OF TERMS

NOTE: In what follows **"device"** can refer to a card, module, satellite or peripheral, according to context.

acknowledge - A control signal. When two devices (e.g. Control card and TD computer) are communicating, acknowledge is a code or signal sent from the receiving device to the transmitting device to indicate that the data sent has been received correctly. If acknowledge is not received, the transmitting device will either attempt to retransmit, or report a fault.

address - The binary code used by the system to select a device.

AK - shorthand for **acknowledge**.

alpha-numeric - A contraction of alphabetic-numeric. When applied to a device this term indicates that the device responds to, or generates, data which is to be interpreted as representing letters of the alphabet or numbers.

annunciator - An audible device, such as a bell or buzzer, used to attract the operator's attention.

ASCII - **A**merican **S**tandard **C**ode for **I**nformation **I**nterchange. A code established by the American National Standards Institute to provide an agreed interpretation of transmitted binary data. The code is based on 7 bits. In an 8 bit binary word, such as may be transmitted along a data bus, the 7 least significant bits (b0-b6) would, if ASCII is used, represent an agreed alpha-numeric character or control message. The 8th bit would be either ignored or interpreted as a parity bit. e.g. In ASCII, 1000001 represents the letter A and would appear on the data bus as 01000001.

asynchronous - Not synchronous. Synchronous communication between devices relies on the devices carrying out complimentary operations at the same time. Each device carries out a predetermined sequence of operations at a set rate and in a set order. The sequence must start and finish at the same time in both devices. Communication between synchronous devices relies on the receiving device being at the point in its sequence when it reads data in, at the same time as the transmitting device is at the point in its sequence when it outputs data. That is, the operation of the devices must be synchronised. In asynchronous communication the transmitting device is free to send data at any time. The start and end of each word in the message will be marked as specified by the transmission protocol. The receiving device will either respond to an interrupt generated by the incoming message, or test its receiving circuits for a message at intervals of less than the transmission time for the shortest possible message.

ATR - **A**utomatic **T**rain **R**eporting (page 4-2).

auxiliary - The literal meaning is "helpful". An auxiliary device is one which is an addition to the basic concept of the system. It may cover tasks which were overlooked at the design stage or thought useful later: or it may expand the capabilities of part of the system (see **auxiliary MR card**).

auxiliary MR card - This card "helps" the main MR card by providing the routeing system with an additional 16 Group Select signals; thus increasing the addressing capability of the system.

backplane - The cards and modules of the system plug into edge connectors mounted in the card frame. The terminal pins of these connectors, which are accessible from the rear of the card frame, are known as the backplane.

backplane wiring - This is the wiring terminated on the pins of the edge connectors constituting the backplane. It includes both point to point wire wrapping and PCB or ribbon cable bussing, and connects together the devices which constitute the system.

baud rate - The rate at which information passes down a communication channel. In a serial transmission link the baud rate will correspond to the number of bits passing over the link in one second. However, the baud rate is not equivalent to bits per second. An 8 bit **parallel link**, operating at 1200 baud will pass 8x1200 (i.e. 9600) bits per second.

berth - The location in memory where a description is stored (page 1-1).

berth-conditional step - A step, one of the conditions for which, is the presence in (or absence from) a berth of a description.

berth number - The number which the computer uses internally to identify a berth (page 2-3).

berth name - The name by which the berth is known to the Signalman (page 2-3).

binary - The system of counting to the base 2. In the decimal system we count to the base 10 and each of the digits can represent 10 numbers. e.g. In the decimal number "25" the LSD (least significant digit) "5" represents one of the ten possible "unit" numbers (0-9), and the MSD (most significant digit) "2" represents one of the ten possible "tens" numbers (0x10-9x10). - Each increase in significance of a digit multiplies its value by ten. In the binary system, each digit can represent one of only two numbers (0 or 1), and each increase in significance of a digit multipies its value by two. Thus the decimal number 25 is equivalent to the binary number 11001.

i.e.	binary	decimal
	1	1
	0x2	0
	0x2x2	0
	1x2x2x2	8
	1x2x2x2x2	16
	1 1 0 0 1	25

The number 25, which requires two digits to express it in decimal, requires five digits to express it in binary. However, binary has the advantage of being easy to represent electrically. - The two numbers of each digit can be represented by the two states of an electric circuit (ON and OFF). In practice, the circuit is switched to the potential of one of its (5V) power supply rails; 5V being taken to represent the condition of the binary digit represented above by 1, and 0V being taken to represent the condition of the binary digit represented above by 0. The condition (1) represented by 5V is also referred to as **HIGH**: and the condition (0) represented by 0V is also referred to as **LOW**.

bit - Shorthand for **b**inary dig**it** - see **binary**.

blind berth - A berth which is not displayed on the Signalman's panel.

BR 800 - A specification issued by the D of S&T regulating the design of train describers (page 2-4).

BR 1810 - A specification issued by the D of S&T detailing the protocol to be followed in communications between electronic systems used by the S&T. - The purpose being to ensure compatibility and ease the assimilation of individual systems into any future Integrated Electronic Control Centre.

buffer - A circuit providing for the temporary storage of data passing between two devices. One of the devices will place the data in the buffer and set a control bit indicating that the buffer is full, the second device will test the control bit and, when appropriate, take the data from the buffer.

bug - A design fault which has managed to remain undetected throughout the development and commissioning of the system. The designer has to ensure that the system behaves correctly under all conceivable circumstances. If circumstances combine in a manner which he has not foreseen, or which he believed could not happen, the system may produce unusual effects - or even place itself in a condition from which it cannot recover.

The design error which allows this to happen is called a "bug"; and, precisely because the circumstances which produce them are difficult to predict, bugs can be extremely difficult to eliminate. Having said this - it may be some consolation for you to know that, due to the small number of cards used and their simplicity, and because the programme is largely a standard package common to all ScR TDs (and has more limited responsibilities than in most other TDs), you are unlikely to be plagued by bugs.

bus - You get on a bus to travel between areas of the town: data gets on a bus to travel between areas of the system. A bus is a group of conductors with a common purpose connecting together devices in the system. The conductors may be ribbon cable, wire wrap or PCB tracks. The bus will have associated conductors carrying signals which control access to the bus.

byte - The smallest block of data with which the computer works. The computers used in the ScR TD have 8 bit buses for the passage of internal data; hence in the TD system a byte is a group of 8 bits.

BY-PASS module - A device which doesn't really do anything! Data passes into a BY-PASS module and is routed through it unchanged. A BY-PASS module is usually provided to give the system a degree of flexibility - you may not want to do anything with the data today, but in a year's time you may well wish to do something with it. The BY-PASS module can then be replaced by a module which can perform the required task without the need to alter the backplane wiring to accommodate the new module.

carrier - A signal, at a fixed frequency, which is present on a MODEM communication link when no data is passing over the link (see **MODEM**).

clock - A signal which controls the rate at which a circuit operates. Each time clock goes HIGH (or LOW) the circuit is free to change state; clock goes alternately HIGH and LOW at a fixed rate. There are several clock signals in the system: these may be either free-running or synchronised with a master clock signal on the computer or main MR card.

comparitor - A circuit which compares two bytes of data and gives an output indicating which byte has the greater binary value, or, if such be the case, that they are of equal binary value. It will be appreciated that this later indication is of considerable convenience in decoding address data.

condition - A term used in stepping (page 2-3).

configuration - The design of the ScR TD allows a considerable degree of flexibility. The cards can be combined in several ways to produce systems with differing capabilities, and some of the cards have circuit options built in to allow them to perform different tasks within the system. Once the system has been designed, the cards will have been combined in a particular way, and their role in the system, and hence their circuit options, will have been decided. - The circuit and cards are then said to be "configured" in a particular way. The combination of cards is known as the system configuration; and the circuit options chosen for the individual cards are known as the cards' configurations.

corruption - When the data in the system changes in a way not controlled by the programme, perhaps through power supply noise or radio interference, it is said to have been "corrupted". This phenomenon is known as corruption.

co-systems - See section 4.

current-loop - A serial transmission method using the presence or absence of a 20mA current in the transmission pair to indicate a 1 or 0. This method is less susceptible to interference than V24 and can be used over greater distances.

data - This is what it's all about! Data is what information is known as when it's inside a computer system. The job of the TD is to take information from the signalling system on the condition of tracks and routes and translate this to produce information on train movements for the operating staff. The translation process is known as data processing. - More specifically, the binary pattern of 1s and 0s within the system is the data.

Data can be split into two categories:-

(a) **variable data** is obtained through the systems I/O circuits and changes as traffic conditions change.

(b) **fixed data** is placed in the system by the designer and only changes when the system is modified or extended (e.g. the look-up table in ROM relating the berth numbers to berth names).

default - The circuits in the system have been designed to be in a particular condition unless instructed to assume a different condition by the programme. This condition is known as the "default" condition for that circuit or device. When the system is reset, the circuits and devices will assume their default conditions. They are then said to have "defaulted" to that condition.

description - page 1-1.

"D" - A type of multi-pin plug connector; so called because, when viewed head-on, the casing resembles the letter "D".

DIL - **D**ual **I**n-**L**ine (**P**ackage). A form of packaging in which the component lead-out pins are arranged in two rows of pins set at a pitch of 0.1". In the most commonly used integrated circuit package these rows are set 0.3" apart.

DIP - See DIL.

DIN - The initials of the institute which sets the standards to which German electronic equipment must comply. As you might expect of the Germans, these standards are very comprehensive and widely complied with. The edge connectors and racking system we use are to the DIN standards; these being by far the most widely adopted in this country for equipment of this nature.
duplex - The term used to describe a two-way transmission system. Simplex is transmission in one direction only between two devices: duplex is transmission in both directions between two devices. A full-duplex system is capable of transmitting in both directions at the same time: a half-duplex system must wait for transmission in one direction to stop before transmitting in the other direction. The ScR TD links are configured as 4 wire full-duplex systems. 2 wire full-duplex is possible, however we have chosen not to use it since fault-finding on the link then becomes rather difficult.

enable - To allow a circuit to operate. For example: If several cards are configured to place data onto a bus, only one must be allowed access at any given time. The bus buffer of the card which is to be allowed access is enabled by addressing the card through the routeing system. Enable is also the name of a signal performing such a function.

event-driven - An event-driven circuit is one which operates only when required to do so by something happening rather than as part of a timed sequence.

eurorack - The name in common use for racks to the DIN standard to which those used to contain the TD are built.

fault - A hypothetical condition which the ScR TD will never enter.

fringe box - One of the signalboxes to which the signalbox in which the TD is situated works (i.e. a box at the fringe of the TD's area of control). The term is not used of a signalbox which has its own TD installation, this would usually be termed an "adjacent box". The fringe box Signalman is usually provided with a satellite unit which can communicate with the TD and which takes the place of the block bell system (page 3-9).

FET - **F**ield **E**ffect **T**ransistor. A type of transistor which is effectively a voltage controlled switch.

FM - **F**requency **M**odulation. The method of encoding data on a carrier signal by altering its frequency.

full-duplex - see **duplex**.

group select - A routeing system signal generated by a MR card: used either to select a group of 8 berths on a BSDD card (which is how it gets its name) or to direct data to, or from, a control card.

handshaking - When two devices communicate, control signals are necessary to determine the sequence of data flow. That is, to determine in which direction the data is to pass, and, whether the device is ready to send or receive.

hardware - The physical components of the system.

header - The receptacle into which an insulation displacement connector plugs.

HIGH - see **binary**.

HP - The unit in which the width of a eurorack is measured, and hence, the unit in which the width of the components fitted to it are specified.
IC - **I**ntegrated **C**ircuit. A package containing part of the logic circuit. It will contain several logic gates, some of which can be tested individually, but all of which have to be replaced together due to the packaging. The ICs used in the system are usually "74 series" circuits, and the number printed on the package, following the series identifier, identifies the logic elements present in the circuit.

IDC - **I**nsulation **D**isplacement **C**onnector. A type of connector the electrical contact of which relies for its mechanical integrity on a system of twin blades which cut through the insulation around the conductor and bite into the conductor to establish an electrical connection.

IEC - Yet another standard. This one defines the connectors which we use for 110V.

inter-computer link - page 4-1.

interface - As a noun: the junction between two devices or systems. As a verb: to link two devices or systems.

interrogate - To ask the TD for the location of a train or the contents of a berth.

interrupt - page 2-2.

inter-system link - page 4-3.

isolation supply - The system is connected to the interlocking and panel indication circuits via opto-isolators. To maintain the integrity of this isolation, separate power supplies are required on the input side of the opto-isolators. These supplies are known as the isolation supplies.

keyswitch - The single pole push to make switches used in the keyboard.

La - The system uses double-eurocard format PCBs each of which has two indirect edge connectors fitted, which, when the board is fitted in the rack, can be thought of as an upper edge connector and a lower edge connector. "L" refers to the lower of these edge connectors. The pins of these edge connectors are in two vertical rows: "a" refers to the right-hand row (when viewed from the rear) and "c" to the left-hand row. Hence La10 is the tenth pin down in the right-hand row of the lower edge connector.

Lc - see **La**.

latch - A storage device into which data can be written and in which data will remain until cleared.

LED - **L**ight **E**mitting **D**iode. A semiconductor which has the usual properties of a diode, but which in addition emits light of a fixed wavelength when forward biased.

LJU - **L**ine **J**ack **U**nit. The standard box for terminating telecommunication line circuits (as used in your home).

LSB - **L**east **S**ignificant **B**it. In a binary code, the LSB is the digit with the lowest numerical significance (see **binary**).

LOW - see **binary**.

Main MR card - Each TD system must have one MR card to handle interrupts, provide the system clock and convert the display data to a serial stream. This is the main MR card. All other MR cards present, used solely to expand the range of the routeing system, are referred to as auxiliary MR cards.

matrix - A collection of objects organised into a network of rows and columns such as the keyswitches in the keyboard or the LEDs forming the display characters. Each object in the matrix is known as an "element" and can be identified by reference to its row and column. This junction of row and column is known as a "node".

memory - The area of the computer in which is stored: (a) the programme and (b) the data.

This memory is of two distinct types:-

(i) ROM - Read Only Memory, the contents of which have been determined by the programmer and do not change even if the power is removed from the system.

(ii) RAM - Random Access Memory, which would be known as RWM or Read/Write Memory if consonants were more readily pronounceable, the contents of which can be changed readily and which are determined by the operation of the programme. If the power is removed from the system the contents of RAM are lost.

The system's ROM contains the programme and the fixed data. The system's RAM is used for data processing: i.e. it contains the variable data.

meshing - page 2-3.

MSB - **M**ost **S**ignificant **B**it. In a binary code, the MSB is the digit with the highest numerical significance (see **binary**).

MOD - Shorthand for modification. This appears after the SES number identifying the card on some of the cards used in the system. It distinguishes small variations in the build characteristics of the card. The number following "MOD" identifies the exact variation. Cards with higher MOD numbers have extra facilities but are interchangeable with any card bearing the same SES number.

MODEM - **MOD**ulator/**DEM**odulator. A device used to transmit serial data over long distances in a comparatively interference-free form. It works by transmitting a fixed frequency known as the carrier when no data is present and shifting to one of two other frequencies (known as mark and space), one either side of the carrier frequency, to represent the two binary states of the data.

MULDEM - **MUL**tiplexer/**DEM**ultiplexer. When multiplexing the MULDEM handles multiple inputs in such a way that the data from them can be passed along an 8 bit bus. When demultiplexing the MULDEM handles the data from an 8 bit bus in such a way as to maintain multiple outputs. page 3-13.

NSB - **N**ext **S**ignificant **B**it. In a binary code, the digit next in numerical significance, either more or less, to one previously identified (see **LSB** & **MSB**).

octal - The system of counting to the base 8, i.e. the least significant digit represents the states equivalent to decimal 0-7.

OCU - **O**perators **C**ontrol **U**nit. The Signalman's means of communicating with the TD, consisting of the keyboard plus the SET-UP and ALARM berths.

on-line - The term used to describe a working system in use. An off-line system is one which is not being used as a TD, having been taken possession of by programmer or technicians.

opto-isolator - A device consisting of an LED and a photo-sensitive transistor encapsulated in a light-proof package: used to provide electrical isolation between two signals. One signal switches the light from the LED on and off, thus turning the photo-transistor on and off. The transistor controls the second signal and hence the first signal effectively controls the second without any electrical connection existing between the two.

oscillator - A device which produces a regular waveform: often used to provide a fixed frequency clock signal.

PCB - **P**rinted **C**ircuit **B**oard. A fibre-glass board carrying a pattern of copper tracking on its surface. This tracking forms the electrical connection between circuit elements.

peripherals - Almost anything connected to a computer. When dealing with the ScR TD the term is used mainly of the remote ATR equipment.

port - A path in or out of the computer. In the ScR system usually a bi-directional buffer in which the data can be stored until the receiving device is ready to accept it.

populate - To fit the components to a board. Some of the boards in the system are designed such that they can be populated in more than one way: how they are to be used in the system decides how they are to be populated. The ASAD is one such board. The "population" of a board differs from the "configuration" of a board in that boards which have been populated differently have different components fitted and cannot function in each other's place; whereas boards which are configured differently have the same components present with optional links (which can of course be changed) determining how they are to be used.

processor - The part of the computer which does all the work. The processor takes each programme instruction in turn and carries out the logical operation required by that instruction, on the data specified by that instruction, before moving on to the next instruction.

programme - A list of instruction for the processor to carry out. The programmer's skill lies in picking the sequence of instructions which will produce the required results from the input data.

protocol - The rules governing communication between two devices or systems. The protocol will specify the handshaking, message format, baud rate etc.. It will be obvious that, to avoid the data being misinterpreted, the protocol must be strictly adhered to. Data which does not conform to the protocol will be ignored.

pulse - A short burst of electrical activity. For example, a control signal will normally sit at one logic level (at which level it is said to be "inactive"). When it is required to fulfil its purpose it will move to the other logic level for a short period of time (when it is said to be "active"). This change in logic level is a pulse. The pulse will be specified by the direction of change in logic level (e.g. a negative going pulse changes from high to low and a positive going pulse changes from low to high), and by duration: i.e. the time spent in the active state.

RAM - **R**andom **A**ccess **M**emory (see **memory**).

reporting point - page 4-2.

RD - **R**ea**D**. A control pulse issued by a receiving device to obtain data from a transmitting device.

RDY - **R**ea**DY**. A handshaking signal associated with the main TD computer's I/O buffers. RDY is set if the buffer contains data.

refresh - The data in the berth displays is retransmitted at frequent intervals. The purpose of this is to guard against the display of wrong data which may have entered the display, either through a previous transmission being corrupted or as the effect of a power surge.

ribbon cable - A flat multi-core cable with the cores running parallel to each other at a fixed spacing in a single plane, with the insulation of each attached to that of its neighbours. This format makes the cable ideal for use with multi-way IDC systems.

ringlock - A circular multi-pole connector with a bayonet latch to ensure firm mating.

ROM - **R**ead **O**nly **M**emory (see **memory**).

routeing system - page 2-2.

RS 232 - An internationally accepted communications interfacing standard, originating from America, based on a 3 wire communication channel with voltage polarity changes of the Rx and Tx wires (relative to the 3rd wire reference voltage) representing mark and space. RS232 also specifies the handshaking signals used and the pin allocations of the interfacing connector. V24 is essentially the same standard as defined by a European standards authority. The SES has adopted the convention of referring to RS 232 when the link under discussion uses the complete specification and to V24 when only the polarity changing principle has been used: This is incorrect usage but it does come in handy!

RX - shorthand for receive.

satellite - page 3-1, also page 3-9 (satellite fringe box).

scan - to examine sequentially. For example, in the stepping routine, the computer scans the output buffers of the BS cards, examining bit 8 of each in turn to determine whether a step is required from that card. Also used to refer to a complete "run-through" of the programme: i.e. from start instruction to start instruction.

SDCK - **S**erial **D**ata **C**loc**K**. A signal used in the display system to determine the rate of transmission of data to the display units.

SES - **S**ignalling **E**lectronics **S**ection. At the time of writing, the section in the Regional Signal Engineer's Office charged with responsibility for all of the S&T Dept.'s (non-telecom.) electronic systems.

simplex - One way data transmission (see **duplex**).

step - page 2-3.

stepping - page 1-1 and 2-3.

sub-chassis - The metalwork supporting an electronic circuit situated within the casing of a larger system element.

swingframe - A sub-chassis supporting the main TD (or ATR) computer within the drawer unit. The swing-frames are hinged, allowing the computer to be swung clear of drawer the for test purposes, and giving access to the spare computers.

trigger - page 2-3.

tri-state - A type of logic, mainly used in circuits connected to a bus, which can assume, in addition to the binary logic levels, a third state which presents a high impedance to the bus; allowing other devices to use the bus without electrically stressing either circuit.

TX - shorthand for transmit.

U - The unit in which the height of a eurorack is measured, and hence, the unit in which the height of the components fitted to it are specified. Note, however, that a 6U card is more than twice the height of a 3U card since it includes the height which, when two 3U racks are stacked, is occupied by the upper rail of the lower rack and the lower rail of the upper rack.

Ua - The system uses double-eurocard format PCBs each of which has two indirect edge connectors fitted, which, when the board is fitted in the rack, can be thought of as an upper edge connector and a lower edge connector. "U" refers to the upper of these edge connectors. The pins of these edge connectors are in two vertical rows: "a" refers to the right-hand row (when viewed from the rear) and "c" to the left-hand row. Hence Ua10 is the tenth pin down in the right-hand row of the upper edge connector.

Uc - see **Ua**.

V24 - see **RS 232**.

validation - page 2-4.

wire-wrap - A system of wire termination which has largely replaced soldering in backplane wiring. The termination pins are square in cross-section with sharp edges. A special tool is used to wrap the wire tightly around the pin such that the edges of the pin bite into the wire; forming a firm electrical connection.

word - The smallest block of data representing a meaningful character. This often coincides with a byte, but not always. For example, to transmit a description to the display units, 4 characters must be sent and hence 4 words are transmitted. However a modified 6 bit code (known as truncated ASCII) is used allowing the 4 characters to be represented by 24bits; hence the 4 words are transmitted as 3 bytes of data.

WR - **WR**ite. A control pulse used by a transmitting device to transfer data to a receiving device.