ScR. TRAIN DESCRIBER

FIRST LINE MANUAL

VOLUME 1

Revision 1

DUNDEE TRAIN DESCRIBER - RECORD OF MODIFICATION

ISSUE DATE	MODIFICATION
April 1992	**Meshing changes arising from Plan S877075 :-**
	Block A Step 16 Trigger - from 3487 etc.T to 3485 etc.T Block B Step 8 Trigger - from 524T to 526T Condition - from 528T to 714UR Block B Step 9 Trigger - from 533T to 525T Condition - from 523T to 715UR
March 1995	**Major changes arising from Plan L011/DS/0001 :-**
	Broughty Ferry F.B. decommissioned Carnoustie F.B. Commissioned New 16 display Distribution Box in Dundee Panel New Stepping Block H Stepping & E.T. changes Dundee T.D. Program update
	Changes to pages in First Line Manual :- VOLUME 1 Section 5 - 7, 20 Section 6 - 1, 2, 4, 5, 10 to 15
	VOLUME 2 Section 1 - Index, Dgn2 - Dgn10 Section 2 - Index, 1 Section 3 - Index, 8 Section 4 - Index, 2, 3, 4, 5 Section 5 - 1, 2, 3 Section 6 - Index, 2, 3 Section 7 - 4, 5, 6 Section 8 - 1 Section 9 - 1 Section 10 - 1

VOLUME 1

VOLUME 1

SECTION 1 - INTRODUCTION

Train Describers

The core of a Train Describer is the **BERTH DATA**.

The berth data is a continuously updated record of the location of each train within the Signalman's area of control.

A unique four character code for each train, known as the **DESCRIPTION**, is held in the Train Describer memory: The area of memory in which each description is held is known as a **BERTH**.

Each berth can be thought of as representing a geographic location within the Signalman's area of control - usually a signal section. The description is put into the system by the Signalman's, either at the main box or at one of its fringe boxes, via an alphanumeric keyboard.

The main function of the Train Describer is to automatically update the berth data as the train moves within the area of control.

This is known as **STEPPING**.

So that the Signalman may make use of this information, the computer displays the contents of each berth on the control panel (alongside the representation of the area with which the berth is associated).

This is the **DISPLAY** function.

A number of functions of the system involve its interaction with either its human operators or associated systems. For example:-

(i) When a train leaves the area of control of the main box its description must be transmitted to the adjacent box.

(ii) When a train enters the area of control, the TD, and the Signalman, must be made aware of the new data.

(iii) Incorrect operation of the system, or malfunctions, must be brought to the Signalman's attention.

(iv) The Signalman must be able to alter or remove data via the keyboard.

All of these can be grouped as the **INTERFACE** function.

<u>The Manual</u>

VOLUME 1 consists of seven sections, this introduction, a glossary, and five others each of which deals with an aspect of the TD system.

The first of these sections, **DESCRIPTION**, describes the architecture of the TD hardware used to provide the functions mentioned above. It aims to show how each function is accomplished and includes a brief description of the cards used.

The nature of the INTERFACE function is such that much of the hardware involved must be situated remote from the main TD installation. In the ScR TD, each interfacing piece of remote hardware (e.g. the Signalman's KEYBOARD) is termed a "satellite" of the TD. The **SATELLITES** are the subject of a separate section.

Further sections deal with the TD's **CO-SYSTEMS** (a term which will be explained in the relevant section), and **FAULT INVESTIGATION** (a term which will require no explanation).

All the sections referred to above can be used with any ScR TD installation. Variations in configuration which are applicable at the specific installation which this manual documents are covered by the **SITE APPENDIX** which completes this volume.

VOLUME 2 contains drawings, intended to aid understanding of this volume, and tabulated site data; included in order that this manual should constitute a complete record of those aspects of the TD which will be of interest to the first line maintenance staff.

It should not be necessary to stress that **THE MASTER COPY RETAINED ON SITE SHOULD BE REGARDED AS CORRECT** whenever the data it contains differs from that recorded here.

Please note that, due to the limitations of the word-processor used, where specific control pulses are mentioned in the text no indication of the logical sense of the pulse has been included. Please check with the site drawings, where all "active low" pulses are indicated by a bar placed over the name of the pulse.

VOLUME 1

SECTION 2 - DESCRIPTION

Architecture

The system is built around a Z80-microprocessor based computer in the form of a single card development board. The programme is contained in plug-in ROM. Within the computer data passes to and from the central processor over a **DATA BUS**. The source, direction and destination of this data are controlled by an **ADDRESS BUS**.

For the TD to operate data must pass between the computer and the other cards in the system. The board is configured to communicate in three ways:-

(i) Immediately via the DATA and ADDRESS buses
(ii) On request over a serial RS232 link
(iii) In parallel via on board storage

This last option provides four independent paths to and from the computer which the computer can write to, or read from, as and when required. These are known as **I/O** (Input/Output) **PORTS**.

The serial link is used during programme development and is available on a 'D' type socket on the computer drawer. It is not used by an on-line system.

The TD has three main functions. These are:- **STEPPING**
INTERFACE
DISPLAY

STEPPING data passes over the **STEPPING BUS** which is connected to the computer via one of the I/O ports.

INTERFACE data passes over the **INTERFACE BUS** which is connected to the computer via another of the I/O ports.

DISPLAY data passes directly over the **DATA BUS**.

Four types of card are used in the TD mainframe.

These are:-	The Master Routeing cards	**(MR)**
	The Berth Select and Display Drive cards	**(BSDD)**
	The Berth Stepping cards	**(BS)**
	The Control cards	

The Control cards are used in the interface function and the BS cards in the stepping function.

The MR and BSDD cards are used to route data between the processor, the other cards, and the displays. The data passing between computer and BSDD or Control card is controlled by the MR cards and the data passing between computer and BS cards or Display units is in turn controlled by the BSDD cards.

This control structure is referred to as the **ROUTEING SYSTEM**.

Architecture (cont.)

The Routeing System

The essence of computer architecture is the bus system.

Both the source and the destination of data on the data bus must be under the control of the computer. Internally this is done by the address bus which accesses the peripheral devices (such as memory and I/O ports).

When data passes into the system beyond the computer board, some of the data will be passed directly on the bus and some indirectly (using ports as access to the bus).

The source and the destination of this data is controlled by the routeing system - an extension of the addressing system which is tailored to the needs of the hardware.

The computer indicates that it requires to use the bus for external data by generating the control signal **IORQ**. This signal is used to enable the MR card which is the first stage of the routeing system.

Both external addressing and data passing between the computer and the external device is carried on the data bus. The computer address bus is used to differentiate these two functions of the data bus - routeing the data either to the display system as data or to the latch on the MR card which stores the address of the selected external destination (or source).

If the system contains more than one MR card, the address bus is used to select the required card.

The routeing system also controls the **INTERRUPTS** to the processor.

Interrupts are, as the term implies, a method whereby the normal running of the computer programme can be suspended (or interrupted) and the computer used to perform some urgent task. The routeing system determines the priority of any co-incident interrupts and passes the identity of the highest priority interrupt present over the data bus to the processor.

This use of the bus is controlled by dedicated interrupt controls which the computer activates on receipt of the interrupt signal.

Stepping

In the ScR Train Describer, the data for each description is stored in three eight bit words (bytes) of RAM. These three bytes of RAM, together with a fourth byte used to record berth status, are identified as one berth store.

Each berth store is allocated a unique hexadecimal number. This number is the **BERTH NUMBER** used by the computer.

Each berth must also have a **BERTH NAME** which a human being can easily associate with a geographic location - usually a signal number is used. Some berths will have more than one name.

A table is held in ROM relating the internal number of each berth to its name (or names).

The stepping function consists of transferring the data representing the train description from the RAM allocated to one berth to the RAM allocated to the other. - This represents the passage of the train from the control of one signal to that of the next.

The transfer is known as a **STEP**.

The step is made from the **FROM BERTH** to the **TO BERTH**.

In most cases the description steps when the train occupies the track ahead of the signal. The occupation of this track is called the **TRIGGER** of the step since it initiates (or triggers) the step.

Since the track could be occupied during movements through a conflicting route - and since many signals read over more than one route - the system must be able to distinguish whether a step is intended and, if so, which berth to move the data to.

A little reflection will show that the direction of passage can be determined by detecting that the route has been set, and that diverging routes from a berth can be distinguished by proving facing points set.

This string of contacts used to establish that the route has been set is known as the **CONDITION** since the execution of the step is conditional (i.e. depends) upon the completion of this chain.

The construction of this chain is known as **MESHING**.

In the ScR Train Describer the meshing of conditions is accomplished by free wiring within the interlocking system.

To recap, each step is triggered by the closure of one contact and is conditional upon the route being set for that step, this being established by the completion of the condition chain of contacts.

Each signal will have as many steps as there are different destinations from that signal.

Stepping (cont.)

The design of train describers is regulated by a written specification issued by the DIRECTOR OF S&T ENGINEERING and known as BR SPEC. 800.

To ensure that contact bounce and "bobbing" tracks do not give rise to false steps, BR SPEC. 800 requires:

(a) that a condition be present for 3 seconds before being accepted by the TD.

and

(b) that the trigger be absent for 3 seconds following a step before the TD accepts any further trigger for that step.

If these requirements are met the step is said to be **VALID**. The process of establishing that a step meets these requirements is known as **VALIDATION**.

In the ScR TD the hardware proves that each step is valid before presentation of the data to the computer: Thus the stepping programme has only to transfer data within store.

The hardware provides a separate validation circuit for each step. These are on the BS cards.

Each berth is allocated a separate validation circuit for each step possible from that berth: Each validation circuit can be separately enabled onto the bus.

The stepping programme checks for steps by outputting the address of each berth (i.e. its internal berth number) in turn.

When an address is output it results in all the validation circuits allocated to that berth being enabled; when the validation circuits are enabled the bus is read.

In each validation circuit is an eight bit d.i.l. switch which will have been preset such that, when a step has been validated and the circuit enabled, an eight bit code will be written to the bus.

The most significant bit **(MSB)** of this code will indicate that a valid step is present on the bus, the remaining bits indicate the address to which the description is to be transferred. Each of the validation circuits allocated to a given **FROM** berth will contain a different address. This will be the berth number of the **TO** berth.

As the bus is read the computer checks the most significant bit.

If this bit indicates that no valid step is present the programme passes on to check the next berth.

Should the MSB indicate the presence of a valid step, the programme will test the contents of the FROM berth and, if a description is present, transfer the contents of the RAM allocated to the FROM berth into the RAM allocated to the TO berth before passing on to check the next berth.

If no description is present the programme will trigger the NDA alarm and place the **NON-DESCRIBED** code **(****)** in the TO berth RAM.

Display

The computer writes the contents of the berth RAM to the corresponding display unit under the following circumstances:-

(a) When a step either to or from the berth occurs.

(b) When data is entered to the berth by the interface system.

(c) When the **REFRESH SEQUENCE** is initiated.

The **REFRESH SEQUENCE** is initiated every 30 seconds. Its purpose is to guard against corrupt data being allowed to stand in a display unit. During refresh the **DISPLAY ROUTINE** is called for each berth in numerical sequence.

The display routine operates as follows:

The computer outputs the address of the required berth. The routeing system selects the BSDD card and enables the display drive circuit allocated to that berth.

With the Display drive enabled the RAM word containing the most significant digit of the description is loaded into the parallel to serial converter on the MR card. Once loaded the converter outputs the word in serial form, most significant bit of the most significant digit leading, to the display connected to the enabled display drive. When the computer receives the signal indicating completion of transmission of the first word, it loads the second and in a similar manner the third.

On completion the enable is removed from the display drive.

A TEST switch is provided on the computer swingframe which initiates a routine to write the contents of the ROM containing the berth names to the displays. This operates in a manner similar to that described above - differing in that the data is obtained from ROM and is output continuously.

Interface

All interface links exchange data with the computer via a common I/O port.

When the processor wishes to pass data to the interface it places the data in the port buffer and selects, via the routeing system, the Control card allocated to the required link.

Local processing in the card is continuously testing for selection. When selection is detected the card enters a routine to read the port buffer.

In this routine the Control card tests the buffer's RDY signal which indicates whether or not the buffer holds data. When the Control card reads the buffer, RDY will change to indicate that the buffer is empty.

The computer also tests RDY, and when it detects the empty buffer (indicating that the link has read the data) it will place the next word of the message in the buffer, or, if the message is complete, will deselect the link.

After reading the buffer the Control card will continue to test RDY for a limited time. If the buffer remains empty during this period the Control card will stop monitoring RDY and leave the routine. - If RDY indicates that the buffer is full during this period the sequence will be repeated.

When the link wishes to pass data to the computer the Control card interrupts the computer via the routeing system. Sensing an interrupt, the computer determines the source of the interrupt from the routeing system and sends an acknowledging signal to the interrupting Control card.

When the Control card receives this acknowledge it writes its data into the bus buffer, removes its interrupt and waits for deselection. When the computer senses that the buffer is full it reads the data and deselects the interrupting link.

Master Routeing Card 83SES2

This card performs four functions:-

1) An oscillator which is used both to control the frequency of the serial transmission of data to the display, and to generate the system clock pulse which provides the timing element necessary for step validation.

2) A parallel to serial converter which, when loaded with an eight bit word of parallel data, outputs a stream of eight serial data bits - each with an accompanying clock pulse.

3) An interrupt handling circuit which processes interrupts from eight sources, identifies the interrupt of highest priority, and passes the interrupt signal to the TD computer - together with the identity of the highest priority source present.

4) A routeing circuit into which can be latched the eight bit address of the external function with which the computer wishes to exchange data.

Bits 3-6 are used as a four bit word which is presented to a four to sixteen decoder to select one of sixteen enabling signals known as GROUP SELECT (GS).

Bits 0-3 are output as a three bit word for use to further expand each of these sixteen outputs.

One MR card will be designated the **MAIN** MR card; all other MR cards present will be designated **AUXILIARY** MR cards.

The auxiliary MR cards will be used only for routeing purposes - the oscillator and parallel to serial converter in the Main MR card being sufficient for the whole system.

Interrupt handling will be via the circuit on the main MR card - although in an exceptionally large system it may be necessary to use the circuits on the auxiliary cards cascaded via the main card.

<u>BSDD Card</u> 80SES1

For routeing purposes the berths can be considered in groups of eight. Each BSDD card routes two of these groups.

A three bit word identifying one of the eight is presented to a three-to-eight converter. When the converter is enabled (by a signal known as the **GROUP SELECT**), the resulting single output enables one of eight display drivers - allowing serial data to be routed to the display selected.

Additionally, the eight outputs of the converter are presented to an eight bit latch. The outputs of this latch are designated **BERTH SELECT** and are used to select berth validation circuits for test.

<u>Berth Stepping Card</u> 83SES1

This card contains eight separate circuits which are connected to the bus via a common tri-state buffer.

Each of these circuits is used to validate a single step.

By validation is meant ensuring that the trigger and condition for the step meet the requirements of BR 800.

The validation circuits are connected to the signalling inputs (i.e. the condition and trigger contacts) by opto-isolators.

In each of these validation circuits a tri-state buffer (known as the STEP buffer), all of whose data inputs are tied low, is connected to the bus buffer via an eight way switch. The inputs of the bus buffer are pulled high by resistors. Thus if one of the switches is closed one input of the bus buffer will be pulled low when the step buffer is enabled.

If a switch is closed for each low in the TO BERTH address and left open for each high in the TO BERTH address, then, when the step buffer is enabled, the TO BERTH address will be encoded in the eight bit binary number which is presented to the bus buffer.

The step buffer can only be enabled when the step has been validated, and the validation circuit selected by the berth select pulse.

Control Card 82SES1

The Control card is an intelligent serial to parallel converter.

It is used on the INTERFACE BUS to convert the data passing between the TD and its satellites from the serial form used for transmission to the parallel form used on the bus (and vice-versa).

Since the satellites will usually be situated remote from the housing of the TD electronics, the interface is designed around commonly used distance communication techniques. **These techniques are serial in nature - the computer handles data in parallel form.** The role of the Control card is essentially that of converting parallel data blocks to serial data streams and vice-versa. An on-board micro-controller is used to check that incoming messages conform to the transmission protocol and to configure outgoing messages to that protocol.

Certain aspects of the protocol are determined by inputs which the processor tests on power-up. The condition of these inputs is determined by wire-wrapping on the backplane at the position which the card occupies. These include:-

(a) The number of bits per data word (generally 7 if the word represents an ASCII character and 8 otherwise).

(b) Which of three transmission sequences the card will follow.

   (i) The card will attempt three transmissions in the event that it does not receive an AK code from the receiving system. (This is the sequence used for communicating with satellites).

   (ii) The card will transmit once only with a message format conforming to BR SPEC 1810. (Used for communicating with some non-SES developed systems)

   (iii) The card will transmit once only - checking after each character received from the main computer for a special code signifying that the next code is to be interpreted as a number of "space" codes which are to be transmitted after the character. (Used for transmission to peripherals - e.g. ATR printers).

The connections are:- Default - 8 bit, 3 transmissions.
Ua17/Uc17 strapped - 7 bit.
Ua18/Uc17 strapped - transmission type (ii).
Uc18/Uc17 strapped - transmission type (iii).

NOTE that the above arrangement requires the presence of a DIL plug in the SKT2 position of the Control card. This plug should be strapped 1/3, 4/6, 8/10 and 11/13 on MOD2 Control cards and 2/3, 5/6, 8/9 and 11/12 on earlier boards.
No plug necessary.

All transmission protocols used by the Train Describer and its Co-systems use even parity. The Control card is programmed accordingly.

Wire-wrap links on the card select the baud rate and plug-in links select V24 or current loop transmission.
TD - F7 LINKED
ATR - F9 LINKED

Control Card 82SES1 (cont.)

Three LEDs which give an indication as to whether or not the link is functioning correctly are mounted on the card edge. Their use is detailed in the **FAULT INVESTIGATION** section.

VOLUME 1

SECTION 3 - SATELLITES

Introduction

The satellites are those parts of the train describer which are situated remote from the cabinet housing the main computer.

The computer communicates with its satellites over a bus system driven by one of its I/O ports (the INTERFACE bus). Control cards on the bus communicate serially with the satellites - either by directly wired V24 or via an intermediate modem.

The passage of data between the links and the computer is detailed in the description of the INTERFACE function.

Passage of data over the link is event driven and asynchronous.

Each satellite has a local processor to minimise the requirement to communicate with the main computer. This processor will usually be an ASAD card having programming and hardware configuration appropriate to the function of the satellite.

The communication link is wired directly to the ASAD card which controls any other cards used in the satellite. These other cards will be referred to as **SUPPORT CARDS**.

Introduction

The keyboard is the Signalman's means of communication with the computer.

Using the keyboard the Signalman is able to do the following :-

(i) Enter a description in any berth of the train describer.

(ii) Remove a description from any berth of the train describer.

(iii) Determine the location of any train in the area of control.

(iv) Determine the contents of any berth on the panel.

(v) Receive and acknowledge "non-described" alarms (NDA).

(vi) Receive and acknowledge equipment fault alarms (EFA).

The keyboard is mounted in the horizontal surface of the control panel.

It will usually have the appearance of a flat metal plate bearing five rows of keyswitches and three berth display modules. Handles mounted proud of the panel on either side of the keyswitches protect them from side impact and facilitate the removal of the OCU from the control panel.

The displays are labelled BERTH, DESCRIPTION and ALARM.

Immediately beneath the displays, the top row of ten keyswitches are engraved with the numerals 0-9. Beneath these the second row are engraved with the letters A-J, the third K-T and the fourth U-Z.

Of the remaining four keyswitches in the fourth row, two are engraved with special characters (* and -) and two are blank.

The remaining row consists of special function keyswitches - four which are double sized and labelled INTERPOSE, INTERROGATE, RESET and CANCEL, and two - standard sized but illuminated - beneath which are the legends NDA and EFA.

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.

All the keyswitches are mounted on the matrix card. The printed circuit of this card connects the keyswitches in a 6x8 matrix and also carries the necessary blocking diodes.

The ASAD card is programmed to scan the matrix, drive the EFA and NDA lamps and buzzer, and communicate with the main computer.

Introduction (cont.)

The matrix card plugs into a frame bolted beneath the metal faceplate. The location of the ASAD varies between installations.

A buzzer mounted in the panel serves as audible warning of NDA or EFA. This buzzer is connected by plug to the edge connector of the matrix card and can be disabled by withdrawing the plug.

The keyboard and the three berths mentioned above are together referred to as the Operator's Control Unit (OCU).

Using the OCU

To place a description in a berth:

Type the berth name on the keyboard - the BERTH display will display each character as it is entered (when the BERTH display is full any further entries will appear in the DESCRIPTION display).

When the berth name, which must be four characters long, has been entered the BERTH display should be full and the DESCRIPTION display empty.

Type the description to be entered, which should again be four characters long, on the keyboard. The DESCRIPTION berth will display each character as it is entered. When the DESCRIPTION berth display is full, further use of the alphanumeric keys will have no effect.

When you have checked that the berth name and description are correctly displayed - push the key marked INTERPOSE.

The description will appear in the display allocated to the berth addressed, and the BERTH and DESCRIPTION displays - known collectively as the **SET-UP BERTHS** - will clear.

Should you make a mistake when entering the berth name or the description, pressing the key marked RESET will clear the current SET-UP berth. If you have entered the description and realise that you have incorrectly entered the berth name, RESET must be pressed twice. The first push will clear DESCRIPTION and the second BERTH.

To remove a description from a berth:

Type the berth name on the keyboard. With the berth name in BERTH, press the key marked CANCEL. The berth addressed will be cleared, as will BERTH. If the berth is one which transmits to an adjacent box a cancel code will be automatically transmitted to the adjacent box as the berth clears.

To check the contents of a berth:

Type the berth name on the keyboard. With the berth name in BERTH, press the key marked INTERROGATE. Any description present in the berth addressed will be displayed in the DESCRIPTION berth. If no description is present this will be indicated by "-ND-" (for NO DESCRIPTION) appearing in the DESCRIPTION berth. If the berth name entered does not exist "-NB-" (for NO BERTH) will be displayed.

Using the OCU (cont.)

To check the location of a train:

Enter four characters in the BERTH display - this is to allow access to the DESCRIPTION display. To avoid any possibility of confusion between the characters entered and a genuine berth name it is recommended that the code **** be used.

With the BERTH display full, enter the train description in the DESCRIPTION berth. With the description in DESCRIPTION, press the key marked INTERROGATE. If any train is present bearing that description the name of the berth which it currently occupies will be displayed in BERTH. If no train bearing the description is present this will be indicated by "-NP-" (for NOT PRESENT) appearing in BERTH. If more than one train bears the description (e.g. ****), an indication of the number of berths in which trains bearing the description are present will be given - e.g. " 3BS" (for THREE BERTHS) if three trains bearing the description are present.

The Equipment Fault Alarm (EFA):

Should a major fault develop in the TD a warning buzzer will sound and the red keyswitch marked **EFA** will flash. To acknowledge the alarm the Signalman must press this keyswitch.

When he does so the audible warning will cease. The keyswitch will no longer flash but will remain illuminated as a reminder that a fault is present until such time as the fault is cleared.

The Non-Described Alarm (NDA):

If a step takes place from a berth in which no description is present the Signalman's attention will be drawn to the non-described train by a one second audible warning. In addition the keyswitch marked **NDA** will flash and the name of the berth which the train occupied when the warning sounded will be displayed in the DESCRIPTION berth.

If an NDA is not acknowledged the computer will queue each subsequent NDA and present each when the previous one has been acknowledged.

Functional description

The ASAD card continuously scans the keyswitch matrix by pulling one of the eight rows low and reading the eight columns. The keyswitches each connect one of the rows to one of the columns. If, when it reads the columns, the ASAD card detects a low, this indicates that the switch connecting that row to the driven column is being pushed.

For all keyswitches other than NDA and EFA, once the push has been identified a code representing the keyswitch is transmitted to the main computer. For the alpha-numeric characters this code is the ASCII code for the character engraved on the key.

EFA is activated by default. Normally the main computer transmits a code to the keyboard at regular intervals - indicating that the train describer is functioning correctly.

Should the keyboard fail to receive this code within a set time it activates, in flashing mode, both the lamp within the EFA keyswitch and the buzzer.

When the alarm is acknowledged, the ASAD removes the flashing alarms and switches a steady feed onto the EFA lamp. Should the button be pushed when the alarm is not activated the ASAD will take no action.

If the alarm is on, either steady or flashing, when the ASAD receives the code, the ASAD will turn it off.

NDA is transmitted to the ASAD whenever a step is made from a berth which does not contain a description.

When the ASAD receives the NDA code it activates the NDA lamp (flashing) and the buzzer (steady) and starts a one second timer within the processor. When the timer times out the feed to the buzzer is removed.

When the alarm is acknowledged, the processor removes the feed to the NDA lamp. This also causes the ASAD to transmit a code to the main computer indicating that the NDA has been acknowledged. This code is used as follows:-

When the computer detects a non-described step it transmits the NDA code to the keyboard and displays the TO BERTH number in the ALARM display. When the computer receives the NDA acknowledge it clears the display. Should more than one NDA occur together, the computer will then transmit the berth address of the next NDA until all have been acknowledged.

If the NDA keyswitch is pushed when no alarm has been given the ASAD takes no action.

Introduction

The panel satellite consists of a single ASAD card from which ribbon cable is run to a klippon screw-terminal interface block.

The function of this satellite is to interface the computer with buttons and annunciators on the signal panel which are associated with fringe-box working. These are:-

DESCRIPTION RECEIVED WARNING (DRW) - a buzzer which sounds for three seconds whenever the train describer receives a description from a fringe box.

TRANSMITTER FAULT ALARM (TFA) - a lamp and buzzer, acknowledged by a push-button on the panel, which indicates a fault in the transmission system between the train describer and one of its fringe boxes.

RECEIVER CANCEL (RxC) - a lamp and buzzer, acknowledged by a push-button on the panel, which indicates that an approaching train has been cancelled by one of the fringe boxes.

Functional description

The Klippon unit is used to connect the buttons and lamps to the panel ASAD.

On the ASAD, FET outputs drive the lamps and buzzers of RxC, TFA and DRW, and opto-isolators buffer the inputs from the RxC and TFA acknowledgement buttons.

When the ASAD receives the DRW code from the computer, it turns on the FET drivers allocated to the DRW buzzer and starts a 3 second timer within the processor. When the timer times out the processor turns off the driver.

Each fringe box is allocated unique RxC and TFA codes.

The RxCs share the DRW buzzer and all the TFAs another buzzer.

When an RxC code is received the processor will turn on the RxC lamp for the fringe box to which the code refers and the RxC buzzer.

All RxC lamps and buzzers will have been allocated drivers which have been configured to a flashing mode.

When the Signalman acknowledges by pressing the RxC button, the processor removes the feed from lamp and buzzer.

The TFA operates as does the RxC with the addition that the TFA lamps are also allocated a steady feed. When the processor senses a TFA acknowledge it removes the flashing feed from buzzer and lamp and turns on the steady feed to the lamp.

The TFA steady lamp is a reminder to the Signalman of the transmitter fault. When the transmitter has been repaired the main computer, following successful exchange of data on the transmission link, will send the panel satellite a code which causes the ASAD to turn off the lamp.

Introduction

The ScR fringe box unit uses MR, BSDD cards and display units in a structure similar to that of the main train describer.

An ASAD card acts as the computer controlling the routeing system, scans the keyboard matrix, drives the alarms and also communicates with the main train describer over a serial modem link.

The standard satellite unit consists of a 3U total access equipment case. The rear of the case carries a 3U Eurorack in which are mounted the cards and power supplies. The front of the case carries the faceplate on which are mounted the keyboard and the LED display boards for four berths.

These berths are:-

The **SET-UP** berth - in which train descriptions entered by the fringe box Signalman are held prior to transmission.

The **LEAVING** berth - in which the description is displayed following transmission until the train has stepped out of the main box approach berth.

And two **APPROACH** berths - in which trains approaching the fringe box from the main box are displayed.

It is important that the relationship between the TD and its fringe boxes be clearly understood.

As generally used in this document, "satellite" takes its usual meaning and is intended simply to be descriptive of the relationship between the main TD and its remote units.

The term **"SATELLITE FRINGE BOX"** however has a technical meaning in general use throughout B.R..

The implication of the use of this term is that the berth contents at the fringe box are under the control of the main TD. - Even if the fringe box has local stepping the details of the step must first be transmitted to the main TD which will update its own record of the contents of the fringe box berths and transmit instructions to the fringe box to alter the contents of the relevant berths. - The purpose being to ensure that both signalmen are at all times presented with identical information.

The ScR fringe box unit operates as a satellite fringe box. The SET-UP berth is the only one into which the Signalman can independently enter descriptions. Thus when a description leaves the SET-UP berth and enters the LEAVING berth it is a clear indication that the train is correctly described on the main box panel.

Functional Description

The role of the ASAD at the fringe box is analogous to that of the TD computer at the main box.

The ASAD memory has space allocated for 16 berths. Each berth has an internal berth number in the range 00 - 15 (e.g. the SET-UP berth is berth 00). The ASAD has the task of recording the contents of these berths and controlling the display of these contents on the fringe box display units. Not all of these berths will be used - the standard fringe box unit uses only 4 berths.

When the fringe box powers up the initialising routine clears the contents of all 16 berths.

The ASAD is also charged with the tasks which, at the main box, are handled by the OCU, PANEL and MULDEM satellites. It is programmed to scan the keyboard matrix and the local signalling inputs continuously.

When it detects a closure of one of the alpha-numeric keyswitches it places the code for the character represented by that switch in the SET-UP berth memory location and sets an internal marker which indicates that the contents of that berth need to be output to the display unit.

When 4 characters have been placed in the SET-UP berth, all set-up keyswitches other than TRANSMIT and RESET have no effect. Pushing the TRANSMIT key sets an internal marker which indicates that the transmitter is required by the SET-UP berth.

Similarly , if the scanning routine detects the closure of the C/O track contact, a marker is set indicating that the transmitter is require for a C/O code.

On the completion of every programme cycle a routine checks whether any berths are marked as having altered and if so, outputs the contents of the marked berths to the relevant display units. This is done by routeing the data via MR and BSDD cards as in the main TD.

Another routine checks whether any transmitter markers have been set and if so, initiates the appropriate transmission. The ASAD requires that all its transmissions be acknowledged by the main box and if no acknowledge is received a TFA sounds.

Note that the ASAD is capable of direct serial communication (via the MODEM) and consequently the Fringe Box Unit does not require an INTERFACE bus.

Transmissions from the main box are dealt with on an interrupt basis. As each word is received the ASAD routine is interrupted and the word read and stored. When the entire message has been received the ASAD sends a single acknowledge to the main box.

The contents of the APPROACH and LEAVING berths are under the control of the main TD which keeps a record of the fringe box berth contents.

When the main box receives a transmission from the SET-UP berth it retransmits the description to the fringe box - preceded by a code which directs the description to the LEAVING berth. When the train has cleared the main box APPROACH berth a C/O code is sent to the fringe box preceded by a code directing it to the LEAVING berth. Thus causing the fringe box to clear the berth.

Functional Description (cont.)

When a train is leaving the main box, the TD checks its own record of the fringe box APPROACH berth contents and then transmits the description preceded by a code directing it to the appropriate fringe box APPROACH berth.

When the TD receives a C/O code from the fringe box it checks the contents of the fringe box APPROACH berths and, if 2ND APPROACHING is occupied, transmits a special code which instructs the fringe box to step the description from 2ND APPROACH to 1ST APPROACH. If 2ND APPROACH is not occupied a C/O code is transmitted for 1ST APPROACH.

Fringe Box with Local Stepping

The fringe box unit may be equipped for up to 16 steps.

Fringe box stepping operates as does main box stepping; with a BS signal being directed by the routeing system (MR and BSDD cards) to the step validation circuits allocated to the FROM berth - resulting in the address of the TO berth being output on the stepping bus. The fringe box has no dedicated stepping bus - the ASAD data bus performs this function.

Details of the step are transmitted to the main box and the step does not take place until the transmission is acknowledged.

It is important to grasp the idea that the fringe box unit is a slave to the main box. Any changes in the berth contents at the fringe box only take place with the permission of the main TD.

Operation

The fringe box keyboard matrix differs from that fitted at the main box in the following respects:-

(a) The display circuits have been removed to allow the board to fit vertically on the 3U faceplate.

(b) The two button positions which are unused at the main box are here allocated to TFA and RXC acknowledge buttons.

(c) The four double-size keys are allocated as follows:-

TRANSMIT - This key is operable only when a train description has been entered in the SET-UP berth and causes the description to be transmitted to the main box.

RESET - This key clears the SET-UP berth (should an error have been made when entering the description) and is inoperable during transmission.

CLEAR OUT - The fringe box unit will be wired such that descriptions are automatically removed from the "FIRST APPROACHING" berth by track occupation establishing that the train has passed the home signal. This key is provided for those occasions when track failure prevents automatic clear-out.

Pressing the key will place the code **"-CO-"** in the set-up berth. Pressing **TRANSMIT** will then transmit a code to the main box requesting that the data be cleared from the approach berth.

CANCEL - This key is used when a previously transmitted description is no longer valid. Pressing the key will place the code **"CANC"** in the set-up berth. Pressing **TRANSMIT** will then transmit a cancel code to the main box.

As part of the cancel procedure, the main box will transmit a code to the fringe box which will clear the leaving berth and sound RXC.

It should be noted that both **CANCEL** and **CLEAR OUT** are only operable with the set-up berth empty - with the exception of their single key entry they operate as do all codes entered from the keyboard.

Introduction

The MULDEM (MULtiplexing/DEMultiplexing) system is an addition to the basic TD. Its purpose is to provide an interface with the relay room which can be used by the TD to pick relays or to input contact closures.

For example:- In systems which include berth-conditional stepping, berth occupation is represented by picking a relay external to the TD. The contacts of this relay are then incorporated in the meshing.

The cards used are :-
CONTROL CARD
MULTIPLEXING CARD
DEMULTIPLEXING CARD

Because of its use of the INTERFACE bus it is often convenient to treat the MULDEM as a satellite. However the MULDEM is not a true satellite in that data passes directly between the computer and the "support" cards rather than via a serial link.

Description

The computer communicates with the MULDEM over the INTERFACE BUS.

A CONTROL CARD is therefore used in the MULDEM so that communication between computer and MULDEM can approximate as closely as possible to normal use of the bus.

The MULDEM however, being used for parallel multiplexing and not for serial communication, is not a satellite - MULDEM data is not routed via the control card but is taken directly to the **MULTIPLEXING** and **DEMULTIPLEXING CARDS**.

The INTERFACE BUS can handle 8 bits of data at a time.

The **MULTIPLEXING CARDS** are used to multiplex the inputs from the relay room so that they can be passed along the bus. Each card accepts fourteen inputs and stores them as two seven bit words, each of which can be accessed by the computer.

The **DEMULTIPLEXING CARDS** demultiplex the data from the bus and output it to the relay room.

Each card accepts data from the bus and stores it as two seven bit words, each of which can be written to by the computer - thus giving fourteen outputs to the relay room.

Inputs are optically isolated and outputs are relay contacts.

Routeing MULDEM Data

When the processor requires to communicate with the MULDEM it outputs the address of the required multiplexing or demultiplexing card to the auxiliary MR card (first placing the data in the buffer if a demultiplexing card is the destination).

Part of the address is shared by a demultiplexing card with a multiplexing card. This part is carried by address bits A0-A2 - which are bussed from the auxiliary MR card to all multiplexing and demultiplexing cards in the system.

The remaining address bits select the CONTROL CARD via the routeing system.

The GS signals which select the CONTROL CARD complete the addressing of the multiplexing and demultiplexing cards, the GS for the receiver function completing the address for the multiplexing cards and the GS for the transmitter function completing the address for the demultiplexing cards.

<u>ASAD Card</u> 85SES2

The ASAD card is intended as a satellite computer. It is designed to be able to handle the localised functions of the interface links:-

Panel
Keyboard
Fringe Box

The core of the card is a microcontroller I.C. which is programmed according to the interface function required.

This card can receive or transmit serial data over a telecommunication link via a UART (Universal Asynchronous Receiver Transmitter). - It can also communicate locally with ancillary cards via an eight bit bus. This bus can be controlled either by the ASAD itself or by any other computer attached to the bus.

The card has a variety of I/O circuits. These include:-

(i) A buffer which can be selected via the card's edge connectors as either input or output.

(ii) Another buffer, optically isolated, which is permanently configured as an input.

(iii) Twelve output bits via optically isolated FETs to give high current capability.

(iv) A three to eight converter giving a "one of eight" output.

Also incorporated on the ASAD are two oscillators one of which is run at high frequency to give a clock signal to the UART, the other at a low frequency to allow the possibility of flashing the FET outputs.

MULTIPLEXING CARD 82SES2

Each MULTIPLEXING CARD is read once every TD scan and handles fourteen inputs organised as two blocks of seven (referred to as DATA WORDS).

The inputs are optically isolated from the logic supply.

A bit is set by completing a dedicated isolating circuit (e.g. via a closed relay contact). A light emitting diode (LED) in series with each isolating diode is mounted on the card edge such that the condition of any input can be seen at a glance.

Each Data Word is presented at the inputs of an octal latch - the outputs of which are presented at the inputs of gated inverting bus buffers. The outputs of the bus buffers are connected to the DATA BUS (in this case the INTERFACE BUS).

A bus comparitor IC enables the card to accept a Read signal (RD) when it detects its identity (five hardwired backplane inputs) on bits 1 to 5 of the ADDRESS. Bit 0 of the address selects which Data Word is to be read.

When a card is addressed, RD clocks the current data for the selected word into the latch and enables the bus buffers, placing the Data Word onto the Bus.

A green LED positioned centrally on the card edge is driven by a monostable which is triggered whenever the card is read. The LED is known as "SCAN OK".

The pulse width of the monostable is sufficient to maintain the LED between TD scans. Thus the LED gives a clear indication that the MULDEM is being serviced during the scan and is therefore of use in fault investigation.

DEMULTIPLEXING CARD 82SES3

Each DEMULTIPLEXING CARD handles fourteen outputs organised as two blocks of seven (referred to as DATA WORDS).

Each Data Word is stored in an octal latch the inputs of which are connected to the INTERFACE BUS.

A bus comparator IC enables the card to accept a Write signal (WR) when it detects its identity (five hardwired backplane inputs) on bits 1 to 5 of the ADDRESS. Bit 0 of the ADDRESS selects the latch for which the data is intended. When the card is addressed the data is clocked into the selected latch by WR.

Output is over the front contact of one board mounted relay per data bit - thus isolating the logic circuit from the relay room. The armatures of the seven contacts of each Data Word are commoned externally. Each output is capable of driving a BR SPEC 930 relay directly and is protected against interference from back EMF, having a varistor and series resistor across each relay contact.

The relay coils are driven from the latch via a line driver IC. LED's in series with the relay coils are mounted on the card edge such that the conditions of any output can be seen at a glance. It should be noted that since a current limiting resistor parallels the relay coil, the LED indicates the driver not the relay.

The latches constitute stick circuits for the output relays and the relays will retain the data until the data word is altered by the computer.

A green LED positioned centrally on the card edge is driven by a monostable which is retriggered whenever the card is written to. The LED is known as "SCAN OK". The pulse width of the monostable is sufficient to give a clear indication when the MULDEM is being serviced and is therefore of use in fault investigation. Please note that the DEMULTIPLEXING cards are written to only as required and consequently the green LED is not normally lit.

VOLUME 1

SECTION 4 - CO-SYSTEMS

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 System (PIS) and other such systems. Indeed, these are often the justification for the installation of the train describer.

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

The design approach to the use of co-systems with the ScR Train Describer is to maintain the independence of the train describer data-base by transferring the berth data to a second computer, of the same type as the main TD 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. Therefore, if the co-system is a ScR product, this second computer will usually function as the central processor of the co-system.

The Inter-computer Link

The inter-computer link is the communication channel between the TD computer and the co-system computer.

It consists of an 8 bit bus linking an I/O port of the TD computer with an I/O port of the co-system computer - plus individual lines for control of the data flow on the link (handshaking).

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. 59 - 300 BAUD

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.

Operation

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.

Fault Finding Aids

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.)

Internal

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.

External

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 extension 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 function. **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.

The Train Describer 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. 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.

The ATR Cabinet

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 *

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).

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

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

All classes of train will transmit from D766/769 berth upon occupation of 623T with D769 and 1001 aspect clear, and berths 1001 and CADP clear. Should D769 change to a restrictive aspect after transmission an automatic CANCEL will be transmitted from D769.

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 - American Standard Code for Information Interchange. 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 - Automatic Train Reporting (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 **binary digit** - 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 **In**-**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 - Least Significant **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 - Random Access Memory (see **memory**).

reporting point - page 4-2.

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

RDY - **ReaDY**. 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 - Read Only Memory (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 - Serial **D**ata Cloc**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.