SPECS

LONDON UNDERGROUND LIMITED

SIGNAL AND ELECTRICAL ENGINEERING DEPARTMENT

DOT MATRIX INDICATORS

SPECIFICATION SE903 C

CONTRACT No. CC 07949

SCHEDULE I & II

SIGNED ..... R. Blakey .....

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2. INTRODUCTION

London Underground intend to improve the quality of information that is given to the public and provide a level of information commensurate with a modern transportation system.

To achieve this, platforms and concourses will be equipped with a sign system which not only will display the train destinations, but also the time to arrival, fixed and variable messages. All of these features may be controlled from a central position on the line.

London Underground consider these signs to form an integral part of the image of London Underground and therefore they must present a display that is clear and easily readable. The external appearance must also be suitable to match the high standards of design achieved on refurbished stations.

2.1 SYSTEM OUTLINE

2.1.1 SYSTEM STATION LAYOUT

In previous stages of the Dot Matrix signs, the system was driven by a central computer which monitored the operation of the railway (On Line Computer) and a system of identifying trains running in the system (Positive Train Identification). Although future Dot Matrix systems will not always be connected to these systems the terms O.L.C. and P.T.I. are used throughout this specification to name various inputs and outputs.
The system will use a local Train Description (T.D.) parallel input in a back-up mode.

The system will comprise,

a) Sign Controller.
This will receive data messages from the central On Line Computer (O.L.C.), the Positive Train Identification (P.T.I.) and the train description (T.D.) systems, and will transmit data messages to the signs. There will be one sign controller for each station, except where two or more lines serve the station when there will be one for each line.

b) Signs
The basic system will have one sign on each platform, both connected to a single sign controller. To avoid multiple labelling, they will always be designated Northbound (NB) and Southbound (SB). Under particular circumstances, further duplicating signs may be added (3.4). Additionally the sign controller will drive a third series of signs primarily intended for use in booking halls and other public areas away from the platforms. (3.4.). These will be designated concourse signs. The concourse signs will not be required to display train information (5.1.3.) but only to display information from the display data stores (5.1.2.).

2.1.2 LONDON UNDERGROUND PASSENGER INFORMATION DATA SYSTEM

The system will be based on a central computer which will communicate messages (called O.L.C. messages) giving the train destination and time to arrival. This information will be determined from timetable data and by tracking the progress of trains through the system. In addition the positive train identification system (P.T.I.) messages will provide train descriptions (T.D.), but not time to arrival, these are termed serial T.D. messages. The sign controllers serial inputs will receive both serial T.D. messages and O.L.C. messages.

On some sites and lines there will be no P.T.I. or O.L.C. system, the message generation and time to arrival determination will be achieved by a Stand Alone Interface. This unit will produce messages in all respects identical to those from the O.L.C. The Stand Alone Interface will not form any part of this specification.

Local train descriptions will be available at many sites from local parallel inputs which will provide a back-up source for the T.D. messages.

3. SIGN CONTROLLER

3.1 DESCRIPTION

The sign controller has two main functions. The first is to provide the interface and primary data storage between the external communication lines and the dot matrix indicator signs. The second is to provide a facility for local interrogation of data, also equipment failure diagnosis.

3.1.1. USE OF COMPONENTS.

All printed circuit boards are to be epoxy glass to NEMA FR4.
All printed circuit board artwork shall be to B.S. 5370 (standard dimensions).

3.1.2. CONNECTORS.

All connectors shall be to B.S. or DIN standards.

3.1.3. CARD SIZING.

All card shall be standard Eurocard sizes.

3.1.4. RAM SUPPORT.

A RAM support system will be provided. If the power is returned within 5 minutes then a 'warm start' routine will be performed. No data must be lost and the system will continue using this data. If the power is lost for more than 5 minutes then a 'cold start' routine will be performed i.e. all RAM stored data will be cleared out and a power up restart performed.

3.1.5. Power Initialisation.

The equipment must be self initialising from the power supply switch-on and must be capable of fully handling and displaying all received external messages without any further control or commands. In particular, the system must initialise (e.g. display messages in O.L.C. mode) without any sign control mode (5.6.4.) or initialise/reset mode (5.6.5.) messages being received.
This is identical to a 'cold start' routine (3.1.4.)

3.2 MECHANICAL DESIGN

3.2.1 Construction

The sign controller will be 19" rack mounted in a cabinet and should be arranged in such a way as to facilitate easy removal for maintenance and testing.

The sign controller cabinet will be dust proof and suitable for installing on station platforms It will

3.3.1 Serial data.

For system compatibility, the modems in the sign controllers are required to be ATS type 1100, channel 46 (2400 baud) or channel 71 (1200 baud), or a functionally equivalent type.

3.3.1.1. Serial data inputs.

The sign controller will have three such inputs via separate terminals.
The serial line data feed to the sign controller is a balanced line and therefore the modem input must not unbalance the line.
The modem input should be earth free and have a high impedance isolation.

3.3.1.2. Serial data outputs.

Serial data output (Talkback) will allow the sign controller to reply to polling messages from the OLC on a multidrop serial link, using 1200 Baud FSK VF Modems.

Up to 16 sign controllers will be possible on any one serial link, and would each bear a unique address determined by a hexadecimal switch on the sign controller. LUL will provide line protection on the OLC link.

3.3.2 Sign Controller/Sign Data Links

Three bi-directional data link ports are required, one each for the respective traffic directions and one for the concourse signs.

Each bi-directional link is used to pass display and control data from the controller to the sign and in turn will pass operational status data from the sign to controller.

It is an operational requirement that up to 4 signs may be operated in parallel on each link. Normally only one sign is used per link but where more are used the controller would also be required to detect the correct operation of each sign connected.

All four signs may be placed up to a maximum of 500 metres from the controller.

The data format between the signs and controllers will be decided by the contracter but it must conform to a recognised standard and full details of the standard and the allocation of the data format will be required by London Underground to enable data for Special Message stores (5.1.2.2.) and Programmed Messages stores (5.1.2.3.) to be generated externally to the sign controller.

conform to IP 52. The cabinet will be lockable with a turnkey.
The door(s) of the equipment must not require more than 0.6 metres of clear space to open fully for access.
The controller will have two 13A sockets (BS1363) able to supply 5 Amps at 240volts for the connection of external test equipment.
This supply may be directly in parallel with the incoming supply.

3.2.2 Dimensions

The overall dimensions of the sign controller should be kept to a minimum as it will often be necessary for controllers to be installed in areas of restricted space.

Proposed cabinet arrangements and sizes including external connectors will be required to be approved by London Underground Ltd.

3.2.3 Installation Considerations

The equipment will be installed by London Underground or its contractors. The fundamental requirement for installation of the controllers is that the equipment can be quickly and easily installed by a minimum number of staff.
The controller will be wall mounted and fixed using standard sized bolts or similar. There may be limited access at the sides, top and bottom. In underground installations the walls upon which the controllers are normally mounted have a radius in the vertical plane and this will need to be accommodated in the fixing arrangements.

Due to the operating environment, inter-connecting cables between equipments are of significant size (typically 1/2" outside dia) and allowance must be made to accommodate this size of cable at the termination point. All connections to the equipment will be on one face which will be the underside of the cabinet.

3.2.4 Operator Terminal

To facilitate fault analysis and the setting up of equipment following installation or failure, a keyboard display terminal is required.

The terminal is required to be of minimum complexity in operation as it would be operated by staff on a non-regular basis i.e. only moderate familiarity with the system at any time can be assumed.

A full description of display and keyboard features is given in the section headed Software (5.7).

3.3 DATA RECEIVERS & TRANSMITTERS.

3.3.3. PARALLEL INPUTS.

The parallel inputs will be voltage driven and will be opto-coupled in the controller with an isolation voltage of 1500 volts.
The contacts or sources which feed the parallel inputs will be located up to 500 metres from the controller and will feed on open wires.

The inputs will be 24 volts D.C. and will be either from a switched external source or will use an internal supply in the controller, this will detect the state of relay contacts. The internal supply will be provided in all controllers. The positive line must be capable of being common to all inputs.

Voltage limits :-

Supply (either internal or external)
Minimum 18 volts Maximum 28 volts.

current available from internal supply 20mA per input.
current sinking capablity 20mA per input.

Logic levels.

Logic 0 0-5.0 volts from positive line.
Logic 1 Greater than 15.0 volts from positive line.

4. SIGNS

4.1 DESCRIPTION

A platform sign will consist of a display matrix of 256 columns by 24 rows of discrete dots per face. The display and its associated electronics are required to be housed in a case which has been designed to meet London Underground's requirements and design philosophy. General Arrangement drawings of the sign case are appended to this specification (see section 4.2.2.).

4.1.1. LEGIBILITY

The final acceptance of the sign display will be made by London Underground, based on a demonstration of the proposed system. However as a guide the sign should be easily readable at a distance of half a station's length (typically a station is 135 metres).

4.1.2 READABILITY

Signs will be fitted to outdoor stations and will have to readable in conditions of bright sunlight, although the signs will be placed under station canopies or shields.

Where the display cannot cope with background lighting levels ranging between those found in tunnel and open platforms, then the supplier may offer two types of display. This must be clearly stated and it should be possible to change from one type of sign to another using the same sign casework and basic electronics.

4.1.3. APPEARANCE.

The sign will normally display two horizontal lines with text which are independently controlled, but can also display double height characters or graphics using the entire display area.
The dots must be of a uniform colour and must not be red or green as these colours may be confused with signal aspects.

When a character such as a direction arrow is displayed on both sides of a sign, then it must point in opposite directions on either side of the sign. The contractor must have a method of having both arrows etc pointing in the same direction when the sign is sent one identical message. To ensure that direction indicated by an arrow is clear, then it may be necessary to place the arrow at opposite ends of the display on each face (i.e. at the same physical end).

4.1.4. FLICKER.

There will be no visible judder or flicker on the display under static or dynamic conditions. This will include periods when the sign is receiving or transmitting data.

4.1.5. CORRUPTION.

Under no circumstances can any area of the display appear corrupted.

4.1.6. SPEED OF MOVEMENT.

The speed of the moving display must be constant and smooth, no pauses or jitters will be permitted.

4.1.7. SPEED OF UPDATE.

Any message sent to the controller must cause the relevant change on the sign display within 5 seconds.

4.2 MECHANICAL DESIGN

4.2.1 OPTIONAL CONFIGURATION.

There will be three configurations of sign according to site requirements. Two options cover double faced signs, the other a single faced sign.

The double faced sign options differ from each other in their mounting arrangements. One is mounted off a wall via a pivot bracket and supported at the far end by stainless steel cables. The other double faced sign is suspended from above using two fixed pole mountings.

The single faced sign will be half a double faced sign adapted for flat wall mounting. The double faced sign should be designed to ensure that it can be split to form two single signs with a minimum of modifications.
The double faced sign shall have provision for a printed text sign approximately 0.3 metres high by the sign length. It will hang from the underside of the sign.
The contractor will supply the metalwork for the sign, but London Underground will supply the printed paper text. The drawings for the sign case include a design for a fixed text sign.

4.2.2 CONSTRUCTION.

The design will conform to the outline dimensions and style as given in the General Arrangement drawings, the design will be subject to detailed approval by London Underground.

Dies and patterns are available from London Underground to construct a sign from four special aluminium extrusions to form the length of the sign, with cast aluminium end plates completing the assembly. These cast aluminium end plates differ between the configuration of sign. Inter-module wiring

is carried in channels which are also part of the extrusion, the wiring being retained in place by flexible clips.

Access to the inside of the sign will be via a hinged front opening door extending the full length of the sign. The polycarbonate (or other suitable non flammable material) visor shall be mounted on the door through which the display is viewed.

The interior of the sign case will be arranged in such a way as to allow for modular construction of the sign electronics.

4.2.3. INSTALLATION

The sign will be installed by London Underground or its contractors.

The normal configuration of the platform sign is the double sided version secured at one end to the tunnel wall by a pivotted bracket assembly and at the opposite end secured to special tunnel segment clamps by a transverse 'vee' cable arrangement. Details of the mounting arrangements are shown in the appended sign drawings and a 'mounting kit' supplied by the manufacturers would be expected to contain all items from and including the eye nut down to the sign.
London Underground have produced a design of cable supports for the existing signs and will expect a similar design to be use adapted for the contractor's design. The supplier must provide details of mounting arrangements, cable terminations and connector types prior to delivery.

The fundamental requirement for installation of the signs is that the equipment can be quickly and easily installed by a minimum number of staff. This is particularly important for signs which can only be hung during night hours.

The single sided version of the sign will be designed to be mounted on a flat surface only and details of the mounting brackets are included in the appended sign drawings. One pair of these brackets will be provided with this version of the sign.

The sign mounting arrangements will be tested by London Underground to ensure the safety of its construction.

4.2.4 MAINTENANCE CONSIDERATIONS IN DESIGN.

The environment in which the signs and controllers have to be maintained permits access at very limited hours of the day and under difficult conditions, therefore. it is essential that in the design of the sign case a great deal of consideration is been given to maintenance aspects, Care must be taken in the choice of internal layout to ensure that the maintainability of the sign is not compromised. All items must be maintainable by one person standing in a static position facing the centre of the sign. Approval of a proposed layout must be obtained from London Underground (see section 9). See also 9.1. and 9.2. for the maintainenance requirements.

5. SIGN CONTROLLER SOFTWARE.

5.1 SITE CHARACTERISATION

The site characterisation must be achieved by a non-volatile memory method which can be externally changed. If internal access is required to change site data then it must be easily achievable with a minimum of disturbance to the system. If an EPROM is used then it must be of the type 2764.

The site characterisation device will be called the SC-EPROM. It will contain site dependant information of various types, each of which will be described in the relevant sections.
The SC-EPROM will be programmed by London Underground Limited and therefore the contractor must give all details of the data format required.
A summary of the contents is given in Table 5-1:-

Table 5-1: Site Characterisation EPROM - layout.
(All addresses in hexadecimal)

ADDRESSES	PURPOSE
0000	EPROM Checksum
0001 - 002F	L.U.L. EPROM Identification Data
0030	P.T.I. Message Enable Byte
0031	Sign Controller Address
0032 - 0034	Sign Configuration.
0040 - 005F	Northbound T.D. Fixed Train Text.
0060 - 007F	Southbound T.D. Fixed Train Text
0080 - 009F	Northbound O.L.C. Fixed Train Text.
00A0 - 00BF	Southbound O.L.C. Fixed Train Text.
00C0 - 00CA	User-defined Time Message
00D0 - 00D5	T.D. Display Control
00D6 - 00DB	O.L.C. Display Control
00DC	Second Train Hold Time
00DD	Third Train Hold Time
0100 - 017F	Northbound T.D. Queue Lookup Table
0180 - 01FF	Southbound T.D. Queue Lookup Table
0200 - 027F	O.L.C. Queue Lookup Table.
0280 - 0EFF	Train Destination String List
0F00 - 1E7F	Fixed Text Stores
1E80 - 1EFF	Fixed Text Store Addresses and Lengths.
1F00 - 1FFF	Fixed Sequence Definitions

The value of any unspecified location in the EPROM is irrelevant.

5.1.1. SITE CHARACTERISATION LAYOUT.

5.1.1.1 CHECKSUM

This value is the modulo 256 addition of the contents of each location of the EPROM from 0001 hex to 1FFF hex. This is used by London Underground Limited for SC-EPROM testing, and need not be checked by the Sign Controller for correctness.

5.1.1.2 IDENTIFICATION DATA

This area is used by London Underground Limited to identify uniquely a characterisation device fitted into equipment. No use is made of this area by the Sign Controller, but the precise layout is given in an Appendix for reference.

5.1.1.3 SIGN CONFIGURATION

The three bytes will define the number of signs currently fitted to the Northbound, Southbound and Concourse output ports, respectively, and each will have a value from zero to four.

5.1.2 DISPLAY DATA STORES

Display Data is defined as a sequence of ASCII text or display control sequences which is used to define exactly what is required to be displayed on a Sign.
Storage areas within the SC-EPROM and the RAM are allocated to Display Data. The names of the stores reflect the main use to which they will be put by London Underground.
RAM stores will be written into, and all stores will be called for display, by messages received over the Serial Input Ports. Unless stated, any store can be displayed on any sign.

5.1.2.1 FIXED TEXT STORES

There will be 32 variable length Fixed Text Stores, numbered from 0 to 31 decimal (00 to 1F hex). They will be held in the SC-EPROM, occupying the area from 0F00 to 1E7F hex. The start address (within the SC-EPROM), followed by the length (two bytes) of each Fixed Text Store will be held, consecutively in the SC-EPROM from 1E80 hex to 1EFF hex. Both will be held high byte followed by low byte.

5.1.2.2 SPECIAL MESSAGE STORES

There will be three variable length Special Message Stores, designated Northbound, Southbound and Concourse. A Special Message Store may only be displayed on its associated Sign. The Stores are held in RAM, and each one may be loaded with from zero to 512 bytes of Display Data.

5.1.2.3 PROGRAMME MESSAGE STORES

There will be 32 variable length Programme Message Stores, numbered from zero to 31 decimal (or 0 to 1F hex).
The maximum area occupied by the Programme Message Stores will be 16k bytes.

5.1.3 TRAIN INFORMATION STORES

It is required that information concerning trains due to arrive at a station is presented on the Northbound and Southbound Signs. Two independent sources of train information will provide information to the Sign Controller.
The primary, or On-Line Computer (OLC), information, is received from a central computer, over the Serial Input Ports. Destination and time-to-arrival information is available from this source.
The secondary, or back-up source of information, is available from local equipment; information from this being received over the Serial Inputs or the Parallel Inputs. Only destination information is available from this source.
The information is stored in queues, and may be called for subsequent display on the Dot Matrix Signs.

5.1.3.1 TRAIN DESCRIBER (T.D.) QUEUE

There are two T.D. queues, designated Northbound and Southbound. Each queue consists of 32 stages, numbered from 0 (head of the queue) to 31 (tail of the queue). Each stage will contain 5 bytes of P.T.I. Train Data.
Following receipt of a P.T.I. message over a Serial Input Port, or receipt of an input from a Parallel T.D. Input Port, a P.T.I. Train Data block will be formatted and entered into the lowest unoccupied level of the appropriate queue. If the queue is full, it will remain unchanged.
Data will be deleted from the head of the queue by a Cancel input, all other stages moving towards the head by one position. The whole queue can be deleted by a Start of Service Clear serial message.

P.T.I. Train Data.

The components of a P.T.I. Train Data block are normally numbered in Octal and consist of the following:-

Train Destination: 000 to 177 Octal
Empty/Service Flag: 1,if train in service. 0, if not.
Crew Number: 000 to 777 Octal
Train Number: 000 to 777 Octal

The information is stored in five bytes, allocated as follows:-

BYTE 1 : Bits 0 to 6 = Train Destination Code.
Bit 7 = 0

BYTE 2 : Bit 0 to 1 = 0
Bits 2 to 4 = Crew Number (10's Octal)

Bits 5 to 7 = Crew Number (1's Octal)

BYTE 3 : Bits 0 to 2 = Crew Number (100's Octal)
Bits 3 to 6 = 0
Bit 7 = Empty/Service Flag

BYTE 4 : Bit 0 to 1 = 0
Bits 2 to 4 = Train Number (1's Octal)
Bits 5 to 7 = Train Number (10's Octal)

BYTE 5 : Bits 0 to 2 = Train Number (100's Octal)
Bits 3 to 5 = 0
Bits 6 to 7 = P.T.I. message error code.

5.1.3.2 ON-LINE COMPUTER (O.L.C.) QUEUE

There are two O.L.C. queues, designated Northbound and Southbound. Each queue consists of 32 stages, numbered from 0 (head of the queue) to 31 (tail of the queue). Each stage will contain 3 bytes of O.L.C. Train Data.
Data is written into a queue on receipt of an O.L.C. Update message over a Serial Data Input, the whole queue being overwritten by the new data.
Data is deleted from an O.L.C. Queue by an O.L.C. Cancel Serial Input Message, or by a T.D. Cancel Input, if the Local Cancel Enable Flag for queue is set.

O.L.C. Train Data

O.L.C. Train Data consists of the following information:-

Train Destination:	00 to 7F hex.
Empty/Service Flag:	1,if train in service. 0, if not.
Train Number:	0 to 255 decimal
Time Before Arrival:	0 to 63 decimal

The information is stored in three bytes, allocated as follows:-

BYTE 1 : Bits 0 to 7 = Train Number

BYTE 2 : Bits 0 to 6 = Train Destination
Bit 7 = 0

BYTE 3 : Bits 0 to 5 = Time Before Arrival
Bit 6 = Empty/Service Flag.
Bit 7 = Unused, normally 1.

5.1.3.3 O.L.C. QUEUE LOCAL CANCEL ENABLE FLAG.

There is one flag for each O.L.C. queue, and they are set and unset by appropriate Serial Input Messages.

5.2 SIGN DISPLAY CONTROL

5.2.1 STORE REFERENCES

The display on a Sign is directly related to a list of single byte numbers, known as Store References, held within the Sign Controller. These numbers refer to the displayable stores and queues within the Sign Controller, and the method of presentation, as previously defined. Only the seven least significant bits of a Store Reference are used to define the display type, bit 7 being used for display control.
The allocation of Store References is summarised in the table below:-

Table 5-3: Allocation of Store References.

REFERENCE (hex)	DISPLAY REQUIRED
00	T.D. Display
01	O.L.C./ T.D. Display
02	Special Message Store
03 to 0F	Unallocated References
10 to 1F	Fixed Text Stores 0 to 15
20 to 3F	Programme Message Stores
40 to 4F	Fixed Text Stores 16 to 31
50 to 7E	Unallocated References
7F or FF	List Terminator

5.2.2 STORE REFERENCE LIST

A Store Reference List may contain from zero to sixteen Store References, and is the data format that is used in the stores and queues used in the control of the display on the Dot Matrix Sign by the Sign Controller. The values 7F hex, or FF hex may be used to indicate the end of a list, or if the first byte is one of these, an empty list.

5.2.2.1 STORE REFERENCE LIST PRIORITY BIT

Bit seven of the first byte of a Store Reference List is defined as the Priority Bit of the list and is used for display control.

5.2.2.2. FIXED SEQUENCE STORES

There will be 16 Fixed Sequence Stores, numbered from 0 to 15 (0 to F hex), held within the SC-EPROM. Each contains a Store Reference List, padded out, if necessary, by the value FF hex, so that each store occupies 16 bytes.
The Stores are held contiguously in the SC-EPROM, occupying the address range, 1F00 hex to 1FFF hex.

They will enable preset sequences of displays to be achieved.

5.2.3 MASTER LINKER BUFFER

There will be one Master Linker Buffer (MLB), containing a single Store Reference List. The list is written to, or cleared, by messages received over the Serial Data Inputs. It is used to build up a Store Reference List for subsequent display.

5.2.4 DISPLAY LINKER BUFFER

There will be three of these, designated as Northbound, Southbound and Concourse, each containing a Store Reference List.
The Store Reference List within a Display Linker Buffer (DLB) determines what is to be displayed on the corresponding Sign.
Whilst the Display Linker Buffer remains unchanged, the display on a Dot Matrix Sign will automatically cycle.

5.2.5 LINKER BUFFER QUEUE

There will be three of these, designated as Northbound, Southbound and Concourse, each containing from zero to sixteen Store Reference Lists.
Store Reference Lists called for display by messages received over the Serial Data Inputs are first entered into the appropriate Linker Buffer Queue, to ensure that the correct sequencing of displays on a Dot Matrix Sign can be achieved.
When a Dot Matrix Sign is ready to accept new display information, the associated Linker Buffer Queue will be checked. If it is empty, no new information will be sent to the sign. If it is not empty, the Store Reference List at the head of the queue will be copied into the Display Linker Buffer. The list at the head of the queue will then be deleted, all other entries moving towards the head by one position.
The display on the Sign will be changed to that represented by the Display Linker Buffer.
Whilst a Dot Matrix Sign is detected by the Sign Controller as being out of commission, for the purposes of Linker Buffer Queue management, it will be considered as always being ready to accept new information, although data will not be transmitted to the sign.

5.2.6 BACKUP LINKER BUFFER

There will be three of these, designated as Northbound, Southbound and Concourse, each containing a Store Reference List.
They will be used to hold the Current Store Reference List, which will normally be required when the associated Linker Buffer Queue is updated.

5.2.6.1 CURRENT STORE REFERENCE LIST

The Current Store Reference List is defined as the the one contained in the Display Linker Buffer, if the corresponding Linker Buffer

Queue is empty, or the one at the back of the Linker Buffer Queue, if it is not. It is, therefore, the one which would be eventually displayed if no further display updates were required.

5.2.7 DISPLAY CONTROL MODES

There will be three display control modes. The effect on the display control queues and stores depending on the desired effect. The stores and queues affected will be those indicated by the Serial Input message.

5.2.7.1 LINKER BUFFER QUEUE CONDITIONAL UPDATING

In all cases, before a Store Reference List is added, or inserted, into a Linker Buffer Queue, it will be checked against the one which would precede it in the queue, or against the associated Display Linker Buffer, if it would become the head of the queue. If it is identical (including the priority bit), it will not be entered into the queue.

5.2.7.2 DISPLAY TEMPORARILY

The Current Store Reference List is copied into the Backup Linker Buffer after its priority bit has been unset.
The list within the Master Linker Buffer will be added conditionally to the end of the queue if its priority bit is unset, otherwise it will be inserted, conditionally, into the Linker Buffer Queue, immediately following the list, with its priority bit set, nearest the back of the queue, or at the head of the queue if no such list exists.
The list within the Backup Linker Buffer is then added conditionally to the end of the queue.

5.2.7.3. DISPLAY UNTIL FURTHER COMMAND

The operation is similar to a temporary display, except that entries lower down the Linker Buffer Queue after the new list has been entered will be deleted, and the list within the Backup Linker Buffer will not be added to the queue.

5.2.7.4 REVERT TO PREVIOUS DISPLAY.

The list within the Backup Linker Buffer is added conditionally to the end of the Linker Buffer Queue. The Backup Linker Buffer is unaffected.

5.2.8 TRAIN MODE SWITCHING

Two additional functions are provided to allow Dot Matrix Signs to be switched between the two modes of train information display, without affecting the Master Linker Buffer.

5.2.8.1 SWITCH TO T.D. MODE

A Store Reference List with the single entry 0 is formed, and then added conditionally to the end of the queue. The Backup Linker Buffer will be unaffected.

5.2.8.2 SWITCH TO O.L.C.MODE

This is similar to the above, except that the Store Reference List will contain the single entry, 1.

5.3 SIGN UPDATING CONTROL

Whenever new information is called for display (defined as a change in the contents of a Display Linker Buffer), or the source of existing information has changed, the Signs must be updated.

5.3.1 COMPOSITE DISPLAY DATA

Display Data derived from each of the Store References within the Display Linker Buffer will be used, in order, to form the Composite Display Data, which will fully define the required display. The presentation of the required display from start to finish is referred to as a Display Cycle.
The Composite Display Data will specify either the upper, lower or both halves or double height of a sign for information presentation. If a part of a sign is unspecified, it will continue to display its current information during the Display Cycle, with the exception of train information, which must always reflect the state of the train queue from which it is derived (see 5.3.3.).

5.3.2 DISPLAY DATA HEADER

Display Data from each Store Reference in the Display Linker Buffer will contain 'header' information defining a Display Cycle Count and the Display Updating Mode. The header information for the Composite Display Data will be set to that of the first entry in the Store Reference List.

5.3.2.1 DISPLAY CYCLE COUNT

This is the minimum number of Display Cycles which is normally required of a new display.

5.3.2.2 DISPLAY UPDATE MODE

There will be three methods by which a new display can replace existing information on a sign:-

1. Immediate Update.

   The new display will be started regardless of what the sign is currently doing (for example, by interrupting a barrel roll or scrolling message), and will not wait for the minimum number of display cycles of the existing display to take place.

2. End of Part Cycle Update.

   The new display will be started at a 'convenient' place in the existing display cycle (for example, at the end of a barrel roll or scrolling message), after the minimum number of display cycles have taken place.

3. End of Cycle Update.

The new display will be started at the end of the current display cycle of the existing message, after the minimum number of cycles have taken place.

5.3.3 EXISTING DISPLAY UPDATING

If the source of information of an existing display has changed by a programmable message store being changed, or a train queue being updated, the sign must be updated to reflect this change. The way this is done will depend on whether train information or text is being displayed.

1) Programme Message or Special Message Change.

   If one of these is being displayed, and has been overwritten, the sign will be updated with the new information in the update mode of the first entry of the Store Reference List being displayed (which will not necessarily be the store which has changed).

2) Train Queue change.

   Train information can be shown on the sign if the Display Linker Buffer contains a train queue reference, or if previously displayed train information has not been subsequently overwritten. Whenever train information is being displayed on the sign, any change in the source queue must be reflected on the Sign within five seconds of the input causing the change being received. This will be interpreted as the debouncing and acceptance of a parallel input, or the reception of the last byte of a serial input message.
   This requirement must be met during any part of a display cycle, and without disturbance of any part of the sign not displaying train information (for example, the requirement for jitter free scrolling and barrelling must still be met).

5.3.4 TRAIN INFORMATION DISPLAYS

Information held in train queues must be converted into order of arrival, train destination, and, if applicable, time-to-arrival information. The destination information is derived from tables held in the SC-EPROM.

5.3.4.1 DESTINATION STRING LOOK UP

The Sign Controller must convert the single byte Train Destination Codes, held in the T.D. or O.L.C. queues, into Destination Strings, for display on a Sign.
The Northbound or Southbound T.D., or (common) O.L.C. Lookup Tables (depending on the queue) and the Train Destination String List are used. These tables and lists are held within the SC-EPROM.
If the Empty / Passenger flag for a train is unset (0), a number, referred to as the Destination Number, is set to 2. If the flag is set (1), the Train Destination Code is used as an offset into the appropriate table to find the Destination

Number, the value being held at the resultant address. The Destination number will range from zero to 127.
The Destination Number will be used to find the required Destination String. The Destination String List is a contiguous list of variable length Destination Strings, each terminating in a zero byte. There will be 128, corresponding to Destination numbers 0 to 127.

5.3.4.2 TRAIN DISPLAY HOLD TIMES

When the information about a train or trains is presented on a sign it will be held for a certain length of time, as part of the display cycle. Two independent times are required, which will be common to all train queues. They will be known as the 'Second Train Hold Time' and 'Third Train Hold Time', and will be held in the SC-EPROM, at addresses 00DC hex and 00DD hex, respectively.

5.3.5 TRAIN DISPLAY FORMATS

Four standard train display formats can be defined; they are for the display of zero to three trains. In general, each train displayed will be contained within the width of a single line on the sign. The level of the train in its queue (starting from 1) will appear on the left hand end of the line, followed by the train's destination, followed by time-to-arrival information (if applicable) tabulated to the right hand end of the line.

Empty Train Queue.

A Fixed Text display will be presented as a default for an empty queue. The store to be presented will depend on the direction, and queue being displyed.

One Train Display.

The train information will appear statically on the upper half of the sign, at the same time the lower half will be blanked. The display will be held for the time defined by the 'Second Train Hold Time' byte.

Two Train Display

The presentation will be the same as for one train, except that the second train information will appear (at the same time as the first) statically on the lower half of the sign.

Three Train Display

i) The first and second trains will appear at the same time statically, on the upper and lower halves of the sign, respectively. The display will hold for the time defined by the Second Train Hold Time' byte.

ii) The third train will 'barrel roll' upwards, to replace the second train on the lower half of the sign, the upper half

being un-affected. When the train is 'in place', the display will hold for the time defined by the Third Train Hold Time byte.

iii) The second train will replace the third train in a similar manner. When the second train is in place, the display cycle will be complete.

5.3.6 TRAIN DISPLAY MODES

There will be six possible train display modes. Modes 1 to 3 allow the display of a maximum of one to three trains, respectively, in the appropriate format, according to the number of trains in the train queue being displayed.
Modes 4 to 6 are similar to Modes 1 to 3, except that a line of text, the Fixed Train Text, will appear statically on the lower line, or barrel roll in after the second or third train, being held for the third train hold time. If barrelling, it will be barrel-replaced by the second train to complete the cycle.
In all cases, a default Fixed Text Store will be presented for an empty queue.

5.3.6.1 FIXED TRAIN TEXT

There is one for each train queue and they are held in the SC-EPROM at the following hexadecimal addresses, the length of text will be followed by the ASCII characters:

0040 to 005F	Northbound T.D. Queue.
0060 to 007F	Southbound T.D. Queue.
0080 to 009F	Northbound O.L.C. Queue.
00A0 to 00BF	Southbound O.L.C. Queue.

The text will always be presented in normal characters, centre justified.

5.3.7 T.D. DISPLAY

The order and destination of a maximum of three trains from a T.D. queue will be displayed on the signs.
For each queue, the Display Mode, Display Cycle Count and the Update Mode will be held in the SC-EPROM:-

00D0	Northbound T.D. Display Mode Number.
00D1	Northbound T.D. Cycle Count Number.
00D2	Northbound T.D. Update Mode Number.
00D3	Southbound T.D. Display Mode Number.
00D4	Southbound T.D. Cycle Count Number.
00D5	Southbound T.D. Update Mode Number.

The default Fixed Text Stores will be number 30 for Northbound, and number 31 for Southbound.

5.3.8

O.L.C. DISPLAY CONTROL

Information from the O.L.C. queues will only be presented on Dot Matrix Signs if regular updates are being received from the central computer. If no updates for an O.L.C queue are received for 90 seconds, a flag is set to indicate that information from the queue concerned must not be displayed. Instead, train information from the corresponding T.D. queue will be presented, as previously described. Only when regular updates have recommenced will the flag be cleared, allowing information from the O.L.C. queue to be displayed. The exact operation of the feature will be described.

5.3.8.1 O.L.C. TIMEOUT

Each O.L.C. queue will have associated with it a set of three reversion control variables; a 90 Second Timer, an O.L.C. Update Message Counter, and a Timeout Flag. There will be no interaction between the two sets.
The messages referred to below will be described fully under the appropriate section.

The set of variables for each direction will be controlled as follows:-

1. The timer will be incremented automatically, by one, every second, up to a maximum count of 90.
   It will be reset to zero, each time an O.L.C. Update message for the direction is received.

2. Whenever the Timer becomes incremented to 90, the O.L.C. Message Counter will be reset to zero, and the Timeout flag will be set. This step will always apply, regardless of the state of the Timeout Flag, or the current value of the Counter.

3. Provided the Timeout Flag is set, the Message Counter will be incremented by one, up to a maximum count of three, each time an O.L.C. Update message for the direction is received.

4. If the Counter becomes incremented to three, the Timeout Flag will be reset.

5. Following a power on reset (or equivalent), the Timeout Flag will be set, the O.L.C. Message Counter will be set to zero, and the 90 Second Timer will be set to zero.

6. A 'Switch to O.L.C.' message (in addition to its other functions) will reset the Timeout Flag, and set the Timer to zero, if its command byte includes the direction.

A change of state of a Timeount Flag will cause an appropriate display change of the sign.

5.3.9 O.L.C. DISPLAY

If the Timeout Flag is not set, the order, destination, and time before arrival of up to three trains derived from the O.L.C. queue will be displayed.
For each queue, the Display Mode, the Display Cycle Count and the Update Mode will be held in the SC-EPROM:-

00D6	Northbound O.L.C. Display Mode Number.
00D7	Northbound O.L.C. Cycle Count Number.
00D8	Northbound O.L.C. Update Mode Number.
00D9	Southbound O.L.C. Display Mode Number.
00DA	Southbound O.L.C. Cycle Count Number.
00DB	Southbound O.L.C. Update Mode Number.

The default Fixed Text Stores will be number 28 for Northbound, and number 29 for Southbound.
The Time-to-arrival information to be displayed will depend on the time before arrival value held for the train. It can be the actual time, text, or blank:

Time Before Arrival Value (Decimal)	Time to Arrival Display
0	'0 mins'
1	'1 min'
2 to 59	time followed by 'mins'
60	SC-EPROM TBA Text
61	'ready' or 'READY'
62	'here' or 'HERE'
63	no display (blank)

The TBA Text held within the SC-EPROM will start at location 00C0 hex. The first byte refers to the number of characters in the text, followed by the ASCII characters. The maximum number of characters will be 10, the minimum will be zero (blank).

5.4 INPUT/OUTPUT PORTS

A summary of the input/output requirements is given in the table below:-

Table 5-4: Summary of Sign Controller Ports

Port	Description
Serial Data Inputs	3 x 2400 baud Asynchronous
Local T.D. Inputs	2 x 8-bit parallel
Local Cancel Inputs	2 x 1-bit parallel
Sign / Controller link	To be determined by contractor.

5.4.1 T.D. INPUTS

There will be two 8-bit local T.D. Inputs, designated Northbound and Southbound, according to which T.D. queue they are intended.

The Debounce Procedure for each input is as follows:

a) An input on any of the 8 lines starts a 500 ms timer. If all lines return to zero before the timer has expired, the sequence is restarted.

b) When the timer has expired, the input lines are sampled. If the result is zero, the debounce sequence is restarted from step a), otherwise the input is accepted for further processing, moving on to step c).

c) When all input lines have returned to zero, a three second timer will be started. If an input on any of the lines is received during this period, the timer will be restarted at three seconds.

d) When the three second timer has expired, the debounce procedure will be restarted from step a); awaiting the next input.

When a T.D. Input has been successfully debounced, a P.T.I. message will be formed, and added onto the back end of the appropriate T.D. queue. The P.T.I. message will be formed as follows:-

Train Number:	000
Crew Number:	000
T.D. Code:	Bits 0 to 6 of the 8-bit code
E/P Flag:	Inverse of bit 7 of the 8-bit code.

5.4.2 T.D. CANCEL

There will be two single line T.D. Cancel inputs, each having the same hardware requirements as the T.D. Inputs.

The Debounce procedure for each of these will be as follows:-

a) An input will start a 200 ms timer. If it returns to zero during this period, the sequence will be restarted.

b) When the timer has expired, the input will be accepted for further processing, if it is still present, moving on to step c).

c) When the input returns to zero, a three second timer will be started. If the input returns during this period, the timer will be restarted at three seconds.

d) When the three second timer has expired, the debounce procedure will be restarted from step a); awaiting the next input.

On receipt of a T.D. Cancel input, the train at the head of the appropriate T.D. queue will be deleted, all following trains moving towards the head of the queue.

The train at the head of the corresponding O.L.C. queue will be deleted in a similar manner, if the Local Cancel Enable flag is set for that queue.

5.5 SERIAL INPUT MESSAGES

The protocols and formats of all messages which will appear on these links are summarised on CS63625 (four sheets).

With one exception (P.T.I. Message), the link over which a message has been received plays no part in its interpretation.
Data is transmitted as a sequence of bytes. Each byte has one start bit, eight data bits (transmitted from least significant bit to most significant bit), no parity bit, and one stop bit.
Each message begins and ends with a framing character, which is FE hex. This character will not appear anywhere else in the serial message.

5.5.1 SUBSTITUTION

Under certain circumstances the message framing character FE hex could occur within the body of a message, for example, as one of the CRC16 check bytes, or as part of a graphic definition. To prevent this happening, a substitution process is carried out by the Serial Data Transmitter. After the CRC16 bytes have been calculated, but prior to transmission, if the character FE hex occurs within a message, it is substituted by the two character ascii sequence 'SUB,A', where 'SUB' is 1A hex and 'A' is 41 hex. If SUB occurs within a message, it is substituted by the two character sequence 'SUB,SUB'. The Sign Controller must 'de-substitute these sequences if they occur within a message, prior to CRC16 checking.
If the character following the initial SUB is neither A nor SUB, then the two character sequence will be ignored.
All byte positions in the following paragraphs assume that the incoming message has been de-substituted.

5.5.2 DATA FORMAT - SERIAL INPUT

There will be two message formats, fixed length or variable length. The particular format of a message will be implied by the command byte. The purpose of the first five bytes of any message is common to both formats.

5.5.2.1 FIXED LENGTH FORMAT

These are always twelve bytes long.

Byte 1	= Start of Message Flag (FEh
Byte 2	= CRC16 error check (most significant byte)
Byte 3	= CRC16 error check (least significant byte)
Byte 4	= Message Number
Byte 5	= Command Byte
Byte 6	= Address Byte
Bytes 7 to 11	= Data Field
Byte 12	= End of Message Flag FEh).

5.5.2.2 VARIABLE LENGTH FORMAT

These messages will contain 7 or more bytes.

Byte 1	= Start of Message Flag (FEh)
Byte 2	= CRC16 error check (most significant byte)
Byte 3	= CRC16 error check (least significant byte)
Byte 4	= Message Number
Byte 5	= Command Byte
Bytes 6 to X-1	= Optional List of Addresses
Byte X	= Address List Terminator (FFh)
Bytes X+1 to Y-1	= Optional Data Field
Byte Y	= End of Message Flag (FEh).

5.5.3 MESSAGE ACCEPTANCE

A message received over a Serial Data Link will only be accepted for further processing if all of the following conditions are met:-

i) The CRC16 error check is successful.

ii) The message number is zero or not within the Last Ten Message Number List.

iiia) If the message is a Fixed Format type, the address byte is set to FD hex, FF hex or the Sign Controller Address.

111b) If the message is a Variable Format type, the list of addresses contains FD hex, the Sign Controller Address, or the address field is null (FF terminator follows command byte).

5.5.3.1 CRC16 ERROR CHECKING

Bytes 2 and 3 of every message contain a 16 bit CRC16 check word. This must be checked according to the algorithm given in CS63625 sheet 4, for every message received and the CRC16 error counter updated.

5.5.3.2 LAST TEN MESSAGE NUMBER LIST

Under certain circumstances, a message transmitted by the On-Line Computer may be received by a Sign Controller more than once, due to multiple data routing. To guard against erroneous operation, a list of ten message numbers will be held.
The list may be considered as a first-in-first-out serial mode shift register.
On power up, the list will contain all zeros.
After a message has been de-substituted and has passed the CRC16 check, but before the address field has been checked, the message number will be examined. If this number is zero, the message is accepted for further processing. If it is non-zero and within the list of ten, the message is not accepted. If it is non-zero and not within the list, it will be added to the list after the oldest entry (including initial zeros) has been deleted. The message is then passed for further processing.
It should be noted that further processing in this context includes address checking, but the outcome of this does not affect the Last Ten Message Number List in any way.
There is only one list held within the Sign Controller, and is used for checking messages received through any of the Serial Input Ports.

5.6 ALLOCATION OF COMMANDS

For all messages received over a Serial Input, byte 5, the Command Byte will determine the purpose of that message.
The general form of the command byte is:-

Bit Number:	7	6	5	4	3	2	1	0
	M2	M1	M0	S1	S0	X2	X1	X0

M0, M1 and M2 specify the Mode of the command, and X0, X1 and X2 can either specify a command within that mode, or can be used as flags for that mode.
S1 and S2 are the Sign Selection Bits, indicating which of the Signs, Queues or Special Message Stores the command refers to. They are allocated as follows:-

S1	S0	
0	0	Concourse.
0	1	Northbound.
1	0	Southbound.
1	1	Northbound and Southbound.

The allocation of commands is summarised on CS63625.

All messages with unallocated commands must be ignored and must not cause any operation of the controller.

5.6.1 T.D. MODE

MESSAGE FORMAT - FIXED LENGTH

COMMAND BYTE = 0 0 0 S1 S0 B2 B1 B0

B2	B1	B0		
0	0	0	=	P.T.I. Message.
0	0	1 to		
1	1	1	=	Unused Commands.

5.6.1.1 P.T.I. MESSAGE

Valid Command Byte Values:-

00001000 (08h) (Northbound Queue.)
00010000 (10h) (Southbound Queue.)

Data Field = P.T.I. Message.

Firstly, the P.T.I. Message Enable Byte within the SC-EPROM is examined. Bits 0 to 5 of this byte are allocated as follows:-

Bit 0: Serial Input 1 - Northbound Queue.
Bit 1: Serial Input 1 - Southbound Queue.
Bit 2: Serial Input 2 - Northbound Queue.
Bit 3: Serial Input 2 - Southbound Queue.

Bit 4: Serial Input 3 - Northbound Queue.
Bit 5: Serial Input 3 - Southbound Queue.

The message will be accepted only if the bit corresponding to the input over which the message has been received, and the queue for which the message is intended is set.

If the message has been accepted, the five byte P.T.I. Message contained in the data field will be entered into the lowest unoccupied level of that T.D. queue indicated by the Sign bits.

5.6.2 O.L.C. MODE

MESSAGE FORMAT - VARIABLE LENGTH

COMMAND BYTE = 0 0 1 S1 S0 B2 B1 B0

B2	B1	B0		
0	0	0	=	O.L.C. Update Message.
0	0	1	=	O.L.C. Cancel Message.
0	1	0 to		
1	1	0	=	Unused Commands.
1	1	1	=	(P.T.I. System Test Message.)

5.6.2.1 O.L.C. UPDATE MESSAGE

Valid Command Byte Value:-

00101000 (28h) (Northbound O.L.C. Queue.)
00110000 (30H) (Southbound O.L.C. Queue.)

Data Field = Optional list of O.L.C. Train Data blocks.

The data field contains from zero to 32 groups of three bytes of O.L.C. Train Data.

The list of O.L.C. Train Data must first go through a sorting routine.
Trains with times before arrival of 60 minutes or greater will remain in the positions as transmitted. Other trains will be sorted in order of times before arrival, around these.
The O.L.C. queue indicated by the Sign Bits is then overwritten by the sorted O.L.C. Train Data list.

5.6.2.2 O.L.C. CANCEL MESSAGE

Valid Command Byte Values:-

00101001 (29h) (Northbound O.L.C. Queue.)
00110001 (31h) (Southbound O.L.C. Queue.)

Data Field = One O.L.C. Train Number.

A search is made of the O.L.C. queue indicated by the Sign Bits for a Train whose number matches that contained in the data field. The matching entry is deleted from the queue, all

trains further down moving up to fill the gap. If no match is found, the queue will be unaffected.
This command also clears the Local Cancel Enable Flag for the queue.

5.6.2.3 P.T.I. SYSTEM TEST MESSAGE

Valid Command Byte Value:-

00111111 (27h)

Data Field = Null.

This message is not used by the Sign Controller.

5.6.3 TEXT CONTROL MODES

MESSAGE FORMAT - VARIABLE LENGTH

COMMAND BYTE = C2 C1 C0 S1 S0 M D1 D0

C2	C1	C0		
0	1	0	=	Store Reference Load Message.
0	1	1	=	Fixed Sequence Load Message.
1	0	0	=	Message Data Load and Display Mode.
1	0	1	=	Message Data Load Mode.
		M	=	Master Linker Buffer Control Bit.
	D1	D0	=	Linker Buffer Queue Control Bits.

Each of these commands performs a number of functions, which must be carried out in the order given below:-

i) Carry out any special function specific to the command.

ii) Form an Effective Store Reference List, as defined for the command.

iii) Modify the Master Linker Buffer with the Effective Store Reference List, according to the Master Linker Buffer Control Bit.

iv) Update the Display indicated by the Sign Bits in accordance with the Display Control Bits.

5.6.3.1 MASTER LINKER BUFFER MODIFICATION

If the Master Linker Buffer Control Flag (bit 2) is zero, the Effective Store Reference List will be loaded into the Master Linker Buffer; all previous contents being lost.

If the M.L.B. Control Flag is one, the contents of the Effective Store Reference List will be added onto the end of the existing contents of the Master Linker Buffer, until the end of the ESRL is reached, or the M.L.B. contains 16 entries.

5.6.3.2 DISPLAY CONTROL

The Linker Buffer Queue or Queues indicated by the Sign Selection Bits are updated according to the Display Control Bits as follows:-

D1,D0 = 0,0 - No effect

D1,D0 = 0,1 - Revert to Previous Display

D1,D0 = 1,0 - Display Temporarily the Store Reference List within the Master Linker Buffer.

D1,D0 = 1,1 - Display Until Further Command the Store Reference List within the Master Linker Buffer.

5.6.3.3 STORE REFERENCE LOAD MESSAGE

Valid Command Byte Values:-

01000000 (40h) to 01011111 (5Fh).

Data Field = List of Store References.

The Effective Store Reference List is formed from the list of Store References contained within the data field, in the order in which they appear. If the number of Store References is greater than sixteen, the first sixteen will be accepted.

5.6.3.4 FIXED SEQUENCE LOAD MESSAGE

Valid Command Byte Values:-

01100000 (60h) to 01111111 (8Fh).

Data Field = List of Fixed Sequence Stores.

The Effective Store Reference List is formed by concatenating the contents of the list of Fixed Sequence Stores contained within the data field. The fixed Sequence Stores are held in the SC-EPROM, and are numbered from 0 to F hex.
Each Fixed Sequence Store within the data field is examined in turn, and Store References from that store are copied into the Effective Store Reference List until an FF or 7F hex is found, or the end of the store is reached. A maximum of 16 Store References will be entered into the Effective Store Reference List.

5.6.3.5 MESSAGE DATA LOAD AND DISPLAY MESSAGE

Valid Command Byte Values:-

10000000 (80h) to 10011111 (9Fh).

Data Field = Store Reference, then Display Data.

i) The first byte of the data field is a Store Reference, which indicates a Programme Message Store, or that Special Message Store or Stores indicated by the Sign Bits. The rest of the data field contains display data which is loaded into the indicated store or stores.

ii) The Effective Store Reference List is a single entry set to the above Store Reference.

5.6.3.6 MESSAGE DATA LOAD MESSAGE

Valid Command Byte Values:-

10100000 (AOh) to 10111111 (BFh).

Data Field = Store Reference, then Display Data.

i) Display Data is loaded into the indicated store or stores, as for the previous command.

ii) The Effective Store Reference List is made empty.

5.6.4 SIGN CONTROL MODE

MESSAGE FORMAT - VARIABLE LENGTH

COMMAND BYTE = 1 1 0 S1 S0 B2 B1 B0

B2	B1	B0		
0	0	0	=	O.L.C. Queue Local Cancel Enable.
0	0	1	=	Unused Command.
0	1	0	=	Unused Command.
0	1	1	=	Switch to T.D. Mode.
1	0	0	=	Switch to O.L.C. Mode.
1	0	1 to	=	
1	1	1	=	Unused Commands

5.6.4.1 O.L.C. QUEUE LOCAL CANCEL ENABLE

Valid Command Byte Values:-

11001000 (C8h) Northbound.
11010000 (D0h) Southbound.
11011000 (D8h) Northbound and Southbound.

Data Field = Empty.

The Local Cancel Enable Flag for the O.L.C. queue or queues indicated by the Sign Selection Bits is set.

5.6.4.2 SWITCH TO T.D. MODE

Valid Command Byte Values:-

11001011 (CBh) Northbound.
11010011 (D3h) Southbound.
11011011 (DBh) Northbound and Southbound.

Data Field = Empty.

The Signs indicated by the Sign Selection bits are switched to T.D. Mode.

5.6.4.3 SWITCH TO O.L.C. MODE

Valid Command Byte Values:-

11001100 (CCh) Northbound.
11010100 (D4h) Southbound.
11011100 (DCh) Northbound and Southbound.

Data Field = Empty.

The Sign indicated by the Sign Selection bits are switched to O.L.C. Mode.

5.6.5 INITIALISE/RESET MODE

MESSAGE FORMAT - FIXED LENGTH

COMMAND BYTE = 1 1 1 S1 S0 B2 B1 B0

B2	B1	B0		
0	0	0	=	Unused Command
0	0	1	=	(Initialise P.T.I. F1 Stores)
0	1	0	=	Start of Service Clear.
0	1	1 to		
1	1	1	=	Unused Commands.

5.6.5.1 INITIALISE P.T.I. F1 STORES

Valid Command Byte Value:-

11111001 (F9h)

Data Field = Unused.

This message is not used by the Dot Matrix equipment.

5.6.5.2 START OF SERVICE CLEAR

Valid Command Byte Value:-

11111010 (FAh)

Data Field = Unused (normally all zeros).

Both T.D. Stores within the Sign Controller will be cleared.
No other store or queue will be affected.

5.7 SIGN CONTROLLER - KEYPAD AND DISPLAY

A keypad and display unit will be provided to allow an operator to examine the contents of various stores and queues within the Sign Controller, to examine what is being displayed on the Signs, and to obtain faults detected by the Sign Controller.

5.7.1. DISPLAY UNIT

The Display Unit will be capable of showing information , in the following manner.

1) At least one complete face of a Sign must be shown in a dot for dot representation. All faces controlled by the controller must be selectable for this display.
2) All other information will be given in an easily understood mnemonic form. This information will be available at the same time as the display (1) is showing.

The display will be split into four main areas:-

5.7.1.1. DISPLAY AREA

Information required by the operator will be displayed in this area.

5.7.1.2. PROMPT AREA

Information displayed in this area will serve as a prompt to the operator, indicating which keys may be pressed at the current menu level.

5.7.1.3. STATUS AREA

This area will display what information is currently being presented in the Display Area.

5.7.1.4. ECHO AREA

This area will echo the entry of hexadecimal numbers.

5.7.1.5. KEYPAD

There will be two keypads, one will contain the hexadecimal digits, 0 to F, and the other the following legends, the precise use of which will be described subsequently:-

STORE SELECTION KEYS

TD QUEUE
OLC QUEUE
SPECIAL MESSAGE
FIXED TEXT
PROGRAMME TEXT
ERROR REPORT

SIGN MIMIC

DIRECTION SELECTION

NORTHBOUND
SOUTHBOUND
CONCOURSE

STORE OR QUEUE FUNCTIONS

INCREMENT
DECREMENT

TD QUEUE FUNCTIONS

INSERT
CANCEL

GENERAL FUNCTIONS

EXIT
ENTER

5.7.2 GENERAL OPERATION

The system will be menu driven. The prompt area will indicate to the operator which keys he may operate at any given menu level; any other key having no effect, or generate an error message in the status area.
The operator may examine any message store, the train information queues or the clock, obtain an error report, or review the information currently being displayed on any of the signs. For the latter, the status area will indicate which of the four possible signs are connected to the chosen port.

The keypad software will respond to commands by displaying the relavent information on the keypad display within one second of the command being entered.

5.7.3. MESSAGE STORE DISPLAYS

5.7.3.1. SPECIAL MESSAGE

The Status Area will display for example, 'SPECIAL MESSAGE (NB)'. Operation of the direction keys will allow the other stores within the group to be displayed.
The EXIT key may be used to go back to the Store Selection menu.

5.7.3.2. FIXED AND PROGRAMME TEXT

The name of the store, followed by the level within it will be presented (e.g. 'FIXED TEXT F') in the Status Area.
The Increment and Decrement keys will allow the operator to step through the stores within a group, with 'wrap round' between F to 0 (Programme Message Stores), or between 0 and 1F (Fixed Text Stores).

The EXIT key will again return to the Store Selection stage.

5.7.3.4. T.D. QUEUE DISPLAY

'T.D. QUEUE (SB)', for example, will be displayed in the Status Area. The display will show the position of the train in the queue (from 1 to 32), at the currently selected level, followed by its destination.
The Increment and Decrement keys will allow the levels to be stepped through, with wrap-round. The relevant Direction keys will allow the same or other queue to be selected, returning the current level to the head of the queue.
The INSERT key will allow a train to be inserted into the queue at the currently selected level, all other trains moving down the queue by one position. Any train at the back of the queue will be lost. A hexadecimal number from 0 to FF hex may be entered. A train may not be loaded into the queue if the position immediately below it in the queue is unoccupied, and the Prompt Area must reflect this. The P.T.I. Train Data block will be formed in a manner similar to receipt of a T.D. Code from a Parallel Input.
The CANCEL key will allow a train at any occupied level to be deleted from the queue, trains lower down the queue moving up to fill the gap. The menu must again reflect the availability of this function.
The EXIT key returns to the Store Select stage.

5.7.3.5. OLC QUEUE

This is similar to the TD Queue, except that the Time Before Arrival display will be presented for a train, and that the queues may not be altered.

5.7.3.6. SIGN REVIEWS

The current display on the selected sign will be presented. The status area will show, e.g., 'SIGN (NB) 1234', or 'SIGN (NB) not fitted' where 1,2,3,4 indicate which signs are fitted on the link.
The direction keys allow the other signs to be reviewed.

5.7.3.7. HEXADECIMAL ENTRY

Where a hexadecimal entry is to be made, any number of key depressions may be made to arrive at the required value. The last two digits pressed will be displayed, and reflect the currently selected value, the second from last being the most significant digit. On initial entry, 00 will be displayed, as if the operator had entered this.

5.8. SERIAL OUTPUT - TALKBACK.

The OLC will poll each sign controller address in turn and will receive a fixed length message reply containing sign status information. The message format will be:

From OLC STX <ADDR> EXT BCC
to OLC STX <ADDR> <STATUS> EXT BCC

where <ADDR> is an ASCII character 0-9
A-F
and <STATUS> is a fixed length message to be determined.

The status response will be a simple go - no go status for each sign attached to the sign controller.

6. SIGN SOFTWARE.

6.1. SIGN CONTROLLER TO SIGN DATA LINK

The communication link between the Sign Controller and Sign serves two purposes:

6.1.1. DISPLAY UPDATE TRANSMISSION

The transmission will be preceded by a Status Request transmission to each of the four possible signs in turn. Provided that one sign at least replies the data will be sent.

6.1.2. STATUS REQUESTS

Each Dot Matrix Sign on a link will be uniquely addressed from 1 to 4 to enable each Sign to indicate its presence to the Sign Controller.
Every 30 seconds, and also immediately before a Sign Update Message, the Sign Controller will send to each sign a status request message in turn, waiting up to one second for each sign to reply before addressing the next sign.
If a Sign fails to receive a message from the Sign Controller for a period exceeding 90 seconds, it will automatically blank its display. It will remain in this condition until a Display Update is received from the Sign Controller; the new data being displayed.
The number of signs fitted to each port will be held in the SC-EPROM. To minimise delay in updating sign information, the controller should not request status reports from unfitted signs.

6.2. SIGN DISPLAY MODES

The Dot Matrix Sign will display information in a variety of modes, which will be defined by the Display Data transmitted to it.

The sign will be able to display one or two rows of information.

List of facilities :-

Barrel roll (Up)
Barrel roll (Down)
Horizontal scroll (1 speed)
with 3 column cursor
without cursor
Pause (Followed by parameter to determine the hold time)
Unveil static message (1 speed)
From left

From right
Upwards
Downwards
From centre to both edges
From both edges to centre

Flashing

Entire
Part

Inverse characters

Elongated (Double width)

All these facilities are to be available on either the top or bottom row independently of the display appearing on the other row.

6.3. CHARACTER FONT.

The character font will be New Johnston as used by London Underground. An alternative font will be permitted only on agreement with London Underground. The font will be changeable by EPROM (or whatever memory storage is used) exchange or re-entry.

7. SOFTWARE DESIGN PHILOSOPHY.

7.1 DESIGN AND DOCUMENTATION

Full software documentation must be provided, this should commence with the production of a software functional specification detailing the design of the system in terms of the hardware configuration, modules and the data base. This specification will require approval by London Underground Limited before work commences.

Detailed documentation should be provided for each programme module; a written description, flow charts (or equivalent), data base structure, input output structure and array structure.

The software must be designed to be data base driven such that changes to the operational requirements can be made by amending the static data.

The data generation software must be supplied together with full details of it operation, stating the computer and operating system required to generate new data bases.

7.2 STRUCTURED PROGRAMMING LANGUAGE

Software must be written in a high level language using structured design techniques, preferred languages being coral or pascal. Agreement of London Underground Limited must be obtained for use of another language.

7.3 LISTINGS

Source listings will be required for all designed software, the listings being commented on average at least every 10 lines. The comments should relate to the flow charts (or equivalent).

Full details of the system software must be provided.

7.4 ACCEPTANCE TESTING

A software acceptance specification must be produced and agreed by London Underground Limited. This should provide a schedule of tests and expected results which will demonstrate that the requirements of the functional specification have been met.

The manufacturer must state how he will demonstrate the integrity of the software during the acceptance tests.

7.5. DERIVATION OF SOFTWARE.

For all software, all compliers and assemblers must be made available to London Underground.

8. ENVIRONMENT

In various sections of this specification, the term correct operation is used, this is defined as follows,

a) The equipment must perform to all requirements of this specification.
b) The equipment must not generate interference at frequencies or amplitudes liable to affect the operation of other equipment.
c) No equipment including protection devices may be damaged.
d) No external intervention (manual or from other equipment) to reset or restart will be required.
e) The equipment must not generate corrupt externally transmitted data.

8.1 INTERFERENCE

All equipment must operate correctly in conditions of radiated interference, transients and surges. This interference will occur from train and signalling supplies, from other equipments connected to these supplies and from equipment and cabling found in the railway environment. The traction supply interference may be generated by the use of conventionally and thyristor controlled trains.
The equipment must be tested with the equipment in its normal operating conditions but where doors, covers etc are removable during on site maintenance then these should be removed or opened.
The equipment must contain error checking devices or procedures to detect corrupt incoming data to a level specified in 4.1.7.

8.1.2. AIRBORNE INTERFERENCE

The specified limits for interference levels are as follows:

Using equipment as given in L.T. drawings XC 128/1 and XC 128/1/1
(to be superseded by a L.T. specification)

Where practical, the equipment should be placed within a $1.0m^2$ loop and tested in all 3 planes, where this is impossible the loop is to be placed 75mm away from the equipment in all relevant planes and may be located at any position

8.1.3 SUPPLY INTERFERENCE

The specified limits for interference levels are as follows:

a) Power supplies to equipment are to be tested to tests (A), (B) and (C).

b) Connections made indirectly to all power supplies (e.g. via transformer and relay contacts etc.) are to be tested to tests (A), (B) and (C).

c) All other connections, e.g.open wires, data cabling, is to be tested by placing the cable between two conductors or plates which have an effective coupling capacitance of 50pf (approx) to the data cable. A test voltage as

described in test (C) is then to be applied between the plates.

d) Where connections are fed from the unit across relay contacts etc and use a power supply internal to the unit to detect the contact status, then test (C) will be applied with the contact open.

	Maximum Voltage	Rise Time	Pulse Width
Test (A):			
Voltage: Between conductors	1000 V	300 ns	50 us
Test (B):			
Voltage: Common mode to earth	300 V	300 ns	50 us
Test (C):			
Voltage: Common mode to earth	500 V	5 ns	100 ns

Note: equipment not earth connected shall be placed 50 mm above an earth plane.

8.2 POWER SUPPLY

The equipment will be supplied from a nominal 240V 50 Hz supply which will be derived from either an London Underground or C.E.G.B. supply.

The tolerances on this supply will be as follows:

	Minimum	Nominal	Maximum
Voltage:	200	240	260
Frequency:	48	50	52

It is to be assumed that any combination of minimum and maximum tolerance can occur.

The equipment must correctly operate when the voltage supply changes in either direction between the minimum and maximum tolerances within one second.

8.4 VIBRATION AND BUMP TESTING

All equipment must conform to BR specification 967 category D, but excluding the 10 inch drop test.

8.5 TEMPERATURE

The equipment must operate correctly within the following limits.

	MIN	MAX
Temperature	-20°C	+ 55°C

This temperature is the ambient air temperature surrounding the equipment and its casework.

The equipment must commence correct operation when power is applied at the minimum power levels given in 7.2 following a period of 2 hours at the minimum temperature without power. Similarly after a period of 2 hours at maximum temperature and power supply the power shall be disconnected for 1 minute and then reconnected. Following this the unit must commence correct operation.

8.7 HANDLING AND TRANSPORTATION

All equipment must be designed to enable safe and easy handling during installation and maintenance, and should be designed to be carried by a minimum number of people.
Any transporting cases must be clearly marked with details of the items within. All packing material must be identifiable and any items needed to be retained for transportation or packing for maintenance purposes must be shown in the appropriate drawings.

8.8 HEALTH AND SAFETY

All equipment must be designed to take into account the provisions of Health and Safety at Work Act 1974.
All equipment and components must be non-flammable and, in the event of fire, must not release toxic gases. Full details are given in the relevant London Underground code of practice.
All equipment must not contain any material which will constitute a health hazard to staff during installation, operation or maintenance.

8.9 WEIGHT

The supplier must indicate the weight of each item of equipment.
The maximum weights must not exceed the following:

Sign Controller	50 Kg
Sign (Double faced)	100 Kg
Sign (Single faced)	50 Kg

If the design is heavier than this the contractor must apply to London Underground for permission to use the equipment.

8.10 WATERPROOFING

All signs must be waterproofed to BS 5490 (IP 54) to enable them to be used in an unprotected outdoor station environment. The design of the sign must allow for reasonable protection of the internal equipment when the door is open.

The sign controller will always be fitted in a location where weather protection is provided and therefore should be protected to BS 5490 (IP 52).

9. INSTALLATION AND MAINTENANCE

9.1. ON SITE DIAGNOSTICS.

The diverse locations where this equipment will be installed mean that the technician called to correct failed equipment will be unable to transport extensive amounts of test equipment and therefore the controller will be required to provide much of the fault diagnostic information. It is prefered that no more test equipment that a voltmeter is needed.
Indications must be provided to ensure that a technician can isolate faults to card or major component level so that the system can be restored to full working order by the methods indicated above. Indications must also be provided to enable the technician to determine the status of individual bits of the actual parallel incoming data messages and the correct level of any serial messages stream.

9.2 ON SITE MAINTENANCE

Maintenance on site will be either by complete unit replacement or by card replacement. Other major components, e.g. supply transformers, must be site replaceable. Because of the importance of this equipment to the operation of the railway and the difficulty of access to equipment on or near public areas, it is imperative that access for maintenance purposes of all cards and major components is as easy as possible and, at a minimum, the following:-

a) All connections to boards must be via connectors (i.e. not soldered etc.)

b) All board mountings must be easily unscrewed or unclipped.

9.3 WORKSHOP MAINTENANCE

London Underground requires that all possible faults can be corrected within London Underground (or external) Workshops and that no equipment needs to be returned to the manufacturer for repair or routine service.

9.4 AUTOMATIC TEST EQUIPMENT

London Underground's workshops will soon be equipped with automatic test equipment. When the manufacturer uses an ATE system to test individual areas or modules of this equipment then all relevant details are to be included in the workshop manual. Suitable test points to enable the equipment to be fully tested and exercised shall be included in the design.

9.5 SPARES

The supplier must guarantee the availability of all spares for a minimum period of 15 years and must give 2 years notice of cessation of availability. It is the responsibility of the supplier to choose components or subcontractors to ensure that this availability is met.

9.6 OPERARTING LIFE AND RELIABILITY OF EQUIPMENT

The equipment shall be designed to have an operating life of a minimum of 20 years. Any part of the equipment requiring routine replacement or overhaul must have a minimum of 7 years maintenance-free service. All parts of equipment requiring maintenance during equipment life must be so designated on the relevant drawings.

The supplier must demonstrate prior to contract an expected MTBF (Mean Time Between Failures) of a typical site comprising one sign controller and two double faced signs of more than 10,000 hours. A failure shall mean that the system fails use valid data to give correct and easily readable information on any relevant display.

9.7 MANUALS

The supplier will provide at least six copies of each of the following manuals.

a) Installation
This will include the following:-

1) Mechanical installation details

2) Details of all connections external to the unit (including the sign/controller link).

3) The physical location of any ROMs to be installed by London Underground.

4) Any keypad instruction to generate test sequences.

5) The setting of any internal or external switch or link.

6) Any initialisation sequence commands to enable commissioning.

7) A list of all test equipment required.

b) Site Maintenance
This will incorporate the following:

1) Clear diagrams showing the location of all relevant cards and components.

2) An unambiguous step-by-step guide to enable faults to be traced to card or component level with a minimum of equipment.

3) A detailed instruction list to enable the system to be fully recommissioned following any failure or loss of power or data.

4) A list of all test equipment required.

c) Workshop Manual.
This will contain the following :

1) Complete board layout identifying each component.

2) Parts list of each board giving type and specification for component.

3) Details and nomenclature of signals appearing at board connectors.

4) Detail of any automatic test equipment used to test board and a full listing of any software necessary to operate such equipment to test these boards.

5) A list of all test equipment required.

d) Software Manual.

1) This is given in section 7.1.

9.8 TEST EQUIPMENT

The supplier shall supply, as part of this contract, all test equipment listed by the manuals in 9.7. Where it is appropriate to use commercial equipment this need not be supplied but this must be clearly indicated on the test equipment lists.

10. MODIFICATION AND REVISION

10.1 MODIFICATION

Any system modification or design alteration (including component changes) must have the prior approval of London Underground.

10.2 REVISIONS

ISSUE A	CHANGES	DATE	AUTHORITY
Preliminary draft.			

ISSUE B	CHANGES	DATE	AUTHORITY
Issued for Tenders.		20.11.85	RB

ISSUE C	CHANGES	DATE	AUTHORITY

1) Section 5.7.3.3. incorrectly numbered

2) Appendices 2 (speech synthesis) and 4 (Local control inputs) deleted. No longer required.

3) Add to 2.1.1.(B).

The concourse signs will not be required to display train information (5.1.3.) but only to display information from the display data stores (5.1.2.).

4) New section 3.1.5.

Power Initialisation.

The equipment must be self initialising from the power supply switch-on and must be capable of fully handling and displaying all received external messages without any further control or commands. In particular, the system must initialise (e.g. display messages in O.L.C. mode) without any sign control mode (5.6.4.) or initialise/reset mode (5.6.5.) messages being received.
This is identical to a 'cold start' routine (3.1.4.)

5) Add to 3.2.1.

The controller will have two 13A sockets (BS1363) able to supply 5 Amps at 240volts for the connection of external test equipment.
This supply may be directly in parallel with the incoming supply.

6) Add to 3.3.1.

The serial line data feed to the sign controller is a balanced line and therefore the modem input must not unbalance the line. The modem input should be earth free and have a high impedance isolation.

7) Add to 4.1.3.

The dots must be of a uniform colour and must not be red or green as these colours may be confused with signal aspects.

8) Add to 4.2.1.

The double faced sign shall have provision for a printed text sign approximately 0.3 metres high by the sign length. It will hang from the underside of the sign.
The contractor will supply the metalwork for the sign, but London Underground will supply the printed paper text. The drawings for the sign case include a design for a fixed text sign.

9) Appendix 1 (Talkback) deleted. Becomes section 5.8. Modem arrangements changed in section 3.3.1. / 3.3.1.1. / 3.3.1.2.

Appendix 2 (Reversible characters) deleted. Added to section 4.1.3.

APPENDIX I.

LIST OF DRAWINGS.

CS 65162	Dimensional Information.
AS 65163	Overall Pictorial drawing.
AS 65164	Cross section of single face of sign.
AS 65165	Cable support arrangements.

REMARKS.	MESSAGE GENERATED BY: ON-LINE COMPUTER.	MESSAGE GENERATED BY: JUNCTION PROCESSOR	MESSAGE USED BY: SIGN CONTROLLER	MESSAGE USED BY: JUNCTION PROCESSOR.	MESSAGE MEANING.	MESSAGE MODE.	MESSAGE TYPE.
FIXED LENGTH MESSAGES CARRY A SINGLE ADDRESS AND FIVE DATA BYTES.					GENERAL FORMAT.	T.D. MODE.	FIXED LENGTH 12 BYTES
		✓	✓	✓	P.T.I. MESSAGE.		
/	—	—	—	—	UNUSED COMMAND.		
	—	—	—	—	UNUSED COMMAND.		
	—	—	—	—	UNUSED COMMAND.		
	—	—	—	—	UNUSED COMMAND.		
	—	—	—	—	UNUSED COMMAND.		
	—	—	—	—	UNUSED COMMAND.		
	—	—	—	—	UNUSED COMMAND.		
UPDATE LOCAL REAL TIME CLOCK TO O.L.C. REAL TIME (24 HOUR).	✓		✓		TIME UPDATE MESSAGE.		
INITIALISE.		✓		✓	INITIALISE F1. TYPE STORE.	INITIALISE RESET MODE.	
INITIALISE ALL F1 STORES.	✓						
CLEAR P.T.I, F1, F2, F3 STORES OR SIGN CONTROLLER T.D. STORES.	✓		✓	✓	START OF SERVICE CLEAR.		
					UNUSED COMMAND		
					UNUSED COMMAND		
					UNUSED COMMAND		
					ILLEGAL COMMAND		
					ILLEGAL COMMAND.		

END OF MESSAGE FLAG.	P.T.I MESSAGE OR DATA.						ADDRESS.	COMMAND BYTE.	MESSAGE NUMBER.	CRC-16 CHECK.		START OF MESSAGE FLAG	VALID HEX. VALUES FOR COMMAND BYTE.
BYTE 12. (FE)	BYTE 11.	BYTE 10.	BYTE 9.	BYTE 8.	BYTE 7		BYTE 6.	BYTE 5.	BYTE 4.	BYTE 3.	BYTE 2.	BYTE 1 (FE)	
				TRAIN NUMBER. H T U	EMPTY/ SERVICE FLAG.	CREW NUMBER. H T U	TRAIN DESTINATION. T U						
FE	7 6 5 4 3 2 1 0	7 6 5 4 3 2 1 0	7 6 5 4 3 2 1 0	7 6 5 4 3 2 1 0	7 6 5 4 3 2 1 0	7 6 5 4 3 2 1 0	mm.	0 0 0 0 0 0 0 0	00	yy	yy	FE	08, 10
	DATA DEPENDANT ON USE.												
FE							mm	000 00 001	xx	yy	yy	FE	—
	DATA DEPENDANT ON USE.												
FE							mm	000 00 010	xx	yy	yy	FE	—
	DATA DEPENDANT ON USE.												
FE							mm	000 00 011	xx	yy	yy	FE	—
	DATA DEPENDANT ON USE.												
FE							mm	000 00 100	xx	yy	yy	FE	—
	DATA DEPENDANT ON USE.												
FE							mm	000 00 101	xx	yy	yy	FE	—
	DATA DEPENDANT ON USE.												
FE							mm	000 00 110	xx	yy	yy	FE	—
	DATA DEPENDANT ON USE												
FE							mm	000 00 111	xx	yy	yy	FE	—
			SECONDS. 0-59 10	MINUTES. 0-59 10	HOURS. 0-23 10								
FE	0	0	0-59 10	0-59 10	0-23 10		mm	111 11 1000	xx	yy	yy	FE	F8.
FE	0	0	0	0	0		mm	111 11 001	xx	yy	yy	FE	F9.
FE	0	0	0	0	0		mm	111 11 010	xx	yy	yy	FE	FA.
	DATA DEPENDANT ON USE												
FE							mm	111 00 011	xx	yy	yy	FE	—
	DATA DEPENDANT ON USE												
FE							mm	111 00 100	xx	yy	yy	FE	—
	DATA DEPENDANT ON USE.												
FE							mm	111 00 101	xx	yy	yy	FE	—
FE							mm	111 00 110	xx	yy	yy	FE	—
FE							mm	111 00 111	xx	yy	yy	FE	—

TRAIN DESCRIBER SIGNS AND INDICATORS

DOT MATRIX SIGN

INTER-EQUIPMENT DATA PROTOCOLS

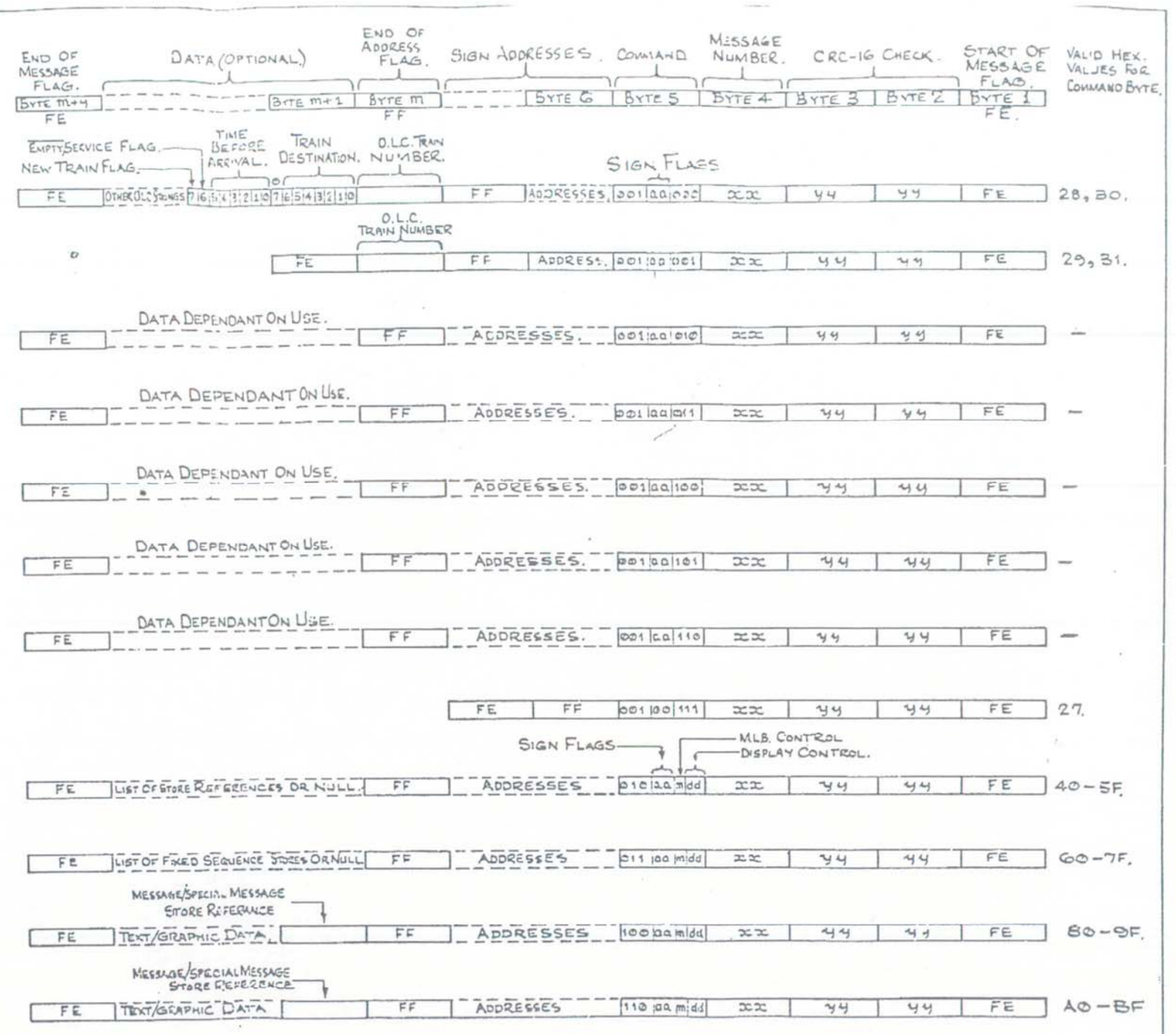
LONDON TRANSPORT EXECUTIVE
DEPARTMENT OF THE
DIRECTOR OF SIGNAL & ELECTRICAL ENGINEERING
270/320 BOLLO LANE, ACTON W.3 8QY
Drawn- G.C. Checked- Jam Date- 1.12.83.

Appd. Date 13th Dec 83

DRAWING No.

CS63625 (SH1. of 4)

REMARKS	MESSAGE GENERATED BY: ON-LINE COMPUTER	MESSAGE GENERATED BY: JUNCTION PROCESSOR	MESSAGE USED BY: SIGN CONTROLLER	MESSAGE USED BY: JUNCTION PROCESSOR	MESSAGE MEANING.	MESSAGE MODE.	MESSAGE TYPE.
					GENERAL FORMAT.		
	✓		✓		O.L.C. MESSAGE.	O.L.C. MODE.	VARIABLE LENGTH MESSAGES.
SWITCH OFF TRACK CIRCUIT CANCEL, AND CANCEL MATCHING O.L.C. TRAIN NUMBER IF IT EXISTS	✓		✓		O.L.C CANCEL.		
					UNUSED COMMAND.		
					UNUSED COMMAND.		
					UNUSED COMMAND.		
					UNUSED COMMAND.		
					UNUSED COMMAND.		
THIS MESSAGE NOT RETRANSMITTED BUT REPLIED TO OVER CONTROL ROOM DATA LINK.	✓			✓	JUNCTION PROCESSOR TEST MESSAGE.	JUNCTION PROCESSOR TEST MODE	
1. LOAD OR APPEND THE MASTER LINKER BUFFER WITH THE STORE REFERENCE LIST 2. MODIFY DISPLAYS ACCORDING TO SIGN FLAGS AND DISPLAY CONTROL BITS.	✓		✓		STORE REFERENCE LOAD MESSAGE.	TEXT/ GRAPHIC CONTROL MODE.	
1. LOAD OR APPEND THE MASTER LINKER BUFFER WITH THE CONTENTS OF THE FIXED SEQUENCE STORE LIST. 2. MODIFY DISPLAYS ACCORDING TO SIGN FLAGS AND DISPLAY CONTROL BITS.	✓		✓		FIXED SEQUENCE LOAD MESSAGE.		
1. LOAD MESSAGE DATA INTO A MESSAGE STORE OR THAT SPECIAL MESSAGE STORE INDICATED BY THE SIGN BITS. 2. LOAD OR APPEND THE MASTER LINKER BUFFER WITH THE MESSAGE/SPECIAL MESSAGE STORE REFERENCE. 3. COPY DISPLAYS ACCORDING TO SIGN FLAGS & DISPLAY CONTROL BITS.	✓		✓		MESSAGE DATA LOAD / DISPLAY MODE		
1. MESSAGE DATA INTO A MESSAGE STORE OR THAT SPECIAL MESSAGE STORE INDICATED BY THE SIGN BITS. 2. MODIFY DISPLAYS ACCORDING TO SIGN FLAGS AND DISPLAY CONTROL BITS.	✓		✓		MESSAGE DATA LOAD MODE.		



qq ≡ $S_1 S_0$

0 0	Concourse Sign
0 1	Northbound Sign
1 0	Southbound Sign
1 1	North & Southbound Sign

TRAIN DESCRIBER SIGNS AND INDICATORS. DOT MATRIX SIGN INTER-EQUIPMENT DATA PROTOCOLS.	LONDON TRANSPORT EXECUTIVE DEPARTMENT OF THE DIRECTOR OF SIGNAL & ELECTRICAL ENGINEERING 270/320 BOLLO LANE, ACTON W.3 8QY Drawn – G.C Checked – JGH Date – 1·12·83	Appd. R. Bl Date 13 Dec. 83 DRAWING No. CS63625 (SH.2. of 4)

REMARKS.	MESSAGE GENERATED BY. ON-LINE COMPUTER	MESSAGE GENERATED BY. JUNCTION PROCESSOR	MESSAGE USED BY. SIGN CONTROLLER	MESSAGE USED BY. JUNCTION PROCESSOR	MESSAGE MEANING.	MESSAGE MODE.	MESSAGE TYPE.
					GENERAL FORMAT.		
NABLE CANCELLATION OF O.L.C ?AINS BY TRACK CIRCUIT INPUT.	✓		✓		TRACK CIRCUIT O.L.C CANCEL ENABLE MESSAGE.		
					UNUSED COMMAND		
					UNUSED COMMAND		
SWITCH TO T.D. MODE AS PER SIGN FLAGS.	✓		✓		SWITCH TO TD. MODE.	SIGN CONTROL MODE.	VARIABLE LENGTH MESSAGES.
SWITCH TO O.L.C. MODE AS PER SIGN FLAGS.	✓		✓		SWITCH TO O.L.C. MODE.		
					UNUSED COMMAND.		
					UNUSED COMMAND.		
					UNUSED COMMAND.		

	END OF MESSAGE FLAG FE	END OF ADDRESS FLAG FF	SIGN ADDRESSES.	COMMAND.	MESSAGE NUMBER.	CRC-16 CHECK.		START OF MESSAGE FLAG FE	VALID HEX. VALUES FOR COMMAND BYTE
	BYTE m+1	BYTE m	BYTE 6.	BYTE 5.	BYTE 4.	BYTE 3	BYTE 2.	BYTE 1.	
				SIGN FLAGS.					
	FE	FF	ADDRESSES	110 aa 000	xx	yy	yy	FE	CB, D0, D8.
	FE	FF	ADDRESSES	110 aa 001	xx	yy	yy	FE	
	FE	FF	ADDRESSES	110 aa 010	xx	yy	yy	FE	
	FE	FF	ADDRESSES	110 aa 011	xx	yy	yy	FE	CB, D3, DB.
	FE	FF	ADDRESSES	110 aa 100	xx	yy	yy	FE	CC, D4, DC.
	FE	FF	ADDRESSES	110 aa 101	xx	yy	yy	FE	
	FE	FF	ADDRESSES	110 aa 110	xx	yy	yy	FE	
	FE	FF	ADDRESSES	110 aa 111	xx	yy	yy	FE.	

"ADDRESSES" INCLUDE JUNCTION PROCESSOR ADDRESSES TO REDUCE TOTAL DATA TRAFFIC.

Appd. R. BC Date 13 Dec 83

TRAIN DESCRIBER SIGNS AND INDICATORS.

DOT MATRIX SIGN INTER-EQUIPMENT DATA PROTOCOLS

LONDON TRANSPORT EXECUTIVE
DEPARTMENT OF THE
DIRECTOR OF SIGNAL & ELECTRICAL ENGINEERING
270/320 BOLLO LANE, ACTON W.3 8QY
Drawn - G.C. Checked - JAM Date - 1.12.83

DRAWING No.

CS63625 (SH.3 OF 4)

MESSAGE FORMAT, ORDER OF BIT TRANSMISSION, CRC-16 GENERATION.

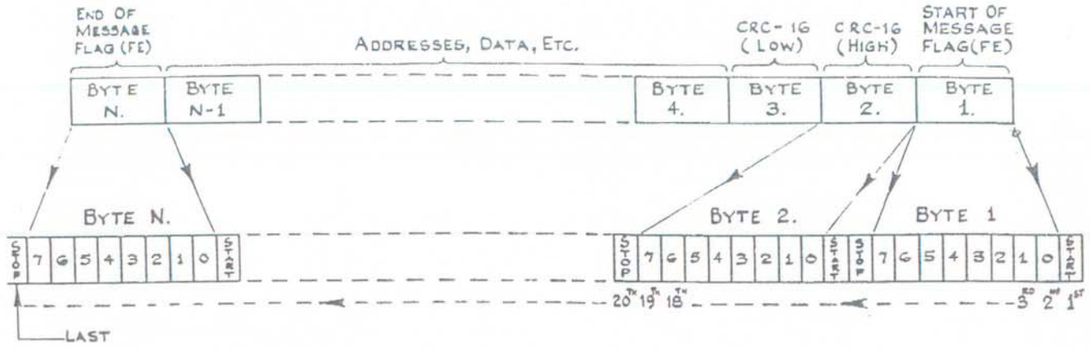


FIG. 1. FORMAT OF TRANSMITTED MESSAGE.

FIG.2. BIT POSITIONS AND ORDER OF TRANSMISSION

NOTE: BIT 0 = LEAST SIGNIFICANT BIT
BIT 1 = MOST SIGNIFICANT BIT

SIGN FLAG (a.a)	SIGN.
ø ø	CONCOURSE.
ø 1	NORTH BOUND.
1 ø	SOUTH BOUND.
1 1	NORTH & SOUTH BOUND.

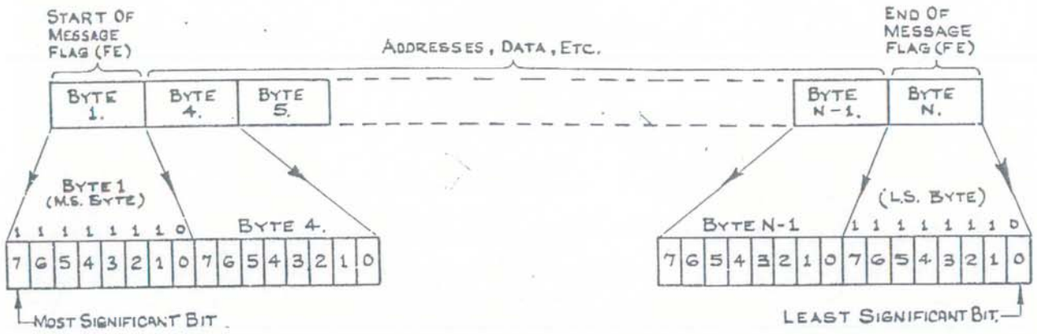
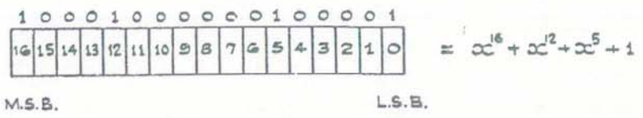


FIG.3. DIVIDEND FORMED FROM MESSAGE FOR CRC-16 GENERATION.

FIG.4. BIT ORDER FOR DIVISION.



$= x^{16} + x^{12} + x^5 + 1$

FIG.5. DIVISOR-GENERATING POLYNOMIAL.

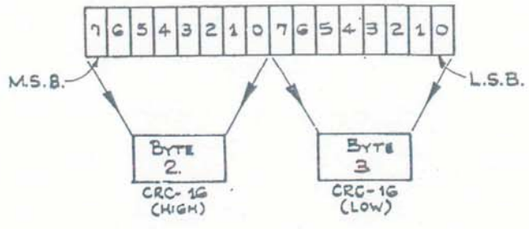


FIG.6. BIT POSITIONS OF REMAINDER AFTER MODULO 2 DIVISION.

FIG.7 CRC-16 BYTES FORMED.

For CRC-16 checking the dividend, Fig.3, is formed by making Byte 1 of the message the most significant byte, followed by Byte 4, Byte 5, etc.. Byte N is the least significant byte. Bit 7 of Byte 1 is the most significant bit. Bit 0 of Byte N is the is the least significant bit. (Fig.4)
Modulo 2 division is performed on the dividend by the generating polynomial (Fig.5)
The eight most significant bits of the 16 bit remainder (Fig6) form Byte 2 (CRC-16 (high)) of the transmitted message, while the eight least significant bits form Byte 3 (CRC-16 (low)) of the transmitted message.

SUBSTITUTION.
To ensure that FE hex. does not appear within a transmitted message substitution is performed as follows :-
1. TRANSMITTING EQUIPMENT.
After the CRC16 bytes have been calculated and added, if FEh occurs within the message, it will be substituted by the two byte ASCII sequence, SUB, A (1Ah, 41h). If SUB(1Ah) occurs within the message it will be substituted by the two byte ASCII sequence, SUB, SUB(1Ah, 1Ah)
2. RECEIVING EQUIPMENT.
Before CRC16 checking, if the aforementioned sequences occur within a message, they will be de-substituted as appropriate.

STORE REFERENCE FOR LINKER BUFFER.	
ØØ h	T.D.
Ø1 h	O.L.C.
Ø2 h	SPECIAL MESSAGES.
Ø3 h	CLOCK (24 HOUR).
Ø4 h	CLOCK (12 HOUR).
Ø5 h	ERROR STORE.
Ø6 h	POWER DOWN FLAG RESET.
Ø7 h	
Ø8 h	
Ø9h-ØFh	
10 hTo 1Fh	FIXED TEXT. GROUP 1.
20h To 2Fh	PROGRAM TEXT.
30h To 3Fh	PROGRAM GRAPHIC
40h To 4Fh	FIXED TEXT GROUP 2

MASTER LINKER BUFFER (M.L.B) UPDATE MODE BIT (m)	ACTION.
Ø.	LOAD M.L.B. WITH EFFECTIVE STORE REFERENCE LIST.
1.	APPEND M.L.B. WITH EFFECTIVE STORE REFERENCE LIST.

DISPLAY CONTROL BITS dd.	ACTION.
Ø Ø	NO EFFECT ON SIGNS.
Ø 1	REVERT SELECTED SIGNS TO PREVIOUS MODE OF OPERATION.
1 Ø	DISPLAY TWICE THE CONTENTS OF THE M.L.B. ON THE SELECTED SIGNS, THEN REVERT TO PREVIOUS MODE OF OPERATION.
1 1	DISPLAY THE CONTENTS OF THE M.L.B. ON THE SELECTED SIGNS.

SELECTED SIGNS ARE THOSE, OR THAT INDICATED BY THE SIGN FLAGS.

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