PROPOSAL FOR SERIAL DATA INTERFACE FOR PAGING EQUIPMENT

CONTENTS

APPENDIX A

1.   **INTRODUCTION**

Telephone systems and paging systems today, are reaching levels of sophistication that were hardly to be considered just a few years ago. Far more information about subscribers is available in such systems, enabling more intelligent and more efficient use to be made of the facilities that are available to caller and subscriber alike.

This information requires a degree of intersystem control above that which has so far been required and will, as systems become more powerful, require yet more capability from intersystem communications.

As higher degrees of machine intelligence become available and digital electronic designs replace the old electro-mechanical systems, so the methods of communication between systems become oriented towards the rapid transfer of information between such systems. To this end, ESPA have decided to recommend a serial data interface for paging systems, which is both powerful and flexible, and opens an extendible path for the future.

The method recommended conforms to ISO 1745 "Information Processing – Basic mode control procedures for data communication systems". It uses conventional stop-start character formats, a 'handshake' protocol with error detection, is suitable for half-duplex operation and may be used via modems if required.

Proposals for a Tieline Type Interface and for a Subscriber Line Interface can be found in ESPA Publication 4.4.3.

NB: For conventions and a glossary of terms used in this publication see chapters 6 and 7.

2.   CHARACTER DESCRIPTION

2.1 CHARACTER STRUCTURE

The data communication is a serial, bit synchronous, character asynchronous format as defined by ISO 1177, utilising one start bit, seven information bits, one even parity bit and two stop bits.
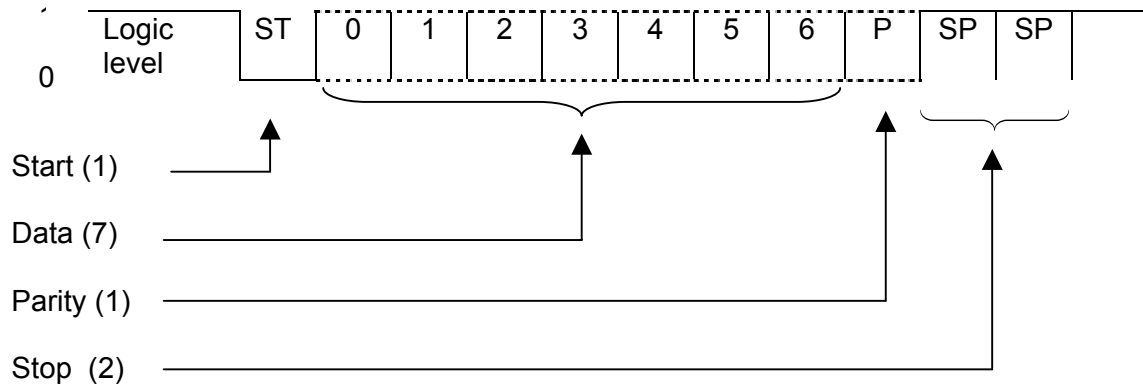
2.2 THE CHARACTER SET

The character set conforms to the international alphabet number 5 (CCITT V3 & ISO 646, see Appendix A) referred to in this text as IA5.

2.3 CONTROL CHARACTERS

2.3.1   Transmission Control Characters

The following Control Characters have a special meaning in the protocol and will be referred to as Transmission Control Characters.

TC1   SOH   start of header
Start of a header of a message

TC2   STX   start of text
Precedes a text field and terminates a header

TC3   ETX   end of text
Terminates a text field

TC4   EOT   end of transmission
Terminates a transaction of one or more texts. Returns control to the Control Station

TC5   ENQ   enquiry
Requests a response from a remote station, may include station identity

TC6   ACK   acknowledge
Transmitted by the receiving station as a positive response to the sender

TC7   DLE   data link escape
Not used

TC8   NAK   negative acknowledge

Transmitted by the receiving station as a negative response to the sender

TC9   SYN   synchronous idle
Not used

TC10 ETB   end of transmission block
Not used

2.3.2 Information Separator Characters

Control Characters used to separate and qualify data logically.

IS1   US   unit separator
IS2   RS   record separator
IS3   GS   group separator
Not used
IS4   FS   file separator
Not used

2.4 TRANSMISSION CONTROL PREFIXES

A number of these characters may be prefixed to control information at various stages during the protocol: -

ENQ   May be prefixed to the device address for polling and selecting.

NAK   May be prefixed to an error identifier if known.
The presently defined errors are: -

'1'   Transmission error
Corrupt character(s) or corrupt BCC, received by the station (BCC Block Checking Character, ISO 1155)

'2'   Busy
Unable to accept a transaction e.g. queue full etc

'3'   Invalid message
Type or content of message not recognised by this station

ACK and EOT are not prefixed within this protocol.

NB: Character within ' ' means character according to IA 5.

3.   **THE PROTOCOL**

The protocol used conforms to International Standard ISO 1745 "Information processing-Basic mode control procedures for data communication systems".   It is a multi-drop protocol utilising a Control Station.   Typically, the telephone or computer system acts as Control Station, however, the paging system will act as a Control Station when required.

3.1 POLLING

The Control Station polls a device on the communication line with the sequence <address> ENQ. On receipt of this sequence, the polled device becomes Temporary Master Station.

>   A polling sequence <u>always</u> follows an EOT (see 3.3 Termination)
>   <Address> is the address of the device being polled

The characters'0' to'9' shall be available as addresses. Where only two stations are interconnected it is recommended that the telephone system has address'1' and the paging system has address '2'.

3.2 SELECTING

The polled device sends <address> ENQ to select the device to which it has data to transfer or EOT to indicate that it does not have data to transfer (see 3.3 Termination). When the polled device sends <address> ENQ, then the selected device sends ACK if it is ready to receive data. The Temporary Master Station may now communicate with the selected device that has become Slave Station. If the selected device is not able to receive data it sends NAK with an appropriate prefix.   The Temporary Master Station then sends EOT to terminate the communication.

>   A selecting sequence <u>never</u> follows an EOT
>   <Address> is the address of the device being selected

3.3 TERMINATION

Upon completion of its transaction(s), the Temporary Master Station sends EOT which both indicates to the Slave Station that transactions are now complete and that control is returned to the Control Station.

If the Control Station does not detect valid transaction on the communication line within 10 seconds, then it sends EOT to terminate the communication and regain control.

3.4 EXAMPLES OF POLL & SELECT SEQUENCE

Control Station	Code	Code	Polled Station	Code	Code	Selected Station

No data to be transferred

Poll seq.	<address> →					
	ENQ →					
	←	EOT	Negative reply to polling			

Data is to be transferred

Poll seq.	<address> →					
	ENQ →		Becomes Temporary Master			

			Select seq.<address> →			
				ENQ →		
				←	ACK	Becomes Temp Slave

			Comm. line utilised by polled device	↔		

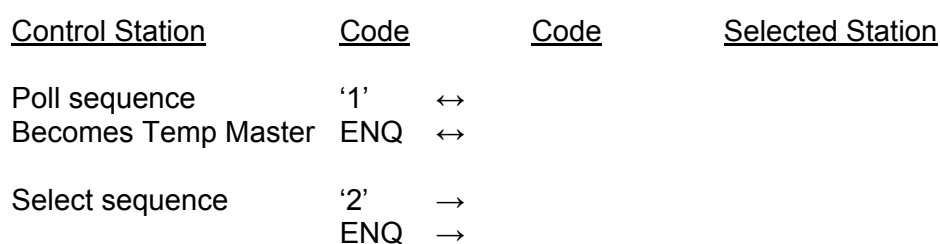|	←	EOT	End of usage EOT →			

Control returns
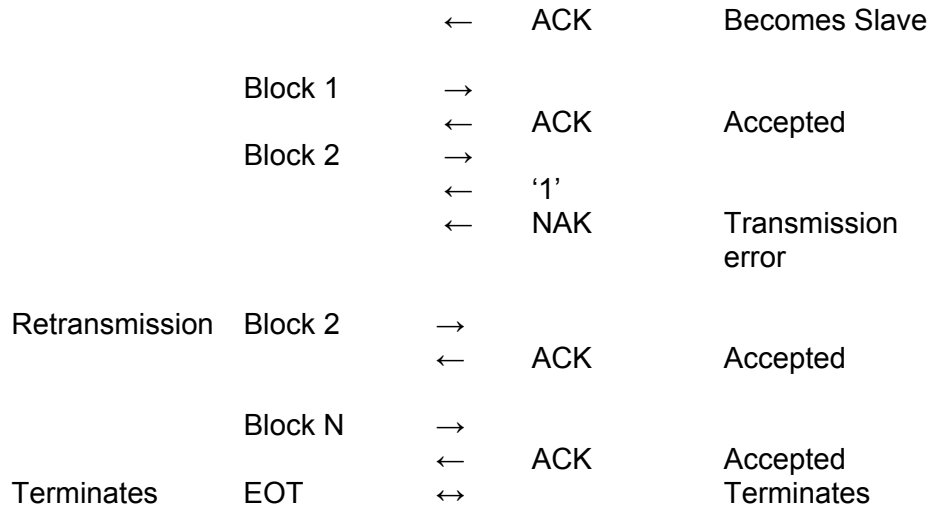to Control station
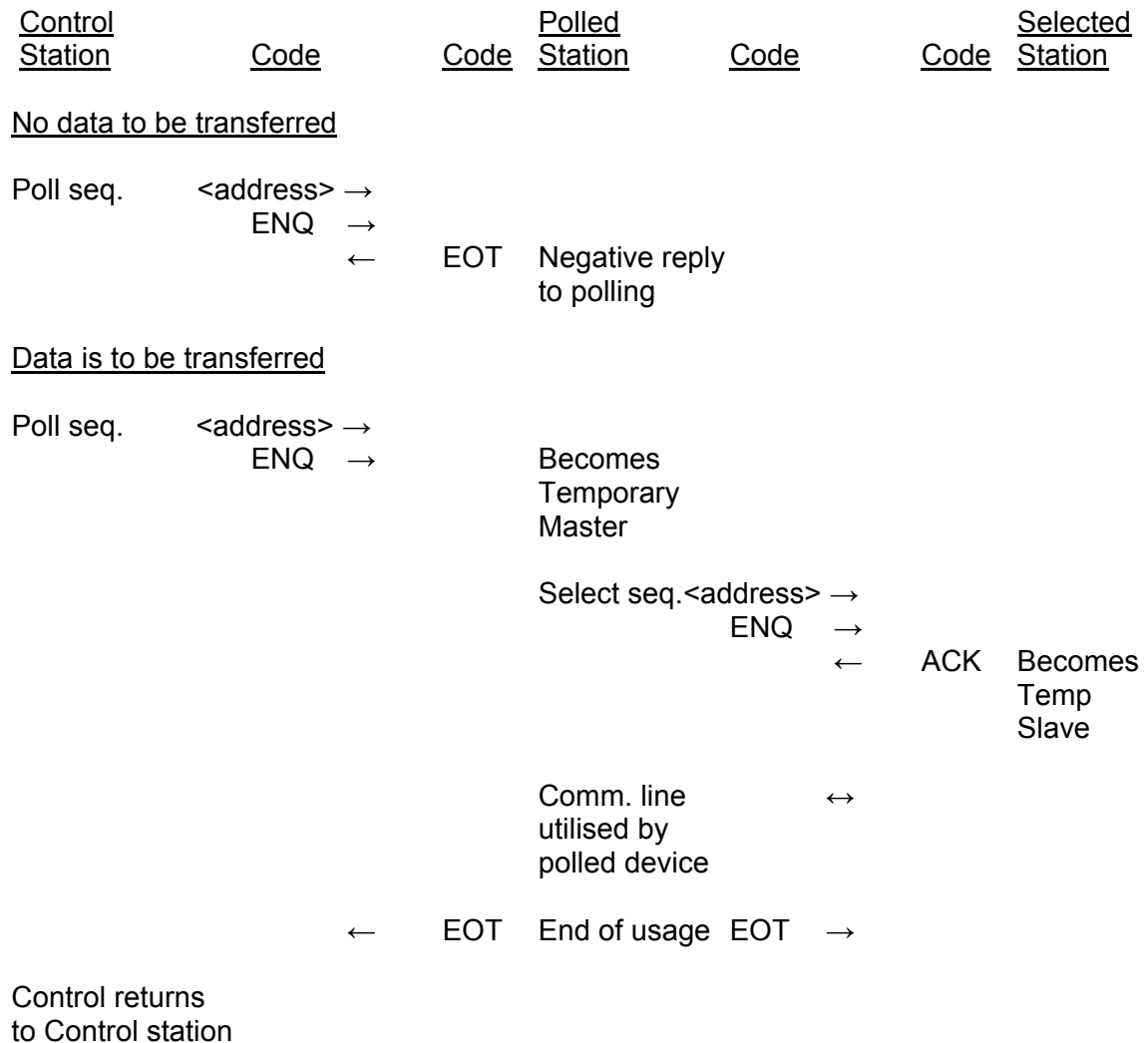
3.5 TRANSFER OF DATA BLOCKS

When a device is a Temporary Master of the communication line it may transfer data to the slave. When the slave correctly receives a block of data it acknowledges receipt with the ACK character. If, however, the slave is unable to accept the message, it will Negative Acknowledge with a NAK sequence (see paragraph 2.4) and the Temporary Master may then retransmit the block. If, after two attempts, the transmission still fails, then the Temporary Master will terminate transmission with the EOT character.

3.6 EXAMPLE OF TRANSMISSION OF BLOCKS OF DATA

In this example, the Control Station with address '1' polls itself and is thus able to transmit to the Slave Station with address '2'.
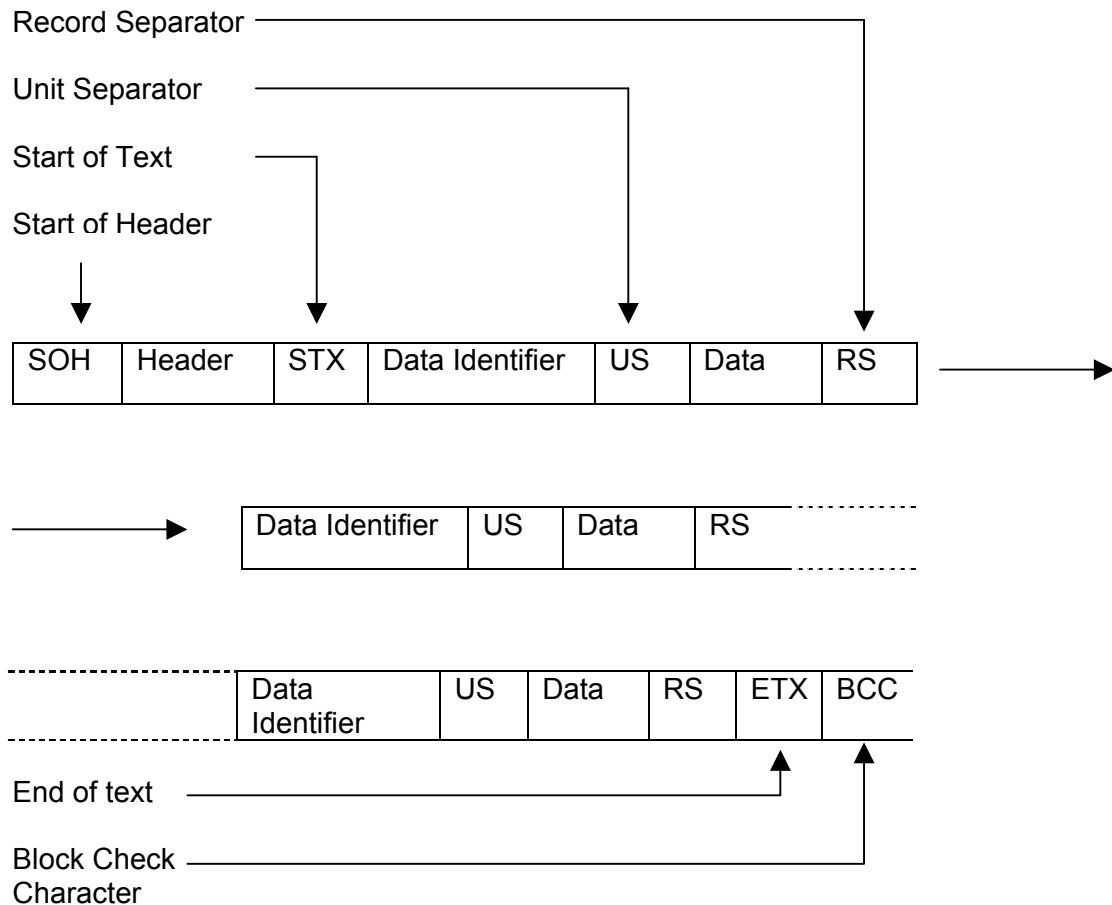
Example of transmission sequence: -

Control Station	Code	Code	Selected Station
Poll sequence	'1'	↔	
Becomes Temp Master	ENQ	↔	
Select sequence	'2'	→	
	ENQ	→	

		←	ACK	Becomes Slave
Block 1	→			
		←	ACK	Accepted
Block 2	→			
		←	'1'	
		←	NAK	Transmission error
Retransmission	Block 2	→		
		←	ACK	Accepted
	Block N	→		
		←	ACK	Accepted
Terminates	EOT	↔		Terminates

4.   DATA BLOCK DESCRIPTION

4.1 BLOCK STRUCTURE

Data blocks have the following form: -

Record Separator

Unit Separator

Start of Text

Start of Header

SOH	Header	STX	Data Identifier	US	Data	RS

Data Identifier	US	Data	RS

Data Identifier	US	Data	RS	ETX	BCC

End of text

Block Check Character

The Block Check Character shall be the modulo 2 binary sum of the characters in the transmitted block excluding the SOH. The longitudinal parity including the BCC shall be made even.

4.2 HEADERS

The header specifies the type of block (transaction).

The headers are defined in the following table: -

'1'   Call to pager
'2'   Status Information
'3'   Status Request
'4'   Call to subscriber line
'5'   Other Information (To be specified by the paging equipment manufacturer)

4.3 RECORDS

The contents and meaning of each record are defined in the following table. Note that data may have more characters, for example, to indicate a type or subdivision in the data. In most cases the character '0' is reserved for future expansion e.g. '1' is not the same as '01' or '001' etc.

Record type	Data Identifier	Data	Meaning
Call address	'1'	max 16 Characters	Address of the pager or a group of pagers
Display message	'2'	max 128 Characters	The message to be displayed
Beep coding	'3'	'0'	Reserved
		'1' to '9'	System dependant
Call type	'4'	'0'	Reserved
		'1'	Reset (cancel) call
		'2'	Speech call
		'3'	Standard call
Number of transmissions	'5'	'0'	Reserved
		'1'	1 transmission
		'2'	2 transmissions
		etc	etc
Priority	'6'	'0'	Reserved
		'1'	Alarm (Emergency)
		'2'	High
		'3'	Normal
Call Status	'7'	'0'	Reserved
		'1'	Busy
		'2'	In Queue
		'3'	Paged
		'4'	Absent
		'5'	Call terminated
		'6'	Ack. from called party
		'7'	Speech channel open

		'71'	Speech channel open (paged)
		''72'	Speech channel open (absent)
		'8'	Fault indications
System Status	'8'	'0'	Reserved
		'1'	Transmitter failure

A block consists of one or more of the above data beginning with a 'block type' header, with other data in any sequence separated by Record Separators.

In most systems, many of the data have pre-determined default values, in these cases, only the information which is required to be different to the default value need to be transferred e.g. for a standard priority call there is no need to send a 'standard priority' message.

4.4 EXAMPLES OF TRANSACTIONS
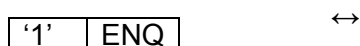
Example 1: -

Standard call to receiver number '123' is to be transmitted 3 times at high priority.

<u>Telephone System</u>   <u>Paging System</u>

POLL SEQUENCE
Polls itself

| '1' | ENQ | ↔

SELECT SEQUENCE
Selects Paging System

| '2' | ENQ | →   POSITIVE REPLY TO SELECTING

                    ← | ACK |

BLOCK 1:   →

HEADER
Type of block: Paging

| SOH | '1' | STX |——→

RECORD 1
Call Address

——→| '1' | US | '1' | '2' | '3' |——→

RECORD SEPARATOR

——→| RS |——→
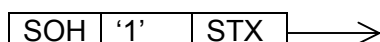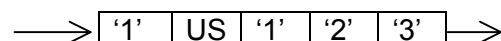
RECORD 2
Number of transmissions

——→| '5' | US | '3' |——→

RECORD SEPARATOR

$$\longrightarrow \boxed{\text{RS}} \longrightarrow$$

RECORD 3
Priority

$$\longrightarrow \boxed{\text{'6'} \mid \text{US} \mid \text{'3'}} \longrightarrow$$

TAIL

$$\longrightarrow \boxed{\text{ETX} \mid \text{BCC}}$$
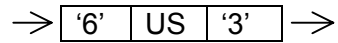
ACKNOWLEDGE
$$\longleftrightarrow \quad \boxed{\text{ACK}}$$
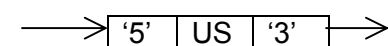
TRANSACTIONS
COMPLETE
$\boxed{\text{EOT}}$ $\qquad\longleftrightarrow$

Example 2: -

Paging System gives status information concerning a call made by the Telephone System. The call is identified by call number (123), beep coding (1) and display message (4567)

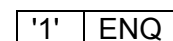<u>Telephone System</u>   <u>Paging System</u>

POLL SEQUENCE
Polls the Paging System
$\boxed{\text{'2'} \mid \text{ENQ}}$ $\longleftrightarrow$

SELECT SEQUENCE
Selects the Telephone System
$\longleftarrow$ $\boxed{\text{'1'} \mid \text{ENQ}}$

POSITIVE REPLY TO SELECTING
$\boxed{\text{ACK}}$ $\longrightarrow$

$\longleftarrow$ BLOCK 1: -

HEADER
Type of block: -
Status information
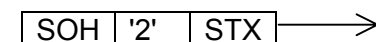
$\boxed{\text{SOH} \mid \text{'2'} \mid \text{STX}} \longrightarrow$

RECORD 1
Call address (123)
$\longrightarrow \boxed{\text{'1'} \mid \text{US} \mid \text{'1'} \mid \text{'2'} \mid \text{'3'}} \longrightarrow$

RECORD SEPARATOR
$\longrightarrow \boxed{\text{ACK}} \longrightarrow$

RECORD 2

⟶ | '3' | US | '1' | ⟹

RECORD SEPARATOR

⟶ | RS | ⟹

RECORD 3
Display message (4567)

⟶ | '2' | US | '4' | '5' | '6' | '7' | ⟹

RECORD SEPARATOR

⟶ | RS | ⟹

RECORD 4
Status (paged)

⟶ | '7' | US | '3' | ⟹

TAIL

⟶ | ETX | BCC | ⟶

ACKNOWLEDGE

| ACK | →
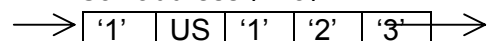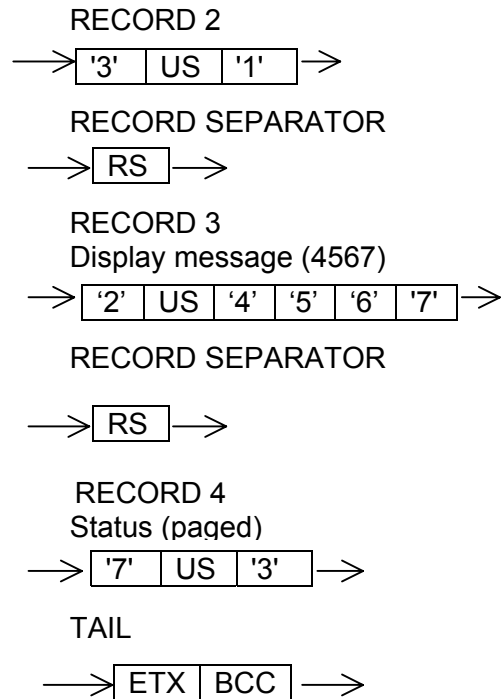
                    TRANSACTIONS COMPLETE

         ↔ | EOT |

Example 3: -

The Telephone System asks the paging system for status information concerning the progress of a paging call.   In order to completely identify the paging call, the Telephone System must transfer the same information as it did when the paging call was initiated.

The transaction will be exactly the same as in example 1, except for the header. The header now specifies that the transaction is a status request.

HEADER
Type of block (transaction): Status request

| '7' | US | '3' | ⟹

etc as example 1.

5. HARDWARE SPECIFICATION

5.1 DEFINITION OF INTERCHANGE CIRCUITS

The interchange circuits conform to CCITT recommendation X20.

Interchange Circuit Number	Interchange Name
G	Signal ground or common return
G_a	DTE common return
G_b	DCE common return
T	Transmitted data
R	Received data

5.2 ELECTRICAL CHARACTERISTICS

The electrical characteristics conform to CCITT recommendation V.11 (X.27/RS422/RS485) "Electrical characteristics for balanced double-current interchange circuits for general use with integrated circuit equipment in the field of data communications".

5.3 CONNECTOR SPECIFICATION

The connector specification conforms to ISO 4903 15 way 'D' type.

5.4 AUDIO SIGNALS

600 Ohms balanced with respect to earth.
Signal adjustable between –6dBm and –20dBm.

5.5 BAUD RATES

All standard baud rates between 300 and 9600 are available.

6. CONVENTIONS

< > Indicate that the value of the contents is to be considered: e.g. <address> indicates the address of something, not the word 'address'.

' ' Characters within ' ' indicate IA 5 characters: e.g. '0' is the character zero which has the hexadecimal code 3/0.

/ Used as a separator for the upper 3 bits and the lower 4 bits of an IA 5 code. When shown in this form, characters can be defined using either hex or decimal notation: e.g. character 'K' is 4/11 or 4/B.

↔
← } Indicate the direction of data flow: ↔ means bi-directional.
→

7. GLOSSARY

Control Station	The station which has overall responsibility for the communication line.
Data Block	A contiguous piece of information passed on the communication line.
Header	The identifying field at the front of a data block.
Multidrop	A configuration in which a connection is established between more than two terminal installations.
Polling	The process of inviting another station to become a temporary master station. Performed by the control station.
Selecting	Performed by a master station. Establishes a communication between the master and a slave station.
Slave Station	A station which is intended to receive an information message from a master station.
Temporary Master Station	The station which, at a given instant, has the right to select and to transmit an information message to a slave station.
Transmission Control Characters	Characters from the IA 5 alphabet which are used to control in the process of controlling transmission of data blocks on the communication line.

8.   LIST OF REFERENCES

ISO 646   7 bit character set for information interchange.
See appendix

ISO 1155   Information processing – use of longitudinal parity to detect data
                   errors in information messages.

ISO 1177   Information processing – character structure for start / stop and
                   synchronous transmission.

ISO 1745   Information processing – basic mode control procedures for data
                   communication systems.

ISO 2110   Data communication – 25-pin DTE/DCE interface connector and pin
                   assignments.

ISO 4903   Data communication – 15-pin DTE/DCE interface connector and pin
                   assignment.

CCITT V11/X27   Electrical characteristics for balanced double-current interchange
                   circuits for general use with integrated circuit equipment in the field
                   of data communications.

CCITT X20   Interface between data terminal equipment (DTE) and data circuit-
                   terminating equipment (DCE) for start/stop transmission services on
                   public data networks.

APPENDIX A

International alphabet number 5 (IA 5)

CCITT V3 & ISO 646

b7							row/col	0	0	0	0	1	1	1	1
b6								0	0	1	1	0	0	1	1
b5								0	1	0	1	0	1	0	1
	b4	b3	b2	b1	column / row		**column**	0	1	2	3	4	5	6	7
	0	0	0	0	0			NUL	TC7 (DLE)	SP	0	@	P	`	p
	0	0	0	1	1			TC1 (SOH)	DC1	!	1	A	Q	a	q
	0	0	1	0	2			TC2 (STX)	DC2	"	2	B	R	b	r
	0	0	1	1	3			TC3 (ETX)	DC3	#	3	C	S	c	s
	0	1	0	0	4			TC4 (EOT)	DC4	¤	4	D	T	d	t
	0	1	0	1	5			TC5 (ENQ)	TC8 (NAK)	%	5	E	U	e	u
	0	1	1	0	6			TC6 (ACK)	TC9 (SYN)	&	6	F	V	f	v
	0	1	1	1	7			BEL	TC10 (ETB)	'	7	G	W	g	w
	1	0	0	0	8			FE0 (BS)	CAN	(	8	H	X	h	x
	1	0	0	1	9			FE1 (HT)	EM	)	9	I	Y	i	y
	1	0	1	0	10			FE2 (LF)	SUB	*	:	J	Z	j	z
	1	0	1	1	11			FE3 (VT)	ESC	+	;	K	[	k	{
	1	1	0	0	12			FE4 (FF)	IS4 (FS)	,	<	L	\	l		
	1	1	0	1	13			FE5 (CR)	IS3 (GS)	-	=	M	]	m	}
	1	1	1	0	14			SO	IS2 (RS)	.	>	N	^	n	~
	1	1	1	1	15			SI	IS1 (US)	/	?	O	_	o	DEL