SYSTEM 6000 COMMUNICATIONS HANDBOOK

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EUROTHERM
PROCESS
AUTOMATION

To whom it may concern

Re: System 6000 Communications Handbook

This manual is supplied on a standalone basis to allow customers to write their own drivers to System 6000 equipment.

It details all the information required to, in conjunction with the relevant instrument manuals when necessary, enable other devices to communicate with our System 6000 equipment through the RS422 serial communications interface.

The information in this document is given in good faith, but is intended for guidance only. The specifications may be changed without notice. Eurotherm Process Automation will accept no responsibility for any losses arising from errors in the document or the implementation of it.

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SECTION 1 INTRODUCTION

1.1 General Communications Strategy

Microprocessors are incorporated into each System 6000 Instrument not just to increase the performance and flexibility compared to conventional analogue units, but also to permit dramatic improvements to be made in 3 key areas of communications, viz:-

a) Instrument to Operator communications,

b) Instrument to Instrument and Plant communications,

c) Instrument to Central Supervisory Computer communications.

This manual is concerned with the means of implementation and methods of using communication categories a) and c) above.

1.2 Instrument to Operator Communications

Every System 6000 instrument is fitted with 2 ports for serial data communication. Instrument to Operator communications is effected primarily by means of front-panel Operator push-buttons and displays, but also by an RS232 port available via a front-panel socket. This port is used for connection of the 8260 Hand-held Programming Terminal which is described in detail in Section 2. This terminal is used to enter a number of so called "Command Parameters" which are used to characterise an instrument for a particular function within a control system. These parameters are then stored digitally in non-volatile memory where they are retained indefinitely while the instrument is powered, and for at least 5 years if it is unpowered. This approach to data entry gives the following advantages :-

a) All parameters are entered as 4 digit numbers, mostly in meaningful engineering units.

b) The use of 4 digit numbers allows much greater precision of setting than with conventional analogue methods. This also means that greater resolution, accuracy and repeatability are obtained.

c) The wide use of engineering units makes the setting up of an instrument very easy. Furthermore the 8260 Terminal is made very "user friendly" by means of Operator prompts, flashing digits and comprehensive editing facilities as described in Section 3.

d) Critical parameters cannot be tampered with by personnel who do not have access to an 8260 Terminal.

e) An all digital data entry system eliminates many unreliable and cumbersome electromechanical components such as digit switches, drums and potentiometers.

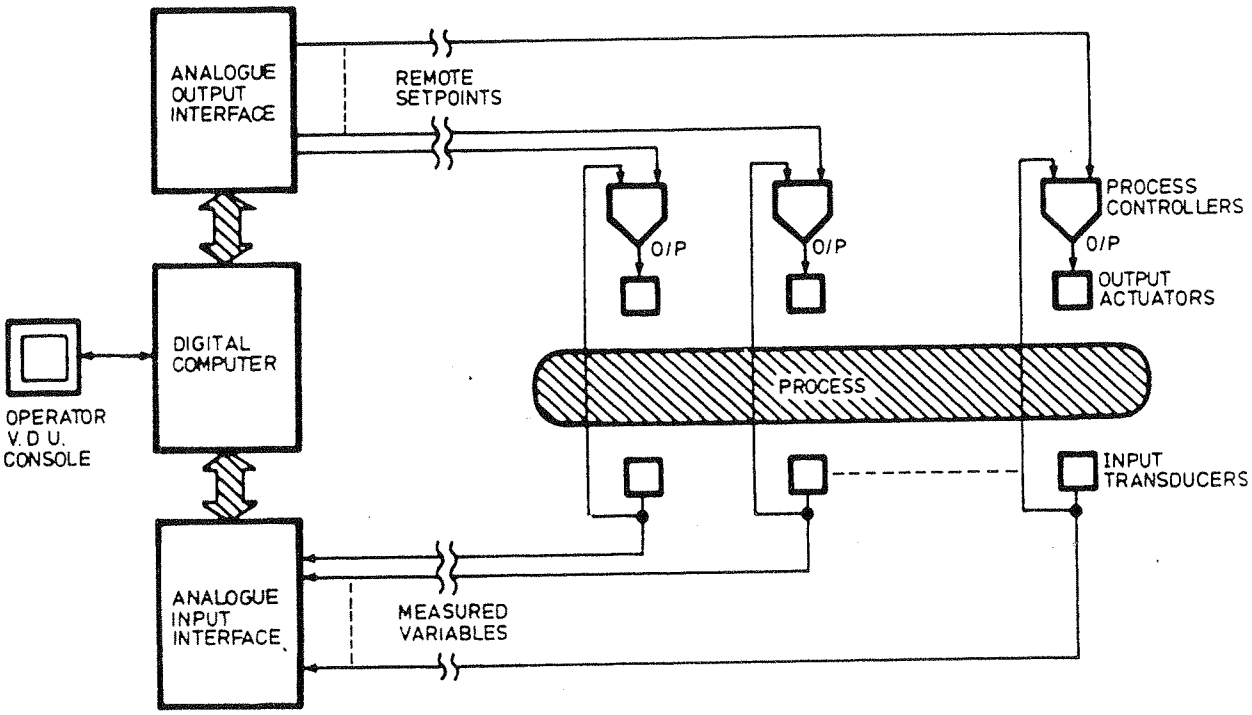


FIG 1·1 COMPUTER SUPERVISORY CONTROL SYSTEM SCHEMATIC USING CONVENTIONAL ANALOGUE CONTROLLERS.

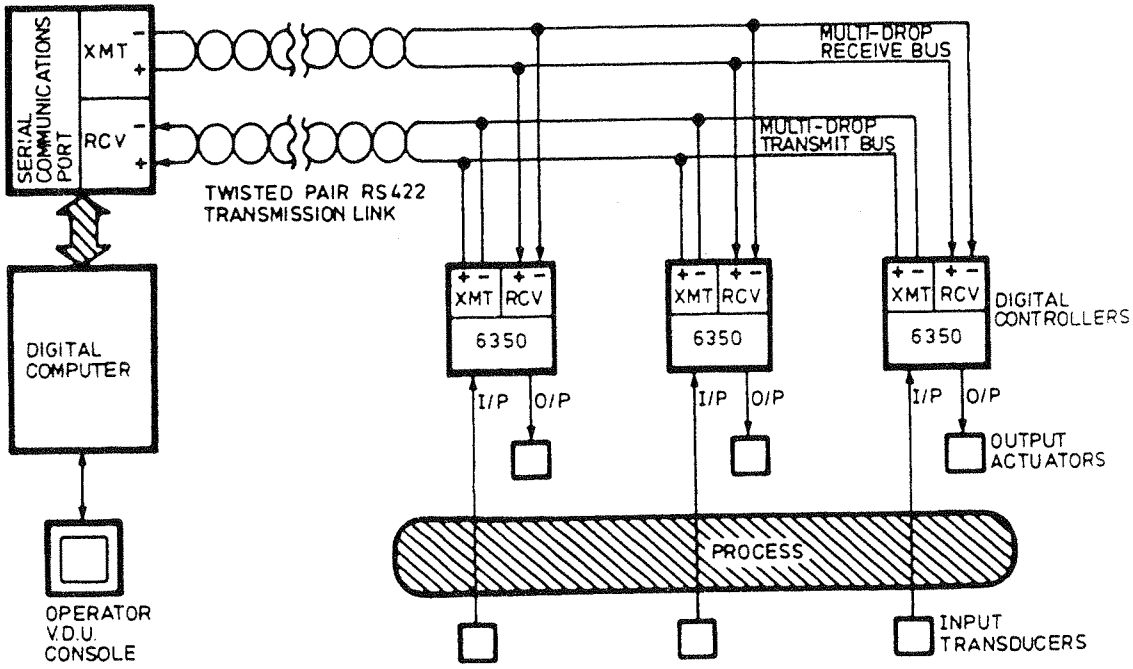


FIG 1·2 CENTRAL SUPERVISORY SCHEME FOR MONITORING 6350 MICROPROCESSOR BASED DIGITAL CONTROLLERS

1.3 Instrument to Supervisory Computer Communications

Supervision and monitoring of System 6000 instruments is made particularly simple by the provision of a supervisory communications interface. This is the function of the second serial data port fitted to each instrument which is an RS422 interface available on the module rear connector pins. This is bussed onto the supervisory data link common to all modules and so allows an intelligent device to monitor or update the parameters of a whole network of instruments. The benefits of this second communications port can best be illustrated by considering the implementation of a distributed control system.

1.3.1 Supervisory Control Systems

A simple definition of a Computer Supervisory Control System can be given as follows:-

"The process or system is controlled by a number of locally self-contained feedback loops which are implemented with individual Process Controllers. The central computer acts merely in a supervisory role monitoring the Measured Variables from each loop and providing remote setpoints to the Controllers".

Thus each loop is under continuous local control and the central computer is only required to perform periodic setpoint updating as required by the particular plant control strategy. A typical scheme for this is illustrated in Fig 1.1 using conventional Analogue Controllers. Here, the central Computer has to monitor the Process Variable from each transducer and provide the Remote Setpoint to each Controller via analogue input/output interfaces.

When such a scheme is upgraded with 6350 microprocessor-based Process Controllers the system is re-configured along the lines of Figure 5.2. The main differences and advantages of this new configuration can be listed as follows:-

a) Multi-wire analogue transmission is replaced by a bussed digital system using serial data transmission over twisted pairs. Thus cabling costs are considerably reduced.

b) Digital transmission is fundamentally less noise-prone than analogue methods and the accuracy of the transmitted data is unaffected by the transmission medium. The use of intelligent devices at either end of the data link allows error checking and correcting codes to be used which virtually eliminate the effects of electrical noise on data integrity.

c) The RS422 standard permits typically 16 units to be multi-dropped onto a single line driven by very simple hardware at the computer end as shown in Figure 5.2. Most computers are equipped with RS232 serial ports for driving teletypes, VDUs or printers and these are easily modified to accommodate the RS422 standard.

d) For long distance communications serial data transmission is readily accomplished by means of conventional Fibre-optic data links. The passive nature of this transmission medium makes it ideally suited for use in hazardous areas and electrically noisy environments. Ultra-long distance communications can also be implemented with the use of standard modem equipment.

e) The use of digital transmission with a microprocessor-based instrument means that data can be pre-processed so that only high-level messages are transmistted via standard communications protocols. When using System 6000 instruments in the ASCII mode of the protocol data is transmitted in engineering units preceeded by simple 2 character identification mnemonics. This greatly reduces the processing and communications load on the Supervisory Computer and simplifies its software to such an extent that it too need only be a microprocessor.

It should be noted that any parameter that can be updated via the 8260 terminal can also be accessed via the RS422 supervisory data link.

1.3.2 Communications Protocols

All data transfers between System 6000 instruments and the Supervisory Computer are carried out using a communications protocol. Section 4.3.1 discusses how TCS have chosen an ANSI standard protocol called BISYNC (Binary Synchronous) and known by the abbreviation X3.28. Section 4.3.3 further shows that each System 6000 instrument can operate this protocol in either the ASCII or Binary mode. The benefits of using a standard protocol can be summarised as follows:-

a) X3.28 is an internationally recognised ANSI standard protocol and is widely used by manufacturers of computers, computer peripherals, and communications equipment.

b) The protocol can operate in one of two modes:-

   i) The ASCII mode uses ASCII characters for all data representation which makes it very easy to implement with languages like BASIC, PASCAL, and FORTRAN. It is also very convenient to implement in 8 or 16 bit microprocessor assembly languages.

   ii) The Binary mode compresses the data parts of messages into a close-packed binary format. This compression of data makes this mode even more efficient than the ASCII mode as fewer characters are required to transmit a given message.

c) The use of the "Fast Select" features in the Polling and Selection Sequences (ACK or NAK) are very timesaving when accessing parameters repetitively or in sequential blocks. This is because it is not necessary to re-establish communications with the required instrument for each Poll or Select.

d) The use of a longitudinal redundancy block check control (BCC) character gives good data security and is simpler to implement in software than full cyclic redundancy check (CRC) systems.

The ASCII protocol mode is described in Section 5 of this manual and the Binary mode is described in Section 6.

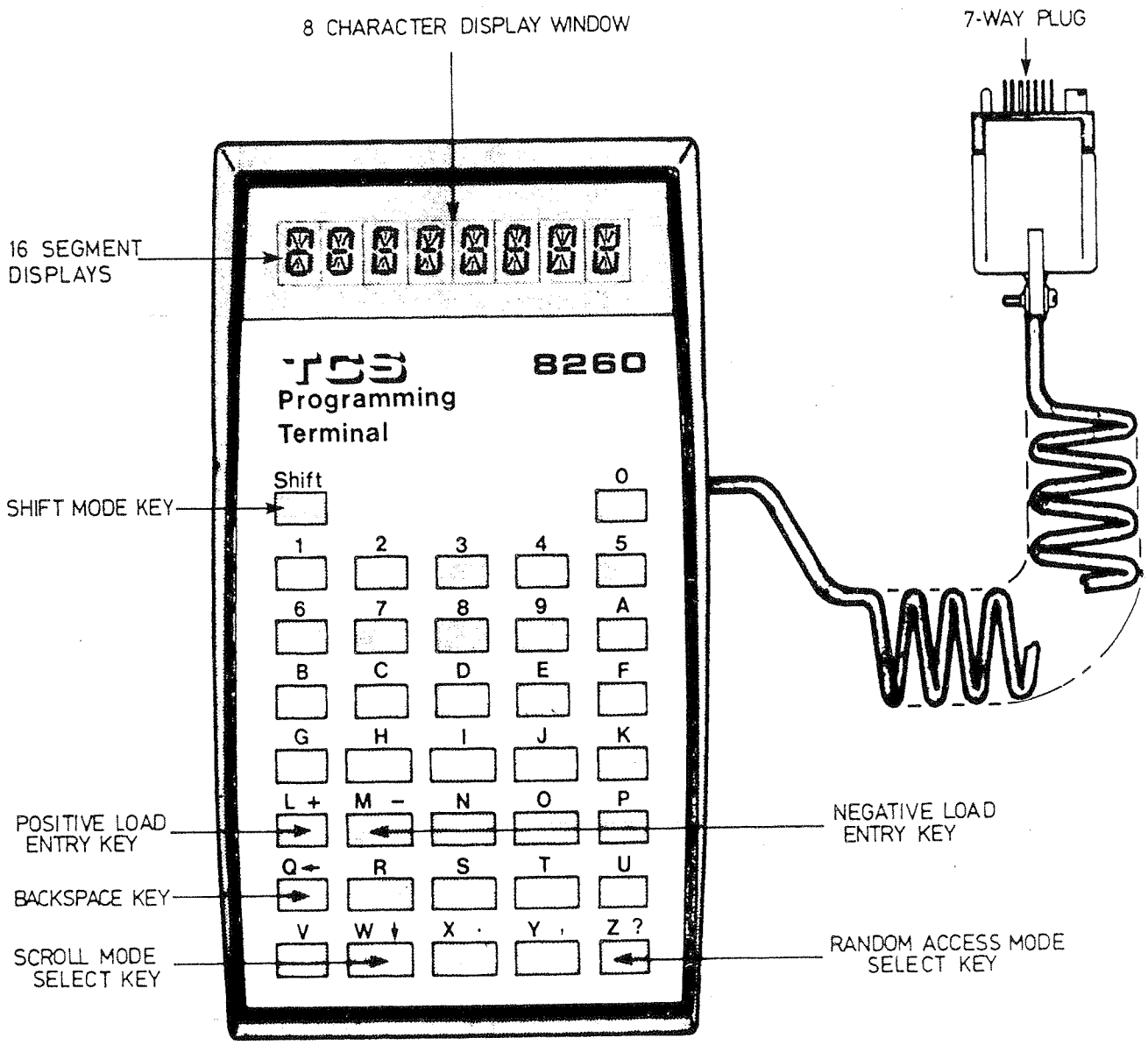


FIG 2.1
8260 HAND-HELD TERMINAL KEYBOARD LAYOUT

SECTION 2 THE 8260 HAND-HELD PROGRAMMING TERMINAL

2.1 Terminal Characteristics

Each System 6000 microprocessor-based instrument can be set up using a plug-in 8260 Hand-Held programming terminal. Every parameter is accessed by means of a simple 2 character command mnemonic and most data is entered directly in engineering units. This technique ensures the accuracy and security of parameter settings.

The 8260 terminal itself is a device the same size as a pocket calculator that is capable of transmitting and receiving serial ASCII code. The terminal contains a display and keyboard as illustrated in Fig 2.1 and it has the following technical specification :-

2.1.1 Display

Number of characters	:	8 (only first 7 used)
Type of display	:	red LED 16-segment "starburst"

2.1.2 Keyboard

Number of keys	:	37
Type of keys	:	positive, tactile response
Key functions	:	10 numeric, 26 alpha, 1 shift

2.1.3 Interface

Transmission standard	:	RS232/V24 (±12V)
Data rate	:	300 baud
Character length	:	10 bits made up of:- 1 start + 7 data + 1 parity (even) + 1 stop

2.1.4 Power Requirements

Supply voltage	:	+5V ±5%
Supply current	:	400mA

SWITCH NUMBER	SWITCH FUNCTION	SWITCH ACTION	
		OFF	ON
1	Stop bit select	2	1
2	Control code select	enable	disable
5	Baud rate select	110	300
6	Output mode select	non-floating	floating

TABLE 2.1 Switch functions 1, 2, 5, 6

SWITCH 4	SWITCH 3	PARITY MODE
Off	Off	Reset
Off	On	Set
On	Off	Even
On	On	Odd

TABLE 2.2 Switch functions 3, 4

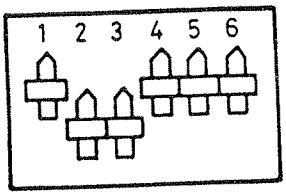


FIG 2.2 Factory pre-set switch positions

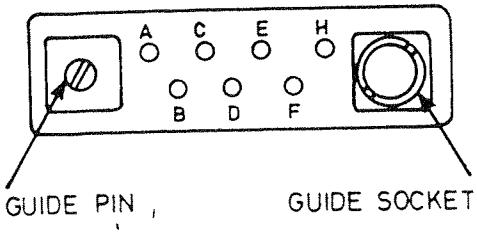


FIG 2.3 Outside view of plug showing positions of guide pin and socket

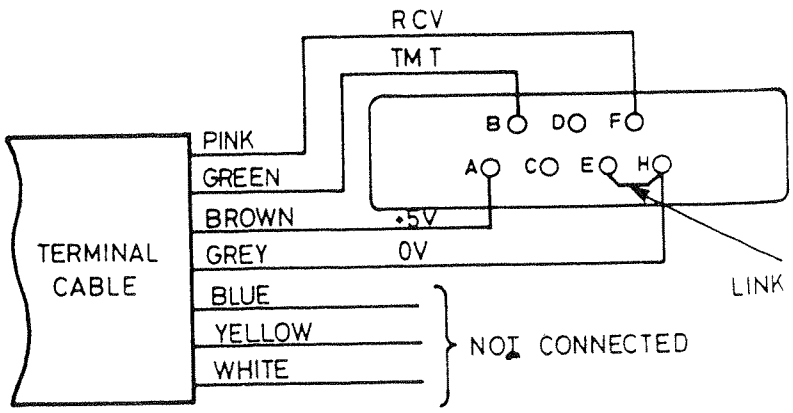


FIG 2.4 Plug viewed from wiring side

2.2 Terminal Set-up

The terminal is set up for correct operation with System 6000 instruments by means of a 6 way slide switch located underneath the removable cover at the back of the unit. These switches are factory pre-set by T.C.S., but for reference purposes the normal positions and switch functions are given in Fig 2.2 and Table 2.1 and 2.2 respectively.

2.3 Terminal Connection

Each terminal is supplied with a connection cable terminated with a 7-way plug as shown in Fig 2.1. The pin designations of this plug are shown in Fig 2.3 while the pin functions and cable wiring details are given in Fig 2.4. The terminal is connected to a System 6000 instrument by means of a mating 7-way socket which is situated behind a small door just above the catch-handle on the instrument front panel.

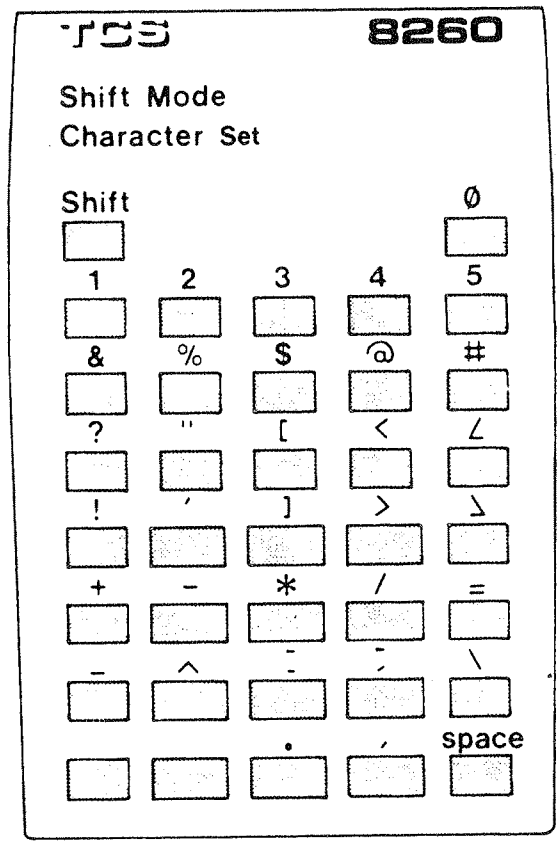


FIG. 2·5 SHIFT MODE CHARACTER SET KEYBOARD OVERLAY

2.4 Shift Mode Operation

Certain multi-channel System 6000 instruments like the 6358, 6432, 6433 and 6434, permit the user to programme 8 character loop or channel tag names via the 8260 terminal. In these cases there is often a requirement to enter space characters, asterisks or brackets for example. This is facilitated by means of the shift mode key situated at the top left hand corner of the keyboard. When this key is pressed the other 36 keys generate shift mode characters which in most cases are different from the normal key data indicated on the keyboard layout of Fig 2.1. To ascertain these shift mode characters a template is supplied with each 8260 terminal which may be placed over the keyboard. Fig 2.5 illustrates this template and shows which characters are obtainable in the shift mode. Note that the numbers 0 to 5 inclusive are not affected by shift mode operation, while the two left-hand keys on the bottom row are not operational in the shift mode.

Only the first key pressed after the shift key will generate a shift mode character, subsequent keys will generate their normal codes. If the shift key is pressed inadvertently then it can be cancelled by pressing it a second time before operating any other key.

SECTION 3 PARAMETER ENTRY PROCEDURES USING THE 8260 HAND-HELD TERMINAL

3.1 Terminal Initialisation

When the 8260 hand-held terminal is first plugged into the front-panel of a System 6000 instrument,the CPU detects its presence via one of the pins of the 7-way connector. As soon as this occurs, the RS422 supervisory communications channel on the rear connector is disabled and after a delay of about 2 seconds, the terminal is initialised and the following message is transmitted to the display:-

?? CMD

This message is a prompt to the operator requesting that a 2 character Command Parameter is entered in the position of the question marks. The types of Command Parameters that can then be entered depend upon the actual System 6000 instrument being programmed, and these can be divided into 2 classes as follows:-

3.1.1 Single Channel Instruments

Those System 6000 instruments which are effectively single channel or function are :-

6350, 6351, 6352, 6353, 6360, 6850

These devices have a single continuous list of Command Parameters which are given in the appropriate sections of Appendix A.

3.1.2 Multi-Channel Instruments

Those System 6000 instruments which contain multiple loops or channels are :-

6358, 6432, 6433, 6434

The Command Parameters for these instruments are divided into the following 2 types:-

a) Instrument Command Parameters which are concerned with the overall functions and operation of the module.

b) Loop, or Channel Command Parameters which are concerned with the individual status and operating characteristics of each control loop or input/output channel.

FORMAT	RANGE	POLARITY	DECIMAL POINT POSITION
1	0000 to +/-9999	BIPOLAR (+/-)	DEFINED BY STATUS WORD
2	0000 to +9999	POSITIVE (+)	DEFINED BY STATUS WORD
3	00.00 to +99.99	POSITIVE (+)	FIXED
4	000.0 to +999.9	POSITIVE (+)	FIXED
5	0000 to FFFF	4 HEXADECIMAL DIGITS	
6	00 to 99	2 DECIMAL DIGITS	
7	0 to 9	1 DECIMAL DIGIT	
8	AAAA to ZZZZ	4 ASCII CHARACTERS (UPPER CASE)	
9	0.000 to +9.999	POSITIVE (+)	FIXED
10	0000 to 9999	POSITIVE (+)	FIXED
11	.0000 to +.9999	POSITIVE (+)	FIXED
12	.0000 to +/-.9999	BIPOLAR (+/-)	FIXED
13	0.000 to +/-9.999	BIPOLAR (+/-)	FIXED
14	00.00 to +/-99.99	BIPOLAR (+/-)	FIXED
15	000.0 to +/-999.9	BIPOLAR (+/-)	FIXED
16	0000 to +/-9999	BIPOLAR (+/-)	FIXED

TABLE 3.1 List of Command Parameter Data Formats

Appendix A shows that the Instrument Command Parameters for these modules forms a continuous list, while each active loop or channel has a separate continuous list associated with it. It is recommended when setting up a multi-channel instrument for the first time to always start off with the Instrument Command parameters.

It should be noted that not all the Command Parameters given in Appendix A always appear in the parameter list. For example, Appendix A.1 shows that those parameters associated with the Ratio mode of a 6350 Conroller only appear in the list when switch no 1 of switch bank S2 is ON. Similarly, the Measured Power Parameter, MP, only appears in the table when S2 no 2 is ON.

3.2 Command Parameter Formats

It can be seen from the tables of Command Parameters for each instrument given in Appendix A that each parameter has an associated data format. These formats define the range, polarity, and decimal point position for each parameter according to the list given in Table 3.1.

3.2.1 Range

The range indicates how many digits have to be entered for a particular parameter and the span of the data.

3.2.2 Polarity

Certain parameters are entered as either positive or negative values (bipolar), others are always positive, while formats 5, 6, 7, and 8 are effectively unsigned (see Section 3.3).

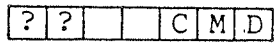
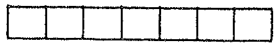
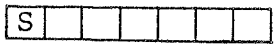
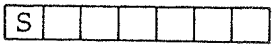
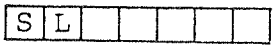
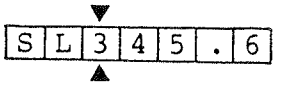
3.2.3 Decimal Point Position

An operator never has to enter a decimal point for a parameter, most of them appear in the display in a fixed position for each format. Some formats have no decimal point (formats 5, 6, 7, 8), while formats 1 and 2 have the position defined by command parameters called status words. For example the Process Variable for a 6350 Controller is a format 1 parameter and Appendix A.1 shows that its decimal point position is defined by the first digit of the "DP" command parameter. The DP parameter itself is a status word with a format 5 data structure.

3.3 Entry of a Parameter

The desired 2 character mnemonic from the tables of Appendix A is entered in response to the ?? CMD prompt of Section 3.1. The instrument will respond by transmitting the current value of the selected parameter with the number of characters, polarity, and decimal point position as appropriate for the parameter data format (see Table 3.1).

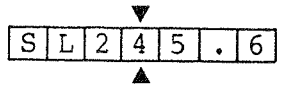
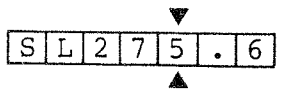
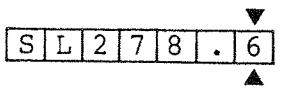
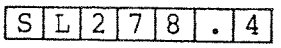
As an example, the following sequence would occur if the operator required to access the current Local Setpoint (SL) value of a 6350 Process Controller :-

	OPERATOR ACTIONS	DISPLAY READING
a)	After terminal initialisation (section 3.1)	
b)	Operator presses the S Key which causes the Controller to first clear the complete display :	
c)	The Controller then echoes the character S at the extreme left-hand end of the display :	
d)	Operator presses L key :	
e)	The Controller echoes the character L in the second character position :	
f)	The Controller then replies to the command with the current parameter value :	

KEY

 = Flashing digit

At this point the first digit of the parameter, i.e. the 3, will flash on and off to indicate to the operator that new data may now be entered starting with the most-significaant digit. If, for example, the operator required to update the setpoint to 278.4, then he would continue with the following sequence :-

	OPERATOR ACTIONS	DISPLAY READING
g)	The Operator presses the 2 key which causes the Controller to replace the 3 with the 2 and then flash the next digit, i.e. the 4 :	
h)	The Operator presses the 7 key which causes the Controller to replace the 4 with the 7 and then flash the next digit, i.e. the 5 :	
i)	The Operator presses the 8 key which causes the Controller to replace the 5 with the 8 and then flash the last digit, i.e. the 6 :	
j)	The Operator presses the 4 key which causes the Controller to replace the 6 with the 4 and leaves all the digits steady :	

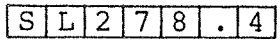
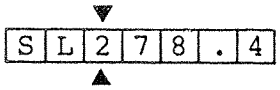
3.4 Loading a Parameter

Once the 4 new characters of the parameter have been correctly entered into the display as described in the previous section, the appropriate sign must be entered before the instrument will load the data into its parameter storage area. Again, using the example of Section 3.3, Appendix A.1 shows that SL is a format 1 parameter and Table 3.1 shows that format 1 parameters are bipolar so that they can be entered as either positive or negative numbers. It can be seen from the keyboard layout diagram of Fig 2.1 that the plus (+) and minus (-) characters share keys with the letters L and M respectively, thus :-

a) For a positive load sign press the L key (+).

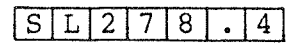
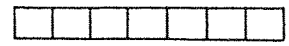
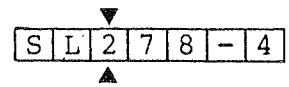
b) For a negative load sign press the M key (-).

To continue loading the new SL Parameter given in the example of the previous section, the following sequence would occur :-

	OPERATOR ACTIONS	DISPLAY READING
j)	Display after last digit has been entered :	
k)	For a positive entry the operator presses the L key (+) which causes the Controller to first clear the complete display :	
l)	The Controller then responds by echoing the complete parameter to show that it has been entered successfully :	

The first digit, i.e. the 2, will again be flashing to indicate that the whole parameter could be re-entered as in the sequence (g) to (j) of Section 3.3.

If in the previous example it were required to enter a negative number (Format 1 only), then steps (k) and (l) would be replaced as follows :-

	OPERATOR ACTIONS	DISPLAY READING
j)	Display after the last digit has been entered :	
m)	For a negative entry the operator presses the M key (-) which causes the Controller to first clear the display :	
n)	The Controller then responds by echoing the complete parameter but in this case the decimal point is replaced by a minus sign to indicate that the number is negative:	

Again, the first digit will be flashing so allowing complete re-entry of the parameter if required.

3.5 Terminal Control Functions

Three Control functions have been implemented by software on the hand-held terminal to give the Operator greater programming speed and flexibility. These use single key-strokes as follows:-

3.5.1 Backspace Edit Facility (Q←)

This facility allows the operator to change any of the four characters being entered for a new parameter at any time after entering the two character mnemonic but before entering the + or - load parameter. This is achieved by pressing the backspace key (Q←) during a typical entry sequence such as from steps (g) to (j) of Section 3.3. The key is pressed once for each character to be backspaced and then that character may be re-entered in the normal manner. The flashing digit will move one position to the left successively after each key depression but once the most-significant digit is flashing as in Section 3.3 step (f), further backspacing will be interpreted as an illegal operation. In this case the whole display will be cleared and the command parameter will be re-transmitted with its existing value as described in Section 3.7.5.

3.5.2 Scroll Mode Entry and Inspection (W↓)

When programming an instrument from the initial power-up state or when it is required to rapidly read out all the stored parameters one after the other use can be made of the scroll mode facility. Using the example of a 6350, this works as follows :-

a) The terminal has to have been initialised and a valid 2 character mnemonic entered first.

b) Using the example of Section 3.3 the display will be reading "SL345.6" with a flashing 3 as at step (f).

c) If instead of entering a digit at this stage the scroll mode character is pressed (W↓) then the next parameter down as listed in Appendix A.1.1 will be displayed. In the example chosen this would be the Controller Output which might read :-

OP344.9 - with a flashing 3

d) Entering another scroll-mode character will cause the Controller to display the Resultant Setpoint SP and so on.

e) Once the last parameter of Appendix A.1.1 has been displayed, i.e. the Operating Mode MD, a subsequent scroll-mode character will step the display back to the top of the Table again so that the Status Word DP will be displayed. The operator can then step right through the Table again as many times as desired.

f) Whenever it is required to change a parameter rather than merely inspect it, data is entered after step (f) of Section 3.3 in a sequence like steps (g) to (l). After the Controller has echoed the complete parameter as in step (l) then a scroll-mode character may be entered again to step on to the next parameter in the table.

It should be noted that an instrument will only accept the scroll-mode character if it is entered immediately after the 2 character mnemonic as the first data digit, e.g. Section 3.3 step (f). Entry of a scroll-mode character at any other time will cause the Controller to interpret it as a letter W and give one of the error conditions of Section 3.6.

3.5.3 Random Access Entry Mode (Z?)

When it is required to access one of the stored parameters directly without having to cycle through all the intervening entries using the scroll mode, then use can be made of the Random Access facility. This is achieved by pressing the Z key (Z?) which will cause the Controller to be re-initialised and generate the "?? CMD" prompt as in Section 3.1. Any two character mnemonic can now be entered thus allowing the Operator to go directly to any of the parameters of Appendix A.1.

The Z key can be pressed at any time during a parameter entry sequence (unlike scroll-mode) and can thus be used to abort an entry if required.

3.6 Access to Command Parameter lists of multi-channel Instruments

It was mentioned in Section 3.1.2 that multi-loop or channel instruments contain 2 types of Command Parameters viz:-

a) Instrument Command Parameters.

b) Loop, Block, or Channel Command Parameters.

Section 3.1.2 recommended that the Instrument Command Parameters be set up first after 8260 Terminal initialisation. Once the last parameter in the list has been set up the scroll mode key (W↓) will take the Terminal back to the first of the Instrument Parameters again. When it is required to access the Loop, Block, or Channel Parameters of a particular instrument then a different procedure must be used. This procedure is discussed for the various multi-channel instruments in the following sections.

3.6.1 Parameter access with the 6432 and 6433 Signal Processors

The 4 input/output Blocks that can be fitted to the 6432 and 6433 Signal Processors each have their own set of Block Command Parameters associated with them. These are used for setting up the operating characteristics of each of the 8 channels within the Block. The actual list of Block Command Parameters are given in Appendix A.7 and A.8 where it can be seen that they vary depending upon the type of board fitted in a particular Block (input/output slot position). However, the access mechanism is common to all types of Block and is as follows :-

a) Re-initialise the 8260 Terminal by means of the Z key (Z?), as described in Section 3.5.3, so that the CPU issues the usual operator prompt:-

    ?? CMD

b) Enter one of the Block Command Parameter lists by typing in :-

    CN - in place of the question marks

c) The CPU will now reply with the current Block and Channel number as displayed on the front-panel Address/Identity display in the following format:-

    CN BC where:-

    B is the current Block address from 1 to 4
    C is the current Channel address from 1 to 8

d) If the scroll mode key (W↓) is now pressed the display will access the list of Block Command Parameters associated with the currently selected channel. This list will be one of the 4 types depending on the input/output Block, and the front-panel Address/Identity display will always show the currently selected Block and Channel.

e) If it is required to examine the Block Command Parameters of a new Block or Channel, then this can be achieved by entering the required address in response to the CN command of c) above, e.g.:-

    CN B'C' where:-

    B' is the new Block Address from 1 to 4
    C' is the new Channel Address from 1 to 8

f) Upon receipt of these two digits the CPU will clear the display and check the following :-

   i) The required Block Address lies in the range 1 to 4.

   ii) The required Channel Address lies in the range 1 to 8.

   iii) An input/output board is actually fitted at the required address.

   iv) The input/output channel at the required address has been enabled by the appropriate Instrument Parameter Block Status words S1, S2, S3 or S4 (see Appendix A.7, A.8)

g) If these conditions are all valid the 6432 or 6433 will go to the required address and display it on the Front-Panel Address/Identity display and also echo the address on the 8260 Terminal display as :-

   CN B'C'

   The new list of Command Parameters can now be accessed as described in d) above

h) If the conditions of f) above are not all met then the 6432 or 6433 will not allow that channel to be accessed and the last address selected will remain up on the Front-Panel Address/Identity display. The CPU will also re-output the current channel address on the 8260 Terminal display as in c) above, thus :-

   CN BC

j) The above discussion shows that it is possible to access a new list of Block Command Parameters at any time in one of two ways :-

   i) Re-initialise the 8260 Terminal and enter a new CN value as described in a) above.

   ii) Scroll down the current list of Block Command Parameters as described in d) above until the end of the list is reached and the CN command reappears at the top of the list. Then enter a new CN value as described in e) above.

It should be noted that the CN Command Parameter is only available via the 8260 Terminal. It cannot be accessed via the serial data link as this uses a different technique for selecting the address of a required Block Command Parameter.

3.6.2 Parameter access with the 6358 Controller

The 8 control loops contained within the 6358 Controller each have their own set of Loop Command Parameters associated with them for setting up the individual Loop operating characteristics. The actual list of Loop Command Parameters is given in Appendix A.5 and the access mechanism, which is similar to that for the 6432 or 6433, is as follows :-

a) Re-initialise the 8260 Terminal as described in Section 3.6.1 a).

b) Enter one of the Loop Command Parameter lists by typing in :-

    LN - in place of the question marks

c) The CPU will now reply with the current Loop number as displayed on the front-panel Address/Identity display in the following format.

    LN D where:-

    D is the current Loop number from 1 to 8

d) If the scroll mode key (W↓) is now pressed the display will access the list of Loop Command Parameters associated with the currently selected Loop. This Loop number or identity will always be indicated on the Front-panel Address/Identity display.

e) If it is required to examine the Loop Command Parameters of a different Loop, then this can be achieved by entering the required Loop number in response to the LN command of c) above, e.g:-

    LN D' where:-

    D' is the new Loop number from 1 to 8

f) Upon receipt of this digit the CPU will clear the display and check the following :-

    i) The required Loop number lies in the range 1 to 8.

    ii) The required Loop has been enabled by the Instrument Parameter Block status word, S1 (see Appendix A.5)

g) If these conditions are both valid the 6358 will go to the required Loop and display its number or identity on the front-panel Address/Identity display. It will also echo the Loop number on the 8260 Terminal display as :-

LN D'

The new list of Loop Command Parameters can now be accessed as described in d) above.

h) If the conditions of f) above are not both met then the 6358 will not allow that Loop to be accessed and the last Loop selected will remain up on the Front-panel Address/Identity display. The CPU will also re-output the current Loop number on the 8260 Terminal display as in c) above, thus :-

LN D

j) The above discussion shows that it is possible to access a new list of Loop Command Parameters at any time in one of two ways :-

i) Re-initialise the 8260 Terminal and enter a new LN value as described in a) above.

ii) Scroll down the current list of Loop Command Parameters as described in d) above until the end of the list is reached and the LN command reappears at the top of the list. Then enter a new LN value as described in e) above.

It should be noted that the LN Command Parameter is only available via the 8260 Terminal. It cannot be accessed via the RS422 supervisory link as this uses a different technique for selecting a required Loop Command Parameter.

3.6.3 Parameter access with the 6434 Totaliser

The 8 flow totalisation channels contained within the 6434 Totaliser each have their own set of Channel Command Parameters associated with them for setting up the individual Channel operating characteristics. The actual list of Channel Command Parameters is given in Appendix A.9 and the access mechanism is the same as that for the 6358 of Section 3.6.2. The only difference is that a Loop is selected from the 6358 via the LN command parameter, while a channel is selected from the 6434 via the CN command parameter. Note that the CN parameter for the 6434 is a Format 7 parameter requiring a 1 digit entry as shown in Table 3.1, while the CN parameter for the 6432 is a Format 6 parameter requiring a 2 digit entry.

3.7 Error Conditions

Although the entry of parameters via the 8260 Terminal has been made as fool-proof as possible by the use of Operator prompts etc., it is still possible to make illegal entries in a number of ways. These error conditions will either cause the instrument to ignore characters until a legal entry is made, or they will cause the whole parameter to be aborted to a known state. The possible errors and their effects are listed as follows :-

3.7.1 Initialisation Error

If the terminal does not initialise properly after it is first plugged in it may not display the "?? CMD" prompt. This can be caused by taking longer than 2 seconds to plug in the terminal or by not pushing the plug fully home in the socket. In this condition there are two possibilities:-

a) The terminal may still accept a 2 character mnemonic in the normal way in which case no action need be taken.

b) If the Z character (Z?) is entered, the instrument will re-initialise the terminal and transmit the ?? CMD prompt.

3.7.2 Illegal Command Mnemonic

If either the first or second characters of the command mnemonic are entered illegally, the instrument will ignore the entry and repeat the "?? CMD" prompt.

Examples :-

a) Bad letter combination :- XL, HP etc

b) Numbers instead of letters :- 12, 99 etc,

c) Bad mix of letters and numbers :- H8, E2 etc.

d) Use of control characters :- Backspace (Q←)
Scroll-mode (W↓)

3.7.3 Illegal Data Entry

After a valid 2 character command mnemonic has been successfully entered the instrument is expecting to receive the correct number of digits or characters depending on the parameter data format (see Table 3.1). It will also accept a Backspace (Q←), Scroll-mode (W↓), or Z (Z?) control mode character, but any other character will be illegal. In this case the characters are simply ignored until a valid entry is made and then the flashing will step on to the next digit position in the normal manner.

Example :- Enter alpha characters H, I, J, etc. where numbers are expected

It is to be noted, however, that Format 5 commands, for example "IC" (for 6350) will accept hexadecimal entries so that the alpha characters A, B, C, D, E and F will be accepted in addition to the 0 to 9 numerics.

3.7.4 Illegal Load Parameters

Once the 4 new digits of a parameter have been entered successfully, the Controller is waiting to receive a positive or negative sign character before loading it into the memory as described in Section 3.4. Characters that will be legally accepted at this point are as follows :-

a) A Format 1, 12, 13, 14, 15 or 16 command will accept a positive (L+) or a negative (M-) sign entry.

b) Format 2, 3, 4, 5, 6, 7, 8, 9, 10, or 11 commands will only accept a positive (L+) sign entry.

c) All commands will accept a Backspace (Q←) or a Z (Z?) control mode character.

Entry of any other character will result in an error condition which will simply cause the instrument to ignore it until an appropriate valid character is entered.

3.7.5 Illegal Operation

Certain Command Parameter functions listed in Appendix A mainly indicate the various instrument outputs and operating status and are hence intended for monitoring purposes only, e.g. for a 6350:-

a) MP is the value of the Measured (Remote) Power signal when S2 no 2 is ON.

b) OP is the 3-Term output as calculated by the 6350 Controller (when not in MANUAL).

c) SP is the resultant operating Setpoint after trim etc.

d) PV is the Process Variable and is an input measurement.

e) ER is the Error Value formed from the Setpoint and Process Variable signal.

f) TS is the 3-Term Control algorithm sampling period and is derived from the value of the TI and TD time constants.

g) SW is a readout of the internal switch banks S1 and S2.

h) DS is a readout of the 8 digital outputs and 8 digital inputs, though bits 6 and 7 are read/write.

i) MD is a readout of the Front-panel controls and Controller operating modes though bits 11, 12 and 13 are read/write.

Consequently after these nine command mnemonics have been entered the only characters that will be accepted in most cases are the scroll-mode character (W↓) to enter the scroll mode and the Z character (Z?) to generate a "?? CMD" prompt. Entry of any other character at this point will result in an error condition which will cause the instrument to first clear the whole display and then re-transmit the complete command with the current parameter value. This error condition can therefore be used as a quick way of monitoring a read-only parameter repetitively by simply entering an illegal character every time the latest parameter value is required.

Multi-channel instruments like the 6358, 6432 etc. can also generate error conditions from specific illegal operations, viz:-

j) A required 6432 or 6433 input/output channel has not been enabled by the appropriate status word (See 3.6.2 f)).

k) A required 6358 Loop or 6434 Channel has not been enabled by the appropriate status word (See 3.6.3 f)).

3.7.6 Invalid or out of range data

It is possible that a valid 2 character command mnemonic has been entered, followed by the 4 new parameter digits and a valid load parameter. But after clearing the display the instrument responds with the original value of the parameter. This error condition is caused by trying to enter invalid or out of range data for the selected parameter. e.g. for a 6350 :-

a) Attempting to enter a value of SL greater than 1H or less than 1L.

b) Attempting to enter a value of RB greater than 1H or less than 1L when operating in the Ratio mode.

c) Attempting to enter a hexadecimal value other than 2000, 1000, or 800 into the MD status parameter.

It should be noted , however, that in a) above for example if SL were entered as a value less than 1H but greater than HS then the data would be accepted but is truncated to the HS value.

PROTOCOL MODE	BAUD RATE	CHARACTER LENGTH	NUMBER OF BITS				
			START	DATA	CONTROL	PARITY	STOP
ASCII	110	11	1	7	0	1	2
ASCII	300-9600	10	1	7	0	1	1
Binary	110	12	1	7	1	1	2
Binary	300-9600	11	1	7	1	1	1

TABLE 4.1 Character lengths for the different protocol modes and baud rates of the RS422 link

SECTION 4 COMPUTER SUPERVISION OF SYSTEM 6000 INSTRUMENTS

4.1 Serial Data Link Characteristics

Each System 6000 microprocessor-based instrument is fitted with an RS422 communications port which enables it to send and receive command parameters over a simple four-wire data link. A central supervisory computer is normally used to monitor a number of instruments via this link to form a distributed control system. All command parameters that can be monitored via the 8260 Terminal as described in Section 3 can also be accessed and updated via the link.

4.1.1 Technical Specification

The technical specification of the RS422 data link is given below:-

a) Transmission standard	:	4 wire RS422 (0-5V)
b) Line impedance	:	120-240 ohm twisted pair
c) Line length	:	4000ft. max (at 9600 baud)
d) No of instruments/line	:	16
e) Data rate	:	Switch selectable from:- 110, 300, 600, 1200, 2400, 3600, 4800, or 9600 bauds
f) Character length	:	Varies from 10 to 12 bits depending on baud rate and protocol mode (see Table 4.1)

4.1.2 Serial Link Implementation

The correct method of wiring up the RS422 lines of a number of instruments to form a distributed control system is given in Section 7 of the "System 6000 Installation Guide".

SWITCH NUMBER	SWITCH ACTION		SWITCH FUNCTION	
	ON (UP)	OFF(DOWN)		
1			Instrument dedicated function	
2 3 4	See	Table 4.2	Baud rate selection switches for RS422 data link	
5	Binary	ASCII	Protocol mode select	
6	4	0	2^2	Instrument Group identifier (GID)
7	2	0	2^1	
8	1	0	2^0	

TABLE 4.2 DIL switch S1 functions

SWITCH NUMBER			BAUD RATE	NUMBER OF STOP BITS
2	3	4		
Off	Off	Off	110	2
Off	Off	On	300	1
Off	On	Off	600	1
Off	On	On	1200	1
On	Off	Off	2400	1
On	Off	On	3600	1
On	On	Off	4800	1
On	On	On	9600	1

TABLE 4.3 Baud rate switch selections

4.1.3 Instrument Internal Switch Settings

The characteristics of the RS422 data link for each System 6000 instrument are set up by means of an 8 way DIL switch, S1, which can be accessed at the top of the unit once it is withdrawn from the rack, bin or sleeve. Switch S1 is always the left-hand of two switch banks and is situated in each instrument as follows:-

INSTRUMENT	DAUGHTER BOARD POSITION(CONNECTOR)	DAUGHTER BOARD NAME
6350, 6351, 6352, 6353, 6360, 6850	3	Digital input/output
6358, 6432, 6434,	3	Analogue I/O Processor
6433	4	Analogue I/O Processor

The functions assigned to each of the 8 switches of S1 are shown in Table 4.2 and are detailed below:-

a) Switches no 2, 3 and 4

These 3 switches are used to select the baud rate at which the RS422 link operates according to the 8 possible settings shown in Table 4.3.

b) Switch no 5

This switch determines whether the line protocol used is based on an ASCII or Binary format (See Section 4.4.1)

c) Switches no 6, 7 and 8

These 3 switches are used to set up the instrument Group Identifier (GID) where the binary weighting of each switch can be seen from Table 4.1 to be as follows :-

S1 no 8 = 1
S1 no 7 = 2
S1 no 6 = 4 - when in the ON position

Thus these 3 switches can be used to select a Group Identifier from 0 to 7, the use of which is discussed in Section 4.5.

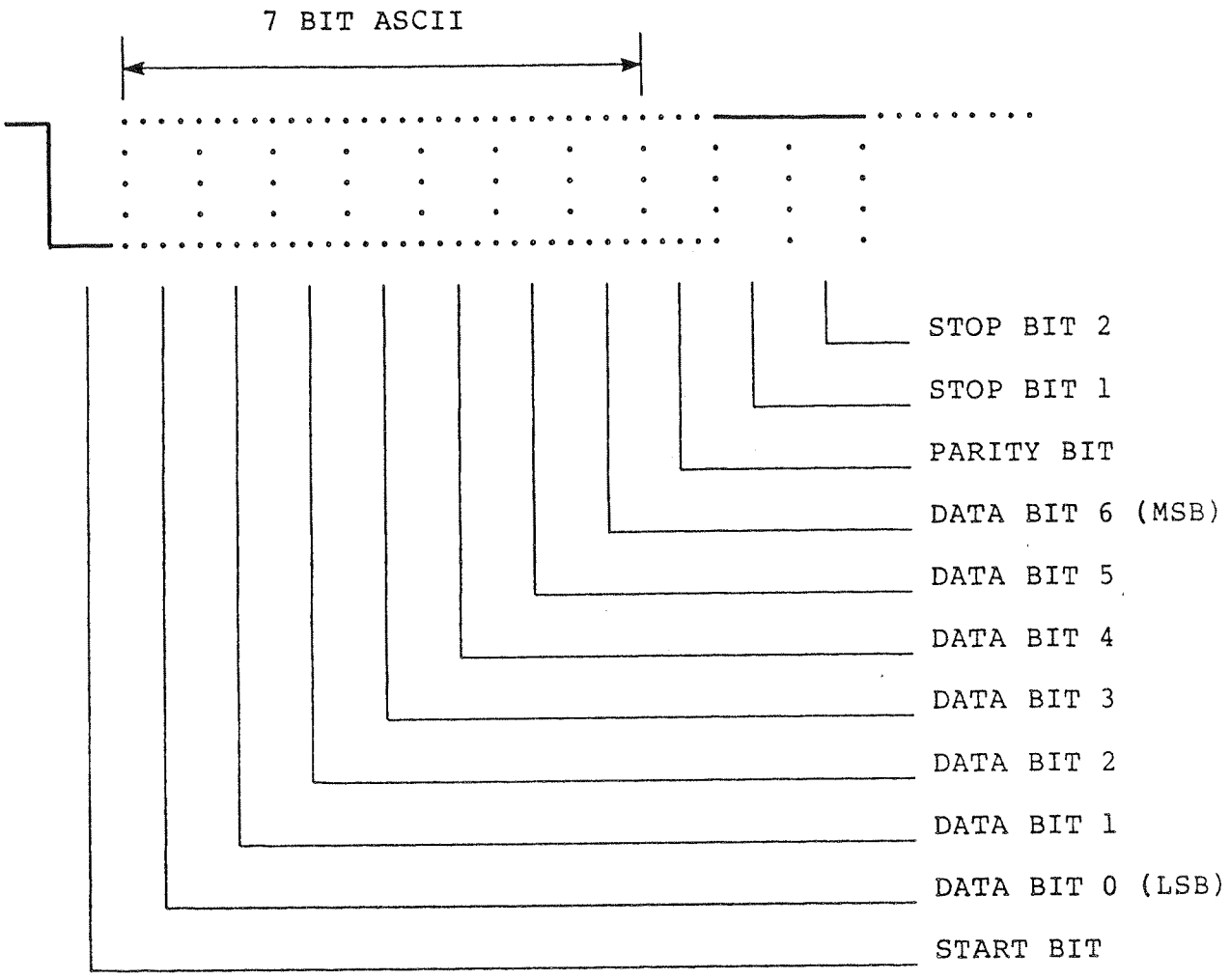


FIG 4.1 Asynchronous character format for ASCII mode at 110 baud

4.2 Serial Data Transmission

All System 6000 microprocessor based instruments communicate with a computer via the RS422 supervisory data link using the Standard Binary Synchronous (BSC) communications protocol. This means that every character sent down the link is transmitted as a serial pulse train consisting of a fixed number of pulses or "bits" depending upon the selected data rate and whether the protocol mode is ASCII or binary. Table 4.1 shows how the character length is related to baud rate and protocol mode, and how the bits in the character are broken down for each of the 4 cases. Fig 4.1 illustrates how an 11 bit data stream is formed when the ASCII protocol mode is used at a 110 baud data rate.

When no transmission is taking place the line is idling at logic one i.e. the "MARK" or "OFF" condition. As soon as the transmitter is ready to transmit a character it drives the line low to the logic zero state, i.e. the "SPACE" or "ON" condition, for one bit period called the "Start bit". This alerts the receiver that a character is on its way and allows it to synchronise to the incoming data stream. The 7 bit ASCII code for the required character is then transmitted starting with the least-significant data bit (bit 0) as shown in Fig 4.1. If the character to be transmitted is a control character, its ASCII equivalent will be found in Appendix B, Table B.1. If the character is a data character then it will be found in Appendix B, Table B.2.

The next bit to be transmitted is the parity bit which is set for even parity for System 6000 instruments. Finally 2 stop bits are transmitted to signify the end of the character transmission. Note that only 1 stop bit is transmitted at data rates of from 300 to 9600 bauds. Thus it can be seen that each 7 bit character is "packaged" into a data stream with Start bits, Parity bits and Stop bits so that they can be successfully transmitted down the data link in serial form.

4.3 Binary Synchronous Communications Data Link Control

4.3.1 General

Section 4.2 has shown how individual characters are transmitted to and from System 6000 instruments via the serial data link. In order for this data to have any meaning it is necessary to arrange the individual characters into message strings. It is also necessary to implement a standard message structure or protocol between communicating devices.

This protocol establishes for example which device should be transmitting and which receiving at any time, whether the message is a request for data to be monitored or if it is new data to be received and whether messages have been successfully received or not. The communications protocol employed by System 6000 instruments comes under the general heading of Binary Synchronous Communications Data Link Control (BSCDLC). The specific form of BSC implemented by TCS corresponds with the following full American National Standard definition:-

ANSI standard:- X3.28
Revision:- 1976
Establishment and Termination Control Procedures Subcategory 2.5:- Two-way Alternate, Nonswitched Multipoint with Centralised Operation and Fast Select.
Message Transfer Control Procedure Subcategory A4:- Message orientated, with Replies and with Longitudinal checking.

This is known by the following abbreviation:-

ANSI - X3.28 - 2.5 - A4.

4.3.2 Terminology

Before the BSC protocol can be described further it is necessary to define the standard terminology associated with it and communication protocols in general. This is done by considering the hardware and software terminology separately.

a) Hardware Terminology

The hardware associated with any communications network can be considered to consist of two basic parts:-

i) Devices which can transmit or receive messages within a network may be termed "Communications Processors", "Remote Data Terminals" or "Remote Peripherals" and are known collectively as "Stations".

In the system illustrated in Figure 1.2 there is a single Central Communicating Device, i.e. the digital computer, which is permanently designated the "Supervisor Station". All messages are delivered via the "Supervisor Station" and so the System 6000 instruments which are connected to it are termed "Tributary Stations".

ii) The communications medium which actually interconnects the "Stations" comprising the network is known as a Data Link.

In the system illustrated in Figure 1.2 one or more Tributary Stations are permanently connected to the Supervisor Station via a common line. This configuration is termed a non-switched "multi-drop" or "multipoint" data link. The stations may both receive and transmit data so the communications is said to be "Two Way" and furthermore stations are not allowed to transmit and receive simultaneously so that data transfers are "Alternate". Figure 1.2 also shows that the transmit and receive paths are separate so that so-called "Full Duplex" communications is implemented. However, because "Alternate" data transfers only are permitted by the protocol the transmit and receive connections could share a common path and implement the so-called "Half Duplex" configuration.

b) Software Terminology

Whenever data is to be transferred from one station to another this is carried out by means of a data transfer "sequence". The BSC protocol permits the following two sequences depending upon the direction of data flow:-

i) A Polling Sequence for transmitting data from a Tributary Station (instrument) to the Supervisor Station (Computer).

ii) A Selection Sequence for transmitting data from the Supervisor Station (Computer) to a Tributary Station (instrument).

Each of these data transfer sequences is subdivided into 3 sections termed "Procedures" thus :-

i) An Establish Connection Procedure to make a logical connection between the Supervisor Station and a chosen Tributary Station.

ii) A Message Transfer Procedure to transfer data between the Supervisor and Tributary Station in the desired direction.

iii) A Termination Procedure to close-down or abort the data transmission in an orderly fashion and allow further data transfers to take place via different logical connections.

Within any one of these Procedures, the Station originating the data during a data transfer is assigned so-called "Master Status", while the station receiving the data assumes "Slave Status" for the duration of the transfer. In the System shown in Figure 1.2 it is the responsibility of the Supervisor Station (computer) to monitor the data link at all times to ensure orderly operation and to assign the correct status to the Tributary Stations thus:-

i) During a Polling Sequence the Supervisor assigns Master Station Status to a particular System 6000 instrument so that it may transmit data. The Supervisor then assumes Slave Station Status so that it may receive the data during the Message Transfer procedure.

ii) During a Selection Sequence the Supervisor assigns Slave Station Status to a particular System 6000 instrument so that it may receive data. The Supervisor then retains Master Station Status so that it may transmit the data during the Message Transfer procedure.

It should be noted that in subcategory 2.5 of the X3.28 standard BSC protocol, all messages are delivered via the Supervisor Station (computer) so that direct Tributary to Tributary communications (System 6000 instrument to instrument) is not permitted. The Supervisor Station is also responsible for re-establishing order on the data link, via an error recovery procedure, should control be lost for any reason during an exchange with a Tributary Station.

4.3.3 BSC Protocol Modes

In every System 6000 instrument, the BSC protocol is implemented in two modes which differ by the manner in which the data itself is represented. These two modes are called :-

a) The ASCII protocol mode
b) The Binary protocol mode

- and are switch selectable via S1 no 5 as shown in Table 4.2.

a) ASCII mode

In this mode every control or data character, such as the command parameter mnemonic and associated numerical digits, is transmitted as a separate 7 bit ASCII character. These characters are packaged to form 10 or 11 bit pulse trains for transmission as shown in Fig 4.1. This protocol is very easy to implement and debug as each transmitted pulse stream corresponds to one ASCII character which can be directly displayed on a VDU or printer.

The data transfer sequences in the ASCII mode offer the following facilities:-

i) Polling Sequence

a) Single Parameter Poll.

b) Continuous polling of one parameter.

c) Sequential polling down the parameter list.

ii) Selection Sequence

a) Single parameter update.

b) Continuous updating of one parameter. (fast select)

These data transfer sequences are described in Section 5.

b) Binary mode

In this mode the format of the control characters are very similar to the ASCII mode. However, data characters such as command mnemonics are transmitted as a single parameter number instead of 2 ASCII characters.

Also, the 4 digit data field is compressed to a 16 bit 2's complement binary integer instead of the 4 separate characters of the ASCII mode. This compression of data makes the Binary mode more efficient than the ASCII as fewer characters are required to transmit a given message. The Binary mode is more difficult to implement and debug than the ASCII because the data structures are more complex and have to be decoded to be understood. However, it does possess more comprehensive data transfer sequences the use of which can greatly speed up the effective data transfer rate down the RS422 link. These data transfer sequences in the Binary mode offer the following facilities:-

i) Polling Sequence

a) Single Parameter Poll and continuous polling of the same parameter.

b) Multi-Parameter Polling of a specified number of parameters starting from a given parameter.

c) Enquiry Polling of selected parameters to indicate whether any have changed since the last Poll.

ii) Selection Sequence

a) Single parameter update.

b) Continuous updating of one parameter (fast select)

These data transfer sequences are described in Section 6.

4.4 Instrument Group and Unit Addressing

In a large Supervisory Control system many System 6000 microprocessor-based instruments may be connected to the Supervisory Computer via a single RS422 serial data link. In this configuration each instrument must have some sort of unique address identity so that when the computer sends a message to a particular instrument, only the one that has been pre-programmed with that identity will reply. The System 6000 instrument hardware allows up to 128 separate instruments or units to be uniquely identified by means of a 7 bit binary address. The 4 least-significant bits of this address are called the Unit Identifier [UID], and the 3 most-significant bits are called the Group Identifier [GID]. This scheme thus allows the instruments or units to be addressed in 8 groups of 16 individual units.

4.4.1 Instrument Group Identifier [GID]

All System 6000 instruments have their 3 Group Identifier bits selected by means of switches 6, 7 and 8 of switch bank S1. Section 4.1.3 c) shows that these three switches allow the GID to be set over the range 0 to 7.

4.4.2 Instrument Unit Identifier [UID]

The way in which the Instrument UID is set up depends upon whether the instrument is a single or multi-channel device, and this is described below:-

a) Single Channel Instruments

This applies to those System 6000 Instruments which are effectively single channel or single function devices, viz:-

6350, 6351, 6352, 6353, 6360, 6850

The UID of all the above instruments are set up by means of back-plane wiring on the rear connector slot to digital inputs 1 to 4 (pins 24 to 27 inclusive) designated as ADD.1.IN(1) to ADD.4.IN(1) respectively. These 4 inputs are connected to logic ones or zeroes via the back-plane wiring to provide a unique slot address pattern. This slot address becomes the UID of the instrument and the binary weighting of each input is as follows :-

INPUT NO	INPUT NAME	PIN NO	BINARY WEIGHTING
1	ADD.1.IN(1)	24	1
2	ADD.2.IN(1)	25	2
3	ADD.3.IN(1)	26	4
4	ADD.4.IN(1)	27	8

SWITCH BANK S2 SWITCH NO 1	UID TRANSMITTED	CONTROL LOOP ADDRESSED	6358 NO.
OFF	0 1 2 3 4 5 6 7	1 2 3 4 5 6 7 8	1
ON	8 9 A B C D E F	1 2 3 4 5 6 7 8	2

TABLE 4.4 Relationship between the transmitted UID and the loop addressed with two 6358 Controllers on the same Group address

It should be noted that unconnected digital inputs are pulled down to logic zero within the instrument so that if these 4 pins are not connected the UID becomes zero. Furthermore it can be seen from the above that these 4 inputs allow the UID to span the range 0 to 15.

b) 8 Channel Instruments

This applies to those System 6000 Instruments which contain 8 control loops or channels, viz:-

6358, 6434

Conceptually each control loop of a 6358, and each totalisation channel of a 6434 is addressed as a separate unit so that these two instruments occupy up to 8 consecutive unit addresses. Consequently only the top bit of the UID is set in the 6358 or 6434 while the bottom 3 bits are used by the computer to select which of the 8 loops or channels are being accessed. The top bit of the UID is set by means of switch no 1 of switch bank S2 for both the 6358 and the 6434. Now, a 4 bit UID allows 16 units to be addressed within a group. This switch therefore places the 8 loops or channels of the 6358 or 6434 within the upper or lower half of a group, thus:-

S2 no 1 OFF, UID = 0 to 7
S2 no 1 ON , UID = 8 to 15 (F)

This addressing scheme is illustrated in Table 4.4 which shows that if a UID of "A" were transmitted, for example, this would access loop 3 of the second 6358 module in the group.

c) 32 Channel Instruments

The 6432 Signal Processor contains 32 input/output channels configured as 4 blocks of 8 channels.

A 6432 module is addressed by the computer as 4 separate units and conceptually each 8 channel block therefore occupies a unique UID. Consequently each 6432 occupies 4 consectuive UIDs and thus a maximum of 4 devices can be connected to a single Group Address. The top 2 bits of the UID are set within the 6432 by means of switches 1 and 2 of switch bank S2.

The UID transmitted by the computer can vary from binary 0 to F (15) and the top 2 bits are used to select 1 of 4 6432 devices depending upon these two switch settings. The bottom 2 bits then effectively select which of the 4 input/output blocks within the selected 6432 are actually being addressed. This addressing scheme is illustrated in Table 4.5 which shows that if a UID of 6 were transmitted, for example, this would address input/output Block 3 of the second 6432 module in the Group.

SWITCH BANK S2		UID TRANSMITTED	INPUT/OUTPUT BLOCK ACCESSED	6432 NO.
NO 1	NO 2			
OFF	OFF	0 1 2 3	1 2 3 4	1
OFF	ON	4 5 6 7	1 2 3 4	2
ON	OFF	8 9 A B	1 2 3 4	3
ON	ON	C D E F	1 2 3 4	4

TABLE 4.5 Relationship between the transmitted UID and the input/output block accessed with four 6432 modules on the same Group address

d) 64 Channel Instruments

The 6433 Programmable Signal Processor consists of the same basic hardware as the 6432 so that it contains 4 blocks of 8 input/output channels. However, unlike the 6432 it possesses a further 4 blocks of 8 "dummy" or pseudo input/output channels used to permit intermediate variables to be displayed on the front panel and accessed via the 8260 terminal or the RS422 serial data link. Consequently the 6433 is treated like a 6358 in that it occupies 8 consecutive unit addresses. Thus switch no 1 of switch bank S2 is used to set the UID range from 0 to 7 or 8 to 15 (F) just as described in Section 4.4 b) above. However, unlike the 6358/6434 case a given UID does not address a single loop or channel, but addresses a complete 8 channel input/output block as for the 6432 scheme of Section 4.4 c).

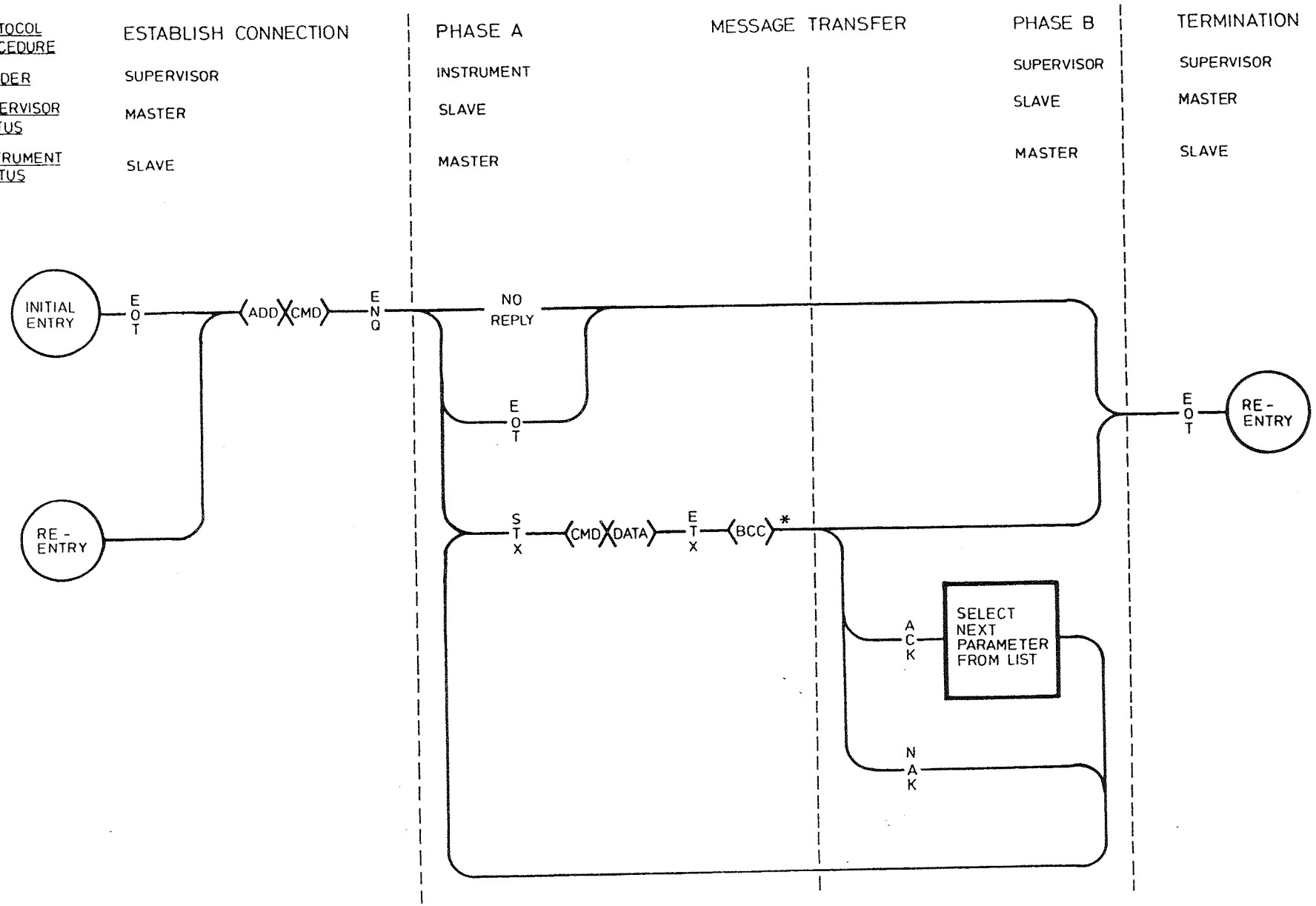


FIG 5.1 POLLING SEQUENCE FOR TRANSMITTING DATA FROM A SYSTEM 6000 INSTRUMENT TO THE SUPERVISOR (ASCII MODE)

SECTION 5 BSC PROTOCOL - ASCII MODE

5.1 Polling

System 6000 instruments are polled for data by the Supervisor Station using the Polling Sequence illustrated in Figure 5.1. It can be seen from this diagram that the Sequence can be divided up into three distinctive Procedures which are described in the following sections.

5.1.1 Establish Connection Procedure

The Supervisor Station initially has Master Station Status and begins by transmitting an 8 character polling supervisory message. This message identifies a single tributary station and includes other information while the ENQ Control character defines the end of the message. The 8 character message is in the following format:-

(EOT) [GID] [GID] [UID] [UID] [C1] [C2] (ENQ)

where (XXX) denotes an ASCII Control character (see Appendix B, Table B.1) and [YYY] denotes an ASCII Data character (see Appendix B, Table B.2). These characters have the following function:-

i) (EOT)

This Control character resets all the Tributary Stations (Instruments) from text mode to control mode. This causes them to examine the next 4 transmitted characters to see if they correspond with their own Group-Unit address identifier.

ii) [GID] [GID]

These Data characters are the required Group Address Identifier repeated twice for security. The Group Identifier is set up on switches 6, 7 and 8 of switch bank S1 as defined in Table 4.2 and can vary from binary 0 to 7.

iii) [UID] [UID]

These Data characters are the required Unit Address Identifier repeated twice for security. The Unit Identifier is selected depending on instrument type as described in Section 4.4.2 and can vary from binary 0 to 15. Thus there are 8 possible GIDs and 16 possible UIDs allowing the Supervisor Station to address a maximum of 128 Tributary Stations (Instruments).

BINARY NUMBER	ASCII CHARACTER
0 0 0 0	0
0 0 0 1	1
0 0 1 0	2
0 0 1 1	3
0 1 0 0	4
0 1 0 1	5
0 1 1 0	6
0 1 1 1	7
1 0 0 0	8
1 0 0 1	9
1 0 1 0	A
1 0 1 1	B
1 1 0 0	C
1 1 0 1	D
1 1 1 0	E
1 1 1 1	F

TABLE 5.1 Binary numbers and their ASCII equivalents

iv) [C1] [C2]

These two alphanumeric characters specify the required parameter within the System 6000 instrument to be interrogated by the Control Station. The full list of 2 character command mnemonics is given in Appendix A.1 to A.10 inclusive and it should be noted that C1 and C2 are thus the same as the characters entered via the Hand-held programming terminal.

v) (ENQ)

Finally the Polling Sequence ends with the ENQ Control character.

It can be seen from Figure 5.1 that the Supervisor Station starts off the Polling Sequence initially with an EOT character to reset all the System 6000 instruments and cause them to look for a valid Group-Unit address identifier. The Polling Sequence can be Re-Entered subsequently if required after the EOT character as shown. This would be done after coming from the Termination Procedure, for example, as it can be seen that an EOT character is generated by the Supervisor Station as part of the Termination Procedure itself. It should also be noted that the Supervisor Station can generate EOT characters at any time to terminate a transmission by a Tributary Station and restore order on the data link (see Section 5.1.3).

When it is required to transmit a binary number as an ASCII character, as in the case of the GID or UID, then the hexadecimal number representation is used as shown in Table 5.1.

It should be noted that the above procedure applies to single channel or single function instruments, viz:-

6350, 6351, 6352, 6353, 6360, 6850

The Establish Connection Procedures for the multi-channel instruments differ from this in the manner described below.

8 Channel Instruments - 6358, 6434

It was shown in Section 4.4.2 b) that these instruments are addressed by the Supervisor Station as up to 8 separate units (only active loops or channels are addressable, see Section 3.7.5). The transmitted UID character establishes a logical connection with one of these loops or channels. Once this connection has been established it is only possible to access parameters within the list of selected loop or channel parameters, or the Instrument parameters. It is not possible to access parameters from another loop or channel within the same instrument unless the Establish Connection Procedure is repeated with a new UID parameter.

The [C1] [C2] characters specifying the polled command parameters may consist of a mnemonic from :-

The Instrument Command Parameters

or

The Loop or Channel Command Parameters of Appendix A.5 and A.9 for the 6358 and 6434 respectively, with the exception of the LN or CN parameters

32 and 64 Channel Instruments - 6432, 6433

It was shown in Section 4.4.2 c) and d) that the 6432 and 6433 instruments occupy 4 and 8 consecutive UIDs respectively. The transmitted UID character establishes a logical connection with one of the 4 or 8 blocks of 8 Input/Output channels contained within the 6432 and 6433. To access one of the 8 channels within the selected block an extra character is added to the polling sequence. Thus the following 9 character message has to be transmitted:-

(EOT) [GID] [GID] [UID] [UID] [CN] [C1] [C2] (ENQ)

Here, all the Data and Control characters have the same function as for the single channel instrument polling message described previously except for the [CN] character. This character is a digit that must lie in the range 1 to 8 and specifies the required channel number of the Input/Output block selected by the UID parameter. This therefore corresponds to the second digit of the "CN" command parameter described in Section 3.6.1.

The [C1] [C2] characters specifying the polled command parameters may consist of a mnemonic from :-

The Instrument Command Parameters

or

The Channel Command Parameters of Appendix A.7 and A.8 for the 6432 and 6433 respectively, with the exception of the CN parameter

It should be noted that even if the Instrument Command parameters are being accessed a valid CN character must be transmitted to satisfy the protocol. Furthermore, once the logical connection has been established it is not possible to access parameters from a different channel in the same block, or from a different block unless the Establish Connection Procedure is repeated with a new CN value or UID parameter respectively.

5.1.2 Message Transfer Procedure

After the Supervisor Station has transmitted the ENQ character at the end of the Establish Connection Procedure, the Protocol enters the Message Transfer Procedure. It can be seen from Figure 5.1 that the Message Transfer Procedure itself can be divided into 2 Phases according to which device is acting as the sending station. These two Phases are considered as follows:-

A) Phase A - System 6000 Instrument Sender

Figure 5.1 shows that upon initial entry to the Message Transfer Procedure there are three possible replies that a Tributary Station can make :-

a) No Reply

Under certain circumstances the Supervisor Station may not receive any message at all in response to a Polling Sequence. This can be due to any of the following reasons:-

1) Group-Unit address parameters not recognised.

2) An error (e.g. parity) is found in one of the characters up to and including the ENQ.

3) Polled instrument has an 8260 Hand-Held terminal connected so disabling its RS422 bus.

4) Polled instrument has wrong baud rate set on switches 2, 3 and 4 of switch bank S1 (see Section 4.1.3 a)).

5) Noise on the communications links or link failure.

6) Hardware failure in the polled instrument.

In these cases the Supervisor Station will either find the reply invalid or "timed-out" and so it will retain Master Status and enter the Termination Procedure of Section 5.1.3 directly.

b) Invalid Reply

A polled instrument may recognise the Group-Unit address parameter transmitted by the Supervisor Station but could find that the 2 command characters do not correspond to any of the valid mnemonic combinations listed in its appropriate command parameter list in Appendix A. In this case the instrument will terminate its Master Status by sending an EOT Control character to terminate the logical connection. Master Status then reverts to the Supervisor Station which may then Poll or Select another station after entering the Termination Procedure of Section 5.1.3.

COMMAND PARAMETER FORMAT	COMMAND PARAMETER FORMAT	DECIMAL POINT POSITION	"D" DATA CHARACTERS				
			D1	D2	D3	D4	D5
1	+	0	N	N	N	N	.
		1	N	N	N	.	N
		2	N	N	.	N	N
		3	N	.	N	N	N
		4	.	N	N	N	N
	-	0	N	N	N	N	-
		1	N	N	N	-	N
		2	N	N	-	N	N
		3	N	-	N	N	N
		4	-	N	N	N	N
2	+	0	N	N	N	N	.
		1	N	N	N	.	N
		2	N	N	.	N	N
		3	N	.	N	N	N
		4	.	N	N	N	N
3	+	FIXED	N	N	.	N	N
4	+	FIXED	N	N	N	.	N
5	N/A	N/A	>	H	H	H	H
6	N/A	N/A	N	N			
7	N/A	N/A	N				
8	N/A	N/A	A	A	A	A	

TABLE 5.2 Command Parameter "D" Data Character Formats 1 to 8

KEY

N = Decimal digit in the range 0 to 9
H = Hexadecimal digit in the range 0 to F
A = Upper case ASCII character
. = Decimal point position for positive numbers
- = Decimal point position for negative numbers
> = Greater than sign precedes hexadecimal data

It should be noted that a System 6000 instrument that has recognised its own GID-UID address parameters will start transmitting the 10 character valid reply message of Section 5.1.2 A) c) before it has decoded the 2 command characters following. If these are subsequently found to be invalid the instrument will then immediately transmit the EOT Control character and terminate the transmission as above. Thus a typical invalid reply message would be of the following form:-

(STX) [C1] [C2] (EOT)

c) Valid Reply

Once a System 6000 instrument has successfully recognised the GID-UID and command parameters and it has a message to send it assumes Master Status and initiates the Message Transfer Procedure. The Supervisor Station assumes Slave Status for the duration of this Procedure and the instrument starts off by transmitting the following 10 character sequence:

(STX) [C1][C2] [D1][D2][D3][D4][D5] (ETX) [BCC]

These characters have the following function:-

i) (STX)

This Control character indicates that the instrument is now a Master Station and is transmitting data in the text mode.

ii) [C1][C2]

These characters are a repeat of the requested Command Mnemonic specified in the Establish Connection Phase. They are repeated for security and are listed in the appropriate section of Appendix A.

iii) [D1] [D2] [D3] [D4] [D5]

These parameters represent the value of the requested parameter transmitted in engineering units with a sign digit and decimal point as appropriate. The Command mnemonics of Appendix A are divided up into 16 parameter formats according to range, polarity, decimal point positions and type of data as listed in Table 3.1. When the data for a required parameter is transmitted the 5 "D" characters D1 to D5 are sent by the instrument containing all the polarity and decimal point information.

COMMAND PARAMETER FORMAT	COMMAND PARAMETER FORMAT	DECIMAL POINT POSITION	"D" DATA CHARACTERS				
			D1	D2	D3	D4	D5
9	+	FIXED	N	.	N	N	N
10	+	FIXED	N	N	N	N	.
11	+	FIXED	.	N	N	N	N
12	+	FIXED	.	N	N	N	N
	-	FIXED	-	N	N	N	N
13	+	FIXED	N	.	N	N	N
	-	FIXED	N	-	N	N	N
14	+	FIXED	N	N	.	N	N
	-	FIXED	N	N	-	N	N
15	+	FIXED	N	N	N	.	N
	-	FIXED	N	N	N	-	N
16	+	FIXED	N	N	N	N	.
	-	FIXED	N	N	N	N	-

TABLE 5.2 (contd.) Command Parameter "D" Data Character Formats 9 to 16

KEY

N = Decimal digit in the range 0 to 9
. = Decimal point position for positive numbers
- = Decimal point position for negative numbers

A full list of possible "D" character formats for each command parameter is given in Table 5.2. the following points should be noted from this table:-

1) The decimal point position of a positive number is always indicated by transmitting a period (.).

2) The decimal point position of a negative number is always indicated by transmitting a minus sign (-).

3) Hexadecimal characters are preceded by the "greater than" sign (>) for format 5 commands.

The decimal point positions for parameter formats 1 and 2 are programmed via status words as described in Section 3.3.3.

iv) (ETX)

The ETX Control character terminates the transmission of the textual part of the message.

v) [BCC]

This character is transmitted by the instrument at the end of its message to be used by the Supervisor Station for data verification purposes. It is in fact a Longitudinal Redundancy Block Check Control (BCC) performed upon the last 8 characters transmitted previously. Thus the BCC character field excludes the initial STX but includes the following 8 characters:-

[C1] [C2] [D1] [D2] [D3] [D4] [D5] (ETX)

The BCC character itself is formed by computing the binary sum (without carry) independently on each of the 7 individual levels (bits) of the transmitted code for each character, i.e. DATA BIT 0 to DATA BIT 6 inclusive of Figure 4.1. It should be noted that this procedure is the same as calculating the bitwise "exclusive OR" function for each level of the 8 characters.

Within each code level the number of "ONE" bits (including those in the BCC character) is caused to be even. Thus the sense of longitudinal parity is said to be even. Furthermore, the character parity bit of the BCC character is itself set for even parity (see Figure 4.1). The BCC character is transmitted as a single 7 bit ASCII character with even parity and consequently care must be taken by the Supervisor Station not to interpret it as a control character.

It should be noted that once the instrument has started transmitting the above 10 character message it will ignore all other characters sent to it from the Supervisor Station except for an EOT. This will cause the instrument to terminate transmission at the end of the next complete character and resume Slave Status.

8 Channel Instruments - 6358, 6434

These instruments can make no reply or an invalid reply for the same reasons as for the single channel units. The valid reply format is identical to that given in Section 5.1.2 A) c) above, but the following points should be noted:-

i) [C1] [C2]

These characters which repeat the polled command parameters may consist of a mnemonic from:-

The Instrument Command Parameters,

or

The Loop or Channel Command Parameters of Appendix A.5 and A.9 for the 6358 and 6434 respectively, with the exception of the LN or CN parameters.

ii) [D1] [D2] [D3] [D4] [D5]

These characters represent the value of the polled parameter in engineering units, with a sign digit and decimal point positioned appropriately. If a sumcheck error exists on either the Instrument parameters, or the selected loop or channel parameters, then all transmitted periods (.), minus signs (-), or "greater than" signs (>), are replaced by an asterisk (*). This immediately informs the supervisor station of a sumcheck error condition without the need for reference to the associated ST status parameter or common sumcheck bit in the MD parameter.

32 and 64 Channel Instruments - 6432, 6433

These instruments can make no reply or an invalid reply for the same reasons as for the single channel units. The valid reply, though contains the extra [CN] character to specify the required channel within the selected block as described in the previous section. Thus, a valid reply message consists of the following 11 character sequence:-

(STX) [CN] [C1][C2] [D1][D2][D3][D4][D5] (ETX) [BCC]

Here, all the Data and Control characters have the same function as for the single channel instruments reply described previously except for the [CN] character. (see 6432, 6433 Establish Connection Procedure). It should be noted, however, that the Block Check Control [BCC] character is computed from the last 9 characters of the message, i.e from [CN] up to and including (ETX). The method of computation, though, is the same as for the single channel instruments.

B) Phase B - Supervisor Sender

After the polled instrument has transmitted a valid 10 character message in Phase A of the Message Transfer Procedure, the protocol enters Phase B where the Supervisor Station becomes the sender. At this point, indicated by * in Fig. 5.1, the instrument will ignore all characters on the data link other than those shown along a specific path. It therefore remains at this point until one of the 3 valid replies are received, as follows :-

a) Repeat Parameter Facility - NAK

If the Supervisor Station transmits a NAK response it causes the polled instrument to remain in the Message Transfer Procedure, retain Master Status and re-transmit the last parameter polled. This response saves time when the Supervisor Station needs to continuously monitor the same parameter from a particular instrument because it is not necessary to enter the Establish Connection Procedure before each poll.

b) Scroll-Mode Facility - ACK

If the Supervisor Station transmits an ACK response it causes the polled instrument to remain in the Message Transfer Procedure, retain Master Status and transmit the next parameter from the appropriate command parameter table in Appendix A. This response is very time saving when the Supervisor Station requires to sequence through all the parameters of the same instrument because it is not necessary to enter the Establish Connection Procedure before each poll.

c) Termination Reply

Figure 5.1 shows that if the Supervisor Station wishes to stop polling a particular instrument after the Message Transfer Procedure then it may enter the Termination Procedure of Section 5.1.3 directly and break the logical connection.

8 Channel Instruments - 6358, 6434

The Supervisor Station can make the same 3 possible replies to a 6358 or 6434 module during this Phase as it does for the single channel instruments described above. Only the second case will be considered as the NAK reply, and termination reply are identical to the single channel case.

b) Scroll-Mode Facility - ACK

If the Supervisor Station transmits an ACK response, it causes the polled 6358 or 6434 to remain in the Message Transfer Procedure, retain Master Status and transmit one of two possible replies depending upon the parameter transmitted previously thus:-

i) Loop or Channel Command Parameters

If the previous command parameter was a Loop Command or Channel Command Parameter, then the 6358 or 6434 fetches the next parameter from the list of Appendix A.5 or A.9. When it reaches the last parameter, 2T, it will reset to the second entry from the top of the list and start with ST as subsequent ACK replies are received (LN or CN are not accessible via the serial link).

ii) Instrument Command Parameters

If the previous command parameter was an Instrument Parameter, then the 6358 or 6434 fetches the next parameter from the list of Appendix A.5 or A.9. When it reaches the last parameter, MD, it will reset to the top of the list and start with II as subsequent ACK replies are received.

32 and 64 Channel Instruments - 6432, 6433

The Supervisor Station can make the same 3 possible replies to a 6432 or 6433 module during this Phase as it does for the single channel instruments described previously. Only the second case will be considered as the NAK reply, and termination reply are identical to the single channel case.

b) Scroll-Mode Facility -(ACK)

If the Supervisor Station transmits an ACK response it causes the polled 6432 or 6433 to remain in the Message Transfer Procedure, retain Master Status and transmit one of two possible replies depending upon the parameter transmitted previously thus:-

i) Block Command Parameters

If the previous command parameter was a Block Command parameter, then the 6432 or 6433 will automatically increment the CN character value by one and transmit the corresponding parameter from the next channel in the same input/output block.

e.g. If the command parameter transmitted previously was:-

2PV123.4 - PV value of Channel 2

Then after an ACK response the 6432 replies:-

3PV567.8 - the PV value of Channel 3

Each subsequent ACK response will cause the 6432 or 6433 to increment the CN value until it reaches 8 or the channel scan limit set by digit 2 of the corresponding Block Status parameter, S1, S2, S3 or S4. The CN value will then be reset to 0 and continue incrementing up to the limit again.

It should be noted that if the UID parameter corresponds with a digital input or output Block then the CN value will be incremented as described above, but the command parameter accessed will always be the same. This is because digital input/output Blocks only have Block parameters and not individual channel parameters. Hence, an ACK response accesses the same data as a NAK response in this case.

ii) Instrument Command Parameters

If the previous command parameter was an Instrument Parameter then the CN character is not incremented but the 6432 or 6433 fetches the next parameter from the list of Appendix A.7 or A.8. When it reaches the last parameter, MD, it will reset to the top of the list and start with II as subsequent ACK replies are received.

5.1.3 Termination Procedure

The Termination Procedure of the protocol is entered whenever the Supervisor Station wishes to stop polling a particular Tributary Station and establish a new logical connection. Figure 5.1 shows that this can occur if a System 6000 instrument does not respond to a Poll or if it replies with an EOT during Phase A of the Message Transfer Procedure. It can also occur after the instrument has made a valid reply in Phase B of the Message Transfer Procedure. In these cases the Supervisor Station first assumes Master Status and then transmits an EOT to reset all Tributary Stations back to looking for the next GID-UID address parameter. After transmitting the EOT the Supervisor Station may Poll a different instrument perform a Selection Sequence (see Section 5.2) via Re-Entry points, or wait.

5.2 Selection

The Supervisor Station transmits data to a System 6000 instrument using the Selection Sequence illustrated in Figure 5.2. It can be seen from this diagram that the Sequence can be divided up into three distinctive Procedures which are described in the following sections.

5.2.1 Establish Connection Procedure

The Supervisor Station retains Master Status throughout the whole of the Selection Sequence as it is the originator of all data transfers. The Selection Sequence is initiated by the Supervisor Station transmitting the following 5 character message:-

(EOT) [GID] [GID] [UID] [UID]

It can be seen from Section 5.1.1 that this sequence of characters is identical to the first 5 characters of the Polling Sequence, thus:-

i) (EOT)

The EOT Control character resets all the instruments from text mode to control mode.

ii) [GID] [GID] [UID] [UID]

These repeated Data characters constitute the Group and Unit address identifier parameters of the required instrument.

Figure 5.2 shows that the Initial Entry point of the Selection sequence starts off with the Supervisor Station transmitting an EOT character to reset all the Tributary Stations. However, the Selection Sequence may be Re-Entered after the EOT character as shown provided that an EOT character has been transmitted within a previous Termination Procedure such as Section 5.1.3 a) or Section 5.2.3.

Multi-Channel Instruments

It should be noted that this Procedure is identical for the 8 channel instruments (6358, 6434), and the 32 and 64 channel instruments (6432, 6433).

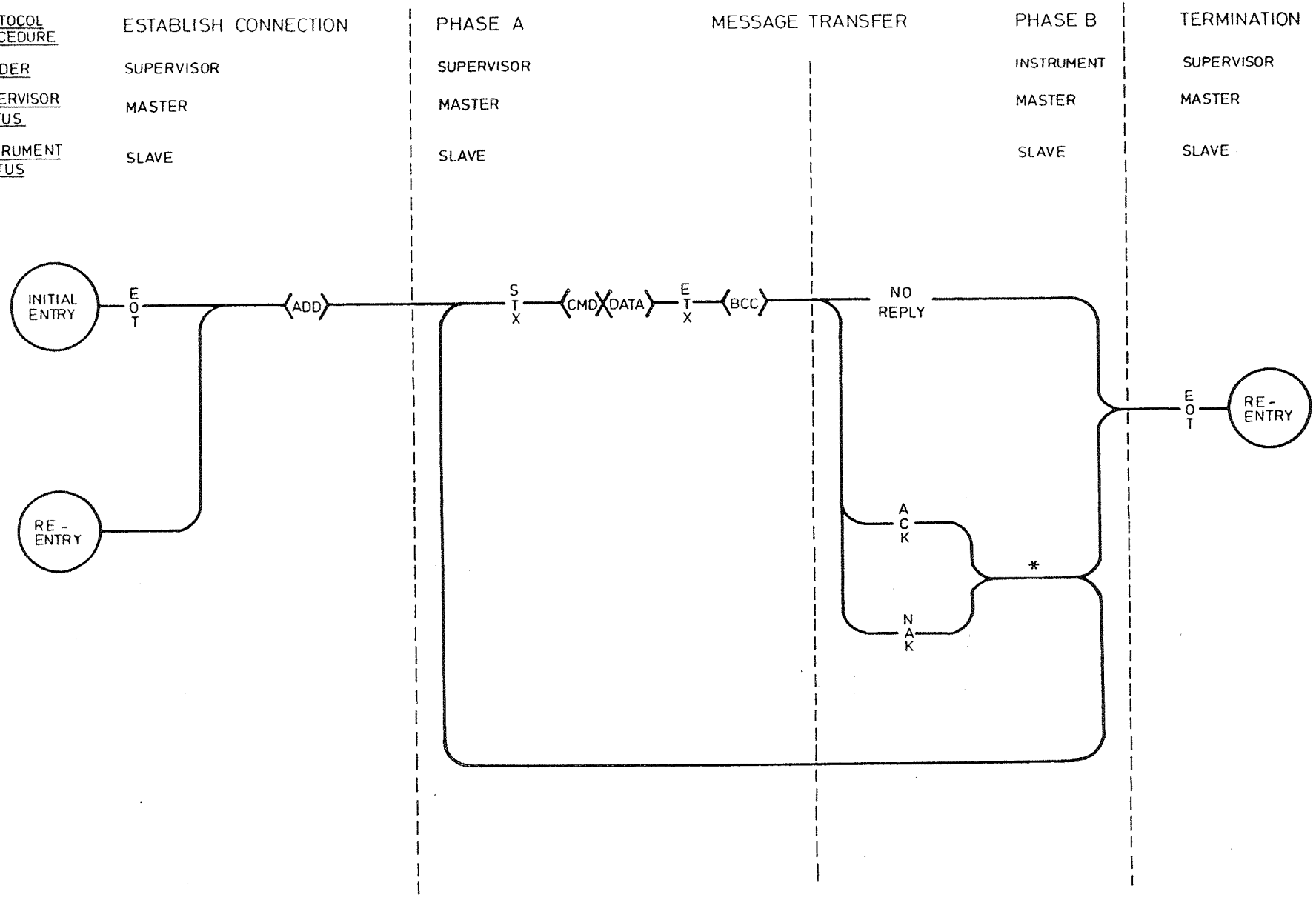


FIG 5.7 SELECTION SEQUENCE FOR TRANSMITTING DATA FROM THE SUPERVISOR TO A SYSTEM 6000 INSTRUMENT (ASCII MODE)

5.2.2 Message Transfer Procedure

After the Supervisor Station has transmitted the 5 character message of the Establish Connection Procedure, it retains Master Status and enters the Message Transfer Procedure directly. It can be seen from Figure 5.2 that the Message Transfer Procedure itself can be divided up into 2 Phases according to which device is acting as the sending Station. These 2 Phases are considered as follows:-

A) Phase A - Supervisor Sender

Figure 5.2 shows that upon initial entry to the Message Transfer Procedure the Supervisor Station transmits the new parameter value by means of the following 10 character message:-

(STX) [C1][C2] [D1][D2][D3][D4][D5] (ETX) [BCC]

It can be seen from Section 5.1.2 A) c) that this message is identical to that transmitted by the instrument in response to a Poll. The exact significance of each character is as follows:-

i) (STX)

The STX Control character identifies the message as being part of a Selection sequence. Any other non-control character transmitted at this point would be interpreted by the Tributary Station as being the first half of the Command Mnemonic in a Polling Sequence. The STX therefore informs the selected instrument that it has Slave Status and that new data is contained in the 7 characters preceding the ETX control character.

ii) [C1][C2]

These characters are the Command Mnemonics of the parameter to be updated by the transfer and can be any one of those listed in Appendix A provided that it is not a monitor-only parameter.

iii) [D1][D2][D3][D4][D5]

These 5 characters represent the value of the selected parameter to be updated in engineering units with a sign digit and decimal point positioned appropriately. The format of the "D" characters is identical to those transmitted by an instrument during the Message Transfer Procedure of a Polling Sequence and are listed in Table 5.2.

It should be noted, however, that the selected instrument only examines the decimal point character to determine the sign of a parameter, viz:-

period (.) = positive parameter
minus sign (-) = negative parameter

The decimal point position of a parameter is pre-determined by status words for format 1 and 2 commands (see Section 3.3.3) or by Table 3.1 for format 3 to 15 commands. Therefore the Supervisor Station may transmit these 5 data characters with the sign in any position, e.g. at the beginning, if this is more convenient.

iv) (ETX)

The ETX Control character indicates that transmission of the textual part of the message has been completed.

v) [BCC]

This is the Longitudinal Redundancy Block Check Control Character (BCC) performed on the last 8 characters previously transmitted. Thus the BCC character field excludes the initial STX but includes the following 8 characters:-

[C1][C2] [D1][D2][D3][D4][D5] (ETX)

The BCC character itself is formed in exactly the same manner as described in Section 5.1.2 A) c) for a Polling sequence.

8 Channel Instruments - 6358, 6434

Phase A of the Message Transfer Procedure for these instruments is identical to that for the single channel instruments described above.

32 and 64 Channel Instruments - 6432, 6433

Upon initial entry into the Message Transfer Procedure the Superivisor Station transmits the new command value by means of the following 11 character message:-

(STX) [CN] [C1][C2] [D1][D2][D3][D4][D5] (ETX) [BCC]

This message is exactly the same as the message transmitted by the 6432 or 6433 in response to a Poll as described at the end of Section 5.1.2 A). The CN parameter again has to be a valid channel number from 1 to 8 for Block Command parameters and must be present for the Instrument Command parameters even though it has no significance. The BCC character checks the 9 characters between the [CN] and (ETX) characters as before.

B) Phase B - System 6000 Instrument Sender

After the Supervisor Station has transmitted the 10 character message in Phase A of the Message Transfer Procedure, the protocol enters Phase B where the instrument becomes the sender. Figure 5.2 shows that there are 3 possible replies the instrument can make at this stage:-

a) Positive Acknowledgement - (ACK)

When the instrument identified by the GID-UID address parameters of the Establish Connection Procedure has received the message transmitted by the Supervisor Station during Phase A of the Message Transfer Procedure, it performs 3 tasks:-

1. Verifies that the BCC character corresponds to the data pattern actually received. If so then it:-

2. Verifies that the [C1] [C2] command parameters correspond with a valid mnemonic combination as listed in Appendix A. If so then it:-

3. Verifies that the data specified by the [D1], [D2], [D3], [D4], and [D5] characters contain valid data. If so then it:-

4. Updates the selected parameter with the new value contained in the data field of the message.

Only when all of these tasks have been successfully completed does the instrument send the ACK response back to the Supervisor Station. This signifies that the message was correctly received, verified, and the parameter updated by the instrument. Upon receipt of the ACK the Supervisor Station may enter the Termination Procedure of Section 5.2.3 or may remain in the Message Transfer Procedure. If the Supervisor Station stays in the Message Transfer Procedure it may send another 10 character message to the same instrument without having to re-establish the logical connection. This is known as a "Fast Select" sequence and saves time when the Supervisor Station wishes to continuously update parameters in the same instrument because it is not necessary to enter the Establish Connection Procedure before each selection.

b) Negative Acknowledgement - (NAK)

The instrument selected by the Establish Connection Procedure may detect an error in the message transmitted by the Supervisor Station during Phase A of the Message Transfer Procedure. An error may occur for one or more of the following reasons:-

1. The command parameter defined by the [C1] [C2] characters may not be a valid mnemonic combination as discussed in Section 3.7.2.

2. The command parameter specified by the [C1] [C2] characters may be a monitor-only parameter as discussed in Section 3.7.5.

3. The data field specified by the [D1], [D2], [D3], [D4], and [D5] characters may be invalid or out of range as discussed in Section 3.7.6.

4. The BCC character may not correspond with the data actually received by the instrument due to line noise etc.

5. The COMPUTER ENABLE logic input, pin 28, is at 0V so disabling the Supervisor Station from updating parameters. (Single channel instruments only)

If any of these conditions are detected by the instrument it sends back a NAK response to the Supervisor Station. This signifies to the Supervisor Station that the message received by the instrument contained an error. Upon receipt of the NAK the Supervisor Station may enter the Termination Procedure of Section 5.2.3, or may remain in the Message Transfer Procedure and re-transmit the message by means of the "Fast Select" Sequence. If the Supervisor Station stays in the Message Transfer Procedure it may re-send the 10 character message to the same instrument without having to re-establish the logical connection. The use of this "Fast Select" sequence saves time when the Supervisor wishes to transmit re-tries on a message after an instrument has found an error because it is not necessary to enter the Establish Connection Procedure before each re-try.

It can be seen from Fig. 5.2 that on "Fast Selection" after an ACK or NAK reply the instrument will ignore all transmitted characters except STX or EOT. i.e. at the point marked * the instrument ignores all characters on the data link other than those shown along the 2 specific paths.

c) No response

Under certain circumstances the Supervisor Station may not receive any message at all in response to a Selection Sequence. This can be due to any of the following reasons:-

1. Group-Unit address parameters not recognised.

2. An error (e.g. parity) is found in any of the characters up to and including the BCC.

3. Selected instrument has an 8260 Hand-Held terminal connected so disabling its RS422 bus.

4. Selected instrument has wrong baud rate set on switches 2, 3 and 4 of switch bank S1 (see Section 4.1.3 a)).

5. Noise on the communications link, or link failure.

6. Hardware failure in the selected instrument.

In these cases the Supervisor Station will either find the reply invalid or "timed-out" and so it will enter the Termination Procedure of Section 5.2.3.

8 Channel Instruments - 6358, 6434

The selected 6358 or 6434 can make an ACK, NAK or no response in the same way as the single channel instruments described above. Note that an ACK or NAK response allows the Supervisor Station to update the same Instrument or Loop channel parameter, a different Instrument or Loop Channel parameter, or enter the Termination Procedure. It is not possible to access a different set of loop or channel parameters without re-establishing the logical connection and selecting a new UID as described in section 5.2.1.

32 and 64 Channel Instruments - 6432, 6433

The selected 6432 or 6433 can make an ACK, NAK or no response in the same way as the single channel instruments described above. Note that an ACK or NAK response allows the Supervisor Station to update the same Instrument or Block parameter, a different Instrument or Block parameter, or a different Block parameter from another channel. It is not possible to access a different set of Block parameters without re-establishing the logical connection and selecting a new UID as described in Section 5.2.1

5.2.3 Termination Procedure

The Termination Procedure of the protocol is entered whenever the Supervisor Station wishes to stop selecting a particular instrument and establish a new logical connection, or when order has to be re-established on the data link after an aborted transfer. These 2 cases are considered as follows:-

a) Break Logical Connection

Figure 5.2 shows that afer the instrument has transmitted an ACK or NAK response in Phase B of the Message Transfer Procedure, then the Supervisor Station may enter the Termination Procedure. The Supervisor Station retains Master Status and transmits an EOT character to reset all Tributary Stations back to looking for the next GID-UID address parameter. After transmitting the EOT the Supervisor Station may Select a different instrument, perform a Polling Sequence (see Section 5.1) via Re-entry Points, or wait.

b) Re-Establish the Link

Figure 5.2 also shows that if the instrument does not respond at all to the Selection Sequence the Supervisor Station also enters the Termination Procedure. It retains Master Status, transmits an EOT character and may then re-Select or Poll via Re-Entry points or wait.

SECTION 6 BSC PROTOCOL - BINARY MODE

6.1 Differences between the ASCII and Binary modes

The major differences between the ASCII-based protocol mode described in Section 5 and the Binary mode can be considered under the following headings:-

6.1.1 Character Format

Table 4.1 shows that in Binary mode the character length for transmission at baud rates from 300 to 9600 is 11 bits made up as follows :-

1 start bit;
7 data bits;
1 control bit;
1 parity bit (even);
1 stop bit;

For 110 baud transmission 2 stop bits are used so that each character consists of a total of 12 bits.

6.1.2 Control Characters

As in the ASCII mode case the protocol requires a number of Control characters which have to be distinguished from Data characters. In the Binary mode, Control characters are identified by always having their control bit set to logic zero (0). The Control characters recognised by the protocol in Binary mode are as follows:-

EOT, STX, ETX, ETB, ENQ, ACK, NAK

For a full list of Control characters and their corresponding ASCII codes refer to Appendix B, Table B.1.

6.1.3 Data Characters

All Data characters used with the Binary protocol are distinguished from Control characters by having their control bit set to logic one (1). The 7 data bits in these data characters are used to represent 3 categories of information:-

a) Simple Numeric Information

When it is required to transmit simple numeric information the 7 data bits are used to represent the direct binary equivalent of numbers in the range 0-127. The protocol requires 3 types of simple numeric characters, thus:-

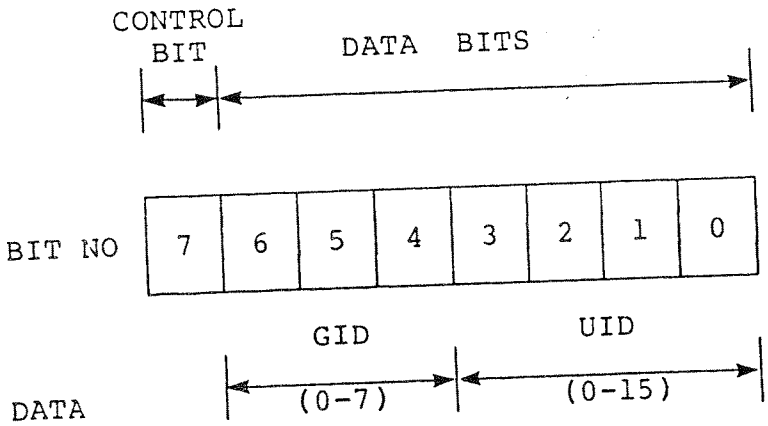
i) Instrument Number [INO]

In the ASCII mode an instrument is addressed by means of a Group (GID) and Unit (UID) identifier. The GID varies from 0 to 7 and the UID varies from 0 to 15 allowing a total of 128 instruments to be addressed as described in Section 4.4. Furthermore, in an ASCII mode message an instrument is addressed by 4 characters.

[GID] [GID] [UID] [UID]

i.e the GID and UID are each repeated.

In the Binary mode the GID and UID are compressed into a single character called the Instrument Number [INO] which is made up as shown below:-



Thus it can be seen that a data compression of 4 to 1 is obtained in the instrument addressing.

ii) Parameter Number [PNO]

In the ASCII mode a particular command parameter is accessed by means of its corresponding 2 character mnemonic e.g. 1H or SL. In the Binary mode, each parameter is assigned a Parameter Number [PNO] which is a single 7 bit byte covering the range 0-127. Appendix A.1 shows that in the case of the 6350 Controller, for example, the Setpoint High Range 1H has a PNO value of 2, while the Local Setpoint SL has a PNO value of 18. Thus it can be seen that this mode of parameter access gives a data compression of 2 to 1 with the Binary protocol.

8 Channel Instruments - 6358,6434

It was shown in Section 4.4.2 b) that these instruments occupy 8 consecutive UIDs within a group. Appendix A.5 and A.9 for the 6358 and 6434 respectively show that at each UID all the Instrument parameters are available as well as the required set of loop or channel parameters. e.g. for a 6358 the Local Setpoint SL for a particular loop has a [PNO] value of 18 at the specified UID, while the Instrument Operating Mode MD has a [PNO] value of 36 at each of the 8 possible UIDs. This shows that with the Binary protocol the parameter access method for 8 channel instruments is the same as for single channel instruments.

32 and 64 Channel Instruments - 6432, 6433

It was shown in Section 4.4.2 c) and d) that the 6432 and 6433 instruments occupy 4 and 8 consecutive UIDs within a group respectively. Each UID addresses one of the 4 or 8 Blocks of 8 input/output channels contained within the 6432 or 6433. In the ASCII protocol mode it is necessary to add an extra character [CN] to a Polling or Selection sequence to specify which channel within the Block is actually being accessed. In the Binary protocol mode this extra character is unnecessary and the parameter access mechanism is the same as for the single channel instruments. The reason for this is shown in Appendix A.7 and A.8 where it can be seen that each type of input/output Block has its own table of Parameter Numbers. Within each table the 8 individual channels have separate PNOs while the Instrument Parameters are also included in each input/output Block. e.g. for a 6432 Analogue input block:-

[PNO] value for channel 1 PV = 21
[PNO] value for channel 5 PV = 53
[PNO] value for Instrument Operating Mode MD = 10

iii) Count Number [CNO]

When the Multi-parameter Polling facility of the Binary protocol is being used (see Section 6.3.1) it is possible to access up to 127 parameters in response to a single Polling request. With this type of Poll the sequence includes a Count Number [CNO] parameter which is a single 7 bit byte specifying the number of parameters to be polled from 1 to 127.

It should be noted that for single channel instruments the Count Number includes the spaces in the parameter list. For example, a CNO of 8 starting at a PNO of 8 for a 6352 (see Appendix A.3 Table A.3.2) returns only 6 blocks of valid data. No data is returned for the spaces.

b) Check Characters

The second category of Data characters are the check characters used for data verification purposes. The Binary mode protocol requires 2 types of check characters to be transmitted at various places within the data exchange sequences. The check characters themselves are formed by computing the binary sum (without carry) independently on each of the 7 individual levels (bits) of the transmitted code for each character to be checked. This procedure is the same as for the ASCII checksum character described in Section 5.1.2 A) c) (v). The 2 types of check characters are as follows:-

i) Connection Check Control Character [CCC]

The [CCC] character checks all characters after the EOT character at the beginning of the Establish Connection Procedure until the start of the Message Transfer Procedure within a Polling or Selection sequence.

ii) Block Check Control Character [BCC]

The [BCC] character checks all characters after the STX character at the beginning of the Message Transfer Procedure until the ETX or ETB character within a Polling or Selection sequence.

c) Data Blocks

In the ASCII protocol mode the Data Block contained within the Message Transfer Procedure of a Polling or Selection sequence consists of 7 ASCII characters thus:-

[C1] [C2] [D1] [D2] [D3] [D4] [D5]

where [C1] and [C2] specify the command parameter mnemonic, and [D1] to [D5] represent the value of the parameter transmitted as a 4 digit number in engineering units with a decimal point (See Section 5.1.2 A) c).

In the Binary protocol mode the Data Block contains 4 characters, thus:-

[PNO] [D1] [D2] [D3]

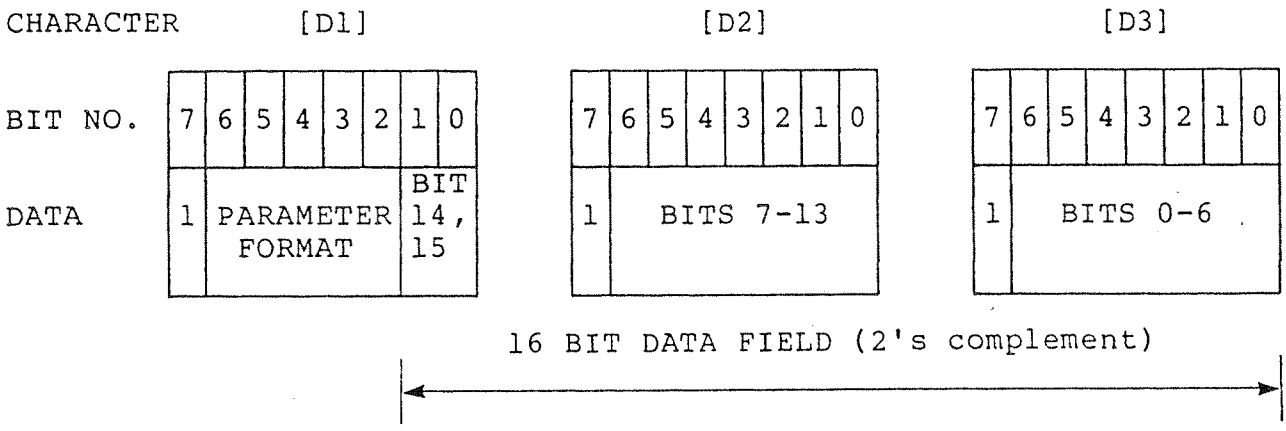
These characters have the following representation.

i) [PNO]

This character specifies the command parameter by means of the Parameter Number as described in Section 6.1.3 a) (ii).

ii) [D1] [D2] [D3]

These 3 characters specify the parameter data in the following format:-



Bit 7 the control bit of each of the 3 characters is set to 1 to indicate that they are data characters. Bits 2 to 6 of [D1] are a 5 bit parameter Format Number while bits 0 to 6 of [D3], 0 to 6 of [D2] and bits 0 and 1 of [D1] constitute a 16 bit data field. The parameter value is represented by this field as a 16 bit 2's complement binary integer while the Format Number gives the decimal point position according to the following:-

FORMAT NUMBER	DECIMAL POINT POSITION
0	X X X X
1	X X X.X
2	X X.X X
3	X.X X X
4	.X X X X

Hexadecimal data (format 5 parameters of Table 3.1) is transmitted as 16 bits with the format number always set to zero. Similarly, ASCII characters (format 8 parameters of Table 3.1) are sent as two 8 bit pairs with a format number of zero.

MODE NO.	INSTRUMENT					
	6350	6351	6352	6353	6358	6360
0	HOLD	HOLD	-	HOLD	-	HOLD
1	TRACK	-	-	-	-	TRACK
2	MANUAL	MANUAL	MANUAL	MANUAL	MANUAL	MANUAL
3	AUTO	AUTO	AUTO	AUTO	AUTO	AUTO
4	RATIO	RATIO	-	-	-	RATIO
5	CASCADE (REM SP)	CASCADE (REM SP)	-	-	CASCADE (REM SP)	CASCADE (REM SP)
6	FORCED MANUAL	FORCED MANUAL	FORCED MANUAL	FORCED MANUAL	FORCED MANUAL	FORCED MANUAL
7	FORCED AUTO	FORCED AUTO	FORCED AUTO	-	FORCED AUTO	FORCED AUTO

TABLE 6.1 List of Controller operating modes and their corresponding Mode Number (MN) parameters

6.1.4 Mode Number Parameter - MN

With the ASCII mode of the protocol it is necessary to examine the state of individual bits of the "MD" command parameter in order to ascertain the current operating state of a controller. With the Binary mode of the protocol a new command parameter has been added which allows this information to be obtained by examining a single character. This new parameter, called the Mode Number (MN), is a single character defined over the range 0 to 7 and is only implemented on those System 6000 instruments classified as Controllers. The permitted MN values and their corresponding operating modes for the 6 Controllers are listed in Table 6.1 . It is also possible to change the operating state of a Controller by writing to the MN parameter but it should be noted that modes 0, 1, 6 and 7 are always read-only.

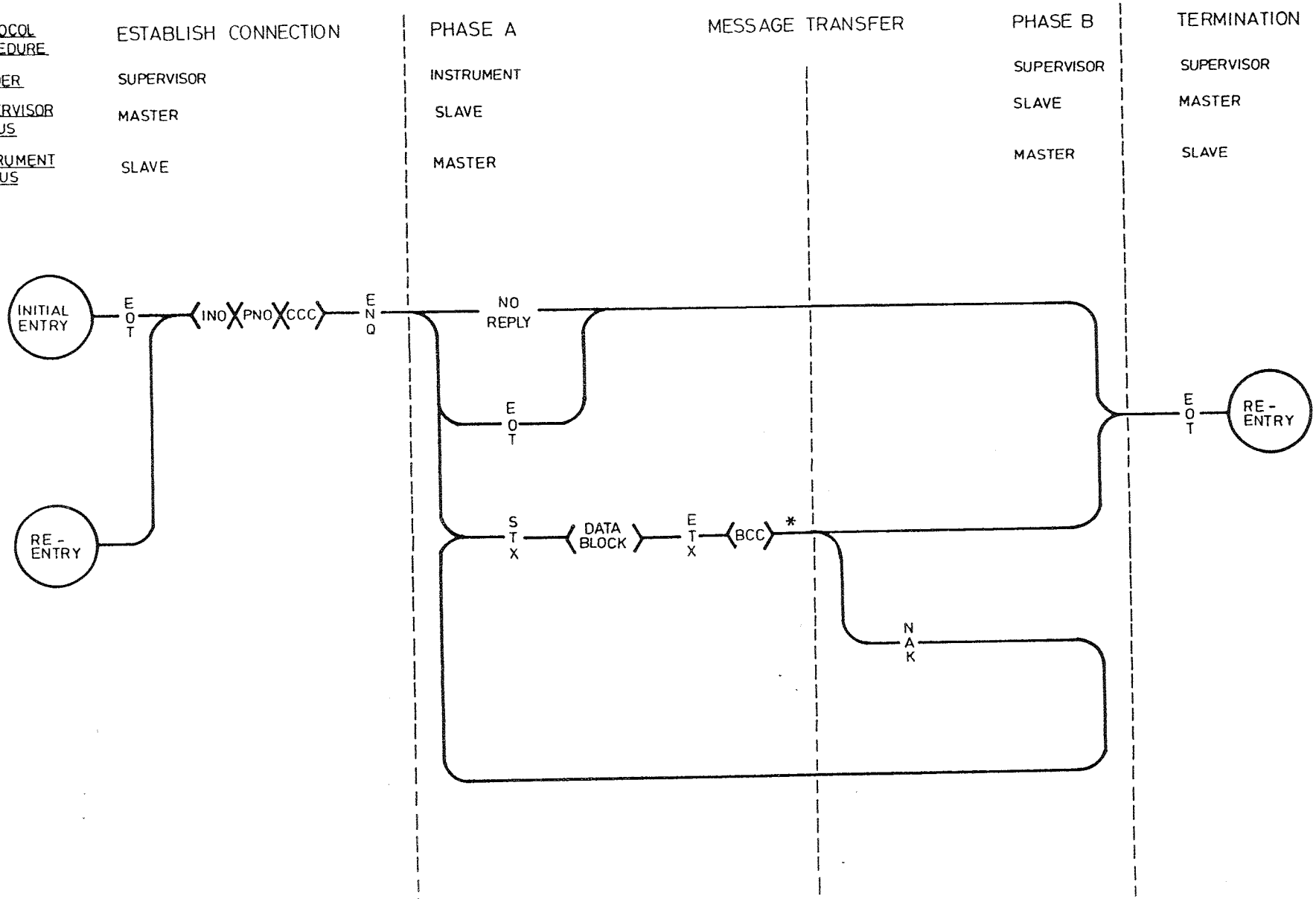


FIG 6 1 SINGLE PARAMETER POLLING SEQUENCE (BINARY MODE)

6.2 Single Parameter Poll

Section 4.3.3 b) stated that there are 3 types of Polling Sequences that may be used by the Supervisor Station to obtain data from a System 6000 instrument when in the Binary mode of the protocol. The most straightforward of these is the "Single Parameter Polling Sequence" which is illustrated in Fig 6.1. This Sequence is very similar to the Polling Sequence used in the ASCII mode of Section 5.1 and is similarly divided up into the following 3 distinctive Procedures:-

6.2.1 Establish Connection Procedure

The Supervisor Station initially has Master Station Status and begins by transmitting a 5 character polling supervisory message. This message identifies a single Tributary Station and command parameter while the ENQ Control character defines the end of the message. The 5 character message is in the following format:-

(EOT) [INO] [PNO] [CCC] (ENQ)

where (XXX) denotes an ASCII Control character (See Appendix B, Table B.1) and [YYY] denotes an ASCII Data character (See Appendix B, Table B.2). These characters have the following functions:-

i) (EOT)

This Control character resets all the Tributary Stations (Instruments) from text mode to control mode. This causes them to examine the next transmitted character to see if it corresponds with their own Instrument Number.

ii) [INO]

This Data character is the Instrument Number constructed as described in Section 6.1.3 a) (i).

iii) [PNO]

This Data character is the Parameter Number constructed as described in Section 6.1.3 a) (ii).

iv) [CCC]

This Data character is the Connection Check Control character which is the exclusive OR function of the 2 Data characters transmitted previously and is calculated as described in Section 6.1.3 b) (i).

v) (ENQ)

The Polling Sequence is terminated with this Control character.

Fig 6.1 shows that the Supervisor Station starts off the Polling Sequence initially with an EOT character to reset all the System 6000 instruments and cause them to look for a valid INO address identifier. The Polling Sequence can be Re-Entered subsequently if required after the EOT character as shown. This would be done after coming from the Termination Procedure, for example, as it can be seen that an EOT character is generated by the Supervisor Station as part of the Termination Procedure itself. It should also be noted that the Supervisor Station can generate EOT characters at any time to terminate a transmission by a Tributary Station and restore order on the data link. (See Section 6.2.3)

6.2.2 Message Transfer Procedure

After the Supervisor Station has transmitted the ENQ character at the end of the Establish Connection Procedure, the protocol enters the Message Transfer Procedure. It can be seen from Fig 6.1 that the Message Transfer Procedure itself can be divided into two Phases according to which device is acting as the sending Station. These two Phases are considered as follows:-

A) Phase A - System 6000 Instrument Sender

Figure 6.1 shows that upon initial entry to the Message Transfer Procedure there are three possible replies that a Tributary Station can make.

a) No Reply

Under certain circumstances the Supervisor Station may not receive any message at all in response to a Polling Sequence. This can be due to any of the following reasons:-

1) Instrument Number [INO] not recognised.

2) Connection Check Character [CCC] found to disagree with transmitted data.

3) An error (e.g. parity) is found in any of the characters up to and including the ENQ.

4) Polled instrument has an 8260 Hand-held terminal connected so disabling its RS422 bus.

5) Polled instrument has wrong baud rate set on switches 2, 3 and 4 of switch bank S1 (see Section 4.1.3 a)).

6) Noise on the communications links or link failure.

7) Hardware failure in the polled instrument.

In these cases the Supervisor Station will either find the reply invalid or "timed-out" and so it will retain Master Status and enter the Termination Procedure of Section 6.2.3

b) Invalid Reply

A polled instrument may recognise its [INO] address, agree with the [CCC] Check Character, but find that the Parameter Number [PNO] does not correspond with a valid entry in the list given in the appropriate section of Appendix A, e.g. PNO = 16 for a 6352 (see Appendix A.3, Table A.3.2). In this case the instrument will terminate its Master Status by sending an EOT control character to terminate the logical connection. Master Status then reverts to the Supervisor Station which may then Poll or Select another station after entering the Termination Procedure of Section 6.2.3.

c) Valid Reply

Once an instrument has successfully recognised (ENQ) and the [INO] and [PNO] parameters and agrees with the [CCC] Check Character it assumes Master Status and initiates the Message Transfer Procedure. The Supervisor Station assumes Slave Status for the duration of this Procedure and the instrument starts off by transmitting the following 7 character sequence:-

(STX) [PNO] [D1] [D2] [D3] (ETX) [BCC]

These characters have the following function:-

i) (STX)

This Control character indicates that the instrument is now a Master Station and is transmitting data in the text mode.

ii) Data Block - [PNO] [D1] [D2] [D3]

The first character in the Data Block [PNO] is a repeat of the [PNO] transmitted during the Establish Connection Procedure of Section 6.2.1. The next 3 Data characters contain the parameter value coded as given in Section 6.1.3 c) (ii).

iii) (ETX)

The ETX Control character terminates the transmission of the textual part of the message.

iv) [BCC]

This Block Check Control Character is transmitted by the instrument at the end of its message to be used by the Supervisor Station for data verification purposes. The [BCC] value is computed from the 5 characters transmitted previously, i.e. excluding (STX) but including (ETX), according to the method given in Section 6.1.3 b) (ii).

It should be noted that once the instrument has started transmitting the above 7 character message it will ignore all other characters sent to it from the Supervisor Station except for an EOT. This will cause the instrument to terminate transmission at the end of the next complete character and resume Slave Status.

B) Phase B - Supervisor Sender

After the polled instrument has transmitted a valid 7 character message in Phase A of the Message Transfer Procedure, the protocol enters Phase B where the Supervisor Station becomes the sender. At this point, indicated by * in Fig 6.1, the instrument will ignore all characters on the data link other than those shown along a specific path. It will therefore remain at this point until one of the 2 valid replies are received as follows:-

a) Repeat Parameter Facility - NAK

If the Supervisory Station transmits a NAK response it causes the polled instrument to remain in the Message Transfer Procedure, retain Master Status and re-transmit the last parameter polled. This response is very time saving when the Supervisor Station needs to continuously monitor the same parameter from a particular instrument because it is not necessary to enter the Establish Connection Procedure before each Poll.

b) Termination Reply

Fig 6.1 shows that if the Supervisor Station wishes to stop polling a particular instrument after the Message Transfer Procedure then it may enter the Termination Procedure of Section 6.2.3 directly and break the logical connection.

6.2.3 Termination Procedure

The Termination Procedure of the protocol is entered whenever the Supervisor Station wishes to stop polling a particular Tributary Station and establish a new logical connection. Fig 6.1 shows that this can occur if a System 6000 instrument does not respond to a Poll or if it replies with an EOT during Phase A of the Message Transfer Procedure. It can also occur after the instrument has made a valid reply in Phase B of the Message Transfer Procedure. In these cases the Supervisor Station first assumes Master Status and then transmits an EOT to reset all Tributary Stations back to looking for the next valid INO parameter. After transmitting the EOT the Supervisor may Poll a different instrument, perform a Selection Sequence (see Section 6.5) via Re-Entry points, or wait.

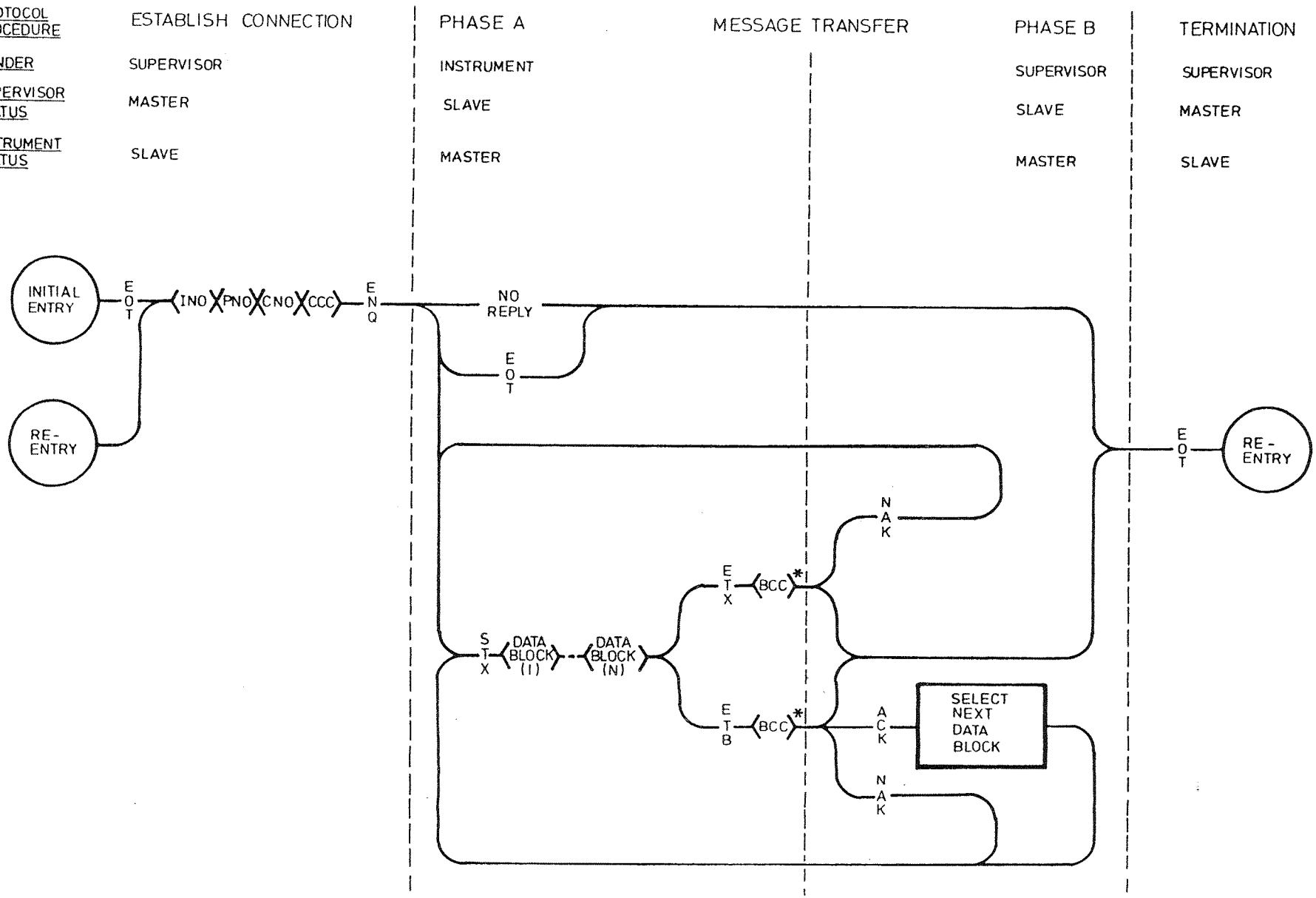


FIG 6·2 MULTI-PARAMETER POLLING SEQUENCE (BINARY MODE)

6.3 Multi-Parameter Poll

The second type of Polling Sequence mentioned in Section 4.3.3 b) is the Multi-Parameter Poll which is a feature only available with the Binary mode of the protocol. This Sequence allows the Supervisor Station to access a sequential block of command parameters from a selected instrument by transmitting only a single message. It is therefore a very fast method of accessing a number of parameters from a given instrument. The Multi-Parameter Polling Sequence itself is divided up into the same 3 Procedures as the Single Parameter Poll of Section 6.2 and is illustrated in Fig 6.2.

6.3.1 Establish Connection Procedure

The Supervisor Station initially has Master Station Status and begins by transmitting a 6 character polling supervisory message in the following format:-

(EOT) [INO] [PNO] [CNO] [CCC] (ENQ)

These characters have the following functions:-

i) (EOT)

This Control character resets all the instruments from text mode to control mode so that they examine the next character to see if it corresponds with their own Instrument Number.

ii) [INO]

This Data character is the Instrument Number constructed as described in Section 6.1.3 a) (i).

iii) [PNO]

This Data character is the Parameter Number of the first parameter in the sequential block to be polled and is constructed as described in Section 6.1.3 a) (ii).

iv) [CNO]

This Data character is the Count Number and specifies the number of sequential parameters to be transmitted in the block starting from [PNO]. The [CNO] parameter is constructed as described in Section 6.1.3 a) (iii).

v) [CCC]

This Data character is the Connection Check Control character which is the exclusive OR function of the 3 Data characters transmitted previously and is calculated as described in Section 6.1.3 b) (i).

vi) (ENQ)

This Control character is used to terminate this part of the polling sequence.

Figure 6.2 shows that the Supervisor Station can initiate the Establish Connection Procedure through an Initial or Re-Entry point depending upon whether an EOT has been transmitted previously. This is the same as for the Single Parameter Poll of 6.2.1. It can be seen that the Establish Connection Procedure only differs from the Single Parameter case by the addition of the [CNO] parameter. Therefore, the Single Parameter Poll can be considered a special case of the more general Multi-Parameter Poll where the count parameter [CNO] is omitted and always assumed to be 1.

6.3.2 Message Transfer Procedure

After the Supervisor Station has transmitted the ENQ character at the end of the Establish Connection Procedure the protocol enters the Message Transfer Procedure. It can be seen from Fig 6.2 that the Message Transfer Procedure itself can be divided into two Phases according to which device is acting as the sending station. These two Phases are considered as follows :-

A) Phase A - System 6000 Instrument Sender

Figure 6.2 shows that upon initial entry to the Message Transfer Procedure there are four possible replies that a Tributary Station can make:-

a) No Reply

The Supervisor Station may receive no response to a Multi-Parameter Poll for the same reasons as for the Single Parameter Poll. These are described in Section 6.2.2 A) a).

b) Invalid Reply

The instrument will terminate its Master Status by transmitting an EOT Control character for the same reason as for a Single Parameter Poll. This is described in Section 6.2.2 A) b).

c) Valid Reply - Message Complete

Once the instrument has successfully recognised the [INO], [PNO], and [CNO], and agrees with the [CCC] Check Character it assumes Master Status and initiates the Message Transfer Procedure. The Supervisor Station assumes Slave Status for the duration of this procedure and the instrument starts off by transmitting the following sequence:-

(STX) [PNO(1)] [D1] [D2] [D3]
[PNO(2)] [D1] [D2] [D3]
.
.
.
[PNO(N)] [D1] [D2] [D3] (ETX) [BCC]

These characters have the following function:-

i) (STX)

This Control character indicates that the instrument is now a Master Station and is transmitting data in the text mode.

ii) Data Block 1 - [PNO(1)] [D1] [D2] [D3] to

Data Block N - [PNO(N)] [D1] [D2] [D3]

The first character in Data Block 1, [PNO(1)] is a repeat of the [PNO] transmitted during the Establish Connection Procedure of Section 6.3.1. The next 3 data characters contain the value of this first parameter coded as discussed in Section 6.1.3 c) (ii). There now follows a sequence of data blocks constructed in the same manner until the last block, beginning with [PNO(N)], is transmitted. The number of data blocks transmitted, (N), corresponds to the Count Number [CNO] specified by the Supervisor Station during the Establish Connection Procedure. The Multi-Parameter Polling Sequence only permits a maximum of 8 data blocks to be transmitted in any one message during the Message Transfer Procedure. It therefore follows that for a complete message at this stage the value of [CNO] and hence (N) must be between 1 and 8.

iii) (ETX)

The ETX Control character informs the Supervisor that all required data blocks have been transmitted and that the textual part of the message has been terminated.

iv) [BCC]

The Block Check Control Character [BCC] is computed for all the data blocks transmitted between (STX) and (ETX) though (STX) is not included in the calculation described in Section 6.1.3 b) (ii).

d) Valid Reply - Message Incomplete

If the number of parameters specified by [CNO] during the Establish Connection Procedure is greater than 8 then all the required data blocks cannot be transmitted in a single message. In this case the instrument will transmit the following sequence:-

(STX) [PNO(1)] [D1] [D2] [D3]
[PNO(2)] [D1] [D2] [D3]
.
.
.
[PNO(8)] [D1] [D2] [D3] (ETB) [BCC]

Here it can be seen that the first 8 data blocks are transmitted after the (STX) in the same manner as for the "message complete" reply of 6.3.2 A) c) above. However, the instrument transmits an (ETB) control character after the 8th data block instead of an (ETX). This informs the Supervisor Station that the block of text is complete but there are further blocks to be transmitted to complete the message. The [BCC] Check Character excludes (STX) but includes (ETB) and all the data blocks as before.

If the [CNO] value is between 9 and 16 then one further transmission of the "message complete" type of Section 6.3.2 A) c) is required. If [CNO] lies between 17 and 24 then a further "message incomplete" transmission is necessary before the "message complete" transmission can be sent, and so on.

It should be noted that once the instrument has started transmitting the "message complete" or "message incomplete" data sequence of c) or d) above, it will ignore all other characters sent to it from the Supervisor Station except for an EOT. This will cause it to terminate the transmission at the end of the next complete character and resume Slave Status.

B) Phase B - Supervisor Sender

After the polled instrument has transmitted a valid message of the complete or incomplete type in Phase A of the Message Transfer Procedure, the protocol enters Phase B where the Supervisor Station becomes the sender. At these points, indicated by * in Fig 6.2, the instrument will ignore all characters on the data link other than those shown along a specific path. It will therefore remain at these points until a valid reply is received as follows:-

a) Message Complete

Fig 6.2 shows that there are only 2 valid replies that the Supervisor Station can make after a "message complete" transmission:-

i) Repeat Message Facility - NAK

If the Supervisor Station transmits a NAK response it causes the polled instrument to remain in the Message Transfer Procedure, retain Master Status and re-transmit the last message sent.

ii) Termination Reply

If the Supervisor Station wishes to stop polling a particular instrument after the Message Transfer Procedure then it may enter the Termination Procedure of Section 6.3.3 directly and break the logical connection.

b) Message Incomplete

Fig 6.2 shows that there are 3 valid replies that the Supervisor Station can make after a "message incomplete" transmission:-

i) Next Message Facility - ACK

After a "message incomplete" transmission in Phase A, the Supervisor Station can transmit an ACK response. This causes the polled instrument to remain in the Message Transfer Procedure, retain Master Status and transmit the next sequence of data blocks. This sequence can be either a complete message or another incomplete message as discussed in Section 6.3.2 A) c) and d) respectively. This ACK response must therefore be used by the Supervisor in order to access a complete sequence of data blocks where the Count Number [CNO] is greater than 8.

ii) Repeat Message Facility - NAK

If the Supervisor Station transmits a NAK response it causes the polled instrument to remain in the Message Transfer Procedure, retain Master Status and re-transmit the last message sent.

iii) Termination Reply

If the Supervisor Station wishes to stop polling a particular instrument after the Message Transfer Procedure then it may enter the Termination Procedure of Section 6.3.3 directly and break the logical connection.

6850 Setpoint Programmer

The 6850 Setpoint Programmer does not have a fixed data base like other System 6000 instruments. The number of parameters within it vary according to the number of programmes it contains and the number of segments within each programme. Consequently, there are a number of restrictions that occur when Multi-Parameter Polling is used, viz:-

a) A data block will always be terminated prior to sending the SI parameter (PNO=21).

b) A data block will always be terminated when all the parameters for that programme have been sent.

This ensures that whenever SI is polled it always appears as the first parameter in a block so that segment data is grouped into complete data blocks. Once the parameters of a segment have been sent, if there are still more parameters to send (i.e. CNO has not yet been reached), then the value of SI will be incremented by the 6850 and the data for the next segment will be transmitted starting with the new SI value.

If the data for the last segment of the programme has been sent and there are still more parameters to send, then the value of PI will be incremented by the 6850 and the data for the next programme will be transmitted starting with the new PI value.

If the data for the last segment of the last programme (i.e. 9) has been sent the data block will be terminated with ETX as for the "message complete" reply of section 6.3.2A) c). No further parameters will be sent in that Polling Sequence even if more parameters have been requested.

6.3.3 Termination Procedure

The Termination Procedure of the protocol is entered whenever the Supervisor Station wishes to stop polling a particular Tributary Station and establish a new logical connection. Fig 6.2 shows that this can occur if a System 6000 instrument does not respond to a Poll, or if it replies with an EOT during Phase A of the Message Transfer Procedure. It can also occur after the instrument has replied with a "message complete" transmission in Phase B of the Message Transfer Procedure. In these cases the Supervisor Station first assumes Master Status and then transmits an EOT to reset all Tributary Stations back to looking for the next valid [INO] parameter. After transmitting the EOT the Supervisor may Poll a different instrument, perform a Selection Sequence (see Section 6.5) via Re-Entry points, or wait.

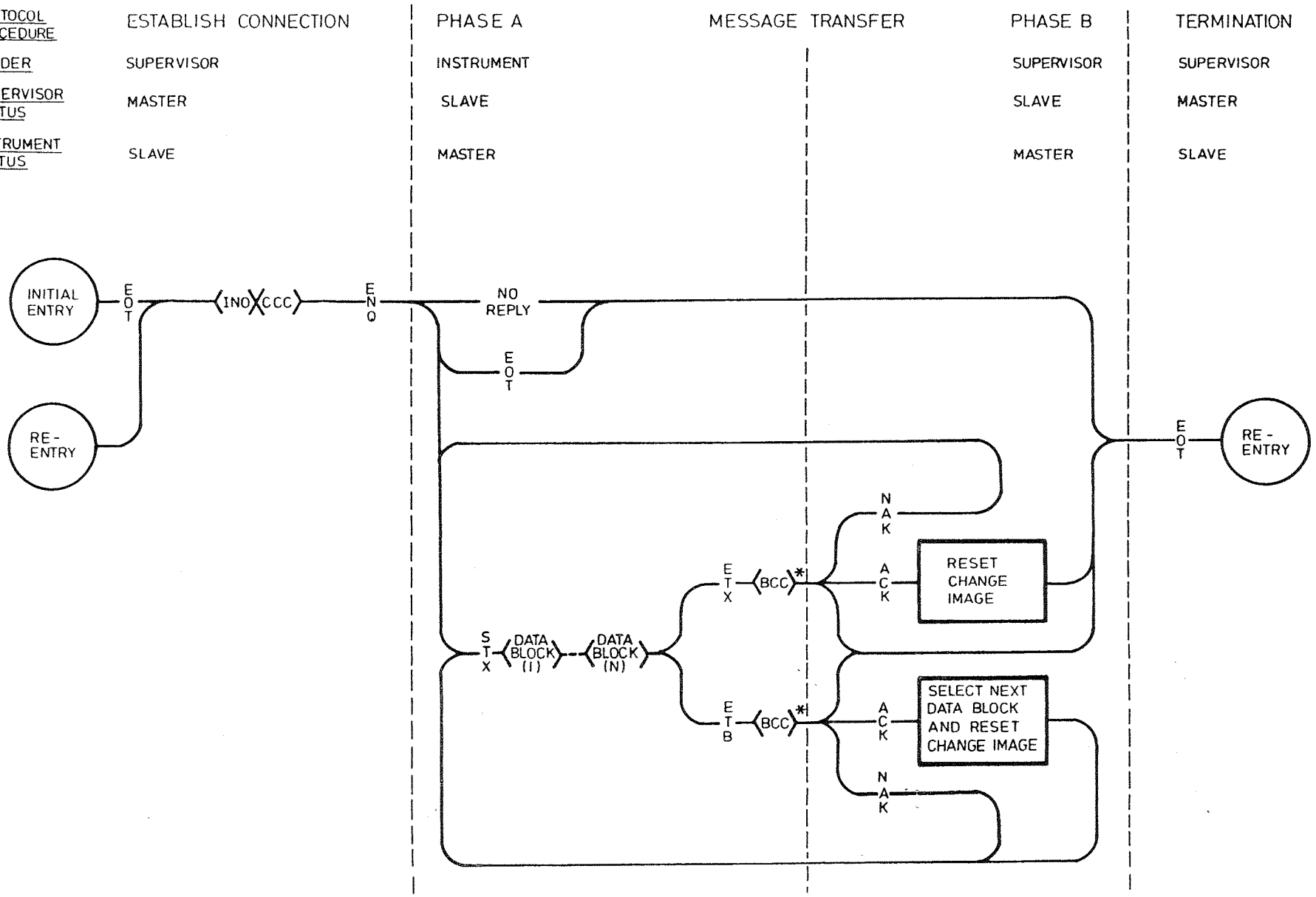


FIG 6.3 ENQUIRY POLLING SEQUENCE (BINARY MODE)

6.4 Enquiry Poll

The third type of Polling Sequence mentioned in Section 4.3.3 b) is the Enquiry Poll which is a feature unique to the Binary mode of the protocol. This Sequence can increase the efficiency of the data link by a factor of four as it allows the Supervisor to access certain parameters within an instrument only when their value has changed from the previous Poll. Furthermore, each instrument will transmit all those parameters that have changed their value in response to a single enquiry from the Supervisor. This facility has obvious advantages in large Supervisory control systems where the central computer is trying to maintain a copy of each instruments data base within its own memory. An Enquiry Polling sequence to each instrument quickly establishes which parameters have changed since the last Enquiry Poll, and the new values are rapidly available to update the data base within the Supervisory computer.

The Parameter lists for each System 6000 instrument given in Appendix A indicate which parameters are subject to Enquiry Polling. For example, Table A.1.2 of Appendix A.1 shows that only the following parameters are available for Enquiry Polling from a 6350 Single Loop Controller:-

1H, 1L, HA, LA, MN, SP, PV, OP

The instrument maintains a "Change Image Register" which is set whenever any of the 8 parameters listed above changes value, each parameter having a separate "flag" within the register. Upon receipt of an Enquiry Poll, all parameters with a flag set in the Change Image Register will be transmitted. The flags can then be reset by the Supervisor ready for the next poll. If no flags are set in the Change Image Register then the instrument makes a different response.

The Enquiry Polling Sequence is divided up into the same 3 Procedures as the Single Parameter Poll of Section 6.2, and is illustrated in Fig 6.3.

6.4.1 Establish Connection Procedure

The Supervisor Station initally has Master Station Status and begins by transmitting a 4 character polling supervisory message in the following format:-

(EOT) [INO] [CCC] (ENQ)

This is called a "short selection" sequence as no [PNO] is transmitted as for Single or Multi-Parameter Polling. The characters in the message have the following functions.

i) (EOT)

This Control character resets all the instruments from text mode to control mode so that they examine the next character to see if it corresponds with their own Instrument Number.

ii) [INO]

This Data character is the Instrument Number constructed as described in Section 6.1.3 a) (i).

iii) [CCC]

This Data character is the Connection Check Control character which is the exclusive OR function of the Data character transmitted previously and is calculated as described in Section 6.1.3 b) (i).

iv) (ENQ)

This Control character is used to terminate this part of the Polling Sequence.

Fig 6.3 shows that the Supervisor Station can initiate the Establish Connection Procedure through an Initial or Re-Entry point depending upon whether an EOT has been transmitted previously. This is the same as for the Single Parameter Poll of 6.2.1. It can be seen that the Establish Connection Procedure only differs from the Single Parameter case by the omission of the [PNO] parameter.

6.4.2 Message Transfer Procedure

After the Supervisor Station has transmitted the ENQ character at the end of the Establish Connection Procedure the protocol enters the Message Transfer Procedure. It can be seen from Fig 6.3 that the Message Transfer Procedure itself can be divided into two Phases according to which device is acting as the sending Station. These two Phases are considered as follows:-

A) Phase A - System 6000 Instrument Sender

Fig 6.3 shows that upon initial entry to the Message Transfer procedure there are four possible replies that a Tributary Station can make:-

a) No Reply

The Supervisor Station may receive no response to an Enquiry Poll for the same reasons as for the Single Parameter Poll described in Section 6.2.2 A) a).

b) No Changes

If there have been no changes in the values of the key parameters since the last Enquiry Poll (i.e no flags set in the Change Image Register) the instrument informs the Supervisor by transmitting an EOT control character.

c) Valid Reply - Message Complete

Once the instrument has successfully recognised the [INO], agrees with the [CCC] check character, and has parameter changes to report, it assumes Master Status and initiates the Message Transfer Procedure. The Supervisor Station assumes Slave Status for the duration of this Procedure and the instrument starts off by transmitting the following sequence:-

(STX) [PNO(1)] [D1] [D2] [D3]
[PNO(2)] [D1] [D2] [D3]
.
.
.
[PNO(N)] [D1] [D2] [D3] (ETX) [BCC]

These characters have the following function:-

i) (STX)

This Control character indicates that the instrument is now a Master Station and is transmitting data in the text mode.

ii) Data Block 1 - [PNO(1)] [D1] [D2] [D3] to

Data Block N - [PNO(N)] [D1] [D2] [D3]

The first character in Data Block 1, [PNO(1)] is the Parameter number of the first of the key parameters that has changed since the last Enquiry Poll. The next 3 data characters contain the new value of this parameter coded as discussed in Section 6.1.3 c) (ii). There now follows a sequence of data blocks constructed in the same manner which corresponds to all the remaining key parameters that have also changed their value. The last block beginning with [PNO(N)] is transmitted where (N) represents the total number of blocks or parameter changes in the message. The Enquiry Polling Sequence only permits a maximum of 8 data blocks to be transmitted in any one message during the Message Transfer Procedure. It therefore follows that for a complete message at this stage the value of (N) must be between 1 and 8.

iii) (ETX)

The ETX Control character informs the Supervisor that all required data blocks have been transmitted and that the textual part of the message has been terminated.

iv) [BCC]

The Block Check Control Character [BCC] is computed for all the data blocks transmitted between (STX) and (ETX) though (STX) is not included in the calculation described in Section 6.1.3 b) (ii).

d) Valid Reply - Message Incomplete

If the number of parameters that have changed since the previous Enquiry Poll is greater than 8 then it is not possible to transmit all the required data blocks in a single message. In this case the instrument will transmit the following sequence:-

(STX) [PNO(1)] [D1] [D2] [D3]
[PNO(2)] [D1] [D2] [D3]
.
.
.
[PNO(8)] [D1] [D2] [D3] (ETB) [BCC]

Here it can be seen that the first 8 data blocks are transmitted after the (STX) in the same manner as for the "Message Complete" reply of 6.4.2 A) c) above. However, the instrument transmits an (ETB) control character after the 8th data block instead of an (ETX). This informs the Supervisor Station that the block of text is complete but there are further blocks to be transmitted to complete the message. The [BCC] check character excludes (STX) but includes (ETB) and all the data blocks as before.

If the number of parameters with changes is between 9 and 16 then one further transmission of the "message complete" type of Section 6.4.2 A) c) is required. If the number lies between 17 and 24 then a further "message incomplete" transmission is necessary before the "message complete" transmission can be sent, and so on.

B) Phase B - Supervisor Sender

After the polled instrument has transmitted a valid message of the "complete" or "incomplete" type in Phase A of the Message Transfer Procedure, the protocol enters Phase B where the Supervisor Station becomes the sender. At these points, indicated by * in Fig 6.3, the instrument will ignore all characters on the data link other than those shown along a specific path. It will therefore remain at one of these points until a valid reply is received as follows:-

a) Message Complete

Fig 6.3 shows that there are 3 valid replies that the Supervisor Station can make after a "message complete" transmission:-

i) Reset Change Image - ACK

If the Supervisor Station transmits an ACK response to a "message complete" data sequence it causes the instrument to reset all the flags in the Change Image Register and then enter the Termination Procedure of Section 6.4.3.

ii) Repeat Message Facility - NAK

If the Supervisor Station transmits a NAK response it causes the polled instrument to remain in the Message Transfer Procedure, retain Master Status and re-transmit the last message sent.

iii) Termination Reply

If the Supervisor Station wishes to stop polling a particular instrument after the Message Transfer Procedure then it may enter the Termination Procedure of Section 6.4.3 directly and break the logical connection.

b) Message Incomplete

Fig 6.3 shows that there are also 3 valid replies that the Supervisor Station can make after a "message incomplete" transmission:-

i) Next Message Facility - ACK

After a "message incomplete" transmission in Phase A, the Supervisor Station can transmit an ACK response. This causes the polled instrument to remain in the Message Transfer Procedure, retain Master Status and transmit the next sequence of data blocks. This sequence can be either a complete message or another incomplete message as discussed in Section 6.4.2 A) c) and d) respectively. Therefore this ACK response must be used by the Supervisor in order to access a complete sequence of data blocks where there are more than 8 to be transmitted.

It can also be seen from Fig 6.3 that the ACK response causes the instrument to reset all the flags in the Change Image Register corresponding to those parameters transmitted in the last sequence of data blocks.

ii) Repeat Message Facility - NAK

If the Supervisor Station transmits a NAK response it causes the polled instrument to remain in the Message Transfer Procedure, retain Master Status and re-transmit the last message sent.

iii) Termination Reply

If the Supervisor Station wishes to stop polling a particular instrument after the Message Transfer Procedure then it may enter the Termination Procedure of Section 6.4.3 directly and break the logical connection.

The following points should be noted in connection with the Message Transfer Procedure:-

1) Once the instrument has started transmitting the "message complete" or "message incomplete" data sequence of 6.4.2 A) c) or d) it will ignore all other characters sent to it from the Supervisor Station except for an EOT. This will cause it to terminate the transmission at the end of the next complete character and resume Slave Status. However, the instrument will not reset the Change Image of those parameters already sent because they have not received the ACK response of Section 6.4.2 B) a) (i) or b) (i). This means that these parameters will be transmitted automatically as soon as the next Enquiry Poll is received. This situation will also occur after the Termination replies of Section 6.4.2 B) a) (iii) and b) (iii) as it can be seen that the Change Image is not reset by an ACK before the EOT.

2) Whenever the System 6000 instrument is powered up all the flags in the Change Image Register are set to indicate that all the key parameters have changed. Thus they will all be transmitted upon receipt of the first Enquiry Poll.

6.4.3 Termination Procedure

The Termination Procedure of the protocol is entered whenever the Supervisor Station wishes to stop polling a particular Tributary Station and establish a new logical connection. Fig 6.3 shows that this can occur if a System 6000 instrument does not respond to a Poll, or if it replies during Phase A of the Message Transfer Procedure to indicate that no parameters have changed. It can also occur after the instrument has replied with a "complete message" or if the Change Image has been reset by an ACK response in Phase B of the Message Transfer Procedure. In these cases the Supervisor Station first assumes Master Status and then transmits an EOT to reset all Tributary Stations back to looking for the next valid [INO] parameter. After transmitting the EOT the Supervisor may Poll a different instrument, perform a Selection Sequence (see Section 6.5) via Re-Entry points, or wait.

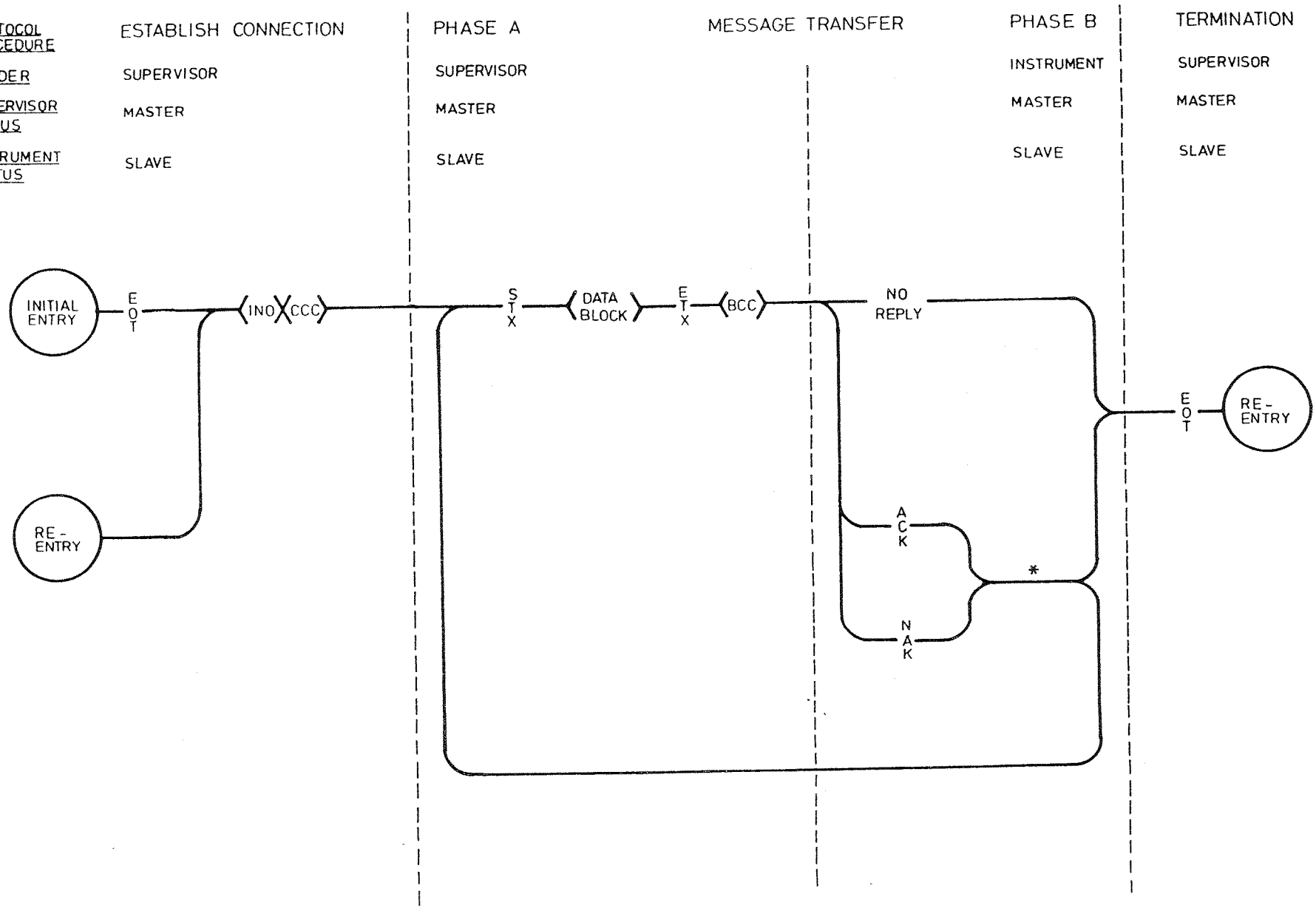


FIG 6·4 SELECTION SEQUENCE (BINARY MODE)

6.5 Selection

The purpose of the Selection Sequence is to transfer data from the Supervisor Station to a System 6000 instrument in order to update the value of a command parameter. Although this may only be done to one parameter at a time, once connection has been made to a particular instrument, re-connection for subsequent Selections to the same instrument is not required. This feature is known as "Fast Selection".

The Supervisor Station transmits data to a System 6000 Instrument using the Selection Sequence illustrated in Fig 6.4. It can be seen from this diagram that the Sequence can be divided up into three distinctive Procedures which are described in the following sections.

6.5.1 Establish Connection Procedure

The Supervisor Station retains Master Status throughout the whole of the Selection Sequence as it is the orginator of all data transfers. The Selection Sequence is initiated by the Supervisor Station transmitting the following 3 character message:-

(EOT) [INO] [CCC]

It can be seen from Section 6.4.1 that this sequence of characters is identical to the first 3 characters of the Enquiry Polling Sequence, thus:-

i) (EOT)

This Control character resets all the instruments from text mode to control mode so that they examine the next character to see if it corresponds with their own Group - Unit address identifier.

ii) [INO]

This Data character is the Instrument Number constructed as described in Section 6.1.3 a) (i).

iii) [CCC]

This Data character is the Connection Check Control character which is the exclusive OR function of the Data character transmitted previously (i.e. the [INO] character repeated).

Figure 6.4 shows that the Initial Entry point of the Selection Sequence starts off with the Supervisor Station transmitting an EOT character to reset all the Tributary Stations. However, the Selection Sequence may be Re-Entered after the EOT character as shown provided that an EOT character has been transmitted within a previous Termination Procedure such as 6.2.3 or 6.3.3.

6.5.2 Message Transfer Procedure

After the Supervisor Station has transmitted the 3 character message of the Establish Connection Procedure, it retains Master Status and enters the Message Transfer Procedure directly. It can be seen from Fig 6.4 that the Message Transfer Procedure itself can be divided up into 2 Phases according to which device is acting as the sending Station. These 2 Phases are considered as follows:-

A) Phase A - Supervisor Sender

Fig 6.4 shows that upon initial entry to the Message Transfer procedure the Supervisor Station transmits the new parameter value by means of the following 7 character message:-

(STX) [PNO] [D1] [D2] [D3] (ETX) [BCC]

It can be seen from Section 6.2.2 A) c) that this message is identical to that transmitted by the instrument in response to a Single Parameter Poll. The exact significance of each character is as follows:-

i) (STX)

The STX Control character identifies the message as being part of a Selection Sequence and informs the selected instrument that it has Slave Status.

ii) Data Block - [PNO] [D1] [D2] [D3]

The new data for the parameter to be updated is contained in this 4 character Data Block. The first character, [PNO] is the Parameter Number which indicates the Command Parameter to be updated as discussed in Section 6.1.3 a) (ii). The next 3 data characters contain the new value of the parameter coded as discussed in Section 6.13 c) (ii).

iii) (ETX)

The ETX Control character terminates the transmission of the textual part of the message.

iv) [BCC]

This Block Check Control character is transmitted by the Supervisor Station at the end of its message to be used by the Instrument for data verification purposes. The [BCC] value is computed from the 5 characters transmitted previously i.e. excluding (STX) but including (ETX), according to the method given in Section 6.1.3 b) (ii).

B) Phase B - System 6000 Instrument Sender

After the Supervisor Station has transmitted the 7 character message in Phase A of the Message Transfer Procedure, the protocol enters Phase B where the instrument becomes the sender. Figure 6.4 shows that there are 3 possible replies the instrument can make at this stage:-

a) Positive Acknowledgement - (ACK)

When the instrument identified by the [INO] address parameter of the Establish Connection Procedure has received the message transmitted by the Supervisor Station during Phase A of the Message Transfer Procedure, it performs 3 tasks:-

1. Verifies that the BCC character corresponds to the data pattern actually received. If so then it:-

2. Verifies that the Parameter Number, [PNO], corresponds with a valid Command Parameter as listed in Appendix A. If so then it:-

3. Verifies that the data specified by the [D1], [D2], and [D3] characters contain valid data. If so then it:-

4. Updates the selected parameter with the new value contained in the data field of the message.

Only when all of these tasks have been successfully completed does the instrument send the ACK response back to the Supervisor Station. This signifies that the message was correctly received, verified, and the parameter updated by the instrument. Upon receipt of the ACK the Supervisor Station may enter the Termination Procedure of Section 6.5.3 or may remain in the Message Transfer Procedure. If the Supervisor Station stays in the Message Transfer Procedure it may send another 7 character message to the same instrument without having to re-establish the logical connection. This is known as a "Fast Select" sequence and saves time when the Supervisor Station wishes to continuously update parameters in the same instrument because it is not necessary to enter the Establish Connection Procedure before each Selection.

b) Negative Acknowledgement - (NAK)

The instrument selected by the Establish Connection Procedure may detect an error in the message transmitted by Supervisor Station during Phase A of the Message Transfer Procedure. An error may occur for one or more of the following reasons:-

1. The command parameter defined by the [PNO] character may not correspond with a valid command parameter as discussed in Section 3.7.2.

2. The command parameter specified by the [PNO] character may be a monitor-only parameter as discussed in Section 3.7.5.

3. The data field specified by the [D1], [D2] and [D3] characters may be invalid or out of range as discussed in Section 3.7.6.

4. The BCC character may not correspond with the data actually received by the instrument due to line noise etc.

5. The COMPUTER ENABLE logic input, pin 28, is at 0V so disabling the Supervisor Station from updating parameters. (Single channel instruments only)

If any of these conditions are detected by the instrument once the STX has been received, it sends back a NAK response to the Supervisor Station provided an ETX is found. This signifies to the Supervisor Station that the message received by the instrument contained an error. Upon receipt of the NAK the Supervisor Station may enter the Termination Procedure of Section 6.5.3, or may remain in the Message Transfer Procedure and re-transmit the message by means of the "Fast Select" sequence. If the Supervisor Station stays in the Message Transfer Procedure it may re-send the 7 character message to the same instrument without having to re-establish the logical connection. The use of this "Fast Select" sequence saves time when the Supervisor wishes to transmit re-tries on a message after an instrument has found an error because it is not necessary to enter the Establish Connection Procedure before each re-try.

It can be seen from Fig. 6.4 that on "Fast Selection" after an ACK or NAK reply the instrument will ignore all transmitted characters except STX or EOT. i.e. at the point marked * the instrument ignores all characters on the data link other than those shown along the 2 specific paths.

c) No Response

Under certain circumstances the Supervisor Station may not receive any message at all in response to a Selection Sequence. This can be due to any of the following reasons:-

1. Instrument Number [INO] not recognised.

2. An error (e.g parity) is found in any of the characters up to and including the STX.

3. Selected instrument has an 8260 Hand-Held terminal connected so disabling its RS422 bus.

4. Selected instrument has wrong baud rate set on switches 2, 3 and 4 of switch bank S1 (see Section 4.1.3 (a)).

5. Noise on the communications link or link failure.

6. Hardware failure in the selected instrument.

In these cases the Supervisor Station will either find the reply invalid or "timed-out" and so it will enter the Termination Procedure of Section 6.5.3.

6.5.3 Termination Procedure

The Termination Procedure of the protocol is entered whenever the Supervisor Station wishes to stop selecting a particular instrument and establish a new logical connection, or when order has to be re-established on the data link after an aborted transfer. These 2 cases are considered as follows:-

a) Break Logical Connection

Figure 6.4 shows that after the instrument has transmitted an ACK or NAK response in Phase B of the Message Transfer Procedure, then the Supervisor Station may enter the Termination Procedure. The Supervisor Station retains Master Status and transmits an EOT character to reset all Tributary Stations back to looking for their own [INO] address parameter. After transmitting the EOT the Supervisor Station may Select a different instrument, perform a Polling Sequence via Re-Entry points, or wait.

b) Re-Establish the Link

Figure 6.4 also shows that if the instrument does not respond at all to the Selection Sequence the Supervisor Station also enters the Termination Procedure. It retains Master Status, transmits an EOT character and may then re-Select or Poll via Re-Entry points or wait.

APPENDIX A

SYSTEM 6000 INSTRUMENT COMMAND PARAMETER TABLES (ASCII AND BINARY)

APPENDIX A.1 6350 Parameter Tables

Software part No. RD 069525 issue 5, release 3

Table A.1.1 lists the 2 character command parameters of the 6350 Process Controller used when accessing data via the 8260 Hand-held Terminal or the ASCII mode of the serial link protocol (see Section 5). Table A.1.2 lists the corresponding Parameter Numbers used with the Binary mode of the protocol (see Section 6).

The table below shows the modification history of the 6350 software with respect to changes in these parameter tables:-

SOFTWARE ISSUE	SOFTWARE RELEASE	MEMORY BOARD	REMARKS
4	1	MK 2	ASCII protocol only
4	2	MK 3	ASCII protocol only
5	1,2,3	MK 3	Binary protocol supported

NOTES

The following points should be noted with regards to tables A.1.1 and A.1.2:-

TABLE A.1.1

(1) These parameters only appear in the list in the RATIO mode, i.e. S2 no 1 is ON.

(2) The MP parameter only appears in the list when S2 no 2 is ON.

TABLE A.1.2

(*) Only those parameters marked (*) are available with Enquiry Polling.

CMD MNE-MONIC	COMMAND PARAMETER FUNCTION	UNITS	FORMAT	DP CHAR POSN	PARAMETER TYPE
DP	Decimal point position	-	5	-	Status words
IC	Input channel processing and push-button disable	-	5	-	
1H	Process Variable high range	Eng	1	A	CH1 Input channel ranging
1L	Process Variable low range	Eng	1	A	
2H(1)	Ratio PV high range	Eng	1	B	CH2
2L(1)	Ratio PV low range	Eng	1	B	
3H	Trim/Meas. Power high range	Eng	1	C	CH3
3L	Trim/Meas. Power low range	Eng	1	C	
HR(1)	Ratio Setpoint high limit	-	1	D	Limit and Alarm settings
LR(1)	Ratio Setpoint low limit	-	1	D	
HS	Setpoint high limit	Eng	1	A	
LS	Setpoint low limit	Eng	1	A	
HA	High Deviation Alarm limit	Eng	2	A	
LA	Low Deviation Alarm limit	Eng	2	A	
HO	3-Term Output high limit	%	3	-	
LO	3-Term Output low limit	%	3	-	
EL	Error limit	%	3	-	3-Term Algorithm related parameters
IF	Input channel filter const.	sec	3	-	
XP	Proportional band constant	%	4	-	
TI	Integral time constant	min/s	3	-	
TD	Derivative time constant	min/s	3	-	
SL	Local Setpoint	Eng	1	A	Setpoint related parameters
RS(1)	Ratio Setpoint	-	1	D	
RB(1)	Ratio Bias	Eng	1	A	
MP(2)	Measured (remote) Power	Eng	1	C	Monitor-only parameters
OP	3-Term Output level	%	3	-	
SP	Resultant internal Setpoint	Eng	1	A	
PV	Process Variable	Eng	1	A	
ER	Error value	Eng	1	A	
TS	Algorithm sampling period	min/s	3	-	
SW	Switch bank S1/S2 settings	-	5	-	Status words
DS	Digital Input/Output states	-	5	-	
MD	Controller Operating Mode	-	5	-	

TABLE A.1.1 List of 6350 parameter functions and their respective mnemonics

	0	1	2	3	4	5	6	7
0	II	DP	(*) 1H	(*) 1L	(*) HA	(*) LA	(*) MN	(*) SP
8	(*) PV	(*) OP			HS	LS	HO	LO
16	HR	LR	SL	EL	XP	TI	TD	2H
24	2L	3H	3L	MP	RS	RB	IC	SW
32	DS	IF	TS	ER	MD			

TABLE A.1.2 List of 6350 Parameter Numbers, [PNO]s, and their respective mnemonics

APPENDIX A.2 6351 Parameter Tables

Software part No. RD 069526 issue 4, release 1

Table A.2.1 lists the 2 character command parameters of the 6351 Incremental Controller used when accessing data via the 8260 Hand-held Terminal or the ASCII mode of the serial link protocol (see Section 5). Table A.2.2 lists the corresponding Parameter Numbers used with the Binary mode of the protocol (see Section 6).

The table below shows the modification history of the 6351 software with respect to changes in these parameter tables:-

SOFTWARE ISSUE	SOFTWARE RELEASE	MEMORY BOARD	REMARKS
1	1	MK 1	ASCII protocol only
1	2	MK 3	ASCII protocol only
1	3	MK 2	ASCII protocol only
3	1,2	MK 3	ASCII protocol only
4	1	MK 3	Binary protocol supported

NOTES

The following points should be noted with regards to tables A.2.1 and A.2.2:-

TABLE A.2.1

(1) These parameters only appear in the list in the RATIO mode, i.e. S2 no 1 is ON.

(2) The MP parameter only appears in the list when S2 no 2 is ON.

TABLE A.2.2

(*) Only those parameters marked (*) are available with Enquiry Polling.

CMD MNE-MONIC	COMMAND PARAMETER FUNCTION	UNITS	FORMAT	DP CHAR POSN	PARAMETER TYPE
DP	Decimal point position	-	5	-	Status words
IC	Input channel processing and push-button disable	-	5	-	
1H	Process Variable high range	Eng	1	A	CH1 Input channel ranging
1L	Process Variable low range	Eng	1	A	
2H(1)	Ratio PV high range	Eng	1	B	CH2
2L(1)	Ratio PV low range	Eng	1	B	
3H	Trim/Meas. Power high range	Eng	1	C	CH3
3L	Trim/Meas. Power low range	Eng	1	C	
HR(1)	Ratio Setpoint high limit	-	1	D	Limit and Alarm settings
LR(1)	Ratio Setpoint low limit	-	1	D	
HS	Setpoint high limit	Eng	1	A	
LS	Setpoint low limit	Eng	1	A	
HA	High Deviation Alarm limit	Eng	2	A	
LA	Low Deviation Alarm limit	Eng	2	A	
IF	Input channel filter const.	sec	3	-	3-Term Algorithm related parameters
TT	Control element travel time	sec	4	-	
TP	Algorithm update period	sec	3	-	
TM	Minimum response time	sec	3	-	
XP	Proportional band constant	%	4	-	
TI	Integral time constant	min/s	3	-	
TD	Derivative time constant	min/s	3	-	
SL	Local Setpoint	Eng	1	A	Setpoint related parameters
RS(1)	Ratio Setpoint	-	1	D	
RB(1)	Ratio Bias	Eng	1	A	
MP(2)	Measured (remote) Power	Eng	1	C	Monitor-only parameters
OP	3-Term Output level	%	14	-	
SP	Resultant internal Setpoint	Eng	1	A	
PV	Process Variable	Eng	1	A	
ER	Error value	Eng	1	A	
TS	Algorithm sampling period	min/s	3	-	
SW	Switch bank S1/S2 settings	-	5	-	Status words
DS	Digital Input/Output states	-	5	-	
MD	Controller Operating Mode	-	5	-	

TABLE A.2.1 List of 6351 parameter functions and their respective mnemonics

	0	1	2	3	4	5	6	7
0	II	DP	(*) 1H	(*) 1L	(*) HA	(*) LA	(*) MN	(*) SP
8	(*) PV	(*) OP			HS	LS		
16	HR	LR	SL		XP	TI	TD	2H
24	2L	3H	3L	MP	RS	RB	IC	SW
32	DS	IF	TS	ER	MD	TT	TP	TM

TABLE A.2.2 List of 6351 Parameter Numbers, [PNO]s, and their respective mnemonics

APPENDIX A.3 6352 Parameter Tables

Software part No. RD 069622 issue 3, release 1

Table A.3.1 lists the 2 character command parameters of the 6352 Bushing/Averaging Controller used when accessing data via the 8260 Hand-held Terminal or the ASCII mode of the serial link protocol (see Section 5). Table A.3.2 lists the corresponding Parameter Numbers used with the Binary mode of the protocol (see Section 6).

The table below shows the modification history of the 6352 software with respect to changes in these parameter tables:-

SOFTWARE ISSUE	SOFTWARE RELEASE	MEMORY BOARD	REMARKS
1	1	MK 1	ASCII protocol only
1	2	MK 1	HO parameter added
1	3,4	MK 3	ASCII protocol only
2	1	MK 3	DL parameter added
2	2	MK 3	ASCII protocol only
3	1	MK 3	Binary protocol supported

NOTES

The following points should be noted with regards to tables A.3.1 and A.3.2:-

TABLE A.3.1

(1) The MP parameter only appears in the list when S2 no 2 is ON.

TABLE A.3.2

(*) Only those parameters marked (*) are available with Enquiry Polling.

CMD MNE-MONIC	COMMAND PARAMETER FUNCTION	UNITS	FORMAT	DP CHAR POSN	PARAMETER TYPE
II	Instrument identity	-	5	-	Status words
DP	Decimal point position	-	5	-	
IC	Input channel processing and push-button disable	-	5	-	
1H	Prime Variable high range	Eng	1	A	CH1 Input channel ranging
1L	Prime Variable low range	Eng	1	A	
2H	Secondary Var. high range	Eng	1	B	CH2
2L	Secondary Var. low range	Eng	1	B	
3H	Trim/Meas. Power high range	Eng	1	C	CH3
3L	Trim/Meas. power low range	Eng	1	C	
HS	Setpoint high limit	Eng	1	A	Limit and Alarm settings
LS	Setpoint low limit	Eng	1	A	
HA	High Deviation Alarm limit	Eng	2	A	
LA	Low Deviation Alarm limit	Eng	2	A	
1P	3-Term Output limit (CV ⩽ 15% span)	%	3	-	
2P	3-Term Output limit (15 < CV ⩽ 30% span)	%	3	-	
3P	3-Term Output limit (30 < CV ⩽ 50% span)	%	3	-	
4P	3-Term Output limit (50 < CV ⩽ 75% span)	%	3	-	
HO	3-Term Output high limit	%	3	-	
LO	3-Term Output low limit	%	3	-	
DL	Difference limit	Eng	1	A	

TABLE A.3.1 List of 6352 parameter functions and their respective mnemonics

CMD MNE-MONIC	COMMAND PARAMETER FUNCTION	UNITS	FORMAT	DP CHAR POSN	PARAMETER TYPE
IF	Input channel filter const.	sec	3	-	3-Term
XP	Proportional band constant	%	4	-	Algorithm
TI	Integral time constant	min/s	3	-	related
TD	Derivative time constant	min/s	3	-	parameters
RR	Ramp rate				Spt. related
SD	Setpoint depression	Eng	1	A	parameters
PV	Primary process variable	Eng	1	A	
SV	Secondary process variable	Eng	1	A	Monitor-
CV	Control process variable	Eng	1	A	only
MP(1)	Measured (remote) Power	Eng	1	C	parameters
OP	3-Term Output level	%	3	-	
SL	Local Setpoint	Eng	1	A	(Read/write)
SP	Resultant internal Setpoint	Eng	1	A	
MD	Controller Operating Mode	-	5	-	
DS	Digital Input/Output states	-	5	-	Status
SW	Switch bank S1/S2 settings	-	5	-	words
ER	Error value	Eng	1	A	Monitor-
TS	Algorithm sampling period	min/s	3	-	only

TABLE A.3.1 (contd.) List of 6352 parameter functions and their respective mnemonics

	0	1	2	3	4	5	6	7
0	II	DP	(*) 1H	(*) 1L	(*) HA	(*) LA	(*) MN	(*) SP
8	(*) CV	(*) OP			HS	LS	HO	LO
16			SL		XP	TI	TD	2H
24	2L	3H	3L	MP			IC	SW
32	DS	IF	TS	ER	MD	PV	SV	DL
40	RR	SD	1P	2P	3P	4P		

TABLE A.3.2 List of 6352 Parameter Numbers, [PNO]s, and their respective mnemonics

APPENDIX A.4 6353 Parameter Tables

Software part No. RD 069706 issue 2, release 1

Table A.4.1 lists the 2 character command parameters of the 6353 Flow Controller used when accessing data via the 8260 Hand-held Terminal or the ASCII mode of the serial link protocol (see Section 5). Table A.4.2 lists the corresponding Parameter Numbers used with the Binary mode of the protocol (see Section 6).

The table below shows the modification history of the 6353 software with respect to changes in these parameter tables:-

SOFTWARE ISSUE	SOFTWARE RELEASE	MEMORY BOARD	REMARKS
1	1,2	MK 3	ASCII protocol only
2	1	MK 3	Binary protocol supported; PD/FL parameters replaced by 1V; PA and TA parameters added.

NOTES

The following points should be noted with regards to table A.4.2:-

TABLE A.4.2

(*) Only those parameters marked (*) are available with Enquiry Polling.

CMD MNE-MONIC	COMMAND PARAMETER FUNCTION	UNITS	FORMAT	DP CHAR POSN	PARAMETER TYPE
II	Instrument identity	-	5	-	Status words
DP	Decimal point position	-	5	-	
IC	Input channel processing and push-button disable	-	5	-	
1H	Process Var. Hi range (flow)	Eng	1	A	CH1 Input channel ranging
1L	Process Var. Lo range (flow)	Eng	1	A	
2H	Process Var. Hi range (temp)	Eng	1	B	CH2
2L	Process Var. Lo range (temp)	Eng	1	B	
3H	Process Var. Hi range (pres)	Eng	1	C	CH3
3L	Process Var. Lo range (pres)	Eng	1	C	
SH	Setpoint high range	Eng	1	D	
SL	Setpoint low range	Eng	1	D	
SI	Setpoint increment	%	3	-	
1V	Primary Variable (read-only)	Eng	1	A	
TF	Temperature (read-only)	Eng	1	B	
PF	Pressure/Density (read-only)	Eng	1	C	
HS	Setpoint high limit	Eng	1	D	Limit and Alarm settings
LS	Setpoint low limit	Eng	1	D	
HA	High Deviation Alarm limit	Eng	2	D	
LA	Low Deviation Alarm limit	Eng	2	D	
HO	3-Term Output high limit	%	3	-	
LO	3-Term Output low limit	%	3	-	

TABLE A.4.1 List of 6353 parameter functions and their respective mnemonics

CMD MNE-MONIC	COMMAND PARAMETER FUNCTION	UNITS	FORMAT	DP CHAR POSN	PARAMETER TYPE
1K	Scaling factor	-	15	-	
2K	Scaling factor	-	14	-	
SG	Specific gravity (rel. dens)	-	13	-	
PA	Offset to absolute pressure	Eng	13	-	Input
PO	Reference pressure	Eng	13	-	
XO	Base compressibility	-	12	-	
3K	compressibility constants	-	15	-	computation
4K		-	14	-	
5K		-	13	-	
6K		-	15	-	functions
7K		-	14	-	
8K		-	13	-	
TA	Offset to abs. temperature	Eng	15	-	
TO	Reference temperature	Eng	15	-	
EL	Error limit	%	3	-	
IF	Input channel filter const.	sec	3	-	3-Term
XP	Proportional band constant	%	4	-	Algorithm
TI	Integral time constant	min/s	3	-	related
TD	Derivative time constant	min/s	3	-	parameters
SP	Local Setpoint	Eng	1	D	Setpoint
FS	Flow total scaling factor	-	4	-	4 digit
FT	Flow total (computed)	Eng	10	-	Totaliser
OP	3-Term Output level	%	3	-	
PV	Primary Process Variable	Eng	1	A	Monitor-
ER	Error value	Eng	1	A	only
TS	Algorithm sampling period	min/s	3	-	parameters
SW	Switch bank S1/S2 settings	-	5	-	
DS	Digital Input/Output states	-	5	-	Status
MD	Controller Operating Mode	-	5	-	words

TABLE A.4.1 (contd.) List of 6353 parameter functions and their respective mnemonics

	0	1	2	3	4	5	6	7
0	II	DP	(*) SH	(*) SL	(*) HA	(*) LA	(*) MN	(*) SP
8	(*) PV	(*) OP			HS	LS	HO	LO
16				EL	XP	TI	TD	2H
24	2L	3H	3L				IC	SW
32	DS	IF	TS	ER	MD	1H	1L	1V
40	TF	TA	TO	PF	PA	PO	FS	FT
48	SI	1K	2K	SG	XO	3K	4K	5K
56	6K	7K	8K					

TABLE A.4.2 List of 6353 Parameter Numbers, [PNO]s, and their respective mnemonics

APPENDIX A.5 6358 Parameter Tables

Software part No. RD 069542 issue 2, release 4

Table A.5.1 lists the 2 character Instrument command parameters of the 6358 8 Loop Controller used when accessing data via the 8260 Hand-held Terminal or the ASCII mode of the serial link protocol (see Section 5). Table A.5.2 lists the similarly accessed Loop command parameters, while Table A.5.3 gives the corresponding Parameter Numbers used with the Binary mode of the protocol (see Section 6).

The table below shows the modification history of the 6358 software with respect to changes in these parameter tables:-

SOFTWARE ISSUE	SOFTWARE RELEASE	MEMORY BOARD	REMARKS
1	1,2	MK 3	ASCII protocol only
2	1	MK 3	Binary protocol supported; LI parameter added.
2	2,3,4	MK 3	Binary protocol supported

NOTES

The following points should be noted with regards to tables A.5.2 and A.5.3:-

TABLE A.5.2

(1) LN does not appear in the parameter list when accessing parameters via the serial data link. Loops are individually addressed via the link with their own address identifier (see Section 4.4.2 b)).

(2) The 1T and 2T Loop Tag characters do not appear when the parameter list is scrolled via the W↓ command on the 8260 Hand-held Terminal. Instead, they must be accessed individually by first using the ?? CMD prompt once the required Loop number (LN) has been selected previously.

TABLE A.5.3

(*) Only those parameters marked (*) are available with Enquiry Polling.

(3) Loop Tag Characters

As stated in Section 6.1.3 c) (ii), ASCII characters are sent as two 8 bit pairs with the Binary mode of the protocol.

e.g. Loop Tag - ABCDEFGH

Hence:-

T1 = AB; T2 = CD;

T3 = EF; T4 = GH;

With the ASCII mode of the protocol, however:-

1T = ABCD

2T = EFGH

Thus:-

1T = T1 + T2

and

2T = T3 + T4

COMMAND MNEMONIC	COMMAND PARAMETER FUNCTION	UNITS	FORMAT	PARAMETER TYPE
II	Instrument Identity	-	5	Monitor-only
S1	Slot 1 board type and status indication with active loop selection 1-8	-	5	Input/ Output Board Status
S2	Slot 2 board type and status indication	-	5	
S3	Slot 3 board type and status indication	-	5	
S4	Slot 4 board type and status indication	-	5	
LT	Loop type selection:- Setpoint Trim/Remote Setpt. and Process Variable 0-10V/ 1-5V input selection	-	5	Loop type
LI	Loop Inverted Output select	-	5	
AC	Current HI and LO Alarm indications	-	5	Alarms
AH	Historic change of state indication of HI/LO alarms	-	5	
SW	Switch bank S1/S2 settings	-	5	Status words
MD	Front panel and diagnostic status indications	-	5	

TABLE A.5.1 List of 6358 Instrument Command Parameters and their respective mnemonics

COMMAND MNEMONIC	COMMAND PARAMETER FUNCTION	UNITS	FORMAT	PARAMETER TYPE
LN(1)	Loop number	-	7	Status words
ST	Loop status:- Decimal Point /Input Conditioning/Input Filter/Operating Mode	-	5	
1H	Process Variable high range	Eng	1	CH1 Input channel ranging
1L	Process Variable low range	Eng	1	
2H	Setpoint Trim high range	Eng	1	CH2 ranging
2L	Setpoint Trim low range	Eng	1	
HS	Setpoint high limit	Eng	1	Limit and Alarm Settings Parameters
LS	Setpoint low limit	Eng	1	
DA	Deviation Alarm limit	Eng	2	
DD	Deviation Display setting	Eng	2	
HO	3-Term Output high limit	%	3	
LO	3-Term Output low limit	%	3	
XP	Proportional band constant	%	4	3-Term Algorithm related parameters
TI	Integral time constant	mins	3	
TD	Derivative time constant	mins	3	
SL	Local Setpoint	Eng	1	
OP	3-Term Output level	%	3	Monitor-only parameters
SP	Resultant internal Setpoint	Eng	1	
PV	Process Variable input	Eng	1	
1T(2)	Loop Tag characters 1 to 4	ASCII	8	Loop Tag names
2T(2)	Loop Tag characters 5 to 8	ASCII	8	

TABLE A.5.2 List of 6358 Loop Command Parameters and their respective mnemonics

	0	1	2	3	4	5	6	7
0	II	ST	(*) 1H	(*) 1L	(*) DA	DD	(*) MN	(*) SP
8	(*) PV	(*) OP			HS	LS	HO	LO
16			SL		XP	TI	TD	2H
24	2L	(3) T1	(3) T2	(3) T3	(3) T4	LT	LI	SW
32	S1	S2	S3	S4	MD	AC	AH	

TABLE A.5.3 List of 6358 Parameter Numbers, [PNO]s, and their respective mnemonics

APPENDIX A.6 6360 Parameter Tables

Software part No. RD 075228 issue 1, release 1

Table A.6.1 lists the 2 character command parameters of the 6360 Process Controller used when accessing data via the 8260 Hand-held Terminal or the ASCII mode of the serial link protocol (see Section 5). Table A.6.2 lists the corresponding Parameter Numbers used with the Binary mode of the protocol (see Section 6).

The table below shows the modification history of the 6360 software with respect to changes in these parameter tables:-

SOFTWARE ISSUE	SOFTWARE RELEASE	MEMORY BOARD	REMARKS
1	1	MK 3	ASCII and Binary modes of the protocol both supported

NOTES

The following points should be noted with regards to tables A.6.1 and A.6.2:-

Table A.6.1

(1) These parameters only appear in the list in the RATIO mode, i.e. S2 no 1 is ON.

(2) The MP parameter only appears in the list when S2 no 2 is ON.

TABLE A.6.2

(*) Only those parameters marked (*) are available with Enquiry Polling.

CMD MNE-MONIC	COMMAND PARAMETER FUNCTION	UNITS	FORMAT	DP CHAR POSN	PARAMETER TYPE
II	Instrument identity	-	5	-	Status words
DP	Decimal point position	-	5	-	
IC	Input channel processing and push-button disable	-	5	-	
1H	Process Variable high range	Eng	1	A	CH1 Input channel ranging
1L	Process Variable low range	Eng	1	A	
2H(1)	Ratio PV high range	Eng	1	B	CH2
2L(1)	Ratio PV low range	Eng	1	B	
3H	Trim/Meas. Power high range	Eng	1	C	CH3
3L	Trim/Meas. power low range	Eng	1	C	
HR(1)	Ratio Setpoint high limit	-	1	D	Limit and Alarm settings
LR(1)	Ratio Setpoint low limit	-	1	D	
HS	Setpoint high limit	Eng	1	A	
LS	Setpoint low limit	Eng	1	A	
HA	High Absolute Alarm limit	Eng	1	A	
LA	Low Absolute Alarm limit	Eng	1	A	
HD	High Deviation Alarm limit	Eng	2	A	
LD	Low Deviation Alarm limit	Eng	2	A	
HO	3-Term Output high limit	%	3	-	
LO	3-Term Output low limit	%	3	-	
EL	Error limit	%	3	-	3-Term Algorithm related parameters
IF	Input channel filter const.	sec	3	-	
XP	Proportional band constant	%	4	-	
TI	Integral time constant	min/s	3	-	
TD	Derivative time constant	min/s	3	-	
SL	Local Setpoint	Eng	1	A	Setpoint related parameters
RS(1)	Ratio Setpoint	-	1	D	
RB(1)	Ratio Bias	Eng	1	A	
MP(2)	Measured (remote) Power	Eng	1	C	Monitor-only parameters
OP	3-Term Output level	%	3	-	
SP	Resultant internal Setpoint	Eng	1	A	
PV	Process Variable	Eng	1	A	
ER	Error value	Eng	1	A	
TS	Algorithm sampling period	min/s	3	-	
SW	Switch bank S1/S2 settings	-	5	-	Status words
DS	Digital Input/Output states	-	5	-	
MD	Controller Operating Mode	-	5	-	

TABLE A.6.1 List of 6360 parameter functions and their respective mnemonics

	0	1	2	3	4	5	6	7
0	II	DP	(*) 1H	(*) 1L	(*) HD	(*) LD	(*) MN	(*) SP
8	(*) PV	(*) OP	(*) HA	(*) LA	HS	LS	HO	LO
16	HR	LR	SL	EL	XP	TI	TD	2H
24	2L	3H	3L	MP	RS	RB	IC	SW
32	DS	IF	TS	ER	MD			

TABLE A.6.2 List of 6360 Parameter Numbers, [PNO]s, and their respective mnemonics

APPENDIX A.7 6432 Parameter Tables

Software part No. RD 069527 issue 3, release 1

Table A.7.1 lists the 2 character Instrument command parameters of the 6432 Signal Processor used when accessing data via the 8260 Hand-held Terminal or the ASCII mode of the serial link protocol (see Section 5). Table A.7.2 lists the similarly accessed Channel command parameters for the 4 different types of Input/Output Blocks. Tables A.7.3 a) to d) inclusive give the corresponding Parameter Numbers for the 4 types of Blocks used with the Binary mode of the protocol (see Section 6).

The table below shows the modification history of the 6432 software with respect to changes in these parameter tables:-

SOFTWARE ISSUE	SOFTWARE RELEASE	MEMORY BOARD	REMARKS
1	1	MK 3	ASCII protocol only
2	1	MK 4	Binary protocol supported; Channel Tag characters 1T, 2T introduced.
3	1	MK 4	DS parameter for digital output block includes mask bits.

NOTES

The following points should be noted with regards to tables A.7.2 and A.7.3 a) to d) inclusive:-

TABLE A.7.2

(1) CN does not appear in the parameter list when accessing parameters via the serial data link. Channels are individualy addressed via the link as described in Section 5.1.1 for the ASCII mode, and Section 6.1.3 a) (ii) for the Binary mode of the protocol.

(2) The 1T and 2T Channel Tag characters do not appear when the parameter list is scrolled via the (W↓) command of the 8260 Hand-held Terminal. Instead, they must be accessed individually by first using the ?? CMD prompt once the required Block and Channel number (CN) has been selected previously.

TABLE A.7.3a) to d)

(*) Only those parameters marked (*) are available with Enquiry Polling.

(3) Channel Tag Characters

As described in Appendix A.5 it should be noted that for each Channel:-

$$1T = T1 + T2$$

and

$$2T = T3 + T4$$

Instrument Parameters

It can be seen from tables A.7.3 a) to d) inclusive that all the instrument parameters can be accessed from each type of Input/Output Block.

COMMAND MNEMONIC	COMMAND PARAMETER FUNCTION	UNITS	FORMAT	PARAMETER TYPE
II	Instrument Identity	-	5	Monitor-only
S1	Channel scan and board type	-	5	Input/Output block 1
A1	Historic alarms	-	5	
S2	Channel scan and board type	-	5	Input/Output block 2
A2	Historic alarms	-	5	
S3	Channel scan and board type	-	5	Input/Output block 3
A3	Historic alarms	-	5	
S4	Channel scan and board type	-	5	Input/Output block 4
A4	Historic alarms	-	5	
SW	Switch bank S1/S2 settings	-	5	Status words
MD	Front panel and diagnostic status indications	-	5	

TABLE A.7.1 List of 6432 Instrument Command Parameters and their respective mnemonics

COMMAND MNEMONIC	COMMAND PARAMETER FUNCTION	UNITS	FORMAT	PARAMETER TYPE
CN(1)	Block/Channel number	-	6	Analogue Input channels
ST	Channel status	-	5	
HR	Prime Variable high range	Eng	1	
LR	Prime Variable low range	Eng	1	
HA	High alarm (absolute)	Eng	1	
LA	Low alarm (absolute)	Eng	1	
AR	Alarm routing	-	5	
PV	Prime Variable value	Eng	1	
1T(2)	Channel Tag characters 1-4	ASCII	8	Channel Tag names
2T(2)	Channel Tag characters 5-8	ASCII	8	

CN(1)	Block/Channel number	-	6	Analogue Output channels
ST	Channel status	-	5	
HR	Prime Variable high range	Eng	1	
LR	Prime Variable low range	Eng	1	
HO	High output limit	Eng	1	
LO	Low output limit	Eng	1	
OP	Prime Variable value	Eng	1	
1T(2)	Channel Tag characters 1-4	ASCII	8	Channel Tag names
2T(2)	Channel Tag characters 5-8	ASCII	8	

CN(1)	Block/Channel number	-	6	Digital Input channels
ST	Block status	-	5	
AM	Alarm masking bits	-	5	
DS	Digital Input states	-	5	
1T(2)	Channel Tag characters 1-4	ASCII	8	Channel Tag names
2T(2)	Channel Tag characters 5-8	ASCII	8	

CN(1)	Block/Channel number	-	6	Digital Output channels
ST	Block status	-	5	
AM	Alarm masking bits	-	5	
DS	Digital Output states and enable bits	-	5	
1T(2)	Channel Tag characters 1-4	ASCII	8	Channel Tag names
2T(2)	Channel Tag characters 5-8	ASCII	8	

TABLE A.7.2 List of 6432 Channel Command Parameters and their respective mnemonics

		0	1	2	3	4	5	6	7
	0	II	S1	A1	S2	A2	S3	A3	S4
	8	A4	SW	MD					
CHAN 1	16	(*) ST	(*) HR	(*) LR	(*) HA	(*) LA	(*) PV	(*) AR	
CHAN 2	24	(*) ST	(*) HR	(*) LR	(*) HA	(*) LA	(*) PV	(*) AR	
CHAN 3	32	(*) ST	(*) HR	(*) LR	(*) HA	(*) LA	(*) PV	(*) AR	
CHAN 4	40	(*) ST	(*) HR	(*) LR	(*) HA	(*) LA	(*) PV	(*) AR	
CHAN 5	48	(*) ST	(*) HR	(*) LR	(*) HA	(*) LA	(*) PV	(*) AR	
CHAN 6	56	(*) ST	(*) HR	(*) LR	(*) HA	(*) LA	(*) PV	(*) AR	
CHAN 7	64	(*) ST	(*) HR	(*) LR	(*) HA	(*) LA	(*) PV	(*) AR	
CHAN 8	72	(*) ST	(*) HR	(*) LR	(*) HA	(*) LA	(*) PV	(*) AR	
CHAN 1-2	80	(3) T1	(3) T2	(3) T3	(3) T4	T1	T2	T3	T4
CHAN 3-4	88	T1	T2	T3	T4	T1	T2	T3	T4
CHAN 5-6	96	T1	T2	T3	T4	T1	T2	T3	T4
CHAN 7-8	104	T1	T2	T3	T4	T1	T2	T3	T4

TABLE A.7.3 a) List of 6432 Parameter Numbers, [PNO]s, and their respective mnemonics for Analogue Input Boards

		0	1	2	3	4	5	6	7
	0	II	S1	A1	S2	A2	S3	A3	S4
	8	A4	SW	MD					
CHAN 1	16	(*) ST	(*) HR	(*) LR	(*) OP	(*) HO	(*) LO		
CHAN 2	24	(*) ST	(*) HR	(*) LR	(*) OP	(*) HO	(*) LO		
CHAN 3	32	(*) ST	(*) HR	(*) LR	(*) OP	(*) HO	(*) LO		
CHAN 4	40	(*) ST	(*) HR	(*) LR	(*) OP	(*) HO	(*) LO		
CHAN 5	48	(*) ST	(*) HR	(*) LR	(*) OP	(*) HO	(*) LO		
CHAN 6	56	(*) ST	(*) HR	(*) LR	(*) OP	(*) HO	(*) LO		
CHAN 7	64	(*) ST	(*) HR	(*) LR	(*) OP	(*) HO	(*) LO		
CHAN 8	72	(*) ST	(*) HR	(*) LR	(*) OP	(*) HO	(*) LO		
CHAN 1-2	80	(3) T1	(3) T2	(3) T3	(3) T4	T1	T2	T3	T4
CHAN 3-4	88	T1	T2	T3	T4	T1	T2	T3	T4
CHAN 5-6	96	T1	T2	T3	T4	T1	T2	T3	T4
CHAN 7-8	104	T1	T2	T3	T4	T1	T2	T3	T4

TABLE A.7.3 b) List of 6432 Parameter Numbers, [PNO]s, and their respective mnemonics for Analogue Output Boards

		0	1	2	3	4	5	6	7
	0	II	S1	A1	S2	A2	S3	A3	S4
	8	A4	SW	MD					
CHAN 1-8	16	(*) ST	(*) AM	(*) DS					
	24								
	32								
	40								
	48								
	56								
	64								
	72								
CHAN 1-2	80	(3) T1	(3) T2	(3) T3	(3) T4	T1	T2	T3	T4
CHAN 3-4	88	T1	T2	T3	T4	T1	T2	T3	T4
CHAN 5-6	96	T1	T2	T3	T4	T1	T2	T3	T4
CHAN 7-8	104	T1	T2	T3	T4	T1	T2	T3	T4

TABLE A.7.3 c) List of 6432 Parameter Numbers, [PNO]s, and their respective mnemonics for Digital Input Boards

		0	1	2	3	4	5	6	7
	0	II	S1	A1	S2	A2	S3	A3	S4
	8	A4	SW	MD					
CHAN 1-8	16	(*) ST	(*) AM	(*) DS					
	24								
	32								
	40								
	48								
	56								
	64								
	72								
CHAN 1-2	80	(3) T1	(3) T2	(3) T3	(3) T4	T1	T2	T3	T4
CHAN 3-4	88	T1	T2	T3	T4	T1	T2	T3	T4
CHAN 5-6	96	T1	T2	T3	T4	T1	T2	T3	T4
CHAN 7-8	104	T1	T2	T3	T4	T1	T2	T3	T4

TABLE A.7.3 d) List of 6432 Parameter Numbers, [PNO]s, and their respective mnemonics for Digital Output Boards

APPENDIX A.8 6433 Parameter Tables

Software part No. RD 069748 issue 1, release 1

Table A.8.1 lists the 2 character Instrument command parameters of the 6433 Programmable Signal Processor used when accessing data via the 8260 Hand-held Terminal or the ASCII mode of the serial link protocol (see Section 5). The similarly accessed Channel command parameters for the 4 different types of Input/Output Blocks are the same as for the 6432 and are hence given in Table A.7.2.

Tables A.7.3 a) to d) inclusive give the corresponding Parameter Numbers for the 4 types of real Input/Output Blocks used with the Binary mode of the protocol (see Section 6). Tables A.8.2 a) to d) inclusive give the corresponding Parameter Numbers for the 4 types of pseudo-Input/Output Blocks when accessed in the same way.

The table below shows the modification history of the 6433 software with respect to changes in these parameter tables:-

SOFTWARE ISSUE	SOFTWARE RELEASE	MEMORY BOARD	REMARKS
1	1	MK 5	ASCII and Binary modes of the protocol supported.

NOTES

The following points should be noted with regards to tables A.8.2 a) to d) inclusive:-

Table A.8.2 a) to d)

(*) Only those parameters marked (*) are available with Enquiry Polling.

(1) Channel Tag Characters

As described in Appendix A.5 it should be noted that for each Channel:-

$$1T = T1 + T2$$

and

$$2T + T3 + T4$$

Instrument Parameters

a) It can be seen from Tables A.7.3 a) to d) inclusive that II, SW, MD and those Instrument parameters relating to the real Input/Output Blocks can be accessed from each of the 4 types.

b) It can be seen from Tables A.8.2 a) to d) inclusive that II, SW, MD and those Instrument parameters relating to the pseudo-Input/Output Blocks can be accessed from each of the 4 types.

COMMAND MNEMONIC	COMMAND PARAMETER FUNCTION	UNITS	FORMAT	PARAMETER TYPE
II	Instrument Identity	-	5	Monitor-only
S1	Channel scan and board type	-	5	Input/Output block 1
A1	Historic alarms	-	5	
S2	Channel scan and board type	-	5	Input/Output block 2
A2	Historic alarms	-	5	
S3	Channel scan and board type	-	5	Input/Output block 3
A3	Historic alarms	-	5	
S4	Channel scan and board type	-	5	Input/Output block 4
A4	Historic alarms	-	5	
S5	Channel scan and board type	-	5	Pseudo-Input/Output block 1
A5	Historic alarms	-	5	
S6	Channel scan and board type	-	5	Pseudo-Input/Output block 2
A6	Historic alarms	-	5	
S7	Channel scan and board type	-	5	Pseudo-Input/Output block 3
A7	Historic alarms	-	5	
S8	Channel scan and board type	-	5	Pseudo-Input/Output block 4
A8	Historic alarms	-	5	
SW	Switch bank S1/S2 settings	-	5	Status words
MD	Front panel and diagnostic status indications	-	5	

TABLE A.8.1 List of 6433 Instrument Command Parameters and their respective mnemonics

		0	1	2	3	4	5	6	7
	0	II	S5	A5	S6	A6	S7	A7	S8
	8	A8	SW	MD					
CHAN 1	16	(*) ST	(*) HR	(*) LR	(*) HA	(*) LA	(*) PV	(*) AR	
CHAN 2	24	(*) ST	(*) HR	(*) LR	(*) HA	(*) LA	(*) PV	(*) AR	
CHAN 3	32	(*) ST	(*) HR	(*) LR	(*) HA	(*) LA	(*) PV	(*) AR	
CHAN 4	40	(*) ST	(*) HR	(*) LR	(*) HA	(*) LA	(*) PV	(*) AR	
CHAN 5	48	(*) ST	(*) HR	(*) LR	(*) HA	(*) LA	(*) PV	(*) AR	
CHAN 6	56	(*) ST	(*) HR	(*) LR	(*) HA	(*) LA	(*) PV	(*) AR	
CHAN 7	64	(*) ST	(*) HR	(*) LR	(*) HA	(*) LA	(*) PV	(*) AR	
CHAN 8	72	(*) ST	(*) HR	(*) LR	(*) HA	(*) LA	(*) PV	(*) AR	
CHAN 1-2	80	(1) T1	(1) T2	(1) T3	(1) T4	T1	T2	T3	T4
CHAN 3-4	88	T1	T2	T3	T4	T1	T2	T3	T4
CHAN 5-6	96	T1	T2	T3	T4	T1	T2	T3	T4
CHAN 7-8	104	T1	T2	T3	T4	T1	T2	T3	T4

TABLE A.8.2 a) List of 6433 Parameter Numbers, [PNO]s, and their respective mnemonics for pseudo-Analogue Input Boards

		0	1	2	3	4	5	6	7
	0	II	S5	A5	S6	A6	S7	A7	S8
	8	A8	SW	MD					
CHAN 1	16	(*) ST	(*) HR	(*) LR	(*) OP	(*) HO	(*) LO		
CHAN 2	24	(*) ST	(*) HR	(*) LR	(*) OP	(*) HO	(*) LO		
CHAN 3	32	(*) ST	(*) HR	(*) LR	(*) OP	(*) HO	(*) LO		
CHAN 4	40	(*) ST	(*) HR	(*) LR	(*) OP	(*) HO	(*) LO		
CHAN 5	48	(*) ST	(*) HR	(*) LR	(*) OP	(*) HO	(*) LO		
CHAN 6	56	(*) ST	(*) HR	(*) LR	(*) OP	(*) HO	(*) LO		
CHAN 7	64	(*) ST	(*) HR	(*) LR	(*) OP	(*) HO	(*) LO		
CHAN 8	72	(*) ST	(*) HR	(*) LR	(*) OP	(*) HO	(*) LO		
CHAN 1-2	80	(1) T1	(1) T2	(1) T3	(1) T4	T1	T2	T3	T4
CHAN 3-4	88	T1	T2	T3	T4	T1	T2	T3	T4
CHAN 5-6	96	T1	T2	T3	T4	T1	T2	T3	T4
CHAN 7-8	104	T1	T2	T3	T4	T1	T2	T3	T4

TABLE A.8.2 b) List of 6433 Parameter Numbers, [PNO]s, and their respective mnemonics for pseudo-Analogue Output Boards

		0	1	2	3	4	5	6	7
	0	II	S5	A5	S6	A6	S7	A7	S8
	8	A8	SW	MD					
CHAN 1-8	16	(*) ST	(*) AM	(*) DS					
	24								
	32								
	40								
	48								
	56								
	64								
	72								
CHAN 1-2	80	(1) T1	(1) T2	(1) T3	(1) T4	T1	T2	T3	T4
CHAN 3-4	88	T1	T2	T3	T4	T1	T2	T3	T4
CHAN 5-6	96	T1	T2	T3	T4	T1	T2	T3	T4
CHAN 7-8	104	T1	T2	T3	T4	T1	T2	T3	T4

TABLE A.8.2 c) List of 6433 Parameter Numbers, [PNO]s, and their respective mnemonics for pseudo-Digital Input Boards

		0	1	2	3	4	5	6	7
	0	II	S5	A5	S6	A6	S7	A7	S8
	8	A8	SW	MD					
CHAN 1-8	16	(*) ST	(*) AM	(*) DS					
	24								
	32								
	40								
	48								
	56								
	64								
	72								
CHAN 1-2	80	(1) T1	(1) T2	(1) T3	(1) T4	T1	T2	T3	T4
CHAN 3-4	88	T1	T2	T3	T4	T1	T2	T3	T4
CHAN 5-6	96	T1	T2	T3	T4	T1	T2	T3	T4
CHAN 7-8	104	T1	T2	T3	T4	T1	T2	T3	T4

TABLE A.8.2 d) List of 6433 Parameter Numbers, [PNO]s, and their respective mnemonics for pseudo-Digital Output Boards

APPENDIX A.9 6434 Parameter Tables

Software part No. RD 069747 issue 1, release 2

Table A.9.1 lists the 2 character Instrument command parameters of the 6434 Flow Totaliser used when accessing data via the 8260 Hand-held Terminal or the ASCII mode of the serial link protocol (see Section 5). Table A.9.2 lists the similarly accessed Channel command parameters, while Table A.9.3 gives the corresponding Parameter Numbers used with the Binary mode of the protocol (see Section 6).

The table below shows the modification history of the 6434 software with respect to changes in these parameter tables:-

SOFTWARE ISSUE	SOFTWARE RELEASE	MEMORY BOARD	REMARKS
1	1,2	MK 4	ASCII and Binary modes of the protocol supported.

NOTES

The following points should be noted with regards to tables A.9.2 and A.9.3:-

TABLE A.9.2

(1) CN does not appear in the parameter list when accessing parameters via the serial data link. Channels are individually addressed via the link with their own address identifier (see Section 4.4.2. b)).

(2) To update/clear the Flow Total using the Hand-held Terminal:-

a) Write the most-significant part of the 8 digit total into parameter 1B.

b) Write the least-significant part of the 8 digit total into parameter 2B.

c) Set the write strobe bit in the ST status word to:-

X4XX - where X means re-write the original data

(3) The 1T and 2T Channel Tag characters do not appear in the parameter list when scrolled via the 8260 Hand-held Terminal (W ↓) button. Instead they must be accessed individually by first using the ?? CMD prompt once the required channel number (CN) has been selected previously.

TABLE A.9.3

(*) Only those parameters marked (*) are available with Enquiry Polling.

(4) These parameters are reserved for future use but currently read back as FT.

(5) Channel Tag characters

As described in Appendix A.5 it should be noted that for each Channel:-

1T = T1 + T2

and

2T = T3 + T4

COMMAND MNEMONIC	COMMAND PARAMETER FUNCTION	UNITS	FORMAT	PARAMETER TYPE
II	Instrument Identity	-	5	Monitor Only
S1	Slot 1 board type and status indication with active channel selection 1-8.	-	5	Input/ Output Board Status
S2	Slot 2 board type and status indication	-	5	
S3	Slot 3 board type and status indication	-	5	
S4	Slot 4 board type and status indication	-	5	
CT	Channel Type selection, Digital Output option card used for common absolute Alarms or Pulse Output Totalisation signal	-	5	Channel type
AC	Current HI and LO Alarm indication	-	5	Alarms
AH	Historic change of state indication of HI/LO Alarms	-	5	
TA	Temperature offset to Absolute zero from measurement scale zero	Eng	4	Flow Calculation related parameters
PA	Pressure offset to Absolute zero from gauge pressure zero (local atmospheric pressure)	Eng	9	
SW	Switch bank S1/S2 settings	-	5	Operating Mode
MD	Front panel and diagnostic status indications	-	5	

TABLE A.9.1 List of 6434 Instrument Command Parameters and their respective mnemonics

COMMAND MNEMONIC	COMMAND PARAMETER FUNCTION	UNITS	FORMAT	PARAMETER TYPE
CN(1)	Channel Number	-	7	
ST	Channel Status	-	5	Status words
FP	Flow Processing	-	5	
1P	Input 1 Signal Processing	-	5	
2P	Input 2 Signal Processing	-	5	
3P	Input 3 Signal Processing	-	5	
HR	Calculated Flow high range	Eng	2	Flow Range
LR	Calculated Flow low range	Eng	2	
1H	Input 1 high range	Eng	2	IP1 Input ranging
1L	Input 1 low range	Eng	2	
2H	Input 2 high range	Eng	1	IP2
2L	Input 2 low range	Eng	1	
3H	Input 3 high range	Eng	1	IP3
3L	Input 3 low range	Eng	1	
HA	Flow Absolute high Alarm	Eng	2	Limit and Alarm settings
LA	Flow Absolute low Alarm	Eng	2	
LF	Low Flow threshold	Eng	2	
DF	Default Flow (Totalisation)	Eng	2	
1K	Scaling factor	-	4	Flow Calculation Algorithm related parameters
2K	2V Default (Flow Calc)	Eng	1	
3K	3V Default (Flow Calc)	Eng	1	
4K	Scaling Factor	-	3	
SG	Relative Density	-	9	
TO	Reference Temperature (abs)	Eng	4	
PO	Reference Pressure (abs)	Eng	9	
FL	Calculated Flow	Eng	2	Monitor-only parameters
1V	Input 1 value	Eng	2	
2V	Input 2 value	Eng	1	
3V	Input 3 value	Eng	1	
FS	Scaling factor	-	4	4 digit totaliser
FT	Pulse Total Setpoint	Eng	10	
1F	Flow total M.S. part	Eng	10	Flow total display
2F	Flow total L.S. part	Eng	10	
1B(2)	Flow tot. M.S. write buffer	Eng	10	Write buffers
2B(2)	Flow tot. L.S. write buffer	Eng	10	
1T(3)	Channel Tag characters 1-4	ASCII	8	Channel Tag names
2T(3)	Channel Tag characters 5-8	ASCII	8	

TABLE A.9.2 List of 6434 Channel Command Parameters and their respective mnemonics

	0	1	2	3	4	5	6	7
0	II	S1	S2	S3	S4	CT	AC	AH
8	TA	PA	SW	MD	(4)	(4)	(4)	(4)
16	FP	1P	2P	3P	(*) ST	(*) HR	(*) LR	(*) HA
24	(*) LA	(*) FL	(*) 1F	(*) 2F	1H	1L	2H	2L
32	3H	3L	1V	2V	3V	LF	DF	1K
40	2K	3K	4K	SG	TO	PO	FS	FT
48	(5) T1	(5) T2	(5) T3	(5) T4				

TABLE A.9.3 List of 6434 Parameter Numbers, [PNO]s, and their respective mnemonics

APPENDIX A.10 6850 Parameter Tables

Software part No. RD 069528 issue 3, release 1

Table A.10.1 lists the 2 character command parameters of the 6850 Setpoint Programmer used when accessing data via the 8260 Hand-held Terminal or the ASCII mode of the serial link protocol (see Section 5). Table A.10.2 lists the corresponding Parameter Numbers used with the Binary mode of the protocol (see Section 6).

The table below shows the modification history of the 6850 software with respect to changes in these parameter tables:-

SOFTWARE ISSUE	SOFTWARE RELEASE	MEMORY BOARD	REMARKS
1	1	MK 3	ASCII protocol only
2	1	MK 3	ASCII protocol only
3	1	MK 3	Binary protocol supported

NOTES

The following points should be noted with regards to tables A.10.1 and A.10.2:-

TABLE A.10.1

(1) If the scroll feature (W↓) of the Hand-held terminal is used when 2C is reached, the next parameter displayed is SI which is automatically incremented to the next segment number. When this is repeated after the last segment, the PI parameter is displayed but not altered. Thus all the segments (NS) of a programme may be inspected just by using the scroll button.

When this procedure is carried out via the serial link using the ACK response of the ASCII mode of the protocol (see section 5.1.2 B) b)), after the last segment is accessed the next parameter is PI incremented by one.

Note that the PI and SI values for Hand-held terminal and serial data link access are stored completely independently. Inspecting programmes via the Hand-held terminal, for example, does not interfere with the serial link which can access starting from the last segment polled as soon as the 8260 is unplugged.

(2) The SS parameter does not appear in the "Reset" or "End" segments.

(3) The SL parameter does not appear in the "End" segment or in a segment where SS=0.

(4) The ST parameter only appears in those segments where SS=0.

Table A.10.2

(*) Only those parameters marked (*) are available with enquiry polling.

(5) SL and ST are both accessed as parameter number 24 because they cannot both be present in the same Programme Segment (see notes (3) and (4) above).

CMD MNE-MONIC	COMMAND PARAMETER FUNCTION	UNITS	FORMAT	DP CHAR POSN	PARAMETER TYPE
II	Instrument identity	-	5	-	
MD	Programmer Operating Mode	-	5	-	Status
PB	Digital Inputs and Push-buttons	-	5	-	words
SW	Switch bank S1/S2 settings	-	5	-	
TM	Time remaining	hrs/ min/s	2	DO-C	
PV	Track Input value (normally PV)	Eng	1	DP-A	Current
SP	Setpoint Output	Eng	1	DP-A	Programme
CC	Current Cycle execution count	-	6	-	parameters
PG	Current Programme number	-	6	-	
SG	Current Segment number	-	6	-	
OS	Option status word	-	5	-	Status word
PI(1)	Inspected Programme number	-	6	-	
NS	Number of Segments	-	6	-	
DP	Decimal point position (Setpoint and 2nd Channel)	-	5	-	
1H	Setpoint high range	Eng	1	DP-A	Programme
1L	Setpoint low range	Eng	1	DP-A	
2H	2nd Channel high range	Eng	1	DP-B	definition
2L	2nd Channel low range	Eng	1	DP-B	
CN	Set number of cycles	-	6	-	
CS	First Segment of cycle path	-	6	-	
CF	Last Segment of cycle path	-	6	-	
SI(1)	Inspected Segment number	-	6	-	
DO	Digital Outputs; Slope/Time decimal points & time units	-	5	-	
SS(2)	Set Slope	Eng	1	DO-C	Segment
SL(3)	Set Level	Eng	1	DP-A	
ST(4)	Set Time	hrs/ min/s	2	DO-C	definition
2C(1)	2nd Channel set Level	Eng	1	DP-B	

TABLE A.10.1 List of 6850 parameter functions and their respective mnemonics

	0	1	2	3	4	5	6	7
0	II	(*) MD	PB	SW	TM	PV	(*) SP	CC
8	(*) PG	(*) SG	OS	PI	NS	DP	(*) 1H	(*) 1L
16	2H	2L	CN	CS	CF	SI	DO	SS
24	(5) SL/ST	2C						

TABLE A.10.2 List of 6850 Parameter Numbers; [PNO]s, and their respective mnemonics

APPENDIX B

USA STANDARD CODE FOR INFORMATION INTERCHANGE - ASCII

CHARACTER	7-BIT BINARY CODE	HEXA-DECIMAL	DECIMAL CODE
NUL - Null	000 0000	00	0
SOH - Start of Heading	000 0001	01	1
STX - Start of Text	000 0010	02	2
ETX - End of Text	000 0011	03	3
EOT - End of transmission	000 0100	04	4
ENQ - Enquiry	000 0101	05	5
ACK - Acknowledge	000 0110	06	6
BEL - Bell	000 0111	07	7
BS - Backspace	000 1000	08	8
HT - Horizontal tabulation	000 1001	09	9
LF - Line feed	000 1010	0A	10
VT - Vertical tabulation	000 1011	0B	11
FF - Form feed	000 1100	0C	12
CR - Carriage return	000 1101	0D	13
SO - Shift Out	000 1110	0E	14
SI - Shift In	000 1111	0F	15
DLE - Data link escape	001 0000	10	16
DC1 - Device control 1	001 0001	11	17
DC2 - Device control 2	001 0010	12	18
DC3 - Device control 3	001 0011	13	19
DC4 - Device control 4 (stop)	001 0100	14	20
NAK - Negative acknowledge	001 0101	15	21
SYN - Synchronous idle	001 0110	16	22
ETB - End of Transmission Block	001 0111	17	23
CAN - Cancel	001 1000	18	24
EM - End of Medium	001 1001	19	25
SUB - Substitute	001 1010	1A	26
ESC - Escape	001 1011	1B	27
FS - File Separator	001 1100	1C	28
GS - Group Separator	001 1101	1D	29
RS - Record Separator	001 1110	1E	30
US - Unit Separator	001 1111	1F	31
DEL - Delete, Rubout	111 1111	7F	127

TABLE B.1 ASCII Control codes

CHARACTER	7-BIT BINARY CODE	HEXA-DECIMAL	DECIMAL CODE
- space	010 0000	20	32
! - exclamation mark	010 0001	21	33
" - double quotation mark	010 0010	22	34
# - hash (£ sign - ISO 7)	010 0011	23	35
$ - dollar sign (← or £ sign)	010 0100	24	36
% - percentage sign	010 0101	25	37
& - ampersand	010 0110	26	38
' - single quotation mark	010 0111	27	39
(- left-hand bracket(round)	010 1000	28	40
) - right-hand bracket(round)	010 1001	29	41
* - asterisk	010 1010	2A	42
+ - plus	010 1011	2B	43
, - comma	010 1100	2C	44
- - minus	010 1101	2D	45
. - period	010 1110	2E	46
/ - oblique	010 1111	2F	47
0 }	011 0000	30	48
1	011 0001	31	49
2	011 0010	32	50
3	011 0011	33	51
4	011 0100	34	52
5 } numerals	011 0101	35	53
6	011 0110	36	54
7	011 0111	37	55
8	011 1000	38	56
9 }	011 1001	39	57
: - colon	011 1010	3A	58
; - semi-colon	011 1011	3B	59
< - less than	011 1100	3C	60
= - equals	011 1101	3D	61
> - greater than	011 1110	3E	62
? - question mark	011 1111	3F	63

TABLE B.2 ASCII character codes

CHARACTER	7-BIT BINARY CODE	HEXA-DECIMAL	DECIMAL CODE
@ - "at" sign	100 0000	40	64
A	100 0001	41	65
B	100 0010	42	66
C	100 0011	43	67
D	100 0100	44	68
E	100 0101	45	69
F	100 0110	46	70
G	100 0111	47	71
H	100 1000	48	72
I	100 1001	49	73
J	100 1010	4A	74
K	100 1011	4B	75
L	100 1100	4C	76
M	100 1101	4D	77
N	100 1110	4E	78
O } upper case letters	100 1111	4F	79
P	101 0000	50	80
Q	101 0001	51	81
R	101 0010	52	82
S	101 0011	53	83
T	101 0100	54	84
U	101 0101	55	85
V	101 0110	56	86
W	101 0111	57	87
X	101 1000	58	88
Y	101 1001	59	89
Z	101 1010	5A	90
[- LH bracket (square)	101 1011	5B	91
\ - oblique	101 1100	5C	92
] - RH bracket (square)	101 1101	5D	93
^ - up arrow (↑ common usage)	101 1110	5E	94
_ - underline(← common usage)	101 1111	5F	95

TABLE B.2 ASCII character codes

CHARACTER	7-BIT BINARY CODE	HEXA-DECIMAL	DECIMAL CODE
` -	110 0000	60	96
a	110 0001	61	97
b	110 0010	62	98
c	110 0011	63	99
d	110 0100	64	100
e	110 0101	65	101
f	110 0110	66	102
g	110 0111	67	103
h	110 1000	68	104
i	110 1001	69	105
j	110 1010	6A	106
k	110 1011	6B	107
l	110 1100	6C	108
m	110 1101	6D	109
n	110 1110	6E	110
o } lower case letters	110 1111	6F	111
p	110 0000	70	112
q	111 0001	71	113
r	111 0010	72	114
s	111 0011	73	115
t	111 0100	74	116
u	111 0101	75	117
v	111 0110	76	118
w	111 0111	77	119
x	111 1000	78	120
y	111 1001	79	121
z	111 1010	7A	122
{ - LH bracket (curly)	111 1011	7B	123
| - vertical broken line	111 1100	7C	124
} - RH bracket (curly)	111 1101	7D	125
~ - tilde	111 11100	7E	126

TABLE B.2 ASCII character codes