6358 - MICROPROCESSOR BASED
EIGHT LOOP PROCESS CONTROLLER

TECHNICAL MANUAL

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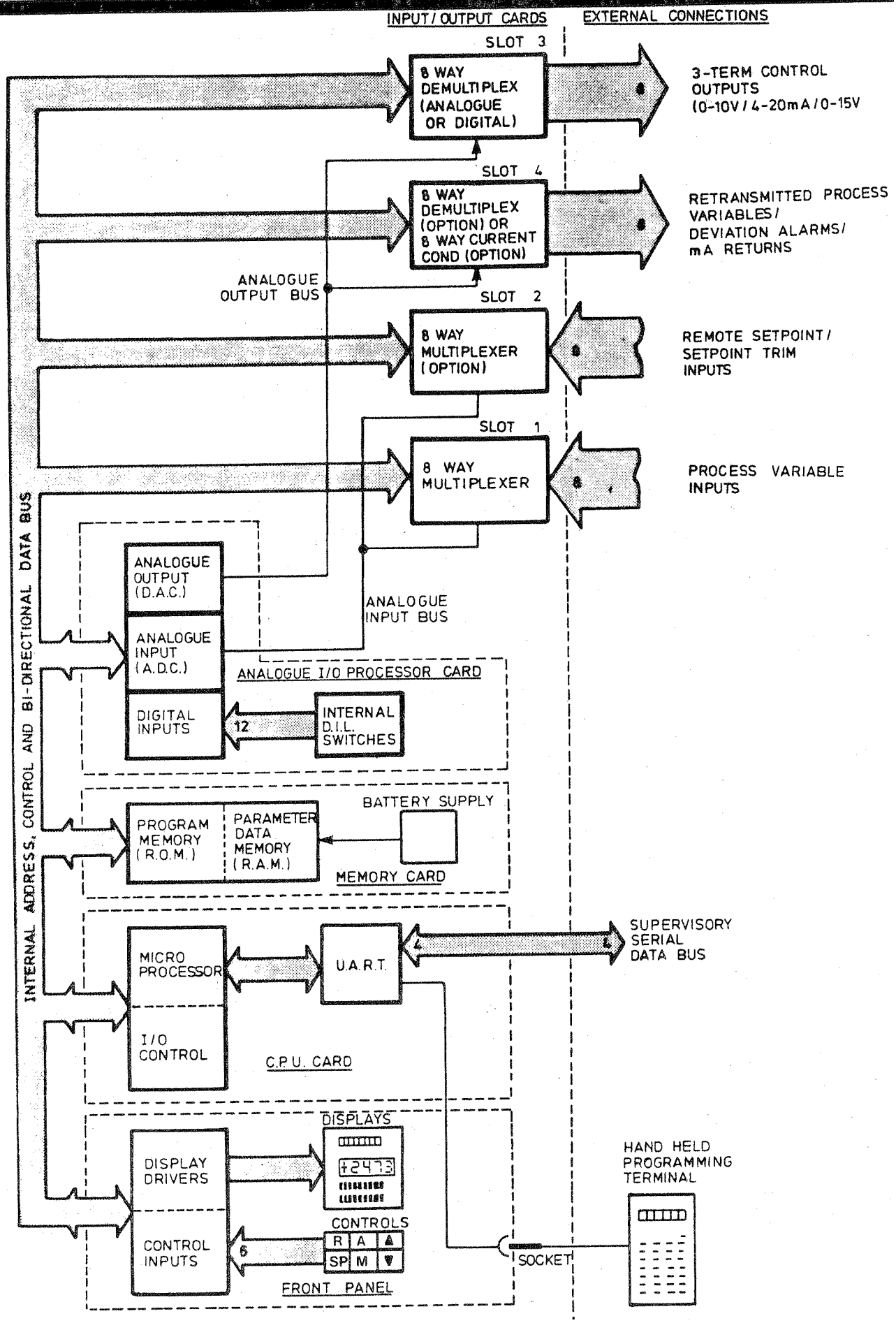


FIG 1.1 6358 MK 2 8 LOOP CONTROLLER SCHEMATIC BLOCK DIAGRAM

Section 1 GENERAL DESCRIPTION

1.1 Introduction

The Model 6358 Microprocessor based 8-loop Process Controller is fully compatible, both electrically and mechanically, with the Turnbull Control Systems Matric 6000 Range of modular control equipment.

As a Systems component it plugs directly into the model 7000 Rack unit or 7600 Bin unit for plant installation and integrates with the full capabilities of the range which includes modules for signal conditioning, actuator driving and centralised monitoring and control facilities.

The 6358 8-loop Controller is also available housed within a 72mm DIN compatible sleeve for front of panel mounting.

1.2 Features and General Description

The features of the 6358 Process Controller are best described with reference to the schematic Block Diagram shown in Fig 1.1. It can be seen that the hardware structure is such that each of the Controller functions, namely:-

Front Panel Displays and Operator Controls
Analogue Input/Output signals
Digital Output signals

are implemented as separate hardware blocks. Each of these functional blocks communicate with the Central Processor Unit (CPU) which controls the overall operation of the unit via the internal communication busses shown. The CPU itself contains the microprocessor which is the intelligent 'heart' of the device and it in turn has to communicate with a Memory block which stores the necessary set of control programs together with all the control parameters.

The Front Panel contains all the indicators and displays necessary to allow an operator to monitor one of 8 Process Control Loops. It also has a number of control push-buttons which allow the operator to interact with a Control Loop changing its mode from Manual to Automatic with local or remotely supplied setpoints and also to change the operating conditions within these control modes. A socket is provided on the front panel to allow an 8260 Hand-held programming terminal to be connected which is used to set up the control loop characteristics initially, or monitor and change any of the control parameters subsequently. Access to all the loop parameters for monitoring or updating purposes is also possible by means of a second communication channel available at the rear connector which is intended for computer supervisory use.

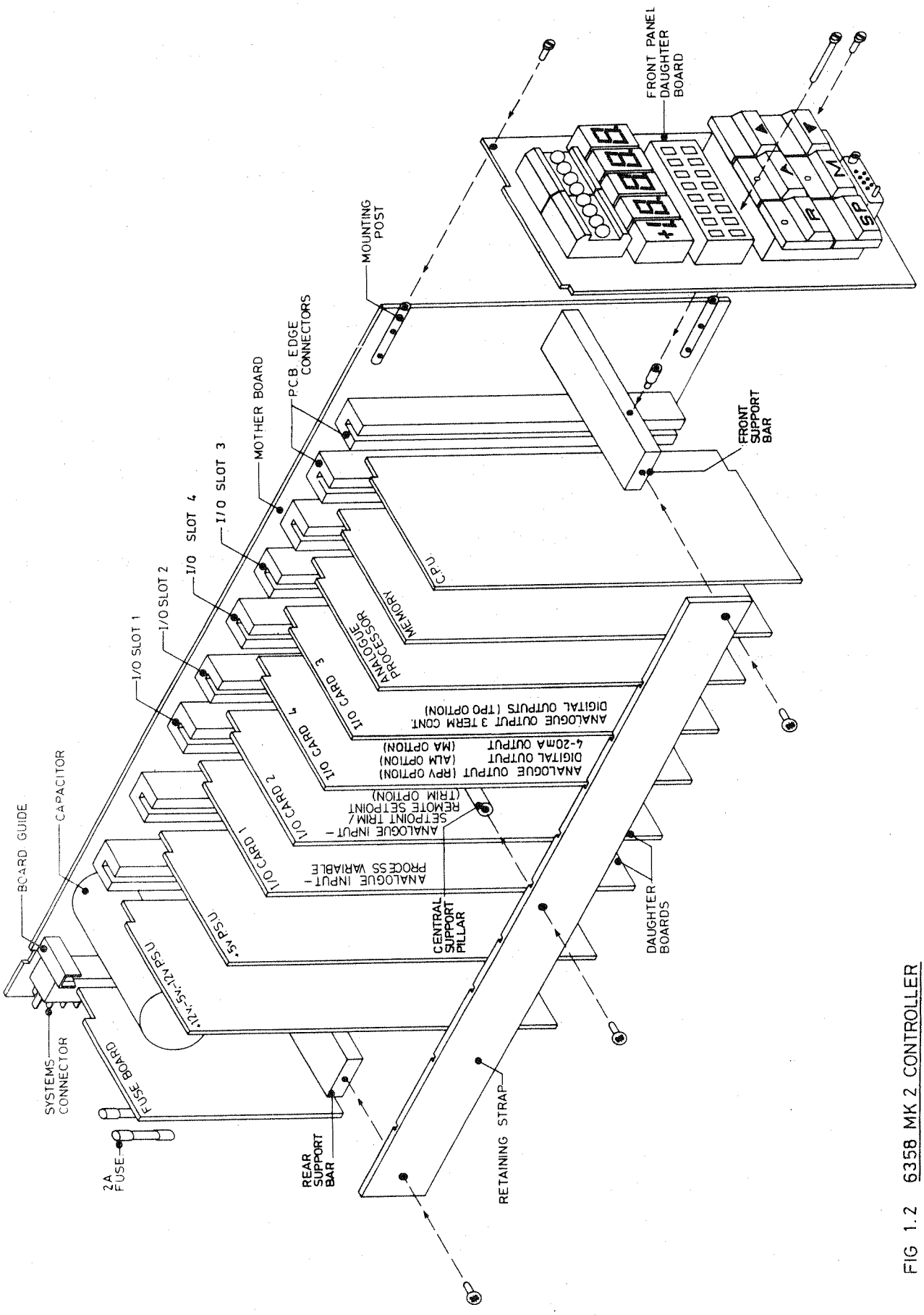


FIG 1.2 6358 MK 2 CONTROLLER INTERNAL STRUCTURE

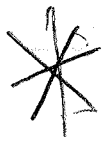
The 8-way analogue inputs of slot 1 are used to monitor the plant Process Variables, while the 8-way analogue outputs of slot 3 provide the necessary Control signals to the Actuator drivers.

When the TPO option is specified, the analogue output board of slot 3 is replaced by a digital output board, which provides Time-proportioned 3-term control outputs. The TPO option is mutually exclusive with the MA option.

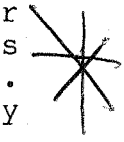
When the TRIM option is specified the 6358 is fitted with an additional 8-way analogue input board in slot 2 which provides a Setpoint Trim or Remote Setpoint input for each loop.

When the RPV option is specified an additional 8-way analogue output board is fitted in slot 4 to provide a re-transmitted Process Variable output for each loop. Analogue input and output signals are all in the range 0 to 10V and in addition the Process Variable inputs can be optionally programmed to accept 1 to 5V inputs.

When the ALM option is specified the 6358 is fitted with an 8-way digital output board in slot 4 to provide a separate common deviation alarm output for each loop. These digital outputs use 0 and 15V logic levels.



When the MA option is specified an 8-way current conditioner board is installed in slot 4, and the 8 links between I/O slots 3 and 4 are removed, to provide 4-20mA 3-term control signals. It should be noted that the ALM, RPV and MA options are mutually exclusive.



1.3 Mechanical Structure

The Mechanical Structure of the 6358 Process Controller is shown in Fig 1.2. Each of the functional blocks is implemented on a single printed-circuit board (pcb) which plugs into an interconnection or Mother board (Assembly: AC 076032) via pcb edge connectors. The Front-panel pcb is connected to the Mother board via a 15-way single-in-line connector and is secured via two retaining screws and the front support bar. All the other daughter boards plug into 48-way pcb edge connectors except for a small Fuse board at the rear of the module. This pcb carries the fuses and power supply protection circuitry and is connected directly to the Mother board via soldered 'F' pins and is restrained by board guides. The large reservoir smoothing capacitor, C1, is mounted directly onto the Mother board.

The rear end of the Mother board (Assembly: AC 076032) carries the 48-way male systems edge connector which plugs directly into the TCS racking connector system. It also incorporates polarising slots in connector positions 37, 39 and 47 to mate with polarising pegs fitted to the 48-way female system connector if required.

CONNECTOR NUMBER	CONNECTOR TYPE	DAUGHTER BOARD FUNCTION	POLARISING KEY POSITION
1	Double-sided	Central Processor Unit	39 - 40
2	Double-sided	Memory Mk 6 (010)	40 - 41
3	Single-sided	Analogue I/O processor	19 - 20
4	Single-sided	8-way An. out 8-way Dig. out (TPO) -I/O slot 3	27 - 28
5	Single-sided	8-way An. out (RPV) 8-way Dig. out (ALM) 8-way 4-20mA out (MA) -I/O slot 4	27 - 28
6	Single-sided	8-way An. in (TRIM) -I/O slot 2	27 - 28
7	Single-sided	8-way An. in -I/O slot 1	27 - 28
8	Single-sided	+5V Power Supply	25 - 26
9	Single-sided	±12V, -5V Power Supply	14 - 15

TABLE 1.1 Daughter Board Edge Connector Characteristics

The connectors for the other daughter boards are provided with polarising clips to ensure that the boards are always inserted in the correct order. The daughter board connector characteristics are listed in Table 1.1. The 9 daughter boards are firmly held in the Mother-board edge connectors by means of a retaining strap. This strap has lateral grooves for positive mating with each daughter board and is provided with three fixing screws. These are connected to the front support bar a central support pillar in between I/O slots 2 and 3, and the rear support bar next to the Fuse board.

The positions of I/O slots 3 and 4 have been interchanged on the Mk 2 Mother Board as shown in Fig. 1.2 and a row of 8 jumpers and associated shorting plugs (LK1 to 8) have been situated between them. These jumpers should always be fitted unless a 4-20mA output option board is plugged into I/O slot 4.

The complete set of daughter boards and the Mother board slide into a 72mm case assembly which is fitted with a Front-panel fascia as illustrated in Fig 1.3. The fascia carries the cover for the 8260 Hand-held programming terminal socket and the metal catch-handle for module withdrawal. A metal clip is mounted at the rear of the sleeve to hold the Mother board assembly firmly in position.

1.3.1 Rack-Mounting Controllers

The 6358 Controller may be rack mounted in the standard TCS type 7000 racking system. A 19" rack will house up to 6 Controllers in their 72mm metal cases, and they can be mixed with other TCS Matric 6000 modules. A half width rack is also available, and this can hold up to 3 Controllers. Rack wiring is carried out in the conventional manner, and a rack-wiring schedule may be prepared from the 6358 rear connector pin chart given in Appendix A.

1.3.2 Bin-Mounting Controllers

The 6358 Controller may be mounted in the TCS 7600 Bin system, where the Controller pins are wired to customer screw terminals. The system can be configured by referring to the B6358 rear termination assembly given in Appendix B.

1.3.3 Panel-Mounting Controllers

The 6358 Controller can be used as a stand-alone panel-mounted instrument by using the 7900 single or multi-way sleeve assembly. In this case each instrument is provided with a 7358 rear termination assembly that contains a power supply and gives access to all the instrument connections via screw terminals. Full data sheets on the 7900 sleeve unit and the 7358 rear termination assembly are provided in Appendix C.

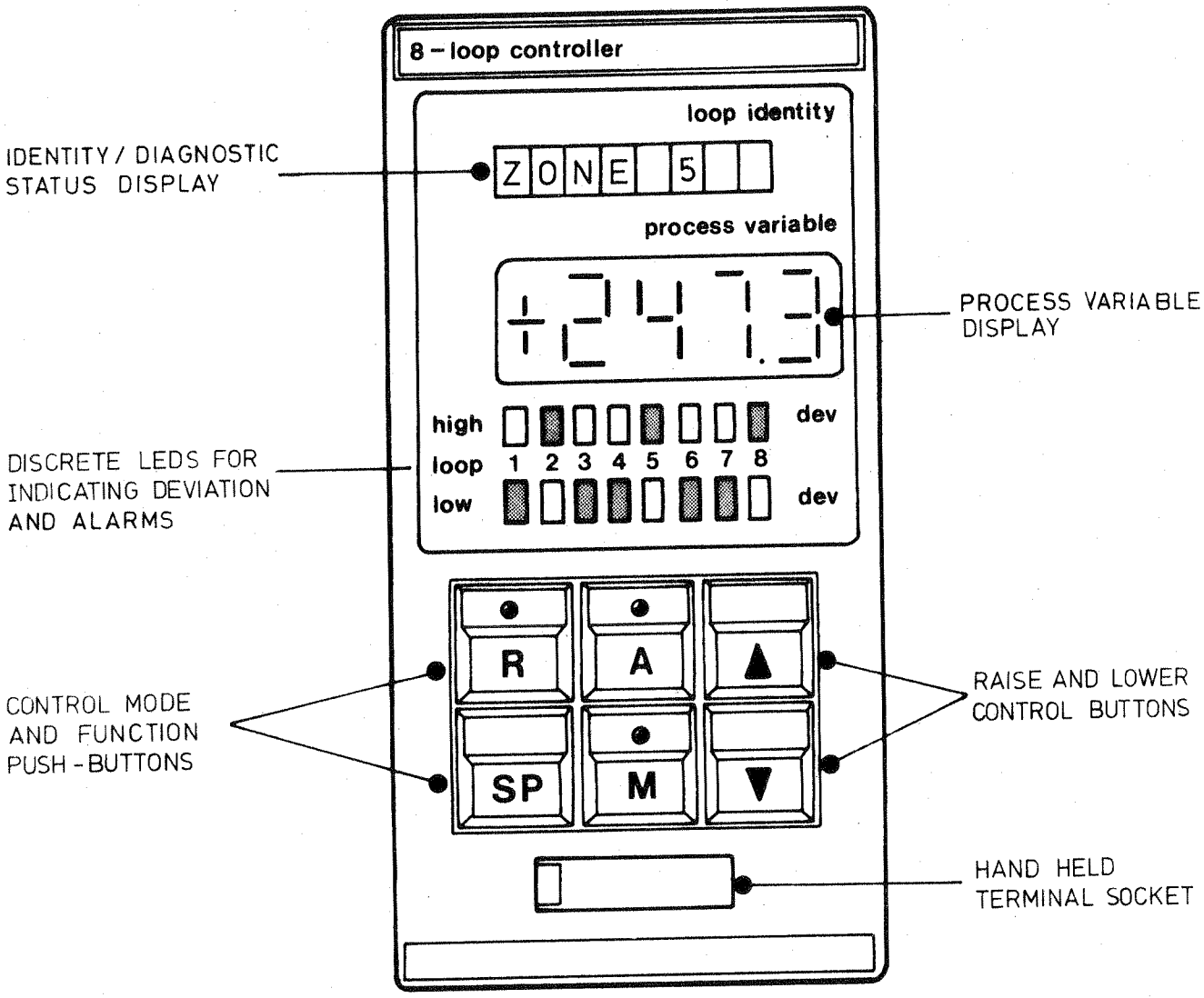


FIG 1.3
6358 8 - LOOP CONTROLLER – FASCIA DIAGRAM

1.4 Daughter Board Functional Descriptions

Each of the daughter boards are described in turn to indicate their function within the basic 6358 Process Controller.

1.4.1 Front-Panel Daughter Board (Assembly: AC 069452)

The front-panel daughter board holds all the indicator and display components together with the Operator Control push-buttons. The display components actually visible to the Operator can be seen from the fascia diagram of Fig 1.3 and consist of the following:-

a) Digital Readout

A 4 digit, orange, 7-segment LED display with a sign digit and programmable decimal point position is provided for Process Variable, Setpoint, or 3-Term output indication in the range -9999 to +9999.

b) Deviation status LED's

These consist of 2 horizontal rows of 8 red LED's situated below the 4 digit readout. They are used to indicate high or low deviation status for each loop when in the steady ON state, and FLASH to indicate alarm level deviations.

c) Identity/Diagnostic Display

This consists of a row of 8, red, 17-segment alphanumeric LED displays situated above the 4 digit readout. Each of the 8 digits is capable of displaying a full 64 ASCII character set and is used to indicate loop identities (tags) and numbers, or certain instrument diagnostic messages.

The 6 operator Control push-buttons are all of the momentary type and have the following functions:-

a) 3 Control Mode Push Buttons

These are the MANUAL (M), LOCAL AUTO (A), and REMOTE AUTO (R) buttons which incorporate yellow, green and green LED's respectively. These buttons select the actual operating mode of the Controller.

b) 2 Function Push-Buttons

These are the RAISE (▲) and LOWER (▼) push-buttons which are used in conjunction with the (M) and (SP) buttons to increase and decrease respectively the output levels, and Local Setpoints. They are also used to select a particular loop for display.

c) Display Select Push-Buttons

Normally the digital readout displays the Process Variable but when the SETPOINT (SP) display button is pressed it shows the current Setpoint

The Daughter board contains all the drive electronics associated with these displays and push-buttons and also carries the 7 pin socket into which the 8260 Hand-held programming terminal may be plugged.

1.4.2 Central Processor Daughter Board (Assembly: AC 069932)

The CPU Daughter board contains the 16 bit microprocessor together with the associated support logic required for interrupt handling and for providing the necessary input/output decoding logic. A Universal Asynchronous Receiver Transmitter (UART) circuit and associated drivers are used to communicate with either the 8260 Hand-held programming terminal via the Front panel socket, or with a supervisory system via the rear connector serial data bus.

The CPU card also contains a Watchdog timer circuit which monitors the microprocessor input/output functions. Upon detection of a failure all the Analogue outputs are 'frozen' and all Front panel displays are cleared except for the 8 character alphanumeric readout (see also Section 2.6.1)

1.4.3 Memory Daughter Board (Assembly: AC 076042)

The Memory daughter board is used to store the actual Controller programs in Read-Only Memory (ROM) and also the Control Loop parameters and other variables are stored in non-volatile Random-Access Memory (RAM). The RAM chip is made non-volatile by means of a standby battery supply circuit which powers it when the main supply has failed or undergoes a transient failure. A long-life Lithium primary cell is used for this purpose which may be isolated from the circuit, during long shelf storage periods, if required, be means of switch SW1.

This switch is pushed in to connect the battery and pulled out to isolate the battery from the RAM.

The battery is not soldered directly to the memory board itself but is fitted to a separate battery board (Assembly: AC 076044) which is connected to the memory board via two 2-way plugs and sockets. This plug-on battery board is held in place by a board restraining bracket.

When the battery board is disconnected to facilitate battery replacement, standby current to the CMOS RAM is supplied by a high value 'Supercap' fitted to the Mk 6 memory board. This capacitor will maintain the RAM in its non-volatile state for a minimum period of 20 minutes while the battery board is being replaced.

1.4.4 Analogue I/O Processor Board (Assembly: AC 069398)

The Analogue I/O Processor Board provides a number of digital and analogue functions as follows :-

a) Digital Functions

The board contains 12 internal switches which are used to set up the 6358 for certain control modes and communication channel characteristics. Certain CPU busses are also routed through to the selected Input/Output slots 1 to 4 as necessary by logic on this board.

b) Analogue Functions

The board contains the circuitry necessary to provide an analogue output bus for driving 8-way Analogue Output cards when they are plugged into the Input/Output slots. It also provides an analogue input bus facility which is driven by 8-way Analogue input cards when they are plugged into the Input/Output slots. In addition, circuitry is provided on the board which allows the CPU to measure the battery voltage under dynamic loading conditions (see Section 2.6.3).

BOARD TYPE IDENTITY	NUMBER OF CHANNELS	BOARD DESCRIPTION	BOARD CATEGORY
00 01 02 03 04 05 06 07	8	0-10V non-isol. 1M Zin	Analogue inputs Process Variables; Setpoint Trim/ Remote Setpoints (TRIM option)
08 09 0A 0B 0C 0D 0E 0F	8 8	0-10V non-isol + S/Hold 4-20mA non-isol	Analogue outputs 3-Term Control outputs; Re-transmitted PVs (RPV option); 4-20mA 3-Term O/Ps (MA option)
10 11 12 13 14 15 16 17	8	0-15V non-isol, non-latched	Digital inputs (not used in 6358)
18 19 1A 1B 1C 1D 1E	8	0-15V non-isol, O/C 2k2 pup	Digital outputs Common Deviation alarms (ALM option) Time proportioned outputs, (TPO option)
1F	-	No board fitted	

TABLE 1.2 Table of I/O daughter board types and their corresponding board identities

1.4.5 Input/Output Daughter Boards

The 6358 Controller has 4 slots into which general purpose Input/Output daughter boards are plugged. These boards come in 4 basic categories, viz:-

a) Analogue input cards
b) Analogue output cards
c) Digital input cards
d) Digital output cards

The basic version of the 6358 is supplied with an analogue input card in slot 1 and an analogue output card in slot 3. With the TRIM option, a second analogue input card is fitted in slot 2 while with the RPV option, a second analogue output card is fitted in slot 4. When the ALM option is specified a digital output card is fitted in the slot 4 position. With the TPO option, the analogue output card in slot 3 is replaced by a digital output card, which provides digital time-proportioned control outputs. With the MA option a 4-20mA current output board is fitted in slot 4.

The 6358 hardware has the ability to detect which type of card is plugged into each of the 4 Input/Output slots by monitoring a board identity which is pre-programmed onto each card. The 6358 software verifies that the correct type of card is plugged into each slot and can also distinguish between the 8 different types of card within each category. Table 1.2 lists the types of Input/Output boards currently available together with their corresponding hardware identity codes.

The 4 types of Input/output boards that can be fitted to the 6358 Controller are described in the following paragraphs.

a) Analogue Input Daughter Board (Assembly: AC 069400)

This board basically multiplexes 8 non-isolated input signals in the range 0-10V onto the analogue input bus of the Analogue Processor card. Each channel is provided with an input network comprising a pull-down resistor, a 100 usec CR filter, and a 12V zener diode clamping circuit.

b) Analogue Output Daughter Board (Assembly: AC 069402)

This board demultiplexes the 0-10V analogue output bus from the Analogue Processor card into 8 non-isolated output channels. Each output channel consists of a medium term sample-and-hold circuit and buffer amplifier stage capable of driving ±5mA signals.

c) Digital Output Daughter Board (Assembly: AC 069401)

This board contains 8 non-isolated digital latch circuits driven by the CPU control and address busses. The outputs of each latch are buffered by a 0-15V open-collector TTL gate fitted with a 2k2 pull-up resistor to the 15V supply.

d) 8 Channel 4-20mA Output Daughter Board (Assembly: AC 076102)

This board takes the 0-10V output from each channel of the Analogue output board fitted in I/O slot 3 and converts it to a 4-20mA signal. The 4-20mA outputs are non-isolated and source current referenced to a set of common 0V return inputs. The span of each channel is fixed at 16mA by precision resistors, but a potentiometer fitted to the board serves as a common offset adjustmnet for all 8 channels.

1.4.6 +5V Power Supply Daughter Board (Assembly: AC 066518)

This board basically consists of a switching regulator circuit which draws its power from a 20-30 volt smoothed unregulated input and can supply up to 2.5A before current limiting. The board also contains the necessary logic circuitry to detect Power On and the Power Failure conditions and alert the CPU accordingly.

1.4.7 +12V, -5V, -12V Power Supply Daughter Board (Assembly : AC 066519)

This board also draws its power from the 20-30 volt supply input and uses a monolithic regulator to produce the +12V supply rail. A -16V supply is also generated on the board by means of an inverting regulator circuit and the -12V and -5V supply rails are derived from this with two further monolithic regulators. All 3 of these regulators incorporate current limit and thermal shutdown facilities.

1.4.8 Fuse Daughter Board (Assembly: AC 076089)

This board is used to mount the main 2A supply fuse together with circuitry capable of blowing it in the event of any internal supply rail exceeding its voltage tolerance limit. In addition the fuse board generates a regulated 15V supply for the Watchdog and other digital outputs, while a spare 2A fuse is also mounted on the board for convenience. The board incorporates special fuse clips which allow the mounting of 20mm or 1¼ inch fuses in either the active or spare fuse position.

1.5 Technical Specification

1.5.1 Operator displays

a) Digital Readout (for Setpoint, Process Variable, and 3 Term Output indication) : 4 digit, orange LED display with sign and a decimal point that can be programmed to 4 positions:-

±.9999
or ±9.999
or ±99.99
or ±999.9
or none, i.e. ±9999

b) Deviation status display : 2 rows of red LED's programmed to indicate for each loop:-

(i) HI/LO deviation error when steady

(ii) HI/LO deviation alarm when flashing

c) Identity/ diagnostic display : Row of 8 red 17 segment alphanumeric LED's capable of displaying 64 character ASCII set to indicate:-

(i) Loop numbers/loop names

(ii) Instrument diagnostic messages

1.5.2 Operator Controls

a) Control Mode Selection : 3 Momentary action illuminated push-buttons:-

(i) Manual (M) with integral yellow LED

(ii) Local Auto (A) with integral green LED

(iii) Remote Auto (R) with integral green LED

b) Function Selection : 2 Momentary action, non-illuminated push-buttons:

(i) Raise (▲) increases the 3-Term Output when Manual (M) is pressed, or the Setpoint when Setpoint display (SP) is pressed.

(ii) Lower (▼) decreases the 3-Term Output when Manual (M) is pressed, or the Setpoint when Setpoint display (SP) is pressed.

c) Loop Selection : (i) When used alone, the Raise (▲) button increments the loop number at each depression i.e. from 1 through 8 and back to 1 again. The loop number is displayed on the upper alphanumeric readout as long as the button is depressed. The corresponding loop name is displayed once the button is released.

(ii) When used alone, the Lower (▼) button decrements the loop number at each depression and causes the same display as the Raise (▲) button.

d) Display Selection : 1 momentary action, non-illuminated push button which causes the digital readout to display the current Setpoint as long as it is pressed.

NOTE

Holding the Manual, Auto or Remote buttons pressed in will cause the digital readout to display the current 3-Term Control Output level as a 4 digit value in the range 0 to 99.99%. At the same time, the loop number is shown on the upper alphanumeric display.

1.5.3 Analogue Inputs

a) Number of Channels	:	8 non-isolated inputs as standard plus 8 optional inputs
b) Channel Functions	:	Slot 1, channels 1 to 8 = Process Variable inputs
	:	Slot 2, channels 1 to 8 = Remote Setpoint/Setpoint Trim (TRIM option)
c) Input Signal Levels	:	Inputs are 0-10V range.
	:	(slot 1 inputs may be 1-5V selected by software)
d) Resolution	:	12 bit binary ADC (.025%) applied to inputs.
	:	15 bit binary representation obtained after digital filtering and signal averaging giving resolution of 1 digit in ±9999.
e) Accuracy	:	±1 LSB typical over 0 to 50°C range for hardware. ±1 digit of reading for 0-4000 range. ±2 digits of reading for 0-8000 range. ±3 digits of reading for 0-9999 range. - after input filtering.
f) Sampling Rate	:	ADC samples each channel every 304ms, (8 loops enabled)
g) Input Impedance	:	1M ohm pull-down to 0V on all Channels.
h) Input Signal Processing (slot 1 Process Variable inputs only)	:	Linear: normal or inverse;
	:	Normalised square root;
	:	Type J, K, T, S, R, E, B thermocouples;
	:	Platinum resistance thermometers;
	:	Up to 5 user specified linearisations;

1.5.4 Analogue Outputs

a) Number of Channels	:	8 non-isolated outputs plus 8 optional outputs.
		OR
	:	8 non-isolated current outputs with 8 common returns (MA)
b) Channel Functions	:	Slot 3, Channels 1 to 8 = 3 Term Control outputs
	:	Slot 4, Channels 1 to 8 = Process Variable outputs (RPV option)
		OR
	:	Slot 3, Channels 1 to 8 = 3 Term current outputs (sources)
		Slot 4, Channels 1 to 8 = Common current returns (MA option)
c) Output Signal Levels - Voltage outputs	:	0-10V
- Current outputs	:	4-20mA
d) Output Circuit type	:	Medium-term analogue sample-and-hold circuits preceded by DAC
e) Output resolution	:	12 bit binary (.025%) giving minimum analogue voltage steps of 2.5mV
f) Accuracy, 0-10V Output - Voltage outputs	:	±1 LSB typical over 0 to 50°C range
- Current outputs	:	± 20uA typical (100uA max) at 20mA over 0 to 50°C range and 0 to 600 ohm load.
g) Sample and Hold	:	DAC updates each channel every 304ms, (8 loops enabled)
h) Output Drift Rate under Watchdog Failure Conditions	:	0.5mV/sec maximum (equivalent to 1% of full scale in 3 minutes)

j) Output Drive Capability		
- Voltage outputs	:	± 5mA
- Current outputs	:	0-12V
k) Current Output adjustment range	:	± 0.3mA offset adjustment
l) MA option board power supply requirements	:	170mA from 24V supply (all 8 channels sourcing 20mA)

1.5.5 Digital Outputs

a) Number of Outputs	:	8 or 16 non-isolated outputs plus Watchdog
b) Output Functions	:	Slot 3, Outputs 1 to 8 = Digital Time-proportioned control outputs (TPO option)
	:	Slot 4, Outputs 1 to 8 = common deviation alarms (ALM option)
c) Output Voltage Levels	:	15V = logic one 0V = logic zero
d) Output Drive Capability	:	2k2 open-collector pullup to +15V supply
	:	Maximum logic zero sink current = 16mA
e) Output update rate	:	Each loop alarm output is updated every 304ms (8 loops enabled)
	:	Each digital Time-proportioned output is updated every 38ms

1.5.6 3 Term Control and Setpoint Characteristics

a) Algorithm Sampling Period	:	304 msecs (8 loops enabled)
b) Setpoint - range	:	low, high -9999 to +9999
- limits	:	low, high -9999 to +9999
c) Setpoint Trim Range	:	low, high -9999 to +9999 in Engineering units.
d) Alarm Limits (on Deviation)	:	low, high, 0 to 9999 with hysteresis of 0.5% of Setpoint span
e) Input Filter Range (all inputs)	:	0 to 60 seconds (first order)
f) Input Signal Processing	:	One of 16 functions including square root and linearisations.
g) Control Output - range	:	0-99.99% = 0-10V (standard) = 4-20mA (MA option) = digital time - proportioned (TPO option)
- limits	:	low, high 0 to 99.99%
- polarity	:	Inverse Output mode software selectable.
- raise/lower rate in Manual	:	0 to 99.99% in 20 secs. with accelerating action.
h) Proportional Band range	:	0 to 999.9% (0 sets loop to act as ON/OFF controller)
i) Integral Time Constant Range	:	0.01 to 99.99 minutes 0 = off
j) Derivative Time Constant Range	:	0.01 to 99.99 minutes 0 = off

1.5.7 Power Supplies

a) Input voltage : (May be unsmoothed, full-wave rectified AC)
: 20-30V DC recommended operating range.
: 19-35V DC absolute maximum input limits.

b) Input current : 550mA without Hand-held terminal at 28V DC.
: 650mA with Hand-held terminal at 28V DC.

c) Input fuse rating : 2A

d) Internal supply rails :

Nominal Voltage	Voltage Tolerance	Current Limit
+12V	±0.5V	200mA
+ 5V	±0.25V	2.5A
- 5V	±0.2V	200mA
-12V	+0.5V	300mA

e) Power failure detect threshold : when input voltage falls below 16.5 ± 2V.

f) Memory standby battery characteristics : Lithium type
: 3V nominal output at 160mAh
: 8-10 year shelf life typical
: 5 year life typical on continuous standby
: 20 minute holdup time minimum with battery board removed

g) Output supply characteristics : 15V DC ±0.5V at 200mA max

1.5.8 Communications

a) No. of communication channels	:	2 serial ports
b) Type	:	Full duplex
c) Functions	:	(A) Dedicated data link via the front-panel used by the Hand-held terminal.
	:	(B) Multi-drop data link via the rear connector used by a supervisory computer.

(A) Hand-Held Terminal Link

a) Transmission standard	:	2 wire RS232/V24 (±12V)
b) Data rate	:	300 baud
c) Character length	:	10 bits made up of:- 1 start + 7 data + 1 parity (even) + 1 stop

(B) Multi-drop Supervisory Link

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	:	Selectable from 110, 300, 600, 1200, 2400, 3600, 4800, or 9600 baud
f) Character Length		
(i) ASCII mode - 110 Baud	:	11 bits made up of:- 1 start + 7 data + 1 parity (even) + 2 stop.
(ii) ASCII mode - 300 to 9600 Baud	:	10 bits made up of:- 1 start + 7 data + 1 parity (even) + 1 stop.
(iii) Binary mode - 110 Baud	:	12 bits made up of:- 1 start + 8 data + 1 parity (even) + 2 stop.
(iv) Binary mode - 300 to 9600 Baud	:	11 bits made up of:- 1 start + 8 data + 1 parity (even) + 1 stop.

1.5.9 Physical Specification

a) Mechanical

(i)	Width	:	72 mm
(ii)	Height	:	142 mm
(iii)	Depth	:	300 mm
(iv)	Weight	:	1.7 kg

b) Environmental

(i)	Operating temperature	:	0 to +50°C
(ii)	Storage temperature	:	-20 to +55°C
(iii)	Relative humidity	:	5 to 90% non-condensing
(iv)	Ventilation	:	Rack or Bin mounted Controllers must have at least a 1U gap above and below the case for proper ventilation.
		:	Sleeve mounted Controllers should be mounted as specified in the 7900 Sleeve data sheet (see Appendix C).

1.6 Order Sheet

DESCRIPTION	ORDER CODE
8-Loop Controller with 8-way Process Variable inputs and 8-way 3-Term Control outputs	6358
Additional 8-way Analogue input card to provide Setpoint Trim or Remote Setpoint facilities for each loop	/TRIM
Additional 8-way Analogue output card to provide re-transmitted Process Variable outputs for each loop Note This option is mutually exclusive with the MA and ALM options	/RPV
Additional 8-way Digital output card to provide Common Deviation alarms for each loop Note This option is mutually exclusive with the RPV and MA options	/ALM
Additional 8-way Current output card to provide 4-20mA controller outputs Note This option is mutually exclusive with the ALM, RPV and TPO options	/MA
8-way Digital output card to replace the 8-way Analogue output card in slot 3, to provide time proportional digital output of the 3-term control signal Note This option is mutually exclusive with the MA option	/TPO

Example

6358/TRIM/ALM - 8-loop Controller with Setpoint Trims and Deviation Alarms on each loop

Section 2 INSTALLATION

2.1 General Requirements

The sequence of events for installing a 6358 Process Controller in a system should be as follows:-

a) Rack or Bin Systems

(i) Ensure that a 72mm slot, fitted with a 48 way connector and all the correct mounting hardware, is available in a TCS 7000 Rack or 7600 Bin (See sections 1.3.1 and 1.3.2).

(ii) Ensure that an appropriate 24V DC supply is available and has been wired to the slot in the manner outlined in the System 6000 Installation Guide Section 5.

b) Self-Powered Sleeves

(i) Ensure that a 7900/7358 Self-Powered Sleeve is available (See Section 1.3.3).

(ii) Ensure that the 7900/7358 Self-Powered Sleeve has been correctly wired to either a 110/240V AC mains supply or a 24V DC supply (See Appendix C).

c) Before sliding the Controller into the rack, Bin or 7900/7358 sleeve check that all the internal switches have been set correctly as outlined in Section 2.3

d) Check that all the plant connections and other external inputs have been implemented correctly and that the signals are at the right levels as outlined in Section 2.4.

e) Power up the Controller in the manner outlined in Section 2.5.

f) The Controller can now be programmed with the Control Loop parameters following the instructions given in Section 4.

g) Once the Controller has been loaded with these parameters it can be operated in the various modes and control loop configurations as described in Section 3.

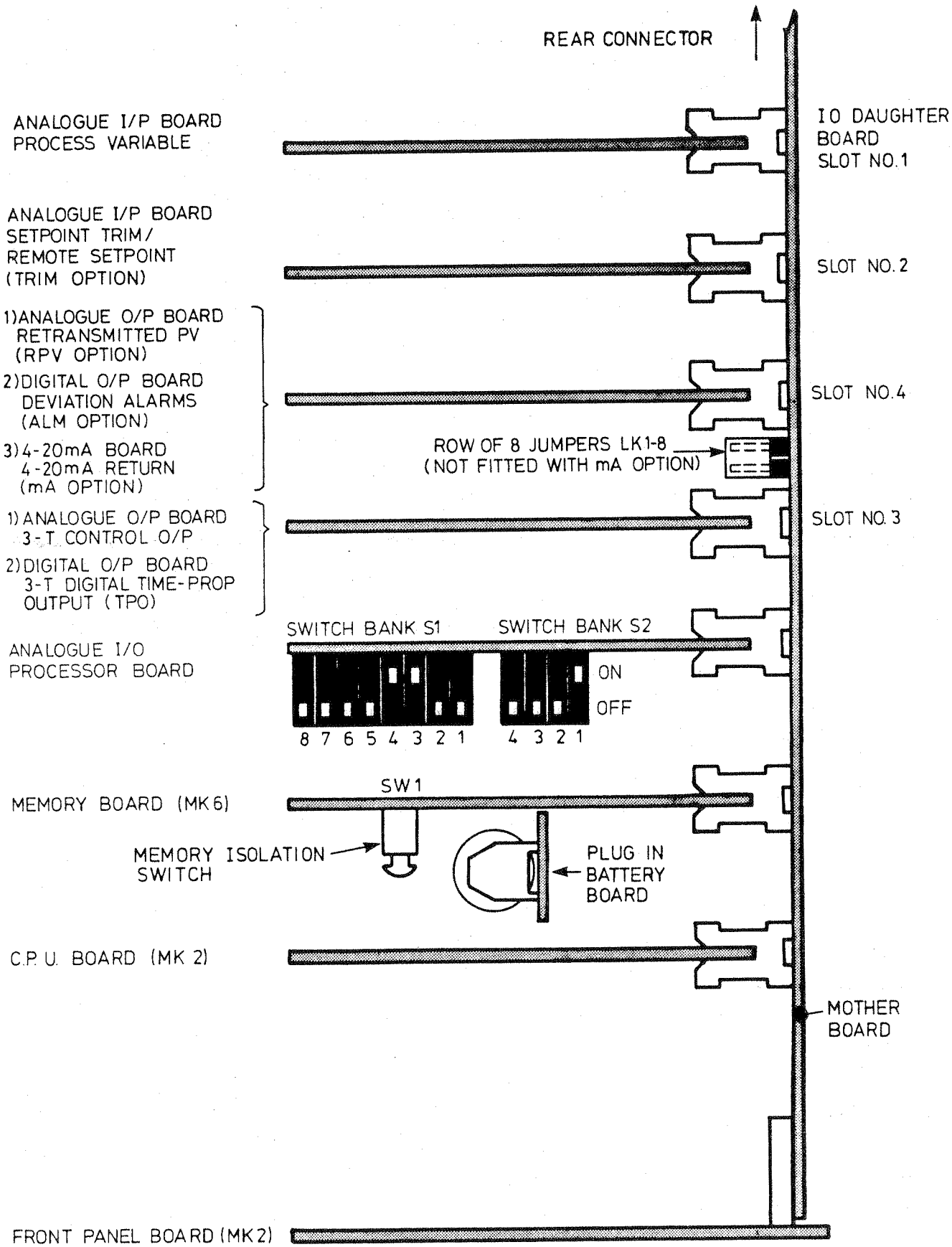


FIG 2.1 PLAN VIEW OF CONTROLLER WITH INTERNAL SWITCHES SHOWN

2.2 Power Supply Connections

For a description of Power Supply connections including discussions of:

Basic Ground connections,
Connection of Separate 24V DC supplies,
Common Parallel Supply configuration,
Combination supply configuration
and External Ground connections

refer to the System 6000 Installation Guide Section 5.

2.3 Internal Switch Settings

Fig 2.1 is a view of the 6358 Process Controller looking down at the top of the sleeve and illustrates the relative positions of the various daughter boards and their associated internal switches.

2.3.1 Memory Isolation Switch

This switch, SW 1, is situated on the Mk 6 Memory daughter board and its function is to isolate the CMOS parameter memory from the standby battery supply. In normal operation this switch should always be pushed in to ensure that all the instrument parameters are stored safely when the external power supply is interrupted for any reason. When power is re-established the instrument will continure operation using the last set of stored parameters.

If the instrument is to be stored or left un-powered for any length of time without parameters programmed into the memory, then the switch can be pulled out to avoid draining the standby battery. It should be checked carefully that the switch has been pushed in before attempting to power up the instrument and start entering parameters. Note that whenever this switch is pulled out, all stored parameters will be stored for a minimum period of 20 minutes after which they will be lost. This storage period is to enable easy replacement of the plug-in battery board. (see Section 1.4.3).

SWITCH BANK	SWITCH NUMBER	SWITCH ACTION		SWITCH FUNCTION	
		ON (UP)	OFF(DOWN)		
S2 RIGHT	1	UID range 8-F	UID range 0-7	Instrument Unit identifier (UID) select	
	2	MAN - LOW	Previous mode	Power fail	Fail Mode
		MAN - LOW	MAN-OP unchanged	1-5V out-of-range PV error	
	3	Enable	Disable	I/O slot 4 enable (RPV/ALM option boards)	
	4	Enable	Disable	I/O slot 2 enable (TRIM option board)	
S1 LEFT	1	Inverted Output Display	Normal Output Display	Output Display Inversion (Loops 1-4 only)	
	2 3 4	see	Table 2.2	Baud rate selection switches for RS422 data link	
	5	Binary	ASCII	Protocol mode select	
	6 7 8	4 2 1	0 0 0	2 2 2	Instrument Group identifier (GID)

TABLE 2.1 Analogue I/O Processor Board internal switches S1 and S2 functions

2.3.2 Analogue I/O Processor Board Internal Status Switches

Fig 2.1 shows that the Analogue Input/Output Processor daughter board carries a 4 way and an 8 way DIL switch situated along the top edge. These two switch banks S1 and S2 are used for setting up various internal functions within the 6358 Process Controller to characterise it for a specific control system application. The functions assigned to each of the switches contained within S1 and S2 are listed in Table 2.1 and are detailed below.

NOTE: The functions of some of the switches are related to the use of the supervisory serial data link. Remote supervision and monitoring of TCS microprocessor-based instruments by an external intelligent device is discussed fully in Section 4 of the System 6000 Communications Manual.

SWITCH BANK	SWITCH NUMBER			BAUD RATE	NUMBER OF STOP BITS
	2	3	4		
1	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 2.2 RS422 Supervisory Serial Data Link Baud Rate Selections

a) Switch Bank S1 Functions

The switches on this bank are used as follows:-

(i) Switch no. 1

Switch no. 1 of switch bank S1 is used to provide the facility of Output Display Inversion. This facility applies to loops 1-4 only.

The function applies both to the display of the Controller Output, OP, on the communications links, and to the display on the four digit readout whenever the M, A or R buttons are pressed. The action of S1 no. 1 is as follows:-

S1 no. 1 OFF = Normal display

e.g. if electrical output is at 60% of maximum, then OP reads as 60%.

S1 no. 1 ON = Inverted display

e.g. if electrical output is at 60% of maximum, then OP reads as 40%.

This facility does not affect the control process, only the output display. Indeed, S1 no. 1 can even be altered while in closed-loop control without any effect on the process.

Note

With the Output Display Inversion switch ON, the Raise and Lower push-buttons affect the displayed value. Pressing Raise and M raises the displayed output value and lowers the electrical output. Similarly error conditions that cause the electrical output to fall to a minimum, will result in OP being set to HO.

This facility can only be enabled on all four loops together, and is not available at all on loop 5-8.

(ii) Switches no. 2, 3 and 4

These switches select the baud rate at which the RS422 data link operates. The 8 possible data rates are 110, 300, 600, 1200, 2400, 3600, 4800 and 9600 baud and the required switch settings to obtain them are given in Table 2.2.

(iii) Switch no. 5

This switch selects the operating mode of the serial link communications protocol thus:-

S1 no. 5 OFF = ASCII mode protocol

S1 no. 5 ON = Binary mode protocol

NOTE: All instruments on the RS422 data link must use the same protocol mode.

(iv) Switches no. 6, 7 and 8

In a large Supervisory Control system many System 6000 instruments may be connected to the central computer via a single serial data link. In such a configuration each instrument must have a unique identity so that when the computer sends a message to a particular instrument, only the unit with that identity will reply. When a 6358 Controller is connected to the RS422 data link, it is addressed by the supervisory computer as 8 separate devices or units, each of which correspond to an individual control loop. The hardware of the 6358 allows up to 128 control loops, i.e. 16 instruments, to be uniquely identified via 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 of this address are called the Group Identifier (GID). Conceptually each control loop within the 6358 is addressed as a separate unit so that the instrument occupies up to 8 consecutive unit addresses. Consequently only the top bit of the UID is set in the 6358 by switch no. 1 of switch bank S2, while the bottom 3 bits are used by the computer to select which of the 8 input/output blocks are being accessed (see Section 2.3.2 b) (i)).

The 3 Group Identifier (GID) bits are selected by means of switches 6, 7 and 8 of switch bank S1. Table 2.1 shows that the binary weighting of each switch is 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 - 7.

b) Switch Bank S2 Functions

The switches on this bank are allocated to the following functions.

(i) Switch no. 1

This switch represents the most-significant bit of the UID and a four bit UID allows 16 units to be addressed within a group. Hence this switch places the 8 loops of a 6358 in the upper or lower half of a group, thus:-

S2 no. 1 OFF, UID = 0-7

S2 no. 1 ON, UID = 8-F

As the UID transmitted by the computer varies from binary 0 to F (15) the top bit is used to select one of two 6358 Controllers within a group depending on the S2 no. 1 switch setting. The bottom 3 bits then effectively select which of the 8 loops within the selected 6358 is actually being addressed. This addressing scheme is illustrated in Table 2.3 which shows that if a UID of A were transmitted, for example, this would access loop 3 of the second 6358 Controller in the group.

(ii) Switch no. 2

This switch is used to select which mode the 6358 Controller will operate in after a power failure or the detection of an open-circuit Process Variable input as follows:-

A) Return mode after power failure

Normally, after an input power failure all loops will resume operation in the same control modes and using the same loop parameters as were current before the failure occurred (see Section 2.5.2). However, in certain applications it would be a requirement that the loops always revert to the Manual Mode after a power failure regardless of the previous operating mode. Consequently, switch no. 2 can be used to select the operation of the loops after power failure as follows:-

S2 no. 2 - OFF

In this case all loops resume operation in the mode in which they were operating just prior to the power failure.

SWITCH BANK S2 SWITCH NO 1	UID TRANSMITTED	CONTROL LOOP ACCESSED	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 2.3 Relationship between the transmitted UID and the control loop addressed with two 6358 Process Controllers on the same Group address

S2 no. 2 - ON

In this case all loops resume operation in the MANUAL mode, with the electrical controller outputs set low. Where output display inversion is selected, then on loops 1-4, OP is set to HO.

B) Mode selected after out-of-range PV detection

Switch 2 is also used to select the action a loop takes upon detecting an out-of-range Process Variable input (see Section 2.6.2 h)). Once this condition has been detected the loop will enter the FORCED MANUAL Mode, and the tag display will show the message 'Ln OR ER' (where n is the loop number). Also, if this loop is the current front panel loop, the Manual LED will flash to indicate the faulty input and the digital display will show only the lower horizontal bar of each digit. If the loop was operating in the AUTO or REMOTE AUTO modes when the fault occurred, the subsequent control action can be selected as follows:-

S2 no. 2 - OFF

In this case the 3-Term Control output will remain at the last calculated level prior to the fault condition occurring.

S2 no. 2 ON

In this case the electrical output of the loop will be set low. Where output display inversion is not selected, this results in OP being set to LO. Where output display inversion is selected, then on loops 1-4, OP is set to HO.

Note that when a loop is in this FORCED MANUAL operating condition all the operating characteristics of Section 3.1.2 and 3.1.3 still apply e.g. the Output can be raised or lowered and so can the Local Setpoint. The only difference is that it is not possible to select any other operating mode via the Front-panel push-buttons until the out-of-range input condition has been corrected.

(iii) Switch no. 2

Not used.

(iv) Switch no. 3 and 4

These are set to enable the optional I/O boards (if fitted) in slots 4 and 2 respectively.

2.3.3 Mother Board Jumpers (LK1-8)

The row of 8 jumpers situated between I/O slots 3 and 4 (connectors 4 and 5) on the Mk2 Mother Board should be factory fitted with 8 shorting plugs (LK1-8) for all 6358 options except the 4-20mA output option (MA).

2.4 Plant and Other External Connections

Appendix A lists the functions of the rear connector pins of the 6358 Process Controller. For correct operation of the instrument in a system it is necessary that external plant and equipment is connected up to it in the following manner.

2.4.1 Power Supplies

Connection of the 0V ref., 0V power and +24V supply rails of pins 2, 3 and 8 respectively are fully dealt with in the System 6000 Installation Guide Section 5.

2.4.2 Analogue Inputs

Each control loop within the 8-Loop Controller is provided with one analogue input for the Process Variable signal using rear connector pins 10 to 17 inclusive. These inputs accept 0-10V or 1-5V signal levels as described in Section 4.3.4 (LT parameter).

When the TRIM option is specified a second analogue input board is fitted to the 6358 in the slot 2 position. This provides an extra analogue input for each loop using rear connector pins 18 to 25 inclusive. These inputs may be interpreted as either a Setpoint Trim or Remote Setpoint signal, as described in Section 4.3.4 (LT parameter).

When this board is fitted, switch no. 4 of switch bank S2 must be in the ON position.

2.4.3 Analogue Outputs

Each control loop within the 8-Loop Controller is normally provided with one analogue output for the 3-Term Control signal using rear connector pins 26 to 33 inclusive. These outputs are 0-10V signals. However, with the TPO option, this is replaced by a digital output.

When the RPV option is specified, a second analogue output board is fitted to the 6358 in the slot 4 position. This provides an extra analogue output for each loop using rear connector pins 34 to 41 inclusive. These outputs are used to re-transmit the Process Variable for each loop after filtering and linearisation.

When this board is fitted, switch no. 3 of switch bank S2 must be in the ON position.

When the MA option is specified an 8 channel 4-20mA board is fitted to the 6358 in the slot 4 position and the 8 jumpers on the Mother Board are removed (LK's 1 to 8). This then causes the 8 output signals on rear connector pins 26 to 33 inclusive to become 4-20mA 3-Term outputs instead of 0-10V signals. The 8 rear connector pins 34 to 41 inclusive are then used for the 4-20mA return current connections referred to 0V power.

2.4.4 Digital Outputs

When the ALM option is specified, a digital output board is fitted in the slot 4 position of the 6358. This provides a common deviation alarm output for each loop using rear connector pins 34 to 41 inclusive. These alarm outputs use 0 and 15V logic levels with 15V representing the safe condition and consist of open-collector type TTL gates. Each output is provided with a 2k2 pull-up resistor to the +15V rail and can sink a maximum current of 16mA in the logical zero (alarm) state.

When this board is fitted, switch no. 3 of switch bank S2 must be in the ON position.

When the TPO option is specified, a digital output board is fitted in the slot 3 position of the 6358. This provides a time-proportioned output in place of the standard analogue controller output. With this board fitted OP is used to set the ON pulse duration expressed as a percentage of the cycle length.

2.4.5 Serial Data Bus

For a full description of the Serial Data Bus, including discussions of:

Interface Connections,
Cable Impedance and Termination,
and Interface Signal Polarity

refer to the System 6000 Installation Guide Section 7.

2.5 Instrument Power-Up Sequence

There are two possibilities that can occur when the 6358 8-Loop Controller is connected to an external power supply and these are as follows:-

2.5.1 Power-Up from Initial Un-programmed State

When the Controller is first powered-up before any parameters have been programmed, the parameter storage area of the non-volatile memory will be empty. The first thing that the CPU does after the power-up sequence has been completed is to check the memory for stored sumcheck patterns. These sumchecks are only updated as parameters are entered into the memory so this check will cause a memory error condition to occur upon initial power-up. Consequently the CPU will force the controller to behave as for MEMORY SUMCHECK FAIL conditions as described in Sections 2.6.2 f) and g).

2.5.2 Power-Up from a Previously Programmed State

If the power supply to a controller is interrupted during its normal working state then all the parameters will be stored in the non-volatile memory area, provided that the standby battery is properly connected (see Section 2.3.1). Upon subsequent re-establishment of the power supply the CPU will verify the stored memory sumcheck values. This test should be carried out successfully and the CPU will then return the controller to exactly the same set of operating conditions as were present before the power interruption.

INSTRUMENT FAULT	DIAGNOSTIC MESSAGE	PRIME VARIABLE DISPLAY	OPERATING MODE CHANGE	COMMAND PARAMETER INDICATION	ERROR RECOVERY PROCEDURE
Watchdog (hardware) failure	None	Blanked	Analogue outputs are not updated	All comms. disabled	Replace Instru-ment
Front-Panel hardware fault	FP ERROR	No change	HHT and push-buttons disabled	MD bit 6 set to 1;	Replace Front-Panel board
I/O board 1 hardware fault (Process Variables)	B1 HW ER	Err	Forced MANUAL; 3-term outputs all set electrical low	S1 bit 12 set to 1; MD bit 12 set to 1;	Replace slot 1 board
I/O board 2 hardware fault (TRIM option)	B2 HW ER	No change	REM AUTO reverts to AUTO FALL-BACK only	S2 bit 12 set to 1; MD bit 12 set to 1;	Replace slot 2 board or set S2 no. 4 OFF
I/O board 3 hardware fault (3-term control)	B3 HW ER	Err	Forced MANUAL; 3-term O/Ps not updated	S3 bit 12 set to 1; MD bit 12 set to 1;	Replace slot 3 board
I/O board 4 hardware fault (RPV, ALM option)	B4 HW ER	No change	No B4 An. outs are updated; All B4 Dig. outs set to 0V	S4 bit 12 set to 1; MD bit 12 set to 1;	Replace slot 4 board or set S2 no. 3 OFF

TABLE 2.4 6358 Instrument Diagnostics

2.6 6358 Hardware Diagnostic Facilities

The 6358 incorporates a number of diagnostic facilities for continuously monitoring and checking the status of the Instrument hardware during operation. Each of these diagnostic facilities provides the following features:-

a) Indication and identification of the fault via the 3 operator interfaces, viz:-

   (i) Front-panel display indication
   (ii) Local indication via rear connector logic signals
   (iii) Remote indication via the serial data links.

b) Well defined shut-down procedures for each type of fault with the instrument taking up pre-determined operating conditions to maximise plant safety.

c) Automatic restart under certain transient fault conditions.

Table 2.4 lists the 8 major instrument faults that can occur and shows that they have a number of common characteristics, viz:-

a) Certain faults are indicated by an appropriate message on the 8 character alphanumeric display.

b) Certain faults affect the large 4 digit Process Variable display.

c) Certain faults affect the 6358 Operating mode in a controlled "fail-safe" manner.

d) Each fault sets various status bits within the Command Parameters so that the condition can be monitored remotely via the supervisory data link.

e) Each of the faults has a well-defined error recovery procedure allowing the operator to quickly identify and rectify a fault condition.

The diagnostic facilities listed in Table 2.4 are described in the following sections.

INSTRUMENT FAULT	DIAGNOSTIC MESSAGE	PRIME VARIABLE DISPLAY	OPERATING MODE CHANGE	COMMAND PARAMETER INDICATION	ERROR RECOVERY PROCEDURE
Instrument parameter sumcheck failure	IP SC ER	No change	All loops enter forced MANUAL	MD bit 8 set to 1; > set to * in list of parameters	Set MD bit 8 to 0; re-enter corrupted parameters
Control loop parameter sumcheck failure (Ln = 1 to 8)	Ln SC ER (Ln=loop number)	No change	Loop Ln enters forced MANUAL with O/P set to zero (real sumcheck only)	ST digit F set to 1; MD bit 13 set to 1; >, –, . set to * in list of parameters	Set ST bit 3 to 0 for loop Ln; re-enter corrupted parameters
1 to 5V Process Variable input out of range	Ln OR ER (Ln=loop number)	PV >5.5V PV <0.5V	Loop Ln enters forced MANUAL O/P depends on switch 2/2	ST bit 2 set to 1; MD bit 10 set to 1;	Restore Process Variable input to 1-5V range
Battery voltage low	None	Unused decimal points flash	No change	MD bit 11 set to 1	Replace battery

TABLE 2.4 6358 Instrument Diagnostics (contd.)

2.6.1 Watchdog Timer

The CPU card incorporates a Watchdog Timer circuit which has to be refreshed periodically by the CPU to maintain correct operation, as described in Section 1.4.2. If the CPU fails to refresh the Watchdog at the normal rate due to some fault condition, the following actions occur:-

a) All the Front-panel displays are extinguished except for the 8 character alphanumeric readout. This provides immediate visual indication to the operator.

b) The WATCHDOG TIMER logic output on pin 9 of the rear connector is reset from 15V to 0V to indicate the fault condition and will stay low as long as the fault persists. This feature allows the pin 9 output to be used for external alarm monitoring purposes or for switching in Manual back-up systems etc.

c) All 8 outputs of the optional digital output board fitted in I/O slot 4 (ALM) are reset from 15V to 0V to indicate the fault condition and will stay low as long as pin 9 is at 0V.

d) The 'sample and hold' circuitry is forced into the 'hold' state so that all 8 outputs of the analogue output boards fitted in I/O slots 3 or 4 (RPV option) will retain the last voltage level set by the CPU before the Watchdog tripped out. Under these conditions the capacitors are not refreshed by the DAC and an output drift rate of up to 0.5mV/sec maximum may occur (equivalent to a drift of 1% of full scale in 3 minutes worst case).

While the Watchdog is tripped out, a circuit automatically attempts to restart the instrument at approximately 10ms intervals, using the same restart procedure as when the 6358 is first powered up. Consequently there are three possibilities that can occur after each restart attempt:-

(i) If the failure was due to a transient fault without loss of memory the Controller will re-start automatically as described in Section 2.5.2. The Watchdog output, pin 9, is reset to 15V by the CPU about 30ms after the restart occurs.

(ii) If the failure was due to a transient fault which has corrupted the memory, then the Controller will restart automatically as described in Section 2.5.1. The Watchdog output will again be reset to 15V after a 30ms period.

(iii) If the failure was due to a permanent hardware fault such as a damaged integrated circuit, then the CPU will not be able to refresh the Watchdog and the pin 9 logic output will remain at 0V.

2.6.2 Instrument Diagnostic Messages

The 6358 8-Loop Controller software continually monitors various functions within the instrument, apart from the Watchdog and Battery checking described in Sections 2.6.1 and 2.6.3. These additional diagnostic functions are listed in Table 2.4 where it can be seen that each one is capable of displaying a diagnostic message on the upper alphanumeric readout, e.g.

B2 HW ER

These messages will flash alternately with the name or identity of the loop currently being displayed on the front-panel.

The 6358 hardware incorporates data input/output ports on the Front-panel, Analogue I/O processor, and Input/Output daughter boards of Section 1.4.1, 1.4.4, and 1.4.5 respectively. Before the CPU carries out a data transfer to or from any of these ports, the hardware itself is checked. This is done by connecting a bit from each output port back to a spare bit on the corresponding input port. The CPU then checks that these test bits can be set or reset correctly before each port is used for a data transfer. If any input/output port fails this hardware check the appropriate diagnostic message a) to h) is displayed. All the diagnostic messages produced by the 6358 (shown in Table 2.4) are described briefly below.

a) Front-Panel Hardware Fault

When the CPU finds that it cannot communicate correctly with the data I/O ports on the front-panel board, it attempts to flash the diagnostic message:-

FP ERROR (Front Panel hardware Error)

The Process Variable display is unchanged but all the Front-panel push-buttons and the Hand-held terminal socket are disabled. The 'MD' parameter has bit 6 set to logic 1 and the fault may only be corrected by replacing the front-panel board.

b) Input/Output Board 1, Hardware Fault

When a hardware fault is detected on the Analogue Input board fitted to I/O Slot 1, the following message is displayed on the alphanumeric readout:-

B1 HW ER (Board 1 Hardware Error)

Since this board monitors all the Process Variable signals the 4 digit readout will display the following:-

Err

Under these conditions, all the control loops enter the forced MANUAL mode with the 3-Term outputs forced to the low electrical limit.

The fault is indicated via the RS232 and RS422 serial links by setting bit 12 of the S1 parameter to a logic one. The Common Hardware Alarm, bit 12 of the MD command parameter, is also set to a logic one. The fault can be rectified by replacing the faulty board in slot 1.

c) Input/Output Board 2 Hardware Fault

When the TRIM option is specified an Analogue Input board is fitted in the I/O slot 2 position. If a hardware fault is detected on this board the following message is displayed on the alphanumeric readout:-

B2 HW ER (Board 2 Hardware Error)

Since this board is used for an optional Setpoint Trim or Remote Setpoint input, a hardware fault will not affect the Process Variable display. If the 6358 Operating mode was REMOTE AUTO then it will revert to the AUTO FALL-BACK mode, if it was in AUTO or MANUAL, however, then no mode change occurs.

The fault is indicated via the RS232 and RS422 serial links by setting bit 12 of the S2 parameter to a logic one. The Common Hardware Alarm, bit 12 of the MD parameter, is also set to a logic one. The fault can be rectified by replacing the faulty board in Slot 2 with a working board, but the error indications may be inhibited by setting S2 no. 4 to the OFF position.

d) Input/Output Board 3 Hardware Fault

When a hardware fault is detected on the analogue or digital output board fitted to I/O slot 3 the following message is displayed on the alphanumeric readout:-

B3 HW ER (Board 3 Hardware Error)

Since this board provides the 3-term control output signals, it follows that whenever the operator attempts to display the output level by pressing the Manual (M), Auto (A), or Remote (R) push-button, the 4 digit readout will display the following:-

Err

Under these conditions all the control loops enter the forced MANUAL operating mode and each output is put into a 'hold' state as for a Watchdog failure of section 2.6.1 d). The fault is indicated via the RS232 and RS422 serial links by setting bit 12 of the S3 parameter to a logic one. The Common Hardware Alarm, bit 12 of the MD parameter, is also set to a logic one. The fault can be rectified by replacing the faulty board in Slot 3.

e) Input/Output Board 4 Hardware Fault

When the RPV, ALM or MA options are specified an analogue, digital or current output board respectively is fitted in the I/O slot 4 position. If a hardware fault is detected on any of these boards the following message is displayed on the alphanumeric readout:-

B4 HW ER (Board 4 Hardware Error)

Since these boards are used for optional re-transmitted Process Variables or Deviation Alarms, a hardware fault will not affect the 4 digit readout or the 6358 operating mode. If the faulty board is an analogue output type (RPV option) all 8 outputs will be put into a 'hold' state as for a Watchdog failure of section 2.6.1 d). If the faulty board is a Digital Output type (ALM option) all 8 outputs will be set to 0V as for a Watchdog failure of Section 2.6.1 c).

The fault is indicated via the RS232 and RS422 serial links by setting bit 12 of the S4 parameter to a logic one. The Common Hardware Alarm, bit 12 of the MD parameter, is also set to a logic one. The fault can be rectified by replacing the faulty board in slot 4 with a working board, but the error indication may be inhibited by setting S2 no. 3 to the OFF position.

f) Instrument Parameter Sumcheck Failure

The 6358 Controller maintains a separate sumcheck of the set of Instrument Parameters that are entered and stored in the non-volatile memory area. Any corruption of these stored parameters will cause the subsequently calculated sumcheck to differ from the stored sumcheck value. When the CPU detects this failure condition, the following message is displayed on the alphanumeric readout:-

IP SC ER (Instrument Parameters Sumcheck Error)

Table 2.4 shows that under these conditions the 4 digit readout is unaffected but all active control loops enter the FORCED MANUAL operating mode. Bit 8 of the 'MD' instrument status parameter is set to logic 1 and all the instrument parameters will have the greater-than sign (>) replaced by an asterisk (*) when read back via the Hand-held terminal or the supervisory data link using the ASCII mode of the communications protocol.

If the sumcheck error was due only to a transient memory corruption then it can be corrected by resetting bit 8 of the 'MD' parameter to logic 0. The Instrument Parameters should first be checked for possible corruption and re-entered where necessary. The control loops will then be released from the FORCED MANUAL condition and operation will continue as normal.

If the sumcheck error was due to a permanent hardware fault it will not be possible to reset bit 8 of the 'MD' parameter and the operating conditions given in Table 2.4 will prevail. The error can, in this case, be corrected by replacing the memory board with a new unit.

g) Loop Parameter Sumcheck Failure

The 6358 Controller maintains a separate sumcheck of each of the 8 sets of control loop parameters that are entered and stored in the non-volatile memory area. Any corruption of these stored parameters will cause the subsequently calculated sumcheck to differ from the stored value. When the CPU detects this condition, the following message is displayed on the alphanumeric readout.

Ln SC ER (Loop Ln parameters Sumcheck Error)

Where Ln is the number of the loop which has the sumcheck error. Table 2.4 shows that under these conditions the 4 digit readout is unaffected, but control loop Ln is forced into the MANUAL operating mode. Bit 3 of the loop status word 'ST' for loop Ln will be set to logic 1 to indicate the sumcheck failure, and as the loop is in forced MANUAL, ST digit D will read back as F (see Section 4.4.1 d)). Bit 13 of the 'MD' status word will also be set to logic 1. All associated parameters of loop Ln will have the greater-than (>), minus (-) or decimal point (.) signs replaced by an asterisk (*), when read back via the Hand-held terminal or supervisory data link using the ASCII mode of the communication protocol.

If the sumcheck error was due only to a transient memory corruption then it can be corrected by resetting bit 3 of the appropriate 'ST' loop parameter to logic 0. The parameter list of loop Ln should first be checked for possible corruption and re-entered where necessary. Control loop Ln will then be released from the FORCED MANUAL condition and operation will continue as normal.

If the sumcheck error was due to a permanent hardware fault it will not be possible to reset bit 3 of the 'ST' parameter of loop Ln and the operating conditions given in Table 2.4 will prevail. The error can in this case be corrected by replacing the memory board with a new unit.

h) 1-5V Analogue Inputs Out of Range

The 6358 Controller has the facility to programme individual control loops to accept 1-5V Process Variable inputs by setting the appropriate status bits in the LT parameter of Section 4.3.4.

When any of the 8 loops has been set-up for 1-5V operation, the CPU checks that the signal level lies within range. As soon as the Process Variable is detected as having gone out of range, the 3-Term output for that control loop is put into a 'hold' state for 3 seconds, that loop of the 6358 continues in its current operating mode. A 3-term balance is performed so that the 3-term output is restored from the 'hold' state in a bumpless manner.

If the out-of-range condition still exists after the 3 seconds the CPU causes the following actions to occur:-

(i) Loop Ln of the Controller will enter the FORCED MANUAL operating mode as described in Section 3.1 with the Manual (M) push-button LED flashing to indicate the fault condition to the operator.

(ii) The 3-Term Control Output of Loop Ln will be affected as follows:-

A) If the Control loop was operating in the MANUAL mode or switch S2 no. 2 is OFF the 3-Term Control Output will remain at the level set just prior to the occurrence of the fault condition.

B) If the Control loop was operating in the local AUTO or REMOTE AUTO modes and switch S2 no. 2 is ON the 3-Term Control Output will be set to the value of the 3-Term Control output Low Limit parameter, LO, of Section 4.4.7.

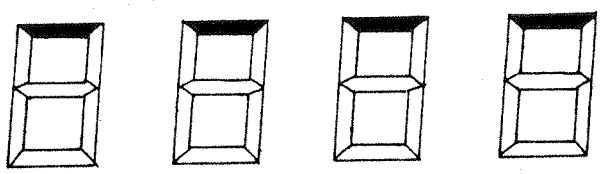
In both of these cases the 3-Term Control output level can be altered by means of the Front-panel Raise/Lower push-buttons.

(iii) Table 2.4 shows that when the PV of Loop Ln lies outside the range 0.5V to 5.5V the following message is flashed on the alphanumeric readout:

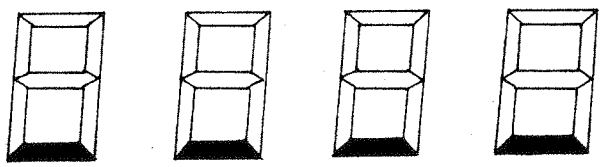
Ln OR ER (Loop Ln Out of Range Error)

(iv) Table 2.4 shows that under these conditions when loop Ln is selected for display on the front-panel, the Process Variable readout will indicate the following:-

A) If the PV signal is greater than 5.5V, then only the top bars of each 7-segment display will be illuminated indicating 'input over-range', i.e.:-



B) If the PV signal is less than 0.5V, then only the bottom bars of each 7-segment display will be illuminated indicating 'input under-range', i.e.:-



(v) Table 2.4 shows that the Common out of Range Alarm, bit 10, of the MD parameter will be set to logic one as described in Section 4.3.9 a) (vi).

To release the control loop from the FORCED MANUAL operating mode the Process Variable signal must be restored to a value within the range of 1-5V. Only when this has occurred will the CPU cause the following actions to take place:-

(i) Loop Ln of the Controller will revert to the normal MANUAL operating mode of Section 3.2 with the Manual (M) push-button LED steady.

(ii) Any other operating modes can be selected as required.

(iii) The alphanumeric display reverts to indicating the loop identity tag.

(iv) The Process Variable readout reverts to displaying the PV in Engineering Units over the range 1L to 1H.

(v) Bit 10 of the MD parameter is reset to zero provided that no other loops have an out-of-range condition present.

NOTE: If the 6358 is used with 1-5V signals or 4-20mA signals (with burden resistors) the out-of-range detection described above will indicate open-circuit Process Variable inputs.

2.6.3 Standby Battery Check

The memory daughter board incorporates a long life Lithium standby battery which powers the RAM circuits when the external power supply has failed or is interrupted for any reason (see Section 1.4.3). A comparator on the Analogue I/O Processor board is monitored every 500ms and will indicate a failure if the battery voltage falls below 2.7 volts. Should a battery failure be detected the CPU takes the following actions:-

a) All the unused decimal points on the Front-panel digital readout are flashed continuously to warn an operator of the battery condition.

b) The Battery Voltage Low bit of the 'MD' status word, bit 11, is set to 1.

These indications will continue to be operative until the battery on the Memory board is replaced by a new unit. When the Controller is subsequently powered up, the CPU immediately starts with a battery voltage test and, if this is successful, the following actions are taken:-

a) Only the decimal point programmed via digit A of the ST status word (see Section 4.4.1 a)) will be illuminated, the others will remain off.

b) All parameters stored in the non-volatile memory will have been lost, so the instrument will behave as if powered up from an initially un-programmed state (see Section 2.5.1). The CPU will thus force a memory sumcheck failure condition and the operator must re-program the instrument as detailed in Sections 2.6.2 f) and g).

2.7 Use of the 6358 with 4-20mA Input Signals

The 6358 8-loop Controller has the facility to program any of the 8 Process Variable inputs to accept 1-5V signal levels by setting the appropriate status bits in the LT parameter of Section 4.3.4. Once any Process Variable has been set up in this way it can be used with 4-20mA input signals provided that a 250 ohm precision resistor is used to convert this to a 1-5V signal. When these external resistors are used it is very important that they are connected in a manner that does not inject current into the 0V reference bus and so degrade the system 0V reference. (See the System 6000 Installation guide Section 6.2 for a fuller description of the use of TCS instrumentation with 4-20mA Input signals).

2.8 Use of the 6358 with 4-20mA Output Signals

The 6358 8-loop controller has the facility to produce 4-20mA controller output signals. A current output board is inserted in slot 4 in addition to the standard analogue output in slot 3, and the motherboard links mounted between slots 3 and 4 are removed. In this configuration the 4-20mA controller output send line is from slot 3, and the return line is to slot 4.

Section 3 6358 Process Controller Operating Modes

The 6358 Process Controller is capable of operating in one of 5 different control modes. These modes are listed below in descending priority order:-

CONTROL MODE	PRIORITY ORDER
FORCED MANUAL	1 - highest
MANUAL	2
AUTO (Local Setpoint)	3
REMOTE AUTO	4
AUTO FALL-BACK	5 - lowest

The operating modes as listed are described in priority order in the next 5 sub-sections of Section 3. Each operating mode has a truth table, such as Table 3.1.1, showing which combinations of Front-panel push-button selections, status switches, and status bits produce that particular mode. A second table, such as Table 3.1.2, then shows the effect that the operating mode has on the Front-panel push-button LEDs. The effects that the Raise/Lower buttons are allowed to have on the Local Setpoint is listed, while their action on the Controller output is also indicated separately.

The 6358 Process Controller implements 8 control loops each with separately programmable characteristics. For the purpose of explanation of 6358 operating modes and applications, it is only necessary to consider one of the eight loops. Unless specifically mentioned, all further discussions concerning a control loop are generally applicable to all active loops.

CATEGORY			STATE
Push-buttons	MANUAL AUTO REMOTE/RATIO	(M) (A) (R)	X X X
Switch bank S2 , switch number 4 Input/output slot number 2 daughter board LT parameter loop bit (high byte) Loop Process Variable (1 - 5V operation only)			X X X 0.5V or 5.5V

TABLE 3.1.1 6358 FORCED MANUAL mode entry conditions

CATEGORY			STATE
Push-button LEDs	MANUAL AUTO REMOTE/RATIO	(M) (A) (R)	FLASH OFF OFF
Local Setpoint action			Raise/Lower
3-Term Control output action			Raise/lower

TABLE 3.1.2 6358 FORCED MANUAL mode operating characteristics

KEY

X = don't care

3.1 Forced Manual Mode

3.1.1 Forced Manual mode entry conditions

The 6358 Controller will enter the FORCED MANUAL operating mode when any of the following conditions occur :-

a) A MEMORY SUMCHECK FAILURE condition is detected either at power-on or during operation as described in Section 2.6.2 f) and g).

b) A Process Variable out-of-range condition is detected with a 1-5V Process Variable analogue input as shown in Table 3.3.1 and described in Section 2.6.2 h).

c) A board 1 or board 3 hardware error is detected as described in Section 2.6.2 b) and d).

The FORCED MANUAL condition overrides all other operating modes. The following Front-panel indications are operative in FORCED MANUAL:-

a) The yellow Manual Mode (M) push-button LED flashes continuously.

b) Digit D of the ST status word will stay at F for condition a) or 7 for conditions b) or c).

3.1.2 Forced Manual Mode operating characteristics

The operating characteristics of a Controller in the FORCED MANUAL mode are identical to those of the normal MANUAL mode given in Section 3.2.2. The only difference seen by an operator is that it is not possible to exit from this mode by pressing another push-button while the entry conditions of Section 3.1.1 persist.

3.1.3 Local Setpoint updating in Forced Manual Mode

Table 3.1.2 shows that the Local Setpoint can be updated in FORCED MANUAL mode in exactly the same way as for normal MANUAL mode described in Section 3.2.3.

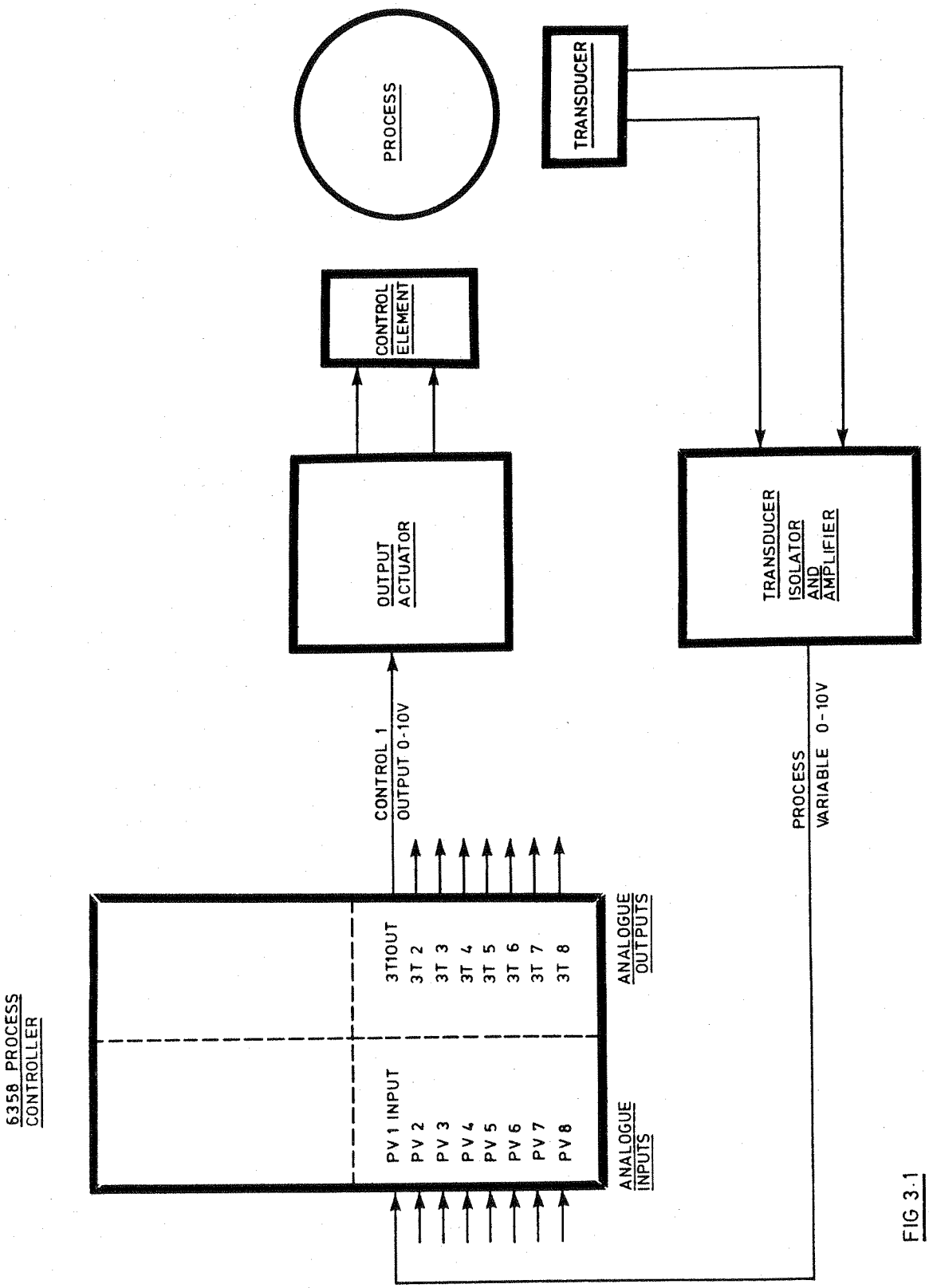


FIG 3.1
TYPICAL CONTROL LOOP CONFIGURATION FOR MANUAL OR LOCAL AUTO MODES

3.2 Manual Mode

Fig 3.1 illustrates how a 6358 Controller may be configured within a control loop to function as a conventional Manual or Operator station. The Controller must be operating in the Manual mode when used in this way. Means of achieving this and the operating characteristics obtained are listed in the following sections.

3.2.1 Manual Mode Entry Conditions

It can be seen from Table 3.2.1 that the control loop will enter the normal MANUAL operating mode when either of the following conditions occur:-

a) The MANUAL mode (M) push-button was the last one pressed.

b) Digit D of the ST status word is set to 4 for a given loop, either via the Hand-held terminal or the RS422 data link (see Section 4.4.1 d))

Thus the MANUAL mode is the second highest priority operating condition. While operating in MANUAL the following Front-panel indications and command parameter status bit settings apply:-

a) The yellow Manual Mode (M) push-button LED is illuminated.

b) Digit D of the ST status word will read back as 4.

3.2.2 Manual Mode Operating Characteristics

While in the normal MANUAL mode Table 3.2.2 shows that the 6358 exhibits the following operating characteristics:-

a) The 3-Term Control Output, is continuously maintained by the CPU at the level that existed at the instant of switching over from any previously selected operating mode.

b) The 3-Term Control output level may be inspected as a 4 digit number in the range 0 to 99.99% on the digital readout by holding in the Manual Mode (M) push-button. While this push-button is held in an operator may alter the 3-Term Control output level by means of the Raise/Lower buttons. The buttons have an accelerating action and will Raise/Lower the 3-Term Output through the full 100% range in approximately ten seconds. Releasing either of these buttons causes the acceleration to be reset to the initial rate allowing very small incremental changes to be made to the 3-Term output level by repeatedly pressing and releasing the appropriate button. These Raise/Lower buttons have no effect on the Output level unless the Manual (M) button is held in. If inadvertently all 3 buttons are pressed at the same time the 6358 will inhibit all of them and put the 3-Term output into a temporary Hold state.

CATEGORY			STATE
Push-buttons	MANUAL AUTO REMOTE/RATIO	(M) (A) (R)	ON OFF OFF
Switch bank S2 , switch number 4 Input/output slot number 2 daughter board LT parameter loop bit (high byte) Loop Process Variable (1 - 5V operation only)			X X X 1-5V

TABLE 3.2.1 6358 MANUAL mode entry conditions

CATEGORY			STATE
Push-button LEDs	MANUAL AUTO REMOTE/RATIO	(M) (A) (R)	ON OFF OFF
Local Setpoint action			Raise/Lower
3-Term Control output action			Raise/lower

TABLE 3.2.2 6358 MANUAL mode operating characteristics

KEY

X = don't care

c) If a Process Variable out-of-range condition (see Section 2.6.2 h)) should occur the Controller will enter the FORCED MANUAL mode of Section 3.1 and operation will be as described in Section 3.1.2.

d) If the Process Variable signal is connected to the Channel 1 analogue input, as indicated in Fig. 1, then with no push-buttons held in this signal will be displayed on the digital readout in engineering units as described in Section 3.2.4 b).

It should be noted that the 3-Term Control algorithm continuously adjusts the integral term so that upon subsequent selection of the AUTO or REMOTE AUTO operating modes the transfer will occur in a bumpless and procedureless manner.

3.2.3 Local Setpoint Updating in Manual Mode

In the MANUAL mode, the Resultant Setpoint (SP) is the Local Setpoint value (SL) after any Trim has been applied as described in Section 3.6. The Local Setpoint remains constant when not in AUTO. Table 3.2.2 shows that the Raise/Lower push-buttons can be used to alter the Local Setpoint provided that the Display Setpoint button (SP) is held in at the same time.

The Raise/Lower buttons have the same accelerating effect on the Setpoint as on the Output described previously. It should be noted, however, that as long as the SP button is depressed the Raise/Lower buttons only affect the Local Setpoint and not the Controller Output level. Also, Local Setpoint changes are permitted via either of the serial data links at all times.

3.2.4 Programming Parameters in Manual Mode

In order that a control loop of the 6358 Process Controller can function correctly in the MANUAL mode it is necessary to programme certain control loop parameters into it using the procedures described in Section 4. The minimum number of parameters that are required to obtain operation at each level of Manual control are listed as follows:-

a) Raise/Lower Control of Output Level

In order that the Raise/Lower push-buttons can control the output level, two parameters are required thus:-

HO, LO - Control output High and Low Limit (see Section 4.4.7)

The Output can then be altered within these two limits.

CATEGORY			STATE
Push-buttons	MANUAL AUTO REMOTE/RATIO	(M) (A) (R)	OFF ON OFF
Switch bank S2 , switch number 4 Input/output slot number 2 daughter board LT parameter loop bit (high byte) Loop Process Variable (1 - 5V operation only)			X X X 1-5V

TABLE 3.3.1 6358 AUTO mode entry conditions

CATEGORY			STATE
Push-button LEDs	MANUAL AUTO REMOTE/RATIO	(M) (A) (R)	OFF ON OFF
Local Setpoint action			Raise/Lower
3-Term Control output action			Computed 3-term value

TABLE 3.3.2 6358 AUTO mode operating characteristics

KEY

X = don't care

c) When no push-buttons are held in the Front-panel digital readout will display the Process Variable (PV) in Engineering units as described in Section 3.2.4 b).

d) If a 1-5V out-of-range error condition is detected on the Process Variable analogue input, the Controller will enter the FORCED MANUAL mode of Section 3.1 and operation will be as described in Section 3.1.2.

e) If the value of (PV - SL) is greater than the deviation limit parameter DD (deviation display parameter), the upper front panel LED for the given loop will be ON. Similarly, if the value of (SL - PV) is greater than DD, the lower front panel LED will be ON. These provide programmable symmetrical, high and low deviation indications respectively.

f) In a similar manner to that described in e), the upper and lower LEDs will be ON, but flashing for the conditions of deviations greater than DA (deviation alarm parameter). If either of the upper or lower LEDs are flashing, the digital output for the given loop will be active, (if the optional digital output card is fitted), providing a common alarm output for each loop.

g) In certain Control loop configurations it may be required to invert the sense of the 3-Term output to compensate for an output actuator characteristic. To achieve this condition the appropriate bit must be set in the most significant byte of the LI parameter as described in Section 4.3.5. However, the Digital readout will display the true 3-Term output as a percentage regardless of the setting.

   The sense of the output display of loops 1-4 may be inverted (without affecting the control action) by setting switch no. 1 of switch bank S1 to the ON position (see Section 2.3.2 a (1).

The 3-Term Control algorithm continuously adjusts the Integral term so that transfer to any other control mode will occur in a bumpless and procedureless manner.

3.3.3 Local Setpoint Updating in Automatic Mode

In the AUTO mode, the Resultant Setpoint (SP) is the Local Setpoint value (SL) after any Trim has been applied as described in Section 3.6. The Local Setpoint can always be updated via either of the serial data links in this mode. When the Display Setpoint button (SP) is depressed the Front-panel digital readout displays the Local Setpoint and the Raise/Lower buttons can then be used to alter it in the same way as in MANUAL (see Section 3.2.3). When in AUTO, however, the Raise/Lower buttons can only operate on the Local Setpoint and are inhibited when the SP button is not held in. If by accident the Raise and Lower buttons are pressed simultaneously, then the Controller will inhibit both of them and put the Local Setpoint into a temporary Hold state as if neither were pressed.

3.3.4 Programming Parameters in Automatic Mode

In order that a control loop of the 6358 Process Controller can function correctly in the AUTO mode, it must first have all the control loop parameters programmed as for the MANUAL mode sections 3.2.4 a), b) and c). Then in addition the following are required:-

a) 3-Term Control Algorithm Characteristics

If the Process Variable is likely to have superimposed noise then an input filter should be specified thus:-

ST, digit C - Input channel filter constant (see Section 4.4.1 c))

To characterise a particular control loop the following parameters must be entered:-

XP - Proportional band constant (see Section 4.4.8) Setting XP = 0 initiates ON/OFF control (See Section 3.8).

TI, TD - Integral and derivative time constants (see Section 4.4.9)

b) Alarm Limits

Visible indication of the Error signal exceeding preset alarm limits can be obtained when the limit parameters are programmed appropriately:-

DD - Deviation display parameter (see Section 4.4.6)

DA - Deviation alarm parameter (see Section 4.4.5)

3.4 Remote Auto

Fig 3.2 illustrates how a 6358 Process Controller may be operated as a conventional 3-Term Controller within a closed-loop control system but using an externally generated Setpoint. This configuration is termed REMOTE AUTO.

3.4.1 Remote Auto Mode Entry Conditions

Table 3.4.1 shows that the conditions necessary for REMOTE AUTO operation are as follows:-

a) The optional analogue input I/O daughter board is fitted in slot 2, see Section 2.4.2.

b) Slot 2 is enabled by setting switch 4 of switch bank 2 in the ON position, see Section 2.3.2 b).

c) The appropriate bit in the Loop Type parameter has been set, selecting the corresponding analogue input as a remote setpoint input and not a trim input, see Section 4.3.4 a).

If these three conditions are satisfied, then the REMOTE AUTO mode may be entered in one of two ways:-

a) The REMOTE AUTO button on the front panel is the last one pressed.

b) Digit D of the ST status word for the given loop is set to a 1.

When all these conditions are true the Controller will be in the REMOTE AUTO mode which is the fourth highest priority mode. In this state the following Front-panel indications and command parameter status bit settings apply:-

a) The green Remote mode (R) push-button LED is illuminated.

b) Digit D of the ST status word will read back as 1.

3.4.2 Remote Auto Mode Operating Characteristics

Apart from the derivation of the Setpoint, the behaviour of the Controller in the REMOTE AUTO mode is virtually the same as in the local AUTO described in Section 3.3.2, and also given in Table 3.4.2:-

a) The 3-Term Control Output is generated by the 3-Term Control algorithm using the signal applied to the Channel 2 analogue input, as the Setpoint (SP) instead of the locally programmed value (SL).

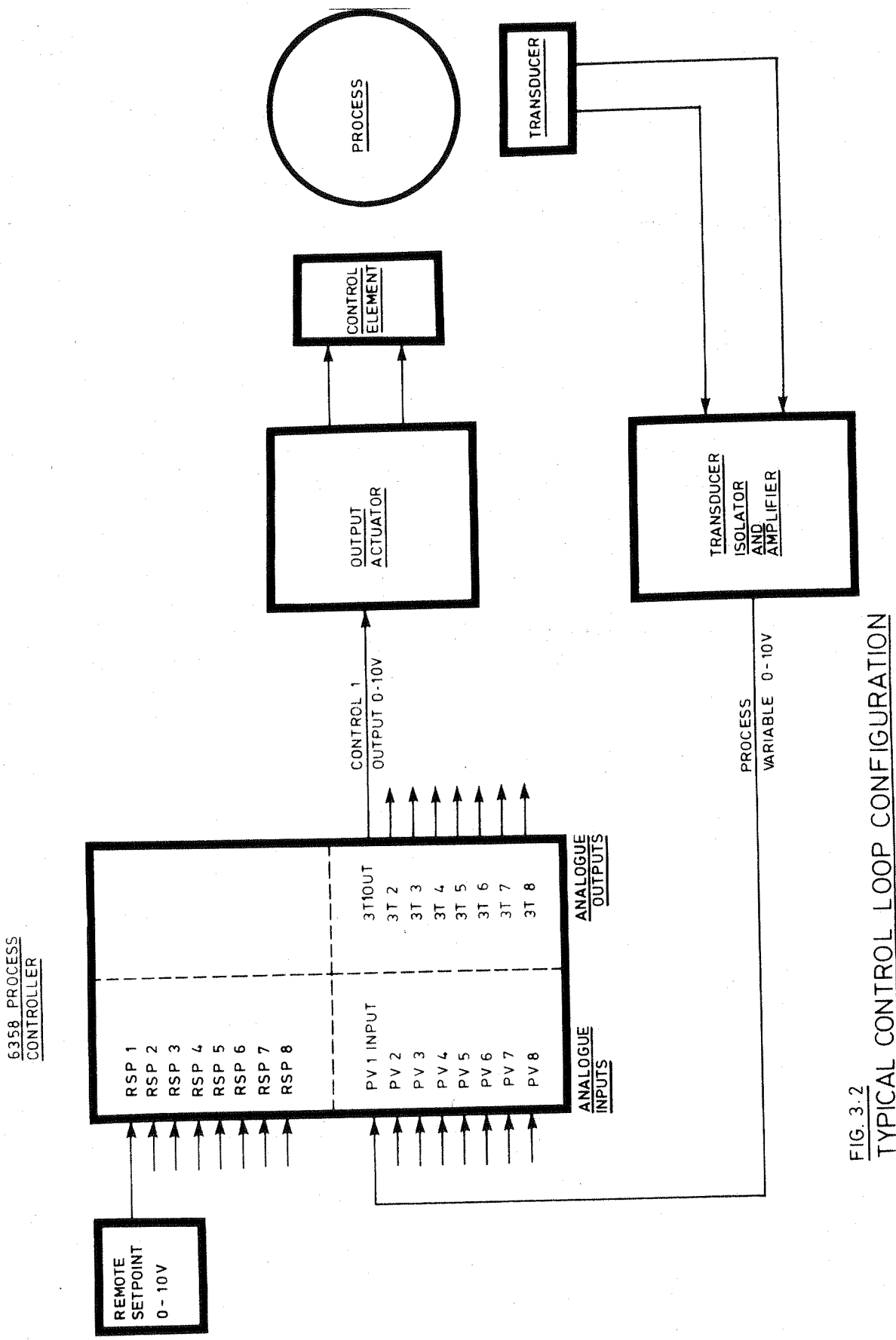


FIG. 3.2
TYPICAL CONTROL LOOP CONFIGURATION
FOR REMOTE AUTO MODE

b) The 3-Term Control Output level may be inspected as a 4 digit number in the range 0 to 99.99% on the digital readout by holding in the Remote Auto mode (R) push-button. The Raise/Lower buttons are inhibited from affecting the 3-Term output.

c) When no push-buttons are held in the Front-panel digital readout will display the Process Variable (PV) in Engineering Units as described in Section 3.2.4 b).

d) If a 1-5V out-of-range error is detected on the Process Variable analogue input, the Controller will enter the FORCED MANUAL mode of Section 3.1 and operation will be as described in Section 3.1.2.

e) The Deviation signal is displayed on the front panel, as described in Section 3.1.2 e).

f) High and Low Alarm conditions are displayed on the front panel, as described in Section 3.1.2 f).

It should be noted that the 3-Term Control algorithm continuously adjusts the Integral term so that transfer to any other control mode will occur in a bumpless and procedureless manner. However, when in REMOTE, any step changes in the Remote Setpoint input will appear as step changes in the 3-Term Output level (OP) multiplied by the Proportional band (XP) gain factor. Protection against these rapid 3-Term output changes can be obtained by suitable choice of the Input Filter constant (ST digit C) in those cases where the Remote Setpoint input is known to be a noisy signal.

When returning to REMOTE AUTO care should be taken that the setpoint required is set to the same value as the existing control setpoint because reversion to this mode of operation is not bumpless.

3.4.3 Setpoint Updating in the Remote Auto Mode

When the 6358 is operating in REMOTE AUTO, the Setpoint is provided from an external source and effectively the Controller forces its Local Setpoint to follow the Remote Setpoint input for as long as it is in this mode. consequently, the Raise/Lower buttons are permanently inhibited from altering the Local Setpoint, and updates via either of the serial data links are also not permitted. It is possible, however, to examine the Remote Setpoint level by depressing the Display Setpoint button which will cause the Resultant Setpoint (SP) to be indicated on the Front-panel digital readout as a 4 digit number.

CATEGORY			STATE
Push-buttons	MANUAL AUTO REMOTE/RATIO	(M) (A) (R)	OFF OFF ON
Switch bank S2 , switch number 4 Input/output slot number 2 daughter board LT parameter loop bit (high byte) Loop Process Variable (1 - 5V operation only)			ON Fitted Logic 1 1-5V

TABLE 3.4.1 6358 REMOTE AUTO mode entry conditions

CATEGORY			STATE
Push-button LEDs	MANUAL AUTO REMOTE/RATIO	(M) (A) (R)	OFF OFF ON
Local Setpoint action			Remote value
3-Term Control output action			Computed 3-term value

TABLE 3.4.2 6358 REMOTE AUTO mode operating characteristics

3.4.4 Programming Parameters in the Remote Auto Mode

For the 6358 Process Controller to function correctly in the REMOTE AUTO mode it requires the same set of control loop parameters programmed as for the AUTO mode described in Section 3.3.4 a), b) and c). The only difference is that the Local Setpoint cannot be changed via the SL command mnemonic, but the Remote Setpoint can be inspected via the SP command.

CATEGORY			STATE
Push-buttons	MANUAL AUTO REMOTE/RATIO	(M) (A) (R)	OFF OFF ON
Switch bank S2 , switch number 4 Input/output slot number 2 daughter board LT parameter loop bit (high byte) Loop Process Variable (1 - 5V operation only)			OFF (*) Not fitted(*) Logic 0 (*) 1-5V

TABLE 3.5.1 6358 AUTO FALL-BACK mode entry conditions (from REMOTE AUTO)

CATEGORY			STATE
Push-button LEDs	MANUAL AUTO REMOTE/RATIO	(M) (A) (R)	OFF FLASH OFF
Local Setpoint action			Raise/Lower
3-Term Control output action			Computed 3-term value

TABLE 3.5.2 6358 AUTO FALL-BACK mode operating characteristics (from REMOTE AUTO)

KEY

(*) Any one of these conditions being present will cause entry into the AUTO FALL-BACK mode.

3.5 Auto Fall-Back Mode (from REMOTE AUTO)

3.5.1 Auto Fall-Back Mode Entry Conditions

In Section 3.4.1, three conditions are shown as pre-requisites for entering the REMOTE AUTO mode. In the event that:-

a) One or more of these conditions is not satisfied when the REMOTE AUTO mode is selected (via front panel or either serial data link),

OR

b) These conditions are satisfied, REMOTE AUTO mode is entered and then LT is altered or the I/O daughter board is disabled or removed (so that the conditions are no longer satisfied).

When all these conditions are true as shown in Table 3.5.1 the Controller is in the AUTO FALL-BACK mode which is the lowest priority mode. In this state the following Front-panel indications and command parameter status bit settings apply:-

a) The green Auto mode (A) push-button LED flashes continuously.

b) Digit D of the ST parameter reads back as 3.

3.5.2 Auto Fall-Back Mode Operating Characteristics

It can be seen from Table 3.5.2 that the AUTO FALL-BACK mode operating characteristics are identical to AUTO. Thus the Deviation and Process Variable are displayed exactly as in AUTO (see Section 3.3.2) and the Raise/Lower buttons are inhibited from changing the output level. The only difference between the AUTO and AUTO FALL-BACK modes is that the Auto mode (A) LED is flashing to inform an operator that the Controller is still primed for REMOTE AUTO operation. Hence, the Controller reverts to REMOTE AUTO mode as soon as the REMOTE AUTO entry conditions are once again satisfied. In this event the Auto mode (A) LED is extinguished and the Remote mode (R) LED is illuminated as in Section 3.4.1. The AUTO FALL-BACK mode can be overriden by selecting any operating mode with a higher priority than REMOTE AUTO, such as AUTO. In this case the Auto Mode (A) LED goes steady and operation is as described in Section 3.3. It should be noted that just as a transfer from AUTO to any other mode occurs in a bumpless, procedureless manner as described in Section 3.3.2, so is a transfer from the AUTO FALL-BACK mode.

3.5.3 Local Setpoint Updating in Auto Fall-Back Mode

Control of the Local Setpoint in the Auto Fall-back mode is identical to that for the AUTO mode as described in Section 3.3.3. It should be noted, however, that when the Auto Fall-back mode is first entered the Local Setpoint will take up the last value that the Remote Setpoint had, just prior to the changeover from REMOTE.

3.5.4 Programming Parameters in Auto Fall-Back Mode

Since the operating mode for a Controller in AUTO FALL-BACK is the same as for AUTO it follows that the same set of control loop parameters must be programmed as for AUTO and these are listed in Section 3.3.4 a) and b).

3.6 Setpoint Trim (TRIM option only)

It is possible to trim the Local Setpoint (SL) if required by applying an external analogue signal to the Setpoint Trim input as described in Section 2.4.2. If the 6358 is operating in the FORCED MANUAL, MANUAL, AUTO, or AUTO FALL-BACK modes then the Local Setpoint (SL) is trimmed. If the 6358 is operating in the REMOTE mode then the second analogue input has been selected as a Remote Setpoint and the Trim facility has been disabled. The effect that the 0-10V Trim signal has on the Local Setpoint is programmed by means of the two ranging parameters of Table 4.1:-

2L - Setpoint Trim low range
2H - Setpoint Trim high range

It can be seen from Section 4.4.3 that these two parameters are entered directly in Engineering Units so that for a 0V Trim input the value of 2L is added to the Local Setpoint, while 2H is added to it when the Setpoint Trim input is at 10V. In general, the Resultant Setpoint may be calculated from the following expression:-

RESULTANT SETPOINT (SP) = LOCAL SETPOINT (SL)
+ (NORMALISED TRIM SIGNAL x TRIM SPAN)
+ TRIM LOW RANGE

i.e. :-

$$SP = SL + \frac{\text{TRIM VOLTAGE}}{10}(2H - 2L) + 2L$$

This expression assumes a linear Setpoint Trim input and the Resultant Trimmed Setpoint value may be accessed via the SP command parameter for monitoring purposes only (see Section 4.4.12). It can be seen from this expression that the Setpoint Trim facility can be inhibited by setting both the 2L and 2H parameters to zero.

The effect that the Trim input has on the Local Setpoint can best be illustrated by means of the following 3 examples:-

a) Symmetrical Trim - Elevated Zero

Assume that the 6358 has been programmed with the following parameters:-

SL = +5000 (PV range 1L to 1H = 0 to 9999)
2H = +0500
2L = -0500

The Setpoint Trim input signal will affect the Resultant Setpoint as follows:-

TRIM INPUT	RESULTANT SETPOINT (SP)
0V	4500
5V	5000
10V	5500

b) Asymmetric Trim - Elevated Zero

Assume in this case:-

SL = +5000
2H = +1000
2L = -0500

Then :-

TRIM INPUT	RESULTANT SETPOINT (SP)
0V	4500
5V	5250
10V	6000

c) Asymmetric Trim - Suppressed Zero

Assume in this case:-

SL = +5000
2H = +1000
2L = +0500

Then :-

TRIM INPUT	RESULTANT SETPOINT (SP)
0V	5500
5V	5750
10V	6000

3.7 6358 3-Term Control algorithm

3.7.1 Analogue 3-Term Control equation

Conventional analogue controllers implement the classical 3-Term (PID) control equation using operational amplifier techniques. This equation is usually written as follows:-

$$OP = -\frac{100}{XP}\left(ER + \frac{1}{TI}\int ER\,dt + TD\,\frac{dER}{dt}\right) \quad (1)$$

where:-

OP = Controller Output
XP = Proportional band
TI = Integral time constant
TD = Derivative time constant
ER = Error (PV - SP)

This equation may be rewritten in the Y(s) terminology of the Laplace transformation thus:-

$$\frac{OP(s)}{ER} = -\frac{100}{XP}\left(1 + \frac{1}{sTI} + sTD\right) \quad (2)$$

Limiting of the high frequency response introduces a digital limit filter, typically chosen to have a time constant equal to a quarter of the derivative time. The complete transfer function is then:-

$$\frac{OP(s)}{ER} = -\frac{100}{XP}\left(1 + \frac{1}{sTI} + sTD\right)\left(\frac{1}{1 + sTD/4}\right) \quad (3)$$

3.7.2 Digital Control algorithm

In microprocessor-based Controllers like the 6358 it is necessary to use sampling techniques for the calculation of the various terms of the control equation. It is also more convenient to rewrite the transfer function in terms of difference equations rather than the Y(s) Laplace transform terminology. Thus the 3-Term calculated output after n samples is given by:-

$$OPn = \frac{-100}{XP}\left[ERn + \frac{TS}{TI}\sum_{1}^{n} ERr + \frac{TD}{TS}\Delta PV\right] + 50\% \qquad (4)$$

where:-

OP = Controller Output after n samples
XP = Proportional band
TS = Algorithm sampling period
TI = Integral time constant
TD = Derivative time constant
ERn = Value of Error term
ERr = Value of Error at sample r = PVr - SP
ΔPV = Change in Process Variable value between current and previous sample

PV is obtained after first order filtering with an effective time constant TD/4 thus:-

$$\Delta PVn = \Delta PVn\text{-}1 + \frac{4TS}{TD}(dN - \Delta PVn\text{-}1) \qquad (5)$$

where:- $dN = PVn - PVn\text{-}1$

The Process Variable PV is itself a filtered version of the sampled channel 1 analogue input value, MV thus:-

$$PVn = PVn\text{-}1 + \frac{AS}{IF}(MVn - PVn\text{-}1) \qquad (6)$$

where:-

AS = Analogue input sampling period (304mS)
IF = input channel filter constant as defined by digit C of the loop ST parameter (see Section 4.4.1 c))

NOTE

The 50% offset of equation (4) is apparent at zero error under proportional - only control action with the integral term disabled be setting TI = 0. Although this allows the output to respond to both positive and negative errors it has the disadvantage that stability may occur about an undesirable operating point. It is usually better to set a very long integral time which has an effect equivalent to Manual reset.

3.7.3 Equivalence between analogue and digital equations

When the Setpoint is constant the digital algorithm of equation (4) may be written as the following equivalent continuous transfer function:-

$$\frac{OP(s)}{ER} = -\frac{100}{XP}\left[1 + \frac{1}{sTI} + \frac{sTD}{1+sTD/4}\right] \qquad (7)$$

This can now be compared with the classical Y(s) version of the analogue controller shown in equation (2) where it can be seen that the Proportional (P) and Integral (I) Terms are identical. The Derivative (D) Term is slightly modified however due to the additional first order filtering applied to the derivative value PV, rather than to the error directly.

For further descriptions of the 3-Term Algorithm and Integral Desaturation refer to Section 3 of the System 6000 Controller Applications Handbook.

3.8 ON/OFF Control

The 6358 can operate as a simple ON/OFF Controller in those applications where the facilities of full 3-term control are not required. The ON/OFF control action will operate in all the 6358 closed-loop operating modes, i.e. AUTO, REMOTE AUTO or AUTO FALL-BACK.

3.8.1 Programming Parameters for ON/OFF Control

Only 3 parameters are affected by ON/OFF control as follows:-

a) XP - Proportional Band Constant

The XP parameter is used to select the ON/OFF control action as follows:-

XP = 000.0 - ON/OFF control action

XP = 000.1 to 999.9 - 3-term control action

b) TI - Integral Time Constant

When ON/OFF control action has been selected by setting XP = 0, the TI parameter is used to define the deadband expressed as a percentage of the PV span of 1L to 1H.

c) OP - Control Output

When ON/OFF control action has been selected by setting XP = 0, the Control Output parameter, OP, can only take up one of two possible states as follows:-

Controller OFF:- OP = LO

Controller ON:- OP = HO

3.8.2 ON/OFF Control Operating Characteristics

The action of the 6358 in the ON/OFF control mode can be described by the expressions below:-

Controller OFF (OP = LO) when PV > SP

Controller ON (OP = HO) when PV < SP - Deadband (TI)

If inverse control action is selected, by setting the appropriate bit in LI high, then the expressions are modified thus:-

Controller OFF (OP = LO) when PV < SP - Deadband (TI)

Controller ON (OP = HO) when PV > SP

3.9 Digital Time - Proportioned Output

A digital output board can be used in slot 3 which causes the 6358 to automatically configure itself for digital time-proportioned output. In this configuration OP represents the ON pulse duration expressed as a percentage of the cycle length. Hence where OP = 0, the output never turns ON, and where OP = 99.99, the output is permanently ON. HO and LO can therefore be used to set maximum and minimum ON pulse durations.

Where output display inversion is in operation, OP represents the OFF duration.

Two cycle lengths are selected via the lower 8 bits of LI. Bit 7 selects for loop 1, bit 0 for loop 8. With the respective bit set to a 0, a 0.6 second cycle length is selected. With the bit set to a 1, a 15 second cycle length is selected. (See Section 4.3.5 b)).

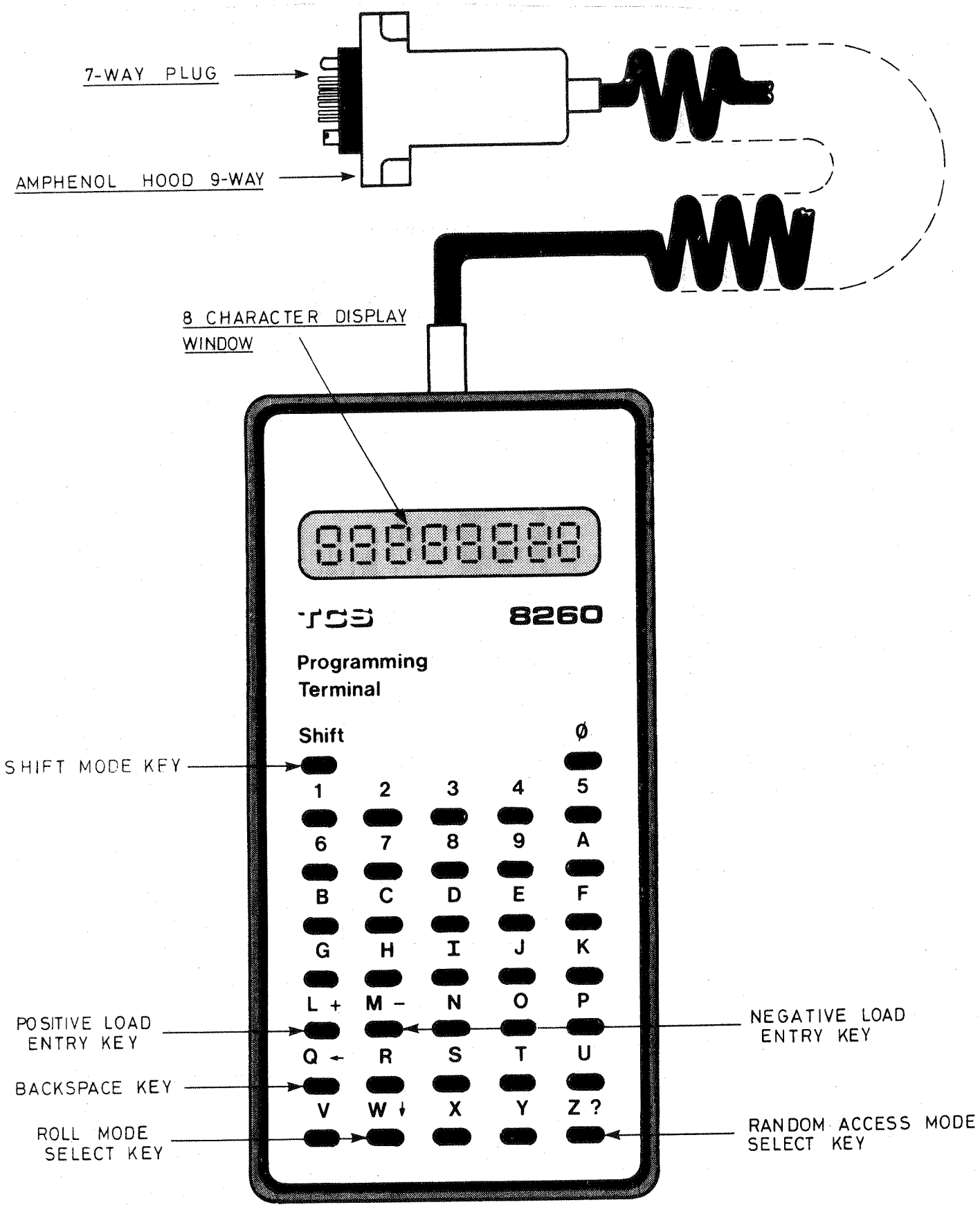


FIG 4-1) HAND-HELD TERMINAL KEYBOARD LAYOUT

Section 4 Programming the 6358 Process Controller via the 8260 Hand-held terminal

4.1 Programming Terminal Characteristics

The 8260 Hand-held programming terminal is a device the same size as a pocket calculator. It is provided with a 37-key positive tactile response keyboard and is capable of sending and receiving data in eight bit serial ASCII code.

The terminal has a single line display of eight characters using 16-segment 'starburst' LEDs which can clearly and legibly generate all 64 ASCII upper case alphanumerics and symbols. When it is being used to enter parameters into the 6358 Process Controller though, only the first 7 character positions are used starting from the left-hand end of the display. These 7 characters include the decimal point position so that a typical message would have the following structure:-

S	L	3	4	.	5	6

The interface between the 8260 terminal and the Controller is at standard RS232/V24 voltage levels using a transmission rate of 300 baud and 10 bit characters as defined in Section 1.5.8 A. Connection to the Controller is via a 7-pin plug and socket arrangement, the socket being situated behind a small door just above the catch handle on the front panel of the Controller. This 7-pin connector is also used to provide power to the terminal from the +5V supply within the Controller and it requires typically 350mA.

A plan view of the keyboard of the 8260 Hand-held terminal is given in Fig 4.1, and for a more detailed description of its characteristics refer to Section 2 of the System 6000 Communications Handbook.

4.2 Terminal Initialisation and Parameter Entry Procedures

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

?	?			C	M	D

This message is a prompt to the operator requesting that a 2 character Command Parameter is entered in the position of the two question marks. Lists of all possible user commands are given in Tables 4.2, and 4.3, together with their corresponding 2 character mnemonics that are actually entered via the terminal keyboard. These parameters themselves are divided into the following 2 types:-

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

b) Loop Command Parameters, which are concerned with the status and operating characteristics of each of the control loops. There may be up to 8 active control loops within the 6358 each of which has a set of loop command parameters.

A full description of Parameter entry procedures using the 8260 Hand-held terminal is given in Section 3 of the System 6000 Communications Handbook. It is recommended that this document is consulted before the user attempts to programme the 6358 via the Hand-held terminal. It is also recommended that the Instrument Command parameters are always set up first and that a record of each parameter is made on a 6358 Set-up Sheet like the example shown in Appendix D. This will assist in record keeping and programming spare or replacement instruments.

4.2.1 Command Parameter Formats

It can be seen from the pages of Command parameters given in Tables 4.2 and 4.3, 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 4.1.

a) Range

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

b) 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.

c) 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 is a format 1 parameter and Section 4.4.1 a) shows that its decimal point position is defined by the first digit of the associated 'ST' command parameter. The ST parameter itself is a status word with a format 5 data structure.

4.2.2 Instrument Parameter access

Section 4.2 recommended that the Instrument Command Parameters are programmed first and this can be done by entering 'II' in response to the '?? CMD' command prompt. Table 4.2 shows that the Instrument parameters form a continuous list and once the last parameter has been entered (MD), the scroll mode key (W ↓) will take the terminal back to the first parameter (II) again.

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 4.1 List of Command Parameter Data Formats

4.2.3 Control Loop Parameter access

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 Table 4.3 and the access mechanism, is as follows:-

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

?? CMD

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. The front-panel Address/ Identity display will always show the currently selected Loop number or identity.

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 Section 4.3.2 b))

g) If these conditions are both valid the 6358 will go to the required loop and display its loop number 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.

4.3 Instrument Command Parameters

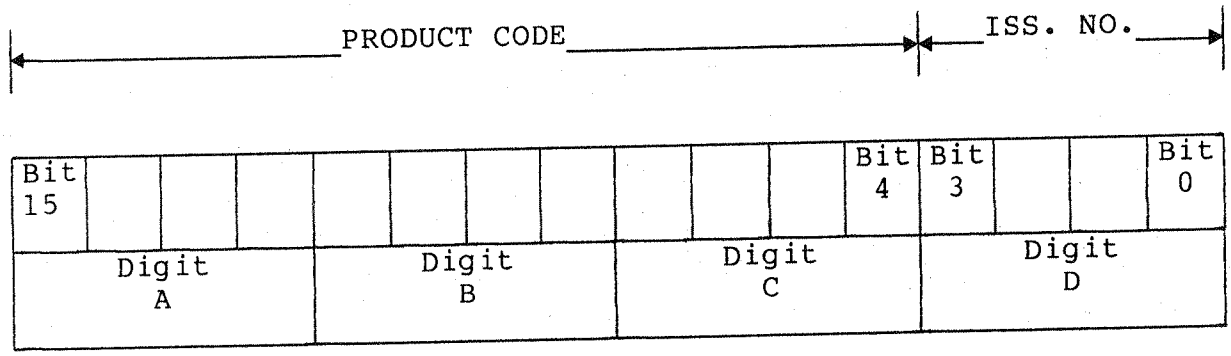
Table 4.2 shows that there are 11 Instrument Command parameters associated with the overall operation of the 6358 and they are all format 5 parameters. Table 4.2 shows that they consist of 4 hexadecimal characters in the range 0000 to FFFF with a positive sign character for parameter entry. When any of these parameters are entered via the 8260 Hand-held terminal the Instrument replies with the current value of the parameter preceded by a 'greater than' sign to indicate that the data is in hexadecimal notation, e.g:-

M	D	>	4	0	3	0

Detailed descriptions of each of the 11 status word parameters are given in the following Sections.

4.3.1 II - Instrument Identity

This parameter returns the instrument identity and issue number, i.e. 3583 for the 6358 issue 3. II is a read-only parameter and its exact format is given below:-



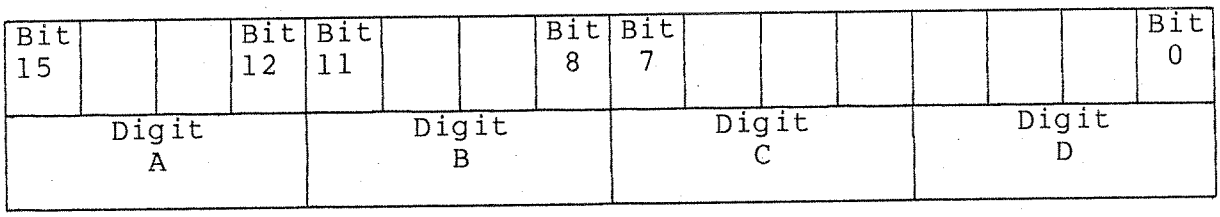
DIGIT	BIT	FUNCTION
A,B,C	15-4	Product Code (6) 358
D	3-0	Issue Number 3

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 and push button masking	-	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 4.2 List of 6358 Instrument Command Parameters and their respective mnemonics

4.3.2 S1 - Input/Output slot 1 status, active loop select and pushbutton masking

The S1 command parameter is used to give access to the status of the slot 1 input/output board. This parameter is also used to set-up the number of active loops within the 6358 and read back the board type fitted in I/O slot 1. The format of this parameter is given below:-



DIGIT	BIT	FUNCTION
A	15-13	Pushbutton masking bits (0 = active; 1 = masked).
	12	Hardware Error (0 = O.K.; 1 = Error).
B	11-8	Number of active loops 1 to 8
C,D	7-0	Board Type (for S1 this will always be 00, see Table 1.2)

The exact function of the individual digits within the S1 parameter are described in the following sections.

a) Push button masking bits (digit A - bits 15-13)

The setting of any of the bits 15-13 of S1 to a '1' masks the corresponding push-button from causing a mode change on any of the eight loops. Bit 15 masks the 'R' pushbutton, bit 14 the 'A', and bit 13 the 'M'. For example, setting bit 14 to a '1' will prevent Auto mode being selected by the 'A' pushbutton, whilst it will still be possible to select Manual or Remote Auto from the 'M' and 'R' pushbuttons. (Pressing 'A' would still result in the display of OP on the digital display, however).

b) Hardware Error (digit A)

This bit is read-only and should read back as a zero under normal conditions. If it reads back as a 1 it means that there is a Hardware error in the Analogue input board fitted to slot 1. This error condition will occur under the following conditions:-

(i) No input/output board is fitted in the slot 1 position on the 6358 motherboard.

(ii) A hardware fault exists on the slot 1 input/output board.

The Hardware Error condition is indicated to the operator, by flashing the message:-

Bl HW ER

on the Address/Identity display where Bl signifies I/O slot number 1. Under these conditions all the control loops enter the FORCED MANUAL mode as described in Section 2.6.2 b). The Error message can only be removed by replacing the faulty board.

c) Channel Scan (digit B)

This digit is entered via the Hand-held Terminal or serial link to select the number of control loops it is required to have active within the 6358 Controller. If the digit is set to 0 then the entire instrument is disabled. When the digit is set from 1 to 8 then that number of loops will be activated always starting from loop 1. e.g.

B = 1 - activates loop 1 only

B = 2 - activates loops 1 and 2

B = 3 - activates loops 1, 2 and 3 etc.

It should be noted that all control loops that are disabled by digit 2 of the S1, parameter will have their alarms cleared automatically but not Historic alarms.

d) Input/Output board type (digits C,D)

As described in Section 1.4.5 there are 5 basic types of board which may be fitted into each input/output slot on the motherboard. Each board is fitted with a hardware identity which can be accessed via the CPU to ascertain which type of board is fitted in each slot position. This hardware identity is in the form of a 2 digit hexadecimal number in the range 00 to 1E and may be accessed via digits C and D of the slot status parameter. These two digits correspond to the different board types given in Table 1.2 as follows:-

Digits C,D	Board type
00 to 07	Analogue input
08 to 0E	Analogue output
0F	Current output
10 to 17	Digital input
18 to 1E	Digital output

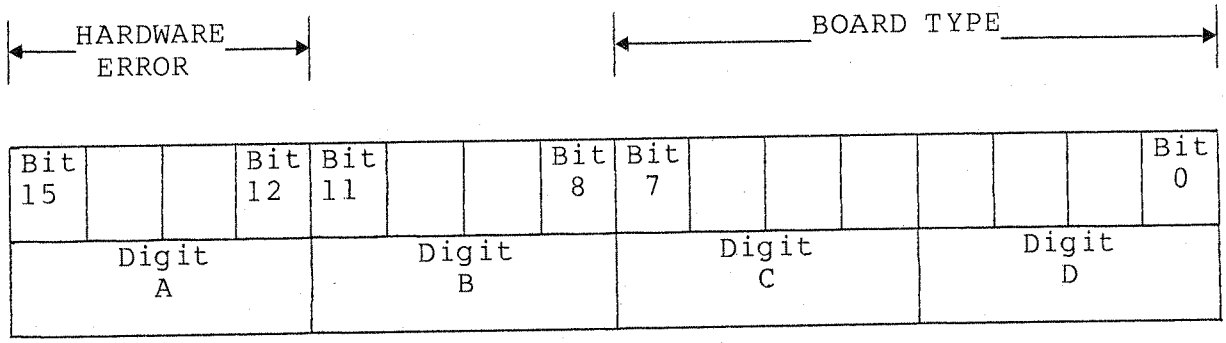
This scheme allows different versions of each board type to be identified, though presently only board types 00, 08, 0F, 10 or 18 are available.

It should be noted that a slot without a board fitted will read back a board identity of 1F.

For the case of the analogue input board fitted to the I/O slot 1 position digits C and D should read back as 00.

4.3.3 S2, S3, S4 - Input/Output slot 2, 3 and 4 status

The 3 command parameters S2, S3 and S4 are used to give access to the status of the slot 2, 3 and 4 input/output boards. These parameters are also used to read back the board type fitted in each I/O slot position in the format given below:-



DIGIT	BIT	FUNCTION
A	12	Hardware Error (0 = O.K.; 1 = Error)
B	11-8	Unallocated
C,D	7-0	Board Type 00 to 1E; 1F = no board fitted

The exact function of the individual digits within the S2, S3 or S4 parameters are described in the following sections.

a) Hardware Error (digit A)

This digit is read-only and should read back as a zero under normal conditions. If it reads back as a 1 it means that there is a hardware error in the corresponding slot 2, 3 or 4 input/output board. These error conditions will occur under the following conditions:-

(i) S2 digit A will be set to 1 if slot 2 is enabled by setting switch S2 no. 4 ON, but no analogue input board is fitted in the slot 2 position on the 6358 motherboard. This condition will also occur if a board is fitted in slot 2 but it has a hardware fault.

(ii) S3 digit A will be set to 1 if no analogue or digital output board is fitted in the slot 3 position on the 6358 motherboard. This condition will also occur if a board is fitted in slot 3 but it has a hardware fault.

(iii) S4 digit A will be set to 1 if slot 4 is enabled by setting switch S2 no. 3 ON, but no analogue, digital or 4-20mA output board is fitted in the slot 4 position on the 6358 motherboard. This condition will also occur if a board is fitted in slot 4 but it has a hardware fault.

These Hardware Error conditions are indicated to the operator by flashing the message:-

Bn HW ER

On the Address/Identity display where n signifies the faulty I/O board 2, 3 or 4. The Error message can only be removed by replacing the corresponding faulty board, or disabling them in the case of I/O slots 2 or 4 by setting switch S2 no. 4 or 3 to the OFF position respectively.

b) Digit B

This is unallocated and reads back as zero.

c) Input/Output Board Type (digits C, D)

The functions of these 2 digits are the same as for the S1 parameter described in Section 4.3.2 c). The actual board identities read back for I/O slots 2,3 and 4 are as follows:-

(i) I/O Slot 2

When the TRIM option is specified an analogue input board is fitted in the I/O slot 2 position so that S2 digits C and D should read back as 00. If TRIM is not specified then no board is fitted and digits C and D will read back as 1F.

(ii) I/O slot 3

An analogue or digital output board is always fitted in the I/O slot 3 position so that S3 digits C and D should read back as 08 (analogue) or 18 (digital).

(iii) I/O slot 4

When the RPV option is specified an analogue output board is fitted in the I/O slot 4 position so that S4 digits C and D should read back as 08. When the ALM option is specified a digital output board is fitted so that S4 digits C and D should read back as 18. When the MA option is specified a current output board is fitted so that S4 digits C and D should read back as 0F. If neither the RPV, ALM or MA options are specified no board is fitted in the I/O slot 4 position and S4 digits C and D will read back as 1F.

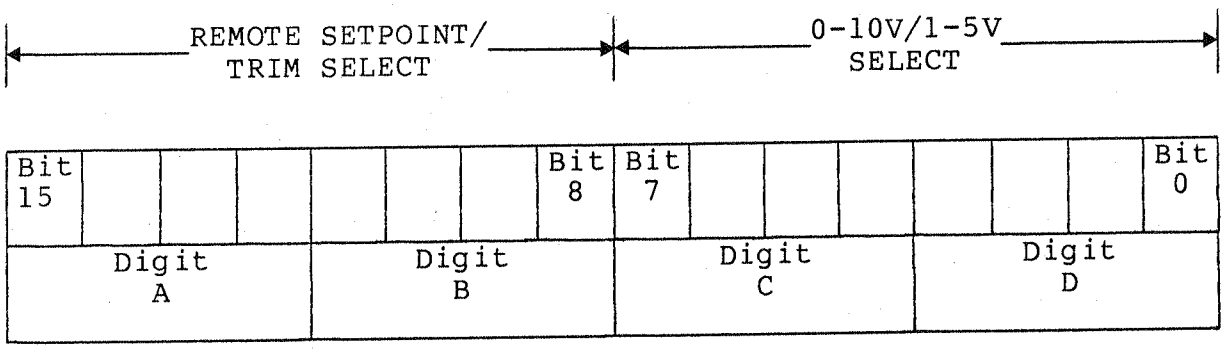
4.3.4 LT - Loop Type

The Loop Type parameter, LT, has two functions for each of the control loops within the 6358, viz:-

a) Functional interpretation of the second analogue input (provided when the optional analogue input board is fitted in I/O slot 2) as either a Remote Setpoint or Setpoint Trim.

b) Range interpretation of the Process Variable inputs as being either 0-10V or 1-5V.

The format of the LT parameter is given below:-



DIGIT	BIT	LOOP	FUNCTION
A	15	1	Remote Setpoint/Setpoint Trim select (0 = Trim; 1 = Remote Setpoint)
	14	2	
	13	3	
	12	4	
B	11	5	
	10	6	
	9	7	
	8	8	
C	7	1	Process Variable input select (0 = 0-10V; 1 = 1-5V)
	6	2	
	5	3	
	6	4	
D	3	5	
	2	6	
	1	7	
	0	8	

The exact function of the individual digits within the LT parameter are described in the following sections:-

a) Remote Setpoint/Setpoint Trim select (digits A, B)

When the TRIM option is specified a second 8-way analogue input board is fitted in the I/O slot 2 position of the 6358 motherboard (see Section 2.4.2). This board provides a second analogue input for each control loop provided that the I/O slot has been enabled by setting switch no. 4 of switch bank S2 to the ON position. Digits A and B of the LT parameter are then used to determine whether each input is to be used as a Remote Setpoint or a Setpoint Trim. The most-significant bit of digit A corresponds to loop 1 and the least-significant bit of digit B corresponds to loop 8. When any bit is set to a logic '0' the second analogue input of the corresponding loop is used to provide a Setpoint trim facility as described in Section 3.6. When any bit is set to a logic '1' the second analogue input of the corresponding loop is used to provide a Remote Setpoint input as described in Section 3.4

b) Process Variable input select (digits C, D)

The Process Variable input for each loop may be software selected for either 0-10V or 1-5V operation. The most-significant bit of digit C corresponds to loop 1 and the least-significant bit of digit D corresponds to loop 8. When any bit is set to a logic '0' the Process Variable input for the loop is treated as being a signal in the range 0-10V. When any bit is set to a logic '1' the input for the corresponding loop is treated as being a signal in the range 1-5V.

These features are illustrated by the following example:-

```
LT >C35A
```

Here loops 1, 2, 7 and 8 have Remote Setpoint inputs while loops 3, 4, 5 and 6 have Setpoint Trim inputs. Also, loops 2, 4, 5 and 7 operate with 1-5V Process Variable inputs, while loops 1, 3, 6 and 8 operate with 0-10V signals.

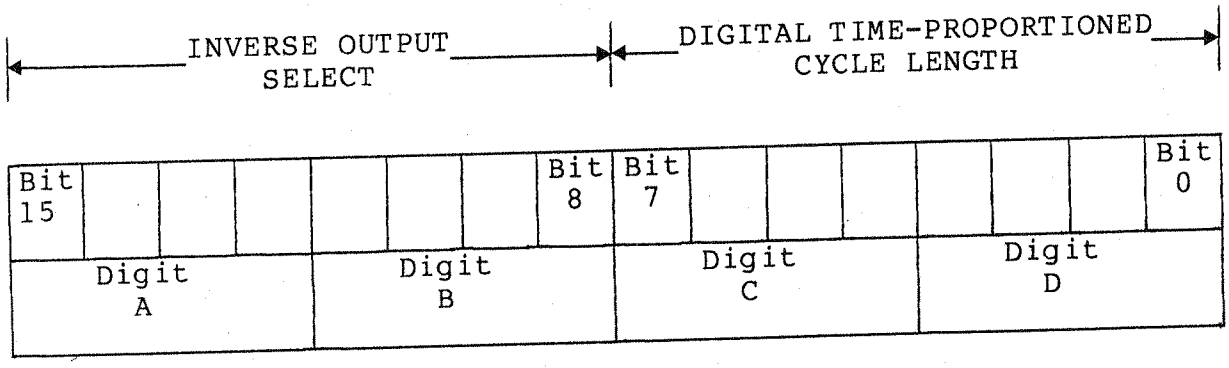
4.3.5 LI - Loop Inversion and Digital Time Proportioned Cycle Length

The LI parameter has two functions for each of the control loops within the 6358, viz:-

a) To select whether the output of each control loop is direct or inverse acting.

b) To select the cycle length when a digital time - proportioned output is used.

The format of the LI parameter is as follows:-



DIGIT	BIT	LOOP	FUNCTION
A	15	1	Loop Inverse Output select (0 = normal; 1 = inverted)
	14	2	
	13	3	
	12	4	
B	11	5	
	10	6	
	9	7	
	8	8	
C	7	1	Digital Time-proportioned Cycle length (0 = 0.6 seconds; 1 = 15 seconds)
	6	2	
	5	3	
	4	4	
D	3	5	
	2	6	
	1	7	
	0	8	

The exact function of the individual digits within the LI parameter are described in the following sections:-

a) Loop Inverse Output select (digits A, B)

The 3-term output of each of the 8 control loops within the 6358 Controller may be software selected to have normal or inverted outputs. Digits A and B of the LI parameter are used to select which loop has a normal or inverted output. The most-significant bit of digit A corresponds to loop 1 and the least-significant bit of digit B corresponds to loop 8. When any bit is set to a logic '0' the corresponding loop has a normal 3-Term output, while if it is set to a logic '1' the output is inverted (see Section 3.5.2 g)). This is illustrated by the following example:-

LI >6800

Here loops 2, 3 and 5 are selected for inverse operation while loops 1, 4, 6, 7 and 8 have normal outputs.

NOTE

The sense of Normal and Inverse output may not conform to conventions adopted by other manufacturers.

b) Digital Time-proportioned cycle length (digits C, D)

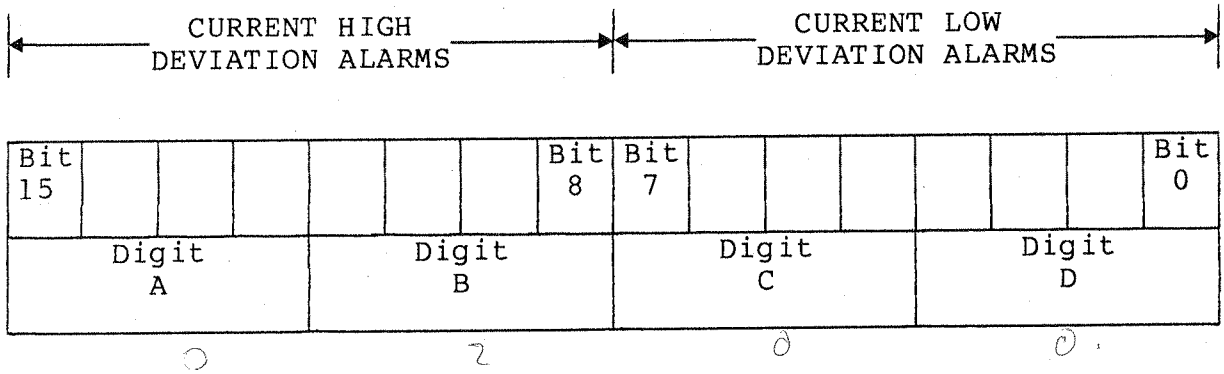
The eight control loops within the 6358 may have either conventional 0-10V analogue control outputs (with an analogue output board in slot 3), or time proportioned digital outputs (with a digital output board in slot 3). In the latter case, OP represents the ON time of the digital output expressed as a percentage of the cycle length. The cycle length can be one of two values 0.6 seconds or 15 seconds. Digits C and D of the LI parameter are used to select the cycle length for individual loops. The most-significant bit of digit C corresponds to loop 1 and the least-significant bit of digit D corresponds to loop 8. When any bit is set to a logic '0' the corresponding loop has a cycle length of 0.6 seconds, while if it is set to a logic '1' the cycle length is 15 seconds.

NOTE

Digits C and D of LI are ignored if a digital output board is not fitted in slot 3 (i.e., if conventional analogue outputs are used).

4.3.6 AC - Current Deviation Alarms

The Current Alarm parameter, AC, shows the current deviation alarm condition of each control loop of the 6358 Controller. The High and Low deviation alarm conditions are indicated separately in the format given below:-



DIGIT	BIT	LOOP	FUNCTION
	15	1	Current High Deviation Alarms (0 = safe; 1 = alarm)
A	14	2	
	13	3	
	12	4	
	11	5	
B	10	6	
	9	7	
	8	8	
	7	1	Current Low Deviation Alarms (0 = safe; 1 = alarm)
C	6	2	
	5	3	
	6	4	
	3	5	
D	2	6	
	1	7	
	0	8	

The exact function of the individual digits within the AC parameter are described in the following sections:-

a) Current High Deviation Alarms (digits A, B)

Each bit of the most-significant byte of AC is set when the corresponding control loop goes into High Deviation Alarm, where the most-significant bit of digit A corresponds to loop 1 and the least-significant bit of digit B corresponds to loop 8. Each bit is set to logic '1' as soon as the corresponding control loop enters a High Deviation Alarm condition, and it is reset to logic '0' as soon as the loop comes out of alarm.

b) Current Low Deviation Alarms (digits C, D)

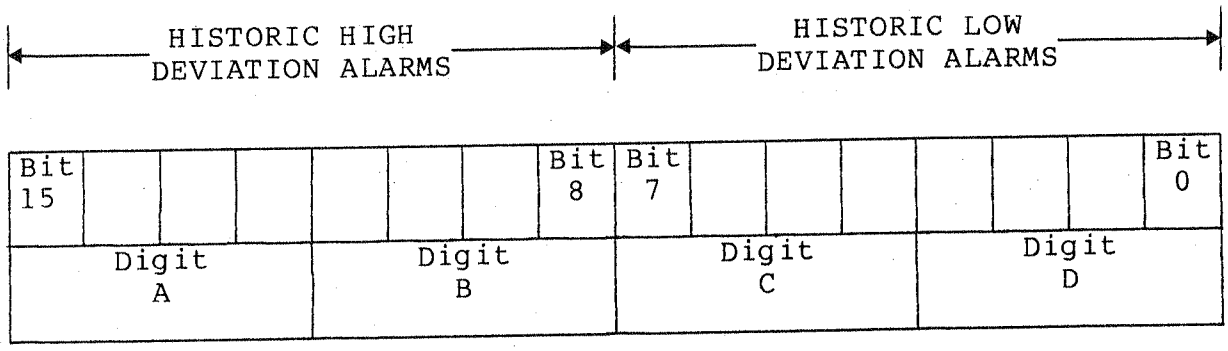
Each bit of the least-significant byte of AC is set when the corresponding control loop goes into Low Deviation Alarm, where the most-significant bit of digit C corresponds to channel 1 and the least-significant bit of digit D corresponds to channel 8. Otherwise it is very similar to the most-significant byte, for example:-

AC > 4228

means that Control loops 2 and 7 are currently in High Deviation Alarm and Control loops 3 and 5 are currently in Low Deviation Alarm. Control loops 1, 4, 6 and 8 are not in Alarm.

4.3.7 AH - Historic Deviation Alarms

The Historic Alarm parameter, AH, indicates the occurrence of a change of deviation alarm status into High or Low alarm since the status bits for each loop were last cleared. The format of the AH parameter is given below:-



DIGIT	BIT	LOOP	FUNCTION
A	15	1	Historic High Deviation Alarms (0 = safe; 1 = alarm)
	14	2	
	13	3	
	12	4	
B	11	5	
	10	6	
	9	7	
	8	8	
C	7	1	Historic Low Deviation Alarms (0 = safe; 1 = alarm)
	6	2	
	5	3	
	6	4	
D	3	5	
	2	6	
	1	7	
	0	8	

The exact function of the individual digits within the AH parameter are described in the following sections:-

a) Historic High Deviation Alarms (digits A, B)

Each bit of the most-significant byte of AH is set when the corresponding control loop goes into High Deviation Alarm, where the most-significant bit of digit A corresponds to loop 1 and the least-significant bit of digit B corresponds to loop 8. Each bit remains set at logic '1' even if the corresponding control loop subsequently goes out of alarm. Each bit therefore serves as an historic alarm record for the corresponding control loop and can only be reset by writing a logic '0' to the appropriate bit position via the Hand-held terminal or serial data link.

b) Historic Low Deviation Alarms (digits C, D)

Each bit of the least-significant byte of AH is set when the corresponding control loop goes into Low Alarm, where the most-significant bit of digit C corresponds to loop 1 and the least-significant bit of digit D corresponds to loop 8. Otherwise it is very similar to the most-significant byte, for example:-

AH>8442

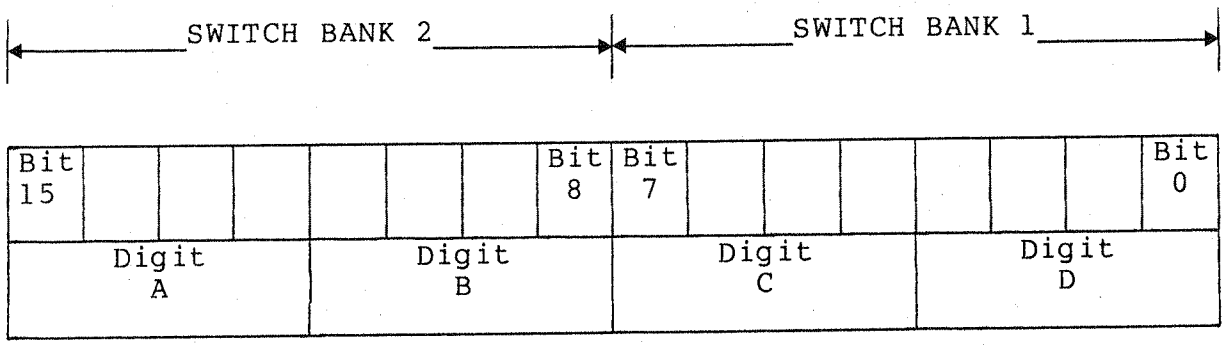
means that Control loops 1 and 6 have been in High Deviation Alarm and Control loops 2 and 7 have been in Low Deviation Alarm since the AH parameter was last accessed and reset to zero. Control loops 3, 4, 5 and 8 have not been in either the Higher or Low Deviation Alarm conditions since AH was last reset.

A pictorial explanation of the behaviour of the AC and AH parameters in response to changing alarm conditions is given in Appendix F.

4.3.8 SW - Internal Switch Status

The status word command parameter, SW, is a monitor-only parameter and is used to obtain a readout of the settings of the 12 internal switches of switch banks S1 and S2. This facility allows the internal switch status of a 6358 Controller to be determined via the Hand-held terminal or the RS422 supervisory link without removing the instrument from the rack or sleeve.

The format of the SW parameter is shown below:-



DIGIT	BIT	SWITCH		FUNCTION
	15	1	S2	UID select (0 = 0 - 7; 1 = 8 - F)
A	14	-		N/A
	13	-		
	12	-		
	11	-		
B	10	2		Fail Mode (Power Fail and Out-of-range PV)
	9	3		Slot 4 enable (re-transmitted PV/Alarm)
	8	4		Slot 2 enable (Setpoint Trim/Remote Setpoint)
	7	1	S1	Output Display Inversion (loops 1-4 only)
C	6	2		Baud rate selection switches for RS422 data link (see Table 2.2)
	5	3		
	4	4		
	3	5		Protocol mode select (0 = ASCII; 1 = Binary)
D	2	6		4
	1	7		2 Group Identifier (GID)
	0	8		1

Each bit of the SW parameter is set to a logic 1 when the corresponding switch is in the ON position, a logic 0 will be read back for a switch in the OFF position.

The exact functions of the digits within the SW parameter are discussed in the following sections:-

a) Switch bank S2 (digits A, B)

Bits 14 and 15 of digit A, and bits 8 and 9 of digit B read back the status of internal switch bank S2. The individual switch functions within S2 are discussed in Section 2.3.2 b) and are listed in Table 2.1.

b) Switch banks S1 (digits C, D)

The two least-significant digits of SW read back the status of internal switch bank S1. The individual switch functions within S1 are discussed in Section 2.3.2 a) and are listed in Table 2.1.

For example, the controller may respond to the SW command as follows:-

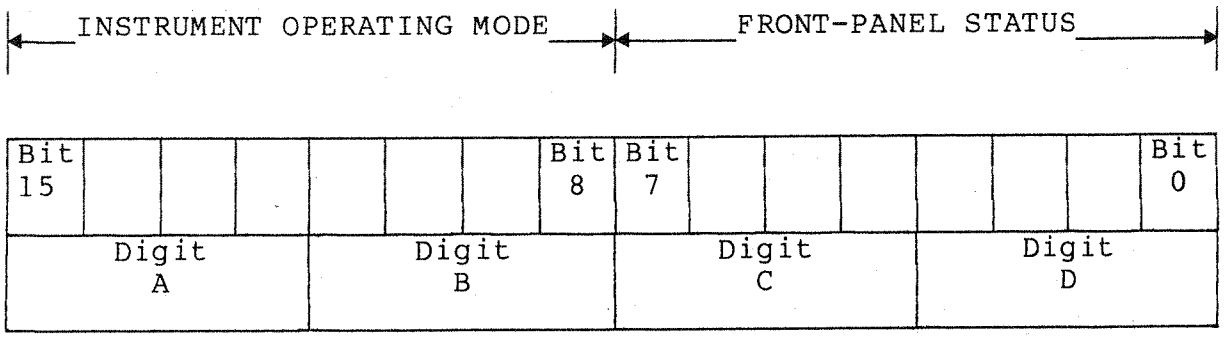
S	W	>	8	1	2	9

This means that switch numbers 1 and 4 of switch bank S2 are ON, and switch numbers 3, 5 and 8 of switch bank S1 are ON. All other switches are OFF.

4.3.9 MD - 6358 Operating Status

The status word parameter MD is used to give access to the current Operating Status of the 6358 Process Controller and the state of the Front-panel controls via the 8260 Hand-held terminal or Supervisory data link.

The format of the MD parameter is shown below:-



DIGIT	BIT	FUNCTION		READ/WRITE STATUS	
	15	Collected state change alarm			Read-write
A	14	Parameter change of state bit			Read-write
	13	Common loop parameters sumcheck failure			Read/write
	12	Common I/O hardware failure		OPERATING	Read/write
	11	Battery voltage LOW		MODE	Read/only
B	10	Common 1-5V I/P out of range			Read-write
	9	Power Failure Warning bit			Read-write
	8	Instrument parameters sumcheck failure			Read-write
	7	8260 Terminal connected			Read-only
C	6	LED Test Bit			Write-only
	5	RAISE button	(▲)	FRONT-	Read-only
	4	AUTO button	A		Read-only
				PANEL	
	3	REMOTE button	R		Read-only
D	2	LOWER button	(▼)	STATUS	Read-only
	1	MANUAL button	M		Read-only
	0	SETPOINT button	SP		Read-only

The exact functions of the digits within the MD parameter are discussed in the following sections:-

a) 6358 Operating Status (digits A, B)

The first two digits of the MD command parameter, A and B corresponding to bits 15 to 8 inclusive, indicate the current operating status of the 6358. The functions of each of these 8 bits are described below:-

(i) Bit 15 - Alarm Change of State bit

The most-significant bit of digit A is set to a logic '1' whenever any of the Active Control loops goes into deviation alarm. It will stay set until reset to '0' by the Hand-held terminal or serial data link. It is not reset when the corresponding bit in the Historic Alarm parameter AH is reset. This bit, corresponding to an MD value of 8000 is read/write.

(ii) Bit 14 - Parameter Change of State bit

The second bit of digit A is set to a logic '1' whenever the Hand-held terminal or Raise/Lower push-buttons have been used to change the value of a Command Parameter. This bit will always read as a logic '1' via the Hand-held terminal and must be reset via the serial data link. This bit, corresponding to an MD value of 4000 is therefore read-only via the Hand-held terminal, but read/write via the serial data link.

(iii) Bit 13 - Loop Parameter Sumcheck failure

This third bit of digit A is set to a logic '1' whenever a sumcheck failure occurs on any of the loop Command Parameters. This bit cannot be reset to logic '0' until the appropriate sumcheck failure bit in the loop Command Parameters has been reset first. This bit corresponding to an MD value of 2000 is read/write.

(iv) Bit 12 - Common Hardware Alarm

The least-significant bit of digit A is set to a logic '1' to indicate a Common Hardware Alarm condition caused by any of the 4 input/output slots having a Hardware Error (see Section 2.6.2 b) to e) inclusive).

This bit cannot be reset by writing a logic '0' from the Hand-held terminal or serial data links until the alarm condition causing it has been removed. This bit corresponding to an MD value of 1000 is read/write.

(v) Bit 11 - Battery voltage LOW

The most-significant bit of digit B is set to a logic '1' as soon as the battery voltage on the memory card drops below the level required to guarantee non-volatility of the parameter memory area. Under these conditions the unused decimal points on the Process Variable display will also flash to give a visual indication that the battery should be replaced. This bit is reset automatically by the CPU as soon as it detects that the battery is reading a safe voltage. This bit corresponding to an MD value of 800 is read-only.

(vi) Bit 10 - Common Out of Range Alarm

The second bit of digit B is set to a logic '1' to indicate a common out of range condition on 1-5V analogue input channels. This will occur when any Process Variable input that has been set up for a 1-5V input (see Section 4.3.4 b)) receives a signal less than 0.5V or greater than 5.5V. This bit cannot be reset by writing a logic '0' from the Hand-held terminal or serial data links while the out of range condition exists. This bit corresponding to an MD value of 400 is read/write.

(vii) Bit 9

This bit is set to a logic '1' by any hardware reset or power failure condition detected within the 6358.

(viii) Bit 8 - Instrument Parameter Sumcheck failure

The least-significant bit of digit B is set to a logic '1' whenever a sumcheck failure occurs on any of the Instrument Command Parameters of Table 4.2. Under these conditions the greater than sign which precedes all format 5 parameters is replaced by an asterisk for all the Instrument Command Parameters. Furthermore, the error condition is indicated to the operator by flashing the message:- IP SC ER - on the alphanumeric Address/Identity display as described in Section 2.6.2 f). The condition is rectified by re-entering all the Instrument Command Parameters and finally writing a zero to Bit 8. This bit, corresponding to an MD value of 100 is read/write.

b) Front-Panel Status (digit C, D)

The last two digits of the MD command parameter, C and D, corresponding to bits 0 to 7 inclusive, indicate the current state of the Front-panel push-buttons etc. The functions of each of these 8 bits are described below:-

(i) Bit 7 - Hand-held Terminal Connected

The most-significant bit of digit C is used to indicate whether the Hand-held terminal is plugged into the Front-panel socket or not. Bit 7 will normally be a logic '0' but will set to logic '1' as soon as the terminal is plugged in.

Note that the Hand-held terminal should always read this bit back as a logic '1' and the supervisory computer can only read back the MD status word when this bit is at logic '0'.

(ii) Bit 6 - LED Test Bit

This bit can be set via the 8260 Hand-held terminal or the RS 422 serial data link. When set to a logic 1 all the front-panel LED's are turned ON for 1.5 seconds. This allows a visual check of the front-panel LED's to be made.

(iii) Bits 0 to 5 inclusive - Front panel push-buttons

These 2 bits of digit C and 4 bits of digit D are normally at logic '0' and are set to logic '1' whenever the corresponding front-panel push-button is being pressed.

Note that when no alarms are present and no push-buttons are being pressed the MD parameter should read back as >4080 on the Hand-held terminal.

COMMAND MNEMONIC	COMMAND PARAMETER FUNCTION	UNITS	FORMAT	PARAMETER TYPE
LN(1)	Loop number	-	7	
ST	Loop status:- Decimal Point /Input Conditioning/Input Filter/Operating Mode	-	5	Status words
1H	Process Variable high range	Eng	1	CH1 Input channel
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	
LS	Setpoint low limit	Eng	1	
DA	Deviation Alarm limit	Eng	2	Limit and Alarm Settings Parameters
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 4.3 List of 6358 Loop Command Parameters and their respective mnemonics

NOTES

(1) LN does not appear in the parameter list when accessing parameters via the serial data link.

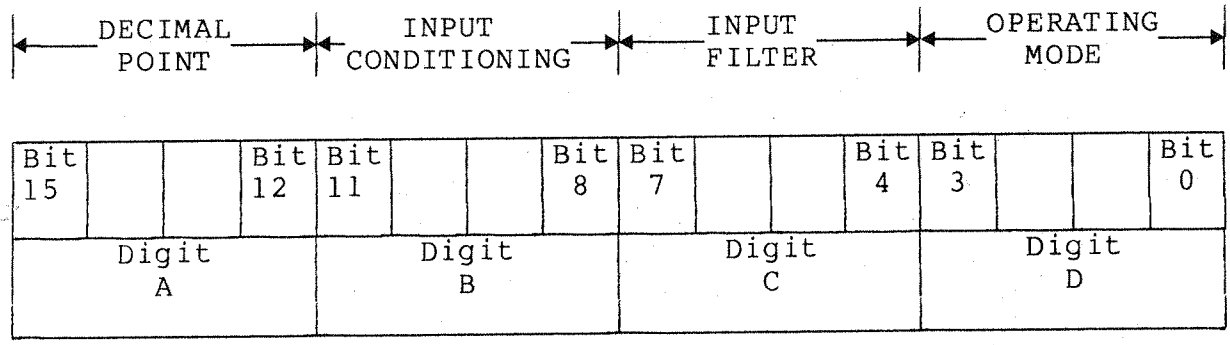
(2) The 1T and 2T Loop Tag characters do not appear when the parameter list is scrolled via the (W ↓) command of the 8260 Hand-held terminal. Instead, they must be accessed individually by first using the ?? CMD prompt once the required Loop Number (LN) has been previously selected. (See Section 4.5)

4.4 Loop Command Parameters

Each control loop within the 6358 Controller has a set of Loop Command Parameters associated with it for setting up the individual Loop operating characteristics. Table 4.3 shows that there are 21 parameters associated with each loop starting with the Loop Number Parameter LN. This is used to select the required control loop as discussed in Section 4.2.3, and the remaining 20 parameters are discussed in the following sections.

4.4.1 ST - Loop Status

The Loop Status parameter, ST, is of the format 5 type and consists of 4 hexadecimal digits in the range 0000 to FFFF with a positive sign character for parameter entry. It is used to define the decimal point position, input signal processing and filter time constant for the Process Variable input. The current operating mode of the loop is also indicated and this facility allows for mode changes initiated remotely via the RS422 supervisory data link. The format of the ST parameter is given below:-



DIGIT	BIT	FUNCTION	
A	12-15	Decimal point position select (0 to 4)	
B	8-11	Process Variable input channel processing (0 to F)	
C	4-7	Process Variable input filtering (0 to F)	
D	3	Loop sumcheck failure bit	Operating Modes
	2	MANUAL (M) mode selected	
	1	AUTO (A) mode selected	
	0	REMOTE (R) mode selected	

HEX. CHAR	PROCESSING ROUTINE FUNCTION	RANGE
0	No Processing	0 to 10V
1	Square Root Function:- Vout = $\sqrt{\text{Vin} \times 10\text{V}}$	0 to 10V
2	Thermocouple type J (Iron-Constantan)	0 to 800 °C
3	Thermocouple type K (Chromel-Alumel)	0 to 1280 °C
4	Thermocouple type T (Copper-Constantan)	-240 to 400 °C
5	Thermocouple type S (Pt10%Rh-Pt)	0 to 1750 °C
6	Thermocouple type R (Pt13%Rh-Pt)	0 to 1750 °C
7	Thermocouple type E (Chromel-Constantan)	0 to 1000 °C
8	Thermocouple type B (Pt30%Rh-Pt6%Rh)	0 to 1800 °C
9	Platinum Resistance Thermometer (Pt100%)	-200 to 1000 °C
A	Reserved for User Specified Linearisation	As Required
B	Reserved for User Specified Linearisation	As Required
C	Reserved for User Specified Linearisation	As Required
D	Reserved for User Specified Linearisation	As Required
E	Reserved for User Specified Linearisation	As Required
F	Inversion Function:- Vout = 10V - Vin	0 to 10V

TABLE 4.4 List of the Available Input Signal Processing Functions (Selected by ST Parameter, Digit B)

(i) Function 1 - Square Root Function

The formula of Table 4.4 shows that the output of the Square Root function is a value that may be considered as corresponding with a voltage. This effective output voltage, Vout, is a 0-10V value and is formed by taking the square root of the input voltage Vin multiplied by 10 where Vin is also in the range 0-10V, e.g:-

Vin	Vout (effective)
0V	0V
0.4V	2.0V
1.6V	4.0V
10.0V	10.0V (theoretical)

(ii) Functions 2 to 8 - Thermocouple Linearisation

Table 4.4 shows that functions 2 to 8 are used for linearisation of the 7 most common thermocouple types, i.e. types J, K, T, S, R, E and B respectively.

Table 4.4 also shows the maximum temperature range over which the linearisation will function for each type and the programmed setpoint span of the Control Loop must always lie within this range.

For example, the type J thermocouple linearisation from Table 4.4 can be used over the range 0 to 800°C which means that for the Process Variable input:-

1L = 000.0 (Process Variable low range)
1H = 800.0 (Process Variable high range)

Furthermore, if, for example, a Process Variable range of 0 to 400.0°C were required, then 1L = 000.0 and 1H = 400.0, but in addition the thermocouple amplifier or input converter must be scaled to provide a 0 to 10V output for a 0 to 400.0°C input.

Thus, in general, when the thermocouple linearisation functions of Table 4.4 are used:-

6358 PROCESS VARIABLE SPAN 1L to 1H

= INPUT CONVERTER SPAN 0 TO 10V

The exact functions of the digits within the ST parameter are discussed in the following sections:-

a) Decimal Point Selection (digit A)

The first or most-significant digit of the ST parameter is used to select the decimal point position for the Process Variable analogue input as it is displayed on the Front-panel digital readout. The number entered must lie within the range 0 to 4 and will position the decimal point according to the table shown below:-

DIGIT 1 (M.S)	DISPLAY FORMAT
0	9 9 9 9
1	9 9 9.9
2	9 9.9 9
3	9.9 9 9
4	.9 9 9 9

Once the decimal point position has been programmed the resulting display format will appear on the Hand-held terminal for every Command function that is related to the Process Variable range of that control loop. This means in fact that most of the Format 1 and 2 commands listed in Table 4.3 will be displayed with the same decimal point position as for the Process Variable, viz:-

1H, 1L, 2H, 2L, HS, LS, DA, DD, SL, SP, PV

b) Input Channel processing (digit B)

It has been mentioned that each of the 8 Process Variable inputs of the 6358 Controller can be linked independently to a digital processing routine before its resultant value is used by the 3-Term Control algorithm. The second digit of ST is used to select which of the 16 possible processing routines are linked to each Process Variable input. Digit B can lie in the full hexadecimal range of 0 to F, and Table 4.4 lists the 16 possible processing routines with their corresponding hexadecimal numbers. If no processing is required for the Process Variable then it can be seen from Table 4.4 that a zero is entered in the digit B position of the ST parameter. The use of the input channel processing functions is discussed in the following sections.

The Controller automatically decides which portion of the linearisation table is to be used for the selected Process Variable span by referring to the Decimal Point Position (ST digit A), Process Variable High Range (1H), and Process Variable Low Range (1L) parameters of Sections 4.4.1 a) and 4.4.2 respectively. When using the thermocouple linearisation functions the 1H and 1L ranging parameters should always be integers. If they are inadvertently entered as non-integers the 6358 will automatically round them to the nearest integer value internally for linearisation purposes. However, for display purposes the PV will remain scaled to the non-integer values of 1H and 1L.

Again, for example, if a Process Variable range of 0 to 1000 °C is required with a type S thermocouple then the following parameters would be entered to give Process Variable readings with a 1°C resolution:-

ST > 0500

1H = 1000

1L = 0000

The associated Input Converter must be ranged to provide a 0 to 10V output for a 0 to 1000°C input.

It should also be noted that greater display resolution can be obtained by appropriate selection of the Decimal Point Position and Process Variable Range. For example, the type J thermocouple linearisation could be used to obtain Process Variable readings with a 0.01°C resolution over a 100°C span by entering the following parameters:-

ST > 2200

1H = 99.99

1L = 00.00

It is not possible, however, to exceed 0.01°C resolution on any of the thermocouple ranges specified in Table 4.4.

(iii) Function 9 - Platinum Resistance Thermometer

The Platinum Resistance Thermometer linearisation function of Table 4.4 requires the same operating characteristics as for the thermocouples, viz:- the Process Variable span must lie within the range -200.0 to 1000°C and the associated input converter must be ranged appropriately.

(iv) Function A to E - User Specified Linearisations

These 5 processing routines are reserved for any special linearisation functions required by the user that are not catered for by functions 1 to 9. Each linearisation function must be specified by the user in the form of a 24 element break-point table over the required range of values. The TCS factory will then be able to quote a price and delivery for including these functions in a 6358 Process Controller.

(v) Function F - Inversion Function

The formula of Table 4.4 shows that the output of the inversion function is a value that may be considered as corresponding with a voltage. This effective output voltage, Vout, is a 0-10V value formed by direct inversion of the Vin signal which is also in the range 0-10V, e.g:-

Vin	Vout (effective)
0V	10V
5V	5V
10V	0V

The Vout value will then be used by the 6358 as the resultant signal obtained from the Process Variable (PV) signal. The inversion effectively occurs before any other processing is carried out so that the Process Variable as displayed on the digital readout would be the inverted value in this case.

As an example, to demonstrate the effect of the Inversion function, assume that the 6358 control loop has been programmed with the following parameters :-

ST > 1F00

1H = 500.0

1L = 000.0

The Process Variable will now be displayed on the front-panel digital readout, or read back via the serial data links as follows:-

ANALOGUE INPUT	PROCESS VARIABLE DISPLAY
0.0V	500.0
2.5V	375.0
5.0V	250.0
7.5V	125.0
10.0V	000.0

c) Input filter time selection (digit C)

The third digit of ST is used to select an input filter time constant for the Process Variable. This is a simple, digitally implemented, first order filter whose time constant varies from 200ms to 60 seconds as digit C varies from 1 to F as shown in Table 4.5.

d) Status bits (digit D)

The fourth or least-significant digit of ST is used as four separate bits for providing information about the operating mode of the control loop as follows:-

(i) Bit 3

This bit is automatically set to a logic '1' by the CPU whenever a sumcheck failure is detected on any of the command parameters associated with the selected control loop. The diagnostic messages generated on the front panel and the indications via the serial data links are described in Section 2.6.2 g). This condition is rectified by re-entering any corrupted control loop command parameters and re-setting bit 3 to logic '0'.

(ii) Bit 2 - MANUAL

This bit of digit D is set to a logic '1' whenever the Control loop is operating in the MANUAL mode as described in Section 3.2. This bit is a read/write bit so that the control loop may be set to the MANUAL operating mode by entering a value of 4 for digit D of the ST parameter.

(iii) Bit 1 - AUTO

This bit of digit D is set to a logic '1' whenever the Control loop is operating in the AUTO mode as described in Section 3.3. This bit is a read/write bit so that the control loop may be set to the AUTO operating mode by entering a value of 2 for digit D of the ST parameter.

(iv) Bit 0 - REMOTE

The least-significant bit of digit D is set to a logic '1' whenever the Control loop is operating in the REMOTE AUTO mode as described in Section 3.4. This bit is a read/write bit so that the control loop may be set to the REMOTE AUTO operating mode by entering a value of 1 for digit D of the ST parameter.

HEXADECIMAL CHARACTER	SELECTED INPUT FILTER TIME IN SECONDS
0	0
1	0.2
2	0.4
3	0.6
4	0.8
5	1.0
6	2.0
7	4.0
8	6.0
9	8.0
A	10.0
B	15.0
C	20.0
D	25.0
E	30.0
F	60.0

TABLE 4.5 List of the available input filter time values (selected by ST parameter digit C)

It should be noted that in the FORCED MANUAL operating mode of Section 3.1 bits 0, 1 and 2 of ST are all set to logic '1', i.e. digit D will read back as 7. In the case of a sumcheck error, bit 3 of ST is also set to logic '1' and the FORCED MANUAL mode is entered so that digit D will read back as F.

4.4.2 1H, 1L - Process Variable input ranging

These parameters define, in Engineering Units, the span of the Process Variable input, PV. The value entered in 1H is equivalent to an input of 10V when the appropriate bit of LT digit C or D is set to logic '0', or 5V when the bit is set to logic '1'. Similarly, 1L is equivalent to an input of 0V when the appropriate bit of LT digit C or D is set to logic '0', or 1V when the bit is set to logic '1'. 1H and 1L are bipolar entries so that the range of values is -9999 to +9999 and 1H must be greater than 1L. The decimal point position for both of these parameters is programmed by digit A of the ST parameter as described in Section 4.4.1 a).

4.4.3 2H, 2L - Setpoint Trim input ranging

These parameters define, in Engineering Units, the span of the second analogue input for each control loop when the TRIM option is fitted, S2 no. 4 is ON and the appropriate bit of LT digit A or B is set to logic '0'. This second input then becomes the Local Setpoint Trim signal and is 0-10V only. Under these conditions 2H becomes the Setpoint Trim High range and is the value added to the Local Setpoint, SL, when a signal of 10V is applied to the second analogue input. Similarly 2L is the Setpoint Trim Low range and is the value added to SL when a signal of 0V is applied to the second analogue input.

If the TRIM facility has been selected but is not required, then 2H and 2L should both be set to zero. For a more detailed description of the Setpoint Trim facility refer to Section 3.6.

4.4.4 HS, LS - Setpoint Limits

These parameters define in Engineering Units the range over which the Resultant Setpoint, SP is allowed to vary. HS and LS affect SP according to the 6358 control loop operating mode thus:-

a) 6358 Control Loop in MANUAL or AUTO

In MANUAL or in AUTO, HS and LS limit the range over which the Local Setpoint, SL, can be varied by the Raise/Lower buttons or either of the serial links. With the TRIM facility enabled (see Section 3.6), a Local Setpoint Trim can be added to SL and the resultant value is again limited by HS and LS before it becomes the Resultant Setpoint SP.

b) 6358 Control Loop in REMOTE

With the 6358 Controller in REMOTE, the Remote Setpoint from channel 2 is limited by HS and LS before becoming the SL value.

The range of HS and LS are the same as the Process Variable, i.e. 1L to 1H, and HS must be greater than LS. If HS is set equal to LS then this locks SL and hence SP to this value and prevents it from being altered by any means. The decimal point position for HS and LS is the same as for the PV, i.e. it is programmed by digit A of the ST parameter as described in Section 4.4.1 a).

4.4.5 DA - Deviation Alarm Limit

The Deviation Alarm limit parameter DA is used to set the levels, in Engineering units, at which the Deviation (ER = PV - SP) will generate symmetrical High or Low Deviation alarms respectively. The 6358 control loop will enter the High Alarm condition if the Positive Deviation (PV - SP) exceeds the value set in DA. Under these conditions the high Alarm LED for this loop will flash. The 6358 control loop will enter the Low Alarm condition if the Negative Deviation (SP - PV) exceeds the value set in DA. Under these conditions the low Alarm LED for this loop will flash.

If the optional digital output daughter board is fitted (ALM option), then the corresponding alarm logic output will fall to 0V if either the low or high alarm LED is flashing for that loop.

It should be noted that DA is always entered as a positive number and its range is 0 to the modulus of the span 1L to 1H. If alarms are not required, then they may be disabled by setting DA to the modulus of the span 1L to 1H. The decimal point position for DA is the same as for the PV, i.e. it is programmed by digit A of the ST parameter as described in Section 4.4.1 a).

4.4.6 DD - Deviation Display setting

The Deviation Display Setting parameter, DD, is used to program symmetrical display limits for the High and Low devation LED's provided for each loop. The action of these LED's is similar to that described with the DA parameter of section 4.4.5 except that the LED's merely turn ON and do not flash. Also the Deviation Display condition is for indication purposes only and does not affect the Alarm outputs when the ALM option is fitted. Thus the High Alarm LED for a control loop will come ON when the Positive Deviation exceeds the value set in DD, and the Low Alarm LED will be illuminated when the negative Deviation exceeds DD.

It should be noted that DD is always entered as a positive number and its range is 0 to the modulus of the span 1L to 1H. If Deviation Display indication is not required, then it may be inhibited by setting DD to the modulus of the span 1L to 1H. The decimal point position for DD is the same as for the PV, i.e. it is programmed by digit A of the ST parameter as described in Section 4.4.1 a).

4.4.7 HO, LO - 3 Term Output Limits

The HO and LO limit parameters restrict the range over which the 3-Term Output parameter, OP can vary. They operate on OP whether it is being varied by the Raise/Lower buttons or serial links in MANUAL mode, or when OP is being calculated by the 3-Term Algorithm in AUTO, or REMOTE AUTO, modes. HO and LO are set in percent over the full scale operating range of 0 to 99.99% and HO should always be set greater than LO. Where digital time-proportioned output is used HO and LO represent the maximum and minimum pulse widths, respectively.

4.4.8 XP - Proportional Band Constant

The XP parameter defines the overall gain of the Controller as described in Section 3.7. The exact relationship between XP and the gain is given by the expression:-

$$\text{GAIN} = \frac{100}{\text{XP}}$$

e.g. A proportional band value of 100 = Unity gain
A proportional band value of 5 = Gain of 20

XP is a format 4 parameter and is hence always positive with a range of 0.1 to 999.9% corresponding to a gain range of 1000 to 0.1 respectively.

If XP is set to zero, the loop acts as an ON/OFF controller as described in Section 3.8.1 a).

4.4.9 TI, TD - Integral and Derivative time constants

The TI and TD time constant parameters define the value of the Integral and Derivative time constants used in the 6358 3-Term algorithm described in Section 3.7. They are both format 3 parameters and can be set over the range 0.01 to 99.99 minutes, while a value of 0.00 will set either of the terms off completely. When a loop is operating in ON/OFF control, TI defines the ON/OFF deadband as a percentage of the range 1L to 1H. A full description of ON/OFF control is given in Section 3.8.1 b). TD is not used in ON/OFF control.

4.4.10 SL - Local Setpoint

This parameter defines, in Engineering Units, the internal Setpoint before Trim is applied. SL can be derived from a number of sources depending upon the operating mode of the 6358 control loop thus:-

a) MANUAL

Here the SL value may be altered via the Raise/Lower buttons or serial data links.

b) AUTO

Here SL can be altered as in a) above.

c) REMOTE

Here the 6358 control loop is in REMOTE SETPOINT mode and SL tracks the value on the channel 2 analogue input. Thus SL cannot be altered but only monitored via the front-panel or serial data links.

In all these cases SL is constrained within the range defined by the HS and LS Setpoint Limit parameters as described in Section 4.4.4. Table 4.1 shows that the decimal point position for SL is the same as for the PV, i.e. it is programmed by digit A of the DP parameter as described in Section 4.4.1 a)

4.4.11 OP - 3-Term Output Level

Table 4.3 shows that the OP parameter is the current output value of the 3-Term control algorithm expressed as a percentage of the full scale operating range of 0 to 99.99%. OP is always constrained to lie within the limits defined by HO and LO as described in Section 4.4.7. It should be noted that OP is a read-only parameter in all operating modes except for MANUAL or FORCED MANUAL. In these two modes OP can be altered via either of the serial data links.

With the ON/OFF control mode selected via XP, the Control Output level, OP, can only take up either the ON state or the OFF state as described in Section 3.8.1 c).

Where digital time-proportioned outputs are used, OP represents the ON pulse duration expressed as a percentage of cycle length.

4.4.12 SP - Resultant Internal Setpoint

This parameter defines, in Engineering Units, the resultant internal Setpoint after Trim has been applied as described in Section 3.6. This is effectively the Local Setpoint value, SL, after Trim has been added and the Setpoint limits HS and LS have been applied. The effects of Trim on the SP parameter may be summarised as follows.

a) Local Setpoint Trim

In Manual or AUTO modes SP is simply the value of SL plus the trim signal as described in Section 3.6.

b) Remote Setpoint

In REMOTE mode SL tracks the REMOTE Setpoint input so that SP is the same as in a) above. The Remote Setpoint cannot be trimmed in REMOTE mode because the LT parameter is set to select the second analogue channel to be a Remote Setpoint and not a Trim input.

The decimal point position for SP is the same as for the PV, i.e. it is programmed by digit A of the ST parameter as described in Section 4.4.1 a).

4.4.13 PV - Process Variable

This parameter defines, in Engineering Units, the value of the Process Variable input signal after it has been filtered and had any signal processing applied. The PV input is scaled by the Channel 1 input ranging parameters 1L and 1H as described in Section 4.4.2. Input channel processing for PV is defined by digit B of the ST parameter as described in Section 4.4.1 b) and input filtering is defined by digit C as described in Section 4.4.1 c). The decimal point position is programmed by digit A of the ST parameter as described in Section 4.4.1 a).

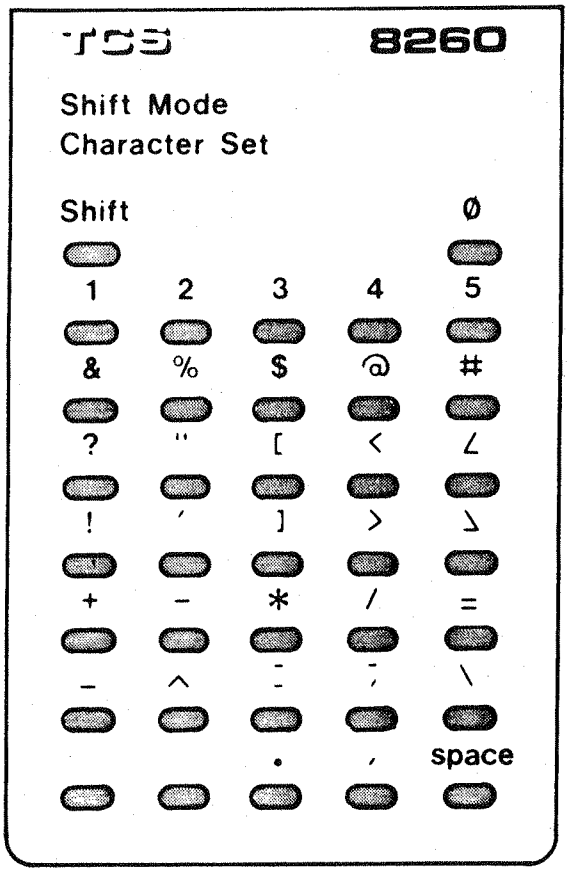


FIG 4.2) SHIFT MODE CHARACTER SET KEYBOARD OVERLAY

4.5 1T, 2T - Loop Tag Characters

Section 1.4.1 c) describes how the address/identity display can be used to display an 8 character label to identify each of the 8 control loops of the 6358. These 8 character labels or tags can consist of any combination of the 64 character ASCII set, i.e. numerals 0-9, upper case letters A-Z, plus 28 other symbols. Typical examples of such tags would be:-

TIC 003
FIC 001
PUMP 2
ZONE 5 etc.

The 1T and 2T loop tag parameters are used to enter the first 4 and last 4 characters respectively of these tags into the memory of the 6358 Process Controller. The means of accessing the loop tag parameters depends upon whether the 8260 Hand-held terminal or serial data link is being used as follows:-

4.5.1 1T, 2T - Access via the 8260 Hand-held terminal

When setting up the 1T and 2T parameters via the 8260 Hand-held terminal it should be noted that they cannot be accessed by scrolling (W ↓) through the parameter list of any of the control loops. Instead, the following procedure must be adopted:-

a) Select the required control loop for front-panel display by means of the appropriate LN parameter entry (see section 4.2.3)

b) Re-initialise the terminal by means of the Z key (Z?), so that the 6358 issues the usual prompt:-

?? CMD

c) Enter the first half of the 8 character tag name by specifying the 1T mnemonic.

d) The 6358 will respond with 1T followed by the first 4 characters of the existing tag name. At this stage the user must enter four ASCII characters to complete the data entry.

e) After entering the fourth character the 6358 will clear the 8360 terminal display and issue the prompt:-

?? CMD

The 4 characters entered at step c) will now appear in the left hand half of the alphanumeric display.

f) Enter the second half of the 8 character tag name by specifying the 2T mnemonic.

g) The 6358 will respond with 2T followed by the last 4 characters of the existing tag name. At this stage the user must enter four ASCII characters to complete the data entry as described in step d) above.

NOTES

1) When entering all other parameters via the 8260 terminal, some of the keys have specific functions, e.g. Q is the back-space key, W is the scroll mode key etc. (See the System 6000 Communications Handbook section 3.5). However, when 1T or 2T are being entered these functions are disabled so that all the alphanumeric characters are available for the tag fields. This means that once the 1T and 2T parameters are started, they must be completed or can only be aborted by pulling out the 8260 terminal plug.

2) It is often required to programme non alphanumeric characters like spaces or asterisks within a tag field. The 8260 keyboard layout of Fig. 4.1 shows that these are not normally available. However, if the SHIFT key is pressed an additional set of shift mode characters are available as illustrated by the keyboard overlay shown in Fig. 4.2. Additional information on the shift mode is given in Section 2.4 of the System 6000 Communications Handbook.

4.5.2 1T, 2T - Access via the RS 422 Supervisory Link

The exact means of access of the Loop Tag parameters via the RS 422 supervisory link depends upon whether the ASCII or binary modes of the communications protocol are employed as follows:-

a) ASCII Mode Protocol (S1 no. 5 - OFF)

The 1T or 2T parameters of any control loop may be polled or updated in the same manner as any other parameter discussed in Section 5 of the System 6000 Communications Handbook. It therefore follows that the 1T or 2T parameters may also be accessed via the Scroll-mode facility (ACK) during a Poll or Select sequence. This may be demonstrated by the following example:-

Control loop 1 tag = FIC 001

If the previous command parameter polled was:-

1T'FIC - 1T parameter of loop 1

then after an ACK response the 6358 replies:-

2T'001 - 2T parameter of loop 1

It should be noted that 1T and 2T are format 8 parameters so that the 5 character 'D' field in the Poll or Select Message Transfer Procedure are as follows:-

(i) D1

The first character is always ' - a single quotation mark (hex 27) to denote an ASCII parameter.

(ii) D2 - D5

The last 4 characters are any combination of the 64 character ASCII set with hexadecimal equivalents from 20 to 5F inclusive.

b) Binary Mode Protocol (S1 no. 5 - ON)

With the Binary mode of the protocol ASCII characters are transmitted as two 8 bit pairs which may be illustrated by the following example:-

Control loop 1 tag = ABCDEFGH

This would be split up into 8 bit pairs as follows:-

T1 = AB; T2 = CD;

T3 = EF; T4 = GH;

- and these are shown in the 6358 parameter number (PNO) Table 5.1.

Using the same tag field as in the above example, the corresponding 1T and 2T parameters for the ASCII mode of the protocol would be as follows:-

1T = ABCD

2T = EFGH

Thus it can be deduced that the relationship between the tag character fields for the two protocol modes is as follows:-

1T = T1 + T2

2T = T3 + T4

Section 5 Computer Supervision of 6358 Process Controllers

In common with all System 6000 instruments the 6358 Process Controller is fitted with 2 ports for serial data communications. The first of these is the RS232 port available on the front-panel which is used for connection of the 8260 Hand-held terminal as described in Section 4.1. This port allows local operators to communicate on a one-to-one basis when entering the Command Parameters which are used to set-up control loops within the 6358 for particular characteristics.

The second communications port is an RS422 serial interface available on the module rear connector pins 45 to 48 inclusive. The RS422 ports of a number of 6358 Controllers may be bussed onto a supervisory data link connected to a remote Supervisory Computer or other intelligent device. This bus structure then allows the Supervisory Computer to monitor or update the Command Parameters of a whole network of 6358 Controllers and other System 6000 instruments. As the means of implementing the Supervisory link are common to all System 6000 instruments, these are described in other TCS documents as follows:-

5.1 Serial Data Bus Hardware Installation

A full definition of the RS422 transmission standards are given in Section 7 of the System 6000 Installation Guide together with a discussion of:-

a) Interface connections.

b) Cable impedance and termination.

c) Interface signal polarity.

5.2 Serial Data Transmission

Section 2.3.2 a) briefly mentions the role of Switch bank S1 in setting up the RS422 baud rate and Group Identifier (GID). While Section 2.3.2 b) (i) covers the use of S2 switch no. 1 to generate the necessary Unit Identifier (UID). A more complete description is given in Section 4 of the System 6000 Communications Handbook together with a discussion of:-

a) RS422 characteristics and technical specification.

b) Serial data transmission.

c) Binary Synchronous Communications Data Link Control.

d) Instrument Group and Unit addressing.

	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	(1) T1	(1) T2	(1) T3	(1) T4	LT	LI	SW
32	S1	S2	S3	S4	MD	AC	AH	

TABLE 5.1 List of 6358 Parameter Numbers, [PNO]s, and their respective mnemonics

NOTES

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

(1) Loop Tag Characters

As described in Section 4.5 it should be noted that for each Control Loop:-

$$1T = T1 + T2$$

and

$$2T = T3 + T4$$

5.3 Communication Protocols

All data transfers between the 6358 and a Supervisory Computer via the RS422 data link are carried out using a communications protocol. TCS has chosen an ANSI standard protocol called BISYNC (Binary Synchronous) for System 6000 instruments and this is known by the abbreviation X3.28. The 6358 Controller can operate this protocol in either the ASCII or Binary mode depending upon the setting of S1 no. 5 (see Section 2.3.2 a) (iii)). A full definition of these two protocol modes may be found as follows:-

a) ASCII protocol

This is discussed in Section 5 of the System 6000 Communications Handbook, while the list of ASCII Command Mnemonics are given in Table 4.1 and Table 4.2 of this manual.

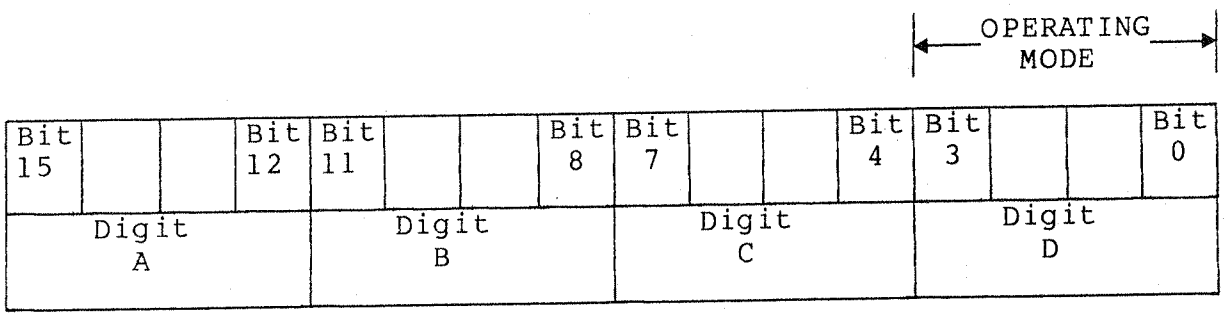
b) Binary Protocol

This is discussed in Section 6 of the System 6000 Communications Handbook, while the associated list of Parameter Numbers is given in Table 5.1 of this manual.

5.4 MN - Mode Number Parameter

The MN parameter is used to give the Supervisory Computer access to the operating mode of each loop of the 6358, and also to provide other related status information. The MN parameter does not appear in the parameter list when using an 8260 Hand-held terminal, nor can it be accessed using the ASCII mode of the protocol via the RS422 data link. It can only be accessed as parameter number 6 (PNO = 6) via the Binary mode of the serial link protocol.

The Mode Number, MN, is a format 5 read/write parameter consisting of 4 hexadecimal digits in the range 0000 to FFFF with a positive sign character for parameter entry. The format of the MN parameter is given below:-



DIGIT	BIT	FUNCTION
	15	N/A
	14	Parameter change of state bit
A	13	N/A
	12	N/A
	11	N/A
B	10	N/A
	9	Power failure warning bit
	8	N/A
C	4-7	N/A
D	0-3	6358 Operating Mode

The exact functions of the digits within the MN parameter are discussed in the following sections:-

a) Parameter Change of State Bit (digit A, bit 14)

The only bit used within digit A is bit 14 which is set to a logic '1' whenever the Hand-held terminal or Front-panel push-buttons have been used to change the value of a Command Parameter, or the 6358 operating mode.

This bit, corresponding to an MN value of 4000 cannot be read via the Hand-held terminal, but must be reset via the RS422 serial link using the Binary mode of the protocol.

b) Power Failure Warning Bit (digit B, bit 9)

The only bit used within digit B is bit 9 which is set at a logic '1' by any hardware Reset or Power Failure detected within the 6358. This bit can only be reset via the RS422 serial link using the Binary mode of the protocol.

c) Digit C

This digit is unallocated and reads back as zero.

d) Control Loop Operating mode (digit D)

The function of this digit is to give the supervisory computer a direct indication of which of the 5 operating modes are currently active for any of the 8 control loops within the 6358. The significance of each of these mode numbers is as follows:-

MN digit D	6358 Loop Operating Mode
0	N/A
1	N/A
2	MANUAL
3	AUTO (Local Setpoint)
4	N/A
5	REMOTE AUTO (Cascade)
6	FORCED MANUAL
7	AUTO FALL-BACK (from REMOTE)

Each of the 6358 loop operating modes indicated by digit D of the MN parameter can be controlled via the serial data link as follows:-

(i) Modes 0 and 1 are not applicable

(ii) Modes 2 and 3 can be selected

(iii) Mode 4 is not applicable

(iv) Mode 5 can only be selected when S2 no. 4 is ON and the appropriate bit of the LT parameter digits A and B has been set to a logic '1'.

(v) Mode 6 cannot be selected and is read-only

(vi) Mode 7 is read-only and is selected automatically by the 6358 if mode 5 is entered and S2 no. 4 is OFF or the appropriate bit of the LT parameter digits A and B is set to a logic '0'.

Pin No.	Designation	Function	
1			
2	0VR	0V Reference	POWER SUPPLIES
3	0VP	0V Power	
4			
5			
6			
7	+15V.OUT	+15V Supply Output	
8	DC SUPP.IN	DC Supply (20-30V) input	
9	W.DOG.OUT(1)	Watchdog Timer output	
10	PV1.IN	Process Variable inputs Loops 1 to 8	
11	PV2.IN		
12	PV3.IN		
13	PV4.IN		
14	PV5.IN		
15	PV6.IN		
16	PV7.IN		
17	PV8.IN		
18	REM.SP1.IN	Remote Setpoint/ Setpoint Trim inputs (TRIM option) Loops 1 to 8	
19	REM.SP2.IN		
20	REM.SP3.IN		
21	REM.SP4.IN		
22	REM.SP5.IN		
23	REM.SP6.IN		
24	REM.SP7.IN		
25	REM.SP8.IN		
26	3T1.OUT	3-Term Control outputs Loops 1 to 8 (0-10V)/ Digital outputs (0-15V) (TPO option)	
27	3T2.OUT		
28	3T3.OUT		
29	3T4.OUT		
30	3T5.OUT		
31	3T6.OUT		
32	3T7.OUT		
33	3T8.OUT		
34	PV1/ALM1.OUT	Re-transmitted PV outputs (RPV option)/ Deviation Alarm outputs (ALM option) Loops 1 to 8	
35	PV2/ALM2.OUT		
36	PV3/ALM3.OUT		
37	PV4/ALM4.OUT		
38	PV5/ALM5.OUT		
39	PV6/ALM6.OUT		
40	PV7/ALM7.OUT		
41	PV8/ALM8.OUT		
42			
43			
44			
45	XMT.OUT(-)	Transmit Outputs	RS 422 SUPERVISORY SERIAL DATA BUS
46	XMT.OUT(+)		
47	RCV.IN(-)	Receive Inputs	
48	RCV.IN(+)		

Pin No.	Designation	Function	
1			
2	0VR	0V Reference	POWER SUPPLIES
3	0VP	0V Power	
4			
5			
6			
7	+15V.OUT	+15V Supply Output	
8	DC SUPP.IN	DC Supply (20-30V) input	
9	W.DOG.OUT(1)	Watchdog Timer output	
10	PV1.IN	Process Variable inputs Loops 1 to 8	
11	PV2.IN		
12	PV3.IN		
13	PV4.IN		
14	PV5.IN		
15	PV6.IN		
16	PV7.IN		
17	PV8.IN		
18	REM.SP1.IN	Remote Setpoint/ Setpoint Trim inputs (TRIM option) Loops 1 to 8	
19	REM.SP2.IN		
20	REM.SP3.IN		
21	REM.SP4.IN		
22	REM.SP5.IN		
23	REM.SP6.IN		
24	REM.SP7.IN		
25	REM.SP8.IN		
26	3T1.OUT (I+)	3-Term Control outputs Loops 1 to 8 (4-20mA) (MA option)	
27	3T2.OUT (I+)		
28	3T3.OUT (I+)		
29	3T4.OUT (I+)		
30	3T5.OUT (I+)		
31	3T6.OUT (I+)		
32	3T7.OUT (I+)		
33	3T8.OUT (I+)		
34	COM (I-)	4-20mA common returns (MA option)	
35	COM (I-)		
36	COM (I-)		
37	COM (I-)		
38	COM (I-)		
39	COM (I-)		
40	COM (I-)		
41	COM (I-)		
42			
43			
44			
45	XMT.OUT(-)	Transmit Outputs	RS 422 SUPERVISORY SERIAL DATA BUS
46	XMT.OUT(+)		
47	RCV.IN(-)	Receive Inputs	
48	RCV.IN(+)		

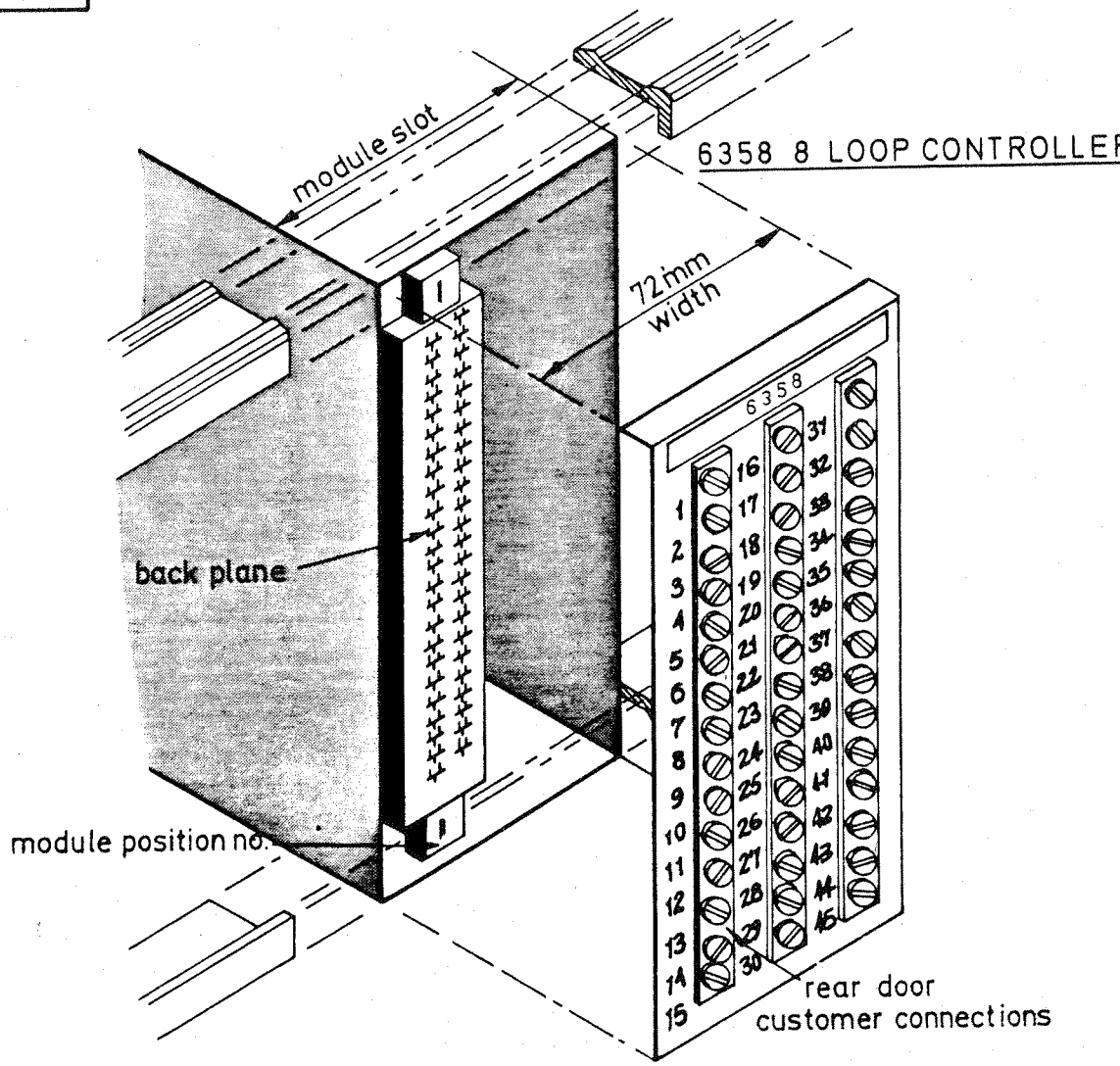
Aids to Wiring

	8 LOOP CONTROLLER																	
	6358 VOLTAGE O/P			6358 mA CURRENT O/P														
PIN NO	FUNCT	FROM	TO	FUNCT	FROM	TO	FUNCT	FROM	TO	FUNCT	FROM	TO	FUNCT	FROM	TO	FUNCT	FROM	TO
1																		
2	OV R			OV R														
3	OV P			OV P														
4																		
5																		
6																		
7	+15V OUT			+15V OUT														
8	DC SUP IN			DC SUP IN														
9	W.DOG OUT(1)			W.DOG OUT(1)														
10	PV 1 IN			PV 1 IN														
11	PV 2 IN			PV 2 IN														
12	PV 3 IN			PV 3 IN														
13	PV 4 IN			PV 4 IN														
14	PV 5 IN			PV 5 IN														
15	PV 6 IN			PV 6 IN														
16	PV 7 IN			PV 7 IN														
17	PV 8 IN			PV 8 IN														
18	REM SP1 IN			REM SP1 IN														
19	REM SP2 IN			REM SP2 IN														
20	REM SP3 IN			REM SP3 IN														
21	REM SP4 IN			REM SP4 IN														
22	REM SP5 IN			REM SP5 IN														
23	REM SP6 IN			REM SP6 IN														
24	REM SP7 IN			REM SP7 IN														
25	REM SP8 IN			REM SP8 IN														
26	3T 1 OUT			3T 1 OUT(I+)														
27	3T 2 OUT			3T 2 OUT(I+)														
28	3T 3 OUT			3T 3 OUT(I+)														
29	3T 4 OUT			3T 4 OUT(I+)														
30	3T 5 OUT			3T 5 OUT(I+)														
31	3T 6 OUT			3T 6 OUT(I+)														
32	3T 7 OUT			3T 7 OUT(I+)														
33	3T 8 OUT			3T 8 OUT(I+)														
34	ALM 1 /PV 1			COM (I-)														
35	ALM 2 /PV 2			COM (I-)														
36	ALM 3 /PV 3			COM (I-)														
37	ALM 4 /PV 4			COM (I-)														
38	ALM 5 /PV 5			COM (I-)														
39	ALM 6 /PV 6			COM (I-)														
40	ALM 7 /PV 7			COM (I-)														
41	ALM 8 /PV 8			COM (I-)														
42																		
43																		
44																		
45	XMT OUT(-)			XMT OUT(-)														
46	XMT OUT(+)			XMT OUT(+)														
47	RCV IN (-)			RCV IN (-)														
48	RCV IN (+)			RCV IN (+)														

APPENDIX B

loop identifier

rack & module no.



The B6358 termination assembly consists of a 48 pin back plane connector with a wire loom linking the module connections on the back plane to three rows of 15 customer terminals.

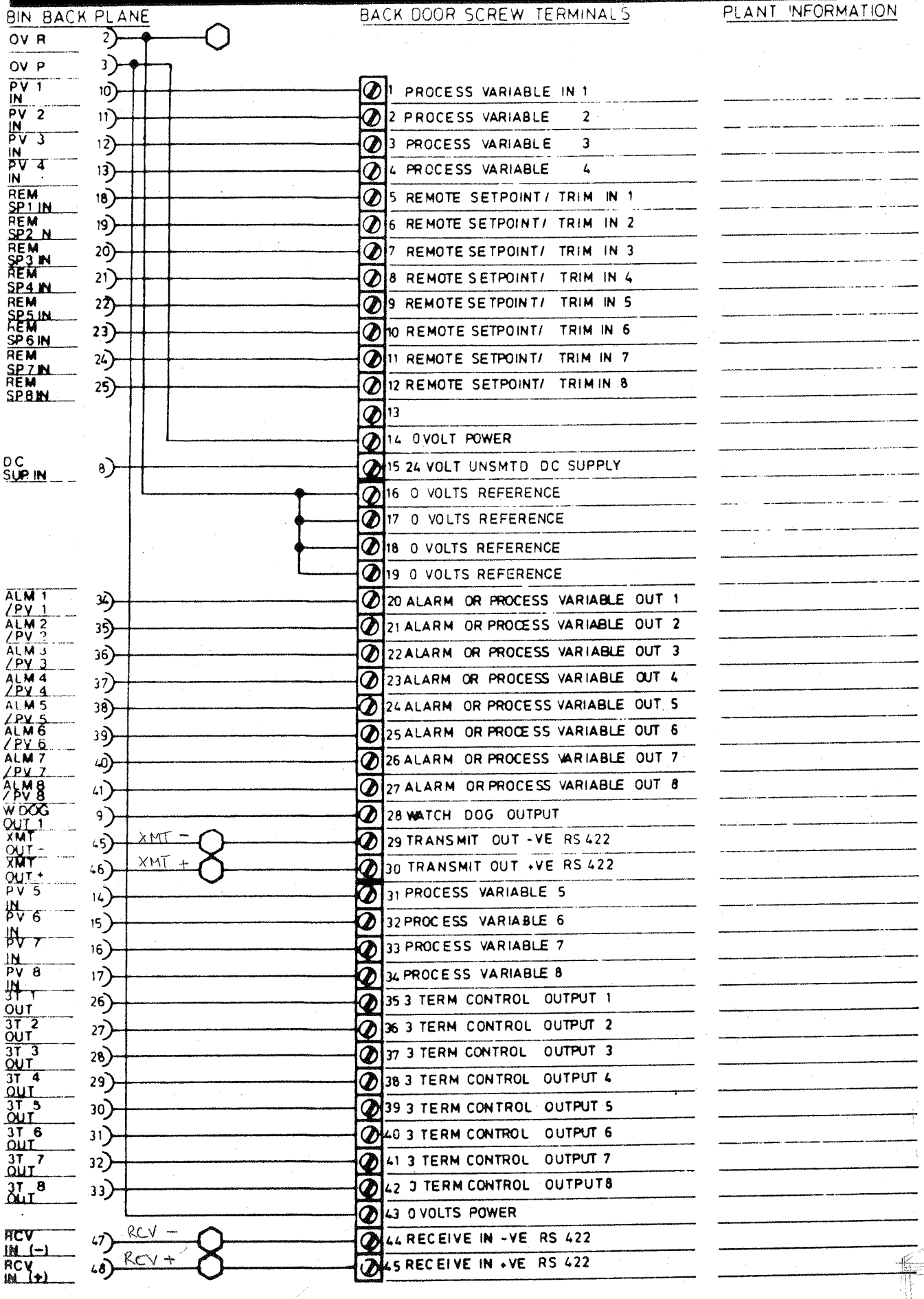
The assembly is used to mount 6358 8 Loop Controllers into 7600 bin units and can only be ordered as part of a 7600 bin system

Detailed technical and mechanical specifications can be found in the following documents :-

7600 Sales Literature
6358 Product Specification
6358 Technical Manual

Turnbull Control Systems Limited
Broadwater Trading Estate Worthing Sussex BN14 8NW Telex 87437
Telephone Worthing (0903) 205277

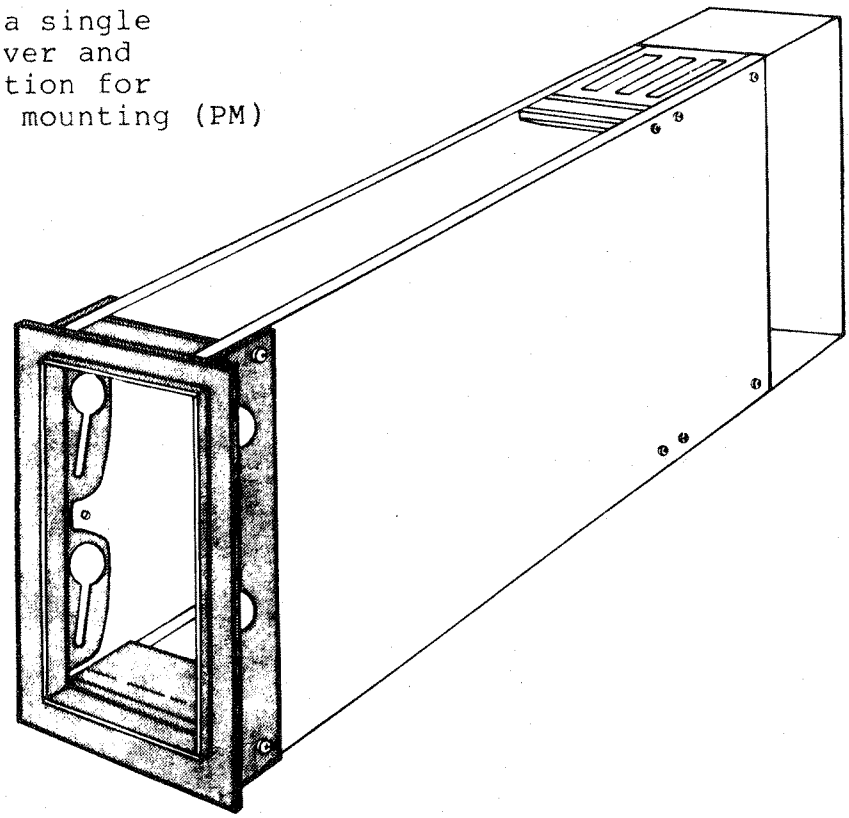
BIN INTERCONNECTIONS



⬡ THESE LINES MAY BE BUSED TO OTHER MODULES IN THE BIN

SINGLE OR MULTI-WAY SLEEVE ASSEMBLY FOR MICROPROCESSOR BASED INSTRUMENTATION

NOTE
Drawing shows a single sleeve with cover and gland plate option for standard panel mounting (PM)



* Single, 3-way or 6-way panel mounting versions
* 6-way 19" rack mounting version
* all module connections available via screw terminals
* each module individually powered from 24V d.c. or mains

The 7900 assembly enables from 1 to 6 modules from the TCS System 6000 range of microprocessor based instruments to be panel or rack mounted in sleeves. Any combination of modules can be specified including Controllers, Signal Processors, and Flow Totalisers. Each instrument within the 7900 unit is individually powered via its own rear termination assembly, which also gives access to all the module connections.

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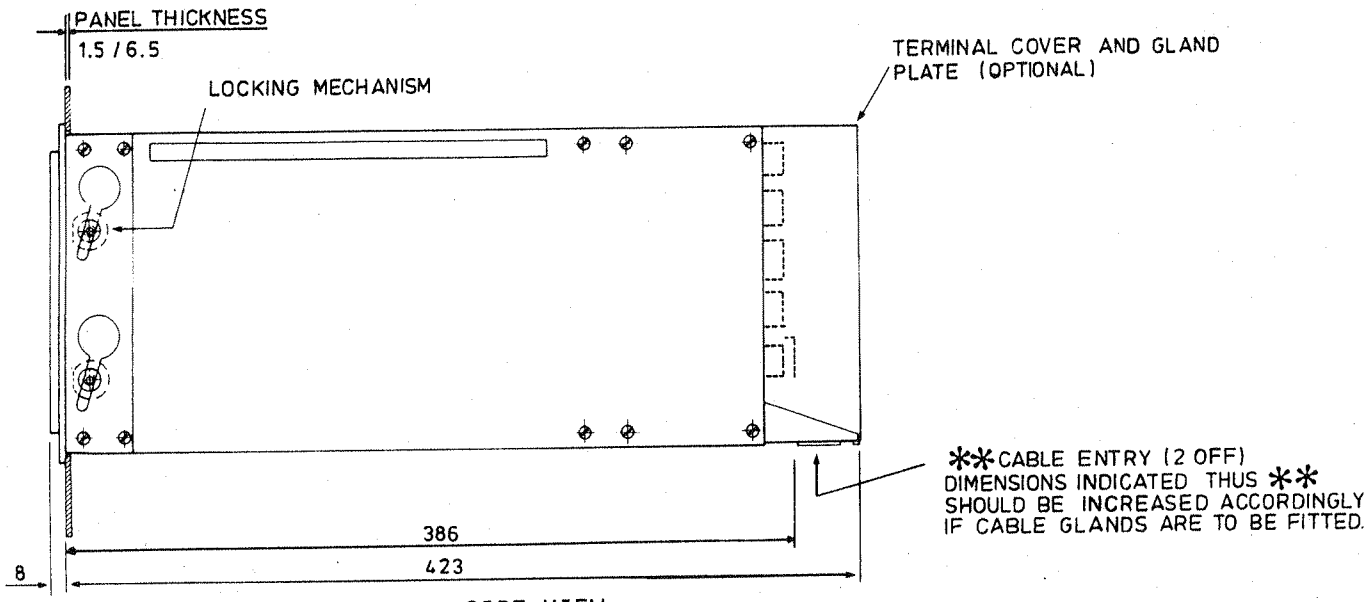
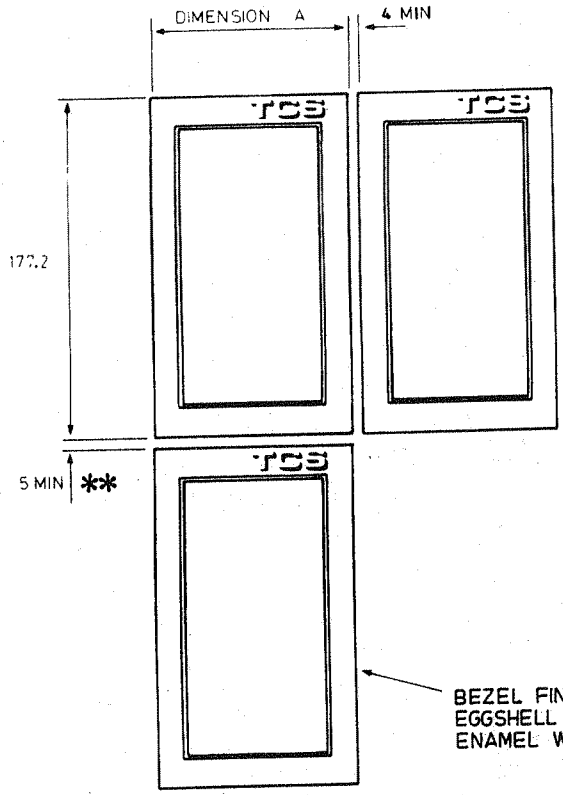
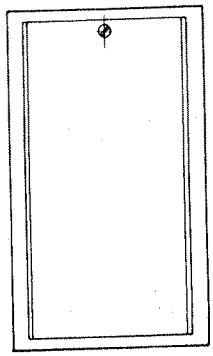
TECHNICAL SPECIFICATION

1) Installation Details for Panel Mounting Sleeves



SIDE VIEW





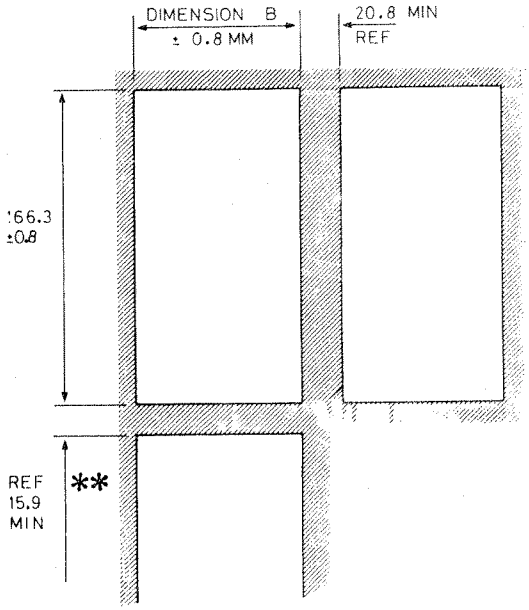
REAR VIEW

DIMENSION A	SLEEVE WIDTH
105	1-WAY
249	3-WAY
465	6-WAY

FRONT VIEW SHOWING OTHER POSSIBLE ADJACENT SLEEVES

2) Mounting Instructions

The dimensions of the various 7900 assemblies can be ascertained from the side and front view diagrams which also show the closest positioning of adjacent units. The diagram below gives the panel cut-out dimensions corresponding with the closest unit positioning.



DIMENSION B	SLEEVE WIDTH
88.2	1-WAY
232.2	3-WAY
448.2	6-WAY

PANEL CUT-OUT DETAILS

To position a 7900 assembly in a panel and subsequently mount a microprocessor based instrument within it, the following installation procedure is carried out:-

(i) Press an empty 7900 sleeve assembly firmly into the panel cut-out.

(ii) On the 1-way sleeves, insert the 2 locking mechanisms into the lower keyhole slots on either side and push them down as far as possible. On 3 and 6 way sleeves, fit locking mechanisms in all four positions.

(iii) Tighten the socket screw inside each locking mechanism in a clockwise direction using the 2.5 A/F Hex Key provided.

(iv) For the TPM option fit the locating spigot on the DIN clip into the slot on the side plates, with the face pressed against the rear of the panel then tighten the screw until the assembly is secure.

(v) Slide the instrument, with its own 72mm module sleeve firmly into the recess using the catch-handle to lock it into position.

(vi) The optional rear-terminal cover may be removed to allow wiring access for power-supply and plant connections which may be brought in via the 2 cable entry glands provided. Rear supporting is recommended especially on mains powered versions.

TECHNICAL SPECIFICATION

a) Length : 423mm with CGP option
: 386mm without CGP option

b) Width
(i) 1-Way PM or TPM : 105mm
(ii) 3-Way PM or TPM : 249mm
(iii) 6-Way PM or TPM : 465mm
(iv) 6-Way 19" RM : 482.6mm (19")

c) Height (all versions) : 177.2mm (7")

d) Panel cut-out dimensions
(i) 1-Way : 88.2 x 166.3 + 0.8mm
(ii) 3-Way : 232.2 x 166.3 + 0.8mm
(iii) 6-Way : 448.2 x 166.3 + 0.8mm

e) Panel thickness
(i) PM version : 1.5 to 6.5mm
(ii) TPM version : 6.5 to 24mm

f) Permissible mounting angle : Panel may slope from vertical by -45 to +90 degrees

g) Customer cable size : 0.5 to 1.5mm

h) Bezel finish : Eggshell black stove enamel with silver trim

i) Weight

	DC VERSION	MAINS VERSION
(i) 1-Way PM or TPM :	3.6Kg	4.3Kg
(ii) 3-Way PM or TPM :	8.4Kg	10.5Kg
(iii) 6-Way PM or TPM or RM :	15.6Kg	19.8Kg

DESCRIPTION	ORDER CODE
Single or Multi-way Sleeve Assembly	7900
Sleeve Width a) Single Sleeve or b) 3-Way Sleeve Panel Mounting or c) 6-Way Sleeve Panel Mounting or d) 6-Way Sleeve Rack Mounting or e) 1-Way Sleeve Thick Panel Mounting or f) 3-Way Sleeve Thick Panel Mounting or g) 6-Way Sleeve Thick Panel Mounting	 1-WAY PM 3-WAY PM 6-WAY PM 6-WAY 19" RM 1-WAY TPM 3-WAY TPM 6-WAY TPM
Supply Voltage a) 24V DC or b) 110V AC or c) 240V AC N.B. Multi-Way assemblies all have the same supply voltage	 24V 110V 240V
Rear door cover and gland plate option for the rear termination assemblies	CGP

DESCRIPTION	ORDER CODE
Rear Termination Assemblies Specify which instrument is to fit into each sleeve position starting from the left-hand end (front view). Select from the following:-	
a) 6350, 6351, 6352, 6353, 6355, 6356 - single loop Controllers	7350, 7351, 7352, 7353, 7355, 7356
or b) 6358 - 8-loop Controller	7358
or c) 6360, 6363, 6365, 6366 - Bargraph Controllers	7360, 7363, 7365, 7366
or d) 6432, 6433 - Signal Processors	7432, 7433
or e) 6434, 6435, 6436, 6437 - Flow Totalisers	7434, 7435, 7436, 7437
or f) 6255, 6445 - Communications units	7255, 7445
or g) 6850 - Setpoint Programmer	7850
or h) Blank slot	BLANK
Current Inputs For the following modules the option of 1-5V or 4-20mA is provided. (All channels to be the same) a) 7350, 7351, 7352, 7353, 7355, 7356 b) 7360, 7363, 7365, 7366 c) 7850	
1-5V (Standard)	--
4-20mA (Option)	BR
N.B. Every slot must be specified in order:- /slot 6 /slot 5 /...../slot 2 /slot 1 / where slot 1 is in the most right-hand position viewed from the front. These options form the second line of the Ordering Code.	

ORDER CODE EXAMPLES

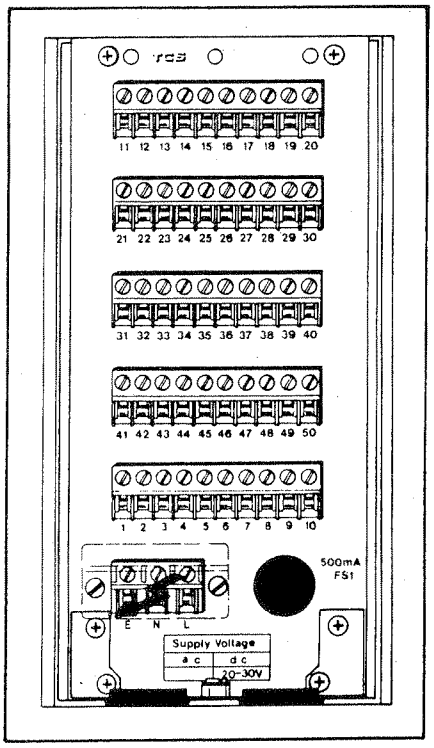
a) A 6350 Process Controller in a single sleeve with 4-20mA current input on all three channels:-
7900/1-WAY PM/240V/CGP/7350/BR

b) A 3-way panel mounting assembly with two Controllers and a Programmer:-
7900/3-WAY PM/240V/CGP/7350/7350/BR/7850

c) A 6-way 19" rack mounting assembly:-
7900/6-WAY 19" RM/240V/7350/7350/7350/7350/BR/7432/7850/BR

d) A 1-way thick-panel mounting sleeve:-
7900/1-WAY TPM/24V/CGP/7432

8-LOOP CONTROLLER REAR TERMINATION ASSEMBLY



* Panel Mounting
* Modular Construction
* All Module Connections Available Via Screw Terminals
* 24V DC and Mains Powered
* Input/Output terminals ergonomically arranged in blocks of 8

REAR VIEW WITH TERMINAL COVERS REMOVED
DRAWING SHOWS 1WAY/MAINS POWERED VERSION

The 7358 Rear Termination assembly enables 6358 8-Loop Controllers to be fitted into 7900 single or multi-way sleeves. Each 7358 assembly allows an associated 6358 module to function as a stand-alone instrument and enables it to be fitted into conventional panel cut-outs.

The Block Diagram shows that the 7358 contains a mains transformer and bridge rectifier assembly. A 0.5A screw-in type fuse is provided and 110V or 240V AC operation is selected internally. The mains input terminals have a separate 3-way connector block (51-53), while a further terminal (2) may be used for a 24V DC input or back-up supply, if required.

The input/output connections are arranged in 4 rows of 10 terminals for the PV inputs (11-18), Remote SP/SP Trims (21-28), 3-T Outputs (31-38), and the Deviation Alarms/Retransmitted PVs (41-48). Each row also has a 0V ref. terminal (19,29,39,49), and a 0V power terminal (20,30,40,50), to facilitate plant wiring.

The inter-connections between the 7358 screw terminals and the 6358 module pins are given in the cross-reference table which lists all those connections not shown in the Block Diagram.

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SLEEVE TERMINAL NUMBER	MODULE PIN NUMBER	FUNCTION	
1		0V.POW	POWER SUPPLIES
2	8	DC.SUPP.IN	
3	7	+15V.OUT	
4			
5			
6	9	W.DOG.OUT(1)	
7	45	XMT.OUT(-)	RS422 SERIAL BUS
8	46	XMT.OUT(+)	
9	47	RCV.IN(-)	
10	48	RCV.IN(+)	
11	10	PV1.IN	PV INPUTS
12	11	PV2.IN	
13	12	PV3.IN	
14	13	PV4.IN	
15	14	PV5.IN	
16	15	PV6.IN	
17	16	PV7.IN	
18	17	PV8.IN	
19	2	0V.REF	
20	3	0V.POW	
21	18		
22	19		
23	20		
24	21		
25	22		
26	23		
27	24		
28	25		
29	2	0V.REF	
30	3	0V.POW	
31	26	3T1.OUT	0-10V 3-TERM CONTROL OUTPUTS
32	27	3T2.OUT	
33	28	3T3.OUT	
34	29	3T4.OUT	
35	30	3T5.OUT	
36	31	3T6.OUT	
37	32	3T7.OUT	
38	33	3T8.OUT	
39	2	0V.REF	
40	3	0V.POW	
41	34		
42	35		
43	36		
44	37		
45	38		
46	39		
47	40		
48	41		
49	2	0V.REF	
50	3	0V.POW	
51		EARTH	AC MAINS
52		NEUTRAL	
53		LINE	

OPTION 7358/TRIM (S4 ON)	OPTION 7358/RPV (S3 ON)	OPTION 7358/ALM (S3 ON)	OPTION 7358/TPO	OPTION 7358/MA
REM.SP1.IN REM.SP2.IN REM.SP3.IN REM.SP4.IN REM.SP5.IN REM.SP6.IN REM.SP7.IN REM.SP8.IN				
			3T1.OUT 3T2.OUT 3T3.OUT 3T4.OUT 3T5.OUT 3T6.OUT 3T7.OUT 3T8.OUT	3T1.OUT(I+) 3T2.OUT(I+) 3T3.OUT(I+) 3T4.OUT(I+) 3T5.OUT(I+) 3T6.OUT(I+) 3T7.OUT(I+) 3T8.OUT(I+)
	PV1.OUT PV2.OUT PV3.OUT PV4.OUT PV5.OUT PV6.OUT PV7.OUT PV8.OUT	ALM1.OUT ALM2.OUT ALM3.OUT ALM4.OUT ALM5.OUT ALM6.OUT ALM7.OUT ALM8.OUT		COM(I-) COM(I-) COM(I-) COM(I-) COM(I-) COM(I-) COM(I-) COM(I-)
REMOTE SPT/ SETPOINT TRIM INPUTS(0-10V)	PROCESS VARIABLE O/PUTS(0-10V)	DEVIATION ALARM O/PUTS(0-15V)	DIGITAL TIME PROPORTIONED O/PUTS(0-15V)	3-TERM CONTROL O/P'S(4-20mA)

TECHNICAL SPECIFICATION

(A) Electrical

The 6358 Controller module which is plugged into the 7358 sleeve contains eight independent control loops. The electrical specification for each control loop is as follows:-

a) Analogue Inputs

No. of Channels	: 2 non-isolated 0-10V or 1-5V inputs, selected by software.
Channel Functions	: Channel 1 = Process Variable
	: Channel 2 = Remote Setpoint or setpoint trim (0-10V)

b) Analogue Outputs

No. of Channels	: 1 standard (except where digital time-proportioned output, or current output is used) + 1 optional non-isolated 0-10V output.
Channel Functions	: Channel 1 = 3-term control output.
	: Channel 2 = Re-transmitted Process Variable (optional)

c) Digital Outputs

No. of Outputs	: Watchdog + 1 optional non-isolated common deviation alarm output plus one optional digital time-proportioned output.
Output Voltage Levels	: 15V = logic one 0V = logic zero

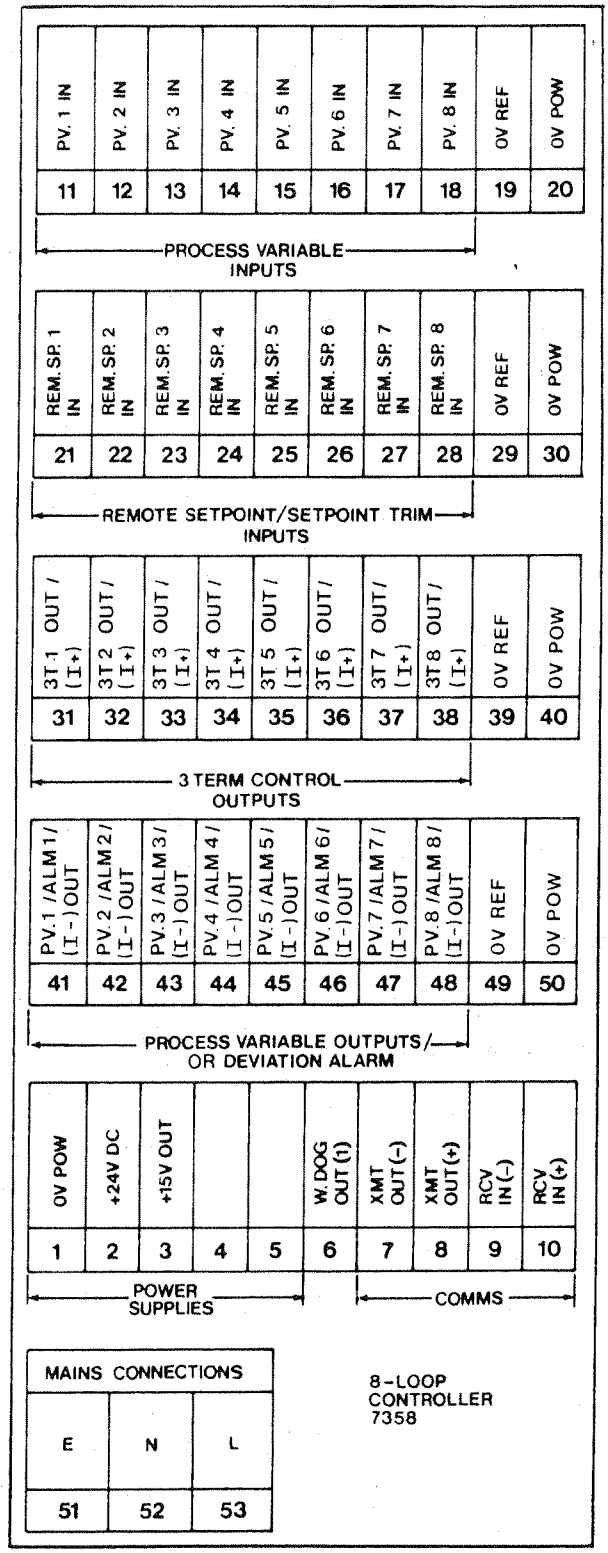
d) Current Outputs

No. of Outputs	: 1 optional 4-20mA non-isolated current output.
Channel Functions	: 3-term control output.

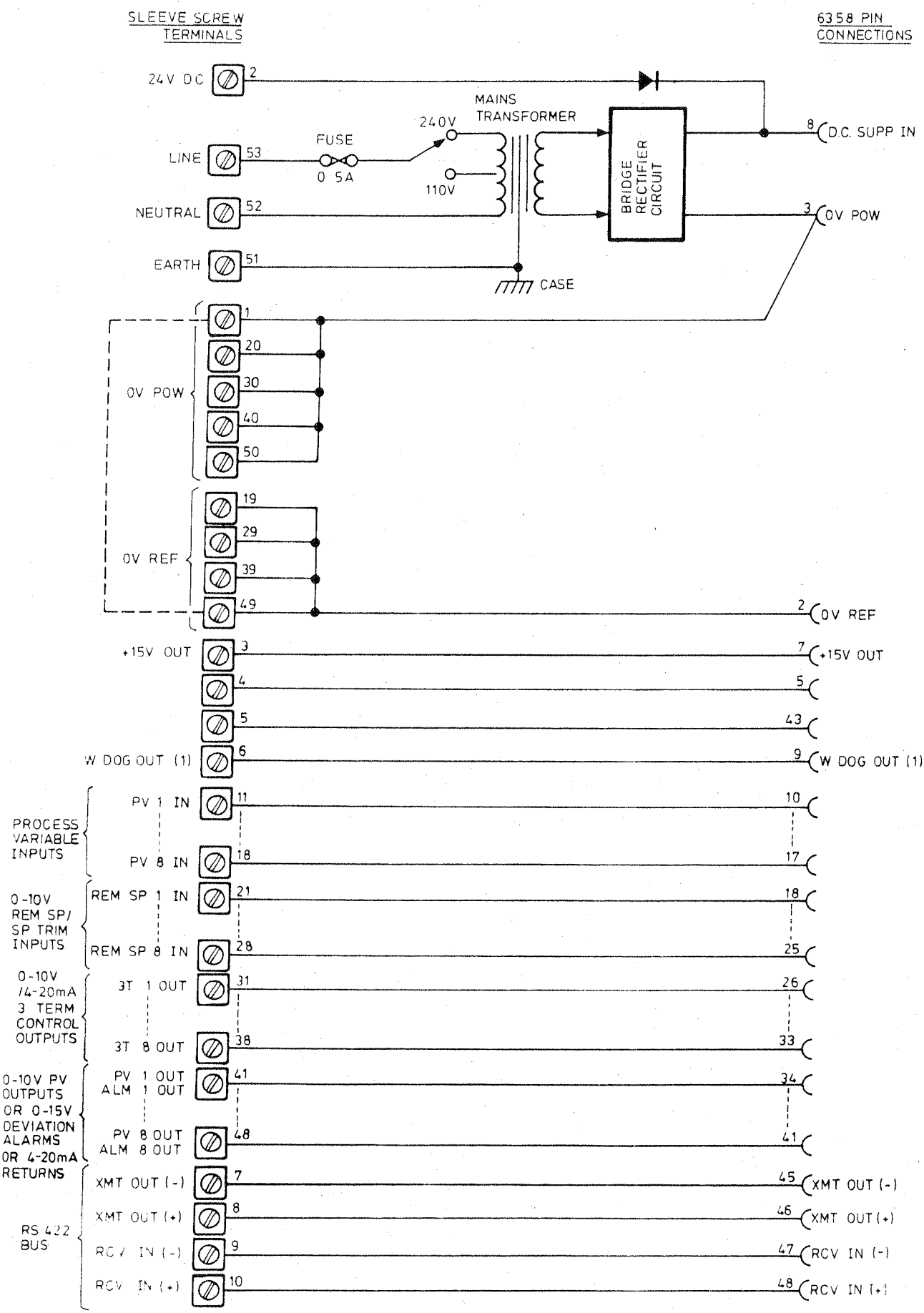
(B) Power Supplies

a) Supply Inputs

Mains Version	: 110V AC at 220mA rms 240V AC at 100mA rms
24V DC Version	: 23-35V DC at 650mA
Back-up Supply Input	: 23-35V.DC on mains versions only
b) Supply Outputs	: 15V DC ± 0.5V at 100mA max
c) Fuse Rating	: Separate 0.5A screw-in type fuse provided with mains versions only



SLEEVE REAR TERMINAL FUNCTIONS


SLEEVE SCREW TERMINALS
6358 PIN CONNECTIONS
24V DC
2
MAINS TRANSFORMER
240V
110V
FUSE
0 5A
LINE
53
NEUTRAL
52
EARTH
51
CASE
BRIDGE RECTIFIER CIRCUIT
8 D.C. SUPP IN
3 0V POW
0V POW
1
20
30
40
50
0V REF
19
29
39
49
2 0V REF
+15V OUT
3
7 +15V OUT
4
5
5
43
W DOG OUT (1)
6
9 W DOG OUT (1)
PROCESS VARIABLE INPUTS
PV 1 IN
11
10
PV 8 IN
18
17
0-10V REM SP/ SP TRIM INPUTS
REM SP 1 IN
21
18
REM SP 8 IN
28
25
0-10V /4-20mA 3 TERM CONTROL OUTPUTS
3T 1 OUT
31
26
3T 8 OUT
38
33
0-10V PV OUTPUTS OR 0-15V DEVIATION ALARMS OR 4-20mA RETURNS
PV 1 OUT ALM 1 OUT
41
34
PV 8 OUT ALM 8 OUT
48
41
RS 422 BUS
XMT OUT (-)
7
45 XMT OUT (-)
XMT OUT (+)
8
46 XMT OUT (+)
RCV IN (-)
9
47 RCV IN (-)
RCV IN (+)
10
48 RCV IN (+)

SERIAL COMMS

*DELETE AS APPLICABLE

GID	BAUDRATE
7	9600

1 2 4

8 7 6 5 4 3 2 1 — ON / OFF — STATUS SWITCH S1 (LEFT)

4 3 2 1 — ON / OFF — STATUS SWITCH S2 (RIGHT)

MODE SELECTION

FUNCTION	OFF *	ON *
PROTOCOL MODE	~~ASCII~~	BINARY
O/P DISP INVERSION	NORM	INV
SLOT 2 ENBL(TRIM)	~~DISABLE~~	ENABLE
SLOT 4 ENBL(RPV/ALM)	~~DISABLE~~	ENABLE
FAIL MODE POWER OR INPUT	PREV MODE	MAN-LOW
	MAN	MAN-LOW
UID SELECT	RANGE 0-7	RANGE ~~8-F~~

BOARD FUNCTION

BOARD CODE/TYPE	00 ANALOGUE I/P	00 ANALOGUE I/P * 1F BOARD NOT FITTED	08 ANALOGUE O/P DIGITAL O/P	08 OR 18 ANALOGUE O/P CURRENT O/P * DIGITAL O/P 1F BOARD NOT FITTED

CHANNEL	CHAN ACTIVE	SLOT 1 (PROC VAR I/PS)	SLOT 2 (REM S/P OR TRIM)	SLOT 3 (3 TERM O/PS)	DIR / INV	SLOT 4 (PV O/P OR DEV ALM)	
1	✓	1-5V	TRIM	0-10V	DIR	0-10V	RPV
2	✓	1-5V	TRIM	0-10V	DIR	0-10V	RPV
3	✓	1-5V	REMOTE	0-10V	DIR	0-10V	RPV
4	✓	1-5V	TRIM	0-10V	DIR	0-10V	RPV
5							
6							
7							
8							

INSTRUMENT PARAMETERS

PARAMETER TYPE	PARAMETER FUNCTION	MNEMONIC	VALUE (4 CHARS)	UNITS
		II		
INPUT/OUTPUT BOARD STATUS	SLOT 1 BOARD TYPE & STATUS, ACTIVE LOOP SELECT, PUSHBUTTON MASK BITS	S1	0400	
	SLOT 2 BOARD TYPE & STATUS	S2	0000	
	SLOT 3 BOARD TYPE & STATUS	S3	0008	
	SLOT 4 BOARD TYPE & STATUS	S4	0000	
LOOP TYPE	LOOP TYPE: TRIM/REM SETPT & PV 0-10V/1-5V SEL	LT	40F0	
	LOOP INVERTED OUTPUT: TIME PROP CYCLE LENGTH	LI	0000	

= READ ONLY OR READ / WRITE

ISS	DATE	COMPILED	INSTRUMENT IDENTITY II 6358/3	FUNCTION FURNACE CONTROL (SAMPLE PROGRAM)
		CHECKED	SERIAL NO INT/205	

TURNBULL CONTROL SYSTEMS LTD

6358 8 LOOP PROCESS CONTROLLER SET-UP DATA SHT

KE075432

PARAMETER TYPE	PARAMETER FUNCTION	MNEMONIC	LOOP 1 VALUE	LOOP 1 UNITS	LOOP 2 VALUE	LOOP 2 UNITS	LOOP 3 VALUE	LOOP 3 UNITS	LOOP 4 VALUE	LOOP 4 UNITS	LOOP 5 VALUE	LOOP 5 UNITS	LOOP 6 VALUE	LOOP 6 UNITS	LOOP 7 VALUE	LOOP 7 UNITS	LOOP 8 VALUE	LOOP 8 UNITS
			1		2		3		4		5		6		7		8	
STATUS WORDS	LOOP NUMBER	LN	1152		3052		0652		0652									
	LOOP STATUS: DEC. POINT, I/P CONDITIONING, INPUT FILTER MODE	ST					-											
INPUT CHANNEL RANGING	PROCESS VARIABLE HIGH RANGE	1H	6999	Kg/Hr	2000	BAR	1600	°C	1600	°C								
	PROCESS VARIABLE LOW RANGE	1L	0000	"	0000	"	0000	"	0000	"								
	SETPOINT TRIM HIGH RANGE	2H	0000	"	1000	"	1600	"	0000	"								
	SETPOINT TRIM LOW RANGE	2L	0000	"	1-000	"	0000	"	0000	"								
LIMIT AND ALARM SETTINGS	SETPOINT HIGH LIMIT	HS	6000	"	1800	"	1600	"	1400	"								
	SETPOINT LOW LIMIT	LS	4000	"	1013	"	0000	"	0700	"								
	DEVIATION ALARM LIMIT	DA	0100	"	0010	"	0010	"	0005	"								
	DEVIATION DISPLAY SETTING	DD	0050	"	0005	"	0005	"	0002	"								
	3 TERM OUTPUT HIGH LIMIT	HO	9999	%	9999	%	9999	%	9000	%								
	3 TERM OUTPUT LOW LIMIT	LO	0000	"	0000	"	0000	"	1000	"								
3 TERM ALGORITHM RELATED PARAMETERS	PROPORTIONAL BAND CONSTANT	XP	0025	%	0075	%	0015	%	0020	%								
	INTEGRAL TIME CONSTANT	TI	0500	MINS	0800	MINS	0500	MINS	0200	MINS								
	DERIVATIVE TIME CONSTANT	TD	0100	"	0180	"	0100	"	0040	"								
TAGS	LOOP TAG CHARACTERS 1-4	1T	FIC-	ASCII	PIC-	ASCII	TIC-	ASCII	TIC-	ASCII		ASCII		ASCII		ASCII		ASC
	LOOP TAG CHARACTERS 5-8	2T	101		102		103		104									
	LOOP FUNCTION		COKE OVEN GAS FLOW		FURNACE PRESSURE		FURNACE TEMP.		PRODUCT TEMP.									
	IDENTIFICATION		FIC-101		PIC-102		TIC-103		TIC-104									

6358 8 LOOP PROCESS CONTROLLER LOOP PARAMETERS

TURNBULL CONTROL SYSTEMS LTD

Software part No. RD 069542 issue 3, release 1

Table 4.2 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 of the System 6000 Communications Handbook). Table 4.3 lists the similarly accessed Loop command parameters. Table 5.1 gives the corresponding Parameter Numbers used with the Binary mode of the protocol (see Section 6 of the System 6000 Communications Handbook). The table below shows the modification history of the 6358 software with respect to changes in these parameter tables:-

SOFTWARE		DATE	MEMORY BOARD	PROMS		REMARKS
ISS.	REL			TYPE	NO	
1	1		Mk 3	2532	2	Initial release.
1	2	16/03/82	Mk 3 (001) (002)	 2532 2732	 2 2	Improved setpoint trim.
2	1	05/10/82	Mk 3 (001) (002)	 2532 2732	 3 3	Binary protocol added. LI added to instrument parameter list
2	2	14/03/82	Mk 3 (001) (002)	 2532 2732	 3 3	Add 5 user linearisations (linearisation starts at hex 106).
2	3	02/06/83	Mk 3 (001) (002)	 2532 2732	 3 3	Re-released due to faulty copying of IC3 PROM.
2	4	09/06/83	Mk 3 (001) (002)	 2532 2732	 3 3	Correct problem in issue 2/3 with the PID hold on channels 2,4,6 and 8.
2	5	01/02/84	Mk 5 (003)	2764	2	As issue 2/4 but runs on Mk 5 memory (003) with Mk 1 CPU (9980)
2	6	01/02/84	Mk 5 (004)	2764	2	As issue 2/5 but runs with Mk 2 CPU card (9995). RAM starts at hex 8000.
2	7	11/04/84	Mk 5 (004)	2764	2	Correct problem with issue 2/6 HHT drive routines.
2	8	04/07/85	Mk 6 (010)	27128	1	As issue 2/1 but runs on Mk 6 memory version 010.

SOFTWARE		DATE	MEMORY BOARD	PROMS		REMARKS
ISS.	REL			TYPE	NO	
3	1	01/02/86	Mk 6	27128	1	Add Output Display Inversion, ON/OFF control, LED test, push-button disable, power fail and parameter change lists in MN, 3 sec. delay out-of-range detection, power fail/out-of-range action option switch, time proportioned digital output.

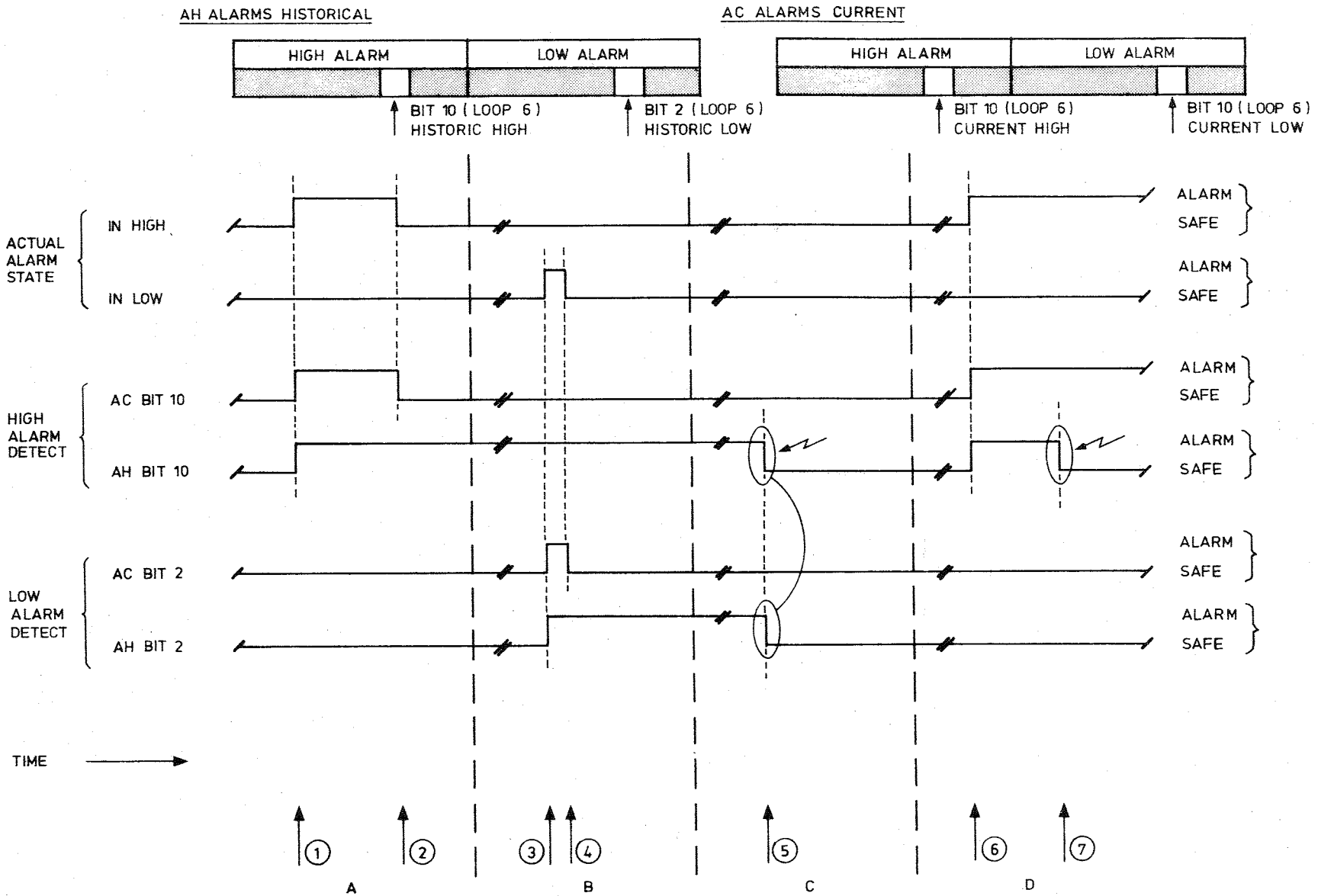


FIG F·1 CORRELLATION BETWEEN ACTUAL DEVIATION ALARM CONDITIONS AND THE AC AND AH PARAMETERS

An explanation of the behaviour of the AH and AC parameters in response to changing alarm conditions is given with reference to the diagram of Fig. F.1.

A. Entry and Exit of High Alarm Conditions

1) High alarm condition entered, AC indicates a current high alarm. AH records the occurrence of an entry into high alarm.

2) High alarm condition disappears, AC indicates no current alarm, AH maintains a record that the alarm has occurred.

B. Fleeting Low Alarm Conditions

3-4) AC indicates a low alarm for the duration of the alarm condition. AH records the occurrence of an entry into low alarm.

C. Hand-Held Terminal/Serial Link Clearing AH (no Current Alarms)

5) Bits 2 and 10 of AH are set to zero via the hand-held terminal or serial data link, clearing the record of entry into alarm state.

D. Hand-Held Terminal/Serial Link Clearing AH (Current High Alarm)

6) High alarm condition entered, AC indicates a current high alarm, AH records the occurrence of an entry into the high alarm state.

7) Bit 10 of AH set to zero via hand-held terminal or serial data link, clearing the record of entry into alarm state. The high alarm state still exists so AC still indicates a high alarm.

MANUAL ISS.	MANUAL REV	DATE	PAGE	AMENDMENT
1	A	08/81		Initial release
1	B	10/82		Manual re-printed with Addendum sheet at the back for issue 2/1 software covering the following:- Direct or Inverse output can be selected by LI parameter. S1 switch no. 5 selects ASCII or Binary mode of protocol.
2	A	06/85		Re-formatted and expanded as follows:-
			1.22	New section 1.5.9 added.
			2.3	Section 2.2 reduced and covered by System 6000 Installation Guide.
			2.10	Section 2.4.5 reduced and covered by System 6000 Communications Handbook.
			2.16	Section 2.6.2 was 2.6.3.
			2.22	Section 2.6.3 was 2.6.2.
			2.23	Section 2.7.1 removed and included in System 6000 Installation Guide.
			3.3	Separate Section 3.1 for FORCED MANUAL mode.
			3.5	Section 3.2 is now MANUAL mode (was Section 3.1).
			3.9	Section 3.3 is now AUTO mode (was Section 3.2)
			3.13	Section 3.4 is now REMOTE AUTO mode (was Section 3.3)
			3.19	Section 3.5 is now AUTO FALL-BACK mode (was Section 3.3)
			3.21	Section 3.6 is now Setpoint Trim (was Section 3.2.5). Cascade applications (was Section 3.4) removed.

ISS.	DATE	ISS.	DATE	TECHNICAL MANUAL AMENDMENT RECORD SHEET		
1 2	08/05/85 01/09/86			DRAWN : MEE	MANUAL TITLE : 6358 Technical Manual	
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MANUAL ISS.	MANUAL REV	DATE	PAGE	AMENDMENT
			3.23	New Section 3.7 added.
			4.4	Section 4.2.2 added.
			4.6	Section 4.2.3 added (was Section 4.4).
			4.8	Section 4.3 re-written and expanded.
			4.28	Section 4.4 (was section 4.5) re-written and expanded.
			4.42	New Section 4.5 added.
			5.1	New Section 5 replaces old section which is now contained in System 6000 Communications Handbook.
			B.1	New Appendix B.
			D.1	New Appendix D.
			E.1	New Appendix E.
			F.1	Appendix F was old Appendix D.
3	A	09/86		Modification to include new facilities of issue 3 software.
			4.1	Fig. 4.1 shows new 8260 Hand-held terminal.

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