TCS 6366

6366 - PROGRAMMABLE ADVANCED CONTROLLER

TECHNICAL MANUAL

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BIBLIOGRAPHY

A number of TCS manuals and other items of documentation are referred to in the text. Some of these should definitely be consulted before attempting to use certain functions of the 6366, while others are for more general reference. A full list of these items is given below together with their corresponding TCS part numbers.

	DOCUMENT TITLE	TCS PART NUMBER
a)	6366 specific items	
	6366 Facts Card	HA 076330 U002
	6366 Users Manual	HA 076330 U005
	B6366 Rear Termination Assembly (Appendix B)	HA 076330 U007
	7366 Rear Termination Assembly (Appendix C)	HA 076330 U009
	6366 Set-up sheet (Appendix D)	HA 076330 U011
	6366 Applications library (Appendix F)	HA 076635 U001 to U006
b)	System 6000 general items	
	System 6000 Installation Guide	HA 076567 U005
	System 6000 Communications Handbook	HA 076568 U003
	System 6000 Controller Applications Handbook	HA 076570 U005
	System 6000 Programmable Instruments Programming Manual	HA 076878 U005
	6360 Technical Manual	HA 075415 U003

Section 1 GENERAL DESCRIPTION

1.1 Introduction

The TCS Model 6366 Programmable Advanced Controller provides a stand-alone industrial instrument for a wide range of process control applications. TCS have combined their experience in single loop controllers and programmable instruments to provide a standard controller that can be configured to handle most control applications.

In cases where the standard configurations do not meet a user´s requirements, the control strategy can easily be adjusted. This allows simple variations to be made such as computing Process Variable or Feed-forward terms, but could extend to replacing PID with alternative user defined control algorithms. To ease programming, many of the standard features of the instrument are retained, thus allowing users to concentrate on their specific applications.

Installation of the controller involves two stages. Initially the user will configure a range of blocks that describe the types of inputs and outputs used, and the value of controller constants. This process is described in Section 4. The second stage involves linking the blocks together, either by using a standard configuration, or by modifying this configuration for a specific application. This is described in Section 6.

The Model 6366 Programmable Advanced 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 6366 Programmable Advanced Controller is also available housed within a 72mm DIN compatible sleeve for front of panel mounting.

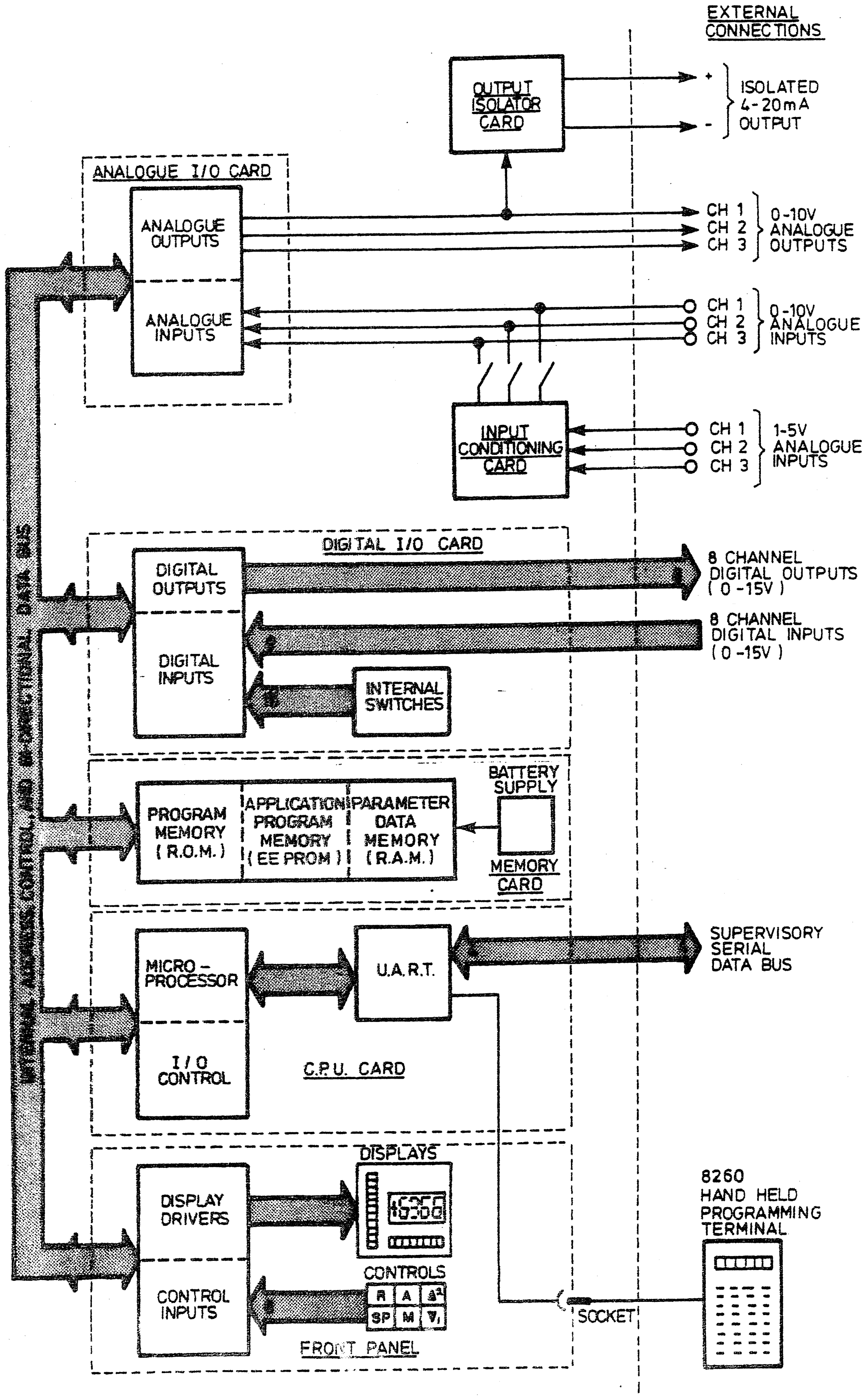


FIG 1.1 6366 PROGRAMMABLE ADVANCED CONTROLLER SCHEMATIC BLOCK DIAGRAM

1.2 Features and General Description

The features of the 6366 Programmable Advanced 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
Digital Input/Output signals
Analogue Input/Output signals

are implemented as separate hardware blocks. Each of these functional blocks communicates 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 the two Process Control Loops that can be implemented within the 6366. It also has a number of control push-buttons which allow the operator to interact with the 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.

The Digital outputs are fully configurable by the user to provide alarm and status information about the Controller via 8 logic signals. The Digital inputs are also fully configurable and can be used to control the operation of the Controller via external logic signals when it is interacting with other Controllers in complex situations such as Cascade loops.

The three configurable Analogue inputs can be used to monitor the plant Process Variable and receive external setpoints and trims. The two Manual Output Stations and one general purpose analogue output can be configured to provide the necessary control signals to the Actuator drivers and also re-transmit the Process Variable and Setpoint or Error.

The Input Conditioning card may be utilised when the Analogue inputs are 1 - 5V signals. This card also provides a supply for powering external Transmitters.

The first Manual Station Output is available in two forms; namely a 0 - 10V non-isolated signal, and a 4 - 20mA isolated signal.

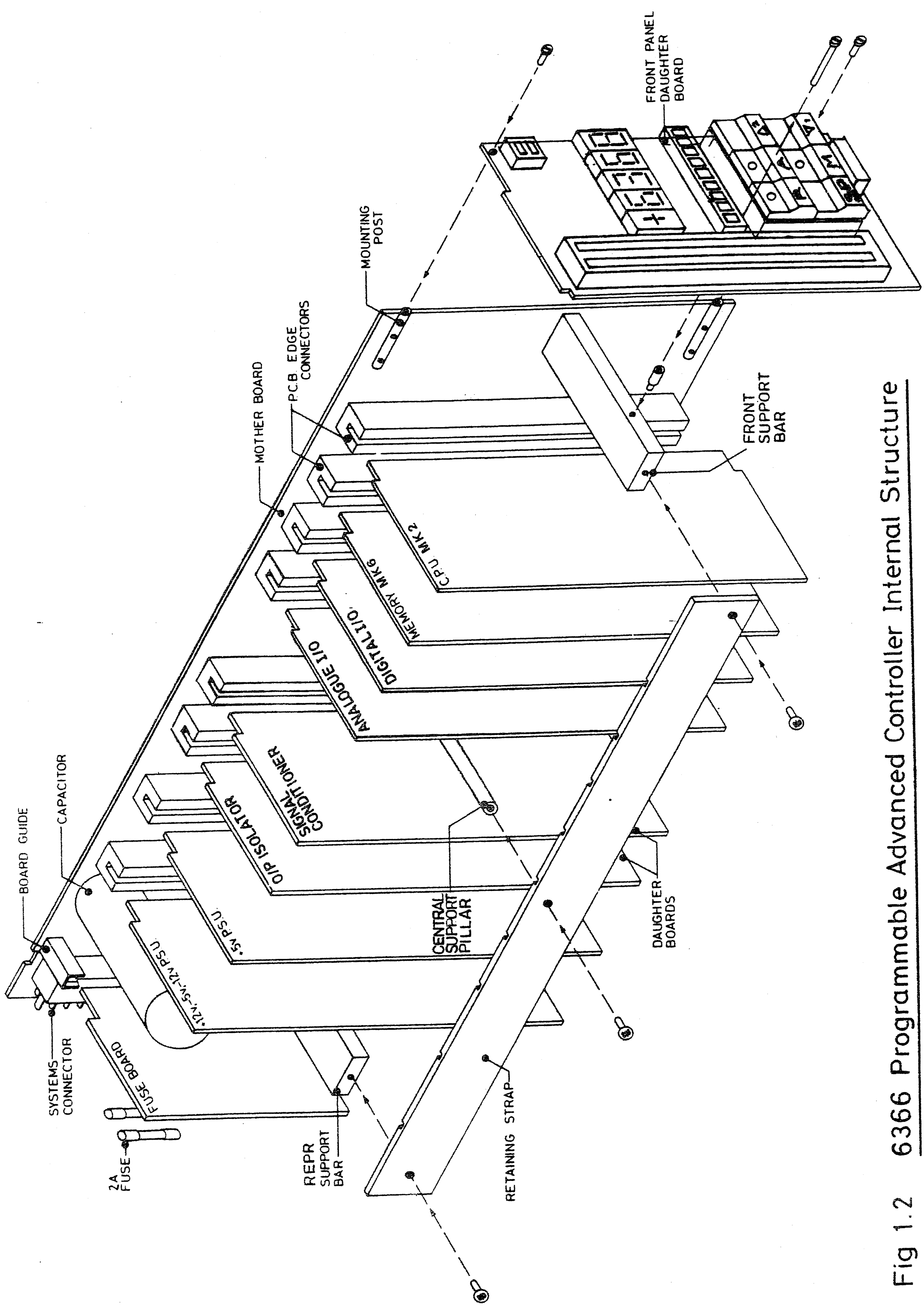


Fig 1.2 6366 Programmable Advanced Controller Internal Structure

1.3 Mechanical Structure

The Mechanical Structure of the 6366 Programmable Advanced 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 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 069488) 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 35, 39 and 47 to mate with polarising pegs fitted to the 48 way female system connector if required.

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 8 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 next to the Signal Conditioner card and the rear support bar next to the Fuse board.

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 6366 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 6366 rear-connector pin chart given in Appendix A.

1.3.2 Bin-Mounting Controllers

The 6366 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 B6366 rear termination assembly given in Appendix B.

CONNECTOR NUMBER	CONNECTOR TYPE	DAUGHTER BOARD FUNCTION	POLARISING KEY POSITION
1	Double-sided	Central processor unit	39 - 40
2	Double-sided	Memory Mk 6 (015)	40 - 41
3	Single-sided	Digital input/output	43 - 44
4	Single-sided	Analog input/output (1)	46 - 47
5	-	-	-
6	Single-sided	Input signal conditioner	5 - 6
7	Single-sided	Output isolator	33 - 34
8	Single-sided	+5V Power supply	25 - 26
9	Single-sided	±12V, -5V Power supply	14 - 15

TABLE 1.1 6366 Daughter Board Edge Connector Characteristics

1.3.3 Panel-Mounting Controllers

The 6366 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 7366 rear termination assembly that contains the power supply, two output relays, and also gives access to all the instrument connections via screw terminals. Full data sheets on the 7900 sleeve unit and the 7366 rear termination assembly are provided in Appendix C.

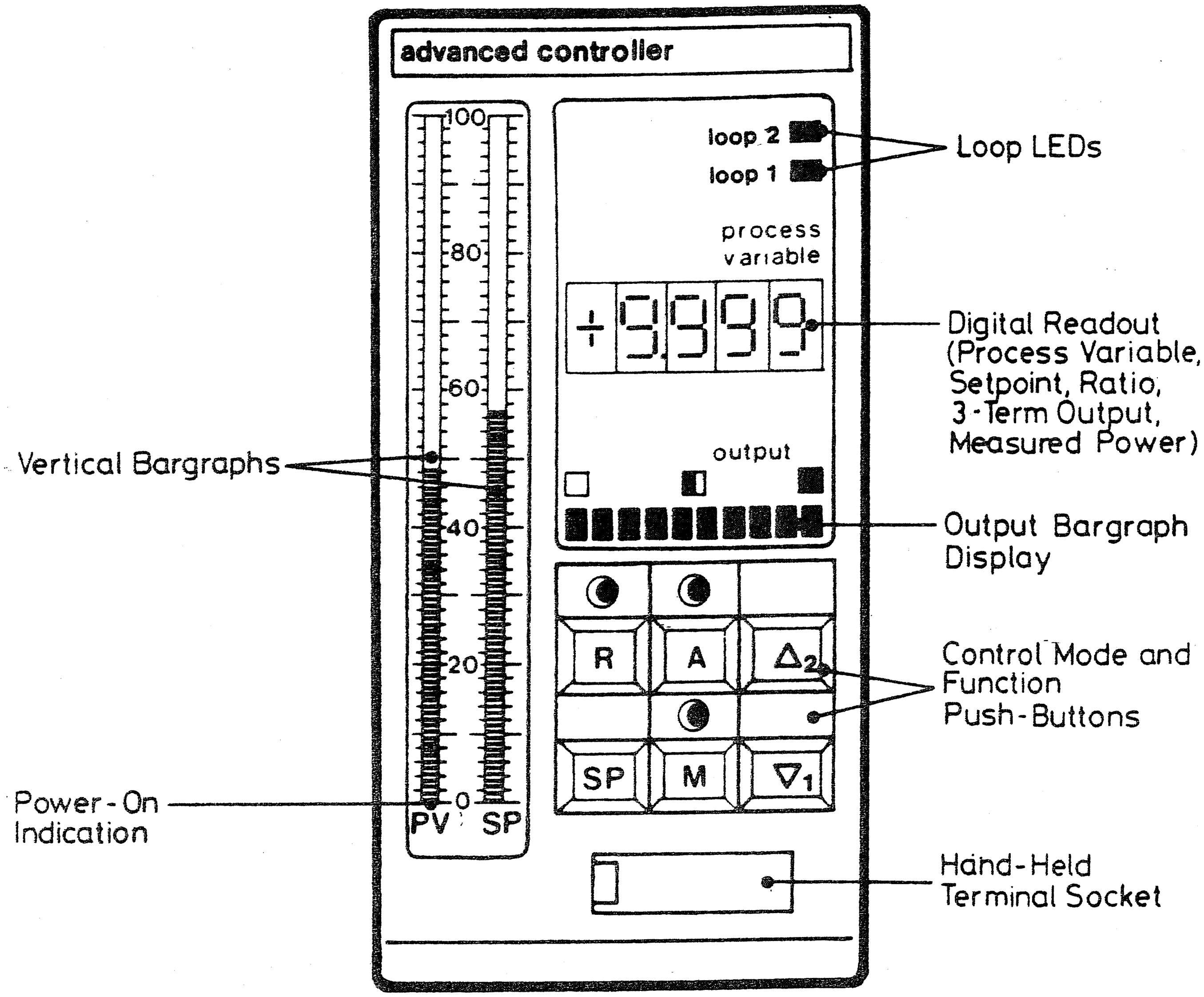


Fig 1.3 Programmable Advanced Controller Fascia Diagram

1.4 Daughter Board Functional Description

Each of the daughter boards are described in turn to indicate their function within the basic 6366 Programmable Advanced Controller.

1.4.1 Front-Panel Daughter Board (Assembly: AC 075225)

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

a) Vertical Bargraphs

Two 101 segment, red LED bargraph displays are provided and each has the bottom bar permanently lit to indicate power on. The remaining 100 segments indicate values of 0 - 100% in 1% steps. The left-hand bar displays the value of the variable defined by the 1B parameter while the right-hand bar displays the variable defined by 2B.

b) Digital Readout (Assembly : AC 075226)

A 4 digit, orange 7-segment LED display with a sign digit and programmable decimal point position is provided to indicate the value of the variable defined by the DD parameter in the range - 9999 to +9999.

c) Output Display

A 10 segment, yellow LED horizontal bargraph is provided to indicate the value of the variable defined by the 3B parameter from 0 to 100% in 10% steps.

d) Status LED´s

Two rectangular yellow LED´s are provided to indicate whether loop 1 or loop 2 is currently being displayed on the front panel.

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/RATIO (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 level, Local Setpoint, or Ratio settings.

Pressing only the Raise (△) or Lower (▽) buttons will select whether loop 2 or loop 1 respectively is displayed on the front panel.

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 or Ratio setting in RATIO mode.

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 the bottom bar on each of the bargraph displays.

1.4.3 **Memory Daughter Board** (Assembly: AC 076042)

The Memory daughter board is divided into three separate memory areas as follows:-

a) ROM Area

The ROM area contains the actual 6366 Controller operating software together with the library of standard TCS Configurations or Application Programs.

b) RAM Area

The non-volatile RAM area contains the Instrument Data Base consisting of the Control Loop parameters and other variables. It is also used to store User Application Programs created by editing existing TCS configurations, or linking the various types of data blocks together via the TCS FORTH high-level programming language.

c) EEPROM Area

The EEPROM memory can be used to store both the Instrument Data base and User Application Program for additional security. Programs are always executed from RAM to allow on-line debugging and subsequent editing. Once the program has been checked out fully the CPU can transfer data from the RAM area into the Electrically Erasable PROM (EEPROM). Whenever the 6366 is subsequently powered up, or a sumcheck is detected, the CPU automatically copies the program from EEPROM back into the RAM area to allow program execution. The CPU can also copy data from the EEPROM area back into the RAM under operator control to permit further editing and debugging cycles to be carried out. It should be noted that with issue 1 software 1500 bytes of User memory were available, issue 2 now has 4500 bytes.

The RAM chips are made non-volatile by means of a standby battery supply circuit which powers them when the main supply has failed or undergoes a transient failure. A long-life Lithium primary cell is used for this purpose and the features of the supply circuit are as follows:-

a) Lithium Battery

The Lithium 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.

b) Battery Standby

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 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.

c) Battery Isolation Switch

The battery supply can be isolated from the RAM by means of switch SW1. This might be done to conserve battery life when the 6366 is to be left unpowered for any great length of time. This switch is pushed in to connect the battery and pulled out to isolate the battery from the RAM.

1.4.4 **Digital Input/Output Daughter Board** (Assembly: AC 066520)

This daughter board has provision for 8 external 0/15V logic level inputs via the rear connector. Sixteen internal switches are also provided on the board to set up digital inputs to characterise the Controller with certain control mode parameters. In addition the board provides 8 external 0/15V logic level outputs for indicating Controller modes and status such as HIGH or LOW alarms.

The use of 0 and 15V logic levels for external inputs and outputs allows the 6366 Process Controller to interface directly with other modules in the Matric 6000 range.

1.4.5 **Analogue Input/Output Daughter Board** (Assembly: AC 065517)

The Analogue Input/Output Daughter board contains the circuitry necessary to provide the 3 non-isolated 0-10V output channels, each of which incorporates a medium-term sample-and-hold output stage. The board accepts 3 non-isolated 0-10V input channels which are multiplexed before being converted into digital form for the CPU. In addition, circuitry is provided on the board which allows the CPU to measure the battery voltage under dynamic loading conditions.

This board also contains circuitry capable of detecting an open-circuit 0-10V channel 1 input, or a zero current channel 1 signal when using the Input Conditioning Card with a 4-20mA input.

1.4.6 **Input Conditioning Daughter Board** (Assembly: AC 068056)

This board contains 3 independent amplifier circuits that convert a 1-5V input signal to a 0-10V output signal. The 3 outputs are internally connected to the three 0-10V input channels of the Analogue Input/Output Daughter board via switch S3, and can also be monitored via the rear connector. Each input conditioning amplifier can be switched in or out of the circuit via S3 so allowing a mixture of 0-10V and 1-5V inputs to be applied to the 6366 Controller.

The board also contains an isolated Transmitter Power Supply which is available via the rear connector for powering remote 4-20mA transmitters.

1.4.7 **Output Isolator Daughter Board** (Assembly: AC 068119)

The Channel 1 output of the Analogue Input/Output daughter board is internally connected as the 0-10V input to the Output Isolator. This board then converts this signal to a 4-20mA isolated output signal available on separate rear connector pins.

1.4.8 **+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 Power Failure conditions and alert the CPU accordingly.

1.4.9 **+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 the regulators incorporate current limit and thermal shut-down facilities.

The board also generates 2 pairs of isolated, unregulated, supplies which are used for the Transmitter Power Supply on the Input Conditioning board and the isolated output supply on the Output Isolator board.

1.4.10 **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. A spare 2A fuse is also mounted on the board for convenience, and the type of fuse holders used allow either 20mm or 1.25 inch fuses to be fitted.

1.5 Technical Specification

Unlike a fixed function instrument, the technical specification of the 6366 is split up to correspond with the software Functional Blocks of Section 3.3. These cover all the I/O and internal processing functions, while the specification of Power supplies, communications, etc. follows the same format as other System 6000 instruments.

1.5.1 Analogue Inputs

a) Number of Channels : 3 non-isolated 0-10V inputs or 3 conditioned non-isolated inputs.

b) Channel Functions : Application Program dependent

c) Input Signal Levels : Non-isolated inputs are 0-10V range

: Conditioned inputs are 1-5V. (Derived from 4-20mA across 250R Burden resistor.)

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 1 channel every 12ms, i.e. any one channel is sampled once every 36ms.

g) Input Impedance : 1M ohm pull-down to -5V on Channel 1

: 1M ohm pull-down to 0V on channels 2, 3

h) Input Signal Processing	:	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;
j) Input Filter Range	:	0 to 60 seconds (first order)

1.5.4 Analogue Outputs

a)	Number of Channels	: 3 non-isolated 0-10V outputs plus 1 isolated output
b)	Channel Functions	: Channel 1 = Manual Station 1 or user configurable
		: Channel 2 = Manual Station 2 or user configurable
		: Channel 3 = Analogue output block 1 or user configurable
c)	Output Signal Levels	: Non-isolated outputs are 0-10V range
		: Isolated output is 4-20mA (Channel 1 only)
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	: ±1 LSB typical over 0 to 50°C range
g)	Isolated Output accuracy	: ±0.5% of full scale
h)	Sample and Hold	: DAC updates 1 channel every 12ms, i.e. any one channel is refreshed once every 36ms.
j)	Output Drift Rate under Watchdog Failure Conditions	: 0.5mV/sec maximum (equivalent to 1% of full scale in 3 minutes)
k)	Output Drive Capability	: ±5mA for non-isolated 0-10V outputs
		: 0 to 12V for 4-20mA isolated output
l)	Isolation Voltage	: ±50V minimum with respect to system ground

1.5.3 Digital Inputs

a)	Number of Inputs	: 8 non-isolated inputs
b)	Input Functions	: All 8 input functions are application program dependent and user configurable
c)	Input Voltage Levels	: 15V = logic one 0V = logic zero
d)	Input Impedance	: 100k ohm pulldown to 0V (gives 150uA logic one current)
e)	Bit Inversion	: Exclusive OR mask allows individual bits to be inverted for use within programs

1.5.4 Digital Outputs

a)	Number of Outputs	: 8 non-isolated outputs plus Watchdog
b)	Output Function	: All 8 output functions are application program dependent and user configurable
c)	Output Voltage Levels	: 15V = logic one 0V = logic zero
d)	Output Drive Capability	: 2k2 open-collector pull-up to +15V supply
		: Maximum logic zero sink current = 16mA
e)	Write Protection	: Write protection mask protects individual bits being changed via the serial links

1.5.5 Setpoint Block

a)	Setpoint - range	: low, high -9999 to +9999
	- limits	: low, high -9999 to +9999
	- rate limit	: Same range as Process Variable set in Engineering units/second
b)	Setpoint Bias Range	: low, high -9999 to +9999 in Engineering units.
c)	Alarm Limits - Deviation	: low, high, 0 to 9999 with hysteresis of 0.5% of Setpoint span
	- Absolute	: low, high, -9999 to +9999 with hysteresis of 0.5% of Process Variable span

1.5.6 Ratio Block

a)	Ratio setting range	: low, high, 0 to 9999 with Inverse Ratio option
b)	Ration Trim range	: low, high -9999 to +9999
c)	Ratio Bias	: same range as Setpoint

1.5.7 3-Term (PID) Control Block

a)	Proportional Band range	: 0 to 999.9%
b)	Integral Time Constant Range	: 0.01 to 99.99 secs. or 0.01 to 99.99 minutes 0 = off
c)	Derivative Time Constant Range	: 0.01 to 99.99 secs. or 0.01 to 99.99 minutes 0 = off
d)	Feed-forward term	: -99.99% to +99.99%
e)	Feed-back term	: 0 - 99.99%
f)	Control output range	: 0 - 99.99% (with reverse action option)
g)	Algorithm Sampling Period	: 100 msecs to 0.2 mins dependent upon Integral and Derivative times

1.5.8 **Manual Output Station Block**

a) Control Output - limits : low, high 0 to 99.99%

- velocity/rate limits : 0 - 99.99% /sec

- polarity : Inverse Output mode switch selectable

b) Output raise/lower rate in Manual : 0 to 99.99% in 10 secs. with accelerating action

1.5.9 **Display and Control Status Block**

Operator Displays

a) Two vertical Bargraphs : Two 101 segment red LED bargraph displays (each with bottom bar always on) configurable to display selected variable from 0 - 100% with resolution of 1%

b) Digital Readout : Configurable 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

c) Horizontal Bargraphs : Configurable horizontal yellow LED bargraph with 10 segments to indicate 0-100% output in 10% steps.

d) Alarm Indication : Any of the 3 bargraphs on the Digital readout can be programmed to flash under alarm conditions.

e) Loop Indicators : Two yellow rectangular LED's to indicate loop 1 or loop 2 being displayed.

Operator Controls

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

(i) Manual (M) with integral yellow LED

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

(iii) Remote Auto or Ratio (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 or Ratio Setting when Setpoint display (SP) is pressed.

When used alone it selects loop 2 for display.

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

When used alone it selects loop 1 for display.

c) 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%.

1.5.10 Alarm Block

a)	Number of alarms	: 2 high, 2 low alarms.
b)	Alarm type	: User configurable for:- Absolute, Deviation or Rate Alarms
c)	Range:- Deviation	: Low, high, 0 to 9999
	Absolute	: Low, high, -9999 to +9999
	Rate	: Same range as Process Variable set in engineering units/second
		- all with programmable decimal points

1.5.11 Constants Block

a)	Number of constants	: Four
b)	Range	: -9999 to +9999 with programmable decimal point
c)	User flags	: 8 user flag bits with individual bit masks

1.5.12 Filter Block

a)	Filter type	: Lead/lag
b)	Filter gain range	: -99.99 to +99.99
c)	Lead time constant range	: 0 to 99.99 seconds or minutes
d)	Lag time constant range	: 0 to 99.99 seconds or minutes
e)	Feed-forward/output bias	: -99.99% to +99.99%

1.5.13 **Delay Block**

a) Delay range	:	8 to 9999 seconds

1.5.14 **Totalisation Block**

a) Type	:	Integrating flow totaliser:- $\sum$[flow signal]*dT - where dT is the time since the last call of the routine
b) Flow Total Range	:	0 to 9999 seconds, minutes, hours or days
c) Flow scaling factor	:	0.1 to 999.9

1.5.15 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 : 600mA without hand-held terminal at 28V DC

: 700mA 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) Remote Transmitter Supply characteristics : 26V ±1.5V at 4mA output

: 30V ±0.5V at 20mA output

: ±50V minimum isolation with respect to system ground

g) Memory Standby Battery Characteristics : Lithium type

: 3.0V 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 board removed.

1.5.16 **Communications**

a)	Number 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 RS 232/V24 (±12V)
b)	Data Rate	: 300 baud or as RS422
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	: 4000 ft 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

1.5.17 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)

Section 2 INSTALLATION

2.1 General Requirements

The sequence of events for installing a 6366 Programmable Advanced Controller in a system should be as follows:-

2.1.1 Rack or Bin Systems

a) 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).

b) 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.

2.1.2 Self-powered Sleeves

a) Ensure that a 7900/7366 Self-Powered Sleeve is available (See Section 1.3.3).

b) Ensure that the 7900/7366 Self-Powered Sleeve has been correctly wired to either a 110/240V AC mains supply or a 24V DC supply (See Appendix C).

2.1.3 Before sliding the Controller into the rack, Bin or 7900/7366 sleeve check that all the internal switches have been set correctly as outlined in Section 2.3

2.1.4 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.

2.1.5 Power up the Controller in the manner outlined in Section 2.5.

2.1.6 The Controller can now be programmed with the Functional Block parameters for each Control Loop following the instructions given in Section 4.

2.1.7 Once the Controller has been loaded with these parameters the Functional Blocks will operate in the various modes and control loop configurations as described in Section 3.

2.1.8 If there are no suitable Time-scheduled or Background programs in the Application library the user can create new ones by FORTH programming as described in Section 6.

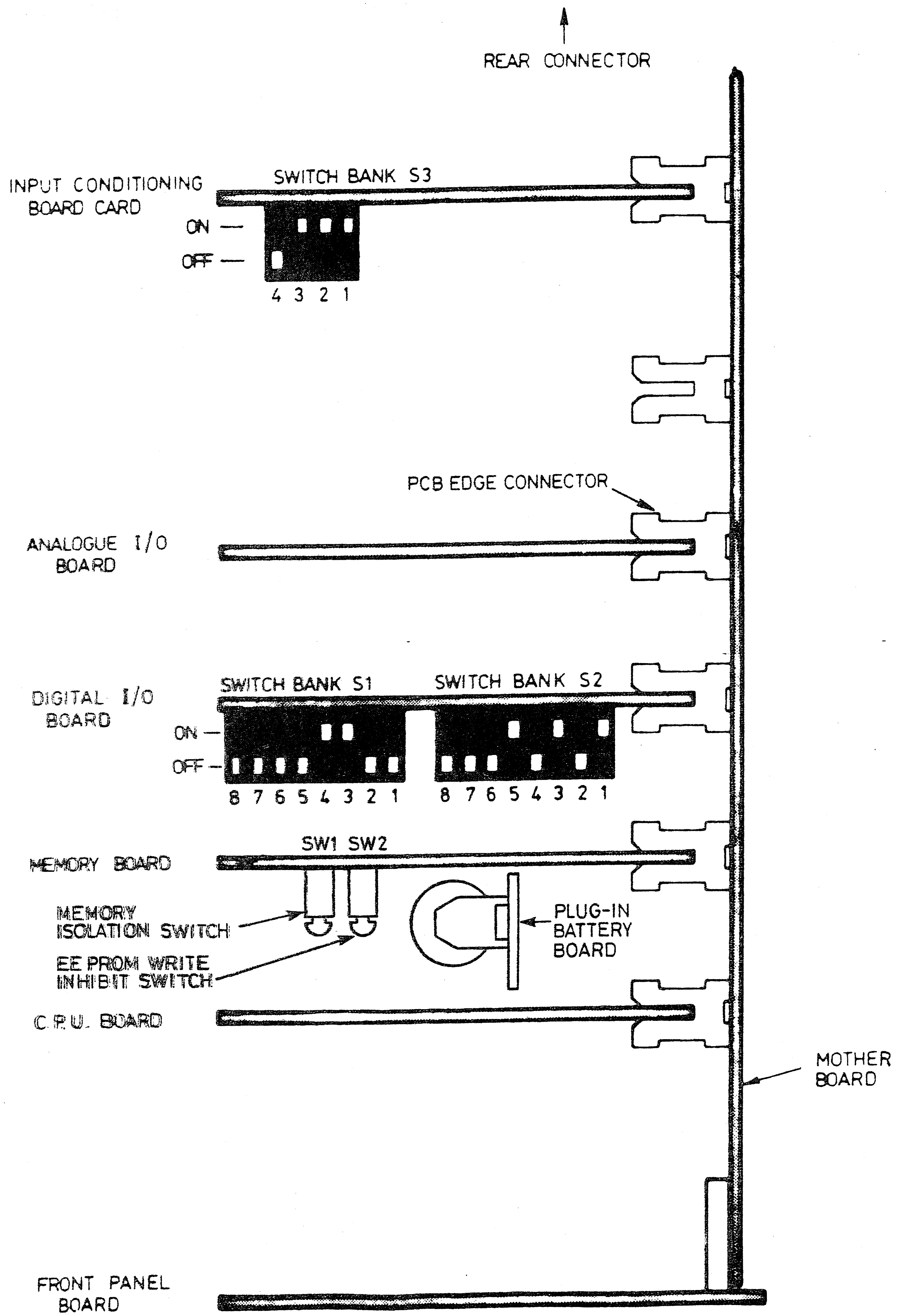


FIG 2·1 TOP VIEW OF CONTROLLER SHOWING INTERNAL SWITCH POSITIONS

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 6366 Programmable Advanced 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 Board Switches

Fig. 2.1 shows that there are two ON/OFF switches situated along the top edge of the Mk 6 memory daughter board and their functions are as follows:-

a) Memory Isolation Switch

This switch, SW 1, is situated furthest from the plug-in Battery 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 continue 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 ON (UP)	SWITCH ACTION OFF(DOWN)	SWITCH FUNCTION	
S2 RIGHT	1	8	0	2^3	Instrument Unit identifier (UID)
	2	4	0	2^2	
	3	2	0	2^1	
	4	1	0	2^0	
	5	Dual loop	Single loop	Control loop communication mode	
	6	-	-	N/A	
	7	Inverse	Normal	Manual Station 2 output action	
	8	Inverse	Normal	Manual Station 1 output action	
S1 LEFT	1	Same as RS 422	300 baud	RS 232 data link baud rate selection	
	2	see	Table 2.2	Baud rate selection switches for RS422 data link	
	3				
	4				
	5	Binary	ASCII	Protocol mode select	
	6	4	0	2^2	Instrument Group identifier (GID)
	7	2	0	2^1	
	8	1	0	2^0	

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

b) EEPROM Write Enable Switch

This switch, SW2, is situated closest to the plug-in Battery board and it controls the Write Enable input of the EEPROM as follows:-

SW2 OFF (pulled out) = writing inhibited (read-only)

SW2 ON (pushed in) = writing enabled

If SW2 is OFF and the user attempts to copy an Application Program from RAM into EEPROM via the 'SAVE' utility, an error condition will be indicated, (see Programmable Instruments Programming Manual).

2.3.2 Digital Input/Output Board Internal Status Switches

Fig 2.1 shows that the Digital Input/Output daughter board carries two 8 way DIL switches situated along the top edge. These two switch banks S1 and S2 are used for setting up various internal functions within the 6366 Programmable Advanced 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.

a) Switch Bank S1 Functions

Most of the switches on this bank are used to set up the RS422 supervisory data link as follows:-

(i) Switch no. 1

This switch is used to select the baud rate for operation of the front-panel RS232 programming socket thus:-

S1 no. 1 OFF = 300 baud (8260 Hand-held terminal)

S1 no. 1 ON = baud rate as determined by S1 switches 2, 3 and 4 for the RS422 data link.

(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 bauds and the required switch settings to obtain them are given in Table 2.2.

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

(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. The 6366 hardware allows up to 128 separate units 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 are selected via switch S2 numbers 1 to 4, described in Section 2.3.2 b) (i). The 3 most-significant bits are called the Group Identifier (GID) and 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 } when in the 'ON' position
S1 no. 6 = 4 }

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 used to set up internal operating modes within the 6366 Controller and the RS 422 communications link as follows:-

(i) Switches no. 1, 2, 3 and 4

These 4 switches are used to set up the Unit Identifier (UID) of the instrument required by the RS422 communications link. Table 2.1 shows that the binary weighting of each switch is as follows:-

S2 no. 4 = 1 }
S2 no. 3 = 2 } when in the 'ON' position
S2 no. 2 = 4 }
S2 no. 1 = 8 }

LOOP MODE	S2 No. 5	UID SELECT SWITCHES 4	3	2	1	LOOP 1 UID	LOOP 2 UID
Single	Off	Off	Off	Off	Off	0	-
	Off	Off	Off	Off	On	1	-
	Off	Off	Off	On	Off	2	-
	Off	Off	Off	On	On	3	-
	Off	Off	On	Off	Off	4	-
	Off	Off	On	Off	On	5	-
	Off	Off	On	On	Off	6	-
	Off	Off	On	On	On	7	-
	Off	On	Off	Off	Off	8	-
	Off	On	Off	Off	On	9	-
	Off	On	Off	On	Off	A	-
	Off	On	Off	On	On	B	-
	Off	On	On	Off	Off	C	-
	Off	On	On	Off	On	D	-
	Off	On	On	On	Off	E	-
	Off	On	On	On	On	F	-
Dual	On	Off	Off	Off	X	0	1
	On	Off	Off	On	X	2	3
	On	Off	On	Off	X	4	5
	On	Off	On	On	X	6	7
	On	On	Off	Off	X	8	9
	On	On	Off	On	X	A	B
	On	On	On	Off	X	C	D
	On	On	On	On	X	E	F

TABLE 2.3 Relationship between the instrument UID and the settings of S2 numbers 1 to 5 inclusive

KEY

X = don't care

Thus these 4 switches can be used to select a Group Identifier from 0 to F, but this in turn depends upon the setting of switch S2 number 5 which is described in the next paragraph.

(ii) Switch no. 5

This switch determines whether the 6366 appears as a single or dual loop instrument to a computer using the RS 422 data link as follows:-

S2 no. 5 OFF - Single-loop Mode

In this case the 6366 appears as a single loop instrument and switches 1 to 4 select a UID from 0 to F as shown in the top half of Table 2.3.

S2 no. 5 ON - Dual-loop Mode

In this case the 6366 appears as a dual loop instrument and each loop has its own independent UID setting. The state of S2 number 1 is ignored and S2 numbers 2, 3 and 4 provide eight possible switch settings to make the loop 1 UID take up even values from 0 to E, while the loop 2 UID takes up odd values from 1 to F. This arrangement is illustrated in the lower half of Table 2.3.

(iii) Switch no. 6

This switch is not used by the 6366.

(iv) Switches no. 7 and 8

These two switches are used to invert the sense of the Manual station 2 and 1 outputs respectively. They do not affect the display but only invert the electrical output as follows:-

S2 no. 7 or 8 OFF = Normal output

e.g. Manual station output (OP) is at 60%, then display shows 60% and electrical output is 6V.

S2 no. 7 or 8 ON = Inverted Output

e.g. OP is at 60%, then display shows 60% but electrical output is 4V.

S3 BANK		SWITCH ACTION					
		OFF			ON		
SWITCH NUMBER	PIN NO.	SIGNAL FUNCTION	SIGNAL SENSE	VOLTAGE RANGE	SIGNAL FUNCTION	SIGNAL SENSE	VOLTAGE RANGE
1	10	N/A	-	-	Analogue Input 1	Input	1-5V
	13	Analogue Input 1	Input	0-10V	Analogue Input 1	Output	0-10V
2	11	N/A	-	-	Analogue Input 2	Input	1-5V
	14	Analogue Input 2	Input	0-10V	Analogue Input 2	Output	0-10V
3	12	N/A	-	-	Analogue Input 3	Input	1-5V
	15	Analogue Input 3	Input	0-10V	Analogue Input 3	Output	0-10V

TABLE 2.4 Switch Bank S3 Selection Functions

2.3.3 Analogue Input Conditioning Daughter Board Switches

It can be seen from Figure 2.1 that the Analogue Input Conditioning daughter board has a third 4-way DIL switch bank, S3, available along its top edge. Three of the switches in S3 are used to individually select which of the three analogue input channels have direct 0-10V inputs and which of them have 1-5V conditioned inputs. The effect of the three switches is illustrated in Table 2.4.

It can be seen from Table 2.4 that with all 3 switches in the OFF position, the direct 0-10V analogue inputs can be connected directly to pins 13, 14 and 15 as described in Section 2.4.2 A). When switches 1, 2 or 3 are set ON, the 1-5V conditioned inputs are connected to pins 10, 11 and 12 while pins 13, 14 and 15 then serve as 0-10V output signals respectively. (See Section 2.4.2 B)). The remaining switch of switch bank S3, namely number 4 is not used and can be left in either position.

It should be noted that the settings of switch bank S3 can not be accessed via the 8260 Hand-held terminal or serial data link using the SW status word of Section 4.5.5.

2.4 Plant and Other External Connections

Appendix A lists the functions of the rear connector pins of the 6366 Programmable Advanced 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 reference, 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

The Controller has 3 separate analogue input channels which are allocated to the following functions:-

a) Analogue Input 1 (Pin 10: 1-5V; Pin 13: 0-10V)

The function of Analogue Input 1 is totally dependent upon the application for which the 6366 has been configured. Circuitry is provided which will detect when the 0-10V input goes open-circuit, or when zero-current is applied to the 1-5V inputs via external burden resistors. Under these conditions the Control action will be as described in Section 2.6.3.

b) Analogue Input 2 (Pin 11: 1-5V; Pin 14: 0-10V)

The function of Analogue Input 2 is totally dependent upon the application for which the 6366 has been configured.

c) Analogue Input 3 (Pin 12: 1-5V; Pin 15: 0-10V)

The function of Analogue Input 3 is totally dependent upon the application for which the 6366 has been configured.

These 3 channels are available as two separate sets of input pins as follows:-

A) Non-Isolated 0-10V Inputs

When the Controller is used with other Matric 6000 series modules, which have a standard 0-10V output range, then these may be connected directly to the 0-10V Controller input pins. In this case the Input Channels use the following pins on the rear connector respectively:-

Input Channel	0-10V Connector Pin
Channel 1	13
Channel 2	14
Channel 3	15

B) Non-Isolated 4-20mA or 1-5V Inputs

When the Controller is used with external transmitters producing 4-20mA outputs these first have to be converted to 1-5V signals by means of external precision resistors. The 1-5V signals can then be applied to the 3 channel Analogue Input Conditioning card via the following rear connector pins:-

Input Channel	1-5V Connector Pin
Channel 1	10
Channel 2	11
Channel 3	12

The Input conditioning card has 3 independent amplifier circuits that convert a 1-5V input signal to a 0-10V output signal. These 3 outputs are internally connected to pins 13, 14 and 15 which are the 0-10V input pins described above. Thus when the conditioning card inputs are being used, the 3 channels can be monitored as buffered 0-10V signals on pins 13, 14 and 15 respectively. Each input conditioning amplifier can be switched in or out of the circuit as described in Section 2.3.3 thus allowing a mixture of 0-10V and 1-5V inputs.

Methods of connecting 4-20mA signals to the 6366 Controller and the use of the Transmitter supply are discussed more fully in Section 6 of the System 6000 Installation Guide.

2.4.3 Analogue Outputs

The Controller has 3 separate analogue output channels which are allocated to the following functions:-

a) Channel 1, pin 32, is the Manual Station 1 output which is a 0-10V signal representing 0-100% of full scale output.

   If the Manual Station 1 output is required in isolated form, then this signal is available from the Output Isolator daughter board. This card takes the signal on connector pin 32 as a 0-10V input and converts it to a 4-20mA isolated output. The positive and negative current outputs are available on connector pins 45 and 43 respectively and an accuracy of ±0.5% of full scale is maintained with an isolation of ±50V minimum with respect to system ground.

b) Channel 2, pin 33, is the Manual Station 2 output which is a 0-10V signal representing 0-100% of full scale output.

c) Channel 3, pin 34, is allocated to the Analogue Output 1 function and is a 0-10V signal representing the 0-100% of full scale output from the Analogue Output block.

2.4.4 Digital Inputs

The Controller is provided with 8 digital inputs for use with 0-15V logic levels which occupy pins 24 to 31 inclusive of the rear connector as can be seen from Appendix A. Each of the Digital Inputs is fitted with a 100k ohm pull-down resistor to 0V so that the maximum input current required to maintain a logic 1 is 0.15mA. The functions of these inputs are all dependent upon the application for which the 6366 has been configured.

2.4.5 Digital Outputs

The Controller is provided with 8 digital outputs which produce 0-15V logic levels and occupy pins 16 to 23 inclusive as can be seen from Appendix A. Each of the Digital Outputs consists of an open-collector type TTL gate with a 2k2 pull-up resistor to the +15V rail and can sink a maximum current of 16mA in the logical zero state. The functions of these outputs are all dependent upon the application for which the 6366 has been configured.

2.4.6 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 Controller Power-up Sequence

There are two possibilities that can occur when the 6366 Programmable Advanced Controller is connected to an external power supply and these are as follows:-

2.5.1 Power-up from Initial Un-programmed State

When a Controller is first powered-up before any configuration data or 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 instrument to flash the following message on the 4 digit readout.

Err

2.5.2 Power-up from a Previously Programmed State

If the power supply to an instrument 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 cause the User program to be loaded from EEPROM back into the non-volatile memory area. The CPU will then sumcheck the memory area and if this is successful it will run the 3 programs defined by the following parameters in the General Purpose Block (see Sections 4.5.3 and 4.5.4):-

L1 - defines the loop 1 program
L2 - defines the loop 2 program
BG - defines the background program

INSTRUMENT FAULT	EXTERNAL LOGIC INDICATION	PROCESS VARIABLE DISPLAY	OPERATING MODE CHANGE	COMMAND PARAMETER INDICATION	ERROR RECOVERY PROCEDURE
Watchdog (hardware) failure	Pin 9 =0V; Pins 16 to 23 incl. set to 0V	Blanked	Analogue outputs not updated	All communications disabled	Replace Instrument
Function Block Sumcheck failure	Application dependent	No change	Application dependent	ST bit 8 set to 1 in GP Block; ST bit 3 set to 1 in each failed Block	Re-enter corrupted parameters in Block; Set ST bit 3 to 0 in Block
Loop 1 Program Run-time Error	Application dependent	Flashes	Application dependent	ST bit 7 set to 1 in GP Block	Correct and re-run program
Loop 2 Program Run-time Error	Application dependent	Flashes	Application dependent	ST bit 6 set to 1 in GP Block	Correct and re-run program
Background Program Run-time Error	Application dependent	Flashes	Application dependent	ST bit 5 set to 1 in GP Block	Correct and re-run program
Background Program halted	Application dependent	Flashes	Application dependent	ST bit 4 set to 1 in GP Block	Run the Background program
Open-circuit Analogue Input 1	Application dependent	No change	Application dependent	ST bit 1 and 2 set to 1 in AI Block	Apply valid analogue input
Battery voltage low	Application dependent	Decimal points flash	No change	ST bit 11 set to 1 in GP Block	Replace battery

TABLE 2.5 6366 Controller Diagnostics

2.6 6366 Controller Hardware Diagnostic Facilities

The 6366 incorporates a number of diagnostic facilities for continuously monitoring and checking the status of the Controller 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 2.5 lists the 8 major instrument faults that can occur and shows that they have a number of common characteristics, viz:-

a) Each fault is identified by a particular external logic indication on the rear connector.

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

c) Certain faults affect the 6366 Operating mode in a controlled ´fail-safe´ manner.

d) Each fault sets various status bits within the Block Status 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 2.5 are described in the following 6 sections.

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 bottom segments of the two bargraph displays. 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 of the digital outputs (pins 16 to 23 inclusive) 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 the associated analogue outputs will retain the last voltage level set by the CPU before the Watchdog tripped out. (See Sections 1.4.5 and 2.4.3) 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 6366 is first powered up. Consequently there are three possibilities that can occur after each restart attempt:-

a) If the failure was due to a transient fault without loss of memory the instrument will restart 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.

b) If the failure was due to a transient fault which has corrupted the memory, then the instrument will restart automatically as described in Section 2.5.2 but a Block sumcheck failure condition will exist as described in Section 2.6. The Watchdog output will again be reset to 15V after a 30ms period.

c) 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.

The 6366 Controller hardware incorporates data input/output ports on the Front-panel, Digital Input/Output, and Analogue 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 CPU stops refreshing the Watchdog so that the Watchdog Timer trips out as described above.

2.6.2 Block Sumcheck Failure

The 6366 Controller maintains a separate sumcheck of the set of command parameters associated with each of the Functional Blocks contained within the instrument. Any corruption of these stored parameters will cause the subsequently calculated sumcheck to differ from the stored value. When the CPU detects this condition it takes the following actions:-

a) Bit 3 of the ST status parameter associated with the failed block is set to logic 1. This allows individual failed blocks to be identified.

b) Bit 8 of the ST status parameter of the General Purpose block (GP) is set to logic 1 and this acts as a common block sumcheck failure bit for the whole instrument.

Table 2.5 shows that under these conditions the 4 digit readout is unaffected and that external logic indications and operating mode changes are application dependent.

If the sumcheck error was due only to a transient memory corruption then it can be corrected by resetting bit 3 of the appropriate Block 'ST' parameter to logic 0. The parameter list of the whole Block should first be checked for possible corruption and re-entered where necessary. ST, Bit 8 of the General Purpose Block will then be set back to logic 0 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 the Block, and the operating conditions given in Table 2.5 will prevail. The error can in this case be corrected by replacing the memory board with a new unit.

2.6.3 **Program Run-time Errors**

The 6366 software is capable of detecting Run-time Errors in either of the two Control Loop programs or the Background program. These Errors, such as attempting to operate on an empty stack, are listed in Appendix E of the TCS Programmable Instrument Programming Manual. An Error in any of the three programs cause a different bit to be set to logic 1 in the ST status parameter of the General Purpose Block (GP) as follows:-

Program	ST bit set in GP block
Loop 1	Bit 7
Loop 2	Bit 6
Background	Bit 5

Table 2.5 shows that under these conditions the 4 digit read-out will flash and external logic indications and operating mode changes are application dependent.

The Error Condition can only be removed by finding the Error within the affected program and correcting it.

2.6.4 **Background Program Halted**

When the Background Program is not running, which may be deliberate or as a result of a fault condition, bit 4 of the ST parameter of the General Purpose Block (GP) is set to logic 1. Table 2.5 shows that under these conditions the 4 digit readout will flash and external logic indications and operating mode changes are application dependent.

The Error Condition can only be removed by actually running the Background Program.

2.6.5 **Open-circuit Analogue Input 1**

The circuitry associated with the channel 1 analogue input is capable of detecting on open-circuit condition as described in Section 2.4.2 a). When the CPU detects this condition the following action is taken:

a) As soon as the condition is detected bit 2 of the ST parameter of the Analogue Input Block 1 (AI) is set to logic 1.

b) If the condition persists for longer than 3 seconds then bit 1 of the ST parameter is also set to logic 1.

These facilities allow the channel 1 analogue input to differentiate between short-term and long-term effects. Short-term effects might be caused at power-up for example, if the 6366 powers-up slightly before the input conditioning equipment such as a Matric 6015 module or a D001 unit. Long-term effects would be caused by failures in the input conditioning equipment or genuinely open-circuit transducers.

Table 2.5 shows that under these conditions the 4 digit readout is unaffected and external logic indications and operating mode changes are application dependent.

The Open-circuit condition can only be removed by applying a valid drive signal to the channel 1 analogue input, i.e. 1-5V to pin 10 or 0-10V to pin 13. As soon as this occurs both bit 1 and 2 of the ST parameter of the Analogue input block 1 will reset to logic 0.

2.6.6 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). At approximately 10 minute intervals the CPU connects the battery to a dummy load and measures it´s voltage. If this voltage drops below the threshold necessary to keep the memory non-volatile under power failure conditions 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 11 of the ST status parameter of the General Purpose Block (GP) will be set to logic 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 programmed decimal point will be illuminated, the others will remain off.

b) The BATTERY VOLTAGE LOW bit 11 of the ST status parameter of the General Purpose Block (GP) will be reset to logic 0.

It should be noted that if the memory isolation switch, SW1 of Fig. 2.1, is inadvertently left out, the CPU will immediately detect this as soon as the Controller is powered up and the ´Supercap´ has discharged (see Section 1.4.3). Operation will then continue as if the battery voltage were low.

Section 3 6366 PROGRAMMABLE ADVANCED CONTROLLER OPERATION

The operation of the 6366 Controller depends very much upon the application for which it is programmed. Consequently, this section will not attempt to cover all the possible modes of operation that could be programmed into the 6366, instead it will discuss the principles and techniques involved.

3.1 Configurable and Programmable Instrumentation

Before being able to operate the 6366 successfully, the user should appreciate the differences between a ´fixed-function´ instrument like the 6360 Process Controller, and a ´programmable´ instrument like the 6366.

3.1.1 Configurable Instruments

With instruments like the 6360 the functions of the input/output signals, the front-panel displays and control push-buttons are all pre-determined. Signal processing functions, control algorithms and the different operating modes of the instrument are also fixed. All the user has to do is to set up the values of the fixed bit of command parameters in order to ´characterise´ or ´configure´ the 6360 for any particular control loop application.

3.1.2 Programmable Instruments

With instruments like the 6366, the loop ´characterisation´ or ´configuration´ procedure of Section 3.1.1 is still carried out, but this represents the lowest level of user access to the instrument and is usually done last. Prior to entering values into the list of command parameters the function and operation of the instrument have first to be defined. This can be thought of as occurring in two stages as follows:-

a) Definition

Firstly the functions of the 6366 have to be defined and this is done under the following headings:-

(i) Input/output signal functions - analogue and digital

(ii) Front-panel display functions.

(iii) Front-panel control push-button functions.

(iv) Setpoint functions.

(v) Control functions (PID etc.).

(vi) Signal processing functions.

All the above facilities are controlled by a number of Functional Blocks, each of which has a number of associated command parameters as shown in Table 3.1.

Block Description	Block Mn'nic	Block No.	Block Type	Rel'tv Block	Ø	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F
General Purpose	GP	0	0	1	ST	II	L1	L2	BG	SW	PB									
Analogue Input	AI	1	1	1	ST	HR	LR	AI	AV											
		2		2	ST	HR	LR	AI	AV											
		3		3	ST	HR	LR	AI	AV											
Analogue O/P	AO	4	2	1	ST	HR	LR	HL	LL	AO										
Digital Input	DI	5	3	1	ST	XM	DS													
Digital O/P	DO	6	4	1	ST	WM	DS													
Setpoint	SP	7	5	1	ST	HR	LR	HL	LL	PV	SP	ER	SL	SR	SB	RL	HA	LA	HD	LD
		8		2	ST	HR	LR	HL	LL	PV	SP	ER	SL	SR	SB	RL	HA	LA	HD	LD
Ratio	RB	9	6	1	ST	HR	LR	RS	RT	RB										
		10		2	ST	HR	LR	RS	RT	RB										
PID Control	3T	11	7	1	ST	XP	TI	TD	FF	FB	OP	TS								
		12		2	ST	XP	TI	TD	FF	FB	OP	TS								
Manual Output Station	MS	13	8	1	ST	HV	LV	HL	LL	AO	OP	OT								
		14		2	ST	HV	LV	HL	LL	AO	OP	OT								
Display & Control	DC	15	9	1	ST	1B	2B	3B	DD	ES	SM									
		16		2	ST	1B	2B	3B	DD	ES	SM									
Alarm Block	AB	17	A	1	ST	HV	LV	HL	LL	PV	SP	AH								
		18		2	ST	HV	LV	HL	LL	PV	SP	AH								
Constants Block	CB	19	B	1	ST	1K	2K	3K	4K	US										
		20		2	ST	1K	2K	3K	4K	US										
Filter Block	FB	21	C	1	ST	XK	1T	2T	FF	FI	OP									
		22		2	ST	XK	1T	2T	FF	FI	OP									
Delay Block	DB	23	D	1	ST	DT														
		24		2	ST	DT														
Totalisation Block	TB	25	E	1	ST	FS	FT													
		26		2	ST	FS	FT													

Table 3·1 List of Functional Block types and their associated command parameters.

b) Definition of 6366 Operation

Once the appropriate number and type of Functional Blocks have been set up for the application, they have to be linked together to form the final 6366 control program. The way the blocks are linked will define the possible operating modes of the 6366, and this control program will execute automatically whenever the instrument is powered up, or can be initiated from a programming terminal such as the 8260 or 8261. This set of linked Functional Blocks is termed the 'Run-time Environment' of the 6366, and is covered in more detail in Section 3.2.1.

Once these two stages have been carried out the 6366 has effectively been 'programmed' for a specific application and will now behave as a fixed-function instrument, i.e. it can now be 'characterised' for the application by entering appropriate values into the list of command parameters.

APPLICATION PROGRAM NUMBER	LOOP TYPE	PROGRAM FUNCTION
S0	single	Single-loop Controller (Cascade Controller)
S1	single	Single-loop Controller (Ratio Controller)
S2	single	Simple Single-loop Controller (Channel 1 I/O; Output = 0-10V/4-20mA)
S3	single	Simple Single-loop Controller (Channel 2 I/O; Output = 0-10V only)
S4/ S5	dual	Cascade pair
S6/ S7	dual	Ratio pair

Table 3.2 List of Time-scheduled programs in the Application Library

3.2 Programing the 6366 Controller

Detailed instructions for programming the 6366 are given in Section 4, and the System 6000 Programmable Instruments Programming Manual (Part no. HA 076878 U005). However, it is necessary to discuss briefly the concepts involved so that the role of the Functional Blocks becomes apparent. This Section will then discuss the operation of the 6366 in relation to these Functional Blocks.

3.2.1 6366 Run-time Environment

Section 3.1.2 b) showed how the 6366 control program consists of a number of linked Functional Blocks known as the Run-time Environment. In fact the 6366 supports two time-scheduled programs L1 and L2, and a background program BG in the Run-time Environment. These programs are selected by setting the appropriate two character program names into the L1, L2 and BG parameters of the General Purpose Block (see Section 3.3.1, 4.5.3 and 4.5.4). The choice of programs that currently exist in the Applications Library with issue 1 software can be made from the following:-

a) Time Scheduled Programs

Table 3.2 shows that there are four single-loop Application Programs, S0 to S3 inclusive, which may be entered into L1 to create single-loop control programs. There are also two dual-loop Application Programs, S4/S5 and S6/S7 which are entered into L1 and L2 when either a full Cascade or Ratio pair of Controllers is required.

b) Background Programs

Table 3.3 shows that there is a choice of eight different background programs, B0 to B7 inclusive which can be used with the time scheduled programs in the combinations indicated.

It can be seen from the Application Library of Table 3.2 and 3.3 that a very large number of different Controller configurations can be programmed by linking the standard applications in different combinations. This is illustrated by the following example:-

EXAMPLE

If it were required to program the 6366 to behave as a 6360 Process Controller operating in the RATIO mode, then the following Run-time environment would be set up in the General Purpose Block (GP):-

L1 (loop 1) = S1
L2 (loop 2) = blank
BG (background) = B3

BACKGROUND PROGRAM NUMBER	POWER-UP MODE	OPEN-CIRCUIT INPUT ACTION	OTHER FEATURES
B0	last mode with last output value	FORCED MANUAL with last output value	
B1	MANUAL with Output at LO	FORCED MANUAL with last output value	
B2	last mode with last output value	FORCED MANUAL with Output at LO	
B3	MANUAL with Output at LO	FORCED MANUAL with Output at LO	
B5	last mode with last output value	no action	
B6	last mode with last output value	FORCED MANUAL on O/C PV1 only	
B7	last mode with last output value	FORCED MANUAL on O/C PV1. Clears RATIO ENABLE on loop 2	O/C PV2 not detected. Sumcheck error gives FORCED MANUAL loop 1/2

Table 3.3 List of Background programs in the Application Library

The 6366 will now operate as a Ratio Controller as described in Section 3.7 of the 6360 Technical Manual (part no. HA 075416 U003) corresponding to switch number 1 of switch bank S2 being ON. Furthermore, the choice of the B3 background program will force the 6366 to behave like a 6360 with S2 number 5 switched ON for power failure and open-circuit PV detection.

Examples of all the Programs currently available in the Application Library will be found in Appendix F.

3.2.2 Levels of 6366 Programming

Programmable Instruments like the 6366 can be considered as having 3 levels of user access to program them. The two lower levels have been mentioned earlier and the highest level is described in more detail in other documents. The three levels are as follows:-

a) Level 1 - Instrument Configuration

The lowest level of access of the 6366 is the same as if it were a fixed function instrument as described in Section 3.1.1. This requires that the L1, L2 and BG parameters of the General Purpose Block (GP) are set up with the appropriate Time Scheduled and Background Programs as described in Section 3.2.1. The 6366 will then run this Run-time Environment as soon as it is powered up or when RUN is entered via a programming terminal. All the user now has to do is to enter the appropriate parameter values in the Functional Blocks that form the configuration specified by L1, L2 and BG. This procedure is analogous to ´characterising´ a fixed function instrument for a specific control loop application. The parameters of each Functional Block may be set-up using the 8260 Hand-held terminal as detailed in Section 4.

b) Level 2 - Instrument Function and Operation

The second level of access to the 6366 is where the user wishes to change the instrument function and operation as defined in Section 3.1.2. To achieve this it is necessary to program a new Run-time Environment. This is done by setting up new parameters for L1, L2 and BG in the General Purpose Block (GP) as described in Section 3.2.1. Assuming the required Time Scheduled and Background programs already exist in the Application Library, then it is merely necessary to enter their mnemonics in the L1, L2 and BG parameters. This new Run-time Environment can then be executed and the 6366 re-configured using the level 1 access as described in Section 3.2.2 a).

If the required Time Scheduled and/or Background programs do not exist already in the Applications Library, then they need to be created using the level 3 access mechanism as described in Section 3.2.2 c).

c) Level 3 - Applications Program Creation

The third or highest level of access to the 6366 is when the user wishes to program a new Run-time Environment but finds that there are not suitable Time Scheduled or Background programs already in the Application Library. In this case the user can create new programs and add these to the Library, either by editing existing programs or writing completely new ones. In either case these operations are carried out by using the TCS version of the FORTH programming language. Brief mention is made of this in Section 6, but the System 6000 Programmable Instruments Programming Manual should always be consulted before any FORTH programming is attempted.

3.2.3 Programming Terminals for the 6366

The 8260 Hand-held terminal is perfectly suitable for level 1 and 2 programming of the 6366. However, when using level 3 programming of the 6366 the seven character display of the 8260 is inadequate and one of the following devices should be used:-

a) A BBC microcomputer running the 8270 VDU ROM software.

b) The 8261 terminal (Epson PX8) running the 8271 Data Base Configurator Software.

c) A 'Teletype' compatible dumb terminal or VDU e.g. VT 100.

3.3 Functional Blocks

When using the 6366 Controller an operator normally interacts with the Functional Blocks described in this Section. As described in Section 3.1.2, these cover the interface between analogue and digital signals, setpoints, control and the displays. For convenience these have been separated into modules or blocks that can be configured using an 8260 Hand-held terminal or similar programming device, as shown in Table 3.1.

Data is presented in engineering units where applicable. Notable exceptions are the analogue inputs - before they are linearised, and the output of a PID calculation which by inference produces a percentage output.

Many of the signals can be monitored both in engineering units and as percentages, this facility is only available when programming at level 3, and is provided to avoid normalisation computations when cascaded blocks have different engineering ranges.

To simplify installation of the 6366 Controller the Functional blocks listed below are automatically grouped together:-

Group 1	Group 2
Setpoint block 1	Setpoint block 2
Ratio block 1	Ratio block 2
PID control block 1	PID control block 2
Manual Station 1	Manual Station 2
Display and control block 1	Display and control block 2

This provides the following connections:-

1. Front panel to Setpoint block - for operator interaction with local setpoints.
2. Front panel to Ratio block - for operator interaction with ratio settings.
3. Front panel to Manual Station - for operator interaction with outputs in manual mode.
4. Front panel to Display and Control block - so an operator can change the operating mode of a loop
5. PID block to Setpoint block - the Setpoint block provides a Setpoint and Process Variable for the PID computation.

The functions and operation of the fifteen different types of Functional Blocks listed in Table 3.1 are detailed in the following Sections 3.3.1 to 3.3.15 inclusive.

3.3.1 General Purpose Block - GP (Type 0)

The General Purpose Block (GP) contains information concerning the overall operation of the 6366 Programmable Advanced Controller. It also is used for setting up the required Run-time Environment as described in Section 3.2.1. It can be seen from Table 3.1 that there are seven parameters associated with the General Purpose Block as follows:-

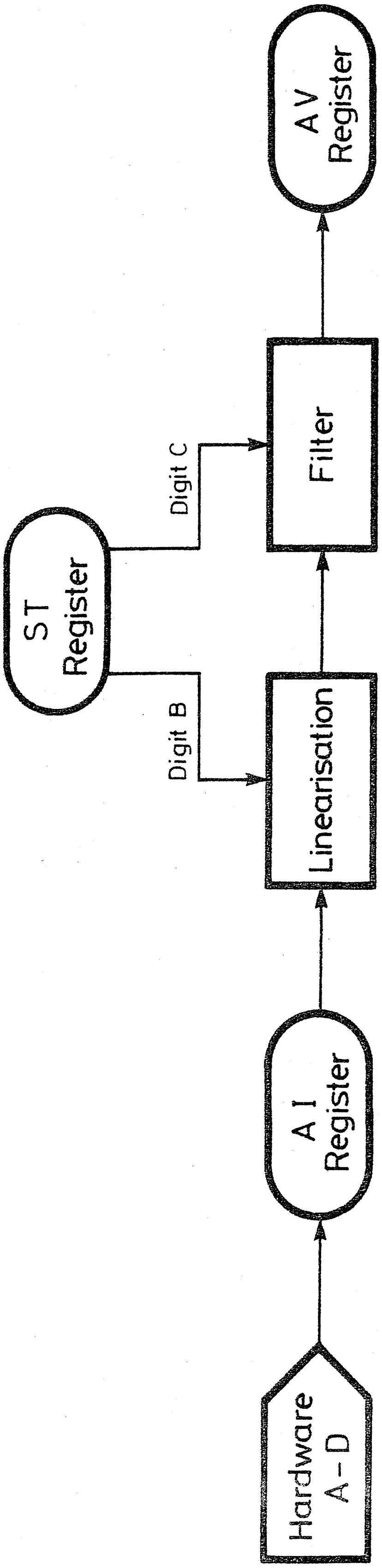
ST - Instrument status
II - Instrument identity
LI - Name of Time-scheduled Program 1
L2 - Name of Time-scheduled Program 2
BG - Name of Background Program
SW - Switch Bank S1/S2 settings
PB - Front-panel push-button status

a) Error Recovery

If the 6366 software maintenance routines discover that a sumcheck failure has occurred on any of the parameters associated with this Block the following action is taken:-

(i) ST bit 3 is set to logic 1 (see Section 4.5.1 d) (i)).

Details of the format of the General Purpose Block parameters and how they are programmed are given in Section 4.5.



Block Type 1
Block Mnemonic - A I

Fig. 3·1 Analogue Input Block Operation

3.3.2 Analogue Input Block - AI (type 1)

Table 3.1 shows that the 6366 can have up to three Analogue Input Blocks (AI) which are used to convert the signals of the analogue input channels into Engineering units. It can be seen from Table 3.1 that there are five parameters associated with each Analogue Input Block as follows:-

ST - Block status
HR - Analogue input High Range in Engineering Units
LR - Analogue input Low Range in Engineering Units
AI - Analogue input in the range 0 to 100%
AV - Analogue Variable after linearisation and filtering, in Engineering units

The schematic diagram of Fig. 3.1 shows the action of the Analogue Input Block on each input channel and this is described below:-

a) Analogue Input Block Function

Fig. 3.1 shows that after hardware analogue to digital conversion by the CPU, the value of each analogue input is stored in the AI parameter as a percentage. This value is then expressed in Engineering Units over the range defined by the LR and HR parameters. Subsequent linearisation and filtering of the signal can then be carried out under the control of data programmed into the ST status word. Finally, the resultant engineering units value is available as the Analogue Variable in the AV parameter.

The Analogue Variable AV is thus a filtered version of the sampled analogue input value, MV thus:-

$$AVn = AVn\text{-}1 + \frac{AS}{IF} (MVn - AVn\text{-}1)$$

where:-

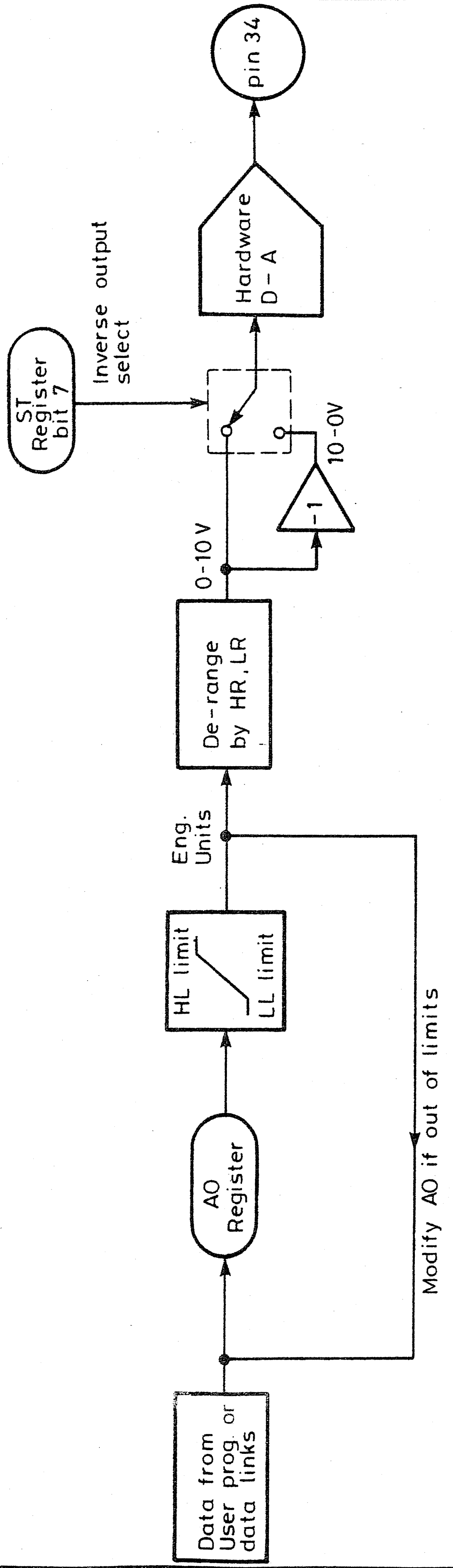
AVn = value of Analogue Variable sample n
AS = Analogue Input sampling period (36 ms)
IF = input channel filter constant defined by digit C of the ST parameter
MVn = value of Analogue Input AI sample n expressed in Engineering units

b) Error Recovery

If the 6366 Software Maintenance routines discover that a sumcheck failure has occurred on any of the parameters associated with this Block the following action is taken:-

(i) ST bit 3 is set to logic 1 (see Section 4.6.1 d) (i)).

Details of the format of the Analogue Input Block parameters and how they are programmed are given in Section 4.6.



Block Type 2
Block Mnemonic-AO
Fig. 3·2 Analogue Output Block Operation

3.3.3 Analogue Output Block - AO (type 2)

The Analogue Output Block (AO) is used to configure the interface between the 6366 Control Program and a real analogue output signal. It can be seen from Table 3.1 that it has six associated parameters as follows:-

ST - Block status
HR - Analogue output High Range in Engineering Units
LR - Analogue output Low Range in Engineering Units
HL - High output limit in Engineering Units
LL - Low output limit in Engineering Units
AO - Analogue Output value

The schematic diagram of Fig. 3.2 shows the action of the Analogue Output Block and this is described below:-

a) Analogue Output Block Function

Fig. 3.2 shows that the Analogue Output value is stored in the AO parameter in Engineering Units. As this value varies from the Low Range LR, to the High Range HR the output signal varies from 0 to 10V but is limited to lie within the operating range LL to HL as specified by the Output Limit parameters.

b) Inverse Output Mode

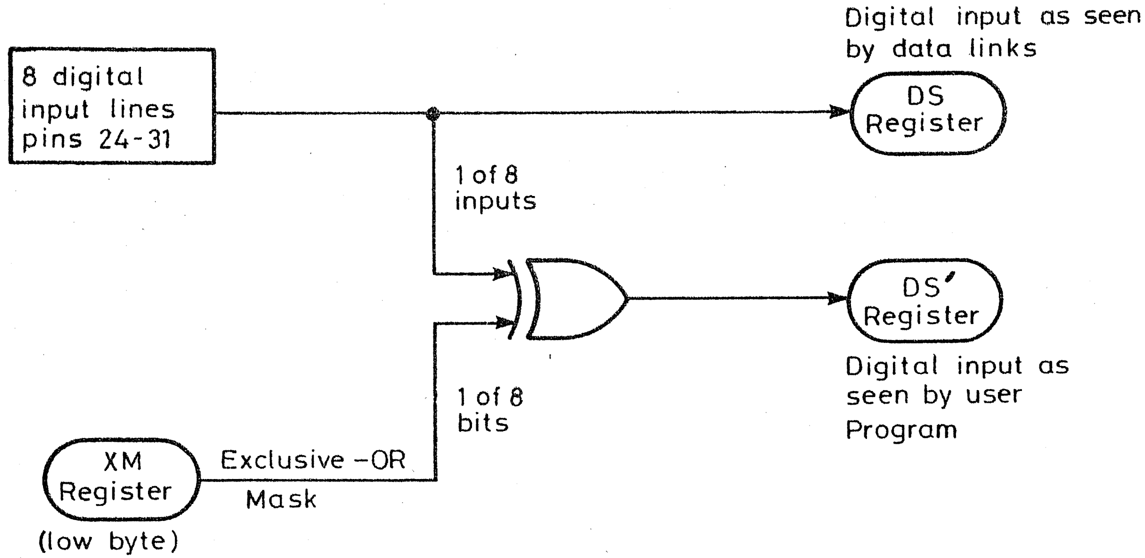
It is also possible to configure the Analogue Output Block for inverse operation by setting bit 7 of the Block Status parameter, ST, as described in Section 4.7.1. In this case as AO varies from LR to HR the analogue output signal varies from 10 to 0V respectively.

c) Error Recovery

If the 6366 Software Maintenance routines discover that a sumcheck failure has occurred on any of the parameters associated with this Block the following action is taken:-

(i) ST bit 3 is set to logic 1 (see Section 4.7.1 d)).

Details of the format of the Analogue Output Block parameters and how they are programmed are given in Section 4.7.



Block Type 3
Block Mnemonic – DI
Fig 3·3 Digital Input Block Operation

3.3.4 Digital Input Block - DI (type 3)

The Digital Input Block (DI) is used to give the 6366 Control program access to the logic states of the eight digital input lines of the instrument. It can be seen from Table 3.1 that there are 3 parameters associated with the Digital Input Block as follows:-

ST - Block status
XM - Exclusive-OR mask
DS - Digital input states

The action of the Digital Input Block is shown schematically in Fig. 3.3 and is described below:-

a) Digital Input Block Function

Fig. 3.3 shows that the logic state of each of the eight digital input lines is given in the DS parameter. This can be monitored via the 8260 Hand-held terminal, or RS422 supervisory data link.

Each time the user accesses the Digital Input State parameter, DS, the eight digital inputs are scanned by the 6366. This ensures that only current data is used and so eliminates possible delays that could occur if the data base was updated asynchronously.

b) Logic State Inversion

An additional feature of the Digital Input Block is the ability to invert the logic state of individual digital inputs when this is required within a user application program. This is achieved by setting one of the eight bits as appropriate in the lower byte of the XM mask parameter. Fig. 3.3 shows that if the XM mask bit is set to logic 0 then the corresponding DS bit (DS´) is unaffected. However, if the XM mask bit is set to logic 1 then the DS bit (DS´) is inverted.

c) Error Recovery

If the 6366 Software Maintenance routines discover that a sumcheck failure has occurred on any of the parameters associated with this Block the following actions are taken:-

(i) ST bit 3 is set to logic 1 (see Section 4.8.1 b) (i)).

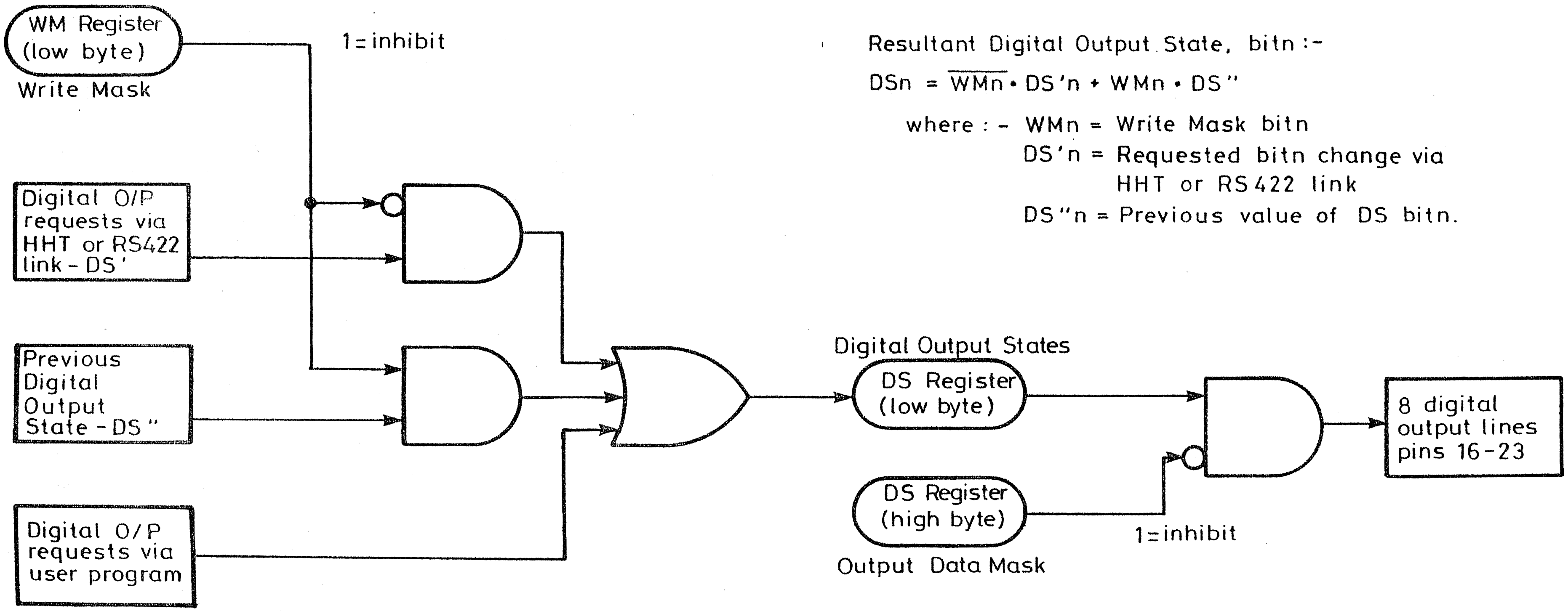
(ii) The XM mask parameter is set to zero (see Section 4.8.2).

Details of the format of the Digital Input Block parameters and how they are programmed are given in Section 4.8.

Resultant Digital Output State, bitn :-

$DSn = \overline{WMn} \cdot DS'n + WMn \cdot DS''$

where : - WMn = Write Mask bitn
$DS'n$ = Requested bitn change via HHT or RS422 link
$DS''n$ = Previous value of DS bitn.



Block Type 4

Block Mnemonic – DO

Fig 3·4 Digital Output Block Operation

3.3.5 Digital Output Block - DO (type 4)

The Digital Output Block (DO) is used to enable the 6366 Control Program to alter the logic states of the eight digital output lines of the instrument. It can be seen from Table 3.1 that there are three parameters associated with the Digital Output Block as follows:-

ST - Block status
WM - Write mask
DS - Digital Output states

The action of the Digital Output Block is shown schematically in Fig. 3.4 and is described below:-

a) Digital Output Block Function

Fig. 3.4 shows that the low byte of the DS parameter controls the logic state of each of the eight digital output lines. The high byte of the DS parameter is used to hold individual mask bits for each corresponding digital output. The mask bit must be set to logic 0 to allow the data bit in the DS word to alter the corresponding logic output, while a logic 1 inhibits all output changes.

Each time the user writes to the Digital Output states parameter, DS, the 6366 updates the digital outputs immediately. This minimises any delay that could occur if the outputs were updated asynchronously.

b) Write Mask

Fig. 3.4 shows that the DS parameter can always be changed directly from a user program, but changes via the 8260 Hand-held terminal or RS422 data link are controlled by the Write Mask parameter, WM. This provides protection against bits in DS being changed via either of the data links unless the corresponding WM bit is set to logic 0.

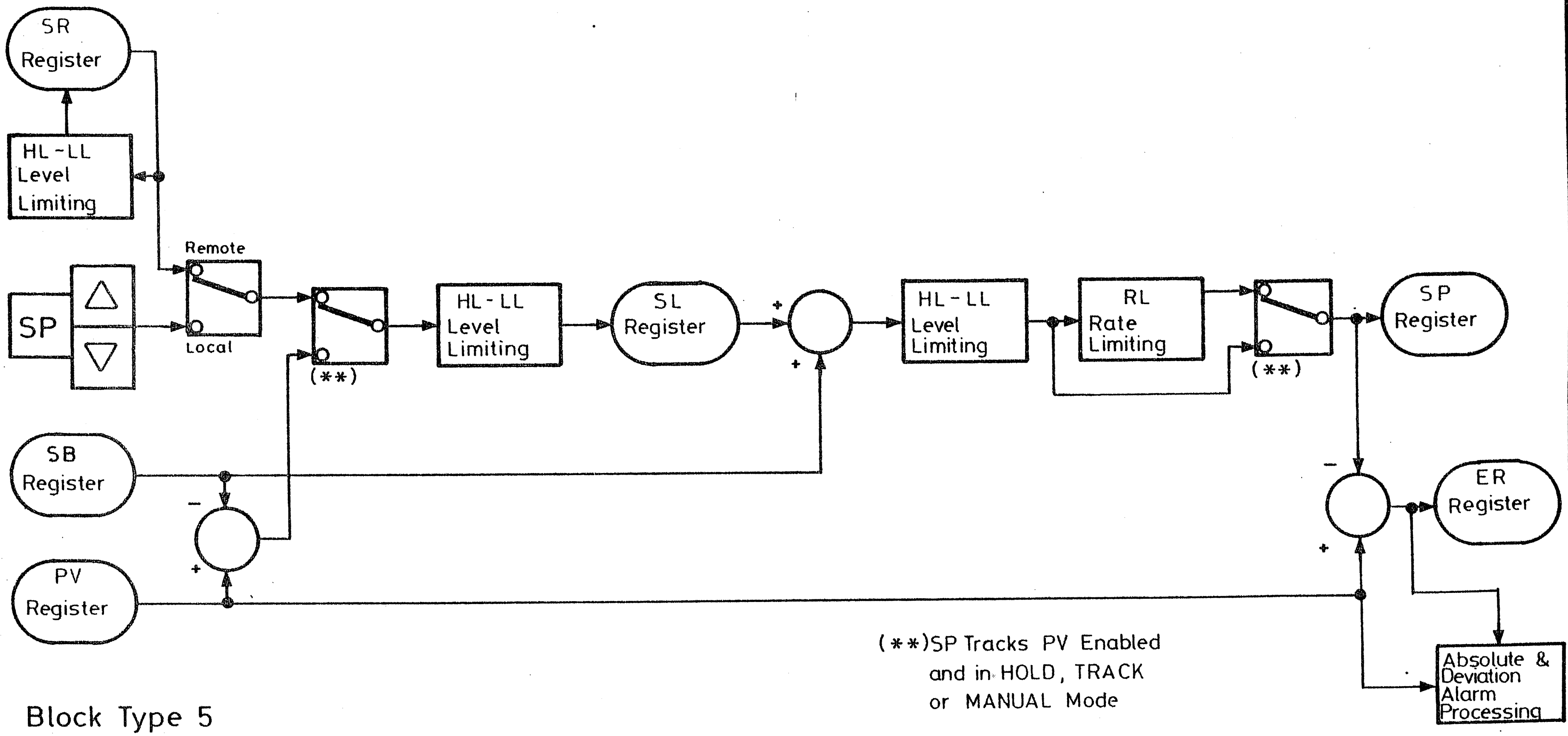
c) Error Recovery

If the 6366 Software Maintenance routines discover that a sumcheck failure has occurred on any of the parameters associated with this Block the following actions are taken:-

(i) ST bit 3 is set to logic 1 (see Section 4.9.1 b) (i)).

(ii) The WM parameters is set to zero (see Section 4.9.2).

Details of the format of the Digital Output Block parameters and how they are programmed are given in Section 4.9.



Block Type 5

Block Mnemonic – SP

Fig. 3·5 Setpoint Block Operation

3.3.6 Setpoint Block - SP (type 5)

The Setpoint Block (SP) is used when it is required to generate a Resultant Internal Setpoint for linking into a PID Block to perform closed-loop control. It can be seen from Table 3.1 that there are 16 parameters associated with the Setpoint Block as follows:-

ST - Block Status
HR - Setpoint High Range
LR - Setpoint Low Range
HL - Setpoint High limit
LL - Setpoint Low limit
PV - Process Variable
SP - Resultant Internal Setpoint
ER - Error (= PV - SP)
SL - Local Setpoint
SR - Remote Setpoint
SB - Setpoint Bias
RL - Setpoint Rate limit
HA - High Absolute Alarm limit
LA - Low Absolute Alarm limit
HD - High Deviation Alarm limit
LD - Low Deviation Alarm limit

The action of the Setpoint Block is shown schematically in Fig. 3.5 and is described below:-

a) Local Setpoint derivation

The prime function of the Setpoint Block is to generate the Local Setpoint parameter, SL, and this can be derived from a number of sources depending upon the control loop operating mode, thus:-

(i) MANUAL mode

In the MANUAL operating mode two actions can occur depending upon the setting of the ST parameter bit 10 viz:-

ST bit 10 = logic 0 - Setpoint Constant

In this mode the SL value remains constant and may be altered via the Raise/Lower buttons or either of the serial data links.

ST bit 10 = logic 1 - Setpoint Track

In this mode the SL value is forced to track the Process Variable input and cannot be altered but only monitored via the front-panel or serial data links.

(ii) AUTO mode

In the AUTO operating mode the SL value may be altered via the Raise/Lower buttons or either of the serial data links.

(iii) REMOTE AUTO mode

In the REMOTE AUTO operating mode the Setpoint is provided via the Remote Setpoint parameter, SR, and the SL parameter is forced to track this value. Thus SL cannot be altered but only monitored via the front-panel or serial data links.

(iv) RATIO mode

In the RATIO operating mode the Setpoint is provided via the Ratio Setpoint parameter, SR, and the SL parameter is forced to track this value. Thus SL cannot be altered but only monitored via the serial data links.

b) Resultant Setpoint derivation

In all operating modes, Fig. 3.5 shows that the Resultant Internal Setpoint is simply the Local Setpoint value after Bias has been added, viz:-

RESULTANT SETPOINT (SP) = LOCAL SETPOINT (SL)

+ SETPOINT BIAS (SB)

c) Setpoint limits

The Setpoint Block is provided with both Setpoint limits HL, LL and Rate limits RL and their action is as follows:-

(i) Setpoint limits

The Setpoint limits act on the SP value depending upon the Control loop operating mode thus:-

Control loop in MANUAL or AUTO

Fig. 3.5 shows that in MANUAL or AUTO the HL and LL parameters limit the range over which SL can be varied by the Raise/Lower buttons or either of the serial links. These limits are then applied a second time after Bias has been added to produce the Resultant Setpoint.

Control loop in REMOTE

With the control loop in REMOTE, the Remote Setpoint value from the SR parameter is limited by HL and LL before becoming the SL value.

(ii) Rate limits

Fig. 3.5 shows that Rate limiting can be applied after Setpoint Bias has been added and the range of the Resultant Setpoint has been limited by HL and LL

d) Alarm Processing

The Setpoint Block has facilities for generating Absolute or Deviation Alarms within it as follows:-

(i) Absolute Alarms

The Process Variable Parameter, PV is brought into the Setpoint Block so that it may be checked for High or Low absolute alarms via HA and LA.

(ii) Deviation Alarms

The Process Variable Parameter, PV, is used in conjunction with the Resultant Setpoint to produce a Deviation value thus:-

Deviation (ER) = PV - SP

The Deviation or Error value is then checked for High or Low deviation alarms via the HD and LD parameters.

e) Programming considerations

To simplify programming the following functions are automatically updated independently of the user program:-

(i) The SP parameter is updated depending on the operating mode, and then limited with respect to the absolute and rate limits.

(ii) The ER parameter is updated as PV - SP.

(iii) The alarm bits in the Status parameter (ST) are updated with respect to the current PV, HA, LA, HD and LD.

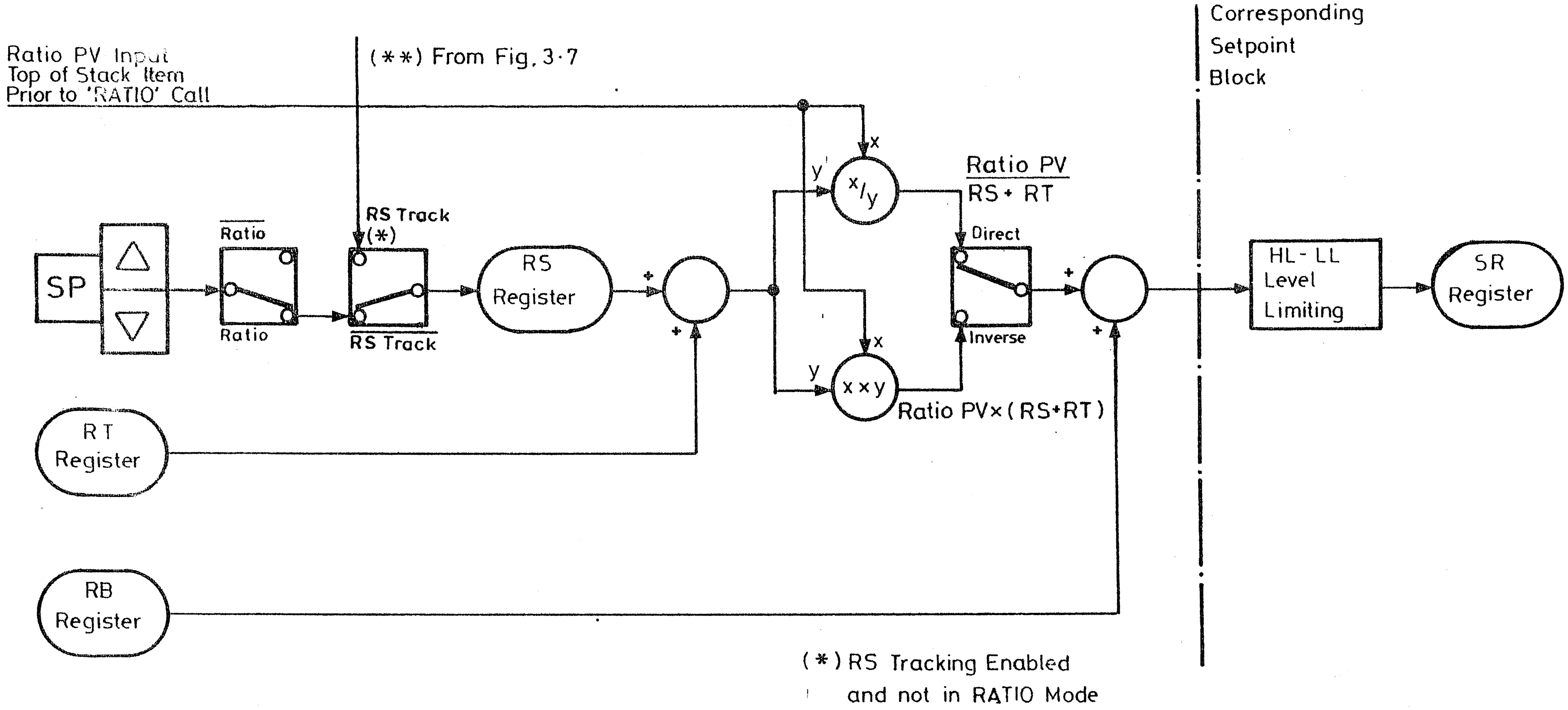
f) Error Recovery

If the 6366 Software Maintenance routines discover that a sumcheck failure has occurred in any of the parameters associated with this Block the following actions are taken:-

(i) ST bit 3 is set to logic 1 (see Section 4.10.1 d)(i)).

(ii) The RL parameter is disabled by setting its value to zero (see Section 4.10.10).

Details of the Setpoint Block parameters and how they are programmed are given in Section 4.10.



Block Type 6
Block Mnemonic – RB

Fig. 3·6 Ratio Block Operation

3.3.7 Ratio Block - RB (type 6)

The Ratio Block (RB) is used when it is required to derive a Remote Setpoint for performing Ratio control on a Secondary Process Variable. It can be seen from Table 3.1 that there are 6 parameters associated with the Ratio Block as follows:-

ST - Block Status
HR - Ratio Setting high limit
LR - Ratio Setting low limit
RS - Ratio Setting
RT - Ratio Trim
RB - Ratio Bias

The action of the Ratio Block is shown schematically in Fig. 3.6 and is described below:-

a) Ratio Setpoint

The prime function of the Ratio Block is to generate a Ratio Setpoint to be linked in as the Remote value (SR) of an associated Setpoint Block. The Ratio Setpoint is derived from the Ratio Setting Parameter, RS, and the Ratio (Secondary) Process Variable input.

(i) Ratio setting, RS

Fig. 3.6 shows that the operation of the Ratio Block is simplified by automatically linking the Raise/Lower push-buttons to the RS parameter whenever the RATIO operating mode is enabled and Ratio Tracking is disabled. The value of RS can also be monitored and updated via either of the serial links provided Ratio Tracking is disabled.

(ii) Ratio Trim

The Ratio Setting can be trimmed by the simple addition of the value specified in the RT parameter.

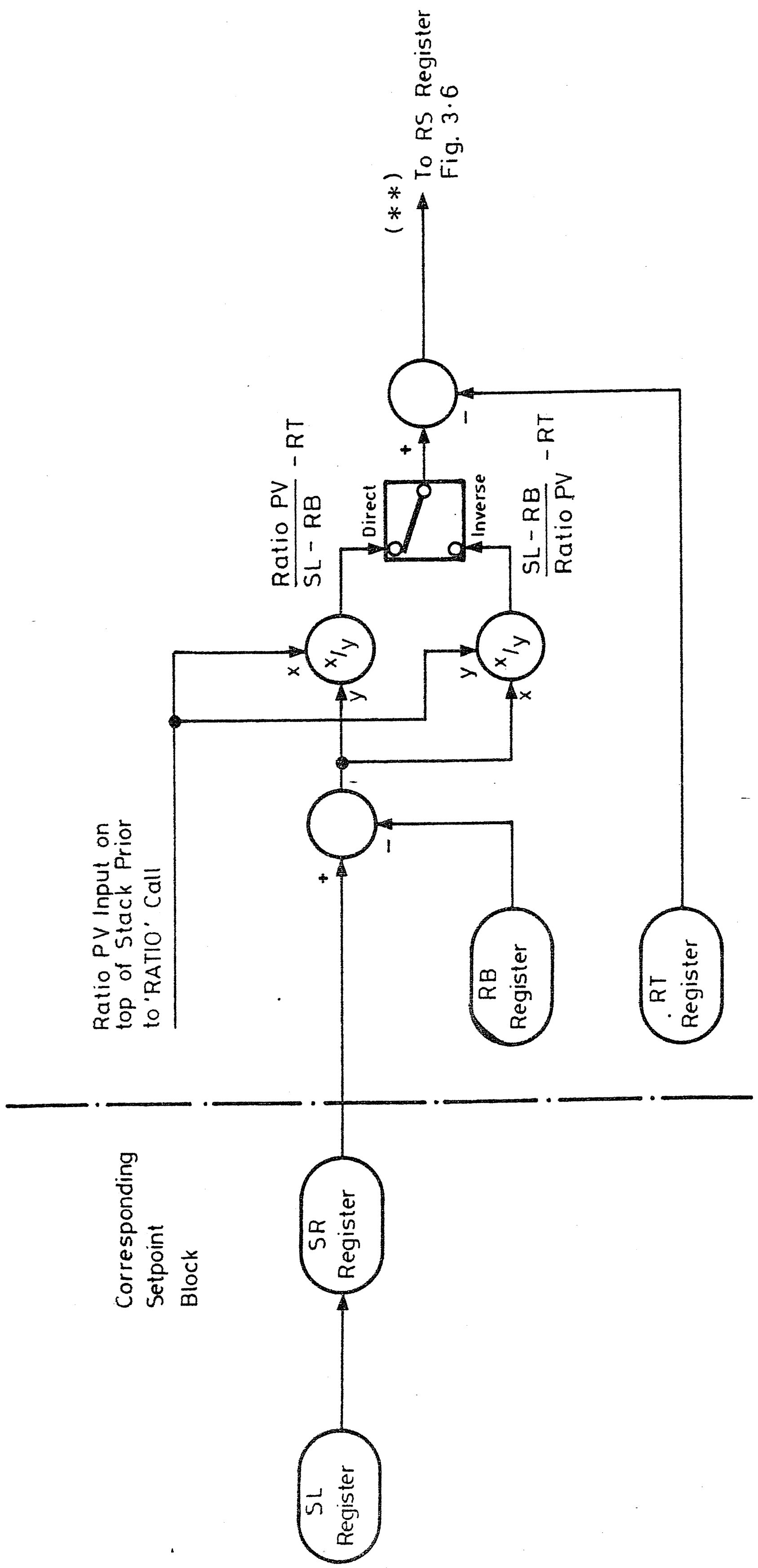


Fig. 3·7 Derivation of RS Value when Tracking Enabled

(iii) Ratio Calculations

After Ratio Trim has been applied Fig. 3.6 shows that the Ratio Setpoint is generated by one of two means depending upon whether Direct or Inverse Ratio Operation has been specified, thus:-

Direct Ratio mode

In this case:-

$$\text{RATIO SETPOINT} = \frac{\text{RATIO PROCESS VARIABLE}}{\text{RATIO SETTING (RS) + RATIO TRIM (RT)}}$$

where the Ratio or Secondary Process Variable is the value at the top of the stack prior to the RATIO word being called by the User Program.

Inverse Ratio mode

In this case:-

$$\text{RATIO SETPOINT} = \text{RATIO PROCESS VARIABLE(RS + RT)}$$

(iv) Ratio Bias, RB

Finally, Fig. 3.6 shows that a Ratio Bias term as specified by the RB parameter can be added to the Ratio calculations of (iii) above before the Ratio Setpoint is linked to the SR parameter of the associated Setpoint Block, thus:-

Direct Ratio mode

In this case:-

$$\text{RESULTANT RATIO SETPOINT (SR)} = \frac{\text{RATIO PV}}{\text{RS + RT}} + \text{RB}$$

Inverse Ratio mode

In this case:-

$$\text{RESULTANT RATIO SETPOINT (SR)} = \text{RATIO PV(RS + RT) + RB}$$

b) Ratio Tracking mode

Bit 10 of the ST status parameter can be used to initiate RS parameter tracking when the RATIO mode has been configured but it is not actually enabled. The effect of RS tracking is to 'back calculate' the value of RS such that the Ratio Setpoint that would be produced, SR, is the same as the existing Local Setpoint, SL, value within the Setpoint Block. This ensures that there is no bumping of the Local Setpoint when the RATIO mode is subsequently enabled. Fig. 3.6 shows that in the RS Tracking mode the RS register is forced to follow the value derived in Fig. 3.7 indicated by (**). This shows that the Remote Setpoint value SR first tracks the Local Setpoint value SL within the associated Setpoint Block. Two calculations for the RS tracking value are then used depending upon whether direct or inverse operation has been selected as follows:-

(i) Direct Ratio mode

In this case the Ratio Setting tracks the following value:-

$$RS' = \frac{RATIO\ PV}{SR - RB} - RT \text{ ; and } SL = SR$$

(ii) Inverse Ratio mode

In this case the expression for the Ratio Setting tracking value is as follows:-

$$RS' = \frac{SR - RB}{RATIO\ PV} - RT \text{ ; and } SL = SR$$

c) Error Recovery

If the 6366 Software Maintenance routines discover that a sumcheck failure has occurred in any of the parameters associated with this Block the following action is taken:-

(i) ST bit 3 is set to logic 1 (see Section 4.11.1 d) (i)).

Details of the Ratio Block parameters and how they are programmed are given in Section 4.11.

3.3.8 PID Control Block - 3T (type 7)

The PID Control Block (3T) is used when it is required to apply 3-term, closed-loop control. It can be seen from Table 3.1 that there are 8 parameters associated with the PID Control Block as follows:-

ST - Block Status
XP - Proportional Band constant
TI - Integral time constant
TD - Derivative time constant
FF - Feed-forward term
FB - Feed-back term
OP - PID Output
TS - Algorithm sampling period

The action of the PID Control Block is shown schematically in Fig. 3.8 and is described below:-

a) 3-Term algorithm

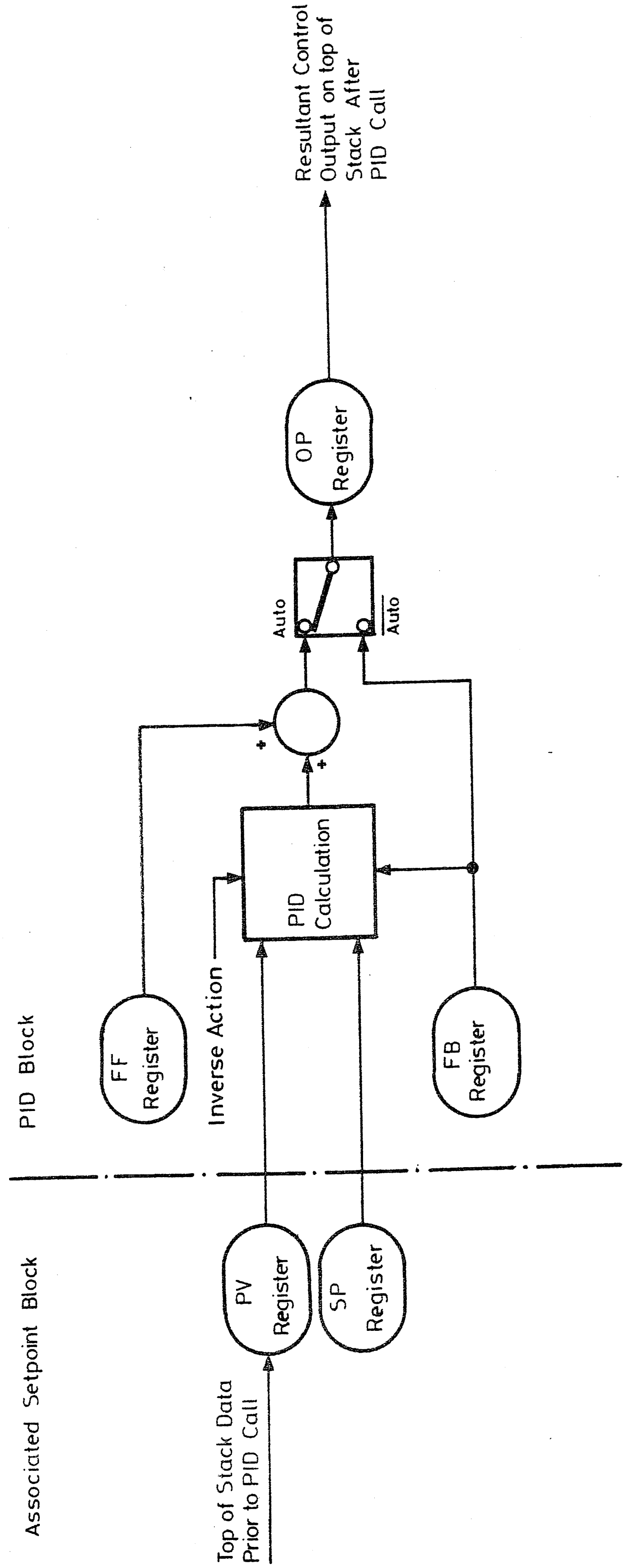
Fig. 3.8 shows that the Process Variable (PV) and Setpoint (SP) are fed into the PID Control Block where they are used to form an Error term, ER. The Error term is then used by the PID calculation in conjunction with the 3-Term constants to generate the appropriate 3-Term output.

In microprocessor-based Controllers like the 6366 it is necessary to use sampling techniques for the calculation of the various terms of the control equation. It is also convenient to write the transfer function in terms of difference equations. Thus the 3-Term calculated output after n samples is given by:-

$$OPn = \frac{-100}{XP}\left[ERn + \frac{TS}{TI}\sum_{1}^{n} ERr + \frac{TD \Delta PV}{TS}\right] + FF$$

where:-

OP = Controller Output after n samples
TS = Algorithm sampling period
XP = Proportional band
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
FF = Feed-forward term



Block Type 7

Block Mnemonic – 3T

Fig. 3·8 PID Control Block Operation

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

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

where:- dN = PVn - PVn-1

b) Feed-forward term

The Feed-forward term offset, FF, is apparent at zero error under proportional-only control action with the integral term disabled by setting TI = 0. This allows the output to respond to both positive and negative errors so that the operating point about which stability occurs may be adjusted.

c) Integral de-saturation and the FB parameter

The technique used within the PID Control Block for detecting when the PID Output has reached saturation is different from instruments like the 6350/60 Controllers. The PID output value is usually linked to a Manual Station Block so that Output or Rate limits can be applied (see Section 3.3.9). The resultant limited output then has to be linked back to the PID calculation via the Feed-back parameter, FB. By comparing the value of FB with the PID Output, OP, the conditions of high or low output limiting can be detected. The PID calculation can then implement the appropriate form of integral de-saturation.

d) Other facilities

The other main facilities of the PID Control Block are illustrated in Fig. 3.8 and are as follows:-

(i) Inverse 3-Term action

Bit 7 of the ST status parameter is used to select whether the output of the PID Block, OP, is in the Normal or Inverse operating mode. (see Section 4.12.1 c) (i)).

(ii) Integral balance

Bit 6 of the ST status parameter is used to force the CPU to perform an Integral balance next time the PID Control Block is scheduled.

(iii) Output track when not in AUTO

Fig. 3.8 shows that the PID output, OP tracks the Feed-back parameter, FB whenever the control loop is not in AUTO e.g. when it is in MANUAL. This ensures that the output does not reach a limit and that subsequent return to the AUTO operating mode occurs in a bumpless manner.

e) Programming considerations

The user calls the PID function at regular intervals by including the routine in one of the time scheduled programs L1 or L2. To ensure that PID is calculated at realistic intervals, the PID algorithm updates the program repeat timer as a function of the time constants, and the program computation time. This means that only one PID loop can be active in each of the time scheduled programs.

f) Error Recovery

If the 6366 Software Maintenance routines discover that a sumcheck failure has occurred on any of the parameters associated with this Block the following action is taken:-

(i) ST bit 3 is set to logic 1 (see Section 4.12.1 d) (i)).

Details of the PID Control Block parameters and how they are programmed are given in Section 4.12.

3.3.9 Manual Output Station Block - MS (type 8)

The Manual Output Station Block allows a user to vary a control loop output when the loop is in MANUAL mode. It also allows the output to be varied automatically by an associated PID Block in AUTO mode, or to be set into the HOLD or TRACK modes if required. Table 3.1 shows that there are 8 parameters associated with the Manual Output Station Block as follows:-

ST - Block Status
HV - High velocity/Rate limit
LV - Low velocity/Rate limit
HL - High Output limit
LL - Low Output limit
AO - Analogue Output
OP - Output demand
OT - Output tracking value

The action of the Manual Output Station Block is shown schematically in Fig. 3.9 and is described below:-

a) Output demand, OP

The OP parameter represents the demanded output level fed into the Manual Output Station Block after limiting by the Output limiting parameters HL and LL. The value of OP is varied from different sources depending upon the control loop operating mode as follows:-

(i) TRACK mode

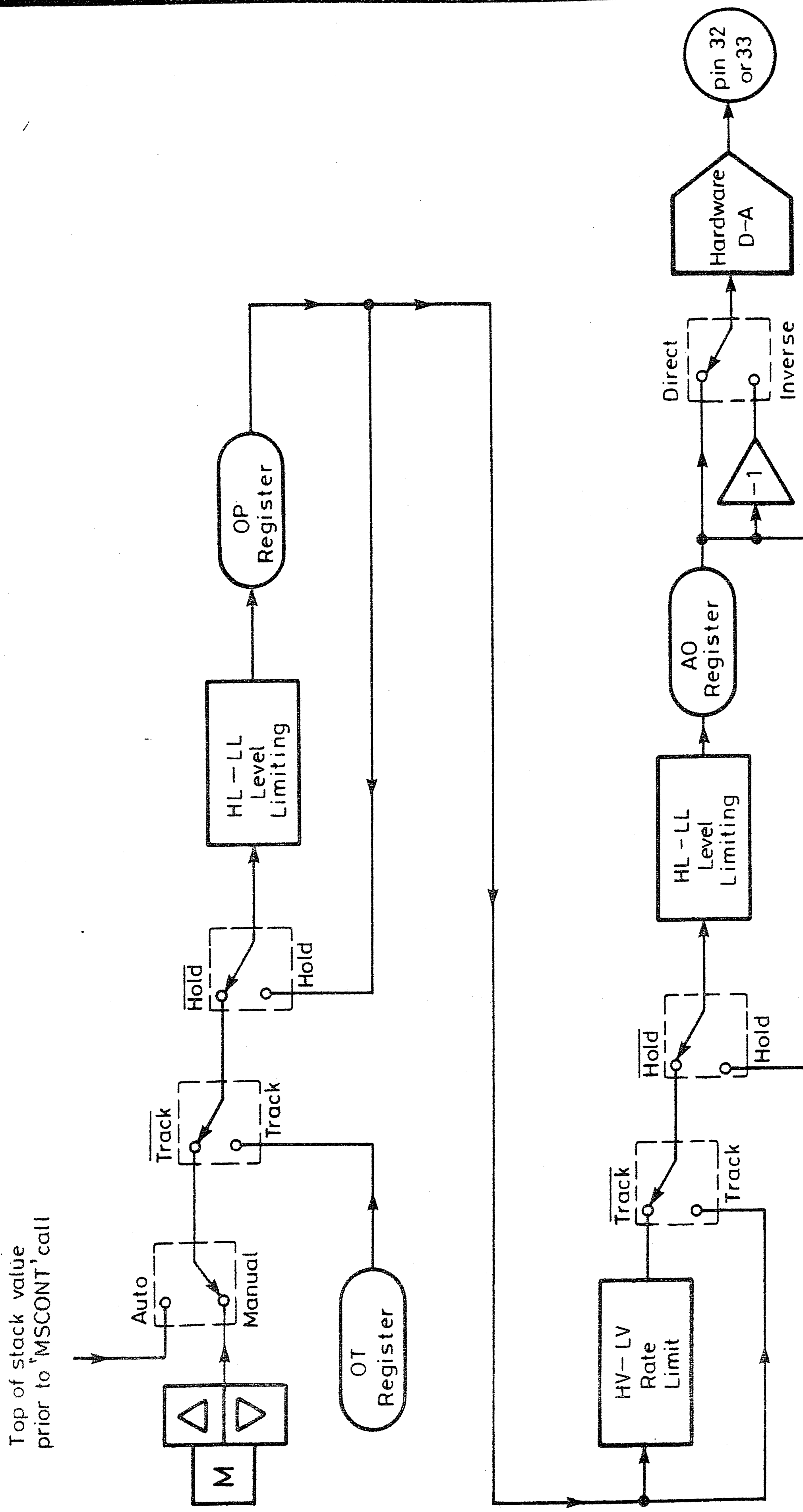
In the TRACK mode OP is updated from the Output Tracking value OT.

(ii) MANUAL mode

In the MANUAL mode the value of OP can be varied by the Raise/Lower buttons or either of the serial data links.

(iii) AUTO, REMOTE or RATIO mode

In any of these operating modes the value of OP is supplied from another Functional Block such as the output, OP, of the PID Control Block of Section 3.3.8.



Block Type 8
Block Mnemonic - MS
Fig 3.9 Manual Output Station Block Operation

b) Analogue Output, AO

Fig. 3.9 shows that the AO parameter represents the resultant output value produced by the Manual Output Station Block. AO is effectively updated from OP after initial limiting by the Velocity/Rate limit parameters HV and LV except in the TRACK mode. It is then further restricted by the Output Limiting parameters HL and LL before being linked to the Master Station 1 or 2 outputs of pins 32 and 33 respectively. The AO value would also be fed back to the associated PID Block to facilitate output saturation detection.

c) Inverse Output mode selection

Bit 7 of the ST parameter indicates whether Normal or Inverse Output mode has been selected by either S2 number 7 or 8 as described in Section 4.13.1 b) (i). When the Inverse Output mode has been selected the analogue output voltage moves from 10 to 0 volts as the OP value moves from 0 to 100%.

d) Programming considerations

Various connections are provided automatically including the linking of the change over and display mechanisms to the appropriate Display and Control Block (see Section 3.3.10). To simplify programming, the following functions are automatically updated independently of the user program:-

(i) The OP parameter is updated depending on the operating mode.

(ii) The AO parameter is updated from the OP parameter and is then limited with respect to the absolute and Velocity/Rate limits.

It should be noted that in the AUTO, REMOTE or RATIO modes the value fed into OP is the value on top of the stack when the MSCONT word is executed.

e) <u>Error recovery</u>

If the 6366 Software Maintenance routines discover that a sumcheck failure has occurred on any of the parameters associated with this Block the following actions are taken:-

(i) ST bit 3 is set to logic 1 (see Section 4.13.1 c) (i)).

(ii) HV is disabled by setting to 00.00%.

(iii) LV is disabled by setting to 00.00%.

(iv) HL is set to the maximum of 99.99%.

(v) LL is set to the minimum of 00.00%.

(vi) OP is adjusted to give an analogue output of 0 Volts.

Details of the Manual Output Station Block parameters and how they are programmed are given in Section 4.13.

3.3.10 Display and Control Status Block - DC (type 9)

The Display and Control Status Block allows a user to specify the data that is presented on each of the four front panel displays. This block also contains information concerning the status of a control loop and the front panel push-button mask. Table 3.1 shows that there are 7 parameters associated with the Display and Control Status Block as follows:-

ST - Block Status
1B - Bargraph 1 data source
2B - Bargraph 2 data source
3B - Bargraph 3 data source
DD - Digital display data source
ES - Enable status word
SM - Front-panel switch mask

The action of the Display and Control Status Block is shown schematically in Fig. 3.10 and is described below.

a) Display Data Sources

The source of data for the 3 bargraph displays and the digital readout are defined by the 1B, 2B, 3B and DD parameters respectively. The horizontal bargraph and the digital readout are not solely defined by 3B and DD respectively. However, they also depend on which front-panel push buttons are being pressed, and the control loop operating mode as shown by Table 3.4.

A bit within each of the display parameters allows the corresponding display to flash or remain steady.

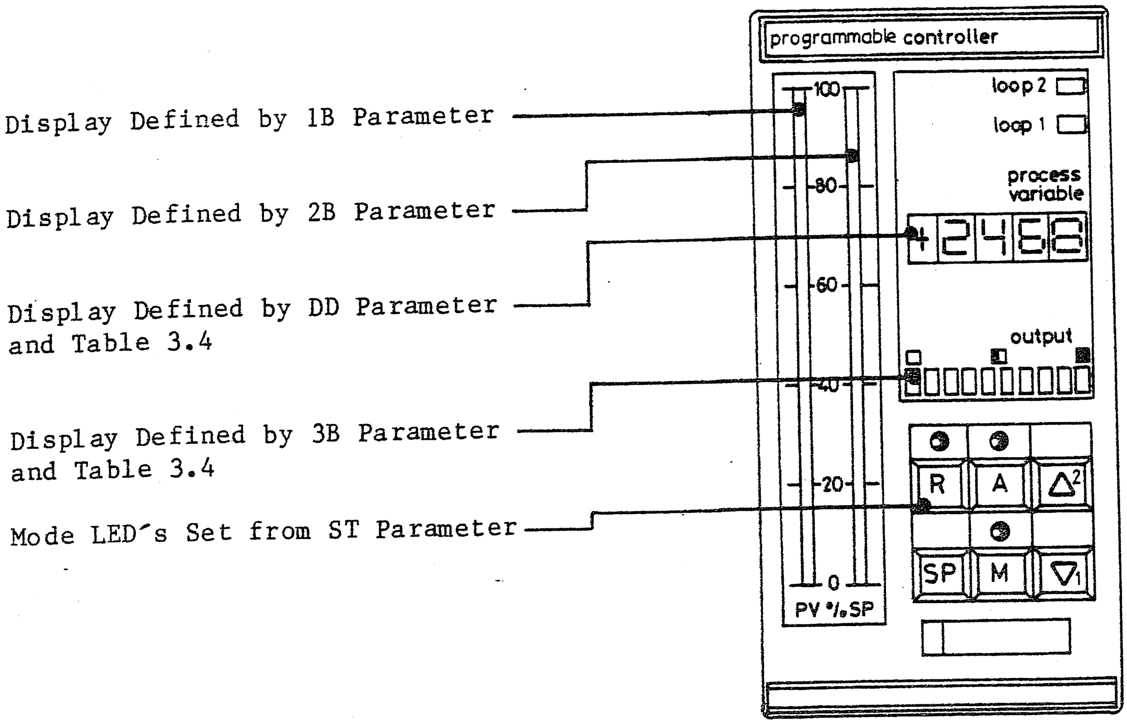
b) Control loop operating mode

The operating mode of each of the control loops contained within the 6366 can be selected by means of the Enable Status word parameter, ES. The least-significant 8 bits of the ES parameter are used to select any of the following possible operating modes:-

HOLD
TRACK
MANUAL
AUTO (Local Setpoint)
RATIO
REMOTE AUTO (Cascade)
FORCED MANUAL

One of the bits is used to enable REMOTE/RATIO setpoint operation, and the most-significant 8 bits are used as mask bits.

The Operating mode is also reflected in the Block Status word parameter, ST, and these operating modes can also be selected by writing to the appropriate bits within this parameter.



Block Type 9

Block Mnemonic DC

FIG. 3.10 Display and Control Status Block Operation

c) Push-button masking

The three front-panel control mode push-buttons, Remote (R), Auto (A), and Manual (M) can be masked out by means of the Front-panel switch mask parameter, SM. Any combination of buttons can be inhibited from operation including all 3 or none. The Raise/Lower and Setpoint (SP) buttons are not affected by this parameter.

d) Error Recovery

If the 6366 Maintenance routines discover a sumcheck failure on any of the parameters associated with this Block the following action is taken:-

(i) ST bit 3 is set to logic 1 (see Section 4.14.1 b) (i)).

Details of the Display and Control Status Block parameters and how they are programmed are given in Section 4.14.

Buttons Pressed		Ratio Mode	Digital Display	Horizontal Bars Display
SP	M or A or R			
0	0	X	User defined in DD	User defined in 3B
1	X	0	Setpoint Block SL	User defined in 3B
1	X	1	Ratio Block RS Data	User defined in 3B
0	1	X	User defined in DD	Manual Station OP Data

TABLE 3.4 Relationship Between Display and Push-Button Status

KEY

0 = False or no Button pressed

1 = True or Button pressed

X = Don't care

3.3.11 Alarm Block - AB (type 10)

The Alarm Block is used to detect if a parameter value exceeds pre-defined limits. Table 3.1 shows that there are 8 parameters associated with the Alarm Block as follows:-

ST - Block Status
HV - High value alarm limit
LV - Low value alarm limit
HL - High alarm limit
LL - Low alarm limit
PV - Alarm Process Variable
SP - Alarm Setpoint
AH - Alarm hysterisis

The action of the Alarm Block is shown schematically in Fig. 3.11 and is described below:-

a) Alarm types

The two least-significant bits of the ST parameter select whether the alarms are absolute, deviation, rate/velocity, or disabled.

b) Alarm Parameters

The Alarm Block has 2 separate High Alarm parameters, HV and HL, and 2 Low Alarm parameters, LV and LL. These are completely separate and may be used for HI/EXTRA HI and LO/EXTRA LO alarm strategies as each parameter sets a separate bit in the ST status word when the corresponding alarm condition occurs.

c) Alarm Processing

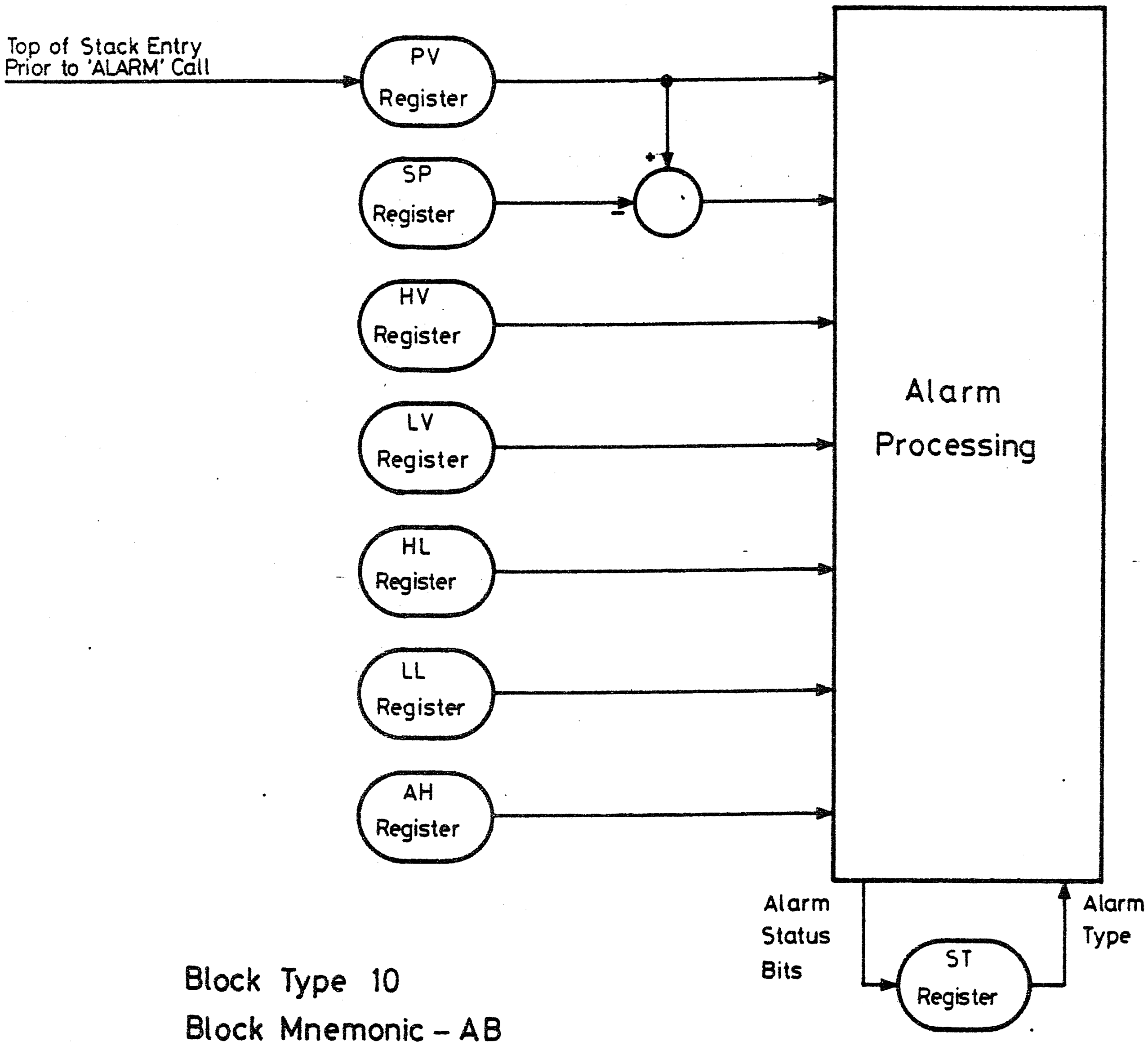
The alarm Process Variable, PV, is linked into the Alarm Block from other Functional Blocks such as the Analogue Input Block in order to generate the various alarm conditions. When deviation alarms are required the alarm Setpoint parameter, SP, is used to generate an Error value (ER = PV - SP) so that this may be checked against the High and Low alarm settings. The Alarm hysterisis parameter, AH, may be programmed to set up the dead-band that is used for clearing the alarm when it re-enters the 'safe area'.

d) Error Recovery

If the 6366 Maintenance routines discover a sumcheck failure has occurred on any of the parameters associated with this Block the following action is taken:-

(i) ST bit 3 is set to logic 1 (see Section 4.15.1 d) (i)).

Details of the Alarm Block parameters and how they are programmed are given in Section 4.15.



Block Type 10

Block Mnemonic – AB

Fig. 3·11 Alarm Block Operation

3.3.12 Constants Block - CB (type 11)

The Constants Block is provided to allow users some interaction with a User Program from an 8260 Hand-held terminal or Supervisory Computer system. Table 3.1 shows that there are 6 parameters associated with the Constants Block as follows:-

ST - Block Status
1K - Constant 1
2K - Constant 2
3K - Constant 3
4K - Constant 4
US - User status word

The features of the Constants Block are described below:-

a) Constants

The four constants parameters 1K, 2K, 3K and 4K can all span the range -9999 to +9999 with their decimal point positions programmed via digits A, B, C and D of the ST parameter respectively. These parameters may be accessed by a User Program and can also be read or updated via the Hand-held terminal or RS 422 data link.

b) User status word

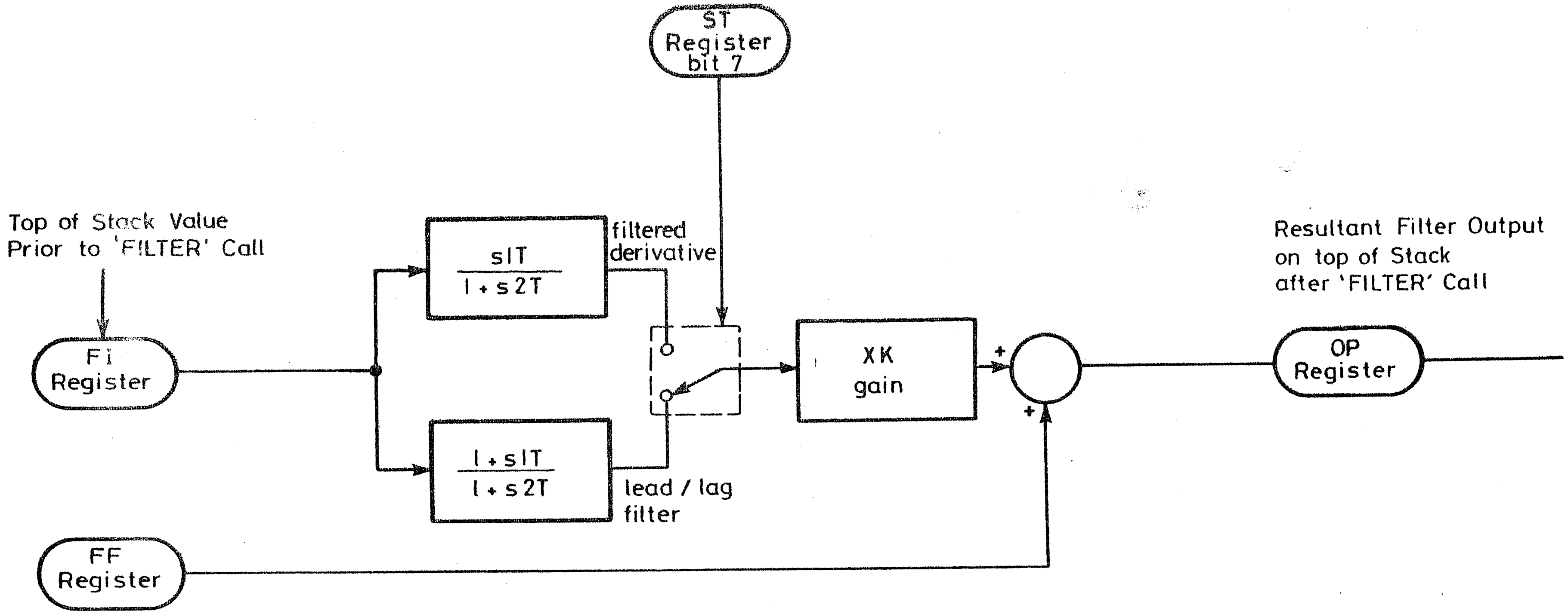
The User Status word, US, contains 8 user flag bits in the lower byte with 8 corresponding mask bits in the upper byte. Each flag bit may be set or cleared via a User Program or either of the serial links, and the flag may only be changed when the corresponding mask bit is set to logic 0.

c) Error Recovery

If the 6366 maintenance routines discover that a sumcheck failure has occurred on any of the parameters associated with this Block the following action is taken:-

(i) ST bit 3 is set to logic 1 (see Section 4.16.1 b) (i)).

Details of the Constants Block parameters and how they are programmed are given in Section 4.16.



Block Type 12
Block Mnemonic-FB

Fig 3·12 Filter Block Operation

3.3.13 Filter Block - FB (type 12)

The Filter Block provides a lead/lag filter for use in feed-forward computations or for setting up plant models. Table 3.1 shows that there are 7 parameters associated with the Filter Block as follows:-

ST - Block Status
XK - Filter gain
1T - Lead Time constant
2T - Lag Time constant
FF - Feed-forward/Output bias
FI - Filter input
OP - Filter output

The action of the Filter Block is shown schematically in Fig. 3.12 and is described below:-

a) Filter characteristics

The characteristics of the Filter Block correspond to the following equation:-

$$\frac{\text{Filter Output (OP)}}{\text{Filter Input (FI)}} = XK \frac{[1+s1T]}{1+s2T} + FF$$

where:-

- XK defines the overall gain of the filter;
- 1T and 2T are the lead and lag time constants respectively and may be set either in seconds or minutes;
- FF defines the value of bias that is added to the filter equation before it is transferred to the Filter Output, OP.

b) Filter initialisation

Initialisation removes the filter effect by setting the Output parameter (OP) directly to the steady-state value, i.e. 1 for a lead/lag filter and 0 for filtered derivative. This is achieved by setting the Initialise flag bit in the ST status word.

c) Filtered derivative

In normal operation a conventional lead/lag filter is implemented as characterised by the equation given in Section 3.3.13 a) above. However, if the filtered derivative select bit of the ST parameter is set the DC gain becomes 0 and a filtered derivative characteristic is obtained thus:-

$$\frac{OP}{FI} = XK \frac{s1T}{1+s2T} + FF$$

d) Filter timing

The user calls the filter routine at regular intervals using the FILTER word in the fixed directory. Precise timing is not important as the filter block uses its own timers to monitor the frequency of the call.

It should be noted that FI and OP are only updated when the FILTER word is called and this also applies to initialisation. Thus, if the initialise bit is set in the ST status word, then the next time FILTER is called the new FI value is transferred to the OP, and the initialise bit is reset.

e) Error Recovery

If the 6366 Maintenance routines discover that a sumcheck failure has occurred on any of the parameters associated with this Block the following action is taken:-

(i) ST Bit 3 is set to logic 1 (see Section 4.17.1 c) (i)).

Details of the Filter Block parameters and how they are programmed are given in Section 4.17.

3.3.14 Delay Block - DB (type 13)

The Delay Block is used to implement a pure time delay within a User Program. Table 3.1 shows that there are 2 parameters associated with the Delay Block:-

ST - Block Status
DT - Maximum delay time

The features of the Delay Block are described below:-

a) Delay Block function

The Delay Block allows the User to set the maximum delay required by means of the DT parameter which will accept any time up to a maximum of 9999 seconds (approximately 2.7 hours). The Delay Block allows data to be monitored at any time up to this maximum.

b) Delay implementation

The Delay Block uses a buffer of 80 points which is divided into equal time segments, again defined by DT. The user puts data into the delay buffer at regular intervals using the SETDEL word in the fixed dictionary. Precise timing is not important as the Delay Block uses its own timers to monitor the frequency of the call.

Whenever SETDEL is called the input data is passed through a first order digital filter with a time constant of DT/80 seconds. If at this call the Delay Buffer should be updated, a new value will be put into the head of the buffer.

Data from the Delay Block is recalled using the GETDEL word. The user supplies a time (up to the maximum defined in DT), and the data for this point is returned on the stack. Where the required data point lies between two points in the buffer, the result is estimated by linear interpolation between the two points.

c) Delay initialisation

The Delay Buffer can be re-initialised by setting all elements equal to the current input. This is achieved by setting the initialise flag in the status word to 1, or whenever the value in DT is altered.

d) Delay timing

The Delay Block buffers are only updated when the SETDEL word is called. This also applies to the initialisation, thus if the initialise bit is set in the status word, then the next time SETDEL is called the delay buffer is reset and the initialise bit is reset to 0.

e) <u>Error recovery</u>

If the 6366 Maintenance routines discover that a sumcheck failure has occurred on any of the parameters associated with this Block the following action is taken:-

(i) ST bit 3 is set to logic 1 (see Section 4.18.1 c) (i)).

Details of the Delay Block parameters and how they are programmed are given in Section 4.18.

3.3.15 Totalisation Block - TB (type 14)

The totalisation Block is used to totalise a variable within a User Program. Table 3.1 shows that there are 3 parameters associated with the Totalisation Block:-

ST - Block Status
FS - Flow Scaling factor
FT - Flow Total

The features of the Totalisation Block are described below:-

a) Totalisation Block Function

The Totalisation Block is used in conjunction with the TOTAL word in the fixed dictionary and the user would totalise a flow by calling the word at regular intervals with the current Flow signal. The units of totalisation can be selected as seconds, minutes, hours or days via the ST status parameter.

b) Totalisation implementation

The TOTAL word returns a flag to indicate when the Flow Total parameter (FT) has been incremented, and this allows the result to be used to pulse a digital output.

The routine holds an internal Intermediate Flow Total. Each time the routine is called this total is increased by the:-

[Flow Signal] *dT

- where dT is the time since the routine was last called.

Whenever the Intermediate Flow Total is greater than the Flow Scaling parameter (FS), the Flow Total is incremented and the intermediate total is modified to compensate.

It should be noted that the Flow Total can only be incremented by one each time the TOTAL word is called. If the Flow Total should have increased by more than one, then further increments are made the next time the TOTAL word is called. However, this type of result would indicate that the routine was not called regularly enough, or that the Flow Scaling factor was too small.

c) Totalisation Initialisation

Initialisation is carried out by setting the Intermediate Flow Total value to zero. This is done by setting the initialise bit in the ST status parameter to logic 1 and this is automatically reset to logic 0 when the TOTAL word is next called by the User Program.

d) Total Roll-over

In the course of normal operation the Flow Total parameter, FT, is periodically cleared, e.g. at the end of the day or working shift etc. Should the total be left to reach 9999 it will automatically 'Roll-over' through zero and totalisation will continue uninterrupted. Whenever this condition occurs the Total Roll-over bit is set in the ST status parameter.

e) Error Recovery

If the 6366 Maintenance Routines discover a sumcheck failure has occurred on any of the parameters associated with this Block the following actions are taken:-

(i) ST bit 3 is set to logic 1 (see Section 4.19.1 d) (i)).

(ii) The Intermediate flow Total value is reset to zero as for initialisation.

It should be noted that the initialisation as in (ii) above is also carried out if the TOTAL word has not been called for approximately 2 minutes.

Details of the Totalisation Block parameters and how they are programmed are given in Section 4.19.

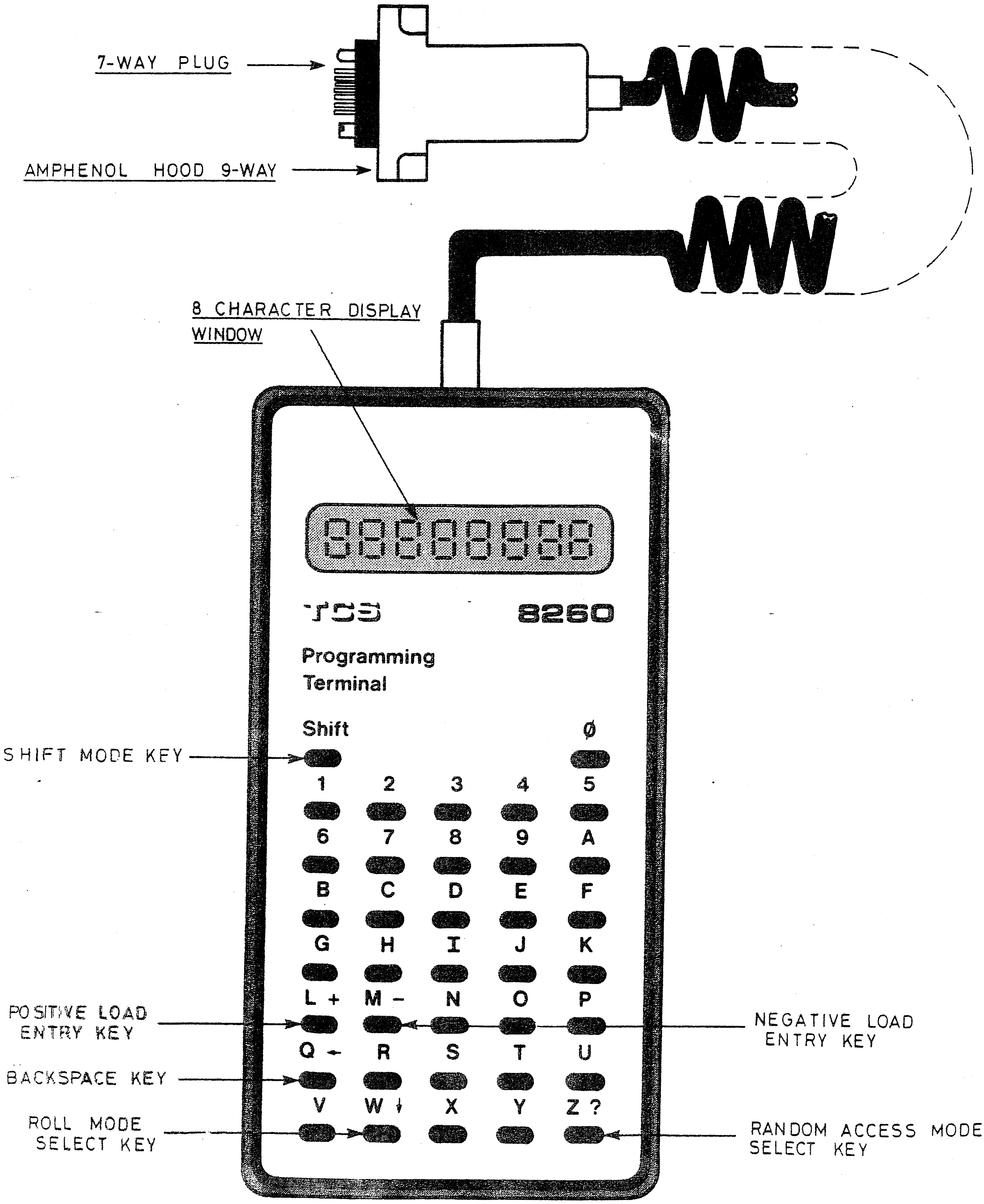


FIG 4.1 HAND-HELD TERMINAL KEYBOARD LAYOUT

Section 4 PROGRAMMING THE 6366 PROGRAMMABLE ADVANCED CONTROLLER

It has already been mentioned in Section 3.2.2 that there are three levels of user access to the 6366 and that the 8260 Hand-held terminal is quite suitable for programming at the first two levels. Consequently, Sections 4.1 to 4.4 inclusive deal with the use of the 8260 in programming the 6366. Sections 4.5 to 4.19 inclusive are devoted to giving details of the formats and structure of the command parameters associated with each of the Functional Blocks of Sections 3.3.1 to 3.3.15 inclusive. Level three programming of the 6366 is outlined briefly in Section 6 but for a detailed description of programming in FORTH reference should be made to the Programmable Instruments Programming Manual.

4.1 8260 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 6366 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 1.5.16 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.

LIMITED COMMAND MNEMONIC	FULL MNEMONIC			PARAMETER FUNCTION	PARAMETER TYPE
	BT	LN [BN]	CMD		
FX (1)	-	-	-	Fix data base	Hand-held Terminal control
LT (1)	-	-	-	LED test	
LN (1)	-	-	-	Loop Number	
II	GP	[1]	II	Instrument Identity	Status Words
DP	SP	1-2	ST	Decimal points and alarms	
PH	SP	1-2	HR	Setpoint high range	Setpoint ranging
PL	SP	1-2	LR	Setpoint low range	
HR (2)	RB	1-2	HR	Ratio Setting high limit	Limit and alarm settings
LR (2)	RB	1-2	LR	Ratio Setting low limit	
HS	SP	1-2	HL	Setpoint high limit	
LS	SP	1-2	LL	Setpoint low limit	
HA	SP	1-2	HA	High absolute alarm limit	
LA	SP	1-2	LA	Low absolute alarm limit	
HD	SP	1-2	HD	High deviation alarm limit	
LD	SP	1-2	LD	Low deviation alarm limit	
HO	MS	1-2	HL	High Output limit	
LO	MS	1-2	LL	Low Output limit	
XP	3T	1-2	XP	Proportional Band constant	PID algorithm parameters
TI	3T	1-2	TI	Integral Time constant	
TD	3T	1-2	TD	Derivative Time constant	
FF	3T	1-2	FF	Feed-forward term	
SL	SP	1-2	SL	Local Setpoint	Setpoint related parameters
RS (2)	RB	1-2	RS	Ratio Setting	
RB (2)	RB	1-2	RB	Ratio Bias	
OP	MS	1-2	OP	Output	Control values
SP	SP	1-2	SP	Resultant Internal Setpt.	
PV	SP	1-2	PV	Process Variable	
SW	GP	[1]	SW	Switch settings	Status words
DI	DI	[1]	DS	Digital inputs	
DO	DO	[1]	DS	Digital outputs	
MN	DC	1-2	ST	Loop operating mode	
1V	AI	[1]	AV	Analogue input 1	Analogue input values
2V	AI	[2]	AV	Analogue input 2	
3V	AI	[3]	AV	Analogue input 3	
DK	CB	1-2	ST	Dec. points for constants	User constants
1K	CB	1-2	1K	Constant 1	
2K	CB	1-2	2K	Constant 2	
3K	CB	1-2	3K	Constant 3	
4K	CB	1-2	4K	Constant 4	
US	CB	1-2	US	User status word	

TABLE 4.1 List of 6366 Parameter Functions and their respective Mnemonics in the Limited Database Access Mode

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 RS422 supervisory serial data link on the rear connector is disabled and after a delay of about 1 second, the terminal is initialised. The following message is then 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. At this stage it is possible to access data in one of two ways depending upon what response is made to this prompt:-

a) If a normal two character Command parameter is entered from the list given in Table 4.1, then a limited part of the data base can be accessed. It can be seen from this list that in this mode the 6366 is programmed very much like a fixed-function instrument such as the 6360 Process Controller.

b) If a 'space' character is entered in response to the ?? CMD prompt the Hand-held Terminal goes into the Block Command mode. Initially the user selects one of the 15 Block types to examine by entering the appropriate two character Block mnemonic from the list of Table 4.3. Then all the parameters associated with that block can be examined in the usual manner by entering the Command Mnemonics listed in Tables 4.4, 4.5, 4.8 to 4.15, and 4.17 to 4.21 inclusive.

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 6366 Controller via the Hand-held terminal. It is also recommended that a record of each parameter is made on a 6366 Set-up Sheet like the example shown in Appendix D. This will assist in record keeping and programming spare or replacement instruments.

Notes

The following points should be noted with respect to Table 4.1:-

(1) These parameters are only available on the 8260 Hand-held terminal.

(2) These parameters only appear in the list when the RATIO mode is selected.

When scrolling past the US parameter at the bottom of the list the Hand-held terminal will return to the LN parameter and through the list again, i.e. the FX and LT parameters can only be accessed in response to the ?? CMD prompt and will not re-appear after subsequent scrolling.

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
17	AA to ZZ	2 ASCII characters (upper case)	

TABLE 4.2 List of Command Parameter Data Formats

4.2.1 Command Parameter Formats

It can be seen from the lists of Command parameters given in Tables 4.1 and 4.4, 4.5, 4.8 to 4.15 and 4.17 to 4.21 inclusive 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 4.2.

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, 8 and 17 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 Local Setpoint (SL) is a format 1 parameter and Section 4.10.1 a) shows that its decimal point position is defined by the first digit of the 'ST' command parameter of the Setpoint Block. The ST parameter itself is a status word with a format 5 data structure.

4.2.2 Limited Data Base Access

For limited access to the 6366 data base the 8260 Hand-held terminal is first initialised as described in Section 4.2. The user then enters a 2 character command mnemonic from the extreme left-hand column of Table 4.1 in response to the ?? CMD prompt. This will then give access to the list of command parameters shown in Table 4.1. It can be seen from this table that these parameters are a subset of the full parameter list associated with each Functional Block, and that some mnemonics have been changed in the short list to avoid duplication and confusion. The fourth column from the left of Table 4.1 gives the corresponding full mnemonic for each command pre-fixed by the Functional Block type from Table 4.3.

BLOCK MNEMONIC	BLOCK TYPE	RELATIVE BLOCK NO. BN RANGE	BLOCK DESCRIPTION
GP	0	1	General purpose
AI	1	1-3	Analogue Input
AO	2	1	Analogue Output
DI	3	1	Digital Inputs
DO	4	1	Digital Outputs
SP	5	1-2	Setpoint Block
RB	6	1-2	Ratio Block
3T	7	1-2	PID control Block
MS	8	1-2	Manual Station Raise/Lower Block
DC	9	1-2	Display and Control Block
AB	A	1-2	Alarm Block
CB	B	1-2	Constants Block
FB	C	1-2	Filter Lead-Lag Block
DB	D	1-2	Delay Block
TB	E	1-2	Totalisation Block

TABLE 4.3 List of 6366 Functional Block types and their respective mnemonics

4.2.3 **Dual Loop Parameter Access**

In certain applications such as Cascade or Ratio the 6366 Controller can be programmed to contain 2 separate control loops each with it's own set of Command Parameters. In this case Table 4.1 shows that the following parameters are common to the instrument operation and appear in the list for each loop:-

FX, LT, LN, II, SW, DI, DO, 1V, 2V, 3V

However, all the other parameters are associated with either loop 1 or loop 2 and are set up separately to characterise each loop individually. The means of accessing the loop 1 or loop 2 parameters 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 either of the Loop Command Parameter lists by typing in:-

LN - in place of the question marks

c) The CPU will now respond with the current Loop number corresponding to the front-panel loop 1/loop 2 display LED's in the following format:-

LN D where:-

D is the current Loop number 1 or 2

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 Loop 1/Loop 2 display LED's will always show the currently selected Loop number.

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

LN D´ where:-

D´ is the new Loop number 1 or 2

f) Upon receipt of this digit the CPU will clear the display and check that the required Loop number has been entered as 1 or 2.

g) If this condition is valid the 6366 will go to the required loop and display it on the Front-panel Loop 1/Loop 2 LED. It will also echo the loop number on the 8260 Terminal display as:-

LN D′

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

h) If the condition of f) above is not met then the 6366 will not allow the other loop to be accessed and the original loop selected will remain up on the Front-panel Loop 1/Loop 2 LED. 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 either of the lists 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 re-appears 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.

4.2.4 **Block Command Mode**

For full access to the 6366 data base via the 8260 Hand-held terminal it is first necessary to enter the Block Command Mode described at the beginning of Section 4.2. The features of the Block Command mode are described below:-

a) Block Command Mode Entry Procedures

The procedure for entering Block Command mode from the normal limited data base access mode of Section 4.2.2 is given in the following steps:-

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

?? CMD

(ii) Instead of entering a 2 character command mnemonic in place of the question marks, enter a 'space' character. This is not marked on the standard 8260 keyboard layout of Fig. 4.1 as it is a 'shift mode' character and can be generated by entering the following two key sequence:-

[SHIFT] [Z]

Additional information on the shift mode is given in Section 2.4 of the System 6000 Communications Handbook.

(iii) The CPU will now respond with the Block Command mode prompt on the 8260 Terminal display:-

?? BCMD

b) Re-initialising the 8260 Terminal in Block Command Mode

While in the Block Command mode it is always possible to re-initialise the 8260 Terminal in order to obtain random access to any Functional Block command mode. This is achieved by pressing the Z key (Z?) at any time and this will cause the ?? BCMD prompt to be issued.

c) Block Command Mode Exit Procedures

The procedure for exiting Block Command mode and returning to the limited data base access mode of Section 4.2.2 is given in the following steps:-

(i) Re-initialise the 8260 Terminal as described in 4.2.4 b) above so that the CPU issues the Block Command mode prompt:-

?? BCMD

(ii) Enter the Z character (Z?) in place of the two question marks the CPU will re-issue the Block Command prompt:-

?? BCMD

(iii) Enter the 2 character a second time in place of the two question marks, the CPU will now respond with the usual operator prompt:-

?? CMD

The user has now returned to the limited data base access mode of Section 4.2.2.

d) Use of the 8270 VDU ROM Software

It is possible to use the 8270 VDU ROM software running on the BBC microcomputer to download command parameter data to the 6366. This can be done in either the limited data base access mode, or the Block Command mode.

However, if parameters are to be sent in the Block Command Mode then this mode must be entered first by sending a space character as for the 8260 Terminal described in Section 4.2.4 a). The Block Command Mode parameters can then be transmitted and the limited data base access mode can be re-entered using the same procedure as described in Section 4.2.4 c).

4.2.5 **Full Data Base Access**

Full access to every parameter of each of the different Functional Block types can be obtained by means of the Block Command mode as follows:-

a) Enter the Block Command mode by means of the procedure given in Section 4.2.4 a) so that the CPU issues the prompt:-

?? BCMD

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

BT - in place of the question marks

c) The CPU will now respond with the current Functional Block type in the following format:-

BT XY where:-

XY is the mnemonic of the current Functional Block corresponding to one of those listed in Table 4.3.

d) If the scroll mode key (W↓) is now pressed the display will access the list of command parameters associated with the currently selected Functional Block.

e) If it is required to access the command parameters of a different Functional Block, then this can be achieved by entering the required Block type mnemonic in response to the BT command of c) above, e.g:-

BT X′Y′ where:-

X′Y′ is the mnemonic of the new Functional Block taken from the list of Table 4.3.

f) Upon receipt of this mnemonic the CPU will clear the display and check that the required Block type corresponds with one of those listed in Table 4.3.

g) If the mnemonic is valid the 6366 will go to the required Functional Block and echo the Block type mnemonic on the 8260 Terminal display as:-

BT X′Y′

The new list of Functional Block parameters can now be accessed as described in d) above.

h) If the condition of f) above is not met then the 6366 will not allow that Functional Block to be accessed and the CPU will re-output the current Block Type mnemonic on the 8260 Terminal display as in c) above, thus:-

BT XY

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

(i) Re-initialise the 8260 Terminal using the procedure of Section 4.2.4 b) and enter a new Block Type, BT, mnemonic as described in b) above.

(ii) Scroll down the current list of Functional Block Command Parameters as described in d) above until the end of the list is reached and the BT command re-appears at the top of the list. Then enter a new BT mnemonic as described in e) above.

It should be noted that the BT 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 accessing a required Functional Block command parameter.

4.2.6 Relative block Number Access

The list of Functional Block types and their associated command parameters given in Table 3.1 shows that certain Functional Blocks occur more than once. This happens for 2 basic reasons:-

1) Functional Blocks like the Analogue inputs are associated with the three input channels of the 6366 and so three separate analogue input blocks are required.

2) Functional Blocks like the Setpoint or PID control Block are associated with an individual control loop. Since the 6366 can be configured for two independent control loops it follows that these blocks may occur twice in this case (see Section 4.2.3).

To allow access to all the Blocks, the second parameter of every Functional Block parameter list contains the Relative Block Parameter, BN. This parameter is very similar in operation to the Loop Number, LN, parameter when using the limited data base access mode of the Hand-held terminal. The use of the Relative Block Parameter, BN is described below:-

a) First enter the Block Command mode of the 8260 Terminal as described in Section 4.2.4 a).

b) Enter the required Functional Block parameter list by typing in the appropriate BT mnemonic as described in Section 4.2.5 b).

c) Scroll to the second entry in the parameter list by pressing the scroll mode key (W↓).

d) The CPU will now respond with the current Relative Block number in the following format:-

   BN J where:-
   J is the current Relative Block number 1, 2 or 3.

e) If the scroll mode key (W↓) is now pressed the display will access the list of Functional Block command parameters associated with the currently selected Block number.

f) If it is required to examine the command parameters of a different Block number of the same Functional Block type (e.g. AI block 2 instead of AI block 1), then this can be achieved by entering the required Relative Block number in response to the BN command of d) above, e.g.:-

   BN J´ where:-
   J´ is the new Relative Block number 1, 2 or 3

g) Upon receipt of this digit the CPU will clear the display and check that the required Relative Block number is valid for the corresponding Block type according to the list given in Table 4.3.

h) If the Relative Block number is valid the 6366 will go to the required Functional Block and echo the Block number value on the 8260 Terminal display as:-

BN J'

The new list of Functional Block parameters can now be accessed as described in e) above.

j) If the condition of g) above is not met then the 6366 will not allow that Functional Block to be accessed and the CPU will re-output the current Relative Block number on the 8260 Terminal display as in d) above, thus:-

BN J

It should be noted that all Functional Block types have a Relative Block number parameter, BN, even if they only occur once in the data base like GP, DI or DO. In these cases the BN value is always echoed back to the 8260 Terminal as a 1 whatever number is entered.

k) The above discussion shows that it is possible to access the command parameters of different relative Block numbers of the same functional Block type in one of two ways:-

(i) Re-initialise the 8260 Terminal using the procedure of Section 4.2.4 b) and enter a new Relative Block Number, BN, as described in b) above.

(ii) Scroll down the current list of Functional Block Command parameters as described in e) above until the end of the list is reached and the BT command re-appears at the top of the list. Then scroll down once more until the BN parameter appears and a new Relative Block number can be entered as described in f) above.

It should be noted that the BN 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 accessing the relative blocks of each Functional Block type.

4.3 Limited Data Base Command Parameters

It has already been mentioned in Section 4.2.2 that the programming of the 6366 can be made as straightforward as for a fixed-function instrument like the 6360. This is done by using the limited data base access method where only the shortened list of command parameters given in Table 4.1 are available on the 8260 Hand-held terminal. The first 3 of these parameters, namely FX, LT and LN, only appear in this limited access mode and so their function will be described in Sections 4.3.1 to 4.3.3 inclusive. All the remaining parameters are equivalent to parameters within the Functional Blocks of the full data base. The second and third columns from the left of Table 4.1 show which Functional Block and Relative Block number these parameters come from. While the fourth column gives the Functional Block command mnemonic equivalent of the parameter.

It should be noted that in many cases this differs from the shortened list mnemonic e.g. HS in the shortened list is equivalent to the HL parameter in the Setpoint Block (SP). Because these parameter equivalents are covered in their respective Functional Block parameter lists of Section 4.5 to 4.19 inclusive, they are not duplicated here. For cross-reference purposes, however, whenever a Functional Block parameter has a shortened list equivalent, its mnemonic is given in brackets in the appropriate parameter list of Tables 4.4, 4.5, 4.8 to 4.15 and 4.17 to 4.20 inclusive.

4.3.1 FX - Fix Data Base

It can be seen from Table 4.1 that FX is a type 17 parameter consisting of 2 ASCII characters. It is used for transferring the entire list of 6366 Command Parameters between the EEPROM and the non-volatile RAM area of the memory as follows:-

a) Transfer from RAM to EEPROM

Once the Parameter Data base has been fully configured it is desirable to make a copy of it in EEPROM. This can be used to quickly reload the RAM in case of memory corruption, or it can represent a standard set of parameters to be used in a fall-back or shut-down situation. The procedure for 'fixing' the data base is given below:-

(i) Initialise the Hand-held terminal as described in Section 4.2 so that it is in the Limited Data Base access mode of Section 4.2.2. This should result in the usual operator prompt:-

?? CMD

(ii) Enter the Fix data base mode by typing in

FX - in place of the question marks.

(iii) The CPU will now respond with the last message echoed by the FX parameter in the following format.

FX JK - where
JK was the last message (i.e. OK, ER or RE)

(iv) To fix the data base into EEPROM type in SA in place of the last message followed by the positive load character (L+), i.e.:-

FX SA (L+)

(v) The CPU will clear the Terminal display and start to transfer the Parameter Data base from RAM to the EEPROM. This takes about 2 seconds during which time the 2 time scheduled program and the Background program are suspended. This means that the Input/output channels are not scanned or updated and the front panel displays are ´frozen´.

(vi) After this 2 second period if the transfer has been successful the 6366 operation is resumed and the following message is echoed to the terminal:-

FX OK

(vii) If the transfer has not been successful the following message is displayed.

FX ER

In this case the entire procedure should be repeated and if it is still not successful then SW2 on the Memory Board should be checked to ensure that it is in the EEPROM Write Enable position (see Section 2.3.1 b)).

b) <u>Transfer from EEPROM to RAM</u>

Once the EEPROM has been loaded with a copy of the Parameter data base as described above it can be re-loaded back into RAM at any time by using the following procedure:-

(i) Initialise the Hand-held terminal as before to obtain the usual Operator prompt:-

?? CMD

(ii) Enter the Fix data base mode by typing in

FX in place of the question marks.

(iii) The CPU will now respond with the last message echoed by the FX parameters in the following format:-

FX JK - where:-

JK uses the last message (i.e. OK, ER or RE)

(iv) To reload the data base into RAM type in RE in place of the last message followed by the positive load character (L+), i.e.:-

FX RE (L+)

(v) The CPU will clear the Terminal display and transfer the Parameter Data base from EEPROM to RAM. This process is very fast and does not affect the 6366 operation while it is taking place.

4.3.2 LT - LED Test Parameter

It can be seen from Table 4.1 that LT is a format 7 parameter consisting of a single decimal digit. When the LT parameter is accessed the CPU responds with a 0. To initiate the LED Test a 1 is loaded into the parameter and this will cause every single Front-panel LED to be illuminated for approximately 2 seconds. After this period the front panel displays will be restored to their state prior to the test and the CPU will echo the LT parameter value as a 0 on the terminal display.

4.3.3 LN - Loop Number Parameter

It can be seen from Table 4.1 that LN is a format 7 parameter consisting of a single decimal digit in the range 1 or 2. This parameter is used for accessing the 2 different sets of command parameters associated with the 6366 when it has been set-up for dual loop operation. The LN parameter is only used in the limited data base access mode and a detailed description of its use is given in Section 4.2.3.

4.4 Full Data Base Command Parameters

Access to the full data base of the 6366 via the 8260 Hand-held terminal can be achieved using the Block Command mode. In this mode the full list of 15 different Functional Block types of Table 4.3 can be accessed. These Functional Blocks are covered in Sections 4.5 to 4.19 while the corresponding lists of command parameters for each Functional Block are given in Table 4.4, 4.5 and 4.8 to 4.20 inclusive. The first 2 parameters of each of these 15 lists always serve the same function as follows:-

4.4.1 BT - Block Type Parameter

The first parameter of each list is the Block type (BT) which is a format 6 parameter consisting of two ASCII characters. These two characters correspond with one of the 15 different Functional Block type mnemonics listed in Table 4.3. The Block Type parameter is used to access any of the Functional Blocks when in The Block Command mode using the procedure given in Section 4.2.5.

It should be noted that whenever the user has scrolled to the end of a list of Functional Block Command parameters using the Scroll mode key (W↓), the next parameter accessed will be the BT mnemonic.

4.4.2 BN - Relative Block Number

The second parameter of each list is the Relative Block number (BN) which is a format 7 parameter consisting of a single decimal digit in the range 1 to 3.

This parameter is used for accessing different Blocks of the same Functional Block type where these occur in the 6366 data base, e.g. AI, SP and 3T Blocks. The second column from the left in Table 4.3 shows the range of valid BN values for each Functional Block type and it should be noted that even non-duplicated blocks like GP, DI or DO require a BN value of 1 to be entered. The use of the BN parameter in accessing relative Block numbers is described more fully in Section 4.2.6.

4.5 General Purpose Block (GP) Parameters

Table 4.4 shows that there are 9 parameters associated with the General Purpose Block. The first parameter is the Block Type (BT) mnemonic which is GP, and the second parameter if the relative Block number (BN) which is always 1 for the General Purpose Block. The ST, II, SW and PB parameters are all format 5 types and 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 6366 responds with the current value of the parameter preceded by a ´greater than´ sign to indicate that the data is in hexadecimal notation, e.g:-

S	W	>	4	0	3	0

Detailed descriptions of each of the 7 parameters excluding BT and BN are given in the following sections.

4.5.1 ST - Block Status

The Block Status parameter ST is used to give access to the current operating status of the 6366 Controller via the 8260 Hand-held terminal or Supervisory data link.

The format of the ST parameter is shown below:-

<table>
<tr><td colspan="4"></td><td colspan="12">← INSTRUMENT OPERATING MODE →</td></tr>
<tr><td>Bit 15</td><td></td><td></td><td>Bit 12</td><td>Bit 11</td><td></td><td></td><td>Bit 8</td><td>Bit 7</td><td></td><td></td><td>Bit 4</td><td>Bit 3</td><td></td><td></td><td>Bit 0</td></tr>
<tr><td colspan="4">Digit A</td><td colspan="4">Digit B</td><td colspan="4">Digit C</td><td colspan="4">Digit D</td></tr>
</table>

DIGIT	BIT	FUNCTION	READ/WRITE STATUS
A	12-15	Unallocated	
B	11	Battery voltage LOW	Read-only
	10	Common Program sumcheck failure	Read-only
	9	Instrument Power failure	Read/Write
	8	Common Block sumcheck failure	Read-only
C	7	L1 Program error	Read-only
	6	L2 Program error	Read-only
	5	BG Program error	Read-only
	4	BG Program halted	Read-only
D	3	GP Block sumcheck failure bit (0 = O.K.; 1 = fail)	Read/Write
	0-2	Unallocated	

COMMAND MNEMONIC	COMMAND PARAMETER FUNCTION	UNITS	FORMAT	PARAMETER TYPE
GP(1) BN(1)	Block Type - BT Relative Block Number, 1	- -	17 7	Block Header
ST II[II]	Block Status Instrument Identity	- -	5 5	Status Words
L1 L2 BG	Name of Time-scheduled program 1 Name of Time-scheduled program 2 Name of Background program	- - -	17 17 17	Run-time Environment
SW[SW] PB	Switch bank S1/S2 settings Front-panel push-button status	- -	5 5	Status Words

TABLE 4.4 List of General Purpose (GP) Block Command Parameters and their respective mnemonics

NOTES

(1) These parameters only appear when accessing parameters via the Hand-held terminal.

[xx] These parameters also appear in the short-form parameter list of Table 4.1 with the mnemonic shown in brackets.

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

a) Digit A

This digit is unallocated.

b) Digit B

The four bits of digit B are used to provide status information concerning the 6366 instrument hardware as follows:-

(i) 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 4 digit readout 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 ST value of 800 is read-only.

(ii) Bit 10 - Common Program sumcheck failure

The second bit of digit B is set to a logic 1 whenever a sumcheck failure occurs in the User FORTH program code. If the sumcheck failure is caused by a transient corruption of the RAM area then the condition can be rectified by switching the instrument off and powering it back on again. This causes the RAM to be reloaded from the EEPROM. This bit corresponding to an ST value of 400 is read-only.

(iii) Bit 9 - Instrument Power Failure

The third bit of digit B is set to a logic 1 by any hardware Reset or Power Failure detected within the 6366. This facility serves as a warning to the user that there has been a Power Supply interruption or a Watchdog trip and that functions such as counters or totalisations may no longer be valid. This bit corresponding to an ST value of 200 is read/write and can be set to logic 0 via the Hand-held terminal, supervisory data link, or from a user program.

(iv) Bit 8 - Common Block sumcheck failure

The least-significant bit of digit B is set to a logic 1 whenever a sumcheck failure occurs on any of the Functional Block parameters including the General Purpose Block itself, i.e. this bit is set whenever bit 3 of the ST parameter of any Functional Block is set to logic 1. This bit will only reset to logic 0 when the ST parameter bit 3 of the Functional Block with the sumcheck failure has been reset to logic 0. This bit corresponding to an ST value of 100 is read-only.

c) Digit C

The four bits of digit C are used to provide status information about the programs operating in the Run-time Environment of the 6366 as follows:-

(i) Bit 7 - L1 Program error

The most-significant bit of digit C is set to logic 1 whenever a run-time error is detected in the Time-scheduled Program 1 specified by the L1 parameter. This bit corresponding to an ST value of 80 is read-only and will only reset to logic 0 when the error has been corrected.

(ii) Bit 6 - L2 Program error

The second bit of digit C is set to logic 1 whenever a run-time error is detected in the Time-scheduled Program 2 specified by the L2 parameter. This bit corresponding to an ST value of 40 is read-only and will only reset to logic 0 when the error has been corrected.

(iii) Bit 5 - BG Program error

The third bit of digit C is set to logic 1 whenever a run-time error is detected in the Background Program specified by the BG parameter. This bit corresponding to an ST value of 20 is read-only and will only reset to logic 0 when the error has been corrected.

(iv) Bit 4 - BG Program halted

The least-significant bit of digit C is set to logic 1 whenever the Background Program specified by the BG parameter is not running. This bit corresponding to an ST value of 10 is read-only and will only reset to logic 0 once the Background Program has been started.

d) Digit D

Only the most-significant bit of digit D is used for status information as follows:-

(i) Bit 3 - GP Block sumcheck failure

The most-significant bit of digit D is set to logic 1 whenever a sumcheck failure occurs on any of the General Purpose Block command parameters listed in Table 4.4.

The condition is rectified by re-entering all the General Purpose Block command parameters and finally writing a zero to bit 3. This bit corresponding to an ST value of 8 is read/write.

(ii) Bits 0, 1 and 2

These bits are unallocated.

4.5.2 II - Instrument Identity

This parameter returns the instrument identity and issue number, i.e. 3661 for the 6366 issue 1. II is a read-only parameter and its exact format is given below:-

PRODUCT CODE | ISS. NO.

Bit 15											Bit 4	Bit 3			Bit 0
Digit A				Digit B				Digit C				Digit D			

DIGIT	BIT	FUNCTION
A,B,C	15-4	Product code (6) 366
D	3-0	Issue Number 1

The II parameter also appears in the Command Parameter list of Table 4.1 in the limited data base access mode.

4.5.3 L1, L2 - Name of Time-scheduled Programs 1 and 2

These two parameters are used to specify the names of the two Time-scheduled programs that form the 6366 Run-time environment. Table 4.4 shows that L1 and L2 are format 17 parameters consisting of 2 ASCII characters. These specify the program mnemonics from the Application Library of Table 3.2 i.e. S0 to S7, or they specify a User program using the mnemonic U0, U1 etc. For more information on the use of these parameters refer to Section 3.2.1 a).

4.5.4 BG - Name of Background Program

This parameter is used to specify the name of the Background program that forms the 6366 Run-time environment. Table 4.4. shows that it is a format 17 parameter consisting of 2 ASCII characters. These specify the program mnemonic from the Application Library of Table 3.3, i.e. B0 to B3. For more information on the use of this parameter refer to Section 3.2.1 b).

4.5.5 SW - Switch Bank S1/S2 Settings

Table 4.4. shows that the status word command parameter, SW, is a format 5 monitor-only parameter and is used to obtain a readout of the settings of the 16 internal switches of switch banks S1 and S2. This facility allows the internal switch status of a 6366 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:-

SWITCH BANK 2								SWITCH BANK 1							
Bit 15							Bit 8	Bit 7							Bit 0
Digit A				Digit B				Digit C				Digit D			

DIGIT	BIT	SWITCH		FUNCTION
A	15	1	S2	8 – Unit Identifier (UID)
	14	2	S2	4 – Unit Identifier (UID)
	13	3	S2	2 – Unit Identifier (UID)
	12	4	S2	1 – Unit Identifier (UID)
B	11	5	S2	Control loop communication mode
	10	6	S2	Unallocated
	9	7	S2	Manual Station 2 output action
	8	8	S2	Manual Station 1 output action
C	7	1	S1	RS232 data link baud rate selection
	6	2	S1	Baud rate selection switches for RS422 data link (see Table 2.2)
	5	3	S1	Baud rate selection switches for RS422 data link (see Table 2.2)
	4	4	S1	Baud rate selection switches for RS422 data link (see Table 2.2)
D	3	5	S1	Protocol mode select
	2	6	S1	4 – Group Identifier (GID)
	1	7	S1	2 – Group Identifier (GID)
	0	8	S1	1 – Group Identifier (GID)

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 described in the following sections:-

a) <u>Switch bank S2</u> (digits A, B)

The two most-significant digits of SW read back the status of internal switch bank S2. The individual switch functions within S2 are described in Section 2.3.2 b) and are listed in Table 2.1.

b) <u>Switch banks S1</u> (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 described 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	>	5	2	7	9

This means that switch nos. 2, 4 and 7 of switch bank S2 are ON, and switch nos. 2, 3, 4, 5 and 8 of switch bank S1 are ON. All other switches are OFF.

It should be noted that the settings of switch bank S3 cannot be accessed via the 8260 Hand-held terminal or serial data link via the SW parameter. The SW parameter also appears in the Command Parameter list of Table 4.1 in the limited data base access mode.

4.5.6 **PB - Front-panel Push-button Status**

The PB status word parameter is used to give access to the current state of the 6366 front-panel controls via the 8260 Hand-held terminal or Supervisory data link. It is a format 5 parameter and is structured as shown below:-

								FRONT-PANEL STATUS							
Bit 15							Bit 8	Bit 7							Bit 0
Digit A				Digit B				Digit C				Digit D			

DIGIT	BIT	FUNCTION		READ/WRITE STATUS
A	12-15	Unallocated		
B	8-11	Unallocated		
C	7	LOWER button	(▽)	Read-only
	6	RAISE button	(△)	Read-only
	5	Test bit		Read-only
	4	8260 Terminal connected		Read-only
D	3	SETPOINT button	(SP)	Read-only
	2	REMOTE/RATIO button	(R)	Read-only
	1	AUTO button	(A)	Read-only
	0	MANUAL button	(M)	Read-only

The exact functions of the digits within the PB parameter are described in the following sections:-

a) Digit A

This digit is unallocated and reads back as zero.

b) Digit B

This digit is unallocated and reads back as zero.

c) Front-Panel Status (digits C and D)

The last two digits of the PB 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) Bits 6 and 7 - Raise/Lower Buttons

The two most-significant bits of digit C are normally at logic 0 and are set to a logic 1 respectively whenever the Raise (Δ) or Lower (∇) buttons are being pressed.

(ii) Bit 5 - Test bit

The third bit of digit C is used as a Test bit by the CPU to check out the functions of the input/output ports on the Front-panel hardware. Consequently this bit may appear as either a 1 or a 0 depending at what instant in time the PB parameter is accessed.

(iii) Bit 4 - 8260 Hand-held Terminal Connected

The least-significant bit of digit C is used to indicate whether the 8260 Hand-held terminal is plugged into the 6366 Front-panel socket or not. Bit 4 will normally be at logic 0 but will set to logic 1 when 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 PB status word when this bit is at logic 0.

(iv) Bits 0 to 3 - Manual, Auto, Remote and Setpoint Buttons

These 4 bits of digit D are normally at logic 0 and are set to logic 1 whenever the manual (M), Auto (A), Remote/Ratio (R) or Setpoint display (SP) buttons are pressed as shown in the Format Table.

4.6 Analogue Input Block (AI) Parameters

Table 4.5 shows that there are 7 parameters associated with the Analogue Input Block. The first parameter is the Block Type (BT) mnemonic which is AI. The second parameter is the Relative Block number (BN) which can take the value 1, 2 or 3 depending upon which of the 3 analogue input channel parameters are required. Detailed descriptions of the remaining 5 parameters excluding BT and BN are given in the following Sections.

4.6.1 ST - Block Status

The Block 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 each Analogue Variable input. Information about whether the channel 1 analogue input has an open-circuit condition is also provided by status bits. The format of the ST parameter is given below:-

DECIMAL POINT				INPUT CONDITIONING				INPUT FILTER				STATUS			
Bit 15			Bit 12	Bit 11			Bit 8	Bit 7			Bit 4	Bit 3			Bit 0
Digit A				Digit B				Digit C				Digit D			

DIGIT	BIT	FUNCTION
A	12-15	Decimal point position select (0 to 4)
B	8-11	Analogue Variable input channel processing (0 to F)
C	4-7	Analogue Variable input filtering (0 to F)
	3	AI Block sumcheck failure bit (0 = O.K.; 1 = fail)
	2	Input open-circuit } Channel 1 only
D	1	Input open-circuit for 3 seconds } Channel 1 only
	0	Unallocated

COMMAND MNEMONIC	COMMAND PARAMETER FUNCTION	UNITS	FORMAT	PARAMETER TYPE
AI(1) BN(1)	Block Type - BT Relative Block Number 1-3	- -	17 7	Block Header
ST	Block Status	-	5	Status word
HR LR	Analogue input High range Analogue input Low range	Eng Eng	1 1	Input channel Ranging
AI AV[1V] [2V] [3V]	Analogue input Analogue Variable (1,2,3)	% Eng	3 1	Monitor- only

TABLE 4.5 List of Analogue Input (AI) Block Command Parameters and their respective mnemonics

NOTES

(1) These parameters only appear when accessing parameters via the Hand-held terminal.

[xx] This parameter also appears in the short-form parameter list of Table 4.1 with the mnemonic shown in brackets.

The exact functions of the digits within the ST parameter are described 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 Analogue 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 Analogue Variable range of that Analogue input channel. This means in fact that all of the Format 1 commands listed in Table 4.5 will be displayed with the same decimal point position as for the Analogue Variable, viz:-

HR, LR, AV

b) Input Channel Processing (Digit B)

It has been mentioned that each of the 3 Analogue input Channels of the 6366 Controller can be linked independently to a digital processing routine before its resultant value is available to other Functional Blocks. The second digit of ST is used to select which if the 16 possible processing routines are linked to each Analogue input channel. Digit B can lie in the full hexadecimal range of 0 to F, and Table 4.6 lists the 16 possible processing routines with their corresponding hexadecimal numbers. If no processing is required for the Analogue Variable then it can be seen from Table 4.6 that a zero is entered in the digit B position of the ST parameter. The use of the input channel processing functions is described in the following sections.

HEX. CHAR	PROCESSING ROUTINE FUNCTION	RANGE
0	No Processing	0 to 10V
1	Square Root Function:- Vout = $\sqrt{\text{Vin x 10V}}$	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 4.6 List of the Available Input Signal Processing Functions

(Selected by ST Parameter, Digit B)

(i) Function 1 - Square Root Function

The formula of Table 4.6 shows that the output of the Square Root functions 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 4.6 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 4.6 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 4.6 can be used over the range 0 to 800°C which means that for the analogue input:-

LR = 000.0 (Analogue Variable low range)
HR = 800.0 (Analogue Variable high range)

Furthermore, if, for example, an Analogue Variable range of 0 to 400.0°C were required, then LR = 000.0 and HR = 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 4.6 are used:-

6366 ANALOGUE INPUT SPAN LR to HR

= INPUT CONVERTER SPAN 0 to 10V

The Controller automatically decides which portion of the linearisation table is to be used for the selected Analogue Input span by referring to the Decimal Point Position (ST digit A), Analogue Input High Range (HR), and Analogue Input Low Range (LR) parameters of Sections 4.6.1 a) and 4.6.2 respectively. When using the thermocouple linearisation functions the HR and LR ranging parameters should always be integers. If they are inadvertently entered as non-integers the 6366 will automatically round them to the nearest integer value internally for linearisation purposes. However, for display purposes the AV will remain scaled to the non- integer values of HR and LR.

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

ST > 0500

HR = 1000

LR = 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 Analogue Input Range. For example, the type J thermocouple linearisation could be used to obtain Analogue Variable readings with a 0.01°C resolution over a 100°C span by entering the following parameters:-

ST > 2200

HR = 99.99

LR = 00.00

It is not possible, however, to exceed 0.01°C resolution on any of the thermocouple ranges specified in Table 4.6.

(iii) Function 9 - Platinum Resistance Thermometer

The Platinum Resistance Thermometer linearisation function of Table 4.6 requires the same operating characteristics as for the thermocouples, viz:- the Analogue 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 30 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 6366 Programmable Advanced Controller.

(v) Function F - Inversion Function

The formula of Table 4.6 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 6366 as the resultant signal obtained from the Analogue Variable (AV) signal. The inversion effectively occurs before any other processing is carried out so that the Analogue 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 6366 control loop has been programmed with the following parameters:-

ST > 1F00

HR = 500.0

LR = 000.0

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

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

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

c) Input filter time selection (digit C)

The third digit of ST is used to select an input filter time constant for the Analogue 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 4.7.

d) Status bits (digit D)

The fourth or least-significant digit of ST is used as separate bits for providing information about the status of the Analogue Input Block as follows:-

(i) Bit 3 - AI Block sumcheck failure

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 Analogue Input Block. This condition is rectified by re-entering any corrupted Block command parameters and re-setting bit 3 to logic 0. Bit 3 is read/write and corresponds to an ST value of 8.

(ii) Bit 2 - Channel 1 input open-circuit

The second bit of digit D is set to a logic 1 as soon as the CPU detects an open-circuit condition on the channel 1 analogue input (see Section 2.6.5). This bit corresponding to an ST value of 4 is read-only and will only reset to logic 0 when the channel 1 analogue input is back in range.

(iii) Bit 1 - Channel 1 input open-circuit for 3 seconds

The third bit of digit 0 is set to a logic 1 only if bit 2 is already at logic 1 and the open-circuit condition of the channel 1 analogue input has persisted for a period greater than 3 seconds. (see Section 2.6.5). This bit corresponding to an ST value of 2 is read-only and will only reset to logic 0 when the channel 1 analogue input is back in range.

(iv) Bit 0

The least-significant bit of digit D is unallocated.

4.6.2 **HR, LR - Analogue Input Ranging**

These parameters define, in Engineering Unit, the span of the Analogue Variable input, AV, for each of the 3 input channels. The value entered in HR is equivalent to an input of 10V on pin 13, 14 or 15 or 5V on pin 10, 11 or 12 when S3 no. 1, 2 or 3 is ON respectively. Similarly LR is equivalent to an input of 0V on pin 13, 14 or 15 or 1V on pin 10, 11 or 12 when S3 no. 1, 2 or 3 is ON respectively. The range of values is -9999 to +9999 and HR must be greater than LR. The decimal point position for both of these parameters is programmed by digit A of the ST parameter as described in Section 4.6.2 a).

4.6.3 **AI - Analogue Input**

Table 4.5 shows that the AI parameter represents the current value of each analogue input channel expressed as a percentage of the full-scale operating range of 0 to 99.99%. For 0-10V inputs (S3 no. 1, 2 or 3 OFF) 0V will give a reading of 0, and 10V will give a reading of 99.99%. For 1-5V inputs (S3 no. 1, 2 or 3 ON) 1V will give a reading of 0, and 5V will give a reading of 99.99%. The AI parameter is read-only and gives the instantaneous value of each analogue input before any ranging, filtering or signal processing is applied.

4.6.4 **AV - Analogue Variable**

This parameter defines, in Engineering Units, the value of the Analogue Variable input signal for each channel after it has been filtered and had any signal processing applied. The AV input is scaled by the input ranging parameters LR and HR as described in Section 4.6.2. Input channel processing for AV is defined by digit B of the ST parameter as described in Section 4.6.1 b) and input filtering is defined by digit C as described in Section 4.6.1 c). The decimal point position is programmed by digit A of the ST parameter as described in Section 4.6.1 a).

AV appears in the Command parameter list of Table 4.1 under the mnemonics 1V, 2V or 3V in the limited data base access mode.

4.7 Analogue Output Block (AO) Parameters

Table 4.8 shows that there are 8 parameters associated with the Analogue Output Block. The first parameter is the Block Type (BT) mnemonic which is AO, and the second parameter is the relative Block Number (BN) which is always 1 for the Analogue Output Block. Detailed descriptions of the remaining 6 parameters excluding BT and BN are given in the following Sections.

4.7.1 ST - Block Status

The Block 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 for the analogue output and provide channel status information in the format given below:-

DECIMAL POINT								CHANNEL STATUS							
Bit 15			Bit 12	Bit 11			Bit 8	Bit 7			Bit 4	Bit 3			Bit 0
Digit A				Digit B				Digit C				Digit D			

DIGIT	BIT	FUNCTION
A	12-15	Decimal point position select (0 to 4)
B	8-11	Unallocated
C	7	Inverse output select (0 = normal; 1 = inverse)
	4-6	Unallocated
D	3	AO Block sumcheck failure bit (0 = O.K.; 1 = fail)
	0-2	Unallocated

COMMAND MNEMONIC	COMMAND PARAMETER FUNCTION	UNITS	FORMAT	PARAMETER TYPE
AO(1) BN(1)	Block Type - BT Relative Block Number, 1	- -	17 7	Block Header
ST	Block Status	-	5	Status word
HR LR	Analogue output High range Analogue output Low range	Eng Eng	1 1	Output channel ranging
HL LL	High output limit Low output limit	Eng Eng	1 1	Limit Settings
AO	Analogue output	Eng	1	Monitor-only

TABLE 4.8 List of Analogue Output (AO) Block Command Parameters and their respective mnemonics

NOTE

(1) These parameters only appear when accessing parameters via the Hand-held terminal.

The exact functions of the digits within the ST parameter are described 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 analogue output AO as it is displayed on the Hand-held terminal display. 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 analogue output. This means in fact that all of the Format 1 commands listed in Table 4.8 will be displayed with the same decimal point position as for the analogue output, viz:-

HR, LR, HL, LL, AO

b) Digit B

This is unallocated.

c) Digit C

Bit 7 of digit C is used to select whether the analogue output is normal or inverse acting as described in Section 3.3.3. Setting bit 7 to a logic 0 gives normal output action while a logic 1 selects inverse output action. The remaining bits of digit C, bits 4, 5 and 6 are unallocated.

d) Digit D

Bit 3 of digit D is automatically set to logic 1 by the CPU whenever a sumcheck failure is detected on any of the command parameters associated with the Analogue Output Block. This condition is rectified by re-entering an corrupted Block command parameters and re-setting bit 3 to logic 0. The remaining bits of digit D, bit 0, 1 and 2 are unallocated.

4.7.2 HR, LR - Analogue Output Ranging

These parameters define in Engineering Units the span of the analogue output, AO. The value entered in HR is equivalent to an output of 10V on pin 34, while the value entered in LR is equivalent to an output of 0V. The range of values is -9999 to +9999 and HR must be greater than LR. The decimal point position for both of these parameters is programmed by digit A of the ST parameter as described in Section 4.7.2 a).

4.7.3 HL, LL - Analogue Output Limits

The HL and LL limit parameters restrict the range in Engineering Units over which the analogue output parameter, AO, can vary. They operate on AO whether its value is being defined by another Functional Block, from an application program, or from either of the serial data links. The range of values is -9999 to +9999 and HL must be greater than LL. The decimal point position for both of these parameters is programmed by digit A of the ST parameter as described in Section 4.7.2 a).

4.7.4 AO - Analogue Output

This parameter defines in Engineering Units the value of the pin 34 Analogue Output signal. The AO output is scaled by the ranging parameters HR and LR of Section 4.7.2 and is always constrained to lie within the limits defined by HL and LL of Section 4.7.3. The AO parameter may be written to from either of the serial data links or its value may be defined as the output of another Functional Block. The decimal point position for the AO parameter is programmed by digit A of the ST parameter as described in Section 4.7.2 a).

4.8 Digital Input Block (DI) Parameters

Table 4.9 shows that there are 5 parameters associated with the Digital Input Block. The first parameter is the Block Type (BT) mnemonic which is DI. The second parameter is the Relative Block Number (BN) which is always 1 for the Digital Input Block. Detailed descriptions of the remaining 3 parameters excluding BT and BN are given in the following sections.

4.8.1 ST - Block Status

The Block 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. Only 1 bit of the ST parameters is used to provide status information in the format given below:-

BLOCK STATUS

<table>
<tr><td>Bit 15</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td>Bit 4</td><td>Bit 3</td><td></td><td></td><td>Bit 0</td></tr>
<tr><td colspan="4">Digit A</td><td colspan="4">Digit B</td><td colspan="4">Digit C</td><td colspan="4">Digit D</td></tr>
</table>

DIGIT	BIT	FUNCTION
A	12-15	Unallocated
B	8-11	Unallocated
C	4-7	Unallocated
	3	DI Block sumcheck failure bit (0 = O.K.; 1 = fail)
D	2	Unallocated
	1	Unallocated
	0	Unallocated

The exact functions of the digits within the ST parameter are described in the following Sections:-

a) Digits A, B and C

These are unallocated.

b) Status bits (digit D)

The fourth or least-significant digit of ST is used as four separate bits for status information as follows:-

COMMAND MNEMONIC	COMMAND PARAMETER FUNCTION	UNITS	FORMAT	PARAMETER TYPE
DI(1) BN(1)	Block Type - BT Relative Block Number, 1	- -	17 7	Block Header
ST XM DS[DI]	Block Status Exclusive-OR mask Digital input states	- - -	5 5 5	Status Words

TABLE 4.9 List of Digital Input (DI) Block Command Parameters and their respective mnemonics

NOTES

(1) These parameters only appear when accessing parameters via the Hand-held terminal.

[xx] This parameter also appears in the short-form parameter list of Table 4.1 with the mnemonic shown in brackets.

(i) Bit 3 - DI Block sumcheck failure

This bit is automatically set to a logic 1 by the CPU whenever a sumcheck failure is detected on any of the common parameters associated with the Digital Input Block. This condition is rectified by re-entering any corrupted block command parameters and re-setting bit 3 to logic 0. Bit 3 is read/write and corresponds to an ST value of 8.

(ii) Bits 0, 1 and 2

These bits are unallocated.

4.8.2 XM - Exclusive-OR Mask

The Exclusive-OR mask parameter, XM, is of the format 5 type and consists of 4 hexadecimal digits in the range 0000 to 00FF with a positive sign character for parameter entry. Only the low byte of XM is used as individual Exclusive-OR mask bits to invert the state of the Digital Inputs, DS, as seen by a user program. The format of the XM parameter is given below:-

EXCLUSIVE-OR MASK BITS (bits 7 to 0)

Bit 15							Bit 8	Bit 7							Bit 0

Digit A	Digit B	Digit C	Digit D

DIGIT	BIT	INPUT	FUNCTION
A	12-15		Unallocated
B	8-11		Unallocated
	7	8	Exclusive-OR Mask (0 = no effect; 1 = bit inverted)
C	6	7	
	5	6	
	4	5	
	3	4	
D	2	3	
	1	2	
	0	1	

The exact function of the individual digits within the XM parameter are described in the following Sections:-

a) Digits A and B

The high byte of XM (digits A and B) is unallocated.

b) Exclusive - OR Mask (digits C and D)

Each bit of digit C and D is set to a logic 1 when it is required that the corresponding digital input bit in the DS parameter should be inverted when applied to a user application program. The most-significant bit of digit C corresponds to digital input 8 of DS, and the least-significant bit of digit D corresponds to digital input 1 and so on. This inversion will not apply to the bits of the DS parameter when accessed via the Hand-held terminal or RS422 supervisory data link. When any bit of digit C or D is set to logic 0 then this has no effect on the corresponding DS parameter bit.

The following examples illustrate the use of the XM Command parameter:-

XM > 000F - the least-significant 4 bits of the Exclusive-OR Mask are set to logic 1

DS > 0055 - the 8 digital inputs of the DS parameter are set as follows:-

```
BIT:-  7 6 5 4 3 2 1 0
DATA:- 0 1 0 1 0 1 0 1
```

DS > 005A - the least-significant 4 bits of DS are inverted when accessed via a user program:-

```
BIT:-  7 6 5 4 3 2 1 0
DATA:- 0 1 0 1 1 0 1 0
```

4.8.3 DS - Digital Input States

The Digital Input States parameter, DS, is of the format 5 type and consists of 4 hexadecimal digits in the range 0000 to 00FF with a positive sign character for parameter entry. DS is a read-only parameter and the two most-significant digits indicate the logic states of the digital inputs in the format given below:-

<table>
<tr><td colspan="8"></td><td colspan="8">← DIGITAL INPUT STATES →</td></tr>
<tr><td>Bit 15</td><td></td><td></td><td>Bit 12</td><td>Bit 11</td><td></td><td></td><td>Bit 8</td><td>Bit 7</td><td></td><td></td><td></td><td></td><td></td><td></td><td>Bit 0</td></tr>
<tr><td colspan="4">Digit A</td><td colspan="4">Digit B</td><td colspan="4">Digit C</td><td colspan="4">Digit D</td></tr>
</table>

DIGIT	BIT	INPUT	FUNCTION
A	12-15		Unallocated
B	8-11		Unallocated
C	7	8	Digital Input States (0 = 0V; 1 = 15V)
	6	7	
	5	6	
	4	5	
D	3	4	
	2	3	
	1	2	
	0	1	

The exact functions of the individual digits within the DS parameter are described in the following Sections:-

a) Digits A and B

The high byte of DS (digits A and B) is unallocated and reads back as zero.

b) Digital Input States (digits C and D)

Each bit of digit C and D is used to indicate the current state of the 8 digital inputs of the 6366 Controller. The most-significant bit of digit C represents the state of digital input 8 (pin 31) and the least-significant bit of digit D represents the state of digital input 1 (pin 24) and so on. A 0V input is represented by logic 0, and a 15V input by logic 1. This is illustrated in the following example where the input levels are as shown below:-

INPUT :-	8	7	6	5	4	3	2	1
PIN NO :-	31	30	29	28	27	26	25	24
VOLTAGE:-	0V	0V	15V	15V	0V	15V	15V	0V

This would correspond to a DS parameter reading:-

DS > 0036

DS appears in the Command Parameter list of Table 4.1 under the mnemonic DI in the limited data base access mode.

4.9 Digital Output Block (DO) Parameters

Table 4.10 shows that there are 5 parameters associated with the Digital Output Block. The first parameter is the Block Type (BT) mnemonic which is DO. The second parameter is the Relative Block Number (BN) which is always 1 for the Digital Output Block. Detailed descriptions of the remaining 3 parameters excluding BT and BN are given in the following Sections.

4.9.1 ST - Block Status

The Block 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. Only 1 bit of the ST parameters is used to provide status information in the format given below:-

												BLOCK STATUS			
Bit 15											Bit 4	Bit 3			Bit 0
Digit A				Digit B				Digit C				Digit D			

DIGIT	BIT	FUNCTION
A	12-15	Unallocated
B	8-11	Unallocated
C	4-7	Unallocated
	3	DO Block sumcheck failure bit (0 = O.K.; 1 = fail)
D	2	Unallocated
	1	Unallocated
	0	Unallocated

The exact functions of the digits within the ST parameter are described in the following Sections:-

a) Digits A, B and C

These are unallocated.

b) Status bits (digit D)

The fourth or least-significant digit of ST is used as four separate bits for status information as follows:-

COMMAND MNEMONIC	COMMAND PARAMETER FUNCTION	UNITS	FORMAT	PARAMETER TYPE
DO(1) BN(1)	Block Type - BT Relative Block Number, 1	- -	17 7	Block Header
ST WM DS[DO]	Block Status Write mask Digital output states	- - -	5 5 5	Status Words

TABLE 4.10 List of Digital Output (DO) Block Command Parameters and their respective mnemonics

NOTES

(1) These parameters only appear when accessing parameters via the Hand-held terminal.

[xx] This parameter also appears in the short-form parameter list of Table 4.1 with the mnemonic shown in brackets.

(i) Bit 3 - DO Block sumcheck failure

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 Digital Output Block. This condition is rectified by re-entering any corrupted Block command parameters and re-setting bit 3 to logic 0. Bit 3 is read/write and corresponds to a ST value of 8.

(ii) Bits 0, 1 and 2

These bits are unallocated.

4.9.2 WM - Write Mask

The Write Mask parameter, WM, is of the format 5 type and consists of 4 hexadecimal digits in the range 0000 to 00FF with a positive sign character for parameter entry. Only the low byte of WM is used as individual mask bits to prevent the corresponding digital output bits of DS from being altered via the Hand-held terminal or RS 422 data link. The format of the WM parameter is given below:-

								DIGITAL OUTPUT MASK BIT							
Bit 15			Bit 12	Bit 11			Bit 8	Bit 7			Bit 4	Bit 3			Bit 0
Digit A				Digit B				Digit C				Digit D			

DIGIT	BIT	OUTPUT	FUNCTION
A	12-15		Unallocated
B	8-11		Unallocated
C	7	8	Digital Output mask bits (0 = enable; 1 = mask)
	6	7	
	5	6	
	4	5	
D	3	4	
	2	3	
	1	2	
	0	1	

The exact function of the individual digit within the WM parameter are described in the following Sections:-

a) Digits A and B

The high byte of WM (digits A and B) is unallocated.

b) Write Mask (digits C and D)

Each bit of digit C and D is set to a logic 1 when it is required that the corresponding digital output bit in the DS parameter should be masked from changes via the Hand-held Terminal or RS422 supervisory data link. The most-significant bit of digit C corresponds to digital output 8 of DS, and the least-significant bit of digit D corresponds to digital output 1 and so on. This masking action has no effect when the digital output bit changes originate from a User Program. When any bit of digit C or D is set to logic 0, then this enables changes to be made to the corresponding DS parameter bit via either of the serial data links.

The following example illustrates the use of the WM Command parameter:-

DS >	0000 -	current state of digital outputs is all at logic 0
WM >	00F0 -	all 4 bits of digit C of the Write Mask are set to logic 1
DS >	00FF -	it is attempted to set all 8 digital outputs via the Hand-held terminal
DS′ >	000F -	the resultant state of the DS parameter is that only the 4 least-significant bits are set. The 4 bits of digit C are masked by the WM parameter

4.9.3 DS - Digital Output States

The Digital Output States parameter, DS, 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. The two least-significant digits of the DS parameter indicate the logic states of the digital outputs. The two most-significant digits hold individual mask bits for each output bit in the format given below:-

DIGITAL OUTPUT MASK BITS								DIGITAL OUTPUT STATES							
Bit 15			Bit 12	Bit 11			Bit 8	Bit 7			Bit 4	Bit 3			Bit 0
Digit A				Digit B				Digit C				Digit D			

DIGIT	BIT	OUTPUT	FUNCTION
	15	8	
A	14	7	
	13	6	
	12	5	Digital Output mask bits (0 = enable; 1 = mask)
	11	4	
B	10	3	
	9	2	
	8	1	
	7	8	
C	6	7	
	5	6	
	4	5	Digital Output States (0 = 0V; 1 = 15V)
	3	4	
D	2	3	
	1	2	
	0	1	

The exact functions of the individual digits within the DS parameter are described in the following Sections:-

a) Digital Output Mask Bits (digits A and B)

Each bit of digit A and B of the DS parameter is used to hold individual mask bits for each corresponding digital output. To enable any of the 8 output bits to be changed via the 8260 Hand-held terminal, RS422 data link, or a User program, the corresponding mask bit must be set to logic 0. When the mask bit is set to logic 1 the corresponding digital output bit cannot have its state changed. This facility allows individual outputs to be set or cleared by means of a single write operation to the DS parameter without having to read its value first. Whenever the DS parameter is written, the digital outputs are immediately updated to minimise delays and digits A and B are reset to zero for subsequent write operations. This is illustrated by the following examples.

Action		DS Parameter Data Entry	Previous DS Output State	Resultant DS Output State
(i)	Set LS bit	> 0001	> 0000	> 0001
(ii)	Inhibit LS bit	> 0101	> 0000	> 0000
(iii)	Set MS bit	> 0080	> 0000	> 0080
(iv)	Inhibit MS bit	> 8080	> 0000	> 0000
(v)	Set MS bit only (all others inhibited)	> 7FFF	> 0000	> 0080

Note that digits A and B always read back as zero.

b) Digital Output States (digits C and D)

Each bit of digit C and D is used to control the state of the 8 digital outputs of the 6366 Controller. The most-significant bit of digit C controls the state of digital output 8 (pin 23) and the least-significant bit of digit D controls the state of digital output 1 (pin 16) and so on. A 0V output is represented by logic 0, and a 15V output by logic 1. This is illustrated in the following example where the output levels are as shown below:-

INPUT :-	8	7	6	5	4	3	2	1
PIN NO :-	23	22	21	20	19	18	17	16
VOLTAGE:-	15V	0V	0V	15V	0V	15V	0V	15V

This would correspond to a DS parameter reading:-

DS > 0095

The 8 bits of digit C and D can be altered via the 8260 Hand-held terminal, RS422 supervisory link or via a User program provided the appropriate mask bits in digit A and B or the WM parameter has been set.

DS appears in the Command Parameter list of Table 4.1 under the mnemonic DO in the limited data base access mode.

COMMAND MNEMONIC	COMMAND PARAMETER FUNCTION	UNITS	FORMAT	PARAMETER TYPE
SP(1) BN(1)	Block Type - BT Relative Block Number 1-2	- -	17 7	Block Header
ST	Block Status	-	5	Status word
HR[PH] LR[PL]	Setpoint High range Setpoint Low range	Eng Eng	1 1	Setpoint Ranging
HL[HS] LL[LS]	Setpoint High limit Setpoint Low limit	Eng Eng	1 1	Setpoint Limits
PV[PV] SP[SP] ER	Process Variable Resultant Internal Setpoint Error	Eng Eng Eng	1 1 1	Monitor-only
SL[SL] SR SB RL	Local Setpoint Remote Setpoint Setpoint Bias Setpoint Rate limit	Eng Eng Eng Eng/s	1 1 1 1	Setpoint Related Parameters
HA[HA] LA[LA] HD[HD] LD[LD]	High Absolute Alarm limit Low Absolute Alarm limit High Deviation Alarm limit Low Deviation Alarm limit	Eng Eng Eng Eng	1 1 2 2	Alarm Settings

TABLE 4.11 List of Setpoint (SP) Block Command Parameters and their respective mnemonics

NOTES

(1) These parameters only appear when accessing parameters via the Hand-held terminal.

[xx] These parameters also appear in the short-form parameter list of Table 4.1 with the mnemonic shown in brackets.

4.10 Setpoint Block (SP) Parameters

Table 4.11 shows that there are 18 parameters associated with the Setpoint Block. The first parameter is the Block Type (BT) mnemonic which is SP. The second parameter is the Relative Block number (BN) which can take the value 1 or 2 depending upon whether single or dual loop operation is required. Detailed descriptions of the remaining 16 parameters excluding BT and BN are given in the following Sections.

4.10.1 ST - Block Status

The Block 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 decimal point positions, Setpoint operating modes and provides alarm indications. The format of the ST parameter is given below:-

DECIMAL POINT				SETPOINT MODE				ALARM OUTPUTS				BLOCK STATUS			
Bit 15			Bit 12	Bit 11			Bit 8	Bit 7			Bit 4	Bit 3			Bit 0
Digit A				Digit B				Digit C				Digit D			

DIGIT	BIT	FUNCTION
A	12-15	Decimal point position select (0 to 4)
B	11	Integral term balance disable on SL changes (0 = enable; 1 = disable)
	10	Setpoint action when not in AUTO mode (0 = constant; 1 = track)
	8-9	Unallocated
C	7	High absolute alarm (read-only)
	6	Low absolute alarm (read-only)
	5	High deviation alarm (read-only)
	4	Low deviation alarm (read-only)
D	3	SP Block sumcheck failure bit (0 = O.K.; 1 = fail)
	0-2	Ratio Block decimal point position (read-only)

The exact functions of the digits within the ST parameter are described 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 Local Setpoint, SL, 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 in Section 4.6.1 a) for the Process Variable.

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 Setpoint range of that control loop. This means in fact that all of the Format 1 and 2 commands listed in Table 4.11 will be displayed with the same decimal point position as for the Local Setpoint, viz:-

HR, LR, HL, LL, PV, SP, ER, SL, SR, SB, RL,
HA, LA, HD, LD

b) Setpoint Operating Mode (digit B)

The 2 most-significant bits of digit B are used to select features of the Setpoint Operation as follows:-

(i) Bit 11 - Integral balance disable

The most-significant bit of digit B is used to disable the balancing of the Integral term on Local Setpoint (SL) changes. Setting bit 11 to logic 1 disables balancing, while a logic 0 enables balancing. This bit is read/write and corresponds to an ST value of 800.

(ii) Bit 10 - Setpoint action

The second bit of digit B is used to determine what happens to the Local Setpoint value when the control loop is not operating in the AUTO mode. When this bit is set to logic 0 the setpoint remains constant. When this bit is set to logic 1 the Local Setpoint tracks the Process Variable input, thus ensuring a bumpless changeover upon subsequent return to the AUTO mode. This bit corresponds to an ST value of 400 and is read/write.

(iii) Bits 8 and 9

Neither of these bits are allocated.

c) Alarm Outputs (digit C)

The 4 bits of digit C are used to indicate when the Process Variable, PV, has exceeded the Absolute or Deviation alarm limits programmed by the HA, LA, HD and LD parameters respectively. All 4 bits are read only and normally read as logic 0 but set to a logic 1 when an alarm condition occurs as follows:-

(i) Bit 7 corresponds to an HA alarm - ST value of 80

(ii) Bit 6 corresponds to an LA alarm - ST value of 40

(iii) Bit 5 corresponds to an HD alarm - ST value of 20

(iv) Bit 4 corresponds to an LD alarm - ST value of 10

d) Block Status (digit D)

The 4 bits of digit D are allocated as follows:-

(i) Bit 3 - SP Block sumcheck failure

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 Setpoint Block. This condition is rectified by re-entering any corrupted Block command parameters and re-setting bit 3 to logic 0. This bit corresponds to an ST value of 8 and is read/write.

(ii) Bits 0, 1 and 2 - Ratio decimal point

When the 6366 is configured for Ratio Control the Ratio Setpoint is linked to the Setpoint Block. Bits 0, 1 and 2 of digit D are then used to indicate the Decimal Point Position of the Ratio Block. They will therefore take up the same setting as bits 12, 13 and 14 of the ST parameter of the Ratio Block as described in Section 4.11.1 a). This value is in the range 0 to 4 and positions the decimal point according to the table shown in Section 4.6.1 a) for the Process Variable. These 3 bits are read- only and correspond to an ST reading in the range 0 to 4.

4.10.2 HR, LR - Setpoint Ranging

These parameters define, in Engineering Units, the span of the Setpoint. HR and LR are bipolar entries so that the range of values is -9999 to +9999 and HR must be greater than LR. The decimal point position for both of these parameters is programmed by digit A of the ST parameter as described in Section 4.10.1 a).

HR and LR appear in the Command Parameter list of Table 4.1 under the mnemonic PH and PL respectively in the limited data base access mode.

4.10.3 HL, LL - Setpoint Limits

These parameters define in Engineering Units the range over which the Resultant Setpoint, SP is allowed to vary. HL and LL affect SP according to the 6366 control loop operating mode thus:-

a) 6366 Control Loop in MANUAL or AUTO

In MANUAL or in AUTO, HL and LL limit the range over which the Local Setpoint, SL, can be varied by the Raise/Lower buttons or either of the serial links. A Setpoint Bias can be added to SL via the SB parameter and the resultant value is again limited by HL and LL before it becomes the Resultant Setpoint SP.

b) 6366 Control Loop in REMOTE

With the 6366 Control loop in REMOTE, the Remote Setpoint from the SR parameter is limited by HL and LL before becoming the SL value.

The range of HL and LL are the same as the Setpoint, i.e. LR to HR, and HL must be greater than LL. If HL is set equal to LL then this locks SL and hence SP to this value and prevents it from being altered by any means. The decimal point position for HL and LL is the same as for the Setpoint, i.e. it is programmed by digit A of the ST parameter as described in Section 4.10.1 a).

HL and LL appear in the Command Parameter list of Table 4.1 under the mnemonic HS and LS respectively in the limited data base access mode.

4.10.4 PV - Process Variable

This parameter defines, in Engineering Units the value of the Process Variable signal that is applied to the PID Block of Section 3.3.8. It appears in the Setpoint Block because it is used to form the Error value, ER and hence the Absolute and Deviation alarms. Also the Local Setpoint, SL, can be made to track the PV under the conditions described in Section 4.10.1 b) (ii).

The Process Variable is scaled by the Setpoint Ranging parameters HR and LR and is automatically adjusted even if it's decimal point position is different from that specified by digit A of the ST parameter. PV appears in the Command Parameter list of Table 4.1 under the same mnemonic in the limited data base access mode.

4.10.5 SP - Resultant Internal Setpoint

This parameter defines, in Engineering Units, the resultant internal Setpoint after Bias has been applied that is linked as an input to an associated PID Control Block as described in Section 3.3.8. Fig. 3.5 shows that SP is effectively the Local Setpoint Value, SL, after Bias has been added and the Setpoint limits HL and LL, and the Rate limit RL have been applied.

The decimal point position for SP is the same as for SL, i.e. it is programmed by digit A of the ST parameter as described in Section 4.10.1 a). Furthermore, SP appears in the Command Parameter list of Table 4.1 under the same mnemonic in the limited data base access mode.

4.10.6 ER - Error Value

The Error Value parameter ER is obtained by subtracting the Resultant Setpoint, SP, from the Process Variable PV as illustrated in Fig 3.5. The ER value is then available for the Deviation Alarm calculations as described in Section 4.10.12. ER is thus in Engineering Units and spans the same range as PV, i.e. 1L to 1H. The decimal point position is programmed by digit A of the ST parameter as described in Section 4.10.1 a).

4.10.7 SL - Local Setpoint

This parameter defines, in Engineering Units, the internal Setpoint before Bias is applied. Fig 3.5 shows that SL can be derived from a number of sources depending upon the operating mode of the 6366, thus:-

a) MANUAL (ST bit 10 = logic 0)

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

b) MANUAL (ST bit 10 = logic 1)

Here SL tracks the Process Variable and cannot be altered but only monitored via the front-panel or serial data links.

c) AUTO

Here SL can be altered as in a) above.

d) REMOTE

Here the 6366 is in REMOTE SETPOINT mode and SL tracks the value of the Remote Setpoint parameter SR. Thus SL cannot be altered but only monitored via the front-panel or serial data links.

e) RATIO

In the RATIO mode SL tracks the Ratio Setpoint SR and can only be monitored via the serial links.

In all these cases SL is constrained within the range defined by the HL and LL Setpoint Limit parameters as described in Section 4.10.3. The decimal point position for SL is the same as for the PV, i.e. it is programmed by digit A of the ST parameter as described in Section 4.10.1 a).

SL appears in the Command Parameter bit of Table 4.1 under the same mnemonic in the limited data base access mode.

4.10.8 **SR - Remote Setpoint**

This parameter defines, in Engineering Units, the Remote Setpoint value before Bias is applied. The SR parameter can be derived from a User calculation or may be linked to the output of another Functional Block such as the Analogue Input, Ratio or Filter Blocks. In all these cases Fig. 3.5 shows that SR is constrained within the range defined by the HL and LL setpoint limit parameters of Section 4.10.3. In the REMOTE or RATIO modes the Local Setpoint, SL, is mode to track the Remote Setpoint value, SR as described in Section 4.10.7. The decimal point position for SR is the same as for SL and is programmed by digit A of the ST parameter as described in Section 4.10.1 a).

4.10.9 **SB - Setpoint Bias**

The SB parameter defines the value of bias in Engineering Units that is added to the Local Setpoint, SL, before it becomes the Resultant Internal Setpoint. Fig. 3.5 shows that after SB is added to SL the resulting value is limited to the Setpoint range defined by the HL and LL parameters of Section 4.10.3. The decimal point position for SB is the same as for SL and is programmed by digit A of the ST parameter as described in Section 4.10.1 a).

4.10.10 **RL - Setpoint Rate Limit**

The RL parameter defines the maximum rate of change in Engineering Units per second to which the Resultant Setpoint, SP, is limited. Fig. 3.5 shows that this rate limiting occurs after Setpoint Bias, SB, has been added and the range of the resultant value has been constrained within the limits defined by HL and LL of Section 4.10.3. The decimal point position of RL is programmed by digit A of the ST parameter as described in Section 4.10.1 a).

4.10.11 HA, LA - Absolute Alarm Limits

The Absolute Alarm Limit parameters HA and LA are used to set the levels, in Engineering Units, at which the PV will generate High or Low Absolute alarms respectively. The Setpoint Block will enter the High Alarm condition if the PV exceeds the value set in HA. Under these conditions the Process Variable bargraph on the front-panel can be made to flash and bit 7 of the ST parameter is set to logic 1 as described in Section 4.10.1 c). The Setpoint Block will enter the Low Alarm condition if the PV is less than the value set in LA. Under these conditions the Process Variable bargraph can be made to flash and bit 6 of the ST parameter is set to logic 1 as described in Section 4.10.1 c).

The range of HA and LA are the same as the Setpoint, i.e. LR to HR. If Absolute alarms are not required they may be disabled by setting HA to the HR value, and LA to the LR value. The decimal point position for HA and LA is the same as for the Setpoint, i.e. it is programmed by digit A of the ST parameter as described in Section 4.10.1 a). HA and LA appear in the Command Parameter list of Table 4.1 under the same mnemonics in the limited data base access mode.

The High and Low alarm conditions are triggered when PV equals the HA or LA settings. However, hysterisis is built in such that the alarm condition is only subsequently cleared when the PV returns to the HA or LA settings less 0.5%.

4.10.12 HD, LD - Deviation Alarm Limits

The Deviation Alarm limit parameters HD and LD are used to set the levels, in Engineering units, at which the Deviation (ER = PV - SP) will generate High or Low Deviation alarms respectively. The Setpoint Block will enter the High Alarm condition if the Positive Deviation (PV - SP) exceeds the value set in HD. Under these conditions the Process Variable bargraph can be made to flash and bit 5 of the ST parameter is set to logic 1 as described in Section 4.10.1 c). The Setpoint Block will enter the Low Alarm condition if the Negative Deviation (SP - PV) exceeds the value set in LD. Under these conditions the Process Variable bargraph can be made to flash and bit 4 of the ST parameter is set to logic 1 as described in Section 4.10.1 c).

It should be noted that HD and LD are always entered as positive numbers with a maximum value equal to the Setpoint span LR to HR. There is no restriction on the relative magnitudes of HD and LD, i.e. LD can be greater than HD for example. If Deviation alarms are not required they may be disabled by setting both HD and LD to the span of LR or HR. The decimal point position for HD and LD is the same as for the Setpoint, i.e. it is programmed by digit A of the ST parameter as described in Section 4.10.1 a).

HD and LD appear in the Command Parameter list of Table 4.1 under the same mnemonics in the limited data base access mode.

COMMAND MNEMONIC	COMMAND PARAMETER FUNCTION	UNITS	FORMAT	PARAMETER TYPE
RB(1) BN(1)	Block Type - BT Relative Block Number 1-2	- -	17 7	Block Header
ST	Block Status	-	5	Status word
HR[HR] LR[LR]	Ratio Setting high limit Ratio Setting low limit	- -	1 1	Limit parameters
RS[RS] RT RB[RB]	Ratio Setting Ratio Trim Ratio Bias	- - Eng	1 1 1	Ratio setting related parameters

TABLE 4.12 List of Ratio (RB) Block Command Parameters and their respective mnemonics

NOTES

(1) These parameters only appear when accessing parameters via the Hand-held terminal.

[xx] These parameters also appear in the short-form parameter list of Table 4.1 with the mnemonic shown in brackets.

d) Block status (digit D)

Only 2 bits of digit D are allocated as follows:-

(i) Bit 3 - RB Block sumcheck failure

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 Ratio Block. This condition is rectified by re-entering any corrupted Block command parameters and re-setting bit 3 to logic 0. This bit corresponds to an ST value of 8 and is read/write.

(ii) Bits 1 and 2

Neither of these bits are allocated.

(iii) Bit 0 - Inverse Ratio mode select

The least-significant bit of digit D is used to select whether the Ratio Block operates in the Normal or Inverse modes. When bit 0 is at logic 0 normal Ratio operation is selected, and when it is at logic 1 the operation is inverted. The effect the Inverse Ratio mode has on the Ratio Setpoint is discussed in Section 3.3.7.

4.11.2 HR, LR - Ratio Setting Limits

These 2 command parameters are used to limit the range over which the Ratio Setting, RS, can be varied. Fig 3.6 shows that RS can be varied by the Raise/Lower buttons or either of the serial links when the controller is in RATIO. If it is in AUTO or MANUAL then RS can only be varied by means of the serial links. Fig 3.6 also shows that HR and LR are used to limit the value of RS after the Ratio Setting Trim has been applied and ratio Bias added. The maximum value that RS can ever achieve will be limited to that programmed into HR, while the minimum value will be LR. If HR is set equal to LR then this locks RS to this value and prevents it from being altered by any means. The range of values for HR and LR is the same as for RS, i.e. -9999 to +9999 and HR must be greater than LR. The decimal point position is programmed by digit A of the ST parameter as described in Section 4.11.1 a).

HR and LR appear in the Command Parameter list of Table 4.1 under the same mnemonics in the limited data base access mode only when RATIO is selected.

4.11.3 RS - Ratio Setting

The RS parameter is the actual value of the Ratio Setting used by the Controller in calculating the Ratio Setpoint as described in Section 3.3.7. Fig 3.6 shows that RS is always constrained within the range defined by the HR and LR Ratio Setting Limit parameters as described in Section 4.11.2. Furthermore RS can be altered by the Raise/Lower buttons or either of the serial links in RATIO, but only via the serial links in AUTO or MANUAL. RS is dimensionless and the decimal point position is programmed by digit A of the ST parameter as described in Section 4.11.1 a).

RS appears in the Command Parameter list of Table 4.1 under the same mnemonic in the limited data base access mode only when RATIO is selected.

4.11.4 RT - Ratio Trim

The RT parameter is the value of Trim that is added to the Ratio Setting, RS, before it is used to generate the Ratio Setpoint as described in Section 3.3.7. Fig. 3.6 shows that RT is always constrained within the range defined by the HR and LR Ratio Setting limit parameters as described in Section 4.11.2. RT is dimensionless and the decimal point position is defined by digit A of the ST parameter as described in Section 4.11.1 a).

4.11.5 RB - Ratio Bias

The RB parameter defines the value of bias in Engineering Units that is added to the Ratio Setpoint as described in Section 3.3.7. The RB parameter is ranged according to the Setpoint Block HR and LR parameters. Its decimal point position is programmed by digit A of the Setpoint Block ST parameter (see Section 4.10.1 a)).

RB appears in the Command Parameter list of Table 4.1 under the same mnemonic in the limited data base access mode only when RATIO is selected.

d) Block status (digit D)

Only 2 bits of digit D are allocated as follows:-

(i) Bit 3 - RB Block sumcheck failure

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 Ratio Block. This condition is rectified by re-entering any corrupted Block command parameters and re-setting bit 3 to logic 0. This bit corresponds to an ST value of 8 and is read/write.

(ii) Bits 1 and 2

Neither of these bits are allocated.

(iii) Bit 0 - Inverse Ratio mode select

The least-significant bit of digit D is used to select whether the Ratio Block operates in the Normal or Inverse modes. When bit 0 is at logic 0 normal Ratio operation is selected, and when it is at logic 1 the operation is inverted. The effect the Inverse Ratio mode has on the Ratio Setpoint is discussed in Section 3.3.7.

4.11.2 **HR, LR - Ratio Setting Limits**

These 2 command parameters are used to limit the range over which the Ratio Setting, RS, can be varied. Fig 3.6 shows that RS can be varied by the Raise/Lower buttons or either of the serial links when the controller is in RATIO. If it is in AUTO or MANUAL then RS can only be varied by means of the serial links. Fig 3.6 also shows that HR and LR are used to limit the value of RS after the Ratio Setting Trim has been applied and ratio Bias added. The maximum value that RS can ever achieve will be limited to that programmed into HR, while the minimum value will be LR. If HR is set equal to LR then this locks RS to this value and prevents it from being altered by any means. The range of values for HR and LR is the same as for RS, i.e. -9999 to +9999 and HR must be greater than LR. The decimal point position is programmed by digit A of the ST parameter as described in Section 4.11.1 a).

HR and LR appear in the Command Parameter list of Table 4.1 under the same mnemonics in the limited data base access mode only when RATIO is selected.

4.11.3 **RS - Ratio Setting**

The RS parameter is the actual value of the Ratio Setting used by the Controller in calculating the Ratio Setpoint as described in Section 3.3.7. Fig 3.6 shows that RS is always constrained within the range defined by the HR and LR Ratio Setting Limit parameters as described in Section 4.11.2. Furthermore RS can be altered by the Raise/Lower buttons or either of the serial links in RATIO, but only via the serial links in AUTO or MANUAL. RS is dimensionless and the decimal point position is programmed by digit A of the ST parameter as described in Section 4.11.1 a).

RS appears in the Command Parameter list of Table 4.1 under the same mnemonic in the limited data base access mode only when RATIO is selected.

4.11.4 **RT - Ratio Trim**

The RT parameter is the value of Trim that is added to the Ratio Setting, RS, before it is used to generate the Ratio Setpoint as described in Section 3.3.7. Fig. 3.6 shows that RT is always constrained within the range defined by the HR and LR Ratio Setting limit parameters as described in Section 4.11.2. RT is dimensionless and the decimal point position is defined by digit A of the ST parameter as described in Section 4.11.1 a).

4.11.5 **RB - Ratio Bias**

The RB parameter defines the value of bias in Engineering Units that is added to the Ratio Setpoint as described in Section 3.3.7. The RB parameter is ranged according to the Setpoint Block HR and LR parameters. Its decimal point position is programmed by digit A of the Setpoint Block ST parameter (see Section 4.10.1 a)).

RB appears in the Command Parameter list of Table 4.1 under the same mnemonic in the limited data base access mode only when RATIO is selected.

4.12 PID Control Block (3T) Parameters

Table 4.13 shows that there are 10 parameters associated with the PID Control Block. The first parameter is the Block Type (BT) mnemonic which is 3T. The second parameter is the Relative Block number (BN) which can take the value 1 or 2 depending upon whether single or dual loop operation is required. Detailed descriptions of the remaining 8 parameter excluding BT and BN are given in the following sections.

4.12.1 ST - Block Status

The Block 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 control the operation of the PID Block and provide status information in the format given below:-

OPERATING MODE												BLOCK STATUS			
Bit 15			Bit 12	Bit 11			Bit 8	Bit 7			Bit 4	Bit 3			Bit 0
Digit A				Digit B				Digit C				Digit D			

DIGIT	BIT	FUNCTION
A	12-15	Unallocated
B	9-11	Unallocated
	8	3-term time constant (TI, TD) range select (0 = secs; 1 = mins)
C	7	Inverse 3-term output select (0 = normal; 1 = inverse)
	6	Integral balance
	5	High Output limit } (0 = normal; 1 = limited)
	4	Low Output limit } (0 = normal; 1 = limited)
D	3	3T Block sumcheck failure bit (0 = O.K.; 1 = fail)
	0-2	Unallocated

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

a) Digit A

This digit is unallocated.

COMMAND MNEMONIC	COMMAND PARAMETER FUNCTION	UNITS	FORMAT	PARAMETER TYPE
3T(1) BN(1)	Block Type - BT Relative Block Number 1-2	- -	17 7	Block Header
ST	Block Status	-	5	Status
XP[XP] TI[TI] TD[TD]	Proportional Band constant Integral Time constant Derivative Time constant	% min/s min/s	4 3 3	PID algorithm constants
FF[FF] FB	Feed-forward term Feed-back term	% %	14 3	PID related terms
OP TS	PID Output Algorithm sampling period	% min/s	3 3	Monitor-only

TABLE 4.13 List of PID Control (3T) Block Command Parameters and their respective mnemonics

NOTES

(1) These parameters only appear when accessing parameters via the Hand-held terminal.

[xx] These parameters also appear in the short-form parameter list of Table 4.1 with the mnemonic shown in brackets.

b) Digit B

Only 1 bit of digit B is allocated as follows:-

(i) Bits 9-11

These bits are unallocated.

(ii) Bit 8 - Time constant range select

The state of this bit determines whether the Integral and Derivative Time constants are ranged in seconds or minutes. When bit 8 is at logic 0 the seconds mode is selected and when it is at logic 1 the minutes mode is selected. This bit corresponds to an ST value of 100 and is read/write.

c) PID Operating mode (digit C)

The 4 bits of digit C are concerned with the operation of the PID Block as follows:-

(i) Bit 7 - Inverse 3-term Output select

The state of this bit determines whether the output of the PID Block, OP, is in the Normal or Inverse operating mode. In the Normal mode (bit 7 = logic 0) the PID Output moves towards full scale to counteract a negative-going Process Variable, i.e. typically when the Setpoint (SP) is greater than the Process Variable (PV). In the Inverse mode (bit 7 = logic 1) the reverse occurs and the PID Output moves towards zero to counteract a negative-going Process Variable. It should be noted that the Output Bargraph and Digital readout will always indicate the actual output as a percentage regardless of the state of bit 7. This bit corresponds to an ST value of 80 and is read/write.

NOTE

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

(ii) Bit 6 - Integral balance

When bit 6 is set to a logic 1 it forces the CPU to perform an integral balance next time the PID Block is scheduled. When this has been done bit 6 is automatically reset to logic 0. This bit corresponds to a ST value of 40 and is read/write.

(iii) Bits 4 and 5 - Output limited

The two least-significant bits of digit C are used to indicate when the PID Output value has reached a High or Low Output limit. These conditions are detected by comparing the PID Output value OP with the fed back value FB after any absolute or rate limits have been applied. Bits 4 and 5 are at logic 0 under normal operating conditions. If the PID Output value OP is greater than FB Bit 5 is set to logic 1 and when OP is less than FB bit 4 is set to logic 1. Bits 4 and 5 correspond to ST values of 10 and 20 respectively and are read-only.

d) Block Status (digit D)

Only 1 bit of digit D is allocated as follows:-

(i) Bit 3 - 3T Block sumcheck failure

This bit is automatically set to a logic 1 by the CPU whenever a sumcheck failure is detected on any of the parameters associated with the PID Output Block. This condition is rectified by re-entering any corrupted Block command parameters and re-setting bit 3 to logic 0. Bit 3 corresponds to an ST value of 8 and is read/write.

(ii) Bits 0 to 2

None of these bits are allocated.

4.12.2 XP - Proportional band constant

The XP parameter defines the overall gain of the PID Control Block as described in Section 3.3.8. The exact relationship between XP and the gain is given by the expression:-

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

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.

XP appears in the Command Parameter list of Table 4.1 under the same mnemonic in the limited data base access mode.

4.12.3 **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 6366 3-Term algorithm described in Section 3.3.8. They are both format 3 parameters and their range depends upon the logic state of bit 8 of the ST Status parameter as described in Section 4.12.1 b) (ii). The effect this status bit has is as follows:-

a) ST bit 8 = logic 0 - seconds mode.

In the seconds mode both TI and TD can be set over the range 0.01 to 99.99 seconds, while a value of 00.00 disables the terms.

b) ST bit 8 = logic 1 - minutes mode.

In the minutes mode both TI and TD can be set over the range 0.01 to 99.99 minutes, while a value of 0.00 disables the terms.

TI and TD appear in the Command Parameter list of Table 4.1 under the same mnemonics in the limited data base access mode.

4.12.4 **FF - Feed Forward Term**

The FF parameter effectively defines the value of bias that is added to the output of the PID calculation. Fixed function Controllers like the 6350 or 6360 have FF terms fixed at 50% in their PID algorithms. Table 4.13 shows that FF is a format 14 parameter and is thus bipolar with a range of -99.99 to +99.99%.

FF appears in the Command Parameter list of Table 4.1 under the same mnemonic in the limited data base access mode.

4.12.5 **FB - Feed-back Term**

The PID output value, OP, is usually linked to a Manual Station Block so that output absolute or rate limits can be applied. The resultant limited output is then linked back to the PID calculation via the Feed-back parameter, FB. This allows the conditions of high or low output limiting to be detected and the appropriate integral de-saturation strategies to be applied. Fig. 4.13 shows that FB is a format 3 parameter and is thus always positive with a range of 0 to 99.99%.

4.12.6 **OP - 3-Term Output Level**

The OP parameter is the output value of the 3-Term control algorithm after Feed-forward bias has been added as a percentage of the full scale operating range of 0 to 99.99%. OP is not limited within the PID Control Block itself, but the value of the Feed-back term, FB is used to determine whether limits have been reached and these conditions are indicated by bits 4 and 5 of the ST parameter as described in Section 4.12.1 c) (iii).

4.13 Manual Output Station Block (MS) Parameters

Table 4.14 shows that there are 10 parameters associated with the Manual Output Station Block. The first parameter is the Block Type (BT) mnemonic which is MS. The second parameter is the Relative Block number (BN) which can take the value 1 or 2 depending upon whether single or dual loop operation is required. Detailed descriptions of the remaining 8 parameters excluding BT and BN are given in the following Sections.

4.13.1 ST - Block Status

The Block 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 provide information concerning the operation and status of the Block in the format given below:-

								OPERATING MODE				BLOCK STATUS			
Bit 15							Bit 8	Bit 7			Bit 4	Bit 3			Bit 0
Digit A				Digit B				Digit C				Digit D			

DIGIT	BIT	FUNCTION
A	12-15	Unallocated
B	8-11	Unallocated
C	7	Inverse Output mode select (0 = normal; 1 = inverse)
	4-6	Unallocated
D	3	MS Block sumcheck failure bit (0 = O.K.; 1 = fail)
	0-2	Unallocated

The exact function of the digits within the ST parameter are described in the following Sections:-

a) Digits A and B

These are unallocated.

b) Operating mode (digit C)

Only 1 bit of digit C is allocated to provide operating mode information as follows:-

COMMAND MNEMONIC	COMMAND PARAMETER FUNCTION	UNITS	FORMAT	PARAMETER TYPE
MS(1) BN(1)	Block Type - BT Relative Block Number 1-2	- -	17 7	Block Header
ST	Block Status	-	5	Status word
HV LV HL LL	High velocity/Rate limit Low velocity/Rate limit High output limit Low output limit	%/s %/s % %	3 3 3 3	Output limit settings
AO OP OT	Analogue output Output demand Output Tracking value	% % %	3 3 3	Output related parameters

TABLE 4.14 List of Manual Output Station (MS) Block Command Parameters and their respective mnemonics

NOTE

(1) These parameters only appear when accessing parameters via the Hand-held terminal.

(i) Bit 7 - Inverse Output mode select

The most-significant bit of digit C is used to indicate whether the Manual Output Station is operating in the Normal or Inverse Output modes. When bit 7 is set to logic 0 the normal mode is selected, and when it is set to logic 1 Reverse mode is selected. The mode selection itself is carried out by switch bank S2 switch numbers 7 or 8 as described in Section 2.3.2 b) (iii). The actual switch used depends upon the Relative Block number, thus:-

Manual Station 1 (BN = 1) uses S2 no. 8
Manual Station 2 (BN = 2) uses S2 no. 7

Bit 7 is therefore read-only and corresponds to an ST value of 80.

(ii) Bits 4 to 6

None of these bits are allocated.

c) Block Status (digit D)

Only 1 bit of digit D is allocated as follows:-

(i) Bit 3 - MS Block sumcheck failure

This bit is automatically set to a logic 1 by the CPU whenever a sumcheck failure is detected on any of the parameters associated with the Manual Output Station Block. This condition is rectified by re-entering any corrupted Block Command parameters and re-setting bit 3 to logic 0. Bit 3 corresponds to an ST value of 8 and is read/write.

(ii) Bits 0 to 2

None of these bits are allocated.

4.13.2 HV, LV - Velocity/Rate Limits

The HV and LV parameters are used to limit the Velocity or Rate of Change of the Analogue Output parameter, AO. The High Velocity/Rate limit, HV, represents the maximum rate of change that AO can achieve while increasing, while the Low Velocity/Rate limit, LV, represents the maximum rate of change that AO can achieve while decreasing. Table 4.14 shows that HV and LV are format 3 parameters and span the range 0 to 99.99% per second.

4.13.3 **HL, LL - Output Limits**

The HL and LL parameters are used to limit both the Output demand parameter, OP and the Analogue Output parameter AO. 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 supplied from another Functional block in AUTO. OP is also limited to the range LL to HL when the block is in TRACK mode and the tracking value is supplied by the OT parameter. Table 4.14 shows that HL and LL are set in percent over the full scale operating range of 0 to 99.99% and HO should always be set greater than LO.

4.13.4 **AO - Analogue Output**

The AO parameter represents the resultant output value produced by the Manual Output Station Block. AO is effectively updated from the OP parameter, as shown in Fig. 3.9, and is then limited by the Rate limit and Output limit parameters HV, LV and HL, LL respectively. The AO value would normally be linked to the Master Station 1 or 2 outputs of pins 32 and 33 and would be fed back to the PID Block as the FB parameter of Section 4.12.5. Table 4.14 shows that AO is a format 3 parameter set in percent over the full-scale operating range of 0 to 99.99%.

4.13.5 **OP - Output Demand**

The OP parameter represents the demanded output level fed into the Manual Output Station Block after limiting by HL and LL of Section 4.13.3. The value of OP is varied from different sources depending upon the loop operating mode as follows:-

a) TRACK mode

In the TRACK mode OP is updated from the OT parameter of Section 4.13.6.

b) MANUAL mode

In the MANUAL mode the value of OP can be varied by the Raise/Lower buttons or either of the serial links.

c) AUTO, REMOTE or RATIO mode

In any of these operating modes the value of OP is supplied from another Functional Block such as the output, OP, of the PID Control Block of Section 4.12.6.

Table 4.14 shows that OP is a format 3 parameter set in percent over the full-scale operating range of 0 to 99.99%.

4.13.6 **OT - Output Tracking Value**

The OT parameter is used to update the value of OP when the Control loop is in the TRACK mode, and Table 4.14 shows that it is a format 3 parameter set in percent over the full-scale operating range of 0 to 99.99%.

4.14 Display and Control Status Block (DC) Parameters

Table 4.15 shows that there are 9 parameters associated with the Display and Control Status Block. The first parameter is the Block Type (BT) mnemonic which is DC. The second parameter is the Relative Block Number (BN) which can take the value 1 or 2 depending upon whether single or dual loop operation is required. Detailed descriptions of the remaining 7 parameters excluding BT and BN are given in the following Sections. It can be seen from Table 4.15 that these 7 parameters are all of the format 5 type and consist of 4 hexadecimal digits in the range 0000 to FFFF with a positive sign character for parameter entry.

4.14.1 ST - Block Status

The Block Status parameter, ST, is used to provide information concerning the operation of the associated loop in the format given below:-

LOOP OPERATING MODE												BLOCK STATUS			
Bit 15			Bit 12	Bit 11			Bit 8	Bit 7			Bit 4	Bit 3			Bit 0
Digit A				Digit B				Digit C				Digit D			

DIGIT	BIT	FUNCTION	READ/WRITE STATUS
	15	HOLD mode selected	Read-only
A	14	TRACK mode selected	Read-only
	13	MANUAL mode selected	Read/write
	12	AUTO mode selected	Read/write
	11	REMOTE/RATIO mode selected	Read/write
B	10	REMOTE/RATIO enable	Read-only
	9	RATIO mode configured	Read-only
	8	Unallocated	-
	7	Unallocated	-
C	6	AUTO mode active (1)	Read-only
	5	HOLD/MANUAL mode active (0)	Read-only
	4	REMOTE/RATIO mode active (0)	Read-only
	3	DC Block sumcheck failure bit (0 = O.K.; 1 = fail)	Read/write
D			
	0-2	Mode number (0-7)	Read/write

The exact functions of the digits within the ST parameter are described in the following Sections:-

COMMAND MNEMONIC	COMMAND PARAMETER FUNCTION	UNITS	FORMAT	PARAMETER TYPE
DC(1) BN(1)	Block Type - BT Relative Block Number 1-2	- -	17 7	Block Header
ST[MN]	Block Status	-	5	Status word
1B 2B 3B DD	Bargraph 1 data source Bargraph 2 data source Bargraph 3 data source Digital display data source	- - - -	5 5 5 5	Display selection parameters
ES SM	Enable status word Front-panel switch mask	- -	5 5	Status words

TABLE 4.15 List of Display and Control Status (DC) Block Command parameters and their respective mnemonics

NOTES

(1) These parameters only appear when accessing parameters via the Hand-held terminal.

[xx] This parameter also appears in the short-form parameter list of Table 4.1 with the mnemonic shown in brackets.

a) Control Loop Operating Mode (digits A, B and C)

The first 3 digits of the ST command parameter A, B and C corresponding to bits 4 to 15 inclusive indicate the current Operating Mode of the 6366 control loop. The functions of each of these 12 bits are described below:-

(i) Bit 15 - HOLD

The most-significant bit of digit A is set to a logic 1 whenever the control loop is in the HOLD mode, i.e. when bit 7 of the ES parameter is at logic 0. This bit, corresponding to an ST value of 8000 is read-only.

(ii) Bit 14 - TRACK

The second bit of digit A is set to a logic 1 whenever the control loop is in the TRACK mode, i.e. when bit 6 of the ES parameter is at logic 1. This bit, corresponding to an ST value of 4000 is read-only.

(iii) Bit 13 - MANUAL

The third bit of digit A is set to a logic 1 whenever the control loop is in the MANUAL mode. 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 2000 for the ST command parameter. It is also automatically set to logic 1 whenever bit 0 of the ES parameter is set to logic 1.

(iv) Bit 12 - AUTO

The least-significant bit of digit A is set to a logic 1 whenever the control loop is operating in the AUTO mode. 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 1000 for the ST command parameter. It is also automatically set to logic 1 whenever bit 1 of the ES parameter is set to logic 1.

(v) Bit 11 - REMOTE/RATIO

The most-significant bit of digit B is set to a logic 1 whenever the control loop is operating in the REMOTE AUTO or RATIO modes. This bit is a read/write bit so that the control loop may be set to the REMOTE AUTO or RATIO modes by entering a value of 800 for the ST command parameter. It is also automatically set to logic 1 whenever bit 2 of the ES parameter is set to logic 1.

(vi) Bit 10 - REMOTE/RATIO mode enabled

The second bit of digit B is set to a logic 1 whenever the Remote/Ratio Setpoint has been enabled by setting bit 5 of the ES parameter to logic 1. This bit corresponding to an ST value of 400 is read-only.

(vii) Bit 9 - REMOTE/RATIO mode configured

The third bit of digit B is automatically set by the 6366 control program to indicate how the control loop has been configured. This bit is set to logic 1 whenever the word RATIO is encountered in the program, and it is reset to logic 0 by the word REMOTE. This bit corresponding to an ST value of 200 is read-only.

(viii) Bits 7 and 8

None of these bits are allocated.

(ix) Bit 6 - AUTO mode active (1)

The second bit of digit C is set to a logic 1 whenever the control loop is operating in the AUTO mode. This bit is read-only and corresponds to an ST value of 40.

(x) Bit 5 - HOLD or MANUAL mode active (0)

The third bit of digit C is set to logic 0 when the control loop is operating in either the HOLD or MANUAL modes. It is set to logic 1 in all other operating modes. Bit 5 is read-only and corresponds to an ST value of 20.

(xi) Bit 4 - REMOTE or RATIO mode active (0)

The least-significant bit of digit C is set to logic 0 whenever the REMOTE or RATIO operating modes have been selected. It is set to logic 1 in all other operating modes. Bit 4 is read-only and corresponds to an ST value of 10.

b) Block Status (digit D)

The most-significant digit of the ST parameter provides Block Status information as follows:-

(i) Bit 3 - DC Block sumcheck failure

The most-significant bit of digit D is set to logic 1 whenever a sumcheck failure occurs on any of the Display and Control Status Block command parameters listed in Table 4.15. The condition is rectified by re-entering any corrupted parameters and re-setting bit 3 to logic 0. This bit corresponds to an ST value of 8 and is read/write.

(ii) Bits 0, 1 and 2 - Control loop operating mode

The function of these 3 bits is to give the supervisory computer a direct indication of which of the 7 operating modes are currently active. The significance of each of these mode numbers is as follows:-

Bit 2	Bit 1	Bit 0	Mode Number	6366 Operating Mode
0	0	0	0	HOLD
0	0	1	1	TRACK
0	1	0	2	MANUAL
0	1	1	3	AUTO (Local Setpoint)
1	0	0	4	RATIO
1	0	1	5	REMOTE AUTO (Cascade)
1	1	0	6	FORCED MANUAL
1	1	1	7	AUTO FALL-BACK (from REMOTE or RATIO)

Each of the 6366 operating modes indicated by bits 0, 1 and 2 of the ST parameter can be controlled via the serial data link as follows:-

1) Modes 0 and 1 cannot be selected and are read-only.

2) Modes 2 and 3 can be selected.

3) Mode 4 can be selected only in RATIO, i.e. ST bits 9 and 10 are at logic 1.

4) Mode 5 can only be selected in REMOTE, i.e. ST bit 10 is at logic 1 and bit 9 is at logic 0.

5) Mode 6 cannot be selected and is read-only.

6) Mode 7 is selected automatically by the 6366 if modes 4 or 5 are entered and ST bit 10 is reset to logic 0.

ST appears in the command parameter list of Table 4.1 under the mnemonic MN in the limited data base access mode.

4.14.2 1B, 2B, 3B, DD - Display Data Sources

The 4 parameters 1B, 2B, 3B and DD are used to specify the source of data for bargraph 1, 2, 3 and the digital readout respectively. They all have the same format as shown below:-

BLOCK TYPE				BLOCK NUMBER				PARAMETER NUMBER				FLASH DISPLAY			
Bit 15											Bit 4	Bit 3			Bit 0
Digit A				Digit B				Digit C				Digit D			

DIGIT	BIT	FUNCTION
A	12-15	Block Type (0 to E)
B	8-11	Relative Block number (1 to 3)
C	4-7	Parameter number (0 to F)
D	1-3	Unallocated
	0	Flash display (0 = steady; 1 = flash)

The exact functions of the digits within the 1B, 2B, 3B or DD parameters are described in the following Sections:-

a) Block Type (digit A)

The most-significant digit of the 1B, 2B, 3B or DD parameters is used to define the Block Type of the source of the display. This digit varies from 0 to E and corresponds to the Block Type mnemonics GP to TB as listed in the first 2 columns of Table 4.3.

b) Relative Block number (digit B)

The second digit of the 1B, 2B, 3B or DD parameters is used to define the Relative Block number to be used for the source of the display. This digit varies from 1 to 3 depending upon the exact Block type (BT). The range of Relative Block numbers (BN) for each Block Type is indicated in the third column of Table 4.3 and further information is given in Section 4.4.2.

c) Parameter number (digit C)

The third digit of the 1B, 2B, 3B or DD parameters is used to specify the actual parameter to be used as the source of the display. This digit varies from 0 to F to specify the parameters within each Block type according to the scheme illustrated in Table 3.1.

d) Digit D

Only 1 bit of digit D is allocated as follows:-

(i) Bits 1, 2 and 3

All 3 of these bits are unallocated.

(ii) Bit 0 - Flash display

Bit 0 of the 1B, 2B, 3B or DD parameter is used to flash the Bargraph 1, 2, 3 or the digital readout respectively. When bit 0 is at logic 0 the display is steady, and when it is at logic 1 the display flashes.

The following examples illustrate the use of the 1B, 2B, 3B and DD parameters:-

1) 1B > 1140 - This causes the channel 1 Analogue Variable 1V of the Analogue Input Block to be displayed on the left-hand bargraph.

2) 2B > 5280 - This causes the loop 2 Local Setpoint, SL, of the Setpoint Block to be displayed on the right-hand bargraph.

3) 3B > 8160 - This causes the Manual Output Station 1 output, OP, to be displayed on the horizontal bargraph.

4) DD > 1241 - This causes the channel 2 Analogue Variable 2V of the Analogue Input Block to be displayed flashing on the 4 digit readout.

4.14.3 ES - Enable Status Word

The Enable Status word parameter, ES, is used to select the operating mode of either of the control loops contained within the 6366. The format of the ES parameter is shown below:-

INDIVIDUAL BIT MASKS								CONTROL LOOP OPERATING MODE							
Bit 15							Bit 8	Bit 7							Bit 0
Digit A				Digit B				Digit C				Digit D			

DIGIT	BIT	FUNCTION		READ/WRITE STATUS
	15	Bit 7 mask	mask bits for bits 0 to 7 (0 = enable; 1 = mask)	Write-only
A	14	Bit 6 mask		
	13	Bit 5 mask		
	12	Bit 4 mask		
	11	Bit 3 mask		
B	10	Bit 2 mask		
	9	Bit 1 mask		
	8	Bit 0 mask		
	7	HOLD enable (0)		Read/write
C	6	TRACK enable (1)		Read/write
	5	REMOTE/RATIO setpoint enable (1)		Read/write
	4	Unallocated		
	3	FORCED MANUAL select (1)		Read/write
D	2	REMOTE select		Write-only
	1	AUTO select		Write-only
	0	MANUAL select		Write-only

The exact functions of the digits within the ES parameter are described in the following Sections:-

a) Bits masks (digit A and B)

Each bit of digit A and B is set to a logic 1 when it is required that the corresponding bit in the low byte (digits C and D) should be masked from changes via the Hand-held terminal, RS422 data link, or a User program. The most-significant bit of digit A (bit 15) masks the most-significant bit of digit C (bit 7), and the least-significant bit of digit B (bit 8) masks the least-significant bit of digit D (bit 0) and so on. When any bit of digit A or B is set to a logic 0 then this enables changes to be made to the corresponding bit of digit C or D via the serial data links or a User program.

The 8 mask bits of digit A and B are write-only which means that they are reset to zero as soon as the ES parameter is entered and executed and they always read back as zero. This feature allows any one of the bits in the lower byte to be changed without having to read them all back first to ensure that the other bits are not affected. Any delays between the reading and subsequent writing could allow the bits to be altered from other sources and result in a conflict situation. Thus all 16 bits of ES are written to every time with the guarantee that only the bits specified will be changed.

b) Control loop operating mode (digits C and D)

The low byte of the ES parameter is divided into individual bits for setting the control loop operating mode as follows:-

(i) Bit 7 - HOLD enable (0)

When set to logic 0 this bit causes the control loop to enter the HOLD condition, and when set to logic 1 it is released from HOLD and can enter the operating mode with the next highest priority. Bit 7 corresponds to an ES value of 80 and is read/write. Whenever it is set to logic 0 it causes bit 15 of the ST parameter of the DC Block to be set to logic 1 and the mode number is set to 0 (see Section 4.14.1 a) (i)).

(ii) Bit 6 - TRACK enable (1)

When set to logic 1 this bit causes the control loop to enter the TRACK mode, and when set to logic 0 it is released from TRACK and can enter the operating mode with the next highest priority. Bit 6 corresponds to an ES value of 40 and is read/write. Whenever it is set to logic 1 it causes bit 14 of the ST parameter of the DC Block to be set to logic 1 (see section 4.14.1 a) (ii)), and the mode number is set to 1.

(iii) Bit 5 - REMOTE/RATIO setpoint enable (1)

When set to logic 1 this bit enables the Setpoint Block to use the Remote/Ratio Setpoint instead of the Local value provided the appropriate mode has been configured by bit 11 of the ST parameter of the DC Block and either REMOTE or RATIO mode operation has been selected. When bit 5 is set to logic 0 the Local Setpoint value is used by the Setpoint Block. Bit 5 corresponds to an ES value of 20 and is read/write, and whenever it is set to logic 1 it causes bit 10 of the ST parameter of the DC Block to be set to logic 1 (see Section 4.14.1 a) (vi)).

(iv) Bit 4

The least-significant bit of digit C is unallocated.

(v) Bit 3 - FORCED MANUAL select (1)

When set to logic 1 this bit causes the control loop to enter the FORCED MANUAL mode, and when set to logic 0 it is released from FORCED MANUAL and can enter the operating mode with the next highest priority. Bit 3 corresponds to an ES value of 8 and is read/write and whenever it is set to logic 1 it causes the mode number of the ST parameter of the DC Block to be set to 6 (see Section 4.14.1 b) (ii)).

(vi) Bit 2 - REMOTE select

When set to logic 1 this bit causes the control loop to enter the REMOTE mode provided that bit 5 is at logic 1 and bit 9 of the ST parameter of the DC Block is at logic 1. Bit 2 is automatically reset and will subsequently read back as logic 0. Bit 2 corresponds to an ES value of 4 and is write-only so that it always reads back as zero. Whenever it is set to logic 1 it causes the mode number of the ST parameter of the DC Block to be set to 5 (see Section 4.14.1 b) (ii)).

(vii) Bit 1 - AUTO select

When set to logic 1 this bit causes the control loop to enter the AUTO mode. Bit 1 is automatically reset and will subsequently read back as logic 0. Bit 1 corresponds to an ES value of 2 and is write-only so that it always reads back as zero. Whenever it is set to logic 1 it causes the mode number of the ST parameter of the DC Block to be set to 3 (see Section 4.14.1 b) (ii)).

(viii) Bit 0 - MANUAL select

When set to logic 1 this bit causes the control loop to enter the MANUAL mode. Bit 0 is automatically reset and will subsequently read back as logic 0. Bit 0 corresponds to an ES value of 1 and is write-only so that it always reads back as zero. Whenever it is set to logic 1 it causes the mode number of the ST parameter of the DC Block to be set to 2 (see Section 4.14.1 b) (ii)).

The use of the ES parameter can best be illustrated by the following examples:-

ES > FE01 - Here only bit 0 is unmasked by the high byte and so it will set the Control loop to MANUAL mode.

ES > FEFF - Because the mask pattern is unchanged this will also set the Control loop to MANUAL mode.

ES > 7F00 - This unmasks bit 7 and writes it to a zero so setting the Control loop into HOLD.

SM parameter - digit D				Front-panel push-buttons		
bit 2	bit 1	bit 0	mask level value	Remote/ Ratio (R)	Auto (A)	Manual (M)
0	0	0	0	Enabled	Enabled	Enabled
0	0	1	1	Enabled	Enabled	Disabled
0	1	0	2	Enabled	Disabled	Enabled
0	1	1	3	Enabled	Disabled	Disabled
1	0	0	4	Disabled	Enabled	Enabled
1	0	1	5	Disabled	Enabled	Disabled
1	1	0	6	Disabled	Disabled	Enabled
1	1	1	7	Disabled	Disabled	Disabled

TABLE 4.16 Front-Panel Push-Button Masking Levels

4.14.4 SM - Front-panel switch mask

The Front-panel switch mask parameter, SM, is used to inhibit the 3 Front-panel control mode push-buttons Remote (R), Auto (A), and Manual (M) from being used by an operator. The format of the SM parameter is shown below:-

												← PUSH-BUTTON MASKING			→
Bit 15											Bit 4	Bit 3			Bit 0
Digit A				Digit B				Digit C				Digit D			

DIGIT	BIT	FUNCTION	
A	12-15	Unallocated	
B	8-11	Unallocated	
C	4-7	Unallocated	
D	3	Unallocated	
	2	Remote (R) button disable	(0 = enable; 1 = disable)
	1	Auto (A) button disable	
	0	Manual (M) button disable	

The exact functions of the digits within the SM parameter are described in the following Sections:-

a) Digits A, B and C

All 3 of these digits are unallocated.

b) Digit D

The individual bits of digit D are used for push-button masking as follows:-

(i) Bit 3

This bit is unallocated.

(ii) <u>Bits 0, 1, 2 - Mask level</u>

The 3 least-significant bits, 0, 1 and 2 of digit D are used to specify a mask level of 0 to 7 which affects the 3 front-panel control mode select push-buttons R, A and M as shown in Table 4.16. For example, a mask level of 0 enables all 3 buttons, while a mask value of 6 only permits the Manual (M) button to be operated. It can be seen from Table 4.16 that the 3 bits correspond to the 3 push-buttons thus:-

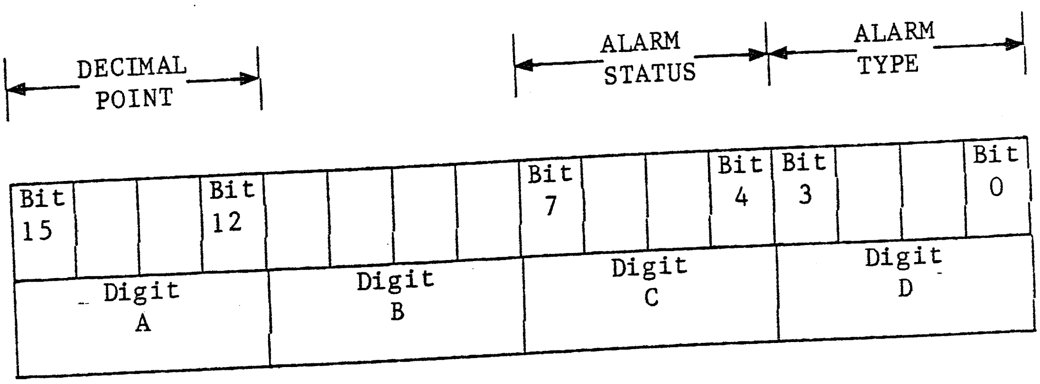
Bit 0 masks the Manual (M) button
Bit 1 masks the Auto (A) button
Bit 2 masks the Remote (R) button

4.15 Alarm Block (AB) Parameters

Table 4.17 shows that there are 10 parameters associated with the alarm block. The first parameter is the Block Type (BT) mnemonic which is AB. The second parameter is the Relative Block Number (BN) which is 1 or 2 depending upon whether single or dual-loop operation is being used. Detailed descriptions of the remaining 8 parameters excluding BT and BN are given in the following sections:-

4.15.1 ST - Block Status

The Block 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 provide Alarm status indication and select the alarm block type as indicated below:-



DIGIT	BIT	FUNCTION
A	15	Unallocated
	12-14	Decimal point position select (0 to 4)
B	8-11	Unallocated
C	7	HV alarm bit } (0 = O.K.; 1 = alarm)
	6	LV alarm bit
	5	HL alarm bit
	4	LL alarm bit
D	3	AB Block sumcheck failure bit (0 = O.K.; 1 = fail)
	2	Unallocated
	0-1	Alarm Block type

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

COMMAND MNEMONIC	COMMAND PARAMETER FUNCTION	UNITS	FORMAT	PARAMETER TYPE
AB(1) BN(1)	Block Type - BT Relative Block Number 1-2	- -	17 7	Block Header
ST	Block Status	-	5	Status word
HV LV HL LL	High value alarm limit Low value alarm limit High alarm limit Low alarm limit	Eng Eng Eng Eng	1 1 1 1	Alarm settings
PV SP AH	Alarm Process Variable Alarm Setpoint Alarm hysteresis	Eng Eng Eng	1 1 2	Alarm related parameters

TABLE 4.17 List of Alarm (AB) Block Command Parameters and their respective mnemonics

NOTE

(1) These parameters only appear when accessing parameters via the Hand-held terminal.

a) Decimal Point Selection (Digit A)

The most-significant digit of the ST parameter is used to select the decimal point position for all the alarm related parameters. The number entered must lie within the range 0 to 4 (bit 15 is always 0) and will position the decimal point according to the table given in Section 4.6.1 a). 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 alarm settings. This means in fact that all of the Format 1 and 2 parameters listed in Table 4.17 will be displayed with the same decimal point position, viz:-

HV, LV, HL, LL, PV, SP, AH

b) Digit B

This digit is unallocated.

c) Alarm Status (Digit C)

The 4 bits of digit C are used to indicate the alarm status of the 4 alarm setting parameters as follows:-

Bit 7 is the HV alarm bit
Bit 6 is the LV alarm bit
Bit 5 is the HL alarm bit
Bit 4 is the LL alarm bit

Each bit is normally at logic 0 but is set to logic 1 whenever the corresponding alarm setting parameter causes an alarm condition to be generated. These 4 bits are read-only and correspond to ST values of 80, 40, 20 and 10 respectively.

d) Block Type (Digit D)

The 4 bits of the least-significant digit of the ST parameter are allocated as follows:-

(i) Bit 3 - AB Block Sumcheck failure

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 Alarm Block. This condition is rectified by re-entering any corrupted Block command parameters and re-setting bit 3 to logic 0. Bit 3 is read/write and corresponds to an ST value of 8.

(ii) Bit 2

This bit is unallocated and read back as zero.

(iii) Bits 0 and 1 - Alarm Block type

These 2 bits determine what type of alarm function is defined by the alarm setting parameters HV, LV, HL and LL according to the following table:-

Bit 1	Bit 0	Digit D Value	Alarm Type Selected
0	0	0	Alarms disabled
0	1	1	Absolute alarms
1	0	2	Deviation alarms
1	1	3	Rate/Velocity alarms

Bits 0 and 1 are read/write and correspond to ST parameter values as shown above.

4.15.2 HV, HL - High Alarm Limits

The Alarm Block has 2 separate High Alarm parameters, HV and HL which are completely independent and may be used for HI/EXTRA HI Alarm type strategies etc. HV and HL may be used as Absolute, Deviation or Rate Alarms or disabled completely depending upon the settings of bits 0 and 1 of the ST parameter (see Section 4.15.1 d) (iii)). When a High Alarm condition occurs HV sets bit 7 of the ST parameter and HL sets bit 5 as described in Section 4.15.1 c). HV and HL are both set in Engineering units with their decimal point programmed by digit A of the ST parameter as described in Section 4.15.1 a).

4.15.3 LV, LL - Low Alarm Limits

The Alarm Block has 2 separate Low Alarm parameters, LV and LL which are completely independent and may be used for LO/EXTRA LO Alarm type strategies etc. LV and LL may be used as Absolute, Deviation or Rate Alarms or disabled completely depending upon the settings of bits 0 and 1 of the ST parameter (see Section 4.15.1 d) (iii)). When a Low Alarm condition occurs LV sets bit 6 of the ST parameter and LL sets bit 4 as described in Section 4.15.1 c). LV and LL are both set in Engineering units with their decimal point programmed by digit A of the ST parameter as described in Section 4.15.1 a).

4.15.4 PV - Alarm Process Variable

The alarm Process Variable, PV, is linked into the Alarm Block from other Functional Blocks such as the Analogue Input Block in order to generate the various alarm conditions. The Alarm Process Variable is scaled by the Setpoint Ranging parameters HR and LR of Section 4.10.2.

4.15.5 SP - Alarm Setpoint

The Alarm Block has a Setpoint SP associated with it so that Deviation Alarms can be generated. Thus when Deviation Alarms are specified (ST bit 1 = 1, bit 0 = 0) an Error value is formed from the expression:-

ER = PV - SP

- and this is checked against the High and Low alarm settings. The value of SP may be specified from a User program or either of the Serial data links. The SP decimal point position is defined by digit A of the ST parameter.

4.15.6 AH - Alarm Hysterisis

The Alarm Block has the facility to specify the required value of hysterisis used by the 4 Alarm Setting parameters HV, LV, HL and LL. AH is a format 2 parameter and is set in Engineering Units over the range 0 to 9999 with the decimal point position defined by digit A of the ST parameter.

COMMAND MNEMONIC	COMMAND PARAMETER FUNCTION	UNITS	FORMAT	PARAMETER TYPE
CB(1) BN(1)	Block Type - BT Relative Block Number 1-2	- -	17 7	Block Header
ST	Block Status	-	5	Status word
1K[1K] 2K[2K] 3K[3K] 4K[4K]	Constant 1 Constant 2 Constant 3 Constant 4	- - - -	1 1 1 1	User constants
US[US]	User status word	-	5	Status word

TABLE 4.18 List of Constants (CB) Block Command Parameters and their respective mnemonics

NOTES

(1) These parameters only appear when accessing parameters via the Hand-held terminal.

[xx] These parameters also appear in the short-form parameter list of Table 4.1 with the mnemonic shown in brackets.

4.16 Constants Block (CB) Parameters

Table 4.18 shows that there are 8 parameters associated with the Constants Block. The first parameter is the Block Type (BT) mnemonic which is CB. The second parameter is the Relative Block Number (BN) which is 1 or 2 depending upon whether single or dual-loop operation is being used. Detailed descriptions of the remaining 6 parameters excluding BT and BN are given in the following sections.

4.16.1 ST - Block Status

The Block 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. Each digit is used to program the decimal point position for the 4 Constants as indicated below:-

1K DECIMAL POINT				2K DECIMAL POINT				3K DECIMAL POINT				4K DECIMAL POINT			
Bit 15			Bit 12	Bit 11			Bit 8	Bit 7			Bit 4	Bit 3			Bit 0
Digit A				Digit B				Digit C				Digit D			

DIGIT	BIT	FUNCTION
A	15	Unallocated
	12-14	1K decimal point position select (0 to 4)
B	11	Unallocated
	8-10	2K decimal point position select (0 to 4)
C	7	Unallocated
	4-6	3K decimal point position select (0 to 4)
D	3	CB Block sumcheck failure bit (0 = O.K.; 1 = fail)
	0-2	4K decimal point position select (0 to 4)

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

a) 1K, 2K, 3K Decimal Point Selections (Digits A, B, C)

The most-significant bit of digits A, B and C, i.e. bits 15, 11 and 7 are all unallocated. Bits 12-14 of digit A, bits 8-10 of digit B and bits 4-6 of digit C are used to select the decimal point position according to the table given in Section 4.6.1 a).

b) 4K Decimal Point Selection (Digit D)

The least-significant digit of the ST parameters serves two functions as follows:-

(i) Bit 3 - CB Block Sumcheck Failure

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 Constants Block. This condition is rectified by re-entering any corrupted Block Command parameters and re-setting bit 3 to logic 0. Bit 3 is read/write and corresponds to an ST value of 8.

(ii) Bits 0 to 2 - 4K Decimal Point Selection

Bits 0-2 of digit D are used to select the decimal point position for the 4K Constants parameter. The number entered must lie within the range 0 to 4 and will position the decimal point according to the table given in Section 4.6.1 a).

4.16.2 1K, 2K, 3K, 4K - Constants 1, 2, 3 and 4

The four Constants parameters 1K, 2K, 3K and 4K can all span the range -9999 to +9999 with their decimal point positions specified by digits A, B, C and D of the ST parameter respectively (see Section 4.16.2). These parameters may be accessed by a User program and can also be read or updated via the Hand-held terminal or RS 422 data link.

1K, 2K, 3K and 4K appear in the Command Parameter list of Table 4.1 under the same mnemonics in the limited data base access mode.

4.16.3 US - User Status Word

The User Status word parameter, US, 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. The 2 least-significant digits of the US parameter provide 8 user flags while the two most-significant digits hold corresponding mask bits. The exact format of the US parameter is illustrated below:-

USER FLAG MASK BITS								USER FLAG BITS							
Bit 15							Bit 8	Bit 7							Bit 0
Digit A				Digit B				Digit C				Digit D			

DIGIT	BIT	FLAG	FUNCTION
	15	7	
A	14	6	
	13	5	
	12	4	User flag mask bits (0 = enable; 1 = mask)
	11	3	
B	10	2	
	9	1	
	8	0	
	7	7	
C	6	6	
	5	5	
	4	4	User flag bits (0 = cleared; 1 = set)
	3	3	
D	2	2	
	1	1	
	0	0	

The exact functions of the individual digits within the US parameter are described in the following sections.

a) User Flag Mask Bits (Digits A and B)

Each bit of digit A and B of the US parameter is used to hold individual mask bits for each corresponding flag bit of digit C and D. To enable any of the 8 user flag bits to be altered via the 8260 Hand-held terminal, RS422 data link, or a User program, the corresponding mask bit must be set to logic 0. When the mask bit is set to logic 1 the corresponding flag bit cannot have its state changed. This facility allows individual flags to be set or cleared by means of a single write operation to the US parameter without having to read its value first. Whenever the US parameter is written, digits A and B are reset to zero for subsequent write operations, and hence always read back as zero. This is illustrated by the following example:-

Action		US Parameter Data entry	Previous US State	Resultant US State
(i)	Set flag 0	>0001	>0000	>0001
(ii)	Inhibit flag 0	>0101	>0000	>0000
(iii)	Set flag 7	>0080	>0000	>0080
(iv)	Inhibit flag 7	>8080	>0000	>0000
(v)	Set flag 7 only (all others inhibited)	>7FFF	>0000	>0080

b) User Flags (Digits C and D)

Each bit of digit C and D is used as a User flag which may be set or cleared via a User program or either of the serial data links. Each flag has a corresponding mask bit which must be set to logic 0 to enable the flag to be changed. Bit 15 is the mask bit for flag 7, Bit 0 is the mask bit for flag 0 and so on.

4.17 Filter Lead/Lag Block (FB) Parameters

Table 4.19 shows that there are 9 parameters associated with the Filter Block. The first parameter is the Block Type (BT) mnemonic which is FB. The second parameter is the Relative Block Number (BN) which is 1 or 2 depending upon whether single or dual-loop operation is being used. Detailed descriptions of the remaining 7 parameters excluding BT and BN are given in the following Sections:-

4.17.1 ST - Block Status

The Block 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 provide information concerning the operation and status of the Block in the format given below:-

				OPERATING MODE								BLOCK STATUS			
Bit 15			Bit 12	Bit 11			Bit 8	Bit 7			Bit 4	Bit 3			Bit 0
Digit A				Digit B				Digit C				Digit D			

DIGIT	BIT	FUNCTION
A	12-15	Unallocated
B	9-11	Unallocated
	8	Filter time constant (1T, 2T) range select (0 = secs.; 1 = minutes)
	7	Filtered derivative select (0 = normal; 1 = derivative)
C	6	Filter initialise (0 = normal; 1 = initialise)
	4,5	Unallocated
D	3	Filter block sumcheck failure bit (0 = O.K.; 1 = fail)
	0-2	Unallocated

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

COMMAND MNEMONIC	COMMAND PARAMETER FUNCTION	UNITS	FORMAT	PARAMETER TYPE
FB(1) BN(1)	Block Type - BT Relative Block Number 1-2	- -	17 7	Block Header
ST	Block Status	-	5	Status
XK 1T 2T FF	Filter gain Lead Time constant Lag Time constant Feed-forward/Output bias	- min/s min/s %	14 3 3 14	Filter terms
FI OP	Filter input Filter output	% %	3 3	Filter input/output

TABLE 4.19 List of Filter Lead-lag (FB) Block Command Parameters - and their respective mnemonics

NOTE

(1) These parameters only appear when accessing parameters via the Hand-held terminal.

a) Digit A

This digit is unallocated.

b) Filter Operating mode (Digits B, C)

Three bits of digit B and C are concerned with the Filter Block operating mode as follows:-

(i) Bits 9-11

These three bits are unallocated.

(ii) Bit 8 - Time constant range select

The state of this bit determines whether the two Filter Time constants are ranged in seconds or minutes. When bit 8 is at logic 0 the seconds mode is selected and when it is at logic 1 the minutes modes is selected. This bit corresponds to an ST value of 100 and is read/write.

(iii) Bit 7 - Filtered derivative select

The state of bit 7 determines the characteristics of the filter equation thus:-

Bit 7 = 0 - Normal lead/lag filter

With bit 7 set to logic 0 the Filter Block implements a conventional lead/lag filter characterised by the equation:-

$$\frac{1 + s1T}{1 + s2T}$$

Bit 7 = 1 - Filtered derivative

When Bit 7 is set to logic 1 the equation is modified such that the DC gain becomes 0 and a filtered derivative characteristic is obtained thus:-

$$\frac{s1T}{1 + s2T}$$

Bit 7 corresponds to an ST value of 80 and is read/write.

(iv) Bit 6 - Filter Initialise

This bit is used to initialise the filter by setting the Output parameter (OP) directly to the steady state value. For a lead/lag filter this value is 1 plus the feed-forward term, and for the filtered derivative it is just the feed-forward term. Whenever bit 6 is set to logic 1 the Output parameter is set the next time the FILTER word is called by the User program. Bit 6 is then automatically reset to logic 0 ready for the next time. Bit 6 corresponds to an ST value of 40 and is read/write.

(v) Bits 4 and 5

Neither of these bits are allocated.

c) Block Status (Digit D)

Only 1 bit of digit D is allocated as follows:-

(i) Bit 3 - FB Block sumcheck failure

This bit is automatically set to a logic 1 by the CPU whenever a sumcheck failure is detected on any of the parameters associated with the Filter Block. This condition is rectified by re-entering any corrupted Block command parameters and re-setting bit 3 to logic 0. Bit 3 corresponds to an ST value of 8 and is read/write.

(ii) Bits 0 to 2

None of these bits are allocated.

4.17.2 **XK - Filter Gain**

The characteristic of the Filter Block corresponds to the following equation:-

$$\frac{\text{Filter Output (OP)}}{\text{Filter Input (FI)}} = XK \frac{[1 + s1T]}{1 + s2T} + FF$$

The XK parameter therefore defines the overall gain of the filter in the expression above. XK is a format 14 parameter and is therefore bipolar spanning a range of -99.99 to +99.99.

4.17.3 1T, 2T - Filter Time constants

The 1T and 2T time constant parameters define the value of the Lead and Lag time constants in the Filter equation of Section 4.17.2 respectively. They are both format 3 parameters and their range depends upon the logic state of bit 8 of the ST Status parameter as described in Section 4.17.1 b) (ii). The effect this status bit has is as follows:-

a) ST bit 8 = logic 0 - seconds mode

In the seconds mode both 1T and 2T can be set over the range 0.01 to 99.99 seconds, while a value of 00.00 will set either of the terms off completely.

b) ST bit 8 = logic 1 - minutes mode

In the minutes mode both 1T and 2T can be set over the range 0.01 to 99.99 minutes, while a value of 00.00 will set either of the terms off completely.

4.17.4 FF - Feed Forward/Output bias

The FF parameter effectively defines the value of bias that is added to the filter equation before it is transferred to the Filter Output, OP. Table 4.19 shows that FF is a format 14 parameter and is thus bipolar with a range of -99.99% to +99.99%.

4.17.5 FI - Filter Input

The FI parameter represents the current value of the input to the Filter Block. A user program would typically link FI to the output of another Block such as an Analogue Input or PID Control Block. The Filter Input parameter is always set within the range 0 to 99.99% and its value may be determined via either of the serial data links.

4.17.6 OP - Filter Output

The equation of Section 4.17.2 shows that the Filter Output, OP, is derived by adding the Output Bias term FF to the filtered input value. Whenever bit 6 of the ST status parameter is set, however, the filter is initialised by transferring the current input value held in FI directly to the OP parameter.

A User Program would typically link OP to the input of another Block such as an Analogue Output, Manual Station, PID Control or Setpoint Block. The Filter Output parameter is always set within the operating range 0 to 99.99% and its value may be determined via either of the serial data links.

COMMAND MNEMONIC	COMMAND PARAMETER FUNCTION	UNITS	FORMAT	PARAMETER TYPE
DB(1) BN(1)	Block Type - BT Relative Block Number 1-2	- -	17 7	Block Header
ST	Block Status	-	5	Status word
DT	Maximum delay time	sec	10	Delay time

TABLE 4.20 List of Delay (DB) Block Command Parameters and their respective mnemonics

NOTE

(1) These parameters only appear when accessing parameters via the Hand-held terminal.

4.18 Delay Block (DB) Parameters

Table 4.20 shows that there are 4 parameters associated with the Delay Block. The first parameter is the Block Type (BT) Mnemonic which is DB. The second parameter is the Relative Block number (BN) which is 1 or 2 depending upon whether single or dual-loop operation is being used. Detailed descriptions of the remaining 2 parameters excluding BT and BN are given in the following sections:-

4.18.1 ST - Block Status

The Block 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 provide information concerning the operation and status of the Block in the format given below:-

<table>
<tr><td colspan="8"></td><td colspan="4">← OPERATING MODE →</td><td colspan="4">← BLOCK STATUS →</td></tr>
<tr><td>Bit 15</td><td></td><td></td><td></td><td></td><td></td><td></td><td>Bit 8</td><td>Bit 7</td><td></td><td></td><td>Bit 4</td><td>Bit 3</td><td></td><td></td><td>Bit 0</td></tr>
<tr><td colspan="4">Digit A</td><td colspan="4">Digit B</td><td colspan="4">Digit C</td><td colspan="4">Digit D</td></tr>
</table>

DIGIT	BIT	FUNCTION
A	12-15	Unallocated
B	8-11	Unallocated
	7	Unallocated
C	6	Delay initialise (0 = normal; 1 = initialise)
	4,5	Unallocated
D	3	Delay Block sumcheck failure bit (0 = O.K.; 1 = fail)
	0-2	Unallocated

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

a) Digits A and B

The high byte of the ST parameter (digits A and B) is unallocated and reads back as zero.

b) Delay Operating Mode (Digit C)

Only 1 bit of digit C is allocated as follows:-

(i) Bit 7

This bit is unallocated.

(ii) Bit 6 - Delay Initialise

This bit is used to initialise the Delay Block by forcing all entries in the Delay Buffer to be made equal to the most recent value. Whenever bit 6 is set to logic 1 all the Delay Buffer entries are equalised the next time the SETDEL word is called by the User Program. Bit 6 is then automatically reset to logic 0 ready for the next time. Bit 6 corresponds to an ST value of 40 and is read/write.

(iii) Bits 4 and 5

Neither of these bits are allocated.

c) Block Status (Digit D)

Only 1 bit of digit D is allocated as follows:-

(i) Bit 3 - DB Block sumcheck failure

This bit is automatically set to a logic 1 by the CPU whenever a sumcheck failure is detected on any of the parameters associated with the Delay Block. This condition is rectified by re-entering any corrupted Block Command Parameters and re-setting Bit 3 to logic 0. Bit 3 corresponds to an ST value of 8 and is read/write.

(ii) Bits 0 to 2

None of these bits are allocated.

4.18.2 DT - Maximum delay time

The DT parameter specifies the Maximum Delay time that can be obtained with the Delay Block. Table 4.20 shows that DT is a format 10 parameter so that it is always positive and can span the range 0 to 9999 seconds. For further information on this parameter refer to Section 3.3.14.

4.19 Totalisation Block (TB) Parameters

Table 4.21 shows that there are 5 parameters associated with the Totalisation Block. The first parameter is the Block Type (BT) mnemonic which is TB. The second parameter is the Relative Block Number (BN) which is 1 or 2 depending upon whether single or dual-loop operation is being used. Detailed descriptions of the remaining 3 parameters excluding BT and BN are given in the following Sections:-

4.19.1 ST - Block Status

The Block 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 provide information concerning the operation and status of the Block in the format given below:-

UNITS SELECT								OPERATING MODE				BLOCK STATUS			
Bit 15			Bit 12	Bit 11			Bit 8	Bit 7			Bit 4	Bit 3			Bit 0
Digit A				Digit B				Digit C				Digit D			

DIGIT	BIT	FUNCTION
A	14,15	Unallocated
	12,13	Totalisation Units (00 = secs; 01 = minutes; 10 = hours; 11 = days)
B	8-1	Unallocated
C	7	Total Roll over (0 = normal; 1 = roll-over)
	6	Total initialise (0 = normal; 1 = initialise)
	4,5	Unallocated
D	3	Totalisation Block sumcheck failure bit (0 = O.K.; 1 = fail)
	0-2	Unallocated

The exact functions of the digits within the ST parameter are described in the following Sections:-

COMMAND MNEMONIC	COMMAND PARAMETER FUNCTION	UNITS	FORMAT	PARAMETER TYPE
TB(1) BN(1)	Block Type - BT Relative Block Number 1-2	- -	17 7	Block Header
ST	Block Status	-	5	Status word
FS FT	Flow scaling factor Flow total	- s/min h/day	4 10	Flow related parameters

TABLE 4.21 List of Totalisation (TB) Block Command Parameters and their respective mnemonics

NOTE

(1) These parameters only appear when accessing parameters via the Hand-held terminal.

Dual-loop mode (S2 no. 5 - ON)

In this case the 6366 appears as a dual-loop instrument and each loop has its own independent UID setting. The state of S2 number 1 is ignored and S2 numbers 2, 3 and 4 provide eight possible switch settings. This makes the loop 1 UID take up even values from 0 to E, while the loop 2 UID takes up odd values from 1 to F. This arrangement is illustrated in the lower half of Table 2.3.

(iii) [C1][C2]

These two alphanumeric characters specify the required command mnemonic from the short-form parameter list of Table 4.1:-

i.e. II, DP, PH, PL etc.

The following points should be noted concerning the 2 character command mnemonics.

(1) The FX, LT and LN parameters are not available via the ASCII protocol.

(2) The first parameter is II and the last parameter is US.

(3) If the Scroll-mode facility (ACK) is used then II appears immediately after US is reached in the parameter list.

(4) In the Dual-loop mode the parameters of the first control loop are obtained with even UID settings of 0 to E. This is equivalent to the Loop number, LN, parameter being 1 as for Hand-held terminal access of Section 4.2.3. The parameters of the second control loop are obtained with odd UID settings of 1 to F where:-

UID (loop 2) = UID (loop 1) + 1

This is equivalent to a Loop number setting of LN = 2.

b) 5 Character command mnemonics

Although the 2 character access method described in Section 5.3.1 a) is compatible with other System 6000 single-loop controllers it only gives access to the limited database parameter list of Table 4.1. If access to the full data base of Table 3.1 is required then the 5 character form of the parameter command mnemonics must be used. In this case a typical message would contain the following sequence of ASCII characters:-

[GID][GID][UID][UID][B1][B2][B3][C1][C2]

These characters have the following function:-

(i) [GID][GID]

These are the Group Identifiers as described previously in Section 5.3.1 a) (i).

(ii) [UID][UID]

These are the Unit Identifiers as described previously in Section 5.3.1 a) (ii).

(iii) [B1][B2]

These two characters are the Block Mnemonic and specify one of the fifteen types of Functional Blocks given in Table 4.3.

(iv) [B3]

This character is the Relative Block Number, BN parameter and takes the value 1, 2 or 3 as described in Section 4.4.2. This allows the loop 1 or loop 2 Functional Blocks to be accessed as well as the 3 Analogue Input Blocks.

(v) [C1][C2]

These two alphanumeric characters specify the required command mnemonic from any of the Functional Block parameter lists given in Tables 4.4, 4.5, 4.8 to 4.15 and 4.17 to 4.21 inclusive (or Table 3.1).

e.g. for the Analogue Input Block (AI):-

ST, HR, LR, AI, AV

The following points should be noted concerning the five character command mnemonics:-

(1) The Block Type (BT), and Relative Block number (BN) parameters are not available via the ASCII protocol as they are already embedded in the message structure as [B1][B2] and [B3] respectively.

(2) If the Scroll-mode facility (ACK) is used then the 6366 sequences through the parameter list of the Functional Block already specified, e.g. for the Analogue Input Block ST would scroll to HR, LR, AI to AV and back to ST again.

(3) The use of S2 no. 5 to select the Dual-loop access mode is redundant as the [B3] character (BN) is used for this purpose. The 6366 will in fact respond to both of the UID settings available if S2 no. 5 is ON but the full data base can be accessed from either setting.

(4) With the two character access method the 6366 replies to a poll with a repeat of the [C1][C2] mnemonic followed by the five data characters [D1][D2][D3][D4][D5]

e.g. II > 3661

With the five character access method the reply contains a repeat of the full five character mnemonic:-

e.g. GP1II > 3661

	0	1	2	3	4	5	6	7
0	GP1.II (II)	SPn.ST (DP)	(*) SPn.HR (PH)	(*) SPn.LR (PL)	(*) SPn.HD (HD)	(*) SPn.LD (LD)	(*) DCn.ST (MN)	(*) SPn.SP (SP)
8	(*) SPn.PV (PV)	(*) MSn.OP (OP)	(*) SPn.HA (HA)	(*) SPn.LA (LA)	SPn.HL (HS)	SPn.LL (LS)	MSn.HL (HO)	MSn.LL (LO)
16	RBn.HR (HR)	RBn.LR (LR)	SPn.SL (SL)	------	3Tn.XP (XP)	3Tn.TI (TI)	3Tn.TD (TD)	------
24	------	------	------	------	RBn.RS (RS)	RBn.RB (RB)	------	GP1.SW (SW)
32	------	------	3Tn.TS (TS)	SPn.ER (ER)	------	------	------	------
40	GP1.ST	GP1.L1	GP1.L2	GP1.BG	GP1.PB	------	------	------
48	AI1.ST	AI1.HR	AI1.LR	AI1.AI	AI1.AV (1V)	------	AI2.ST	AI2.HR
56	AI2.LR	AI2.AI	AI2.AV (2V)	------	AI3.ST	AI3.HR	AI3.LR	AI3.AI
64	AI3.AV (3V)	------	AO1.ST	AO1.HR	AO1.LR	AO1.HL	AO1.LL	AO1.AO
72	DI1.ST	DI1.XM	DI1.DS (DI)	DO1.ST	DO1.WM	DO1.DS (DO)	SPn.SR	SPn.SB
80	SPn.RL	RBn.ST	RBn.RT	------	3Tn.ST	3Tn.FF (FF)	3Tn.FB	3Tn.OP
88	MSn.ST	MSn.HV	MSn.LV	MSn.AO	MSn.OT	------	DCn.1B	DCn.2B
96	DCn.3B	DCn.DD	DCn.ES	DCn.SM	------	ABn.ST	ABn.HV	ABn.LV
104	ABn.HL	ABn.LL	ABn.PV	ABn.SP	ABn.AH	CBn.ST (DK)	CBn.1K (1K)	CBn.2K (2K)
112	CBn.3K (3K)	CBn.4K (4K)	CBn.US (US)	FBn.ST	FBn.XK	FBn.1T	FBn.2T	FBn.FF
120	FBn.FI	FBn.OP	DBn.ST	DBn.DT	TBn.ST	TBn.FS	TBn.FT	------

TABLE 5.1 List of 6366 parameter numbers, [PNO]s, and their respective mnemonics.

NOTES: (*) Only those parameters marked (*) are available with Enquiry Polling.
n Represents the loop number 1 or 2.
(II) Is the short-form parameter mnemonic from Table 4.1.

5.3.2 Binary protocol

A detailed discussion of the Binary mode of the protocol will be found in Section 6 of the System 6000 Communications Handbook. The differences between the implementation of the Binary protocol in the 6366 Controller and single loop Controllers like the 6350/6360 are discussed in the following paragraphs.

a) Instrument Number [INO]

The Instrument Number [INO] consists of a 7 bit word where bits 0-3 represent the Unit Identifier [UID] value and bits 4-6 represents the Group Identifier value [GID]. Thus as the UID varies from 0 to 15 and the GID varies from 0 to 7, the INO varies from 0 to 127. The interpretation of the INO depends upon the operating mode of the 6366 as follows:-

(i) Single-loop mode (S2 no. 5 - OFF)

In this case the 6366 behaves like any other single-loop controller such as the 6350 or 6360 and the full data base given in Table 5.1 can be accessed via the INO set up on switch banks S1 and S2.

(ii) Dual-loop mode (S2 no. 5 - ON)

In this case the 6366 appears as two separate controllers and each loop has its own independent INO setting at consecutive addresses. Thus the parameter list of Table 5.1 can be accessed twice. At the first address the loop number, n, equivalent to the BN parameter is set to 1. At the next address n is set to 2 to access the parameters of the second loop. This is illustrated by the following example:-

S1 settings	S2 settings
no. 8 - ON	no. 4 - ON
no. 7 - ON	no. 3 - OFF
no. 6 - OFF	no. 2 - ON
	no. 1 - don't care
GID value = 3	UID value = A

This corresponds to an INO = 58 (decimal)
Hence loop 1 parameters (n = 1) are at INO = 58
and loop 2 parameters (n = 2) are at INO = 59

b) <u>Parameter number [PNO]</u>

The Parameter number [PNO] is a single 7 bit byte covering the range 0 - 127 and corresponds to the parameters given in Table 5.1 such that each value of [PNO] accesses one of the parameters in the list as shown. The following features of Table 5.1 should be noted:-

(i) The full 6366 data base of Table 3.1 can be accessed via the [PNO] and so Table 5.1 lists the parameters by their full mnemonic e.g. 3Tn.XP.

(ii) Where a parameter is also available via the short form data base of Table 4.1, the corresponding mnemonic is shown in brackets.

e.g. (DP)

(iii) Parameters in Functional Blocks that have a fixed Relative Block Number, i.e. GP, AI, DI and DO, appear in both tables of control loop parameters in the dual-loop mode.

e.g. In the example of 5.3.2 a) (ii):-

INO = 58; PNO = 40 accesses GP1.ST

INO = 59; PNO = 40 accesses GP1.ST

Section 6 APPLICATION PROGRAM CREATION

It has been mentioned in Section 3.2.2 that conceptually the 6366 Controller has 3 levels of user access for programming, viz:-

a) Level 1 - Instrument Configuration

This, the lowest level of access is described in Section 3.2.2 a).

b) Level 2 - Instrument Function and Operation

The second level of user access is described in Section 3.2.2 b).

c) Level 3 - Application Program creation

The third or highest level of access to the 6366 is used when the existing Time-scheduled or Background programs already in the Applications library are not sufficient. In this case new programs can be created and added to the Library either by editing existing programs or writing completely new ones.

The purpose of this Section of the 6366 Technical Manual is to give a brief introduction to the Level 3 user access described in c) above.

6.1 Basic Programming requirements

Before any Application programming of the 6366 can begin it is necessary to connect up an appropriate programming terminal as detailed in the following Sections.

6.1.1 RS232 data link

The 6366 Controller is programmed by means of the front-panel RS232 data link. When the 8260 Hand-held terminal is being used for level 1 or 2 user access, the baud rate is set at 300 baud by having S1 no. 1 OFF (see Section 2.3.2 a) (i)). When any other terminal is being used S1 no. 1 should be switched to ON and this allows a choice of baud rates to be set by means of S1 switches 2, 3 and 4 which are used for the RS422 data link. The 8 possible data rates are:-

110, 300, 600, 1200, 2400, 3600, 4800 and 9600 bauds

- and the required switch settings to obtain them are given in Table 2.2.

6.1.2 Programming Terminals

It has been mentioned in Section 3.2.3 that the 8260 Hand-held terminal is not suitable for level 3 programming of the 6366. Consequently one of the following devices are recommended:-

a) BBC Microcomputer model B

When a BBC model B microcomputer is fitted with the TCS 8270 VDU ROM, part no. RD 075798, it can be used as a terminal for the 6366. The 8270 VDU ROM allows baud rates of 300, 1200, 4800 or 9600 to be set and it can operate in an 8260 Terminal emulation mode if required. Details of the cables required to connect the computer to the 6366 are given in the Appendices of the 8270 Operator's Guide, part no. HA 076647 U005.

b) Epson PX8 microcomputer

The Epson PX8 microcomputer is a battery operated portable with built in 40 character by 8 line LCD display and a micro-cassette drive. When the PX8 is loaded with the TCS 8271 Data Base Configurator software, part no. RD 076332, if offers similar facilities to the BBC microcomputer. Details of the cables required to connect the computer to the 6366 are given in the Appendices of the 8271 Operator's Guide, part no. HA 076648 U005.

c) Dumb terminal

Most 'Teletype' compatible dumb terminals such as the DEC VT 100, ADDS Viewpoint etc. can be successfully operated with the 6366. It should be noted however that only basic VDU operation will be obtained and not the full data base management facilities of the 8270 or 8271 TCS software.

6.1.3 **Logging-on**

When any of the terminals mentioned in Section 6.1.2 are plugged into the 6366 front-panel they can be operated just like the 8260 Hand-held terminal. Hence they can access all the Functional Block parameters by the methods described in Section 4. The Functional Blocks themselves and the Application Programs linking them together are all written in TCS FORTH. Consequently in order to access them for editing purposes it is necessary to 'log-on' to the FORTH interpreter software permanently resident within the 6366.

The method for 'logging-on' is detailed in Section 4.2.1 of the System 6000 Programmable Instruments Programming Manual, (part no. HA 076878 U005) while 'logging-off' is covered in Section 4.2.2.

6.2 6366 FORTH Programming

It is beyond the scope of this manual to cover general aspects of the FORTH programming language and it's implementation by TCS in instruments like the 6366. This information will be found in the Programmable Instruments Programming Manual which should be read before any FORTH programming is attempted by the user. This section will instead be restricted to describing those features of TCS FORTH that are unique to the 6366.

6.2.1 Run-time Environment

The 6366 supports two time-scheduled programs, and a background program as described in Section 3.2.1. These programs are selected by setting their names into the parameters L1, L2 and BG in the General Purpose Block. The selected programs are automatically installed at power up, or when a user types RUN from a programming terminal.

The two time-scheduled programs can have a repeat time set in the range 0.1 to 999.9 seconds. To avoid excessive computations in the time-scheduled programs from stopping the background program, the instrument watchdog is not fired whilst these programs are running. This means that a user must limit the amount of computation done here, since if the watchdog is not fired for around 0.5 seconds the instrument is forced to go through a power up cycle.

A list of standard time-scheduled programs in the Applications library is given in Table 3.2 and the corresponding Background programs are given in Table 3.3. Detailed FORTH listings of each time-scheduled program are given in the Applications library of Appendix F and in Appendix G.2. Listings of the Background programs are given in Appendix G.3.

6.2.2 Running Programs and Program timing

The 6366 can run two time-scheduled programs in addition to a background program. To simplify operation when PID is used in a time-scheduled program it automatically adjusts the program repeat time. The following words are used to modify and monitor the program repeat times, or to start and stop the User programs.

GETREP — Moves the program repeat time (in seconds) to the top of the stack. The following example would print the program repeat time for the first time-scheduled program.

```
1 GETREP .
```

SETREP — Sets the program repeat time. The following example would set the second time-scheduled program to run at 0.5 second intervals.

```
.5 2 SETREP
```

RUN — This forces a dictionary search for the programs defined in the General Purpose Block parameters L1, L2 and BG. If the programs are found they are then installed and run. (This is automatically done when the instrument is powered up).

HALT — This stops all user programs. Successful attempts to edit user programs automatically force a HALT.

6.2.3 Data Base Access routines

The 6366 has special FORTH words to allow User programs to access parameters in the instrument data base. All 6366 parameters are referenced by means of the Block Number, and a Parameter Number (PNO). The Block Number varies from 0 to 26 depending on which Functional Block and which control loop is being accessed and these are shown in Table 3.1. The Parameter number is the same as used for the Binary protocol of Section 5.3.2 b) and a list of 6366 parameter numbers is given in Table 5.1.

To simplify access to the data base fixed words are provided to place the Block and Parameter Numbers on the stack. The Block Numbers are given by a 3 character word, the first two characters are the Block Type mnemonic (BT) and the third character is the Relative Block Number (BN). The following example would print the absolute Block Number of Setpoint Block 2.

```
SP2 .
```

The Parameter Numbers are given by a 2 character word which is identical to the mnemonic used by the Hand-held terminal. The following example would print the Parameter Number for PV.

```
PV .
```

The following words are used to access the Advanced Controller data base.

GET — Moves the analogue data from the required block and parameter to the top of the stack. The following example would print the Process Variable from Setpoint Block 1.

```
SP1 PV GET .
```

SET — Moves data to the required Block and Parameter. The following example would set the Local Setpoint in Setpoint Block 2 to 40 units.

```
40 SP2 SL SET
```

%GET — This is similar to GET, however, the word returns the data as a normalised value in the range -100% to +100%. The following example prints the Process Variable from Setpoint Block 1 as a percentage of its range.

```
SP1 PV %GET .
```

%SET This is similar to SET, however, the data on the stack is expressed as a percentage of full range. The following example would set the Local Setpoint in Setpoint Block 2 to 20% of its range.

20 SP2 SL %SET

GETDIG Moves the digital status from the required digital input to the top of the stack. The value returned is either a 1 or 0 depending on the status of the input or output. The following example would print the current status of digital input 3.

DI1 3 GETDIG .

SETDIG Modifies the required digital output. The output is set low if the data is zero, otherwise it is set high. The following example would set digital output 4 low.

0 DO1 4 SETDIG

6.2.4 Special FORTH words associated with the 6366

The 6366 uses a number of additional words associated with the Functional Blocks within the data base. These words are briefly described below:-

PID This word is used to compute a control output from the Process Variable on the stack. The following example takes an input of 1200 units and stores the value as the Process Variable in Setpoint Block 1. It then calculates an output dependent on the Setpoint in Setpoint Block 1, the 3-term parameters in PID Control Block 1 and the mode in Display and Control Block 1. The result is then discarded.

```
1200 3T1 PID DROP
```

PIDX Normally a control loop is made up of a Setpoint Block, a PID Block, a Manual Station Block and a Display and Control Block, which are automatically linked together. In some cases only one control loop is required, but with two sets of 3-term constants. The PIDX word allows the user to specify which PID block is used, and which loop it is linked to. The following example takes an input of 1500 units and stores the value as the Process Variable in Setpoint Block 1. It then calculates an output dependent on the Setpoint in Setpoint Block 1, the 3-term parameters in PID control Block 2 and the mode in Display and Control Block 1. The result is then discarded.

```
1500 1 3T2 PIDX DROP
```

MSCONT Moves data from the stack to the output register of the appropriate Manual Station Block only when the loop is in an AUTO mode. The following example sets the output of Manual Station 1 to 50% when loop 1 is in AUTO.

```
50 MS1 MSCONT
```

REMOTE Moves data from the stack to the Remote Setpoint of the required Setpoint Block. This also configures the loop as a Remote Setpoint Controller by resetting bit 9 in the appropriate Display and Control Block status word, ST. The following example sets the Remote Setpoint register of Setpoint Block 2 to 65 units.

```
65 SP2 REMOTE
```

%REMOTE This word is similar to REMOTE, however, the Setpoint is expressed as a percentage of the Setpoint range. The following example would set the Remote Setpoint of Setpoint Block 1 to 25%.

```
25 SP1 %REMOTE
```

RATIO Uses data on the stack as the Ratio Process Variable and moves the result to the Remote Setpoint of the appropriate Setpoint Block. This also configures the loop as a Ratio Controller by setting bit 9 in the appropriate Display and Control Block status word, ST. The following example takes a Ratio Process Variable of 800, and calculates the Remote Setpoint for Setpoint Block 1, using the values in Ratio Block 1.

```
800 SP1 RATIO
```

ALARM Moves the data on the stack to the appropriate Alarm Block and updates the Alarm Block status bits. The following example would set Alarm Block 2 Process Variable to 400, check this value against the alarm limits, and update the alarm status bits.

```
400 AB2 ALARM
```

FILTER Uses the data on the stack as the input to the appropriate Filter Block, and returns the resultant output on the stack. The following example prints the result of applying an input of 30% to Filter Block 1.

```
30 FB1 FILTER .
```

SETDEL Moves data from the stack into the buffer of the appropriate Delay Block. The following example moves the value 18 into Delay Block 1.

```
18 DB1 SETDEL
```

GETDEL Moves data from the appropriate delay line to the stack. If the following example is included in a program it will use Delay Block 1 to retransmit an analogue input delayed by 20 seconds.

```
AI1 AV GET  DB1 SETDEL  20 DB1 GETDEL  AO1 AO SET
```

TOTAL Takes data from the stack as the input to the appropriate Totalisation Block. The word returns a flag which is 0 if the Flow Total is unchanged, or 1 if the Flow Total has been incremented. The following example uses the value 10 as the current input to Totalisation Block 1, and prints the flag on the terminal.

```
10 TB1 TOTAL .
```

WORD	STACK NOTATION	DESCRIPTION
GET	(Bn Pn -- n)	Return data n from the Block and Parameter.
SET	(n Bn Pn --)	Move data n to the Block and Parameter.
%GET	(Bn Pn -- n)	Return data n from the Block and Parameter. The data is returned as a percentage of range.
%SET	(n Bn Pn -- n)	Store the value n expressed as a percentage in the Block and Parameter.
GETDIG	(Bn Dn -- f)	Return a flag depending on the status of the Block and Digital channel.
SETDIG	(f Bn Dn --)	Modify status on Block and Digital channel.
GETREP	(nl -- n2)	Return program nl repeat time in seconds.
SETREP	(nl n2 --)	Sets program n2 to run every nl seconds.
RUN	(--)	Search install and run the programs defined in parameters L1, L2 and BG.
HALT	(--)	Stop all user programs.
PID	(PV Bn -- OP)	Compute the control output from the Process Variable using parameters in PID block Bn.
PIDX	(PV n Bn -- OP)	Compute the control output from the Process Variable using parameters in PID block Bn. Link PID constants to loop n.

TABLE 6.1 6366 Controller Special Function Words

WORD	STACK NOTATION	DESCRIPTION
MSCONT	(OP Bn --)	Update the OP register of the Manual Station Block Bn when the loop is in an AUTO mode.
REMOTE	(SP Bn --)	Update the Remote Setpoint of Setpoint Block Bn.
%REMOTE	(%SP Bn --)	Update the Remote Setpoint of Setpoint Block Bn. Setpoint expressed in percentage.
RATIO	(RPV Bn --)	Uses Ratio Process Variable to update the Remote Setpoint of Setpoint Block Bn.
ALARM	(PV Bn --)	Update the Alarm Block PV and ST registers.
FILTER	(PV Bn -- OP)	Update the Filter Block FI and OP registers.
SETDEL	(n1 Bn --)	Push data n1 into the buffer of the Delay Block.
GETDEL	(n1 Bn -- n2)	Return data delayed by n1 seconds from Delay Block Bn.
TOTAL	(n1 Bn -- f)	Totalise data n1 in Totalisation Block Bn. The flag is set if the Flow Total has increased.
SETLN	(n --)	Set front panel display to loop n. If n is negative, disable front panel loop changes.

TABLE 6.1 (continued) 6366 Controller Special Function Words

6.2.5 Display Control

Although the user programs can lock the front panel to a particular loop, this lock is removed whenever there is an error in any of the programs, or when the background program is halted.

The following word allows a user program to change or lock the front panel display to a particular loop.

SETLN Takes the front panel loop number from the stack. If the loop number is negative this locks the front panel to the selected loop, and means the user cannot change the displayed loop from the front panel. The following example would set the front panel to display loop 2.

2 SETLN

6.2.6 Summary of 6366 Special words

Table 6.1 summarises all the data base access routines and special Functional Block words associated with the 6366 Controller. A listing of the application words used by the 6366 to form the library of Application programs will be found in Appendix G.1.

Pin No.	Designation	Function	Group
1			POWER SUPPLIES
2	0VR	0V Reference	
3	0VP	0V Power	
4			
5			
6			
7			
8	DC SUPP.IN	DC Supply (20-30V) input	
9	W.DOG.OUT(1)	Watchdog Timer output	
10	AN1.IN(1-5V)	Analogue Input 1	4-20mA/1-5V ANALOGUE INPUTS
11	AN2.IN(1-5V)	Analogue Input 2	
12	AN3.IN(1-5V)	Analogue Input 3	
13	AN1.IN(0-10V)	Analogue Input 1	0-10V ANALOGUE INPUTS
14	AN2.IN(0-10V)	Analogue Input 2	
15	AN3.IN(0-10V)	Analogue Input 3	
16	DIG1.OUT	Digital Output 1	8 - WAY 0 - 15V DIGITAL OUTPUTS
17	DIG2.OUT	Digital Output 2	
18	DIG3.OUT	Digital Output 3	
19	DIG4.OUT	Digital Output 4	
20	DIG5.OUT	Digital Output 5	
21	DIG6.OUT	Digital Output 6	
22	DIG7.OUT	Digital Output 7	
23	DIG8.OUT	Digital Output 8	
24	DIG1.IN	Digital Input 1	8 - WAY 0 - 15V DIGITAL INPUTS
25	DIG2.IN	Digital Input 2	
26	DIG3.IN	Digital Input 3	
27	DIG4.IN	Digital Input 4	
28	DIG5.IN	Digital Input 5	
29	DIG6.IN	Digital Input 6	
30	DIG7.IN	Digital Input 7	
31	DIG8.IN	Digital Input 8	
32	MS1.OUT(0-10V)	Manual Station 1 output	0-10V NON-ISOLATED OUTPUTS
33	MS2.OUT(0-10V)	Manual Station 2 output	
34	AN1.OUT(0-10V)	Analogue Output 1	
35	XMT.OUT(-)	Transmit outputs	RS422 SUPERVISORY SERIAL DATA BUS
36	XMT.OUT(+)		
37	RCV.IN(-)	Receive inputs	
38	RCV.IN(+)		
39			
40	TX.SUPP(-)	Transmitter Supply	
41	TX.SUPP(+)		
42			
43	MS1.OUT.ISOL(-)	Manual Station 1 isolated 4-20mA output	
44			
45	MS1.OUT.ISOL(+)		
46			
47			
48			

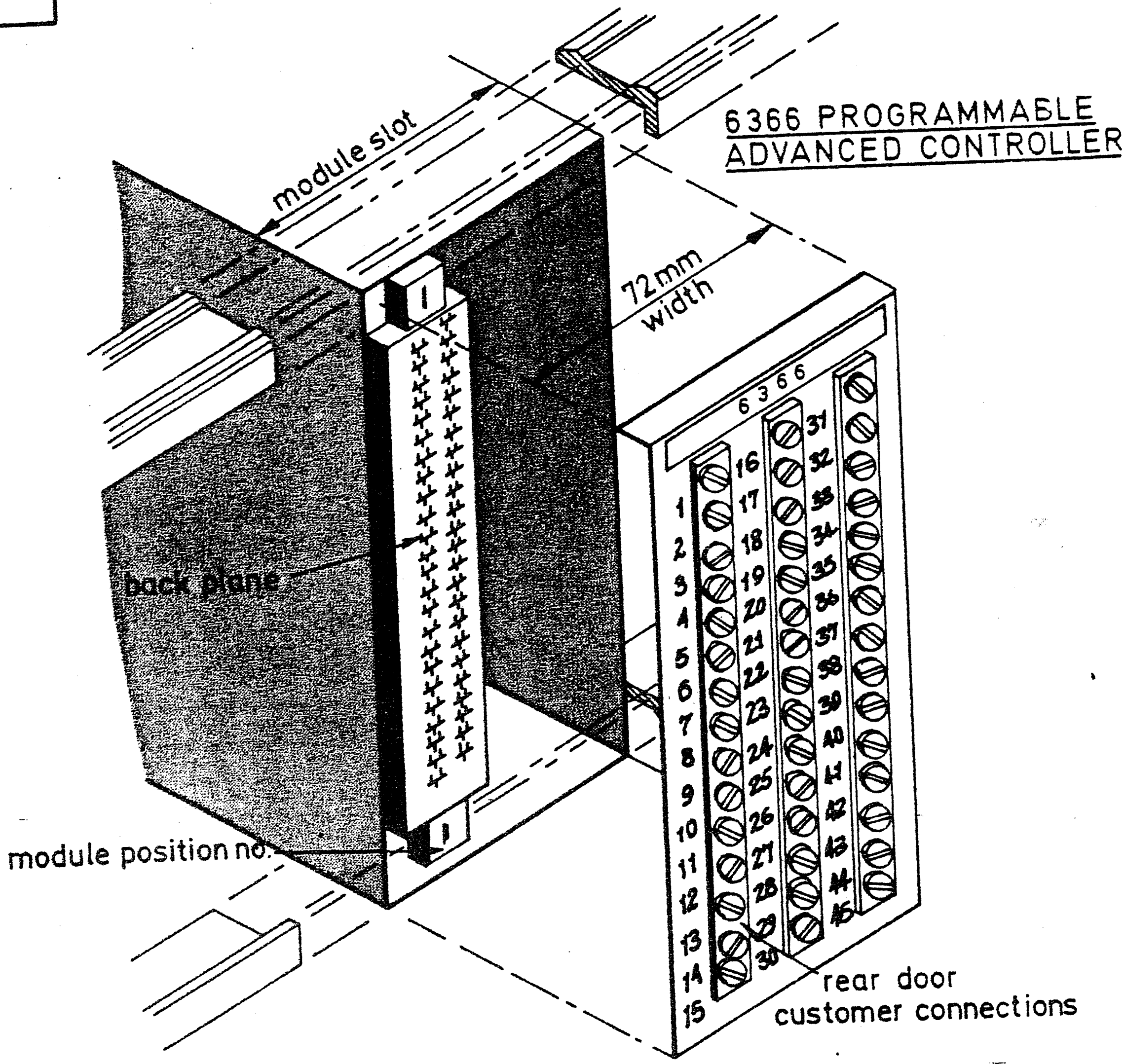
Aids to Wiring

PIN NO	FUNCT	FROM	TO	FUNCT	FROM	TO	FUNCT	FROM	TO	FUNCT	FROM	TO	FUNCT	FROM	TO	FUNCT	FROM	TO
1																		
2	OVR																	
3	OVP																	
4																		
5																		
6																		
7																		
8	DC.SUP IN																	
9	W DOG OUT 1																	
10	AN 1-IN 1-5V																	
11	AN 2-IN 1-5V																	
12	AN 3-IN 1-5V																	
13	AN 1-IN 0-10V																	
14	AN2-IN 0-10V																	
15	AN 3-IN 0-10V																	
16	DIG 1 OUT																	
17	DIG 2 OUT																	
18	DIG 3 OUT																	
19	DIG 4 OUT																	
20	DIG 5 OUT																	
21	DIG 6 OUT																	
22	DIG 7 OUT																	
23	DIG 8 OUT																	
24	DIG 1 IN																	
25	DIG 2 IN																	
26	DIG 3 IN																	
27	DIG 4 IN																	
28	DIG 5 IN																	
29	DIG 6 IN																	
30	DIG 7 IN																	
31	DIG 8 IN																	
32	MS1OUT 0-10V																	
33	MS2OUT 0-10V																	
34	AN1OUT 0-10V																	
35	XMT OUT-																	
36	XMT OUT+																	
37	RCV IN-																	
38	RCV IN+																	
39																		
40	TX SUPP-																	
41	TX SUPP+																	
42																		
43	MS1OUT ISOL-																	
44																		
45	MS2OUT ISOL+																	
46																		
47																		
48																		

APPENDIX B

loop identifier

rack & module no.



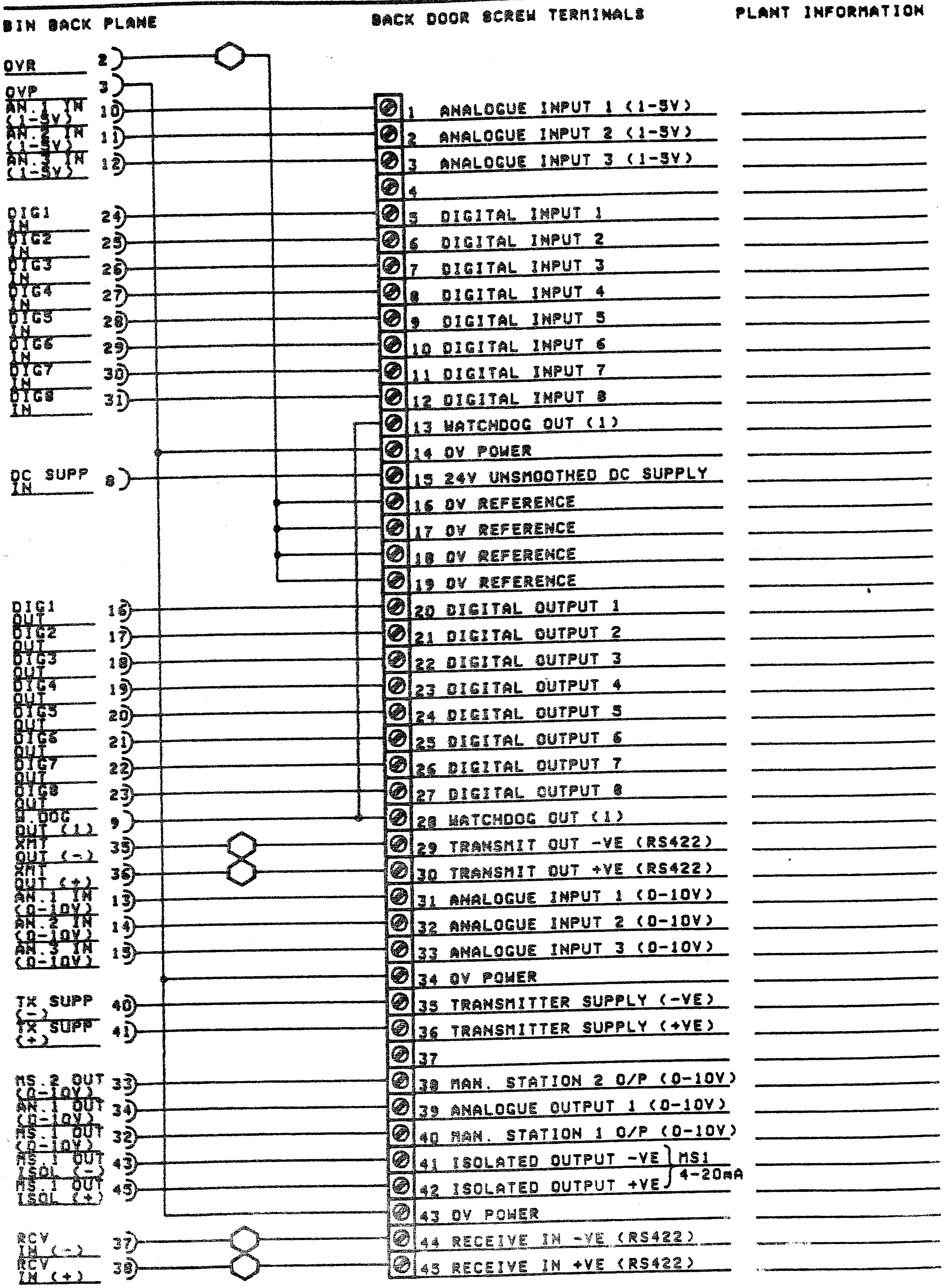
The B6366 termination assembly consists of a 48 pin back plane connector with a wire loom linking the module connections on the back plane to three rows of 15 customer terminals.

The assembly is used to mount 6366 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
6366 Product Specification
6366 Technical Manual

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



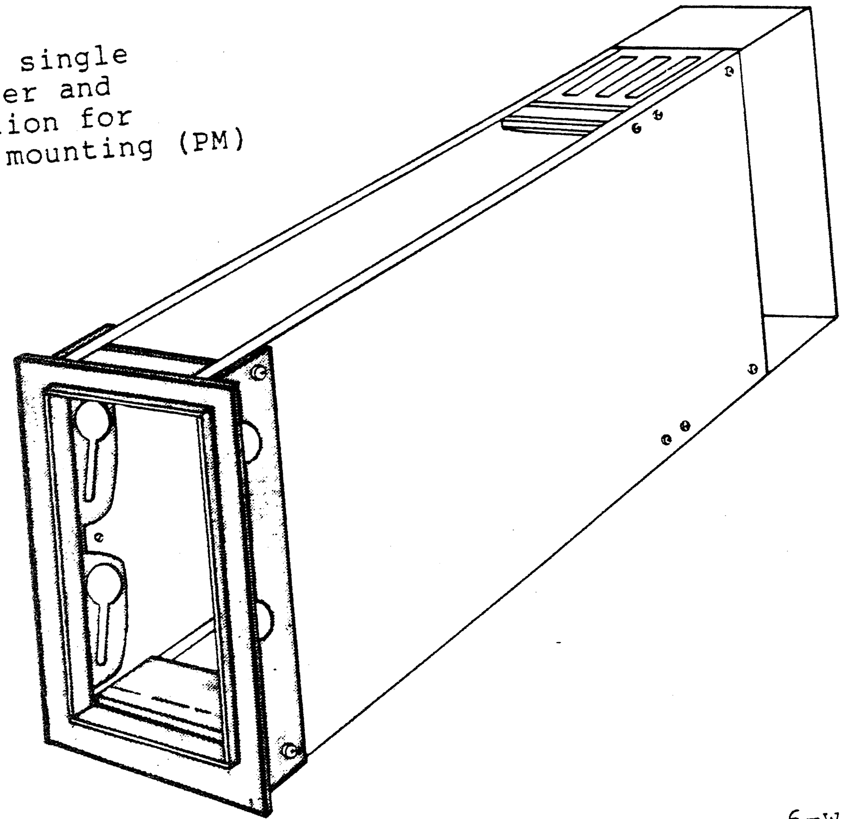
⬡ THESE LINES MAY BE BUSED TO OTHER MODULES IN THE BIN

7900

CS

SINGLE OR MULTI-WAY SLEEVE ASSEMBLY FOR MICROPROCESSOR BASED INSTRUMENTATION

TE
awing shows a single
eeve with cover and
and plate option for
andard 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.

Part no: HA 076524 U006

Issue 3; Jul 86

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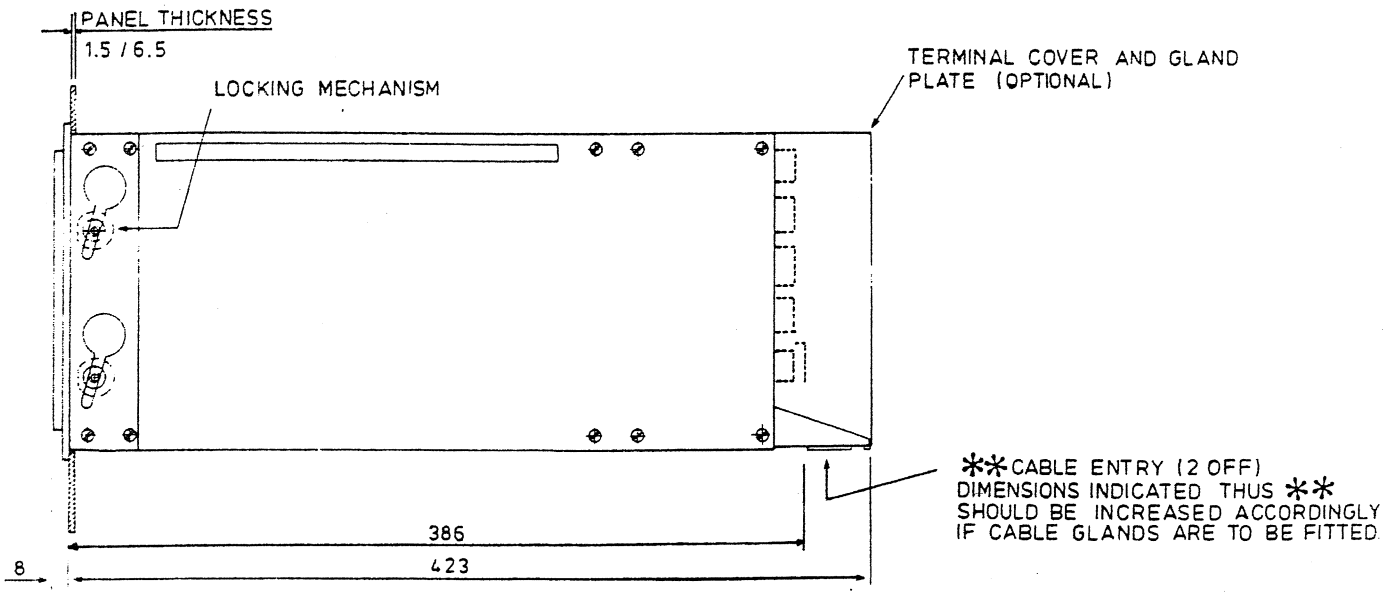
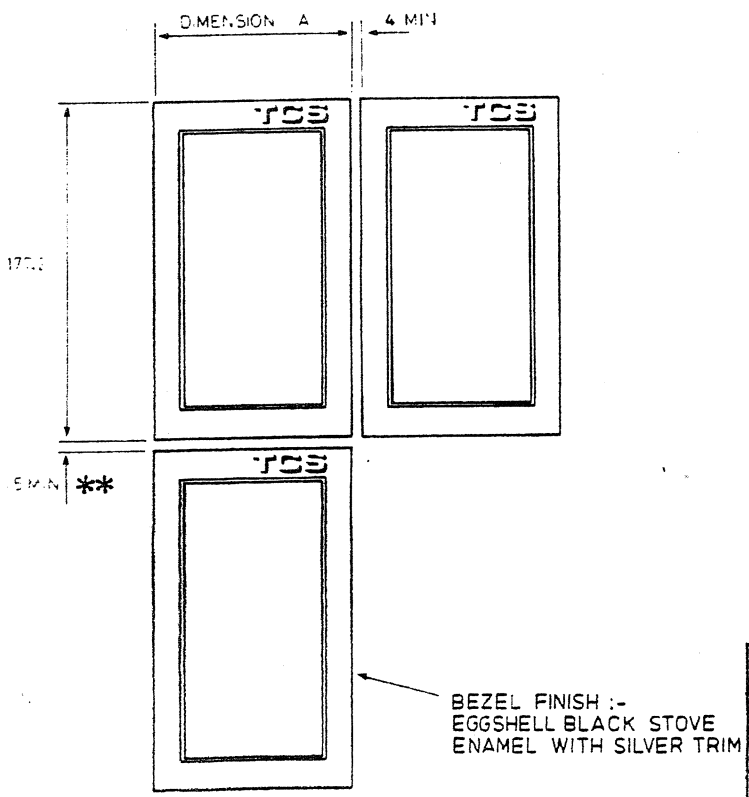
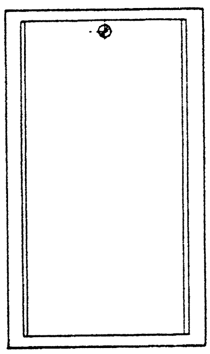
TECHNICAL SPECIFICATION

1) Installation Details for Panel Mounting Sleeves



SIDE VIEW





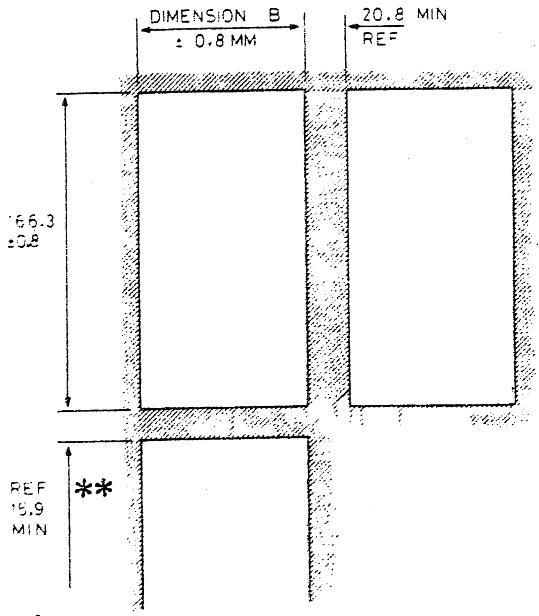
REAR VIEW

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
<u>Sleeve Width</u> 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
<u>Supply Voltage</u> a) 24V DC or b) 110V AC or c) 240V AC <u>N.B.</u> 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

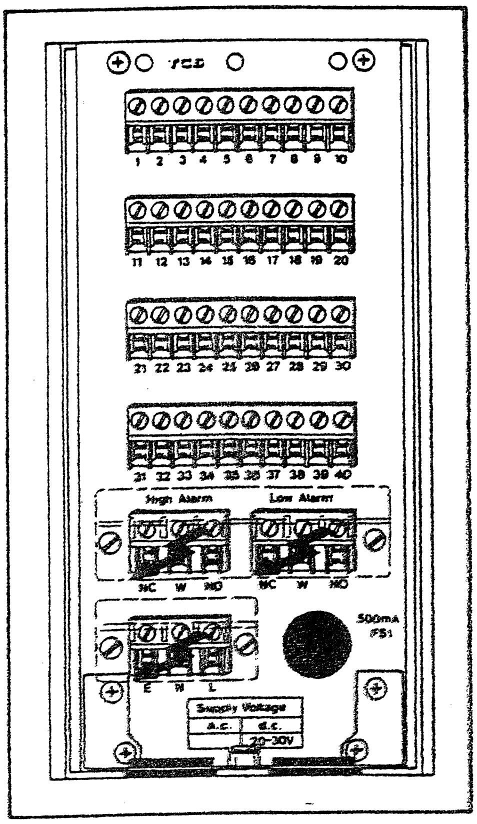
a) A 6350 Process Controller in a single sleeve with 4-20mA current input on all three channels:-
7900/1-WAY PM/240V/CGP/7350/BR

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

PROGRAMMABLE ADVANCED CONTROLLER REAR TERMINATION ASSEMBLY



* Panel Mounting
* Modular Construction
* All Module Connections Available Via Screw Terminals
* 24V DC and Mains Powered
* Incorporates High and Low Alarm Relays

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

The 7366 Rear Termination assembly enables 6366 Programmable Advanced Process Controllers to be fitted into 7900 single or multi-way sleeves. Each 7366 assembly allows an associated 6366 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 7366 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 (47-49), while a further terminal (30) may be used for a 24V DC input or back-up supply, if required.

The Digital Output 1 and 2 logic lines are used to drive separate relays whose outputs appear on individual screw connector blocks (41-43, 44-46). The earth and voltage free contacts of these 2A relays are fitted with transient suppression circuitry.

The inter-connections between the 7366 screw terminals and the 6366 module pins are given in the cross-reference table which lists all those connections not shown in the Block Diagram.

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Telex 87437

SLEEVE TERMINAL NUMBER	MODULE PIN NUMBER	FUNCTION		OPTION (S3)
1	41	TX.SUPP(+)		
2	10*	AN1.IN	1-5V INPUTS	S3/1 ON
3	11*	AN2.IN		S3/2 ON
4	12*	AN3.IN		S3/3 ON
5	45	MS1.OUT.ISOL(+)		
6	32	MS1.OUT	0-10V OUTPUTS	
7	33	MS2.OUT		
8	34	AN1.OUT		
9	35	XMT.OUT(-)	RS422	
10	36	XMT.OUT(+)		
11	40	TX.SUPP(-)		
12	2*	0V.REF	1-5V INPUTS	S3/1 ON
13	2*	0V.REF		S3/2 ON
14	2*	0V.REF		S3/3 ON
15	43	MS1.OUT.ISOL(-)		
16	13	AN1.IN	0-10V INPUTS	S3/1 OFF
17	14	AN2.IN		S3/2 OFF
18	15	AN3.IN		S3/3 OFF
19	37	RCV.IN(-)	RS422	
20	38	RCV.IN(+)		
21	16*	DIG1.OUT	DIGITAL OUTPUTS	
22	17*	DIG2.OUT		
23	18	DIG3.OUT		
24	19	DIG4.OUT		
25	20	DIG5.OUT		
26	21	DIG6.OUT		
27	22	DIG7.OUT		
28	23	DIG8.OUT		
29	9	W.DOG.OUT(1)		
30	*	DC.SUPP.IN		
31	24	DIG1.IN	DIGITAL INPUTS	
32	25	DIG2.IN		
33	26	DIG3.IN		
34	27	DIG4.IN		
35	28	DIG5.IN		
36	29	DIG6.IN		
37	30	DIG7.IN		
38	31	DIG8.IN		
39	2*	0V.REF		
40	3*	0V.POW		
41	*	N/O	DIGITAL OUTPUT 1 RELAY	
42	*	WIPER		
43	*	N/C		
44	*	N/O	DIGITAL OUTPUT 2 RELAY	
45	*	WIPER		
46	*	N/C		
47	*	EARTH	AC MAINS	
48	*	NEUTRAL		
49	*	LINE		

PINS MARKED * APPEAR ON THE BLOCK DIAGRAM, ALL OTHER CONNECTIONS ARE DIRECT FROM MODULE TO SLEEVE.

OPTIONS: S3-ON = 1-5V INPUTS
S3-OFF = 0-10V INPUTS

TECHNICAL SPECIFICATION

(A) Electrical

a) Analogue Inputs

No. of Channels : 3 direct non-isolated 0-10V inputs.

: 3 non-isolated 1-5V inputs.

Channel Functions : Defined by User Application program.

b) Analogue Outputs

No. of Channels : 3 direct non-isolated 0-10V outputs.

: 1 isolated 4-20mA output (Channel 1).

Channel Functions : Channel 1 = Manual Station 1 output.

: Channel 2 = Manual Station 2 output.

: Channel 3 = Analogue output 1

c) Digital Inputs

No. of Inputs : 8 non-isolated inputs.

Input Voltage Levels : 15V = logic one
0V = logic zero

d) Digital Outputs

No. of Outputs : 8 non-isolated outputs plus Watchdog.

Output Voltage Levels : 15V = logic one
0V = logic zero

e) Relay Outputs

No. of Relays : 2

Type : Single-pole changeover

Function : Digital output 1 relay
Digital output 2 relay

Rating : 2A earth and voltage free contacts fitted with transient suppression

(B) Power Supplies

a) Supply Inputs

Mains Version	: 110V AC at 290mA rms 240V AC at 130mA rms
24V DC Version	: 20-30V DC at 680mA
Back-up Supply Input	: 20-30V DC on mains versions only

b) Supply Outputs

External Transmitter Supply	: 26V ± 1.5V at 4mA output : 30V ± 0.5V at 20mA output

c) Fuse Rating : Separate 0.5A screw-in type fuse provided with mains versions only

TX SUPP (+)	AN1·IN 1-5V (4-20mA)	AN2·IN 1-5V (4-20mA)	AN3·IN 1-5V (4-20mA)	MS1 OUT ISOL (+)	MS1·OUT	MS2·OUT	AN1 OUT	XMT OUT (-)	XMT OUT (+)
1	2	3	4	5	6	7	8	9	10
CURRENT INPUTS / OUTPUTS					VOLTAGE INPUTS / OUTPUTS			COMMS	
TX SUPP (-)	0V REF	0V REF	0V REF	MS1 OUT ISOL (-)	AN1·IN (0-10V)	AN2·IN (0-10V)	AN3·IN (0-10V)	RCV IN (-)	RCV IN (+)
11	12	13	14	15	16	17	18	19	20

DIG 1 OUT	DIG 2 OUT	DIG 3 OUT	DIG 4 OUT	DIG 5 OUT	DIG 6 OUT	DIG 7 OUT	DIG 8 OUT	W DOG OUT (1)	24VDC IN
21	22	23	24	25	26	27	28	29	30
DIGITAL INPUTS / OUTPUTS									PWR SUPS
DIG 1 IN	DIG 2 IN	DIG 3 IN	DIG 4 IN	DIG 5 IN	DIG 6 IN	DIG 7 IN	DIG 8 IN	0V REF	0V P
31	32	33	34	35	36	37	38	39	40

RELAY RATING 2 AMPS

DIGITAL OUTPUT 1 RELAY		
*NO	W	*NC
41	42	43

DIGITAL OUTPUT 2 RELAY		
*NO	W	*NC
44	45	46

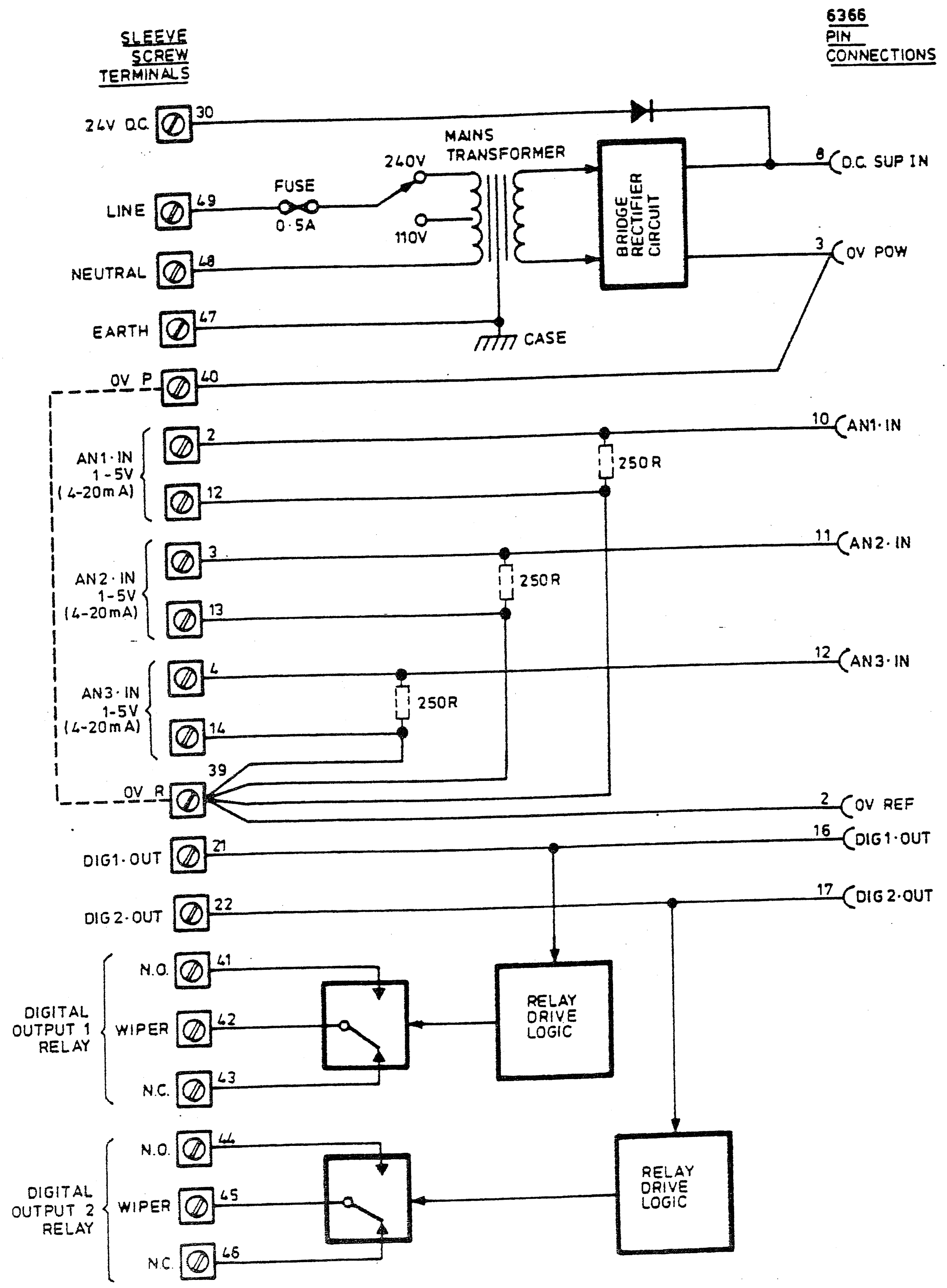
*NOTE: RELAY CONTACT DESIGNATIONS ARE FOR THE UNPOWERED / LOGIC ZERO STATE

MAINS CONNECTIONS		
E	N	L
47	48	49

PROGRAMMABLE ADVANCED CONTROLLER 7366

SLEEVE REAR TERMINAL FUNCTIONS

7366 (1)


SLEEVE SCREW TERMINALS
6366 PIN CONNECTIONS
24V D.C. 30
LINE 49
NEUTRAL 48
EARTH 47
0V P 40
FUSE
0·5A
240V
110V
MAINS TRANSFORMER
BRIDGE RECTIFIER CIRCUIT
CASE
8 D.C. SUP IN
3 0V POW
AN1·IN 1-5V (4-20mA)
2
12
250R
10 AN1·IN
AN2·IN 1-5V (4-20mA)
3
13
11 AN2·IN
AN3·IN 1-5V (4-20mA)
4
14
12 AN3·IN
0V R 39
2 0V REF
DIG1·OUT 21
16 DIG1·OUT
DIG2·OUT 22
17 DIG2·OUT
DIGITAL OUTPUT 1 RELAY
N.O. 41
WIPER 42
N.C. 43
RELAY DRIVE LOGIC
DIGITAL OUTPUT 2 RELAY
N.O. 44
WIPER 45
N.C. 46

4.12.7 TS - Algorithm Sampling Period

The PID algorithm takes the PV and SP values and computes a new OP value every TS seconds or minutes. Thus TS is called the algorithm sampling or scheduling period and is closely related to the Integral and Derivative time settings, TI and TD of Section 4.12.3. The exact relationships also depends upon whether the PID Control Block is operating in the seconds or minutes mode as defined by Bit 8 of the ST parameter (see Section 4.12.1 b) (ii)), thus:-

a) Seconds mode (ST bit 8 = logic 0)

In the seconds mode the value of TS is held constant at 0.1s (100ms) until the Integral (TI) or Derivative (TD) times exceed 18.4 seconds, or this time is exceeded by the running time of the PID task itself. At this point TS is computed to be TI or TD/512 seconds, i.e. at the maximum value of TI or TD of 99.99 seconds, TS is increased to 0.2 seconds.

b) Minutes mode (ST bit 8 = logic 1)

In the minutes mode the value of TS is held constant at 0.01 minutes until TI or TD exceed 5.12 minutes, or this time is exceeded by the running time of the PID task itself. At this point TS is computed to be TI or TD/512 minutes, i.e. at the maximum value of TI or TD of 99.99 minutes, TS is increased to 0.2 minutes.

6366 MODULE PIN CONNECTIONS AND PLANT TERMINATIONS

PIN No.	RACK TYPE 7600	7950	7900	MODULE FUNCTION	PLANT IDENTIFICATION
	REAR ASSY				
6366	B6366	TA6366	7366		
2	16 , 17	1 , 2	12 , 13	0 VOLTS REFERENCE	
	18 , 19	3 , 4	14 , 39	0 VOLTS REFERENCE	
3	14 , 34	5 , 6	40	0 VOLTS POWER	
	43	7 , 8		0 VOLTS POWER	
8	15	9 , 10	30	24 VOLTS D.C. SUPPLY I/P	
9	13 , 28	12	29	WATCH DOG OUT 1	
10	1	17	2	ANALOG I/P 1(1 - 5V)	
11	2	18	3	ANALOG I/P 2(1 - 5V)	
12	3	19	4	ANALOG I/P 3(1 - 5V)	
13	31	20	16	ANALOG I/P 1(0 - 10V)	
14	32	21	17	ANALOG I/P 2(0 - 10V)	
15	33	22	18	ANALOG I/P 3(0 - 10V)	
16	20	23	21	DIGITAL O/P 1	
17	21	24	22	DIGITAL O/P 2	
18	22	25	23	DIGITAL O/P 3	
19	23	26	24	DIGITAL O/P 4	
20	24	27	25	DIGITAL O/P 5	
21	25	28	26	DIGITAL O/P 6	
22	26	29	27	DIGITAL O/P 7	
23	27	30	28	DIGITAL O/P 8	
24	5	31	31	DIGITAL I/P 1	
25	6	32	32	DIGITAL I/P 2	
26	7	33	33	DIGITAL I/P 3	
27	8	34	34	DIGITAL I/P 4	
28	9	35	35	DIGITAL I/P 5	
29	10	36	36	DIGITAL I/P 6	
30	11	37	37	DIGITAL I/P 7	
31	12	38	38	DIGITAL I/P 8	
32	40	39	6	O/P STATION 1(0 - 10V)	
33	38	40	7	O/P STATION 2(0 - 10V)	
34	39	41	8	ANALOG O/P 1(0 - 10V)	
35	29	13	9	XMT. OUT (–) RS422	
36	30	14	10	XMT. OUT (+) RS422	
37	44	15	19	RCV. IN (–) RS422	
38	45	16	20	RCV. IN (+) RS422	
40	35	47	11	TX. SUPPLY (–)	
41	36	48	1	TX. SUPPLY (+)	
43	41	44	15	OS1 ISOL 4 - 20mA (–)	
45	42	45	5	OS1 ISOL 4 - 20mA (+)	

AN I/PS

INPUTS	OFF *	ON *	PROC. FUNCT.
ANALOG INPUT 3	0 - 10V	1 - 5V	
ANALOG INPUT 2	0 - 10V	1 - 5V	
ANALOG INPUT 1	0 - 10V	1 - 5V	

4 3 2 1 ON OFF STATUS SWITCH S3

* DELETE AS APPLICABLE

MODE SELECTION

FUNCTION	OFF *	ON *
PROTOCOL SELECT	ASCII	BINARY
HHT BAUD RATE	300	SWITCH
MAN. STN 1 ACTION	NORMAL	REVERSE
MAN. STN 2 ACTION	NORMAL	REVERSE
UNUSED		
LOOP COMMS	SINGLE	DUAL

SERIAL COMMS

GID 1 2 4 BAUD RATE

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

UID 1 2 4 8

8 7 6 5 4 3 2 1 ON OFF STATUS SWITCH S2 (RIGHT)

PARAMETER TYPE	PARAMETER FUNCTION	MNEMONIC FULL	CMD	LOOP 1 VALUE	LOOP 1 UNITS	LOOP 2 VALUE	LOOP 2 UNITS
HHT CONTROL	* FIX DATA BASE	N/A	FX				
	* LAMP TEST	N/A	LT				
	* LOOP NUMBER	N/A	LN				
STATUS WORD	DECIMAL POINTS AND ALARMS	SPn.ST	DP				
SETPOINT RANGING	SETPOINT HIGH RANGE	SPn.HR	PH				
	SETPOINT LOW RANGE	SPn.LR	PL				
LIMIT AND ALARM SETTINGS	☼ RATIO SETTING HIGH LIMIT	RBn.HR	HR				
	☼ RATIO SETTING LOW LIMIT	RBn.LR	LR				
	SETPOINT HIGH LIMIT	SPn.HL	HS		(AS PH,PL)		(AS PH,PL)
	SETPOINT LOW LIMIT	SPn.LL	LS				
	ABSOLUTE HIGH ALARM LIMIT	SPn.HA	HA				
	ABSOLUTE LOW ALARM LIMIT	SPn.LA	LA				
	DEVIATION HIGH ALARM LIMIT	SPn.HD	HD				
	DEVIATION LOW ALARM LIMIT	SPn.LD	LD				
	HIGH OUTPUT LIMIT	MSn.HL	HO		%		%
	LOW OUTPUT LIMIT	MSn.LL	LO				
PID ALGORITHM PARAMETERS	PROPORTIONAL BAND CONSTANT	3Tn.XP	XP		%		%
	INTEGRAL TIME CONSTANT	3Tn.TI	TI		mins/secs		mins/secs
	DERIVATIVE TIME CONSTANT	3Tn.TD	TD				
	FEED FORWARD TERM	3Tn.FF	FF		%		%
SETPOINT RELATED PARAMETERS	LOCAL SETPOINT	SPn.SL	SL		(AS PH,PL)		(AS PH,PL)
	☼ RATIO SETTING	RBn.RS	RS		(AS HR,LR)		(AS HR,LR)
	☼ RATIO BIAS	RBn.RB	RB		(AS PH,PL)		(AS PH,PL)
USER CONSTANTS	DECIMAL POINTS FOR CONSTANTS	CBn.ST	DK				
	CONSTANT 1	CBn.1K	1K				
	CONSTANT 2	CBn.2K	2K				
	CONSTANT 3	CBn.3K	3K				
	CONSTANT 4	CBn.4K	4K				
	USER STATUS WORD	CBn.US	US				

DISPLAY ALLOCATION	DISPLAY	LOOP 1 FUNCTION	LOOP 2 FUNCTION
	BARGRAPH 1 (% PV)		
	BARGRAPH 2 (% SP)		
	BARGRAPH 3 (OUTPUT) ◇		
	DIGITAL DISPLAY ◇		

* THESE PARAMETERS ONLY AVAILABLE ON THE H.H.T.
☼ THESE PARAMETERS ONLY AVAILABLE IF RATIO SELECTED
n REPRESENTS THE LOOP NUMBER SELECTED IN LN

◇ THESE DISPLAYS CHANGE FUNCTION UNDER PUSHBUTTON CONTROL – SEE TECHNICAL MANUAL

ISS	DATE	COMPILED	INSTRUMENT IDENTITY II 6366/1	FUNCTION
		CHECKED	SERIAL NO.	
			PROGRAM FILE REF. /	

TCS TURNBULL CONTROL SYSTEMS LTD

6366 CONTROLLER SET-UP DATA SHT

KE076435 : 1 OF 2

GENERAL INSTRUMENT RELATED BLOCK PARAMETERS

BLOCK FUNCTION & PARAMETERS	RELATIVE BLOCK NO 1		RELATIVE BLOCK NO 2		RELATIVE BLOCK NO 3	
	VALUE	UNITS	VALUE	UNITS	VALUE	UNITS
GENERAL PURPOSE (GP)						
ST						
I1						
L1						
L2						
BG						
SW						
PB						
ANALOGUE INPUT (AI)						
ST						
HR						
LR						
AI		%		%		%
AV						
ANALOGUE OUTPUT (AO)						
ST						
HR						
LR						
HL						
LL						
AO						
DIGITAL INPUT (DI)						
ST						
XM						
DS						
DIGITAL OUTPUT (DO)						
ST						
WM						
DS						

NOTES:

LOOP RELATED BLOCK PARAMETERS

BLOCK FUNCTION & PARAMETERS	LOOP 1		LOOP 2	
	VALUE	UNITS	VALUE	UNITS
SETPOINT (SP)				
ST				
HR				
LR				
HL				
LL				
PV				
SP		(AS HR,LR)		(AS HR,LR)
ER				
SL				
SR				
SB				
RL		units/sec	units/sec	
HA				
LA		(AS HR,LR)		(AS HR,LR)
HD				
LD				
RATIO (RB)				
ST				
HR				
LR				
RS				
RT		AS HR,LR		(AS HR,LR)
RB		setpoint range		setpoint range
P.I.D. CONTROL (3T)				
ST				
XP		%		%
TI		mins/secs		mins/secs
TD				
FF				
FB		%		%
OP				
TS		mins/secs		mins/secs
MANUAL OUTPUT STATION (MS)				
ST				
HV		%/sec		%/sec
LV				
HL				
LL				
AO		%		%
OP				
OT				

BLOCK FUNCTION & PARAMETERS	LOOP 1		LOOP 2	
	VALUE	UNITS	VALUE	UNITS
DISPLAY AND CONTROL (DC)				
ST				
1B				
2B				
3B				
DD				
ES				
SM				
ALARM BLOCK (AB)				
ST				
HV				
LV				
HL				
LL				
PV				
SP				
AH				
CONSTANTS BLOCK (CB)				
ST				
1K				
2K				
3K				
4K				
US				
FILTER BLOCK (FB)				
ST				
XK				
1T		mins/secs		mins/secs
2T				
FF				
FI		%		%
OP				
DELAY BLOCK (DB)				
ST				
DT		secs		secs
TOTALISATION BLOCK (TB)				
ST				
FS				
FT				

APPENDIX E 6366 Parameter Tables - Revision History

Software part No. RD 076056 issue 1, release 5

Tables 4.4, 4.5, 4.8 to 4.15, and 4.17 to 4.21 inclusive list the 2 character command parameters of the 6366 Programmable Advanced 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 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 6366 software with respect to changes in these parameter tables:-

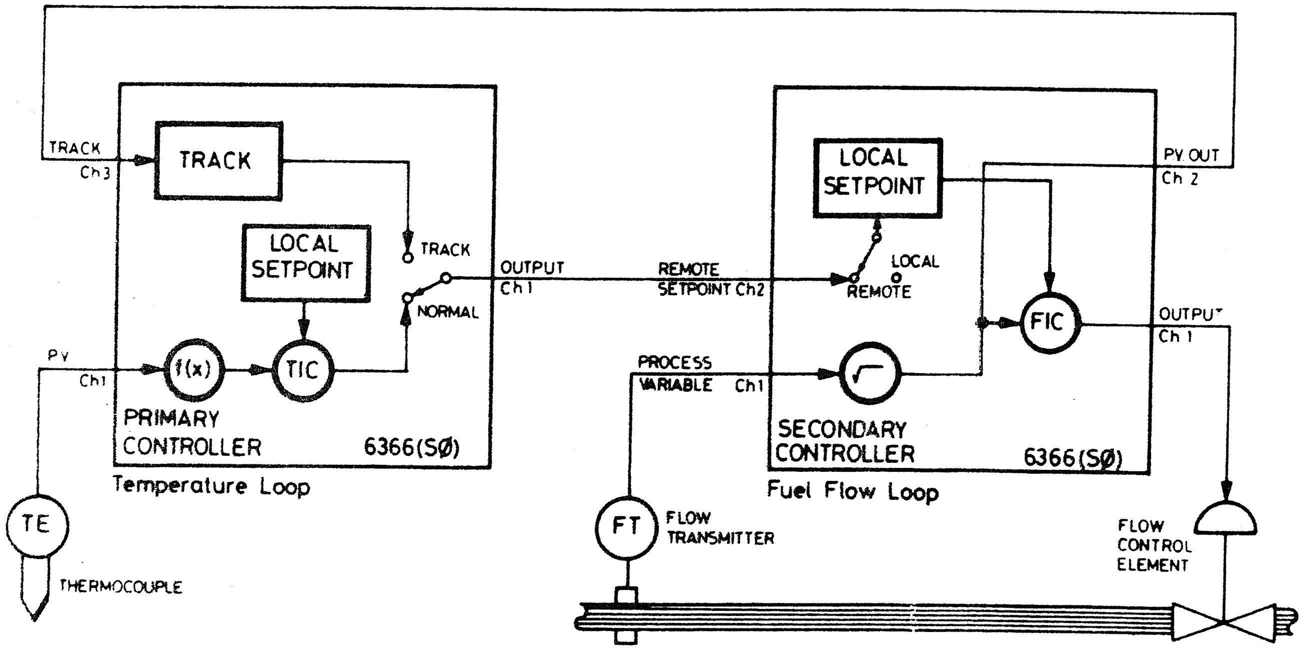
SOFTWARE		DATE	MEMORY BOARD	PROMS		REMARKS
ISS.	REL			TYPE	NO	
1	1	16/01/85	Mk 5 (007)	27128	2	Initial release.
1	2	30/05/85	Mk 5 (007)	27128	2	Cure problems with initial release, including PID, and bumpless transfer. Add new word, allow crossed ranges.
1	3	26/06/85	Mk 5 (007)	27128	2	Cure error in previous release on S5 application word.
		04/07/85	Mk 6 (007)	27128	2	No PROM changes but runs on Mk 6 version 007 memory.
1	4	01/08/85	Mk 6 (007)	27128	2	Cure problem with loop 2 comms.
1	5	10/09/85	Mk 6 (007)	27128	2	Cure binary comms. error where updates of PNO 92 actually update PNO 9.

SOFTWARE		DATE	MEMORY BOARD	PROMS		REMARKS
ISS.	REL			TYPE	NO	
1	6	18/12/85	Mk 6 (007)	27128	2	Cure following problems:- a) Enquiry Poll not flagged on changes between MANUAL and FORCED MANUAL. b) B1 and B2 changed to include new AWORD SET1MAN to ensure MAN-LO at Power-up. c) Enable Binary comms. writing to hex parameters with top bit set. d) Clear error flags in GP1.ST only at Power-up and when ESC is typed.
2	1	01/08/86	Mk 6 (015)	27256	1	New Memory build option using 8K EEPROM instead of 2K device. User program area increased from 1500 to 4500 bytes.

Programmable Advanced Controller 6366

Applications Library Number 001

SINGLE LOOP CONTROLLER (LOCAL/REMOTE SETPOINT) SØ



Single Loop Controller (Cascade Controller)

The example shows a process temperature being controlled through a secondary fuel flow loop using two 6366 controllers. To effect bumpless and procedureless switching between Remote, Auto and Manual on the secondary controller, its Process Variable is retransmitted to the primary controller. This allows the output of the primary controller to track the Process Variable of the secondary controller whenever it is in Manual.

The loop setpoint of the secondary controller will track the remote setpoint value as long as it is in Remote. In addition, an option allows the local setpoint of each controller to track its own Process Variable while it is in Manual.

Applications

Single Loop Integrity
Combustion Control
Boiler Control
Furnace Control
Gas Pressure Control
Glass Furnace/Forehearth
Reheat Furnaces
Blast Furnaces
Chemical Reaction Vessels
Cement Drying

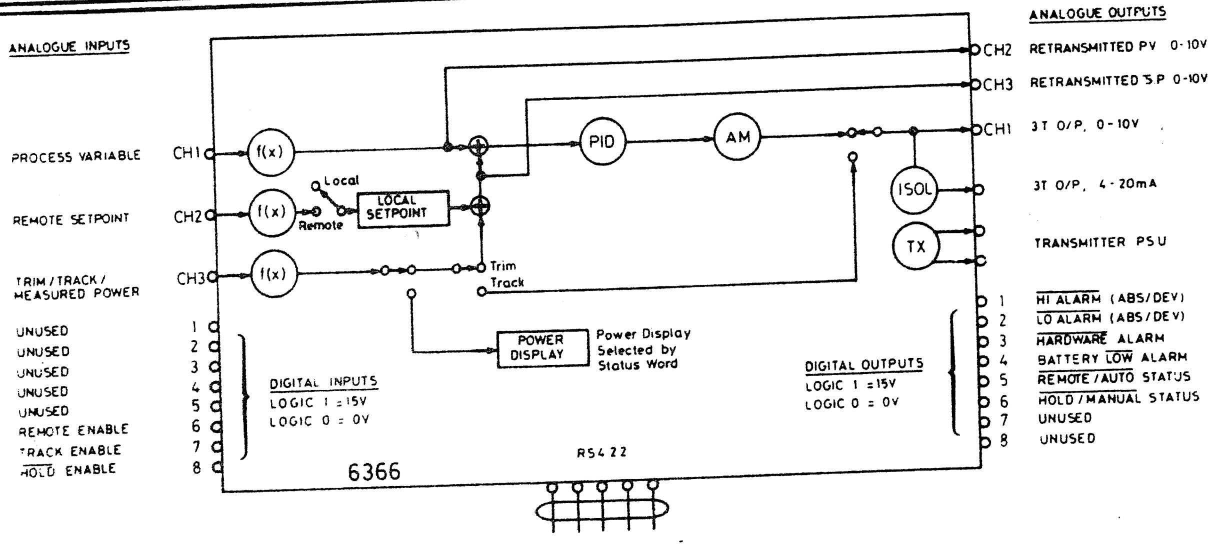
Further Information

Further data may be found in the following Manuals:

6366 Technical Manual.
6366 Programming Manual.
6366 Applications Manual.

6366 Programmable Advanced Controller

Applications Program



Program Listing

```
S0          (Standard controller configuration)
TRACK1      (Set up track register)
TRIM1       (Set up trim register)
REMOTE1     (Set up remote setpoint register)
PV1         (Stack process variable)
PID1        (Stack PID output)
SETOP1      (Store PID output)
```

Summary of Configuration Parameters

Block Description	Block Mn'nic	Block Type	Ref'v Block	Block No	Parameter Number 0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F
General Purpose	GP	0	1	0	ST	II	L1	L2	BG	SW	PB									
Analogue Input	AI	1	1	1	ST	HR	LR	AI	AV											
			2	2	ST	HR	LR	AI	AV											
			3	3	ST	HR	LR	AI	AV											
Analogue O/P	AO	2	1	4	ST	HR	LR	HL	LL	AO										
Digital Input	DI	3	1	5	ST	XM	DS													
Digital O/P	DO	4	1	6	ST	WM	DS													
Setpoint	SP	5	1	7	ST	HR	LR	HL	LL	PV	SP	ER	SL	SR	SB	RL	HA	LA	HD	LD
PID Control	3T	7	1	11	ST	XP	TI	TD	FF	FB	OP	TS								
Manual Output Station	MS	8	1	13	ST	HV	LV	HL	LL	AO	OP	OT								
			2	14	ST	HV	LV	HL	LL	AO	OP	OT								
Display & Control	DC	9	1	15	ST	1B	2B	3B	DD	ES	SM									

Background Programs

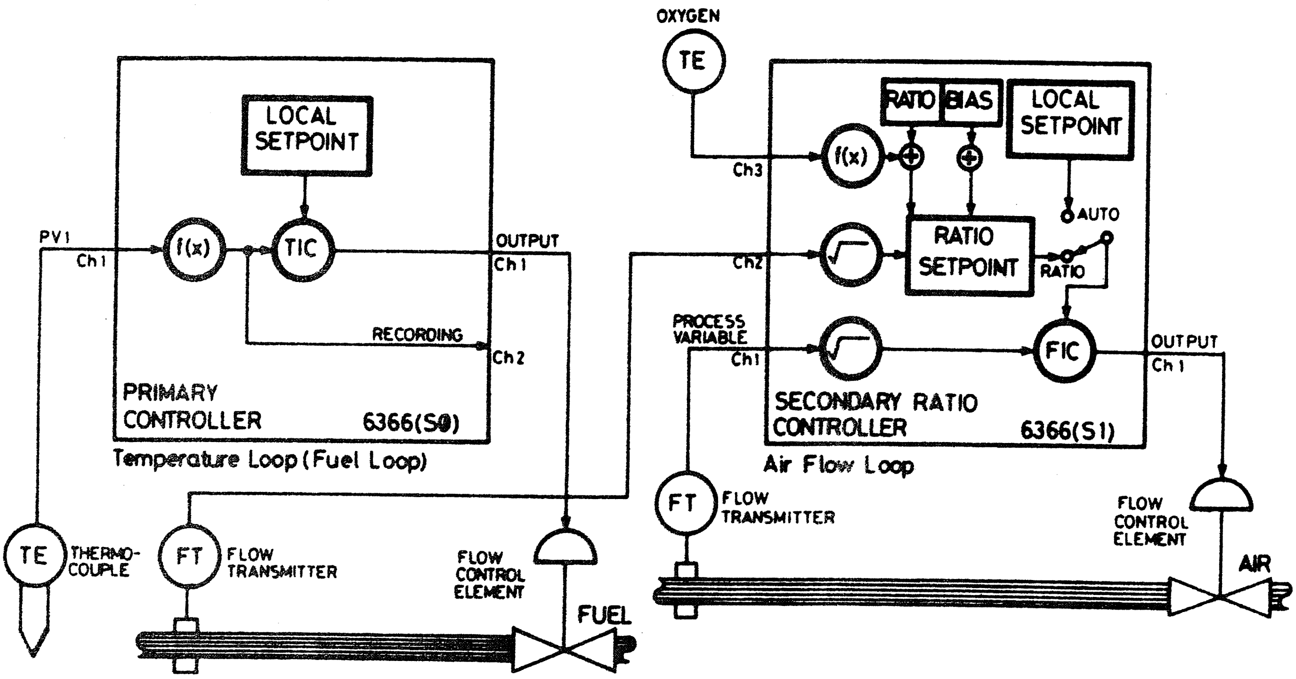
B0 Power up in last mode with last out. O/C input forces Manual mode with last output.
B1 Power up in Manual with output low limit. O/C input forces Manual Mode with last output.
B2 Power up as B0 but O/C input forces Manual with low output.
B3 Power up as B1 but O/C input forces Manual with low output.

Programmable Advanced Controller 6366

Applications Library

Number 002

SINGLE LOOP CONTROLLER (RATIO CONTROLLER) S1



Single Loop Controller (Ratio Control)

The fuel-air control system illustrated demonstrates several features of the 6366 Programmable Advanced Controller. The furnace temperature controller regulates the fuel flow and makes the linearised process temperature available for recording. The fuel flow is measured and linearised within the combustion air controller where the ratio bias functions are executed to generate the correct setpoint to maintain the desired relationship between fuel and air flows. The combustion air controller also linearises an input from an oxygen monitor and uses this to trim the ratio setting to ensure efficient combustion.

Applications

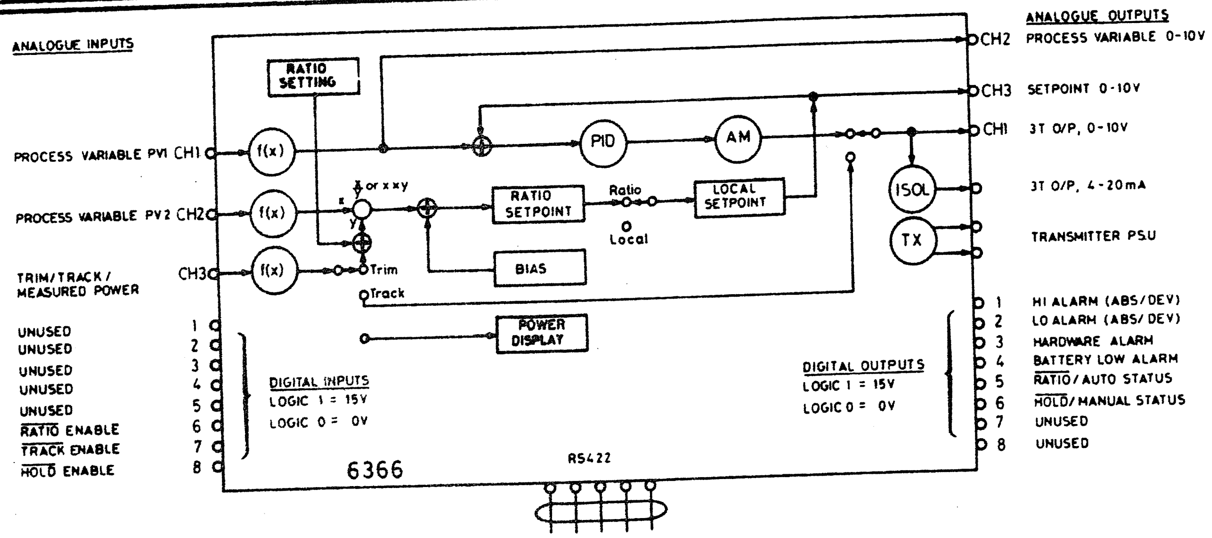
Furnace Combustion
Boiler Control Systems
Dryers

Further Information

Further data may be found in the following Manuals:

6366 Technical Manual.
6366 Programming Manual.
6366 Applications Manual.

Applications Program



Program Listing

```
S1        (Ratio controller configuration)
TRACK1    (Set up track register)
RATRIM1   (Set up ratio setting trim register)
RATIO1    (Calculate setpoint from ratio PV)
PV1       (Stack process variable)
PID1      (Stack PID output)
SETOP1    (Store PID output)
```

Summary of Configuration Parameters

Block Description	Block Mn'nic	Block Type	Ref'v Block	Block No.	Parameter Number 0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F
General Purpose	GP	0	1	0	ST	II	L1	L2	BG	SW	PB									
Analogue Input	AI	1	1	1	ST	HR	LR	AI	AV											
			2	2	ST	HR	LR	AI	AV											
			3	3	ST	HR	LR	AI	AV											
Analogue O/P	AO	2	1	4	ST	HR	LR	HL	LL	AO										
Digital Input	DI	3	1	5	ST	XM	DS													
Digital O/P	DO	4	1	6	ST	WM	DS													
Setpoint	SP	5	1	7	ST	HR	LR	HL	LL	PV	SP	ER	SL	SR	SB	RL	HA	LA	HD	LD
Ratio	RB	6	1	9	ST	HR	LR	RS	RT	RB										
PID Control	3T	7	1	11	ST	XP	TI	TD	FF	FB	OP	TS								
Manual Output Station	MS	8	1	13	ST	HV	LV	HL	LL	AO	OP	OT								
			2	14	ST	HV	LV	HL	LL	AO	OP	OT								
Display & Control	DC	9	1	15	ST	1B	2B	3B	DD	ES	SM									

Background Programs

B0 Power up in last mode with last out. O/C input forces Manual mode with last output.

B1 Power up in Manual with output low limit. O/C input forces Manual Mode with last output.

B2 Power up as B0 but O/C input forces Manual with low output.

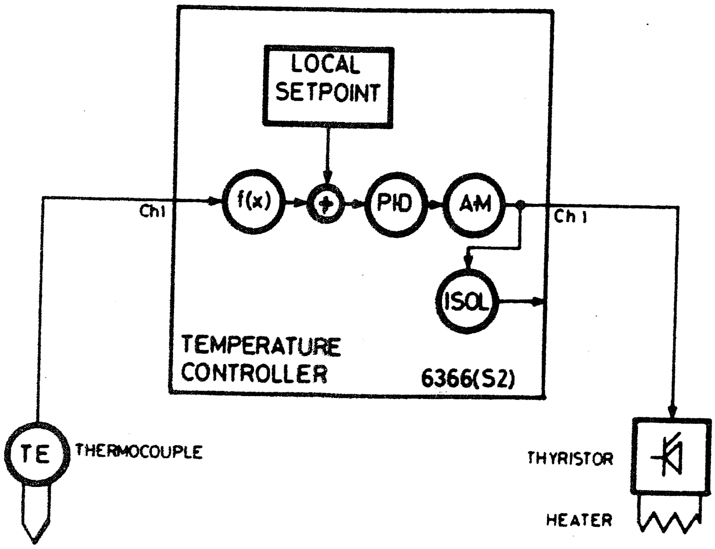
B3 Power up as B1 but O/C input forces Manual with low output.

Programmable Advanced Controller 6366

Applications Library

Number 003

SIMPLE SINGLE LOOP CONTROLLER S2



Simple Single Loop Controller

The example shows a simple PID controller with 0-10V (1-5V) input, linearisation of the measurement, local setpoint, Auto/Manual station and 0-10V and 4-20mA outputs.

S2 may be used in conjunction with S3 to produce a 2-loop controller and is designed as a basic building block for user applications.

Applications

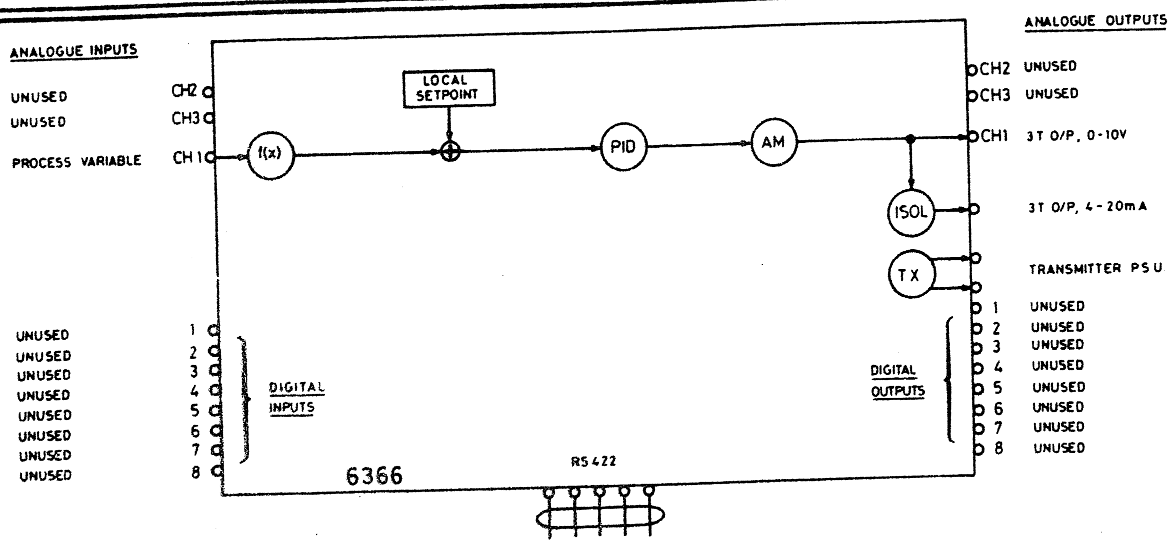
Simple Loop Process Control
Dual Loop Process Control
Multi-zone Ovens
Multi-zone Forehearths
Multi-zone Furnaces
Multi-zone Dryers

Further Information

Further data may be found in the following Manuals:

6366 Technical Manual.
6366 Programming Manual.
6366 Applications Manual.

Applications Program



Program Listing

S2 (Simple PID loop 1)
PV1
PID1
SETOP1

Summary of Configuration Parameters

Block Description	Block Mnemonic	Block Type	Ref Block	Block No	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F
General Purpose	GP	0	1	0	ST	II	L1	L2	BG	SW	PB									
Analogue Input	AI	1	1	1	ST	HR	LR	AI	AV											
Setpoint	SP	5	1	7	ST	HR	LR	HL	LL	PV	SP	ER	SL	SR	SB	RL	HA	LA	HD	LD
PID Control	3T	7	1	11	ST	XP	TI	TD	FF	FB	OP	TS								
Manual Output Station	MS	8	1	13	ST	HV	LV	HL	LL	AO	OP	OT								
Display & Control	DC	9	1	15	ST	1B	2B	3B	DD	ES	SM									

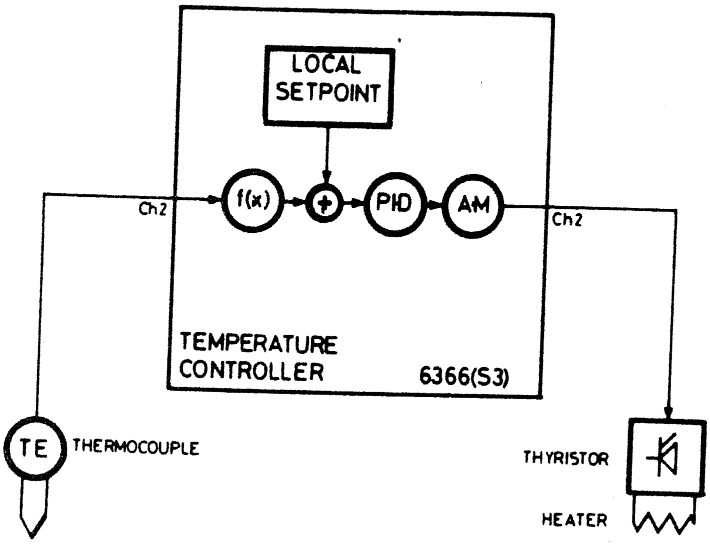
Background Programs

B5 Power up in last mode with last output.
O/C P.V. causes Hold mode while condition exists.
Hi/Lo alarms are not displayed. (Registered in Communications Alarm state only).

Programmable Advanced Controller 6366

Applications Library Number 004

SIMPLE SINGLE LOOP CONTROLLER S3



Simple Single Loop Controller

The example shows a simple PID controller with 0-10V input, linearisation of the measurement, local setpoint, Auto/Manual station and 0-10V output.

S3 may be used in conjunction with S2 to produce a 2-loop controller and is designed as a basic building block for user applications.

Applications

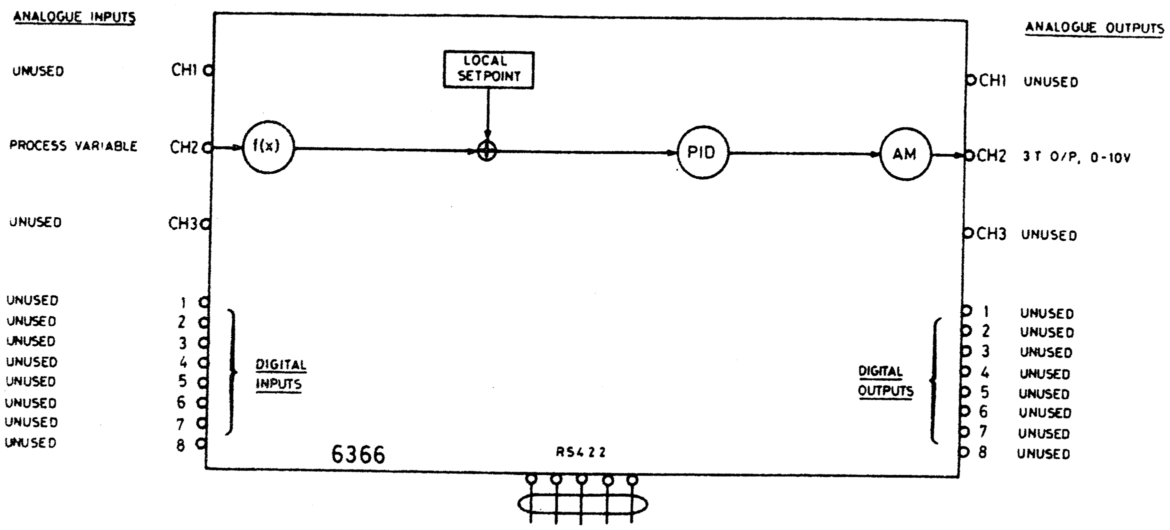
Simple Loop Process Control
Dual Loop Process Control
Multi-zone Ovens
Multi-zone Forehearths
Multi-zone Furnaces
Multi-zone Dryers

Further Information

Further data may be found in the following Manuals:

6366 Technical Manual
6366 Programming Manual
6366 Applications Manual

Applications Program



Program Listing

```
S3        (Simple PID loop 2)
PV2
PID2
MS2 MSCONT
```

Summary of Configuration Parameters

Block Description	Block Mnmc	Block Type	Reltv Block	Block No	Parameter Number 0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F
General Purpose	GP	0	1	0	ST	II	L1	L2	BG	SW	PB									
Analogue Input	AI	1.	2	2	ST	HR	LR	AI	AV											
Setpoint	SP	5	2	8	ST	HR	LR	HL	LL	PV	SP	ER	SL	SR	SB	RL	HA	LA	HD	LD
PID Control	3T	7	2	12	ST	XP	TI	TD	FF	FB	OP	TS								
Manual Output Station	MS	8	2	14	ST	HV	LV	HL	LL	AO	OP	OT								
Display & Control	DC	9	2	16	ST	1B	2B	3B	DD	ES	SM									

Background Programs

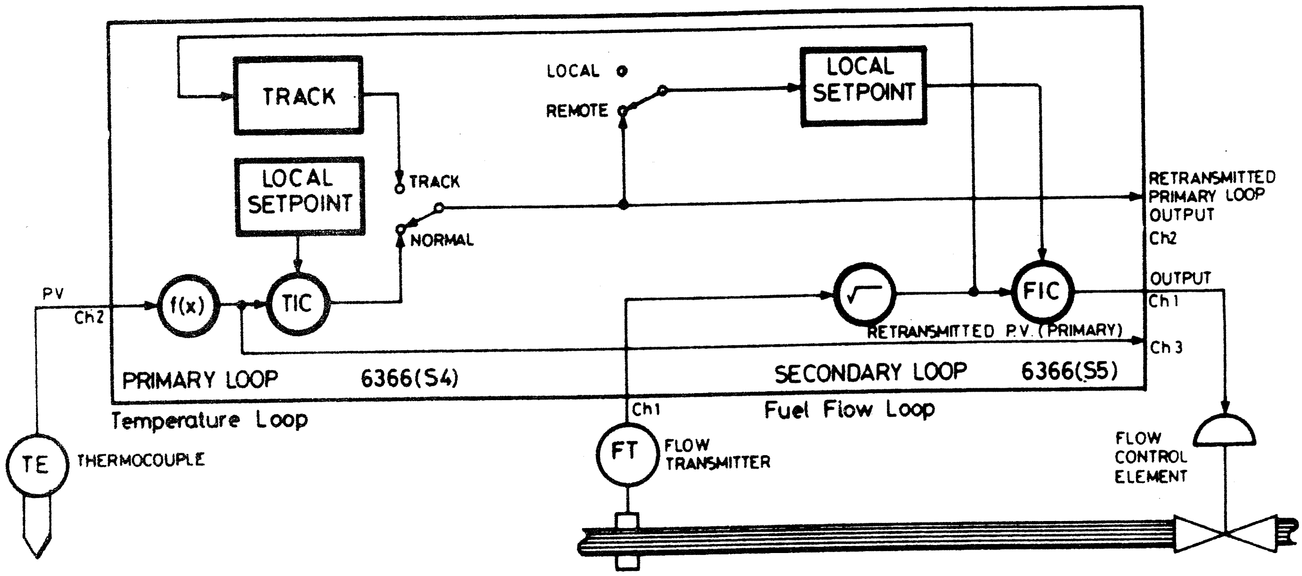
```
B5  Power up in last mode with last output.
    No O/C detection.
    Hi/Lo alarms not displayed.
```

Programmable Advanced Controller 6366

Applications Library

Number 005

CASCADE PAIR CONTROLLER S4/S5



Cascade Pair Controller

The example shows a process temperature being controlled through a secondary fuel flow loop using a single 6366 Programmable Advanced Controller.

The Process Variable is used in the primary control loop to provide a tracking facility which allows completely procedureless and bumpless transfer between modes.

This application provides similar features to those described in S0 but using a single instrument instead of 2.

Applications

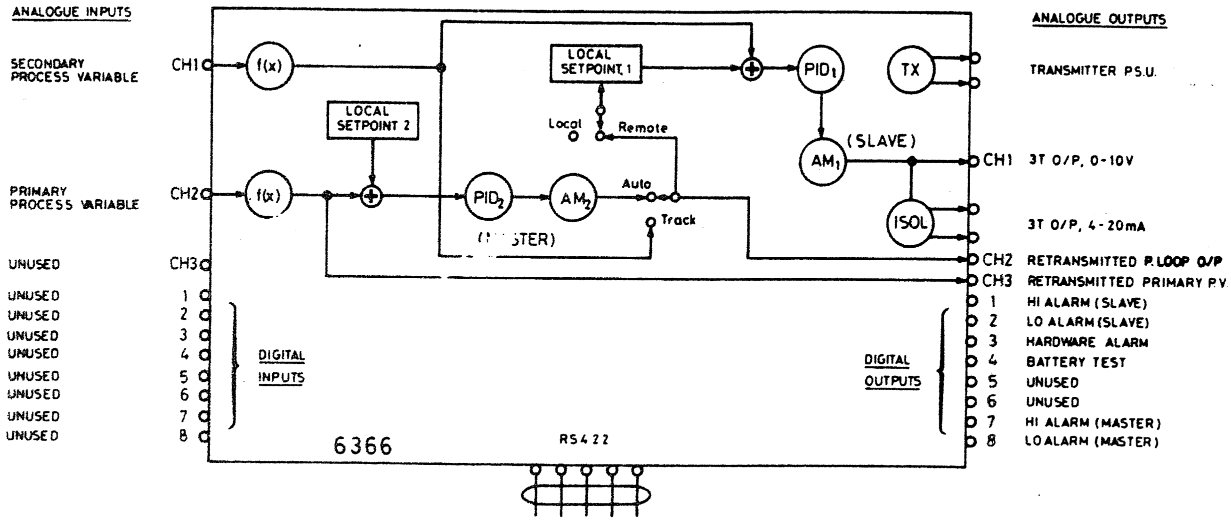
Single Loop Integrity
Combustion Control
Boiler Control
Furnace Control
Gas Pressure Control
Glass Furnace/Forehearth
Reheat Furnaces
Blast Furnaces
Chemical Reaction Vessels
Cement Drying

Further Information

Further data may be found in the following Manuals:

6366 Technical Manual
6366 Programming Manual
6366 Applications Manual

Applications Program



Program Listing

```
S4              (Slave PID control program name for HHT L1 parameter)
S.ENB           (Update the Slave REMOTE status)
MS2 AO %GET     (Get the Master loop control output)
SP1 %REMOTE     (and set into the Remote Setpoint register 'SR')
PV1             (Get Channel 1 Analogue input for the 'PV')
PID1            (Calculate and set the 3T control output)
SETOP1
;

S5              (Master PID Control program name for HHT L2 parameter)
M.ENB           (Update the Master TRACK status)
SP1 PV %GET     (Get slave PV)
MS2 OT %SET     (Set masters output track register)
PV2             (Get channel 2 analogue input)
PID2            (Calculate and set the 3T control output)
MS2 MSCONT      (Transfer to MS2.OP if loop is in Auto)
```

Summary of Configuration Parameters

Block Description	Block Mnhic	Block Type	Relliv Block	Block No	Parameter Number 0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F
General Purpose	GP	0	1	0	ST	II	L1	L2	BG	SW	PB									
Analogue Input	AI	1	1	1	ST	HR	LR	AI	AV											
			2	2	ST	HR	LR	AI	AV											
Analogue O/P	AO	2	1	4	ST	HR	LR	HL	LL	AO										
Setpoint	SP	5	1	7	ST	HR	LR	HL	LL	PV	SP	ER	SL	SR	SB	RL	HA	LA	HD	LD
			2	8	ST	HR	LR	HL	LL	PV	SP	ER	SL	SR	SB	RL	HA	LA	HD	LD
PID Control	3T	7	1	11	ST	XP	TI	TD	FF	FB	OP	TS								
			2	12	ST	XP	TI	TD	FF	FB	OP	TS								
Manual Output Station	MS	8	1	13	ST	HV	LV	HL	LL	AO	OP	OT								
			2	14	ST	HV	LV	HL	LL	AO	OP	OT								
Display & Control	DC	9	1	15	ST	1B	2B	3B	DD	ES	SM									
			2	16	ST	1B	2B	3B	DD	ES	SM									

Background Programs

B6 Power up in last mode with last output

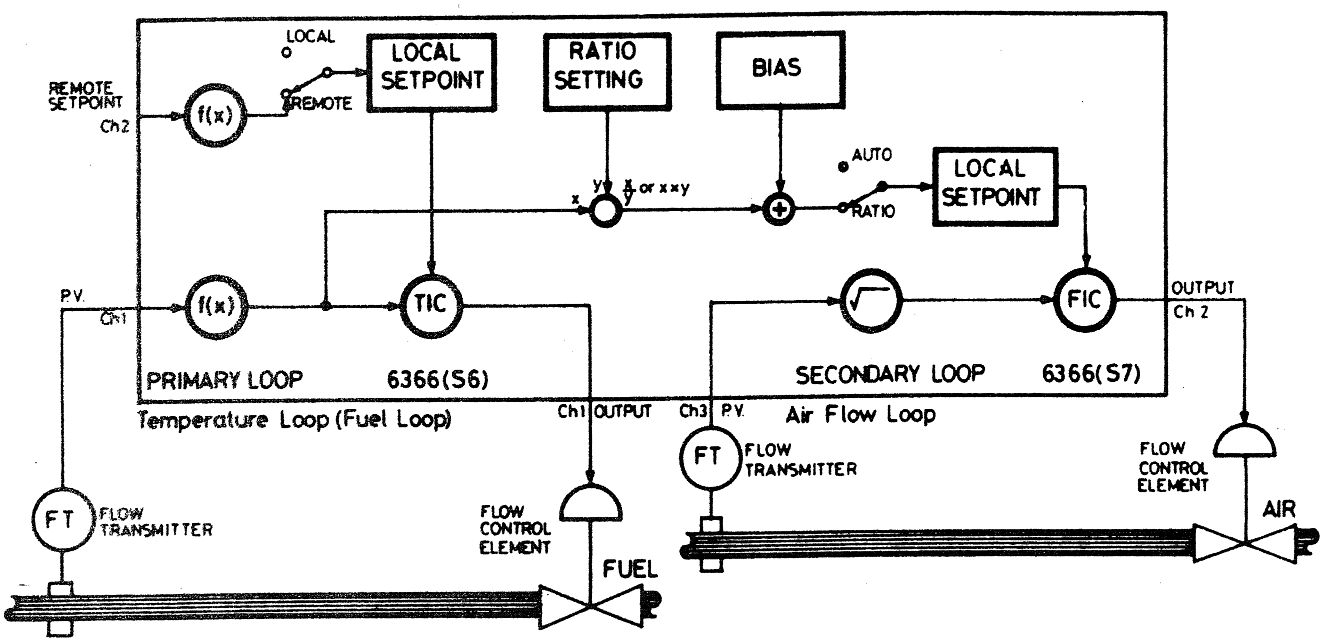
O/C PV (CH1 only) or sum-check error places relevant loop in to Forced Manual.

Programmable Advanced Controller 6366

Applications Library

Number 006

RATIO PAIR CONTROLLER S6/S7



Ratio Pair Controller

The fuel-air ratio control system illustrated demonstrates the full potential of the 6366 dual loop capability. The fuel flow control loop can be cascaded from an external temperature loop which in turn provides a Ratio process variable for the secondary air flow loop.

The Ratio control loop provides a local (Auto) setpoint, a Ratio setpoint plus a Ratio Bias set via the configuration terminal.

Applications

Single Loop Integrity
Combustion Control
Boiler Control
Furnace Control
Gas Pressure Control

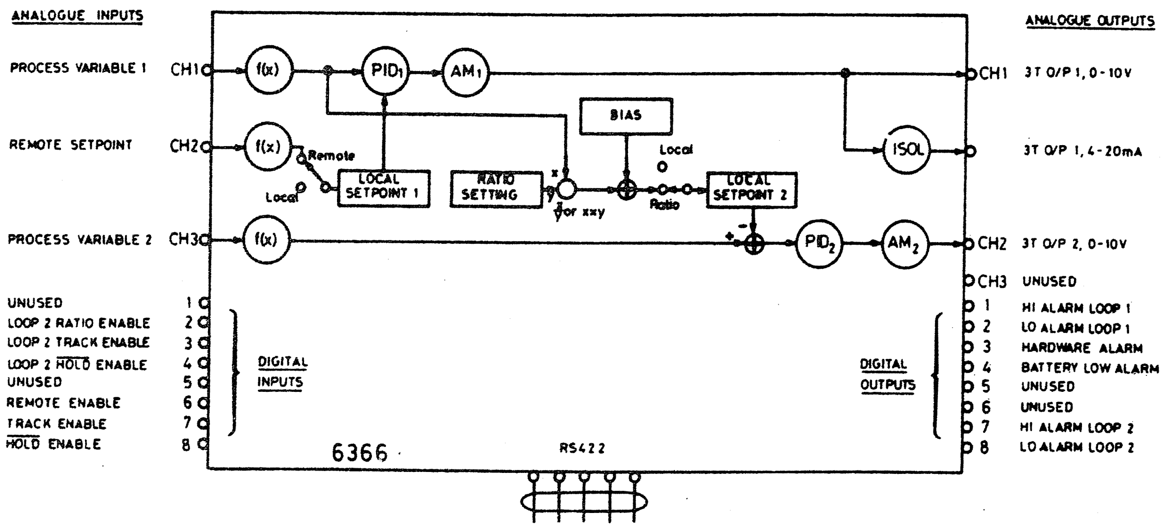
Glass Furnace/Forehearth
Reheat Furnaces
Blast Furnaces
Chemical Reaction Vessels
Cement Drying

Further Informaton

Further data may be found in the following Manuals:

6366 Technical Manual
6366 Programming Manual
6366 Applications Manual

Applications Program



Program Listing

```
S6              (Loop 1 of Ratio pair-Program name for L1 parameter)
REMOTE1         (Set up remote setpoint register)
PV1             (Stack process variable)
PID1            (Stack PID output)
SETOP1          (Store PID output)
;

S7              (Loop 2 of Ratio pair-program name for L2 parameter)
PV1 SP2 RATIO   (Calculate Loop 2 setpoint using input 1)
PV3             (Stack PV from input 3)
PID2            (Stack PID output)
MS2 MSCONT      (Store PID output)
```

Summary of Configuration Parameters

Block Description	Block Mnmc	Block Type	Refv Block	Block No	Parameter Number 0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F
General Purpose	GP	0	1	0	ST	II	L1	L2	BG	SW	PB									
Analogue Input	AI	1	1	1	ST	HR	LR	AI	AV											
			2	2	ST	HR	LR	AI	AV											
			3	3	ST	HR	LR	AI	AV											
Setpoint	SP	5	1	7	ST	HR	LR	HL	LL	PV	SP	ER	SL	SR	SB	RL	HA	LA	HD	LD
			2	8	ST	HR	LR	HL	LL	PV	SP	ER	SL	SR	SB	RL	HA	LA	HD	LD
Ratio	RB	6																		
			2	10	ST	HR	LR	RS	RT	RB										
PID Control	3T	7	1	11	ST	XP	TI	TD	FF	FB	OP	TS								
			2	12	ST	XP	TI	TD	FF	FB	OP	TS								
Manual Output Station	MS	8	1	13	ST	HV	LV	HL	LL	AO	OP	OT								
			2	14	ST	HV	LV	HL	LL	AO	OP	OT								
Display & Control	DC	9	1	15	ST	1B	2B	3B	DD	ES	SM									
			2	16	ST	1B	2B	3B	DD	ES	SM									

Background Programs

B7 Power up in previous mode, O/C PV1 Forced Manual after 3 secs.
Clears Ratio Enable loop 2.
O/C PV2 undetected.
Sumcheck Error Forced Manual in loop 1 and loop 2.

Section G.1 LIST OF 6366 APPLICATION WORDS

```
:
 PV3    (Form Process variable 3)
        AI3 AV GET      (Get scaled channel 3 input)
;
:
 PV2    (Form Process variable 2)
        AI2 AV GET      (Get scaled channel 2 input)
;
:
 PV1    (Form Process variable 1)
        AI1 AV GET      (Get scaled channel 1 input)
;
:
 PV1.OC?         (Stack input 1 open circuit flags)
        AI1 ST GET
        #0006 AND
;
:
 FLASH2 (Flash left bargraph if any alarms on SP block 2)
        DC2 1B GET      (Get current display data)
        #FFFE AND       (Clear flasher bit)
        SP2 ST GET      (Get alarm status on this block)
        #00F0 AND
        IF      (IF any alarms on this block THEN)
          #0001 OR      (Set flasher bit)
        ENDIF
        DC2 1B SET      (Set display register)
;
:
 FLASH1 (Flash left bargraph if any alarms on SP block 1)
        DC1 1B GET      (Get current display data)
        #FFFE AND       (Clear flasher bit)
        SP1 ST GET      (Get alarm status on this block)
        #00F0 AND
        IF      (IF any alarms on this block THEN)
          #0001 OR      (Set flasher bit)
        ENDIF
        DC1 1B SET      (Set display register)
;
:
 ALARM2 (Use Digital Outputs 7 & 8 for SP block 2 alarms)
        SP2 ST GET      (Get alarms from status)
        DUP     (Save a copy)
        #00A0 AND       (Separate high alarm bits)
        NOT     (Negative logic for alarms)
        DO1 7 SETDIG    (Modify high alarm digital output bit 7)
        #0050 AND       (Separate low alarm bits)
        NOT     (Negative logic for alarms)
        DO1 8 SETDIG    (Modify low alarm digital output bit 8)
;
```

```
: ALARM1        (Use Digital Outputs 1 & 2 for SP block 1 alarms)
        SP1 ST GET      (Get alarms from status)
        DUP     (Save a copy)
        #00A0 AND       (Separate high alarm bits)
        NOT     (Negative logic for alarms)
        DO1 1 SETDIG    (Modify high alarm digital output bit 1)
        #0050 AND       (Separate low alarm bits)
        NOT     (Negative logic for alarms)
        DO1 2 SETDIG    (Modify low alarm digital output bit 2)
;
:
 CLRXMSK        (Clear the XOR mask)
        #0000 DI1 XM SET
;
:
 DOMASK1
        #003F DO1 WM SET        (Assign DO1=Loop 1 High Alarm)
                (       DO2=  "    Low    "  )
                (       DO3=Hardware      "  )
                (       DO4=Low battery   "  )
                (       DO5=NOT.Rem/Ratio Auto)
                (       DO6=NOT.[Hold OR Man])
;
:
 DOMASK2        (Set a Digital Output Mask)
        #00CF DO1 WM SET        (Assign DO1=Loop 1 High Alarm)
                (       DO2=  "    Low    "  )
                (       DO3=Hardware      "  )
                (       DO4=Low battery   "  )
                (       DO7=Loop 2 High   "  )
                (       DO8=  "  " Low    "  )
;
:
 TRACK1 (Set track value)
        AI3 AI %GET     (Get raw analogue input)
        MS1 OT %SET     (Set to track register in MS output block)
;
:
 TRIM1  (Form SP trim)
        PV3     (Get trim value from input 3)
        SP1 SB SET      (Set SP bias register)
;
:
 REMOTE1        (Form Remote setpoint)
        PV2     (Get scaled channel 2 input)
        SP1 REMOTE      (Store in RS register and reset ratio bit)
;
:
 RATRIM1        (Form ratio setting trim)
        PV3     (Get trim value from input 3)
        RB1 RT SET      (Set RB ratio trim register)
;
:
```

```
RATIO1 (Form Ratio setpoint)
       PV2      (Get scaled analogue value from input 2)
       SP1 RATIO        (Form ratio setpoint, store in RS register
                and set ratio bit)
;
: SETES2          (Set Loop 2 Enable status)
       DC2 ES SET
;
:
SETES1 (Set Loop 1 Enable status)
       DC1 ES SET
;
:
SETMAN1          (Set Loop 1 into manual)
       DC1 ST GET       (Stack current operating status)
       #0008 AND        (Do not alter sumcheck bit)
       #2000 OR         (Include manual status bit)
       DC1 ST SET       (Set loop 1 into manual)
;
:
SET1MAN          (Alternate technique to set loop 1 to manual)
       BEGIN    (Ensures output can be changed)
         #0081 DC1 ES SET  (Select manual, no hold, no track)
         DC1 ST GET       (Stack current operating status)
         #F800 AND        (Separate operating mode bits)
         #2000 =          (Check for manual mode)
       UNTIL    (LOOP until loop in manual)
;
:
MAN.LO (Set loop to manual and low output limit)
       DC1 ST GET       (IF in AUTO mode THEN)
       #0040 AND
       IF
         SETMAN1          (Set loop into manual)
         0 MS1 OP SET     (Set to low output limit)
       ENDIF   (ENDIF)
;
:
S.REM? (Return the Slave REMOTE status)
    DC1 ST GET  (Separate the Slave Remote status flag)
    #0010 AND   (On return #0000=Remote, #0010=NOT.Remote)
;
:
M.HM?  (Return the Master HOLD/MANUAL status)
    DC2 ST GET  (Separate the Master Hold/Manual flag)
    #0020 AND   (On return #0000=Hold/Manual, #0020=NOT.Hold/Manual)
;
:
S.ENB  (Update slave REMOTE Enable)
    M.HM?           (Get Master Hold/Manual status)
       #DF00 OR           (Include mask)
    SETES1          (Modify Slave Remote Enable)
;
:
```

```
 M.ENB  (Update Master TRACK status)
    S.REM?      (Find the slave Remote status)
    IF  (IF the slave is NOT in REMOTE THEN)
      #BF40        (Master should be in Track)
    ELSE        (ELSE)
      #BF00        (Master is not in Track)
    ENDIF       (ENDIF)
    SETES2      (Modify Master Track status)
;
: RTL2.EN       (Set Ratio loop 2 enable flags)
        DI1 DS GET       (Assign DI2=Ratio Enable)
        #000E AND        (        DI3=Track Enable)
                (        DI4=NOT.Hold Enable)
        16 *    (Shift data left 4 places)
        PV1.OC?
        IF      (IF Open circuit on PV1 THEN)
          #00C0 AND        (Clear Ratio Enable)
        ENDIF   (ENDIF)
        #1F00 OR           (Mask other data)
        SETES2  (Set Loop 2 enable flags)
;
:
ENABLE1         (Set Loop 1 enable flags)
        DI1 DS GET       (Get digital inputs)
        #00E0 AND        (Separate NOT.Hold, Track and Rem/Ratio enable)
        #1F00 OR         (Include mask in high byte)
        SETES1  (Set Loop 1 enable flags)
;
:
COM.SC?         (Stack common sumcheck error flag)
        GP1 ST GET       (Get general purpose status)
        #0100 AND        (Separate common data base sumcheck error)
;
:
HWCHECK         (Check the hardware status, update the hardware
                hardware alarm output and forced manual status)
        PV1.OC? #0002 AND       (Stack Channel 1 open circuit for 3 secs flag)
        COM.SC? (Stack common sumcheck flag)
        OR
        DUP NOT (Form flag for hardware alarm output)
        DO1 3 SETDIG     (Set/clear hardware alarm output)
        IF      (IF open circuit OR sumcheck error THEN)
          #F708   (Stack value to set forced manual in DC1.ES)
        ELSE              (ELSE)
          #F700   (Stack value to clear forced manual in DC1.ES)
        ENDIF   (ENDIF)
        SETES1  (Set/clear forced manual flag on loop 1)
;
:
```

```
HWLOCHK (Check the hardware status. This word is similar to
                HWCHECK, but sets MS1.OP to low limit if any faults)
        PV1.OC? #0002 AND       (Stack Channel 1 open circuit for 3 secs flag)
        COM.SC? (Stack common sumcheck flag)
        OR
        DUP NOT (Form flag for hardware alarm output)
        DO1 3 SETDIG    (Set/clear hardware alarm output)
        IF      (IF open circuit OR sumcheck error THEN)
          MAN.LO          (IF Auto THEN set loop 1 to Man & Low limit ENDIF)
          #F708   (Stack value to set forced manual in DC1.ES)
        ELSE              (ELSE)
          #F700   (Stack value to clear forced manual in DC1.ES)
        ENDIF   (ENDIF)
        SETES1  (Set/clear forced manual flag on loop 1)
;
PE
: HWCHKL2       (Monitor the common sumcheck bit and update
                the forced manual status on loop 2)
        COM.SC? (Stack common sumcheck flag)
        IF      (IF Sumcheck error THEN)
          #F708   (Stack value to set forced manual in DC2.ES)
        ELSE              (ELSE)
          #F700   (Stack value to clear forced manual in DC2.ES)
        ENDIF   (ENDIF)
        SETES2  (Set/clear forced manual flag on loop 2)
;
:
 BATTEST        (Check battery)
        GP1 ST GET      (Get battery low bit)
        #0800 AND
        NOT     (Inverse logic on digital output)
        DO1 4 SETDIG    (Set battery status in digital outputs)
;
:
 DIGOP1         (Set digital outputs with loop status)
        DC1 ST GET      (Get status)
        #0030 AND       (Separate NOT.Hold+Manual and NOT.Rem/Ratio)
        #CF00 OR        (Include mask in high byte)
        DO1 DS SET      (Set digital outputs)
;
:
 PID2   (Loop 2 PID calculation)
                (Enter with PV on stack--Return with OP on stack)
        MS2 AO %GET     (Find current output)
        3T2 FB SET      (Feed value back to PID block 2 for desaturation)
        3T2 PID (Calculate PID output leave OP value on stack)
;
:
 PID1   (Loop 1 PID calculation)
                (Enter with PV on stack--Return with OP on stack)
        MS1 AO %GET     (Find current output)
        3T1 FB SET      (Feed value back to PID 1 block for desaturation)
        3T1 PID (Calculate PID output leave OP value on stack)
;
:
```

```
 ER1OUT (Retransmit SP1.ER on Analogue Output Block 1)
        SP1 ER %GET
        8 *      (Amplify the signal)
        50 +     (Add in 50% offset)
        AO1 AO %SET      (Re transmit the Error signal)
;
:
 SP1OUT (Retransmit SP1.SP on Analogue Output Block 1)
        SP1 SP %GET
        AO1 AO %SET      (Retransmit the Setpoint value)
;
:
 PV2OUT (Retransmit PV2 on Analogue Output Block 1)
        SP2 PV %GET
        AO1 AO %SET      (Retransmit the PV)
;
PE
: PV1OUT        (Retransmit PV1 on channel 2 output)
        #3FC0 SETES2     (Set into track)
        SP1 PV %GET
        MS2 OT %SET      (Force channel 2 output to track PV)
;
:
 SETOP1 (Set Channel 1 control output)
        PV1.OC? (Get open circuit flags)
        IF      (IF Open circuit flag set THEN)
          DROP    (Discard output due to dubious PV value)
        ELSE    (ELSE)
          MS1 MSCONT      (Store loop 1 required output)
        ENDIF   (ENDIF)
;
:
 FLOWTOT        (Totalise value on top of stack and transmit a
                pulse on Dig O/P 7 whenever FT is incremented)
        0 DO1 7 SETDIG  (Reset Dig O/P 7 to zero)
        TB1 TOTAL       (Totalise entry data)
        DO1 7 SETDIG    (Use return flag to modify Dig O/P 7)
;
```

Section G.2 LIST OF TIME-SCHEDULED PROGRAMS

```
: S0    (Standard controller configuration)
        TRACK1  (Set up track register)
        TRIM1   (Set up trim register)
        REMOTE1 (Set up remote setpoint register)
        PV1     (Stack process variable)
        PID1    (Stack PID output)
        SETOP1  (Store PID output)
;
:
 S1     (Ratio controller configuration)
        TRACK1  (Set up track register)
        RATRIM1 (Set up ratio setting trim register)
        RATIO1  (Calculate setpoint from ratio PV)
        PV1     (Stack process variable)
        PID1    (Stack PID output)
        SETOP1  (Store PID output)
;
:
 S2     (Simple PID loop 1)
        PV1
        PID1
        SETOP1
;
:
 S3     (Simple PID loop 2)
        PV2
        PID2
        MS2 MSCONT
;
:
 S4     (Slave PID control program name for HHT L1 parameter)
    S.ENB       (Update the Slave REMOTE status)
    MS2 AO %GET (Get the Master loop control output)
    SP1 %REMOTE         (and set into the Remote Setpoint register 'SR')
    PV1         (Get Channel 1 Analogue input for the 'PV')
    PID1        (Calculate and set the 3T control output)
        SETOP1
;
```

```
:
 S5     (Master PID control program name for HHT L2 parameter)
    M.ENB       (Update the Master TRACK status)
    SP1 PV %GET (Get slave PV)
    MS2 OT %SET (Set masters output track register)
    PV2 (Get channel 2 analogue input)
    PID2        (Calculate and set the 3T control output)
        MS2 MSCONT      (Transfer to MS2.OP if loop is in Auto)
;
:
 S6     (Loop 1 of Ratio pair-Program name for L1 parameter)
        REMOTE1 (Set up remote setpoint register)
        PV1     (Stack process variable)
        PID1    (Stack PID output)
        SETOP1  (Store PID output)
;
:
 S7     (Loop 2 of Ratio pair-Program name for L2 parameter)
    PV1 SP2 RATIO       (Calculate Loop 2 setpoint using input 1)
        PV3     (Stack PV from input 3)
        PID2    (Stack PID output)
        MS2 MSCONT      (Store PID output)
;
```

Section G.3 LIST OF BACKGROUND PROGRAMS

```
: B0    (Background program)
        BEGIN   (Infinite loop)
          ENABLE1         (Enable loop 1 states)
          HWCHECK         (Check hardware status)
          BATTEST
          DIGOP1          (Set status digital outputs)
          ALARM1          (Set alarm digital outputs)
          FLASH1          (Flash left bar if any alarms)
          DOMASK1         (Set WM mask)
          CLRXMSK         (Clear XM mask)
          PV1OUT          (Retransmit PV on Manual Station 2)
          SP1OUT          (Retransmit SP on Analogue Output 1)
        REPEAT  (Back to start of loop)
;
:
 B1     (Program to intialise in Man with Low Output)
        SET1MAN (Set loop 1 into Manual)
        0 MS1 OP SET    (Set to Low Output)
        B0      (Share B0 background program)
;
:
 B2     (Background program)
        BEGIN   (Infinite loop)
          ENABLE1         (Enable loop 1 states)
          HWLOCHK         (Check hardware status & select LO on errors)
          BATTEST
          DIGOP1          (Set status digital outputs)
          ALARM1          (Set alarm digital outputs)
          FLASH1          (Flash left bar if any alarms)
          DOMASK1         (Set WM mask)
          CLRXMSK         (Clear XM mask)
          PV1OUT          (Retransmit PV on Manual Station 2)
          SP1OUT          (Retransmit SP on Analogue Output 1)
        REPEAT  (Back to start of loop)
;
:
 B3     (Program to intialise in Man with Low Output)
        SET1MAN (Set loop 1 into Manual)
        0 MS1 OP SET    (Set to Low Output)
        B2      (Share B2 background program)
;
:
 B5     (Simple Background Program to enable both loops)
        BEGIN   (Infinite loop)
          #1F80 SETES1    (Remove Track Hold & Remote Enable on Loop 1)
          #1F80 SETES2    (  "       "    "  "    "      "    "   2)
        REPEAT  (Back to start of loop)
;
```

```
: B6    (Background program)
        BEGIN   (BEGIN infinite loop)
      #3F80 SETES1        (Clear Hold & Track Enables on slave loop 1)
          #5F80 SETES2    (Clear Hold & Remote Enables on Master loop 2)
          DOMASK2         (Update the Digital Output Mask)
          HWCHECK         (Monitor Hardware, update Dig O/P 3 & loop 1 status)
          HWCHKL2         (   "       "        "   loop 2 status)
          BATTEST         (Monitor battery and update Dig O/P 4)
          FLASH1          (Flash Loop 1 PV bar if any alarms on SP block 1)
          FLASH2          (  "    "   2 "   "  "   "    "    "  "    "   2)
          ALARM1          (Modify Dig O/P 1 & 2 if any alarms on SP block 1)
          ALARM2          (  "    "   "  7 & 8 "   "    "    "  "    "   2)
          PV2OUT          (Retransmit Master PV on A01)
        REPEAT  (LOOP back to start)
;
:
 B7     (Background program for Ratio Pair)
        BEGIN   (Infinite loop)
          ENABLE1         (Enable loop 1 states)
          RTL2.EN         (Enable loop 2 states)
          HWCHECK         (Monitor Hardware, update Dig O/P 3 & loop 1 status)
          HWCHKL2         (   "       "        "   loop 2 status)
          BATTEST
          ALARM1          (Set alarm digital outputs)
          ALARM2
          FLASH1          (Flash left bar if any alarms)
          FLASH2
          DOMASK2         (Set WM mask)
          CLRXMSK         (Clear XM mask)
        REPEAT  (Back to start of loop)
;
```

MANUAL ISS.	MANUAL REV	DATE	PAGE	AMENDMENT
A		Jun 84		Initial release in the form of a New Product Proposal specification.
B		Aug 84		Issue A modified and corrected. Alarm and Constants Block added.
C		Jan 85		Issue B expanded and Filter Block added.
C		Jun 85		Delay and Totalisation Blocks added. Incorrectly labelled issue C instead of D.
1	A	Jun 86		Completely re-written, expanded and re-formatted as a standard System 6000 Technical Manual. Restricted print run produced in Provisional/draft format.
2	A	Aug 86	E.2	Basically the same as issue 1/A but with typographical corrections and minor revisions. Appendix B, C, D, F and G included but Section 6.3 and Fig. 6.1 omitted. Appendix E updated to refer to issue 2/1 software.

ISS.	DATE	ISS.	DATE	TECHNICAL MANUAL AMENDMENT RECORD SHEET	
1 2	02/06/86 01/08/86			DRAWN : MEE CHECKED : [signature] APPROVED : [signature]	MANUAL TITLE : Technical Manual PRODUCT CODE : 6366
				TURNBULL CONTROL SYSTEMS LTD.	DRAWING NO. ZZ 076330 C003 — SHT 1 OF 1 SHTS