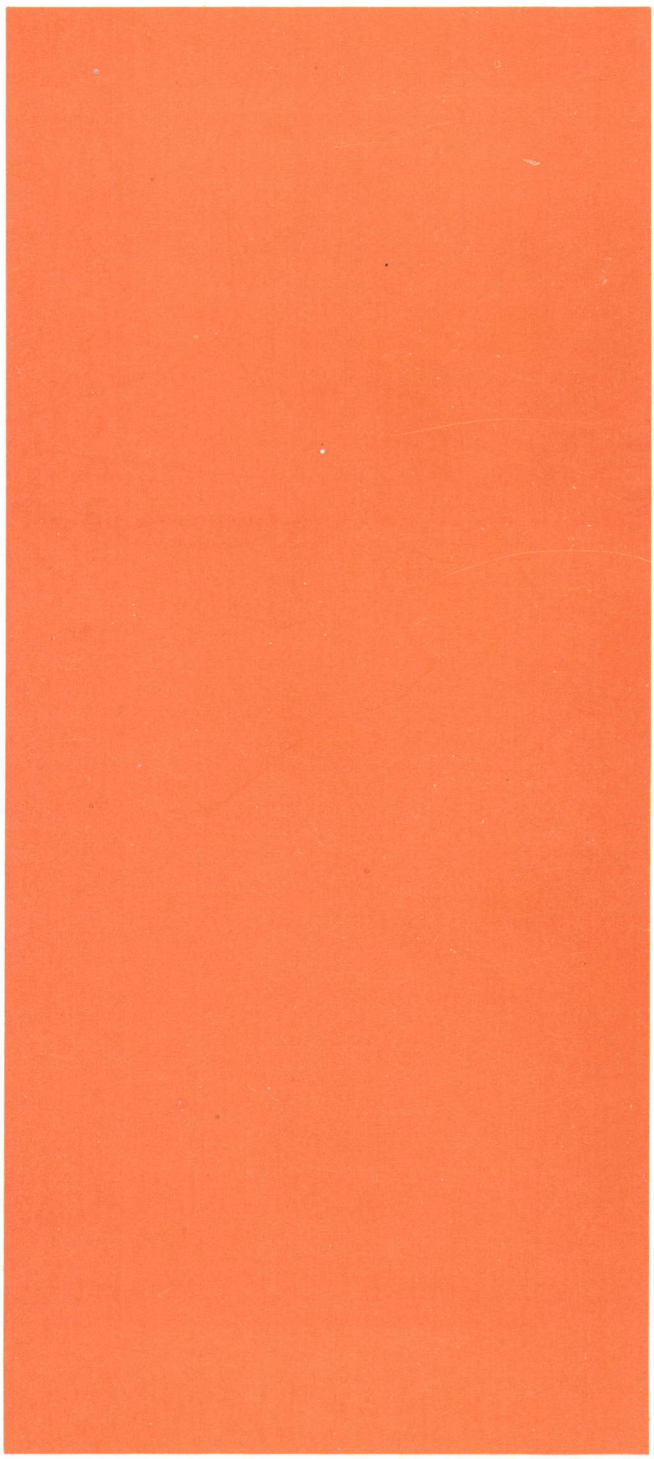
Honeywell

VUPAK 2
OPERATORS GUIDE

SERIES 16

SOFTWARE



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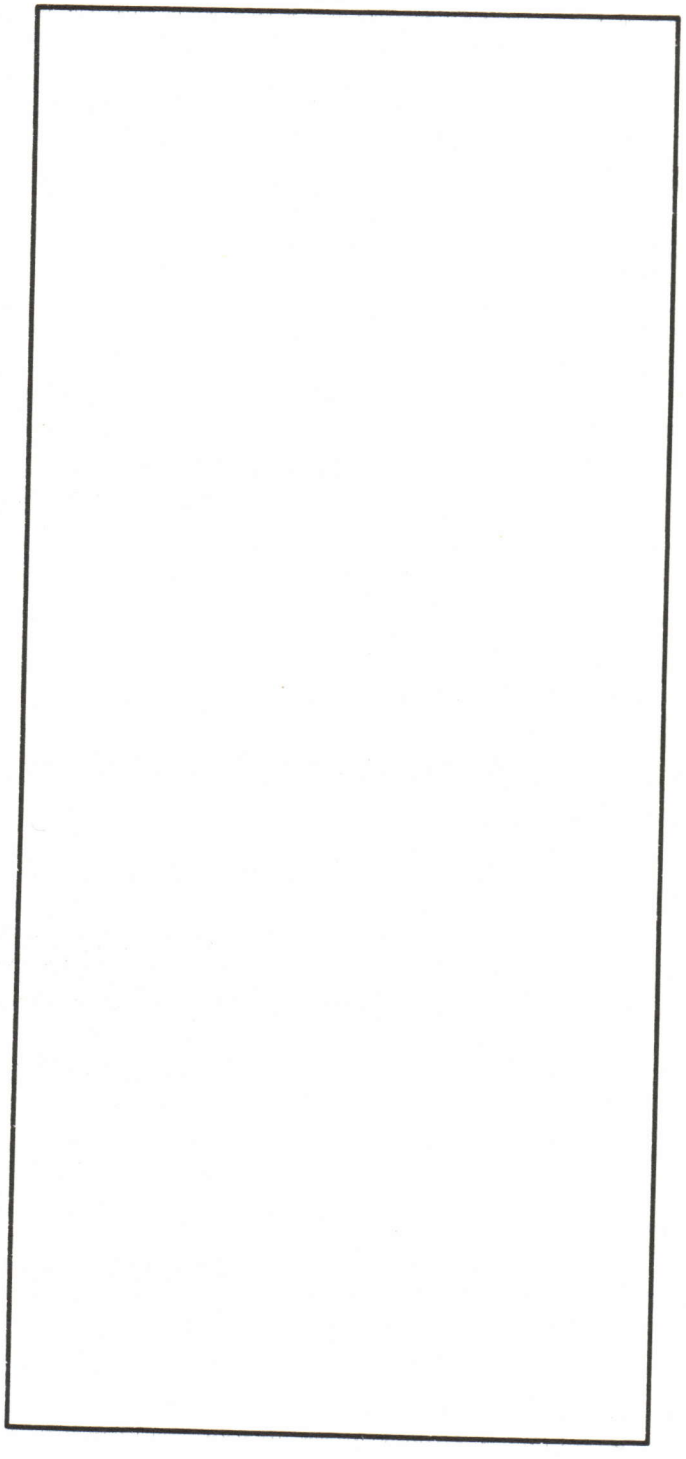

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September 1972

PREFACE

This manual details the general arrangement and use of VUPAK 2 Hardware from an Operator's point of view. Introducing a typical hardware arrangement, a more detailed description follows for the Operator's Console (both display and keyboard), the Logging and Alarm Typewriters, and Pen Recorder.

A description of the three basic DDC Stations covers the manual/automatic computer back-up aspects of a Computer Manual Station, Computer Manual/Auto Station and a Computer Manual Auto Tracking Station. The Manual is concluded with sections concerning system characteristics, in particular point records and system control, and finally System Operation of VUPAK 2.

Associated Documents

Title	*Document No.*
VUPAK 2 – Operators Console Programmers Reference Manual	41286103181
Vutronik Back-Up Stations	As Model No.
Pen Recorder	As Model No.

Reference Documents

Title	*Document No.*
VUPAK 2 – Utilities and Drivers Programmers Reference Manual	41286103178
VUPAK 2 – Control and Output Programmers Reference Manual	41286103179
VUPAK 2 – Message System Programmers Reference Manual	41286103180

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TABLES

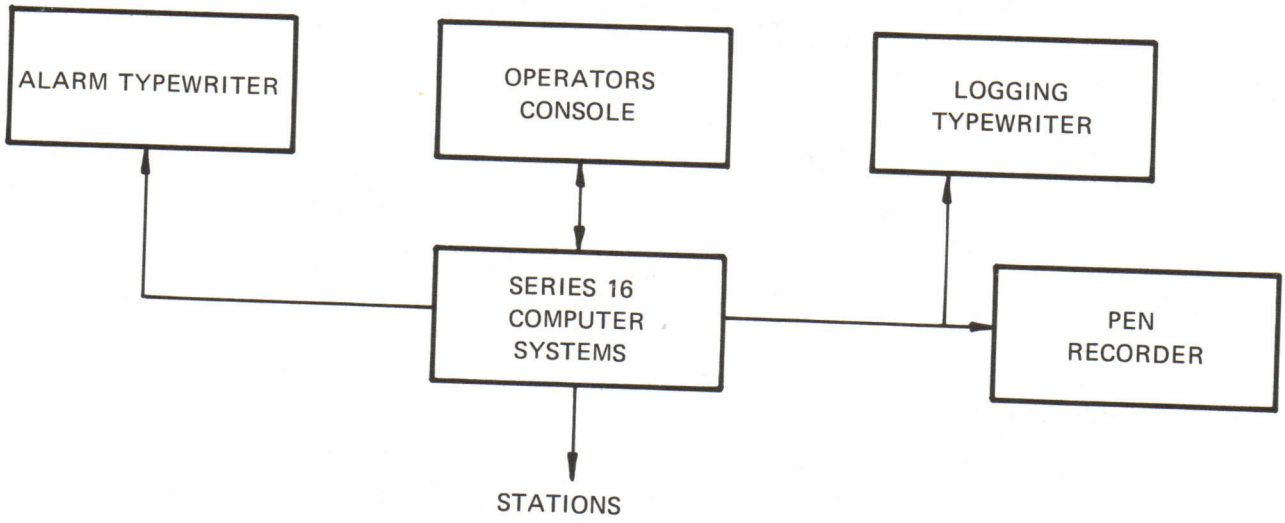
ILLUSTRATIONS

1 INTRODUCTION

1.1 General

VUPAK is a hardware/software package which may be supplied with Data Acquisition (DAS) facilities only, or Data Acquisition with Direct Digital Control (DDC) capabilities. When the term DAS is used in this manual, the reference is applicable to only a DAS system; when the term DDC is used it is applicable to a combined DDC/DAS system.

This manual details those aspects of a VUPAK system which are not documented elsewhere and are necessary for operator understanding. Figure 1 - 1 shows a block diagram of the VUPAK hardware, relevant to an operator.



VUPAK - OPERATORS HARDWARE FIG. 1 - 1

1.2 Operators Console

The Operators Console is an easily operated interface permitting communication between the human operator and the computer. The interface comprises a functional keyboard and message display unit. Facilities also permit the addition of various alarms and status indicators.

Fig. 1 - 2 shows the console as a table-top installation, where the keyboard and display unit are brought together in a common assembly. Alternatively, the display portion may be rack mounted and the keyboard fitted in a separate table-top case.

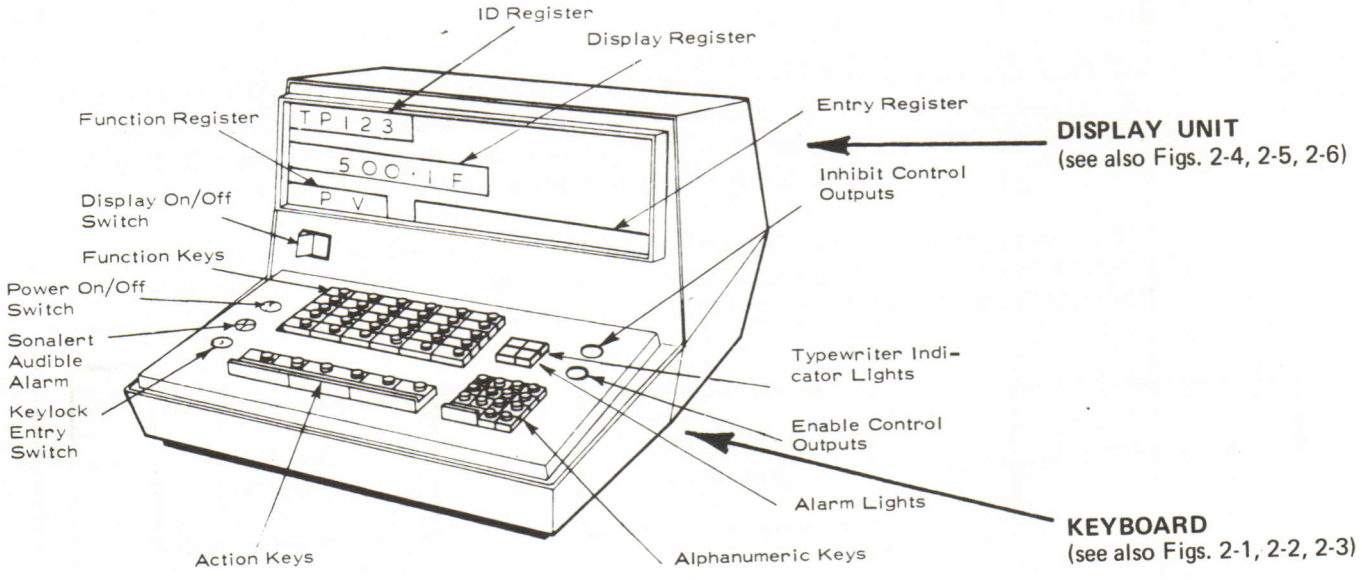


FIG. 1 - 2 TYPICAL TABLE MOUNTED OPERATORS CONSOLE

1.3 Alarm Typewriter

The Alarm Typewriter is a Teletype ASR-35 machine which operates at a speed of 10 characters per second. Its input capabilities are not used when the system is on line.

The typewriter has a colour shift facility that enables alarm messages to be printed in red; upon return to normal operating conditions, print-out is in black.

1.4 Logging Typewriter

The Logging Typewriter is an IBM Selectric 735, capable of printing a maximum of 154 characters per line at a speed of 14 characters per second. A colour shift facility enables alarm messages to be printed in red.

The typewriter keyboard can be used by the operator to type information on to records, but the keyboard does not communicate with the computer.

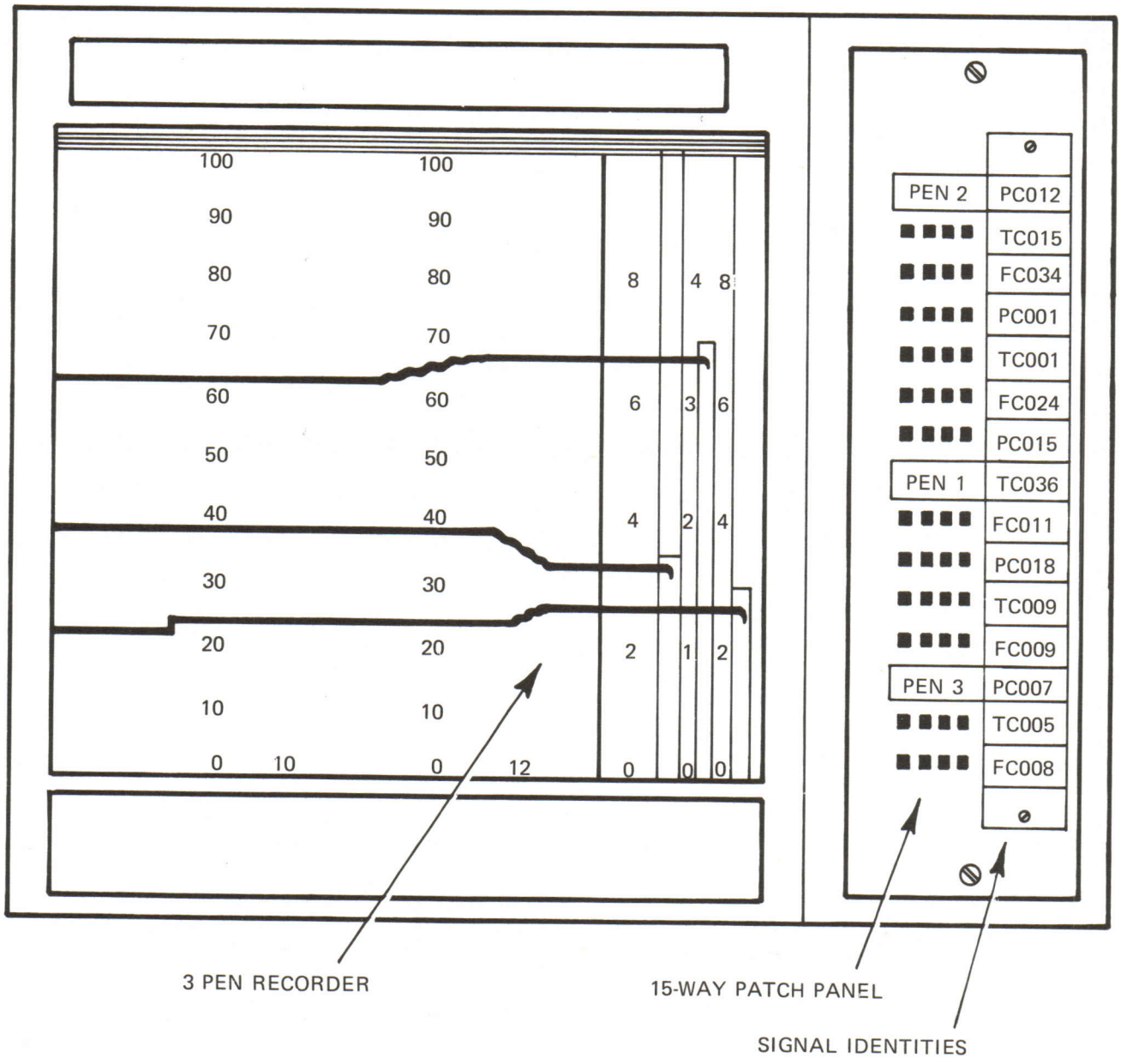
1.5 Pen Recorder

The pen recorder (see Figure 1 - 3) uses up to three pens to provide a continuous record of variables in the system. The process variable, or output value for any point, can be tracked by output from the computer. The results obtained will be useful to the control engineer in optimising the system.

An optional Patch Panel allows up to 12 other signals to be tracked via direct connection to the pen recorder, i.e. they are not output from the computer. The Patch Panel permits selection of any 3 signals to be recorded; the signal names are listed on this Panel, and a plug labelled 'PEN 1, 2 or 3' is plugged-in adjacent to the required signal name. The signal is then tracked by the specified pen.

Three Panel locations refer to computer outputs, and when attaching a pen to a variable from computer point records using the operators console, the number specified will refer to the 1st, 2nd or 3rd panel locations and not the pen number. The pen number will depend upon the plug used. When this option is not available the specified number refers to the pen number.

Pen recorders have a standard basic paper speed of ¾, 1½ or 3 inches per hour, but a two speed alternative is available with the second speed 60 times faster than the basic speed. The pens will record in different colours for easy reference to a particular signal.



PEN RECORDER FIG. 1 - 3

2 OPERATORS CONSOLE

2.1 Keyboards

Two versions of the keyboard are available; one being suitable for DAS system and the other designed for DDC systems. Figure 2 - 1 illustrates the various control areas common to both keyboards. These controls are detailed in Table 2 - 1.

Figures 2 - 2 and 2 - 3 illustrate the keyboards available for typical DAS and DDC systems. The operation and use of the Function, Action and Alphanumeric Key areas is described as follows:

(1) Function Keys

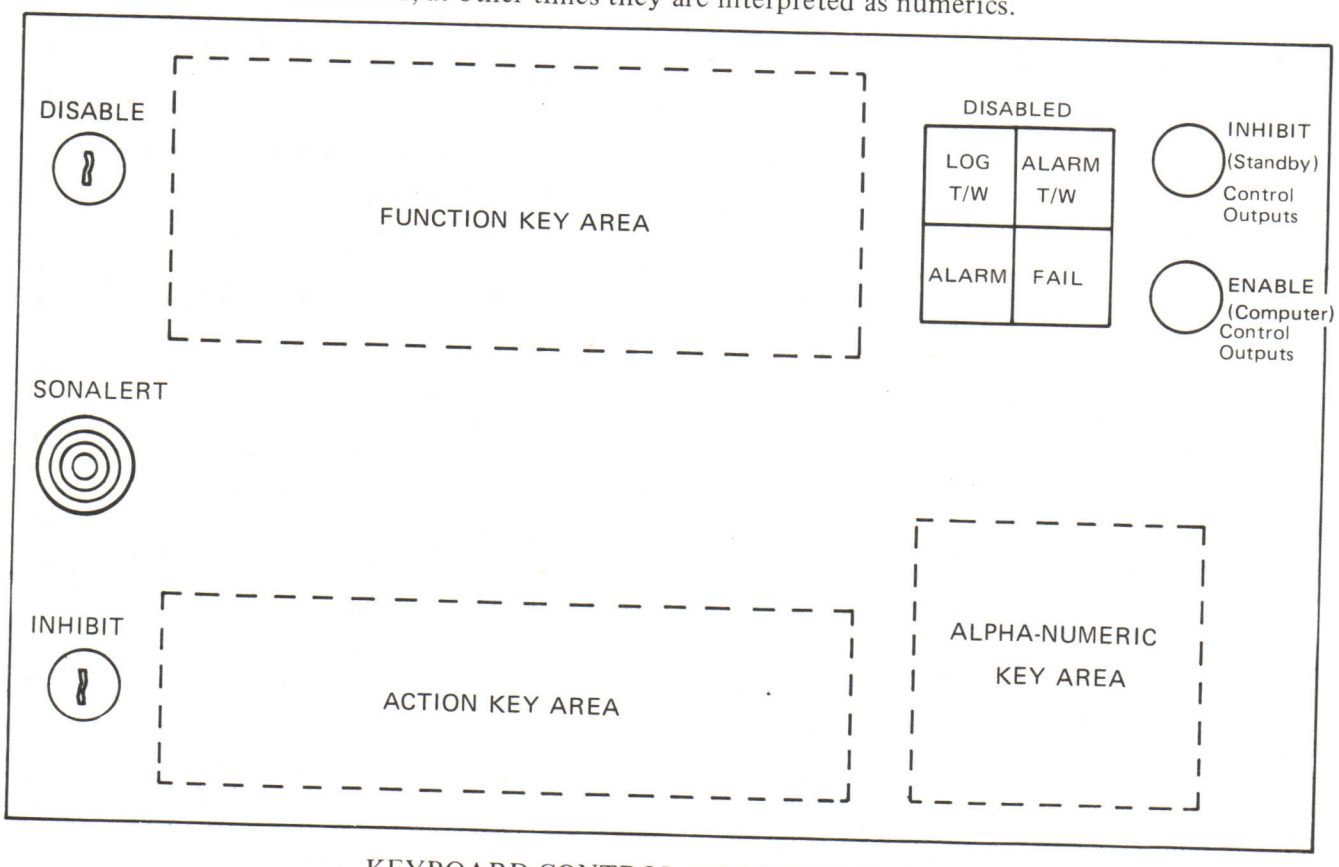
These keys are used to designate which variable is to be displayed or entered. In most cases the functions displayed are associated with the loop identification appearing in the Identity Register (see section 2.2) on the display.

(2) Action Keys

These keys are used to indicate the type of action that the operator is requesting such as IDENTITY or ENTER. They also cause the execution of system operations which are not associated with a specific control point, e.g. DEMAND PROGRAM, REAL TIME.

(3) Alphanumeric Keys

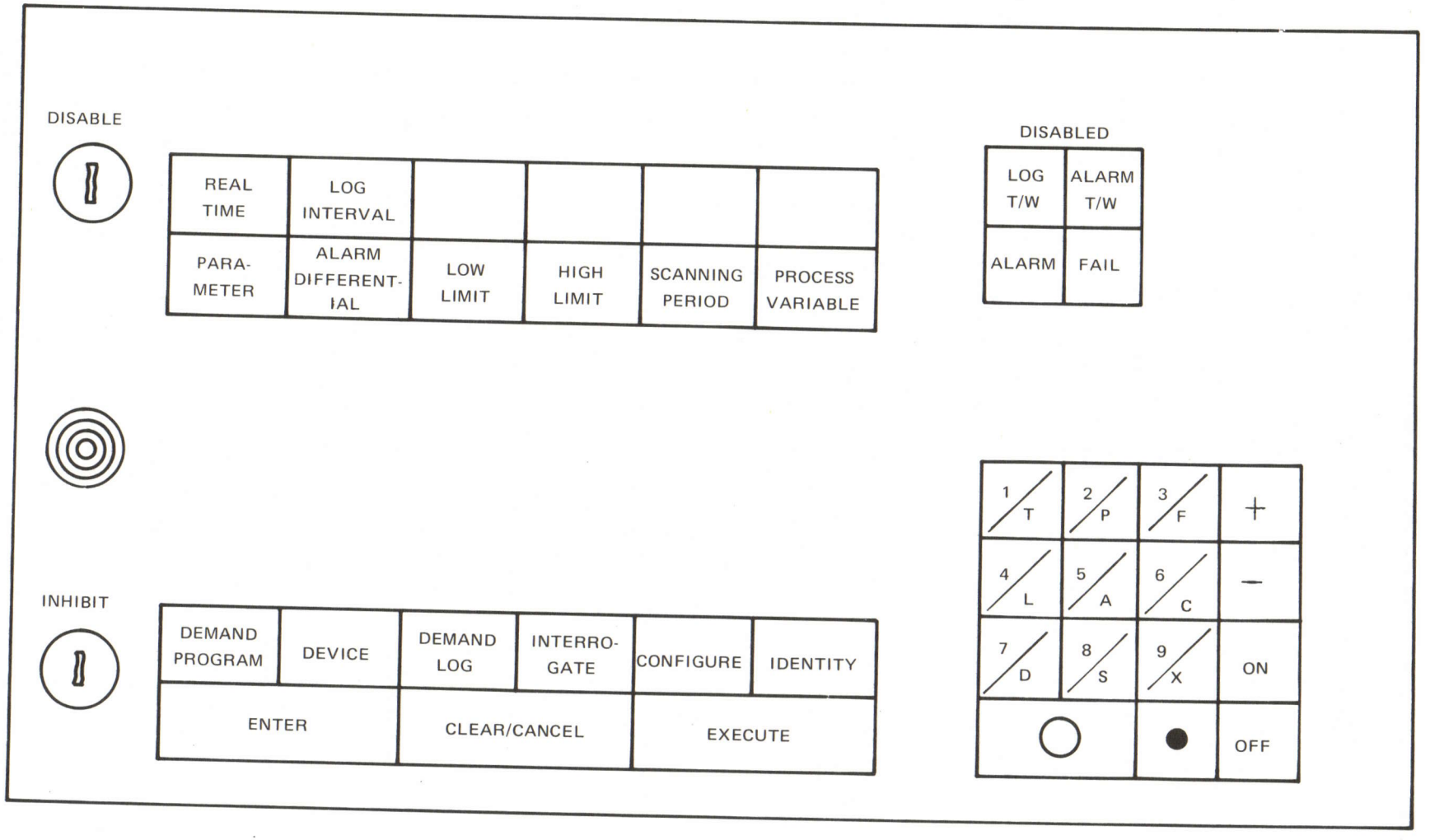
These keys are used to specify a required action, and also to specify required information for entry. Some keys have both an alphabetic character and a numeric character; the system determines which of the two is indicated by the sequence in which the keys are pressed, i.e. the first two pressed after point identity are alphabetic characters, at other times they are interpreted as numerics.



KEYBOARD CONTROL AND INDICATORS FIG. 2 - 1

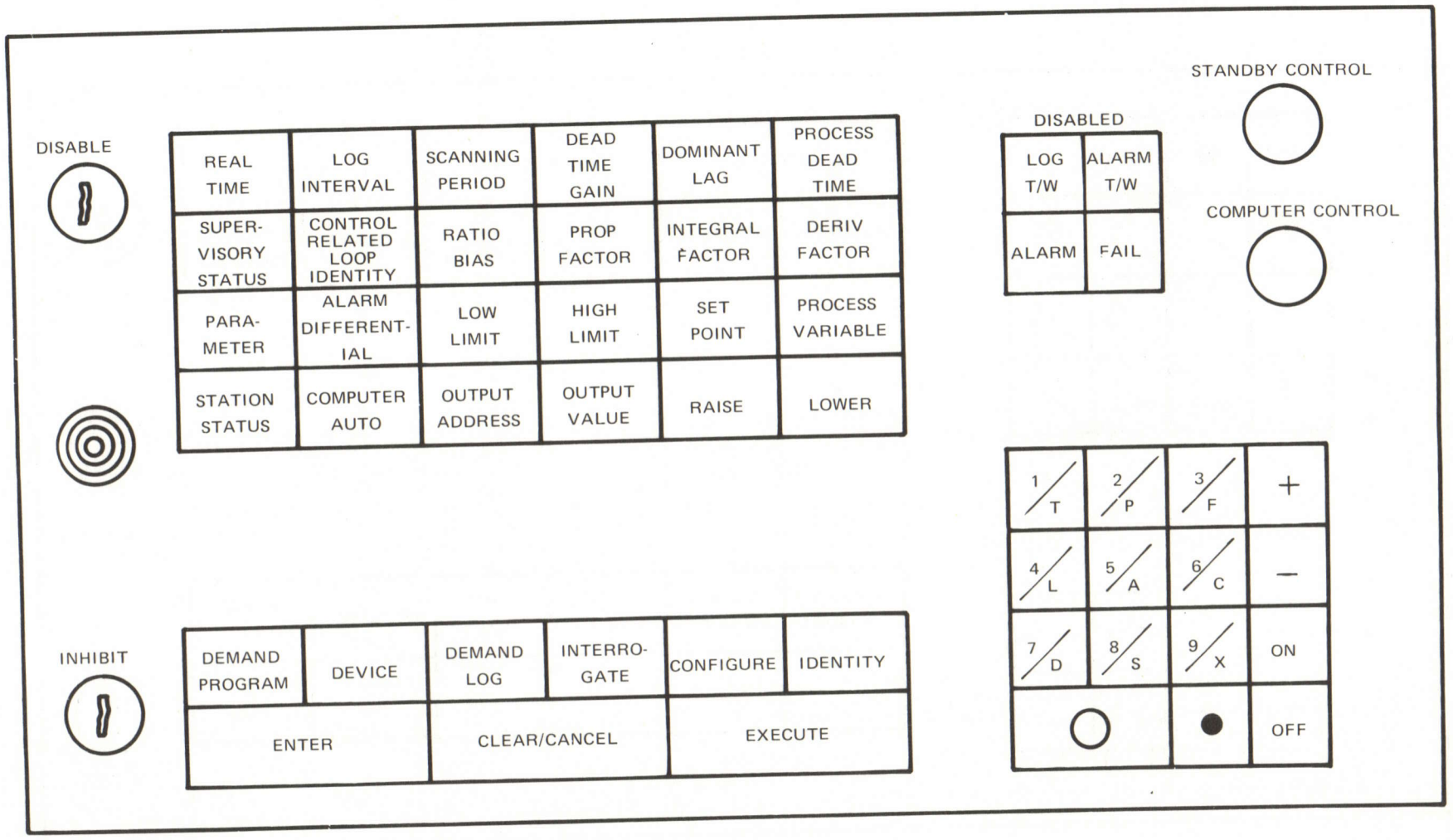
TABLE 2 - 1
KEYBOARD INDICATORS AND CONTROLS

Control or Indicator	Description	Function
DISABLE	Keyboard switch two-position	Disables all keyboard buttons
INHIBIT	Keylock switch two-position	In the INHIBIT position only a selected number of functions (determined by software) may be changed by the keyboard. In the other position all available operator console functions may be used.
LOG T/W DISABLED	Lamp	When lit indicates that the Logging Typewriter has been disabled via the keyboard.
ALARM T/W DISABLED	Lamp	When lit indicates that the Alarm Typewriter has been disabled via the keyboard
ALARM	Latching switch with lamp	When lit indicates an alarm. Extinguished by depressing the switch and hence acknowledging the alarm condition.
FAILURE	Latching switch with lamp	Indicates state of Watchdog timer and hence of devices. If lit indicates a failure. Depressing switch removes audible alarm. Lamp remains lit until cause of failure is removed.
INHIBIT CONTROL	Push Button Switch with lamp	DDC Keyboard Only. When the INHIBIT CONTROL button is depressed the Plant Process is set to Manual Control, indicated by the lamp being lit.
ENABLE CONTROL	Push Button Switch	When the ENABLE CONTROL button is depressed the Plant Process is set to Computer Control, indicated by the INHIBIT CONTROL lamp being extinguished.
SONALERT	Audible Alarm	When sounding, gives indication that Alarm and/or Failure has occurred and not been acknowledged. Sound is cancelled by depressing the relevent switch (i.e. ALARM or FAILURE)



TYPICAL DAS KEYBOARD

FIG. 2 - 2

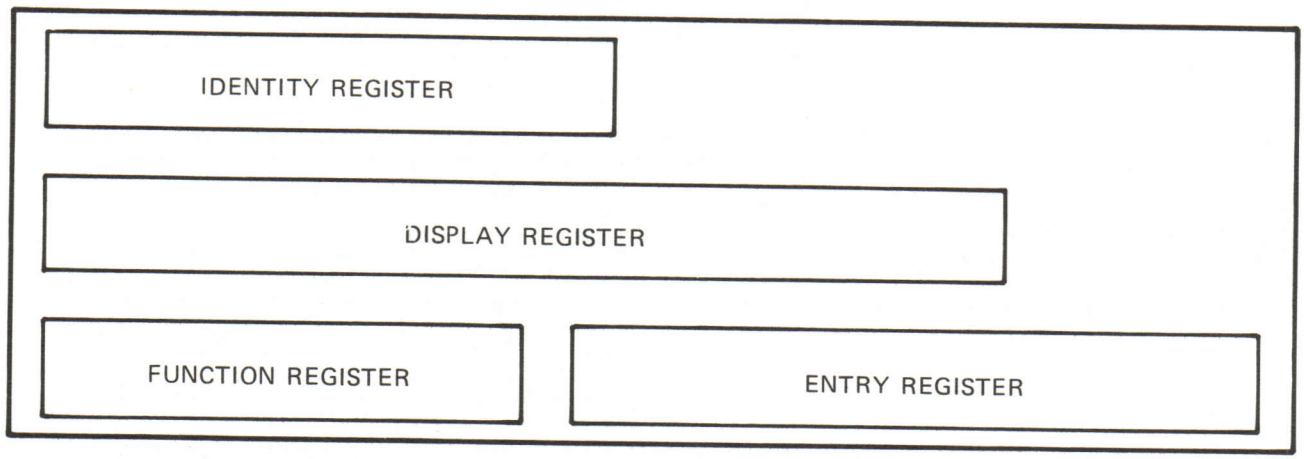


TYPICAL DDC KEYBOARD

FIG. 2 - 3

2.2 Display Units

A Display Unit can contain up to three rows of 12 windows (displays). Each window can display up to 12 characters, digits, or messages. For VUPAK the windows are arranged to form four registers, as shown in Figure 2 - 4.



TYPICAL DISPLAY REGISTER LAYOUT FIG. 2 - 4

The function of these four displays is outlined as follows:

(1) The Identity Register

Used to display the current point identity (see section 5 - 1) when the operator is displaying, entering or configuring a point record. An exception to this is when the related loop for process variable or set point is required; in this case the name of the related loop is displayed.

(2) The Display Register

Used to indicate the value or status, together with associated units (e.g. ^{o}C, % etc), of the function requested by the operator.

(3) The Function Register

Used to indicate which function or action is being serviced.

(4) The Entry Register

Used to display a new value being entered.

As described for the keyboard, two versions of the display are available. One is suitable for a DAS system and the other for DDC. These displays are illustrated in Figures 2 - 5 and 2 - 6 respectively, and display content is detailed in Table 2 - 2.

LEGEND: A = ALPHA, M = MESSAGE, N = NUMERIC, U = UNITS.
(Applicable to Figures 2 - 5 and 2 - 6 below.)

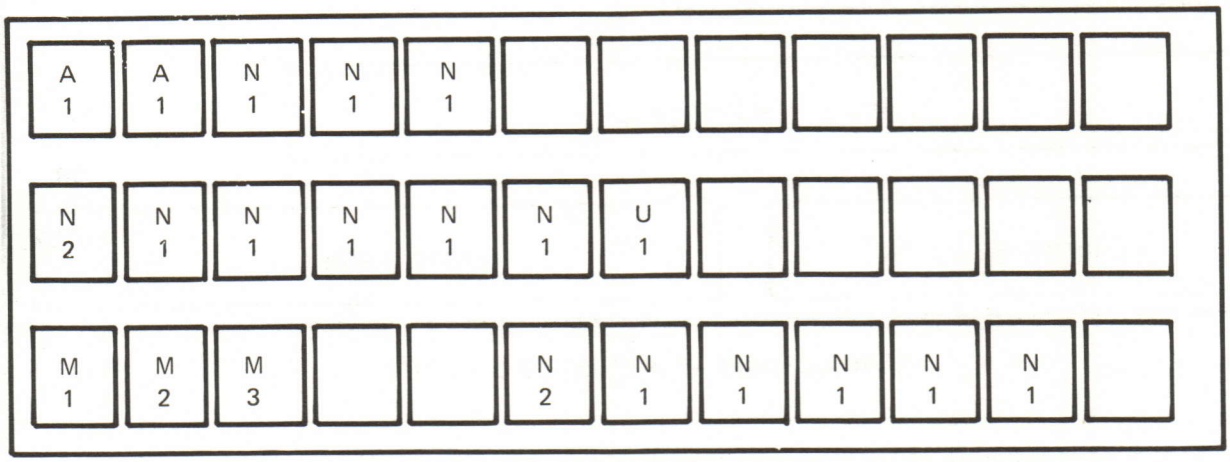


FIG. 2 - 5 TYPICAL DAS DISPLAY LAYOUT

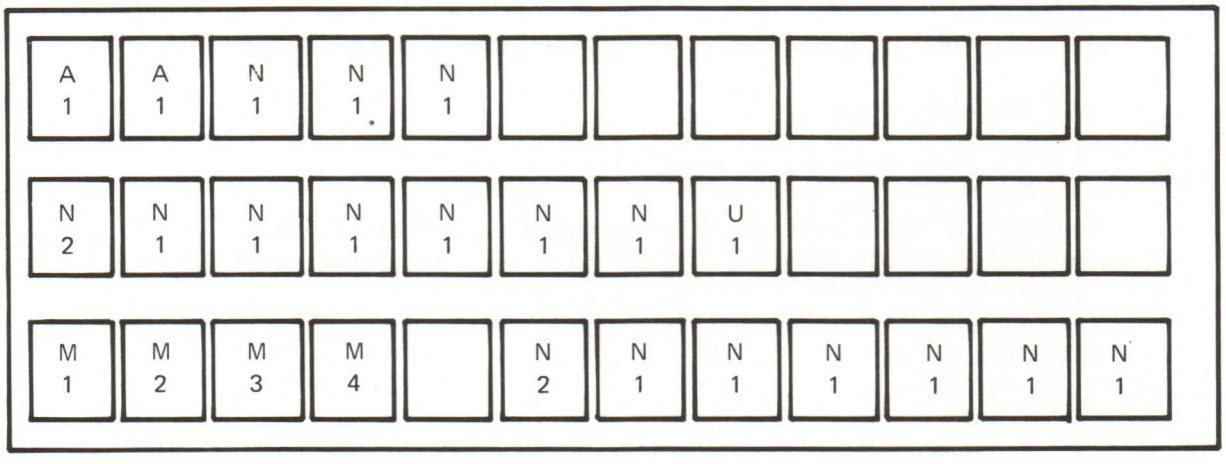


FIG. 2 - 6 TYPICAL DDC DISPLAY LAYOUT

TABLE 2 - 2
DISPLAY UNIT WINDOW CONTENTS

Window	Content
NUMERIC 1	0, 1, 2, 3, 4, 5, 6, 7, 8, 9, ·, ERROR
NUMERIC 2	0, 1, 2, 3, 4, 5, 6, 7, +, -, ON, OFF.
ALPHA 1	T, P, F, L, A, C, D, S, X.
UNITS 1	GPM, SCFH, ^{O}F, PSIG, %, RPM, INCHES, ^{O}C, HOURS, MINS, SECS, IN WG.
MESSAGE 1	ALGORITHM INDEX, INPUT MODE SPEC, ENG. FORMAT SPEC, MPLXOR ADDRESS, PROCESS VARIABLE (PV) RELATED LOOP IDENT, ISOTHERMAL BLOCK NO., DIGITAL FILTER CONSTANT, LINEAR ROUTINE INDEX, HIGH LIMIT, LOW LIMIT, ALARM DIFFERENTIAL, LOG STATUS
MESSAGE 2	OUTPUT ADDRESS, SCAN PERIOD, SUPERVISORY STATUS, COMPTR MANUAL, COMPTR AUTO, OUTPUT VALUE, PROCESS VARIABLE, POINT IDENT, CONFIGURE, PEN RECORDER, DEMAND LOG, DEVICE.
MESSAGE 3	DEMAND PROG, REAL TIME, OCTAL, LOG INTERVL, STATION STATUS CONFIG COMPLT, SUBRTNE INDEX, PARAMTR, INTROGT.
MESSAGE 4	CONTROL RELATED LOOP IDENT, SET POINT, PROP FACTOR, RATIO BIAS, INTEGRAL FACTOR, DERIV FACTOR, DIRECT/REVERSE ACTION, DEAD TIME GAIN, PROCESS DEAD TIME, DOMINANT LAG, OUTPUT LIMITS INDEX, DEAD BAND.

3 SYSTEM TYPEWRITERS

In addition to the Operators Console the operator is able to monitor messages output from the system via the Logging and Alarm Typewriters.

3.1 Logging Typewriter

There are two types of output sent to the Logging Typewriter; a log which is initiated cyclically or on demand from the Operators Console, and a loop summary demanded from the Operators Console.

3.1.1 Log Format

Points to be logged (see section 5.1) are those with a LOG STATUS of ON, but this may be easily changed for any point using the entry facility on the Operators Console. In many applications a special log format will be used as decided at system build time, however the following characteristics are provided by the standard log.

(1) Points and headings are printed in black, except when a Process Variable is currently in an alarm status and that particular value is printed in red.

(2) A heading consists of the date in the form 04 10 71, signifying the 4th October 1971.

(3) Each log begins with the time in the form 1435, signifying 2.35 p.m. and a list of Point Identities and Process Variables. Each Point Identity 'on log' is typed alongside its Process Variable.

Each value has a maximum of six characters including a sign and decimal point; the associated engineering units are not printed.

3.1.2 Loop Summary

A list of all Point Identities currently in core can be requested via the Operators Console. This consists of the date_time and a list of Point Identities. There is no maximum number that can be output.

The Point Identities are printed in black unless the associated Process Variable is in alarm in which case the Point Identity is printed in red.

3.2 Alarm Typewriter

The Alarm Typewriter is used to record errors in the hardware and control system that can be detected by the software system.

There are six standard alarm messages which can be supplemented by additional codes and text, as required at system configuration time. For each message the alarm condition is printed in red and upon return to normal, printout is in black.

3.2.1 Process Variable Alarm

This alarm is printed out under the following assumed headings:

TIME	POINT IDENT	ALARM STATE	VALUE	UNITS

The alarm state would be HI, LO, or OK.

As a typical example, if a Process Variable goes above its alarm limits at 2.35 p.m. and returns to normal 3 mins. later, the printout is:

1435	TA123	HI	203	DEGF
1438	TA123	OK	198	DEGF

3.2.2 ADC Alarm

Standard inputs are read in from those pages specified at system configuration time. These inputs are made for each level per page. When any point is found to lie outside the specified tolerance it is shown as an alarm.

The alarm is printed under the following assumed headings, in red:

TIME	ERROR ID & ADC	TYPE	PAGE	GAIN
1435	AD	XX	Y	123

where 1435 is the time, XX the analogue input level (HI or LO) Y the page number (0 to 7) and 1, 2, 3 are the gain settings, i.e. if 1, 2 and 3 are all present, then all gain settings are in error.

Once the faults have been corrected, the amplifiers can be re-intialised using DEMAND PROGRAM 4 on the Operators Console. This causes the affected amplifiers to be checked using the standard inputs. If the fault still exists the alarm is output again. No message is provided to indicate a return to normal working.

3.2.3 Station Address Alarm

If the station output check hardware detects a fault, the following message is printed in red:

1435	TA123	OP

where 1435 is the time and TA123 is the point identification.

When the station is next correctly addressed, the same message is printed in black.

3.2.4 Digital Status Change Alarm

When the asynchronous input program (refer to programmers reference manual) detects a change in any of its digital statii, other than the Operators Console interrupt status, it will relay the fact to the operator by printing the following alarm message:

1435	CA	XXX	Y

where XXX uniquely defines the asynchronous input point and Y indicates the current status. The alarm condition is defined for each point at system configuration time.

3.2.5 Input Range Alarm

When an input is normalised and the result is outside the range of zero to one, the following printout occurs on the alarm typewriter in red:

1234 TA123 IP

where 1234 is the time, and TA 123 the point identification. The next time the input normalises to a permitted value, the same message is printed in black.

3.2.6 Alarm Table Saturation

All alarms are entered into an alarm table in preparation for printout on the alarm typewriter. If the table becomes full the following message is printed in red:

1234 AT

when the alarms in the table have been printed, and hence there is room in the table, then the same message will be printed in black.

If this alarm condition exists, then those faults detected in the system during the *alarm table full* period and which clear themselves in the same period, will not be brought to the attention of the operator by means of a printout.

3.3 Operator Action Printout

All new system data is recorded via the Operator Action Printout and although normally output on the Alarm typewriter, it may be diverted to a separate typewriter in special cases.

The format gives the time, function, old and new value. For Point Record information the format is as follows:

TIME POINT ID FUNCTION OLD VALUE NEW VALUE

For the Octal Address facility the format is:

TIME OCTAL ADDRESS OLD VALUE NEW VALUE

Other special functions follow a similar format.

3.4 Servicing Typewriters

When a typewriter is being serviced (i.e. changing the paper or ribbon etc) the typewriter should be disabled via the device disable sequence of the Operators Console, and re-enabled on completion of the servicing, (see 6.3.3).

Messages are queued while a typewriter is disabled and are output when the typewriter is re-enabled.

4 DDC STATIONS

4.1 Introduction

The DDC stations serve the following purposes:

(1) They interface the process control computer with the final control element, while the process is in computer mode.

(2) They act as a safety device if the computer fails.

(3) They enable manual control and display of their associated process variables at all times.

A DDC station is available in three forms to provide complete back-up, either automatic or manual:

(1) Computer Manual (CM)

(2) Computer Manual Auto (CMA)

(3) Computer Manual Auto Tracking (CMAT)

4.2 Computer Manual Station (CM)

The computer manual station is equipped as follows:

(1) Process Actuator Meter

This is a 1-¼ inch meter calibrated in units from 0 to 100%, corresponding to zero to full value of station output.

(2) Process Variable Meter (Optional on the CM Station)

This is a 3 inch vertical scale meter calibrated in units from 0 to 100%. If no Process Variable (PV) signal is supplied, the meter may be removed as the signal is used as an indicator and does not affect the operation of the station.

(3) Mode Switch

This switch has three positions: 'C' - Computer. 'M' - Manual, and 'P' - Preset.

(a) In position 'C' the 4-20mA station output signal is controller by the computer.

If the computer fails to update the station, the output corresponding to the last computer update is maintained.

(b) In position 'M' the output signal from the station is determined by the operator.

(c) In position 'P' the signal from the station is maintained at a predetermined level.

When the CM Station chassis is fully extended the preset value can be adjusted by means of a dial positioned on the side of the chassis. The dial is calibrated from 0 to 100% of the full scale.

(4) Raise/Lower Thumb Wheel

When the station mode switch is in the M position, the raise/lower thumb wheel below the valve meter allows the operator to re-position the station output. The output can be moved at two speeds depending upon the pressure applied,

permitting a full scale change of output signal in 5 or 100 seconds. When the mode switch is in the 'P' position the operation of this wheel is overridden.

(5) Tag Plate

This plate is engraved with the point identity of the loop.

(6) Indicator Lamps (Optional)

Two indicator lamps are available, and can be connected to an external circuit for alarm indication. The lights are positioned behind the tag plate.

4.3 Computer Manual Automatic (CMA) Station

This station is shown in Fig. 4 - 1. In addition to the facilities provided by the CM Station (excluding the preset option) the CMA Station acts as a conventional three term controller when in 'Automatic' mode. The following facilities are provided:

(1) Set Point Adjustment

The station set point is adjusted by the thumb wheel adjacent to the PV meter. The value of the Set Point is indicated by the red marker adjacent to this scale. This set point is used when the mode switch is in the 'A' position.

(2) Mode Switch

The mode switch has three positions 'C', 'M' and 'A'. The 'C' and 'M' positions are the same as those of the computer manual station.

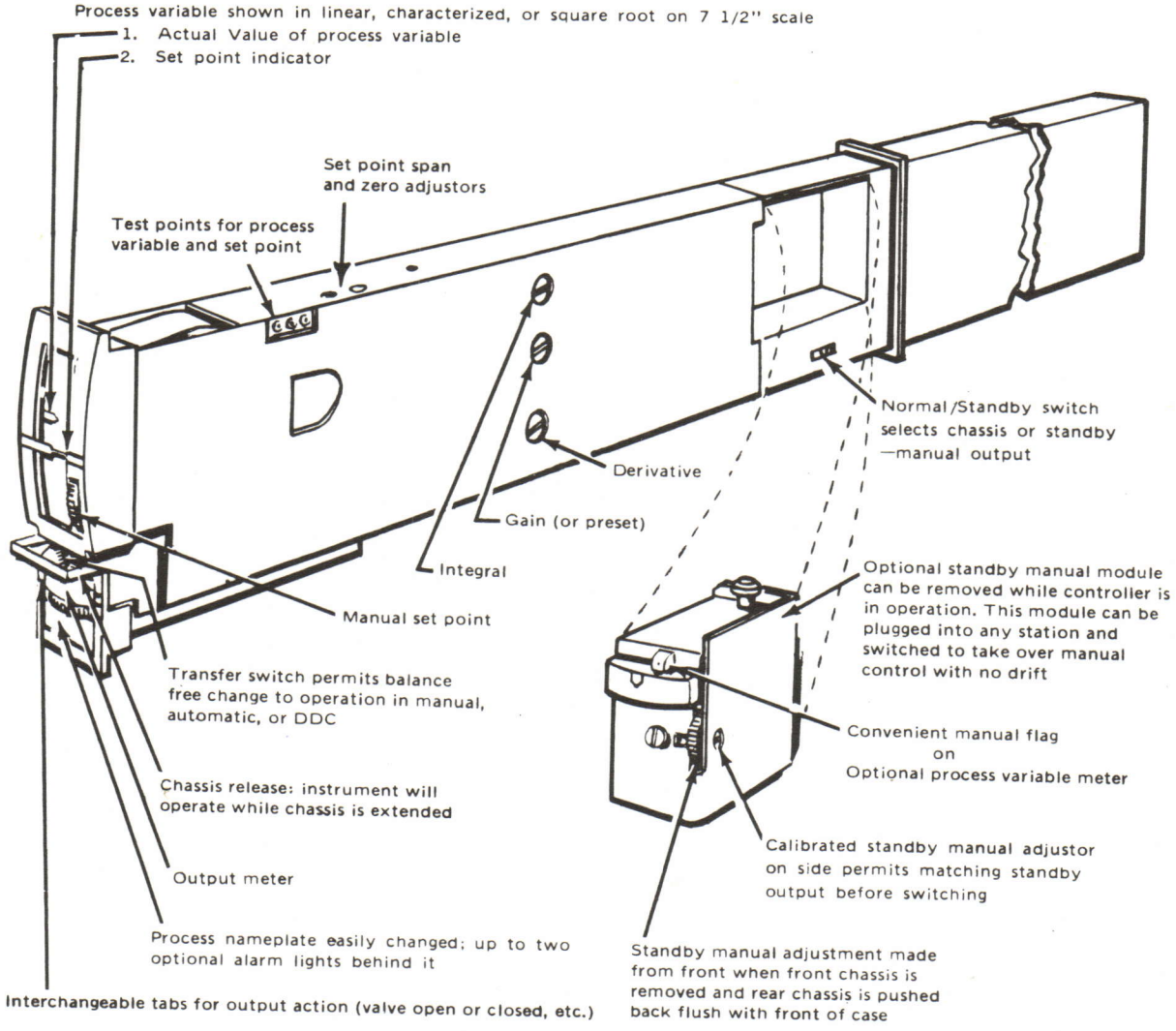
In the 'A' (Automatic) position, the station operates as a normal 3 term controller. The proportional, integral and derivative values used are set by dials on the chassis when it is extended. The proportional gain is calibrated from 1 to 100%, the integral gain from 0 to 10 repeats/minute and the derivative gain from 0 to 10 minutes.

(3) Time-Out Option

The Time-Out Option causes the station to revert to either a manual or automatic mode, as previously selected, if the station is not updated within a set interval of time.

4.4 Computer Manual Automatic Tracking (CMAT) Station

The CMAT Station is an extension of the CMA station in that its automatic Set Point continuously tracks the process variable during computer control, so that reversion to automatic from computer control will allow only a minimum process upset. The Time-Out feature is standard on this station.



TYPICAL CMA OR CMAT STATION

FIG. 4 - 1

5 SYSTEM CHARACTERISTICS

5.1 Point Records

The information required for data acquisition (DAS) and direct digital control (DDC) is held in data tables called point records. There is a point record for each data acquisition loop and for each control loop, and there are two types of point records – DAS and DDC.

(1) DAS point records contain the value of the process variable for that point, multiplexor address, process variable high and low limits and other items associated with data acquisition.

(2) DDC point records contain all the information for data acquisition plus the additional values required for control, such as the control setpoint and output address.

Each point record is identified by a two-alpha three-numeric character name, referred to as the point identity – for example TP123, DX456, etc.

The operator may examine the point record information either directly or indirectly via the operators console. In general, those parameters required for normal plant operation are available directly by pressing the appropriate function buttons.

Other parameters primarily concerned with basic point data are available indirectly under an INTERROGATE facility (see Section 6.2.1).

This division of data avoids crowding the console with unnecessary information and leads to less operator fatigue and error.

(1) A DAS point record contains the following information which the operator may directly display.

Process Variable
Scanning Period
Parameter (for derived inputs)
Process Variable high limit
Process Variable low limit
Alarm differential

(2) A DDC point record allows direct display of the above information together with the following parameters.

Set Point
Control Related loop identity (for secondary loops)
Proportional factor
Ratio bias
Integral factor
Derivative factor
Dead Time Gain
Process dead time
Dominant lag
Supervisory status
Computer auto
Station status
Output value

5.2 System Control

The DDC system may be operating in one of three states, generally at the command of the operator.

(1) Computer Control

(2) Standby Control

(3) Back-up Control

5.2.1 Computer Control

Computer control is implemented by control loops based on the values of measured process variables which have undergone data acquisition techniques.

5.2.1.1 *Control Modes* – A control loop may operate in three modes:

(1) Computer Automatic

In Computer Automatic Mode the computer calculates the necessary corrective action and transmits this to the control actuator by controlling the station output current. To operate in this mode, the station must be on 'Computer' (Station Status ON) and the loop be in 'Computer Auto ON' (set from Console).

(2) Computer Manual

In computer manual mode all the normal computer functions are carried out such as logging and alarms, but the output increment from the control algorithm is forced to zero. The operator may centrally control the output of each station by using the RAISE or LOWER buttons on the console. To operate in this mode the station must be on 'Computer', (station Status ON) and the loop be in Computer Auto OFF (set from Console).

(3) Local

In Local mode, loop control is carried out entirely by the back-up station, providing manual control, preset output value or automatic control dependent on station type. Local control occurs under two conditions:-

(a) Station mode switch on any position except COMPUTER.

(b) A failure in the computer system causing Computer Isolate to Local mode.

In both computer Manual and Local control the computer loop 'Set Point' traces the loop 'Process Variable'.

5.2.1.2 *Control Type* – On-line loop building is facilitated by the use of basic 'building blocks' which may be built into all envisaged control configuration. On 'Computer Automatic' the type of control provided for each loop depends upon the algorithm number of the loop. The following control types are provided as standard, but more may be added off-line for special applications:

(1) Data Acquisition (DAS)

No control is carried out by this type of block, however, its input may be used as a derived input for another block or simply for data logging by periodic output of its Process Variable to the logging typewriter.

(2) Derived Input

This block allows the effective input to a DAS or control block to be a function of other system variables. A typical function is where the effective input to a block is the lowest of two other Process Variables.

(3) 3-Term Loop

This loop is a conventional 3-Term Controller, used for tracking a Process Variable, comparing it with the Set Point, and outputting a correction.

(4) Secondary 3-Term Loop

This loop is a 3-Term Controller whose set point is obtained from the output of another control block. The 'donor' block is known as the Primary block.

(5) Dead Time Controller

This controller may be added to either 3-Term Controller to compensate for a process containing a time delay. In effect, a smaller correction is output than would be calculated by the 3-Term Controller alone.

(6) Ratio Loop

The output of this loop is proportional to its input, plus a pre-determined offset (bias). The block is used for scaling or defining a fixed relationship between Process Variables.

(7) Secondary Ratio Loop

The bias of this ratio loop is obtained from the output of a primary control loop. This is most often used as a feed forward summing junction.

5.2.1.3 *Mode Switching* – When switching between the various operating modes of a loop a bump in the process may occur if an apparent step change in Set Point occurs. The principle mechanism for achieving a bumpless transfer in the Honeywell DDC package is to cause the Set Point of the inactive state to track the Process Variable caused by control, by the active state.

Full details of this mechanism are given in the Applications Manual. In general no balancing is required by the operator in switching between modes.

5.2.2 Standby Control

Standby Operation allows the plant operator to hold the plant in a steady condition and to carry out manual adjustments on operating level from the console.

This mode of operation may be used during system start-up or shut-down, or for system trouble shooting.

When Standby is selected via the panel switch, all primary control loops are forced to computer manual condition and commence Set Point Tracking. The secondary loops stay in computer automatic. By using RAISE and LOWER on the primary loops, the plant operating level may be centrally controlled.

On Standby Operation certain critical loops selected at system design may revert immediately to local mode control.

5.2.3 Back-Up Control

Back-Up Control may be selected either by the operator on an individual loop basis, or automatically on all loops as a result of computer malfunction.

The System Watch-Dog Timer detects computer malfunction and causes all stations to isolate to local mode. Further computer action is unable to influence the plant.

The operator may then control the plant entirely from the back-up instrumentation. Since this condition may have arisen from an emergency action the operator should be familiar with back-up operation by carrying out regular training sessions.

5.2.4 Station Operation

DDC Station Basic Functions

(1) When operating in the 'Computer' mode, the station provides a means of accepting incremental RAISE/LOWER signals, which are converted to control signals, maintained and applied to the process between computer updates.

(2) In the event of computer failure, or when so desired by the operator, the stations can be used to control the process independently of the computer.

The type of control facilitated by the backup station depends on which of the three types of station, described in section 4, is used:

Computer Manual	(CM)
Computer Manual Auto	(CMA)
Computer Manual Auto Tracking	(CMAT)

5.2.4.1 *CM Station* – The control signal is positioned by the operator, and remains fixed unless it is changed by the operator.

5.2.4.2 *CMA Station* – If the computer fails to update the station, the station will maintain the last output value, unless a time-out gate option is fitted, then reversion to local automatic control may occur. The station will operate as a conventional analogue controller, and the Set Point will have to be altered when necessary by the operator. With no time-out option, the station will have to be switched to automatic by the operator.

5.2.4.3 *CMAT Station* – This is a CMA station with tracking capability. The set point of the back-up analogue controller continuously tracks the process variable during computer operation, allowing only a minimum process upset if the computer relinquishes control. The time-out feature is standard with this type of station.

6 SYSTEM OPERATION

6.1 System Start-Up

The standard VUPAK system provides for two starts, known as initialisation and re-initialisation. Initialisation is used for the preliminary start and provides basic system information to the computer. Re-initialisation is used for subsequent restarts.

6.1.1 Initial Procedures

Both starts have the same initial procedure. Reference should be made to the computer operating guide (see Preface) for loading and starting tapes.

The procedure for the VUPAK system is as follows:

(1) Load the Self loading system tape either in its basic form or in the initialised form.

(2) Start the program at P register – '1000

(3) On the computer I/O typewriter type '$'

(4) This starts the program and will cause a message to be output, the operator should respond with the underlined characters:

SF = RP Δ BL <CR>

NOTE: 1. <CR> symbolises a 'carriage return'

2. For certain systems step (4) may be omitted by the program

The VUPAK2 system will now start.

6.1.2 System Initialisation

The following printout sample illustrates the Computer/Operator dialogue during VUPAK-DDC subsystem initialisation:

VUPAK DDC INITIALISATION

YOU ARE GOING TO BE ASKED A SERIES OF QUESTIONS WHICH CONCERN THE START UP DATA OF THE VUPAK DDC PACKAGE.

IF YOU ENCOUNTER ANY PROBLEMS PLEASE REFER TO THE VUPAK USER GUIDE 'VUPAK-INIT'

NOTE: YOU HAVE * * * * * ('#####) WORDS OF CONFIGURABLE CORE
YOU HAVE * * * * * ('#####) WORDS OF RESERVABLE CORE

OK? THEN LET'S GO . . . . (Notes 1 & 2)

* *

1. WHAT IS THE DATE (DAY.MONTH.YEAR)? Section 6.1.3(1)

2. WHAT IS THE MAINS FREQUENCY (50/60)? (2)

3. HOW MANY SIU PACS (1, 2 OR 3) (3)

4. HOW MANY DAS POINTS (INCL DDC)? (4)

5. HOW MANY DDC LOOPS (ADD 1 FOR EACH DEAD TIME)? (5)

6. WHAT IS THE DERIVED BLOCK DATA (SIZE, NO OF BLX)? (6)

FINE, * * * * ('####) WORDS OF CONFIGURABLE CORE LEFT
* * * * ('####) WORDS OF RESERVABLE CORE LEFT (Notes 1 & 2)

DO YOU WANT TO MAKE ANY CHANGES (N OR QUES NO)? (Section 6.1.4)

OK, GOING TO SYSTEM START UP!

* *

Notes: *1.* CONFIGURABLE CORE. The core area that can be written into during the initialisation sequence.

RESERVABLE CORE. The core area that can be reserved for use once the system goes on line.

2. * * * * core area in decimal

'#### core area in octal

Answer entry, special characters:

'Carriage Return' terminates any entry

'Rubout' deletes preceeding character entered

'←' deletes preceeding string entered

6.1.3 Initialisation Questions

(1) QUESTION: What is the date.

ENTRY: DAY. MONTH. YEAR.

EXAMPLE: 10.5.73.

CHECKS: DAY – 1 ⩽ DAY ⩽ DAYS IN MONTH (Inc.leap year correction)

MONTH – 1 ⩽MONTH⩽ 12

YEAR – 1971 ⩽YEAR⩽ 1980

DIAGNOSTIC: IE DATA ERROR

(2) QUESTION: What is the mains frequency

ENTRY: 50 OR 60

EXAMPLE: 50

CHECKS: Must be 50 OR 60

DIAGNOSTIC: IE DATA ERROR

(3) QUESTION: How many SIU PAC s

ENTRY: 1, 2 or 3

EXAMPLE: 3

CHECKS: 1 ⩽ NO ⩽ 3

DIAGNOSTIC: IE DATA ERROR

(4) QUESTION: How many DAS Points

ENTRY: Decimal number of DAS points. Must include any DDC points as well.

EXAMPLE: 100

CHECKS: (a) 1 ⩽ NO ⩽ 500

(b) Core required must fit in reservable core available.

DIAGNOSTIC: (a) IE DATA ERROR

(b) IE CORE OVERFLOW

(5) QUESTION How many DDC loops.

ENTRY: Decimal number of DDC loops. Must add 1 for each dead time compensated loop.

EXAMPLE: 50

CHECKS: (a) 0 ⩽ NO ⩽ Number of DAS points

(b) Core required must fit in reservable core available.

DIAGNOSTIC: (a) IE DATA ERROR

(b) IE CORE OVERFLOW

(6)	QUESTION:	What is the derived block data.
	ENTRY:	Size of blocks (decimal), Number of blocks (decimal)
	EXAMPLE:	3,20
	CHECKS:	(a) $1 \leqslant SIZE \leqslant 16$, $1 \leqslant NO \leqslant$ Number of DAS points.
		(b) Core required must fit in reservable core available.
	DIAGNOSTIC:	(a) IE DATA ERROR
		(b) IE CORE OVERFLOW

6.1.4 Call Back

In response to the question 'ANY CHANGES', questions 1, 2 and 3 can be freely called back. Questions 4, 5 and 6 are inter-related so that whichever question is called back all three will have to be reconfigured. (The system will automatically revert to Question 3 if either 4 or 5 is entered.)

Upon completion of initialisation the system is running, and on-line configuration of the control may proceed (see Section 6.4).

It is advisable that a system tape be made of the initialisation to allow subsequent restarts. The standard Punch Program (PALAP) should be used for this procedure. This may be included in the basic tape.

6.1.5 System Restarts

At subsequent restarts only steps (1) to (4), Section 6.1.1, should be executed to enable the system to run.

6.2 Operators Console Sequences

The Operators Console provides an easy means of communication between the operator and the system. The operator can request a display and/or enter required information for system operation.

The entry facilities provided for changing point records are also used for on line configuration of new point records.

6.2.1 Examining Point Records

The sequence of keyboard operations necessary to display a value from point records is as follows:

(1) Press the CLEAR/CANCEL button; this clears all display windows.

(2) Press the IDENTITY button.

(3) Sequentially press two alpha and three numeric keys, thus specifying the name of the point identity. This Point identity is displayed in the Identity Register and the current process variable is displayed in the Display Register.

(4) To display further point parameters directly, press the required function button. The function name then appears in the Function Register and the current status or value of the function is displayed in the Data Register. The function value is updated once

a second without further operator action.

All further function requests may be displayed by following the procedure detailed in (4) above, provided the function is available for direct display.

To display indirect information a separate action sequence must be entered, this is the INTERROGATE sequence (see 5 below).

(5) With the point identity still displayed, pressing the INTERROGATE button displays the first of the indirect functions. Successive pressing of the EXECUTE button steps through the indirect functions, displaying each in turn. A Temporary exit and return to this sequence may be made by pressing the direct function buttons followed by INTERROGATE. This allows the inter-relationship of direct and indirect functions to be cross examined.

System functions such as Log Interval or Real Time are displayed by clearing the Display, step 1, and by pressing the required function button.

6.2.2 Entry of System Data

The entry of all system data into existing records is as follows:

(1) Display the required function (see Section 6.2.1)

(2) Enter the new data using the alphanumeric buttons sequentially. The new data will be displayed in the Entry Register.

(3) Examine the register to verify the new data.

If satisfied continue with step (4), otherwise proceed to step (5).

(4) Press the EXECUTE button. The new data is now displayed in the Data Register and the system tables update.

If a second entry attempt is necessary . . . .

(5) Press the ENTER button. This clears the Entry Register and displays entry markers - a row of dots.

(6) Proceed from (2) above, as required.

All entries made to the system are recorded on one of the system typewriters for future reference. The record includes the function mnemonic, the old value and the new value. This facility also provides a hard copy of any control configuration carried out and a useful analysis aid.

6.2.2.1 *Error Display* – During a display entry errors may occur for a number of reasons. All information presented to the computer is checked against limits for validity.

The most common errors are:

(1) Reference to a non-existant point identity.

(2) The function requested is inapplicable to the point record being examined.

(3) Entry is made to functions protected by the keyboard inhibit lock.

(4) A non octal character is specified where octal is required, for example: MPLXOR ADDRESS.

(5) New data is entered out of the range of the function.

6.2.2.2 *Special Data Formats* – The following formats must be used for entry of data.

(1) Engineering Values

The required value and decimal point as required, starting with the most significant numeral. Leading zeros are not required. All values are assumed positive unless preceded by a negative sign.

(2) Real Time

Time is expressed in hours and minutes, using the 24 hour clock. Leading zeros are not required.

(3) Multiplexor Address

The multiplexor address is entered and displayed as an octal number. It includes hardware address and amplifier gain as shown in Figure 6 - 1.

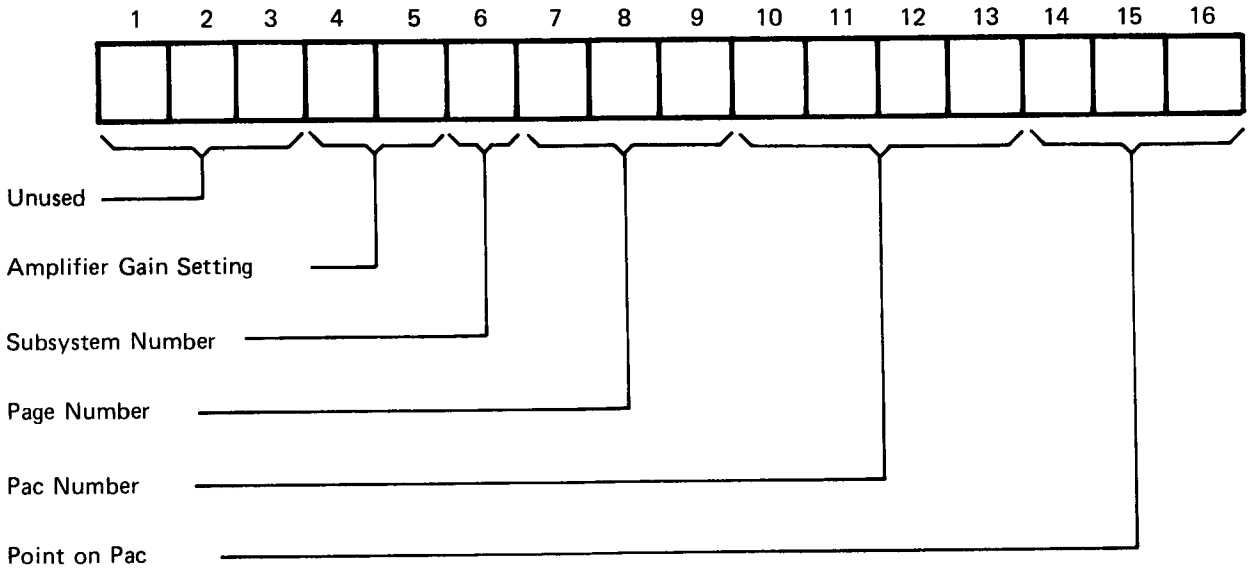


FIG. 6 - 1 MULTIPLEXER ADDRESS FORMAT

To obtain the required octal value for entry, the word should first be written in binary. For example, if the address consisted of the following features:

Amplifier gain setting	2
One subsystem	1
Page number	4
PAC number	10
Point on PAC	1

.... then the address would be formed as follows.

BIT NO.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
DECIMAL ADDRESS	0			2		1	4			10				1		
BINARY ADDRESS	0	0	0	1	0	1	1	0	0	1	0	1	0	0	0	1
OCTAL ADDRESS	0	1		3			1			2				1		

The required insert for this example is 013121.

(4) Output Value

The Output Value cannot be entered in the normal manner. However, in computer manual mode the output from the related back-up station can be raised or lowered by 1% of the full range per second for as long as the operator presses the appropriate RAISE or LOWER button. Since this operation does not cause the deletion of the current display, and since all displays are updated continuously by the computer, the output value can be tracked during this operation provided that it is displayed before the operation begins.

6.3 Action Sequences

The following action sequences are provided as standard:

DEMAND PROGRAM
DEMAND LOG
DEVICE

Additional action sequences under DEMAND PROGRAM may be provided in special applications.

6.3.1 Demand Program Button

This button allows the operator to run special application programs on a demand basis. The relevant programs are actioned by the following sequence.

(1) Press the DEMAND PROGRAM button followed by the index number of the required program.

(2) Press the EXECUTE button.

The program is now run and may request further programs via the Operators console.

The following programs are provided as standard:

(1) Demand Program 1

Loop summary – This program causes a printout in block form on the logging typewriter of all the point identities currently in the system.

(2) Demand Program 2

Operators Console test program – This program functionally tests the console keyboard and display for failure. It is specifically designed to trace faulty bulb operation or poor keyboard switches.

All displays show their first character. On pressing a keyboard button, the displays clock round one character.

Pressing the CLEAR/CANCEL button aborts the program.

(3) Demand Program 3

Octal Entry and display – This program allows direct access to any core location and may be used for changing basic system data tables. There is no memory protection on this facility so extreme caution must be exercised when entering data.

The following procedure should be used:

(a) Press the DEMAND PROGRAM button and then number 3 – Octal is displayed in the function register.

(b) Enter the required octal address.

(c) Press the EXECUTIVE button – the contents of the octal location are displayed in the data register.

New data may be entered into the displayed location by using the entry procedure described in subsection 6.2.2.

To display the contents of adjacent memory locations the RAISE or LOWER buttons should be pressed the required number of times to increase or decrease the memory location address as required. The new address and data will now be displayed in the correct registers.

Pressing the CLEAR/CANCEL button aborts the program.

(4) Demand Program 4

Re-initialises the Analogue to Digital Converter checking program.

6.3.2 Demand Log Button

This button may be used to demand a log in addition to the normal cyclic log. The procedure is as follows:

(1) Press the DEMAND LOG button.

(2) Press the EXECUTE button.

The log will now be output on the logging typewriter, if the typewriter is enabled.

In systems with multiple logs, step (1) should be modified as follows

(3) Press the DEMAND LOG button, followed by the relevant log number.

6.3.3 Device

The sequence associated with the DEVICE button allows the system typewriters to be enabled or disabled. The status of each typewriter is permanently displayed on the console keyboard by status lights. When the typewriter is disabled the appropriate light is lit.

The sequence is as follows:

(1) Press the DEVICE button followed by the device number.

.... ON or OFF is displayed. This may be changed using the entry facility described in subsection 6.2.2.

The following device numbers are standard

Device 1	Alarm Typewriter
Device 2	Logging Typewriter

When the typewriters are disabled a limited number of logs and alarms are queued. If the typewriters is disabled for long periods, information may be lost.

6.4 Configuration

A discussion on the choice of parameter values for configuring point records is contained in the Applications Manual.

The On-line configuring facilities allow the Control Engineer to initiate and change control loops using the facilities provided by the Operators Console. A point record may be configured by the operator provided there is room available in core for the control blocks required. If the operator attempts to configure a point when there is no core space available, an error message will be displayed on the console.

A point record is deleted from core when the scanning interval is set to zero. When this occurs the space left may be used by the operator to configure a new point record.

The following sequence is used with the INHIBIT Key unlocked:

(1) Press the CLEAR/CANCEL button

(2) Press the CONFIGURE button – this informs the system that configuration is about to start.

(3) Press the EXECUTE button – ALGORITHM INDEX is displayed in the Function Register.

(4) Press the required index number using the alphanumeric set – press the EXECUTE button. An error message displayed here indicates that there is insufficient room in core for the required point record.

(5) POINT IDENT appears in the function window indicating that the required name should be entered by sequentially pressing two alpha and three numeric buttons. If the name already exists, an error message will be displayed.

(6) Each function relevant to the specified control type will be displayed in the function windows in sequential order. As each one is lit, the operator must enter the required data for that function using steps (2) to (6) in subsection 6.2.2 – Entry of System Data. The next function will not be displayed until a satisfactory value has been entered. The functions are displayed in the same order as they appear in Table 2 - 1 and only those functions applicable to the control block type are displayed.

(7) When all functions have been correctly entered CONFIG COMPLT will be displayed in the function register, and the operator can display or enter functions as with any other point.

NOTE: At the end of configuration the point will be in computer manual mode, and the supervisory status 'OFF'.

Configuration can be aborted by pressing the CLEAR/CANCEL button. At the end of configuration putting the scan rate to zero will delete the point.

APPENDIX A

GLOSSARY

Abbreviation	Meaning	Originating Document (*denotes this document)
ADC	Analogue to Digital Converter	Utilities and Drivers
ASR-35	Alarm Typewriter	*
AT	Alarm Typewriter	Message System
CM	Computer/Manual	*
CMA	Computer/Manual Auto	*
CMAT	Computer/Manual Auto Tracking	*
C,M,P	Computer, Manual, Preset (Mode Switch)	*
CONFIG COMPLT	Configuration Complete	OP-16
DAS	Data Acquisition System	General
DDC	Direct Digital Control	General
IBM-735	Logging Typewriter	*
KEY IDENTITIES	Derived from Console keyboard	*
MPLXOR ADDRESS	Multiplexor Address	OP-16
OC	Operators Console Program	Operators Console
PALAP	Standard Punch Program	OP-16
PEN 1,2,3	Patch Panel Identities	*
PV	Process Variable	General
3 TRM	3-Term Algorithm Subroutine	Control and Output
VUTRONIK	Manufacturers Trade Name	General