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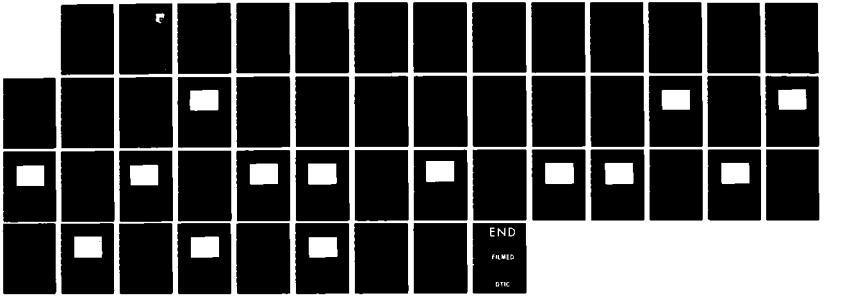

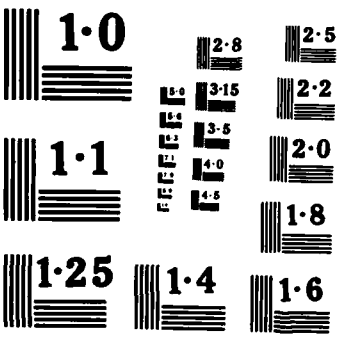

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AFWAL-TR-84-3117
Volume I

DIGITAL SERVOCONTROLLER SYSTEM
Volume I - Operations Manual

Jorge Lopez
Kevin Miller

Southwest Research Institute
San Antonio, Texas

February 1985

Final Report for Period July 1983 - November 1984

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This final report describes an exploratory development effort for the design and fabrication of a digital servocontroller system for load control in full-scale air-frame fatigue tests. Each digital controller replaces four analog controllers. The LSI-11/23 microcomputer in the digital controller executes a PI algorithm to implement direct digital control. It may operate in a stand-alone mode or as a slave processor to a master computer via fiber optic link. Other programmable features specifying loop parameters, building load profiles, adjusting control system gains and monitoring alarm and abort conditions.

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PREFACE

This is the final report of work accomplished and results achieved at the Experimental Control Group, Structures Test Branch, AFWAL/FIBT, WPAFB, Ohio. The digital servocontroller was developed by Southwest Research Institute, San Antonio, Texas, under Contract F33615-83-C-3201 during the time period July 83 thru November 84.

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1.0 INTRODUCTION

The digital servocontroller was developed by Southwest Research Institute (SwRI) for the Air Force Wright Aeronautical Laboratories. This document contains the information necessary to operate the servocontroller system. Section 2.0 provides a list of documents which may be referenced for additional information. A brief description of the system is given in Section 3.0. Detailed descriptions of the system's controls and display is provided in Section 4.0. Step-by-step instructions on the operations of the system is given in Section 5.0. This section also describes the various operating modes available to the operator.

2.0 APPLICABLE DOCUMENTS

The following documents may be referenced for additional information: Digital Servocontroller System, Maintenance Manual; Southwest Research Institute, 1984.

3.0 SYSTEM DESCRIPTION

The digital servocontroller system was designed and programmed to function as a general purpose load controller. The system offers various modes of operations and an easy to learn operator interface. The servocontroller system is designed to control one to four channels. A menu driven display guides the operator in performing the different tasks associated with load control tests including: specifying loop parameters, building load profiles, adjusting the control system gains and monitoring alarm and abort conditions. The servocontroller system consists of the following components:

(1) Microcomputer system;
(2) Discrete interface card;
(3) Servo driver cards;
(4) Signal conditioning cards;
(5) Signal conditioning terminal panel;
(6) Fiber optic system; and
(7) System enclosure.

Figure 1 shows a block diagram of the system and Figure 2 shows the system and its components. Two serial ports link the microcomputer with the operator. One is used to interface the system terminal (GFE). The terminal is the main operator interface with the system. The operator is able to monitor loop parameters as well as alter them. Control of load profile runs is done through the terminal. This includes building and executing. The other serial port is used to interface the system with a master computer (GFE). The master computer has the ability to generate profiles and download them to the servocontroller system. The servocontroller system interfaces with the hydraulic system through the signal conditioning terminal panel. Signals from each of the microcomputer system's digital-to-analog (D/A) converters are converted into current signals used to drive the servovalves. The feedback signals from the load cells are conditioned to high level signals at the signal conditioning terminal panel before being measured by the microcomputer system's analog-to-digital (A/D) converters. Discrete signals are provided to the signal conditioning terminal panel from the servocontroller system via its discrete output lines. The front panel switches interface with the servocontroller system through the discrete interface card. For a complete description of the system hardware and firmware, refer to the Digital Servocontroller System, Maintenance Manual.

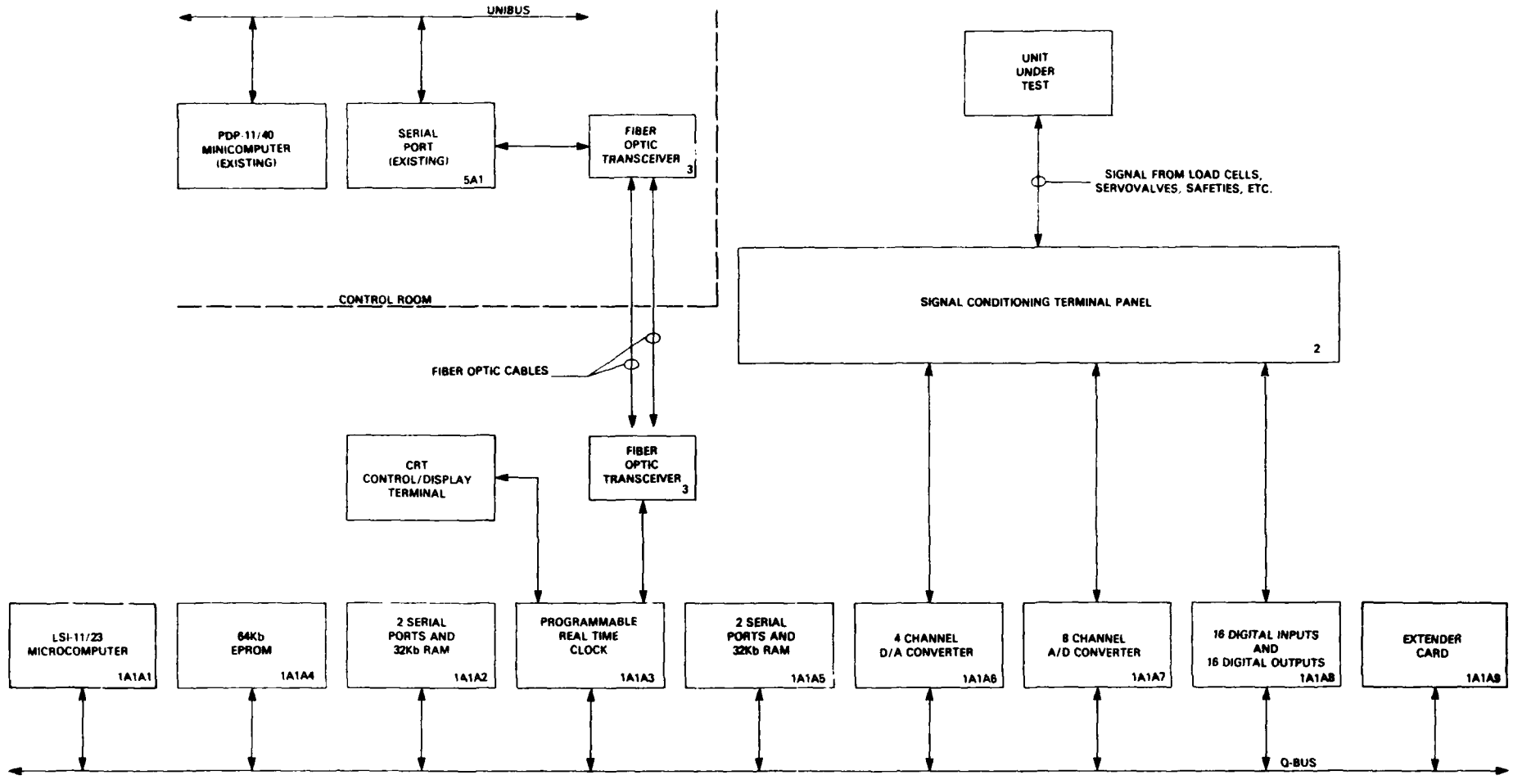


FIGURE 1. DIGITAL SERVOCONTROLLER
SIMPLIFIED BLOCK DIAGRAM

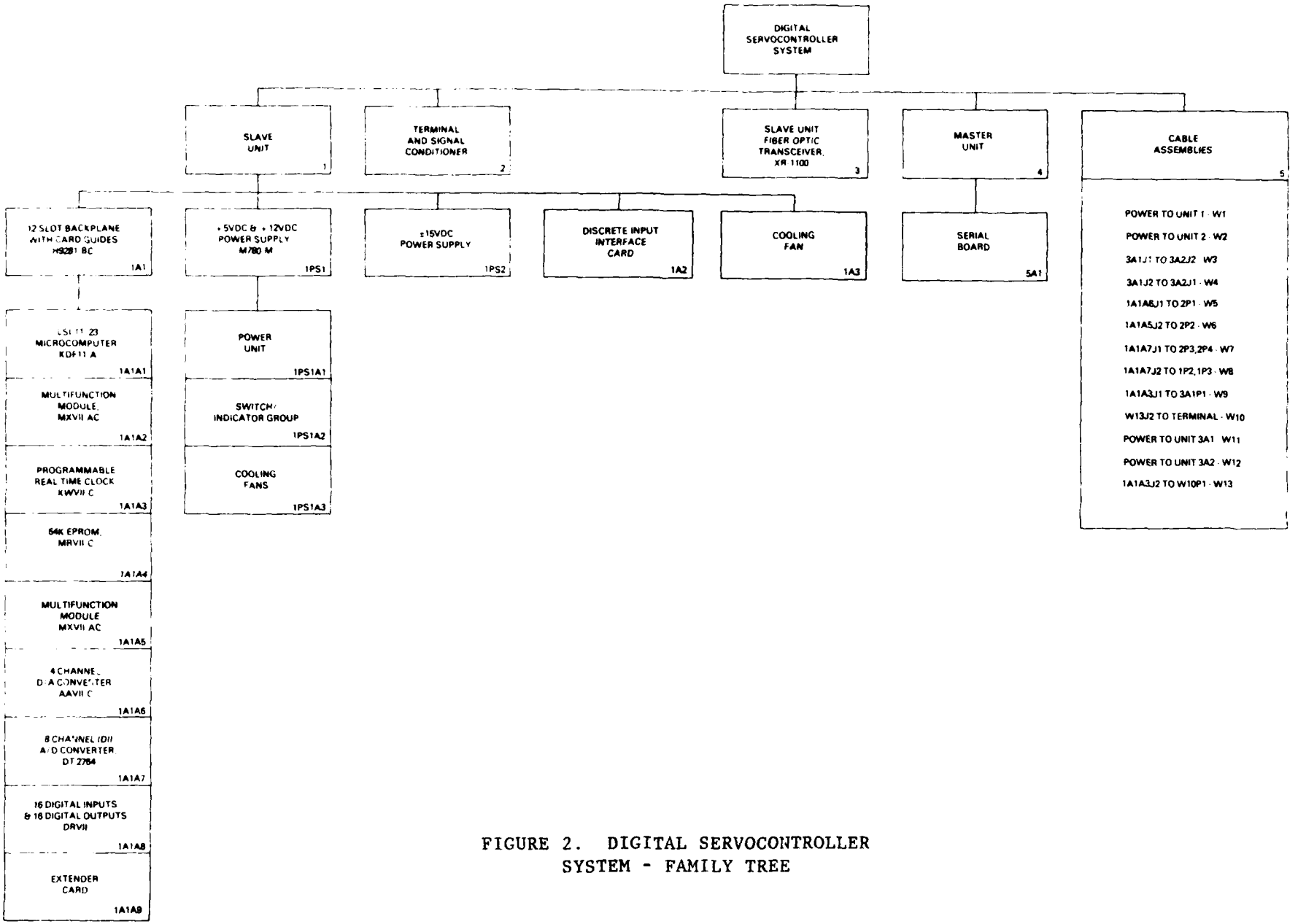


FIGURE 2. DIGITAL SERVOCONTROLLER SYSTEM - FAMILY TREE

4.0 OPERATOR CONTROLS AND DISPLAY

4.1 System Enclosure Controls

Power Switch, 1S1: This switch is located on the rear of the system enclosure (see Figure 3). The switch is used to apply 120 VAC to the enclosure.

Microcomputer Control Switch and Indicator Group: Three switches and two LED indicators are located on the front panel which control and monitor the microcomputer system (see Figure 4).

- DC ON/OFF Switch - This switch is used to apply 120 VAC to the microcomputer power supplies 1PS1.
- ENABLE/HALT Switch - This switch is used as an external control of the microcomputer. In the ENABLE position, the microcomputer is free to run the system program. When the switch is in the HALT position, a HALT sequence is generated and maintained on the microcomputer. The system program will stop execution.
- LTC ON/OFF Switch - This switch is used when running DEC's diagnostic programs. The switch must be in the OFF position under normal operating conditions.
- DC ON Indicator - This indicator is lit when DC power is applied to the microcomputer system.
- RUN Indicator - This indicator is lit whenever the microcomputer is executing programmed instructions.

CHANNEL SELECT Switch, 1S2: This switch is located on the front panel of the system enclosure (see Figure 4). Manual adjustment of a channel's controller gains is selected using this switch. The OFF position disables the manual adjustment for all channels.

COARSE/FINE Switch, 1S3: This switch is located on the front panel of the system enclosure (see Figure 4). The operator may select the rate of manual adjustment for a selected channel using this switch. The COARSE position will raise/lower a selected gain (A or B) 10 times faster than the FINE position.

A RAISE/LOWER Switch, 1S4: This switch is located on the front panel of the system enclosure (see Figure 4). The selected channel's A gain is raised/lowered by holding the switch in the desired position. The rate of change in the A gain is determined by the COARSE/FINE switch.

B RAISE/LOWER Switch, 1S5: This switch is located on the front panel of the system enclosure (see Figure 4). The selected channel's B gain is raised/lowered by holding the switch in the desired position. The rate of change in the B gain is determined by the COARSE/FINE switch.

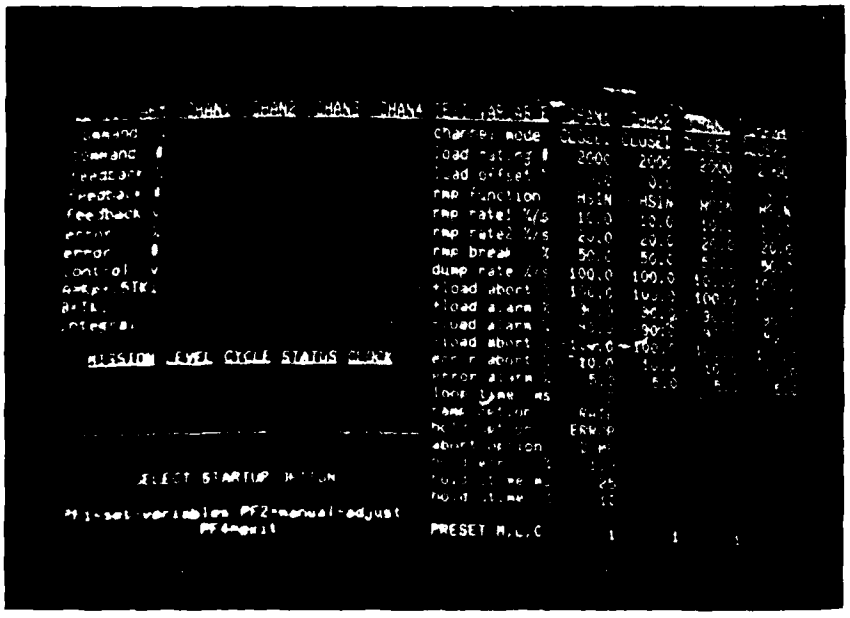


Figure 8. Start-Up Mode Display

5.3 Select Controller Mode

The system program is initialized to this state. Options to be selected are the modes of operation. The operator options at this point are only three:

(1) PF1 = startup: Entry of PF1 sets the program to the startup mode and displays the options available in the startup mode.

(2) PF2 = load mission: Entry of PF2 sets the program to the load mission mode and displays the options available in the load mission mode.

(3) PF3 = on-ddc: Entry of PF3 sets the program to the on-ddc mode and displays the options available in the on-ddc mode.

5.4 Startup

The startup mode is entered to perform two functions: (1) enter and edit loop parameters and (2) manual adjustment of the outputs to the servovalves. Figure 8 shows the display for the startup mode. Three options are available to the operator:

(1) PF1 = set variables: Entry of PF1 sets the program to the set variables routines and displays the options available in the set variables state. This state is used to enter and edit the loop parameters for each channel.

(2) PF2 = manual-adjust: Entry of PF2 sets the program to the manual-adjust routines and displays the options available in the manual-adjust state. This state is used to provide an open loop manual adjust or "bump" of any of the control channels.

(3) PF4 = exit: Entry PF4 returns the program to the select controller mode state and displays its corresponding display.

5.4.1 Set Variables

The set variables state allows the operator to enter and edit the loop parameters. The display is shown in Figure 9. Two options are available:

(1) Loop parameter data entry/edit:

(a) Using the four cursor control keys, move the cursor to the loop parameter to be entered/edited.

(b) The numeric keypad is to be used to enter data as follows:

1 = increments the parameter x 1
4 = increments the parameter x 10
7 = increments the parameter x 100
2 = decrements the parameter x 1
5 = decrements the parameter x 10
8 = decrements the parameter x 100

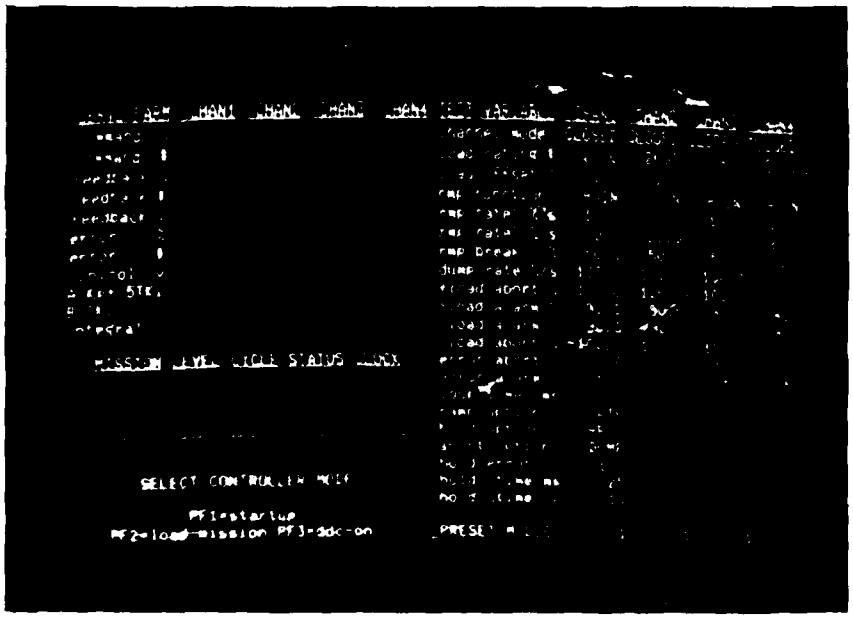


Figure 7. Select Controller Mode Display

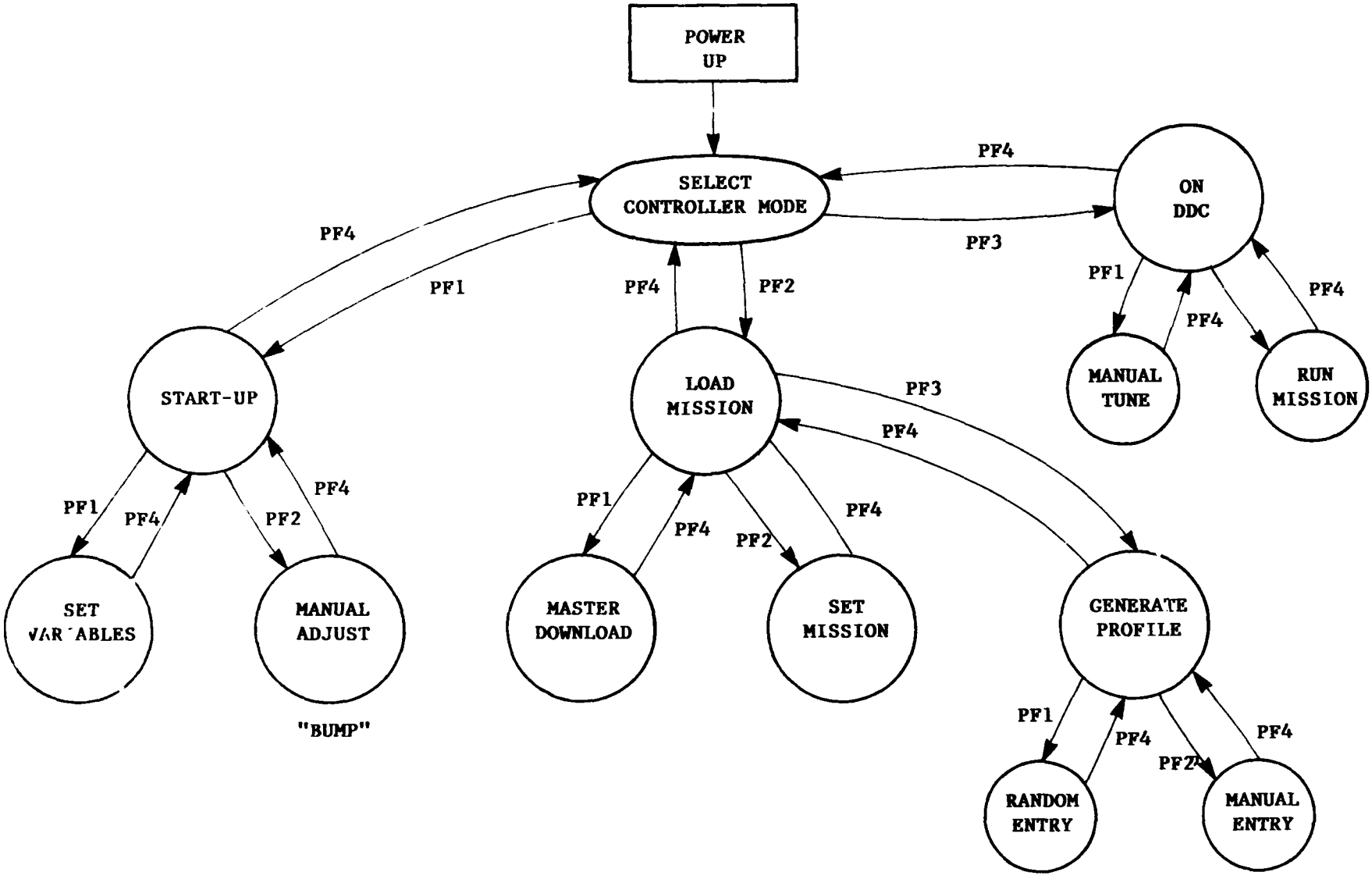


FIGURE 6. DIGITAL SERVOCONTROLLER SYSTEM STATE DIAGRAM

5.0 OPERATING PROCEDURES

5.1 Operating Philosophy

The system program was designed and structured as shown in Figure 6. Application of power to the digital servocontroller system commences the initialization routines of the system program. Following initialization, the system is ready to accept operator entered commands. Three major modes of system operation have been identified and constitute the next state levels in the system program. They are: start-up, load mission and ddc-on. The start-up mode allows the operator to enter and edit the loop parameters (see Section 4.3.1). It is within this mode that the operator can configure each channel to perform for the desired response. This mode also allows for an open loop manual adjust or "bump" of any of the control channels. This feature is expected to be primarily used in the physical linking of the struts and the hydraulic cylinders. The load mission mode provides the routines required to enter a load profile. Specifically, it allows structuring of the mission, random generation of a profile, manual generation of a profile and downloading of a profile from the master computer. The on-ddc's main function is the execution of the mission. This mode allows for an orderly hydraulic start-up prior to mission execution through the use of two commands. The "/" command is a soft toggle switch which turns the DDC algorithm on and off. The "Z" command is another soft toggle switch which is used to turn the DDC algorithm's integrator on and off as required. Together these commands can be used in the initial start-up of the system. A manual-tune routine is accessed in the on-ddc mode. The execution of the mission is also controlled through this mode.

The system program is a menu driven program. Associated with each state in the system is a menu which provides the available options to the operator. These options include actual control functions and jump to higher and lower states. The operator displays indicate the state in which the system is in and should be used as a guide through the system.

5.2 Power-Up

(1) Verify that the hydraulic system is shut off.

(2) Verify that the system cabling is correct per Section 9.0 of the Digital Servocontroller System Maintenance Manual.

(3) Verify that the wiring between the hydraulic system and the Signal Conditioning Terminal Panel is correct per the Digital Servocontroller System Maintenance Manual.

(4) Apply power to the servocontroller system. 1S1 is in the ON position.

(5) Initialize the servocontroller system program by moving the DC ON/OFF switch, 1PS1 on the front panel, to the ON position.

(6) The initial screen, Figure 7, should now be displayed on the terminal screen.

integral - The current value of the servocontroller algorithm's integral.

MISSION - The current mission being executed.

LEVEL - The current level being executed.

CYCLE - The current cycle being executed.

STATUS - The current status of the system.

OFF - The DDC algorithm is not executing. The digital-to-analog converter outputs are set to 0.00 VDC.

HOLD - The DDC algorithm is maintaining the current load level.

GO - The DDC algorithm is executing and running through a programmed profile.

ABORT - The system has executed an ABORT sequence.

CLOCK - This clock maintains the accumulated time (hrs:min) that the DDC algorithm has been running.

4.3.3 Profile Data and Operator Menus

The profile data and operator menus are displayed in the lower left-hand corner of the screen. The operator menus guide the operator through the execution of the system program. The profile data, whether it be entered manually or from the master computer, is set up within the operator menus. Section 5.0 describes in detail the menus and provides the procedures required to initialize and execute the various modes of operation.

hold % time % - Defines the hold time as a % of the ramp time used to reach the level. This option is used when the hold option is %TIME. The limits for this value are 1 to 100.0%. The default value for all channels is 10%.

PRESET M,L,C, - Defines the mission (M), level (L) and cycle (C) for a preset hold. The three parameters are mission, level and cycle, respectively. The limits for these values are:

mission (M) - 1-9999
level (L) - 1-500
cycle (C) - 1-9999

The default values are:

mission (M) - 1
level (L) - 1
cycle (C) - 1

4.3.2 Loop Data

The loop data is presented on the upper left hand section of the screen. This data represents the real-time measurements of key loop variables.

command % - The current command in % of full scale. Commands are generated by the system program following the entered profile.

command # - The current command in pounds (#).

feedback % - The current feedback as measured by the system analog-to-digital converter. The measured feeback is a direct measurement in %. The feedback is the output from the Strain Gauge Signal Conditioning Cards.

feedback # - The current feedback converted to pounds (#).

feedback v - The current feedback voltage measured by the analog-to-digital converter. 100% full scale load is equal 9.766 VDC.

error % - The current difference between command % and feedback %.

error # - The current difference between command # and feedback #.

control v - The current output voltage of the system digital-to-analog converters.

A = Kp + 0.5 TKi - The current value of the servocontroller algorithm's A gain.

B = TKi - The current value of the servocontroller algorithm's B gain.

and chooses the slowest of these times as the ramp time for the system. These calculations are repeated for each load level change.

TIME - In this mode, the ramp time is assumed to have been previously entered with the profile. A profile which is entered in this mode has associated with each load level a TIME which defines the ramp time to the next level.

hold option - Defines the criteria to be used in determining the hold time between levels for all channels.

ERROR - In this mode the hold time is not calculated. The level will be held until the error falls within the limits specified by the hold error parameter (see below).

CTIME - In this mode, the hold time is a constant specified by the hold Ctime parameter (see below).

%TIME - In this mode, the hold time is calculated as a % of the ramp time needed to reach the load level. The % is specified by the hold % time parameter (see below).

abort option - Defines the ABORT sequence to be followed for all channels.

HOLD - Under ABORT conditions, the current load levels will be held.

DUMP - Under ABORT conditions, the system is dumped. That is, the load levels are returned to a 0% level.

LOCK - Under ABORT conditions, the current load levels will be held. Additionally, a discrete output is made available and switched on to initiate a mechanical lock-up of the system.

hold error % - Defines the error % used to determine the hold criteria when the hold option is ERROR. The system will hold at a level until all of the active channels meet the ± hold error % limit. The limits for this value are .1 to 100.0%. The default value for all channels is 1.0%.

hold Ctime ms - Defines the hold time constant when the hold option is CTIME. The limits for this value are 1 to 32,767 ms. The default value for all channels is 25 ms.

break, rmp rate 2 is used. The limits for values are 0.0 to 200.0%. The default value for each channel is 50.0%.

dump rate %/s - Defines the rate (%/sec) at which a DUMP will occur. The DUMP will occur as a straight line ramp. The limits for values are 1.0 to 1000.0 %/sec. The default value for each channel is 100.0 %/sec.

+ load abort % - Defines the upper load level (%) limit which, if exceeded, will initiate an ABORT sequence. The limits for values are 1.0 to 100.0%. The default value for each channel is 100.0%.

+ load alarm % - Defines the upper load level (%) limit which, if exceeded, will cause an ERROR status output to be made. The limits for values are 1.0 to 100.0%. The default value for each channel is 90%.

- load alarm % - Defines the lower load level (%) limit which, if exceeded, will cause an ERROR status output to be made. The limits for values are 1.0 to 100.0%. The default value for each channel is 90%.

- load abort % - Defines the lower load level (%) limit which, if exceeded, will initiate an ABORT sequence. The limits for values are 1.0 to 100.0%. The default value for each channel is -100%.

error abort % - Defines an upper and lower error level (%) limit which, if exceeded, will initiate an ABORT sequence. Error is defined as the difference between the command and feedback signals. The limits for values are 0.1% to 100.0%. The default value for each channel is 10.0%.

error alarm % - Defines an upper and lower error level (%) limit which, if exceeded, will cause an ERROR status output to be made. The limits for values are 0.1 to 100.0%. The default value for each channel is 5.0%.

loop time ms - Defines the time interval between updates of the DDC control algorithm. The one time is set for all four channels. The limits for the value are 2 to 10 ms. The default value is 2 ms.

ramp option - Defines the mode by which the time to change from one level to another (ramp time) is calculated for all channels.

RATE - In this mode, the ramp time is calculated using the rmp rate 1, rmp rate 2 and rmp break data previously entered for each channel. The system program calculates the ramp time for each channel

OFF - Loop will not be functional for the selected channel. Selection of a channel to be OFF requires that the higher numbered channels also be in the OFF mode, e.g., if channel 3 is OFF then channel 4 must also be OFF.

Default mode is CLOSED for all channels.

load offset % - The expected or measured load offset is entered here for each channel. The load offset is entered as a percentage of full scale load. The limits for values are 0.0 to 100.0%. The default value for each channel is 0.0%.

load rating # - The maximum load cell rating in # is entered here for each channel. The limits for values are 1.0 to 999999.0 #'s. The default value for each channel is 2000.0 #'s.

rmp function - Describes the function to be used in changing from one load level to the next.

RAMP - A straight line ramp between levels is used.

HSIN - A haversine function between levels is used.

FCTN - A master computer function is downloaded and used to change between levels.

STEP - A step function between levels is used.

Default function is HSIN for all channels.

rmp rate 1 %/s - Functional only when the ramp option (see below) is RATE. Defines the rate (%/sec) at which the controller moves from one level to the next. This rate is applicable as long as the change in level, does not exceed the ramp break (see following) specified. The limits for values are 1.0 to 1000.0 %/sec. The default value for each channel is 10.0 %/sec.

rmp rate 2 %/s - Functional only when the ramp option (see below) is RATE. Defines the rate (%/sec) at which the controller moves from one level to the next. This rate is applicable so long as the change in level exceeds the ramp break (see below) specified. The limits for values are 1.0 to 1000.0 %/sec. The default value for each channel is 20.0 %/sec.

rmp break % - Functional only when the ramp option (see below) is RATE. Defines the magnitude of a change in load levels (%) which specifies the ramp rate to be used. For load level changes less than or equal to the rmp break, rmp rate 1 is used. For load level changes greater than rmp

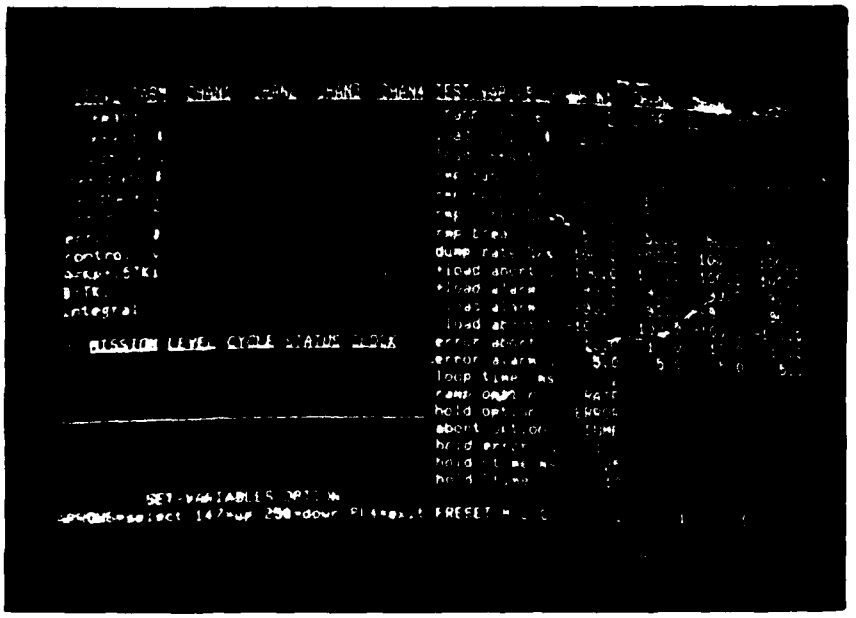


Figure 5. Typical Data Display

4.2 Terminal Keyboard Controls

Cursor Control Keys: The selection of test parameters to be altered and profile data to be entered is made through the use of the cursor control keys on the keyboard. The selection cursor is moved in the direction of the arrows on the cursor control keys.

Programmable Function Keys, PF1-PF4: The system program is designed in a hierarchical manner. Four levels of program states exist. The programmable function keys facilitate the entering and exiting between states. PF1, PF2 and PF3 are used to select the next higher level. PF4 is used to exit states to select the next higher level.

Numeric Keypad: Variable parameters for each loop and profiles are entered or altered using the numeric keypad. Discrete numbers are not entered, rather the keys are used to increment the present value of the selected parameter.

"/" Key: This key command is used in the DDC-ON mode. It is used as a toggle switch for the DDC algorithm. When "/" is entered, the DDC control algorithm is initiated for the "CLOSED" channels. Entering "/" again stops the DDC algorithm execution.

"Z" Key: This key command is used in the DDC-ON mode. It is used as a toggle switch for the integrator element of the DDC algorithm. Initially when "Z" is entered, the integrator element within the DDC algorithm is set to zero. Entering "Z" again, the integrator element within the DDC algorithm is reinstated. This control is expected to be used in start-up.

"C" Key: This key command is used in the RUN-MISSION mode. It is entered to reset the clock display on the terminal.

4.3 Terminal Display

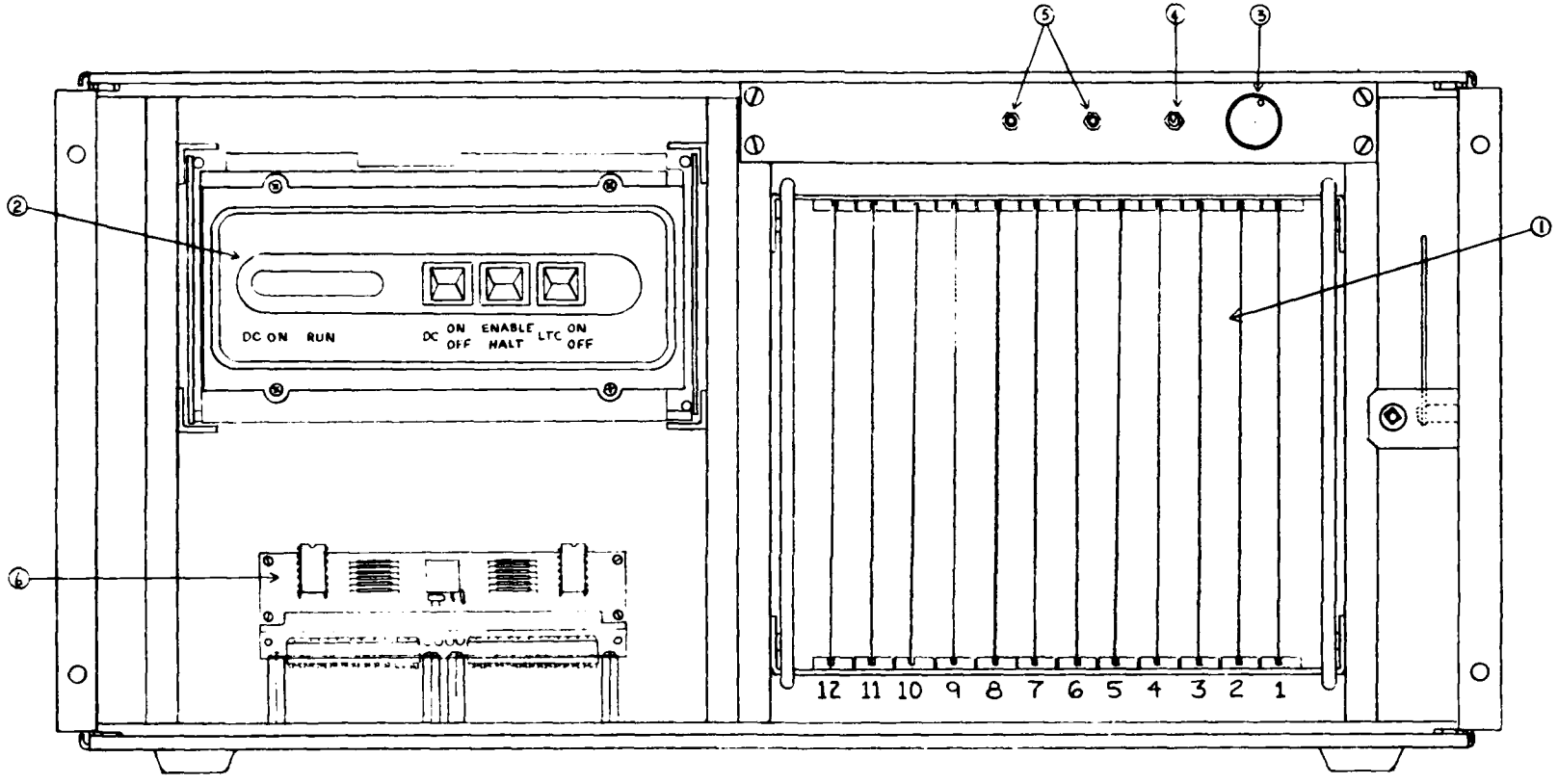
The terminal display is used to display four types of data on the screen. They are: loop parameters, loop data, profile data and operator menu. Figure 5 shows a typical display of data. The data types are called out. The loop parameters are variables which specify the characteristics for each loop. The loop data is a real-time display of actual loop signals, namely, command, feedback, error control and three controller parameters. The profile data includes profile command levels for each channel as well as mission specification data. The operator is guided through the system program via the menus which appear on the display.

4.3.1 Loop Parameters

channel mode - Describes the mode of operation for each channel:

CLOSED - Loop will be run in a closed loop mode, i.e., with feedback.

OPEN - Loop will be run in an open loop mode, i.e., without feedback.



① MICROCOMPUTER CARD CAGE / MOTHER BOARD - 1A1
② MICROCOMPUTER POWER SUPPLY / CONTROL CONSOLE - 1PS1
③ CHANNEL SELECT SWITCH - 1S2
④ COARSE/FINE SWITCH - 1S3
⑤ RAISE - LOWER SWITCH - 1S4, 1S5
⑥ SERVO CONTROLLER SWITCH INTERFACE CARD - 1A2

REVISIONS

ZONE	LTR	DESCRIPTION	DATE	APPROVED

CONTRACT F33615 83-C 3201		
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REVISED	H HAEGELIN	3-5-84

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DATA SYSTEMS DEPARTMENT
SAN ANTONIO, TEXAS

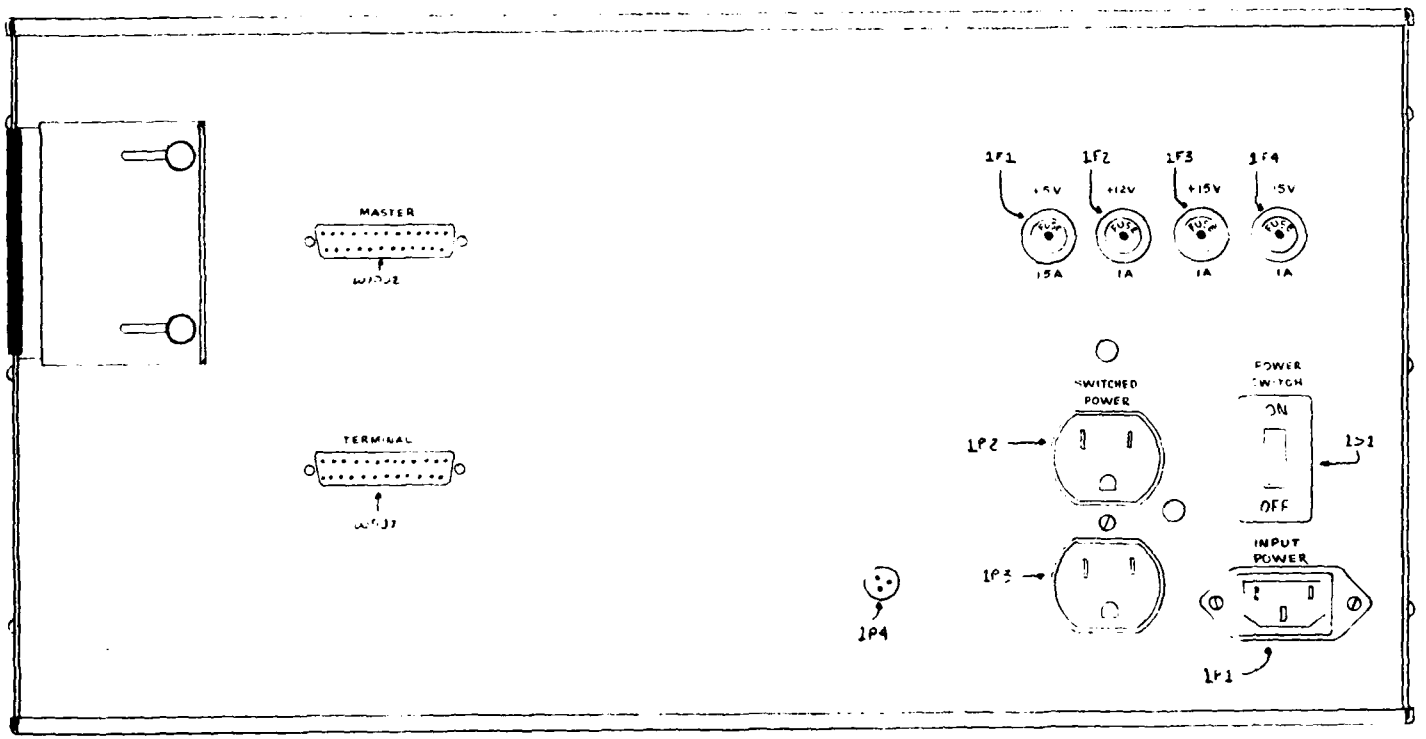
SERVO CONTROLLER
FRONT VIEW - PANEL OFF

SIZE	CODE IDENT NO.	DRAWING NO.
C	26401	14-7676-102

SCALE 1 to 1 SHEET

DRAWING NUMBER

FIGURE 4. SYSTEM ENCLOSURE FRONT VIEW



REVISIONS

ZONE	LTR	DESCRIPTION	DATE	APPROVED

CONTRACT F33615 83-C-3E01			
APPROVALS SIGNATURE & DATE			
DRAWN	N GUERRA		
CHECKED			
MECH			
ELECT	Jorge Lopez	11/30/84	
STDS			

SOUTHWEST RESEARCH INSTITUTE
DATA SYSTEMS DEPARTMENT
SAN ANTONIO, TEXAS

SERVO CONTROLLER
BACK PLATE

SIZE	CODE IDENT NO.	DRAWING NO.
C	26401	14-7676-101

SCALE 1:01 SHEET

DRAWING NUMBER

FIGURE 3. SYSTEM ENCLOSURE
REAR VIEW

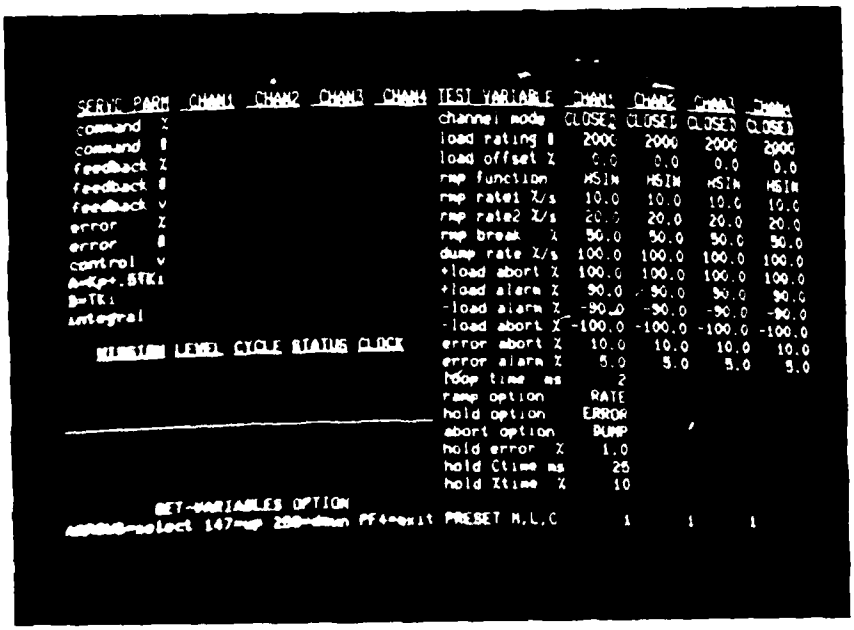


Figure 9. Set Variables Display

Incrementing and decrementing will not be allowed if it results in the parameter exceeding its upper/lower limits. Data is entered upon entry on the keypad.

(2) PF4 = exit: Entry of PF4 returns the program to the startup state and display.

5.4.2 Manual-Adjust

The manual-adjust state allows the operator to manually pulse or "bump" a selected output channel. The display for this state is shown in Figure 10. The feedback servoparameters are displayed for operator convenience. Two options are available:

(1) Manual-adjust: The operator may alter these characteristics of the pulse to be applied: (1) output channel, CHAN; (2) pulse amplitude, MAGNITUDE (v); and (3) pulse width, DURATION (ms). Default values are CHAN = 1, MAGNITUDE (v) = 10.0 V and DURATION (ms) = 500 ms. Application of a pulse is as follows:

(a) Use the cursor control keys to select the CHAN parameter.

(b) Use the numeric keypad to select the desired channel:

1 = increments the channel x 1
2 = decrements the channel x 1

(c) Use the cursor control keys to select the MAGNITUDE (v) parameter.

(d) Use the numeric keypad to select the desired pulse magnitude.

1 = increments the magnitude x 1
4 = increments the magnitude x 10
2 = decrements the magnitude x 1
5 = decrements the magnitude x 10

The limits on the MAGNITUDE (v) are 0.0 to 10.0 VDC. Incrementing and decrementing is not allowed if it results in the parameter exceeding its upper or lower limits.

(e) Use the cursor control keys to select the DURATION (ms) parameter.

(f) Use the numeric keypad to select the desired pulse duration:

1 = increments the duration x 1
4 = increments the duration x 10
2 = decrements the duration x 1
5 = decrements the duration x 10

The limits on the DURATION (ms) are 1 to 1000 ms. Incrementing and decrementing is not allowed if it results in the parameter exceeding its upper or lower limits.

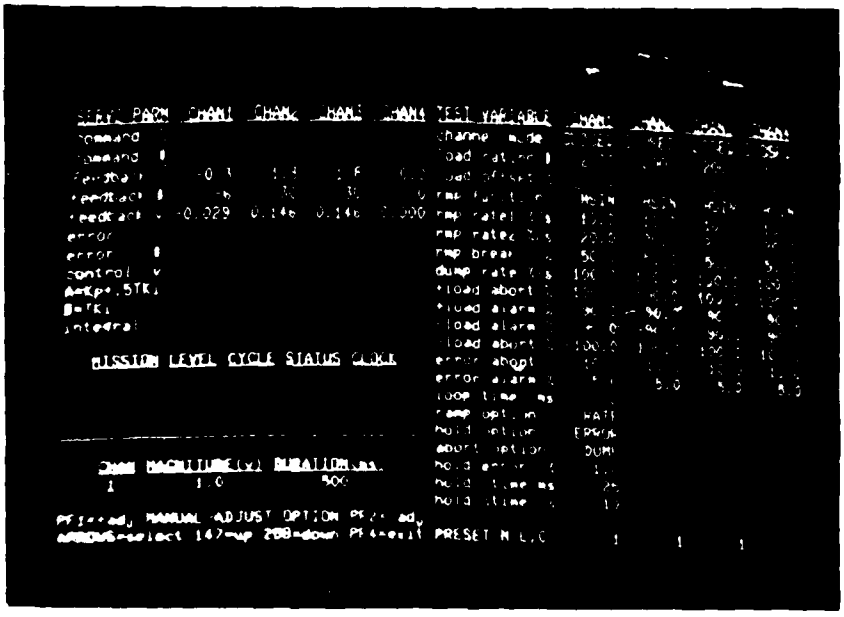


Figure 10. Manual-Adjust Display

(g) Apply the pulse:

PF1 = + adj: Entry of PF1 applies a positive pulse as has been specified.

PF2 = - adj: Entry of PF2 applies a negative pulse as has been specified.

(h) Repeat steps (a)-(g) as required.

(2) PF4 = Exit: Entry of PF4 returns the program to the startup state and display.

5.5 Load Mission

The load mission mode provides the functions necessary to load a mission. Different states within this mode allow for the loading of a mission by: (1) downloading the master computer, (2) random generation, and (3) manual entry from the terminal keyboard. Another state sets the number of missions to be run and the number of levels per mission. Figure 11 shows the display for the load mission mode. Four options are available to the operator:

(1) PF1 = master download: Entry of PF1 sets the program to the master download state. This state is used to download a profile from the master computer.

(2) PF2 = set mission: Entry of PF2 sets the program to the set mission routines and displays the options available in the set mission state. This state is used to set the structure of the mission to be executed. Mission names can also be assigned.

(3) PF3 = generate profile: Entry of PF3 sets the program to the generate profile routines and displays the options available in the generate profile state. This state is used to select between random and manual entry of a profile.

(4) PF4 = exit: Entry of PF4 returns the program to the start-up state and display.

5.5.1 Master-Download

The master-download state provides the interface for the downloading of data from the master computer. Figure 12 shows the master download display. Three options are available to the operator:

(1) PF1 = go: Entry of PF1 initializes the interface and sets the controller ready to accept the download. The STATUS is set to GO.

(2) PF2 = stop: Entry of PF2 terminates the interface. The current WORD-COUNT and CHECKSUM are displayed. WORD-COUNT is the number of words received by the controller during a download. CHECKSUM is the algebraic sum of all the words received. It is used as a validation of transmitted data. The STATUS is set to STOP.

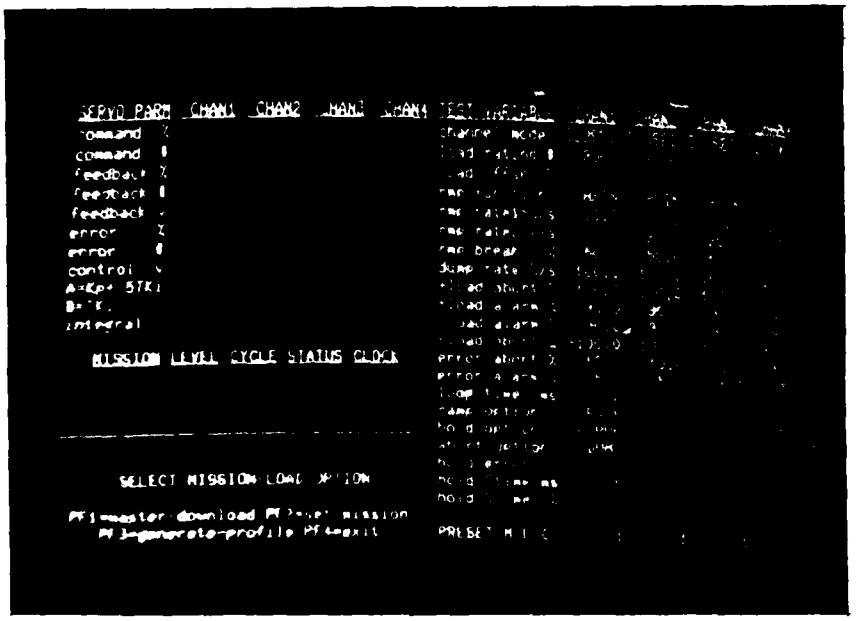


Figure 11. Load Mission Display

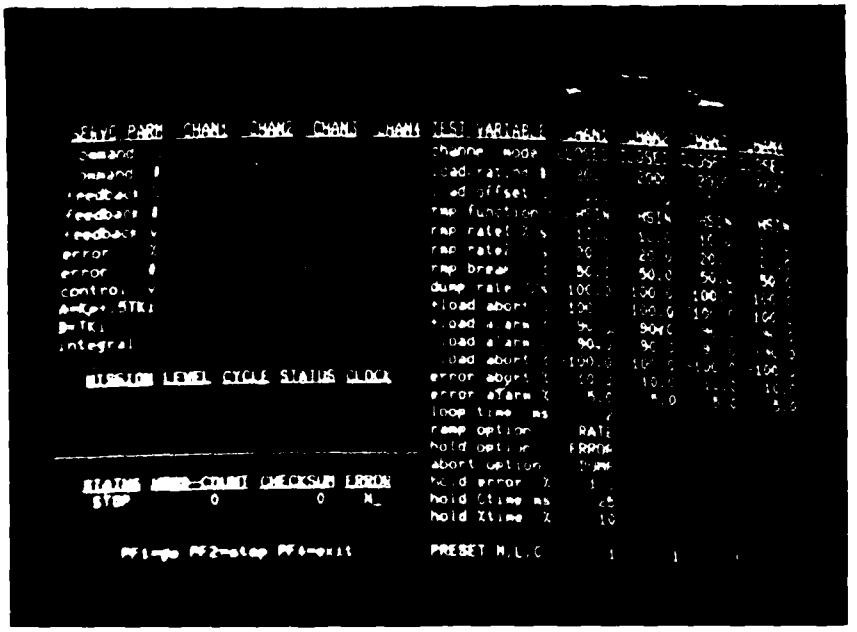


Figure 12. Master Download Display

(3) PF4 = exit: Entry of PF4 returns the program to the load mission state and display.

Download data as follows:

(1) Prepare the master computer for downloading.

(2) Verify the fiber optic system cabling and switch settings per Section 11 of the DIGITAL SERVOCONTROLLER SYSTEM, MAINTENANCE MANUAL.

(3) Enter PF1.

(4) Download data from the master computer.

(5) Successful reception of the data results in the display of WORD-COUNT and CHECKSUM. The ERROR will display N. Go to Step 9.

(6) If a checksum error has occurred, the ERROR will display Y.

(7) If the incorrect number of words was received (≠3240), no display will occur. Following a reasonable amount of time (>1 minute) after downloading was started and the display has not changed, enter PF2. The interface is terminated and the current WORD-COUNT and CHECKSUM are displayed. The ERROR will display Y.

(8) Repeat Steps 1 through 7 if necessary.

(9) Verify the STATUS to be STOP.

(10) Enter PF4.

5.5.2 Set Mission

The set mission state gives the operator the capability to structure the size of the mission to be executed. A mission name can also be assigned. Figure 13 shows the set mission display. Four options are available:

(1) PF1 = name: Entry of PF1 moves the cursor to the beginning location for the profile name. The keyboard is used to enter the name (alphanumeric). The name is terminated by entering a CR (carriage return). Following entry of the CR, the program is returned to the set mission state.

Setting the mission structure: The operator may set the number of missions and the number of levels within a mission as follows: Limit values for MISSION are 1 to 9999. Limit values for LEVEL are 1 to 500. Default values are MISSION = 1 and LEVEL = 500:

(a) Use the cursor control keys to position the cursor at the MISSION parameter.

(b) Use the numeric keypad to increment/decrement the MISSION parameter as desired:

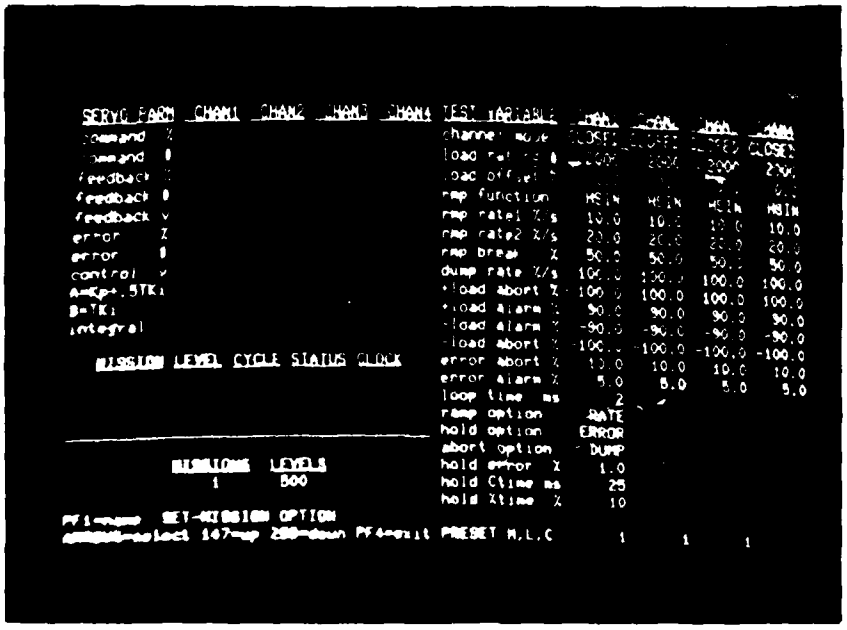


Figure 13. Set Mission Display

1 = increments the parameter x 1
4 = increments the parameter x 10
7 = increments the parameter x 100
2 = decrements the parameter x 1
5 = decrements the parameter x 10
8 = decrements the parameter x 100

Incrementing and decrementing will not be allowed if it results in the parameter exceeding its upper or lower limits. Data is entered upon entry on the keypad.

(2) PF4 = exit: Entry of PF4 returns the program to the load mission state and display.

5.5.3 Generate Profile

The generate profile state allows the operator to generate a load profile at the terminal. The display for this state is shown in Figure 14. Three options are available:

(1) PF1 = random entry: Entry of PF1 selects a new state which allows for the random generation of a load profile.

(2) PF2 = manual entry: Entry of PF2 selects a new state which allows for the manual entry of a load profile.

(3) PF4 = exit: Entry of PF4 returns the program to the load mission state and display.

5.5.3.1 Random Entry

The random entry state provides the facilities to generate a random profile given an exceedance level spectrum. Figure 15 shows the display for this state. For each channel, four parameters are defined.

POINT: The exceedance level is number 1-20. Each exceedance level is referred to as a point.

LOAD (%): The magnitude of the exceedance level. The range of values is -100.0% to 100% load.

LEVELS: The number of levels to be executed at the displayed exceedance level.

TOTAL: The sum of all of the LEVELS for each exceedance level in a given spectrum. The TOTAL cannot exceed 500. The total shown in the current number of levels defined for the spectrum.

To generate a random profile:

(1) Use cursor control keys to select the POINT parameter.

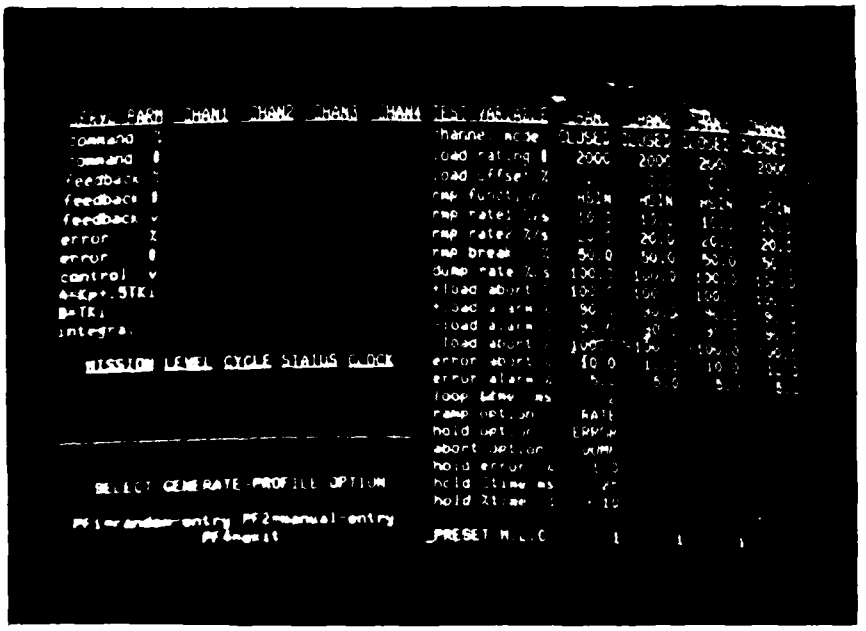


Figure 14. Generate - Profile Display

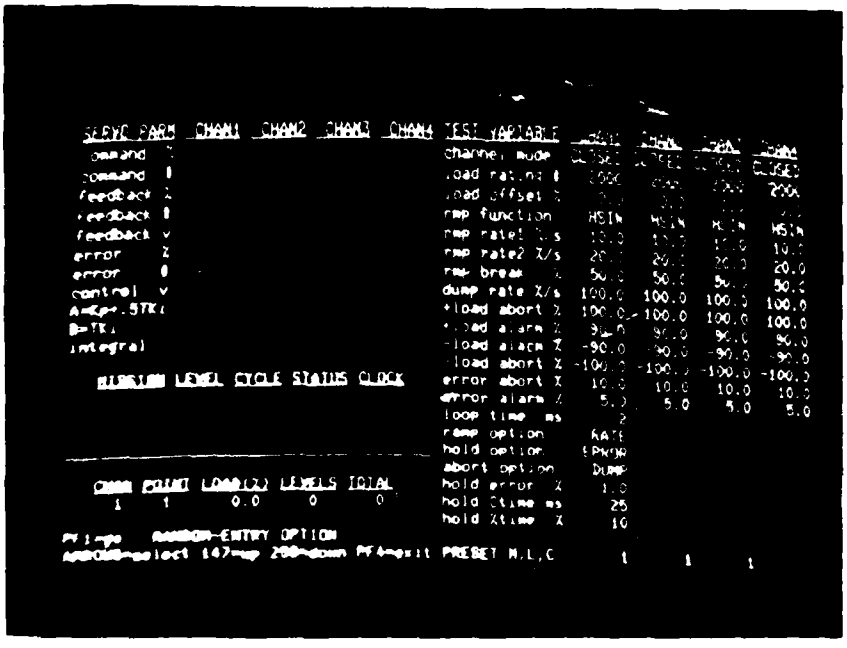


Figure 15. Random-Entry Display

(2) Use the numeric keypad to select the desired POINT (exceedance level.

1 = increments the parameter x 1
4 = increments the parameter x 10
2 = decrements the parameter x 1
5 = decrements the parameter x 10

Incrementing and decrementing will not be allowed if it results in the parameter exceedings its upper or lower limits. Data is entered upon entry on the keypad. The upper limit for POINT is 1.

(3) Use the cursor control keys to select the LOAD (%) parameter.

(4) Use the numeric keypad to enter the magnitude of the exceedance level.

1 = increments the parameter x 1
4 = increments the parameter x 10
7 = increments the parameter x 100
2 = decrements the parameter x 1
5 = decrements the parameter x 10
8 = decrements the parameter x 100

Incrementing and decrementing will not be allowed if it results in the parameter exceeding its upper or lower limits.

(5) Use the cursor control keys to select the LEVELS parameter.

(6) Use the numeric keypad to enter the number of levels to be executed at the specified exceedance level [see Step (4)].

PF4 = Exit: Entry of PF4 returns the program to the generate profile state and display.

5.5.3.2 Manual Entry

The manual entry state provides the functions necessary to manually enter a load profile from the terminal. Figure 16 shows the display for this state. For each load level, six parameters are entered.

CMD 1 % - Command set point in % of full scale for Channel 1. Limits are -100.0% to 100.0%. Default value is 0.0%

CMD 2 % - Command set point in % of full scale for Channel 2. Limits are -100.0% to 100.0%. Default value is 0.0%

CMD 3 % - Command set point in % of full scale for Channel 3. Limits are -100.0% to 100.0%. Default value is 0.0%

CMD 4 % - Command set point in % of full scale for Channel 4. Limits are -100.0% to 100.0%. Default value is 0.0%

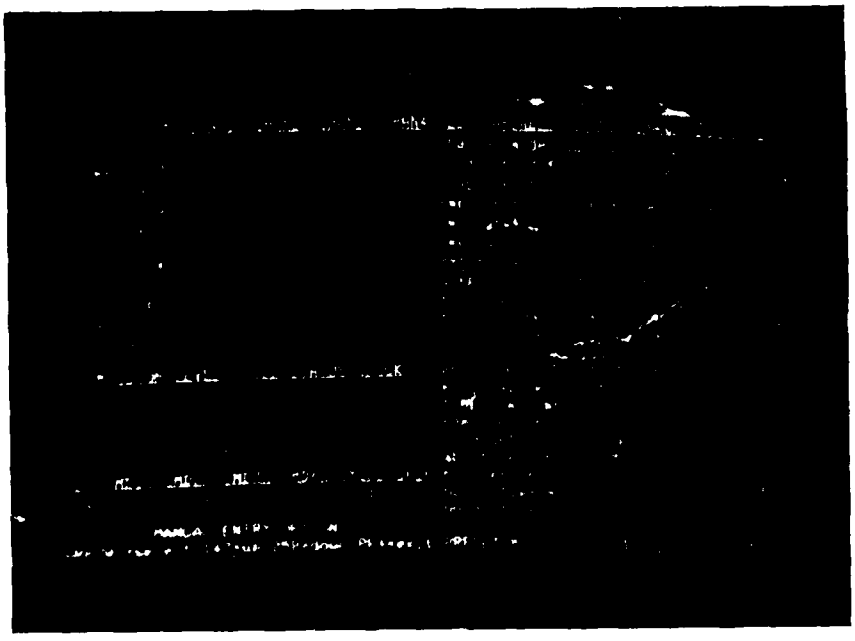


Figure 16. Manual Entry Display

CYCLE - The number of oscillations to be made between the previous load level and the current one. An oscillation is defined as going from the current level back to the previous level and returning to the current level. Not defined for Level = 1. Limits are 0 to 9999. The default value is 0.

SKIP or TIME - The final parameter in the manual entry state takes on different meanings depending on the ramp option selection (see Section 4.0). With the RATE option selected, SKIP is the parameter defined. SKIP defines the occurrence of the level during the execution of a mission. A positive number (n) entered for SKIP means that this level will be skipped every nth mission. A negative number (n) entered for SKIP means this level will be executed every nth mission. An entry of 0 means that this level will always be executed. Limits for this parameter are -99 to 99.

With the TIME option selected, TIME is the parameter defined. TIME defines the time to ramp from the previous level to the current level. A positive number is used to define the number as milliseconds. A negative number is used to define the number as seconds. Limits for this parameter are -3,276 to 32,767. The default value is 0 for either ramp option used.

Entry of a profile requires that the commands, CYCLEs and SKIPs or TIMEs be entered for the levels defined by the set mission parameter. Two options are available.

To enter profile data:

(1) Use cursor control keys to select the LEVEL parameter.

(2) Use numeric keypad to select the desired LEVEL.

1 = increments the parameter x 1
4 = increments the parameter x 10
7 = increments the parameter x 100
2 = decrements the parameter x 1
5 = decrements the parameter x 10
8 = decrements the parameter x 100

Incrementing and decrementing will not be allowed if it results in the parameter exceeding its upper or lower limits. Data is entered upon entry on the keypad. The upper limit for Level is defined in Set Mission.

(3) Use cursor control keys to select the command parameter for a desired channel (CMD 1 %, CMD 2 %, CMD 3 %, CMD 4 %).

(4) Use numeric keypad to select the desired command [see Step (2)].

(5) Use cursor control keys to select CYCLE or SKIP/TIME.

(6) Use numeric keypad to select desired values [see Step (2)].

PF4 = Exit: Entry of PF4 returns the program to the generate profile state and display.

5.6 On-DDC Mode

The on-ddc mode provides the functions necessary to run the system under the DCC algorithm. The operator may conduct the self-tuning routines or execute the mission. Figure 17 shows the display for this mode. In this mode, two "soft" switches are provided to control application of the DDC algorithm and the DDC algorithm integrator. Five options are available. However, there are important restrictions in their use. These are discussed below. The operator should understand these controls prior to performing an actual run.

(1) "/" = ddc switch: The "/" key is used as a control switch for the execution of the dcc algorithm. Initially, the system enters this mode in the OFF status. Entry of the "/" command begins execution of the DDC algorithm. The system STATUS changes to HOLD. The loop data begins to be updated at this time. The next entry of the "/" command turns the DDC algorithm off. The STATUS changes to OFF and the loop data updates halt. The "/" command is active whenever the system is in the on-ddc mode.

(2) Z = integration-switch: The Z key is used as a control switch for the integrator of the DDC algorithm. Initially the system enters this mode with the integrator as part of the algorithm. Entry of the Z command sets the B gain of the algorithm to zero and sets the integrator value to zero. The typical use of this switch is in start-up, when DDC is first applied to the system. The integrator is switched out of the algorithm to prevent a runaway condition. The next entry of the Z command restores the values of B and the integrator. The Z command is active whenever the system is in the ddc-on mode.

(3) PF1 = manual-tune: Entry of PF1 can only be made if the "/" command has been entered and the DDC algorithm is executing. That is the system is in the HOLD status. The entry of PF1 under the stated conditions selects a new state in which manual-tuning for each channel may be performed.

(4) PF2 - run-mission: Entry of PF2 can only be made if the "/" command has been entered and the DDC algorithm is executing. That is, the system is in the HOLD status. The entry of PF1 under the stated conditions selects a new state in which the loaded profile may be run.

(5) PF4 = Exit: Entry of PF4 can only be made if the DDC algorithm has been switched off by the "/" command. That is, the system is in the OFF status. The entry of PF4 under the stated conditions returns the program to the select controller mode state and display.

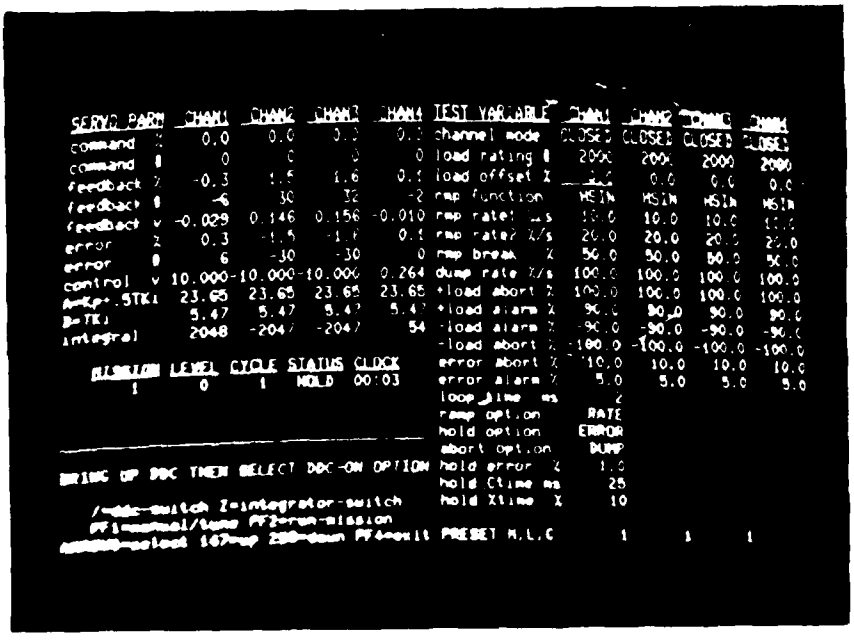


Figure 17. DDC-On Mode Display

5.6.1 Manual/Tune

The manual/tune state provides a mechanism which facilitates the manual tuning of each control loop. Figure 18 shows the display for this state. In this state the DDC algorithm is running and holding a command of 0% load for all of the active channels. The operator is given the options of selecting a channel and applying a programmed pulse or step input command. Operator controlled applications of the programmed pulses or steps will aid in the manual tuning of the system. Typically, the operator will program a channel for a pulse or step output followed by its application to the system. DDC is functioning throughout the application of the pulse or step. An ABORT option is available to return the system to a 0% load command. The operator enters three parameters which define the system output.

TUNE - This parameter defines the type of system output to be applied.

ON - A pulsed output to the servovalves is applied. The duration of the pulse is determined by the magnitude of the pulse, defined by LOAD GOAL (%) (see below), and the hold option in effect.

OFF - A step output to the servovalves is applied. The magnitude of the step is determined by the LOAD GOAL (%) parameter (see below). The servocontroller will maintain the magnitude of the step until a new step is entered or the ABORT command executed.

The default for this parameter is OFF.

CHAN - This parameter specifies the channel (1-4) to which the pulse/step is applied. The default value is 1 (Channel 1).

LOAD GOAL (%) - This parameter specifies the magnitude in % load of the pulse/step applied. The limit values are -100% to 100%. The default value is 0%.

CHAN GAIN - Undefined.

The following steps are required to program and apply an output to the servalves in this state:

(1) Setting the system output parameters:

(a) Use the cursor control keys to move the cursor to the TUNE parameter.

(b) Use the numeric keypad to toggle the TUNE parameter.

1 = toggles TUNE to ON
2 = toggles TUNE to OFF

(c) Use the cursor control keys to move the cursor the CHAN parameter.

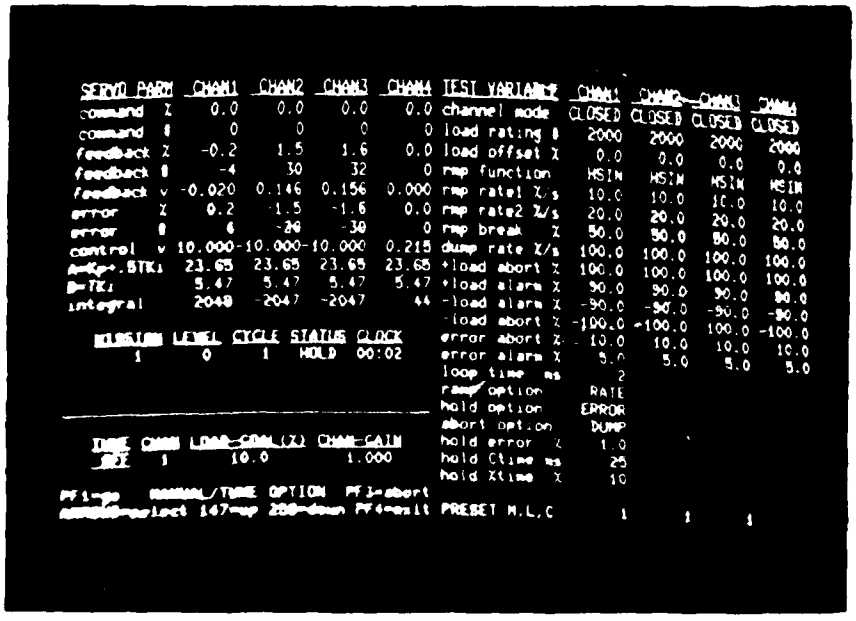


Figure 18. Manual-Tune Display

(d) Use the numeric keypad to select the desired channel.

1 = increments the parameter x 1
2 = decrements the parameter x 1

Incrementing and decrementing will not be allowed if it results in the parameter exceeding its upper or lower limits.

(e) Use the cursor control keys to move the cursor to the LOAD GOAL (%) parameter.

(f) Use the numeric keypad to select the desired magnitude of the pulse/step.

1 = increments parameter x 1
4 = increments parameter x 10
7 = increments parameter x 100
2 = decrements parameter x 1
5 = decrements parameter x 10
8 = decrements parameter x 100

Incrementing and decrementing will not be allowed if it results in the parameter exceeding its upper or lower limits.

(g) Enter PF1 = GO to apply the specified system output.

(h) Repeat any of the Steps 1-7 as required.

(i) Entry of PF4 returns the program to the DDC-ON mode only if all of the channels are holding at 0% load.

NOTE: PF3 = ABORT is available to immediately set the command level of all channels to 0% load. PF3 may be entered at any time in this state.

5.6.2 Run Mission

The run mission state provides for the execution of a loaded profile using the DDC algorithm. Figure 19 shows the display for this state. In this state the DDC algorithm is running and holding a command of 0% load for all of the active channels. The MISSION is initialized to 1 and LEVEL to 0. The STATUS is HOLD. Five options are available. However, there are important restrictions in their use. These are discussed below. The operator should understand these controls prior to performing an actual run.

Editing loop parameter data: The following loop parameters for each channel may be altered while in the run mission state.

(1) rmp rate 1 %/s
(2) rmp rate 2 %/s
(3) rmp break %
(4) dump rate %/s
(5) + load abort %
(6) + load alarm %

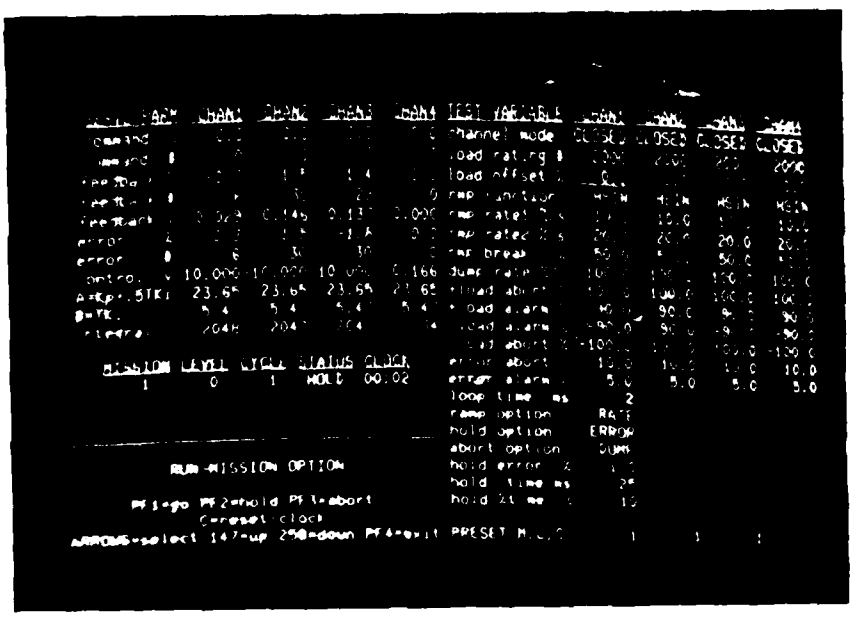


Figure 19. Run Mission Display

(7) - load abort %
(8) - load alarm %
(9) error abort %
(10) error alarm %
(11) loop time ms
(12) hold option
(13) abort option
(14) hold error %
(15) hold Ctime ms
(16) hold % time %
(17) Preset M,L,C

The cursor is initialized to be positioned over rmp rate 1 %/s for Channel 1. Alter loop, parameters as follows:

(1) Use the cursor control keys to move the cursor to the desired loop parameter.

(2) Use the numeric keypad to increment/decrement the selected parameter as desired.

1 = increments the parameter x 1
4 = increments the parameter x 10
7 = increments the parameter x 100
2 = decrements the parameter x 1
5 = decrements the parameter x 10
8 = decrements the parameter x 100

Incrementing and decrementing will not be allowed if it results in the parameter exceeding its upper or lower limits. Data is entered upon entry on the keypad. Editing of loop parameters may be performed at any time while the system is in the run mission state.

(1) PF1 = go: Entry of PF1 begins/resumes execution of the loaded profile for all active channels under the DDC algorithm if the following conditions are met:

(a) The STATUS is HOLD.

(b) The mission is not complete.

The STATUS changes to GO. The loop data is updated. Editing of the loop parameters is allowed.

(2) PF2 = hold: Entry of PF2 holds the current command level for all active channels. The STATUS changes to HOLD. The load profile is held as long as the system is in the HOLD status. The PF2 command is also used to resume a mission following an abort sequence.

(3) PF3 = abort: Entry of PF3 initiates an abort sequence. The abort sequence is defined by the abort-option parameter (DUMP, HOLD, LOCK). The DUMP option sets the command level to 0% and holds it there. The HOLD option holds the current command level. The LOCK

mechanically freezes the servovalves. The STATUS changes to ABORT. The operator is given the capability to resume the execution of a mission by:

(1) Enter PF2 (HOLD).
(2) Enter PF1 (GO).

This is subject to the conditions outlined for PF1 = go.

(4) PF4 = exit: Entry of PF4 is allowed if the following conditions are met:

(1) System status is (HOLD).
(2) Command levels for each channel is 0%.

Entry of PF4 returns the program to the on-ddc mode.

The GO status can be entered only by the entry of PF1.

The HOLD status can be entered by:

(1) Entry of PF2.
(2) End of mission execution.
(3) Entry into run mission state.

The ABORT status can be entered by:

(1) Entry of PF3.
(2) A load-abort condition.
(3) Initialization of an abort.

The status applies to all active channels.

U.S. GPO 559-065

END

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