

## **General Disclaimer**

### **One or more of the Following Statements may affect this Document**

- This document has been reproduced from the best copy furnished by the organizational source. It is being released in the interest of making available as much information as possible.
- This document may contain data, which exceeds the sheet parameters. It was furnished in this condition by the organizational source and is the best copy available.
- This document may contain tone-on-tone or color graphs, charts and/or pictures, which have been reproduced in black and white.
- This document is paginated as submitted by the original source.
- Portions of this document are not fully legible due to the historical nature of some of the material. However, it is the best reproduction available from the original submission.

**NASA Contractor Report 144876**

(NASA-CR-144876) PROPULSION/FLIGHT CONTROL  
INTEGRATION TECHNOLOGY (PROFIT) SOFTWARE  
SYSTEM DEFINITION (Boeing Aerospace Co.,  
Seattle, Wash.) 351 p HC A16/MF A01

N78-29102

Unclas

CSSL 01C G3/07 27243

**PROPULSION/FLIGHT CONTROL INTEGRATION TECHNOLOGY (PROFIT)  
SOFTWARE SYSTEM DEFINITION**

**Christopher M. Carlin and William J. Hastings**

**Boeing Aerospace Company  
Seattle, Washington**

**July 1978**

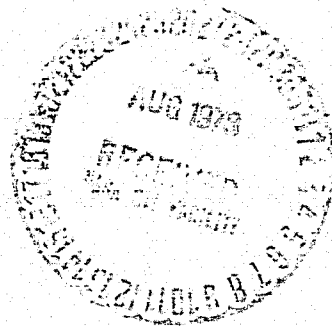
**Unlimited Distribution**

**NAS4 - 2391**

**NASA**

National Aeronautics and  
Space Administration

**Hugh L. Dryden Flight Research Center**  
PO Box 273  
Edwards, California 93523  
AC 805 258-3311



## NOTICE

When Government drawings, specifications, or other data are used for any purpose other than in connection with a definitely related Government procurement operation, the United States Government thereby incurs no responsibility nor any obligation whatsoever; and the fact that the government may have formulated, furnished or in any way supplied the said drawings, specifications, or other data, is not to be regarded by implication or otherwise as in any manner licensing the holder or any other person or corporation, or conveying any rights or permission to manufacture, use, or sell any patented invention that may in any way be related thereto.

This report was submitted by the Boeing Aerospace Company under Contract NAS4-2391. The effort was sponsored by NASA/Dryden Flight Research Center with T. Putnam as Program Manager. Mr. E. Tjonneland of the Boeing Aerospace Company was technically responsible for the work, with Christopher M. Carlin and William J. Hastings as principal investigators performing the detail work represented in this report.

1. Report No. NASA CR-144876	2. Government Accession No.	3. Recipient's Catalog No.	
4. Title and Subtitle  "PROFIT Software System Definition"		5. Report Date July 1978	6. Performing Organization Code
		8. Performing Organization Report No.	
7. Author(s) Christopher M. Carlin and William J. Hastings		10. Work Unit No.	
9. Performing Organization Name and Address Boeing Aerospace Company P. O. Box 3999 Seattle, WA 98124		11. Contract or Grant No. NAS4-2391	
		13. Type of Report and Period Covered Contractor Report - Topical	
12. Sponsoring Agency Name and Address National Aeronautics & Space Administration Washington, D.C. 20546		14. Sponsoring Agency Code	
15. Supplementary Notes Project Manager: Terrill W. Putnam NASA Dryden Flight Research Center			
16. Abstract  The Propulsion Flight Control Integration Technology (PROFIT) program is designed to develop a flying testbed dedicated to controls research. This document defines the control software for PROFIT. Maximum flexibility, needed for long term use of the flight facility, is achieved through a modular design. The Host program, defined in Section 4.0, processes inputs from the telemetry uplink, aircraft central computer, cockpit computer control and plant sensors to form an input data base for use by the control algorithms. The control algorithms, programmed as application modules, process the input data to generate an output data base. The Host program formats the data for output to the telemetry downlink, the cockpit computer control, and the control effectors. Two applications modules are defined - the bill of materials F-100 engine control and the bill of materials F-15 inlet control.			
17. Key Words (Suggested by Author(s)) Integrated controls      Flight control Flight tests Software Digital control Propulsion control		18. Distribution Statement Unclassified - Unlimited STAR Category:07	
19. Security Classif. (of this report) Unclassified	20. Security Classif. (of this page) Unclassified	21. No. of Pages 350	22. Price*

\*For sale by the National Technical Information Service, Springfield, Virginia 22161

## TABLE OF CONTENTS

		PAGE
	List of Illustrations	ix
	List of Tables	xiii
	Unit Definitions and Metric Conversions	xvi
1.0	Scope	1
1.1	Identification	1
1.2	Functional Summary	1
2.0	Applicable Documents	3
3.0	Programming/Coding Ground Rules	4
3.1	Shift Operations	4
3.2	Relative Address Specification	4
3.3	Double-Precision Operations and Data Items	4
3.4	Multilevel Indirect Addressing	4
3.5	Data Items	5
3.6	Entry Points and Branch Locations	5
3.7	Function and Device Codes	5
3.8	Arithmetic Scaling	5
3.9	Linkage	6
3.10	Documentation	6
3.11	Octal-Decimal Integer Specification	8
3.12	Extended Addressing	8
3.13	Use of Output Data Base	9
3.14	Standard Modules	9
4.0	Host Program Definition	10
4.1	Real Time Executive Definition	10
4.1.1	Program Sequence	12
4.1.1.1	Minor Cycle Execution Sequence	12
4.1.2	Status and Engage Logic	19
4.1.3	Interrupts	22
4.1.3.1	DCU Power Failure Interrupt	22
4.1.3.2	DCU Power Recovery Interrupt	22
4.1.3.3	Real Time Clock Interrupt	26
4.1.3.4	IFU Power Failure Interrupt	26

## TABLE OF CONTENTS (Cont)

		PAGE
4.1.3.5	Central Computer Bus Failure Interrupt	29
4.1.3.6	Recorder Word Synch Interrupt	29
4.1.3.7	Recorder Data Request Interrupt	29
4.1.3.8	Uplink Data Interrupt	33
4.1.3.9	Uplink Frame Synch Interrupt	37
4.1.3.10	Buzz Interrupt	39
4.1.3.11	Fill Interrupt	39
4.1.3.12	DMA Interrupt	39
4.1.3.13	Input Bus Interrupt	39
4.2	Host Program Data Base	41
4.2.1	Input Data Base	41
4.2.2	Output Data Base	41
4.2.3	Common Constants	69
4.3	Host Program Scratch Pad	69
4.4	Input Processing Definition	74
4.4.1	Analog Transducers	74
4.4.1.1	Minor Cycle 7 Processing	74
4.4.1.2	Minor Cycle 12 Processing	75
4.4.1.3	Thermocouple Data	75
4.4.2	Resolvers	81
4.4.3	Tachometer Data Processing	85
4.4.4	Quartz Crystal Transducers	87
4.4.5	Central Computer Data	90
4.4.6	Input Discretes	90
4.5	Output Processing Definition	90
4.5.1	First Ramp	90
4.5.2	Third Ramp	94
4.5.3	Bypass Door	94
4.5.4	Compressor Inlet Variable Vanes	94
4.5.5	Rear Compressor Variable Vanes	94
4.5.6	Gas Generator Fuel Flow	101

## TABLE OF CONTENTS (cont.)

		PAGE
4.5.7	A/B Core Fuel Flow	101
4.5.8	A/B Duct Fuel Flow	101
4.5.9	Segment and Sequence Valve	101
4.5.10	Exhaust Nozzle	107
4.5.11	Customer Bleed	107
4.5.12	Control Augmentation System	107
4.5.13	Cockpit Displays	107
4.5.14	Output Discretes	107
5.0	BOM Engine Control Definition	115
5.1	Engine Electronic Control	116
5.1.1	Common Routines	125
5.1.1.1	Filter	125
5.1.1.2	Proportional Plus Derivative Compensation	125
5.1.2	High Frequency Calculations	131
5.1.2.1	Speed Filters	131
5.1.2.2	CIVV Control	131
5.1.2.3	Nozzle Trim Loop	131
5.1.2.4	PLAP limiting Solenoid Delay Logic	132
5.1.2.5	PLA Trim Loop	132
5.1.2.6	Stall Recovery	132
5.1.2.7	Nozzle and PLA Trim Integers	132
5.1.3	Intermediate Frequency Calculations	151
5.1.3.1	Rocket Fire Response to Stall Recovery	151
5.1.3.2	Transient Reset	151
5.1.3.3	N2 High Rate Solenoid	151
5.1.3.4	PLA Uptrim Inhibit	151
5.1.3.5	N1 Setpoint Calculations	152
5.1.4	Low Frequency Calculations	165
5.1.4.1	Burner Pressure Filters	165
5.1.4.2	PLAP Limiting Logic	165
5.1.4.3	Derivative Gain Bias	165

## TABLE OF CONTENTS (Cont.)

		PAGE
5.1.4.4	Pb Input to Minimum PLAP Loop	165
5.1.4.5	Pb Input to PLA Trim Loop	166
5.1.4.6	N1 Input to Minimum PLAP Loop	166
5.1.4.7	Minimum PLAP Loop	166
5.1.4.8	T2 Compensation and Tables	166
5.1.4.9	VMAX Logic	167
5.1.4.10	FTIT Input to PLA Trim Loop	167
5.1.4.11	Upmatch Logic	167
5.1.4.12	N2 Setpoint Calculation	167
5.1.4.13	Airflow Cutback Multiplier	167
5.2	Unified Fuel Control	198
5.2.1	Gas Generator	198
5.2.1.1	Power Lever Logic	198
5.2.1.2	T2.5 Compensation	199
5.2.1.3	Fuel Flow	199
5.2.1.4	RCVV Control	199
5.2.1.5	Compressor Bleed	200
5.2.2	Afterburner	218
5.2.2.1	Nozzle Area	218
5.2.2.2	Segment Sequence Valve	218
5.2.2.3	Fuel Flow	219
5.3	Control Executive	231
5.3.1	Fill Interrupt Processing	231
5.3.2	Minor Cycle Calculations	232
5.3.3	Major Cycle Calculation Order	232
5.4	Data Base	236
5.4.1	Schedules	236
5.4.2	Constants	236
5.4.3	Variables	236
5.4.4	Table Lookup Routines	237
5.4.4.1	Univariate Table Lookup	237
5.4.4.2	Bivariate Table Lookup	237



## TABLE OF CONTENTS (Cont.)

		PAGE
6.0	BOM Inlet Control Definition	299
6.1	Control Description	299
6.1.1	Freestream Pressure Ratio Calibration and Filter	299
6.1.2	Mach Block and Mach Number to the Engine Control	299
6.1.3	First Ramp Control	300
6.1.4	Third Ramp Control	300
6.1.5	Bypass Control	301
6.1.6	Buzz and Supercritical Test	301
6.2	Control Executive	315
6.2.1	High Rate Calculations	315
6.2.2	Major Cycle Calculations	315
6.3	Data Base	317
6.3.1	Schedules	317
6.3.2	Constants	317
6.3.3	Variables	317
6.3.4	Table Lookup Routines	318

## LIST OF ILLUSTRATIONS

FIGURE		PAGE
3.10-1	Typical Data Base Summary Format	7
4.0-1	PROFIT Software Functional Configuration	11
4.1-1	PROFIT Executive Configuration	13
4.1-2	Major Cycle Executive Sequence	14
4.1-3	Minor Cycle Executive Logic	15
4.1-4	Real Time Executive Sequence	18
4.1-5	Status and Engage Logic	20
4.1-6	Power Failure Interrupt Processing	25
4.1-7	Power Recovery Interrupt Processing	25
4.1-8	Minor Cycle Executive (Real Time Clock Interrupt)	28
4.1-9	Central Computer Bus Failure Interrupt	30
4.1-10	Recorder Word Synch Processing	31
4.1-11	Recorder Data Word Processing	32
4.1-12	Downlink Timing Diagram	34
4.1-13	Uplink Data Interrupt	35
4.1-14	Uplink Interface Timing Diagram	36
4.1-15	Uplink Frame Synch Interrupt	38
4.1-16	Fill Interrupt Processing	40
4.2-1	ICP Data Base Structure	42
4.2-2	Sector 0 Location Allocation	43
4.2-3	Input Data Base Structure	44
4.4-1	Analog Input Data Processing and Gross Failure Detection	76
4.4-2	Thermocouple Processing	80
4.4-3	PLA Resolver Calibration	82
4.4-4	Resolver Processing	83
4.5-1	First Ramp Servo	95
4.5-2	Third Ramp Servo	96
4.5-3	Bypass Door Servo	97

## LIST OF ILLUSTRATIONS (Cont.)

FIGURE		PAGE
4.5-4	CIVV Servo Loop	99
4.5-5	RCVV Servo Loop	100
4.5-6	Main Fuel Servo	102
4.5-7	A/B Core Fuel Flow Servo	104
4.5-8	A/B Duct Fuel Flow Servo	105
4.5-9	Segment and Sequence Valve Servo Loop	106
4.5-10	Nozzle Servo	108
4.5-11	Pitch CAS Command Output Processing	109
4.5-12	Roll CAS Command Output Processing	110
4.5-13	Cockpit Analog Displays	111
5.1-1	Nozzle Area Trim Loop Block Diagram	117
5.1-2	PLA Trim Loop Block Diagram	119
5.1-3	Minimum PLAP Loop Block Diagram	121
5.1-4	CIVV and Solenoid Control Block Diagram	123
5.1-5	Filter Block Diagram	126
5.1-6	FTIT Filter	126
5.1-7	Proportional Plus Derivative Compensation	128
5.1-8	Special DBG Modification for T2 and FTIT	130
5.1-9	Speed Filters and N2 Rate	133
5.1-10	CIVV Control Loop	135
5.1-11	Nozzle Area Trim Loop	137
5.1-12	PLAP Limiting Solenoid Delay Logic	141
5.1-13	PLA Trim Loop	143
5.1-14	Stall Recovery	147
5.1-15	Integrators	149
5.1-16	Rocket Fire Logic	153
5.1-17	Transient Reset Logic	155
5.1-18	N2 High Rate Solenoid	157
5.1-19	PLA Uptrim Inhibit	160
5.1-20	N1 Setpoint Calculation	162

## LIST OF ILLUSTRATIONS (Cont.)

FIGURE		PAGE
5.1-21	Burner Pressure Filters	168
5.1-22	PLAP Limiting Logic	170
5.1-23	Derivative Gain Bias	172
5.1-24	PB Input to the Minimum PLAP Loop	174
5.1-25	PB Input to PLA Trim Loop	176
5.1-26	N1 Input to Minimum PLAP Loop	176
5.1-27	Minimum PLAP Loop	179
5.1-28	T2 Compensation and Tables	185
5.1-29	VMAX Logic	187
5.1-30	FTIT Input to the PLA Trim Loop	189
5.1-31	Upmatch Logic	191
5.1-32	N2 Setpoint	194
5.1-33	Airflow Cutback Multiplier	196
5.2-1	Power Level Angle Logic	201
5.2-2	T25 Compensation	207
5.2-3	Gas Generator Fuel Flow Loop	209
5.2-4	Rear Compressor Variable Vane Schedule	212
5.2-5	RCVV Logic	213
5.2-6	Compressor Start Bleed	216
5.2-7	Nozzle Area	220
5.2-8	Basic Jet Area Schedule	222
5.2-9	Segment Sequence Valve	224
5.2-10	Afterburner Fuel Flow Logic	228
5.2-11	Afterburner Fuel Flow/Burner Pressure	229
5.3-1	Gas Generator Calculation Order	233
5.3-2	Afterburner Calculation Order	235
6.1-1	Freestream Pressure Ratio Calibration and Filter	302
6.1-2	Mach Block and Mach Number to Engine Number	304

LIST OF ILLUSTRATIONS (Cont.)

FIGURE		PAGE
6.1-3	First Ramp Control	306
6.1-4	Third Ramp Control	309
6.1-5	Bypass Door Control	311
6.1-6	Supercritical Test	313
6.2-1	Inlet Control Calculation Order	316

## LIST OF TABLES

TABLE		PAGE
1.1-1	System Element Configuration Relationships	2
4.1-1	Priority Interrupt Assignments	23
4.1-2	Initialization Data Base	27
4.2-1	Raw Input Data Base	45
4.2-2	Input Discrete Word	51
4.2-3	Raw Input Data Base (Uplink)	52
4.2-4	Calibrated Input Data Base	53
4.2-5	Calibrated Control Output Data Base	63
4.2-6	Formatted Control Output Data Base	64
4.2-7	Analysis Data Base Menu	65
4.2-8	Common Constants	70
4.3-1	Host Scratch Pad	71
4.4-1	Tachometer Interfaces	86
4.4-2	Quartz Crystal Transducer Failure Response	89
4.4-3	Quartz Crystal Transducer Calibration Data	89
4.5-1	D/A Channel Allocation	91
4.5-2	Type NWC Servo Valve Characteristics	92
4.5-3	Engine Type PW/B Servo Valve Characteristics	93
4.5-4	Fuel Valve Calibration	103
4.5-5	Output Discrete Word Definition	112
5.1-1	Filter Data	127
5.1-2	Proportional Plus Derivative Routine Data	129
5.1-3	Block 1.2.1 Data	134
5.1-4	Block 1.2.2 Data	136
5.1-5	Block 1.2.3 Data	140
5.1-6	Block 1.2.4 Data	142
5.1-7	Block 1.2.5 Data	146
5.1-8	Block 1.2.6 Data	148
5.1-9	Block 1.2.7 Data	150
5.1-10	Block 1.3.1 Data	154

## LIST OF TABLES (Cont.)

TABLE		PAGE
5.1-11	Block 1.3.2 Data	156
5.1-12	Block 1.3.3 Data	159
5.1-13	Block 1.3.4 Data	161
5.1-14	Block 1.3.5 Data	164
5.1-15	Block 1.4.1 Data	169
5.1-16	Block 1.4.2 Data	171
5.1-17	Block 1.4.3 Data	173
5.1-18	Block 1.4.4 Data	175
5.1-19	Block 1.4.5 Data	177
5.1-20	Block 1.4.6 Data	178
5.1-21	Block 1.4.7 Data	183
5.1-22	Block 1.4.8 Data	186
5.1-23	Block 1.4.9 Data	188
5.1-24	Block 1.4.10 Data	190
5.1-25	Block 1.4.11 Data	193
5.1-26	Block 1.4.12 Data	195
5.1-27	Block 1.4.13 Data	197
5.2-1	Block 2.1.1 Data	205
5.2-2	Block 2.1.2 Data	208
5.2-3	Block 2.1.3 Data	211
5.2-4	Block 2.1.4 Data	215
5.2-5	Block 2.1.5 Data	217
5.2-6	Block 2.2.1 Data	223
5.2-7	Block 2.2.2 Data	227
5.2-8	Block 2.2.3 Data	230
5.4-1	Control Schedules	238
5.4-2	Control Schedule Data	239
5.4-3	Program Constants	283
5.4-4	Compute Interval Dependent Constants	288
5.4-5	Program Variables	289
5.4-6	BOM Engine Control Inputs	297
5.4-7	BOM Engine Control Commands	298

LIST OF TABLES (Cont.)

TABLE		PAGE
6.1-1	Block 6.1.1 Data	303
6.1-2	Block 6.1.2 Data	305
6.1-3	Block 6.1.3 Data	308
6.1-4	Block 6.1.4 Data	310
6.1-5	Block 6.1.5 Data	312
6.1-6	Block 6.1.6 Data	314
6.3-1	Control Schedules	319
6.3-2	Control Schedule Data	320
6.3-3	Program Constants	332
6.3-4	Program Variables	333
6.3-5	BOM Inlet Control Inputs	335
6.3-6	BOM Inlet Control Outputs	336



## UNIT DEFINITIONS AND METRIC CONVERSIONS

### o UNIT DEFINITIONS

The units used in the data base tables (sections 4.1, 4.2, 4.3, 5.4, 6.3) are defined as follows.

DEG	Degrees
DED F	Degrees Farenheit
MNC	Minor Cycles
MJC	Major Cycles
%AJ	% Nozzle Area Variation
PPH	Pounds Mass per Hour
PPS	Pounds Mass per Second
PSI	Pounds Force per Square Inch
RPM	Revolutions per Minute
RU	Ratio Units

$$- \frac{\text{Fuel Flow in PPH}}{\text{Burner Pressure in PSI}}$$

SEC	Seconds
STEPS	Stepper Motor Steps

$$S * \text{SEC} / \% \text{MJC} \quad \left( \frac{\text{Stepper Motor Steps}}{\% \text{ Nozzle Area Variation}} \right) \left( \frac{\text{Seconds}}{\text{Major Cycle}} \right)$$

### o METRIC CONVERSIONS

Deg F	=	9/5 (Deg C) + 32
1 Foot	=	0.3048 Meter
1 Pound Mass	=	0.4536 Kilogram
1 PSI	=	6.8948 Kilopascals

## 1.0 SCOPE

This document defines the software configuration required to operate the HDC 601 C Digital Computer Unit (DCU) as an element of the Propulsion Flight Control Integration Technology System (PROFITS) when that system is used as a real time controller either aboard the PROFIT F-15 aircraft or in simulated flight conditions.

### 1.1 IDENTIFICATION

The computer program defined by this document is designated Integrated Control System Computer Program (ICP) and is controlled by an appropriate contractor part number. Because of the flexibility inherent in PROFITS, and the various research goals identified for the system an array of ICP variants will exist. Table 1.1-1 identifies the variant designators, usage, and status as of the indicated release, and their relations to hardware and data system configuration variations. Use of appropriate document releases and hardware configurations is imperative at all times.

### 1.2 FUNCTIONAL SUMMARY

The ICP shall perform the computations necessary to monitor and control the elements of PROFITS and systems interfaced with PROFITS.

The ICP shall process inputs from the telemetry uplink, aircraft central computer, cockpit computer control (CCC), and plant sensors to form an input data base for use by control algorithms. The control algorithms shall process the input data to generate an output data base which the ICP shall format for output to the telemetry downlink (PCM), the CCC, and control effectors. The ICP shall operate in a real time priority interrupt environment.

TABLE 1.1-1 - SYSTEM ELEMENT CONFIGURATION RELATIONS

ICP RELEASE	REL PROFITS DATE CONFIGURATION	DATA SYSTEM CONFIGURATION	TEST FACILITY	TEST PURPOSE	SIMULATION RELEASE	COMMENTS
0	1/15/79 BASIC	BASIC	DFRC	SYSTEM INTEGRATION	INITIAL	PHASE 1A

## 2.0 APPLICABLE DOCUMENTS

The following documents, of the exact issue shown, form a part of this specification to the extent specified herein. Documents listed as primary below shall supercede secondary documents. Conflicts between primary documents, if encountered, represent a system anomaly and shall be eliminated by hardware, software, or document revision as required.

### Primary Documents

#### BOEING

D251-10101	PROFIT Hardware System Definition Document
D251-10102	PROFIT Simulation Interface Definition Document
D251-10103	PROFIT Test Plan Document
D251-10104	PROFIT Data Acquisition and Processing Definition Document

### Secondary Documents

#### Boeing Documents

D251-10006	Interface Control Document for the Digital Propulsion Control Unit (Integrated Propulsion Control System)
------------	---

#### Honeywell Documents

DS24712-01	Detail Specification for the Digital Propulsion Control Unit (System), Part I, II
DS24713-01	Detail Specification for the Digital Computer System, Part I, II
DS24714-01	Detail Specification for the Computer Monitor Unit, Part I, II
DS24715-01	Detail Specification for the Interface Unit, Part I, II

### 3.0 PROGRAMMING/CODING GROUND RULES

In order to assure compatibility between CPC's the following ground rules are established. Deviations may be allowed, but shall be coordinated with the software integrator prior to implementation.

#### 3.1 SHIFT OPERATIONS

All predetermined shift operations shall be specified by the appropriate instruction mnemonic and an unsigned decimal integer denoting the number of shift positions.

#### 3.2 RELATIVE ADDRESS SPECIFICATION

Relative and self-relative memory address specifications, in the absence of indexing, shall not exceed a relative location count of ten. The relative count shall be specified as a signed decimal integer.

#### 3.3 DOUBLE-PRECISION OPERATIONS AND DATA ITEMS

The double-precision operation mnemonics shall be employed whenever a double-precision operation is intended. All single-precision and double-precision data items shall address the most significant word. The most significant word of a double-precision data item shall occupy an even addressed memory location.

#### 3.4 MULTILEVEL INDIRECT ADDRESSING

In general, multilevel indirect addressing shall be limited to two levels in the absence of indexing and one level if pre-indexing is employed. If necessary, these limits may be exceeded. However, any and all exceptions shall be justified and described within this document, or its equivalent, and shall be further identified and described through source program annotation.

### 3.5 DATA ITEMS

All programmer-defined labels used to identify variable and constant data items shall be related, whenever possible to the prosiac and mathematical symbology, terminology, and nomenclature set forth in this document. Labels identifying scratch pad memory locations assigned to temporary data storage shall clearly indicate that assignment.

### 3.6 ENTRY POINTS AND BRANCH LOCATIONS

All programmer-defined labels used to identify subfunction entry points within the instruction memory shall be related to the functional terminology or nomenclature of the subfunction.

### 3.7 FUNCTION AND DEVICE CODES

Programmer-defined symbolic assembly parameters shall be employed to designate the device and function codes for all I/O operations. Whenever possible, the symbology shall be descriptive and indicative of the device nomenclature and the function performed.

### 3.8 ARITHMETIC SCALING

Whenever possible, a binary scale factor shall be associated with each arithmetic data item. The implied radix point shall be positioned between the sign and most significant bit of the data word. The sign and magnitude of the binary scale factor,  $n$ , shall be such that the relationship between the true value,  $X$ , and its computer representation,  $x$ , is

$$X = x \cdot 2^n \quad (-1.0 < x < 1.0)$$

where necessary input/output routines will convert or format raw data to or from binary scaling to permit the main program data base to be entirely binary scaled.

### 3.9 LINKAGE

The DAP16M2 loader/assembler default mode assigns intersector links to sector 0. The DFRC assembly procedure assigns them to the sector in which they are used. Therefore modules must be coded leaving sufficient space in sectors for the necessary intersector links.

### 3.10 DOCUMENTATION

CPC documentation will provide block diagrams and/or flow charts of all program components in a format suitable for inclusion in this document. In addition, the data base for each program component shall be summarized in tabular form organized as shown in Figure 3.10-1. Other formats containing the same information are acceptable if the programming organization finds them more convenient. Consider however that standardization of format will benefit the overall program user substantially. Note also that clever use of either the assembly or simulation program data bases should permit some automation of this documentation.

Source coding commenting shall provide as a minimum the following:

1. Each major block of code shall be referenced to the relevant flow chart or block diagram via a 3 or 4 digit reference number and the purpose of the code block shall be identified.
2. Parameters and variables shall be identified at their permanent locations and their scale factors shall be indicated.
3. Scale factors shall be noted as variables and constants are introduced in computations and the scale factors of intermediate results shall be noted whenever they change. The scale factor of calculation results shall be indicated when they are stored.

## CONTROL INPUT INTERFACES

DESCRIPTION	VARIABLE <sup>1</sup>	MEMORY <sup>2</sup> LOCATION	SCALE FACTOR	UNITS
LOW ROTOR SPEED	N1		B14	RPM
HIGH ROTOR SPEED	N2			RPM
BURNER PRESSURE	PB			PSIA
INLET TEMPERATURE	T2			°F
FAN EXIT TEMPERATURE	T25			°F
FAN TURBINE EXIT TEMP	FTIT			°F
AIRPLANE MACH NUMBER	MN			
POWER LEVER ANGLE	PLA			DEG
CIVV	CIVP			
SEGMENT/SEQUENCE VALVE POS	SSVP			
FTIT TRIM	FTRM			
N2 TRIM	NTRM			
IDLE SPEED TRIM	IDTM			
INTERMEDIATE TRIM	INTM			
AUGMENTOR RATIO UNITS TRIM	ARUT			
VMAX/IDLE AREA RESET	IAR			
SQUAT SWITCH	SQWS			

<sup>1</sup> OR CONSTANT

<sup>2</sup> IF DATA ARE STORED IN BLOCKS ONLY INITIAL LOCATION IS NECESSARY.

*Figure 3.10-1. Typical Data Base Summary Format*



4. Comments on the intent of code identifying purpose of logical operations and intermediate results should be provided to a level to permit rapid program modification by persons other than the original programmer.

### 3.11 OCTAL-DECIMAL INTEGER SPECIFICATION

In general, all integer values specified in the operand field of an assembly language symbolic source line shall be specified in decimal. Exceptions include but are not limited to, specification of hardware dedicated memory location addresses, program origins, and symbolic definitions of external device codes, function codes and logic masks.

### 3.12 EXTENDED ADDRESSING

When the memory size exceeds 16K, it is necessary to enter the extend mode to address the full memory. The extend mode changes the interpretation of the index bit of the indirect address word which becomes part of a 15-bit address. Only one level of indexing is possible in the extend mode. It is specified by bit 2 of the instruction word and is always the final operation in generating the effective address.

The extended mode indicator (EXTMD) is set or reset by the generic instructions EXA or DXA, respectively, and by an OTK, set if  $(A)_3$  is a one, reset if a zero. It is also set by the occurrence of a program interrupt.

Because memory reference instructions of the form MR \* XXXX,1 are interpreted as preindexing in DXA and post indexing in extended mode they shall only be used after formal review and coordination with the systems integrator. The machine will normally operate in extended mode. It is the applications programmer's responsibility to clearly identify requirements to the contrary.

### 3.13 USE OF OUTPUT DATA BASE

Each application module will transfer all data to be output to the control effectors to the output data base at completion of application module execution.

### 3.14 STANDARD MODULES

As code develops standard MACRO modules will be developed and made available to applications programmers. These MACROS include:

1. Univariate Function Linear Interpolation
2. Bivariate Function Linear Interpolation
3. Square Root
4. First Order Lag (EULER)

## 4.0 HOST PROGRAM DEFINITION

The ICP consists of a Host Program (HP) defined in this section and research user application modules (AM) defined in the following sections. The minimum ICP consists of the HP which by itself supports Research Digital Control hardware functional test. The addition of at least one AM to the HP results in useful research software.

The configuration functional concept is shown in Figure 4.0-1. The Host Program provides all data input/output functions and executive functions including interrupt processing, program execution sequence, and status and engage functions. In general, the HP includes all failure detection and response functions necessary to insure system integrity. Research modules may incorporate additional failure mode response features as required by research goals.

This host program definition is being released at a time when the system is undergoing radical change. At this point it represents a structural concept and an assembly of anticipated features. It should not be construed or critiqued as a final design.

### 4.1 REAL TIME EXECUTIVE DEFINITION

The Real Time Executive (RTE) provides program sequencing, performs status and engage logic functions, and processes real time interrupts. In order to minimize executive changes on addition or removal of application modules executive interface with the application modules is limited to calling the module as a subprogram and providing interrupt processing as specified by the AM author. Thus, as a goal, modules shall be designed to be executed at a 60 millisecond interval. The executive shall access modules by executing a JST to a specified entry point and the module shall return control to the executive through a JMP\* on the entry point. The executive will sequence input and output activities

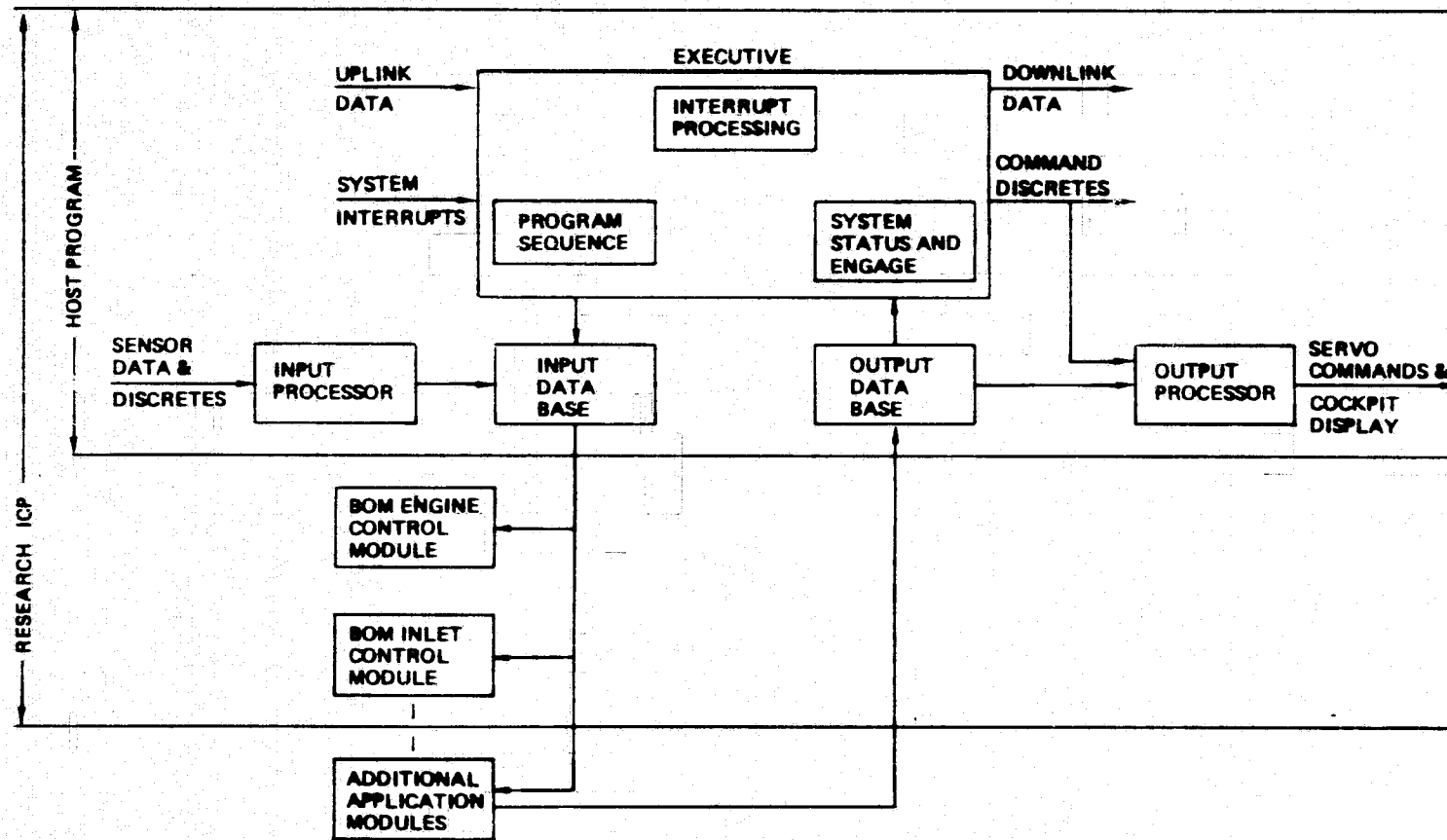


Figure 4.0-1. PROFIT Software Functional Configuration

as indicated in Figure 4.1-1. Application module requirements for specific locations within this sequence, data not available in the data base, or for execution at rates other than once per 60 msec shall be identified in the research module definition and as early as possible in the research module design cycle.

The executive provides for sequential execution of control algorithms and experiment software in the real time interrupt environment. The real time clock interrupt (PIL01) is used to produce a series of 5 millisecond long minor cycles, 12 of which constitute a major cycle corresponding to the basic control sample interval of 60 msec.

#### 4.1.1 Program Sequence

As shown in Figure 4.1-1, a number of program modules are required to provide proper program sequencing. The major cycle executive (MJCE) sequences 60 msec processing as indicated in Figure 4.1-2. The MJCE is entered from the minor cycle executive (MNCE) on completion of minor cycle "one" minor cycle processing by stuffing the PIL01 address with the MJCE entry point. The MJCE then sequences through the indicated subroutines, Figure 4.1-2. Processing is interrupted by repetitive asynchronous interrupts from the data system and by the real time clock interrupt. Each real time clock interrupt initiates execution of the minor cycle executive, Paragraph 4.1.3.3. Because the MNCE requires substantial execution time critical parameters (A, B, X & Keys) are saved for eventual return and interrupts are enabled to permit data interrupts to be honored during MNCE execution. All MNCE returns pass through the real time clock interrupt routine to restore A, B, X and Keys and return to the main program.

##### 4.1.1.1 Minor Cycle Execution Sequence

As shown in Figure 4.1-3, the minor cycle counter (EMCC) is incremented and EMCC is compared to 13.  $EMCC > 13_{10}$  implies that the previous major cycle was not completed and hence results in

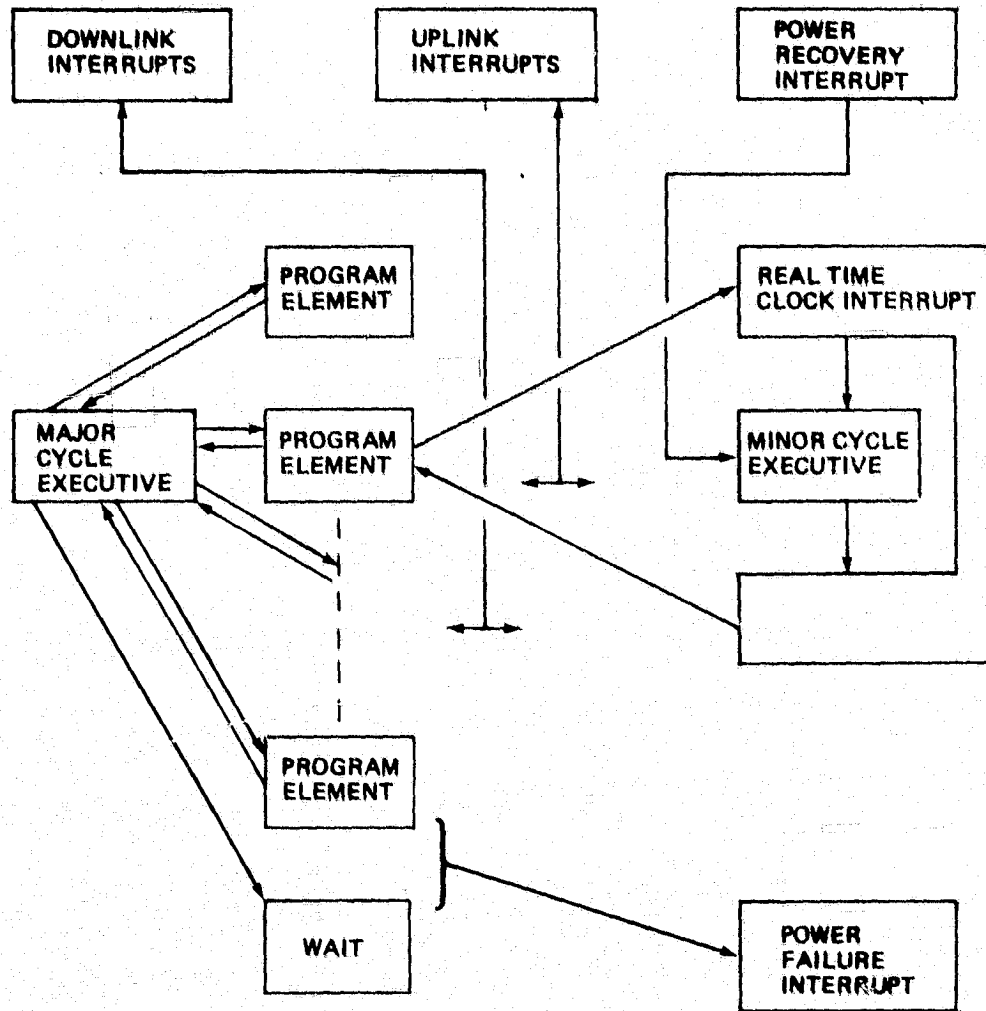


Figure 4.1-1. PROFIT Executive Configuration

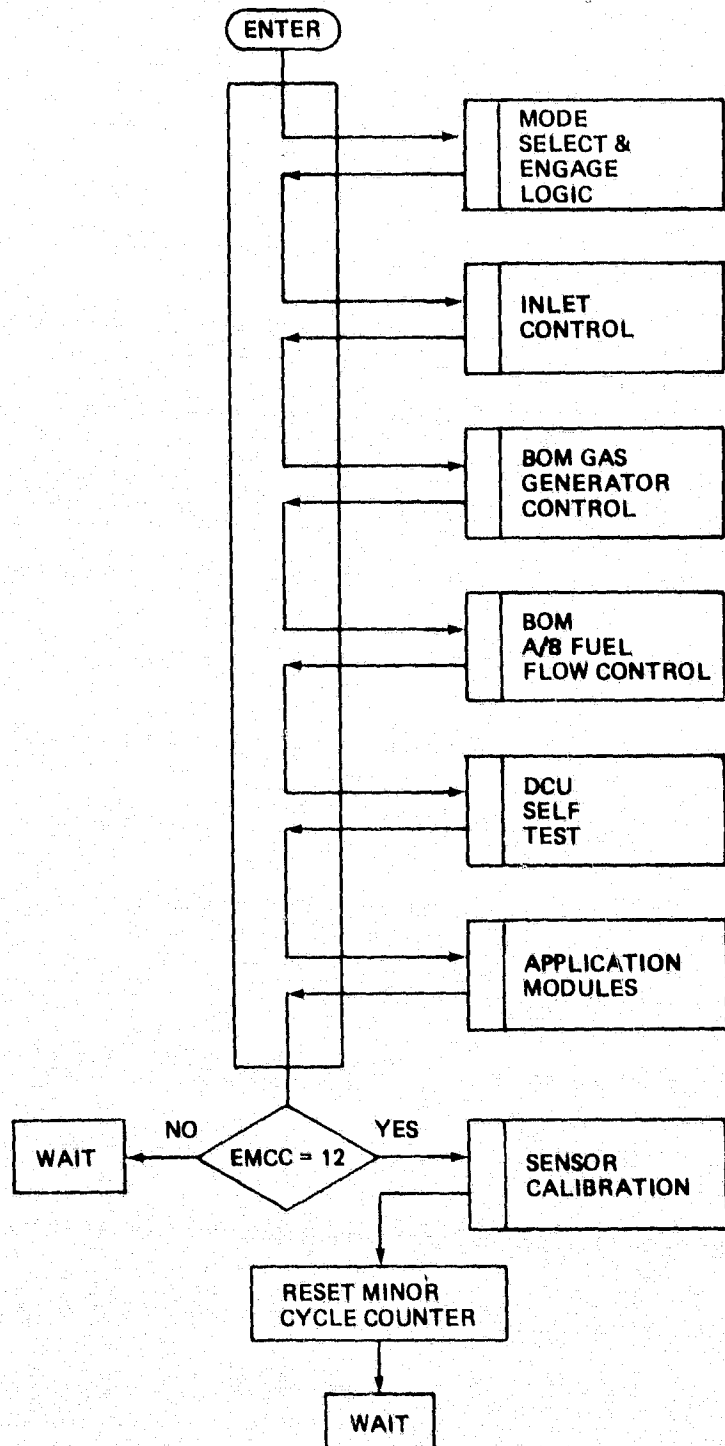
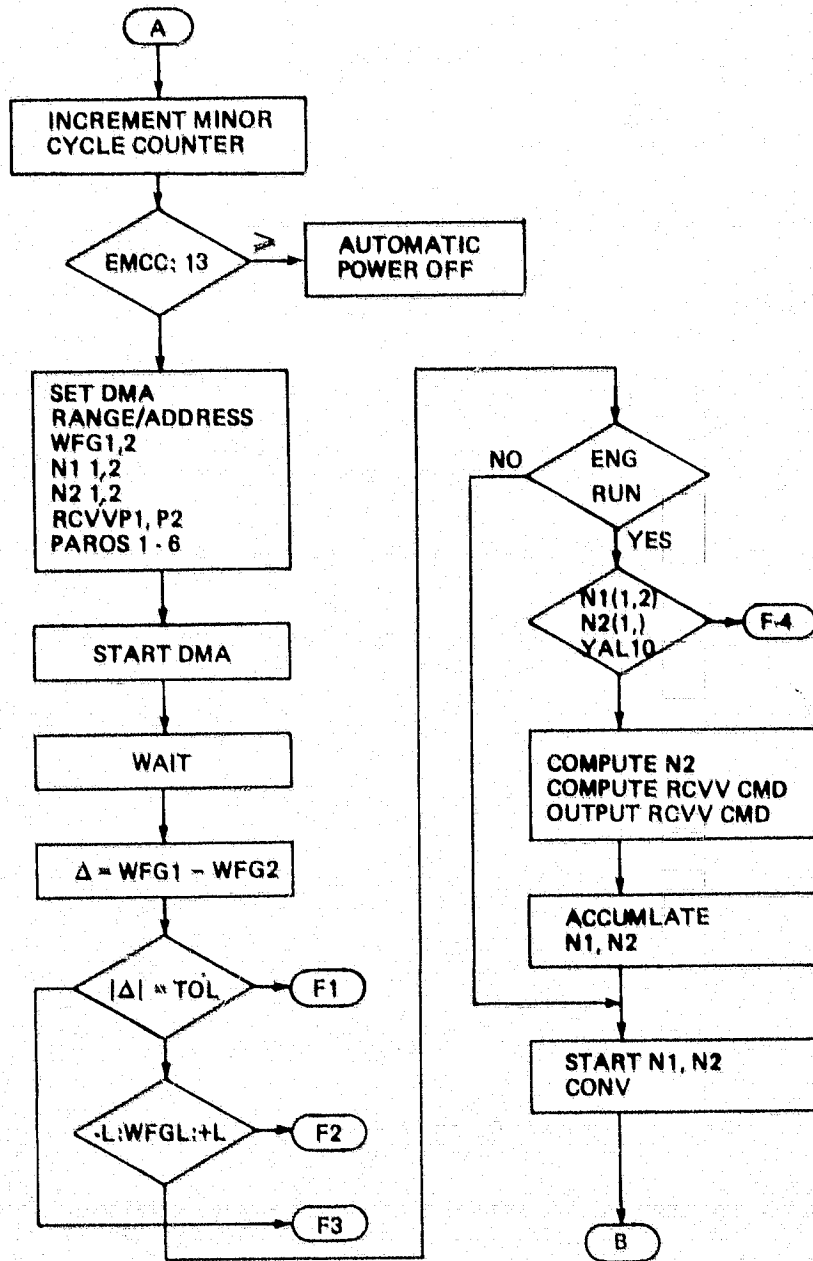


Figure 4.1-2. Major Cycle Executive Sequence



CONTINUED ON NEXT PAGE

Figure 4.1-3. Minor Cycle Executive Logic



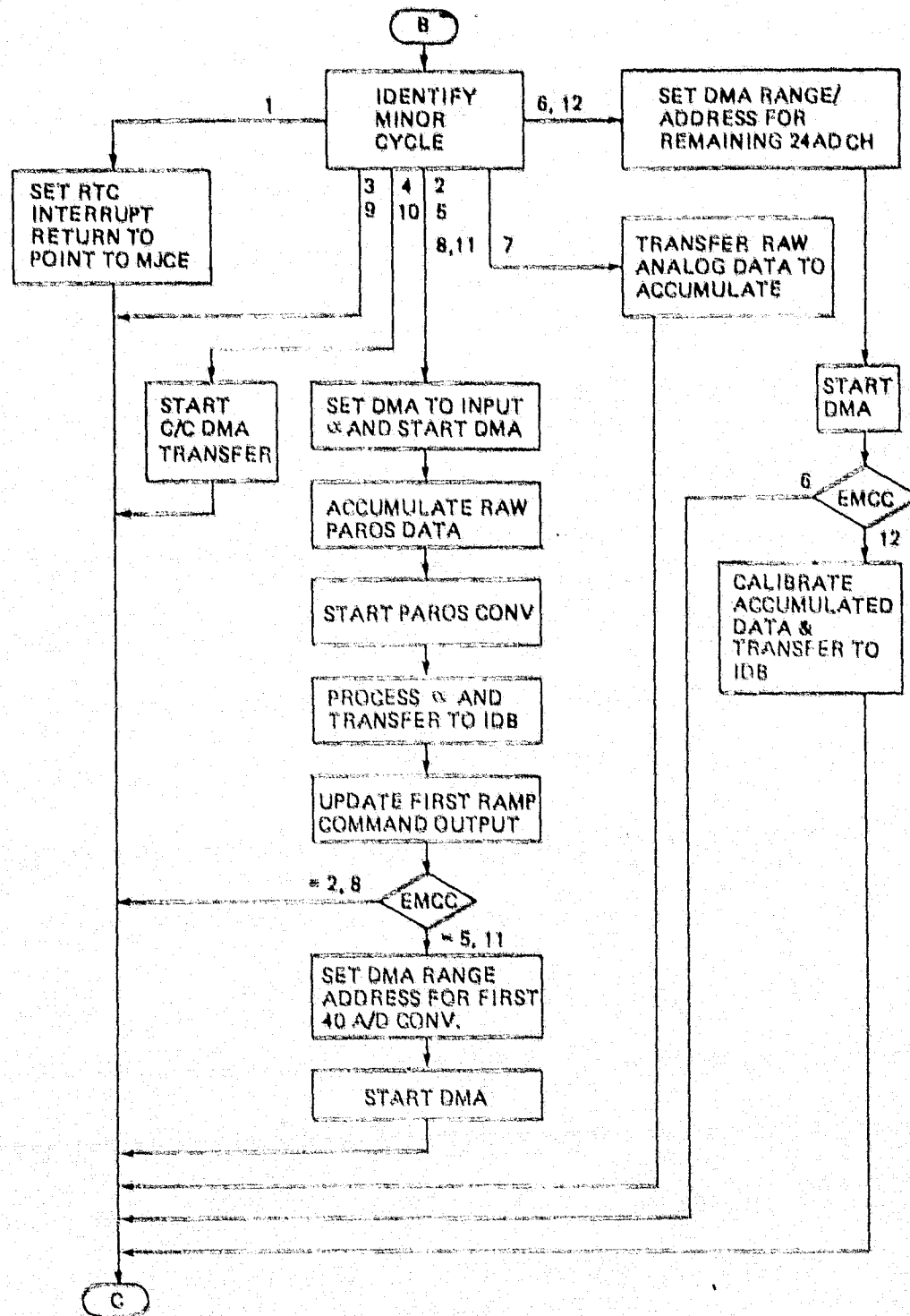


Figure 4.1-3 Continued

system disengagement and power down. Processing common to all minor cycles follows. The DMA system is activated to input all digital data. A delay of 5 microseconds is provided to permit the redundant fuel flow data to be transferred to the raw data locations. Fuel flow failure checks are performed while the remainder of the digital data are transferred. Tachometer data are then validity checked and accumulated for eventual inclusion in the input data base. An unfiltered N2 value is also calculated and the minor cycle RCVV update subroutine (UFG block diagram 2.1.4A) is executed. Finally the N1 and N2 converters are reset so that new data will be available on the next minor cycle.

The minor cycle is again identified and processing unique to particular minor cycles, see timing diagram, Figure 4.1-4, is executed.

Minor cycle 1 resets the interrupt return pointer to restart the major cycle.

Minor cycles 2, 5, 8, and 11 are all used to process PAROS transducer data and perform limited inlet control functions. The DMA is set to fetch angle of attack data prior to processing Paros data input during the common sequence of the MNCE. Note that PAROS data input during the other minor cycles are invalid since the converter data are only valid after the conversion is complete.

After completing PAROS conversion  $\alpha$  is converted from raw data to engineering units and transferred to the input data base. The first ramp command is then updated based on the new  $\alpha$  and output to the first ramp servo.

During minor cycles 5 and 11, the first portion (40 channels) of the A/D DMA data transfer also is initiated.

Minor cycles 6 and 12 complete the A/D DMA data transfer. The remainder of minor cycle 12 is committed to calibrating all data and transferring it to the Input Data Base (IDB).



A/D data transferred to locations 400-477 (raw data buffer) during minor cycles 5 and 6 is transferred to an accumulator during minor cycle 7 to be averaged with minor cycle 11 and 12 data during minor cycle 12. The various data accumulation processes described above are provided to prevent potential aliasing problems.

Minor cycles 4 and 10 are used to transfer central computer bus data from the I/F buffer memory to the 601 core (loc 500-560). Since these data are already in scaled engineering units, no further action is taken on them by the executive.

#### 4.1.2 Status and Engage Logic (SEL)

Figure 4.1-5a depicts the basic functions of the SEL. Failure words generated in various elements of the ICP, primarily the Input Processor, and stored in the Failure Mode Data Base portion of the IDB are decoded by the SEL to generate status information for display on the Caution Light Panel. If a system anomaly is detected the SEL identifies it as Level I requiring pilot communication and perhaps change of data source to input data base (IDB) or modification of a control mode, as Level II requiring disengagement of affected controllers, or as Level III requiring system automatic shutdown. Note that Figure 4.1-5a shows a single set of actions, but that in reality a separate set of decisions will generally be made for each research module.

For each controller a set of "Track" criteria are established which must be satisfied prior to controller engagement. To prevent accidental engages these criteria must be met for a significant number of major cycles prior to engagement. The track mode flags are used to control this delay and thus require resetting in various failure paths. Mode engagement is controlled by the mixture of software and hardware sketched in Figure 4.1-5b. Note that successful tracking, a pilot engage request

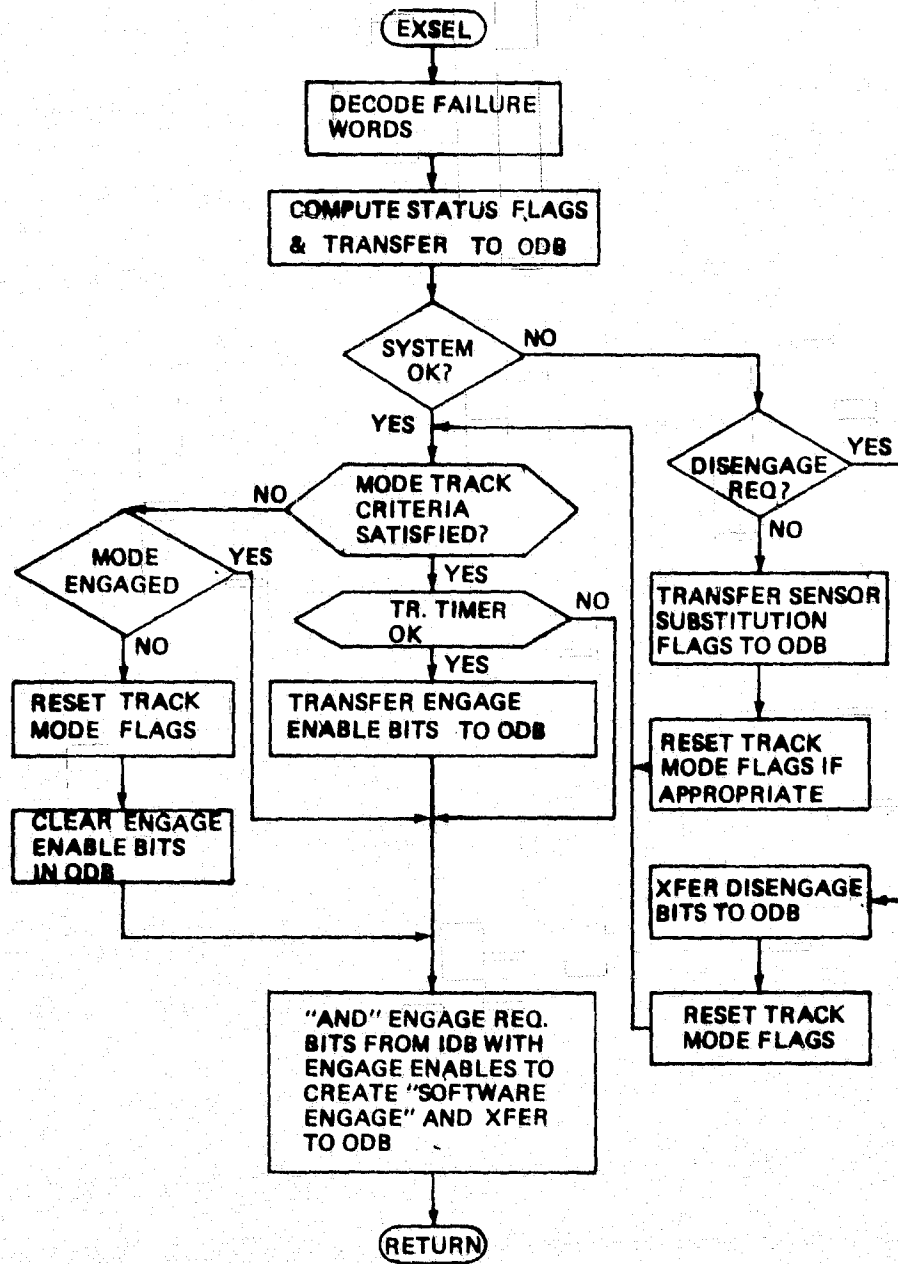
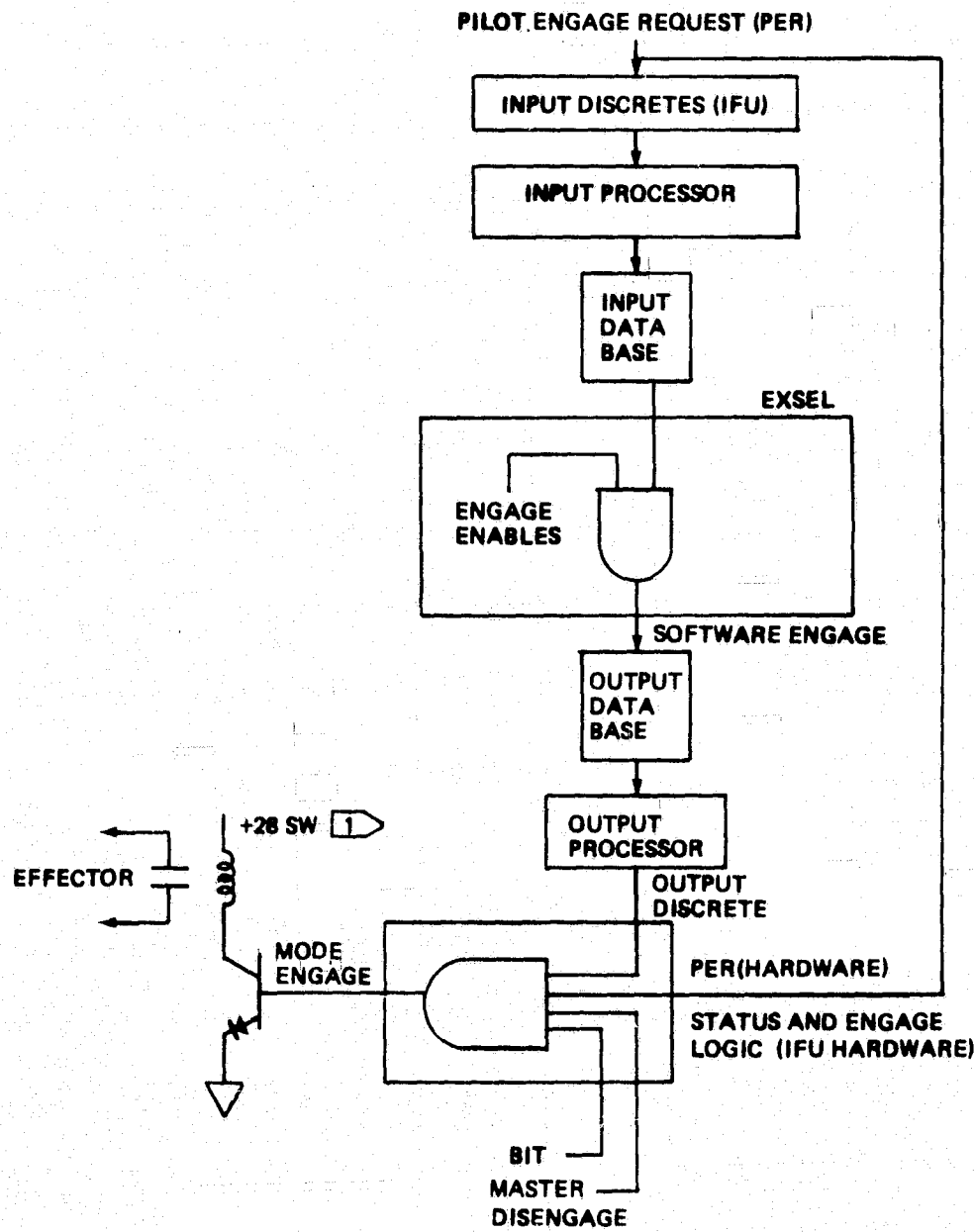


Figure 4.1-5a. Status and Engage Logic (Software)




 +28 SW GOES OFF WHEN DPCU TURNED OFF.  
 RELAY SHOWN SCHEMATICALLY MAY BE  
 SOLENOID VALVE

Figure 4.1-5b. Status and Engage Logic Hardware Software Organization

through both hardware and software, and a "BIT" test okay are required to permit or maintain mode engagement.

#### 4.1.3 Interrupts

Table 4.1-1 lists in order of priority the interrupts used in the PROFIT. The following paragraphs discuss the processing performed in response to each interrupt.

##### 4.1.3.1 DCU Power Failure Interrupt

The power failure interrupt (PFI) subroutine provides the response to the IFU power failure interrupt and the DCU power failure interrupt. A flow chart of the PFI subroutine is shown in Figure 4.1-6.

The PFI subroutine is entered only by the normal interrupt sequences generated by the DCU power failure interrupt (PFIO) or by the IFU power failure interrupt (PILO60).

The auto-power off command is transmitted directly to the IFU via output of the value 177777 (octal) as DIS01. That output is followed by execution of a computer halt instruction to prevent subsequent interrupts from interfering with the orderly shut-down of the DPCU.

##### 4.1.3.2 DCU Power Recovery Interrupt

The power recovery interrupt (PRI) subroutine provides the response to the DCU power recovery interrupt. A flow chart of the PRI subroutine is shown in Figure 4.1-7.

The PRI subroutine is entered only by the normal interrupt sequence generated by the power recovery interrupt (PRIO).

TABLE 4.1-1  
PRIORITY INTERRUPT ASSIGNMENTS

CORE LOCATION OF INT. POINTER	NOMENCLATURE	DESCRIPTION	CORE LOCATION OF INTRUP PROC. ROUTINE
60	PWRF	DCU POWER FAILURE	
61	PERTC	EXTERNAL REAL TIME CLOCK	▷
62	PWRR	DCU POWER RECOVERY	
63	PILO0	STANDARD INTERRUPT	▷
64	PILO1	IFU REAL TIME CLOCK	
65	PILO2		
66	PILO3		
67	PILO4		
70	PILO5		
71	PILO6	IFU POWER FAILURE	
72	PILO7	CENTRAL COMPUTER BUS FAILURE	
73	PILO8	RECORDER WORD SYNCH INTERRUPT	
74	PILO9	RECORDER DATA REQUEST INTERRUPT	
75	PILO10	UPLINK DATA WORD INTERRUPT	
76	PILO11	UPLINK SYNCH WORD INTERRUPT	
77	PILO12	BUZZ	
100	PILO13	A/B ZONE FILL COMPLETE INTERRUPT	
101	PILO14	DMA	
102	PILO15	INPUT BUS	
103	PILO16		

▷ NOT USED BY PROFIT REAL TIME SYSTEM



TABLE 4.1-1 (Cont.)

<u>INTERRUPT</u>	<u>MAXIMUM ALLOWABLE TIME TO INDICATED ACTION</u>
DCU PWR FAIL	100 $\mu$ sec OF EXECUTION IS AVAILABLE
EXT R.T. CLCK	NOT USED
DCU PWR REC	NO MAXIMUM DEFINED
STD. INT.	NOT USED
IFU R.T. CLCK	ALL PROCESSING MUST BE COMPLETED PRIOR TO NEXT RTCI
IFU PWR FAIL	1. MILLISEC. (MAY BE REVISED BASED ON FMEA)
CC BUS FAILURE	5. MILLISEC. (HARDWARE STOPS DATA TRANSFER TO BUFFER INTERRUPT RESPONSE REQMT. IS FMEA DEPENDENT)
REC. W. SYNCH	186.5 $\mu$ sec
REC. D. REQ.	686. $\mu$ sec
UPLK. D.W.	2.5 MILLISEC
UPLK. F. SYNCH	2.5 MILLISEC
BUZZ	5.0 MILLISEC
DMA	NO REQUIREMENT DEFINED
INPUT BUS	NO REQUIREMENT DEFINED
FILL	2.5 MILLISEC

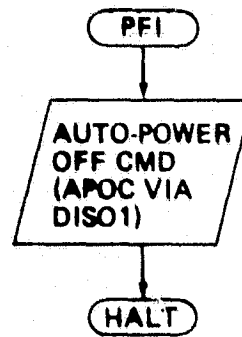


Figure 4.1-6. Power Failure Interrupt Processing

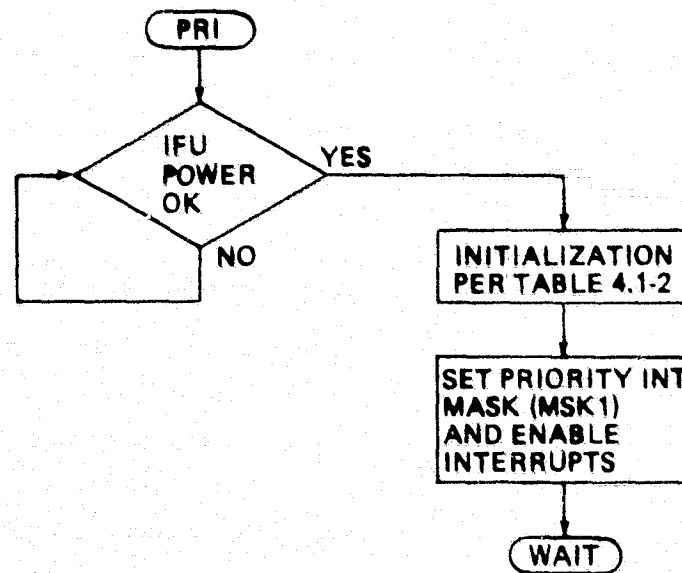


Figure 4.1-7. Power Recovery Interrupt Processing

The IFU power OK sense line is tested. Further processing is not accomplished until that sense line indicates restoration of power within the IFU. Next, all CPCEI data parameters which require initialization to commence operation in the TRACK mode are initialized. The identification of those parameters and their initial value are shown in Table 4.1-2. Following that initialization, the priority interrupt mask is set to accept all CPCEI-defined interrupts and the interrupts are enabled. A wait state is entered to await the arrival of the IFU real time clock interrupt. Initialization is such that the first IFU real time clock interrupt denotes the beginning of the first minor cycle (5 msec interval) of a major cycle (60 msec interval).

#### 4.1.3.3 Real Time Clock Interrupt

The real time clock interrupt (RTCI) subroutine provides the response to the real time clock interrupt (PIL01), Figure 4.1-8. The RTCI subroutine is only entered through the normal interrupt sequence generated by the PIL01 interrupt.

The routine saves the keys and the A, B and X registers, again using double storage for the A. The interrupts are enabled and the routine exits to the minor cycle executive, MNCE (paragraph 4.1.1). Following completion of the MNCE, the registers are restored, the keys output and interrupts enabled.

#### 4.1.3.4 IFU Power Failure Interrupt

The response to the IFU power failure interrupt is to enter the Power Failure Interrupt (PFI) subroutine, Paragraph 4.1.3.1 above.

TABLE 4.1-2

INITIALIZATION DATA BASE (ITDB)

CORE LOCATION	NOMENCLATURE	DESCRIPTION	VALUE
	DELA	EEC NOZZLE TRIM	0.
	DELP	EEC PLA TRIM	0.
	PLAM	MINIMUM PLAP	0.

FURTHER VARIABLES WILL BE ADDED AS IDENTIFIED.

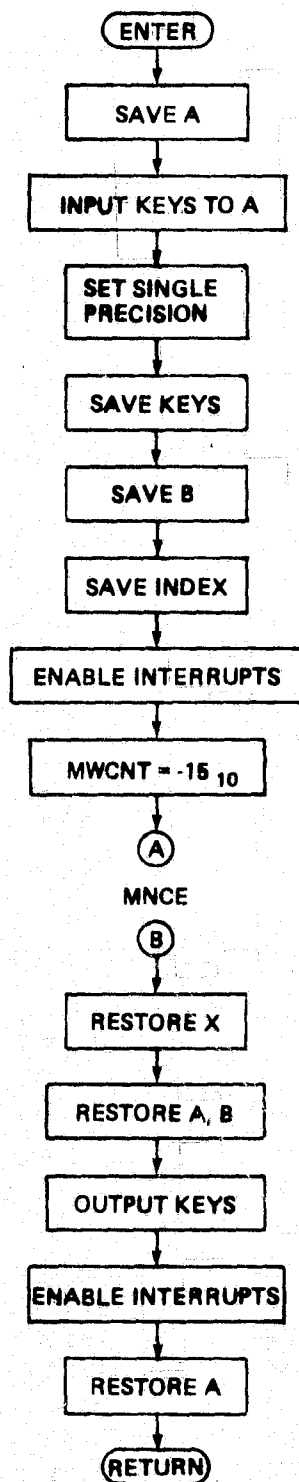


Figure 4.1-8. Minor Cycle Executive (Real Time Clock Interrupt)

#### 4.1.3.5 Central Computer Bus Failure Interrupt

The central computer bus failure interrupt (CCBFI) subroutine provides the response to the central computer bus failure interrupt. The CCBFI subroutine, see flow chart Figure 4.1-9, is entered only by the normal interrupt sequence generated by the bus failure interrupt (PIL070).

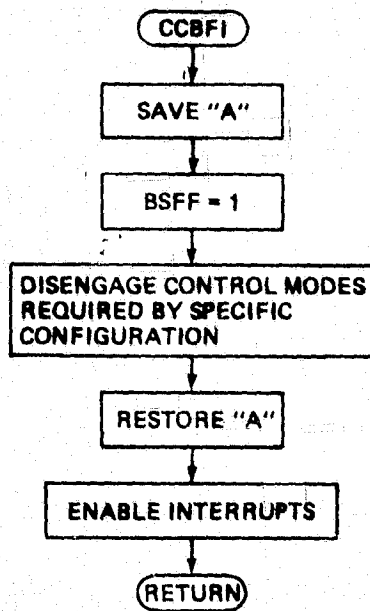
After saving the accumulator the routine sets the bus failed flag (BSFF) which disables CC bus data transfers in the major cycle and depending on control configuration can be used to disengage any or all control modes during the major cycle. Alternatively an immediate mode disengage may be implemented in this routine if required. After processing the accumulator is restored and interrupts are enabled.

#### 4.1.3.6 Recorder Word Synch Interrupt

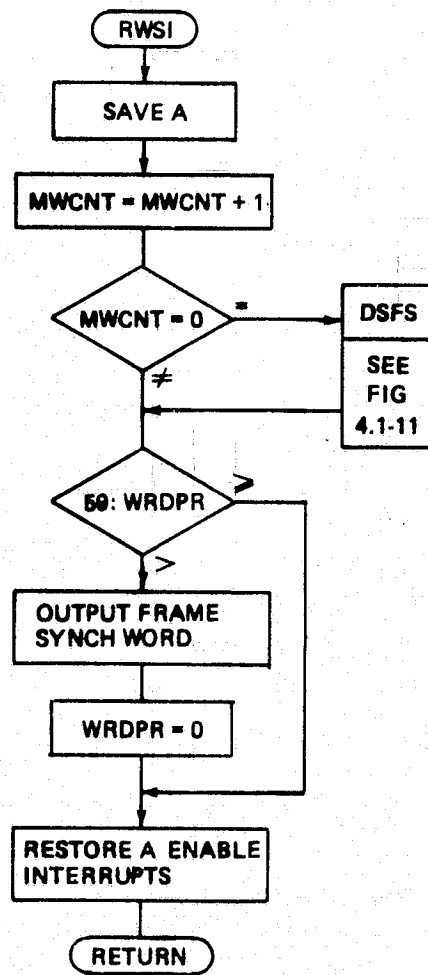
The recorder word synch interrupt (RWSI) subroutine provides the response to the recorder word synch interrupt. A flow chart of the RWSI subroutine is shown in Figure 4.1-10. The subroutine is only entered as a result of the normal interrupt sequence generated by the PIL 08 interrupt. The accumulator is saved, again two locations must be provided, and the excessive data counter is checked as in RDRI. Since only one in ten frame synch requests actually require output of a frame synch word, the word pointer is checked to establish if a frame is complete. If it is the frame synch word is output and the word pointer is reset. In either case the subroutine exits restoring A and enabling interrupts.

#### 4.1.3.7 Recorder Data Request Interrupt

The recorder data request interrupt (RDRI) subroutine provides the response to the recorder data request interrupt. The RDRI subroutine, see flow chart Figure 4.1-11, is entered only by the normal interrupt sequence generated by the recorder data request interrupt (PIL090).



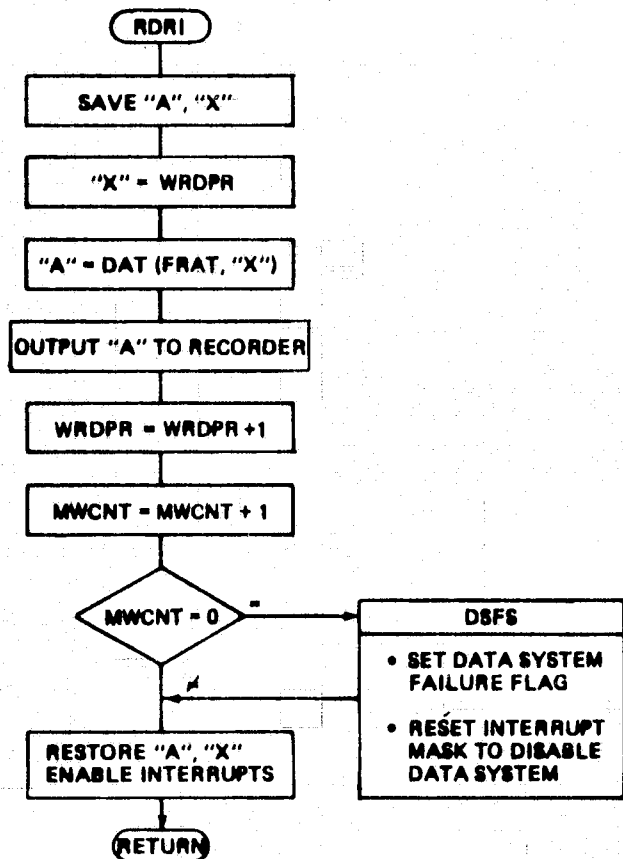
*Figure 4.1-9. Central Computer Bus Failure Interrupt*



NOMENCLATURE -- SEE FIGURE 4.1-11

Figure 4.1-10. Recorder Word Synch Processing





**NOMENCLATURE**

**DISCRIPTION**

"A"	CONTENTS OF A REGISTER
"X"	CONTENTS OF X REGISTER
WRDPR	DATA WORD POINTER POINTS TO LINK FOR DATA WORD TO BE OUTPUT
FRAT	FLIGHT RECORDER ADDRESS (LINK) TABLE INITIAL LOCATION' FRAT TABLE IS DEFINED IN TABLE 4.1-2.
DAT	DATA TO BE OUTPUT
MWCNT	COUNTER SET IN REAL TIME CLOCK INTERRUPT TO DETECT EXCESSIVE DATA REQUESTS

*Figure 4.1-11. Recorder Data Word Processing*

The RDRI subroutine saves the accumulator and index register for eventual restoration. The machine may be in double precision mode when it enters the routine, hence double storage is required to save the accumulator. The index register is set to point to the indirect address of the data to be input this pass and the data is brought into the accumulator. Note that the word pointer (WRDPR) is reset in the frame synch subroutine (RWSI). After the data item is output the word pointer is incremented.

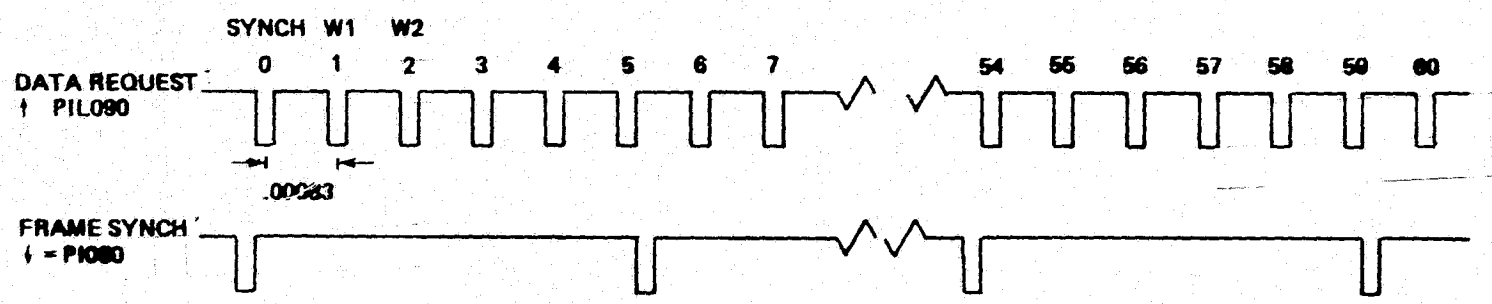
The anticipated rate of data and frame synch interrupts is shown in Figure 4.1-12. If this rate is exceeded, which indicates a failure of the recorder system, excessive processing time is spent in the RDRI and RWSI. To prevent this a counter (MWCNT) is preset to negative 15<sub>10</sub> in the real time clock interrupt routine (RTCI). Both RDRI and RWSI subroutines increment this counter and compare it to zero. A zero value indicates excessive interrupts. This condition is flagged, communicated to the pilot, and the data and frame synch interrupts are inhibited by clearing the appropriate mask bits. Upon completion of processing the A and X are restored, interrupts are enabled and a return is executed.

#### 4.1.3.8 Uplink Data Interrupt

The uplink data interrupt (UDI) subroutine provides the response to the uplink data interrupt. The UDI subroutine, see flow chart Figure 4.1-13, is entered only by the normal interrupt sequence generated by the uplink data interrupt (PIL100).

The accumulator and index register are saved, using double storage for A. Because recorder interrupts must be honored within .186 msec and uplink interrupts need only be honored within 2.5 msec, see timing diagram Figure 4.1-14, and the uplink interrupt processing will exceed .186 msec, interrupts must immediately be enabled. However, real time clock/minor cycle executive processing is potentially lengthy so it must be delayed until uplink processing is complete. The mask is manipulated in both the uplink data and frame synch routines to achieve this.

Figure 4.1-12. Downlink Timing Diagram



ORIGINAL PAGE IS  
OF POOR QUALITY

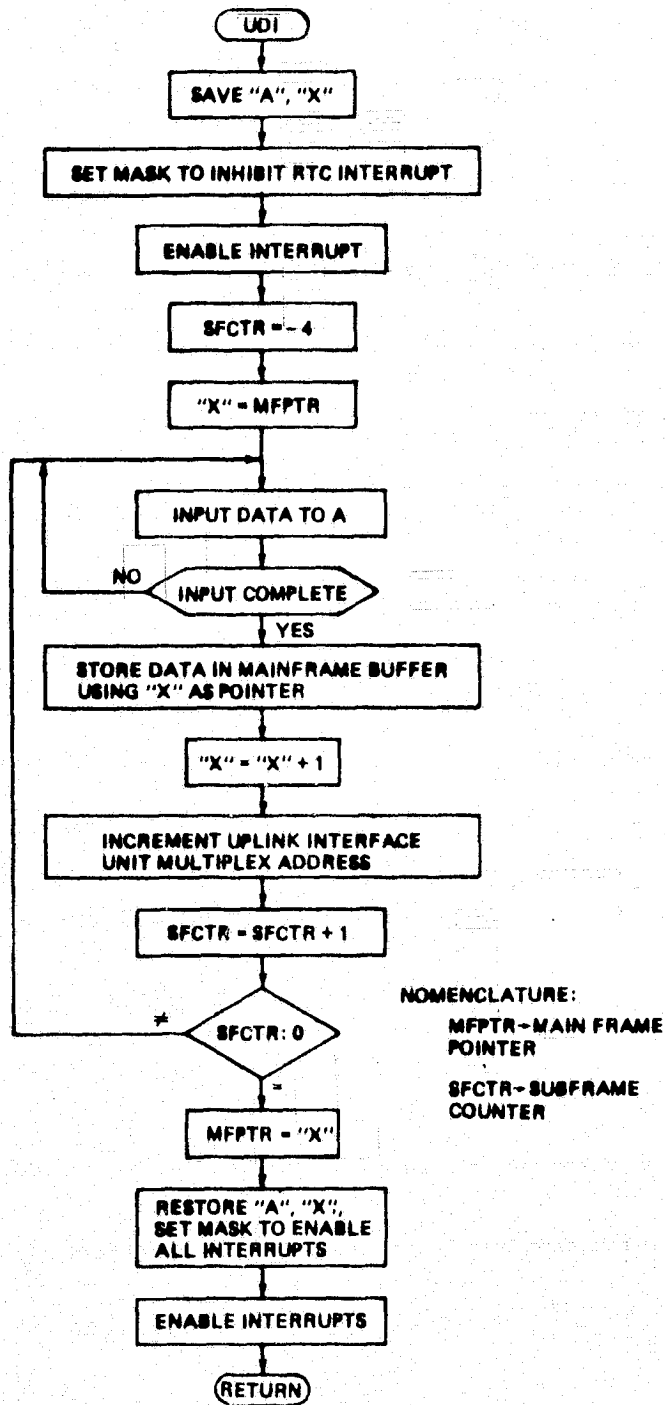
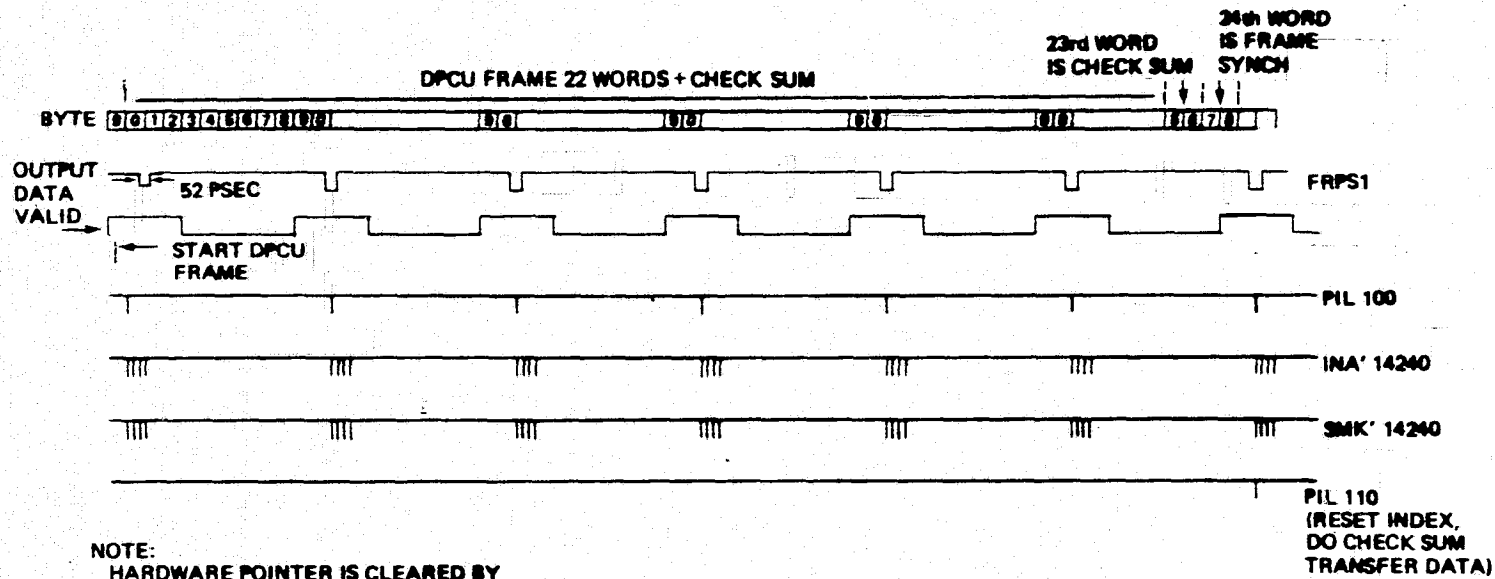


Figure 4.1-13 Uplink Data Interrupt



NOTE:  
HARDWARE POINTER IS CLEARED BY  
PIL100. THE FOURTH SMK. 14240 HAS  
NO EFFECT BUT SIMPLIFIES CODE.

PIL 110  
(RESET INDEX,  
DO CHECK SUM  
TRANSFER DATA)

Figure 4.1-14. Uplink Interface Timing Diagram

ORIGINAL PAGE IS  
OF POOR QUALITY

The index register is loaded with a pointer (MFPTR) which vectors the data in the main frame buffer and the subframe counter is set to -4. The routine then cycles four times through the subframe loop to input the four words available at the output of the uplink interface unit. The main frame pointer is saved for the next pass and A, X are restored, the mask is reset to enable the real time clock interrupt and interrupts are enabled prior to return from the subroutine.

#### 4.1.3.9 Uplink Frame Synch Interrupt

The uplink frame synch interrupt (UFSI) subroutine provides the response to the uplink frame synch interrupt. The UFSI subroutine, see flow chart Figure 4.1-15, is entered only by the normal interrupt sequence generated by the uplink frame synch interrupt (PIL110).

The accumulator and index register are saved and the mask set to inhibit real time clock interrupt as in the UDI subroutine. The "A" is then cleared and the checksum of the first 22 words in the raw data buffer is computed as follows:

$$CSUM = \sum_{i=1}^{22} ULRD_i$$

where:      The addition is 2's complement arithmetic  
              Overflows are ignored  
              CSUM is the checksum  
              ULRD<sub>i</sub> is the ith element of uplink raw data

Word 23 of the raw data is the same checksum computed by the ground station prior to data transmission. It is compared to CSUM. If the two agree, the data are transferred to the CIDB. If not, a flag is set and the old data (last valid data) remain in

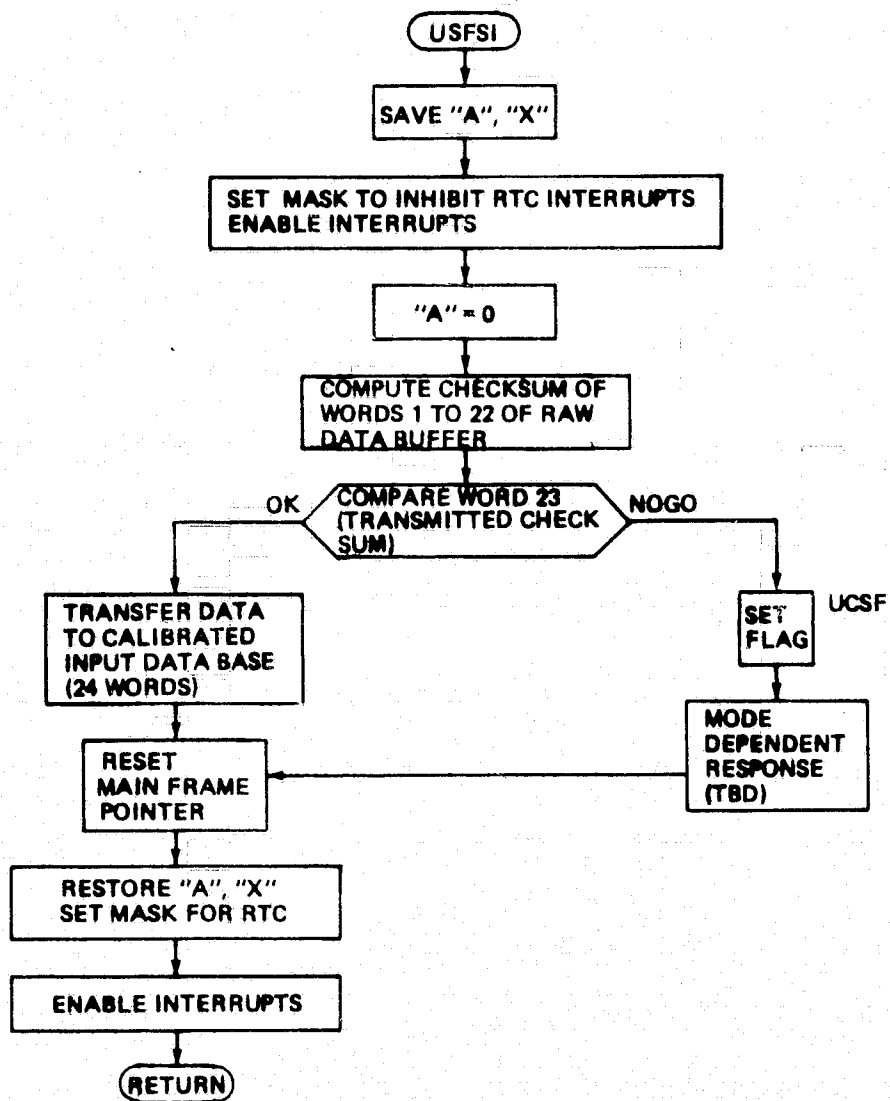


Figure 4.1-15. Uplink Frame Synchronism Interrupt

the CIDB. Further action may then be taken dependent on the system configuration. For example, disengaging DPCU from CAS if the uplink is being used for trajectory control. Initially no use other than perhaps data display is identified hence no action beyond setting a flag is required. The main frame pointer is reset to initialize the UDI for the next frame of data and the subroutine is exited similarly to the UDI routine.

#### 4.1.3.10 Buzz Interrupt

The buzz interrupt (BZZI) subroutine provides the response to the buzz interrupt. The routine is only entered through the normal interrupt sequence generated by PIL120. The BZZI subroutine saves the A register double precision and the keys and then sets a flag BZZF which lights the cockpit buzz indicator via the IFU and the output processor. BZZF is cleared when the buzz level falls below a threshold as identified in inlet major cycle processing.

#### 4.1.3.11 Fill Interrupt

The fill interrupt (FILI) subroutine provides the response to the fill interrupt. The FILI subroutine, see flow chart Figure 4.1-16, is entered only by the normal interrupt sequence generated by the fill interrupt (PIL130).

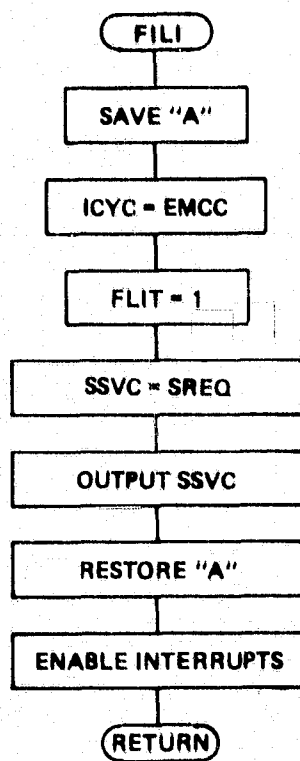
#### 4.1.3.12 DMA Interrupt

A DMA interrupt is provided in the hardware to indicate completion of DMA data transfer. Interrupt currently is masked out.

#### 4.1.3.13 Input Bus Interrupt

An INA interrupt is provided in the hardware to indicate data ready from a previously addressed peripheral. Interrupt is currently masked out.





*Figure 4.1-16. Fill Interrupt Processing*

## 4.2 HOST PROGRAM DATA BASE

The Host Program data base structure and data flow is depicted in Figure 4.2-1. Host Program control of the ICP is achieved primarily through restrictions on data base intercommunications designed to prevent invalid or extraneous data from entering applications modules or being output to the IFU. To this end all data enters applications modules from either the calibrated input data base or the executive data base and exits through the output data base. The Host Program then exercises control over the interface to the outside world by failure checking data entering or leaving the respective data bases. The following paragraphs describe the various data bases. For user convenience sector 0 allocation is documented in Figure 4.2-2.

### 4.2.1 Input Data Base

The input data base is composed of the raw DMA input data base (Table 4.2-1), the raw uplink data base (Table 4.2-3), and the calibrated input data base (Table 4.2-4). Figure 4.2-3 indicates the input data base subsets.

All data entering the raw input data base are transferred from the outside world through the IFU under Host Program control. The raw input data base is accessed only by the HP data validation, calibration, and transfer module, and the fill interrupt routine. Data enters the calibrated input data base only from the data validation, calibration, and transfer module. The calibrated input data base may be accessed by all other program modules.

### 4.2.2 Output Data

The output data base is composed of the calibrated control output data base, the formatted output data base, and the analysis data base.

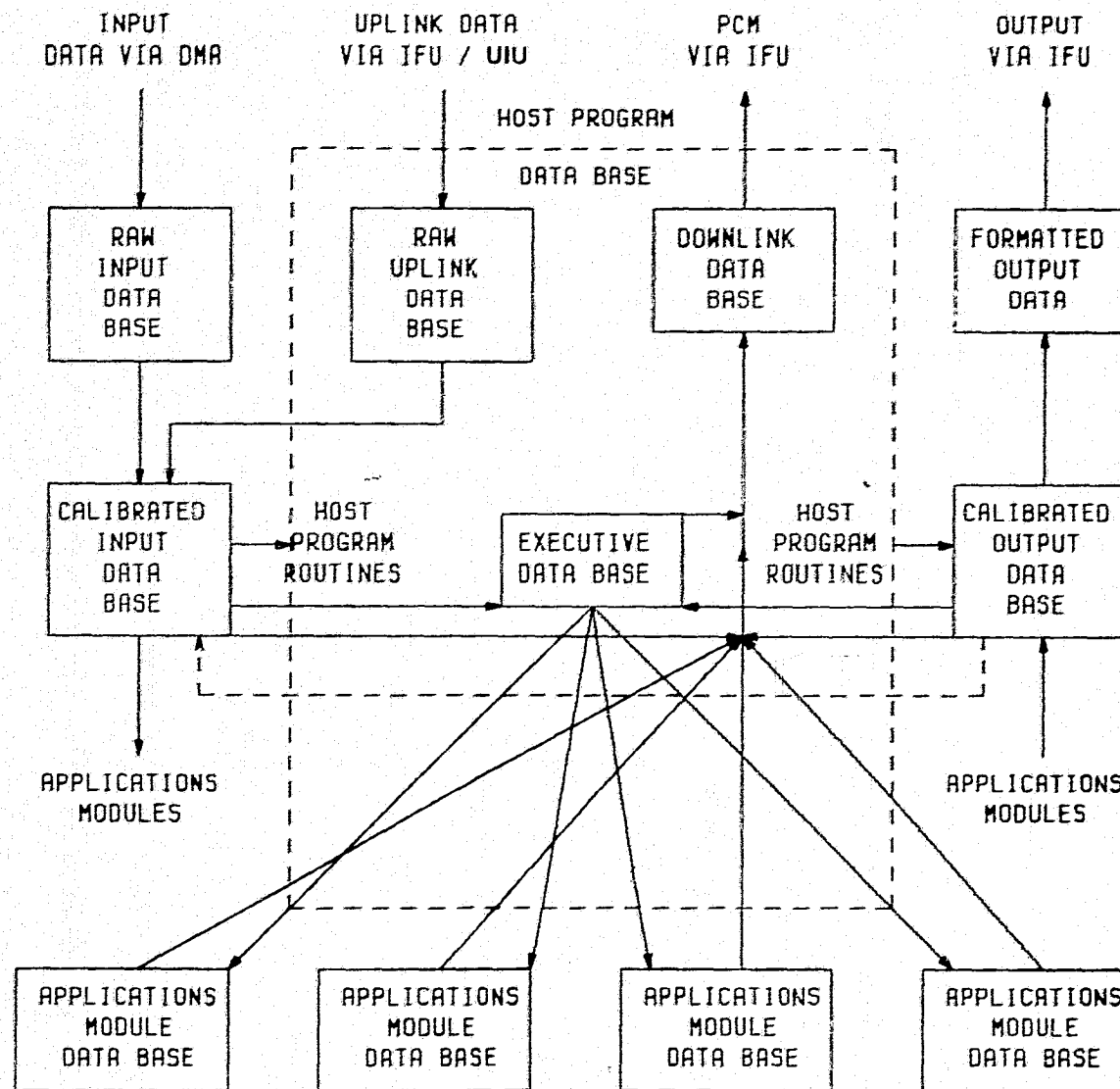


Figure 4.2-1. ICP Data Base Structure

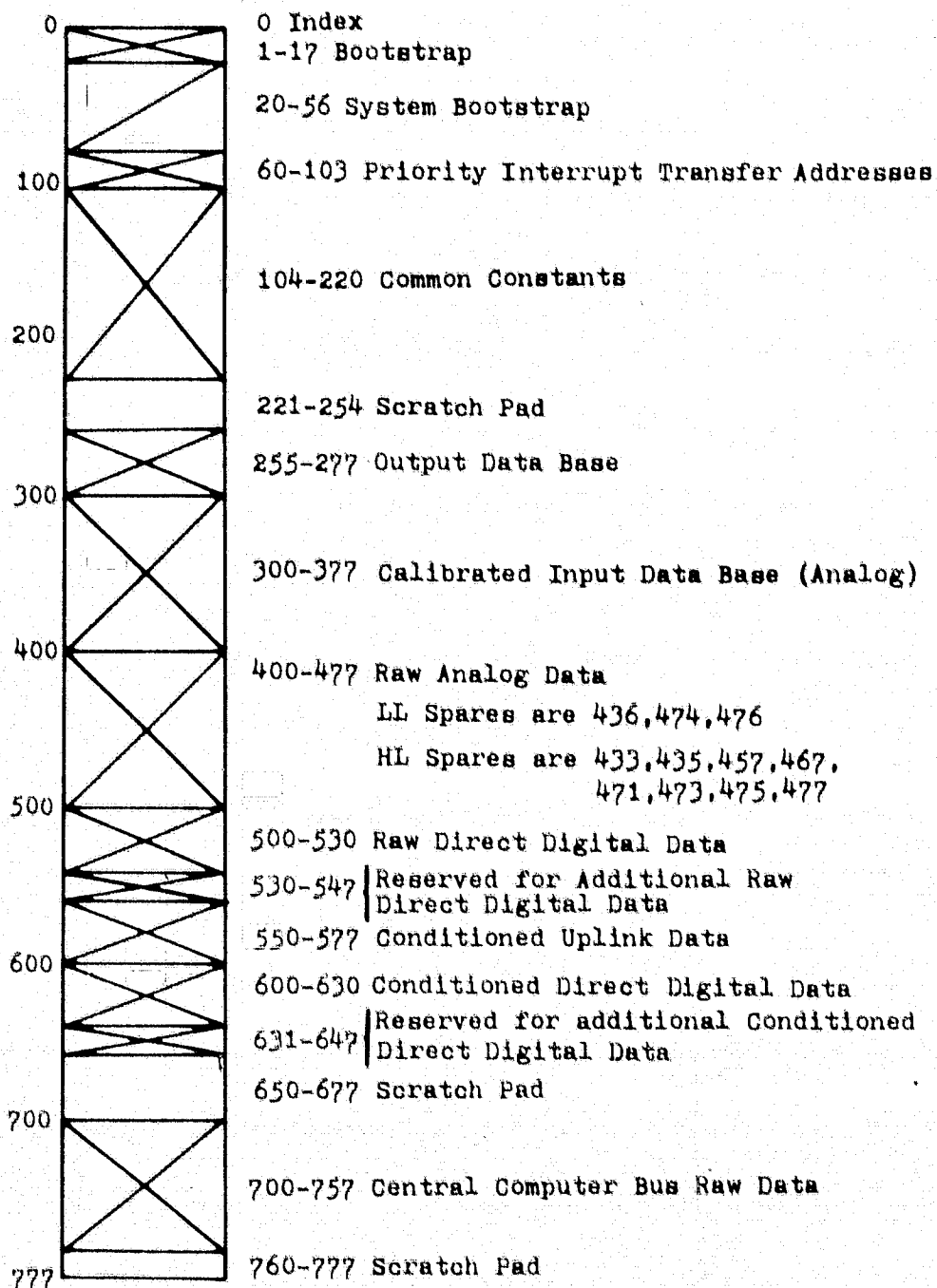
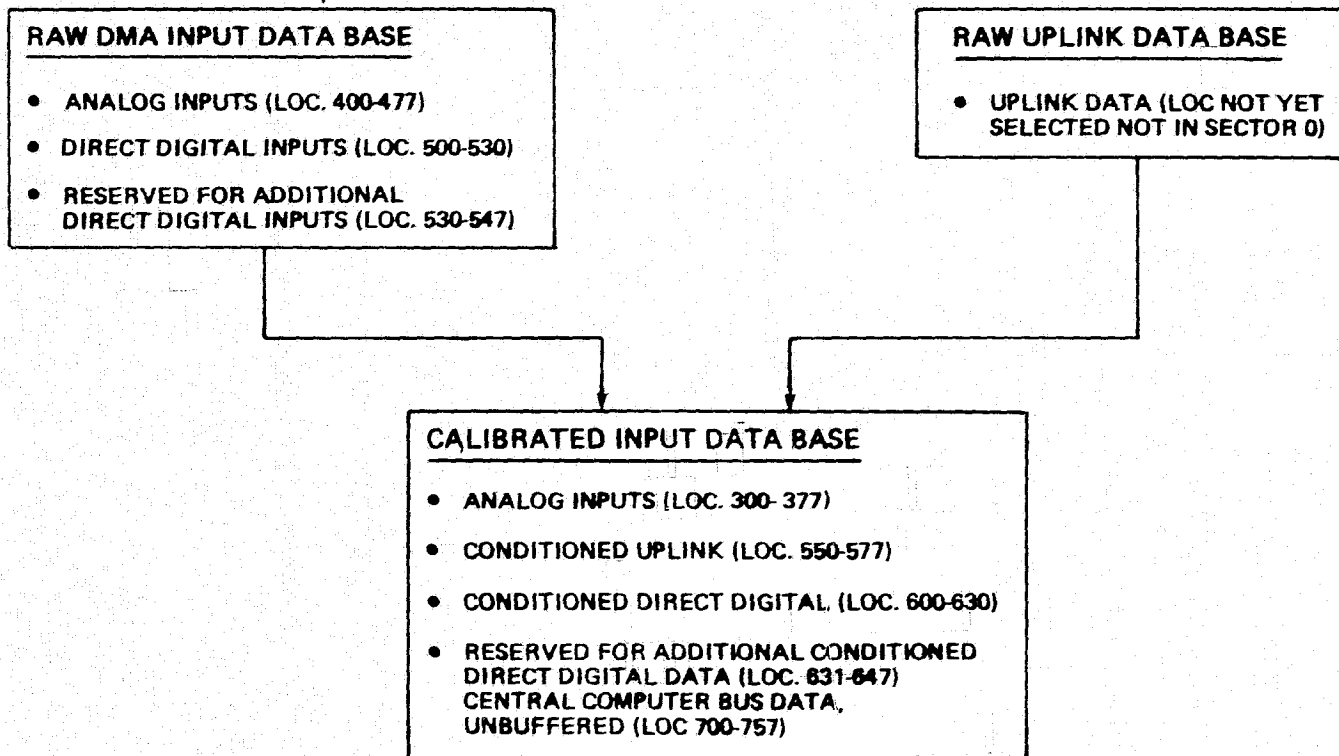


Figure 4.2-2. Sector 0 Location Allocation



44

Figure 4.2-3. Input Data Base Structure

TABLE 4.2-1  
RAW INPUT DATA BASE

CORE LOCATION (OCTAL)	DATA TYPE	SIGNAL NAME	DESCRIPTION	UNITS	SCALE FACTOR	SENSITIVITY ENG. UNITS/COUNT
400	LLA	AD1G	LLA GRD. REF.	COUNTS	B11	FINAL XDUCER SELECTION
401	HLA	AD2G	HLA GRD. REF.			NOT COMPLETE
402	LLA	RT2CA	T2 COLD STREAM A			
403	HLA	EX1M5V	-5VDC SENSOR EXC. EXT			
404	LLA	RT25CA	T2.5 COLD STREAM A			
405	HLA	EX1P5V	+5VDC SENSOR EXC. EXT			
406	LLA	RT3A	T3 A			
407	HLA	IFUP5V	+5VDC IFU LOGIC SUPPLY			
410	LLA	RT45A	FAN TURBINE INLET TEMP A			
411	HLA	RUTIL1	C'PIT UTILITY POT #1			
412	LLA	RT6A	T6 A			
413	HLA	RUTIL2	C'PIT UTILITY POT #2			
414	LLA	RP25	P25 2			
415	HLA	EX2ZA1K	1 Kh <sub>2</sub> EXCITATION EX2			
416	LLA	AD2REF	HLA REFERENCE VOLTAGE			
417	HLA	AD1REF	LLA REFERENCE VOLTAGE			
420	LLA	RP3	P3			
421	HLA	IFUP15V	+15 VDC IFU ANALOG SUPPLY			
422	LLA	RP6M	P6M			

▽ LOW LEVEL ADC GAIN IS HIGH 14.6mV/COUNT  
 HIGH LEVEL ADC GAIN IS .0025 VDC/COUNT  
 SOME INPUTS ARE MODIFIED TO BRING THEM WITHIN A/D INPUT  
 RANGES (LL = +30 mV., HL = +5.0 VDC)

TABLE 4.2-1 (Cont.)  
RAW INPUT DATA BASE

CORE LOCATION (OCTAL)	DATA TYPE	SIGNAL NAME	DESCRIPTION	UNITS	SCALE FACTOR	SENSITIVITY ENG. UNITS/COUNT
423	HLA	IFM15V	-15VDC IFU ANALOG SUPPLY	COUNTS	811	FINAL TRANSDUCER
424	LLA	RPD13	P13 - PS13	↓	↓	↓
425	HLA	EX439K	RESOLVER EXC. 3.9KHz/9V			
426	LLA	KPF2	MAIN FUEL PUMP DISC. PRES.			
427	HLA	RUT1L3	C'PIT UTILITY POT #3			
430	LLA	RPF4	MAIN CONTROL DISC. PRES.			
431	HLA	RUT1L4	C'PIT UTILITY POT #4			
432	LLA	RPFA4	AUG. CTRL. DISC. PRES.			
433	HLA	RBUZZ				
434	LLA	RPFA5	AUG. CTRL. DISC. PRES.			
435	HLA	RTURB				
436	LLA					
437	HLA	EX5P9V	+9VDC PAROS EXC. EX5			
440	LLA	RT2CB	T2 COLD STREAM B			
441	HLA					
442	LLA	RT25CB	T2.5 COLD STREAM B			
443	HLA					
444	LLA	RT3 B	T3 B			
445	HLA	RRHO	FIRST RAMP ANGLE			
446	LLA	RT45B	FTIT B			
447	HLA	RDEL3	3RD RAMP ANGLE			

TABLE 4.2-1 (Cont.)  
RAW INPUT DATA BASE

CORE LOCATION (OCTAL)	DATA TYPE	SIGNAL NAME	DESCRIPTION	UNITS	SCALE FACTOR	SENSITIVITY ENG. UNITS/COUNT
450	LLA	RT6B	T6B			FINAL TRANSDUCER
451	HLA	RT0	AMBIENT TOTAL TEMPERATURE	COUNTS	B11	SELECTION NOT COMPLETE
452	LLA	RP25	P25			
453	HLA	RTRIM3	C'PIT TRIM POT #3			
454	LLA	RPB	BURNER PRESSURE			
455	HLA	RALPHA	AIRCRAFT ANGLE OF ATTACK			
456	LLA	RP13	P13			
457	HLA	RRUMBL	RUMBLE			
460	LLA	RPS13	PS13			
461	HLA	RTRIM4	C'PIT TRIM POT #4			
462	LLA	RPFIA	AUG. FUEL PUMP DISC PRES.			
463	HLA	RCBLOP	CUSTOMER BLEED POS			
464	LLA	RPFI	MAIN PUMP INTERSTAGE PRES.			
465	HLA	RAJPOS	ACTUAL NOZZLE POSITION			
466	LLA	RPF4A1	AUG. CTRL. DISC. PRES.			
467	HLA	RTRIM1	COCKPIT TRIM POT #1			
470	LLA	RPF4A2	AUG. CTRL. DISC. PRES.			
471	HLA	RTRIM2	COCKPIT TRIM POT #2			
472	LLA	RPF4A3	AUG. CTRL. DISC. PRES.			
473	HLA	-	SPARE			
474	LLA	-	SPARE			
475	HLA	-	SPARE			

47

ORIGINAL PAGE IS  
OF POOR QUALITY



TABLE 4.2-1 (Cont.)  
RAW INPUT DATA BASE

CORE LOCATION (OCTAL)	DATA TYPE	SIGNAL NAME	DESCRIPTION	UNITS	SCALE FACTOR	SENSITIVITY ENG. UNITS/COUNT
476	LLA		SPARE			
477	HLA		SPARE			
500	RTD	RWFG1	FUEL FLOW RESOLVER #1	COUNTS	B11	FINAL TRANSDUCER SELECTION NOT COMPLETE
501	RTD	RWFG2	FUEL FLOW RESOLVER #2		B11	
502	RFD-T	RN11T	N1 TACH TOOTH COUNT #1		B15	
503	RFD-T	RN12T	N1 TACH TOOTH COUNT #2			
504	RFD-T	RN21T	N2 TACH TOOTH COUNT #1			
505	RFD-T	RN22T	N2 TACH TOOTH COUNT #2			
506	RFD-T	RN11C	N1 TACH CLOCK COUNT #1			
507	RFD-T	RN12C	N1 TACH CLOCK COUNT #2			
510	RFD-T	RN21C	N2 TACH CLOCK COUNT #1			
511	RFD-T	RN22C	N2 TACH CLOCK COUNT #2			
512	FD-P	RP1	INLET THROAT TOTAL PRESSURE		B15	
513	RTD	RDCVV1	RCVV POSITION #1		B11	
514	FD-P	RPS1	INLET THROAT STATIC PRESSURE		B15	
515	RTD	RRCVV2	RCVV POSITION #2		B11	
516	FD-P	RPO	AMBIENT TOTAL PRESSURE		B15	
517	RTD	RSSV	SEGMENT AND SEQUENCE VALVE PDS.		B11	
520	FD-P	RPS0	AMBIENT STATIC PRESSURE		B15	
521	RTD	RWFCOR	A/B FUEL FLOW CORE (Z 1, 5)		B11	
522	FD-P	RP2	FAN INLET TOTAL PRESSURE		B15	FINAL TRANSDUCER SELECTION NOT COMPLETE
523	RTD	RWFDOC	A/B FUEL FLOW DUCT (Z 2, 3, 4)		B11	
524	FD-P	RPS2	FAN INLET STATIC PRESSURE	COUNTS	B15	

TABLE 4.2-1 (Cont.)  
RAW INPUT DATA BASE

CORE LOCATION (OCTAL)	DATA TYPE	SIGNAL NAME	DESCRIPTION	UNITS	SCALE FACTOR	SENSITIVITY ENG. UNITS/COUNT
525	RTD	RPLA	POWER LEVER ANGLE	COUNTS	B11	FINAL TRANSDUCER
526	RTD	RAJPSR	AJ POSITION REQUEST		B11	SELECTION NOT COMPLETE
527	RTD	RCIVVP	CIVV POSITION		B11	
530			INPUT DISCRETE REGISTER		N/A	
531			SPARE RESERVED FOR			
532			ADDITIONAL SIGNALS			
533						
534						
535						
536						
537						
540						
541						
542						
543						
544						
545						
546						
547						
550			THIS AREA USED			
551			BY CALIBRATED			
552			INPUT DATA BASE	COUNTS		

SEE TABLE 4.2-2

ORIGINAL PAGE IS  
OF POOR QUALITY

TABLE 4.2-1 (Cont.)  
 RAW INPUT DATA BASE

CORE LOCATION (OCTAL)	DATA SIGNAL TYPE NAME	DESCRIPTION	UNITS	SCALE FACTOR	SENSITIVITY ENG. UNITS/COUNT
553		THIS AREA USED BY CALIBRATED INPUT DATA BASE			
554					
555					
556					
557					
560					
561					
562					
563					
564					
565					
566					
567					
570					
571					
572					
573					
574					
575					
576					
577					

TABLE 4.2-2  
INPUT DISCRETE WORD

BIT	SOURCE	NAME SIGNAL	DESCRIPTION	LOGICAL RELATION
1 (MSB)	FUEL CTRL	RMODE	ENGINE HMC OR ELEC. CONTROL IND.	TRUE IMPLIES
2	FUEL CTRL	RPTDGC	HMC PRES. OR TEMP. FAIL IND.	TRUE IMPLIES
3	FUEL CTRL	REFILL	ZONE FILL COMPLETION IND.	TRUE IMPLIES
4	AIRFRAME	RIAR	IDLE AREA RESET	TRUE IMPLIES
5	AIRFRAME	RSQWS	SQUAT SWITCH (WOW)	TRUE IMPLIES
6				
7				
8				
9				
10				
11				
12				
13				
14				
15				
16				

TABLE 4.2-3  
RAW INPUT DATA BASE (UPLINK)

CORE LOCATION	NOMENCLATURE	DESCRIPTION
NOT YET SELECTED	RUW01	NOT CURRENTLY USED
	RUW02	
	RUW03	
	RUW04	
	RUW05	
	RUW06	
	RUW07	
	RUW08	
	RUW09	
	RUW10	
	RUW11	
	RUW12	
	RUW13	
	RUW14	
	RUW15	
	RUW16	
	RUW17	
	RUW18	
	RUW19	
	RUW20	
	RUW21	
	RUCLK	NOT CURRENTLY USED UPLINK CLOCK SYNCHRONIZER
	RUCSM	UPLINK CHECKSUM
	RUF SK	UPLINK FRAME SYNCH

TABLE 4.2-4  
CALIBRATED INPUT DATA BASE (ANALOG)

CORE LOCATION (OCTAL)	NOMENCLATURE	DESCRIPTION	UNITS	SCALE FACTOR
300	AD1G	LLA GRD. REF.	VOLTS	B0
301	AD2G	HLA GRD. REF.	VOLTS	B0
302	T2	T2 SELECTED	DEG. F	B9
303	EX1M5V	-5VDC SENSOR EXC. EX1	VOLTS	B3
304	T25	T2.5 SELECTED	DEG. F	B10
305	EX1P5V	+5VDC SENSOR EXC. EX1	VOLTS	B3
306	T3A	T3A	DEG. F	B11
307	IFUP5V	+5VDC IFU LOGIC SUPPLY	VOLTS	B3
310	T45A	FAN TURBINE INLET TEMP SELECTED	DEG. F	B12
311	UTIL1	C'PIT UTILITY POT #1	FRAC	B0
312	T6A	T6A	DEG. F	B12
313	UTIL2	C'PIT UTILITY POT #2	FRAC	B0
314	P25	P25	PSIA	B7
315	EX2A1K	1 Khz EXCITATION E-2	PSIA	B4
316	AD2REF	HLA REFERENCE VOLTAGE	VOLTS	B4
317	AD1REF	LLA REFERENCE VOLTAGE	VOLTS	B4
320	P3	P3	PSIA	B9
321	IFUP15V	+15VDC IFU ANALOG SUPPLY	VOLTS	B4
322	P6	P6M	PSIA	B6
323	IFUM15V	-15VDC IFU ANALOG SUPPLY	VOLTS	B4
324	PD13	P13 - PS13	PSIA	B5
325	EX4A3.9K	RESOLVER EXC. 3.9 Khz/9V	VOLTS	B4
326	PF2	MAIN FUEL PUMP DISC. PRES.	PSIA	-
327	UTIL3	C'PIT UTILITY POT #3	FRAC	B0
330	PF4	MAIN CONTROL DISC. PRES.	PSIA	-

ORIGINAL PAGE IS  
OF POOR QUALITY

TABLE 4.2-4 (Cont.)  
 CALIBRATED INPUT DATA BASE (ANALOG)

CORE LOCATION (OCTAL)	NOMENCLATURE	DESCRIPTION	UNITS	SCALE FACTOR
331	NTRM	C'PIT UTILITY POT #4 (N2 GRD. TRIM)	RPM	-
332	PFA4	AUG. CTRL. DISC. PRES.	PSIA	-
333	BUZZ	BUZZ INDICATOR	%	-
334	PFA5	AUG. CTRL. DISC. PRES.	PSIA	-
335	TURB	TURB INDICATOR	%	-
336		SPARE		
337	EX5P9V	+9VDC PAROS EXC. EX5	VOLTS	B4
340	T2CB	T2 COLD STREAM B	DEG. F	B9
341		SPARE		
342	T25CB	T25 COLD STREAM B	DEG. F	-
343		SPARE		
344	T3B	T3B	DEG. F	-
345	X1	FIRST RAMP ACTUATOR POSITION	INCHES	-
346	T45B	FTIT B	DEG. F	-
347	X4	3RD RAMP ACTUATOR POSITION	INCHES	-
350	T6B	T6B	DEG. F	-
351	T0	AMBIENT TOTAL TEMPERATURE	DEG. F	-
352	P25	P25	PSIA	-
353	ARUT	C'PIT TRIM POT #3 (A/B R/U GRD. TRM)	RU	-
354	PB	BURNER PRESSURE	PSIA	-
355	ALPHA	AIRCRAFT ANGLE OF ATTACK	DEG. F	-
356	P13	P13	PSIA	-
357	RUMBL	RUMBLE	-	-
360	PS13	PS13	PSIA	-

TABLE 4.2-4 (Cont.)  
 CALIBRATED INPUT DATA BASE (ANALOG)

CORE LOCATION (OCTAL)	NOMENCLATURE	DESCRIPTION	UNITS	SCALE FACTOR
361	FIRM	C'PIT TRIM POT #4 (FTIT TRIM)	DEG. F	
362	PFIA	AUG. FUEL PUMP DISC. PRES.	PSIA	
363	CBLDP	CUSTOMER BLEED POS		
364	PFI	MAIN PUMP INTERSTAGE PRES.	PSIA	
365	AJPOS	ACTUAL NOZZLE POSITION	PERCENT	
366	PF4A1	AUG. CTRL. DISC. PRES.	PSIA	
367	IDTM	COCKPIT TRIM POT #1 (IDLE GROUND TRIM)	COUNTS	
370	PF4A2	AUG. CTRL. DISC. PRES.	PSIA	
371	INTM	COCKPIT TRIM POT #2 (INTER. GROUND TRIM)	DEG.	
372	PF4A3	AUG. CTRL. DISC. PRES.	PSIA	
373	SPARE	SPARE		
374				
375				
376				
377	SPARE	SPARE		

55

ORIGINAL PAGE IS  
 OF POOR QUALITY



TABLE 4.2-4 (Cont.)  
 CALIBRATED INPUT DATA BASE (UPLINK)

CORE LOCATION	NOMENCLATURE	DESCRIPTION
550	UW01	NOT CURRENTLY USED
551	UW02	
552	UW03	
553	UW04	
554	UW05	
555	UW06	
556	UW07	
557	UW08	
560	UW09	
561	UW10	
562	UW11	
563	UW12	
564	UW13	
565	UW14	
566	UW15	
567	UW16	
570	UW17	
571	UW18	
572	UW19	
573	UW20	
574	UW21	NOT CURRENTLY USED
575	UCLK	UPLINK CLOCK SYNCHRONIZER
576	UCSM	UPLINK CHECKSUM
577	UFSK	UPLINK FRAME SYNCH

56

TABLE 4.2-4 (Cont.)  
CALIBRATED INPUT DATA BASE (DIRECT DIGITAL)

CORE LOCATION (OCTAL)	NOMENCLATURE	DESCRIPTION	UNITS	SCALE FACTOR
600	WFG1	GAS GENERATOR FUEL FLOW #1	PPH	B14
601	WFG2	GAS GENERATOR FUEL FLOW #2	PPH	B14
602	N1	LOW ROTOR SPEED #1 (SELECTED)	RPM	B14
603	N12	LOW ROTOR SPEED #2	RPM	B14
604	N2	HIGH ROTOR SPEED #1 (SELECTED)	RPM	B14
605	N22	HIGH ROTOR SPEED #2	RPM	B14
606	P1	INLET THROAT TOTAL PRESSURE	PSIA	
607	RCVV1	RCVV POSITION #1	DEG	
610	PS1	INLET THROAT STATIC PRESSURE	PSIA	
611	RCVV2	RCVV POSITION #2	DEG	
612	PO	AMBIENT TOTAL PRESSURE	PSIA	
613	SSVP	SEGMENT AND SEQUENCE VALVE POS.	DEG.	
614	PSD	AMBIENT STATIC PRESSURE	PSIA	
615	WFCOR	A/B FUEL FLOW CORE (Z 2, 3, 4)	PPH	
616	P2	FAN INLET TOTAL PRESSURE	PSIA	
617	WFDUC	A/B FUEL FLOW DUCT (Z 1, 5)	PPH	
620	PS2	FAN INLET STATIC PRESSURE	PSIA	
621	CPLA	POWER LEVER ANGLE	DEG	
622	AJPSR	AJ POSITION REQUEST	FT. <sup>2</sup>	B3
623	CIVVP	CIW POSITION	DEG	
624	N2MC	MINOR CYCLE UPDATED N2	RPM	
625	FILL	A/B MAN. FILL SIG. (1- FILLED)	DISCRETE	LSB
626	FLIT	FILL INTERRUPT FLAG (1- EVENT)	DISCRETE	LSB
627	IAR	IDLE AREA RESET	DISCRETE	LSB
630	ICYC	MINOR CYCLE CTR (FLIT)	B15	

TABLE 4.2-4 (Cont.)  
CALIBRATED INPUT DATA BASE (DIRECT DIGITAL)

CORE LOCATION (OCTAL)	NOMENCLATURE	DESCRIPTION	UNITS	SCALE FACTOR
631	SQWS	SQUAT SWITCH	DISCRETE	LSB
632		UNASSIGNED		
633		UNASSIGNED		
634		UNASSIGNED		
635		UNASSIGNED		
636		UNASSIGNED		
337		UNASSIGNED		
640		UNASSIGNED		
641		UNASSIGNED		
642		UNASSIGNED		
643		UNASSIGNED		
644		UNASSIGNED		
645		UNASSIGNED		
646		UNASSIGNED		
647		UNASSIGNED		

TABLE 4.2-4 (Cont.)  
CALIBRATED INPUT DATA BASE (CENTRAL COMPUTER)

CORE LOCATION (OCTAL)	SIGNAL NAME	DESCRIPTION	UNITS	SCALE FACTOR
700	IASPD	TRUE AIRSPEED	KTS	
	ITASPV	TRUE AIRSPEED VALIDITY (BIT 16)	LOGICAL	
701	IAATK	TRUE ANGLE OF ATTACK	DEG	
	IAATKV	TRUE ANGLE OF ATTACK VALIDITY (BIT 16)	LOGICAL	
702	IHHALT	PRESSURE ALTITUDE + VALIDITY (BIT 16)	FT.	
703	IASPO1	INDICATED AIRSPEED	KTS	B10
	IIASPV	INDICATED AIRSPEED VALIDITY BIT 16	KTS	
704	ILAOAD	LOCAL ANGLE OF ATTACK	SEMICIRCLE	B01
	ILAOAV	LOCAL AOA VALIDITY BIT 16	LOGICAL	
705	IMACHN	MACH NUMBER	ND	B02
	IMCHNV	MACH NUMBER VALIDITY BIT 16	LOGICAL	
706	IPRRAT	PRESSURE RATIO	ND	B01
	IPRRTV	PRESSURE RATIO VALIDITY BIT 16	LOGICAL	
707	IAIRDN	RELATIVE AIR DENSITY	ND	B01
	IAIRDV	RELATIVE AIR DENSITY VALIDITY BIT 16	LOGICAL	
710	ISTAOD	OPTIMUM ANGLE OF ATTACK	SEMICIRCLE	B01
	ISTAOV	OPTIMUM AOA VALIDITY BIT 16	LOGICAL	
711	IBCALT	BAROMETRIC CORRECTED PRESS. ALT	FEET	
712	IINSVL	INS VALIDITY	LOGICAL	
	IATTVI	INS ATTITUDE VALIDITY	LOGICAL	
713	IBIALT	INERTIAL ALTITUDE	FEET	B16
714	IPPLAT	PRESENT POSITION LATITUDE	CIRCLE	B00

TABLE 4.2-4 (Cont.)  
 CALIBRATED INPUT DATA BASE (CENTRAL COMPUTER)

CORE LOCATION (OCTAL)	SIGNAL NAME	DESCRIPTION	UNITS	SCALE FACTOR
715	IPPLAT	2 LSB'S IN BIT 1, 2		
716	IPPLON	PRESENT POSITION LONGITUDE	CIRCLE	B00
717	IPPLON	2 LSB'S IN BIT 1, 2		
720	IPTCHI	PITCH	CIRCLE	B00
721	IROLI	ROLL	CIRCLE	B00
722	ITUHDI	TRUE HEADING	CIRCLE	B00
723	IVELNS	NORTH - SOUTH VELOCITY	KTS	B12
724	IVELEW	EAST - WEST VELOCITY	KTS	B12
725	IVELVT	VERTICAL VELOCITY	KTS	B11
726	IACCNS	NORTH - SOUTH ACCELERATION	FPS <sup>2</sup>	B08
727	IACCEW	EAST - WEST ACCELERATION	FPS <sup>2</sup>	B08
730	IACCVE	VERTICAL ACCELERATION	FPS <sup>2</sup>	B09
731	IHSICS	COURSE SET	CIRCLE	B00
732	IHSIMS	HEADING SET	CIRCLE	B00
733	IRGTCN	TACAN DISTANCE	NM	
734	IBRTCN	TACAN BEARING	CIRCLE	B00
735	IMSIXI	BIT 1 BEARING REL. ALARM	LOGICAL	
		BIT 2 DISTANCE REL. ALARM		
		BIT 3 LOCALIZER REL. ALARM		
		BIT 4 GLIDESLOPE REL. ALARM		
		BIT 5 MIDDLE/OUTER MARKER	LOGICAL	

09

TABLE 4.2-4 (Cont.)  
 CALIBRATED INPUT DATA BASE (CENTRAL COMPUTER)

CORE LOCATION (OCTAL)	SIGNAL NAME	DESCRIPTION	UNITS	SCALE FACTOR
736	ILSLVD	LOCALIZER DEVIATION	ND	800
737	ILSGSD	GLIDESLOPE DEVIATION	ND	800
740	IPTCHA	PITCH ANGLE (AHR)	CIRCLE	800
741	IROLLA	ROLL ANGLE (AHR)	CIRCLE	800
742	IMAGHD	MAGNETIC HEADING (AHR)	CIRCLE	800
743				
744		MAGNETIC HEADING (AHR)		
745		RESERVED FOR		
746		FURTHER C/C DATA		
747				
750				
751				
752				
753				
754				
755				
756		RESERVED FOR		
757		FURTHER C/C DATA		

Data are entered into the calibrated control output data base (Table 4.2-5) from the applications modules and the Host Program. Data are accessed from this data base by the output driver which formats the data, and provides inhibit/enable functions, and outputs the data to the IFU.

The formatted control output data base (Table 4.2-6) is created by the output driver from the calibrated output data base in light of data obtained from the status engage logic and the data validation module. Thus, the data in this base incorporates failure response and engage functions.

The analysis output data base is the set of variables accessed from any desired location in core by the down link data interrupt ventive. The data base menu is tabulated in Table 4.2-7. Further data base menus may be defined as required for analysis purposes.

TABLE 4.2-5  
CALIBRATED CONTROL OUTPUT DATA BASE

LOCATION	VARIABLE	DESCRIPTION	UNITS	SCALING
	X1C	FIRST RAMP POSITION CMD	INCHES	
	X4C	3RD RAMP POSITION CMD	INCHES	
	BPDI	BYPASS DOOR T/M CMD	MA	
	AJC	NOZZLE AREA COMMAND	SQ FT	
	BLED	START BLEED COMMAND	DISCRETE	
	CIVC	CIVV COMMAND	DEG	
	IGN	A/B IGNITION COMMAND	DISCRETE	
	IGNM	MAIN BURNER IGNITION CMD	DISCRETE	
	RCVC	COMMANDED RCVV POSITION	DEG	
	SSVC	COMMANDED SSV POSITION	DEG	
	WFAD	DUCT A/B FUEL FLOW CMD	PPH	
	WFC	GAS GEN FUEL FLOW CMD	PPH	
	WFCR	CORE A/B FUEL FLOW CMD	PPH	
	ETAC	CAS NORMAL ACCEL CMD	G	
	PHDC	CAS ROLL RATE CMD	°/SEC	
	CPD1C	COCKPIT DISP. #1 (AUTOTHROTTLE)	DEG	
	CPD2C	COCKPIT DISP. #2	%	
	CPD3C	COCKPIT DISP. #3	%	

63

ORIGINAL PAGE IS  
OF POOR QUALITY



TABLE 4.2-6  
 FORMATTED CONTROL OUTPUT DATA BASE

VARIABLE	DESCRIPTION	SENSITIVITY
X1C	FIRST RAMP POSITION CMD	
X2C	3RD RAMP POSITION CMD	
BPDI	BYPASS DOOR T/M CMD	
AJC	NOZZLE AREA COMMAND	
CIVC	CIVV COMMAND	
RCVC	COMMANDED RCVV POSITION	
SSVC	COMMANDED SSV POSITION	
WFAD	DUCT A/B FUEL FLOW CMD	
WFC	GAS GEN FUEL FLOW CMD	
WFCR	CORE A/B FUEL FLOW CMD	
ETAC	CAS NORMAL ACCEL CMD	
PHDC	CAS ROLL RATE CMD	
BLED	START BLEED COMMAND	
IGNM	MAIN BURNER IGNITION CMD	
IGN	A/B IGNITION COMMAND	
CPD1C	COCKPIT DISP. 1 (AUTOTHROTTLE)	
CPD2C	COCKPIT DISP. 2	
CPD3C	COCKPIT DISP. 3	

TABLE 4.2-7  
ANALYSIS DATA BASE MENU

WORD #	VARIABLE ACCESSED	DESCRIPTION	UNITS	SCALE FACTOR
0		FRAME SYNCH	N/A	N/A
1	ALPA	AIRCRAFT ANGLE OF ATTACK	DEG	NOT YET ESTAB.
2	BPDE	BYPASS DOOR PRT ERROR	ND	
3	DEL3	THIRD RAMP ANGLE CMD	INCHES	
4	PROC	FILTERED PRO	ND	
5	PRBZ	BUZZ PRESSURE RATIO	ND	
6	PRS	SUPERCRITICAL PRESSURE RATIO	ND	
7	PRT	THROAT PRESSURE RATIO	ND	
8	TO	FREESTREAM TOTAL TEMP.	DEG. F	
9	X1	FIRST RAMP ACTUATOR POSITION	INCHES	
10	X4	THIRD RAMPACTUATOR POSITION	INCHES	
11	XBP	BYPASS DOOR ACTUATOR POSITION	INCHES	
12	AJC	NOZZLE AREA CMD	FT <sup>2</sup>	
13	CIVC	CIVV CMD	DEG.	
14	DMOP	MN COMMANDED MIN PLAP	ND	
15	DN2	N2 ERROR FOR AIRFLOW ADJ	RPM	NOT YET ESTAB.

65

ORIGINAL PAGE IS  
OF POOR QUALITY

TABLE 4.2-7 (Cont.)  
ANALYSIS DATA BASE MENU

WORD #	VARIABLE ACCESSED	DESCRIPTION	UNITS	SCALE FACTOR
16	DN2E	AIRFLOW ERROR FOR N2 BIAS	PPS	NOT YET ESTAB.
17	DN2U	N2 UPMATCH	RPM	
18	DPLU	PLA UPMATCH	DEG	
19	ERRR	FTIT ERROR FOR N2 BIAS	DEG. F	
20	FTDS	DESIGN FTIT	DEG. F	
21	FTLL	COMPENSATED FTIT	DEG. F	
22	NTRM	N2 GROUND TRIM	RPM	
23	N1	LOW ROTOR SPEED	RPM	
24	N2	HIGH COMPRESSOR SPEED	RPM	
25	PB	BURNER PRESSURE	PSIA	
26	PBLL	COMPENSATED PB	PSIA	
27	PLA	POWER LEVER ANGLE	DEG	
28	PLAP	RATE LIMITED PLA	DEG /SEC	
29	RCVC	COMMANDED RCVV POSITION	DEG	
30	SPLT	CORE/TOTAL A/B FUEL FLOW	FRAC.	
31	T2LG	FILTERED T2	DEG. F	NOT YET ESTAB.

TABLE 4.2-7 (Cont.)  
ANALYSIS DATA BASE MENU

WORD #	VARIABLE ACCESSED	DESCRIPTION	UNIT	SCALE FACTOR
32	T25C	COMPENSATED T25	DEG. F	NOT YET ESTAB.
33	WCDS	DESIRED CORRECTED AIRFLOW	PPS	
34	WFCR	CORE A/B FUEL FLOW CMD	PPH	
35	WFAD	DUET A/B FUEL FLOW CMD	PPH	
36	WFPO	OPERATING LINE WF/Pb	RU	
37	WFPX	ACCEL SCHEDULE WF/Pb	RU	
38	IAS PDT	TRUE AIRSPEED + VALIDITY	KTS	
39	IAATKT	TRUE ANGLE OF ATTACK + V	DEG	
40	IHHALT	PRESSURE ALTITUDE + V	FT	
41	IAS P01	INDICATED AIRSPEED + V	KTS	
42	ILAOAD	LOCAL ANGLE OF ATTACK	SEMICIRCLE	
43	MN	MACH NUMBER (INLET)	ND	
44	IMACHN	AIRPLANE MACH NUMBER	ND	
45	IBIALT	INERTIAL ALTITUDE	FT	
46	IPTCHI	PITCH	CIRCLE	
47	IROLLI	ROLL	CIRCLE	
48	ITUHDI	TRUE HEADING	CIRCLE	
49	IVELNS	NORTH-SOUTH VELOCITY	KTS	
50	IVELEW	EAST-WEST VELOCITY	KTS	NOT YET ESTAB.

ORIGINAL PAGE  
OF POOR QUALITY

TABLE 4.2-7 (Cont.)  
ANALYSIS DATA BASE MENU

WORD #	VARIABLE ACCESSED	DESCRIPTION	UNITS	SCALE FACTOR
51	IVELVT	VERTICAL VELOCITY	KTS	NOT YET ESTAB.
52		SPARE		
53		SPARE		
54		SPARE		
55		SPARE		
56		SPARE		
57		SPARE		
58		SPARE		
59		SPARE		

#### 4.2.3 Common Constants

For user convenience common constants are provided as indicated in Table 4.2-8. User programs requiring additions to the common constants table should request their inclusion by the systems integrator.

#### 4.3 HOST PROGRAM SCRATCH PAD

As shown in Table 4.3-1 a portion of sector zero has been reserved for Host Program scratch pad. As software development proceeds portions of this may be reallocated to other CPC's on an as required basis.

TABLE 4.2-8  
COMMON CONSTANTS

LOCATION	NOMENCLATURE	DESCRIPTION	UNITS	SCALING
----------	--------------	-------------	-------	---------

NON ALLOCATED TO DATE

TABLE 4.3-1  
HOST SCRATCH PAD

CORE LOCATION (OCTAL)	SIGNAL NAME	DESCRIPTION	UNITS	SCALE FACTOR	SOURCE
221		RESERVED FOR SCRATCH PAD			
222					
223					
224					
225					
226					
227					
230					
231					
232					
233					
234					
235					
236					
237					
240					
241					
242					
243					
244					
245					
246					
247					
250					
251					
252					
253					
254		RESERVED FOR SCRATCH PAD			

ORIGINAL PAGE IS  
OF POOR QUALITY



TABLE 4.3-1 (Cont.)  
HOST SCRATCH PAD

CORE LOCATION (OCTAL)	SIGNAL NAME	DESCRIPTION	UNITS	SCALE FACTOR	SOURCE
650		RESERVED FOR SCRATCH PAD			
651					
652					
653					
654					
655					
656					
657					
660					
661					
662					
663					
664					
665					
666					
667					
670					
671					
672					
673					
674					
675					
676					
677		RESERVED FOR SCRATCH PAD			

72

TABLE 4.3-1 (Cont.)  
HOST SCRATCH PAD

CORE LOCATION (OCTAL)	SIGNAL NAME	DESCRIPTION	UNITS	SCALE FACTOR	SOURCE
760		RESERVED FOR SCRATCH PAD			
761					
762					
763					
764					
765					
766					
767					
770					
771					
772					
773					
774					
775					
776					
777			RESERVED FOR SCRATCH PAD		

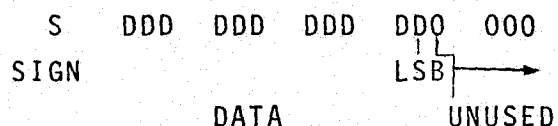
ORIGINAL PAGE IS  
OF POOR QUALITY

#### 4.4 INPUT PROCESSING DEFINITION

Data enter the DCU to form the raw input data base from three sources - the direct memory access (DMA) system, DCU sense lines, and the uplink system via the input bus. Section 4.2.1 documents the input data base. Raw data from these sources are processed per the requirements of the following paragraphs to create the calibrated input data base (IDB) of Table 4.2-4. IDB update rate is once per 60 milliseconds and occurs, see timing diagram Figure 4.1-4, during the 11th and 12th minor cycles.

##### 4.4.1 Analog Transducers

Raw analog data are input to locations 400 through 477 during minor cycles 5 and 6, and 11 and 12 by the executive. Processing of the data occurs during minor cycle 7 and 12. Analog data word format is:



Data are 2's complement. LSB values for HL and LL mux are:

HL	LSB = 2.5 mvolt
LL	LSB = 14.7058 $\mu$ volt

##### 4.4.1.1 Minor Cycle 7 Processing

During minor cycle 7 data input during minor cycles 5 and 6 are shifted right one and buffered (RD56) for further processing in minor cycle 12.

#### 4.4.1.2 Minor Cycle 12 Processing

During minor cycle 12 data input during minor cycles 11 and 12 are combined with buffered data from minor cycle 7 and processed as indicated in the flow chart Figure 4.4-1. All 64 analog input channels are processed through the analog input data processing and gross failure detection routine, to perform the following:

1. Average data sampled in minor cycles 5, 6 and 11, 12;
2. Verify all analog data falls within gross limits of  $\pm 98\%$  of the A/D converter range;
3. Calibrate all data to engineering units using the linear relation shown in Figure 4.4-1.

Transducers excited by the IFU  $\pm 5$  volt precision supply are corrected for supply variation. Because the raw data requiring correction are not conveniently stacked logic is provided to selectively correct variables.

The index register value associated with transducer failures is saved as is the nature of the failure (high or low).

More than two indicated transducer failures in a single pass cause a transfer to the immediate disengage routine, see paragraph 4.1.2.

#### 4.4.1.3 Thermocouple Data

Thermocouple data are further processed as shown in Figure 4.4-2. Thermocouple pairs are compared for validity and averaged if valid. If invalid, further processing, not yet defined, is performed to identify a valid signal. In either case each of the resulting temperatures, at this point in millivolts, is converted

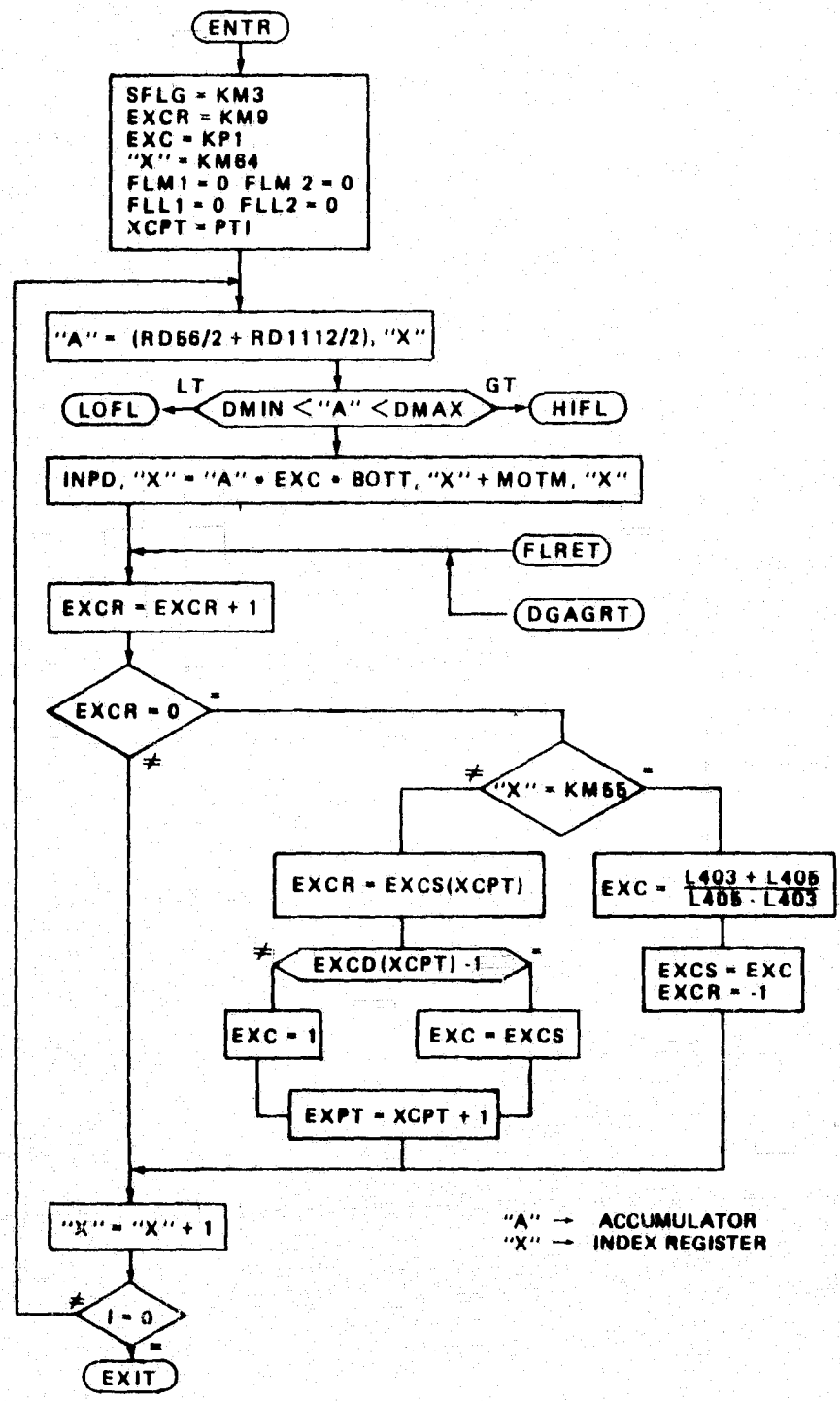


Figure 4.4-1 Analog Input Data Processing and Gross Failure Detection

ORIGINAL PAGE IS  
OF POOR QUALITY

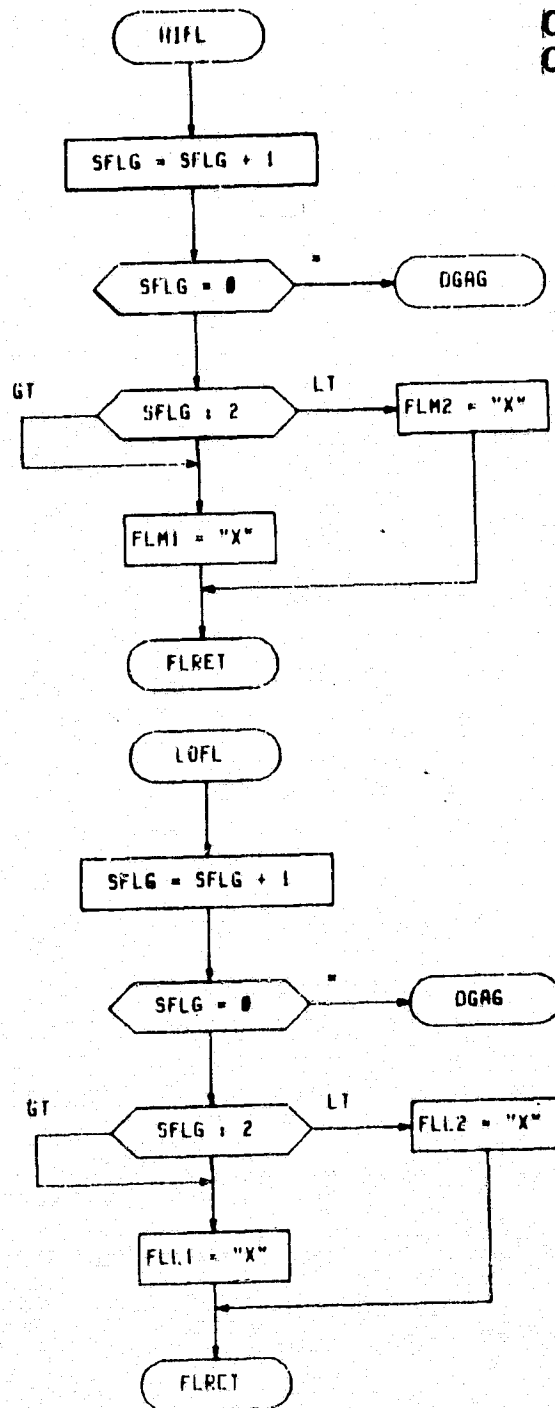


Figure 4.4-1 (cont.)

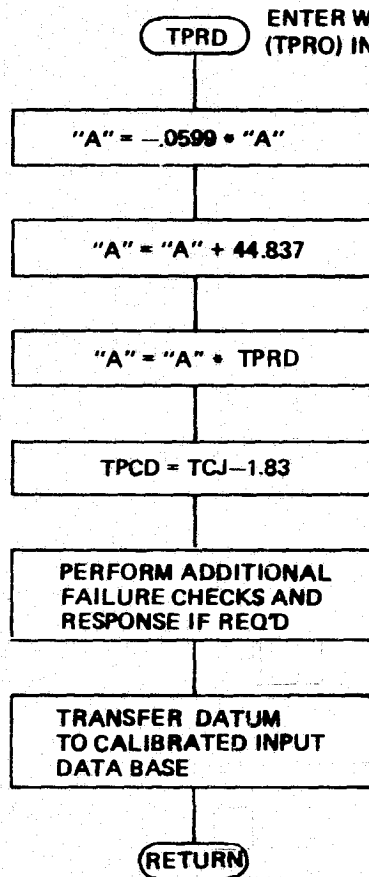
78

DGAG	BRANCH TO IMMEDIATE DISENGAGE ROUTINE	
DGAGRT	RETURN FROM IMMEDIATE DISENGAGE ROUTINE	
DMAX	MAXIMUM ALLOWABLE A/D CONVERTER OUTPUT COUNT ( $.98_{10} B0$ )	
DMIN	MINIMUM ALLOWABLE A/D CONVERTER OUTPUT COUNT ( $-.98_{10} B0$ )	
EXC	CORRECTION FACTOR FOR EXCITATION VOLTAGE DEVIATION	
EXCD	LOGICAL FLAG ARRAY TO IDENTIFY PARAMETERS REQUIRING EXCITATION CORRECTION	
EXCR	RANGE COUNTER TO IDENTIFY BLOCKS OF DATA REQUIRING EXCITATION CORRECTION	
EXCS	ARRAY OF EXCR VALUES	
FLL1	INDEX VALUE FOR FIRST LOW FAILED DATUM	
FLL2	INDEX VALUE FOR SECOND LOW FAILED DATUM	
FLM1	INDEX VALUE FOR FIRST HIGH FAILED DATUM	
FLM2	INDEX VALUE FOR SECOND HIGH FAILED DATUM	
FLRET	RETURN FROM FAILURE IDENTIFICATION ROUTINE	
HIFL	BRANCH TO HIGH FAILURE IDENTIFICATION ROUTINE	
INPD	INPUT DATA BASE REFERENCE ADDRESS ('377) SEE TABLE 4.2-1	
KM3	$-3_{10}$	B15
KM9	$-9_{10}$	B15
KM55	$-55_{10}$	B15
KM64	$-64_{10}$	B15
KP1	.99999	B0
LOFL	BRANCH TO LOW FAILURE IDENTIFICATION ROUTINE	
PTI	POINTER TO THE INITIAL LOCATION OF EXCS, EXCD ARRAYS	
RD1112	ANALOG RAW DATA FOR MINOR CYCLES 11, 12 (loc 400-477)	

Figure 4.4-1. (Cont.)

RD56	ANALOG RAW DATA FOR MINOR CYCLES 5, 6 (LOC NOT YET ASSIGNED)
SFLG	SENSOR FLAG MONITORS NUMBER OF SENSOR FAILURES
XCPT	POINTER TO CURRENT LOCATION OF EXCS, EXCD ARRAYS
BOTT	ARRAY OF TRANSDUCER SENSITIVITIES
BOTM	ARRAY OF TRANSDUCER OFFSETS





<u>VARIABLE</u>	<u>DESCRIPTION</u>	<u>UNITS</u>	<u>SCALE FACTOR</u>
TCPR	TEMPERATURE CALIBRATION ROUTINE ENTRY POINT	-	-
TPRD	TEMPERATURE (T/C) RAW DATUM	mV	B5
TCJ	COLD REFERENCE TEMPERATURE (32 deg EXCEPT FTIT REFERENCE IS NOT YET DEFINED BUT WILL BE ~600 deg	deg F	B12
TPCD	CALIBRATED DATA	deg F	B12

Figure 4.4-2 Thermocouple Processing

80

ORIGINAL PAGE IS  
OF POOR QUALITY

to degrees F by a table look up corresponding to NBS-561. The resulting data are then stored in the processed input data base, see Table 4.2-4.

#### 4.4.2 Resolvers

Resolvers provide feedback for control of all engine actuators. Since the actuator servo loops are closed on an analog basis in the IFU, resolver data are incorporated in the input data base for use only in data reduction and control algorithms. The resolver data word format is:

	DATA			UNUSED	
E	TTT	TTT	TTT	TTO	000
1				LSB	16

where: E is error bit  
E=0 implies normal conversion  
E=1 implies failure  
T is an 11 bit data word  
LSB = .0909 degrees.

Due to hardware limitations useful range of the data is 5 degrees to 175 degrees. Figures 4.5-4 through -10 document the application of the resolvers used in engine sensors. PLA calibration curve is depicted in Figure 4.4-3.

Resolver processing is depicted in Figure 4.4-4. Fuel flow and RCVV resolvers are validity checked independent of this processing on a minor cycle basis and hence are not checked here. The remaining resolver data are validity checked. Invalid data are identified by saving the related pointer. An indicated failure of any resolver causes immediate disengagement of the engine control mode. Dual resolver data are averaged and the resulting array of raw resolver data is converted to engineering units by

e-2

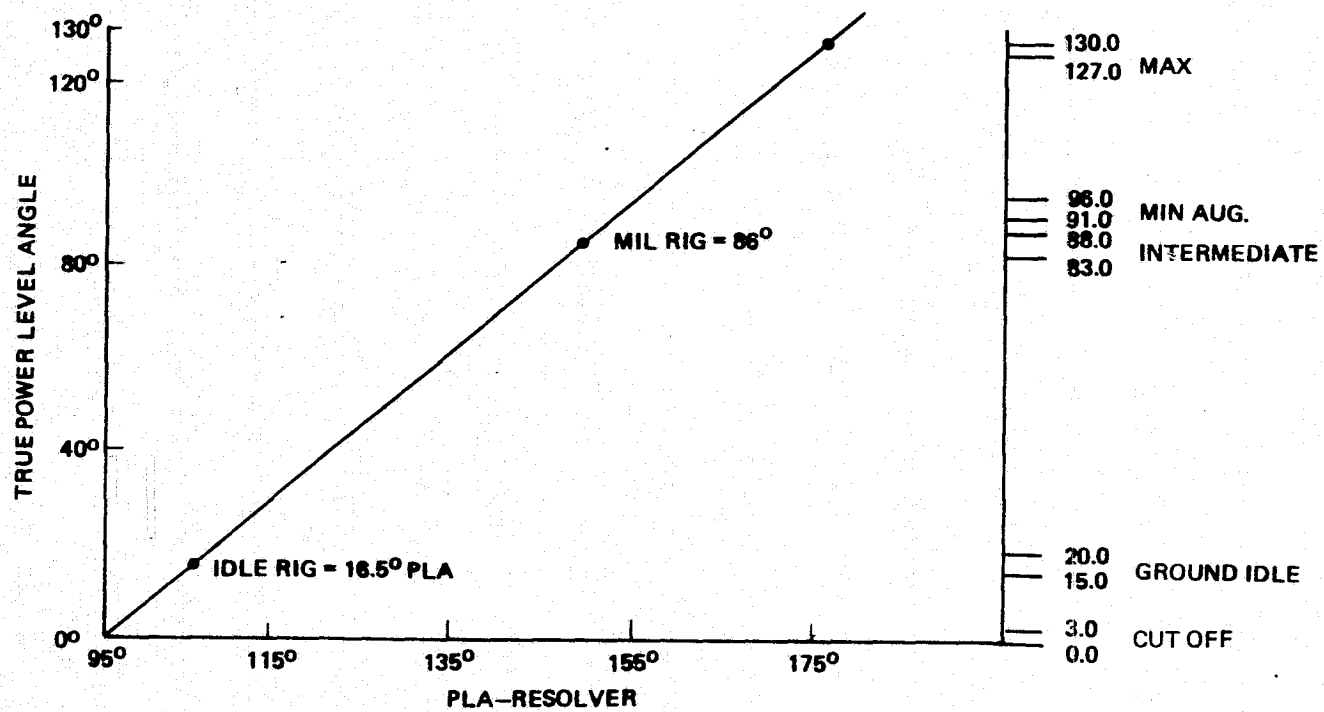


Figure 4.4-3 PLA Resolver Calibration

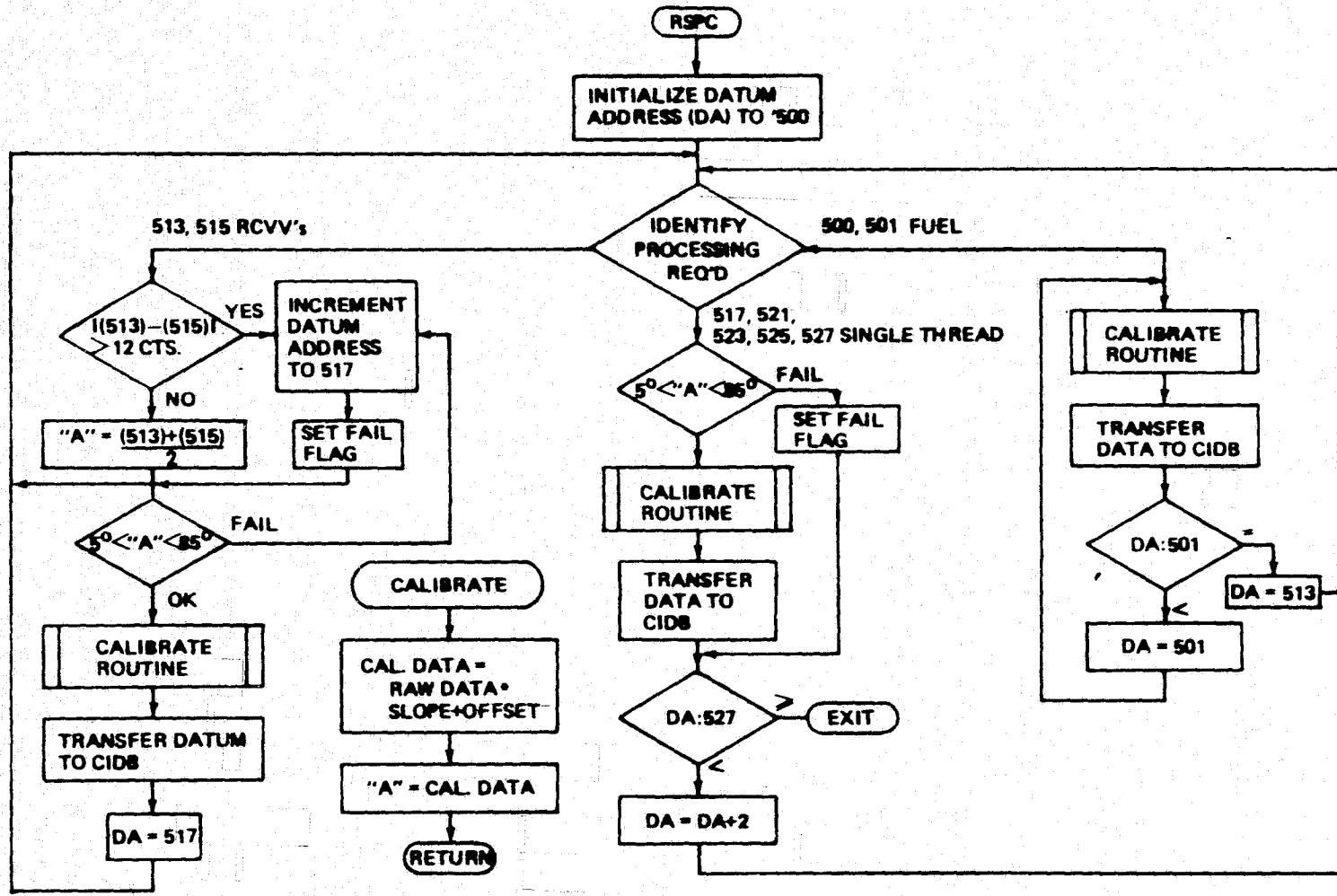


Figure 4.4.4 Resolver Processing

the indicated linear equation. Relevant coefficients are obtained from Figures 4.5-4 through 10. After conversion the data are checked against actuator limits. Out of range data are considered indicative of failure and result in engine control disengagement. The last valid data point is retained in the input data base when a failure is identified. Finally, the calibrated and verified data are transferred to the input data base.

### 4.4.3 Tachometer Data Processing

Tachometer data are obtained from redundant pulse tachometers geared to the low rotor and from redundant EEC generator windings, geared to N2. Relevant data for the two devices are provided in Table 4.4-1.

The tachometer data format is as follows:

WORD 1    X XXX TTT TTT TTT TTT    LSB = 1 μsec  
                Time  
                (for P teeth)

WORD 2    X XXX XXX XXX XX P PPP  
                                Period (number of teeth  
                                counted in time  
                                sample LSB = 1  
                                count)

$$N = (\text{EGR}) * \left(\frac{P}{T}\right) * \frac{1}{NT} * 60$$

- EGR = Engine gear ratio (Engine speed/tach speed)
- P = Number of teeth counted in time T
- T = Time to count P teeth, seconds
- NT = Number of teeth on tach
- N = Engine shaft speed in RPM

ORIGINAL PAGE IS  
OF POOR QUALITY

#### Validity Criterion

If the period is zero, the data are out of range; that is, the frequency is too low for measurement. If the number of recorded events is 15 (decimal) and the number of clock periods is less than 1792 (decimal), the data are out of range; that is, the frequency is too high for measurement. The allowable frequency range is  $260 \text{ hz} < P/T < 8370 \text{ hz}$ .

TABLE 4.4-1  
TACHOMETER INTERFACES

N1 TACHOMETER

Fan Speed ( $N_1$ ) signals are supplied from a dual element magnetic sensor mounted to detect the frequency of pulses generated by 38 magnetic lobes in the engine  $N_1$  rotor assembly.

Signal Range: 1,800 r/min to 15,000 r/min.  
Frequency Range: 1139.94 Hz to 9499.5 Hz  
Waveform Output: Waveform is a distorted sinusoid, fundamental frequency =  $0.6333 N_1$ .  
Voltage Output: Minimum peak positive pulse is 300 millivolts at  $N_1 = 1420$  r/min. Maximum peak positive pulse should not exceed 60 volts at  $N_1 = 12700$  r/min.

N2 TACHOMETER

The high compressor speed ( $N_2$ ) signal is derived from the single phase generator power winding that supplies the EEC 20 volt power. The generator has nine-pole pairs and is geared to the compressor rotor at a ratio of 1.073 to 1.

Therefore: frequency (Hz) =  $1.073 (9/60) N_2$   
=  $0.16095 N_2$   
Signal Range: 7300 r/min to 18000 r/min.  
Frequency Range: 1174.935 Hz to 2897.1 Hz  
Voltage Output: 20 volts min. at 3700 r/min.  
25 volts max.  
Waveform: Sinusoid

## Processing:

Tachometer data are processed in all minor cycles to save minor cycle samples of data and during minor cycle 12 to calibrate the data.

### Minor Cycle Processing

Both N1 and N2 redundant signals are checked for validity per the criterion above. Invalid data are flagged by saving the relevant pointer and failure response, not yet defined, is taken. N2 is then computed from available valid data and control is transferred to the high rate RCVV command computation. Upon return from the high rate computation, N1 and N2 counters are accumulated for processing in minor cycle 12.

### Major Cycle Processing (Minor Cycle 12)

Raw redundant N1 and N2 data accumulated during the 12 minor cycles are compared as a validity check. The data are then averaged and converted to engineering units per the relationships indicated above. Before transfer to the input data base, data are checked against limits. Failure of either check results in immediate disengage of the engine control mode.

#### 4.4.4 Quartz Crystal Transducers (QCT)

The six QCT's generate raw data in the format defined below. The data word format is:

ORIGINAL PAGE IS  
OF POOR QUALITY



E DDD DDD DDD DDD DDD

E is error bit

Zero implies normal conversion

One implies out of range

D is 15 bit data word

LSB = 250 nanoseconds

The converter counts 32768 clock pulses before starting to accumulate the output word and accumulates time for 420 transducer output cycles. Thus transducer frequency is

$$F \text{ (khz)} = (4000 \frac{\text{counts}}{\text{msec}}) \times (420 \frac{\text{input cycles}}{\text{sample}}) \times (\frac{1}{D_{10} + 32768 \text{ counts/sample}})$$

It is necessary to start these converters with OCP 1324. This OCP clears the converters and at the trailing edge starts the conversion sequence. This converter may require up to 13.5 milliseconds to complete its conversion; therefore, it shall not be read until 15 milliseconds has elapsed from the OCP 1324.

These data are processed on minor cycles 2, 5, 8, and 11. The error bits are checked and failed transducers are recorded by the pointer. Failure response is as indicated in Table 4.4-2. Valid data are then converted to engineering units using the following relationships.

$$P = A + B \cdot K + C \cdot K^2$$

P = Pressure in PSIA

K = Counts - 6208

Coef. A, B, C are tabulated in Table 4.4-3

TABLE 4.4-2  
 Quartz Crystal Transducer Failure Response

PS0	DISENGAGE INLET FUNCTIONS
P0	DISENGAGE INLET FUNCTIONS
PS1	DISENGAGE INLET FUNCTIONS
P1	DISENGAGE INLET FUNCTIONS
PS2	NOT DEFINED AT THIS TIME
P2	NOT DEFINED AT THIS TIME

TABLE 4.4-3  
 Quartz Crystal Transducer Calibration Data

TRANSDUCER S / N	FUNCTION	A	B	C
	PS0	-3.345978 E1	7.685421 E-3	-1.74279 E-7
	P0			
	PS1	Typical data. Coefficients will		
	P1	be available upon transducer		
	PS2	acquisition and designation.		
	P2			

#### 4.4.5 Central Computer Data

Central computer bus data are transmitted from their sources in scaled engineering units. The executive causes this data to be transferred to location 700-757 from the IFU buffer during minor cycles 4 and 10. The available data array is presented in Table 4.2-4.

#### 4.4.6 Input Discretes

The input discrete register, Table 4.2-2, is transferred from the raw data base where it is updated every minor cycle to the input data base during minor cycle 12.

### 4.5 OUTPUT PROCESSING DEFINITION

The PROFIT system is capable of outputting 16 analog channels and 48 discretes. Thirteen of the analog channels are used to provide commands to engine, inlet actuators, and the CAS interface. The remaining three are committed to driving programmable cockpit displays, but may be applied as required to provide commands to additional servos. D/A channel allocation is shown in Table 4.5-1. The 48 output discretes are used to provide engaging control for each PROFIT system, control cockpit caution lights, and perform other functions that will be defined subsequently.

In the following sections substantial information concerning the actuator servo systems is provided for information only. Table 4.5-2 documents the characteristics of the inlet servo valves and Table 4.5-3 provides the same information for the engine actuators.

#### 4.5.1 First Ramp

Commands to the first ramp are generated in terms of inches of actuator stroke by the inlet control. As indicated in Figure

TABLE 4.5-1  
D/A Channel Allocation

D/A CHANNEL	CALIBRATED OUTPUT DATA BASE VARIABLE	NOMENCLATURE
1	X1C	FIRST RAMP CMD
2	X4C	3RD RAMP CMD
3	BPDI	BYPASS DOOR CMD
4	CIVC	CIVV CMD
5	RCVC	RCVC CMD
6	WFC	GAS GENERATOR FUEL CMD
7	WFCR	CORE A/B FUEL CMD
8	WFAD	DUCT A/B FUEL CMD
9	SSVC	SEGMENT/SEQ. VALVE CMD
10	AJC	EXHAUST NOZZLE AREA
11	ETAC	CAS NORMAL ACCEL. CMD
12	PHDC	CAS ROLL RATE CMD
13	CPD1C	C'PIT DISPLAY 1 (THROTTLE ERROR)
14	CPD2C	C'PIT DISPLAY 2
15	CPD3C	C'PIT DISPLAY 3
16	-	SPARE

TABLE 4.5-2  
TYPE HMC SERVO VALVE CHARACTERISTICS

COIL WINDINGS  
 D.C. RESISTANCE = 125. ± 12 OHMS @ 70°F  
 RATED CURRENT = ± 20. MA  
 MAX. CURRENT = ± 40. ± 3. MA  
 COIL CONFIGURATION = PARALLEL AIDING  
 INDUCTANCE = .58 HENRIES @ 50 Hz

VALVE CHARACTERISTICS

UNIT	GAIN (NOMINAL)	HULL BIAS	+RATE LIMIT	-RATE LIMIT	SERVO OPEN LOOP GAIN
FIRST RAMP	+1.02 in/sec/ma	0.	+21. in/sec	-21. in/sec	29.12 sec
BYPASS DOOR	+1.68 in/sec/ma	0.	+18.3 in/sec	-18.3 in/sec	VARIABLE
3RD RAMP	+1.47 in/sec/ma	0.	+10. in/sec	-10. in/sec	32.36 sec

TABLE 4.5-3  
ENGINE TYPE PW/B SERVO VALVE CHARACTERISTICS

COIL ALL UNITS  
 D.C. RESISTANCE = 158 OHMS/COIL  
 RATED CURRENT =  $\pm 20$  ma  
 MAX CURRENT =  $\pm 57$  ma  
 COIL CONFIGURATION = DUAL PARALLEL AIDING  
 INDUCTANCE = .238 HENRIES/COIL

VALVE CHARACTERISTICS

93

<u>UNIT</u>	<u>GAIN (NOMINAL)</u>	<u>NULL BIAS</u>	<u>+ RATE LIMIT</u>	<u>- RATE LIMIT</u>	<u>SERVO OPEN LOOP GAIN</u>
RCVV	-6. DEG/SEC/MA	-4. MA	+120. DEG/SEC	-120. DEG/SEC	40. SEC <sup>-1</sup>
CIVV	+6. DEG/SEC/MA	-4. MA	+120. DEG/SEC	-120. DEG/SEC	10. SEC <sup>-1</sup>
SSV	+7.75 DEG/SEC/MA	-4. MA	+155. DEG/SEC	-155. DEG/SEC	20. SEC <sup>-1</sup>
WFG	+25.5 DEG/SEC/MA	-4. MA	+510. DEG/SEC	-510. DEG/SEC	20. SEC <sup>-1</sup>
WFAC	+8. DEG/SEC/MA	-20. MA	+160. DEG/SEC	-160. DEG/SEC	20. SEC <sup>-1</sup>
WFAD	-8. DEG/SEC/MA	-20. MA	+160. DEG/SEC	-160. DEG/SEC	20. SEC <sup>-1</sup>
CENC	-5.63 DEG/SEC/MA	-6. MA	+112.5 DEG/SEC	-112.5 DEG/SEC	20. SEC <sup>-1</sup>

4.5-1 the output processor provides an offset and gain adjustment to accommodate installation tolerances and scales, formats and outputs the command to the D/A converter during minor cycles 2, 5, 8, and 11.

#### 4.5.2 Third Ramp

Third ramp processing, as shown in Figure 4.5-2, is identical to first ramp processing.

#### 4.5.3 Bypass Door

As indicated in Figure 4.5-3 the bypass door control loop is closed in the DCU software. Thus the outputs from the control module are in milliamperes of torque motor current. This is formatted and output directly through the D/A during minor cycles 2, 5, 8, and 11.

#### 4.5.4 Compressor Inlet Variable Vanes (CIVV)

As indicated in Figure 4.5-4 CIVV position command is generated by the control in terms of CIVV vane rotation angle. This is converted to inches of CIVV stroke by the output processor formatted and output through the D/A converter during minor cycle 11.

#### 4.5.5 Rear Compressor Variable Vanes (RCVV)

As indicated in Figure 4.5-5 RCVV commands are generated in the engine control in degrees of RCVV vane rotation. The output processor converts this to inches of actuator stroke, formats it and outputs it through the D/A in every minor cycle.

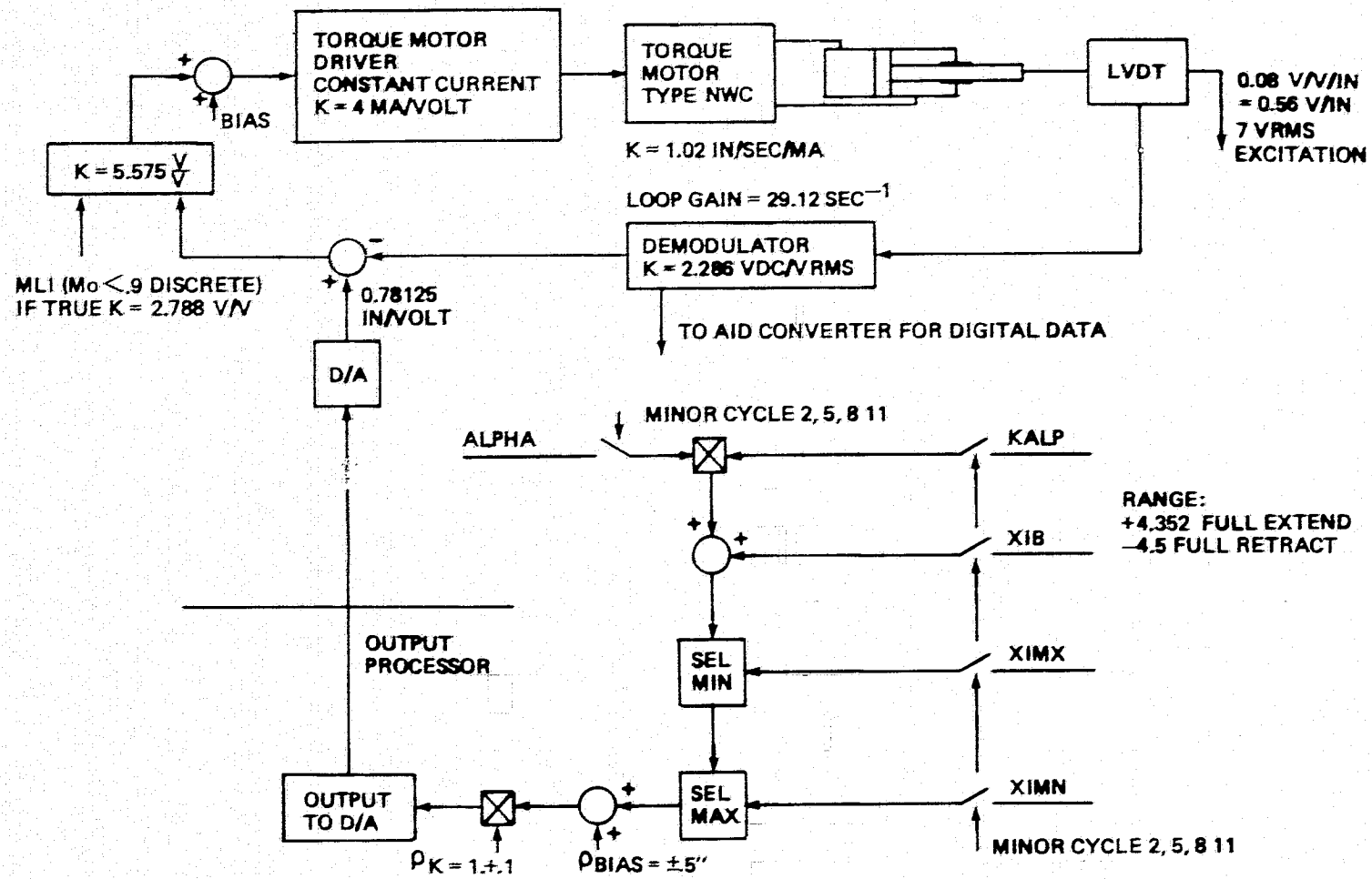
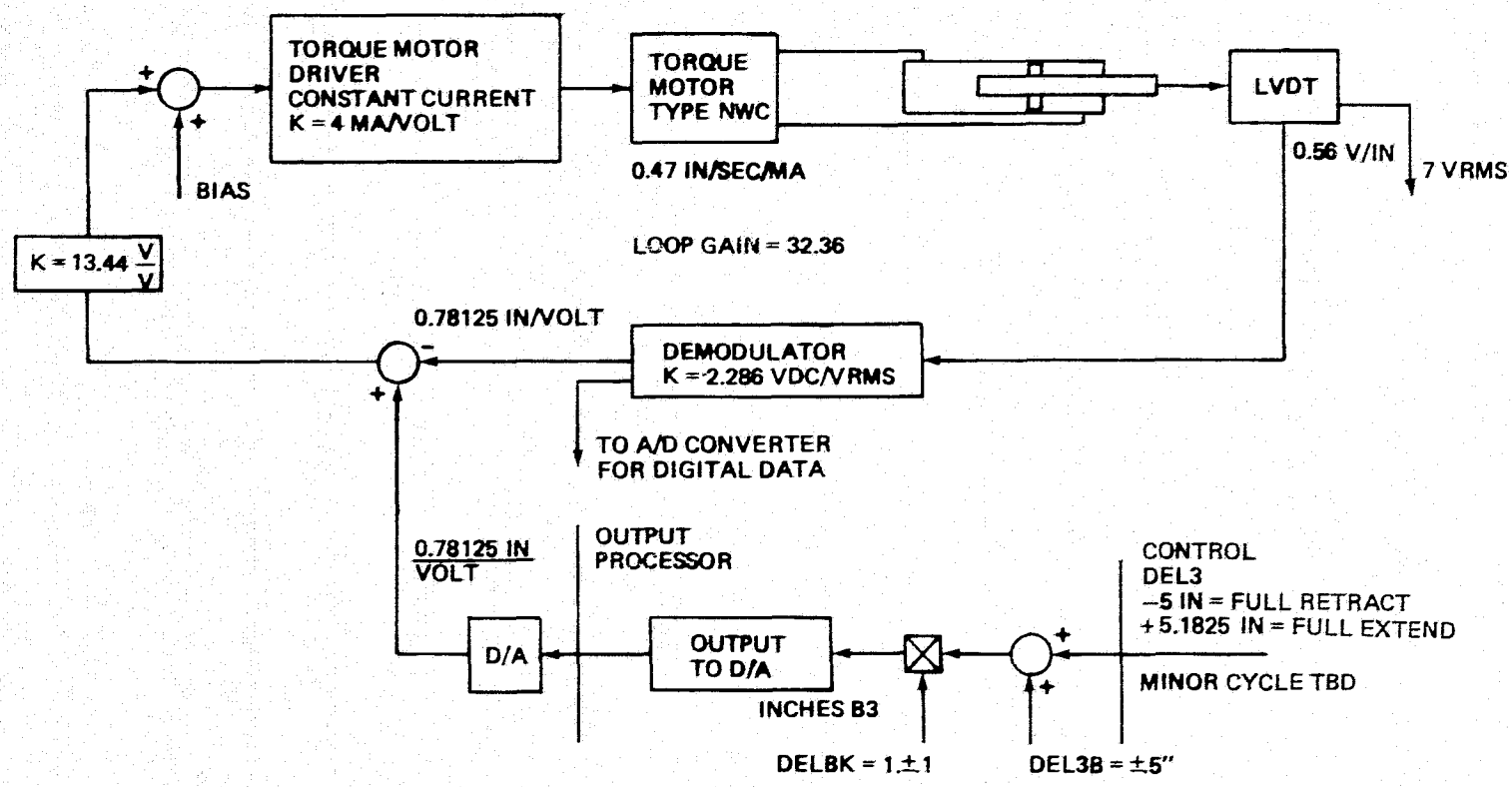


Figure 4.5-1 First Ramp Servo

ORIGINAL PAGE IS  
OF POOR QUALITY

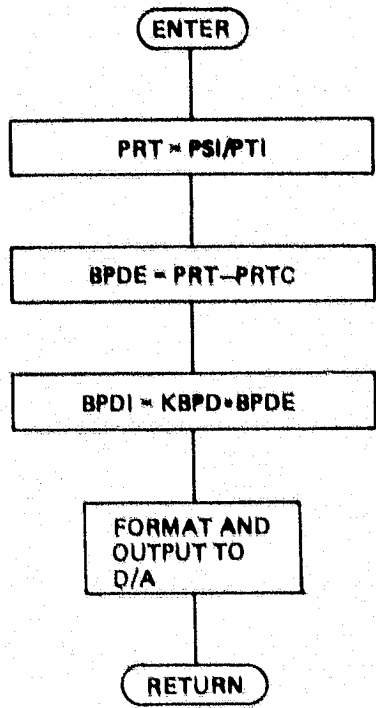
9b





96

Figure 4.5-2 Third Ramp Servo



ORIGINAL PAGE IS  
OF POOR QUALITY

Figure 4.5-3a Bypass Door Output Processing

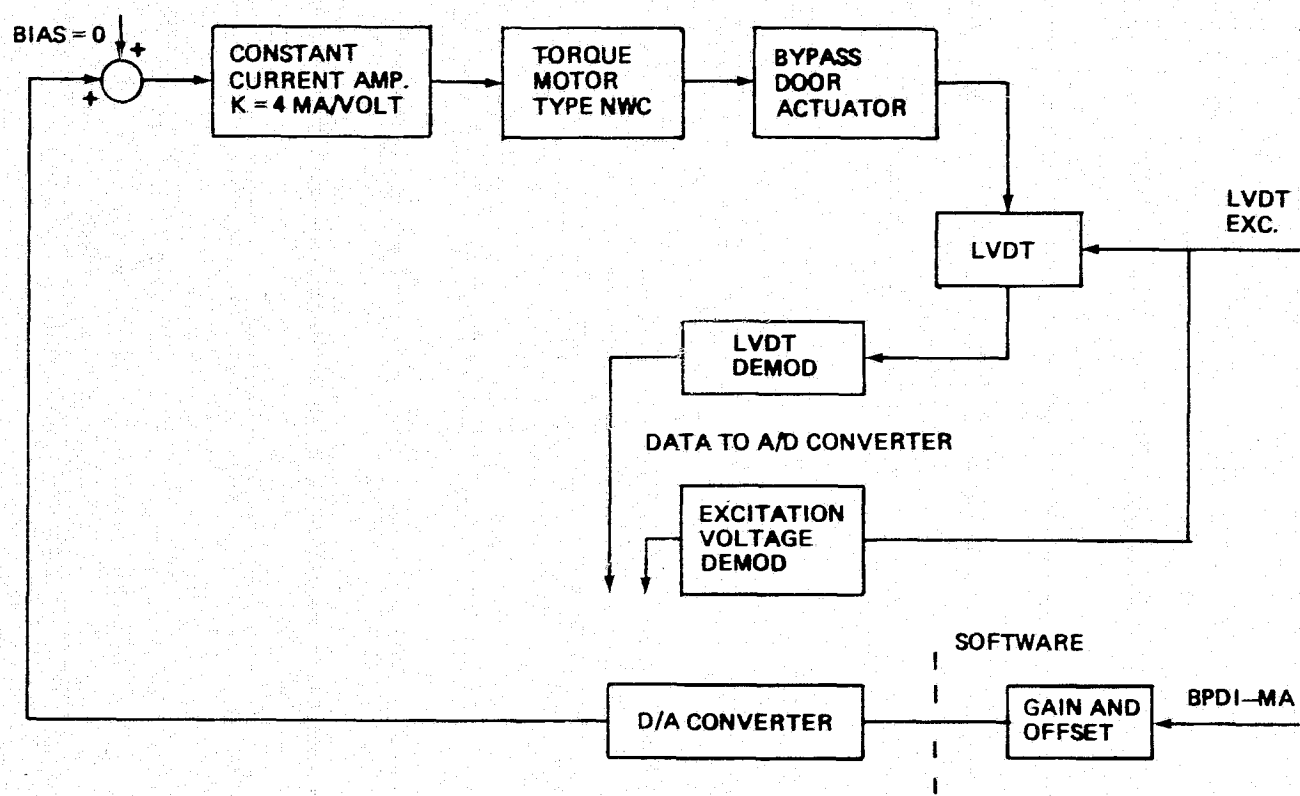


Figure 4.5-3b Bypass Door Servo Loop

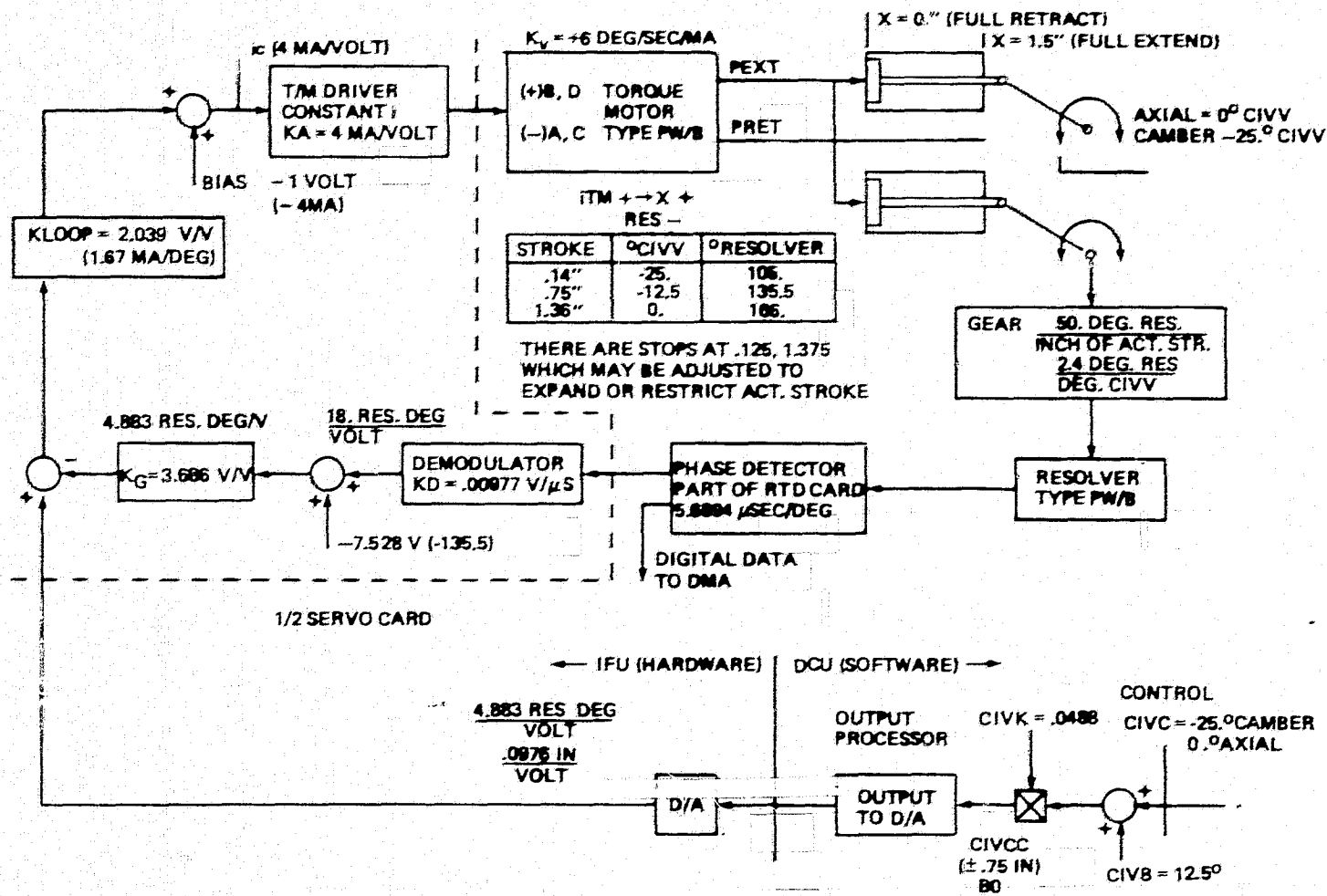


Figure 4.5-4 CIVV Servo Loop

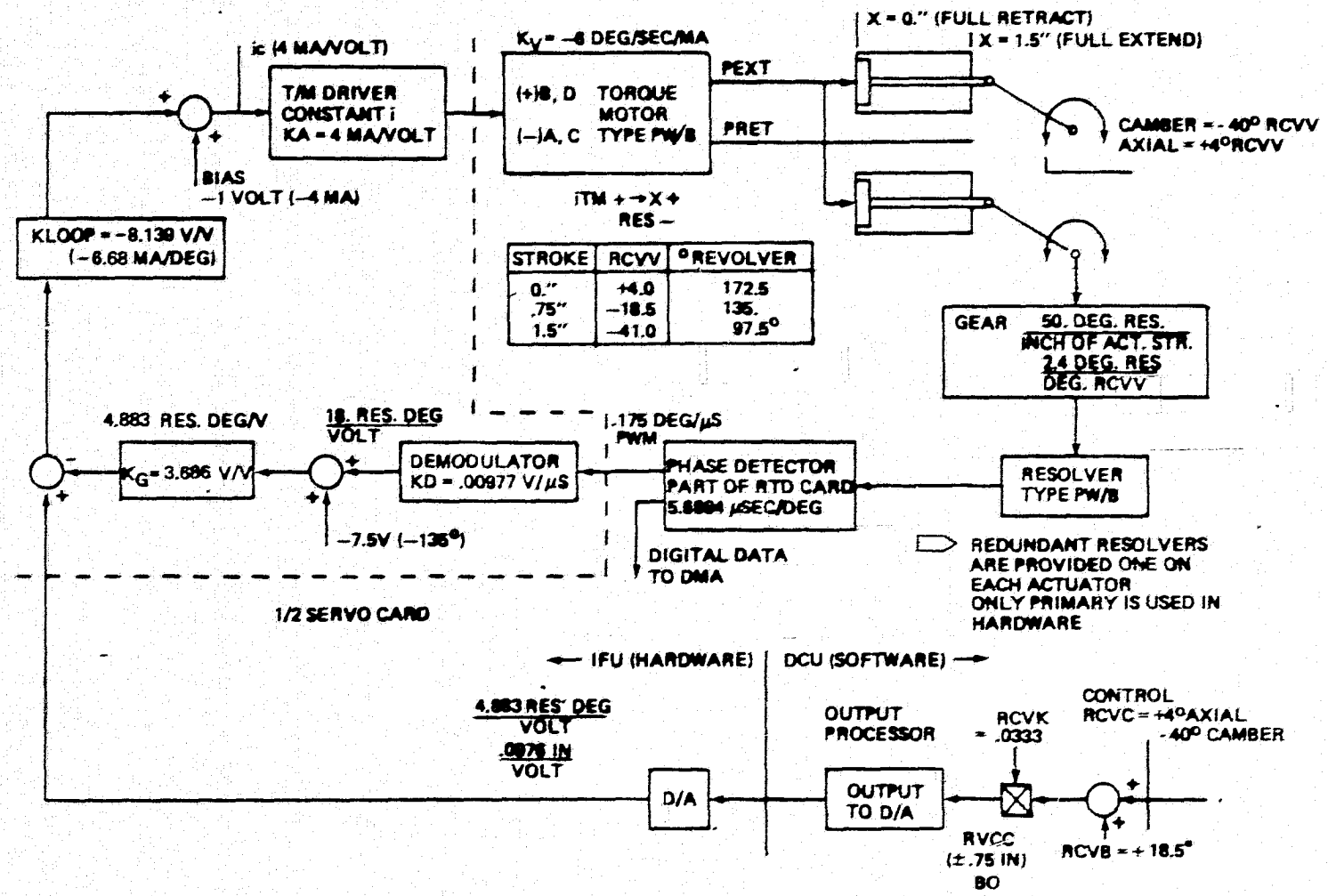


Figure 4.5-5 RCVV Servo Loop

#### 4.5.6 Gas Generator Fuel Flow

As indicated in Figure 4.5-6 gas generator fuel command is transferred to the calibrated output data base by the engine control in PPH of fuel flow during minor cycle not yet established. The output processor converts this to resolver degrees and outputs the data through the D/A converter during minor cycle 11.

#### 4.5.7 A/B Core Fuel Flow

As indicated in Figure 4.5-7 A/B core fuel flow command is transferred to the calibrated output data base by the engine control in PPH of fuel flow during minor cycle not yet established. The output processor converts them to resolver degrees and outputs the analog servo command through the D/A converter during minor cycle 11.

#### 4.5.8 A/B Duct Fuel Flow

As indicated in Figure 4.5-8 A/B duct fuel flow command is transferred to the calibrated output data base by the engine control in PPH of fuel flow during minor cycle not yet established. The output processor converts them to resolver degrees and outputs the analog servo command through the D/A converter during minor cycle 11.

#### 4.5.9 Segment and Sequence Valve

As indicated in Figure 4.5-9 segment and sequence value position command is transferred to the calibrated output data base by the engine control in minor cycle not yet established, converted by the output processor to resolver degrees and output by the D/A to the servo during minor cycle 11.

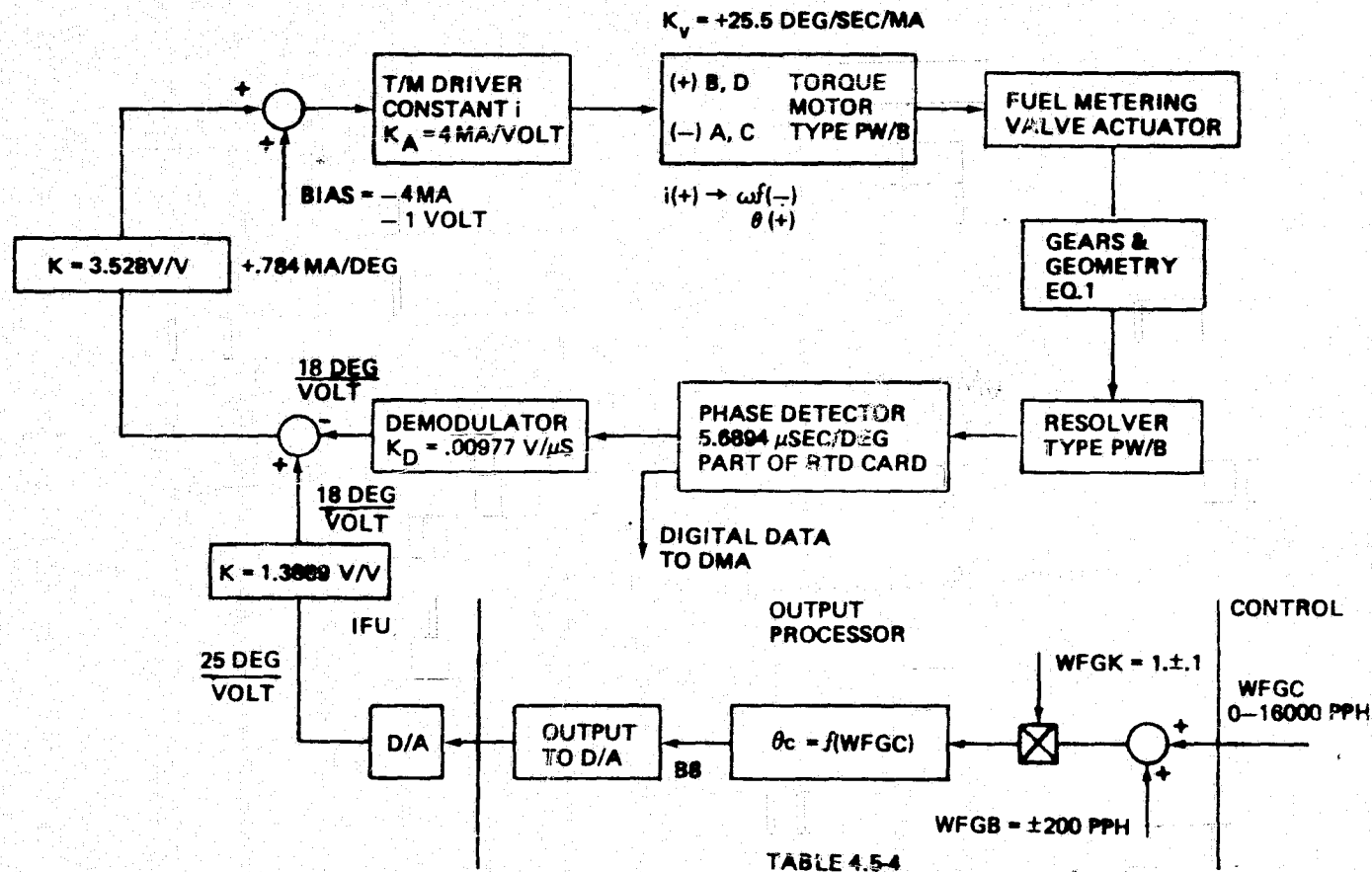


Figure 4.5-6 Main Fuel Servo

TABLE 4.5-4  
FUEL VALVE CALIBRATION

EQ. 1

$$\theta = 175. - [19.923 - \text{ARCSIN} (.225 - \frac{\sqrt{\text{WF} - 60.}}{295.1423959})] \times \frac{137.}{55.} \times \frac{90.}{54.}$$

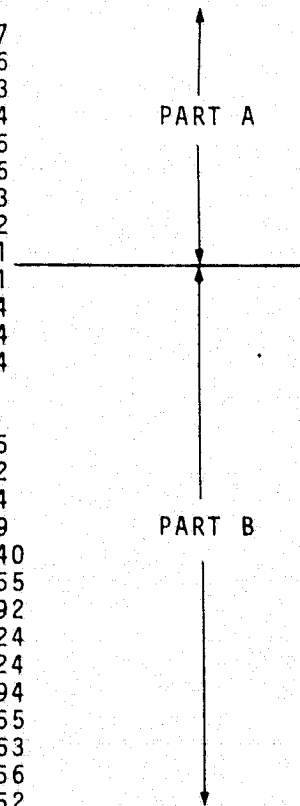
.66

where:

$\theta$  = RESOLVER ANGLE - DEG  
WF = FUEL FLOW - PPH

TABLE 1

WFGC	$\theta$ C
60.	175.
110.	165.97
160.	162.26
210.	159.43
260.	157.04
310.	154.95
360.	153.06
410.	151.33
460.	149.72
510.	148.21
510.	148.21
1510.	127.44
2510.	113.54
3510.	102.34
4510.	92.7
5510.	84.1
6510.	76.25
7510.	68.62
8510.	62.14
9510.	55.69
10510.	49.540
11510.	43.655
12510.	37.992
13510.	32.524
14510.	27.224
15510.	22.094
16510.	17.055
17510.	12.153
18510.	7.356
19510.	2.652



NOTES:

1. Part A, B to be implemented as separate table look ups.
2. Resolver is displaced 45° from DEEC STD to work with IFU RTD CONV.
3. Error analysis not complete.



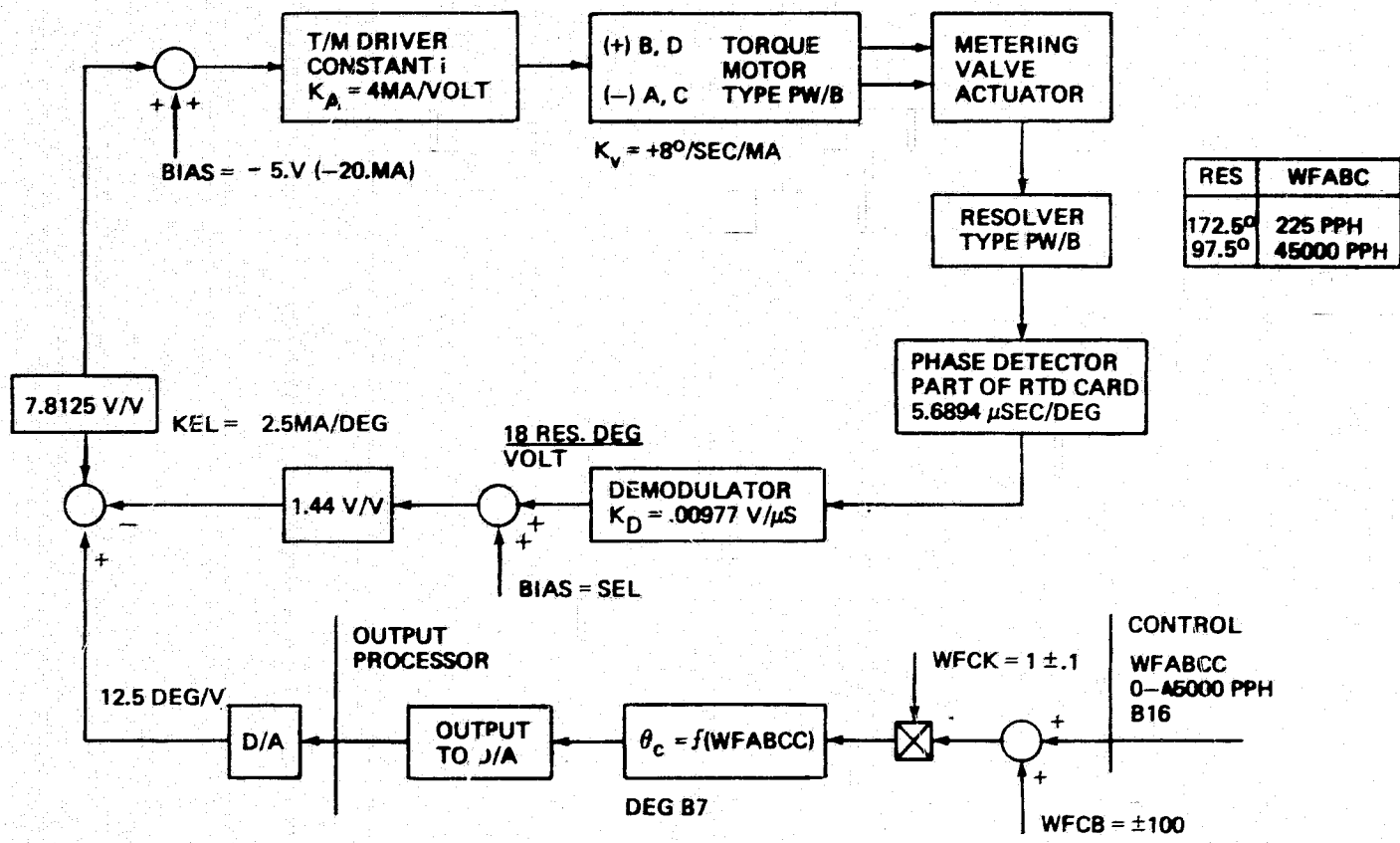


Figure 4.5-7 A/B Core Fuel Flow Servo

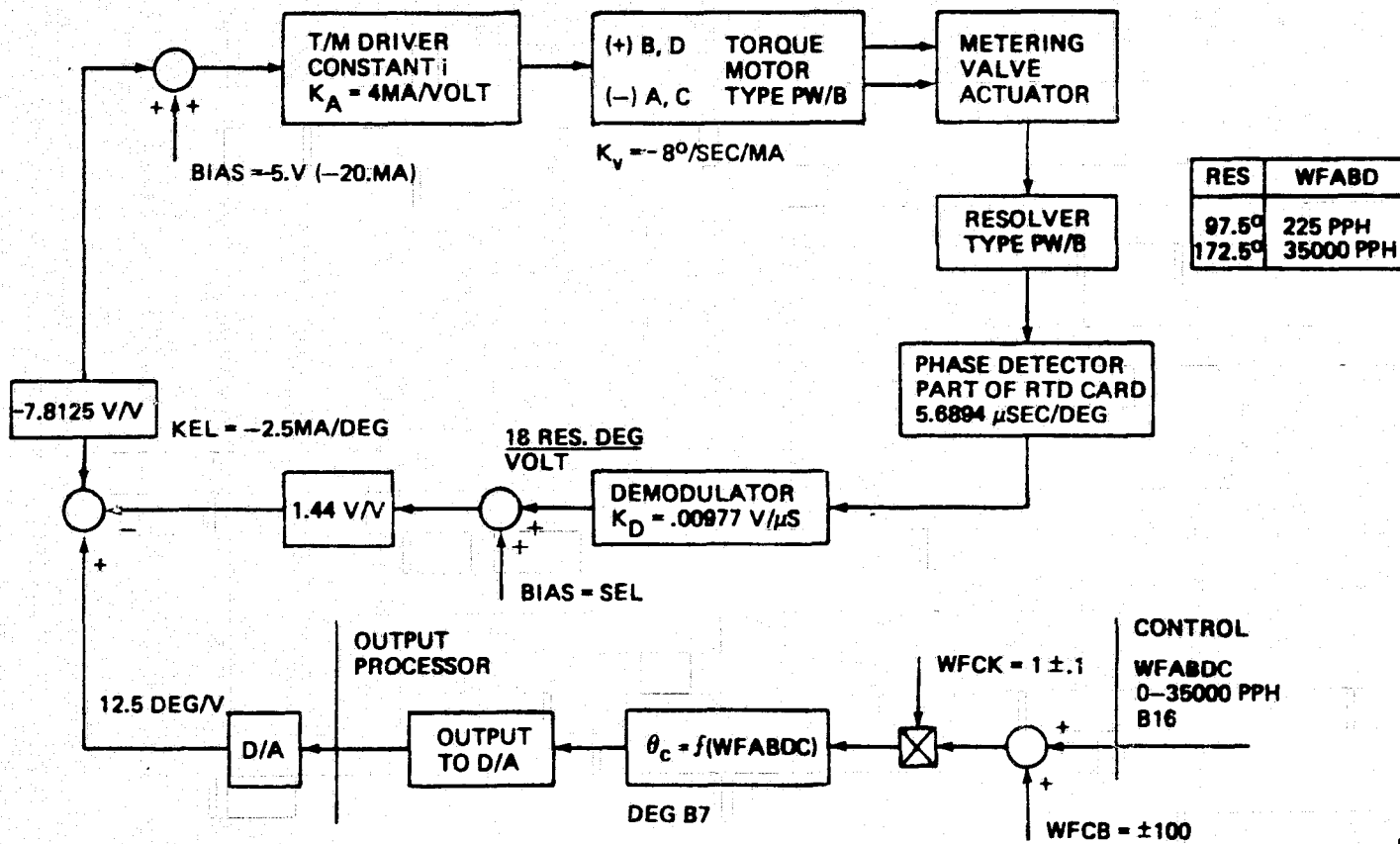


Figure 4.5-8 A/B Duct Fuel Flow Servo

ORIGINAL PAGE IS  
OF POOR QUALITY

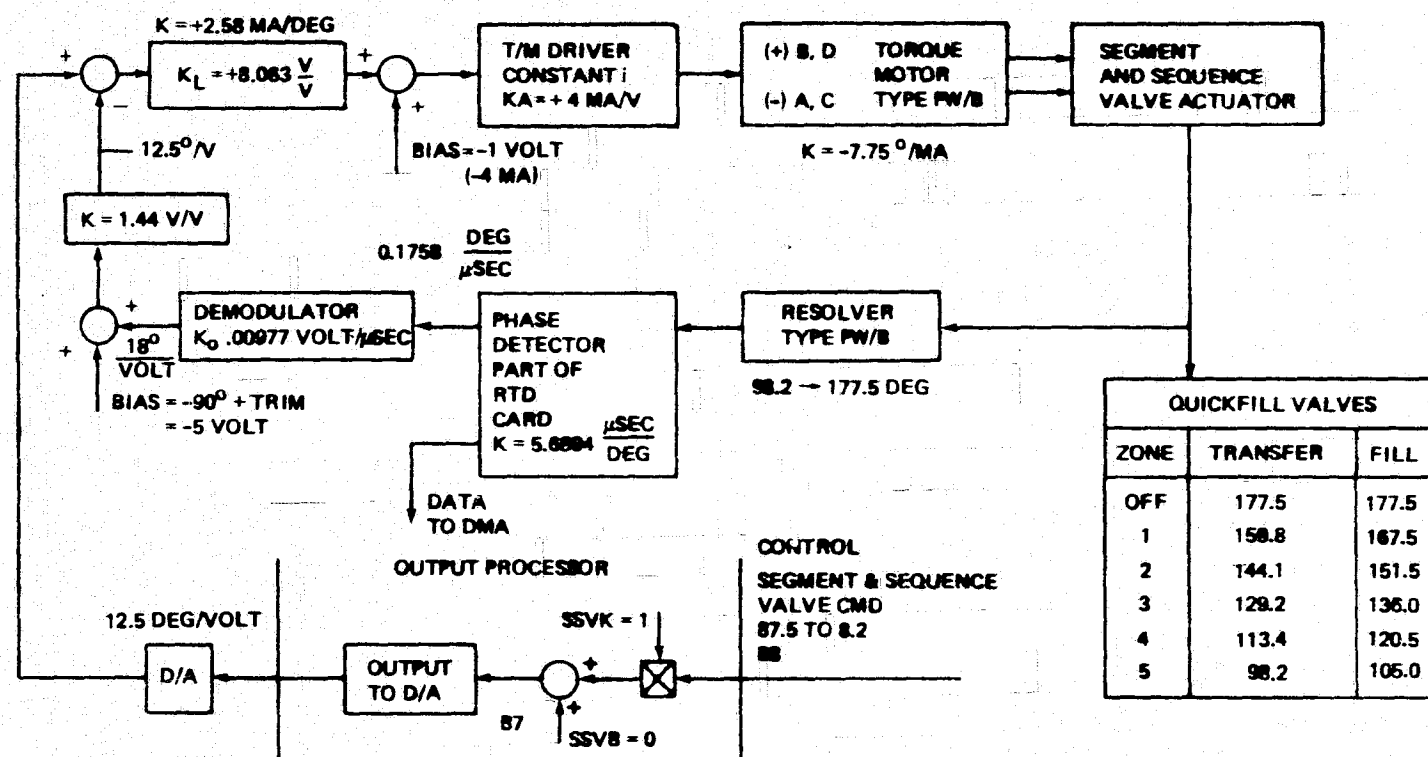


Figure 4.5-9 Segment and Sequence Valve Servo Loop

#### 4.5.10 Exhaust Nozzle

As indicated in Figure 4.5-10 the engine control provides nozzle commands in square feet during minor cycle not yet established. These are converted to actuator commands in resolver degrees and output during minor cycle 11.

#### 4.5.11 Customer Bleed

No requirements for customer bleed exist at this time.

#### 4.5.12 Control Augmentation System

Pitch and roll control signals are generated by research modules not yet defined and passed to the calibrated output data base during minor cycle not yet established. These are limit checked as a validity test, see Figures 4.5-11, -12. Failure response is not yet established and will change as a function of research control mode. The data are then processed to compensate for the CAS deadband and formatted for output to the CAS during minor cycle 11. Provision is made for slope and offset adjustments and for an attitude hold mode to permit the pilot to null the DPCU outputs with the aircraft trim system.

#### 4.5.13 Cockpit Displays

Three analog cockpit displays, Figure 4.5-13, are driven by D/A converters.

#### 4.5.14 Output Discrettes

Table 4.5-5 tabulates the output discrettes used. Unless otherwise indicated they are output during minor cycle 11.

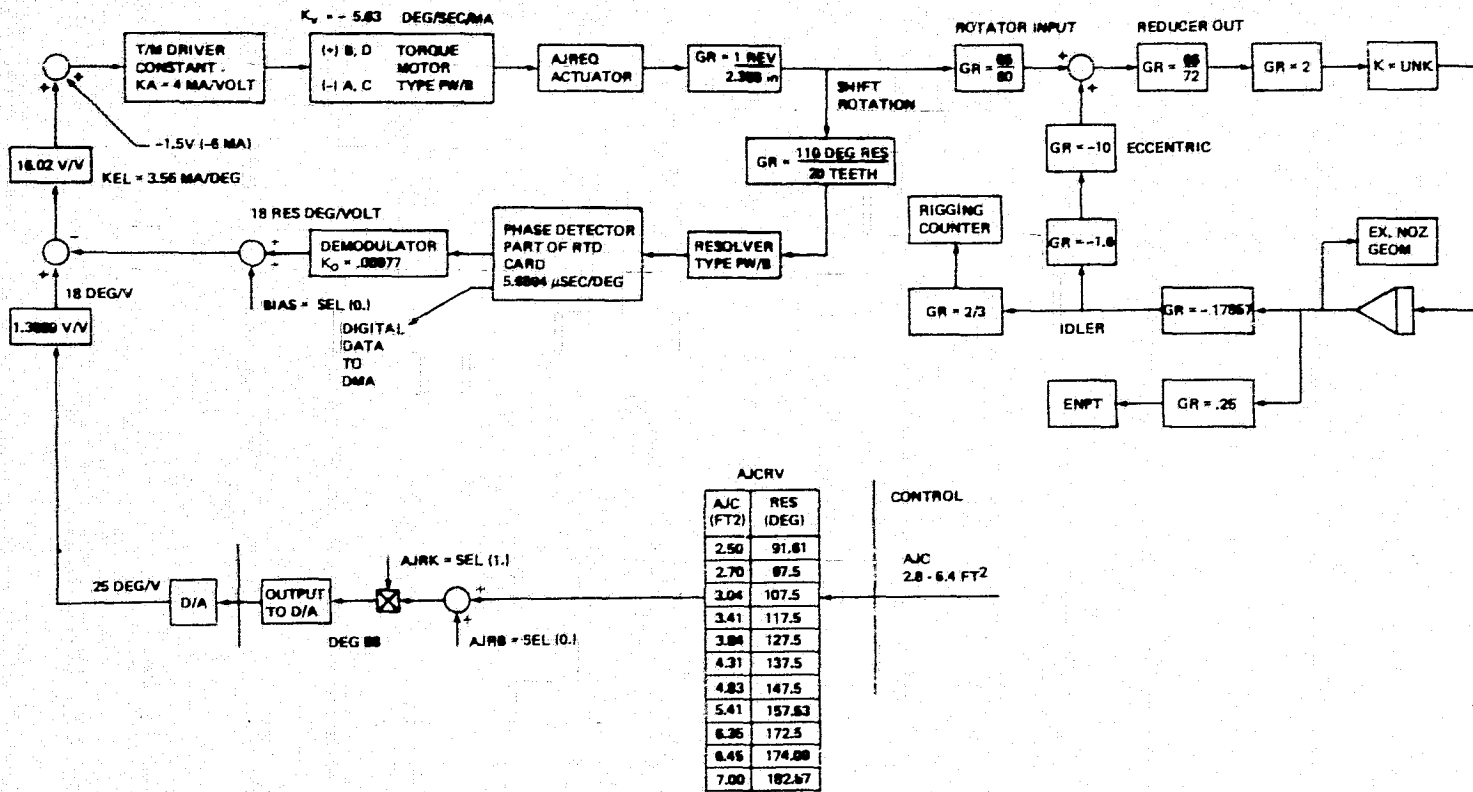


Figure 4.5-10 Nozzle Servo

ORIGINAL PAGE IS  
OF POOR QUALITY

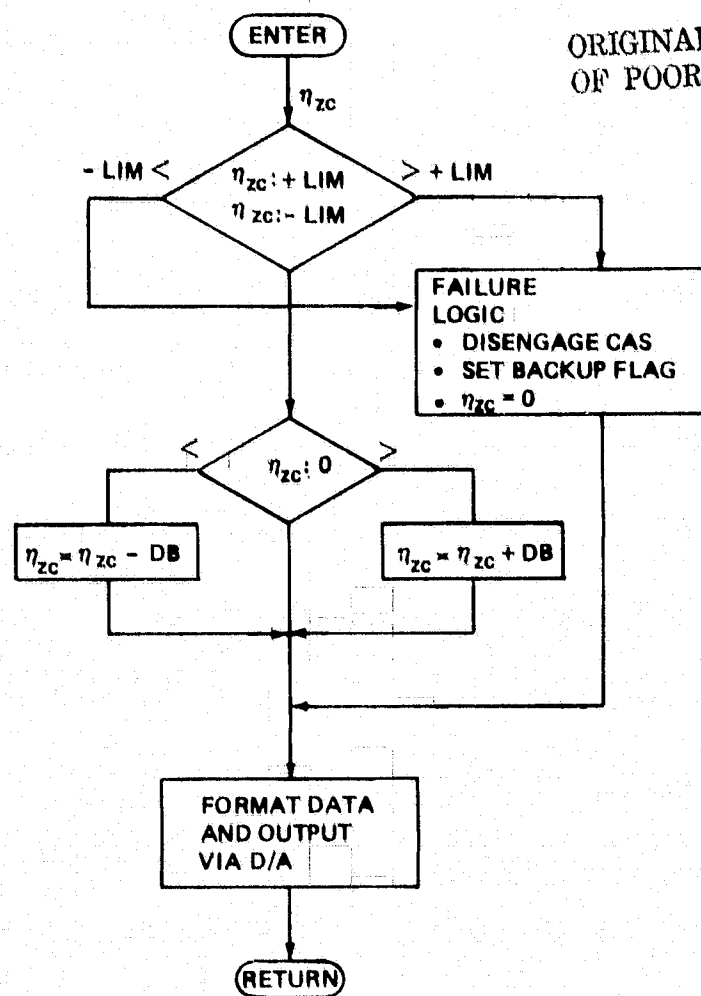


Figure 4.5-11 Pitch CAS Command Output Processing

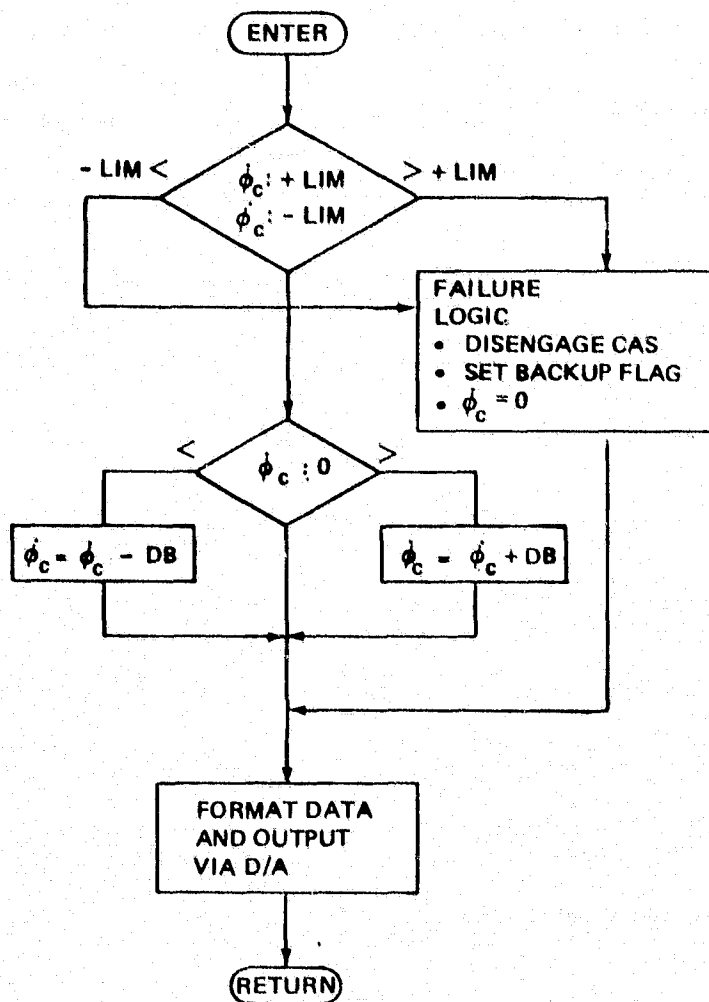


Figure 4.5-12 Roll CAS Command Output Processing

COCKPIT ANALOG DISPLAY REQUIREMENTS  
HAVE NOT BEEN DEFINED AT THIS TIME

*Figure 4.5-13. Cockpit Analog Displays*



TABLE 4.5-5  
 OUTPUT DISCRETE WORD DEFINITION (1)

OUTPUT DISCRETE WORD	BIT # (16=LSB)	FUNCTION	LOGIC	SOURCE
1	1	ENGINE ENGAGED		
	2	INLET ENGAGED		
	3	CAS ENGAGED		
	4	RESEARCH ENGAGED		
	5	INLET TRACK		
	6	ENGINE BOM TRACK		
	7	ENGINE RESEARCH TRACK		
	8	CAS TRACK		
	9	RESEARCH TRACK		
	10	BACKUP		
	11	DISENGAGE		
	12	DOWNLINK STATUS		
	13	UPLINK STATUS		
	14	CENTRAL COMPUTER INTERFACE STATUS		
	15	AUTOMATIC POWER OFF		
	16	AUTOMATIC POWER OFF		

TABLE 4.5-5  
 OUTPUT DISCRETE WORD DEFINITION (2)

OUTPUT DISCRETE WORD	BIT # (16-LSB)	FUNCTION	LOGIC	SOURCE
2	1	ENGINE START BLEED		
	2	ENGINE DERICH		
	3	BUZZ WARNING		
	4	IGNITION RELAY		
	5	IGNITION RELAY		
	6	RAMP GAIN CHANGE		
	7	SPARE		
	8	SPARE		
	9	SPARE		
	10	SPARE		
	11	SPARE		
	12	SPARE		
	13	SPARE		
	14	SPARE		
	15	SPARE		
	16	SPARE		

TABLE 4.5-5  
OUTPUT DISCRETE WORD DEFINITION (3)

OUTPUT DISCRETE WORD	BIT # (16-LSB)	FUNCTION	LOGIC	SOURCE
3	1	SPARE		
	2	SPARE		
	3	SPARE		
	4	SPARE		
	5	SPARE		
	6	SPARE		
	7	SPARE		
	8	SPARE		
	9	SPARE		
	10	SPARE		
	11	SPARE		
	12	SPARE		
	13	SPARE		
	14	SPARE		
	15	SPARE		
	16	SPARE		

## 5.0 BOM ENGINE CONTROL DEFINITION

This section defines the computer program component to duplicate the bill of materials F100 engine control. Sections 5.1 and 5.2 present the logic for the engine electronic control, EEC, and the unified fuel control, UFC. The control executive, which determines the order of calculation, is defined in section 5.3. The data base identified in section 5.4. The data base defines the values of all schedules and constants and the memory locations for all constants, schedules, and stored variables.

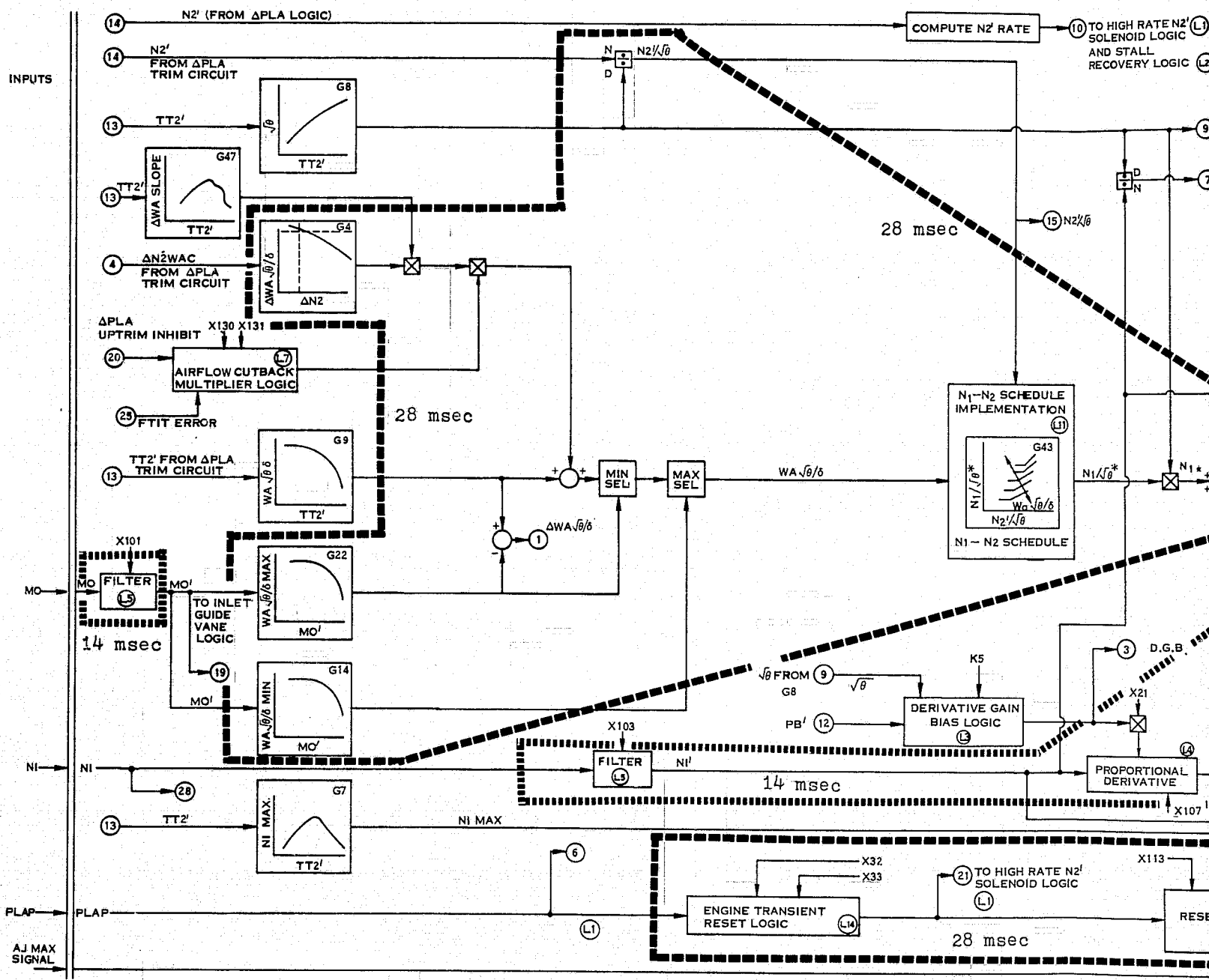
The control logic has been divided into relatively small units. Each is defined by a block diagram and the related constants and schedules. The block diagram number consists of the last three digits of the number of the paragraph which discusses it. This number is also used to define where variables are computed and used. The first two digits identify the portion of the control involved:

- 1.1.x = EEC Common Routines
- 1.2.x = EEC High Frequency Calculations
- 1.3.x = EEC Intermediate Frequency Calculations
- 1.4.x = EEC Low Frequency Calculations
- 2.1.x = UFC Gas Generator
- 2.2.x = UFC Afterburner

Although the computations are performed at different rates in the BOM control, the PROFIT control will operate essentially at a single rate. Only a few computations, identified in section 5.3, are to be performed at a different rate. As a result all of the computation rate dependent constants have been evaluated for an interval of 60 milliseconds.

## 5.1 ENGINE ELECTRONIC CONTROL

The EEC logic has been divided into three major sections on the basis of the calculation frequency in the BOM EEC. For PROFIT the majority of the calculations are performed in the major cycle (section 5.3), but this division provided a convenient breakdown and formed the basis for simulation studies of computation rate requirements. Figures 5.1-1 through 5.1-4 present the bill-of-material overall block diagrams taken from T.O. 6J3-4-102-3. Those portions which operate at 14 and 28 milliseconds intervals in the BOM program are identified. The remaining logic operates at 56 milliseconds. These block diagrams are representative of the control presented in this section with the exception of the stepper motors and a few logic elements which were removed because the EEC and UFC are operated in a single electronic control.



FOLDOUT FRAME /

ORIGINAL PAGE IS OF POOR QUALITY

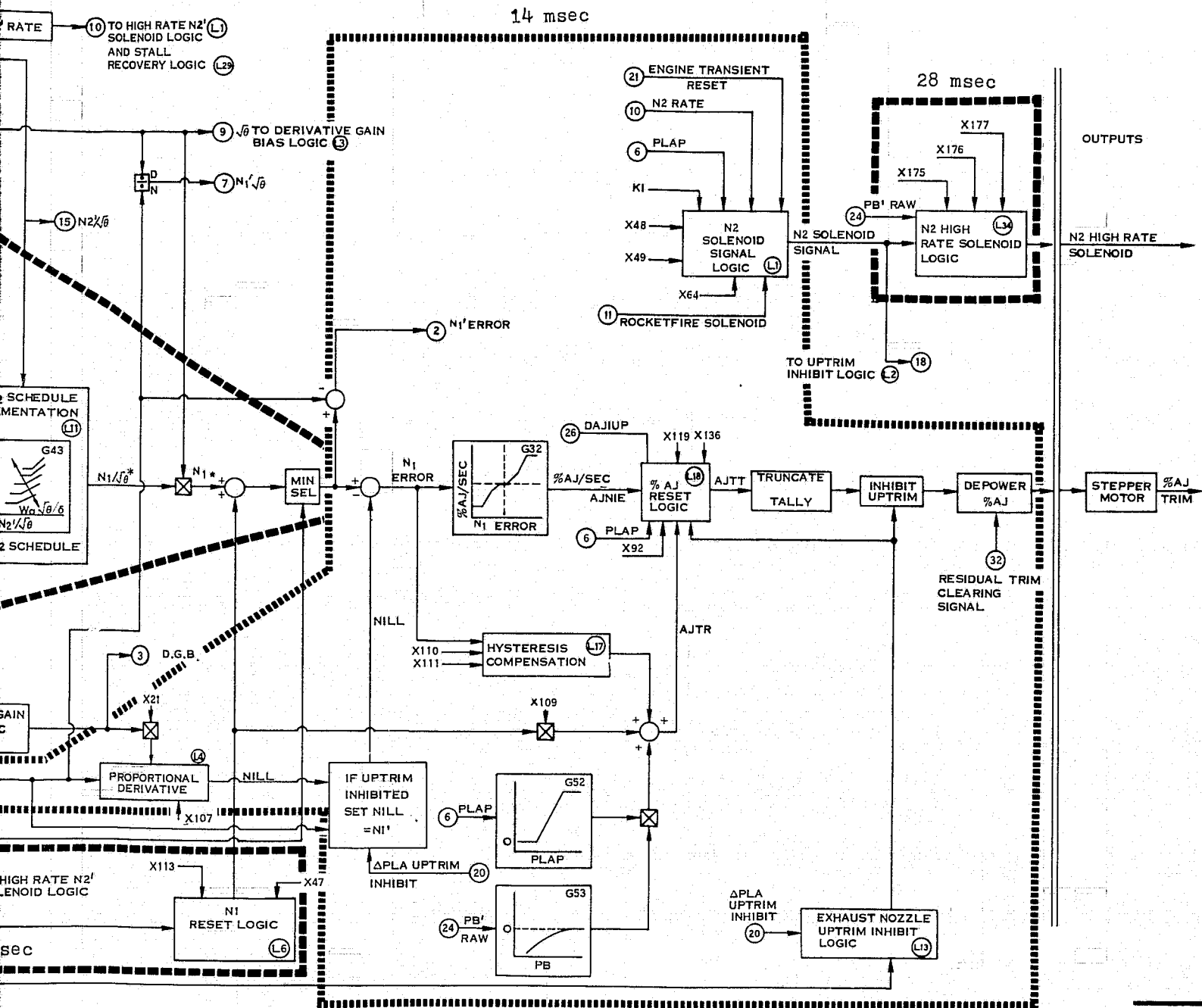
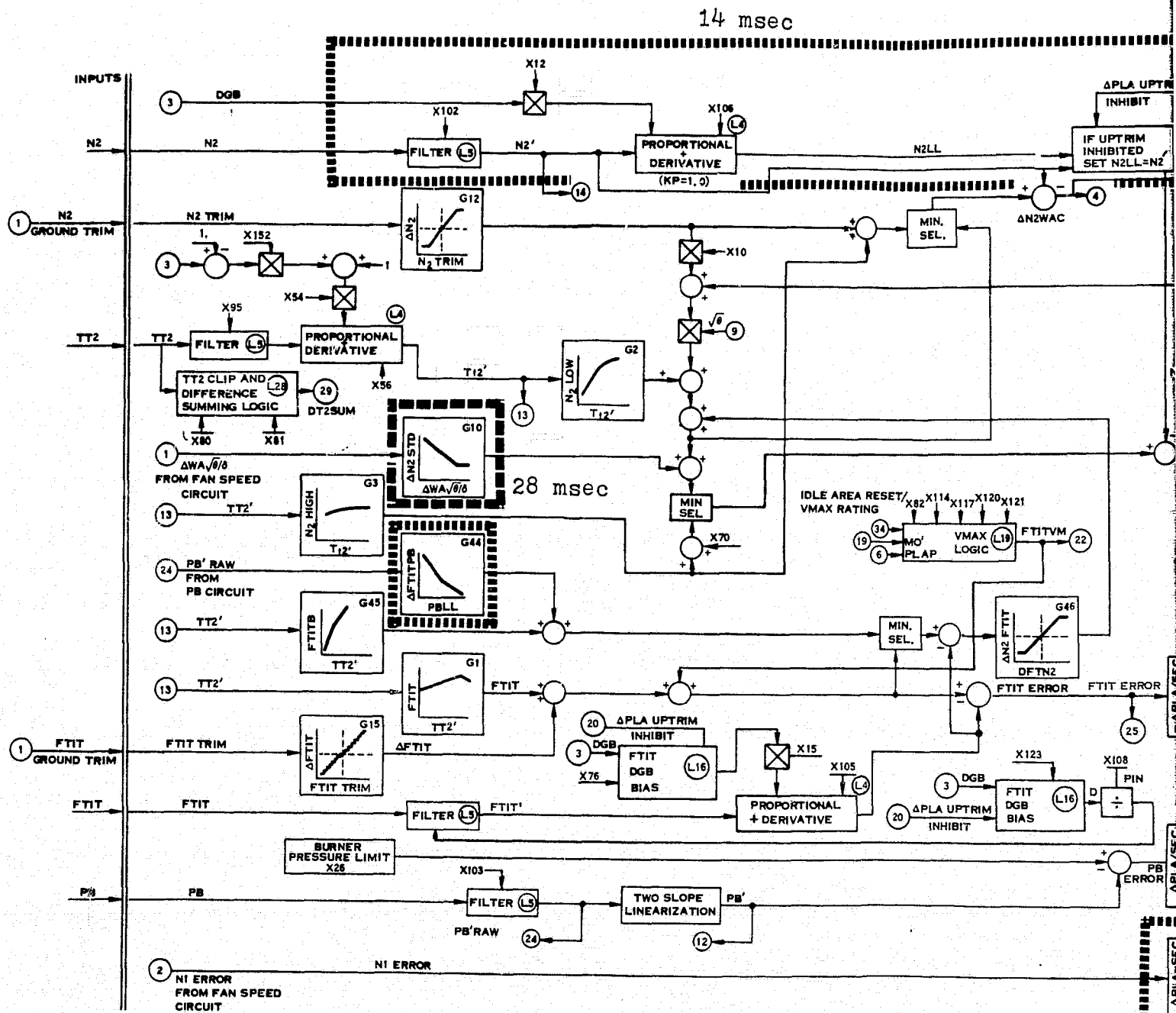


Figure 5.1-1.  
Nozzle Area Trim Loop Block Diagram

ORIGINAL PAGE IS  
POOR QUALITY

FOLDOUT FRAME

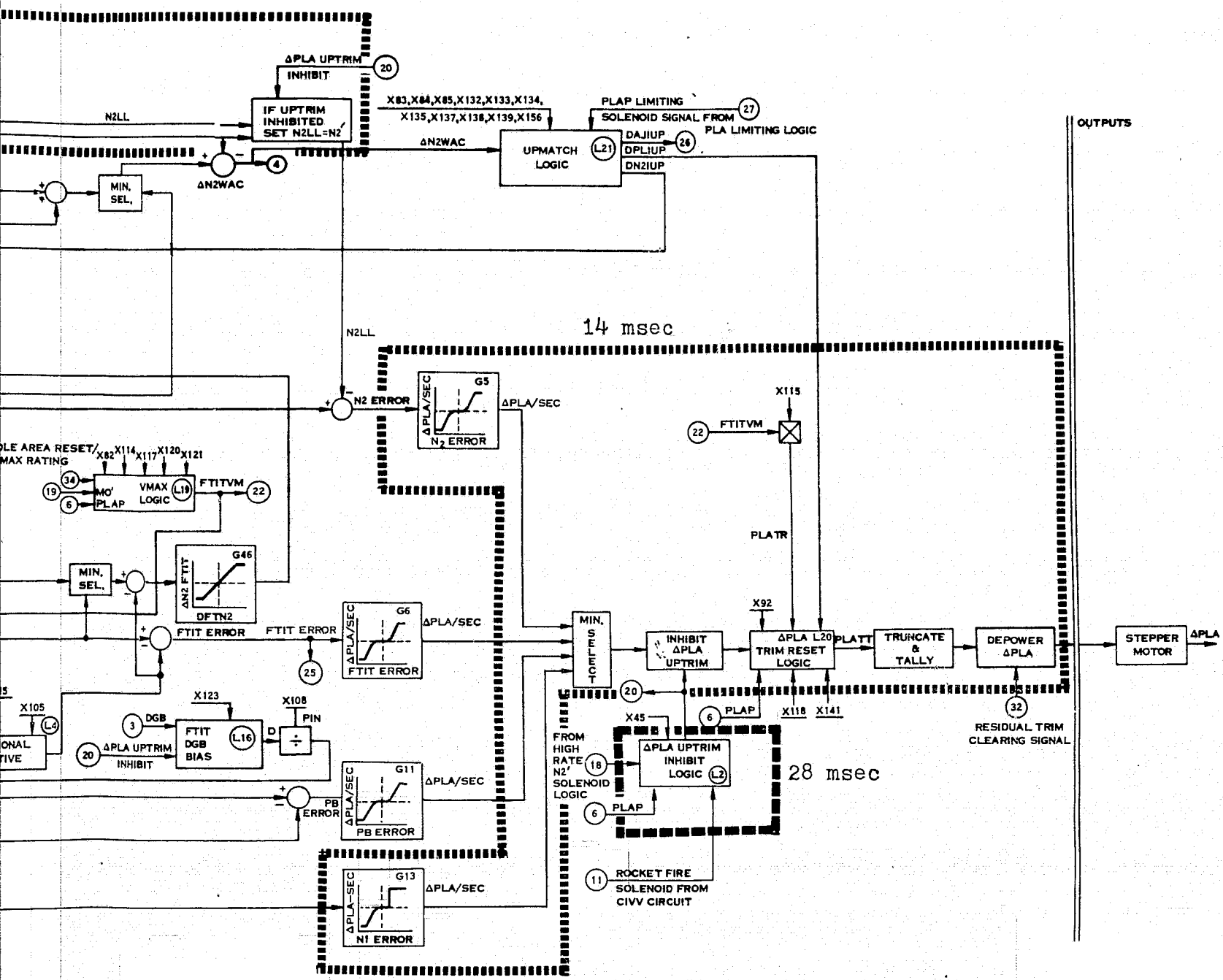
PRECEDING PAGE BLANK NOT FILMED



FOLDOUT FRAME /

ORIGINAL PAGE IS  
OF POOR QUALITY



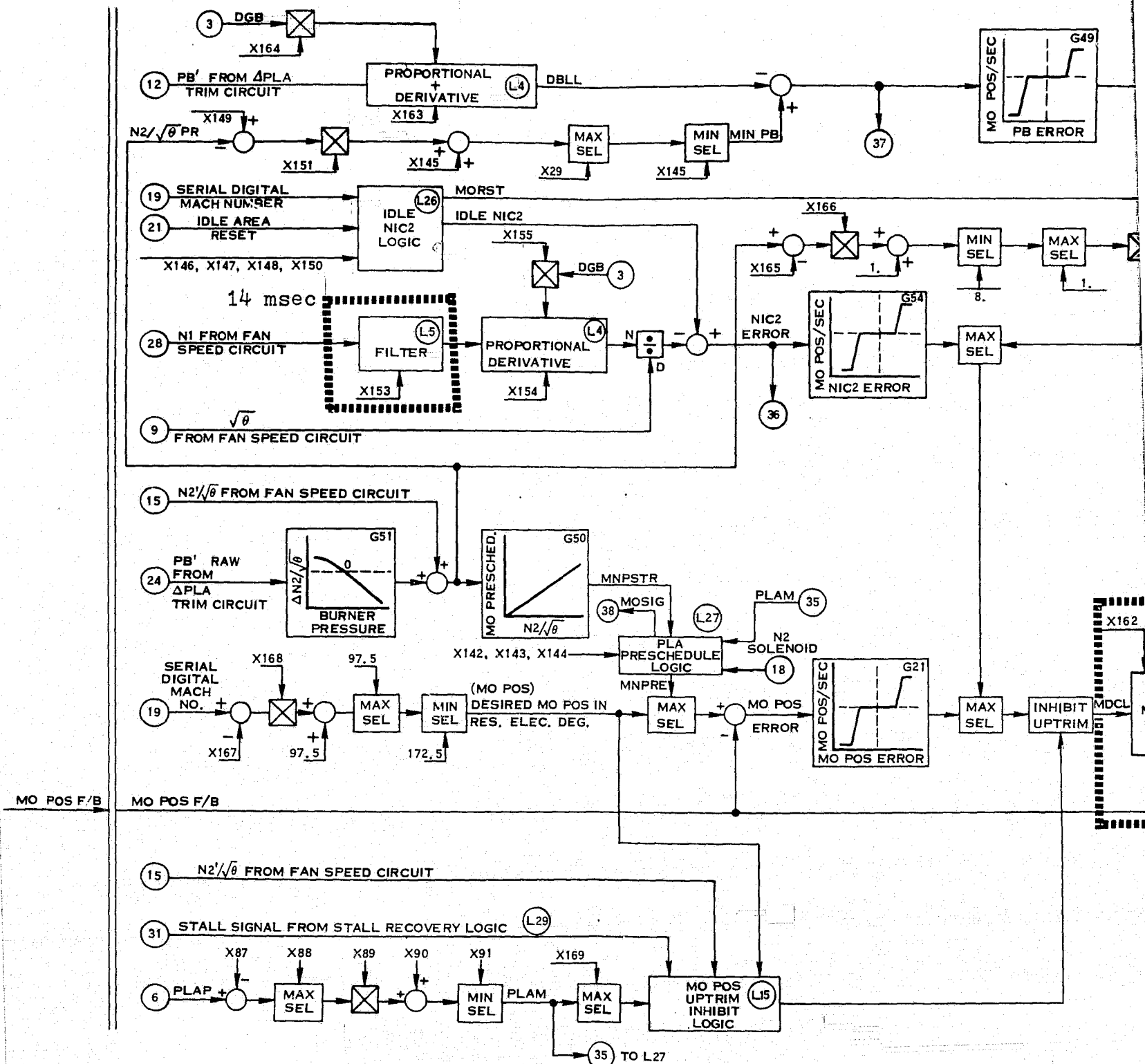


ORIGINAL PAGE 18  
OF POOR QUALITY

BOLDOUT FRAME 2

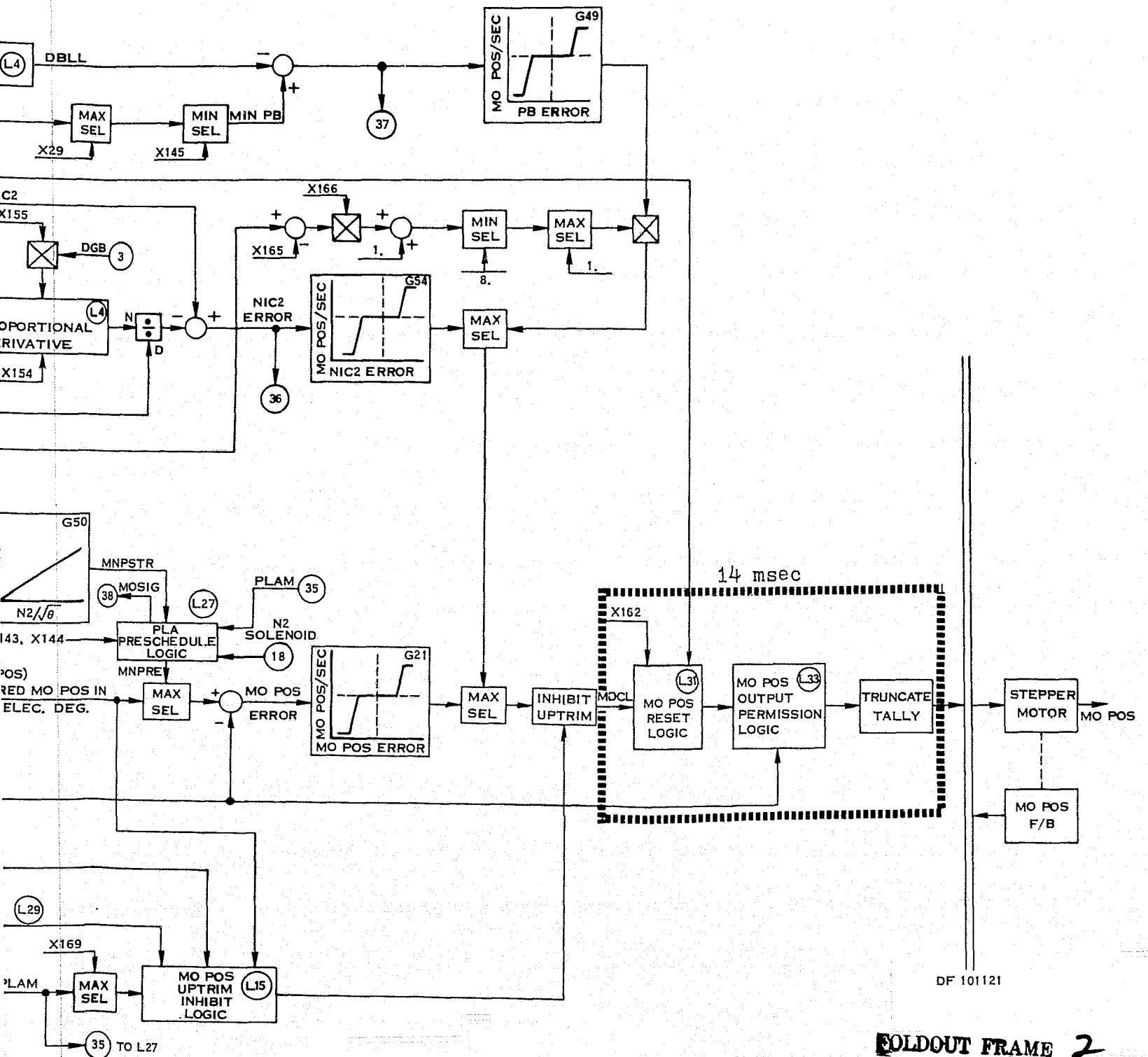
Figure 5.1-2.  
PLA Trim Loop Block Diagram

PRECEDING PAGE BLANK NOT FILMED



FOLDOUT FRAME /

ORIGINAL PAGE IS OF POOR QUALITY



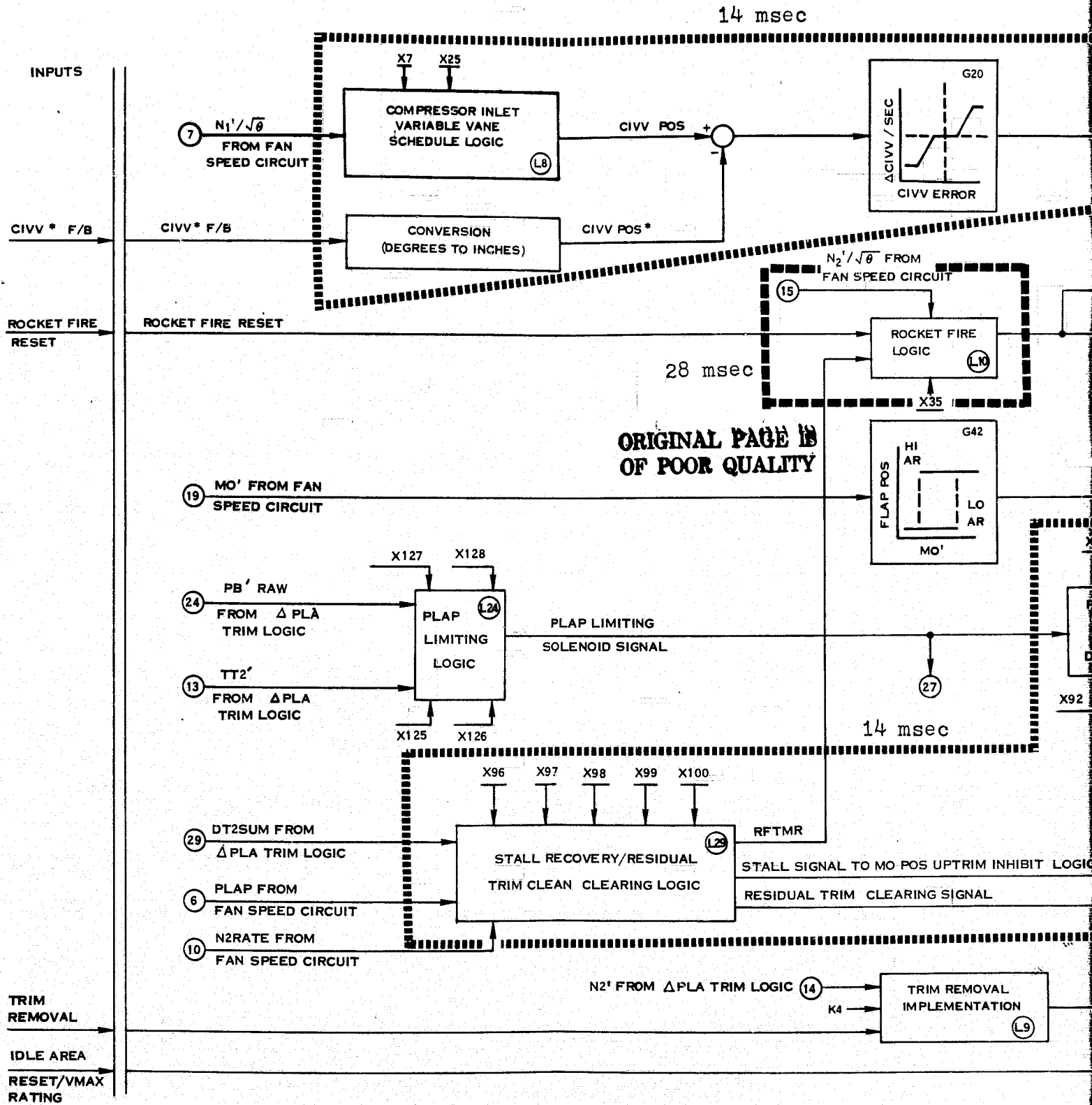
DF 101121

**EXCISE FRAME 2**

Figure 5.1-3.  
Minimum PLAP Loop Block Diagram

ORIGINAL PAGE IS  
OF POOR QUALITY

PRECEDING PAGE BLANK NOT FILMED



FOLDOUT FRAME /

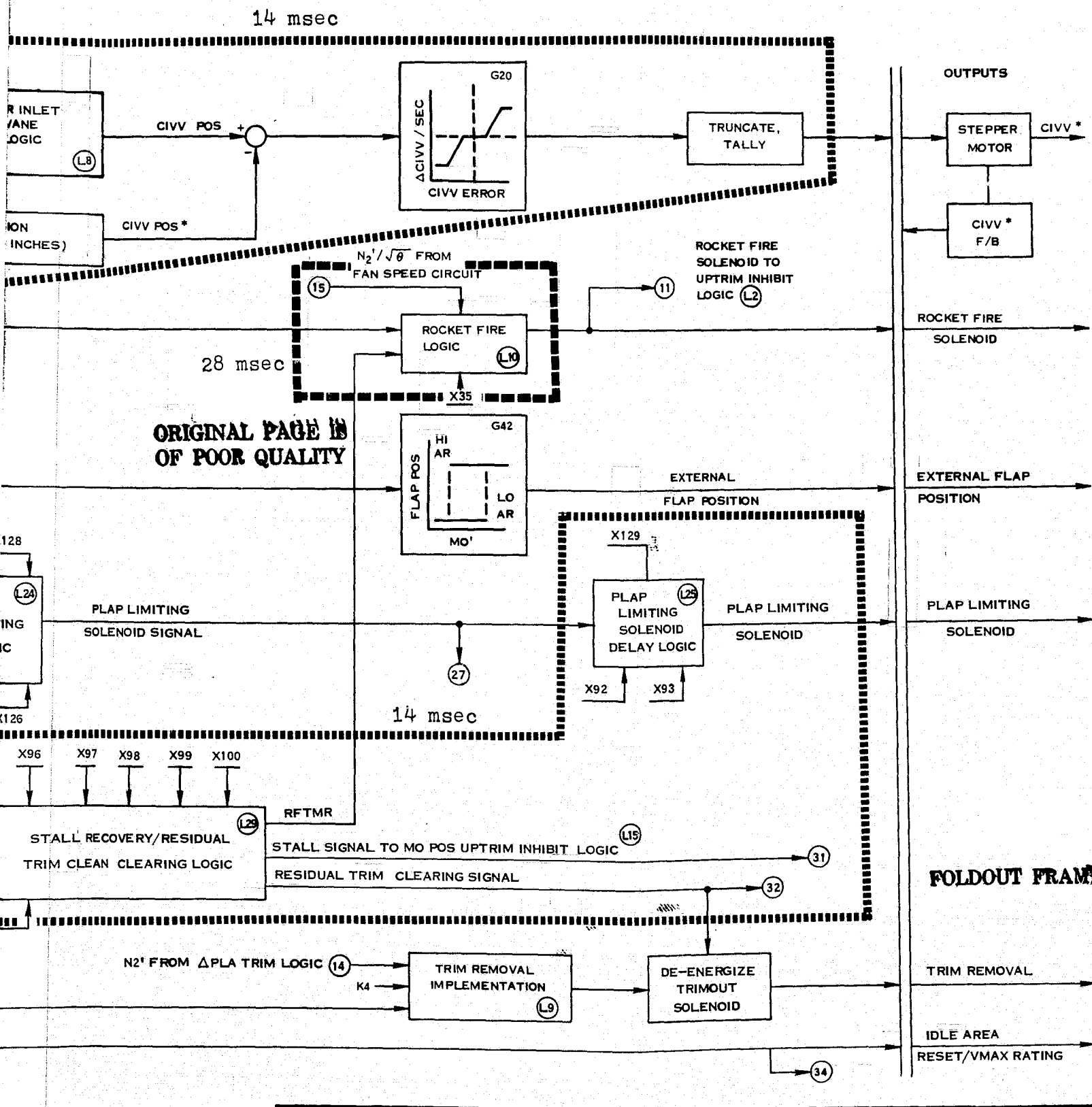


Figure 5.1-4.  
CIVV and Solenoid Control Block Diagram

PRECEDING PAGE BLANK NOT FIEMED

### 5.1.1 Common Routines

Two routines are called from various places in the EEC - the filter and the proportional plus derivative compensation. These are described in the following paragraphs. Table lookup routines, common to the entire control, are discussed in paragraph 5.4.4.

#### 5.1.1.1 Filter

The filter is a first order lag of the form:

$$\text{Output} = \text{Input} - (\text{Input} - \text{Past Output}) e^{-\Delta T/\tau}$$

where  $\Delta T$  is the calculation interval and  $\tau$  is the desired time constant. Figure 5.1-5 presents the block diagram and table 5.1-1 identifies the required constants. Additional filter logic is provided for FTIT compensation, figure 5.1-6.

#### 5.1.1.2 Proportional Plus Derivative Compensation

Proportional plus derivative compensation is applied to most of the EEC input signals. This routine incorporates signal hysteresis with a different deadband for each loop and a variable derivative gain which is a function of  $\sqrt{\theta}$  and Pb. Figure 5.1-7 presents the block diagram and table 5.1-2 lists the required constants. Additional logic is provided for compensation of the T2 and FTIT signals (figure 5.1-8).

BLOCK DIAGRAM 1.1.1

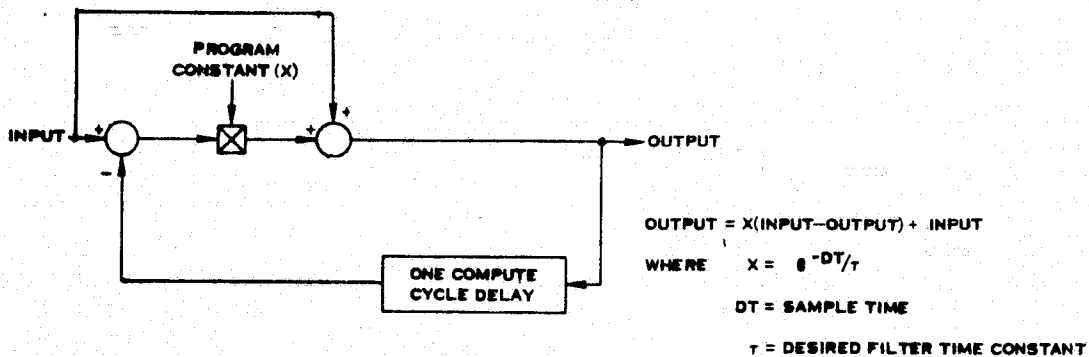


Figure 5.1-5. Filter Block Diagram

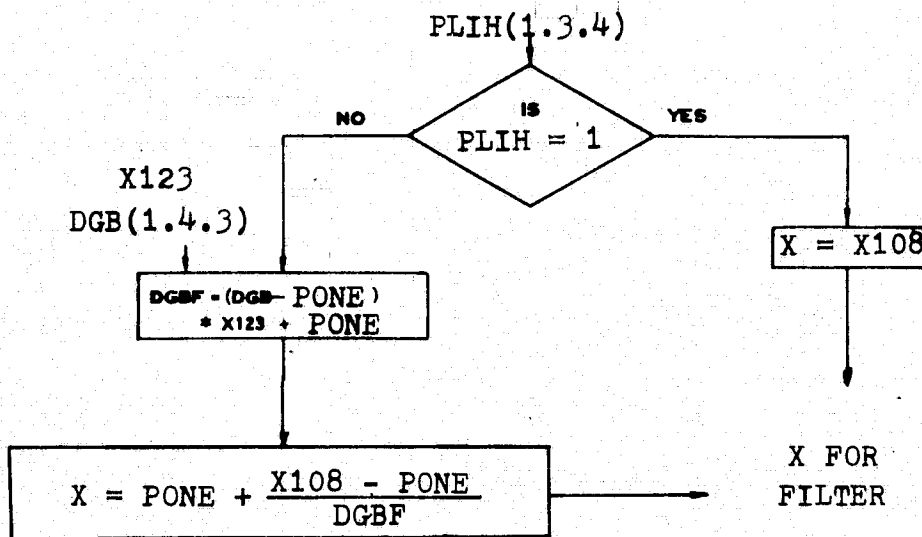


Figure 5.1-6. FTIT Filter

TABLE 5.1-1 FILTER DATA

LOOP		CONSTANT	
CON PB	X268	= 0.	--
DT2	X81	= .82960	--
EEC PB	X103	= .78735	--
FTIT	X108	= .97645	--
FTIT	X123	= .30000	--
FTIT	PUNE	= 1.0000	--
MN	X101	= .47367	--
N1	X103A	= .38430	--
N11	X153	= .74289	--
N2	X102	= .63664	--
T2	X95	= .82960	--

LOOP		VARIABLE	
FTIT	DGB	DERIVATIVE GAIN BIAS	--
FTIT	PLIH	PLA UPTRIM INHIBIT	DISCRETE



BLOCK DIAGRAM 1.1.2

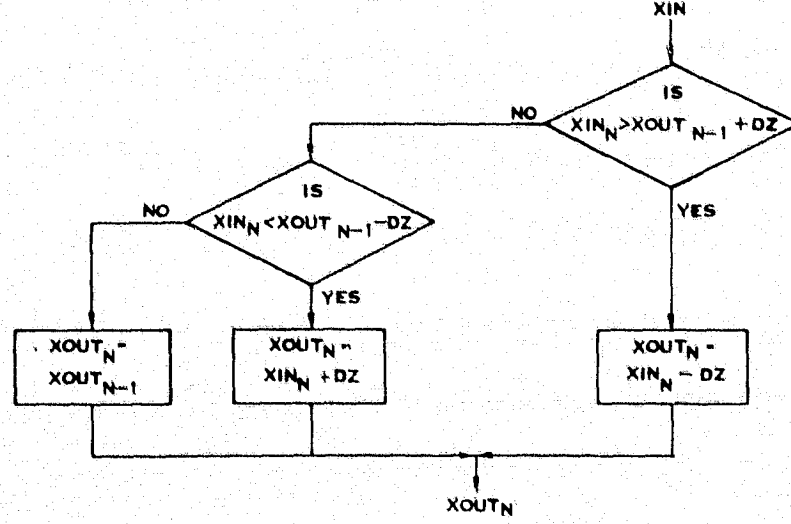
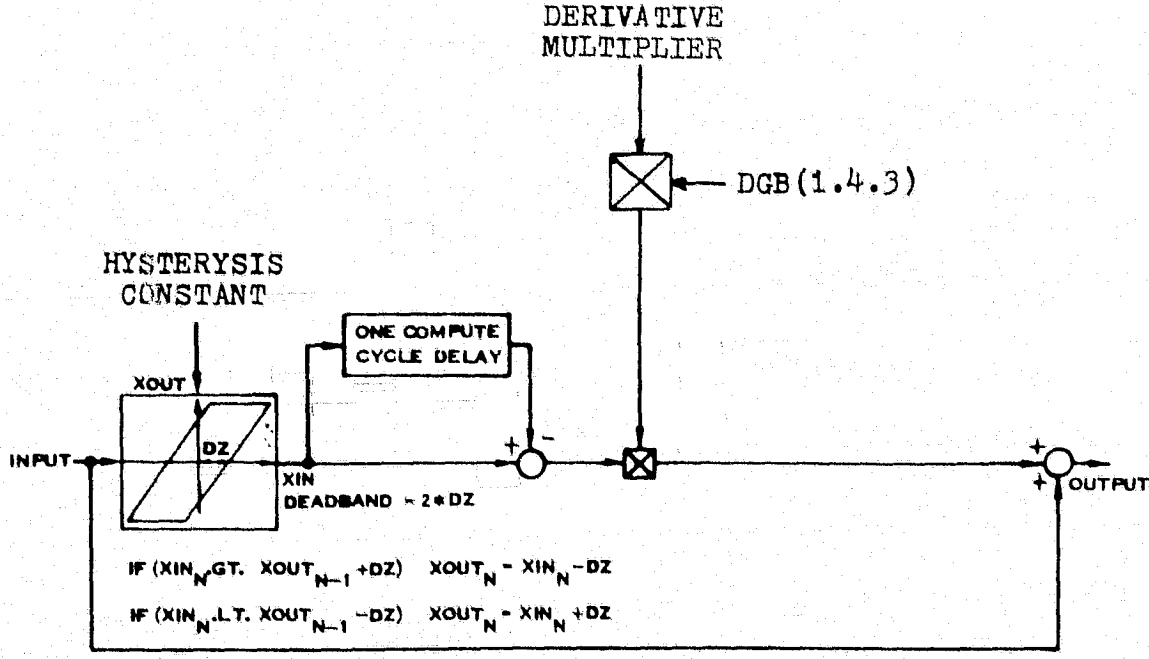


Figure 5.1-7. Proportional Plus Derivative Compensation

TABLE 5.1-2

PROPORTIONAL + DERIVATIVE ROUTINE DATA

LOOP		DERIVATIVE MULTIPLIER	
FEC PB	X164	= 4.8530	--
FTIT	X15	= 93.330	--
FTIT	X76	= .63000	--
N1	X21	= 4.6675	--
N1I	X155	= 6.5330	--
N2	X12	= 9.3325	--
T2	X54	= 0.	--
T2	X152	= .46660	--

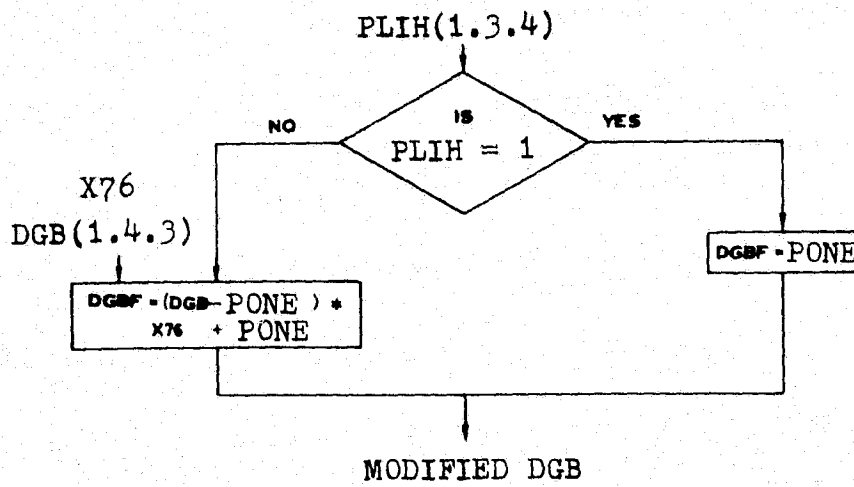
LOOP		HYSTERYSIS	
FEC PB	X163	= .25000	PSI
FTIT	X105	= 1.0000	DEG F
N1	X107	= 25.000	RPM
N1I	X154	= 2.5000	RPM
N2	X106	= 25.000	RPM
T2	X56	= 4.0000	DEG F

COMMON

PONE = 1.0000 -- --  
 DGB DERIVATIVE GAIN BIAS -- --  
 PLIH PLA UPTRIM INHIBIT DISCRETE

BLOCK DIAGRAM 1.1.2 (Cont)

● FTIT



● T2

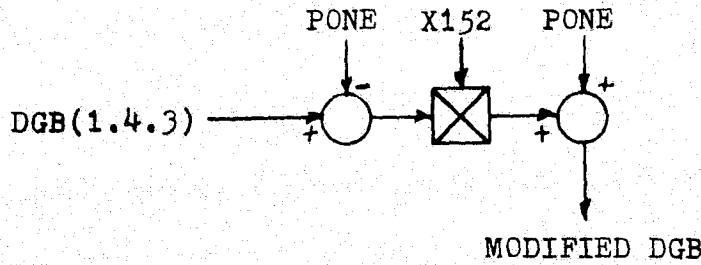


Figure 5.1-8. Special DBG Modification for T2 and FTIT

## 5.1.2 High Frequency Calculations

The following paragraphs present the logic for the portions of the EEC executed every 14 milliseconds in the BOM EEC. The values of all compute DT dependent constants are for the 60 millisecond interval anticipated for the PROFIT system.

### 5.1.2.1 Speed Filters

Three calls to the filter subroutine are used for the speed inputs providing a different N1 filter for the idle loop. N2 rate is calculated at the same time as the filter for computational convenience. Figure 5.1-9 presents the block diagram and Table 5.1-3 presents the required data.

### 5.1.2.2 CIVV Control

The CIVV position is scheduled as a function of the corrected low rotor speed,  $N1/\sqrt{\theta_2}$ . The vanes are axial (0.DEG) for high speeds and cambered (-25. DEG) for low speeds. The logic is presented in figure 5.1-10 and the data in table 5.1-4.

### 5.1.2.3 Nozzle Trim Loop

This is the high speed portion of the nozzle trim loop shown in figure 5.1-1. Basically it computes the N1 error relative to a desired value, computed at a slower rate, and converts this error to a nozzle area rate of change. Nozzle area uptrim is inhibited if  $\Delta$ PLA uptrim inhibited or if the nozzle is already full open. The block diagrams and data are contained in figure 5.1-11 and table 5.1-5.

#### 5.1.2.4 PLAP Limiting Solenoid Delay Logic

This logic (figure 5.1-12) keeps the PLAP limiting solenoid on for 1 second after the PLAP limit signal has been turned off. No delay is applied to turning the solenoid on. Table 5.1-6 lists the data.

#### 5.1.2.5 PLA Trim Loop

This loop computes the PLA trim rate. Rate inputs from the maximum FTIT logic, N2 design, N1 design, and the minimum burner pressure logic are compared and the minimum selected. Uptrim is inhibited below intermediate, during transients in N2 and during rocket firing. Biases are added from the upmatch and VMAX logic. The block diagrams are presented in figure 5.1-13 and the data in Table 5.1-7.

#### 5.1.2.6 Stall Recovery

Stall is identified by an increasing T2 combined with a decreasing N2. The N2 rate corresponds to 500 RPM/second. In response to the stall the rocket fire solenoid is turned on for 0.5 seconds and the PLA and nozzle trims are set to 0 for 0.25 seconds (figure 5.1-14 and table 5.1-8).

#### 5.1.2.7 Nozzle and PLA Trim Integrators

The rate inputs for nozzle area and PLA trim are limited and then integrated for use in the UFC. As described above stall inhibits the trims. In addition, negative nozzle rate is inhibited if the nozzle is fully closed. This keeps the integrator from saturating when the nozzle is closed. The logic is shown in figure 5.1-15 and the data in table 5.1-9.

ORIGINAL PAGE IS  
OF POOR QUALITY

BLOCK DIAGRAM 1.2.1

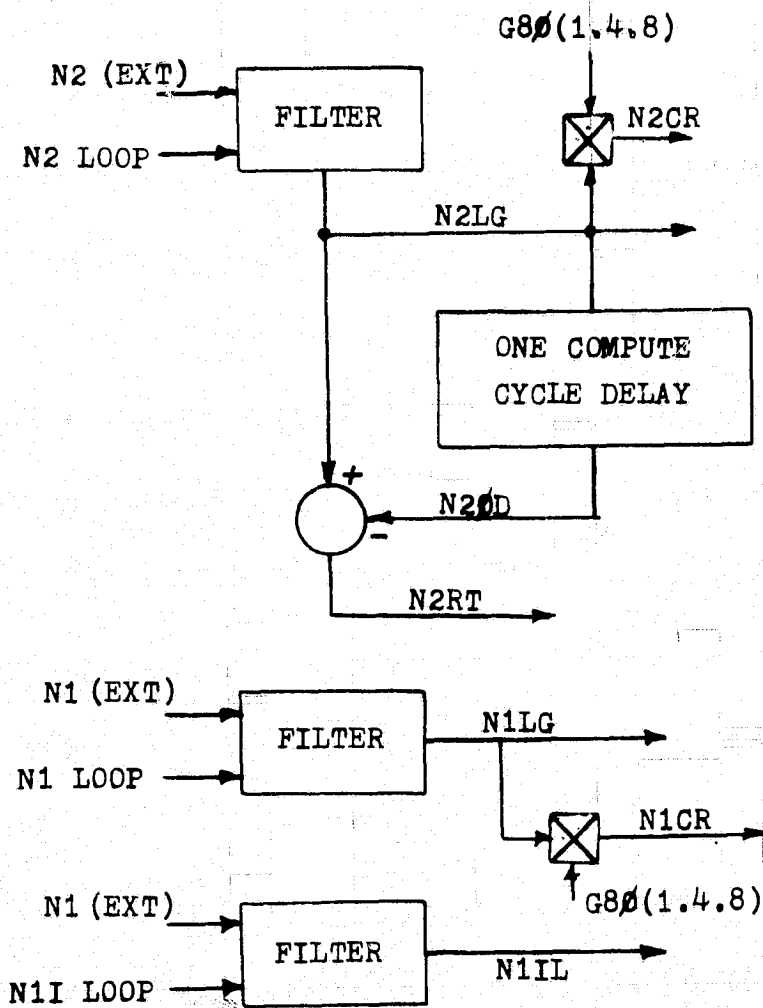


Figure 5.1-9. Speed Filters and N2 Rate

TABLE 5.1-3 BLOCK 1.2.1 DATA

\*\*\*\*\* INPUT VARIABLES \*\*\*\*\*

G80	1./((SQUARE ROOT CF THETA)	--
N1	LOW ROTOR SPEED	RPM
N2	HIGH COMPRESSOR SPEED	RPM

\*\*\*\*\* OUTPUT VARIABLES \*\*\*\*\*

N1CR	CORRECTED LOW ROTOR SPEED	RPM
N1IL	FILTERED N1 FOR IDLE LOOP	PPM
N1LG	FILTERED LOW ROTOR SPEED	RPM
N2CR	CORRECTED N2	RPM
N2LG	FILTERED HIGH ROTOR SPEED	RPM
N2RT	N2 RATE -- (N2LG -N20D)	RPM

\*\*\*\*\* INTERNAL VARIABLES \*\*\*\*\*

N20D	PAST VALUE OF N2LG	RPM
------	--------------------	-----

BLOCK DIAGRAM 1.2.2

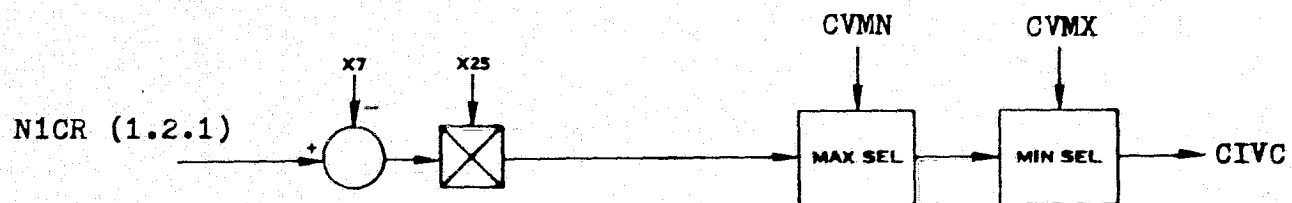


Figure 5.1-10. CIVV Control Loop

ORIGINAL PAGE IS  
OF POOR QUALITY



TABLE 5.1-4 BLOCK 1.2.2 DATA

\*\*\*\*\* CONSTANTS \*\*\*\*\*

CVMX	=	0.	DEG
CVMN	=	-25.000	DEG
X7	=	10385.	RPM
X25	=	.17340E-01	DEG/RPM

\*\*\*\*\* INPUT VARIABLES \*\*\*\*\*

NICR CORRECTED LOW FOTOR SPEED RPM

\*\*\*\*\* OUTPUT VARIABLES \*\*\*\*\*

CIVC CIVV COMMAND DEG

BLOCK DIAGRAM 1.2.3

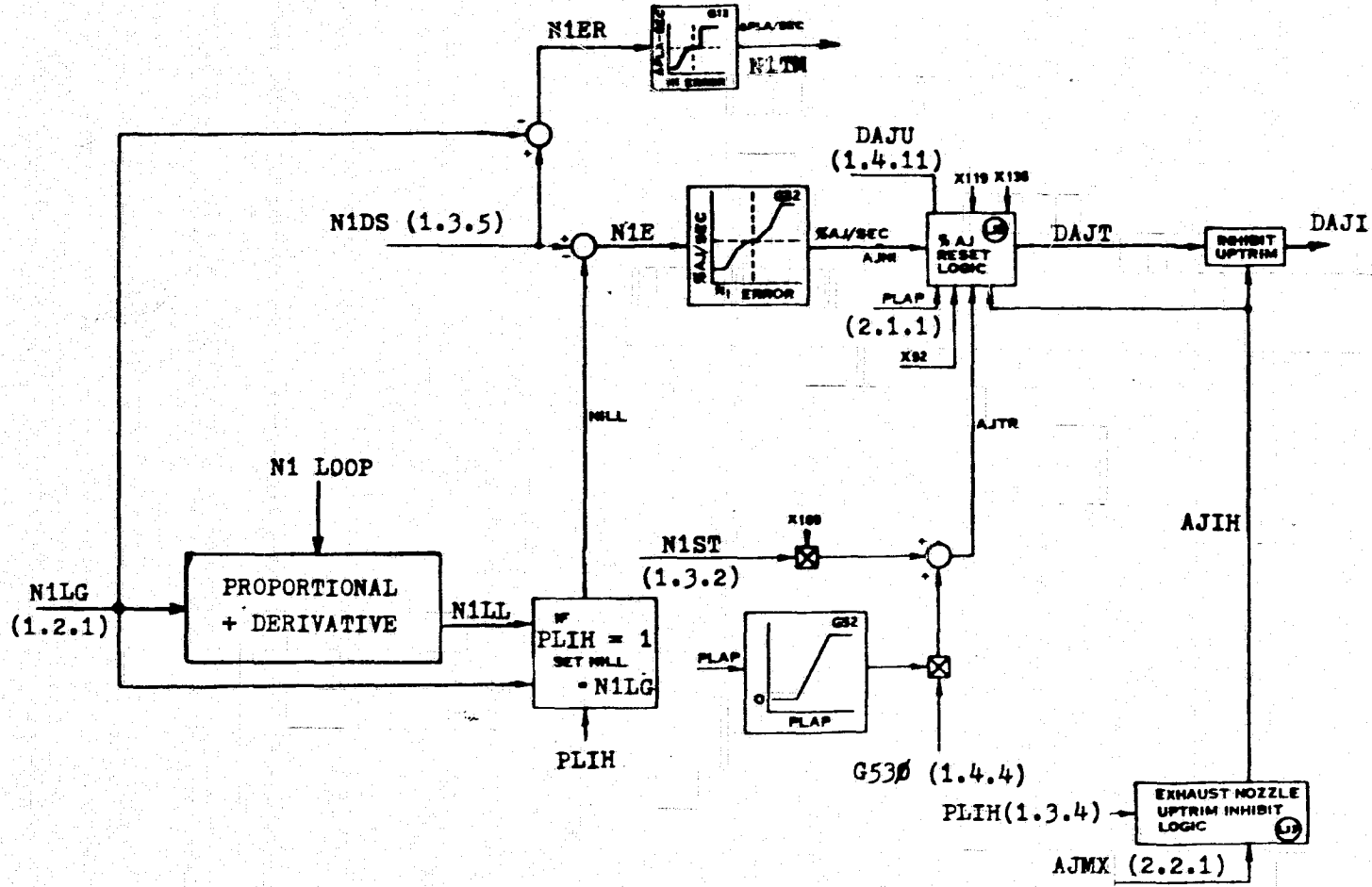


Figure 5.1-11. Nozzle Area Trim Loop

137

ORIGINAL PAGE IS  
OF POOR QUALITY

BLOCK DIAGRAM 1.2.3 (Cont)

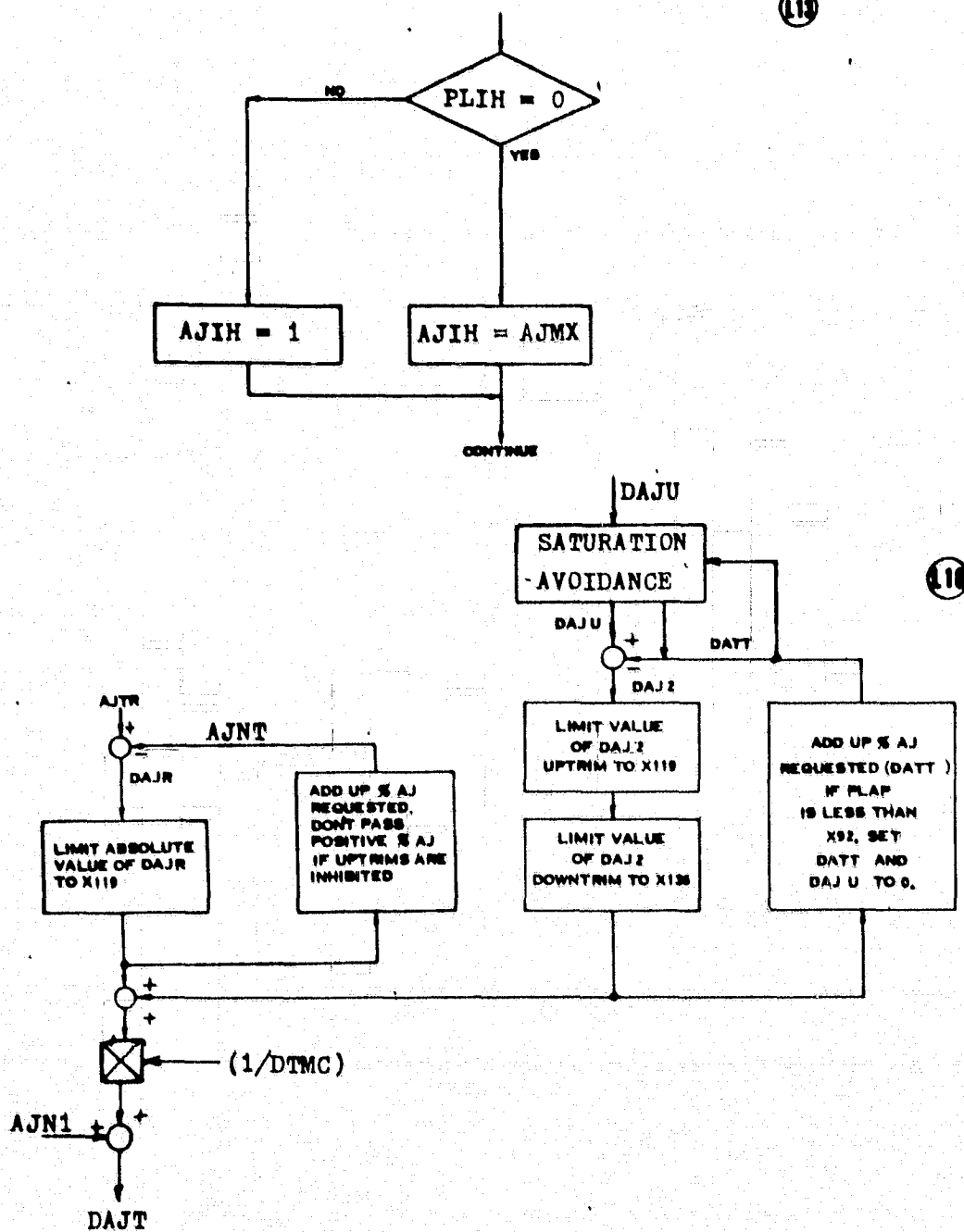
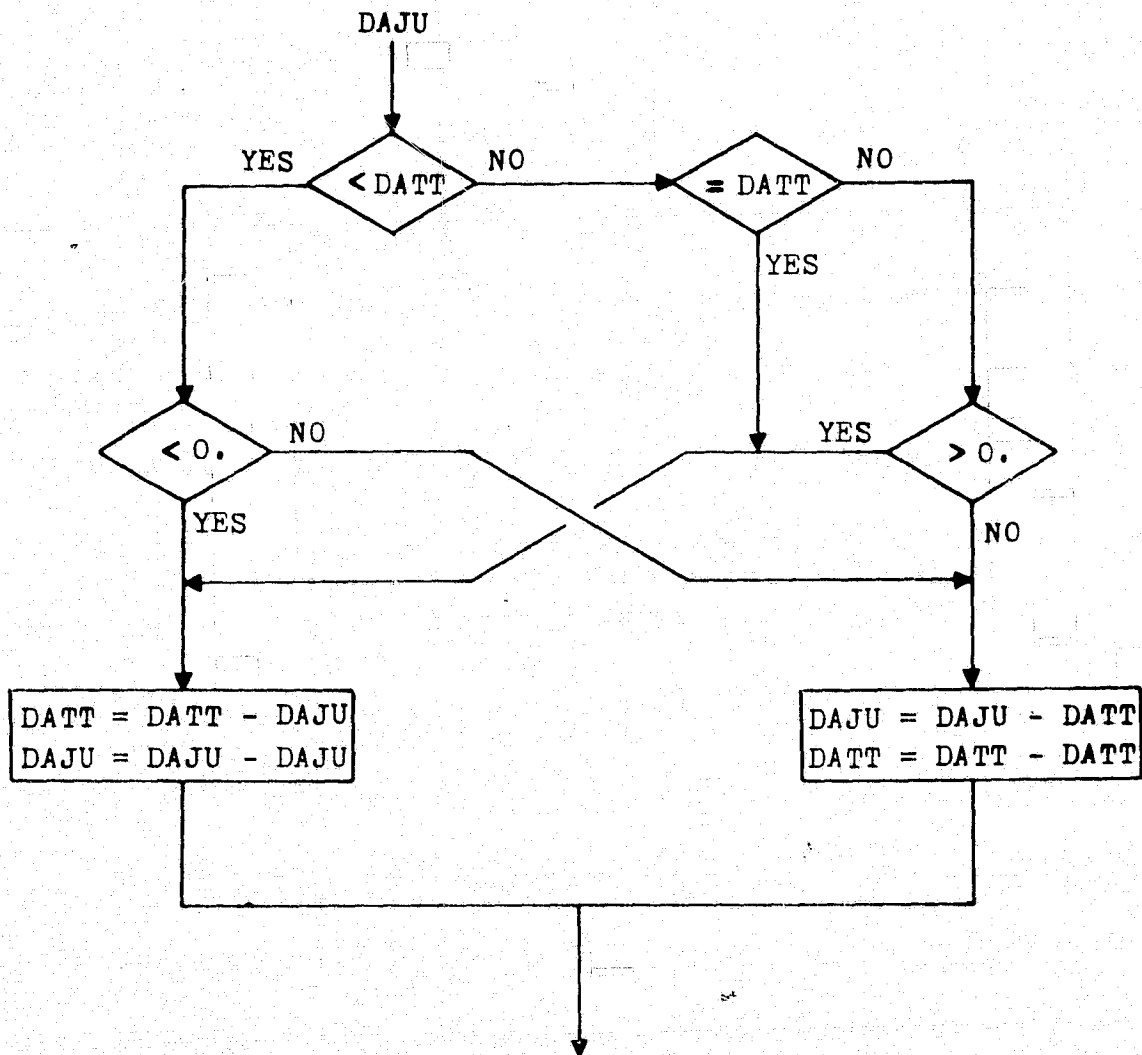


Figure 5.1-11. (Cont.)

BLOCK DIAGRAM 1.2.3 (Cont.)



SATURATION AVOIDANCE LOGIC

Figure 5.1-11. (Cont.)

TABLE 5.1-5 BLOCK 1.2.3 DATA

\*\*\*\*\* SCHEDULES \*\*\*\*\*

G13 FAN OVERSPEED LOOP GAIN  
 G32 NOZZLE AREA TRIM LOOP GAIN  
 G52 PLAP BIAS TO NOZZLE TRIM

\*\*\*\*\* CONSTANTS \*\*\*\*\*

DTMC = .60000E-01 SEC/MJC  
 X92 = 98.120 DEG  
 X109 = .20000E-01 AJ/RPM  
 X119 = 4.4400 AJ/MJC  
 X136 = -.22560 AJ/MJC

\*\*\*\*\* INPUT VARIABLES \*\*\*\*\*

AJMX NOZZLE FULL OPEN SWITCH DISCRETE  
 DAJU NOZZLE UPMATCH AJ  
 G530 AJ BIAS FOR PB AJ  
 N1DS DESIGN N1 RPM  
 N1LG FILTERED LOW ROTOR SPEED RPM  
 N1ST N1 RESET RPM  
 PLAP RATE LIMITED PLA DEG  
 PLIH PLA UPTRIM INHIBIT DISCRETE

\*\*\*\*\* OUTPUT VARIABLES \*\*\*\*\*

DAJI NOZZLE TRIM RATE AJ/SEC  
 N1TM N1 INPUT TO THE PLA LOOP DEG/SEC

\*\*\*\*\* INTERNAL VARIABLES \*\*\*\*\*

AJIH NOZZLE UPTRIM INHIBIT DISCRETE  
 AJNT CUM AJTR PREV COMMANDED AJ  
 AJN1 EXHAUST NOZZLE TRIM RATE AJ/SEC  
 AJTR PB COMPONENT OF AJ TRIM AJ  
 DAJR CURRENT AJTR INPUT AJ/MJC  
 DAJT NON-INHIBITED AJ TRIM AJ/SEC  
 DAJ2 CURRENT AJ UPMATCH INPUT AJ/MJC  
 DATT CUM DAJU PREV COMMANDED AJ  
 G520 NOZZLE TRIM BIAS --  
 N1F N1 ERROR FOR AJ LOOP RPM  
 N1ER N1 ERROR FOR PLA LOOP RPM  
 N1LL COMPENSATED N1 RPM

ORIGINAL PAGE IS  
 OF POOR QUALITY

BLOCK DIAGRAM 1.2.4

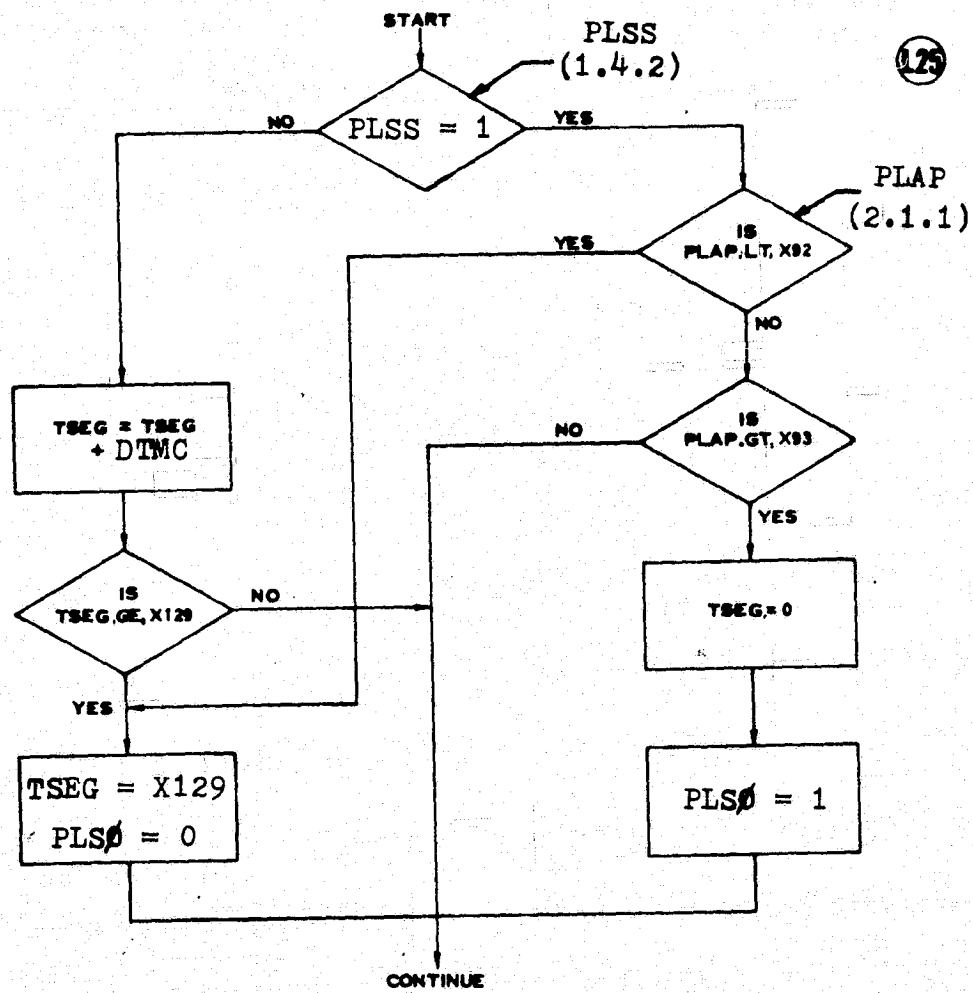


Figure 5.1-12. PLAP Limiting Solenoid Delay Logic

ORIGINAL PAGE IS  
OF POOR QUALITY

TABLE 5.1-6 BLOCK 1.2.4 DATA

\*\*\*\*\* CONSTANTS \*\*\*\*\*

DTMC	=	.60000E-01	SEC/NJC
X92	=	98.120	DEG
X93	=	99.180	DEG
X129	=	1.0000	SEC

\*\*\*\*\* INPUT VARIABLES \*\*\*\*\*

PLAP	RATE LIMITED	PLA	DEG
PLSS	PLAP LIMIT	SOLENOID SIG	DISCRETE

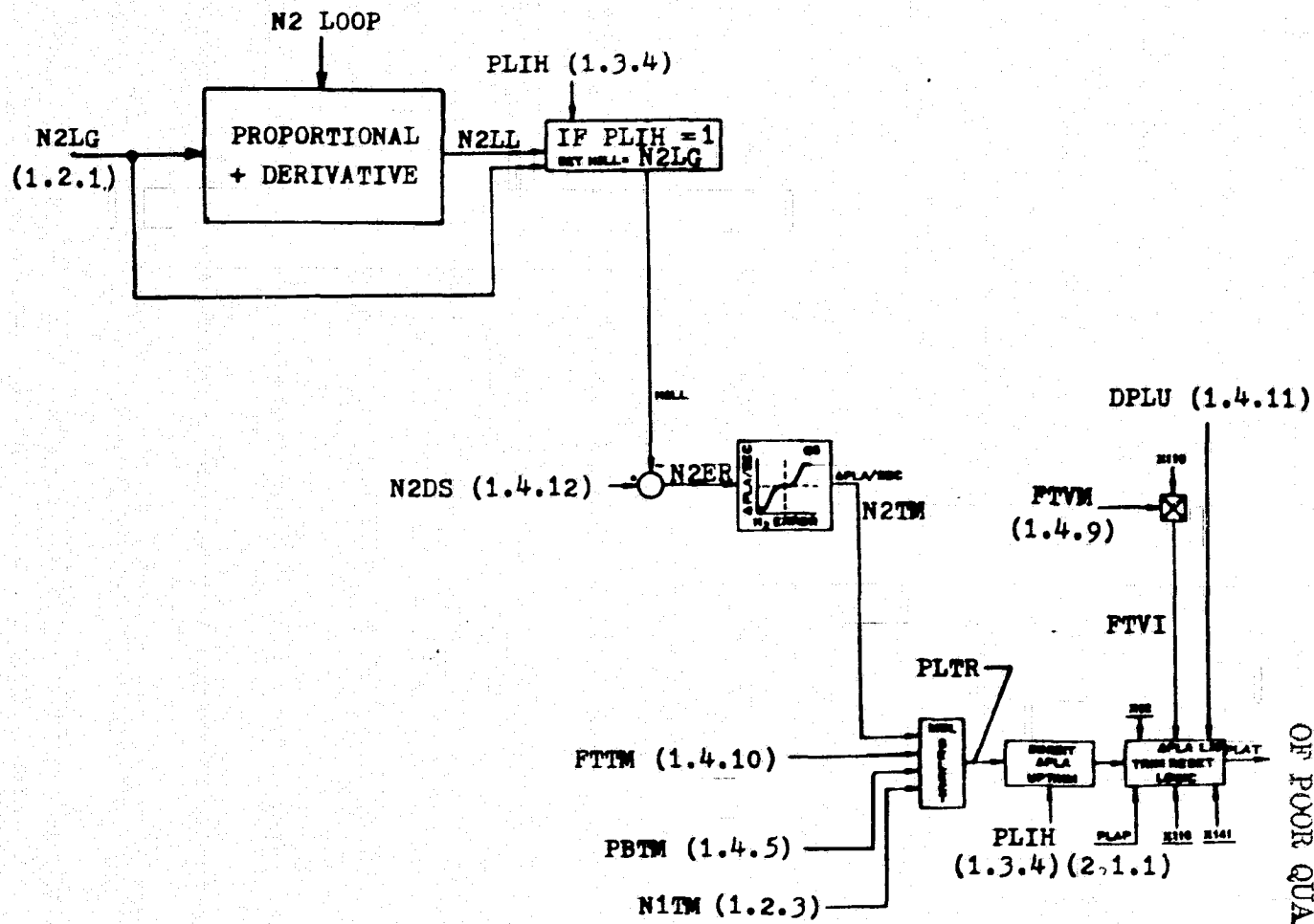
\*\*\*\*\* OUTPUT VARIABLES \*\*\*\*\*

PLSU	PLAP LIMIT	SOLENCID	DISCRETE
------	------------	----------	----------

\*\*\*\*\* INTERNAL VARIABLES \*\*\*\*\*

TSEG	PLAP LIMIT	DELAY TIMER	SEC
------	------------	-------------	-----

BLOCK DIAGRAM 1.2.5



143

Figure 5.1-13. PLA Trim Loop

ORIGINAL PAGE IS  
OF POOR QUALITY



BLOCK DIAGRAM 1.2.5 (Cont)

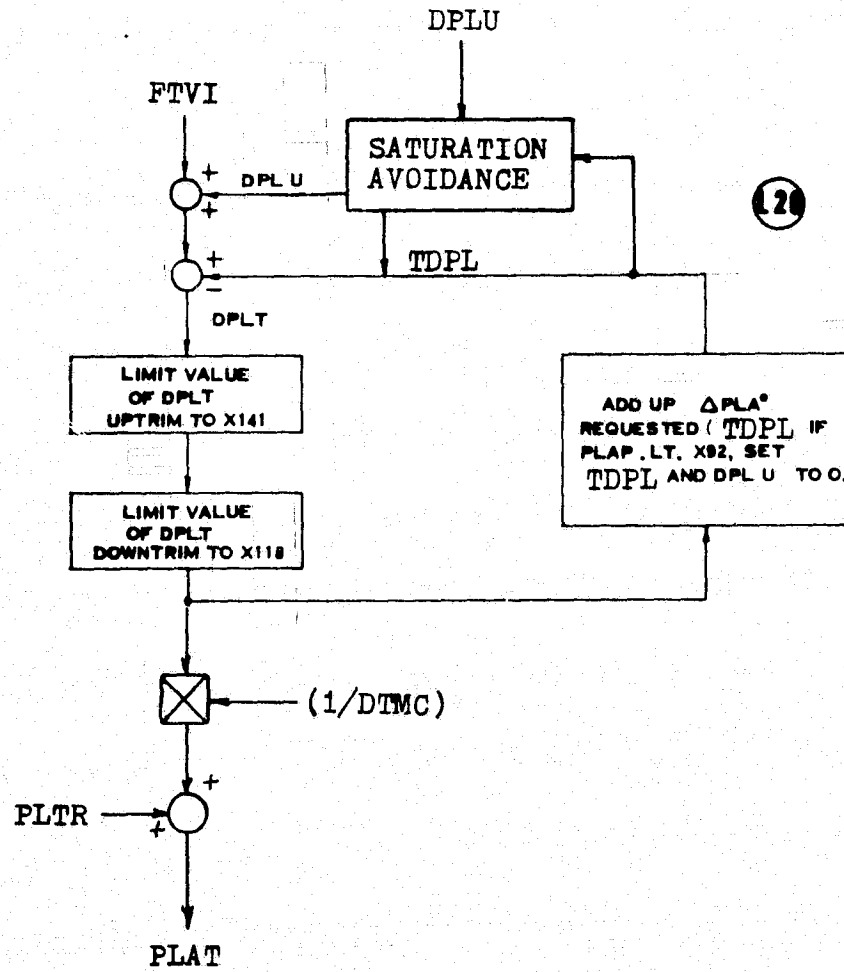
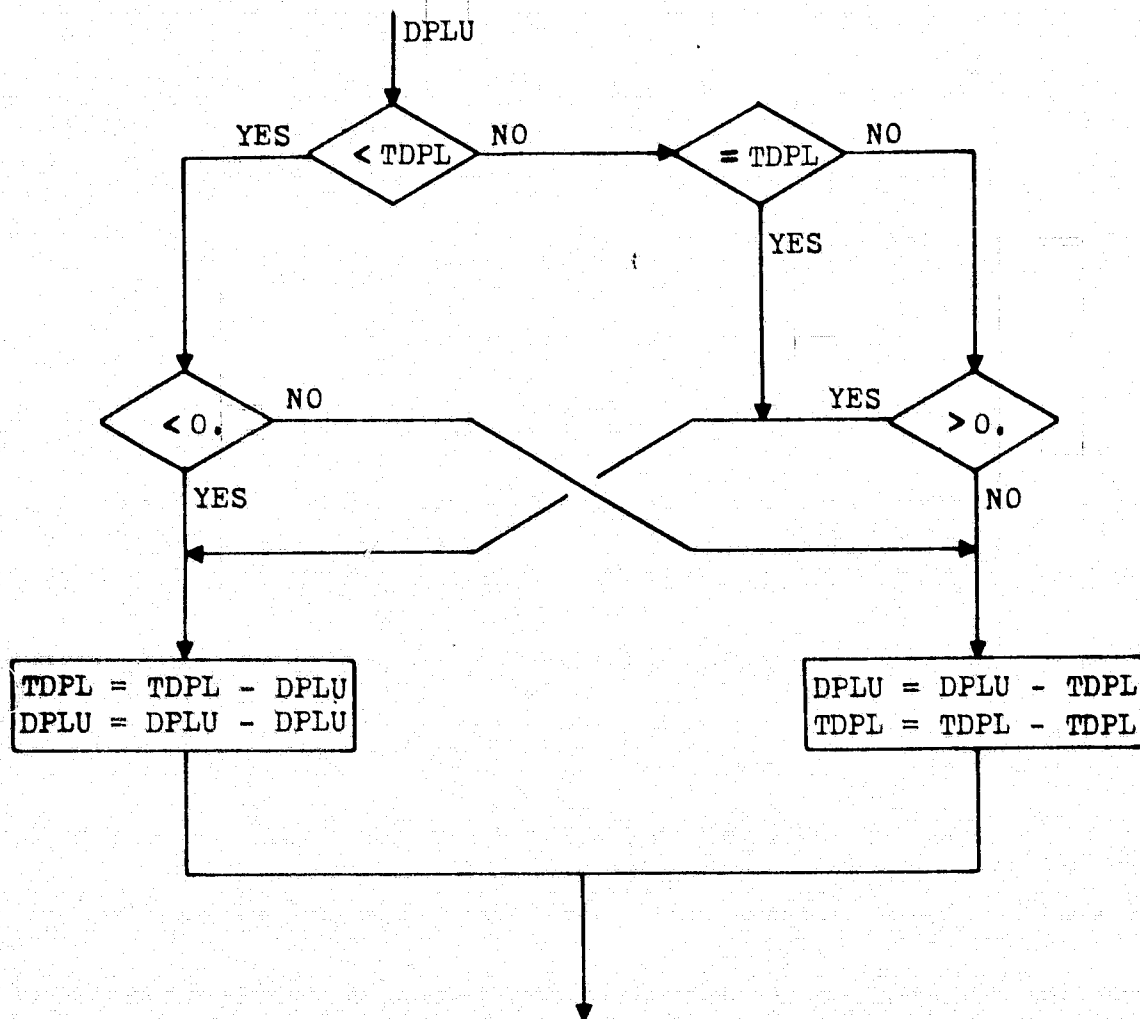


Figure 5.1-13. (Cont.)

BLOCK DIAGRAM 1.2.5 (Cont.)

ORIGINAL PAGE IS  
OF POOR QUALITY



SATURATION AVOIDANCE LOGIC

Figure 5.1-13. (Cont.)

TABLE 5.1-7 BLOCK 1.2.5 DATA

\*\*\*\*\* SCHEDULES \*\*\*\*\*

G5 HIGH COMPRESSOR SPEED LOOP GAIN

\*\*\*\*\* CONSTANTS \*\*\*\*\*

DTMC = .60000E-01 SEC/MJC  
 X92 = 98.120 DEG  
 X115 = .30000E-01 DEG/DEG F  
 X118 = -2.4000 DEG/MJC  
 X141 = .12856 DEG/MJC

\*\*\*\*\* INPUT VARIABLES \*\*\*\*\*

DPLU PLA UPMATCH DEG  
 FTIM FTIT INPUT TO PLA LOOP DEG/SEC  
 FTVM FTIT INPUT TO DEL PLA LP DEG F  
 N1TM N1 INPUT TO THE PLA LOOP DEG/SEC  
 N2DS DESIGN N2 RPM  
 N2LC FILTERED HIGH ROTOR SPEED RPM  
 PBTM MAX PB INPUT TO PLA LOOP DEG/SEC  
 PLAP RATE LIMITED PLA DEG  
 PLIH PLA UPTRIM INHIBIT DISCRETE

\*\*\*\*\* OUTPUT VARIABLES \*\*\*\*\*

PLAT PLA TRIM RATE DEG/SEC

\*\*\*\*\* INTERNAL VARIABLES \*\*\*\*\*

DPLT CURRENT FTVI INPUT DEG/MJC  
 FTVI FTIT COMPONENT OF DEL PLA DEG  
 N2ER N2 ERROR FOR PLA LOOP RPM  
 N2LL COMPENSATED N2 RPM  
 N2TM N2 INPUT TO THE PLA LOOP DEG/SEC  
 PLTR NON-INHIBITED PLA TRIM DEG/SEC  
 TOPL CUM (DPLU+FTVI) PREV CMD DEG

BLOCK DIAGRAM 1.2.6

ORIGINAL PAGE IS  
OF POOR QUALITY

INITIALIZE  
STAL = 0  
RTCS = 0

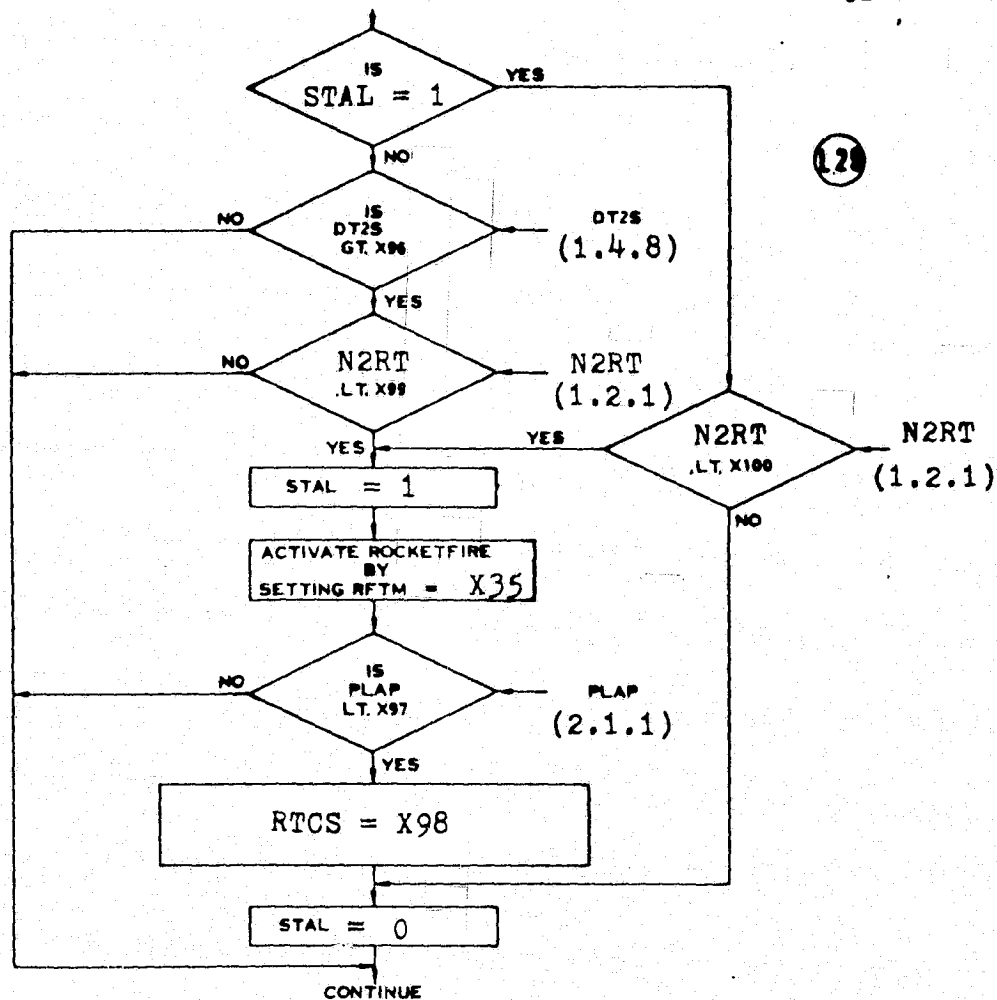


Figure 5.1-14. Stall Recovery

TABLE 5.1-8 BLOCK 1.2.6 DATA

\*\*\*\*\* CONSTANTS \*\*\*\*\*

X35	=	-.50000	SEC
X96	=	2.5000	DEG F
X97	=	49.900	DEG
X98	=	.25000	SEC
X99	=	-30.000	RPM/MJC
X100	=	-30.000	RPM/MJC

\*\*\*\*\* INPUT VARIABLES \*\*\*\*\*

DT2S	T2 RATE	DEG F
N2RT	N2 RATE -- (N2LG -N2OD)	RPM
PLAP	RATE LIMITED PLA	DEG

\*\*\*\*\* OUTPUT VARIABLES \*\*\*\*\*

RFTM	STALL INPUT TO ROCKETFIRE	SEC
RTCS	RESIDUAL TRIM CLEAR SIG	SEC
STAL	STALL SIGNAL	DISCRETE

BLOCK DIAGRAM 1.2.7

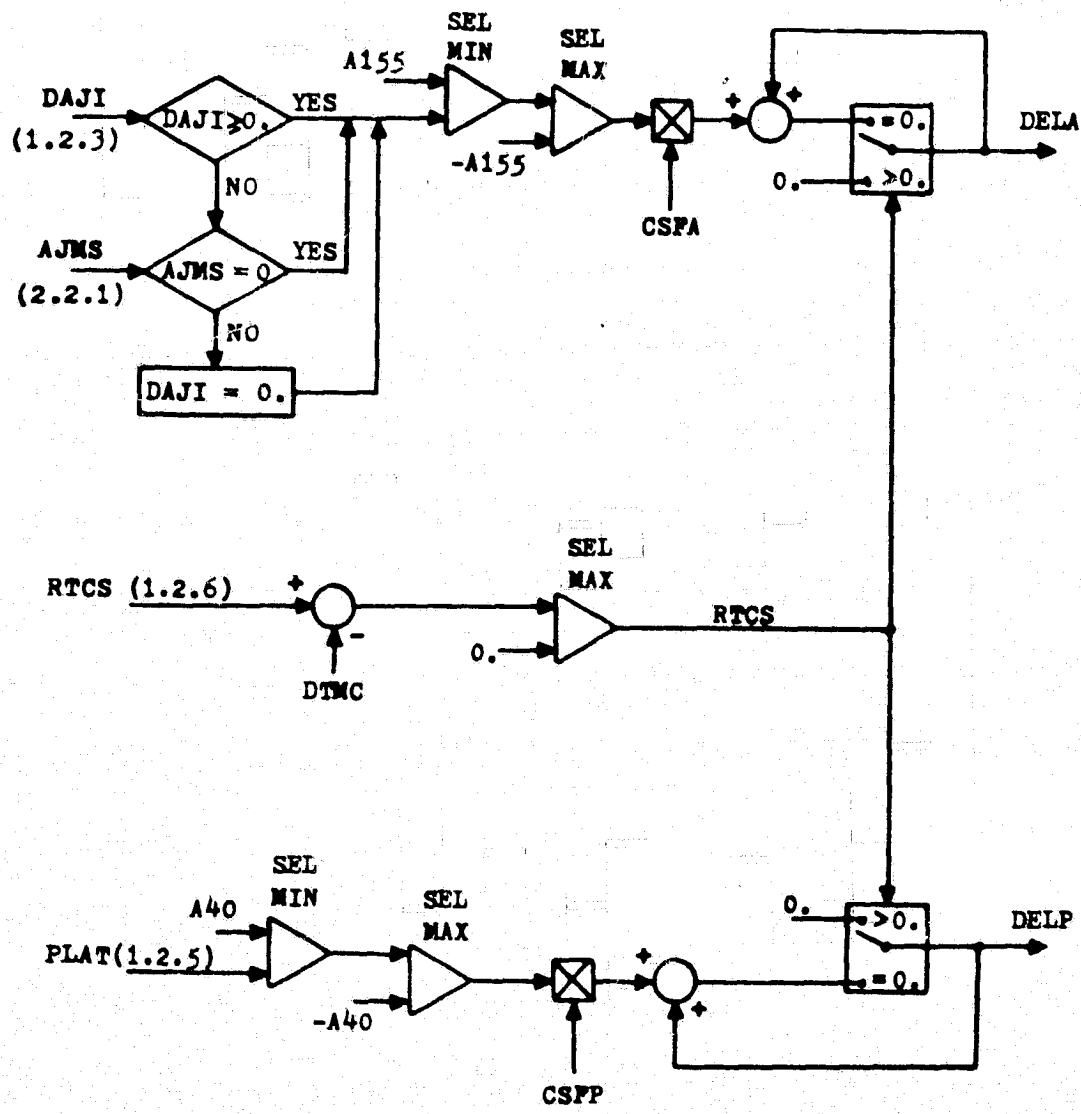


Figure 5.1-15. Integrators

TABLE 5.1-9 BLOCK 1.2.7 DATA

\*\*\*\*\* CONSTANTS \*\*\*\*\*

A40	=	40.000	DEG/SEC
A155	=	155.00	/SEC
CSFA	=	.19356	S*SEC/ MJC
CSFP	=	.60000E-01	SEC/MJC
DTMC	=	.60000E-01	SEC/MJC

\*\*\*\*\* INPUT VARIABLES \*\*\*\*\*

AJMS	NOZZLE CLOSED SWITCH	DISCRETE
DAJI	NOZZLE TRIM RATE	AJ/SEC
PLAT	PLA TRIM RATE	DEG/SEC
RTCS	RESIDUAL TRIM CLEAR SIG	SEC

\*\*\*\*\* OUTPUT VARIABLES \*\*\*\*\*

DELA	EEC NOZZLE TRIM	STEPS
DELP	EEC PLA TRIM	DEG

### 5.1.3 Intermediate Frequency Calculations

The calculations described in paragraphs 5.1.3.1 - 5.1.3.5 are performed every 28 milliseconds in the BOM EEC.

#### 5.1.3.1 Rocket Fire Response to Stall Recovery

For the PROFIT program only the portion of the rocket fire calculation activated by the stall recovery logic is required (figure 5.1-16 and table 5.1-10). This logic turns on the rocket fire solenoid for 0.5 seconds in response to the signal generated in the stall recovery logic (paragraph 5.1.2.6) providing the corrected N2 is above 8000 RPM.

#### 5.1.3.2 Transient Reset

Significant rapid PLAP transients are detected and a reset signal (TRS) is set. For decelerations, the N1 setpoint is increased by 200 RPM. The transient reset signal is also used in the computation of the N2 solenoid (para 5.1.3.3). Block diagrams are presented in figure 5.1-17 and required data in table 5.1-11.

#### 5.1.3.3 N2 High Rate Solenoid

This block computes the position of the N2 high rate solenoid. It is turned on if the N2 rate exceeds 200 RPM per second for more than 0.224 seconds, if TRS is on, or if the rocket fire solenoid is on. In addition it is turned on for low burner pressure if the PLAP is below 69.9 degrees. The block diagrams and data are shown in figure 5.1-18 and table 5.1-12.

#### 5.1.3.4 PLA Uptrim Inhibit

PLA uptrim is inhibited for power settings below intermediate or if the rocket fire solenoid is on (figure 5.1-19 and table 5.1-13).



Once turned on the inhibit signal is latched if the N2 solenoid signal is on.

#### 5.1.3.5 N1 Setpoint Calculation

This logic block computes the N1 setpoint. The desired fan face corrected airflow is computed from a schedule as a function of T2, biased for N2 error, and limited by maximum and minimum airflow as a function of aircraft Mach number. The desired airflow is converted to corrected N1 through a three step curve (schedules G431, G432, and G433). The N1 setpoint is calculated by multiplying by  $\sqrt{\theta}$  (G80) and limiting with the maximum N1 as a function of T2. The block diagram is presented in figure 5.1-20. Portions are labeled 1.3.5 and 1.3.5A because they are performed at different times in the major cycle (section 5.3). The required data is identified in table 5.1-14.

BLOCK DIAGRAM 1.3.1

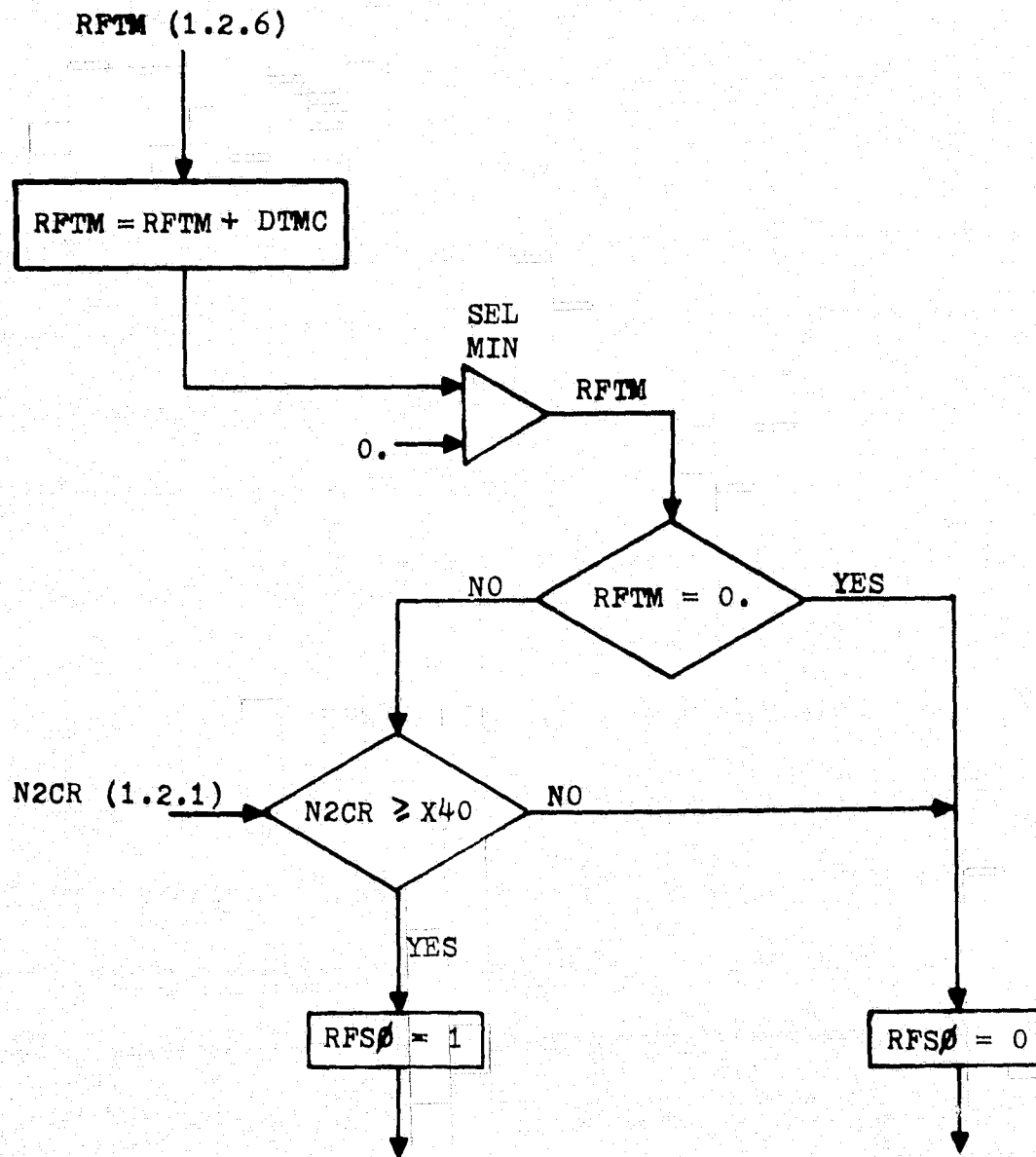


Figure 5.1-16. Rocket Fire Logic

TABLE 5.1-10 BLOCK 1.3.1 DATA

\*\*\*\*\* CONSTANTS \*\*\*\*\*

DTMC = .60000E-01 SEC/MJC  
X40 = 8000.0 RPM

\*\*\*\*\* INPUT VARIABLES \*\*\*\*\*

N2CR CORRECTED N2 RPM  
RFTM STALL INPUT TO ROCKETFIRE SEC

\*\*\*\*\* OUTPUT VARIABLES \*\*\*\*\*

RFSO ROCKET FIRE SOLENOID DISCRETE

BLOCK DIAGRAM 1.3.2

ORIGINAL PAGE IS  
OF POOR QUALITY

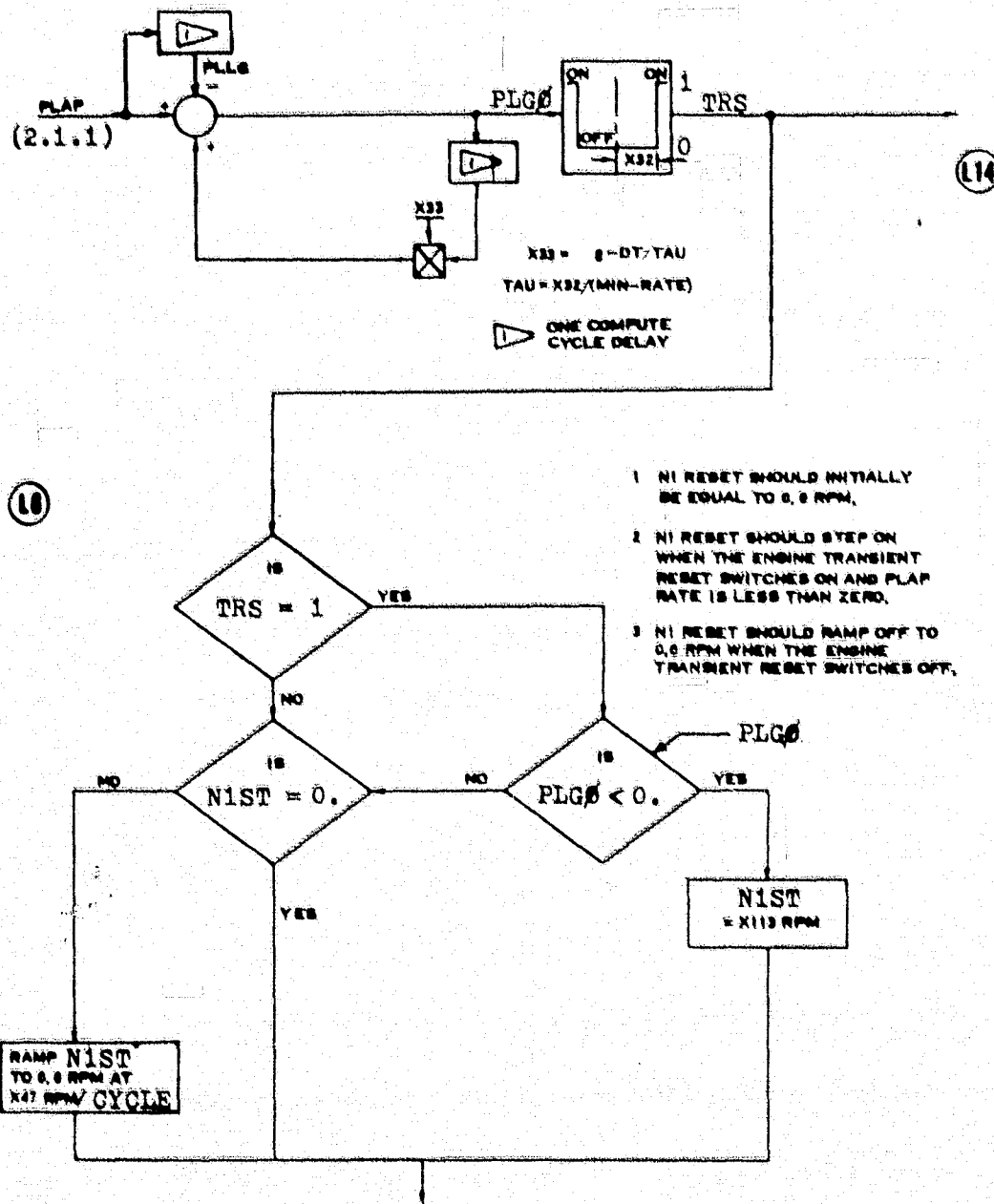


Figure 5.1-17. Transient Reset Logic

TABLE 5.1-11 BLOCK 1.3.2 DATA

\*\*\*\*\* CONSTANTS \*\*\*\*\*

X32	=	2.0000	DEG
X33	=	.91916	--
X47	=	12.000	RPM/MJC
X113	=	200.00	RPM

\*\*\*\*\* INPUT VARIABLES \*\*\*\*\*

PLAP	RATE LIMITED PLA	DEG
------	------------------	-----

\*\*\*\*\* OUTPUT VARIABLES \*\*\*\*\*

N1ST	N1 RESET	RPM
TRS	TRANSIENT RESET SIGNAL	DISCRETE

\*\*\*\*\* INTERNAL VARIABLES \*\*\*\*\*

PLGO	PLAP RATE FOR TRS COMP.	DEG
PLLG	FILTERED PLAP	DEG

BLOCK DIAGRAM 1.3.3

ORIGINAL PAGE IS  
OF POOR QUALITY

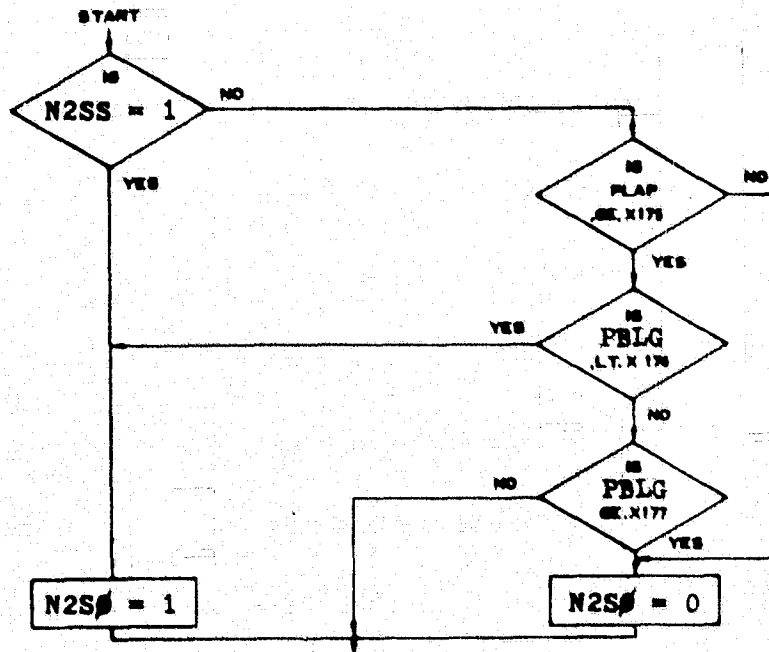
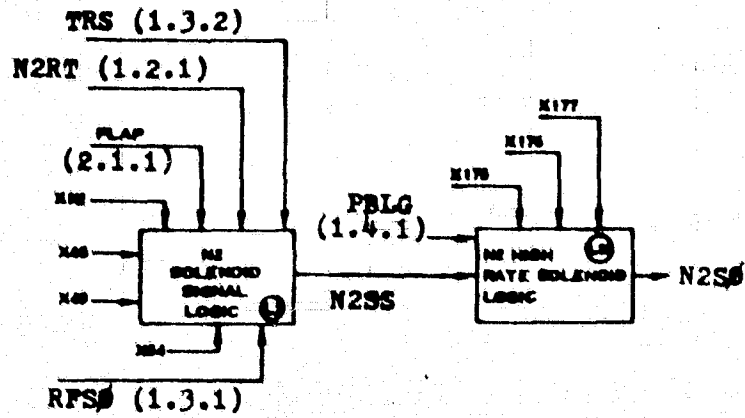


Figure 5.1-18. N2 High Rate Solenoid

BLOCK DIAGRAM 1.3.3 (Cont)

NOTE: CYCL  
LIMITS:  
MINIMUM = 0.0  
MAXIMUM = X64  
INITIALLY = 0.0

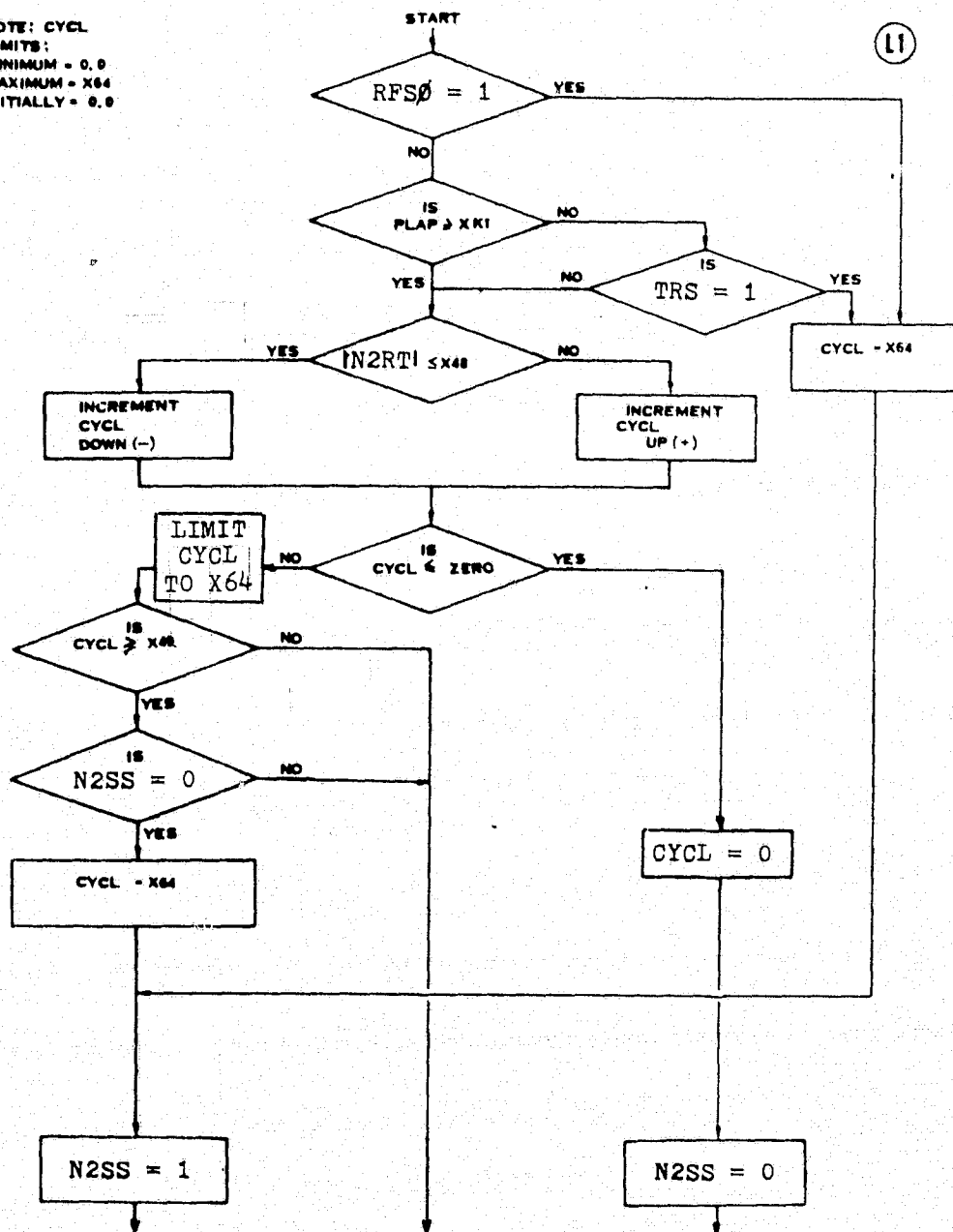


Figure 5.1-18. (Cont.)

TABLE 5.1-12 BLOCK 1.3.3 DATA

\*\*\*\*\* CONSTANTS \*\*\*\*\*

X48	=	12.000	RPM/MJC
X49	=	3.7335	--
X64	=	6.5650	--
X175	=	69.900	DEG
X176	=	49.340	PSI
X177	=	52.330	PSI
XK1	=	82.900	DEG

\*\*\*\*\* INPUT VARIABLES \*\*\*\*\*

N2RT	N2 RATE -- (N2LG -N2OD)	RPM
PBLG	FILTERED PB	PSI
PLAP	RATE LIMITED PLA	DEG
RFSO	ROCKET FIRE SOLENOID	DISCRETE
TRS	TRANSIENT RESET SIGNAL	DISCRETE

\*\*\*\*\* OUTPUT VARIABLES \*\*\*\*\*

N2SO	N2 SOLENOID	DISCRETE
N2SS	N2 SOLENOID SIGNAL	DISCRETE

\*\*\*\*\* INTERNAL VARIABLES \*\*\*\*\*

CYCL	N2 SOLENOID SIG COUNTER	--
------	-------------------------	----



BLOCK DIAGRAM 1.3.4

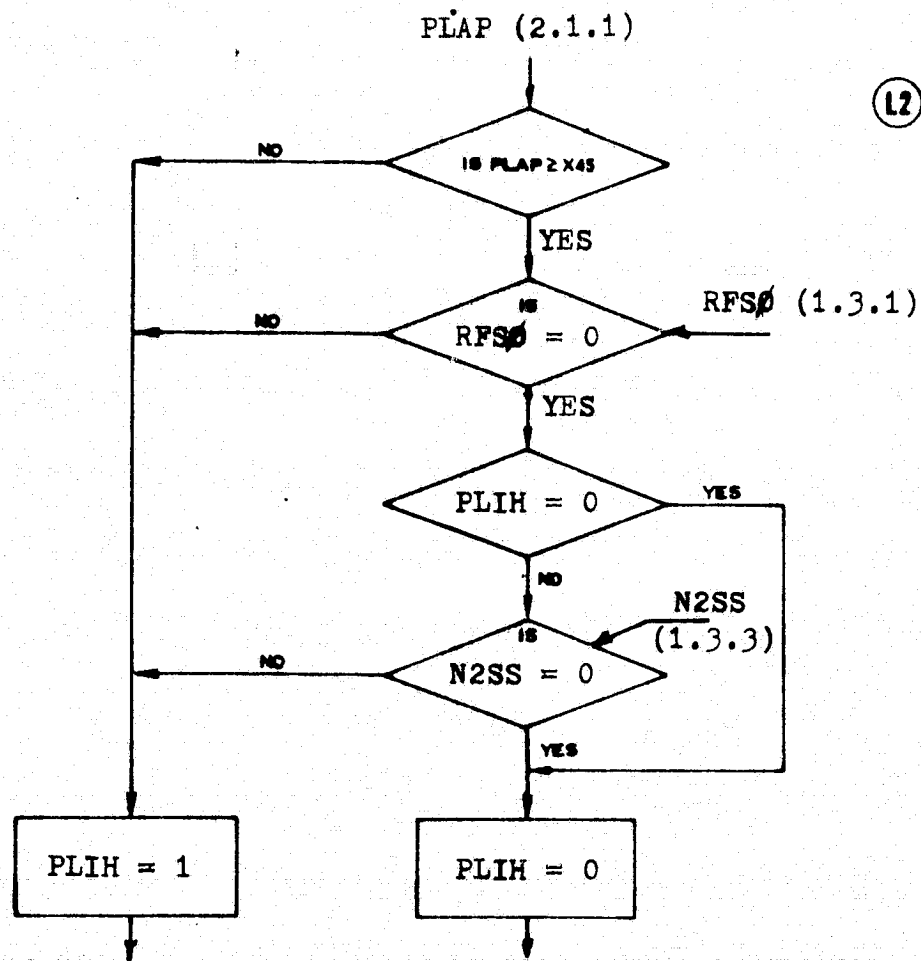


Figure 5.1-19. PLA Uptrim Inhibit

TABLE 5.1-13 BLOCK 1.3.4 DATA

ORIGINAL PAGE IS  
OF POOR QUALITY

\*\*\*\*\* CONSTANTS \*\*\*\*\*

X45 = 82.900 DEG

\*\*\*\*\* INPUT VARIABLES \*\*\*\*\*

N2SS	N2 SOLENOID SIGNAL	DISCRETE
PLAP	RATE LIMITED PLA	DEG
RFSU	ROCKET FIRE SOLENOID	DISCRETE

\*\*\*\*\* OUTPUT VARIABLES \*\*\*\*\*

PLIH	PLA UPTRIM INHIBIT	DISCRETE
------	--------------------	----------

BLOCK DIAGRAM 1.3.5

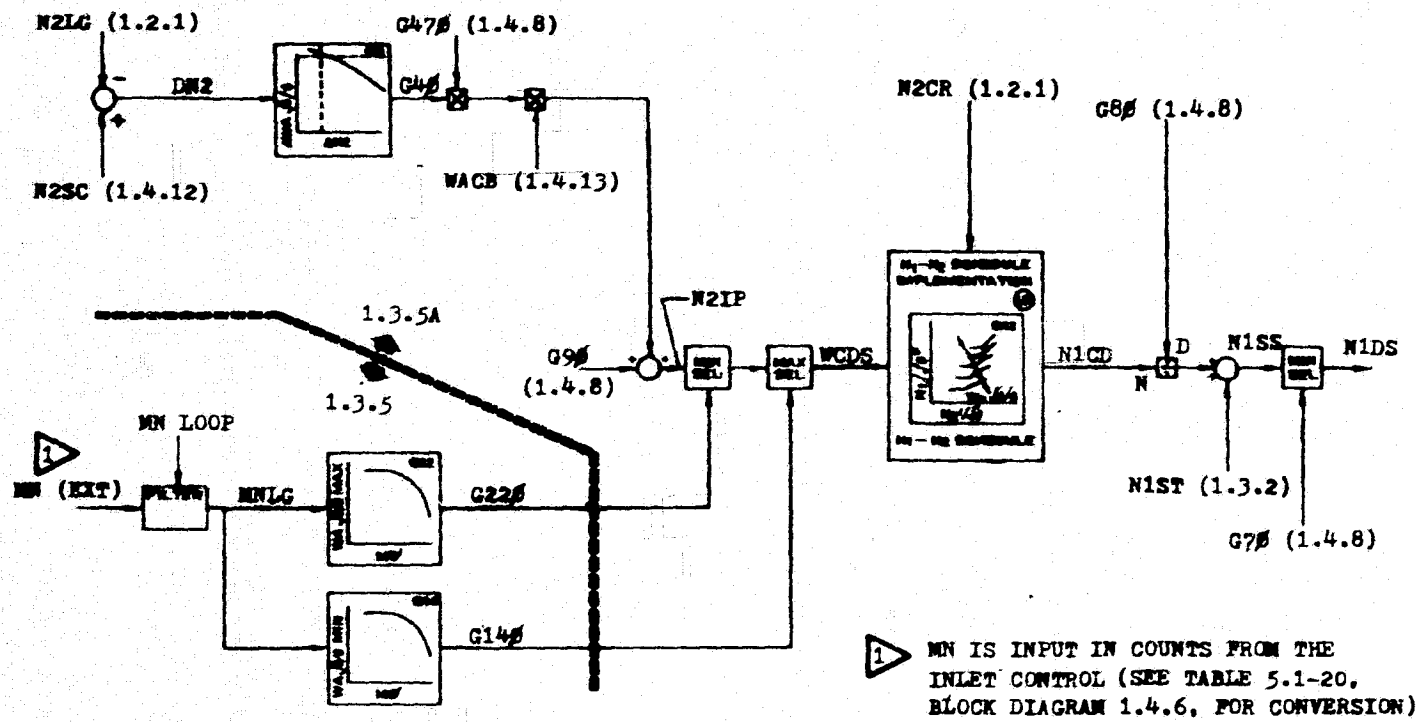


Figure 5.1-20. N1 Setpoint Calculation

BLOCK DIAGRAM 1.3.5(Cont)

ORIGINAL PAGE IS  
OF POOR QUALITY

(11)

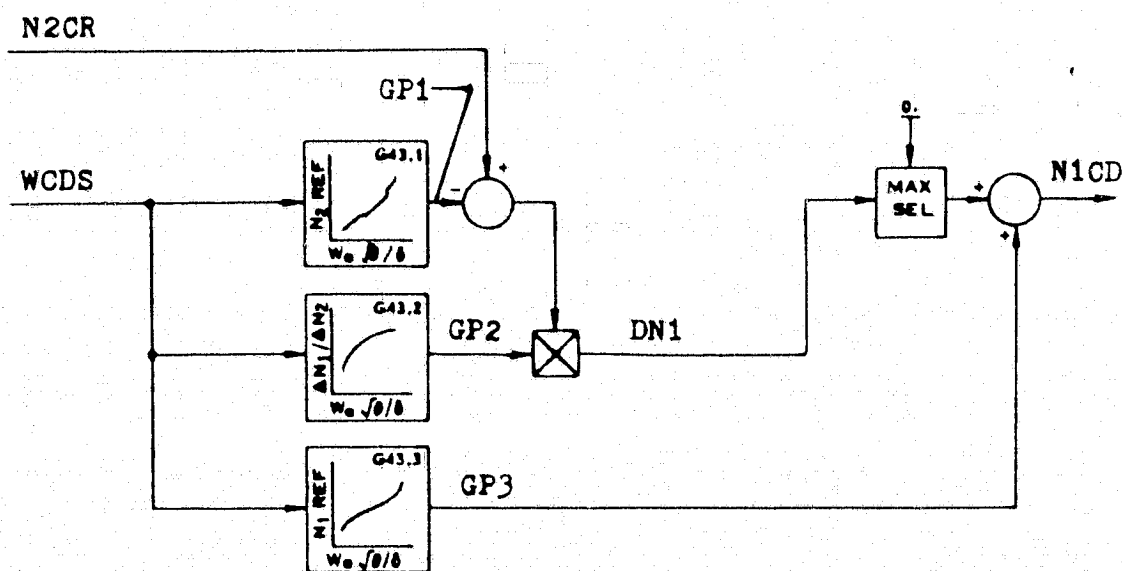


Figure 5.1-20. (Cont.)

TABLE 5.1-14 BLOCK 1.3.5 DATA

\*\*\*\*\* SCHEDULES \*\*\*\*\*

G4	N2 AIRFLOW ADJUSTMENT	
G14	MINIMUM CORRECTED AIRFLOW	
G22	MAXIMUM CORRECTED AIRFLOW	
G43.1	N2 REFERENCE	
G43.2	N2 TO N1 CORRECTION	
G43.3	N1 REFERENCE	

\*\*\*\*\* INPUT VARIABLES \*\*\*\*\*

G70	MAXIMUM N1	RPM
G80	1./((SQUARE ROOT OF THETA)	--
G90	SCHEDULED CORRECTED FLOW	PPS
G470	AIRFLOW CUTBACK SLOPE	--
MN	AIRPLANE MACH NUMBER	--
N1ST	N1 RESET	RPM
N2CR	CORRECTED N2	RPM
N2LG	FILTERED HIGH ROTOR SPEED	RPM
N2SC	N2 SETPOINT (UPMATCH)	RPM
WACB	AIRFLOW CUTBACK MULT.	--

\*\*\*\*\* OUTPUT VARIABLES \*\*\*\*\*

G220	MAXIMUM CORRECTED AIRFLOW	PPS
MNLG	FILTERED A/C MACH NUMBER	COUNTS
N1DS	DESIGN N1	RPM

\*\*\*\*\* INTERNAL VARIABLES \*\*\*\*\*

DN1	DELTA N1 FOR N1 DESIGN	RPM
DN2	N2 ERROR FOR AIRFLOW ADJ	RPM
GP1	REFERENCE CORRECTED N2	RPM
GP2	DELTA N1 / DELTA N2	--
GP3	REFERENCE CORRECTED N1	RPM
G40	DELTA AIRFLOW	PPS
G140	MINIMUM CORRECTED AIRFLOW	PPS
N1CD	CORRECTED N1 DESIGN	RPM
N1SS	N1 DESIGN W/O N1 LIMITING	RPM
N2IP	N2 INPUT TO N1 DESIGN	PPS
WCDS	DESIRED CORRECTED AIRFLOW	PPS

#### 5.1.4 Low Frequency Calculations

The remaining calculations, described in this section, are executed once per major cycle (56 milliseconds) in the BOM EEC.

##### 5.1.4.1 Burner Pressure Filters

Two filters are applied to the burner pressure. The first simulates the response of the BOM Pb sensor. Its output, PBC, is equivalent to the BOM control Pb. PBC is input to the EEC Pb filter and is used in the gas generator and afterburner fuel flow command computations (para 5.2.1.3 and 5.2.2.3). The block diagram and data are shown in figure 5.1-21 and table 5.1-15.

##### 5.1.4.2 PLAP Limiting Logic

The PLAP limiting solenoid signal is turned on if PBLG is less than 124.55 psi and T2 is less than 25°F (figure 5.1-22, table 5.1-16). The solenoid signal is processed by the PLAP limiting solenoid delay logic (para 5.1.2.4) which turns on the solenoid if PLSS is on, but delays turning off the solenoid by one second.

##### 5.1.4.3 Derivative Gain Bias

The gain to the proportional plus derivative calculation (paragraph 3.2.4.1.1.3) is varied as a function of burner pressure and T2 (figure 5.1-23 and table 5.1-17). The BOM logic was developed using a twoslope approximate PB calibration. Thus a correction curve is applied to PBLG for the DGB computation.

##### 5.1.4.4 PB Input to Minimum PLAP Loop

This logic computes the minimum burner pressure input to minimum PLAP loop. The G44 and G53 table lookups were included; they have the same X input as the G51 which is in this logic. The block

diagrams are in figure 5.1-24 and the data are identified in table 5.1-18. Since the upper and lower limits used in the MNPB computation, X145 and X29, are the same, that logic path can be simplified to  $MNPB=X29$  for the PROFIT control code.

#### 5.1.4.5 PB Input to PLA Trim Loop

The maximum burner pressure input to the PLA trim loop consists of a gained error relative to a fixed PB limit (figure 5.1-25, table 5.1-19).

#### 5.1.4.6 N1 Input to Minimum PLAP Loop

The idle corrected N1 setpoint is computed as a function of aircraft Mach number and the idle area reset switch (figure 5.1-26, table 5.1-20). The gained error is input to the minimum PLAP Loop (para 5.1.4.7).

#### 5.1.4.7 Minimum PLAP Loop

This logic computes the Mach number input to the minimum PLAP loop; selects the maximum of the Mach input, the Pb input, and the N1 input; and outputs a rate of change of the minimum PLAP. Since the stepper motor will not exist an integrator is required as it was in the PLA and nozzle trim loops (para 5.1.2.7). Figure 5.1-27 presents the block diagrams. Table 5.1-21 lists the required data.

#### 5.1.4.8 T2 Compensation and Tables

Figure 5.1-28 presents the block diagrams of the T2 compensation. A series of table lookups are executed using the compensated T2. Table 5.1-22 presents the required data.

#### 5.1.4.9 VMAX Logic

The VMAX logic computes the increase in allowable FTIT in response to an aircraft switch the block diagram and data are presented in figure 5.1-29 and table 5.1-23.

#### 5.1.4.10 FTIT Input to PLA Trim Loop

The sensed FTIT is filtered and compensated. The gained error relative to a schedule as a function of T2, biased by VMAX and ground trim, is input to the select min of the PLA trim loop. The block diagram and required data are presented in figure 5.1-30 and table 5.1-24.

#### 5.1.4.11 Upmatch Logic

The upmatch logic computes the biases to the N2 setpoint, the  $\Delta$ PLA loop, and the nozzle trim loop. Figure 5.1-31 and table 5.1-25 present the block diagrams and data.

#### 5.1.4.12 N2 Setpoint Calculation

This logic computes the N2 setpoint (figure 5.1-32). The setpoint is determined from a scheduled value as function T2 with biases for ground trim, upmatch, and FTIT. The setpoint is limited by maximum N2 also scheduled as a function of T2. The required data is identified in table 5.1-26.

#### 5.1.4.13 Airflow Cutback Multiplier

The airflow cutback multiplier block diagram and data are presented in figure 5.1-33 and table 5.1-27.



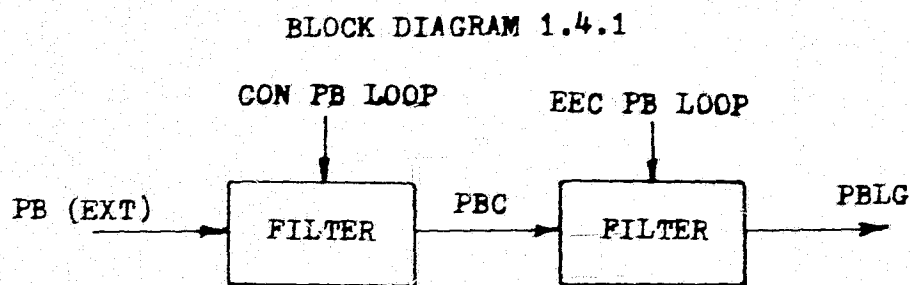


Figure 5.1-21. Burner Pressure Filters

TABLE 5.1-15 BLOCK 1.4.1 DATA

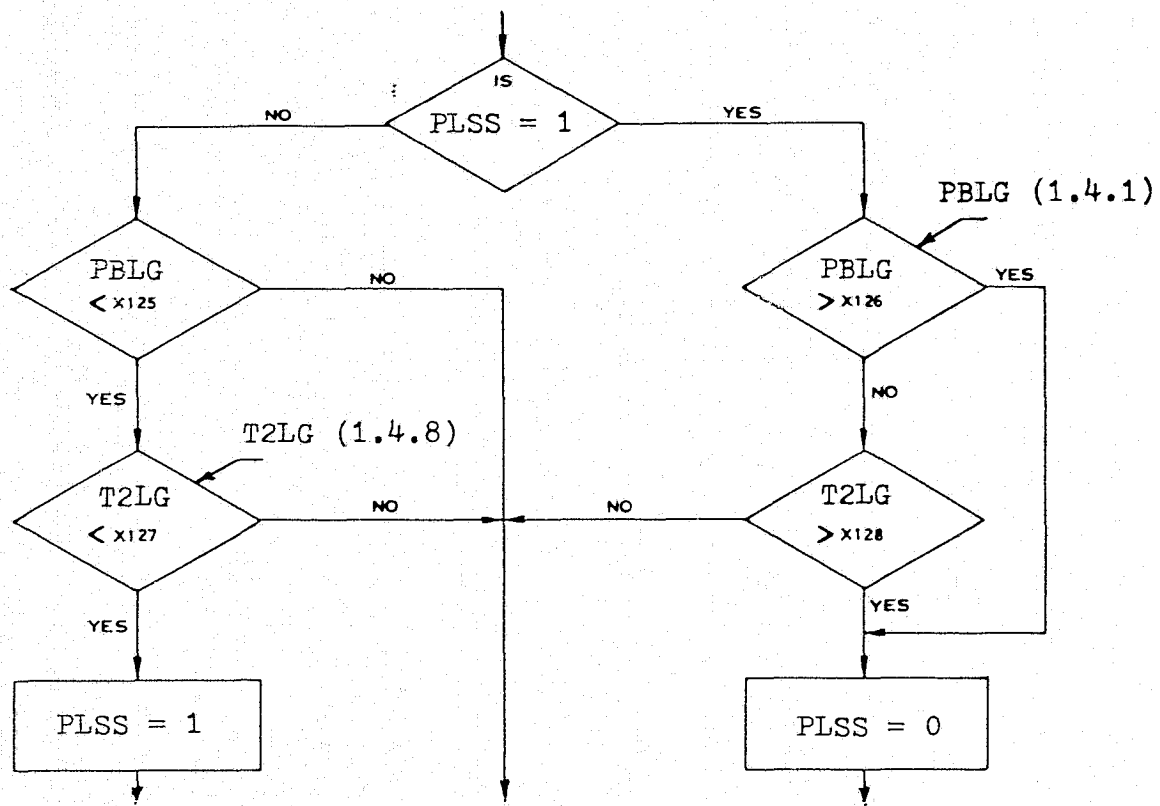
\*\*\*\*\* INPUT VARIABLES \*\*\*\*\*

PB	BURNER PRESSURE	PSI
----	-----------------	-----

\*\*\*\*\* OUTPUT VARIABLES \*\*\*\*\*

PBC	COMP. BURNER PRESSURE	PSI
PBLG	FILTERED PB	PSI

BLOCK DIAGRAM 1.4.2



170

Figure 5.1-22. PLAP Limiting Logic

ORIGINAL PAGE IS  
OF POOR QUALITY

TABLE 5.1-16 BLOCK 1.4.2 DATA

\*\*\*\*\* CONSTANTS \*\*\*\*\*

X125	=	124.55	PSI
X126	=	132.94	PSI
X127	=	25.000	DEG F
X128	=	30.000	DEG F

\*\*\*\*\* INPUT VARIABLES \*\*\*\*\*

PBLG	FILTERED	PB	PSI
T2LG	FILTERED	T2	DEG F

\*\*\*\*\* OUTPUT VARIABLES \*\*\*\*\*

PLSS PLAP LIMIT SOLENOID SIG DISCRETE

BLOCK DIAGRAM 1.4.3

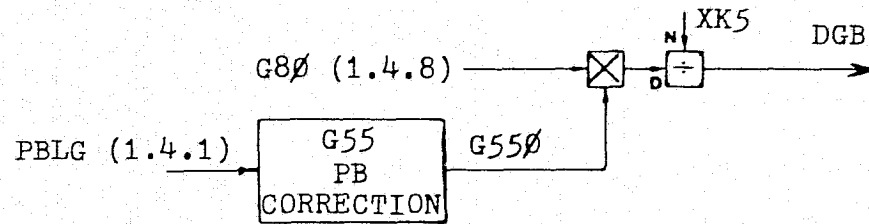


Figure 5.1-23. Derivative Gain Bias

TABLE 5.1-17 BLOCK 1.4.3 DATA

\*\*\*\*\* SCHEDULES \*\*\*\*\*

G55 BURNER PRESSURE CORRECTION FOR DGB

\*\*\*\*\* CONSTANTS \*\*\*\*\*

XK5 = 350.00 PSI

\*\*\*\*\* INPUT VARIABLES \*\*\*\*\*

G80 1./((SQUARE ROOT OF THETA) --

\*\*\*\*\* OUTPUT VARIABLES \*\*\*\*\*

DGB DERIVATIVE GAIN BIAS --

\*\*\*\*\* INTERNAL VARIABLES \*\*\*\*\*

G550 TWO SLOPE CORRECTED PB PSI

BLOCK DIAGRAM 1.4.4

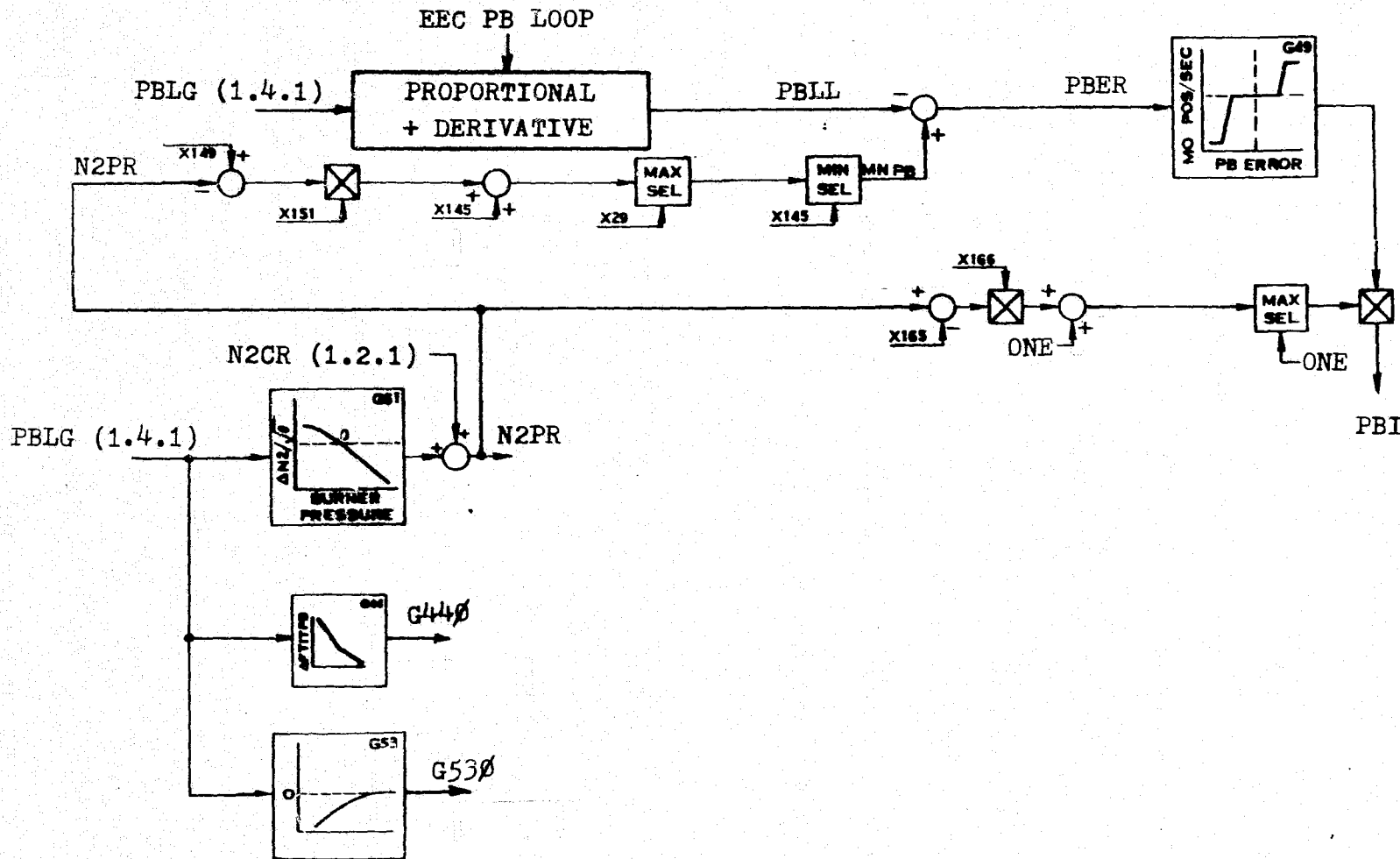


Figure 5.1-24. PB Input to the Minimum PLAP Loop

TABLE 5.1-18 BLOCK 1.4.4 DATA

\*\*\*\*\* SCHEDULES \*\*\*\*\*

G44 PB BIAS TO REFERENCE FTIT  
 G49 MINIMUM BURNER PRESSURE LOOP GAIN  
 G51 PB BIAS TO N2 SETPOINT  
 G53 PB BIAS TO NOZZLE TRIM

\*\*\*\*\* CONSTANTS \*\*\*\*\*

ONE	=	1.0000	--
X29	=	47.000	PSI
X145	=	47.000	PSI
X149	=	9900.0	RPM
X151	=	.50000E-02	DEG/RPM
X165	=	8900.0	RPM
X166	=	.14000E-02	--

\*\*\*\*\* INPUT VARIABLES \*\*\*\*\*

N2CR	CORRECTED N2	RPM
PBLG	FILTERED PB	PSI

\*\*\*\*\* OUTPUT VARIABLES \*\*\*\*\*

G440	FTIT BIAS FOR PB	DEG F
G530	AJ BIAS FOR PB	AJ
N2PR	REFERENCE N2	RPM
PBI	BURNER PRESS TO MIN PLAP	DEG/SEC

\*\*\*\*\* INTERNAL VARIABLES \*\*\*\*\*

G490	MINIMUM PLAP RATE - PB	DEG/SEC
G510	N2 BIAS FOR PB	RPM
MNPB	MINIMUM BURNER PRESSURE	PSI
PBER	MINIMUM PB ERROR	PSI
PBL	COMPENSATED PB	PSI



BLOCK DIAGRAM 1.4.5

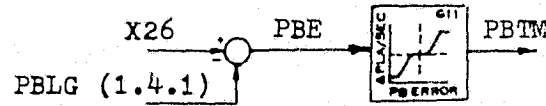


Figure 5.1-25. PB Input to PLA Trim Loop

BLOCK DIAGRAM 1.4.6

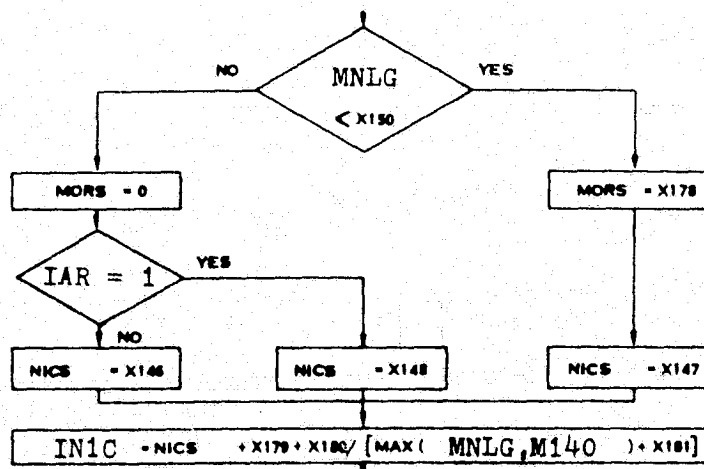
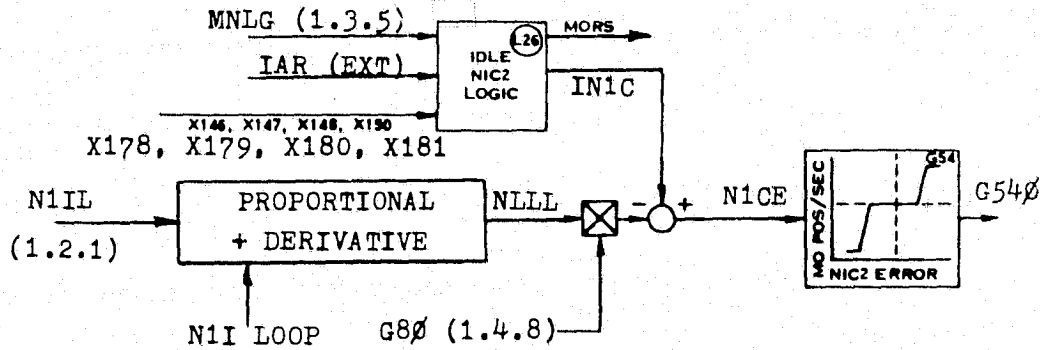


Figure 5.1-26. N1 Input to Minimum PLAP Loop

TABLE 5.1-19 BLOCK 1.4.5 DATA

\*\*\*\*\* SCHEDULES \*\*\*\*\*

G11 MAX BURNER PRESSURE LOOP GAIN

\*\*\*\*\* CONSTANTS \*\*\*\*\*

M140 = 140.00 COUNTS  
X26 = 580.00 PSI

\*\*\*\*\* INPUT VARIABLES \*\*\*\*\*

PBLG FILTERED PB PSI

\*\*\*\*\* OUTPUT VARIABLES \*\*\*\*\*

PBTM MAX PB INPUT TO PLA LOOP DEG/SEC

\*\*\*\*\* INTERNAL VARIABLES \*\*\*\*\*

PBE MAX BURNER PRESSURE ERROR PSI

TABLE 5.1-20 BLOCK 1.4.6 DATA

\*\*\*\*\* SCHEDULES \*\*\*\*\*

G54 IDLE N2 LOOP GAIN

\*\*\*\*\* CONSTANTS \*\*\*\*\*

X146	=	4100.0	RPM
X147	=	3650.0	RPM
X148	=	4300.0	RPM
X150	=	130.00	COUNTS
X178	=	-2.0000	DEG
X179	=	1331.0	RPM
X180	=	-74100.	RPM/COUNT
X181	=	-84.300	COUNTS

\*\*\*\*\* INPUT VARIABLES \*\*\*\*\*

G80	1./[SQUARE ROOT OF THETA]	--
IAR	A/C IDLE AREA RESET/VMAX	DISCRETE
MNLG	FILTERED A/C MACH NUMBER	COUNTS
N1IL	FILTERED N1 FOR IDLE LOOP	RPM

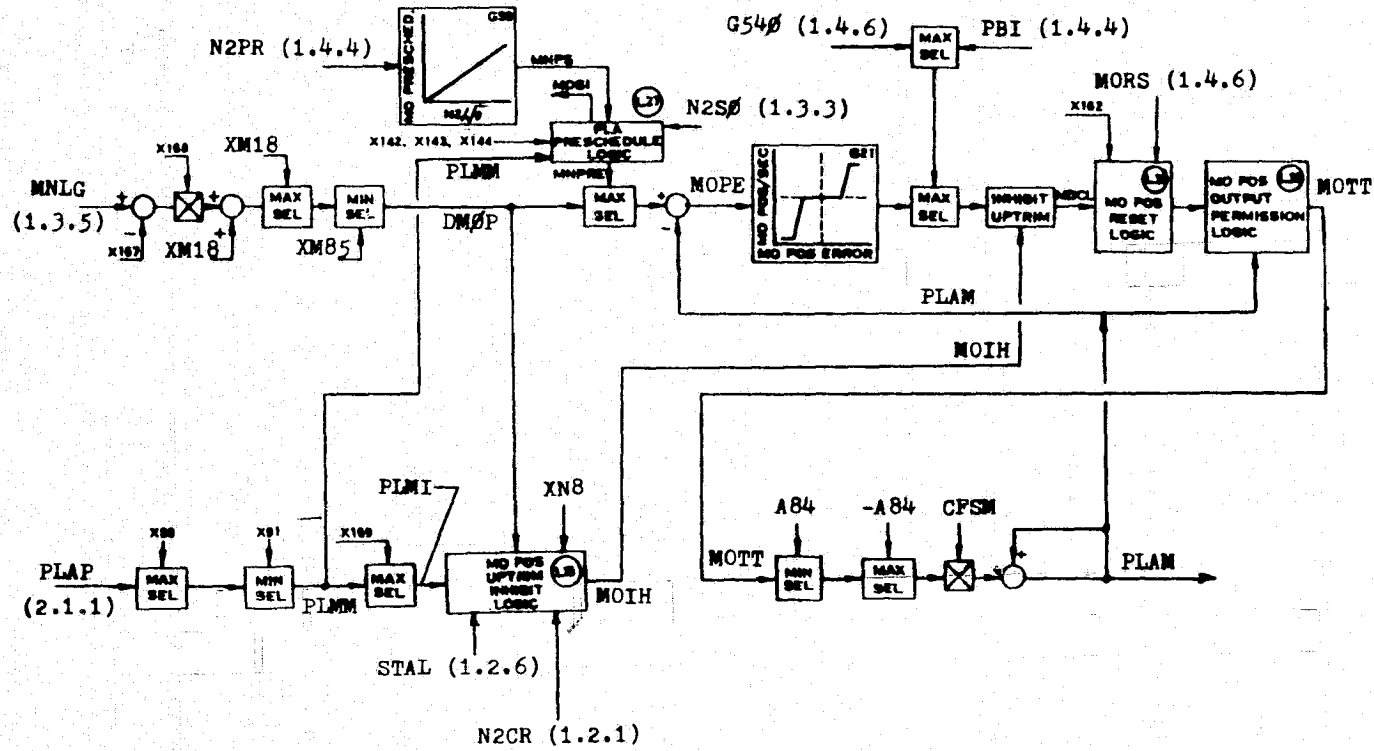
\*\*\*\*\* OUTPUT VARIABLES \*\*\*\*\*

G540	MINIMUM PLAP RATE - IDLE	DEG/SEC
MORS	IDLE INPUT TO MIN PLAP	DEG

\*\*\*\*\* INTERNAL VARIABLES \*\*\*\*\*

INIC	IDLE N1 SETPOINT	RPM
NLLL	COMPENSATED N1 FOR IDLE	RPM
NICE	IDLE N2 ERROR	RPM
NICS	GROUND IDLE BIAS	RPM

BLOCK DIAGRAM 1.4.7



179

2-3

ORIGINAL PAGE IS  
OF POOR QUALITY

Figure 5.1-27. Minimum PLAP Loop

BLOCK DIAGRAM 1.4.7 (Cont)

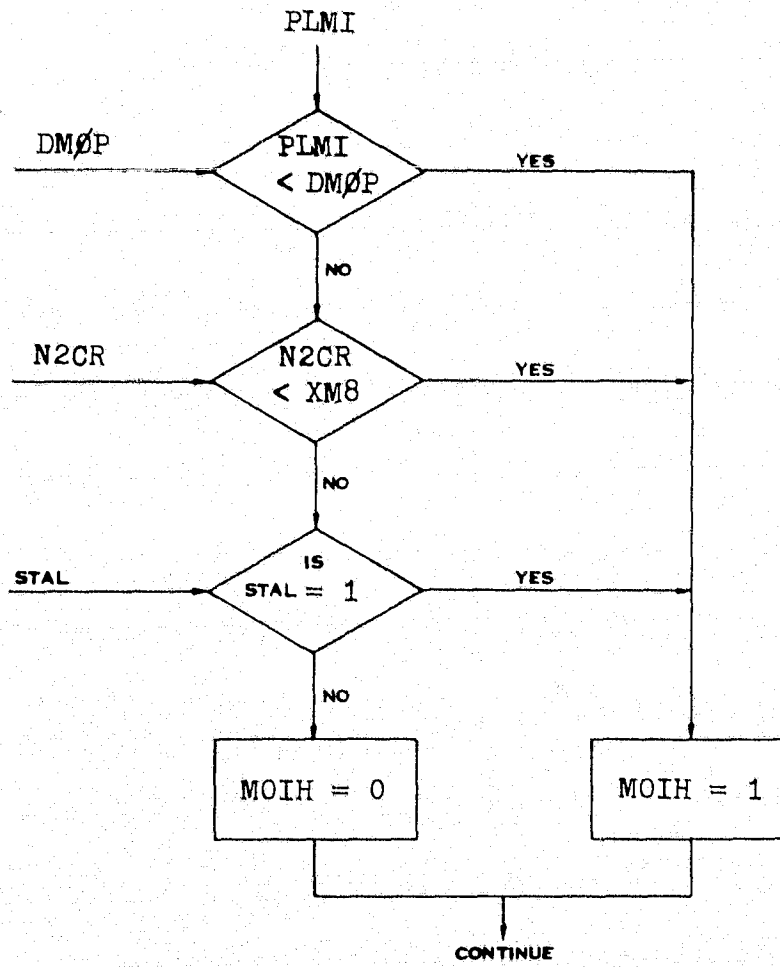


Figure 5.1-27. (Cont.)

BLOCK DIAGRAM 1.4.7 (Cont)

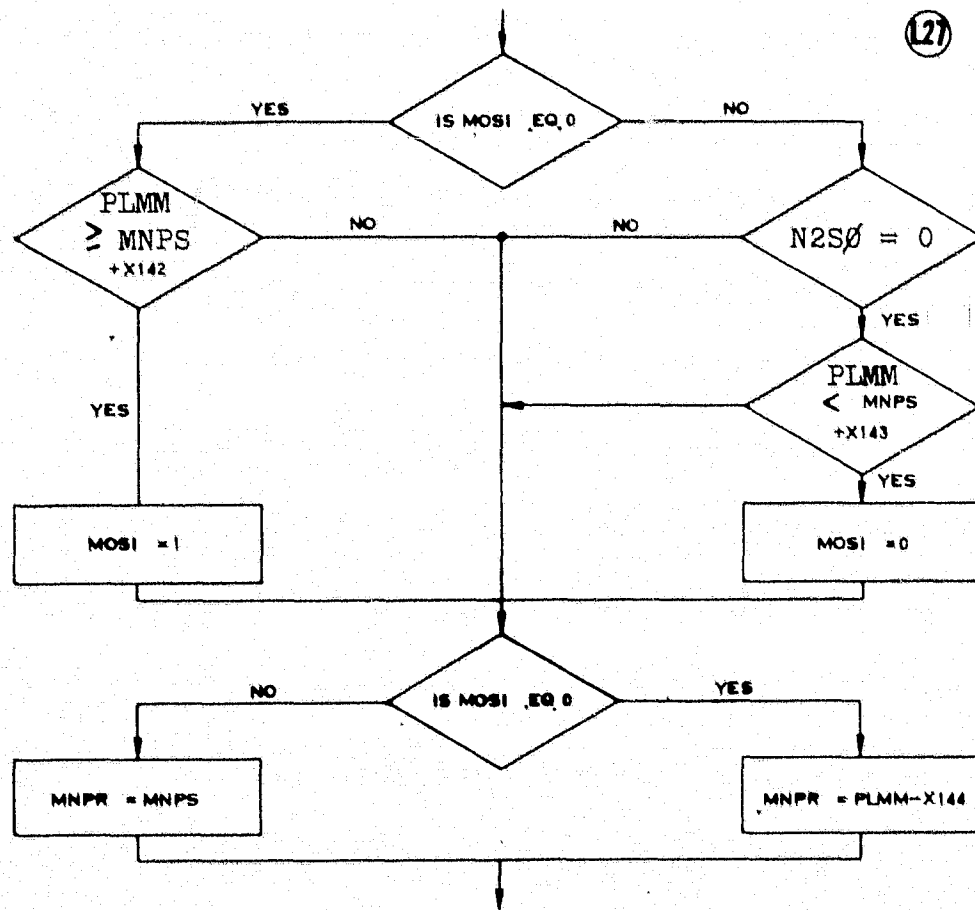
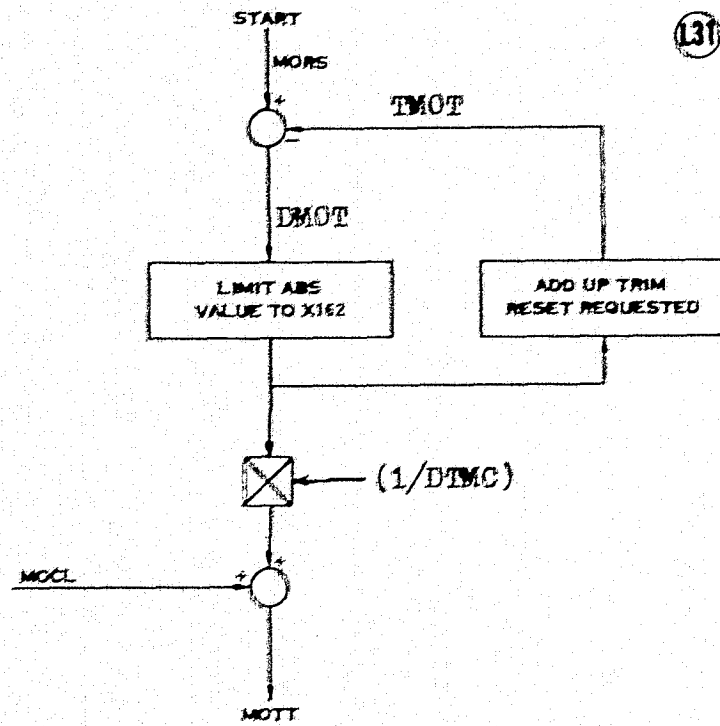


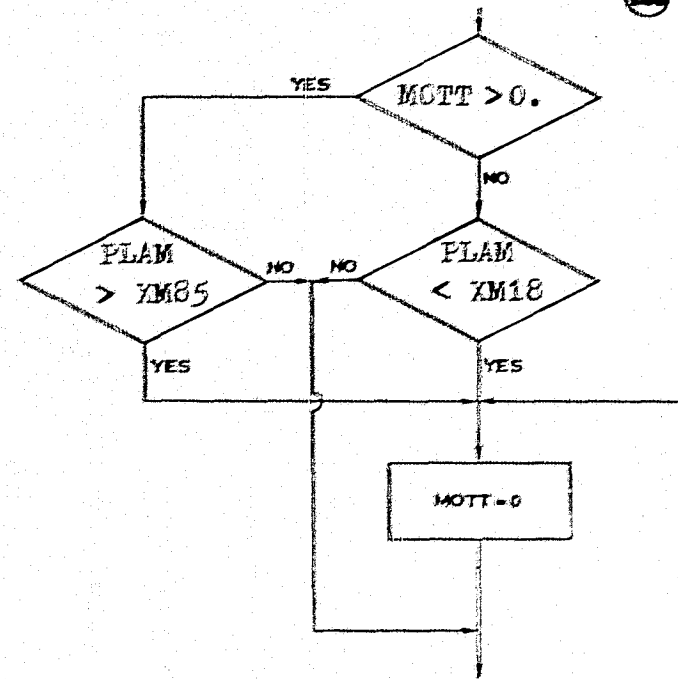
Figure 5.1-27. (Cont.)

BLOCK DIAGRAM 1.4.7 (Cont)

182



(L31)



(L32)

Figure 5.1-27. (Cont.)

TABLE 5.1-21 BLOCK 1.4.7 DATA

\*\*\*\*\* SCHEDULES \*\*\*\*\*

G21 MINIMUM PLAP LOOP GAIN  
 G50 MINIMUM PLAP PRESCHEDULE

\*\*\*\*\* CONSTANTS \*\*\*\*\*

A84	=	84.000	DEG/SEC
CSFM	=	.60000E-01	SEC/MJC
DTMC	=	.60000E-01	SEC/MJC
X88	=	18.000	DEG
X91	=	85.000	DEG
X142	=	7.0000	DEG
X143	=	6.0000	DEG
X144	=	6.0000	DEG
X162	=	3.8571	DEG
X167	=	276.00	COUNTS
X168	=	.28090	DEG/COUNT
X169	=	41.500	DEG
XM18	=	18.000	DEG
XM85	=	85.000	DEG
XN8	=	8000.0	RPM

\*\*\*\*\* INPUT VARIABLES \*\*\*\*\*

G540	MINIMUM PLAP RATE - IDLE	DEG/SEC
MNLG	FILTERED A/C MACH NUMBER	COUNTS
MORS	IDLE INPUT TO MIN PLAP	DEG
N2CR	CORRECTED N2	RPM
N2PR	REFERENCE N2	RPM
N2SO	N2 SOLENOID	DISCRETE
PBI	BURNER PRESS TO MIN PLAP	DEG/SEC
PLAP	RATE LIMITED PLA	DEG
STAL	STALL SIGNAL	DISCRETE

\*\*\*\*\* OUTPUT VARIABLES \*\*\*\*\*

PLAM	MIN PLAP	DEG
------	----------	-----



TABLE 5-1-21 BLOCK 1.4.7 DATA (CONT.)

\*\*\*\*\* INTERNAL VARIABLES \*\*\*\*\*

DMOP	MN COMMANDED MIN PLAP	DEG
DMOT	CURRENT IDLE INPUT-MINPLP	DEG/MJC
G210	MINIMUM PLAP RATE - MN	DEG/SEC
MNPR	N2 COMMANDED MIN PLAP	DEG
MNPS	PRESCHEDULED MIN PLAP	DEG
MOCL	MIN PLAP RATE-W/O IDLE	DEG/SEC
MOIH	MIN PLAP INHIBIT	DISCRETE
MOPE	MINIMUM PLAP ERROR	DEG
MOST	IDLE RESET FLAG	DISCRETE
MOTT	MIN PLAP RATE	DEG/SEC
PLMI	PLAP INPUT-PLAM INHIBIT	DEG
PLMM	PLAP INPUT-PRESCHEDULE	DEG
TMOT	CUM MORS PREV COMMANDED	DEG

ORIGINAL PAGE IS  
OF POOR QUALITY

BLOCK DIAGRAM 1.4.8

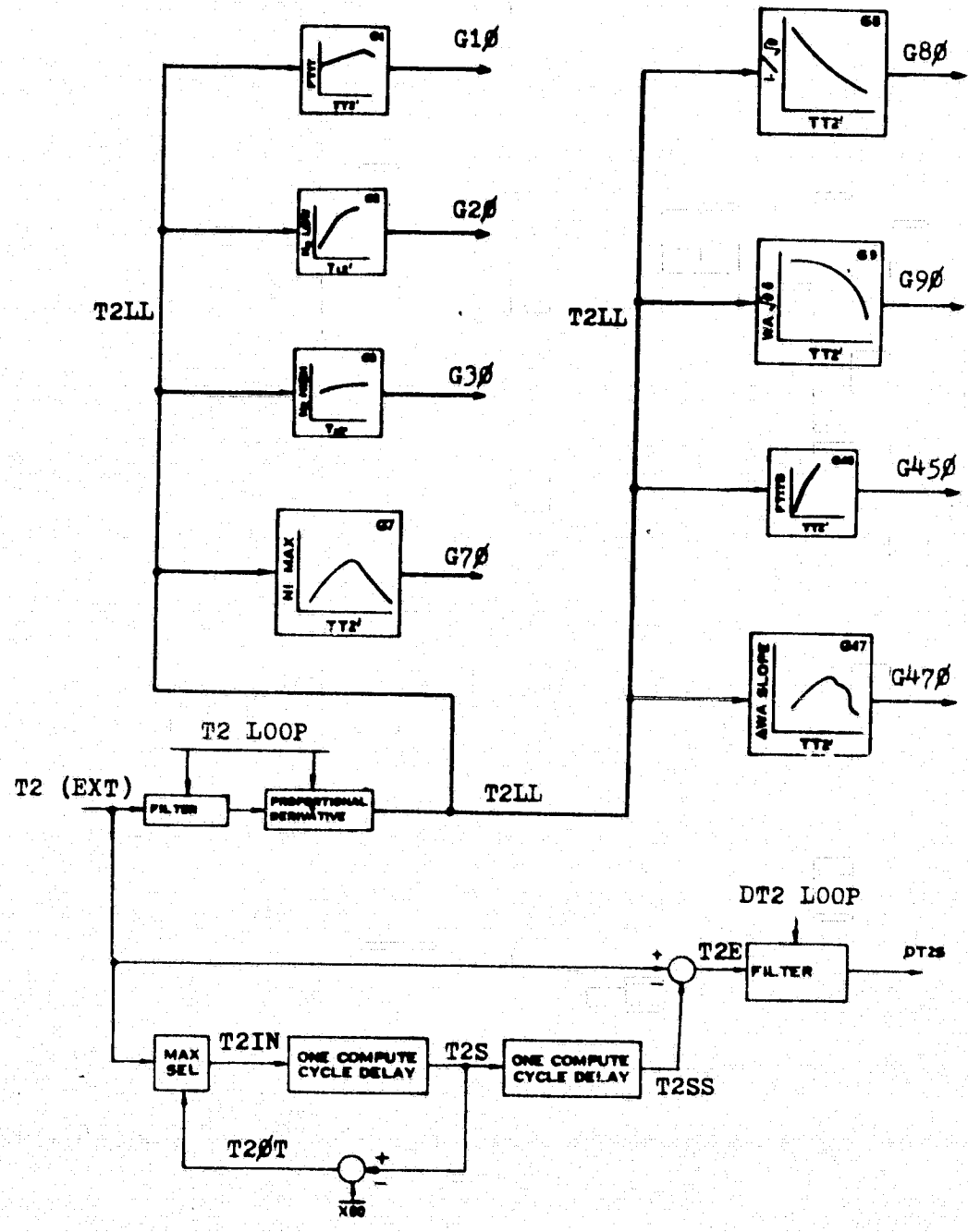


Figure 5.1-28. T2 Compensation and Tables

TABLE 5.1-22 BLOCK 1.4.8 DATA

\*\*\*\*\* SCHEDULES \*\*\*\*\*

G1	FAN TURBINE INLET TEMPERATURE LIMIT
G2	MINIMUM HIGH COMPRESSOR SPEED
G3	MAXIMUM HIGH COMPRESSOR SPEED
G7	FAN SPEED LIMIT
G8	1./[SQUARE ROOT OF THETA]
G9	TOTAL CORRECTED AIRFLOW SCHEDULE
G45	REFERENCE FTIT SCHEDULE
G47	AIRFLOW CUTBACK SLOPE MULTIPLIER

\*\*\*\*\* CONSTANTS \*\*\*\*\*

X80 = 2.0000 DEG F

\*\*\*\*\* INPUT VARIABLES \*\*\*\*\*

T2	COMPRESSOR FACE TEMP	DEG F
----	----------------------	-------

\*\*\*\*\* OUTPUT VARIABLES \*\*\*\*\*

DT2S	T2 RATE	DEG F
G10	FTIT LIMIT	DEG F
G20	MINIMUM N2	RPM
G30	MAXIMUM N2	RPM
G70	MAXIMUM N1	RPM
G80	1./[SQUARE ROOT OF THETA]	--
G90	SCHEDULED CORRECTED FLOW	PPS
G450	REFERENCE FTIT	DEG F
G470	AIRFLOW CUTBACK SLOPE	--
T2LG	FILTERED T2	DEG F

\*\*\*\*\* INTERNAL VARIABLES \*\*\*\*\*

T2E	INPUT TO DT2S FILTER	DEG F
T2IN	CALC VAR1 IN DT2S	DEG F
T2LL	COMPENSATED T2	DEG F
T20T	CALC VAR2 IN DT2S	DEG F
T2S	CALC VAR3 IN DT2S	DEG F
T2SS	CALC VAR4 IN DT2S	DEG F

BLOCK DIAGRAM 1.4.9

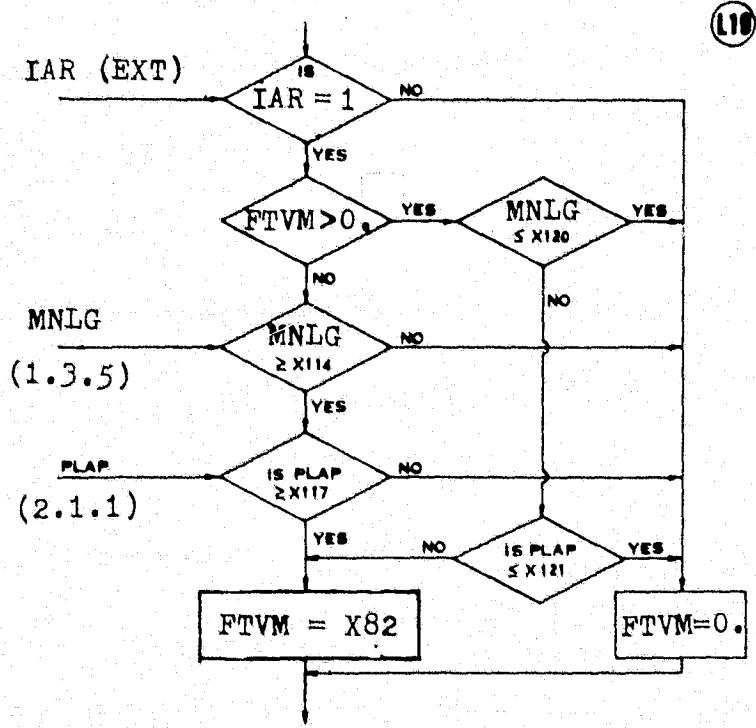


Figure 5.1-29. VMAX Logic

TABLE 5.1-23 BLOCK 1.4.9 DATA

\*\*\*\*\* CONSTANTS \*\*\*\*\*

X82	=	40.000	DEG F
X114	=	347.00	COUNTS
X117	=	127.00	DEG
X120	=	307.00	COUNTS
X121	=	122.00	DEG

\*\*\*\*\* INPUT VARIABLES \*\*\*\*\*

IAR	A/C IDLE AREA RESET/VMAX	DISCRETE
MNLG	FILTERED A/C MACH NUMBER	COUNTS
PLAP	RATE LIMITED PLA	DEG

\*\*\*\*\* OUTPUT VARIABLES \*\*\*\*\*

FTVM FTIT INPUT TO DEL PLA LP DEG F

BLOCK DIAGRAM 1.4.10

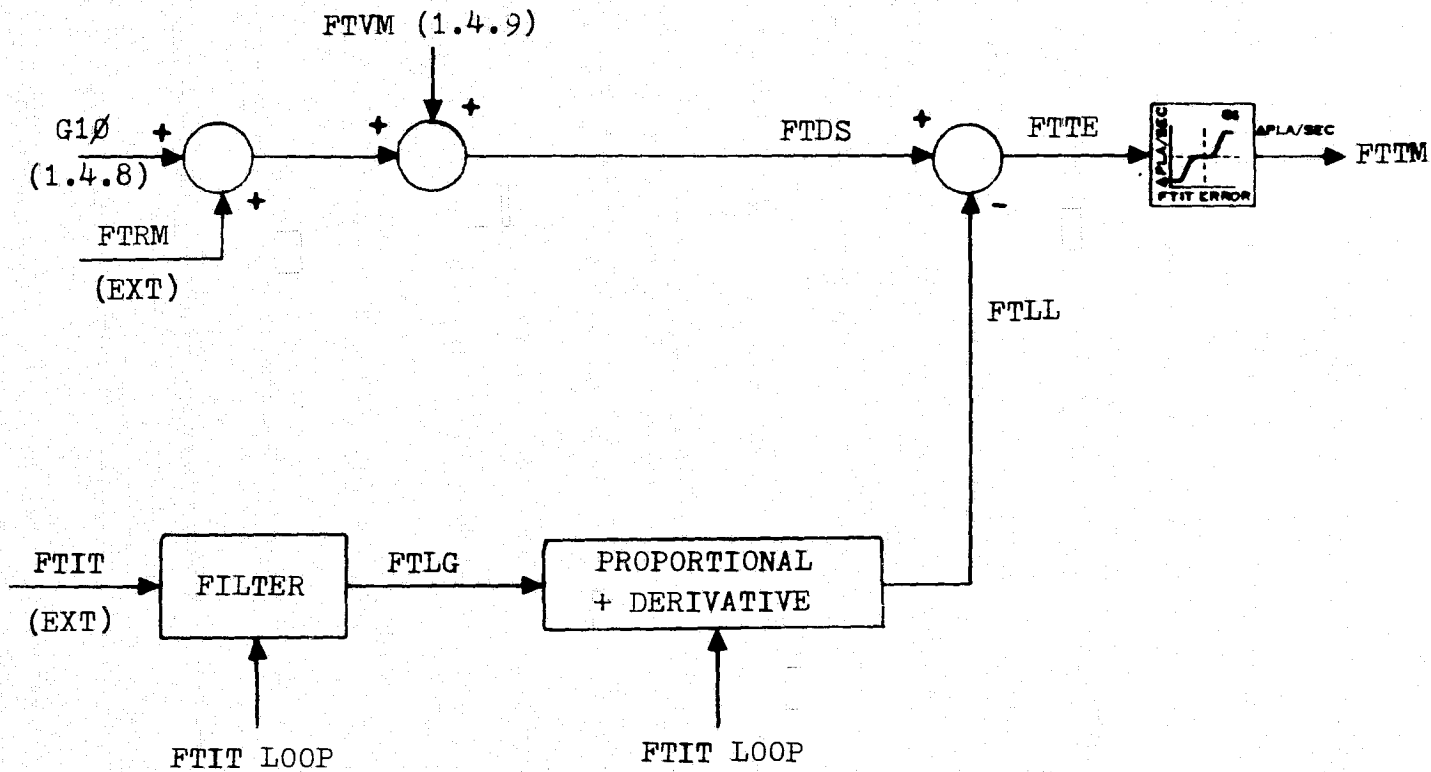


Figure 5.1-30. FTIT Input to the PLA Trim Loop

ORIGINAL PAGE IS  
OF POOR QUALITY

TABLE 5.1-24 BLOCK 1.4.10 DATA

\*\*\*\*\* SCHEDULES \*\*\*\*\*

G6 FTIT LOOP GAIN

\*\*\*\*\* INPUT VARIABLES \*\*\*\*\*

FTIT	FAN TURBINE INLET TEMP	DEG F
FTRM	FTIT TRIM	DEG F
FTVM	FTIT INPUT TO DEL PLA LP	DEG F
G10	FTIT LIMIT	DEG F

\*\*\*\*\* OUTPUT VARIABLES \*\*\*\*\*

FTDS	DESIGN FTIT	DEG F
FTLL	COMPENSATED FTIT	DEG F
FTTE	FTIT ERROR	DEG
FTTM	FTIT INPUT TO PLA LOOP	DEG/SEC

\*\*\*\*\* INTERNAL VARIABLES \*\*\*\*\*

FTLG	FILTERED FTIT	DEG F
------	---------------	-------

BLOCK DIAGRAM 1.4.11

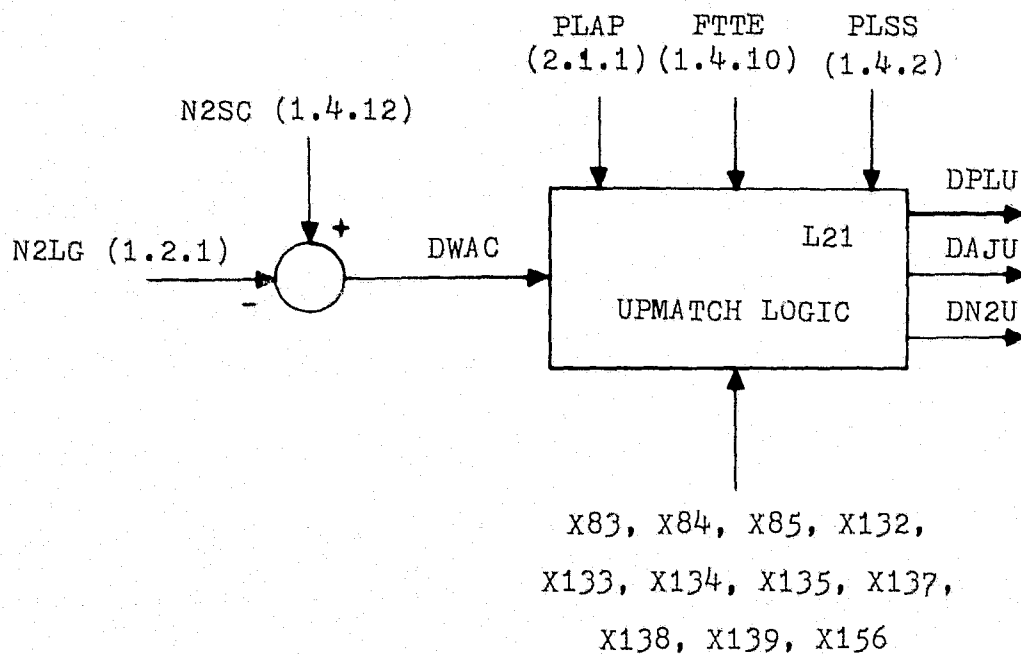


Figure 5.1-31. Upmatch Logic



BLOCK DIAGRAM 1.4.11 (Cont)

(L21)

INITIALIZE:  
 DAJU = 0  
 UPSG = 0  
 DPLU = 0

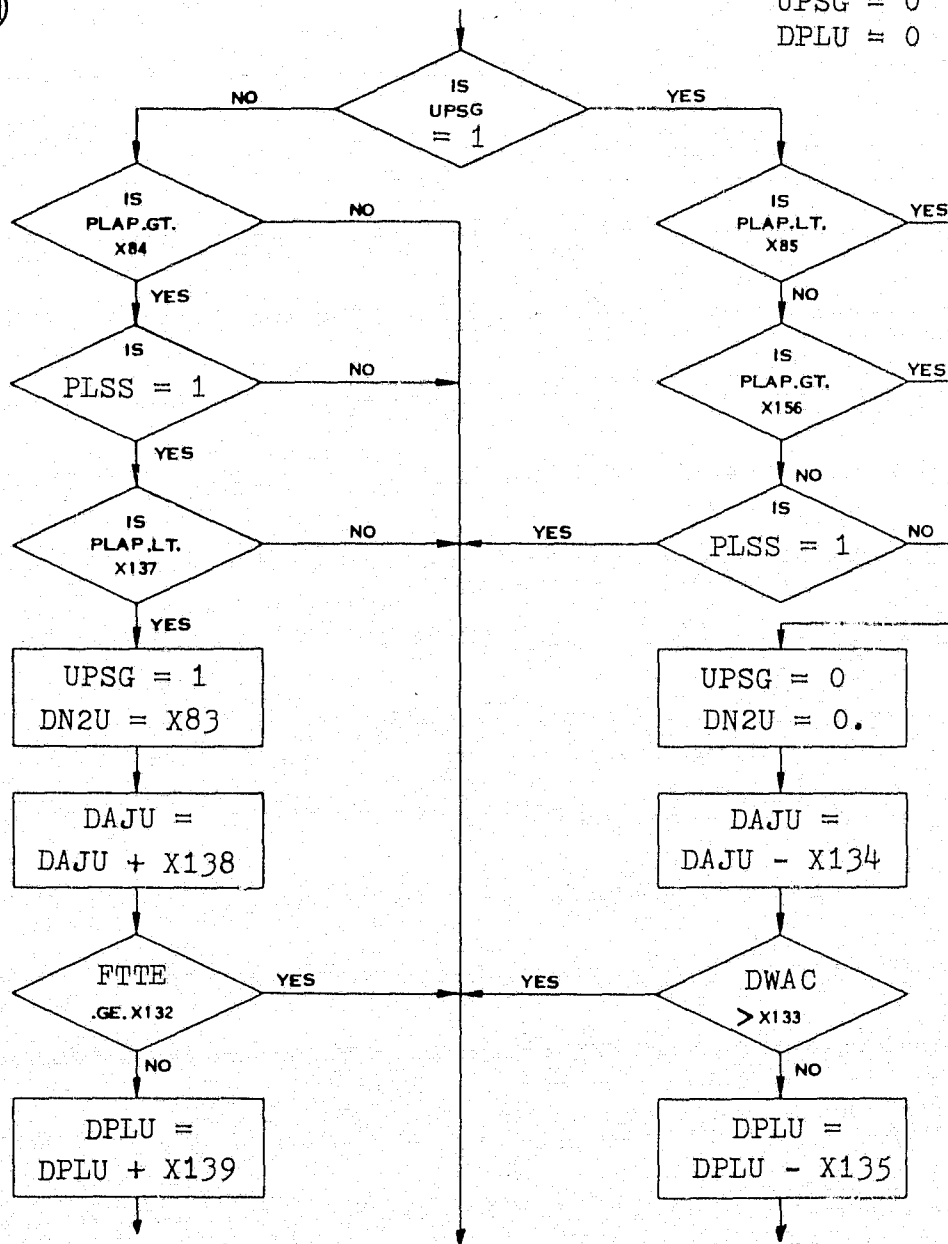


Figure 5.1-31. (Cont.)

TABLE 5.1-25 BLOCK 1.4.11 DATA

\*\*\*\*\* CONSTANTS \*\*\*\*\*

X83	=	93.000	RPM
X84	=	119.00	DEG
X85	=	118.50	DEG
X132	=	50.000	DEG F
X133	=	250.00	RPM
X134	=	-3.7600	AJ
X135	=	1.8800	DEG
X137	=	123.70	DEG
X138	=	0.	AJ
X139	=	1.1300	DEG
X156	=	124.80	DEG

ORIGINAL PAGE IS  
OF POOR QUALITY

\*\*\*\*\* INPUT VARIABLES \*\*\*\*\*

FTTE	FTIT ERROR	DEG
N2LG	FILTERED HIGH ROTOR SPEED	RPM
N2SC	N2 SETPOINT (UPMATCH)	RPM
PLAP	RATE LIMITED PLA	DEG
PLSS	PLAP LIMIT SOLENOID SIG	DISCRETE

\*\*\*\*\* OUTPUT VARIABLES \*\*\*\*\*

DAJU	NOZZLE UPMATCH	AJ
DN2U	N2 UPMATCH	RPM
DPLU	PLA UPMATCH	DEG

\*\*\*\*\* INTERNAL VARIABLES \*\*\*\*\*

DMAC	N2 ERROR INPUT TO UPMATCH	RPM
UPSG	UPMATCH SIGNAL	DISCRETE

BLOCK DIAGRAM 1.4.12

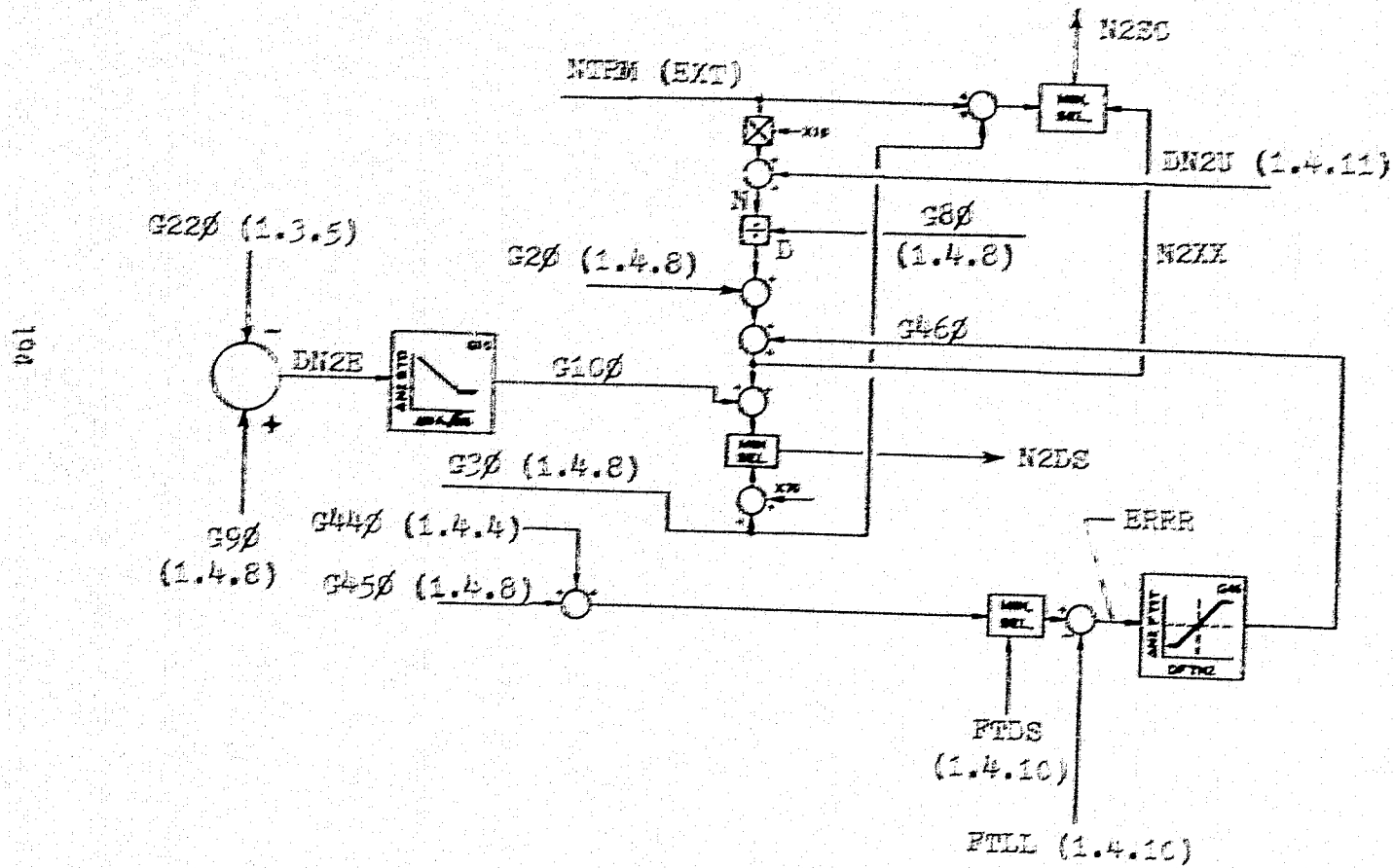


Figure 5.1-32. N2 Setpoint

TABLE 5.1-26 BLOCK 1.4.12 DATA

\*\*\*\*\* SCHEDULES \*\*\*\*\*

G10 SURGE PROTECTION AIRFLOW CUTBACK  
 G46 FTIT ADJUSTMENT TO N2 SETPOINT

\*\*\*\*\* CONSTANTS \*\*\*\*\*

X10 = 2.0000 --  
 X70 = 200.00 RPM

\*\*\*\*\* INPUT VARIABLES \*\*\*\*\*

DN2U N2 UPMATCH RPM  
 FTDS DESIGN FTIT DEG F  
 FTLL COMPENSATED FTIT DEG F  
 G20 MINIMUM N2 RPM  
 G30 MAXIMUM N2 RPM  
 G80 1./((SQUARE ROOT OF THETA)) --  
 G90 SCHEDULED CORRECTED FLOW PPS  
 G220 MAXIMUM CORRECTED AIRFLOW PPS  
 G440 FTIT BIAS FOR PB DEG F  
 G450 REFERENCE FTIT DEG F  
 NTRM N2 GROUND TRIM RPM

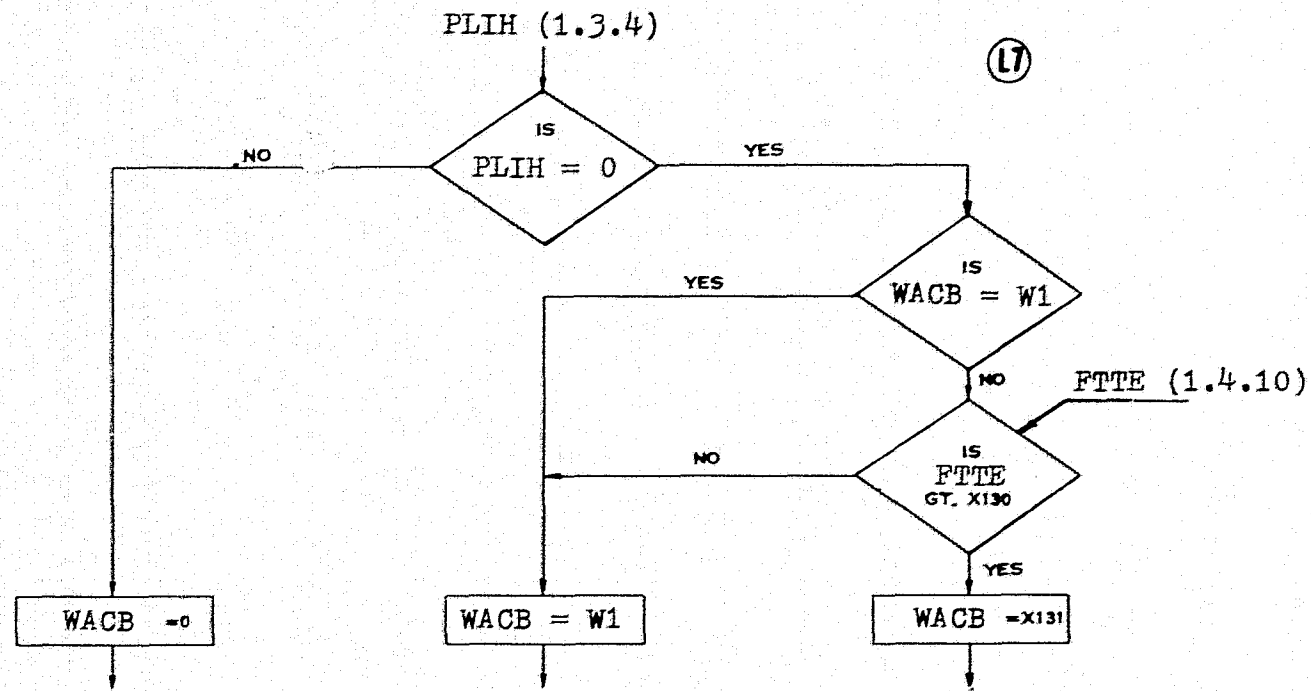
\*\*\*\*\* OUTPUT VARIABLES \*\*\*\*\*

N2DS DESIGN N2 RPM  
 N2SC N2 SETPOINT (UPMATCH) RPM

\*\*\*\*\* INTERNAL VARIABLES \*\*\*\*\*

DN2E AIRFLOW ERROR FOR N2 BIAS PPS  
 ERRR FTIT ERROR FOR N2 BIAS DEG F  
 G100 N2 SETPOINT BIAS -AIRFLOW RPM  
 G460 N2 SETPOINT BIAS - FTIT RPM  
 N2XX DESIGN N2 SETPONT-UPMATCH RPM

BLOCK DIAGRAM 1.4.13



196

Figure 5.1-33. Airflow Subpack Multiplier

TABLE 5.1-27 BLOCK 1.4.13 DATA

\*\*\*\*\* CONSTANTS \*\*\*\*\*

W1	*	1.0000	--
X130	*	60.000	DEG
X131	*	.50000	--

\*\*\*\*\* INPUT VARIABLES \*\*\*\*\*

FTTE	FTIT ERROR	DEG
PLIH	PLA UPTRIM INHIBIT	DISCRETE

\*\*\*\*\* OUTPUT VARIABLES \*\*\*\*\*

WACH	AIRFLOW CUTBACK MULT.	--
------	-----------------------	----

## 5.2 UNIFIED FUEL CONTROL

This section defines the control logic for the unified fuel control which in the BOM system is hydromechanical. The gas generator control is defined in section 5.2.1 and the afterburner and nozzle in 5.2.2.

### 5.2.1 Gas Generator

The gas generator control takes two inputs from the EEC (nozzle trim and PLA trim), N2, T2.5, PLA, and aircraft discrettes and computes the commands for the RCVV, gas generator fuel flow, and the start bleed.

#### 5.2.1.1 Power Lever Logic

The input power lever angle is limited by the afterburner logic (manifold filling and PLAP limiting from the EEC) and by the minimum position from the EEC. The rate limited PLA (PLAP) is used to drive both the gas generator and afterburner. Idle and intermediate trim and the PLA trim input from the EEC are included in the PLA input to the gas generator fuel flow loop (PLAB). Figure 5.2-1 presents the block diagram and table 5.2-1 lists the required data. The logic is divided into 211 and 211A because it is not performed sequentially. The PLAP computation (211) is the first thing computed in the control since PLAP is used throughout the EEC. The gas generator PLA, PLAB, is not computed until after the EEC computations have been completed to permit the incorporation of the EEC PLA trim.

PLAP hold (PLPH) is computed in the afterburner segment sequence valve logic (para 2.2.2). It is designed to hold the afterburner at the zone minimum fuel flow until the manifold is filled. This hold is released as part of the power level logic to avoid additional time delay during afterburner transients. The hydromechanical hardware has a switch which indicates when the manifold is

full. The switch is examined by the IFU and an interrupt generated when the switch is turned on. In response to the interrupt the control executive (section 5.3) stores the value of the minor cycle counter in ICYC, sets FLIT to 1, and advances the segment sequence valve to the operating position from the fill position. The PLAP hold release logic uses FLIT to identify manifold filling and releases either the ignition timer (segment 1) or PLAP hold (all other segments). The minor cycle counter value ICYC is used to compute an interval corresponding to a major cycle plus the fraction of a major cycle since the fill interrupt was received. Thus PLAP is effectively released as soon as the fill interrupt is received.

#### 5.2.1.2 T2.5 Compensation

The logic presented in figure 5.2-2 simulates the response of the BOM hydromechanical T2.5 sensor. It was included to permit duplication of the BOM control response to changes in T2.5. Table 5.2-2 identifies the required data.

#### 5.2.1.3 Fuel Flow

This loop commands the gas generator fuel flow as a function of input PLA (PLAB), N2, and T2.5. The fuel flow command is generated as a Wf/Pb with steady-state control through a droop governor with variable droop slope. Acceleration and deceleration schedules protect the engine during transients. The rocket fire solenoid limits the Wf/Pb to 25.5 RU. Figure 5.2-3 presents the block diagram and table 5.2-3 the data for the fuel flow logic.

#### 5.2.1.4 RCVV Control

The RCVVs are scheduled as a function of N2 and T25C. Figure 5.2-4 shows the schedule. Control stability studies demonstrated the need to compute the RCVV command more frequently than the

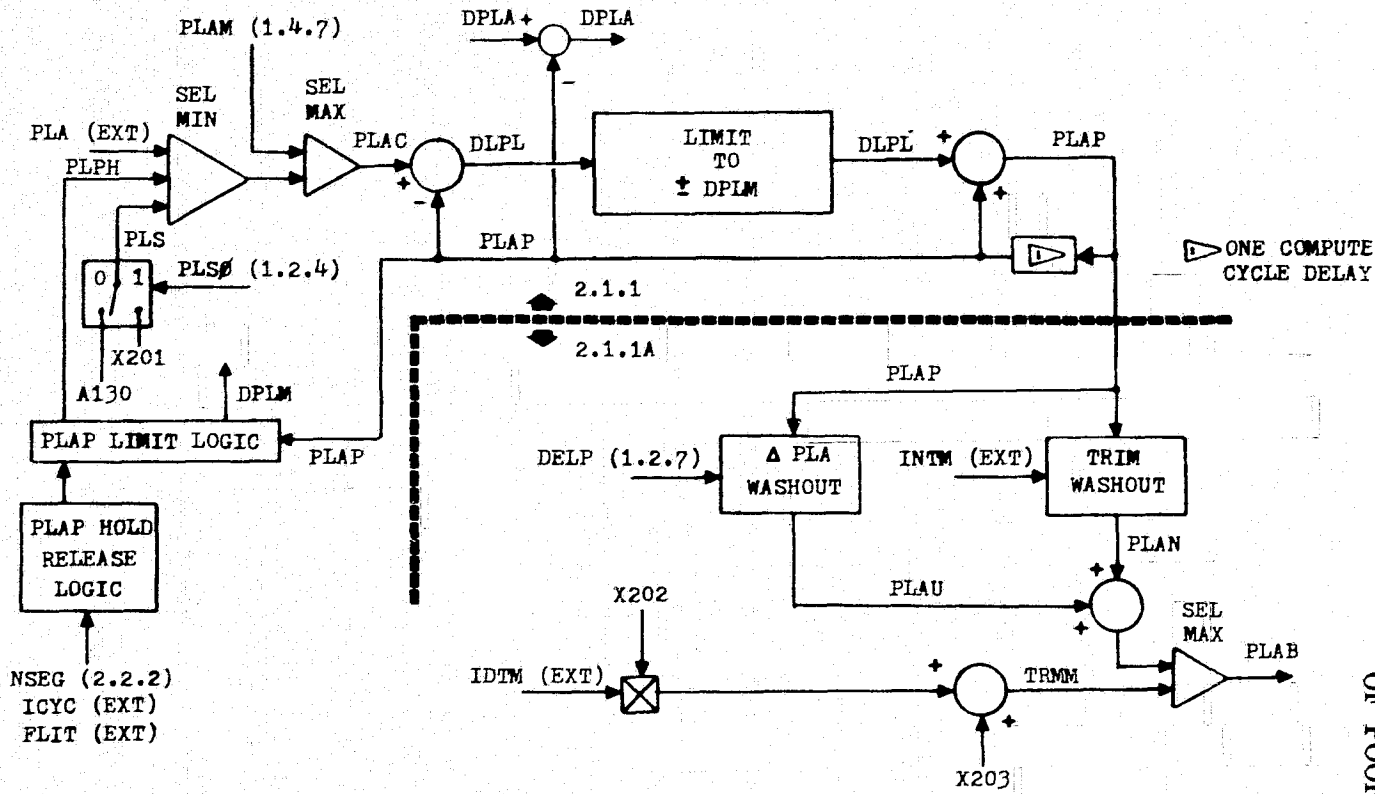


major cycle rate; however, it is not necessary to perform the entire schedule computation at the high rate. As a result the RCVV command has been divided into the computation of the T25C effect and the computation of the N2 effect (see figure 5.2-5). The T25C portion (214) is computed every major cycle with the resulting setpoint and slopes used each minor cycle to actually compute the RCVV command (214A). Table 5.2-4 lists the required data.

#### 5.2.1.5 Compressor Bleed

Figure 5.2-6 and table 5.2-5 present the logic and data for the compressor bleed control. The bleed is opened during starting as a function of N2 and T25C.

BLOCK DIAGRAM 2.1.1



201

Figure 5.2-1. Power Level Angle Logic

ORIGINAL PAGE IS  
OF POOR QUALITY

BLOCK DIAGRAM 2.1.1 (Cont.)

PLAP LIMIT LOGIC

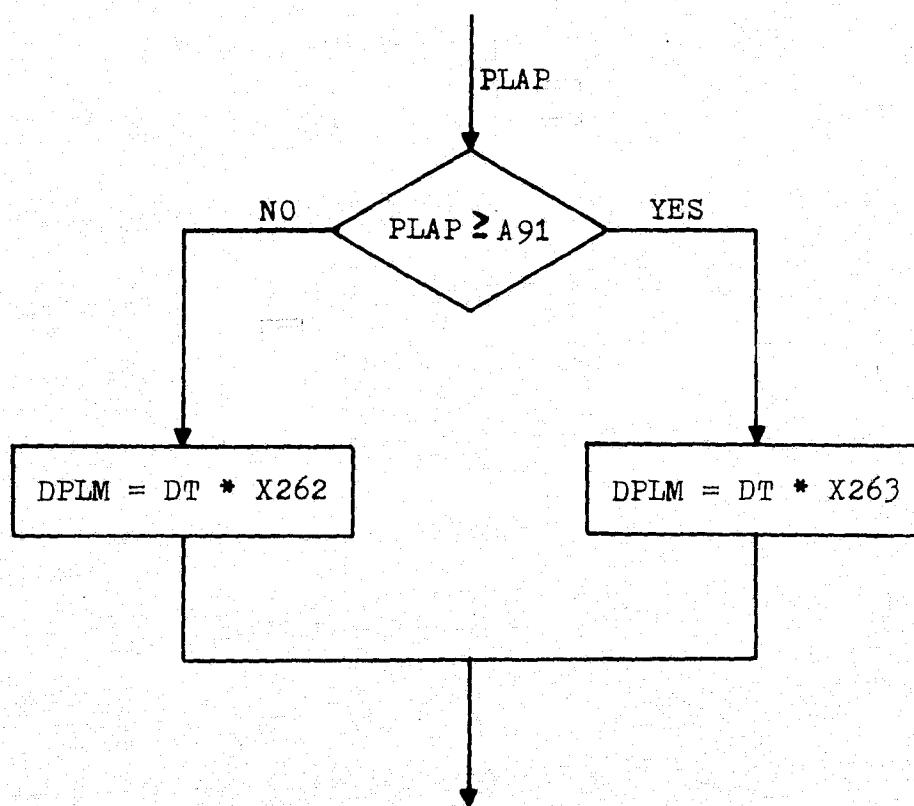


Figure 5.2-1. (Cont.)

ORIGINAL PAGE IS  
OF POOR QUALITY

BLOCK DIAGRAM 2.1.1 (Cont)  
PLAP HOLD RELEASE LOGIC

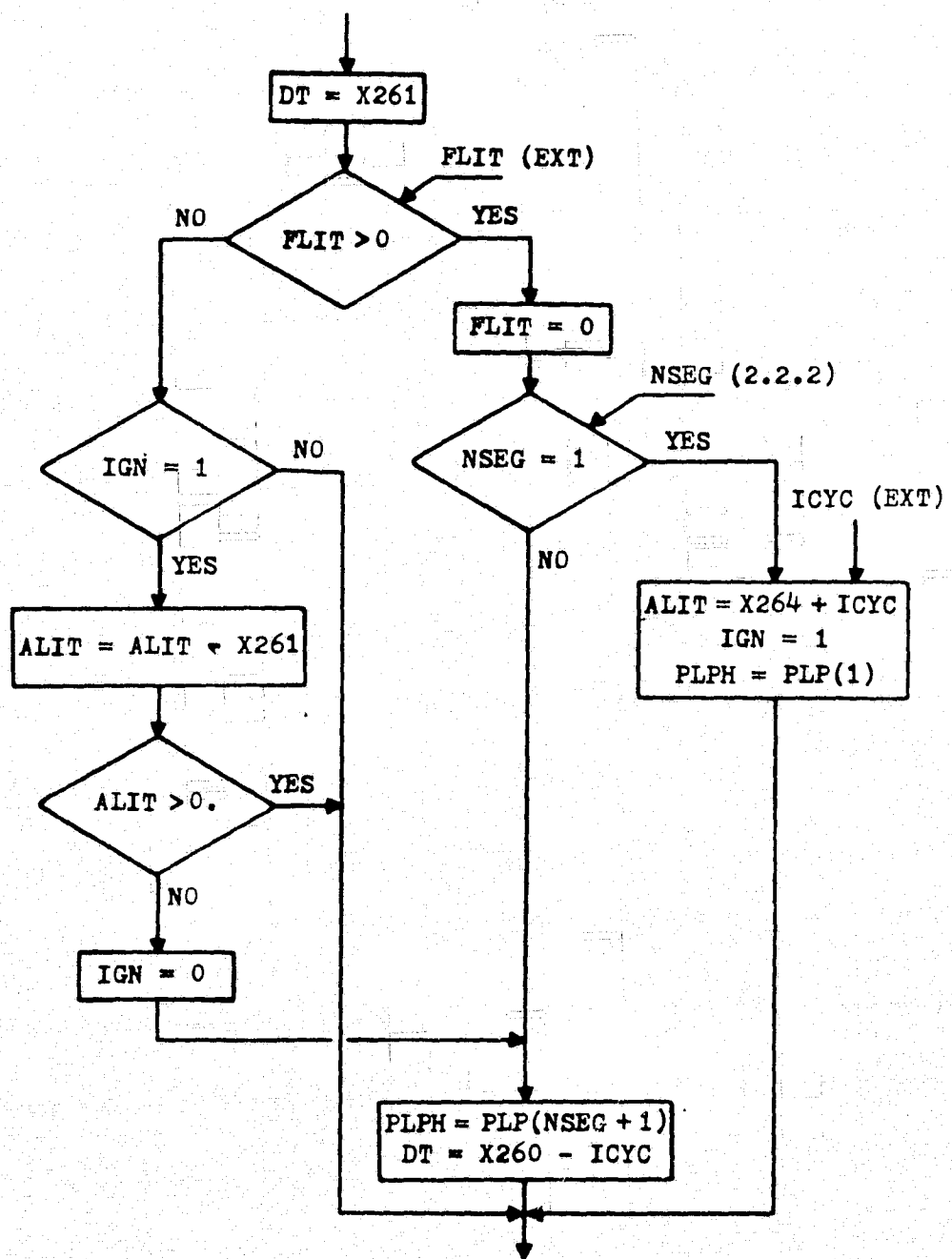
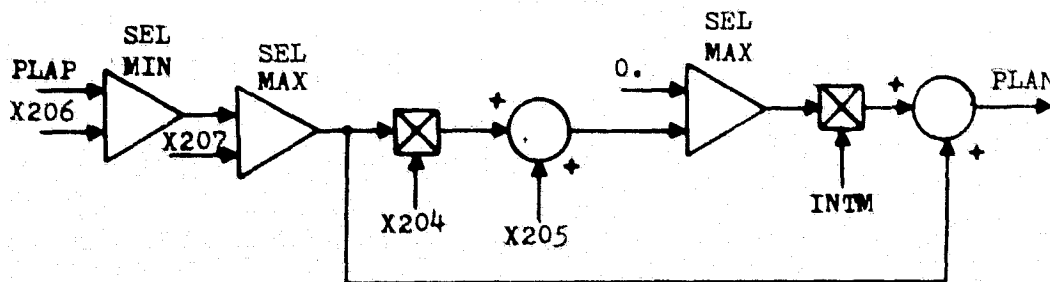


Figure 5.2-1. (Cont.)

BLOCK DIAGRAM 2.1.1 (Cont)

● TRIM WASHOUT



● Δ PLA WASHOUT

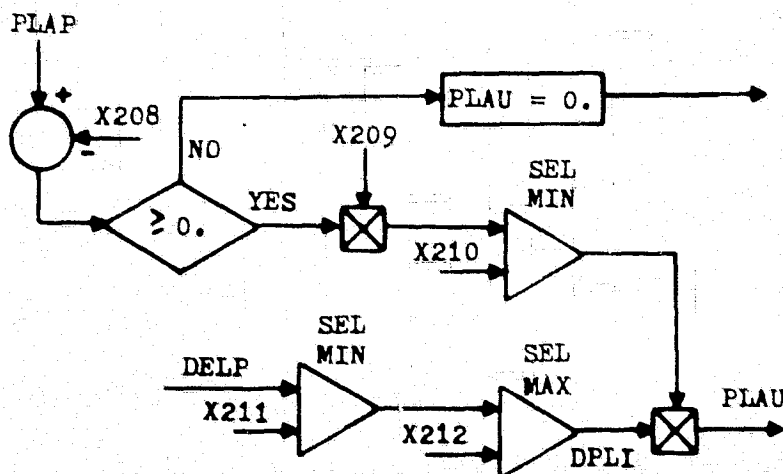


Figure 5.2-1. (Cont.)

TABLE 5.2-1 BLOCK 2.1.1 DATA

\*\*\*\*\* CONSTANTS \*\*\*\*\*

A91	=	91.000	DEG
A130	=	130.00	DEG
PLP(1)	=	93.500	DEG
PLP(2)	=	102.70	DEG
PLP(3)	=	110.00	DEG
PLP(4)	=	116.30	DEG
PLP(5)	=	122.50	DEG
PLP(6)	=	130.00	DEG
X201	=	119.95	DEG
X202	=	1.0000	DEG/COUNT
X203	=	0.	DEG
X204	=	0.	--
X205	=	1.0000	1/DEG
X206	=	83.000	DEG
X207	=	20.000	DEG
X208	=	37.000	DEG
X209	=	.21740E-01	--
X210	=	1.0000	--
X211	=	28.500	DEG
X212	=	-35.000	DEG
X260	=	24.000	MNC
X261	=	12.000	MNC
X262	=	.35500	DEG/MNC
X263	=	.21500	DEG/MNC
X264	=	108.00	MNC

\*\*\*\*\* INPUT VARIABLES \*\*\*\*\*

DELP	EEC PLA TRIM	DEG
FLIT	FILL INTERRUPT SIGNAL	DISCRETE
IAR	A/C IDLE AREA RESET/VMAX	DISCRETE
ICYC	MINOR CYCLE COUNTER -FLIT	MNC
IDTM	IDLE GROUND TRIM	COUNTS
INTM	INTERMEDIATE GROUND TRIM	DEG
NSEG	A/B SEGMENT COUNTER	--
PLA	POWER LEVER ANGLE	DEG
PLAM	MIN PLAP	DEG
PLPH	PLAP HOLD	DEG
PLSO	PLAP LIMIT SOLENOID	DISCRETE

\*\*\*\*\* OUTPUT VARIABLES \*\*\*\*\*

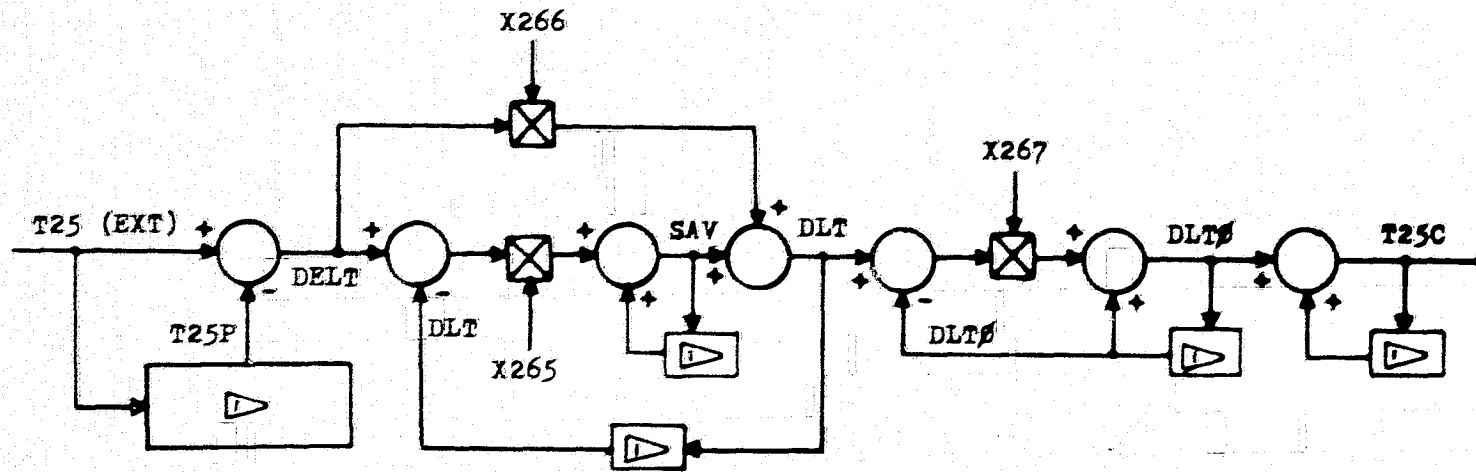
DPLA	PLAP ERROR (PLA - PLAP)	DEG
IGN	A/B IGNITION COMMAND	DISCRETE
PLAB	GAS GENERATOR PLA	DEG
PLAP	RATE LIMITED PLA	DEG

TABLE 5.2-1 BLOCK 2.1.1 DATA (CONT.)

\*\*\*\*\* INTERNAL VARIABLES \*\*\*\*\*

ALIT	A/B IGNITION TIMER	MJC
DLPL	RATE LIMITED DELTA PLAP	DEG
DPLI	CALC VAR-DELP WASHOUT CAM	DEG
DPLM	DPLA LIMIT	DEG
DT	DELTA TIME FOR PLAP RATE	MJC
PLAC	CONTROL PLA	DEG
PLAN	GAS GEN PLA W/O EEC DELP	DEG
PLAU	EEC INPUT TO PLAB	DEG
PLS	PLAP LIMIT INPUT TO PLAC	DEG
TRMM	IDLE TRIM INPUT TO PLAB	DEG

BLOCK DIAGRAM 2.1.2



207

▷ ONE COMPUTE CYCLE DELAY

Figure 5.2-2. T25 Compensation



TABLE 5.2-2 BLCCK 2.1.2 DATA

\*\*\*\*\* CONSTANTS \*\*\*\*\*

X265	=	.30000	--
X266	=	15.000	--
X267	=	1.2000	--

\*\*\*\*\* INPUT VARIABLES \*\*\*\*\*

T25	FAN EXIT TEMP - DUCT	DEG F
-----	----------------------	-------

\*\*\*\*\* OUTPUT VARIABLES \*\*\*\*\*

T25C	COMPENSATED T25	DEG F
------	-----------------	-------

\*\*\*\*\* INTERNAL VARIABLES \*\*\*\*\*

DELT	CURRENT - PAST T25	DEG F
DLT	CALC VAR2 - T25 COMP	DEG F
DLTD	CALC VAR3 - T25 COMP	DEG F
SAV	CALC VAR1 - T25 COMP	DEG F
T25P	PAST VALUE OF T25	DEG F

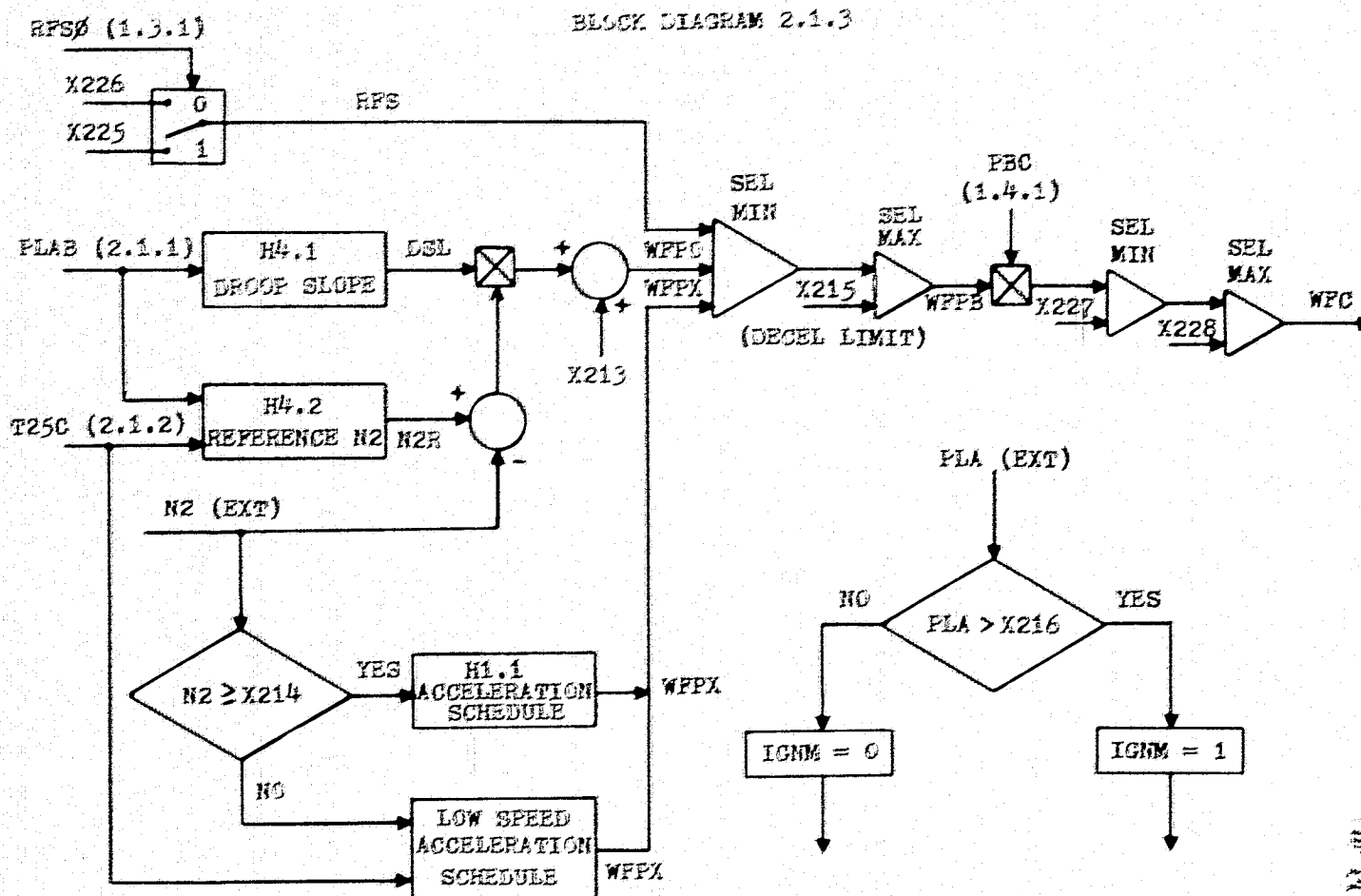


Figure 5.2-3. Gas Generator Fuel Flow Loop

ORIGINAL PAGE IS  
OF POOR QUALITY

BLOCK DIAGRAM 2.1.3 (Cont)

LOW SPEED ACCELERATION SCHEDULE

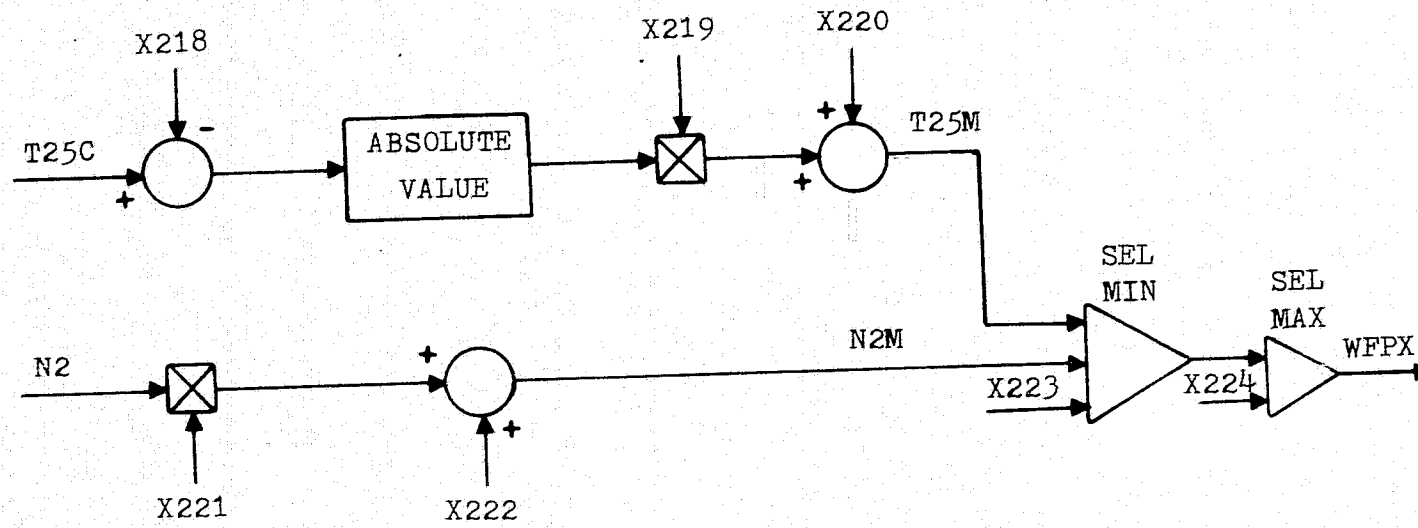


Figure 5.2-3. (Cont.)

TABLE 5.2-3 BLOCK 2.1.3 DATA

\*\*\*\*\* SCHEDULES \*\*\*\*\*

H1.1 ACCELERATION SCHEDULE  
H4.1 OPERATING LINE DROOP SLOPE  
H4.2 OPERATING LINE REFERENCE N2

\*\*\*\*\* CONSTANTS \*\*\*\*\*

X213	=	40.000	RU
X214	=	2200.0	RPM
X215	=	10.000	RU
X216	=	10.000	DEG
X218	=	250.00	DEG
X219	=	-.25000E-01	RU/DEG
X220	=	27.450	RU
X221	=	-.10000E-01	RU/RPM
X222	=	28.700	RU
X223	=	26.600	RU
X224	=	18.700	RU
X225	=	25.500	RU
X226	=	42.000	RU
X227	=	16000.	PPH
X228	=	400.00	PPH

\*\*\*\*\* INPUT VARIABLES \*\*\*\*\*

N2	HIGH COMPRESSOR SPEED	RPM
PBC	COMP. BURNER PRESSURE	PSI
PLA	POWER LEVER ANGLE	DEG
PLAB	GAS GENERATOR PLA	DEG
RFSQ	ROCKET FIRE SOLENOID	DISCRETE
T25C	COMPENSATED T25	DEG F

\*\*\*\*\* OUTPUT VARIABLES \*\*\*\*\*

IGNM	MAIN BURNER IGNITION CMD	DISCRETE
WFC	GAS GEN FUEL FLOW CMD	PPH
WFPB	MAIN BURNER WF/PB	RU

\*\*\*\*\* INTERNAL VARIABLES \*\*\*\*\*

DSL	DROOP SLOPE	RU/RPM
N2M	N2 INPUT - LOW SPEED WFPX	RU
N2R	REFERENCE N2	RPM
N2S	ROCKET FIRE LIMIT OF WFPB	RU
T25M	T25 INPUT-LOW SPEED WFPX	RU
WFPQ	OPERATING LINE WF/PB	RU
WFPX	ACCEL SCHEDULE WF/PB	RU

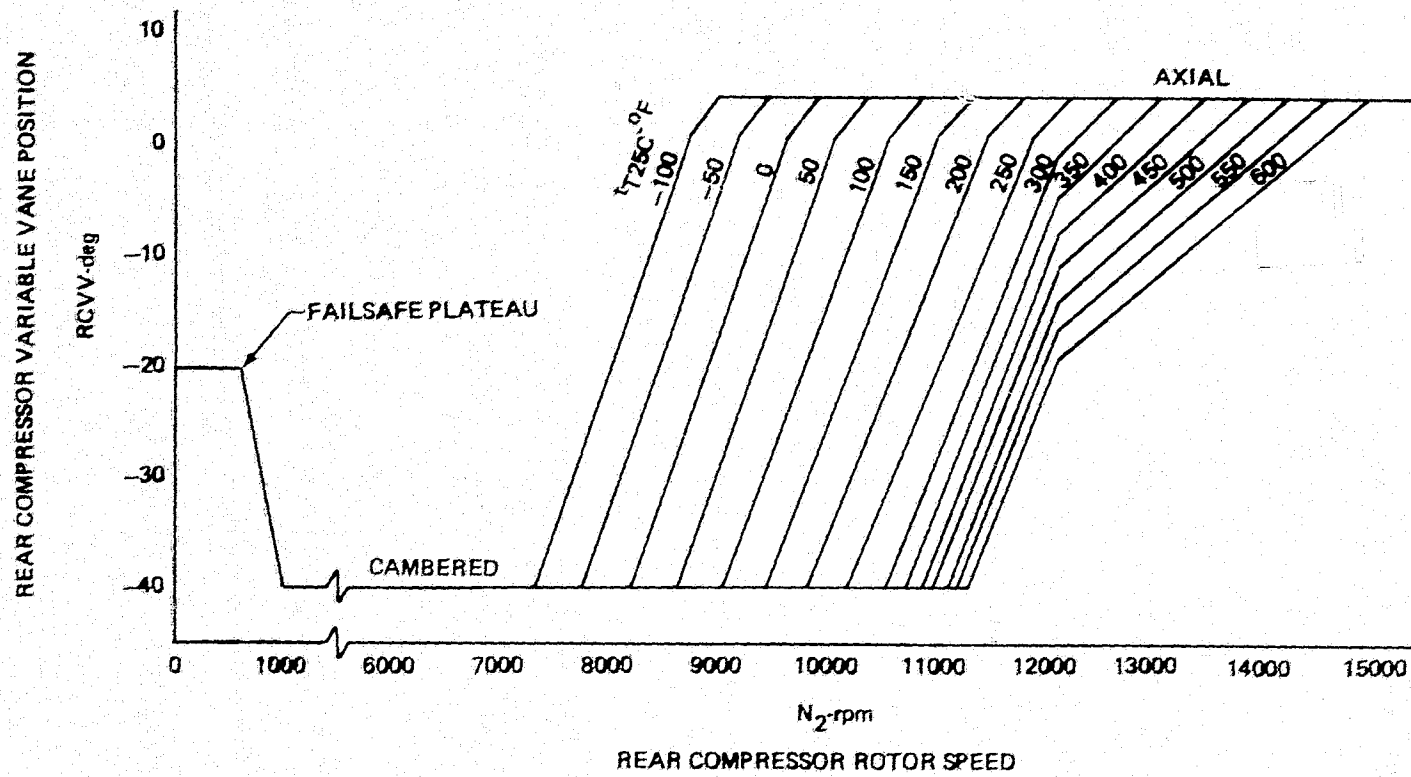
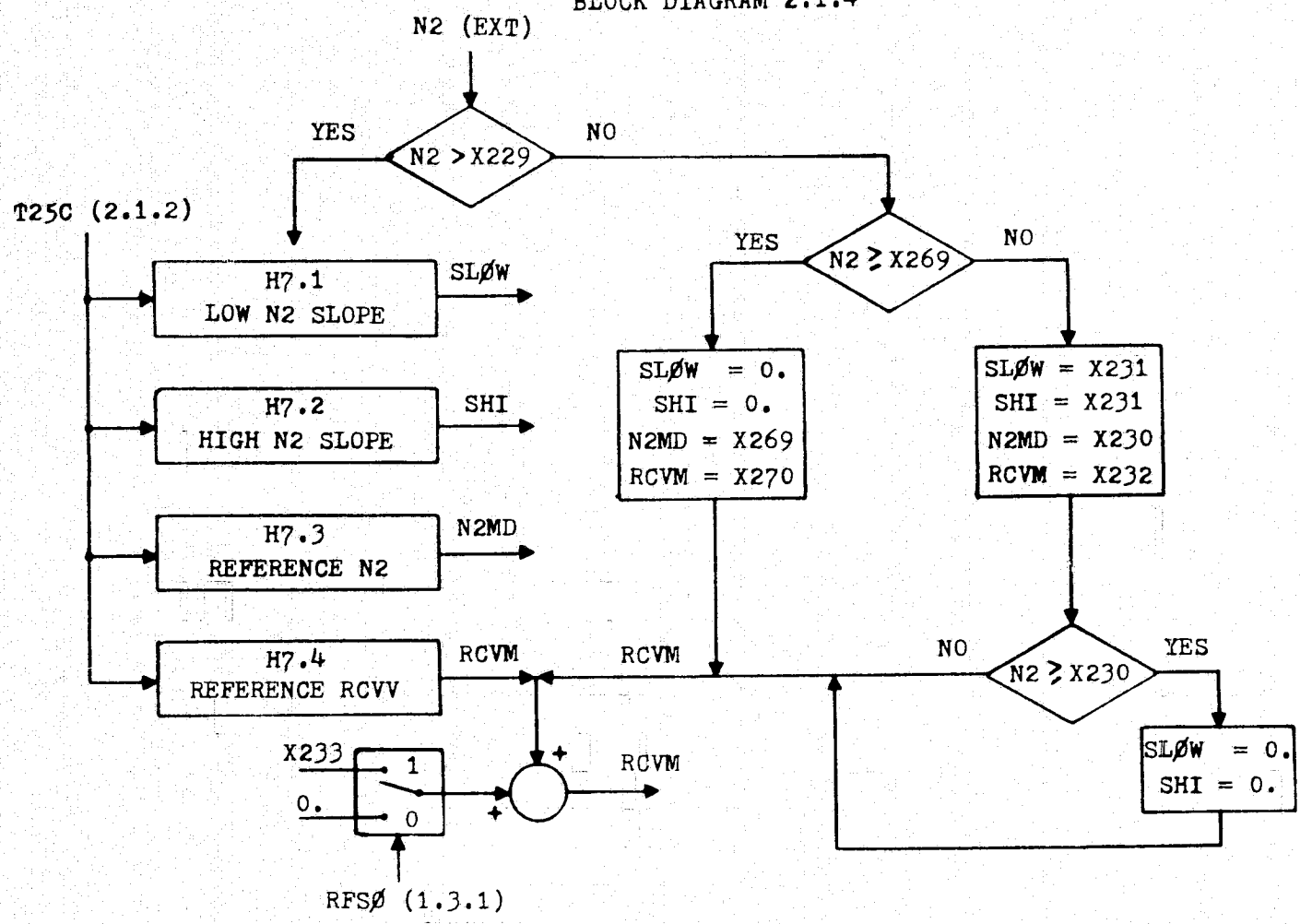


Figure 5.2.4 Rear Compressor Variable Vane Schedule

BLOCK DIAGRAM 2.1.4

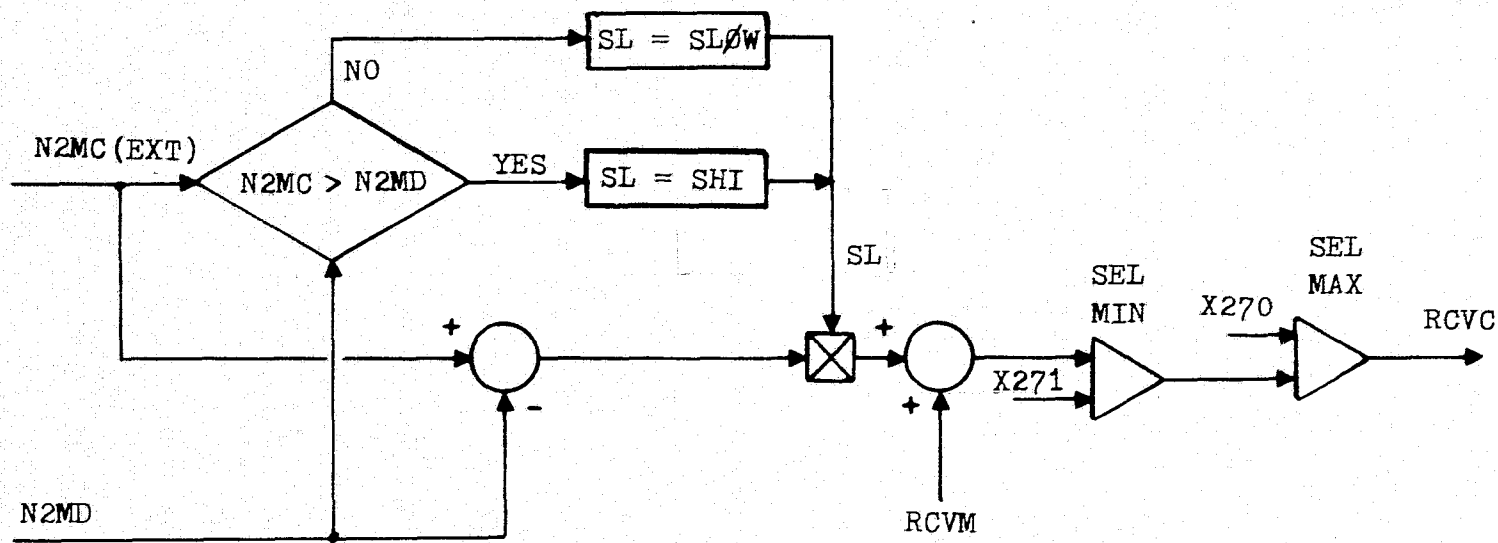


213

Figure 5.2-5. RCVV Logic

BLOCK DIAGRAM 2.1.4 (Cont)

2.1.4A -- MINOR CYCLE CALCULATIONS



214

Figure 5.2-5. (Cont.)

TABLE 5.2-4 BLOCK 2.1.4 DATA

\*\*\*\*\* SCHEDULES \*\*\*\*\*

H7.1 RCVV SETPOINT - LOW N2 SLOPE  
 H7.2 RCVV SETPOINT - HIGH N2 SLOPE  
 H7.3 RCVV SETPOINT - REF N2  
 H7.4 RCVV SETPOINT - REF RCVV

\*\*\*\*\* CONSTANTS \*\*\*\*\*

X229 = 7304.0 RPM  
 X230 = 600.00 RPM  
 X231 = -.50000E-01 DEG/RPM  
 X232 = -20.000 DEG  
 X233 = -7.0000 DEG  
 X269 = 1000.0 RPM  
 X270 = -40.000 DEG  
 X271 = 4.0000 DEG

\*\*\*\*\* INPUT VARIABLES \*\*\*\*\*

N2 HIGH COMPRESSOR SPEED RPM  
 N2MC MINOR CYCLE HPC SPEED RPM  
 RFSO ROCKET FIRE SOLENOID DISCRETE  
 T25C COMPENSATED T25 DEG F

\*\*\*\*\* OUTPUT VARIABLES \*\*\*\*\*

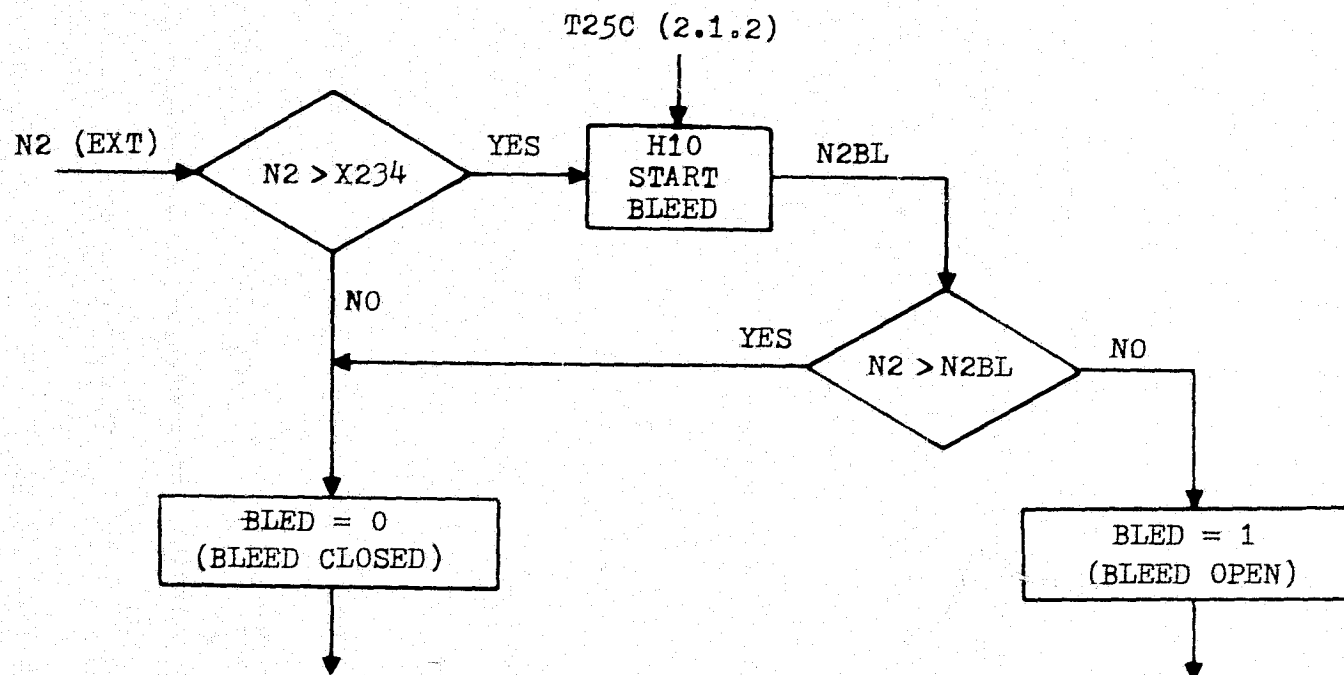
RCVC COMMANDED RCVV POSITION DEG

\*\*\*\*\* INTERNAL VARIABLES \*\*\*\*\*

N2MD REF N2 FOR RCVV COMMAND RPM  
 RCVM REF RCVV FOR RCVV COMMAND DEG  
 SHI RCVV SLOPE FOR HIGH N2 DEG/RPM  
 SLOW RCVV SLOPE FOR LOW N2 DEG/RPM



BLOCK DIAGRAM 2.1.5



216

Figure 5.2-6. Compressor Start Bleed

TABLE 5.2-5 BLOCK 2.1.5 DATA

\*\*\*\*\* SCHEDULES \*\*\*\*\*

H10 START BLEED

\*\*\*\*\* CONSTANTS \*\*\*\*\*

X234 = 1000.0 RPM

\*\*\*\*\* INPUT VARIABLES \*\*\*\*\*

N2 HIGH COMPRESSOR SPEED RPM  
T25C COMPENSATED T25 DEG F

\*\*\*\*\* OUTPUT VARIABLES \*\*\*\*\*

BLED START BLEED COMMAND DISCRETE

\*\*\*\*\* INTERNAL VARIABLES \*\*\*\*\*

N2BL REF N2 FOR START BLEED RPM

## 5.2.2 Afterburner

The afterburner logic computes the commands for the nozzle area, segment sequence valve position, core afterburner fuel flow, duct afterburner fuel flow, and the afterburner ignition. EEC inputs to the UFC afterburner control include the nozzle area trim, the rocket fire solenoid, and the N2 solenoid.

### 5.2.2.1 Nozzle Area

The base nozzle area is a function of PLAP and T25C. The nozzle is opened at idle on the ground indicated by the aircraft squat switch to reduce the thrust for taxi operation. The EEC nozzle trim is washed out as a function of PLAP.

Two signals generate nozzle area reset: rocket fire solenoid from the EEC and large decels indicated by DPLA, the difference between control PLA and PLAP, and the N2 solenoid from the EEC. Each reset is phased out gradually when the signal goes away. The nozzle area is limited and maximum or minimum nozzle area signals are generated. Figure 5.2-7 presents the block diagram, figure 5.2-8 the base nozzle area schedule, and table 5.2-6 the required data.

### 5.2.2.2 Segment Sequence Valve

The segment sequence valve controls the turning on and filling of each of the five afterburner manifolds or segments. The valve has ten positions, two for each segment. The first turns on a high rate of fuel flow to fill the manifold. During filling PLAP is held at the minimum value for that zone. When the manifold is full (indicated by a switch) the valve is sequenced to the transfer position and fuel flow is modulated. For the PROFIT system the fill switch will be monitored continuously in the IFU. An interrupt will be generated when the segment is filled. The

control executive will, in response to the interrupt, move the segment sequence valve to the operating position. In effect the PLAP is released at the same time (paragraph 5.2.1.1). Figure 5.2-9 presents the block diagrams and table 5.2-7 the data for this logic.

#### 5.2.2.3 Fuel Flow

Total afterburner Wf/PB is scheduled as a function of PLAP and T25C, biased by an external trim and main burner pressure, PB. Due to differences between the BOM and PROFIT hydromechanical fuel valve systems new logic must be devised for split between core and duct fuel flow. The eventual output of this logic block is commanded core fuel flow and commanded duct fuel flow. Figure 5.2-10 and table 5.2-8 show the block diagrams and required data. Figure 5.2-11 shows the total A/B fuel flow/main burner pressure schedule.

BLOCK DIAGRAM 2.2.1

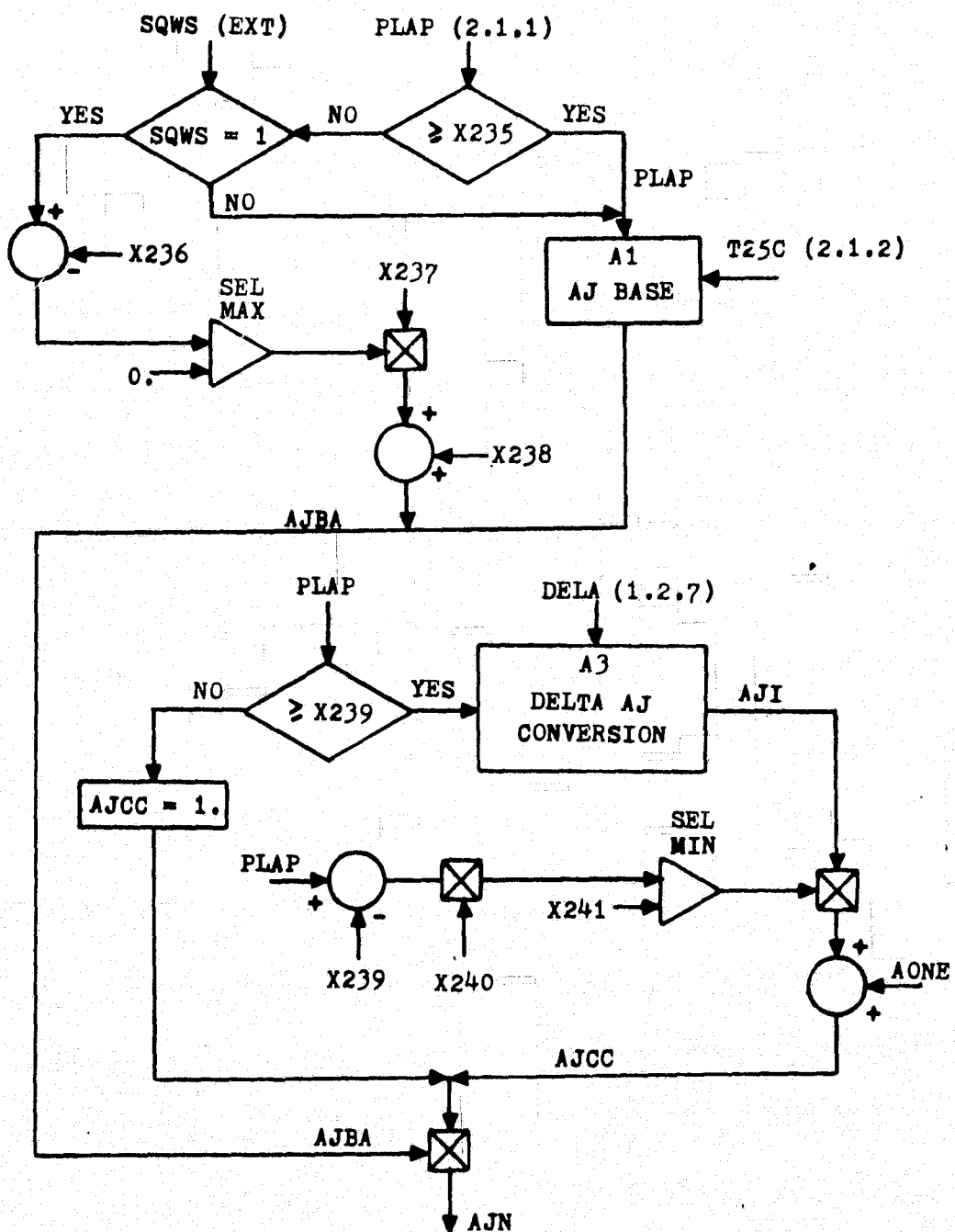


Figure 5.2-7. Nozzle Area

ORIGINAL PAGE IS  
OF POOR QUALITY

BLOCK DIAGRAM 2.2.1 (Cont)

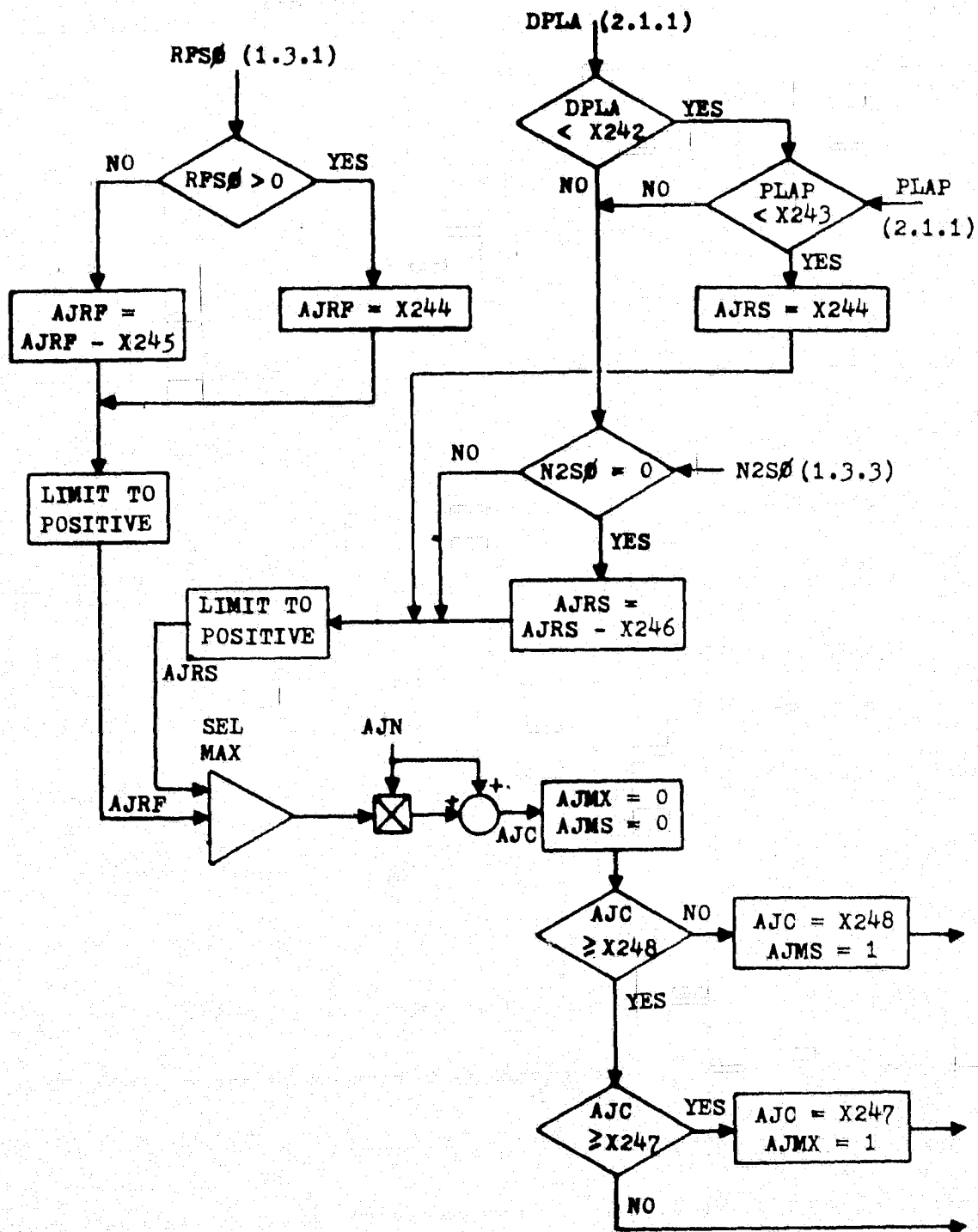


Figure 5.2-7. (Cont.)

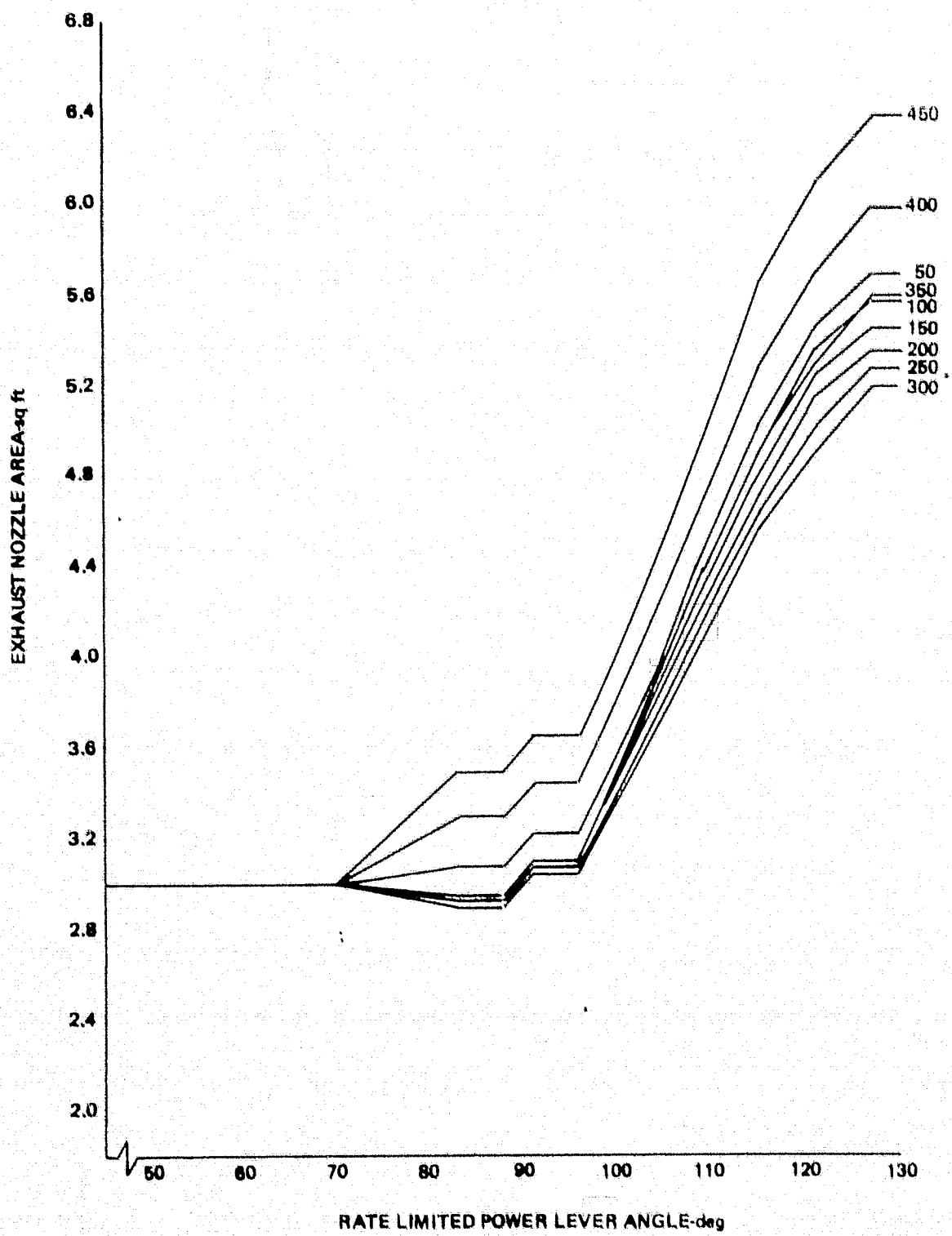


Figure 5.2-8 Basic Jet Area Schedule

TABLE 5.2-6 BLOCK 2.2.1 DATA

\*\*\*\*\* SCHEDULES \*\*\*\*\*

A1 BASE NOZZLE AREA  
 A3 DELTA AJ CONVERSION

\*\*\*\*\* CONSTANTS \*\*\*\*\*

ADNE	=	1.0000	--
X235	=	51.000	DEG
X236	=	24.000	DEG
X237	=	-.98890E-01	SQ FT/DEG
X238	=	5.6700	SQ FT
X239	=	64.500	DEG
X240	=	.57140E-01	1/DEG
X241	=	1.0000	--
X242	=	-10.000	DEG
X243	=	83.000	DEG
X244	=	.10000	--
X245	=	.12000E-01	--
X246	=	.30000E-02	--
X247	=	6.3500	SQ FT
X248	=	2.6640	SQ FT

ORIGINAL PAGE IS  
 OF POOR QUALITY

\*\*\*\*\* INPUT VARIABLES \*\*\*\*\*

DELA	EGC NOZZLE TRIM	STEPS
DPLA	PLAP ERROR (PLA - PLAP)	DEG
N2SO	N2 SOLENOID	DISCRETE
PLAP	RATE LIMITED PLA	DEG
RFSO	ROCKET FIRE SOLENOID	DISCRETE
SQWS	A/C SQUAT SWITCH	DISCRETE
T25C	COMPENSATED T25	DEG F

\*\*\*\*\* OUTPUT VARIABLES \*\*\*\*\*

AJC	NOZZLE AREA COMMAND	SQ FT
AJMS	NOZZLE CLOSED SWITCH	DISCRETE
AJMX	NOZZLE FULL OPEN SWITCH	DISCRETE

\*\*\*\*\* INTERNAL VARIABLES \*\*\*\*\*

AJBA	BASE NOZZLE AREA	SQ FT
AJCC	EGC BIAS OF AJ	--
AJCI	AJ TRIM	--
AJN	EGC BIASED BASE AJ	SQ FT
AJRF	ROCKET FIRE AJ RESET	SEC
AJRS	N2 SOLENOID AJ RESET	SEC



BLOCK DIAGRAM 2.2.2

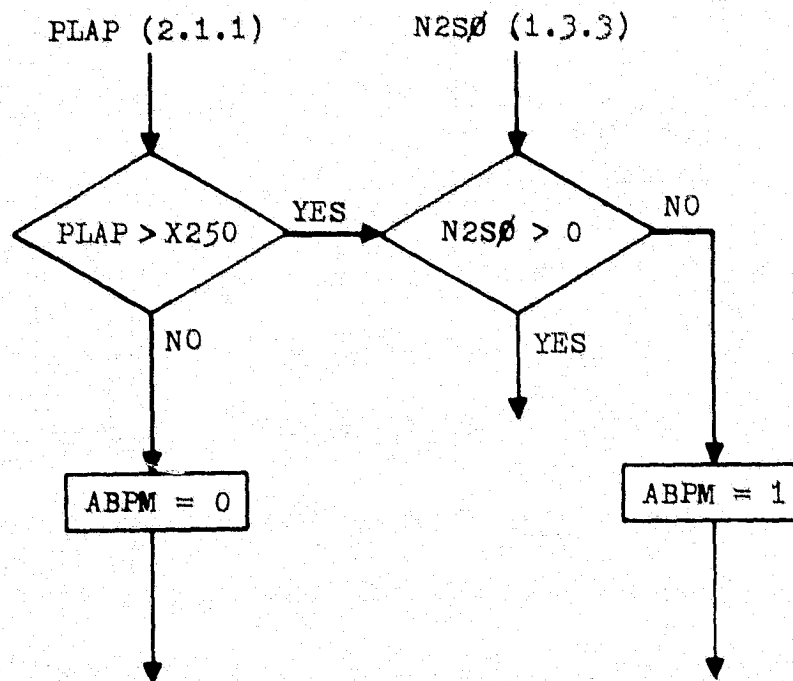


Figure 5.2-9. Segment Sequence Valve  
a. Afterburner Permission

BLOCK DIAGRAM 2.2.2 (Cont)

AL PAGE 19  
OF POOR QUALITY

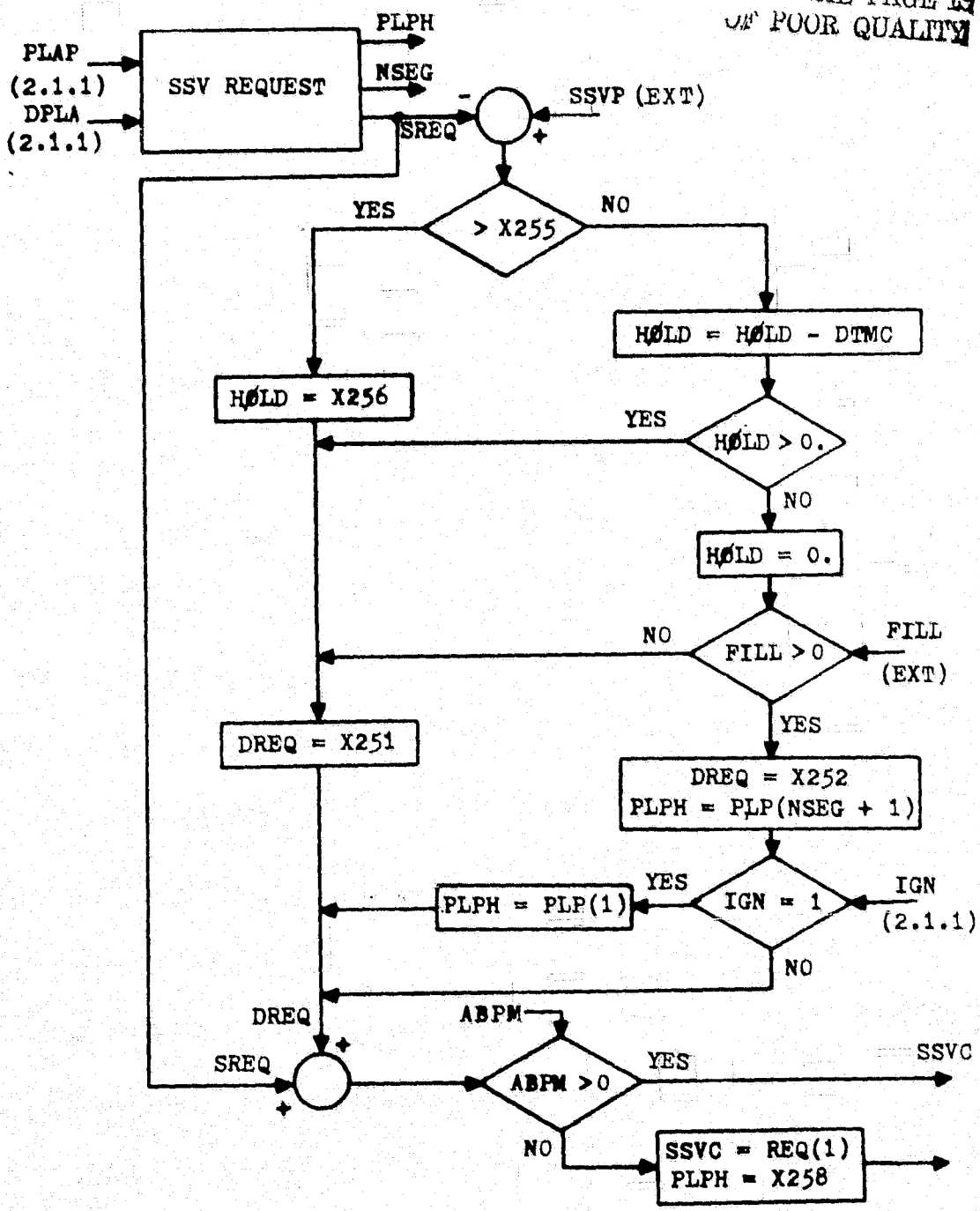


Figure 5.2-9. (Cont.)  
b. Segment Sequence Valve Command

BLOCK DIAGRAM 2.2.2 (Cont)

• SSV REQUEST

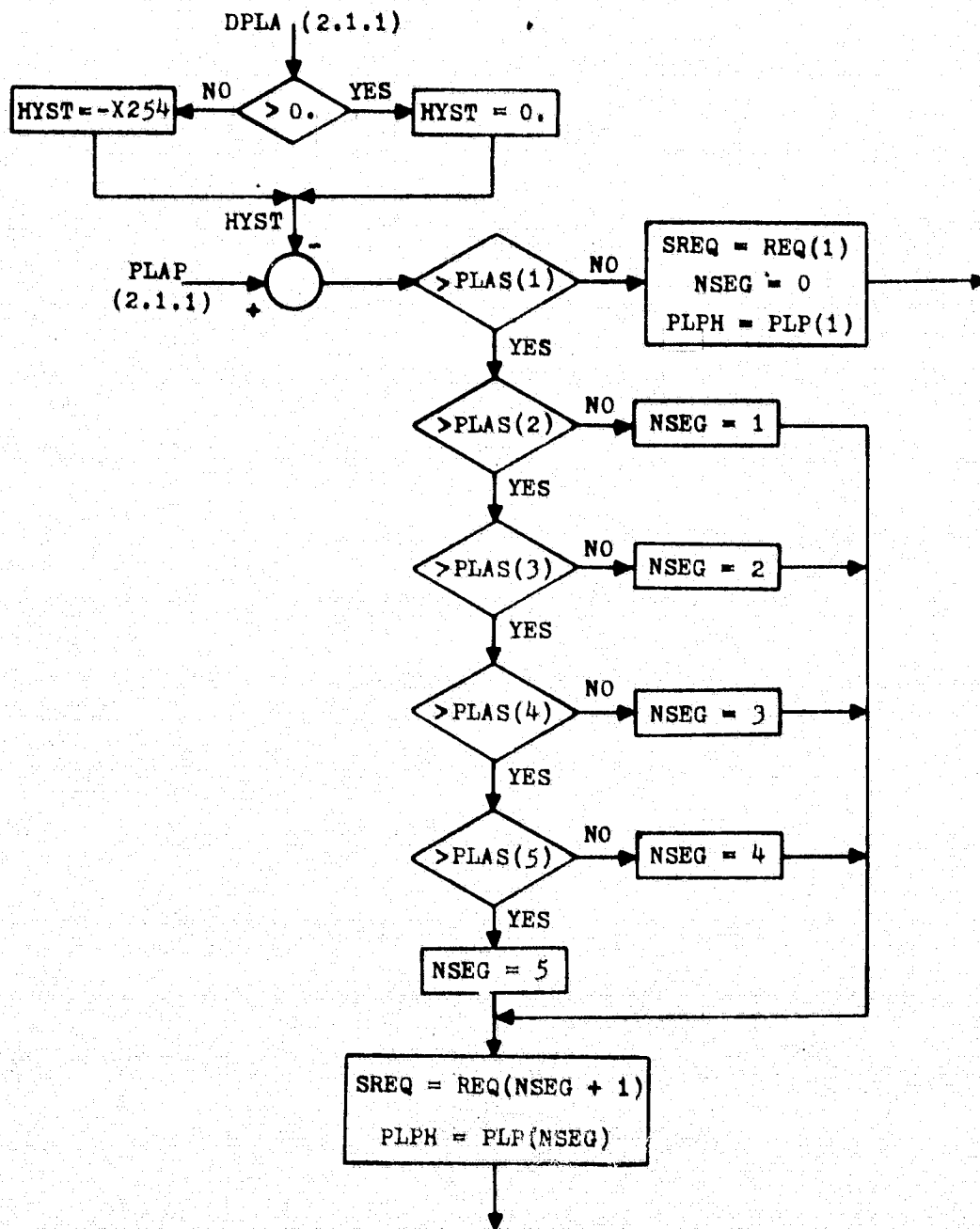


Figure 5.2-9. (Cont.)

TABLE 5.2-7 BLOCK 2.2.2 DATA

\*\*\*\*\* CONSTANTS \*\*\*\*\*

DTMC	=	.60000E-01	SEC/MJC
PLAS(1)	=	91.000	DEG
PLAS(2)	=	102.00	DEG
PLAS(3)	=	108.70	DEG
PLAS(4)	=	115.00	DEG
PLAS(5)	=	121.00	DEG
PLP(1)	=	93.500	DEG
PLP(2)	=	102.70	DEG
PLP(3)	=	110.00	DEG
PLP(4)	=	116.30	DEG
PLP(5)	=	122.50	DEG
PLP(6)	=	130.00	DEG
REQ(1)	=	87.500	DEG
REQ(2)	=	69.800	DEG
REQ(3)	=	54.100	DEG
REQ(4)	=	39.200	DEG
REQ(5)	=	23.400	DEG
REQ(6)	=	8.2000	DEG
X250	=	89.000	DEG
X251	=	6.8000	DEG
X252	=	0.	DEG
X254	=	.70000	DEG
X255	=	10.000	DEG
X256	=	.10000	SEC
X258	=	89.100	DEG

\*\*\*\*\* INPUT VARIABLES \*\*\*\*\*

DPLA	PLAP ERROR (PLA - PLAP)	DEG
FILL	A/B MANIFOLD FILL SIG	DISCRETE
IGN	A/B IGNITION COMMAND	DISCRETE
N2SU	N2 SOLENOID	DISCRETE
PLAP	RATE LIMITED PLA	DEG
SSVP	SSV POSITION	DEG

\*\*\*\*\* OUTPUT VARIABLES \*\*\*\*\*

NSEG	A/B SEGMENT COUNTER	--
PLPH	PLAP HOLD	DEG
SREQ	SCHEDULED SSV POSITION	DEG
SSVC	COMMANDED SSV POSITION	DEG

\*\*\*\*\* INTERNAL VARIABLES \*\*\*\*\*

ABPM	AFTERBURNER PERMISSION	DISCRETE
DREQ	FILL REDUCTION IN SSVC	DEG
HOLD	INITIAL FILL TIMER	SEC
HYST	PLAP HYSTER.- SSVC	DEG

BLOCK DIAGRAM 2.2.3

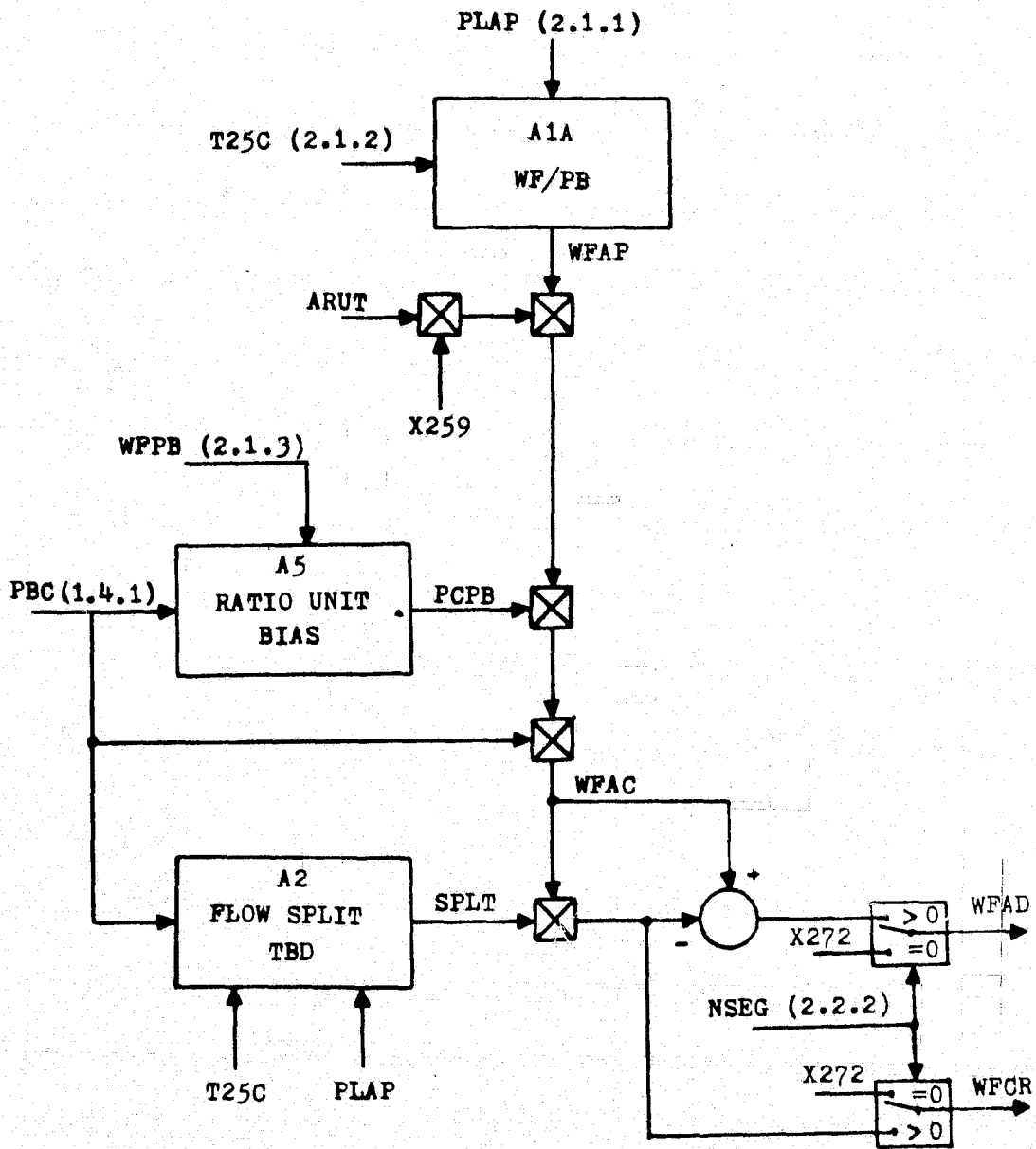


Figure 5.2-10. Afterburner Fuel Flow Logic

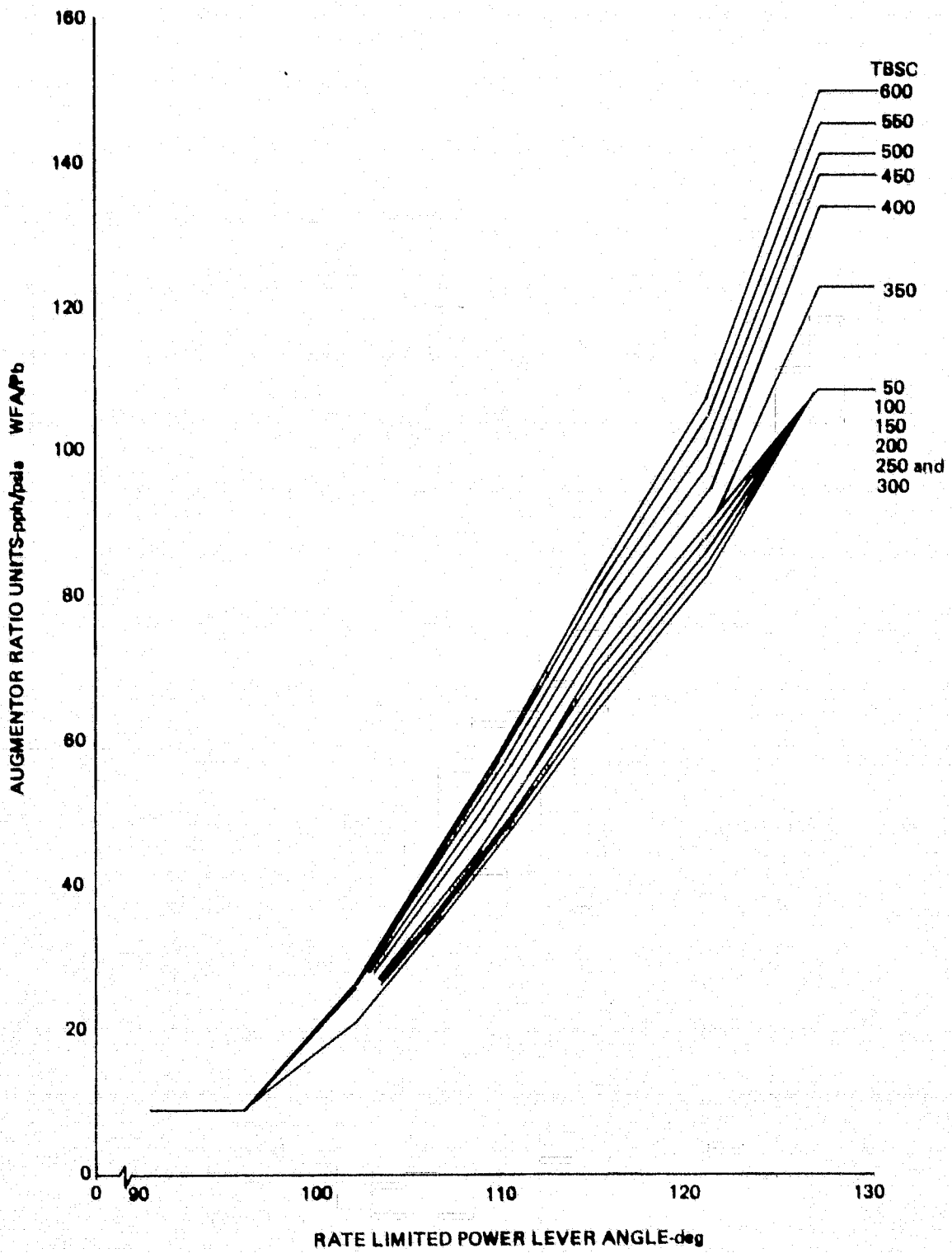


Figure 5.2-11 Afterburner Fuel Flow/Burner Pressure

TABLE 5.2-8 BLOCK 2.2.3 DATA

\*\*\*\*\* SCHEDULES \*\*\*\*\*

A1A TOTAL AFTERBURNER WF/PB  
 A2 FLOW SPLIT  
 A5 RATIO UNIT BIAS

\*\*\*\*\* CONSTANTS \*\*\*\*\*

X259 = 1.0000 --  
 X272 = 200.00 PPH

\*\*\*\*\* INPUT VARIABLES \*\*\*\*\*

ARUT A/B RATIO UNIT GRND TRIM --  
 NSEG A/B SEGMENT COUNTER --  
 PBC COMP. BURNER PRESSURE PSI  
 PLAP RATE LIMITED PLA DEG  
 T25C COMPENSATED T25 DEG F  
 WFPB MAIN BURNER WF/PB RU

\*\*\*\*\* OUTPUT VARIABLES \*\*\*\*\*

WFAD DUCT A/B FUEL FLOW CMD PPH  
 WFCR CORE A/B FUEL FLOW CMD PPH

\*\*\*\*\* INTERNAL VARIABLES \*\*\*\*\*

PCPB A/B RATIO UNIT BIAS --  
 SPLT CORE/TOTAL A/B FUEL FLOW --  
 WFAC COMMANDED A/B FUEL FLOW PPH  
 WFAP TOTAL A/B WF/PB RU

### 5.3 CONTROL EXECUTIVE

This section describes the executive functions for the BOM control module. The host program executive described in section 4.1 sets up the 60 millisecond major cycle, inputs and processes all the data, outputs all commands, and controls the minor cycle processing. The following paragraphs discuss all the required executive functions for the BOM control even though the fill interrupt logic and calling the minor cycle computations is performed in the host program executive. Each paragraph identifies those portions of the logic that will be in the host program executive.

#### 5.3.1 Fill Interrupt Processing

The entire fill interrupt processing logic will be a part of the host program executive (paragraph 4.1.3.8). Its function is described here to assist in understanding the BOM control operation. The hardware fill signal, in addition to being input to the control as a data word every 60 milliseconds, will be examined continuously by the IFU. An interrupt will be generated when fill first comes on. In response to that interrupt the host executive will perform the following functions:

1. set fill interrupt signal, FLIT, to 1 (FLIT is reset to 0 in logic block 2.1.1)
2. store the value of the minor cycle counter in ICYC
3. set segment sequence value position command, SSVC, to the operating position for the current segment, SREQ, computed in logic block 2.2.2
4. output the segment sequence value position command.



### 5.3.2 Minor Cycle Calculations

As described in paragraph 5.2.1.4 a portion of the RCVV computation must be performed at the 5 millisecond minor cycle rate. The logic identified in figure 5.2-5 as logic block 2.1.4A is to be done every minor cycle. The host program executive will call block 2.1.4A as part of the minor cycle processing (paragraph 4.1.1).

### 5.3.3 Major Cycle Calculation Order

The major cycle processing has been divided into gas generator and afterburner control. They are called separately from the host program executive (paragraph 4.1.1). The order of calculation within each is controlled by the BOM control executive. Figure 5.3-1 presents the calculation order for the gas generator. The logic is identified by block diagram numbers from sections 5.1 and 5.2. All of the EEC logic is included in the gas generator. Figure 5.3-2 presents the calculation order for the afterburner.

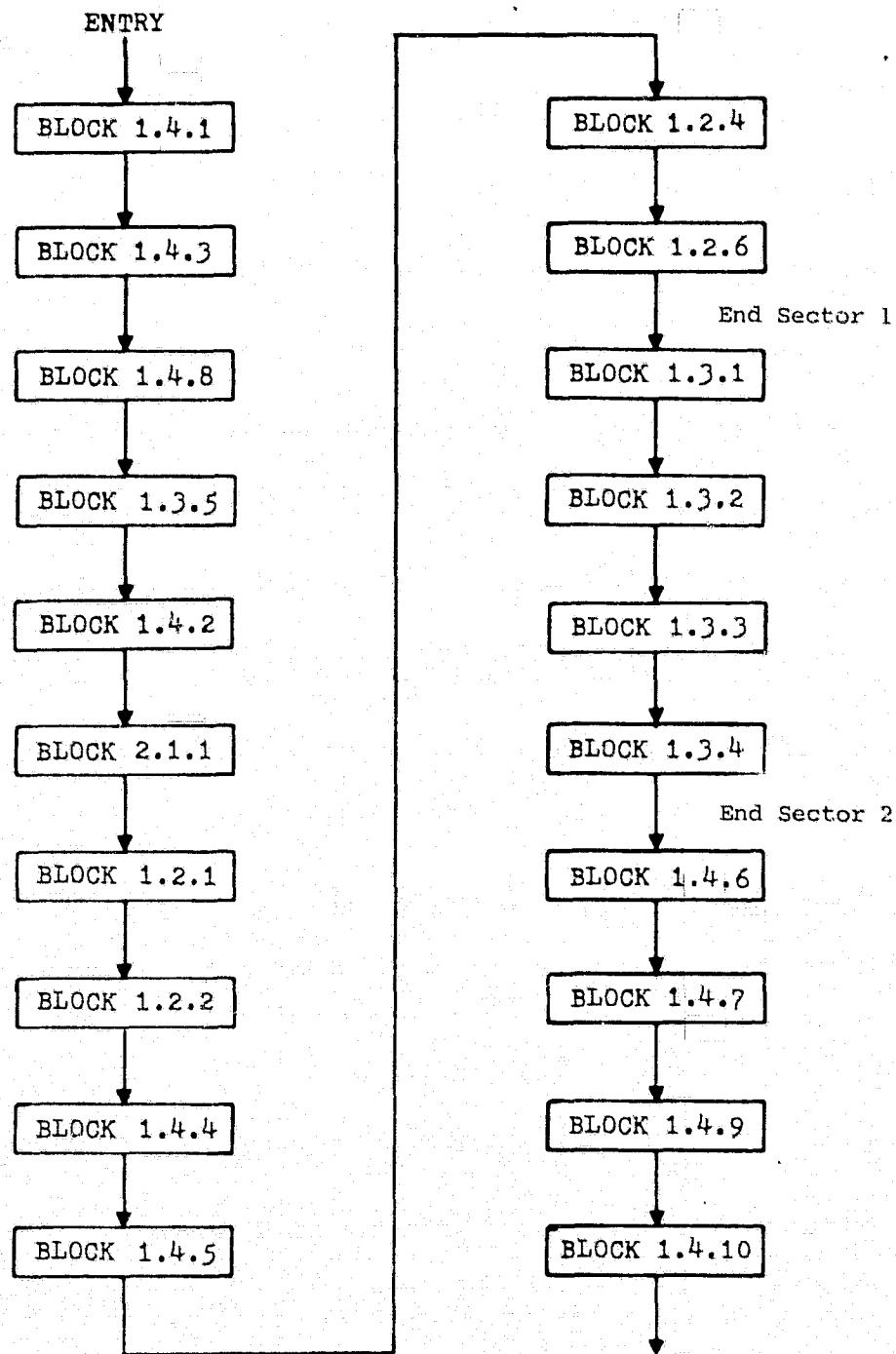


Figure 5.3-1. Gas Generator Calculation Order

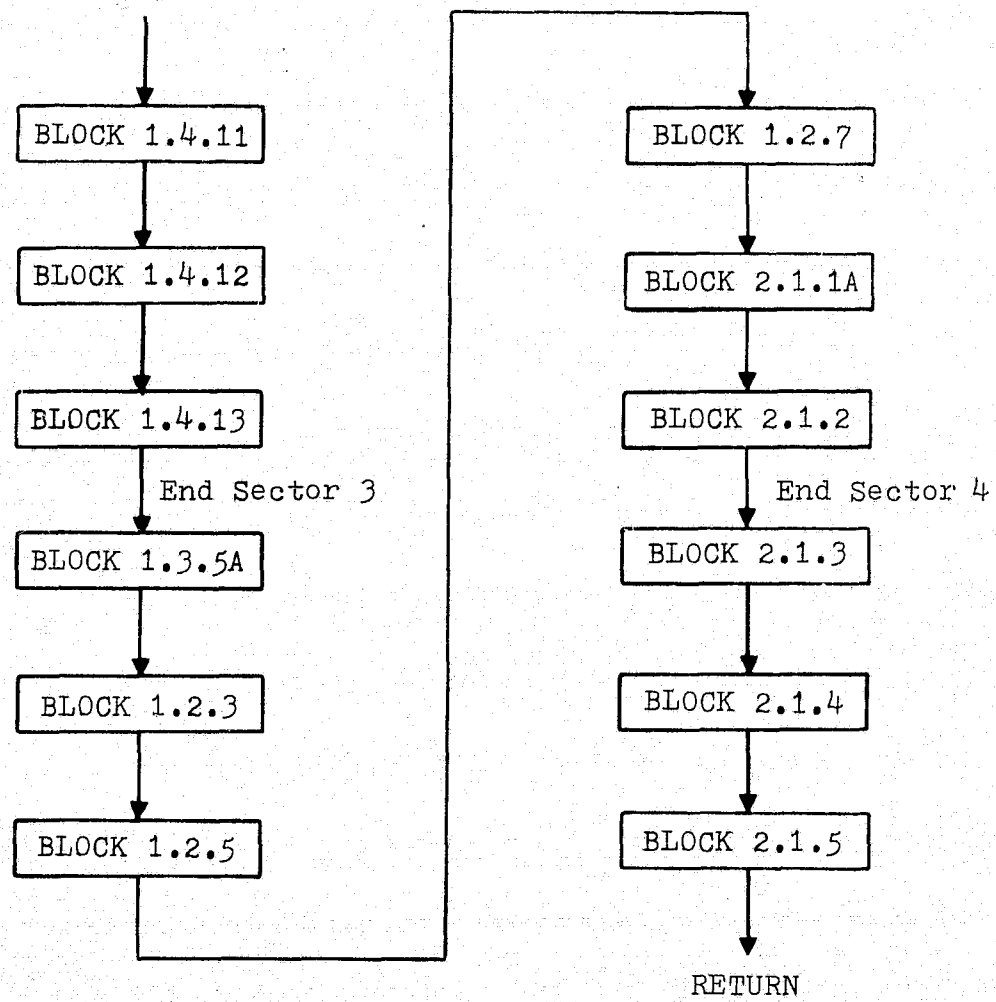
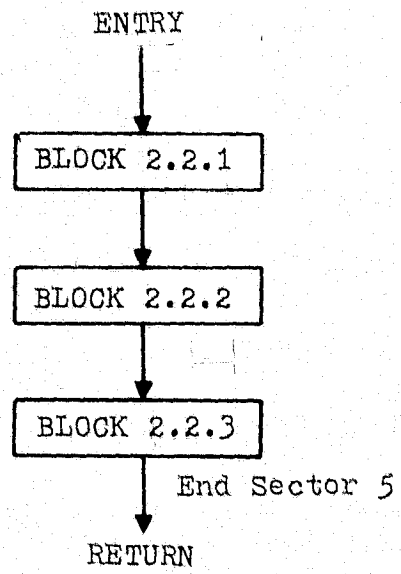


Figure 5.3-1. (Cont.)



*Figure 5.3-2. Afterburner Calculation Order*

## 5.4 DATA BASE

This section defines the values, scale factors, memory location, and using logic blocks for all schedules (5.4.1) and constants (5.4.2). Paragraph 5.4.3 defines the memory location, scale factor, the defining logic block, and the using logic block for the variables used in the control. Paragraph 5.4.4 defines the requirements for table lookup routines.

### 5.4.1 Schedules

This paragraph defines all the schedules used in the BOM control. Table 5.4-1 lists the schedules and identifies the logic block in which the table lookup is executed. Table 5.4-2 presents the data, memory location, and scale factor for all the schedules. The schedules are arranged in Table 5.4-2 in the same order as in Table 5.4-1. The memory location will be filled in when the program has been assembled. It will be the location of the first item in each array. It is not the location of the current values of the input and output variables. Those are defined in paragraph 5.4.3.

### 5.4.2 Constants

Table 5.4-3 defines the constants used in the BOM control. Memory location and scale factor information will be completed as they become available. Some of the constants are a function of the control computation interval, DTMC. Table 5.4-4 identifies these constants and how they were computed.

### 5.4.3 Variables

Table 5.4-5 lists the variables used in the control routines described in sections 5.1 and 5.2. The few remaining scale factors and memory locations will be added as the information is available. Tables 5.4-6, -7 define control inputs and commands.

#### 5.4.4 Table Lookup Routines

The same table lookup routines are to be used throughout the control. All tables are to be linearly interpolated with no extrapolation beyond the table end points. Both univariate and bivariate routines are required.

##### 5.4.4.1 Univariate Table Lookup

Two options are required for the univariate routines. The first is a table lookup with no prior information in which the X array is searched to find the values on either side of the input X and a Y value calculated. The second is one in which a series of tables have the same X values and the output Y value is computed using the previously computed  $(X-X_n)/(X_{n-1} - X_n)$  and n. This mode saves computation time for many of the control schedules.

##### 5.4.4.2 Bivariate Table Lookup

The following options are required for the bivariate routine:

1. full table lookup with no prior information computed
2. full interpolation of Y variable with previous values of X index and slope
3. Z computation using previous values of X index and slope and Y index and slope
4. capability of inputting externally computed X index and slope values. This option is useful in the UFC where uniform increments of T25C are used in several tables and the index and slope can be conveniently computed.

TABLE 5.4-1 CONTROL SCHEDULES

SCHEDULE	FUNCTION	BLOCK DIAGRAM
*** EEC ***		
G1	FAN TURBINE INLET TEMPERATURE LIMIT	1.4.8
G2	MINIMUM HIGH COMPRESSOR SPEED	1.4.8
G3	MAXIMUM HIGH COMPRESSOR SPEED	1.4.8
G4	N2 AIRFLOW ADJUSTMENT	1.3.5
G5	HIGH COMPRESSOR SPEED LOOP GAIN	1.2.5
G6	FTIT LOOP GAIN	1.4.10
G7	FAN SPEED LIMIT	1.4.8
G8	1./ $(\text{SQUARE ROOT OF THETA})$	1.4.8
G9	TOTAL CORRECTED AIRFLOW SCHEDULE	1.4.8
G10	SURGE PROTECTION AIRFLOW CUTBACK	1.4.12
G11	MAX BURNER PRESSURE LOOP GAIN	1.4.5
G13	FAN OVERSPEED LOOP GAIN	1.2.3
G14	MINIMUM CORRECTED AIRFLOW	1.3.5
G21	MINIMUM PLAP LOOP GAIN	1.4.7
G22	MAXIMUM CORRECTED AIRFLOW	1.3.5
G32	NOZZLE AREA TRIM LOOP GAIN	1.2.3
G43.1	N2 REFERENCE	1.3.5
G43.2	N2 TO N1 CORRECTION	1.3.5
G43.3	N1 REFERENCE	1.3.5
G44	PB BIAS TO REFERENCE FTIT	1.4.4
G45	REFERENCE FTIT SCHEDULE	1.4.8
G46	FTIT ADJUSTMENT TO N2 SETPOINT	1.4.12
G47	AIRFLOW CUTBACK SLOPE MULTIPLIER	1.4.8
G49	MINIMUM BURNER PRESSURE LOOP GAIN	1.4.4
G50	MINIMUM PLAP PRESCHEDULE	1.4.7
G51	PB BIAS TO N2 SETPOINT	1.4.4
G52	PLAP BIAS TO NOZZLE TRIM	1.2.3
G53	PB BIAS TO NOZZLE TRIM	1.4.4
G54	IDLE N2 LOOP GAIN	1.4.6
G55	BURNER PRESSURE CORRECTION FOR DGB	1.4.3
*** UFC ***		
A1	BASE NOZZLE AREA	2.2.1
A1A	TOTAL AFTERBURNER WF/PB	2.2.3
A2	FLOW SPLIT	2.2.3
A3	DELTA AJ CONVERSION	2.2.1
A5	RATIO UNIT BIAS	2.2.3
H1.1	ACCELERATION SCHEDULE	2.1.3
H4.1	OPERATING LINE DROOP SLOPE	2.1.3
H4.2	OPERATING LINE REFERENCE N2	2.1.3
H7.1	RCVV SETPOINT - LOW N2 SLOPE	2.1.4
H7.2	RCVV SETPOINT - HIGH N2 SLOPE	2.1.4
H7.3	RCVV SETPOINT - REF N2	2.1.4
H7.4	RCVV SETPOINT - REF RCVV	2.1.4
H10	START BLEED	2.1.5

TABLE 5.4-2 CONTROL SCHEDULE DATA

G1 SCHEDULE  
 FAN TURBINE INLET TEMPERATURE LIMIT

T2LL	G10
-110.00	1696.6
-53.000	1700.0
-3.0000	1703.0
22.000	1704.5
37.000	1705.5
42.000	1705.7
47.000	1706.0
52.000	1706.4
57.000	1706.7
62.000	1707.0
72.000	1707.7
97.000	1709.3
147.00	1712.7
197.00	1716.4
247.00	1720.6
297.00	1725.3
322.00	1714.7
347.00	1701.2
397.00	1665.0
440.00	1628.2

T2LL - COMPENSATED T2  
 DEG F ,B10 , LOC =

G10 - FTIT LIMIT  
 DEG F ,B12 , LOC =



TABLE 5.4-2 (CONT.)

G2 SCHEDULE  
 MINIMUM HIGH COMPRESSOR SPEED

T2LL	G20
-110.00	10876.
-53.000	11696.
-3.0000	12374.
22.000	12701.
37.000	12895.
42.000	12957.
47.000	13020.
52.000	13081.
57.000	13143.
62.000	13207.
72.000	13329.
97.000	13630.
147.00	14000.
197.00	14000.
247.00	14000.
297.00	14000.
322.00	14000.
347.00	14000.
397.00	14000.
440.00	14000.

T2LL - COMPENSATED T2  
 DEG F ,B10 , LOC =

G20 - MINIMUM N2  
 RPM ,B14 , LOC =

TABLE 5.4-2 (CONT.)

G3 SCHEDULE  
 MAXIMUM HIGH COMPRESSOR SPEED

T2LL	G30
-110.00	13000.
-53.000	13000.
-3.0000	13000.
22.000	13087.
37.000	13130.
42.000	13148.
47.000	13162.
52.000	13177.
57.000	13192.
62.000	13208.
72.000	13238.
97.000	13317.
147.00	13250.
197.00	13250.
247.00	13250.
297.00	13250.
322.00	13250.
347.00	13250.
397.00	13250.
440.00	13250.

T2LL - COMPENSATED T2  
 DEG F ,B10 , LOC =

G30 - MAXIMUM N2  
 RPM ,B14 , LOC =

TABLE 5.4-2 (CONT.)

G4 SCHEDULE  
N2 AIRFLOW ADJUSTMENT

DN2	G40
-300.00	3.0000
200.00	-2.0000
700.00	-12.0000
1400.0	-34.0000

DN2 - N2 ERROR FOR AIRFLOW ADJ  
RPM ,B12 , LOC =

G40 - DELTA AIRFLOW  
PPS ,B6 , LOC =

TABLE 5.4-2 (CONT.)

G5 SCHEDULE  
HIGH COMPRESSOR SPEED LOOP GAIN

N2ER	N2TM
-8000.0	-80.000
-150.00	-.75000
-15.000	0.
15.000	0.
375.00	1.2500
8000.0	80.000

N2ER - N2 ERROR FOR PLA LOOP  
RPM ,B14 , LOC =

N2TM - N2 INPUT TO THE PLA LOOP  
DEG/SEC ,B8 , LOC =

TABLE 5.4-2 (CONT.)

G6 SCHEDULE

FTIT LOOP GAIN

FTTE	FTTM
-1440.0	-160.00
-100.00	-5.0000
-50.000	-1.4000
-4.0000	0.
4.0000	0.
100.00	1.0000
300.00	5.0000

FTTE - FTIT ERROR  
 DEG ,B11 , LOC =

FTTM - FTIT INPUT TO PLA LOOP  
 DEG/SEC ,B8 , LOC =

TABLE 5.4-2 (CONT.)

G7 SCHEDULE  
FAN SPEED LIMIT

T2LL	G70
-110.00	9471.0
-53.000	9870.0
-3.0000	10220.
22.000	10395.
37.000	10490.
42.000	10530.
47.000	10570.
52.000	10610.
57.000	10640.
62.000	10670.
72.000	10670.
97.000	10650.
147.00	10595.
197.00	10540.
247.00	10480.
297.00	10420.
322.00	10395.
347.00	10365.
397.00	10310.
440.00	10262.

T2LL - COMPENSATED T2  
DEG F ,B10 , LOC =

G70 - MAXIMUM N1  
RPM ,B14 , LOC =

TABLE 5.4-2 (CONT.)

G8 SCHEDULE  
 1./(SQUARE ROOT OF THETA)

T2LL	G80
-110.00	1.2129
-53.000	1.1252
-3.0000	1.0623
22.000	1.0345
37.000	1.0189
42.000	1.0138
47.000	1.0088
52.000	1.0039
57.000	.99900
62.000	.99423
72.000	.98493
97.000	.96265
147.00	.92234
197.00	.88668
247.00	.85492
297.00	.82631
322.00	.81301
347.00	.80038
397.00	.77676
440.00	.75804

T2LL - COMPENSATED T2  
 DEG F ,810 , LOC =

G80 - 1./(SQUARE ROOT OF THETA)  
 -- ,81 , LOC =

TABLE 5.4-2 (CONT.)

G9 SCHEDULE

TOTAL CORRECTED AIRFLOW SCHEDULE

T2LL	G90
-110.00	230.00
-53.000	230.00
-3.0000	230.00
22.000	230.00
37.000	230.00
42.000	230.00
47.000	229.35
52.000	228.90
57.000	228.30
62.000	228.00
72.000	225.90
97.000	218.60
147.00	208.80
197.00	199.70
247.00	190.60
297.00	181.50
322.00	174.20
347.00	167.10
397.00	152.50
440.00	139.90

T2LL - COMPENSATED T2  
 DEG F ,B10 , LOC =

G90 - SCHEDULED CORRECTED FLOW  
 PPS ,B8 , LOC =



TABLE 5.4-2 (CONT.)

G10 SCHEDULE  
SURGE PROTECTION AIRFLOW CUTBACK

DN2E	G100
0.	0.
4.0000	-100.00
14.000	-560.00
36.000	-1200.0

DN2E - AIRFLOW ERROR FOR N2 BIAS  
PPS ,B8 , LOC =

G100 - N2 SETPOINT BIAS -AIRFLOW  
RPM ,B14 , LOC =

TABLE 5.4-2 (CONT.)

G11 SCHEDULE

MAX BURNER PRESSURE LOUP GAIN

PBE	PBTM
-853.00	-139.90
-11.300	-.28200
-4.5000	0.
4.5000	0.
11.300	.28200
853.00	139.90

PBE - MAX BURNER PRESSURE ERROR  
PSI ,B10 , LDC =

PBTM - MAX PB INPUT TO PLA LOOP  
DEG/SEC ,B8 , LDC =

TABLE 5.4-2 (CONT.)

G13 SCHEDULE  
FAN OVERSPEED LOOP GAIN

N1ER	N1TM
-4400.0	-160.00
-400.00	0.
-399.00	160.00

N1ER - N1 ERROR FOR PLA LOOP  
RPM ,B14 , LOC =

N1TM - N1 INPUT TO THE PLA LOOP  
DEG/SEC ,B8 , LOC =

TABLE 5.4-2 (CONT.)

G14 SCHEDULE  
MINIMUM CORRECTED AIRFLOW

MNLG	G140
249.00	122.90
265.00	122.90
346.00	122.90
454.00	171.40
516.00	170.80
583.00	170.10
656.00	168.30
815.00	162.90
995.00	153.70
1195.0	136.70
1413.0	103.40
1529.0	85.800
1908.0	33.000

MNLG - FILTERED A/C MACH NUMBER  
COUNTS ,811 , LOC =

G140 - MINIMUM CORRECTED AIRFLOW  
PPS ,88 , LOC =

TABLE 5.4-2 (CONT.)

G21 SCHEDULE  
 MINIMUM PLAP LOOP GAIN

MOPE	G210
-80.000	-75.000
-6.0000	-2.0000
-2.0000	-2.0000
-.30000	0.
.30000	0.
75.000	75.000

MOPE - MINIMUM PLAP ERROR  
 DEG ,B8 , LOC =

G210 - MINIMUM PLAP RATE - MN  
 DEG/SEC ,B8 , LOC =

TABLE 5.4-2 (CONT.)

G22 SCHEDULE  
MAXIMUM CORRECTED AIRFLOW

MNLG	G220
249.00	233.00
265.00	233.00
346.00	233.00
454.00	230.00
516.00	225.10
583.00	220.00
656.00	214.70
815.00	197.50
995.00	179.10
1195.0	161.40
1413.0	145.50
1529.0	141.80
1908.0	130.00

MNLG - FILTERED A/C MACH NUMBER  
COUNTS ,B11 , LOC =

G220 - MAXIMUM CORRECTED AIRFLOW  
PPS ,B8 , LOC =

TABLE 5.4-2 (CONT.)

G32 SCHEDULE  
NOZZLE AREA TRIM LOOP GAIN

NIE	AJN1
-9000.0	-492.80
-52.500	-.51750
-15.000	0.
15.000	0.
52.500	.51750
9000.0	492.80

NIE - N1 ERROR FOR AJ LOOP  
RPM ,B14 , LOC =

AJN1 - EXHAUST NOZZLE TRIM RATE  
AJ/SEC ,B9 , LOC =

TABLE 5.4-2 (CONT.)

G43.1 SCHEDULE

N2 REFERENCE

WCDS	GPI
80.000	9175.0
100.00	9450.0
120.00	9825.0
140.00	10325.
150.00	10600.
160.00	10900.
170.00	11225.
180.00	11550.
190.00	11875.
200.00	12250.
210.00	12625.
220.00	13050.
225.00	13250.
235.00	13750.

WCDS - DESIRED CORRECTED AIRFLOW  
PPS ,B8 , LOC =

GPI - REFERENCE CORRECTED N2  
RPM ,B14 , LOC =



TABLE 5.4-2 (CONT.)

G43.2 SCHEDULE  
N2 TO N1 CORRECTION

WCDS	GP2
80.000	.70000
100.00	.70000
120.00	.50000
140.00	.50000
150.00	.50000
160.00	.50000
170.00	.50000
180.00	.42000
190.00	.34000
200.00	.27000
210.00	.19000
220.00	.12000
225.00	.70000E-01
235.00	0.

WCDS - DESIRED CORRECTED AIRFLOW  
PPS ,B8 , LOC =

GP2 - DELTA N1 / DELTA N2  
-- ,B1 , LOC =

TABLE 5.4-2 (CONT.)

G43.3 SCHEDULE

NI REFERENCE

WCDS	GP3
80.000	4400.0
100.00	5425.0
120.00	6400.0
140.00	7200.0
150.00	7600.0
160.00	7975.0
170.00	8350.0
180.00	8750.0
190.00	9100.0
200.00	9375.0
210.00	9630.0
220.00	9975.0
225.00	10150.
235.00	10732.

WCDS - DESIRED CORRECTED AIRFLOW  
PPS ,B8 , LOC =

GP3 - REFERENCE CORRECTED NI  
RPM ,B15 , LOC =

TABLE 5.4-2 (CONT.)

G44 SCHEDULE  
PB BIAS TO REFERENCE FTIT

PBLG	G44D
20.000	50.000
54.000	50.000
58.000	50.000
100.00	50.000
130.00	50.000
170.00	38.000
200.00	-6.0000
230.00	-40.000
250.00	-50.000
280.00	-50.000
300.00	-50.000
320.00	-50.000
600.00	-50.000

PBLG - FILTERED PB  
PSI ,B10 , LOC =

G44D - FTIT BIAS FOR PB  
DEG F ,B12 , LOC =

TABLE 5.4-2 (CONT.)

G45 SCHEDULE  
 REFERENCE FTIT SCHEDULE

T2LL	G450
-110.00	1108.4
-53.000	1352.2
-3.0000	1563.9
22.000	1664.0
37.000	1731.6
42.000	1752.5
47.000	1773.3
52.000	1794.1
57.000	1814.9
62.000	1834.9
72.000	1876.5
97.000	1980.0
147.00	1980.0
197.00	1980.0
247.00	1980.0
297.00	1980.0
322.00	1980.0
347.00	1980.0
397.00	1980.0
440.00	1980.0

T2LL - COMPENSATED T2  
 DEG F , B10 , LOC =

G450 - REFERENCE FTIT  
 DEG F , B12 , LOC =

TABLE 5.4-2 (CONT.)

G46 SCHEDULE  
FTIT ADJUSTMENT TO N2 SETPOINT

ERRR	G46D
-975.00	-1000.0
-270.00	-420.00
321.00	500.00

ERRR - FTIT ERROR FOR N2 BIAS  
DEG F ,B12 , LOC =

G46D - N2 SETPOINT BIAS - FTIT  
RPM ,B14 , LOC =

TABLE 5.4-2 (CONT.)

G47 SCHEDULE  
AIRFLOW CUTBACK SLOPE MULTIPLIER

T2LL	G470
-110.00	1.2500
-53.000	1.2500
-3.0000	1.2500
22.000	1.0000
37.000	1.0000
42.000	1.0000
47.000	1.0000
52.000	1.0000
57.000	1.0000
62.000	1.0000
72.000	1.0000
97.000	1.0000
147.00	0.
197.00	0.
247.00	0.
297.00	0.
322.00	0.
347.00	0.
397.00	0.
440.00	0.

T2LL - COMPENSATED T2  
DEG F ,B10 , LOC =

G470 - AIRFLOW CUTBACK SLOPE  
-- ,B1 , LOC =

TABLE 5.4-2 (CONT.)

G49 SCHEDULE  
MINIMUM BURNER PRESSURE LOOP GAIN

PBER	G490
-300.00	-25.000
-1.0000	0.
1.0000	0.
300.00	25.000

PBER - MINIMUM PB ERROR  
PSI ,B10 , LOC =

G490 - MINIMUM PLAP RATE - PB  
DEG/SEC ,B7 , LOC =

TABLE 5.4-2 (CONT.)

G50 SCHEDULE  
MINIMUM PLAP PRESCHEDULE

N2PR	MNPS
8800.0	25.500
10550.	40.900
13072.	85.000

N2PR - REFERENCE N2  
RPM ,B14 , LOC =

MNPS - PRESCHEDULED MIN PLAP  
DEG ,88 , LOC =



TABLE 5.4-2 (CONT.)

G51 SCHEDULE  
PB BIAS TO N2 SETPOINT

PBLG	G51D
20.000	842.00
54.000	-500.00
58.000	-660.00
100.00	-1923.0
130.00	-2568.0
170.00	-3300.0
200.00	-3818.0
230.00	-4353.0
250.00	-4700.0
280.00	-5268.0
300.00	-5268.0
320.00	-5268.0
600.00	-5268.0

PBLG - FILTERED PB  
PSI ,810 , LOC =

G51D - N2 BIAS FOR PB  
RPM ,814 , LOC =

TABLE 5.4-2 (CONT.)

G52 SCHEDULE  
PLAP BIAS TO NOZZLE TRIM

PLAP	G520
96.000	0.
108.70	.50000
115.00	.50000
120.00	1.0000

PLAP - RATE LIMITED PLA  
DEG ,88 , LOC =

G520 - NOZZLE TRIM BIAS  
-- ,81 , LOC =

TABLE 5.4-2 (CONT.)

G53 SCHEDULE  
PB BIAS TO NOZZLE TRIM

PBLG	G530
20.000	-27.000
54.000	-17.200
58.000	-16.000
100.00	-8.0000
130.00	-5.4000
170.00	-3.6000
200.00	-2.8000
230.00	-2.1500
250.00	-1.6500
280.00	-1.0500
300.00	-.50000
320.00	0.
600.00	0.

PBLG - FILTERED PB  
PSI ,B10 , LOC =

G530 - AJ BIAS FOR PB  
AJ ,B5 , LOC =

TABLE 5.4-2 (CONT.)

G54 SCHEDULE

IDLE N2 LOOP GAIN

NICE	G540
-6000.0	-50.000
-2000.0	-7.5000
-1000.0	-1.2500
-60.000	0.
60.000	0.
1000.0	2.0000
2000.0	7.5000
6000.0	50.000

NICE - IDLE N2 ERROR  
RPM ,814 , LOC =

G540 - MINIMUM PLAP RATE - IDLE  
DEG/SEC ,88 , LOC =

TABLE 5.4-2 (CONT.)

G55 SCHEDULE  
 BURNER PRESSURE CORRECTION FOR DGB

PBLG	G550
0.	-24.300
25.000	22.300
50.000	60.800
75.000	91.200
100.00	115.50
150.00	154.00
200.00	182.40
223.60	192.90
250.00	246.70
300.00	320.80
400.00	441.10
500.00	524.40
580.00	580.00
620.00	612.40

PBLG - FILTERED PB  
 PSI ,B10 , LOC =

G550 - TWO SLOPE CORRECTED PB  
 PSI ,B10 , LOC =

TABLE 5.4-2 (CONT.)

A1 SCHEDULE

BASE NOZZLE AREA

	PLAP	71.000	83.000	88.000	91.000
T25C					
50.000		3.0000	2.9500	2.9500	3.1000
100.00		3.0000	2.9500	2.9500	3.1000
150.00		3.0000	2.9500	2.9500	3.1000
200.00		3.0000	2.9500	2.9500	3.1000
250.00		3.0000	2.9300	2.9300	3.0800
300.00		3.0000	2.9000	2.9000	3.0500
350.00		3.0000	3.0800	3.0800	3.2300
400.00		3.0000	3.3000	3.3000	3.4500
450.00		3.0000	3.5000	3.5000	3.6500

	PLAP	96.000	102.00	108.70	115.00
T25C					
50.000		3.1000	3.6700	4.4100	5.0200
100.00		3.1000	3.6400	4.3300	4.9100
150.00		3.1000	3.6200	4.2500	4.8000
200.00		3.1000	3.5800	4.1800	4.7000
250.00		3.0800	3.5500	4.1000	4.6200
300.00		3.0500	3.5000	4.0200	4.5500
350.00		3.2300	3.7300	4.3200	4.9000
400.00		3.4500	3.9600	4.6000	5.2800
450.00		3.6500	4.2000	4.9000	5.6500

PLAP - RATE LIMITED PLA , DEG ,88 , LOC =

T25C - COMPENSATED T25 , DEG F ,810 , LOC =

AJBA - BASE NOZZLE AREA , SQ FT ,84 , LOC =

TABLE 5.4-2 (CONT.)

A1 SCHEDULE -- BASE NOZZLE AREA (CONT.)

	PLAP	121.00	127.00
T25C			
50.000		5.4600	5.7000
100.00		5.3600	5.5800
150.00		5.2500	5.4700
200.00		5.1500	5.3600
250.00		5.0200	5.2500
300.00		4.9000	5.2000
350.00		5.3000	5.6000
400.00		5.7000	6.0000
450.00		6.1000	6.4000

PLAP - RATE LIMITED PLA , DEG ,88 , LOC =  
 T25C - COMPENSATED T25 , DEG F ,810 , LOC =  
 AJBA - BASE NOZZLE AREA , SQ FT ,84 , LOC =

TABLE 5.4-2 (CONT.)

A1A SCHEDULE

TOTAL AFTERBURNER WF/PB

	PLAP	96.000	102.00	108.70	115.00
T25C					
50.000	9.0000	23.000	44.000	71.000	
100.00	9.0000	22.200	43.400	69.000	
150.00	9.0000	21.600	42.800	67.500	
200.00	9.0000	21.100	42.200	65.700	
250.00	9.0000	20.800	41.600	64.000	
300.00	9.0000	20.800	41.600	64.000	
350.00	9.0000	22.100	44.600	69.500	
400.00	9.0000	23.700	47.600	73.700	
450.00	9.0000	24.800	49.500	77.000	
500.00	9.0000	25.500	51.100	78.800	
550.00	9.0000	26.000	52.500	81.000	
600.00	9.0000	26.300	53.600	82.500	

	PLAP	121.00	127.00
T25C			
50.000	90.300	109.35	
100.00	88.500	109.35	
150.00	86.600	109.35	
200.00	85.000	109.35	
250.00	83.300	109.35	
300.00	83.300	109.35	
350.00	88.500	123.38	
400.00	94.500	134.50	
450.00	98.000	138.86	
500.00	101.50	141.76	
550.00	105.00	146.12	
600.00	108.00	150.47	

PLAP - RATE LIMITED PLA , DEG ,88 , LOC =

T25C - COMPENSATED T25 , DEG F ,810 , LOC =

WFAP - TOTAL A/B WF/PB , RU ,88 , LOC =



TABLE 5.4-2 (CONT.)

A3 SCHEDULE  
DELTA AJ CONVERSION

DELA	AJI
-314.00	-.62200
-300.00	-.60500
-250.00	-.53900
-200.00	-.46100
-150.00	-.37100
-100.00	-.26600
-50.000	-.14300
0.	0.
50.000	.16700
100.00	.36200
150.00	.59000
186.00	.77800

DELA - EEC NOZZLE TRIM  
STEPS ,89 , LOC =

AJI - AJ TRIM  
-- ,80 , LOC =

TABLE 5.4-2 (CONT.)

A5 SCHEDULE

RATIO UNIT BIAS

PBC	WFPB	10.000	12.000	14.000	16.000
40.000		.48000	.56750	.85500	.92000
70.000		.69000	.82500	.96000	.99000
100.00		.81000	.89500	.98000	1.0033
130.00		.87000	.93500	1.0000	1.0167
180.00		.96000	.99800	1.0360	1.0360
200.00		1.0000	1.0150	1.0300	1.0300
280.00		1.0100	1.0100	1.0100	1.0100
350.00		1.0000	1.0000	1.0000	1.0000
460.00		.99000	.99000	.99000	.99000
580.00		.98000	.98000	.98000	.98000

PBC	WFPB	18.000	20.000
40.000		.98500	1.0500
70.000		1.0200	1.0500
100.00		1.0267	1.0500
130.00		1.0333	1.0500
180.00		1.0360	1.0360
200.00		1.0300	1.0300
280.00		1.0100	1.0100
350.00		1.0000	1.0000
460.00		.99000	.99000
580.00		.98000	.98000

WFPB - MAIN BURNER WF/PB , RU ,86 , LOC =

PBC - COMP. BURNER PRESSURE , PSI ,810 , LOC =

PCPB - A7B RATIO UNIT BIAS , -- ,81 , LOC =

TABLE 5.4-2 (CONT.)

H1.1 SCHEDULE  
ACCELERATION SCHEDULE

N2	WFPX
2200.0	18.700
5000.0	35.000
6750.0	35.000
7400.0	32.500
12200.	40.000
13725.	40.000
16000.	10.000

N2 - HIGH COMPRESSOR SPEED  
RPM ,B14 , LOC =

WFPX - ACCEL SCHEDULE WF/PR  
RU ,B6 , LOC =

TABLE 5.4-2 (CONT.)

H4.1 SCHEDULE  
OPERATING LINE DROOP SLOPE

PLAB	DSL
30.000	.26400E-01
35.000	.24000E-01
40.000	.21600E-01
50.000	.18600E-01
60.000	.16600E-01
70.000	.15100E-01
83.000	.13200E-01

PLAB - GAS GENERATOR PLA  
DEG ,88 , LOC =

DSL - DROOP SLOPE  
RU/RPM ,8-5 , LOC =

TABLE 5.4-2 (CONT.)

H4.2 SCHEDULE

OPERATING LINE REFERENCE N2

	PLAB	20.000	22.000	25.000	30.000
T25C					
-100.00		6107.0	6374.0	6920.0	7272.0
-50.000		6638.0	6906.0	7387.0	7730.0
0.		7132.0	7419.0	7825.0	8198.0
50.000		7604.0	7898.0	8313.0	8646.0
100.00		8062.0	8360.0	8776.0	9104.0
150.00		8488.0	8795.0	9231.0	9562.0
200.00		8916.0	9219.0	9677.0	9975.0
250.00		8981.0	9294.0	9723.0	10016.
300.00		9001.0	9314.0	9771.0	10050.
350.00		9063.0	9376.0	9803.0	10102.
400.00		9125.0	9438.0	9845.0	10124.
450.00		9172.0	9485.0	9875.0	10169.
500.00		9034.0	9347.0	9764.0	10073.
550.00		8889.0	9202.0	9659.0	9989.0

	PLAB	35.000	40.000	50.000	60.000
T25C					
-100.00		7473.0	7593.0	7952.0	8345.0
-50.000		7953.0	8069.0	8420.0	8815.0
0.		8425.0	8535.0	8898.0	9289.0
50.000		8866.0	9006.0	9362.0	9760.0
100.00		9333.0	9477.0	9826.0	10240.
150.00		9800.0	9959.0	10290.	10731.
200.00		10191.	10266.	10553.	10911.
250.00		10219.	10303.	10590.	10954.
300.00		10276.	10346.	10642.	11002.
350.00		10294.	10379.	10648.	10991.
400.00		10342.	10403.	10669.	11031.
450.00		10367.	10447.	10680.	11031.
500.00		10277.	10317.	10565.	10911.
550.00		10171.	10216.	10456.	10764.

PLAB - GAS GENERATOR PLA , DEG , B8 , LOC =

T25C - COMPENSATED T25 , DEG F , B10 , LOC =

N2R - REFERENCE N2 , RPM , B14 , LOC =

*CH*

TABLE 5.4-2 (CONT.)

H4.2 SCHEDULE -- OPERATING LINE REFERENCE N2 (CONT.)

	PLAB	70.000	83.000	90.000	118.00
T25C					
-100.00		8702.0	9203.0	9695.0	11340.
-50.000		9158.0	9687.0	10173.	11831.
0.		9634.0	10162.	10669.	12341.
50.000		10141.	10678.	11157.	12795.
100.00		10610.	11164.	11630.	13261.
150.00		11136.	11712.	12166.	13791.
200.00		11281.	11847.	12329.	13974.
250.00		11280.	11847.	12329.	13974.
300.00		11280.	11847.	12329.	13974.
350.00		11280.	11847.	12329.	13974.
400.00		11280.	11847.	12329.	13974.
450.00		11354.	11864.	12358.	14002.
500.00		11215.	11721.	12192.	13814.
550.00		11085.	11565.	12051.	13673.

PLAB - GAS GENERATOR PLA , DEG ,88 , LOC =  
 T25C - COMPENSATED T25 , DEG F ,B10 , LOC =  
 N2R - REFERENCE N2 , RPM ,B14 , LOC =

TABLE 5.4-2 (CONT.)

H7.1 SCHEDULE

RCVV SETPOINT - LOW N2 SLOPE

T25C	SLOW
-100.00	.28243E-01
-50.000	.28243E-01
0.	.28243E-01
50.000	.27989E-01
100.00	.26697E-01
150.00	.25584E-01
200.00	.24605E-01
250.00	.23726E-01
300.00	.24476E-01
350.00	.25326E-01
400.00	.25443E-01
450.00	.25401E-01
500.00	.25907E-01
550.00	.25271E-01
600.00	.25182E-01

T25C - COMPENSATED T25  
 DEG F , B10 , LOC =

SLOW - RCVV SLOPE FOR LOW N2  
 DEG/RPM , , LOC =

TABLE 5.4-2 (CONT.)

H7.2 SCHEDULE

RCVV SETPOINT - HIGH N2 SLOPE

T25C	SHI
-100.00	.13158E-01
-50.000	.13158E-01
0.	.12367E-01
50.000	.11745E-01
100.00	.11218E-01
150.00	.10736E-01
200.00	.10355E-01
250.00	.99715E-02
300.00	.98743E-02
350.00	.93071E-02
400.00	.90909E-02
450.00	.88571E-02
500.00	.86077E-02
550.00	.83066E-02
600.00	.81783E-02

T25C - COMPENSATED T25  
 DEG F .810 , LOC =

SHI - RCVV SLOPE FOR HIGH N2  
 DEG/RPM , LOC =



TABLE 5.4-2 (CONT.)

H7.3 SCHEDULE

RCVV SETPOINT - REF N2

T25C	N2MD
-100.00	8738.0
-50.000	9181.0
0.	9624.0
50.000	10071.
100.00	10554.
150.00	11015.
200.00	11458.
250.00	11884.
300.00	12102.
350.00	12102.
400.00	12102.
450.00	12102.
500.00	12102.
550.00	12102.
600.00	12102.

T25C - COMPENSATED T25  
 DEG F , B10 , LOC =

N2MD - REF N2 FOR RCVV COMMAND  
 RPM , , LOC =

TABLE 5.4-2 (CONT.)

H7.4 SCHEDULE

RCVV SETPOINT - REF RCVV

T25C	RCVM
-100.00	.50000
-50.000	.50000
0.	.50000
50.000	.50000
100.00	.50000
150.00	.50000
200.00	.50000
250.00	.50000
300.00	-1.5000
350.00	-5.0000
400.00	-8.4000
450.00	-11.500
500.00	-14.300
550.00	-16.700
600.00	-19.300

T25C - COMPENSATED T25  
 DEG F ,B10 , LOC \*

RCVM - REF RCVV FOR RCVV COMMAND  
 DEG ,B6 , LOC \*

TABLE 5.4-2 (CONT.)

H10 SCHEDULE  
START BLEED

T25C	N2BL
-100.00	6545.0
0.	7397.0
59.000	7856.0
150.00	8520.0
250.00	9191.0
350.00	9818.0
450.00	10405.
500.00	10689.

T25C - COMPENSATED T25  
DEG F ,B10 , LOC =

N2BL - REF N2 FOR START BLEED  
RPM ,B14 , LOC =

TABLE 5.4-3 PROGRAM CONSTANTS

CONSTANT	VALUE	UNITS	SCALE FACTOR	MEMORY LOCATION	BLOCK DIAGRAM
AQNE	1.0000	--			2.2.1
A40	40.000	DEG/SEC			1.2.7
A84	84.000	DEG/SEC			1.4.7
A91	91.000	DEG			2.1.1
A130	130.00	DEG			2.1.1
A155	155.00	/SEC			1.2.7
CSFA	.19356	S*SEC/ MJC			1.2.7
CSFM	-.60000E-01	SEC/MJC			1.4.7
CSFP	-.60000E-01	SEC/MJC			1.2.7
CVMX	0.	DEG			1.2.2
CVMN	-25.000	DEG			1.2.2
DTMC	-.60000E-01	SEC/MJC			1.2.3 1.2.4 1.2.5 1.2.7 1.3.1 1.4.7 2.2.2
M140	140.00	COUNTS			1.4.5
ONE	1.0000	--			1.4.4
PONE	1.0000	--			PPDC FILTER
PLAS(1)	91.000	DEG			2.2.2
PLAS(2)	102.00	DEG			2.2.2
PLAS(3)	108.70	DEG			2.2.2
PLAS(4)	115.00	DEG			2.2.2
PLAS(5)	121.00	DEG			2.2.2
PLP(1)	93.500	DEG			2.1.1 2.2.2
PLP(2)	102.70	DEG			2.1.1 2.2.2
PLP(3)	110.00	DEG			2.1.1 2.2.2
PLP(4)	116.30	DEG			2.1.1 2.2.2
PLP(5)	122.50	DEG			2.1.1 2.2.2
PLP(6)	130.00	DEG			2.1.1 2.2.2
REQ(1)	87.500	DEG			2.2.2
REQ(2)	69.800	DEG			2.2.2
REQ(3)	54.100	DEG			2.2.2
REQ(4)	39.200	DEG			2.2.2
REQ(5)	23.400	DEG			2.2.2
REQ(6)	8.2000	DEG			2.2.2
W1	1.0000	--			1.4.13
X7	10385.	RPM			1.2.2
X10	2.0000	--			1.4.12
X12	9.3325	--			PPDC N2
X15	93.330	--			PPDC FTIT
X21	4.6675	--			PPDC N1
X25	.17340E-01	DEG/RPM			1.2.2
X26	580.00	PSI			1.4.5

TABLE 5.4-3 PROGRAM CONSTANTS (CONT.)

CONSTANT	VALUE	UNITS	SCALE FACTOR	MEMORY LOCATION	BLOCK DIAGRAM
X29	47.000	PSI			1.4.4
X32	2.0000	DEG			1.3.2
X33	.91916	--			1.3.2
X35	-.50000	SEC			1.2.6
X40	8000.0	RPM			1.3.1
X45	82.900	DEG			1.3.4
X47	12.000	RPM/MJC			1.3.2
X48	12.000	RPM/MJC			1.3.3
X49	3.7335	--			1.3.3
X54	0.	--			PPDC T2
X56	4.0000	DEG F			PPDC T2
X64	6.5650	--			1.3.3
X70	200.00	RPM			1.4.12
X76	.63000	--			PPDC FTIT
X80	2.0000	DEG F			1.4.8
X81	.82960	--			FILTER DT2
X82	40.000	DEG F			1.4.9
X83	93.000	RPM			1.4.11
X84	119.00	DEG			1.4.11
X85	118.50	DEG			1.4.11
X88	18.000	DEG			1.4.7
X91	85.000	DEG			1.4.7
X92	98.120	DEG			1.2.3 1.2.4
X93	99.180	DEG			1.2.5
X95	.82960	--			1.2.4
X96	2.5000	DEG F			FILTER T2
X97	49.900	DEG			1.2.6
X98	.25000	SEC			1.2.6
X99	-30.000	RPM/MJC			1.2.6
X100	-30.000	RPM/MJC			1.2.6
X101	-.47367	--			FILTER MN
X102	.63664	--			FILTER N2
X103	.78735	--			FILTER FEC PB
X103A	.38430	--			FILTER N1
X105	1.0000	DEG F			PPDC FTIT
X106	25.000	RPM			PPDC N2
X107	25.000	RPM			PPDC N1
X108	.97645	--			FILTER FTIT
X109	.20000E-01	AJ/RPM			1.2.3
X113	200.00	RPM			1.3.2
X114	347.00	COUNTS			1.4.9
X115	.30000E-01	DEG/DEG F			1.2.5

TABLE 5.4-3 PROGRAM CONSTANTS (CONT.)

CONSTANT	VALUE	UNITS	SCALE FACTOR	MEMORY LOCATION	BLOCK DIAGRAM
X117	127.00	DEG			1.4.9
X118	-2.4000	DEG/MJC			1.2.5
X119	4.4400	AJ/MJC			1.2.3
X120	307.00	COUNTS			1.4.9
X121	122.00	DEG			1.4.9
X123	.30000	--			FILTER FTIT
X125	124.55	PSI			1.4.2
X126	132.94	PSI			1.4.2
X127	25.000	DEG F			1.4.2
X128	30.000	DEG F			1.4.2
X129	1.0000	SEC			1.2.4
X130	60.000	DEG			1.4.13
X131	.50000	--			1.4.13
X132	50.000	DEG F			1.4.11
X133	250.00	RPM			1.4.11
X134	-3.7600	AJ			1.4.11
X135	1.8800	DEG			1.4.11
X136	-.22560	AJ/MJC			1.2.3
X137	123.70	DEG			1.4.11
X138	0.	AJ			1.4.11
X139	1.1300	DEG			1.4.11
X141	.12856	DEG/MJC			1.2.5
X142	7.0000	DEG			1.4.7
X143	6.0000	DEG			1.4.7
X144	6.0000	DEG			1.4.7
X145	47.000	PSI			1.4.4
X146	4100.0	RPM			1.4.6
X147	3650.0	RPM			1.4.6
X148	4300.0	RPM			1.4.6
X149	9900.0	RPM			1.4.4
X150	130.00	COUNTS			1.4.6
X151	.50000E-02	DEG/RPM			1.4.4
X152	.46660	--			PPDC T2
X153	.74289	--			FILTER N1I
X154	2.5000	RPM			PPDC N1I
X155	6.5330	--			PPDC N1I
X156	124.80	DEG			1.4.11
X162	3.8571	DEG			1.4.7
X163	.25000	PSI			PPDC EEC P8
X164	4.8530	--			PPDC EEC P8
X165	8900.0	RPM			1.4.4
X166	.14000E-02	--			1.4.4
X167	276.00	COUNTS			1.4.7

TABLE 5.4-3 PROGRAM CONSTANTS (CONT.)

CONSTANT	VALUE	UNITS	SCALE FACTOR	MEMORY LOCATION	BLOCK DIAGRAM
X168	.28090	DEG/COUNT			1.4.7
X169	41.500	DEG			1.4.7
X175	69.900	DEG			1.3.3
X176	49.340	PSI			1.3.3
X177	52.330	PSI			1.3.3
X178	-2.0000	DEG			1.4.6
X179	1331.0	RPM			1.4.6
X180	-74100.	RPM/COUNT			1.4.6
X181	-84.300	COUNTS			1.4.6
X201	119.95	DEG			2.1.1
X202	1.0000	DEG/COUNT			2.1.1
X203	0.	DEG			2.1.1
X204	0.	--			2.1.1
X205	1.0000	1/DEG			2.1.1
X206	83.000	DEG			2.1.1
X207	20.000	DEG			2.1.1
X208	37.000	DEG			2.1.1
X209	.21740E-01	--			2.1.1
X210	1.0000	--			2.1.1
X211	28.500	DEG			2.1.1
X212	-35.000	DEG			2.1.1
X213	40.000	RU			2.1.3
X214	2200.0	RPM			2.1.3
X215	10.000	RU			2.1.3
X216	10.000	DEG			2.1.3
X218	250.00	DEG			2.1.3
X219	-.25000E-01	RU/DEG			2.1.3
X220	27.450	RU			2.1.3
X221	-.10000E-01	RU/RPM			2.1.3
X222	28.700	RU			2.1.3
X223	26.600	RU			2.1.3
X224	18.700	RU			2.1.3
X225	25.500	RU			2.1.3
X226	42.000	RU			2.1.3
X227	16000.	PPH			2.1.3
X228	400.00	PPH			2.1.3
X229	7304.0	RPM			2.1.4
X230	600.00	RPM			2.1.4
X231	-.50000E-01	DEG/RPM			2.1.4
X232	-20.000	DEG			2.1.4
X233	-7.0000	DEG			2.1.4
X234	1000.0	RPM			2.1.5
X235	51.000	DEG			2.2.1

TABLE 5.4-3 PROGRAM CONSTANTS (CONT.)

CONSTANT	VALUE	UNITS	SCALE FACTOR	MEMORY LOCATION	BLOCK DIAGRAM
X236	24.000	DEG			2.2.1
X237	-.98890E-01	SQ FT/DEG			2.2.1
X238	5.6700	SQ FT			2.2.1
X239	64.500	DEG			2.2.1
X240	.57140E-01	1/DEG			2.2.1
X241	1.0000	--			2.2.1
X242	-10.000	DEG			2.2.1
X243	83.000	DEG			2.2.1
X244	.10000	--			2.2.1
X245	.12000E-01	--			2.2.1
X246	.30000E-02	--			2.2.1
X247	6.3500	SQ FT			2.2.1
X248	2.6640	SQ FT			2.2.1
X250	89.000	DEG			2.2.2
X251	6.8000	DEG			2.2.2
X252	0.	DEG			2.2.2
X254	.70000	DEG			2.2.2
X255	10.000	DEG			2.2.2
X256	.10000	SEC			2.2.2
X258	89.100	DEG			2.2.2
X259	1.0000	--			2.2.3
X260	24.000	MNC			2.1.1
X261	12.000	MNC			2.1.1
X262	.35500	DEG/MNC			2.1.1
X263	.21500	DEG/MNC			2.1.1
X264	108.00	MNC			2.1.1
X265	.30000	--			2.1.2
X266	15.000	--			2.1.2
X267	1.2000	--			2.1.2
X268	0.	--			FILTER CON PB
X269	1000.0	RPM			2.1.4
X270	-40.000	DEG			2.1.4
X271	4.0000	DEG			2.1.4
X272	200.00	PPH			2.2.3
XK1	82.900	DEG			1.3.3
XK5	350.00	PSI			1.4.3
XM18	18.000	DEG			1.4.7
XM85	85.000	DEG			1.4.7
XN8	8000.0	RPM			1.4.7



TABLE 5.4-4  
 COMPUTE INTERVAL DEPENDENT CONSTANTS

FILTER CONSTANTS  $X = \text{EXP}(-\text{DTMC}/\text{TAU})$

X33 =  $\text{EXP}(-\text{DTMC}/0.71181492)$   
 X108 =  $\text{EXP}(-\text{DTMC}/2.51765155)$   
 X81 =  $\text{EXP}(-\text{DTMC}/0.32117916)$   
 X95 =  $\text{EXP}(-\text{DTMC}/0.32117916)$   
 X101 =  $\text{EXP}(-\text{DTMC}/0.08029599)$   
 X102 =  $\text{EXP}(-\text{DTMC}/0.13287414)$   
 X103 =  $\text{EXP}(-\text{DTMC}/0.25095950)$   
 X103A =  $\text{EXP}(-\text{DTMC}/0.06273987)$   
 X153 =  $\text{EXP}(-\text{DTMC}/0.20187508)$   
 X268 =  $\text{EXP}(-\text{DTMC}/.00001)$

PRODER CONSTANTS  $X = \text{CONST} / \text{DTMC}$

X12 =  $0.55995/\text{DTMC}$   
 X21 =  $0.28005/\text{DTMC}$   
 X15 =  $5.5998 / \text{DTMC}$   
 X152 =  $0.027996/\text{DTMC}$   
 X155 =  $0.39198/\text{DTMC}$   
 X164 =  $0.29118/\text{DTMC}$

OTHER CONSTANTS

CSFA =  $3.226 * \text{DTMC}$   
 CSFP =  $\text{DTMC}$   
 X48 =  $200 * \text{DTMC}$   
 X99 =  $-500. * \text{DTMC}$   
 X100 =  $-500. * \text{DTMC}$   
 X118 =  $-40. * \text{DTMC}$   
 X119 =  $74. * \text{DTMC}$   
 X136 =  $-3.76 * \text{DTMC}$   
 X141 =  $2.142667 * \text{DTMC}$   
 X245 =  $0.2 * \text{DTMC}$   
 X246 =  $0.05 * \text{DTMC}$   
 X47 =  $200. * \text{DTMC}$   
 X162 =  $64.285 * \text{DTMC}$   
 X49 =  $0.22401 / \text{DTMC}$   
 X64 =  $0.3939 / \text{DTMC}$   
 X264 =  $(.6 - \text{DTMC})/0.005$   
 X260 =  $\text{DTMC}/0.0025$   
 X261 =  $\text{DTMC}/0.005$   
 CSFM =  $\text{DTMC}$   
 X265 =  $\text{DTMC}/.2$   
 X267 =  $\text{DTMC}/.05$

TABLE 5.4-5 PROGRAM VARIABLES

VARIABLE	DESCRIPTION	UNIT	SCALE FACTOR	MEMORY LOCATION	BLOCK DEFINED	DIAGRAM USED
ABPM	AFTERBURNER PERMISSION	DISCRETE	--		2.2.2	2.2.2
AJBA	BASE NOZZLE AREA	SQ FT	B4		2.2.1	2.2.1
AJC	NOZZLE AREA COMMAND	SQ FT	B3		2.2.1	COM
AJCC	EEC BIAS OF AJ	--	B1		2.2.1	2.2.1
AJI	AJ TRIM	--	B0		2.2.1	2.2.1
AJIH	NOZZLE UP TRIM INHIBIT	DISCRETE	--		1.2.3	1.2.3
AJN	EEC BIASED BASE AJ	SQ FT	B4		2.2.1	2.2.1
AJMS	NOZZLE CLOSED SWITCH	DISCRETE	--		2.2.1	1.2.7
AJMX	NOZZLE FULL OPEN SWITCH	DISCRETE	--		2.2.1	1.2.3
AJNT	CUM AJTR PREV COMMANDED	AJ	B6		1.2.3	1.2.3
AJNI	EXHAUST NOZZLE TRIM RATE	AJ/SEC	B9		1.2.3	1.2.3
AJRF	ROCKET FIRE AJ RESET	SEC	B-3		2.2.1	2.2.1
AJRS	N2 SOLENOID AJ RESET	SEC	B-3		2.2.1	2.2.1
AJTR	PB COMPONENT OF AJ TRIM	AJ	B6		1.2.3	1.2.3
ALIT	A/B IGNITION TIMER	MJC	B0		2.1.1	2.1.1
ARUT	A/B RATIO UNIT GRND TRIM	--	B1		EXT	2.2.3
BLED	START BLEED COMMAND	DISCRETE	--		2.1.5	COM
CIVC	CIVV COMMAND	DEG	B5		1.2.2	COM
CYCL	N2 SOLENOID SIG COUNTER	--	B15		1.3.3	1.3.3
DAJI	NOZZLE TRIM RATE	AJ/SEC	B9		1.2.3	1.2.7
DAJR	CURRENT AJTR INPUT	AJ/MJC	B6		1.2.3	1.2.3
DAJT	NON-INHIBITED AJ TRIM	AJ/SEC	B9		1.2.3	1.2.3
DAJU	NOZZLE UPMATCH	AJ	B6		1.4.11	1.2.3
DAJ2	CURRENT AJ UPMATCH INPUT	AJ/MJC	B6		1.2.3	1.2.3
DATT	CUM DAJU PREV COMMANDED	AJ	B6		1.2.3	1.2.3
DELA	EEC NOZZLE TRIM	STEPS	B9		1.2.7	2.2.1
DELP	EEC PLA TRIM	DEG	B8		1.2.7	2.1.1
DELT	CURRENT - PAST T25	DEG F	B10		2.1.2	2.1.2
DGB	DERIVATIVE GAIN BIAS	--	B5		1.4.3	PPDC , FILTER
DLPL	RATE LIMITED DELTA PLAP	DEG			2.1.1	2.1.1
DLT	CALC VAR2 - T25 COMP	DEG F	B10		2.1.2	2.1.2
DLT0	CALC VAR3 - T25 COMP	DEG F	B10		2.1.2	2.1.2

TABLE 5.4-5 PROGRAM VARIABLES (CONT.)

VARIABLE	DESCRIPTION	UNIT	SCALE	MEMORY	BLOCK DIAGRAM	
					FACTOR	LOCATION DEFINED USED
DMOP	MN COMMANDED MIN PLAP	DEG	B8		1.4.7	1.4.7
DMOT	CURRENT IDLE INPUT-MINPLP	DEG/MJC	B4		1.4.7	1.4.7
DN1	DELTA N1 FOR N1 DESIGN	PPM			1.3.5	1.3.5
DN2	N2 ERROR FOR AIRFLOW ADJ	RPM	B12		1.3.5	1.3.5
DNZE	AIRFLOW ERROR FOR N2 BIAS	PPS	B8		1.4.12	1.4.12
DNZU	N2 UPMATCH	RPM	B14		1.4.11	1.4.12
DPLA	PLAP ERROR (PLA - PLAP)	DEG	B8		2.1.1	2.2.1, 2.2.2
DPLI	CALC VAR-DELP WASHOUT CAM	DEG	B8		2.1.1	2.1.1
DPLM	DPLA LIMIT	DEG	B8		2.1.1	2.1.1
DPLT	CURRENT FTVI INPUT	DEG/MJC	B3		1.2.5	1.2.5
DPLU	PLA UPMATCH	DEG	B3		1.4.11	1.2.5
DREQ	FILL REDUCTION IN SSV	DEG	B7		2.2.2	2.2.2
DSL	DROOP SLOPE	RU/RPM	B-5		2.1.3	2.1.3
DT	DELTA TIME FOR PLAP RATE	MJC	B15		2.1.1	2.1.1
DT2S	T2 RATE	DEG F	B9		1.4.8	1.2.6
DWAC	N2 ERROR INPUT TO UPMATCH	RPM	B14		1.4.11	1.4.11
ERRR	FTIT ERROR FOR N2 BIAS	DEG F	B12		1.4.12	1.4.12
FILL	A/B MANIFOLD FILL SIG	DISCRETE	--		EXT	2.2.2
FLIT	FILL INTERRUPT SIGNAL	DISCRETE	--		EXEC	2.1.1
FTDS	DESIGN FTIT	DEG F	B12		1.4.10	1.4.10, 1.4.12
FTIT	FAN TURBINE INLET TEMP	DEG F	B12		EXT	1.4.10
FTLG	FILTERED FTIT	DEG F	B12		1.4.10	1.4.10
FTLL	COMPENSATED FTIT	DEG F	B13		1.4.10	1.4.10, 1.4.12
FTRM	FTIT TRIM	DEG F	B8		EXT	1.4.10
FTTE	FTIT ERROR	DEG	B11		1.4.10	1.4.10, 1.4.11, 1.4.13
FTTM	FTIT INPUT TO PLA LOOP	DEG/SEC	B8		1.4.10	1.2.5
FTVI	FTIT COMPONENT OF DEL PLA	DEG	B3		1.2.5	1.2.5
FTVM	FTIT INPUT TO DEL PLA LP	DEG F	B7		1.4.9	1.2.5, 1.4.10
GP1	REFERENCE CORRECTED N2	RPM	B14		1.3.5	1.3.5
GP2	DELTA N1 / DELTA N2	--	B1		1.3.5	1.3.5
GP3	REFERENCE CORRECTED N1	RPM	B15		1.3.5	1.3.5

TABLE 5.4-5 PROGRAM VARIABLES (CONT.)

VARIABLE	DESCRIPTION	UNIT	SCALE	MEMORY	BLOCK	DIAGRAM
			FACTOR	LOCATION	DEFINED	USED
G10	FTIT LIMIT	DEG F	B12		1.4.8	1.4.10
G20	MINIMUM N2	RPM	B14		1.4.8	1.4.12
G30	MAXIMUM N2	RPM	B14		1.4.8	1.4.12
G40	DELTA AIRFLOW	PPS	B6		1.3.5	1.3.5
G70	MAXIMUM N1	RPM	B14		1.4.8	1.3.5
G80	1./[SQUARE ROOT OF THETA]	--	B1		1.4.8	1.2.1 , 1.3.5 , 1.4.3 , 1.4.6 , 1.4.12
G90	SCHEDULED CORRECTED FLOW	PPS	B8		1.4.8	1.3.5 , 1.4.12
G100	N2 SETPOINT BIAS -AIRFLOW	FPM	B14		1.4.12	1.4.12
G140	MINIMUM CORRECTED AIRFLOW	PPS	B8		1.3.5	1.3.5
G210	MINIMUM PLAP RATE - MN	DEG/SEC	B8		1.4.7	1.4.7
G220	MAXIMUM CORRECTED AIRFLOW	PPS	B8		1.3.5	1.3.5 , 1.4.12
G440	FTIT BIAS FOR PB	DEG F	B12		1.4.4	1.4.12
G450	REFERENCE FTIT	DEG F	B12		1.4.8	1.4.12
G460	N2 SETPOINT BIAS - FTIT	RPM	B14		1.4.12	1.4.12
G470	AIRFLOW CUTBACK SLOPE	--	B1		1.4.8	1.3.5
G490	MINIMUM PLAP RATE - PB	DEG/SEC	B7		1.4.4	1.4.4
G510	N2 BIAS FOR PB	RPM	B14		1.4.4	1.4.4
G520	NOZZLE TRIM BIAS	--	B1		1.2.3	1.2.3
G530	AJ BIAS FOR PB	AJ	B5		1.4.4	1.2.3
G540	MINIMUM PLAP RATE - IDLE	DEG/SEC	B8		1.4.6	1.4.7
G550	TWO SLOPE CORRECTED PB	PSI	B10		1.4.3	1.4.3
HOLD	INITIAL FILL TIMER	SEC	B-3		2.2.2	2.2.2
HYST	PLAP HYSTER.- SSVC	DEG	B8		2.2.2	2.2.2
IAP	A/C IDLE AREA RESET/VMAX	DISCRETE	--		EXT	1.4.6 , 1.4.9 , 2.1.1
ICYC	MINOR CYCLE COUNTER -FLIT	MNC	B15		EXEC	2.1.1
ICTM	IDLE GROUND TRIM	COUNTS	B8		EXT	2.1.1
IGN	A/B IGNITION COMMAND	DISCRETE	--		2.1.1	COM , 2.2.2
IGNM	MAIN BURNER IGNITION CMD	DISCRETE	--		2.1.3	COM
INTM	INTERMEDIATE GROUND TRIM	DEG	B1		EXT	2.1.1

TABLE 5.4-5 PROGRAM VARIABLES (CONT.)

VARIABLE	DESCRIPTION	UNIT	SCALE FACTOR	MEMORY LOCATION	BLOCK DEFINED	DIAGRAM USED
INIC	IDLE N1 SETPOINT	RPM	815		1.4.6	1.4.6
M4	AIRPLANE MACH NUMBER	—	811		EXT	1.3.5
M4LS	FILTERED A/C MACH NUMBER	COUNTS	811		1.3.5	1.3.5, 1.4.6, 1.4.7, 1.4.9
M4PS	MINIMUM BURNER PRESSURE	PSI	811		1.4.4	1.4.4
M4PR	N2 COMMANDED MIN FLAP	DEG	88		1.4.7	1.4.7
M4PS	PRESCHEDULED MIN FLAP	DEG	88		1.4.7	1.4.7
M4SL	MIN FLAP RATE-W/O IDLE	DEG/SEC	88		1.4.7	1.4.7
M4IH	MIN FLAP INHIBIT	DISCRETE	—		1.4.7	1.4.7
M4PE	MINIMUM FLAP ERROR	DEG	88		1.4.7	1.4.7
M4PS	IDLE INPUT TO MIN FLAP	DEG	88		1.4.6	1.4.7
M4SI	IDLE RESET FLAG	DISCRETE	—		1.4.7	1.4.7
M4TT	MIN FLAP RATE	DEG/SEC	88		1.4.7	1.4.7
M4LL	COMPENSATED N1 FOR IDLE	RPM			1.4.6	1.4.6
M4SEG	A/B SEGMENT COUNTER	—			2.2.2	2.1.1, 2.2.2, 2.2.3
M4TRM	N2 GROUND TRIM	RPM	812		EXT	1.4.12
N1	LOW ROTOR SPEED	RPM	814		EXT	1.2.1
N1CC	CORRECTED N1 DESIGN	RPM			1.3.5	1.3.5
N1CE	IDLE N2 ERROR	RPM	814		1.4.6	1.4.6
N1CR	CORRECTED LOW ROTOR SPEED	RPM	814		1.2.1	1.2.2
N1CS	GROUND IDLE BIAS	RPM	815		1.4.6	1.4.6
N1DS	DESIGN N1	RPM	814		1.3.5	1.2.3
N1F	N1 ERROR FOR A3 LOOP	RPM	814		1.2.3	1.2.3
N1ER	N1 ERROR FOR PLA LOOP	RPM	814		1.2.3	1.2.3
N1IL	FILTERED N1 FOR IDLE LOOP	RPM	814		1.2.1	1.4.6
N1LG	FILTERED LOW ROTOR SPEED	RPM	814		1.2.1	1.2.1, 1.2.3
N1LL	COMPENSATED N1	RPM	815		1.2.3	1.2.3
N1SS	N1 DESIGN W/O N2 LIMITING	RPM	814		1.3.5	1.3.5
N1ST	N1 RESET	RPM	88		1.3.2	1.2.3, 1.3.2, 1.3.5
N1TM	N1 INPUT TO THE PLA LOOP	DEG/SEC	88		1.2.3	1.2.5

TOP

TABLE 5.4-5 PROGRAM VARIABLES (CONT.)

VARIABLE	DESCRIPTIVE	UNIT	SCALE FACTOR	MEMORY LOCATION	BLOCK DIAGRAM DEFINED	DIAGRAM USED
N2	HIGH COMPRESSOR SPEED	RPM	814		EXT	1.2.1, 2.1.3, 2.1.4, 2.1.5
N2BL	REF N2 FOR START BLEED	RPM	814		2.1.5	2.1.5
N2CR	CORRECTED N2	RPM	814		1.2.1	1.3.1, 1.3.5, 1.4.4, 1.4.7
N2DS	DESIGN N2	RPM	814		1.4.12	1.2.5
N2ER	N2 ERROR FOR PLA LOOP	RPM	814		1.2.5	1.2.5
N2IP	N2 INPUT TO N1 DESIGN	PPS	88		1.3.5	1.3.5
N2LG	FILTERED HIGH ROTOR SPEED	RPM	814		1.2.1	1.2.1, 1.2.5, 1.3.5, 1.4.11
N2LL	COMPENSATED N2	RPM	815		1.2.5	1.2.5
N2M	N2 INPUT - LOW SPEED WPA	FO			2.1.3	2.1.3
N2MC	MINOR CYCLE HPC SPEED	RPM			EXT	2.1.4
N2MS	REF N2 FOR FCVV COMMAND	RPM			2.1.4	2.1.4
N2OD	PAST VALUE OF N2LG	RPM	814		1.2.1	1.2.1
N2PR	REFERENCE N2	RPM	814		1.4.4	1.4.4, 1.4.7
N2R	REFERENCE N2	RPM	814		2.1.3	2.1.3
N2RT	N2 RATE -- (N2LG - N2OD)	RPM	88		1.2.1	1.2.6, 1.3.3
N2SC	N2 SETPOINT (UPMATCH)	RPM	814		1.4.12	1.3.5, 1.4.11
N2SO	N2 SOLENOID	DISCRETE	--		1.3.3	1.4.7, 2.2.1, 2.2.2
N2SS	N2 SOLENOID SIGNAL	DISCRETE	--		1.3.3	1.3.3, 1.3.4
N2TM	N2 INPUT TO THE PLA LOOP	DEG/SEC	88		1.2.5	1.2.5
N2XX	DESIGN N2 SETPOINT-UPMATCH	RPM	814		1.4.12	1.4.12
PB	BURNER PRESSURE	PSI	810		EXT	1.4.1
PBC	COMP. BURNER PRESSURE	PSI	810		1.4.1	1.4.1, 2.1.3, 2.2.3
PBE	MAX BURNER PRESSURE ERROR	PSI	810		1.4.5	1.4.5
PBER	MINIMUM PB ERROR	PSI	810		1.4.4	1.4.4
PEI	BURNER PRESS TO MIN PLA	DEG/SEC	88		1.4.4	1.4.7
PBLG	FILTERED PB	PSI	810		1.4.1	1.3.3, 1.4.2, 1.4.4, 1.4.5

TABLE 5.4-5 PROGRAM VARIABLES (CONT.)

VARIABLE	DESCRIPTION	UNIT	SCALE FACTOR	MEMORY LOCATION	BLOCK OFFINED	DIAGRAM USED
PBLL	COMPENSATED PB	POI	B11		1.4.4	1.4.4
PRIM	MAX PB INPUT TO PLA LOOP	DEG/SEC	B2		1.4.5	1.2.5
PCPS	A/B RATIO UNIT BIAS	--	B1		2.2.3	2.2.3
PLA	POWER LEVER ANGLE	DEG	B2		EXT	2.1.1, 2.1.3
PLAB	GAS GENERATOR PLA	DEG	B2		2.1.1	2.1.3
PLAC	CONTROL PLA	DEG	B2		2.1.1	2.1.1
PLAM	MIN PLAP	DEG	36		1.4.7	1.4.7, 2.1.1
PLAN	GAS GEN PLA W/ FEED DELP	DEG	B2		2.1.1	2.1.1
PLAP	RATE LIMITED PLA	DEG	B2		2.1.1	1.2.3, 1.2.4, 1.2.5, 1.2.6, 1.3.2, 1.3.3, 1.3.4, 1.4.7, 1.4.9, 1.4.11, 2.1.1, 2.2.1, 2.2.2, 2.2.3
PLAT	PLA TRIM RATE	DEG/SEC	B2		1.2.5	1.2.7
PLAS	FEED INPUT TO PLAB	DEG	B2		2.1.1	2.1.1
PLGS	PLAP RATE FOR TRS COMP.	DEG	B2		1.3.2	1.3.2
PLIH	PLA TRIM INHIBIT	DISCRETE	--		1.3.4	1.2.3, 1.2.5, 1.3.4, 1.4.13, FILTER, PSC
PLIG	FILTERED PLAP	DEG	B2		1.3.2	1.3.2
PLMI	PLAP INPUT-PLAM INHIBIT	DEG	B2		1.4.7	1.4.7
PLMP	PLAP INPUT-PRESCHEDULE	DEG	B2		1.4.7	1.4.7
PLPH	PLAP HOLD	DEG	B2		2.2.2	2.1.1
PLS	PLAP LIMIT INPUT TO PLAC	DEG			2.1.1	2.1.1
PLSC	PLAP LIMIT SOLENOID	DISCRETE	--		1.2.4	2.1.1
PLSD	PLAP LIMIT SOLENOID SIG	DISCRETE	--		1.4.2	1.2.4, 1.4.2, 1.4.11
PLTE	WV-INHIBITED PLA TRIM	DEG/SEC	B2		1.2.5	1.2.5
PLVS	COMPANDED PGM POSITION	DEG	B2		2.1.4	2.1.4
PLVM	REF PLVS FOR PGM COMMAND	DEG	B2		2.1.4	2.1.4

TABLE 2.4-2 PROGRAM VARIABLES (CONT.)

VARIABLE	DESCRIPTION	UNIT	SCALE FACTOR	MEMORY LOCATION	BLOCK DEFINED	DIAGRAM USED
PF5	ROCKET FIRE LIMIT OF WEP5	KU	--		2.1.3	2.1.3
PF55	ROCKET FIRE SOLENOID	DISCRETE	--		1.3.1	1.3.3, 1.3.4, 2.1.3, 2.1.4, 2.2.1
PF7M	STALL INPUT TO PCKETFIRE	DC	80		1.2.6	1.3.1
PT05	RESIDUAL TRIM CLEAR SIG	DC	80		1.2.6	1.2.7
QAY	CALC VAR1 - T25 COMP	DEG F			2.1.2	2.1.2
QHI	NOZY SLOPE FOR HIGH W2	DEG/PPH			2.1.4	2.1.4
QLO	NOZY SLOPE FOR LOW W2	DEG/PPH			2.1.4	2.1.4
QPLT	CORE/TOTAL A/B FUEL FLOW	--	80		2.2.3	2.2.3
QWAS	A/C SOLAT SWITCH	DISCRETE	--		EXT	2.2.1
QWEG	SCHEDULED SOV POSITION	DEG	87		2.2.2	2.2.2, EXEC
QWFC	COMMANDED SOV POSITION	DEG	87		2.2.2	COM
QWVP	SOV POSITION	DEG	87		EXT	2.2.2
STAL	STALL SIGNAL	DISCRETE	--		1.2.6	1.2.6, 1.4.7
TOP1	QJM (DPLU+ETV1) PREV CMD	DEG	88		1.2.5	1.2.5
TR0T	QJM WRS PREV COMMAND	DEG	84		1.4.7	1.4.7
TRIM	IDLE TRIM INPUT TO PLAR	DC			2.1.1	2.1.1
T25	TRANSIENT RESET SIGNAL	DISCRETE	--		1.3.2	1.3.2, 1.3.3
T25B	PLAR LIMIT DELAY TIMEP	SEC	81		1.2.4	1.2.4
T2	COMPRESSED FACE TEMP	DEG F	89		EXT	1.4.8
T25	INPUT TO DT25 FILTER	DEG F			1.4.8	1.4.8
T2IN	CALC VAR1 IN DT25	DEG F			1.4.8	1.4.8
T25B	FILTERED T2	DEG F	89		1.4.8	1.4.2, 1.4.8
T2LL	COMPENSATED T2	DEG F	810		1.4.8	1.4.8
T25T	CALC VAR2 IN DT25	DEG F			1.4.8	1.4.8
T25	CALC VAR3 IN DT25	DEG F			1.4.8	1.4.8
T25C	CALC VAR4 IN DT25	DEG F			1.4.8	1.4.8
T25	FAI EXIT TEMP - LUOT	DEG F	810		EXT	2.1.2
T25C	COMPENSATED T25	DEG F	810		2.1.2	2.1.2, 2.1.3, 2.1.4, 2.1.5, 2.2.1, 2.2.3

900



TABLE 5.4-5 PROGRAM VARIABLES (CONT.)

VARIABLE	DESCRIPTION	UNIT	SCALE FACTOR	MEMORY LOCATION	BLOCK DEFINED	DIAGRAM USED
T25M	T25 INPUT-LOW SPEED WFPX	RU			2.1.3	2.1.3
T25P	PAST VALUE OF T25	DEG F	B10		2.1.2	2.1.2
UPSG	UPMATCH SIGNAL	DISCRETE	--		1.4.11	1.4.11
WACB	AIRFLOW CUTBACK MULT.	--	B1		1.4.13	1.3.5
WCDS	DESIRED CORRECTED AIRFLOW	PPS	B8		1.3.5	1.3.5
WFAC	COMMANDED A/B FUEL FLOW	PPH	B17		2.2.3	2.2.3
WFAD	DUCT A/B FUEL FLOW CMD	PPH			2.2.3	COM
WFAP	TOTAL A/B WF/PB	RU	B6		2.2.3	2.2.3
WFC	GAS GEN FUEL FLOW CMD	PPH	B14		2.1.3	COM
WFCR	CORE A/B FUEL FLOW CMD	PPH			2.2.3	COM
WFPB	MAIN BURNER WF/PB	RU	B6		2.1.3	2.1.3 ,2.2.3
WFPD	OPERATING LINE WF/PB	RU	B6		2.1.3	2.1.3
WFPX	ACCEL SCHEDULE WF/PB	RU	B6		2.1.3	2.1.3

TABLE 5.4-6 BQM ENGINE CONTROL INPUTS

ARUT	A/B RATIO UNIT GRND TRIM	--
FILL	A/B MANIFOLD FILL SIG	DISCRETE
FLIT	FILL INTERRUPT SIGNAL	DISCRETE
FTIT	FAN TURBINE INLET TEMP	DEG F
FTRM	FTIT TRIM	DEG F
IAR	A/C IDLE AREA RESET/VMAX	DISCRETE
ICYC	MINOR CYCLE COUNTER -FLIT	MNC
IDTM	IDLE GROUND TRIM	COUNTS
INTM	INTERMEDIATE GROUND TRIM	DEG
IN	AIRPLANE MACH NUMBER	--
NTRM	N2 GROUND TRIM	RPM
N1	LOW ROTOR SPEED	RPM
N2	HIGH COMPRESSOR SPEED	RPM
N2MC	MINOR CYCLE HPC SPEED	RPM
PB	BURNER PRESSURE	PSI
PLA	POWER LEVER ANGLE	DEG
SQWS	A/C SQUAT SWITCH	DISCRETE
SSVP	SSV POSITION	DEG
T2	COMPRESSOR FACE TEMP	DEG F
T25	FAN EXIT TEMP - DUCT	DEG F

TABLE 5.4-7 BOM ENGINE CONTROL COMMANDS

AJC	NOZZLE AREA COMMAND	SQ FT
BLED	START BLEED COMMAND	DISCRETE
CIVC	CIVV COMMAND	DEG
IGN	A/B IGNITION COMMAND	DISCRETE
IGNM	MAIN BURNER IGNITION CMD	DISCRETE
RCVC	COMMANDED RCVV POSITION	DEG
SSVC	COMMANDED SSV POSITION	DEG
WFAJ	DUCT A/B FUEL FLOW CMD	PPH
WFC	GAS GEN FUEL FLOW CMD	PPH
WFCR	CORE A/B FUEL FLOW CMD	PPH

## 6.0 BOM INLET CONTROL DEFINITION

This section defines the computer program component to duplicate the bill of materials F-15 inlet control. The control logic is presented in section 6.1, the executive functions in section 6.2, and the data base in section 6.3. The values for all schedule and constant data are tabulated in the data base along with references to all program variables.

The inlet control is divided into relatively small logic blocks. Each is defined by a block diagram and the related constants and schedules. The block diagram number, corresponding to the defining paragraph number, is used for all references.

### 6.1 CONTROL DESCRIPTION

The following paragraphs define the BOM inlet control logic. A simulation study is to be performed to verify use of the 60 millisecond major cycle. This study will determine exactly what portions of the control must be computed more frequently. Potential high rate computations are identified in the block diagrams.

#### 6.1.1 Freestream Pressure Ratio Calibration and Filter

The measured pressure ratio,  $P_0/PS_0$ , is corrected for installation effects as a function of aircraft probe, angle of attack and Mach number, and filtered (Fig. 6.1-1). The filtered pressure ratio,  $PROL$ , is the input to the schedules. Required data are identified in Table 6.1-1.

#### 6.1.2 Mach Block and Mach Number to the Engine Control

The freestream pressure ratio,  $PROL$ , is rescaled and output to the engine control, paragraph 5.1.4.6. The pressure ratio is also used to set a discrete which locks the third ramp actuator in the

event of hydraulic power loss if the Mach number is above 1.45. The logic and related data are presented in Figure 6.1-2 and Table 6.1-2.

### 6.1.3 First Ramp Control

The first ramp is scheduled as a function of freestream pressure ratio, freestream total temperature, and aircraft angle of attack (Fig. 6.1-3). The maximum limit is computed as a function of freestream pressure ratio and freestream total temperature. The minimum limit is only a function of freestream pressure ratio.

A gain discrete, HL1, is set to change the servo gain above Mach 0.9. As is the case with the engine servos, the control output is the commanded position and the loop is closed in the IFU (see paragraph 4.5.1). A portion of the logic is identified as possibly being performed in the output processing to accommodate high rate computation. All the table lookups will be performed in the major cycle with the application of the angle of attack bias and limiting performed at the high rate. A simulation study will define the precise requirements.

Table 6.1-3 identifies the data required for this logic block. The actuator command is computed for a range of 8.852 inches. Full retracted actuator corresponds to -4.5 inches.

### 6.1.4 Third Ramp Control

The third ramp angle is scheduled as a function of freestream pressure ratio and freestream total temperature (Fig. 6.1-4). The commanded actuator position is determined from the linkage relationship as a function of the desired ramp angle, DEL3, and the actual position of the first ramp actuator. Table 6.1-4 identifies the required data. Actuator position range is 10.1825 inches with -5 inches corresponding to full retracted.

### 6.1.5 Bypass Control

The bypass door controls the throat pressure ratio. Commanded pressure ratio,  $P_{S1}/P_1$ , is scheduled as a function of freestream pressure ratio as is the loop gain (Fig. 6.1-5). This loop is closed in the software since actuator position is not commanded and a future control mode may require direct servo control. As a result it is possible that it will be necessary to close the loop more than once per major cycle. Data are identified in Table 6.1-5.

### 6.1.6 Buzz and Supercritical Test

The only error test included in the inlet control logic is for supercritical operation. Input and output failure detection are included in the host program. Supercritical operation is detected by excessive error in throat pressure ratio (Fig. 6.1-6). A flag, DFLG, is set if supercritical operation is detected for seven consecutive passes. The flag is reset after 50 consecutive passes without supercritical operation. Data are identified in Table 6.1-6. Buzz will be detected in the IFU using the circuit developed and demonstrated in the IPCS program. When the rectified output of the buzz circuit exceeds a threshold, a priority interrupt will be generated. The host program will turn on the cockpit light in response to the interrupt.

BLOCK DIAGRAM 6.1.1

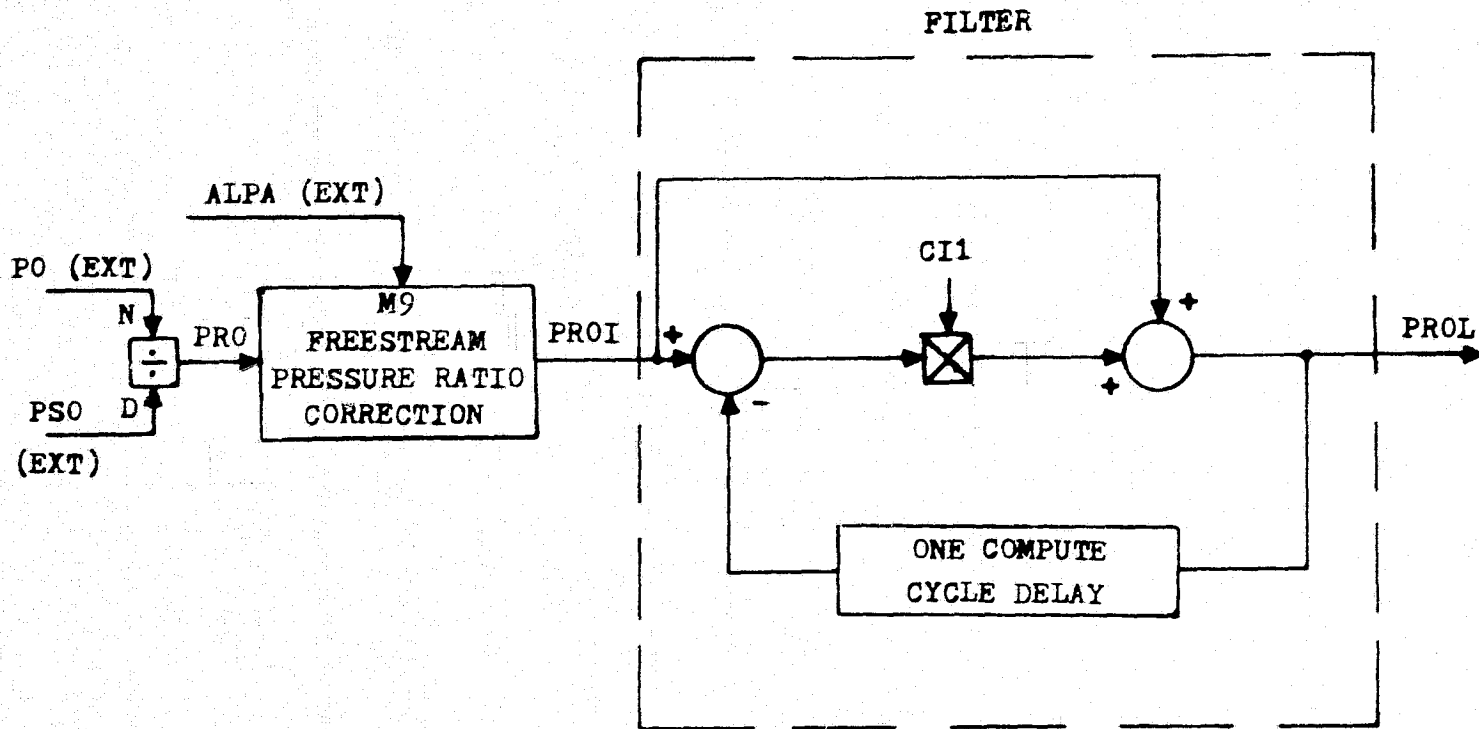


Figure 6.1-1. Freestream Pressure Ratio Calibration and Filter

TABLE 6.1-1 BLOCK 6.1.1 DATA

\*\*\*\*\* SCHEDULES \*\*\*\*\*

M9 FREESTREAM PRESSURE RATIO CORRECTION

\*\*\*\*\* CONSTANTS \*\*\*\*\*

C11 = .54881 --

\*\*\*\*\* INPUT VARIABLES \*\*\*\*\*

ALPA AIRCRAFT ANGLE OF ATTACK DEG  
PSO FREESTREAM STATIC PRESS PSI  
PTO FREESTREAM TOTAL PRESSURE PSI

\*\*\*\*\* OUTPUT VARIABLES \*\*\*\*\*

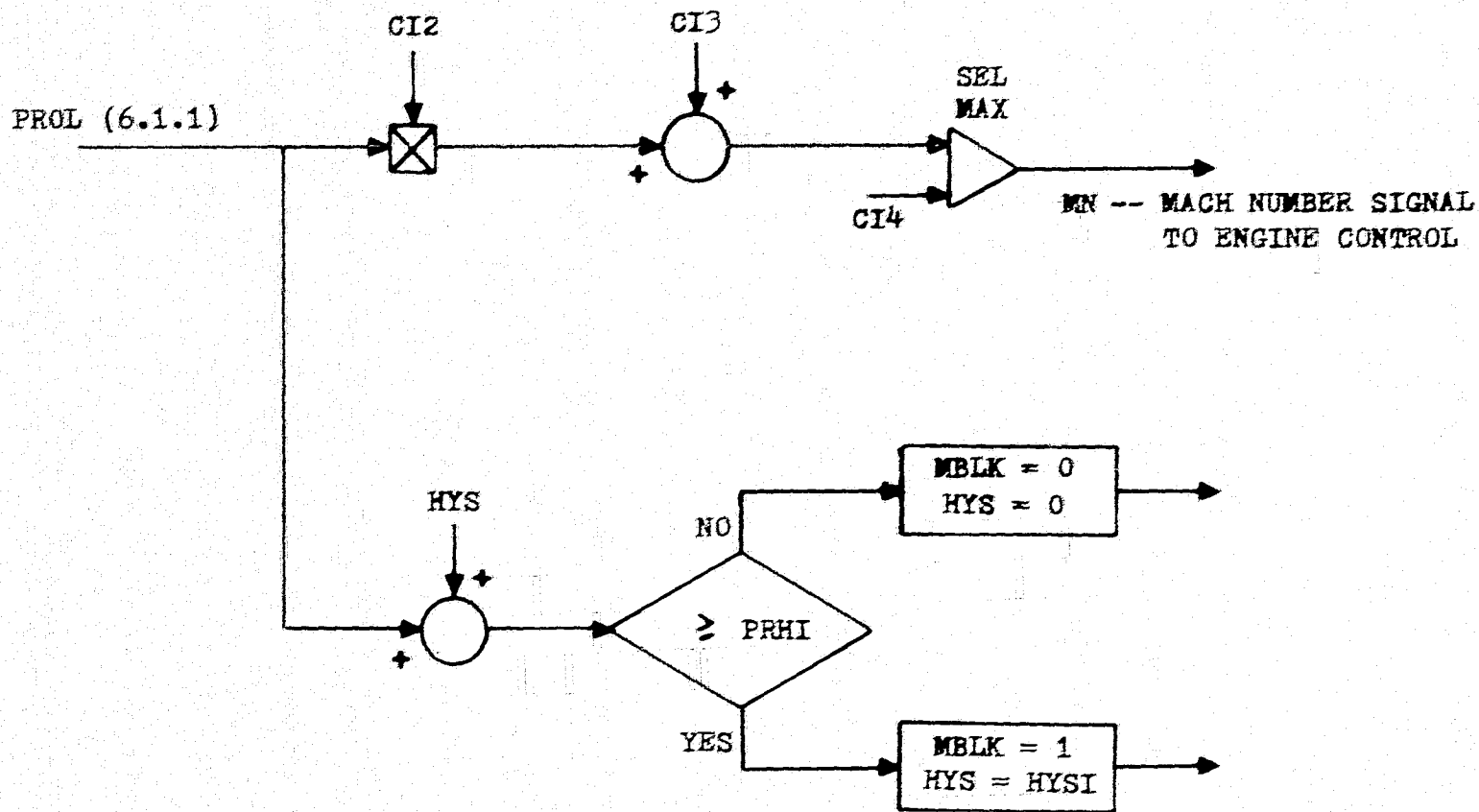
PROL FILTERED PRO --

\*\*\*\*\* INTERNAL VARIABLES \*\*\*\*\*

PRO FREESTREAM PRESSURE RATIO --  
PROI CALIBRATED PRO --



BLOCK DIAGRAM 6.1.2



304

Figure 6.1-2. Mach Block and Mach Number to Engine Control

TABLE 6.1-2 BLOCK 6.1.2 DATA

\*\*\*\*\* CONSTANTS \*\*\*\*\*

CI2	=	184.53	1/COUNT
CI3	=	-47.540	COUNT
CI4	=	140.00	COUNT
HYSI	=	.21850	--
PHRI	=	3.3382	--

\*\*\*\*\* INPUT VARIABLES \*\*\*\*\*

PROL FILTERED PRO --

\*\*\*\*\* OUTPUT VARIABLES \*\*\*\*\*

MBLK	MACH BLOCK SIGNAL	DISCRETE
MN	MACH NUMBER SIG TO ESC	COUNT

\*\*\*\*\* INTERNAL VARIABLES \*\*\*\*\*

HYS HYSYER. FOR MACH BLOCK --

BLOCK DIAGRAM 6.1.3

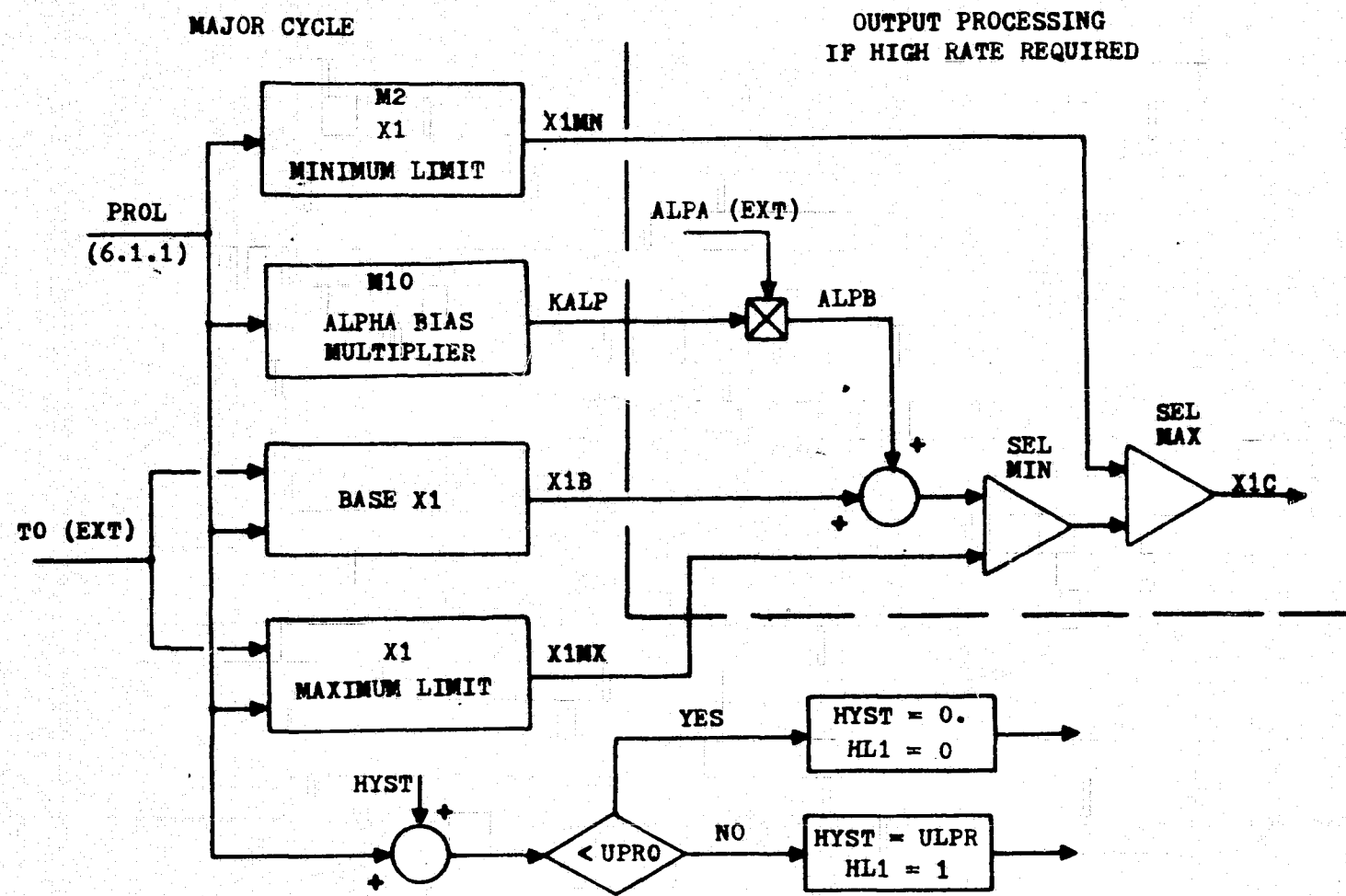


Figure 6.1-3. First Ramp Control

306 ORIGINAL PAGE IS OF POOR QUALITY.

BLOCK DIAGRAM 6.1.3 (Cont)  
 BASE X1 & X1 MAXIMUM LIMIT

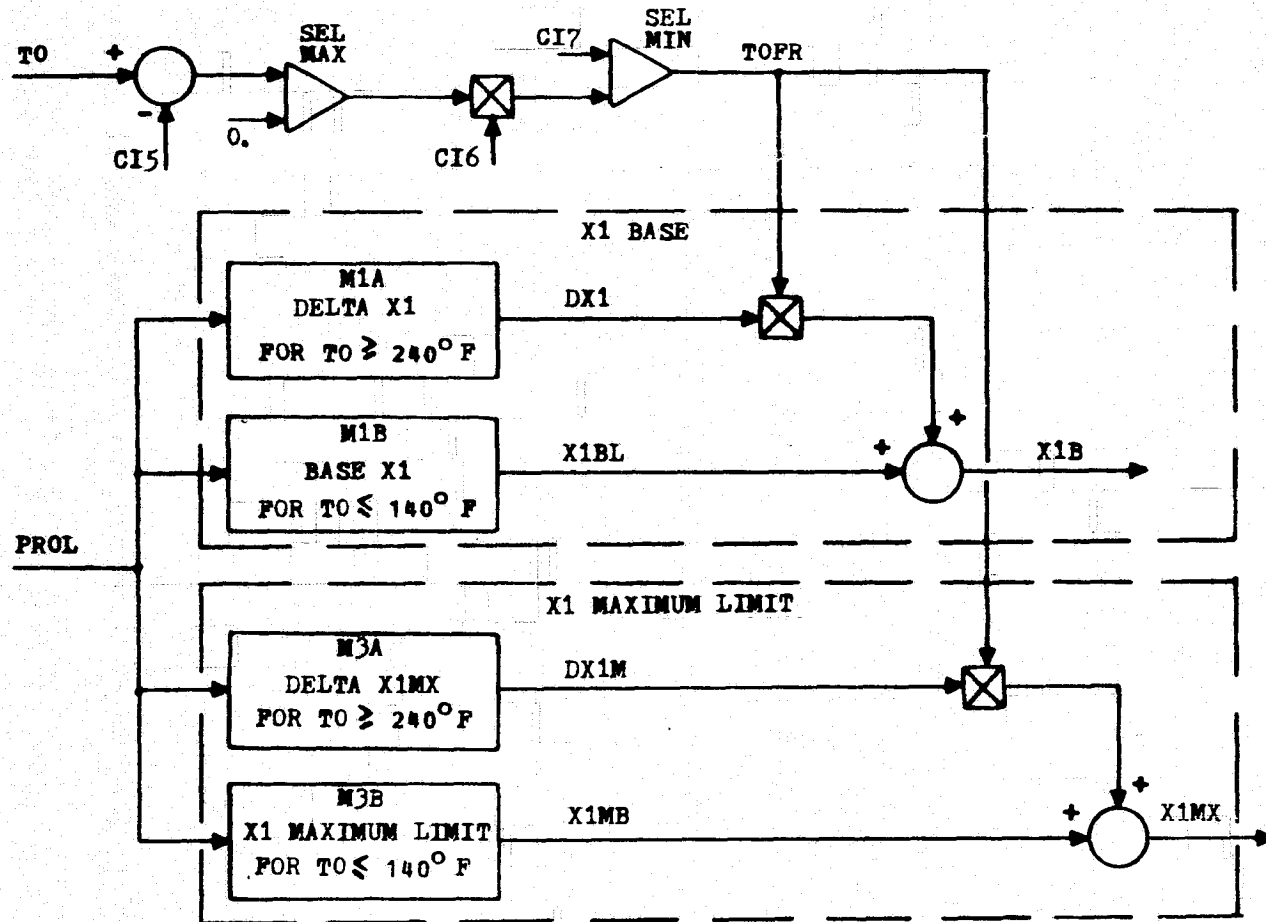


Figure 6.1-3 (cont.)

TABLE 6.1-3 BLOCK 6.1.3 DATA

\*\*\*\*\* SCHEDULES \*\*\*\*\*

M1A	DELTA X1 FOR TO GE 230 DEG F
M1B	BASE X1 FOR TO LE 130 DEG F
M2	X1 MINIMUM LIMIT
M3A	DELTA X1MX FOR TO GE 230 DEG F
M3B	X1 MAXIMUM LIMIT FOR TO LE 130 DEG F
M10	ALPHA BIAS MULTIPLIER

\*\*\*\*\* CONSTANTS \*\*\*\*\*

CI5	=	140.00	DEG F
CI6	=	.10000E-01	1/DEG F
CI7	=	1.0000	--
ULPR	=	.56600E-01	--
UPRO	=	1.7480	--

\*\*\*\*\* INPUT VARIABLES \*\*\*\*\*

ALPA	AIRCRAFT ANGLE OF ATTACK	DEG
PROL	FILTERED PRO	--
TO	FREESTREAM TOTAL TEMP	DEG F

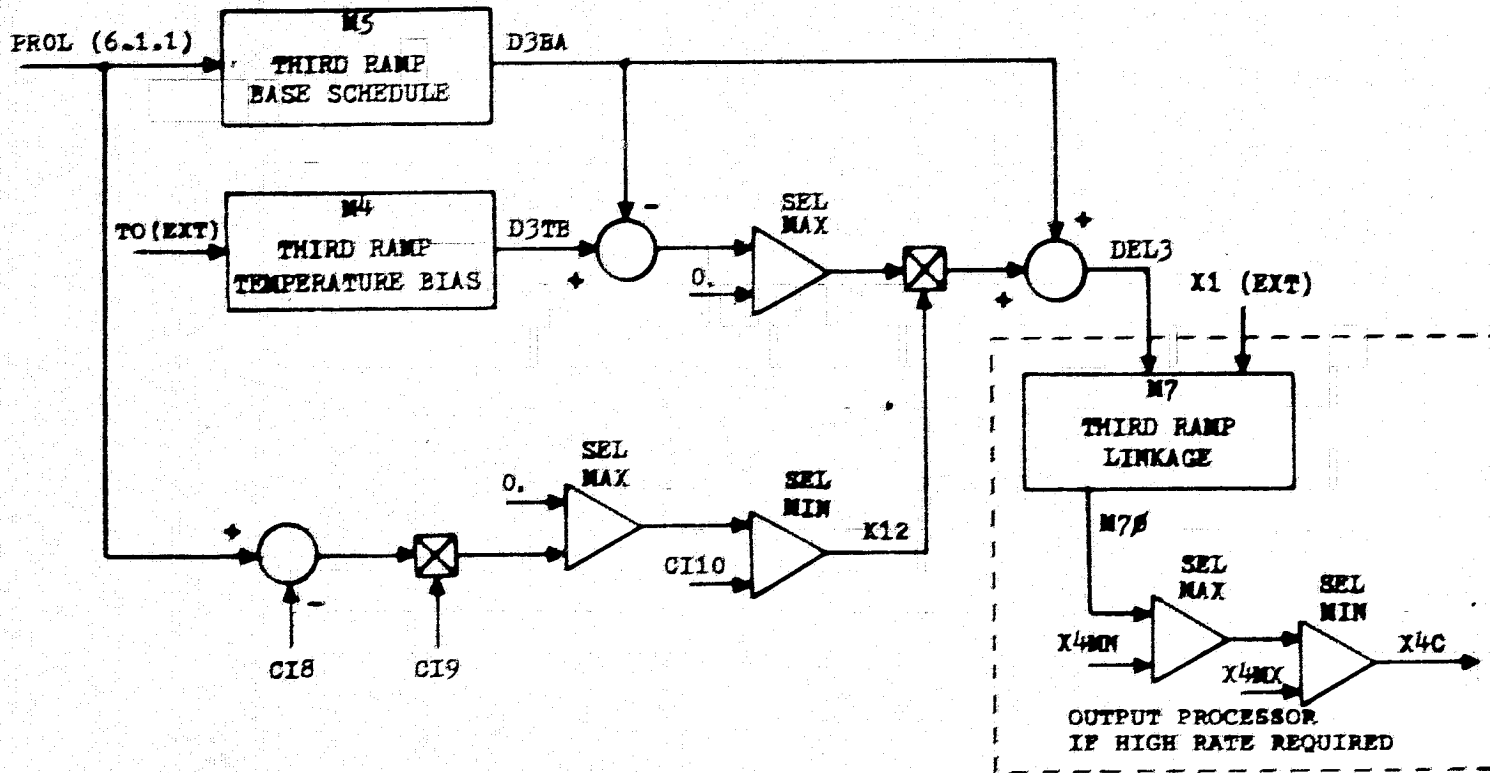
\*\*\*\*\* OUTPUT VARIABLES \*\*\*\*\*

H1I	FIRST RAMP GAIN SIGNAL	DISCRETE
X1C	FIRST RAMP POS. COMMAND	INCH

\*\*\*\*\* INTERNAL VARIABLES \*\*\*\*\*

ALPB	FIRST RAMP ALPHA BIAS	INCH
DX1	DELTA X1 FOR TO GE 230	INCH
DX1M	DELTA MAX X1 FOR TO GE230	INCH
HYST	FIRST RAMP GAIN HYSTER.	--
KALP	ALPHA BIAS MULTIPLIER	INCH/DEG
TOFR	TO FRACTION FOR X1B, X1MX	--
X1B	BASE X1 COMMAND	INCH
X1BL	BASE X1 FOR TO LE 130	INCH
X1MB	MAX X1 FOR TO LE 130	INCH
X1MN	X1 LOWER LIMIT	INCH
X1MX	X1 UPPER LIMIT	INCH

BLOCK DIAGRAM 6.1.4



309

Figure 6.1-4. Third Ramp Control

ORIGINAL PAGE IS  
OF POOR QUALITY

TABLE 6.1-4 BLOCK 6.1.4 DATA

\*\*\*\*\* SCHEDULES \*\*\*\*\*

M4 THIRD RAMP BASE SCHEDULE  
M5 THIRD RAMP TEMPERATURE BIAS  
M7 THIRD RAMP LINKAGE

\*\*\*\*\* CONSTANTS \*\*\*\*\*

C18 = 1.8929 --  
C19 = 1.9326 --  
C110 = 1.0000 --  
X4MN = -5.2000 INCH  
X4MX = 5.0000 INCH

\*\*\*\*\* INPUT VARIABLES \*\*\*\*\*

PROL FILTERED PKD --  
T0 FREESTREAM TOTAL TEMP DEG F  
X1 FIRST RAMP ACTUATOR POS INCH

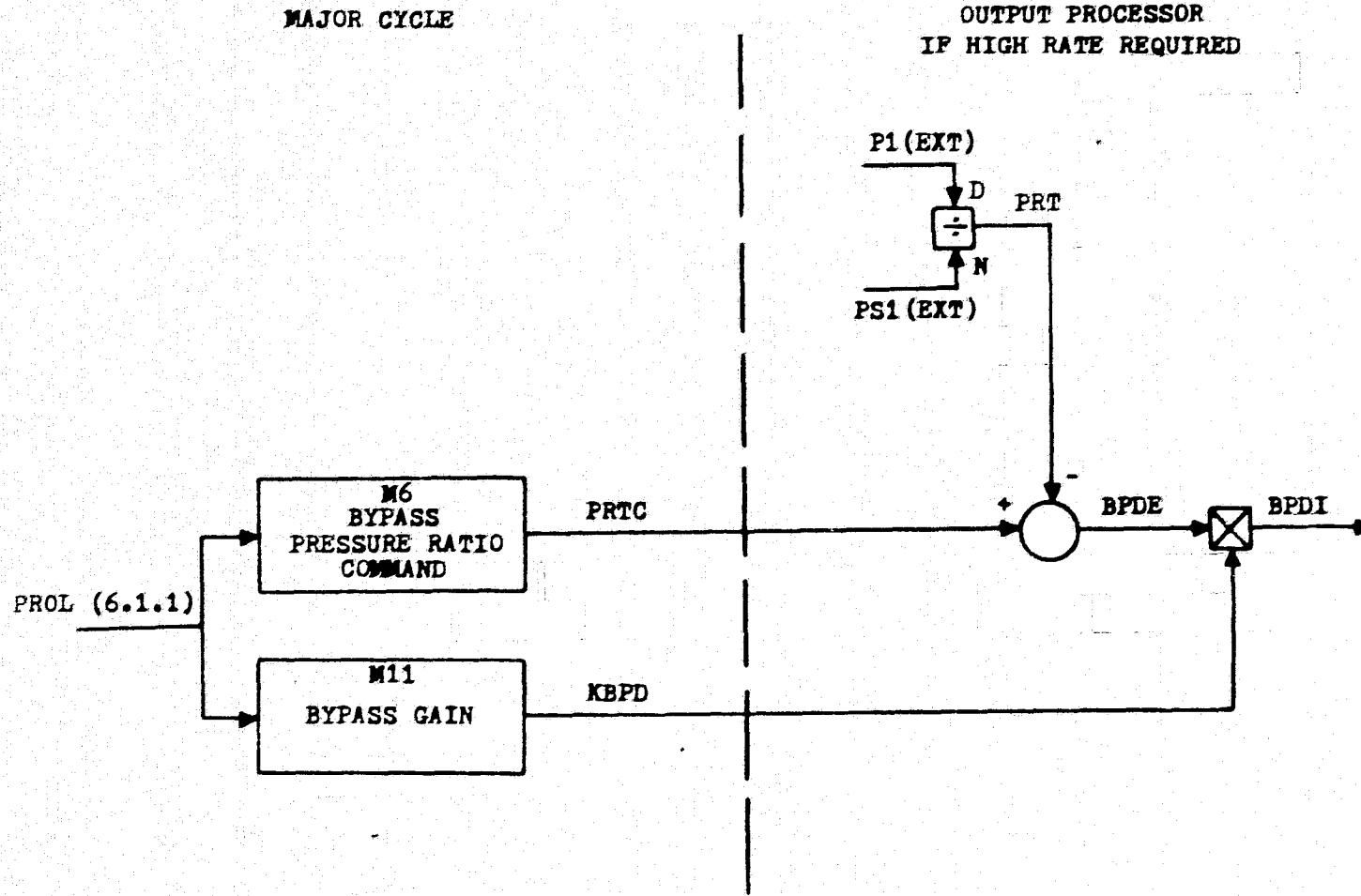
\*\*\*\*\* OUTPUT VARIABLES \*\*\*\*\*

X4C THIRD RAMP ACT COMMAND INCH

\*\*\*\*\* INTERNAL VARIABLES \*\*\*\*\*

DEL3 THIRD RAMP ANGLE COMMAND DEG  
D3B4 THIRD RAMP BASE COMMAND DEG  
D3T8 THIRD RAMP TEMP BIAS DEG  
K12 THIRD RAMP MACH MPY --  
M70 UNLIMITED THIRD RAMP CMD INCH

BLOCK DIAGRAM 6.1.5



311

Figure 6.1-5. Bypass Door Control

ORIGINAL PAGE IS  
OF POOR QUALITY



TABLE 6.1-5 BLOCK 6.1.5 DATA

\*\*\*\*\* SCHEDULES \*\*\*\*\*

M6 BYPASS PRESSURE RATIO COMMAND  
M11 BYPASS GAIN

\*\*\*\*\* INPUT VARIABLES \*\*\*\*\*

PROL FILTERED PRO --  
PS1 THROAT STATIC PRESSURE PSI  
PTL THROAT TOTAL PRESSURE PSI

\*\*\*\*\* OUTPUT VARIABLES \*\*\*\*\*

BPDI BYPASS DOOR SERVO CURRENT MA  
PRT THROAT PRESSURE RATIO --  
PRTC BYPASS PRESS RATIO CMD --

\*\*\*\*\* INTERNAL VARIABLES \*\*\*\*\*

BPDE BYPASS DOOR PRT ERROR --  
KBPD BYPASS DOOR GAIN MA

BLOCK DIAGRAM 6.1.6

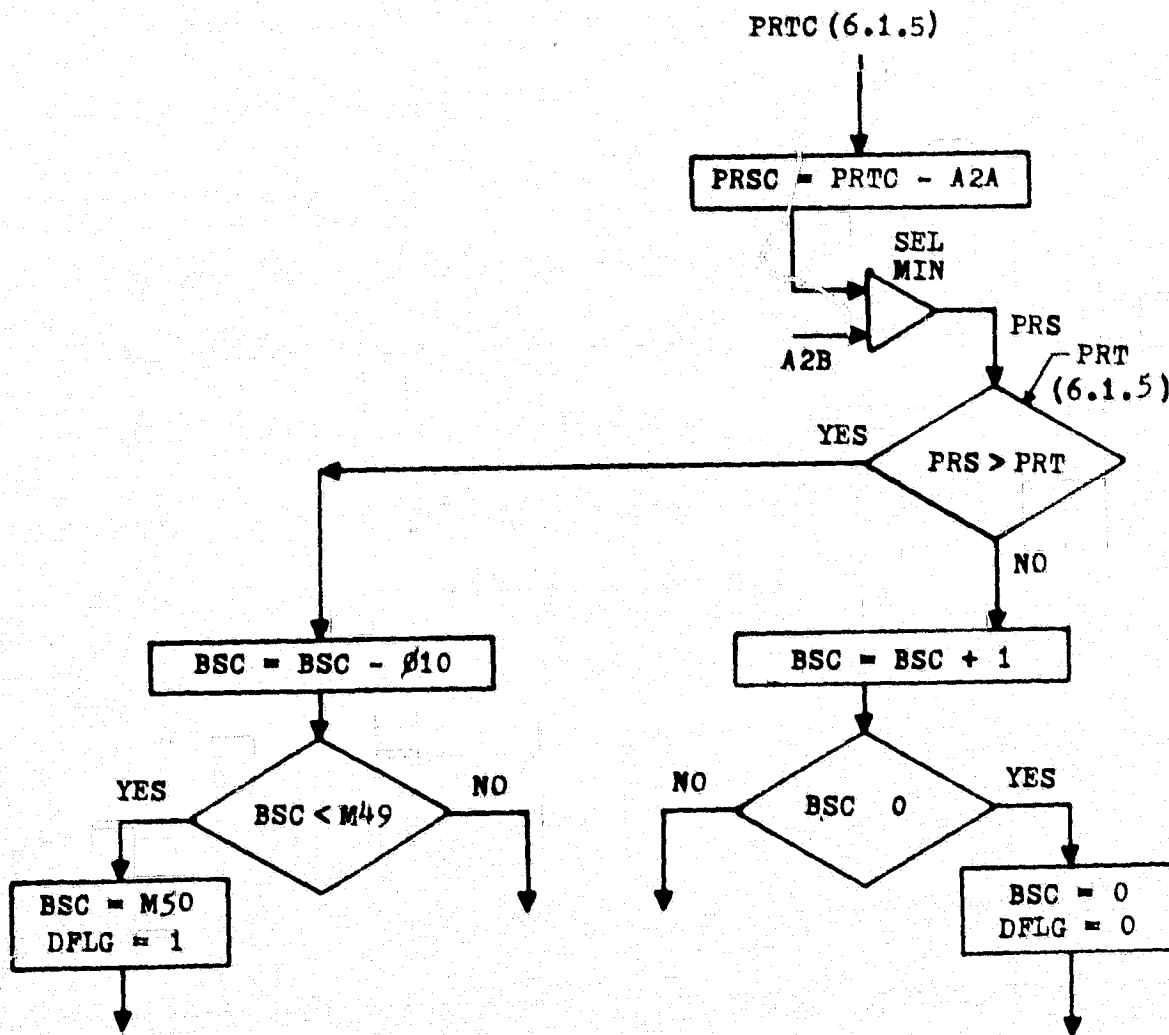


Figure 6.1-6. Supercritical Test

TABLE 6.1-6 BLOCK 6.1.6 DATA

\*\*\*\*\* CONSTANTS \*\*\*\*\*

A2A	=	.10500	--
A2B	=	.58500	--
A2C	=	.90000E-01	--
MN14	=	3.0490	--
M49	=	-49.000	--
M50	=	-50.000	--
Q10	=	8.0000	--

\*\*\*\*\* INPUT VARIABLES \*\*\*\*\*

PRT	THROAT PRESSURE RATIO	--
PRTC	BYPASS PRESS RATIO (MD)	--

\*\*\*\*\* OUTPUT VARIABLES \*\*\*\*\*

DFLG	SUPERCRITICAL FLAG	DISCRETE
------	--------------------	----------

\*\*\*\*\* INTERNAL VARIABLES \*\*\*\*\*

BSC	SUPERCRITICAL COUNTER	COUNT
PRS	SUPERCRITICAL PRESS RATIO	--
PRSC	UNLIM SUPERCRIT PR	--

## 6.2 CONTROL EXECUTIVE

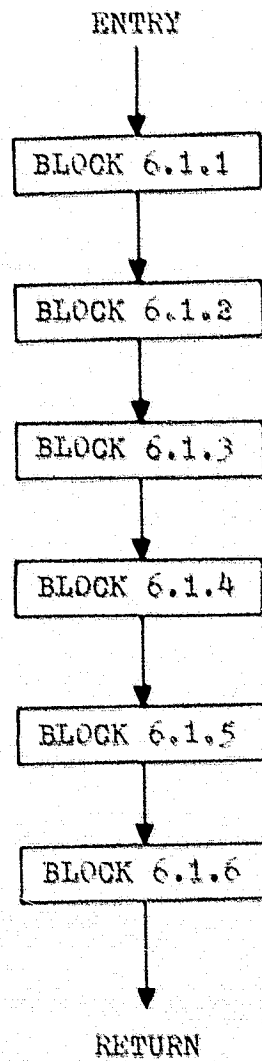
The control executive functions to determine the order of computation and those portions to be computed more frequently than once per major cycle. Paragraph 6.2.1 identifies those areas in which multirate computations may be required. The remainder of the control will be executed at the major cycle rate in the order defined in paragraph 6.2.2.

### 6.2.1 High Rate Calculations

A simulation study will be performed to precisely define the requirements for high rate computation. Three functions have been identified as possible high rate computations--angle of attack bias to first ramp command, the first ramp position input to the third ramp, and bypass door loop closure. Figures 6.1-3, 6.1-4, and 6.1-5 define the logic under consideration for high rate computation.

### 6.2.2 Major Cycle Calculations

The major cycle portion of the inlet control is called from the host program executive (paragraph 4.1.1). Figure 6.2-1 presents the order of execution of the logic blocks defined in section 6.1.



*Figure 6.2-1. Inlet Control Calculation Order*

## 6.3 DATA BASE

This section defines the values, scale factors, memory location, and using logic blocks for all schedules (6.3.1) and constants (6.3.2). Paragraph 6.3.3 defines the memory location, scale factor, the defining logic block and the using logic blocks for the variables used in the control. Paragraph 6.3.4 defines the requirements for table lookup routines.

### 6.3.1 Schedules

This paragraph defines all the schedules used in the BOM inlet control. Table 6.3-1 lists the schedules and identifies the logic block in which the table lookup is executed. Table 6.3-2 presents the data, memory location, and scale factor for all the schedules. The schedules are arranged in table 6.3-2 in the same order as in Table 6.3-1. The memory location and scale factor will be filled in when the information becomes available. It will be the location of the first item in each array. It is not the location of the current values of the input and output variables. Those are defined in paragraph 6.3.3.

### 6.3.2 Constants

Table 6.3-3 defines the constants used in the BOM inlet control. Memory location and scale factor information will be completed as they become available. The PRO filter constant, CII, is a function of the control computation interval, DTMC. The expression is:

$$CII = e^{-(DTMC/0.1)}$$

### 6.3.3 Variables

Table 6.3-4 lists the variables used in the control routines described in section 6.1. The scale factors and memory locations will be added as the information is available. Table 6.3-5 lists the control inputs and Table 3.6-6 lists the outputs.

#### 6.3.4 Table Lookup Routines

The table lookup routines used for the engine control, paragraph 5.4.4, will be used for the inlet control. Since the values of PROL are the same for 9 tables, a single interpolation of PROL should be used for all the tables as described in paragraph 5.4.4.1.

TABLE 6.3-1 CONTROL SCHEDULES

SCHEDULE	FUNCTION	BLOCK DIAGRAM
M1A	DELTA X1 FOR TO GE 230 DEG F	6.1.3
M1B	BASE X1 FOR TO LE 130 DEG F	6.1.3
M2	X1 MINIMUM LIMIT	6.1.3
M3A	DELTA X1MX FOR TO GE 230 DEG F	6.1.3
M3B	X1 MAXIMUM LIMIT FOR TO LE 130 DEG F	6.1.3
M4	THIRD RAMP BASE SCHEDULE	6.1.4
M5	THIRD RAMP TEMPERATURE BIAS	6.1.4
M6	BYPASS PRESSURE RATIO COMMAND	6.1.5
M7	THIRD RAMP LINKAGE	6.1.4
M9	FREESTREAM PRESSURE RATIO CORRECTION	6.1.1
M10	ALPHA BIAS MULTIPLIER	6.1.3
M11	BYPASS GAIN	6.1.5



TABLE 6.3-2 CONTROL SCHEDULE DATA

MIA SCHEDULE  
 DELTA XI FOR TO GE 230 DEG F

PROL	DX1
1.0000	0.
1.0283	0.
1.0783	0.
1.6913	0.
1.8929	0.
2.4075	2.8796
2.8113	3.8516
3.4703	5.2543
3.8050	5.9037
4.6692	3.5598
5.1417	2.3780
6.6015	1.2701
8.6873	0.
10.570	0.

PROL - FILTERED PRO  
 -- , LOC =

DX1 - DELTA XI FOR TO GE 230  
 INCH , LOC =

TABLE 6.3-2 (CONT.)

MIB SCHEDULE  
 BASE XI FOR TO LE 130 DEF F

PROL	XIBL
1.0000	-1.32850
1.0283	-1.32850
1.0783	-1.32850
1.6913	2.2356
1.8929	5.2205
2.4075	2.7653
2.8113	.68970
3.4703	-1.8599
3.8050	-2.9739
4.6692	-2.9143
5.1417	-2.8248
6.6015	-2.7053
8.6873	-2.8051
10.570	-2.8051

PROL - FILTERED PRO  
 -- , LOG \*

XIBL - BASE XI FOR TO LE 130  
 INCH , LOG \*

TABLE 6.3-2 (CONT.)

M2 SCHEDULE

X1 MINIMUM LIMIT

PROL	X1MN
1.0000	4.3520
1.0283	4.3520
1.0783	-4.5000
1.6913	-4.5000
1.8929	-2.3476
2.4075	-2.3476
2.8113	-2.6578
3.4703	-3.0992
3.8050	-3.3020
4.6692	-3.7812
5.1417	-4.0208
6.6015	-4.7000
8.6873	-4.7000
10.570	-4.7000

PROL - FILTERED PRO  
 -- , , LOC =

X1MN - X1 LOWER LIMIT  
 INCH , , LOC =

TABLE 6.3-2 (CONT.)

M3A SCHEDULE

DELTA XIMX FOR TO GE 230 DEG F

PROL	DXIM
1.0000	0.
1.0283	0.
1.0783	0.
1.6913	0.
1.8929	.58150
2.4075	.66060
2.8113	.71230
3.4703	.78610
3.8050	.81900
4.6692	.60430
5.1417	.49730
6.6015	.18720
8.6873	0.
10.570	0.

PROL - FILTERED PRO  
 -- , , LOC =

DXIM - DELTA MAX X1 FOR TO GE230  
 INCH , , LOC =

TABLE 6.3-2 (CONT.)

M3B SCHEDULE

X1 MAXIMUM LIMIT FOR TO LE 130 DEG F

PROL	X1MB
1.0000	4.3520
1.0283	4.3520
1.0783	4.3520
1.6913	4.3520
1.8929	2.6100
2.4075	2.3175
2.8113	2.1274
3.4703	1.8565
3.8050	1.7325
4.6692	1.7325
5.1417	1.7325
6.6015	1.7325
8.6873	1.7325
10.570	1.7325

PROL - FILTERED PRO  
 -- , , LOC =

X1MB - MAX X1 FOR TO LE 130  
 INCH , , LOC =

TABLE 6.3-2 (CONT.)

M4 SCHEDULE  
THIRD RAMP BASE SCHEDULE

PROL	D3BA
1.0000	6.5690
1.0283	6.5690
1.0783	6.5690
1.6913	6.5690
1.8929	11.150
2.4075	11.150
2.8113	11.150
3.4703	11.150
3.8050	13.000
4.6692	17.400
5.1417	18.750
6.6015	22.750
8.6873	25.484
10.570	26.600

PROL - FILTERED PRO  
-- , , LOC =

D3BA - THIRD RAMP BASE COMMAND  
DEG , , LOC =

TABLE 6.3-2 (CONT.)

M5 SCHEDULE  
THIRD RAMP TEMPERATURE BIAS

TO	D3TB
-106.55	11.150
108.82	11.150
149.84	14.760
182.30	17.400
211.53	18.687
279.35	20.654
349.16	22.678
426.46	24.920
457.46	26.600

TO - FREESTREAM TOTAL TEMP  
DEG F , , LOC =

D3TB - THIRD RAMP TEMP BIAS  
DEG , , LOC =

TABLE 6.3-2 (CONT.)

M6 SCHEDULE  
 BYPASS PRESSURE RATIO COMMAND

PROL	PRTC
1.0000	1.1000
1.0283	1.1000
1.0783	1.1000
1.6913	1.1000
1.8929	.84000
2.4075	.84000
2.8113	.84000
3.4703	.84000
3.8050	.84000
4.6692	.71300
5.1417	.69250
6.6015	.63500
8.6873	.62210
10.570	.61180

PROL - FILTERED PRO  
 -- , LOC =

PRTC - BYPASS PRESS RATIO CMD  
 -- , LOC =



TABLE 6.3-2 (CONT.)

47 SCHEDULE

THIRD RAMP LINKAGE

	DEL3 6.5690	14.250	17.500	20.500
X1				
-5.1737	-5.5775	-1.3171	.24270	1.7541
-3.3020	-5.8436	-2.0920	-.44000	1.1620
-2.1090	-6.3365	-2.5215	-.82600	.82500
-.92000	-6.7196	-2.8810	-1.1560	.53300
.26300	-6.9947	-3.1675	-1.4260	.29300
1.4400	-7.1620	-3.3770	-1.6310	.11000
2.6100	-7.2155	-3.5025	-1.7620	-.70000E-02
3.7730	-7.1568	-3.5335	-1.8100	-.48000E-01
5.0237	-6.9638	-3.4806	-1.7841	-.17800E-01
	DEL3 23.000	25.000	26.600	
X1				
-5.1737	3.1046	4.2816	5.3166	
-3.3020	2.5890	3.8270	4.9120	
-2.1090	2.2950	3.5700	4.6880	
-.92000	2.0420	3.3520	4.5038	
.26300	1.8360	3.1800	4.3670	
1.4400	1.1830	3.0610	4.2880	
2.6100	1.5930	3.0070	4.2820	
3.7730	1.5780	3.0350	4.3760	
5.0237	1.6385	3.1516	4.6072	

DEL3 - THIRD RAMP ANGLE COMMAND , DEG , , LCC =

X1 - FIRST RAMP ACTUATOR POS , INCH , , LCC =

M70 - UNLIMITED THIRD RAMP CMD , INCH , , LCC =

TABLE 6.3-2 (CONT.)

M9 SCHEDULE

FREESTREAM PRESSURE RATIO CORRECTION

	ALPA -19.850	0.	6.1000	51.850
PRO				
1.0000	1.0000	1.0000	1.0000	1.0000
1.7000	1.6900	1.6900	1.6900	1.5990
1.8100	1.8920	1.8920	1.8920	1.8100
2.1000	2.1330	2.1330	2.1330	2.0080
2.4500	2.6300	2.7110	2.5150	2.1800
3.0500	3.1070	3.3400	3.4120	2.4670
3.5200	3.5540	3.8600	3.9730	2.7100
4.9000	5.0660	5.4960	5.6380	4.6000
5.4200	5.6400	6.1500	6.4000	5.2030
6.1400	6.2740	6.9920	7.2970	6.1790
7.6430	7.6560	8.8430	9.2200	8.2540
8.6750	9.1600	10.272	10.570	9.6830

ALPA - AIRCRAFT ANGLE OF ATTACK , DEG , LCC =

PRO - FREESTREAM PRESSURE RATIO, -- , LOC =

PROI - CALIBRATED PRO , -- , LOC =

TABLE 6.3-2 (CONT.)

M10 SCHEDULE  
ALPHA BIAS MULTIPLIER

PROL	KALP
1.0000	.41493
1.0263	.41493
1.0783	.36454
1.6913	.33431
1.8929	.32957
2.4075	.31564
2.8113	.42678
3.4703	.44695
3.8050	.41238
4.6692	.31942
5.1417	.33134
6.6015	.38187
8.6873	.46923
10.570	.46923

PROL - FILTERED PRO  
-- , LUC =

KALP - ALPHA BIAS MULTIPLIER  
INCH/DES , LUC =

TABLE 6.3-2 (CONT.)

M11 SCHEDULE

BYPASS GAIN

PROL	KBPD
1.0000	100.00
1.0283	100.00
1.0783	100.00
1.6913	100.00
1.8929	128.90
2.4075	270.00
2.8113	270.00
3.4703	270.00
3.8050	270.00
4.6692	270.00
5.1417	270.00
6.6015	221.60
8.6873	100.00
10.570	100.00

PROL - FILTERED PRO  
 -- , , LOC =

KBPD - BYPASS DOOR GAIN  
 MA , , LOC =

TABLE 6.3-3 PROGRAM CONSTANTS

CONSTANT	VALUE	UNITS	SCALE FACTOR	MEMORY LOCATION	BLOCK DIAGRAM
A2A	.10500	--			6.1.6
A2B	.58500	--			6.1.6
A2C	.90000E-01	--			6.1.6
CI1	.54881	--			6.1.1
CI2	184.53	1/COUNT			6.1.2
CI3	-47.540	COUNT			6.1.2
CI4	140.00	COUNT			6.1.2
CI5	140.00	DEG F			6.1.3
CI6	.10000E-01	1/DEG F			6.1.3
CI7	1.0000	--			6.1.3
CI8	1.8929	--			6.1.4
CI9	1.9326	--			6.1.4
CI10	1.0000	--			6.1.4
HYSI	.21850	--			6.1.2
MN14	3.0490	--			6.1.6
M49	-49.000	--			6.1.6
M50	-50.000	--			6.1.6
O10	8.0000	--			6.1.6
PHR I	3.3382	--			6.1.2
ULPR	.56600E-01	--			6.1.3
UPRO	1.7480	--			6.1.3
X4MN	-5.2000	INCH			6.1.4
X4MX	5.0000	INCH			6.1.4

TABLE 6.3-4 PROGRAM VARIABLES

VARIABLE	DESCRIPTION	UNIT	SCALE FACTOR	MEMORY LOCATION	BLOCK DIAGRAM DEFINED	BLOCK DIAGRAM USED
ALPA	AIRCRAFT ANGLE OF ATTACK	DEG			EXT	6.1.1 ,6.1.3
ALPB	FIRST RAMP ALPHA BIAS	INCH			6.1.3	6.1.3
BPDE	BYPASS DOOR PRT ERROR	--			6.1.5	6.1.5
BPDI	BYPASS DOOR SERVO CURRENT	MA			6.1.5	COM
BSC	SUPERCRITICAL COUNTER	COUNT			6.1.6	6.1.6
DEL3	THIRD RAMP ANGLE COMMAND	DEG			6.1.4	6.1.4
DFLG	SUPERCRITICAL FLAG	DISCRETE			6.1.6	EXT
DX1	DELTA X1 FOR TO GE 230	INCH			6.1.3	6.1.3
DX1M	DELTA MAX X1 FOR TO GE230	INCH			6.1.3	6.1.3
D3BA	THIRD RAMP BASE COMMAND	DEG			6.1.4	6.1.4
D3TB	THIRD RAMP TEMP BIAS	DEG			6.1.4	6.1.4
HL1	FIRST RAMP GAIN SIGNAL	DISCRETE			6.1.3	COM
HYS	HYSYER. FOR MACH BLOCK	--			6.1.2	6.1.2
HYST	FIRST RAMP GAIN HYSTER.	--			6.1.3	6.1.3
KALP	ALPHA BIAS MULTIPLIER	INCH/DEG			6.1.3	6.1.3
KBPD	BYPASS DOOR GAIN	MA			6.1.5	6.1.5
K12	THIRD RAMP MACH MPY	--			6.1.4	6.1.4
MBLK	MACH BLOCK SIGNAL	DISCRETE			6.1.2	COM
MN	MACH NUMBER SIG TO ESC	COUNT			6.1.2	EXT
M70	UNLIMITED THIRD RAMP CMD	INCH			6.1.4	6.1.4
PRC	FREESTREAM PRESSURE RATIO	--			6.1.1	6.1.1
PROI	CALIBPATED PRO	--			6.1.1	6.1.1
PROL	FILTERED PRO	--			6.1.1	6.1.2 ,6.1.3 , 6.1.4 ,6.1.5
PRS	SUPERCRITICAL PRESS RATIO	--			6.1.6	6.1.6
PRSC	UNLIM SUPERCRIT PF	--			6.1.6	6.1.6
PRT	THROAT PRESSURE RATIO	--			6.1.5	6.1.5 ,6.1.6
PRTC	BYPASS PRESS RATIO CMD	--			6.1.5	6.1.5 ,6.1.6
PSO	FREESTREAM STATIC PRESS	PSI			EXT	6.1.1
PSI	THROAT STATIC PRESSURE	PSI			EXT	6.1.5
PTO	FREESTREAM TOTAL PRUSSURE	PSI			EXT	6.1.1
PTI	THROAT TOTAL PRESSURE	PSI			EXT	6.1.5

TABLE 6.3-4 PROGRAM VARIABLES (CONT.)

VARIABLE	DESCRIPTION	UNIT	SCALE FACTOR	MEMORY LOCATION	BLOCK DEFINED	DIAGRAM USED
TO	FREESTREAM TOTAL TEMP	DEG F			EXT	6.1.3 ,6.1.4
TOFR	TO FRACTION FOR X1B, X1MX	—			6.1.3	6.1.3
X1	FIRST RAMP ACTUATOR POS	INCH			EXT	6.1.4
X1B	BASE X1 COMMAND	INCH			6.1.3	6.1.3
X1BL	BASE X1 FOR TO LE 130	INCH			6.1.3	6.1.3
X1C	FIRST RAMP POS. COMMAND	INCH			6.1.3	COM
X1MB	MAX X1 FOR TO LE 130	INCH			6.1.3	6.1.3
X1MN	X1 LOWER LIMIT	INCH			6.1.3	6.1.3
X1MX	X1 UPPER LIMIT	INCH			6.1.3	6.1.3

TABLE 6.3-5 BOM INLET CONTROL INPUTS

ALPA	AIRCRAFT ANGLE OF ATTACK	DEG
PSO	FREESTREAM STATIC PRESS	PSI
PSI	THROAT STATIC PRESSURE	PSI
PTO	FREESTREAM TOTAL PRUSSURE	PSI
PTI	THROAT TOTAL PRESSURE	PSI
TO	FREESTREAM TOTAL TEMP	DEG F
XI	FIRST RAMP ACTUATOR POS	INCH



TABLE 6.3-6 BOM INLET CONTROL OUTPUTS

\*\*\*\*\* COMMANDS \*\*\*\*\*

BPDI	BYPASS DOOR SERVO CURRENT	MA
HL1	FIRST RAMP GAIN SIGNAL	DISCRETE
MBLK	MACH BLOCK SIGNAL	DISCRETE
X1C	FIRST RAMP POS. COMMAND	INCH
X4C	THIRD RAMP ACT COMMAND	INCH

\*\*\*\*\* DATA + DISPLAY \*\*\*\*\*

DFLG	SUPERCritical FLAG	DISCRETE
MN	MACH NUMBER SIG TO ESC	COUNT