STS 83-0008B
Volume 2

SPACE SHUTTLE ORBITER
OPERATIONAL

LEVEL C
FUNCTIONAL SUBSYSTEM SOFTWARE REQUIREMENTS
GUIDANCE, NAVIGATION, AND CONTROL

PART C
FLIGHT CONTROL--ASCENT
VOLUME 2

June 30, 1987

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FOREWORD

The primary avionics software system (PASS) requirements for the computer programs that execute in the Shuttle general-purpose computers (GPC's) are specified in the Computer Program Development Specifications (CPDS's) and the Functional Subsystem Software Requirements (FSSR) documents. The requirements are specified at three levels:

Level A CPDS - System-level constraints and capabilities
Level B CPDS - Functional requirements
Level C FSSR - Detailed-level requirements

The Level A CPDS specifies system-level constraints and capabilities that are not oriented toward any particular program end item. The Level B CPDS specifies system-level requirements for guidance, navigation, and control (GN&C) and detailed requirements for systems management (SM) and vehicle utility (VU). The Level C FSSR's specify the detailed requirements for GN&C and display/controls. The Level C reconfigurable requirements are specified in the systems management and payload documents. The Level A, Level B, and Level C requirements documents are listed in Section 2, Applicable Documents.

DOCUMENT CHANGE RECORD

The following tabulation summarizes the change activity associated with this document since Revision A dated June 30, 1985. A vertical line (change bar) and the appropriate CR number in the outer margin indicate the latest change(s) to each page.

Issue and Date	Change Summary
OI-8B Release (Revision B) June 30, 1987	This issue updates the baseline to OI-8B and includes the following CR's: 89140E, 89495B.
PCN-1 March 25, 1988	This page change notice updates Revision A to include the following CR: 89645A.
PCN-2 March 25, 1988	This PCN is administrative and adjusts I-load documentation to agree with the automated data base. PCN-2 is an addendum to PCN-1.

CHANGE REQUEST SUMMARY

The following tabulation lists the tables (T) and figures (F) that have been changed as a result of approved change requests commencing with OI-8A. Changes incorporated prior to OI-8A are listed in the Historical Change Request Summary.

Tables/Figures	CR No.	OI	Title
4.4.2-1 (T)	89140E	8A	Centaur Requirements Deletion
4.4.4.2-1 (F)	89140E	8A	Centaur Requirements Deletion
4.4.4.2.2.1-1 (F)	89140E	8A	Centaur Requirements Deletion
4.4.4.2.2.1-2 (F)	89140E	8A	Centaur Requirements Deletion
4.4.4.2.2.1-8 (F)	89140E	8A	Centaur Requirements Deletion
N/A	89495B	8B	FSSR STS 83-0008B, Vol. 2, 8B errata

CR89645

CR89645

HISTORICAL CHANGE REQUEST SUMMARY

The following tabulation is a historical record of approved change requests incorporated since the initial baseline up to OI-8A. Change requests commencing with OI-8A are reformatted and listed in the Change Request Summary.

CR No.	Title
12071A	MNVR Executive
12088	RCS Downmoding Logic Correction
12090D	Deorbit DIP Trim Angles
12109	On-Orbit 1 I/O Update
12190D	PEG Mode TAEM Approved for Changes Ascent/RTLS Guidance
12225B	GN&C LVLV U/L Requirements
12233	Transition DAP Rate Change
12257	Lack of Error Needles, +X RCS Burn
12269	MSID Corrections
12270A	Block Update to OPS-3
12313C	Addition to TLM Requirements
12316	GN&C SW RM Rate Change
12317	A/E ATT PROC Rate, TRANS_DAP
12334	Deorbit DIP/TRANS DAP I/F Change
12336	I-Load for OFT-1 Baseline
12337	I-Load for OFT-1 Baseline
12356A	3-Axis Pulse Mode, TRANS_DAP
12369D	RCS RM
12411B	OMS FDI Simplification
12413C	TRANS_DAP Mod/Rate Gyro Noise
12443	I-Load for Entry FACI
12474C	Reduce IMU Velocity Processing Rate
12485B	TRANS_DAP Cleanup
12543A	Delete JSL Pre-ET Separation Roll/Yaw Coupling Logic
12565	TRANS_DAP Minimum Impulse
12586	Integrated Signal, Maneuver DIPS
12624A	S/W Mod Required to Support FCS SW Changes
12689B	Command Body Attitude During OMS Burn
12690	Definition of TVC P/Y Integrator Limits
12744	Vehicle Thrust Body Geometry
12781A	Vehicle OMS Trim Angle I/F
12833A	Jet Selection Change
12866B	Add Auto +X Capability to TRANS_DAP
12874	CR 12485 Cleanup
12948	Addition of Automatic Maneuver
12975	3-Axis RHC Detent
12981D	On-Orbit Flight Control

HISTORICAL CHANGE REQUEST SUMMARY (Cont)

CR No.	Title
12993	I-Loads FACI
12994	I-Load FACI
19010	I-Load, MSID's for All New Parameters in 9-4-78/9-11-78 SCB Baseline of 9-21-78
19065	I-Load Discrepancy Cleanup
19100	FSSR Update
19143	ET Separation Documentation Change
19179	TRANS_DAP/RCS SOP Rate Reduction
19658	Jet Selection Modifications to Maintain Attitude Control During ET Separation With Two Failures
19712	Corrections to I-Load Data Tape for CPDS
19757A	Correction to TRANS DAP RHC
19777A	STS-2 Requirements Incorporation Into STS-1 Code, TRANS DAP
19827A	-Z Maneuver Initialization Modification
29000	JSL Changes to Assure Front Strut Clearance During ET Separation
29191	Actuation of RCS Jet Activity Lights During OPS 2, OPS 8, and MM 301-303
29300	FSSR Update No. 6
29341	Delete OMS Delta V Indicator
29407C	MNVR EXEC DISP PFS 18/BFS 12
29438	TRANS DAP Disc Rate Reduction
29466B	Simplified TRANS DAP Pulse Mode
29471B	HFE Overrun Definition
29497C	OMS Actuator Lock-Up Inhibit I/L
29500	FSSR Update No. 7
29509D	TRANS DAP Low Bandwidth TVC
29543A	RCS Firings During OMS/Shutdown
29565	High -Z Translation Change
29566A	Single-Axis Translation Logic
29567A	Combined -Pitch/Roll Acceleration
29568A	-X Translation Aft Pitch Default
29575A	TRANS DAP I/L to Constants
29667A	Eliminate TRANS DAP I-LOADS
29719	TRANS DAP/RCS RM Signal
29722	Pitch/Roll Rate Reduction
29762A	ATT_PROC IDD Cleanup
29787A	I-Load OMS/RCS Force Flight
29800	FSSR Updated
29879	TRANS DAP Rate and Attitude D/B I/L
29947	TRANS DAP Attitude Error Sign
39000	FSSR Update No. 9
39012	DAP TVC Filter Gain I-Loads
39014	Remove Duplicate DAP MSID's
39074A	OMS TVC Yaw Limit Changes

HISTORICAL CHANGE REQUEST SUMMARY (Cont)

CR No.	Title
39155D	RCS Jet Priority Control
39250B	Flight Control for IUS P/L
39401A	Transatlantic Abort Landing
39407A	TRANS DAP AUTO MNVR RATE
39419	TRANS_DAP CONSTANT CHANGES
39431A	ADI ERROR From Q_B_I_CMD
39445	ET SEP AUTO MNVR INITIATE
39449	TRANS DAP AUTO MNVR LOGIC
39552	TVC_MIXER and TRANS DAP I/L
39849	ET_SEP Complete Flag in OPS 3
39856	Augmentation of CR 39449
39990E	STS-5 Cycle 3 ASC I-Loads
39997	Doc UPDATE-TRANS and ORBIT DAP's
59187	TRANS DAP Parameter Renaming
59205	TRANS DAP AUTO MNVR RATE I/L (Ref Only)
59350	FSSR Update
59570	Clarify TRANS_RECON Pulse
59924A	Derived BFS IL's To Accommodate IMRB (Ref Only)
69070	FSSR Update
69220	Centaur Abort Dump
69700	FSSR Update
79044	FSSR 83-0008 Document Correction
79081	Document Correction of CR 39849
79166C	RCS Document Priority Corrections
79499	FSSR Update 5
79790A	CR Implementation Baseline--November 1985
89181F	Errata STS 83-0008A Vol. 2

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*Sections 4.0, 4.1, 4.2, and 4.3 appear in STS 83-0008, Volume 1.

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CR89645

1.0 INTRODUCTION

1.1 PURPOSE

The purpose of the Flight Control (FC) Level C document is to present the requirement details and formulations of the FC Level B functional requirements for the integrated vehicle GN&C flight software.

1.2 SCOPE

This document contains the requirement details and formulations for those FC functions which are operative during the transition phase of flight. The FC functions are those specified in the GN&C Level B functional requirements document.

1.3 ORGANIZATION

This document is organized into the following sections:

1.0 Introduction

2.0 Applicable Documents

3.0 Overview

4.0 Flight Control Functional Requirements

Section 1 defines the purpose, scope, and organization of this document. Section 2 lists the applicable documents. Section 3 provides an overview of the OFP software functions and discusses the contents of Section 4. Section 4 specifies the requirement details.

2.0 APPLICABLE DOCUMENTS

2.1 LEVEL A DOCUMENTS

SS-P-0002-140	NSTS Downlist/Uplink Software Requirements
SS-P-0002-150	NSTS Launch Data Bus Software Interface Requirements
SS-P-0002-170	NSTS Systems Level Requirements, Software

2.2 LEVEL B DOCUMENTS

SS-P-0002-510	NSTS Functional Level Requirements, GN&C
SS-P-0002-550	NSTS Functional Level Requirements, Vehicle Utility
SS-P-0002-580	NSTS Functional Level Requirements, Systems Management

2.3 LEVEL C DOCUMENTS

STS 83-0001	Operational Flight Level C, Functional Subsystem Software Requirements; Guidance, Navigation, and Control, Part A, Entry Through Landing Guidance
STS 83-0002	Operational Flight Level C, Functional Subsystem Software Requirements; Guidance, Navigation, and Control, Part A, Guidance Ascent/RTLS
STS 83-0003	Operational Flight Level C, Functional Subsystem Software Requirements; Guidance, Navigation, and Control, Part A, Guidance On-Orbit/Deorbit
STS 83-0004	Operational Flight Level C, Functional Subsystem Software Requirements; Guidance, Navigation, and Control, Part B, Entry Through Landing Navigation
STS 83-0005	Operational Flight Level C, Functional Subsystem Software Requirements; Guidance, Navigation, and Control, Part B, Navigation Ascent/RTLS

STS 83-0006	Operational Flight Level C, Functional Subsystem Software Requirements; Guidance, Navigation, and Control, Part B, On-Orbit Navigation
STS 83-0007	Operational Flight Level C, Functional Subsystem Software Requirements; Guidance, Navigation, and Control, Part C, Flight Control Entry--GRTLS
STS 83-0008	Operational Flight Level C, Functional Subsystem Software Requirements; Guidance, Navigation, and Control, Part C, Flight Control, Volumes 1 and 2
STS 83-0009	Operational Flight Level C, Functional Subsystem Software Requirements; Guidance, Navigation, and Control, Part C, Flight Control Orbit DAP
STS 83-0010	Operational Flight Level C, Functional Subsystem Software Requirements; Guidance, Navigation, and Control, Part D, Redundancy Management
STS 83-0013	Operational Flight Level C, Functional Subsystem Software Requirements; Guidance, Navigation, and Control, Part E, Inertial Measurement Unit Subsystem Operating Program
STS 83-0014	Operational Flight Level C, Functional Subsystem Software Requirements; Guidance, Navigation, and Control, Part E, Volume 1, Navigation Aids Subsystem Operating Program, Volume 2, Star Tracker Subsystem Operating Program
STS 83-0015	Operational Flight Level C, Functional Subsystem Software Requirements; Guidance, Navigation, and Control, Part E, Subsystem Operating Programs, FC Sensor/Controller
STS 83-0016	Operational Flight Level C, Functional Subsystem Software Requirements; Guidance, Navigation, and Control, Part E, Subsystem Operating Programs, FC Effector
STS 87-0017	Operational Flight Level C, Functional Subsystem Software Requirements; Remote Manipulator System
STS 83-0020	Operational Flight Level C, Functional Subsystem Software Requirements; Displays and Controls
STS 83-0026	Operational Flight Level C, Functional Subsystem Software Requirements; Guidance, Navigation, and Control, Sequencing

STS 83-0006	Operational Flight Level C, Functional Subsystem Software Requirements; Guidance, Navigation, and Control, Part B, On-Orbit Navigation
STS 83-0007	Operational Flight Level C, Functional Subsystem Software Requirements; Guidance, Navigation, and Control, Part C, Flight Control Entry--GRTLS
STS 83-0008	Operational Flight Level C, Functional Subsystem Software Requirements; Guidance, Navigation, and Control, Part C, Flight Control, Volumes 1 and 2
STS 83-0009	Operational Flight Level C, Functional Subsystem Software Requirements; Guidance, Navigation, and Control, Part C, Flight Control Orbit DAP
STS 83-0010	Operational Flight Level C, Functional Subsystem Software Requirements; Guidance, Navigation, and Control, Part D, Redundancy Management
STS 83-0013	Operational Flight Level C, Functional Subsystem Software Requirements; Guidance, Navigation, and Control, Part E, Inertial Measurement Unit Subsystem Operating Program
STS 83-0014	Operational Flight Level C, Functional Subsystem Software Requirements; Guidance, Navigation, and Control, Part E, Volume 1, Navigation Aids Subsystem Operating Program, Volume 2, Star Tracker Subsystem Operating Program
STS 83-0015	Operational Flight Level C, Functional Subsystem Software Requirements; Guidance, Navigation, and Control, Part E, Subsystem Operating Programs, FC Sensor/Controller
STS 83-0016	Operational Flight Level C, Functional Subsystem Software Requirements; Guidance, Navigation, and Control, Part E, Subsystem Operating Programs, FC Effector
STS 87-0017	Operational Flight Level C, Functional Subsystem Software Requirements; Remote Manipulator System
STS 83-0020	Operational Flight Level C, Functional Subsystem Software Requirements; Displays and Controls
STS 83-0026	Operational Flight Level C, Functional Subsystem Software Requirements; Guidance, Navigation, and Control, Sequencing

JSC-19350	STS Flight Software Initialization Load • Volume I General Requirements • Volume II Mission I-Load Requirements
JSC-19478	Payload Management, Level C Flight Software Requirements
JSC-19590	Systems Management, Level C Flight Software Requirements

2.4 ICD DOCUMENTS

ICD 3-1011-02	GPC/DEU ICD
ICD 3-0068-03	PASS/BFS ICD

In the event of a conflict between the documents referenced herein and the contents of this specification, the precedence shall be determined as defined in paragraph 1.3 of CPDS SS-P-0002-170, Volume 1, System Level Requirements, Software.

3.0 OVERVIEW

3.1 OPERATIONAL FLIGHT PROGRAM

The Operational Flight Program (OFP) represents the total computer program which operates in the orbiter general-purpose flight computer subsystem. The requirements for each OFP are specified at three levels: system-level (A), functional-level (B), and detail-level (C) requirements. In addition, the Level B and C requirements are specified in separate documents for guidance, navigation, and control (GN&C); for system management (SM), and for vehicle utility. This document is the flight control (FC) part of the GN&C Level C OFP requirements for the transition flight phase.

3.2 GN&C SOFTWARE MAJOR FUNCTIONS

The orbiter general-purpose computers (GPC's) provide the following GN&C major functions:

A. Guidance

B. Navigation

C. Flight control

D. Redundancy management/moding, sequencing, and control

E. Subsystems operating programs

F. Display interface processor

Additional GN&C major functions provided by the GPC software are the flight computer operating system, GN&C system management and performance monitoring, and checkout.

This document specifies the software functional requirements for the GN&C flight control major function.

3.3 FLIGHT CONTROL SYSTEM OVERVIEW

In this FSSR release, the detailed functional requirements are presented for the following principal function:

- Transition DAP

The flight control (FC) module can be thought of as containing a hierarchy of modules, the top level of which is shown in Figure 3.3-1.

Subsection 4.4 presents the detailed functional requirements for the Transition DAP module shown in Figure 3.3-1. These requirements include constraints on execution times, delay times, cycle frequencies, and module sequencing order.

3.4 TRACEABILITY

Table 3.4-1 shows the traceability of the software segments in the FSSR Level C with respect to the Level B CPDS.

Table 3.4-1. Level C to Level B Traceability

Level C Document Section	Level B Principal Function Name	Level B Principal Function Paragraph Number
4.4 Transition DAP Functional Requirements	Transition Digital Autopilot	4.201

3.5 DOCUMENTED REQUIREMENTS PRECEDENCE

Requirements precedence in this document shall be as follows:

1. If there is a conflict between the data in the function subtables and the standard principal function tables, the principal function tables shall have precedence.

2. If there is a conflict between the data in the flow diagrams and the written requirements, the written requirements shall have precedence.

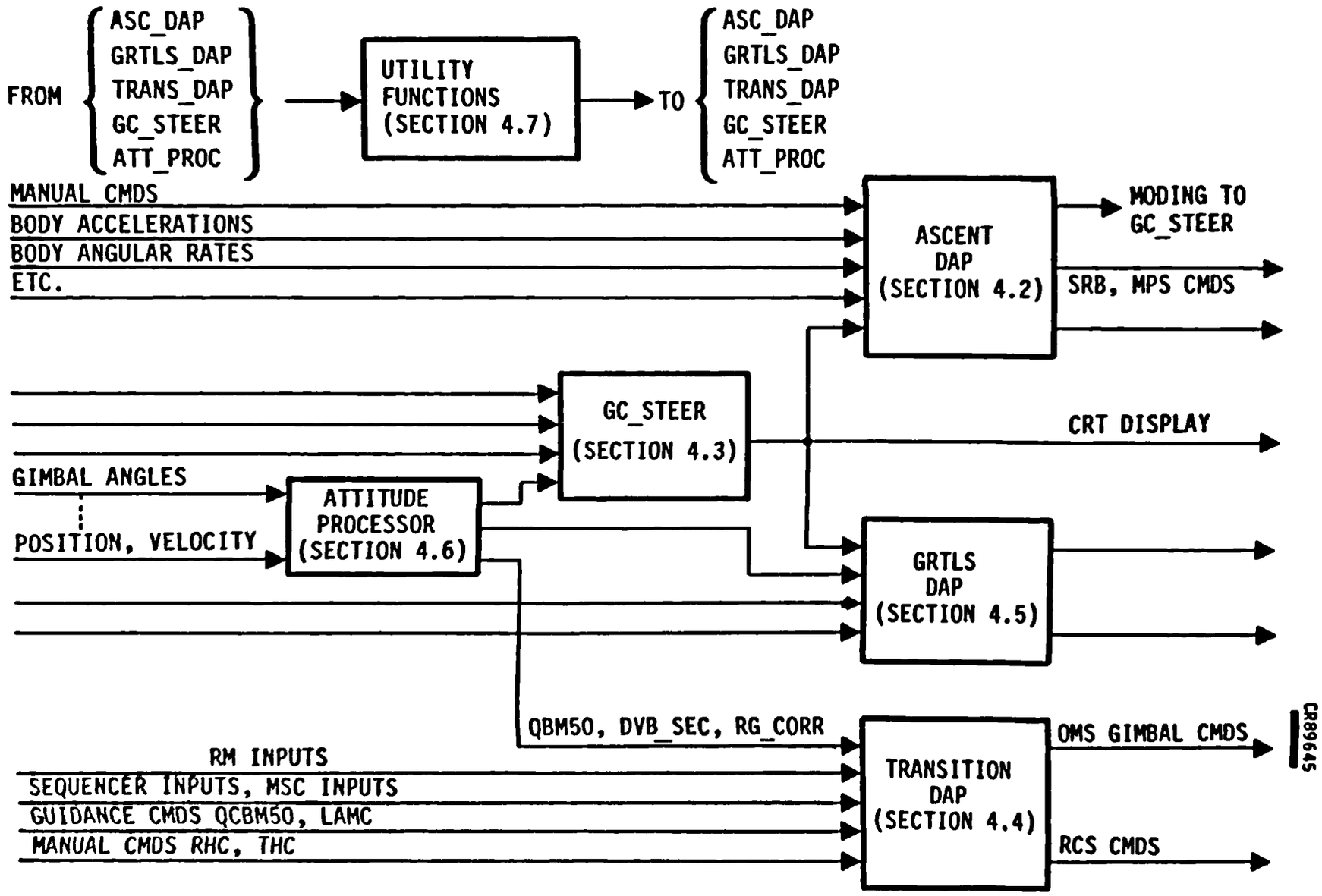

Figure 3.3-1. Ascent Phase Flight Control High-Level Organization

4.4 TRANSITION DIGITAL AUTOPILOT (DAP) (G4.201) FUNCTIONAL REQUIREMENTS

4.4.1 Introduction

The flight control (FC) module controls the vehicle in response to either automatic or manual commands during the insertion (OPS 1) and deorbit (OPS 3) flight phases. The effectors used to produce control forces and moments on the vehicle are the OMS engines and primary RCS jets. When the OMS engines are firing, the main control mode is engine thrust vector control (TVC); but the RCS jets are also available to provide additional control authority (e.g., to cover a single OMS engine failure).

4.4.2 Interface and I-Load Requirements

The interface requirements for the transition DAP are given in Tables 4.4.2-1 and 4.4.2-2. Table 4.4.2-1 lists the input variables, including some that are I-loads for the insertion phase and some that are carry-overs from the on-orbit phase (OPS 2) for use in the deorbit phase. (Some input variables have both attributes.) Table 4.4.2-2 lists the output variables. Update rates and sample rates in Tables 4.4.2-1 and 4.4.2-2 mean, respectively, the rate at which a parameter is assigned and the rate at which it is referenced. Thus, the update rates in Table 4.4.2-1 and the sample rates in Table 4.4.2-2 are rates at which functions interfacing with the DAP are expected to perform their I/O operations. In both of these tables, the MSID column gives an identifying code. For multi-element variables (such as arrays, vectors, or structures) of reasonable size, one code is given for each element. The order of listing of the codes corresponds to a certain order of elements. This ordering is given parenthetically below the codes, is included in the description column, or is understood to be X, Y, Z or roll, pitch, yaw, whichever applies.

Tables 4.4.2-3A and 4.4.2-3B list the I-load parameters that are either mission-dependent or design-dependent. These I-load constants are also listed in the constants tables associated with the individual modules. Table 4.4.2-3C lists I-load variables required for the insertion phase.

Table 4.4.2-1. Input Parameters for the Transition DAP Module

Name	Description	MSID	Source	Type	Range	Unit	Sample Rate (Hz)	Update Rate Req'd (Hz)
Crew Variables								
OMS_PITCH_TRIM	OMS engines pitch trim angle with respect to center of gimbal travel	V93H6915C	See Note 1; also XXXXX MVR YYYYY (6.35), U/L	S	-10 to 10	deg	12.5	
OMS_YAW_TRIM	Left and right OMS engines yaw trim angles with respect to center of gimbal travel	V93H6916C V93H6918C	See Note 1; also XXXXX MVR YYYYY (6.35), U/L	A(2)S	-10 to 10	deg	12.5	
Display Data								
Q_B_I_CMD	Commanded vehicle attitude with respect to reference attitude, given as the M50-to-body quaternion	V94U3980C V94U3981C V94U3982C V94U3983C	ASC MNVR DIP (4.210) or DEORB MNVR DIP (4.211); ORB INS GUID (4.3) or DEORB GUID (4.209)	Struct: S; V(3)S	0 to 1; -1 to 1	none	12.5	1/maneuver, 1.04
Effector Fault Flags								
AVAILABLE_JET_AFT	Aft jet available status (1 = available)	V90X4520X to V90X4531X, V90X4534X to V90X4545X (PRCS only)	RCS RM (4.91)	A(28)B	0, 1	none	12.5	12.5
AVAILABLE_JET_FWD	Fwd jet available status (1 = available)	V90X4548X to V90X4561X (PRCS only)	RCS RM (4.91)	A(16)B	0, 1	none	12.5	12.5
JET_FAIL_CHANGE_FLAG	Flag signifying change in HFAIL (1 = changed)	V90X4619X	RCS RM (4.91)	B	0, 1	none	12.5	12.5
JET_MAP	Mapping of jet use preference within groups	V90J5727C to V90J5764C	RCS RM (4.91) or carry-over from previous OPS	A(38)I	1-28	none	12.5	12.5

Table 4.4.2-1. Input Parameters for the Transition DAP Module (Cont)

Table 4.4.2-1. Input Parameters for the Transition DAP Module (Cont)

Name	Description	MSID	Source	Type	Range	Unit	Sample Rate (Hz)	Update Rate Req'd (Hz)
Guidance Commands								
LAMC	Commanded vehicle velocity-to-go unit vector in reference coordinates	V90U1954C V90U1955C V90U1956C	ORB INS GUID (4.3) or DEORB GUID (4.209)	V(3)S	-1 to 1	none	1.04	0.52
LAMDC	Commanded derivative of LAMC in reference coordinates	V90U1957C V90U1958C V90U1959C	ORB INS GUID (4.3) or DEORB GUID (4.209)	V(3)S		1/s	1.04	0.52
TLAMC	Time of issuance of LAMC command, expressed as mission elapsed time	V90W1953C	ORB INS GUID (4.3) or DEORB GUID (4.209)	S	0 to 1.0E07	s	1.04	0.52
HC Commands								
RHC	Rotational hand controller deflection	V96H0005CB V96H0007CB V96H0004CA	3-AX RHC SOP (4.171)	A(3)S	-50 to 50	deg	12.5	12.5
RHC_STATE	Rotational hand controller command	V96I0015CA V96I0017CA V96I0019CA	3-AX RHC SOP (4.171)	A(3)I	-1,0,1	none	12.5	12.5
SOFT_STOP	Flag indicating rotational hand controller is deflected beyond soft stop (1=beyond soft stop)	V96X1069XA V96X1070XA V96X1071XA	3-AX RHC SOP (4.171)	A(3)B	0,1	none	12.5	12.5
THC_FSN	Translational hand controller negative command	V90X7694X V90X7695X V90X7696X	GN&C SW RM (4.180)	A(3)B	0,1	none	6.25	6.25
THC_FSP	Translational hand controller positive command	V90X7697X V90X7698X V90X7699X	GN&C SW RM (4.180)	A(3)B	0,1	none	6.25	6.25
Mode/Event Flags								
ABORT_PLUSX_JET_CMD	Command to fire +X RCS jets (1=fire)	V90X8510X	ABT CNTL SEQ (4.192)	B	0,1	none	12.5	12.5

Table 4.4.2-1. Input Parameters for the Transition DAP Module (Cont)

Name	Description	MSID	Source	Type	Range	Unit	Sample Rate (Hz)	Update Rate Req'd (Hz)
CROSSFEED_OPEN	Crossfeed between aft RCS tanks is open (1=open)	V90X1540X	RCS/RCS XFEED (4.185)	B	0,1	none	12.5	12.5
SEP_MINUSZ_CMD	Flag indicating auto ET separation burn is to begin	V90X8268X	ET SEP SEQ (4.116)	B	0,1	none	12.5	12.5
GUIDED_DELTA_V_ BURN	Flag indicating RCS delta-V burn is in progress (1=burn in progress: from 1 second before ignition time to burn cutoff)	V90X8647X	MSC	B	0,1	none	12.5	
NOSE_DUMP	Command to dump RCS fuel through forward jets (1=dump)	V94X4059X	DEORB MNVR DIP (4.211)	B	0,1	none	12.5	12.5
MM_103	Major Mode 103	V90X8156X	MSC	B	0,1	none	12.5	12.5
OMSL_ON_CMD	Left OMS engine turn-on command (1=on)	V90X8271X	OMS FIRE SEQ (4.182)	B	0,1	none	12.5	12.5
OMSR_ON_CMD	Right OMS engine turn-on command (1=on)	V90X8272X	OMS FIRE SEQ (4.182)	B	0,1	none	12.5	12.5
OPS1_INDICATOR	Flag indicating OPS1 is in progress	V90X8648X	MSC	B	0,1	none	12.5	12.5
PREBURN_MNVR	Flag commanding preburn auto RCS maneuver (1=maneuver)	V93X6912X	XXXXX MVR YYYYY (6.35)	B	0,1	none	12.5	12.5
TRIM_OMS_GIMBALS	Preburn OMS trim command (1=trim)	V90X8021X	MSC	B	0,1	none	12.5	
Panel Switch-Derived Commands								
AUTO_REQUEST	Auto mode request (momentary; 1=auto)	V90X7692X	GN&C SW RM (4.180)	B	0,1	none	6.25	6.25

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Table 4-4 2-1. Input Parameters for the Transition DAP Module

Table 4.4.2-1. Input Parameters for the Transition DAP Module (Cont)

Name	Description	MSID	Source	Type	Range	Unit	Sample Rate (Hz)	Update Rate Req'd (Hz)
DISC_REQUEST	Discrete rate mode request by axis (momentary; 1=disc)	V90X7727X V90X7728X V90X7729X	GN&C SW RM (4.180)	B(3)	0,1	none	6.25	6.25
MANUAL_REQUEST	Manual mode request (momentary; 1=manual)	V90X7693X	GN&C SW RM (4.180)	B	0,1	none	6.25	6.25
PULSE_REQUEST	Pulse rate mode request by axis (momentary; 1=pulse)	V90X7730X V90X7731X V90X7732X	GN&C SW RM (4.180)	B(3)	0,1	none	6.25	6.25
TAL_ABORT_DECLARED	Flag indicating a transatlantic abort is in progress	V90X8658X	MSC	B	0,1	none	1.04	12.5
Reference Parameters								
KP2	Pitch filter gain for TVC (two engines)	V97U2354C	See Note 2	S	0 to 10	deg/(deg/s)	1/maneuver	1/phase
KR	Roll filter gain for TVC (two engines)	V97U2355C	See Note 2	S	0 to 10	deg/(deg/s)	12.5	1/phase
KY2	Yaw filter gain for TVC (two engines)	V97U2356C	See Note 2	S	0 to 10	deg/(deg/s)	1/maneuver	1/phase
PHASE_PLANE_ACCEL	Magnitude of average control acceleration available for each axis, scaled for phase plane use	V97U2370C V97U2371C V97U2372C	See Note 1	A(3)S	0 to 5	deg/(s)(s)	12.5	1/phase
Vehicle State								
ATTITUDE_INCREMENT	Body angle increment over sampling interval	V90U2333C V90U2334C V90U2335C	ASCENT/ENTRY ATT PROC (4.226)	V(3)S	-4 to 4	deg	12.5	12.5
DVB_SEC	Vehicle velocity increment over past 0.96 second	V90U2307C V90U2308C V90U2309C	ASCENT/ENTRY ATT PROC (4.226)	V(3)S	-4 to 4	ft/s	1.04	1.04

Table 4.4.2-1. Input Parameters for the Transition DAP Module (Cont)

Name	Description	MSID	Source	Type	Range	Unit	Sample Rate (Hz)	Update Rate Req'd (Hz)
Q_B_I	Vehicle attitude with respect to reference attitude, given as the M50-to-body quaternion	V90U2240C V90U2241C V90U2242C V90U2243C	ASCENT/ENTRY ATT PROC (4.226)	Struct: S; V(3)S	0 to 1; -1 to 1	none	1.04	12.5
RATE_GYRO_CORR	Measured vehicle angular rate	V90R2692C V90R2693C V90R2694C	ASCENT/ENTRY ATT PROC (4.226)	V(3)S	Roll: -40 to 40; pitch, yaw -20 to 20	deg/s	12.5	12.5
T_NOW	IMU attitude data time tag, expressed as mission elapsed time	V90W2310C	ASCENT/ENTRY ATT PROC (4.226)	S	0 to 1.0E07	s	1.04	12.5

Note 1. I-load (insertion); carry-over value from on-orbit phase (deorbit).
Note 2. I-load (insertion); subsequent to OPS 1, carry-over from previous OPS.

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Table 4.4.2-2. Output Parameters for the Transition DAP Module

Name	Description	MSID	Destination	Type	Range	Unit	Update Rate (Hz)	Sample Rate Req'd (Hz)
Display Data								
MNVR_IN_PROGRESS	Flag signifying auto maneuver in progress (1=maneuver in progress)	V90X1589X	XXXXX MVR YYYYY (6.35)	B	0,1	none	12.5	12.5
OMS_PITCH_TRIM	OMS engines pitch trim angle with respect to center of gimbal travel	V93H6915C	AS MNVR DIP (4.210) or DEORB MNVR DIP (4.211); XXXXX MVR YYYYY (6.35); ORB INS GUID (4.3) or DEORB GUID (4.209)	S	-6 to 6	deg	12.5	1.04
OMS_YAW_TRIM	Left and right OMS engines yaw trim angles with respect to center of gimbal travel	V93H6916C V93H6918C	AS MNVR DIP (4.210) or DEORB MNVR DIP (4.211); XXXXX MVR YYYYY (6.35); ORB INS GUID (4.3) or DEORB GUID (4.209)	A(2)S	-8 to 8	deg	12.5	1.04
Q_B_I_CMD_ DISPLAY	Commanded vehicle attitude with respect to reference attitude, given as the M50-to-body quaternion	V90H2721C to V90H2724C	ASCENT/ENTRY ATT PROC (4.226)	Struct: S; V(3)S	0 to 1; -1 to 1	none	12.5	1.04
Effector Commands								
NEW_JOHLST_AFT	RCS aft jet commands (1=on; 0=off)	V90X1455X to V90X1457X, V90X1459X, V90X1673X to V90X1692X (PRCS only)	AS RCS CMD SOP (4.190)	A(28)B	0,1	none	12.5	12.5

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Table 4.4.2-2. Output Parameters for the Transition DAP Module (Cont)

Name	Description	MSID	Destination	Type	Range	Unit	Sample Rate (Hz)	Update Rate Req'd (Hz)
NEW_JOHLST_FWD	RCS fwd jet commands (1 = on; 0 = off)	V90X1441X to V90X1454X (PRCS only)	AS RCS CMD SOP (4.190)	A(16)B	0,1	none	12.5	12.5
OMSL_PITCH_YAW_ CMD	Left OMS engine pitch and yaw commands with respect to center of gimbal travel	V90H2180C V90H2181C	OMS TVC CMD SOP (4.64)	A(2)S	Pitch: -6 to 6 Yaw: -8 to 8	deg	12.5	12.5
OMSR_PITCH_YAW_ CMD	Right OMS engine pitch and yaw commands with respect to center of gimbal travel	V90H2730C V90H2182C	OMS TVC CMD SOP (4.64)	A(2)S	Pitch: -6 to 6 Yaw: -8 to 8	deg	12.5	12.5
Indicator Lamp Drives								
AUTO_MODE	Auto mode indicator (1 = auto)	V72X2850X V72X6498X	HDWR	B	0,1	none	12.5	On demand
DISC_MODE	Discrete rate mode indicator by axis (1 = disc) r,p,y	V72X2790X V72X2793X V72X2796X	HDWR	B(3)	0,1	none	12.5	On demand
MANUAL_MODE	Manual mode indicator (1 = manual)	V72X2849X V72X6499X	HDWR	B	0,1	none	12.5	On demand
PULSE_MODE	Pulse rate mode indicator by axis (1 = pulse) r,p,y	V72X2792X V72X2795X V72X2798X	HDWR	B(3)	0,1	none	12.5	On demand
ROT_JET_CMD	Rotation command	V90U1697C V90U1698C V90U1699C	RCS ACT LT (4.230)	A(3)I	-1,0,1	none	12.5	12.5

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Table 4.4.2-2. Output Parameters for the Transition DAP Module (Cont)

Table 4.4.2-2. Output Parameters for the Transition DAP Module (Cont)

Name	Description	MSID	Destination	Type	Range	Unit	Sample Rate (Hz)	Update Rate Req'd (Hz)
Sequencing Data								
SEP_COMPLETE	External tank separation maneuver complete indication (1=complete)	V90X1460X	MSC	B	0,1	none	1.04	TBD

Tables 4.4.2-3A and 3B lists the I-load parameters that are either mission-dependent or design-dependent. These I-load constants are also listed in the constants tables associated with the individual modules. Table 4.4.2-3C also lists I-load variables required for the insertion phase.

Table 4.4.2-3A. Transition DAP I-Load, Mission-Dependent

Name	Description	Type	MSID	Units	Module(s) Used by
ONE_ENG_OMS_PITCH_TRIM	OMS engines pitch trim angle for thrusting through C.G.	S	V97U2367C	deg	TVC_LAW_PITCH_YAW
ONE_ENG_OMS_YAW_TRIM(1)	Left OMS engine yaw trim angle for thrusting through C.G.	S	V97U2368C	deg	TVC_LAW_PITCH_YAW
CR89645 ONE_ENG_OMS_YAW_TRIM(2)	Right OMS engine yaw trim angle for thrusting through C.G.	S	V97U2369C	deg	TVC_LAW_PITCH_YAW

Table 4.4.2-3B. Transition DAP I-Load Parameters

Name	Description	Type	MSID	Units	Module(s) Used by
DESIRED_DVZ	Desired Z-axis velocity change at ET separation completion	S	V97U2339C	ft/s	ET_SEP_PROCESSOR
TAL_DVZ_INC	Desired Z-axis velocity increment at ET SEP complete for transatlantic abort	S	V99U7404C	ft/s	ET_SEP_PROCESSOR
MR	Maximum angular rate during OMS TVC	A(3)S	V97U2357C V97U2358C V97U2359C	deg/s	GUIDANCE_COMPENSATION, MANUAL_TVC
PROPGRAD	Manual TVC stick gain	A(3)S	V97U2374C V97U2375C V97U2376C	(deg/s)/deg	MANUAL_TVC
D2	TVC filter coefficient (pitch and yaw)	S	V97U2340C	None	TVC_LAW_PITCH_YAW

Table 4.4.2-3B. Transition DAP I Load Parameters (Cont)

Name	Description	Type	MSID	Units	Module(s) Used by
D3	TVC filter coefficient (pitch and yaw)	S	V97U2341C	None	TVC_LAW_ PITCH_YAW
D4	TVC filter coefficient (pitch and yaw)	S	V97U2342C	None	TVC_LAW_ PITCH_YAW
KINT_PY	TVC integrator gain (pitch and yaw)	S	V97U2352C	None	TVC_LAW_ PITCH_YAW
PLIM	TVC pitch command limit	S	V97U2373C	deg	TVC_LAW_ PITCH_YAW
YLIM1	TVC yaw command inner limit	S	V97U2392C	deg	TVC_LAW_ PITCH_YAW
YLIM2	TVC yaw command outer limit	S	V96U9802C	deg	TVC_LAW_ PITCH_YAW
D5	TVC filter coefficient (roll)	S	V97U2343C	None	TVC_LAW_ ROLL
KINT_R	TVC integrator gain	S	V97U2353C	None	TVC_LAW_ ROLL
R_LIM	TVC roll command limit	S	V97U2389C	deg	TVC_LAW_ ROLL
K_REL*	Rate error lead function gain	A(3)S	V97U1318C V97U1319C V97U1320C	deg/s	PHASE_ PLANE_ TRANSI- TION
K_LIM	Incrementation limit	I	V97U2418C	None	PHASE_ PLANE_ TRANSI- TION
ITLIM	Left and right OMS yaw integrator limit	R	V97U1309C	deg	TVC LAW_ PITCH_YAW
IP LM	OMS pitch integrator limit	R	V97U1308C	deg	TVC LAW PITCH YAW

*Mission-dependent I-load parameter

Table 4.4.2-3B. Transition DAP I-Load Parameters (Cont)

Name	Description	Type	MSID	Units	Module(s) Used by
KSTEP	Incrementation size factor	I	V97U2417C	None	PHASE_ PLANE_ TRANSI- TION
RTH	Rate threshold	A(3)S	V97U2414C V97U2416C V97U2415C	deg/s	PHASE_ PLANE_ TRANSI- TION
TOTAL_PITCH_ LIM	Limit of total pitch command	S	V97U2390C	deg	TVC_MIXER
DB_COAST	Phase plane attitude deadbands for use during post-ET SEP coast	A(3)S	V97U2326C V97U2327C V97U2328C	deg	TRNS_ RECON
DB_PLUSX_ RCS	Phase plane attitude deadbands for use during RCS +X delta-V burn	A(3)S	V97U2332C V97U2333C V97U2334C	deg	TRNS_ RECON
DB_TVC	Phase plane attitude deadband for use during OMS burn	A(3)S	V97U2338C V97U2404C V97U2405C	deg	TRNS_ RECON
RL_COAST	Phase plane angular rate error limits for use during post-ET SEP coast	A(3)S	V97U2377C V97U2378C V97U2379C	deg/s	TRNS_ RECON
LRL_COAST	Phase plane angular rate error limits for use during post-ET SEP coast	S	V97U2423C	deg/s	TRNS_ RECON
RL_PLUSX_ RCS	Phase plane angular rate error limits for use during RCS +X delta-V burn	A(3)S	V97U2380C V97U2381C V97U2382C	deg/s	TRNS_ RECON
LRL_PLUSX_ RCS	Phase plane angular rate error limits for use during RCS +X delta-V burn	S	V97U2421C	deg/s	TRNS_ RECON

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Table 4.4.2-38. Transition DAP I Load Parame ers (t

Name	Description	Type	M#ID	e	Mod sed
RL TVC	Phase plane angular rate error limits for use during OMS burn	A(3)S	V97 2 44 V97 2387C V97 2 48	deg/s	TR RZ
LRL TVC	Phase plane angular rate error limits for use during OMS burn	S	V97U2422C	deg/s	TR RZ
GUID_COMP_ GAIN_ONE_ ENGINE	Filter gain for GUIDANCE_COMPENSATION during one-engine TVC burns	A(3)S	V97U2 44C V97U2345C V97U2346C	None	TRNS RECOM
GUID_COMP_ GAIN_TWO_ ENGINE	Filter gain for GUIDANCE_COMPENSATION during two-engine TVC burns	A(3)S	V97U2347C V97U2348C V97U2349C	None	TRNS RECOM
MIN_DVB	Minimum sensed delta-V for cross product steering	S	V97U2784C	ft s	OMS_ STEER_ TRANS
DELAY	Threshold for zeroing module output	I	V97U2663C	N ne	OMS STE_R_ TRANS
DES_ RATE	Desired discrete angular rate	S	V97 1317C	deg s	R TRA
MAG_ PULS	Mag itude of a erage angular rate change a ilable for each axis per P e ple	A(3)S	V96 9747C V96U9748C V 6 9749C	deg s	R TRAN
MAN MVR RATE	Magnitude of maneu er ra e about eigen axis	S	V96 8589C	deg s	A MNVR
MVR	Maneu er hold threshold		\ 8590	deg	A MN
R T IM	Dura ia f f drif ata at ate f ET sepa ati bu		\ 8 5	s	R h

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Table 4.4.2-3B. Transition DAP I-Load Parameters (Cont)

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Name	Description	Type	MSID	Units	Module(s) Used by
RFGM*	Rate filter gain values (mated)	A(5)S	V99U7294C to V99U7298C	None	TRNS_ RECON
RFGU*	Rate filter gain values (unmated)	A(5)S	V99U7299C to V99U7303C	None	TRNS_ RECON
L_REL*	Rate error lead function gain	A(3)S	V99U7285C V99U7286C V99U7287C	deg/s	PHASE_ PLANE_ TRANSITION
KXFPY	Pitch and yaw crossfeed gain	S	V96U9708C	deg	TVC_LAW_ PITCH_YAW
KXFR	Roll crossfeed gain	S	V96U9709C	deg	TVC_LAW_ ROLL
WHIGH	Upper target rate error for TVC crossfeed	S	V96U9710C	deg/s	PHASE_ PLANE_ TRANSITION
WLOW	Lower target rate error for TVC crossfeed	S	V96U9711C	deg/s	PHASE_ PLANE_ TRANSITION

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*Mission-dependent I-load parameter

Table 4.4.2-3C. Transition DAP I-Load Variables, Insertion Phase

Name	Description	Type	MSID	Units	Module(s) Used by
KP2	Pitch filter gain for TVC (2 engines)	S	V97U2354C	deg/ (deg/s)	TVC_LAW_ PITCH_YAW
KY2	Yaw filter gain for TVC (2 engines)	S	V97U2356C	deg/ (deg/s)	TVC_LAW_ PITCH_YAW
KR	Roll filter gain for TVC (2 engines)	S	V97U2355C	deg/ (deg/s)	TVC_LAW_ ROLL
PHASE_ PLANE_ ACCEL*	Magnitude of average control accelerations, scaled for phase-plane use	A(3)S	V97U2370C V97U2371C V97U2372C	deg/s^2	PHASE_ PLANE_ TRANSITION
OMSL_PITCH_ YAW_CMD*	Left OMS engine pitch and yaw servo commands with respect to center of gimbal travel	A(2)S	V97U2361C V97U2362C	deg	Output
OMSR_PITCH_ YAW_CMD*	Right OMS engine pitch and yaw servo commands with respect to center of gimbal travel	A(2)S	V97U2363C V97U2364C	deg	Output
OMS_PITCH_ TRIM*	OMS engine pitch trim angle with respect to center of gimbal travel	S	V93H6915C	deg	TVC_LAW_ PITCH_YAW
OMS_YAW_ TRIM*	Left and right OMS engines yaw trim angles with respect to center of gimbal travel	A(2)S	V93H6916CC V93H6918CC	deg	TVC_LAW_ PITCH_YAW
INT_PITCH*	Pitch integrator	S	V97U2406C	deg	TVC_LAW_ PITCH_YAW
INT_YAW*	Yaw integrators	A(2)S	V97U2407C V97U2408C	deg	TVC_LAW_ PITCH_YAW

*Mission-dependent I-load parameter

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4.4.3 Overview and Functional Description

A high-level diagram (Figure 4.4.3-1) shows the major sections of the Transition DAP. The transition FC system converts automatic and manual maneuver commands (from the insertion or deorbit guidance algorithms or from the crew) to OMS engine deflections and RCS jet firings by utilizing attitude rate feedback from the rate gyros, and attitude feedback and velocity increments from the IMU via the attitude processor module. As shown in the figure, the Transition DAP consists of two major subsections: the reconfiguration logic and the control laws. The control law section is composed of three subsections: the steering processor, the RCS processor, and the OMS processor.

A. Transition Reconfiguration Logic (TRNS_RECON). This logic controls the moding, sequencing, and initialization of the control law modules by processing inputs from other principal functions. It also sets gains, deadbands, and rate limits for the control law module.

B. Steering Processor. This subfunction is an interface between the steering commands from the insertion or deorbit guidance functions and the Transition DAP. It also processes manual command inputs, provides commands for the -Z-axis separation maneuver at ET_SEP, and provides attitude error information for display.

C. RCS Processor. This subfunction generates the RCS jet commands required to produce the commanded vehicle translations and rotations. Its primary inputs are attitude and rate error signals from the steering processor, although there is a manual input acceleration mode. Additional inputs are deadbands, rate limits, etc. The outputs are individual jet commands, as well as data to other principal functions.

D. OMS Processor. This subfunction generates the OMS engine actuator commands required to gimbal the engines and produce the desired vehicle/engine attitude and thrust direction. Its primary inputs are the attitude rate commands from the steering processor, along with rate gyro feedback signals and initial engine trim values. There are also discrete inputs for initialization and gain changing. The outputs are the OMS engine actuator commands, as well as the engine trim values for display.

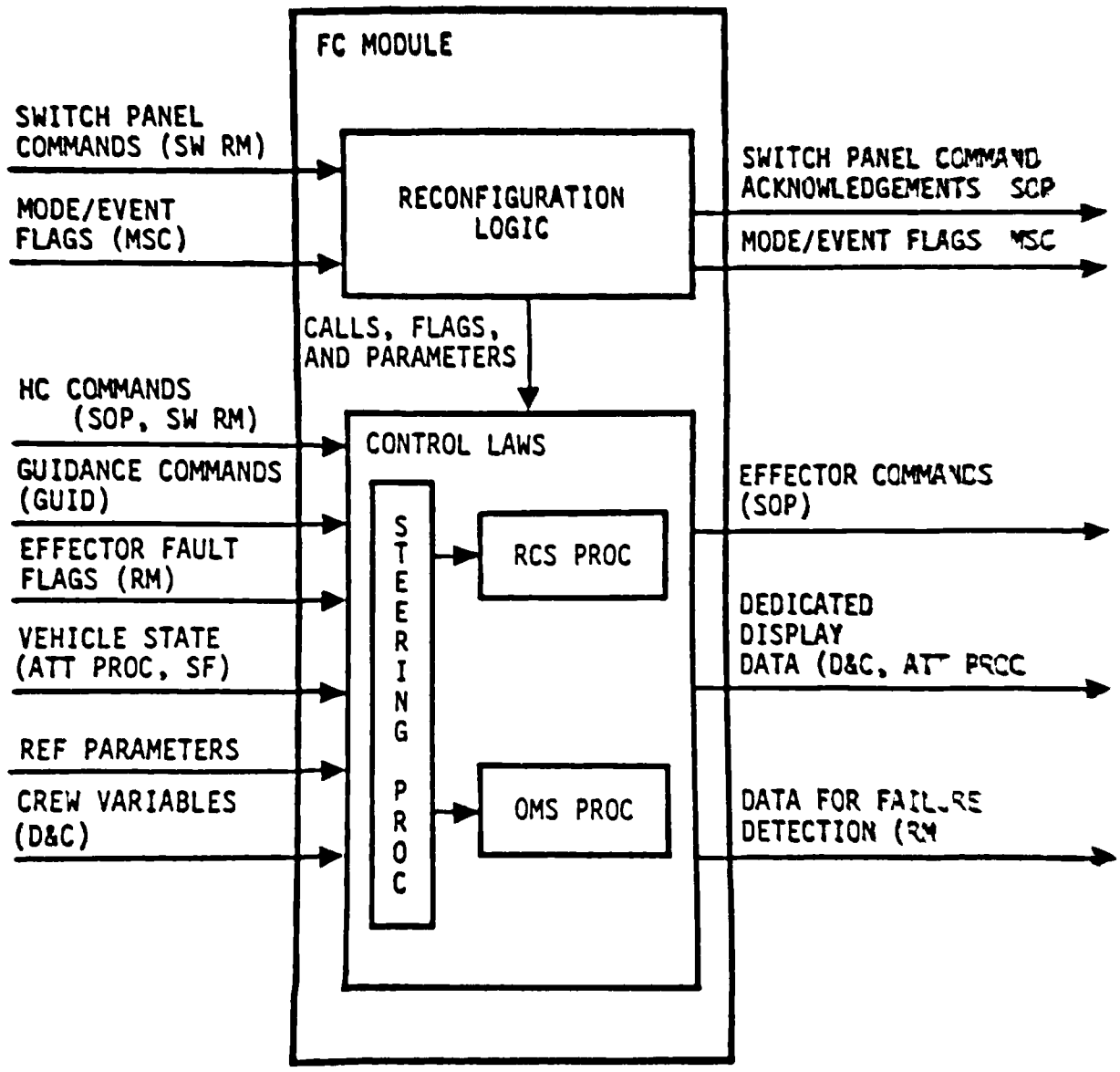

Figure 4.4.3-1. Relationship of FC Module Reconfiguration Logic and Co t

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4.4.4 Detailed Functional Requirements

4.4.4.1 Reconfiguration Module (TRNS_RECON).

4.4.4.1.1 Function. The primary function of TRNS_RECON is to call the various modules of the TRNS_DAP in their proper sequence. This sequence is determined by checking parameters that define the current operating mode. It is also the function of TRNS_RECON to specify configuration-dependent parameters, such as rates and gains; set initialization flags when required; set up the signals to light panel lamps; keep a clock to time the processing of "slow" modules; and perform certain "housekeeping" operations.

The inputs to TRNS_RECON are used to determine how the modules of the Transition DAP should be strung together to perform the desired processing. Table 4.4.4.1.1-1 describes the positions of the switches of Figure 4.4.4.2-1 in terms of these inputs. The switches in this diagram control data flow among the function modules; their positions define which modules are needed and, to an extent, their sequencing requirements. If, with a given switch configuration, module A's outputs are not received anywhere, then module A is not needed. Also, if module B drives only module A, it too is not needed. Generally, if B drives A and both are needed, B should precede A; however, exceptions can be found, such as one-cycle delays in Figure 4.4.4.2-1. These one-cycle delays occur when a downstream module must pass information back to an upstream module. The upstream module will not be able to process the new information until the following pass. Logical combinations of controlling inputs required for each switch position are given in the table.

4.4.4.1.2 Moding and Sequencing. Attitude control for the Transition DAP will be performed in one of two modes, TVC or RCS. However, the RCS processor will run during both the RCS and TVC modes. Translation control by the RCS processor will be active at all times. The control modes may be broken down into a number of submodes that are defined in terms of moding inputs. These modes are defined in Table 4.4.4.1.2-1. This table serves as an index to Figure 4.4.4.1.2-1, which gives the module-by-module sequencing requirements for each listed mode.

The diagrams of Figure 4.4.4.1.2-1 are read vertically from top to bottom. Requirements for sequential execution are indicated with solid-line arrows. For those cases in which two or more modules are at a given level, there is no execution sequencing requirement. For example, in diagram I.A.1., TVC_LAW_ROLL must be executed before TVC_MIXER in a given cycle; similarly, TVC_LAW_PITCH_YAW must be executed before TVC_MIXER. However, there is no requirement as to the execution sequence of TVC_LAW_ROLL with respect to TVC_LAW_PITCH_YAW. (Later developments may indicate that transport delays might be alleviated by executing one or the other of these first, but this document does not deal with such considerations.)

It should be noted that ROT_ACCEL and TRANS_ACCEL_TRANSITION are treated as modules in Figure 4.4.4.1.2-1, although they are simple unity gains and, therefore, not described in Subsection 4.4.4.2.

In general, the sequential execution requirements are determined by the data flow requirements between OFC modules. There are some cases, however, in which the outputs of one module may overwrite the outputs of another. Consequently, the order in which these modules are processed is important; and this relationship is indicated by the use of a dashed line in the diagram.

Table 4.4.4.1.1-1. Switch Settings for Major Block Diagram (Figure 4.4.4.2-1)

Switch Settings for Figure 4.4.4.2-1		Moding Input Combination (See Notes 1 and 2)
Switch	Position	
S1	A	$\overline{\text{SEP_COMPLETE}} \cdot \overline{\text{THC_RESPOND}} \cdot \text{SEP_MINUSZ_CMD} \cdot \text{OPS1_INDICATOR}$
	B	THC_RESPOND
	C	ABORT_PLUSX_JET_CMD $\cdot$ $\overline{\text{THC_RESPOND}}$
	D (Momentary)	SEP_MINUSZ_CMD = 0→1
S2	A	$\text{ROT_SUBMODE}_{axis} = 6$
	B	$\text{ROT_SUBMODE}_{axis} = 2$
	C	$\text{ROT_SUBMODE}_{axis} = 5$
	D	$(\text{ROT_SUBMODE}_{axis} = 3) + (\text{ROT_SUBMODE}_{axis} = 4)$
S3	A	TVC $\cdot$ MANUAL_MODE
	B	TVC $\cdot$ AUTO_MODE
S4	A	$\overline{\text{SEP_COMPLETE}} \cdot \text{SEP_MINUSZ_CMD} \cdot \text{OPS1_INDICATOR}$
	B	$\text{SEP_COMPLETE} + \overline{\text{SEP_MINUSZ_CMD}} + \overline{\text{OPS1_INDICATOR}}$
S5	A	$(\text{ROT SUBMODE}_{axis} = 2) + (\text{ROT_SUBMODE}_{axis} = 5) + (\text{ROT_SUBMODE}_{axis} = 6)$
	B	SOFT_STOP_{axis}
	C	$\text{ROT_SUBMODE}_{axis} = 3$
	D	DRIFT_{axis}

Table 4.4.4.1.1-1. Switch Settings for Major Block Diagram (Figure 4.4.4.2-1) (Cont)

Switch Settings for Figure 4.4.4.2-1		Moding Input Combination (See Notes 1 and 2)
Switch	Position	
S6	A	TVC • TWO_ENG
	B	TVC • $\overline{\text{TWO_ENG}}$ + RCS • TRIM_OMS_GIMBALS
S7	A	TVC + RCS • TRIM_OMS_GIMBALS
	B	RCS • $\overline{\text{TRIM_OMS_GIMBALS}}$
S8	A	RCS • PREBURN_MNVR • AUTO_MODE + TVC + GUIDED_DELTA_V_BURN
	B	(First pass insertion) + (first pass deorbit) + ((RCS = 0→1) • $\overline{\text{PREBURN_MNVR}}$) + (GUIDED_DELTA_V_BURN = 1→0) + (SEP_MINUSZ_CMD = 0→1) + ($\overline{\text{GUIDED_DELTA_V_BURN}}$ • RCS • (AUTO_MODE = 1→0 + AUTO_MODE = 0→1) • $\overline{\text{PREBURN_MNVR}}$) + (NEW_QBI_CMD_FLAG • MNVR_HOLD)
	C	$\bar{A} \cdot \bar{B}$
S9	A	MM_103
	B	$\overline{\text{MM 103}}$
S10	A	$\overline{\text{SEP_COMPLETE}}$ • SEP_MINUSZ_CMD • OPS1_INDICATOR
	B	$\bar{A}$

Table 4.4.4.1.1-1. Switch Settings for Major Block Diagram (Figure 4.4.4.2-1) (Cont)

Notes:

1. Logical symbols used:

   + → OR

   $\oplus$ → exclusive OR

   • → AND

   $\bar{x}$ → NOT x

   [y] ≠ OFF at least one element of y array ≠ OFF

2. The following mode abbreviations are used:

   TVC = OMSL_ON_CMD + OMSR_ON_CMD

   RCS = $\overline{\text{OMSL_ON_CMD}}$ • $\overline{\text{OMSR_ON_CMD}}$

   TWO_ENG = OMSL_ON_CMD • OMSR_ON_CMD

   ACCEL_{axis} = SOFT_STOP_{axis} + DRIFT_{axis}

   DRIFT_{axis} = ((RCS + TVC • $\overline{\text{TWO_ENG}}$ • roll axis only)
   •(RHC was, and is no longer, beyond the soft stop by axis and has not yet been returned to detent or changed sign of deflection in that axis))

   THC_RESPOND = set to ON: initially

   = set to OFF: SEP_MINUSZ_CMD = 0 → 1 or
   ABORT_PLUSX_JET_CMD = 0 → 1

   = set to ON: [THC_FSN] ≠ OFF or [THC_FSP] ≠ OFF
   or SEP_COMPLETE = 0 → 1
   or ABORT_PLUSX_JET_CMD = 1 → 0

Table 4.4.4.1.1-1. Switch Settings for Major Block Diagram (Figure 4.4.4.2-1) (Cont)

ROT_OPTION_{axis}	= set to 2 (disc):	$(DISC_REQUEST_{axis} = 0 \rightarrow 1) \cdot ((RHC_STATE_{axis} = 0) \rightarrow TVC)$
	= set to 3 (pulse)	$(PULSE_REQUEST_{axis} = 0 \rightarrow 1) \cdot ((RHC_STATE_{axis} = 0) \rightarrow TVC)$
$ROT_SUBMODE_{axis}$	= set to 2 (disc):	$MANUAL_MODE \cdot \overline{ACCEL}_{axis} \cdot (RCS \cdot (ROT_OPTION_{axis} = 2) \rightarrow GUIDED_DELTA_V_BURN \rightarrow TVC \cdot \overline{TWO_ENG} \cdot (axis = roll))$
	= set to 3 (pulse):	$MANUAL_MODE \cdot \overline{ACCEL}_{axis} \cdot \overline{GUIDED_DELTA_V_BURN} \cdot RCS \cdot (ROT_OPTION_{axis} = 3)$
	= set to 4 (accel):	$ACCEL_{axis}$
	= set to 5 (TVC rate):	$\overline{ACCEL}_{axis} \cdot TVC \cdot (AUTO_MODE \rightarrow TWO_ENG \rightarrow (axis \neq roll))$
	= set to 6 (auto mnvr):	$RCS \cdot AUTO_MODE$
$PREBURN_LATCH$	= set to ON:	$RCS \cdot PREBURN_MNVR \cdot AUTO_MODE$
	= set to OFF:	$((\overline{RCS} \cdot AUTO_MODE \cdot \overline{GUIDED_DELTA_V_BURN}) = 1 \rightarrow 0) \rightarrow (NEW_QBI_CMD_FLAG)$
$NEW_QBI_CMD_FLAG$	= set to ON:	$PREBURN_LATCH \cdot (Q_B_I_CMD \neq Q_B_I_CMD_DESIRED)$
	= set to OFF:	$NEW_QBI_CMD_FLAG = 0 \rightarrow 1$

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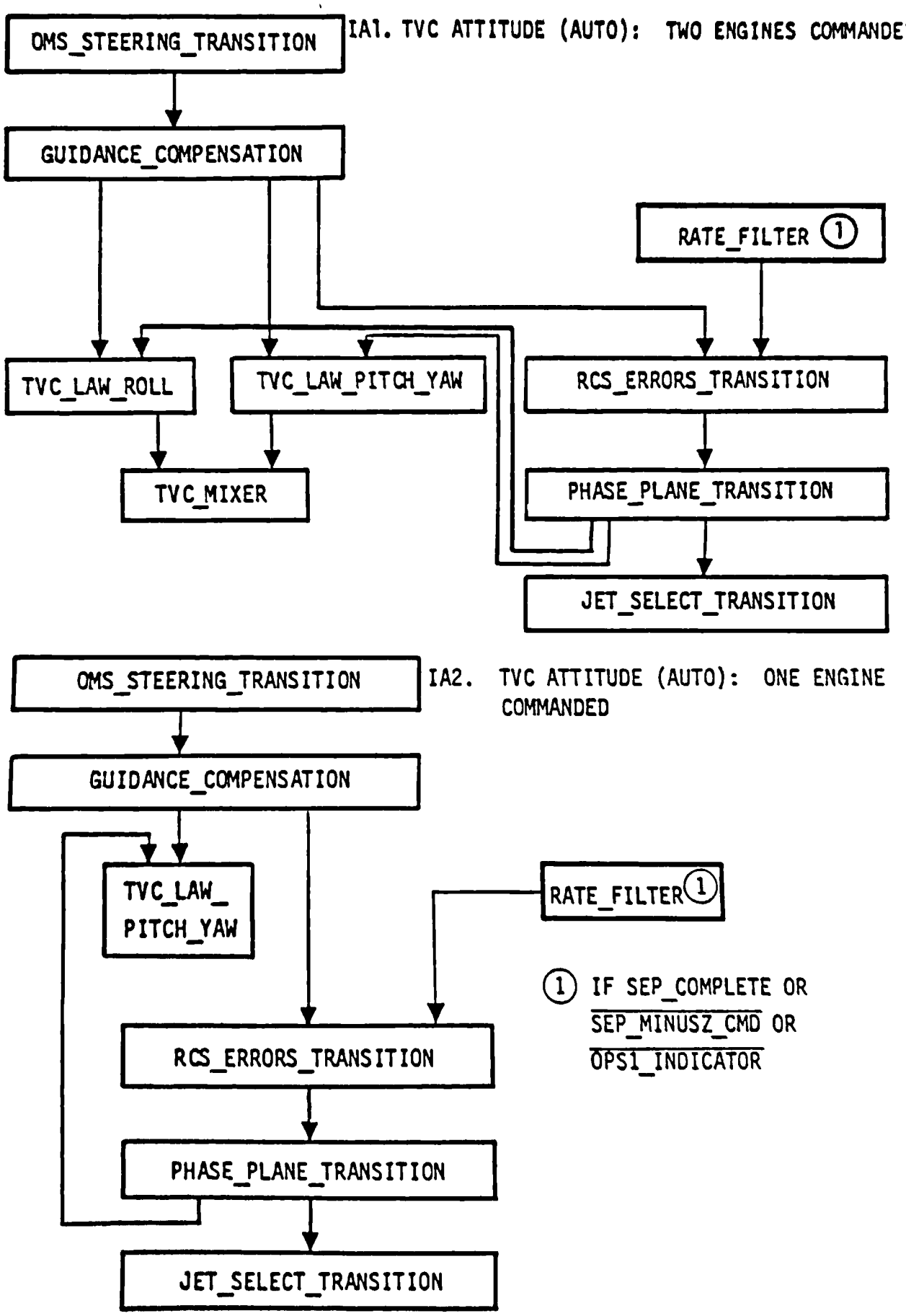
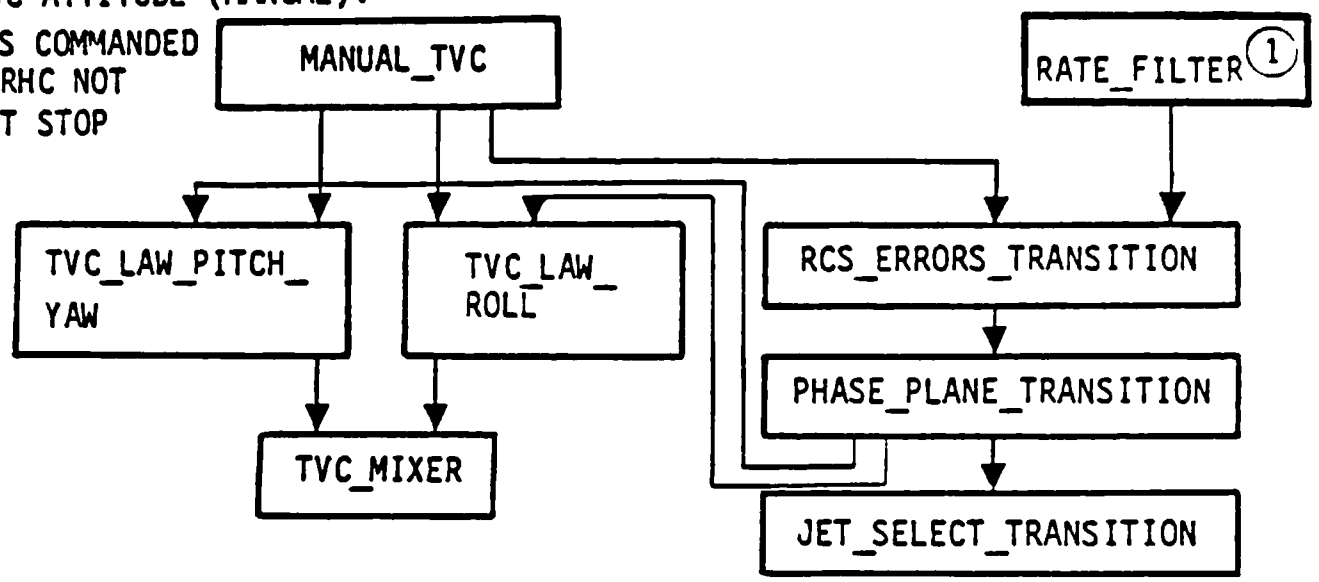


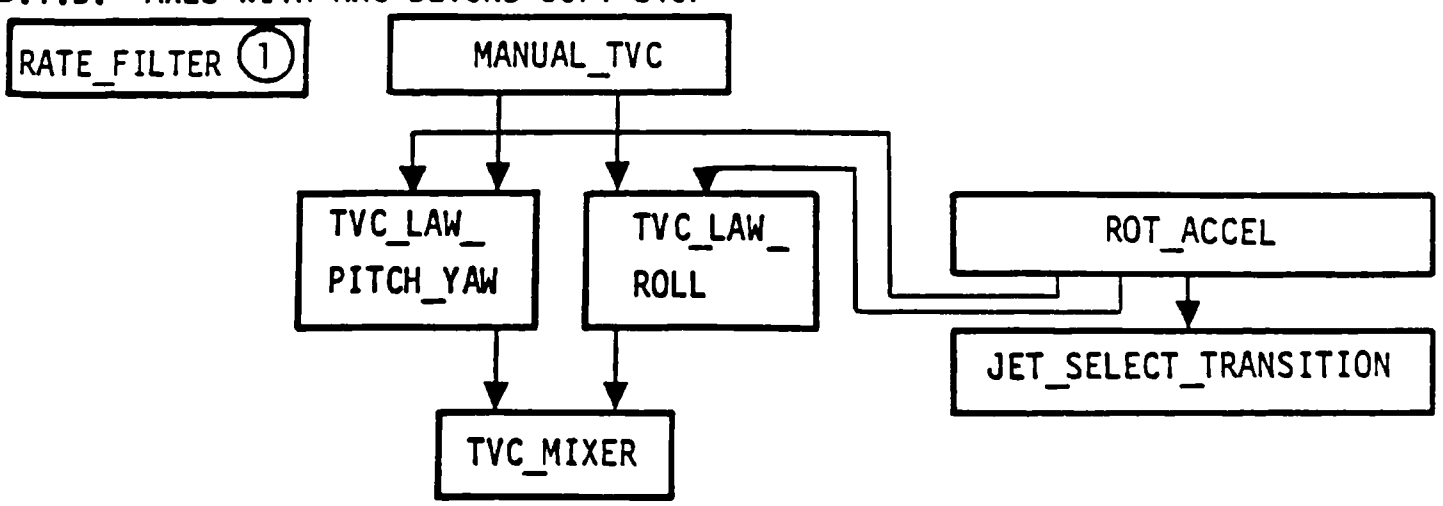
Figure 4.4.4.1.2-1. Control Law Function Module Sequencing Requirements
(Sheet 1 of 6)

I.B.1.A. TVC ATTITUDE (MANUAL):

TWO ENGINES COMMANDED AXES WITH RHC NOT BEYOND SOFT STOP



I.B.1.B. AXES WITH RHC BEYOND SOFT STOP

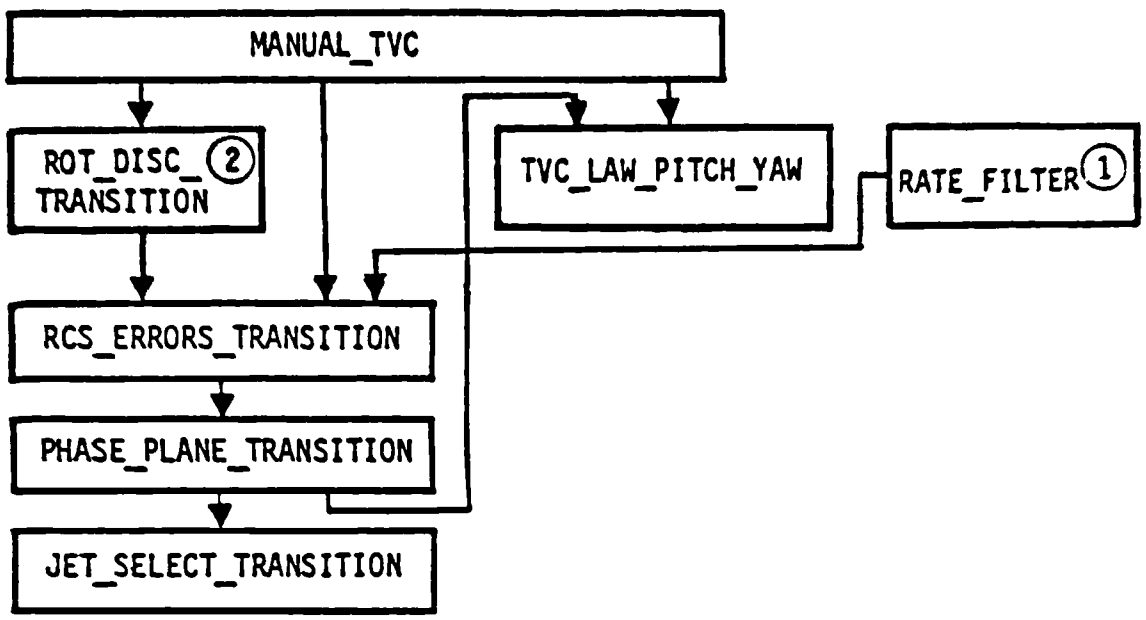


(1) IF SEP_COMPLETE OR $\overline{\text{SEP_MINUSZ_CMD}}$ OR $\overline{\text{OPS1_INDICATOR}}$

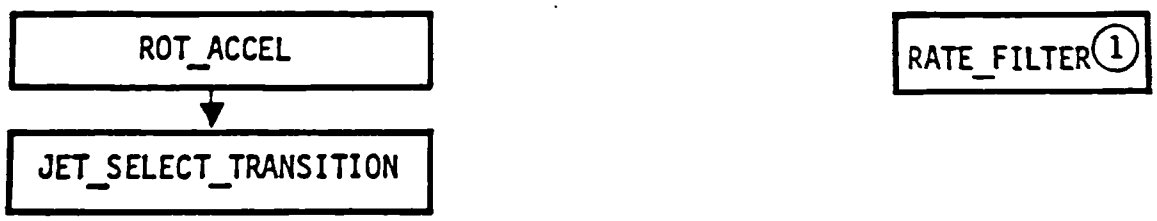
Figure 4.4.4.1.2-1. Control Law Function Module Sequencing Requirements (Sheet 2 of 6)

I.B.2.A. TVC ATTITUDE (MANUAL):

ONE_ENGINE COMMANDED; AXES WITH RHC NOT DOWN-MODED TO ACCEL



I.B.2.B.1. RHC DOWN-MODED TO ACCEL IN ROLL



I.B.2.B.2. RHC DOWN-MODED TO ACCEL IN PITCH AND/OR YAW

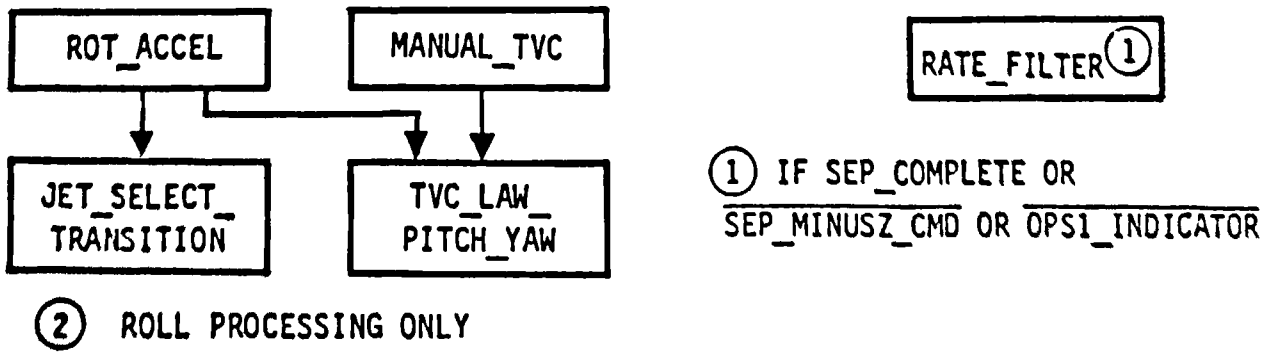
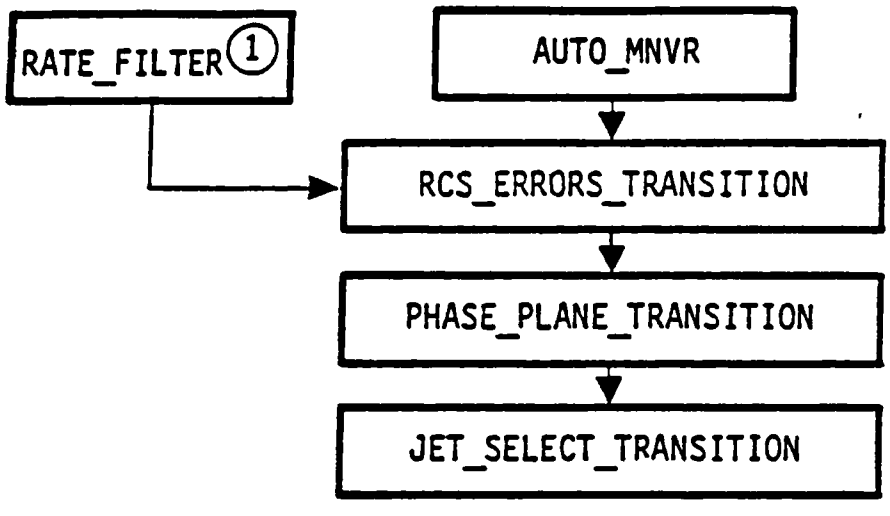


Figure 4.4.4.1.2-1. Control Law Function Module Sequencing Requirements (Sheet 3 of 6)

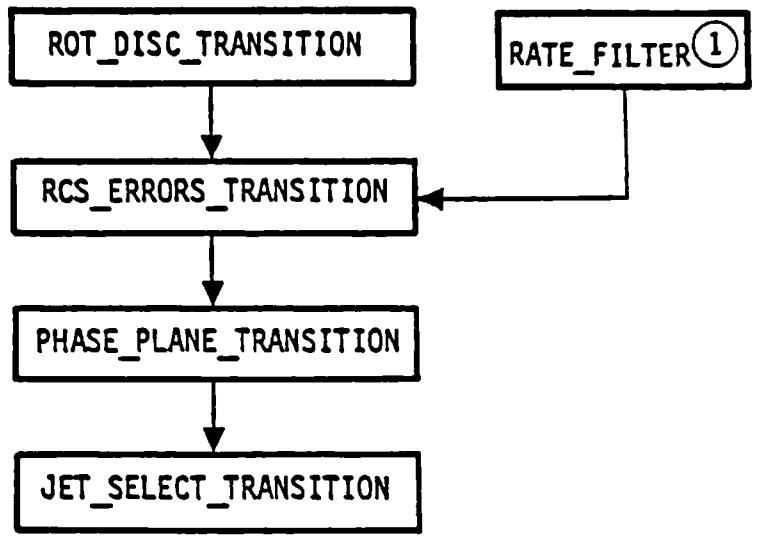
II.A. RCS ATTITUDE: AUTO MANEUVER/HOLD



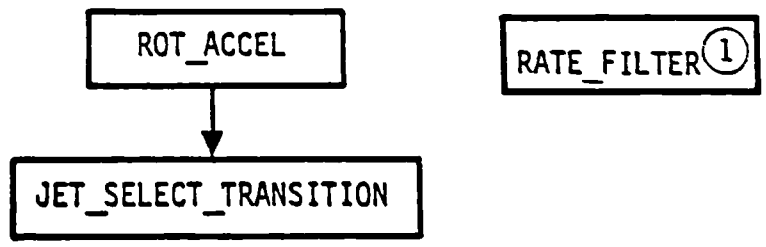
① IF SEP_COMPLETE OR $\overline{\text{SEP_MINUSZ_CMD}}$ OR $\overline{\text{OPS1_INDICATOR}}$

Figure 4.4.4.1.2-1. Control Law Function Module Sequencing Requirements
(Sheet 4 of 6)

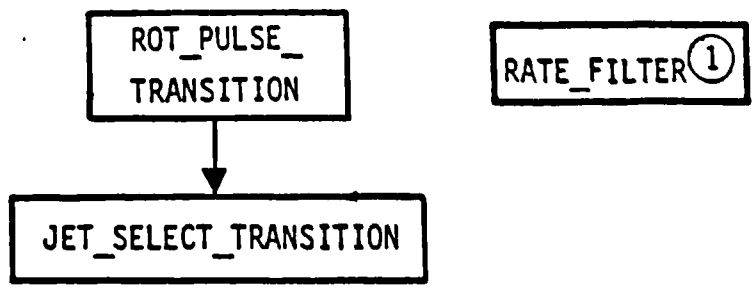
II.B.1. RCS ATTITUDE: MANUAL DISCRETE RATE COMMAND/ATTITUDE HOLD



II.B.2. RCS ATTITUDE: MANUAL ACCELERATION COMMAND



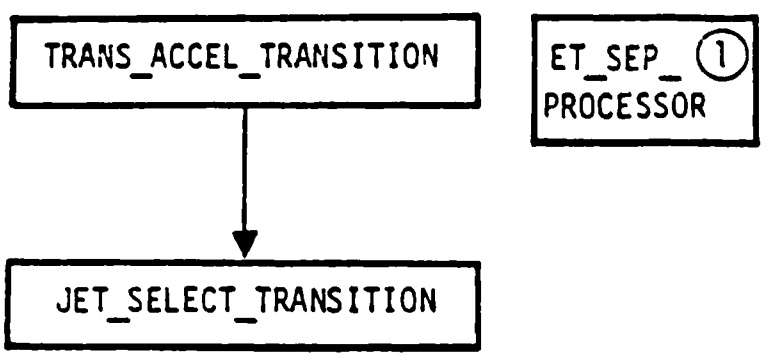
II.B.3. RCS ATTITUDE: MANUAL PULSE RATE COMMAND



(1) IF SEP_COMPLETE OR $\overline{\text{SEP_MINUSZ_CMD}}$ OR $\overline{\text{OPSI_INDICATOR}}$

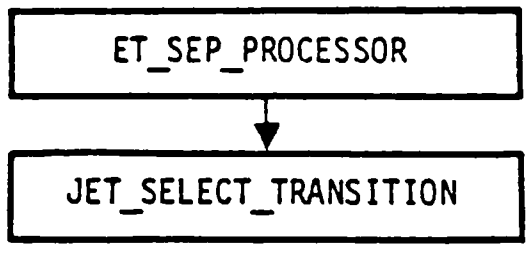
Figure 4.4.4.1.2-1. Control Law Function Module Sequencing Requirements (Sheet 5 of 6)

III.A. RCS TRANSLATION: ACCELERATION COMMAND



(1) CALLED ONLY IF $\overline{\text{SEP_COMPLETE}}$ • THC_OVERRIDE

III.B. RCS TRANSLATION: AUTO -Z



III.C. RCS TRANSLATION: AUTO +X

Figure 4.4.4.1.2-1. Control Law Function Module Sequencing Requirements (Sheet 6 of 6)

Table 4.4.4.1.2-1. Control Law Function Module Sequencing Requirements

Relationship Between TRNS_DAP Modes and TRNS_RECON Moding Inputs				
Mode and Submode				Input Condition[1]
I. TVC attitude	A. AUTO	1. Two engines commanded		OMSL_ON_CMD · OMSR_ON_CMD · AUTO_MODE
		2. One engine commanded		(OMSL_ON_CMD ⊕ OMSR_ON_CMD) · AUTO_MODE
	B. MANUAL	1. Two engines commanded	a. RHC not beyond soft stop by axis	OMSL_ON_CMD · OMSR_ON_CMD · $\overline{\text{AUTO_MODE}}$ · $\overline{\text{SOFT_STOP}}_{\text{axis}}$
			b. RHC beyond soft stop by axis	OMSL_ON_CMD · OMSR_ON_CMD · $\overline{\text{AUTO_MODE}}$ · $\text{SOFT_STOP}_{\text{axis}}$
		2. One engine commanded	a. RHC not downmoded to ACCEL by axis	(OMSL_ON_CMD ⊕ OMSR_ON_CMD) · $\overline{\text{AUTO_MODE}}$ · $\overline{\text{ACCEL}}_{\text{axis}}$
			b. RHC downmoded to ACCEL by axis: 1. In roll 2. In pitch/yaw	(OMSL_ON_CMD ⊕ OMSR_ON_CMD) · $\overline{\text{AUTO_MODE}}$ · $\text{ACCEL}_{\text{axis}}$
II. RCS attitude	A. AUTO			$\overline{\text{OMSL_ON_CMD}}$ · $\overline{\text{OMSR_ON_CMD}}$ · AUTO_MODE
	B. MANUAL	1. Discrete rate command/ attitude hold		$\overline{\text{OMSL_ON_CMD}}$ · $\overline{\text{OMSR_ON_CMD}}$ · MANUAL_MODE · $\overline{\text{ACCEL}}_{\text{axis}}$ · ((ROT_OPTION$_{\text{axis}}$ = 2) + GUIDED_RCS)
		2. Acceleration command		$\overline{\text{OMSL_ON_CMD}}$ · $\overline{\text{OMSR_ON_CMD}}$ · $\text{ACCEL}_{\text{axis}}$
		3. Pulse command		$\overline{\text{OMSL_ON_CMD}}$ · $\overline{\text{OMSR_ON_CMD}}$ · MANUAL_MODE · $\overline{\text{ACCEL}}_{\text{axis}}$ · (ROT_OPTION$_{\text{axis}}$ = 3) · $\overline{\text{GUIDED_RCS}}$
III. RCS translation[2]	A. Acceleration command			THC_RESPOND
	B. Auto -Z			$\overline{\text{SEP_COMPLETE}}$ · $\overline{\text{THC_RESPOND}}$ · SEP_MINUSZ_CMD · OPS1_INDICATOR
	C. Auto +X			ABORT_PLUSX_JET_CMD · $\overline{\text{THC_RESPOND}}$

Notes: 1. Symbols and some of the terms used in this column are defined in the notes to Table 4.4.4.1.1-1.
2. RCS translation is compatible with both RCS and TVC attitude control.

4.4.4.1.2.1 TVC Attitude Control. The TVC mode is entered when an ON command is present for one or both OMS engines. Six submodes exist, depending on the number of OMS engines burning - whether auto or manual has been selected - and on the position of the RHC. The processing requirements differ for each submode, as indicated in Table 4.4.4.1.2-1 and Figure 4.4.4.1.2-1.

It is assumed that for a two-engine burn, the ON commands for both engines will be turned on together and off together.

TRNS_RECON will configure for a two-engine burn if an ON command is present for both engines. If one of the ON commands is turned off during a two-engine burn for any reason, TRNS_RECON will automatically reconfigure the TRANS_DAP to one-engine status. This reconfiguration cannot be reversed during the remainder of the burn. It is possible to make a nominal one-engine burn, whether or not the unused engine has failed.

The crew may choose to perform the OMS burn under automatic or manual control by means of the AUTO/MANUAL PBI's. Changes from auto to manual or manual to auto are allowed at any time. Manual submodes may also be selected by moving the RHC out of detent. The TRNS_DAP will then remain in manual until the RHC is returned to detent and the AUTO PBI is depressed.

The auto submodes are determined on the basis of engine status (two engines or one engine). The RCS processor will run while the OMS processor is running during all auto submodes.

The manual submodes are determined on the basis of engine status and RHC position. The nominal manual mode will be proportional rate command, processed by the MANUAL_TVC module of the steering processor. The RCS processor will be driven by MANUAL_TVC except in the following cases:

a. If the soft stop for a given axis is exceeded, then that axis is downmoded to the ACCEL submode. The other axes are not affected. This submode passes RHC commands straight to JET_SELECT_TRANSITION and bypasses the phase plane. Moding returns to proportional rate command when the RHC is no longer deflected beyond the soft stop.

b. Discrete rate command/attitude hold will be provided during single-engine burns for the roll axis only. If soft stop for the roll axis is exceeded, the roll axis is downmoded to acceleration command. Moding returns to discrete rate command/attitude hold upon the return of the RHC to detent. This scheme allows for a free drift about the roll axis while the RHC is between detent and the soft stop.

4.4.4.1.2.2 RCS Attitude Control. The RCS mode is entered in the absence of an ON command for either OMS engine. Selection of the automatic or manual mode of RCS attitude control is a function of PBI selection and RHC "hot stick" downmoding. The automatic mode is entered when the DAP AUTO PBI is pressed with the RHC in detent. TRNS_RECON selects a target attitude, and AUTO_MNVR performs the maneuver and/or attitude hold. This mode implements an attitude hold by selecting the target attitude as the existing attitude upon a mode change from manual to automatic or vice versa, so long as a guided RCS burn is not under way, upon first pass insertion and deorbit, upon ET SEP initiation, and upon completion of an OMS burn. Also, if the PREBURN_MNVR flag is set on during automatic mode, the target attitude is the attitude commanded by the XXXXX MNVR YYYYY display. If the target attitude is a displacement of more than AMM from the current attitude, an automatic maneuver will precede the attitude held. If the PREBURN_MNVR flag is set on during manual mode, the flag is ignored. As long as the target attitude is identical with the commanded attitude on the XXXXX MNVR YYYYY display and AUTO_MNVR is active, the MNVR_IN_PROGRESS flag is on to indicate that the autopilot is automatically tracking the displayed attitude. If the commanded attitude is changed while the MNVR_IN_PROGRESS flag is on, the flag will be set off. Additionally, if maneuvering, the maneuver is terminated and attitude hold is established at the existing attitude. The target attitude is sent to A/E ATT_PROC as the display attitude pre-MM 104. Upon entering MM 104 and thereafter, the commanded attitude, Q_B_I_CMD, is sent to the A/E ATT_PROC as the display attitude. The manual mode is entered if the DAP MAN PBI is pressed or the RHC is moved out of detent. If a preburn maneuver was in progress at the time of the mode change, it cannot be resumed simply by remoding to automatic; the PREBURN_MNVR flag must be turned ON again by the XXXXX MNVR YYYYY display. In the manual mode, the TRANS_DAP may be configured in the discrete rate command/attitude hold submode or the pulse submode through axis-by-axis PBI selection. If the soft stop is exceeded for a given axis, control for that axis is downmoded to acceleration command. Moding returns to the previously selected submode upon return of the RHC to detent. This scheme allows for a free drift about the downmoded axis while the RHC is between detent and the soft stop.

For a time interval equal to DRIFT_TIME after receipt of the ET separation command, SEP_MINUSZ_CMD, there is no RCS attitude control; i.e., all three body rotation axes are in free drift. The free drift is implemented without reconfiguring by zeroing the rotation command ROT_JET_CMD while rotation control modules dictated by the current mode continue to execute. Attitude control is resumed by allowing ROT_JET_CMD to pass unchanged after expiration of DRIFT_TIME. Since no module initializations occur upon resumption of attitude control, the attitude hold reference continues to be the attitude of the vehicle at the time SEP_MINUSZ_CMD was set, assuming a closed loop mode (manual discrete/attitude hold or auto) is in use.

4.4.4.1.2.3 Translation Control Mode. The TRNS_DAP is in a manual translation acceleration command submode at all times except the following:

a. Automatic -Z maneuver. This submode will be active from the time that the SEP_MINUSZ_CMD is received until the separation is complete. TRNS_RECON will set [TRANS_JET_CMD] to [0,0,0,0,0,1] upon receipt of

SEP_MINUSZ_CMD. If the THC is moved from detent during this maneuver, automatic -Z commands will no longer be issued. The override is not reversible, and the manual acceleration command submode will take over. However, the ET_SEP_PROCESSOR will continue to run until the SEP_COMPLETE flag is turned on. If the THC is then returned to detent before the SEP_COMPLETE flag is turned ON, TRNS_RECON will set the SEP_COMPLETE flag to ON at the start of the ensuing OMS burn.

b. Automatic +X maneuver. This submode is active in an AOA or ATO situation. TRNS_RECON will set [TRANS_JET_CMD] to [1,0,0,0,0,0] on receipt of ABORT_PLUSX_JET_CMD. If the THC is moved from detent during the ensuing maneuver, the manual acceleration command submode will take over. This override is not reversible.

4.4.4.1.3 Other TRNS_RECON Functions.

a. Set module initialization flags. TRNS_RECON will set the initialization flags used by the control law modules. The names of the flags and the conditions for setting them are given in Table 4.4.4.1.3-1.

b. OMS gimbal trim. TRNS_RECON must initialize and call the module TVC_LAW_PITCH_YAW to trim the OMS engines. TRNS_RECON will cause a gimbal trim to occur whenever either of the following two events takes place:

(1) The TRIM_OMS_GIMBALS flag is ON and an OMS burn is not in progress. TVC_LAW_PITCH_YAW will be initialized and executed each pass while this flag is set. The trim values are I-load values or the I-load values updated by the crew or the trim integrator during a burn.

(2) One OMS engine has been shut down during a two-engine burn. TRNS_RECON will initialize TVC_LAW_PITCH_YAW at the time of shutdown. Execution of TVC_LAW_PITCH_YAW will continue without interruption. The trim values will be taken from an I-load.

(OMS engine trimming after ET separation, in preparation for the OMS 1 burn, is accomplished externally to the Transition DAP, using the I-loaded values of OMSL_PITCH_YAW_CMD and OMSR_PITCH_YAW_CMD. This trim is initiated by activating the OMS TVC CMD SOP at the transition into MM 104.) TRNS_RECON will also set the value of TVC_LAW_P_Y_GAIN_FLAG (Table 4.4.4.1.3-2) as a function of the number of OMS engines commanded on.

c. Set gains, deadbands, flags, etc. Table 4.4.4.1.3-3 is a list of TRNS_DAP interface parameters that are modified by TRNS_RECON. Table 4.4.4.1.3-2 is a list of parameters used within the TRNS_DAP whose values are modified by TRNS_RECON. The need for most of the latter are found in the module descriptions of Subsection 4.4.4.2.

d. Clocking slow modules. TRNS_RECON will keep the clocks that are necessary to determine the proper time for calls to modules that are processed at a rate lower than 12.5 Hz. TRNS_RECON and the higher

level scheduler must ensure that OMS_STEERING_TRANSITION is executed no later than 180 milliseconds after the IMU accelerometer read that generated the current value of DVB_SEC.

e. Panel switch interfacing. TRNS_RECON will respond to moding requests from eight ORB DAP panel PBI's and will provide illumination to those PBI's indicating the moding in effect, except as noted in paragraph (2). The PBI's are DAP AUTO and DAP MAN, used to specify automatic or manual moding, and a DISC RATE PBI and a PULSE PBI for each rotational axis, used to specify discrete rate or pulse rotation submodes of RCS-only operation. Inputs from these switches are momentary; that is, ON when a switch is presented, OFF when it is released.

(1) Automatic/manual moding. The logical expressions for response to the AUTO_REQUEST and MANUAL_REQUEST discretes are given in Table 4.4.4.1.3-3. RHC out-of-detent override to manual mode will be indicated by the PBI's.

(2) Discrete/pulse RCS rotation moding. The logical expressions for response to the DISC_REQUEST and PULSE_REQUEST discretes are given in the notes to Table 4.4.4.1.1-1 and in Table 4.4.4.1.3-3. RCS submodes in use during TVC, a guided RCS translation burn, or RHC soft-stop downmoding at any time, will not be indicated by the PBI's. During RCS-only operation, TRNS_RECON will not respond to or remember rotation submode change requests while the RHC is out of detent, and that fact will be indicated by the PBI's. RCS rotation submodes can be preset by PBI in either TVC mode regardless of RHC state, or guided RCS mode so long as the RHC is in detent. In this case, the PBI's indicate the mode that will be in effect during nonguided RCS-only operations.

4.4.4.1.4 Processing Rate. TRNS_RECON is processed at 12.5 Hz.

4.4.4.1.5 Interface Requirements. The interface requirements of TRNS_RECON are given in Table 4.4.4.1.5-1.

4.4.4.1.6 I-Loads/Constants. I-loads/constants for TRNS_RECON are given in Table 4.4.4.1.6-1.

4.4.4.1.7 Initialization Requirements. The initialization requirements of TRNS_RECON are given in Table 4.4.4.1.7-1.

Table 4.4.4.1.3-1. Control Law Function Module Initialization Conditions

Initialization Flag	Set flag on ENTRY into the specified mode or submode or when condition occurs
INIT_AUTO_MNVR	[(RCS • AUTO_MODE) = 0 → 1] + (RCS • PREBURN_MNVR • AUTO_MODE) + (NEW_QBI_CMD_FLAG • MNVR_HOLD) + [SEP_MINUSZ_CMD = 0 → 1]
INIT_GUIDANCE_COMPENSATION	1. TVC auto, change from two engines to one engine (flag = 1) 2. TVC auto (flag = 2)
INIT_OMS_STEERING	TVC auto
INIT_PHASE_PLANE	1. Each time PHASE_PLANE_TRANSITION is called if it was not called on the previous pass for a given axis 2. Every pass while ($\overline{\text{SEP_COMPLETE}}$ • SEP_MINUSZ_CMD • OPS1_INDICATOR) = 1
[INIT_RCS_ERRORS]*	1. TVC 2. RCS 3. Set by axis each time ACCEL_{axis} = 1 → 0 4. SEP_MINUSZ_CMD = 0 → 1 5. GUIDED_DELTA_V_BURN
INIT_ROT_DISC	Each time ROT_DISC_TRANSITION is called if it was not called on the previous pass for a given axis
INIT_ROT_PULSE	Each time ROT_PULSE_TRANSITION is called if it was not called on the previous pass for a given axis
INIT_TVC_LAW_PITCH_YAW	1. RCS • TRIM_OMS_GIMBALS (flag = 1) 2. Change from TVC two engines to TVC one engine (flag = 2) 3. TVC (flag = 3)
INIT_TVC_LAW_ROLL	TVC two-engine

*See also Subsection 4.4.4.2.1.7 for information about setting this flag.

Table 4.4.4.1.3-2. TRNS_DAP Internal Parameters Whose Values Are Modified by TRNS_RECON

Variable Name	Value	Condition*
AXIS	1,2,3 set sequentially	Used when a loop variable for axis-by-axis processing of modules is required
DEADBAND	DB_MATED_COAST	First pass insertion until ET SEP start
	DB_SEP	ET SEP start until SEP_COMPLETE = ON
	DB_PLUSX_RCS	GUIDED_DELTA_V_BURN or ABORT_PLUSX_JET_CMD · $\overline{\text{TVC}}$
	DB_TVC	TVC
	DB_COAST	All other times
FORCE_FIRE$_{axis}$	ON	ACCEL$_{axis}$ = ON → OFF and either RCS or TVC manual 1-engine roll axis
GUID_COMP_GAIN	GUID_COMP_GAIN_ONE_ENGINE	TVC auto 1-engine
	GUID_COMP_GAIN_TWO_ENGINES	TVC auto 2-engine
OMEGA_E_DESIRED$_{axis}$	0	TVC · ACCEL$_{axis}$ = OFF → ON
RATE_LIMIT, LOWER_RATE_LIMIT	RL_SEP, LRL_SEP	First pass insertion until SEP_COMPLETE = ON
	RL_PLUSX_RCS, LRL_PLUSX_RCS	GUIDED_DELTA_V_BURN or ABORT_PLUSX_JET_CMD · $\overline{\text{TVC}}$
	RL_TVC, LRL_TVC	TVC
	RL_COAST, LRL_COAST	All other times

*ACCEL and TVC are defined in notes to Table 4.4.4.1.1-1.

Table 4.4.4.1.3-2. TRNS_DAP Internal Parameters Whose Values Are Modified by TRNS_RECON (Cont)

Variable Name	Value	Condition*
[RFG]	[RFGM]	First pass insertion until ET_SEP start
	[RFGU]	SEP_COMPLETE or $\overline{\text{OPS1_INDICATOR}}$
[ROT_JET_CMD]	[0,0,0]**	(SEP_TIME < DRIFT_TIME). SEP_MINUSZ_CMD
SEP_TIME	0	Initially
	SEP_TIME + TDAP (incremented once per cycle)	(SEP_TIME < DRIFT_TIME). SEP_MINUSZ_CMD
TVC_LAW_P_Y_GAIN_FLAG	2	TVC 1-engine
	1	TVC 2-engine

*ACCEL and TVC are defined in notes to Table 4.4.4.1.1-1.
**After execution of PHASE_PLANE_TRANSITION, before execution of JET_SELECT_TRANSITION

Table 4.4.4.1.3-3. Input and Output Parameters of the TRNS_DAP Whose Values Are Modified by TRNS_RECON

Variable Name	Value	Condition*
AUTO_MODE	OFF	(RHC out of detent in any axis) or MANUAL_REQUEST = 0 → 1
	ON	(RHC in detent in all axes) and AUTO_REQUEST = 0 → 1
$DISC_MODE_{axis}$	ON	$ROT_OPTION_{axis} = 2$
	OFF	$ROT_OPTION_{axis} \neq 2$
MANUAL_MODE	$\overline{AUTO_MODE}$	Always
MNVR_IN_PROGRESS	PREBURN_LATCH · $\overline{NEW_QBI_CMD_FLAG}$	Always
PREBURN_MNVR	OFF	PREBURN_MNVR = 0 → 1
$PULSE_MODE_{axis}$	$\overline{DISC_MODE}_{axis}$	Always
SEP_COMPLETE	ON	TVC = 0 → 1 or OPS1_INDICATOR = 0
TERM_AUTO	ON	NEW_QBI_CMD_FLAG · MNVR_HOLD
	OFF	$\overline{NEW_QBI_CMD_FLAG}$ + $\overline{MNVR_HOLD}$

*RCS and TVC are defined in notes to Table 4.4.4.1.1-1.

Table 4.4.4.1.5-1. TRNS_RECON Interface Requirements

Name	Description	Source or Destination	Type	Range	Unit	Sample Rate (Hz)
INPUTS						
ABORT_PLUSX_JET_CMD	Command to fire all available +X RCS jets	ABT CNTL SEQ	B	0,1	none	12.5
AUTO_REQUEST	Auto mode request (momentary; 1=auto)	GN&C SW RM	B	0,1	none	12.5
DISC_REQUEST	Discrete rate mode request by axis (momentary; 1=disc)	GN&C SW RM	B(3)	0,1	none	12.5
SEP_MINUSZ_CMD	Flag indicating auto ET SEP is to begin (1=begin)	ET SEP SEQ	B	0,1	none	12.5
GUIDED_DELTA_V_BURN	Flag indicating RCS delta-V burn is in progress (1=burn in progress: from 1 second before ignition time to burn cutoff)	MSC	B	0,1	none	12.5
MANUAL_REQUEST	Manual mode request (momentary; 1=manual)	GN&C SW RM	B	0,1	none	12.5
MM_103	Major Mode 103	MSC	B	0,1	none	12.5
MNVR_HOLD	Flag specifying maneuver or hold state (1=mnvr)	AUTO_MNVR	B	0,1	none	12.5
OMSL_ON_CMD	Left OMS engine turn-on command (1=command to turn on)	OMS FIRE SEQ	B	0,1	none	12.5
OMSR_ON_CMD	Right OMS engine turn-on command (1=command to turn on)	OMS FIRE SEQ	B	0,1	none	12.5
OPS1_INDICATOR	Flag indicating OPS1 is in progress	MSC	B	0,1	none	12.5
PREBURN_MNVR	Flag commanding preburn auto RCS maneuver	XXXXX MNVR YYYYY	B	0,1	none	12.5
PULSE_REQUEST	Pulse rate mode request by axis (momentary; 1=pulse)	GN&C SW RM	B(3)	0,1	none	12.5
RHC_STATE	Rotational hand controller command	3-AX RHC SOP	A(3)I	-1,0,1	none	12.5

Table 4.4.4.1.5-1. TRNS_RECON Interface Requirements (Cont)

Name	Description	Source or Destination	Type	Range	Unit	Sample Rate (Hz)
SEP_COMPLETE	-Z separation velocity has been achieved (1=complete)	ET_SEP_PROCESSOR, TRNS_RECON	B	0,1	none	12.5
SOFT_STOP	Flag indicating rotational hand controller is deflected beyond soft stop (1=beyond soft stop)	3-AX RHC SOP	A(3)B	0,1	none	12.5
THC_FSN	Translational hand controller negative command	GN&C SW RM	A(3)B	0,1	none	12.5
THC_FSP	Translational hand controller positive command	GN&C SW RM	A(3)B	0,1	none	12.5
TRIM_OMS_GIMBALS	OMS prethrust trim set-up enable (1=enable)	MSC	B	0,1	none	12.5
OUTPUTS						
AUTO_MODE	Auto mode indicator (1=auto)	HDWR	B	0,1	none	12.5
AXIS	Body axis for this execution	ROT_DISC_TRANSITION, ROT_PULSE_TRANSITION, PHASE_PLANE_TRANSITION	I	1,2,3	none	12.5/axis
DEADBAND	Attitude deadbands	PHASE_PLANE_TRANSITION	A(3)S	0 to 20	deg	12.5
DISC_MODE	Discrete rate mode indicator by axis (1=disc)	HDWR	B(3)	0,1	none	12.5
FORCE_FIRE	Rate damping initiation flag by axis (1=damp rate)	PHASE_PLANE_TRANSITION	B(3)	0,1 for each bit	none	12.5
GUID_COMP_GAIN	TVC compensation gains	GUIDANCE_COMPENSATION	A(3)S	0 to 5	none	12.5
INIT_AUTO_MNVR	Module initialization flag (1=init)	AUTO_MNVR	B	0,1	none	12.5
INIT_GUIDANCE_COMPENSATION	Module initialization flag (0=no init; 1=two engine to one engine transition init; 2=normal init)	GUIDANCE_COMPENSATION	I	0,1,2	none	12.5
INIT_OMS_STEERING	Module initialization flag (1=init)	OMS_STEERING_TRANSITION	B	0,1	none	12.5

Table 4.4.4.1.5-1. TRNS_RECON Interface Requirements (Cont)

Name	Description	Source or Destination	Type	Range	Unit	Sample Rate (Hz)
INIT_PHASE_PLANE	Module initialization flag (1=init)	PHASE_PLANE_TRANSITION	A(3)B	0,1	none	12.5
INIT_RCS_ERRORS	Module initialization flag (1=init)	RCS_ERRORS_TRANSITION	A(3)B	0,1	none	12.5
INIT_ROT_DISC	Module initialization flag (1=init)	ROT_DISC_TRANSITION	B	0,1	none	12.5
INIT_ROT_PULSE	Module initialization flag (1=init)	ROT_PULSE_TRANSITION	B	0,1	none	12.5
INIT_TVC_LAW_PITCH_YAW	Module initialization flag (0=no init; 1=prethrust trim; 2=two engine to one engine transition trim; 3=first dynamic pass after prethrust trim)	TVC_LAW_PITCH_YAW	I	0,1,2,3	none	12.5
INIT_TVC_LAW_ROLL	Module initialization flag (1=init)	TVC_LAW_ROLL	B	0,1	none	12.5
LOWER_RATE_LIMIT	Phase plane lower rate limit	PHASE_PLANE_TRANSITION	S	0 to 2	deg/s	12.5
MANUAL_MODE	Manual mode indicator (1=manual)	HDWR	B	0,1	none	12.5
MNVR_IN_PROGRESS	Flag signifying auto RCS maneuver in progress	XXXXX MVR YYYYY	B	0,1	none	12.5
OMEGA_E_DESIRED	Desired angular rate error	TVC_LAW_PITCH_YAW TVC_LAW_ROLL	V(3)S	-5 to 5	deg/s	12.5
PULSE_MODE	Pulse rate mode indicator by axis (1=pulse)	HDWR	B(3)	0,1	none	12.5
RATE_LIMIT	Angular rate error limit by axis	PHASE_PLANE_TRANSITION	A(3)S	0 to 3.5	deg/s	12.5
RFG	Rate filter gains	RATE_FILTER	A(5)S		none	12.5
ROT_JET_CMD	RCS rotation command	PHASE_PLANE_TRANSITION, JET_SELECT_TRANSITION, RCS ACT LT	A(3)I	-1,0,1	none	12.5

Table 4.4.4.1.5-1. TRNS_RECON Interface Requirements (Cont)

Name	Description	Source or Destination	Type	Range	Unit	Sample Rate (Hz)
SEP_COMPLETE	-Z separation velocity has been achieved (1=complete)	TRNS_RECON, JET_SELECT_TRANSITION, MSC	B	0,1	none	12.5
TRANS_JET_CMD	Translation command (+X, -X, +Y, -Y, +Z, -Z)	JET_SELECT_TRANSITION	A(6)B	0,1	none	12.5
TVC_LAW_P_Y_GAIN_FLAG	Flag indicating number of OMS engines to burn (1=two engines; 2=one engine)	TVC_LAW_PITCH_YAW	I	1,2	none	12.5
TERM_AUTO	Flag indicating that guidance has updated the desired attitude during a preburn maneuver	AUTO_MNVR	B	0,1	none	12.5

Table 4.4.4.1.6-1. TRNS_RECON I-Loads/Constants

Name	Description	Type	MSID/Value	Unit
DB_COAST	Phase plane attitude deadbands for use during post-ET SEP coast	A(3)S	V97U2326C V97U2327C V97U2328C	deg
DB_MATED_COAST	Phase plane attitude deadbands for use during coast while mated to ET	A(3)S	10.0,10.0,10.0	deg
DB_PLUSX_RCS	Phase plane attitude deadbands for use during RCS +X delta-V burn	A(3)S	V97U2332C V97U2333C V97U2334C	deg
DB_SEP	Phase plane attitude deadbands for use during ET separation	A(3)S	3.0,3.0,3.0	deg
DB_TVC	Phase plane attitude deadbands for use during OMS burn	A(3)S	V97U2338C V97U2404C V97U2405C	deg
GUID_COMP_GAIN_ONE_ENGINE	Filter gain for GUIDANCE_COMPENSATION during one engine TVC burns	A(3)S	V97U2344C V97U2345C V97U2346C	none
GUID_COMP_GAIN_TWO_ENGINES	Filter gain for GUIDANCE_COMPENSATION during two engine TVC burns	A(3)S	V97U2347C V97U2348C V97U2349C	none
RL_COAST	Phase plane angular rate error limits for use during post-ET SEP coast	A(3)S	V97U2377C V97U2378C V97U2379C	deg/s
LRL_COAST	Phase plane angular rate error limits for use during post-ET SEP coast	S	V97U2423C	deg/s
RL_PLUSX_RCS	Phase plane angular rate error limits for use during RCS +X delta-V burn	A(3)S	V97U2380C V97U2381C V97U2382C	deg/s
LRL_PLUSX_RCS	Phase plane angular rate error limits for use during RCS +X delta-V burn	S	V97U2421C	deg/s
RL_SEP	Phase plane angular rate error limits for use during coast while mated to ET and during ET separation	A(3)S	0.5,0.5,0.5	deg/s

Table 4.4.4.1.6-1. TRNS_RECON I-Loads/Constants (Cont)

Name	Description	Type	MSID/Value	Unit
LRR_SEP	Phase plane angular rate error limits for use during coast while mated to ET and during ET separation	S	0.1	deg/s
RL_TVC	Phase plane angular rate error limits for use during OMS burn	A(3)S	V97U2386C V97U2387C V97U2388C	deg/s
LRL_TVC	Phase plane angular rate error limits for use during OMS burn	S	V97U2422C	deg/s
RFGM	Rate filter gain values (mated)	A(5)S	V99U7294C to V99U7298C	none
RFGU	Rate filter gain values (unmated)	A(5)S	V99U7299C to V99U7303C	none
DRIFT_TIME	Duration of free drift state at start of ET separation burn	S	V96U8956C	S
TDAP	Period of TRANS DAP cycle	S	0.08	S

Table 4.4.4.1.7-1. TRNS_RECON Initialization Requirements

Initialize on Transition From	Initialize on Transition To	Variable	Initial Value
	First pass	AUTO_MODE	ON
		INIT_RCS_ERRORS	ON
		INIT_ROT_DISC	ON
		MANUAL_MODE	OFF
		ROT_JET_CMD	0
		ROT_OPTION	2

4.4.4.2 Control Law Module. Figure 4.4.4.2-1 is the major block diagram of the transition FC control law module. This module contains a number of function modules that execute the control laws. On any given pass, the configuration of the control law module (i.e., the effective interconnection and behavior of the function modules) is determined by inputs from the supervisory module TRNS_RECON.

Configuration control is implemented in four ways:

1. By executing the particular function modules necessary to perform a given task in the sequence required. This function is performed by TRNS_RECON and indicated in Figure 4.4.4.2-1 by switches whose logic was described in Subsection 4.4.4.1.

2. By passing initialization flags to the function modules which, in general, initialize pass-to-pass storage elements, such as filters, counters, and integrators.

3. By passing flags defining qualitative behavior of certain function modules. These flags perform low-level reconfigurations within the modules.

4. By passing parameters defining quantitative behavior of certain function modules. These parameters include gains and deadbands. (Certain other parameters are padloaded values that remain constant throughout the transition phases.)

The control law function modules are grouped into three categories: steering processor, RCS processor, and OMS processor. The general sequence of processing is (1) steering processor and (2) RCS, or RCS and OMS, processor.

A. Steering Processor. The steering processor converts a variety of input commands and data to forms acceptable by the RCS and OMS processors. It also generates an ET separation complete flag, and an attitude command used to generate an error display for manual steering in OMS TVC and guided manual RCS delta-V burns. In Figure 4.4.4.2-1, these modules are divided into the following types:

1. One manual RCS translation (TRANS_ACCEL_TRANSITION).

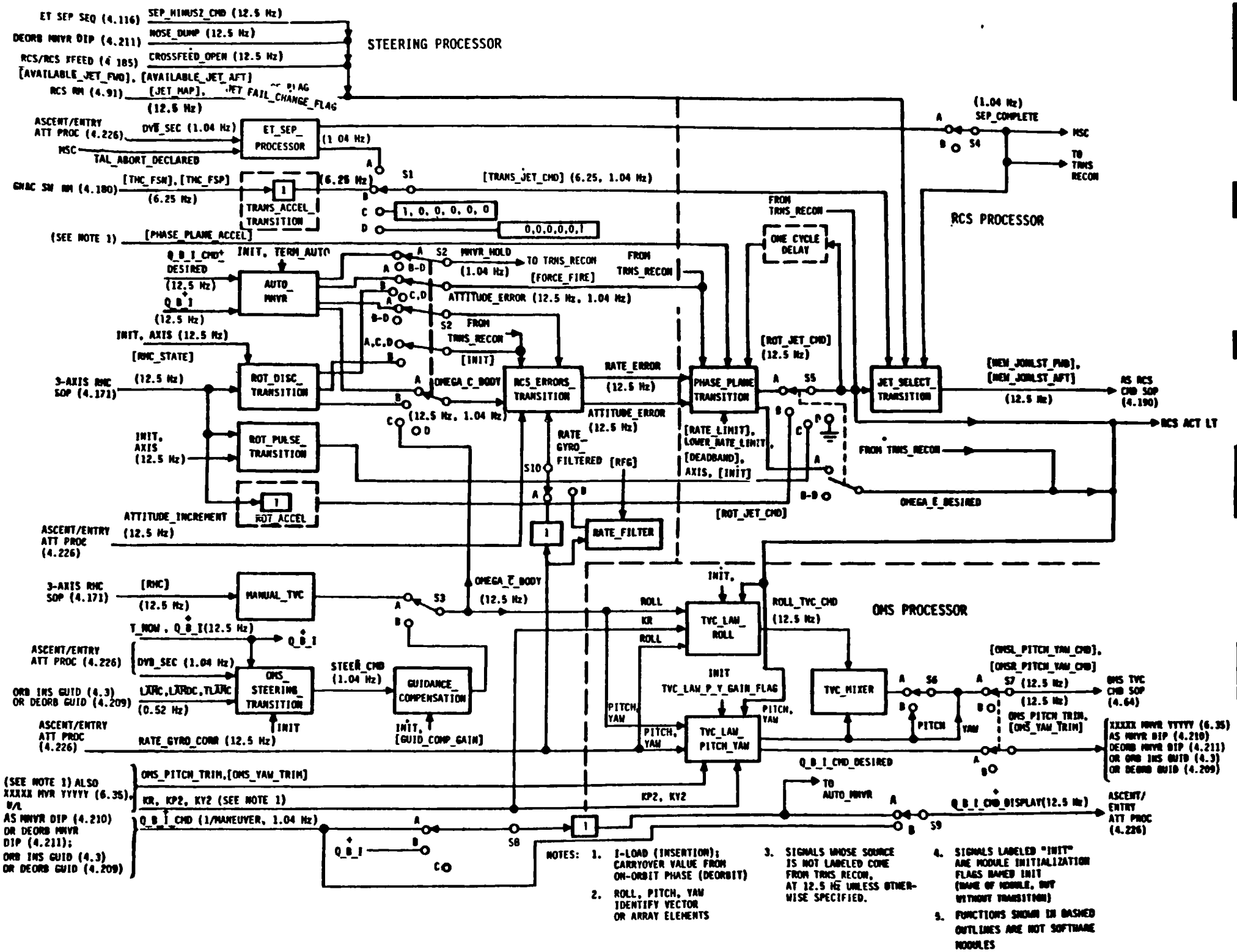


Figure 4.4.4.2-1. Transition DAP Control Law Module

2. One automatic RCS translation and ET separation monitor (ET_SEP_PROCESSOR).

3. Three manual RCS rotation (ROT_ACCEL, ROT_DISC_TRANSITION, and ROT_PULSE_TRANSITION).

4. One automatic RCS rotation (AUTO_MNVR).

5. Two automatic OMS steering (OMS_STEERING_TRANSITION and GUIDANCE_COMPENSATION).

6. One manual OMS steering (MANUAL_TVC).

7. One RCS error determination and attitude data processing (RCS_ERRORS_TRANSITION).

8. One rate gyro output filter (RATE_FILTER).

The RCS translation modules generate commands for the jet selection module in the RCS processor. The manual RCS translation module processes the three vehicle axes together. The automatic RCS translation module processes only the vehicle Z-axis and, in addition, monitors the separation velocity in both manual and automatic translation modes, setting the SEP_COMPLETE flag when the desired separation velocity is achieved.

One of the RCS manual rotation modules, ROT_DISC_TRANSITION, generates rate commands for the RCS error determination module; the other two, ROT_ACCEL and ROT_PULSE_TRANSITION, drive the jet selection routine directly. Each RCS manual rotation module processes one axis at a time, enabling axis-by-axis downmoding from the discrete rate or pulse submode to the acceleration submode.

The automatic RCS rotation module, AUTO_MNVR, provides rate commands and attitude errors to the RCS error determination module to effect either an attitude hold or a maneuver to a commanded preburn attitude followed by an attitude hold.

The rotation modules ROT_DISC_TRANSITION and AUTO_MNVR supply the RCS processor with a FORCE_FIRE flag, which acts as a rate damping command. ROT_DISC_TRANSITION requests rate damping each time the RHC is deflected from detent, commanding a nonzero angular rate and, each time the RHC is returned to detent, commanding an attitude hold; TRNS_RECON makes the FORCE_FIRE request if the RHC was moved beyond soft stop and then back to detent. AUTO_MNVR commands FORCE_FIRE in all three axes when starting or ending a maneuver. This request causes the phase-plane switching logic in the RCS processor to initiate a firing such as to reduce the angular rate error. Hysteresis logic in the phase plane then continues the firing as needed to bring the rate error to an acceptably small magnitude, whereupon the phase-plane switching logic resumes normal limit cycle operation. The ROT_DISC_TRANSITION module must also initialize the RCS_ERRORS_TRANSITION module at three events in the discrete rate/attitude hold mode. This initialization sets the desired attitude

Figure 4.4.4.2-1. Transition DAP Control Law Module

equal to the present attitude; it is needed (1) when the mode is first entered, (2) when the RHC goes out of detent, and (3) when the RHC returns to detent.

The RATE_FILTER generates filtered rate gyro data for the RCS processor and is turned off during ET_SEP. The module RCS_ERRORS_TRANSITION accepts attitude errors from AUTO_MNVR, rate commands from the various steering command generators, and attitude and rate data from the external interface. From these, it derives attitude and rate errors for the RCS processor. After SEP_COMPLETE the rate data is filtered by RATE_FILTER.

The OMS steering modules generate body rate commands for the RCS processor (via RCS_ERRORS_TRANSITION) and for the OMS processor. The automatic steering module, OMS_STEERING_TRANSITION, commands a steering angle equal to the cross product of the desired and actual vehicle velocity vectors. The output of this module is scaled, filtered, and limited by GUIDANCE_COMPENSATION. The manual steering module, MANUAL_TVC, simply commands a rate proportional to the RHC deflection.

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B. RCS Processor. The RCS processor consists of jet selection logic for rotation and translation, preceded by a phase-plane switching logic for rotation only, which processes attitude and angular rate errors to drive the vehicle into a limit cycle about the desired attitude and angular rate. In addition the phase plane logic provides crossfeed signals to the OMS processor indicating the desired angular rate error and the RCS rotation commands. The jet selection logic produces the primary RCS processor output, the on-off commands to the RCS jets.

The command by which the phase plane drives the jet selection logic, ROT_JET_CMD, may be zeroed by TRNS_RECON to implement either of two kinds of free drift: axis-by-axis drift, discussed in part D below, and three-axis free drift for the initial part of the ET separation burn, discussed in paragraph 4.4.4.1.2.2.

C. OMS Processor. The OMS processor contains all the functions required for thrust vector control of the OMS engines. Because pitch and yaw may be controlled differently from roll, the TVC law function is split into two modules to prevent execution of unnecessary code, a mixer module performing the required roll/pitch command summations. Preburn trimming of the OMS engines is detailed in the functional description of the module TVC_LAW_PITCH_YAW.

D. RCS Manual Rotation Control Configuration. Anytime the discrete rate/attitude hold or pulse rotation mode is available (i.e., during all manual RCS-only operations and, in the roll axis only, during a manual one-engine OMS burn), the acceleration mode is also available when the RHC is beyond the soft stop. To prevent fuel waste, the vehicle drifts freely when the RHC is returned to within soft stop but not to detent. When the RHC is returned to detent, or is on the opposite side of detent (having passed through detent undetected due to the finite RHC sampling rate) but not at the soft stop, the mode reverts to that previously in effect. Table 4.4.4.2-1 summarizes the control action and key signal states for three RHC deflection sequences: Sequence 1, in which the RHC remains within soft stop and the mode remains

discrete rate attitude hold; Sequence 2, in which the RHC remains within a soft stop and the mode remains pulse; and Sequence 3, in which the RHC moves beyond soft stop and the accel/drift/discrete or accel/drift/pulse hysteresis is implemented. The signals described appear in Table 4.4.4.2 1.

E. RCS Translation Control Configuration. RCS translation is effected in one manual mode (through TRANS_ACCEL_TRANSITION) and two special-purpose automatic modes. All translation modes supply an RCS jet command to the RCS processor. The manual acceleration mode is always available to the crew and generates a jet command for a given axis, as long as the THC is out of detent in that axis, to accelerate the vehicle along that axis in a direction corresponding to the sense of the THC deflection. TRNS_RECON and ET_SEP_PROCESSOR implement the automatic -Z maneuver mode, which is active only during ET separation. In this mode, TRNS_RECON generates a -Z jet command until the vehicle has accelerated in -Z to the desired separation velocity, at which time ET_SEP_PROCESSOR terminates the command and sets the flag SEP_COMPLETE. Any use of the THC while this mode is in progress downmodes translation control to manual acceleration mode; however, ET_SEP_PROCESSOR continues to monitor separation velocity until the desired value is reached. The second automatic translation mode is the automatic +X maneuver, which is active for AOA or ATO. In this mode, TRNS_RECON commands +X translation. Use of the THC downmodes translation control to manual acceleration mode.

F. TVC Control Configuration. In TVC operation, the OMS and RCS processors are driven by three-axis commands from the steering processor. For axes in which the OMS processor has control capability (roll, pitch, and yaw in a two-engine burn; pitch and yaw in a one-engine burn), it has the primary control responsibility; and the RCS processor operates as a wraparound controller, exercising RCS control only if the TVC control authority is inadequate, as evidenced by excessive attitude or angular rate errors. In a one-engine burn, roll is controlled exclusively by the RCS processor, operating with the same attitude and angular rate error tolerances as in the two-engine case.

The steering processor provides the drive signals to the OMS and RCS processors. For the OMS processor, these drive signals are body rate commands. For the RCS processor, they are either attitude error and angular rate error signals derived from body rate commands, or RCS jet commands. In automatic TVC mode, OMS_STEERING_TRANSITION and GUIDANCE_COMPENSATION provide the body rate commands to the OMS processor, and RCS_ERRORS_TRANSITION generates error signals based on these commands for the RCS processor.

In manual TVC mode, MANUAL_TVC provides the body rate commands to the OMS processor, and the RCS processor is driven by signals that are a function of the number of OMS engines active, the RHC deflection (within or beyond soft stop), and (in the one-engine case) the particular body axis. In a two-engine burn, with the RHC within soft stop, RCS_ERRORS TRANSITION supplies error signals to the RCS processor based on the rate commands from MANUAL TVC. If the

Table 4.4.4.2-1. RCS Manual Rotation Moding and Signal Flow

FORCE_FIRE, RHC Position and Relevant Conditions	Control Action	INIT_RCS_ ERRORS	ROT_JET_ CMD
Sequence 1: RHC remains within soft stop for discrete rate/attitude hold mode			
In detent	Hold attitude	OFF	As required
Out of detent, first pass	Damp to rate	ON	±1
Out of detent, rate not achieved	Damp to rate	OFF	±1
*Out of detent, rate achieved	Maintain rate	OFF	As required
Back in detent, first pass	Damp to zero	ON	±1
Back in detent, rate not zeroed	Damp to zero	OFF	±1
Back in detent, rate zeroed	Hold attitude	OFF	As required
Sequence 2: RHC remains within soft stop for pulse mode.			
In detent	Free drift	Don't care	0
Out of detent, rate change not achieved	Acceleration	Don't care	±1
Out of detent, rate change achieved	Free drift	Don't care	0
In detent	Free drift	Don't care	0
Sequence 3: RHC moves beyond soft stop for either mode.			
In detent	———	See above	———
Out of detent, all conditions	———	See above	———
Beyond soft stop	Acceleration	Don't care	±1
Within soft stop, out of detent	Free drift	Don't care	0
Back in detent, all conditions	———	See above	———

*This step is skipped if the RHC is returned to detent before the RCS can achieve the discrete rate.

RHC is deflected beyond soft stop in any axis, that axis is driven by RCS jet commands from ROT_ACCEL. In a one-engine burn, pitch and yaw control operate identically to the two-engine case for both RHC conditions. Roll control in the one-engine case is by ROT_DISC_TRANSITION via RCS_ERRORS_TRANSITION when the RHC is within soft stop and by RCS jet command from ROT_ACCEL when the RHC is beyond soft stop. The acceleration/drift/discrete hysteresis described in Paragraph D applies to roll control in the one-engine case.

Table 4.4.4.2-2 summarizes the TVC control configurations. Control inputs to the OMS and RCS processors are indicated for all relevant combinations of mode, number of engines, RHC deflection, and axis.

G. Attitude Command Control Configuration. The steering processor selects either of two attitude quaternions for the automatic maneuver module, AUTO_MNVR, which maneuvers to and/or holds the commanded attitude if in RCS automatic mode. It also supplies either of two quaternions to the A/E ATT PROC, which generates an attitude error signal on the ADI. In Major Mode 103, the quaternion sent to A/E ATT PROC is the same as that selected for AUTO_MNVR. After entering Major Mode 104, the quaternion shipped to A/E ATT PROC is always Q_B_I_CMD. The rate at which Q_B_I_CMD is supplied to the DAP and sent on to A/E ATT PROC depends on the circumstances. For a preburn maneuver, Q_B_I_CMD is supplied once. During a TVC or guided RCS burn, the commanded attitude, Q_B_I_CMD, is supplied at 1.04 Hz. The resulting display can be used by the crew as visual input for manual attitude control using the RCS and/or OMS, and to monitor attitude control during an automatic OMS burn or an automatic RCS maneuver or hold.

The quaternion received by AUTO_MNVR depends on whether it is desired to maneuver to and/or hold a commanded attitude or to hold the current attitude. AUTO_MNVR receives the commanded attitude Q_B_I_CMD if PREBURN_MNVR goes high during RCS automatic mode and during a guided RCS burn. (It also "receives" Q_B_I_CMD, but is not executed, during a TVC burn.) A snapshot value of the current attitude, Q_B_I, is provided to AUTO_MNVR at (1) the end of an OMS or guided RCS burn, (2) ET separation, (3) the start of the insertion and deorbit phases, (4) change from RCS automatic to RCS manual mode or, vice versa, if a guided RCS burn is not in progress, and (5) if the commanded attitude is changed (different from the target attitude) while in the course of an automatic PREBURN maneuver.

H. Function Module Descriptions. The control law function modules are described in Subsections 4.4.4.2.1 through 4.4.4.2.3. Within these subsections, the modules are ordered alphanumerically by name. The groupings are as follows:

Section	Subject
4.4.4.2.1	Steering processor modules
4.4.4.2.2	RCS processor modules
4.4.4.2.3	OMS processor modules

4.4.4.2.1 Steering Processor

4.4.4.2.1.1 AUTO_MNVR.

A. Function. This module generates control signals to effect an attitude hold or maneuver to a commanded attitude followed by an attitude hold. The module initiates in a maneuver or hold mode as a function of the magnitude of the difference between the actual vehicle attitude and the target attitude. If the initial mode is maneuver, the module computes the time needed to complete the maneuver. The mode is changed to hold at the end of this time. The FORCE_FIRE flags are used to ensure prompt vehicle response to transitions between these modes. The detailed block diagram for the module AUTO_MNVR is presented in Figures 4.4.4.2.1.1-1 and 4.4.4.2.1.1-2.

B. Processing Requirements. The module AUTO_MNVR is processed at 1.04 Hz.

C. Interface Requirements. The interface requirements for the module AUTO_MNVR are shown in Table 4.4.4.2.1.1-1.

D. I-Loads/Constants. The I-loads/constants for the module AUTO_MNVR are shown in Table 4.4.4.2.1.1-2.

E. Initialization Requirements. The initialization requirements for the module AUTO_MNVR are included in Figure 4.4.4.2.1.1-1.

Table 4.4.4.2-2. TVC Control Configuration

TVC Mode	Automatic			Manual					
No. of engines	2	1		2		1			
RHC Deflection	(In detent)	(In detent)		Within SS	Beyond SS	Within SS		Beyond SS	
Axis	All	Roll	Pitch, Yaw	Any	Any	Roll	Pitch, yaw	Roll	Pitch, yaw
OMS Processor Control Inputs	Rate cmds from 1	Not used	Rate cmds from 1	Rate cmds from 2	Rate cmds from 2	Not used	Rate cmds from 2	Not used	Rate cmds from 2
RCS Processor Control Inputs	Errors from 1 + 4	Errors from 1 + 4	Errors from 1 + 4	Errors from 2 + 4	Jet cmds from 5	Errors from 3 + 4 Ⓐ See note	Errors from 2 + 4	Jet cmds from 5 Ⓑ See note	Jet cmds from 5

1 OMS_STEERING_TRANSITION + GUIDANCE_COMPENSATION

2 MANUAL_TVC

3 ROT_DISC_TRANSITION

4 RCS_ERRORS_TRANSITION

5 ROT_ACCEL

NOTE: Accel/drift/discrete hysteresis logic applies to transitions between states Ⓐ and Ⓑ.

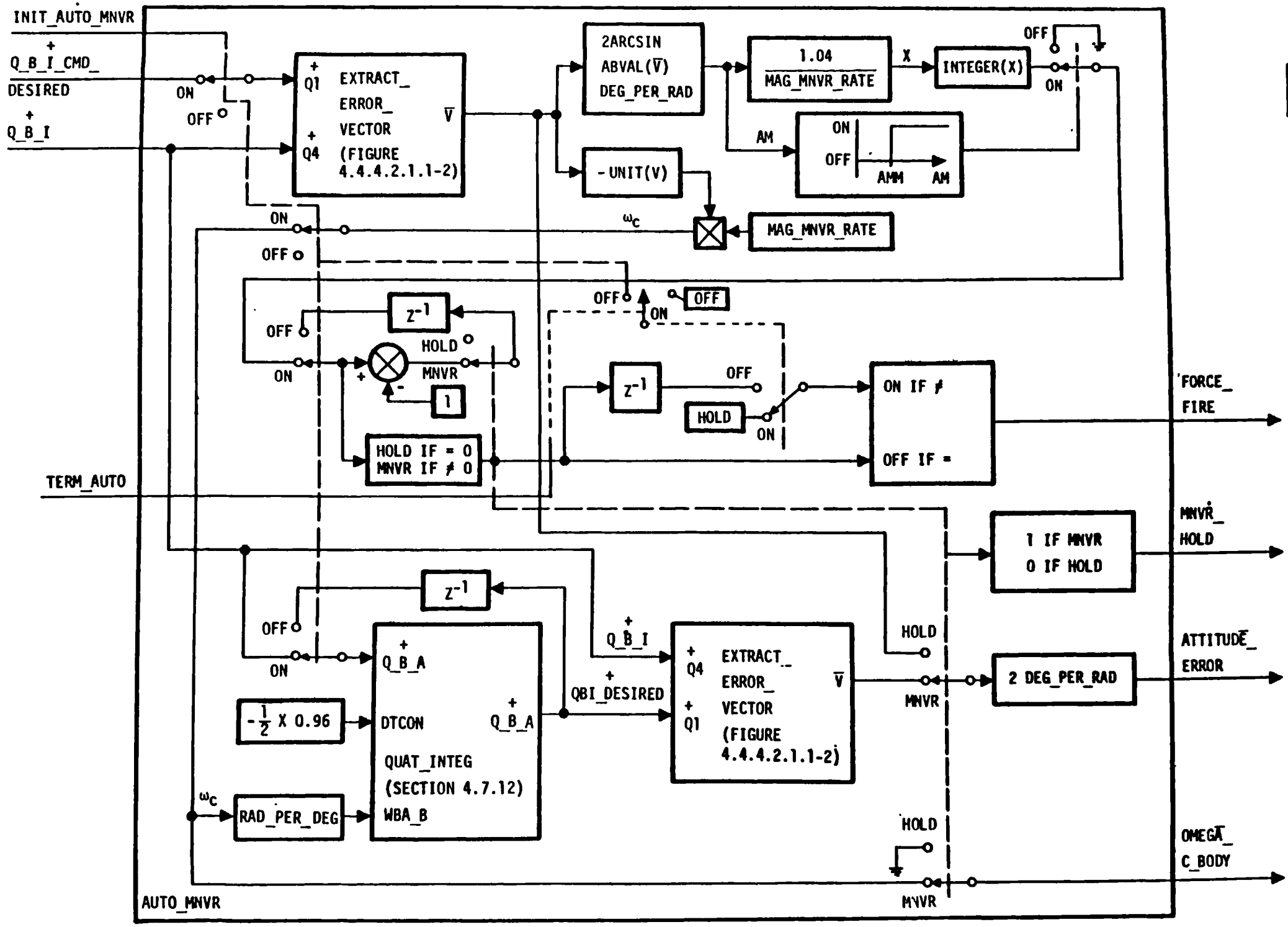

Figure 4.4.4.2.1.1-1. AUTO_MNVR

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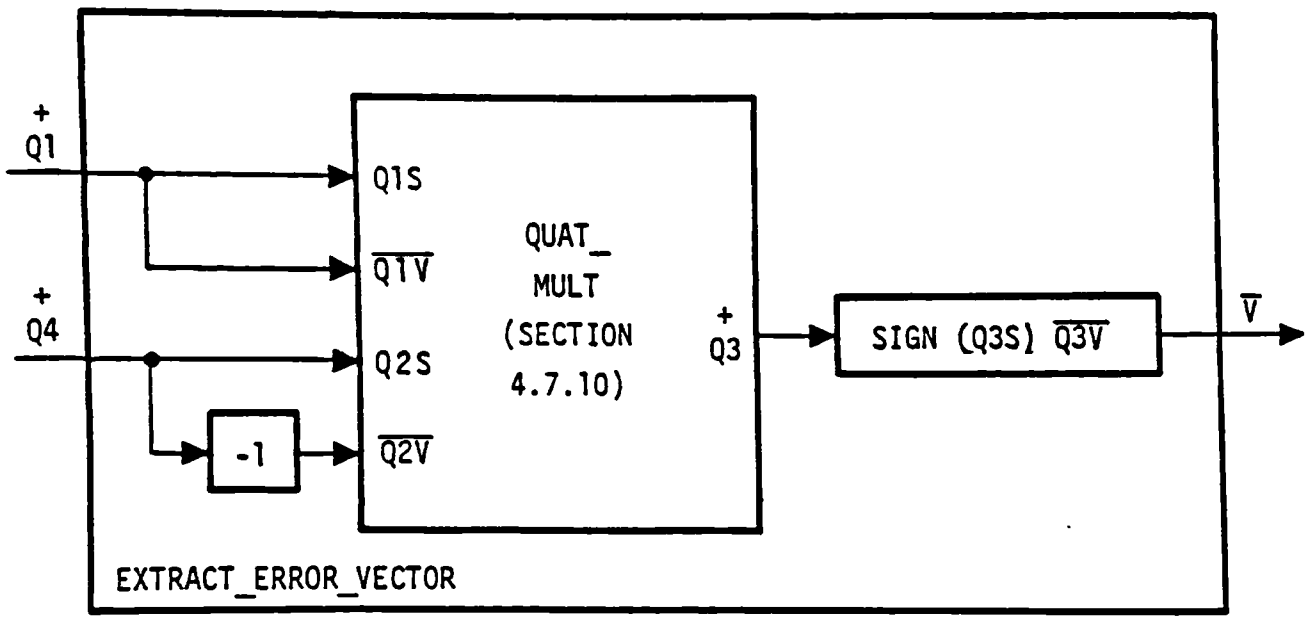

Figure 4.4.4.2.1.1-2. EXTRACT_ERROR_VECTOR

Table 4.4.4.2.1.1-1. AUTO_MNVR Interface Requirements

Name	Description	Source or Destination	Type	Range	Unit	Sample Rate (Hz)
Inputs						
INIT_AUTO_MNVR	Module initialization flag (1=init)	TRNS_RECON	B	0,1	none	1.04
Q_B_I	Vehicle attitude with respect to reference attitude, given as the M50-to-body quaternion	ASCENT/ENTRY ATT PROC	Struct: S; V(3)S	0 to 1; -1 to 1	none	1.04
Q_B_I_CMD_DESIRED	Commanded vehicle attitude with respect to reference attitude, given as the M50-to-body quaternion	ASCENT/ENTRY ATT PROC, AS MNVR DIP, DEORB MNVR DIP, ORB INS GUID, or DEORB GUID (via unity gain)	Struct: S; V(3)S	0 to 1; -1 to 1	none	1.04
TERM_AUTO	Flag indicating that guidance has updated the desired attitude during a preburn maneuver	TRNS_RECON	B	0,1	none	1.04
Outputs						
ATTITUDE_ERROR	Body angle error	RCS_ERRORS_TRANSITION	V(3)S	-360 to 360	deg	1.04
FORCE_FIRE	Rate damping initiation flag by axis (1=damp rate)	PHASE_PLANE_ TRANSITION	B(3)	0,1 for each bit	none	1.04
OMEGA_C_BODY	Desired body angular rate	RCS_ERRORS_TRANSITION	V(3)S	-5 to 5	deg/s	1.04
MNVR_HOLD	Flag specifying maneuver or hold state (1=mnvr)	TRNS_RECON	B	0,1	none	1.04

Table 4.4.4.2.1.1-2. AUTO_MNVR I-Loads/Constants

Name	Description	Type	MSID/Value	Unit
AMM	Maneuver/hold threshold	S	V96U8590C	deg
MAG_MNVR_RATE	Magnitude of maneuver rate about eigenaxis	S	V96U8589C	deg/s
DEG_PER_RAD	Radians to degrees conversion factor	S	180/pi	deg/rad
RAD_PER_DEG	Degrees to radians conversion factor	S	pi/180	rad/deg

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4.4.4.2.1.2 ET_SEP_PROCESSOR.

A. Function. This module monitors translation along the vehicle -Z axis until a desired velocity increment is achieved. The module operates closed loop by using the measured vehicle velocity increments. When the module determines that the desired velocity increment has been achieved, it zeroes the translation command and sets a flag. The detailed block diagram for the module ET_SEP_PROCESSOR is presented in Figure 4.4.4.2.1.2-1.

B. Processing Requirements. The module ET_SEP_PROCESSOR is processed at 1.04 Hz.

C. Interface Requirements. The interface requirements for the module ET_SEP_PROCESSOR are shown in Table 4.4.4.2.1.2-1.

D. I-loads. The I-loads for the module ET_SEP_PROCESSOR are shown in Table 4.4.4.2.1.2-2.

E. Initialization Requirements. The initialization requirements for the module ET_SEP_PROCESSOR are shown in Table 4.4.4.2.1.2-3.

4.4.4.2.1.2 ET_SEP_PROCESSOR.

A. Function. This module monitors translation along the vehicle -Z axis until a desired velocity increment is achieved. The module operates closed loop by using the measured vehicle velocity increments. When the module determines that the desired velocity increment has been achieved, it zeroes the translation command and sets a flag. The detailed block diagram for the module ET_SEP_PROCESSOR is presented in Figure 4.4.4.2.1.2-1.

B. Processing Requirements. The module ET_SEP_PROCESSOR is processed at 1.04 Hz.

C. Interface Requirements. The interface requirements for the module ET_SEP_PROCESSOR are shown in Table 4.4.4.2.1.2-1.

D. I-loads. The I-loads for the module ET_SEP_PROCESSOR are shown in Table 4.4.4.2.1.2-2.

E. Initialization Requirements. The initialization requirements for the module ET_SEP_PROCESSOR are shown in Table 4.4.4.2.1.2-3.

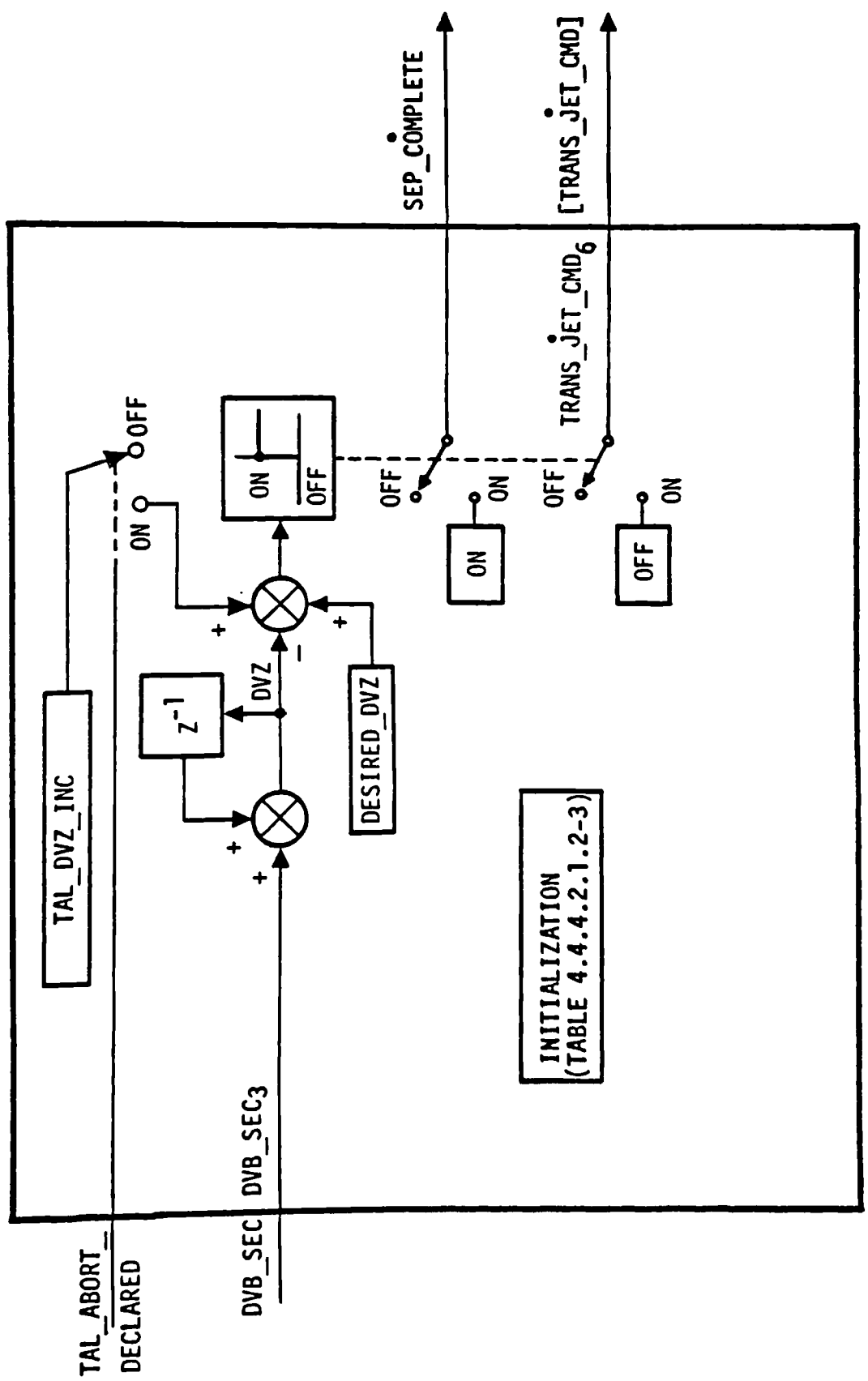

Figure 4.4.4.2.1.2-1. ET_SEP_PROCESSOR

Table 4.4.4.2.1.2-1. ET_SEP_PROCESSOR Interface Requirements

Name	Description	Source or Destination	Type	Range	Unit	Sample Rate (Hz)
Inputs						
DVB_SEC	Vehicle velocity increment over past 0.96 second	ASCENT/ENTRY ATT PROC	V(3)S	-1 to 1	ft/s	1.04
TAL_ABORT_DECLARED	Transatlantic abort flag	MSC	B	0,1	none	1.04
Outputs						
SEP_COMPLETE	Flag indicating desired velocity change has been achieved (1=complete)	MSC, TRNS_RECON, JET_SELECT_TRANSITION	B	0,1	none	1.04
TRANS_JET_CMD	Translation command (+X, -X, +Y, -Y, +Z, -Z)	JET_SELECT_TRANSITION	A(6)B	0,1	none	1.04

Table 4.4.4.2.1.2-2. ET_SEP_PROCESSOR I-Loads

Name	Description	Type	MSID	Unit
DESIRED_DVZ	Desired Z-axis velocity change	S	V97U2339C	ft/s
TAL_DVZ_INC	Desired Z-axis velocity increment for transatlantic abort	S	V99U7404C	ft/s

Table 4.4.4.2.1.2-3. ET_SEP_PROCESSOR Initialization Requirements

Initialize on Transition From	Initialize on Transition To	Variable	Initial Value
	First pass	DVZ	0

4.4.4.2.1.3 GUIDANCE_COMPENSATION.

A. Function. This module provides gain, compensation filtering, and rate limiting for the guidance loop in pitch and yaw. The roll rate command is set to zero. The detailed block diagram for GUIDANCE_COMPENSATION is shown in Figure 4.4.4.2.1.3-1.

B. Processing Rate. GUIDANCE_COMPENSATION is processed at 12.5 Hz.

C. Interface Requirements. The interface requirements for GUIDANCE_COMPENSATION are shown in Table 4.4.4.2.1.3-1.

D. I-loads. The I-loads for GUIDANCE_COMPENSATION are shown in Table 4.4.4.2.1.3-2.

E. Initialization Requirements. The initialization requirements for GUIDANCE_COMPENSATION are shown in Table 4.4.4.2.1.3-3.

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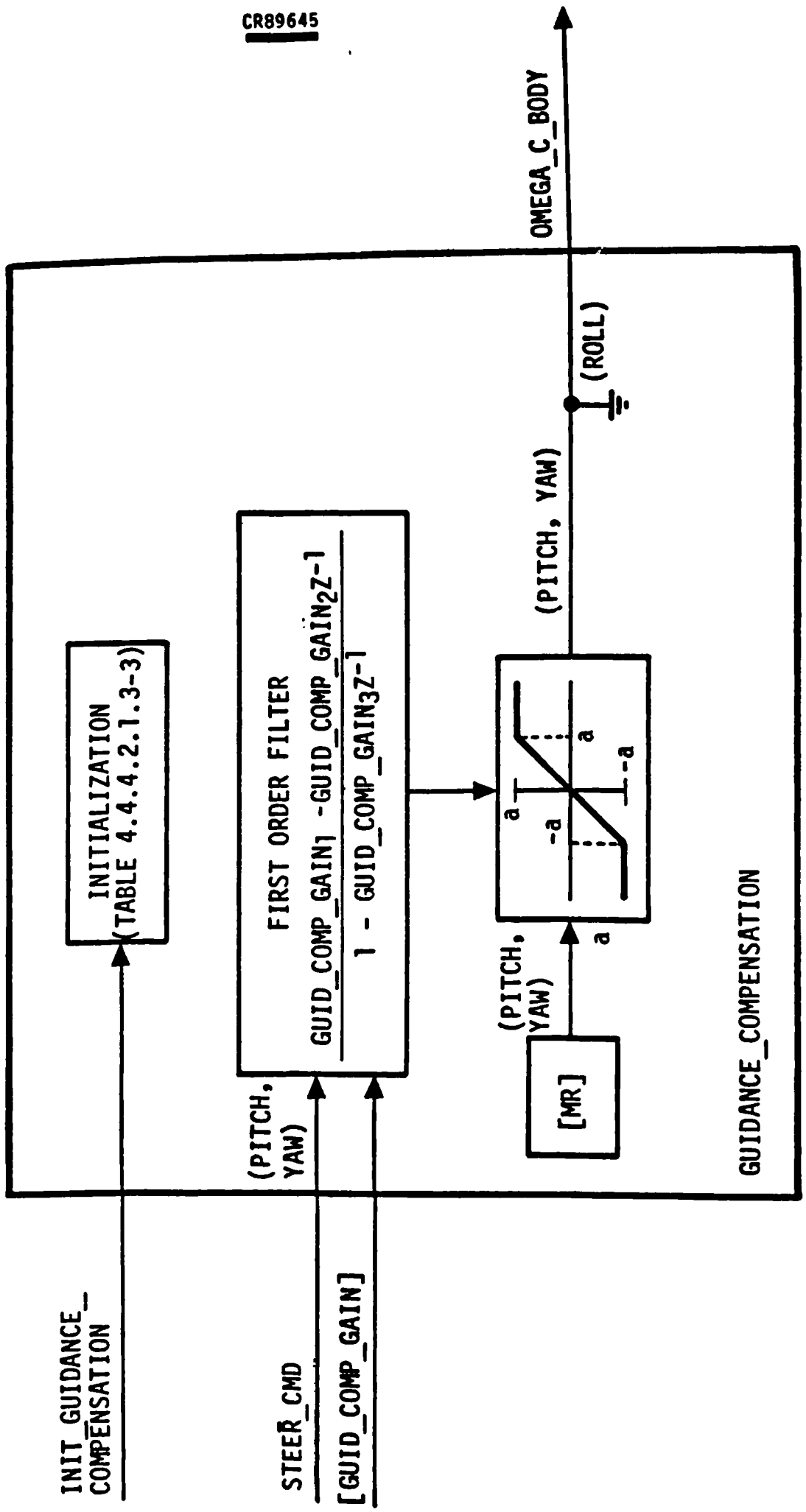

Figure 4.4.4.2.1.3-1. GUIDANCE_COMPENSATION

Table 4.4.4.2.1.3-1. GUIDANCE_COMPENSATION Interface Requirements

Name	Description	Source or Destination	Type	Range	Unit	Sample Rate (Hz)
Inputs						
GUID_COMP_GAIN	TVC compensation gains	TRNS_RECON	A(3)S	0 to 5	none	12.5
INIT_GUIDANCE_ COMPENSATION	Module initialization flag (0=no init; 1=two engine to one engine transition init; 2=normal init)	TRNS_RECON	I	0,1,2	none	12.5
STEER_CMD (pitch and yaw components)	Commanded body steering angle	OMS_STEERING-TRANSITION	V(3)S	-100 to 100	deg	12.5
Outputs						
OMEGA_C_BODY	Commanded body angular rate	RCS_ERRORS_ TRANSITION, Roll component: TVC_LAW_ROLL, Pitch and Yaw components: TVC_LAW_PITCH_YAW	V(3)S	-5 to 5	deg/s	12.5

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Table 4.4.4.2.1.3-2. GUIDANCE_COMPENSATION I-Loads

Name	Description	Type	MSID/ Value	Units
MR	Maximum angular rate command during OMS TVC	A(3)S	V97U2357C to V97U2359C	deg/s

Table 4.4.4.2.1.3-3. GUIDANCE_COMPENSATION Initialization Requirements (Note 1)

Initialize on Transition From	Initialize on Transition To	Variable	Initial Value
INIT_GUIDANCE_COMPENSATION not = 1	INIT_GUIDANCE_ COMPENSATION = 1	First order filter node	OMEGA_C_BODY$(2 to 3) GUIDE_COMP_GAIN$3 - STEER_CMD$(2 to 3) GUID_COMP_GAIN$2
INIT_GUIDANCE_COMPENSATION not = 2	INIT_GUIDANCE_ COMPENSATION = 2	STEER_CMD OMEGA_C_BODY First order filter node	0 OMEGA_C_BODY$(2 to 3) GUIDE_COMP_GAIN$3 - STEER_CMD$(2 to 3) GUID_COMP_GAIN$2

Note 1. Do not perform filter and limiter processing on the initialization pass.

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4.4.4.2.1.4 MANUAL_TVC

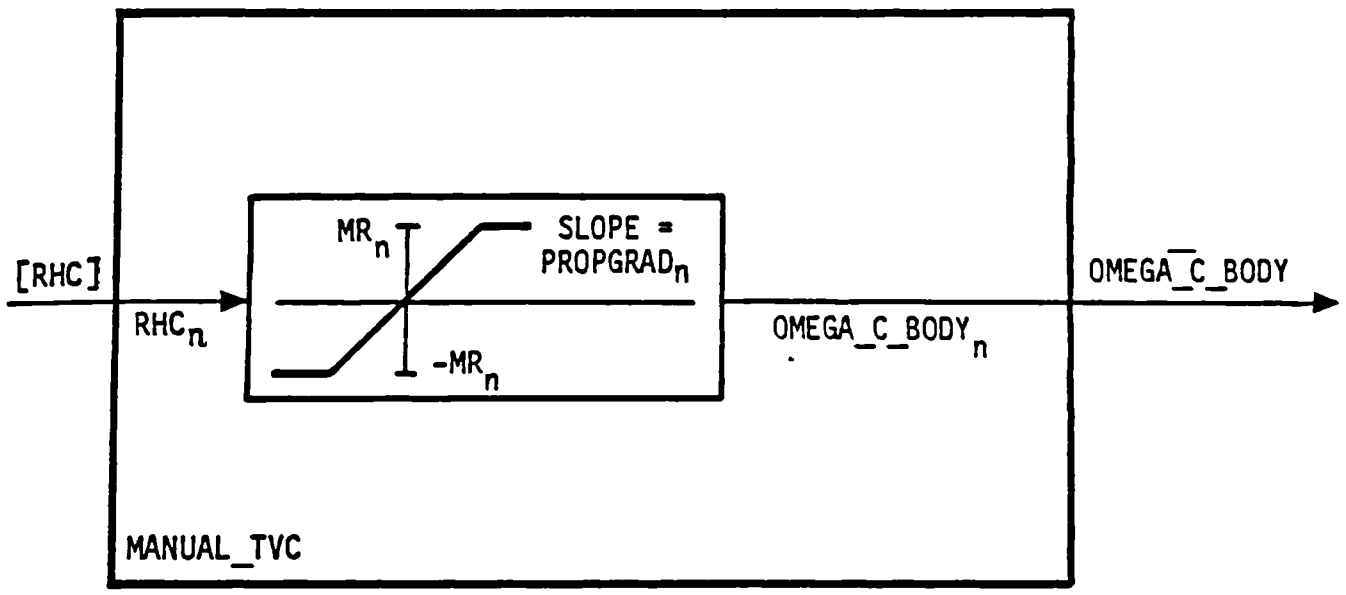
A. Function. This module provides commands to generate a three-axis vehicle angular rate during a TVC burn. The generated rate corresponds in sense and magnitude to the RHC deflection and is constrained to a limiting value. The detailed block diagram for MANUAL_TVC is presented in Figure 4.4.4.2.1.4-1.

B. Processing Rate. MANUAL_TVC is processed at 12.5 Hz.

C. Interface Requirements. The interface requirements for MANUAL_TVC are shown in Table 4.4.4.2.1.4-1.

D. I-loads. The I-loads for MANUAL_TVC are shown in Table 4.4.4.2.1.4-2.

E. Initialization Requirements. There are no initialization requirements for MANUAL_TVC.



NOTE: ARRAY OR VECTOR SUBSCRIPT n SHOULD BE TAKEN AS INDICATING THAT THE PROCESSING SHOWN IS FOR ONE ELEMENT, AND ALL THREE ELEMENTS ARE PROCESSED.

Figure 4.4.4.2.1.4-1. MANUAL_TVC

Table 4.4.4.2.1.4-1. MANUAL_TVC Interface Requirements

Name	Description	Source or Destination	Type	Range	Unit	Sample Rate (Hz)
Inputs						
RHC	Rotational hand controller deflection	3-AX RHC SOP	A(3)S	-50 to 50	deg	12.5
Output						
OMEGA_C_BODY	Commanded vehicle angular rate in body axes	RCS_ERRORS_ TRANSITION Roll component: TVC_LAW_ROLL Pitch and Yaw components: TVC_LAW_PITCH_YAW	V(3)S	-5 to 5	deg/s	12.5

Table 4.4.4.2.1.4-2. MANUAL TVC I-Loads

Name	Description	Type	MSID	Unit
MR	Maximum rate command during TVC	A(3)S	V97U2357C to V97U2359C	deg/s
PROPGRAD	Gain: commanded body rate divided by RHC deflection	A(3)S	V97U2374C to V97U2376C	(deg/s)/deg

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4.4.4.2.1.5 OMS_STEERING_TRANSITION.

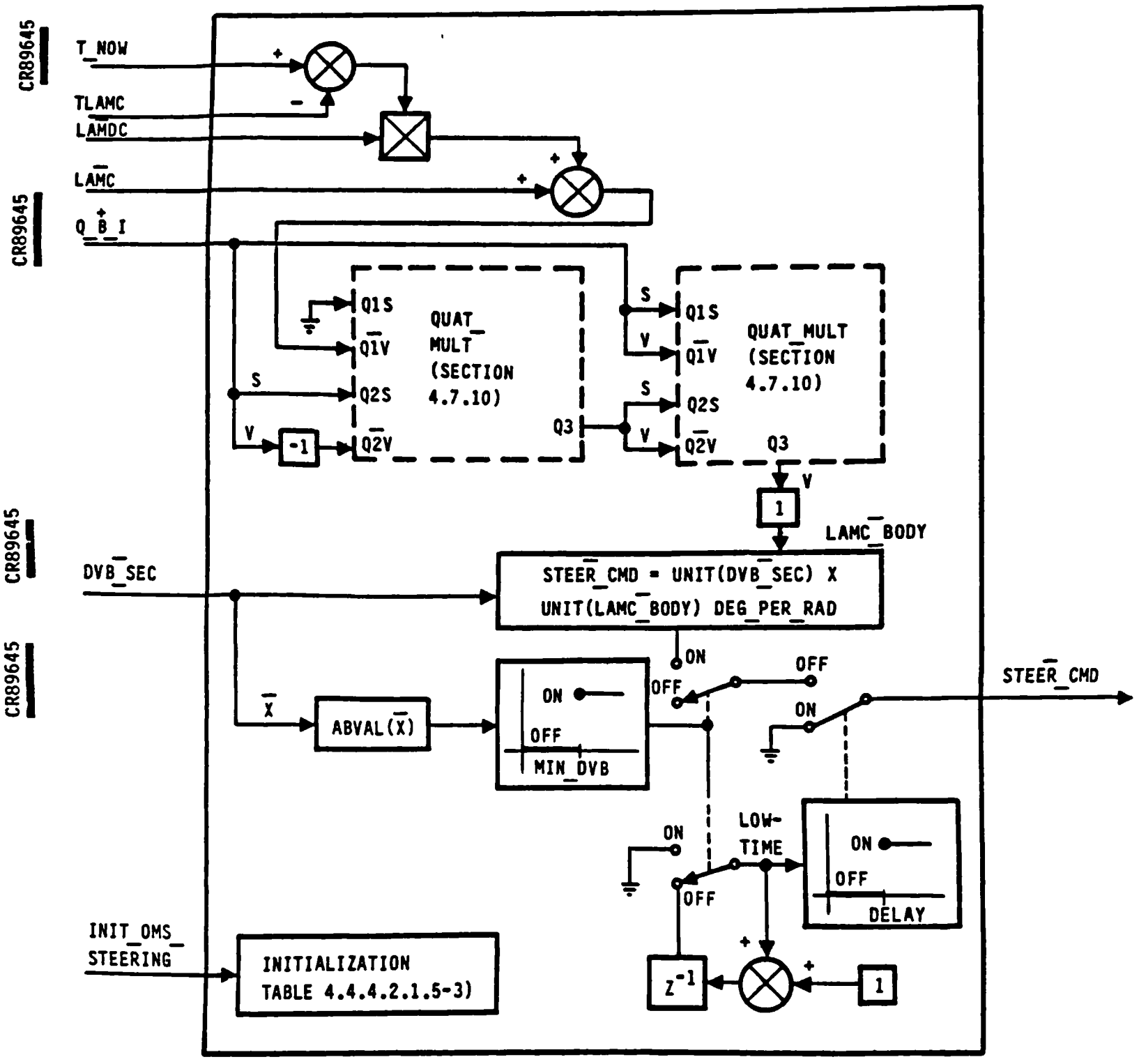
A. Function. This module commands a vehicle steering angle equal to the vector cross product of the commanded thrust direction and the sensed vehicle velocity change. If the sensed velocity falls below a threshold value, the module holds its output at the previous value until passage of a time delay (measured in cycles at the module processing rate); the output is then set to zero. However, anytime the sensed velocity change equals or exceeds the threshold value, normal processing is resumed and the delay timer is reset. The detailed block diagram for OMS_STEERING_TRANSITION is presented in Figure 4.4.4.2.1.5-1.

B. Processing Rate. OMS_STEERING_TRANSITION is processed at 1.04 Hz.

C. Interface Requirements. The interface requirements for OMS_STEERING_TRANSITION are presented in Table 4.4.4.2.1.5-1.

D. I-Loads/Constants. The I-loads/constants for OMS_STEERING_TRANSITION are presented in Table 4.4.4.2.1.5-2.

E. Initialization Requirements. The initialization requirements for OMS_STEERING_TRANSITION are presented in Table 4.4.4.2.1.5-3.



NOTES

1. X SYMBOLIZES VECTOR CROSS PRODUCT.

2. S AND V REPRESENT THE SCALAR AND VECTOR PARTS, RESPECTIVELY, OF THE INDICATED QUATERNION

Figure 4.4.4.2.1.5-1. OMS_STEERING_TRANSITION

Table 4.4.4.2.1.5-1. OMS_STEERING_TRANSITION Interface Requirements

Name	Description	Source or Destination	Type	Range	Unit	Sample Rate (Hz)
Inputs						
DVB_SEC	Vehicle velocity increment past 0.96 second	ASCENT/ENTRY ATT PROC	V(3)S	-4 to 4	ft/s	1.04
INIT_OMS_STEERING	Module initialization flag (1 = init)	TRNS_RECON	B	0,1	none	1.04
LAMC	Commanded vehicle velocity-to-go unit vector in reference coordinates	ORB INS GUID or DEORB GUID	V(3)S	-1 to 1	none	1.04
LAMDC	Commanded derivative of LAMC in reference coordinates	ORB INS GUID or DEORB GUID	V(3)S	-1 to 1	1/S	1.04
Q_B_I	Vehicle attitude with respect to reference attitude, given as the M50-to-body quaternion	ASCENT/ENTRY ATT PROC	Struct: S; V(3)S	0 to 1; -1 to 1	none	1.04
TLAMC	Time of issuance of LAMC	ORB INS GUID or DEORB GUID	S	0 to 10^7	s	1.04
TNOW	Present time	ASCENT/ENTRY ATT PROC	S	0 to 10^7	s	1.04
Output						
STEER_CMD	Commanded vehicle steering angle in body axes	GUIDANCE_COMPENSATION	V(3)S	-100 to 100	deg	1.04

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Table 4.4.4.2.1.5-2. OMS_STEERING_TRANSITION
I-Loads/Constants

CR89645

Name	Description	Type	MSID/ Value	Unit
DELAY	Number of passes sensed delta-V can be below minimum before module output is zeroed	I	V97U2663C	none
MIN_DVB	Minimum magnitude of sensed delta-V for cross product steering	S	V97U2784C	ft/s
DEG_PER_ RAD	Radians to degrees conversion factor	S	180/pi	deg/rad

Table 4.4.4.2.1.5-3. OMS_STEERING_TRANSITION Initialization
Requirements

CR89645

Initialize on Transition From	Initialize on Transition To	Variable	Initial Value
INIT_OMS_STEERING = OFF	INIT_OMS_STEERING = ON	STEER_CMD LOW_TIME	0 0

4.4.4.2.1.6 RCS_ERRORS_TRANSITION.

A. Function. This module obtains the vehicle attitude error and angular rate error based upon an angular rate command from steering processor modules, an attitude error signal from AUTO_MNVR, and vehicle measurement data. It first forms the desired attitude increment by multiplying the desired angular rate by the time step. Then the attitude error is updated by the difference between the desired and measured attitude increments. The angular rate error is the difference between the desired and measured rates.

The initialization flag for this module sets a given component of the attitude error to zero. This action is typically invoked upon assumption or resumption of control of a given body axis by a steering processor module. In the particular case of the manual discrete rate command/attitude hold submode, the initialization flag is set (in addition to entry into the submode) when the RHC is moved into or out of detent. The detailed block diagram for the module RCS_ERRORS_TRANSITION is presented in Figure 4.4.4.2.1.6-1.

B. Processing Requirements. The module RCS_ERRORS_TRANSITION is processed at 12.5 Hz.

C. Interface Requirements. The interface requirements for the module RCS_ERRORS_TRANSITION are shown in Table 4.4.4.2.1.6-1.

D. Constants. The constants for the module RCS_ERRORS_TRANSITION are shown in Table 4.4.4.2.1.6-2.

E. Initialization Requirements. The initialization requirements for the module RCS_ERRORS_TRANSITION are shown in Table 4.4.4.2.1.6-3.

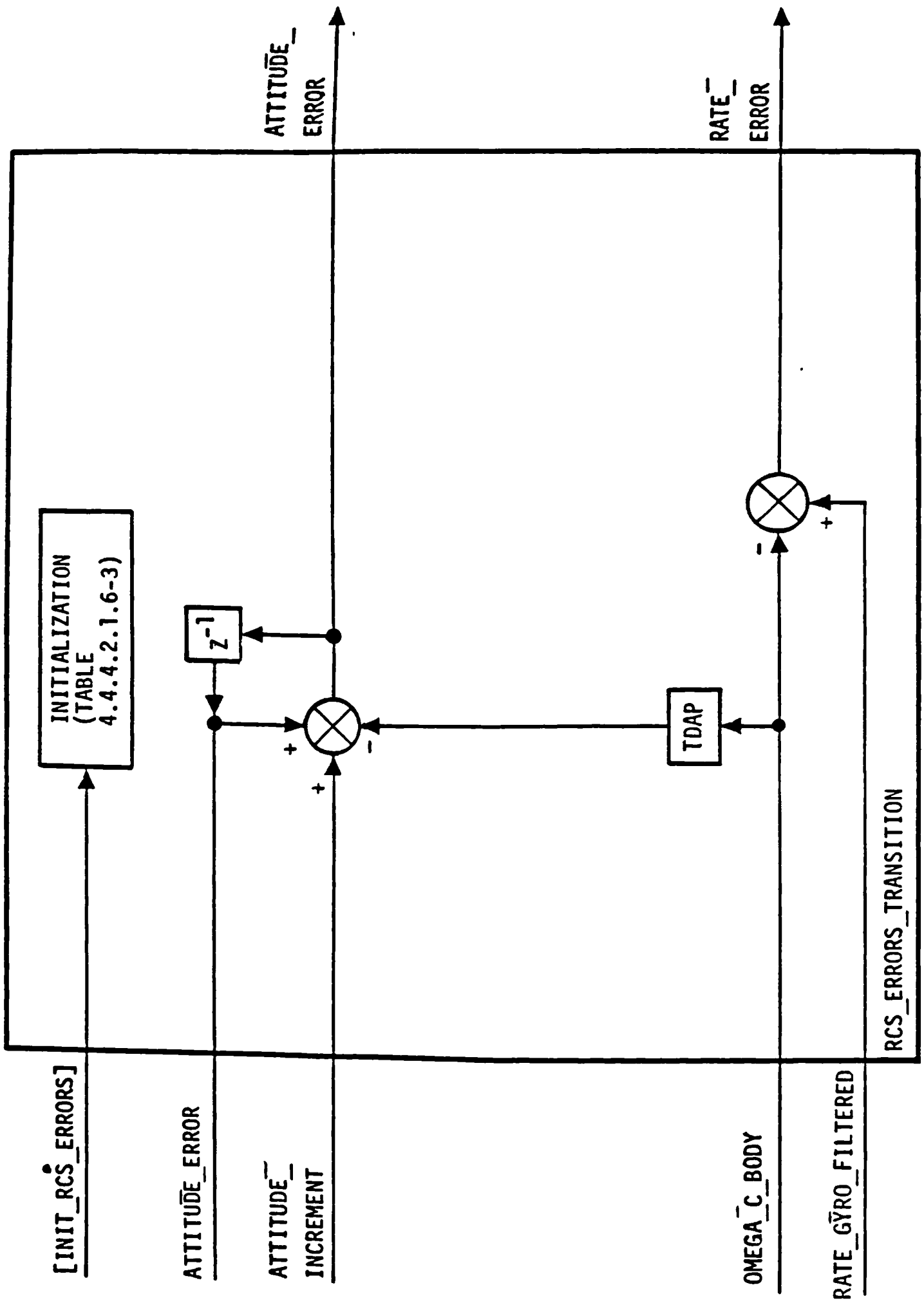

Figure 4.4.4.2.1.6-1. RCS_ERRORS_TRANSITION

Table 4.4.4.2.1.6-1. RCS_ERRORS_TRANSITION Interface Requirements

Name	Description	Source or Destination	Type	Range	Unit	Sample Rate (Hz)
Inputs						
ATTITUDE_ERROR	Body angle error	AUTO_MNVR	V(3)S	-360 to 360	deg	12.5
ATTITUDE_INCREMENT	Body angle increment over sampling interval	ASCENT/ENTRY ATT PROC	V(3)S	-4 to 4	deg	12.5
INIT_RCS_ERRORS	Module initialization flag	TRNS_RECON, ROT_DISC_TRANSITION	A(3)B	0,1	none	12.5
OMEGA_C_BODY	Desired body angular rate	MANUAL_TVC, GUIDANCE_ COMPENSATION, ROT_DISC_TRANSITION, AUTO_MNVR	V(3)S	-5 to 5	deg/s	12.5
RATE_GYRO_FILTERED	Measured vehicle angular rate	ASCENT/ENTRY ATT PROC, via RATE_FILTER or unity gain	V(3)S	Roll: -40 to 40 Pitch, Yaw: -20 to 20	deg/s	12.5
Outputs						
ATTITUDE_ERROR	Body angle error	PHASE_PLANE_TRANSITION	V(3)S	-360 to 360	deg	12.5
RATE_ERROR	Body angular rate error	PHASE_PLANE_TRANSITION	V(3)S	-20 to 20	deg/s	12.5

Table 4.4.4.2.1.6-1. RCS_ERRORS_TRANSITION Interface Requirements

Name	Description	Source or Destination	Type	Range	Unit	Sample Rate (Hz)
Inputs						
ATTITUDE_ERROR	Body angle error	AUTO_MNVR	V(3)S	-360 to 360	deg	12.5
ATTITUDE_INCREMENT	Body angle increment over sampling interval	ASCENT/ENTRY ATT PROC	V(3)S	-4 to 4	deg	12.5
INIT_RCS_ERRORS	Module initialization flag	TRNS_RECON, ROT_DISC_TRANSITION	A(3)B	0,1	none	12.5
OMEGA_C_BODY	Desired body angular rate	MANUAL_TVC, GUIDANCE_COMPENSATION, ROT_DISC_TRANSITION, AUTO_MNVR	V(3)S	-5 to 5	deg/s	12.5
RATE_GYRO_FILTERED	Measured vehicle angular rate	ASCENT/ENTRY ATT PROC, via RATE_FILTER or unity gain	V(3)S	Roll: -40 to 40 Pitch, Yaw: -20 to 20	deg/s	12.5
Outputs						
ATTITUDE_ERROR	Body angle error	PHASE_PLANE_TRANSITION	V(3)S	-360 to 360	deg	12.5
RATE_ERROR	Body angular rate error	PHASE_PLANE_TRANSITION	V(3)S	-20 to 20	deg/s	12.5

Table 4.4.4.2.1.6-2. RCS_ERRORS_TRANSITION Constants

Name	Description	Type	Value	Unit
TDAP	Period of RCS DAP cycle	S	0.08	s

Table 4.4.4.2.1.6-3. RCS_ERRORS_TRANSITION
Initialization Requirements

Initialize on Transition From	Initialize on Transition To	Variable	Initial Value
INIT_RCS_ERRORS$(n) = OFF	INIT_RCS_ERRORS$(n) = ON	ATTITUDE_ERROR$(n)	0

4.4.4.2.1.7 ROT_DISC_TRANSITION.

A. Function. For each vehicle axis that is in the manual discrete rate rotation submode, this module provides commands to generate a predetermined vehicle angular rate about that axis while the RHC is out of detent in that axis. The sense of the angular rate corresponds to the sense of the RHC deflection. When the RHC is in detent, an attitude hold is performed in the affected axis; the vehicle maintains the attitude it had at the instant the RHC went into detent. The detailed block diagram for the module ROT_DISC_TRANSITION is presented in Figure 4.4.4.2.1.7-1.

B. Processing Requirements. The module ROT_DISC_TRANSITION is processed at 12.5 Hz per axis.

C. Interface Requirements. The interface requirements for the module ROT_DISC_TRANSITION are shown in Table 4.4.4.2.1.7-1.

D. I-loads. The I-loads for the module ROT_DISC_TRANSITION are shown in Table 4.4.4.2.1.7-2.

E. Initialization Requirements. The initialization requirements for the module ROT_DISC_TRANSITION are included in Figure 4.4.4.2.1.7-1.

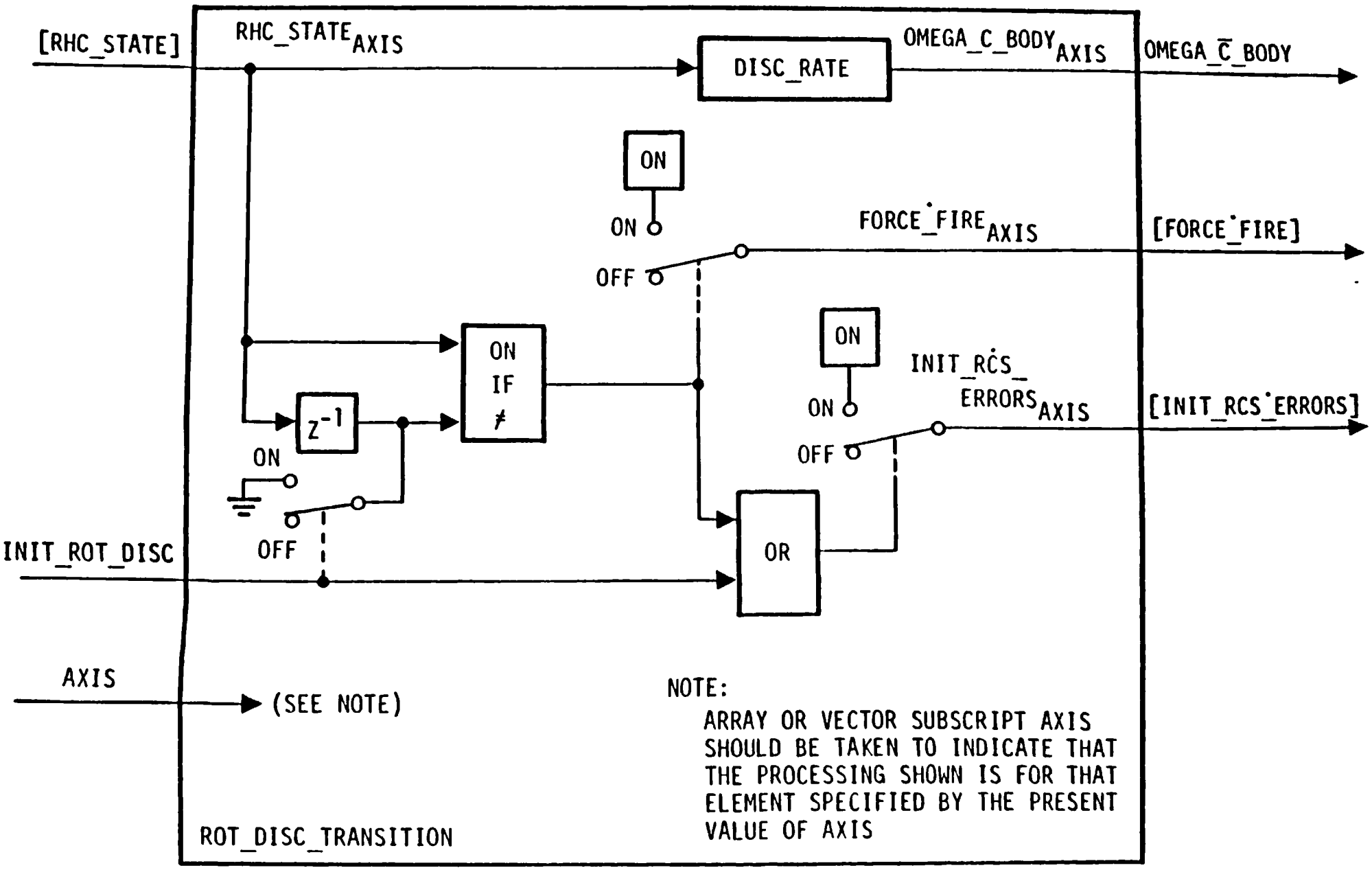

Figure 4.4.4.2.1.7-1. ROT_DISC_TRANSITION

Table 4.4.4.2.1.7-1. ROT_DISC_TRANSITION Interface Requirements

Name	Description	Source or Destination	Type	Range	Unit	Sample Rate Hz
Inputs						
AXIS	Body axis for this execution	TRNS_RECON	I	1 to 3	none	12.5 axis
INIT_ROT_DISC	Module initialization flag	TRNS_RECON	B	0,1	none	12.5 axis
RHC_STATE	Rotational hand controller command with sense of deflection	3-AX RHC SOP	A(3)I	-1,0,1	none	12.5 axis
Outputs						
FORCE_FIRE	Rate damping initiation flag by axis (1=damp rate)	PHASE_PLANE_TRANSITION	B(3)	0,1 for each bit	none	2.5 axis
INIT_RCS_ERRORS	Module initialization flag	RCS_ERRORS_TRANSITION	A(3)B	0,1	none	12.5 axis
OMEGA_C_BODY	Desired body angular rate	RCS_ERRORS_TRANSITION	V(3)S	-5 to 5	deg/s	12.5 axis

Table 4.4.4.2.1.7-2. ROT_DISC_TRANSITION I-Loads

Name	Description	Type	MSID	Unit
DISC_RATE	Desired body angular rate during deflection of rotational hand controller	S	V97U1317C	deg/s

4.4.4.2.1.8 ROT_PULSE_TRANSITION.

A. Function. For each vehicle axis that is in the manual pulse rotation submode, this module provides a command to generate a predetermined vehicle angular rate increment about that axis for each time the RHC is moved out of detent in that axis. The sense of the angular rate increment corresponds to the sense of the RHC deflection. When the sum of all commanded rate increments about a given axis has been attained, vehicle rotation about that axis is in free drift, regardless of whether the RHC is in detent or out of detent in that axis. The module operates open loop by determining how many passes the RCS jets must fire to implement each commanded rate increment and maintaining a jet command of the correct sign for the total number of passes needed.

B. Block Diagram. The block diagram for ROT_PULSE_TRANSITION is shown in Figure 4.4.4.2.1.8-1.

C. Processing Rate. The module ROT_PULSE_TRANSITION is processed at 12.5 Hz/axis.

D. Interface Requirements. The interface requirements for the module ROT_PULSE_TRANSITION are shown in Table 4.4.4.2.1.8-1.

E. I-Loads/Constants. The I-loads/constants for the module ROT_PULSE_TRANSITION are shown in Table 4.4.4.2.1.8-2.

F. Initialization Requirements. The initialization requirements for the module ROT_PULSE_TRANSITION are shown in Table 4.4.4.2.1.8-3.

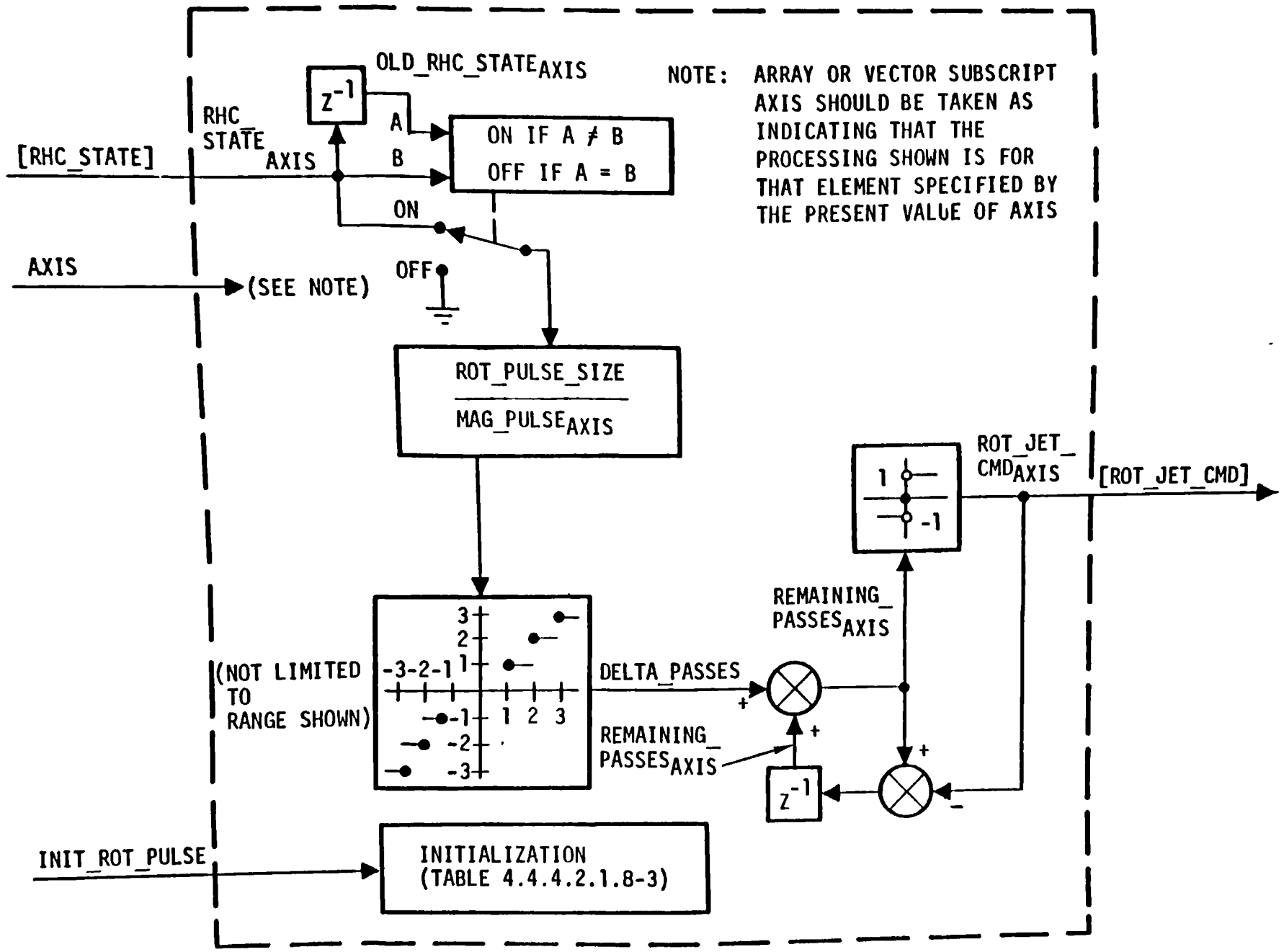

Figure 4.4.4.2.1.8-1. ROT_PULSE_TRANSITION

Table 4.4.4.2.1.8-1. ROT_PULSE_TRANSITION Interface Requirements

Name	Description	Source or Destination	Type	Range	Unit	Sample Rate (Hz)
Inputs						
AXIS	Body axis for this execution	TRNS_RECON	I	1,2,3	none	12.5/axis
INIT_ROT_PULSE	Module initialization flag	TRNS_RECON	B	0,1	none	12.5/axis
RHC_STATE	Rotational hand controller command with sense of deflection	3-AX RHC SOP	A(3)I	-1,0,1	none	12.5/axis
Output						
ROT_JET_CMD	RCS rotation command	JET_SELECT_ TRANSITION, RCS ACT LT	A(3)I	-1,0,1	none	12.5/axis

Table 4.4.4.2.1.8-2. ROT_PULSE_TRANSITION I-Loads/Constants

Name	Description	Type	MSID/Value	Unit
MAG_PULSE	Magnitude of average angular rate change available for each axis per FC cycle	A(3)S	V96U9747C V96U9748C V96U9749C	deg/s
ROT_PULSE_SIZE	Magnitude of desired angular rate change per deflection of rotational hand controller	S	0.0972	deg/s

Table 4.4.4.2.1.8-3. ROT_PULSE_TRANSITION Initialization Requirements

Initialize on Transition From	Initialize on Transition To	Variable	Initial Value
INIT_ROT_PULSE = OFF	INIT_ROT_PULSE = ON	OLD_RHC_STATE$ (AXIS)	0
		REMAINING_PASSES$ (AXIS)	0

4.4.4.2.1.9 RATE_FILTER.

A. Function. This module provides filtering of the rate gyro data for the RCS section of the Transition DAP.

B. Processing Rate. RATE_FILTER is processed at 12.5 Hz.

C. Interface Requirements. The interface requirements for RATE_FILTER are shown in Table 4.4.4.2.1.9-1.

D. Constants. There are no constants for RATE_FILTER.

E. Initialization Requirements. The initialization requirements for RATE_FILTER are shown in Table 4.4.4.2.1.9-2.

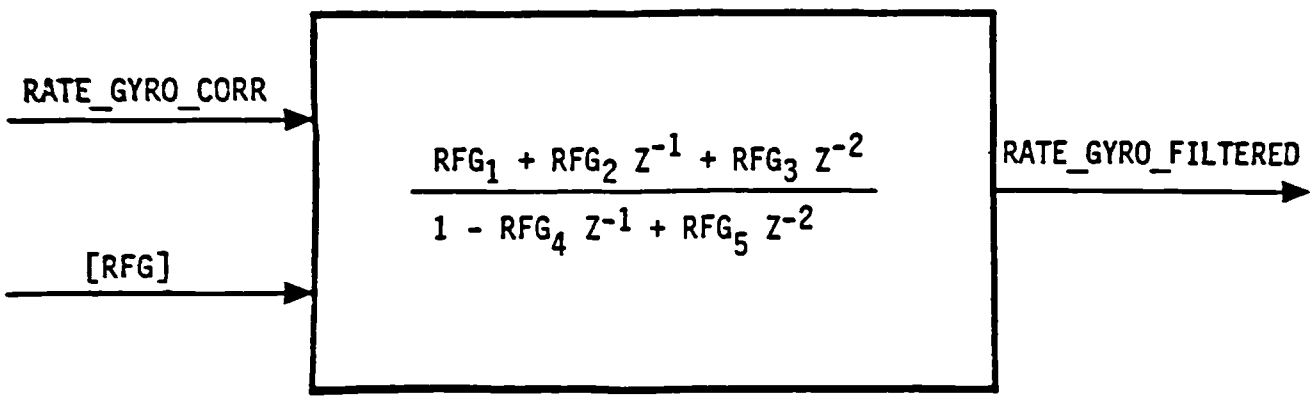

Figure 4.4.4.2.1.9-1. RATE_FILTER

Table 4.4.4.2.1.9-1. RATE_FILTER Interface Requirements

Name	Description	Source or Destination	Type	Range	Unit	Sample Rate (Hz)
Inputs						
RATE_GYRO_CORR	Corrected rate gyro data	ASCENT/ENTRY ATT PROC	V(3)S	-5 to 5	deg/s	12.5
RFG	Rate filter gain values	TRNS_RECON	A(5)S		none	12.5
Outputs						
RATE_GYRO_FILTERED	Filtered rate gyro data	RCS_ERRORS_TRANSITION	V(3)S	-5 to 5	deg/s	12.5

Table 4.4.4.2.1.9-2. RATE_FILTER Initialization Requirements

Initialize on Transition From	Initialize on Transition To	Variable	Initial Value
***	First pass	Second order filter nodes	0

Table 4.4.4.2.1.9-1. RATE_FILTER Interface Requirements

Name	Description	Source or Destination	Type	Range	Unit	Sample Rate (Hz)
Inputs						
RATE_GYRO_CORR	Corrected rate gyro data	ASCENT/ENTRY ATT PROC	V(3)S	-5 to 5	deg/s	12.5
RFG	Rate filter gain values	TRNS_RECON	A(5)S		none	12.5
Outputs						
RATE_GYRO_FILTERED	Filtered rate gyro data	RCS_ERRORS_TRANSITION	V(3)S	-5 to 5	deg/s	12.5

Table 4.4.4.2.1.9-2. RATE_FILTER Initialization Requirements

Initialize on Transition From	Initialize on Transition To	Variable	Initial Value
***	First pass	Second order filter nodes	0

4.4.4.2.2 RCS Processor.

4.4.4.2.2.1 JET_SELECT_TRANSITION.

A. Function. This module generates jet firing commands required to implement commanded translations and rotations. The transition jet select contains logic enabling selection of primary jets only. The algorithm takes into account jet failures, ET separation, RCS propellant crossfeed valve position, and tank constraints. Logic is included to permit propellant dumping through forward RCS jets for vehicle mass and c.g. control. Translation commands are ignored during dumping. Jet selection is according to a table lookup scheme, described in this subsection under paragraph F and in Tables 4.4.4.2.2.1-1 through 4.4.4.2.2.1-4. The detailed block diagram for the module JET_SELECT_TRANSITION is presented in Figures 4.4.4.2.2.1-1 through 4.4.4.2.2.1-12.

B. Processing Requirements. The module JET_SELECT_TRANSITION is processed at 12.5 Hz.

C. Interface Requirements. The interface requirements for the module JET_SELECT_TRANSITION are shown in Table 4.4.4.2.2.1-5.

D. Constants. There are no constants for JET_SELECT_TRANSITION.

E. Initialization Requirements. There are no initialization requirements for JET_SELECT_TRANSITION.

F. Detailed Function. This paragraph explains the table lookup logic and provides supporting comments for some of the block diagrams. Also included are data on RCS jet configuration.

The tables are divided into three sections (Tables 4.4.4.2.2.1-1 through 4.4.4.2.2.1-3). The first section provides the logic for the 19 jets that fire into the Z-axis: Part A for through ET separation, -Z translation, no -X translation, and either crossfeed closed or no +X translation; Part B for through ET separation, -Z translation, and -X translation; Part C for through ET separation, -Z translation, +X translation, and crossfeed open; Part D for after ET separation and -Z translation; Part E for all other cases (i.e., no -Z translation). These jets divide into seven directional jet clusters; namely, Groups 4, 5, 6, 11, 12, 13, and 14. The second section provides logic for the 12 jets that fire into the Y-axis. These jets divide into four directional jet clusters; namely, Groups 2, 3, 9, and 10. The third section provides logic for the seven jets that fire into the X-axis. These jets divide into three directional jet clusters; namely, Groups 1, 7, and 8 (see Figure 4.4.4.2.2.1-13 for RCS jet locations and plume directions).

Each page of the table lookup logic has three main divisions. The left-most division provides the command to be responded to. The middle division lists all relevant failure combinations (through one failure with translation and two failures with no translation). The right-most division specifies how many jets must be commanded to fire in each directional group under the conditions specified. In the middle division, the first row of each command configuration is always the no-failure case. The rows that follow list a group

number for the location of a failed jet (e.g., 9 means a jet has failed in Group 9). In the event that more failures occur than are covered by the tables, all the unfailed jets of those jets specified by the tables should be used.

The table lookup logic determines (for nominal and failure conditions) the total number by group of RCS jets to be fired. This information, in conjunction with the availability of jets (HFAIL_JSL), is used to determine which jets within a particular RCS jet group should be fired (NEW_JONLST_JSL). This selection is performed by choosing the required number of jets for each group among the unfailed jets within that group and with the highest priority within that group. Table 4.4.4.2.2.1-6 gives the jet group and jet priority associated with each element of NEW_JONLST_JSL and HFAIL_JSL. Note that no particular RCS jet is associated with each element of either parameter.

As a limited example, suppose the second- and third-priority jets of Group 9 were not available for firing ($HFAIL_JSL_{19\ to\ 22} = (0,1,\ 1,0)$) and that the table lookup logic required that two jets in Group 9 be fired, then $NEW_JONLST_JSL_{19\ to\ 22}$ would be set equal to (1,0, 0,1).

The principle behind the table lookup scheme is that all jets that fire in the Z-axis can give Z-translation and/or roll rotation and/or pitch rotation control. These 19 jets are considered independent of other axes, however. All jets fired in the Y-axis are considered to give Y-translation and/or yaw rotation only. All jets fired in the X-axis are considered to give X-translation control only. Interactions between axes are handled by phase-plane feedback and/or closed-loop feedback.

The priority of a particular RCS jet within its group is a mission-dependent and/or a crew-dependent function. Thus a mechanism is needed to identify which particular jet is associated with a particular in-group priority. This mechanism is the parameter JET_MAP. For JET_MAP to work properly, the input and output interfaces (AVAILABLE_JET_FWD, AVAILABLE_JET_AFT, NEW_JONLST_FWD, and NEW_JONLST_AFT) must be aligned identically, i.e., each respective element must refer to the same RCS jet. JET_MAP is an array of input/output interface array element numbers arranged by ascending group number and in order of descending priority (see Table 4.4.4.2.2.1-4 for arrangement). JET_MAP is used in the following equations (Figures 4.4.4.2.2.1-1 and -11):

$$I=1 \text{ TO } 14$$
$$HFAIL_JSL_I = \overline{AVAILABLE_JET_FWD}_{JET_MAP_I}$$

$$I=15 \text{ TO } 38$$
$$HFAIL_JSL_I = \overline{AVAILABLE_JET_AFT}_{JET_MAP_I}$$

$$I=1 \text{ TO } 14$$
$$NEW_JONLST_FWD_{JET_MAP_I} = NEW_JONLST_JSL_I$$

$$I=15 \text{ TO } 38$$
$$NEW_JONLST_AFT_{JET_MAP_I} = NEW_JONLST_JSL_I$$

As a limited example note that Group 1 Jets F1F, F2F, and F3F availability and commands are represented by Elements 1, 5, and 13, respectively, on the input/output interface for the forward jets. Suppose that the preferred firing order within Group 1 is F2F, F3F, F1F, then

$$JET_MAP_{1 \text{ to } 3} = (5,13,1), \text{ and}$$

$$HFAIL_JSL_1 = \overline{AVAILABLE_JET_FWD_5}$$

$$HFAIL_JSL_2 = \overline{AVAILABLE_JET_FWD_{13}}$$

$$HFAIL_JSL_3 = \overline{AVAILABLE_JET_FWD_1}$$

$$NEW_JONLST_FWD_5 = NEW_JONLST_JSL_1$$

$$NEW_JONLST_FWD_{13} = NEW_JONLST_JSL_2$$

$$NEW_JONLST_FWD_1 = NEW_JONLST_JSL_3$$

Table 4.4.4.2.2.1-1 is in five parts. Parts A through C are to be accessed only if there is a -Z translation and SEP_COMPLETE = OFF. Part A is for the case with CROSSFEED_OPEN = OFF or no +X translation command combined with no -X translation command. Part B is for the case with -X translation command. Part C is for the case with CROSSFEED_OPEN = ON combined with +X translation command. Part D is to be accessed only if there is -Z translation command and SEP_COMPLETE = ON. Part E is to be accessed only if there is no -Z translation command. The following inputs signify the following commands:

ACOM:	$ACOM_{1 \text{ to } 4}$	Ignore
	$ACOM_6$	ON = Z translation required
		OFF = No Z translation required
	$ACOM_5$	ON = Minus sign for Z translation
		OFF = Plus sign for Z translation
	$ACOM_8$	ON = Roll rotation required
		OFF = No roll rotation required

	$ACOM_7$	ON = Minus sign for roll rotation
		OFF = Plus sign for roll rotation
	$ACOM_{10}$	ON = Pitch rotation required
		OFF = No pitch rotation required
	$ACOM_9$	ON = Minus sign for pitch rotation
		OFF = Plus sign for pitch rotation
	$ACOM_{11 \text{ to } 12}$	Ignore

In Table 4.4.4.2.2.1-2, the following inputs signify the following commands:

ACOM:	$ACOM_{1 \text{ to } 2}$	Ignore
	$ACOM_4$	ON = Y translation required
		OFF = No Y translation required
	$ACOM_3$	ON = Minus sign for Y translation
		OFF = Plus sign for Y translation
	$ACOM_{5 \text{ to } 10}$	Ignore
	$ACOM_{12}$	ON = Yaw rotation required
		OFF = No yaw rotation required
	$ACOM_{11}$	ON = Minus sign for yaw rotation
		OFF = Plus sign for yaw rotation

In Table 4.4.4.2.2.1-3, the following inputs signify the following commands:

ACOM:	$ACOM_2$	ON = X translation required
		OFF = No X translation required
	$ACOM_1$	ON = Minus sign for X translation
		OFF = Plus sign for X translation
	$ACOM_{3 \text{ to } 12}$	Ignore

RCS tank constraints are met by either modifying the translation and rotation commands (represented by the ACOM array) prior to the table look-up or by modifying the jet commands (represented by the NEW_JOWLST_JSL array) after the table look up. The requirements are written in this way so that when the tank constraints are removed, the basic look-up tables will not change. Thus, even though simultaneous X and Z translations are prevented by the single-axis translation logic, the look-up tables contain entries for simultaneous X and Z translation.

The purpose of the single axis translation logic (Figure 4.4.4.2.2.1-3A) is to prevent jets from being commanded simultaneously in the X and Z translation axes in the event of simultaneous translation commands. The result is a reduced likelihood of exceeding the number of simultaneous jet firings that permit helium gas ingestion into the RCS propellant tank lower compartment. In the event that both the X and Z translation commands are generated, priorities for response are used. The priorities are Z axis first and X axis second through ET separation and X axis first and Z axis second after ET separation.

The purpose of the Y translation default (Figure 4.4.4.2.2.1-4) condition is to ensure that no Y translation is attempted when both forward Y-firing jets on the same side of the vehicle nose have failed. Without so doing, translation could only be accomplished with excessive yaw rotation.

The purpose of the aft Z-rate default (Figure 4.4.4.2.2.1-5) condition is to meet post-ET separation tank constraints with an open RCS propellant crossfeed valve or an open RCS/OMS interconnect valve. After ET separation, only five aft jets can fire simultaneously with open crossfeed. If +X translation and -Z translation occur simultaneously, -Z translation must be degraded to keep within the five-jet limit.

The purpose of the X-rate default (Figure 4.4.4.2.2.1-6) condition is to meet tank constraints. After ET separation with open crossfeed, a limit of five aft jets applies. Between degrading -Z translation to two aft jets and +X translation to two aft jets, the constraint can be met. The +X translation is thus degraded if any Z jets are used. Through ET separation, two problem areas occur. With open crossfeed, a seven-aft-jet limit applies. If -Z translation and +X translation occur simultaneously, both must be degraded to stay within constraints. The +X change is reflected in the block diagram, the -Z change in the tables (it is reduced from high -Z to near nominal). With c osed crossfeed, a constraint of five jets per aft pod must be met. This can be exceeded when -Z and +X translation occur simultaneously with Y translation or yaw rotation. By degrading +X, the constraint is met.

The aft pitch default (Figure 4.4.4.2.2.1-7) prevents forward pitch jets from being utilized during -X translation. This assures that no more than three forward tank jets are simultaneously commanded on nominally, reducing the li ihood of helium gas ingestion in the forward propellant tank lower compartment.

The high-level roll command (Figures 4.4.4.2.2.1-8 and -9) condition increases the number of roll jets used, when possible, if a yaw rotation is commanded simultaneously with roll in a direction that couples unfavorably into the roll axis. This is required to overcome very large roll coupling due to inertia properties with a connected ET.

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The high yaw command logic (Figure 4.4.4.2.2.1-8A) increases the number of aft yaw jets used if the following conditions apply: (1) -Z translation is commanded, (2) both yaw jets and both +pitch jets on the same side of the nose have failed (e.g., two manifold closures), and (3) the commanded yaw opposes the failure-induced disturbance.

The purpose of the pitch/roll rate reduction logic (Figure 4.4.4.2.2.1-10) is to reduce the number of jets used for combined -pitch and roll maneuvers after ET separation. This results in a reduced likelihood of exceeding the number of simultaneous jet firings that cause helium gas ingestion into the RCS propellant tank lower compartment.

The failure reconfiguration block (Figure 4.4.4.2.2.1-11) outputs several discretes which indicate failure status of various jet groupings. It is executed only when JET_FAIL_CHANGE_FLAG is set ON. JET_SELECT_TRANSITION then resets this flag. The outputs are as follows:

1. HFAIL_JSL is the complement of AVAILABLE_JET_FWD and AVAILABLE_JET_AFT mapped into the array order used within the jet selection algorithms.

2. NEG_ZFAIL indicates failure status in the two aft -Z firing jet groups.

3. NO_DUMP indicates failure status in the nose Y jets.

The forward propellant dump logic (Figure 4.4.4.2.2.1-12) block executes only when the forward RCS dump is required and is possible. It determines whether two or four opposing Y jets in the nose are to fire and outputs the commands. It also reduces attitude control to aft only by turning off other forward jets. Translation is inactive when this option is in use.

Figure 4.4.4.2.2.1-13 shows RCS jet locations and plume directions.

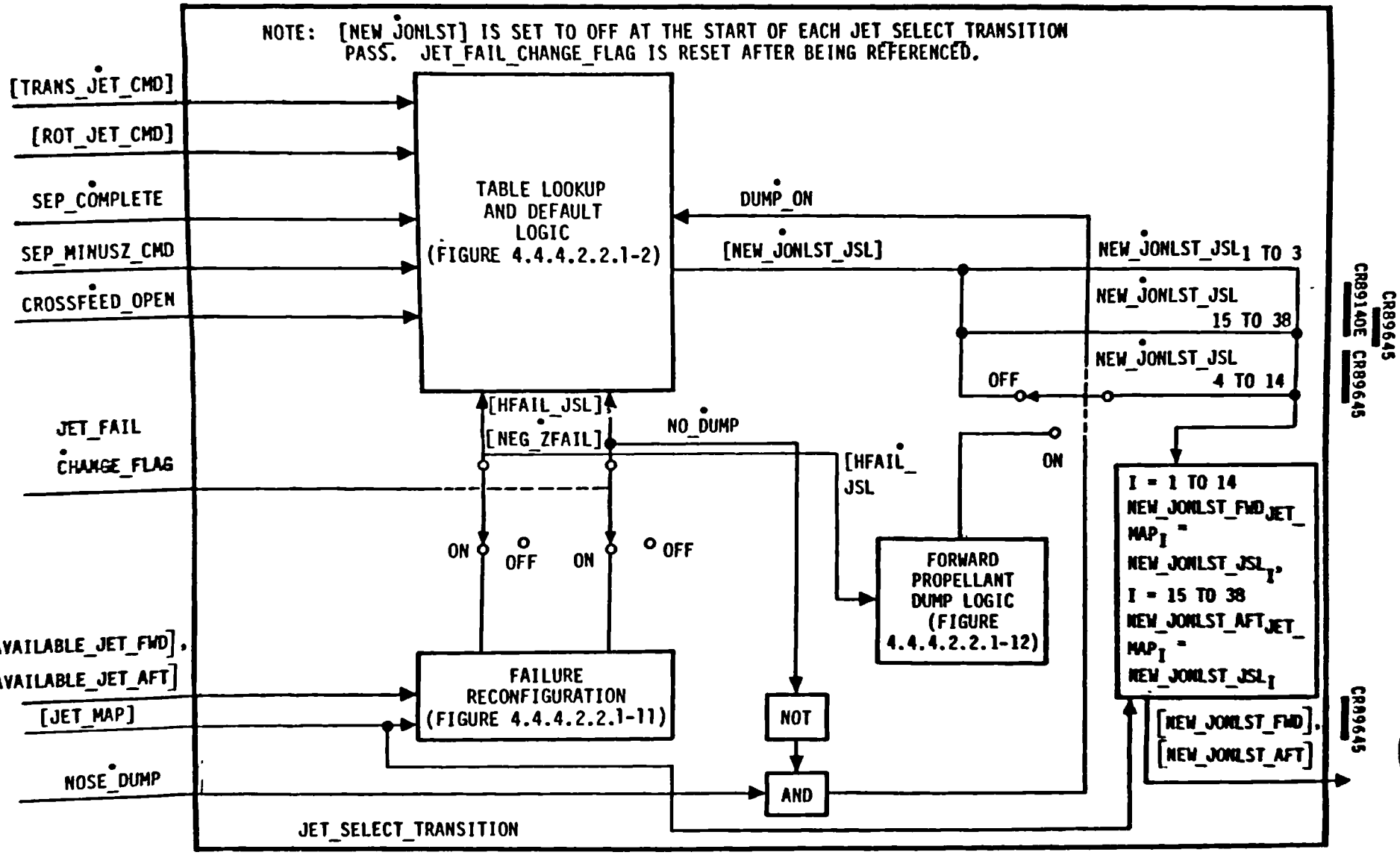

Figure 4.4.4.2.2.1-1. JET_SELECT_TRANSITION

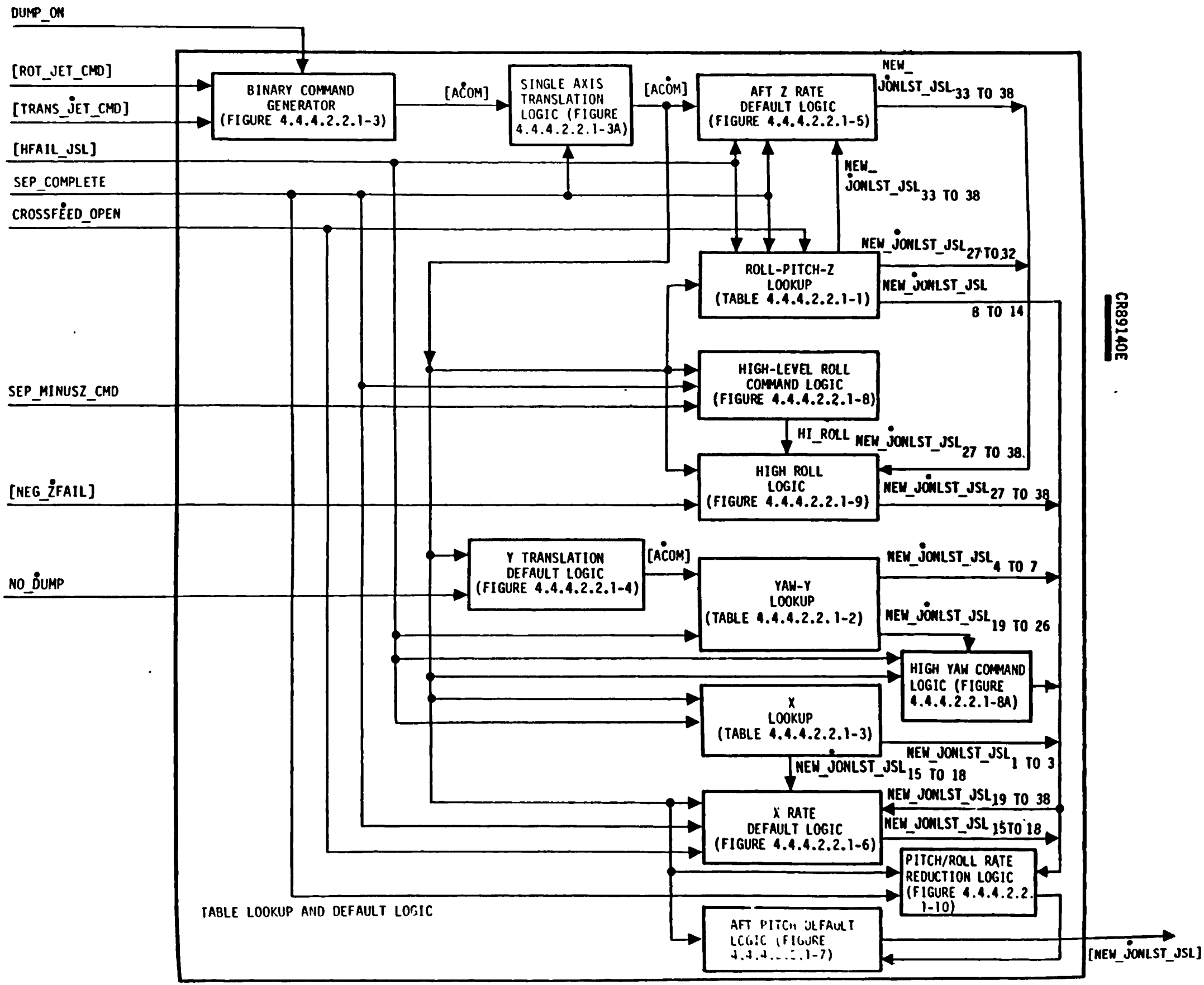

Figure 4.4.4.2.2.1-2. Table Lookup and Default Logic

Figure 4.4.4.2.2.1 2. Table Lookup and Default Logic

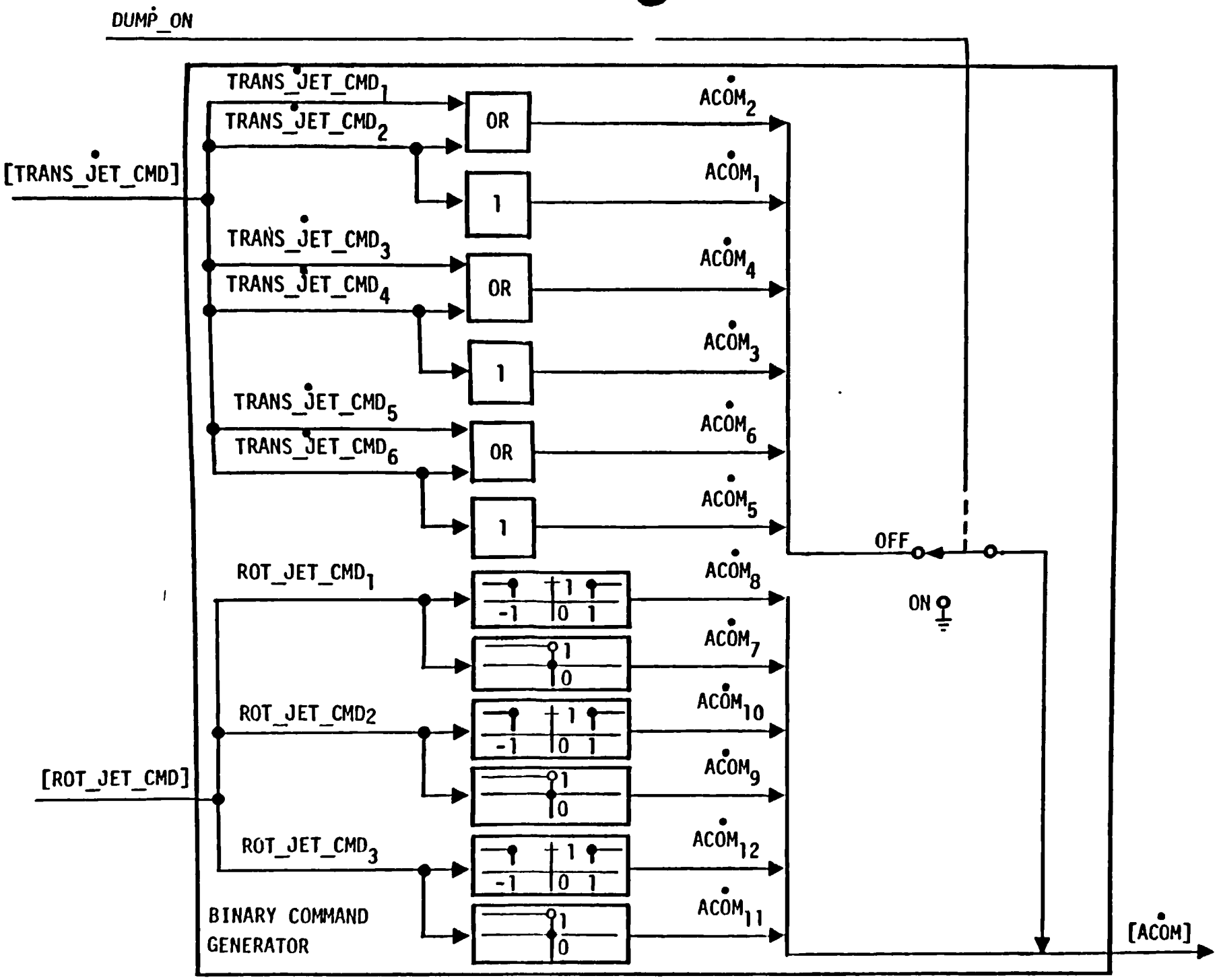

Figure 4.4.4.2.2.1-3. Binary Command Generator

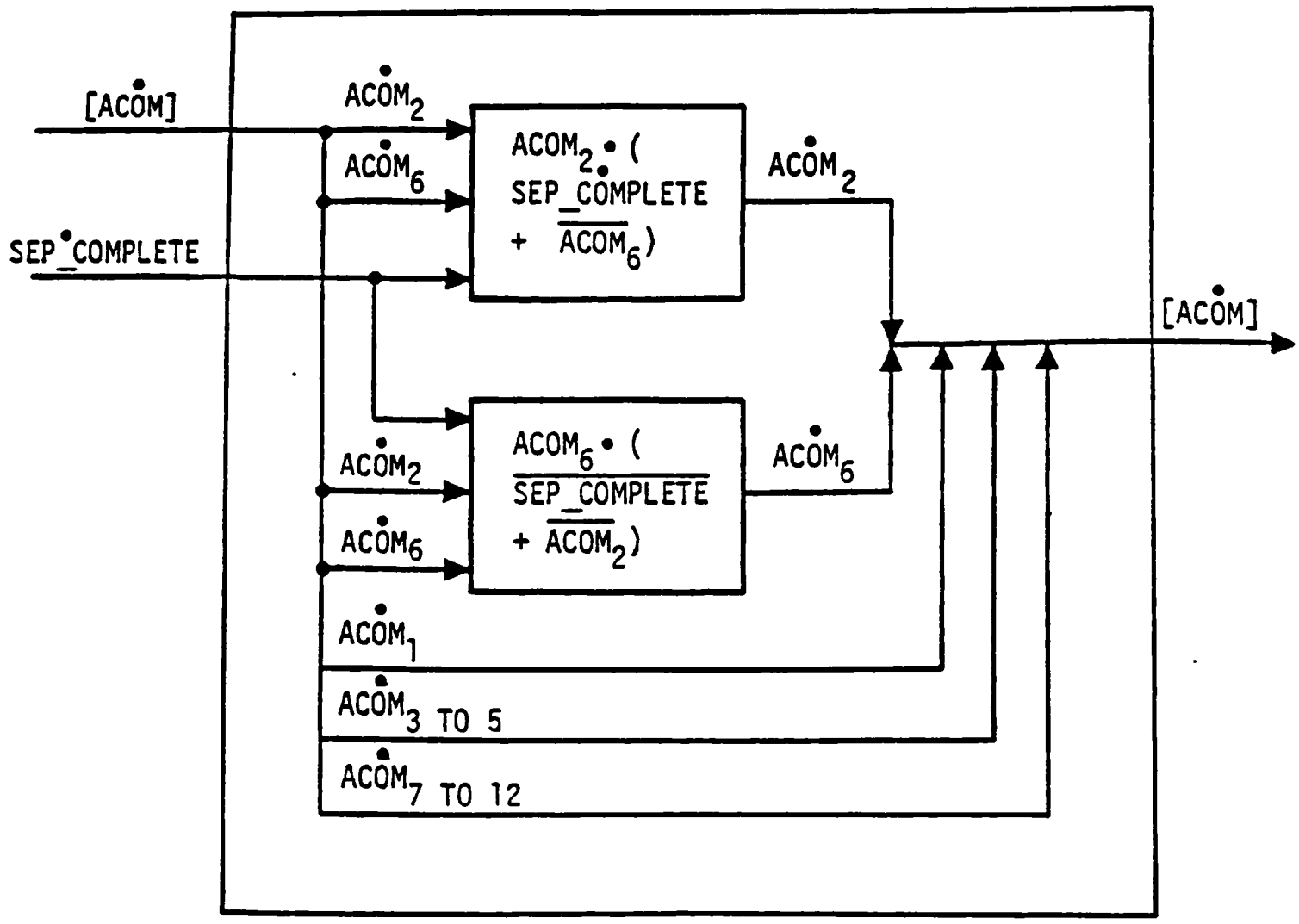

Figure 4.4.4.2.2.1-3A. _Single Axis Translation Logic

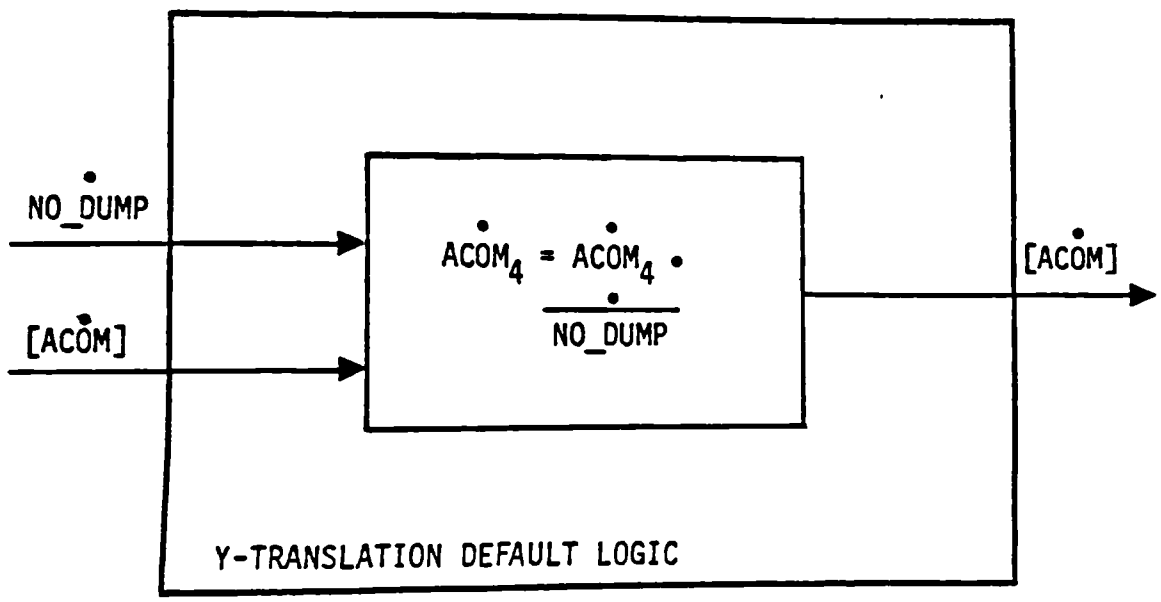

Figure 4.4.4.2.2.1-4. Y-Translation Default Logic

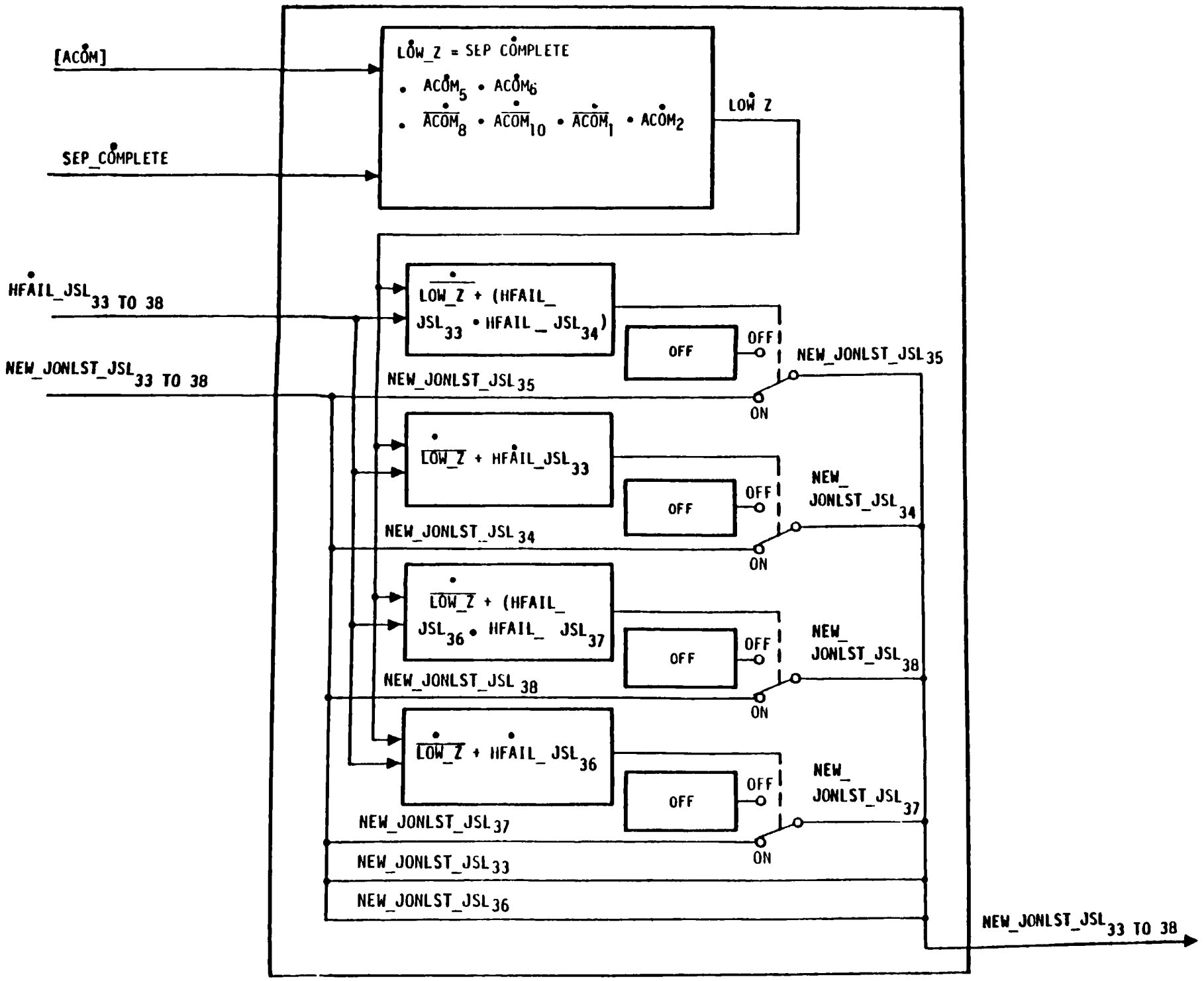

Figure 4.4.4.2.2.1-5. Aft Z-Rate Default Logic

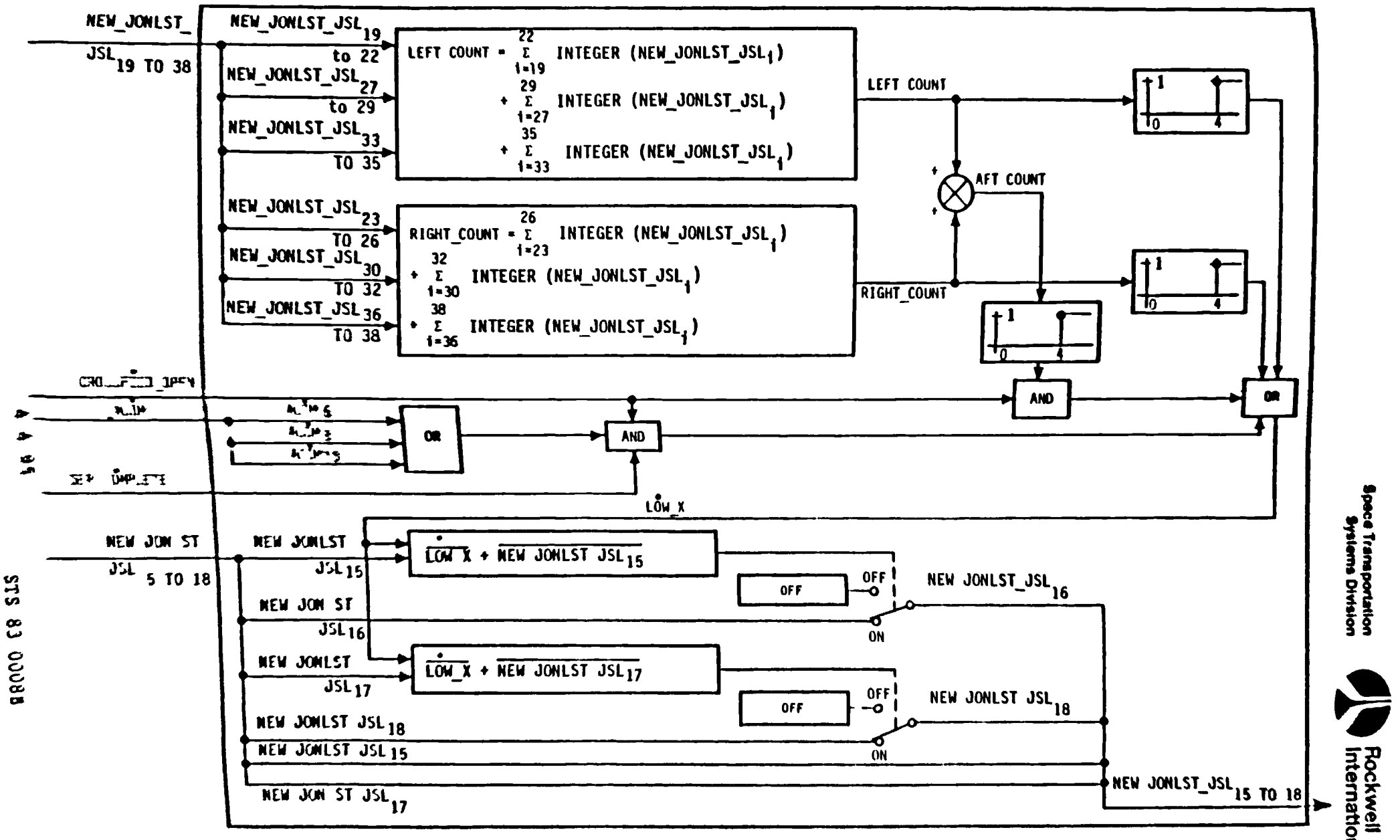

Figure 4.4.4.2.2.1-6. X RAIL Default Logic

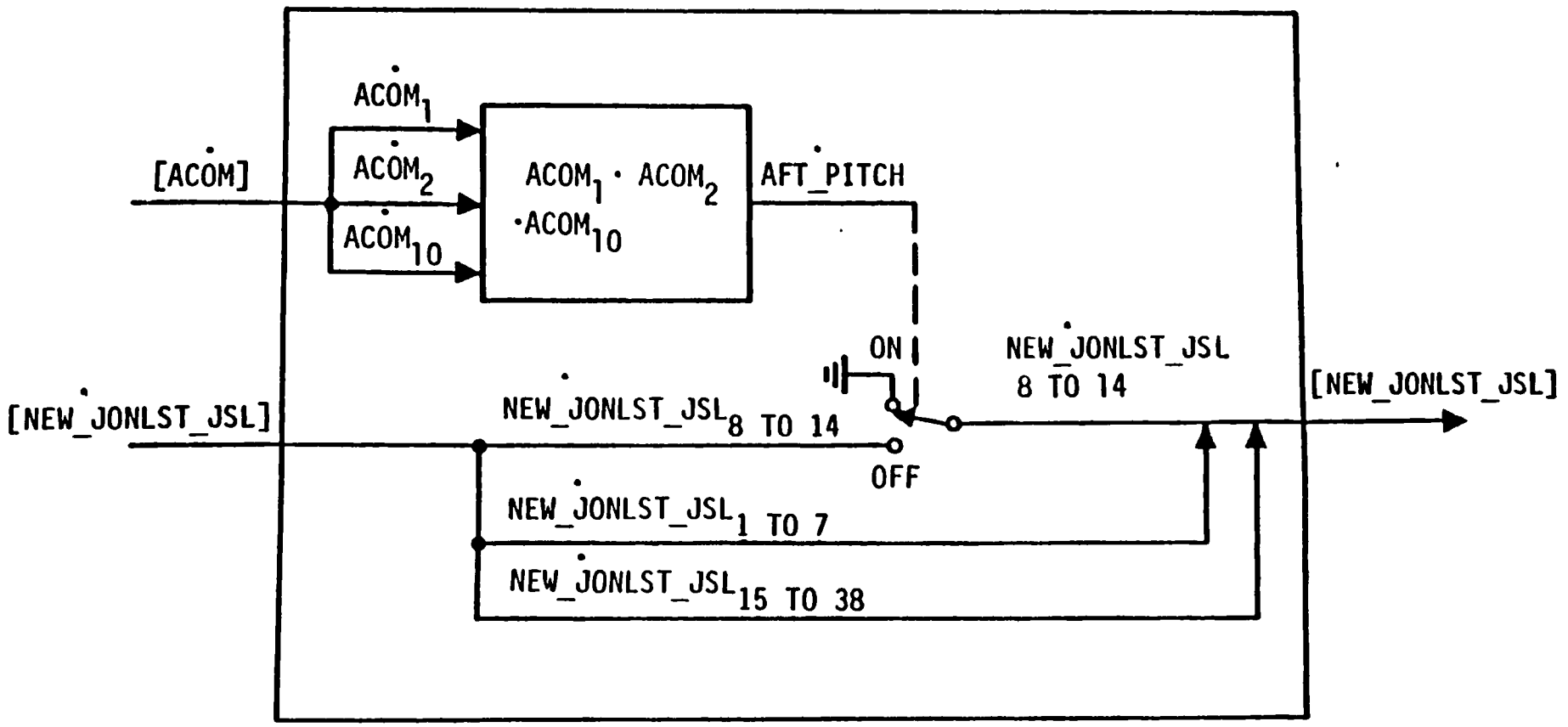

Figure 4.4.4.2.2.1-7. Aft Pitch Default Logic

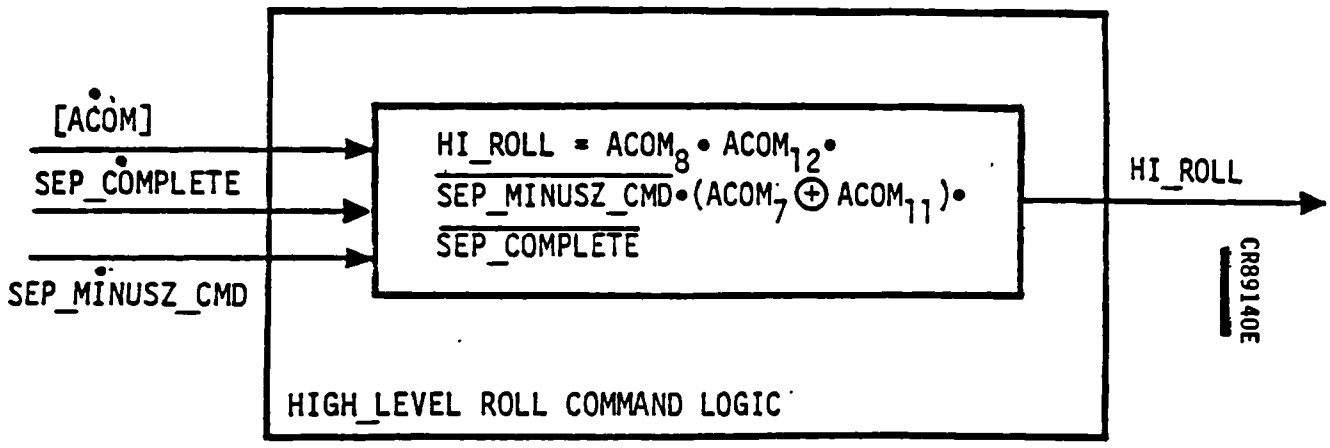

Figure 4.4.4.2.2.1-8. High-Level Roll Command Logic

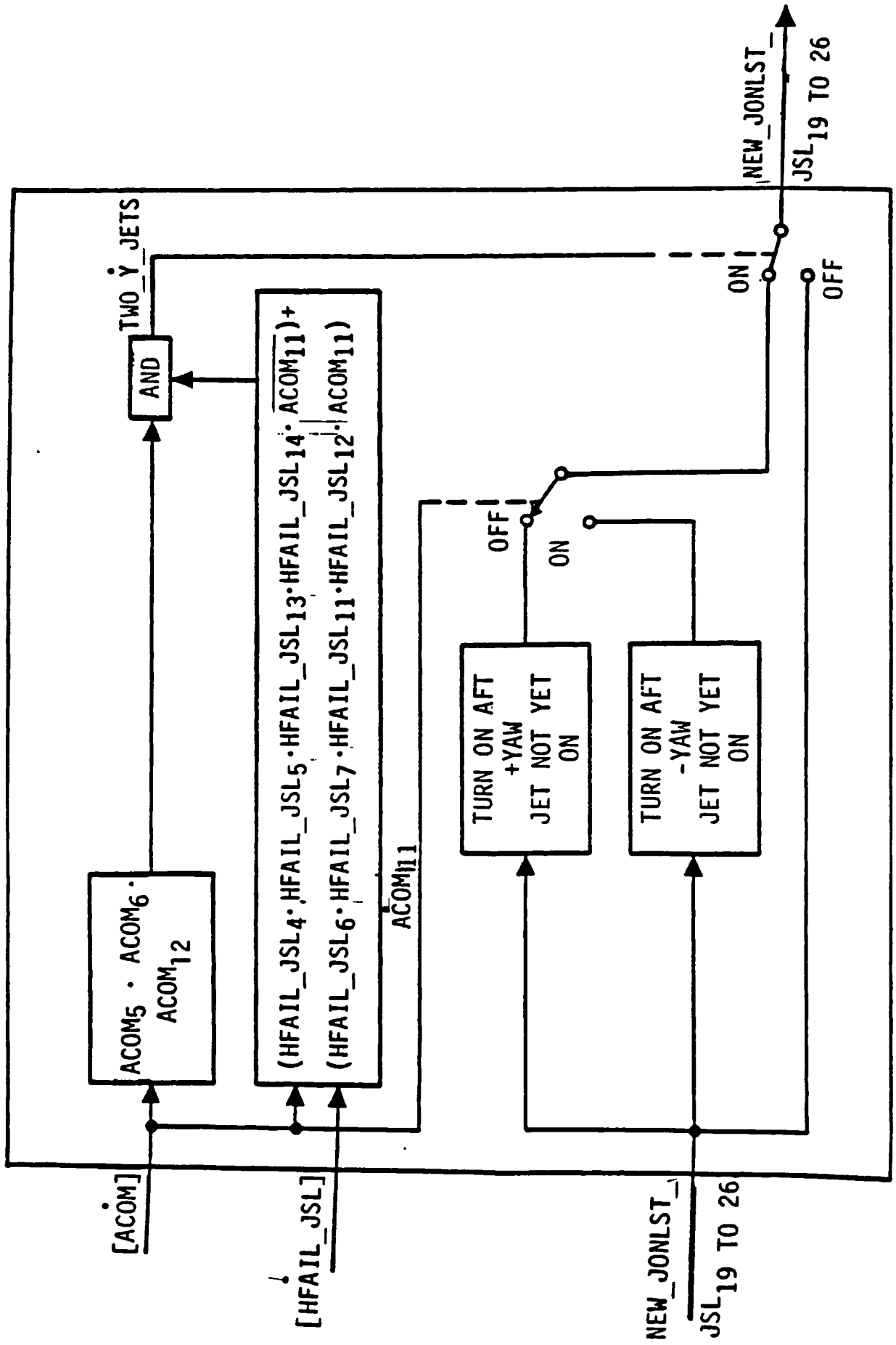

Figure 4.4.4.2.2.1-8A. High Yaw Command Logic

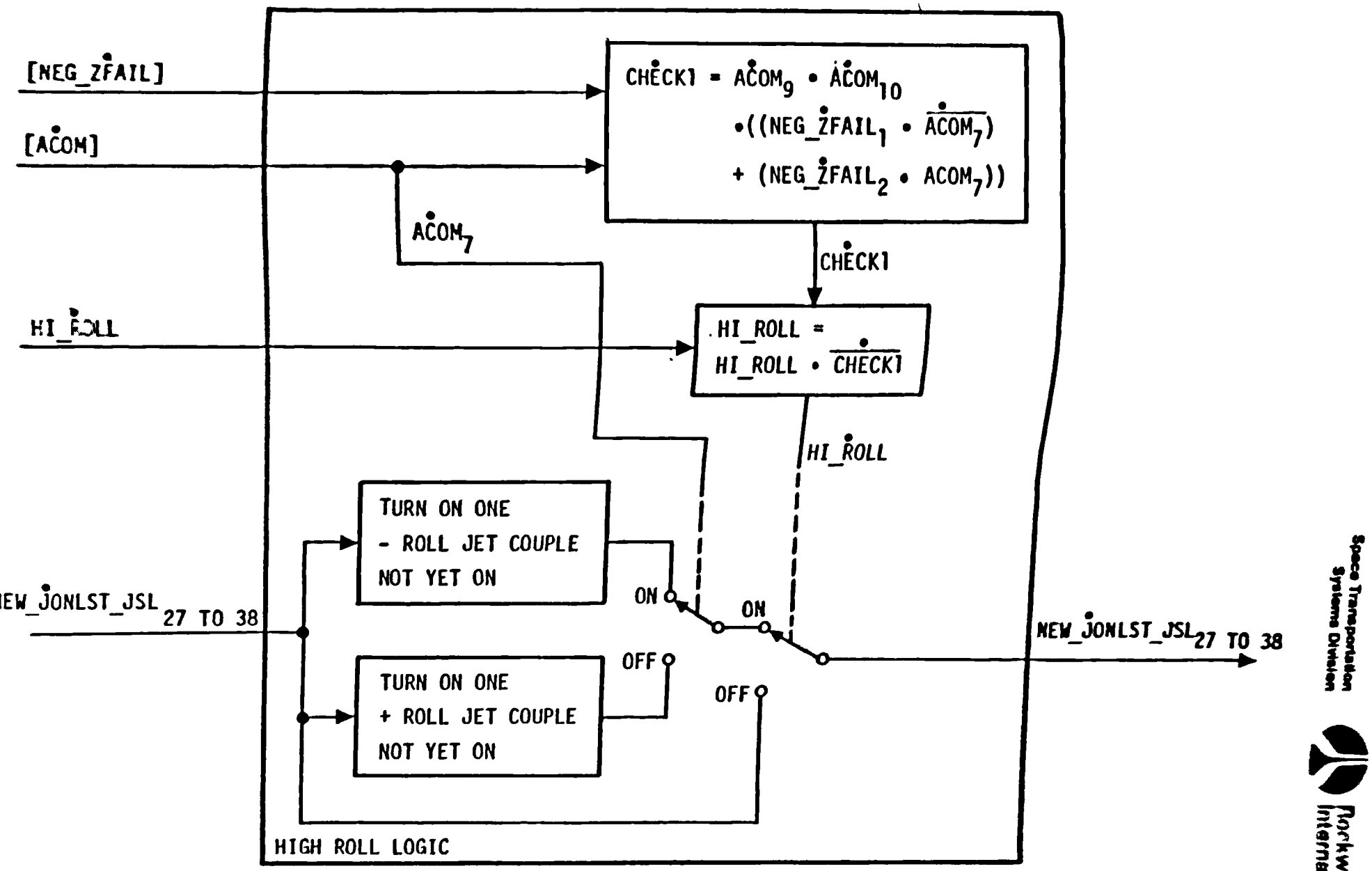

Figure 4.4.4.2.2.1-9. High Roll Logic

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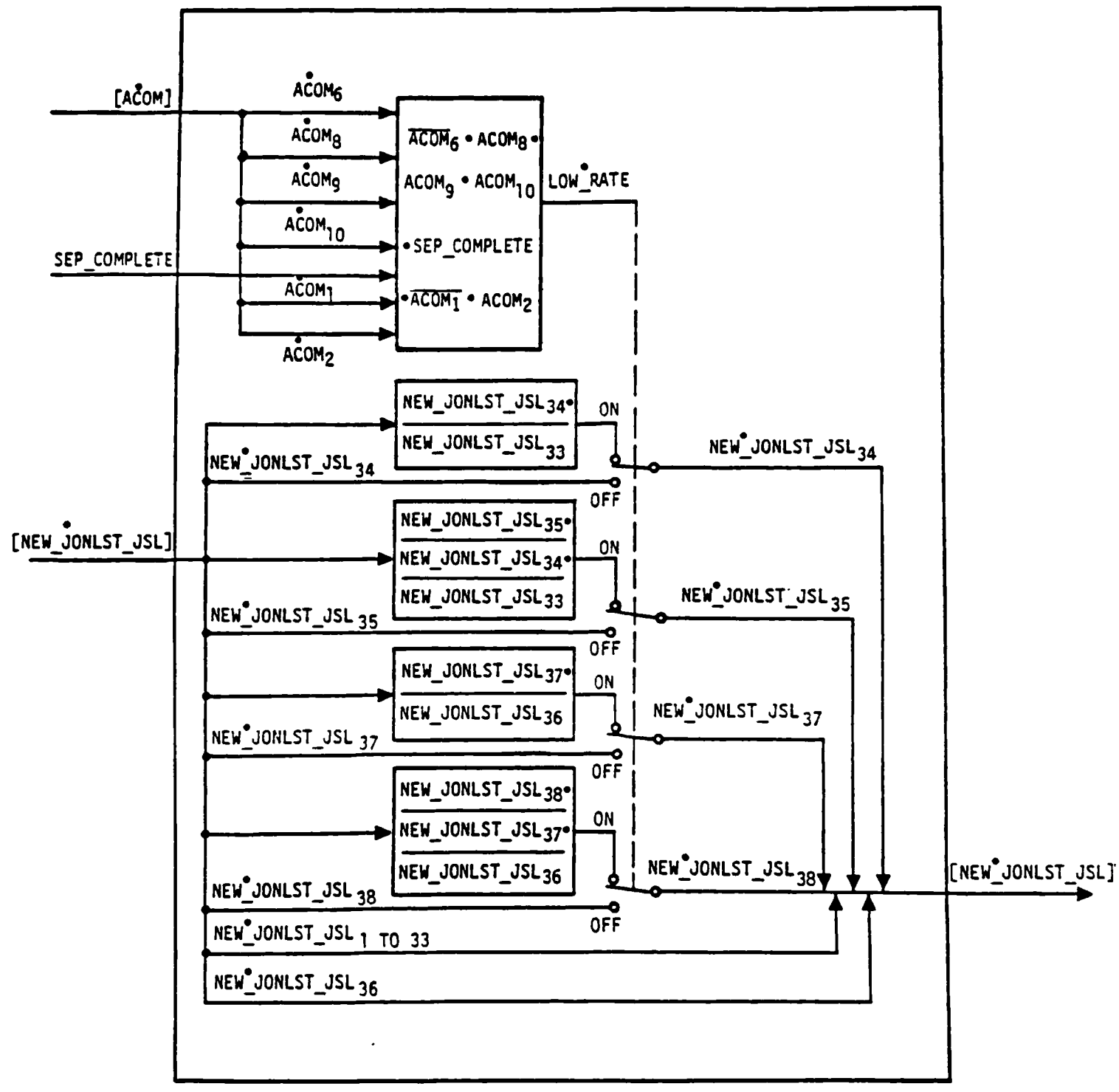

Fig. 4.4.4.2.2.1-10. Pitch/Roll Rate Reduction Logic

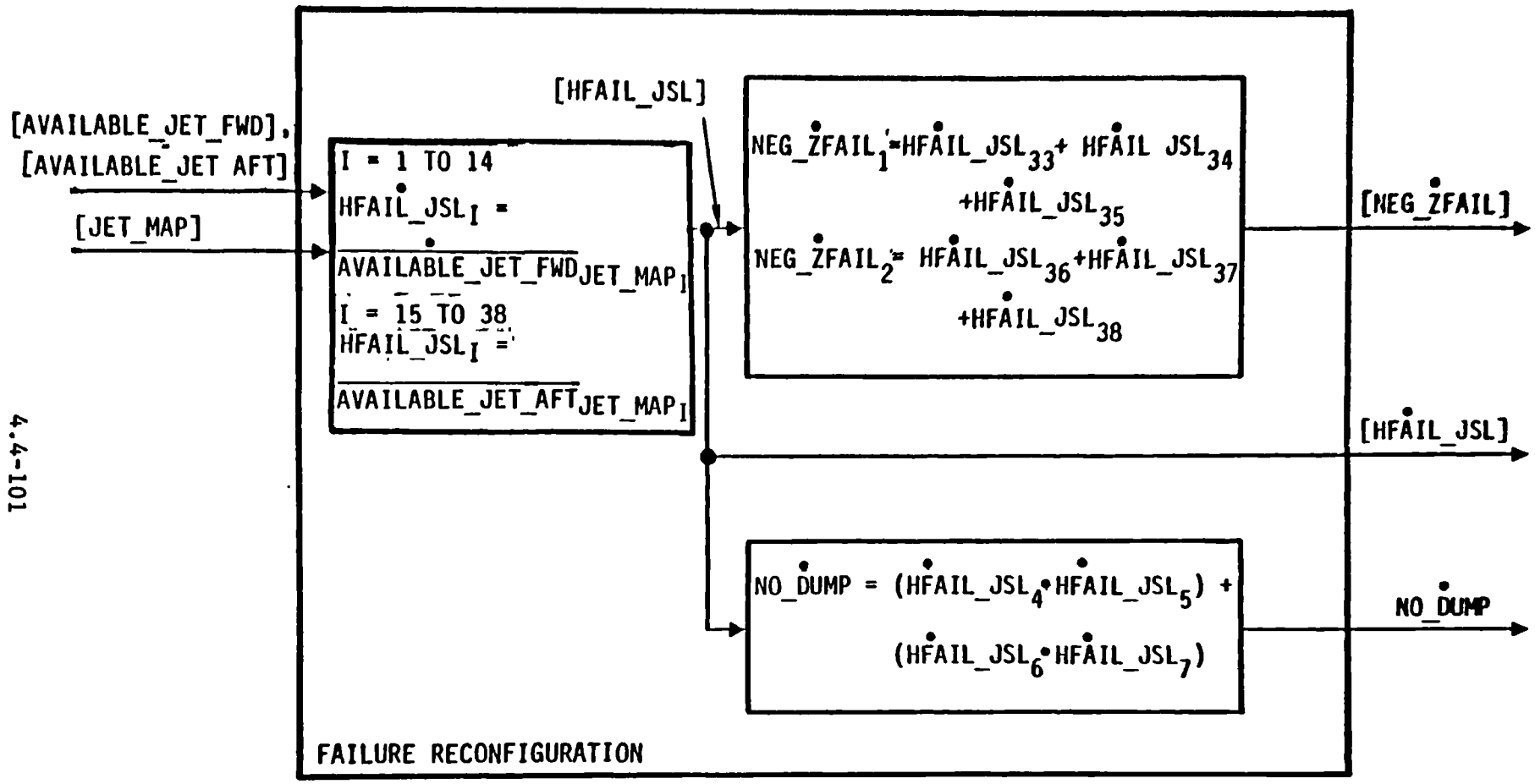

Figure 4.4.4.2.2.1-11. Failure Reconfiguration

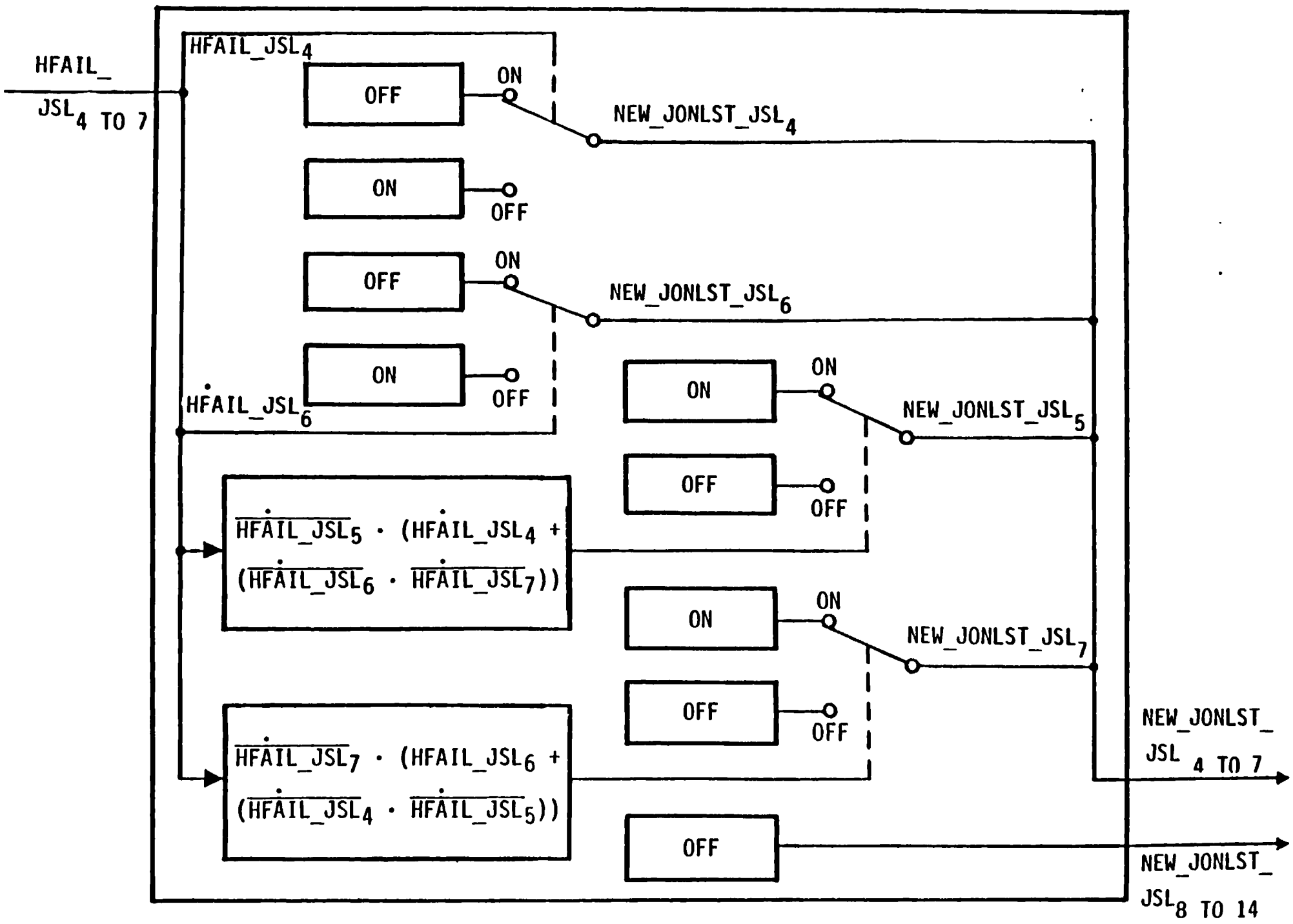

Figure 4.4.4.2.2.1-12. Forward Propellant Dump Logic

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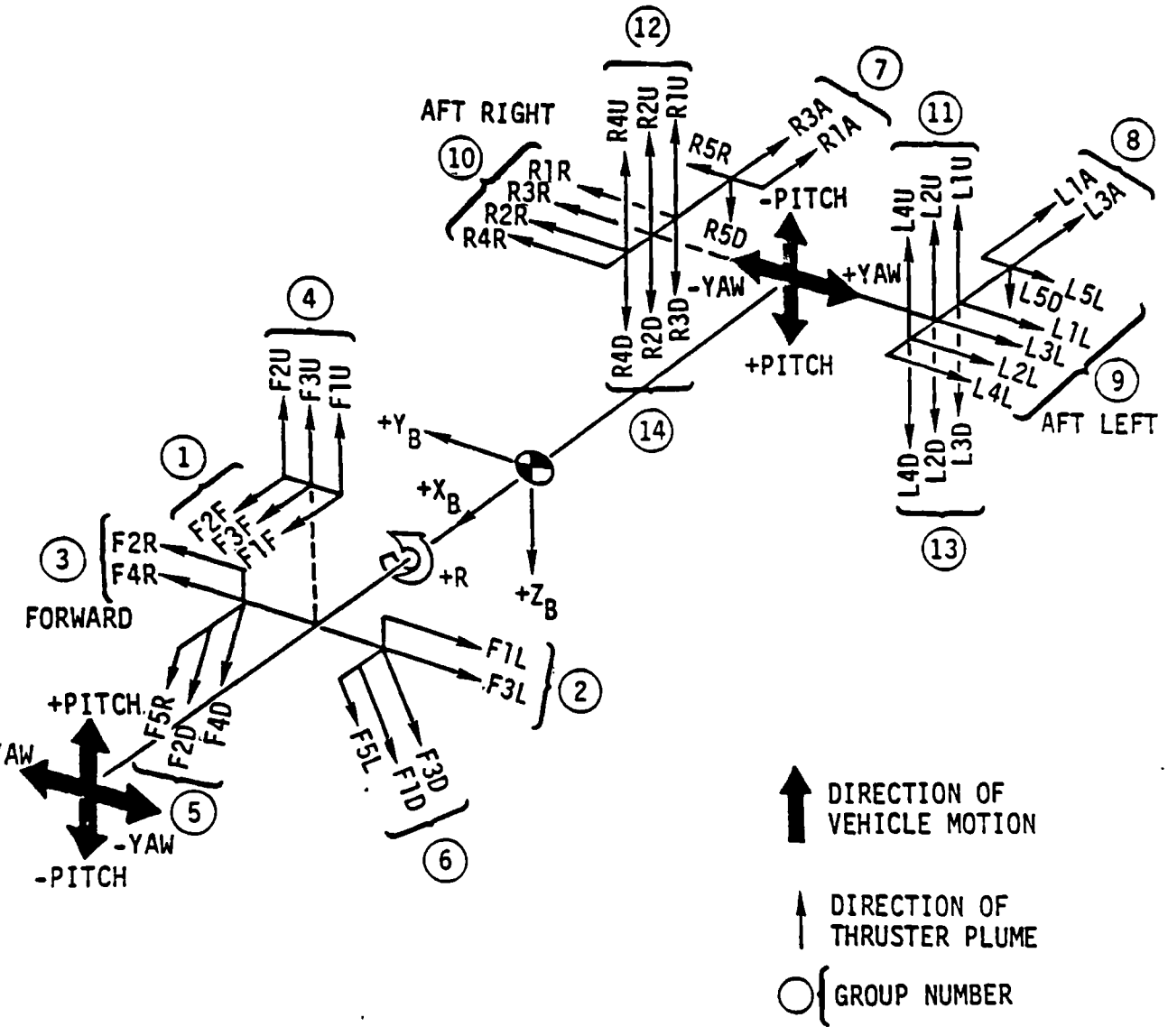

Figure 4.4.4.2.2.1-13. RCS Jet Locations and Plume Directions

Figure 4.4.4.2.2.1-12. Forward Propellant Dump Logic

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JSL8 TO 14

Table 4.4.4.2.2.1-1A. Z Translation and/or Roll Rotation and/or Pitch Rotation Jet Groups (Separation Phase With -Z Translation, Without -X Translation, and Either With Crossfeed Closed or Without +X Translation)

Commands	Failure Locations by Group	Number of Jets Used by Group						
		G-4	G-5	G-6	G-11	G-12	G-13	G-14
-Z	NONE	0	2	2	0	0	3	1
+ROLL	5	0	1	1	0	0	2	0
+PITCH	6	0	1	1	0	0	2	0
	13	0	1	1	0	0	2	0
	14	0	1	1	0	0	2	0
	5 5	0	0	1	0	0	1	0
	5 6	0	1	1	0	0	2	0
	5 13	0	1	1	0	0	2	0
	5 14	0	1	1	0	0	2	0
	6 6	0	1	0	0	0	1	0
	6 13	0	1	1	0	0	2	0
	6 14	0	1	1	0	0	2	0
	13 13	0	1	1	0	0	1	0
	13 14	0	1	1	0	0	2	0
	14 14	0	1	1	0	0	2	0
	5 5 6	0	0	1	0	0	1	0
	5 6 6	0	1	0	0	0	1	0
-Z	NONE	0	1	1	0	0	3	1
+ROLL	5	0	1	1	0	0	2	0
	6	0	1	1	0	0	2	0
	13	0	1	1	0	0	2	0
	14	0	1	1	0	0	2	0
	5 5	0	0	1	0	0	2	0
	5 6	0	1	1	0	0	2	0
	5 13	0	1	1	0	0	2	0
	5 14	0	1	1	0	0	2	0
	6 6	0	1	0	0	0	2	0
	6 13	0	1	1	0	0	2	0
	6 14	0	1	1	0	0	2	0
	13 13	0	1	1	0	0	1	0
	13 14	0	1	1	0	0	2	0
	14 14	0	1	1	0	0	2	0
	5 5 6	0	0	1	0	0	2	0
	5 6 6	0	1	0	0	0	2	0

Table 4.4.4.2.2.1-1A. Z Translation and/or Roll Rotation and/or Pitch Rotation Jet Groups (Separation Phase With -Z Translation, Without -X Translation, and Either With Crossfeed Closed or Without +X Translation) (Cont)

Commands	Failure Locations by Group	Number of Jets Used by Group						
		G-4	G-5	G-6	G-11	G-12	G-13	G-14
-Z +ROLL -PITCH	NONE 5 6	0 0 0	0 0 0	0 0 0	0 0 0	0 0 0	3 2 2	1 0 0
	13 14 5 5	0 0 0	0 0 0	0 0 0	0 0 0	0 0 0	2 2 2	0 0 0
	5 6 5 13 5 14	0 0 0	0 0 0	0 0 0	0 0 0	0 0 0	2 2 2	0 0 0
	6 6 6 13 6 14	0 0 0	0 0 0	0 0 0	0 0 0	0 0 0	2 2 2	0 0 0
	13 13 13 14 14 14	0 0 0	0 0 0	0 0 0	0 0 0	0 0 0	1 2 2	0 0 0
	5 5 6 5 6 6	0 0	0 0	0 0	0 0	0 0	2 2	0 0
-Z +PITCH	NONE 5 6	0 0 0	2 1 1	2 1 1	0 0 0	0 0 0	1 1 1	1 1 1
	13 14 5 5 5 6 5 13 5 14	0 0 0 0 0 0	1 1 0 1 1 1	1 1 1 1 1 1	0 0 0 0 0 0	0 0 0 0 0 0	1 1 0 1 1 1	1 1 0 1 1 1
	6 6 6 13 6 14	0 0 0	1 1 1	0 1 1	0 0 0	0 0 0	0 1 1	0 1 1
	13 13 13 14 14 14	0 0 0	1 1 1	1 1 1	0 0 0	0 0 0	1 1 1	1 1 1
	5 5 6 5 6 6	0 0	0 1	1 0	0 0	0 0	0 0	0 0

Table 4.4.4.2.2.1-1A. Z Translation and/or Roll Rotation and/or Pitch Rotation Jet Groups (Separation Phase With -Z Translation, Without -X Translation, and Either With Crossfeed Closed or Without +X Translation) (Cont)

Commands	Failure Locations by Group	Number of Jets Used by Group						
		G-4	G-5	G-6	G-11	G-12	G-13	G-14
-Z	NONE	0	2	2	0		3	3
	5	0	1	2	0	0	2	2
	6	0	2	1	0	0	2	2
	13	0	2	2	0	0	2	3
	14	0	2	2	0	0	3	2
	5 5	0	0	2	0	0	2	2
	5 6	0	1	1	0	0	2	2
	5 13	0	1	2	0	0	2	2
	5 14	0	1	2	0	0	2	2
	6 6	0	2	0	0	0	2	2
	6 13	0	2	1	0	0	2	2
	6 14	0	2	1	0	0	2	2
	13 13	0	1	1	0	0	1	2
	13 14	0	2	2	0	0	2	2
	14 14	0	1	1	0	0	2	1
	5 5 6	0	0	1	0	0	1	1
	5 6 6	0	1	0	0	0	1	1
-Z	NONE	0	1	1	0	0	3	3
	5	0	0	0	0	0	2	2
-PITCH	6	0	0	0	0	0	2	2
	13	0	0	0	0	0	2	2
	14	0	0	0	0	0	2	2
	5 5	0	0	0	0	0	2	2
	5 6	0	0	0	0	0	2	2
	5 13	0	0	0	0	0	2	2
	5 14	0	0	0	0	0	2	2
	6 6	0	0	0	0	0	2	2
	6 13	0	0	0	0	0	2	2
	6 14	0	0	0	0	0	2	2
	13 13	0	0	0	0	0	1	2
	13 14	0	0	0	0	0	2	2
	14 14	0	0	0	0	0	2	1
	5 5 6	0	0	0	0	0	2	2
	5 6 6	0	0	0	0	0	2	2

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Table 4.4.4.2.2.1-1A. Z Translation and or Roll Rotation and/or Pitch Rotation Jet Groups (Separation Phase With -Z Translation, Without -X Translation, and Either With Crossfeed Closed or Without +X Translation) (Cont)

Commands	Failure Locations by Group	Number of Jets Used by Group						
		G-4	G-5	G-6	G-11	G-12	G-13	G-14
-Z -ROLL +PITCH	NONE	0	2	2	0	0	1	3
	5	0	1	1	0	0	0	2
	6	0	1	1	0	0	0	2
	13	0	1	1	0	0	0	2
	14	0	1	1	0	0	0	2
	5 5	0	0	1	0	0	0	1
	5 6	0	1	1	0	0	0	2
	5 13	0	1	1	0	0	0	2
	5 14	0	1	1	0	0	0	2
	6 6	0	1	0	0	0	0	1
	6 13	0	1	1	0	0	0	2
	6 14	0	1	1	0	0	0	2
	13 13	0	1	1	0	0	0	2
	13 14	0	1	1	0	0	0	2
	14 14	0	1	1	0	0	0	1
	5 5 6	0	0	1	0	0	0	1
	5 6 6	0	1	0	0	0	0	1
-Z -ROLL	NONE	0	1	1	0	0	1	3
	5	0	1	1	0	0	0	2
	6	0	1	1	0	0	0	2
	13	0	1	1	0	0	0	2
	14	0	1	1	0	0	0	2
	5 5	0	0	1	0	0	0	2
	5 6	0	1	1	0	0	0	2
	5 13	0	1	1	0	0	0	2
	5 14	0	1	1	0	0	0	2
	6 6	0	1	0	0	0	0	2
	6 13	0	1	1	0	0	0	2
	6 14	0	1	1	0	0	0	2
	13 13	0	1	1	0	0	0	2
	13 14	0	1	1	0	0	0	2
	14 14	0	1	1	0	0	0	1
	5 5 6	0	0	1	0	0	0	2
	5 6 6	0	1	0	0	0	0	2

Table 4.4.4.2.2.1-1A. Z Translation and/or Roll Rotation and/or Pitch Rotation Jet Groups (Separation Phase With -Z Translation, Without -X Translation, and Either With Crossfeed Closed or Without +X Translation) (Cont)

Commands	Failure Locations by Group			Number of Jets Used by Group						
				G-4	G-5	G-6	G-11	G-12	G-13	G-14
-Z	NONE			0	0	0	0	0	1	3
-ROLL	5			0	0	0	0	0	0	2
-PITCH	6			0	0	0	0	0	0	2
	13			0	0	0	0	0	0	2
	14			0	0	0	0	0	0	2
	5	5		0	0	0	0	0	0	2
	5	6		0	0	0	0	0	0	2
	5	13		0	0	0	0	0	0	2
	5	14		0	0	0	0	0	0	2
	6	6		0	0	0	0	0	0	2
	6	13		0	0	0	0	0	0	2
	6	14		0	0	0	0	0	0	2
	13	13		0	0	0	0	0	0	2
	13	14		0	0	0	0	0	0	2
	14	14		0	0	0	0	0	0	1
	5	5	6	0	0	0	0	0	0	2
	5	6	6	0	0	0	0	0	0	2

Table 4.4.4.2.2.1-1B. Z Translation and/or Roll Rotation and/or Pitch Rotation Jet Groups (Separation Phase With -Z Translation and With -X Translation)

Commands	Failure Locations by Group			Number of Jets Used by Group						
				G-4	G-5	G-6	G-11	G-12	G-13	G-14
-Z	NONE			0	1	1	0	0	2	0
+ROLL	5			0	1	1	0	0	2	0
+PITCH	6			0	1	1	0	0	2	0
-X	13			0	1	1	0	0	2	0
	14			0	1	1	0	0	2	0
	5	5		0	0	1	0	0	1	0
	5	6		0	1	1	0	0	2	0
	5	13		0	1	1	0	0	2	0
	5	14		0	1	1	0	0	2	0
	6	6		0	1	0	0	0	1	0
	6	13		0	1	1	0	0	2	0
	6	14		0	1	1	0	0	2	0
	13	13		0	1	1	0	0	1	0
	13	14		0	1	1	0	0	2	0
	14	14		0	1	1	0	0	2	0
	5	5	6	0	0	1	0	0	1	0
	5	6	6	0	1	0	0	0	1	0
-Z	NONE			0	1	1	0	0	2	0
+ROLL	5			0	1	1	0	0	2	0
	6			0	1	1	0	0	2	0
-X	13			0	1	1	0	0	2	0
	14			0	1	1	0	0	2	0
	5	5		0	0	1	0	0	2	0
	5	6		0	1	1	0	0	2	0
	5	13		0	1	1	0	0	2	0
	5	14		0	1	1	0	0	2	0
	6	6		0	1	0	0	0	2	0
	6	13		0	1	1	0	0	2	0
	6	14		0	1	1	0	0	2	0
	13	13		0	1	1	0	0	1	0
	13	14		0	1	1	0	0	2	0
	14	14		0	1	1	0	0	2	0
	5	5	6	0	0	1	0	0	2	0
	5	6	6	0	1	0	0	0	2	0

Table 4.4.4.2.2.1-1B. Z Translation and/or Roll Rotation and/or Pitch Rotation Jet Groups (Separation Phase With -Z Translation and With -X Translation) (Cont)

Commands	Failure Locations by Group			Number of Jets Used by Group						
				G-4	G-5	G-6	G-11	G-12	G-13	G-14
-Z	NONE			0	0	0	0	0	2	0
+ROLL	5			0	0	0	0	0	2	0
-PITCH	6			0	0	0	0	0	2	0
-X	13			0	0	0	0	0	2	0
	14			0	0	0	0	0	2	0
	5	5		0	0	0	0	0	2	0
	5	6		0	0	0	0	0	2	0
	5	13		0	0	0	0	0	2	0
	5	14		0	0	0	0	0	2	0
	6	6		0	0	0	0	0	2	0
	6	13		0	0	0	0	0	2	0
	6	14		0	0	0	0	0	2	0
	13	13		0	0	0	0	0	1	0
	13	14		0	0	0	0	0	2	0
	14	14		0	0	0	0	0	2	0
	5	5	6	0	0	0	0	0	2	0
	5	6	6	0	0	0	0	0	2	0
-Z	NONE			0	1	1	0	0	1	1
	5			0	1	1	0	0	1	1
+PITCH	6			0	1	1	0	0	1	1
-X	13			0	1	1	0	0	1	1
	14			0	1	1	0	0	1	1
	5	5		0	0	1	0	0	0	0
	5	6		0	1	1	0	0	1	1
	5	13		0	1	1	0	0	1	1
	5	14		0	1	1	0	0	1	1
	6	6		0	1	0	0	0	0	0
	6	13		0	1	1	0	0	1	1
	6	14		0	1	1	0	0	1	1
	13	13		0	1	1	0	0	1	1
	13	14		0	1	1	0	0	1	1
	14	14		0	1	1	0	0	1	1
	5	5	6	0	0	1	0	0	0	0
	5	6	6	0	1	0	0	0	0	0

Table 4.4.4.2.2.1-1B. +Z Translation and/or Roll Rotation and/or Pitch Rotation Jet Groups (Separation Phase With -Z Translation and With -X Translation) (Cont)

Commands	Failure Locations by Group	Number of Jets Used by Group						
		G-4	G-5	G-6	G-11	G-12	G-13	G-14
-Z	NONE	0	1	1	0	0	2	2
	5	0	1	1	0	0	2	2
	6	0	1	1	0	0	2	2
-X	13	0	1	1	0	0	2	2
	14	0	1	1	0	0	2	2
	5 5	0	0	1	0	0	1	1
	5 6	0	1	1	0	0	2	2
	5 13	0	1	1	0	0	2	2
	5 14	0	1	1	0	0	2	2
	6 6	0	1	0	0	0	1	1
	6 13	0	1	1	0	0	2	2
	6 14	0	1	1	0	0	2	2
	13 13	0	1	1	0	0	1	2
	13 14	0	1	1	0	0	2	2
	14 14	0	1	1	0	0	2	1
	5 5 6	0	0	1	0	0	1	1
	5 6 6	0	1	0	0	0	1	1
-Z	NONE	0	0	0	0	0	2	2
	5	0	0	0	0	0	2	2
-PITCH	6	0	0	0	0	0	2	2
-X	13	0	0	0	0	0	2	2
	14	0	0	0	0	0	2	2
	5 5	0	0	0	0	0	2	2
	5 6	0	0	0	0	0	2	2
	5 13	0	0	0	0	0	2	2
	5 14	0	0	0	0	0	2	2
	6 6	0	0	0	0	0	2	2
	6 13	0	0	0	0	0	2	2
	6 14	0	0	0	0	0	2	2
	13 13	0	0	0	0	0	1	2
	13 14	0	0	0	0	0	2	2
	14 14	0	0	0	0	0	2	1
	5 5 6	0	0	0	0	0	2	2
	5 6 6	0	0	0	0	0	2	2

Table 4.4.4.2.2.1-1B. Z Translation and/or Roll Rotation and/or Pitch Rotation Jet Groups (Separation Phase With -Z Translation and With -X Translation) (Cont)

Commands	Failure Locations by Group	Number of Jets Used by Group						
		G-4	G-5	G-6	G-11	G-12	G-13	G-14
-Z	NONE	0	1	1	0	0	0	2
-ROLL	5	0	1	1	0	0	0	2
+PITCH	6	0	1	1	0	0	0	2
-X	13	0	1	1	0	0	0	2
	14	0	1	1	0	0	0	2
	5 5	0	0	1	0	0	0	1
	5 6	0	1	1	0	0	0	2
	5 13	0	1	1	0	0	0	2
	5 14	0	1	1	0	0	0	2
	6 6	0	1	0	0	0	0	1
	6 13	0	1	1	0	0	0	2
	6 14	0	1	1	0	0	0	2
	13 13	0	1	1	0	0	0	2
	13 14	0	1	1	0	0	0	2
	14 14	0	1	1	0	0	0	1
	5 5 6	0	0	1	0	0	0	1
	5 6 6	0	1	0	0	0	0	1
-Z	NONE	0	1	1	0	0	0	2
-ROLL	5	0	1	1	0	0	0	2
	6	0	1	1	0	0	0	2
-X	13	0	1	1	0	0	0	2
	14	0	1	1	0	0	0	2
	5 5	0	0	1	0	0	0	2
	5 6	0	1	1	0	0	0	2
	5 13	0	1	1	0	0	0	2
	5 14	0	1	1	0	0	0	2
	6 6	0	1	0	0	0	0	2
	6 13	0	1	1	0	0	0	2
	6 14	0	1	1	0	0	0	2
	13 13	0	1	1	0	0	0	2
	13 14	0	1	1	0	0	0	2
	14 14	0	1	1	0	0	0	1
	5 5 6	0	0	1	0	0	0	2
	5 6 6	0	1	0	0	0	0	2

Table 4.4.4.2.2.1-1B. Z Translation and/or Roll Rotation and/or Pitch Rotation Jet Groups (Separation Phase With -Z Translation and With -X Translation) (Cont)

Commands	Failure Locations by Group			Number of Jets Used by Group						
				G-4	G-5	G-6	G-11	G-12	G-13	G-14
-Z	NONE			0	0	0	0	0	0	2
-ROLL	5			0	0	0	0	0	0	2
-PITCH	6			0	0	0	0	0	0	2
-X	13			0	0	0	0	0	0	2
	14			0	0	0	0	0	0	2
	5	5		0	0	0	0	0	0	2
	5	6		0	0	0	0	0	0	2
	5	13		0	0	0	0	0	0	2
	5	14		0	0	0	0	0	0	2
	6	6		0	0	0	0	0	0	2
	6	13		0	0	0	0	0	0	2
	6	14		0	0	0	0	0	0	2
	13	13		0	0	0	0	0	0	2
	13	14		0	0	0	0	0	0	2
	14	14		0	0	0	0	0	0	1
	5	5	6	0	0	0	0	0	0	2
	5	6	6	0	0	0	0	0	0	2

Table 4.4.4.2.2.1-1C. Z Translation and/or Roll Rotation and/or Pitch Rotation Jet Groups (Separation Phase With -Z Translation, +X Translation, and Open Crossfeed)

Commands	Failure Locations by Group	Number of Jets Used by Group						
		G-4	G-5	G-6	G-11	G-12	G-13	G-14
-Z	NONE	0	1	1	0	0	2	0
+ROLL	5	0	1	1	0	0	2	0
+PITCH	6	0	1	1	0	0	2	0
+X	13	0	1	1	0	0	2	0
	14	0	1	1	0	0	2	0
	5 5	0	0	1	0	0	1	0
	5 6	0	1	1	0	0	2	0
	5 13	0	1	1	0	0	2	0
	5 14	0	1	1	0	0	2	0
	6 6	0	1	0	0	0	1	0
	6 13	0	1	1	0	0	2	0
	6 14	0	1	1	0	0	2	0
	13 13	0	1	1	0	0	1	0
	13 14	0	1	1	0	0	2	0
	14 14	0	1	1	0	0	2	0
	5 5 6	0	0	1	0	0	1	0
	5 6 6	0	1	0	0	0	1	0
-Z	NONE	0	1	1	0	0	2	0
+ROLL	5	0	1	1	0	0	2	0
	6	0	1	1	0	0	2	0
+X	13	0	1	1	0	0	2	0
	14	0	1	1	0	0	2	0
	5 5	0	0	1	0	0	2	0
	5 6	0	1	1	0	0	2	0
	5 13	0	1	1	0	0	2	0
	5 14	0	1	1	0	0	2	0
	6 6	0	1	0	0	0	2	0
	6 13	0	1	1	0	0	2	0
	6 14	0	1	1	0	0	2	0
	13 13	0	1	1	0	0	1	0
	13 14	0	1	1	0	0	2	0
	14 14	0	1	1	0	0	2	0
	5 5 6	0	0	1	0	0	2	0
	5 6 6	0	1	0	0	0	2	0

Table 4.4.4.2.2.1-1C. Z Translation and/or Roll Rotation and/or Pitch Rotation Jet Groups (Separation Phase With -Z Translation, +X Translation, and Open Crossfeed) (Cont)

Commands	Failure Locations by Group			Number of Jets Used by Group						
				G-4	G-5	G-6	G-11	G-12	G-13	G-14
-Z	NONE			0	0	0	0	0	2	0
+ROLL	5			0	0	0	0	0	2	0
-PITCH	6			0	0	0	0	0	2	0
+X	13			0	0	0	0	0	2	0
	14			0	0	0	0	0	2	0
	5	5		0	0	0	0	0	2	0
	5	6		0	0	0	0	0	2	0
	5	13		0	0	0	0	0	2	0
	5	14		0	0	0	0	0	2	0
	6	6		0	0	0	0	0	2	0
	6	13		0	0	0	0	0	2	0
	6	14		0	0	0	0	0	2	0
	13	13		0	0	0	0	0	1	0
	13	14		0	0	0	0	0	2	0
	14	14		0	0	0	0	0	2	0
	5	5	6	0	0	0	0	0	2	0
	5	6	6	0	0	0	0	0	2	0
-Z	NONE			0	1	1	0	0	1	1
	5			0	1	1	0	0	1	1
+PITCH	6			0	1	1	0	0	1	1
+X	13			0	1	1	0	0	1	1
	14			0	1	1	0	0	1	1
	5	5		0	0	1	0	0	0	0
	5	6		0	1	1	0	0	1	1
	5	13		0	1	1	0	0	1	1
	5	14		0	1	1	0	0	1	1
	6	6		0	1	0	0	0	0	0
	6	13		0	1	1	0	0	1	1
	6	14		0	1	1	0	0	1	1
	13	13		0	1	1	0	0	1	1
	13	14		0	1	1	0	0	1	1
	14	14		0	1	1	0	0	1	1
	5	5	6	0	0	1	0	0	0	0
	5	6	6	0	1	0	0	0	0	0

Table 4.4.4.2.2.1-1C. Z Translation and/or Roll Rotation and/or Pitch Rotation Jet Groups (Separation Phase With -Z Translation, +X Translation, and Open Crossfeed) (Cont)

Commands	Failure Locations by Group	Number of Jets Used by Group						
		G-4	G-5	G-6	G-11	G-12	G-13	G-14
-Z	NONE	0	1	1	0	0	2	2
	5	0	1	1	0	0	2	2
	6	0	1	1	0	0	2	2
+X	13	0	1	1	0	0	2	2
	14	0	1	1	0	0	2	2
	5 5	0	0	1	0	0	1	1
	5 6	0	1	1	0	0	2	2
	5 13	0	1	1	0	0	2	2
	5 14	0	1	1	0	0	2	2
	6 6	0	1	0	0	0	1	1
	6 13	0	1	1	0	0	2	2
	6 14	0	1	1	0	0	2	2
	13 13	0	1	1	0	0	1	2
	13 14	0	1	1	0	0	2	2
	14 14	0	1	1	0	0	2	1
	5 5 6	0	0	1	0	0	1	1
	5 6 6	0	1	0	0	0	1	1
-Z	NONE	0	0	0	0	0	2	2
	5	0	0	0	0	0	2	2
-PITCH	6	0	0	0	0	0	2	2
+X	13	0	0	0	0	0	2	2
	14	0	0	0	0	0	2	2
	5 5	0	0	0	0	0	2	2
	5 6	0	0	0	0	0	2	2
	5 13	0	0	0	0	0	2	2
	5 14	0	0	0	0	0	2	2
	6 6	0	0	0	0	0	2	2
	6 13	0	0	0	0	0	2	2
	6 14	0	0	0	0	0	2	2
	13 13	0	0	0	0	0	1	2
	13 14	0	0	0	0	0	2	2
	14 14	0	0	0	0	0	2	1
	5 5 6	0	0	0	0	0	2	2
	5 6 6	0	0	0	0	0	2	2

Table 4.4.4.2.2.1-1C. Z Translation and/or Roll Rotation and/or Pitch Rotation Jet Groups (Separation Phase With Z Translation, +X Translation, and Open Crossfeed) (Cont)

Commands	Failure Locations by Group			Number of Jets Used by Group						
				G-4	G-5	G 6	G 11	G 12	G 13	G 14
-Z -ROLL +PITCH	NONE 5 6			0 0 0	1 1 1	1 1 1	0 0 0	0 0 0	0 0 0	2 2
+X	13 14 5	 5		0 0 0	1 1 0	1 1 1	0 0 0	0 0 0	0 0 0	2 2 1
	5 5 5	6 13 14		0 0 0	1 1 1	1 1 1	0 0 0	0 0 0	0 0 0	 2 2
	6 6 6 13 13 14	6 13 14 13 14 14		0 0 0 0 0 0	1 1 1 1 1 1	0 1 1 1 1 1	0 0 0 0 0 0	0 0 0 0 0 0	0 0 0 0 0 0	1 2 2 2 2 1
	5 5	5 6	6 6	0 0	0 1	1 0	0 0	0 0	0 0	1 1
-Z -ROLL	NONE 5 6			0 0 0	1 1 1	1 1 1	0 0 0	0 0 0	0 0 0	2 2 2
+X	13 14 5	 5		0 0 0	1 1 0	1 1 1	0 0 0	0 0 0	0 0 0	2 2 2
	5 5 5	6 13 14		0 0 0	1 1 1	1 1 1	0 0 0	0 0 0	0 0 0	2 2 2
	6 6 6	6 13 14		0 0 0	1 1 1	0 1 1	0 0 0	0 0 0	0 0 0	2 2 2
	13 13 14	13 14 14		0 0 0	1 1 1	1 1 1	0 0 0	0 0 0	0 0 0	2 2 1
	5 5	5 6	6 6	0 0	0 1	1 0	0 0	0 0	0 0	2 2

Table 4.4.4.2.2.1-1C. Z Translation and/or Roll Rotation and/or Pitch Rotation Jet Groups (Separation Phase With -Z Translation, +X Translation, and Open Crossfeed) (Cont)

Commands	Failure Locations by Group	Number of Jets Used by Group						
		G-4	G-5	G-6	G-11	G-12	G-13	G-14
-Z	NONE	0	0	0	0	0	0	2
-ROLL	5	0	0	0	0	0	0	2
-PITCH	6	0	0	0	0	0	0	2
+X	13	0	0	0	0	0	0	2
	14	0	0	0	0	0	0	2
	5 5	0	0	0	0	0	0	2
	5 6	0	0	0	0	0	0	2
	5 13	0	0	0	0	0	0	2
	5 14	0	0	0	0	0	0	2
	6 6	0	0	0	0	0	0	2
	6 13	0	0	0	0	0	0	2
	6 14	0	0	0	0	0	0	2
	13 13	0	0	0	0	0	0	2
	13 14	0	0	0	0	0	0	2
	14 14	0	0	0	0	0	0	1
	5 5 6	0	0	0	0	0	0	2
	5 6 6	0	0	0	0	0	0	2

Table 4.4.4.2.2.1-1D. Z Translation and/or Roll Rotation and/or Pitch Rotation Jet Groups (Post-Separation Phase With -Z Translation)

Commands	Failure Locations by Group	Number of Jets Used by Group						
		C-4	C-5	C 6	C-11	C-12	C-13	C-14
-Z +ROLL +PITCH	NONE 5 6	0 0 0	1 1 1	1 1 1	0 0 0	0 0 0	2 2 2	0 0 0
	13 14	0 0	1 1	1 1	0 0	0 0	2 2	0 0
-Z +ROLL	NONE 5 6	0 0 0	1 1 1	1 1 1	0 0 0	0 0 0	2 2 2	0 0 0
	13 14	0 0	1 1	1 1	0 0	0 0	2 2	0 0
-Z +ROLL -PITCH	NONE 5 6	0 0 0	0 0 0	0 0 0	0 0 0	0 0 0	2 2 2	0 0 0
	13 14	0 0	0 0	0 0	0 0	0 0	2 2	0 0
-Z +PITCH	NONE 5 6	0 0 0	1 1 1	1 1 1	0 0 0	0 0 0	0 0 0	0 0 0
	13 14	0 0	1 1	1 1	0 0	0 0	0 0	0 0
-Z	NONE 5 6	0 0 0	1 1 1	1 1 1	0 0 0	0 0 0	2 2 2	2 2 2
	13 14	0 0	1 1	1 1	0 0	0 0	2 2	2 2
-Z -PITCH	NONE 5 6	0 0 0	0 0 0	0 0 0	0 0 0	0 0 0	1 1 1	1 1 1
	13 14	0 0	0 0	0 0	0 0	0 0	1 1	1 1

Table 4.4.4.2.2.1-1D. Z Translation and/or Roll Rotation and/or Pitch Rotation Jet Groups (Post-Separation Phase With -Z Translation) (Cont)

Commands	Failure Locations by Group	Number of Jets Used by Group						
		G-4	G-5	G-6	G-11	G-12	G-13	G-14
-Z -ROLL +PITCH	NONE 5 6	0 0 0	1 1 1	1 1 1	0 0 0	0 0 0	0 0 0	2 2 2
	13 14	0 0	1 1	1 1	0 0	0 0	0 0	2 2
-Z -ROLL	NONE 5 6	0 0 0	1 1 1	1 1 1	0 0 0	0 0 0	0 0 0	2 2 2
	13 14	0 0	1 1	1 1	0 0	0 0	0 0	2 2
-Z -ROLL -PITCH	NONE 5 6	0 0 0	0 0 0	0 0 0	0 0 0	0 0 0	0 0 0	2 2 2
	13 14	0 0	0 0	0 0	0 0	0 0	0 0	2 2

Table 4.4.4.2.2.1-1E. Z Translation and/or Roll Rotation and/or Pitch Rotation Jet Groups (+Z Translation or No Z Translation)

Commands	Failure Locations by Group	Number of Jets Used by Group						
		G-4	G-5	G-6	G-11	G-12	G-13	G-14
+Z +ROLL +PITCH	NONE 4 11	0 0 0	0 0 0	0 0 0	0 0 0	1 1 1	0 0 0	0 0 0
	12	0	0	0	0	1	0	0
+Z +ROLL	NONE 4 11	1 1 1	0 0 0	0 0 0	0 0 0	1 1 1	0 0 0	0 0 0
	12	1	0	0	0	1	0	0
+Z +ROLL -PITCH	NONE 4 11	1 1 1	0 0 0	0 0 0	0 0 0	1 1 1	0 0 0	0 0 0
	12	1	0	0	0	1	0	0
+Z +PITCH	NONE 4 11	0 0 0	0 0 0	0 0 0	1 1 1	1 1 1	0 0 0	0 0 0
	12	0	0	0	1	1	0	0
+Z 	NONE 4 11	1 1 1	0 0 0	0 0 0	1 1 1	1 1 1	0 0 0	0 0 0
	12	1	0	0	1	1	0	0
+Z -PITCH	NONE 4 11	1 1 1	0 0 0	0 0 0	0 0 0	0 0 0	0 0 0	0 0 0
	12	1	0	0	0	0	0	0
+Z -ROLL +PITCH	NONE 4 11	0 0 0	0 0 0	0 0 0	1 1 1	0 0 0	0 0 0	0 0 0
	12	0	0	0	1	0	0	0
+Z -ROLL	NONE 4 11	1 1 1	0 0 0	0 0 0	1 1 1	0 0 0	0 0 0	0 0 0
	12	1	0	0	1	0	0	0

Table 4.4.4.2.2.1-1E. Z Translation and/or Roll Rotation and/or Pitch Rotation Jet Groups (+Z Translation or No Z Translation) (Cont)

Commands	Failure Locations by Group	Number of Jets Used by Group						
		G-4	G-5	G-6	G-11	G-12	G-13	G-14
+Z -ROLL -PITCH	NONE	1	0	0	1	0	0	0
	4	1	0	0	1	0	0	0
	11	1	0	0	1	0	0	0
	12	1	0	0	1	0	0	0
+ROLL +PITCH	NONE	0	1	1	0	1	0	0
	5	0	1	1	0	1	0	0
	6	0	1	1	0	1	0	0
	11	0	1	1	0	1	0	0
	12	0	1	1	0	1	0	0
	5 5	0	0	0	0	1	0	0
	5 6	0	1	1	0	1	0	0
	5 11	0	1	1	0	1	0	0
	5 12	0	1	1	0	1	0	0
	6 6	0	0	0	0	1	0	0
	6 11	0	1	1	0	1	0	0
	6 12	0	1	1	0	1	0	0
	11 11	0	1	1	0	1	0	0
	11 12	0	1	1	0	1	0	0
	12 12	0	1	1	0	1	0	0
+PITCH	NONE	0	1	1	1	1	0	0
	5	0	1	1	1	1	0	0
	6	0	1	1	1	1	0	0
	11	0	1	1	1	1	0	0
	12	0	1	1	1	1	0	0
	5 5	0	0	0	1	1	0	0
	5 6	0	1	1	1	1	0	0
	5 11	0	1	1	1	1	0	0
	5 12	0	1	1	1	1	0	0
	6 6	0	0	0	1	1	0	0
	6 11	0	1	1	1	1	0	0
	6 12	0	1	1	1	1	0	0
	11 11	0	1	1	1	1	0	0
	11 12	0	1	1	1	1	0	0
	12 12	0	1	1	1	1	0	0

Table 4.4.4.2.2.1-1E. Z Translation and/or Roll Rotation and/or Pitch Rotation Jet Groups (+Z Translation or No Z Translation) (Cont)

Commands	Failure Locations by Group	Number of Jets Used by Group						
		G-4	G-5	G-6	G-11	G-12	G-13	G-14
-ROLL +PITCH	NONE	0	1	1	1	0	0	0
	5	0	1	1	1	0	0	0
	6	0	1	1	1	0	0	0
	11	0	1	1	1	0	0	0
	12	0	1	1	1	0	0	0
	5 5	0	0	0	1	0	0	0
	5 6	0	1	1	1	0	0	0
	5 11	0	1	1	1	0	0	0
	5 12	0	1	1	1	0	0	0
	6 6	0	0	0	1	0	0	0
	6 11	0	1	1	1	0	0	0
	6 12	0	1	1	1	0	0	0
	11 11	0	1	1	1	0	0	0
	11 12	0	1	1	1	0	0	0
	12 12	0	1	1	1	0	0	0
+ROLL -PITCH	NONE	1	0	0	0	0	2	0
	4	1	0	0	0	0	2	0
	13	1	0	0	0	0	2	0
	14	1	0	0	0	0	2	0
	4 4	1	0	0	0	0	2	0
	4 13	1	0	0	0	0	2	0
	4 14	1	0	0	0	0	2	0
	13 13	1	0	0	0	0	1	0
	13 14	1	0	0	0	0	2	0
	14 14	1	0	0	0	0	2	0
-PITCH	NONE	1	0	0	0	0	1	1
	4	1	0	0	0	0	1	1
	13	1	0	0	0	0	1	1
	14	1	0	0	0	0	1	1
	4 4	1	0	0	0	0	1	1
	4 13	1	0	0	0	0	1	1
	4 14	1	0	0	0	0	1	1
	13 13	1	0	0	0	0	1	1
	13 14	1	0	0	0	0	1	1
	14 14	1	0	0	0	0	1	1

Table 4.4.4.2.2.1-1E. Z Translation and/or Roll Rotation and/or Pitch Rotation Jet Groups (+Z Translation or No Z Translation) (Cont)

Commands	Failure Locations by Group	Number of Jets Used by Group						
		G-4	G-5	G-6	G-11	G-12	G-13	G-14
-ROLL -PITCH	NONE	1	0	0	0	0	0	2
	4	1	0	0	0	0	0	2
	13	1	0	0	0	0	0	2
	14	1	0	0	0	0	0	2
	4 4	1	0	0	0	0	0	2
	4 13	1	0	0	0	0	0	2
	4 14	1	0	0	0	0	0	2
	13 13	1	0	0	0	0	0	2
	13 14	1	0	0	0	0	0	2
	14 14	1	0	0	0	0	0	1
+ROLL	NONE	0	0	0	0	1	1	0
	12	0	0	0	0	1	1	0
	13	0	0	0	0	1	1	0
	12 12	0	0	0	0	1	1	0
	12 13	0	0	0	0	1	1	0
	13 13	0	0	0	0	1	1	0
-ROLL	NONE	0	0	0	1	0	0	1
	11	0	0	0	1	0	0	1
	14	0	0	0	1	0	0	1
	11 11	0	0	0	1	0	0	1
	11 14	0	0	0	1	0	0	1
	14 14	0	0	0	1	0	0	1

Table 4.4.4.2.2.1-2. Y Translation and/or Yaw Rotation Jet Groups

Commands	Failure Locations by Group	Number of Jets Used by Group			
		C-2	C-3	C 9	C 10
+Y +Yaw	None 2 9	1 1 1	0 0 0	0 0 0	0 0 0
+Y	None 2 9	1 1 1	0 0 0	1 1 1	0 0 0
+Y -Yaw	None 2 9	0 0 0	0 0 0	1 1 1	0 0 0
-Y +Yaw	None 3 10	0 0 0	0 0 0	0 0 0	1 1 1
-Y	None 3 10	0 0 0	1 1 1	0 0 0	1 1 1
-Y -Yaw	None 3 10	0 0 0	1 1 1	0 0 0	0 0 0
+Yaw	None 2 10	1 1 1	0 0 0	0 0 0	1 1 1
	2 2 2 10 10 10	0 1 1	0 0 0	0 0 0	1 1 1
-Yaw	None 3 9	0 0 0	1 1 1	1 1 1	0 0 0
	3 3 3 9 9 9	0 0 0	0 1 1	1 1 1	0 0 0

Table 4.4.4.2.2.1-3. X Translation Jet Groups

Commands	Failure Locations by Group	Number of Jets Used by Group		
		G-1	G-7	G-8
+X	None	0	2	2
	7	0	1	2
	8	0	2	1
-X	None	2	0	0
	1	2	0	0

Table 4.4.4.2.2.1-4. RCS Jet Grouping, Prioritization, and I/O Mapping

Element Number in NEW_JONLST_JSL, HFAIL_JSL, and JET_MAP	Jet Group	Priority of RCS Jet Within Group*	Principal Thrust Direction of Group	JET_MAP Values (Each Element in a Group Will Have One of the Given Values, Mapping That Element to the Associated Jet)
1	1	1	-X	1(F1F), 5(F2F), 13(F3F)
2	1	2		
3	1	3		
4	2	1	+Y	2(F1L), 14(F3L)
5	2	2		
6	3	1	-Y	6(F2R), 9(F4R)
7	3	2		
8	4	1	+Z	3(F1U), 7(F2U), 15(F3U)
9	4	2		
10	4	3		
11	5	1	-Z	8(F2D), 10(F4D)
12	5	2		
13	6	1	-Z	4(F1D), 16(F3D)
14	6	2		
15	7	1	+X	4(R1A), 12(R3A)
16	7	2		
17	8	1	+X	1(L1A), 9(L3A)
18	8	2		
19	9	1	+Y	2(L1L), 17(L2L), 10(L3L), 23(L4L)
20	9	2		
21	9	3		
22	9	4		
23	10	1	-Y	5(R1R), 20(R2R), 13(R3R), 26(R4R)
24	10	2		
25	10	3		
26	10	4		
27	11	1	+Z	3(L1U), 18(L2U), 24(L4U)
28	11	2		
29	11	3		
30	12	1	+Z	6(R1U), 21(R2U), 27(R4U)
31	12	2		
32	12	3		
33	13	1	-Z	19(L2D), 11(L3D), 25(L4D)
34	13	2		
35	13	3		
36	14	1	-Z	22(R2D), 14(R3D), 28(R4D)
37	14	2		
38	14	3		

*Note: Lowest number = highest priority (i.e., No. 1 is selected first).

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Table 4.4.4.2.2.1-5. JET_SELECT_TRANSITION Interface Requirements

Name	Description	Source or Destination	Type	Range	Unit	Sample Rate (Hz)
Inputs						
CROSSFEED_OPEN	Crossfeed between aft RCS tanks is open (1=open)	RCS/RCS XFEED	B	0,1	none	12.5
AVAILABLE_JET_AFT	Aft jet available status (1=available)	RCS RM	A(28)B	0,1	none	12.5
AVAILABLE_JET_FWD	Forward jet available status (1=available)	RCS RM	A(16)B	0,1	none	12.5
JET_FAIL_CHANGE_FLAG	Flag signifying change in HFAIL (1=changed)	RCS RM	B	0,1	none	12.5
JET_MAP	Mapping of jet use preference within groups	RCS RM or carryover from previous OPS	A(38)I	1-28	none	12.5
NOSE_DUMP	Request for RCS propellant dump using forward jets	DEORB MNVR DIP	B	0,1	none	12.5
ROT_JET_CMD	Rotation command	3-AX RHC SOP (via unity gain), ROT_PULSE_TRANSITION,or PHASE_PLANE_TRANSITION	A(3)I	-1,0,1	none	12.5
SEP_COMPLETE	-Z separation velocity has been achieved (1=complete)	TRNS_RECON, ET_SEP_PROCESSOR	B	0,1	none	12.5
SEP_MINUSZ_CMD	Flag indicating auto ET separation burn is to begin	ET SEP SEQ	B	0,1	none	12.5
TRANS_JET_CMD	Translation command (+X, -X, +Y, -Y, +Z, -Z)	GN&C SW RM (via unity gain),ET_SEP_PROCESSOR, or TRNS_RECON	A(6)B	0,1	none	12.5
Output						
NEW_JONLST_AFT	RCS aft jet command (1=on; 0=off)	AS RCS CMD SOP	A(28)B	0,1	none	12.5
NEW_JONLST_FWD	RCS forward jet command (1=on; 0=off)	AS RCS CMD SOP	A(16)B	0,1	none	12.5

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Unit	Sample Rate (Hz)
none	12.5
none	12.5
none	12.5
none	12.5
none	12.5
none	12.5
none	12.5
none	12.5
none	12.5
none	12.5
none	12 5

4.4.4.2.2.2 PHASE_PLANE_TRANSITION

A. Function. For each body axis requiring RCS rotation control and not in the manual rotation acceleration submode, this module determines whether an angular rate change is needed and the sign of the desired rate change. The sign and magnitude of the desired rate error and the RCS rotation commands are supplied to the OMS processor as well. The module operates individually by axis. The algorithm drives and holds the vehicle in a limit cycle about the desired attitude and attitude rate. Rate error extrapolation logic compensates for lags in RCS jet thrust buildup and angular rate measurement. The block diagrams for the module PHASE_PLANE_TRANSITION are presented in Figures 4.4.4.2.2.2-1 and 4.4.4.2.2.2-2. Region boundaries and control actions of the function P_P_TRANSITION are shown in Table 4.4.4.2.2.2-1. The switching lines are defined in Table 4.4.4.2.2.2-2.

B. Processing Rate. The module PHASE_PLANE_TRANSITION is processed at 12.5 Hz.

C. Interface Requirements. The interface requirements for the module PHASE_PLANE_TRANSITION are shown in Table 4.4.4.2.2.2-3.

D. I-Loads/Constants. The I-loads/constants for the module PHASE_PLANE_TRANSITION are shown in Table 4.4.4.2.2.2-4.

E. Initialization Requirements. Initialization requirements for the module PHASE_PLANE_TRANSITION are shown in Table 4.4.4.2.2.2-5.

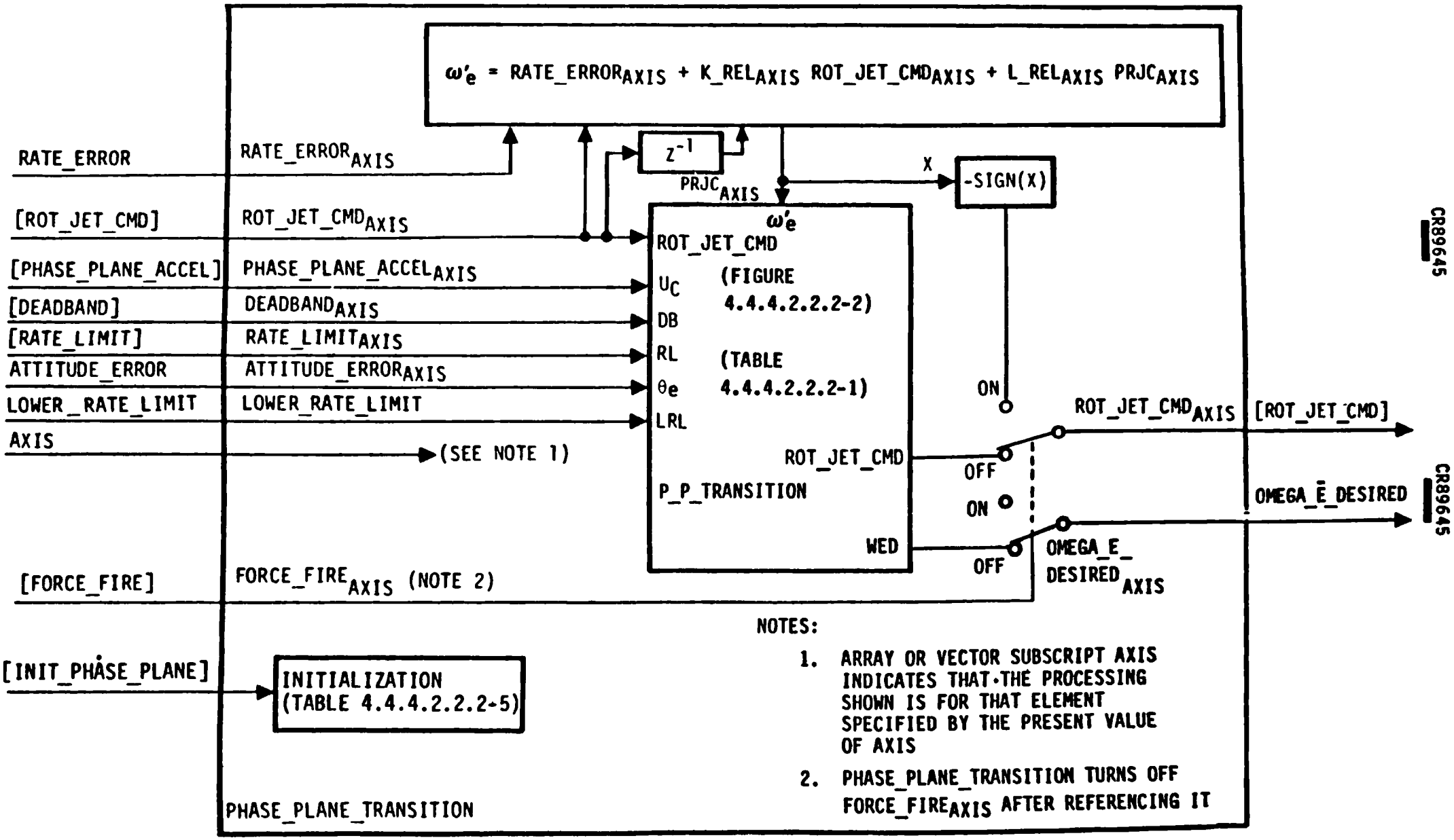
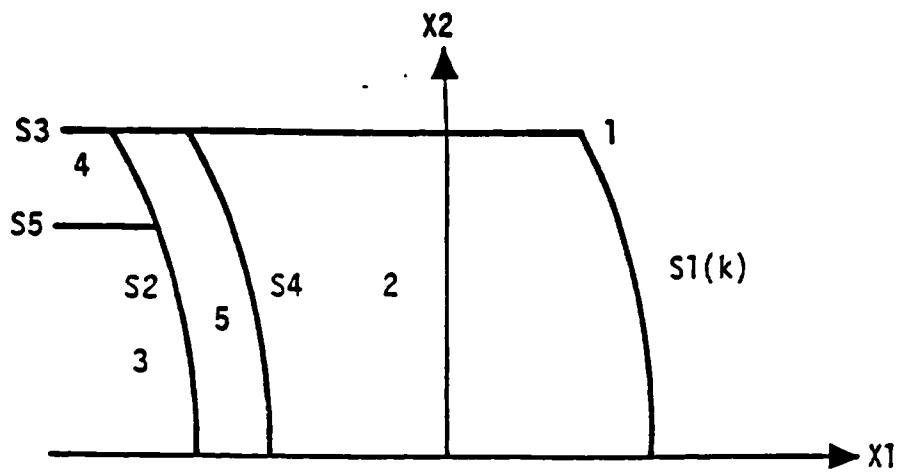


Figure 4.4.4.2.2.2-1. PHASE_PLANE_TRANSITION



LOCAL VARIABLE DEFINITIONS:

VARIABLE	DEFINITION
SE	$\begin{cases} \text{SIGN}(\omega_e'); & \lvert\omega_e'\rvert > \text{RTH} \\ \text{SIGN}(\theta_e); & \lvert\omega_e'\rvert \leq \text{RTH} \end{cases}$
X1	SE θ_e
X2	$\begin{cases} \lvert\omega_e'\rvert; & \lvert\omega_e'\rvert > \text{RTH} \\ 0 \ ; & \lvert\omega_e'\rvert \leq \text{RTH} \end{cases}$
k	SET TO ZERO IF $\lvert X1\rvert \leq$ 0.9 DB; OTHERWISE, UNCHANGED

Figure 4.4.4.2.2.2-2. Phase Plane for Function P_P

Table 4.4.4.2.2.2-1. Control Actions by Function P_P_TRANSITION in Regions of the Phase Plane

Region	Action	Region Definition
1	ROT_JET_CMD = -SE; IF X2 ≤ S3 THEN k = MINIMUM [k + 1, KLIM]; and WED = - SE WLOW ELSE k UNCHANGED and WED = SE WHIGH	X1 ≥ S1 or X2 > S3
2	IF ROT_JET_CMD (from previous cycle) = -SE, and X2 ≠ 0 THEN (leave ROT_JET_CMD at that value) ELSE ROT_JET_CMD = 0 WED = 0	S3 ≥ X2 and S1 > X1 ≥ S4
3	ROT_JET_CMD = SE WED = SE WLOW	X1 < S2 and X2 < S5
4	ROT_JET_CMD = 0 WED = SE WLOW	X1 < S2 and S3 ≥ X2 ≥ S5
5	ROT_JET_CMD = 0 WED = SE WLOW	S2 ≤ X1 < S4 and X2 ≤ S3

Table 4.4.4.2.2.2-2. Definition of Switching Lines

Line	Definition
S1	$X1 = -\frac{X2^2}{2U_C} + DB + \frac{0.2\ DB\ k}{KSTEP}$, $0 \leq X2 < +RL$
S2	$X1 = -\frac{CX2^2}{2U_C} - 1.2\ DB$, $0 \leq X2 < +RL$ (see note)
S3	X2 = +RL, bounded on the right by S1
S5	X2 = LRL, bounded on the right by S2
S4	$X1 = \frac{-X2^2}{2U_C} - DB$, $0 \leq X2 < +RL$

Note: $C = \begin{cases} 1.25, & |ROT_JET_CMD| \neq 1 \\ 1.0, & |ROT_JET_CMD| = 1 \end{cases}$

Table 4.4.4.2.2.2-3. PHASE_PLANE_TRANSITION Interface Requirements

Name	Description	Source or Destination	Type	Range	Unit	Sample Rate (Hz)
Inputs						
ATTITUDE_ERROR	Body angle error	RCS_ERRORS_TRANSITION	V(3)S	-360 to 360	deg	12.5
AXIS	Body axis for this execution	TRNS_RECON	I	1,2,3	none	12.5/ axis
DEADBAND	Attitude deadband by axis	TRNS_RECON	A(3)S	0 to 20	deg	12.5
FORCE_FIRE	Rate damping initiation flag by axis (1=damp rate)	ROT_DISC_TRANSITION, AUTO_MNVR, TRNS_RECON	B(3)	0,1 for each bit	none	12.5
INIT_PHASE_PLANE	Module initialization flag (1 = init.)	TRNS_RECON	A(3)B	0,1	none	12.5
PHASE_PLANE_ACCEL	Magnitude of average control acceleration available for each axis, scaled for phase-plane use	See Note 1	A(3)S	0 to 5	deg/s s	12.5
RATE_ERROR	Body angular rate error	RCS_ERRORS_TRANSITION	V(3)S	-20 to 20	deg/s	12.5
RATE_LIMIT	Angular rate error limit by axis	TRNS_RECON	A(3)S	0 to 5	deg/s	12.5
ROT_JET_CMD	Rotation command from previous cycle	PHASE_PLANE_ TRANSITION	A(3)I	-1,0,1	none	12.5
LOWER_RATE_LIMIT	Phase-plane lower rate limit	TRNS_RECON	S	0 to 2	deg/s	12.5
Outputs						
OMEGA_E_DESIRED	Desired angular rate error	TVC_LAW_PITCH_YAW, TVC_LAW_ROLL	V(3)S	-5 to 5	deg/s	12.5
ROT_JET_CMD	Rotation command	PHASE_PLANE_ TRANSITION, JET_ SELECT_TRANSITION, TVC_LAW_PITCH_YAW, TVC_LAW_ROLL, RCS ACT LT	A(3)I	-1,0,1	none	12.5

Note 1. I-load (Insertion); carryover value from On-Orbit phase (Deorbit)

Table 4.4.4.2.2.2-4. PHASE_PLANE_TRANSITION I-Loads/Constants

Name	Description	Type	MSID/Value	Unit
K_REL	Rate error lead function gain	A(3)S	V97U1318C V97U1319C V97U1320C	deg/s
KLIM	Switching line incrementation limit	I	V97U2418C	none
KSTEP	Switching line incrementation size factor	I	V97U2417C	none
L_REL	Rate error lead function gain to compensate for filter lags	A(3)S	V99U7285C V99U7286C V99 728~C	deg s
TDAP	Period of RCS DAP cycle	S	0.08	s
RTH	Rate threshold	A(3)S	V97U2414C to V97U2416C	deg s
WHIGH	Upper target rate error for TVC crossfeed	S	V96U9710C	deg s
WLOW	Lower target rate error for TVC crossfeed	S	V96U9711C	deg s

Table 4.4.4.2.2.2-5. PHASE_PLANE_TRANSITION Initialization Requirements

Initialize on Transition From	Initalize on Transition To	Variable	Initial Value
$INIT_PHASE_PLANE_{AXIS} = 0$	$INIT\ PHASE_PLANE_{AXIS} = 1$	$PRJC_{AXIS}$	0

4.4.4.2.3 OMS Processor.

4.4.4.2.3.1 TVC_LAW_PITCH_YAW.

A. Function. This module closes the inner loop of the TVC DAP. Commanded pitch and yaw rates and the corresponding desired rate errors are subtracted from the vehicle rates to form rate errors, which are processed by compensation filters and passed through proportional-plus-integral paths. The integral paths are incremented as a function of the RCS rotation commands. The outputs are limited and passed on as position commands to the OMS engine actuator servos. Initialization of this module consists of subfunctions, which are invoked as required. These subfunctions are described separately, and the initialization modes are then summarized.

The pitch and yaw channels each consist of an upstream error determination and filter section, and a downstream proportional-plus-integral path and limiting section (Figure 4.4.4.2.3.1-1). A switch between the sections, operated by the initialization flag, allows a trim mode, with the downstream section operating alone with input zeroed, and a dynamic mode, with the sections connected together.

The I-loaded trim angles can be over written by adjusting the values of OMS_PITCH_TRIM and OMS_YAW_TRIM via the maneuver display principal function; or the trim angles may be left alone, in which case they would either be their I-loaded values or the values remaining from the previous burn. Operating the downstream section causes the existing trim value to be output from the module as the engine pitch and yaw commands. In case of a mid-burn transition from two OMS engines to one engine, the trim angles are automatically adjusted for thrusting through the c.g. by the use of internally stored constants.

The OMS_PITCH_TRIM and OMS_YAW_TRIM values provided by the maneuver display principal function are identified in the principal function interface tables (See Tables 4.4.2-1, 4.4.2-2, and 4.4.5-1) using different MSID and Level B mnemonic numbers from those numbers used to identify the trim values which are outputs from this module. Providing unique identification for the input and output values is done for accounting of principal function interfaces only and is not intended to preclude the possibility of using a common compool location for storage of both values.

Dynamic gains must also be adjusted as a function of the number of OMS engines operating. Thus, on the first dynamic pass following prethrust trimming or upon a two to one engine transition, the reconfiguration module indicates the number of engines via a gain flag and forces a gain calculation via the initialization flag. The first dynamic pass also requires initialization of the filters. The various initialization modes are summarized below.

4.4.4.2.3 OMS Processor.

4.4.4.2.3.1 TVC_LAW_PITCH_YAW.

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The I-loaded trim angles can be over written by adjusting the values of OMS_PITCH_TRIM and OMS_YAW_TRIM via the maneuver display principal function; or the trim angles may be left alone, in which case they would either be their I-loaded values or the values remaining from the previous burn. Operating the downstream section causes the existing trim value to be output from the module as the engine pitch and yaw commands. In case of a mid-burn transition from two OMS engines to one engine, the trim angles are automatically adjusted for thrusting through the c.g. by the use of internally stored constants.

The OMS_PITCH_TRIM and OMS_YAW_TRIM values provided by the maneuver display principal function are identified in the principal function interface tables (See Tables 4.4.2-1, 4.4.2-2, and Appendix A) using different MSID and Level B mnemonic numbers from those numbers used to identify the trim values which are outputs from this module. Providing unique identification for the input and output values is done for accounting of principal function interfaces only and is not intended to preclude the possibility of using a common compool location for storage of both values.

Dynamic gains must also be adjusted as a function of the number of OMS engines operating. Thus, on the first dynamic pass following prethrust trimming or upon a two to one engine transition, the reconfiguration module indicates the number of engines via a gain flag and forces a gain calculation via the initialization flag. The first dynamic pass also requires initialization of the filters. The various initialization modes are summarized below.

Initialization Flag Value	Description	Action
0	Normal dynamic pass	Operate both sections of module.
1	Prethrust trim	Zero filter nodes, set trim angles to externally supplied values, and operate downstream section only.
2	Two to one engine transition trim	Set trim angles to internal one-engine values, calculate gains, and operate both sections of module.
3	First dynamic pass after prethrust trim	Calculate gains and operate both sections.

These modes are sequenced as follows:

Event	Initialization Flag Value
Prethrust trim commanded	1
Engine(s) ignition	3
Engine(s) on, subsequent	0
Midburn two to one engine transition	2
Remainder of burn	0

The detailed block diagram for TVC_LAW_PITCH_YAW is presented in Figure 4.4.4.2.3.1-1.

B. Processing Rate. TVC_LAW_PITCH_YAW is processed at 12.5 Hz.

C. Interface Requirements. The interface requirements for TVC_LAW_PITCH_YAW are shown in Table 4.4.4.2.3.1-1.

D. I-Loads/Constants. The I-loads/constants for TVC_LAW_PITCH_YAW are shown in Table 4.4.4.2.3.1-2.

E. Initialization Requirements. The initialization requirements for TVC_LAW_PITCH_YAW are shown in Table 4.4.4.2.3.1-3.

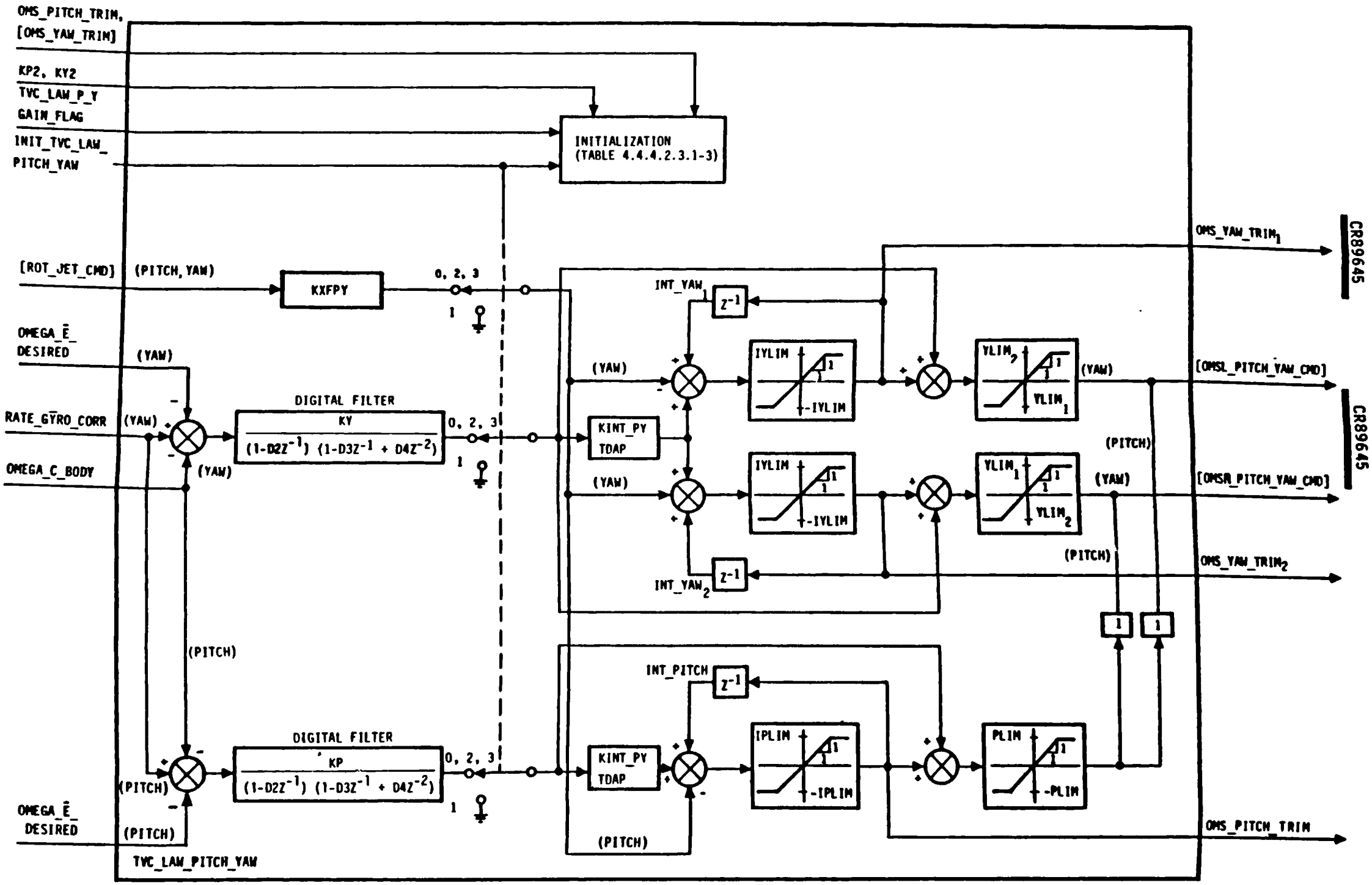

Figure 4.4.4.2.3.1-1. TVC_LAW_PITCH_YAW

Table 4.4.4.2.3.1-1. TVC_LAW_PITCH_YAW Interface Requirements

Name	Description	Source or Destination	Type	Range	Units	Sample Rate (Hz)
Inputs						
INIT_TVC_LAW_PITCH_YAW	Module initialization flag (0=no init; 1=prethrust trim; 2=two engine to one engine transition trim 3=first dynamic pass after prethrust trim)	TRNS_RECON	I	0,1,2,3	none	12.5
KP2	Pitch filter gain (two engines)	See Note 2	S	0 to 10	deg/(deg/s)	12.5
KY2	Yaw filter gain (two engines)	See Note 2	S	0 to 10	deg/(deg/s)	12.5
OMEGA_C_BODY (pitch and yaw components)	Commanded body angular rate	GUIDANCE_COMPENSATION or MANUAL_TVC	V(3)S	-5 to 5	deg/s	12.5
OMEGA_B_DESIRED (pitch and yaw components)	Desired angular rate error	PHASE_PLANE_TRANSITION	V(3)S	-5 to 5	deg/s	12.5
OMS_PITCH_TRIM	OMS engines pitch trim angle with respect to center of gimbal travel	See Note 1; also XXXXX MNVR YYYYY, U/L	S	-10 to 10	deg	12.5
OMS_YAW_TRIM	Left and right OMS engines yaw trim angles with respect to center of gimbal travel	See Note 1; also XXXXX MNVR YYYYY, U/L	A(2)S	-10 to 10	deg	12.5
RATE_GYRO_CORR (pitch and yaw components)	Measured body angular rate	ASCENT/ENTRY ATT PROC	V(3)S	-20 to 20	deg/s	12.5
ROT_BT_CMD (pitch and yaw components)	RCS rotation command	PHASE_PLANE_TRANSITION	A(3)I	-1,0,1	none	12.5
TVC_LAW_P_Y_GAIN_FLAG	Gain multiplication factor based on number of OMS engines operating (1=two engines, 2=one engine)	TRNS_RECON	I	1,2	none	12.5
Outputs						
OMS_PITCH_TRIM	OMS engines pitch trim angle with respect to center of gimbal travel	AS MNVR DIP or DEORB MNVR DIP, XXXXX MNVR YYYYY, ORB INS GUID or DEORB GUID	S	-6 to 6	deg	12.5
OMS_YAW_TRIM	Left and right OMS engines yaw trim angles with respect to center of gimbal travel	AS MNVR DIP or DEORB MNVR DIP, XXXXX MNVR YYYYY; ORB INS GUID or DEORB GUID	A(2)S	-8 to 8	deg	12.5
OMSL_PITCH_YAW_CMD	Left OMS engine pitch and yaw servo commands with respect to center of gimbal travel	OMS TVC CMD SOP, TVC_MIXER	A(2)S	Pitch: -5 to 5 Yaw: -8 to 8	deg	12.5
OMSR_PITCH_YAW_CMD	Right OMS engine pitch and yaw servo commands with respect to center of gimbal travel	OMS TVC CMD SOP	A(2)S	Pitch: -5 to 5 Yaw: -8 to 8	deg	12.5

Note 1 I-load (insertion carry over value from on-orbit phase (deorbit).
Note 2 I-load (insertion subsequent to OPS 1, carry over from previous OPS.

Figure 4.4.4.2.3.1-1. TVC LAW_PITCH YAW

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Table 4.4.4.2.3.1-2. TVC_LAW_PITCH_YAW I-Loads/Constants

Name	Description	Type	MSID / Value	Unit
D2	Filter coefficient	S	V97U2340C	none
D3	Filter coefficient	S	V97U2341C	none
D4	Filter coefficient	S	V97U2342C	none
IYLIM	Left and right OMS yaw-indicator limit	S	V97U1305C	deg
IPLIM	OMS pitch integrator limit	S	V97U1306C	deg
KINT_PY	Integrator gain	S	V97U2352C	none
KXFPY	Pitch and yaw crossfeed gain	S	V96U9708C	deg
ONE_ENG_ OMS_PITCH_ TRIM (Note 1)	OMS engines pitch trim angles for thrusting through c.g.	S	V97U2367C	deg
ONE_ENG_ OMS_YAW_ TRIM (Note 1)	Left and right OMS engines yaw trim angles for thrusting through c.g.	A(2)S	V97U2368C V97U2369C	deg
PLIM	Left and right OMS pitch command limit	S	V97U2373C	deg
TDAP	Period of TVC DAP cycle	S	0.08	s
YLIM1	Left-negative and right-positive OMS yaw command limit	S	V97U2392C	deg
YLIM2	Left-positive and right-negative OMS yaw command limit	S	V96U9802C	deg

Note 1. Mission-dependent I-load parameter.

Table 4.4.4.2.3.1-3. TVC_LAW_PITCH_YAW Initialization Requirements

Initialize on Transition From	Initialize on Transition To	Variable	Initial Value
INIT_TVC_LAW_PITCH_YAW = 0	INIT_TVC_LAW_PITCH_YAW = 1	INT_PITCH	OMS_PITCH_TRIM
		INT_YAW	OMS_YAW_TRIM
		NODES (3 FOR EACH FILTER)	0,0,0
INIT_TVC_LAW_PITCH_YAW = 0	INIT_TVC_LAW_PITCH_YAW = 2	INT_PITCH	ONE_ENG_OMS_PITCH_TRIM
		INT_YAW	ONE_ENG_OMS_YAW_TRIM
		KP	KP2 TVC_LAW_P_Y_GAIN_FLAG
		KY	KY2 TVC_LAW_P_Y_GAIN_FLAG
INIT_TVC_LAW_PITCH_YAW = 0	INIT_TVC_LAW_PITCH_YAW = 3	KP	KP2 TVC_LAW_P_Y_GAIN_FLAG
		KY	KY2 TVC_LAW_P_Y_GAIN_FLAG
	FIRST PASS INSERTION PHASE	INT_PITCH INT_YAW $ 1 INT_YAW $ 2	OMS_PITCH_TRIM OMS_YAW_TRIM (1) OMS_YAW_TRIM (2)

4.4.4.2.3.2 TVC_LAW_ROLL.

A. Function. This module provides control of the vehicle in roll during two-engine TVC burns. Commanded roll rate and desired rate error are subtracted from the vehicle rate to form a rate error, which is processed by a compensation filter and passed through proportional-plus-integral paths. The integral path is incremented as a function of the RCS rotation command and limited. The output is passed on as a roll command to the TVC mixer module. The detailed block diagram for TVC_LAW_ROLL is presented in Figure 4.4.4.2.3.2-1.

B. Processing Rate. TVC_LAW_ROLL is processed at 12.5 Hz.

C. Interface Requirements. The interface requirements for TVC_LAW_ROLL are shown in Table 4.4.4.2.3.2-1.

D. I-Loads/Constants. The I-loads/constants for TVC_LAW_ROLL are shown in Table 4.4.4.2.3.2-2.

E. Initialization Requirements. The initialization requirements for TVC_LAW_ROLL are shown in Table 4.4.4.2.3.2-3.

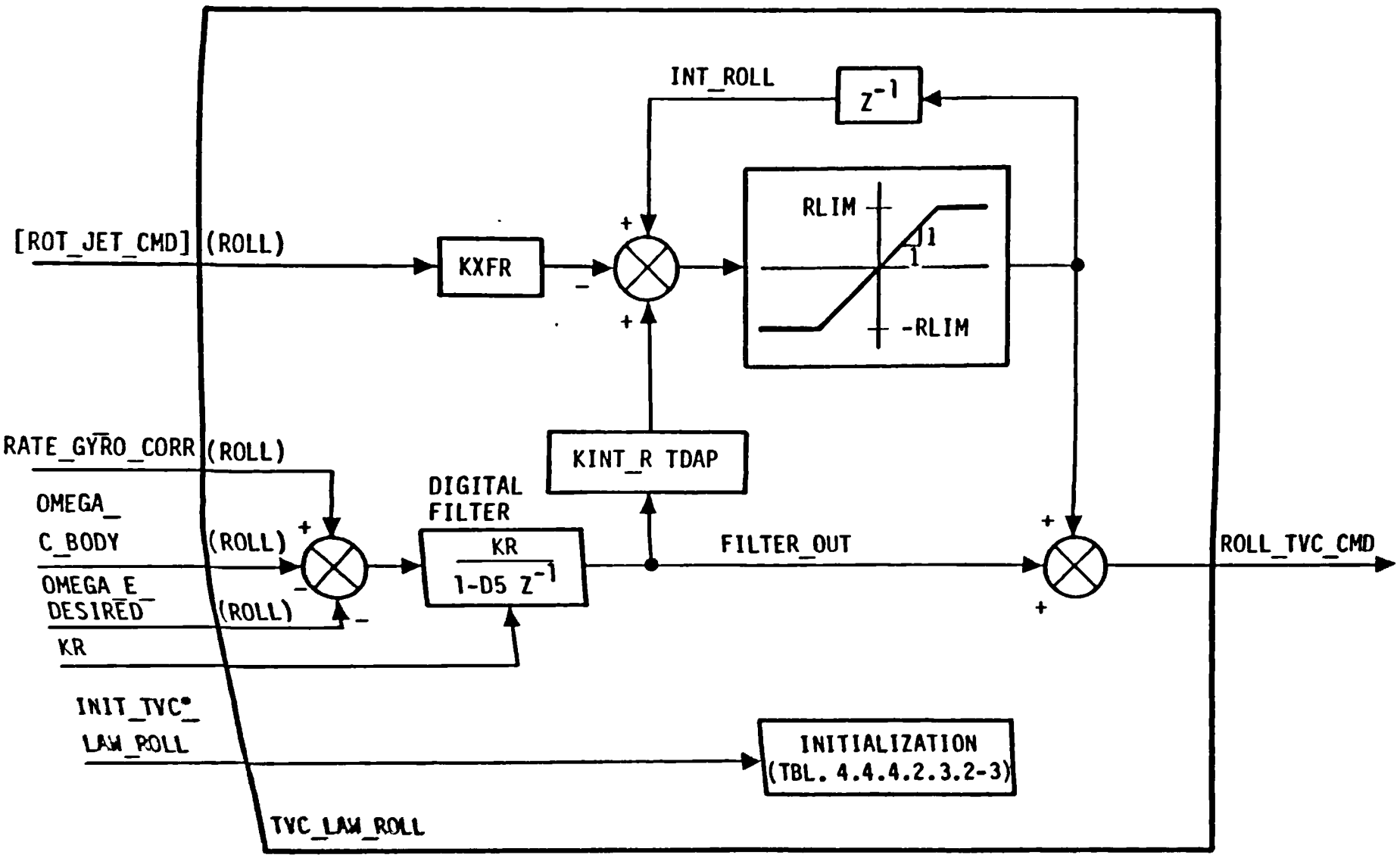

Figure 4.4.4.2.3.2-1. TVC LAW ROLL

Table 4.4.4.2.3.2-1. TVC_LAW_ROLL Interface Requirements

Name	Description	Source or Destination	Type	Range	Unit	Sample Rate (Hz)
Inputs						
INIT_TVC_LAW_ROLL	Module initialization flag	TRNS_RECON	B	0,1	none	12.5
KR	Roll filter gain	See Note 1	S	0 to 10	deg/(deg/s)	12.5
OMEGA_C_BODY (roll component)	Commanded body angular rate	GUIDANCE_COMPENSATION or MANUAL_TVC	V(3)S	-5 to 5	deg/s	12.5
OMEGA_E_DESIRED (roll component)	Desired angular rate error	PHASE_PLANE_TRANSITION	V(3)S	-5 to 5	deg/s	12.5
RATE_GYRO_CORR (roll component)	Measured body angular rate	ASCENT/ENTRY ATT PROC	V(3)S	-40 to 40	deg/s	12.5
ROT_JET_CMD	RCS rotation command	PHASE_PLANE_TRANSITION	A(3)I	-1,0,1	none	12.5
Outputs						
ROLL_TVC_CMD	Roll component of pitch servo command for OMS engines	TVC_MIXER	S	-20 to 20	deg	12.5

Note 1. I-Load (insertion) subsequent to OPS 1; carry-over value from previous OPS.

Table 4.4.4.2.3.2-2. TVC_LAW_ROLL I-Loads/Constants

Name	Description	Type	MSID/Value	Unit
D5	Filter coefficient	S	V97U2343C	none
KINT_R	Integrator gain	S	V97U2353C	none
KXFR	Roll crossfeed gain	S	V96U9709C	deg
RLIM	Limiting value for roll integrator	S	V97U2389C	deg
TDAP	Period of TVC DAP cycle	S	0.08	s

Table 4.4.4.2.3.2-3. TVC_LAW_ROLL Initialization Requirements

Initialize on Transition From	Initialize on Transition To	Variable	Initial Value
INIT_TVC_ROLL = OFF	INIT_TVC_ROLL = ON	FILTER_OUT	0
		INT_ROLL	0

4.4.4.2.3.3 TVC_MIXER.

A. Function. This module derives the left and right OMS pitch actuator servo commands as the difference and sum respectively of the pitch and roll TVC commands. The roll command is limited as a function of the pitch command, so that the total pitch command cannot exceed the desired limit. The detailed block diagram for the module TVC_MIXER is presented in Figure 4.4.4.2.3.3-1.

B. Processing Requirements. The module TVC_MIXER is processed at 12.5 Hz.

C. Interface Requirements. The interface requirements for the module TVC_MIXER are shown in Table 4.4.4.2.3.3-1.

D. I-Loads. The I-loads for the module TVC_MIXER are shown in Table 4.4.4.2.3.3-2.

E. Initialization Requirements. There are no initialization requirements for TVC_MIXER.

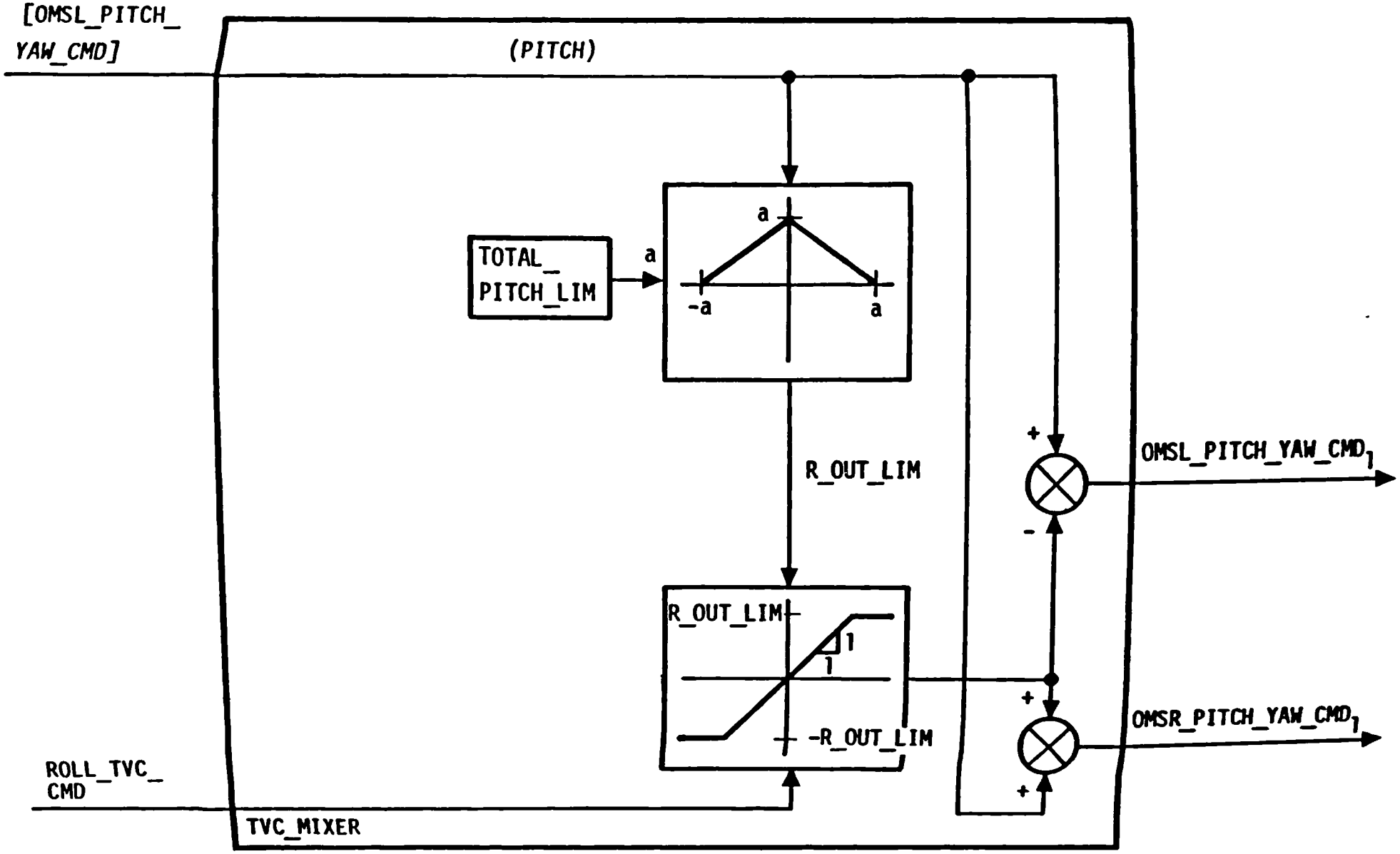

Figure 4.4.4.2.3.3-1. TVC_MIXER

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Table 4.4.4.2.3.3-1. TVC_MIXER Interface Requirements

Name	Description	Source or Destination	Type	Range	Unit	Sample Rate (Hz)
Inputs						
OMSL_PITCH_YAW_CMD (pitch element)	Left OMS engine pitch and yaw servo commands	TVC_LAW_PITCH_YAW	A(2)S	Pitch: -5 to 5 Yaw: -8 to 8	deg	12.5
ROLL_TVC_CMD	Roll component of pitch servo command for OMS engines	TVC_LAW_ROLL	S	-20 to 20	deg	12.5
Outputs						
CR89645 OMSL_PITCH_YAW_CMD (pitch element)	Left OMS engine pitch and yaw servo commands	OMS TVC CMD SOP	A(2)S	Pitch: -6 to 6 Yaw: -8 to 8	deg	12.5
CR89645 OMSR_PITCH_YAW_CMD (pitch element)	Right OMS engine pitch and yaw servo commands	OMS TVC CMD SOP	A(2)S	Pitch: -6 to 6 Yaw: -8 to 8	deg	12.5

Unit	Sample Rate (Hz)
deg	12.5
deg	12.5
deg	12.5
deg	12.5

Table 4.4.4.2.3.3-2. TVC_MIXER I-Load

Name	Description	Type	MSID	Unit
TOTAL_ PITCH_LIM	Limit of total pitch command	S	V97U2390C	deg

4.4.5 Transition DAP Principal Function Tables

The transition DAP principal function IDD inputs and outputs are listed in Table 4.4.5-1. Values for the I-loads are contained in the I-loads requirements document (JSC-19350); however, I-load definitions applicable to this principal function are listed in Table 4.4.5-2. K-loads are listed in Table 4.4.5-3.

The automated Interface Definition Document (IDD) table (Table 4.4.5-1) defines signal (parameter) interface requirements either between hardware (LRU) and software elements or between software elements and other software elements.[1] In the event of a conflict between the IDD tables and other internal text input/output tables, the SASCB data base-controlled IDD tables take precedence.

Note that IDD output (source) tables which reflect parameters going to input (destination) "TLM" shall not be interpreted as a signal actually being downlisted. The parameter may only be available for downlist in COMPOOL and may not appear in a downlist format.

[1]A GN&C software element is either a sequenced principal function, crew-generated specialist/display function, or an OPS display function.

Table 4.4.5-1. Transition Digital Autopilot (G4.201) Input/Output Functional Parameters

TABLE 4.4.5 1 TRANSITION DIGITAL AUTOPILOT (G4.201) INPUT/OUTPUT FUNCTIONAL PARAMETERS

DBFN: D2B039-A PN: VP707100026P00L MAY 31, 1988
INPUT FUNCTIONAL PARAMETERS FOR TRANSITION DIGITAL AUTOPILOT TRANS DAP OI88 REV00 G4.201 PAGE 432 BOOK: 8-2

FSSR NAME	M/S ID	NOMENCLATURE	SOURCE	UNITS	DATA TYPE	PREC	
ABORT_PLUSX_JET_CMD	V90X8310X	POST MECO RCS +X ON CMD	ABT CNTL SEQ				
ATTITUDE_INCREMENT(1)	V90U2333C	ATTITUDE INCREMENT-HI RATE ROLL	A/E ATT PROC	DEG			CR89645
ATTITUDE_INCREMENT(2)	V90U2334C	ATTITUDE INCREMENT-HI RATE PITCH	A/E ATT PROC	DEG			
ATTITUDE_INCREMENT(3)	V90U2335C	ATTITUDE INCREMENT-HI RATE YAW	A/E ATT PROC	DEG			
AUTO_REQUEST	V90X7692X	SEL FWD DAP AUTO	GN&C SW RM				
AVAILABLE_JET_AFT(01)	V90X4520X	JET L1A AVAILABLE	RCS RM		BD		
AVAILABLE_JET_AFT(02)	V90X4521X	JET L1L AVAILABLE	RCS RM		BD		
AVAILABLE_JET_AFT(03)	V90X4522X	JET L1U AVAILABLE	RCS RM		BD		
AVAILABLE_JET_AFT(04)	V90X4534X	JET R1A AVAILABLE	RCS RM		BD		
AVAILABLE_JET_AFT(05)	V90X4535X	JET R1R AVAILABLE	RCS RM		BD		
AVAILABLE_JET_AFT(06)	V90X4536X	JET R1U AVAILABLE	RCS RM		BD		
AVAILABLE_JET_AFT(09)	V90X4526X	JET L3A AVAILABLE	RCS RM		BD		
AVAILABLE_JET_AFT(09)	V90X4560X	JET F4R AVAILABLE	RCS RM		BD		
AVAILABLE_JET_AFT(10)	V90X4527X	JET L3L AVAILABLE	RCS RM		BD		
AVAILABLE_JET_AFT(11)	V90X4528X	JET L3D AVAILABLE	RCS RM		BD		
AVAILABLE_JET_AFT(12)	V90X4540X	JET R3A AVAILABLE	RCS RM		BD		
AVAILABLE_JET_AFT(13)	V90X4541X	JET R3R AVAILABLE	RCS RM		BD		
AVAILABLE_JET_AFT(14)	V90X4542X	JET R3D AVAILABLE	RCS RM		BD		
AVAILABLE_JET_AFT(17)	V90X4523X	JET L2L AVAILABLE	RCS RM		BD		
AVAILABLE_JET_AFT(18)	V90X4524X	JET L2U AVAILABLE	RCS RM		BD		
AVAILABLE_JET_AFT(19)	V90X4525X	JET L2D AVAILABLE	RCS RM		BD		
AVAILABLE_JET_AFT(20)	V90X4537X	JET R2R AVAILABLE	RCS RM		BD		
AVAILABLE_JET_AFT(21)	V90X4538X	JET R2U AVAILABLE	RCS RM		BD		
AVAILABLE_JET_AFT(22)	V90X4539X	JET R2D AVAILABLE	RCS RM		BD		
AVAILABLE_JET_AFT(23)	V90X4529X	JET L4L AVAILABLE	RCS RM		BD		
AVAILABLE_JET_AFT(24)	V90X4530X	JET L4U AVAILABLE	RCS RM		BD		
AVAILABLE_JET_AFT(25)	V90X4531X	JET L4D AVAILABLE	RCS RM		BD		
AVAILABLE_JET_AFT(26)	V90X4543X	JET R4R AVAILABLE	RCS RM		BD		
AVAILABLE_JET_AFT(27)	V90X4544X	JET R4U AVAILABLE	RCS RM		BD		
AVAILABLE_JET_AFT(28)	V90X4545X	JET R4D AVAILABLE	RCS RM		BD		
AVAILABLE_JET_FWD(01)	V90X4548X	JET F1F AVAILABLE	RCS RM		BD		
AVAILABLE_JET_FWD(02)	V90X4549X	JET F1L AVAILABLE	RCS RM		BD		
AVAILABLE_JET_FWD(03)	V90X4550X	JET F1U AVAILABLE	RCS RM		BD		
AVAILABLE_JET_FWD(04)	V90X4551X	JET F1D AVAILABLE	RCS RM		BD		
AVAILABLE_JET_FWD(05)	V90X4552X	JET F2F AVAILABLE	RCS RM		BD		
AVAILABLE_JET_FWD(06)	V90X4553X	JET F2R AVAILABLE	RCS RM		BD		
AVAILABLE_JET_FWD(07)	V90X4554X	JET F2U AVAILABLE	RCS RM		BD		
AVAILABLE_JET_FWD(08)	V90X4555X	JET F2D AVAILABLE	RCS RM		BD		
AVAILABLE_JET_FWD(10)	V90X4561X	JET F4D AVAILABLE	RCS RM		BD		
AVAILABLE_JET_FWD(13)	V90X4556X	JET F3F AVAILABLE	RCS RM		BD		
AVAILABLE_JET_FWD(14)	V90X4557X	JET F3L AVAILABLE	RCS RM		BD		
AVAILABLE_JET_FWD(15)	V90X4558X	JET F3U AVAILABLE	RCS RM		BD		
AVAILABLE_JET_FWD(16)	V90X4559X	JET F3D AVAILABLE	RCS RM		BD		
CROSSFEED_OPEN	V90X1540X	RCS CROSSFEED SEQ COMPLETE FLAG	RCS/RCS XFEED				
DAMAN/RHC(1)	V96H0005CB	MANUAL ROLL CMD	3-AX RHC SOP	DEG			
DEMAN/RHC(2)	V96H0007CB	MANUAL PITCH CMD	3-AX RHC SOP	DEG			
DISC_REQUEST(1)	V90X7727X	SEL FWD ROTATION PITCH DISC RATE	GN&C SW RM				
DISC_REQUEST(2)	V90X7728X	SEL FWD ROTATION ROLL DISC RATE	GN&C SW RM				
DISC_REQUEST(3)	V90X7729X	SEL FWD ROTATION YAW DISC RATE	GN&C SW RM				
DVB_SEC(1)	V90U2307C	BODY VEL INCREMENT LO RATE X AXIS	A/E ATT PROC	FT/S/S			
DVB_SEC(2)	V90U2308C	BODY VEL INCREMENT LO RATE Y AXIS	A/E ATT PROC	FT/S/S			
DVB_SEC(3)	V90U2309C	BODY VEL INCREMENT LO RATE Z AXIS	A/E ATT PROC	FT/S/S			

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Table 4.4.5-1. Transition Digital Autopilot (G4.201) Input/Output Functional Parameters (Cont)

TABLE 4.4.5-1 TRANSITION DIGITAL AUTOPILOT (G4.201) INPUT/OUTPUT FUNCTIONAL PARAMETERS

DBFN: D2B039-A PN: VP707100026P00L MAY 31, 1988 OI88 REV00 PAGE 433
INPUT FUNCTIONAL PARAMETERS FOR TRANSITION DIGITAL AUTOPILOT TRANS DAP G4.201 BOOK: 8-2

FSSR NAME	M/S ID	NOMENCLATURE	SOURCE	UNITS	DATA TYPE	PREC
DYMAN/RHC(3)	V96H0004CA	MANUAL YAW COMMAND	3-AX RHC SOP	DEG		
EVENT_A37	V90X8250X	ET SEPARATION CMD FLAG	ET SEP SEQ		BD	
GMTC/T_NOW	V90W2310CA	M50 TO BODY QUAT TIME	A/E ATT PROC			
GUIDED_DELTA_V_BURN	V90X8647X	GUIDED DELTA V BURN IND	MSC			
JET_FAIL_CHANGE_FLAG	V90X4619X	JET STATUS CHANGED	RCS RM			
JET_MAP(01)	V90J5727C	1ST PRIORITY JET IN GROUP 1	RCS RM			
JET_MAP(02)	V90J5728C	2ND PRIORITY JET IN GROUP 1	RCS RM			
JET_MAP(03)	V90J5729C	3RD PRIORITY JET IN GROUP 1	RCS RM			
JET_MAP(04)	V90J5730C	1ST PRIORITY JET IN GROUP 2	RCS RM			
JET_MAP(05)	V90J5731C	2ND PRIORITY JET IN GROUP 2	RCS RM			
JET_MAP(06)	V90J5732C	1ST PRIORITY JET IN GROUP 3	RCS RM			
JET_MAP(07)	V90J5733C	2ND PRIORITY JET IN GROUP 3	RCS RM			
JET_MAP(08)	V90J5734C	1ST PRIORITY JET IN GROUP 4	RCS RM			
JET_MAP(09)	V90J5735C	2ND PRIORITY JET IN GROUP 4	RCS RM			
JET_MAP(10)	V90J5736C	3RD PRIORITY JET IN GROUP 4	RCS RM			
JET_MAP(11)	V90J5737C	1ST PRIORITY JET IN GROUP 5	RCS RM			
JET_MAP(12)	V90J5738C	2ND PRIORITY JET IN GROUP 5	RCS RM			
JET_MAP(13)	V90J5739C	1ST PRIORITY JET IN GROUP 6	RCS RM			
JET_MAP(14)	V90J5740C	2ND PRIORITY JET IN GROUP 6	RCS RM			
JET_MAP(15)	V90J5741C	1ST PRIORITY JET IN GROUP 7	RCS RM			
JET_MAP(16)	V90J5742C	2ND PRIORITY JET IN GROUP 7	RCS RM			
JET_MAP(17)	V90J5743C	1ST PRIORITY JET IN GROUP 8	RCS RM			
JET_MAP(18)	V90J5744C	2ND PRIORITY JET IN GROUP 8	RCS RM			
JET_MAP(19)	V90J5745C	1ST PRIORITY JET IN GROUP 9	RCS RM			
JET_MAP(20)	V90J5746C	2ND PRIORITY JET IN GROUP 9	RCS RM			
JET_MAP(21)	V90J5747C	3RD PRIORITY JET IN GROUP 9	RCS RM			
JET_MAP(22)	V90J5748C	4TH PRIORITY JET IN GROUP 9	RCS RM			
JET_MAP(23)	V90J5749C	1ST PRIORITY JET IN GROUP 10	RCS RM			
JET_MAP(24)	V90J5750C	2ND PRIORITY JET IN GROUP 10	RCS RM			
JET_MAP(25)	V90J5751C	3RD PRIORITY JET IN GROUP 10	RCS RM			
JET_MAP(26)	V90J5752C	4TH PRIORITY JET IN GROUP 10	RCS RM			
JET_MAP(27)	V90J5753C	1ST PRIORITY JET IN GROUP 11	RCS RM			
JET_MAP(28)	V90J5754C	2ND PRIORITY JET IN GROUP 11	RCS RM			
JET_MAP(29)	V90J5755C	3RD PRIORITY JET IN GROUP 11	RCS RM			
JET_MAP(30)	V90J5756C	1ST PRIORITY JET IN GROUP 12	RCS RM			
JET_MAP(31)	V90J5757C	2ND PRIORITY JET IN GROUP 12	RCS RM			
JET_MAP(32)	V90J5758C	3RD PRIORITY JET IN GROUP 12	RCS RM			
JET_MAP(33)	V90J5759C	1ST PRIORITY JET IN GROUP 13	RCS RM			
JET_MAP(34)	V90J5760C	2ND PRIORITY JET IN GROUP 13	RCS RM			
JET_MAP(35)	V90J5761C	3RD PRIORITY JET IN GROUP 13	RCS RM			
JET_MAP(36)	V90J5762C	1ST PRIORITY JET IN GROUP 14	RCS RM			
JET_MAP(37)	V90J5763C	2ND PRIORITY JET IN GROUP 14	RCS RM			
JET_MAP(38)	V90J5764C	3RD PRIORITY JET IN GROUP 14	RCS RM			
LAMC(X)	V90U1954CC	X-COMP OF M50 REF THR VECTOR	ORB INS GUID			
LAMC(X)	V90U1954CD	X-COMP OF M50 REF THR VECTOR	DEORB GUID			
LAMC(Y)	V90U1955CC	Y-COMP OF M50 REF THR VECTOR	ORB INS GUID			
LAMC(Y)	V90U1955CD	Y-COMP OF M50 REF THR VECTOR	DEORB GUID			
LAMC(Z)	V90U1956CC	Z-COMP OF M50 REF THR VECTOR	ORB INS GUID			
LAMC(Z)	V90U1956CD	Z-COMP OF M50 REF THR VECTOR	DEORB GUID			
LAMDC(X)	V90U1957CC	X-M50 DESIRED THR TRNING RATE VCTR	ORB INS GUID	RAD/S		
LAMDC(X)	V90U1957CD	X-M50 DESIRED THR TRNING RATE VCTR	DEORB GUID	RAD/S		
LAMDC(Y)	V90U1958CC	Y-M50 DESIRED THR TRNING RATE VCTR	ORB INS GUID	RAD/S		
LAMDC(Y)	V90U1958CD	Y-M50 DESIRED THR TRNING RATE VCTR	DEORB GUID	RAD/S		

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Table 4.4.5-1. Transition Digital Autopilot (G4.201) Input/Output Functional Parameters (Cont)

TABLE 4.4.5-1 TRANSITION DIGITAL AUTOPILOT (G4.201) INPUT/OUTPUT FUNCTIONAL PARAMETERS

DBFN: D2B039-A PN: VP707100026P00L MAY 31, 1988
INPUT FUNCTIONAL PARAMETERS FOR TRANSITION DIGITAL AUTOPILOT

TRANS DAP OI88 REV00 G4.201 PAGE 434 BOOK: 8-2

FSSR NAME	M/S ID	NOMENCLATURE	SOURCE	UNITS	DATA TYPE	PREC	
LAMDC(Z)	V90U1959CC	Z-M50 DESIRED THR TRNING RATE VCTR	ORB INS GUID	RAD/S			CR89645
LAMDC(Z)	V90U1959CD	Z-M50 DESIRED THR TRNING RATE VCTR	DEORB GUID	RAD/S			
MANUAL_REQUEST	V90X7693X	SEL FWD DAP MAN	GN&C SW RM				
MM_CODE_103/MM_103	V90X8156X	MAJOR MODE 103 FLAG	MSC				
MM_CODE_301/MM_301	V90X8183X	MAJOR MODE 301 FLAG	MSC				
MM_CODE_CMD_IND	V90X8271X	OMS-L ON CMD IND	OMS FIRE SEQ				
OMS_L_ON_CMD_TRIM	V93H6915CA	OMS PITCH TRIM	6.35	DEG	SPL		
OMS_PITCH_TRIM	V93H6915CB	OMS PITCH TRIM	ORB DAP	DEG	SPL		CR89645
OMS_PITCH_TRIM	V93H6915CD	OMS PITCH TRIM	UL	DEG	SPL		
OMS_PITCH_CMD_IND	V90X8272X	OMS-R ON CMD IND	OMS FIRE SEQ				
OMS_R_ON_CMD_TRIM(1)	V93H6916CA	OMS L YAW TRIM	6.35	DEG	SPL		
OMS_YAW_TRIM(1)	V93H6916CB	OMS L YAW TRIM	ORB DAP	DEG	SPL		CR89645
OMS_YAW_TRIM(1)	V93H6916CD	OMS L YAW TRIM	UL	DEG	SPL		
OMS_YAW_TRIM(2)	V93H6918CA	OMS R YAW TRIM	6.35	DEG	SPL		
OMS_YAW_TRIM(2)	V93H6918CB	OMS R YAW TRIM	ORB DAP	DEG	SPL		
OMS_YAW_TRIM(2)	V93H6918CD	OMS R YAW TRIM	UL	DEG	SPL		
OMS_YAW_TRIM	V90X8648X	OPS 1 IND	MSC				
OPSI_INDICATOR	V90X8649X	OPS 3 IND	MSC				
OPS3_INDICATOR	V90R5301CA	SELECTED RGA ROLL RATE	SF	DEG/S			
P_ORB	V93X6912X	PREBURN MNVR CMD	6.35		BD		
PREBURN_MNVR	V94J3791CA	PRIME PROP SYS INDICATOR FLAG	ASC MNVR DIP				
PROP_FLAG_OFS	V94J3791CC	PRIME PROP SYS INDICATOR FLAG	DEORB MNVR DIP				
PROP_FLAG_OFS	V96X1070XA	PITCH RHC SOFT-STOP FLAG	3-AX RHC SOP				
PSS_EXCEED/SOFT_STOP(2)	V90X7730X	SEL FWD ROTATION PITCH PULSE	GN&C SW RM				
PSS_EXCEED/SOFT_STOP(1)	V90X7731X	SEL FWD ROTATION ROLL PULSE	GN&C SW RM				CR89645
PULSE_REQUEST(2)	V90X7732X	SEL FWD ROTATION YAW PULSE	GN&C SW RM				
PULSE_REQUEST(3)	V90U2240CA	M50 TO BODY QUAT MEASURED ELEM 1	A/E ATT PROC				
PULSE_REQUEST(1)	V90U2241CA	M50 TO BODY QUAT MEASURED ELEM 2	A/E ATT PROC				
Q_BOD-M50(1)/Q_B_I(1)	V90U2242CA	M50 TO BODY QUAT MEASURED ELEM 3	A/E ATT PROC				
Q_BOD-M50(2)/Q_B_I(2)	V90U2243CA	M50 TO BODY QUAT MEASURED ELEM 4	A/E ATT PROC				
Q_BOD-M50(3)/Q_B_I(3)	V94U3980CB	M50 TO BODY QUAT ELEM 1	DEORB GUID				
Q_BOD-M50(4)/Q_B_I(4)	V94U3980CC	M50 TO BODY QUAT ELEM 1	ORB INS GUID				
Q_BOD_M50_S	V94U3980CE	M50 TO BODY QUAT ELEM 1	ASC MNVR DIP				
Q_CB_M50_S	V94U3980CF	M50 TO BODY QUAT ELEM 1	DEORB MNVR DIP				
Q_CB_M50_V(1)	V94U3981CB	M50 TO BODY QUAT ELEM 2	DEORB GUID				
Q_CB_M50_V(2)	V94U3981CC	M50 TO BODY QUAT ELEM 2	ORB INS GUID				
Q_CB_M50_V(3)	V94U3981CE	M50 TO BODY QUAT ELEM 2	ASC MNVR DIP				
Q_CB_M50_V(11)	V94U3981CF	M50 TO BODY QUAT ELEM 2	DEORB MNVR DIP				
Q_CB_M50_V(12)	V94U3982CB	M50 TO BODY QUAT ELEM 3	DEORB GUID				
Q_CB_M50_V(13)	V94U3982CC	M50 TO BODY QUAT ELEM 3	ORB INS GUID				
Q_CB_M50_V(21)	V94U3982CE	M50 TO BODY QUAT ELEM 3	ASC MNVR DIP				
Q_CB_M50_V(22)	V94U3982CF	M50 TO BODY QUAT ELEM 3	DEORB MNVR DIP				
Q_CB_M50_V(23)	V94U3983CB	M50 TO BODY QUAT ELEM 4	DEORB GUID				
Q_CB_M50_V(31)	V94U3983CC	M50 TO BODY QUAT ELEM 4	ORB INS GUID				
Q_CB_M50_V(32)	V94U3983CE	M50 TO BODY QUAT ELEM 4	ASC MNVR DIP				
Q_CB_M50_V(33)	V94U3983CF	M50 TO BODY QUAT ELEM 4	DEORB MNVR DIP				
Q_CB_M50_V	V90R5321CA	SELECTED RGA PITCH RATE	SF	DEG/S			
Q_CB_M50_	V90R5341CA	SELECTED RGA YAW RATE	SF	DEG/S			
Q_ORB/Q	V90R2692C	COMPENSATED BODY ROLL RATE	A/E ATT PROC	DEG/S			
RATE_GYRO_CORR(1)	V90R2693C	COMPENSATED BODY PITCH RATE	A/E ATT PROC	DEG/S			
RATE_GYRO_CORR(2)	V90R2694C	COMPENSATED BODY YAW RATE	A/E ATT PROC	DEG/S			
RATE_GYRO_CORR(3)	V94X4059X	RCS DUMP ENABLE DISCRETE	DEORB MNVR DIP				
RCS_DUMP_DAP/NOSE_DUMP	V90X1539X	RCS XFD RECONFIG SEQ COMPL FL	RCS/RCS XFEED				
RECONFIG_CMPL							

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Table 4.4.5-1. Transition Digital Autopilot (G4.201) Input/Output Functional Parameters (Cont)

TABLE 4.4.5-1 TRANSITION DIGITAL AUTOPILOT (G4.201) INPUT/OUTPUT FUNCTIONAL PARAMETERS

DBFN: D2B039-A PN: VP707100026P00L MAY 31, 1988
INPUT FUNCTIONAL PARAMETERS FOR TRANSITION DIGITAL AUTOPILOT

TRANS DAP OI8B REV00 G4.201 PAGE 435 BOOK: 8-2

FSSR NAME	M/S ID	NOMENCLATURE	SOURCE	UNITS	DATA TYPE	PREC
RHC_STATE(1)	V96J0015CA	RHC OUT OF DETENT ROLL	3-AX RHC SOP			
RHC_STATE(2)	V96J0017CA	RHC OUT OF DETENT PITCH	3-AX RHC SOP			
RHC_STATE(3)	V96J0019CA	RHC OUT OF DETENT YAW	3-AX RHC SOP			
RSS_EXCEED/SOFT_STOP(1)	V96X1069XA	ROLL RHC SOFT-STOP FLAG	3-AX RHC SOP			
SEP_MINUSZ_CMD	V90X8268X	SEPARATION MINUS Z CMD	ET SEP SEQ			
TAL_ABORT_DECLARED	V90X8658X	TAL ABORT DECLARED	MSC			
THC_FSN(1)	V90X7694X	SEL FWD THC NEG X OUTPUT	GN&C SW RM		BD	
THC_FSN(2)	V90X7695X	SEL FWD THC NEG Y OUTPUT	GN&C SW RM		BD	
THC_FSN(3)	V90X7696X	SEL FWD THC NEG Z OUTPUT	GN&C SW RM		BD	
THC_FSP(1)	V90X7697X	SEL FWD THC POS X OUTPUT	GN&C SW RM		BD	
THC_FSP(2)	V90X7698X	SEL FWD THC POS Y OUTPUT	GN&C SW RM		BD	
THC_FSP(3)	V90X7699X	SEL FWD THC POS Z OUTPUT	GN&C SW RM		BD	
TLAMC	V90W1953CC	TIME ASSOC M REF THR VECTOR	ORB INS GUID	SS		
TLAMC	V90W1953CD	TIME ASSOC M REF THR VECTOR	DEORB GUID			
TRIM_OMS_GIMBALS	V90X8021X	PREBURN OMS TRIM COMMAND	MSC			
YSS_EXCEED/SOFT_STOP(3)	V96X1071XA	YAW RHC SOFT-STOP FLAG	3-AX RHC SOP			

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Table 4.4.5-1. Transition Digital Autopilot (G4.201) Input/Output Functional Parameters (Cont)

TABLE 4.4.5-1 TRANSITION DIGITAL AUTOPILOT (G4.201) INPUT/OUTPUT FUNCTIONAL PARAMETERS

DBFN: D2B039-A PN: VP707100026P00L MAY 31, 1988
OUTPUT FUNCTIONAL PARAMETERS FROM TRANSITION DIGITAL AUTOPILOT TRANS DAP OI8B REV00 G4.201 PAGE 296 BOOK: 8-2

FSSR NAME	M/S ID	NOMENCLATURE	DESTINATION	UNITS	DATA TYPE	PREC
AUTO MODE	V72X2850XB	FWD DAP AUTO (LIGHT)	D&C PNL,TLM			
AUTO MODE	V72X6498XB	AFT DAP AUTO (LIGHT)	D&C PNL			
DISC_MODE(1)	V72X2790XB	ROTATION ROLL DSCR (LIGHT)	D&C PNL			
DISC_MODE(2)	V72X2793XB	ROTATION PITCH DSCR (LIGHT)	D&C PNL			
DISC_MODE(3)	V72X2796XB	ROTATION YAW DSCR (LIGHT)	D&C PNL			
MANUAL MODE	V72X2849XB	FWD DAP MANUAL (LIGHT)	D&C PNL,TLM			
MANUAL MODE	V72X6499XB	AFT DAP MANUAL (LIGHT)	D&C PNL			
NEW_JONLST_AFT(01)	V90X1455XA	RCS JET L1A ON CMD	ASC RCS CMD SOP			
NEW_JONLST_AFT(02)	V90X1673XB	RCS JET L1L ON CMD	ASC RCS CMD SOP,TLM			
NEW_JONLST_AFT(03)	V90X1674XB	RCS JET L1U ON CMD	ASC RCS CMD SOP,TLM			
NEW_JONLST_AFT(04)	V90X1457XA	RCS JET R1A ON CMD	ASC RCS CMD SOP,TLM			
NEW_JONLST_AFT(05)	V90X1683XB	RCS JET R1R ON CMD	ASC RCS CMD SOP,TLM			
NEW_JONLST_AFT(06)	V90X1684XB	RCS JET R1U ON CMD	ASC RCS CMD SOP,TLM			
NEW_JONLST_AFT(09)	V90X1456XA	RCS JET L3A ON CMD	ASC RCS CMD SOP,TLM			
NEW_JONLST_AFT(10)	V90X1678XB	RCS JET L3L ON CMD	ASC RCS CMD SOP,TLM			
NEW_JONLST_AFT(11)	V90X1679XB	RCS JET L3D ON CMD	ASC RCS CMD SOP,TLM			
NEW_JONLST_AFT(12)	V90X1459XA	RCS JET R3A ON CMD	ASC RCS CMD SOP,TLM			
NEW_JONLST_AFT(13)	V90X1688XB	RCS JET R3R ON CMD	ASC RCS CMD SOP,TLM			
NEW_JONLST_AFT(14)	V90X1689XB	RCS JET R3D ON CMD	ASC RCS CMD SOP,TLM			
NEW_JONLST_AFT(17)	V90X1675XB	RCS JET L2L ON CMD	ASC RCS CMD SOP,TLM			
NEW_JONLST_AFT(18)	V90X1676XB	RCS JET L2U ON CMD	ASC RCS CMD SOP,TLM			
NEW_JONLST_AFT(19)	V90X1677XB	RCS JET L2D ON CMD	ASC RCS CMD SOP,TLM			
NEW_JONLST_AFT(20)	V90X1685XB	RCS JET R2R ON CMD	ASC RCS CMD SOP,TLM			
NEW_JONLST_AFT(21)	V90X1686XB	RCS JET R2U ON CMD	ASC RCS CMD SOP,TLM			
NEW_JONLST_AFT(22)	V90X1687XB	RCS JET R2D ON CMD	ASC RCS CMD SOP,TLM			
NEW_JONLST_AFT(23)	V90X1680XB	RCS JET L4L ON CMD	ASC RCS CMD SOP,TLM			
NEW_JONLST_AFT(24)	V90X1681XB	RCS JET L4U ON CMD	ASC RCS CMD SOP,TLM			
NEW_JONLST_AFT(25)	V90X1682XB	RCS JET L4D ON CMD	ASC RCS CMD SOP,TLM			
NEW_JONLST_AFT(26)	V90X1690XB	RCS JET R4R ON CMD	ASC RCS CMD SOP,TLM			
NEW_JONLST_AFT(27)	V90X1691XB	RCS JET R4U ON CMD	ASC RCS CMD SOP,TLM			
NEW_JONLST_AFT(28)	V90X1692XB	RCS JET R4D ON CMD	ASC RCS CMD SOP,TLM			
NEW_JONLST_FWD(01)	V90X1441XA	RCS JET F1F ON CMD	ASC RCS CMD SOP			
NEW_JONLST_FWD(02)	V90X1442XB	RCS JET F1L ON CMD	ASC RCS CMD SOP			
NEW_JONLST_FWD(03)	V90X1443XB	RCS JET F1U ON CMD	ASC RCS CMD SOP			
NEW_JONLST_FWD(04)	V90X1444XB	RCS JET F1D ON CMD	ASC RCS CMD SOP			
NEW_JONLST_FWD(05)	V90X1445XA	RCS JET F2F ON CMD	ASC RCS CMD SOP			
NEW_JONLST_FWD(06)	V90X1446XB	RCS JET F2R ON CMD	ASC RCS CMD SOP			
NEW_JONLST_FWD(07)	V90X1447XB	RCS JET F2U ON CMD	ASC RCS CMD SOP			
NEW_JONLST_FWD(08)	V90X1448XB	RCS JET F2D ON CMD	ASC RCS CMD SOP			
NEW_JONLST_FWD(09)	V90X1453XB	RCS JET F4R ON CMD	ASC RCS CMD SOP			
NEW_JONLST_FWD(10)	V90X1454XB	RCS JET F4D ON CMD	ASC RCS CMD SOP			
NEW_JONLST_FWD(13)	V90X1449XA	RCS JET F3F ON CMD	ASC RCS CMD SOP			
NEW_JONLST_FWD(14)	V90X1450XB	RCS JET F3L ON CMD	ASC RCS CMD SOP			
NEW_JONLST_FWD(15)	V90X1451XB	RCS JET F3U ON CMD	ASC RCS CMD SOP			
NEW_JONLST_FWD(16)	V90X1452XB	RCS JET F3D ON CMD	ASC RCS CMD SOP			
OMS_PITCH_TRIM	V93H6915CC	OMS PITCH TRIM	6.35,ASC MNVR DIP,DEORB GUID, ORB INS GUID,ORB DAP,TLM	DEG	SPL	
OMS_YAW_TRIM(1)	V93H6916CC	OMS L YAW TRIM	6.35,ASC MNVR DIP,DEORB GUID, ORB INS GUID,ORB DAP,TLM	DEG	SPL	
OMS_YAW_TRIM(2)	V93H6918CC	OMS R YAW TRIM	6.35,ASC MNVR DIP,DEORB GUID, ORB INS GUID,ORB DAP,TLM	DEG	SPL	
OMSL_PITCH_YAW_CMD(1)	V90H2180CA	OMS CMD PITCH LEFT	OMS TVC CMD SOP	DEG		

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Table 4.4.5-1. Transition Digital Autopilot (G4.201) Input/Output Functional Parameters (Cont)

TABLE 4.4.5-1 TRANSITION DIGITAL AUTOPILOT (G4.201) INPUT/OUTPUT FUNCTIONAL PARAMETERS

DBFN: D2B039-A PN: VP707100026P00L MAY 31, 1988
OUTPUT FUNCTIONAL PARAMETERS FROM TRANSITION DIGITAL AUTOPILOT

FSSR NAME	M/S ID	NOMENCLATURE	DESTINATION	UNITS	DATA TYPE	PREC
OMSL_PITCH_YAW_CMD(2)	V90H2181CA	OMS CMD YAW LEFT	OMS TVC CMD SOP	DEG		
OMSR_PITCH_YAW_CMD(1)	V90H2730CA	OMS CMD PITCH RIGHT	OMS TVC CMD SOP	DEG		
OMSR_PITCH_YAW_CMD(2)	V90H2182CA	OMS CMD YAW RIGHT	OMS TVC CMD SOP	DEG		
PREBURN_MNVR_IN_PROGRESS	V90X1589XA	PRE-BURN MNVR-IN-PROGRESS FLAG	6.35			
PULSE_MODE(1)	V72X2792XB	ROTATION ROLL PULSE (LIGHT)	D&C PNL			
PULSE_MODE(2)	V72X2795XB	ROTATION PITCH PULSE (LIGHT)	D&C PNL			
PULSE_MODE(3)	V72X2798XB	ROTATION YAW PULSE (LIGHT)	D&C PNL			
Q_B_I_CMD_DISPLAY(1)	V90H2721CC	CMD BODY WRT M50 QUAT ELEM 1	A/E ATT PROC			
Q_B_I_CMD_DISPLAY(2)	V90H2722CC	CMD BODY WRT M50 QUAT ELEM 2	A/E ATT PROC			
Q_B_I_CMD_DISPLAY(3)	V90H2723CC	CMD BODY WRT M50 QUAT ELEM 3	A/E ATT PROC			
Q_B_I_CMD_DISPLAY(4)	V90H2724CC	CMD BODY WRT M50 QUAT ELEM 4	A/E ATT PROC			
ROT_JET_CMD(1)	V90U1697CB	RCS ROTATION COMMAND (ROLL)	RCS ACT LT			
ROT_JET_CMD(2)	V90U1698CB	RCS ROTATION COMMAND (PITCH)	RCS ACT LT			
ROT_JET_CMD(3)	V90U1699CB	RCS ROTATION COMMAND (YAW)	RCS ACT LT			
SEP_COMPLETE	V90X1460X	ET SEP MNVR COMPLETE IND	MSC			
	V90X1480X	AUTO/MANUAL MODE INDICATOR	HDWR			
	V90X1481X	FORWARD DUMP COMMAND VERIFICATION	6.35			
	V90X2728X	JSL FIRST HALF FLAG	ASC RCS CMD SOP			

Table 4.4.5-2. Transition DAP (G4.201) I-Loads

OI08B MISSIONS - ILOADS
G4.201 - 0008 - TRANSITION DIGITAL AUTOPILOT

FSSR NAME	MSID	ENG UNIT	DT	PR	D	S	PR	FCTN	CAT
AMM	V96U8590C	DEG	F	S	D	P	G4.201		ZSN0
DB_COAST(1)	V97U2326C	DEG	F	S	D	C	G4.201		ZFN0
DB_COAST(2)	V97U2327C	DEG	F	S	D	C	G4.201		ZFN0
DB_COAST(3)	V97U2328C	DEG	F	S	D	C	G4.201		ZFN0
DB_PLUSX_RCS(1)	V97U2332C	DEG	F	S	D	C	G4.201		ZSN0
DB_PLUSX_RCS(2)	V97U2333C	DEG	F	S	D	C	G4.201		ZSN0
DB_PLUSX_RCS(3)	V97U2334C	DEG	F	S	D	C	G4.201		ZSN0
DB_TVC(1)	V97U2338C	DEG	F	S	D	C	G4.35 G4.201		TVB0
DB_TVC(2)	V97U2404C	DEG	F	S	D	P	G4.35 G4.201		TVB0
DB_TVC(3)	V97U2405C	DEG	F	S	D	P	G4.35 G4.201		TVB0
DELAY	V97U2663C	ND	I	S	D	P	G4.201		ZSN0
DESIRED_DVZ	V97U2339C	FT/SEC	F	S	D	C	G4.201		ZFN0
DISC_RATE	V97U1317C	DEG/SEC	F	S	M	C	G4.201		TDM0
DRIFT_TIME	V96U8956C	SEC	F	S	D	P	G4.201		ZSN0
D2	V97U2340C	ND	F	S	D	P	G4.35 G4.201		TVB0
D3	V97U2341C	ND	F	S	D	P	G4.35 G4.201		TVB0
D4	V97U2342C	ND	F	S	D	P	G4.35 G4.201		TVB0
D5	V97U2343C	ND	F	S	D	P	G4.35 G4.201		TVB0
GUID_COMP_GAIN_ONE_ENGINE(1)	V97U2344C	ND	F	S	D	P	G4.35 G4.201		TVB0
GUID_COMP_GAIN_ONE_ENGINE(2)	V97U2345C	ND	F	S	D	P	G4.35 G4.201		TVB0
GUID_COMP_GAIN_ONE_ENGINE(3)	V97U2346C	ND	F	S	D	P	G4.35 G4.201		TVB0

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Table 4.4.5-2. Transition DAP (G4.201) I-Loads (Cont)

OI08B MISSIONS - ILOADS
G4.201 - 0008 - TRANSITION DIGITAL AUTOPILOT

FSSR NAME	MSID	ENG UNIT	DT	PR	D	S	PR FCTN	CAT
GUID_COMP_GAIN_TMO_ENGINE(1)	V97U2347C	NO	F	S	D	P	G4.35 G4.201	TVB0
GUID_COMP_GAIN_TMO_ENGINE(2)	V97U2348C	NO	F	S	D	P	G4.35 G4.201	TVB0
GUID_COMP_GAIN_TMO_ENGINE(3)	V97U2349C	NO	F	S	D	P	G4.35 G4.201	TVB0
INT_PITCH	V97U2406C	DEG	F	S	M	P	G4.201	OHT0 OHT0
INT_YAW(1)	V97U2407C	DEG	F	S	M	P	G4.201	OHS1
INT_YAW(2)	V97U2408C	DEG	F	S	M	P	G4.201	OHS1
IPLIM	V97U1306C	DEG	F	S	D	C	G4.35 G4.201	TVC0
IYLIM	V97U1305C	DEG	F	S	D	C	G4.35 G4.201	TVC0
K_REL(1)	V97U1318C	DEG/SEC	F	S	D	C	G4.201	TDP0
K_REL(2)	V97U1319C	DEG/SEC	F	S	M	C	G4.201	TDP0
K_REL(3)	V97U1320C	DEG/SEC	F	S	M	C	G4.201	TDP0
KINT_PY	V97U2352C	NO	F	S	D	P	G4.35 G4.201	TVB0
KINT_R	V97U2353C	NO	F	S	D	P	G4.35 G4.201	TVB0
KLIM	V97U2418C	NO	I	S	D	C	G4.201	ZFN0
KP2	V97U2354C	DEG/DEG/SEC	F	S	D	P	G4.35 G4.201	OHF0
KR	V97U2355C	SEC	F	S	D	P	G4.35 G4.201	OHF0
KSTEP	V97U2417C	NO	I	S	D	X	G4.201	ZFN0
KXFPY	V96U9708C	DEG	F	S	D	P	G4.201 G4.35	TVB0
KXFR	V96U9709C	DEG	F	S	D	P	G4.201 G4.35	TVB0
KY2	V97U2356C	DEG/DEG/SEC	F	S	D	P	G4.35 G4.201	OHF0

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Table 4.4.5-2. Transition DAP (G4.201) I-Loads (Cont)

OI08B MISSIONS - ILOADS
G4.201 - 0008 - TRANSITION DIGITAL AUTOPILOT

FSSR NAME	MSID	ENG UNIT	DT	PR	D	S	PR	FCTN	CAT
L_REL(1)	V99U7285C	DEG/SEC	F	S	M	C	G4.201		TDP0
L_REL(2)	V99U7286C	DEG/SEC	F	S	M	C	G4.201		TDP0
L_REL(3)	V99U7287C	DEG/SEC	F	S	M	C	G4.201		TDP0
LRL_COAST	V97U2423C	DEG/SEC	F	S	B	C	G4.201		ZSN0
LRL_PLUSX_RCS	V97U2421C	DEG/SEC	F	S	B	C	G4.201		ZSN0
LRL_TVC	V97U2422C	DEG/SEC	F	S	B	C	G4.35 G4.201		TVB0
MAG_MNVR_RATE	V96U8589C	DEG/SEC	F	S	M	P	G4.201		TDM0
MAG_PULSE(1)	V96U9747C	DEG/SEC	F	S	B	P	G4.201		ZFN0
MAG_PULSE(2)	V96U9748C	DEG/SEC	F	S	B	P	G4.201		ZFN0
MAG_PULSE(3)	V96U9749C	DEG/SEC	F	S	B	P	G4.201		ZFN0
MIN_DVB	V97U2784C	FT/SEC	F	S	B	P	G4.35 G4.201		ZSN0
MR(1)	V97U2357C	DEG/SEC	F	S	B	C	G4.35 G4.201		ZSN0
MR(2)	V97U2358C	DEG/SEC	F	S	B	C	G4.35 G4.201		ZSN0
MR(3)	V97U2359C	DEG/SEC	F	S	B	C	G4.35 G4.201		ZSN0
OMS_PITCH_TRIM	V93H6915C	DEG	F	S	M	X	G4.201		OMS1
OMS_YAW_TRIM(1)	V93H6916CC	DEG	F	S	M	C	G4.201		OMS1
OMS_YAW_TRIM(2)	V93H6918CC	DEG	F	S	M	C	G4.201		OMS1
OMSL_PITCH_YAW_CMD(1)	V97U2361C	DEG	F	S	M	P	G4.201		OMS1
OMSL_PITCH_YAW_CMD(2)	V97U2362C	DEG	F	S	M	P	G4.201		OMS1
OMSR_PITCH_YAW_CMD(1)	V97U2363C	DEG	F	S	M	P	G4.201		OMS1
OMSR_PITCH_YAW_CMD(2)	V97U2364C	DEG	F	S	M	P	G4.201		OMS1

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Table 4.4.5-2. Transition DAP (G4.201) I-Loads (Cont)

OI088 MISSIONS - ILOADS
G4.201 - 0008 - TRANSITION DIGITAL AUTOPILOT

FSSR NAME	MSID	ENG UNIT	DT	PR	D	S	PR FCTN	CAT
ONE_ENG_OMS_PITCH_TRIM	V97U2367C	DEG	F	S	M	X	G4.201	OMTO
							G4.35	OMTO
							G4.7	OMTO
							G4.158	OMTO
							G4.3	
							G4.209	
							G4.210	
							G4.211	
ONE_ENG_OMS_YAW_TRIM(1)	V97U2368C	DEG	F	S	M	C	G4.201	OMTO
							G4.35	OMTO
							G4.7	OMTO
							G4.158	OMTO
							G4.3	
							G4.209	
							G4.210	
							G4.211	
ONE_ENG_OMS_YAW_TRIM(2)	V97U2369C	DEG	F	S	M	C	G4.201	OMTO
							G4.35	OMTO
							G4.7	OMTO
							G4.158	OMTO
							G4.3	
							G4.209	
							G4.210	
							G4.211	
PHASE_PLANE_ACCEL(1)	V97U2370C	DEG/SEC**2	F	S	M	X	G4.201	ZSNO
PHASE_PLANE_ACCEL(2)	V97U2371C	DEG/SEC**2	F	S	M	X	G4.201	ZSNO
PHASE_PLANE_ACCEL(3)	V97U2372C	DEG/SEC**2	F	S	M	X	G4.201	ZSNO
PLIM	V97U2373C	DEG	F	S	D	C	G4.35	ZSNO
							G4.201	
PROPGRAD(1)	V97U2374C	(DEG/SEC)/DEG	F	S	D	C	G4.35	ZSNO
							G4.201	
PROPGRAD(2)	V97U2375C	(DEG/SEC)/DEG	F	S	D	C	G4.35	ZSNO
							G4.201	
PROPGRAD(3)	V97U2376C	(DEG/SEC)/DEG	F	S	D	C	G4.35	ZSNO
							G4.201	
RFGM(1)	V99U7294C	NONE	F	S	M	C	G4.201	TDPO
RFGM(2)	V99U7295C	NONE	F	S	M	C	G4.201	TDPO
RFGM(3)	V99U7296C	NONE	F	S	M	C	G4.201	TDPO
RFGM(4)	V99U7297C	NONE	F	S	M	A	G4.201	TDPO

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Table 4.4.5-2. Transition DAP (G4.201) I-Loads (Cont)

OI08B MISSIONS - ILOADS
G4.201 - 0008 - TRANSITION DIGITAL AUTOPILOT

FSSR NAME	MSID	ENG UNIT	DT	PR	B	S	FR	FCTN	CAT
RFGH(5)	V99U7298C	NONE	F	S	M	C	G4.201		TDPO
RFGUN(1)	V99U7299C	NONE	F	S	M	C	G4.201		TDPO
RFGUN(2)	V99U7300C	NONE	F	S	M	C	G4.201		TDPO
RFGUN(3)	V99U7301C	NONE	F	S	M	C	G4.201		TDPO
RFGUN(4)	V99U7302C	NONE	F	S	M	A	G4.201		TDPO
RFGUN(5)	V99U7303C	NONE	F	S	M	C	G4.201		TDPO
RL_COAST(1)	V97U2377C	DEG/SEC	F	S	B	C	G4.201		ZSNO
RL_COAST(2)	V97U2378C	DEG/SEC	F	S	B	C	G4.201		ZSNO
RL_COAST(3)	V97U2379C	DEG/SEC	F	S	B	C	G4.201		ZSNO
RL_PLUSX_RCS(1)	V97U2380C	DEG/SEC	F	S	B	C	G4.201		ZSNO
RL_PLUSX_RCS(2)	V97U2381C	DEG/SEC	F	S	B	C	G4.201		ZSNO
RL_PLUSX_RCS(3)	V97U2382C	DEG/SEC	F	S	B	C	G4.201		ZSNO
RL_TVC(1)	V97U2386C	DEG/SEC	F	S	B	C	G4.35 G4.201		TVBO
RL_TVC(2)	V97U2387C	DEG/SEC	F	S	B	P	G4.35 G4.201		TVBO
RL_TVC(3)	V97U2388C	DEG/SEC	F	S	B	P	G4.35 G4.201		TVBO
RLIM	V97U2389C	DEG	F	S	B	P	G4.35 G4.201		TVBO
RTHH(1)	V97U2414C	DEG/SEC	F	S	B	C	G4.201		ZSNO
RTHH(2)	V97U2416C	DEG/SEC	F	S	B	C	G4.201		ZSNO
RTHH(3)	V97U2415C	DEG/SEC	F	S	B	C	G4.201		ZSNO
TAL BVZ INC	V99U7404C	FT/SEC	F	S	B	C	G4.201		ZFNO
TOTAL PITCH LIM	V97U2390C	DEG	F	S	B	C	G4.35 G4.201		ZSNO
WHIGH	V96U9710C	DEG/SEC	F	S	B	P	G4.201 G4.35		TVBO
WLOW	V96U9711C	DEG/SEC	F	S	B	P	G4.201 G4.35		TVBO

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Table 4.4.5-2. Transition DAP (G4.201) I-Loads (Cont)

OI08B MISSIONS - ILOADS
G4.201 - 0008 - TRANSITION DIGITAL AUTOPILOT

FSSR NAME	MSID	ENG UNIT	DT	PR	B	S	PR	FCTN	CAT
YLIM1	V97U2392C	DEG	F	S	B	C	G4.201 G4.35		TVC0
YLIM2	V96U9802C	DEG	F	S	B	P	G4.201 G4.35		TVC0

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Table 4.4.5-3. Transition DAP (G4.201) K-Loads

OI88 MISSIONS

FSSR NAME DESCRIPTION	MSID	MC KLOAD VALUE	ENG UNIT	DT PR S PR FCTN	LAST CR EQTN MSID
DB_MATED_COAST(1)	V97U2329C	+1.0	E+01 DEG	F S C G4.201	29879
DB_MATED_COAST(2)	V97U2330C	+1.0	E+01 DEG	F S C G4.201	29879
DB_MATED_COAST(3)	V97U2331C	+1.0	E+01 DEG	F S C G4.201	29879
DB_SEP(1)	V97U2335C	+3.0	E+00 DEG	F S C G4.201	29667A
DB_SEP(2)	V97U2336C	+3.0	E+00 DEG	F S C G4.201	29667A
DB_SEP(3)	V97U2337C	+3.0	E+00 DEG	F S C G4.201	29667A
LRL_SEP	V97U2420C	+1.0	E-01 DEG/SEC	F S C G4.201	29667A
RL_SEP(1)	V97U2383C	+5.0	E-01 DEG/SEC	F S C G4.201	29879
RL_SEP(2)	V97U2384C	+5.0	E-01 DEG/SEC	F S C G4.201	29879
RL_SEP(3)	V97U2385C	+5.0	E-01 DEG/SEC	F S C G4.201	29879
ROT_PULSE_SIZE	V96U9707C	+9.72	E-02 DEG/SEC	F S P G4.201	29575A

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