

Space Program Operations Contract

SPACE SHUTTLE ORBITER OPERATIONAL LEVEL C FUNCTIONAL SUBSYSTEM SOFTWARE REQUIREMENTS GUIDANCE, NAVIGATION AND CONTROL PART C

FLIGHT CONTROL-ASCENT FLIGHT PHASE VOLUME 1

PREPARED BY THE BOEING COMPANY
Space Exploration

Under Subcontract 6000132079, PDRD P1433q

December 14, 2007

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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 – System-level constraints and capabilities

Level B CPDS – Functional requirements

Level C – Detailed-level requirements

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.

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DOCUMENT CHANGE RECORD

The following tabulation summarizes the change activity associated with this document.

DOCUMENT CHANGE RECORD			
Issue and Date	Change Summary/Effectivity		
OI-34 Release December 14, 2007	This baseline release for effectivity OI-34 and subs includes:		
	<u>SCR</u>	<u>OI</u>	<u>Title</u>
	93017G	33	Baseline RSS99D0100 with Expanded Downlist
	93160B	32	Year End Roll Over (YERO) Reset
	93175	32	Expand Effectivity of SCR 93160B

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CHANGE REQUEST SUMMARY

The following tabulation lists the paragraphs, tables (T), and figures (F) that have been changed as a result of approved change requests for this release. Changes incorporated prior to this release are listed in Appendix R. Changes from approved change requests (CRs) to this document are indicated by a change bar in the outer margin of the changed page.

CHANGE REQUEST SUMMARY			
Paragraph	SCR No.	OI	SCR Title
N/A	93175	32	Expand Effectivity of SCR 93160B
1.3-1.(T)	93017G	33	Baseline RSS99D0100 with Expanded Downlist
4.2.11-1.(T)	93160B	32	Year End Roll Over (YERO) Reset
	93017G	33	Baseline RSS99D0100 with Expanded Downlist
4.2.11-2.(T)	93017G	33	Baseline RSS99D0100 with Expanded Downlist
4.3.5-1.(T)	93160B	32	Year End Roll Over (YERO) Reset
	93017G	33	Baseline RSS99D0100 with Expanded Downlist
4.3.5-2.(T)	93017G	33	Baseline RSS99D0100 with Expanded Downlist
4.6.5-1.(T)	93160B	32	Year End Roll Over (YERO) Reset
	93017G	33	Baseline RSS99D0100 with Expanded Downlist
4.6.5-2.(T)	93017G	33	Baseline RSS99D0100 with Expanded Downlist

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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 Ascent phase of OFT. 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. It also contains applicable tables (Interface Definition Document (IDD) inputs/outputs, I-Loads, K-Loads, and Constants) located at the end of each Principal Function.

The automated IDD tables provided herein define signal (parameter) interface requirements either between hardware (LRU) and software elements or between software elements and other software elements. A GN&C software element is either a sequenced principal function (PF), crew generated specialist/display function, or an OPS display function. 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.

The following table defines the data elements found in the IDD input/output, I-Load, K-Load, and Constant tables for each principal function.

Table 1.3-1. Parameter Element Description		
Title	Definition	Valid Entries
CAT	Category of the I-Load (**Note)	Three alphanumeric characters: the first character must be alphabetic.
D	Dependency of the I-Load	D = Design M = Mission L = LRU
DESCRIPTION	Parameter description of the K-Load or Constant.	A string of ≤ 64 characters.
DESTINATION	Destination of the output parameter	Abbreviated functional titles. (***)Note)
DT or DATA TYPE	Data Type	* See reference (1) for valid I-Load, K-Load and Constant data types. * See reference (2) for valid IDD data types for parameters with destination TLM. * See reference (3) for valid IDD data types for all other parameters.
ENG UNITS or UNITS	Engineering Units	* See reference (1) for valid I-Load, K-Load and Constant units. * See reference (2) for valid IDD units for parameters with destination TLM. * See reference (3) for valid IDD units for all other parameters.
FSSR NAME	Requirements parameter name	A string (with no embedded blanks) of ≤ 32 characters consisting of alphanumerics, underscores, parentheses, commas and slashes. Parentheses are used for array elements. Commas separate the different indices of multidimensional arrays. Slashes are used to separate multiple names used for a single MSID.
LAST CR	The last CR affecting the parameter	5 digit number with an alphabetic revision letter.
MC	Memory Configuration	00 = Generic 05 = SM4 Orbit P/L 01 = GN1 Ascent/GN6 RTLS 06 = P/L9 MMU 02 = GN2 Orbit 07 = Not Assigned 03 = GN3 Entry 08 = GN8 On-Orbit C/O 04 = SM2 On-Orbit 09 = GN9 Preflight
MSID or M/S ID	Measurement/Stimulus Identification	Maximum of 10 alphanumeric characters. * See reference (3) for specifications
NOMENCLATURE	Parameter description of the IDD parameter.	String of ≤ 34 characters (including underscores and blank spaces).
PR or PREC	Precision	D, DP = Double S, SP = Single
SOURCE	Origin of the input parameter	Abbreviated functional titles.

Table 1.3-1. Parameter Element Description		
Title	Definition	Valid Entries
S	Software Utilization	C = Common B = BFS Unique P = Primary X = BFS Derived A = BFS Converted
PR FCTN	Cross reference of the principal function identifiers that are applicable to this parameter.	See Level B GN&C CPDS SS-P-0002-510
VALUE	The value of the K-Load or Constant	* See reference (1) for valid value formats.
REV	Revision indicator	An asterisk (*) indicates changes for the current OI version.
* References:	(1) JSC 19350 I-Load Requirements Document Volume I (2) SS-P-0002-140 Level A SS Downlist/Uplink CPDS (3) JSC 18206 Shuttle Data Integration Plan Volume III MAST II/STAR Deliverable Products.	
** Note	For additional information on any I-Load, contact the I-Load owner defined in CR 98032, JSC, USA, and Boeing I-Load Owner Assignments	
*** Note	IDD output (source) tables which reflect parameters going to input (destination) "TLM" shall not be interpreted as a signal actually being downlisted. The parameter is only available for downlist in COMPOOL and does not appear in a downlist format. Parameters actually on the downlist will be designated with a destination denoting the downlist Format with a Rate Code. The Rate Code legend appears at the end of each FSSR data table. To complete the downlist information, Parent MSIDs (indicated by a 'P' in the 9 th character of the MSID) are now included in the software function output data tables in which a Child MSID already appears. A Parent MSID will have the same downlist destinations as its Child(ren) MSID(s).	

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2.0 APPLICABLE DOCUMENTS

2.1 LEVEL A DOCUMENTS

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

2.2 LEVEL B DOCUMENTS

- SS-P-0002-510 Shuttle Functional Level Requirements, GN&C
- SS-P-0002-550 Shuttle Functional Level Requirements, Vehicle Utility
- SS-P-0002-580 Shuttle 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 Volume 1, Ascent Flight Phase, Volume 2, Ascent
- 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 83-0008V1-34
December 14, 2007

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	Shuttle Flight Software Initialization Load <ul style="list-style-type: none">• 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-2-1S001	Orbiter Primary Flight Software System and Backup Flight System Software Interface

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. For the orbiter flight tests, the OFP will consist of two versions: one for the approach and landing test (ALT) and one for the orbital flight test (OFT). 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 OFT ascent flight phase.

3.2 GN&C SOFTWARE MAJOR FUNCTIONS

The orbiter general-purpose computers (GPC) 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 major function C above, Flight Control.

3.3 FLIGHT CONTROL SYSTEM OVERVIEW

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

- Ascent DAP
- A/E Attitude Processor
- GC Steer

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. The presentation of the detailed functional requirements in Section 4.0 follows the same organization, as indicated by the subsection numbers shown on the figure.

Subsection 4.1 presents the high-level requirements for the module shown in Figure 3.3-1. These requirements include constraints on execution times, delay times, cycle frequencies, and module sequencing order.

Functions, such as filters and quaternion operations that are utilized in several modules, are grouped in subsection 4.7 under the heading of Utility Functions. This grouping is done for convenience to avoid repeating detailed specifications. Furthermore, it makes explicit the existence of identical specifications in several modules. It does not, however, imply that these functions need necessarily be subroutines in the software implementation.

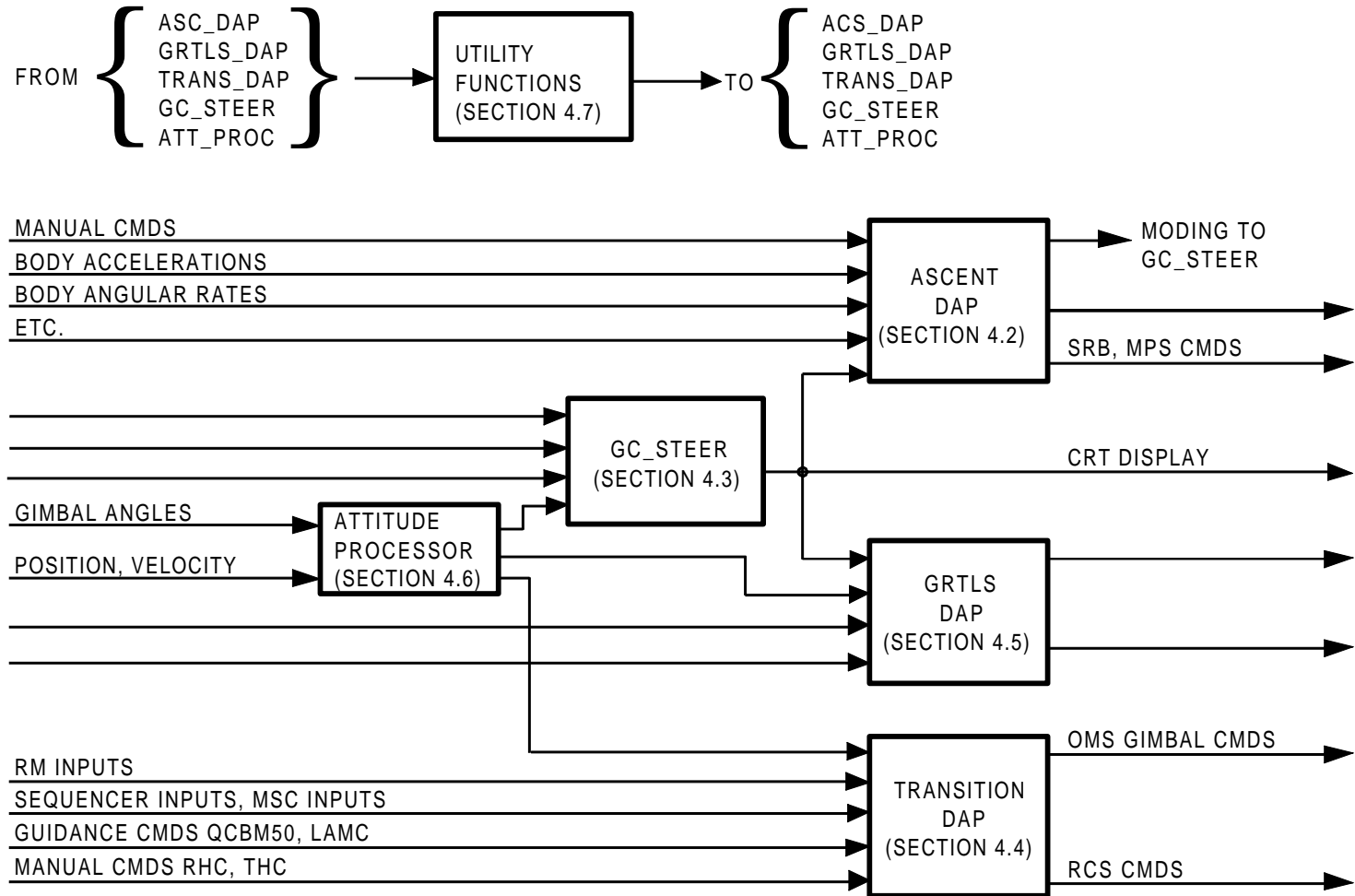


FIGURE 3.3-1. Ascent Phase Flight Control High-Level Organization

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4.0 FLIGHT CONTROL FUNCTIONAL REQUIREMENTS

4.1 TIMING, SEQUENCING, AND INITIALIZATION REQUIREMENTS

4.1.1 Interpretation of Detailed Material

The term “module” is used generally in this document to mean a group of related functions. Specifically, the term “function module” is used in reference to the basic building blocks of this specification. Function modules are to be traceable in the flight software as identifiable entities that perform the functions specified in this document, such as filtering, limiting, integrating, and fading.

The general rules for determining the order for executing any set of modules are set forth in Subsection 4.1.3. In addition, as part of the description of each module in Section 4.0 which contains smaller, internal modules, there is a flow chart which strings together the internal modules. Although these flow charts are presented as “sequencing requirements,” it should be understood that they only present one particular way of correctly sequencing these modules.

Wherever details are presented within a function module, they are included to facilitate the presentation, not as a specification. It is required only that the functional relationship between input and output of a function module be preserved. For example, if a function module contains a filter followed by a constant gain, as shown in Figure 4.1.1–1, it would be permissible to implement the module with the gain merged into the filter coefficients, as suggested by Figure 4.1.1–2. On the other hand, this document does specify everything not contained within the function modules, including traceability in the flight code and input–output signals of the modules.

It is required that initialization be functionally equivalent to that indicated in the discussions of the individual modules. It is not required that the initialization be done within the module. See Subsection 4.1.4 for a further discussion of initialization.

4.1.2 Timing Requirements

Timing in this document is related to error–free processing conditions. See Level A CPDS, SS–P–0001–170, paragraph 4.4.2A, for timing related to error processing conditions.

Timing control is performed by the flight computer operating system (FCOS). Requirements relating to the FC module are as follows:

- A. A minor cycle rate of 25 Hz. The cycle–to–cycle time period tolerance of the minor cycle is specified in CPDS Level A, Section 4.4.2.
- B. Worst–case transport delay in the minor cycle of 20 ms from data input to data output, including delays associated with MDM/IOP operation.

The allowable software–incurred delays are specified in CPDS Level A, Section 4.4.2

- C. A requirement for execution rates that are the following submultiples of the minor cycle rate: 25, 12.5, 6.25, $25/12 \cong 2.08$, $25/48 \cong 0.52$ Hz. Some of these rates may be achieved by use of counters within the FC module, rather than by scheduling through FCOS.

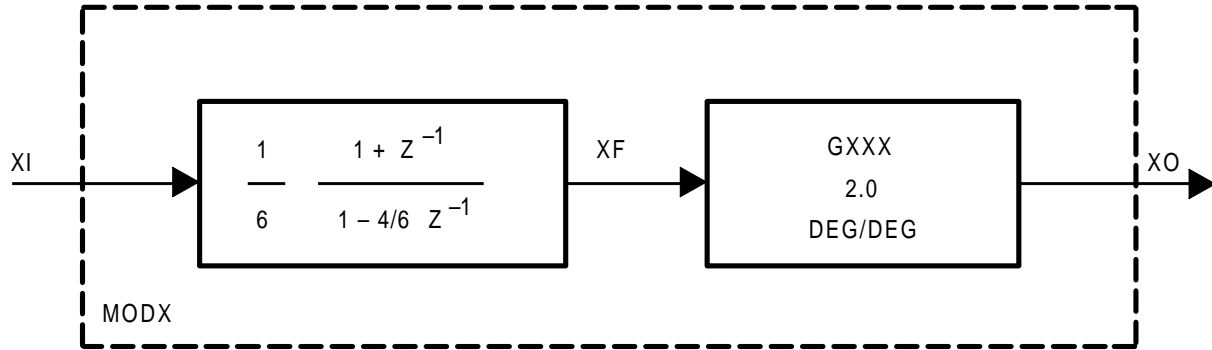


FIGURE 4.1.1-1. Specification of Function Module MODX

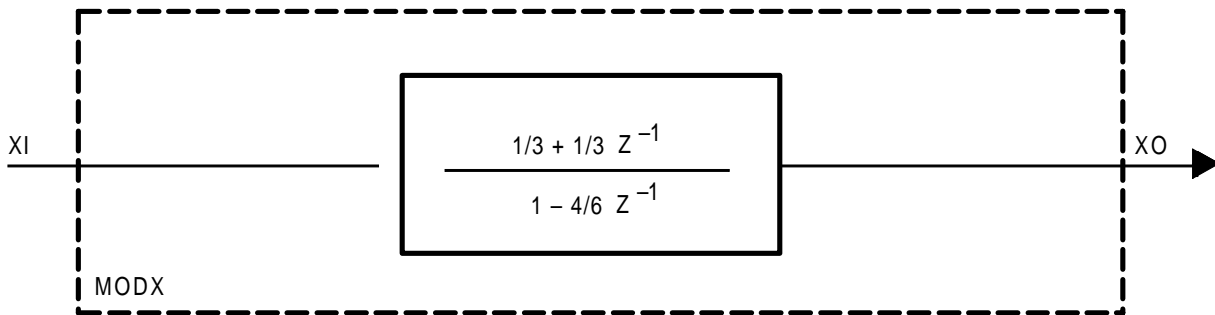


FIGURE 4.1.1-2. Diagram of a Permissible Implementation of Function Module MODX

4.1.3 Sequencing Requirements

Sequencing requirements for GUID, NAV, MSC, SOP's, etc., as they relate to flight control are not dealt with, per se, in this document. A rough attempt to lay down some requirements is presented in Figure 4.1.3-1. (Note that the functions shown in dashed lines are not covered by this document.) In lieu of firm sequencing requirements for GN&C (from the flight control point of view) consideration has been given to the maximum transport lag tolerable by the flight control system or input variables. These transport lag requirements are summarized in Subsection 6.4 of the Level A CPDS SS-P-0002-170.

Whereas sequencing requirements for all of ASCENT GN&C cannot be dealt with properly in this document, the sequencing requirements for the ASCENT phase flight control can (including ASCENT DAP, GRTLS DAP, TRANSITION DAP, ATTITUDE PROCESSOR and GC STEER). These requirements are shown in Figure 4.1.3-1.

The following general statements are made regarding the sequencing requirements for the flight control system:

- A. Within a rate group, modules are executed prior to modules to which they supply data.
- B. Modules not processed at 25 Hz may be performed in that portion of the minor cycle which does not contribute to 25 Hz transport delay. High-rate computations which do not contribute to the output of the current non-transport-delay-critical part of the minor cycle. They are not flagged out in this document.
- C. When reconfiguration (including first pass) occurs, those modules that supply data to transport-delay-critical modules will be executed before the first pass in the new configuration. Note that this requirement, together with the requirement to mechanize reconfiguration within 80 ms of recognition of a valid mode-change request, may necessitate an unscheduled execution of low-rate modules.
- D. Sequencing requirements for GN&C are presented in Figure 4.1.3-1. Functions shown in dashed lines are not covered by this document. The modules that do not contribute to transport-delay-critical modules, e.g., a separate HAL process, may be used.

4.1.4 Parameter Initialization

Parameter initialization requirements are specified in this document at the local level. The detailed requirements subsection for each function module specifies initialization requirements for variables and/or parameters within the module. This does not preclude centralized remote initialization in the software implementation, subject to the stated initialization requirements. Some general notes on initialization follow:

- A. Initialization of a module is the processor assigning values to quantities referenced by that module (variables and/or parameters), whenever required by discrete changes in external conditions.
- B. Dynamic initialization of a module uses current values of variables, instead of simple constants. An example of dynamic initialization is the dc initialization of a filter based upon the current value of its input, instead of simple nulling of the filter output and nodes.
- C. Local initialization of a module is performed by the module itself, at the local module level.

- D. Remote initialization of a module is performed in some central place, along with other similar remote initializations. Constants or globally available variables can be used.
- E. Local dynamic initialization of a module permits the use of quantities computed in modules executed prior to the one being initialized.
- F. In general, filter initialization has been specified to occur when, and only when, the filter goes from an inactive to an active state. Filters are inactive (not executed) when their outputs are not being used. Filters are discussed further in Subsections 4.7.1, 4.7.2, 4.7.3 and 4.7.4.
- G. The “first pass” condition, which is specified for some initializations, is defined as the initial activation pass through the FC module after it has been in an inactive state. Such remote initialization can be implementationally efficient, and so is suggested even though the module may not be activated until several subphases later.
- H. The impact of initialization on function module grouping according to sample rate is discussed in Subsection 4.1.3, Item C.

4.1.5 Software Implementation Constraints

Several constraints and assumptions apply to the flight software implementation of the requirements in the following subsections. The flight software shall be capable of recovering from transient erroneous inputs without causing a processing halt. Check or error interrupts shall be prevented by appropriate safeguards. Specifically, the standard fixup and error returns described below shall be provided:

- A. Floating Point Overflow. The task in process should be terminated and the previous stored value of the variable retained.
- B. Floating Point Underflow. This may be treated in the same manner as floating point overflow, or the variable may be set to zero and processing continued.
- C. Divide by Zero. This should be treated in the same manner as floating point overflow.
- D. Square Root. The square root of a negative number should be treated in the same manner as floating point overflow.

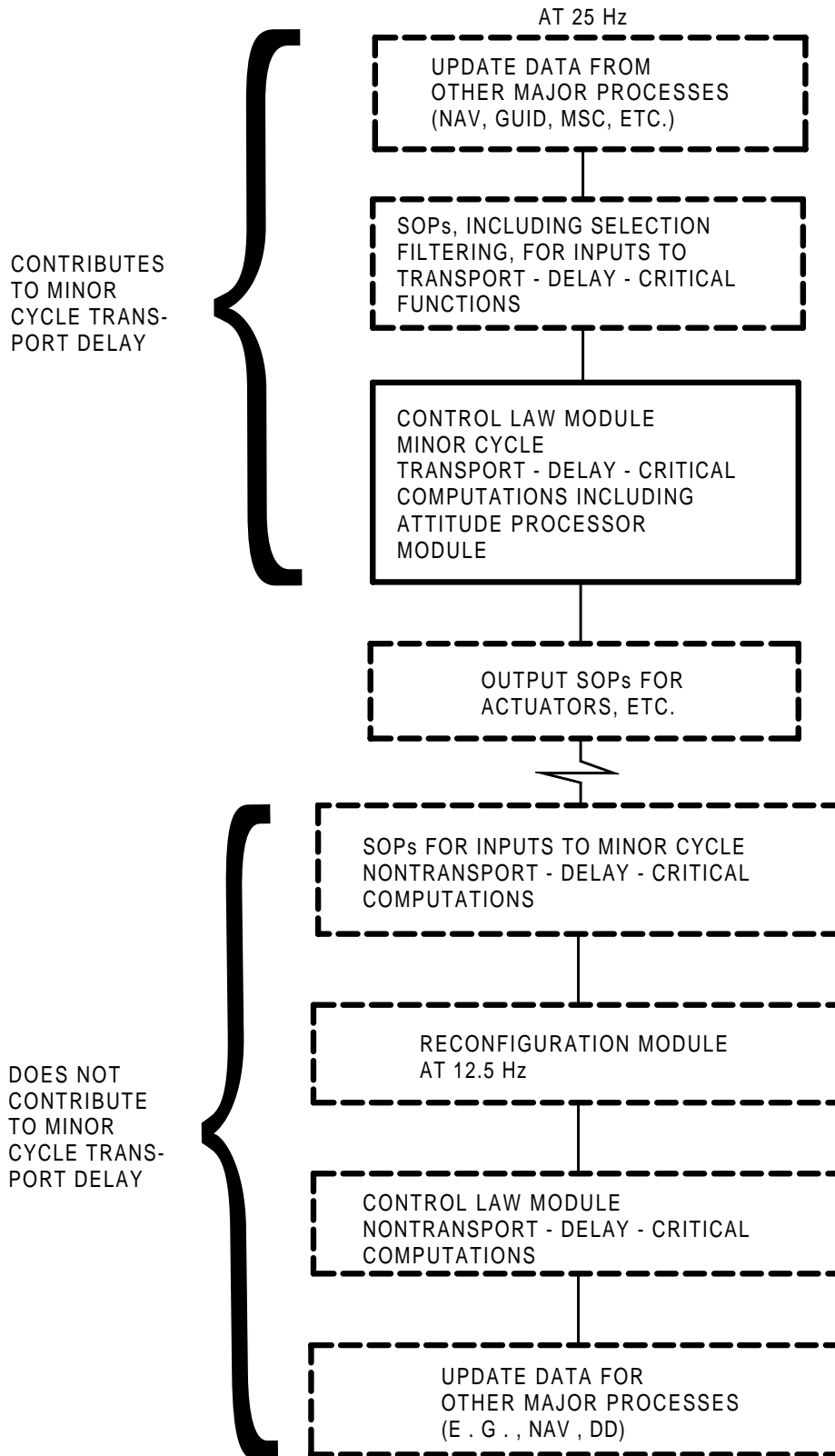


FIGURE 4.1.3-1. GN&C High-Level Sequencing Requirements

4.1.6 Traceability

Table 4.1.6–1 shows the traceability of the software paragraphs in this FSSR with respect to the corresponding Sections of the Level B CPDS’ documentation. In addition, Table 4.1.6–2 shows the traceability of the PASS GN&C principal functions located in this FSSR with respect to the applicable BFS paragraphs in the Level C PRD specifications. These tables are provided for information only.

Table 4.1.6-1.Level B to Level C Traceability		
Level B PF No.	Level B PF Name (Acronym)	Level C FSSR Principal FunctionSection No. Paragraph Number
4.176	Ascent Digital Autopilot (ASC DAP) Functional Requirements	4.2
4.175	Guidance/Control Steering (G/C STEER) Interface	4.3
4.226	Ascent/Entry Attitude Processing (A/E ATT PROC)	4.6

Table 4.1.6-2.Ascent Digital Autopilot FSSR/PRD Correlation					
Principal Function	FSSR Paragraph	FSSR Title	BFS PRD	PRD Paragraph	BFS Title
G4.175	4.3	Guidance/Control Steering Interface	MG038105	3.2.4.3.4	Ascent Steering (ASC_STR)
G4.176	4.2	Ascent DAP Functional Requirements	MG038105	3.2.4.3	Ascent Flight Control (ASC_DAP)
G4.226	4.6	Ascent/Entry Attitude Processor	MG038106	3.2.5.1.2	Attitude Processor (ATT_PROC)

4.1.7 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.

4.2 ASCENT DAP FUNCTIONAL REQUIREMENTS

4.2.1 Introduction

The ASCENT DAP module controls the vehicle in response to automatic commands during the ascent flight phase, using the SRB and SSME TVC actuating systems and RCS.

4.2.2 Interface Requirements

The interface variables required to properly execute the ASCENT DAP function are given in Tables 4.2.2-1 and 4.2.2-2.

Table 4.2.2-1. Input Variables, ASCENT DAP							
FSSR Name	Description	MSID (MNEMONIC)	Source	Type	Range	Units	Sample Rate (Hz) Required
MPS_SLEW_COMPLETE	Indicator, Event 5A; MPS hydraulic system slew test complete flag	V90X8400X (G51127)	ORB ACT SLEW, RS LCH SEQ	B	0, 1	–	*
DBFOFB	COMP BF POS	V95H8310C (G09601)	BF PFB SOP	S	– 15.825, +26.675	deg	6.25
DELTAP_LIB	LIB elevon actuator differential pressure	V95P8015C (G37803)	DELTA P FB SOP	S	±3,000	lb/in. ²	6.25
DELTAP_LOB	LOB elevon actuator differential pressure	V95P8017C (G37804)	DELTA P FB SOP	S	±3,000	lb/in. ²	6.25
DELTAP_RIB	RIB elevon actuator differential pressure	V95P8016C (G37801)	DELTA P FB SOP	S	±3,000	lb/in. ²	6.25
DELTAP_ROB	ROB elevon actuator differential pressure	V95P8018C (G37802)	DELTA P FB SOP	S	±3,000	lb/in. ²	6.25
GUIDANCE_INITIATE	Indicator, Event 29; Stage 2 guidance ready	V90X8630X (G33610)	MSC	B	0, 1	–	0.521
HYDRFAIL (1)	Hydraulic system 1 failure status indicator	V96X3005X (G46363)	HYD SYS SOP	B	0, 1	–	12.5
HYDRFAIL (2)	Hydraulic system 2 failure status indicator	V96X3006X (G46364)	HYD SYS SOP	B	0, 1	–	12.5
HYDRFAIL (3)	Hydraulic system 3 failure status indicator	V96X3007X (G46365)	HYD SYS SOP	B	0, 1	–	12.5
NY	Lateral acceleration (AA)	V90A5361C (G14445)	SF		±1	g	25
NZ	Normal acceleration (AA)	V90A5381C (G14446)	SF	S	±4	g	25
PC4	SRB 4 thrust chamber press.	V90P2535C (G14512)	SF	S	0, +1,000	lb/in. ²	12.5

Table 4.2.2-1. Input Variables, ASCENT DAP							
FSSR Name	Description	MSID (MNEMONIC)	Source	Type	Range	Units	Sample Rate (Hz) Required
PC5	SRB 5 thrust chamber press.	V90P2536C (G14513)	SF	S	0, +1,000	lb/in. ²	12.5
P_ORB	Roll rate, orbiter rate gyro	V90R5301C (G14443)	SF	S	±40	deg/s	25
Q_ORB	Pitch rate, orbiter rate gyro	V90R5321C (G14442)	SF	S	±20	deg/s	25
QSRB	Pitch rate, SRB rate gyro	V90R2511C	SF	S	±10	deg/s	25
EBFB	Attitude error vector (element order is roll, pitch, yaw)	V95H3523C (G33603) V95H3521C (G33601) V95H3522C (G33602)	GC STEER	V	-180 to +180	deg	12.5
WFBI_FB	Rate command vector flight body inertial (element order is roll, pitch, yaw)	V95H3528C (G33606) V95H3526C (G33604) V95H3527C (G33605)	GC STEER	V	±40	deg/s	12.5
R_ORB	Yaw rate, orbiter rate gyro	V90R5341C (G14444)	SF	S	±20	deg/s	25
RSRB	Yaw rate, SRB rate gyro	V90R2512C	SF	S	±10	deg/s	25
SRB_IGNITION_COMMAND	Indicator, Event 19; initiate SRB ignition command	V90X8377X (G23425)	RS LCH SEQ	B	0, 1	-	12.5
AERO_SLEW	Indicator Event 4A; aerosurface slew check	V99X8822X (G36305)	LPS	B	0, 1	-	12.5
SRB_MODING_SEP	Indicator, Event 27; SRB SEP function moding flag	V90X8330X (G23709)	SRB SEP SEQ, ET SEP SEQ	B	0, 1	-	12.5
SRB_SEP_CMD_FLAG	Indicator, Event 28; SRB_SEP command flag	V90X8331X (G23710)	SRB SEP SEQ, ET SEP SEQ	B	0, 1	-	12.5
ME1_FAIL_SHUTDOWN	Main engine 1 out indicator	V95X1207X (G47293)	SSME OPS	B	0,1	-	12.5
ME2_FAIL_SHUTDOWN	Main engine 2 out indicator	V95X1208X (G47294)	SSME OPS	B	0,1	-	12.5
ME3_FAIL_SHUTDOWN	Main engine 3 out indicator	V95X1209X (G47295)	SSME OPS	B	0,1	-	12.5
CLOCK/CLOCKTIME	CLOCK-COMPUTER (GMT)	V91W5000C (G07829)	FCOS	S	0 to 3.16224 E7	s	12.5
REL_VEL_MAG	Magnitude earth-relative velocity in M50	V95L0151C (G03902)	ASCENT UPP	S	0 to 30,000	ft/s	6.25

Table 4.2.2-1. Input Variables, ASCENT DAP

FSSR Name	Description	MSID (MNEMONIC)	Source	Type	Range	Units	Sample Rate (Hz) Required
S_SSME_TRIM	Indicator, Event 30A; initiate main engine pitch retrim	V90X1960X (G00316)	ASC 2STG GUID, PW RTLS GUID	B	0, 1	–	0.521
MECO_ COMMAND	Indicator, Event 32; initiate main engine cut-off	V90X8569X (G32107)	SSME OPS	B	0, 1	–	12.5
SRB_SLEW_CMD	SRB actuator slew position command	V96H0323C (G48998)	SRB SLEW	S	–4.0 to +4.0	–	25
MPS_SLEW_CMD	MPS actuator slew position command	V90H1572C (G48987)	ORB ACT SLEW	S	–9.0 to +9.0	–	25
AERO_SLEW_CMD	Aerosurface actuator slew position command	V90H1571C (G48986)	ORB ACT SLEW	S	–10.0 to +10.0	–	25
AERO_SLEW_ COMPLETE_FLAG	Aerosurface slew test complete flag, indicator Event 4B	V90X1570X (G48985)	ORB ACT SLEW	B	0, 1	–	12.5
MASS	Estimated vehicle mass	V90U1961C (G48797)	ASC 2STG GUID, PW RTLS GUID, PW CONT GUID, ASC 1STG GUID	S	5,000 to 150,000	slugs	0.521
MDOT	Estimated rate of change of mass with time	V90R1993C	ASC 2STG GUID, PW RTLS GUID, PW CONT GUID	S	0.0 to 1,000	slugs/s	0.521
ME_ZERO	Indicator, Event 33B or A36A; at least two main engines shutdown (zero thrust)	V90X8638X (G51070)	MSC	B	0, 1	–	12.5
MM_CODE_101	Major Mode 101 Flag	V90X8155X (G47944)	MSC	B	0, 1	–	12.5
OPS_6_IND	Indicator, Event A30 and A31 trans to OPS 6	V90X8634X (G50365)	MSC	B	0, 1	–	12.5
SSME_STOW_ COMPLETE	SSME stow complete flag	V95X1622X (G51126)	MPS TVC CMD SOP	B	0, 1	–	1.0
MPS_SLEW	Indicator, Event 5; initiate MPS slew check	V99X8823X (G36400)	LPS	B	0, 1	–	12.5
SRB_SLEW	Indicator, Event 8; initiate SRB hydraulic slew test	V99X8820X (G36601)	LPS	B	0, 1	–	12.5
SRB_SLEW_ COMPLETE	Indicator, Event 8A; SRB hydraulic slew test complete	V96X0321X (G36605)	SRB SLEW	B	0, 1	–	12.5
PREP_SSME	Indicator, Event 18A; CMD SSME's to LIFTOFF position	V90X8373X (G47249)	RS LCH SEQ	B	0, 1	–	12.5

Table 4.2.2-1. Input Variables, ASCENT DAP							
FSSR Name	Description	MSID (MNEMONIC)	Source	Type	Range	Units	Sample Rate (Hz) Required
AUTO_P	Pitch, auto FCS mode pushbutton indicator	V96X1031X (G47665)	GN&C SW RM (4.180)	B		–	6.25
AUTO_RY	Roll/yaw auto FCS mode pushbutton indicator	V96X1041X (G47666)	GN&C SW RM (4.180)	B		–	6.25
CSS_P	Pitch manual mode pushbutton indicator	V96X1035X (G50206)	GN&C SW RM (4.180)	B		–	6.25
CSS_RY	Roll/yaw manual mode pushbutton indicator	V96X1045X (G47669)	GN&C SW RM (4.180)	B		–	6.25
S_QUAT	Attitude quaternion computed flag	V90X1987X (G51128)	ASC 1STG GUID	B	0, 1	–	12.5
S_RTLS_TURN	Indicator, initiate RTLS turnaround	V90X2089X (G00904)	PW RTLS GUID	B	0, 1	–	12.5
S_PPD_QUAT	Indicator, initiate powered pitch down maneuver	V90X2087X (G00903)	PW RTLS GUID, PW CONT GUID	B	0, 1	–	12.5
RETURN_SSME_ TO_START_POS	Indicator, return SSME to start position	V90X8412X (G48989)	RS LCH SEQ	B	0, 1	–	12.5
SRB_SEP_ MONITOR	SRB monitor indicator flag	V90X8193X (G47556)	MSC	B	0, 1	–	12.5
FAST_SEP_FLAG	Fast separation flag	V90X8267X	ET SEP SEQ	D	0,1	–	6.25
MECO_CONFIRM	MECO confirmed flag	V90X8561X (G32108)	SSME OPS	B	0, 1	–	12.5
A_D_RECYCLE_ COUNT	ASC DAP recycle	V90X8669X	RS LCH SEQ	B	0, 1	–	12.5
MPS_LO2_ DUMP_STOP	MPS LO2 dump stop	V90X8302X (G14102)	MPS DUMP SEQ	B	0, 1	–	1.04
TAL_ABORT_ DECLARED	Transatlantic abort declared	V90X8658X	MSC	B	0, 1	–	
QBI_VALID	BODY WRT M50 QUAT VALID flag	V90X2245X	A/E ATT PROC	B	0,1	–	12.5
AVAILABLE_ JET_AFT(2)	Jet available L1L	V90X4521X	RCS RM	B	0, 1	–	12.5
AVAILABLE_ JET_AFT(3)	Jet available L1U	V90X4522X	RCS RM	B	0, 1	–	12.5
AVAILABLE_ JET_AFT(17)	Jet available L2L	V90X4523X	RCS RM	B	0, 1	–	12.5
AVAILABLE_ JET_AFT(18)	Jet available L2U	V90X4524X	RCS RM	B	0, 1	–	12.5
AVAILABLE_ JET_AFT(19)	Jet available L2D	V90X4525X	RCS RM	B	0, 1	–	12.5

Table 4.2.2-1. Input Variables, ASCENT DAP

FSSR Name	Description	MSID (MNEMONIC)	Source	Type	Range	Units	Sample Rate (Hz) Required
AVAILABLE_ JET_AFT(10)	Jet available L3L	V90X4527X	RCS RM	B	0, 1	–	12.5
AVAILABLE_ JET_AFT(11)	Jet available L3D	V90X4528X	RCS RM	B	0, 1	–	12.5
AVAILABLE_ JET_AFT(23)	Jet available L4L	V90X4529X	RCS RM	B	0, 1	–	12.5
AVAILABLE_ JET_AFT(24)	Jet available L4U	V90X4530X	RCS RM	B	0, 1	–	12.5
AVAILABLE_ JET_AFT(25)	Jet available L4D	V90X4531X	RCS RM	B	0, 1	–	12.5
AVAILABLE_ JET_AFT(5)	Jet available R1R	V90X4535X	RCS RM	B	0, 1	–	12.5
AVAILABLE_ JET_AFT(6)	Jet available R1U	V90X4536X	RCS RM	B	0, 1	–	12.5
AVAILABLE_ JET_AFT(20)	Jet available R2R	V90X4537X	RCS RM	B	0, 1	–	12.5
AVAILABLE_ JET_AFT(21)	Jet available R2U	V90X4538X	RCS RM	B	0, 1	–	12.5
AVAILABLE_ JET_AFT(22)	Jet available R2D	V90X4539X	RCS RM	B	0, 1	–	12.5
AVAILABLE_ JET_AFT(13)	Jet available R3R	V90X4541X	RCS RM	B	0, 1	–	12.5
AVAILABLE_ JET_AFT(14)	Jet available R3D	V90X4542X	RCS RM	B	0, 1	–	12.5
AVAILABLE_ JET_AFT(26)	Jet available R4D	V90X4543X	RCS RM	B	0, 1	–	12.5
AVAILABLE_ JET_AFT(27)	Jet available R4U	V90X4544X	RCS RM	B	0, 1	–	12.5
AVAILABLE_ JET_AFT(28)	Jet available R4D	V90X4545X	RCS RM	B	0, 1	–	12.5
AVAILABLE_ JET_FWD(2)	Jet available F1L	V90X4549X	RCS RM	B	0, 1	–	12.5
AVAILABLE_ JET_FWD(6)	Jet available F2R	V90X4553X	RCS RM	B	0, 1	–	12.5
AVAILABLE_ JET_FWD(14)	Jet available F3L	V90X4557X	RCS RM	B	0, 1	–	12.5
AVAILABLE_ JET_FWD(9)	Jet available F4R	V90X4560X	RCS RM	B	0, 1	–	12.5
AVAILABLE_ JET_FWD(7)	Jet available F2U	V90X4554X	RCS RM	B	0, 1	–	12.5

Table 4.2.2-1. Input Variables, ASCENT DAP							
FSSR Name	Description	MSID (MNEMONIC)	Source	Type	Range	Units	Sample Rate (Hz) Required
AVAILABLE_JET_FWD(15)	Jet available F3U	V90X4558X	RCS RM	B	0, 1	–	12.5
AVAILABLE_JET_FWD(3)	Jet available F1U	V90X4550X	RCS RM	B	0, 1	–	12.5
DY1_BIAS	MPS ENG 1 P BIAS	V96U7984C	VU	S	±6.0	deg	
DY2_BIAS	MPS ENG 2 P BIAS	V96U7985C	VU	S	±6.0	deg	
DY3_BIAS	MPS ENG 3 P BIAS	V96U7986C	VU	S	±6.0	deg	
DZ2_BIAS	MPS ENG 2 Y BIAS	V96U7987C	VU	S	–3.5, 0	deg	
DZ3_BIAS	MPS ENG 3 Y BIAS	V96U7988C	VU	S	0, 3.5	deg	
K_CMD	Commanded SSME throttle setting	V90U1948C (G00002)	ASC 1STG GUID, SBTC	I	65, 109	PCT	6.25
K_MAX	Maximum throttle setting for SSME's	V97U4424C	ASC 1STG GUID	I	100, 109	PCT	6.25
CONT_SERC	Contingency single engine roll control flag	V93X6682X	XXXXXX TRAJ 1 DISP	B	0,1	–	1.04
CONT_SERC	Contingency single engine roll control flag	V93X6682XB	XXXXXX TRAJ 2 DISP	B	0,1	–	1.04
CONT_SERC	Contingency single engine roll control flag	V93X6682XC	RTLS TRAJ 2 DISP	B	0,1	–	1.04
RHC_STATE(1)	RHC out of detent, roll axis	V96J0015CA	3AX_RHC_SOP	I	–1, 1	–	12.5
RHC_STATE(2)	RHC out of detent, pitch axis	V96J0017CA	3AX_RHC_SOP	I	–1, 1	–	12.5
RHC_STATE(3)	RHC out of detent, yaw axis	V96J0019CA	3AX_RHC_SOP	I	–1, 1	–	12.5
ME_FLT_DATA_PATH_FAIL(1)	Main engine 1 flight data path fail indicator	V95X1150X	SSME SOP	B	0, 1	–	12.5
ME_FLT_DATA_PATH_FAIL(2)	Main engine 2 flight data path fail indicator	V95X1151X	SSME SOP	B	0, 1	–	12.5
ME_FLT_DATA_PATH_FAIL(3)	Main engine 3 flight data path fail indicator	V95X1152X	SSME SOP	B	0, 1	–	12.5
SEL_V_M50	Selected total velocity in M50 coordinates	V90L2557C V90L2558C V90L2559C	IMU RM	V	±10 ⁶	ft/s	6.25
TIME_V	Time of total selected M50 velocity	V90W2553C	IMU RM	S	0 to 4 x 10 ⁷	s	6.25
VREL_AERO_REF	Aerodynamic reference velocity	V90L2018C	ASC 1STG GUID	S	0, 5000	ft/s	6.25

*Single-shot initialization

Table 4.2.2-2. Output Variables, ASCENT DAP

FSSR Name	Description	MSID (MNEMONIC)	Destination	Type	Range	Units	Sample Rate (Hz) Required
DBFRC	Body flap deflection command	V90H1580C (G06008)	AERO ACT SOP, BF CMD RM	I	±1	–	6.25
DLIBPC	Elevon LIB position CMD	V90H1734C (G36307)	AERO ACT SOP	S	–35, +20	deg	6.25/25*
DLOBPC	Elevon LOB position CMD	V90H1735C (G36308)	AERO ACT SOP	S	–35, +20	deg	6.25/25*
DRIBPC	Elevon RIB position CMD	V90H1737C (G47344)	AERO ACT SOP	S	–35, +20	deg	6.25/25*
DROBPC	Elevon ROB position CMD	V90H1738C (G47345)	AERO ACT SOP	S	–35, +20	deg	6.25/25*
DRPC	Rudder command	V90R1550C (G06024)	AERO ACT SOP	S	±27.1	deg	6.25/25*
DSBPC	Speed brake command	V90R1560C (G06025)	AERO ACT SOP	S	±98.6	deg	6.25/25*
DR4CL	Actuator deflection command, SRB 4 rock	V90H1728C (G33907)	SRB TVC CMD SOP	S	±5.0	deg	25
DR5CL	Actuator deflection command, SRB 5 rock	V90H1729C (G33908)	SRB TVC CMD SOP	S	±5.0	deg	25
DT4CL	Actuator deflection command, SRB 4 tilt	V90H1731C (G33909)	SRB TVC CMD SOP	S	±5.0	deg	25
DT5CL	Actuator deflection command, SRB 5 tilt	V90H1732C (G33910)	SRB TVC CMD SOP	S	±5.0	deg	25
DYC1	Actuator deflection command, SSME 1 pitch	V90H1718C (G33901)	MPS TVC CMD SOP, TLM	S	±10.5	deg	25
DYC2	Actuator deflection command, SSME 2 pitch	V90H1719C (G33902)	MPS TVC CMD SOP, TLM, ASC 2STG GUID	S	±10.5	deg	25
DYC3	Actuator deflection command, SSME 3 pitch	V90H1720C (G33903)	MPS TVC CMD SOP, TLM, ASC 2STG GUID	S	±10.5	deg	25
DZC1	Actuator deflection command, SSME 1 yaw	V90H1724C (G33904)	MPS TVC CMD SOP, TLM	S	±8.5	deg	25

Table 4.2.2-2. Output Variables, ASCENT DAP							
FSSR Name	Description	MSID (MNEMONIC)	Destination	Type	Range	Units	Sample Rate (Hz) Required
DZC2	Actuator deflection command, SSME 2 yaw	V90H1725C (G33905)	MPS TVC CMD SOP, TLM	S	±8.5	deg	25
DZC3	Actuator deflection command, SSME 3 yaw	V90H1726C (G33906)	MPS TVC CMD SOP, TLM	S	±8.5	deg	25
S1G	Indicator, STG1 guidance	V90X1713X	GC STEER, TLM	B	0,1	–	12.5
FRZCMD	Indicator, freeze desired body command	V90X1714X (G50358)	GC STEER, TLM	B	0,1	–	12.5
ATTFILT	Indicator, filter actual body attitude	V90X1709X	GC STEER, TLM	B	0,1	–	12.5
SEC_ME_FL_CNFM	2nd SSME fail confirm	V90X1721X (G50234)	MSC, SSME OPS, ABT CNTL SEQ, ET SEP SEQ, 5.21	B	0,1	–	12.5
NEW_JONLST (4)	RCS Jet F1L ON command	V90X1442X (G39305)	ASC RCS CMD SOP	B	0,1	–	25
NEW_JONLST (5)	RCS Jet F3L ON command	V90X1450X (G39313)	ASC RCS CMD SOP	B	0,1	–	25
NEW_JONLST (6)	RCS Jet F2R ON command	V90X1446X (G39321)	ASC RCS CMD SOP	B	0,1	–	25
NEW_JONLST (7)	RCS Jet F4R ON command	V90X1453X (G39327)	ASC RCS CMD SOP	B	0,1	–	25
NEW_JONLST (22)	RCS Jet L1L ON command	V90X1673X (G06038)	ASC RCS CMD SOP	B	0,1	–	25
NEW_JONLST (29)	RCS Jet L1U ON command	V90X1674X (G06039)	ASC RCS CMD SOP	B	0,1	–	25
NEW_JONLST (20)	RCS Jet L2L ON command	V90X1675X (G06040)	ASC RCS CMD SOP	B	0,1	–	25
NEW_JONLST (28)	RCS Jet L2U ON command	V90X1676X (G06041)	ASC RCS CMD SOP	B	0,1	–	25
NEW_JONLST (34)	RCS Jet L2D ON command	V90X1677X (G06042)	ASC RCS CMD SOP	B	0,1	–	25
NEW_JONLST (21)	RCS Jet L3L ON command	V90X1678X (G06043)	ASC RCS CMD SOP	B	0,1	–	25
NEW_JONLST (35)	RCS Jet L3D ON command	V90X1679X (G06044)	ASC RCS CMD SOP	B	0,1	–	25
NEW_JONLST (19)	RCS Jet L4L ON command	V90X1680X (G06045)	ASC RCS CMD SOP	B	0,1	–	25

Table 4.2.2-2. Output Variables, ASCENT DAP

FSSR Name	Description	MSID (MNEMONIC)	Destination	Type	Range	Units	Sample Rate (Hz) Required
NEW_JONLST (27)	RCS Jet L4U ON command	V90X1681X (G06046)	ASC RCS CMD SOP	B	0,1	–	25
NEW_JONLST (33)	RCS Jet L4D ON command	V90X1682X (G06047)	ASC RCS CMD SOP	B	0,1	–	25
NEW_JONLST (26)	RCS Jet R1R ON command	V90X1683X (G06048)	ASC RCS CMD SOP	B	0,1	–	25
NEW_JONLST (32)	RCS Jet R1U ON command	V90X1684X (G06049)	ASC RCS CMD SOP	B	0,1	–	25
NEW_JONLST (24)	RCS Jet R2R ON command	V90X1685X (G06050)	ASC RCS CMD SOP	B	0,1	–	25
NEW_JONLST (31)	RCS Jet R2U ON command	V90X1686X (G06051)	ASC RCS CMD SOP	B	0,1	–	25
NEW_JONLST (37)	RCS Jet R2D ON command	V90X1687X (G06052)	ASC RCS CMD SOP	B	0,1	–	25
NEW_JONLST (25)	RCS Jet R3R ON command	V90X1688X (G06053)	ASC RCS CMD SOP	B	0,1	–	25
NEW_JONLST (38)	RCS Jet R3D ON command	V90X1689X (G06054)	ASC RCS CMD SOP	B	0,1	–	25
NEW_JONLST (23)	RCS Jet R4R ON command	V90X1690X (G06055)	ASC RCS CMD SOP	B	0,1	–	25
NEW_JONLST (30)	RCS Jet R4U ON command	V90X1691X (G06056)	ASC RCS CMD SOP	B	0,1	–	25
NEW_JONLST (36)	RCS Jet R4D ON command	V90X1692X (G06057)	ASC RCS CMD SOP	B	0,1	–	25
NEW_JONLST (8)	RCS Jet F2U ON command	V90X1447X	ASC RCS CMD SOP	B	0,1	–	12.5
NEW_JONLST (9)	RCS Jet F3U ON command	V90X1451X	ASC RCS CMD SOP	B	0,1	–	12.5
NEW_JONLST (10)	RCS Jet F1U ON command	V90X1443X	ASC RCS CMD SOP	B	0,1	–	12.5
QBI_READY	Indicator, body WRT M50 quaternion ready, for use in STG-1	V90X2250X	GC STEER	B	0,1	–	12.5
RTLS_TURN	Indicator, RTLS turn-around maneuver	V90X1756X (G00904)	GC STEER	B	0,1	–	12.5
PEGCMD	Indicator, SG2 steering mode	V90X1757X (G50357)	GC STEER, TLM	B	0,1	–	12.5
ATTCMD	Indicator, ATTFILT, SIG or PPD steering mode	V90X1712X (G50356)	GC STEER, TLM	B	0,1	–	12.5

Table 4.2.2-2. Output Variables, ASCENT DAP							
FSSR Name	Description	MSID (MNEMONIC)	Destination	Type	Range	Units	Sample Rate (Hz) Required
PPD	Indicator, RTLS powered pitch down maneuver	V90X1760X (G50363)	GC STEER, TLM	B	0,1	–	12.5
AUTO	Indicator, automatic guidance steering mode	V90X1710X (G50361)	MEDS FC GNC XFER, GC STEER, ASC 2STG GUID, PW RTLS GUID, GRTLS DAP, TLM, 3-AX RHC SOP	B	0,1	–	12.5
SRBSEP	Indicator, SRB separation subphase	V90X1761X	GC STEER, TLM	B	0,1	–	12.5
SSME_FAILS	Indicator, SSME failure status	V90J1763C	INTERPS, TLM, SSME_CMD_PROC, GC STEER, XXXXXX TRAJ 1 DISP, XXXXXX TRAJ 2 DISP, RTLS TRAJ 2 DISP	I	0-7	–	12.5
MM101_INIT	Indicator, Event 1; first time ASC_DAP scheduled	V90X1764X	GC STEER, TLM	B	0,1	–	12.5
LAUTO_ PLAMP	Pitch auto FCS mode lamp, left	V72X5240X (G22202)	D&C PNL, TLM	B	0,1	–	12.5
RAUTO_ PLAMP	Pitch auto FCS mode lamp, right	V72X5140X (G22203)	D&C PNL, TLM	B	0,1	–	12.5
LAUTO_ RYLAMP	Roll/yaw auto FCS mode lamp, left	V72X5243X (G22206)	D&C PNL, TLM	B	0,1	–	12.5
RAUTO_ RYLAMP	Roll/yaw auto FCS mode lamp, right	V72X5143X (G22207)	D&C PNL, TLM	B	0,1	–	12.5
LCSS_PLAMP	Pitch manual FCS mode lamp, left	V72X5241X (G22204)	D&C PNL, TLM, 3AX RHC SOP	B	0,1	–	12.5
RCSS_PLAMP	Pitch manual FCS mode lamp, right	V72X5141X (G22205)	D&C PNL, TLM	B	0,1	–	12.5
LCSS_ RYLAMP	Roll/yaw manual FCS mode lamp, left	V72X5245X (G22208)	D&C PNL, TLM	B	0,1	–	12.5
RCSS_ RYLAMP	Roll/yaw manual FCS mode lamp, right	V72X5145X (G22209)	D&C PNL, TLM	B	0,1	–	12.5
LAUTO_ BFLAMP	Auto body flap lamp, left	V72X4996X (G22212)	D&C PNL, TLM	B	0,1	–	12.5
RAUTO_ BFLAMP	Auto body flap lamp, right	V72X4896X (G22213)	D&C PNL, TLM	B	0,1	–	12.5
LMNL_ BFLAMP	Manual body flap lamp, left	V72X4997X (G22210)	D&C PNL, TLM	B	0,1	–	12.5

Table 4.2.2-2. Output Variables, ASCENT DAP

FSSR Name	Description	MSID (MNEMONIC)	Destination	Type	Range	Units	Sample Rate (Hz) Required
RMNL_ BFLAMP	Manual body flap lamp, right	V72X4897X (G22211)	D&C PNL, TLM	B	0,1	–	12.5
LAUTO_ SBLAMP	Auto speed brake lamp, left	V72X5136X (G22214)	D&C PNL, TLM	B	0,1	–	12.5
RAUTO_ SBLAMP	L.C. Auto speed brake lamp, right	V72X5134X (G22215)	D&C PNL, TLM	B	0,1	–	12.5
MNLSB_ CMDR_O	Commander's manual speed brake lamp	V72X5137X (G22216)	D&C PNL, TLM	B	0,1	–	12.5
MNLSB_ PLT_O	Pilot's manual speed brake lamp	V72X5135X (G22217)	D&C PNL, TLM	B	0,1	–	12.5
DY1	Pitch command, SSME 1	V90H1745C	Prelaunch TLM	S	±11.0	deg	25
DZ1	Yaw command, SSME 1	V90H1746C	Prelaunch TLM	S	±9.0	deg	25
DY2	Pitch command, SSME 2	V90H1747C	Prelaunch TLM	S	±11.0	deg	25
DZ2	Yaw command, SSME 2	V90H1748C	Prelaunch TLM	S	±9.0	deg	25
DY3	Pitch command, SSME 3	V90H1749C	Prelaunch TLM	S	±11.0	deg	25
DZ3	Yaw command, SSME 3	V90H1750C	Prelaunch TLM	S	±9.0	deg	25
DT4C	Tilt command, SRB 4	V90H1751C	Prelaunch TLM	S	±6.7	deg	25
DT4CL	TILT ACTR DEF, CMD (SRB 4)	V90H1731C	SRB TVR CMD SOP, TLM				
DR4C	Rock command, SRB 4	V90H1752C	Prelaunch TLM	S	±6.7	deg	25
DR4CL	ROCK ACTR DEF, CMD (SRB 4)	V90H1728C	SRB TVR CMD SOP, TLM				
DT5C	Tilt command, SRB 5	V90H1753C	Prelaunch TLM	S	±6.7	deg	25
DT5CL	TILE ACTR DEF, CMD (SRB 5)	V90H1732C	SRB TVR CMD SOP, TLM				
DR5C	Rock command, SRB 5	V90H1754C	Prelaunch TLM	S	±6.7	deg	25
DR5CL	ROCK ACTR DEF, CMD (SRB 5)	V90H1729C	SRB TVR CMD SOP, TLM				
SRB_NULL_ CMD	Event 27, indicator	V90X1769X	A/E ATT PROC	B	0, 1	–	12.5
DQTVC_INT	Pitch integrator output	V90H1772C	TLM	S	±10.0	deg	12.5
DRTVC_INT	Yaw integrator output	V90H1773C	TLM	S	±10.0	deg	12.5
DPTVC_INT	Roll integrator output	V90H1774C	TLM	S	±10.0	deg	12.5

Table 4.2.2-2. Output Variables, ASCENT DAP							
FSSR Name	Description	MSID (MNEMONIC)	Destination	Type	Range	Units	Sample Rate (Hz) Required
DQTVC	Pitch TVC loop error signal	V90H1758C	TLM	S	±10.0	deg/s	25.0
DRTVC	Yaw TVC loop error signal	V90H1759C	TLM	S	±10.0	deg/s	25.0
ELEV_LR	Elevon load relief indicator	V90H1716X	GC STEER	B	0,1	–	12.5
NZ_FBK	Compensated normal accel error	V90A1765C	GC STEER, TLM	S	±10.0	deg/s	25.0
NY_FBK	Compensated lateral accel error	V90A1766C	GC STEER, TLM	S	±10.0	deg/s	25.0
KM_THETA	Variable gain attitude–pitch	V90U1767C	GC STEER	S		deg/s/ deg	6.25
KN_PSI	Variable gain attitude–yaw	V90U1768C	GC STEER	S		deg/s/ deg	6.25
ZTRANS	Indicator, RTLS external tank separation maneuver	V90X1755X	GC STEER	B	0,1	–	12.5
K_LOAD_RELIEF	Var load relief gain	V90J1704C	ASC 1STG GUID	S		–	6.5
NYSEP_DISABLE	Event 25E, indicator	V90X0373X	ASC 1STG GUID	B	0,1	-	12.5
AUTO_2ND_OUT	Auto recognition of second engine out indicator	V90X1744X	TLM, XXXXXX TRAJ 2 DISP, RTLS TRAJ 2 DISP	B	0,1	–	12.5
CONT_SERC	Contingency single engine roll control flag	V93X6682XA	ABT CNTL SEQ, XXXXXX TRAJ 1 DISP, XXXXXX TRAJ 2 DISP, RTLS TRAJ 2 DISP, MSC, TLM, GC STEER, ASC 2STG GUID	B	0,1	–	12.5
ENA_RCS_CNTL	Enable RCS control discrete	V90X1739X	XXXXXX TRAJ 1 DISP, XXXXXX TRAJ 2 DISP, RTLS TRAJ 2 DISP, TLM	B	0,1	–	12.5
PCGTRM	Net pitch trim thrust angle	V90U0103C	GC STEER	S		deg	6.25
YCGTRM	Net yaw trim thrust angle	V90U0104C	GC STEER	S		deg	6.25
MASS_EST	Mass Estimate	V90U0389C	GC STEER	S		slug	6.25
PRE_SEP	Indicator, initiate separation preparation	V90X0906X	CONT 3E/O GUID	B	0,1	–	12.5

Table 4.2.2-2. Output Variables, ASCENT DAP

FSSR Name	Description	MSID (MNEMONIC)	Destination	Type	Range	Units	Sample Rate (Hz) Required
PC4F	Filtered chamber pressure, SRB4	V90P0907C	CONT 3E/O GUID	S		psi	12.5
PC5F	Filtered chamber pressure, SRB5	V90P0908C	CONT 3E/O GUID	S		psi	12.5

*Rates x/y; x normal, y slew checks

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4.2.3 System Overview

The detailed overview block diagram for the ASCENT DAP (ASC_DAP) system is presented in Figure 4.2.3-1. ASCENT DAP implements and processes the algorithms that convert steering commands and vehicle attitude, attitude rate, and acceleration inputs into control element deflections. A list of input variables is given in Table 4.2.2-1, and a list of output variables is given in Table 4.2.2-2. ASCENT DAP consists of the following functional software modules:

- A. ASCENT RECONFIGURATION LOGIC (ASC_RECON) generates the moding, sequencing and initialization indicators that are required by ASC_DAP and GC_STEER. In addition, it receives AUTO/MANUAL indications from pushbutton indicators and lights appropriate lamps, and provides second stage auto recognition of a second engine out.
- B. ASCENT THRUST VECTOR CONTROL (ASC_TVC) closes acceleration and/or rate loops within the outer attitude loop to generate body axis attitude rate commands for the MPS and SRB.
- C. MPS COMMAND PROCESSOR (CMD_PROC_MPS) applies authority limits, trim biases, and mixing logic to generate SSME actuator commands, and applies position and rate limiting, including priority rate limiting, and also nulling of failed SSMEs.
- D. SRB COMMAND PROCESSOR (CMD_PROC_SRB) applies pitch trim, pitch commands for clearance of the hold-down support, and mixing logic to generate SRB actuator commands. It then applies position and rate limiting.
- E. LINEAR INTERPOLATIONS (INTERPS) generates accelerations profiles, trims, elevon schedules and scheduled gains as functions of earth relative velocity magnitude, aerodynamic reference velocity, mission elapsed time, engine status, and estimated vehicle mass.
- F. AEROSURFACE CONTROL (AEROSURFACE_CONTROL) provides hinge moment load relief for the elevon actuators, positions the body flap, and positions the rudder and speed brake.
- G. RCS COMMANDS (CMD_PROC_RCS) provides RCS jet ON/OFF commands for roll control in the event that two or three SSMEs shut down in first stage or two SSMEs shut down in second stage. During RTLS single engine completion (Powered Contingency modes 0 and 5), CMD_PROC_RCS also augments pitch control by turning on forward up-firing RCS jets if the pitch error exceeds an I-loaded threshold. The CMD_PROC_RCS is initiated when the ENA_RCS_CNTL flag is set and terminated at ZERO_THRUST in MM 103 or MECO_CMD in MM 601.

The sequencing requirements for ASCENT DAP are shown in Figure 4.2.3-2. Figure 4.2.3-2A shows the high level sequencing requirements in terms of the 25, 12.5, 6.25 and 3.125 Hz rate groups. The 25 Hz rate group is denoted ASC_DAP_40 and is shown in Figure 4.2.3-2B. The 12.5 Hz rate group is denoted ASC_DAP_80 and is shown in Figure 4.2.3-2C. The 6.25 Hz rate group is denoted ASC_DAP_160 and is shown in Figure 4.2.3-2D. The 3.125 Hz rate group is denoted by ASC_DAP_320 and is shown in Figure 4.2.3-2E.

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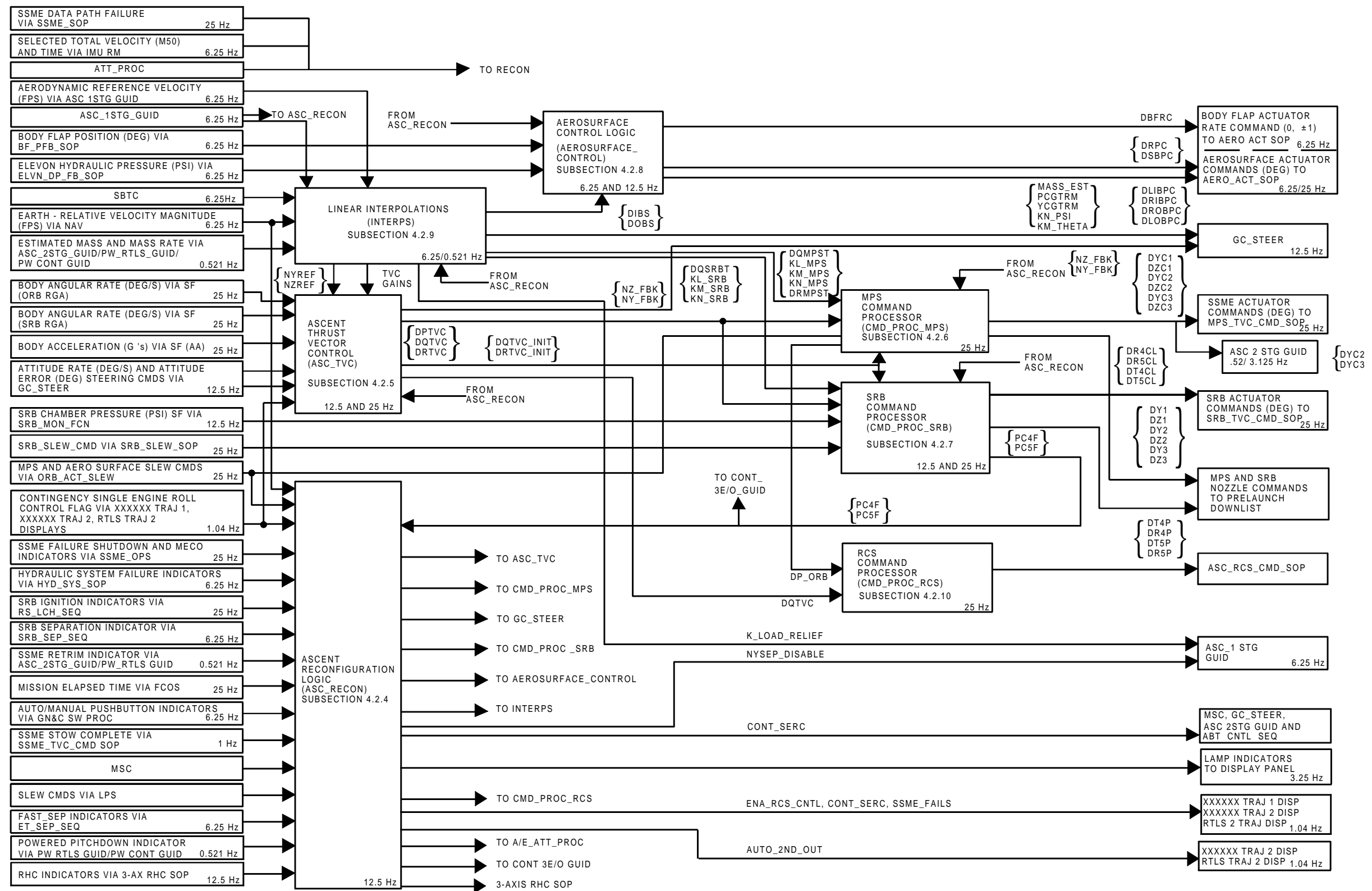


FIGURE 4.2.3-1. Ascent Flight Control, Functional Overview

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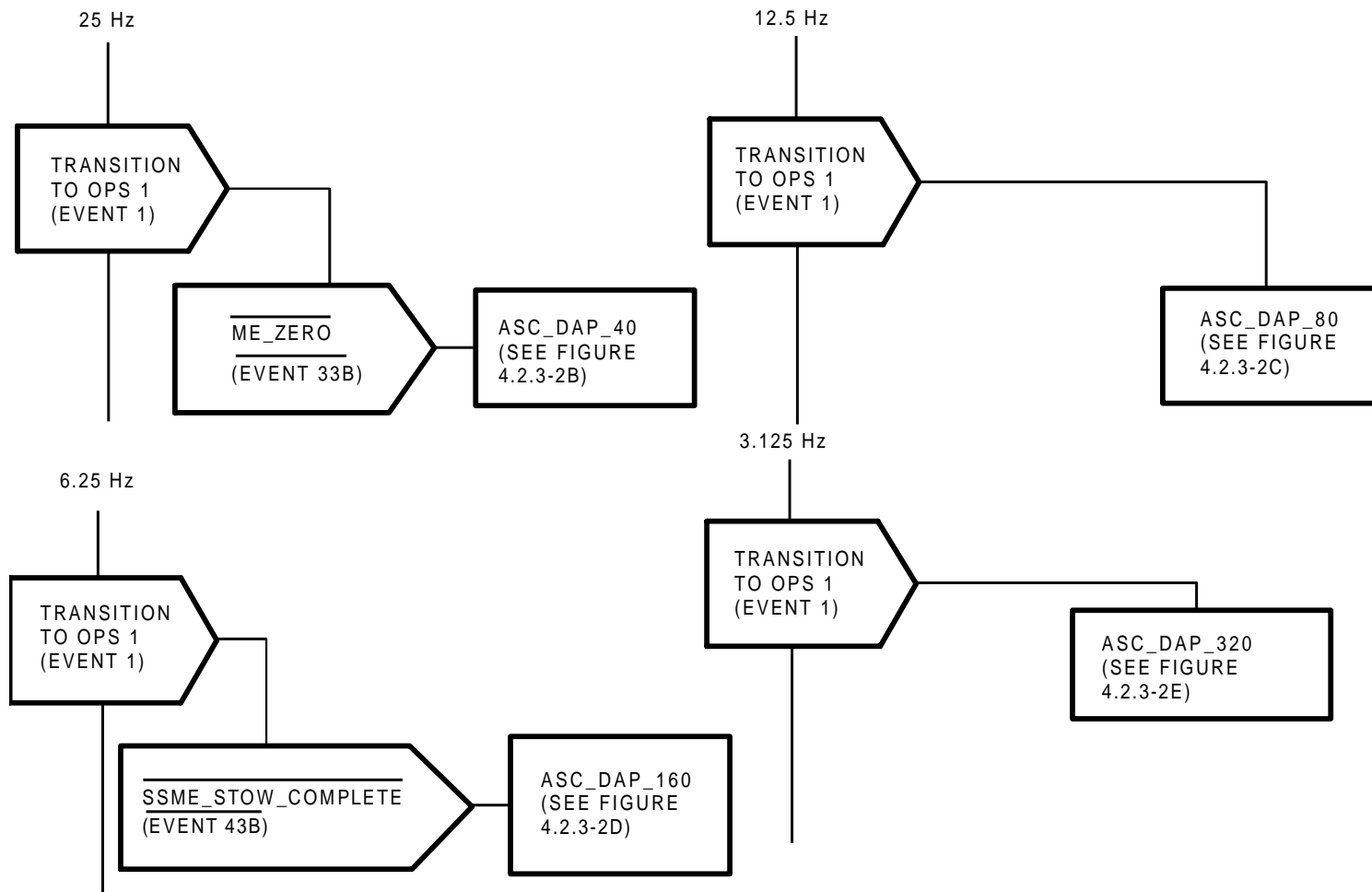


FIGURE 4.2.3-2A. ASCENT DAP Sequencing Requirements

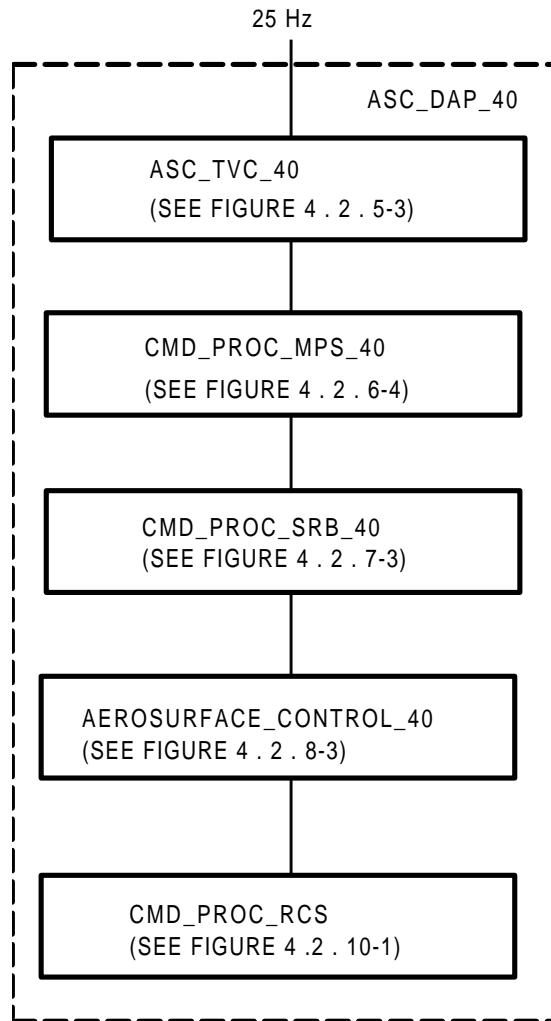


FIGURE 4.2.3-2B. ASC_DAP_40, 25 Hz Sequencing Requirements

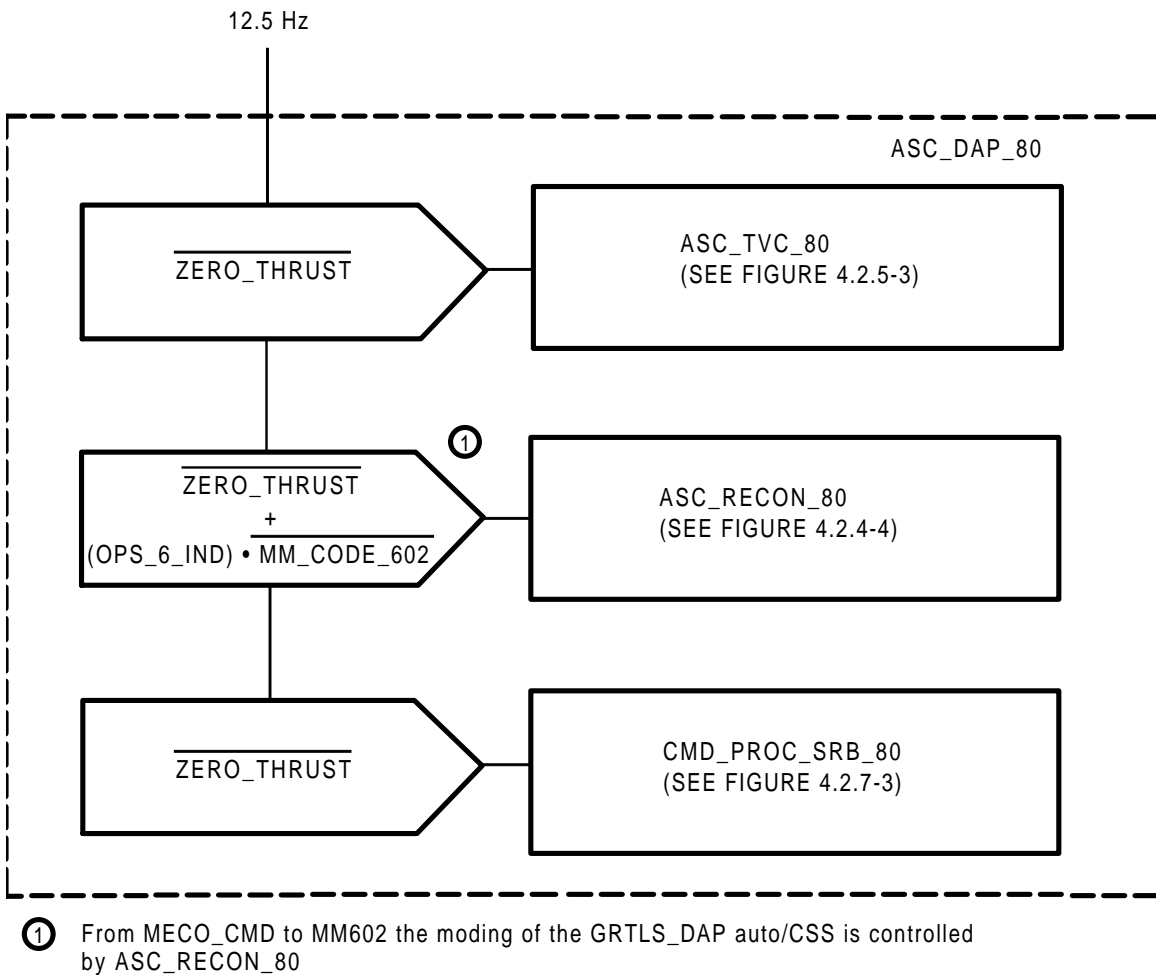


FIGURE 4.2.3-2C. ASC_DAP_80, 12.5 Hz Sequencing Requirements

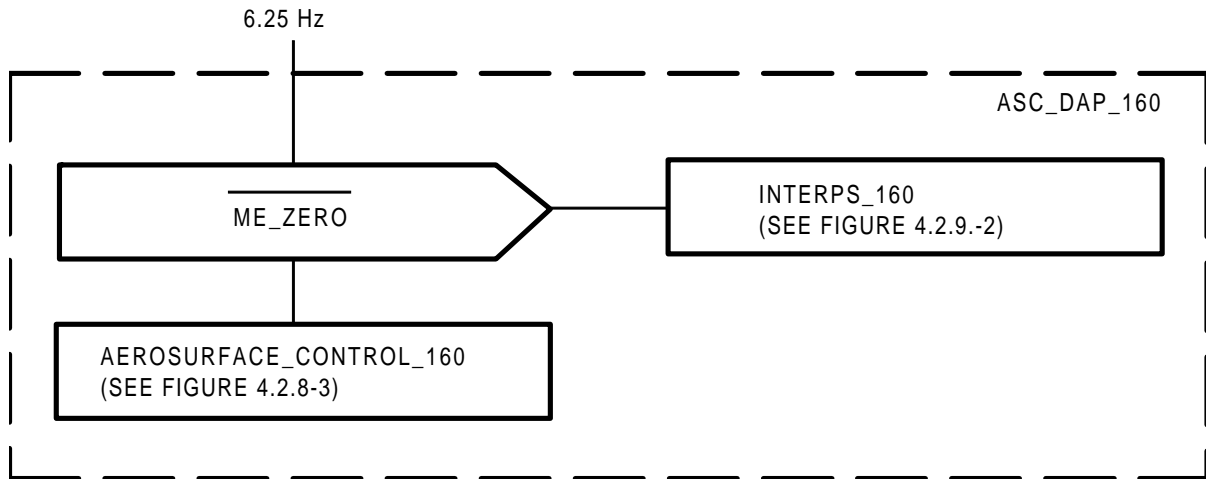


FIGURE 4.2.3-2D. ASC_DAP_160, 6.25 Hz Sequencing Requirements

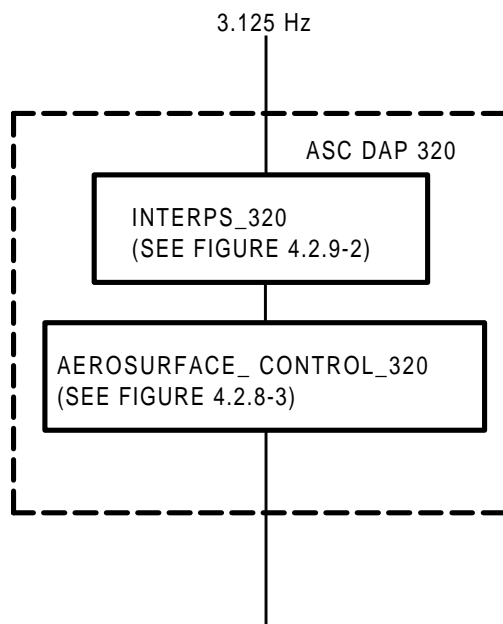


FIGURE 4.2.3-2E. ASC_DAP_320, 3.125 Hz Sequencing Requirements

4.2.4 ASCENT RECONFIGURATION (ASC_RECON)

A. Functional Description. In response to control mode changes, changes in failure status, and the occurrence of events, ASC_RECON generates the indicators that are needed by both ASC_DAP and GC_STEER for moding, sequencing, and initialization. In addition, ASC_RECON generates the indicators used to provide data to the crew. The indicators needed to perform ASCENT reconfiguration are derived from events, failure status indicators, and control mode indicators that are generated externally to ASC_DAP and GC_STEER and from events generated locally by ASC_RECON. External events, failure status indicators, and control mode indicators are buffered by ASC_RECON so that initialization requirements and changes in sequencing requirements can be met prior to the execution of affected modules. Sequencing and initialization functions for ASC_DAP and GC_STEER are not shown to be performed by ASC_RECON. Sequencing requirements shown at the high level of ASC_DAP and GC_STEER are assumed to be met by an executive-type program. Initialization requirements shown at the module level are assumed to be performed by the module itself. It is recognized that, from a software point of view, it is not efficient to perform initializations at the module level. (Initialization requirements are shown at the module level because it is proper to do so from a functional requirements specification point of view.) The proper handling of initialization requirements is strongly implementation-dependent and as such should not necessarily be included as part of the functional specifications document. Part B of this subsection provides the software description of ASC_RECON consistent with the assumption that initializations are performed at the module level.

The mode panel switches and pushbutton indicators of importance to ASC_DAP and GC_STEER are shown in Figure 4.2.4-1. Subphases useful for the functional (and software) description of ASC_DAP and GC_STEER are shown in Figure 4.2.4-2 for a nominal mission and in Figure 4.2.4-3 for an RTLS abort. The subphases are defined in terms of externally and locally derived events. (External event numbers are shown inside circles, and local event numbers are shown in boxes.) A description of the function(s) performed during each subphase is summarized in Table 4.2.4-1. Many subphases have corresponding Boolean indicators that are used for sequencing and initialization purposes. Second stage auto recognition of a second SSME out is shown in Figure 4.2.4-5.

B. Software Specification. ASC_RECON consists of one module, ASC_RECON, which is sequenced at 12.5 Hz. The detailed specifications for ASC_RECON are summarized in the flow diagram shown in Figure 4.2.4-4. Interface requirements for ASC_RECON are presented in Table 4.2.4-2. ASC_RECON generates the indicators needed for sequencing and initialization from externally derived events, control mode indicators, and failure status indicators and from locally derived events. Externally derived events are buffered and given local event names. Detailed specification of the buffered “local” events and derived local events are summarized in Table 4.2.4-3. Detailed specifications of the reconfiguration indicators used for sequencing and initialization are summarized in Table 4.2.4-4. Table 4.2.4-4A summarizes those Boolean reconfiguration indicators which are defined between events. Table 4.2.4-4B summarizes those Boolean reconfiguration indicators which are functions of mode indicators, failure status indicators, and locally derived indicators. Table 4.2.4-4C summarizes those reconfiguration indicators which are integers. Initialization requirements for ASC_RECON are summarized in Table 4.2.4-5. I-Loads for ASC_RECON are shown in Table 4.2.4-6.

Table 4.2.4-1. Functional Description of ASC_DAP and GC_STEER Subphases	
Subphase Name	Function(s) Performed During Subphase
AERO_SLEW	Aerosurface actuator slew test
ATTCMD	GC_STEER processes body attitude quaternion prior to lift-off or guidance commanded body attitude quaternion in Stage 1 guidance or in RTLS or powered contingency guidance during powered pitch-down, mated coast and -Z translation maneuvers
ATTFILT	Body attitude quaternion filtered by GC_STEER prior to lift-off
AUTOTRIM_P	Roll attitude trim control
AUTOTRIM_QR	Pitch/yaw automatic trim control
FRZCMD	Freeze flight body attitude commands
SSME_START_POS	Main engines biased off to start position
INTERPS_S1	Stage 1 linear interpolations; scheduled parameters functions of relative velocity and met
INTERPS_S2	Stage 2 linear interpolations; scheduled parameters functions of estimated mass
ME_SLEW	Main engine actuator slew test
PARALLEL_PITCH_ENABLE	Enable paralleling of main engines in pitch in the event of engine 2 or 3 failure, or all three SSME's are on and PARALLEL_PITCH_NOM is on.
PC_FILTER	SRB chamber pressure filtered for SRB nozzle command vector limiting and for SRB thrust tailoff control
PEGCMD	Stage 2 steering using powered explicit guidance commands or powered RTLS explicit guidance commands or powered contingency guidance commands
PRELO	Pre-lift-off functions, including initialization of GC_STEER, actuator slew test, and attitude filtering
PRL_LCH	Restriction of rate of change of SSME actuator commands so as not to exceed hydraulic system capability while engines are throttling up at launch
PRL_MECO	Restriction of rate of change of SSME actuator commands so as not to exceed hydraulic system capability while engines are throttling down at MECO
PRL_S1	Fixed rate limiting of SSME actuator commands in Stage 1
PRL_S2	Normal restriction of rate of change of SSME actuator commands so that hydraulic system capability is not exceeded with or without APU failures; Stage 2 only

Table 4.2.4-1. Functional Description of ASC_DAP and GC_STEER Subphases	
Subphase Name	Function(s) Performed During Subphase
S1C	Stage 1 automatic thrust vector control using rate gyro feedback, normal and lateral acceleration feedback, and steering commands derived from commanded body attitude profiles
S2C	Stage 2 automatic thrust vector control using rate gyro feedback and steering commands derived from linear tangent or powered contingency guidance parameters
S1G	Stage 1 steering using open-loop guidance profile
S2G	Stage 2 steering using powered explicit guidance commands or powered RTLS explicit guidance commands or powered contingency guidance commands
SRBLIM_ACTV	Imposes narrow limits on SRB actuator deflections at launch
SRBSEP	Activate SRB separation attitude control logic
SRB_SLEW	SRB actuator slew test
FAIL_MIX_ENABLE	Enable main engine mixing logic changes for engine failures
UNPARALLEL_YAW_ENABLE	Enable unparalleling of main engines in yaw in the event of main engine failure
ELEV_LR	Provides vehicle aerodynamic load relief via elevon surface control
NYSEP_FB_ENABLE	Activates Y axis acceleration feedback for SRB separation control
SNGL_ME_CNTL_ENABLE	Allows moding DAP to provide RCS jet commands for roll control if two-SSME-out condition exists
PPD	Stage 2 steering using RTLS or powered contingency powered pitch-down maneuver
RTLS_TURN	Stage 2 steering using RTLS powered explicit guidance commands for the turnaround maneuver
GRAV_POS	Main engine biased to gravity position
ZTRANS	Stage 2 steering during RTLS or powered contingency external tank separation

Table 4.2.4-2. ASC_RECON Interface Requirements

Name	Description	Source or Destination	Type	Range	Units	Rate Required/Produced At (Hz)
<u>Inputs</u>						
ME1_FAIL_SHUTDOWN	Main engine 1 out indicator	SSME_OPS	B		–	12.5
ME2_FAIL_SHUTDOWN	Main engine 2 out indicator	SSME_OPS	B		–	12.5
ME3_FAIL_SHUTDOWN	Main engine 3 out indicator	SSME_OPS	B		–	12.5
MASS	Vehicle mass	ASC_2STG_GUID PW_RTLS_GUID PW_CONT_GUID	S		slug	0.521
ME_FLT_DATA_PATH_FAIL(1)	Main engine 1 flight data path fail indicator	SSME_SOP	B		–	12.5
ME_FLT_DATA_PATH_FAIL(2)	Main engine 2 flight data path fail indicator	SSME_SOP	B		–	12.5
ME_FLT_DATA_PATH_FAIL(3)	Main engine 3 flight data path fail indicator	SSME_SOP	B		–	12.5
SEL_V_M50(1)	Selected total X velocity in M50 coordinates	IMU_RM	S		fps	6.25
SEL_V_M50(2)	Selected total Y velocity in M50 coordinates	IMU_RM	S		fps	6.25
SEL_V_M50(3)	Selected total Z velocity in M50 coordinates	IMU_RM	S		fps	6.25
TIME_V	Time of selected total M50 velocity	IMU_RM	S		sec	6.25
HYDRFAIL(1)	Hydraulic system 1 failure indicator	HYD_SYS_SOP	B		–	12.5
HYDRFAIL(2)	Hydraulic system 2 failure indicator	HYD_SYS_SOP	B		–	12.5
HYDRFAIL(3)	Hydraulic system 3 failure indicator	HYD_SYS_SOP	B		–	12.5
MPS_SLEW_COMPLETE	Indicator, Event 5A; orbiter hydraulic system slew test complete	ORB_ACT_SLEW, RS_LCH_SEQ	B		–	12.5
SRB_IGNITION_COMMAND	Indicator, Event 19; initiate SRB IGN command	RS_LCH_SEQ	B		–	12.5
SRB_MODING_SEP	Indicator, Event 27; initiate SRB null command	SRB_SEP_SEQ ET_SEP_SEQ	B		–	12.5

Table 4.2.4-2. ASC_RECON Interface Requirements

Name	Description	Source or Destination	Type	Range	Units	Rate Required/Produced At (Hz)
SRB_SEPARATION_COMMAND_FLAG	Indicator, Event 28; initiate SRB separation command	SRB_SEP_SEQ ET_SEP_SEQ	B		–	12.5
GUIDANCE_INITIATE	Indicator, Event 29; Stage 2 guidance ready	MSC	B		–	12.5
CLOCK	Clock–computer (GMT)	FCOS	S		sec	25
REL_VEL_MAG	Earth–relative velocity magnitude	ASCENT_UPP	S		fps	6.25
AUTOP	Pitch auto mode push–button indicator	GN&C_SW_RM	B		–	6.25
S_QUAT	Ascent 1st stage guidance ready flag	ASC_1STG_GUID	B		–	6.25
RS_AUTO_SEQ_START	Indicator, Event 6; LPS go for auto sequence start	RS_LCH_SEQ	B			12.5
AUTORY	Roll/yaw auto mode push–button indicator	GN&C_SW_RM	B		–	6.25
CSSP	Pitch manual mode push–button indicator	GN&C_SW_RM	B		–	6.25
CSSRY	Roll/yaw manual mode push–button indicator	GN&C_SW_RM	B		–	6.25
S_SSME_TRIM	Indicator, Event 30A; initiate main engine retrim	ASC_2STG_GUID	B		–	.521
MECO_COMMAND	Indicator, Event 32; initiate main engine cut off	SSME_OPS	B		–	12.5
ME_ZERO	Indicator, Event 33B or A36A; at least two main engines shutdown (zero thrust)	MSC	B		–	12.5
PC4F	Filtered chamber pressure, left SRB	CMD_PROC_SRB	S		–	12.5
PC5F	Filtered chamber pressure, right SRB	CMD_PROC_SRB	S		–	12.5
FAST_SEP_FLAG	Fast separation flag	ET_SEP_SEQ	D		–	6.25
OPS_6_IND	Indicator, Event A30 and A31 trans to OPS 6	MSC	B		–	12.5
SSME_STOW_COMPLETE	SSME stow complete flag	SSME_TVC_CMD_SOP	B		–	1.0

Table 4.2.4-2. ASC_RECON Interface Requirements

Name	Description	Source or Destination	Type	Range	Units	Rate Required/Produced At (Hz)
QBL_VALID	BODY WRT M50 QUAT VALID flag	ATT_PROC	B	0,1	–	12.5
MECO_CONFIRM	MECO_CONFIRMED flag	SSME_OPS	B		–	12.5
TRANSITION_TO_OPS_1	Indicator, Event 1; transition to OPS 1	MSC	B		–	12.5
SRB_SLEW	Indicator, Event 8; initiate SRB slew test	LPS	B		–	12.5
SRB_SLEW_COMPLETE	Indicator, Event 8A; SRB hydraulic slew test complete	SRB_SLEW	B		–	12.5
AERO_SLEW	Indicator, Event 4A; initiate aerosurface hydraulic system slew check	LPS	B		–	12.5
MPS_SLEW	Indicator, Event 5; initiate MPS hydraulic system slew check	LPS	B		–	12.5
PREP_SSME	Indicator, Event 18A; command SSMEs to liftoff position	RS_LCH_SEQ	B		–	12.5
S_RTLS_TURN	Indicator, RTLS turnaround	PW_RTLS_GUID	B		–	12.5
S_PPD_QUAT	Indicator, initiate powered pitch down maneuver	PW_RTLS_GUID, PW_CONT_GUID	B		–	12.5
EVENT_A37	Indicator, Event A37; ET separation command	ET_SEP_SEQ	B		–	12.5
MM_CODE_602	Major Mode 602 flag	MSC	B		–	12.5
AERO_SLEW_COMPLETE	Indicator, Event 4B; aero-surface slew test complete	ORB_ACT_SLEW	B		–	12.5
A_D_RECYCLE_COUNT	ASC DAP recycle indicator	RS_LCH_SEQ	B		–	12.5
RETURN_SSME_TO_START_POS	Indicator, return SSME to start position flare	RS_LCH_SEQ	B		–	12.5
TAL_ABORT_DECLARED	TAL abort declared	MSC	B		–	
CONT_SERC	Contingency single engine roll control flag	XXXXXX TRAJ 1 DISP, XXXXXX TRAJ 2 DISP, RTLS TRAJ 2 DISP	B		–	1.04

Table 4.2.4-2. ASC_RECON Interface Requirements						
Name	Description	Source or Destination	Type	Range	Units	Rate Required/Produced At (Hz)
RHC_STATE(1)	RHC out of detent roll	3AX_RHC_SOP	I		–	12.5
RHC_STATE(2)	RHC out of detent pitch	3AX_RHC_SOP	I		–	12.5
RHC_STATE(3)	RHC out of detent yaw	3AX_RHC_SOP	I		–	12.5
MPS_LO2_DUMP_STOP	MPS dump complete	MPS_DUMP_SEQ	B		–	
<u>Outputs</u>						
HYD_FAILS	Indicator, buffered HYD_FAIL_STATUS	CMD_PROC_MPS, INTERPS	I		–	12.5
S1C	Indicator, Stage 1 control	CMD_PROC_SRB ASC_TVC	B		–	12.5
S2C	Indicator, Stage 2 control	ASC_TVC	B		–	12.5
AUTOTRIM_P	Indicator, enable roll autotrim	ASC_TVC	B		–	12.5
ME_RETRIM	Indicator, initiate trim and bias limit	CMD_PROC_MPS	B		-	12.5
INTERPS_S1	Indicator, Stage 1 INTERPS	INTERPS	B		–	12.5
INTERPS_S2	Indicator, Stage 2 INTERPS scheduling	INTERPS	B		–	12.5
PEGCMD	Indicator, S2G steering mode	GC_STEER	B		–	12.5
ATTCMD	Indicator, ATTFILT, S1G or PPD steering mode	GC_STEER	B		–	12.5
AUTO	Indicator automatic steering mode	3-AX RHC SOP, ASC_2STG_GUID, GC_STEER, PW_RTLS_GUID, GRTLS_DAP, MEDS FC GNC XFER	B		–	12.5
PPD	Indicator, RTLS powered pitch down maneuver	GC_STEER INTERPS	B		–	12.5
S1G	Indicator, Stage 1 guidance	GC_STEER	B		–	12.5
FRZCMD	Indicator, freeze desired body command	GC_STEER	B		–	12.5
ATTFILT	Indicator, filter actual body attitude	GC_STEER	B		–	12.5

Table 4.2.4-2. ASC_RECON Interface Requirements

Name	Description	Source or Destination	Type	Range	Units	Rate Required/Produced At (Hz)
SRB_NULL_CMD	Indicator, initiate SRB null CMD, Event 27	ASC_TVC, CMD_PROC_SRB, A/E ATT_PROC	B		–	12.5
NYSEP_FB_ENABLE	Indicator to switch NY feedback	ASC_TVC, INTERPS	B		–	12.5
PC_FILTER	Indicator, SRB chamber pressure filtering	CMD_PROC_SRB	B		–	12.5
COMLIM4	Indicator, SRB4 component limiting	CMD_PROC_SRB	B		–	12.5
COMLIM5	Indicator, SRB5 component limiting	CMD_PROC_SRB	B		–	12.5
LAUTO_PLAMP	Left pitch auto FCS mode lamp	D&C_PNL, TLM	B		–	12.5
RAUTO_PLAMP	Right pitch auto FCS mode lamp	D&C_PNL, TLM	B		–	12.5
LAUTO_RYLAMP	Left roll/yaw auto FCS mode lamp	D&C_PNL, TLM	B		–	12.5
RAUTO_RYLAMP	Right roll/yaw auto FCS mode lamp	D&C_PNL, TLM	B		–	12.5
LCSS_PLAMP	Left pitch manual FCS mode lamp	D&C_PNL, TLM	B		–	12.5
RCSS_PLAMP	Right pitch manual FCS mode lamp	D&C_PNL, TLM	B		–	12.5
LCSS_RYLAMP	Left roll/yaw manual FCS mode lamp	D&C_PNL, TLM	B		–	12.5
RCSS_RYLAMP	Right roll/yaw manual FCS mode lamp	D&C_PNL, TLM	B		–	12.5
LAUTO_BFLAMP	Left auto body flap lamp	D&C_PNL, TLM	B		–	12.5
RAUTO_BFLAMP	Right auto body flap lamp	D&C_PNL, TLM	B		–	12.5
LMNL_BFLAMP	Left manual body flap lamp	D&C_PNL, TLM	B		–	12.5
RMNL_BFLAMP	Right manual body flap lamp	D&C_PNL, TLM	B		–	12.5
LAUTO_SBLAMP	Left auto speed brake lamp	D&C_PNL, TLM	B		–	12.5
RAUTO_SBLAMP	Right auto speed brake lamp	D&C_PNL, TLM	B		–	12.5
MNLSB_CMDR_0	Commander's manual speed brake lamp	D&C_PNL, TLM	B		–	12.5

Table 4.2.4-2. ASC_RECON Interface Requirements						
Name	Description	Source or Destination	Type	Range	Units	Rate Required/Produced At (Hz)
MNLSB_PLT_0	Pilot's manual speed brake lamp	D&C PNL, TLM	B		–	12.5
SRBSEP	Indicator, SRB separation subphase	GC_STEER	B		–	12.5
SSME_FAILS	Indicator, SSME failure status	CMD_PROC_MPS, INTERPS, GC STEER, XXXXXX TRAJ 1 DISP, XXXXXX TRAJ 2 DISP, RTLS TRAJ 2 DISP	I	0-7	–	12.5
FILTSW	Indicator, TVC filter coefficient switching	ASC_TVC	B		–	12.5
YFILTSW	Indicator, yaw filter coefficient switching	ASC_TVC	B		–	12.5
NNYFILTSW	Indicator, NNY yaw filter coefficient switching	ASC_TVC	B		–	12.5
PARALLEL_PITCH	Indicator, parallel pitch thrust	CMD_PROC_MPS	B		–	12.5
UNPARALLEL_YAW	Indicator, unparallel yaw thrust	CMD_PROC_MPS	B		–	12.5
MECO_CMD	Indicator, initiate MECO command	CMD_PROC_MPS	B		–	12.5
MM101_INIT	Indicator, MM101 startup	INTERPS, AEROSURFACE_CONTROL, ASC_TVC, CMD_PROC_MPS, CMD_PROC_SRB, GC_STEER	B		–	12.5
LIFTOFF	Indicator, nominal vehicle liftoff	CMD_PROC_MPS CMD_PROC_SRB	B		–	12.5
AUTOTRIM_RESET	Indicator, ramp autotrim integrators to zero	CMD_PROC_MPS, ASC_TVC, INTERPS	B		–	12.5
SSME_START_POS	Indicator, SSME start position	CMD_PROC_MPS	B		–	12.5
PRL_MECO	Indicator, PRL lamps reduced	CMD_PROC_MPS	B		–	12.5
PRL_S2	Indicator, rate limit for Stage 2	CMD_PROC_MPS	B		–	12.5

Table 4.2.4-2. ASC_RECON Interface Requirements

Name	Description	Source or Destination	Type	Range	Units	Rate Required/ Produced At (Hz)
PRL_S1	Indicator, rate limit for Stage 1	CMD_PROC_MPS	B		–	12.5
TWR_CLR_BIAS	ME 2 failed at lift-off prior to LO-plus-T2	ASC_TVC	B		–	12.5
SSME_LCH_POS	Indicator, retrim engines to launch position	CMD_PROC_MPS	B		–	12.5
STOW_SB	Indicator, stow speed brake to closed position	AEROSURFACE_CONTROL	B		–	12.5
AUTOTRIM_QR	Indicator, enable pitch and yaw autotrim	ASC_TVC	B		–	12.5
SRBLIM_ACTV	SRB limiting active	CMD_PROC_SRB	B		–	12.5
ELEV_LR	Elevon load relief indicator	AEROSURFACE_CONTROL, GC_STEER	B		–	12.5
PRE_SEP	Indicator, PRE_SEP phase	INTERPS, ASC_TVC, CONT 3E/O GUID	B		–	12.5
SRB_SEP_CMD	Indicator, SRB separation initiated	INTERPS	B		–	12.5
FAIL_MIX_ENABLE	Indicator, enable main engine mixing logic changes for engine failures	CMD_PROC_MPS	B		–	12.5
ME_SLEW	Indicator, main engine actuator slew test	CMD_PROC_MPS, AEROSURFACE_CONTROL	B		–	12.5
SRB_SLEW	Indicator, SRB actuator slew test	CMD_PROC_SRB, AEROSURFACE_CONTROL	B		–	12.5
AERO_SLEW	Indicator, aerosurface actuator slew test	AEROSURFACE_CONTROL	B		–	12.5
RTLS_TURN	Indicator, RTLS turn-around maneuver	GC_STEER	B		–	12.5
PRL_LCH	Indicator, lower rate-limiting	CMD_PROC_MPS	B			12.5
SEC_ME_FL_CNFM	Second SSME fail confirm discrete	MSC, ABT_CTL_SEQ, CMD_PROC_MPS, ASC_TVC, GC STEER	B		–	12.5 12.5 12.5
GRAV_POS	Indicator, SSME gravity position	CMD_PROC_MPS	B		–	12.5

Table 4.2.4-2. ASC_RECON Interface Requirements						
Name	Description	Source or Destination	Type	Range	Units	Rate Required/Produced At (Hz)
ENA_RCS_CNTL	Enable RCS control discrete	CMD_PROC_RCS, XXXXXX TRAJ 1 DISP, XXXXXX TRAJ 2 DISP, RTLS TRAJ 2 DISP, CMD_PROC_MPS, TLM	B		-	12.5
PRELO	Indicator	AEROSURFACE_CONTROL	B		-	12.5
ZTRANS	Indicator, RTLS external tank separation maneuver	GC_STEER	B		-	12.5
QBI_READY	Indicator, Body wrt M50 quaternion ready for use in STG 1	GC_STEER	B	0,1	-	12.5
FADE_ELEVONS	Indicator, fade elevons to null	AEROSURFACE_CONTROL	B		-	12.5
GOOD_SSME	Number of good SSMEs	INTERPS	I		-	12.5
AUTO_2ND_OUT	Auto recognition of second engine out indicator	TLM, XXXXXX TRAJ 2 DISP, RTLS TRAJ 2 DISP	B		-	12.5
CONT_SERC	Contingency single engine roll control flag	ABT CNTL SEQ, XXXXXX TRAJ 1 DISP, XXXXXX TRAJ 2 DISP, RTLS TRAJ 2 DISP, MSC, TLM, GC STEER, ASC_TVC, ASC 2STG GUID	B		-	12.5
NYSEP_DISABLE	Indicator, Event 25E	ASC 1STG GUID	B		-	12.5
MET	Mission elapsed time	INTERPS	S		sec	6.25

Table 4.2.4-3. Definition of Local Events Used for ASC_DAP and GC_STEER Reconfiguration		
Local Event Name	Event No.	Condition Under Which Event is "ON"
MM101_INIT	1	TRANSITION_TO_OPS_1
RECYCLE_COUNT	3	A_D_RECYCLE_COUNT
RECYCLE_DURING_ME_SLEW	3A	RECYCLE_COUNT • ME_SLEW
AERO_SLEW_BEGIN	4A	AEROSURFACE_SLEW_CHECK_INDICATOR
AERO_SLEW_COMPLETE	4B	AEROSURFACE_SLEW_COMPLETE_FLAG
ME_SLEW_BEGIN	5	MPS_GIMBAL_SLEW_CHECK_INDICATOR
ME_SLEW_COMPLETE	5A	MPS_SLEW_CHECK_COMPLETE
STOW_SB	6	RS_AUTO_SEQ_START
SRB_HYD_VERIFY	8	SRB_FCS_HYD_VERIFICATION
SRB_SLEW_COMPLETE	8A	SRB_FCS_HYD_VERIFY_COMPLETE
QBI_READY	11B	QBI_VALID
SSME_LCH_POS	18A	PREP_SSMES_FOR_LIFTOFF
ME_RESTART_POS	20	RETURN_SSME_TO_START_POS
SRB_IGN_CMD	19	SRB_IGNITION_CMD*
LIFTOFF	19A	MET ≥ MET_LIFTOFF
LO_PLUS_T2	19B	MET ≥ MET_LIM_LCH
RL_NOM	19C	MET ≥ (18A + MET_90THRUST)
AUTOTRIM_DISABLE	21A	REL_VEL_MAG ≥ VREL_AUTOTRIM_INHIBIT
FILTSW	21B	REL_VEL_MAG ≥ VREL_FILTSW
YFILTSW	21C	REL_VEL_MAG ≥ VREL_YFILTSW
NNYFILTSW	21D	REL_VEL_MAG ≥ VREL_NNYFILTSW
FADE_ELEVONS	24A	MET ≥ MET_25A - [(32+1)/6.25 HZ]**
PRE_SEP	25A	MET ≥ MET_25A
AUTOTRIM_RESET	25B	PRE_SEP • [(PC4F < PC_TRIM_RESET) • (PC5F < PC_TRIM_RESET)] + MET ≥ MET_25B
COMLIM4	25C	(AUTOTRIM_RESET) • (PC4F < PC_COMLIM)
COMLIM5	25D	(AUTOTRIM_RESET) • (PC5F < PC_COMLIM)
NYSEP_DISABLE	25E	(COMLIM4) • (COMLIM5) + (MET ≥ MET_25E)

Table 4.2.4-3. Definition of Local Events Used for ASC_DAP and GC_STEER Reconfiguration		
Local Event Name	Event No.	Condition Under Which Event is "ON"
SRB_NULL_CMD	27	SRB_MODING_SEP
SRB_SEP_CMD	28 + A30	SRB_SEP_CMD_FLAG
STG2_STEER_INIT	29 + A31A	GUIDANCE_INITIATE
AUTOTRIM_ENABLE	29A	$(SRB_SEP_CMD) \cdot [\overline{SEC_ME_FL_CNFM} \cdot (MET > (MET_SRB_SEP + DELTAT_AUTOTRIM_ENABLE)) + SEC_ME_FL_CNFM \cdot (MET > (MET_SRB_SEP + 60))]$ ①
ME_RETRIM	30A	S_SSME_TRIM
MECO_CMD	32+A35	MECO_COMMAND + MECO_COMMAND (MM601) ②
ME_ZERO_THRUST	33B+A36A	ME_ZERO (Events 33B OR A36A)
PPD_INIT	A34	S_PPD_QUAT
RTLS_ET_SEP_CMD	A37	EVENT_A37
RTLS_TURN_LIMIT	A30A	S_RTLS_TURN
MM_602	A39	MM_CODE_602

*Equivalently set, MET = 0
 **Value (32) is initialization value of ELEVON_SLAVING inboard fader count.

NOTE

① MET_SRB_SEP is a snapshot of MET at SRB_SEP_CMD which must be performed before AUTOTRIM_ENABLE is set.

② Initialization specified to occur at MECO_CMD will only be performed if SRB_SEP_CMD has occurred with the exception of SSME_FAILS. SSME_FAILS will not be reset after MECO_CMD regardless of when it occurs.

Table 4.2.4-4A. Definition of ASC_DAP and GC_STEER Boolean Reconfiguration Indicators				
Indicator Name	Definition of "ON" State			
	From		To	
	Event No.	Local Event Name	Event No.	Local Event Name
AERO_SLEW	4A	AERO_SLEW_BEGIN	4B	AERO_SLEW_COMPLETE
ATTCMD	1	MM101_INIT	28	SRB_SEP_CMD
	1	MM101_INIT	A30	SRB_SEP_CMD
	A34	PPD_INIT	A39	MM_602
ATTFILT	1	MM101_INIT	19A•S_QUAT	LIFTOFF_AND_S_QUAT
AUTOTRIM_P	29A	AUTOTRIM_ENABLE	32	MECO_CMD
	29A	AUTOTRIM_ENABLE	A35	MECO_CMD
AUTOTRIM_QR	19B	LO_PLUS_T2	21A	AUTOTRIM_DISABLE
	29A	AUTOTRIM_ENABLE	32	MECO_CMD
	29A	AUTOTRIM_ENABLE	A35	MECO_CMD
FRZCMD	28	SRB_SEP_CMD	29	STG2_STEER_INIT
	28	SRB_SEP_CMD	A31A	STG2_STEER_INIT
	A30	SRB_SEP_CMD	A31A	STG2_STEER_INIT
	32 • A34	MECO_CMD_AND_NOT_PPD_INIT	33B	ME_ZERO_THRUST
INTERPS_S1	19A	LIFTOFF	28	SRB_SEP_CMD
	19A	LIFTOFF	A30	SRB_SEP_CMD
ME_SLEW	5	ME_SLEW_BEGIN	5A	ME_SLEW_COMPLETE
PARALLEL_PITCH_ENABLE	29A	AUTOTRIM_ENABLE	32	MECO_CMD
	29A	AUTOTRIM_ENABLE	A35	MECO_CMD
PC_FILTER	25A	PRE_SEP	27	SRB_NULL_CMD
PEGCMD	29	STG2_STEER_INIT	32 • A34	MECO_CMD_AND_NOT_PPD_INIT
	29	STG2_STEER_INIT	A34	PPD_INIT
	A31A	STG2_STEER_INIT	A34	PPD_INIT
PPD	A34	PPD_INIT	A37	RTLS_ET_SEP_CMD
			*A36A	*ME_ZERO_THRUST
PRELO (= S1C•S2C)	1	MM101_INIT	19A	LIFTOFF
PRL_LCH	1	MM101_INIT	19C	RL_NOM

Table 4.2.4-4A. Definition of ASC_DAP and GC_STEER Boolean Reconfiguration Indicators				
Indicator Name	Definition of "ON" State			
	From		To	
	Event No.	Local Event Name	Event No.	Local Event Name
S1C	19A	LIFTOFF	28	SRB_SEP_CMD
	19A	LIFTOFF	A30	SRB_SEP_CMD
S2C	28	SRB_SEP_CMD	33B	ME_ZERO_THRUST
	28	SRB_SEP_CMD	A36A	ME_ZERO_THRUST
	A30	SRB_SEP_CMD	A36A	ME_ZERO_THRUST
INTERPS_S2	28	SRB_SEP_CMD	33B	ME_ZERO_THRUST
	28	SRB_SEP_CMD	A36A	ME_ZERO_THRUST
	A30	SRB_SEP_CMD	A36A	ME_ZERO_THRUST
SIG	19A•S_QUAT	LIFTOFF_AND_S_QUAT	29	STG2_STEER_INIT
	19A•S_QUAT	LIFTOFF_AND_S_QUAT	A31A	STG2_STEER_INIT
SRBLIM_ACTV	1	MM101_INIT	19B	LO_PLUS_T2
SRBSEP	28	SRB_SEP_CMD	29	STG2_STEER_INIT
	28	SRB_SEP_CMD	A31A	STG2_STEER_INIT
	A30	SRB_SEP_CMD	A31A	STG2_STEER_INIT
SRB_SLEW	8	SRB_HYD_VERIFY	8A	SRB_SLEW_COMPLETE
FAIL_MIX_ENABLE	25A	PRE_SEP	33B	ME_ZERO_THRUST
	25A	PRE_SEP	A36A	ME_ZERO_THRUST
UNPARALLEL_YAW_ENABLE	25B	AUTOTRIM_RESET	32	MECO_CMD
	25B	AUTOTRIM_RESET	A35	MECO_CMD
PRL_S1	19C	RL_NOM	28	SRB_SEP_CMD
	19C	RL_NOM	A30	MECO_CMD
PRL_S2	28	SRB_SEP_CMD	32	MECO_CMD
	28	SRB_SEP_CMD	A35	MECO_CMD
	A30	SRB_SEP_CMD	A35	MECO_CMD
PRL_MECO	32	MECO_CMD	33B	ME_ZERO_THRUST
	A35	MECO_CMD	A36A	ME_ZERO_THRUST
ELEV_LR	19B	LO_PLUS_T2	25A	PRE_SEP

Table 4.2.4-4A. Definition of ASC_DAP and GC_STEER Boolean Reconfiguration Indicators				
Indicator Name	Definition of "ON" State			
	From		To	
	Event No.	Local Event Name	Event No.	Local Event Name
NYSEP_FB_ENABLE	25A	PRE_SEP	25E	NYSEP_DISABLE
S2G	29	STG2_STEER_INIT	$32 \cdot \overline{A34}$	MECO_CMD_AND_NOT_PPD_INIT
	29	STG2_STEER_INIT	A34	PPD_INIT
	A31A	STG2_STEER_INIT	A34	PPD_INIT
RTLS_TURN	A30A	RTLS_TURN_INIT	A34	PPD_INIT
ZTRANS	A37	RTLS_ET_SEP_CMD	A39	MM_602
SNGL_ME_CNTL_ENABLE	25B	AUTOTRIM_RESET	$33B + A35$	ME_ZERO_THRUST + MECO_CMD
INHIBIT_START_POS	3A	RECYCLE_DURING_ME_SLEW	5	ME_SLEW_BEGIN ¹
¹ Start of ME_SLEW, if any, after the one in progress at time of recycle count			* TLM COPY ONLY	

Table 4.2.4-4B. Definition of ASC_DAP and GC_STEER Complex Boolean Reconfiguration Indicators	
Indicator Name	Definition of "ON" Stage
DETENT AUTO	$[RHC_STATE(1) = 0] \cdot [RHC_STATE(2) = 0] \cdot [RHC_STATE(3) = 0]$ $\overline{LIFTOFF} + \{[(AUTOP + AUTORY) + AUTO \cdot (\overline{CSSP + CSSRY})] \cdot$ $(\overline{FAST_SEP_FLAG})\} + \{[(AUTOP + AUTORY + AUTO) \cdot$ $(\overline{CSSP + CSSRY})] \cdot (DETENT) \cdot (FAST_SEP_FLAG)\}$
⑦ PARALLEL_ PITCH	$[PARALLEL_PITCH_ENABLE] \cdot [(SSME_FAILS = 2 \text{ OR } 3) +$ $(SSME_FAILS = 0) \cdot (PARALLEL_PITCH_NOM)]$
UNPARALLEL_ YAW	$(SSME_FAILS = 2 \text{ or } 3) \cdot (UNPARALLEL_YAW_ENABLE) +$ $HYD_FAILS > 0 + UNPARALLEL_YAW$
TWR_CLR_BIAS	$LIFTOFF \cdot \overline{LO_PLUS_T2} \cdot (ME2_FAIL_SHUTDOWN = ON)$
⑥ SSME_START_ POS	$[(ME_RESTART_POS \cdot \overline{GRAV_POS})] + [(\overline{ME_SLEW}) \cdot (SSME_LCH_POS)] \cdot$ $[(ME_SLEW_COMPLETE) \cdot \overline{INHIBIT_START_POS} +$ $(RS_AUTO_SEQ_START)]$
② TWO_SSME_ FAIL	⑤ $(SNGL_ME_CNTL_ENABLE) \cdot [(SSME_FAILS \geq 4) \cdot (\overline{SRB_SEP_CMD}) +$ $(SSME_FAILS \geq 4) \cdot (SRB_SEP_CMD) \cdot (\overline{MECO_CONFIRM})]$
⑥ GRAV_POS	$(RECYCLE_COUNT \cdot \overline{ME_SLEW} + INHIBIT_START_POS)$
③ SEC_ME_ FL_CNFM	$[MET > (MET_TWO_SSME_FAIL + MM_DL)] \cdot (TWO_SSME_FAIL) +$ $SEC_ME_FL_CNFM$
④ ENA_RCS_CNTL	$[MET > (MET_TWO_SSME_FAIL + ORI_DL)] \cdot (SEC_ME_FL_CNFM) \cdot$ $(SNGL_ME_CNTL_ENABLE) + [MET > (MET_CONT_SERC + ORI_DL)] \cdot$ $(SNGL_ME_CNTL_ENABLE) \cdot (CONT_SERC)$

Table 4.2.4-4B. Definition of ASC_DAP and GC_STEER Complex Boolean Reconfiguration Indicators

- ① Deleted
- ② In first stage, this indicates that 2 engines are in shutdown phase during the RCS control enable window. In second stage, it indicates that 2 engines (and not the third) have shut down during the enable window. It starts a time which allows time for a 3 sigma slow engine to reach 30 percent thrust.
- ③ DAP initiates abort control sequencer to interconnect OMS and RCS propellant systems, starts the RCS Command SOP, and disables roll commands to the SSME TVC.
- ④ Initiates commanding of RCS jets by CMD_PROC_RCS.
- ⑤ This allows RCS roll control.
- ⑥ If a recycle count is done, gravity positions are to be used. If the ME_SLEW is active at the time the recycle count is done, care must be taken to ensure use of gravity positions instead of start at completion of the slew. (This is the purpose of INHIBIT_START_POS.) When a pad shutdown is done, start positions are to be used until SSMEprevalve closure is complete, after which gravity positions are to be used.
- ⑦ The discrete PARALLEL_PITCH_NOM will be latched to “off” by the ASC_RECON if the hydraulic system fail indicator HYD_FAILS > 0. (In other words, for no hydraulic system fails and PARALLEL_PITCH_NOM enabled for the 3-engine burning case, PARALLEL_PITCH will be allowed, otherwise not).

NOTES • Logical “and” + Logical “or” $\overline{\text{XXXXX}}$ Logical “not”

Table 4.2.4-4C. Definition of ASC_DAP and GC_STEER Integer Recognition Indicators		
Indicator Name	Integer Values	Condition for Integer Value
HYD_FAILS	0	No hydraulic system failures
	1	HYDR_SYS1_TVC_FAIL_STATUS=ON
	2	HYDR_SYS2_TVC_FAIL_STATUS=ON
	3	HYDR_SYS3_TVC_FAIL_STATUS=ON
	4	Hydraulic System 1 and 2 failed resulting in SSME 2 lockup
	5	Hydraulic System 1 and 3 failed resulting in SSME 1 lockup
	6	Hydraulic System 2 and 3 failed resulting in SSME 3 lockup
SSME_FAILS ①	0	No SSME failures
	1	$(ME1_FAIL_SHUTDOWN=ON) \cdot \overline{MECO_CMD} \cdot SRB_IGN_CMD$
	2	$(ME2_FAIL_SHUTDOWN=ON) \cdot \overline{MECO_CMD} \cdot SRB_IGN_CMD$
	3	$(ME3_FAIL_SHUTDOWN=ON) \cdot \overline{MECO_CMD} \cdot SRB_IGN_CMD$
	4	$(ME1_FAIL_SHUTDOWN=ON) \cdot (ME2_FAIL_SHUTDOWN=ON) \cdot \overline{MECO_CMD}$
	5	$(ME1_FAIL_SHUTDOWN=ON) \cdot (ME3_FAIL_SHUTDOWN=ON) \cdot \overline{MECO_CMD}$
	6	$(ME2_FAIL_SHUTDOWN=ON) \cdot (ME3_FAIL_SHUTDOWN=ON) \cdot \overline{MECO_CMD}$
	7	$(ME1_FAIL_SHUTDOWN=ON) \cdot (ME2_FAIL_SHUTDOWN=ON) \cdot (ME3_FAIL_SHUTDOWN=ON) \cdot \overline{MECO_CMD}$
GOOD_SSME	3	No SSME failures
	2	$(SSME_FAILS = 1) + (SSME_FAILS = 2) + (SSME_FAILS = 3)$
	1	$(SSME_FAILS = 4) + (SSME_FAILS = 5) + (SSME_FAILS = 6)$
	0	$(SSME_FAILS = 7)$
	① A value of SSME_FAILS = 7 is currently not possible, as the SSME OPS sets MECO_CMD when it sets all three ME fail flags to ON.	

Table 4.2.4-5. ASC_RECON Initialization Requirements

Module	Component	Initialize on Transition		Variable	Initial Value
		From	To		
ASC_RECON	Boolean local events	-	MM101_INIT	ORB_HYD_VERIFY	OFF
				RECYCLE_COUNT	OFF
				AERO_SLEW_COMPLETE	OFF
				RECYCLE_DURING_ME_SLEW	OFF
				ME_SLEW_BEGIN	OFF
				ME_SLEW_COMPLETE	OFF
				SRB_HYD_VERIFY	OFF
				SRB_SLEW_COMPLETE	OFF
				LAUNCH_HOLD	OFF
				LAUNCH_RESTART	OFF
				SSME_LCH_POS	OFF
				ME_RESTART_POS	OFF
				SRB_IGN_CMD	OFF
				LIFTOFF	OFF
				PRL_S1	OFF
				PRL_S2	OFF
				AUTOTRIM_DISABLE	OFF
				FILTSW	OFF
				YFILTSW	OFF
				NNYFILTSW	OFF
				AUTOTRIM_RESET	OFF
				COMLIM4	OFF
				COMLIM5	OFF
				NYSEP_DISABLE	OFF
				SRB_NULL_CMD	OFF
				SRB_SEP_CMD	OFF
				STG2_STEER_INIT	OFF
				AUTOTRIM_ENABLE	OFF
				QBI_READY	OFF
				ME_RETRIM	OFF
SRBLIM_ACTV	ON				

Table 4.2.4-5.ASC_RECON Initialization Requirements					
Module	Component	Initialize on Transition		Variable	Initial Value
		From	To		
ASC_RECON (Cont.)	Boolean reconfiguration indicators (Cont.)	-	MM101_INIT	AUTOTRIM_QR	OFF
				FRZCMD	OFF
				SSME_START_POS	OFF
				INTERPS_S1	OFF
				INTERPS_S2	OFF
				ME_SLEW	OFF
				PARALLEL_PITCH_ENABLE	OFF
				PC_FILTER	OFF
				PEGCMD	OFF
				PPD	OFF
				ZTRANS	OFF
				SNGL_ME_CNTL_ENABLE	OFF
				PRL_LCH	ON
				RTLS_TURN	OFF
				S1C	OFF
				S2C	OFF
				S1G	OFF
				S2G	OFF
				SRBSEP	OFF
				SRB_SLEW	OFF
				ELEV_LR	OFF
				NYSEP_FB_ENABLE	OFF
				FAIL_MIX_ENABLE	OFF
				UNPARALLEL_YAW_ENABLE	OFF
				AUTO	ON
				GRAV_POS	OFF
				PARALLEL_PITCH	OFF
				INHIBIT_START_POS	OFF
				UNPARALLEL_YAW	OFF
				HYD_FAILS	0
SSME_FAILS	0				

Table 4.2.4-5.ASC_RECON Initialization Requirements					
Module	Component	Initialize on Transition		Variable	Initial Value
		From	To		
ASC_RECON (Cont.)	Boolean reconfiguration indicators (Cont.)	–	MM101_INIT	GOOD_SSME	3
				AUTO_2ND_OUT	OFF
				I	0
			FPASS	ON	
		HYD_FAILS = 0	HYD_FAILS = 0	PARALLEL_PITCH_NOM	OFF
				UNPARALLEL_YAW	ON
	Slew phase indicators	AERO_SLEW_BEGIN	AERO_SLEW_BEGIN	AERO_SLEW	ON
		AERO_SLEW_COMPLETE	AERO_SLEW_COMPLETE	AERO_SLEW	OFF
		ME_SLEW_BEGIN • ME_RESTART_POS	ME_SLEW_BEGIN • ME_RESTART_POS	ME_SLEW	ON
		ME_SLEW_COMPLETE	ME_SLEW_COMPLETE	ME_SLEW	OFF
		ME_RESTART_POS	ME_RESTART_POS	ME_SLEW	OFF
		SRB_HYD_VERIFY	SRB_HYD_VERIFY	SRB_SLEW	ON
		SRB_SLEW_COMPLETE	SRB_SLEW_COMPLETE	SRB_SLEW	OFF
		Main engine position indicators	ME_SLEW • SSME_LCH_POS • INHIB_START_POS	ME_SLEW • SSME_LCH_POS • INHIBIT_START_POS	SSME_START_POS
	RS_AUTO_SEQ_START		RS_AUTO_SEQ_START	SSME_START_POS	ON
	SSME_LCH_POS		SSME_LCH_POS	SSME_START_POS	OFF
	RECYCLE_COUNT • ME_SLEW		RECYCLE_COUNT • ME_SLEW	GRAV_POS	ON
	ME_SLEW • INHIBIT_START_POS • SSME_LCH_POS		ME_SLEW • INHIBIT_START_POS • SSME_LCH_POS	GRAV_POS	ON
	ME_RESTART_POS		ME_RESTART_POS	SSME_LCH_POS	OFF
				SSME_START_POS	ON

Table 4.2.4-5.ASC_RECON Initialization Requirements

Module	Component	Initialize on Transition		Variable	Initial Value
		From	To		
ASC_RECON (Cont.)	Main engine position indicators (Cont.)	$\overline{\text{ME_SLEW}} \cdot \overline{\text{SSME_LCH_POS}}$	$\overline{\text{ME_SLEW}} \cdot \overline{\text{SSME_LCH_POS}}$	SSME_START_POS	OFF
				GRAV_POS	OFF
				RECYCLE_DURING_ME_SLEW	OFF
				LAUTO_PLAMP	OFF
	Display panel Boolean indicators	AUTO	$\overline{\text{AUTO}}$	RAUTO_PLAMP	OFF
				LAUTO_RYLAMP	OFF
				RAUTO_RYLAMP	OFF
				LCSS_PLAMP	ON
				RCSS_PLAMP	ON
				LCSS_RYLAMP	ON
				RCSS_RYLAMP	ON
				$\overline{\text{AUTO}}$	AUTO
		RCSS_PLAMP	OFF		
		LCSS_RYLAMP	OFF		
		RCSS_RYLAMP	OFF		
		LAUTO_PLAMP	ON		
		RAUTO_PLAMP	ON		
		LAUTO_RYLAMP	ON		
		RAUTO_RYLAMP	ON		
		$\overline{\text{SRB_SEP_CMD}}$	SRB_SEP_CMD	MET_SRB_SEP	MET
$\overline{\text{TWO_SSME_FAIL}}$	TWO_SSME_FAIL	MET_TWO_SSME_FAIL	MET		
$\overline{\text{MECO_CMD}} \cdot \overline{\text{SRB_SEP_CMD}}$	MECO_CMD • $\overline{\text{SRB_SEP_CMD}}$	CONT_SERC	ON		
$\overline{\text{CONT_SERC}}$	CONT_SERC ③	MET_CONT_SERC	MET		
$\overline{\text{ME_ZERO_THRUST}}$	ME_ZERO_THRUST	LAUTO_SBLAMP	OFF		
		RAUTO_SBLAMP	OFF		
		MNLSB_CMDR_Q	OFF		
		MNLSB_PLT_Q	OFF		

Table 4.2.4-5.ASC_RECON Initialization Requirements					
Module	Component	Initialize on Transition		Variable	Initial Value
		From	To		
ASC_RECON (Cont.)	Display panel Boolean indicators (Cont.)	$\overline{(\text{TAL_ABORT_DECLARED} \bullet \text{SSME_STOW_COMPLETE} \bullet \text{OPS_6_IND})} + (\text{TAL_ABORT_DECLARED} \bullet \text{MPS_LO2_DUMP_STOP})$	$\overline{(\text{TAL_ABORT_DECLARED} \bullet \text{SSME_STOW_COMPLETE} \bullet \text{OPS_6_IND})} + (\text{TAL_ABORT_DECLARED} \bullet \text{MPS_LO2_DUMP_STOP})$	LAUTO_BFLAMP RAUTO_BFLAMP	OFF OFF
		$\overline{\text{ME_ZERO_THRUST} \bullet \text{OPS_6_IND}}$	$\overline{\text{ME_ZERO_THRUST} \bullet \text{OPS_6_IND}}$	LAUTO_PLAMP RAUTO_PLAMP LAUTO_RYLAMP RAUTO_RYLAMP LCSS_PLAMP RCSS_PLAMP LCSS_RYLAMP RCSS_RYLAMP	OFF OFF OFF OFF OFF OFF OFF OFF
		$\overline{\text{RECYCLE_COUNT}}$	RECYCLE_COUNT ①	RS_AUTO_SEQ_START ME_SLEW_COMPLETE STOW_SB RECYCLE_COUNT ②	OFF OFF OFF OFF

① Causes ME to move to gravity and SB to DSB_BIAS_SLEW.
 ② RECYCLE_COUNT is turned off after all other initializations are done.
 ③ Only perform this initialization once.

Table 4.2.4-6.ASC_RECON I-Loads					
Module	Name	Description	Type	MSID	Units
ASC_RECON	VREL_AUTOTRIM_INHIBIT	Velocity during STG 1 above which pitch and yaw autotrim functions are inhibited	S	V97U2275C	ft/s
	MET_LIFTOFF	Nominal mission elapsed time of liftoff	S	V97U2061C	sec
	DELTAT_AUTOTRIM_ENABLE	Time relative to SRB_SEP_CMD after which roll, pitch, and yaw autotrim functions are enabled	S	V98U9809C	sec
	MET_LIM_LCH	MET (post-liftoff) at which SRB limits are raised to nominal values	S	V97U2062C	sec
	VREL_FILTSW	VREL at which TVC filters are switched	S	V97U2284C	ft/s
	VREL_YFILTSW	VREL at which yaw filters are switched	S	V99U9597C	ft/s
	VREL_NNYFILTSW	VREL at which NNY filters are switched	S	V99U9668C	ft/s
	PC_COMLIM	Value of filtered SRB chamber pressure at which vector limiting is activated for that SRB	S	V97U2203C	psi
	PC_TRIM_RESET	Minimum value of filtered SRB chamber pressures at which integrators are ramped to null	S	V97U2202C	psi
	MM_DL	Time delay to allow for manual MECO before setting SEC_ME_FL_CNFM flag	S	V97U2403C	sec
	MET_90THRUST	Time from SSMEs at 90% thrust when SSME rate limits changed to normal	S	V97U2487C	sec
	MET_25A	Event 25A time	S	V97U2435C	sec
	MET_25B	Backup time for E25B	S	V97U2436C	sec
	MET_25E	Backup time for E25E	S	V97U2437C	sec
	ORI_DL	Time delay to permit OMS to RCS switching	S	V97U1362C	sec
	PARALLEL_PITCH_NOM	Discrete indicating SSME pitch paralleling is allowed for all three SSMEs burning	D	V99U7557C	ND
	ACCEL_COEF	Acceleration coefficient used in determining threshold for auto engine out recognition	S	V99U7677C	ND
	ACC_THR_CNTR	Acceleration threshold counter. Number of consecutive passes of low acceleration required before triggering AUTO_2ND_OUT flag	S	V99U7678C	ND
	FT_SSME	Nominal SSME thrust level	S	V97U4392C	LBF

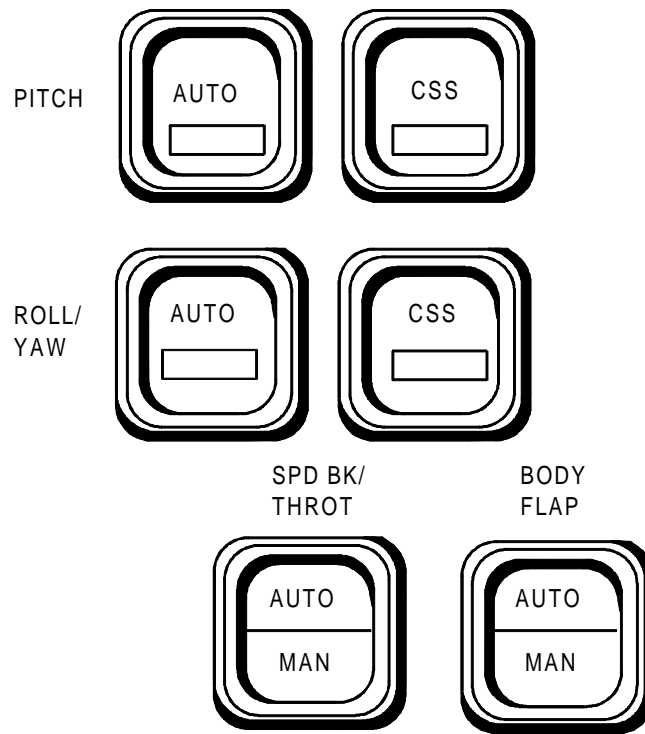


FIGURE 4.2.4-1. Mode Panel Switches and Pushbutton Indicators Affecting ASC_DAP and GC_STEER

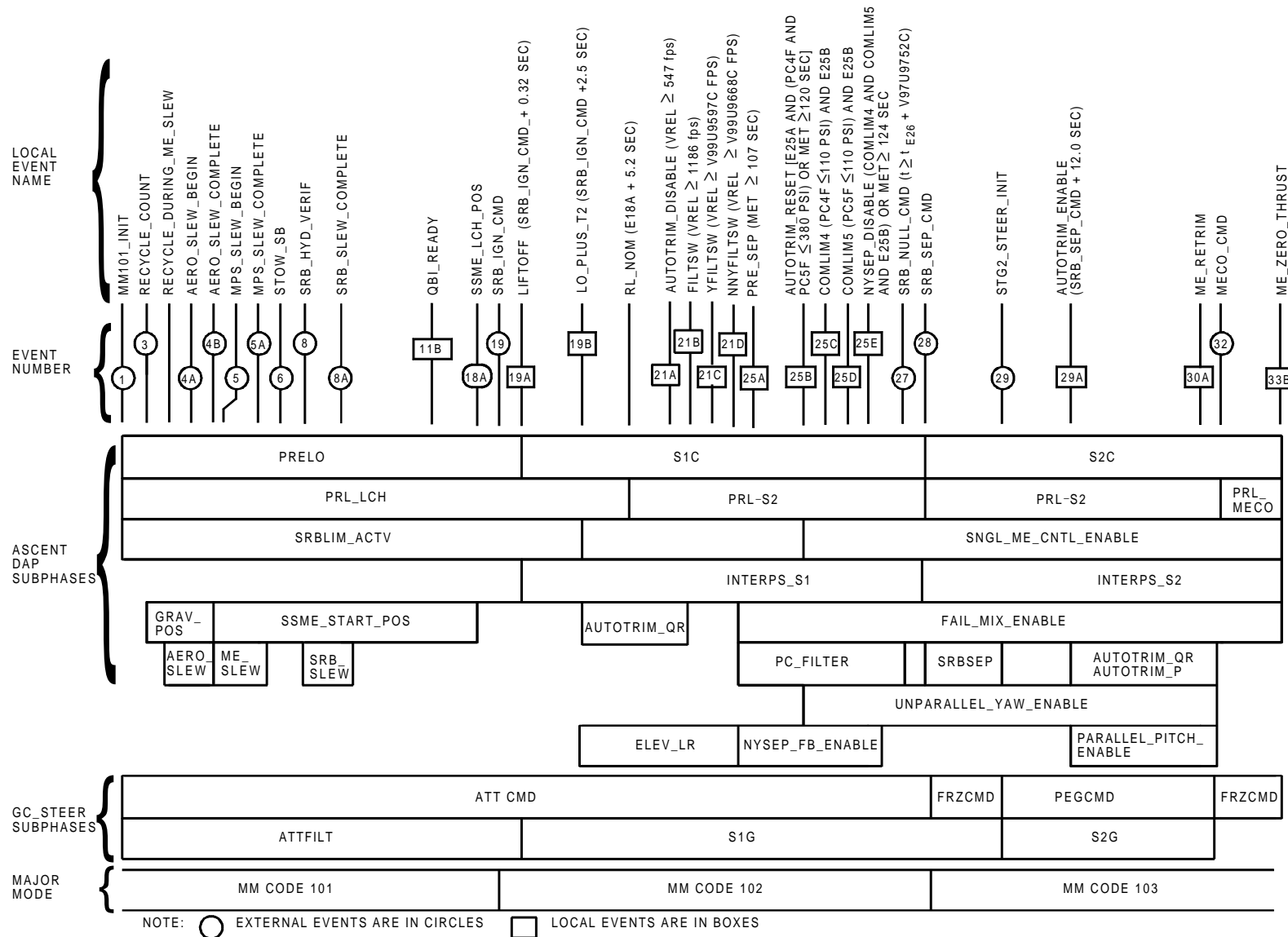


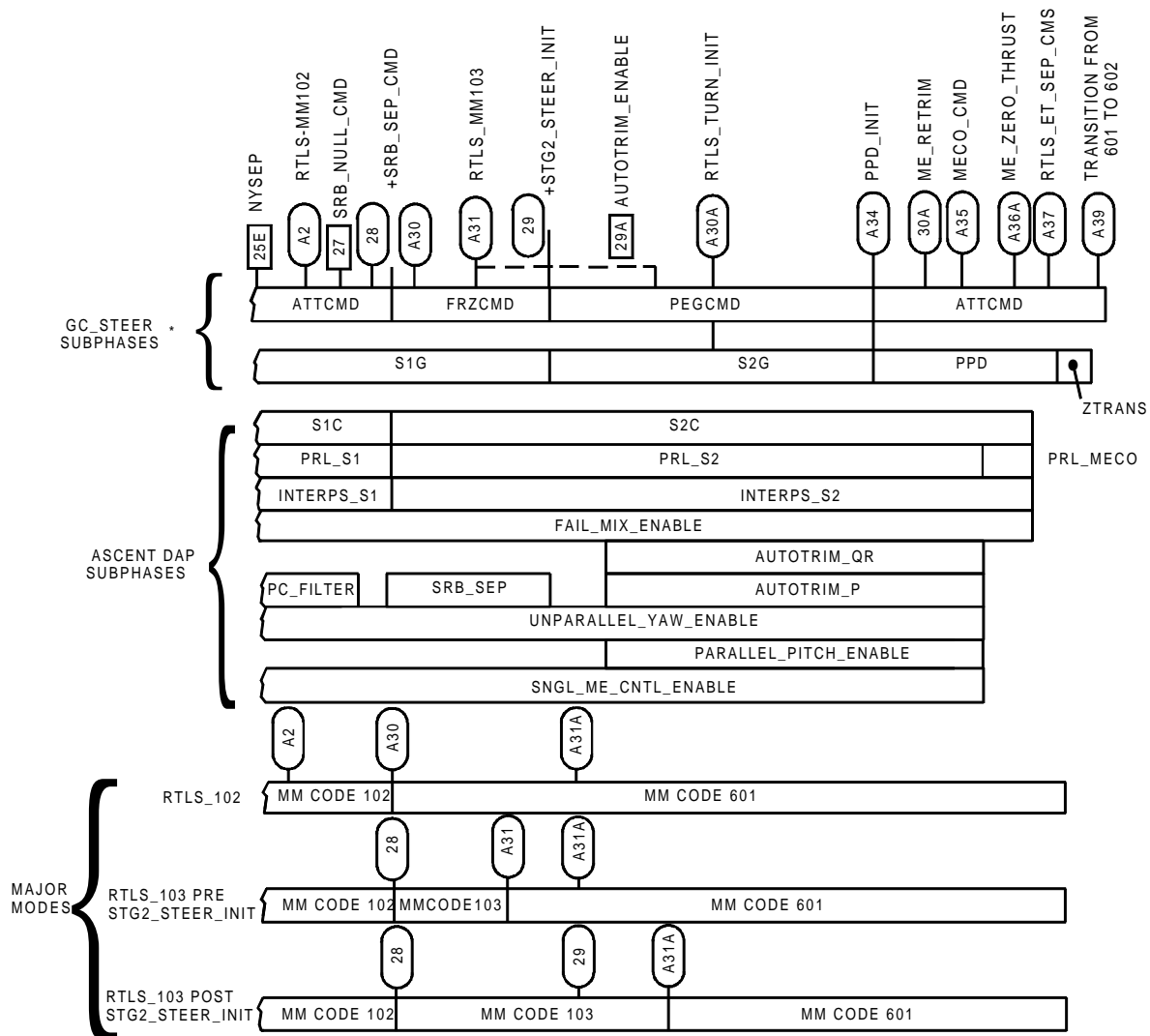
FIGURE 4.2.4-2. ASC_DAP and GC_STEER Subphases, Nominal Mission

PRE-E19 INITIAL CONDITIONS:				
PRELO, S1C, S2C; INTERPS_S1, INTERPS_S2; S1G, S2G, ATTFILT, ATTCMD, FRZCMD, PEGCMD; PRL_LCH, PRL_S1, PRL_S2, PRL_MECO; SRBLIM_ACTV; AUTOTRIM_QR, AUTOTRIM_P; AUTOTRIM_RESET; ELEV_LR; FILTSW, FAIL_MIX_ENABLE; PC_FILTER; NYSEP_FB_ENABLE; COMLIM4, COMLIM5; UNPARALLEL_YAW_ENABLE, PARALLEL_PITCH_ENABLE; AUTO; RTLS_TURN; SRBSEP; TWR_CLR_BIAS; ORB_HYD_VERIFY; AERO_SLEW_COMPLETE; ME_SLEW_COMPLETE; SRB_HYD_VERIFY; SRB_SLEW_COMPLETE; LAUNCH_HOLD; LAUNCH_RESTART; SSME_LCH_POS; ME_RESTART_POS; SRB_IGN_CMD; LIFTOFF; AUTOTRIM_DISABLE; SRB_NULL_CMD; SRB_SEP_CMD; STG2_STEER_INIT; AUTOTRIM_ENABLE; ME_RETRIM; MECO_CMD; PPD_INIT; PPD_COMPLETE; LAUTO_BFLAMP, RAUTO_BFLAMP, LMNL_BFLAMP, RMNL_BFLAMP, LAUTO_SBLAMP, RAUTO_SBLAMP, MNLSB_CMDR_0, MNLSB_PLT_0; LAUTO_PLAMP, RAUTO_PLAMP, LCSS_PLAMP, RCSS_PLAMP, LAUTO_RYLAMP, RAUTO_RYLAMP, LCSS_RYLAMP, RCSS_RYLAMP; AERO_SLEW; SSME_START_POS; ME_SLEW; PPD; SRB_SLEW; PARALLEL_PITCH; UNPARALLEL_YAW; ME_ZERO_THRUST; AERO_SLEW_BEGIN; ME_SLEW_BEGIN; STOW_SB; GRAV_POS; RECYCLE_COUNT; RECYCLE_DURING_ME_SLEW; INHIBIT_START_POS; SINGL_ME_CNTL_ENABLE; ZTRANS; YFILTWS; FADE_ELEVONS; QBI_READY; NNYFILTSW				
HYD_FAILS = 0				
SSME_FAILS = 0				
EVENT	EVENT NAME	LOCAL VARIABLE	FORCING FUNCTION*	ACTION*
19	SRB_IGN_CMD		SRB IGNITION COMMAND	
19A	(LIFTOFF)	· S1C, PRELO · LIFTOFF · INTERPS_S1 · S1G · ATTFILT	MET = MET_LIFTOFF (WORST CASE LIFTOFF) (19A)-(S_QUAT)	· CONTROL LOOPS CLOSED · INITIATE FADER ON HOLDDOWN BIAS · STAGE 1 GAIN SCHEDULING INITIATED · STAGE 1 GUIDANCE COMMANDS INITIATED · ACCEPT GUIDANCE CMDS
19B	(LO_PLUS_T2)	· LO_PLUS_T2 · SRBLIM_ACTV · AUTOTRIM_QR · ELEV_LR	MET = MET_LIM_LCH	· NORMAL SRB COMPONENTS LIMITS ENGAGED · PITCH AND YAW TRIM INTEGRATOR TURNED ON · ELEVON LOAD RELIEF TURNED ON
19C	(RL_NOM)	PRL_S1, PRL_LCH	MET ≥ (18A) + MET_90THRUST	· NORMAL SSME FIXED RATE LIMITS ENGAGED
21A	(AUTOTRIM_DISABLE)	· AUTOTRIM_QR	V_REL ≥ V_REL_AUTOTRIM_INHIBIT	· PITCH AND YAW TRIM INTEGRATORS TURNED OFF
21B	(FILTSW)	· FILTSW	V_REL ≥ V_REL_FILTSW	· ROLL BENDING FILTER SWITCHED TO B
21C	(YFILTSW)	· YFILTSW	V_REL ≥ V_REL_YFILTSW	· SWITCH YAW BENDING FILTER GAINS
21D	NNYFILTSW	· NNYFILTSW	V_REL ≥ V_REL_NNYFILTSW	· SWITCH NNY BENDING FILTER GAINS
24A	(FADE_ELEVONS)	· FADE_ELEVONS	MET ≥ MET_25A - [(32+1)/6.25]	· ENABLE FADERS ON ELEVON CMDS
25A	(PRE_SEP)	· FAIL_MIX_ENABLE · PRE_SEP · NYSEP_FB_ENABLE	MET ≥ MET_25A	· ENABLE ROLL MIXING LOGIC CHANGE IF SSME FAILURE HAS OCCURRED · ROLL LEAD-LAG SWITCHED · ENABLE FADER ON KL_MPS AND KN_NY GAINS · ENABLE NY FEEDBACK FOR SRB SEPARATION CONTROL · P _c MONITORING/FILTERING INITIATED · DISABLE ELEVON LOAD RELIEF
25B	(AUTOTRIM_RESET)	· AUTOTRIM_RESET	E25A • [(PC4F < PC_TRIM_RESET) · (PC5F < PC_TRIM_RESET)] + MET ≥ MET_25B	· ENABLE FADER ON TRIM INTEGRATORS · ENABLE FADER ON KN_MPS, KL_SRB, KL_DELPSI, KM_MPS AND KM_SRB GAINS · ENABLE STAGE 2 ROLL MIXING LOGIC CHANGE FOR NO SSME FAILURES · ENABLE FADER TO DQMPST PITCH TRIM
<p>○ DENOTES EXTERNAL FORCING FUNCTION/EVENT</p> <p>*NUMBERS IN THIS COLUMN CHANGE WHEN I-LOADS ARE CHANGED</p>				

FIGURE 4.2.4-2A.(1) Overview of Events/Sequencing (Sheet 1 of 2)

EVENT	EVENT NAME	LOCAL VARIABLE	FORCING FUNCTION*	ACTION*
25B (CONT)		· UNPAR_YAW_ENABLE · SNGL_ME_CNTL_ENABLE		· LATERAL ATTITUDE GAIN SWITCHED · ENABLE RCS JET CMDS AT TWO SSME OUT
25C	(COMLIM4)	· COMLIM4	E25B · PC4F < PC_COMLIM	· ENGAGE V97U2427C COMPONENT LIMITING ON BOTH SRBs
25D	(COMLIM5)	· COMLIM5	E25B · PC5F < PC_COMLIM	· ENGAGE V97U2427C COMPONENT LIMITING ON BOTH SRBs
25E	(NYSEP_DISABLE)	· NYSEP_FB_ENABLE	(COMLIM4 · COMLIM5) + MET ≥ MET_25E	· DISENGAGE NyFEEDBACK THROUGH 4-SEC FADER
27	SRB_NULL_CMD	· PC_FILTER · SRB_NULL_CMD	SRB_MODING_SEP = ON	· TERMINATE Pc MONITORING FILTERING · NULL SRB ACTUATORS · EMPLOY ORBITER PITCH AND YAW RGAs
28	(SRB_SEP_CMD) SRB SEPARATION COMMAND ISSUED)	· S2C, S1C · INTERPS_S2, INTERPS_S1 · ATTCMD · SRBSEP · FRZ_CMD · PRL_S2, PRL_S1		· STAGE 2 CONTROL; SELECTED SOPs AND FDIR DISABLED (SEPARATE CR) · ENABLE 2ND STAGE PITCH TRIM · STAGE 2 GAIN SCHEDULING INITIATED · ROLL BENDING FILTER SWITCHES TO C · PITCH AND YAW TRIM INTEGRATOR LIMITS CHANGED TO SECOND STAGE VALUES · 4-SEC SRB SEPARATION PERIOD INITIATED · THREE-AXIS ATTITUDE HOLD ENGAGED; GUIDANCE INITIATED FOR CONVERGENCE · ENGAGE PRL
29	STG2_STEER_INIT (STAGE 2 GUIDANCE READY)	· SRBSEP · PEGCMD, FRZCMD · S2G, S1G	GUIDANCE_INITIATE = ON	· 4-SEC SRB SEPARATION PERIOD COMPLETE · STAGE 2 GUIDANCE ENGAGED FOR CONTROL
29A	(AUTOTRIM_ENABLE)	· AUTOTRIM_QR · AUTOTRIM_P · PAR_PITCH_ENABLE	[t ≥ (t _{E28} + 12 SEC) · SEC_ME_FL_CNFM] + [t ≥ (t _{E28} + 60 SEC) · SEC_ME_FL_CNFM]	· ROLL, PITCH, AND YAW TRIM INTEGRATORS TURNED ON · LATERAL ATTITUDE GAIN SWITCHED
30A	ME_RETRIM	· ME_RETRIM	S_SSME_TRIM = ON	· INITIATE TRIM AND BIAS LIMIT FOR PITCH PARALLEL
32	MECO_CMD	· AUTOTRIM_QR · AUTOTRIM_P · UNPAR_YAW_ENABLE · PRL_S2, PRL_MECO · FRZCMD, PEGCMD · S2G	MECO_CMD (32) · (A34) (32) · (A34)	· TRIM INTEGRATORS DISABLED · UNPARALLEL MEs IN YAW · PRL LIMITS REDUCED
33B	ME_ZERO_THRUST		ME_ZERO	· ASC_DAP DEACTIVATED (EXCEPT BODY FLAP) AND TRANS_DAP ACTIVATED
<p>○ DENOTES EXTERNAL FORCING FUNCTION/EVENT *NUMBERS IN THIS COLUMN CHANGE WHEN I-LOADS ARE CHANGED</p>				

FIGURE 4.2.4-2A.(2) Overview of Events/Sequencing (Sheet 2 of 2)



*The G/C STEER subphases given above also apply for powered contingency guidance. An additional timeline for the G/C STEER subphase is possible during powered contingency guidance as given below:

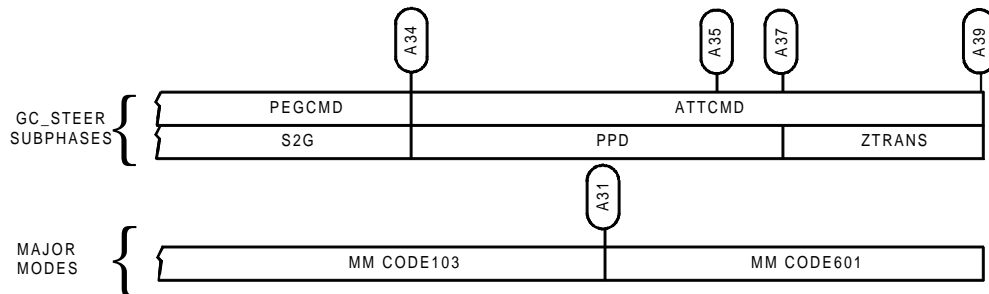


FIGURE 4.2.4-3. RTLS Abort Subphases

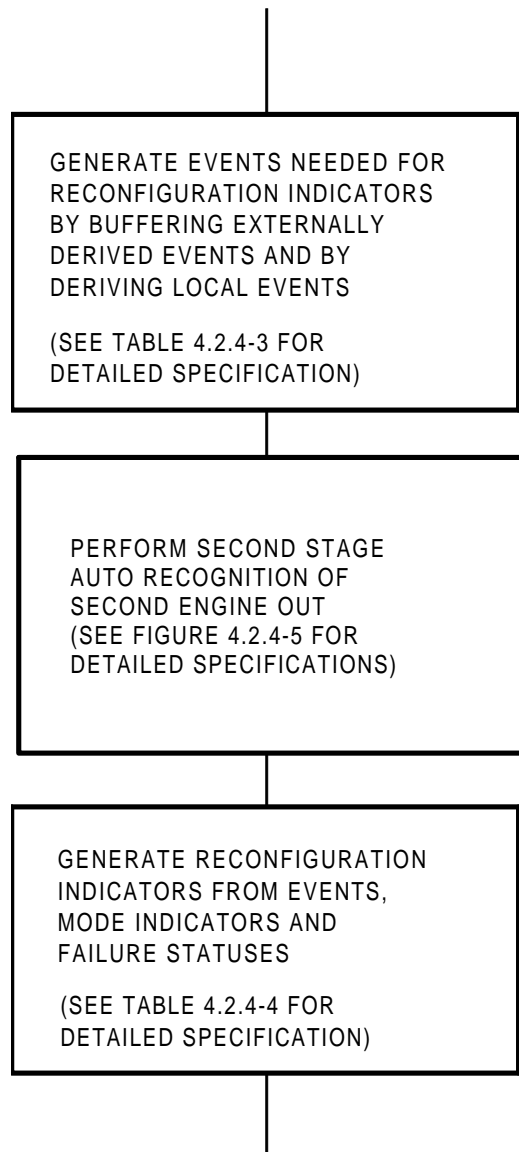


FIGURE 4.2.4-4. ASC_RECON Function Module, Detailed Flow Diagram

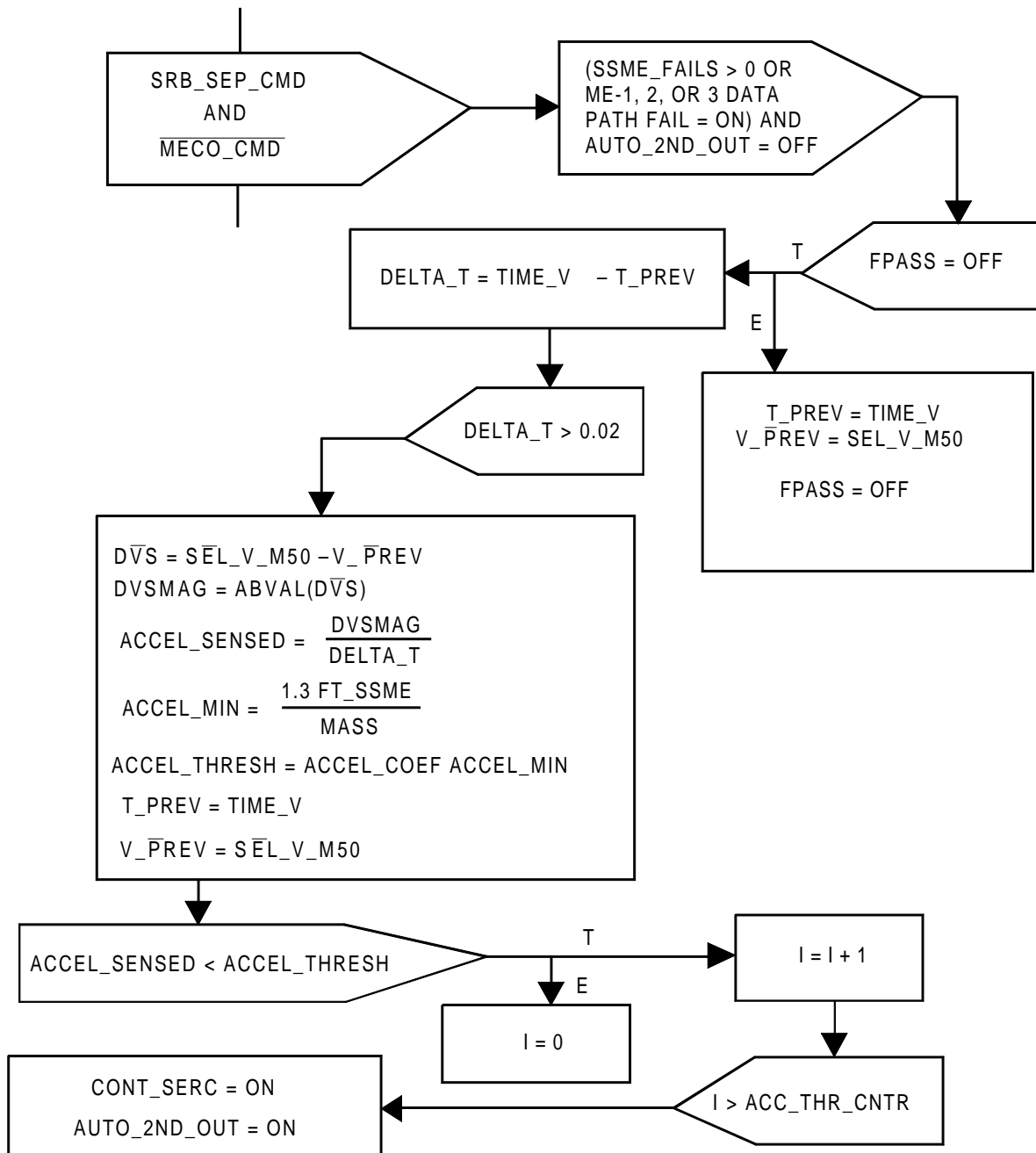


FIGURE 4.2.4-5. Second Stage Auto Recognition of Second Engine Out, Functional Flow Chart

4.2.5 Ascent Thrust Vector Control Laws (ASC_TVC)

A. Functional Description. The functional block diagram for ASC_TVC are shown in Figures 4.2.5-1A through E.

Functions of ASC_TVC are conveniently presented on an axis-by-axis basis, i.e., roll, pitch, and yaw body-axis control algorithms. Figure 4.2.5-1B and 1C present the roll-axis overview block diagram. Figure 4.2.5-1D presents the pitch-axis overview block diagram. Figure 4.2.5-1E presents the yaw-axis overview block diagram.

TVC control differs for first- and second-stage flight. From navigation initiation until lift-off, the control subphase is designated PRELO, during which time orbiter outputs are sent to R/S_LAUNCH_SEQUENCER. From lift-off until SRB separation command, the control subphase is designated S1C. From the nulling of the SRBs to the post-MECO descheduling of the TVC, the control subphase is designated S2C. Transition from first- to second-stage flight (MM_CODE = 102 to 103) occurs at the SRB separation command.

Body-axis attitude errors and body-axis rate commands from GC_STEER are the command inputs to each axis. During S1C, the primary feedback inputs are body-axis rates; roll from the ORB RGA, pitch from the SRB RGA, and yaw from the SRB RGA. A normal and lateral acceleration obtained from the AA is also fed back during S1C in the pitch and yaw axes, respectively, for load relief. Acceleration command references, which are functions of VREL_AERO_REF or constant, are obtained from INTERPS. Body-axis rates from the orbiter RGA are the feedback inputs during S2C.

During S1C, the yaw attitude error is crossfed from the yaw axis to the roll axis. The yaw TVC loop error signal is crossfed from yaw to roll axis during SRB thrust tailoff and the early part of S2C. Scheduled gains from INTERPS are utilized during both first and second stages. The transition from S1C to S2C gains is accomplished by ramping from one gain level to the other over a specified time interval.

The output signals, namely, roll, pitch, and yaw thrust vector deflection commands for the orbiter and the SRB, are sent to the CMD_PROC_MPS and CMD_PROC_SRB modules, respectively, for trimming, mixing, biasing, and limiting.

B. Software Description. An overview of ASC_TVC is presented in Figure 4.2.5-2. Its input/output requirements are summarized in Table 4.2.5-1. ASC_TVC consists of ten modules separated into three functional groupings: ASC_TVC_ROLL, ASC_TVC_PITCH, and ASC_TVC_YAW. Sequencing requirements for the ten modules are shown in Figure 4.2.5-3.

ASC_TVC_ROLL consists of two modules, CMD_ROLL and ROLL_ATT_INTEGRAL, which are shown in detail in Figures 4.2.5-4A and B, respectively. The intermodule interface requirements for ASC_TVC_ROLL are presented in Table 4.2.5-2. Initialization and I-loads/constant requirements are presented in Tables 4.2.5-3 and 4.2.5-4, respectively.

ASC_TVC_PITCH consists of four modules, CMD_PITCH, FDBK_S1C_PITCH, FDBK_S2C_PITCH, and PITCH_ATT_INTEGRAL, which are shown in detail in Figures 4.2.5-5, 4.2.5-6, 4.2.5-7, and 4.2.5-8, respectively. The intermodule interface requirements for ASC_TVC_PITCH are presented in Table 4.2.5-5. Initialization and I-loads/constants requirements are presented in Tables 4.2.5-6 and 4.2.5.7, respectively.

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ASC_TVC_YAW consists of four modules, CMD_YAW, FDBK_S1C_YAW, FDBK_S2C_YAW, and YAW_ATT_INTEGRAL, which are shown in detail in Figures 4.2.5-12, 4.2.5-11, 4.2.5-10, and 4.2.5-9, respectively. The intermodule interface requirements for ASC_TVC_YAW are presented in Table 4.2.5-8. Initialization and I-loads/constants requirements are presented in Tables 4.2.5-9 and 4.2.5-10, respectively.

Table 4.2.5-1.ASC_TVC Interface Requirements

Name	Description	Source or Destination	Type	Range	Units	Rate Required/Produced At (Hz)
<u>Inputs</u>						
\bar{E} BFB	Attitude errors	GC_STEER	V		deg	12.5
\bar{W} FBI_FB	Rotational velocity, flight body wrt inertial, coordinatized in flight body	GC_STEER	V		deg/s	12.5
PORB	Roll rate, orbiter rate gyros	SF (ORB RGA)	S		deg/s	25
QORB	Pitch rate, orbiter rate gyros	SF (ORB RGA)	S		deg/s	25
RORB	Yaw rate, orbiter rate gyros	SF (ORB RGA)	S		deg/s	25
QSRB	Pitch rate, SRB rate gyro	SF (SRB RGA)	S		deg/s	25
RSRB	Yaw rate, SRB rate gyro	SF (SRB RGA)	S		deg/s	25
NY	Lateral acceleration	SF (AA)	S		g	25
NZ	Normal acceleration	SF (AA)	S		g	25
NYREF	Scheduled lateral acceleration reference	INTERPS	S		g	6.25
NZREF	Scheduled normal acceleration reference	INTERPS	S		g	6.25
SRB_NULL_CMD	Indicator, SRB_NULL_CMD	ASC_RECON	B		–	12.5
AUTOTRIM_P	Indicator, enable roll autotrim	ASC_RECON	B		–	12.5
AUTOTRIM_QR	Indicator, enable yaw and pitch autotrim	ASC_RECON	B		–	12.5
KL_PHI	Variable gain (attitude roll)	INTERPS	S		(deg/s)/deg	6.25
KL_DELPISI	Variable gain (yaw cmd crossfeed, roll)	INTERPS	S		(deg/s)/deg	6.25
TWR_CLR_BIAS	Indicator SSME No. 2 failed at lift off	ASC_RECON	B		–	12.5
NYSEP_FB_ENABLE	Indicator, NY feedback	ASC_RECON	B		–	12.5

Table 4.2.5-1.ASC_TVC Interface Requirements

Name	Description	Source or Destination	Type	Range	Units	Rate Required/Produced At (Hz)
<u>Inputs</u> (Cont.)						
S1C	Indicator, Stage 1	ASC_RECON	B		–	12.5
S2C	Indicator, Stage 2	ASC_RECON	B		–	12.5
KM_INT	Variable gain (pitch attitude integral)	INTERPS	S		–	6.25
KN_INT	Variable gain (yaw attitude integral)	INTERPS	S		–	6.25
KL_PS1	Variable gain (yaw attitude error crossfeed roll)	INTERPS	S		(deg/s)/deg	6.25
TRM_NYREF	Trim lateral acceleration reference	INTERPS	S		deg/s	6.25
CONT_SERC	Contingency single engine roll control flag	XXXXXX TRAJ 1 DISP, XXXXXX TRAJ 2 DISP, RTLS TRAJ 2 DISP, ASC_RECON	B		–	1.04, 1.04, 1.04, 12.5
KN_PRHP	Variable gain (H.P. roll–yaw rate, yaw)	INTERPS	S		(deg/s)/ (deg/s)	6.25
KM_THETA	Variable gain (attitude, pitch)	INTERPS	S		(deg/s)/deg	6.25
KM_NZ	Variable gain (NZ feedback, pitch)	INTERPS	S		(deg/s)/g	6.25
KN_PSI	Variable gain (attitude/rate ratio, yaw)	INTERPS	S		(deg/s)/deg	6.25
KN_NY	Variable gain (NY feedback, yaw)	INTERPS	S		(deg/s)/g	6.25
AUTOTRIM_RESET	Indicator	ASC_RECON	B		–	12.5
PRE_SEP	Indicator	ASC_RECON	B		–	12.5
FILTSW	Indicator	ASC_RECON	B		–	12.5
YFILTSW	Indicator	ASC_RECON	B		–	12.5
NNYFILTSW	Indicator	ASC_RECON	B		–	12.5
MM101_INIT	Indicator	ASC_RECON	B		–	12.5
NYSEP_FB_ENABLE	Indicator	ASC_RECON	B		–	12.5

Table 4.2.5-1.ASC_TVC Interface Requirements

Name	Description	Source or Destination	Type	Range	Units	Rate Required/Produced At (Hz)
<u>Outputs</u>						
DPTVC	Roll TVC loop error signal	CMD_PROC_MPS CMD_PROC_SRB	S		deg/s	25
<u>Outputs (Cont.)</u>						
DQTV	Pitch TVC loop error signal	CMD_PROC_MPS CMD_PROC_SRB CMD_PROC_RCS	S		deg/s	25
DRTVC	Yaw TVC loop error signal	CMD_PROC_MPS CMD_PROC_SRB CMD_ROLL	S		deg/s	25
DQTV_INT	Pitch TVC trim integrator output	CMD_PROC_MPS CMD_PROC_SRB	S		deg	25
DRTVC_INT	Yaw TVC trim integrator output	CMD_PROC_MPS CMD_PROC_SRB	S		deg	25
NY_FBK	Compensated lateral acceleration error	GC_STEER	S		deg/s	25
NZ_FBK	Compensated normal acceleration error	GC_STEER	S		deg/s	25

Table 4.2.5-2. ASC_TVC_ROLL Inter-Module Interface Requirements								
Module	Name	Description	Source or Destination	Type	Range	Units	Rate Required/Produced At (Hz)	
ROLL_ATT_INTEGRAL	<u>Inputs</u>							
	AUTOTRIM_P	Indicator, enable roll autotrim	ASC_RECON	B		–	12.5	
	KL_PHI	Variable gain (attitude, roll)	INTERPS	S		(deg/s)/deg	6.25	
	EBFB ₁	Roll attitude error	GC_STEER	S(V)		deg	12.5	
	EBFB ₃	Yaw attitude error	GC_STEER	S(V)		deg	12.5	
	KL_PSI	Variable gain (yaw attitude crossfeed, roll)	INTERPS	S		(deg/s)/deg	6.25	
	<u>Outputs</u>							
	DPTVC_INT	Roll integrator output	CMD_ROLL, TLM	S		deg/s	12.5	
	PHI_ERR	Gained roll attitude error	CMD_ROLL	S		deg/s	12.5	
CMD_ROLL	<u>Inputs</u>							
	WFBI_FB ₁	Roll rotational velocity, flight-body wrt inertial, coordinatized in flight body	GC_STEER	S(V)		deg/s	12.5	
	PORB	Roll rate, orbiter rate gyros	SF (ORB RGA)	S		deg/s	25	
	FILTSW	Indicator	ASC_RECON	B		–	12.5	
	DRTVC	Yaw TVC loop error signal	CMD_YAW	S		deg/s	25	
	KL_DELPSI	Variable gain (yaw actuator command crossfeed, roll)	INTERPS	S		–	6.25	
	MM101_INIT	Indicator	ASC_RECON	B		–	12.5	
	S2C	Indicator	ASC_RECON	B		–	12.5	
	PRE_SEP	Indicator, E25A	ASC_RECON	B		–	12.5	

Table 4.2.5-2. ASC_TVC_ROLL Inter-Module Interface Requirements							
Module	Name	Description	Source or Destination	Type	Range	Units	Rate Required/ Produced At (Hz)
CMD_ROLL (Cont.)	<u>Inputs</u>						
	DPTVC_INT	Roll TVC trim integrator output	ROLL_ATT_INTEGRAL	S		deg/s	12.5
	PHI_ERR	Gained roll attitude error	ROLL_ATT_INTEGRAL	S		deg/s	12.5
	CONT_SERC	Contingency single engine roll control flag	XXXXXX TRAJ 1 DISP, XXXXXX TRAJ 2 DISP, RTLS TRAJ 2 DISP, ASC_RECON	B		–	1.04, 1.04, 1.04, 12.5
	SEC_ME_FL_CNFM	Second ME fail confirm discrete	ASC_RECON	B		–	12.5
	<u>Outputs</u>						
	DPTVC	Roll TVC loop error signal	CMD_PROC_MPS CMD_PROC_SRB TLM	S		deg/s	25

Table 4.2.5-3.ASC_TVC_ROLL Initialization Requirements					
Module	Component	Initialize on Transition		Variable	Initial Value
		From	To		
ROLL_ ATT_ INTEGRAL	LIMITED INTEGRATOR				
	Output	–	MM101_INIT	Output	0.0
CMD_ ROLL	First-order filter L_LL	–	MM101_INIT	INIT flag	
	Init flag	–	MM101_INIT	INIT flag	OFF
	Output			Output	0.0
	Node			Nodes	0.0 (see Subsection 4.7.1)
	Coefficients (i = 1–5)	–	MM101_INIT	CL_LL _i	CL_LLA _i
		$\overline{\text{PRE_SEP}}$	PRE_SEP	CL_LL _i	CL_LL _B _i
	Fourth-order filter L_PB				
	Init flag	–	MM101_INIT	INIT flag	OFF
	Output			Output	0.0
	Nodes			Nodes	0.0 (see Subsection 4.7.4)
	Coefficients (i = 1–5)			CL_PB1 _i CL_PB2 _i	CL_PBA1 _i CL_PBA2 _i
		$\overline{\text{FILTSW}}$	FILTSW	CL_PB1 _i CL_PB2 _i	CL_PBB1 _i CL_PBB2 _i
		$\overline{\text{S2C}}$	S2C	CL_PB1 _i CL_PB2 _i	CL_PBC1 _i CL_PBC2 _i
	Second-order filter L_RO				
	Init flag	–	MM101_INIT	INIT flag	OFF
	Output			Output	0.0
Nodes			Nodes	0.0 (see Subsection 4.7.2)	
	$\overline{\text{SEC_ME_FL_CNFM}} \cdot \overline{\text{CONT_SERC}}$	SEC_ME_FL_CNFM + CONT_SERC	R_XFD	0.0	
	$\overline{\text{CONT_SERC}} \cdot \overline{\text{SEC_MF_FL_CNFM}}$	$\overline{\text{CONT_SERC}} \cdot \overline{\text{SEC_ME_FL_CNFM}}$	R_XFD	①	

① If CONT_SERC switches from ON to OFF and SEC_ME_FL_CNFM is OFF, R_XFD is set to the value determined in Figure 4.2.5-4B.

Table 4.2.5-4.ASC_TVC_ROLL I-Loads/Constants					
Module	Name	Description	Type	MSID/ Value	Units
ROLL_ ATT_ INTEGRAL	PC_LIM	Roll attitude error rate limit	S	V97U2200C	deg/s
	KL_INT	Roll trim integrator gain	S	V97U1810C	1/s
	PCIDOT_LIM	Roll trim integrator rate limit	S	V97U2206C	deg/s ²
	PCI_LIM	Roll trim integrator limit	S	V97U2205C	deg/s
CMD_ ROLL	CL_LLA1	Filter L_LL coefficient	S	V97U1420C	–
	CL_LLA2	Filter L_LL coefficient	S	V97U1421C	–
	CL_LLA3	Filter L_LL coefficient	S	V97U1422C	–
	CL_LLA4	Filter L_LL coefficient	S	V97U2456C	–
	CL_LLA5	Filter L_LL coefficient	S	V97U2457C	–
	CL_LL1	Filter L_LL coefficient	S	V97U1423C	–
	CL_LL2	Filter L_LL coefficient	S	V97U1424C	–
	CL_LL3	Filter L_LL coefficient	S	V97U1425C	–
	CL_LL4	Filter L_LL coefficient	S	V97U2458C	–
	CL_LL5	Filter L_LL coefficient	S	V97U2459C	–
	CL_PBA11	Filter L_PB coefficient	S	V97U1432C	–
	CL_PBA12	Filter L_PB coefficient	S	V97U1433C	–
	CL_PBA13	Filter L_PB coefficient	S	V97U1434C	–
	CL_PBA14	Filter L_PB coefficient	S	V97U1435C	–
	CL_PBA15	Filter L_PB coefficient	S	V97U1436C	–
	CL_PBA21	Filter L_PB coefficient	S	V97U1437C	–
	CL_PBA22	Filter L_PB coefficient	S	V97U1438C	–
	CL_PBA23	Filter L_PB coefficient	S	V97U1439C	–
	CL_PBA24	Filter L_PB coefficient	S	V97U1440C	–
	CL_PBA25	Filter L_PB coefficient	S	V97U1441C	–
	CL_PBB11	Filter L_PB coefficient	S	V97U1447C	–
	CL_PBB12	Filter L_PB coefficient	S	V97U1448C	–
	CL_PBB13	Filter L_PB coefficient	S	V97U1449C	–
	CL_PBB14	Filter L_PB coefficient	S	V97U1450C	–
	CL_PBB15	Filter L_PB coefficient	S	V97U1451C	–
	CL_PBB21	Filter L_PB coefficient	S	V97U1452C	–
CL_PBB22	Filter L_PB coefficient	S	V97U1453C	–	
CL_PBB23	Filter L_PB coefficient	S	V97U1454C	–	

Table 4.2.5-4.ASC_TVC_ROLL I-Loads/Constants					
Module	Name	Description	Type	MSID/ Value	Units
CMD_ ROLL (Cont.)	CL_PBB24	Filter L_PB coefficient	S	V97U1455C	–
	CL_PBB25	Filter L_PB coefficient	S	V97U1456C	–
	CL_PBC11	Filter L_PB coefficient	S	V97U2460C	–
	CL_PBC12	Filter L_PB coefficient	S	V97U2461C	–
	CL_PBC13	Filter L_PB coefficient	S	V97U2462C	–
	CL_PBC14	Filter L_PB coefficient	S	V97U2463C	–
	CL_PBC15	Filter L_PB coefficient	S	V98U9577C	–
	CL_PBC21	Filter L_PB coefficient	S	V98U9578C	–
	CL_PBC22	Filter L_PB coefficient	S	V98U9579C	–
	CL_PBC23	Filter L_PB coefficient	S	V98U9580C	–
	CL_PBC24	Filter L_PB coefficient	S	V98U9581C	–
	CL_PBC25	Filter L_PB coefficient	S	V98U9582C	–
	CL_RO1	Filter L_RO coefficient	S	V97U1462C	–
	CL_RO2	Filter L_RO coefficient	S	V97U1463C	–
	CL_RO3	Filter L_RO coefficient	S	V97U1464C	–
	CL_RO4	Filter L_RO coefficient	S	V97U1465C	–
	CL_RO5	Filter L_RO coefficient	S	V97U1466C	–
	TM	12.5 Hz cycle update interval for integrator	S	0.08	S

Table 4.2.5-5.ASC_TVC_PITCH Inter-Module Interface Requirements								
Module	Name	Description	Source or Destination	Type	Range	Units	Rate Required/Produced At (Hz)	
CMD_PITCH	<u>Inputs</u>							
	QFDBK	Pitch rate + normal acceleration feedback error signal	FDBK_S1C_PITCH	S		deg	25	
	MM101_INIT	Indicator	ASC_RECON	B		-	12.5	
	<u>Outputs</u>							
	DQTVC	Pitch TVC loop error signal	CMD_PROC_MPS CMD_PROC_SRB CMD_PROC_RCS	S		deg/s	25	
FDBK_S1C_PITCH	<u>Inputs</u>							
	QSRB	Pitch rate, SRB rate gyros	SF (SRB RGA)	S		deg/s	25	
	WFBI_FB ₂	Pitch rotational velocity, flight body wrt inertial, coordinatized in flight body	GC_STEER	S(V)		deg/s	12.5	
	NZ	Normal acceleration	SF (AA)	S		g	25	
	NZREF	Scheduled normal acceleration reference	INTERPS	S		g	6.25	
	KM_NZ	Variable gain (NZ feedback, pitch)	INTERPS	S		(deg/s)/g	6.25	
	THETA_ERR	Gained pitch attitude error	PITCH_ATT_INTEGRAL	S		deg/s	12.5	
	MM101_INIT	Indicator	ASC_RECON	B		-	12.5	
		<u>Outputs</u>						
		QFDBK	Pitch rate + normal acceleration feedback error signal	CMD_PITCH	S		deg/s	25
	NZ_FBK	Compensated normal acceleration error	GC_STEER	S		deg/s	25	

Table 4.2.5-5.ASC_TVC_PITCH Inter-Module Interface Requirements							
Module	Name	Description	Source or Destination	Type	Range	Units	Rate Required/Produced At (Hz)
FDBK_S2C_PITCH	<u>Inputs</u>						
	QORB	Pitch rate, orbiter rate gyros	SF (ORB RGA)	S		deg/s	25
	WFBI_FB ₂	Pitch rotational velocity, flight body wrt inertial, coordinatized in flight body	GC_STEER	S(V)		deg/s	12.5
	THETA_ERR	Gained pitch attitude error	PITCH_ATT_INTEGRAL	S		deg/s	12.5
	MM101_INIT	Indicator, first time ASCENT DAP sequenced	ASC_RECON	B		–	12.5
	<u>Outputs</u>						
	QFDBK	Pitch rate feedback error signal	CMD_PITCH	S		deg/s	25
PITCH_ATT_INTEGRAL	<u>Inputs</u>						
	AUTOTRIM_QR	Indicator, enable pitch and yaw autotrim	ASC_RECON	B		–	12.5
	KM_THETA	Variable gain (pitch attitude)	INTERPS	S		(deg/s)/deg	6.25
	EBFB ₂	Pitch attitude error	GC_STEER	S(V)		deg	12.5
	KM_INT	Pitch trim integrator gain	INTERPS	S		1/s	6.25
	AUTOTRIM_RESET	Indicator	ASC_RECON	B		–	12.5
	MM101_INIT	Indicator	ASC_RECON	B		–	12.5
	<u>Outputs</u>						
	DQTVC_INT	Pitch trim integrator output signal	CMD_PROC_MPS, CMD_PROC_SRB, TLM	S		deg	12.5
	THETA_ERR	Pitch attitude error signal	FDBK_S1C_PITCH FDBK_S2C_PITCH	S		deg/s	12.5

Table 4.2.5-6. ACS_TVC_PITCH Initialization Requirements					
Module	Component	Initialize on Transition		Variable	Initial Value
		From	To		
PITCH_ATT_INTEGRAL	LIMITED_INTEGRATOR	–	MM101_INIT	Output	0.0
		$\overline{\text{AUTOTRIM_RESET}}$	AUTOTRIM_RESET	Output	0.0
	FADER QCI	–	MM101_INIT	NFADE_INT	0.0
		$\overline{\text{AUTOTRIM_RESET}}$	AUTOTRIM_RESET	NFADE_INT	NFADE_INT_NOM
	Integrator output	–	MM101_INIT	QCI_LIM	QCI_LIMS ₁
Limit	S1C	S2C	QCI_LIM	QCI_LIMS ₂	
CMD_PITCH	Second-order filter M_RO				
	Initialization flag	–	MM101_INIT	INIT_FLAG	OFF
	Output	–	MM101_INIT	Output	0.0
	Nodes	–	MM101_INIT	Nodes	0.0 (See Subsection 4.7.2)
FDBK_S1C_PITCH	First-order filter M_QHP				
	Initialization flag	–	MM101_INIT	INIT_FLAG	OFF
	Output	–	MM101_INIT	Output	0.0
	Node	–	MM101_INIT	Node	0.0 (See Subsection 4.7.1)
	First-order filter M_NZLAG				
	Initialization flag	–	MM101_INIT	INIT_FLAG	OFF
	Output	–	MM101_INIT	Output	0.0
	Node	–	MM101_INIT	Nodes	0.0 (See Subsection 4.7.1)
	Second-order filter M_NZ				
	Initialization flag	–	MM101_INIT	INIT_FLAG	OFF
	Output	–	MM101_INIT	Output	0.0
	Nodes	–	MM101_INIT	Nodes	0.0 (See Subsection 4.7.2)

Table 4.2.5-6. ACS_TVC_PITCH Initialization Requirements					
Module	Component	Initialize on Transition		Variable	Initial Value
		From	To		
FDBK_S1C_PITCH (Cont.)	Second-order filter M_QB				
	Initialization flag	–	MM101_INIT	INIT_FLAG	OFF
	Output	–	MM101_INIT	Output	0.0
	Nodes	–	MM101_INIT	Nodes	0.0 (See Subsection 4.7.2)
	Second-order filter M_STG1				
	Initialization flag	–	MM101_INIT	INIT_FLAG	OFF
	Output	–	MM101_INIT	Output	0.0
	Nodes	–	MM101_INIT	Nodes	0.0 (See Subsection 4.7.2)
	Second-order filter M_LLS1				
	Initialization flag	–	MM101_INIT	INIT_FLAG	OFF
	Output	–	MM101_INIT	Output	0.0
	Nodes	–	MM101_INIT	Nodes	0.0 (See Subsection 4.7.2)
FDBK_S2C_PITCH	Fourth-order filter M_Q0				
	Initialization flag	–	MM101_INIT	INIT_FLAG	OFF
	Output	–	MM101_INIT	Output	0.0
	Nodes	–	MM101_INIT	Nodes	0.0 (See Subsection 4.7.3)
	Second-order filter M_LLS2				
	Initialization flag	–	MM101_INIT	INIT_FLAG	OFF
	Output	–	MM101_INIT	Output	0.0
	Nodes	–	MM101_INIT	Nodes	0.0 (See Subsection 4.7.2)

Table 4.2.5-7.ASC_TVC_PITCH I-Loads/Constants					
Module	Name	Description	Type	MSID	Units
PITCH_ ATT_ INTEGRAL	QC_LIM	Pitch attitude error rate limit	S	V97U2222C	deg/s
	QCIDOT_LIM	Pitch trim integrator rate limit	S	V97U2224C	deg/s
	QCI_LIMS1	Pitch trim integration limit, S1	S	V97U2438C	deg
	QCI_LIMS2	Pitch trim integration limit, S2	S	V97U2223C	deg
	NFADE_INT_ NOM	Cycles to fade QCI to zero	S	V97U2075C	counts
	TM	Medium cycle time	S	0.08	s
CMD_ PITCH	CM_RO1	Filter M_RO coefficient	S	V97U1558C	–
	CM_RO2	Filter M_RO coefficient	S	V97U1559C	–
	CM_RO3	Filter M_RO coefficient	S	V97U1560C	–
	CM_RO4	Filter M_RO coefficient	S	V97U1561C	–
	CM_RO5	Filter M_RO coefficient	S	V97U1562C	–
FDBK_ S1C_ PITCH	KM_QHP	Fixed gain, pitch high pass	S	V97U1895C	g/d/s
	CM_QHP1	Filter M_QHP coefficient	S	V97U1540C	–
	CM_QHP2	Filter M_QHP coefficient	S	V97U1541C	–
	CM_QHP3	Filter M_QHP coefficient	S	V97U1542C	–
	CM_NZLAG1	Filter M_NZLAG coefficient	S	V97U1482C	–
	CM_NZLAG2	Filter M_NZLAG coefficient	S	V97U1483C	–
	CM_NZLAG3	Filter M_NZLAG coefficient	S	V97U1484C	–
	CM_NZ1	Filter M_NZ coefficient	S	V97U1485C	–
	CM_NZ2	Filter M_NZ coefficient	S	V97U1486C	–
	CM_NZ3	Filter M_NZ coefficient	S	V97U1487C	–
	CM_NZ4	Filter M_NZ coefficient	S	V97U1488C	–
	CM_NZ5	Filter M_NZ coefficient	S	V97U1489C	–
	CM_QB1	Filter M_QB coefficient	S	V97U1500C	–
	CM_QB2	Filter M_QB coefficient	S	V97U1501C	–
	CM_QB3	Filter M_QB coefficient	S	V97U1502C	–
	CM_QB4	Filter M_QB coefficient	S	V97U1503C	–
	CM_QB5	Filter M_QB coefficient	S	V97U1504C	–
	CM_STG11	Filter STG1 coefficient	S	V98U9583C	–
	CM_STG12	Filter STG1 coefficient	S	V98U9584C	–
	CM_STG13	Filter STG1 coefficient	S	V98U9585C	–

Table 4.2.5-7.ASC_TVC_PITCH I-Loads/Constants					
Module	Name	Description	Type	MSID	Units
FDBK_ S1C_ PITCH (Cont.)	CM_STG14	Filter STG1 coefficient	S	V98U9586C	–
	CM_STG15	Filter STG1 coefficient	S	V98U9587C	–
	CM_LLS11	Filter LLS1 coefficient	S	V98U9588C	–
	CM_LLS12	Filter LLS1 coefficient	S	V98U9589C	–
	CM_LLS13	Filter LLS1 coefficient	S	V98U9564C	–
	CM_LLS14	Filter LLS1 coefficient	S	V98U9565C	–
	CM_LLS15	Filter LLS1 coefficient	S	V98U9566C	–
FDBK_ S2C_ PITCH	CM_QO11	Filter M_QO coefficient	S	V97U1543C	–
	CM_QO12	Filter M_QO coefficient	S	V97U1544C	–
	CM_QO13	Filter M_QO coefficient	S	V97U1545C	–
	CM_QO14	Filter M_QO coefficient	S	V97U1546C	–
	CM_QO15	Filter M_QO coefficient	S	V97U1547C	–
	CM_QO21	Filter M_QO coefficient	S	V97U1548C	–
	CM_QO22	Filter M_QO coefficient	S	V97U1549C	–
	CM_QO23	Filter M_QO coefficient	S	V97U1550C	–
	CM_QO24	Filter M_QO coefficient	S	V97U1551C	–
	CM_QO25	Filter M_QO coefficient	S	V97U1552C	–
	CM_LLS21	Filter LLS2 coefficient	S	V98U9567C	–
	CM_LLS22	Filter LLS2 coefficient	S	V98U9568C	–
	CM_LLS23	Filter LLS2 coefficient	S	V98U9569C	–
	CM_LLS24	Filter LLS2 coefficient	S	V98U9570C	–
	CM_LLS25	Filter LLS2 coefficient	S	V98U9571C	–

Table 4.2.5-8.ASC_TVC_YAW Inter-Module Interface Requirements							
Module	Name	Description	Source or Destination	Type	Range	Units	Rate Required/Produced At (Hz)
CMD_YAW	<u>Inputs</u>						
	RFDBK	Yaw rate feedback error	FDBK_S1C_YAW FDBK_S2C_YAW	S		deg/s	25
	TRM_NYREF	Trim lateral acceleration reference	INTERPS	S		deg/s	6.25
	<u>Outputs</u>						
	DRTVC	Yaw TVC loop error signal	CMD_PROC_MPS CMD_PROC_SRB CMD_ROLL, TLM	S		deg/s	25
FDBK_S1C_YAW	<u>Inputs</u>						
	RSRB	Yaw rate, SRB rate gyro	SF (SRB RGA)	S		deg/s	25
	TWR_CLR_BIAS	Indicator, SSME No. 2 failed at lift-off	ASC_RECON	B			12.5
	WFBI_FB ₃	Yaw rotational velocity, flight-body wrt inertial, coordinatized in flight body	GC_STEER	S		deg/s	12.5
	PORB	Roll rate, orbiter rate gyro	SF (ORB RGA)	S		deg/s	25
	NY	Lateral acceleration	SF (AA)	S		g	25
	NYREF	Scheduled lateral acceleration reference	INTERPS	S		g	6.25
	KN_PRHP	Variable gain (hi passed roll-yaw feedback)	INTERPS	S		-	6.25
	KN_NY	Variable gain (NY feedback, yaw)	INTERPS	S		deg/s	6.25
	PSI_ERR	Gained yaw attitude error	YAW_ATT_INTEGRAL	S		deg/s	12.5

Table 4.2.5-8.ASC_TVC_YAW Inter-Module Interface Requirements								
Module	Name	Description	Source or Destination	Type	Range	Units	Rate Required/Produced At (Hz)	
FDBK_ S1C_YAW (Cont.)	<u>Inputs</u>							
	MM101_INIT	Indicator	ASC_RECON	B		–	12.5	
	NYSEP_FB_ENABLE	Indicator	ASC_RECON	B		–	12.5	
	RORB	Yaw rate, orbiter rate gyro	SF (ORB RGA)	S		deg/s	25	
	YFILTSW	Indicator	ASC_RECON	B		–	12.5	
	NNYFILTSW	Indicator	ASC_RECON	B		–	12.5	
	<u>Outputs</u>							
	RFDBK	Yaw rate feedback error signal	CMD_YAW	S		deg/s	25	
NY_FBK	Compensated lateral acceleration error	GC_STEER	S		deg/s	25		
FDBK_ S2C_YAW	<u>Inputs</u>							
	RORB	Yaw rate, orbiter rate gyros	SF (ORB RGA)	S		deg/s	25	
	WFBI_FB ₃	Yaw rotational velocity flight-body wrt inertial, coordinatized in flight body	GC_STEER	S		deg/s	12.5	
	PSI_ERR	Gained yaw attitude error	YAW_ATT_INTEGRAL	S		deg/s	12.5	
	MM101_INIT	Indicator, first time ASCENT_DAP sequenced	ASC_RECON	B		–	12.5	
	<u>Outputs</u>							
RFDBK	Yaw rate feedback error signal	CMD_YAW	S		deg/s	25		

Table 4.2.5-8.ASC_TVC_YAW Inter-Module Interface Requirements							
Module	Name	Description	Source or Destination	Type	Range	Units	Rate Required/Produced At (Hz)
YAW_ ATT_ INTEGRAL	<u>Inputs</u>						
	EBFB ₃	Yaw attitude error	GC_STEER	S(V)		deg	12.5
	KN_PSI	Variable gain, attitude	INTERPS	S		(deg/s)/deg	6.25
	KN_INT	Yaw attitude error integral gain	INTERPS	S		-	6.25
	AUTOTRIM_QR	Indicator	ASC_RECON	B		-	12.5
	AUTOTRIM_RESET	Indicator	ASC_RECON	B		-	12.5
	S1C	Indicator, Stage 1 control	ASC_RECON	B		-	12.5
	S2C	Indicator, Stage 2 control	ASC_RECON	B		-	12.5
	<u>Outputs</u>						
PSI_ERR	Gained yaw attitude error	FDBK_S1C_YAW, FDBK_S2C_YAW	S		deg/s	12.5	
DRTVC_INT	Yaw trim integrator output	CMD_PROC_MPS, CMD_PROC_SRB, TLM	S		deg	12.5	

Table 4.2.5-9.ASC_TVC_YAW Initialization Requirements						
Module	Component	Initialize on Transition		Variable	Initial Value	
		From	To			
YAW_ ATT_ INTEGRAL	Limited integrator					
	Output	–	MM101_INIT	Output	0.0	
		<u>AUTOTRIM_</u> <u>RESET</u>	AUTOTRIM_	RESET	Output	0.0
	Fader, RCI	–	MM101_INIT	NFADE_	INT	0
		<u>AUTOTRIM_</u> <u>RESET</u>	AUTOTRIM_	NFADE_	INT	NFADE_
	Integrator output limit	–	MM101_INIT	RCI_LIM	RCI_LIMS1	
		S1C	S2C	RCI_LIM	RCI_LIMS2	
CMD_ YAW	Second_order filter N_ROFF					
	Initialization flag	–	MM101_INIT	INIT flag	Off	
	Output	–	MM101_INIT	Output	0.0	
	Nodes	–	MM101_INIT	Nodes	0.0 (See Subsection 4.7.2)	
FDBK_ S1C_YAW	First-order filter N_PRHP					
	Initialization flag	–	MM101_INIT	INIT flag	Off	
	Output	–	MM101_INIT	Output	0.0	
	Node	–	MM101_INIT	Node	0.0 (See Subsection 4.7.1)	
	Second-order filter N_LLA					
	Initialization	–	MM101_INIT	INIT flag	Off	
	Output			Output	0.0	
Node			Node	0.0 (See Subsection 4.7.2)		
	Coefficients (i = 1–5)	<u>PRE_SEP</u>	PRE_SEP	CN_LL _i	CN_LLA _i	

Table 4.2.5-9.ASC_TVC_YAW Initialization Requirements					
Module	Component	Initialize on Transition		Variable	Initial Value
		From	To		
FDBK_ S1C_YAW (Cont.)	First-order filter N_NYLAG			DEL_ DRTVC	0.0
	Initialization flag	–	MM101_INIT	INIT flag	OFF
	Output	–		Output	0.0
	Node			Node	0.0 (See Subsection 4.7.1)
	First-order filter N_NYSEP				
	Initialization flag	–	MM101_INIT	INIT flag	Off
	Output	–		Output	0.0
	Node			Node	0.0 (see Subsection 4.7.1)
	Fourth-order filter N_NY				
	Initialization flag		MM101_INIT	INIT FLAG	Off
	Output	–		Output	0.0
	Nodes	–		Nodes	0.0 (see Subsection 4.7.3)
	Coefficients (i = 1–5)	–	MM101_INIT	CN_NY1 _i CN_NY2 _i	CN_NYA1 _i CN_NYA2 _i
		<u>NNYFILTSW</u>	NNYFILTSW	CN_NY1 _i CN_NY2 _i	CN_NYB1 _i CN_NYB2 _i
	Fourth-order filter N_RB				
	Initialization flag	–	MM101_INIT	INIT flag	Off
	Output	–		Output	0.0
	Nodes	–		Nodes	0.0 (see Subsection 4.7.3)
Coefficients (i = 1–5)	–	MM101_INIT	CN_RB1 _i CN_RB2 _i	CN_RBA1 _i CN_RBA2 _i	
	<u>YFILTSW</u>	YFILTSW	CN_RB1 _i CN_RB2 _i	CN_RBB1 _i CN_RBB2 _i	

Table 4.2.5-9.ASC_TVC_YAW Initialization Requirements					
Module	Component	Initialize on Transition		Variable	Initial Value
		From	To		
FDBK_ S2C_YAW	Fourth-order filter N_RO				
	Initialization flag	–	MM101_INIT	INIT flag	OFF
	Output	–		Output	0.0
	Nodes	–		Nodes	0.0 (see Subsection 4.7.3)
	Second-order filter N_LRB	–			
	Initialization flag	–	MM101_INIT	INIT flag	Off
	Output	–		Output	0.0
	Nodes	–		Nodes	0.0 (see Subsection 4.7.2)

Table 4.2.5-10. ASC_TVC_YAW I-Loads/Constants

Module	Name	Description	Type	MSID/ Value	Units
YAW_ ATT_ INTEGRAL	RC_LIM	Yaw attitude error rate limit	S	V97U2229C	deg/s
	TM	Medium cycle time	S	0.08	s
	RCIDOT_LIM	Yaw trim integrator rate limit	S	V97U2231C	deg/s
	RCI_LIMS1	Yaw trim integrator limit, Stage 1	S	V97U2439C	deg
	RCI_LIMS2	Yaw trim integrator limit, Stage 2	S	V97U2230C	deg
	NFADE_INT_ NOM	Cycles to fade RCI to zero	S	V97U2075C	–
FDBK_ S1C_YAW	KN_PHP	Fixed gain, roll into yaw high pass	S	V97U1953C	–
	CN_PRHP1	Filter N_PRHP coefficient	S	V97U1602C	–
	CN_PRHP2	Filter N_PRHP coefficient	S	V97U1603C	–
	CN_PRHP3	Filter N_PRHP coefficient	S	V97U1604C	–
	CN_NYLAG1	Filter N_NYLAG coefficient	S	V97U1581C	–
	CN_NYLAG2	Filter N_NYLAG coefficient	S	V97U1582C	–
	CN_NYLAG3	Filter N_NYLAG coefficient	S	V97U1583C	–
	CN_NYSEP1	Filter N_NYSEP coefficient	S	V97U1584C	–
	CN_NYSEP2	Filter N_NYSEP coefficient	S	V97U1585C	–
	CN_NYSEP3	Filter N_NYSEP coefficient	S	V97U1586C	–
	CN_NYA11	Filter N_NYA coefficient	S	V97U1587C	–
	CN_NYA12	Filter N_NYA coefficient	S	V97U1588C	–
	CN_NYA13	Filter N_NYA coefficient	S	V97U1589C	–
	CN_NYA14	Filter N_NYA coefficient	S	V97U1590C	–
	CN_NYA15	Filter N_NYA coefficient	S	V97U1591C	–
	CN_NYA21	Filter N_NYA coefficient	S	V97U1592C	–
	CN_NYA22	Filter N_NYA coefficient	S	V97U1593C	–
	CN_NYA23	Filter N_NYA coefficient	S	V97U1594C	–
	CN_NYA24	Filter N_NYA coefficient	S	V97U1595C	–
	CN_NYA25	Filter N_NYA coefficient	S	V97U1596C	–
	CN_NYB11	Filter N_NYB coefficient	S	V97U1690C	–
	CN_NYB12	Filter N_NYB coefficient	S	V97U1691C	–
	CN_NYB13	Filter N_NYB coefficient	S	V97U1692C	–
	CN_NYB14	Filter N_NYB coefficient	S	V97U1693C	–
	CN_NYB15	Filter N_NYB coefficient	S	V97U1694C	–
	CN_NYB21	Filter N_NYB coefficient	S	V97U1695C	–
CN_NYB22	Filter N_NYB coefficient	S	V97U1696C	–	

Table 4.2.5-10. ASC_TVC_YAW I-Loads/Constants					
Module	Name	Description	Type	MSID/ Value	Units
	CN_NYB23	Filter N_NYB coefficient	S	V97U1697C	-
	CN_NYB24	Filter N_NYB coefficient	S	V97U1698C	-
	CN_NYB25	Filter N_NYB coefficient	S	V97U1699C	-
	CN_LLA1	Filter N_LLA coefficient	S	V97U1571C	-
	CN_LLA2	Filter N_LLA coefficient	S	V97U1572C	-
	CN_LLA3	Filter N_LLA coefficient	S	V97U1573C	-
	CN_LLA4	Filter N_LLA coefficient	S	V97U1574C	-
	CN_LLA5	Filter N_LLA coefficient	S	V97U1575C	-
	CN_RB11	Filter N_RB coefficient	S	V97U1605C	-
	CN_RB12	Filter N_RB coefficient	S	V97U1606C	-
	CN_RB13	Filter N_RB coefficient	S	V97U1607C	-
	CN_RB14	Filter N_RB coefficient	S	V97U1608C	-
	CN_RB15	Filter N_RB coefficient	S	V97U1609C	-
	CN_RB21	Filter N_RB coefficient	S	V97U1610C	-
	CN_RB22	Filter N_RB coefficient	S	V97U1611C	-
	CN_RB23	Filter N_RB coefficient	S	V97U1612C	-
	CN_RB24	Filter N_RB coefficient	S	V97U1613C	-
	CN_RB25	Filter N_RB coefficient	S	V97U1614C	-
	DEL_TWR_ CLR	Tower clear bias for SSME 2	S	V97U2440C	deg/s
	KN_ORB	Fixed blending gain of ORB RG	S	V99U9595C	-
	KN_BRG	Fixed blending gain of SRB RG	S	V99U9596C	-
	CN_RBA11	Filter N_RB coefficient	S	V99U9575C	-
	CN_RBA12	Filter N_RB coefficient	S	V99U9576C	-
	CN_RBA13	Filter N_RB coefficient	S	V99U9577C	-
	CN_RBA14	Filter N_RB coefficient	S	V99U9578C	-
	CN_RBA15	Filter N_RB coefficient	S	V99U9579C	-
	CN_RBA21	Filter N_RB coefficient	S	V99U9580C	-
	CN_RBA22	Filter N_RB coefficient	S	V99U9581C	-
	CN_RBA23	Filter N_RB coefficient	S	V99U9582C	-
	CN_RBA24	Filter N_RB coefficient	S	V99U9583C	-
	CN_RBA25	Filter N_RB coefficient	S	V99U9584C	-
	CN_RBB11	Filter N_RB coefficient	S	V99U9585C	-
	CN_RBB12	Filter N_RB coefficient	S	V99U9586C	-
	CN_RBB13	Filter N_RB coefficient	S	V99U9587C	-
	CN_RBB14	Filter N_RB coefficient	S	V99U9588C	-

Table 4.2.5-10. ASC_TVC_YAW I-Loads/Constants

Module	Name	Description	Type	MSID/ Value	Units
	CN_RBB15	Filter N_RB coefficient	S	V99U9589C	-
	CN_RBB21	Filter N_RB coefficient	S	V99U9590C	-
	CN_RBB22	Filter N_RB coefficient	S	V99U9591C	-
	CN_RBB23	Filter N_RB coefficient	S	V99U9592C	-
	CN_RBB24	Filter N_RB coefficient	S	V99U9593C	-
	CN_RBB25	Filter N_RB coefficient	S	V99U9594C	-
FDBK_ S2C_YAW	CN_RO11	Filter N_RO coefficient	S	V97U1645C	-
	CN_RO12	Filter N_RO coefficient	S	V97U1646C	-
	CN_RO13	Filter N_RO coefficient	S	V97U1647C	-
	CN_RO14	Filter N_RO coefficient	S	V97U1648C	-
	CN_RO15	Filter N_RO coefficient	S	V97U1649C	-
	CN_RO21	Filter N_RO coefficient	S	V97U1650C	-
	CN_RO22	Filter N_RO coefficient	S	V97U1651C	-
	CN_RO23	Filter N_RO coefficient	S	V97U1652C	-
	CN_RO24	Filter N_RO coefficient	S	V97C1653C	-
	CN_RO25	Filter N_RO coefficient	S	V97U1654C	-
	CN_LL11	Filter N_LL1 coefficient	S	V98U9572C	-
	CN_LL12	Filter N_LL1 coefficient	S	V98U9573C	-
	CN_LL13	Filter N_LL1 coefficient	S	V98U9574C	-
	CN_LL14	Filter N_LL1 coefficient	S	V98U9575C	-
	CN_LL15	Filter N_LL1 coefficient	S	V98U9576C	-
CMD_ YAW	CN_ROFF1	Filter N_ROFF coefficient	S	V97U2488C	-
	CN_ROFF2	Filter N_ROFF coefficient	S	V97U8889C	-
	CN_ROFF3	Filter N_ROFF coefficient	S	V97U2490C	-
	CN_ROFF4	Filter N_ROFF coefficient	S	V97U2491C	-
	CN_ROFF5	Filter N_ROFF coefficient	S	V97U2492C	-

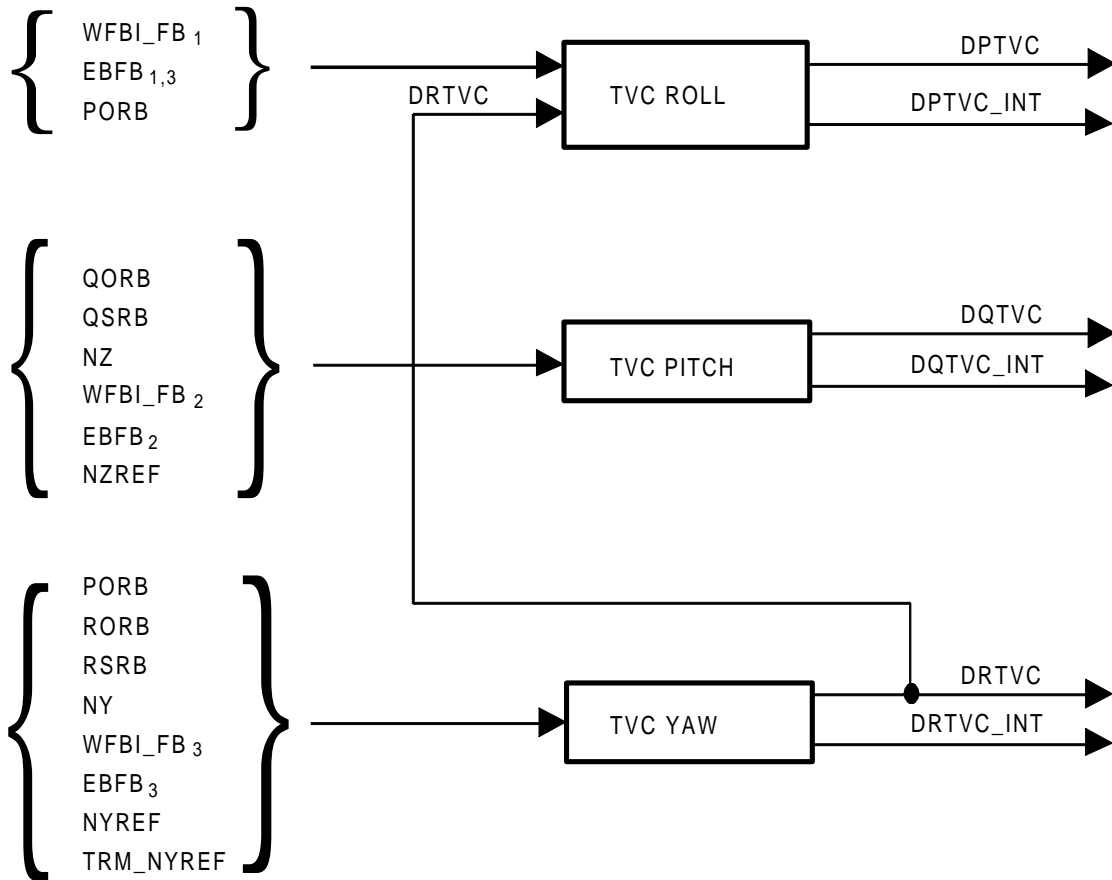


FIGURE 4.2.5-1A. Thrust Vector Control, Functional Overview

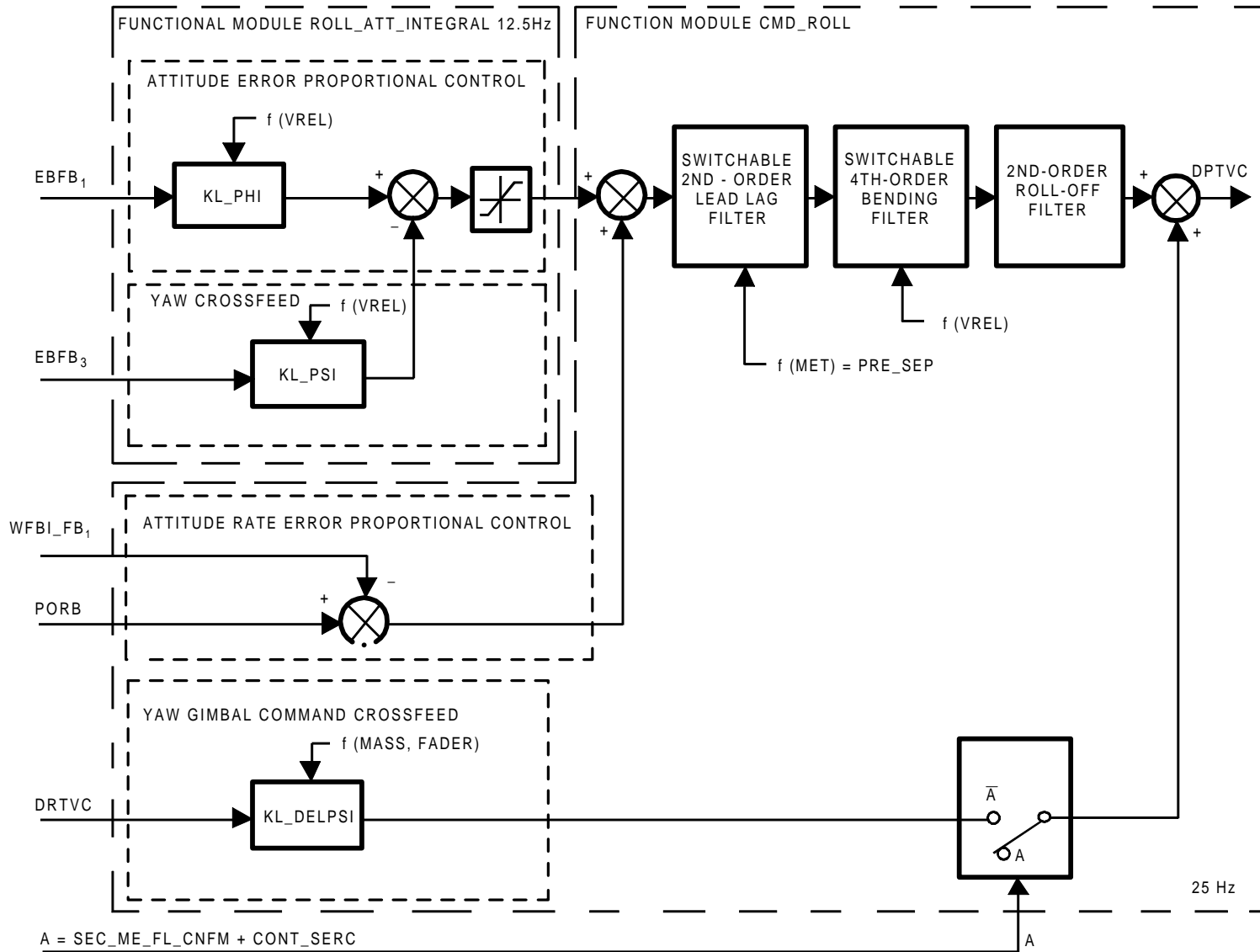


FIGURE 4.2.5-1B. TVC Roll Control, First Stage, Functional Block Diagram

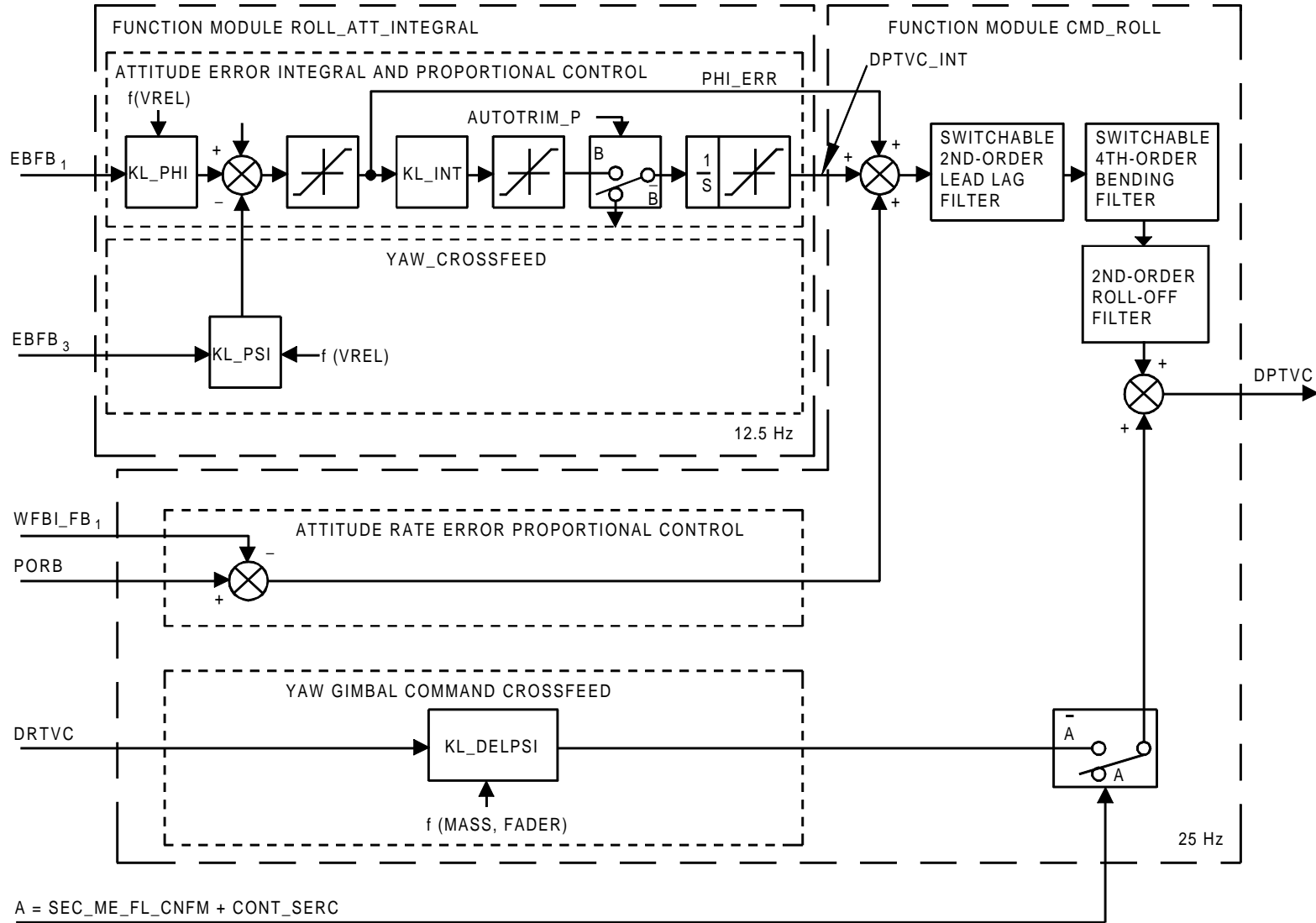


FIGURE 4.2.5-1C. TVC Roll Control, Second Stage, Functional Block Diagram

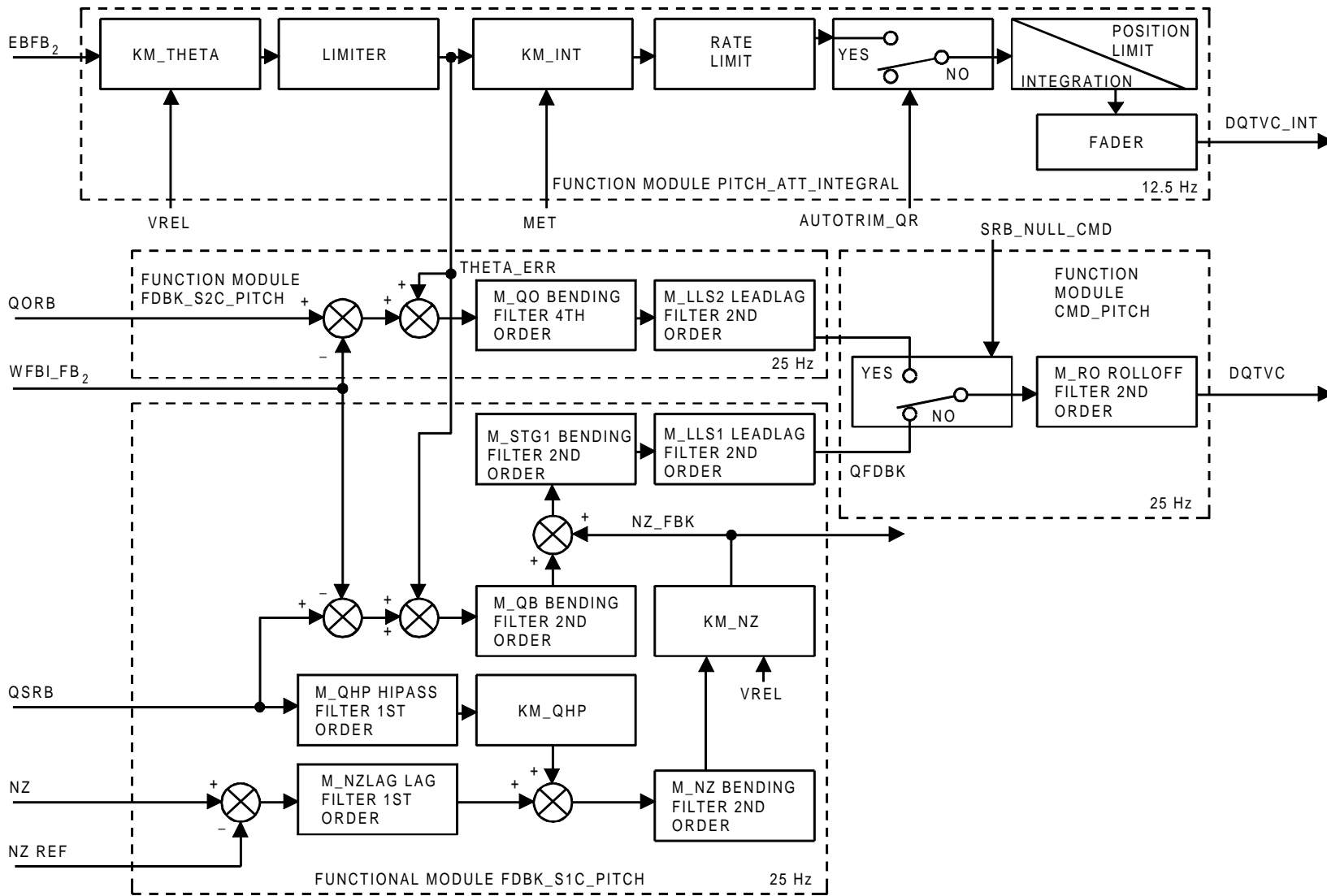


FIGURE 4.2.5.1D. TVC Pitch Control, First and Second Stages, Functional Block Diagram

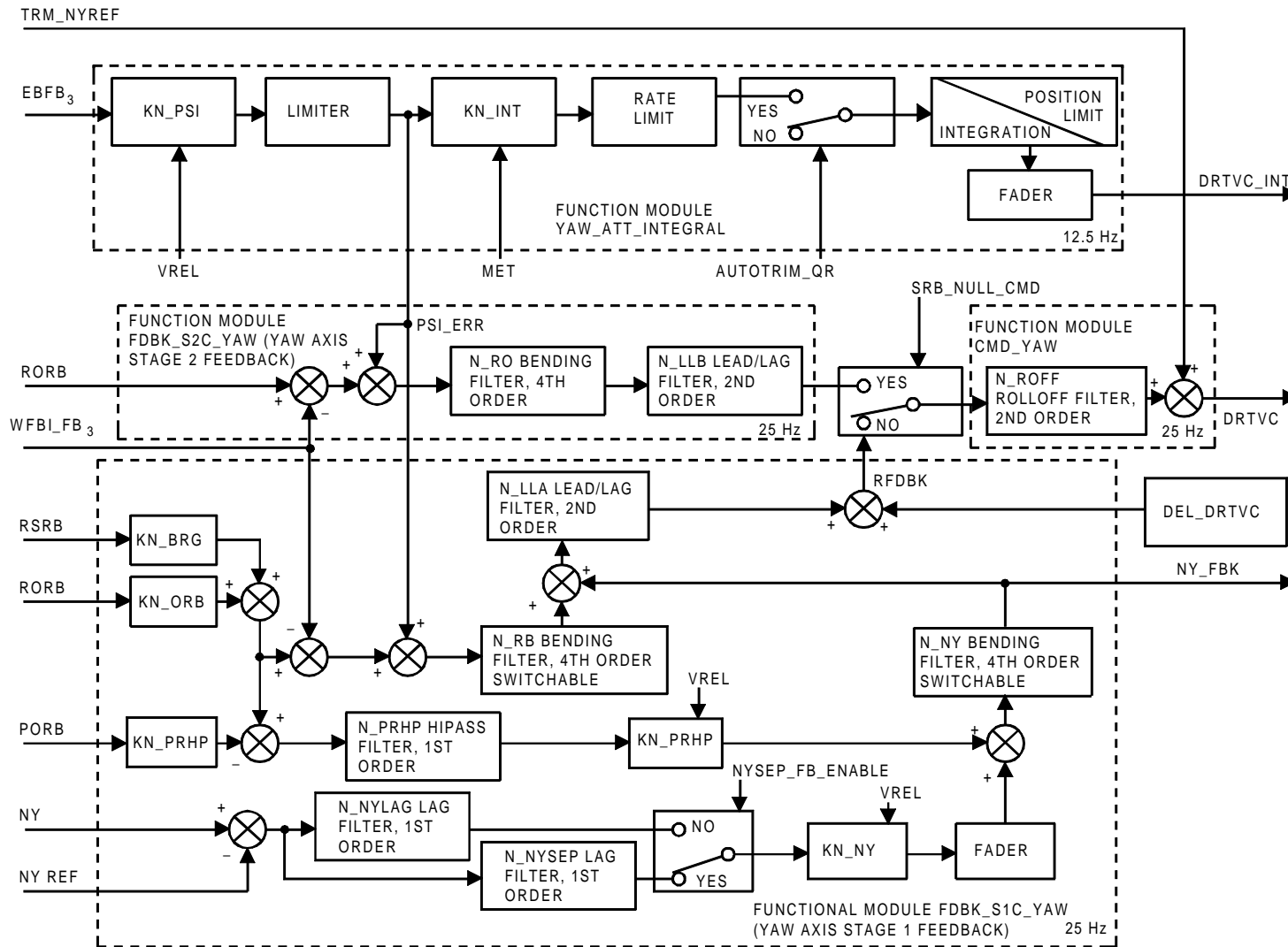


FIGURE 4.2.5-1E. TVC Yaw Control, First and Second Stages, Functional Block Diagram

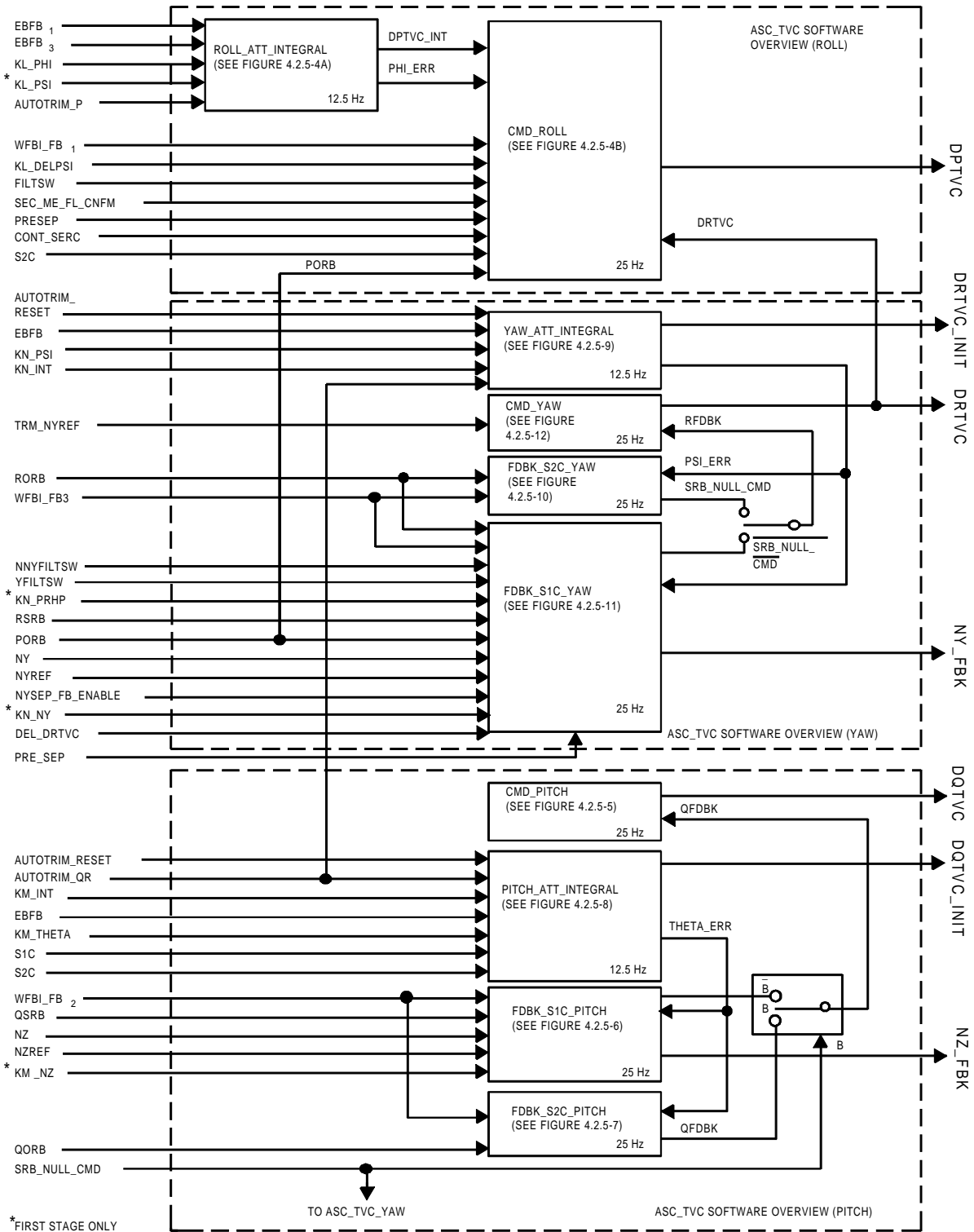
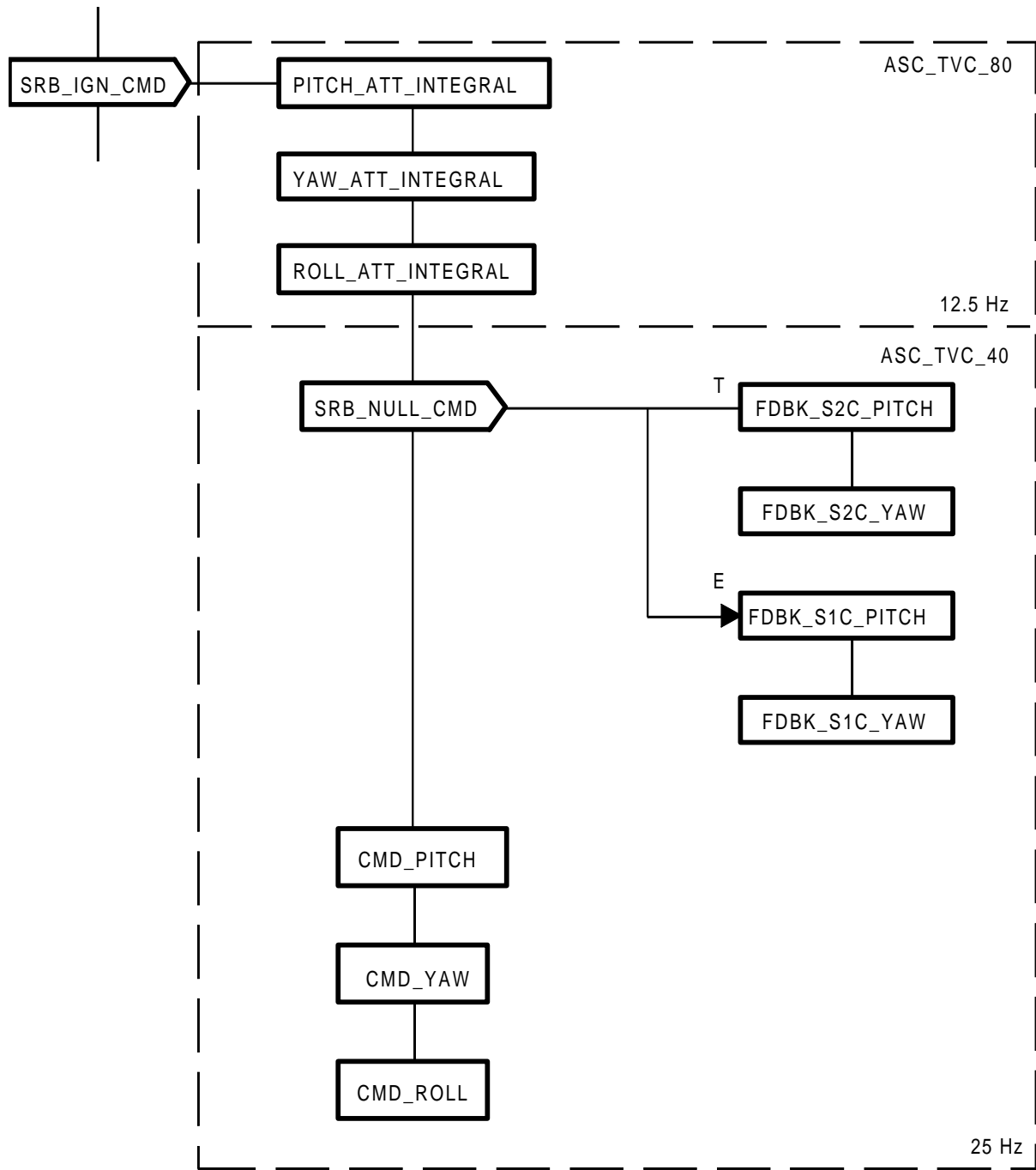


FIGURE 4.2.5-2. ASC_TVC Software Overview



① ASC_TVC_80 MUST BE EXECUTED IN THE CRITICAL LOOP PRIOR TO ASC_TVC_40.

FIGURE 4.2.5-3. ASC_TVC Sequencing Requirements

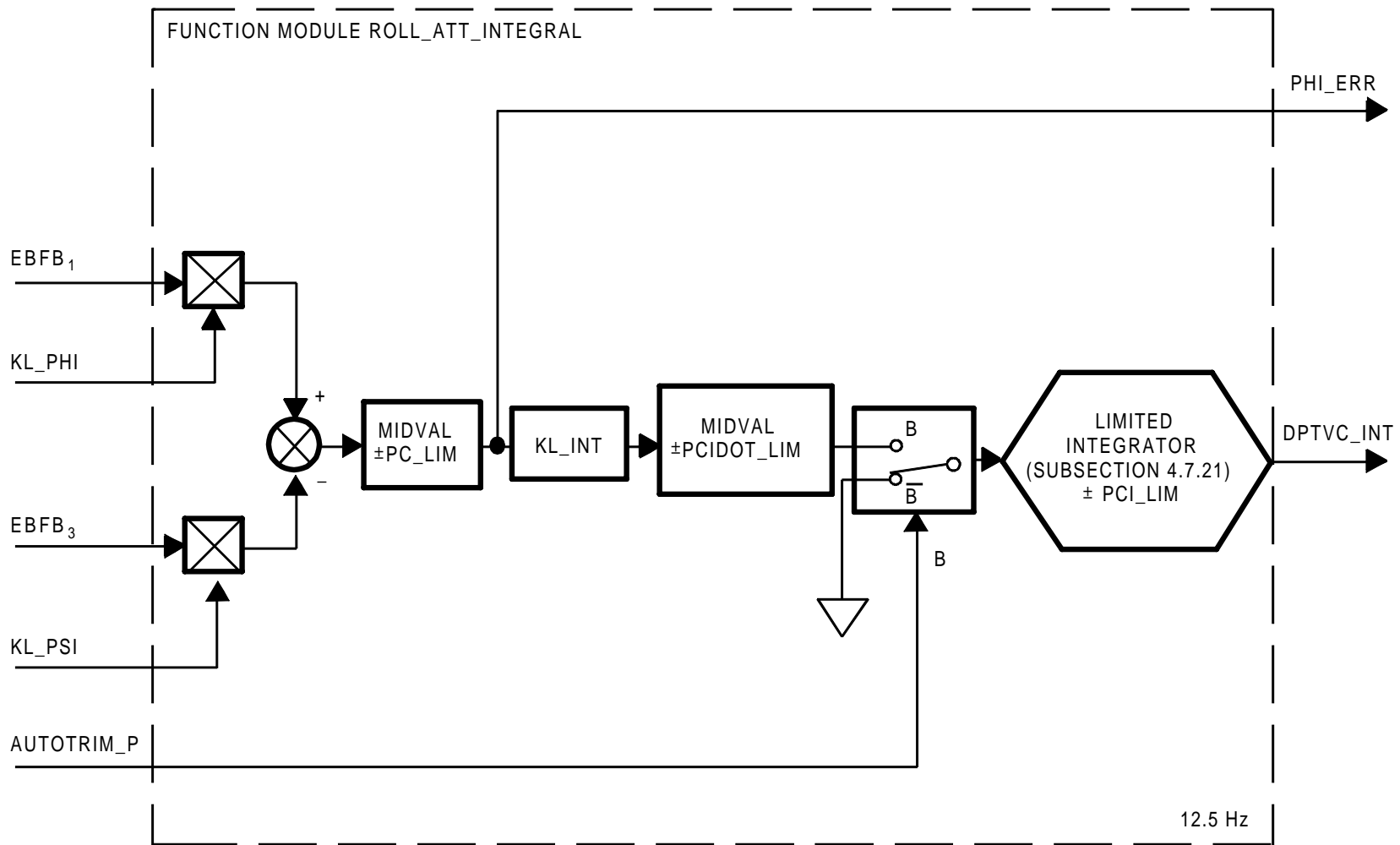
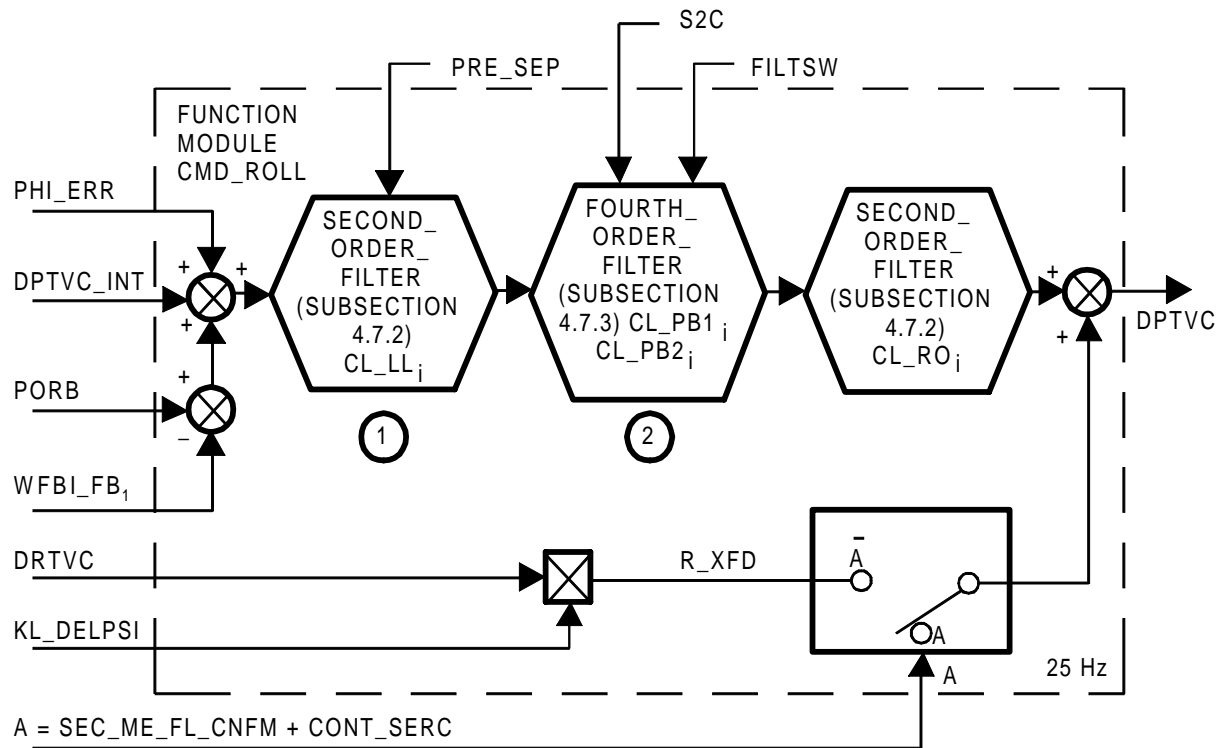


FIGURE 4.2.5-4A. Function Module ROLL_ATT_INTEGRAL, Detailed Diagram



① SWITCHABLE SECOND-ORDER FILTER

	$\overline{\text{PRE_SEP}}$	PRE_SEP
CL_LL _i	CL_LLA _i	CL_LL _B _i

where $i = 1 - 5$

② SWITCHABLE FOURTH-ORDER FILTER

	$\overline{\text{FILTSW}}$	FILTSW • $\overline{\text{S2C}}$	FILTSW • S2C
CL_PB1 _i	CL_PBA1 _i	CL_PBB1 _i	CL_PBC1 _i
CL_PB2 _i	CL_PBA2 _i	CL_PBB2 _i	CL_PBC2 _i

where $i = 1 - 5$

FIGURE 4.2.5-4B. Function Module, CMD_ROLL, Detailed Diagram

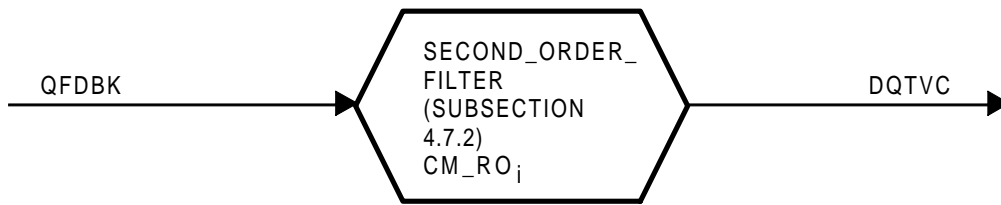


FIGURE 4.2.5-5. Function Module CMD_PITCH, Detailed Diagram

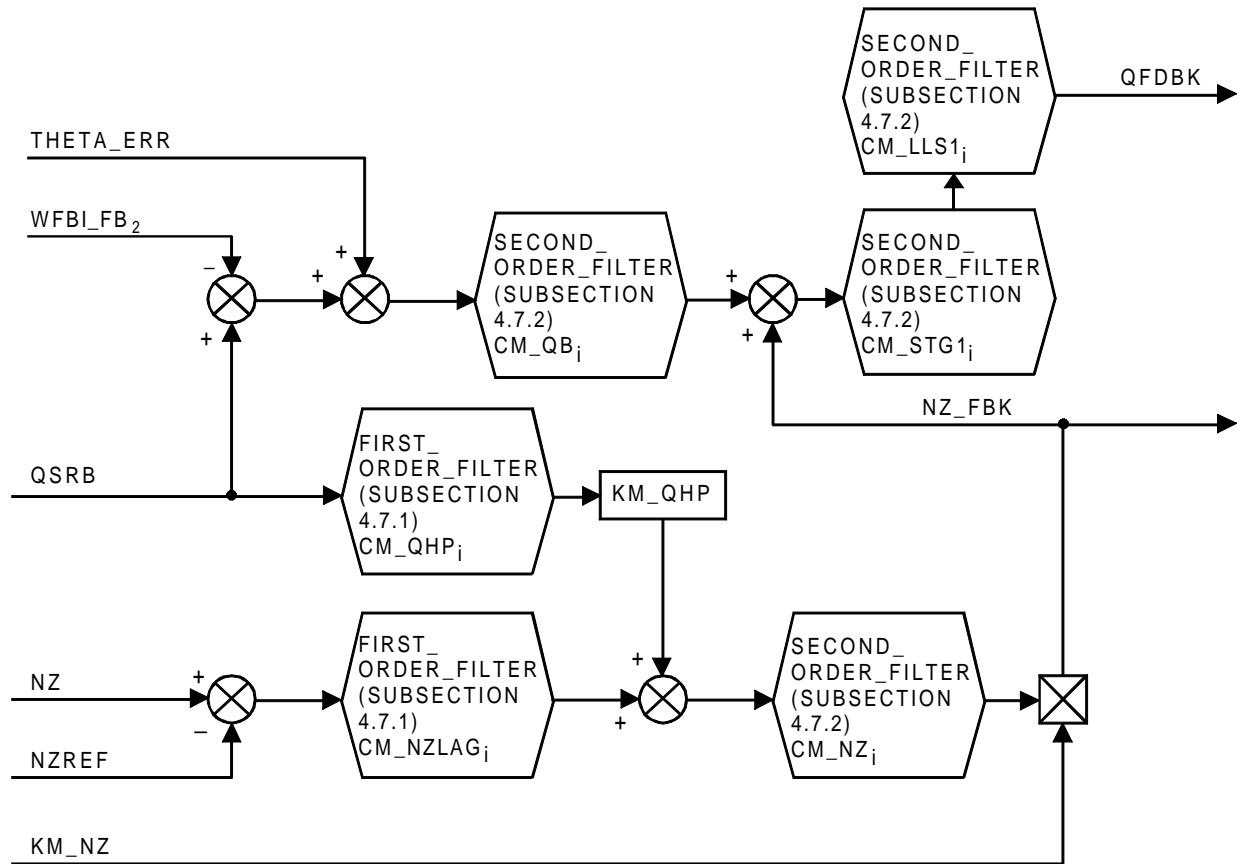


FIGURE 4.2.5-6. Function Module FDBK_S1C_PITCH, Detailed Diagram

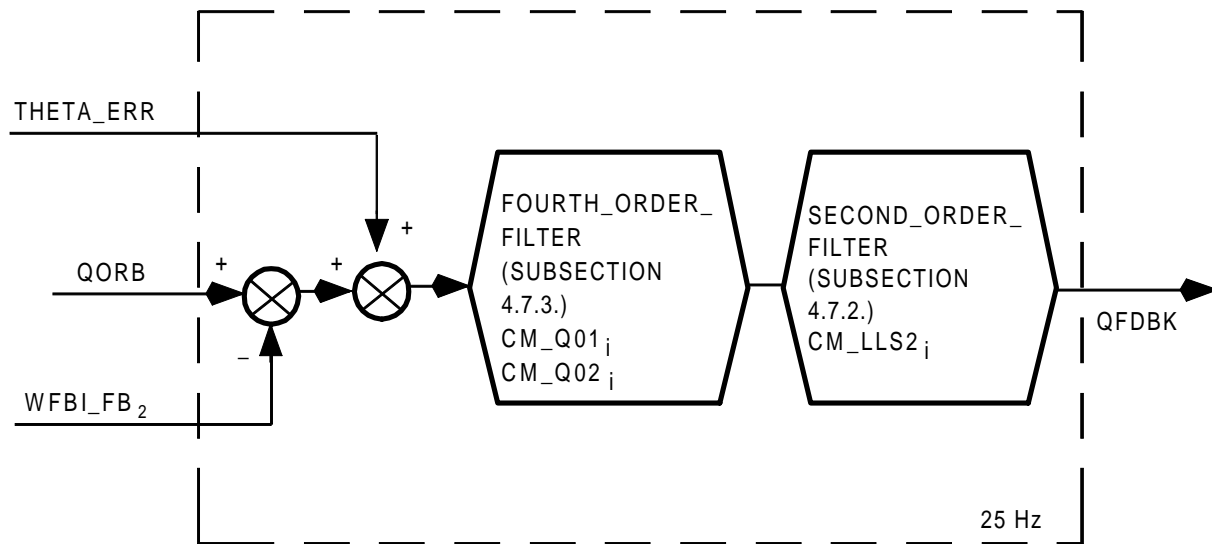
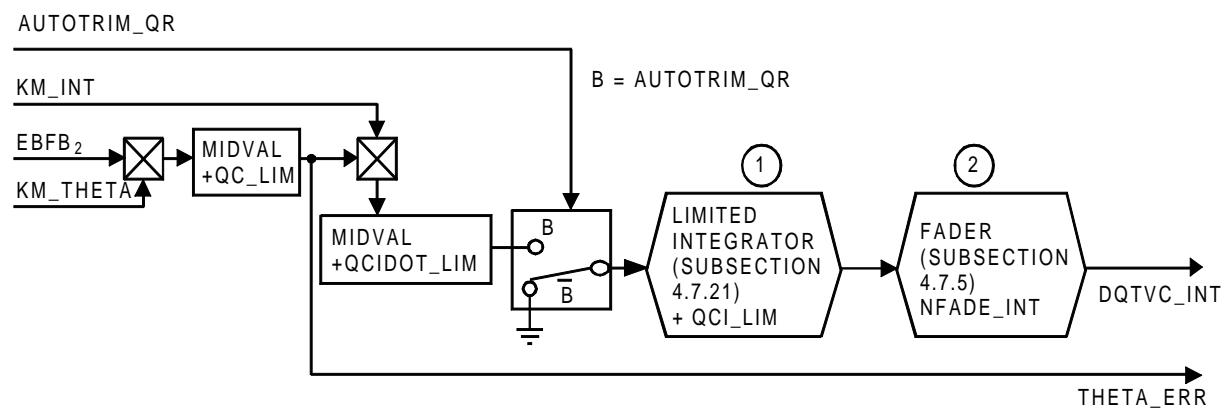


FIGURE 4.2.5-7. Function Module FDBK_S2C_PITCH, Detailed Diagram



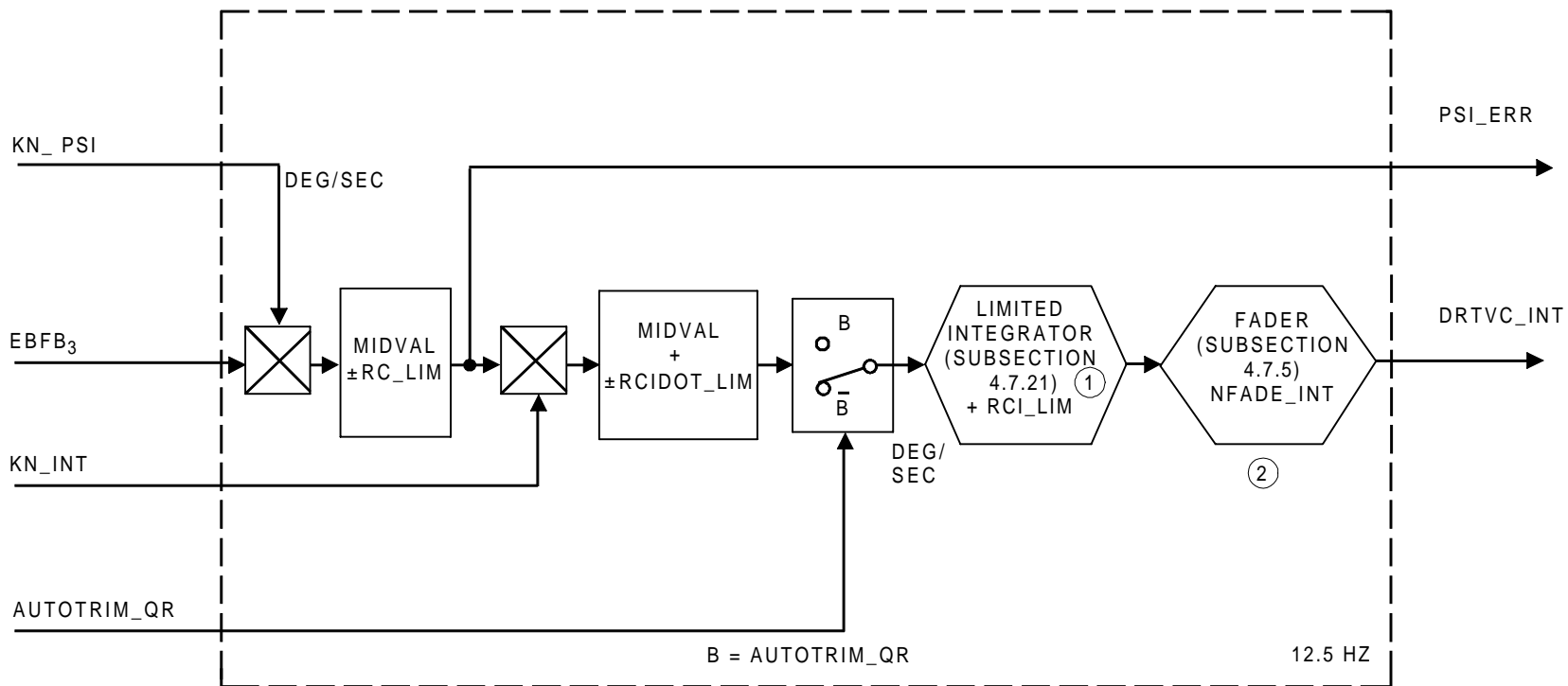
NOTES

①	S1C	S2C
	QCI_LIM	QCI_LIMS1

B: ON FROM EVENT 19B TO EVENT 21A
 AND FROM EVENT 29A TO EVENT 32

② FADE OUT AT AUTOTRIM_RESET

FIGURE 4.2.5-8. Function Module PITCH_ATT_INTEGRAL, Detailed Diagram



①	S1C	S2C
RCI_LIM	RCI_LIMS1	RCI_LIMS2

② FADE OUT AT AUTOTRIM_RESET

FIGURE 4.2.5-9. Function Module YAW_ATT_INTEGRAL, Detailed Diagram

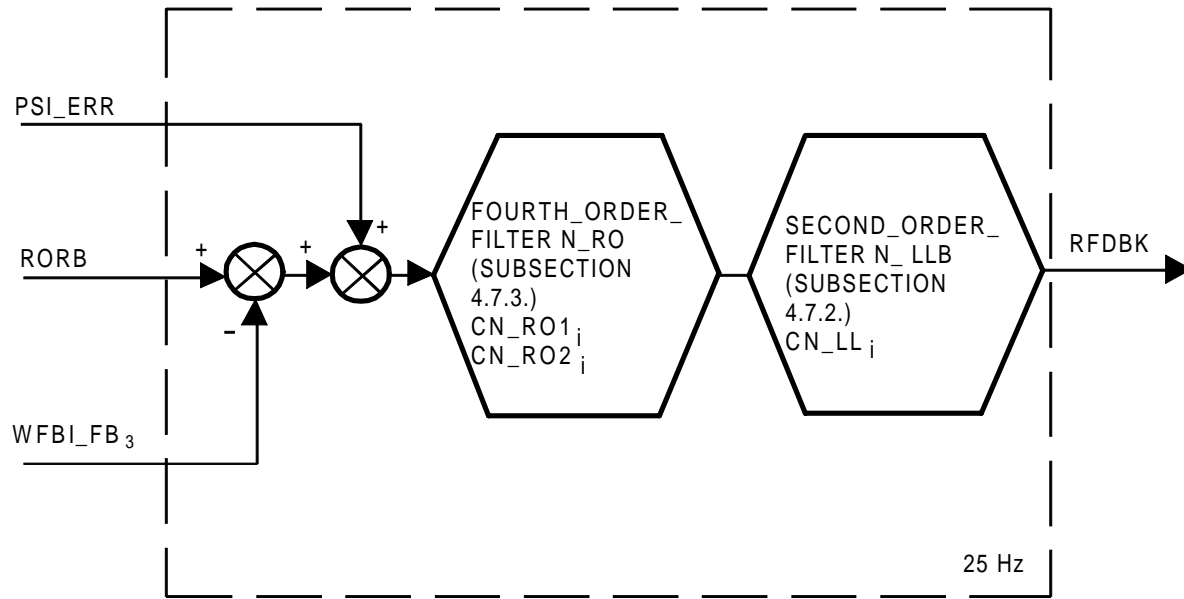


FIGURE 4.2.5-10. Function Module FDBK_S2C_YAW, Detailed Diagram

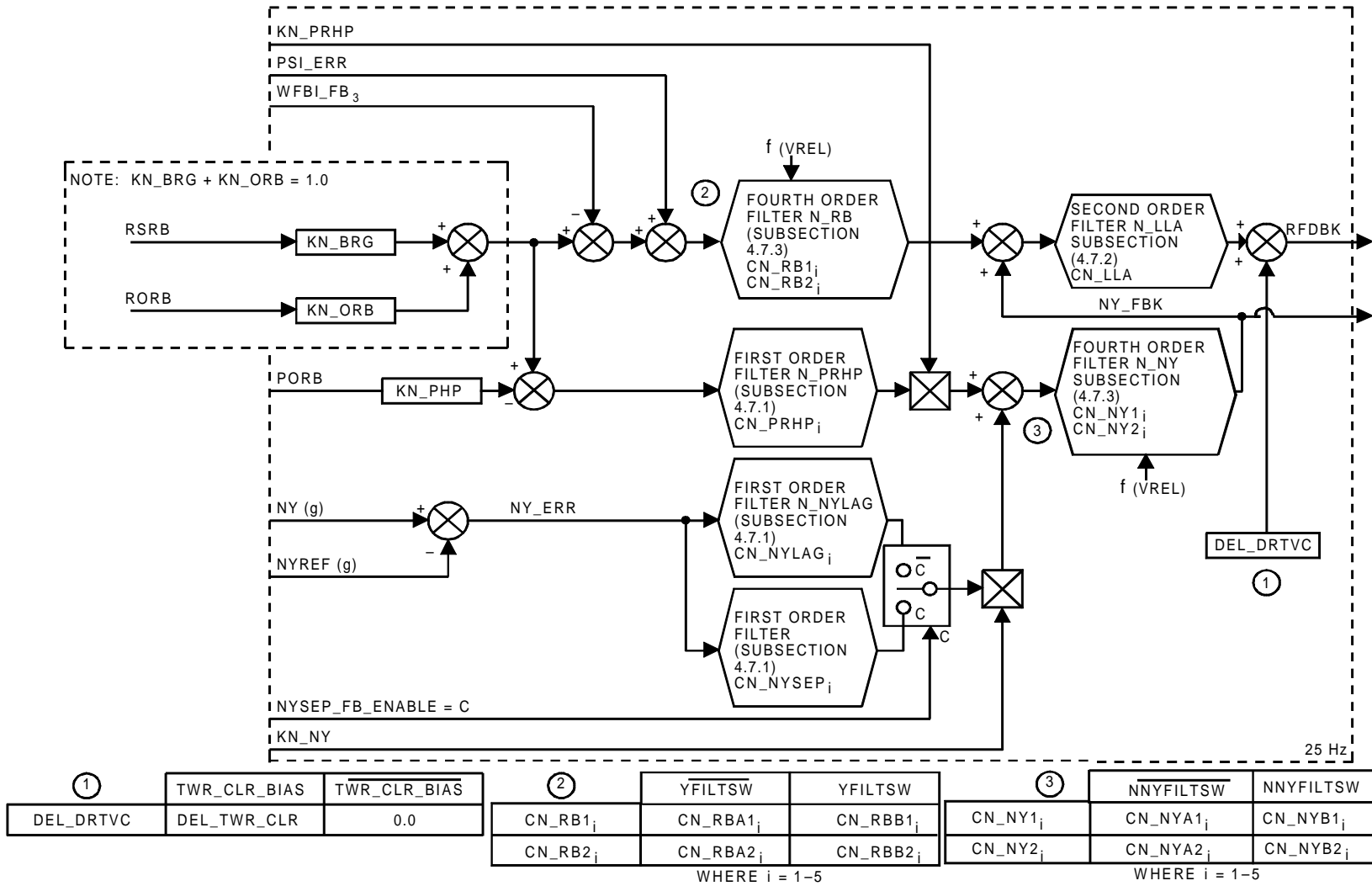


FIGURE 4.2.5-11. Function Module FDBK_S1C_YAW, Detailed Diagram

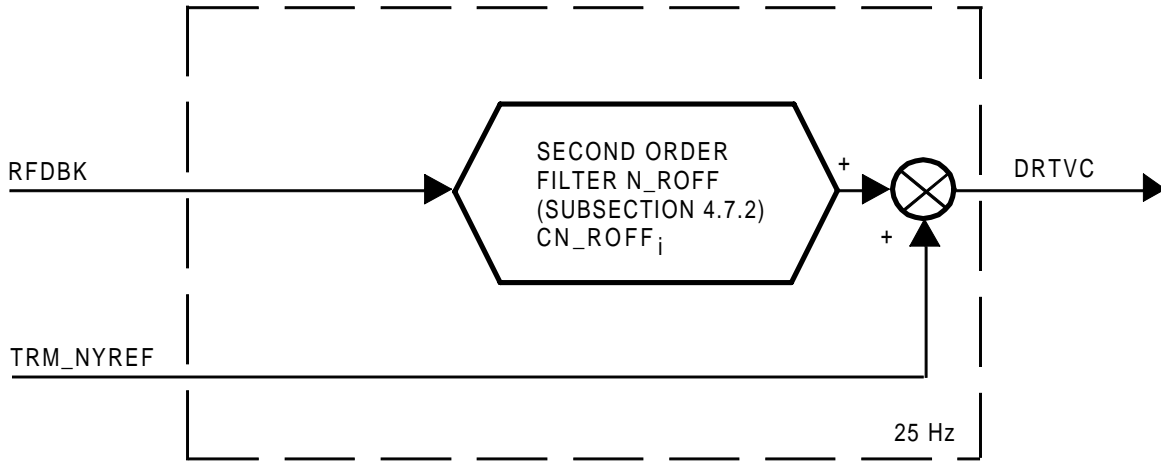


FIGURE 4.2.5-12. Function Module, CMD_YAW

4.2.6 MPS Command Processor (CMD_PROC_MPS)

A. Functional Description. The functional block diagram for CMD_PROC_MPS is shown in Figure 4.2.6-1. The functional requirements specification for priority rate limiting is given in Table 4.2.6-1. A functional flow chart for the priority rate limiting computations is shown in Figure 4.2.6-2.

B. Software Description. An overview of CMD_PROC_MPS is presented in Figure 4.2.6-3. Its input/output requirements are summarized in Table 4.2.6-2. CMD_PROC_MPS consists of three function modules, TRIM_MIX_MPS, BIAS_LIM_MPS, and PRL_MPS, which are sequenced as shown in Figure 4.2.6-4. The detailed block diagrams for the function modules TRIM_MIX_MPS, BIAS_LIM_MPS, and PRL_MPS are shown respectively in Figures 4.2.6-5, 4.2.6-6, and 4.2.6-7. The intermodule interface requirements for CMD_PROC_MPS are presented in Table 4.2.6-3, initialization requirements are presented in Table 4.2.6-4, and I-loads/constants are presented in Table 4.2.6-5.

Table 4.2.6-1. Functional Requirements Specification for Priority Rate Limiting of SSME Bell Deflection Commands From SRB SEP Command				
Hydraulic Sys Failed	Hydraulic Sys Oper	Actuator Rate Limit ① Equations ③ (\dot{Y}_i = Pitch i Actuator Rate, \dot{Z}_i = Yaw i Actuator Rate)	Rate Capability X (deg/sec)	
			Mode I ② SRB SEP CMD to MECO 100% APU – 0,1 Fail 110% APU – 2 Fail	Mode II MECO 100% APU – 0,1 Fail 110% APU – 2 Fail
None	1	$1.24 \dot{Y}_1 + \dot{Z}_2 = XC_1$	18.0 <u>(V97U2228C)</u> TF	15.8 <u>(V97U2225C)</u> TF
	2	$ \dot{Y}_2 + \dot{Z}_3 = XC_2$		
	3	$ \dot{Y}_3 + \dot{Z}_1 = XC_3$		
1	2	$ \dot{Y}_2 + \dot{Z}_2 + \dot{Z}_3 = XC_2$		
	3	$1.24 \dot{Y}_1 + \dot{Y}_3 + \dot{Z}_1 = XC_3$		
2	1	$1.24 \dot{Y}_1 + \dot{Y}_2 + \dot{Z}_2 = XC_1$		
	3	$ \dot{Y}_3 + \dot{Z}_1 + \dot{Z}_3 = XC_3$		
3	1	$1.24 \dot{Y}_1 + \dot{Z}_2 + \dot{Z}_1 = XC_1$		
	2	$ \dot{Y}_2 + \dot{Y}_3 + \dot{Z}_3 = XC_2$		
1&2	3	$1.24 \dot{Y}_1 + \dot{Z}_1 + \dot{Y}_3 + \dot{Z}_3 = XC_3$	18.6 <u>(V97U2227C)</u> TF	16.5 <u>(V97U2226C)</u> TF
1&3	2	$ \dot{Y}_2 + \dot{Z}_2 + \dot{Y}_3 + \dot{Z}_3 = XC_2$		
2&3	1	$1.24 \dot{Y}_1 + \dot{Z}_1 + \dot{Y}_2 + \dot{Z}_2 = XC_1$		

① If the sum of commands (XC) is less than the rate capability (X), ($XC \leq X$); then the actuator's rate = command rate. If $XC > X$, then the actuator's rate = (X/XC) * (commanded rate); an absolute rate limit of 10.0 deg/sec for each actuator is assumed downstream, i.e.,
 $|\dot{Y}_i| \leq 10.0$ deg/sec, $|\dot{Z}_i| \leq 10.0$ deg/sec.

② Includes Δ throttle effects

③ PRL is not executed in MM 102. Fixed actuator rate limits for MM 102 are given in Table 4.2.6-1a.

Table 4.2.6-1A. Functional Requirements Specification for SSME Bell Deflection Commands From Liftoff to SRB SEP Command		
Time or Event	Hydraulic System Failures	SSME TVC Actuator Rate Limit ^① (deg/sec)
Before Event 19C	None	$ \dot{Y}_i \leq (\text{RATE_CAPABILITY_LIFTOFF})/\text{TF}$,
	Any one	$ \dot{Z}_i \leq (\text{RATE_CAPABILITY_LIFTOFF})/\text{TF}$
Event 19C to SRB SEP command	None	$ \dot{Y}_i \leq (\text{RATE_CAPABILITY_NOFAILS})/\text{TF}$,
		$ \dot{Z}_i \leq (\text{RATE_CAPABILITY_NOFAILS})/\text{TF}$
	Any one	$ \dot{Y}_i \leq (\text{RATE_CAPABILITY_ONEFAIL})/\text{TF}$,
		$ \dot{Z}_i \leq (\text{RATE_CAPABILITY_ONEFAIL})/\text{TF}$
	Any two	$ \dot{Y}_i \leq (\text{RATE_CAPABILITY_TWOFAIL})/\text{TF}$,
		$ \dot{Z}_i \leq (\text{RATE_CAPABILITY_TWOFAIL})/\text{TF}$
SRB SEP command through Event 33B (ME_ZERO_THRUST)	See Table 4.2.6-1	Use PRL in Table 4.2.6-1.
① Includes Δ throttle and Δ elevon effects.		

Table 4.2.6-2. CMD_PROC_MPS Interface Requirements

Name	Description	Source or Destination	Type	Range	Units	Rate Required/ Produced At (Hz)
<u>Inputs</u>						
DPTVC	Roll TVC loop error signal	ASC_TVC	S		deg/s	25
DQTV	Pitch TVC loop error signal	ASC_TVC	S		deg/s	25
DRTVC	Yaw TVC loop error signal	ASC_TVC	S		deg/s	25
DQMPST	Pitch thrust vector deflection trim, MPS	INTERPS	S		deg	6.25
KL_MPS	Variable gain (roll rate, MPS)	INTERPS	S		deg/ (deg/s)	6.25
KM_MPS	Variable gain (pitch rate, MPS)	INTERPS	S		deg/ (deg/s)	6.25
KN_MPS	Variable gain (yaw rate, MPS)	INTERPS	S		deg/ (deg/s)	6.25
MPS_SLEW_CMD	MPS actuator slew position command	ORB_ACT_SLEW	S		–	25
SSME_FAILS	Indicator, main engine failures	ASC_RECON	B		–	12.5
SSME_START_POS	Indicator	ASC_RECON	B		–	12.5
ME_SLEW	Indicator	ASC_RECON	B		–	12.5
HYD_FAILS	Indicator, hydraulic system failure	ASC_RECON	I		–	12.5
PRL_MECO	Indicator	ASC_RECON	B		–	12.5
PRL_LCH	Indicator	ASC_RECON	B		–	12.5
FAIL_MIX_ENABLE	Indicator	ASC_RECON	B		–	12.5
PARALLEL_PITCH	Indicator	ASC_RECON	B		–	12.5
PRL_S2	Indicator, Stage 2 control	ASC_RECON	B		–	12.5
UNPARALLEL_YAW	Indicator	ASC_RECON	B		–	12.5

Table 4.2.6-2. CMD_PROC_MPS Interface Requirements						
Name	Description	Source or Destination	Type	Range	Units	Rate Required/Produced At (Hz)
<u>Inputs (Cont.)</u>						
DQTVC_INT	Pitch trim integ output	ASC_TVC	S		deg/s	25
DRTVC_INT	Yaw trim integ output	ASC_TVC	S		deg/s	25
MECO_CMD	Indicator	ASC_RECON	B		-	12.5
SSME_LCH_POS	Indicator	ASC_RECON	B		-	12.5
GRAV_POS	Indicator	ASC_RECON	B		-	12.5
DRMPST	Yaw thrust vector deflection trim, MPS	INTERPS	S		deg	6.25
ENA_RCS_CNTL	Indicator	ASC_RECON	B		-	12.5
MM101_INIT	Indicator	ASC_RECON	B		-	12.5
AUTOTRIM_RESET	Indicator	ASC_RECON	B		-	12.5
ME_RETRIM	Indicator, initiate trim and bias limit	ASC_RECON	B		-	12.5
PRELO	Indicator	ASC_RECON	B		-	12.5
P_BIAS_E1	Center engine pitch trim increment	INTERPS	S		deg	6.25
P_BIAS_E23	Side engine pitch trim increment	INTERPS	S		deg	6.25
PRL_S1	Indicator	ASC_RECON	B		-	12.5
SEC_ME_FL_CNFM	Indicator	ASC_RECON	B		-	12.5
<u>Outputs</u>						
DYC1	Engine bell deflection command SSME 1 pitch	MPS_TVC_CMD_SOP, TLM	S		deg	25
DZC1	Engine bell deflection command SSME 1 yaw	MPS_TVC_CMD_SOP, TLM	S		deg	25

Table 4.2.6-2. CMD_PROC_MPS Interface Requirements

Name	Description	Source or Destination	Type	Range	Units	Rate Required/ Produced At (Hz)
<u>Outputs (Cont.)</u>						
DYC2	Engine bell deflection command SSME 2 pitch	MPS_TVC_CMD_SOP, TLM, ASC 2STG GUID	S		deg	25
DZC2	Engine bell deflection command SSME 2 yaw	MPS_TVC_CMD_SOP, TLM	S		deg	25
DYC3	Engine bell deflection command SSME 3 pitch	MPS_TVC_CMD_SOP, TLM, ASC 2STG GUID	S		deg	25
DZC3	Engine bell deflection command SSME 3 yaw	MPS_TVC_CMD_SOP, TLM	S		deg	25
DP_ORB	Orbiter roll loop error signal	CMD_PROC_RCS	S		deg/s	25

Table 4.2.6-3.CMD_PROC_MPS Inter-Module Interface Requirements

Module	Name	Description	Source or Destination	Type	Range	Units	Rate Required/ Produced At (Hz)
TRIM_ MIX_MPS	<u>Inputs</u>						
	DPTVC	Roll TVC loop error signal	ASC_TVC	S		deg/s	25
	DQTVC	Pitch TVC loop error signal	ASC_TVC	S		deg/s	25
	DQTVC_INT	Pitch TVC integrator output	ASC_TVC	S		deg	12.5
	DRTVC	Yaw TVC loop error signal	ASC_TVC	S		deg/s	25
	DRTVC_INT	Yaw TVC integrator output	ASC_TVC	S		deg	12.5
	DQMPST	Pitch thrust vector deflection trim, MPS	INTERPS	S		deg	6.25
	DRMPST	Yaw thrust vector deflection trim, MPS	INTERPS	S		deg	6.25
	KL_MPS	Fixed gain (roll rate, MPS)	INTERPS	S		deg/ deg/s	6.25
	KM_MPS	Variable gain (pitch rate, MPS)	INTERPS	S		deg/ deg/s	6.25
	KN_MPS	Variable gain (yaw rate, MPS)	INTERPS	S		deg/ deg/s	6.25
	AUTOTRIM_RESET	Indicator	ASC_RECON	B		–	12.5
	MM101_INIT	Indicator	ASC_RECON	B		–	12.5
	FAIL_MIX_ENABLE	Indicator	ASC_RECON	B		–	12.5
	SSME_FAILS	Indicator	ASC_RECON	B		–	12.5
	SEC_ME_FL_CNFM	Indicator, 2nd SSME fail confirmed	ASC_RECON	B		–	12.5
	ENA_RCS_CNTL	Indicator	ASC_RECON	B		–	12.5
	HYD_FAILS	Indicator hydraulic system failure	ASC_RECON	I		–	12.5

Table 4.2.6-3.CMD_PROC_MPS Inter-Module Interface Requirements							
Module	Name	Description	Source or Destination	Type	Range	Units	Rate Required/Produced At (Hz)
TRIM_MIX_MPS (Cont.)	<u>Outputs</u>						
	DY1	Pitch command, SSME 1	BIAS_LIM_MPS	S		deg	25
	DZ1	Yaw command, SSME 1	BIAS_LIM_MPS	S		deg	25
	DY2	Pitch command, SSME 2	BIAS_LIM_MPS	S		deg	25
	DZ2	Yaw command, SSME 2	BIAS_LIM_MPS	S		deg	25
	DY3	Pitch command, SSME 3	BIAS_LIM_MPS	S		deg	25
	DZ3	Yaw command, SSME 3	BIAS_LIM_MPS	S		deg	25
	DP_ORB	Orbiter roll loop error signal	CMD_PROC_RCS	S		deg/s	25
BIAS_LIM_MPS	<u>Inputs</u>						
	DQMPST	Pitch thrust vector deflection trim, MPS	INTERPS	S		deg	6.25
	DY1	Pitch command, SSME 1	TRIM_MIX_MPS	S		deg	25
	DZ1	Yaw command, SSME 1	TRIM_MIX_MPS	S		deg	25
	DY2	Pitch command, SSME 2	TRIM_MIX_MPS	S		deg	25
	DZ2	Yaw command, SSME 2	TRIM_MIX_MPS	S		deg	25
	DY3	Pitch command, SSME 3	TRIM_MIX_MPS	S		deg	25
	DZ3	Yaw command, SSME 3	TRIM_MIX_MPS	S		deg	25
	MM101_INIT	Indicator	ASC_RECON	B		-	12.5
	GRAV_POS	Indicator	ASC_RECON	B		-	12.5
ME_RESTART	Indicator	ASC_RECON	B		-	12.5	

Table 4.2.6-3.CMD_PROC_MPS Inter-Module Interface Requirements

Module	Name	Description	Source or Destination	Type	Range	Units	Rate Required/ Produced At (Hz)	
BIAS_ LIM_MPS (Cont.)	<u>Inputs</u> (Cont.)							
	ME_RETRIM	Indicator, initiate trim and bias limit	ASC_RECON	B		-	12.5	
	SSME_START_POS	Indicator	ASC_RECON	B		-	12.5	
	SSME_LCH_POS	Indicator	ASC_RECON	B		-	12.5	
	SSME_FAILS	Indicator, main engine failure status	ASC_RECON	I		-	12.5	
	ME_SLEW	Indicator	ASC_RECON	B		-	12.5	
	PRL_LCH	Indicator	ASC_RECON	B		-	12.5	
	PARALLEL_PITCH	Indicator	ASC_RECON	B		-	12.5	
	PRL_MECO	Indicator	ASC_RECON	B		-	12.5	
	UNPARALLEL_YAW	Indicator	ASC_RECON	B		-	12.5	
	PRL_S1	Indicator	ASC_RECON	B		-	12.5	
	HYD_FAILS	Indicator	ASC_RECON	I		-	12.5	
	MPS_SLEW_CMD	MPS actuator slew position command	ORB_ACT_SLEW	S		-	25	
	PRL_S2	Indicator	ASC_RECON	B		-	12.5	
	SFY1	ME1 pitch rate scale factor	PRL_MPS	S			deg	12.5
	SFZ1	ME1 yaw rate scale factor	PRL_MPS	S			deg	12.5
	P_BIAS_E1	Center engine pitch trim increment	INTERPS	S			deg	6.25
	P_BIAS_E23	Side engine pitch trim increment	INTERPS	S			deg	6.25
	SFY2	ME2 pitch rate scale factor	PRL_MPS	S			deg	12.5
	SFZ2	ME2 yaw rate scale factor	PRL_MPS	S			deg	12.5

Table 4.2.6-3.CMD_PROC_MPS Inter-Module Interface Requirements								
Module	Name	Description	Source or Destination	Type	Range	Units	Rate Required/Produced At (Hz)	
BIAS LIM_MPS (Cont.)	SFY3	ME3 pitch rate scale factor	PRL_MPS	S		deg	12.5	
	SFZ3	ME3 yaw rate scale factor	PRL_MPS	S		deg	12.5	
	ENA_RCS_CNTL	Indicator	ASC_RECON	B		_	12.5	
	MECO_CMD	Indicator	ASC_RECON	B		-	12.5	
	<u>Outputs</u>							
	DYC1	Engine bell deflection command SSME 1 pitch	MPS_TVC_CMD_SOP	S		deg	25	
	DZC1	Engine bell deflection command SSME 1 yaw	MPS_TVC_CMD_SOP	S		deg	25	
	DYC2	Engine bell deflection command SSME 2 pitch	MPS_TVC_CMD_SOP, ASC 2STG GUID	S		deg	25	
	DZC2	Engine bell deflection command SSME 2 yaw	MPS_TVC_CMD_SOP	S		deg	25	
	DYC3	Engine bell deflection command SSME 3 pitch	MPS_TVC_CMD_SOP, ASC 2STG GUID	S		deg	25	
DZC3	Engine bell deflection command SSME 3 yaw	MPS_TVC_CMD_SOP	S		deg	25		
DEL_DYC1	Main engine bell deflection command increment without priority rate limiting	PRL_MPS	S		deg	25		
DEL_DZC1			S		deg	25		
DEL_DYC2			S		deg	25		
DEL_DZC2			S		deg	25		
DEL_DYC3			S		deg	25		
DEL_DZC3			S		deg	25		

Table 4.2.6-3.CMD_PROC_MPS Inter-Module Interface Requirements

Module	Name	Description	Source or Destination	Type	Range	Units	Rate Required/ Produced At (Hz)
PRL_MPS	<u>Inputs</u>						
	DEL_DYC1	ME1 pitch bell deflection command increment without priority rate limiting	BIAS_LIM_MPS	S		deg	25
	DEL_DZC1	ME1 yaw bell deflection command increment without priority rate limiting	BIAS_LIM_MPS	S		deg	25
	DEL_DYC2	ME2 pitch bell deflection command increment without priority rate limiting	BIAS_LIM_MPS	S		deg	25
	DEL_DZC2	ME2 yaw bell deflection command increment without priority rate limiting	BIAS_LIM_MPS	S		deg	25
	DEL_DYC3	ME3 pitch bell deflection command increment without priority rate limiting	BIAS_LIM_MPS	S		deg	25
	DEL_DZC3	ME3 yaw bell deflection command increment without priority rate limiting	BIAS_LIM_MPS	S		deg	25
	HYD_FAILS	Indicator	ASC_RECON	I		–	12.5
	MM101_INIT	Indicator	ASC_RECON	B		–	12.5
	PRL_MECO	Indicator	ASC_RECON	B		–	12.5
PRL_S2	Indicator	ASC_RECON	B		–	12.5	

Table 4.2.6-3.CMD_PROC_MPS Inter-Module Interface Requirements							
Module	Name	Description	Source or Destination	Type	Range	Units	Rate Required/ Produced At (Hz)
PRL_MPS (Cont.)	<u>Outputs</u>						
	SFY1	Rate scale factor, SSME 1 pitch	BIAS_LIM_ MPS	S		deg	25
	SFZ1	Rate scale factor, SSME 1 yaw	BIAS_LIM_ MPS	S		deg	25
	SFY2	Rate scale factor, SSME 2 pitch	BIAS_LIM_ MPS	S		deg	25
	SFZ2	Rate scale factor, SSME 2 yaw	BIAS_LIM_ MPS	S		deg	25
	SFY3	Rate scale factor, SSME 3 pitch	BIAS_LIM_ MPS	S		deg	25
	SFZ3	Rate scale factor, SSME 3 yaw	BIAS_LIM_ MPS	S		deg	25

Table 4.2.6-4.CMD_PROC_MPS Initialization Requirements

Module	Component	Initialize on Transition		Variable	Initial Value
		From	To		
TRIM_ MIX_MPS	Roll mixing gains		MM101_INIT	KPY1, KPZ23 KPZ1, DRMPST KPY23	0.0 KPZ1_NOM 0.0 1.0
		$\overline{\text{SRB_SEP_CMD}}$	SRB_SEP_CMD	DQMPST	DQMPST_S2_ TRIM
		$\overline{\text{SM}} \cdot \overline{\text{RC}} \cdot \overline{\text{F}} \cdot$ [(SF = 1 + 2 + 3) + HF > 3] + $\overline{\text{SM}} \cdot$ $\overline{\text{RC}} \cdot \text{F} \cdot (\text{SF} = 0)$ $\cdot (\text{HF} \leq 3)$	$\overline{\text{SM}} \cdot \overline{\text{RC}} \cdot \text{F} \cdot$ [(SF = 1 + 2 + 3) + HF > 3]	KPY23	KPY23_S2C
		$\overline{\text{SM}} \cdot \overline{\text{RC}} \cdot \overline{\text{A}} \cdot$ (SF = 0) \cdot (HF ≤ 3)	$\overline{\text{SM}} \cdot \overline{\text{RC}} \cdot \text{A} \cdot (\text{SF}$ = 0) \cdot (HF ≤ 3)	KPY23	KPY23_S2C
		$\overline{\text{SM}} \cdot \overline{\text{RC}} \cdot \overline{\text{F}} \cdot$ [(SF = 2 + 3) + (HF = 4 + 6)] + $\overline{\text{SM}} \cdot \overline{\text{RC}} \cdot \text{F} \cdot (\text{SF}$ = 0) $\cdot (\text{HF} \leq 3)$	$\overline{\text{SM}} \cdot \overline{\text{RC}} \cdot \text{F} \cdot$ [(SF = 2 + 3) + (HF = 4 + 6)]	KPZ1 KPZ23	KPZ1_FAIL23 KPZ23_FAIL23
		$\overline{\text{SM}} \cdot \overline{\text{RC}} \cdot \overline{\text{F}} \cdot$ [(SF = 3) + (HF = 6)] + $\overline{\text{SM}} \cdot \overline{\text{RC}} \cdot$ $\text{F} \cdot (\text{SF} = 0) \cdot$ (HF ≤ 3)	$\overline{\text{SM}} \cdot \overline{\text{RC}} \cdot \text{F} \cdot$ [(SF = 3) + (HF = 6)]	KPY1	KPY1_FAIL23
		$\overline{\text{SM}} \cdot \overline{\text{RC}} \cdot \overline{\text{F}} \cdot$ [(SF = 2) + (HF = 4)] + $\overline{\text{SM}} \cdot$ $\overline{\text{RC}} \cdot \text{F} \cdot (\text{SF} = 0)$ $\cdot (\text{HF} \leq 3)$	$\overline{\text{SM}} \cdot \overline{\text{RC}} \cdot \text{F} \cdot$ [(SF = 2) + (HF = 4)]	KPY1	-KPY1_FAIL23
		$\overline{\text{SM}} \cdot \overline{\text{RC}} \cdot \text{F} \cdot$ (SF = 0) \cdot (HF > 3)	$\overline{\text{SM}} \cdot \overline{\text{RC}} \cdot \text{F} \cdot$ (SF = 0) \cdot (HF ≤ 3)	KPY1, KPZ23 KPZ1	0.0 KPZ1_NOM
		$\overline{\text{SM}} \cdot \overline{\text{RC}} \cdot \overline{\text{A}} \cdot$ $\text{F} \cdot (\text{SF} = 0) \cdot$ (HF > 3)	$\overline{\text{SM}} \cdot \overline{\text{RC}} \cdot \overline{\text{A}} \cdot$ $\text{F} \cdot (\text{SF} = 0) \cdot$ (HF ≤ 3)	KPY23	1.0
		$\overline{\text{SM}} \cdot \overline{\text{RC}}$	SM + RC	KPY1 KPZ1, KPZ23 KPZ23	0.0 *** .35 -.35
$(\text{OPS6} \cdot \overline{\text{M}} +$ $\text{OPS1}) \cdot \overline{\text{RC}}$	$(\text{OPS6} \cdot \overline{\text{M}} +$ $\text{OPS1}) \cdot \overline{\text{RC}}$	KPY23	KPY23_SZC		

Table 4.2.6-4.CMD_PROC_MPS Initialization Requirements					
Module	Component	Initialize on Transition		Variable	Initial Value
		From	To		
TRIM_ MIX_MPS (Cont.)		$(\overline{M} \cdot OPS6 + OPS1) \cdot RC \cdot [(SF = 2 + 3) + (HF = 4 + 6)]$	$(\overline{M} \cdot OPS6 + OPS1) \cdot \overline{RC} \cdot [(SF = 2 + 3) + (HF = 4 + 6)]$	KPZ1 KPZ23	KPZ1_FAIL23 KPZ23_FAIL23
		$(\overline{M} \cdot OPS6 + OPS1) \cdot RC \cdot [(SF = 3) + (HF = 6)]$	$(\overline{M} \cdot OPS6 + OPS1) \cdot \overline{RC} \cdot [(SF = 3) + (HF = 6)]$	KPY1	KPY1_FAIL23
		$(\overline{M} \cdot OPS6 + OPS1) \cdot RC \cdot [(SF = 2) + (HF = 4)]$	$(\overline{M} \cdot OPS6 + OPS1) \cdot \overline{RC} \cdot [(SF = 2) + (HF = 4)]$	KPY1	-KPYP1_FAIL23
		$(\overline{M} \cdot OPS6 + OPS1) \cdot RC \cdot [(SF = 1) + (HF = 5) + (SF = 0) \cdot (HF \leq 3)]$	$(\overline{M} \cdot OPS6 + OPS1) \cdot \overline{RC} \cdot [(SF = 1) + (HF = 5) + (SF = 0) \cdot (HF \leq 3)]$	KPZ1 KPZ23	KPZ1_NOM 0.0
		WHERE, SF = SSME_FAILS HF = HYD_FAILS F = FAIL_MIX_ENABLE A = AUTOTRIM_RESET M = MECO_CMD SM = SEL_ME_FL_CNFM RC = ENA_RCS_CNTL			
BIAS_ LIM_MPS	Pitch bias offset	$\overline{\overline{PARALLEL_PITCH}} \cdot \overline{\overline{ENA_RCS_CNTL}}$	MM101_INIT $\overline{\overline{PARALLEL_PITCH}} \cdot (SSME_FAILS = 2 \text{ or } 3) \cdot \overline{\overline{ENA_RCS_CNTL}}$ $\overline{\overline{PARALLEL_PITCH}} \cdot (SSME_FAILS = 0) \cdot \overline{\overline{ENA_RCS_CNTL}}$	DY1_BIAS DY2_BIAS DY3_BIAS DY1_BIAS DY2_BIAS DY3_BIAS DY1_BIAS DY2_BIAS DY3_BIAS	* PITCH_BIAS_ PARALLEL -PITCH_BIAS_ PARALLEL -PITCH_BIAS_ PARALLEL +4 DEG -2 DEG -2 DEG

Table 4.2.6-4.CMD_PROC_MPS Initialization Requirements

Module	Component	Initialize on Transition		Variable	Initial Value	
		From	To			
BIAS_ LIM_MPS (Cont.)	MPS slew command scale factor	$\overline{\text{PARALLEL_PITCH}} \cdot \text{SSME_FAILS} < 4 \cdot \overline{\text{ENA_RCS_CNTL}}$	$\overline{\text{PARALLEL_PITCH}} + \text{SSME_FAILS} \geq 4$	DY1_BIAS DY2_BIAS DY3_BIAS	0.0 0.0 0.0	
		$\overline{\text{ENA_RCS_CNTL}}$	ENA_RCS_CNTL****	DY1_BIAS DY2_BIAS DY3_BIAS	0.0 0.0 0.0	
		–	MM101_INIT + SSME_START_POS	SF_MPS_SLEW	0.0	
		$\overline{\text{ME_SLEW}}$	$\overline{\text{ME_SLEW}}$	SF_MPS_SLEW	0.0	
		$\overline{\text{ME_SLEW}}$	ME_SLEW	SF_MPS_SLEW	SF_MPS_SLEW_NOM	
		Yaw bias offset	–	MM101_INIT	DZ2_BIAS DZ3_BIAS	*
			$\overline{\text{UNPARALLEL_YAW}} \cdot \overline{\text{ENA_RCS_CNTL}}$	$\text{UNPARALLEL_YAW} \cdot \overline{\text{ENA_RCS_CNTL}}$	DZ2_BIAS DZ3_BIAS	0.0 0.0
			$\overline{\text{MECO_CMD}}$	MECO_CMD	DZ2_BIAS DZ3_BIAS	0.0 0.0
			$\overline{\text{ENA_RCS_CNTL}}$	ENA_RCS_CNTL****	DZ2_BIAS DZ3_BIAS	0.0 0.0
			SSME_FAILS < 4	SSME_FAILS ≥ 4	DZ2_BIAS DZ3_BIAS	0.0 0.0
	Input commands		–	MM101_INIT	DY1 DZ1 DY2 DZ2 DY3 DZ3	0.0 0.0 0.0 0.0 0.0 0.0
		Bias offset	$\overline{\text{ME_SLEW}} \cdot (\text{SSME_LCH_POS})$	$\overline{\text{ME_SLEW}} \cdot (\text{SSME_LCH_POS})$	DY1_BIAS DY2_BIAS DY3_BIAS DZ2_BIAS DZ3_BIAS	0.0 0.0 0.0 0.0 0.0
			$\overline{\text{SSME_START_POS}}$	SSME_START_POS	DY1_BIAS DY2_BIAS DY3_BIAS DZ2_BIAS DZ3_BIAS	DY1_START DY2_START DY3_START DZ2_START DZ3_START

Table 4.2.6-4.CMD_PROC_MPS Initialization Requirements					
Module	Component	Initialize on Transition		Variable	Initial Value
		From	To		
BIAS_LIM_MPS (Cont.)	SSME rate limit increments Rate limit increment SSME No. 1, 2 or 3	$\overline{SSME_LCH_POS}$	SSME_LCH_POS	DY1_BIAS DY2_BIAS DY3_BIAS DZ2_BIAS DZ3_BIAS	0.0 0.0 0.0 -YAW_BIAS_NOM + YAW_BIAS_NOM
			MM101_INIT	ME1_RLIM_TF ME2_RLIM_TF ME3_RLIM_TF	⑦
		(SSME_FAILS = 0)	(SSME_FAILS = i), i = 1, 2, 3	MEi_RLIM_TF i = 1, 2, 3	②
		$\overline{PRL_S1} + (HYD_FAILS = 0)$	(SSME_FAILS = 0) • PRL_S1 • (HYD_FAILS = 0)	MEi_RLIM_TF	⑧
		$\overline{PRL_S1} + HYD_FAILS \neq 1,2,3$	(SSME_FAILS = 0) • PRL_S1 • (HYD_FAILS = 1 or 2, or 3)	MEi_RLIM_TF	⑨
		$\overline{PRL_S1} + HYD_FAILS \neq 4$	(SSME_FAILS = 0) • PRL_S1 • (HYD_FAILS ≥ 4)	MEi_RLIM_TF	⑩
		(SSME_FAILS = 0) • PRL_S1	(SSME_FAILS = 0) • PRL_S1	MEi_RLIM_TF	①
		(SSME_FAILS = 0) • PRL_S1 • (HYD_FAILS = 0)	(SSME_FAILS = 0) • PRL_S1 • (HYD_FAILS = 1 or 2, or 3)	MEi_RLIM_TF	⑨
		$\overline{ME_RESTART_POS}$	ME_RESTART_POS	ME1_RLIM_TF ME2_RLIM_TF ME3_RLIM_TF	⑦
		SSME_FAILS = 0	SSME_FAILS ≥ 4	MEi_RLIM_TF i = **	②

Table 4.2.6-4.CMD_PROC_MPS Initialization Requirements

Module	Component	Initialize on Transition		Variable	Initial Value
		From	To		
BIAS_ LIM_MPS (Cont.)	Engine bell deflection commands	$\overline{\text{GRAV_POS}}$	GRAV_POS	DYC1 DZC1 DYC2 DZC2 DYC3 DZC3	DY1_GRAV 0.0 DY2_GRAV DZ2_GRAV DY3_GRAV DZ3_GRAV
PRL_MPS		$\text{PRL_S1} \cdot (\text{HYD_FAILS} < 4)$	PRL_S2	X_TF	③
		$\text{PRL_S2} \cdot (\text{HYD_FAILS} < 4)$	PRL_MECO	X_TF	⑤
		$\text{PRL_S1} + \text{HYD_FAILS} < 4$	$\text{PRL_S2} \cdot \text{HYD_FAILS} \geq 4$	X_TF	④
		$\text{PRL_S2} + (\text{HYD_FAILS} < 4)$	$\text{PRL_MECO} \cdot (\text{HYD_FAILS} \geq 4)$	X_TF	⑥
	Rate scale factors	–	MM101_INIT	SFY1 SFZ1 SFY2 SFZ2 SFY3 SFZ3	1.0 1.0 1.0 1.0 1.0 1.0
<p>* Carry over values from GNC OPS 9 (V4.18) ** On lowest numbered failed engine only *** If ENA_RCS_CNTL = ON, these gains take precedence. If ENA_RCS_CNTL switches from ON to OFF, the gains switch to whichever column of gains is logically true (see Figure 4.2.6-5). An exception to this is when the switch occurs as a result of MECO_CMD during RTLS abort (Event A35). For this case, do not switch the gains at or after MECO_CMD for any reason. **** Once ENA_RCS_CNTL = ON, all the MPS biases are latched to zero until zero thrust.</p>					
① SSME_RLIM_NOM		⑥ RATE_CAPABILITY_MECO_2_FAILS			
② SSME_RLIM_FAIL		⑦ RATE_CAPABILITY_LIFTOFF			
③ RATE_CAPABILITY_NOM_SYSO_1		⑧ RATE_CAPABILITY_NOFAILS			
④ RATE_CAPABILITY_NOM_2		⑨ RATE_CAPABILITY_ONEFAIL			
⑤ RATE_CAPABILITY_MECO		⑩ RATE_CAPABILITY_TWOFAIL			

Table 4.2.6-5.CMD_PROC_MPS I-Loads/Constants/K-Loads					
Module	Name	Description	Type	MSID/ Value	Units
TRIM_MIX_MPS	DQMPSP_LIM	Pitch axis authority limit	S	V97U1689C	deg
	DRMPSP_LIM	Yaw axis authority limit	S	V97U1775C	deg
	DPY1_LIM	Roll axis authority limit, SSME 1 pitch	S	V97U1685C	deg
	DPZ1_LIM	Roll axis authority limit, SSME 1 yaw	S	V97U1687C	deg
	DPY23_LIM	Roll axis authority limit, SSME 2 and 3 pitch	S	V97U1686C	deg
	DPZ23_LIM	Roll axis authority limit, SSME 2 and 3 yaw	S	V97U1688C	deg
	KPZ1_NOM	Roll axis mixing gain, nominal, for SSME 1 yaw actuator	S	V97U2039C	deg/ deg
	KPZ1_FAIL23	Roll axis mixing gain, ME 2 or 3 fail, for yaw actuator	S	V97U2038C	deg/ deg
	KPY23_S2C	Roll axis mixing gain, for SSME 2 and 3 pitch actuator	S	V97U2037C	deg/ deg
	KPZ23_FAIL23	Roll axis mixing gain, SSME 2 or 3 fail, for SSME 2 and yaw actuator	S	V97U2040C	deg/ deg
	KPY1_FAIL23	Roll axis mixing gain, SSME 1 or 3 fail, for SSME 1 pitch actuator	S	V97U2036C	deg/ deg
	DQMPST_S2_TRIM	Initial second stage pitch trim angle	S	V97U1933C	deg
BIAS_LIM_MPS	PITCH_BIAS_PARALLEL	Nozzle pitch bias for paralleling	S	V97U2208C	deg
	YAW_BIAS_NOM	Nominal nozzle yaw bias	S	V97U2325C	deg
	DY1_START	Nozzle ignition position	S	V97U1782C	deg
	DY2_START	Nozzle ignition position	S	V97U1784C	deg
	DZ2_START	Nozzle ignition position	S	V97U1788C	deg
	DY3_START	Nozzle ignition position	S	V97U1786C	deg
	DZ3_START	Nozzle ignition position	S	V97U1790C	deg
	SSME_RLIM_FAIL	Rate limit SSME failure, LCH through MECO	S	V97U2493C	deg/ cycle
	SSME_RLIM_NOM	Nominal SSME rate limit	S	V97U2494C	deg/ cycle
	SF_MPS_SLEW_NOM	Scale factor for SSME slew command	S	V97U2242C	deg
	RATE_CAPABILITY_NOFAILS	Nominal hydraulic system rate capability for Systems 1 and 2 under condition of no failures	S	V97U2495C	deg/ cycle

Table 4.2.6-5.CMD_PROC_MPS I-Loads/Constants/K-Loads					
Module	Name	Description	Type	MSID/ Value	Units
BIAS_LIM_MPS (Cont.)	TF	Fast cycle update interval	S	0.04	s
	DYLIM	Pitch engine bell limit	S	V97U1360C	deg
	DZLIM	Yaw engine bell limit	S	V97U1361C	deg
	KDYZ1	SSME 1/OMS CLR	S	13.7	deg
	RATE_CAPABILITY_ LIFTOFF	Rate limits prior to Event 19C	S	V97U2496C	deg/ cycle
	RATE_CAPABILITY_ ONEFAIL	Rate limit Stage 1, one failure	S	V97U2497C	deg/ cycle
	RATE_CAPABILITY_ TWOFAIL	Rate limit Stage 1, two failures	S	V97U2498C	deg/ cycle
	DY1_FAIL	Nozzle fail position	S	V97U1781C	deg
	DY2_FAIL	Nozzle fail position	S	V97U1783C	deg
	DZ2_FAIL	Nozzle fail position	S	V97U1787C	deg
	DY3_FAIL	Nozzle fail position	S	V97U1785C	deg
	DZ3_FAIL	Nozzle fail position	S	V97U1789C	deg
	DY1_GRAV	Nozzle gravity position	S	V96U7984C	deg
	DY2_GRAV	Nozzle gravity position	S	V96U7985C	deg
	DZ2_GRAV	Nozzle gravity position	S	V96U7987C	deg
	DY3_GRAV	Nozzle gravity position	S	V96U7986C	deg
	DZ3_GRAV	Nozzle gravity position	S	V96U7988C	deg
	PITCH_BIAS_LIMIT	Limit for SSME #1 pitch trim authority	S	V97U0874C	deg
PRL_MPS	RATE_CAPABILITY_ NOM_SYSO_1	Nominal hydraulic system rate capability under condition of no failures or one failure	S	V97U2228C	deg/ cycle
	RATE_CAPABILITY_ NOM_2	Nominal hydraulic system rate capability under conditions of two failures	S	V97U2227C	deg/ cycle
	TF	Fast cycle update interval	S	0.04	sec
	RATE_CAPABILITY_ MECO	Hydraulic system rate capability under conditions of MECO and no failure or one failure	S	V97U2225C	deg/ cycle
	RATE_CAPABILITY_ MECO_2_FAILS	Hydraulic system rate capability under conditions of MECO and two failures	S	V97U2226C	deg/ cycle

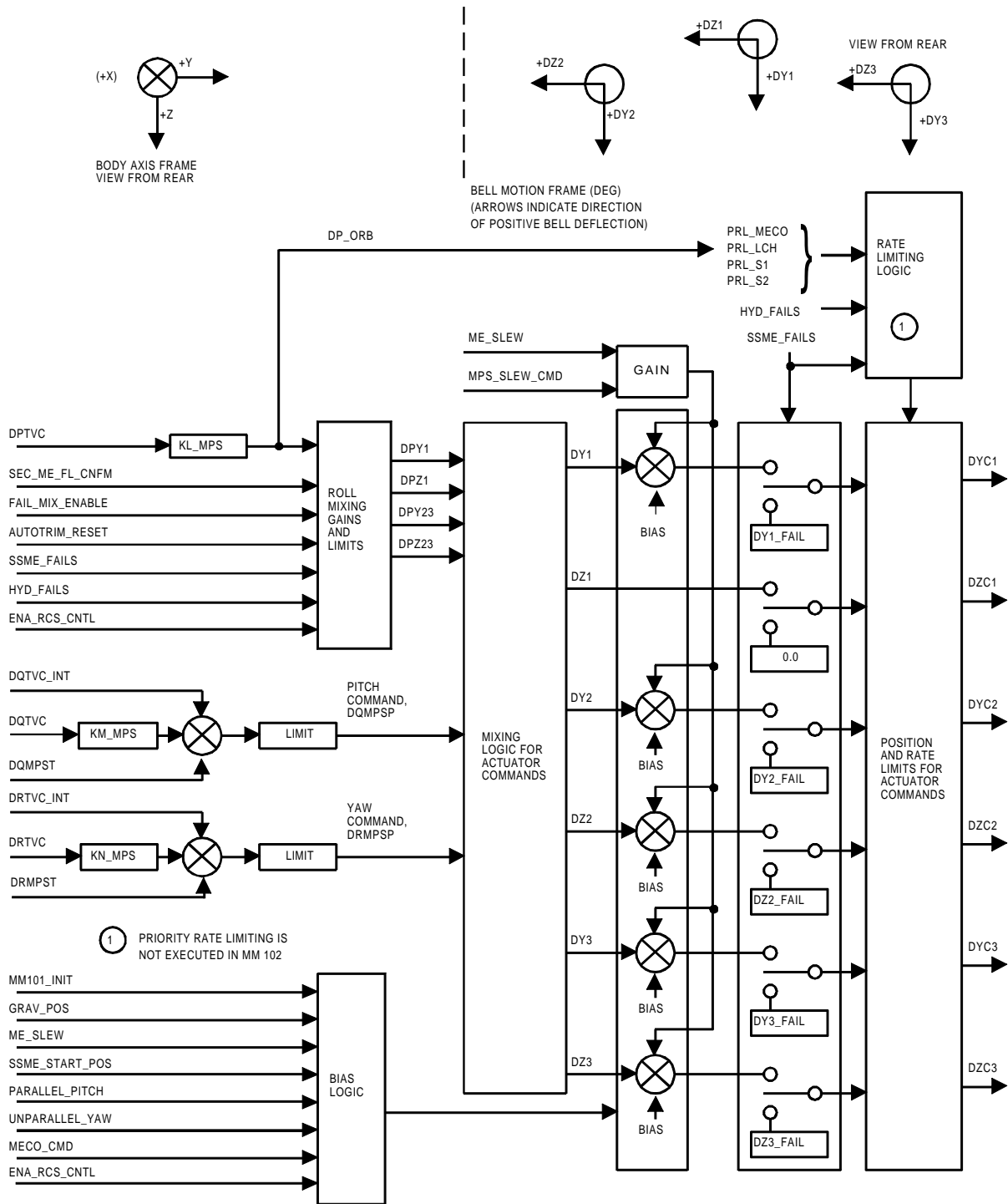


FIGURE 4.2.6-1. MPS Command Processor, Functional Overview

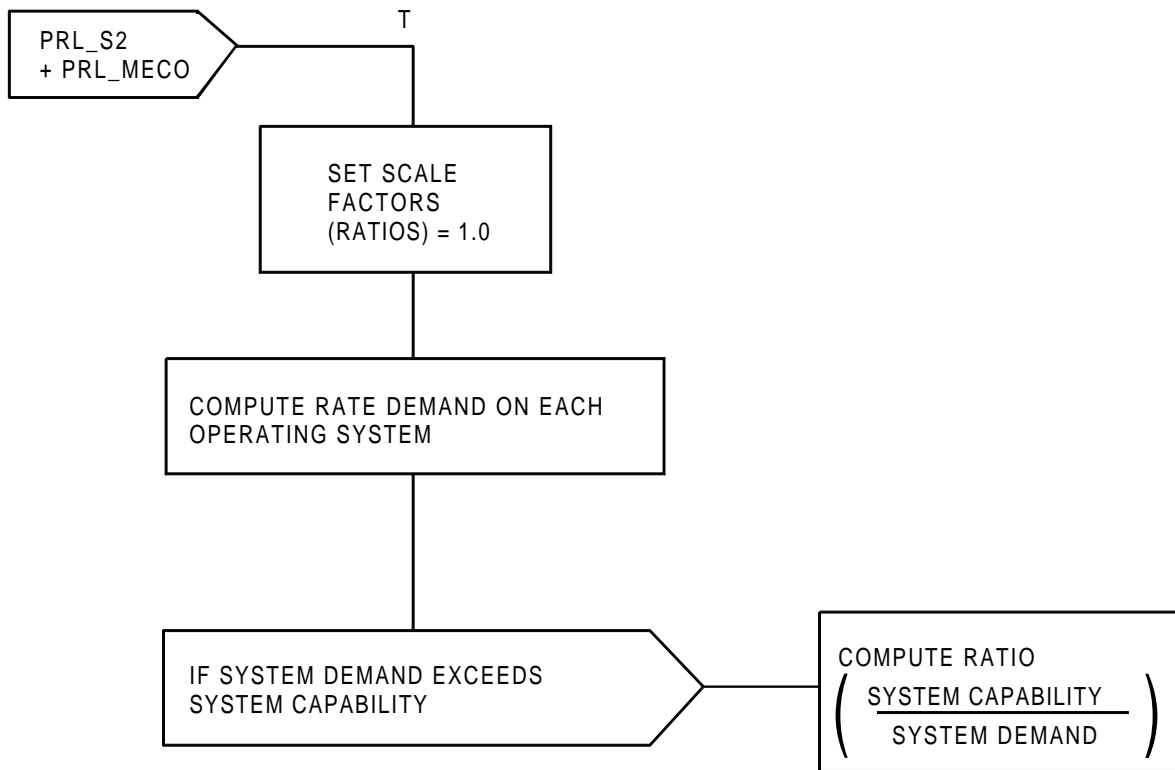


FIGURE 4.2.6-2. Priority Rate Limiting Logic, Functional Flow Chart

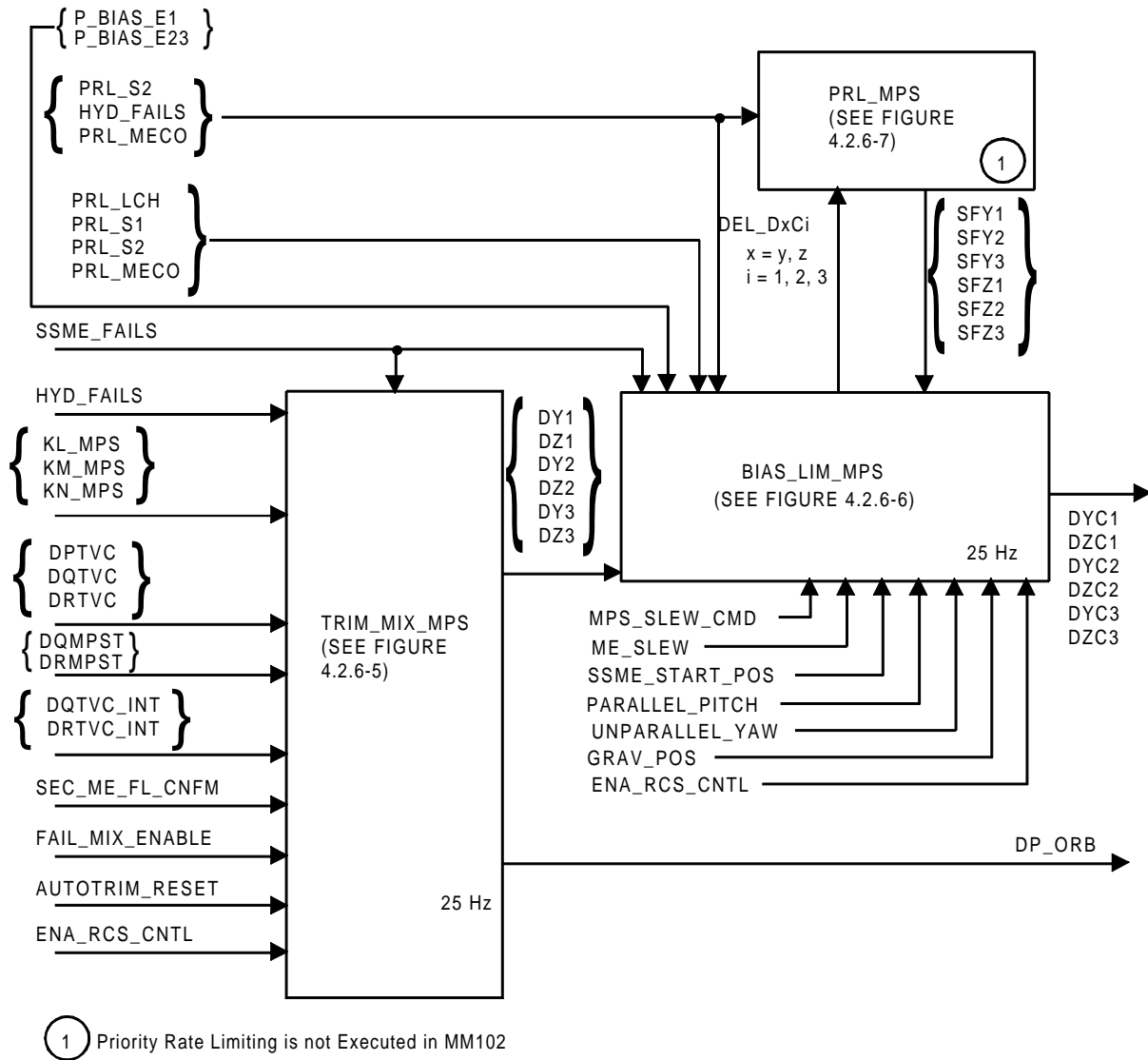
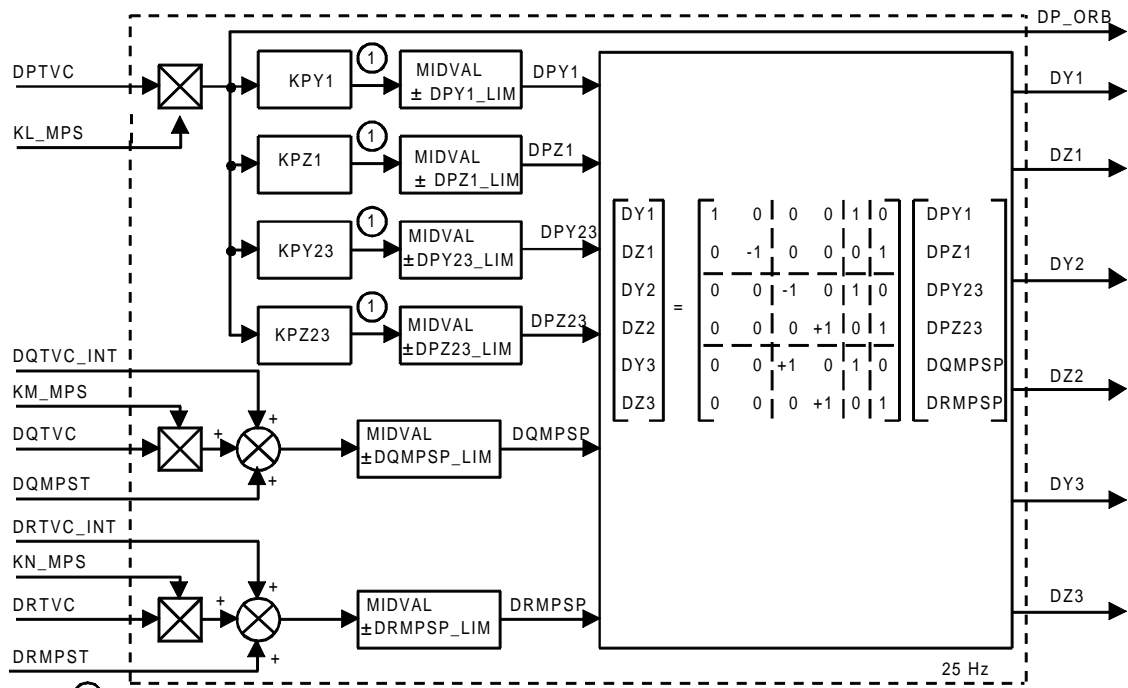


FIGURE 4.2.6-3. CMD_PROC_MPS, Software Overview



NOTE ①

ROLL MIXING GAINS	$(\text{FAIL_MIX_ENABLE}) + (\text{AUTOTRIM_RESET})$ • (SSME_FAILS = 0) • (HYD_FAILS < 4)	(AUTOTRIM_RESET) • (SSME_FAILS = 0) • (HYD_FAILS < 4)	(FAIL_MIX_ENABLE) • [(SSME_FAILS = i ≠ 0) + (HYD_FAILS = j > 3)]			SEC_ME_FL_CNFM + ENA_RCS_CNTL
			i = 1 + j = 5	i = 2 + j = 4	i = 3 + j = 6	
KPY1	0.0	0.0	0.0	-2.5 - KPY1_FAIL23	2.5 KPY1_FAIL23	0.0
KPZ1	0.75 KPZ1_NOM	0.75 KPZ1_NOM	0.75 KPZ1_NOM	2.0 KPZ1_FAIL23	2.0 KPZ1_FAIL23	0.35
KPZ23	0.0	0.0	0.0	2.0 KPZ23_FAIL23	2.0 KPZ23_FAIL23	-0.35
KPY23	1	2.5 KPY23_S2C	2.5 KPY23_S2C	2.5 KPY23_S2C	2.5 KPY23_S2C	0.35



NOTE ② : IF AFTER AN SSME FAILS OR IS LOCKED UP, A DIFFERENT SSME LOCKS UP OR IS FAILED, RESPECTIVELY, DO NOT CHANGE ROLL-MIXING GAINS.

NOTE ③ : IF THE FAILURE TRANSITIONS FROM (SSME_FAILS = 0 AND HYD_FAILS > 3) TO (SSME_FAILS = 0) AND HYD_FAILS ≤ 3), CHANGE BACK TO THE APPROPRIATE NONFAILURE ROLL-MIXING GAINS.

NOTE ④ : IF ENA_RCS_CNTL = ON, THIS LAST COLUMN OF ROLL MIXING GAINS TAKES PRECEDENCE OVER ANY OTHER COLUMN OF GAINS THAT MIGHT ALSO BE LOGICALLY TRUE. IF ENA_RCS_CNTL SWITCHES FROM TRUE TO FALSE, THE ROLL MIXING GAINS SWITCH TO WHICHEVER COLUMN OF GAINS IS LOGICALLY TRUE. AN EXCEPTION TO THIS IS WHEN THE SWITCH OCCURS AS A RESULT OF MECO_CMD DURING RTLS ABORT. FOR THIS CASE, DO NOT SWITCH THE GAINS AT OR AFTER MECO_CMD FOR ANY REASON

FIGURE 4.2.6-5. TRIM_MIX_MPS Function Module, Detailed Diagram

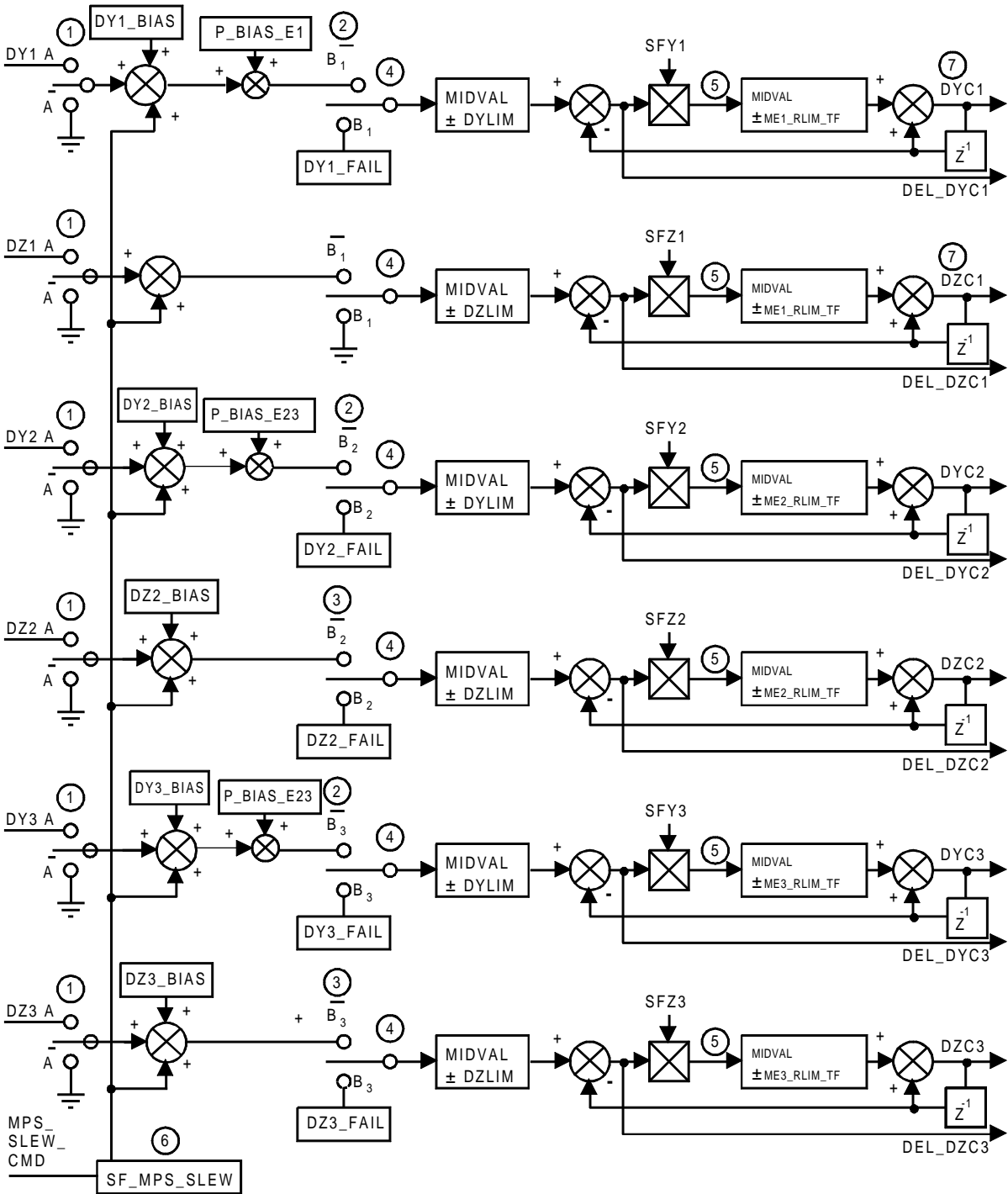


FIGURE 4.2.6-6.(1) BIAS_LIM_MPS Modules, Detailed Diagram (Sheet 1 of 4)

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NOTES

1 $A = S1C + S2C = \overline{\text{PRELO}}$

2	SSME_START_POS	$(SSME_FAILS \geq 4) +$ $(ME_SLEW \cdot SSME_LCH_POS) +$ $(SSME_LCH_POS \cdot$ $PARALLEL_PITCH) +$ ENA_RCS_CNTL	PARALLEL PITCH 9		GRAV_POS	MM101_INIT
			SSME_FAILS = 0	SSME_FAILS = 2 OR 3		
DY1_BIAS	DY1_START	8 0.0	+4 DEG	+ PITCH_BIAS_PARALLEL	DY1_GRAV	CARRYOVER VALUES FROM GNC OPS 9 (V4.18)
DY2_BIAS	DY2_START	0.0	-2 DEG	- PITCH_BIAS_PARALLEL	DY2_GRAV	
DY3_BIAS	DY3_START	0.0	-2 DEG	- PITCH_BIAS_PARALLEL	DY3_GRAV	

3	SSME_START_POS	$(SSME_FAILS \geq 4) +$ $MECO_CMD +$ $(SSME_LCH_POS \cdot ME_SLEW) +$ $UNPARALLEL_YAW +$ ENA_RCS_CNTL	$UNPARALLEL_YAW$ $\cdot SSME_LCH_POS \cdot$ $MECO_CMD$	8	GRAV_POS	MM101_INIT
DZ3_BIAS	DZ3_START	0.0	+ YAW_BIAS_NOM	DZ3_GRAV		

4 B_i IS TRUE IF $SSME_FAILS = i$ OR $SSME_FAILS \geq 4$ AND THE i th ENGINE WAS THE FIRST ONE DETECTED TO BE FAILED. IN THE CASE OF SIMULTANEOUS FAILURES ONLY THE LOWEST NUMBERED FAILED ENGINE WILL BE PLACED IN THE FAILED POSITION.

FIGURE 4.2.6-6.(2) BIAS_LIM_MPS Modules, Detailed Diagram (Sheet 2 of 4)

⑤ RATE LIMIT ON GOOD ENGINES (MEi_RLIM_TF) IS DEFINED AS FOLLOWS:

PRL_LCH + ME_RESTART	PRL_S1			PRL_S2 + PRL_MECO
	HYD_FAILS =			
	0	1, 2, OR 3	≥ 4	
RATE_CAPABILITY_LIFTOFF	RATE_CAPABILITY_NOFAIL	RATE_CAPABILITY_ONE_FAIL	RATE_CAPABILITY_TWO_FAIL	SSME_RLIM_NOM

PRIOR TO MECO_CMD

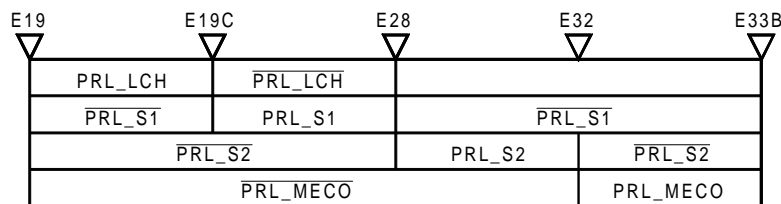
ON FIRST FAILED ENGINE RATE_CAPABILITY = SSME_RLIM_FAIL

ON 2ND FAILED ENGINE DON'T CHANGE RATE LIMIT

SSME_RLIM_FAIL WILL BE USED FOR ENGINE i IF SSME_FAILS = i OR SSME_FAILS ≥ 4 AND THE ith ENGINE WAS THE FIRST ONE DETECTED TO HAVE FAILED. IN THE CASE OF SIMULTANEOUS FAILURES, SSME_RLIM_FAIL WILL ONLY BE USED FOR THE LOWEST NUMBERED FAILED ENGINE

AFTER MECO_CMD

DON'T CHANGE THE RATE LIMIT ON ANY FAILED ENGINE



⑥

	ME_SLEW	ME_SLEW + SSME_START_POS
SF_MPS_SLEW	SF_MPS_SLEW_NOM	0.0

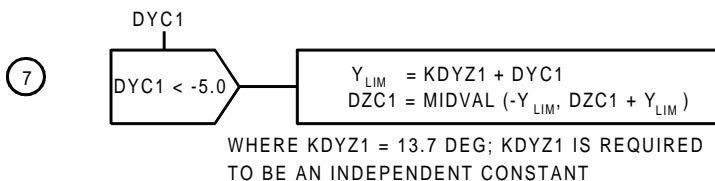


FIGURE 4.2.6-6.(3) BIAS_LIM_MPS Modules, Detailed Diagram (Sheet 3 of 4)

- ⑧ WHEN ENA_RCS_CNTL = ON,
ALL THE MPS BIASES ARE LATCHED TO
ZERO UNTIL ZERO THRUST.
- ⑨ IF ME_RETRIM:
TEMP = PITCH_BIAS_LIMIT - DQMPST
IF SSME_FAILS = 0
DY1_BIAS = MIDVAL (0., TEMP, 4.0)
DY2_BIAS = - DY1_BIAS / 2.0
DY3_BIAS = - DY1_BIAS / 2.0
IF SSME_FAILS = 2 OR 3
DY1_BIAS = MIDVAL (0., TEMP, PITCH_BIAS_PARALLEL)
DY2_BIAS = - DY1_BIAS
DY3_BIAS = - DY1_BIAS

FIGURE 4.2.6-6.(4) BIAS_LIM_MPS Modules, Detailed Diagram (Sheet 4 of 4)

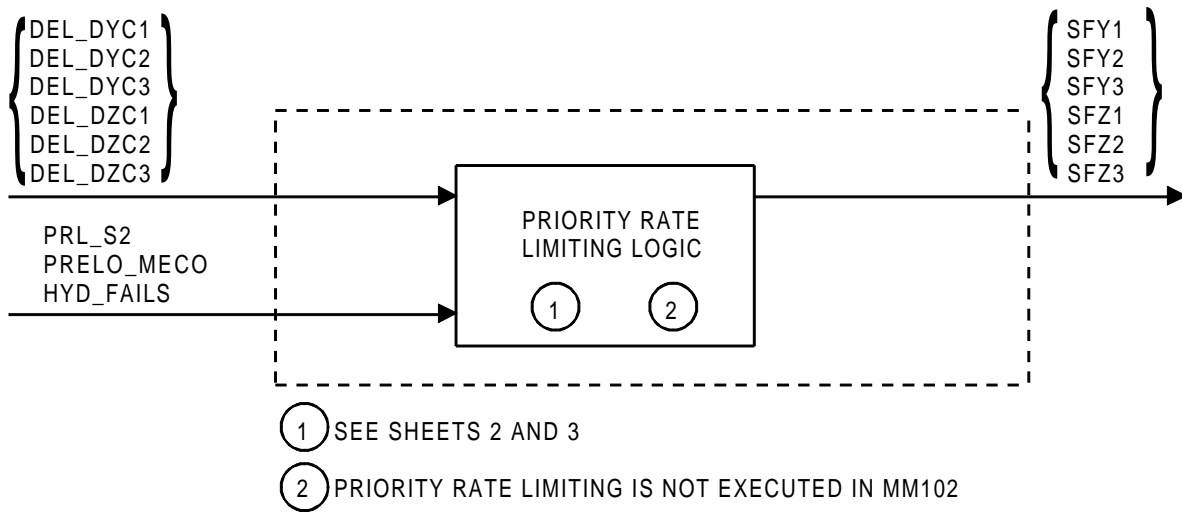


FIGURE 4.2.6-7.(1) PRL_MPS Function Module, Detailed Diagram (Sheet 1 of 3)

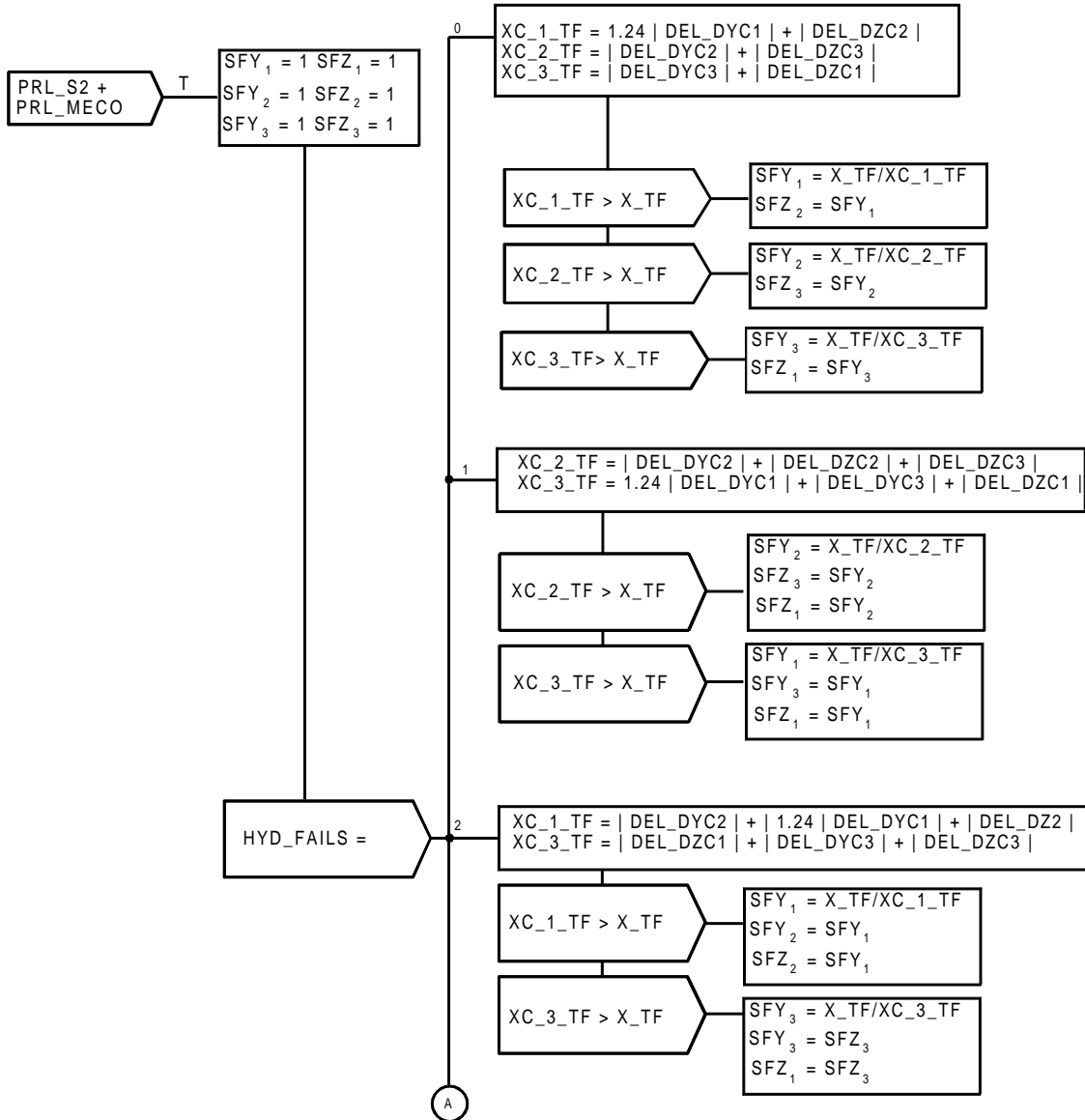


FIGURE 4.2.6-7.(2) PRL_MPS Function Module, Detailed Diagram (Sheet 2 of 3)

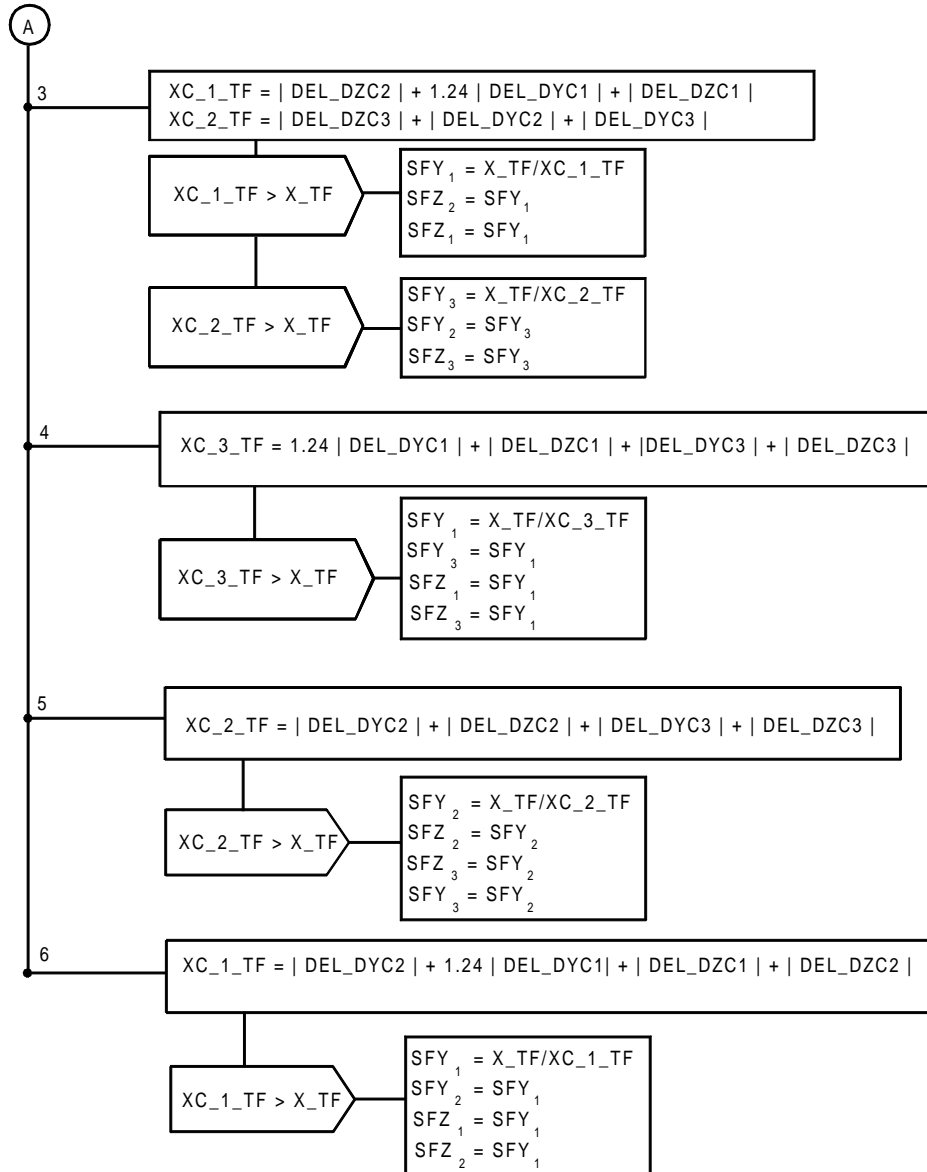


FIGURE 4.2.6-7.(3) PRL_MPS Function Module, Detailed Diagram (Sheet 3 of 3)

4.2.7 SRB Command Processor (CMD_PROC_SRB)

A. Functional Description. The functional block diagram for CMD_PROC_SRB is shown in Figure 4.2.7-1. A correlation with the software mechanization described below is provided by means of the dotted lines which delineate software modules. Functionally, CMD_PROC_SRB takes the body-axis roll, pitch, and yaw outputs from ASC_TVC, and multiplies each by a gain function, adds body-axis trim signals, generates and applies a body-axis pitch command bias for clearance of the hold-down support, and then, by means of the SRB mixing logic, generates the SRB nozzle rock/tilt commands. Prelaunch nozzle slew commands are summed with the mixing logic outputs (which are set to zero until lift-off) during the SRB actuator slew test. The nozzle commands are then amplitude and rate limited. The pressure information required is obtained by filtering the measured chamber pressure through a first-order lag. The filtered pressure is used to generate the switching discretets COMLIM4 and COMLIM5, as well as other discretets.

B. Software Description. An overview of CMD_PROC_SRB is presented in Figure 4.2.7-2. Its input/output requirements are summarized in Table 4.2.7-1. CMD_PROC_SRB consists of three function modules, TRIM_MIX_SRB, BIAS_LIM_SRB and SRB_PC_FILTER, which are sequenced as shown in Figure 4.2.7-3. The detailed diagrams for TRIM_MIX_SRB, BIAS_LIM_SRB, and SRB_PC_FILTER are shown, respectively, in Figures 4.2.7-4, 4.2.7-5, and 4.2.7-6. intermodule interface requirements for CMD_PROC_SRB are presented in Table 4.2.7-2. Initialization requirements are presented in Table 4.2.7-3. I-loads are presented in Table 4.2.7-4.

Table 4.2.7-1. CMD_PROC_SRB Interface Requirements						
Name	Description	Source or Destination	Type	Range	Units	Rate Required/Produced At (Hz)
<u>Inputs</u>						
DPTVC	Roll TVC loop error signal	ASC_TVC	S		deg/s	25
DQTV	Pitch TVC loop error signal	ASC_TVC	S		deg/s	25
DRTVC	Yaw TVC loop error signal	ASC_TVC	S		deg/s	25
DQSRBT	Pitch thrust vector deflection trim, SRB	INTERPS	S		deg	6.25
KL_SRB	Variable gain (roll rate, SRB)	INTERPS	S		deg/ (deg/s)	6.25
KM_SRB	Variable gain (pitch rate, SRB)	INTERPS	S		deg/ (deg/s)	6.25
KN_SRB	Variable gain (yaw rate, SRB)	INTERPS	S		deg/ (deg/s)	6.25
SRB_SLEW_CMD	SRB actuator slew position command	SRB_ACT_SLEW	S		deg	25
PC4	Chamber pressure, SRB4	SF	S		psi	12.5
PC5	Chamber pressure, SRB5	SF	S		psi	12.5
S1C	Indicator, Stage 1 control	ASC_RECON	B		–	12.5
COMLIM4	Indicator, begin vector limiting for SRB4	ASC_RECON	B		–	12.5
COMLIM5	Indicator, begin vector limiting for SRB5	ASC_RECON	B		–	12.5
PC_FILTER	Indicator, SRB chamber pressure filtering	ASC_RECON	B		–	12.5
PRELO	Indicator, pre-liftoff	ASC_RECON	B		–	12.5
SRB_SLEW	Indicator, initiate SRB slew test	ASC_RECON	B		–	12.5
SRBLIM_ACTV	Indicator, initiate SRB rate limiting	ASC_RECON	B		–	12.5
DQTV	Pitch TVC integrator output	ASC_TVC	S		deg	12.5
DRTV	Yaw TVC integrator output	ASC_TVC	S		deg	12.5
MM101_INIT	First pass initialization flag	ASC_RECON	B		–	12.5
SRB_NULL_CMD	Indicator, initiate SRB null command	ASC_RECON	B		–	12.5
SRB_SEP_CMD	Indicator, SRB SEP CMD (Event 28)	ASC_RECON	B		–	12.5
LIFTOFF	Indicator, liftoff (Event 19A)	ASC_RECON	B		–	12.5

Table 4.2.7-1. CMD_PROC_SRB Interface Requirements						
Name	Description	Source or Destination	Type	Range	Units	Rate Required/ Produced At (Hz)
<u>Outputs</u>						
DT4CL	Actuator deflection command, SRB 4 tilt	SRB_TVC_CMD_SOP	S		deg	25
DR4CL	Actuator deflection command, SRB 4 rock	SRB_TVC_CMD_SOP	S		deg	25
DT5CL	Actuator deflection command, SRB 5 tilt	SBB_TVC_CMD_SOP	S		deg	25
DR5CL	Actuator deflection command, SRB 5 rock	SRB_TVC_CMD_SOP	S		deg	25
PC4F	Filtered chamber pressure, SRB 4	ASC_RECON, CONT_3EO_GUID	S		psi	12.5
PC5F	Filtered chamber pressure, SRB 5	ASC_RECON, CONT_3EO_GUID	S		psi	12.5

Table 4.2.7-2.CMD_PROC_SRB Inter-Module Interface Requirements								
Module	Name	Description	Source or Destination	Type	Range	Units	Rate Required/Produced At (Hz)	
TRIM_MIX_SRB	<u>Inputs</u>							
	DPTVC	Roll TVC loop error signal	ASC_TVC	S		deg/s	25	
	DQTVC	Pitch TVC loop error signal	ASC_TVC	S		deg/s	25	
	DRTVC	Yaw TVC loop error signal	ASC_TVC	S		deg/s	25	
	DQSRBT	Pitch thrust vector deflection trim, SRB	INTERPS	S		deg	6.25	
	KL_SRB	Variable gain (roll rate, SRB)	INTERPS	S		deg/ (deg/s)	6.25	
	KM_SRB	Variable gain (pitch rate, SRB)	INTERPS	S		deg/ (deg/s)	6.25	
	KN_SRB	Variable gain (yaw rate, SRB)	INTERPS	S		deg/ (deg/s)	6.25	
	MM101_INIT	First pass initialization flag	ASC_RECON	B		–	12.5	
	S1C	Indicator, Stage 1 control	ASC_RECON	B		–	12.5	
	PRELO	Indicator, pre-liftoff	ASC_RECON	B		–	12.5	
	DQTVC_INT	Pitch TVC integrator output	ASC_TVC	S		deg	12.5	
	DRTVC_INT	Yaw TVC integrator output	ASC_TVC	S		deg	12.5	
	<u>Outputs</u>							
	DT4	Tilt command (actuator degree-equivalent), SRB 4	BIAS_LIM_SRB	S			deg	25
	DR4	Rock command (actuator degree-equivalent), SRB 4	BIAS_LIM_SRB	S			deg	25
	DT5	Tilt command (actuator degree-equivalent), SRB 5	BIAS_LIM_SRB	S			deg	25
DR5	Rock command (actuator degree-equivalent), SRB 5	BIAS_LIM_SRB	S			deg	25	

Table 4.2.7-2.CMD_PROC_SRB Inter-Module Interface Requirements

Module	Name	Description	Source or Destination	Type	Range	Units	Rate Required/Produced At (Hz)
BIAS_LIM_SRB	<u>Inputs</u>						
	DT4	Tilt command (actuator degree-equivalent), SRB 4	TRIM_MIX_SRB	S		deg	25
	DR4	Rock command (actuator degree-equivalent), SRB 4	TRIM_MIX_SRB	S		deg	25
	DT5	Tilt command (actuator degree-equivalent), SRB 5	TRIM_MIX_SRB	S		deg	25
	DR5	Rock command (actuator degree-equivalent), SRB 5	TRIM_MIX_SRB	S		deg	25
	S1C	Indicator, Stage 1 control	ASC_RECON	B		–	12.5
	SRB_NULL_CMD	Indicator, initiate SRB null command	ASC_RECON	B		–	12.5
	SRB_SLEW	Indicator, SRB actuator slew test	ASC_RECON	B		–	12.5
	SRBLIM_ACTV	Indicator, SRB rate limiting is active	ASC_RECON	B		–	12.5
	SRB_SLEW_CMD	SRB actuator slew position command	SRB_ACT_SLEW	S		–	25
	COMLIM4	Indicator, begin vector limiting for SRB 4	ASC_RECON	B			12.5
	COMLIM5	Indicator, begin vector limiting for SRB 5	ASC_RECON	B			12.5
	<u>Outputs</u>						
	DT4CL	Actuator deflection command, SRB 4 tilt	SRB_CMD_SOP	S		deg	25
DR4CL	Actuator deflection command, SRB 4 rock	SRB_CMD_SOP	S		deg	25	
DT5CL	Actuator deflection command, SRB 5 tilt	SRB_CMD_SOP	S		deg	25	
DR5CL	Actuator deflection command, SRB 5 rock	SRB_CMD_SOP	S		deg	25	

Table 4.2.7-2.CMD_PROC_SRB Inter-Module Interface Requirements								
Module	Name	Description	Source or Destination	Type	Range	Units	Rate Required/Produced At (Hz)	
SRB_PC_FILTER	<u>Inputs</u>							
	MM101_INIT	First pass initialization flag	ASC_RECON	B		–	12.5	
	PC4	Chamber pressure, SRB 4	SF	S		psi	12.5	
	PC5	Chamber pressure, SRB 5	SF	S		psi	12.5	
	PC_FILTER	Indicator, SRB chamber pressure filtering	ASC_RECON	B		–	12.5	
	<u>Outputs</u>							
	PC4F	Filtered chamber pressure, SRB4	BIAS_LIM_SRB, ASC_RECON	S		psi	12.5	
PC5F	Filtered chamber pressure, SRB5	BIAS_LIM_SRB, ASC_RECON	S		psi	12.5		

Table 4.2.7-3.CMD_PROC_SRB Initialization Requirements					
Module	Component	Initialize on Transition		Variable	Initial Value
		From	To		
TRIM_MIX_SRB	Fader	–	MM101_INIT	NFADE_HDSCLR	0
		PRELO	S1C	NFADE_HDSCLR	NFADE_HDSCLR_START
BIAS_LIM_SRB	SRB slew command scale factor	–	MM101_INIT	SF_SRB_SLEW	0.0
		$\overline{\text{SRB_SLEW}}$	SRB_SLEW	SF_SRB_SLEW	SF_SRB_SLEW_NOM
		SRB_SLEW	$\overline{\text{SRB_SLEW}}$	SF_SRB_SLEW	0.0
	Rate limit INIT flag	–	MM101_INIT	Rate limit INIT flag, DT4	On

Table 4.2.7-3.CMD_PROC_SRB Initialization Requirements					
Module	Component	Initialize on Transition		Variable	Initial Value
		From	To		
	Outputs for rate limiting	-	MM101_INIT	Rate limit INIT flag, DR4	On
				Rate limit INIT flag, DT5	On
				Rate limit INIT flag, DR5	On
				DT4CL	0.0
				DR4CL	0.0
	SRB nozzle limit	-	MM101_INIT	DR5CL	0.0
				SLIMP	SLIM_LO
				SLIMN	SLIM_LO
				SLIMP	SLIM_NOMP
				SLIMN	SLIM_NOMN
		SRBLIM_ACTV	$\overline{\text{SRBLIM_ACTV}}$	SLIMP	SLIM_TAIL
		$\overline{\text{SRBLIM_ACTV}} \cdot (\text{COMLIM4} + \text{COMLIM5})$	$\overline{\text{SRBLIM_ACTV}} \cdot (\text{COMLIM4} + \text{COMLIM5})$	SLIMP	SLIM_TAIL
SRB_PC_FILTER	SRB chamber pressure filters initialization flags	-	MM101_INIT	Filter SRB PC4 INIT flag	Off
				Filter SRB PC5 INIT flag	Off
		$\overline{\text{PC_FILTER}}$	PC_FILTER	Filter SRB PC4 INIT flag	On
				Filter SRB PC5 INIT flag	On

Table 4.2.7-4.CMD_PROC_SRB I-Loads					
Module	Name	Description	Type	MSID	Units
TRIM_MIX_SRB	NFADE_HDSCLR_START	Fader characteristic time	S	V97U2063C	–
	HOLD_CLEAR_BIAS	Initial value of thrust vector deflection in nozzle deflection frame for clearance of the hold-down support	S	V98U9793C	deg
BIAS_LIM_SRB	SLIM_LO	Actuator stroke limit during SRBLM_ACTV	S	V97U2247C	deg
	SLIM_NOMP	Nominal positive SRB nozzle limit	S	V97U2248C	deg
	SLIM_NOMN	Nominal negative SRB nozzle limit	S	V97U2424C	deg
	SLIM_TAIL	SRB nozzle limits during tail off	S	V97U2427C	deg
	SRB_RLIMTF	SRB nozzle rate limit	S	V97U2426C	deg/cycle
	SF_SRB_SLEW_NOM	SRB slew command scale factor	S	V97U2245C	deg
SRB_PC_FILTER	CSRB_PC1	Filter coefficients, SRB chamber pressure filter	S	V97U1660C	–
	CSRB_PC2		S	V97U1661C	–
	CSRB_PC3		S	V97U1662C	–

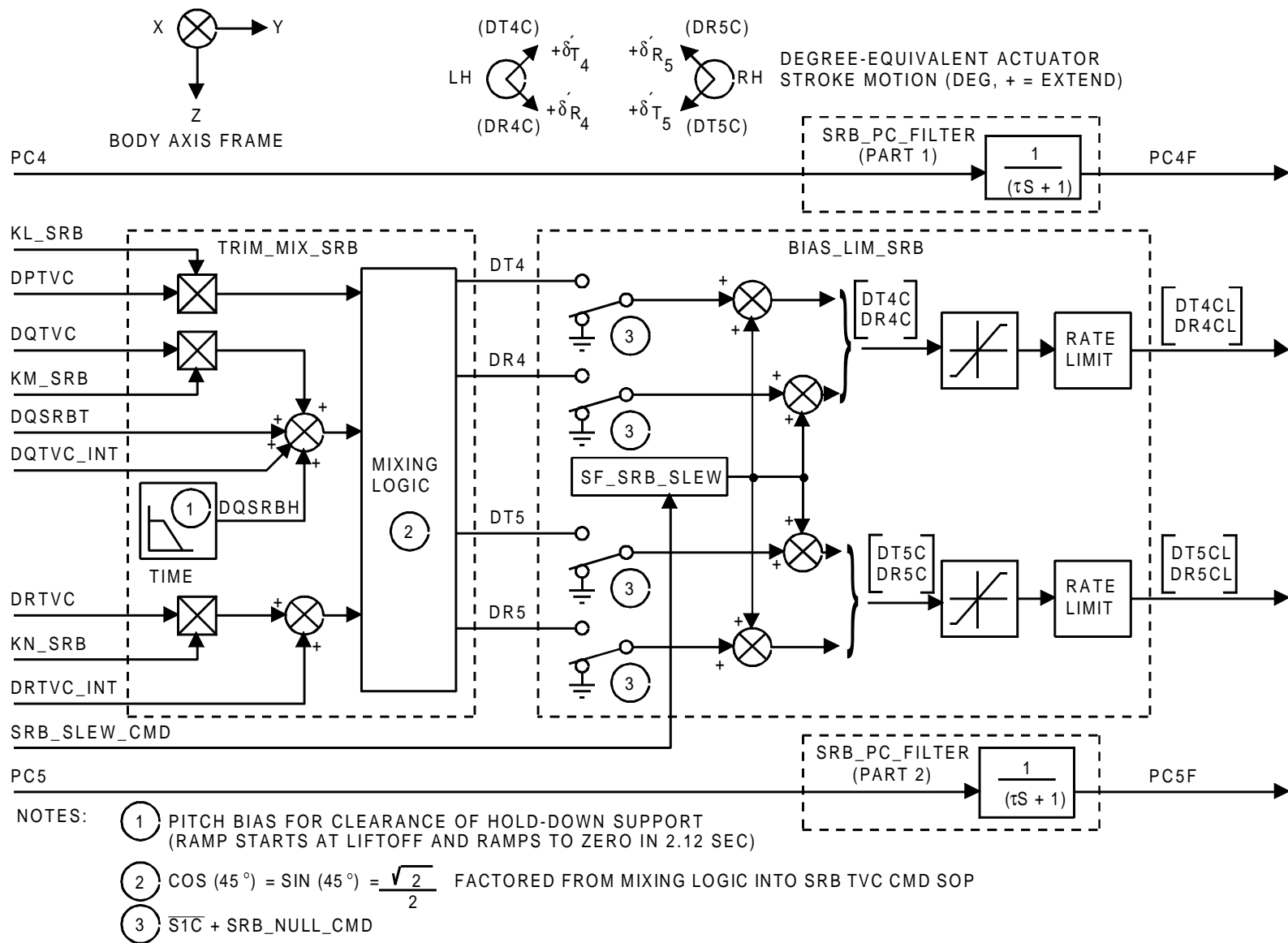


FIGURE 4.2.7-1. SRB Command Processor, Functional Overview

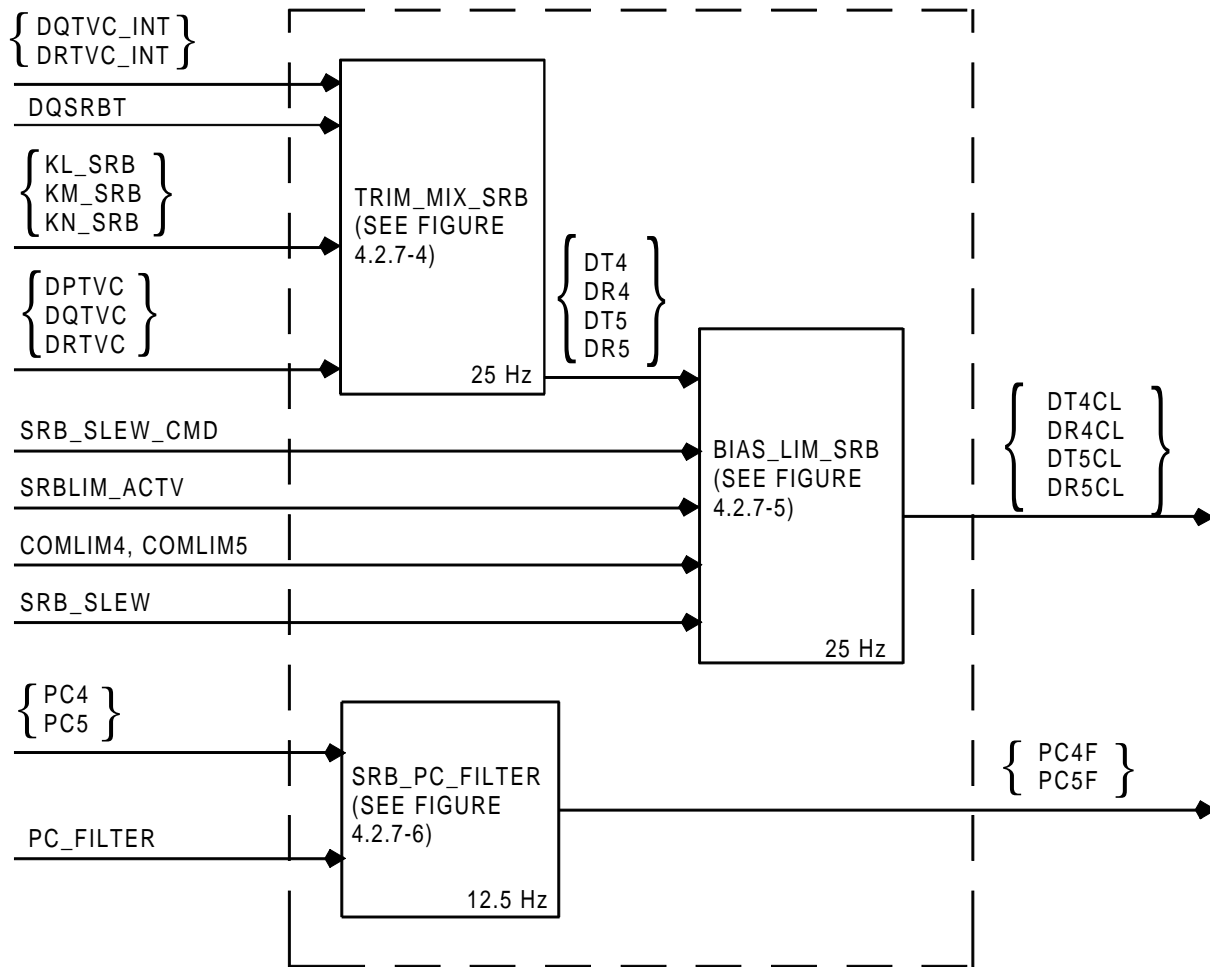


FIGURE 4.2.7-2. CMD_PROC_SRB, Software Overview

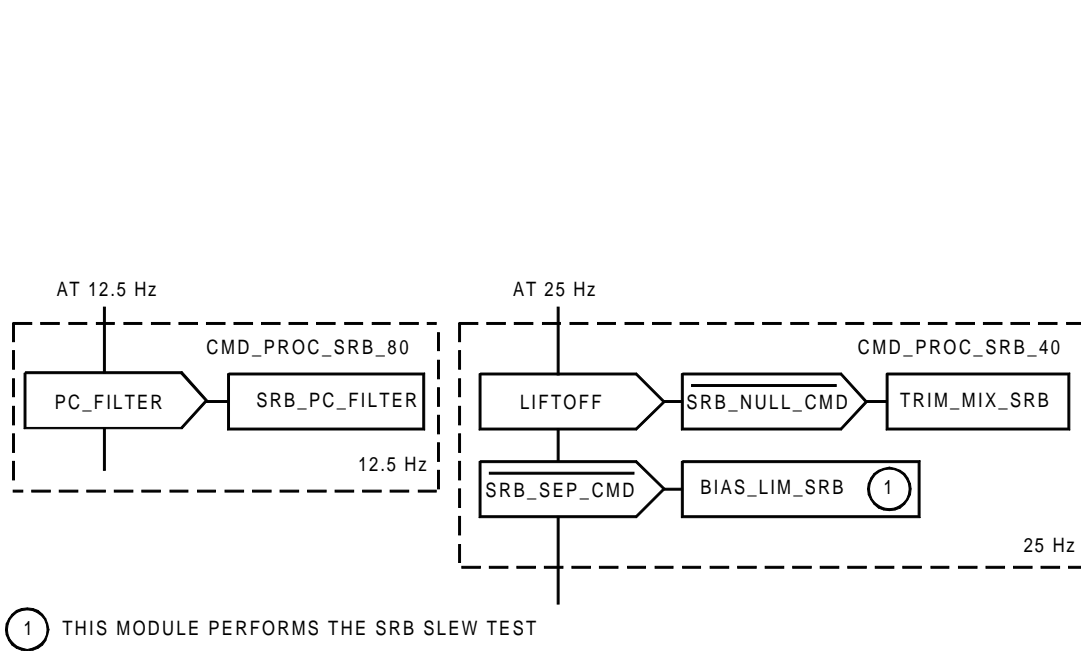


FIGURE 4.2.7-3. CMD_PROC_SRB Function Module Sequencing Requirements

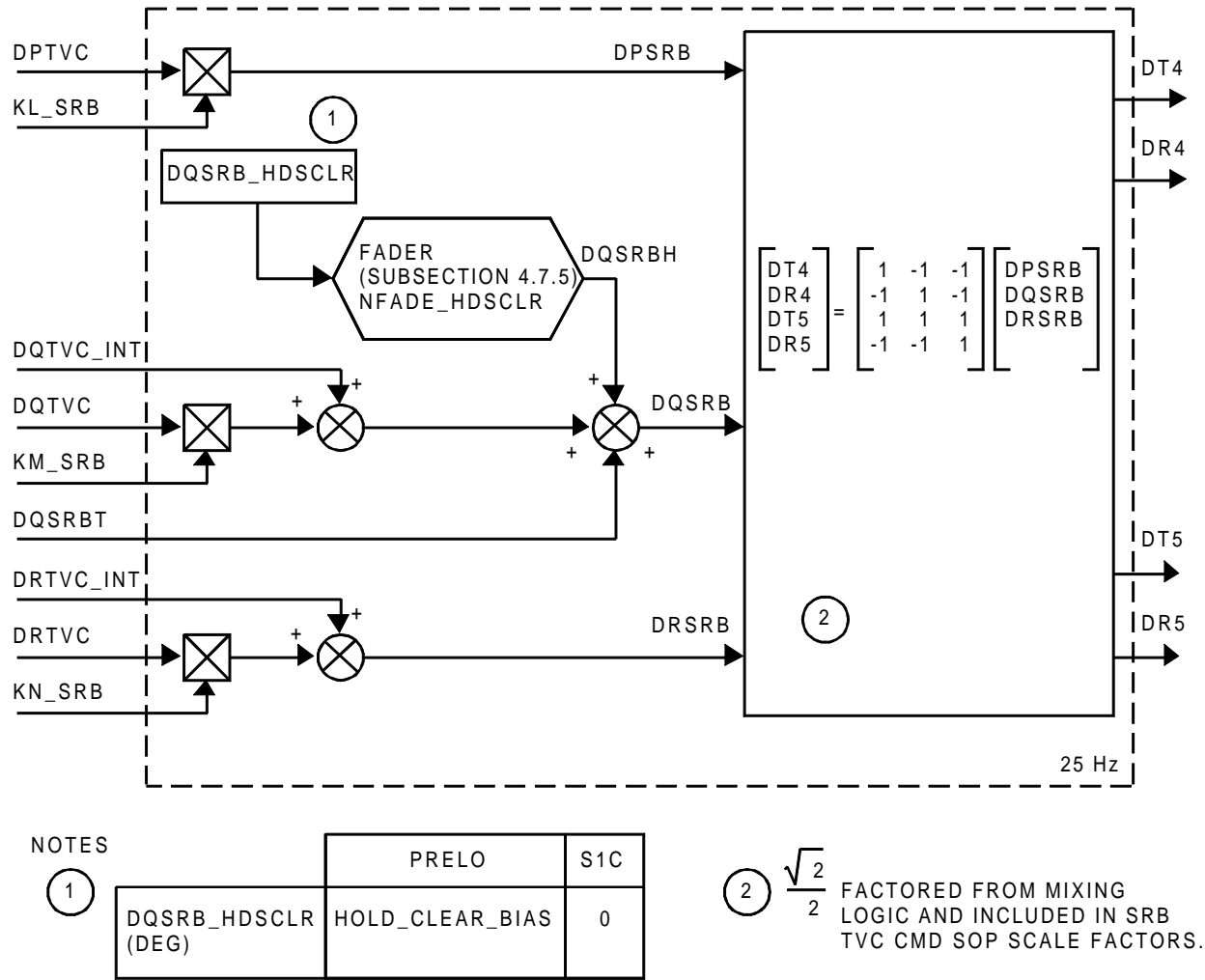
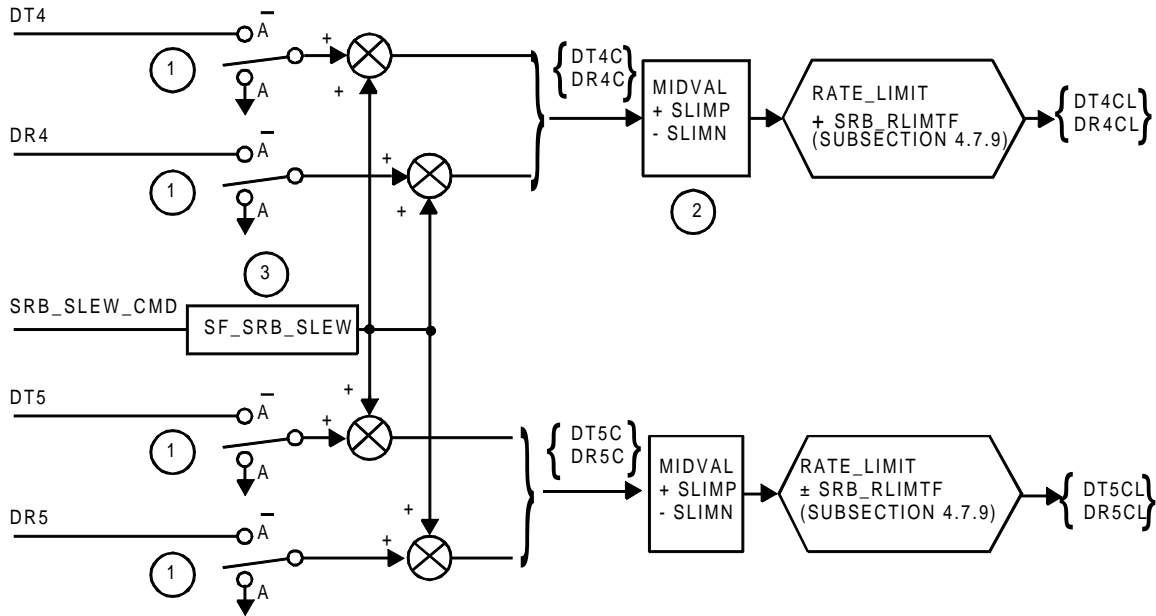


FIGURE 4.2.7-4. TRIM_MIX_SRB Function Module, Detailed Diagram



① $A = \overline{S1C} + SRB_NULL_CMD$

②

	SRBLIM_ACTV	$\overline{SRBLIM_ACTV} \cdot (\overline{COMLIM4} + COMLIM5)$	$\overline{SRBLIM_ACTV} \cdot (COMLIM4 + COMLIM5)$
SLIMP	SLIM_LO	SLIM_NOMP	SLIM_TAIL
SLIMN	SLIM_LO	SLIM_NOMN	SLIM_TAIL

③

	SRB_SLEW	$\overline{SRB_SLEW}$
SF_SRB_SLEW	SF_SRB_SLEW_NOM	0.0

FIGURE 4.2.7-5. BIAS_LIM_SRB Function Module, Detailed Diagram

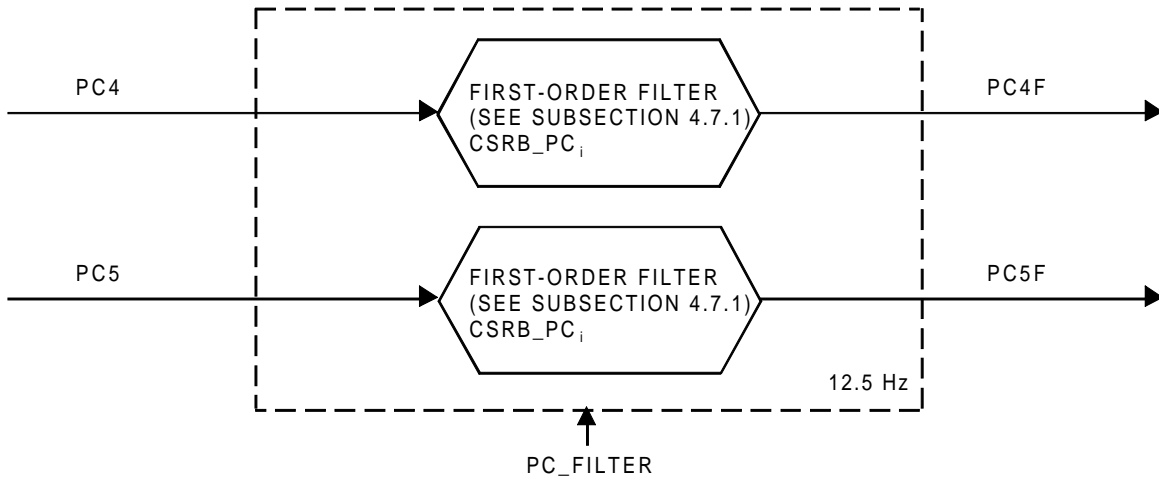


FIGURE 4.2.7-6. SRB_PC_FILTER Function Module, Detailed Diagram

4.2.8 Aerosurface Control

A. Functional Description. AEROSURFACE_CONTROL controls body flap, rudder, speed brake, and elevon aerosurfaces. The functional block diagram for BODY FLAP control is shown in Figure 4.2.8-1A. The functional block diagram for RUDDER and SPEED BRAKE control is shown in Figure 4.2.8-1B, and the functional block diagram for ELEVON control is shown in Figure 4.2.8-1C.

B. Software Description. An overview of AEROSURFACE_CONTROL is shown in Figure 4.2.8-2. Its input/output requirements are summarized in Table 4.2.8-1. AEROSURFACE_CONTROL consists of four functional modules, BODY_FLAP_CONTROL, RUD_SB_CMD, ELEVON_LOAD_RELIEF, and ELEVON_SLAVING, which are sequenced as shown in Figure 4.2.8-3. The detailed diagrams for the function modules are shown in Figures 4.2.8-4 through 4.2.8-7. A common subfunction, ELEVON_LOAD_RELIEF_SUBRO, invoked by ELEVON_LOAD_RELIEF, is defined in Figure 4.2.8-8. The intermodule interface requirements for AEROSURFACE_CONTROL are given in Table 4.2.8-2. Initialization requirements are presented in Table 4.2.8-3, and I-loads are defined in Table 4.2.8-4.

Table 4.2.8-1.AEROSURFACE_CONTROL Interface Requirements					
Name	Description	Type	Source/ Destination	Units	Rate Required/ Produced (Hz)
<u>Inputs</u>					
ELEV_LR	Elevon load relief indicator	B	ASC_RECON	–	6.25
DIBS	Inboard elevon schedule command	S	INTERPS	deg	3.125
DOBS	Outboard elevon schedule command	S	INTERPS	deg	3.125
DELTAP_LIB	Elevon actuator differential pressure, left inboard	S	DELTAP_FB_SOP (4.193)	psi	3.125
DELTAP_RIB	Elevon actuator differential pressure, right inboard	S	DELTAP_FB_SOP (4.193)	psi	3.125
DELTAP_LOB	Elevon actuator differential pressure, left outboard	S	DELTAP_FB_SOP (4.193)	psi	3.125
DELTAP_ROB	Elevon actuator differential pressure, right outboard	S	DELTAP_FB_SOP (4.193)	psi	3.125
DBFOFB	Body flap position	S	BF_PFB_SOP (4.49)	deg	6.25
PRELO	Indicator	B	ASC_RECON	–	12.5
STOW_SB	Indicator, stow speed brake to closed position	B	ASC_RECON	–	12.5
MM101_INIT	Indicator, elevon load relief	B	ASC_RECON	–	12.5
AFCS_FIRST_PASS	Indicator	B	ASC_RECON	–	12.5
AERO_SLEW_CMD	Aerosurface position slew command	S	ORB_ACT_SLEW (4.187)	–	25
AERO_SLEW_COMPLETE	Indicator, aerosurface slew complete	B	ORB_ACT_SLEW (4.187)	–	12.5
AERO_SLEW	Indicator, aerosurface slew check	B	ASC_RECON	–	12.5
PRE_SEP	Indicator, E25A command	B	ASC_RECON	–	12.5
SRB_IGN_CMD	Indicator	B	ASC_RECON	–	12.5
FADE_ELEVONS	Indicator, fade elevons to null	B	ASC_RECON	–	12.5

Table 4.2.8-1.AEROSURFACE_CONTROL Interface Requirements

Name	Description	Type	Source/ Destination	Units	Rate Required/ Produced (Hz)
<u>Outputs</u>					
DLOBPC	Elevon command, left outboard	S	AERO_ACT_SOP (4.50)	deg	25/6.25*
DLIBPC	Elevon command, left inboard	S	AERO_ACT_SOP (4.50)	deg	25/6.25*
DRIBPC	Elevon command, right inboard	S	AERO_ACT_SOP (4.50)	deg	25/6.25*
DROBPC	Elevon command, right outboard	S	AERO_ACT_SOP (4.50)	deg	25/6.25*
DBFRC	Body flap rate drive command	I	AERO_ACT_SOP (4.50)	–	6.25
DRPC	Rudder command	S	AERO_ACT_SOP (4.50)	deg	25/6.25*
DSBPC	Speed brake command	S	AERO_ACT_SOP (4.50)	deg	25/6.25*
*Rate x/y, x = slew, y = normal					

Table 4.2.8-2.AEROSURFACE_CONTROL Inter-Module Interface Requirements						
Module	Name	Description	Type	Source/ Destination	Units	Rate Required/ Produced (Hz)
BODY_ FLAP_ CONTROL	<u>Inputs</u>					
	AERO_SLEW	Indicator, aerosurface slew check	B	ASC_RECON	-	6.25
	MM101_INIT	Indicator, first time ASCENT DAP scheduled	B	ASC_RECON	-	6.25
	AERO_SLEW_CMD	Aerosurface position slew command	S	ORB_ACT_SLEW (4.187)	-	6.25
	DBFOFB	Body flap position	S	BF_PFB_SOP (4.49)	deg	6.25
	<u>Outputs</u>					
	DBFRC	Body flap rate drive	I	AERO_ACT_SOP (4.50)	-	6.25
RUD_ SB_CMD	<u>Inputs</u>					
	STOW_SB	Indicator, stow speed brake to closed position	B	ASC_RECON	-	6.25
	AERO_SLEW	Indicator, aerosurface slew check	S	ASC_RECON	-	6.25
	AERO_SLEW_ COMPLETE	Indicator, aerosurface slew complete	B	ASC_RECON	-	6.25
	MM101_INIT	Indicator, first time ASCENT DAP scheduled	S	ASC_RECON	-	6.25
	AERO_SLEW_CMD	Aerosurface position slew command	S	ORB_ACT_SLEW (4.187)	-	25
	PRELO	Indicator	B	ASC_RECON	-	12.5
	<u>Outputs</u>					
		DSBPC	Speed brake position command	S	AERO_ACT_SOP (4.50)	deg
	DRPC	Rudder position command	S	AERO_ACT_SOP (4.50)	deg	25

Table 4.2.8-2.AEROSURFACE_CONTROL Inter-Module Interface Requirements						
Module	Name	Description	Type	Source/ Destination	Units	Rate Required/ Produced (Hz)
ELEVON_LOAD_RELIEF	<u>Inputs</u>					
	DELTAP_LOB	Elevon actuator differential pressure, left outboard	S	DELTAP_FB_SOP (4.193)	psi	3.125
	DELTAP_LIB	Elevon actuator differential pressure, left inboard	S	DELTAP_FB_SOP (4.193)	psi	3.125
	DELTAP_RIB	Elevon actuator differential pressure, right inboard	S	DELTAP_FB_SOP (4.193)	psi	3.125
	DELTAP_ROB	Elevon actuator differential pressure, right outboard	S	DELTAP_FB_SOP (4.193)	psi	3.125
	DIBS	Inboard elevon schedule	S	INTERPS	deg	3.125
	DOBS	Outboard elevon schedule	S	INTERPS	deg	3.125
	DIBC DOBC	Past values of outputs	S	ELEVON_LOAD_RELIEF	deg	6.25
	MM101_INIT	Indicator, first time ASCENT DAP scheduled	B	ASC_RECON	-	12.5
	<u>Outputs</u>					
	DIBC	Inboard elevon command	S	ELEVON_SLAVING	deg	6.25
	DOBC	Outboard elevon command	S	ELEVON_SLAVING	deg	6.25
	ELEVON_LOAD_RELIEF_SUBRO	<u>Inputs</u>				
DPL		Differential pressure, left elevon	S	DELTAP_FB_SOP (4.193)	psi	-
DPR		Differential pressure, right elevon	S	DELTAP_FB_SOP (4.193)	psi	-
DS		Scheduled elevon command	S	INTERPS	deg	-
BIAS		Command bias to center of structural capability	S	I-LOAD	psi	-

Table 4.2.8-2.AEROSURFACE_CONTROL Inter-Module Interface Requirements						
Module	Name	Description	Type	Source/ Destination	Units	Rate Required/ Produced (Hz)
ELEVON_ LOAD_ RELIEF_ SUBRO (Cont.)	<u>Outputs</u>					
	DC	Total elevon command	S	Dummy variable	deg	–
ELEVON_ SLAVING	<u>Inputs</u>					
	DIBC	Inboard elevon command	S	ELEVON_LOAD_RELIEF	deg	6.25
	DOBC	Outboard elevon command	S	ELEVON_LOAD_RELIEF	deg	6.25
	AERO_SLEW_CMD	Aerosurface position slew command	S	ORB_SLEW_SOP (4.187)	–	25
	MM101_INIT	Indicator, first time ASCENT_DAP sequenced	B	ASC_RECON	–	6.25
	AERO_SLEW	Indicator, aerosurface slew check	B	ASC_RECON	–	12.5
	ELEV_LR	Elevon load relief indicator	B	ASC_RECON	–	6.25
	FADE_ELEVONS	Indicator, fade elevons to null	B	ASC_RECON	–	12.25
	<u>Outputs</u>					
	DLIBPC	Elevon position command, left inboard	S	AERO_ACT_SOP (4.50)	deg	25/6.25*
	DRIBPC	Elevon position command, right inboard	S	AERO_ACT_SOP (4.50)	deg	25/6.25*
	DLOBPC	Elevon position command, left outboard	S	AERO_ACT_SOP (4.50)	deg	25/6.25*
DROBPC	Elevon position command, right outboard	S	AERO_ACT_SOP (4.50)	deg	25/6.25*	

*Rate x/y x = slew, y = normal

Table 4.2.8-3.AEROSURFACE_CONTROL Initialization Requirements					
Function Module	Component	Initialize on Transition		Variable	Initial Value
		From	To		
BODY_FLAP_CONTROL	Rate drive past value	-	AFCS_FIRST_PASS	DBFRC	0.0
	Slew scale factor	-	AFCS_FIRST_PASS	SF_BF_SLEW	0.0
		$\overline{\text{AERO_SLEW}}$	AERO_SLEW	SF_BF_SLEW	SF_BF_SLEW_NOM
		AERO_SLEW	$\overline{\text{AERO_SLEW}}$	SF_BF_SLEW	0.0
RUD_SB_CMD	Rudder command	-	AFCS_FIRST_PASS	DRPC	0.0
		AERO_SLEW	$\overline{\text{AERO_SLEW}}$	DRPC	0.0
	Speed brake command	-	AFCS_FIRST_PASS	DSBPC	DSB_BIAS_SLEW
		$\overline{\text{STOW_SB}}$	STOW_SB	DSBPC	DSB_CLOSED
	Slew scale factors	$\overline{\text{AERO_SLEW}}$	AERO_SLEW	SF_RUD_SLEW	SF_RUD_SLEW_NOM
				SF_SB_SLEW	SF_SB_SLEW_NOM
		AERO_SLEW	$\overline{\text{AERO_SLEW}}$	SF_RUD_SLEW	0.0
	Fader	-	MM101_INIT	SF_SB_SLEW	0.0
		$\overline{\text{STOW_SB}}$	STOW_SB	NFADE_DSBCLOSE	0
		STOW_SB	$\overline{\text{STOW_SB}}$	NFADE_DSBCLOSE	NFADE_DSBCLOSE_NOM
ELEVON_LOAD_RELIEF	Inboard integrator	-	AFCS_FIRST_PASS	NPIB	0.0
	Outboard integrator	-		NPOB	0.0
	Inboard elevon command	-		DIBC	0.0
	Outboard elevon command	-		DOBC	0.0
ELEVON_SLAVING	Slew scale factor	-	AFCS_FIRST_PASS	SF_ELVN_SLEW	0.0
		$\overline{\text{AERO_SLEW}}$	AERO_SLEW	SF_ELVN_SLEW	SF_ELVN_SLEW_NOM
		AERO_SLEW	$\overline{\text{AERO_SLEW}}$	SF_ELVN_SLEW	0.0

Table 4.2.8-3.AEROSURFACE_CONTROL Initialization Requirements					
Function Module	Component	Initialize on Transition		Variable	Initial Value
		From	To		
ELEVON_ SLAVING (Cont.)	Elevon position commands	-	AFCS_FIRST_PASS	DLIBPC	0.0
				DRIBPC	0.0
				DLOBPC	0.0
				DROBPC	0.0
	Fader		MM101_INIT	NFADE_ELEVON_IN	0
			NFADE_ELEVON_OUT	0	
		FADE_ELEVONS	FADE_ELEVONS	NFADE_ELEVON_IN	32*
			NFADE_ELEVON_OUT	16	

*Value (32) is used to derive conditions for Local Event 24A, FADE_ELEVONS.

Table 4.2.8-4.AEROSURFACE_CONTROL I-Loads/K-Loads					
Module	Name	Description	Type	MSID	Units
ELEVON_LOAD_RELIEF	BIAS_IB	Inboard command bias to center of structural capability	S	V97U1413C	psi
	RETLIM_IB	Inboard elevon load relief return limit	S	V97U2232C	psi
	DRVLIM_IB	Inboard elevon load relief drive limit	S	V97U1776C	psi
	BIAS_OB	Outboard command bias to center of structural capability	S	V97U1416C	psi
	RETLIM_OB	Outboard elevon load relief return limit	S	V97U2233C	psi
	DRVLIM_OB	Outboard elevon load relief drive limit	S	V97U1777C	psi
ELEVON_LOAD_RELIEF_SUBRO	TMDPDOT	Commanded active elevon load relief deflection/NP	S	V97U2428C	deg/count
	DCLIM	Elevon position limit	S	V97U2429C	deg
	NPLIM	Deadspace accumulator feedback	S	V96U8977C	deg
	TMDCDOTLIM	Maximum rate limited elevon deflection per major cycle	S	V97U2430C	deg
BODY_FLAP_CONTROL	DBFE_OUTER	Outer or drive level for body flap deadband/hysteresis function	S	V97U1666C	deg
	DBFE_INNER	Inner or deadband level for body flap deadband/hysteresis function	S	V97U1665C	deg
	SF_BF_SLEW_NOM	Body flap slew scale factor	S	V97U2240C	-
RUD_SB_CMD	SF_RUD_SLEW_NOM	Rudder slew scale factor	S	V97U2243C	-
	SF_SB_SLEW_NOM	Speed brake slew scale factor	S	V97U2244C	-
	DSB_CLOSED	Speed brake closed position command	S	V97U2425C	deg
	DSB_BIAS_SLEW	Speed brake biased position for slew check	S	V97U2441C	deg
	NFADE_DSBCLOSE_NOM	Fade time for speed brake closing	S	V97U2431C	-
ELEVON_SLAVING	SF_ELVN_SLEW_NOM	Elevon slew scale factor	S	V97U2241C	-

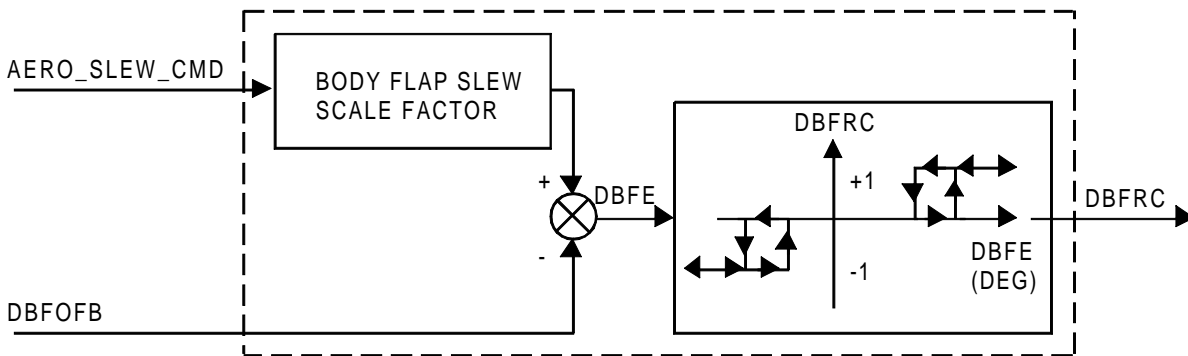
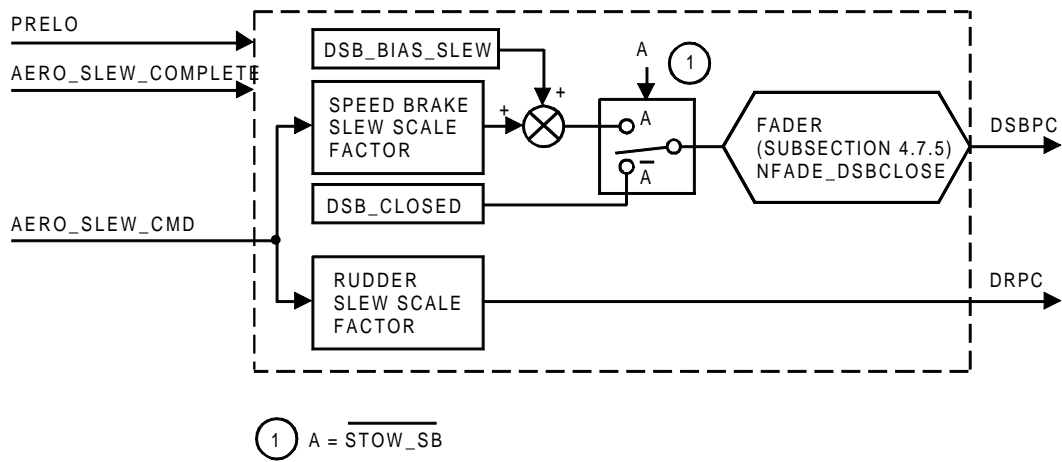


FIGURE 4.2.8-1A. Body Flap Control, Functional Overview



NOTE: THE RUDDER SLEW SCALE FACTOR MUST BE SMALL ENOUGH SO THAT DRPC (RUDDER POSITION COMMAND) NEVER EXCEEDS 20 °. THIS PREVENTS INTERFERENCE BETWEEN RUDDER/SPEED BRAKE HINGES AND RUDDER CONICAL SEAL

FIGURE 4.2.8-1B. Rudder and Speed Brake Control, Functional Overview

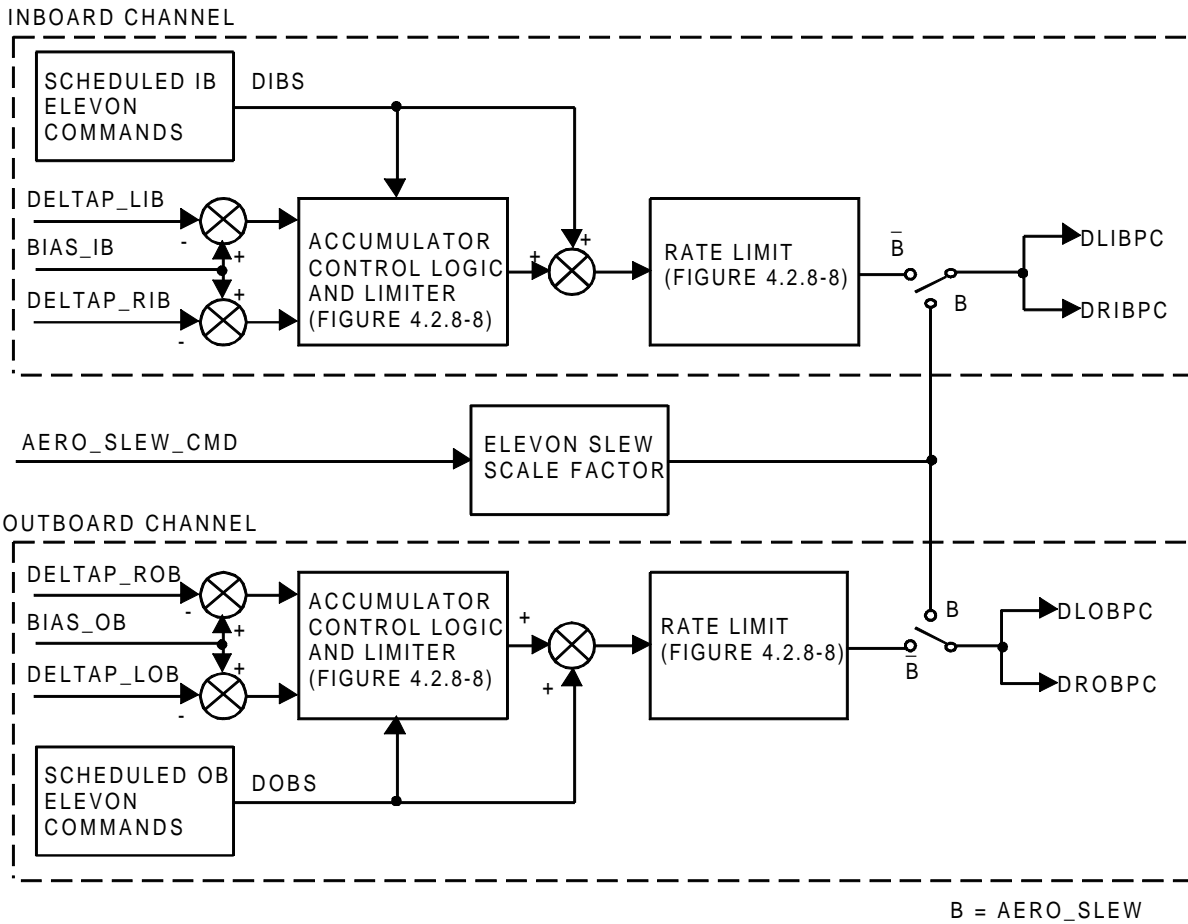


FIGURE 4.2.8-1C. Elevon Control, Functional Overview

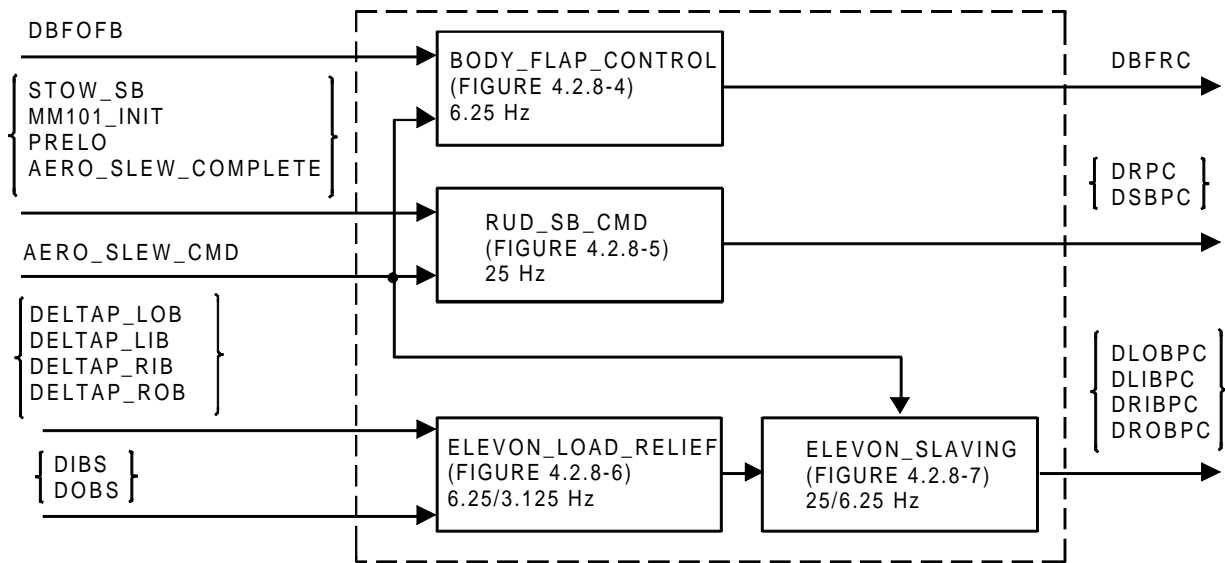


FIGURE 4.2.8-2. AEROSURFACE_CONTROL, Software Overview

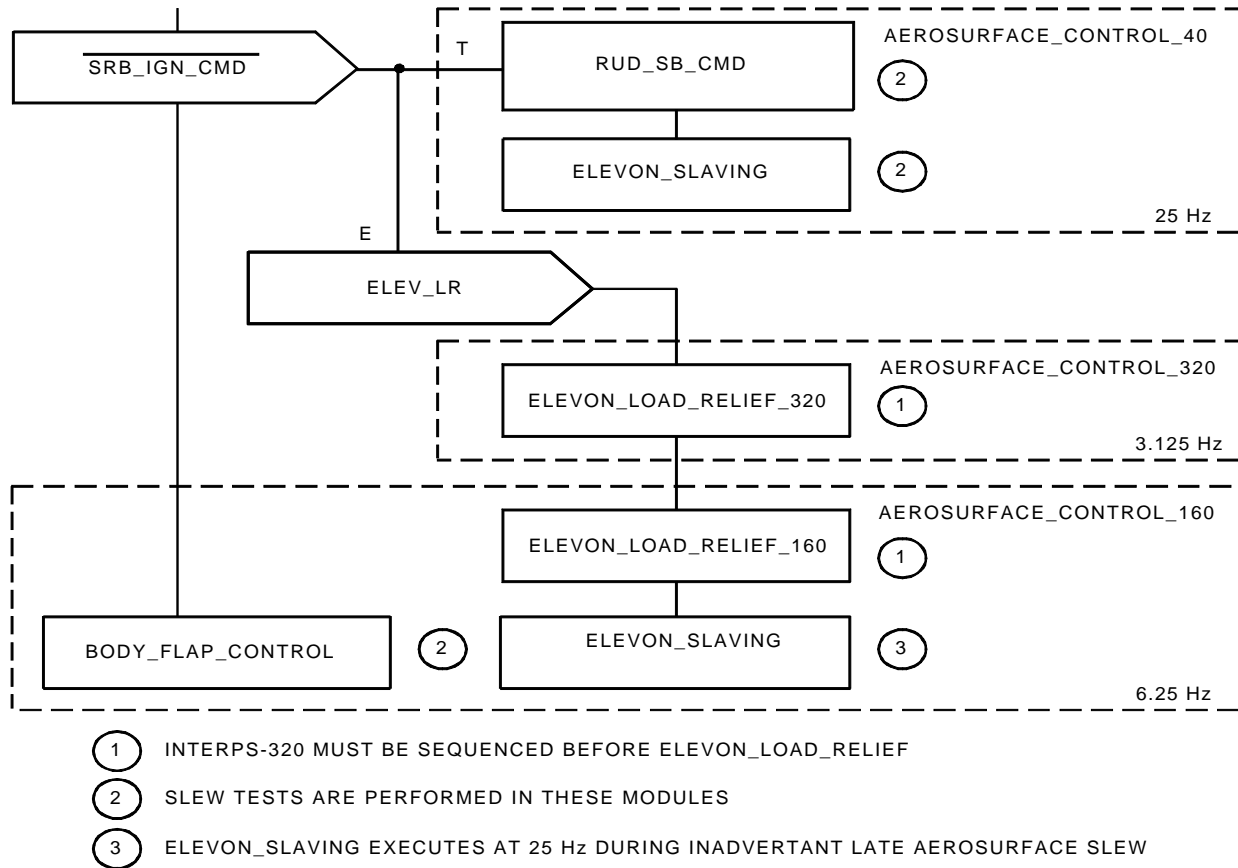
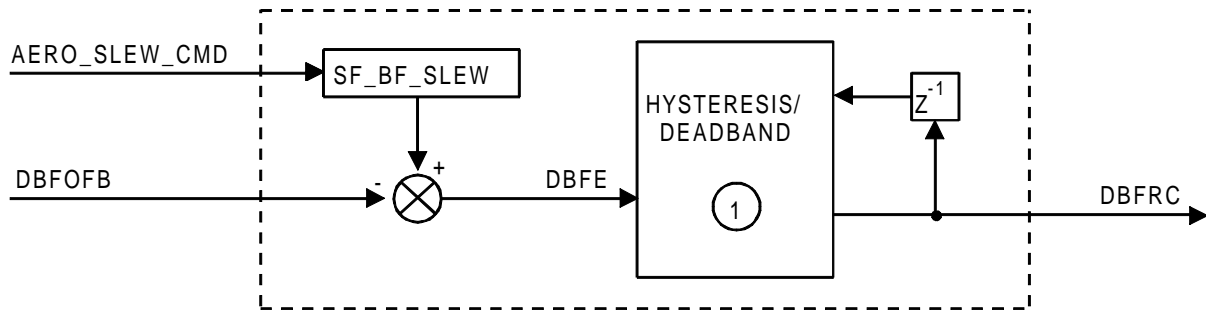


FIGURE 4.2.8-3. AEROSURFACE_CONTROL, Sequencing Requirements



NOTE

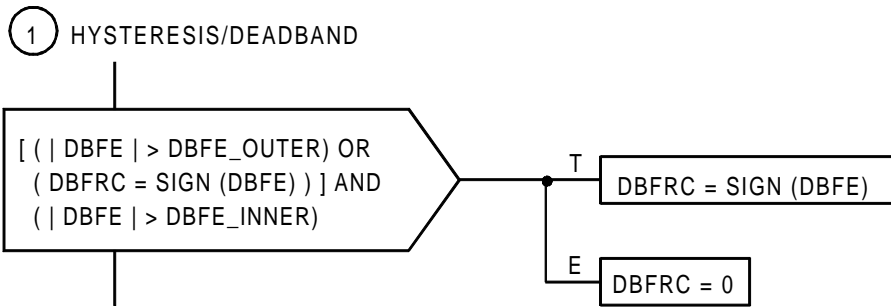
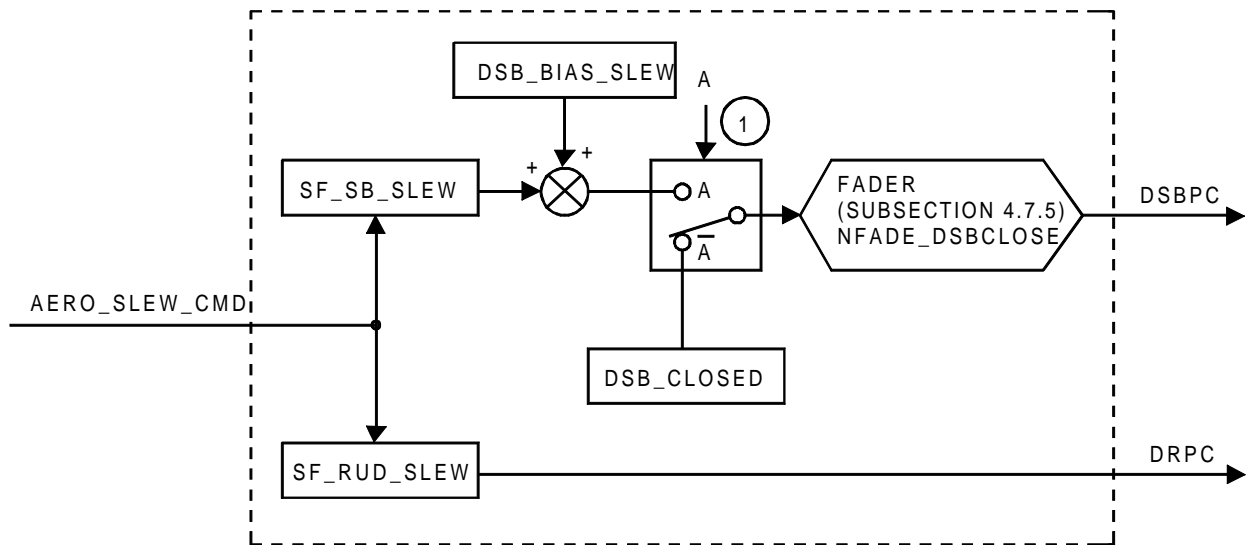


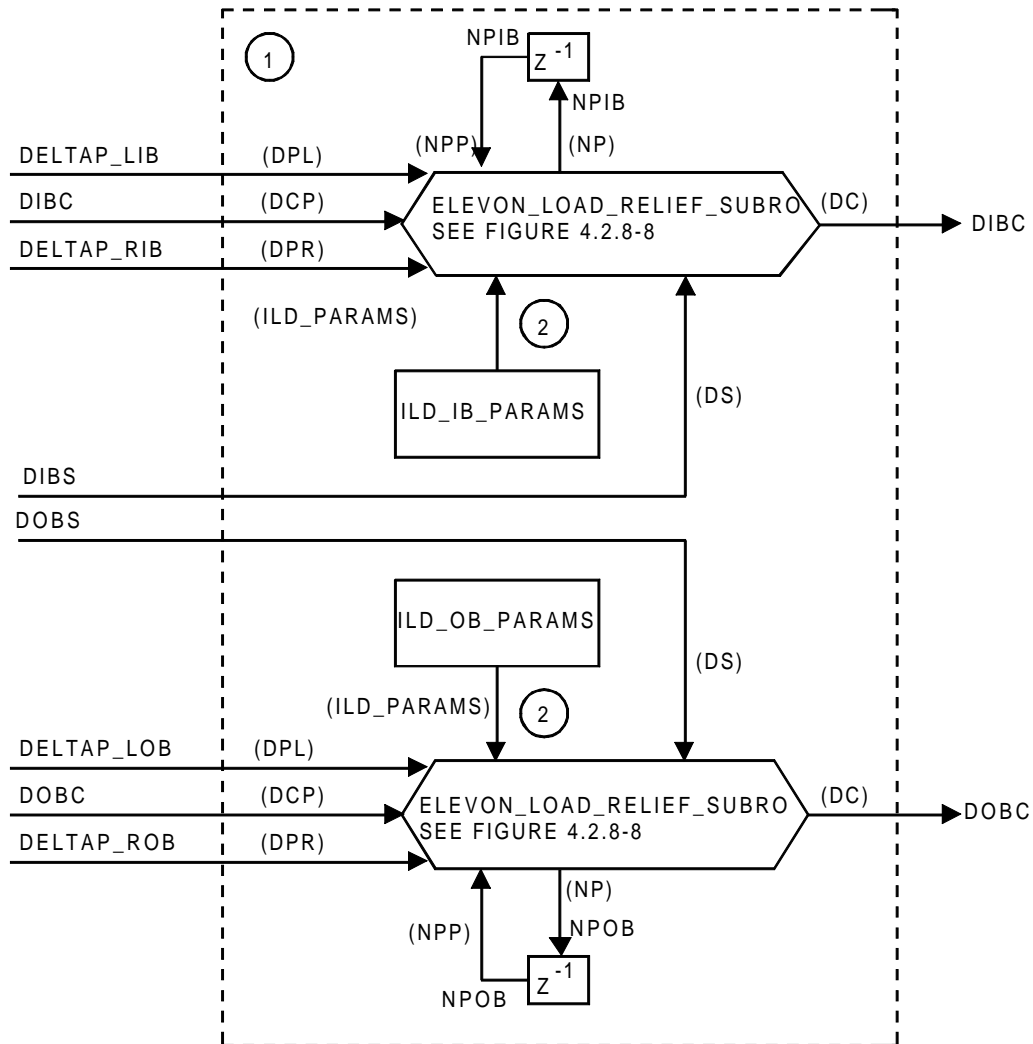
FIGURE 4.2.8-4. BODY_FLAP_CONTROL Function Module, Detailed Diagram

NOTE:
 THE RUDDER SLEW SCALE FACTOR MUST BE SMALL ENOUGH SO THAT DRPC
 (RUDDER POSITION COMMAND) NEVER EXCEEDS 20°. THIS PREVENTS INTERFERENCE
 BETWEEN RUDDER/SPEED BRAKE HINGES AND RUDDER CONICAL SEAL.



① $\overline{A} = \text{STOW_SB}$
 $A = \text{STOW_SB}$ THIS IS NOT A LATCHED TRANSITION. THE SPEED BRAKE IS TO BE FADED BACK TO DSB_BIAS_SLEW WHENEVER A RECYCLE COUNT IS DONE FOLLOWING EVENT 6 TO INSURE CORRECT POSITIONING OF THE SPEED BRAKE SHOULD OPS 1 BE CANCELLED AND TO PERMIT REPETITION OF THE AERO SLEW CHECK AFTER THE RECYCLE COUNT.

FIGURE 4.2.8-5. RUD_SB_CMD Function Module, Detailed Diagram



NOTES

- ① DUMMY VARIABLE NAMES ARE SHOWN IN PARENTHESES
- ② $ILD_PARAMS = \Delta BIAS/RETLIM/DRVLIM$
 $ILD_IB_PARAMS = \Delta BIAS_IB/RETLIM_IB/DRVLIM_IB$
 $ILD_OB_PARAMS = \Delta BIAS_OB/RETLIM_OB/DRVLIM_OB$

FIGURE 4.2.8-6. ELEVON_LOAD_RELIEF Function Module, Detailed Diagram

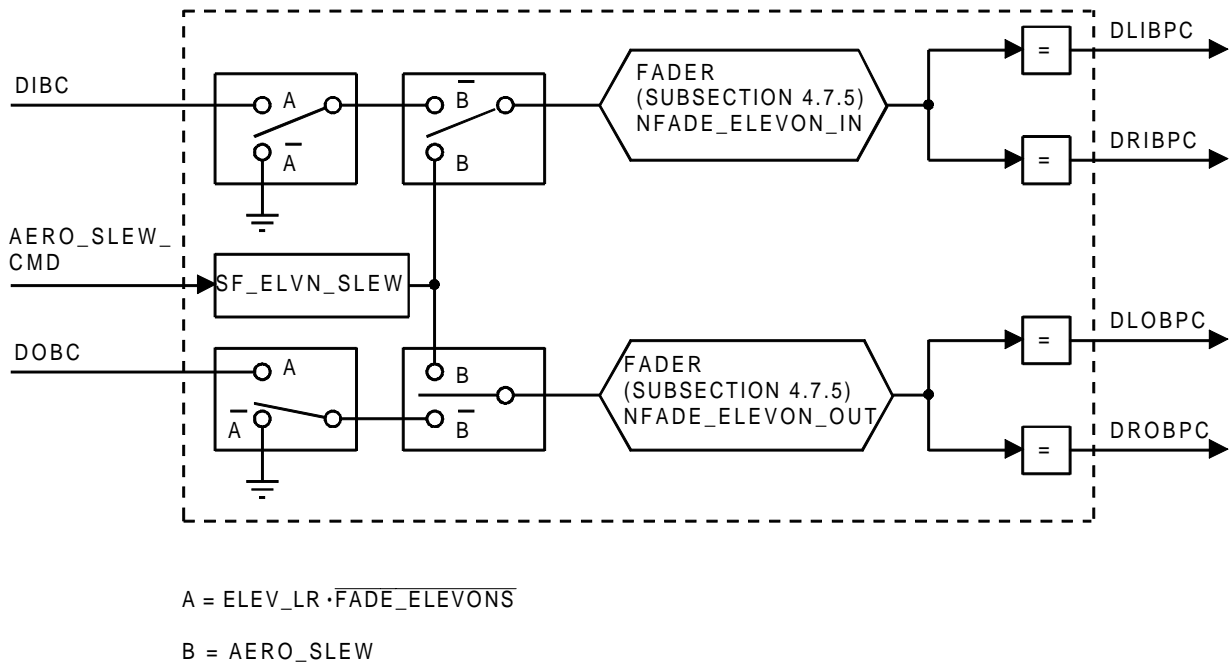


FIGURE 4.2.8-7. ELEVON_SLAVING Functional Module, Detailed Diagram

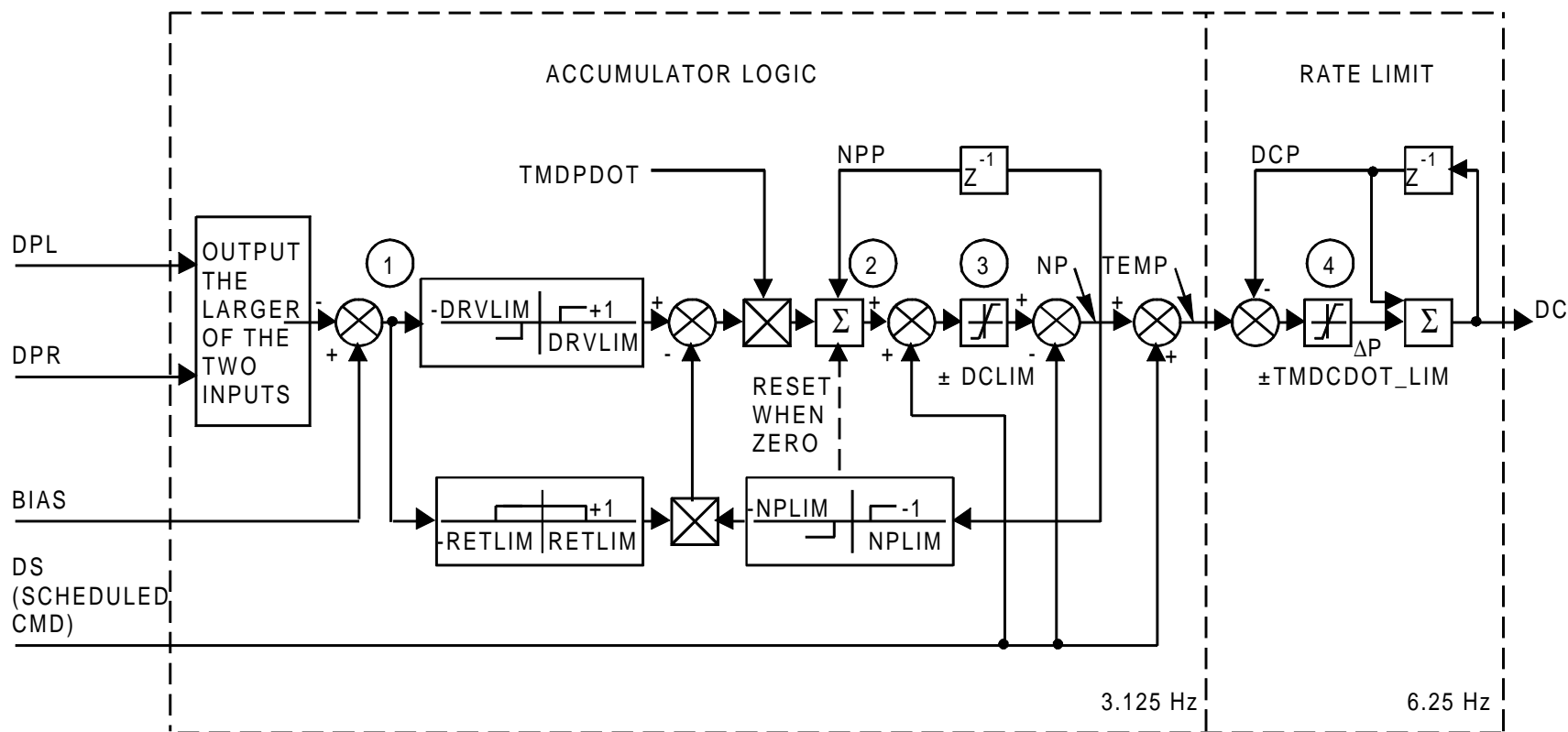
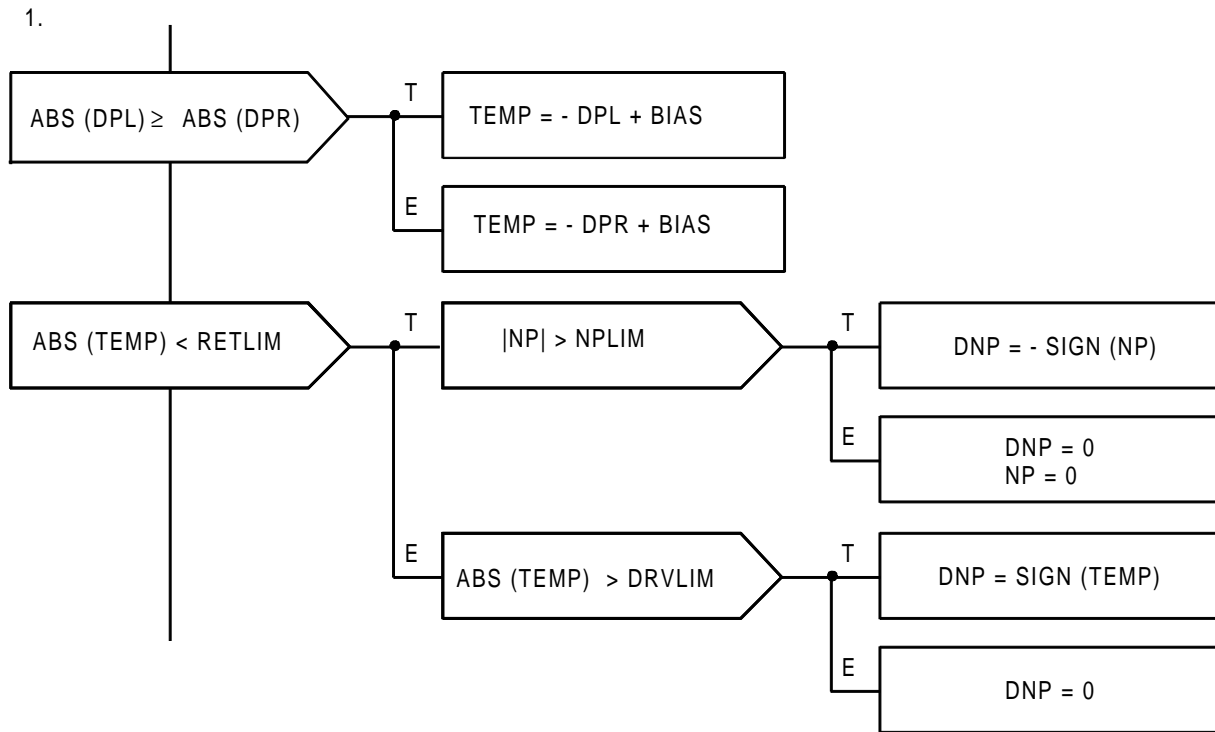


FIGURE 4.2.8-8.(1) ELEVON_LOAD_RELIEF_SUBRO, Detailed Diagram (Sheet 1 of 2)



1. ACCUMULATOR CONTROL LOGIC (3.125 Hz)
2. ACCUMULATOR (3.125 Hz)
 $NP = NPP + DNP * TMDPDOT$
3. POSITION LIMIT (3.125 Hz)
 $NP = MIDVAL [-DCLIM, (NP + DS), DCLIM] - DS$
 $TEMP = NP + DS$
4. RATE LIMIT AND TOTAL COMMAND (6.25 Hz)
 $DP = MIDVAL [-TMDCDOTLIM, (TEMP - DCP), TMDCDOTLIM]$
 $DC = DP + DCP$

FIGURE 4.2.8-8.(2) ELEVON_LOAD_RELIEF_SUBRO, Detailed Diagram (Sheet 2 of 2)

4.2.9 Linear Interpolations (INTERPS)

A. Software Description. An overview of INTERPS is presented in Figure 4.2.9-1. Its input/output requirements are summarized in Table 4.2.9-1. INTERPS consists of six function modules, S1_TRIMS_AND_ACCELREFS, ELEVON_SCHEDULES, MPS_SRB_INT_GAINS, S2_GAINS_AND_CG, S1VREL_S2ATT_GAINS, and S2_TRIM_MPS, which are sequenced as shown in Figure 4.2.9-2. The detail diagrams for S1_TRIMS_AND_ACCELREFS and ELEVON_SCHEDULES are shown in Figures 4.2.9-3 and 4.2.9-4, respectively. The detail diagram for MPS_SRB_INT_GAINS is shown in Figure 4.2.9-5. The detail diagrams for S2_GAINS_AND_CG, S1VREL_S2ATT_GAINS, and S2_TRIM_MPS are shown in Figures 4.2.9-6, 4.2.9-7, and 4.2.9-8. The intermodule interface requirements for INTERPS are given in Table 4.2.9-2. Initialization and I-loads requirements for INTERPS are presented in Tables 4.2.9-3 and 4.2.9-4, respectively.

B. Sequencing Requirements. INTERPS operating at 6.25 Hz does not require an unscheduled execution prior to transport-delay-critical modules provided that reconfiguration is mechanized within 80 ms of recognition of a valid mode change; see paragraph 4.1.3.C.

Table 4.2.9-1.INTERPS Interface Requirements

Name	Description	Source or Destination	Type	Range	Units	Rate Required/Produced At (Hz)
<u>Inputs</u>						
MET	Mission elapsed time	ASC_RECON	S		sec	6.25
REL_VEL_MAG	Earth-relative velocity magnitude	ASCENT_UPP	S		fps	6.25
SSME_FAILS	Buffered version of SSME_FAIL_STATUS	ASC_RECON	I		–	12.5
MASS_DOT	Rate of change of vehicle mass	ASC_2STG_GUID PW_RTLS_GUID PW_CONT_GUID ASC_1STG_GUID	S		slug/s	0.521
MASS	Vehicle mass	ASC_2STG_GUID PW_RTLS_GUID PW_CONT_GUID ASC_1STG_GUID	S		slug	0.521
SRB_SEP_CMD	Indicator, SRB separation command	ASC_RECON	B		–	12.5
AUTOTRIM_RESET	Indicator, reset trim integrators to zero	ASC_RECON	B		–	12.5
MM101_INIT	Indicator, first time ASCENT DAP is scheduled	ASC_RECON	B		–	12.5
INTERPS_S1	Indicator, stage 1 INTERPS active	ASC_RECON	B		–	12.5
INTERPS_S2	Indicator, stage 2 INTERPS active	ASC_RECON	B		–	12.5
AUTOTRIM_ENABLE	Indicator, enable stage 2 AUTOTRIM	ASC_RECON	B		–	12.5
PRE_SEP	Indicator, initiate separation preparation	ASC_RECON	B		–	12.5
NYSEP_FB_ENABLE	Indicator, enable NY feedback for separation	ASC_RECON	B		–	12.5
PPD	Indicator, RTLS powered pitchdown maneuver	ASC_RECON	B		–	12.5

Table 4.2.9-1.INTERPS Interface Requirements

Name	Description	Source or Destination	Type	Range	Units	Rate Required/Produced At (Hz)
<u>Inputs (Cont.)</u>						
K_CMD	Commanded SSME throttle setting	ASC_1STG_GUID, SBTC	I	65, 104	pct	6.25
K_MAX	Maximum throttle setting for SSME's	ASC_1STG_GUID	I	100, 109	pct	6.25
VREL_AERO_REF	Aerodynamic Reference Velocity	ASC_1STG_GUID	S		fps	6.25
GOOD_SSME	Number of good SSME's	ASC_RECON	I	0, 3	-	12.5
HYD_FAILS	Indicator, buffered HYD_FAIL_STATUS	ASC_RECON	I	0, 6	-	12.5
<u>Outputs</u>						
DQMPST	Pitch thrust vector deflection trim, orbiter	CMD_PROC_MPS	S		deg	6.25
DQSRBT	Pitch thrust vector deflection trim, SRB	CMD_PROC_SRB	S		deg	6.25
NZREF	Scheduled normal acceleration reference	ASC_TVC	S		g	6.25
NYREF	Scheduled lateral acceleration reference	ASC_TVC	S		g	6.25
DIBS	Elevon inboard schedule	AEROSURFACE_CONTROL	S		deg	3.125
DOBS	Elevon outboard schedule	AEROSURFACE_CONTROL	S		deg	3.125
KL_PHI	Variable gain (attitude, roll)	ASC_TVC	S		(deg/s)/deg	6.25
KM_THETA	Variable gain (attitude, pitch)	ASC_TVC, GC_STEER	S		(deg/s)/deg	6.25
KN_PSI	Variable gain (attitude, yaw)	ASC_TVC, GC_STEER	S		(deg/s)/deg	6.25
KM_NZ	Variable gain (NZ feedback, pitch)	ASC_TVC	S		(deg/s)/g	6.25
KN_NY	Variable gain (NY feedback, yaw)	ASC_TVC	S		(deg/s)/g	6.25
KL_MPS	Variable gain (rate, roll)	CMD_PROC_MPS	S		deg/(deg/s)	6.25
KM_MPS	Variable gain (rate, pitch)	CMD_PROC_MPS	S		deg/(deg/s)	6.25

Table 4.2.9-1.INTERPS Interface Requirements

Name	Description	Source or Destination	Type	Range	Units	Rate Required/Produced At (Hz)
KN_MPS	Variable gain (rate, yaw)	CMD_PROC_MPS	S		deg/(deg/s)	6.25
KL_SRB	Variable gain (rate, SRB roll)	CMD_PROC_SRB	S		deg/(deg/s)	6.25
KM_SRB	Variable gain (rate, SRB pitch)	CMD_PROC_SRB	S		deg/(deg/s)	6.25
KN_SRB	Variable gain (rate, SRB yaw)	CMD_PROC_SRB	S		deg/(deg/s)	6.25
KL_PSI	Variable gain (yaw attitude error crossfeed, roll)	ASC_TVC	S		(deg/s) deg	6.25
KM_INT	Variable pitch integrator gain	ASC_TVC	S		1/s	6.25
KN_INT	Variable yaw integrator gain	ASC_TVC	S		1/s	6.25
KL_DELPSI	Variable yaw command crossfeed gain	ASC_TVC	S		–	6.25
KN_PRHP	Variable roll/yaw high pass gain	ASC_TVC	S		–	6.25
K_LOAD_RELIEF	Variable load relief gain	ASC_1STG_GUID	S		–	6.25
TRM_NYREF	Trim lateral acceleration reference	ASC_TVC	S		deg/s	6.25
DRMPST	Yaw thrust vector deflection trim, MPS	CMD_PROC_MPS	S		deg	6.25
PCGTRM	Net pitch trim thrust angle	GC_STEER	S		deg	6.25
YCGTRM	Net yaw trim thrust angle	GC_STEER	S		deg	6.25

Table 4.2.9-2.INTERPS Inter-Module Interface Requirements							
Module	Name	Description	Source or Destination	Type	Range	Units	Rate Required/Produced At (Hz)
S1_TRIMS_ AND_ ACCELREFS	<u>Inputs</u>						
	VREL_AERO_REF	Aerodynamic reference velocity	ASC_1STG_GUID	S		fps	6.25
	AUTOTRIM_RESET	Indicator, reset trim integrators to zero	ASC_RECON	B		-	12.5
	SSME_FAILS	Buffered, SSME_FAIL_STATUS	ASC_RECON	I		-	12.5
	MM101_INIT	Indicator, first time ASCENT DAP sequenced	ASC_RECON	B		-	12.5
	SRB_SEP_CMD	Indicator, initiate SRB separation command	ASC_RECON	B		-	12.5
	K_CMD	Commanded SSME throttle setting	ASC_1STG_GUID, SBTC	I	65, 104	pct	6.25
	K_MAX	Maximum throttle setting for SSME's	ASC_1STG_GUID	I	100, 109	pct	6.25
	K_LOAD_RELIEF	Variable load relief gain	S1VREL_ S2ATT_GAINS	S	-	-	6.25
	KN_MPS	Variable gain (rate, yaw)	MPS_SRB_INT_ GAINS	S	-	deg/ (deg/s)	6.25
	GOOD_SSME	Number of good SSME's	ASC_RECON	I	0, 3	-	12.5
	HYD_FAILS	Indicator, buffered HYD_FAIL_STATUS	ASC_RECON	I	0,6	-	12.5
	MET	Mission elapsed time	ASC_RECON	S		sec	6.25

Table 4.2.9-2.INTERPS Inter-Module Interface Requirements							
Module	Name	Description	Source or Destination	Type	Range	Units	Rate Required/Produced At (Hz)
S1_TRIMS_AND_ACCELREFS (Cont.)	<u>Outputs</u>						
	DQMPST	Pitch thrust vector deflection trim orbiter	CMD_PROC_MPS	S		deg	6.25
	DQSRBT	Pitch thrust vector deflection trim, SRB	CMD_PROC_SRB	S		deg	6.25
	NZREF	Scheduled normal acceleration ref	ASC_TVC	S		g	6.25
	NYREF	Scheduled lateral acceleration ref	ASC_TVC	S		g	6.25
	TRM_NYREF	Trim lateral acceleration reference	ASC_TVC	S		deg/s	6.25
	P_BIAS_E1	Center engine pitch trim increment	CMD_PROC_MPS	S		deg	6.25
P_BIAS_E23	Side engine pitch trim increment	CMD_PROC_MPS	S		deg	6.25	
ELEVON_SCHEDULES	<u>Inputs</u>						
	VREL_AERO_REF	Aerodynamic reference velocity	ASC_1STG_GUID	S		fps	6.25
	MM101_INIT	Indicator, first time ASCENT DAP sequenced	ASC_RECON	B		-	12.5

Table 4.2.9-2.INTERPS Inter-Module Interface Requirements							
Module	Name	Description	Source or Destination	Type	Range	Units	Rate Required/Produced At (Hz)
	<u>Outputs</u>						
	DIBS	Elevon inboard command	ELEVON_LOAD_RELIEF	S		deg	6.25
	DOBS	Elevon outboard command	ELEVON_LOAD_RELIEF	S		deg	6.25
S1VREL_ S2ATT_ GAINS	<u>Inputs</u>						
	REL_VEL_MAG	Earth-relative velocity magnitude	ASCENT_UPP	S		fps	6.25
	AUTOTRIM_ENABLE	Indicator, enable AUTOTRIM	ASC_RECON	B		–	12.5
	NYSEP_FB_ENABLE	Indicator, enable NY feedback	ASC_RECON	B		–	12.5
	AUTOTRIM_RESET	Indicator, reset trim integrators to zero	ASC_RECON	B		–	12.5
	MM101_INIT	Indicator, first time ASCENT DAP is sequenced	ASC_RECON	B		–	12.5
	PRE_SEP	Indicator	ASC_RECON	B		–	12.5
	<u>Outputs</u>						
	KL_PHI	Variable gain (attitude roll)	ASC_TVC	S		(deg/s)/deg	6.25
	KM_THETA	Variable gain (attitude pitch)	ASC_TVC	S		(deg/s)/deg	6.25
	KN_PRHP	Variable gain (high pass roll and yaw rates)	ASC_TVC	S		–	6.25
	KL_PSI	Variable gain (yaw attitude error crossfeed, roll)	ASC_TVC	S		(deg/s)/deg	6.25

Table 4.2.9-2.INTERPS Inter-Module Interface Requirements								
Module	Name	Description	Source or Destination	Type	Range	Units	Rate Required/Produced At (Hz)	
MPS_SRB_INT_GAINS	KN_PSI	Variable gain (attitude yaw)	ASC_TVC	S		(deg/s)/deg	6.25	
	KM_NZ	Variable gain (NZ feed-back, pitch)	ASC_TVC	S		(deg/s)/g	6.25	
	KN_NY	Variable gain (NY feed-back, yaw)	ASC_TVC	S		(deg/s)/g	6.25	
	K_LOAD_RELIEF	Variable load relief gain	ASC_1STG_GUID, S1_TRIM_AND_ACCELREFS	S		-	6.25	
	<u>Inputs</u>							
	MET	Mission elapsed time	ASC_RECON	S		s	12.5	
	AUTOTRIM_RESET	Indicator, reset trim integrators to zero	ASC_RECON	B		-	12.5	
	PRE_SEP	Indicator, fade orbiter forward loop roll gain	ASC_RECON	B		-	12.5	
	<u>Outputs</u>							
	KL_MPS	Variable gain (rate, roll)	CMD_PROC_MPS	S		deg/(deg/s)	6.25	
	KM_MPS	Variable gain (rate, pitch)	CMD_PROC_MPS	S		deg/(deg/s)	6.25	
	KN_MPS	Variable gain (rate, yaw)	CMD_PROC_MPS, S1_TRIMS_AND_ACCELREFS	S		deg/(deg/s)	6.25	
	KL_SRB	Variable gain (rate, SRB roll)	CMD_PROC_SRB	S		deg/(deg/s)	6.25	
	KM_SRB	Variable gain (rate, SRB pitch)	CMD_PROC_SRB	S		deg/(deg/s)	6.25	
KN_SRB	Variable gain (rate, SRB yaw)	CMD_PROC_SRB	S		deg/(deg/s)	6.25		

Table 4.2.9-2.INTERPS Inter-Module Interface Requirements							
Module	Name	Description	Source or Destination	Type	Range	Units	Rate Required/Produced At (Hz)
	KM_INT	Variable gain (pitch trim integrator rate gain)	ASC_TVC	S		1/s	6.25
	KN_INT	Variable gain (yaw trim integrator rate gain)	ASC_TVC	S		1/s	6.25
	KL_DELPSI	Variable gain (yaw error signal crossfeed, roll)	ASC_TVC	S		-	6.25
S2_GAINS_AND_CG	<u>Inputs</u>						
	MASS	Estimated vehicle mass	ASC_2STG_GUID, PW_RTLS_GUID, PW_CONT_GUID	S		slug	0.521
	MASS_DOT	Rate of change of vehicle mass	ASC_2STG_GUID, PW_RTLS_GUID, PW_CONT_GUID	S		slug/s	0.521
	MM101_INIT	Indicator, first time	ASC_RECON				6.25
	PPD	Indicator, RTLS powered pitch down maneuver	ASC_RECON	B		-	12.5
	<u>Outputs</u>						
	KL_MPS	Variable gain, roll rate	CMD_PROC_MPS	S		deg/(deg/s)	6.25
	KM_MPS	Variable gain, pitch rate	CMD_PROC_MPS	S		deg/(deg/s)	6.25
	KN_MPS	Variable gain, yaw rate	CMD_PROC_MPS	S		deg/(deg/s)	6.25
	KM_INT	Variable gain (pitch trim integrator gain)	ASC_TVC	S		1/sec	6.25
	KN_INT	Variable gain (yaw trim integrator gain)	ASC_TVC	S		1/sec	6.25

Table 4.2.9-2.INTERPS Inter-Module Interface Requirements								
Module	Name	Description	Source or Destination	Type	Range	Units	Rate Required/Produced At (Hz)	
	KL_DELPSI	Variable gain (yaw to roll)	ASC_TVC	S		-	6.25	
	XCG	Vehicle x-axis center of gravity location	S2_TRIM_MPS	S		ft	6.25	
	ZCG	Vehicle z-axis center of gravity location	S2_TRIM_MPS	S		ft	6.25	
	MASS_EST	Mass Estimate	GC_STEER	S		slug	6.25	
S2_TRIM_MPS	<u>Inputs</u>							
	XCG	Vehicle X-axis center of gravity location	S2_GAINS_AND_CG	S		ft	6.25	
	ZCG	Vehicle Z-axis center of gravity location	S2_GAINS_AND_CG	S		ft	6.25	
	SSME_FAILS	Indicator, main engine failures	ASC_RECON	I	0, 7	-	12.5	
	<u>Outputs</u>							
	DQMPST	Pitch thrust vector deflection trim, MPS	CMD_PROC_MPS	S		deg	6.25	
	DRMPST	Yaw thrust vector deflection trim, MPS	CMD_PROC_MPS	S		deg	6.25	
	PCGTRM	Net pitch trim thrust angle	GC_STEER	S		deg	6.25	
	YCGTRM	Net yaw trim thrust angle	GC_STEER	S		deg	6.25	

Table 4.2.9-3.INTERPS Initialization Requirements					
Module	Component	Initialize on Transition		Variable	Initial Value
		From	To		
S1_TRIMS_ AND_ ACCELREFS	Fader	-	-	NFADE_PBIAS_ END_23	0
	Fader	-	-	NFADE_PBIAS_ MPS	0
	X_INTERP	-	-	J_MET_TRIM	1
	X_INTERP	-	-	J_MET_TRMGN	1
	GAINS	-	-	DEL_TRIM_GAIN	TRIM_GAIN _TAB ₁
	-	-	-	P_BIAS_E1	PBIAS1_TAB ₁
	-	-	-	P_BIAS_E23	PBIAS23_TAB ₁
	Fader	(HYD_FAILS = 0) • (SSME_FAILS = 0)	(HYD_FAILS > 0) + (SSME_FAILS > 0)	NFADE_PBIAS_ END_1	NFADE_MEFAIL
	Fader	-	-	NFADE_PBIAS_ END_23	NFADE_MEFAIL
	Fader	-	-	NFADE_PBIAS_ MPS	NFADE_MEFAIL
ELEVON_ SCHEDULES	Fader	<u>AUTOTRIM_</u> RESET	AUTOTRIM_ RESET	NFADE_PBIAS_ END_1	NFADE_PBIAS_ OFF
	Fader	-	-	NFADE_PBIAS_ END_23	NFADE_PBIAS_ OFF
	Scheduled parameters	-	MM101_INIT	DIBS	DIBS_TAB ₁
	X_INTERP	-	-	DOBS J_VREL_ELVN	DOBS_TAB ₁ 1
MPS_SRB_ INT_GAINS	GAINS			KL_DELPSI	KLDELPSI_S1
				KL_MPS	KLMP_S1
				KL_SRB	KLSRB_TIME_ TAB ₁
				KM_MPS	KMMPS_TIME_ TAB ₁
				KN_MPS	KNMPS_TIME_ TAB ₁
				KM_SRB	(KMMPS_TIME_ TAB ₁)* KMSRB_RATIO
				KM_INT	(KMMPS_TIME_ TAB ₁)* KMINT_S1

Table 4.2.9-3.INTERPS Initialization Requirements

Module	Component	Initialize on Transition		Variable	Initial Value	
		From	To			
MPS_SRB_ INT_GAINS (Cont.)	GAINS	–	MM101_INIT	KN_SRB	(KNMPS_TIME_ TAB ₁)* KNSRB_RATIO	
				KN_INT	(KNMPS_TIME_ TAB ₁)* KNINT_S1	
		<u>PRE_SEP</u>	PRE_SEP	KL_MPS	KLMPMS_S2	
		<u>AUTOTRIM_</u> <u>RESET</u>	AUTOTRIM_ RESET	KL_DELPSI	KLDELPSI_MASS_ TAB ₁	
		<u>AUTOTRIM_</u> <u>RESET</u>	AUTOTRIM_ RESET	KL_SRB	KLSRB_SRBSEP	
		<u>AUTOTRIM_</u> <u>RESET</u>	AUTOTRIM_ RESET	KM_MPS	KMMPS_MASS_ TAB ₁	
			<u>AUTOTRIM_</u> <u>RESET</u>	AUTOTRIM_ RESET	KN_MPS	KNMPS_MASS_ TAB ₁
	X_INTERP Fader			MM101_INIT	J_TIME_GAINS	1
				MM101_INIT	NFADE_ KLDELPSI	0
					NFADE_KLMPS	0
					NFADE_KLSRB	0
					NFADE_KMMPS	0
					NFADE_KNMPS	0
	Fader		<u>AUTOTRIM_</u> <u>RESET</u>	AUTOTRIM_ RESET	NFADE_ KLDELPSI	NFADE_ KLDELPSI_SEP
					NFADE_KLSRB	NFADE_COM_ SRBSEP
					NFADE_KMMPS	NFADE_COM_ SRBSEP
					NFADE_KNMPS	NFADE_COM_ SRBSEP
		<u>PRE_SEP</u>	PRE_SEP	NFADE_KLMPS	NFADE_KLMPS_ SEP	

Table 4.2.9-3.INTERPS Initialization Requirements						
Module	Component	Initialize on Transition		Variable	Initial Value	
		From	To			
S1VREL_ S2ATT_ GAINS	GAINS	-	MM101_INIT	J_VREL_GAINS	1	
				KL_PHI	KLPHI_VREL_TAB ₁	
				KM_THETA	KMTHETA_VREL_TAB ₁	
				KN_PSI	KNPSI_VREL_TAB ₁	
				KLOAD_RELIEF	KLOADRELIEF_VREL_TAB ₁	
				KM_NZ	(KLOADRELIEF_VREL_TAB ₁)* KMNZ_RATIO	
				KL_PSI	(KLOADRELIEF_VREL_TAB ₁)* KLPSI_RATIO	
				KN_NY	(KLOADRELIEF_VREL_TAB ₁)* KNNY_RATIO	
				KN_PRHP	(KLOADRELIEF_VREL_TAB ₁)* KNPRHP_RATIO	
				<u>AUTOTRIM_ENABLE</u>	<u>AUTOTRIM_ENABLE</u>	KL_PHI
	Fader Gain Fader Gain Fader Gain	Gain	<u>NYSEP_FB_ENABLE</u>	<u>NYSEP_FB_ENABLE</u>	KM_THETA	KMTHETA_S2
					KN_PSI	KNPSI_S2
		Gain	<u>NYSEP_FB_ENABLE</u>	<u>NYSEP_FB_ENABLE</u> • <u>AUTOTRIM_RESET</u>	NFADE_KNNY	0
					KNNY_SRBSEP	KNNY_SEP
Gain	<u>PRE_SEP</u>	<u>PRE_SEP</u>	NFADE_KNNY	NFADE_NY_ON		
			KL_PSI	0		
				NFADE_NY_OFF	0.0	

Table 4.2.9-3.INTERPS Initialization Requirements							
Module	Component	Initialize on Transition		Variable	Initial Value		
		From	To				
S2_GAINS_ AND_CG	Scheduled parameters	INTERPS_S2	INTERPS_S2	KL_MPS	KLMP_S2		
				KM_MPS	KMMPS_ MASS_TAB ₁		
				KN_MPS	0.0		
				KL_DELPSI	KL_DELPSI_ MASS_TAB ₁		
				SLOPE_KMMPS XCEPT_KMMPS	③		
				SLOPE_KNMPS XCEPT_KNMPS	④		
				SLOPE_KLDELPSI XCEPT_KLDELPSI	⑤		
				-	MM101_INIT	F_XCG_TAB(I)	⑥
						F_ZCG_TAB(I)	⑥
						F_MASS_TAB(I)	⑥
		SSME_FAILS = i	SSME_FAILS ≠ i		NFADE_DQMPST	⑦	
					NFADE_DRMPST	⑦	
		-	MM101_INIT	PREF	-12.0		
				YREF	0.0		
		-	MM101_INIT	NFADE_KNMPS2	0		
		-	MM101_INIT	B	False		
		\bar{B}	B	NFADE_KNMPS2	NFADE_KNMPS_ S2		
-	⑨	B	True				
-	MM101_INIT	MASS_EST	50,000				

Table 4.2.9-3. INTERPS Initialization Requirements					
Module	Component	Initialize on Transition		Variable	Initial Value
		From	To		
①	NFADE_DQMPST_S1_END				
②	NFADE_MEFAIL				
③	SLOPE_KMMPS	$= \frac{\text{KMMPS_MASS_TAB}_1 - \text{KMMPS_MASS_TAB}_2}{\text{MASS2_GAIN_TAB}_1 - \text{MASS2_GAIN_TAB}_2}$			
	XCEPT_KMMPS	$= \text{KMMPS_MASS_TAB}_1 - (\text{MASS_GAIN_TAB}_1) * (\text{SLOPE_KMMPS})$			
④	SLOPE_KNMPS	$= \frac{\text{KNMPS_MASS_TAB}_1 - \text{KNMPS_MASS_TAB}_2}{\text{MASS2_GAIN_TAB}_1 - \text{MASS2_GAIN_TAB}_2}$			
	XCEPT_KNMPS	$= \text{KNMPS_MASS_TAB}_1 - (\text{MASS_GAIN_TAB}_1) * (\text{SLOPE_KMMPS})$			
⑤	SLOPE_KLDELPSI	$= \frac{\text{KLDELPSI_MASS_TAB}_1 - \text{KLDELPSI_MASS_TAB}_2}{\text{MASS2_KLDELPSI_TAB}_1 - \text{MASS2_KLDELPSI_TAB}_2}$			
	XCEPT_KLDELPSI	$= \text{KLDELPSI_MASS_TAB}_1 - (\text{MASS_KLDELPSI_TAB}_1) * (\text{SLOPE_KLDELPSI})$			
⑥	F_MASS_TAB(I)	$= \text{MASS_GAIN_TAB}(I) + \text{MASS_PL} + \text{MASS_OMS}$			
	F_XCG_TAB(I)	$= \frac{(\text{XCG_TAB}(I) * \text{MASS_GAIN_TAB}(I)) + (\text{XCG_PL} * \text{MASS_PL}) + (\text{XCG_OMS} * \text{MASS_OMS})}{\text{F_MASS_TAB}(I)}$			
	F_ZCG_TAB(I)	$= \frac{(\text{ZCG_TAB}(I) * \text{MASS_GAIN_TAB}(I)) + (\text{ZCG_PL} * \text{MASS_PL}) + (\text{ZCG_OMS} * \text{MASS_OMS})}{\text{F_MASS_TAB}(I)}$			
	I	$= 1, 2, 3, 4, 5, 6, 7$			
⑦	NFADE_TRIM				
⑧	DQSRBT	$= \text{DQSRBT}_0_TAB_1 + (\text{GOOD_SSME}) * (\text{K_DEL_NZ_THROT}) * (\text{K_THROT_REF} - \text{K_THROT_EST}) * (\text{K_TRM_NZ})$			
⑨	B	True on the second pass of the S2_GAINS_AND_CG Function Module			

Table 4.2.9-4.INTERPS I-Loads/K-Loads/Constants					
Module	Name	Description	Type	MSID/Value	Units
S1_TRIMS_ ACCELREFS	VREL_TRIM_TAB(i) i = 02 to 20	Array of mach breakpoints for Stage 1 trims	A(19)	V97U2298C to V97U2316C	fps
	DQSRBT_0_TAB(i) i = 01 to 20	Array of SRB pitch trim breakpoints for no main engine failures	A(20)	V97U1714C to V97U1733C	deg
	NZREF_0_TAB(i) i = 01 to 20	Array of NZREF breakpoints for no main engine failures	A(20)	V97U2138C to V97U2157C	g
	NYREF_0_1	NYREF for no main engine failures or engine No. 1 failed	S	V97U2078C	g
	NYREF_2	NYREF for main engine No. 2 failed	S	V97U2098C	g
	NYREF_3	NYREF for main engine No. 3 failed	S	V97U2118C	g
	NFADE_DQMPST_ S1_END	Cycles to fade MPS pitch trim to final S1C value if main engine failed	S	V97U2432C	–
	DQMPST_S1_END	Orbiter pitch trim at end of Stage 1	S	V97U2450C	deg
	NFADE_MEFAIL	Cycles to fade SRB pitch trim, NZREF, and NYREF to alternate array on main engine fail	S	V97U2073C	counts
	K_DEL_NZ_THT(i) i = 1 to 2	Delta NZ for throttling effects	A(2)	V99U6677C to V99U6678C	g/pct
	K_DEL_NZ_FL(i) i = 1 to 2	Delta NZ for engine fail	A(2)	V99U6675C to V99U6676C	g
	K_TRIM_AERO_1_TAB(i) i = 1 to 4	Delta trim for Engine 1 out aero effects	A(4)	V99U6679C to V99U6682C	deg
	K_TRIM_AERO_2_TAB(i) i = 1 to 4	Delta trim for Engine 2 or 3 out aero effects	A(4)	V99U6683C to V99U6686C	deg
	K_TRIM_AERO_4_TAB(i) i = 1 to 4	Delta trim for Engines 1 and 2 or Engines 1 and 3 out aero effects	A(4)	V99U6687C to V99U6690C	deg
	K_TRIM_AERO_6_TAB(i) i = 1 to 4	Delta trim for Engines 2 and 3 or all 3 engines out aero effects	A(4)	V99U6691C to V99U6694C	deg
	VREL_AERO_TAB(i) i = 1 to 4	Velocity table for engine out aero effects	A(4)	V99U6701C to V99U6704C	ft/sec
	K_TRM_NYREF	Gain for TRM_NYREF	S	V99U6695C	deg/g
	K_TRM_NZ	Delta trim due to throttling	S	V99U6696C	deg

Table 4.2.9-4.INTERPS I-Loads/K-Loads/Constants					
Module	Name	Description	Type	MSID/Value	Units
S1_TRIMS_ ACCELREFS (Cont.)	K_NZ_THRT	Nominal delta NZ for throttling	S	V99U6365C	g/pct
	VREL_EO_TRIM(i) i = 1 to 10	Velocity table for engine out trim and NZREF	A(10)	V99U6705C to V99U6708C, V99U6601C to V99U6606C	ft/sec
	DQSRBT_EO(i) i = 1 to 10	Delta trim for engine out steering	A(10)	V99U6671C to V99U6674C, V99U6607C to V99U6612C	deg
	NZREF_EO(i) i = 1 to 10	Delta NZREF for engine out steering	A(10)	V99U6697C to V99U6700C, V99U6613C to V99U6618C	g
	DEL_NZ_GAIN	NZ Compensation for incremental trim	S	V97U0875C	g/deg
	NFADE_PBIAS_OFF	Cycles to fade out P_BIAS_E1 and P_BIAS_E23	I	V97U0876C	-
	MET_TRMGN_TAB(i) i = 1 to 6	Array of MET breakpoints for scheduled SRB trim gain	S	V97U0877C to V97U0882C	sec
	TRIM_GAIN_TAB(i) i = 1 to 6	Array of DEL_TRIM_GAIN breakpoints for SRB trim gain	S	V97U0883C to V97U0888C	deg/deg
	MET_TRIM_TAB(i) i = 1 to 8	Array of MET breakpoints for scheduled center and side engine pitch trims	S	V97U1812C to V97U1819C	sec
	PBIAS1_TAB(i) i=1 to 8	Array of PBIAS1_TAB breakpoints for center engine pitch trim	S	V97U1820C to V97U1827C	deg
PBIAS23_TAB(i) i=1 to 8	Array of PBIAS23_TAB breakpoints for side engine pitch trim	S	V97U1828C to V97U1835C	deg	
ELEVON_ SCHEDULES	VREL_ELVN_TAB(i) i = 02 to 08	Array of VREL breakpoints for scheduled elevon load relief	A(7)	V97U2277C to V97U2283C	fps
	DIBS_TAB(i) i = 01 to 08	Array of inboard elevon breakpoints for load relief	A(8)	V97U1667C to V97U1674C	deg
	DOBS_TAB(i) i = 01 to 08	Array of outboard elevon breakpoints for load relief	A(8)	V97U1677C to V97U1684C	deg

Table 4.2.9-4.INTERPS I-Loads/K-Loads/Constants					
Module	Name	Description	Type	MSID/Value	Units
MPS_SRB_ INT_GAINS	KLDELPSI_S1	S1C yaw to roll crossfeed gain	S	V97U2434C	–
	KLMPS_S1	S1C roll loop gain	S	V98U9590C	deg/ deg/s
	KLMPS_S2	S2C roll loop gain	S	V97U2477C	deg/ deg/s
	MET_GAIN_TAB(i) i = 01 to 04	S1C time gain schedule common breakpoints	A(4)	V98U9591C to V98U9594C	S
	KLSRB_TIME_TAB(i) i = 01 to 04	Array of KLSRB breakpoints	A(4)	V98U9595C to V98U9598C	deg/ deg/s
	KMMPS_TIME_TAB(i) i = 01 to 04	Array of KM_MPS breakpoints	A(4)	V98U9599C to V98U9602C	deg/ (deg/s)
	KNMPS_TIME_TAB(i) i = 01 to 04	Array of KN_MPS breakpoints	A(4)	V97U2499C V98U9553C V98U9554C V98U9555C	deg/ deg/s
	KMSRB_RATIO	S1C ratio of SRB to MPS pitch loop gains	S	V98U9556C	–
	KMINT_S1	S1C ratio of pitch integral to proportional gains	S	V98U9557C	deg/ deg/s
	KNSRB_RATIO	Ratio of SRB to MPS yaw loop gains	S	V98U9558C	–
	KNINT_S1	Ratio of yaw integral to proportional gains	S	V98U9559C	deg/ deg/s
	KLDELPSI_MASS_TAB(1)	First S2C array point of KLDELPSI	S	V97U2478C	–
	KMMPS_MASS_TAB(1)	First S2C array point for KMMPS	S	V97U1897C	deg/ deg/s
	KNMPS_MASS_TAB(1)	First S2C array point for KNMPS	S	V97U1957C	deg/ deg/s
	NFADE_KLDELPSI_SEP	Cycle to fade KLDELPSI from Stage 1 to Stage 2	S	V98U9560C	–
	NFADE_COM_SRBSEP	Cycle to fade common gains from Stage 1 to Stage 2	S	V98U9561C	–
	NFADE_KLMPS_SEP	Cycles to fade KLMPS to Stage 2	S	V98U9562C	–
	KLSRB_SRBSEP	KLSRB gain for end of Stage 1	S	V98U9563C	deg/ deg/s

Table 4.2.9-4.INTERPS I-Loads/K-Loads/Constants					
Module	Name	Description	Type	MSID/Value	Units
S1VREL_ S2ATT_ GAINS	VREL_GAIN_TAB(i) i = 02 to 05	Array of VREL breakpoints for VREL scheduled gains	A(4)	V97U2286C to V97U2289C	ft/s
	KLPHI_VREL_TAB(i) i = 01 to 05	Array of KL_PHI breakpoints for first stage	A(5)	V97U1840C to V97U1844C	(deg/s)/ deg
	KMTHETA_VREL_TAB(i) i = 01 to 05	Array of KM_THETA breakpoints for first stage	A(5)	V97U1938C to V97U1941C	(deg/s)/ deg
	KNPSI_VREL_TAB(i) i = 01 to 05	Array of KN_PSI breakpoints for first stage	A(5)	V97U2011C to V97U2015C	(deg/s)/ deg
	KLOADRELIEF_VREL_ TAB(i) i = 1 to 5	Array of K_LOAD_RELIEF breakpoints	A(5)	V97U2442C to V97U2446C	–
	KLPHI_S2	Second–stage KL_PHI gain	S	V97U2447C	(deg/s)/ deg
	KMTHETA_S2	Second–stage KM_THETA gain	S	V97U2448C	deg/s
	KNPSI_S2	Second–stage KN_PSI gain	S	V97U2449C	(deg/s)/ deg
	KMNZ_RATIO	Multiplier of K_LOAD_RELIEF for KM_NZ gain	S	V97U2464C	(deg/s)/ deg
	KLPSI_RATIO	Multiplier of K_LOAD_RELIEF for KL_PSI gain	S	V97U2465C	(deg/s)/ deg
	KNNY_RATIO	Multiplier of K_LOAD_RELIEF for KN_NY gain	S	V97U2466C	(deg/s)/ g
	KNPRHP_RATIO	Multiplier of K_LOAD_RELIEF for KN_PRHP gain	S	V97U2467C	–
	KNNY_SEP	Fade – to value of KN_NY during SEP	S	V97U2468C	(deg/s)/ g
	NFADE_NY_ON	Cycles to fade–in KN_NY during SEP	S	V97U2469C	–
	NFADE_NY_OFF	Cycles to fade–out KN_NY during SEP	S	V97U2470C	–

Table 4.2.9-4.INTERPS I-Loads/K-Loads/Constants					
Module	Name	Description	Type	MSID/Value	Units
S2_GAINS_ AND_CG	KLMPS_S2	Second-stage KL_MPS gain	S	V97U2477C	deg/ (deg/s)
	MASS2_GAIN_TAB	Array of mass breakpoints for second-stage gain schedules	A(2)	V97U2475C V97U2476C	slugs
	KMMPS_MASS_TAB	Array of second-stage KM_MPS breakpoints	A(2)	V97U1897C V97U1898C	deg/ (deg/s)
	KNMPS_MASS_TAB	Array of second-stage KN_MPS breakpoints	A(2)	V97U1957C V97U1958C	deg/ (deg/s)
	KLDELPSI_MASS_TAB	Array of second-stage KL_DELPSI breakpoints	A(2)	V97U2478C V97U2479C	-
	MASS_KLDELPSI_TAB	Mass tab for KL_DELPSI	A(2)	V97U2482C V97U2483C	
	KMINT_S2	Pitch integral/proportional gain ratio for second stage	A	V97U2480C	deg/ sec
	KNINT_S2	Yaw integral/proportional gain ratio for second stage	S	V97U2481C	deg/ sec
	K_PPD	PPD forward loop gain	S	V97U1363C	nd
	NFADE_KNMPS_S2	Cycles to fade KN_MPS to full value	I	V97U0889C	-
	XCG_PL	X-axis center of gravity for cargo module	S	V97U1902C	ft
	ZCG_PL	Z-axis center of gravity for cargo module	S	V97U1903C	ft
	MASS_PL	Cargo module mass	S	V97U1901C	slugs
	XCG_OMS	X-axis center of gravity for OMS load	S	V97U1919C	ft
	ZCG_OMS	Z-axis center of gravity for OMS load	S	V97U1920C	ft
	MASS_OMS	OMS load mass	S	V97U1918C	slugs
	XCG_TAB	Array of X-axis center of gravity breakpoints of Orbiter plus ET	A(7)	V97U1904C to V97U1910C	ft
	ZCG_TAB	Array of Z-axis center of gravity breakpoints of Orbiter plus ET	A(7)	V97U1911C to V97U1917C	ft
	MASS_GAIN_TAB	Array of mass breakpoints for XCG and ZCG look-up	A(7)	V97U2056C to V97U2059C and V97U2471C to V97U2473C	slugs

Table 4.2.9-4.INTERPS I-Loads/K-Loads/Constants					
Module	Name	Description	Type	MSID/Value	Units
S2_TRIM_ MPS	$\bar{R}ME1$	SSME 1 location in the mated vehicle reference frame	A(3)	V97U1921C V97U1922C V97U1923C	ft ft ft
	$\bar{R}ME2$	SSME 2 location in the mated vehicle reference frame	A(3)	V97U1924C V97U1925C V97U1926C	ft ft ft
	$\bar{R}ME3$	SSME 3 location in the mated vehicle reference frame	A(3)	V97U1927C V97U1928C V97U1929C	ft ft ft
	PDEFM	First order pitch thrust deformation angle	S	V97U1930C	deg
	YDEFM	First order yaw thrust deformation angle	S	V97U1931C	deg
	NFADE_TRIM	Cycles to fade change in trim due to SSME failure	S	V97U1932C	nd
	RAD_TO_DEG	Conversion factor, radians to degrees	S	180/ π	deg/ rad

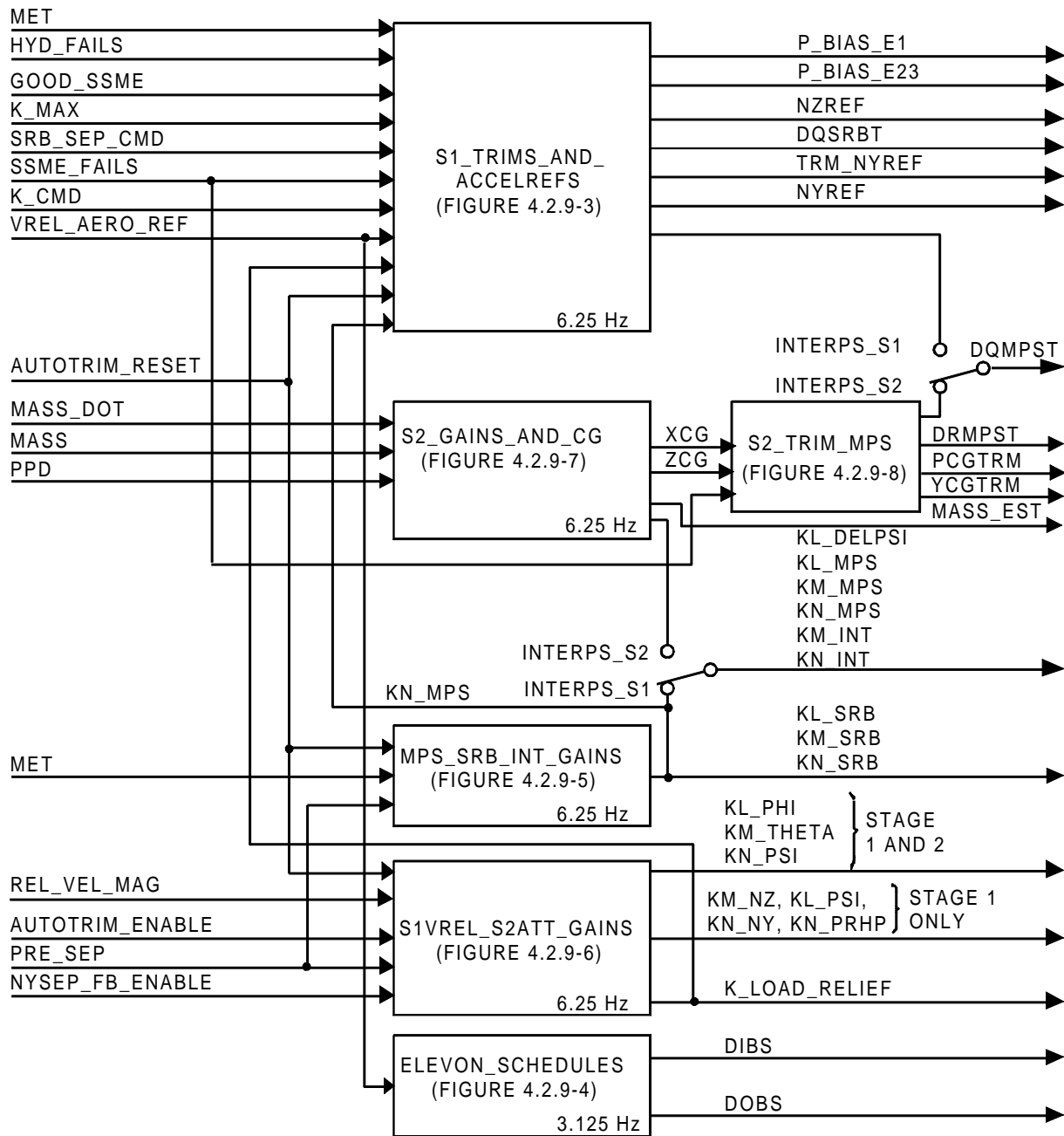


FIGURE 4.2.9-1. INTERPS Functional Overview

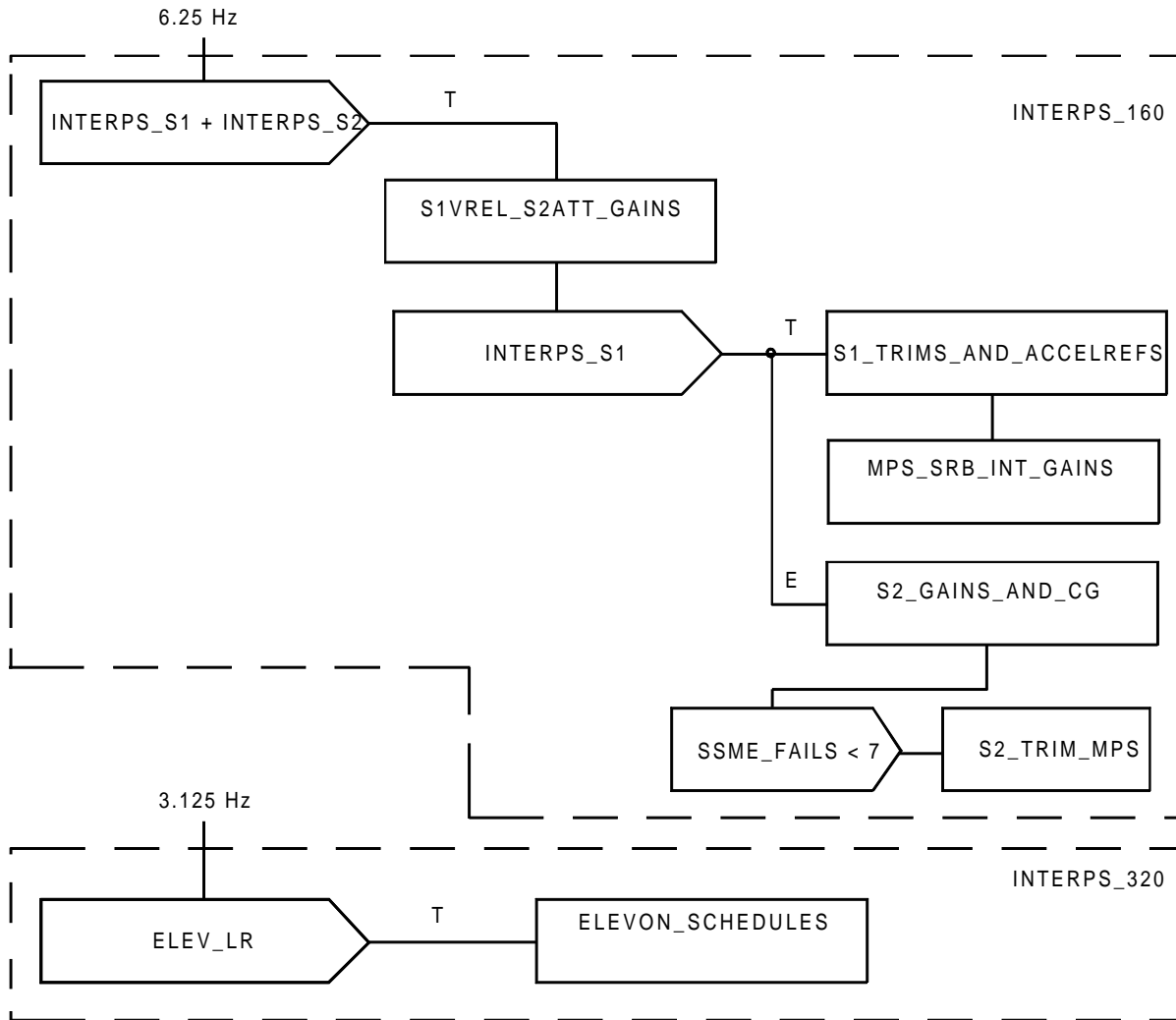


FIGURE 4.2.9-2. INTERPS Software Overview

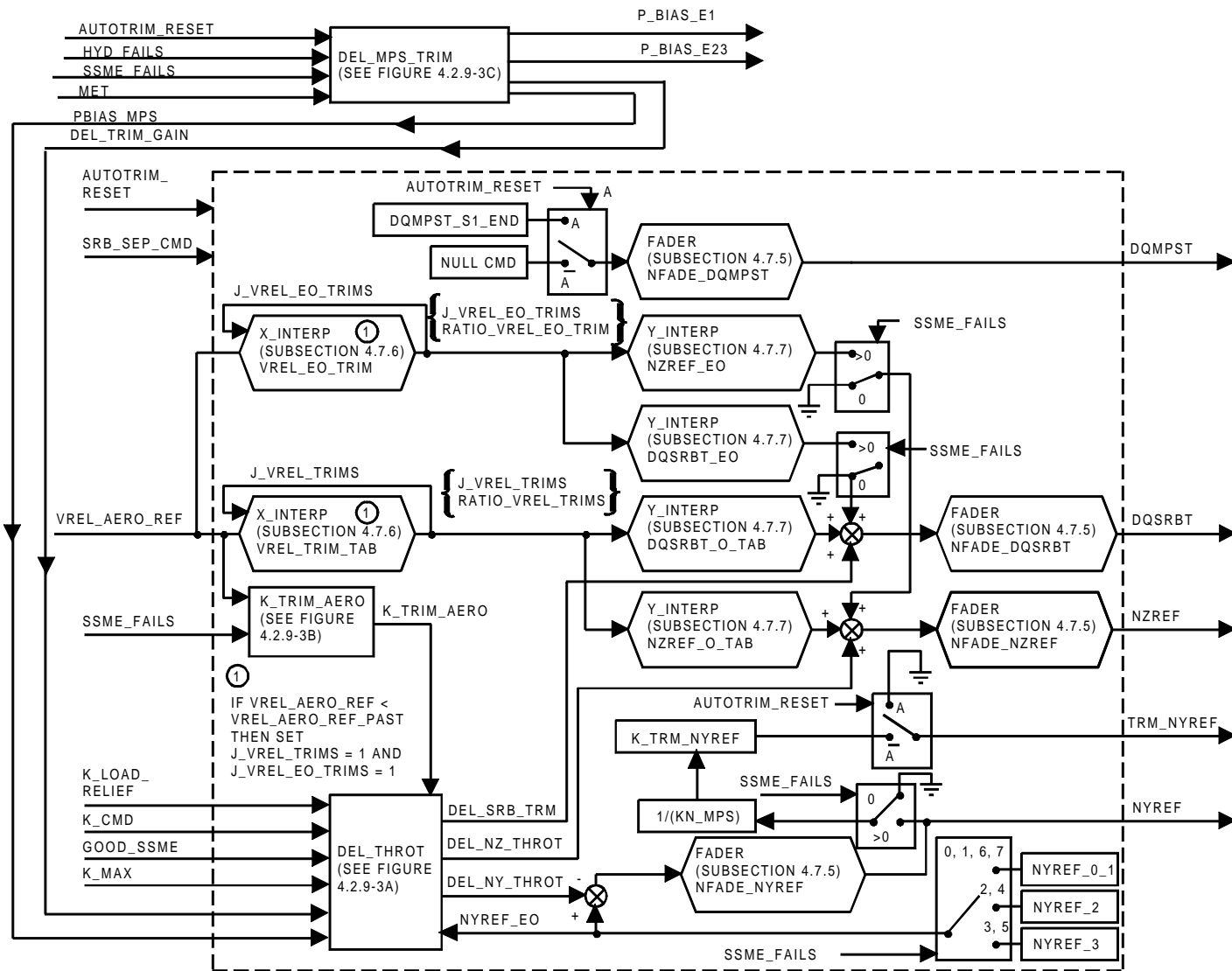
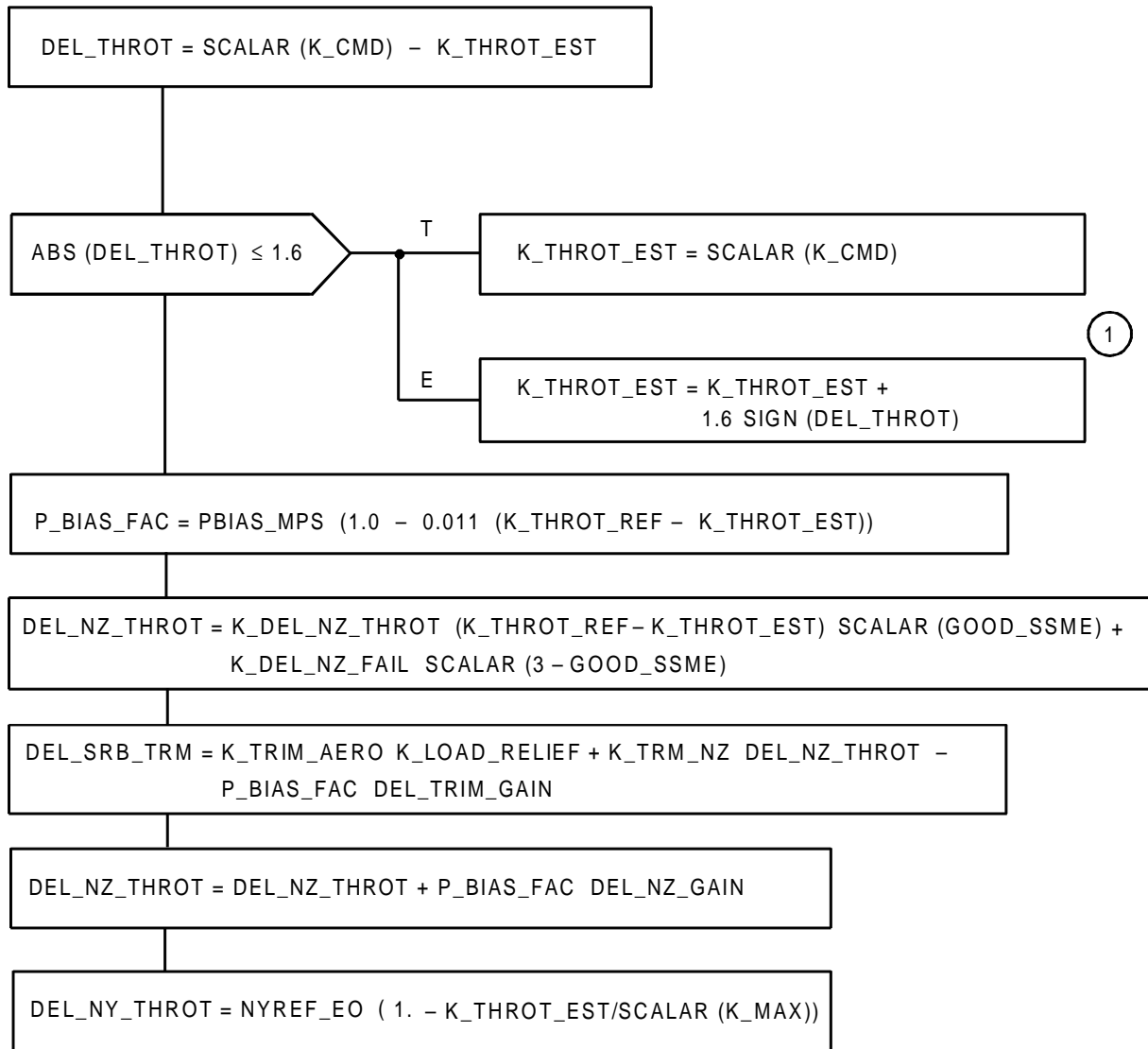


FIGURE 4.2.9-3. S1_TRIMS_AND_ACCELREFS Function Module, Detailed Diagram.



① THE CHANGE IN THROTTLE POSITION IS LIMITED TO 10 PERCENT PER SECOND AND THIS MODULE RUNS AT 6.25 Hz

FIGURE 4.2.9-3A. DEL_THROT Function Module Detailed Diagram

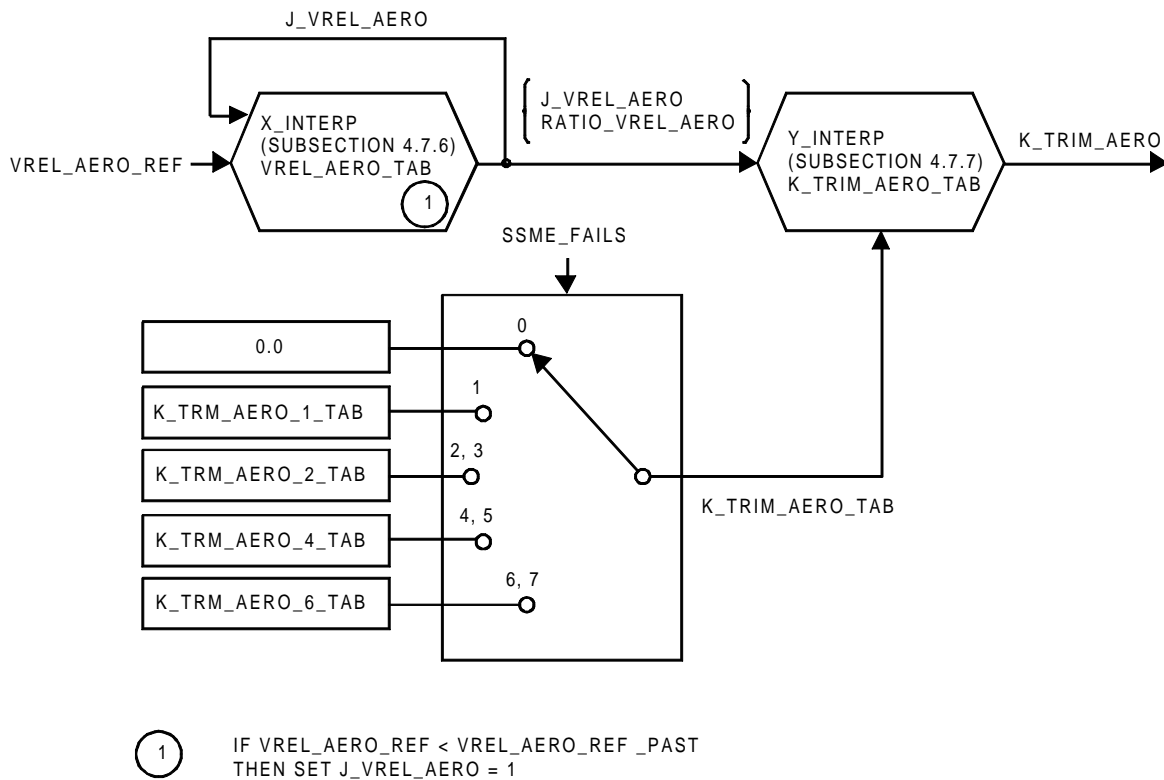


FIGURE 4.2.9-3B. K_TRIM_AERO Function Module, Detailed Diagram

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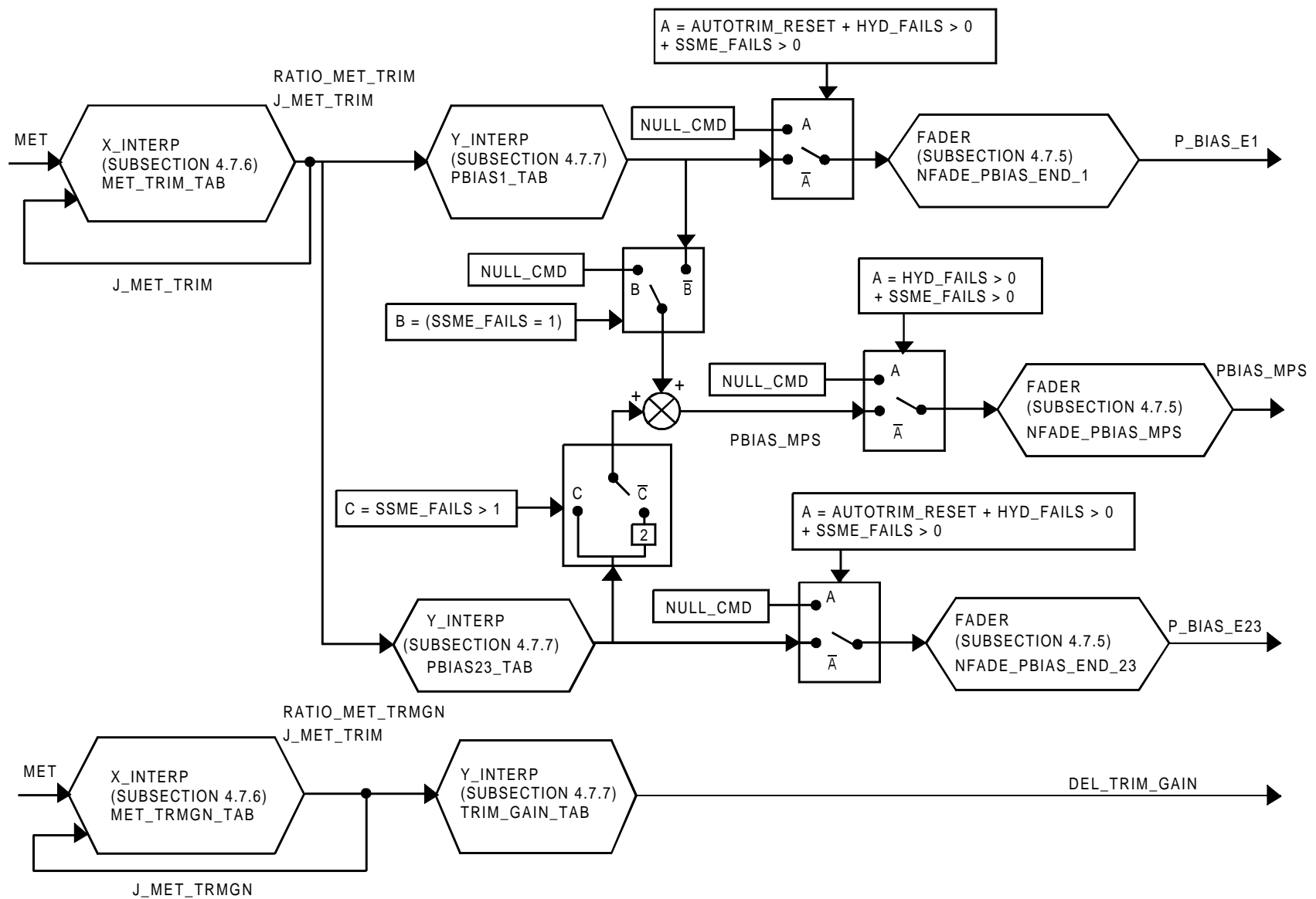


FIGURE 4.2.9-3C. Del MPS TRIM Function Module, Detailed Diagram

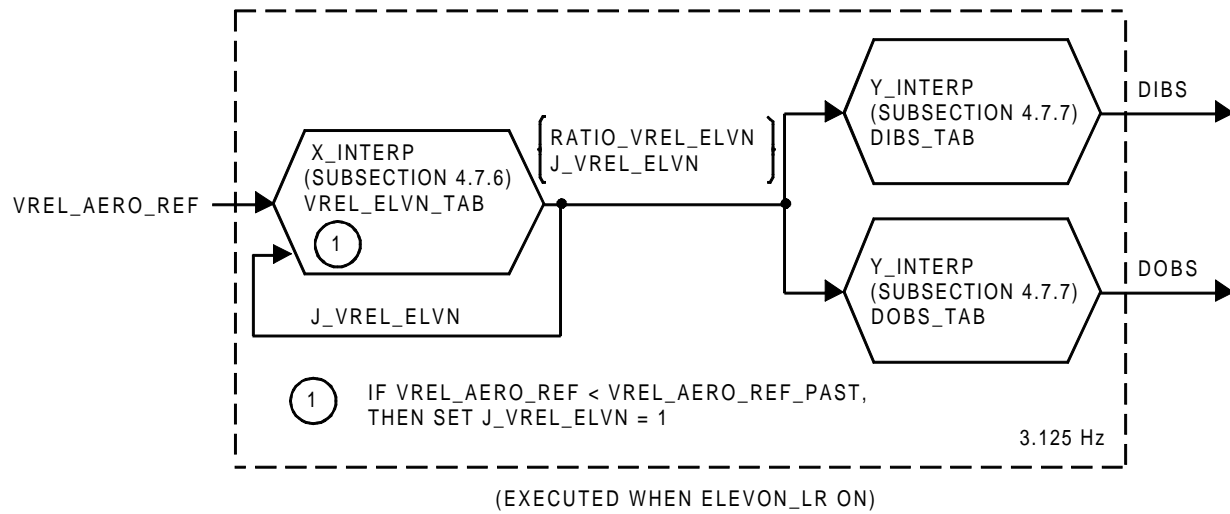


FIGURE 4.2.9-4. Function Module ELEVON_SCHEDULES, Detailed Diagram

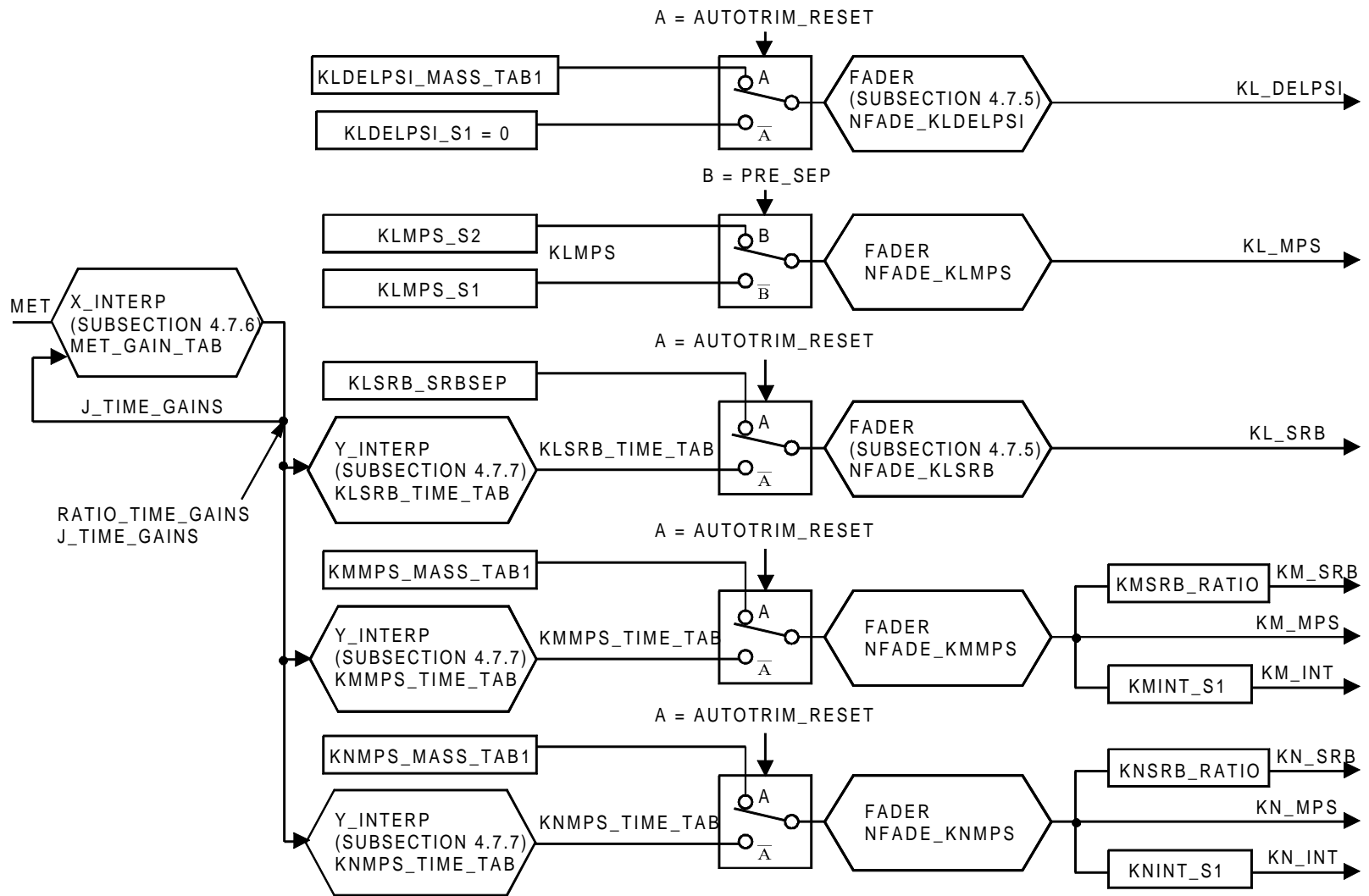
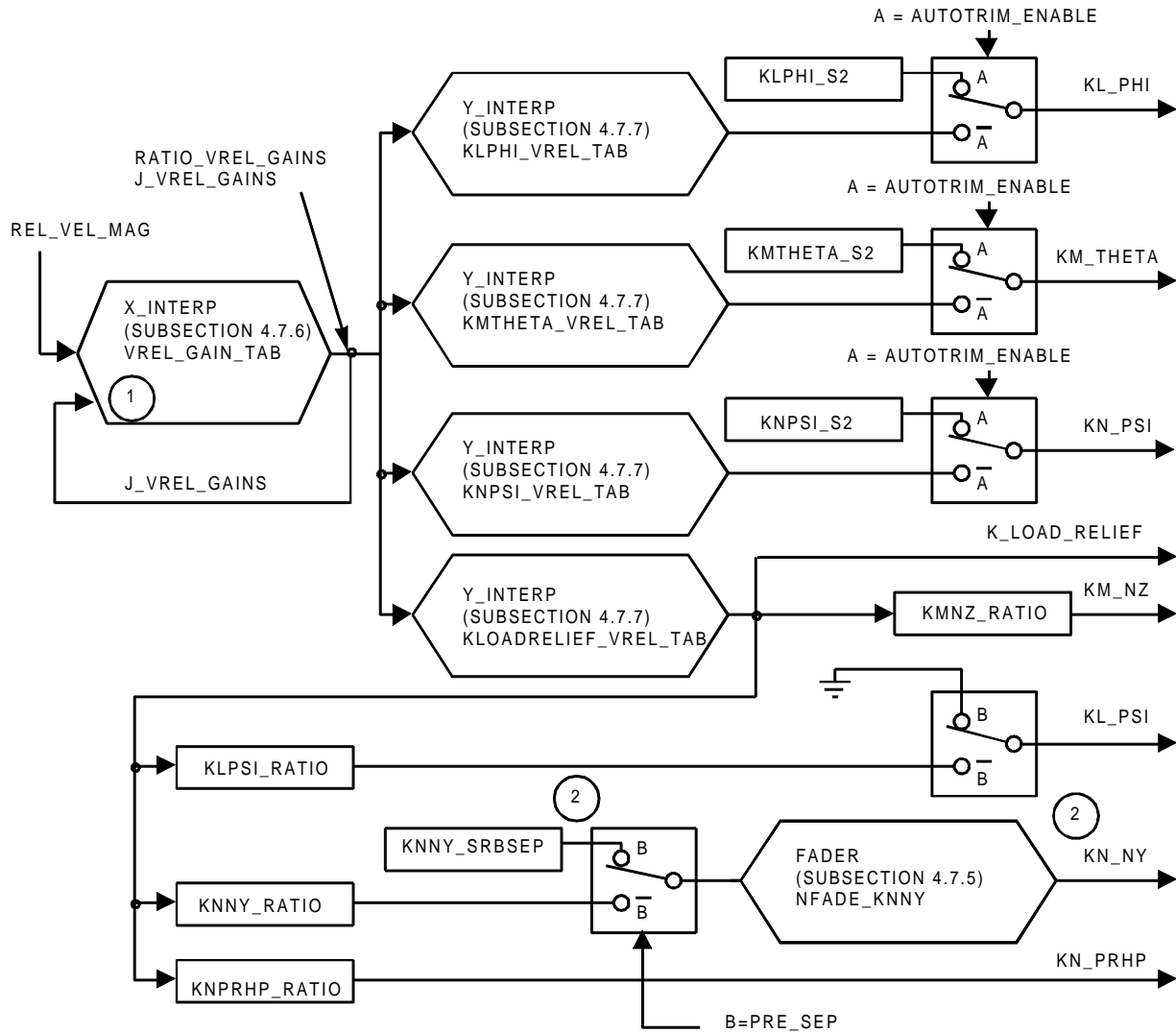


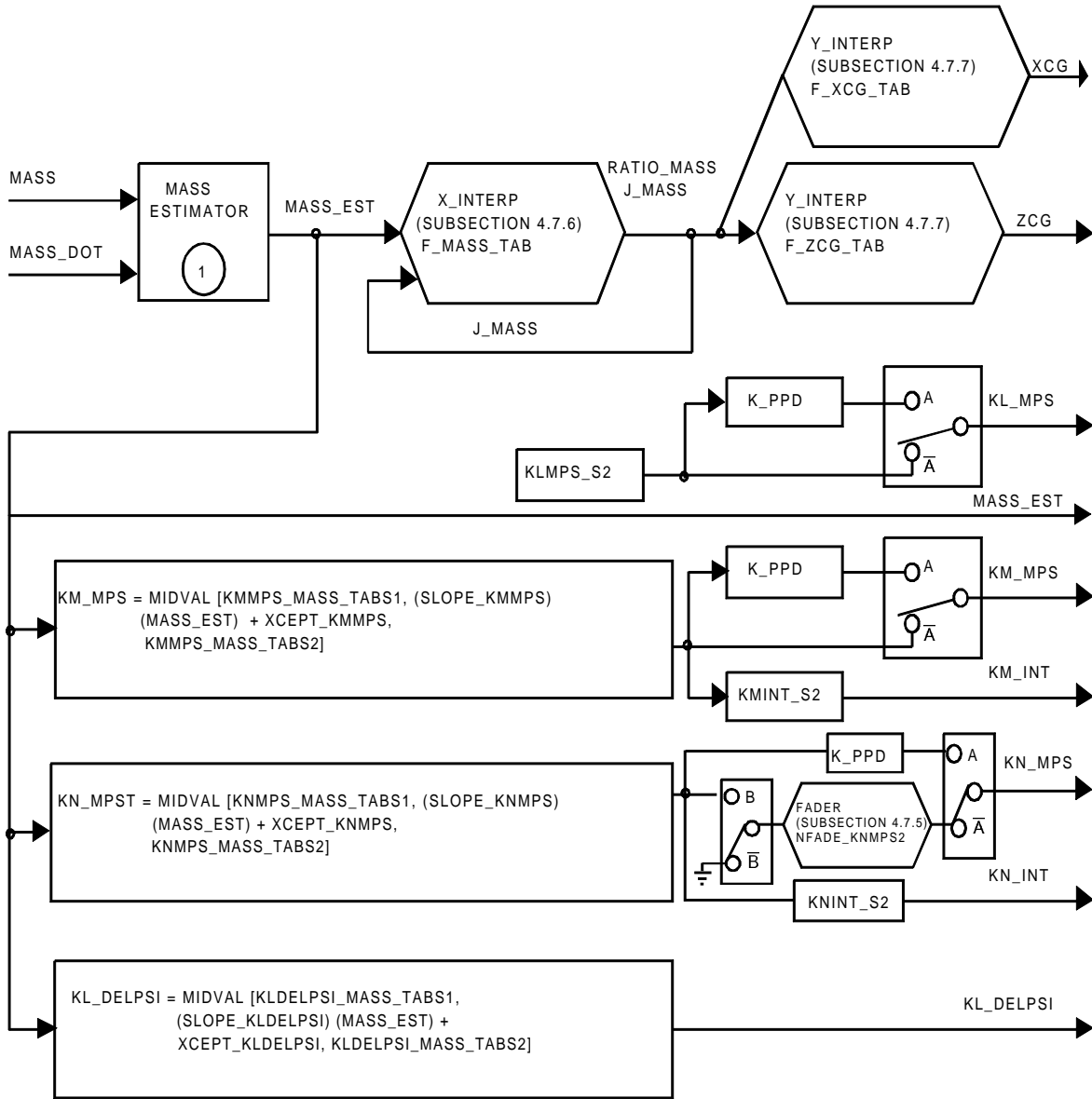
FIGURE 4.2.9-5. Function Module MPS_SRB_INT_GAINS, Detailed Diagram



1 IF REL_VEL_MAG < REL_VEL_MAG_PAST,
 THEN SET J_VREL_GAINS = 1

2	PRE_SEP (25A)	$\overline{\text{NYSEP_FB_ENABLE}} \cdot \text{AUTOTRIM_RESET (25B)}$
NFADE_KNNY	NFADE_NY_ON	NFADE_NY_OFF
KNNY_SRBSEP	KNNY_SEP	0

FIGURE 4.2.9-6. Function Module S1VREL_S2ATT_GAINS Detailed Diagram



A = PPD

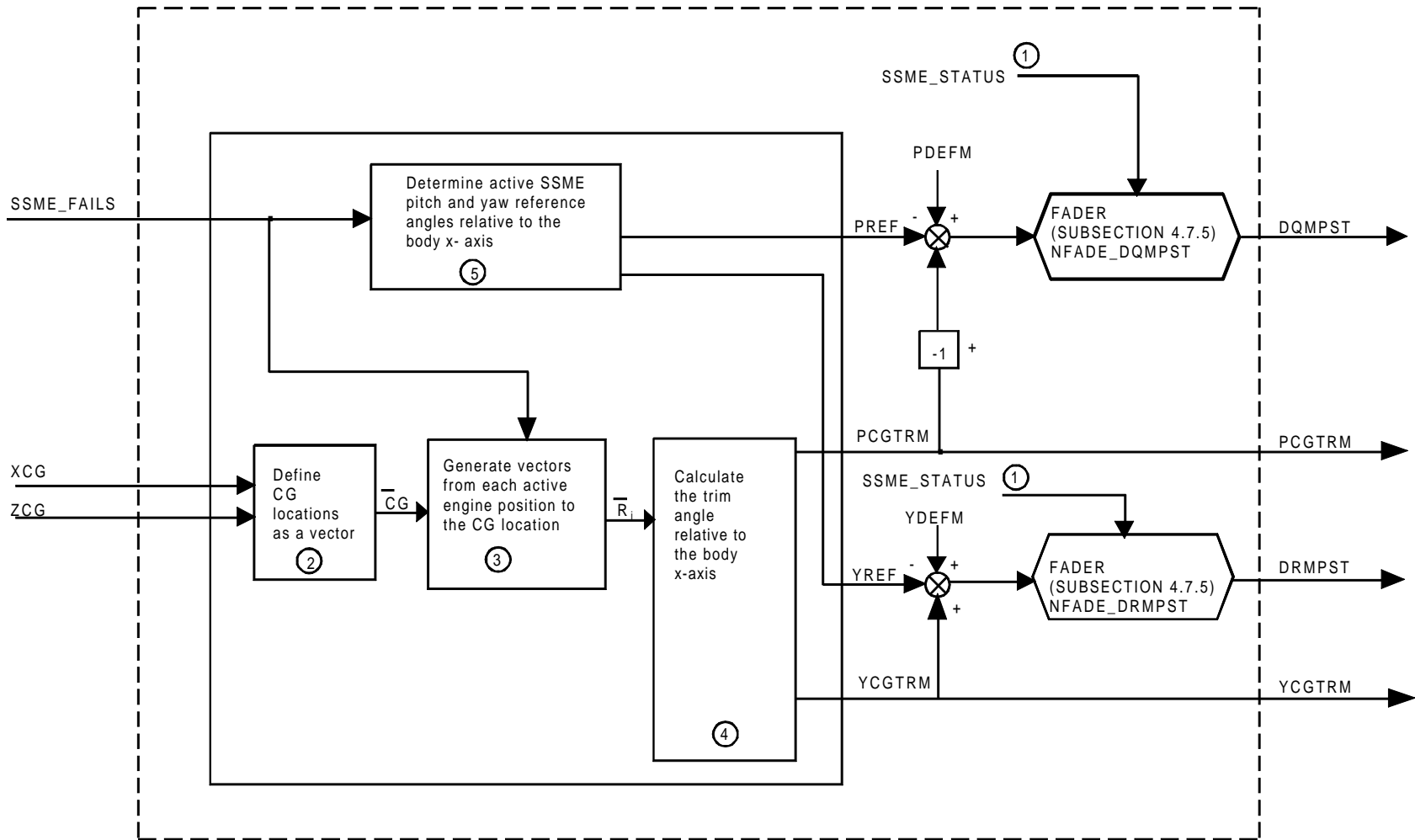


1 MASS_EST = MASS_EST - MASS_DOT * TS
WHERE MASS_EST IS RESET TO THE VALUE OF MASS AT THE 0.521 Hz RATE
(MASS_DOT IS POSITIVE)

B = True on the second pass of the
S2_GAINS_AND_CG Function Module

FIGURE 4.2.9-7. S2_GAINS_AND_CG Function Module, Detailed Diagram

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① Invoke fader when a change occurs in the SSME_FAILS index

FIGURE 4.2.9-8.(1) S2_TRIM_MPS Function Module, Detailed Diagram (Sheet 1 of 4)

NOTE:

- 2 Define center of gravity (CG) location of the vehicle in the mated vehicle reference frame. The CG is formed by incorporation of XCG and ZCG from INTERPS.

$$\bar{CG} = \begin{pmatrix} XCG_x \\ 0.0_y \\ ZCG_z \end{pmatrix}$$

- 3 Generate vectors from each active SSME to the CG location

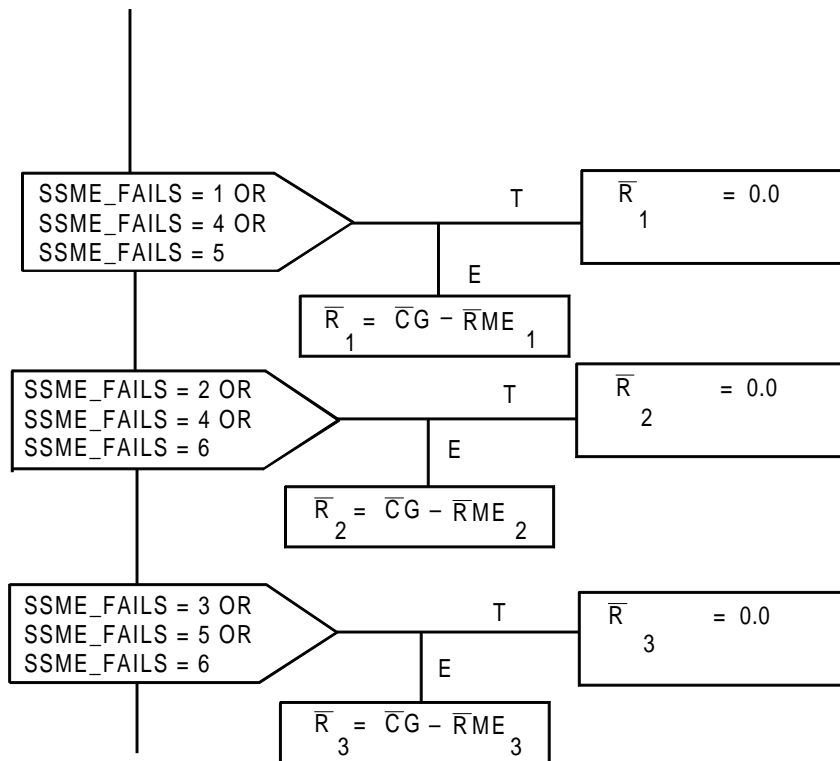


FIGURE 4.2.9-8.(2) S2_TRIM_MPS Function Module, Detailed Diagram (Sheet 2 of 4)

- ④ Calculate net trim unit vector \bar{U}_R and net pitch and yaw trim angles with respect to the vehicle's X-axis.

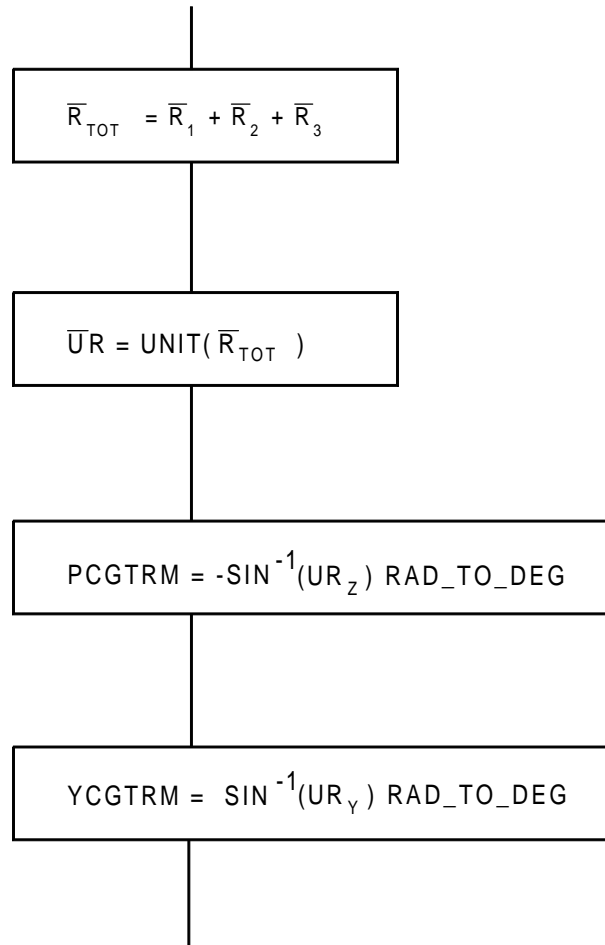


FIGURE 4.2.9-8.(3) S2_TRIM_MPS Function Module, Detailed Diagram (Sheet 3 of 4)

- 5 Determine the active SSME reference frame pitch and yaw angles relative to the body frame.

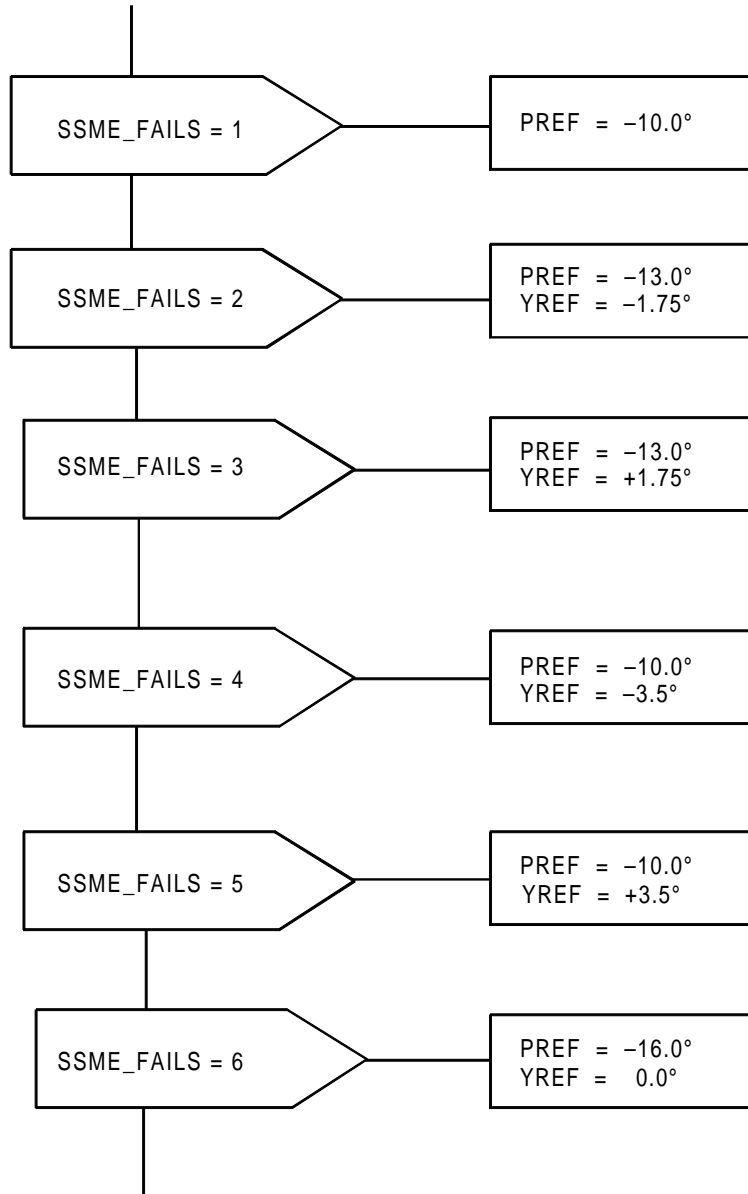


FIGURE 4.2.9-8.(4) S2_TRIM_MPS Function Module, Detailed Diagram (Sheet 4 of 4)

4.2.10 RCS Command Processor (CMD_PROC_RCS)

A. Functional Description. The CMD_PROC_RCS provides roll control when two or three engines shut down in first stage or two engines shut down in second stage. During RTLS single engine completion (Powered Contingency modes 0 and 5), CMD_PROC_RCS also augments pitch control by turning on forward up-firing RCS jets if the pitch error exceeds an I-loaded threshold. The functional block diagram for CMD_PROC_RCS is shown in Figure 4.2.10-1.

B. Software Description. The input/output requirements of CMD_PROC_RCS are given in Table 4.2.10-1. CMD_PROC_RCS consists of two functional modules: DBAND_HYSTER and ASC_JET_SELECT. Detailed diagrams of these two modules are shown, respectively, in Figures 4.2.10-2 and 4.2.10-3. Intermodule interface requirements are given in Table 4.2.10-2. Initialization requirements are given in Table 4.2.10-3. I-loads are given in Table 4.2.10-4.

Table 4.2.10-1. CMD_PROC_RCS Interface Requirements						
Name	Description	Source or Destination	Type	Range	Units	Rate Required/Produced At (Hz)
<u>Inputs</u>						
DP_ORB	Gained roll TVC loop error signal	CMD_PROC_MPS	S		deg	25
DQTVC	Pitch TVC loop error signal	ASC_TVC	S		deg/s	25
ENA_RCS_CNTL	Enable RCS control discrete	ASC_RECON	D		–	12.5
<u>Outputs</u>						
NEW_JON	RCS JET ON/OFF CMDS	ASC_RCS_CMD_SOP	A		–	25

Table 4.2.10-2. CMD_PROC_RCS Inter-Module Interface Requirements							
Module	Name	Description	Source or Destination	Type	Range	Units	Rate Required/Produced At (Hz)
DBAND_HYSTER	<u>Inputs</u> DP_ORB	Gained roll TVC loop error signal	CMD_PROC_MPS	S		deg	25
	<u>Outputs</u> KRCS	± roll command indicator	ASC_JET_SELECT	I		–	25
ASC_JET_SELECT	<u>Inputs</u> KRCS	± roll command indicator	DBAND_HYSTER	I		–	25
	AVAILABLE_JET_AFT(10)	Jet L3L available	RCS RM	B	0, 1	–	12.5
	AVAILABLE_JET_AFT(11)	Jet L3D available	RCS RM	B	0, 1	–	12.5
	AVAILABLE_JET_AFT(13)	Jet R3R available	RCS RM	B	0, 1	–	12.5
	AVAILABLE_JET_AFT(14)	Jet R3D available	RCS RM	B	0, 1	–	12.5
	AVAILABLE_JET_AFT(17)	Jet L2L available	RCS RM	B	0, 1	–	12.5
	AVAILABLE_JET_AFT(18)	Jet L2U available	RCS RM	B	0, 1	–	12.5
	AVAILABLE_JET_AFT(19)	Jet L2D available	RCS RM	B	0, 1	–	12.5
	AVAILABLE_JET_AFT(2)	Jet L1L available	RCS RM	B	0, 1	–	12.5
	AVAILABLE_JET_AFT(20)	Jet R2R available	RCS RM	B	0, 1	–	12.5
	AVAILABLE_JET_AFT(21)	Jet R2U available	RCS RM	B	0, 1	–	12.5
	AVAILABLE_JET_AFT(22)	Jet R2D available	RCS RM	B	0, 1	–	12.5
	AVAILABLE_JET_AFT(23)	Jet L4L available	RCS RM	B	0, 1	–	12.5

Table 4.2.10-2. CMD_PROC_RCS Inter-Module Interface Requirements

Module	Name	Description	Source or Destination	Type	Range	Units	Rate Required/Produced At (Hz)
ASC_ JET_ SELECT (Cont.)	<u>Inputs</u> (Cont.)						
	AVAILABLE_ JET_AFT(24)	Jet L4U available	RCS RM	B	0, 1	–	12.5
	AVAILABLE_ JET_AFT(25)	Jet L4D available	RCS RM	B	0, 1	–	12.5
	AVAILABLE_ JET_AFT(26)	Jet R4R available	RCS RM	B	0, 1	–	12.5
	AVAILABLE_ JET_AFT(27)	Jet R4U available	RCS RM	B	0, 1	–	12.5
	AVAILABLE_ JET_AFT(28)	Jet R4D available	RCS RM	B	0, 1	–	12.5
	AVAILABLE_ JET_AFT(3)	Jet L1U available	RCS RM	B	0, 1	–	12.5
	AVAILABLE_ JET_AFT(5)	Jet R1R available	RCS RM	B	0, 1	–	12.5
	AVAILABLE_ JET_AFT(6)	Jet R1U available	RCS RM	B	0, 1	–	12.5
	AVAILABLE_ JET_FWD(14)	Jet F3L available	RCS RM	B	0, 1	–	12.5
	AVAILABLE_ JET_FWD(2)	Jet F1L available	RCS RM	B	0, 1	–	12.5
	AVAILABLE_ JET_FWD(6)	Jet F2R available	RCS RM	B	0, 1	–	12.5
	AVAILABLE_ JET_FWD(9)	Jet F4R available	RCS RM	B	0, 1	–	12.5
	AVAILABLE_ JET_FWD(7)	Jet F2U available	RCS RM	B	0,1	–	12.5
	AVAILABLE_ JET_FWD(15)	Jet F3U available	RCS RM	B	0,1	–	12.5
	AVAILABLE_ JET_FWD(3)	Jet F1U available	RCS RM	B	0,1	–	12.5
		<u>Outputs</u>					
	NEW_JON	RCS JET ON/OFF commands	ASC_RCS_CMD	A		–	25

Table 4.2.10-3. CMD_PROC_RCS Initialization Requirements			
Module	Initialize on Transition to:	Variable	Initial Value
DBAND_HYSTER	ENA_RCS_CNTL = 1	KRCS	0
ASCENT_JET_SELECT	ENA_RCS_CNTL = 1	NEW_JON(I)	0

Table 4.2.10-4. CMD_PROC_RCS I-Loads				
Name	Description	Type	MSID	Units
DP_INNER	Inner deadband value	S	V97U2484C	deg
DP_OUTER	Outer deadband value	S	V97U2485C	deg
DQ_PITCH_ASSIST	Pitch assist threshold value	S	V97U1700C	deg/sec

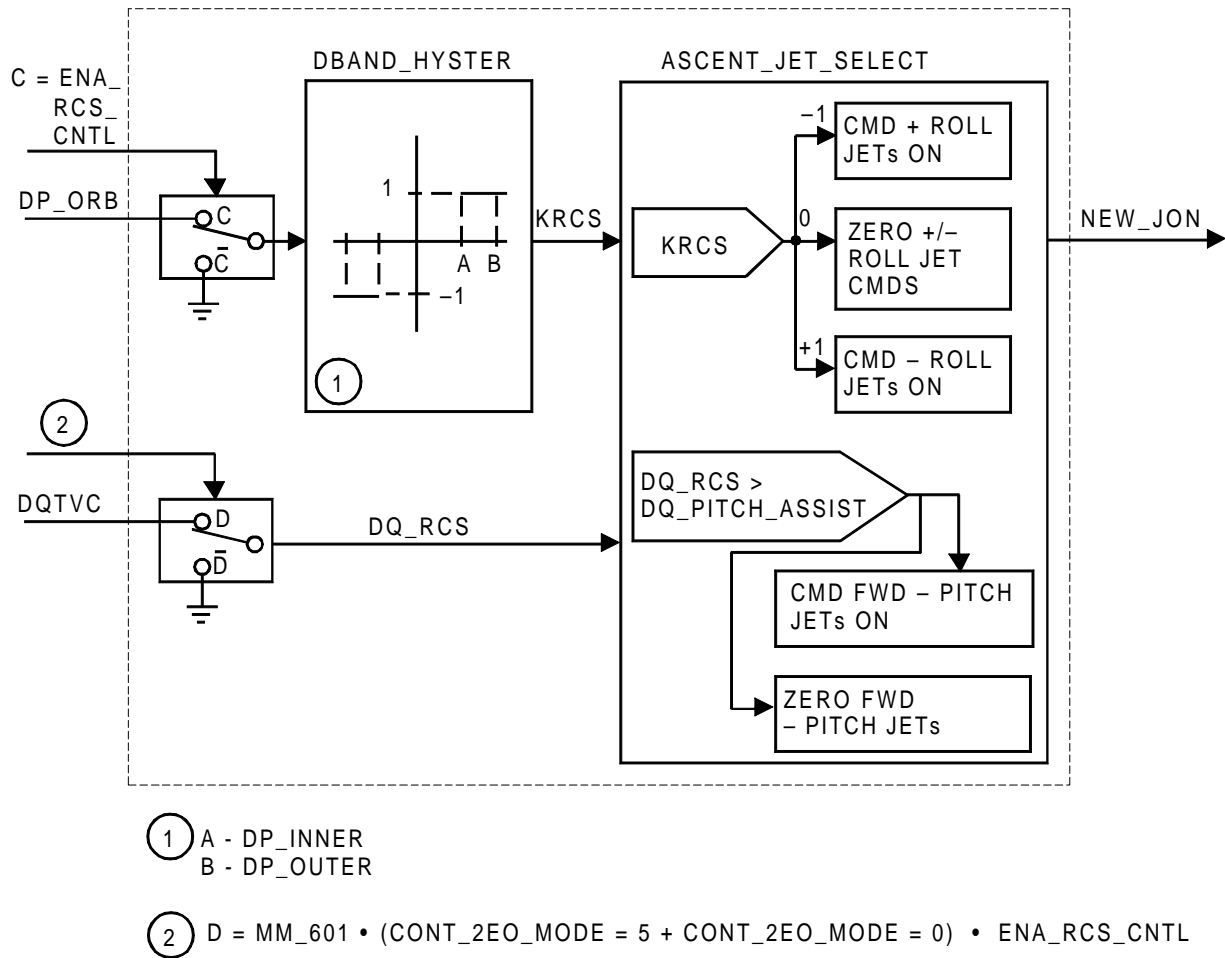


FIGURE 4.2.10-1.RCS Command Processor Functional Overview

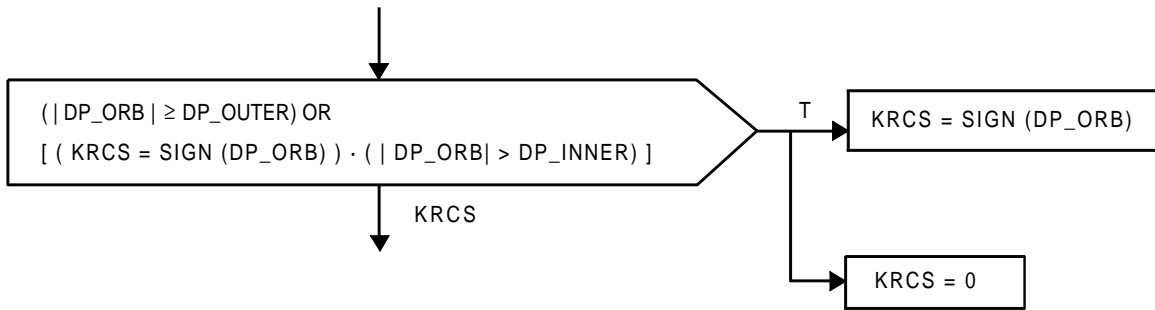


FIGURE 4.2.10-2.DBAND_HYSTER Function Module Detailed Diagram

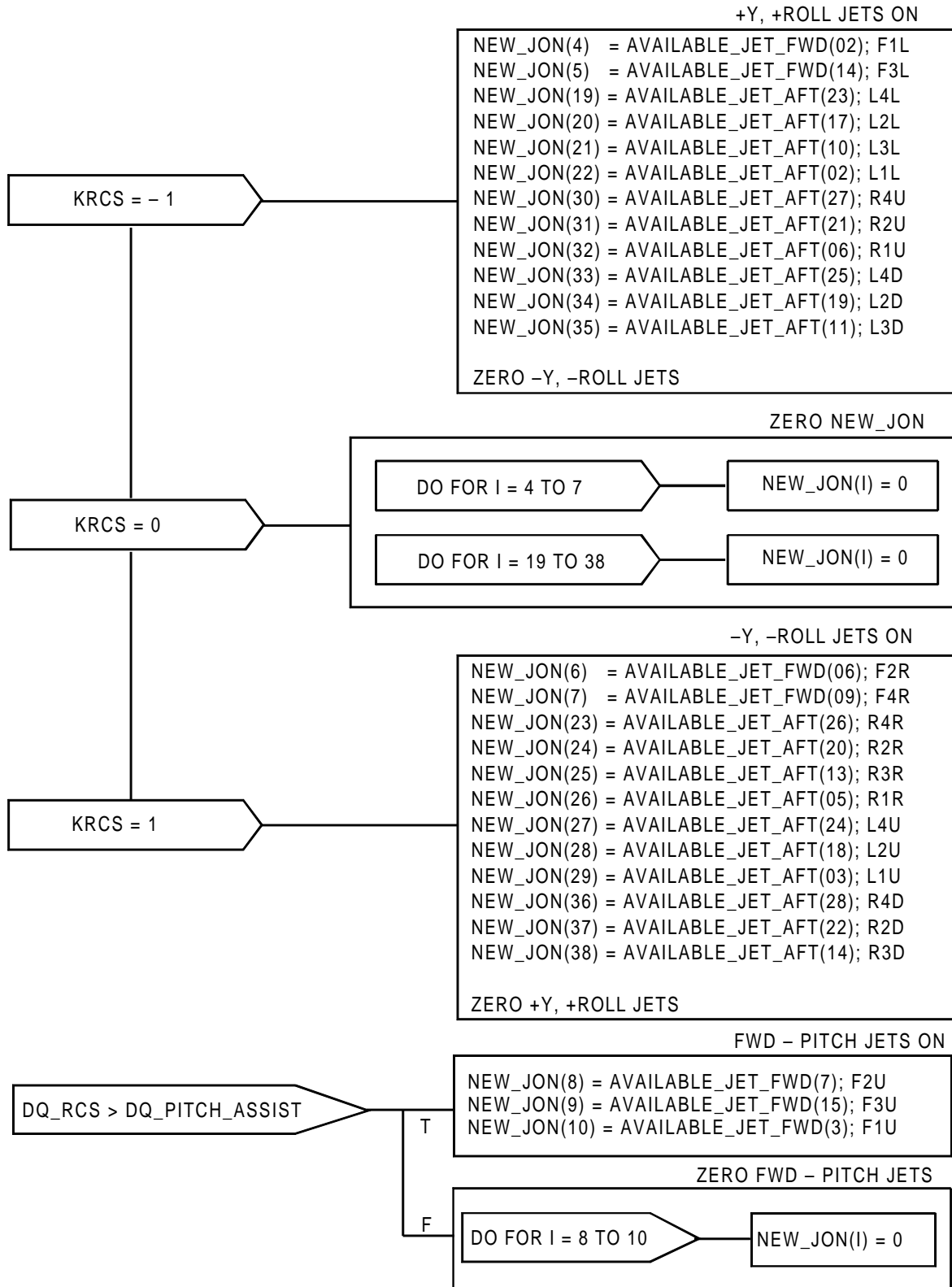


FIGURE 4.2.10-3.ASC_JET_SELECT Function Module Detailed Diagram

4.2.11 Ascent DAP Principal Function Tables

The ascent DAP principal function input and output tables, along with the I-load tables, are presented in Tables 4.2.11-1 through 4.2.11-2. The automated Interface Definition document (IDD) table (Table 4.2.11-1) defines signal (parameter) interface requirements either between hardware (LRU) and software elements or between software elements and other software elements.* 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 that reflect parameters going to input (destination) TLM will 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.

* A GN&C software element is either a sequenced principal function (PF), crew generated specialist/display function, or an OPS display function.

TABLE 4.2.11-1. INPUT FUNCTIONAL PARAMETERS FOR ASCENT DIGITAL AUTOPILOT (G4.176)

FSSR NAME	M/S ID	NOMENCLATURE	SOURCE	UNITS	DATA TYPE	P R E C	LAST CR	R E V
AERO_SLEW	V99X8822X	AEROSURFACE SLEW CHECK INDICATOR	LPS				89599C	
AERO_SLEW_CMD	V90H1571C	AERO ACTR SLEW POSITION CMD	ORB ACT SLEW				89366B	
AERO_SLEW_CMPL	V90X1570X	AEROSURFACE SLEW COMPLETE	ORB ACT SLEW		BD		93017G	*
AUTOP	V96X1031X	STATION SELECTED AUTO-PITCH	GN&C SW RM					
AUTORY	V96X1041X	STATION SELECTED AUTO-ROLL/YAW	GN&C SW RM					
AUTO_SEQ_IND	V90X8683X	INDICATOR EVENT 6 AUTO SEQ START	R/S LCH SEQ				89599C	
AVAILABLE_JET_AFT(02)	V90X4521X	JET L1L AVAILABLE	RCS RM		BD		93017G	*
AVAILABLE_JET_AFT(03)	V90X4522X	JET L1U AVAILABLE	RCS RM		BD		93017G	*
AVAILABLE_JET_AFT(05)	V90X4535X	JET R1R AVAILABLE	RCS RM		BD		93017G	*
AVAILABLE_JET_AFT(06)	V90X4536X	JET R1U AVAILABLE	RCS RM		BD		93017G	*
AVAILABLE_JET_AFT(10)	V90X4527X	JET L3L AVAILABLE	RCS RM		BD		93017G	*
AVAILABLE_JET_AFT(11)	V90X4528X	JET L3D AVAILABLE	RCS RM		BD		93017G	*
AVAILABLE_JET_AFT(13)	V90X4541X	JET R3R AVAILABLE	RCS RM		BD		93017G	*
AVAILABLE_JET_AFT(14)	V90X4542X	JET R3D AVAILABLE	RCS RM		BD		93017G	*
AVAILABLE_JET_AFT(17)	V90X4523X	JET L2L AVAILABLE	RCS RM		BD		93017G	*
AVAILABLE_JET_AFT(18)	V90X4524X	JET L2U AVAILABLE	RCS RM		BD		93017G	*
AVAILABLE_JET_AFT(19)	V90X4525X	JET L2D AVAILABLE	RCS RM		BD		93017G	*
AVAILABLE_JET_AFT(20)	V90X4537X	JET R2R AVAILABLE	RCS RM		BD		93017G	*
AVAILABLE_JET_AFT(21)	V90X4538X	JET R2U AVAILABLE	RCS RM		BD		93017G	*
AVAILABLE_JET_AFT(22)	V90X4539X	JET R2D AVAILABLE	RCS RM		BD		93017G	*
AVAILABLE_JET_AFT(23)	V90X4529X	JET L4L AVAILABLE	RCS RM		BD		93017G	*
AVAILABLE_JET_AFT(24)	V90X4530X	JET L4U AVAILABLE	RCS RM		BD		93017G	*
AVAILABLE_JET_AFT(25)	V90X4531X	JET L4D AVAILABLE	RCS RM		BD		93017G	*
AVAILABLE_JET_AFT(26)	V90X4543X	JET R4R AVAILABLE	RCS RM		BD		93017G	*
AVAILABLE_JET_AFT(27)	V90X4544X	JET R4U AVAILABLE	RCS RM		BD		93017G	*
AVAILABLE_JET_AFT(28)	V90X4545X	JET R4D AVAILABLE	RCS RM		BD		93017G	*
AVAILABLE_JET_FWD(02)	V90X4549X	JET F1L AVAILABLE	RCS RM		BD		93017G	*
AVAILABLE_JET_FWD(03)	V90X4550X	JET F1U AVAILABLE	RCS RM		BD		93017G	*
AVAILABLE_JET_FWD(06)	V90X4553X	JET F2R AVAILABLE	RCS RM		BD		93017G	*
AVAILABLE_JET_FWD(07)	V90X4554X	JET F2U AVAILABLE	RCS RM		BD		93017G	*
AVAILABLE_JET_FWD(09)	V90X4560X	JET F4R AVAILABLE	RCS RM		BD		93017G	*
AVAILABLE_JET_FWD(14)	V90X4557X	JET F3L AVAILABLE	RCS RM		BD		93017G	*
AVAILABLE_JET_FWD(15)	V90X4558X	JET F3U AVAILABLE	RCS RM		BD		93017G	*
A_D_RECYCLE_COUNT	V90X8669X	ASC DAP RECYCLE FLAG	R/S LCH SEQ					
CLOCK/CLOCKTIME	V91W5000C	CLOCK-COMPUTER (GMT)	FCOS	S			93160B	*
CONTING_ABORT	V90X8639X	INITIATE MATED COAST CONTROL	MSC					
CONT_2EO_MODE	V90J2077C	CONTINGENCY 2-ENG OUT MODE INDEX	PW CONT GUID		HXS		93017G	*
CONT_SERC	V93X6682X	CONT SINGLE ENG ROLL CNTL FLAG	XXXXXX TRAJ 1 DISP		BD		93017G	*
CONT_SERC	V93X6682XB	CONT SINGLE ENG ROLL CNTL FLAG	XXXXXX TRAJ 2 DISP		BD		93017G	*
CONT_SERC	V93X6682XC	CONT SINGLE ENG ROLL CNTL FLAG	RTLS TRAJ 2 DISP		BD		93017G	*
CSSP	V96X1035X	STATION SELECTED CSS-PITCH	GN&C SW RM					
CSSRY	V96X1045X	STATION SELECTED CSS-ROLL/YAW	GN&C SW RM					
DBFOFB	V95H8310C	COMP BODY FLAP POS	BF PFB SOP	DEG				
DELTAP_LIB	V95P8015C	LIB ELVN ACTR DIFFERENTIAL PRESS	DELTA P F/B SOP	PSI				
DELTAP_LOB	V95P8017C	LOB ELVN ACTR DIFFERENTIAL PRESS	DELTA P F/B SOP	PSI				
DELTAP_RIB	V95P8016C	RIB ELVN ACTR DIFFERENTIAL PRESS	DELTA P F/B SOP	PSI				

TABLE 4.2.11-1. INPUT FUNCTIONAL PARAMETERS FOR ASCENT DIGITAL AUTOPILOT (G4.176)

FSSR NAME	M/S ID	NOMENCLATURE	SOURCE	UNITS	DATA TYPE	P R E C	LAST CR	R E V
DELTAP_ROB	V95P8018C	ROB ELVN ACTR DIFFERENTIAL PRESS	DELTA P F/B SOP	PSI				
DY1_BIAS	V96U7984C	MPS ENG 1P BIAS	VU	DEG	SPL		89688B	
DY2_BIAS	V96U7985C	MPS ENG 2P BIAS	VU	DEG	SPL		89688B	
DY3_BIAS	V96U7986C	MPS ENG 3P BIAS	VU	DEG	SPL		89688B	
DZ2_BIAS	V96U7987C	MPS ENG 2Y BIAS	VU	DEG	SPL		89688B	
DZ3_BIAS	V96U7988C	MPS ENG 3Y BIAS	VU	DEG	SPL		89688B	
EBFB(1)	V95H3523C	BODY ROLL ATT ERROR	G/C STEER	DEG	SPL		93017G	*
EBFB(2)	V95H3521C	BODY PITCH ATT ERROR	G/C STEER	DEG	SPL		93017G	*
EBFB(3)	V95H3522C	BODY YAW ATT ERROR	G/C STEER	DEG	SPL		93017G	*
FAST_SEP_FLAG	V90X8267X	FAST SEPARATION FLAG	ET SEP SEQ				79643A	
GUIDANCE_INITIATE	V90X8630X	INITIATE STAGE 2 GUIDANCE	MSC		BD		93017G	*
HYDRFAIL(1)	V96X3005X	HYDR SYS 1 FAIL STATUS	HYD SYS SOP		BD		93017G	*
HYDRFAIL(2)	V96X3006X	HYDR SYS 2 FAIL STATUS	HYD SYS SOP		BD		93017G	*
HYDRFAIL(3)	V96X3007X	HYDR SYS 3 FAIL STATUS	HYD SYS SOP		BD		93017G	*
KMAX	V97U4424CA	MAXIMUM THROTTLE SETTING OF SSME'S	ASC 1STG GUID	PCT			90608D	
K_CMD	V90U1948CB	COMMANDED SSME THROTTLE SETTING	ASC 1STG GUID	PCT			93017G	*
K_CMD	V90U1948CE	COMMANDED SSME THROTTLE SETTING	SBTC SOP	PCT			93012D	
M/CURR_ORB_MASS/WEIGHT	V90U1961CF	CURRENT VEHICLE MASS	ASC 1STG GUID	SLUGS			93017G	*
M/CURR_ORB_MASS/WEIGHT	V90U1961CG	CURRENT VEHICLE MASS	ASC 2STG GUID	SLUGS			93017G	*
M/CURR_ORB_MASS/WEIGHT	V90U1961CH	CURRENT VEHICLE MASS	PW RTLS GUID	SLUGS			93017G	*
M/CURR_ORB_MASS/WEIGHT	V90U1961CL	CURRENT VEHICLE MASS	PW CONT GUID	SLUGS			93017G	*
MDOT	V90R1993CA	TOTAL VEHICLE MASS FLOW RATE	ASC 2STG GUID	SLUGS/S				
MDOT	V90R1993CB	TOTAL VEHICLE MASS FLOW RATE	PW RTLS GUID	SLUGS/S				
MDOT	V90R1993CC	TOTAL VEHICLE MASS FLOW RATE	PW CONT GUID	SLUGS/S			89990E	
ME1_FAIL_SHUTDOWN	V95X1207X	MPS E1 FAIL FLAG	SSME OPS		BD		93017G	*
ME2_FAIL_SHUTDOWN	V95X1208X	MPS E2 FAIL FLAG	SSME OPS		BD		93017G	*
ME3_FAIL_SHUTDOWN	V95X1209X	MPS E3 FAIL FLAG	SSME OPS		BD		93017G	*
MECO_CMD	V90X8569XA	MECO COMMAND FLAG	SSME OPS		BD		93017G	*
MECO_CONFIRMED	V90X8561X	MECO CONFIRMED FLAG	SSME OPS		BD		93017G	*
ME_FLT_DATA_PATH_FAIL(1)	V95X1150X	ME-1 FLIGHT DATA PATH FAIL FLAG	SSME SOP				90243C	
ME_FLT_DATA_PATH_FAIL(2)	V95X1151X	ME-2 FLIGHT DATA PATH FAIL FLAG	SSME SOP				90243C	
ME_FLT_DATA_PATH_FAIL(3)	V95X1152X	ME-3 FLIGHT DATA PATH FAIL FLAG	SSME SOP				90243C	
ME_ZERO	V90X8638X	ZERO THRUST	MSC				92522D	
MM_CODE_101/MM_101	V90X8155X	MAJOR MODE 101 FLAG	MSC				93012D	
MM_CODE_601/MM_601	V90X8194X	MAJOR MODE 601 FLAG	MSC		BD		93012D	
MPS_LO2_DUMP_START	V90X8301X	MPS LO2 DUMP START	MPS DUMP				89598A	
MPS_LO2_DUMP_STOP	V90X8302X	MPS LO2 DUMP STOP	MPS DUMP					
MPS_SLEW	V99X8823XB	MPS GIMBAL SLEW CHECK INDICATOR	LPS				89599C	
MPS_SLEW_CMD	V90H1572C	MPS ACTR SLEW POSITION CMD	ORB ACT SLEW				89366B	
MPS_SLEW_COMPLETE	V90X8400XA	MPS SLEW CHECK COMPLETE FLAG	R/S LCH SEQ				89599C	
MPS_SLEW_COMPLETE	V90X8400XB	MPS SLEW CHECK COMPLETE FLAG	ORB ACT SLEW				89599C	
NY	V90A5361C	SELECTED AA LATERAL ACCEL	SF	G	SPL		93017G	*
NZ	V90A5381C	SELECTED AA NORMAL ACCEL	SF	G	SPL		93017G	*
OPS_6_INDICATOR	V90X8634X	OPS 6 IND	MSC				92578B	
PC4	V90P2535C	SELECTED LEFT PRESS SRB CHAMBER	SF	PSIA			89494A	
PC5	V90P2536C	SELECTED RIGHT PRESS SRB CHAMBER	SF	PSIA			89494A	

TABLE 4.2.11-1. INPUT FUNCTIONAL PARAMETERS FOR ASCENT DIGITAL AUTOPILOT (G4.176)

FSSR NAME	M/S ID	NOMENCLATURE	SOURCE	UNITS	DATA TYPE	P R E C	LAST CR	R E V
PREP_SSME	V90X8373X	PREP SSME'S FOR LIFTOFF FLAG	R/S LCH SEQ		BD		93017G	*
P_ORB	V90R5301CA	SELECTED RGA ROLL RATE	SF	DEG/S			93017G	*
QBI_VALID	V90X2245X	BODY WRT M50 QUAT VALID FLAG	A/E ATT PROC		BD		89986H	
Q_ORB/Q	V90R5321CA	SELECTED RGA PITCH RATE	SF	DEG/S			93017G	*
Q_SRB	V90R2511C	SRGA SEL PITCH RATE	SF	DEG/S			93017G	*
REL_VEL_MAG	V95L0151CE	GND REL VEL MAGNITUDE IN M50 SYS	ASC UPP	FT/S			93017G	*
RETURN_SSME_TO_START_POS	V90X8412X	CMD SSME'S TO PRE-START POS FLAG	R/S LCH SEQ		BD		93017G	*
RHC_STATE(1)	V96J0015CA	RHC OUT OF DETENT ROLL	3-AX RHC SOP				89990E	
RHC_STATE(2)	V96J0017CA	RHC OUT OF DETENT PITCH	3-AX RHC SOP				89990E	
RHC_STATE(3)	V96J0019CA	RHC OUT OF DETENT YAW	3-AX RHC SOP				89990E	
R_ORB	V90R5341CA	SELECTED RGA YAW RATE	SF	DEG/S			93017G	*
R_SRB	V90R2512C	SRGA SEL YAW RATE	SF	DEG/S			93017G	*
SEL_V_M50(1)	V90L2557C	SEL TOTAL X VEL M50	IMU RM	FT/S	DPL		93017G	*
SEL_V_M50(2)	V90L2558C	SEL TOTAL Y VEL M50	IMU RM	FT/S	DPL		93017G	*
SEL_V_M50(3)	V90L2559C	SEL TOTAL Z VEL M50	IMU RM	FT/S	DPL		93017G	*
SRB_IGNITION_CMD	V90X8377X	SRB IGNITION CMD FLAG	R/S LCH SEQ		BD		93017G	*
SRB_MODING_SEP	V90X8330XA	SRB SEP FUNCTION MODING FLAG	SRB SEP SEQ				90532	
SRB_MODING_SEP	V90X8330XB	SRB SEP FUNCTION MODING FLAG	ET SEP SEQ					
SRB_SEP_CMD_FLAG	V90X8331XA	SRB SEPARATION COMMAND FLAG	SRB SEP SEQ				93017G	*
SRB_SEP_CMD_FLAG	V90X8331XB	SRB SEPARATION COMMAND FLAG	ET SEP SEQ				93064D	
SRB_SEP_MONITOR	V90X8193X	SRB SEP MONITOR FLAG	MSC				92354	
SRB_SLEW	V99X8820X	SLEW CHECK INDICATOR ACTIVATED	LPS				89599C	
SRB_SLEW_CMD	V96H0323C	SRB ACTR SLEW POSITION CMD	SRB SLEW				89366B	
SRB_SLEW_COMPLETE	V96X0321X	SRB SLEW PROFILE COMPLETED	SRB SLEW				89599C	
SSME_STOW_COMPLETE	V95X1622X	SSME STOW COMPLETE FLAG	MPS TVC CMD SOP					
S_PPD_QUAT	V90X2087XA	DISCRETE INDICATING PPD CMDS	PW RTLS GUID		BD		93017G	*
S_PPD_QUAT	V90X2087XB	DISCRETE INDICATING PPD CMDS	PW CONT GUID		BD		93017G	*
S_QUAT	V90X1987X	ATTITUDE QUATERNION COMPUTED FLAG	ASC 1STG GUID					
S_RTLS_TURN	V90X2089X	DSCR IND START OF TURN AROUND	PW RTLS GUID		BD		93017G	*
S_SSME_TRIM	V90X1960XA	FCS TVC RETRIM DISCRETE	ASC 2STG GUID				93017G	*
S_SSME_TRIM	V90X1960XB	FCS TVC RETRIM DISCRETE	PW RTLS GUID				93017G	*
TAL_ABORT_DECLARED	V90X8658X	TAL ABORT DECLARED	MSC				93090E	
TIME_V	V90W2553CA	TIME OF SEL TOTAL M50 VEL	IMU RM	S			91051K	
VREL_AERO_REF	V90L2018C	AERODYNAMIC REFERENCE VEL	ASC 1STG GUID	FT/S	SPL	S	90256D	
WFBI_FB1	V95H3528C	ROLL RATE, FLIGHT BODY-INERTIAL	G/C STEER	DEG/S	SPL		93017G	*
WFBI_FB2	V95H3526C	PITCH RATE, FLIGHT BODY-INERTIAL	G/C STEER	DEG/S	SPL		93017G	*
WFBI_FB3	V95H3527C	YAW RATE, FLIGHT BODY-INERTIAL	G/C STEER	DEG/S	SPL		93017G	*

NOTE: REFERENCE TABLE 1.3-1 FOR EXPLANATION OF DATA ELEMENTS.

TABLE 4.2.11-2. OUTPUT FUNCTIONAL PARAMETERS FROM ASCENT DIGITAL AUTOPILOT (G4.176)

FSSR NAME	M/S ID	NOMENCLATURE	DESTINATION	UNITS	DATA TYPE	P R E C	LAST CR	R E V
ATTCMD	V90X1712X	STEERING MODE FLAG	DL FMT 21/1 G/C STEER		BD		93017G	*
ATTFILT	V90X1709X	FILTER ACTUAL BODY ATTITUDE FLAG	DL FMT 21/1 G/C STEER		BD		93017G	*
AUTO	V90X1710X	AUTO GUIDANCE MODE FLAG	3-AX RHC SOP ASC 2STG GUID DL FMT 21/1 G/C STEER GRTLS DAP MEDS FC GNC XFER PW RTLS GUID		BD		93017G	*
AUTO_2ND_OUT	V90X1744X	AUTO RECOG OF 2ND ENG OUT FLAG	DL FMT 21/1 RTLS TRAJ 2 DISP XXXXXX TRAJ 2 DISP		BD		93017G	*
CONT_SERC	V93X6682XA	CONT SINGLE ENG ROLL CNTL FLAG	ABT CNTL SEQ ASC 2STG GUID DL FMT 21/1 G/C STEER MSC RTLS TRAJ 2 DISP XXXXXX TRAJ 1 DISP XXXXXX TRAJ 2 DISP		BD		93017G	*
DBFRC	V90H1580CB	BODY FLAP DEFLECTION CMD	AERO ACT SOP BF CMD RM TLM				93064D	
DLIBPC	V90H1734CA	LIB ELEVON POSITION CMD	AERO ACT SOP TLM	DEG				
DLOBPC	V90H1735CA	LOB ELEVON POSITION CMD	AERO ACT SOP TLM	DEG				
DPTVC_INT	V90H1774C	ROLL TVC TRIM INTEGRATOR OUTPUT	DL FMT 21/1	DEG	SPL		93017G	*
DQTVC	V90H1758C	PITCH TVC LOOP ERROR SIGNAL	DL FMT 21/1	DEG/S	SPL		93017G	*
DQTVC_INT	V90H1772C	PITCH TVC TRIM INTEGRATOR OUTPUT	DL FMT 21/1	DEG	SPL		93017G	*
DR4C	V90H1752C	ROCK COMMAND, SRB 4	TLM	DEG				
DR4CL	V90H1728C	SRB 4 ROCK ACTR DEFLECTION CMD	SRB TVC CMD SOP TLM	DEG				
DR5C	V90H1754C	ROCK COMMAND, SRB 5	TLM	DEG				
DR5CL	V90H1729C	SRB 5 ROCK ACTR DEFLECTION CMD	SRB TVC CMD SOP TLM	DEG				
DRIBPC	V90H1737CA	RIB ELEVON POSITION CMD	AERO ACT SOP TLM	DEG				
DROBPC	V90H1738CA	ROB ELEVON POSITION CMD	AERO ACT SOP TLM	DEG				
DRPC	V90R1550CB	RATE LIMITED RUDDER CMD	AERO ACT SOP TLM	DEG				
DRTVC	V90H1759C	YAW TVC LOOP ERROR SIGNAL	DL FMT 21/1	DEG/S	SPL		93017G	*
DRTVC_INT	V90H1773C	YAW TVC TRIM INTEGRATOR OUTPUT	DL FMT 21/1	DEG	SPL		93017G	*

TABLE 4.2.11-2. OUTPUT FUNCTIONAL PARAMETERS FROM ASCENT DIGITAL AUTOPILOT (G4.176)

FSSR NAME	M/S ID	NOMENCLATURE	DESTINATION	UNITS	DATA TYPE	P R E C	LAST CR	R E V
DSBPC	V90R1560CB	RATE LIMITED SPDBK CMD	AERO ACT SOP	DEG				
			TLM					
DT4C	V90H1751C	TILT COMMAND, SRB 4	TLM	DEG				
DT4CL	V90H1731C	SRB 4 TILT ACTR DEFLECTION CMD	SRB TVC CMD SOP	DEG				
			TLM					
DT5C	V90H1753C	TILT COMMAND, SRB 5	TLM	DEG				
DT5CL	V90H1732C	SRB 5 TILT ACTR DEFLECTION CMD	SRB TVC CMD SOP	DEG				
			TLM					
DY1	V90H1745C	PITCH COMMAND, SSME 1	TLM	DEG				
DY2	V90H1747C	PITCH COMMAND, SSME 2	TLM	DEG				
DY3	V90H1749C	PITCH COMMAND, SSME 3	TLM	DEG				
DYC1	V90H1718C	MPS 1 PITCH ACTR DEFLECTION CMD	MPS TVC CMD SOP	DEG				
			TLM					
DYC2	V90H1719C	MPS 2 PITCH ACTR DEFLECTION CMD	ASC 2STG GUID	DEG			91042A	
			MPS TVC CMD SOP					
			TLM					
DYC3	V90H1720C	MPS 3 PITCH ACTR DEFLECTION CMD	ASC 2STG GUID	DEG			91042A	
			MPS TVC CMD SOP					
			TLM					
DZ1	V90H1746C	YAW COMMAND, SSME 1	TLM	DEG				
DZ2	V90H1748C	YAW COMMAND, SSME 2	TLM	DEG				
DZ3	V90H1750C	YAW COMMAND, SSME 3	TLM	DEG				
DZC1	V90H1724C	MPS 1 YAW ACTR DEFLECTION CMD	MPS TVC CMD SOP	DEG				
			TLM					
DZC2	V90H1725C	MPS 2 YAW ACTR DEFLECTION CMD	MPS TVC CMD SOP	DEG				
			TLM					
DZC3	V90H1726C	MPS 3 YAW ACTR DEFLECTION CMD	MPS TVC CMD SOP	DEG				
			TLM					
ELEV_LR	V90X1716X	ELEVON LOAD RELIEF FLAG	G/C STEER					
ENA_RCS_CNTL	V90X1739X	ENABLE RCS CONTROL DISCRETE	DL FMT 21/1		BD		93017G	*
			RTLS TRAJ 2 DISP					
			XXXXXX TRAJ 1 DISP					
			XXXXXX TRAJ 2 DISP					
FRZCMD	V90X1714X	FREEZE DESIRED BODY CMD FLAG	DL FMT 21/1		BD		93017G	*
			G/C STEER					
KM_THETA	V90U1767C	VARIABLE GAIN ATTITUDE-PITCH	G/C STEER	DEG/S/DEG			90185A	
KN_PSI	V90U1768C	VARIABLE GAIN ATTITUDE-YAW	G/C STEER	DEG/S/DEG			90185A	
K_LOAD_RELIEF	V90J1704C	VAR LOAD RELIEF GAIN	ASC 1STG GUID					
LAUTO_BFLAMP	V72X4996XB	LH BODY FLAP AUTO	D&C PNL				93017G	*
			DL FMT 21/A					
LAUTO_PLAMP	V72X5240XB	FCS MODE-LH PITCH AUTO	D&C PNL				93017G	*
			DL FMT 21/A					
LAUTO_RYLAMP	V72X5243XB	FCS MODE-LH R-Y AUTO	D&C PNL				93017G	*
			DL FMT 21/A					
LAUTO_SBLAMP	V72X5136XB	LH SPEEDBRAKE AUTO	D&C PNL				93017G	*
			DL FMT 21/A					

TABLE 4.2.11-2. OUTPUT FUNCTIONAL PARAMETERS FROM ASCENT DIGITAL AUTOPILOT (G4.176)

FSSR NAME	M/S ID	NOMENCLATURE	DESTINATION	UNITS	DATA TYPE	P R E C	LAST CR	R E V
LCSS_PLAMP	V72X5241XB	FCS MODE-LH PITCH CSS	3-AX RHC SOP D&C PNL DL FMT 21/A SPTI SOP				93017G	*
LCSS_RYLAMP	V72X5245XB	FCS MODE-LH R-Y CSS	D&C PNL DL FMT 21/A SPTI SOP				93017G	*
LMNL_BFLAMP	V72X4997XB	LH BODY FLAP MANUAL	D&C PNL DL FMT 21/A				93017G	*
MASS_EST	V90U0389C	MASS ESTIMATE	G/C STEER	SLUG	SPL		92186A	
MM101_INIT	V90X1764X	FIRST-TIME ASC_DAP SCHEDULED FLAG	DL FMT 21/1 G/C STEER		BD		93017G	*
MNLSB_CMDR_O	V72X5137XB	LH SPEEDBRAKE MANUAL	D&C PNL DL FMT 21/A				93017G	*
MNLSB_PLT_O	V72X5135XB	RH SPEEDBRAKE MANUAL	D&C PNL DL FMT 21/A				93017G	*
NEW_JONLST(04)	V90X1442XD	RCS JET F1L ON CMD	ASC RCS CMD SOP				92157	
NEW_JONLST(05)	V90X1450XD	RCS JET F3L ON CMD	ASC RCS CMD SOP				92157	
NEW_JONLST(06)	V90X1446XD	RCS JET F2R ON CMD	ASC RCS CMD SOP				92157	
NEW_JONLST(07)	V90X1453XD	RCS JET F4R ON CMD	ASC RCS CMD SOP				92157	
NEW_JONLST(10)	V90X1443XD	RCS JET F1U ON CMD	ASC RCS CMD SOP				92565A	
NEW_JONLST(19)	V90X1680XE	RCS JET L4L ON CMD	ASC RCS CMD SOP				92157	
NEW_JONLST(20)	V90X1675XE	RCS JET L2L ON CMD	ASC RCS CMD SOP				92157	
NEW_JONLST(21)	V90X1678XE	RCS JET L3L ON CMD	ASC RCS CMD SOP				92157	
NEW_JONLST(22)	V90X1673XE	RCS JET L1L ON CMD	ASC RCS CMD SOP				92157	
NEW_JONLST(23)	V90X1690XE	RCS JET R4R ON CMD	ASC RCS CMD SOP				92157	
NEW_JONLST(24)	V90X1685XE	RCS JET R2R ON CMD	ASC RCS CMD SOP				92157	
NEW_JONLST(25)	V90X1688XE	RCS JET R3R ON CMD	ASC RCS CMD SOP				92157	
NEW_JONLST(26)	V90X1683XE	RCS JET R1R ON CMD	ASC RCS CMD SOP				92157	
NEW_JONLST(27)	V90X1681XE	RCS JET L4U ON CMD	ASC RCS CMD SOP				92157	
NEW_JONLST(28)	V90X1676XE	RCS JET L2U ON CMD	ASC RCS CMD SOP				92157	
NEW_JONLST(29)	V90X1674XE	RCS JET L1U ON CMD	ASC RCS CMD SOP				92157	
NEW_JONLST(30)	V90X1691XE	RCS JET R4U ON CMD	ASC RCS CMD SOP				92157	
NEW_JONLST(31)	V90X1686XE	RCS JET R2U ON CMD	ASC RCS CMD SOP				92157	
NEW_JONLST(32)	V90X1684XE	RCS JET R1U ON CMD	ASC RCS CMD SOP				92157	
NEW_JONLST(33)	V90X1682XE	RCS JET L4D ON CMD	ASC RCS CMD SOP				92157	
NEW_JONLST(34)	V90X1677XE	RCS JET L2D ON CMD	ASC RCS CMD SOP				92157	
NEW_JONLST(35)	V90X1679XE	RCS JET L3D ON CMD	ASC RCS CMD SOP				92157	
NEW_JONLST(36)	V90X1692XE	RCS JET R4D ON CMD	ASC RCS CMD SOP				92157	
NEW_JONLST(37)	V90X1687XE	RCS JET R2D ON CMD	ASC RCS CMD SOP				92157	
NEW_JONLST(38)	V90X1689XE	RCS JET R3D ON CMD	ASC RCS CMD SOP				92157	
NEW_JONLST(8)	V90X1447XD	RCS JET F2U ON CMD	ASC RCS CMD SOP				92565A	
NEW_JONLST(9)	V90X1451XD	RCS JET F3U ON CMD	ASC RCS CMD SOP				92565A	
NYSEP_DISABLE	V90X0373X	NYSEP DISABLE INDICATOR	ASC 1STG GUID		BD		91015C	
NY_FBK	V90A1766C	COMPENSATED LATERAL ACCEL ERROR	DL FMT 21/1 G/C STEER	DEG/S	SPL		93017G	*

TABLE 4.2.11-2. OUTPUT FUNCTIONAL PARAMETERS FROM ASCENT DIGITAL AUTOPILOT (G4.176)

FSSR NAME	M/S ID	NOMENCLATURE	DESTINATION	UNITS	DATA TYPE	P R E C	LAST CR	R E V
NZ_FBK	V90A1765C	COMPENSATED NORMAL ACCEL ERROR	DL FMT 21/1 G/C STEER	DEG/S	SPL		93017G	*
PC4F	V90P0907C	FILTERED LEFT PRESS SRB CHAMBER	CONT 3E/O GUID	PSIA			90705H	
PC5F	V90P0908C	FILTERED RIGHT PRESS SRB CHAMBER	CONT 3E/O GUID	PSIA			90705H	
PCGTRM	V90U0103C	NET PITCH TRIM THRUST ANGLE	G/C STEER	DEG	SPL		90011E	
PEGCMD	V90X1757X	S2G STEERING MODE FLAG	DL FMT 21/1 G/C STEER		BD		93017G	*
PPD	V90X1760X	RTLS POWERED PITCH DOWN MNVR FLAG	DL FMT 21/1 G/C STEER		BD		93017G	*
PRE_SEP	V90X0906X	PRE-SEP INDICATOR	CONT 3E/O GUID		BD		90705H	
QBI_READY	V90X2250X	BODY WRT M50 DAP QUAT READY FLAG	G/C STEER		BD		89986H	
RAUTO_BFLAMP	V72X4896XB	RH BODY FLAP AUTO	D&C PNL TLM					
RAUTO_PLAMP	V72X5140XB	FCS MODE-RH PITCH AUTO	D&C PNL TLM					
RAUTO_RYLAMP	V72X5143XB	FCS MODE-RH R-Y AUTO	D&C PNL TLM					
RAUTO_SBLAMP	V72X5134XB	RH SPEEDBRAKE AUTO	D&C PNL TLM					
RCSS_PLAMP	V72X5141XB	FCS MODE-RH PITCH CSS	D&C PNL DL FMT 21/A				93017G	*
RCSS_RYLAMP	V72X5145XB	FCS MODE-RH R-Y CSS	D&C PNL DL FMT 21/A				93017G	*
RMNL_BFLAMP	V72X4897XB	RH BODY FLAP MANUAL	D&C PNL DL FMT 21/A				93017G	*
RTLS_TURN	V90X1756X	INITIATE RTLS TURNAROUND MNVR FLAG	DL FMT 21/1 G/C STEER		BD		93017G	*
S1G	V90X1713X	STG1 GUIDANCE DISCRETE	DL FMT 21/1 G/C STEER		BD		93017G	*
SEC_ME_FL_CNFM	V90X1721X	2ND SSME FAIL CONFIRM	ABT CNTL SEQ ET SEP SEQ G/C STEER MSC SSME OPS				89990E	
SRBSEP	V90X1761X	SRB SEPARATION SUBPHASE FLAG	DL FMT 21/1 G/C STEER		BD		93017G	*
SRB_NULL_CMD	V90X1769X	INITIATE SRB NULL CMD	A/E ATT PROC					
SSME_FAILS	V90J1763C	SSME FAILURE STATUS FLAG	DL FMT 21/1 G/C STEER RTLS TRAJ 2 DISP XXXXXX TRAJ 1 DISP XXXXXX TRAJ 2 DISP		HXS		93017G	*
YCGTRM	V90U0104C	NET YAW TRIM THRUST ANGLE	G/C STEER	DEG	SPL		90011E	
ZTRANS	V90X1755X	RTLS ET SEP MNVR FLAG	G/C STEER		BD		79967F	
	V72M6630PA	MDM FF01 DSCR OUT SET	CD 10 CH 0	DL FMT 21/A			93017G	*
	V72M6680PA	MDM FF02 DSCR OUT SET	CD 10 CH 0	DL FMT 21/A			93017G	*

TABLE 4.2.11-2. OUTPUT FUNCTIONAL PARAMETERS FROM ASCENT DIGITAL AUTOPILOT (G4.176)

FSSR NAME	M/S ID	NOMENCLATURE	DESTINATION	UNITS	DATA TYPE	P R E C	LAST CR	R E V
	V72M6780PA	MDM FF04 DSCR OUT SET	CD 10 CH 0	DL FMT 21/A			93017G	*
	V90M2854P	CGCB_MC16_FLAG_3		DL FMT 21/1			93017G	*
	V90M2855P	CGCB_MC16_FLAG_1		DL FMT 21/1			93017G	*
	V90M2929PA	CGEB_MC1_LG2_FLAG1_HFE		DL FMT 21/1			93017G	*
	V90M2931P	CGCB_MC16_FLAG_2		DL FMT 21/1			93017G	*
	V90M3173PB	CGCB_MC16_FLAG_6		DL FMT 21/1			93017G	*
	V90X1736X	MANUAL CONTROL FLAG		MSC	BD		89599C	
	V99M1855PC	CONT MNVR DISCRETES		DL FMT 21/1			93017G	*

NOTE: REFERENCE TABLE 1.3-1 FOR EXPLANATION OF DATA ELEMENTS.

**Rate Codes: (HDR Only) 1 = 1 sample/sec 2 = 5 samples/sec 3 = 12.5 samples/sec 4 = 25 samples/sec 5 = 100 samples/sec
(HDR and LDR) A = 1 sample/sec B = 5 samples/sec C = 12.5 samples/sec D = 25 samples/sec E = 100 samples/sec**

TABLE 4.2.11-3. ASCENT DIGITAL AUTOPILOT (G4.176) I-LOADS

FSSR NAME	MSID	ENG UNITS	DT	PR	D	S	PR FCTN	MC	CAT	LAST CR	R E V
ACCEL_COEF	V99U7677C	ND	F	S	D	P	G4.176	00	ADM	90243C	
ACC_THR_CNTR	V99U7678C	ND	I	S	D	P	G4.176	00	ADM	90243C	
BIAS_IB	V97U1413C	LBS/IN**2	F	S	D	C	G4.176	00	ADE	DC0599	
BIAS_OB	V97U1416C	LBS/IN**2	F	S	D	C	G4.176	00	ADE	DC0599	
CL_LLA1	V97U1420C	ND	F	S	D	C	G4.176	00	ADG	DC2593	
CL_LLA2	V97U1421C	ND	F	S	D	C	G4.176	00	ADG	DC2593	
CL_LLA3	V97U1422C	ND	F	S	D	C	G4.176	00	ADG	DC2593	
CL_LLA4	V97U2456C	ND	F	S	D	C	G4.176	00	ADG	DC2593	
CL_LLA5	V97U2457C	ND	F	S	D	C	G4.176	00	ADG	DC2593	
CL_LLB1	V97U1423C	ND	F	S	D	C	G4.176	00	ADG	DC2593	
CL_LLB2	V97U1424C	ND	F	S	D	C	G4.176	00	ADG	DC2593	
CL_LLB3	V97U1425C	ND	F	S	D	C	G4.176	00	ADG	DC2593	
CL_LLB4	V97U2458C	ND	F	S	D	C	G4.176	00	ADG	DC2593	
CL_LLB5	V97U2459C	ND	F	S	D	C	G4.176	00	ADG	DC2593	
CL_PBA11	V97U1432C	ND	F	S	D	C	G4.176	00	ADG	DC2593	
CL_PBA12	V97U1433C	ND	F	S	D	C	G4.176	00	ADG	DC2593	
CL_PBA13	V97U1434C	ND	F	S	D	C	G4.176	00	ADG	DC2593	
CL_PBA14	V97U1435C	ND	F	S	D	C	G4.176	00	ADG	DC2593	
CL_PBA15	V97U1436C	ND	F	S	D	C	G4.176	00	ADG	DC2593	
CL_PBA21	V97U1437C	ND	F	S	D	C	G4.176	00	ADG	DC2593	
CL_PBA22	V97U1438C	ND	F	S	D	C	G4.176	00	ADG	DC2593	
CL_PBA23	V97U1439C	ND	F	S	D	C	G4.176	00	ADG	DC2593	
CL_PBA24	V97U1440C	ND	F	S	D	C	G4.176	00	ADG	DC2593	
CL_PBA25	V97U1441C	ND	F	S	D	C	G4.176	00	ADG	DC2593	
CL_PBB11	V97U1447C	ND	F	S	D	C	G4.176	00	ADG	DC2593	
CL_PBB12	V97U1448C	ND	F	S	D	C	G4.176	00	ADG	DC2593	
CL_PBB13	V97U1449C	ND	F	S	D	C	G4.176	00	ADG	DC2593	
CL_PBB14	V97U1450C	ND	F	S	D	C	G4.176	00	ADG	DC2593	
CL_PBB15	V97U1451C	ND	F	S	D	C	G4.176	00	ADG	DC2593	
CL_PBB21	V97U1452C	ND	F	S	D	C	G4.176	00	ADG	DC2593	
CL_PBB22	V97U1453C	ND	F	S	D	C	G4.176	00	ADG	DC2593	
CL_PBB23	V97U1454C	ND	F	S	D	C	G4.176	00	ADG	DC2593	
CL_PBB24	V97U1455C	ND	F	S	D	C	G4.176	00	ADG	DC2593	
CL_PBB25	V97U1456C	ND	F	S	D	C	G4.176	00	ADG	DC2593	
CL_PBC11	V97U2460C	ND	F	S	D	C	G4.176	00	ADG	DC2593	
CL_PBC12	V97U2461C	ND	F	S	D	C	G4.176	00	ADG	DC2593	
CL_PBC13	V97U2462C	ND	F	S	D	C	G4.176	00	ADG	DC2593	
CL_PBC14	V97U2463C	ND	F	S	D	C	G4.176	00	ADG	DC2593	
CL_PBC15	V98U9577C	ND	F	S	D	C	G4.176	00	ADG	DC2593	
CL_PBC21	V98U9578C	ND	F	S	D	C	G4.176	00	ADG	DC2593	
CL_PBC22	V98U9579C	ND	F	S	D	C	G4.176	00	ADG	DC2593	
CL_PBC23	V98U9580C	ND	F	S	D	C	G4.176	00	ADG	DC2593	
CL_PBC24	V98U9581C	ND	F	S	D	C	G4.176	00	ADG	DC2593	
CL_PBC25	V98U9582C	ND	F	S	D	C	G4.176	00	ADG	DC2593	
CL_RO1	V97U1462C	ND	F	S	D	C	G4.176	00	ADG	DC2593	
CL_RO2	V97U1463C	ND	F	S	D	C	G4.176	00	ADG	DC2593	
CL_RO3	V97U1464C	ND	F	S	D	C	G4.176	00	ADG	DC2593	

TABLE 4.2.11-3. ASCENT DIGITAL AUTOPILOT (G4.176) I-LOADS

FSSR NAME	MSID	ENG UNITS	DT	PR	D	S	PR FCTN	MC	CAT	LAST CR	R E V
CL_RO4	V97U1465C	ND	F	S	D	C	G4.176	00	ADG	DC2593	
CL_RO5	V97U1466C	ND	F	S	D	C	G4.176	00	ADG	DC2593	
CM_LLS11	V98U9588C	ND	F	S	D	C	G4.176	00	ADG	DC2593	
CM_LLS12	V98U9589C	ND	F	S	D	C	G4.176	00	ADG	DC2593	
CM_LLS13	V98U9564C	ND	F	S	D	C	G4.176	00	ADG	DC2593	
CM_LLS14	V98U9565C	ND	F	S	D	C	G4.176	00	ADG	DC2593	
CM_LLS15	V98U9566C	ND	F	S	D	C	G4.176	00	ADG	DC2593	
CM_LLS21	V98U9567C	ND	F	S	D	C	G4.176	00	ADG	DC2593	
CM_LLS22	V98U9568C	ND	F	S	D	C	G4.176	00	ADG	DC2593	
CM_LLS23	V98U9569C	ND	F	S	D	C	G4.176	00	ADG	DC2593	
CM_LLS24	V98U9570C	ND	F	S	D	C	G4.176	00	ADG	DC2593	
CM_LLS25	V98U9571C	ND	F	S	D	C	G4.176	00	ADG	DC2593	
CM_NZ1	V97U1485C	ND	F	S	D	C	G4.176	00	ADG	DC2593	
CM_NZ2	V97U1486C	ND	F	S	D	C	G4.176	00	ADG	DC2593	
CM_NZ3	V97U1487C	ND	F	S	D	C	G4.176	00	ADG	DC2593	
CM_NZ4	V97U1488C	ND	F	S	D	C	G4.176	00	ADG	DC2593	
CM_NZ5	V97U1489C	ND	F	S	D	C	G4.176	00	ADG	DC2593	
CM_NZLAG1	V97U1482C	ND	F	S	D	C	G4.176	00	ADG	DC2593	
CM_NZLAG2	V97U1483C	ND	F	S	D	C	G4.176	00	ADG	DC2593	
CM_NZLAG3	V97U1484C	ND	F	S	D	C	G4.176	00	ADG	DC2593	
CM_QB1	V97U1500C	ND	F	S	D	C	G4.176	00	ADG	DC2593	
CM_QB2	V97U1501C	ND	F	S	D	C	G4.176	00	ADG	DC2593	
CM_QB3	V97U1502C	ND	F	S	D	C	G4.176	00	ADG	DC2593	
CM_QB4	V97U1503C	ND	F	S	D	C	G4.176	00	ADG	DC2593	
CM_QB5	V97U1504C	ND	F	S	D	C	G4.176	00	ADG	DC2593	
CM_QHP1	V97U1540C	ND	F	S	D	C	G4.176	00	ADG	DC2593	
CM_QHP2	V97U1541C	ND	F	S	D	C	G4.176	00	ADG	DC2593	
CM_QHP3	V97U1542C	ND	F	S	D	C	G4.176	00	ADG	DC2593	
CM_QO11	V97U1543C	ND	F	S	D	C	G4.176	00	ADG	DC2593	
CM_QO12	V97U1544C	ND	F	S	D	C	G4.176	00	ADG	DC2593	
CM_QO13	V97U1545C	ND	F	S	D	C	G4.176	00	ADG	DC2593	
CM_QO14	V97U1546C	ND	F	S	D	C	G4.176	00	ADG	DC2593	
CM_QO15	V97U1547C	ND	F	S	D	C	G4.176	00	ADG	DC2593	
CM_QO21	V97U1548C	ND	F	S	D	C	G4.176	00	ADG	DC2593	
CM_QO22	V97U1549C	ND	F	S	D	C	G4.176	00	ADG	DC2593	
CM_QO23	V97U1550C	ND	F	S	D	C	G4.176	00	ADG	DC2593	
CM_QO24	V97U1551C	ND	F	S	D	C	G4.176	00	ADG	DC2593	
CM_QO25	V97U1552C	ND	F	S	D	C	G4.176	00	ADG	DC2593	
CM_R01	V97U1558C	ND	F	S	D	C	G4.176	00	ADG	DC2593	
CM_R02	V97U1559C	ND	F	S	D	C	G4.176	00	ADG	DC2593	
CM_R03	V97U1560C	ND	F	S	D	C	G4.176	00	ADG	DC2593	
CM_R04	V97U1561C	ND	F	S	D	C	G4.176	00	ADG	DC2593	
CM_R05	V97U1562C	ND	F	S	D	C	G4.176	00	ADG	DC2593	
CM_STG11	V98U9583C	ND	F	S	D	C	G4.176	00	ADG	DC2593	
CM_STG12	V98U9584C	ND	F	S	D	C	G4.176	00	ADG	DC2593	
CM_STG13	V98U9585C	ND	F	S	D	C	G4.176	00	ADG	DC2593	
CM_STG14	V98U9586C	ND	F	S	D	C	G4.176	00	ADG	DC2593	

TABLE 4.2.11-3. ASCENT DIGITAL AUTOPILOT (G4.176) I-LOADS

FSSR NAME	MSID	ENG UNITS	DT	PR	D	S	PR FCTN	MC	CAT	LAST CR	R E V
CM_STG15	V98U9587C	ND	F	S	D	C	G4.176	00	ADG	DC2593	
CN_LLA1	V97U1571C	ND	F	S	D	C	G4.176	00	ADG	DC2593	
CN_LLA2	V97U1572C	ND	F	S	D	C	G4.176	00	ADG	DC2593	
CN_LLA3	V97U1573C	ND	F	S	D	C	G4.176	00	ADG	DC2593	
CN_LLA4	V97U1574C	ND	F	S	D	C	G4.176	00	ADG	DC2593	
CN_LLA5	V97U1575C	ND	F	S	D	C	G4.176	00	ADG	DC2593	
CN_LLB1	V98U9572C	ND	F	S	D	C	G4.176	00	ADG	DC2593	
CN_LLB2	V98U9573C	ND	F	S	D	C	G4.176	00	ADG	DC2593	
CN_LLB3	V98U9574C	ND	F	S	D	C	G4.176	00	ADG	DC2593	
CN_LLB4	V98U9575C	ND	F	S	D	C	G4.176	00	ADG	DC2593	
CN_LLB5	V98U9576C	ND	F	S	D	C	G4.176	00	ADG	DC2593	
CN_NYA11	V97U1587C	ND	F	S	D	C	G4.176	00	ADG	92252B	
CN_NYA12	V97U1588C	ND	F	S	D	C	G4.176	00	ADG	92252B	
CN_NYA13	V97U1589C	ND	F	S	D	C	G4.176	00	ADG	92252B	
CN_NYA14	V97U1590C	ND	F	S	D	C	G4.176	00	ADG	92252B	
CN_NYA15	V97U1591C	ND	F	S	D	C	G4.176	00	ADG	92252B	
CN_NYA21	V97U1592C	ND	F	S	D	C	G4.176	00	ADG	92252B	
CN_NYA22	V97U1593C	ND	F	S	D	C	G4.176	00	ADG	92252B	
CN_NYA23	V97U1594C	ND	F	S	D	C	G4.176	00	ADG	92252B	
CN_NYA24	V97U1595C	ND	F	S	D	C	G4.176	00	ADG	92252B	
CN_NYA25	V97U1596C	ND	F	S	D	C	G4.176	00	ADG	92252B	
CN_NYB11	V97U1690C	ND	F	S	D	C	G4.176	00	ADG	92252B	
CN_NYB12	V97U1691C	ND	F	S	D	C	G4.176	00	ADG	92252B	
CN_NYB13	V97U1692C	ND	F	S	D	C	G4.176	00	ADG	92252B	
CN_NYB14	V97U1693C	ND	F	S	D	C	G4.176	00	ADG	92252B	
CN_NYB15	V97U1694C	ND	F	S	D	C	G4.176	00	ADG	92252B	
CN_NYB21	V97U1695C	ND	F	S	D	C	G4.176	00	ADG	92252B	
CN_NYB22	V97U1696C	ND	F	S	D	C	G4.176	00	ADG	92252B	
CN_NYB23	V97U1697C	ND	F	S	D	C	G4.176	00	ADG	92252B	
CN_NYB24	V97U1698C	ND	F	S	D	C	G4.176	00	ADG	92252B	
CN_NYB25	V97U1699C	ND	F	S	D	C	G4.176	00	ADG	92252B	
CN_NYLAG1	V97U1581C	ND	F	S	D	C	G4.176	00	ADG	DC2593	
CN_NYLAG2	V97U1582C	ND	F	S	D	C	G4.176	00	ADG	DC2593	
CN_NYLAG3	V97U1583C	ND	F	S	D	C	G4.176	00	ADG	DC2593	
CN_NYSEP1	V97U1584C	ND	F	S	D	C	G4.176	00	ADG	DC2593	
CN_NYSEP2	V97U1585C	ND	F	S	D	C	G4.176	00	ADG	DC2593	
CN_NYSEP3	V97U1586C	ND	F	S	D	C	G4.176	00	ADG	DC2593	
CN_PRHP1	V97U1602C	ND	F	S	D	C	G4.176	00	ADG	DC2593	
CN_PRHP2	V97U1603C	ND	F	S	D	C	G4.176	00	ADG	DC2593	
CN_PRHP3	V97U1604C	ND	F	S	D	C	G4.176	00	ADG	DC2593	
CN_RBA11	V99U9575C	ND	F	S	D	C	G4.176	00	ADG	DC2593	
CN_RBA12	V99U9576C	ND	F	S	D	C	G4.176	00	ADG	DC2593	
CN_RBA13	V99U9577C	ND	F	S	D	C	G4.176	00	ADG	DC2593	
CN_RBA14	V99U9578C	ND	F	S	D	C	G4.176	00	ADG	DC2593	
CN_RBA15	V99U9579C	ND	F	S	D	C	G4.176	00	ADG	DC2593	
CN_RBA21	V99U9580C	ND	F	S	D	C	G4.176	00	ADG	DC2593	
CN_RBA22	V99U9581C	ND	F	S	D	C	G4.176	00	ADG	DC2593	

TABLE 4.2.11-3. ASCENT DIGITAL AUTOPILOT (G4.176) I-LOADS

FSSR NAME	MSID	ENG UNITS	DT	PR	D	S	PR FCTN	MC	CAT	LAST CR	R E V
CN_RBA23	V99U9582C	ND	F	S	D	C	G4.176	00	ADG	DC2593	
CN_RBA24	V99U9583C	ND	F	S	D	C	G4.176	00	ADG	DC2593	
CN_RBA25	V99U9584C	ND	F	S	D	C	G4.176	00	ADG	DC2593	
CN_RBB11	V99U9585C	ND	F	S	D	C	G4.176	00	ADG	DC2593	
CN_RBB12	V99U9586C	ND	F	S	D	C	G4.176	00	ADG	DC2593	
CN_RBB13	V99U9587C	ND	F	S	D	C	G4.176	00	ADG	DC2593	
CN_RBB14	V99U9588C	ND	F	S	D	C	G4.176	00	ADG	DC2593	
CN_RBB15	V99U9589C	ND	F	S	D	C	G4.176	00	ADG	DC2593	
CN_RBB21	V99U9590C	ND	F	S	D	C	G4.176	00	ADG	DC2593	
CN_RBB22	V99U9591C	ND	F	S	D	C	G4.176	00	ADG	DC2593	
CN_RBB23	V99U9592C	ND	F	S	D	C	G4.176	00	ADG	DC2593	
CN_RBB24	V99U9593C	ND	F	S	D	C	G4.176	00	ADG	DC2593	
CN_RBB25	V99U9594C	ND	F	S	D	C	G4.176	00	ADG	DC2593	
CN_RO11	V97U1645C	ND	F	S	D	C	G4.176	00	ADG	DC2593	
CN_RO12	V97U1646C	ND	F	S	D	C	G4.176	00	ADG	DC2593	
CN_RO13	V97U1647C	ND	F	S	D	C	G4.176	00	ADG	DC2593	
CN_RO14	V97U1648C	ND	F	S	D	C	G4.176	00	ADG	DC2593	
CN_RO15	V97U1649C	ND	F	S	D	C	G4.176	00	ADG	DC2593	
CN_RO21	V97U1650C	ND	F	S	D	C	G4.176	00	ADG	DC2593	
CN_RO22	V97U1651C	ND	F	S	D	C	G4.176	00	ADG	DC2593	
CN_RO23	V97U1652C	ND	F	S	D	C	G4.176	00	ADG	DC2593	
CN_RO24	V97U1653C	ND	F	S	D	C	G4.176	00	ADG	DC2593	
CN_RO25	V97U1654C	ND	F	S	D	C	G4.176	00	ADG	DC2593	
CN_ROFF1	V97U2488C	ND	F	S	D	C	G4.176	00	ADG	DC2593	
CN_ROFF2	V97U8889C	ND	F	S	D	C	G4.176	00	ADG	DC2593	
CN_ROFF3	V97U2490C	ND	F	S	D	C	G4.176	00	ADG	DC2593	
CN_ROFF4	V97U2491C	ND	F	S	D	C	G4.176	00	ADG	DC2593	
CN_ROFF5	V97U2492C	ND	F	S	D	C	G4.176	00	ADG	DC2593	
CSRB_PC1	V97U1660C	ND	F	S	D	C	G4.176	00	ZFR	90014G	
CSRB_PC2	V97U1661C	ND	F	S	D	C	G4.176	00	ZFR	90014G	
CSRB_PC3	V97U1662C	ND	F	S	D	C	G4.176	00	ZFR	90014G	
DBFE_INNER	V97U1665C	DEG	F	S	D	P	G4.176	00	ZSR	90007G	
DBFE_OUTER	V97U1666C	DEG	F	S	D	P	G4.176	00	ZSR	90007G	
DCLIM	V97U2429C	DEG	F	S	D	C	G4.176	00	ZSR	90007G	
DELTAT_AUTOTRIM_ENABLE	V98U9809C	SEC	F	D	D	P	G4.176	00	ZFR	90014G	
DEL_NZ_GAIN	V97U0875C	G/DEG	F	S	D	C	G4.176	00	PED	91018B	
DEL_TWR_CLR	V97U2440C	DEG	F	S	D	C	G4.176	00	ZSR	90007G	
DIBS_TAB(01)	V97U1667C	DEG	F	S	D	C	G4.176	00	ASE	DC2726	
DIBS_TAB(02)	V97U1668C	DEG	F	S	D	C	G4.176	00	ASE	DC2726	
DIBS_TAB(03)	V97U1669C	DEG	F	S	D	C	G4.176	00	ASE	DC2726	
DIBS_TAB(04)	V97U1670C	DEG	F	S	D	C	G4.176	00	ASE	DC2726	
DIBS_TAB(05)	V97U1671C	DEG	F	S	D	C	G4.176	00	ASE	DC2726	
DIBS_TAB(06)	V97U1672C	DEG	F	S	D	C	G4.176	00	ASE	DC2726	
DIBS_TAB(07)	V97U1673C	DEG	F	S	D	C	G4.176	00	ASE	DC2726	
DIBS_TAB(08)	V97U1674C	DEG	F	S	D	C	G4.176	00	ASE	DC2726	
DOBS_TAB(01)	V97U1677C	DEG	F	S	D	C	G4.176	00	ASE	DC2726	
DOBS_TAB(02)	V97U1678C	DEG	F	S	D	C	G4.176	00	ASE	DC2726	

TABLE 4.2.11-3. ASCENT DIGITAL AUTOPILOT (G4.176) I-LOADS

FSSR NAME	MSID	ENG UNITS	DT	PR	D	S	PR FCTN	MC	CAT	LAST CR	R E V
DOBS_TAB(03)	V97U1679C	DEG	F	S	D	C	G4.176	00	ASE	DC2726	
DOBS_TAB(04)	V97U1680C	DEG	F	S	D	C	G4.176	00	ASE	DC2726	
DOBS_TAB(05)	V97U1681C	DEG	F	S	D	C	G4.176	00	ASE	DC2726	
DOBS_TAB(06)	V97U1682C	DEG	F	S	D	C	G4.176	00	ASE	DC2726	
DOBS_TAB(07)	V97U1683C	DEG	F	S	D	C	G4.176	00	ASE	DC2726	
DOBS_TAB(08)	V97U1684C	DEG	F	S	D	C	G4.176	00	ASE	DC2726	
DPY1_LIM	V97U1685C	DEG	F	S	D	C	G4.176	00	ZFR	90014G	
DPY23_LIM	V97U1686C	DEG	F	S	D	C	G4.176	00	ZFR	90014G	
DPZ1_LIM	V97U1687C	DEG	F	S	D	C	G4.176	00	ZFR	90014G	
DPZ23_LIM	V97U1688C	DEG	F	S	D	C	G4.176	00	ZFR	90014G	
DP_INNER	V97U2484C	DEG	F	S	D	P	G4.176	00	ZSR	90007G	
DP_OUTER	V97U2485C	DEG	F	S	D	P	G4.176	00	ZSR	90007G	
DQMPSP_LIM	V97U1689C	DEG	F	S	D	C	G4.176	00	ZFR	90014G	
DQMPST_S1_END	V97U2450C	DEG	F	S	M	C	G4.176	00	ADG	DC2593	
DQMPST_S2_TRIM	V97U1933C	DEG	F	S	M	C	G4.176	00	S2T	91013D	
DQSRBT_0_TAB(01)	V97U1714C	DEG	F	S	D	C	G4.176	00	A1S	92243A	
DQSRBT_0_TAB(02)	V97U1715C	DEG	F	S	D	C	G4.176	00	A1S	92243A	
DQSRBT_0_TAB(03)	V97U1716C	DEG	F	S	D	C	G4.176	00	A1S	92243A	
DQSRBT_0_TAB(04)	V97U1717C	DEG	F	S	D	C	G4.176	00	A1S	92243A	
DQSRBT_0_TAB(05)	V97U1718C	DEG	F	S	D	C	G4.176	00	A1S	92243A	
DQSRBT_0_TAB(06)	V97U1719C	DEG	F	S	D	C	G4.176	00	A1S	92243A	
DQSRBT_0_TAB(07)	V97U1720C	DEG	F	S	D	C	G4.176	00	A1S	92243A	
DQSRBT_0_TAB(08)	V97U1721C	DEG	F	S	D	C	G4.176	00	A1S	92243A	
DQSRBT_0_TAB(09)	V97U1722C	DEG	F	S	D	C	G4.176	00	A1S	92243A	
DQSRBT_0_TAB(10)	V97U1723C	DEG	F	S	D	C	G4.176	00	A1S	92243A	
DQSRBT_0_TAB(11)	V97U1724C	DEG	F	S	D	C	G4.176	00	A1S	92243A	
DQSRBT_0_TAB(12)	V97U1725C	DEG	F	S	D	C	G4.176	00	A1S	92243A	
DQSRBT_0_TAB(13)	V97U1726C	DEG	F	S	D	C	G4.176	00	A1S	92243A	
DQSRBT_0_TAB(14)	V97U1727C	DEG	F	S	D	C	G4.176	00	A1S	92243A	
DQSRBT_0_TAB(15)	V97U1728C	DEG	F	S	D	C	G4.176	00	A1S	92243A	
DQSRBT_0_TAB(16)	V97U1729C	DEG	F	S	D	C	G4.176	00	A1S	92243A	
DQSRBT_0_TAB(17)	V97U1730C	DEG	F	S	D	C	G4.176	00	A1S	92243A	
DQSRBT_0_TAB(18)	V97U1731C	DEG	F	S	D	C	G4.176	00	A1S	92243A	
DQSRBT_0_TAB(19)	V97U1732C	DEG	F	S	D	C	G4.176	00	A1S	92243A	
DQSRBT_0_TAB(20)	V97U1733C	DEG	F	S	D	C	G4.176	00	A1S	92243A	
DQSRBT_EO(1)	V99U6671C	DEG	F	S	D	C	G4.176	00	A1P	DC2726	
DQSRBT_EO(10)	V99U6612C	DEG	F	S	D	C	G4.176	00	A1P	DC2726	
DQSRBT_EO(2)	V99U6672C	DEG	F	S	D	C	G4.176	00	A1P	DC2726	
DQSRBT_EO(3)	V99U6673C	DEG	F	S	D	C	G4.176	00	A1P	DC2726	
DQSRBT_EO(4)	V99U6674C	DEG	F	S	D	C	G4.176	00	A1P	DC2726	
DQSRBT_EO(5)	V99U6607C	DEG	F	S	D	C	G4.176	00	A1P	DC2726	
DQSRBT_EO(6)	V99U6608C	DEG	F	S	D	C	G4.176	00	A1P	DC2726	
DQSRBT_EO(7)	V99U6609C	DEG	F	S	D	C	G4.176	00	A1P	DC2726	
DQSRBT_EO(8)	V99U6610C	DEG	F	S	D	C	G4.176	00	A1P	DC2726	
DQSRBT_EO(9)	V99U6611C	DEG	F	S	D	C	G4.176	00	A1P	DC2726	
DQ_PITCH_ASSIST	V97U1700C	DEG/SEC	F	S	D	P	G4.176	00	ZSR	92565A	
DRMPSP_LIM	V97U1775C	DEG	F	S	D	C	G4.176	00	ZFR	90014G	

TABLE 4.2.11-3. ASCENT DIGITAL AUTOPILOT (G4.176) I-LOADS

FSSR NAME	MSID	ENG UNITS	DT	PR	D	S	PR FCTN	MC	CAT	LAST CR	R E V
DRVLIM_IB	V97U1776C	LBS/IN**2	F	S	D	C	G4.176	00	ADE	DC0599	
DRVLIM_OB	V97U1777C	LBS/IN**2	F	S	D	C	G4.176	00	ADE	DC0599	
DSB_BIAS_SLEW	V97U2441C	DEG	F	S	D	P	G4.176	00	ZFR	90014G	
DY1_FAIL	V97U1781C	DEG	F	S	D	C	G4.176	00	ZFR	90014G	
DY2_FAIL	V97U1783C	DEG	F	S	D	C	G4.176	00	ZFR	90014G	
DY3_FAIL	V97U1785C	DEG	F	S	D	C	G4.176	00	ZFR	90014G	
DYLIM	V97U1360C	DEG	F	S	D	C	G4.176	00	ZFR	90014G	
DZ2_FAIL	V97U1787C	DEG	F	S	D	C	G4.176	00	ZFR	90014G	
DZ3_FAIL	V97U1789C	DEG	F	S	D	C	G4.176	00	ZFR	90014G	
DZLIM	V97U1361C	DEG	F	S	D	C	G4.176	00	ZFR	90014G	
FT_SSME	V97U4392C	LBF	F	S	D	C	G4.176	00	ZF1	90243C	
							G4.2				
							G4.4				
							G4.5				
HOLD_CLEAR_BIAS	V98U9793C	DEG	F	S	D	C	G4.176	00	A1S	92243A	
KLDELPSI_MASS_TAB(01)	V97U2478C	(DEG/SEC)/(DEG/SEC)	F	S	D	X	G4.176	00	ZFR	90014G	
KLDELPSI_MASS_TAB(02)	V97U2479C	(DEG/SEC)/(DEG/SEC)	F	S	D	X	G4.176	00	ZFR	90014G	
KLDELPSI_S1	V97U2434C	ND	F	S	D	C	G4.176	00	ZFR	90014G	
KLMP5_S1	V98U9590C	DEG/DEG/SEC	F	S	D	C	G4.176	00	ADG	DC2593	
KLMP5_S2	V97U2477C	DEG/(DEG/SEC)	F	S	D	C	G4.176	00	ADG	DC2593	
KLOADRELIEF_VREL_TAB(01)	V97U2442C	ND	F	S	D	C	G4.176	00	ZFR	90014G	
KLOADRELIEF_VREL_TAB(02)	V97U2443C	ND	F	S	D	C	G4.176	00	ZSR	90007G	
KLOADRELIEF_VREL_TAB(03)	V97U2444C	ND	F	S	D	C	G4.176	00	ZSR	90007G	
KLOADRELIEF_VREL_TAB(04)	V97U2445C	ND	F	S	D	C	G4.176	00	ZSR	90007G	
KLOADRELIEF_VREL_TAB(05)	V97U2446C	ND	F	S	D	C	G4.176	00	ZSR	90007G	
KLPHI_S2	V97U2447C	DEG/SEC/DEG	F	S	D	C	G4.176	00	ADG	DC2593	
KLPHI_VREL_TAB(01)	V97U1840C	(DEG/SEC)/DEG	F	S	D	C	G4.176	00	ADG	DC2593	
KLPHI_VREL_TAB(02)	V97U1841C	(DEG/SEC)/DEG	F	S	D	C	G4.176	00	ADG	DC2593	
KLPHI_VREL_TAB(03)	V97U1842C	(DEG/SEC)/DEG	F	S	D	C	G4.176	00	ADG	DC2593	
KLPHI_VREL_TAB(04)	V97U1843C	(DEG/SEC)/DEG	F	S	D	C	G4.176	00	ADG	DC2593	
KLPHI_VREL_TAB(05)	V97U1844C	(DEG/SEC)/DEG	F	S	D	C	G4.176	00	ADG	DC2593	
KLPSI_RATIO	V97U2465C	DEG/SEC/DEG	F	S	D	C	G4.176	00	ADG	DC2593	
KLSRB_SRBSEP	V98U9563C	ND	F	S	D	C	G4.176	00	ADG	DC2593	
KLSRB_TIME_TAB(01)	V98U9595C	DEG/(DEG/SEC)	F	S	D	C	G4.176	00	ADG	DC2593	
KLSRB_TIME_TAB(02)	V98U9596C	DEG/(DEG/SEC)	F	S	D	C	G4.176	00	ADG	DC2593	
KLSRB_TIME_TAB(03)	V98U9597C	DEG/(DEG/SEC)	F	S	D	C	G4.176	00	ADG	DC2593	
KLSRB_TIME_TAB(04)	V98U9598C	DEG/(DEG/SEC)	F	S	D	C	G4.176	00	ADG	DC2593	
KL_INT	V97U1810C	SEC**-1	F	S	D	C	G4.176	00	ZFR	90014G	
KMINT_S1	V98U9557C	(DEG/SEC)/(DEG/SEC)	F	S	D	C	G4.176	00	ZFR	90014G	
KMINT_S2	V97U2480C	(DEG/SEC)/(DEG/SEC)	F	S	D	C	G4.176	00	ZFR	90014G	
KMMPS_MASS_TAB(01)	V97U1897C	DEG/(DEG/SEC)	F	S	D	X	G4.176	00	ZFR	90014G	
KMMPS_MASS_TAB(02)	V97U1898C	DEG/(DEG/SEC)	F	S	D	X	G4.176	00	ZFR	90014G	
KMMPS_TIME_TAB(01)	V98U9599C	DEG/(DEG/SEC)	F	S	D	C	G4.176	00	ADG	DC2593	
KMMPS_TIME_TAB(02)	V98U9600C	DEG/(DEG/SEC)	F	S	D	C	G4.176	00	ADG	DC2593	
KMMPS_TIME_TAB(03)	V98U9601C	DEG/(DEG/SEC)	F	S	D	C	G4.176	00	ADG	DC2593	
KMMPS_TIME_TAB(04)	V98U9602C	DEG/(DEG/SEC)	F	S	D	C	G4.176	00	ADG	DC2593	
KMNZ_RATIO	V97U2464C	DEG/SEC/G	F	S	D	C	G4.176	00	ADG	DC2593	

TABLE 4.2.11-3. ASCENT DIGITAL AUTOPILOT (G4.176) I-LOADS

FSSR NAME	MSID	ENG UNITS	DT	PR	D	S	PR FCTN	MC	CAT	LAST CR	R E V
KMSRB_RATIO	V98U9556C	ND	F	S	D	C	G4.176	00	ADG	DC2593	
KMTHETA_S2	V97U2448C	DEG/SEC/DEG	F	S	D	C	G4.176	00	ADG	DC2593	
KMTHETA_VREL_TAB(01)	V97U1938C	(DEG/SEC)/DEG	F	S	D	C	G4.176	00	ADG	DC2593	
KMTHETA_VREL_TAB(02)	V97U1939C	(DEG/SEC)/DEG	F	S	D	C	G4.176	00	ADG	DC2593	
KMTHETA_VREL_TAB(03)	V97U1940C	(DEG/SEC)/DEG	F	S	D	C	G4.176	00	ADG	DC2593	
KMTHETA_VREL_TAB(04)	V97U1941C	(DEG/SEC)/DEG	F	S	D	C	G4.176	00	ADG	DC2593	
KMTHETA_VREL_TAB(05)	V97U1942C	(DEG/SEC)/DEG	F	S	D	C	G4.176	00	ADG	DC2593	
KM_QHP	V97U1895C	G/DEG/SEC	F	S	D	C	G4.176	00	ADG	DC2593	
KNINT_S1	V98U9559C	(DEG/SEC)/(DEG/SEC)	F	S	D	C	G4.176	00	ZFR	90014G	
KNINT_S2	V97U2481C	(DEG/SEC)/(DEG/SEC)	F	S	D	C	G4.176	00	ZFR	90014G	
KNMPS_MASS_TAB(01)	V97U1957C	DEG/(DEG/SEC)	F	S	D	X	G4.176	00	ZFR	90014G	
KNMPS_MASS_TAB(02)	V97U1958C	DEG/(DEG/SEC)	F	S	D	X	G4.176	00	ZFR	90014G	
KNMPS_TIME_TAB(01)	V97U2499C	DEG/(DEG/SEC)	F	S	D	C	G4.176	00	ADG	DC2593	
KNMPS_TIME_TAB(02)	V98U9553C	DEG/(DEG/SEC)	F	S	D	C	G4.176	00	ADG	DC2593	
KNMPS_TIME_TAB(03)	V98U9554C	DEG/(DEG/SEC)	F	S	D	C	G4.176	00	ADG	DC2593	
KNMPS_TIME_TAB(04)	V98U9555C	DEG/(DEG/SEC)	F	S	D	C	G4.176	00	ADG	DC2593	
KNNY_RATIO	V97U2466C	DEG/SEC/G	F	S	D	C	G4.176	00	ADG	DC2593	
KNNY_SEP	V97U2468C	DEG/SEC/G	F	S	D	C	G4.176	00	ADG	DC2593	
KNRHP_RATIO	V97U2467C	ND	F	S	D	C	G4.176	00	ADG	DC2593	
KNPSI_S2	V97U2449C	DEG/SEC/DEG	F	S	D	C	G4.176	00	ADG	DC2593	
KNPSI_VREL_TAB(01)	V97U2011C	(DEG/SEC)/DEG	F	S	D	C	G4.176	00	ADG	DC2593	
KNPSI_VREL_TAB(02)	V97U2012C	(DEG/SEC)/DEG	F	S	D	C	G4.176	00	ADG	DC2593	
KNPSI_VREL_TAB(03)	V97U2013C	(DEG/SEC)/DEG	F	S	D	C	G4.176	00	ADG	DC2593	
KNPSI_VREL_TAB(04)	V97U2014C	(DEG/SEC)/DEG	F	S	D	C	G4.176	00	ADG	DC2593	
KNPSI_VREL_TAB(05)	V97U2015C	(DEG/SEC)/DEG	F	S	D	C	G4.176	00	ADG	DC2593	
KNSRB_RATIO	V98U9558C	ND	F	S	D	C	G4.176	00	ADG	DC2593	
KN_BRG	V99U9596C	ND	F	S	D	C	G4.176	00	ADG	DC2593	
KN_ORB	V99U9595C	ND	F	S	D	C	G4.176	00	ADG	DC2593	
KN_PHP	V97U1953C	ND	F	S	D	C	G4.176	00	ADG	DC2593	
KPY1_FAIL23	V97U2036C	DEG/DEG	F	S	D	C	G4.176	00	ADG	DC2593	
KPY23_S2C	V97U2037C	DEG/DEG	F	S	D	C	G4.176	00	ADG	DC2593	
KPZ1_FAIL23	V97U2038C	DEG/DEG	F	S	D	C	G4.176	00	ADG	DC2593	
KPZ1_NOM	V97U2039C	DEG/DEG	F	S	D	C	G4.176	00	ADG	DC2593	
KPZ23_FAIL23	V97U2040C	DEG/DEG	F	S	D	C	G4.176	00	ADG	DC2593	
K_DEL_NZ_FL(1)	V99U6675C	G	F	S	D	C	G4.176	00	A1P	DC2726	
K_DEL_NZ_FL(2)	V99U6676C	G	F	S	D	C	G4.176	00	A1P	DC2726	
K_DEL_NZ_THT(1)	V99U6677C	G/PCT	F	S	D	C	G4.176	00	A1P	DC2726	
K_DEL_NZ_THT(2)	V99U6678C	G/PCT	F	S	D	C	G4.176	00	A1P	DC2726	
K_NZ_THRT	V99U6365C	G/PCT	F	S	D	C	G4.176	00	A1P	92227	
K_PPD	V97U1363C	ND	F	S	D	P	G4.176	00	ZFR	90014G	
K_TRM_AERO_1_TAB(1)	V99U6679C	DEG	F	S	D	C	G4.176	00	A1P	DC2726	
K_TRM_AERO_1_TAB(2)	V99U6680C	DEG	F	S	D	C	G4.176	00	A1P	DC2726	
K_TRM_AERO_1_TAB(3)	V99U6681C	DEG	F	S	D	C	G4.176	00	A1P	DC2726	
K_TRM_AERO_1_TAB(4)	V99U6682C	DEG	F	S	D	C	G4.176	00	A1P	DC2726	
K_TRM_AERO_2_TAB(1)	V99U6683C	DEG	F	S	D	C	G4.176	00	A1P	DC2726	
K_TRM_AERO_2_TAB(2)	V99U6684C	DEG	F	S	D	C	G4.176	00	A1P	DC2726	
K_TRM_AERO_2_TAB(3)	V99U6685C	DEG	F	S	D	C	G4.176	00	A1P	DC2726	

TABLE 4.2.11-3. ASCENT DIGITAL AUTOPILOT (G4.176) I-LOADS

FSSR NAME	MSID	ENG UNITS	DT	PR	D	S	PR FCTN	MC	CAT	LAST CR	R E V
K_TRM_AERO_2_TAB(4)	V99U6686C	DEG	F	S	D	C	G4.176	00	A1P	DC2726	
K_TRM_AERO_4_TAB(1)	V99U6687C	DEG	F	S	D	P	G4.176	00	A1P	DC2726	
K_TRM_AERO_4_TAB(2)	V99U6688C	DEG	F	S	D	P	G4.176	00	A1P	DC2726	
K_TRM_AERO_4_TAB(3)	V99U6689C	DEG	F	S	D	P	G4.176	00	A1P	DC2726	
K_TRM_AERO_4_TAB(4)	V99U6690C	DEG	F	S	D	P	G4.176	00	A1P	DC2726	
K_TRM_AERO_6_TAB(1)	V99U6691C	DEG	F	S	D	P	G4.176	00	A1P	DC2726	
K_TRM_AERO_6_TAB(2)	V99U6692C	DEG	F	S	D	P	G4.176	00	A1P	DC2726	
K_TRM_AERO_6_TAB(3)	V99U6693C	DEG	F	S	D	P	G4.176	00	A1P	DC2726	
K_TRM_AERO_6_TAB(4)	V99U6694C	DEG	F	S	D	P	G4.176	00	A1P	DC2726	
K_TRM_NYREF	V99U6695C	DEG/G	F	S	D	C	G4.176	00	A1P	DC2726	
K_TRM_NZ	V99U6696C	DEG/G	F	S	D	C	G4.176	00	A1P	DC2726	
MASS2_GAIN_TAB(01)	V97U2475C	SLUGS	F	S	D	X	G4.176	00	ZFR	90014G	
MASS2_GAIN_TAB(02)	V97U2476C	SLUGS	F	S	D	X	G4.176	00	ZFR	90014G	
MASS_GAIN_TAB(1)	V97U2056C	SLUGS	F	S	D	C	G4.176	00	S2T	91013D	
MASS_GAIN_TAB(2)	V97U2057C	SLUGS	F	S	D	C	G4.176	00	S2T	91013D	
MASS_GAIN_TAB(3)	V97U2058C	SLUGS	F	S	D	C	G4.176	00	S2T	91013D	
MASS_GAIN_TAB(4)	V97U2059C	SLUGS	F	S	D	C	G4.176	00	S2T	91013D	
MASS_GAIN_TAB(5)	V97U2471C	SLUGS	F	S	D	C	G4.176	00	S2T	91013D	
MASS_GAIN_TAB(6)	V97U2472C	SLUGS	F	S	D	C	G4.176	00	S2T	91013D	
MASS_GAIN_TAB(7)	V97U2473C	SLUGS	F	S	D	C	G4.176	00	S2T	91013D	
MASS_KLDELPSI_TAB(01)	V97U2482C	SLUGS	F	S	D	X	G4.176	00	ZFR	90014G	
MASS_KLDELPSI_TAB(02)	V97U2483C	SLUGS	F	S	D	X	G4.176	00	ZFR	90014G	
MASS_OMS	V97U1918C	SLUGS	F	S	M	C	G4.176	00	ATM	90011E	
MASS_PL	V97U1901C	SLUGS	F	S	M	C	G4.176	00	ATM	90011E	
MET_25A	V97U2435C	SEC	F	D	D	C	G4.176	00	ADG	DC2593	
MET_25B	V97U2436C	SEC	F	S	D	C	G4.176	00	ADG	DC2593	
MET_25E	V97U2437C	SEC	F	S	D	C	G4.176	00	XS4	DC0599	
MET_90THRUST	V97U2487C	SEC	F	D	D	X	G4.176	00	QSA	90247	
MET_GAIN_TAB(01)	V98U9591C	SEC	F	S	D	C	G4.176	00	ADG	DC2593	
MET_GAIN_TAB(02)	V98U9592C	SEC	F	S	D	C	G4.176	00	ADG	DC2593	
MET_GAIN_TAB(03)	V98U9593C	SEC	F	S	D	C	G4.176	00	ADG	DC2593	
MET_GAIN_TAB(04)	V98U9594C	SEC	F	S	D	C	G4.176	00	ADG	DC2593	
MET_LIFTOFF	V97U2061C	SEC	F	S	D	X	G4.176	00	ZFR	90014G	
MET_LIM_LCH	V97U2062C	SEC	F	S	D	X	G4.176	00	ZFR	90014G	
MET_TRIM_TAB(1)	V97U1812C	SEC	F	S	D	C	G4.176	00	PED	91018B	
MET_TRIM_TAB(2)	V97U1813C	SEC	F	S	D	C	G4.176	00	PED	91018B	
MET_TRIM_TAB(3)	V97U1814C	SEC	F	S	D	C	G4.176	00	PED	91018B	
MET_TRIM_TAB(4)	V97U1815C	SEC	F	S	D	C	G4.176	00	PED	91018B	
MET_TRIM_TAB(5)	V97U1816C	SEC	F	S	D	C	G4.176	00	PED	91018B	
MET_TRIM_TAB(6)	V97U1817C	SEC	F	S	D	C	G4.176	00	PED	91018B	
MET_TRIM_TAB(7)	V97U1818C	SEC	F	S	D	C	G4.176	00	PED	91018B	
MET_TRIM_TAB(8)	V97U1819C	SEC	F	S	D	C	G4.176	00	PED	91018B	
MET_TRMGN_TAB(1)	V97U0877C	SEC	F	S	D	C	G4.176	00	PED	91018B	
MET_TRMGN_TAB(2)	V97U0878C	SEC	F	S	D	C	G4.176	00	PED	91018B	
MET_TRMGN_TAB(3)	V97U0879C	SEC	F	S	D	C	G4.176	00	PED	91018B	
MET_TRMGN_TAB(4)	V97U0880C	SEC	F	S	D	C	G4.176	00	PED	91018B	
MET_TRMGN_TAB(5)	V97U0881C	SEC	F	S	D	C	G4.176	00	PED	91018B	

TABLE 4.2.11-3. ASCENT DIGITAL AUTOPILOT (G4.176) I-LOADS

FSSR NAME	MSID	ENG UNITS	DT	PR	D	S	PR FCTN	MC	CAT	LAST CR	R E V
MET_TRMGN_TAB (6)	V97U0882C	SEC	F	S	D	C	G4.176	00	PED	91018B	
MM_DL	V97U2403C	SEC	F	S	D	P	G4.176	00	ZSR	90007G	
NFADE_COM_SRBSEP	V98U9561C	ND	F	S	D	X	G4.176	00	ZFR	90014G	
NFADE_DQMPST_S1_END	V97U2432C	ND	F	S	D	X	G4.176	00	ADG	DC2593	
NFADE_DSBCLSE_NOM	V97U2431C	ND	F	S	D	P	G4.176	00	ZFR	90014G	
NFADE_HDSCCLR_START	V97U2063C	COUNTS	F	S	D	X	G4.176	00	ZFR	90014G	
NFADE_INT_NOM	V97U2075C	COUNTS	F	S	D	X	G4.176	00	ZSR	90007G	
NFADE_KLDELPSI_SEP	V98U9560C	CYCLES	F	S	D	X	G4.176	00	ZFR	90014G	
NFADE_KLMPS_SEP	V98U9562C	ND	F	S	D	X	G4.176	00	ZFR	90014G	
NFADE_KNMPS_S2	V97U0889C	COUNTS	I	S	D	C	G4.176	00	ZFR	91054B	
NFADE_MEFAIL	V97U2073C	COUNTS	F	S	M	X	G4.176	00	ZFR	90014G	
NFADE_NY_OFF	V97U2470C	ND	F	S	D	X	G4.176	00	ZFR	90014G	
NFADE_NY_ON	V97U2469C	ND	F	S	D	X	G4.176	00	ZFR	90014G	
NFADE_PBIAS_OFF	V97U0876C	ND	I	S	D	C	G4.176	00	PED	91018B	
NFADE_TRIM	V97U1932C	ND	I	S	M	C	G4.176	00	S2T	91013D	
NPLIM	V96U8977C	DEG	F	S	D	P	G4.176	00	ZSR	90007G	
NYREF_2	V97U2098C	G	F	S	M	C	G4.176	00	ZF2	90243C	
NYREF_3	V97U2118C	G	F	S	M	C	G4.176	00	ZF2	90243C	
NYREF_O_1	V97U2078C	G	F	S	M	C	G4.176	00	ZF2	90243C	
NZREF_0_TAB(01)	V97U2138C	G	F	S	D	C	G4.176	00	A1S	92243A	
NZREF_0_TAB(02)	V97U2139C	G	F	S	D	C	G4.176	00	A1S	92243A	
NZREF_0_TAB(03)	V97U2140C	G	F	S	D	C	G4.176	00	A1S	92243A	
NZREF_0_TAB(04)	V97U2141C	G	F	S	D	C	G4.176	00	A1S	92243A	
NZREF_0_TAB(05)	V97U2142C	G	F	S	D	C	G4.176	00	A1S	92243A	
NZREF_0_TAB(06)	V97U2143C	G	F	S	D	C	G4.176	00	A1S	92243A	
NZREF_0_TAB(07)	V97U2144C	G	F	S	D	C	G4.176	00	A1S	92243A	
NZREF_0_TAB(08)	V97U2145C	G	F	S	D	C	G4.176	00	A1S	92243A	
NZREF_0_TAB(09)	V97U2146C	G	F	S	D	C	G4.176	00	A1S	92243A	
NZREF_0_TAB(10)	V97U2147C	G	F	S	D	C	G4.176	00	A1S	92243A	
NZREF_0_TAB(11)	V97U2148C	G	F	S	D	C	G4.176	00	A1S	92243A	
NZREF_0_TAB(12)	V97U2149C	G	F	S	D	C	G4.176	00	A1S	92243A	
NZREF_0_TAB(13)	V97U2150C	G	F	S	D	C	G4.176	00	A1S	92243A	
NZREF_0_TAB(14)	V97U2151C	G	F	S	D	C	G4.176	00	A1S	92243A	
NZREF_0_TAB(15)	V97U2152C	G	F	S	D	C	G4.176	00	A1S	92243A	
NZREF_0_TAB(16)	V97U2153C	G	F	S	D	C	G4.176	00	A1S	92243A	
NZREF_0_TAB(17)	V97U2154C	G	F	S	D	C	G4.176	00	A1S	92243A	
NZREF_0_TAB(18)	V97U2155C	G	F	S	D	C	G4.176	00	A1S	92243A	
NZREF_0_TAB(19)	V97U2156C	G	F	S	D	C	G4.176	00	A1S	92243A	
NZREF_0_TAB(20)	V97U2157C	G	F	S	D	C	G4.176	00	A1S	92243A	
NZREF_EO(1)	V99U6697C	G	F	S	D	C	G4.176	00	A1P	DC2726	
NZREF_EO(10)	V99U6618C	G	F	S	D	C	G4.176	00	A1P	DC2726	
NZREF_EO(2)	V99U6698C	G	F	S	D	C	G4.176	00	A1P	DC2726	
NZREF_EO(3)	V99U6699C	G	F	S	D	C	G4.176	00	A1P	DC2726	
NZREF_EO(4)	V99U6700C	G	F	S	D	C	G4.176	00	A1P	DC2726	
NZREF_EO(5)	V99U6613C	G	F	S	D	C	G4.176	00	A1P	DC2726	
NZREF_EO(6)	V99U6614C	G	F	S	D	C	G4.176	00	A1P	DC2726	
NZREF_EO(7)	V99U6615C	G	F	S	D	C	G4.176	00	A1P	DC2726	

TABLE 4.2.11-3. ASCENT DIGITAL AUTOPILOT (G4.176) I-LOADS

FSSR NAME	MSID	ENG UNITS	DT	PR	D	S	PR FCTN	MC	CAT	LAST CR	R E V
NZREF_EO(8)	V99U6616C	G	F	S	D	C	G4.176	00	A1P	DC2726	
NZREF_EO(9)	V99U6617C	G	F	S	D	C	G4.176	00	A1P	DC2726	
ORI_DL	V97U1362C	SEC	F	S	D	P	G4.176	00	ZSR	90007G	
PARALLEL_PITCH_NOM	V99U7557C	ND	D		M	C	G4.176	00	ADM	90243C	
PBIAS1_TAB(1)	V97U1820C	DEG	F	S	D	C	G4.176	00	PED	91018B	
PBIAS1_TAB(2)	V97U1821C	DEG	F	S	D	C	G4.176	00	PED	91018B	
PBIAS1_TAB(3)	V97U1822C	DEG	F	S	D	C	G4.176	00	PED	91018B	
PBIAS1_TAB(4)	V97U1823C	DEG	F	S	D	C	G4.176	00	PED	91018B	
PBIAS1_TAB(5)	V97U1824C	DEG	F	S	D	C	G4.176	00	PED	91018B	
PBIAS1_TAB(6)	V97U1825C	DEG	F	S	D	C	G4.176	00	PED	91018B	
PBIAS1_TAB(7)	V97U1826C	DEG	F	S	D	C	G4.176	00	PED	91018B	
PBIAS1_TAB(8)	V97U1827C	DEG	F	S	D	C	G4.176	00	PED	91018B	
PBIAS23_TAB(1)	V97U1828C	DEG	F	S	D	C	G4.176	00	PED	91018B	
PBIAS23_TAB(2)	V97U1829C	DEG	F	S	D	C	G4.176	00	PED	91018B	
PBIAS23_TAB(3)	V97U1830C	DEG	F	S	D	C	G4.176	00	PED	91018B	
PBIAS23_TAB(4)	V97U1831C	DEG	F	S	D	C	G4.176	00	PED	91018B	
PBIAS23_TAB(5)	V97U1832C	DEG	F	S	D	C	G4.176	00	PED	91018B	
PBIAS23_TAB(6)	V97U1833C	DEG	F	S	D	C	G4.176	00	PED	91018B	
PBIAS23_TAB(7)	V97U1834C	DEG	F	S	D	C	G4.176	00	PED	91018B	
PBIAS23_TAB(8)	V97U1835C	DEG	F	S	D	C	G4.176	00	PED	91018B	
PCIDOT_LIM	V97U2206C	DEG/SEC**2	F	S	D	C	G4.176	00	ZFR	90014G	
PCI_LIM	V97U2205C	DEG/SEC	F	S	D	C	G4.176	00	ZFR	90014G	
PC_COMLIM	V97U2203C	LBS/IN**2	F	S	D	C	G4.176	00	ADG	DC2593	
PC_LIM	V97U2200C	DEG/SEC	F	S	D	C	G4.176	00	ZFR	90014G	
PC_TRIM_RESET	V97U2202C	PSIA	F	S	D	C	G4.176	00	ADG	DC2593	
PDEFM	V97U1930C	DEG	F	S	M	C	G4.176	00	S2T	91013D	
PITCH_BIAS_LIMIT	V97U0874C	DEG	F	S	D	C	G4.176	00	ZFR	91016C	
PITCH_BIAS_PARALLEL	V97U2208C	DEG	F	S	D	C	G4.176	00	ZFR	90014G	
QCIDOT_LIM	V97U2224C	DEG/SEC	F	S	D	C	G4.176	00	ZFR	90014G	
QCI_LIMS1	V97U2438C	DEG	F	S	D	C	G4.176	00	ZFR	90014G	
QCI_LIMS2	V97U2223C	DEG	F	S	D	C	G4.176	00	ZSR	90007G	
QC_LIM	V97U2222C	DEG/SEC	F	S	D	C	G4.176	00	ZFR	90014G	
RATE_CAPABILITY_LIFTOFF	V97U2496C	DEG/CYCLE	F	S	D	C	G4.176	00	ZFR	90014G	
RATE_CAPABILITY_MECO	V97U2225C	DEG/CYCLE	F	S	D	C	G4.176	00	ZFR	90014G	
RATE_CAPABILITY_MECO_2_FAILS	V97U2226C	DEG/CYCLE	F	S	D	C	G4.176	00	ZFR	90014G	
RATE_CAPABILITY_NOFAILS	V97U2495C	DEG/CYCLE	F	S	D	C	G4.176	00	ZFR	90014G	
RATE_CAPABILITY_NOM_2	V97U2227C	DEG/CYCLE	F	S	D	C	G4.176	00	ZFR	90014G	
RATE_CAPABILITY_NOM_SYSO_1	V97U2228C	DEG/CYCLE	F	S	D	C	G4.176	00	ZFR	90014G	
RATE_CAPABILITY_ONEFAIL	V97U2497C	DEG/CYCLE	F	S	D	C	G4.176	00	ZFR	90014G	
RATE_CAPABILITY_TWOFAIL	V97U2498C	DEG/CYCLE	F	S	D	C	G4.176	00	ZFR	90014G	
RCIDOT_LIM	V97U2231C	DEG/SEC	F	S	D	C	G4.176	00	ZFR	90014G	
RCI_LIMS1	V97U2439C	DEG	F	S	D	C	G4.176	00	ZFR	90014G	
RCI_LIMS2	V97U2230C	DEG	F	S	D	C	G4.176	00	ZSR	90007G	
RC_LIM	V97U2229C	DEG/SEC	F	S	D	C	G4.176	00	ZFR	90014G	
RETLIM_IB	V97U2232C	LBS/IN**2	F	S	D	C	G4.176	00	ADE	DC0599	
RETLIM_OB	V97U2233C	LBS/IN**2	F	S	D	C	G4.176	00	ADE	DC0599	
RME1(1)	V97U1921C	FT	F	S	M	C	G4.176	00	S2T	91013D	

TABLE 4.2.11-3. ASCENT DIGITAL AUTOPILOT (G4.176) I-LOADS

FSSR NAME	MSID	ENG UNITS	DT	PR	D	S	PR FCTN	MC	CAT	LAST CR	R E V
RME1(2)	V97U1922C	FT	F	S	M	C	G4.176	00	S2T	91013D	
RME1(3)	V97U1923C	FT	F	S	M	C	G4.176	00	S2T	91013D	
RME2(1)	V97U1924C	FT	F	S	M	C	G4.176	00	S2T	91013D	
RME2(2)	V97U1925C	FT	F	S	M	C	G4.176	00	S2T	91013D	
RME2(3)	V97U1926C	FT	F	S	M	C	G4.176	00	S2T	91013D	
RME3(1)	V97U1927C	FT	F	S	M	C	G4.176	00	S2T	91013D	
RME3(2)	V97U1928C	FT	F	S	M	C	G4.176	00	S2T	91013D	
RME3(3)	V97U1929C	FT	F	S	M	C	G4.176	00	S2T	91013D	
SF_BF_SLEW_NOM	V97U2240C	DEG	F	S	D	P	G4.176	00	ZFR	90014G	
SF_ELVN_SLEW_NOM	V97U2241C	DEG	F	S	D	P	G4.176	00	ZFR	90014G	
SF_MPS_SLEW_NOM	V97U2242C	DEG	F	S	D	P	G4.176	00	ZFR	90014G	
SF_RUD_SLEW_NOM	V97U2243C	DEG	F	S	D	P	G4.176	00	ZFR	90014G	
SF_SB_SLEW_NOM	V97U2244C	DEG	F	S	D	P	G4.176	00	ZFR	90014G	
SF_SRB_SLEW_NOM	V97U2245C	DEG	F	S	D	P	G4.176	00	ZFR	90014G	
SLIM_LO	V97U2247C	DEG	F	S	D	C	G4.176	00	ZFR	90014G	
SLIM_NOMN	V97U2424C	DEG	F	S	D	C	G4.176	00	ZSR	90007G	
SLIM_NOMP	V97U2248C	DEG	F	S	D	C	G4.176	00	ZSR	90007G	
SLIM_TAIL	V97U2427C	DEG	F	S	D	C	G4.176	00	ZSR	90007G	
SRB_RLIMTF	V97U2426C	DEG/CYCLE	F	S	D	C	G4.176	00	ZFR	90014G	
SSME_RLIM_FAIL	V97U2493C	DEG/CYCLE	F	S	D	C	G4.176	00	ZFR	90014G	
SSME_RLIM_NOM	V97U2494C	DEG/CYCLE	F	S	D	C	G4.176	00	ZFR	90014G	
TMDCDOTLIM	V97U2430C	DEG	F	S	D	C	G4.176	00	ADE	DC0599	
TMDPDOT	V97U2428C	DEG/COUNT	F	S	D	X	G4.176	00	ADE	DC0599	
TRIM_GAIN_TAB(1)	V97U0883C	DEG/DEG	F	S	D	C	G4.176	00	PED	91018B	
TRIM_GAIN_TAB(2)	V97U0884C	DEG/DEG	F	S	D	C	G4.176	00	PED	91018B	
TRIM_GAIN_TAB(3)	V97U0885C	DEG/DEG	F	S	D	C	G4.176	00	PED	91018B	
TRIM_GAIN_TAB(4)	V97U0886C	DEG/DEG	F	S	D	C	G4.176	00	PED	91018B	
TRIM_GAIN_TAB(5)	V97U0887C	DEG/DEG	F	S	D	C	G4.176	00	PED	91018B	
TRIM_GAIN_TAB(6)	V97U0888C	DEG/DEG	F	S	D	C	G4.176	00	PED	91018B	
VREL_AERO_TAB(1)	V99U6701C	FT/SEC	F	S	D	C	G4.176	00	A1P	DC2726	
VREL_AERO_TAB(2)	V99U6702C	FT/SEC	F	S	D	C	G4.176	00	A1P	DC2726	
VREL_AERO_TAB(3)	V99U6703C	FT/SEC	F	S	D	C	G4.176	00	A1P	DC2726	
VREL_AERO_TAB(4)	V99U6704C	FT/SEC	F	S	D	C	G4.176	00	A1P	DC2726	
VREL_AUTOTRIM_INHIBIT	V97U2275C	FT/SEC	F	S	D	C	G4.176	00	ZSR	90007G	
VREL_ELVN_TAB(02)	V97U2277C	FT/SEC	F	S	M	C	G4.176	00	ASE	DC2726	
VREL_ELVN_TAB(03)	V97U2278C	FT/SEC	F	S	M	C	G4.176	00	ASE	DC2726	
VREL_ELVN_TAB(04)	V97U2279C	FT/SEC	F	S	M	C	G4.176	00	ASE	DC2726	
VREL_ELVN_TAB(05)	V97U2280C	FT/SEC	F	S	M	C	G4.176	00	ASE	DC2726	
VREL_ELVN_TAB(06)	V97U2281C	FT/SEC	F	S	M	C	G4.176	00	ASE	DC2726	
VREL_ELVN_TAB(07)	V97U2282C	FT/SEC	F	S	M	C	G4.176	00	ASE	DC2726	
VREL_ELVN_TAB(08)	V97U2283C	FT/SEC	F	S	M	C	G4.176	00	ASE	DC2726	
VREL_EO_TRIM(1)	V99U6705C	FT/SEC	F	S	D	C	G4.176	00	A1P	DC2726	
VREL_EO_TRIM(10)	V99U6606C	FT/SEC	F	S	D	C	G4.176	00	A1P	DC2726	
VREL_EO_TRIM(2)	V99U6706C	FT/SEC	F	S	D	C	G4.176	00	A1P	DC2726	
VREL_EO_TRIM(3)	V99U6707C	FT/SEC	F	S	D	C	G4.176	00	A1P	DC2726	
VREL_EO_TRIM(4)	V99U6708C	FT/SEC	F	S	D	C	G4.176	00	A1P	DC2726	
VREL_EO_TRIM(5)	V99U6601C	FT/SEC	F	S	D	C	G4.176	00	A1P	DC2726	

TABLE 4.2.11-3. ASCENT DIGITAL AUTOPILOT (G4.176) I-LOADS

FSSR NAME	MSID	ENG UNITS	DT	PR	D	S	PR FCTN	MC	CAT	LAST CR	R E V
VREL_EO_TRIM(6)	V99U6602C	FT/SEC	F	S	D	C	G4.176	00	A1P	DC2726	
VREL_EO_TRIM(7)	V99U6603C	FT/SEC	F	S	D	C	G4.176	00	A1P	DC2726	
VREL_EO_TRIM(8)	V99U6604C	FT/SEC	F	S	D	C	G4.176	00	A1P	DC2726	
VREL_EO_TRIM(9)	V99U6605C	FT/SEC	F	S	D	C	G4.176	00	A1P	DC2726	
VREL_FILTSW	V97U2284C	FT/SEC	F	S	D	C	G4.176	00	ADG	DC2593	
VREL_GAIN_TAB(02)	V97U2286C	FT/SEC	F	S	D	C	G4.176	00	ADG	DC2593	
VREL_GAIN_TAB(03)	V97U2287C	FT/SEC	F	S	D	C	G4.1	00	ADG	DC2593	
							G4.176				
VREL_GAIN_TAB(04)	V97U2288C	FT/SEC	F	S	D	C	G4.1	00	ADG	DC2593	
							G4.176				
VREL_GAIN_TAB(05)	V97U2289C	FT/SEC	F	S	D	C	G4.176	00	ADG	DC2593	
VREL_NNYFILTSW	V99U9668C	FT/SEC	F	S	D	C	G4.176	00	ADG	92252B	
VREL_TRIM_TAB(02)	V97U2298C	FT/SEC	F	S	D	C	G4.176	00	A1S	92243A	
VREL_TRIM_TAB(03)	V97U2299C	FT/SEC	F	S	D	C	G4.176	00	A1S	92243A	
VREL_TRIM_TAB(04)	V97U2300C	FT/SEC	F	S	D	C	G4.176	00	A1S	92243A	
VREL_TRIM_TAB(05)	V97U2301C	FT/SEC	F	S	D	C	G4.176	00	A1S	92243A	
VREL_TRIM_TAB(06)	V97U2302C	FT/SEC	F	S	D	C	G4.176	00	A1S	92243A	
VREL_TRIM_TAB(07)	V97U2303C	FT/SEC	F	S	D	C	G4.176	00	A1S	92243A	
VREL_TRIM_TAB(08)	V97U2304C	FT/SEC	F	S	D	C	G4.176	00	A1S	92243A	
VREL_TRIM_TAB(09)	V97U2305C	FT/SEC	F	S	D	C	G4.176	00	A1S	92243A	
VREL_TRIM_TAB(10)	V97U2306C	FT/SEC	F	S	D	C	G4.176	00	A1S	92243A	
VREL_TRIM_TAB(11)	V97U2307C	FT/SEC	F	S	D	C	G4.176	00	A1S	92243A	
VREL_TRIM_TAB(12)	V97U2308C	FT/SEC	F	S	D	C	G4.176	00	A1S	92243A	
VREL_TRIM_TAB(13)	V97U2309C	FT/SEC	F	S	D	C	G4.176	00	A1S	92243A	
VREL_TRIM_TAB(14)	V97U2310C	FT/SEC	F	S	D	C	G4.176	00	A1S	92243A	
VREL_TRIM_TAB(15)	V97U2311C	FT/SEC	F	S	D	C	G4.176	00	A1S	92243A	
VREL_TRIM_TAB(16)	V97U2312C	FT/SEC	F	S	D	C	G4.176	00	A1S	92243A	
VREL_TRIM_TAB(17)	V97U2313C	FT/SEC	F	S	D	C	G4.176	00	A1S	92243A	
VREL_TRIM_TAB(18)	V97U2314C	FT/SEC	F	S	D	C	G4.176	00	A1S	92243A	
VREL_TRIM_TAB(19)	V97U2315C	FT/SEC	F	S	D	C	G4.176	00	A1S	92243A	
VREL_TRIM_TAB(20)	V97U2316C	FT/SEC	F	S	D	C	G4.176	00	A1S	92243A	
VREL_YFILTSW	V99U9597C	FT/SEC	F	S	D	C	G4.176	00	ADG	DC2593	
XCG_OMS	V97U1919C	FT	F	S	M	C	G4.176	00	ATM	90011E	
XCG_PL	V97U1902C	FT	F	S	M	C	G4.176	00	ATM	90011E	
XCG_TAB(1)	V97U1904C	FT	F	S	D	C	G4.176	00	S2T	91013D	
XCG_TAB(2)	V97U1905C	FT	F	S	D	C	G4.176	00	S2T	91013D	
XCG_TAB(3)	V97U1906C	FT	F	S	D	C	G4.176	00	S2T	91013D	
XCG_TAB(4)	V97U1907C	FT	F	S	D	C	G4.176	00	S2T	91013D	
XCG_TAB(5)	V97U1908C	FT	F	S	D	C	G4.176	00	S2T	91013D	
XCG_TAB(6)	V97U1909C	FT	F	S	D	C	G4.176	00	S2T	91013D	
XCG_TAB(7)	V97U1910C	FT	F	S	D	C	G4.176	00	S2T	91013D	
YAW_BIAS_NOM	V97U2325C	DEG	F	S	D	P	G4.176	00	ZFR	90014G	
YDEFM	V97U1931C	DEG	F	S	M	C	G4.176	00	S2T	91013D	
ZCG_OMS	V97U1920C	FT	F	S	M	C	G4.176	00	ATM	90011E	
ZCG_PL	V97U1903C	FT	F	S	M	C	G4.176	00	ATM	90011E	
ZCG_TAB(1)	V97U1911C	FT	F	S	D	C	G4.176	00	S2T	91013D	
ZCG_TAB(2)	V97U1912C	FT	F	S	D	C	G4.176	00	S2T	91013D	

TABLE 4.2.11-3. ASCENT DIGITAL AUTOPILOT (G4.176) I-LOADS

FSSR NAME	MSID	ENG UNITS	DT	PR	D	S	PR FCTN	MC	CAT	LAST CR	R E V
ZCG_TAB(3)	V97U1913C	FT	F	S	D	C	G4.176	00	S2T	91013D	
ZCG_TAB(4)	V97U1914C	FT	F	S	D	C	G4.176	00	S2T	91013D	
ZCG_TAB(5)	V97U1915C	FT	F	S	D	C	G4.176	00	S2T	91013D	
ZCG_TAB(6)	V97U1916C	FT	F	S	D	C	G4.176	00	S2T	91013D	
ZCG_TAB(7)	V97U1917C	FT	F	S	D	C	G4.176	00	S2T	91013D	

NOTE: REFERENCE TABLE 1.3-1 FOR EXPLANATION OF DATA ELEMENTS.

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TABLE 4.2.11-4. ASCENT DIGITAL AUTOPILOT (G4.176) K-LOADS

FSSR NAME DESCRIPTION	MSID	MC	KLOAD VALUE	ENG UNITS	DT	P R	S	PR FCTN	LAST CR	R E V
DSB_CLOSED SPEEDBRAKE CLOSED CMD	V97U2425C	00	-9.9	E+00 DEG	F	S	C	G4.176 G4.227 G4.36 G4.50	89674E	
DY1_GRAV NOZZLE GRAVITY POSITION	V96U7984C	00	+0.0	E+00 DEG	F	S	P	G4.176	89674E	
DY1_START ME1 PITCH DEFLN. FOR SSME START	V97U1782C	00	+0.0	E+00 DEG	F	S	P	G4.176	89674E	
DY2_GRAV NOZZLE GRAVITY POSITION	V96U7985C	00	+0.0	E+00 DEG	F	S	P	G4.176	89674E	
DY2_START ME2 PITCH DEFLN. FOR SSME START	V97U1784C	00	+0.0	E+00 DEG	F	S	P	G4.176	89674E	
DY3_GRAV NOZZLE GRAVITY POSITION	V96U7986C	00	+0.0	E+00 DEG	F	S	P	G4.176	89674E	
DY3_START ME3 PITCH DFLN FOR SSME START	V97U1786C	00	+0.0	E+00 DEG	F	S	P	G4.176	89674E	
DZ2_GRAV NOZZLE GRAVITY POSITION	V96U7987C	00	+0.0	E+00 DEG	F	S	P	G4.176	89674E	
DZ2_START ME2 YAW DFLN FOR SSME START	V97U1788C	00	+0.0	E+00 DEG	F	S	P	G4.176	89674E	
DZ3_GRAV NOZZLE GRAVITY POSITION	V96U7988C	00	+0.0	E+00 DEG	F	S	P	G4.176	89674E	
DZ3_START ME3 YAW DEFLN. FOR SSME START	V97U1790C	00	+0.0	E+00 DEG	F	S	P	G4.176	89674E	

NOTE: REFERENCE TABLE 1.3-1 FOR EXPLANATION OF DATA ELEMENTS.

TABLE 4.2.11-5. ASCENT DIGITAL AUTOPILOT (G4.176) CONSTANTS

FSSR NAME DESCRIPTION	MSID	MC	CONSTANT VALUE	ENG UNITS	DT	P R	S	PR FCTN	LAST CR	R E V
KDYZ1 SSME 1/OMS CLR	V97U6101C	00	+1.37	E+01 DEG	F		S	C G4.176	90374C	
TF DAP FAST CYCLE TIME	V97U6236C	00	+4.0	E-02 SEC	F		D	C G4.176 G4.227 G4.36	90374C	
TM DAP MEDIUM CYCLE TIME	V97U6238C	00	+8.0	E-02 SEC	F		D	C G4.175 G4.176 G4.227 G4.36	90374C	

NOTE: REFERENCE TABLE 1.3-1 FOR EXPLANATION OF DATA ELEMENTS.

4.3 GUIDANCE/CONTROL STEERING INTERFACE (GC_STEER)

4.3.1 Introduction

The requirements for the principal function GC_STEER are presented in this section. During the nominal ascent Stage 1 and Stage 2 mission phases, GC_STEER provides the ASCENT DAP with attitude errors and attitude rate commands for thrust vector control. During the RTLS abort phase of ascent, GC_STEER provides the GRTLS DAP with attitude errors and attitude rate commands for attitude control. In both modes, GC_STEER provides the ascent ADI processor with attitude errors for display.

4.3.2 Interface Requirements

The interface parameters required to properly execute GC_STEER are given in Tables 4.3.2-1 and 4.3.2-2.

Table 4.3.2-1. Input Variables, GC_STEER							
Name	Description	Mnemonic	Source	Type	Range	Units	Rate Required (Hz)
Q_GCB_I	Quaternion, guidance	G00003 G00004 G00005 G00006	ASC_1STG_GUID (4.1), PW_RTLS_GUID (4.4), PW_CONT_GUID (4.5), CONT_3EO_GUID (4.6)	Q	$\pm \bar{U}NIT$	–	6.25/ 2.08
$\bar{L}AMC$	Command thrust direction parameter	G00306 G00307 G00308	ASC_2STG_GUID (4.2), PW_RTLS_GUID (4.4), PW_CONT_GUID (4.5)	V	$\pm \bar{U}NIT$	–	2.08
$\bar{L}AMDC$	Command thrust direction parameter	G00309 G00310 G00311	ASC_2STG_GUID (4.2), PW_RTLS_GUID (4.4), PW_CONT_GUID (4.5)	V	$\pm \bar{U}NIT$	–	2.08
TLAMC	Time associated with command thrust direction parameter	G00305	ASC_2STG_GUID (4.2), PW_RTLS_GUID (4.4)	S	0 to 3.1536 E7	s	2.08
PHI_WING	Wing angle criterion-	G48916	ASC_2STG_GUID (4.2), PW_RTLS_GUID (4.4)	S	$\pm \pi$	rad	2.08
MET	Mission elapsed time		FCOS	S	0 to 800	s	2.08
$\bar{V}ELSUMM50$ (V_IMU_CURRENT)	Selected total accumulated sensed velocity	G14702 G14703 G14704	IMU_RM (4.72)	V	$\pm 10^6$	ft/s	6.25
Q_B_I	Quaternion, body wrt inertial	G19849 G19850 G19851 G19852	AE_ATT_PROC (4.226)	Q	± 1	–	12.5
BETA_N	Nav-derived sideslip angle	G47143	AE_ATT_PROC (4.226)	S	± 10	deg	6.25
$\bar{R}HC_STATE_C$	Commander roll, pitch, and yaw detent integer		3_AX_RHC SOP (4.171)	V	± 1	–	12.5
$\bar{R}HC_STATE_P$	Pilot roll, pitch, and yaw detent integer		3_AX_RHC SOP (4.171)	V	± 1	–	12.5
$\bar{D}RHC$ { DAMAN { DEMAN { DYMAN }	Manual guidance command	G10502 G10501 G33003	3_AX_RHC SOP (4.171)	V		deg	12.5
AUTO	Indicator, automatic TVC mode	G50361	ASC_DAP (4.176)	B	0,1	–	12.5

Table 4.3.2-1. Input Variables, GC_STEER							
Name	Description	Mnemonic	Source	Type	Range	Units	Rate Required (Hz)
ATTCMD	Indicator, attitude command subphase	G50356	ASC_DAP	B	0,1	–	12.5
FRZCMD	Indicator, freeze–attitude command subphases	G50358	ASC_DAP	B	0,1	–	12.5
ZTRANS	Indicator, RTLS external tank separation maneuver		ASC_DAP	B	0,1	–	12.5
CONT_SERC	Contingency single engine roll control flag		XXXXXX TRAJ 1 DISP, XXXXXX TRAJ 2 DISP, RTLS TRAJ 2 DISP, ASC_DAP	B	0,1	–	1.04, 1.04, 1.04, 12.5
CLOCK	Current GMT time	G07829	FCOS	S	0 to 3.16224 E7	s	2.08
PEGCMD	Indicator, powered explicit guidance; either STG2, or RTLS	G50357	ASC_DAP	B	0,1	–	12.5
ATTFILT	Indicator, filter actual body attitude		ASC_DAP	B	0,1	–	12.5
RTLS_TURN	Indicator, initiate RTLS turnaround maneuver	G00904	ASC_DAP	B	0,1	–	12.5
\bar{R}_{AVGG}	Current Shuttle position vector	G02701 G02702 G02703	ASCENT_UPP (4.197) RTLS_UPP (4.200)	V	± 20.93 E6	ft	2.08
\bar{V}_{REL}	Current Shuttle relative velocity vector	G47784 G47785 G47786	ASCENT_UPP, RTLS_UPP	V	$\pm 2.62E$ 4	fps	2.08
ALT	Current Shuttle altitude above reference ellipsoid	G04207	ASCENT_UPP RTLS_UPP	S	–100 to 4.0E4	ft	2.08

Table 4.3.2-1. Input Variables, GC_STEER

Name	Description	Mnemonic	Source	Type	Range	Units	Rate Required (Hz)
MM101_INIT	Indicator, AFCS startup		ASC_DAP	B	0,1	–	12.5
PPD	Indicator, RTLS powered pitch down maneuver	G50363	ASC_DAP	B	0,1	–	12.5
SRBSEP	Indicator, SRB separation subphase		ASC_DAP	B	0,1	–	12.5
SIG	Indicator, Stage 1 guidance		ASC_DAP	B	0,1	–	12.5
PORB	Roll rate, orbiter rate gyro	G14443	SF(ORB_RGA)	S	±40	deg/s	12.5
QORB	Pitch rate, orbiter rate gyro	G14442	SF(ORB_RGA)	S	±20	deg/s	12.5
RORB	Yaw rate, orbiter rate gyro		SF(ORB_RGA)	S	±20	deg/s	12.5
NZ_FBK	Compensated normal acceleration error		ASC_DAP	S		deg/s	12.5
NY_FBK	Compensated lateral acceleration error		ASC_DAP	S		deg/s	12.5
KM_THETA	Variable gain for pitch attitude error		ASC_DAP	S		deg/s/deg	12.5
ELEV_LR	Indicator, elevon load relief active		ASC_DAP	B	0,1	–	12.5
KN_PSI	Variable gain for yaw attitude error		ASC_DAP	S		deg/s/deg	12.5
ET_SEP_CMD	ET separation command flag	G47229	ET_SEP_SEQ	B	0,1	–	12.5
MM_CODE_601	Major Mode 601 flag		MSC	B	0,1	–	2.08

Table 4.3.2-1. Input Variables, GC_STEER							
Name	Description	Mnemonic	Source	Type	Range	Units	Rate Required (Hz)
$\bar{I}ZC$	Unit vector pointing from vehicle to landing site at cutoff		PW_RTLS_GUID, ASC_2STG_GUID	V		–	2.08
QBI_READY	Indication, Body wrt M50 quaternion ready for use in STG 1		ASC_DAP	B	0, 1	–	12.5
AUTO_MODE	Contingency auto mode index		PW_CONT_GUID	I	0, 62	–	2.08/ 6.25
HIGH_RATE_SEP	High rate ET separation flag		PW_CONT_GUID, CONT_3EO_GUID	B	0, 1	–	6.25
MM_CODE_103/ MM_103	Major mode 103 flag		MSC	B	0, 1	–	12.5
PPD_DELAY	PPD delay discrete		PW_RTLS_GUID	B	0, 1	–	6.25
S_CONT_ROLL	Contingency roll heads up flag		PW_CONT_GUID	B	0, 1	–	2.08
S_CONT_ROLL_INHIB	Contingency roll inhibit flag		PW_CONT_GUID	B	0, 1	–	2.08
SEC_ME_FL_CNFM	Second main engine fail confirmed flag		ASC_DAP	B	0, 1	–	12.5
ME_ZERO	Zero thrust		MSC	B	0, 1	–	12.5
SSME_FAILS	Indicator, SSME_failure status		ASC_DAP	I	0, 7	–	12.5
WCB2	Commanded body pitch rate		PW_CONT_GUID, CONT_3EO_GUID	S	± 5	deg/s	6.25
\bar{Y} _SYM_GUID	Right wing unit vector		PW_CONT_GUID	V	$\pm \bar{U}NIT$	–	2.08
PCGTRM	Net pitch trim thrust angle		ASC_DAP	S		deg	6.25
YCGTRM	Net yaw trim thrust angle		ASC_DAP	S		deg	6.25
ALPHA_N	Nav derived angle of attack		A/E ATT PROC	S		deg	12.5

Table 4.3.2-1. Input Variables, GC_STEER							
Name	Description	Mnemonic	Source	Type	Range	Units	Rate Required (Hz)
CONT_3EO_START	Contingency 3EO start flag		CONT_3EO_GUID	B	0, 1	–	12.5
CONT_3EO_REGION	Contingency 3EO region index		CONT_3EO_GUID	I		–	12.5
CONT_ATT_HOLD	Contingency attitude hold discrete		CONT_3E/O_GUID	B	0, 1	–	12.5
ENTRY_GAINS	Mnvr to entry attitude flag		CONT_3EO_GUID	B	0, 1	–	12.5
FRZ_3EO	Contingency 3EO freeze flag		CONT_3EO_GUID	B	0, 1	–	12.5
M	Estimated vehicle mass		ASC_1STG_GUID (4.1), ASC_2STG_GUID (4.2), PW_RTLS_GUID (4.4), PW_CONT_GUID (4.5)	S		slugs	6.25
MM_CODE_102/ MM_102	Major mode 102 flag		MSC	B	0, 1	–	12.5
SELECT_VRELO_CONT	VREL = 0 contingency select flag		PW_CONT_GUID	B	0, 1	–	6.25
NEAR_VRELO_MODE	Near VREL=0 contingency flag		PW_CONT_GUID	B	0,1	–	6.25
MC_PPD	Mated Coast Pitch Down discrete		PW_RTLS_GUID	B	0,1	–	6.25
QDOT_DESIRE	Desired mated coast pitch acceleration		CONT_3EO_GUID	S		deg/s ²	6.25
ECAL_PITCH_UP	Contingency pitch up command		CONT_3EO_GUID	B	0,1	–	12.5
QDESIRED_INIT	Desired initial pitch rate for mated coast		PW_CONT_GUID	S		deg/sec	6.25
MECO_CMD	Indicator, initiate main engine cut-off		SSME OPS	B	0,1	–	12.5

MET = Time from SRB ignition command
= CLOCK – CLOCK_{SRB ignition}

Table 4.3.2-2. Output Variables, GC_STEER

Name	Description	MNEMON	Destination	Type	Range	Units	Rate Required (Hz)
$\bar{E}BFB$	Attitude errors for TVC loops	G33601 G33602 G33603	ASC_DAP, GRTLS_DAP (4.227) ASC_1STG_GUID (4.1)	V		deg	12.5
$\bar{E}BDB$	Attitude errors for display	G33607 G33608 G33609	ASC_ADI_PROC (4.206)	V		deg	6.25
ECBDB(1)	Roll attitude error, commanded to desired body		PW_CONT_GUID	S	$\pm 360/\pi$	deg	2.08
S_TDF	Thrust direction filter ready flag		PW_CONT_GUID	B	0, 1	–	2.08
UFE(2)	Y–component estimated filtered thrust direction		PW_CONT_GUID	S	± 1	–	2.08
UFE(3)	Z–component estimated filtered thrust direction		PW_CONT_GUID	S	± 1	–	2.08
$\bar{W}FBI_FB$	Rotational velocity/ command flight body wrt inertial, coordinatized in flight body	G33604 G33605 G33606	ASC_DAP, GRTLS_DAP	V		deg/s	12.5

4.3.3 Overview and Functional Description

A. Overview. An overview block diagram of GC_STEER is shown in Figure 4.3.3-1. In general, GC_STEER provides an extrapolation and smoothing function for interfacing between the low rate processing of guidance (either automatic or manual) and the high rate processing of flight control. GC_STEER performs three specific functions: AUTOMATIC STEERING, which provides the interfacing between guidance and flight control; MANUAL STEERING, which provides the interfacing between the pilot and flight control; and ATTITUDE ERRORS, which generates the attitude error between desired attitude and actual vehicle attitude.

During first stage, AUTOMATIC STEERING performs smoothing of the commanded attitude quaternion from guidance by means of a second-order filter having rate and acceleration limiting. During second stage, AUTOMATIC STEERING first combines the outputs from the linear tangent guidance routine, or auto contingency abort routines, to form a commanded attitude quaternion and then smooths it as in first stage. The output from AUTOMATIC STEERING is a desired attitude quaternion and a desired attitude rate. ATTITUDE ERRORS takes the desired attitude quaternion generated as described above and combines it with the actual body attitude quaternion to form the attitude errors which are sent to flight control and DISPERRS during automatic and to DISPERRS only during manual. In ATTITUDE ERRORS when ME_ZERO_THRUST in major mode 601 is on, the negative value of BETA_N from A/E_ATT_PROC is substituted for the third element of the attitude error. Attitude errors displayed during first stage are augmented with load relief acceleration errors from the ASC_DAP. If manual guidance is selected during ascent, manual steering will combine the pilot's attitude rate commands to form a desired rate command. This desired rate command replaces the rate command generated by automatic steering. Manual steering also generates an attitude error to replace the one generated by automatic steering. In manual, when the RHC is out of detent at either crew station, the attitude error is zeroed. When the RHC is in detent at both crew stations, the attitude error is formed by integrating the orbiter attitude rate.

B. Functional Description. A detailed functional block diagram of GC_STEER is shown in Figure 4.3.3-2. A simplified block diagram of the maneuver smoother (linearized for coplanar maneuvers) is shown in Figure 4.3.3-3.

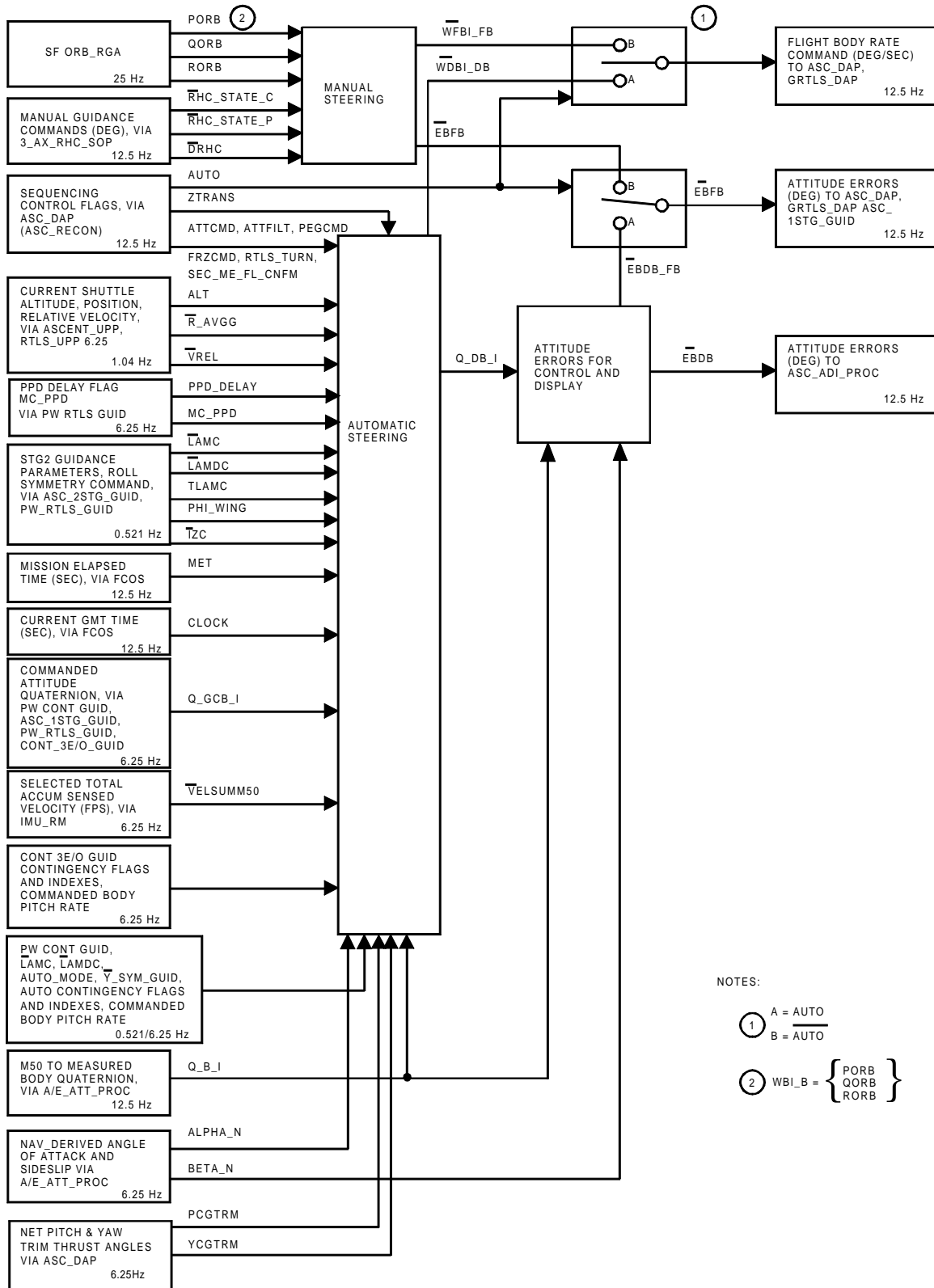


FIGURE 4.3.3-1. Steering Overview, Functional

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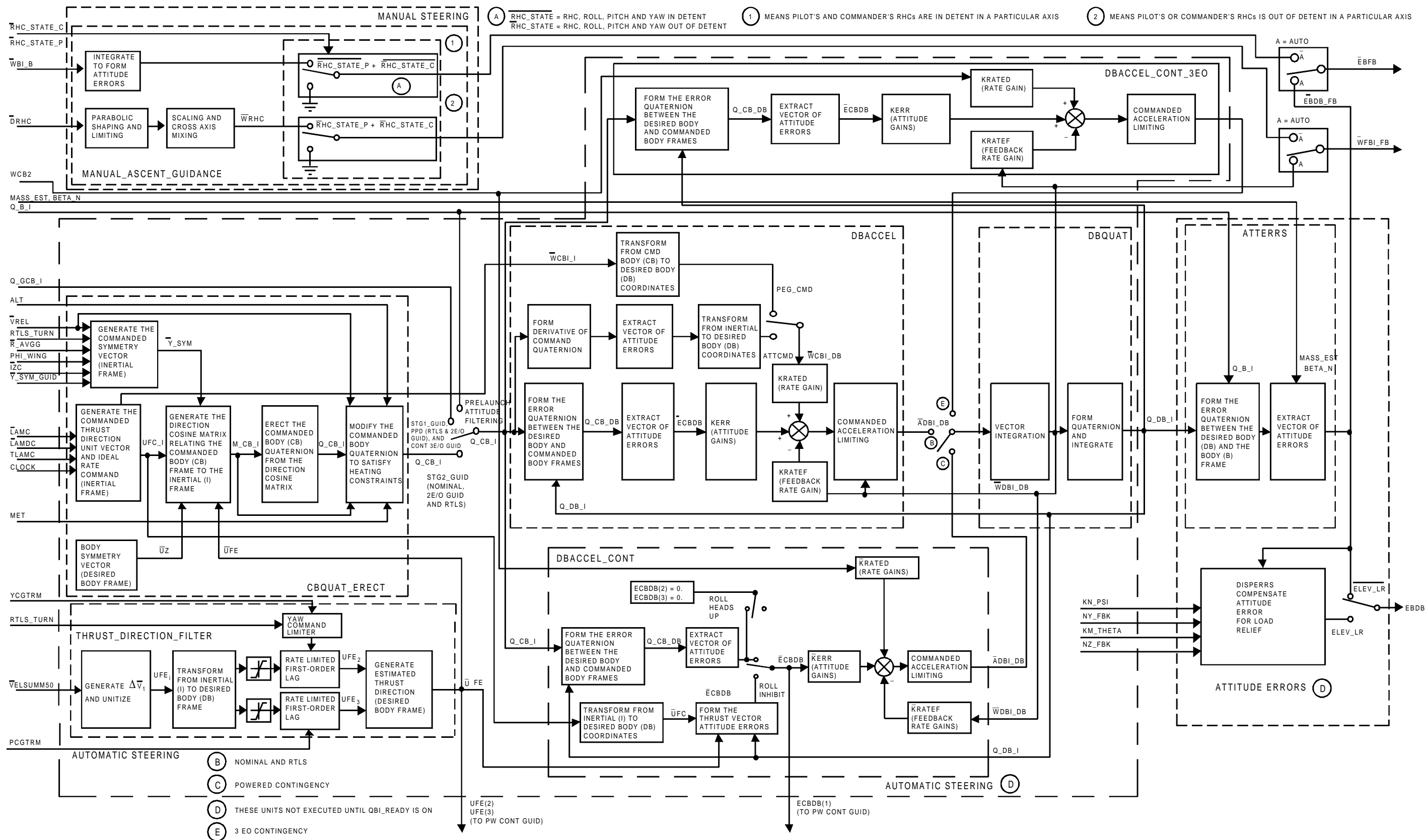
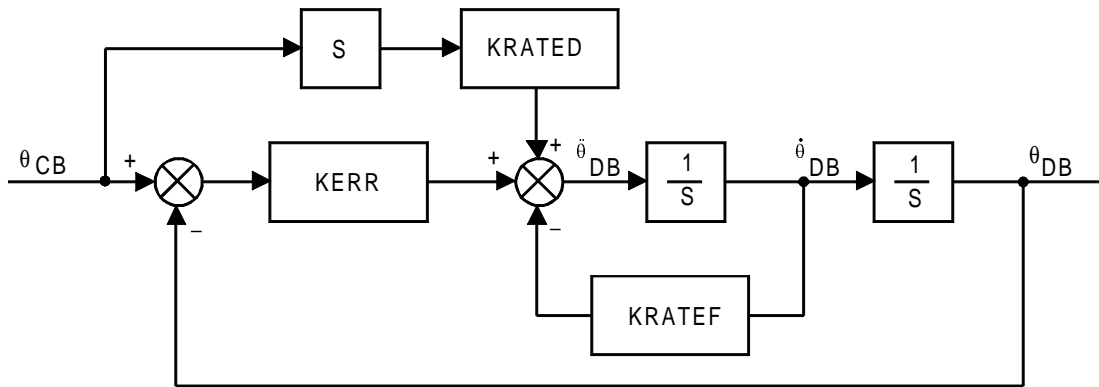


FIGURE 4.3.3-2. Steering Overview, Detailed Functional

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$$\frac{\theta_{DB}}{\theta_{CB}} = \frac{\omega_n^2 (\tau S + 1)}{S^2 + 2\zeta \omega_n S + \omega_n^2}$$

$$\tau = \frac{KRATED}{KERR}$$

$$\omega_n^2 = KERR$$

$$\zeta = \frac{KRATEF}{2\sqrt{KERR}}$$

FIGURE 4.3.3-3. Simplified Maneuver Smoother (Linearized for Coplanar Maneuvers)

4.3.4 GC_STEER Software Description

A software overview of GC_STEER is shown in Figure 4.3.4-1. Its input/output requirements are shown in Tables 4.3.2-1 and 4.3.2-2, respectively. GC_STEER consists of nine function modules, CBQUAT_ERECT, DBACCEL, DBQUAT, ATTERRS, THRUST_DIRECTION_FILTER, DBACCEL_CONT, DBACCEL_CONT_3EO, MANUAL_ASCENT_GUIDANCE, DISPERRS, and four copy cycle modules, CBQUAT_GUID, CBQUAT_FILT, DB_QUAT_COPY, AND FBCMDS_AUTO. The high-level sequencing requirements for GC_STEER are shown in Figure 4.3.4-2A for a nominal mission and in Figure 4.3.4-2B for an RTLS abort. The sequencing requirements are specified in terms of 12.5 Hz rate group, denoted by GC_STEER_80; 6.25 Hz rate group, denoted by GC_STEER_160; the 2.08 Hz rate group, denoted by GC_STEER_480 and 2.08 Hz alternate rate group, denoted by GC_STEER_480 ALT, which are defined in Figure 4.3.4-2C. The detailed diagrams for the function modules are shown in Figures 4.3.4-3 through 4.3.4-9. The intermodule interface requirements for GC_STEER are presented in Table 4.3.4-1. Initialization requirements are presented in Table 4.3.4-2, and I-loads/constants are presented in Table 4.3.4-3.

Table 4.3.4-1.GC_STEER Inter-Module Interface Requirements

Module	Name	Description	Source or Destination	Type	Range	Units	Rate Required Produced At (Hz)
CBQUAT_EREECT	<u>Inputs</u>						
	$\bar{L}AMC$	Desired thrust vector	ASC_2STG_GUID, PW_RTLS_GUID, PW_CONT_GUID	V		–	2.08
	$\bar{L}AMDC$	Desired thrust turning rate vector	ASC_2STG_GUID, PW_RTLS_GUID, PW_CONT_GUID	V		1/s	2.08
	TLAMC	Time associated with desired thrust vector	ASC_2STG_GUID, PW_RTLS_GUID	S		s	2.08
	MET	Mission elapsed time	FCOS	S		s	2.08
	CLOCK	Current GMT time	FCOS	S		s	2.08
	PHI_WING	Commanded roll symmetry angle	ASC_2STG_GUID, PW_RTLS_GUID	S	$\pm \pi$	rad	2.08
	$\bar{U}FE$	Estimated filtered thrust–direction	THRUST_DIRECTION_FILTER	V		–	2.08
	\bar{R}_AVGG	Position wrt earth center, coordinatized in inertial	ASCENT_UPP, RTLS_UPP	V		ft	2.08
	$\bar{V}REL$	Earth–relative velocity vector, coordinatized in inertial	ASCENT_UPP, RTLS_UPP	V		fps	2.08
	ALT	Altitude above reference ellipsoid	ASCENT_UPP, RTLS_UPP	S		ft	2.08
	RTLS_TURN	Indicator, begin RTLS turnaround	ASC_RECON	B		–	2.08
	$\bar{I}ZC$	Unit vector pointing from vehicle to landing site at cutoff	PW_RTLS_GUID	V		–	2.08
	AUTO_MODE	Contingency auto mode index	PW_CONT_GUID	I		–	2.08/6.25
	$Y_{\bar{S}}YM_GUID$	Right wing unit vector	PW_CONT_GUID	V		–	2.08
MM_CODE_601	Major Mode 601	MSC	B		–	2.08	

Table 4.3.4-1.GC_STEER Inter-Module Interface Requirements							
Module	Name	Description	Source or Destination	Type	Range	Units	Rate Required Produced At (Hz)
CBQUAT_EREECT (Cont.)	<u>Outputs</u>						
	Q_CB_I	Quaternion, commanded body wrt inertial	DBACCEL, DBACCEL_CONT	Q		-	2.08
	\overline{WCBI}_I	Ideal rate, commanded body wrt inertial, coordinatized in inertial	DBACCEL DBACCEL_CONT	V		deg/s	2.08
	\overline{UFC}_I	Commanded thrust direction unit vector	DBACCEL_CONT	V		-	2.08
DBACCEL	<u>Inputs</u>						
	Q_DB_I	Quaternion, desired body wrt inertial	DBQUAT	Q		-	6.25/2.08
	Q_CB_I	Quaternion, commanded body wrt inertial	CBQUAT_FILTER, CBQUAT_GUID, CBQUAT_EREECT	Q		-	6.25/2.08
	\overline{WCBI}_I	Ideal rate, commanded body wrt inertial, coordinatized in inertial	CBQUAT_EREECT	V		1/s	2.08
	\overline{WDBI}_{DB}	Rotational velocity, desired body wrt inertial, coordinatized in desired body	DBQUAT	V		deg/s	6.25/2.08
	MM101_INIT	Indicator	ASC_RECON	B		-	12.5
	ATTCMD	Indicator	ASC_RECON	B		-	12.5
	FRZCMD	Indicator	ASC_RECON	B		-	12.5
	PEGCMD	Indicator	ASC_RECON	B		-	12.5
	PPD	Indicator	ASC_RECON	B		-	12.5
	RTLS_TURN	Indicator	ASC_RECON	B		-	12.5
	SIG	Indicator	ASC_RECON	B		-	12.5
	ATTFILT	Indicator	ASC_RECON	B		-	12.5
	ZTRANS	Indicator	ASC_RECON	B		-	12.5
	PPD_DELAY	Indicator	PW_RTLS_GUID	B		-	6.25
MC_PPD	Indicator	PW_RTLS_GUID	B		-	6.25	
SEC_ME_FL_CNFM	Indicator	ASC_RECON	B		-	12.5	

Table 4.3.4-1.GC_STEER Inter-Module Interface Requirements							
Module	Name	Description	Source or Destination	Type	Range	Units	Rate Required Produced At (Hz)
DBACCEL (Cont.)	<u>Outputs</u> \bar{A} DBI DB	Rotational acceleration, desired body wrt inertial, coordinatized in desired body	DBQUAT	V		deg/s ²	6.25/ 2.08
DBACCEL_ CONT	<u>Inputs</u> SSME_FAILS AUTO_MODE Q_CB_I Q_DB_I \bar{W} DBI_DB WCB2 \bar{W} CB_I_I \bar{U} FC_I \bar{U} FE S_CONT_ROLL	SSME failure status flag Contingency auto mode index Quaternion, commanded body wrt inertial Quaternion, desired body wrt inertial Rotational velocity, desired body wrt inertial, coordinatized in desired body Commanded body pitch rate Ideal rate, commanded body wrt inertial, coordinated inertial Unit commanded thrust vector, coordinatized in inertial Estimated filtered thrust direction Contingency roll heads up flag	ASC_DAP PW_CONT_GUID CBQUAT_ERECT CBQUAT_GUID DBQUAT DBQUAT PW_CONT_GUID CBQUAT_ERECT CBQUAT_ERECT THRUST_DIRECTION_FILTER PW_CONT_GUID	I I Q Q V S V V V B	0-7 0, 1	- - - - deg/s deg/s deg/s - - -	12.5 2.08/6.25 6.25/2.08 6.25/2.08 6.25/2.08 6.25 2.08 2.08 2.08 2.08
DBACCEL_ CONT (Cont.)	S_CONT_ROLL_ INHIB	Contingency roll inhibit flag	PW_CONT_GUID	B	0, 1	-	2.08

Table 4.3.4-1.GC_STEER Inter-Module Interface Requirements							
Module	Name	Description	Source or Destination	Type	Range	Units	Rate Required Produced At (Hz)
	HIGH_RATE_SEP	Indicator	PW_CONT_GUID	B	0, 1	-	6.25
	PPD	Indicator	ASC_RECON	B	0, 1	-	12.5
	ZTRANS	Indicator	ASC_RECON	B	0, 1	-	12.5
	SELECT_VRELO_CONT	Indicator	PW_CONT_GUID	B	0, 1	-	6.25
	<u>Outputs</u>						
	\overline{A} DBI_DB	Rotational acceleration, desired body wrt inertial, coordinatized in desired body	DBQUAT	V		deg/s ²	2.08/6.25
	ECBDB(1)	Roll attitude error, commanded body to desired body	PW_CONT_GUID	S		deg	2.08
DBACCEL_CONT_3EO	<u>Inputs</u>						
	M	Estimated vehicle mass	ASC_1STG_GUID, ASC_2STG_GUID, PW_RTLS_GUID, PW_CONT_GUID	S		slugs	6.25
	Q_CB_I	Quaternion, commanded body wrt inertial	CBQUAT_GUID	Q		-	6.25
	Q_DB_I	Quaternion, desired body wrt inertial	DBQUAT	Q		-	6.25
	\overline{W} DBI_DB	Rotational velocity, desired body wrt inertial, coordinatized in desired body	DBQUAT	V		deg/s	6.25
	WCB2	Commanded body pitch rate	CONT_3EO_GUID	S		deg/s	6.25
	CONT_3EO_START	Indicator	CONT_3EO_GUID	B		-	6.25
	CONT_ATT_HOLD	Indicator	CONT_3EO_GUID	B	0, 1	-	6.25
DBACCEL_CONT_3EO (Cont.)	ENTRY_GAINS	Indicator	CONT_3EO_GUID	B	0, 1	-	6.25
	FRZ_3EO	Indicator	CONT_3EO_GUID	B	0, 1	-	6.25

Table 4.3.4-1.GC_STEER Inter-Module Interface Requirements							
Module	Name	Description	Source or Destination	Type	Range	Units	Rate Required Produced At (Hz)
	HIGH_RATE_SEP	Indicator	CONT_3EO_GUID	B	0, 1	–	6.25
	ET_SEP_CMD	ET separation command flag	ET_SEP_SEQ	B	0, 1	–	6.25
	NEAR_VRELO_MODE	Indicator	CONT_3EO_GUID	B	0, 1	–	6.25
	QDOT_DESIRED	Desired mated coast pitch acceleration	CONT_3EO_GUID	S		deg/s ²	6.25
	<u>Outputs</u> ADBI_DB	Rotational acceleration, desired body wrt inertial, coordinatized in desired body	DBQUAT	V		deg/s ²	6.25
DBQUAT DBQUAT (Cont.)	<u>Inputs</u> QDESIRED_INIT	Desired initial mated coast pitch rate	PW_CONT_GUID	S		deg/sec	6.25
	ADBI_DB	Rotational acceleration, desired body wrt inertial, coordinatized in desired body	DBACCEL, DBACCEL_CONT, DBACCEL_CONT_3EO	V		deg/s ²	6.25/2.08
	S_CONT_ROLL	Contingency roll heads up flag	PW_CONT_GUID	B		–	0.52
	MM_CODE_102	Major mode 102 flag	MSC	B	0, 1	–	12.5
	ALPHA_N	Nav derived angle of attack	A/E ATT PROC	S		deg	12.5
	CONT_3EO_START	Contingency 3EO start flag	CONT_3EO_GUID	B	0, 1	–	12.5
	CONT_3EO_REGION	Contingency 3EO region index	CONT_3EO_GUID	I		–	12.5
	CONT_ATT_HOLD	Indicator	CONT_3EO_GUID	B	0, 1	–	12.5
	VREL	Earth relative velocity vector	RTLS UPP	V		ft/sec	12.5
	Q_B_I	Quaternion, actual body wrt inertial	A/E ATT PROC	Q		–	12.5

Table 4.3.4-1.GC_STEER Inter-Module Interface Requirements								
Module	Name	Description	Source or Destination	Type	Range	Units	Rate Required Produced At (Hz)	
	PORB } QORB } RORB }	Orbiter att rates	SF (ORB_RGA)	S		deg/sec	12.5	
	deg/sec					12.5		
	deg/sec					12.5		
	ENTRY_GAINS	Maneuver to entry attitude flag	CONT_3EO_GUID	B	0, 1	–	12.5	
	MM101_INIT	Indicator	ASC_RECON	B		–	12.5	
	AUTO	Indicator	ASC_RECON	B		–	12.5	
	FRZCMD	Indicator	ASC_RECON	B		–	12.5	
	SRBSEP	Indicator	ASC_RECON	B		–	12.5	
	<u>Outputs</u>							
	Q_DB_I	Quaternion, desired body wrt inertial	ATTERRS DB_QUAT_COPY DBACCEL, DBACCEL_CONT	Q		–	12.5	
\overline{W} DBI_DB	Rotational velocity, desired body wrt inertial, coordinatized in desired body	FBCMDS AUTO DBACCEL, DBACCEL_CONT	V		deg/s	12.5		
MANUAL_ASCENT_GUIDANCE	<u>Inputs</u>							
	\overline{D} RHC	Manual attitude commands (rotation hand controller)	3–AX RHC SOP	V		deg	12.5	
	MM101_INIT	Indicator	ASC_RECON	B		–	12.5	
	AUTO	Indicator	ASC_RECON	B		–	12.5	
	FRZCMD	Indicator	ASC_RECON	B		–	12.5	
MANUAL_ASCENT_GUIDANCE (Cont.)	\overline{R} H_C_STATE_C	Commander RHC out of detent signals	3–AX RHC SOP	V		–	12.5	
	\overline{R} H_C_STATE_P	Pilot RHC out of detent signals	3–AX RHC SOP				12.5	

Table 4.3.4-1.GC_STEER Inter-Module Interface Requirements								
Module	Name	Description	Source or Destination	Type	Range	Units	Rate Required Produced At (Hz)	
	PORB } QORB } RORB }	Orbiter att rates	SF (ORB_RGA)	S		deg/s	12.5	
	$\overline{WBI_B}$			S		deg/s	12.5	
				S		deg/s	12.5	
	<u>Outputs</u>							
	$\overline{WFBI_FB}$	Rotational velocity, flight body wrt desired body or inertial, coordinatized in flight body	ASC_TVC	V		deg/s	12.5	
	\overline{EBFB}	Attitude errors for TVC loops	ASC_TVC	V		deg	12.5	
ATTERRS	<u>Inputs</u>							
	Q_DB_I	Quaternion, desired body wrt inertial	DBQUAT	Q		-	12.5	
	Q_B_I	Quaternion, actual body wrt inertial	A/E_ATT_PROC	Q		-	12.5	
	MM_CODE_601	Major mode 601	MSC	B		-	2.08	
	MM101_INIT	Indicator	ASC_RECON	B		-	12.5	
	BETA_N	NAV-derived sideslip angle	A/E_ATT_PROC	S		deg	6.25	
	ME_ZERO	Zero thrust	MSC	B		-	12.5	
	CONT_3EO_START	Indicator	CONT_3EO_GUID	B		-	6.25	
	FRZ_3EO	Indicator	CONT_3EO_GUID	B		-	6.25	
	PPD	Indicator	ASC_RECON	B		-	12.5	
	MASS_EST	Mass Estimate	ASC_DAP	S		slug	6.25	
	SSME_FAILS	Indicator, SSME failure status	ASC_RECON	I	0-7	-	12.5	
	MECO_CMD	Indicator	SSME OPS	B		-	12.5	
ATTERRS (Cont.)	<u>Outputs</u>							
	$\overline{EBDB_FB}$	Attitude errors for thrust vector control	GRTLS_DAP, ASC_TVC, DISPERRS_AUTO	V		deg	12.5	

Table 4.3.4-1.GC_STEER Inter-Module Interface Requirements								
Module	Name	Description	Source or Destination	Type	Range	Units	Rate Required Produced At (Hz)	
THRUST_DIRECTION_FILTER	<u>Inputs</u>							
	PCGTRM	Net pitch trim thrust angle	ASC_DAP	S		deg	6.25	
	YCGTRM	Net yaw trim thrust angle	ASC_DAP	S		deg	6.25	
	\bar{V} _IMU_CURRENT (VELSUMM50)	Selected total accumulated sensed velocity M50	IMU_RM	V		ft/s	6.25	
	Q_DBMID_I	Transformation quaternion, inertial frame to flight body frame at mid THRUST_DIRECTION_FILTER cycle	DB_QUAT_COPY	Q		-	2.08	
	MM101_INIT	Indicator	ASC_RECON	B		-		
	PEGCMD	Indicator	ASC_RECON	B		-	12.5	
	RTLS_TURN	Indicator	ASC_RECON	B		-	12.5	
	<u>Outputs</u>							
	\bar{U} FE	Estimated filtered thrust direction	CBQUAT_ERECT, DBACCEL_CONT	V		-	2.08	
	\bar{U} FE(2)	Y-component, estimated filtered thrust direction	PW_CONT_GUID	S		-	2.08	
	\bar{U} FE(3)	Z-component, estimated filtered thrust direction	PW_CONT_GUID	S		-	2.08	
	S_TDF	Thrust direction filter ready flag	PW_CONT_GUID	B		-	2.08	
	DISPERRS	<u>Inputs</u>						
	\bar{E} BDB_FB	Uncompensated attitude errors for display	ATTERRS	V		deg	6.25	
DISPERRS (Cont.)	KM_THETA	Variable gain for pitch attitude error	ASC_DAP	S		deg/s/deg	6.25	
	KN_PSI	Variable gain for yaw attitude error	ASC_DAP	S		deg/s/deg	6.25	

Table 4.3.4-1.GC_STEER Inter-Module Interface Requirements							
Module	Name	Description	Source or Destination	Type	Range	Units	Rate Required Produced At (Hz)
	NZ_FBK	Compensated normal acceleration error	ASC_DAP	S		deg/s	12.5
	NY_FBK	Compensated lateral acceleration error	ASC_DAP	S		deg/s	12.5
	ELEV_LR	Indicate active elevon load relief	ASC_RECON	B		-	12.5
	<u>Outputs</u> EBDB	Compensated attitude errors for display	ASC_ADI_PROC	V		deg	12.5

Table 4.3.4-2. GC_STEER Initialization Requirements					
Module	Component	Initialize on Transition		Variable	Initial Value
		From	To		
DBACCEL	<u>Input</u> Past value of error quaternion Steering gains	-	MM101_INIT	$\overline{WDBI_DB}$ ADBI_DB	$\overline{NULLVEC}$ NULLVEC
		$\overline{QBI_READY}$	QBI_READY	Q_DB_I Q_CB_I_OLD	Q_B_I ① ② Q_B_I
		\overline{PPD}	PPD	Q_CB_I_OLD	Q_CB_I
			MM101_INIT	TSTR ALIM WLIM KERR KRATED KRATEF	TSTR_160 ALIM_ATT WLIM_ATT KERR_ATT KRATED_ATT/TSTR KRATEF_ATT
		\overline{SIG}	SIG	ALIM WLIM KERR KRATED KRATEF	ALIM_S1G WLIM_S1G KERR_S1G KRATED_S1G/TSTR KRATEF_S1G
		\overline{PEGCMD}	PEGCMD	TSTR ALIM WLIM KERR KRATED KRATEF	TSTR_480 ALIM_S2G WLIM_S2G KERR_S2G KRATED_S2G/ DEG_TO_RAD KRATEF_S2G
		$\overline{RTLS_TURN}$	RTLS TURN	ALIM WLIM KERR KRATED KRATEF	ALIM_S1G WLIM_TURN KERR_TURN KRATED_TURN/ DEG_TO_RAD KRATEF_TURN
		$\overline{PPD + B}$	A	TSTR ALIM WLIM KERR KRATED KRATEF	TSTR_160 ALIM_PPD WLIM_PPD KERR_PPD KRATED_PPD/TSTR KRATEF_PPD
		$\overline{PPD + A}$	B	TSTR ALIM WLIM KERR KRATED KRATEF	TSTR_160 ALIM_PPD WLIM_PPD 0.0 0.0 KRATEF_PDLY

Table 4.3.4-2.GC_STEER Initialization Requirements

Module	Component	Initialize on Transition		Variable	Initial Value
		From	To		
DBACCEL (Continued)	Input Steering gains (Continued)	$\overline{\text{PPD}} + A + B + D$	C	TSTR ALIM WLIM KERR KRATED KRATEF	TSTR_160 ALIM_SEPD WLIM_SEPD KERR_SEPD KRATED_SEPD/TSTR KRATEF_SEPD
		$\overline{\text{PPD}} + A + B + C$	D	TSTR ALIM WLIM KERR KRATED KRATEF	TSTR_160 ALIM_SEPD WLIM_SEPD 0.0 0.0 KRATEF_SEPDY
		<p>WHERE:</p> <p>$A = \text{PPD} \cdot \overline{\text{SEC_ME_FL_CNFM}} \cdot \overline{\text{PPD_DELAY}}$</p> <p>$B = \text{PPD} \cdot \overline{\text{SEC_ME_FL_CNFM}} \cdot \overline{\text{PPD_DELAY}}$</p> <p>$C = \text{PPD} \cdot \overline{\text{SEC_ME_FL_CNFM}} \cdot \overline{\text{PPD_DELAY}}$</p> <p>$D = \text{PPD} \cdot \overline{\text{SEC_ME_FL_CNFM}} \cdot \overline{\text{PPD_DELAY}}$</p>			
DBACCEL (Continued)	Input Steering gains (Continued)	$\overline{\text{MC_PPD}}$	MC_PPD	TSTR ALIM WLIM KERR KRATED KRATEF	TSTR_160 ALIM_MCPD WLIM_MCPD KERR_MCPD KRATED_MCPD/ TSTR KRATEF_MCPD
		$\overline{\text{ZTRANS}}$	ZTRANS	TSTR ALIM WLIM KERR KRATED KRATEF	TSTR_160 ALIM_ZTRANS WLIM_ZTRANS KERR_ZTRANS KRATED_ZTRANS/ TSTR KRATEF_ZTRANS
DBQUAT	Quaternion integral	$\overline{\text{QBI_READY}}$	QBI_READY	-	②
	Input	$\overline{\text{AUTO}}$ $\overline{\text{FRZCMD}}$	AUTO $\overline{\text{FRZCMD}} \cdot \overline{\text{CONT_3EO_START}}$	Q_DB_I $\overline{\text{ADBI_DB}}$	Q_B_I $\overline{\text{NULLVEC}}$
	Rate integral	-	MM101_INIT	$\overline{\text{WDBI_DB}}$	$\overline{\text{NULLVEC}}$

Table 4.3.4-2.GC_STEER Initialization Requirements

Module	Component	Initialize on Transition		Variable	Initial Value
		From	To		
DBQUAT (Continued)	Rate integral (Continued)	FRZCMD	FRZCMD • CONT_3EO_ START	WDBI_DB	NULLVEC
		AUTO_MODE = 0	AUTO_MODE > 0	WDBI_DB ADBI_DB	NULLVEC NULLVEC
		AUTO_MODE = 0	AUTO_MODE > 0 • DROLL_RTLS = 0 • PPD	Q_DB_I	Q_B_I
		S_CONT_ ROLL	S_CONT_ ROLL	Q_DB_I	Q_B_I
		ENTRY_ GAINS	ENTRY_ GAINS • ECAL_ PITCH_UP	Q_DB_I WDBI_DB(1) WDBI_DB(2) WDBI_DB(3)	Q_B_I PORB QORB RORB
		ENTRY_ GAINS	ENTRY_ GAINS • ECAL_ PITCH_UP	Q_DB_I WDBI_DB(1) WDBI_DB(2) WDBI_DB(3)	Q_B_I PORB -(CONT_HIGH_SEP_ RATE) RORB
		CONT_3EO_ START	CONT_3EO_ START • MM_CODE_ 102	S_CONT_ROLL Q_DB_I ADBI_DB	OFF Q_B_I NULLVEC
		CONT_3EO_ START	CONT_3EO_ START • CONT_3EO_ REGION = 1	WDBI_DB	NULLVEC
		CONT_3EO_ START • CONT_3EO_ REGION = 2	CONT_3EO_ START • CONT_3EO_ REGION = 1	WDBI_DB	NULLVEC
		CONT_3EO_ START	CONT_3EO_ START • (CONT_3EO_ REGION = 2 + CONT_3EO_ REGION = 3)	WDBI_DB(1) WDBI_DB(3)	PORB RORB

Table 4.3.4-2. GC_STEER Initialization Requirements

Module	Component	Initialize on Transition		Variable	Initial Value
		From	To		
DBQUAT (Continued)	Rate integral (Continued)	$\overline{\text{CONT_3EO_START}}$	CONT_3EO_START • (CONT_3EO_REGION = 2 + CONT_3EO_REGION = 3) • NEAR_VREL0_MODE	WDBI_DB(2)	QORB
		$\overline{\text{CONT_3EO_START}}$	NEAR_VREL0_MODE • CONT_3EO_START	WDBI_DB(2)	QDESIRED_INIT
		CONT_3EO_REGION = 3	CONT_3EO_REGION = 4	WDBI_DB(2)	QORB
	Quaternion integral	$\overline{\text{AUTO}}$	AUTO	$\overline{\text{WDBI_DB}}$	$\overline{\text{WFBI_FB}}$
		$\overline{\text{SRBSEP}}$	SRBSEP	Q_DB_I	Q_B_I
		$\overline{\text{CONT_ATT_HOLD}}$	CONT_ATT_HOLD	Q_DB_I $\overline{\text{WDBI_DB}}$	Q_B_I NULLVEC
THRUST_ DIRECTION_ FILTER	Thrust direction filter outputs	$\overline{\text{PEGCMD}}$	PEGCMD	UFT ₂ UFT ₃	0.0 0.0
	Accumulated sensed velocity	$\overline{\text{PEGCMD}}$	PEGCMD	$\overline{\text{VELSUMM50_OLD}}$	$\overline{\text{VELSUMM50}}$
	Thrust direction filter ready flag		MM101_INIT	S_TDF	OFF
		$\overline{\text{PEGCMD}}$	PEGCMD	S_TDF	ON
			MM101_INIT	UF2_RLIM_TTDF	④
			MM101_INIT	UF3_RLIM_TTDF	⑤
	Previous Value of YCGTRM		MM101_INIT	YCGTRM_PREV	0
FBCMDS_ AUTO	Output	–	MM101_INIT	$\overline{\text{WFBI_FB}}$ $\overline{\text{EBFB}}$	$\overline{\text{NULLVEC}}$ $\overline{\text{NULLVEC}}$
DB_QUAT_ COPY	Output	$\overline{\text{PEGCMD}}$	PEGCMD	Q_DBMID_I	Q_DB_I
DISPERRS	Copy cycle for display		MM101_INIT	$\overline{\text{EBDB}}$	$\overline{\text{NULLVEC}}$
ATTERRS		–	MM101_INIT	ROLL_COUNT	0

Table 4.3.4-2. GC_STEER Initialization Requirements

Module	Component	Initialize on Transition		Variable	Initial Value
		From	To		
MANUAL_ASCENT_GUIDANCE		AUTO	AUTO	ATT_HOLD(1) ATT_HOLD(2) ATT_HOLD(3)	0 0 0
CBQUAT_ERECT	RTL5 Flyback first pass flag	-	MM101_INIT	FPASS	ON

- ① ATT_PROC_OUTER, at 1.04 Hz, is processed before the first execution of DBACCEL on transition to REFS_RDY.
- ② GC_STEER_160 is processed before the first execution of GC_STEER_80 on transition to QBI_READY
- ④ UF2_RLIM TSTR_480.
- ⑤ UF3_RLIM TSTR_480.
- ⑥ Initialize Q_DB_I via the following:

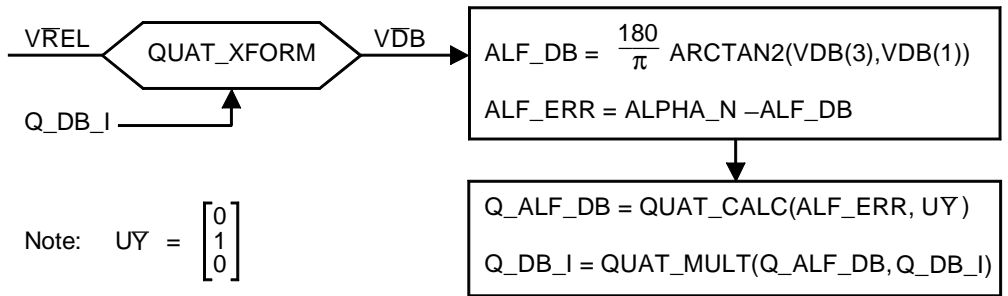


Table 4.3.4-3.GC_STEER I-Loads/K-Loads/Constants					
Module	Name	Description	Type	MSID/ Value	Units
DBACCEL	KRATEF_ATT	Feedback rate gain	S	V97U2046C	1/s
	KRATEF_S1G	Feedback rate gain	S	V97U2048C	1/s
	KRATEF_S2G	Feedback rate gain	S	V97U2049C	1/s
	KRATEF_TURN	Feedback rate gain	S	V97U2050C	1/s
	KRATEF_PPD	Feedback rate gain	S	V97U2047C	1/s
	KRATEF_MCPD	Feedback rate gain	S	V97U1570C	1/s
	KRATED_ATT	Rate gain	S	V97U2041C	1/s
	KRATED_S1G	Rate gain	S	V97U2043C	1/s
	KRATED_S2G	Rate gain	S	V97U2044C	1/s
	KRATED_TURN	Rate gain	S	V97U2045C	1/s
	KRATED_PPD	Rate gain	S	V97U2042C	1/s
	KRATED_MCPD	Rate gain	S	V97U1576C	1/s
	TSTR_160	Steer cycle sample period	S	0.160	s
	TSTR_480	Steer cycle sample period	S	0.480	s
	ALIM_SEPD	Angular acceleration limit	S	V97U8416C	deg/s ²
	KERR_SEPD	Angle error gain	S	V97U8417C	1/s ²
	KRATED_SEPD	Rate gain	S	V97U8418C	1/s
	KRATEF_PDLY	Feedback rate gain	S	V97U8221C	1/s
	KRATEF_SEPD	Feedback rate gain	S	V97U8431C	1/s
	KRATEF_SEPDY	Feedback rate gain	S	V97U8432C	1/s
	WLIM_SEPD	Angular rate limit	S	V97U8433C	deg/s
	ALIM_ATT	Angular acceleration limit	S	V97U1400C	deg/s ²
	ALIM_S1G	Angular acceleration limit	S	V97U1402C	deg/s ²
	ALIM_S2G	Angular acceleration limit	S	V97U1403C	deg/s ²
	ALIM_TURN	Angular acceleration limit	S	V97U1404C	deg/s ²
	ALIM_PPD	Angular acceleration limit	S	V97U1401C	deg/s ²
	ALIM_MCPD	Angular acceleration limit	S	V97U1577C	deg/s ²
	WLIM_ATT	Angular rate limit	S	V97U2319C	deg/s
	WLIM_S1G	Angular rate limit	S	V97U2321C	deg/s
	WLIM_S2G	Angular rate limit	S	V97U2322C	deg/s
	WLIM_TURN	Angular rate limit	S	V97U2323C	deg/s
	WLIM_PPD	Angular rate limit	S	V97U2320C	deg/s
	WLIM_MCPD	Angular rate limit	S	V97U1578C	deg/s
	KERR_ATT	Angle error gain	S	V97U1805C	1/s ²
	KERR_S1G	Angle error gain	S	V97U1807C	1/s ²
	KERR_S2G	Angle error gain	S	V97U1808C	1/s ²
	KERR_TURN	Angle error gain	S	V97U1809C	1/s ²
	KERR_PPD	Angle error gain	S	V97U1806C	1/s ²
	KERR_MCPD	Angle error gain	S	V97U1579C	1/s ²
	NULLVEC	NULL vector	V	(0,0,0)	–
	UNIT_QUAT	Unit quaternion, structure	Q	(1,0,0,0)	–
	DEG_PER_RAD	Conversion factor, radians to degrees	S	180/π	deg/rad

Table 4.3.4-3.GC_STEER I-Loads/K-Loads/Constants					
Module	Name	Description	Type	MSID/ Value	Units
DBACCEL (Cont.)	ALIM_ZTRANS	Angular accel limit	S	V97U1331C	deg/s ²
	WLIM_ZTRANS	Angular rate limit	S	V97U1329C	deg/s
	KERR_ZTRANS	Angle error gain	S	V97U1330C	1/s ²
	KRATED_ZTRANS	Rate gain	S	V97U1328C	1/s
	KRATEF_ZTRANS	Feedback rate gain	S	V97U1327C	1/s
DBACCEL_ CONT	ALIM_CONT1	Angular acceleration limit	S	V97U8245C	deg/s ²
	ALIM_CONT2	Angular acceleration limit	S	V97U8246C	deg/s ²
	ALIM_CONT3	Angular acceleration limit	S	V97U8247C	deg/s ²
	ALIM_CONT4	Angular acceleration limit	S	V97U8248C	deg/s ²
	ALIM_CONT5	Angular acceleration limit	S	V97U8249C	deg/s ²
	ALIM_CONT6	Angular acceleration limit	S	V97U8250C	deg/s ²
	ALIM_CONT7	Angular acceleration limit	S	V97U8251C	deg/s ²
	ALIM_CONT8	Angular acceleration limit	S	V97U8252C	deg/s ²
	ALIM_CONT9	Angular acceleration limit	S	V97U8253C	deg/s ²
	ALIM_CONT10	Angular acceleration limit	S	V97U8254C	deg/s ²
	ALIM_CONT11	Angular acceleration limit	S	V97U8255C	deg/s ²
	ALIM_CONT12	Angular acceleration limit	S	V97U8256C	deg/s ²
	ALIM_CONT13	Angular acceleration limit	S	V97U8481C	deg/s ²
	ALIM_CONT14	Angular acceleration limit	S	V97U8482C	deg/s ²
	ALIM_CONT15	Angular acceleration limit	S	V97U8483C	deg/s ²
	KERR_CONT1	Angle error gain	S	V97U8484C	1/s ²
	KERR_CONT	Angle error gain	S	V97U8272C	1/s ²
	KRATED_CONT1	Rate gain	S	V97U8257C	1/s
	KRATED_CONT2	Rate gain	S	V97U8258C	1/s
	KRATED_CONT3	Rate gain	S	V97U8259C	1/s
	KRATED_CONT4	Rate gain	S	V97U8485C	1/s
	KRATEF_CONT1	Feedback rate gain	S	V97U8273C	1/s
	KRATEF_CONT2	Feedback rate gain	S	V97U8274C	1/s
	KRATEF_CONT3	Feedback rate gain	S	V97U8275C	1/s
	KRATEF_CONT4	Feedback rate gain	S	V97U8276C	1/s
	KRATEF_CONT5	Feedback rate gain	S	V97U8277C	1/s
	KRATEF_CONT6	Feedback rate gain	S	V97U8278C	1/s
	KRATEF_CONT7	Feedback rate gain	S	V97U8279C	1/s
	KRATEF_CONT8	Feedback rate gain	S	V97U8280C	1/s
	KRATEF_CONT9	Feedback rate gain	S	V97U8281C	1/s
	KRATEF_CONT10	Feedback rate gain	S	V97U8282C	1/s
	KRATEF_CONT11	Feedback rate gain	S	V97U8283C	1/s
	KRATEF_CONT12	Feedback rate gain	S	V97U8415C	1/s
KRATEF_CONT13	Feedback rate gain	S	V97U8486C	1/s	
KRATEF_CONT14	Feedback rate gain	S	V97U8487C	1/s	
KRATEF_CONT15	Feedback rate gain	S	V97U8488C	1/s	
RAD_PER_DEG	Conversion factor, degrees to radians	S	$\pi/180$	rad/deg	

Table 4.3.4-3.GC_STEER I-Loads/K-Loads/Constants					
Module	Name	Description	Type	MSID/ Value	Units
DBACCEL_ CONT (Cont.)	TSTR_160	Steer cycle sample period	S	0.160	s
	TSTR_480	Steer cycle sample period	S	0.480	s
	WLIM_CONT1	Angular rate limit	S	V97U8419C	deg/s
	WLIM_CONT2	Angular rate limit	S	V97U8420C	deg/s
	WLIM_CONT3	Angular rate limit	S	V97U8421C	deg/s
	WLIM_CONT4	Angular rate limit	S	V97U8422C	deg/s
	WLIM_CONT5	Angular rate limit	S	V97U8423C	deg/s
	WLIM_CONT6	Angular rate limit	S	V97U8424C	deg/s
	WLIM_CONT7	Angular rate limit	S	V97U8425C	deg/s
	WLIM_CONT8	Angular rate limit	S	V97U8426C	deg/s
	WLIM_CONT9	Angular rate limit	S	V97U8427C	deg/s
	WLIM_CONT10	Angular rate limit	S	V97U8428C	deg/s
	WLIM_CONT11	Angular rate limit	S	V97U8429C	deg/s
	WLIM_CONT12	Angular rate limit	S	V97U8430C	deg/s
	WLIM_CONT13	Angular rate limit	S	V97U8489C	deg/s
	WLIM_CONT14	Angular rate limit	S	V97U8490C	deg/s
WLIM_CONT15	Angular rate limit	S	V97U8491C	deg/s	
DBACCEL_ CONT_3EO	ALIM_CONT16	Angular acceleration limit	S	V97U8552C	deg/s ²
	ALIM_CONT17	Angular acceleration limit	S	V97U8553C	deg/s ²
	ALIM_CONT18	Angular acceleration limit	S	V97U8554C	deg/s ²
	ALIM_MIN	Minimum ang acceleration	S	V97U8555C	deg/s ²
	ALIM_COEFF1	Acceleration coefficient	S	V97U8556C	deg/s ²
	ALIM_COEFF2	Acceleration coefficient	S	V97U8557C	deg/(slug s ²)
	KRATED_CONT3	Rate gain	S	V97U8259C	1/s
	KRATEF_CONT5	Feedback rate gain	S	V97U8277C	1/s
	KRATEF_MIN	Minimum feedback rate gain	S	V97U8558C	1/s
	KRATEF_MAX	Maximum feedback rate gain	S	V97U8559C	1/s
	TSTR_160	Steer cycle sample period	S	0.160	s
	WLIM_CONT5	Angular rate limit	S	V97U8423C	deg/s
	WLIM_CONT16	Angular rate limit	S	V97U8560C	deg/s
	WLIM_CONT17	Angular rate limit	S	V97U8561C	deg/s
DEG_PER_RAD	Conversion factor, radians to degrees	S	180/π	deg/rad	
DBQUAT	RAD_PER_DEG	Conversion factor, degrees to radians	S	π/180	rad/deg
	DEG_PER_RAD	Conversion factor, radians to degrees	S	180/π	deg/rad
	TM	Medium cycle sample period	S	0.08	s
	DTCON_M	Rate vector gain for quaternion integration	S	-TM • RAD_PER_DEG/2	s/deg
	NULLVEC	Null vector	V	(0,0,0)	-
ATTERRS	RTLS_ROLL_INC	RTLS roll for one engine out	S	V97U0097C	deg
	RTLS_ROLL_INC2	RTLS roll for two engines out	S	V97U0098C	deg

Table 4.3.4-3.GC_STEER I-Loads/K-Loads/Constants					
Module	Name	Description	Type	MSID/ Value	Units
THRUST_ DIRECTION_ FILTER	RAD_PER_DEG	Scale factor, degrees to radians	S	$\pi/180$	rad/deg
	GUF	Filter coefficient	S	V97U1799C	–
	RTLS_ROLL_INC	RTLS roll for one engine out	S	V97U0097C	deg
	TSTR_480	Module sample period	S	0.48	s
	UF2_LIM	Lateral position limit	S	V97U2270C	–
	UF3_MAX	Normal maximum position limit	S	V97U2272C	–
	UF3_MIN	Normal minimum position limit	S	V97U2273C	–
	UF2_RLIM	Lateral rate limit	S	V97U2271C	l/s
UF3_RLIM	Normal rate limit	S	V97U2274C	l/s	
MANUAL_ ASCENT_ GUIDANCE	NULLVEC	Null vector	V	(0,0,0)	–
	TM	Medium cycle sample interval	S	0.080	s
	DMAX	Maximum value of shaped manual attitude command	S	V97U1676C	deg
	KDMLIN	Linear coefficient in parabolic shaping equation	S	V97U8755C	deg/deg
	KDMPAR	Parabolic coefficient in parabolic shaping equation	S	V97U1804C	deg/deg ²
	KRH CX	Roll command rate gain	S	V97U2052C	(deg/s/deg)
	KRH CY	Pitch command rate gain	S	V97U2053C	(deg/s/deg)
	KRH CZ	Yaw command rate gain	S	V97U2054C	(deg/s/deg)
	KRH CPZ	Manual attitude commands gain	S	V97U2051C	(deg/deg)
	UNIT_QUAT	Unit quaternion	Q	(1,0,0,0)	–
	WBI_BLM(i) i = 1 to 3	Rate limit for initiation of attitude hold	V	V97U1321C to V97U1323C	deg/s
EBFB_LIM (i)i = 1 to 3	Attitude error limit for initiation of attitude hold	V	V97U1324C to V97U1326C	deg	
CBQUAT_ ERECT	ALT_HEAT	Altitude boundary for heating	S	V97U1408C	ft
	MET_HEAT	Time boundary for heating constraint algorithm	S	V97U2060C	s
	C_ALF_LIM	Cosine of angle-of-attack	S	V97U1419C	–
	S_ALF_LIM	Sine of bias angle-of-attack	S	V97U2237C	–
	C_ALF_BIAS	Cosine of bias angle-of-attack	S	V97U1418C	–
	S_ALF_BIAS	Sine of bias angle-of-attack	S	V97U2236C	–

Table 4.3.4-3.GC_STEER I-Loads/K-Loads/Constants					
Module	Name	Description	Type	MSID/ Value	Units
	DEG_PER_RAD	Conversion factor, degrees to radians	S	$\pi/180$	rad/deg
	$\bar{U}Z$	Unit Z-axis	V	(0,0,1)	-

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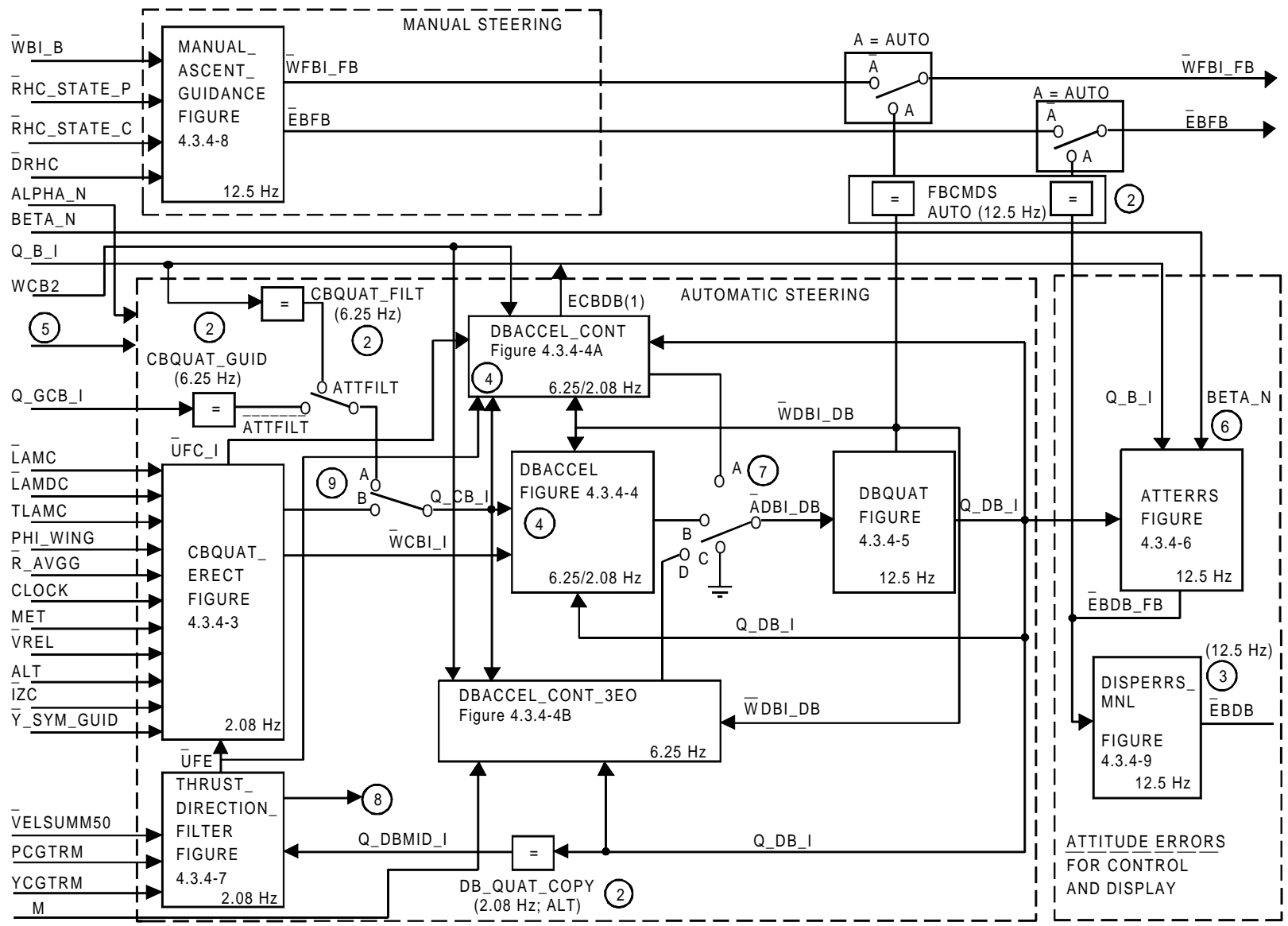


FIGURE 4.3.4-1.(1) Steering Software Overview (Sheet 1 of 2)

NOTES:

① DELETED

② COPY CYCLE MODELS (OUTPUT = INPUT):

CBQUAT_FILT: Q_CB_I = Q_B_I
 CBQUAT_GUID: Q_CB_I = Q_GCB_I
 DB_QUAT_COPY: Q_DBMID_I = Q_DB_I
 FBCMDS_AUTO: \overline{W} FBI_FB = \overline{W} DBI_DB
 \overline{E} BFB = \overline{E} BDB_FB

③ SENSE IS FEEDBACK MINUS COMMAND

④ PROCESS AT 6.25 Hz DURING ATTCMD, AND AT 2.08 Hz DURING PEGCMD

⑤	<u>FROM ASC_DAP (ASC_RECON)</u>	<u>FROM A/E ATT PROC</u>	<u>FROM XXXXXX TRAJ 1</u>
	ATTFILT PPD	ALPHA_N	DISP, XXXXXX TRAJ 2
	ATTCMD SIG	<u>FROM CONT 3E/O GUID</u>	<u>DISP, RTLS TRAJ 2 DISP</u>
	PEGCMD ZTRANS	CONT_3EO_REGION	CONT_SERC
	FRZCMD MM101_INIT	CONT_3EO_START	<u>FROM PW CONT GUID</u>
	RTLS_TURN SRB_SEP	HIGH_RATE_SEP	AUTO_MODE,
	AUTO SEC_ME_FL_CNFM	ENTRY_GAINS	HIGH_RATE_SEP,
	SSME_FAILS CONT_SERC	FRZ_3EO	S_CONT_ROLL,
			S_CONT_ROLL_INHIB
			<u>FROM PW RTLS GUID</u>
			PPD_DELAY
			MC_PPD
			<u>FROM MSC</u>
			MM_CODE_103,
			ME_ZERO,
			MM_CODE_102

QBI_READY (Automatic steering and attitude errors do not execute until QBI_READY)

⑥ IN THE MODULE ATERRS, WHEN MM_CODE_601 • ME_ZERO • CONT_3EO_START IS ON, THE (NEGATIVE) VALUE OF BETA_N FROM A/E_ATT_PROC IS TO BE SUBSTITUTED FOR THE THIRD COMPONENT OF \overline{E} BDB_FB. ACCOUNT SHOULD BE TAKEN OF THE DIFFERENT CYCLING NOTES OF A/E_ATT_PROC AND GC_STEER TO ENSURE THAT WHEN THE SWITCH IS ACTIVATED ONLY -BETA_N IS OUTPUT AS THE Z AXIS COMPONENT

⑦
$$A = \{(\text{AUTO_MODE} > 0) + [(\text{CONT_SERC} + \text{SEC_ME_FL_CNFM}) \cdot \text{MM_CODE_103}]\} \cdot (\text{FRZCMD}) \cdot \text{CONT_3EO_START}$$

$$B = \{(\text{AUTO_MODE} = 0) \cdot [(\text{CONT_SERC} + \text{SEC_ME_FL_CNFM}) \cdot \text{MM_CODE_103}]\} \cdot (\text{FRZCMD}) \cdot \text{CONT_3EO_START}$$

$$C = \text{FRZCMD} \cdot \overline{\text{CONT_3EO_START}}$$

$$D = \text{CONT_3EO_START}$$

⑧ TO PW CONT GUID
 S_TDF, UFE(2)
 UFE(3)

⑨ A = ATTCMD + CONT_3EO_START
 B = PEGCMD • CONT_3EO_START

FIGURE 4.3.4-1.(2) Steering Software Overview (Sheet 2 of 2)

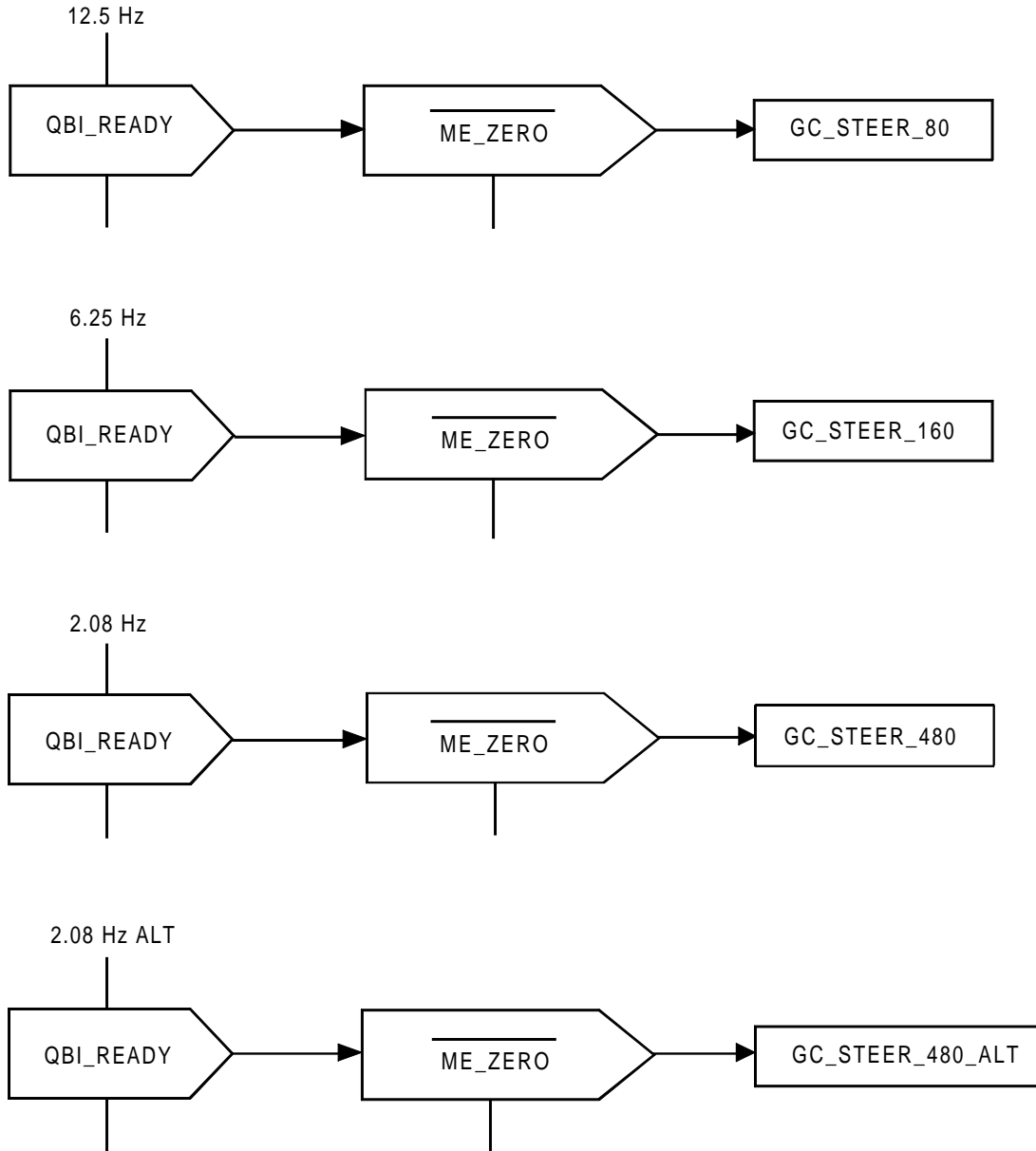


FIGURE 4.3.4-2A. GC_STEER Sequencing Requirements, OPS 1 Mission

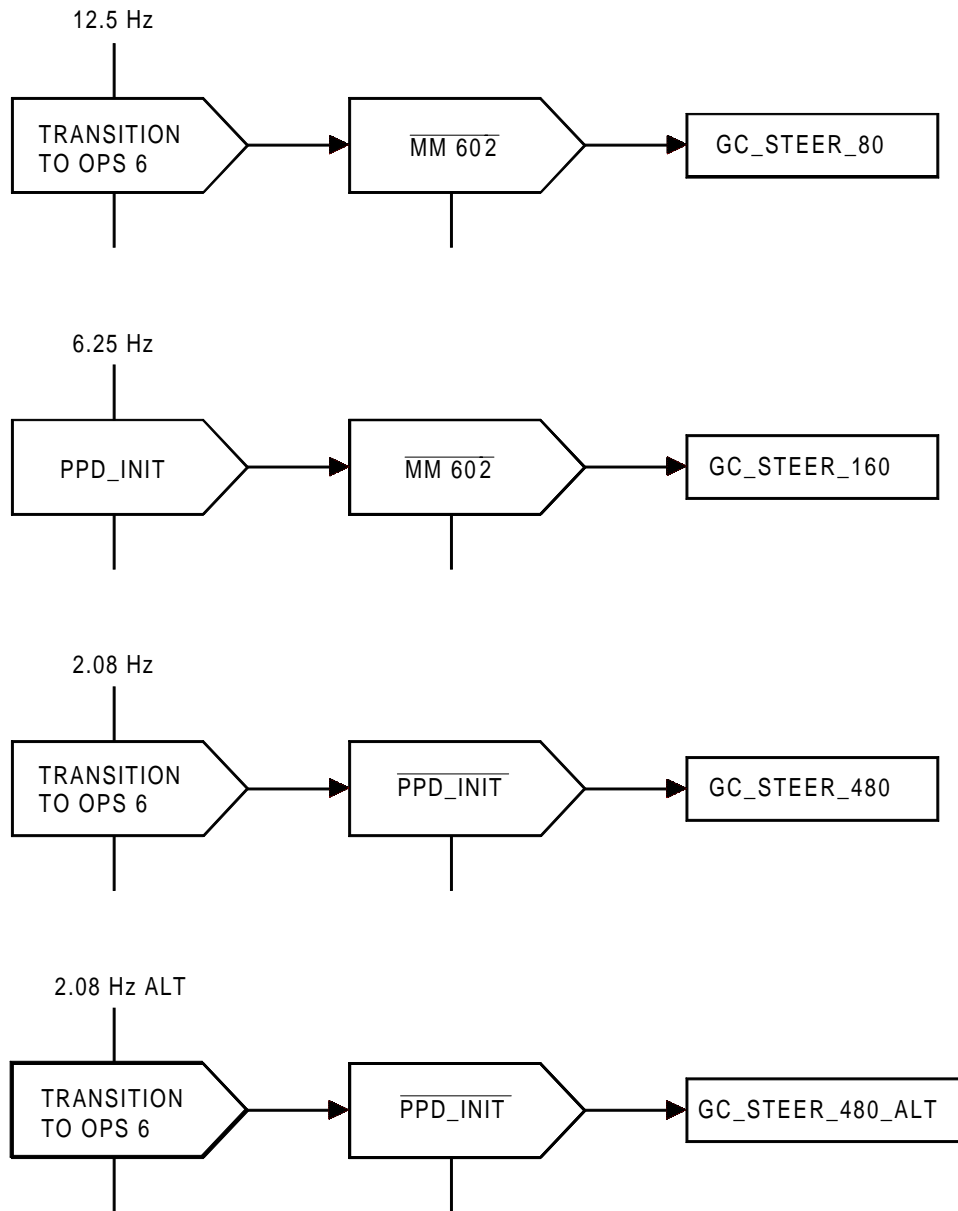


FIGURE 4.3.4-2B. GC_STEER Sequencing Requirements, RTLS_ABORT

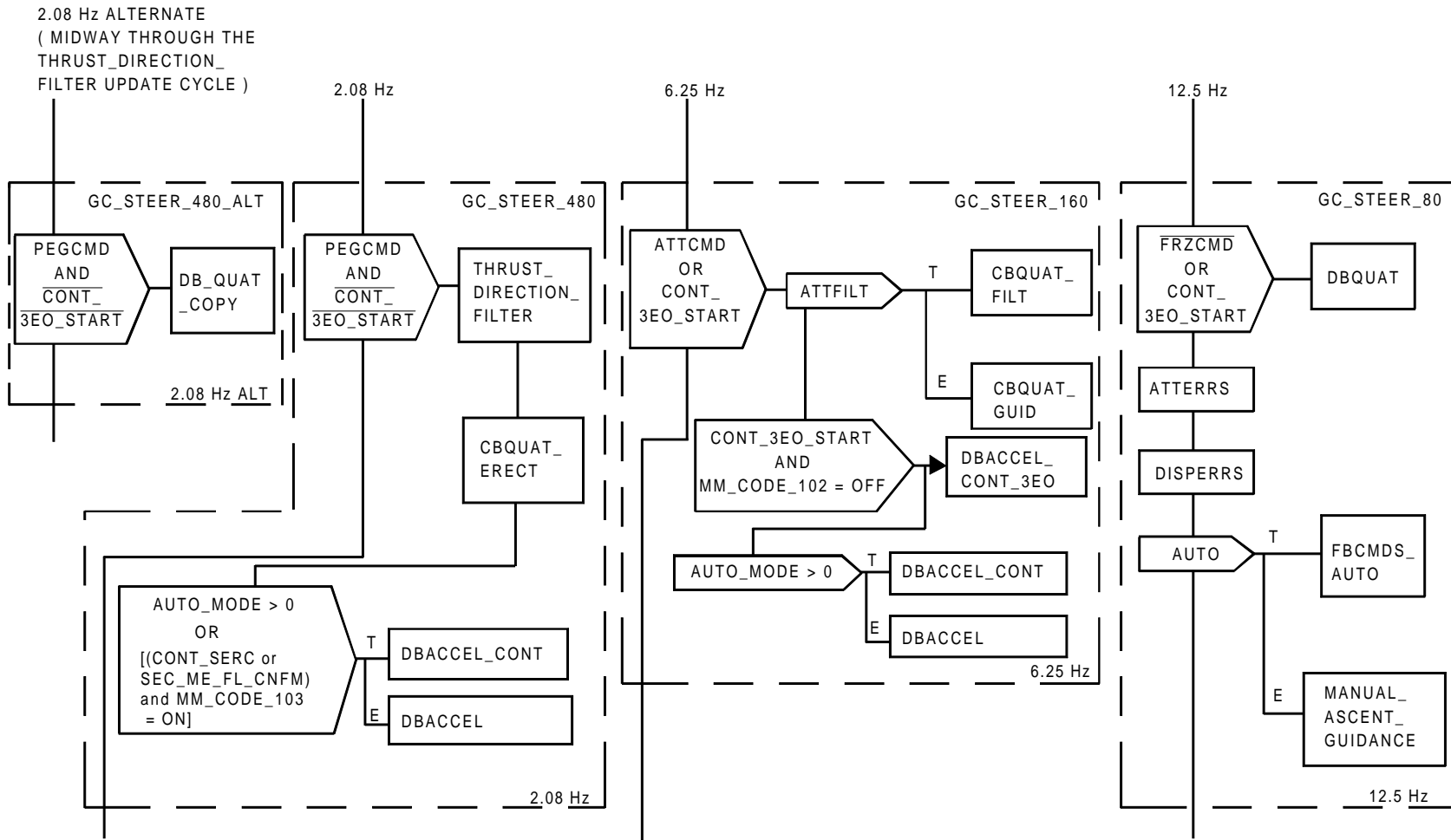


FIGURE 4.3.4-2C. GC_STEER 12.5 Hz, 6.25 Hz, and 2.08 Hz Sequencing Requirements

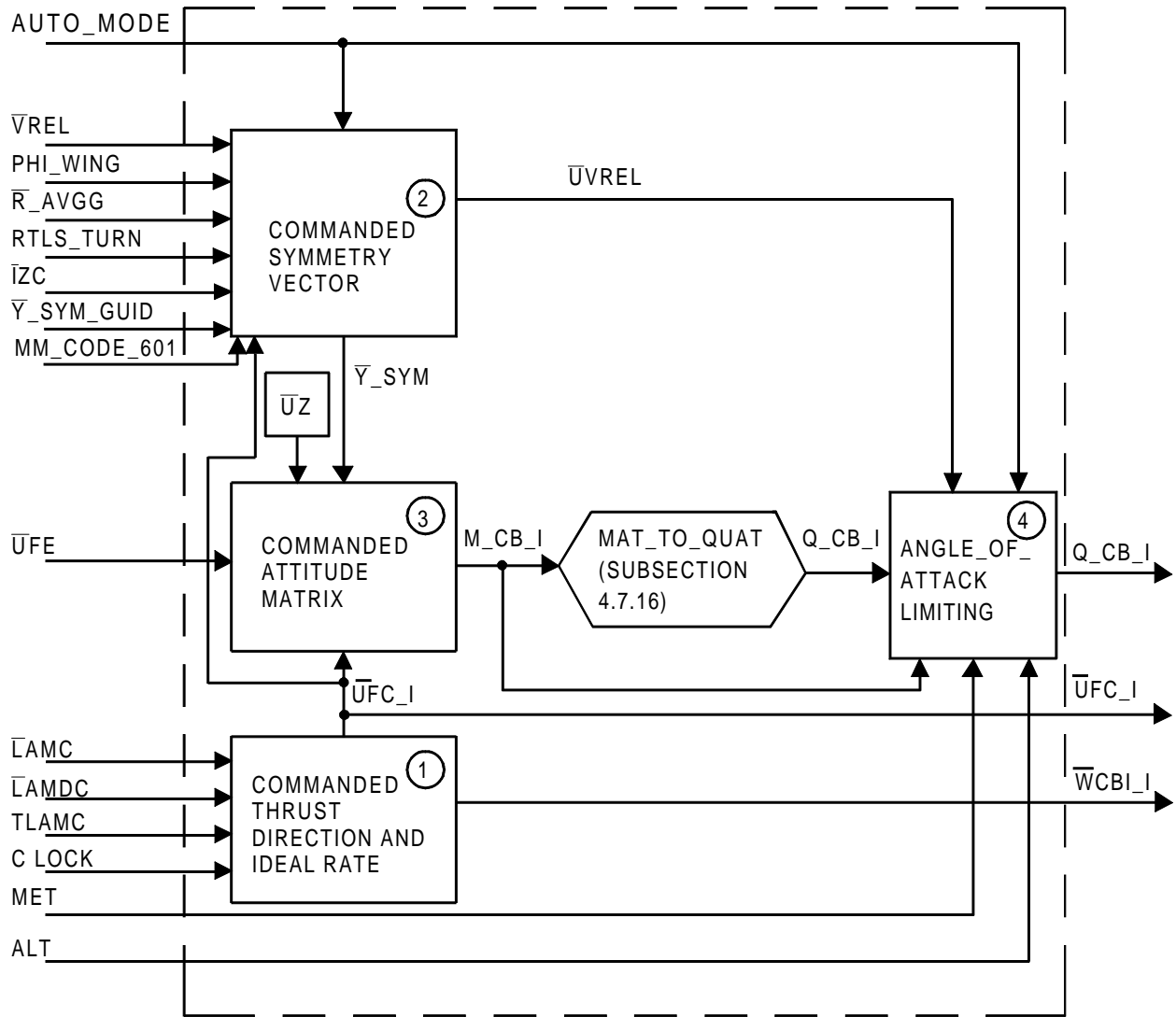
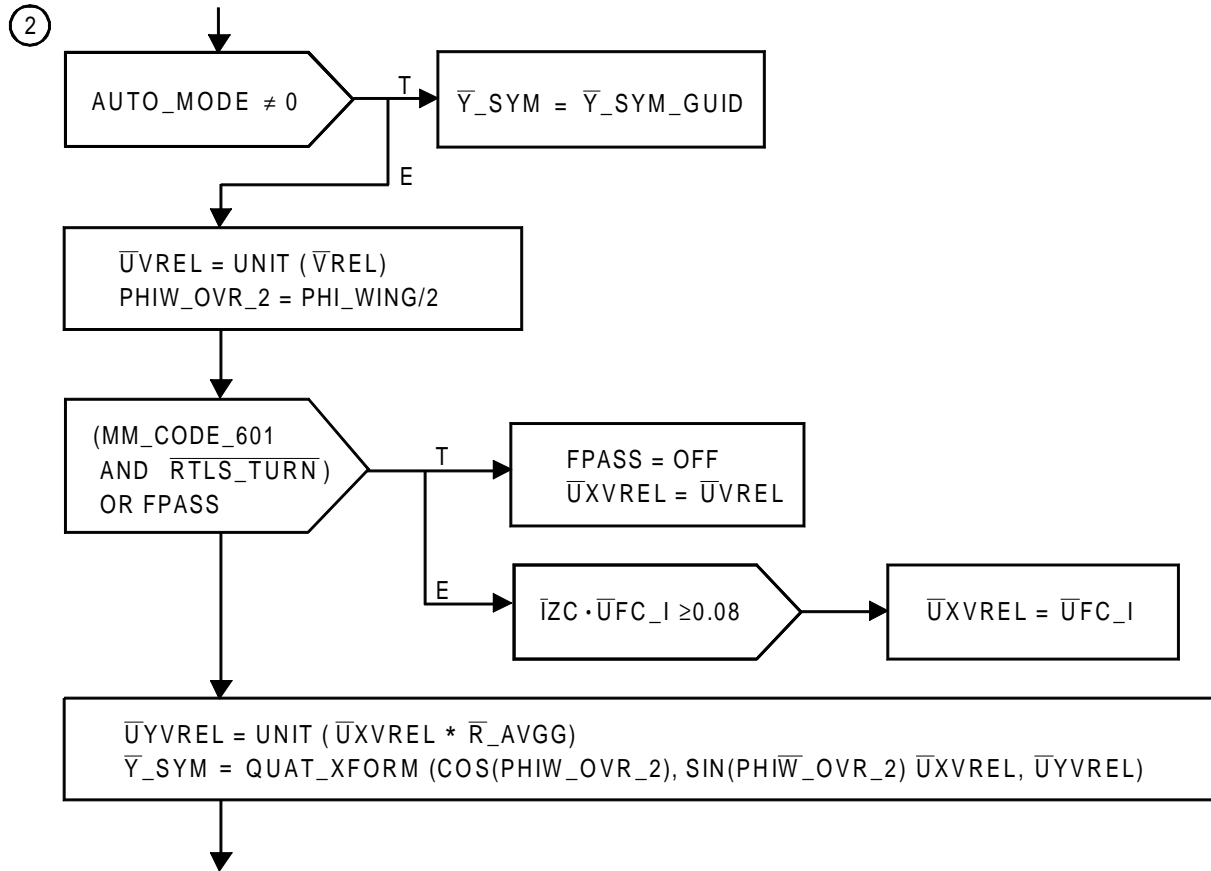


FIGURE 4.3.4-3.(1) CBQUAT_ERECT Function Module Detailed Diagram (Sheet 1 of 3)

NOTES

① $\bar{U}FC_I = \text{UNIT}(\bar{L}AMC + (\text{CLOCK-TL}AMC) \bar{L}AMDC)$
 $\bar{W}CB_I = (\bar{L}AMC * \bar{L}AMDC) (\bar{L}AMC * \bar{U}FC_I)^2$



③ $\bar{V}TEMP1 = \text{UNIT}(\bar{U}Z * \bar{U}FE)$
 $\bar{V}TEMP2 = \text{UNIT}(\bar{U}FC_I * \bar{Y}_SYM)$
 $M_CB_I = \text{TRANPOSE}(\text{MATRIX}(\bar{U}FE, \bar{V}TEMP1, \bar{U}FE * \bar{V}TEMP1)) \text{MATRIX}$
 $(\bar{U}FC_I, \bar{V}TEMP2 * \bar{U}FC_I, \bar{V}TEMP2)$

FIGURE 4.3.4-3.(2) CBQUAT_ERECT Function Module Detailed Diagram (Sheet 2 of 3)

NOTES (CONT)

④

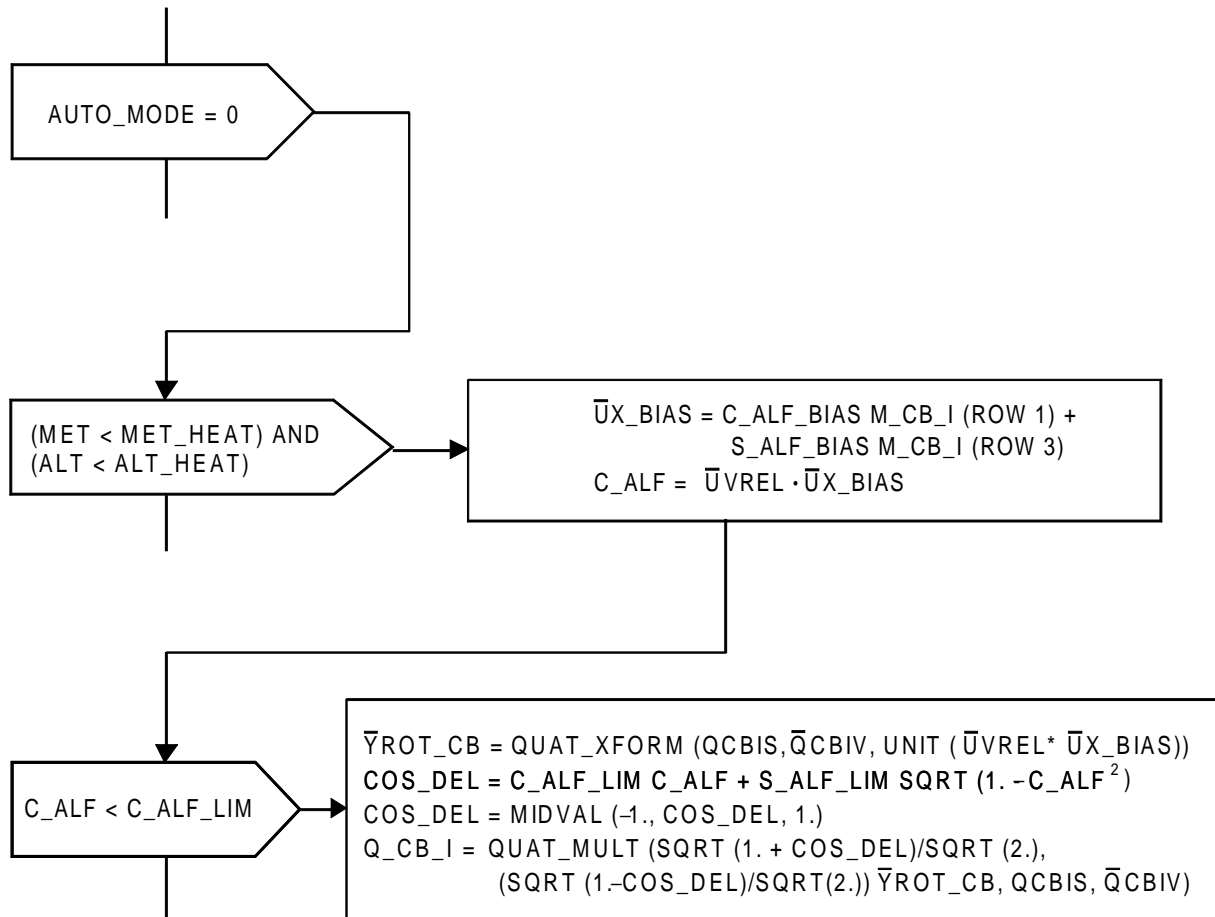


FIGURE 4.3.4-3.(3) CBQUAT_ERECT Function Module Detailed Diagram (Sheet 3 of 3)

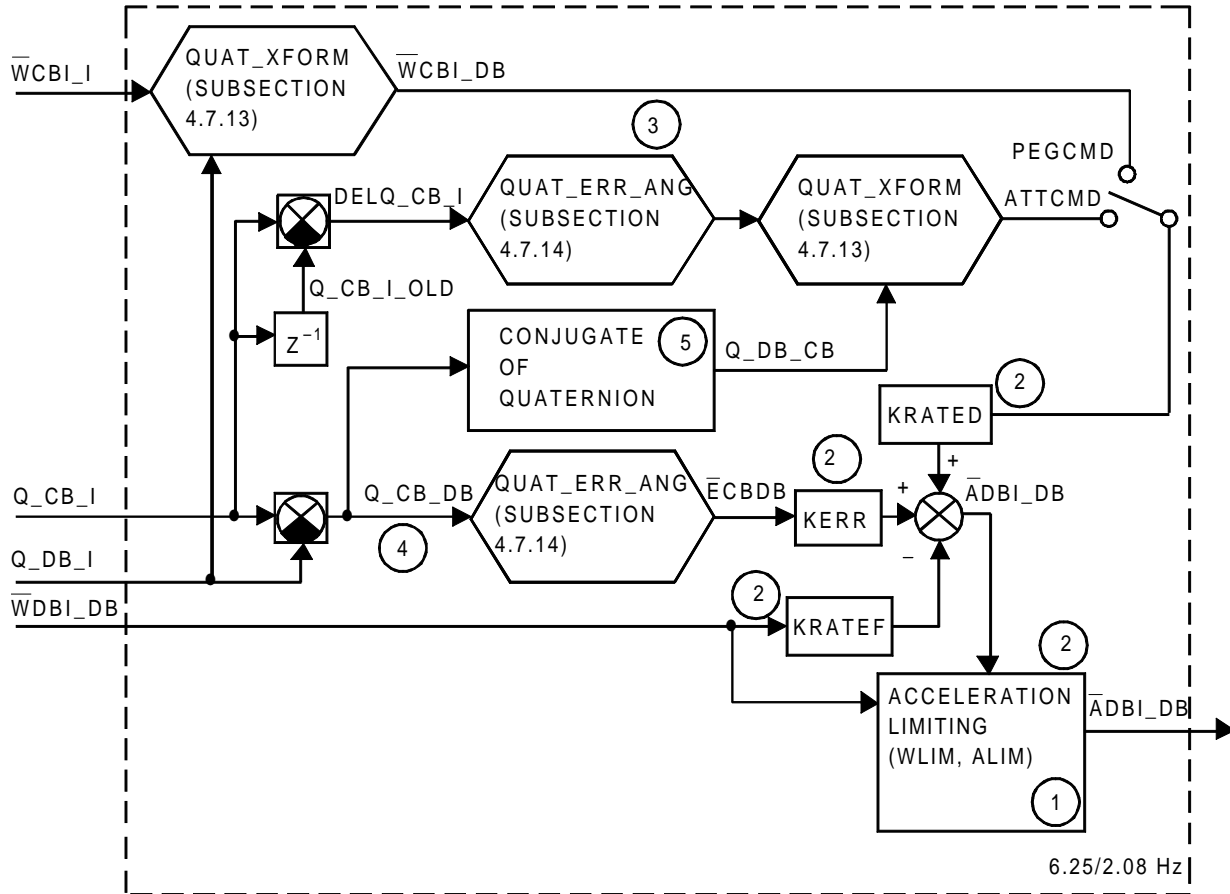
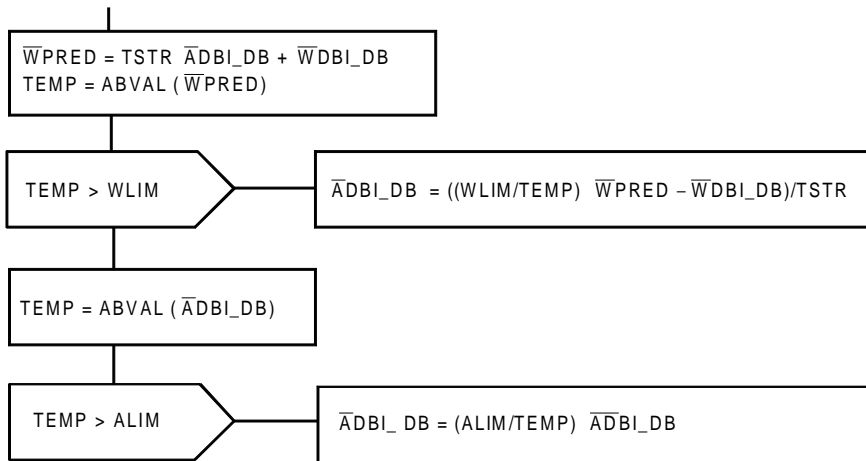


FIGURE 4.3.4-4.(1) DBACCEL Function Module, Detailed Diagram (Sheet 1 of 2)

NOTES

① ACCELERATION LIMITING



② STEERING GAINS. (SEE TABLE 4.3.4-2 FOR GAIN SELECTION BASED ON ALLOWABLE MODE TRANSITIONS)

	ATTFILT	S1G	PEGCMD • RTLS_TURN	RTLS_TURN	ZTRANS	MC_PPD
TSTR	TSTR_160	TSTR_160	TSTR_480	TSTR_480	TSTR_160	TSTR_160
ALIM	ALIM_ATT	ALIM_S1G	ALIM_S2G	ALIM_TURN	ALIM_ZTRANS	ALIM_MCPD
WLIM	WLIM_ATT	WLIM_S1G	WLIM_S2G	WLIM_TURN	WLIM_ZTRANS	WLIM_MCPD
KERR	KERR_ATT	KERR_S1G	KERR_S2G	KERR_TURN	KERR_ZTRANS	KERR_MCPD
KRATED	KRATED_ATT/ TSTR	KRATED_S1G/ TSTR	KRATED_S2G/ DEG_TO_RAD	KRATED_TURN/ DEG_TO_RAD	KRATED_ZTRANS/ TSTR	KRATED_MCPD/ TSTR
KRATEF	KRATEF_ATT	KRATEF_S1G	KRATEF_S2G	KRATEF_TURN	KRATEF_ZTRANS	KRATEF_MCPD

	PPD • SEC_ME_FL_CNFM • PPD_DELAY	PPD • SEC_ME_FL_CNFM • PPD_DELAY	PPD • SEC_ME_FL_CNFM • PPD_DELAY	PPD • SEC_ME_FL_CNFM • PPD_DELAY
TSTR	TSTR_160	TSTR_160	TSTR_160	TSTR_160
ALIM	ALIM_PPD	ALIM_PPD	ALIM_SEPD	ALIM_SEPD
WLIM	WLIM_PPD	WLIM_PPD	WLIM_SEPD	WLIM_SEPD
KERR	KERR_PPD	0.	KERR_SEPD	0.
KRATED	KRATED_PPD/ TSTR	0.	KRATED_SEPD/ TSTR	0.
KRATEF	KRATEF_PPD	KRATEF_PDLY	KRATEF_SEPD	KRATEF_SEPDY

③ DERIVED RATE:
 $DELQ_CB_I \leftarrow QUAT_MULT(QCBIS, \overline{QCBIV}, QCBIOlds, -\overline{QCBIOldV})$
 $Q_CB_I_OLD = Q_CB_I$

④ QUATERNION ERROR:
 $Q_CB_DB \leftarrow QUAT_MULT(QCBIS, \overline{QCBIV}, QDBIS, \overline{QDBIV})$

⑤ CONJUGATE OF QUATERNION
 $QDBCBS = QCBDBS; \overline{QDBC BV} = -\overline{QCBDBV}$

FIGURE 4.3.4-4.(2) DBACCEL Function Module Detailed Diagram (Sheet 2 of 2)

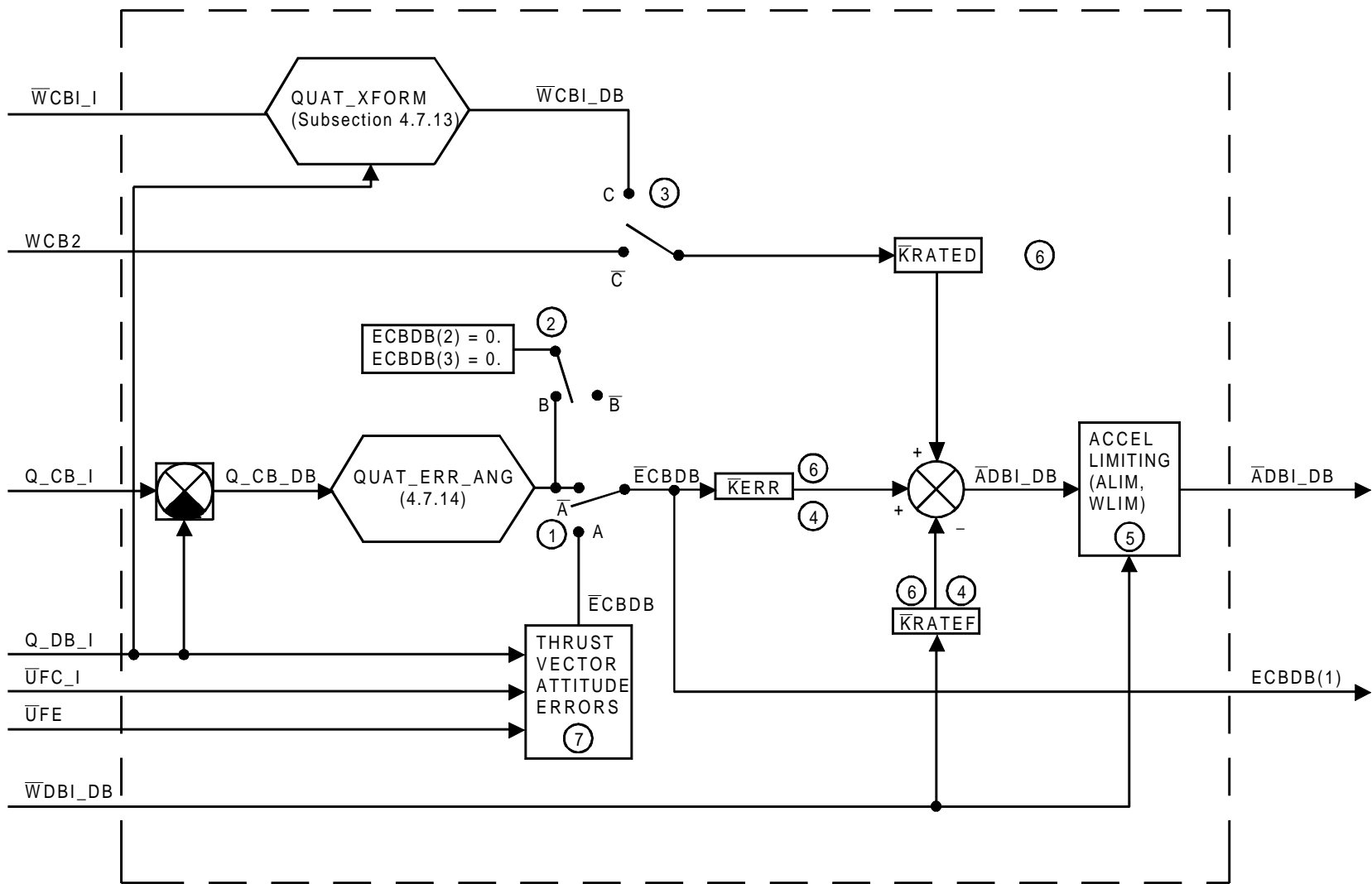


FIGURE 4.3.4-4A.(1) DBACCEL_CONT Function Module, Detailed Diagram (Sheet 1 of 6)

NOTES

- ① A = S_CONT_ROLL_INHIB
 - ② B = S_CONT_ROLL
 - ③ C = (AUTO_MODE = 0)
- } THESE TWO DISCRETES CANNOT BOTH
 BE SET TRUE AT THE SAME TIME

④ DBACCEL_CONT STEERING GAINS

\bar{KERR} is a 3x1 vector of gains. \bar{KRATEF} is a 3x1 vector of gains.

Rather than a scaler gain multiplying all three axes (as in DBACCEL), the gains \bar{KERR} and \bar{KRATEF} in DBACCEL_CONT are vectors. Each component multiplies a component of the input vector.

<u>\bar{KERR}</u>			<u>\bar{KRATEF}</u>		
<u>Input is</u>	<u>Output is</u>		<u>Input is</u>	<u>Output is</u>	
ECBDB(1)	KERR(1)	ECBDB(1)	WDBI_DB(1)	KRATEF(1)	WDBI_DB(1)
ECBDB(2)	KERR(2)	ECBDB(2)	WDBI_DB(2)	KRATEF(2)	WDBI_DB(2)
ECBDB(3)	KERR(3)	ECBDB(3)	WDBI_DB(3)	KRATEF(3)	WDBI_DB(3)

The values of \bar{KERR} and \bar{KRATEF} are determined below:

KERR(1) = KERR_RP	KRATEF(1) = KRATEF_RP
KERR(2) = KERR_RP	KRATEF(2) = KRATEF_RP
KERR(3) = KERR_YW	KRATEF(3) = KRATEF_YW

KERR_RP, KERR_YW, KRATEF_RP and KRATEF_YW are defined in Note 6.

FIGURE 4.3.4-4A.(2) DBACCEL_CONT Function Module, Detailed Diagram (Sheet 2 of 6)

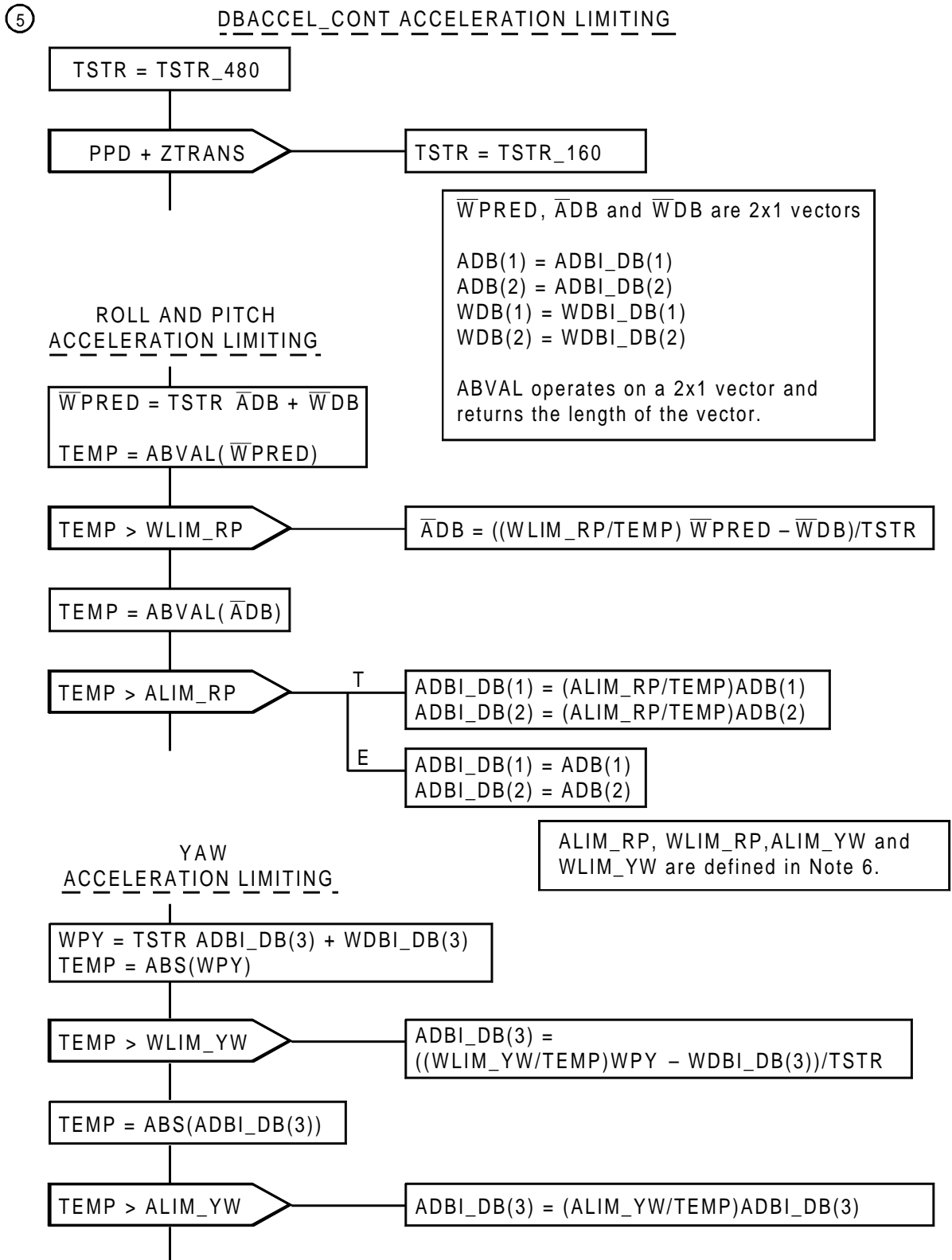


FIGURE 4.3.4-4A.(3) DBACCEL_CONT Function Module, Detailed Diagram (Sheet 3 of 6)

⑥

DBACCEL_CONT STEERING GAIN SELECTION

The roll and pitch axis steering gains are a function of the contingency auto mode index AUTO_MODE and SÉLECT_VRELO_CONT passed from PW CONT GUID.

AUTO_MODE =				
	11	12	13	14
ALIM_RP WLIM_RP KERR_RP KRATEF_RP	ALIM_CONT1 WLIM_CONT1 KERR_CONT KRATEF_CONT1	ALIM_CONT2 WLIM_CONT2 KERR_CONT KRATEF_CONT2	ALIM_CONT3 WLIM_CONT3 KERR_CONT KRATEF_CONT3	ALIM_CONT4 WLIM_CONT4 KERR_CONT KRATEF_CONT4
	21	22	23	24
ALIM_RP WLIM_RP KERR_RP KRATEF_RP	ALIM_CONT1 WLIM_CONT1 KERR_CONT KRATEF_CONT1	ALIM_CONT2 WLIM_CONT2 KERR_CONT KRATEF_CONT2	ALIM_CONT3 WLIM_CONT3 KERR_CONT KRATEF_CONT3	ALIM_CONT5 Ⓐ 0. KRATEF_CONT5
	31	32	41	51
ALIM_RP WLIM_RP KERR_RP KRATEF_RP	ALIM_CONT3 WLIM_CONT3 KERR_CONT KRATEF_CONT3	ALIM_CONT5 ABS(WCB2) 0. KRATEF_CONT5	ALIM_CONT6 WLIM_CONT6 KERR_CONT KRATEF_CONT6	ALIM_CONT7 WLIM_CONT7 KERR_CONT KRATEF_CONT7
	52	53	61	62
ALIM_RP WLIM_RP KERR_RP KRATEF_RP	ALIM_CONT8 WLIM_CONT8 KERR_CONT KRATEF_CONT8	ALIM_CONT9 WLIM_CONT9 KERR_CONT KRATEF_CONT9	ALIM_CONT10 WLIM_CONT10 0. KRATEF_CONT10	ALIM_CONT5 WLIM_CONT5 0. KRATEF_CONT5
	0	Ⓐ If SÉLECT_VRELO_CONT = ON, set WLIM_RP = ABS(WCB2) Otherwise, set WLIM_RP = WLIM_CONT5		
ALIM_RP WLIM_RP KERR_RP KRATEF_RP	ALIM_CONT13 WLIM_CONT13 KERR_CONT KRATEF_CONT13			

FIGURE 4.3.4-4A.(4) DBACCEL_CONT Function Module, Detailed Diagram (Sheet 4 of 6)

⑥ DBACCEL_CONT STEERING GAIN SELECTION (Cont.)

The yaw axis steering gains are a function of AUTO_MODE and SSME_FAILS

	AUTO_MODE > 0		AUTO_MODE = 0	
	SSME_FAILS =		SSME_FAILS =	
	0,2,3,6	1,4,5,7**	0,2,3,6	1,4,5,7**
ALIM_YW WLIM_YW KERR_YW KRATEF_YW	ALIM_CONT11 WLIM_CONT11 KERR_CONT * KRATEF_CONT11	ALIM_CONT12 WLIM_CONT12 KERR_CONT * KRATEF_CONT12	ALIM_CONT14 WLIM_CONT14 KERR_CONT1 KRATEF_CONT14	ALIM_CONT15 WLIM_CONT15 KERR_CONT1 KRATEF_CONT15

*If HIGH_RATE_SEP = ON, or ZTRANS = ON, set KERR_YW = 0.

** Corresponds to values utilized when SSME 1 is confirmed to be non-operational

The steering gain vector $\bar{K}RATED$ is a 3 by 1 vector. When AUTO_MODE > 0 the first and third components are 0 and the input to the steering gain vector is the scalar WCB2. When AUTO_MODE = 0 the input to the steering gain vector is the vector WCB1_DB. The values of $\bar{K}RATED$ are given below:

AUTO_MODE > 0	AUTO_MODE = 0
$KRATED(1) = 0.$ $KRATED(2) = KRATED_PCH$ $KRATED(3) = 0.$	$KRATED(1) = KRATED_CONT4/RAD_PER_DEG$ $KRATED(2) = KRATED_CONT4/RAD_PER_DEG$ $KRATED(3) = KRATED_CONT4/RAD_PER_DEG$

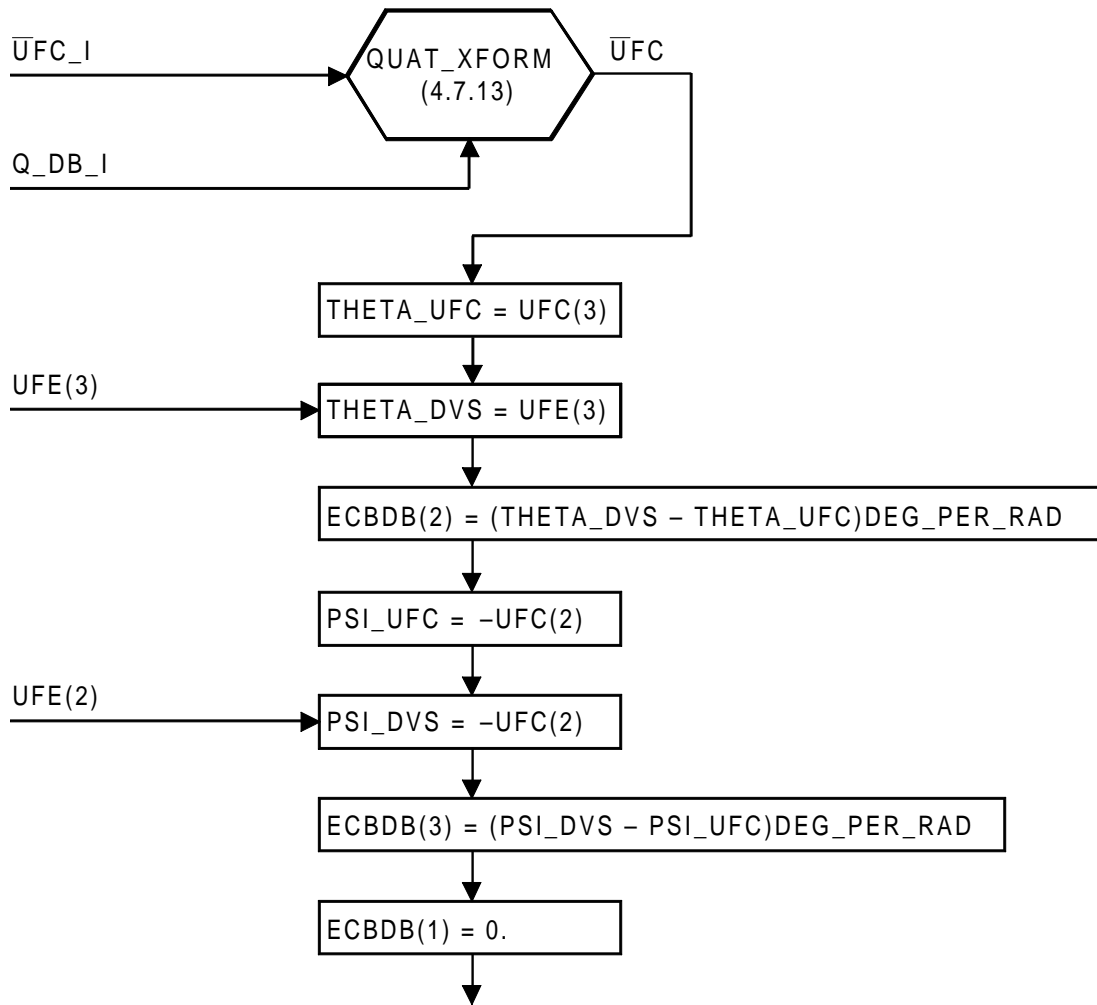
Where the value of KRATED_PCH is determined below:

	HIGH_RATE_SEP • ZTRANS	HIGH_RATE_SEP • ZTRANS	HIGH_RATE_SEP
KRATED_PCH	KRATED_CONT1	KRATED_CONT2	KRATED_CONT3

FIGURE 4.3.4-4A.(5) DBACCEL_CONT Function Module, Detailed Diagram (Sheet 5 of 6)

⑦

THRUST VECTOR ATTITUDE ERRORS



Note: These calculations need to be performed when the discrete
 S_CONT_ROLL_INHIB = ON.

FIGURE 4.3.4-4A.(6) DBACCEL_CONT Function Module, Detailed Diagram (Sheet 6 of 6)

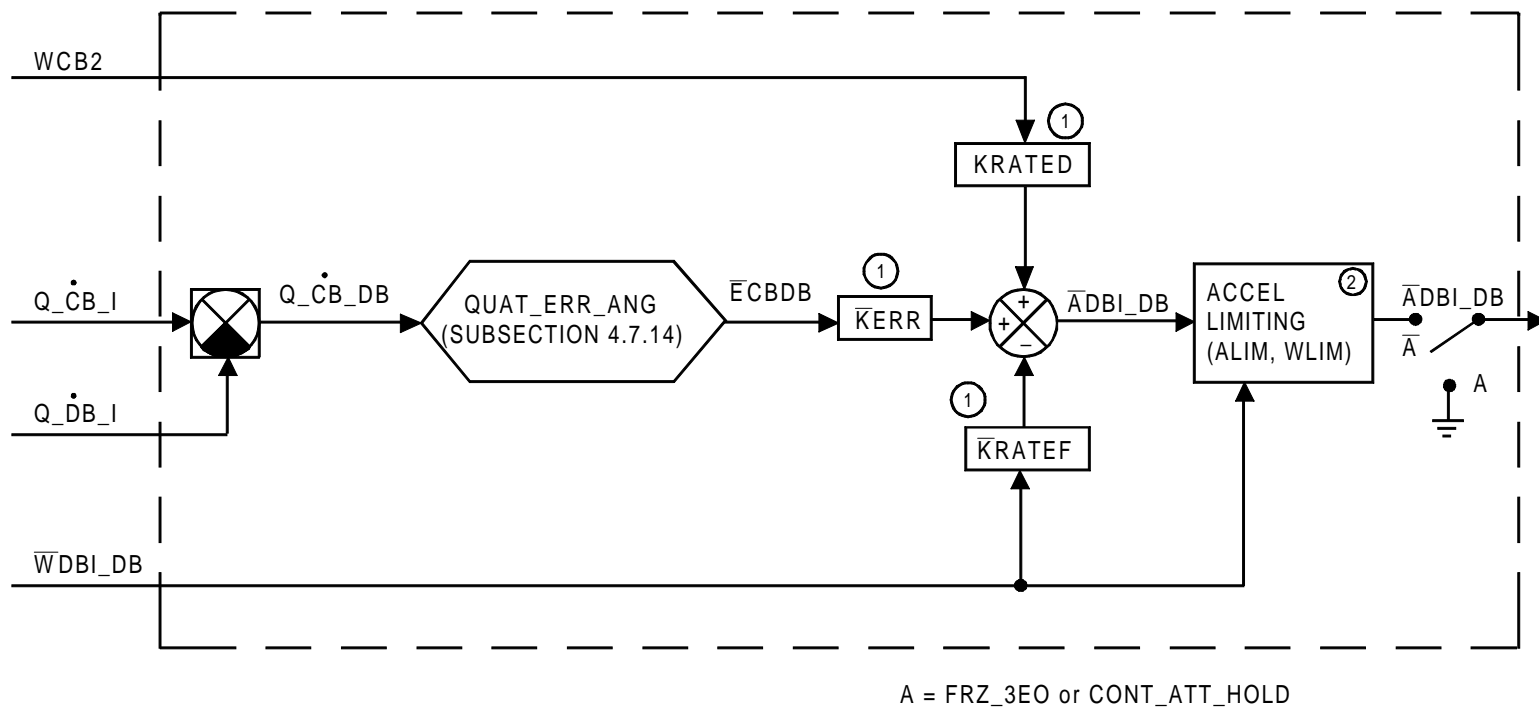


FIGURE 4.3.4-4B.(1) DBACCEL_CONT_3EO Function Module, Detailed Diagram (Sheet 1 of 4)

①

DBACCEL_CONT_3EO

STEERING GAIN SELECTION

Perform this module after $\bar{E}CBDB$ has been computed.

Similar to DBACCEL_CONT, the steering gains KERR and KRATEF in DBACCEL_CONT_3EO are 3 x 1 vectors. Each component of the gain vector multiplies a component of the input vector. Thus:

<u>$\bar{K}ERR$</u>		<u>$\bar{K}RATEF$</u>	
<u>Input is</u>	<u>Output is</u>	<u>Input is</u>	<u>Output is</u>
ECBDB(1)	KERR(1) ECBDB(1)	WDBI_DB(1)	KRATEF(1) WDBI_DB(1)
ECBDB(2)	KERR(2) ECBDB(2)	WDBI_DB(2)	KRATEF(2) WDBI_DB(2)
ECBDB(3)	KERR(3) ECBDB(3)	WDBI_DB(3)	KRATEF(3) WDBI_DB(3)

For all 3 E/O scenarios, KRATED is a scalar gain and is only used in the pitch axis (axis 2). For axis 1 and axis 3, KRATED can be assumed zero.

The values of $\bar{K}ERR$ and KRATED are determined by the flag HIGH_RATE_SEP:

HIGH_RATE_SEP	HIGH_RATE_SEP
KERR(1) = .25 KERR(2) = .25 KERR(3) = .25	KERR(1) = .25 KERR(2) = 0 KERR(3) = .25
KRATED = 1	KRATED = KRATED_CONT3

FIGURE 4.3.4-4B.(2) DBACCEL_CONT_3EO Function Module, Detailed Diagram (Sheet 2 of 4)

①

DBACCEL_CONT_3EO STEERING GAIN SELECTION (CONT'D)

Perform this module after ECBDDB has been formed each pass thru DBACCEL_CONT_3EO

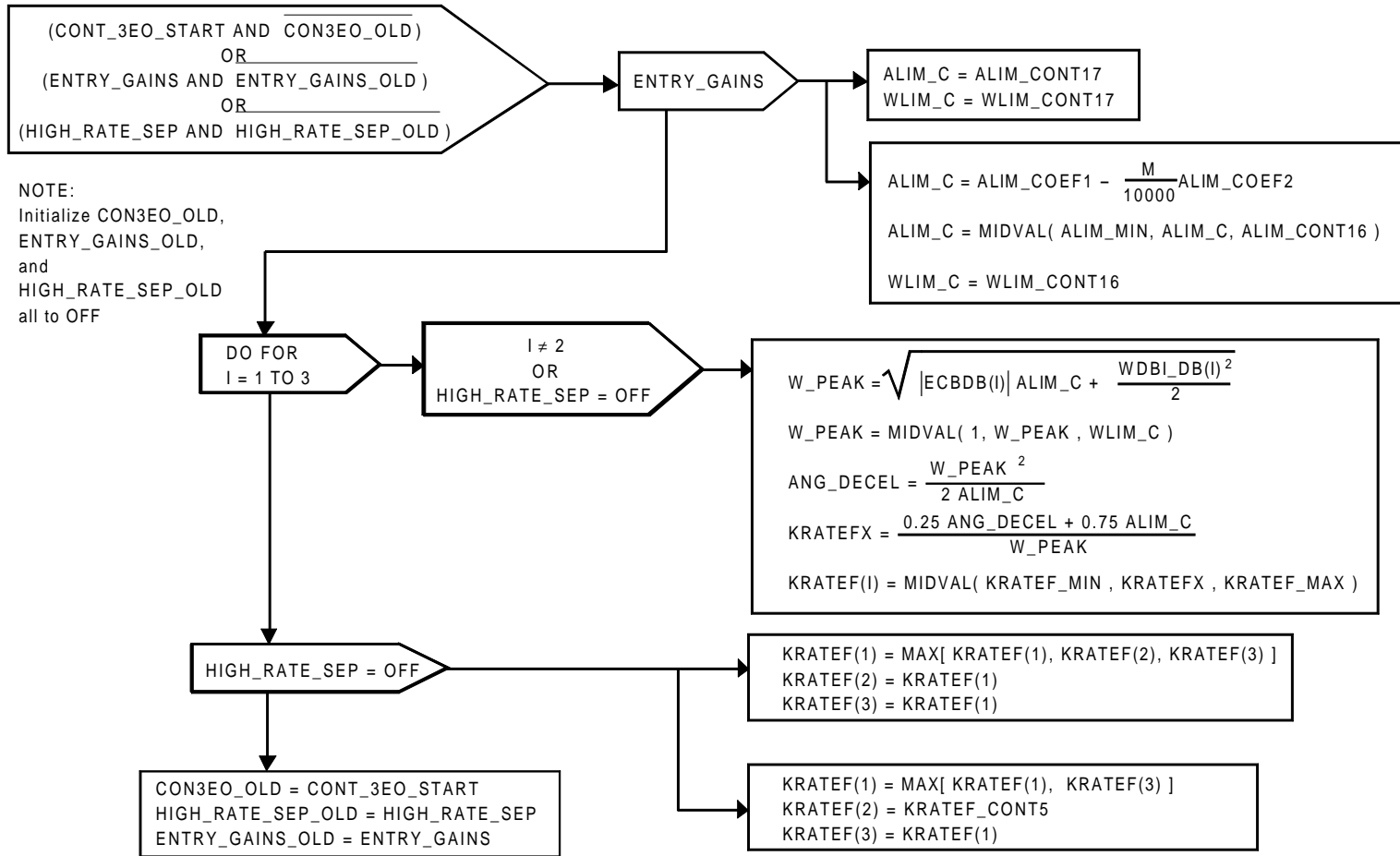


FIGURE 4.3.4-4B.(3) DBACCEL_CONT_3EO Function Module, Detailed Diagram (Sheet 3 of 4)

② DBACCEL_CONT_3EO ACCELERATION LIMITING

Perform this module after STEERING GAIN SELECTION and after the summing function that computes $\bar{A}DBI_DB$ each pass through DBACCEL_CONT_3EO

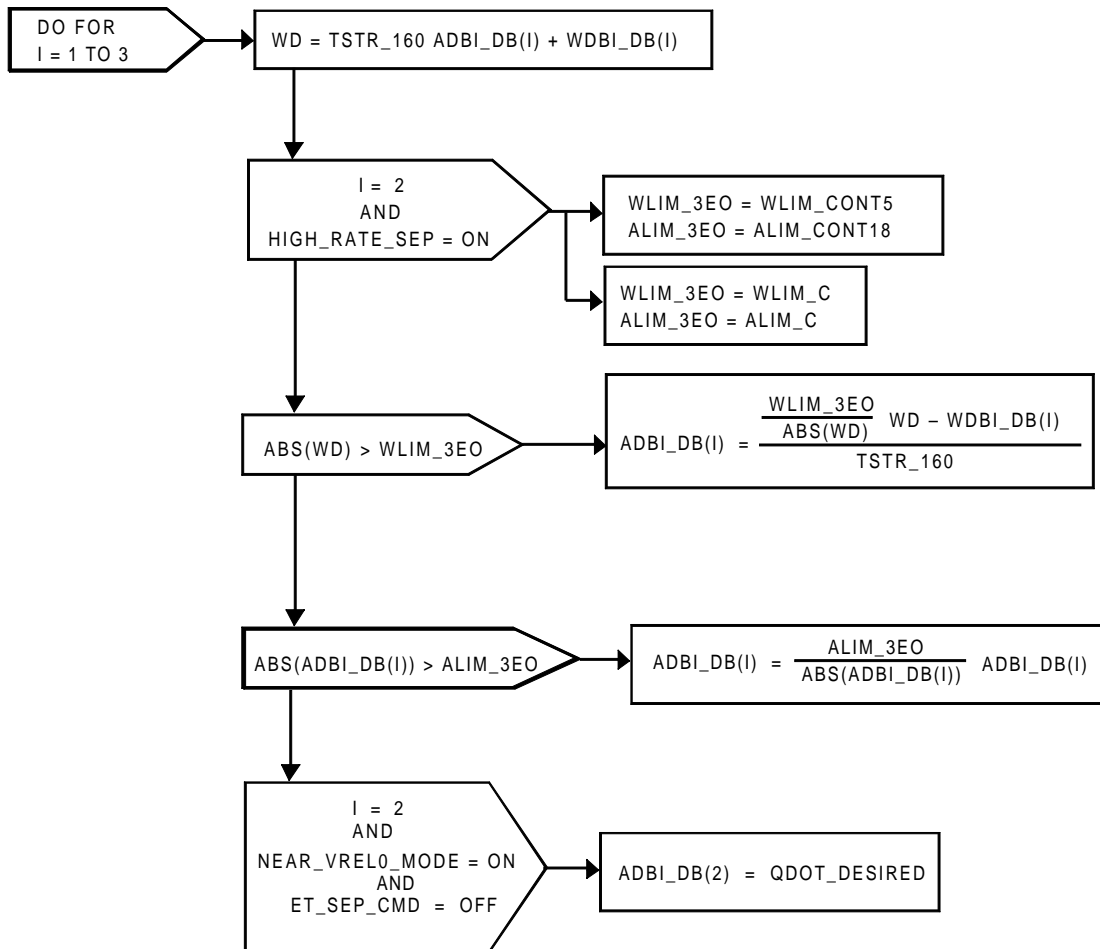
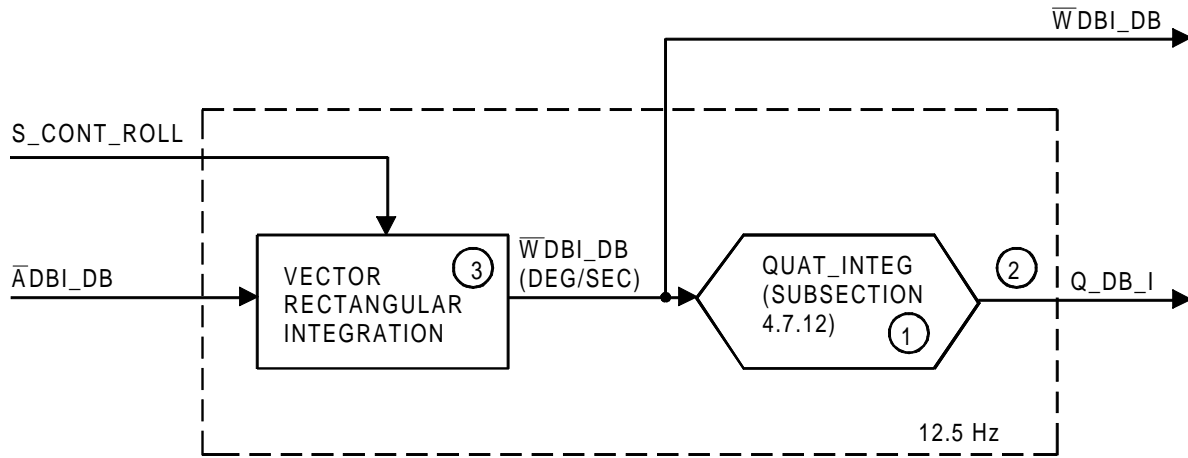


FIGURE 4.3.4-4B.(4) DBACCEL_CONT_3EO Function Module, Detailed Diagram (Sheet 4 of 4)



NOTES:

① $DTCON_M = -\frac{TM}{2} \left(\frac{\pi}{180} \right)$

② Q_DB_I MUST BE NORMALIZED BY A CALL TO QUAT_NORM AT THE 2.08 Hz ALTERNATE RATE JUST PRIOR TO EXECUTION OF DB_QUAT_COPY. NORMALIZATION OF Q_DB_I IS NOT REQUIRED DURING FIRST STAGE.

③ VECTOR RECTANGULAR INTEGRATION

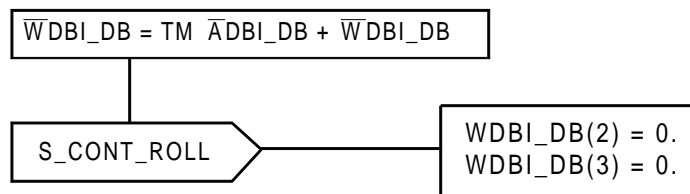
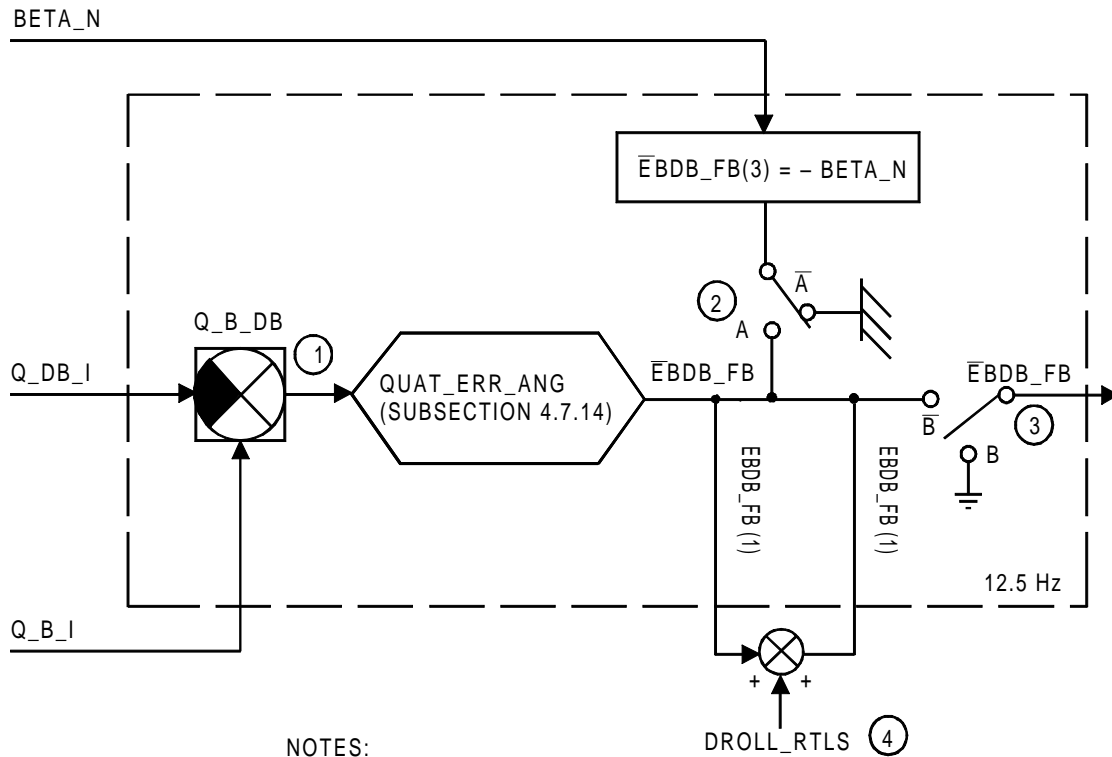


FIGURE 4.3.4-5. DBQUAT Function Module Detailed Diagram



NOTES:

- ① $Q_B_DB = QUAT_MULT(\bar{Q}BIS, \bar{Q}BIV, \bar{Q}DBIS, (-\bar{Q}DBIV))$
- ② $A = MM_CODE_601 \cdot ME_ZERO^* \cdot \overline{CONT_3EO_START}$
- ③ $B = FRZ_3EO$
- ④ ADJUST RTLS ROLL (See Figure 4.3.4-6.(2)) **

* IF MM_CODE_601 = ON OCCURS AFTER ME_ZERO = ON, THEN \bar{A} IS SELECTED.

** ROLL_COUNT IS COMPUTED REGARDLESS OF FRZ_3EO STATE

FIGURE 4.3.4-6.(1) ATTERRS Function Module Detailed Diagram (Sheet 1 of 2)

④ ADJUST RTLS ROLL:

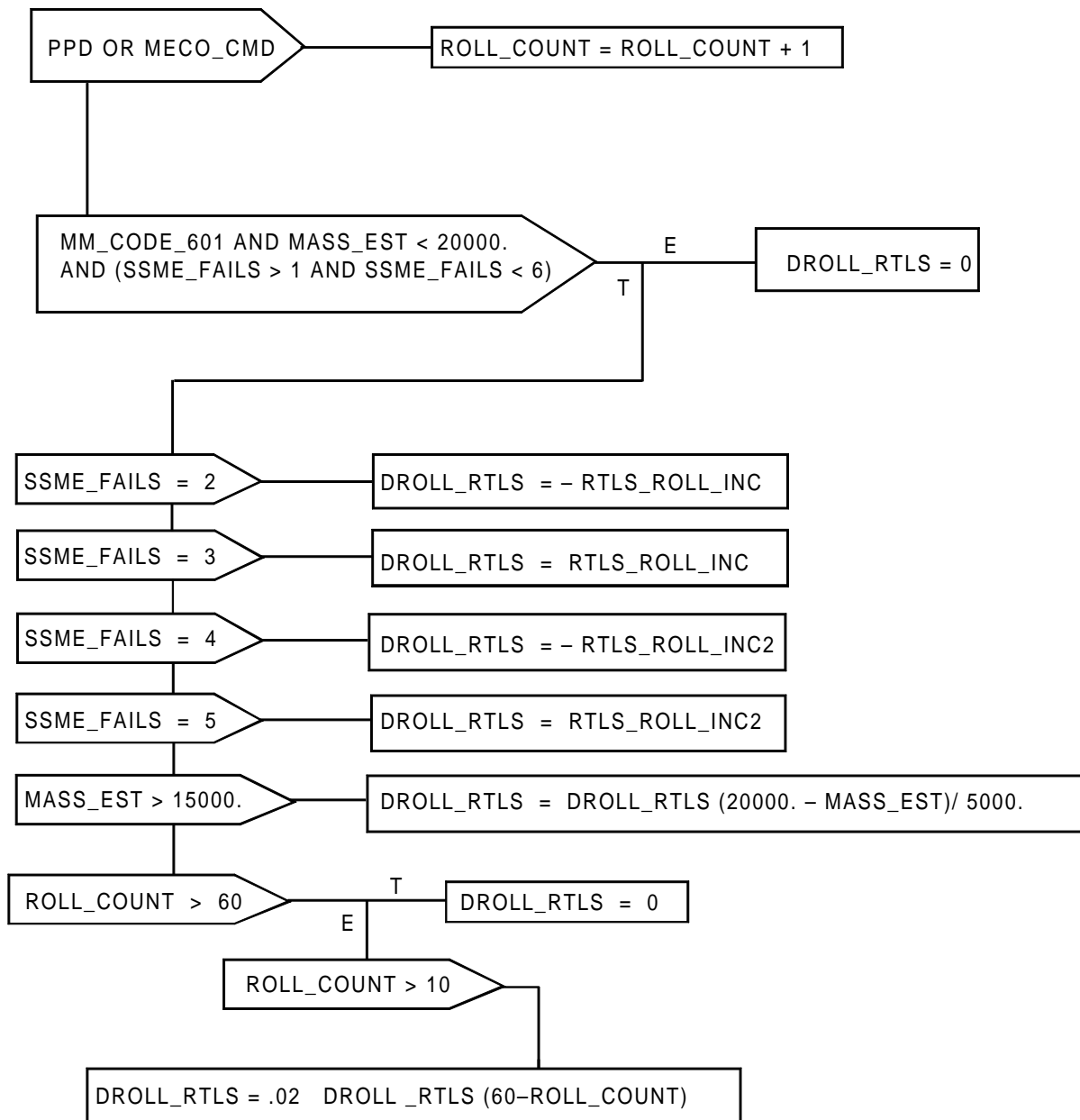
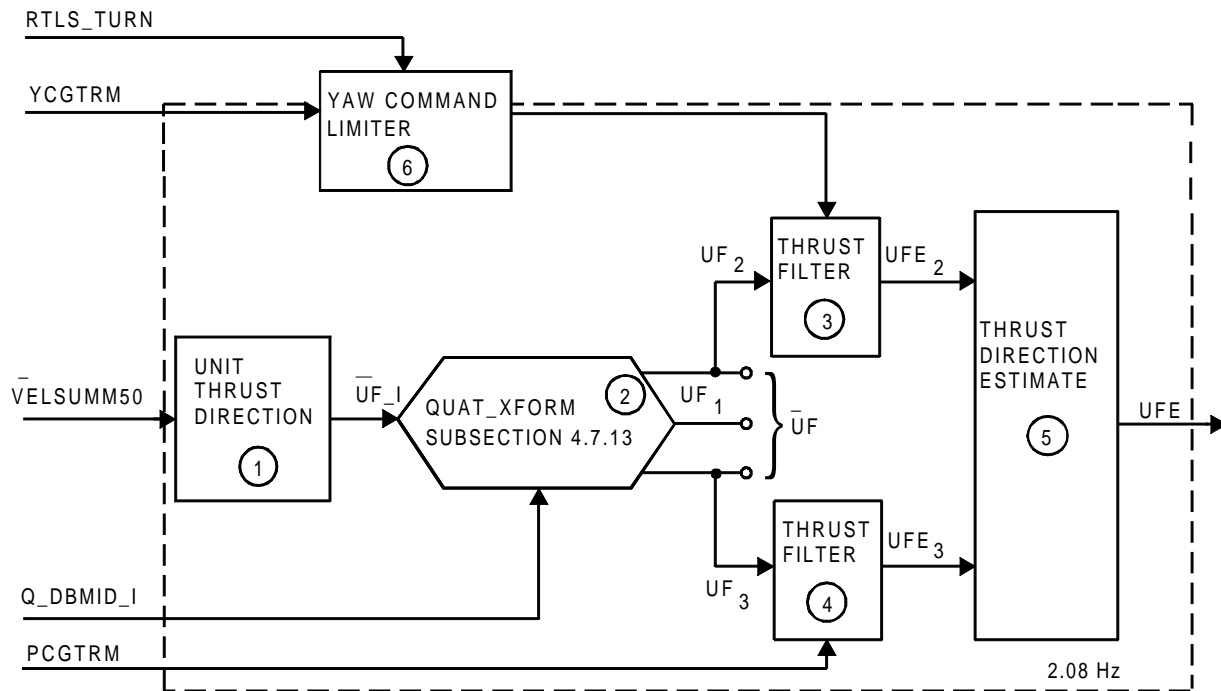


FIGURE 4.3.4-6.(2) ATTERRS Function Module Detailed Diagram (Sheet 2 of 2)



NOTES:

① $\bar{U}_F_I = \text{UNIT} (\bar{V}_{\text{ELSUMM50}} - \bar{V}_{\text{ELSUMM50_OLD}}) * \text{WHERE } \bar{V}_{\text{ELSUMM50}} = \bar{V}_{\text{IMU_CURRENT}}$
 $\bar{V}_{\text{ELSUMM50_OLD}} = \bar{V}_{\text{ELSUMM50}}$

② $\bar{U}_F \leftarrow \text{QUAT_XFORM} (\bar{Q}_{\text{DBMIDIS}}, \bar{Q}_{\text{DBMIDIV}}, \bar{U}_F_I) *$

③ $U_{F_2} = \text{MIDVAL} (-U_{F_2_LIM}, U_{F_2}, +U_{F_2_LIM}) - (YCGTRM) \text{ RAD_PER_DEG} *$
 $U_{F_2} = \text{MIDVAL} (-U_{F_2_RLIM_TTDF}, (U_{F_2} - U_{F_2}) \text{ GUF}, +U_{F_2_RLIM_TTDF}) + U_{F_2} *$
 $U_{FE_2} = U_{F_2} + (YCGTRM) \text{ RAD_PER_DEG}$

④ $U_{F_3} = \text{MIDVAL} (U_{F_3_MIN}, U_{F_3}, U_{F_3_MAX}) - (PCGTRM) \text{ RAD_PER_DEG} *$
 $U_{F_3} = \text{MIDVAL} (-U_{F_3_RLIM_TTDF}, (U_{F_3} - U_{F_3}) \text{ GUF}, +U_{F_3_RLIM_TTDF}) + U_{F_3} *$
 $U_{FE_3} = U_{F_3} + (PCGTRM) \text{ RAD_PER_DEG}$

⑤ $U_{FE_1} = \text{SQRT} (1. - U_{FE_2}^2 - U_{FE_3}^2)$

* BYPASS THESE EQUATIONS ON INITIALIZATION PASSES AND UPDATE $\bar{V}_{\text{ELSUMM50_OLD}}$, U_{F_2} AND U_{F_3} AS SHOWN IN TABLE 4.3.4-2.

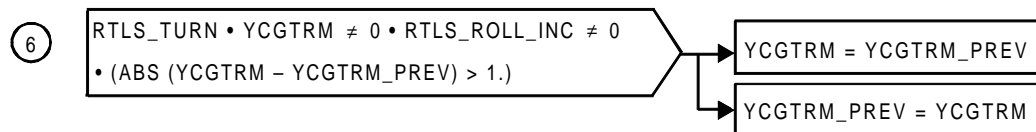


FIGURE 4.3.4-7. THRUST_DIRECTION_FILTER Function Module Detailed Diagram

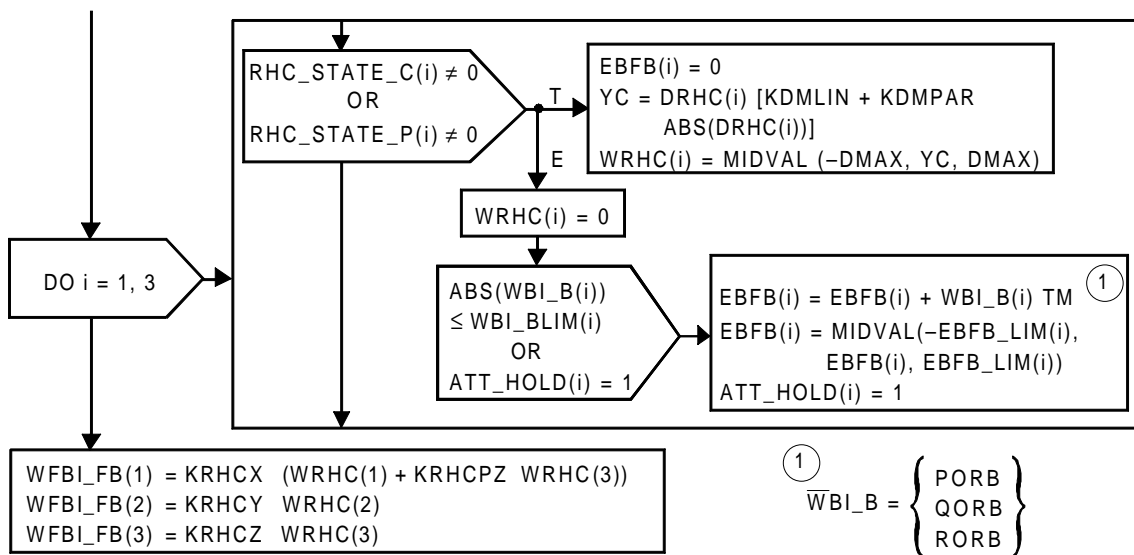
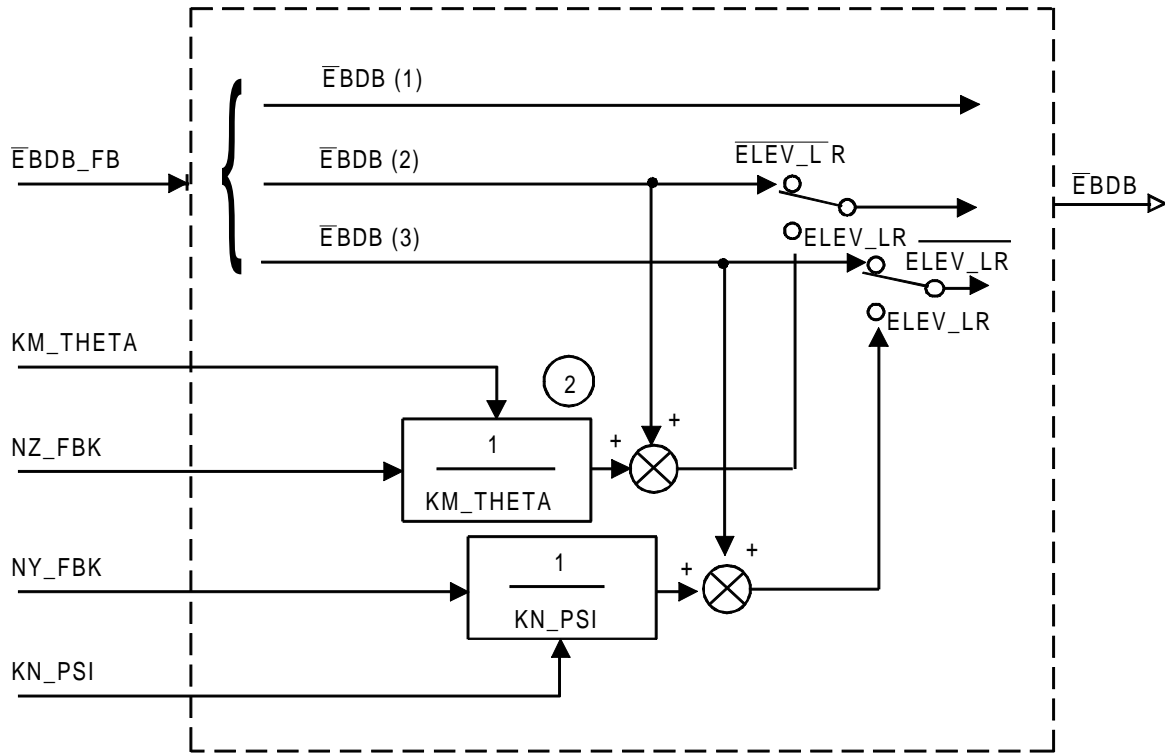
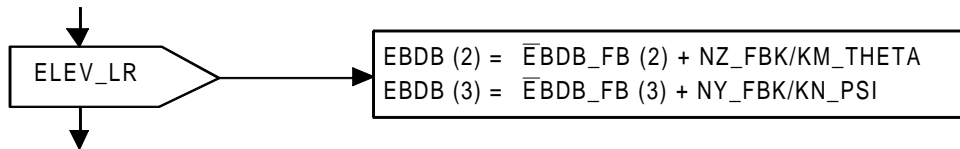


FIGURE 4.3.4-8. MANUAL_ASCENT_GUIDANCE Detailed Block Diagram



(1) REQUIRES ONLY ONE SWITCH



(2) DEFAULT VALUE FOR DIVISION (1/KM_THETA AND 1/KN_PSI) IS 10.0 DIVISOR
 NEVER EXPECTED TO BE LESS THAN 0.1

FIGURE 4.3.4-9. DISPERRS Detailed Block Diagram

4.3.5 Guidance/Control Steering Interface Principal Function Tables

The guidance/control steering interface principal function input and output tables, along with the I-load, K-load and Constant tables, are presented in Tables 4.3.5-1 through 4.3.5-4. The automated Interface Definition Document (IDD) table (Table 4.3.5-1) defines signal (parameter) interface requirements either between hardware (LRU) and software elements or between software elements and other software elements.* 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.

* A GN&C software element is either a sequenced principal function (PF), crew generated specialist/display function, or an OPS display function.

Note that IDD output (source) tables that reflect parameters going to input (destination) TLM will 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.

The input variable cross-references are listed below in Table 4.3.5-0.

Table 4.3.5-0.G/C STEER Input Variable Cross-reference		
MSID	Local Name	Source Name
V90H1969C	PHI_WING	PHI_CMD

TABLE 4.3.5-1. INPUT FUNCTIONAL PARAMETERS FOR GUIDANCE/CONTROL STEERING INTERFACE (G4.175)

FSSR NAME	M/S ID	NOMENCLATURE	SOURCE	UNITS	DATA TYPE	P R E C	LAST CR	R E V
ALPHA_N	V90H2246C	NAV DERIVED ANGLE OF ATTACK	A/E ATT PROC	DEG	SPL		93017G	*
ALT	V95H0175CA	CURR ORB ALT ABOVE REF ELLIPSOID	RTLS UPP	FT	SPL		93017G	*
ALT	V95H0175CB	CURR ORB ALT ABOVE REF ELLIPSOID	ASC UPP	FT			93017G	*
ATTCMD	V90X1712X	STEERING MODE FLAG	ASC DAP		BD		93017G	*
ATTFILT	V90X1709X	FILTER ACTUAL BODY ATTITUDE FLAG	ASC DAP		BD		93017G	*
AUTO	V90X1710X	AUTO GUIDANCE MODE FLAG	ASC DAP		BD		93017G	*
AUTO_MODE	V94J1401C	CONTINGENCY AUTO MODE INDEX	PW CONT GUID				89990E	
BETA_N	V90H2249C	INERTIAL SIDESLIP ANGLE	A/E ATT PROC	DEG	SPL		93017G	*
CLOCK/CLOCKTIME	V91W5000C	CLOCK-COMPUTER(GMT)	FCOS	S			93160B	*
CONT_3EO_REGION	V90J0108C	CONTINGENCY 3 E/O REGION INDEX	CONT 3E/O GUID				93017G	*
CONT_3EO_START	V90X0909X	CONTINGENCY 3 E/O START FLAG	CONT 3E/O GUID		BD		93017G	*
CONT_ATT_HOLD	V90X3298X	CONTINGENCY ATTITUDE HOLD FLAG	CONT 3E/O GUID		BD		92504G	
CONT_SERC	V93X6682X	CONT SINGLE ENG ROLL CNTL FLAG	XXXXXX TRAJ 1 DISP		BD		93017G	*
CONT_SERC	V93X6682XA	CONT SINGLE ENG ROLL CNTL FLAG	ASC DAP		BD		93017G	*
CONT_SERC	V93X6682XB	CONT SINGLE ENG ROLL CNTL FLAG	XXXXXX TRAJ 2 DISP		BD		93017G	*
CONT_SERC	V93X6682XC	CONT SINGLE ENG ROLL CNTL FLAG	RTLS TRAJ 2 DISP		BD		93017G	*
DAMAN/RHC(1)	V96H0005CB	MANUAL ROLL CMD	3-AX RHC SOP	DEG				
DEMAN/RHC(2)	V96H0007CB	MANUAL PITCH CMD	3-AX RHC SOP	DEG				
DYMAN/RHC(3)	V96H0004CA	MANUAL YAW COMMAND	3-AX RHC SOP	DEG				
ECAL_PITCH_UP	V90X3237X	ECAL PITCH UP COMMAND	CONT 3E/O GUID		BD		92504G	
ELEV_LR	V90X1716X	ELEVON LOAD RELIEF FLAG	ASC DAP					
ENTRY_GAINS	V90X0911X	MNVR TO ENTRY ATTITUDE FLAG	CONT 3E/O GUID		BD		90705H	
ET_SEP_CMD	V90X8250X	ET SEPARATION CMD FLAG	ET SEP SEQ		BD		93017G	*
FRZCMD	V90X1714X	FREEZE DESIRED BODY CMD FLAG	ASC DAP		BD		93017G	*
FRZ_3EO	V90X0912X	CONTINGENCY 3 E/O FREEZE FLAG	CONT 3E/O GUID		BD		90705H	
HIGH_RATE_SEP	V90X6989X	HIGH RATE ET SEPARATION FLAG	PW CONT GUID		BD		90705H	
HIGH_RATE_SEP	V90X6989XA	HIGH RATE ET SEPARATION FLAG	CONT 3E/O GUID		BD		90964	
IZC(X)	V90U2095CA	X-UNIT VECTOR TO LANDING SITE	ASC 2STG GUID				90550	
IZC(X)	V90U2095CB	X-UNIT VECTOR TO LANDING SITE	PW RTLS GUID				90550	
IZC(Y)	V90U2096CA	Y-UNIT VECTOR TO LANDING SITE	ASC 2STG GUID				90550	
IZC(Y)	V90U2096CB	Y-UNIT VECTOR TO LANDING SITE	PW RTLS GUID				90550	
IZC(Z)	V90U2097CA	Z-UNIT VECTOR TO LANDING SITE	ASC 2STG GUID				90550	
IZC(Z)	V90U2097CB	Z-UNIT VECTOR TO LANDING SITE	PW RTLS GUID				90550	
KM_THETA	V90U1767C	VARIABLE GAIN ATTITUDE-PITCH	ASC DAP	DEG/S/DEG			90185A	
KN_PSI	V90U1768C	VARIABLE GAIN ATTITUDE-YAW	ASC DAP	DEG/S/DEG			90185A	
LAMC(X)	V90U1954CA	X-COMP OF M50 REF THR VECTOR	ASC 2STG GUID				93017G	*
LAMC(X)	V90U1954CB	X-COMP OF M50 REF THR VECTOR	PW RTLS GUID				93017G	*
LAMC(X)	V90U1954CF	X-COMP OF M50 REF THR VECTOR	PW CONT GUID				93017G	*
LAMC(Y)	V90U1955CA	Y-COMP OF M50 REF THR VECTOR	ASC 2STG GUID				93017G	*
LAMC(Y)	V90U1955CB	Y-COMP OF M50 REF THR VECTOR	PW RTLS GUID				93017G	*
LAMC(Y)	V90U1955CF	Y-COMP OF M50 REF THR VECTOR	PW CONT GUID				93017G	*
LAMC(Z)	V90U1956CA	Z-COMP OF M50 REF THR VECTOR	ASC 2STG GUID				93017G	*
LAMC(Z)	V90U1956CB	Z-COMP OF M50 REF THR VECTOR	PW RTLS GUID				93017G	*
LAMC(Z)	V90U1956CF	Z-COMP OF M50 REF THR VECTOR	PW CONT GUID				93017G	*
LAMDC(X)	V90U1957CA	X-M50 DESIRED THR TRNING RATE VCTR	ASC 2STG GUID	RAD/S			93017G	*
LAMDC(X)	V90U1957CB	X-M50 DESIRED THR TRNING RATE VCTR	PW RTLS GUID	RAD/S			93017G	*

TABLE 4.3.5-1. INPUT FUNCTIONAL PARAMETERS FOR GUIDANCE/CONTROL STEERING INTERFACE (G4.175)

FSSR NAME	M/S ID	NOMENCLATURE	SOURCE	UNITS	DATA TYPE	P R E C	LAST CR	R E V
LAMDC(X)	V90U1957CE	X-M50 DESIRED THR TRNING RATE VCTR	PW CONT GUID	RAD/S			93017G	*
LAMDC(Y)	V90U1958CA	Y-M50 DESIRED THR TRNING RATE VCTR	ASC 2STG GUID	RAD/S			93017G	*
LAMDC(Y)	V90U1958CB	Y-M50 DESIRED THR TRNING RATE VCTR	PW RTLS GUID	RAD/S			93017G	*
LAMDC(Y)	V90U1958CE	Y-M50 DESIRED THR TRNING RATE VCTR	PW CONT GUID	RAD/S			93017G	*
LAMDC(Z)	V90U1959CA	Z-M50 DESIRED THR TRNING RATE VCTR	ASC 2STG GUID	RAD/S			93017G	*
LAMDC(Z)	V90U1959CB	Z-M50 DESIRED THR TRNING RATE VCTR	PW RTLS GUID	RAD/S			93017G	*
LAMDC(Z)	V90U1959CE	Z-M50 DESIRED THR TRNING RATE VCTR	PW CONT GUID	RAD/S			93017G	*
M/CURR_ORB_MASS/WEIGHT	V90U1961CF	CURRENT VEHICLE MASS	ASC 1STG GUID	SLUGS			93017G	*
M/CURR_ORB_MASS/WEIGHT	V90U1961CG	CURRENT VEHICLE MASS	ASC 2STG GUID	SLUGS			93017G	*
M/CURR_ORB_MASS/WEIGHT	V90U1961CH	CURRENT VEHICLE MASS	PW RTLS GUID	SLUGS			93017G	*
M/CURR_ORB_MASS/WEIGHT	V90U1961CL	CURRENT VEHICLE MASS	PW CONT GUID	SLUGS			93017G	*
MASS_EST	V90U0389C	MASS ESTIMATE	ASC DAP	SLUG	SPL		92186A	
MC_PPD	V90X0447X	RTLS MC PITCH DOWN MNVR DISCRETE	PW RTLS GUID		BD		93087E	
MECO_CMD	V90X8569XA	MECO COMMAND FLAG	SME OPS		BD		93017G	*
ME_ZERO	V90X8638X	ZERO THRUST	MSC				92522D	
MM101_INIT	V90X1764X	FIRST-TIME ASC_DAP SCHEDULED FLAG	ASC DAP		BD		93017G	*
MM_CODE_102/MM_102	V90X8158X	MAJOR MODE 102 FLAG	MSC				93012D	
MM_CODE_103/MM_103	V90X8156X	MAJOR MODE 103 FLAG	MSC				93012D	
MM_CODE_601/MM_601	V90X8194X	MAJOR MODE 601 FLAG	MSC		BD		93012D	
NEAR_VREL0_MODE	V90X3238X	NEAR RTLS VREL=0 CONTINGENCY FLAG	PW CONT GUID		BD		92504G	
NY_FBK	V90A1766C	COMPENSATED LATERAL ACCEL ERROR	ASC DAP	DEG/S	SPL		93017G	*
NZ_FBK	V90A1765C	COMPENSATED NORMAL ACCEL ERROR	ASC DAP	DEG/S	SPL		93017G	*
PCGTRM	V90U0103C	NET PITCH TRIM THRUST ANGLE	ASC DAP	DEG	SPL		90011E	
PEGCMD	V90X1757X	S2G STEERING MODE FLAG	ASC DAP		BD		93017G	*
PHI_CMD	V90H1969CA	COMMANDED ROLL ANGLE	ASC 2STG GUID	RAD			89461	
PHI_CMD	V90H1969CB	COMMANDED ROLL ANGLE	PW RTLS GUID	RAD			89461	
PPD	V90X1760X	RTLS POWERED PITCH DOWN MNVR FLAG	ASC DAP		BD		93017G	*
PPD_DELAY	V90X7000X	PPD DELAY DISCRETE	PW RTLS GUID		BD		89990E	
P_ORB	V90R5301CA	SELECTED RGA ROLL RATE	SF	DEG/S			93017G	*
QBI_READY	V90X2250X	BODY WRT M50 DAP QUAT READY FLAG	ASC DAP		BD		89986H	
QDESIRED_INIT	V90R3294C	DESIRED INITIAL MC PITCH RATE	PW CONT GUID	DEG/S	SPL		92504G	
QDOT_DESIRED	V90A3239C	DESIRED MATED COAST PITCH ACCEL	CONT 3E/O GUID	DEG/S2	SPL		92504G	
Q_BOD_M50(1)/Q_B_I(1)	V90U2240CA	M50 TO BODY QUAT MEASURED ELEM 1	A/E ATT PROC		SPL		93017G	*
Q_BOD_M50(2)/Q_B_I(2)	V90U2241CA	M50 TO BODY QUAT MEASURED ELEM 2	A/E ATT PROC		SPL		93017G	*
Q_BOD_M50(3)/Q_B_I(3)	V90U2242CA	M50 TO BODY QUAT MEASURED ELEM 3	A/E ATT PROC		SPL		93017G	*
Q_BOD_M50(4)/Q_B_I(4)	V90U2243CA	M50 TO BODY QUAT MEASURED ELEM 4	A/E ATT PROC		SPL		93017G	*
Q_CB_M50(1)/Q_GCB_1	V90U1949CA	M50-TO-CMD BODY QUATERNION ELE 1	ASC 1STG GUID					
Q_CB_M50(1)/Q_GCB_1	V90U1949CB	M50-TO-CMD BODY QUATERNION ELE 1	PW RTLS GUID					
Q_CB_M50(1)/Q_GCB_1	V90U1949CC	M50-TO-CMD BODY QUATERNION ELE 1	PW CONT GUID				89990E	
Q_CB_M50(1)/Q_GCB_1	V90U1949CD	M50-TO-CMD BODY QUATERNION ELE 1	CONT 3E/O GUID				90964	
Q_CB_M50(2)/Q_GCB_2	V90U1950CA	M50-TO-CMD BODY QUATERNION ELE 2	ASC 1STG GUID					
Q_CB_M50(2)/Q_GCB_2	V90U1950CB	M50-TO-CMD BODY QUATERNION ELE 2	PW RTLS GUID					
Q_CB_M50(2)/Q_GCB_2	V90U1950CC	M50-TO-CMD BODY QUATERNION ELE 2	PW CONT GUID				89990E	
Q_CB_M50(2)/Q_GCB_2	V90U1950CD	M50-TO-CMD BODY QUATERNION ELE 2	CONT 3E/O GUID				90964	
Q_CB_M50(3)/Q_GCB_3	V90U1951CA	M50-TO-CMD BODY QUATERNION ELE 3	ASC 1STG GUID					
Q_CB_M50(3)/Q_GCB_3	V90U1951CB	M50-TO-CMD BODY QUATERNION ELE 3	PW RTLS GUID					

TABLE 4.3.5-1. INPUT FUNCTIONAL PARAMETERS FOR GUIDANCE/CONTROL STEERING INTERFACE (G4.175)

FSSR NAME	M/S ID	NOMENCLATURE	SOURCE	UNITS	DATA TYPE	P R E C	LAST CR	R E V
Q_CB_M50(3)/Q_GCB_3	V90U1951CC	M50-TO-CMD BODY QUATERNION ELE 3	PW CONT GUID				89990E	
Q_CB_M50(3)/Q_GCB_3	V90U1951CD	M50-TO-CMD BODY QUATERNION ELE 3	CONT 3E/O GUID				90964	
Q_CB_M50(4)/Q_GCB_4	V90U1952CA	M50-TO-CMD BODY QUATERNION ELE 4	ASC 1STG GUID					
Q_CB_M50(4)/Q_GCB_4	V90U1952CB	M50-TO-CMD BODY QUATERNION ELE 4	PW RTLS GUID					
Q_CB_M50(4)/Q_GCB_4	V90U1952CC	M50-TO-CMD BODY QUATERNION ELE 4	PW CONT GUID				89990E	
Q_CB_M50(4)/Q_GCB_4	V90U1952CD	M50-TO-CMD BODY QUATERNION ELE 4	CONT 3E/O GUID				90964	
Q_ORB/Q	V90R5321CA	SELECTED RGA PITCH RATE	SF	DEG/S			93017G	*
RHC_STATE_C(1)	V96U0995C	COMMANDER RHC OUT OF DETENT ROLL	3-AX RHC SOP					
RHC_STATE_C(2)	V96U0996C	COMMANDER RHC OUT OF DETENT PITCH	3-AX RHC SOP					
RHC_STATE_C(3)	V96U0997C	COMMANDER RHC OUT OF DETENT YAW	3-AX RHC SOP					
RHC_STATE_P(1)	V96U0998C	PILOT RHC OUT OF DETENT ROLL	3-AX RHC SOP					
RHC_STATE_P(2)	V96U0999C	PILOT RHC OUT OF DETENT PITCH	3-AX RHC SOP					
RHC_STATE_P(3)	V96U1000C	PILOT RHC OUT OF DETENT YAW	3-AX RHC SOP					
RTLS_TURN	V90X1756X	INITIATE RTLS TURNAROUND MNVR FLAG	ASC DAP		BD		93017G	*
R_AVGG(1)	V95H0185CA	X-COMP OF CUR SHUTTLE POS VCTR M50	RTLS UPP	FT	DPL		93017G	*
R_AVGG(1)	V95H0185CB	X-COMP OF CUR SHUTTLE POS VCTR M50	ASC UPP	FT	DPL		93017G	*
R_AVGG(2)	V95H0186CA	Y-COMP OF CUR SHUTTLE POS VCTR M50	RTLS UPP	FT	DPL		93017G	*
R_AVGG(2)	V95H0186CB	Y-COMP OF CUR SHUTTLE POS VCTR M50	ASC UPP	FT	DPL		93017G	*
R_AVGG(3)	V95H0187CA	Z-COMP OF CUR SHUTTLE POS VCTR M50	RTLS UPP	FT	DPL		93017G	*
R_AVGG(3)	V95H0187CB	Z-COMP OF CUR SHUTTLE POS VCTR M50	ASC UPP	FT	DPL		93017G	*
R_ORB	V90R5341CA	SELECTED RGA YAW RATE	SF	DEG/S			93017G	*
S1G	V90X1713X	STG1 GUIDANCE DISCRETE	ASC DAP		BD		93017G	*
SEC_ME_FL_CNFM	V90X1721X	2ND SSME FAIL CONFIRM	ASC DAP				89990E	
SELECT_VREL0_CONT	V90X3299X	CONTINGENCY VREL = 0 SELECT FLAG	PW CONT GUID		BD		92504G	
SRBSEP	V90X1761X	SRB SEPARATION SUBPHASE FLAG	ASC DAP		BD		93017G	*
SSME_FAILS	V90J1763C	SSME FAILURE STATUS FLAG	ASC DAP		HXS		93017G	*
S_CONT_ROLL	V90X8915X	CONTINGENCY ROLL HEADS UP FLAG	PW CONT GUID				89990E	
S_CONT_ROLL_INHIB	V90X8916X	CONTINGENCY ROLL INHIBIT FLAG	PW CONT GUID				89990E	
TLAMC	V90W1953CA	TIME ASSOC W REF THR VECTOR	ASC 2STG GUID	S			93017G	*
TLAMC	V90W1953CB	TIME ASSOC W REF THR VECTOR	PW RTLS GUID	S			93017G	*
T_IMUS	V95W0002C	IMU INPUT TRANS TIME TAG	IMU INT PROC	S	DPL		93017G	*
V_RHO(1)	V95L0215CA	X-COMP OF RELATIVE VEL IN M50	RTLS UPP	FT/S			93090E	
V_RHO(1)	V95L0215CE	X-COMP OF RELATIVE VEL IN M50	ASC UPP	FT/S			93090E	
V_RHO(2)	V95L0216CA	Y-COMP OF RELATIVE VEL IN M50	RTLS UPP	FT/S			93090E	
V_RHO(2)	V95L0216CE	Y-COMP OF RELATIVE VEL IN M50	ASC UPP	FT/S			93090E	
V_RHO(3)	V95L0217CA	Z-COMP OF RELATIVE VEL IN M50	RTLS UPP	FT/S			93090E	
V_RHO(3)	V95L0217CE	Z-COMP OF RELATIVE VEL IN M50	ASC UPP	FT/S			93090E	
WCB2	V90R6980C	COMMANDED BODY PITCH RATE	PW CONT GUID	DEG/S			89990E	
WCB2	V90R6980CA	COMMANDED BODY PITCH RATE	CONT 3E/O GUID	DEG/S			90964	
YCGTRM	V90U0104C	NET YAW TRIM THRUST ANGLE	ASC DAP	DEG		SPL	90011E	
Y_SYM_GUID(X)	V90U8918B	X-M50 RIGHT WING UNIT VECTOR	PW CONT GUID				89990E	
Y_SYM_GUID(Y)	V90U8919B	Y-M50 RIGHT WING UNIT VECTOR	PW CONT GUID				89990E	
Y_SYM_GUID(Z)	V90U8920B	Z-M50 RIGHT WING UNIT VECTOR	PW CONT GUID				89990E	
ZTRANS	V90X1755X	RTLS ET SEP MNVR FLAG	ASC DAP		BD		79967F	

TABLE 4.3.5-1. INPUT FUNCTIONAL PARAMETERS FOR GUIDANCE/CONTROL STEERING INTERFACE (G4.175)

FSSR NAME	M/S ID	NOMENCLATURE	SOURCE	UNITS	DATA TYPE	P R E C	LAST CR	R E V
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NOTE: REFERENCE TABLE 1.3-1 FOR EXPLANATION OF DATA ELEMENTS.

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TABLE 4.3.5-2. OUTPUT FUNCTIONAL PARAMETERS FROM GUIDANCE/CONTROL STEERING INTERFACE (G4.175)

FSSR NAME	M/S ID	NOMENCLATURE	DESTINATION	UNITS	DATA TYPE	P R E C	LAST CR	R E V
EBDB(1)	V95H3534C	ROLL ERROR DISPLAY	ASC ADI PROC TLM	DEG			89219B	
EBDB(2)	V95H3532C	PITCH ERROR DISPLAY	ASC ADI PROC TLM	DEG			89219B	
EBDB(3)	V95H3533C	YAW ERROR DISPLAY	ASC ADI PROC TLM	DEG			89219B	
EBFB(1)	V95H3523C	BODY ROLL ATT ERROR	ASC DAP DL FMT 21/3 GRTLS DAP	DEG	SPL		93017G	*
EBFB(2)	V95H3521C	BODY PITCH ATT ERROR	ASC 1STG GUID ASC DAP DL FMT 21/3 GRTLS DAP	DEG	SPL		93017G	*
EBFB(3)	V95H3522C	BODY YAW ATT ERROR	ASC DAP DL FMT 21/3 GRTLS DAP	DEG	SPL		93017G	*
ECBDB(1)	V95H3550C	ROLL ATT ERR(CMD-TO-DESIRED)	PW CONT GUID	DEG			89990E	
S_TDF	V90X8914X	THRST DIR FLTR READY FLAG	PW CONT GUID		BD		89990E	
UFE(2)	V95H3551C	Y-COMP ESTMTD FLTRD THRST DIR	PW CONT GUID				89990E	
UFE(3)	V95H3552C	Z-COMP ESTMTD FLTRD THRST DIR	PW CONT GUID				89990E	
WFBI_FB1	V95H3528C	ROLL RATE, FLIGHT BODY-INERTIAL	ASC DAP DL FMT 21/2 GRTLS DAP	DEG/S	SPL		93017G	*
WFBI_FB2	V95H3526C	PITCH RATE, FLIGHT BODY-INERTIAL	ASC DAP DL FMT 21/2 GRTLS DAP	DEG/S	SPL		93017G	*
WFBI_FB3	V95H3527C	YAW RATE, FLIGHT BODY-INERTIAL	ASC DAP DL FMT 21/2 GRTLS DAP	DEG/S	SPL		93017G	*

NOTE: REFERENCE TABLE 1.3-1 FOR EXPLANATION OF DATA ELEMENTS.

Rate Codes: (HDR Only) 1 = 1 sample/sec 2 = 5 samples/sec 3 = 12.5 samples/sec 4 = 25 samples/sec 5 = 100 samples/sec
(HDR and LDR) A = 1 sample/sec B = 5 samples/sec C = 12.5 samples/sec D = 25 samples/sec E = 100 samples/sec

TABLE 4.3.5-3. GUIDANCE/CONTROL STEERING INTERFACE (G4.175) I-LOADS

FSSR NAME	MSID	ENG UNITS	DT	PR	D	S	PR FCTN	MC	CAT	LAST CR	R E V
ALIM_ATT	V97U1400C	DEG/SEC**2	F	S	D	C	G4.175	00	ADF	DC0599	
ALIM_COEF1	V97U8556C	DEG/SEC**2	F	S	D	P	G4.175	00	A3F	91036B	
ALIM_COEF2	V97U8557C	DEG/(SLUG*SEC**2)	F	S	D	P	G4.175	00	A3F	91036B	
ALIM_CONT1	V97U8245C	DEG/SEC**2	F	S	D	P	G4.175	00	ACS	DC2067	
ALIM_CONT10	V97U8254C	DEG/SEC**2	F	S	D	P	G4.175	00	ACS	DC2067	
ALIM_CONT11	V97U8255C	DEG/SEC**2	F	S	D	P	G4.175	00	ACS	DC2067	
ALIM_CONT12	V97U8256C	DEG/SEC**2	F	S	D	P	G4.175	00	ACS	DC2067	
ALIM_CONT13	V97U8481C	DEG/SEC**2	F	S	D	P	G4.175	00	ACS	DC2067	
ALIM_CONT14	V97U8482C	DEG/SEC**2	F	S	D	P	G4.175	00	ACS	DC2067	
ALIM_CONT15	V97U8483C	DEG/SEC**2	F	S	D	P	G4.175	00	ACS	DC2067	
ALIM_CONT16	V97U8552C	DEG/SEC**2	F	S	D	P	G4.175	00	A3F	91036B	
ALIM_CONT17	V97U8553C	DEG/SEC**2	F	S	D	P	G4.175	00	A3F	91036B	
ALIM_CONT18	V97U8554C	DEG/SEC**2	F	S	D	P	G4.175	00	A3F	91036B	
ALIM_CONT2	V97U8246C	DEG/SEC**2	F	S	D	P	G4.175	00	ACS	DC2067	
ALIM_CONT3	V97U8247C	DEG/SEC**2	F	S	D	P	G4.175	00	ACS	DC2067	
ALIM_CONT4	V97U8248C	DEG/SEC**2	F	S	D	P	G4.175	00	ACS	DC2067	
ALIM_CONT5	V97U8249C	DEG/SEC**2	F	S	D	P	G4.175	00	ACS	DC2067	
ALIM_CONT6	V97U8250C	DEG/SEC**2	F	S	D	P	G4.175	00	ACS	DC2067	
ALIM_CONT7	V97U8251C	DEG/SEC**2	F	S	D	P	G4.175	00	ACS	DC2067	
ALIM_CONT8	V97U8252C	DEG/SEC**2	F	S	D	P	G4.175	00	ACS	DC2067	
ALIM_CONT9	V97U8253C	DEG/SEC**2	F	S	D	P	G4.175	00	ACS	DC2067	
ALIM_MCPD	V97U1577C	DEG/SEC**2	F	S	D	C	G4.175	00	ZFR	93087E	
ALIM_MIN	V97U8555C	DEG/SEC**2	F	S	D	P	G4.175	00	A3F	91036B	
ALIM_PPD	V97U1401C	DEG/SEC**2	F	S	D	C	G4.175	00	ZFR	90014G	
ALIM_S1G	V97U1402C	DEG/SEC**2	F	S	D	C	G4.175	00	ZFR	90014G	
ALIM_S2G	V97U1403C	DEG/SEC**2	F	S	D	C	G4.175	00	ZFR	90014G	
ALIM_SEPD	V97U8416C	DEG/SEC**2	F	S	D	P	G4.175	00	ACS	DC2067	
ALIM_TURN	V97U1404C	DEG/SEC**2	F	S	D	C	G4.175	00	ZFR	90014G	
ALIM_ZTRANS	V97U1331C	DEG/SEC**2	F	S	D	C	G4.175	00	ZSR	90007G	
ALT_HEAT	V97U1408C	FT	F	S	D	C	G4.104 G4.175	00	ZFR	92522D	
CONT_HIGH_SEP_RATE	V97U8434C	DEG/SEC	F	S	D	P	G4.175 G4.5 G4.6	00	ACG	92504G	
C_ALF_BIAS	V97U1418C	ND	F	S	D	C	G4.175	00	ZFR	90014G	
C_ALF_LIM	V97U1419C	ND	F	S	D	C	G4.175	00	ZFR	90014G	
DMAX	V97U1676C	DEG	F	S	D	P	G4.175	00	ZSR	90007G	
EBFB_LIM(1)	V97U1324C	DEG	F	S	D	P	G4.175	00	ZSR	90007G	
EBFB_LIM(2)	V97U1325C	DEG	F	S	D	P	G4.175	00	ZSR	90007G	
EBFB_LIM(3)	V97U1326C	DEG	F	S	D	P	G4.175	00	ZSR	90007G	
GUF	V97U1799C	ND	F	S	D	C	G4.175	00	ZSR	90007G	
KDMLIN	V97U8755C	DEG/DEG	F	S	D	P	G4.175	00	ZSR	90007G	
KDMPAR	V97U1804C	DEG/DEG**2	F	S	D	P	G4.175	00	ZSR	90007G	
KERR_ATT	V97U1805C	SEC**-2	F	S	D	C	G4.175	00	ADF	DC0599	
KERR_CONT	V97U8272C	SEC**-2	F	S	D	P	G4.175	00	ACS	DC2067	
KERR_CONT1	V97U8484C	SEC**-2	F	S	D	P	G4.175	00	ACS	DC2067	
KERR_MCPD	V97U1579C	SEC**-2	F	S	D	C	G4.175	00	ZFR	93087E	

TABLE 4.3.5-3. GUIDANCE/CONTROL STEERING INTERFACE (G4.175) I-LOADS

FSSR NAME	MSID	ENG UNITS	DT	PR	D	S	PR FCTN	MC	CAT	LAST CR	R E V
KERR_PPD	V97U1806C	SEC**-2	F	S	D	C	G4.175	00	ZFR	90014G	
KERR_S1G	V97U1807C	SEC**-2	F	S	D	C	G4.175	00	ZFR	90014G	
KERR_S2G	V97U1808C	SEC**-2	F	S	D	C	G4.175	00	ZFR	90014G	
KERR_SEPD	V97U8417C	SEC**-2	F	S	D	P	G4.175	00	ACS	DC2067	
KERR_TURN	V97U1809C	SEC**-2	F	S	D	C	G4.175	00	ZFR	90014G	
KERR_ZTRANS	V97U1330C	SEC**-2	F	S	D	C	G4.175	00	ZSR	90007G	
KRATED_ATT	V97U2041C	SEC**-1	F	S	D	C	G4.175	00	ADF	DC0599	
KRATED_CONT1	V97U8257C	SEC**-1	F	S	D	P	G4.175	00	ACS	DC2067	
KRATED_CONT2	V97U8258C	SEC**-1	F	S	D	P	G4.175	00	ACS	DC2067	
KRATED_CONT3	V97U8259C	SEC**-1	F	S	D	P	G4.175	00	ACS	DC2067	
KRATED_CONT4	V97U8485C	SEC**-1	F	S	D	P	G4.175	00	ACS	DC2067	
KRATED_MCPD	V97U1576C	SEC**-1	F	S	D	C	G4.175	00	ZFR	93087E	
KRATED_PPD	V97U2042C	SEC**-1	F	S	D	C	G4.175	00	ZFR	90014G	
KRATED_S1G	V97U2043C	SEC**-1	F	S	D	C	G4.175	00	ZFR	90014G	
KRATED_S2G	V97U2044C	SEC**-1	F	S	D	C	G4.175	00	ZFR	90014G	
KRATED_SEPD	V97U8418C	SEC**-1	F	S	D	P	G4.175	00	ACS	DC2067	
KRATED_TURN	V97U2045C	SEC**-1	F	S	D	C	G4.175	00	ZFR	90014G	
KRATED_ZTRANS	V97U1328C	SEC**-1	F	S	D	C	G4.175	00	ZFR	90014G	
KRATEF_ATT	V97U2046C	SEC**-1	F	S	D	C	G4.175	00	ADF	DC0599	
KRATEF_CONT1	V97U8273C	SEC**-1	F	S	D	P	G4.175	00	ACS	DC2067	
KRATEF_CONT10	V97U8282C	SEC**-1	F	S	D	P	G4.175	00	ACS	DC2067	
KRATEF_CONT11	V97U8283C	SEC**-1	F	S	D	P	G4.175	00	ACS	DC2067	
KRATEF_CONT12	V97U8415C	SEC**-1	F	S	D	P	G4.175	00	ACS	DC2067	
KRATEF_CONT13	V97U8486C	SEC**-1	F	S	D	P	G4.175	00	ACS	DC2067	
KRATEF_CONT14	V97U8487C	SEC**-1	F	S	D	P	G4.175	00	ACS	DC2067	
KRATEF_CONT15	V97U8488C	SEC**-1	F	S	D	P	G4.175	00	ACS	DC2067	
KRATEF_CONT2	V97U8274C	SEC**-1	F	S	D	P	G4.175	00	ACS	DC2067	
KRATEF_CONT3	V97U8275C	SEC**-1	F	S	D	P	G4.175	00	ACS	DC2067	
KRATEF_CONT4	V97U8276C	SEC**-1	F	S	D	P	G4.175	00	ACS	DC2067	
KRATEF_CONT5	V97U8277C	SEC**-1	F	S	D	P	G4.175	00	ACS	DC2067	
KRATEF_CONT6	V97U8278C	SEC**-1	F	S	D	P	G4.175	00	ACS	DC2067	
KRATEF_CONT7	V97U8279C	SEC**-1	F	S	D	P	G4.175	00	ACS	DC2067	
KRATEF_CONT8	V97U8280C	SEC**-1	F	S	D	P	G4.175	00	ACS	DC2067	
KRATEF_CONT9	V97U8281C	SEC**-1	F	S	D	P	G4.175	00	ACS	DC2067	
KRATEF_MAX	V97U8559C	SEC**-1	F	S	D	P	G4.175	00	A3F	91036B	
KRATEF_MCPD	V97U1570C	SEC**-1	F	S	D	C	G4.175	00	ZFR	93087E	
KRATEF_MIN	V97U8558C	SEC**-1	F	S	D	P	G4.175	00	A3F	91036B	
KRATEF_PDLY	V97U8221C	SEC**-1	F	S	D	P	G4.175	00	ACS	DC2067	
KRATEF_PPD	V97U2047C	SEC**-1	F	S	D	C	G4.175	00	ZFR	90014G	
KRATEF_S1G	V97U2048C	SEC**-1	F	S	D	C	G4.175	00	ZFR	90014G	
KRATEF_S2G	V97U2049C	SEC**-1	F	S	D	C	G4.175	00	ZFR	90014G	
KRATEF_SEPD	V97U8431C	SEC**-1	F	S	D	P	G4.175	00	ACS	DC2067	
KRATEF_SEPDY	V97U8432C	SEC**-1	F	S	D	P	G4.175	00	ACS	DC2067	
KRATEF_TURN	V97U2050C	SEC**-1	F	S	D	C	G4.175	00	ZFR	90014G	
KRATEF_ZTRANS	V97U1327C	SEC**-1	F	S	D	C	G4.175	00	ZSR	90007G	
KRHCPZ	V97U2051C	DEG/DEG	F	S	D	P	G4.175	00	ZSR	90007G	
KRHXCX	V97U2052C	(DEG/SEC)/DEG	F	S	D	P	G4.175	00	ZSR	90007G	

TABLE 4.3.5-3. GUIDANCE/CONTROL STEERING INTERFACE (G4.175) I-LOADS

FSSR NAME	MSID	ENG UNITS	DT	PR	D	S	PR FCTN	MC	CAT	LAST CR	R E V
KRHCY	V97U2053C	(DEG/SEC)/DEG	F	S	D	P	G4.175	00	ZSR	90007G	
KRHCZ	V97U2054C	(DEG/SEC)/DEG	F	S	D	P	G4.175	00	ZSR	90007G	
MET_HEAT	V97U2060C	SEC	F	S	D	C	G4.104	00	ZFR	92522D	
							G4.175				
RTLS_ROLL_INC	V97U0097C	DEG	F	S	D	C	G4.175	00	ACS	92186A	
RTLS_ROLL_INC2	V97U0098C	DEG	F	S	D	P	G4.175	00	ACS	92186A	
S_ALF_BIAS	V97U2236C	ND	F	S	D	C	G4.175	00	ZFR	90014G	
S_ALF_LIM	V97U2237C	ND	F	S	D	C	G4.175	00	ZFR	90014G	
UF2_LIM	V97U2270C	ND	F	S	D	C	G4.175	00	ZSR	90007G	
UF2_RLIM	V97U2271C	SEC**-1	F	S	D	A	G4.175	00	ZFR	90014G	
UF3_MAX	V97U2272C	ND	F	S	D	C	G4.175	00	ZSR	90007G	
UF3_MIN	V97U2273C	ND	F	S	D	C	G4.175	00	ZSR	90007G	
UF3_RLIM	V97U2274C	SEC**-1	F	S	D	A	G4.175	00	ZFR	90014G	
WBI_BLIM(1)	V97U1321C	DEG/SEC	F	S	D	P	G4.175	00	ZSR	90007G	
WBI_BLIM(2)	V97U1322C	DEG/SEC	F	S	D	P	G4.175	00	ZSR	90007G	
WBI_BLIM(3)	V97U1323C	DEG/SEC	F	S	D	P	G4.175	00	ZSR	90007G	
WLIM_ATT	V97U2319C	DEG/SEC	F	S	D	C	G4.175	00	ADF	DC0599	
WLIM_CONT1	V97U8419C	DEG/SEC	F	S	D	P	G4.175	00	ACS	DC2067	
WLIM_CONT10	V97U8428C	DEG/SEC	F	S	D	P	G4.175	00	ACS	DC2067	
WLIM_CONT11	V97U8429C	DEG/SEC	F	S	D	P	G4.175	00	ACS	DC2067	
WLIM_CONT12	V97U8430C	DEG/SEC	F	S	D	P	G4.175	00	ACS	DC2067	
WLIM_CONT13	V97U8489C	DEG/SEC	F	S	D	P	G4.175	00	ACS	DC2067	
WLIM_CONT14	V97U8490C	DEG/SEC	F	S	D	P	G4.175	00	ACS	DC2067	
WLIM_CONT15	V97U8491C	DEG/SEC	F	S	D	P	G4.175	00	ACS	DC2067	
WLIM_CONT16	V97U8560C	DEG/SEC	F	S	D	P	G4.175	00	A3F	91036B	
WLIM_CONT17	V97U8561C	DEG/SEC	F	S	D	P	G4.175	00	A3F	91036B	
WLIM_CONT2	V97U8420C	DEG/SEC	F	S	D	P	G4.175	00	ACS	DC2067	
WLIM_CONT3	V97U8421C	DEG/SEC	F	S	D	P	G4.175	00	ACS	DC2067	
WLIM_CONT4	V97U8422C	DEG/SEC	F	S	D	P	G4.175	00	ACS	DC2067	
WLIM_CONT5	V97U8423C	DEG/SEC	F	S	D	P	G4.175	00	ACS	DC2067	
WLIM_CONT6	V97U8424C	DEG/SEC	F	S	D	P	G4.175	00	ACS	DC2067	
WLIM_CONT7	V97U8425C	DEG/SEC	F	S	D	P	G4.175	00	ACS	DC2067	
WLIM_CONT8	V97U8426C	DEG/SEC	F	S	D	P	G4.175	00	ACS	DC2067	
WLIM_CONT9	V97U8427C	DEG/SEC	F	S	D	P	G4.175	00	ACS	DC2067	
WLIM_MCPD	V97U1578C	DEG/SEC	F	S	D	C	G4.175	00	ZFR	93087E	
WLIM_PPD	V97U2320C	DEG/SEC	F	S	D	C	G4.175	00	ZFR	90014G	
WLIM_S1G	V97U2321C	DEG/SEC	F	S	D	C	G4.175	00	ZFR	90014G	
WLIM_S2G	V97U2322C	DEG/SEC	F	S	D	C	G4.175	00	ZFR	90014G	
WLIM_SEPD	V97U8433C	DEG/SEC	F	S	D	P	G4.175	00	ACS	DC2067	
WLIM_TURN	V97U2323C	DEG/SEC	F	S	D	C	G4.175	00	ZFR	90014G	
WLIM_ZTRANS	V97U1329C	DEG/SEC	F	S	D	C	G4.175	00	ZSR	90007G	

NOTE: REFERENCE TABLE 1.3-1 FOR EXPLANATION OF DATA ELEMENTS.

TABLE 4.3.5-4. GUIDANCE/CONTROL STEERING INTERFACE (G4.175) K-LOADS

FSSR NAME DESCRIPTION	MSID	MC	KLOAD VALUE	ENG UNITS	DT	P R	S	PR FCTN	LAST CR	R E V
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NO REQUIREMENTS

NOTE: REFERENCE TABLE 1.3-1 FOR EXPLANATION OF DATA ELEMENTS.

TABLE 4.3.5-5. GUIDANCE/CONTROL STEERING INTERFACE (G4.175) CONSTANTS

FSSR NAME DESCRIPTION	MSID	MC	CONSTANT VALUE	ENG UNITS	DT	P R	S	PR FCTN	LAST CR	R E V
DEG_PER_RAD RADIAN TO DEGREE CONVERSION FACTOR	V97U0112C	00	+5.72957795131E+01	DEG/RAD	F		S	C A6.9 G4.10 G4.126 G4.127 G4.128 G4.175 G4.20 G4.201 G4.204 G4.208 G4.21 G4.213 G4.220 G4.226 G4.227 G4.23 G4.234 G4.237 G4.24 G4.25 G4.35 G4.36 G4.5 G4.6 G4.66 G4.8 G4.9 G4.97 G5.26 G5.27 V4.10 V4.11 V4.11B V4.11C V4.9A	93090E	
DTCON_M RATE VECTOR GAIN FOR QUATERNION INTEGRATION	V97U6141C	00	-6.981	E-04	SEC/DEG	F	S	C G4.175	90374C	
NULLVEC(1) NULL VECTOR ELEM 1	V97U6250C	00	+0		ND	I	S	C G4.175	90374C	
NULLVEC(2) NULL VECTOR ELEM 1	V97U6251C	00	+0		ND	I	S	C G4.175	90374C	
NULLVEC(3) NULL VECTOR ELEM 1	V97U6252C	00	+0		ND	I	S	C G4.175	90374C	

TABLE 4.3.5-5. GUIDANCE/CONTROL STEERING INTERFACE (G4.175) CONSTANTS

FSSR NAME DESCRIPTION	MSID	MC	CONSTANT VALUE	ENG UNITS	DT	P R	S	PR FCTN	LAST CR	R E V
RAD_PER_DEG DEGREE TO RADIAN CONVERSION FACTOR	V97U0383C	00	+1.7453293	E-02	RAD/DEG	F	S	C A6.9 G4.1 G4.126 G4.127 G4.128 G4.144 G4.15 G4.158 G4.175 G4.20 G4.201 G4.204 G4.205 G4.209 G4.210 G4.211 G4.213 G4.220 G4.223 G4.226 G4.227 G4.236 G4.237 G4.3 G4.35 G4.36 G4.7 G4.72 G4.9 G4.97 G5.27	93090E	
TM DAP MEDIUM CYCLE TIME	V97U6238C	00	+8.0	E-02	SEC	F	D	C G4.175 G4.176 G4.227 G4.36	90374C	
TSTR_160 STEER CYCLE SAMPLE PERIOD	V97U6240C	00	+1.60	E-01	SEC	F	S	C G4.175	90374C	
TSTR_480 STEER CYCLE SAMPLE PERIOD	V97U6241C	00	+4.80	E-01	SEC	F	S	C G4.175	90374C	
UNIT_QUAT(1) UNIT QUATERNION, STRUCTURE ELEM 1	V97U6253C	00	+1		ND	I	S	C G4.175	90374C	
UNIT_QUAT(2) UNIT QUATERNION, STRUCTURE ELEM 2	V97U6254C	00	+0		ND	I	S	C G4.175	90374C	
UNIT_QUAT(3) UNIT QUATERNION, STRUCTURE ELEM 3	V97U6255C	00	+0		ND	I	S	C G4.175	90374C	
UNIT_QUAT(4) UNIT QUATERNION, STRUCTURE ELEM 4	V97U6256C	00	+0		ND	I	S	C G4.175	90374C	

TABLE 4.3.5-5. GUIDANCE/CONTROL STEERING INTERFACE (G4.175) CONSTANTS

FSSR NAME DESCRIPTION	MSID	MC	CONSTANT VALUE	ENG UNITS	DT	P R	S	PR FCTN	LAST CR	R E V
UZ(1) UNIT Z-AXIS ELEM 1	V97U6257C	00	+0	ND	I		S	P G4.175	90374C	
UZ(2) UNIT Z-AXIS ELEM 2	V97U6258C	00	+0	ND	I		S	P G4.175	90374C	
UZ(3) UNIT Z-AXIS ELEM 3	V97U6259C	00	+1	ND	I		S	P G4.175	90374C	

NOTE: REFERENCE TABLE 1.3-1 FOR EXPLANATION OF DATA ELEMENTS.

4.6 ASCENT/ENTRY ATTITUDE PROCESSOR (ATT_PROC)

4.6.1 Introduction

The function of the attitude processor is to derive attitude-related data for several user principal functions. These data include attitude, display variables, air data, and velocity coordinatized in the body frame. ATT_PROC is intended to meet these requirements in all flight phases except on-orbit operations (OPS 2 and 8).

ATT_PROC is structured to derive the vehicle attitude quaternion using a selected IMU at low rate (1.04 Hz), and to propagate the attitude by integrating a quaternion differential equation, driven by selected prefiltered RGA outputs, at high rate (12.5 Hz in ascent and transition, 6.25 Hz in entry). All other quantities are derived using the attitude quaternion, at the rate and during those mission phases in which users require them.

In writing software requirements, approximations have been introduced in place of exact solutions to minimize CPU usage. These approximations are indicated in the text.

The overview, functional design, and moding of ATT_PROC are given in Section 4.6.3.

The attitude processor consists of eight modules, as listed in Table 4.6.1-1 and defined in Sections 4.6.4.1 to 4.6.4.8.

Certain I-loads supporting this principal function are required to be in contiguous areas of memory in a specific sequence. Section 4.11 of the STS 83-0002 Level C ASCENT/RTLS Guidance FSSR describes this requirement.

Table 4.6.1-1. ATT_PROC Function Modules	
Subsection	Function Module
4.6.4.1	ATT_PROC_INIT
4.6.4.2	ATT_PROC_OUTER
4.6.4.3	ATT_PROC_INNER
4.6.4.4	ATT_PROC_EULER
4.6.4.5	ATT_PROC_DISP
4.6.4.6	ATT_PROC_PREFIL
4.6.4.7	ATT_PROC_RGASW
4.6.4.8	ADI_QUAT_UPLINK

4.6.2 Interface Tables

Attitude processor input/output is listed in Table 4.6.2-1. Intermodule variables are listed in Table 4.6.2-2. Initialization requirements are listed in Table 4.6.2-3; I-loads/K-loads are listed in Table 4.6.2-4. Constants are listed in Table 4.6.2-5.

Table 4.6.2-1. ATT_PROC Input/Output								
Module	Name	Description	Source or Destination	Type	Range	Unit	Rate Required/Produced (Hz)*	
ATT_PROC_INIT	<u>Inputs</u>							
	DP(K)	Pitch-outer roll gimbal nonorthogonality, IMU _K , K = 1, 2, 3	IMU GND CAL (V4.9A)	A(3)S	±0.006	rad	on demand	
	CLOCKTIME	Current time	FCOS	S	0 to 3.16224 E7		once	
	T_CLUSTERM50(K)	M50 wrt stable number transform matrix, IMU _K , K = 1, 2, 3	IMU ORB A/CAL (4.208) IMU GC ALIGN (V4.11)	A(3)M	±1	–	on demand	
	IMU_QUAT_UPD_REQ	IMU reference quat update request	IMU ORB A/CAL (4.208) IMU GC ALIGN (V4.11)	B	0, 1	–	on demand	
	REFS_RDY	Platform reference update flag		B	0,1	–	on demand	
	<u>Outputs</u>							
	SDP(K)	Sine 1/2 gimbal non-orth, IMU _K , K = 1, 2, 3	ORB ATT PROC (4.97)	A(3)S	±1	–	on demand	
	CDP(K)	Cosine 1/2 gimbal non-orth, IMU _K , K = 1, 2, 3	ORB ATT PROC (4.97)	A(3)S	±1	–	on demand	
	Q_SM_M50(K)	Stable member wrt M50 quat, IMU _K , K = 1, 2, 3	ORB ATT PROC (4.97)	Struc (3) S,V	±1	–	on demand	
QREFS_RDY	Stable member wrt M50 quat react flag	TLM, MSC	B	0,1	–	on demand		
ATT_PROC_OUTER	<u>Inputs</u>							
	ORANG(K)	Compensated outer roll gimbal angle, IMU _K , K = 1, 2, 3	IMU INT PROC (4.38)	A(3)S	0–360	deg	1.04/ 1.04/ 1.04	

Table 4.6.2-1. ATT_PROC Input/Output							
Module	Name	Description	Source or Destination	Type	Range	Unit	Rate Required/Produced (Hz)*
ATT_ PROC_ OUTER (Cont.)	PANG(K)	Compensated pitch gimbal angle, IMU _K , K = 1, 2, 3	IMU INT PROC (4.38)	A(3)S	0–360	deg	1.04/ 1.04/ 1.04
	IRANG(K)	Compensated inner roll gimbal angle, IMU _K , K = 1, 2, 3	IMU INT PROC (4.38)	A(3)S	0–15, 345–360	deg	1.04/ 1.04/ 1.04
	AZANG(K)	Compensated azimuth gimbal angle, IMU _K , K = 1, 2, 3	IMU INT PROC (4.38)	A(3)S	0–360	deg	1.04/ 1.04/ 1.04
	SEL_IMU_ID	Selected IMU number	IMU RM (4.72)	I	1–3	–	1.04/ 1.04/ 1.04
	ATT_DG	Attitude data good flag	IMU RM (4.72)	B	0, 1	–	1.04/ 1.04/ 1.04
	T_IMUS_GA	IMU gimbal angle time tag	IMU INT PROC (4.38)	S	0	s	1.04/ 1.04/ 1.04
	Q_B_M50	Body wrt M50 quaternion computed on-orbit	ORB ATT PROC (4.97)	Struc S, V	±1	–	once**
	R_AVGG	Shuttle position vector	ASC UPP (4.19) RTLS UPP (4.20) ENTRY UPP (4.23) TAEM UPP (4.24) A/L UPP (4.25)	V	TBD	ft	1.04/ 1.04/ 1.04
	I_YD_M50***	Unit vector normal to insertion plane, in M50 system	ASC UPP (4.19) ASC 2STG GUID (4.2) PW RTLS GUID (4.4)	V	±1	–	¥
	MM_CODE_101	Major Mode 101 flag	MSC	B	0, 1	–	1.04/ 1.04/ 1.04
MM_CODE_102	Major Mode 102 flag	MSC	B	0, 1	–	1.04/ 1.04/ 1.04	

Table 4.6.2-1. ATT_PROC Input/Output								
Module	Name	Description	Source or Destination	Type	Range	Unit	Rate Required/Produced (Hz)*	
ATT_PROC_OUTER (Cont.)	MM_CODE_103	Major Mode 103 flag	MSC	B	0, 1	–	1.04/ 1.04/ 1.04	
	MM_CODE_601	Major Mode 601 flag	MSC	B	0, 1	–	1.04/ 1.04/ 1.04	
	\bar{V} _AVGG	Shuttle velocity vector	ASC UPP (4.19) RTLS UPP (4.20) ENT UPP (4.23) TAEM UPP (4.24) A/L UPP (4.25)	V	$\pm 2.62E4$	ft/s	1.04/ 1.04/0	
	ATT_SEL_SW(K)	ADI mode switch ADI _K	GN&C SW RM (4.180)	A(2)I		–	1.04/ 1.04/0	
	IMU_ALIGN_DISP	IMU ALIGN DISP active flag	MSC	B	0, 1	–	0/1.04 ^{YYY} / 0	
	SDP(K)	Sine 1/2 gimbal non-orth, IMU _K , K = 1, 2, 3	ORB ATT PROC (4.97)	A(3)S	± 1	–	0/1.04 ^{YY} /0	
	CDP(K)	Cosine 1/2 gimbal non-orth, IMU _K , K = 1, 2, 3	ORB ATT PROC (4.97)	A(3)S	± 1	–	0/ 1.04 ^{YY} /0	
	Q_SM_M50(K)	Stable member wrt M50 quaternion, IMU _K	ORB ATT PROC (4.97)	Struc (3) S, V	± 1	–	0/ 1.04 ^{YY} /0	
	<u>Outputs</u>							
	PSI_IMU(K)	M50 to body Euler angle, IMU _K , K = 1, 2, 3	IMU ALIGN DISP (6.26)	A(3)S	0–360	deg	0/ 1.04 ^{YYY} / 0	
	THETA_IMU(K)	M50 to body Euler angle, IMU _K , K = 1, 2, 3	IMU ALIGN DISP (6.26)	A(3)S	0–90, 270–360	deg	0/ 1.04 ^{YYY} / 0	
	PHI_IMU(K)	M50 to body Euler angle, IMU _K , K = 1, 2, 3	IMU ALIGN DISP (6.26)	A(3)S	0–360	deg	0/ 1.04 ^{YYY} / 0	
	Q_SM_SM(K)	Platform wrt platform quaternion, IMU pair K	IMU RM (4.72), TLM	Struc (3) S, V	± 1	–	1.04/ 1.04/ 1.04	

Table 4.6.2-1. ATT_PROC Input/Output							
Module	Name	Description	Source or Destination	Type	Range	Unit	Rate Required/ Produced (Hz)*
ATT_ PROC_ OUTER (Cont.)	Q_ROLL_SM(K)	Roll wrt stable member quaternion IMU _K , K = 1, 2, 3	TLM	Struc (3) S, V	±1	–	1.04/ 1.04/ 1.04
	Q_LVLH_BIASLVLH	LVLH wrt BIASLVLH ADI quat	TLM	Struc S, V	±1	–	1.04/ 1.04/0
	Q_M50_LVLH	M50 wrt LVLH quat	TLM, ASC MNVR DIP (4.210) DEORBIT MNVR DIP (4.211)	Struc S, V	±1	–	1.04/ 1.04/0
ATT_ PROC_ INNER	<u>Inputs</u>						
	CLOCKTIME	Current GMT time	FCOS	S	0	s	12.5/ 12.5/ 6.25
	T_IMUS_GA	IMU gimbal angle time tag	IMU INT PROC (4.38)	S	0	s	12.5/ 12.5/ 6.25
	ATT_DG	Attitude data good flag	IMU RM (4.72)	B	0, 1	–	12.5/ 12.5/ 6.25
	OPS3_INDICATOR	OPS 3 Indicator	MSC	B	0,1	–	12.5/ 12.5/ 6.25
RCO_ENABLE	Remote Control Orbiter Capability Indicator	RM SWITCH/ SURF FB DISP (V5.1.7)	B	0,1	–	12.5/ 12.5/ 6.25	

Table 4.6.2-1. ATT_PROC Input/Output							
Module	Name	Description	Source or Destination	Type	Range	Unit	Rate Required/Produced (Hz)*
	<u>Outputs</u>						
	Q_B_I	Body wrt M50 quaternion	ENT UPP (4.23) G/C STEER (4.175) TRANS DAP (4.201) AS MNVR DIP (4.210) ENT NAV (4.127) DEORB MNVR DIP (4.211) DEORB GUID (4.209) ORB INS GUID (4.3) TLM,GN&C/SM-PL IF (4.111) CONT 3E/O GUID (4.6)	Struc S, V	±1	–	12.5/ 12.5/ 6.25
ATT_PROC_INNER (Cont.)	QBI_VALID	Body wrt M50 quat valid flag	ASC DAP (4.176)	B	0,1	–	once/0/0
	RATE_GYRO_CORR	Compensated body rate	TRANS DAP (4.201)	V	±40	deg	0/12.5/0
	PAYLOAD_PITCH	Pitch Euler angle, EF to body	GN&C/SM-PL IF (4.111)	S	± π	rad	0/0.52 [§] /0
	PAYLOAD_YAW	Yaw Euler angle, EF to body	GN&C/SM-PL IF (4.111)	S	± π/2	rad	0/0.52 [§] /0
	PAYLOAD_ROLL	Roll Euler angle, EF to body	GN&C/SM-PL IF (4.111)	S	± π	rad	0/0.52 [§] /0
	ATTITUDE_INCREMENT	Body attitude increment	TRANS DAP (4.201), TLM, ORB DAP (4.35) ^{§§}	V	±10	deg	0/12.5/0
	T_NOW	M50 to body quaternion time tag	TRANS DAP (4.201) GN&C/SM-PL IF (4.111), TLM	S	0	s	0/12.5/0

Table 4.6.2-1. ATT_PROC Input/Output							
Module	Name	Description	Source or Destination	Type	Range	Unit	Rate Required/Produced (Hz)*
ATT_PROC_EULER	<u>Inputs</u>						
	CONT_2EO_START	Contingency 2EO Start Flag	PW CONT GUID (4.5) XXXXXX TRAJ 1 DISP (6.52) XXXXXX TRAJ 2 DISP (6.53) RTLS TRAJ 2 DISP (6.54)	B	0,1		6.25
	CONT_3EO_START	Contingency 3EO Start Flag	CONT 3E/O GUID (4.6)	B	0, 1		6.25
	ANGLE_CORR_TNTOMAG_RW	Magnetic declination at runway	ENTRY SITE LOOKUP (4.124) ASC SITE LOOKUP (4.288)	S	0-2	rad	0/0/6.25
	V_RHO	Earth-relative velocity	ASC UPP (4.19) RLTS UPP (4.20) ENTRY UPP (4.23) TAEM UPP (4.24) A/L UPP (4.25)	V		ft/s ft/s	6.25/ 6.25/ 6.25
	MM_CODE_601	Major Mode 601 flag	MSC	B	0, 1	-	6.25/0/0
ATT_PROC_EULER (Cont.)	ATT_DG	Attitude data good flag	IMU RM (4.72)	B	0, 1	-	6.25/ 6.25/ 6.25
	<u>Outputs</u>						
	COSPHI	Cos(PHI)	TAEM GUID (4.9) AEROJET DAP (4.36) GRTLS TAEM GUID (4.204) GRTLS DAP (4.227) VERT SIT DIP (4.154), TLM	S	±1	-	0/0/6.25
	SINPHI	Sin(PHI)	AEROJET DAP (4.36) GRTLS DAP (4.227) TLM	S	±1	-	0/0/6.25
	BANK	Bank angle	ENT DIP (4.150)	S	±180	deg	0/0/6.25

Table 4.6.2-1. ATT_PROC Input/Output							
Module	Name	Description	Source or Destination	Type	Range	Unit	Rate Required/ Produced (Hz)*
	BETA_N	Nav-derived sideslip angle	AEROJET DAP (4.36) ET SEP SEQ (4.116) GRTLS DAP (4.227) ENT PREC PRED (4.223) ASC PREC PRED (4.236) ASC NAV (4.15) ENT NAV (4.127) RTLS NAV (4.205) HORIZ SIT SPEC (5.7), TLM, CONT 3E/O GUID (4.6), G/C STEER (4.175)	S	±90	deg	6.25/ 6.25/ 6.25
	EULER_GPS_AVAIL	Topodetic Euler angles availability flag	GPS SOP (4.17)	BD	ON,OFF	-	6.25/ 6.25/ 6.25/

Table 4.6.2-1. ATT_PROC Input/Output							
Module	Name	Description	Source or Destination	Type	Range	Unit	Rate Required/Produced (Hz)*
ATT_PROC_EULER (Cont.)	ALPHA_N	Compensated nav-derived angle of attack	PW CONT GUID (4.5) GC_STEER (4.175) ADTA SOP (4.39) ET SEP SEQ (4.116) RTLS UPP (4.20) ENTRY UPP (4.23) TAEM UPP (4.24) A/L UPP (4.25) AEROJET DAP (4.36) ASC NAV (4.15) ENT NAV (4.127) RTLS NAV (4.205) ENT PREC PRED (4.223) ASC PREC PRED (4.236) GRTLS DAP(4.227), TLM ASC 1STG GUID (4.1), CONT 3E/O GUID (4.6)	S	±180	deg	6.25/ 6.25/ 6.25
	PSI_HSIMV	Heading relative to magnetic north	ENT AREA NAV (4.220) ASC AREA NAV (4.237) E/L ADI PROC (4.103) HSI PROC (4.104)	S	±2π	rad	6.25/0/ 6.25
	PSI	Body yaw angle	TLM GPS SOP (4,17)	S	±180	deg	6.25/ 6.25/ 6.25
	UB1	First component of body frame relative velocity vector	GRTLS DAP (4.227)	S		ft/s	6.25/ 6.25/ 6.25

Table 4.6.2-1. ATT_PROC Input/Output							
Module	Name	Description	Source or Destination	Type	Range	Unit	Rate Required/ Produced (Hz)*
ATT_ PROC_ EULER (Cont.)	THETA	Body pitch angle	RTLS UPP (4.20), A/L UPP (4.25), TAEM UPP (4.24), AEROJET DAP (4.36), PRELAND NAV (4.144), RTLS NAV (4.205), GRTLS DAP (4.227), TLM, VERT SIT DIP (4.154), LANDING SOP (4.57), LG WOW RM (4.243), GPS SOP (4.17), MEDS FC GNC XFER (4.128)	S	±90	deg	6.25/ 6.25/ 6.25
	SINTH	Sin(THETA)	RTLS UPP (4.20), TAEM UPP (4.24), A/L UPP (4.25), AEROJET DAP (4.36), TLM, GRTLS DAP (4.227), HUD PROC (4.252)	S	±1	–	0/0/6.25
	COSTH	Cos(THETA)	TAEM GUID (4.9), RTLS UPP (4.20), TAEM UPP (4.24), A/L UPP (4.25), AEROJET DAP (4.36), GRTLS TAEM GUID (4.204), GRTLS DAP (4.227), TLM, HUD PROC (4.252)	S	±1	–	0/0/6.25

Table 4.6.2-1. ATT_PROC Input/Output								
Module	Name	Description	Source or Destination	Type	Range	Unit	Rate Required/Produced (Hz)*	
ATT_PROC_EULER (Cont.)	PHI	Body roll angle	ENT GUID (4.8), AEROJET DAP (4.36), GRTLS DAP (4.227), ENT DIP (4.150), E/L ADI PROC (4.103), HORZ SIT (5.7), TLM, GRTLS TAEM GUID (4.204), GPS_SOP (4.17), TRANS DAP (4.201)	S	±180	deg	6.25/6.25/6.25	
	MEDS_ALPHA	Angle of attack for MEDS	AMI PROC (4.105), ADTA SOP (4.39)	S	±180	deg	6.25/0/6.25	
	MEDS_BETA	Angle of sideslip for MEDS	MEDS FC GNC XFER (4.128)	S	±90	deg	6.25/0/0	
ATT_PROC_DISP	<u>Inputs</u>							
	V_IMU_CURRENT	Selected total accum sensed velocity	IMU RM (4.72)	V	±10 ⁶	ft/s	0/1.04/0	
	Q_B_I_CMD_DISPLAY	Commanded body wrt M50 quaternion	TRANS DAP (4.201)	Struc S, V	±1	–	0/6.25/0	
	FWD_ATT_REF_PB	Attitude reference PB (LH or RH)	GN&C SW RM (4.180)	B	0, 1	–	6.25/6.25/0	
	DESEL	COAS deselect cmd	STRK/COAS DISP (6.44)	I	0, 1	–	6.25/6.25/0	
	ATT_SEL_SW(K)	ADI mode switch, ADI _k , K =1, 2	GN&C SW RM (4.180)	A(2)I	–1, 0, +1	–	6.25/6.25/0	
	EVENT_14	NAV INIT FLAG	R/S LCH SEQ	B	0,1	–	6.25/0/0	
	MM_CODE_101 MM_CODE_102 MM_CODE_103 MM_CODE_601	Major mode code flags	MSC	B	0, 1	–	6.25/6.25/0	
	<u>Outputs</u>							
	DVB_SEC	Body Delta–V over last 0.960 s	TRANS DAP (4.201) OMS RM (4.92) TLM	V	±10	ft/s	0/1.04/0	

Table 4.6.2-1. ATT_PROC Input/Output							
Module	Name	Description	Source or Destination	Type	Range	Unit	Rate Required/Produced (Hz)*
ATT_PROC_DISP (Cont.)	BODY_ERR_ANG	Body attitude error	E/L ADI PROC (4.103) ASC ADI PROC (4.168), TLM	V	±180	deg	0/6.25/0
	PTCHSINE(K)	ADI pitch sine, ADI _K , K = 1, 2	E/L ADI PROC (4.103) ASC ADI PROC (4.168), TLM	A(2)S	±1	–	3.125/ 3.125/ 3.125
	PTHCOS(K)	ADI pitch cosine, ADI _K , K = 1, 2	E/L ADI PROC (4.103) ASC ADI PROC (4.168), TLM	A(2)S	±1	–	3.125/ 3.125/ 3.125
	YAWSINE(K)	ADI yaw sine, ADI _K , K = 1, 2	E/L ADI PROC (4.103) ASC ADI PROC (4.168) TLM	A(2)S	±1	–	3.125/ 3.125/ 3.125
	YAWCOS(K)	ADI yaw cosine, ADI _K , K = 1, 2	E/L ADI PROC (4.103) ASC ADI PROC (4.168) TLM	A(2)S	±1	–	3.125/ 3.125/ 3.125
	ROLLSINE(K)	ADI roll sine, ADI _K , K = 1, 2	E/L ADI PROC (4.103) ASC ADI PROC (4.168) TLM	A(2)S	±1	–	3.125/ 3.125/ 3.125
	ROLLCOS(K)	ADI roll cosine, ADI _K , K = 1, 2	E/L ADI PROC (4.103) ASC ADI PROC (4.168) TLM	A(2)S	±1	–	3.125/ 3.125/ 3.125
	Q_M50_REF	M50 wrt REF ADI quat	TLM	Struc S, V	±1	–	3.125/ 3.125/0
	Q_M50_INRTL	M50 wrt INRTL ADI quat	TLM	Struc S, V	±1	–	3.125/ 3.125/0
	YAW_IY	HSI yaw (PSI) command	HSI PROC (4.104)	S	±π	rad	§§§

Table 4.6.2-1. ATT_PROC Input/Output							
Module	Name	Description	Source or Destination	Type	Range	Unit	Rate Required/Produced (Hz)*
ATT_PROC_DISP (Cont.)	ROLL_SW	HSI heads up (+1) or heads down (-1) indicator	HSI PROC (4.104) MEDS FC GNC XFER (4.128)	I	±1	–	\$\$\$
ATT_PROC_RGASW	<u>Inputs</u>						
	P_ORB	Roll rate, selected orbiter rate gyro	SF(RGA) (4.71)	S	±40	deg/sec	25/12.5/ 25
	Q_ORB	Pitch rate, selected orbiter rate gyro	SF(RGA) (4.71)	S	±20	deg/sec	25/12.5/ 25
	R_ORB	Yaw rate, selected orbiter rate gyro	SF(RGA) (4.71)	S	±20	deg/sec	25/12.5/ 25
	Q_SRB	Pitch rate, SRB rate gyro	SF(RGA) (4.71)	S	±10	deg/sec	25/0/0
	R_SRB	Yaw rate, SRB rate gyro	SF(RGA) (4.71)	S	±10	deg/sec	25/0/0
	SRB_NULL_CMD	Event 27, indicator	ASC_DAP (4.176)	B	0, 1	–	25/0/0
ADI_QUAT_UPLINK	<u>Outputs</u>						
	None						
	<u>Inputs</u>						
	OP_CODE	OP code for uplink	Uplink buffer	B	0011000 0011101 0011110	–	on demand
	Q_M50_REF_UL	Uplinked M50 wrt REF ADI quat	Uplink buffer	Struc S, V	±1	–	on demand
Q_M50_INRTL_UL	Uplinked M50 wrt INRTL ADI quat	Uplink buffer	Struc S, V	±1	–	on demand	
Q_LVLH_BIASLVLH_UL	Uplinked LVLH wrt BIASLVLH ADI quat	Uplink buffer	Struc S, V	±1	–	on demand	

Table 4.6.2-1. ATT_PROC Input/Output							
Module	Name	Description	Source or Destination	Type	Range	Unit	Rate Required/Produced (Hz)*
ADI_ QUAT_ UPLINK (Cont.)	<u>Outputs</u> None						
<p>* Rates are given as X/Y/Z/, in Hz. Rate is X in ascent, Y in transition, and Z in entry.</p> <p>** Carryover from OPS 2 or OPS 8 to OPS 3.</p> <p>*** Computed once by ATT_PROC_INIT when beginning ascent mode (ATT_MODE=1); then recomputed once by ASC UPP when first entering MM 102.</p> <p>¥ Sampled at 1.04 Hz in MM 101 beginning at platform reference update (REFS_RDY), 102, 103, and 601, and at 0 Hz elsewhere.</p> <p>¥¥ Initialized once on transition to MM 301 by ORB_ATT_PROC and subsequently used at 1.04 Hz.</p> <p>¥¥¥ In MM 301 only.</p> <p>§ During MM 301, 302, 303 only.</p> <p>§§ Carryover to OPS 2.</p> <p>§§§ Computed at 3.125 Hz in MM 101 beginning at platform reference update (REFS_RDY), 102, 103, and 601, and at 0 Hz elsewhere.</p>							

Table 4.6.2-2. ATT_PROC Inter-Module Variables							
Module	Name	Description	Source or Destination	Type	Range	Unit	Rate Required/Produced (Hz)
ATT_PROC	ATT_MODE	ATT_PROC mode	Table 4.6.2-3	I	1-3	-	12.5/ 12.5/ 6.25
ATT_PROC_INIT	<u>Inputs</u>						
	None						
	<u>Outputs</u>						
	$\bar{I}_{YD_M50}^{**}$	Unit vector normal to insertion plane in M50 system	ATT_PROC_OUTER	V	± 1	-	once
	SDP(K)	Sine 1/2 gimbal non-orth, IMU _K , K = 1,2,3	ATT_PROC_OUTER	A(3)S	± 1	-	on demand
	CDP(K)	Cosine 1/2 gimbal non-orth, IMU _K , K = 1,2,3	ATT_PROC_OUTER	A(3)S	± 1	-	on demand
	Q_BODY_ROLL(K)	Body wrt roll gimbal quat, IMU _K , K = 1,2,3	ATT_PROC_OUTER	Struc (3) S,V	± 1	-	on demand
Q_SM_M50(K)	Stable member wrt M50 quat, IMU _K , K = 1,2,3	ATT_PROC_OUTER	Struc (3) S,V	± 1	-	on demand	
Q_ROLL_ROLL(K)	IMU _j wrt IMU _i mounting misalignment quat, IMU pair _K , K = 1,2,3	ATT_PROC_OUTER	Struc (3) S,V	± 1	-	on demand	
ATT_PROC_OUTER	<u>Inputs</u>						
	SDP(K)	Sine 1/2 gimbal non-orth, IMU _K , K = 1,2,3	ATT_PROC_INIT	A(3)S	± 1	-	1.04/ 1.04/ 1.04
	CDP(K)	Cosine 1/2 gimbal non-orth, IMU _K , K = 1,2,3	ATT_PROC_INIT	A(3)S	± 1	-	1.04/ 1.04/ 1.04
Q_BODY_ROLL(K)	Body wrt roll gimbal quat, IMU _K , K = 1,2,3	ATT_PROC_INIT	Struc (3) S,V	± 1	-	1.04/ 1.04/ 1.04	

Table 4.6.2-2. ATT_PROC Inter-Module Variables								
Module	Name	Description	Source or Destination	Type	Range	Unit	Rate Required/Produced (Hz)	
ATT_PROC_OUTER (Cont.)	Q_ROLL_ROLL(K)	IMU _j wrt IMU _i mounting misalignment quat, IMU pair _K , K = 1,2,3	ATT_PROC_INIT	Struc (3) S,V	±1	–	1.04/ 1.04/ 1.04	
	Q_SM_M50(K)	Stable member wrt M50 quaternion, IMU _K , K = 1,2,3	ATT_PROC_INIT	Struc (3) S,V	±1	–	1.04/ 1.04/ 1.04	
	I_YD_M50**	Unit vector normal to insertion plane in M50 system	ATT_PROC_INIT	V	±1	–	***	
	Q_LVLH_BIASLVLH	Uplinked LVLH wrt BIASLVLH ADI quat	ADI_QUAT_UPLINK	Struc S,V	±1	–	on demand	
	<u>Outputs</u>							
	QBI_UPDATE	Body wrt M50 quaternion using IMU data	ATT_PROC_INNER	Struc S,V	±1	–	1.04/ 1.04/ 1.04	
	Q_M50_TD	M50 wrt topodetic quaternion	ATT_PROC_EULER	Struc S,V	±1	–	1.04/ 1.04/ 1.04	
	Q_M50_BIASLVLH	M50 wrt BIASLVLH ADI quat	ATT_PROC_DISP	Struc S,V	±1	–	¥	
	Q_M50_REF	M50 wrt REF ADI quaternion	ATT_PROC_DISP	Struc S,V	±1	–	¥¥	
	Q_M50_LVIY	M50 wrt ascent LVIY ADI quaternion	ATT_PROC_DISP	Struc S,V	±1	–	¥¥¥	
ATT_PROC_INNER	<u>Inputs</u>							
	QBI_UPDATE	Body wrt M50 quaternion using IMU DATA	ATT_PROC_OUTER	Struc S,V	±1	–	1.04/ 1.04/ 1.04	
	P_FIL	Filtered selected RGA roll rate	ATT_PROC_PREFIL	S	±40	deg/s	12.5/ 12.5/ 6.25	
	Q_FIL	Filtered selected RGA pitch rate	ATT_PROC_PREFIL	S	±20	deg/s	12.5/ 12.5/ 6.25	
	R_FIL	Filtered selected RGA yaw rate	ATT_PROC_PREFIL	S	±20	deg/s	12.5/ 12.5/ 6.25	

Table 4.6.2-2. ATT_PROC Inter-Module Variables							
Module	Name	Description	Source or Destination	Type	Range	Unit	Rate Required/Produced (Hz)
ATT_PROC_INNER (Cont.)	INT_ROLL_INC	Integrated roll attitude increment	ATT_PROC_DISP	S	0	deg	0/6.25/0
	<u>Outputs</u>						
	Q_B_I	Body wrt M50 quaternion	ATT_PROC_DISP, ATT_PROC_EULER	Struc S,V	±1	–	12.5/12.5/6.25
ATT_PROC_EULER	<u>Inputs</u>						
	Q_M50_TD	M50 wrt topodetic quaternion	ATT_PROC_OUTER	Struc S,V	±1	–	0/0/6.25
	Q_B_I	Body wrt M50 quaternion	ATT_PROC_INNER	Struc S, V	±1	–	6.25/6.25/6.25
	<u>Outputs</u>						
	SINTH	Sin(THETA)	ATT_PROC_DISP	S	±1	–	0/0/6.25
	COSTH	Cos(THETA)	ATT_PROC_DISP	S	±1	–	0/0/6.25
	SINPHI	Sin(PHI)	ATT_PROC_DISP	S	±1	–	0/0/6.25
COSPHI	Cos(PHI)	ATT_PROC_DISP	S	±1	–	0/0/6.25	
ATT_PROC_DISP	<u>Inputs</u>						
	Q_B_I	Body wrt M50 quaternion	ATT_PROC_INNER	Struc S,V	±1	–	3.125/6.25/3.125
	Q_M50_BIASLVLH	M50 wrt BIASLVLH ADI quat	ATT_PROC_OUTER	Struc S,V	±1	–	§
	SINTH	Sin(THETA)	ATT_PROC_EULER	S	±1	–	0/0/3.125
	COSTH	Cos(THETA)	ATT_PROC_EULER	S	±1	–	0/0/3.125
	Q_M50_LVIY	M50 wrt ascent LVIY quaternion	ATT_PROC_OUTER	Struc S,V	±1	–	§§
	Q_M50_REF	M50 wrt REF ADI quaternion	ATT_PROC_OUTER	Struc S,V	±1	–	§§§
	SINPHI	Sin(PHI)	ATT_PROC_EULER	S	±1	–	0/0/3.125
	COSPHI	Cos(PHI)	ATT_PROC_EULER	S	±1	–	0/0/3.125
Q_M50_INRTL	Uplinked M50 wrt INRTL ADI	ADI_QUAT_UPLINK	Struc S,V	±1	None	on demand	

Table 4.6.2-2. ATT_PROC Inter-Module Variables							
Module	Name	Description	Source or Destination	Type	Range	Unit	Rate Required/Produced (Hz)
ATT_PROC_DISP (Cont.)	Q_M50_REF	Uplinked M50 wrt REF ADI	ADI_QUAT_UPLINK	Struc S,V	±1	None	on demand
	<u>Outputs</u> INT_ROLL_INC	Integrated roll attitude increment	ATT_PROC_INNER	S	0	deg	0/6.25/0
ATT_PROC_PREFIL	<u>Inputs</u>						
	P	Selected RGA roll rate	ATT_PROC_RGASW	S	±40	deg/s	25/12.5/25
	Q	Selected RGA pitch rate	ATT_PROC_RGASW	S	±20	deg/s	25/12.5/25
	R	Selected RGA yaw rate	ATT_PROC_RGASW	S	±20	deg/s	25/12.5/25
	<u>Outputs</u> P_FIL	Filtered selected RGA roll rate	ATT_PROC_INNER	S	±40	deg/s	25.0/12.5 ^ε /12.5
	Q_FIL	Filtered selected RGA pitch rate	ATT_PROC_INNER	S	±20	deg/s	25.0/12.5 ^ε /12.5
R_FIL	Filtered selected RGA yaw rate	ATT_PROC_INNER	S	±20	deg/s	25.0/12.5 ^ε /12.5	
ATT_PROC_RGASW	<u>Inputs</u>						
	None						
	<u>Outputs</u> P	Selected RGA roll rate	ATT_PROC_PREFIL	S	±40	deg/s	25/12.5/25
	Q	Selected RGA pitch rate	ATT_PROC_PREFIL	S	±20	deg/s	25/12.5/25
R	Selected RGA yaw rate	ATT_PROC_PREFIL	S	±20	deg/s	25/12.5/25	
ADI_QUAT_UPLINK	<u>Inputs</u>						
	None						
	<u>Outputs</u> Q_M50_INRTL	Uplinked M50 wrt INRTL ADI quat	ATT_PROC_DISP	Struc S,V	±1	–	on demand
Q_M50_REF	Uplinked M50 wrt REF ADI quat	ATT_PROC_DISP	Struc S,V	±1	–	on demand	

Table 4.6.2-2. ATT_PROC Inter-Module Variables

Module	Name	Description	Source or Destination	Type	Range	Unit	Rate Required/Produced (Hz)
ADI_QUAT_UPLINK (con't)	Q_LVLH_BIASLVLH	Uplinked LVLH wrt BIASLVLH quat	ATT_PROC_OUTER	Struct S,V	±1	–	on demand
<p>* Rates are given as X/Y/Z/, in Hz. Rate is X in ascent, Y in transition, and Z in entry.</p> <p>** Computed once by ATT_PROC_INIT when ascent mode (ATT_MODE=1) is begun; then recomputed once by ASC UPP when first entering MM 102 is begun.</p> <p>*** Sampled at 1.04 Hz in MM 101 beginning at platform reference update (REFS_RDY), 102, 103, and 601, and (at 0 Hz elsewhere).</p> <p>¥ At 1.04 Hz when ATT_MODE 101 ≠ ENTRY and when not in MM 101, 102, and 103 and 601 (at 0 Hz elsewhere).</p> <p>¥¥ At 1.04 Hz when in MM 101, 0 Hz elsewhere.</p> <p>¥¥¥ At 1.04 when ATT_MODE ≠ ENTRY and when in MM 101 beginning at platform reference update (REFS_RDY), 102, 103, 601 (at 0 Hz elsewhere).</p> <p>§ At 1.04 Hz when ATT_MODE ≠ ENTRY and when not in MM 101, 102, 103, or 601 (at 0 HZ elsewhere).</p> <p>§§ At 1.04 Hz when ATT_MODE ≠ ENTRY and when in MM 101 beginning at platform reference update (REFS_RDY), 102, 103, or 601 (at 0 Hz elsewhere).</p> <p>§§§ At 1.04 Hz when in MM 101 beginning at platform reference update (REFS_RDY) (at 0 Hz elsewhere).</p> <p>£ During ATT_MODE = TRANSITION, these parameters are set equal to the selected orbiter RGA rates and are not filtered.</p>							

Table 4.6.2-3. ATT_PROC Initialization Requirements						
Module	Name	Initialize on Transition		Variable	Initial Value	Unit
		From	To			
ATT_PROC	ATT_PROC mode	On REFS_RDY flag		ATT_MODE	1	–
	ATT_PROC mode	On MECO_CMD flag in MM 103		ATT_MODE	2	–
	ATT_PROC mode	On MECO_CMD flag in MM 102**		ATT_MODE		
	ATT_PROC mode	On MM 304 flag		ATT_MODE	3	–
	ATT_PROC mode	On MM 602 flag		ATT_MODE	3	
ATT_PROC_INNER	ATT_PROC time increment	On REFS_RDY flag		DELTIME	0.08	s
	ATT_PROC time increment	OPS 1 or OPS 2	OPS 3	DELTIME	0.08	s
	ATT_PROC time increment	ATT_MODE = 2	ATT_MODE = 3	DELTIME	0.16	s
	Body rate vector	On REFS_RDY flag		RATE_GYRO_READ	0	rad/s
	Body rate vector	OPS 2	OPS 3	RATE_GYRO_READ	0	rad/s
	Integrated roll attitude increment	On REFS_RDY flag		INT_ROLL_INC	0	deg
	Integrated roll attitude increment	OPS 2	OPS 3	INT_ROLL_INC	0	deg
	Rate bias	On REFS_RDY flag		W_BIAS	0	rad/s
	Rate bias	OPS 2	OPS 3	W_BIAS	0	rad/s
	Rate gyro correction	On REFS_RDY flag		RG_CORR	0	rad/s
	Rate gyro correction	OPS 2	OPS 3	RG_CORR	0	rad/s
	ATT_PROC_EULER	Initial angle-of-attack and angle-of-sideslip commands	OPS 9	OPS 1	ALPHA_N	0
BETA_N					0	deg
MEDS_ALPHA					0	deg
MEDS_BETA					0	deg
Topodetic Euler angles availability flag	OPS 9	OPS 1 or OPS 3	OPS 1 or OPS 3	EULER_GPS_AVAIL	OFF	–
				EULER_GPS_AVAIL	OFF	–
ATT_PROC_DISP	$\Delta \bar{V}$ body over last 0.96 s	On REFS_RDY flag		$\overline{DVB_SEC}$	0	ft/s
	$\Delta \bar{V}$ body over last 0.96 s	OPS 2	OPS 3	$\overline{DVB_SEC}$	$\bar{0}$	ft/s

Table 4.6.2-3. ATT_PROC Initialization Requirements

Module	Name	Initialize on Transition		Variable	Initial Value	Unit	
		From	To				
ATT_PROC_DISP (Cont.)	Previous \bar{V} _IMU_CURRENT	ATT_MODE = 1	ATT_MODE = 2	\bar{V} _IMU_OLD	\bar{V} _IMU_CURRENT	ft/s	
	Quaternion of M50 frame wrt ADI INRTL frame during ascent	On REFS_RDY flag		Q_M50_INRTL	*		
	Quaternion of M50 frame wrt ADI INRTL frame during entry	OPS 1 or OPS 2	OPS 3	Q_M50_INRTL	*		
	Quaternion of M50 frame wrt ADI REF frame during entry	OPS 1 or OPS 2	OPS 3	Q_M50_REF	***		
	Initial ADI/HSI commands		OPS 9	OPS 1	PTCHSINE(K)	***	-
					PTCHCOS(K)	***	-
					YAWSINE(K) Per	0	-
					ROLLSINE(K) ADI _k	***	-
					YAWCOS(K) K=1,2	1	-
					ROLLCOS(K)	***	-
				YAW_IY	0	rad	
				ROLL_SW	-1	-	
Previous \bar{V} _IMU_CURRENT	OPS 1 or OPS 2	OPS 3	V_IMU_OLD	\bar{V} _IMU_CURRENT	ft/s		
Commanded body attitude quaternion	On REFS_RDY flag	OPS 2	OPS 3	Q_B_I_CMD_DISPLAY	(0, 0, 0, 0)		
				Q_B_I_CMD_DISPLAY	Q_B_I		
ATT_PROC_PREFIL	Prefilter states	On REFS_RDY flag		P_FIL1, Q_FIL1, R_FIL1, P_FILO1, Q_FILO1, R_FILO1	0	deg/s	
	Prefilter states	OPS 1 or OPS 2	OPS 3	P_FIL1, Q_FIL1, R_FIL1, P_FILO1, Q_FILO1, R_FILO1	0	deg/s	
	RGA prefilter init flag	On REFS_RDY flag		PRE_FILT_INT	ON	-	
	RGA prefilter init flag	OPS 1 or OPS 2	OPS 3	PRE_FILT_INT	ON	-	
	Entry RGA prefilter 2nd-stage flag	On REFS_RDY flag		2ND_STAGE_FILT	ON	-	
	Entry RGA prefilter 2nd-stage flag	OPS 1 or OPS 2	OPS 3	2ND_STAGE_FILT	ON	-	
	RGA prefilter entry initialization flag	On REFS_RDY flag		PRE_FILT_ENTRY	OFF	-	
	RGA prefilter entry initialization flag	OPS 1 or OPS 2	OPS 3	PRE_FILT_ENTRY	OFF	-	
	RGA prefilter entry initialization flag	MM 104 or MM 601	MM 602	PRE_FILT_ENTRY	ON	-	

Table 4.6.2-3. ATT_PROC Initialization Requirements						
Module	Name	Initialize on Transition		Variable	Initial Value	Unit
		From	To			
ATT_PROC_OUTER	Quaternion of LVLH frame wrt BIASLVLH frame during ascent	On REFS_RDY flag		Q_LVLH_BIASLVLH	¥¥¥	-
	Quaternion of LVLH frame wrt BIASLVLH frame during entry	OPS 1 or OPS 2	OPS 3	Q_LVLH_BIASLVLH	¥¥¥	-
	IMU ALIGN DISP active flag	On REFS_RDY flag		IMU_ALIGN_DISP	0	-
	Body wrt M50 quaternion using IMU data	OPS 2 or OPS 8	OPS 3	QBI_UPDATE	Q_B_M50 [¥]	-
	Body wrt M50 quaternion using IMU data	OPS 1	OPS 3	QBI_UPDATE	Q_B_I ^{¥¥}	-
<p>* Value specified in A/E_ATT_PROC KLOAD ** (i.e., for fast ET SEP, remain in ASCENT mode.) *** Value specified in A/E_ATT_PROC_ILOAD. ¥ Value carried over from On-orbit ATT PROC ¥¥ Value carried over from A/E_ATT_PROC in OPS 1 ¥¥¥ Value specified in A/E_ATT_PROC K-load</p>						

Table 4.6.2-4. ATT_PROC I-Loads/K-Loads					
Module	Name	Description	Type	MSID/ Value	Unit
ATT_PROC_OUTER	Q_LVLH_BIASLVLH_ASCENT	Quaternion of LVLH frame wrt BIASLVLH frame during ascent	Struc S,V	V97U2210CA to V97U2213CA	–
	Q_LVLH_BIASLVLH_ENTRY	Quaternion of LVLH frame wrt BIASLVLH frame during entry	Struc S,V	V97U2210CB to V97U2213CB	–
ATT_PROC_INNER	DTIMU	Delta time from start of 40 ms period to IMU read	S	V97U1780C	s
ATT_PROC_EULER	UB_EPS	Test value of earth–relative velocity computation in body X–Z plane	S	V97U1315C	ft/sec
ATT_PROC_DISP	Q_M50_INRTL_ASCENT	Quaternion of M50 frame wrt ADI INRTL frame during ascent	Struc S,V,	V97U2214CA to V97U2217CA	–
	Q_M50_INRTL_ENTRY	Quaternion of M50 frame wrt ADI INRTL frame during entry	Struc S,V,	V97U2214CB to V97U2217CB	–
	Q_M50_REF_ENTRY	Quaternion of M50 frame wrt ADI REF frame during entry	Struc S,V,	V97U2218CB to V97U2221CB	–
	ROLLSINE(1)	ADI roll sine, ADI ₁	S	V90H2208CA	–
	ROLLSINE(2)	ADI roll sine, ADI ₂	S	V90H2206CA	–
	ROLLCOS(1)	ADI roll cosine, ADI ₁	S	V90H2209CA	–
	ROLLCOS(2)	ADI roll cosine, ADI ₂	S	V90H2207CA	–
	PTCHSINE(1)	ADI pitch sine, ADI ₁	S	V90H2221CA	–
	PTCHSINE(2)	ADI pitch sine, ADI ₂	S	V90H2220CA	–
	PTCHCOS(1)	ADI pitch cosine, ADI ₁	S	V90H2222CA	–
	PTCHCOS(2)	ADI pitch cosine, ADI ₂	S	V90H2218CA	–
ATT_PROC_INIT	TNBBODY	Nav base to body frame transform matrix	M	V96U7096C to V96U7104C	–
	TNB_CASE(K)	Nav base to IMU case transform matrix, IMU _K , K = 1, 2, 3	A(3)M	V96U7132C to V96U7158C	–
	RGAO(K)	Roll gimbal azimuth offset, IMU _K , K = 1, 2, 3	A(S)S	V99U9559C to V99U9561C	rad
	RGPO(K)	Roll gimbal pitch offset, IMU _K , K = 1, 2, 3	A(3)S	V99U9562C to V99U9564C	rad
	ĪYD	Unit vector normal to insertion plane in earth–fixed or M50 coordinates	V	V97U4413C V97U4414C V97U4415C	–
	EF_PLANE_SW	EF plane constraint switch	D	V99U7441C	–

Table 4.6.2-4. ATT_PROC I-Loads/K-Loads					
Module	Name	Description	Type	MSID/ Value	Unit
ATT_PROC_PREFIL	PRE_R01	First stage filter coefficient for nominal ascent and entry	S	V97U2393C	–
	PRE_R02	First stage filter coefficient for nominal ascent and entry	S	V97U2394C	–
	PRE_R03	First stage filter coefficient for nominal ascent and entry	S	V97U2395C	–
	PRE_R04	Second stage filter coefficient for nominal entry and GRTLS	S	V97U2396C	–
	PRE_R05	Second stage filter coefficient for nominal entry and GRTLS	S	V97U2397C	–
	PRE_R06	Second stage filter coefficient for nominal entry and GRTLS	S	V97U2398C	–

Table 4.6.2-5. ATT_PROC Constants					
Name	Description	Data Type	Precision	Value	Units
ALPHA_GXF1	D_ALPHA first order hold gains	F	S	0.0	–
ALPHA_GXF2		F	S	0.0	–
ALPHA_GXF3		F	S	0.0	–
D_ALPHA_LIM	Limit on D_ALPHA	F	S	10.0	deg
DEG_PER_RAD	Radian to degree conversion	F	S	$180/\pi$	deg/rad
DELTIME	ATT_PROC time increment (ATT_MODE = 1 or 2) (ATT_MODE = 3)	F	S	0.08	s
				0.16	
GE_PRE_R01	First stage filter coefficients for GRTLS	F	S	0.285714	–
GE_PRE_R02		F	S	0.285714	–
GE_PRE_R03		F	S	–0.428572	–
RAD_PER_DEG	Degree to radian conversion	F	S	$\pi/180$	rad/deg

Table 4.6.2-6. Cross-Reference of ATT_PROC Parameter Names and Source Names			
ATT_PROC Parameter	Description	Source Name	Source
CLOCKTIME	Current GMT time	CLOCK	FCOS
IMU_ALIGN_DISP	IMU_ALIGN_DISP active flag	IMU_ALIGN_DISP	MSC
Q_B_I_CMD_DISPLAY	Commanded body wrt M50 quaternion	Q_B_I_CMD_DISP	TRANS DAP
Q_B_M50	Body wrt M50 quaternion computed on-orbit	Q_BOD_M50	ORB_ATT_PROC

Table 4.6.2-7. ATT_PROC Carryout Values						
Name	Description	Type	Range	Unit	Principal Function	
					Source	Used by
PHI	Body Roll Angle	S	+/- 180	deg	A/E ATT PROC	GPS SOP
THETA	Body Pitch Angle	S	+/- 90	deg	A/E ATT PROC	GPS SOP
PSI	Body Yaw Angle	S	+/-180	deg	A/E ATT PROC	GPS SOP

Note: These variables are passed over at OPS -2 transition from either OPS-1 or OPS-3 and are passed over at OPS -3 transition from OPS-1.

4.6.3 Overview and Functional Design

The attitude processor comprises eight modules whose interrelationship is shown in Figure 4.6.3-1. Sequencing of ATT_MODE is shown in Figure 4.6.3-2.

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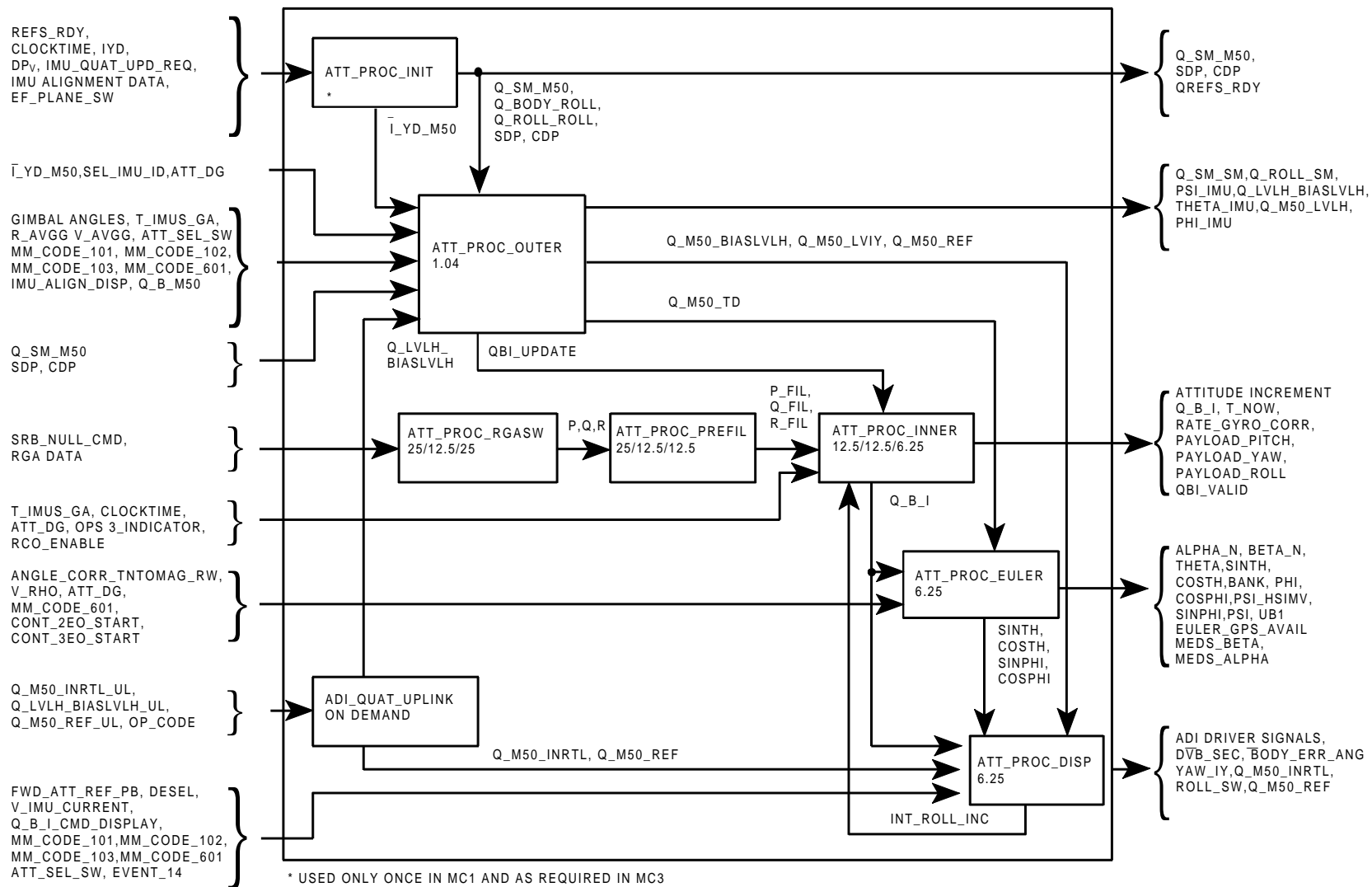
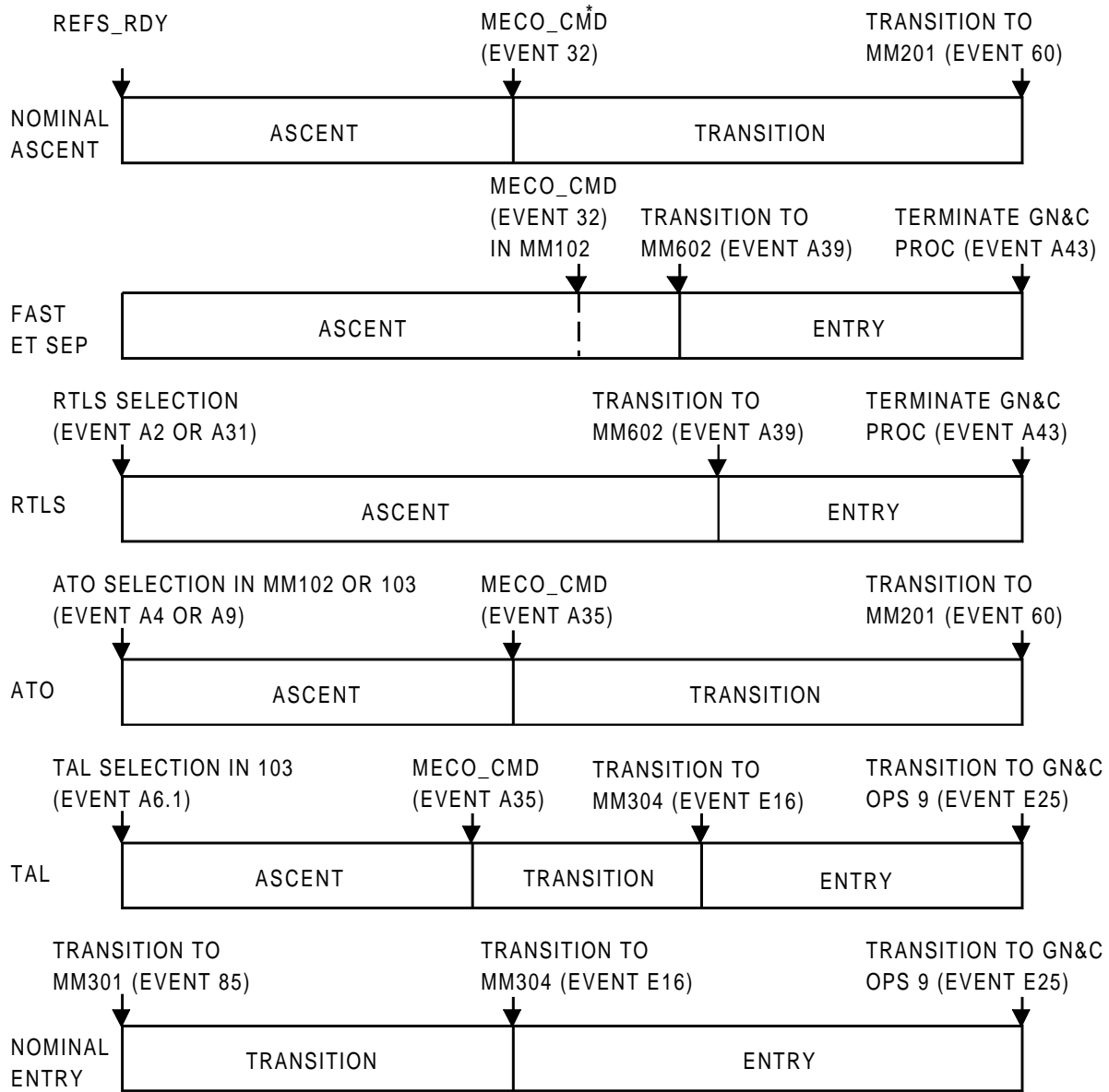


FIGURE 4.6.3-1. ATT_PROC Software Overview



* ONLY FOR MECO IN MM103 (i.e., FOR FAST ET SEP STAY IN ASCENT MODE UNTIL MM602)

FIGURE 4.6.3-2. ATT_PROC Moding

4.6.4 Software Description

The attitude processor comprises eight modules whose interrelationship and processing rates are shown in Figure 4.6.3–1, ATT_PROC Software Overview. Sequencing and processing rates for each module are given in the description of each module. The principal function is not active in MM101 before REFS_RDY is true.

Much of the processing, particularly of display data, is controlled by an internal flag, ATT_MODE. ATT_MODE is initialized to ASCENT (ATT_MODE = 1) at platform reference update (REFS_RDY). On receipt of the OPS 1 MECO_CMD flag, if MM = 103, ATT_MODE is advanced to TRANSITION (ATT_MODE = 2). Otherwise, ATT_MODE remains in ASCENT (e.g., for FAST ET SEP). On receipt of MM304 flag, ATT_MODE is advanced to ENTRY (ATT_MODE = 3). ATT_MODE is advanced directly from ASCENT to ENTRY during FAST ET SEP or RTLS at transition to MM602. Moding is shown in Figure 4.6.3–2. During ASCENT (ATT_MODE = 1) and TRANSITION (ATT_MODE = 2) modes, additional logic branching is shown directly as a function of MSC major modes.

Except where input variables are double precision numbers (for example, \bar{R}_{AVGG} , \bar{V}_{AVGG} , \bar{V}_{RHO} , $\bar{V}_{IMU_CURRENT}$), all processing will be single precision. All ATT_PROC output will be single precision.

The quaternion and direction cosine matrix notation used in this description is explained in Section 4.7.16 of this document.

4.6.4.1 Attitude Processor Initialization (ATT_PROC_INIT)

A. Function. ATT_PROC_INIT serves to initialize certain internal constants. It is performed on demand, on or before the first pass through ATT_PROC, whether prelaunch at platform reference update (REFS_RDY) or predeorbit coast, and following IMU alignments during predeorbit coast. An overview block diagram of ATT_PROC_INIT is provided in Figure 4.6.4.1–1. With the exception of forming Q_SM_M50, all of these steps may be performed after IMU hanger calibration.

B. Processing Requirements. The module ATT_PROC_INIT is performed once to initialize constants in both MC1 and MC3 and following IMU alignments in MM301 to compute Q_SM_M50_K.

C. Interface Requirements. The interface requirements for the module ATT_PROC_INIT are shown in Tables 4.6.2–1 and 4.6.2–2.

D. Constants. The constants used in the module ATT_PROC_INIT are shown in Table 4.6.2–4.

E. Initialization Requirements. None.

F. Detailed Technical Description. ATT_PROC_INIT initializes IMU attitude constants and IMU-to-IMU mounting misalignments.

The following constants are initialized for each IMU_K, K = 1, 2, 3. They are a quaternion representing the transformation from the roll gimbal frame to the body frame, a quaternion representing the transformation from the M50 frame to the platform frame, and the sine and cosine of 1/2 DP_K, the IMU's pitch-outer roll gimbal nonorthogonality.

First, the navigation base to outer roll gimbal transformation matrix, TNB_RL_K , is computed. TNB_RL_K is a product of two single-axis rotations (roll gimbal azimuth and pitch offsets) and the navigation base to case transformation.

$$TAZ_K = \begin{bmatrix} \cos(RGAO_K) & -\sin(RGAO_K) & 0 \\ \sin(RGAO_K) & \cos(RGAO_K) & 0 \\ 0 & 0 & 1 \end{bmatrix}$$

$$TPT_K = \begin{bmatrix} \cos(RGPO_K) & 0 & \sin(RGPO_K) \\ 0 & 1 & 0 \\ -\sin(RGPO_K) & 0 & \cos(RGPO_K) \end{bmatrix}$$

$$TNB_RL_K = TAZ_K TPT_K TNB_CASE$$

Then, the matrix $M_ROLLBODY_K$ is formed by

$$M_ROLLBODY_K = T_NBBODY (TNB_RL_K)^T$$

Then the quaternions $Q_BODY_ROLL_K$ and $Q_SM_M50_K$ are formed from the equivalent matrices $M_ROLLBODY_K$ and $(T_CLUSTERM50_K)^T$ by use of MAT_TO_QUAT , the matrix to quaternion utility routine. The sine and cosine of one-half the pitch-outer roll gimbal nonorthogonality follows from

$$SDP_K = \sin(DP_K/2)$$

$$CDP_K = \cos(DP_K/2)$$

The pairwise IMU gimbal-case mounting misalignments are determined for each IMU pair K , where the index K is the number of the excluded IMU.

$$Q_ROLL_ROLL_K = Q_BODY_ROLL_J^* Q_BODY_ROLL_I$$

where for

$$K = 1: I = 2, J = 3$$

$$K = 2: I = 1, J = 3$$

$$K = 3: I = 1, J = 2$$

For the prelaunch initialization only, the M50 to stable member quaternion ready flag, $QREFS_R$ is set on for the BFS to indicate that the $Q_SM_M50_K$ have been computed.

When the ASCENT mode (ATT_MODE = 1, REFS_RDY) is first begun, the following calculations will be performed for ADI and HSI processing during MM101. If the orbital plane constraint in earth-fixed, EF_PLANE_SW = ON, then the unit vector $\bar{Y}D$ which is normal to the desired trajectory plane is transformed from earth-fixed coordinates to M50 coordinates. That is,

If EF_PLANE_SW = ON, then

$$\bar{I}_{YD_M50} = \text{EARTH_FIXED_TO_M50_COORD}(\text{CLOCKTIME}) \bar{Y}D$$

This unit vector \bar{I}_{YD_M50} is later recomputed by ascent user parameter processing when MM102 is begun, so as to be valid at the time of liftoff.

If the orbital plane constraint is not earth-fixed, EF_PLANE_SW = OFF, indicating a rendezvous mission, then the unit vector $\bar{Y}D$ which is normal to the desired trajectory plane and given in M50 coordinates is renamed for use by ATT_PROC. That is,

If EF_PLANE_SW = OFF, then

$$\bar{I}_{YD_M50} = \bar{Y}D$$

The unit vector \bar{I}_{YD_M50} is later recomputed by ascent user parameter processing when MM102 is begun in order to account for nodal regression between nominal and actual launch times. This delay in launch time, in the case of a rendezvous mission, is constrained to be only a few minutes. This initialization is not required for TRANSITION or ENTRY modes.

When entering MC3, the only initialization required is that associated with the computations of $Q_BODY_ROLL_K$ and $Q_ROLL_ROLL_K$. The values of $Q_SM_M50_K$ and SDP_K , CDP_K are carried over from MC2.

Whenever an IMU alignment is completed in MM 301 (denoted by IMU_QUAT_UPD_REQ = ON), $Q_SM_M50_K$ is computed from $(T_CLUSTERM50_K)^T$ by use of MAT_TO_QUAT. Subsequently, the flag IMU_QUAT_UPD_REQ is reset OFF.

This concludes module ATT_PROC_INIT.

Note that the unit vector \bar{I}_{YD_M50} will be recomputed by ascent second-stage guidance during MM103 if a transatlantic abort is declared or by powered RTLS guidance during MM601.

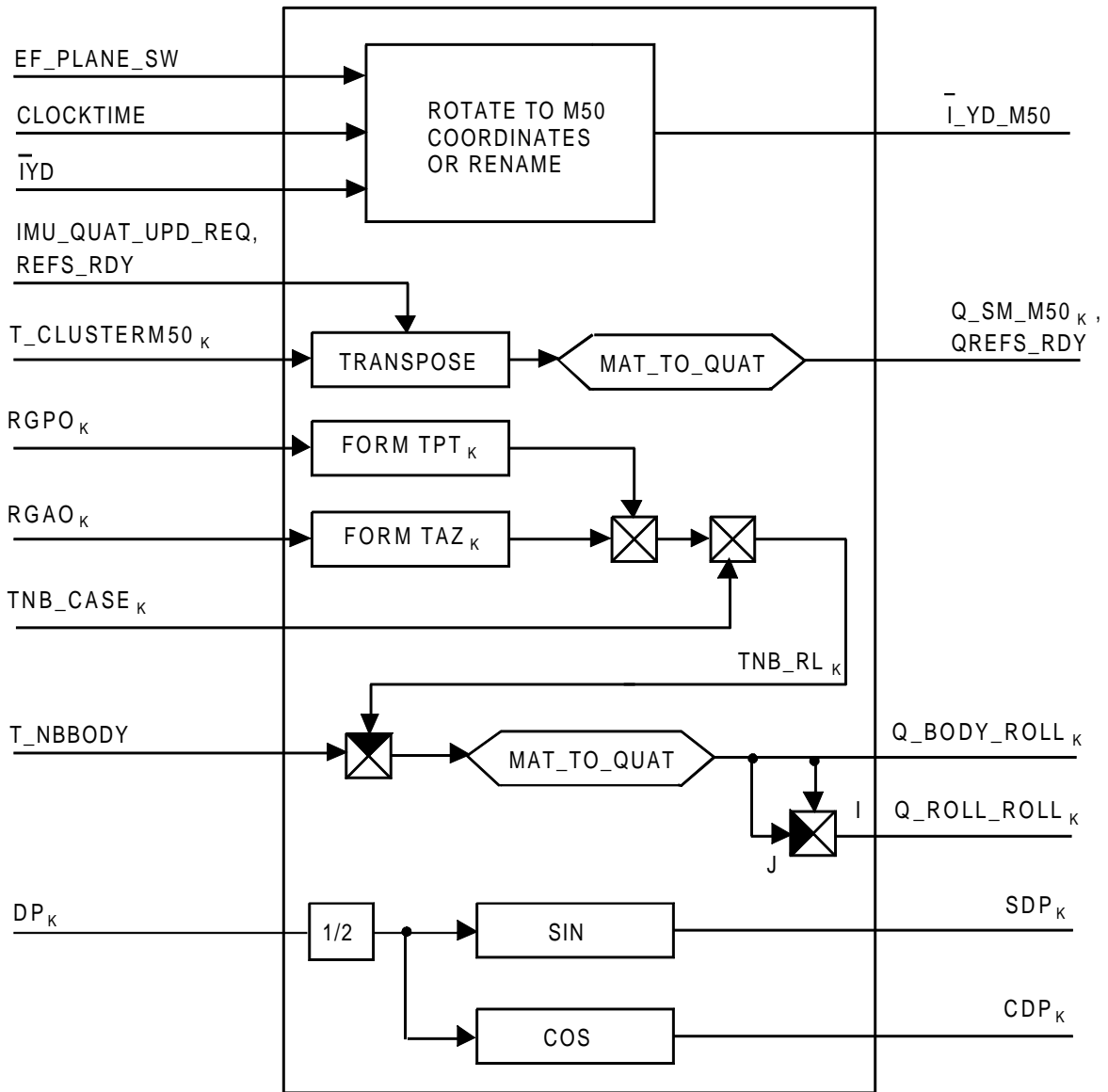


FIGURE 4.6.4.1-1. ATT_PROC_INIT Block Diagram

4.6.4.2 Attitude Processor Outer-Loop (ATT_PROC_OUTER)

A. Function. ATT_PROC_OUTER is a precision attitude processor. It computes the body wrt M50 quaternion (QBI_UPDATE) and the M50 wrt topodetic quaternion (Q_M50_TD). Pairwise stable member wrt stable member quaternions (Q_SM_SM_K) are formed for use in IMU selection and IMU failure detection and isolation. An overview block diagram of ATT_PROC_OUTER is shown in Figure 4.6.4.2-1.

B. Processing Requirements. ATT_PROC_OUTER is performed before the first pass through ATT_PROC_INNER. It is performed thereafter at 1.04 Hz.

C. Interface Requirements. The interface requirements for the module ATT_PROC_OUTER are shown in Tables 4.6.2-1 and 4.6.2-2.

D. Constants. Constants used in module ATT_PROC_OUTER are shown in Table 4.6.2-4.

E. Initialization Requirements. Initialization requirements for ATT_PROC_OUTER are shown in Table 4.6.2-3.

F. Detailed Technical Description. The quaternions Q_SM_SM_K, representing platform wrt platform misalignment of the IMU pair K, are formed for use in selecting an IMU for attitude data and for IMU failure detection and isolation. The following steps are performed for each IMU_K, K = 1, 2, 3.

The roll gimbal mounting wrt stable member quaternion, Q_ROLL_SM_K, is formed for each IMU_K, K = 1 to 3. Q_ROLL_SM_K is the product of five single axis rotations (four gimbal angles and the pitch-outer roll gimbal nonorthogonality).

$$\overline{GA}_K = \frac{RAD_PER_DEG}{2} \begin{bmatrix} ORANG(K) + IRANG(K) \\ ORANG(K) - IRANG(K) \\ PANG(K) \\ AZANG(K) \end{bmatrix}$$

$$SRPL_K = SIN(GA_{K:1}); \quad CRPL_K = COS(GA_{K:1});$$

$$SRMN_K = SIN(GA_{K:2}); \quad CRMN_K = COS(GA_{K:2});$$

$$SP_K = SIN(GA_{K:3}); \quad CP_K = COS(GA_{K:3});$$

$$SY_K = SIN(GA_{K:4}); \quad CY_K = COS(GA_{K:4});$$

$$QROLLSMS_K = CDP_K(CP_K CRPL_K CY_K + SP_K SRMN_K SY_K) - SDP_K (SP_K SRPL_K CY_K + CP_K CRMN_K SY_K)$$

$$\overline{Q}ROLLSMV_K = \begin{bmatrix} CDP_K(-CP_K SRPL_K CY_K + SP_K CRMN_K SY_K) \\ +SDP_K(-SP_K CRPL_K CY_K + CP_K SRMN_K SY_K) \\ CDP_K(-SP_K CRMN_K CY_K - CP_K SRPL_K SY_K) \\ +SDP_K(-CP_K SRMN_K CY_K - SP_K CRPL_K SY_K) \\ CDP_K(-CP_K CRPL_K SY_K + SP_K SRMN_K CY_K) \\ +SDP_K(SP_K SRPL_K SY_K - CP_K CRMN_K CY_K) \end{bmatrix}$$

where

$$Q_ROLL_SM_K = [QROLLSMS_K, \overline{Q}ROLLSMV_K]$$

Stable member wrt stable member quaternions are then formed for each IMU pair K:

$$Q_SM_SM_K = Q_ROLL_SM_J^* Q_ROLL_ROLL_K Q_ROLL_SM_I$$

where for

$$K = 1: I = 2, J = 3$$

$$K = 2: I = 1, J = 3$$

$$K = 3: I = 1, J = 2$$

The three quaternions $Q_SM_SM_K$ are sent to RM (IMU selection), which returns a selected IMU number (SEL_IMU_ID) and an attitude data good flag (ATT_DG). The sense of this flag is ATT_DG = ON implies data are good.

If IMU_ALIGN_DISP = ON, a set of Euler angles from M50 to Body is computed independently for each IMU. A quaternion $XQ_B_I_K$ is formed for each IMU_K and the angles are extracted by the QUAT_TO_EULER routine. Thus, if IMU_ALIGN_DISP = ON, $XQ_B_I_K$ is computed for each IMU_K , $K = 1, 2, 3$. Otherwise, if IMU_ALIGN_DISP = OFF and ATT_DG = ON, it is computed only for $K = SEL_IMU_ID$.

$$XQ_B_I_K = Q_BODY_ROLL_K Q_ROLL_SM_K Q_SM_M50_K$$

If IMU_ALIGN_DISP = ON

CALL QUAT_TO_EULER (XQ_B_I_K) ASSIGN (PSI_IMU_K, THETA_IMU_K, PHI_IMU_K, TEMP, TEMP, TEMP)

The Euler angles are constrained to the range 0–360 degrees by adding 360 degrees to negative angles.

The following processing in the outer loop (ATT_PROC_OUTER) is performed only for the single selected IMU SEL_IMU_ID, where gimbale angle data are incorporated only if ATT_DG = ON. If so,

$$QBI_UPDATE = (XQ_B_I_{SEL_IMU_ID})$$

If ATT_DG = OFF, QBI_UPDATE is not computed.

NOTE: On the first pass after transition from OPS 2 or OPS 8 to OPS 3, QBI_UPDATE is initialized to the last value of Q_B_M50 computed by ON-ORBIT_ATT_PROC. This initialization is performed to protect against possible bad attitude data indication from IMU RM (ATT_DG = OFF). IMU RM may have processed transient IMU commfaults due to unexpected powered-off LRUs or there may be an IMU dilemma. The topodetic Euler angles availability flag for the GPS SOP, EULER_GPS_AVAIL, is initialized OFF.

If this is the first pass after transition from OPS 1 to OPS 3, QBI_UPDATE is initialized to the last value of Q_B_I computed by A/E_ATT_PROC in OPS 1. This initialization is performed to protect against ATT_DG being set OFF during an IMU dilemma.

The following calculations are performed if (ATT_MODE \neq ENTRY and it is not Major Mode 101, 102, 103, or 601). First an M50 wrt LVLH quaternion is computed for guidance and ADI related calculations.

CALL RV_TO_QLVLH(\bar{R}_{AVGG} , \bar{V}_{AVGG}) ASSIGN(Q_M50_LVLH)

Then a quaternion representing M50 wrt BIASLVLH is computed for use in deriving ADI driver functions in ATT_PROC_DISP, but only if (ATT_SEL_SW₁ = 0 and/or ATT_SEL_SW₂ = 0).

Q_M50_BIASLVLH = Q_M50_LVLH Q_LVLH_BIASLVLH

Q_M50_LVLH AND Q_M50_BIASLVLH will be assumed constant for 0.96 second.

The following ADI- and HSI-related calculations are also to be performed by ATT_PROC_OUTER, but only if major mode = 101, 102, 103, or 601.

These calculations define a quaternion of M50 with respect to the desired ascent LVIY reference ADI coordinate system for use in ATT_PROC_DISP. The quaternion is formed from present vehicle position (\bar{R}_{AVGG}) and from an initially defined M50 unit vector (\bar{I}_{YD_M50}) normal to the insertion plane (at MECO), as

1. Compute a temporary vector normal to both \bar{R}_{AVGG} and \bar{I}_{YD_M50}

$$\bar{V}_{TEMP} = \bar{R}_{AVGG} * \bar{I}_{YD_M50}$$

2. Then call the RV_TO_QLVLH utility function to compute the desired quaternion

CALL RV_TO_QLVLH(\bar{R}_{AVGG} , \bar{V}_{TEMP})

ASSIGN(Q_M50_LVIY)

Q_M50_LVIY will be assumed constant for 0.96 second.

If MM = 101, then set Q_M50_REF = Q_M50_LVIY

The M50 wrt topodetic quaternion is derived as a function of time and vehicle position. NAV coordinate transformation functions are used. T_IMUS_GA is the time tag associated with the IMU data read. \bar{R}_{AVGG} is the present vehicle position vector in M50 coordinates.

M_EFM50 = EARTH_FIXED_TO_M50_COORD (T_IMUS_GA)

$$\bar{R} = (M_EFM50)^T \bar{R}_AVGG$$

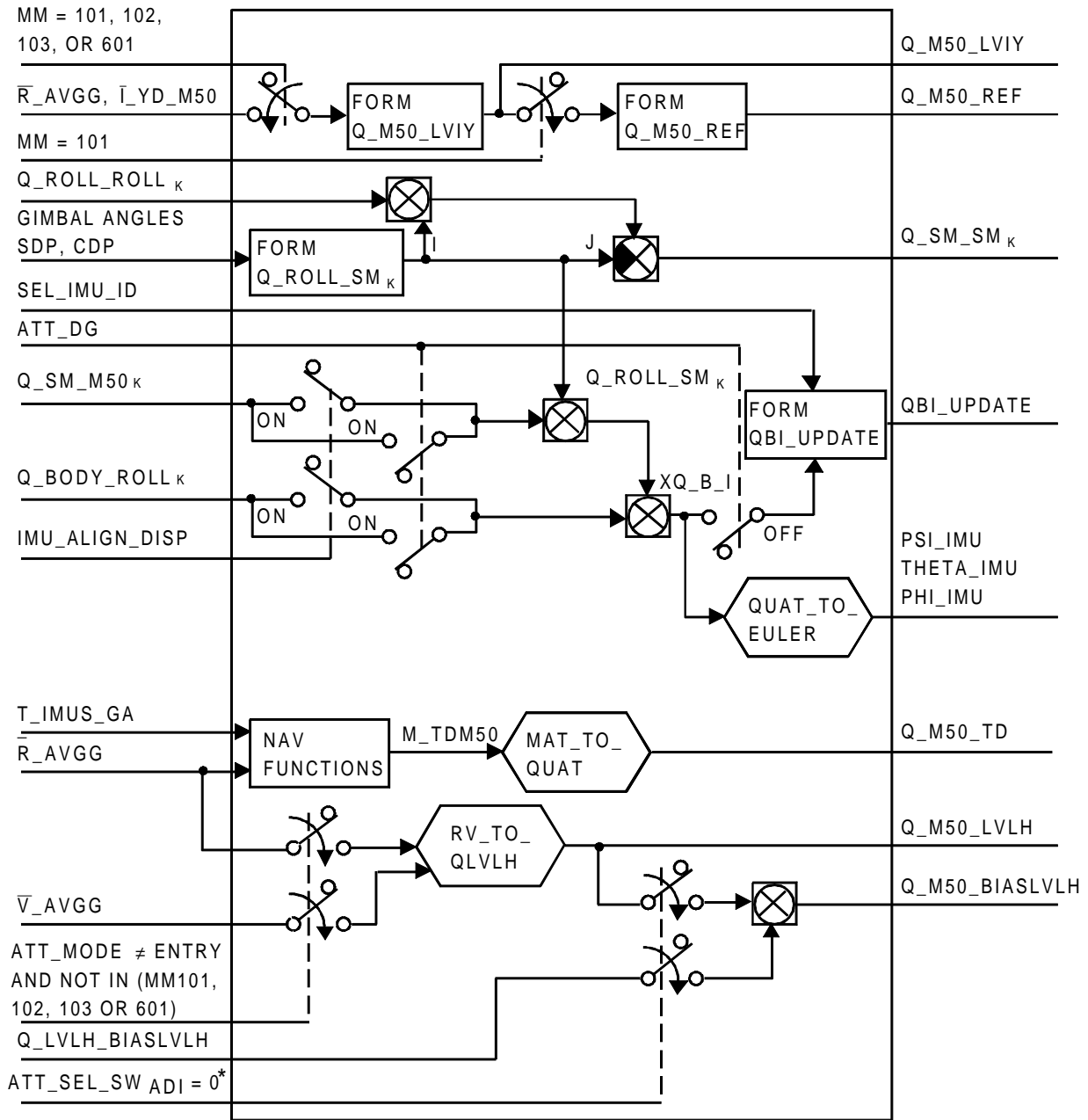
CALL EF_TO_GEODETTIC(\bar{R}) ASSIGN (LAT, LON, ALT)

M_EFTD = EF_TO_TOPDET (LAT, LON)

M_TDM50 = M_EFM50 (M_EFTD)^T

The equivalent quaternion Q_M50_TD is extracted from M_TDM50 using the MAT_TO_QUAT utility routine. Q_M50_TD will be assumed constant for 0.96 second.

This concludes module ATT_PROC_OUTER.



* FOR ADI 1 OR ADI 2

FIGURE 4.6.4.2-1. ATT_PROC_OUTER Block Diagram

4.6.4.3 Attitude Processor Inner Loop (ATT_PROC_INNER)

A. Function. ATT_PROC_INNER serves to propagate the body attitude quaternion incrementally at a high rate using body rate from selected filtered RGA outputs. During ATT_MODE = TRANSITION, the payload attitude is derived at 0.52 Hz rate. Payload attitude must represent vehicle attitude within ±100 milliseconds of the time the vehicle state vector is passed to the payload. An overview block diagram of ATT_PROC_INNER is given in Figure 4.6.4.3-1.

B. Processing Requirements. The ATT_PROC_INNER module is called at 12.5 Hz during ascent and transition and 6.25 Hz during the entry through landing phases.

C. Interface Requirements. The interface requirements for the module ATT_PROC_INNER are shown in Tables 4.6.2-1 and 4.6.2-2.

D. Constants. The I-Loads/K-Loads used in module ATT_PROC_INNER are shown in Table 4.6.2-4. The constants are shown in Table 4.6.2-5.

E. Initialization Requirements. Initialization requirements for ATT_PROC_INNER are shown in Table 4.6.2-3.

F. Detailed Technical Description. The inner loop propagates the attitude reference through trapezoidal integration of filtered body rate compensated for rate bias to form an incremental quaternion, Q_INCR, representing the small rotation BODY (t) wrt BODY (t-Δt). First, if the attitude data good flag indicates bad IMU data, then the rate bias is zeroed. (This only needs to be done once each time ATT_DG is set OFF.)

If ATT_DG = OFF, then $\bar{W}_{BIAS} = \bar{0}$.

$\bar{RATE_GYRO_READ} = RAD_PER_DEG \text{ VECTOR } (P_FIL, Q_FIL, R_FIL)$

$\bar{RG_CORR_PAST} = \bar{RG_CORR}$

$\bar{RG_CORR} = \bar{RATE_GYRO_READ} - \bar{W}_{BIAS}$

$\bar{QINCRV} = -0.25 \text{ DELTIME } (\bar{RG_CORR_PAST} + \bar{RG_CORR})$

If ATT_MODE = TRANSITION, then

$\bar{RATE_GYRO_CORR} = DEG_PER_RAD \bar{RG_CORR}$

The scalar part of the incremental quaternion is given by

$QINCRS = \text{SQRT}(1 - \bar{QINCRV} \cdot \bar{QINCRV})$

which may be approximated by

$QINCRS = 1 - 0.5(\bar{QINCRV} \cdot \bar{QINCRV})$

The body wrt M50 quaternion is then integrated to the current time

$Q_B_I = Q_INCR Q_B_I$

The time tag for Q_B_I is formed:

$$T_NOW = \text{CLOCKTIME}$$

If this is a minor cycle when IMU gimbal angles have just been read and will be used in the outer loop for updating the attitude reference $[(T_NOW - T_IMUS_GA) \leq \text{DELTIME}]$, then the body wrt M50 quaternion at T_IMUS_GA is computed.

$$\overline{Q_TEMPV} = \frac{DTIMU}{DELTIME} \overline{Q_INCRV}$$

$$QTEMP = 1 - 0.5 (\overline{Q_TEMPV} \cdot \overline{Q_TEMPV})$$

$$QBI_IMU_READ = QTEMP Q_B_I$$

If this is a minor cycle when the outer loop (ATT_PROC_OUTER) has just computed the body wrt M50 quaternion using gimbal angles, then Q_B_I is updated by

$$Q_CORR = QBI_UPDATE QBI_IMU_READ^*$$

$$Q_B_I = Q_CORR Q_B_I$$

and the updated Q_B_I is normalized by calling the QUAT_NORM utility routine. If MM101 on the first pass after the platform reference update (REFS_RDY) and after a valid Q_B_I is completed, set the QBI_VALID flag ON for ASC_DAP. The rate bias is determined from the IMU update (Q_CORR). The IMU update is first limited to 0.1 degree per axis to protect against large transients due to changes in selected IMU. If $|QCORRV_i| > 0.05 \text{ RAD_PER_DEG}$, then $QCORRV_i = 0.05 \text{ RAD_PER_DEG SIGN}(QCORRV_i)$.

$$\overline{THINCR} = -2 QCORRS \overline{QCORRV}$$

$$\overline{DEL_W_BIAS} = \frac{-\overline{THINCR}}{9.6}$$

$$\overline{W_BIAS} = \overline{W_BIAS} + \overline{DEL_W_BIAS}$$

The calculation of the rate bias change ($\overline{DEL_W_BIAS}$) over the current update interval (0.96 second) includes the multiplication by a scale factor of 0.1 to help flight control meet gain and phase stability requirements.

When ATT_MODE = TRANSITION, the following additional steps are performed. The body attitude increment is computed at 12.5 Hz (and compensated for IMU updates at 1.04 Hz).

$$\overline{ATTITUDE_INCREMENT} = \text{DEG_PER_RAD} (-2 \overline{Q_INCRV} + \overline{THINCR})$$

$$\overline{THINCR} = 0$$

The roll component of $\overline{ATTITUDE_INCREMENT}$ is integrated over 0.160-second periods as INT_ROLL_INC:

$$\text{INT_ROLL_INC} = \text{INT_ROLL_INC} + \text{ATTITUDE_INCREMENT}_1$$

where INT_ROLL_INC is reset to zero at 6.25 Hz in ATT_PROC_DISP. The requirement to continue INT_ROLL_INC is maintained even though the calculation is no longer used by any principal function.

At the 0.52 Hz rate, perform the following payload attitude computations:

IF OPS3_INDICATOR = ON AND (ATT_MODE = TRANSITION OR RCO_ENABLE = ON),

then the earth-fixed-to-M50 matrix is defined as a function of time. Nav coordinate transformation functions are used. T_NOW is used as the argument in the calling statement

$$M_EFM50 = EARTH_FIXED_TO_M50_COORD(T_NOW)$$

Next, extract Q_M50_EF from the matrix M_EFM50 via the MAT_TO_QUAT utility function. The product Q_BODY_EF = Q_B_I Q_M50_EF is then used as the argument in a call to QUAT_TO_ADI_ANG. QUAT_TO_ADI_ANG returns (XPTCHSINE, XPTCHCOS, XYAWSINE, XYAWCOS, XROLLSINE, XROLLCOS, XFLAG). If XFLAG = OFF, PITCH and ROLL functions were not updated in QUAT_TO_ADI_ANG due to the singularity at YAW = ±90; and PAYLOAD functions are not updated. If XFLAG = ON,

$$PAYLOAD_YAW = ARCSIN(XYAWSINE)$$

$$PAYLOAD_PITCH = ARCTAN2(XPTCHSINE, XPTCHCOS)$$

$$PAYLOAD_ROLL = ARCTAN2(XROLLSINE, XROLLCOS)$$

G. Constraints. Outputs to GN&C/SM-PL IF shall be protected time homogenous parameters. These outputs shall be referenced to T_NOW (time tag of Q_B_I). Q_B_I and its time tag T_NOW shall be protected time homogenous parameters available for downlist.

This concludes ATT_PROC_INNER.

0.52 Hz
OPS3_INDICATOR = ON
AND (ATT_MODE = 2 OR RCO_ENABLE = ON)

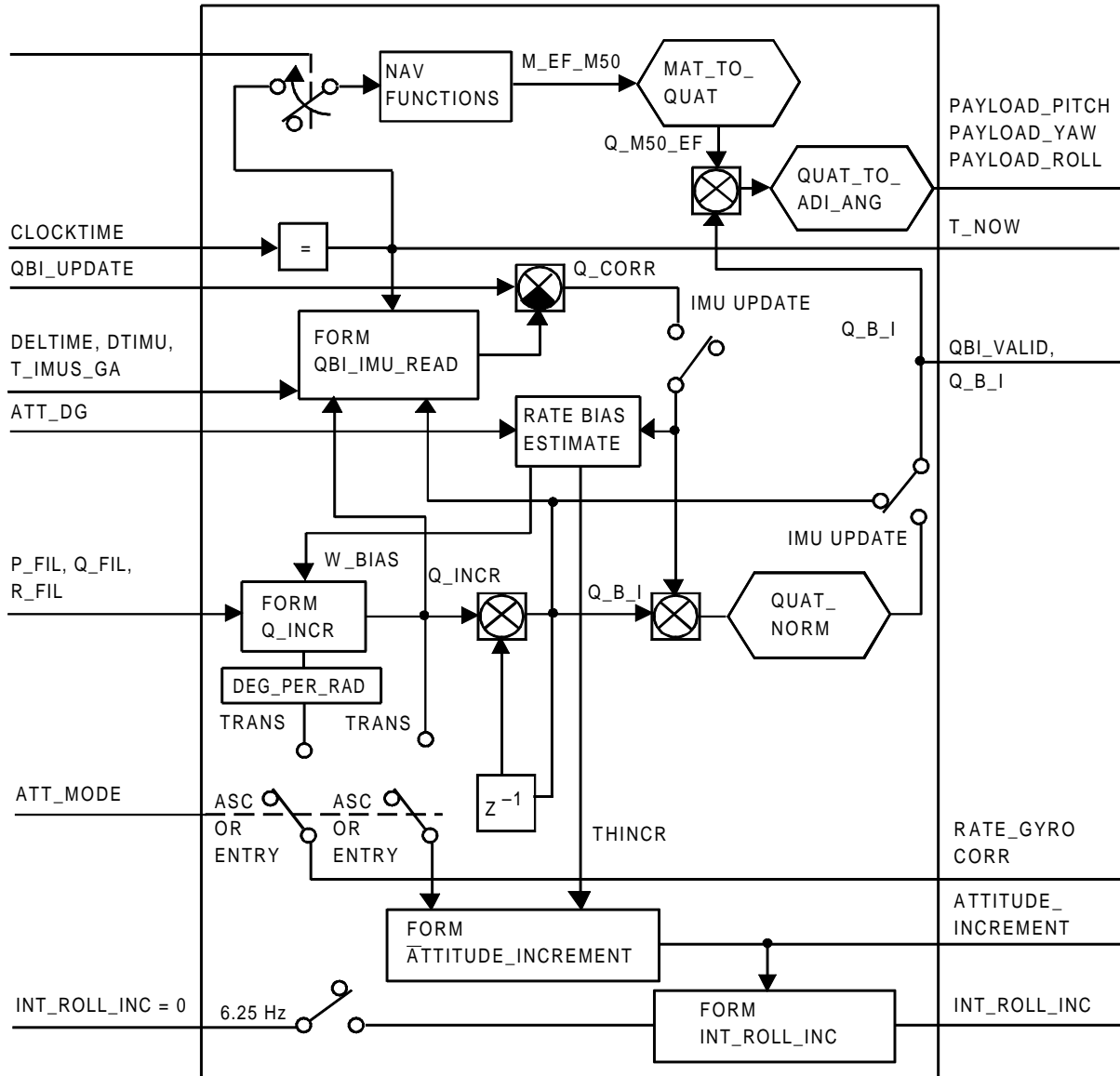


FIGURE 4.6.4.3-1. ATT_PROC_INNER Block Diagram

4.6.4.4 Attitude Processor Derived Air Data and Euler Angle Processing (ATT_PROC_EULER)

- A. Function. ATT_PROC_EULER calculates several additional variables which are required at 6.25 Hz or less. These variables are computed from the body attitude quaternion. An overview block diagram of ATT_PROC_EULER is given in Figure 4.6.4.4-1.
- B. Processing Requirements. ATT_PROC_EULER is performed at 6.25 Hz, after ATT_PROC_INNER.
- C. Interface Requirements. The interface requirements for the module ATT_PROC_EULER are shown in Tables 4.6.2-1 and 4.6.2-2.
- D. Constants. I-Loads/K-Loads used in module ATT_PROC_EULER are given in Table 4.6.2-4. The constants are shown in Table 4.6.2-5.
- E. Initialization. Initialization requirements are shown in Table 4.6.2-3.
- F. Detailed Technical Description. The vehicle velocity relative to the earth-s surface (\bar{V}_{RHO}) is transformed into body coordinates using the QUAT_XFORM utility function. The assigned vector \bar{UB} is used to develop angle of attack, sideslip angle, BANK and trigonometric functions of them. The first component UB_1 of the assigned vector \bar{UB} is sent to GRTLS DAP each time it is computed. CALL QUAT_XFORM with arguments Q_B_I and \bar{V}_{RHO} . ASSIGN \bar{UB} . Then

$$UB_X = \text{SQRT}(UB_1^2 + UB_3^2)$$

If $UB_X < UB_EPS$ (a K-LOADed small test velocity), do not perform the following update calculations for ALPHA_N, BETA_N, MEDS_ALPHA and MEDS_BETA. If $UB_X \geq UB_EPS$, then compute ALPHA_N, BETA_N, MEDS_ALPHA and MEDS_BETA as follows:

If CONT_3EO_START = OFF and CONT_2EO_START = OFF:

$$\text{SINALF} = UB_3/UB_X$$

$$\text{ALPHA_N} = \text{DEG_PER_RAD ARCSIN}(\text{SINALF})$$

$$\text{BETA_N} = \text{DEG_PER_RAD } UB_2 / |\bar{UB}|$$

If CONT_3EO_START = ON or CONT_2EO_START = ON:

$$\text{ALPHA_N} = \text{DEG_PER_RAD ARCTAN2}(UB_3, UB_1)$$

$$\text{BETA_N} = \text{DEG_PER_RAD ARCTAN}(UB_2/UB_X)$$

Determine the angle of attack and the angle of sideslip with corrected sign for MEDS display:

$$\text{MEDS_ALPHA} = \text{DEG_PER_RAD ARCTAN2}(UB_3, UB_1)$$

$$\text{MEDS_BETA} = \text{BETA_N}$$

If $UB_1 < 0$:

$$\text{MEDS_BETA} = - \text{MEDS_BETA}$$

Prior to the first cycle through these calculations, it is necessary that the ATT_PROC_OUTER module execute.

The body wrt topodetic quaternion, Q_BODY_TD, is formed by

$$\text{Q_BODY_TD} = \text{Q_B_I} \text{ Q_M50_TD}$$

The FCS–sequence Euler angles body wrt topodetic, and certain trigonometric functions of them are then obtained. The utility routine QUAT_TO_EULER is called with argument Q_BODY_TD, and PSI, THETA, PHI, SINTH, COSTH, SINPHI, and COSPHI are returned. The angles are in degrees. The topodetic Euler angles availability flag for the GPS SOP, EULER_GPS_AVAIL, is set equal to the attitude data good flag. If ATT_MODE = ENTRY or MM_CODE_601, the following additional step is performed. Heading with respect to magnetic north at the runway is given by

$$\text{PSI_HSIMV} = \text{RAD_PER_DEG} \text{ PSI} - \text{ANGLE_CORR_TNTOMAG_RW}$$

This concludes processing during MM_CODE_601.

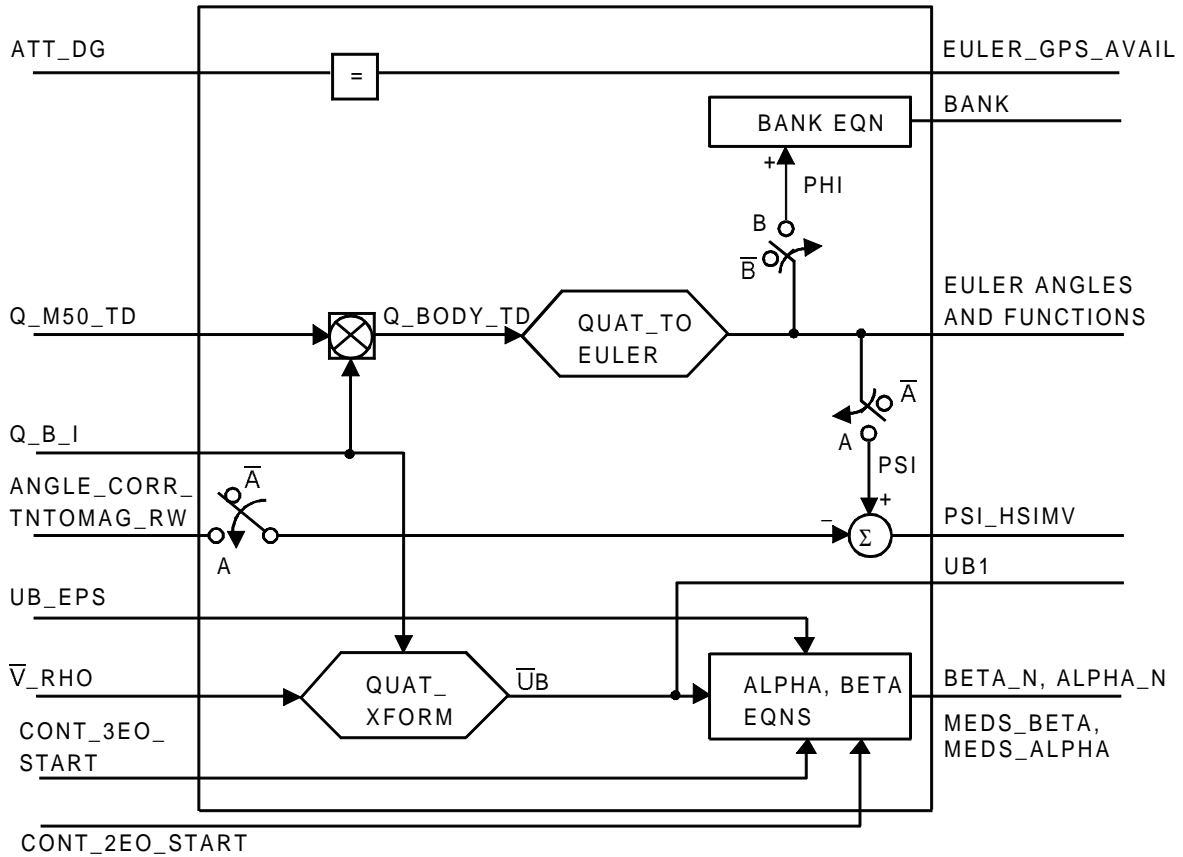
If ATT_MODE = ENTRY, the following additional step is performed.

BANK is then set equal to the body roll angle

$$\text{BANK} = \text{PHI}$$

This concludes processing during ATT_MODE = ENTRY.

This concludes ATT_PROC_EULER.



A = (ATT_MODE = ENTRY or MM_CODE_601)

B = (ATT_MODE = ENTRY)

FIGURE 4.6.4.4-1. ATT_PROC_EULER Block Diagram

4.6.4.5 Attitude Processor Display Processing (ATT_PROC_DISP)

A. Function. ATT_PROC_DISP calculates the ADI ball driver functions. During ATT_MODE = 2 (TRANSITION), delta velocity is calculated and transformed into the body frame, and body attitude errors are derived. An overview block diagram of ATT_PROC_DISP is given in Figure 4.6.4.5-1.

B. Processing Requirements. The module ATT_PROC_DISP is performed at 6.25 Hz, after ATT_PROC_EULER has been performed. ADI driver functions are computed at 3.125 Hz, which may be accomplished either by computing driver functions for both ADI-s every second pass or by computing the driver functions for each on alternate passes. ATT_PROC_DISP also computes HSI driver functions at 3.125 Hz.

C. Interface Requirements. The interface requirements for module ATT_PROC_DISP are shown in Tables 4.6.2-1 and 4.6.2-2.

D. Constants. ATT_PROC_DISP I-loads/K-loads are shown in Table 4.6.2-4. The constants are shown in Table 4.6.2-5.

E. Initialization Requirements. The initialization requirements for ATT_PROC_DISP are shown in Table 4.6.2-3.

F. Detailed Technical Requirements. When ATT_MODE = 2 (TRANSITION), body delta velocity is formed at 1.04 Hz, and attitude errors are derived. The integrated roll attitude increment is first zeroed.

$$\text{INT_ROLL_INC} = 0$$

For derivation of body delta velocity (ΔV) at low rate (1.04 Hz), the body attitude quaternion at the midpoint of the ΔV cycle is saved

$$Q_B_I_MIDPOINT = Q_B_I$$

on every sixth 6.25 Hz cycle starting three cycles after IMU RM velocity processing, i.e.

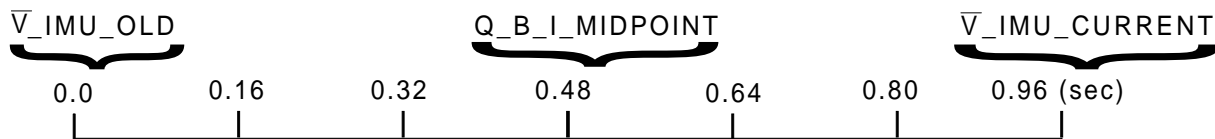


FIGURE 4.6.4.5-0. ATT_PROC_DISP Detailed Technical Requirements

Then at 1.04 Hz

$$\overline{\text{DEL_V_IMU}} = \overline{\text{V_IMU_CURRENT}} - \overline{\text{V_IMU_OLD}}$$

$$\overline{\text{V_IMU_OLD}} = \overline{\text{V_IMU_CURRENT}}$$

$$\overline{\text{DVB_SEC}} = Q_B_I_MIDPOINT \overline{\text{DEL_V_IMU}} Q_B_I_MIDPOINT^*$$

The attitude errors which can be displayed on the ADI error needles are derived from a small angle approximation to the error quaternion. This is not equivalent to the Euler angles which would define the precise rotation angles from the present to the desired attitude. It should be expected, therefore, that for a 3-axis attitude maneuver on the order of five degrees or larger, the crew would have to repeat the maneuver sequence at least once. Q_B_I is the present body wrt M50 quaternion, and $Q_B_I_CMD_DISPLAY$ is the commanded body wrt M50 quaternion. Then

$$\begin{aligned} Q_ERROR &= [QERRORS, \overline{Q}ERRORV] \\ &= Q_B_I_CMD_DISPLAY Q_B_I^* \end{aligned}$$

and the error angles from the body attitude to the commanded attitude are

$$\overline{BODY_ERR_ANG} = +2 \text{ DEG_PER_RAD SIGN}(QERRORS) \overline{Q}ERRORV$$

This concludes processing done only in $ATT_MODE = TRANSITION$.

ATT_PROC_DISP now performs HSI driver function processing. Whenever $MM = 101, 102, 103,$ or 601 , a quaternion of the body with respect to the LVIY reference is computed as follows:

$$Q_B_LVIY = Q_B_I Q_M50_LVIY$$

where Q_M50_LVIY is computed in ATT_PROC_OUTER module at 1.04 Hz.

Next, the utility function $QUAT_TO_EULER$ is called with Q_B_LVIY as the argument and returns $XPSI, XTHETA, XPHI, XSINTH, XCOSTH, XSINPHI,$ and $XCOSPHI$. Then if $|COSTH| \geq 0.03$, the HSI heading parameter, YAW_IY , is assigned the Euler yaw angle $XPSI$,

$$YAW_IY = RAD_PER_DEG XPSI$$

and if NAV_INIT ($EVENT_14$) has occurred, a heads-up/heads-down indicator, $ROLL_SW$, is determined as a function of the Euler roll angle $XPHI$, that is, if $|XPHI| \leq 90^\circ$,

$$ROLL_SW = 1$$

otherwise

$$ROLL_SW = -1$$

The parameters returned from the call to $QUAT_TO_EULER$ are also used in subsequent ADI processing whenever the LVIY reference is desired.

ATT_PROC_DISP next calculates ADI ball driver functions for the two forward balls, as indicated in “B. Processing Requirements” above. In $ASCENT$ and $TRANSITION$, they are driven independently to one of three switch selectable references (showing ADI sequence Euler angles from the reference to the body). These references are chosen by $ATT_SEL_SW_{ADI}$, where $ADI = 1, 2$ to indicate the left forward and right forward station, respectively.

The three ATT_SEL_SW positions indicate reference frames defined by quaternions:

ATT_SEL_SW = -1 (= INRTL)

INRTL is an arbitrary inertial reference frame defined by Q_M50_INRTL.

ATT_SEL_SW = 0 (= BIASLVLH, during TRANSITION mode, but not when Major Mode is MM103)

BIASLVLH is a noninertial frame defined by Q_M50_BIASLVLH which is computed in the ATT_PROC_OUTER module at 1.04 Hz. BIASLVLH is a constant rotation away from LVLH given by Q_LVLH_BIASLVLH. LVLH is the local orbital frame

\bar{X}_{LVLH} = downrange

\bar{Y}_{LVLH} = crossrange

\bar{Z}_{LVLH} = down (along negative \bar{R}_{AVGG})

ATT_SEL_SW = 0 (= LVIY, during ASCENT and TRANSITION modes, but only when in MM101, 102, 103, or 601)

LVIY is a rotating reference frame intended primarily for ascent powered flight regions, and defined by Q_M50_LVIY.

The frame is oriented such that

\bar{Z}_{LVIY} = down (along negative \bar{R}_{AVGG})

\bar{X}_{LVIY} = downrange (normal to plane formed by \bar{R}_{AVGG} and unit vector \bar{I}_{YD_M50})

\bar{Y}_{LVIY} = crossrange (forms right-handed orthogonal triad)

ATT_SEL_SW = +1 (= REF)

In MM101, REF is defined by Q_M50_REF, which is set equal to Q_M50_LVIY in ATT_PROC_OUTER. Otherwise, REF is an inertial reference frame defined by Q_M50_REF. It is then redefined as an inertial frame coincident with the instantaneous BODY frame whenever an ADI attitude reference switch is sensed and COAS mode is not selected.

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Each forward station has an ADI attitude reference switch, which is processed by the switch processor to yield:

$FWD_ATT_REF_PB = OFF = \text{no selection}$

$FWD_ATT_REF_PB = ON = LH \text{ or } RH \text{ forward ADI's attitude reference switch is selected}$

The following processing is done for each ADI in ASCENT and TRANSITION. (ADI processing in ENTRY is treated separately below.)

First, if $FWD_ATT_REF_PB = ON$ and $DESEL = 1$ (COAS DESELECT COMMAND), Q_M50_REF is updated by $Q_M50_REF = Q_B_I^*$.

If not in major modes (101, 102, 103, or 601) or $ATT_SEL_SW_{ADI} \neq 0$, then a quaternion of the body wrt the selected reference, Q_BODY_ADIREF , is formed as a function of $ATT_SEL_SW_{ADI}$. If both ADI's ATT_SEL_SW are set the same, then this computation for Q_BODY_ADIREF need only be performed once.

$ATT_SEL_SW_{ADI} = -1: Q_BODY_ADIREF = Q_B_I Q_M50_INRTL$

$ATT_SEL_SW_{ADI} = 0: Q_BODY_ADIREF = Q_B_I Q_M50_BIASLVLH$

$ATT_SEL_SW_{ADI} = +1: Q_BODY_ADIREF = Q_B_I Q_M50_REF.$

If in major modes (101, 102, 103, or 601) and the $ATT_SEL_SW_{ADI} = 0$, the following ADI commands are computed (for each ADI) from the previous call to QUAT_TO_EULER (see HSI driver function processing).

$PTCHSINE_{ADI} = XSINTH$

$PTCHCOS_{ADI} = XCOSTH$

$YAWSINE_{ADI} = 0$

$YAWCOS_{ADI} = 1$

and, if $|XCOSTH| < 0.03$, the sine and cosine of the roll angle should not be updated on this pass.

If, however, $|XCOSTH| \geq 0.03$, then compute the following roll commands.

$ROLLSINE_{ADI} = XSINPHI$

$ROLLCOS_{ADI} = XCOSPHI$

If both ADI's have their $ATT_SEL_SW = 0$, then the same values are used to update both ADI's.

If in major modes (101, 102, 103, or 601) and the $ATT_SEL_SW_{ADI} \pm 1^\circ$ or if not in major modes (101, 102, 103, or 601), then the utility function QUAT_TO_ADI_ANG is called with Q_BODY_ADIREF . It returns $XPTCHSINE$, $XPTCHCOS$, $XYAWSINE$, $XYAWCOS$, $XROLLSINE$, $XROLLCOS$, and $XFLAG$ (if both ADI's ATT_SEL_SW are set the same, then this call to QUAT_TO_ADI_ANG need only be performed once). Output update equations are:

If XFLAG = ON:

$$PTCHSINE_{ADI} = XPTCHSINE$$

$$PTCHCOS_{ADI} = XPTCHCOS$$

1. If not in MM101, 102, 103, or 601.

$$YAWSINE_{ADI} = XYAWSINE$$

$$YAWCOS_{ADI} = XYAWCOS$$

$$ROLLSINE_{ADI} = XROLLSINE$$

$$ROLLCOS_{ADI} = XROLLCOS$$

If XFLAG = OFF, the yaw functions are updated but the pitch and roll functions are not.

When ATT_MODE = ENTRY the two ADI's display only attitude with respect to the topodetic frame with YAW caged to zero. Q_BODY_ADIREF is not formed. Driver functions are the pitch and roll Euler angle sines and cosines derived in ATT_PROC_EULER. The following processing is to be done for each ADI:

$$PTCHSINE_{ADI} = SINTH$$

$$PTCHCOS_{ADI} = COSTH$$

$$YAWSINE_{ADI} = 0$$

$$YAWCOS_{ADI} = 1.$$

$$ROLLSINE_{ADI} = SINPHI$$

$$ROLLCOS_{ADI} = COSPHI$$

This concludes ATT_PROC_DISP.

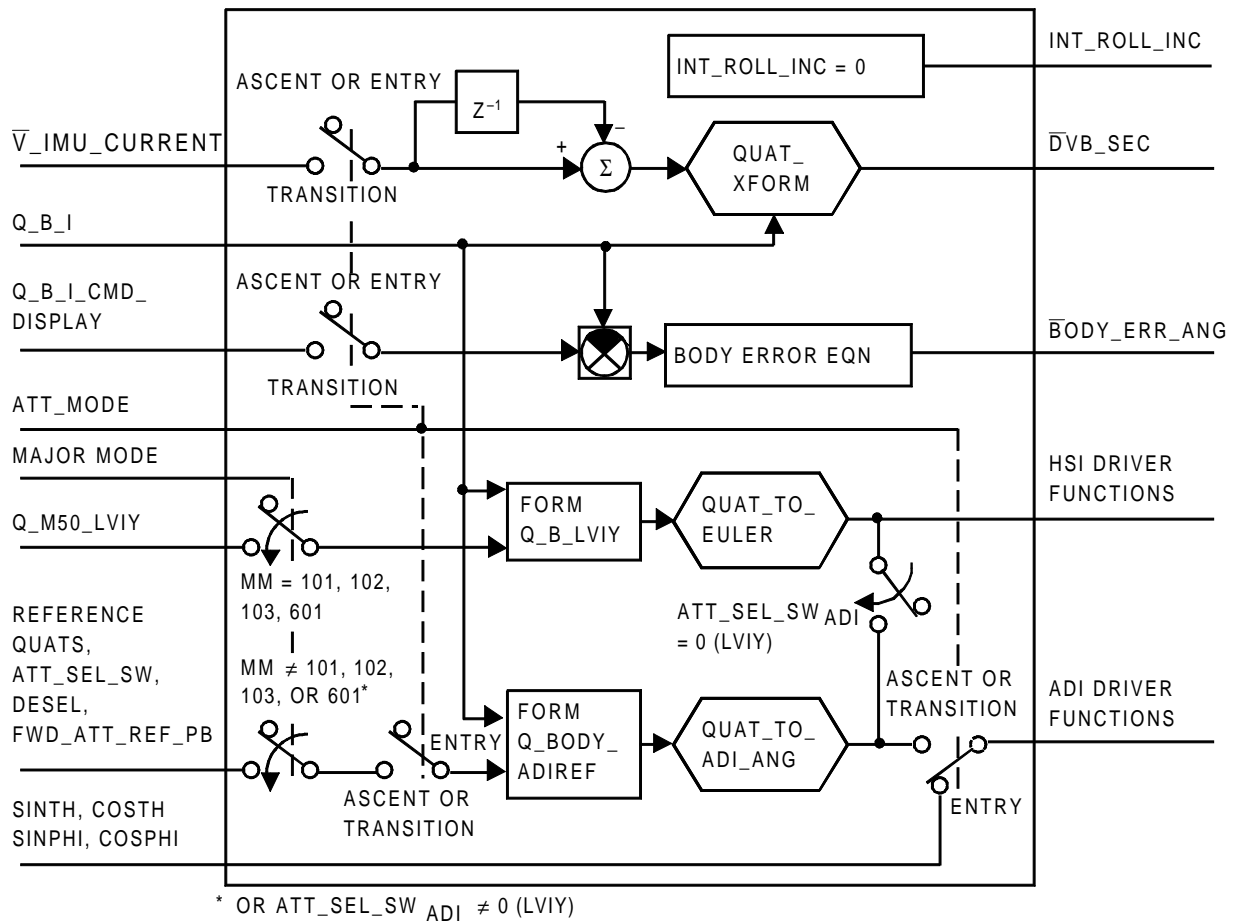


FIGURE 4.6.4.5-1. ATT_PROC_DISP Block Diagram

4.6.4.6 Attitude Processor Rolloff Filter (ATT_PROC_PREFIL)

A. Function. ATT_PROC_PREFIL is a rolloff filter on RGA input rates. It functions to minimize energy content above the half sample rate of ATT_PROC_INNER. The block diagrams are presented in Figure 4.6.4.6–1 for ascent and in Figure 4.6.4.6–2 for entry/landing, RGA data are not filtered during ATT_MODE = TRANSITION.

B. Processing Requirements. ATT_PROC_PREFIL is processed as follows:

Ascent: 25 Hz; beginning at platform reference update (REFS_RDY)

Transition: 12.5 Hz

Entry: 25 Hz – first stage of filter
12.5 Hz – second stage of filter

C. Interface Requirements. Interface requirements for ATT_PROC_PREFIL are shown in Tables 4.6.2–1 and 4.6.2–2.

D. Constants. I–loads/K–loads for ATT_PROC_PREFIL are shown in Table 4.6.2–4. The constants are shown in Table 4.6.2–5.

E. Initialization Requirements. Initialization requirements for ATT_PROC_PREFIL are shown in Table 4.6.2–3 and Figure 4.6.4.6–3 (detailed mechanization).

F. Detailed Description. For ascent, see Figure 4.6.4.6–1. For transition, the outputs are set equal to the selected orbiter RGA rates. For entry, see Figure 4.6.4.6–2. The detailed mechanization for ATT_PROC_PREFIL is shown in Figure 4.6.4.6–3.

The selected RGA rates are filtered via a first–order filter, prior to use in ATT_PROC_INNER. The computations, in order, are:

$$1 \begin{cases} P_{FIL} = RO_FILT_1 P + P_{FILO} \\ Q_{FIL} = RO_FILT_1 Q + Q_{FILO} \\ R_{FIL} = RO_FILT_1 R + R_{FILO} \end{cases}$$

$$2 \begin{cases} P_{FILO} = RO_FILT_2 P - RO_FILT_3 P_{FIL} \\ Q_{FILO} = RO_FILT_2 Q - RO_FILT_3 Q_{FIL} \\ R_{FILO} = RO_FILT_2 R - RO_FILT_3 R_{FIL} \end{cases}$$

Note: On the initial pass of ATT_PROC_PREFIL, the first three equations above (Set 1) should not be computed.

For entry, ATT_PROC_PREFIL consists of two cascaded first–order rolloff filters – – the first operating at 25 Hz and the second at 12.5 Hz.

The technical description given above for ascent applies to each section of ATT_PROC_PREFIL entry with appropriate change of symbols.

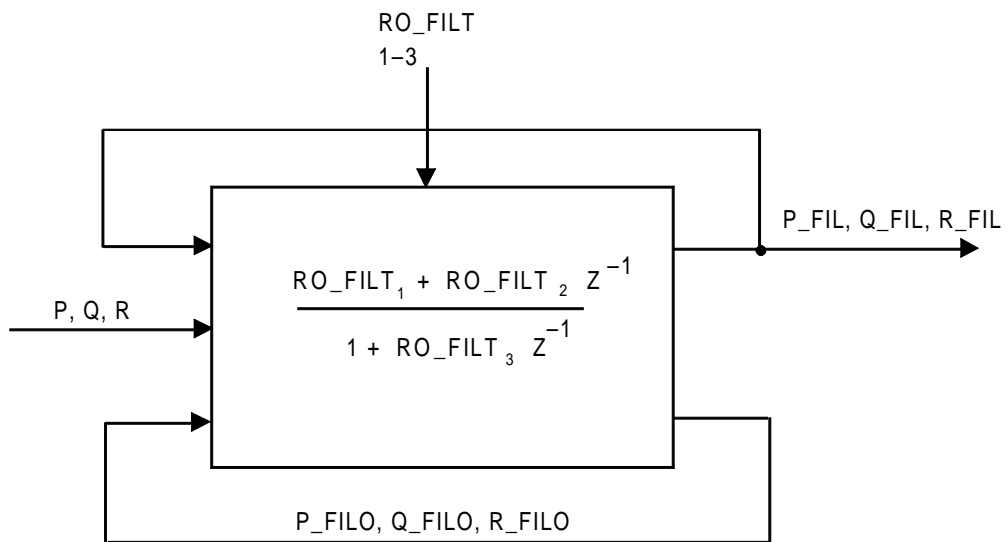


FIGURE 4.6.4.6-1. ATT_PROC_PREFIL Ascent/PRTLs Block Diagram

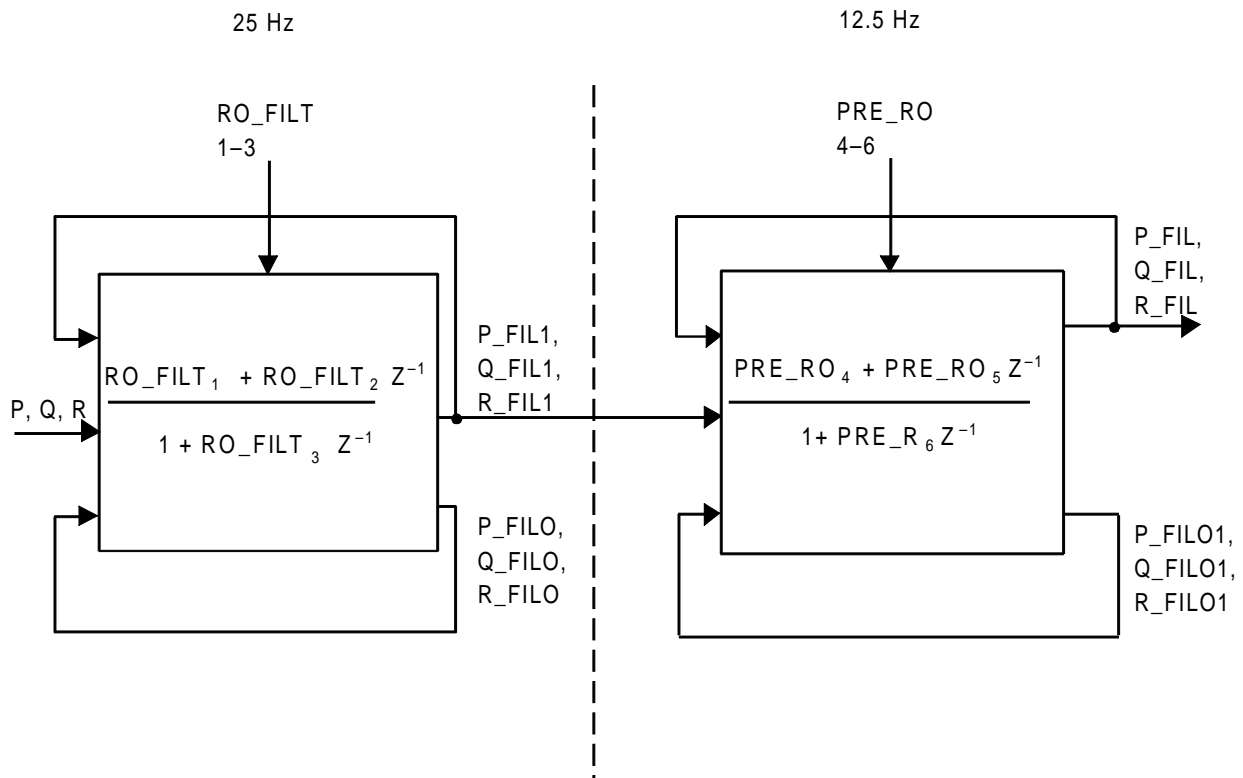


FIGURE 4.6.4.6-2. ATT_PROC_PREFIL Entry/GRTLS Block Diagram

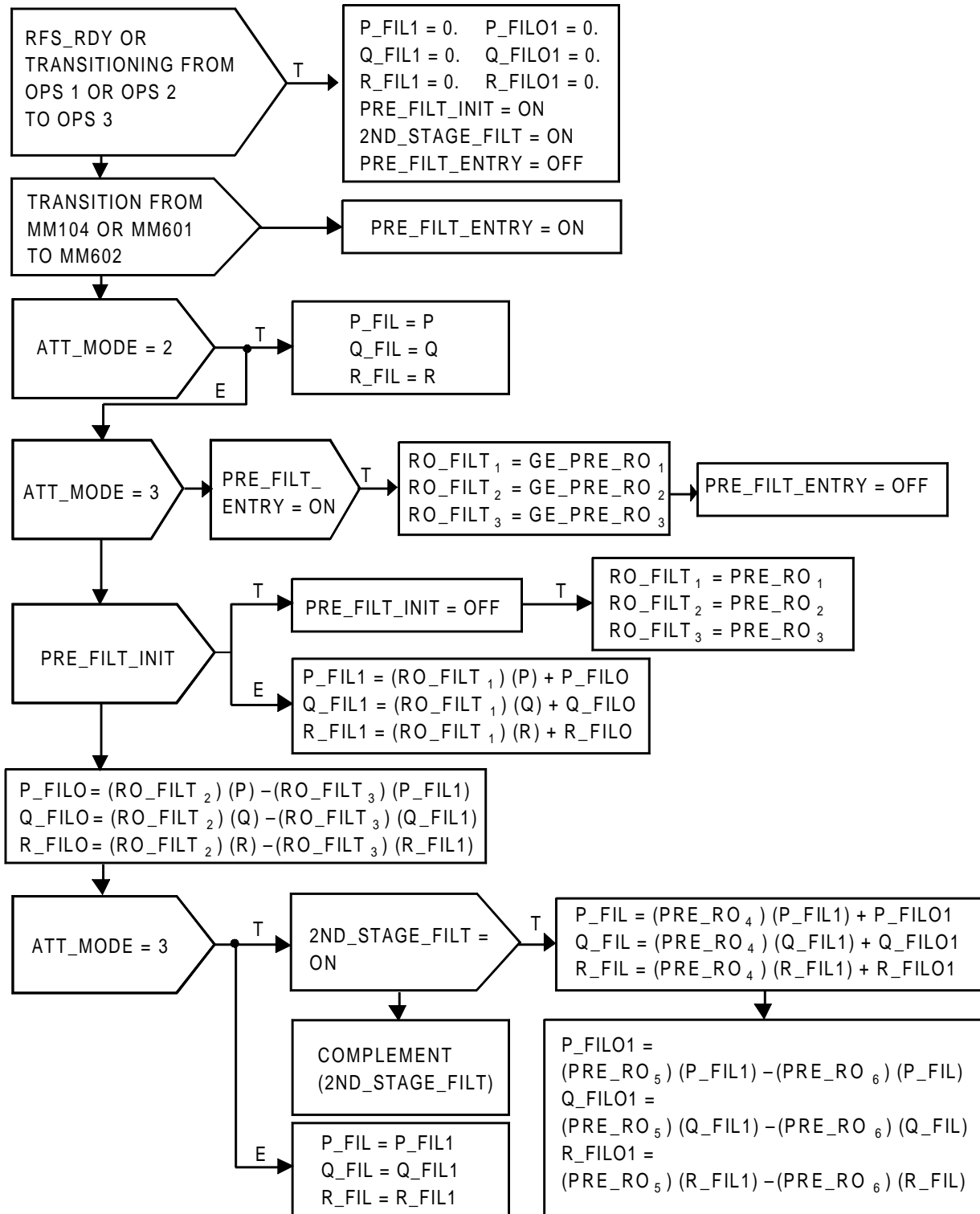


FIGURE 4.6.4.6-3. Detailed Mechanization for ATT_PROC_PREFIL

4.6.4.7 Attitude Processor RGA Switch (ATT_PROC_RGASW)

- A. Function. ATT_PROC_RGASW provides SRB pitch and yaw rate signals to ATT_PROC_PREFIL during ascent first stage, and orbiter pitch and yaw rate signals to ATT_PROC_PREFIL for the remainder of ascent, transition, and entry through landing. It provides orbiter roll rate to ATT_PROC_PREFIL during ascent, transition, entry through landing. The block diagram for ATT_PROC_RGASW is given in Figure 4.6.4.7-1.
- B. Processing Requirements. ATT_PROC_RGASW operates at 25 Hz during ascent beginning at platform reference update (REFS_RDY) and entry through landing. During transition, ATT_PROC_RGASW is performed at 12.5 Hz.
- C. Interface Requirements. The interface requirements for the module ATT_PROC_RGASW are shown in Tables 4.6.2-1 and 4.6.2-2.
- D. Constants. There are no constants for ATT_PROC_RGASW.
- E. Initialization Requirements. There are no initialization requirements for ATT_PROC_RGASW.
- F. Detailed Technical Description. Switching is controlled by SRB_NULL_CMD during ascent.

$$P = PORB$$

If (SRB_NULL_CMD \neq 0),

then Q = QORB and R = RORB

else Q = QSRB and R = RSRB

Orbiter values for P, Q, and R are used during all other flight phases.

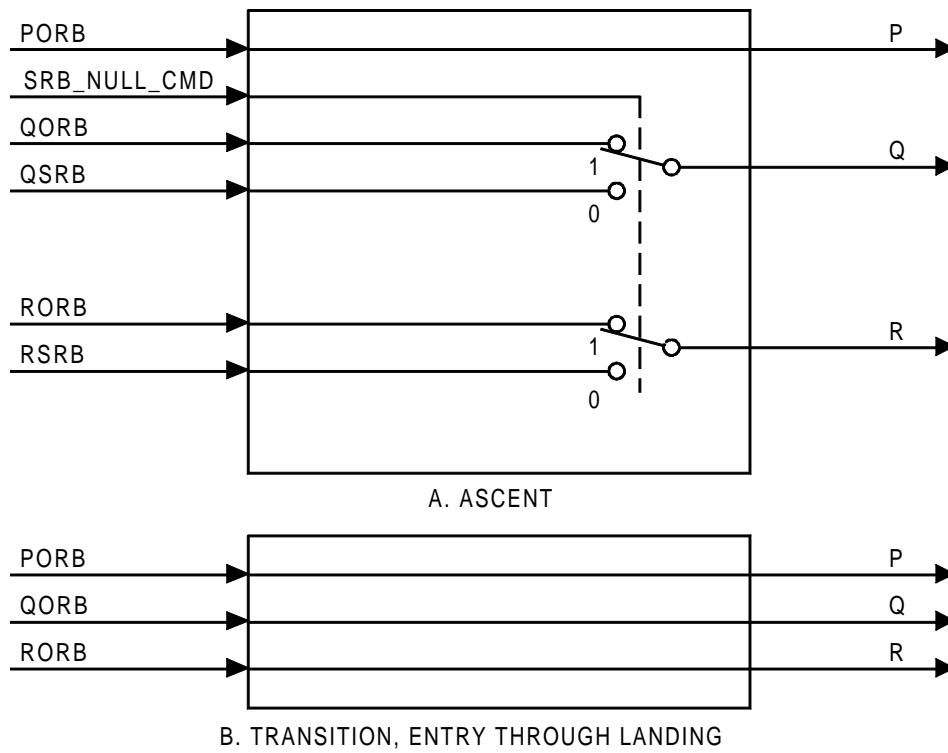


FIGURE 4.6.4.7-1. ATT_PROC_RGASW Block Diagram

4.6.4.8 ADI Quaternion Uplink (ADI_QUAT_UPLINK)

A. Functional Requirements. ADI_QUAT_UPLINK is a procedure that performs the following functions.

1. Determine if new ADI quaternion loads have been uplinked and made available.
2. Move the new data from the uplink buffers into appropriate compool storage locations.

The block diagram for ADI_QUAT_UPLINK is given in Figure 4.6.4.8-1.

B. Processing Requirements. ADI_QUAT_UPLINK is performed on demand.

C. Interface Requirements. The interface requirements for ADI_QUAT_UPLINK are given in Tables 4.6.2-1 and 4.6.2-2.

D. Detailed Requirements. The following set of equations and sequences are used to perform the ADI_QUAT_UPLINK function.

1. If the uplink OP code is for the ADI INERTIAL QUATERNION LOAD (0011000), then transfer the values of the quaternion elements from the uplink buffer into the storage locations used by ATT_PROC_DISP for the ADI inertial quaternion.
2. If the uplink OP code is for the ADI REFERENCE QUATERNION LOAD (0011101), then transfer the values of the quaternion elements from the uplink buffer into the storage locations used by ATT_PROC_DISP for the ADI reference quaternion.
3. If the uplink OP code is for the ADI BIASLVLH QUATERNION LOAD (0011110), then transfer the values of the quaternion elements from the uplink buffer into the storage locations used by ATT_PROC_OUTER for the ADI bias LVLH quaternion.

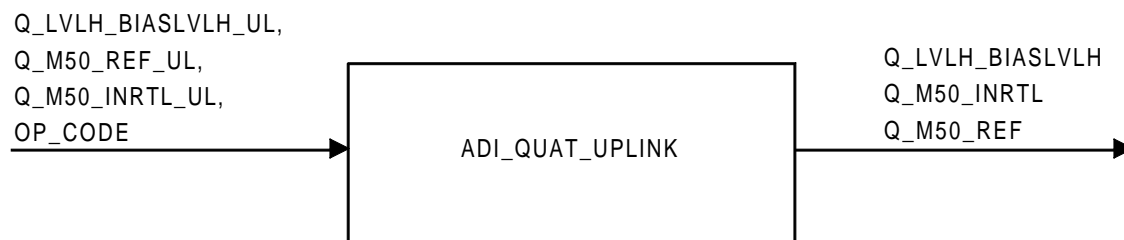


FIGURE 4.6.4.8-1. ADI_QUAT_UPLINK Block Diagram

4.6.5 Ascent/Entry Attitude Processor Principal Function Tables

The ascent/entry attitude processor principal function input and output tables, along with the I-load and K-load tables, are presented in Tables 4.6.5-1 through 4.6.5-3. The automated Interface Definition Document (IDD), Table 4.6.5-1, defines signal (parameter) interface requirements either between hardware (LRU) and software elements or between software elements. * 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.

* A GN&C software element is either a sequenced principal function (PF), crew generated specialist/display function or an OPS display function.

Note that IDD output (source) tables that reflect parameters going to input (destination) TLM will 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.

TABLE 4.6.5-1. INPUT FUNCTIONAL PARAMETERS FOR ASCENT/ENTRY ATTITUDE PROCESSOR (G4.226)

FSSR NAME	M/S ID	NOMENCLATURE	SOURCE	UNITS	DATA TYPE	P R E C	LAST CR	R E V
ANGLE_CORR_TNTOMAG_RW	V90H1820CA	MAGNETIC VARIATION OF RW	ENT SITE LOOKUP	RAD			92297B	
ANGLE_CORR_TNTOMAG_RW	V90H1820CB	MAGNETIC VARIATION OF RW	ASC SITE LOOKUP	RAD			92297B	
ATT_DG	V90X2555X	ATTITUDE DATA GOOD FLAG	IMU RM				93017G	*
ATT_SEL_SW(1)	V90J7503C	LH ADI ATTITUDE SELECT SW	GN&C SW RM		HXS		93017G	*
ATT_SEL_SW(2)	V90J7504C	RH ADI ATTITUDE SELECT SW	GN&C SW RM		HXS		93017G	*
AZANG(1)	V95H0051CA	IMU 1 COMP AZIMUTH RES ANGLE	IMU INT PROC	DEG			93017G	*
AZANG(2)	V95H1051CA	IMU 2 COMP AZIMUTH RES ANGLE	IMU INT PROC	DEG			93017G	*
AZANG(3)	V95H2051CA	IMU 3 COMP AZIMUTH RES ANGLE	IMU INT PROC	DEG			93017G	*
CDP(1)	V90U2648CA	COS OF 1/2 IMU 1 R/P NONORTHOGON	ORB ATT PROC					
CDP(2)	V90U2649CA	COS OF 1/2 IMU 2 R/P NONORTHOGON	ORB ATT PROC					
CDP(3)	V90U2650CA	COS OF 1/2 IMU 3 R/P NONORTHOGON	ORB ATT PROC					
CLOCK/CLOCKTIME	V91W5000C	CLOCK-COMPUTER(GMT)	FCOS	S			93160B	*
CONT_2EO_START	V93X6681XA	CONTINGENCY 2-ENG OUT START FLAG	XXXXXX TRAJ 1 DISP		BD		93017G	*
CONT_2EO_START	V93X6681XB	CONTINGENCY 2-ENG OUT START FLAG	PW CONT GUID		BD		93090E	
CONT_2EO_START	V93X6681XC	CONTINGENCY 2-ENG OUT START FLAG	XXXXXX TRAJ 2 DISP		BD		93017G	*
CONT_2EO_START	V93X6681XD	CONTINGENCY 2-ENG OUT START FLAG	RTLS TRAJ 2 DISP		BD		93017G	*
CONT_3EO_START	V90X0909X	CONTINGENCY 3 E/O START FLAG	CONT 3E/O GUID		BD		93017G	*
DESEL	V93X6647X	COAS DES CMD	STAR TRKR/COAS DISP		BD			
DP(1)	V99H2660CA	IMU-1 ROLL/PITCH NONORTHOGONALITY	IMU GND CAL	RAD			93017G	*
DP(2)	V99H2661CA	IMU-2 ROLL/PITCH NONORTHOGONALITY	IMU GND CAL	RAD			93017G	*
DP(3)	V99H2662CA	IMU-3 ROLL/PITCH NONORTHOGONALITY	IMU GND CAL	RAD			93017G	*
FWD_ATT_REF_PB	V90X7897X	STA SEL FWD ADI ATT REF PB	GN&C SW RM					
IMU_ALIGN_DISP	V90X8020X	IMU ALIGN DISP ON FLAG	MSC				89599C	
IMU_QUAT_UPD_REQ	V95X0532X	IMU REFERENCE QUAT UPDATE REQUEST	IMU ORB A/CAL				89986H	
IRANG(1)	V95H0053CA	IMU 1 COMP INNER ROLL RES ANGLE	IMU INT PROC	DEG			93017G	*
IRANG(2)	V95H1053CA	IMU 2 COMP INNER ROLL RES ANGLE	IMU INT PROC	DEG			93017G	*
IRANG(3)	V95H2053CA	IMU 3 COMP INNER ROLL RES ANGLE	IMU INT PROC	DEG			93017G	*
IYD(X)	V97U4413CB	UNIT VEC NORM TRAJ PLANE X COMP	UL				93090E	
IYD(Y)	V97U4414CB	UNIT VEC NORM TRAJ PLANE Y COMP	UL				93090E	
IYD(Z)	V97U4415CB	UNIT VEC NORM TRAJ PLANE Z COMP	UL				93090E	
I_YD_M50(1)	V95U0494C	M50 INSERTION TARGET UNIT VECTOR-1	ASC UPP				93090E	
I_YD_M50(2)	V95U0495C	M50 INSERTION TARGET UNIT VECTOR-2	ASC UPP				93090E	
I_YD_M50(3)	V95U0496C	M50 INSERTION TARGET UNIT VECTOR-3	ASC UPP				93090E	
MECO_CMD	V90X8569XA	MECO COMMAND FLAG	SSME OPS		BD		93017G	*
MM_CODE_102/MM_102	V90X8158X	MAJOR MODE 102 FLAG	MSC				93012D	
MM_CODE_103/MM_103	V90X8156X	MAJOR MODE 103 FLAG	MSC				93012D	
MM_CODE_601/MM_601	V90X8194X	MAJOR MODE 601 FLAG	MSC		BD		93012D	
MM_CODE_602/MM_602	V90X8174X	MAJOR MODE 602 FLAG	MSC				92355B	
M_M50TOEF_AT_EPOCH(1,1)	V97U5738C	M50 TO EF TRANS MATRIX ELEM 1,1	RNP MAT COMP	ND	DPL		93090E	
M_M50TOEF_AT_EPOCH(1,2)	V97U5739C	M50 TO EF TRANS MATRIX ELEM 1,2	RNP MAT COMP	ND	DPL		93090E	
M_M50TOEF_AT_EPOCH(1,3)	V97U5740C	M50 TO EF TRANS MATRIX ELEM 1,3	RNP MAT COMP	ND	DPL		93090E	
M_M50TOEF_AT_EPOCH(2,1)	V97U5741C	M50 TO EF TRANS MATRIX ELEM 2,1	RNP MAT COMP	ND	DPL		93090E	
M_M50TOEF_AT_EPOCH(2,2)	V97U5742C	M50 TO EF TRANS MATRIX ELEM 2,2	RNP MAT COMP	ND	DPL		93090E	
M_M50TOEF_AT_EPOCH(2,3)	V97U5743C	M50 TO EF TRANS MATRIX ELEM 2,3	RNP MAT COMP	ND	DPL		93090E	
M_M50TOEF_AT_EPOCH(3,1)	V97U5744C	M50 TO EF TRANS MATRIX ELEM 3,1	RNP MAT COMP	ND	DPL		93090E	
M_M50TOEF_AT_EPOCH(3,2)	V97U5745C	M50 TO EF TRANS MATRIX ELEM 3,2	RNP MAT COMP	ND	DPL		93090E	

TABLE 4.6.5-1. INPUT FUNCTIONAL PARAMETERS FOR ASCENT/ENTRY ATTITUDE PROCESSOR (G4.226)

FSSR NAME	M/S ID	NOMENCLATURE	SOURCE	UNITS	DATA TYPE	P R E C	LAST CR	R E V
M_M50TOEF_AT_EPOCH(3,3)	V97U5746C	M50 TO EF TRANS MATRIX ELEM 3,3	RNP MAT COMP	ND	DPL		93090E	
NAV_INIT_FLAG	V90X8414X	NAV INIT FLAG	R/S LCH SEQ		BD		93017G	*
OPS3_INDICATOR	V90X8649X	OPS 3 IND	MSC		BD		93023D	
ORANG(1)	V95H0054CA	IMU 1 COMP OUTER ROLL RES ANGLE	IMU INT PROC	DEG			93017G	*
ORANG(2)	V95H1054CA	IMU 2 COMP OUTER ROLL RES ANGLE	IMU INT PROC	DEG			93017G	*
ORANG(3)	V95H2054CA	IMU 3 COMP OUTER ROLL RES ANGLE	IMU INT PROC	DEG			93017G	*
PANG(1)	V95H0050CA	IMU 1 COMP PITCH RES ANGLE	IMU INT PROC	DEG			93017G	*
PANG(2)	V95H1050CA	IMU 2 COMP PITCH RES ANGLE	IMU INT PROC	DEG			93017G	*
PANG(3)	V95H2050CA	IMU 3 COMP PITCH RES ANGLE	IMU INT PROC	DEG			93017G	*
P_ORB	V90R5301CA	SELECTED RGA ROLL RATE	SF	DEG/S			93017G	*
Q_BOD_M50(1)/Q_B_M50(1)	V90U2240CB	M50 TO BODY QUAT MEASURED ELEM 1	ORB ATT PROC		SPL		93017G	*
Q_BOD_M50(2)/Q_B_M50(2)	V90U2241CB	M50 TO BODY QUAT MEASURED ELEM 2	ORB ATT PROC		SPL		93017G	*
Q_BOD_M50(3)/Q_B_M50(3)	V90U2242CB	M50 TO BODY QUAT MEASURED ELEM 3	ORB ATT PROC		SPL		93017G	*
Q_BOD_M50(4)/Q_B_M50(4)	V90U2243CB	M50 TO BODY QUAT MEASURED ELEM 4	ORB ATT PROC		SPL		93017G	*
Q_B_I_CMD_DISPLAY(1)	V90H2721CC	CMD BODY WRT M50 QUAT ELEM 1	TRANS DAP					
Q_B_I_CMD_DISPLAY(2)	V90H2722CC	CMD BODY WRT M50 QUAT ELEM 2	TRANS DAP					
Q_B_I_CMD_DISPLAY(3)	V90H2723CC	CMD BODY WRT M50 QUAT ELEM 3	TRANS DAP					
Q_B_I_CMD_DISPLAY(4)	V90H2724CC	CMD BODY WRT M50 QUAT ELEM 4	TRANS DAP					
Q_LVLH_BIASLVLH_UL(1)	V97U2210CC	ADI TO LVLH QUAT ELEM 1	UL					
Q_LVLH_BIASLVLH_UL(2)	V97U2211CC	ADI TO LVLH QUAT ELEM 2	UL					
Q_LVLH_BIASLVLH_UL(3)	V97U2212CC	ADI TO LVLH QUAT ELEM 3	UL					
Q_LVLH_BIASLVLH_UL(4)	V97U2213CC	ADI TO LVLH QUAT ELEM 4	UL					
Q_M50_INRTL_UL(1)	V97U2214CC	ADI INERT QUAT ELEM 1	UL					
Q_M50_INRTL_UL(2)	V97U2215CC	ADI INERT QUAT ELEM 2	UL					
Q_M50_INRTL_UL(3)	V97U2216CC	ADI INERT QUAT ELEM 3	UL					
Q_M50_INRTL_UL(4)	V97U2217CC	ADI INERT QUAT ELEM 4	UL					
Q_M50_REF_UL(1)	V97U2218CC	ADI REF QUAT ELEM 1	UL					
Q_M50_REF_UL(2)	V97U2219CC	ADI REF QUAT ELEM 2	UL					
Q_M50_REF_UL(3)	V97U2220CC	ADI REF QUAT ELEM 3	UL					
Q_M50_REF_UL(4)	V97U2221CC	ADI REF QUAT ELEM 4	UL					
Q_ORB/Q	V90R5321CA	SELECTED RGA PITCH RATE	SF	DEG/S			93017G	*
Q_SM_M50(1,1)	V90U2664CA	IMU 1 REFERENCE QUATERNION 1	ORB ATT PROC					
Q_SM_M50(1,2)	V90U2665CA	IMU 1 REFERENCE QUATERNION 2	ORB ATT PROC					
Q_SM_M50(1,3)	V90U2666CA	IMU 1 REFERENCE QUATERNION 3	ORB ATT PROC					
Q_SM_M50(1,4)	V90U2667CA	IMU 1 REFERENCE QUATERNION 4	ORB ATT PROC					
Q_SM_M50(2,1)	V90U2668CA	IMU 2 REFERENCE QUATERNION 1	ORB ATT PROC					
Q_SM_M50(2,2)	V90U2669CA	IMU 2 REFERENCE QUATERNION 2	ORB ATT PROC					
Q_SM_M50(2,3)	V90U2670CA	IMU 2 REFERENCE QUATERNION 3	ORB ATT PROC					
Q_SM_M50(2,4)	V90U2671CA	IMU 2 REFERENCE QUATERNION 4	ORB ATT PROC					
Q_SM_M50(3,1)	V90U2672CA	IMU 3 REFERENCE QUATERNION 1	ORB ATT PROC					
Q_SM_M50(3,2)	V90U2673CA	IMU 3 REFERENCE QUATERNION 2	ORB ATT PROC					
Q_SM_M50(3,3)	V90U2674CA	IMU 3 REFERENCE QUATERNION 3	ORB ATT PROC					
Q_SM_M50(3,4)	V90U2675CA	IMU 3 REFERENCE QUATERNION 4	ORB ATT PROC					
Q_SRB	V90R2511C	SRGA SEL PITCH RATE	SF	DEG/S			93017G	*
RCO_ENABLE	V93X1112X	RCO INHIBIT/ENABLE CMD	RM SWITCH/SURF FB DISP		BD		93017G	*

TABLE 4.6.5-1. INPUT FUNCTIONAL PARAMETERS FOR ASCENT/ENTRY ATTITUDE PROCESSOR (G4.226)

FSSR NAME	M/S ID	NOMENCLATURE	SOURCE	UNITS	DATA TYPE	P R E C	LAST CR	R E V
REFS_RDY	V95X0780X	REFSMAT COMPUTATION COMPLETED	IMU GC ALIGN		BD		93017G	*
REFS_RDY	V95X0780XA	REFSMAT COMPUTATION COMPLETED	IMU INT PROC		BD		93017G	*
R_AVGG(1)	V95H0185CA	X-COMP OF CUR SHUTTLE POS VCTR M50	RTLS UPP	FT	DPL		93017G	*
R_AVGG(1)	V95H0185CB	X-COMP OF CUR SHUTTLE POS VCTR M50	ASC UPP	FT	DPL		93017G	*
R_AVGG(1)	V95H0185CC	X-COMP OF CUR SHUTTLE POS VCTR M50	ENT UPP	FT	DPL		93017G	*
R_AVGG(1)	V95H0185CD	X-COMP OF CUR SHUTTLE POS VCTR M50	TAEM UPP	FT	DPL		93017G	*
R_AVGG(1)	V95H0185CE	X-COMP OF CUR SHUTTLE POS VCTR M50	A/L UPP	FT	DPL		93017G	*
R_AVGG(2)	V95H0186CA	Y-COMP OF CUR SHUTTLE POS VCTR M50	RTLS UPP	FT	DPL		93017G	*
R_AVGG(2)	V95H0186CB	Y-COMP OF CUR SHUTTLE POS VCTR M50	ASC UPP	FT	DPL		93017G	*
R_AVGG(2)	V95H0186CC	Y-COMP OF CUR SHUTTLE POS VCTR M50	ENT UPP	FT	DPL		93017G	*
R_AVGG(2)	V95H0186CD	Y-COMP OF CUR SHUTTLE POS VCTR M50	TAEM UPP	FT	DPL		93017G	*
R_AVGG(2)	V95H0186CE	Y-COMP OF CUR SHUTTLE POS VCTR M50	A/L UPP	FT	DPL		93017G	*
R_AVGG(3)	V95H0187CA	Z-COMP OF CUR SHUTTLE POS VCTR M50	RTLS UPP	FT	DPL		93017G	*
R_AVGG(3)	V95H0187CB	Z-COMP OF CUR SHUTTLE POS VCTR M50	ASC UPP	FT	DPL		93017G	*
R_AVGG(3)	V95H0187CC	Z-COMP OF CUR SHUTTLE POS VCTR M50	ENT UPP	FT	DPL		93017G	*
R_AVGG(3)	V95H0187CD	Z-COMP OF CUR SHUTTLE POS VCTR M50	TAEM UPP	FT	DPL		93017G	*
R_AVGG(3)	V95H0187CE	Z-COMP OF CUR SHUTTLE POS VCTR M50	A/L UPP	FT	DPL		93017G	*
R_ORB	V90R5341CA	SELECTED RGA YAW RATE	SF	DEG/S			93017G	*
R_SRB	V90R2512C	SRGA SEL YAW RATE	SF	DEG/S			93017G	*
SDP(1)	V90U2645CA	SIN OF 1/2 IMU 1 R/P NONORTHOGON	ORB ATT PROC					
SDP(2)	V90U2646CA	SIN OF 1/2 IMU 2 R/P NONORTHOGON	ORB ATT PROC					
SDP(3)	V90U2647CA	SIN OF 1/2 IMU 3 R/P NONORTHOGON	ORB ATT PROC					
SEL_IMU_ID	V90J2560C	SELECTED IMU ID	IMU RM		HXS		93017G	*
SEL_V_M50(1)	V90L2557C	SEL TOTAL X VEL M50	IMU RM	FT/S	DPL		93017G	*
SEL_V_M50(2)	V90L2558C	SEL TOTAL Y VEL M50	IMU RM	FT/S	DPL		93017G	*
SEL_V_M50(3)	V90L2559C	SEL TOTAL Z VEL M50	IMU RM	FT/S	DPL		93017G	*
SRB_NULL_CMD	V90X1769X	INITIATE SRB NULL CMD	ASC DAP					
T_CLUSTER_M50(1,1,1)	V99U3450CA	CLUSTER TO M50/IMU-1 COMPONENT 1,1	IMU ORB A/CAL				93017G	*
T_CLUSTER_M50(1,1,1)	V99U3450CB	CLUSTER TO M50/IMU-1 COMPONENT 1,1	IMU GC ALIGN				93017G	*
T_CLUSTER_M50(1,1,2)	V99U3453CA	CLUSTER TO M50/IMU-1 COMPONENT 1,2	IMU ORB A/CAL				93017G	*
T_CLUSTER_M50(1,1,2)	V99U3453CB	CLUSTER TO M50/IMU-1 COMPONENT 1,2	IMU GC ALIGN				93017G	*
T_CLUSTER_M50(1,1,3)	V99U3456CA	CLUSTER TO M50/IMU-1 COMPONENT 1,3	IMU ORB A/CAL				93017G	*
T_CLUSTER_M50(1,1,3)	V99U3456CB	CLUSTER TO M50/IMU-1 COMPONENT 1,3	IMU GC ALIGN				93017G	*
T_CLUSTER_M50(1,2,1)	V99U3459CA	CLUSTER TO M50/IMU 1 COMPONENT 2,1	IMU ORB A/CAL				93017G	*
T_CLUSTER_M50(1,2,1)	V99U3459CB	CLUSTER TO M50/IMU 1 COMPONENT 2,1	IMU GC ALIGN				93017G	*
T_CLUSTER_M50(1,2,2)	V99U3462CA	CLUSTER TO M50/IMU-1 COMPONENT 2,2	IMU ORB A/CAL				93017G	*
T_CLUSTER_M50(1,2,2)	V99U3462CB	CLUSTER TO M50/IMU-1 COMPONENT 2,2	IMU GC ALIGN				93017G	*
T_CLUSTER_M50(1,2,3)	V99U3465CA	CLUSTER TO M50/IMU-1 COMPONENT 2,3	IMU ORB A/CAL				93017G	*
T_CLUSTER_M50(1,2,3)	V99U3465CB	CLUSTER TO M50/IMU-1 COMPONENT 2,3	IMU GC ALIGN				93017G	*
T_CLUSTER_M50(1,3,1)	V99U3468CA	CLUSTER TO M50/IMU-1 COMPONENT 3,1	IMU ORB A/CAL				93017G	*
T_CLUSTER_M50(1,3,1)	V99U3468CB	CLUSTER TO M50/IMU-1 COMPONENT 3,1	IMU GC ALIGN				93017G	*
T_CLUSTER_M50(1,3,2)	V99U3471CA	CLUSTER TO M50/IMU-1 COMPONENT 3,2	IMU ORB A/CAL				93017G	*
T_CLUSTER_M50(1,3,2)	V99U3471CB	CLUSTER TO M50/IMU-1 COMPONENT 3,2	IMU GC ALIGN				93017G	*
T_CLUSTER_M50(1,3,3)	V99U3474CA	CLUSTER TO M50/IMU-1 COMPONENT 3,3	IMU ORB A/CAL				93017G	*
T_CLUSTER_M50(1,3,3)	V99U3474CB	CLUSTER TO M50/IMU-1 COMPONENT 3,3	IMU GC ALIGN				93017G	*
T_CLUSTER_M50(2,1,1)	V99U3451CA	CLUSTER TO M50/IMU-2 COMPONENT 1,1	IMU ORB A/CAL				93017G	*

December 14, 2007

TABLE 4.6.5-1. INPUT FUNCTIONAL PARAMETERS FOR ASCENT/ENTRY ATTITUDE PROCESSOR (G4.226)

FSSR NAME	M/S ID	NOMENCLATURE	SOURCE	UNITS	DATA TYPE	P R E C	LAST CR	R E V
T_CLUSTER_M50(2,1,1)	V99U3451CB	CLUSTER TO M50/IMU-2 COMPONENT 1,1	IMU GC ALIGN				93017G	*
T_CLUSTER_M50(2,1,2)	V99U3454CA	CLUSTER TO M50/IMU-2 COMPONENT 1,2	IMU ORB A/CAL				93017G	*
T_CLUSTER_M50(2,1,2)	V99U3454CB	CLUSTER TO M50/IMU-2 COMPONENT 1,2	IMU GC ALIGN				93017G	*
T_CLUSTER_M50(2,1,3)	V99U3457CA	CLUSTER TO M50/IMU-2 COMPONENT 1,3	IMU ORB A/CAL				93017G	*
T_CLUSTER_M50(2,1,3)	V99U3457CB	CLUSTER TO M50/IMU-2 COMPONENT 1,3	IMU GC ALIGN				93017G	*
T_CLUSTER_M50(2,2,1)	V99U3460CA	CLUSTER TO M50/IMU-2 COMPONENT 2,1	IMU ORB A/CAL				93017G	*
T_CLUSTER_M50(2,2,1)	V99U3460CB	CLUSTER TO M50/IMU-2 COMPONENT 2,1	IMU GC ALIGN				93017G	*
T_CLUSTER_M50(2,2,2)	V99U3463CA	CLUSTER TO M50/IMU-2 COMPONENT 2,2	IMU ORB A/CAL				93017G	*
T_CLUSTER_M50(2,2,2)	V99U3463CB	CLUSTER TO M50/IMU-2 COMPONENT 2,2	IMU GC ALIGN				93017G	*
T_CLUSTER_M50(2,2,3)	V99U3466CA	CLUSTER TO M50/IMU-2 COMPONENT 2,3	IMU ORB A/CAL				93017G	*
T_CLUSTER_M50(2,2,3)	V99U3466CB	CLUSTER TO M50/IMU-2 COMPONENT 2,3	IMU GC ALIGN				93017G	*
T_CLUSTER_M50(2,3,1)	V99U3469CA	CLUSTER TO M50/IMU-2 COMPONENT 3,1	IMU ORB A/CAL				93017G	*
T_CLUSTER_M50(2,3,1)	V99U3469CB	CLUSTER TO M50/IMU-2 COMPONENT 3,1	IMU GC ALIGN				93017G	*
T_CLUSTER_M50(2,3,2)	V99U3472CA	CLUSTER TO M50/IMU-2 COMPONENT 3,2	IMU ORB A/CAL				93017G	*
T_CLUSTER_M50(2,3,2)	V99U3472CB	CLUSTER TO M50/IMU-2 COMPONENT 3,2	IMU GC ALIGN				93017G	*
T_CLUSTER_M50(2,3,3)	V99U3475CA	CLUSTER TO M50/IMU-2 COMPONENT 3,3	IMU ORB A/CAL				93017G	*
T_CLUSTER_M50(2,3,3)	V99U3475CB	CLUSTER TO M50/IMU-2 COMPONENT 3,3	IMU GC ALIGN				93017G	*
T_CLUSTER_M50(3,1,1)	V99U3452CA	CLUSTER TO M50/IMU-3 COMPONENT 1,1	IMU ORB A/CAL				93017G	*
T_CLUSTER_M50(3,1,1)	V99U3452CB	CLUSTER TO M50/IMU-3 COMPONENT 1,1	IMU GC ALIGN				93017G	*
T_CLUSTER_M50(3,1,2)	V99U3455CA	CLUSTER TO M50/IMU-3 COMPONENT 1,2	IMU ORB A/CAL				93017G	*
T_CLUSTER_M50(3,1,2)	V99U3455CB	CLUSTER TO M50/IMU-3 COMPONENT 1,2	IMU GC ALIGN				93017G	*
T_CLUSTER_M50(3,1,3)	V99U3458CA	CLUSTER TO M50/IMU-3 COMPONENT 1,3	IMU ORB A/CAL				93017G	*
T_CLUSTER_M50(3,1,3)	V99U3458CB	CLUSTER TO M50/IMU-3 COMPONENT 1,3	IMU GC ALIGN				93017G	*
T_CLUSTER_M50(3,2,1)	V99U3461CA	CLUSTER TO M50/IMU-3 COMPONENT 2,1	IMU ORB A/CAL				93017G	*
T_CLUSTER_M50(3,2,1)	V99U3461CB	CLUSTER TO M50/IMU-3 COMPONENT 2,1	IMU GC ALIGN				93017G	*
T_CLUSTER_M50(3,2,2)	V99U3464CA	CLUSTER TO M50/IMU-3 COMPONENT 2,2	IMU ORB A/CAL				93017G	*
T_CLUSTER_M50(3,2,2)	V99U3464CB	CLUSTER TO M50/IMU-3 COMPONENT 2,2	IMU GC ALIGN				93017G	*
T_CLUSTER_M50(3,2,3)	V99U3467CA	CLUSTER TO M50/IMU-3 COMPONENT 2,3	IMU ORB A/CAL				93017G	*
T_CLUSTER_M50(3,2,3)	V99U3467CB	CLUSTER TO M50/IMU-3 COMPONENT 2,3	IMU GC ALIGN				93017G	*
T_CLUSTER_M50(3,3,1)	V99U3470CA	CLUSTER TO M50/IMU-3 COMPONENT 3,1	IMU ORB A/CAL				93017G	*
T_CLUSTER_M50(3,3,1)	V99U3470CB	CLUSTER TO M50/IMU-3 COMPONENT 3,1	IMU GC ALIGN				93017G	*
T_CLUSTER_M50(3,3,2)	V99U3473CA	CLUSTER TO M50/IMU-3 COMPONENT 3,2	IMU ORB A/CAL				93017G	*
T_CLUSTER_M50(3,3,2)	V99U3473CB	CLUSTER TO M50/IMU-3 COMPONENT 3,2	IMU GC ALIGN				93017G	*
T_CLUSTER_M50(3,3,3)	V99U3476CA	CLUSTER TO M50/IMU-3 COMPONENT 3,3	IMU ORB A/CAL				93017G	*
T_CLUSTER_M50(3,3,3)	V99U3476CB	CLUSTER TO M50/IMU-3 COMPONENT 3,3	IMU GC ALIGN				93017G	*
T_EPOCH	V97W5528C	TIME TAG FOR M_M50TOEF_AT_EPOCH	RNP MAT COMP	S	DPL		93090E	
T_IMUS	V95W0002C	IMU INPUT TRANS TIME TAG	IMU INT PROC	S	DPL		93017G	*
UP_OP_CODE	V96J3521C	OP CODE FOR UPLINK	UL		HXS		92067D	
V_AVGG(1)	V95L0190CA	X-COMP OF CUR SHUTTLE VEL VCTR M50	RTLS UPP	FT/S	SPL		93017G	*
V_AVGG(1)	V95L0190CB	X-COMP OF CUR SHUTTLE VEL VCTR M50	ASC UPP	FT/S	SPL		93017G	*
V_AVGG(1)	V95L0190CC	X-COMP OF CUR SHUTTLE VEL VCTR M50	ENT UPP	FT/S	SPL		93017G	*
V_AVGG(1)	V95L0190CD	X-COMP OF CUR SHUTTLE VEL VCTR M50	TAEM UPP	FT/S	SPL		93017G	*
V_AVGG(1)	V95L0190CE	X-COMP OF CUR SHUTTLE VEL VCTR M50	A/L UPP	FT/S	SPL		93017G	*
V_AVGG(2)	V95L0191CA	Y-COMP OF CUR SHUTTLE VEL VCTR M50	RTLS UPP	FT/S	SPL		93017G	*
V_AVGG(2)	V95L0191CB	Y-COMP OF CUR SHUTTLE VEL VCTR M50	ASC UPP	FT/S	SPL		93017G	*
V_AVGG(2)	V95L0191CC	Y-COMP OF CUR SHUTTLE VEL VCTR M50	ENT UPP	FT/S	SPL		93017G	*

TABLE 4.6.5-1. INPUT FUNCTIONAL PARAMETERS FOR ASCENT/ENTRY ATTITUDE PROCESSOR (G4.226)

FSSR NAME	M/S ID	NOMENCLATURE	SOURCE	UNITS	DATA TYPE	P R E C	LAST CR	R E V
V_AVGG(2)	V95L0191CD	Y-COMP OF CUR SHUTTLE VEL VCTR M50	TAEM UPP	FT/S	SPL		93017G	*
V_AVGG(2)	V95L0191CE	Y-COMP OF CUR SHUTTLE VEL VCTR M50	A/L UPP	FT/S	SPL		93017G	*
V_AVGG(3)	V95L0192CA	Z-COMP OF CUR SHUTTLE VEL VCTR M50	RTLS UPP	FT/S	SPL		93017G	*
V_AVGG(3)	V95L0192CB	Z-COMP OF CUR SHUTTLE VEL VCTR M50	ASC UPP	FT/S	SPL		93017G	*
V_AVGG(3)	V95L0192CC	Z-COMP OF CUR SHUTTLE VEL VCTR M50	ENT UPP	FT/S	SPL		93017G	*
V_AVGG(3)	V95L0192CD	Z-COMP OF CUR SHUTTLE VEL VCTR M50	TAEM UPP	FT/S	SPL		93017G	*
V_AVGG(3)	V95L0192CE	Z-COMP OF CUR SHUTTLE VEL VCTR M50	A/L UPP	FT/S	SPL		93017G	*
V_RHO(1)	V95L0215CA	X-COMP OF RELATIVE VEL IN M50	RTLS UPP	FT/S			93090E	
V_RHO(1)	V95L0215CB	X-COMP OF RELATIVE VEL IN M50	ENT UPP	FT/S				
V_RHO(1)	V95L0215CC	X-COMP OF RELATIVE VEL IN M50	TAEM UPP	FT/S				
V_RHO(1)	V95L0215CD	X-COMP OF RELATIVE VEL IN M50	A/L UPP	FT/S				
V_RHO(1)	V95L0215CE	X-COMP OF RELATIVE VEL IN M50	ASC UPP	FT/S			93090E	
V_RHO(2)	V95L0216CA	Y-COMP OF RELATIVE VEL IN M50	RTLS UPP	FT/S			93090E	
V_RHO(2)	V95L0216CB	Y-COMP OF RELATIVE VEL IN M50	ENT UPP	FT/S				
V_RHO(2)	V95L0216CC	Y-COMP OF RELATIVE VEL IN M50	TAEM UPP	FT/S				
V_RHO(2)	V95L0216CD	Y-COMP OF RELATIVE VEL IN M50	A/L UPP	FT/S				
V_RHO(2)	V95L0216CE	Y-COMP OF RELATIVE VEL IN M50	ASC UPP	FT/S			93090E	
V_RHO(3)	V95L0217CA	Z-COMP OF RELATIVE VEL IN M50	RTLS UPP	FT/S			93090E	
V_RHO(3)	V95L0217CB	Z-COMP OF RELATIVE VEL IN M50	ENT UPP	FT/S				
V_RHO(3)	V95L0217CC	Z-COMP OF RELATIVE VEL IN M50	TAEM UPP	FT/S				
V_RHO(3)	V95L0217CD	Z-COMP OF RELATIVE VEL IN M50	A/L UPP	FT/S				
V_RHO(3)	V95L0217CE	Z-COMP OF RELATIVE VEL IN M50	ASC UPP	FT/S			93090E	

NOTE: REFERENCE TABLE 1.3-1 FOR EXPLANATION OF DATA ELEMENTS.

TABLE 4.6.5-2. OUTPUT FUNCTIONAL PARAMETERS FROM ASCENT/ENTRY ATTITUDE PROCESSOR (G4.226)

FSSR NAME	M/S ID	NOMENCLATURE	DESTINATION	UNITS	DATA TYPE	P R E C	LAST CR	R E V
ALPHA_N	V90H2246C	NAV DERIVED ANGLE OF ATTACK	A/L UPP ADTA SOP AEROJET DAP ASC 1STG GUID ASC NAV ASC PREC PRED CONT 3E/O GUID DL FMT 21/A DL FMT 23/1 ENT NAV ENT PREC PRED ENT UPP ET SEP SEQ G/C STEER GRTLS DAP PW CONT GUID RTLS NAV RTLS UPP TAEM UPP VERT SIT DIP	DEG	SPL		93017G	*
ATTITUDE_INCREMENT(1)	V90U2333C	ATTITUDE INCREMENT-HI RATE ROLL	ORB DAP TLM TRANS DAP	DEG			89688A	
ATTITUDE_INCREMENT(2)	V90U2334C	ATTITUDE INCREMENT-HI RATE PITCH	ORB DAP TLM TRANS DAP	DEG			89688A	
ATTITUDE_INCREMENT(3)	V90U2335C	ATTITUDE INCREMENT-HI RATE YAW	ORB DAP TLM TRANS DAP	DEG			89688A	
BANK	V90H2201C	BANK ANGLE	DL FMT 21/A ENT DIP	DEG	SPL		93017G	*
BETA_N	V90H2249C	INERTIAL SIDESLIP ANGLE	AEROJET DAP ASC NAV ASC PREC PRED CONT 3E/O GUID DL FMT 21/1 DL FMT 23/A ENT NAV ENT PREC PRED ET SEP SEQ G/C STEER GRTLS DAP HORIZ SIT SPEC RTLS NAV	DEG	SPL		93017G	*
BODY_ERR_ANG(1)	V90H2234CA	BODY ROLL ATTITUDE ERROR	ASC ADI PROC E/L ADI PROC	DEG			89366	

TABLE 4.6.5-2. OUTPUT FUNCTIONAL PARAMETERS FROM ASCENT/ENTRY ATTITUDE PROCESSOR (G4.226)

FSSR NAME	M/S ID	NOMENCLATURE	DESTINATION	UNITS	DATA TYPE	P R E C	LAST CR	R E V
BODY_ERR_ANG(2)	V90H2233CA	BODY PITCH ATTITUDE ERROR	ASC ADI PROC E/L ADI PROC	DEG			89366	
BODY_ERR_ANG(3)	V90H2235CA	BODY YAW ATTITUDE ERROR	ASC ADI PROC E/L ADI PROC	DEG			89366B	
CDP(1)	V90U2648CB	COS OF 1/2 IMU 1 R/P NONORTHOGON	ORB ATT PROC					
CDP(2)	V90U2649CB	COS OF 1/2 IMU 2 R/P NONORTHOGON	ORB ATT PROC					
CDP(3)	V90U2650CB	COS OF 1/2 IMU 3 R/P NONORTHOGON	ORB ATT PROC					
COSPHI	V90H2204C	EULER ANGLE ROLL COSINE	AEROJET DAP GRTLS DAP GRTLS TAEM GUID TAEM GUID TLM VERT SIT DIP					
COSTH	V90H2215C	EULER ANGLE PITCH COSINE	A/L UPP AEROJET DAP ENT BRG SPEC GRTLS DAP GRTLS TAEM GUID HUD PROC RTLS UPP TAEM GUID TAEM UPP TLM				93090E	
DVB_SEC(1)	V90U2307C	BODY VEL INCREMENT LO RATE X AXIS	OMS RM TLM TRANS DAP	FT/S			89688A	
DVB_SEC(2)	V90U2308C	BODY VEL INCREMENT LO RATE Y AXIS	OMS RM TLM TRANS DAP	FT/S			89688A	
DVB_SEC(3)	V90U2309C	BODY VEL INCREMENT LO RATE Z AXIS	OMS RM TLM TRANS DAP	FT/S			89688A	
EULER_GPS_AVAIL GMTC/T_NOW	V90X2610XB V90W2310CA	TOPODETTIC EULER ANGLES AVAIL FLAG M50 TO BODY QUAT TIME	GPS SOP DL FMT 21/1 DL FMT 23/1 GN&C/SM-PL IF TRANS DAP	S	BD		92144C 93017G	*
MEDS_ALPHA	V90H3908C	ANGLE OF ATTACK FOR MEDS	ADTA SOP AMI PROC				92619A	
MEDS_BETA	V90H3894C	ANGLE OF SIDESLIP FOR MEDS	MEDS FC GNC XFER	DEG			92676B	
PAYLOAD_PITCH	V95L3887CC	EF TO BODY EULER ANGLE PITCH	GN&C/SM-PL IF	RAD				
PAYLOAD_ROLL	V95L3889CC	EF TO BODY EULER ANGLE ROLL	GN&C/SM-PL IF	RAD			91051K	
PAYLOAD_YAW	V95L3888CC	EF TO BODY EULER ANGLE YAW	GN&C/SM-PL IF	RAD			91051K	

TABLE 4.6.5-2. OUTPUT FUNCTIONAL PARAMETERS FROM ASCENT/ENTRY ATTITUDE PROCESSOR (G4.226)

FSSR NAME	M/S ID	NOMENCLATURE	DESTINATION	UNITS	DATA TYPE	P R E C	LAST CR	R E V
PHI/PHI_TOPO	V90H2202C	BODY ROLL ATTITUDE EULER ANGLE	AEROJET DAP DL FMT 21/1 DL FMT 23/B E/L ADI PROC ENT BRG DISP ENT BRG SPEC ENT DIP ENT GUID GPS SOP GRTLS DAP GRTLS TAEM GUID HORIZ SIT SPEC TAEM GUID TRANS DAP	DEG	SPL		93017G	*
PHI_IMU(1)	V90H2317CB	M50 TO BODY EULER ANGLE 1 PHI	IMU ALIGN DISP	DEG			91051K	
PHI_IMU(2)	V90H2318CB	M50 TO BODY EULER ANGLE 2 PHI	IMU ALIGN DISP	DEG			89688B	
PHI_IMU(3)	V90H2319CB	M50 TO BODY EULER ANGLE 3 PHI	IMU ALIGN DISP	DEG			91051K	
PSI/PSI_TOPO	V90H2230C	BODY YAW ATTITUDE EULER ANGLE	DL FMT 21/1 DL FMT 23/2 GPS SOP	DEG	SPL		93017G	*
PSI_HSIMV	V90H2212C	HEADING RELATIVE TO MAG NORTH	ASC AREA NAV ASC BRG SPEC E/L ADI PROC ENT AREA NAV HSI PROC	RAD			93090E	
PSI_IMU(1)	V90H2311CB	M50 TO BODY EULER ANGLE 1 PSI	IMU ALIGN DISP	DEG				
PSI_IMU(2)	V90H2312CB	M50 TO BODY EULER ANGLE 2 PSI	IMU ALIGN DISP	DEG			91051K	
PSI_IMU(3)	V90H2313CB	M50 TO BODY EULER ANGLE 3 PSI	IMU ALIGN DISP	DEG				
PTCHCOS(1)	V90H2222CA	LH ADI SEL EULER ANG PITCH COSINE	ASC ADI PROC E/L ADI PROC TLM					
PTCHCOS(2)	V90H2218CA	RH ADI SEL EULER ANG PITCH COSINE	ASC ADI PROC E/L ADI PROC TLM					
PTCHSINE(1)	V90H2221CA	LH ADI SEL EULER ANG PITCH SINE	ASC ADI PROC E/L ADI PROC TLM					
PTCHSINE(2)	V90H2220CA	RH ADI SEL EULER ANG PITCH SINE	ASC ADI PROC E/L ADI PROC TLM					
QBI_VALID	V90X2245X	BODY WRT M50 QUAT VALID FLAG	ASC DAP		BD		89986H	
QREFS_RDY	V90X2244X	QUATERNION COMPUTATION COMPLETED	DL FMT 21/1 MSC		BD		93017G	*

TABLE 4.6.5-2. OUTPUT FUNCTIONAL PARAMETERS FROM ASCENT/ENTRY ATTITUDE PROCESSOR (G4.226)

FSSR NAME	M/S ID	NOMENCLATURE	DESTINATION	UNITS	DATA TYPE	P R E C	LAST CR	R E V
Q_BOD_M50(1)/Q_B_I(1)	V90U2240CA	M50 TO BODY QUAT MEASURED ELEM 1	ASC MNVR DIP CONT 3E/O GUID DEORB GUID DEORB MNVR DIP DL FMT 21/1 DL FMT 23/1 ENT NAV ENT UPP G/C STEER GN&C/SM-PL IF ORB INS GUID TRANS DAP		SPL		93017G	*
Q_BOD_M50(2)/Q_B_I(2)	V90U2241CA	M50 TO BODY QUAT MEASURED ELEM 2	ASC MNVR DIP CONT 3E/O GUID DEORB GUID DEORB MNVR DIP DL FMT 21/1 DL FMT 23/1 ENT NAV ENT UPP G/C STEER GN&C/SM-PL IF ORB INS GUID TRANS DAP		SPL		93017G	*
Q_BOD_M50(3)/Q_B_I(3)	V90U2242CA	M50 TO BODY QUAT MEASURED ELEM 3	ASC MNVR DIP CONT 3E/O GUID DEORB GUID DEORB MNVR DIP DL FMT 21/1 DL FMT 23/1 ENT NAV ENT UPP G/C STEER GN&C/SM-PL IF ORB INS GUID TRANS DAP		SPL		93017G	*

TABLE 4.6.5-2. OUTPUT FUNCTIONAL PARAMETERS FROM ASCENT/ENTRY ATTITUDE PROCESSOR (G4.226)

FSSR NAME	M/S ID	NOMENCLATURE	DESTINATION	UNITS	DATA TYPE	P R E C	LAST CR	R E V
Q_BOD_M50(4)/Q_B_I(4)	V90U2243CA	M50 TO BODY QUAT MEASURED ELEM 4	ASC MNVR DIP CONT 3E/O GUID DEORB GUID DEORB MNVR DIP DL FMT 21/1 DL FMT 23/1 ENT NAV ENT UPP G/C STEER GN&C/SM-PL IF ORB INS GUID TRANS DAP		SPL		93017G	*
Q_LVLH_BIASLVLH(1)	V97U2210CB	ADI TO LVLH QUAT ELEM 1	TLM					
Q_LVLH_BIASLVLH(2)	V97U2211CB	ADI TO LVLH QUAT ELEM 2	TLM					
Q_LVLH_BIASLVLH(3)	V97U2212CB	ADI TO LVLH QUAT ELEM 3	TLM					
Q_LVLH_BIASLVLH(4)	V97U2213CB	ADI TO LVLH QUAT ELEM 4	TLM					
Q_M50_INRTL(1)	V97U2214CB	ADI INERT QUAT ELEM 1	TLM				89366B	
Q_M50_INRTL(2)	V97U2215CB	ADI INERT QUAT ELEM 2	TLM				89366B	
Q_M50_INRTL(3)	V97U2216CB	ADI INERT QUAT ELEM 3	TLM				89366B	
Q_M50_INRTL(4)	V97U2217CB	ADI INERT QUAT ELEM 4	TLM				89366B	
Q_M50_LVLH(1)	V90U2641CB	M50 WRT LVLH QUAT 1	ASC MNVR DIP DEORB MNVR DIP DL FMT 21/A DL FMT 23/A				93017G	*
Q_M50_LVLH(2)	V90U2642CB	M50 WRT LVLH QUAT 2	ASC MNVR DIP DEORB MNVR DIP DL FMT 21/A DL FMT 23/A				93017G	*
Q_M50_LVLH(3)	V90U2643CB	M50 WRT LVLH QUAT 3	ASC MNVR DIP DEORB MNVR DIP DL FMT 21/A DL FMT 23/A				93017G	*
Q_M50_LVLH(4)	V90U2644CB	M50 WRT LVLH QUAT 4	ASC MNVR DIP DEORB MNVR DIP DL FMT 21/A DL FMT 23/A				93017G	*
Q_M50_REF(1)	V97U2218CB	ADI REF QUAT ELEM 1	DL FMT 21/A DL FMT 23/A				93017G	*
Q_M50_REF(2)	V97U2219CB	ADI REF QUAT ELEM 2	DL FMT 21/A DL FMT 23/A				93017G	*
Q_M50_REF(3)	V97U2220CB	ADI REF QUAT ELEM 3	DL FMT 21/A DL FMT 23/A				93017G	*
Q_M50_REF(4)	V97U2221CB	ADI REF QUAT ELEM 4	DL FMT 21/A DL FMT 23/A				93017G	*
Q_ROLL_SM(1,1)	V90U2337CB	ROLL GMBL WRT STBL MEM QUAT 1(1)	DL FMT 21/A DL FMT 23/A		SPL		93017G	*

TABLE 4.6.5-2. OUTPUT FUNCTIONAL PARAMETERS FROM ASCENT/ENTRY ATTITUDE PROCESSOR (G4.226)

FSSR NAME	M/S ID	NOMENCLATURE	DESTINATION	UNITS	DATA TYPE	P R E C	LAST CR	R E V
Q_ROLL_SM(1,2)	V90U2338CB	ROLL GMBL WRT STBL MEM QUAT 1(2)	DL FMT 21/A DL FMT 23/A		SPL		93017G	*
Q_ROLL_SM(1,3)	V90U2339CB	ROLL GMBL WRT STBL MEM QUAT 1(3)	DL FMT 21/A DL FMT 23/A		SPL		93017G	*
Q_ROLL_SM(1,4)	V90U2340CB	ROLL GMBL WRT STBL MEM QUAT 1(4)	DL FMT 21/A DL FMT 23/A		SPL		93017G	*
Q_ROLL_SM(2,1)	V90U2341CB	ROLL GMBL WRT STBL MEM QUAT 2(1)	DL FMT 21/A DL FMT 23/A		SPL		93017G	*
Q_ROLL_SM(2,2)	V90U2342CB	ROLL GMBL WRT STBL MEM QUAT 2(2)	DL FMT 21/A DL FMT 23/A		SPL		93017G	*
Q_ROLL_SM(2,3)	V90U2343CB	ROLL GMBL WRT STBL MEM QUAT 2(3)	DL FMT 21/A DL FMT 23/A		SPL		93017G	*
Q_ROLL_SM(2,4)	V90U2344CB	ROLL GMBL WRT STBL MEM QUAT 2(4)	DL FMT 21/A DL FMT 23/A		SPL		93017G	*
Q_ROLL_SM(3,1)	V90U2345CB	ROLL GMBL WRT STBL MEM QUAT 3(1)	DL FMT 21/A DL FMT 23/A		SPL		93017G	*
Q_ROLL_SM(3,2)	V90U2346CB	ROLL GMBL WRT STBL MEM QUAT 3(2)	DL FMT 21/A DL FMT 23/A		SPL		93017G	*
Q_ROLL_SM(3,3)	V90U2347CB	ROLL GMBL WRT STBL MEM QUAT 3(3)	DL FMT 21/A DL FMT 23/A		SPL		93017G	*
Q_ROLL_SM(3,4)	V90U2348CB	ROLL GMBL WRT STBL MEM QUAT 3(4)	DL FMT 21/A DL FMT 23/A		SPL		93017G	*
Q_SM_M50(1,1)	V90U2664CB	IMU 1 REFERENCE QUATERNION 1	ORB ATT PROC					
Q_SM_M50(1,2)	V90U2665CB	IMU 1 REFERENCE QUATERNION 2	ORB ATT PROC					
Q_SM_M50(1,3)	V90U2666CB	IMU 1 REFERENCE QUATERNION 3	ORB ATT PROC					
Q_SM_M50(1,4)	V90U2667CB	IMU 1 REFERENCE QUATERNION 4	ORB ATT PROC					
Q_SM_M50(2,1)	V90U2668CB	IMU 2 REFERENCE QUATERNION 1	ORB ATT PROC					
Q_SM_M50(2,2)	V90U2669CB	IMU 2 REFERENCE QUATERNION 2	ORB ATT PROC					
Q_SM_M50(2,3)	V90U2670CB	IMU 2 REFERENCE QUATERNION 3	ORB ATT PROC					
Q_SM_M50(2,4)	V90U2671CB	IMU 2 REFERENCE QUATERNION 4	ORB ATT PROC					
Q_SM_M50(3,1)	V90U2672CB	IMU 3 REFERENCE QUATERNION 1	ORB ATT PROC					
Q_SM_M50(3,2)	V90U2673CB	IMU 3 REFERENCE QUATERNION 2	ORB ATT PROC					
Q_SM_M50(3,3)	V90U2674CB	IMU 3 REFERENCE QUATERNION 3	ORB ATT PROC					
Q_SM_M50(3,4)	V90U2675CB	IMU 3 REFERENCE QUATERNION 4	ORB ATT PROC					
Q_SM_SM(1,1)	V90U2263CA	SM2 TO SM3 TRANS QUAT ELEMENT 1	IMU RM TLM					
Q_SM_SM(1,2)	V90U2264CA	SM2 TO SM3 TRANS QUAT ELEMENT 2	IMU RM TLM					
Q_SM_SM(1,3)	V90U2265CA	SM2 TO SM3 TRANS QUAT ELEMENT 3	IMU RM TLM					
Q_SM_SM(1,4)	V90U2266CA	SM2 TO SM3 TRANS QUAT ELEMENT 4	IMU RM TLM					
Q_SM_SM(2,1)	V90U2259CA	SM1 TO SM3 TRANS QUAT ELEMENT 1	IMU RM TLM					
Q_SM_SM(2,2)	V90U2260CA	SM1 TO SM3 TRANS QUAT ELEMENT 2	IMU RM TLM					

TABLE 4.6.5-2. OUTPUT FUNCTIONAL PARAMETERS FROM ASCENT/ENTRY ATTITUDE PROCESSOR (G4.226)

FSSR NAME	M/S ID	NOMENCLATURE	DESTINATION	UNITS	DATA TYPE	P R E C	LAST CR	R E V
Q_SM_SM(2,3)	V90U2261CA	SM1 TO SM3 TRANS QUAT ELEMENT 3	IMU RM TLM					
Q_SM_SM(2,4)	V90U2262CA	SM1 TO SM3 TRANS QUAT ELEMENT 4	IMU RM TLM					
Q_SM_SM(3,1)	V90U2255CA	SM1 TO SM2 TRANS QUAT ELEMENT 1	IMU RM TLM					
Q_SM_SM(3,2)	V90U2256CA	SM1 TO SM2 TRANS QUAT ELEMENT 2	IMU RM TLM					
Q_SM_SM(3,3)	V90U2257CA	SM1 TO SM2 TRANS QUAT ELEMENT 3	IMU RM TLM					
Q_SM_SM(3,4)	V90U2258CA	SM1 TO SM2 TRANS QUAT ELEMENT 4	IMU RM TLM					
RATE_GYRO_CORR(1)	V90R2692C	COMPENSATED BODY ROLL RATE	TRANS DAP	DEG/S				
RATE_GYRO_CORR(2)	V90R2693C	COMPENSATED BODY PITCH RATE	TRANS DAP	DEG/S				
RATE_GYRO_CORR(3)	V90R2694C	COMPENSATED BODY YAW RATE	TRANS DAP	DEG/S				
ROLLCOS(1)	V90H2209CA	LH ADI SEL EULER ANG ROLL COSINE	ASC ADI PROC E/L ADI PROC TLM				89490B	
ROLLCOS(2)	V90H2207CA	RH ADI SEL EULER ANG ROLL COSINE	ASC ADI PROC E/L ADI PROC TLM				89490B	
ROLLSINE(1)	V90H2208CA	LH ADI SEL EULER ANG ROLL SINE	ASC ADI PROC E/L ADI PROC TLM				89490B	
ROLLSINE(2)	V90H2206CA	RH ADI SEL EULER ANG ROLL SINE	ASC ADI PROC E/L ADI PROC TLM				89490B	
ROLL_SW	V90J2690C	HSI HEADS-UP/HEADS-DOWN INDICATOR	HSI PROC MEDS FC GNC XFER				92522D	
SDP(1)	V90U2645CB	SIN OF 1/2 IMU 1 R/P NONORTHOGON	ORB ATT PROC					
SDP(2)	V90U2646CB	SIN OF 1/2 IMU 2 R/P NONORTHOGON	ORB ATT PROC					
SDP(3)	V90U2647CB	SIN OF 1/2 IMU 3 R/P NONORTHOGON	ORB ATT PROC					
SINPHI	V90H2203C	EULER ANGLE ROLL SINE	AEROJET DAP GRTLS DAP TLM					
SINTH	V90H2216C	EULER ANGLE PITCH SINE	A/L UPP AEROJET DAP ENT BRG SPEC GRTLS DAP HUD PROC RTLS UPP TAEM UPP TLM				93090E	

TABLE 4.6.5-2. OUTPUT FUNCTIONAL PARAMETERS FROM ASCENT/ENTRY ATTITUDE PROCESSOR (G4.226)

FSSR NAME	M/S ID	NOMENCLATURE	DESTINATION	UNITS	DATA TYPE	P R E C	LAST CR	R E V
THETA/THETA_TOPO	V90H2217C	BODY PITCH ATTITUDE EULER ANGLE	A/L UPP AEROJET DAP DL FMT 21/1 DL FMT 23/B GPS SOP GRTLS DAP LANDING SOP LG WOW RM MEDS FC GNC XFER PRELAND NAV RTLS NAV RTLS UPP TAEM UPP VERT SIT DIP	DEG	SPL		93017G	*
THETA_IMU(1)	V90H2314CB	M50 TO BODY EULER ANGLE 1 THETA	IMU ALIGN DISP	DEG				
THETA_IMU(2)	V90H2315CB	M50 TO BODY EULER ANGLE 2 THETA	IMU ALIGN DISP	DEG				
THETA_IMU(3)	V90H2316CB	M50 TO BODY EULER ANGLE 3 THETA	IMU ALIGN DISP	DEG				
UB1	V90U2651C	FRST COMP OF BODY FRM REL VEL VCTR	GRTLS DAP	FT/S			89413B	
YAWCOS(1)	V90H2232CA	LH ADI SEL EULER ANG YAW COSINE	ASC ADI PROC E/L ADI PROC TLM				89490B	
YAWCOS(2)	V90H2294CA	RH ADI SEL EULER ANG YAW COSINE	ASC ADI PROC E/L ADI PROC TLM				92740D	
YAWSINE(1)	V90H2231CA	LH ADI SEL EULER ANG YAW SINE	ASC ADI PROC E/L ADI PROC TLM				89490B	
YAWSINE(2)	V90H2293CA	RH ADI SEL EULER ANG YAW SINE	ASC ADI PROC E/L ADI PROC TLM				89490B	
YAW_IY	V90U2689C	HSI YAW COMMAND	ASC BRG SPEC HSI PROC	RAD			93090E	
	V95M2872PB	CGMB_INERTIAL_IPA	DL FMT 21/1				93017G	*

NOTE: REFERENCE TABLE 1.3-1 FOR EXPLANATION OF DATA ELEMENTS.

Rate Codes: (HDR Only) 1 = 1 sample/sec 2 = 5 samples/sec 3 = 12.5 samples/sec 4 = 25 samples/sec 5 = 100 samples/sec
 (HDR and LDR) A = 1 sample/sec B = 5 samples/sec C = 12.5 samples/sec D = 25 samples/sec E = 100 samples/sec

TABLE 4.6.5-3. ASCENT/ENTRY ATTITUDE PROCESSOR (G4.226) I-LOADS

FSSR NAME	MSID	ENG UNITS	DT	PR	D	S	PR FCTN	MC	CAT	LAST CR	R E V
EF_PLANE_SW	V99U7441C	ND	D		M	C	G4.19 G4.2 G4.20 G4.210 G4.226 G4.3 G5.26	00	A2N	93090E	
IYD(1)	V97U4413C	ND	F	D	M	C	G4.19 G4.2 G4.210 G4.226 G4.3 G5.26	00	A2N	93090E	
IYD(2)	V97U4414C	ND	F	D	M	C	G4.19 G4.2 G4.210 G4.226 G4.3 G5.26	00	A2N	93090E	
IYD(3)	V97U4415C	ND	F	D	M	C	G4.19 G4.2 G4.210 G4.226 G4.3 G5.26	00	A2N	93090E	
PRE_RO1	V97U2393C	ND	F	S	D	P	G4.226	01 03	ZFR	DC0815	
PRE_RO2	V97U2394C	ND	F	S	D	P	G4.226	01 03	ZFR	DC0815	
PRE_RO3	V97U2395C	ND	F	S	D	P	G4.226	01 03	ZFR	DC0815	
PRE_RO4	V97U2396C	ND	F	S	D	P	G4.226	00	ZSR	90007G	
PRE_RO5	V97U2397C	ND	F	S	D	P	G4.226	00	ZSR	90007G	
PRE_RO6	V97U2398C	ND	F	S	D	P	G4.226	00	ZSR	90007G	
PTCHCOS(1)	V90H2222CA	ND	F	S	M	P	G4.226	00	YD2	DC0599	
PTCHCOS(2)	V90H2218CA	ND	F	S	M	P	G4.226	00	YD2	DC0599	
PTCHSINE(1)	V90H2221CA	ND	F	S	M	P	G4.226	00	YD2	DC0599	
PTCHSINE(2)	V90H2220CA	ND	F	S	M	P	G4.226	00	YD2	DC0599	
RGAO(1)	V99U9559C	RAD	F	S	L	P	G4.226 G4.97 V4.9A	00	IH1	DC0599	
RGAO(2)	V99U9560C	RAD	F	S	L	P	G4.226 G4.97 V4.9A	00	IH2	DC0599	
RGAO(3)	V99U9561C	RAD	F	S	L	P	G4.226 G4.97 V4.9A	00	IH3	DC0738	

TABLE 4.6.5-3. ASCENT/ENTRY ATTITUDE PROCESSOR (G4.226) I-LOADS

FSSR NAME	MSID	ENG UNITS	DT	PR	D	S	PR FCTN	MC	CAT	LAST CR	R E V
RGPO(1)	V99U9562C	RAD	F	S	L	P	G4.226 G4.97 V4.9A	00	IH1	DC0599	
RGPO(2)	V99U9563C	RAD	F	S	L	P	G4.226 G4.97 V4.9A	00	IH2	DC0599	
RGPO(3)	V99U9564C	RAD	F	S	L	P	G4.226 G4.97 V4.9A	00	IH3	DC0738	
ROLLCOS(1)	V90H2209CA	ND	F	S	M	P	G4.226	00	YD2	DC0599	
ROLLCOS(2)	V90H2207CA	ND	F	S	M	P	G4.226	00	YD2	DC0599	
ROLLSINE(1)	V90H2208CA	ND	F	S	M	P	G4.226	00	YD2	DC0599	
ROLLSINE(2)	V90H2206CA	ND	F	S	M	P	G4.226	00	YD2	DC0599	
TNBBODY(1,1)	V96U7096C	ND	F	S	L	P	G4.226 G4.66 G4.97 V4.9A	00	IPR	DC0599	
TNBBODY(1,2)	V96U7097C	ND	F	S	L	P	G4.226 G4.66 G4.97 V4.9A	00	IPR	DC0599	
TNBBODY(1,3)	V96U7098C	ND	F	S	L	P	G4.226 G4.66 G4.97 V4.9A	00	IPR	DC0599	
TNBBODY(2,1)	V96U7099C	ND	F	S	L	P	G4.226 G4.66 G4.97 V4.9A	00	IPR	DC0599	
TNBBODY(2,2)	V96U7100C	ND	F	S	L	P	G4.226 G4.66 G4.97 V4.9A	00	IPR	DC0599	
TNBBODY(2,3)	V96U7101C	ND	F	S	L	P	G4.226 G4.66 G4.97 V4.9A	00	IPR	DC0599	
TNBBODY(3,1)	V96U7102C	ND	F	S	L	P	G4.226 G4.66 G4.97 V4.9A	00	IPR	DC0599	
TNBBODY(3,2)	V96U7103C	ND	F	S	L	P	G4.226 G4.66 G4.97 V4.9A	00	IPR	DC0599	

TABLE 4.6.5-3. ASCENT/ENTRY ATTITUDE PROCESSOR (G4.226) I-LOADS

FSSR NAME	MSID	ENG UNITS	DT	PR	D	S	PR FCTN	MC	CAT	LAST CR	R E V
TNBBODY(3,3)	V96U7104C	ND	F	S	L	P	G4.226 G4.66 G4.97 V4.9A	00	IPR	DC0599	
TNB_CASE1(1,1)	V96U7132C	ND	F	S	L	P	G4.226 G4.97 V4.9A	00	IPR	DC0599	
TNB_CASE1(1,2)	V96U7135C	ND	F	S	L	P	G4.226 G4.97 V4.9A	00	IPR	DC0599	
TNB_CASE1(1,3)	V96U7138C	ND	F	S	L	P	G4.226 G4.97 V4.9A	00	IPR	DC0599	
TNB_CASE1(2,1)	V96U7141C	ND	F	S	L	P	G4.226 G4.97 V4.9A	00	IPR	DC0599	
TNB_CASE1(2,2)	V96U7144C	ND	F	S	L	P	G4.226 G4.97 V4.9A	00	IPR	DC0599	
TNB_CASE1(2,3)	V96U7147C	ND	F	S	L	P	G4.226 G4.97 V4.9A	00	IPR	DC0599	
TNB_CASE1(3,1)	V96U7150C	ND	F	S	L	P	G4.226 G4.97 V4.9A	00	IPR	DC0599	
TNB_CASE1(3,2)	V96U7153C	ND	F	S	L	P	G4.226 G4.97 V4.9A	00	IPR	DC0599	
TNB_CASE1(3,3)	V96U7156C	ND	F	S	L	P	G4.226 G4.97 V4.9A	00	IPR	DC0599	
TNB_CASE2(1,1)	V96U7133C	ND	F	S	L	P	G4.226 G4.97 V4.9A	00	IPR	DC0599	
TNB_CASE2(1,2)	V96U7136C	ND	F	S	L	P	G4.226 G4.97 V4.9A	00	IPR	DC0599	
TNB_CASE2(1,3)	V96U7139C	ND	F	S	L	P	G4.226 G4.97 V4.9A	00	IPR	DC0599	
TNB_CASE2(2,1)	V96U7142C	ND	F	S	L	P	G4.226 G4.97 V4.9A	00	IPR	DC0599	
TNB_CASE2(2,2)	V96U7145C	ND	F	S	L	P	G4.226 G4.97 V4.9A	00	IPR	DC0599	

TABLE 4.6.5-3. ASCENT/ENTRY ATTITUDE PROCESSOR (G4.226) I-LOADS

FSSR NAME	MSID	ENG UNITS	DT	PR	D	S	PR FCTN	MC	CAT	LAST CR	R E V
TNB_CASE2(2,3)	V96U7148C	ND	F	S	L	P	G4.226 G4.97 V4.9A	00	IPR	DC0599	
TNB_CASE2(3,1)	V96U7151C	ND	F	S	L	P	G4.226 G4.97 V4.9A	00	IPR	DC0599	
TNB_CASE2(3,2)	V96U7154C	ND	F	S	L	P	G4.226 G4.97 V4.9A	00	IPR	DC0599	
TNB_CASE2(3,3)	V96U7157C	ND	F	S	L	P	G4.226 G4.97 V4.9A	00	IPR	DC0599	
TNB_CASE3(1,1)	V96U7134C	ND	F	S	L	P	G4.226 G4.97 V4.9A	00	IPR	DC0599	
TNB_CASE3(1,2)	V96U7137C	ND	F	S	L	P	G4.226 G4.97 V4.9A	00	IPR	DC0599	
TNB_CASE3(1,3)	V96U7140C	ND	F	S	L	P	G4.226 G4.97 V4.9A	00	IPR	DC0599	
TNB_CASE3(2,1)	V96U7143C	ND	F	S	L	P	G4.226 G4.97 V4.9A	00	IPR	DC0599	
TNB_CASE3(2,2)	V96U7146C	ND	F	S	L	P	G4.226 G4.97 V4.9A	00	IPR	DC0599	
TNB_CASE3(2,3)	V96U7149C	ND	F	S	L	P	G4.226 G4.97 V4.9A	00	IPR	DC0599	
TNB_CASE3(3,1)	V96U7152C	ND	F	S	L	P	G4.226 G4.97 V4.9A	00	IPR	DC0599	
TNB_CASE3(3,2)	V96U7155C	ND	F	S	L	P	G4.226 G4.97 V4.9A	00	IPR	DC0599	
TNB_CASE3(3,3)	V96U7158C	ND	F	S	L	P	G4.226 G4.97 V4.9A	00	IPR	DC0599	

NOTE: REFERENCE TABLE 1.3-1 FOR EXPLANATION OF DATA ELEMENTS.

TABLE 4.6.5-4. ASCENT/ENTRY ATTITUDE PROCESSOR (G4.226) K-LOADS

FSSR NAME DESCRIPTION	MSID	MC	KLOAD VALUE	ENG UNITS	DT	P R	S	PR FCTN	LAST CR	R E V
DTIMU	V97U1780C	00	-2.262	E-02	SEC	F	S	C G4.226	59954	
TIME_BETWEEN_IMU_&_RGA_READS										
Q_LVLH_BIASLVLH_ASCENT(1)	V97U2210CA	00	+1.0000000	E+00	ND	F	S	C G4.226	59955	
		01								
Q_LVLH_BIASLVLH_ASCENT(2)	V97U2211CA	00	+0.0	E+00	ND	F	S	C G4.226	59955	
		01								
Q_LVLH_BIASLVLH_ASCENT(3)	V97U2212CA	00	+0.0	E+00	ND	F	S	C G4.226	59955	
		01								
Q_LVLH_BIASLVLH_ASCENT(4)	V97U2213CA	00	+0.0	E+00	ND	F	S	C G4.226	59955	
		01								
Q_LVLH_BIASLVLH_ENTRY(1)	V97U2210CB	00			ND	F	S	C G4.226	59955	
		03	+1.00	E+00						
Q_LVLH_BIASLVLH_ENTRY(2)	V97U2211CB	00			ND	F	S	C G4.226	59955	
		03	+0.00	E+00						
Q_LVLH_BIASLVLH_ENTRY(3)	V97U2212CB	00			ND	F	S	C G4.226	59955	
		03	+0.00	E+00						
Q_LVLH_BIASLVLH_ENTRY(4)	V97U2213CB	00			ND	F	S	C G4.226	59955	
		03	+0.00	E+00						
Q_M50_INRTL_ASCENT(1)	V97U2214CA	00	+1.0	E+00	ND	F	S	C G4.210 G4.226 G4.3	89688B	
Q_M50_INRTL_ASCENT(2)	V97U2215CA	00	+0.0	E+00	ND	F	S	C G4.210 G4.226 G4.3	89688B	
Q_M50_INRTL_ASCENT(3)	V97U2216CA	00	+0.0	E+00	ND	F	S	C G4.210 G4.226 G4.3	89688B	
Q_M50_INRTL_ASCENT(4)	V97U2217CA	00	+0.0	E+00	ND	F	S	C G4.210 G4.226 G4.3	89688B	
Q_M50_INRTL_ENTRY(1)	V97U2214CB	00			ND	F	S	C G4.209 G4.211 G4.226	89688B	
		03	+1.0	E+00						
Q_M50_INRTL_ENTRY(2)	V97U2215CB	00			ND	F	S	C G4.209 G4.211 G4.226	89688B	
		03	+0.0	E+00						
Q_M50_INRTL_ENTRY(3)	V97U2216CB	00			ND	F	S	C G4.209 G4.211 G4.226	89688B	
		03	+0.00	E+00						
Q_M50_INRTL_ENTRY(4)	V97U2217CB	00			ND	F	S	C G4.209 G4.211 G4.226	89688B	
		03	+0.00	E+00						
Q_M50_REF_ENTRY(1)	V97U2218CB	00			ND	F	S	C G4.226	59955	
ADI REF QUAT ELEM 1		03	+7.0710678	E-01						
Q_M50_REF_ENTRY(2)	V97U2219CB	00			ND	F	S	C G4.226	59955	
ADI REF QUAT ELEM 2		03	+7.0710678	E-01						

TABLE 4.6.5-4. ASCENT/ENTRY ATTITUDE PROCESSOR (G4.226) K-LOADS

FSSR NAME DESCRIPTION	MSID	MC	KLOAD VALUE	ENG UNITS	DT	P R	S	PR FCTN	LAST CR	R E V
Q_M50_REF_ENTRY(3)	V97U2220CB	00		ND	F	S	C	G4.226	59955	
		03	+0.00	E+00						
Q_M50_REF_ENTRY(4)	V97U2221CB	00		ND	F	S	C	G4.226	59955	
		03	+0.00	E+00						
UB_EPS ANGLE OF ATTACK TEST VALUE	V97U1315C	00	+1.0	E+02 FT/SEC	F	S	C	G4.226	59954	

NOTE: REFERENCE TABLE 1.3-1 FOR EXPLANATION OF DATA ELEMENTS.

TABLE 4.6.5-5. ASCENT/ENTRY ATTITUDE PROCESSOR (G4.226) CONSTANTS

FSSR NAME DESCRIPTION	MSID	MC	CONSTANT VALUE	ENG UNITS	DT	P R	S	PR FCTN	LAST CR	R E V
DEG_PER_RAD RADIAN TO DEGREE CONVERSION FACTOR	V97U0112C	00	+5.72957795131E+01	DEG/RAD	F		S	C A6.9 G4.10 G4.126 G4.127 G4.128 G4.175 G4.20 G4.201 G4.204 G4.208 G4.21 G4.213 G4.220 G4.226 G4.227 G4.23 G4.234 G4.237 G4.24 G4.25 G4.35 G4.36 G4.5 G4.6 G4.66 G4.8 G4.9 G4.97 G5.26 G5.27 V4.10 V4.11 V4.11B V4.11C V4.9A	93090E	
GE_PRE_R01 FIRST STAGE FILTER COEFFICIENT FOR GRTLS	V97U6260C	00	+2.85714	E-01 ND	F		S	P G4.226	90374C	
GE_PRE_R02 FIRST STAGE FILTER COEFFICIENT FOR GRTLS	V97U6261C	00	+2.85714	E-01 ND	F		S	P G4.226	90374C	
GE_PRE_R03 FIRST STAGE FILTER COEFFICIENT FOR GRTLS	V97U6262C	00	-4.28572	E-01 ND	F		S	P G4.226	90374C	

TABLE 4.6.5-5. ASCENT/ENTRY ATTITUDE PROCESSOR (G4.226) CONSTANTS

FSSR NAME DESCRIPTION	MSID	MC	CONSTANT VALUE	ENG UNITS	DT	P R	S	PR FCTN	LAST CR	R E V
RAD_PER_DEG DEGREE TO RADIAN CONVERSION FACTOR	V97U0383C	00	+1.7453293	E-02	RAD/DEG	F	S	C A6.9 G4.1 G4.126 G4.127 G4.128 G4.144 G4.15 G4.158 G4.175 G4.20 G4.201 G4.204 G4.205 G4.209 G4.210 G4.211 G4.213 G4.220 G4.223 G4.226 G4.227 G4.236 G4.237 G4.3 G4.35 G4.36 G4.7 G4.72 G4.9 G4.97 G5.27	93090E	

NOTE: REFERENCE TABLE 1.3-1 FOR EXPLANATION OF DATA ELEMENTS.

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4.7 UTILITY FUNCTIONS

Utility functions constitute those modules which appear two or more times in the preceding sections. To avoid redundant specification of these functions, and thus simplifying the documentation, detailed specifications for these functions are presented just once, in this subsection. Note that some of these functions are also used during non-ascent mission phases (e.g., SECOND_ORDER_FILTERS in entry-through-landing flight control); some are also used by principal functions covered in other documents (e.g., MAT_TO_QUAT in first-stage guidance). It must be borne in mind that reentrant capability is required for those functions in use simultaneously by modules which are implemented in more than the HAL task.

CAUTION: Quaternions and direction cosine matrices are used to represent transformations of coordinates. The notation used for both methods is briefly described.

Given two coordinate frames A and B, with common origin, and a vector whose coordinates in each frame are \bar{V}_A and \bar{V}_B , respectively, the notation Q_{B_A} denotes the quaternion which represents the transformation from frame A to frame B:

$$\bar{V}_B = Q_{B_A} \bar{V}_A (Q_{B_A})^*$$

This equation is valid if (i) \bar{V}_A and \bar{V}_B are viewed as quaternions with zero scalar part and (ii) $Q_{B_A} = (QBAS, QBAV)$ is normalized; the conjugate of Q_{B_A} is defined by $(Q_{B_A})^* \Delta (QBAS, -QBAV)$. Transformation of coordinates from frame A to frame B may also be viewed as the result of a rotation through an angle θ about an oriented axis $\bar{\omega}$; the connection with Q_{B_A} is as follows:

$$QBAS = \cos \frac{\theta}{2}, QBAV = -\text{unit}(\bar{\omega}) \sin \frac{\theta}{2}$$

With this convention, transformations from frames A and B, each to a third frame C, are related as follows:

$$Q_{C_A} = Q_{C_B} Q_{B_A}$$

Block diagram symbology for quaternion multiplication is described in Section 4.7.10 (QUAT_MULT) of this document.

Notation for direction cosine matrices is slightly different and is briefly described. Given two coordinate frames A and B, with common origin, and a vector whose coordinates in each frame are \bar{V}_A and \bar{V}_B , respectively, the notation M_{AB} denotes the direction cosine matrix and represents the transformation from frame A to frame B:

$$\bar{V}_B = M_{AB} \bar{V}_A$$

With this convention, transformations from frames A and B, each to a third frame C, are related as follows:

$$M_{AC} = M_{BC} M_{AB}$$

While there are potential core savings when these functions are subroutinized, there are time penalties attendant with the invocation process. In-line replicated code may be desirable in many applications. No implementational constraint is intended by this choice of documentation format. Likewise, the particular form of an algorithm has been chosen to show how the functional requirements could be implemented, but other implementations may produce the same results in a more economical manner.

The utility functions described in this section are listed in Table 4.7-1 with the subsection numbers where detailed descriptions can be found.

Table 4.7-1. Utility Functions	
Subsection	Utility Function
4.7.1	FIRST_ORDER_FILTER
4.7.2	SECOND_ORDER_FILTER
4.7.3	FOURTH_ORDER_FILTER
4.7.4	SIXTH_ORDER_FILTER
4.7.5	FADER
4.7.6	X_INTERP
4.7.7	Y_INTERP
7.7.8	MINITABLE
4.7.9	RATE_LIMIT
4.7.10	QUAT_MULT
4.7.11	QUAT_NORM
4.7.12	QUAT_INTEG
4.7.13	QUAT_XFORM
4.7.14	QUAT_ERR_ANG
4.7.15	SMOOTHER
4.7.16	MAT_TO_QUAT
4.7.17	RV_TO_QLVLH
4.7.18	QUAT_TO_EULER
4.7.19	QUAT_TO_ADI_ANG
4.7.20	PARSHAPE
4.7.21	LIMITED_INTEGRATOR

4.7.1 FIRST_ORDER_FILTER

A. Function. The detailed block diagram for the module FIRST_ORDER_FILTER is presented in Figure 4.7.1-1. With appropriate coefficients, FIRST_ORDER_FILTER can represent any nonintegral first-order filter (low pass, high pass, washout, etc.). The steady-state gain need not be unity, but it must be finite (hence the nonintegral requirement). A nodal implementation has been chosen for illustrative purposes. Local initialization (steady-state response to present input) is provided in response to an initialization flag. Detailed equations are presented in Section F below. Consider FIRST_ORDER_FILTER for generation of in-line code (e.g., a macro), especially if initialization can be handled remotely.

B. Processing Requirements. The module FIRST_ORDER_FILTER is processed when invoked by a user. Single precision coefficients and calculations are utilized.

C. Interface Requirements. The interface requirements for module FIRST_ORDER_FILTER are shown in Table 4.7.1-1.

D. Constants. None.

E. Initialization Requirements. The initialization requirements for the module FIRST_ORDER_FILTER are shown in Table 4.7.1-2.

F. Detailed Technical Descriptions.

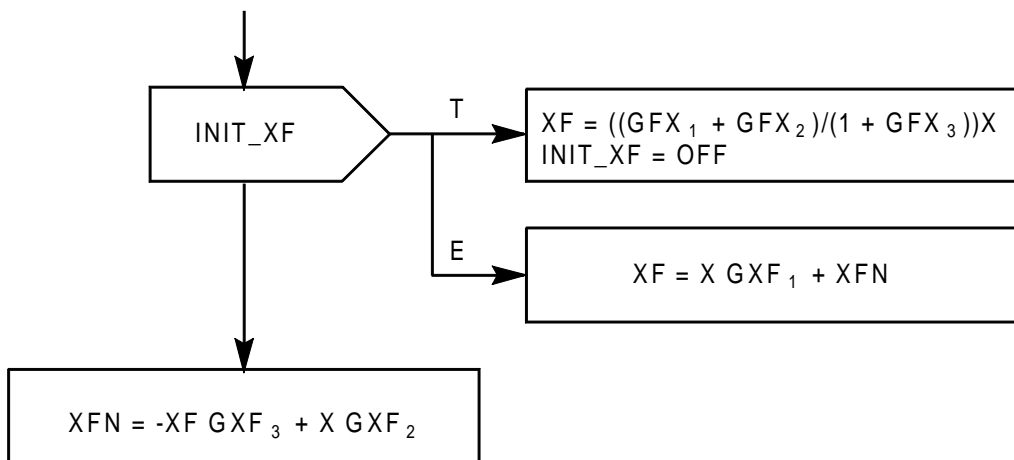


FIGURE 4.7.1-0. FIRST_ORDER_FILTER Detailed Technical Description

Table 4.7.1-1.FIRST_ORDER_FILTER Interface Requirements					
Name	Description	Source or Destination	Type	Units	Rate Required/Produced (Hz)
<u>Inputs</u>					
X	Input		S	—	—
GXF	Coefficients		A(3)	—	—
XF	Past value of output		S	—	—
XFN	Past value of node		S	—	—
INIT_XF	Initialization flag		B	—	—
<u>Outputs</u>					
XF	Output		S	—	—
XFN	Node		S	—	—
INIT_XF	Initialization flag		B	—	—

Table 4.7.1-2.FIRST_ORDER_FILTER Initialization Requirements				
Component	Initialize on Transition		Variable	Initial Value
	From	To		
First-order filter	—	INIT_XF	$\left. \begin{array}{l} XF \\ XFN \end{array} \right\}$	*
<p>*Some appropriate combination of the following (see Section F above for one approach):</p> $XF = \left(\frac{GXF_1 + GXF_2}{1 + GXF_3} \right) X, \text{ where } GXF_3 \neq -1$ $XFN = XF - GXF_1$				

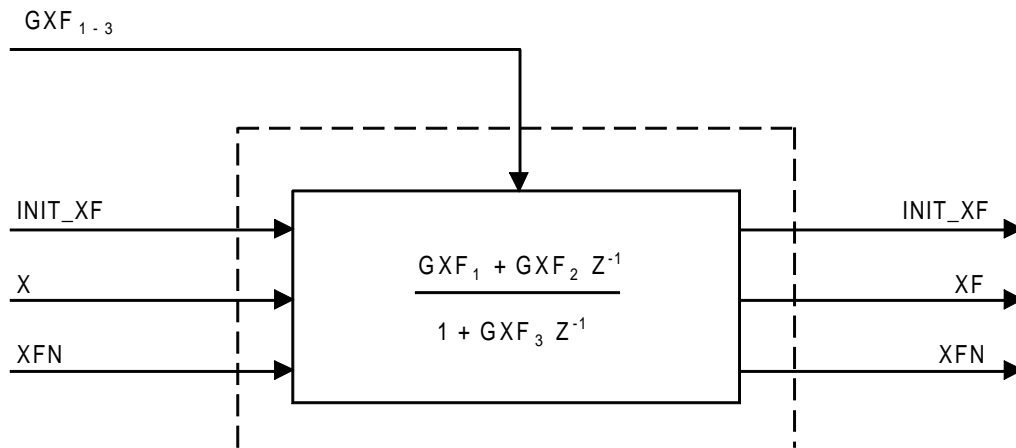


FIGURE 4.7.1-1. FIRST_ORDER_FILTER

4.7.2 SECOND_ORDER_FILTER

A. Function. The detailed block diagram for the module SECOND_ORDER_FILTER is presented in Figure 4.7.2-1. With appropriate coefficients, SECOND_ORDER_FILTER can represent any nonintegral second-order filter (low pass, high pass, washout, notch, rolloff, pair of first-order filters, etc.). The steady-state gain need not be unity, but it must be finite (hence the nonintegral requirement). A nodal implementation has been chosen for illustrative purposes. Local initialization (steady-state response to present input) is provided in response to an initialization flag. Detailed equations are given in Section F below.

B. Processing Requirements. The module SECOND_ORDER_FILTER is processed when invoked by a user. Single precision coefficients and calculations are utilized.

C. Interface Requirements. The interface requirements for SECOND_ORDER_FILTER are shown in Table 4.7.2-1.

D. Constants. None.

E. Initialization Requirements. The initialization requirements for SECOND_ORDER_FILTER are shown in Table 4.7.2-2.

F. Detailed Technical Descriptions.

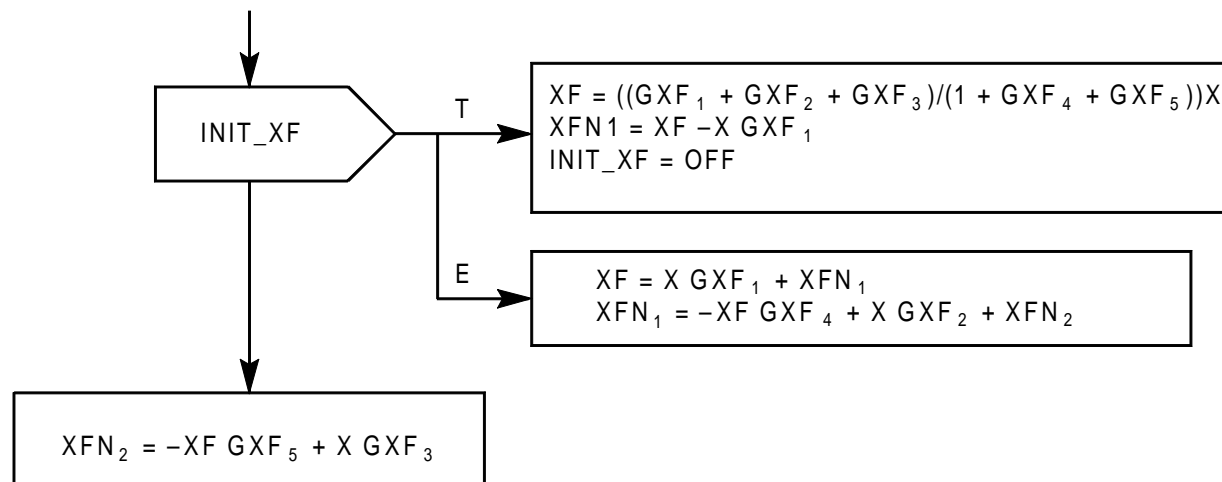


FIGURE 4.7.2-0. SECOND_ORDER_FILTER Detailed Technical Description

Table 4.7.2-1.SECOND_ORDER_FILTER Interface Requirements					
Name	Description	Source or Destination	Type	Units	Rate Required/Produced (Hz)
<u>Inputs</u>					
X	Input		S	—	—
GXF	Coefficients		A	—	—
XF	Past value of output		S	—	—
XFN	Past value of nodes		A(2)	—	—
INIT_XF	Initialization flag		B	—	—
<u>Outputs</u>					
XF	Output		S	—	—
XFN	Nodes		A(2)	—	—
INIT_XF	Initialization flag		B	—	—

Table 4.7.2-2.SECOND_ORDER_FILTER Initialization Requirements				
Component	Initialize on Transition		Variable	Initial Value
	From	To		
Second-order filter	—	INIT_XF	XF XFN _{1,2} }	*
<p>*Some appropriate combination of the following (see Section F above for one approach):</p> $XF = \left(\frac{GXF_1 + GXF_2 + GXF_3}{1 + GXF_4 + GXF_5} \right) X, \text{ where } (GXF_4 + GXF_5) \neq -1$ $XFN_1 = XF - X \text{ GXF}_1$ $XFN_2 = -XF \text{ GXF}_5 + X \text{ GXF}_3$				

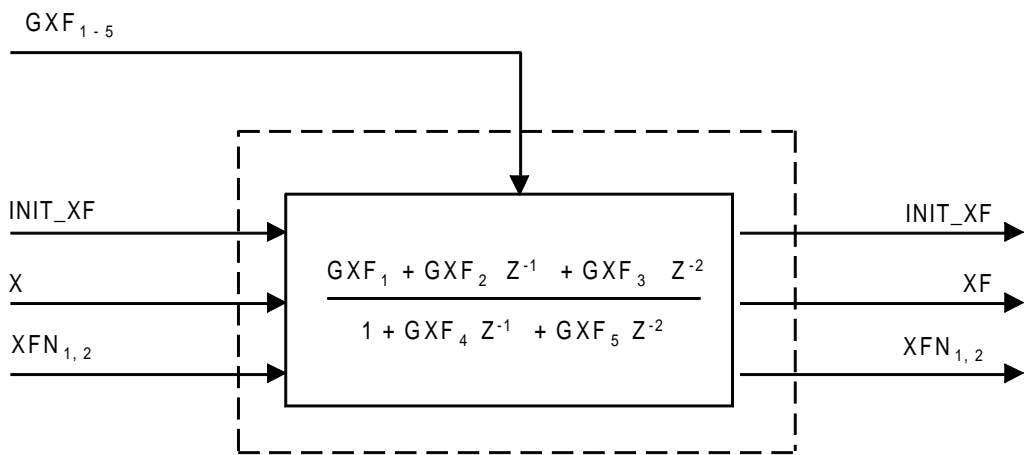


FIGURE 4.7.2-1. SECOND_ORDER_FILTER

4.7.3 FOURTH_ORDER_FILTER

A. Function. The detailed block diagram for the module FOURTH_ORDER_FILTER is presented in Figure 4.7.3-1. With appropriate coefficients, FOURTH_ORDER_FILTER can represent any cascaded pair of nonintegral second-order filters. The choice of cascade versus polynomial implementation avoids numerical inaccuracies and permits use of single precision rather than double precision for coefficients and calculations.

B. Processing Requirements. The module FOURTH_ORDER_FILTER is processed when invoked by a user. Single precision coefficients and calculations are utilized.

C. Interface Requirements. The interface requirements for FOURTH_ORDER_FILTER are shown in Table 4.7.3-1.

D. Constants. None.

E. Initialization Requirements. The initialization requirements for FOURTH_ORDER_FILTER are shown in Table 4.7.3-2.

F. Detailed Technical Descriptions.

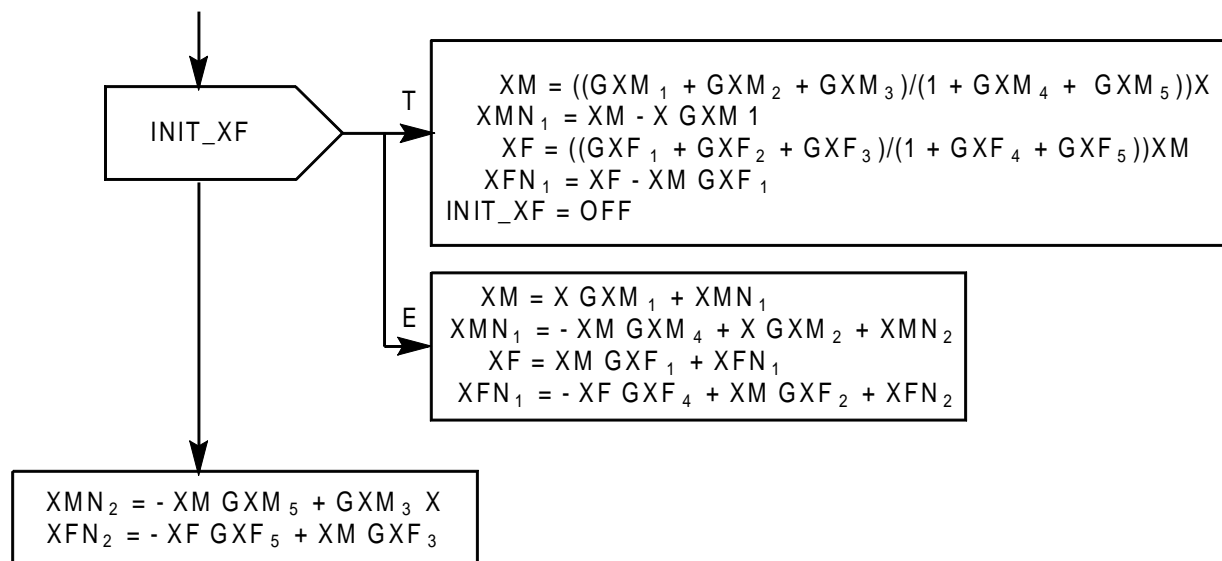


FIGURE 4.7.3-0. FOURTH_ORDER_FILTER Detailed Technical Description

Table 4.7.3-1.FOURTH_ORDER_FILTER Interface Requirements					
Name	Description	Source or Destination	Type	Units	Rate Required/ Produced (Hz)
<u>Inputs</u>					
X	Input		S	-	-
GXM	Coefficients, first or input element		A(5)	-	-
GXF	Coefficients, second or output element		A(5)	-	-
XF	Past value of element outputs		S	-	-
XM	Past value of element outputs		S	-	-
XFN	Past value of element nodes		A(2)	-	-
XMN	Past value of element nodes		A(2)	-	-
INIT_XF	Initialization flag		B	-	-
<u>Outputs</u>					
XF	Output, second element		S	-	-
XFN	Nodes, second element		A(2)	-	-
XM	Output, first element		S	-	-
XMN	Nodes, first element		B	-	-
INIT_XF	Initialization flag		B	-	-

Table 4.7.3-2.FOURTH_ORDER_FILTER Initialization Requirements				
Component	Initialize on Transition		Variable	Initial Value
	From	To		
Fourth-order filter	—	INIT_XF	$\left. \begin{array}{l} \text{XF} \\ \text{XFN}_{1,2} \\ \text{XM} \\ \text{XMN}_{1,2} \end{array} \right\}$	*
<p>*Some appropriate combination of the following (see Section F above for one approach):</p> $\text{XM} = \left(\frac{\text{GXM}_1 + \text{GXM}_2 + \text{GXM}_3}{1 + \text{GXM}_4 + \text{GXM}_5} \right) \text{X}, \text{ where } (\text{GXM}_4 + \text{GXM}_5) \neq -1$ $\text{XMN}_1 = \text{XM} - \text{X GXM}_1$ $\text{XMN}_2 = -\text{XM GXM}_5 + \text{X GXM}_3$ $\text{XF} = \left(\frac{\text{GXF}_1 + \text{GXF}_2 + \text{GXF}_3}{1 + \text{GXF}_4 + \text{GXF}_5} \right) \text{XM}, \text{ where } (\text{GXF}_4 + \text{GXF}_5) \neq -1$ $\text{XFN}_1 = \text{XF} - \text{XM GXF}_1$ $\text{XFN}_2 = -\text{XF GXF}_5 + \text{XM GXF}_3$				

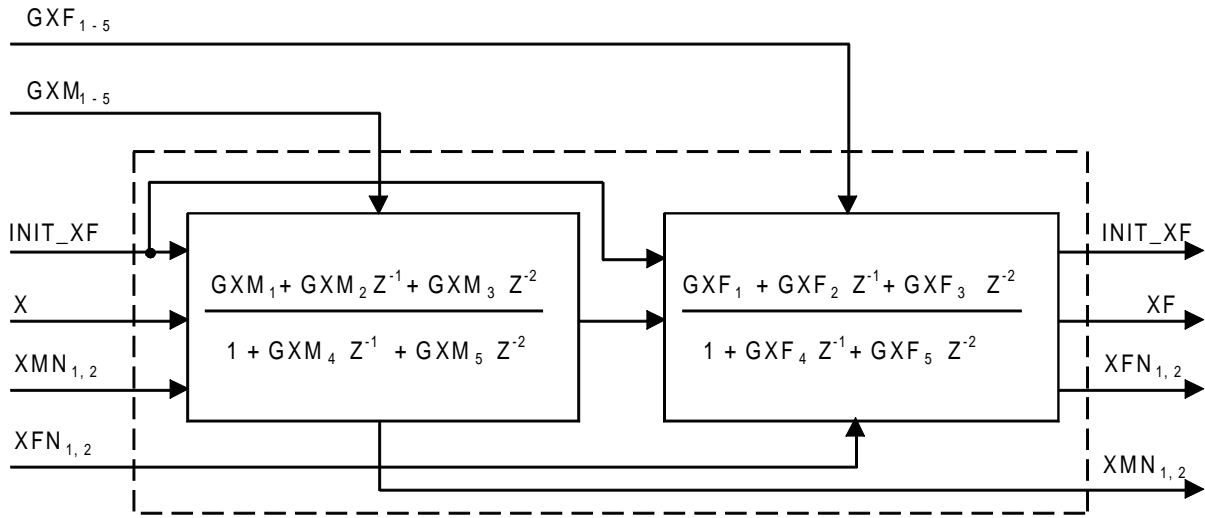


FIGURE 4.7.3-1. FOURTH_ORDER_FILTER

4.7.4 SIXTH_ORDER_FILTER

A. Function. The detailed block diagram for the module SIXTH_ORDER_FILTER is presented in Figure 4.7.4-1. With appropriate coefficients, SIXTH_ORDER_FILTER can represent any cascaded set of three nonintegral second-order filters. The choice of cascaded versus polynomial implementation avoids numerical inaccuracies and permits use of single precision rather than double precision for coefficients and calculations.

B. Processing Requirements. The module SIXTH_ORDER_FILTER is processed when invoked by a user. Single precision coefficients and calculations are utilized.

C. Interface Requirements. This interface requirements for SIXTH_ORDER_FILTER are shown in Table 4.7.4-1.

D. Constants. None.

E. Initialization Requirements. The initialization requirements for SIXTH_ORDER_FILTER are shown in Table 4.7.4-2.

F. Detailed Technical Description.

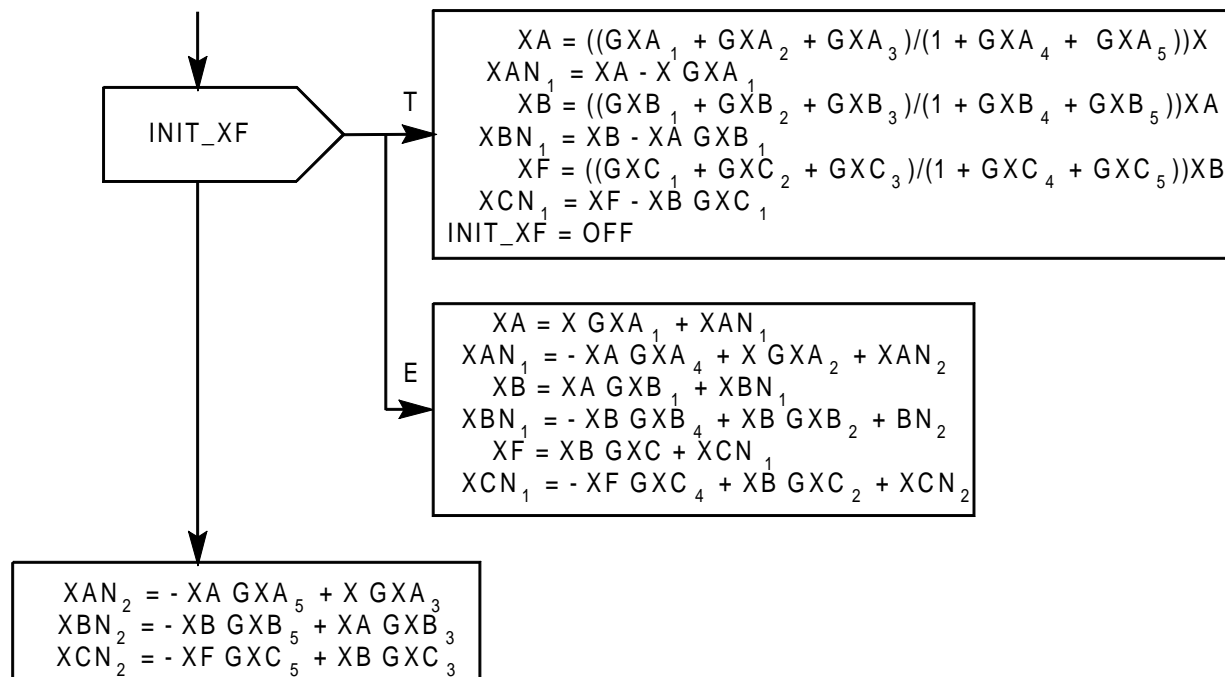


FIGURE 4.7.4-0. SIXTH_ORDER_FILTER Detailed Technical Description

Table 4.7.4-1.SIXTH_ORDER_FILTER Interface Requirements					
Name	Description	Source or Destination	Type	Units	Rate Required/Produced (Hz)
<u>Inputs</u>					
X	Input		S	–	–
GXA	Coefficients, first or input element		A(5)	–	–
GXB	Coefficients, second or middle element		A(5)	–	–
GXC	Coefficients, third or output element		A(5)	–	–
XF	} Past value of element output		S	–	–
XB			S	–	–
XA			S	–	–
XCN	} Past value of element nodes		A(2)	–	–
XBN			A(2)	–	–
XAN			A(2)	–	–
INIT_XF	Initialization flag		B	–	–
<u>Outputs</u>					
XF	Output, third element		S	–	–
XCN	Nodes, third element		A(2)	–	–
XB	Output, second element		S	–	–
XBN	Nodes, second element		A(2)	–	–
XA	Output, first element		S	–	–
XAN	Nodes, first element		A(2)	–	–
INIT_XF	Initialization flag		B	–	–

Table 4.7.4-2.SIXTH_ORDER_FILTER Initialization Requirements				
Component	Initialize on Transition		Variable	Initial Value
	From	To		
Sixth-order filter	—	INIT_XF	$\left. \begin{array}{l} \text{XA} \\ \text{XAN}_{1,2} \\ \text{XB} \\ \text{XBN}_{1,2} \\ \text{XF} \\ \text{XCN}_{1,2} \end{array} \right\}$	*
<p>*Some appropriate combination of the following (see Section F):</p> $\text{XA} = \left(\frac{\text{GXA}_1 + \text{GXA}_2 + \text{GXA}_3}{1 + \text{GXA}_4 + \text{GXA}_5} \right) \text{X}, \text{ where } \text{GXA}_4 + \text{GXA}_5 \neq -1$ $\text{XAN}_1 = \text{XA} - \text{X GXA}_1$ $\text{XAN}_2 = -\text{XA GXA}_5 + \text{X GXA}_3$ $\text{XB} = \left(\frac{\text{GXB}_1 + \text{GXB}_2 + \text{GXB}_3}{1 + \text{GXB}_4 + \text{GXB}_5} \right) \text{X}, \text{ where } \text{GXB}_4 + \text{GXB}_5 \neq -1$ $\text{XBN}_1 = \text{XB} - \text{XA GXB}_1$ $\text{XBN}_2 = -\text{XB GXB}_5 + \text{XA GXB}_3$ $\text{XF} = \left(\frac{\text{GXC}_1 + \text{GXC}_2 + \text{GXC}_3}{1 + \text{GXC}_4 + \text{GXC}_5} \right) \text{X}, \text{ where } \text{GXC}_4 + \text{GXC}_5 \neq -1$ $\text{XCN}_1 = \text{XF} - \text{XB GXC}_1$ $\text{XCN}_2 = -\text{XF GXC}_5 + \text{XB GXC}_3$				

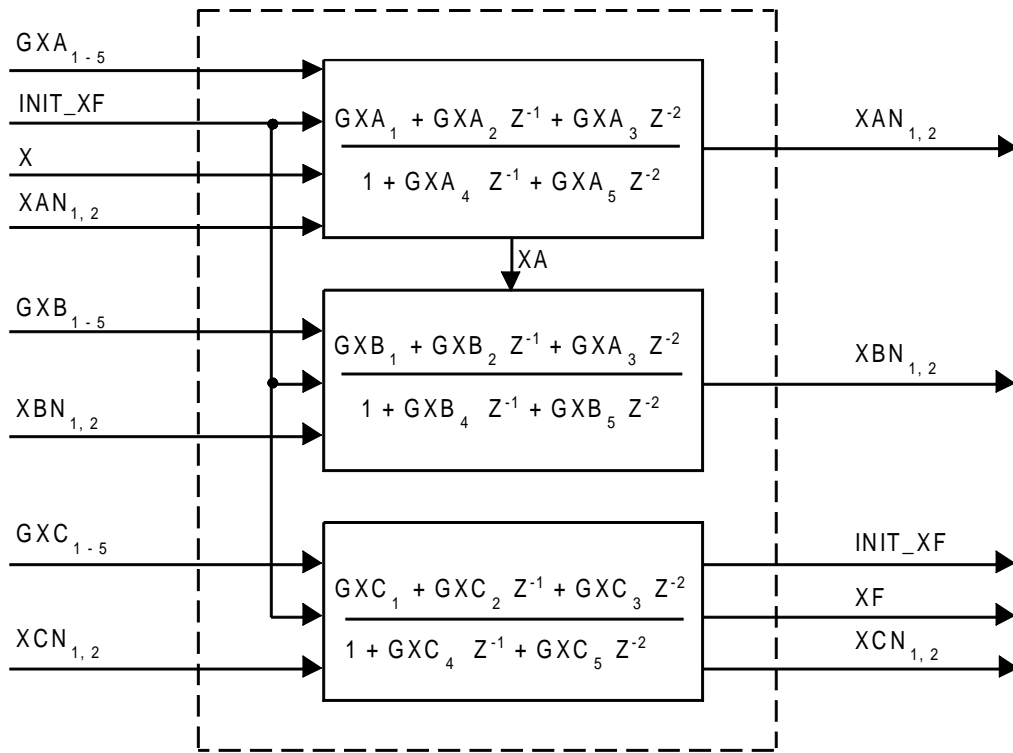


FIGURE 4.7.4-1. SIXTH_ORDER_FILTER

4.7.5 FADER

A. Function. The detailed block diagram for the module FADER is presented in Figure 4.7.5–1. The purpose of a fader is to avoid the jump that might otherwise occur when the source of a signal is switched. Rather than allow the signal to jump from one value to another, the fader is “triggered” at the moment of switching, and the differences between the values of the sources before and after the change are added to the signal incrementally over some time period. The effect of a fader is shown in Figure 4.7.5–2. If the input is constant after the switching time, the output of the fader simply ramps from the value at the switching time to the value of the new input. However, if there are variations in the input, they are reflected in the output without attenuation or delay. Thus, the fader has no effect on the loop gain.

B. Processing Requirements. The module FADER is processed when invoked by user.

C. Interface Requirements. The interface requirements for FADER are shown in Table 4.7.5–1.

D. Constants. None.

E. Initialization Requirements. The initialization requirements for FADER are shown in Table 4.7.5–2.

Table 4.7.5-1.FADER Interface Requirements						
Name	Description	Source or Destination	Type	Range	Units	Rate Required/Produced (Hz)
<u>Inputs</u>						
X	Input		S		-	-
NFADE_X	Counter		I		-	-
XF } BR_XF }	Past value of intermediate variable		S S			
<u>Outputs</u>						
XF	Output		S		-	-
NFADE_X	Counter		I		-	-
BR_XF	Intermediate variable (current input minus past output)/NFADE±X		S		-	-

Table 4.7.5-2.FADER Initialization Requirements				
Component	Initialize on Transition		Variable	Initial Value
	From	To		
Fader	—	NFADE_X > 0	NFADE_X BR_XF	-NFADE_X (X-XF)/NFADE_X

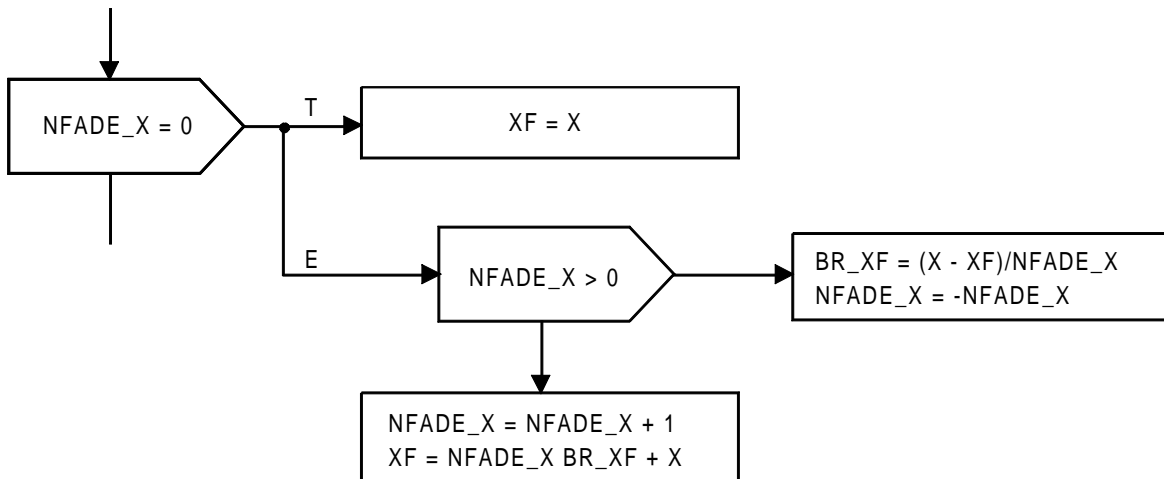


FIGURE 4.7.5-1. FADER, Detailed Block Diagram

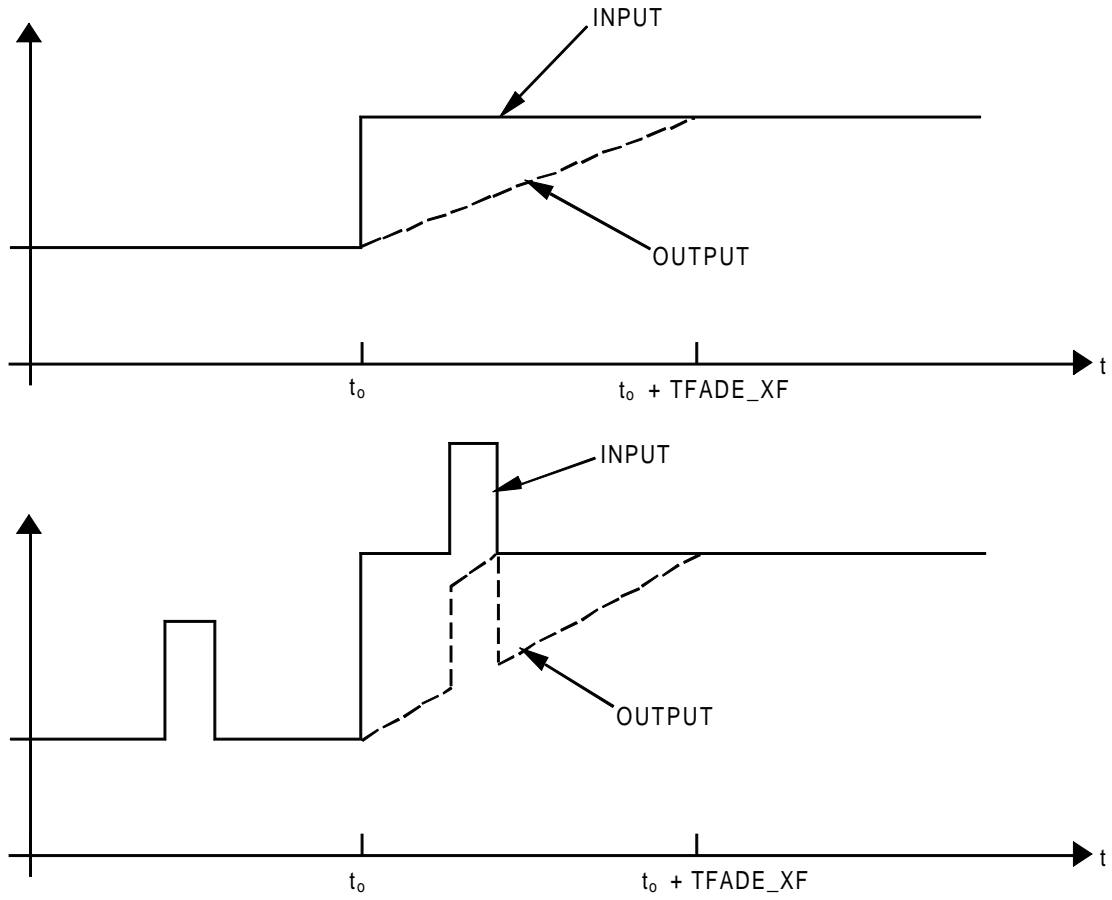


FIGURE 4.7.5-2. Effect of Fading

4.7.6 X_INTERP

A. Function. The detailed block diagram for the module X_INTERP is presented in Figure 4.7.6–1. This utility function is used in conjunction with Y_INTERP (Subsection 4.7.7) for linear interpolation, using a table of breakpoints (tabs). X_INTERP and Y_INTERP are especially useful when dependent variables can be tabulated for a single set of independent variables. The X_TAB is an array of table entry breakpoints of the independent variable X. For a given X, the array index J_X is found so that either

$$X_TAB_{J_X} \leq X \leq X_TAB_{J_X+1}$$

for a monotonically increasing table or

$$X_TAB_{J_X} \geq X \geq X_TAB_{J_X+1}$$

for a monotonically decreasing table.

Then a (scalar) quantity suitable for efficient interpolation of the dependent variable is computed:

$$RATIO_X = (X - X_TAB_{J_X}) / (X_TAB_{J_X+1} - X_TAB_{J_X})$$

Note that infinite slopes (repeated X_j) are not allowed by this algorithm.

In many cases, X is monotonic. With J_X an input, the starting value for the present search can be that value which satisfied the last search. This is especially useful for many-valued tables. The feature is disabled by setting J_X to unity at each invocation.

If $X \leq X_TAB_1$ or $X \geq X_TAB_N$ for an increasing table, or if $X \geq X_TAB_1$ or $X \leq X_TAB_N$ for a decreasing table (beyond left or right extremities of tabular data) then X_INTERP sets RATIO_X = 0, which will force Y_INTERP to provide horizontal extrapolation beyond the tabular extremities.

B. Processing Requirements. The module X_INTERP is processed when invoked by a user.

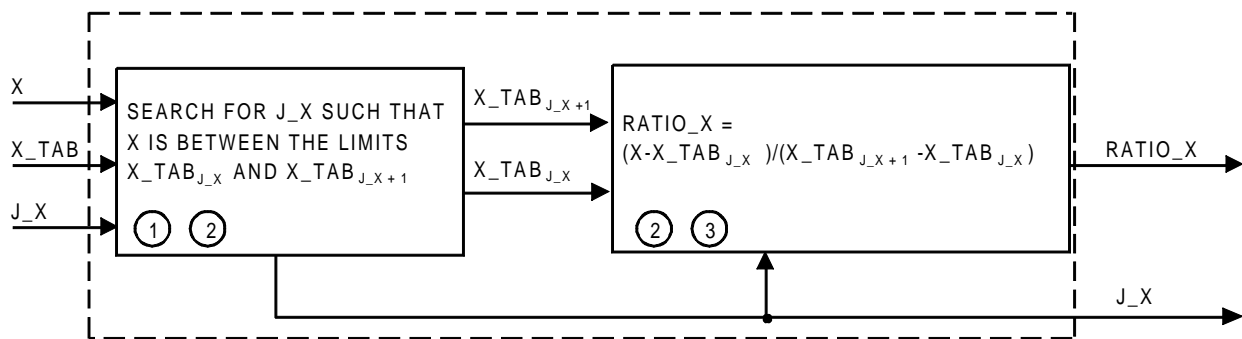
C. Interface Requirements. The interface requirements for the module X_INTERP are shown in Table 4.7.6–1.

D. Constants. None.

E. Initialization Requirements. The initialization requirements for the module X_INTERP are shown in Table 4.7.6–2.

Table 4.7.6-1.X_INTERP Interface Requirements					
Name	Description	Source or Destination	Type	Units	Rate Required Produced (Hz)
<u>Inputs</u>					
X	Independent variable	-	S	-	-
X_TAB	Array of table entry breakpoints for independent variable	-	A(n)	-	-
J_X	Past value of J_X	X_INTERP	I	-	-
<u>Outputs</u>					
RATIO_X	Ratio used for interpolating dependent variable	Y_INTERP	S	-	-
J_X	Index value to left of current value of dependent variable	Y_INTERP	I	-	-

Table 4.7.6-2.X_INTERP Initialization Requirements				
Component	Initialize on Transition		Variable	Initial Value
	From	To		
X_INTERP	As specified in the particular user application		J_X	As required



NOTES

- ① FOR INCREASING TABLE, $X_{TAB_{J_X}} \leq X \leq X_{TAB_{J_X+1}}$
FOR DECREASING TABLE, $X_{TAB_{J_X}} \geq X \geq X_{TAB_{J_X+1}}$
- ② IF X IS OUTSIDE THE RANGE OF THE TABLE
SET RATIO_X = 0, WHICH WILL FORCE Y_INTERP TO PROJECT HORIZONTALLY:
 $Y = Y_{TAB_{J_X}}$
- ③ ASSUME $X_{TAB_{J_X+1}} \neq X_{TAB_{J_X}}$ (I.E., NO VERTICAL SEGMENT)

FIGURE 4.7.6-1. X_INTERP

4.7.7 Y_INTERP

A. Function. The detailed block diagram for the module Y_INTERP is presented in Figure 4.7.7-1. This utility function performs linear interpolation of a dependent variable and is normally used in conjunction with X_INTERP (Subsection 4.7.6), which calculates RATIO_X and J_X. Y_INTERP receives RATIO_X and the index, J_X, corresponding to the first break point prior to X, and an array, Y_TAB, which contains the independent variable breakpoints that correspond to the dependent variable breakpoints. The output Y is the linear interpolated value of the dependent variable, given as follows:

$$Y = (Y_TAB_{J_X+1} - Y_TAB_{J_X}) RATIO_X + Y_TAB_{J_X}$$

Extrapolation beyond the extremities of the tabular data is horizontal: $Y = Y_TAB_{J_X}$. This is indicated in X_INTERP by setting $X_RATIO = 0$.

B. Processing Requirements. The module Y_INTERP is processed when invoked by a user.

C. Interface Requirements. The interface requirements for the module Y_INTERP are shown in Table 4.7.7-1.

D. Constants. There are no constants for Y_INTERP.

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

Table 4.7.7-1. Y_INTERP Interface Requirements

Name	Description	Source or Destination	Type	Units	Rate Required/Produced (Hz)
<u>Inputs</u>					
RATIO_X	Ratio used for interpolating dependent variable	X_INTERP	S	-	-
J_X	Index value to left of current value of dependent variable	X_INTERP	I	-	-
Y_TAB	Array containing dependent variable breakpoints	-	A(n)	-	-
<u>Outputs</u>					
Y	Interpolated value of dependent variable	-	S	-	-

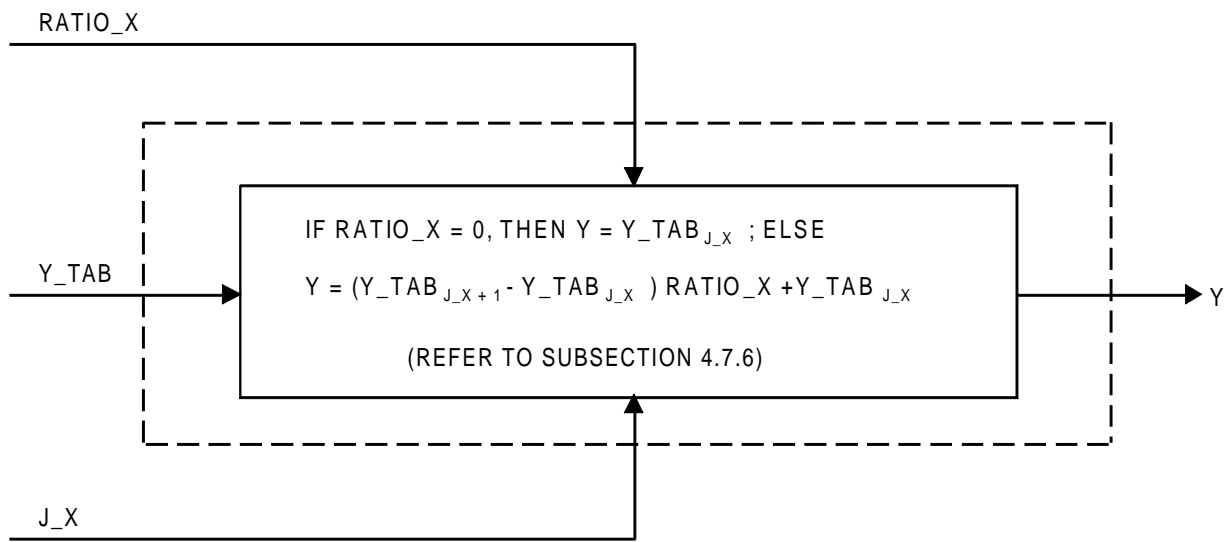


FIGURE 4.7.7-1. Y_INTERP

4.7.8 MINITABLE

A. Function. The detailed block diagram for the module MINITABLE is presented in Figure 4.7.8–1. MINITABLE is useful for interpolating functions with only two breakpoints and is intended for in–line code generation (e.g., a macro). If the input X is between XLFT and XRGT, then a linear interpolation is performed to obtain Y. If $X \leq XLFT$, then $Y = XLFT$; and if $X \geq XRGT$, $Y = YRGT$. It is assumed that $XLFT \leq XRGT$, but is not necessary for YLFT to be less than YRGT; e.g., slopes can be positive or negative but must be finite ($XLFT \neq XRGT$). The HAL in–line implementation is as follows:

$$Y = (X - XLFT) [(YRGT - YLFT)/(XRGT - XLFT)] + YLFT$$

where the term in square brackets will be a HAL–derived constant.

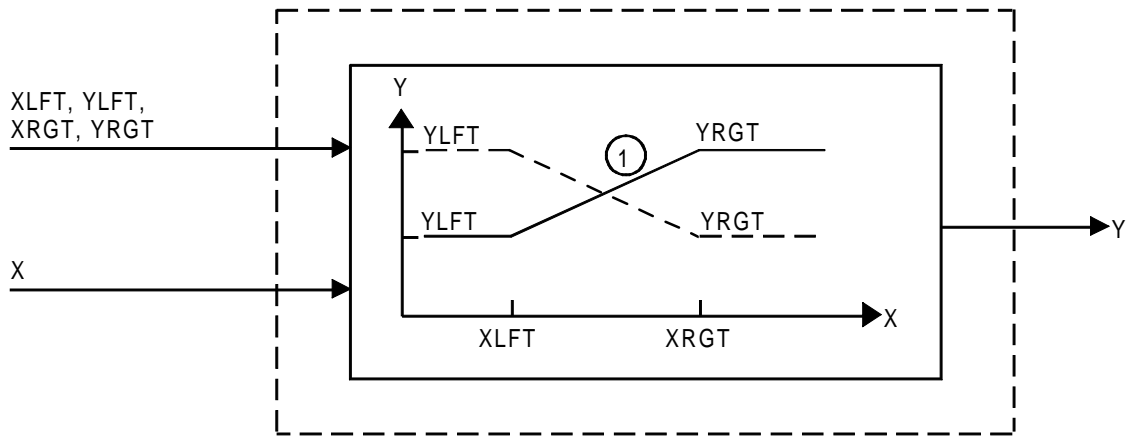
B. Processing Requirements. The module MINITABLE is processed when invoked by the user.

C. Interface Requirements. The interface requirements for the module MINITABLE are shown in Table 4.7.8–1

D. Constants. None.

E. Initialization Requirements. None.

Table 4.7.8-1.MINITABLE Interface Requirements					
Name	Description	Source or Destination	Type	Units	Rate Required Produced (Hz)
<u>Inputs</u>					
X	Independent variable	–	S	–	–
XLFT	Lower value of X between which output is to be interpolated	–	S	–	–
YLFT	Value of dependent variable corresponding to XLFT	–	S	–	–
XRGT	Upper value of X between which output is to be interpolated	–	S	–	–
YRGT	Value of dependent variable corresponding to XRGT	–	S	–	–
<u>Outputs</u>					
Y	Dependent variable	–	S	–	–



NOTES

① FUNCTION SPECIFICATION

IF $X \leq XLFT$: $Y = YLFT$

IF $XLFT < X < XRGT$: $Y = (X - XLFT) [(YRGT - YLFT)/(XRGT - XLFT)] + YLFT$

IF $X \geq XRGT$: $Y = YRGT$

ASSUME $XLFT < XRGT$

② INLINE HAL (WHERE TERM IN SQUARE BRACKETS WILL BE A SINGLE DERIVED CONSTANT):

$Y = \text{MIDVAL}(YLFT, (X - XLFT) [(YRGT - YLFT)/(XRGT - XLFT)] + YLFT, YRGT)$

FIGURE 4.7.8-1. MINITABLE

4.7.9 RATE_LIMIT

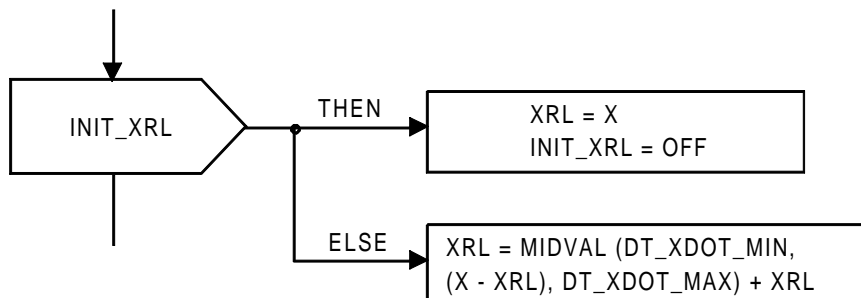
A. Function. The detailed block diagram for the module RATE_LIMIT is presented in Figure 4.7.9-1. This utility function limits the rate of change of the output.

B. Processing Requirements. The module RATE_LIMIT is processed when invoked by the user.

C. Interface Requirements. The interface requirements for the module RATE_LIMIT are shown in Table 4.7.9-1.

D. Constants. There are no constants for RATE_LIMIT.

E. Initialization Requirements. The initialization requirements for the module RATE_LIMIT are shown in Table 4.7.9-2.

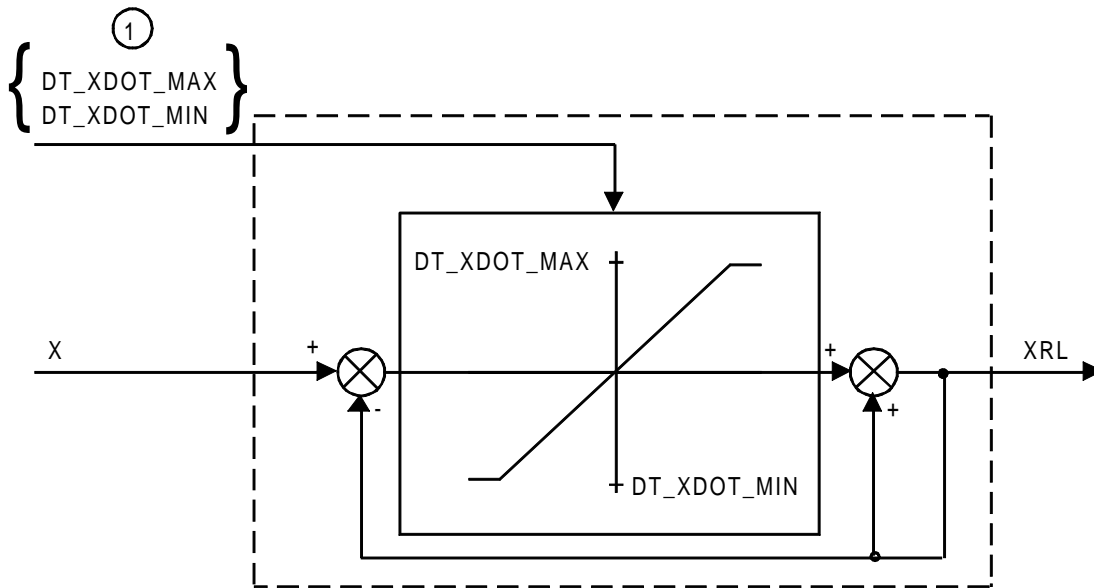


NOTE:
IF ALL USERS REQUIRE ONLY SYMMETRIC LIMITS \pm DT_XDOT_LIM,
THEN USE OF THE SINGLE QUANTITY WILL SAVE CORE

FIGURE 4.7.9-0. RATE_LIMIT Detailed Technical Description

Table 4.7.9-1.RATE_LIMIT Interface Requirements					
Name	Description	Source or Destination	Type	Units	Rate Required/ Produced (Hz)
<u>Inputs</u>					
X	Input to be rate-limited	-	S	-	-
DT_XDOT_MIN	Product of minimum rate limit and processing interval	-	S	-	-
DT_XDOT_MAX	Product of maximum rate limit and processing interval	-	S	-	-
XRL	Past value of output	-	S	-	-
INIT_XRL	Initialization flag		B	-	-
<u>Outputs</u>					
XRL	Rate-limited output	-	S	-	-
INIT_XRL	Initialization flag		B	-	-

Table 4.7.9-2.RATE_LIMIT Initialization Requirements				
Component	Initialize on Transition		Variable	Initial Value
	From	To		
Past value of output	-	INIT_XRL	XRL	X



NOTES:

- (1) PRODUCTS OF SAMPLE INTERVAL AND RATE LIMITS

FIGURE 4.7.9-1. RATE_LIMIT

4.7.10 QUAT_MULT

A. Function. The detailed block diagram for the module QUAT_MULT is presented in Figure 4.7.10–1. QUAT_MULT is invoked with an ordered quadruple of scalar and vector parts of operand quaternions [Q1S, Q1V, Q2S, Q2V]. Quaternion multiplication is generally not commutative, so the order of the operands (leftmost/rightmost) is important. Conjugation, if required, is handled by the user by complementing the appropriate vector part. Figure 4.7.10–2 shows typical user applications and block diagram symbology, including conjugate multiplication and quaternion integration.

B. Processing Requirements. The module QUAT_MULT is processed when invoked by a user.

C. Interface Requirements. The interface requirements for the module QUAT_MULT are shown in Table 4.7.10–1.

D. Constants. None.

E. Initialization Requirements. None.

F. Detailed Technical Descriptions. For the operation $Q3 = Q1 Q2$, where the leftmost quaternion $Q1 = [Q1S, \overline{Q1V}]$ and the rightmost quaternion $Q2 = [Q2S, \overline{Q2V}]$, the product quaternion $Q3 = [Q3S, \overline{Q3V}]$ is given by the following equations:

$$Q3S = Q1S Q2S - \overline{Q1V} \cdot \overline{Q2V}$$

$$\overline{Q3V} = Q1S \overline{Q2V} + Q2S \overline{Q1V} + \overline{Q1V} * \overline{Q2V}$$

Since QUAT_MULT will be used from 75 to 125 times per second, depending upon mode, the equations should be expanded to save significant CPU at the expense of minimal core:

$$Q3S = Q1S Q2S - (Q1V_1 Q2V_1 + Q1V_2 Q2V_2 + Q1V_3 Q2V_3)$$

$$Q3V_1 = Q1S Q2V_1 + Q2S Q1V_1 + Q1V_2 Q2V_3 - Q1V_3 Q2V_2$$

$$Q3V_2 = Q1S Q2V_2 + Q2S Q1V_2 - Q1V_1 Q2V_3 + Q1V_3 Q2V_1$$

$$Q3V_3 = Q1S Q2V_3 + Q2S Q1V_3 + Q1V_1 Q2V_2 - Q1V_2 Q2V_1$$

Table 4.7.10-1. QUAT_MULT Interface Requirements					
Name	Description	Source or Destination	Type	Units	Rate Required/Produced (Hz)
<u>Inputs</u>					
Q1S	A scalar and a vector corresponding to the part of the leftmost quaternion*		S	-	-
Q1V			V	-	-
Q2S	A scalar and a vector corresponding to the parts of the rightmost quaternion*		S	-	-
Q2V			V	-	-
<u>Outputs</u>					
Q3	Output quaternion*		Q	-	-
* Where Q3 = Q1 Q2					

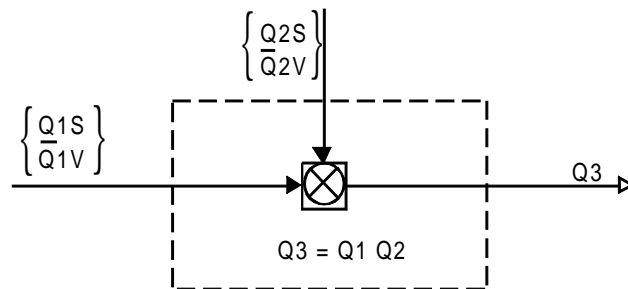


FIGURE 4.7.10-1. QUAT_MULT

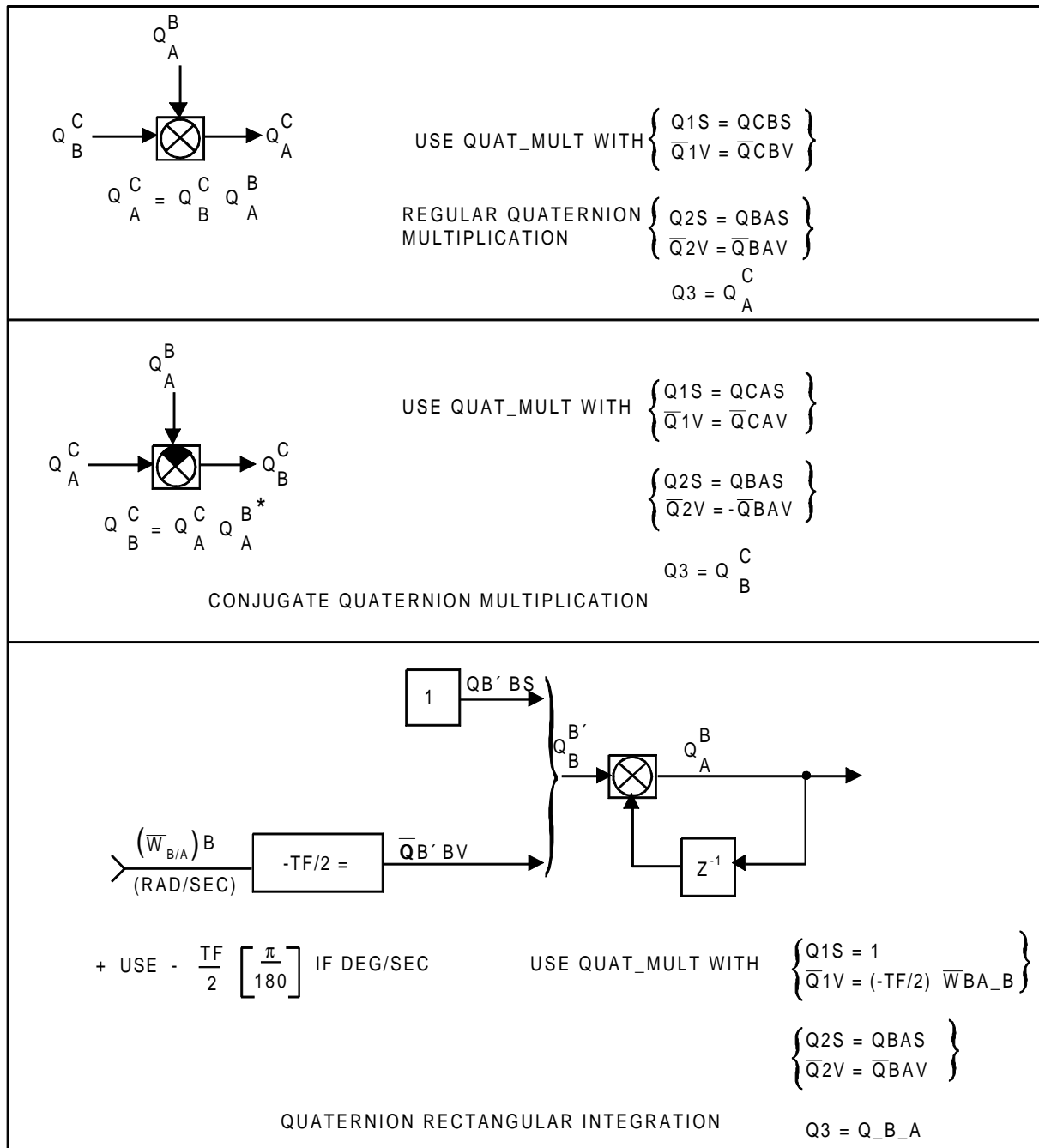
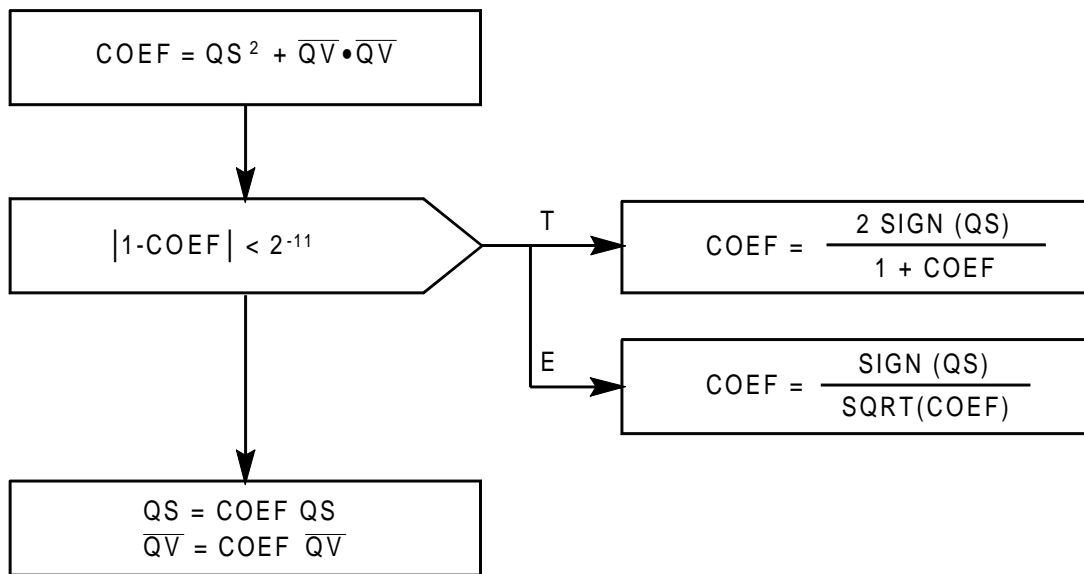


FIGURE 4.7.10-2. QUAT_MULT Symbology and Applications

4.7.11 QUAT_NORM

- A. Function. The detailed block diagram for the module QUAT_NORM is presented in Figure 4.7.11–1. QUAT_NORM yields a properly normalized quaternion, with a positive scalar part. If the incoming scalar is negative, QUAT_NORM complements the elements. It computes the scalar part based on the vector part. Numerical problems in the vicinity of 180 degrees are avoided; the resulting quaternion corresponds to an exact 180-degree rotation.
- B. Processing Requirements. The module QUAT_NORM is processed when invoked by a user.
- C. Interface Requirements. The interface requirements for the module QUAT_NORM are shown in Table 4.7.11–1.
- D. Constants. None.
- E. Initialization Requirements. None.
- F. Detailed Technical Descriptions.



Where the constant 2^{-11} assumes single precision calculation.

FIGURE 4.7.11-0. QUAT_NORM Detailed Technical Descriptions

Table 4.7.11-1. QUAT_NORM Interface Requirements					
Name	Description	Source or Destination	Type	Units	Rate Required/Produced (Hz)
<u>Inputs</u>					
Q	Quaternion to be normalized		Q	-	-
<u>Outputs</u>					
Q	Normalized quaternion		Q	-	-

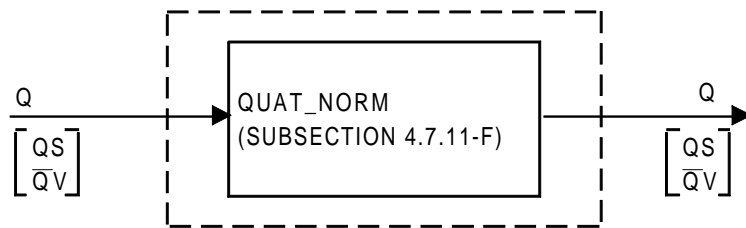


FIGURE 4.7.11-1. QUAT_NORM

4.7.12 QUAT_INTEG

A. Function. The detailed block diagram for the module QUAT_INTEG is presented in Figure 4.7.12–1. QUAT_INTEG performs quaternion integration subject to a specific assumption on the coordinatization of the rate vector; namely, that if \overline{W} represents the angular velocity of frame B with respect to frame A, then \overline{W} is coordinatized in frame B. As such, it is not as general as QUAT_MULT (Subsection 4.7.10), which can handle all four quaternion integration algorithms. QUAT_INTEG is intended for in–line code generation (e.g., a macro), which invokes QUAT_MULT.

B. Processing Requirements. The module QUAT_INTEG is processed when invoked by a user.

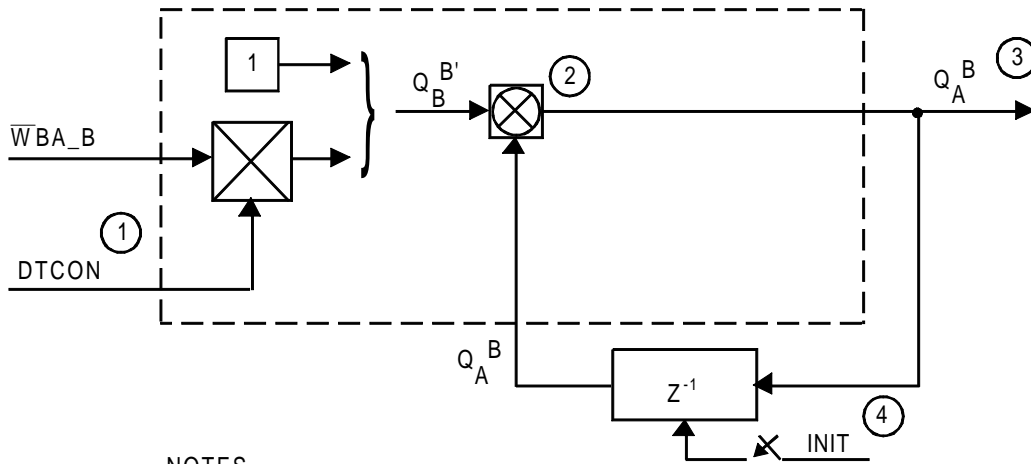
C. Interface Requirements. The interface requirements for QUAT_INTEG are shown in Table 4.7.12–1.

D. Constants. None.

E. Initialization Requirements. The initialization requirements for QUAT_INTEG are shown in Table 4.7.12–2.

Table 4.7.12-1. QUAT_INTEG Interface Requirements					
Name	Description	Source or Destination	Type	Units	Rate Required/Produced (Hz)
<u>Inputs</u>					
WBA_B	Rotational rate, frame B wrt frame A, coordinated in frame B		V	1/s or deg/s	–
DTCON	Multiplicative factor for rate input vector		S	s or s/deg	–
Q_B_A	Past value of output quaternion		Q	–	–
<u>Outputs</u>					
Q_B_A	Quaternion, B frame wrt A frame		Q	–	–

Table 4.7.12-2. QUAT_INTEG Initialization Requirements				
Component	Initialize on Transition		Variable	Initial Value
	From	To		
Past value of quaternion output	User-defined initialization condition		Q_B_A	User dependent



NOTES

- ① $DTCON = \begin{cases} -\frac{\Delta T}{2} & \text{IF } \overline{WBA_B} \text{ IN RAD/SEC} \\ -\frac{\Delta T}{2} \left(\frac{\pi}{180} \right) & \text{IF } \overline{WBA_B} \text{ IN DEG/SEC} \end{cases}$
- ② $Q_A^B = \text{QUAT_MULT}(1, (DTCON \cdot \overline{WBA_B}), Q_{BAS}, \overline{Q_{BAV}})$
(SUBSECTION 4.7.10)
- ③ USE QUAT_NORM (SUBSECTION 4.7.11) TO PERIODICALLY NORMALIZE Q_A^B
- ④ USER INITIALIZATION OF Q_A^B IS REQUIRED

FIGURE 4.7.12-1. QUAT_INTEG

4.7.13 QUAT_XFORM

A. Function. The detailed block diagram for the module QUAT_XFORM is presented in Figure 4.7.13-1. This utility routine performs a coordinate transformation on a vector, using quaternions. The input includes a quaternion representing the coordinate transformation and the vector to be transformed. The output is the transformed vector. It is assumed that the input quaternion is normal.

B. Processing Requirements. The module QUAT_XFORM is processed when invoked by a user.

C. Interface Requirements. The interface requirements for the module QUAT_XFORM are shown in Table 4.7.13-1.

D. Constants. None.

E. Initialization Requirements. None.

F. Detailed Technical Descriptions.

1. $QTMP = (QBAS, \overline{QBAV}) (0, \overline{W}_A)$:
 $QTMP_S = -\overline{QBAV} \cdot \overline{W}_A$
 $\overline{QTMPV} = QBAS \overline{W}_A + \overline{QBAV} * \overline{W}_A$
2. $(0, \overline{W}_B) = (QTMP_S, \overline{QTMPV}) (QBAS, -\overline{QBAV})$:
 $\overline{W}_B = -QTMP_S \overline{QBAV} + \overline{QBAS} \overline{QTMPV} - \overline{QTMPV} * \overline{QBAV}$

Table 4.7.13-1. QUAT_XFORM Interface Requirements

Name	Description	Source or Destination	Type	Units	Rate Required/Produced (Hz)
<u>Inputs</u>					
\overline{W}_A	Input vector in frame A		V	-	-
Q_{B_A}	Quaternion, frame B wrt frame A		Q	-	-
<u>Outputs</u>					
W_B	Output vector in frame B		V	-	-

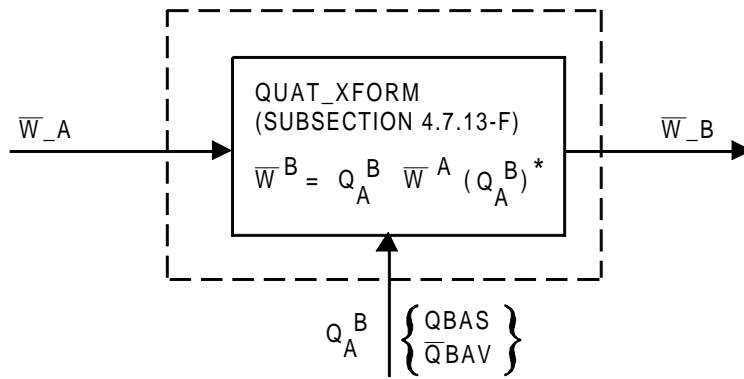


FIGURE 4.7.13-1. QUAT_XFORM

4.7.14 QUAT_ERR_ANG

A. Function. The detailed block diagram for the module QUAT_ERR_ANG is presented in Figure 4.7.14–1. QUAT_ERR_ANG extracts a vector of attitude errors, in degrees, from an error quaternion, using the algorithm:

$$\bar{E}BA_A = -2\left(\frac{180}{\pi}\right) \text{SIGN}(\text{QBAS}) \bar{Q}BAV$$

This algorithm is a linear approximation; it is reasonably valid only to the extent that the true angle of rotation θ represented by the quaternion satisfies the equations $\sin \frac{\theta}{2} \doteq \frac{\theta}{2}$, $\cos \frac{\theta}{2} \doteq 1$.

- B. Processing Requirements. The module QUAT_ERR_ANG is processed upon invocation by a user.
- C. Interface Requirements. The interface requirements for the module are shown in Table 4.7.14–1.
- D. Constants. The constants for QUAT_ERR_ANG are shown in Table 4.7.14–2.
- E. Initialization Requirements. There are no initialization requirements for QUAT_ERR_ANG.

Table 4.7.14-1. QUAT_ERR_ANG Interface Requirements					
Name	Description	Source or Destination	Type	Units	Rate Required/Produced (Hz)
<u>Inputs</u>					
Q_B_A	Quaternion, frame B wrt frame A		Q	–	–
<u>Outputs</u>					
EBA_A	Attitude errors, frame B wrt frame A coordinatized in frame A		V	deg	–

Table 4.7.14-2. QUAT_ERR_ANG Constants					
Name	Description	Type	Value	Units	Other References
DEG_PER_RAD	Conversion factor, radians to degrees	S	$180/\pi$	deg/rad	many
ATTERRCON	Scale factor for extracting a vector of attitude errors in degrees from a quaternion	S	(-2) DEG_PER_RAD	deg	–

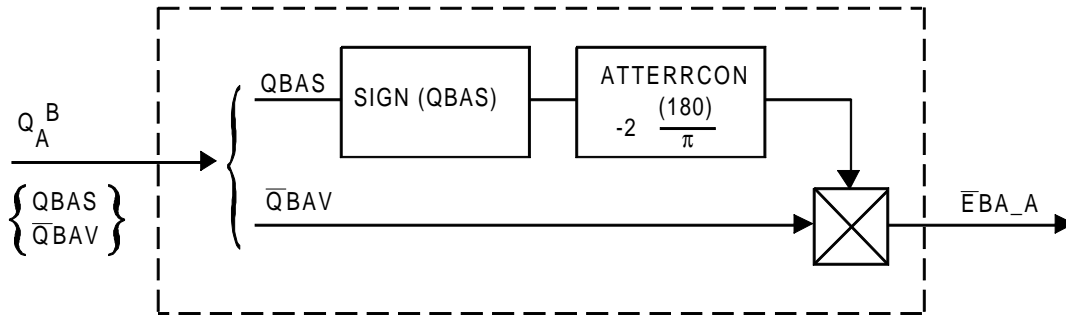


FIGURE 4.7.14-1. QUAT_ERR_ANG

4.7.15 SMOOTHER

A. Function. This routine provides a smoothed, high-rate output between samples of a low-rate input signal. The detailed block diagram for SMOOTHER is presented in Figure 4.7.15-1.

B. Processing Requirements. SMOOTHER is processed at the high rate specified by the particular application.

C. Interface Requirements. The interface requirements for SMOOTHER are shown in Table 4.7.15-1.

D. Constants. The constants for SMOOTHER are shown in Table 4.7.15-2.

E. Initialization Requirements. The initialization requirements for SMOOTHER are shown in Table 4.7.15-3.

F. Detailed Technical Description. A detailed description in terms of a logic flow diagram is presented in Figure 4.7.15-1. XIN is updated at the low rate; that is, every TMAJOR seconds.

Table 4.7.15-1. SMOOTHER Interface Requirements					
Name	Description	Source or Destination	Type	Units	Rate Required/Produced (Hz)
<u>Input</u> XIN	Smoothen input	–	F	*	*
<u>Output</u> XOUT	Smoothen output	–	F	*	*

Table 4.7.15-2. SMOOTHER Constants				
Name	Description	Type	Value	Units
TMAJOR	Period at which the input signal is updated	F	*	sec
TMINOR	Period at which the output signal is updated	F	*	sec
*As specified in the particular application				

Table 4.7.15-3. SMOOTHER Initialization Requirements				
Component	Initialize on Transition		Variable	Initial Value
	From	To		
SMOOTHER	–	First invocation	Last_XIN XOUT	XIN XIN

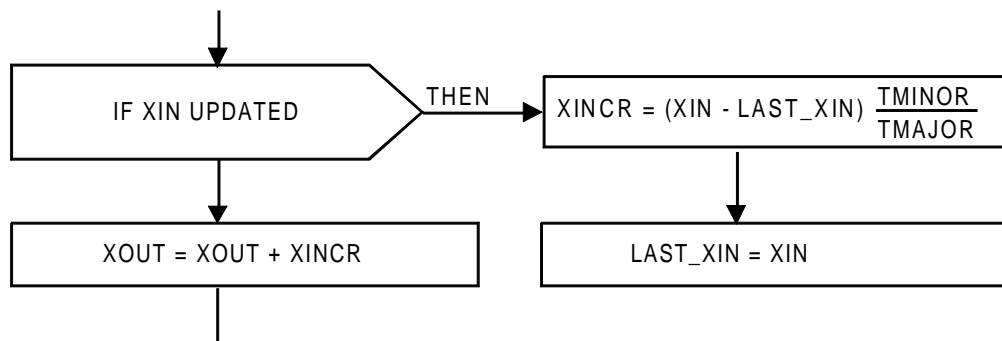


FIGURE 4.7.15-1.SMOOTHER Logic Flow Diagram

4.7.16 MAT_TO_QUAT

A. Function. The detailed block diagram for the module MAT_TO_QUAT presented in Figure 4.7.16-1 extracts a quaternion from its direction cosine matrix. The extraction process avoids singularities. A positive scalar part is arbitrarily chosen for the resulting quaternion. It is assumed that the input matrix is unitary.

CAUTION: Quaternions and direction cosine matrices are used to represent transformations of coordinates. The notation used for both methods is briefly described.

Given two coordinate frames A and B, with common origin, and a vector whose coordinates in each frame are \bar{V}_A and \bar{V}_B , respectively, the notation Q_{B_A} denotes the quaternion which represents the transformation from frame A to frame B:

$$\bar{V}_B = Q_{B_A} \bar{V}_A (Q_{B_A})^*$$

This equation is valid if (i) \bar{V}_A and \bar{V}_B are viewed as quaternions with zero scalar part and (ii) $Q_{B_A} \equiv (QBAS, \bar{QBAV})$ is normalized; the conjugate of Q_{B_A} is defined by $(Q_{B_A})^* \equiv (QBAS, -\bar{QBAV})$. Transformation of coordinates from frame A to frame B may also be viewed as the result of a rotation through an angle θ about an oriented axis $\bar{\omega}$; the connection with Q_{B_A} is as follows:

$$QBAS = \cos \frac{\theta}{2}, \bar{QBAV} = -\text{unit}(\bar{\omega}) \sin \frac{\theta}{2}$$

With this convention, transformations from frames A and B, each to a third frame C, are related as follows:

$$Q_{C_A} = Q_{C_B} Q_{B_A}$$

Block diagram symbology for quaternion multiplication is described in Section 4.7.10 (QUAT_MULT) of this document.

Notation for direction cosine matrices is slightly different and is briefly described. Given two coordinate frames A and B, with common origin, and a vector whose coordinates in each frame are \bar{V}_A and \bar{V}_B , respectively, the rotation M_{AB} denotes the direction cosine matrix that represents the transformation from frame A to frame B:

$$\bar{V}_B = M_{AB} \bar{V}_A$$

With this convention, transformations from frames A and B, each to a third frame C, are related as follows:

$$M_{AC} = M_{BC} M_{AB}$$

B. Processing Requirements. The module MAT_TO_QUAT is processed when invoked by a user.

C. Interface Requirements. The interface requirements for MAT_TO_QUAT are shown in Table 4.7.16-1.

D. Constants. None.

E. Initialization Requirements. None.

Table 4.7.16-1. MAT_TO_QUAT Interface Requirements					
Name	Description	Source or Destination	Type	Units	Produced (Hz)
<u>Input</u> M_A_B	Direction cosine matrix, B frame wrt A frame		M	–	–
<u>Output</u> Q_B_A	Quaternion, B frame wrt A frame		Struc S, V	–	–

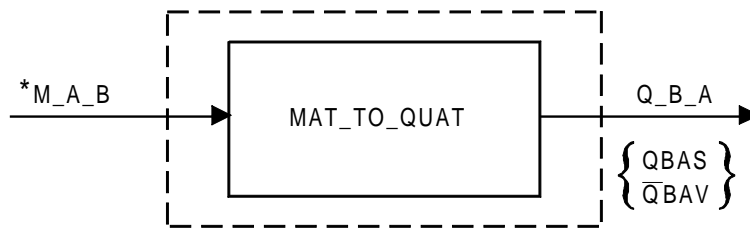


FIGURE 4.7.16-1.MAT_TO_QUAT

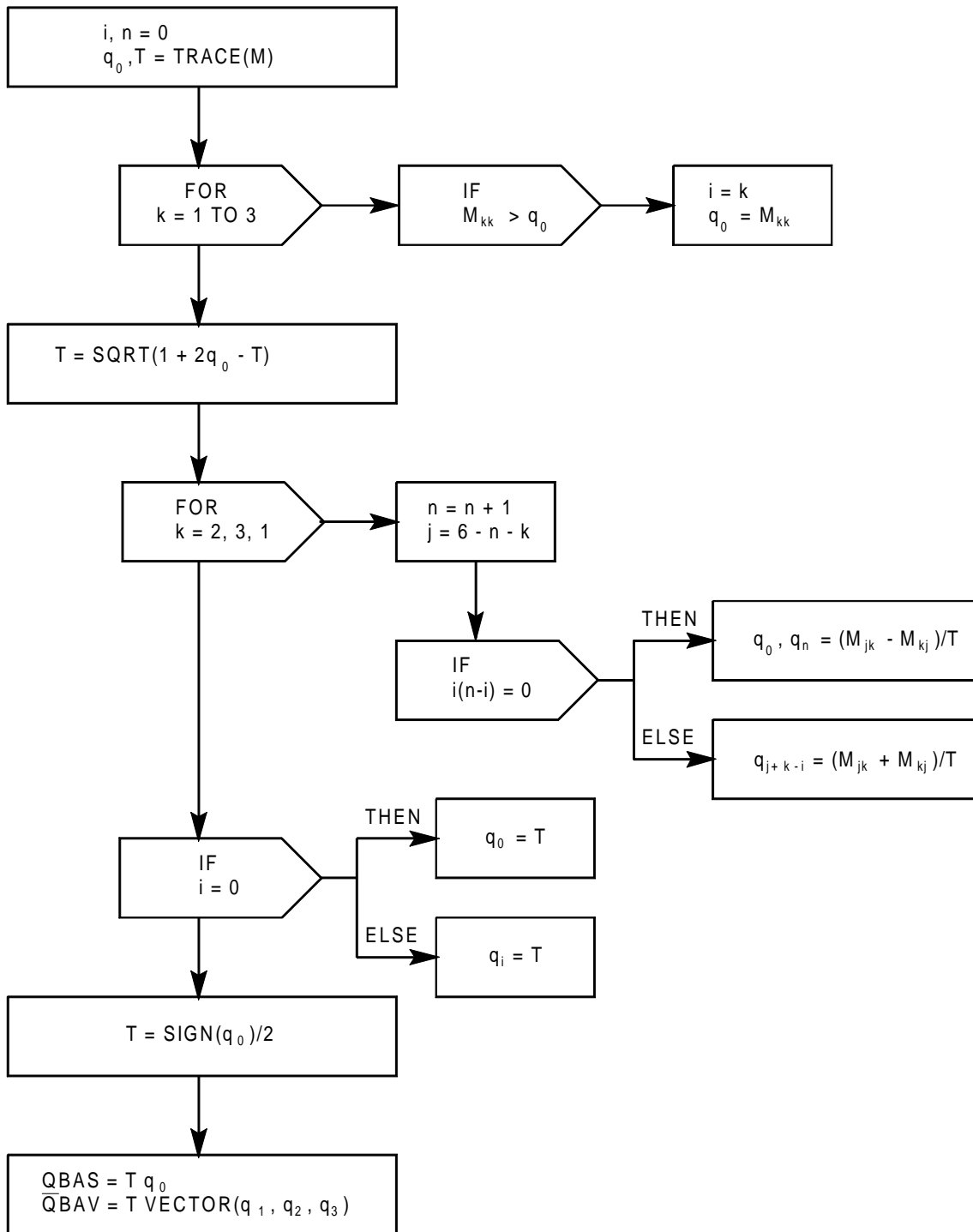


FIGURE 4.7.16-2.MAT_TO_QUAT Detailed Description

4.7.17 RV_TO_QLVLH

A. Function. RV_TO_QLVLH is a procedure which, given a position vector (\overline{XR}) and velocity vector (\overline{XV}), both coordinated in M50, returns a quaternion $XQ_M50_LVLH = (XQM50LVLHS, \overline{XQM50LVLHV})$ representing the M50 frame with respect to the local orbital frame. The CALL to RV_TO_QLVLH is

CALL RV_TO_QLVLH (\overline{XR} , \overline{XV}) ASSIGN (XQ_M50_LVLH)

A block diagram of RV_TO_QLVLH is shown in Figure 4.7.17-1.

B. Processing Requirements. The module RV_TO_QLVLH is processed when invoked by a user.

C. Interface Requirements. The interface requirements for module RV_TO_QLVLH are shown in Table 4.7.17-1.

D. Constants. None.

E. Initialization Requirements. None.

F. Detailed Technical Description.

$$\overline{XZ} = \text{UNIT}(-\overline{XR})$$

$$\overline{XY} = \text{UNIT}(\overline{XV} * \overline{XR})$$

$$\overline{XX} = \text{UNIT}(\overline{XY} * \overline{XZ})$$

$$\overset{*}{X}M = (\text{MATRIX}(\overline{XX}, \overline{XY}, \overline{XZ}))^T$$

XQ_M50_LVLH is formed from $\overset{*}{X}M$ by invoking the utility function MAT_TO_QUAT.

Table 4.7.17-1. RV_TO_QLVLH Interface Requirements						
Name	Description	Source or Destination	Type	Range	Units	Sample Rate (Hz)
<u>Inputs</u>						
\overline{XR}	Vehicle position in M50	CALLing prog	V		ft	once
\overline{XV}	Vehicle position in M50	CALLing prog	V		ft/s	once
<u>Output</u>						
XQ_M50_LVLH	M50 wrt LVLH quaternion	CALLing prog	Struc: S, V		–	once

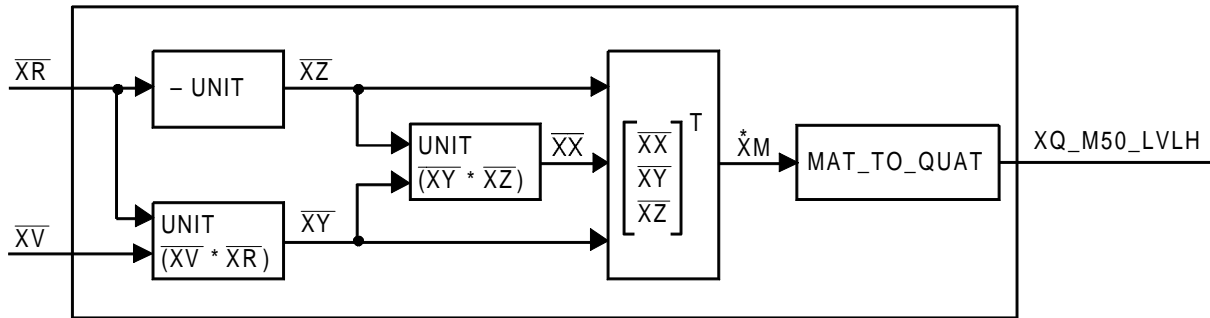


FIGURE 4.7.17-1.RV_TO_QLVLH

4.7.18 QUAT_TO_EULER

A. Function. QUAT_TO_EULER is a procedure which extracts Euler angles from a quaternion assuming a yaw, pitch, roll rotation sequence. The resulting angles (in degrees), XPSI, XTHETA, XPHI, $|\text{XTHETA}| < 90^\circ$, represent the same transformation as the arbitrary quaternion. $\text{Sin}(\text{XPHI})$, $\text{cos}(\text{XPHI})$, $\text{sin}(\text{XTHETA})$, and $\text{cos}(\text{XTHETA})$ are also returned for use in ATT PROC and FCS. $|\text{COS}(\text{XPHI})|$ is limited to be $\geq 2^{-16}$. For $\text{XTHETA} = \pm 90^\circ$, XPHI is arbitrarily chosen to be 0° , and XPSI is extracted so that (XPSI, XTHETA, 0) represents the same attitude as the input quaternion. The CALL to QUAT_TO_EULER is

```
CALL QUAT_TO_EULER (XQ) ASSIGN (XPSI, XTHETA, XPHI, XSINTH, XCOSTH,
                             XSINPHI, XCOSPHI)
```

A block diagram of QUAT_TO_EULER is shown in Figure 4.7.18-1.

B. Processing Requirements. The module QUAT_TO_EULER is processed when invoked by a user.

C. Interface Requirements. The interface requirements for QUAT_TO_EULER are given in Table 4.7.18-1.

D. Constants. The constant $\text{DEG_PER_RAD} = 180/\pi$ deg is used.

Numerical constants are chosen based on single precision computation.

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

F. Detailed Technical Description.

$$\text{XSINTH} = -2(\text{XQV}_1 \text{XQV}_3 + \text{XQS} \text{XQV}_2)$$

$$\text{If } |\text{XSINTH}| > 1 \text{ then } \text{XSINTH} = \text{sign}(\text{XSINTH})$$

$$\text{XCOSTH} = \text{SQRT}(1 - \text{XSINTH}^2)$$

$$\text{XTHETA} = \text{DEG_PER_RAD} \text{ARCSIN}(\text{XSINTH})$$

If $\text{XCOSTH} \geq 2^{-11}$, then the following steps are performed:

$$\text{DUMMY1} = 2(\text{XQV}_2 \text{XQV}_3 - \text{XQS} \text{XQV}_1)$$

$$\text{DUMMY2} = 1 - 2(\text{XQV}_1^2 + \text{XQV}_2^2)$$

$$\text{XPSI} = \text{DEG_PER_RAD} \text{ARCTAN2}[2(\text{XQV}_1 \text{XQV}_2 - \text{XQS} \text{XQV}_3), (1 - 2(\text{XQV}_2^2 + \text{XQV}_3^2))]$$

$$\text{XPHI} = \text{DEG_PER_RAD} \text{ARCTAN2}[\text{DUMMY1}, \text{DUMMY2}]$$

$$\text{XSINPHI} = \text{DUMMY1}/\text{XCOSTH}$$

$$\text{XCOSPHI} = \text{DUMMY2}/\text{XCOSTH}$$

If $|XCOSPFI| < 2^{-16}$, $XCOSPFI = SIGN(XCOSPFI) 2^{-16}$

If $XCOSTH < 2^{-11}$, then the following steps are performed

$$XPHI, XSINPHI = 0$$

$$XCOSPFI = 1$$

$$XPSI = DEG_PER_RAD \text{ ARCTAN2}[-2(XQV_1 XQV_2 + XQS XQV_3), (1 - 2(XQV_1^2 + XQV_3^2))]$$

Table 4.7.18-1. QUAT_TO_EULER Interface Requirements

Name	Description	Source or Destination	Type	Range	Units	Sample Rate (Hz)
<u>Input</u>						
XQ	Quaternion to be decomposed	CALLing prog	Struc: S, V		–	once
<u>Outputs</u>						
XPSI	First Euler angle (YAW)	CALLing prog	S		deg	once
XTHETA	Second Euler angle (PITCH)	CALLing prog	S		deg	once
XPHI	Third Euler angle (ROLL)	CALLing prog	S		deg	once
XCOSTH	Cos(XTHETA)	CALLing prog	S		–	once
XSINTH	Sin(XTHETA)	CALLing prog	S		–	once
XSINPHI	Sin(XPHI)	CALLing prog	S		–	once
XCOSPFI	Cos(XPHI)	CALLing prog	S		–	once

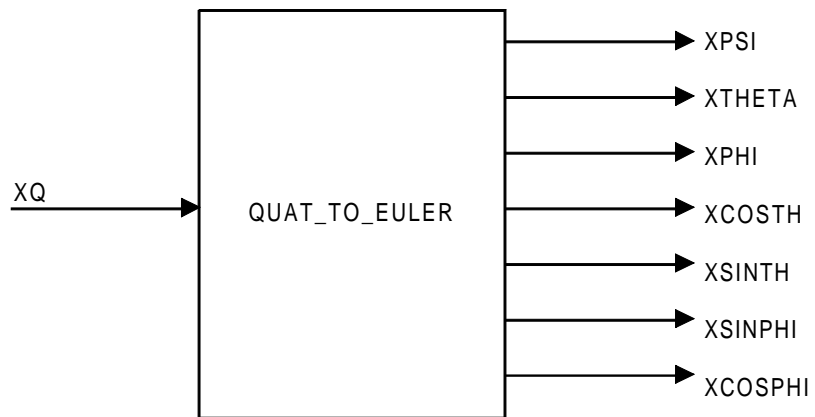


FIGURE 4.7.18-1. QUAT_TO_EULER

4.7.19 QUAT_TO_ADI_ANG

A. Function. QUAT_TO_ADI_ANG is a procedure that extracts sines and cosines of ADI angles (in a pitch, yaw, roll sequence) from an arbitrary quaternion. A flag is returned indicating whether or not PTCH and ROLL functions have been updated. That quaternion represents the rotation of the body frame with respect to the reference frame. The sines and cosines represent the ordered set of angles, PTCH, YAW, ROLL, with $|\text{YAW}| \leq \pi/2$. The call to QUAT_TO_ADI_ANG is

$$\text{CALL QUAT_TO_ADI_ANG (XQ) ASSIGN (XPTCHSINE, XPTCHCOS, XYAWSINE, XYAWCOS, XROLLSINE, XROLLCOS, XFLAG)}$$

where XQ is a structure of a scalar and a vector, $\text{XQ} = (\text{XQS}, \overline{\text{XQV}})$. It is assumed that XQ is normalized. A block diagram of QUAT_TO_ADI_ANG is given in Figure 4.7.19-1.

B. Processing Requirements. The module QUAT_TO_ADI_ANG is processed when invoked by a user.

C. Interface Requirements. The interface requirements for the module QUAT_TO_ADI_ANG are given in Table 4.7.19-1.

D. Constants. The constant EPSILON = 0.03 is used. EPSILON is the lowest value of XYAWCOS for which PTCH and ROLL functions are updated, and is given by COS (88.28).

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

F. Detailed Technical Description.

$$\text{XFLAG} = \text{ON}$$

$$\text{XYAWSINE} = 2(\text{XQV}_1 \text{XQV}_2 - \text{XQS} \text{XQV}_3)$$

$$\text{XYAWCOS} = \text{SQRT}(1 - \text{XYAWSINE}^2)$$

If $\text{XYAWCOS} < \text{EPSILON}$, the PTCH and ROLL functions are not updated on this pass and $\text{XFLAG} = \text{OFF}$. If $\text{XYAWCOS} \geq \text{EPSILON}$, the update equations are:

$$\text{XYAWSEC} = 1/\text{XYAWCOS}$$

$$\text{XROLLSINE} = -2 \text{XYAWSEC} (\text{XQV}_2 \text{XQV}_3 + \text{XQS} \text{XQV}_1)$$

$$\text{XROLLCOS} = \text{XYAWSEC} (1 - 2(\text{XQV}_1^2 + \text{XQV}_3^2))$$

$$\text{XPTCHSINE} = -2 \text{XYAWSEC} (\text{XQV}_1 \text{XQV}_3 + \text{XQS} \text{XQV}_2)$$

$$\text{XPTCHCOS} = \text{XYAWSEC} (1 - 2(\text{XQV}_2^2 + \text{XQV}_3^2))$$

Table 4.7.19-1. QUAT_TO_ADI_ANG Interface Requirements						
Name	Description	Source or Destination	Type	Range	Units	Sample Rate (Hz)
<u>Input</u>						
XQ	Quaternion to be decomposed	CALLing prog	Struc: S, V	±1	–	once
<u>Outputs</u>						
XPTCHSINE	Sin(PTCH)	CALLing prog	S	±1	–	once
XPTCHCOS	Cos(PTCH)	CALLing prog	S	±1	–	once
XYAWSINE	Sin(YAW)	CALLing prog	S	±1	–	once
XYAWCOS	Cos(YAW)	CALLing prog	S	±1	–	once
XROLLSINE	Sin(ROLL)	CALLing prog	S	±1	–	once
XROLLCOS	Cos(ROLL)	CALLing prog	S	±1	–	once
XFLAG	PTCH, ROLL update flag	CALLing prog	B	0, 1	–	once

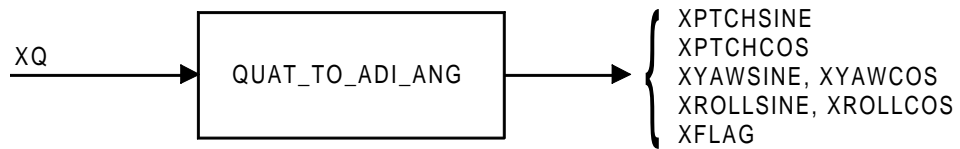


FIGURE 4.7.19-1. QUAT_TO_ADI_ANG

4.7.20 Parabolic Shaping and Limiting (PARSHAPE)

A. Function. The detailed block diagram for the module PARSHAPE is presented in Figure 4.7.20–1. The algorithm is simple enough and used infrequently enough to consider for implementing as in–line code (e.g., a macro). The linear, or small–signal, gain is KLIN, The parabolic correction gain is KPAR. An antisymmetric parabolic curve is generated. Output limiting is asymmetric, via the YMIN and YMAX parameters. Note that bang–bang output can be approximated by selected large KLIN and/or KPAR. Note that there are no inherent restrictions on the numerical values for the four parameters (as there are, for example, in certain alternative implementations used in other FSSRs).

B. Processing Requirements. The module PARSHAPE is processed when invoked by the user.

C. Interface Requirements. The interface requirements for PARSHAPE are presented in Table 4.7.20–1.

D. Constants. None.

E. Initialization Requirements. None.

Table 4.7.20-1. PARSHAPE Interface Requirements						
Name	Description	Source or Destination	Type	Range	Units	Sample Rate (Hz)
<u>Inputs</u>						
X	Input variable	–	S		–	–
KLIN	Linear shaping parameter	–	S		–	–
KPAR	Parabolic shaping parameter	–	S		–	–
YMIN	Output lower limit parameter	–	S		–	–
YMAX	Output upper limit parameters	–	S		–	–
<u>Outputs</u>						
Y	Output variable	–	S		–	–

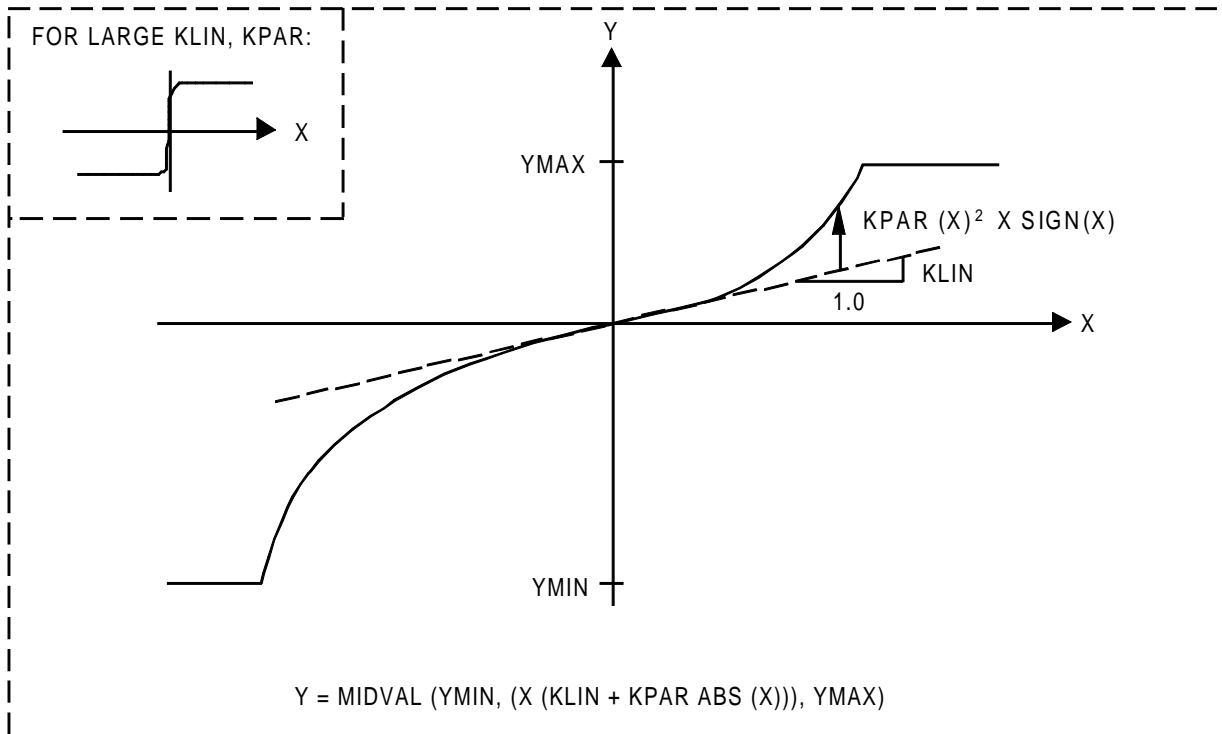


FIGURE 4.7.20-1.PARSHAPE

4.7.21 LIMITED_INTEGRATOR

A. Functional Description. A functional block diagram for the module LIMITED_INTEGRATOR is shown in Figure 4.7.21-1. LIMITED_INTEGRATOR is a rectangular rule digital representation of an integrator. Amplitude limiting is provided to keep the output from going beyond specified limits.

B. Software Description. The software description for LIMITED_INTEGRATOR is given by the statement.

$$XF = \text{MIDVAL}(-XF_LIM, XF + X T, XF_LIM)$$

The interface requirements and initialization requirements for LIMITED_INTEGRATOR are presented in Tables 4.7.21-1 and 4.7.21-2, respectively.

Table 4.7.21-1. LIMITED_INTEGRATOR Interface Requirements						
Name	Description	Source or Destination	Type	Range	Units	Rate Required/Produced (Hz)
<u>Inputs</u>						
X	Input		S		–	–
T	Update period		S		s	–
XF_LIM	Limit value for output		S		–	–
XF	Past value of output		S		–	–
<u>Output</u>						
XF	Output		S		–	–

Table 4.7.21-2. LIMITED_INTEGRATOR Initialization Requirements (Performed by Invoker)				
Component	Initialize on Transition		Variable	Initial Value
	From	To		
LIMITED_INTEGRATOR	–	First pass	XF	As required

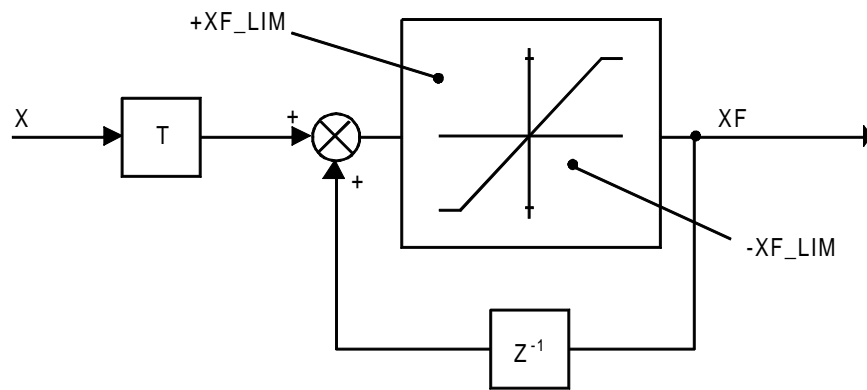


FIGURE 4.7.21-1.LIMITED_INTEGRATOR

4.7.22 QUAT_CALC

A. Function. QUAT_CALC is a procedure that forms a quaternion given an angle, ANG, and a unit vector, \bar{U} . The quaternion represents a coordinate frame rotation of ANG degrees about the unit vector \bar{U} (i.e., a transformation from one coordinate system to another). The call to QUAT_CALC is

CALL QUAT_CALC (ANG, \bar{U}) ASSIGN (XQ)

where \bar{U} is a unit vector, $\bar{U} = (U_1, U_2, U_3)$ and XQ is the quaternion in the structure of a scalar and a vector, $XQ = (XQS, XQV)$. A block diagram of QUAT_CALC is given in Figure 4.7.22-1.

B. Processing Requirements. The module QUAT_CALC is processed when invoked by a user.

C. Interface Requirements. The interface requirements for the module QUAT_CALC are given in Table 4.7.22-1.

D. Constants. The constant for RAD_PER_DEG = $\pi/180$ rad/deg is used.

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

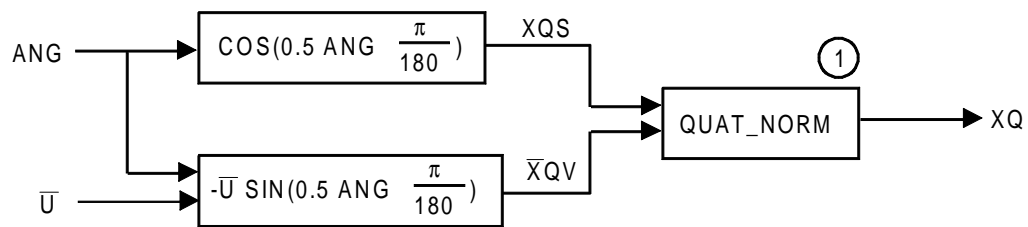
F. Detailed Technical Description.

$$XQS = \text{COS}(0.5 \text{ ANG RAD_PER_DEG})$$

$$XQV_1 = -U_1 \text{ SIN}(0.5 \text{ ANG RAD_PER_DEG})$$

$$XQV_2 = -U_2 \text{ SIN}(0.5 \text{ ANG RAD_PER_DEG})$$

$$XQV_3 = -U_3 \text{ SIN}(0.5 \text{ ANG RAD_PER_DEG})$$



NOTE

① $QUAT_NORM$ is described in Subsection 4.7.11

FIGURE 4.7.22-1. QUAT_CALC

Table 4.7.22-1. QUAT_CALC Interface Requirements						
Name	Description	Source or Destination	Type	Range	Units	Sample Rate (Hz)
<u>Inputs</u>						
ANG	Angle to rotate about unit vector, \bar{U}	CALLing prog	S	$\pm 180^\circ$	deg	once
\bar{U}	Unit vector about which to rotate by ANG	CALLing prog	S	–	–	once
<u>Output</u>						
XQ	Quaternion	CALLing prog	Struc: S, V	–	–	once

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APPENDIX R CHANGE AUTHORIZATION REFERENCES

R.1 CR REFERENCE SUMMARY

Table R.1-1. lists the paragraphs, tables (T), and figures (F) that have been changed as a result of approved change requests commencing with OI-26 up to the current OI. Changes incorporated prior to OI-26 are listed in the Historical Change Request Summary.

Table R.1-1. CR Reference Summary			
Paragraph	CR No.	OI	CR Title
N/A	92740D	30	STS 83-0002 and STS 83-0008V1 Errata Cleanup
	92955A	32	Expand Effectivity of PASS-only RTF SCRs to Include OI-32
	92958A	32	Expand Effectivity of PASS/BFS RTF SCRs to Include OI-32
	92973	32	Reassign Effectivity of SCRs 92542D & 92743D to OI-32
	92989	32	Reassign Effectivity of SCR 92858D to OI-32
4.2.2-1. (T)	92565A	30	SE RTLS Increased Pitch Authority Using Forward RCS Jets
	93012D	32	PASS 6X TRAJ Display Enhancement
4.2.2-2. (T)	91015C	26	Pitch Steering During SRB Tailoff
	91042A	26	Second Stage Pitch Gimbal Relief
	92186A	28	Single Engine RTLS Rolloff Elimination
	92522D	30	Overhaul MEDS Composite Flight Instrument Display
	92535B	30	Display Second SSME Failure Velocity
	92565A	30	SE RTLS Increased Pitch Authority Using Forward RCS Jets
	93012D	32	PASS 6X TRAJ Display Enhancement
4.2.3	93025B	32	Single Engine Throttle Back for NPSP Protection
	93064D	32	Errata Issue Clean-Up Part II
	92565A	30	SE RTLS Increased Pitch Authority Using Forward RCS Jets
	91042A	26	Second Stage Pitch Gimbal Relief
4.2.3-1. (F)	92186A	28	Single Engine RTLS Rolloff Elimination
	92535B	30	Display Second SSME Failure Velocity
	92565A	30	SE RTLS Increased Pitch Authority Using Forward RCS Jets
	93012D	32	PASS 6X TRAJ Display Enhancement
	93025B	32	Single Engine Throttle Back for NPSP Protection
	93068B	32	PASS 6X TRAJ Display Documentation Clean-up
	92535B	30	Display Second SSME Failure Velocity
4.2.4	92535B	30	Display Second SSME Failure Velocity
4.2.4-2. (T)	91015C	26	Pitch Steering During SRB Tailoff
	91016C	26	Extend Pitch Parallel To Meco

Table R.1-1. CR Reference Summary			
Paragraph	CR No.	OI	CR Title
4.2.4-2. (F)	92252B	28	Switchable NNY Filter
	92522D	30	Overhaul MEDS Composite Flight Instrument Display
	92535B	30	Display Second SSME Failure Velocity
	93012D	32	PASS 6X TRAJ Display Enhancement
	93025B	32	Single Engine Throttle Back for NPSP Protection
	91016C	26	Extend Pitch Parallel To Meco
4.2.4-2A. (F)	92252B	28	Switchable NNY Filter
	91016C	26	Extend Pitch Parallel To Meco
4.2.4-3. (F)	92252B	28	Switchable NNY Filter
	91016C	26	Extend Pitch Parallel To Meco
4.2.4-3. (T)	92252B	28	Switchable NNY Filter
4.2.4-4A. (T)	91016C	26	Extend Pitch Parallel To Meco
4.2.4-4B. (T)	93074A	33	MM102 Three Out SERC
4.2.4-4C. (T)	93074A	33	MM102 Three Out SERC
4.2.4-5. (T)	92252B	28	Switchable NNY Filter
	93074A	33	MM102 Three Out SERC
4.2.4-6. (T)	92252B	28	Switchable NNY Filter
4.2.5-1. (T)	92252B	28	Switchable NNY Filter
	92565A	30	SE RTLS Increased Pitch Authority Using Forward RCS Jets
	93012D	32	PASS 6X TRAJ Display Enhancement
4.2.5-2. (T)	93012D	32	PASS 6X TRAJ Display Enhancement
4.2.5-5. (T)	92565A	30	SE RTLS Increased Pitch Authority Using Forward RCS Jets
4.2.5-8. (T)	92252B	28	Switchable NNY Filter
4.2.5-9. (T)	92252B	28	Switchable NNY Filter
4.2.5-10. (T)	92252B	28	Switchable NNY Filter
4.2.5-1E. (F)	92252B	28	Switchable NNY Filter
4.2.5-2. (F)	92252B	28	Switchable NNY Filter
4.2.5-11. (F)	92252B	28	Switchable NNY Filter
4.2.6-2. (T)	91016C	26	Extend Pitch Parallel To Meco
	91018B	26	Ascent Dap Trim For Performance
4.2.6-3. (F)	91018B	26	Ascent Dap Trim For Performance
4.2.6-3. (T)	91018B	26	Ascent Dap Trim For Performance
	91042A	26	Second Stage Pitch Gimbal Relief
4.2.6-5. (T)	91016C	26	Extend Pitch Parallel To Meco

Table R.1-1. CR Reference Summary			
Paragraph	CR No.	OI	CR Title
4.2.6–6. (F)	91016C	26	Extend Pitch Parallel to Meco
	91018B	26	Ascent Dap Trim For Performance
4.2.9–1. (F)	91018B	26	Ascent Dap Trim For Performance
	92186A	28	Single Engine RTLS Rolloff Elimination
4.2.9–1. (T)	91018B	26	Ascent Dap Trim For Performance
4.2.9–2. (T)	91018B	26	Ascent Dap Trim For Performance
	92186A	28	Single Engine RTLS Rolloff Elimination
4.2.9–3. (F)	91018B	26	Ascent Dap Trim For Performance
4.2.9–3. (T)	91018B	26	Ascent Dap Trim For Performance
	91054B	26	SRB Separation Yaw Gain Enhancement
	92670D	30	Abort Improvements to Improve TAL Performance
	92889	30/3 2	Remove Abort PE Engine-Out SSME Pitch Trim
	92920A	30/3 2	Eliminate Undesirable Roll Attitude Error Bias
4.2.9–3A. (F)	91018B	26	Ascent Dap Trim For Performance
4.2.9–3C. (F)	91018B	26	Ascent Dap Trim For Performance
	92670D	30	Abort Improvements to Improve TAL Performance
	92889	30/3 2	Remove Abort PE Engine-Out SSME Pitch Trim
4.2.9–4. (T)	91054B	26	SRB Separation Yaw Gain Enhancement
4.2.9–7. (F)	91054B	26	SRB Separation Yaw Gain Enhancement
	92186A	28	Single Engine RTLS Rolloff Elimination
4.2.10	92565A	30	SE RTLS Increased Pitch Authority Using Forward RCS Jets
4.2.10–1. (T)	92565A	30	SE RTLS Increased Pitch Authority Using Forward RCS Jets
4.2.10–2. (T)	92565A	30	SE RTLS Increased Pitch Authority Using Forward RCS Jets
4.2.10–4. (T)	92565A	30	SE RTLS Increased Pitch Authority Using Forward RCS Jets
4.2.10–1. (F)	92565A	30	SE RTLS Increased Pitch Authority Using Forward RCS Jets
4.2.10–3. (F)	92565A	30	SE RTLS Increased Pitch Authority Using Forward RCS Jets
4.2.11–1. (T)	91015C	26	Pitch Steering During SRB Tailoff
	92067D	27	Three String GPS Capability
	92354	27	Delete Erroneous TLM Destinations
	92208C	28	GPS Issues for Correction on OI-28
	92306A	28	Orbiter Window Protection
	92225A	29	ET SEP Switch Default to Auto on a TAL Abort

Table R.1-1. CR Reference Summary			
Paragraph	CR No.	OI	CR Title
4.2.11-2. (T)	92350A	29	Fails OPS/Fail Safe SSME Repositioning for Drag Chute
	92355B	29	GPC Major Mode to MEDS
	92578B	29	Correction for ET SEP Switch Default
	92504G	30	Alleviate ET Recontact for RTLS 2EO Yellow and Orange Regions
	92522D	30	Overhaul MEDS Composite Flight Instrument Display
	92565A	30	SE RTLS Increased Pitch Authority Using Forward RCS Jets
	92670D	30	Abort Improvements to Improve TAL Performance
	92542D	32	Deletion of LO2 Step Pressurization CMDS
	92950	32	G/C Steer Roll Bias Ramp at PPD or MECO
	93012D	32	PASS 6X TRAJ Display Enhancement
	93025B	32	Single Engine Throttle Back for NPSP Protection
	93023D	32	OI-32 Remote Control Orbiter Capability
	93064D	32	Errata Issue Clean-Up Part II
	93087E	33	RTLS ET Separation Improvements
	93090E	33	Bearing Displays
	91051K	26B	Streamlined Shuttle GPS Capability
	92025B	26B	Onorbit TACAN Deletion
	92354	27	Delete Erroneous TLM Destinations
	92157	28	IDD Clarification to Remove Blanks from FSSR Names
	92186A	28	Single Engine RTLS Rolloff Elimination
4.2.11-3. (T)	92522D	30	Overhaul MEDS Composite Flight Instrument Display
	92535B	30	Display Second SSME Failure Velocity
	92565A	30	SE RTLS Increased Pitch Authority Using Forward RCS Jets
	93012D	32	PASS 6X TRAJ Display Enhancement
	93025B	32	Single Engine Throttle Back for NPSP Protection
	93064D	32	Errata Issue Clean-Up Part II
	91013D	26	Convert Second Stage Trim K-Loads to I-Loads
	91018B	26	Ascent Dap Trim For Performance
	91054B	26	SRB Separation Yaw Gain Enhancement
	92227	27	Recategorization of DOLILU II I-Loads in A1N, A1S and A1T
4.2.11-3. (T)	92243A	27	A1S & A1T I-Load Dependency Change
	92252B	28	Switchable NNY Filter
	92565A	30	SE RTLS Increased Pitch Authority Using Forward RCS Jets

Table R.1-1. CR Reference Summary			
Paragraph	CR No.	OI	CR Title
4.2.11-4. (T)	91013D	26	Convert Second Stage Trim K-Loads to I-Loads
4.3.2-1. (T)	92504G	30	Alleviate ET Recontact for RTLS 2EO Yellow and Orange Regions
	92950	32	G/C Steer Roll Bias Ramp at PPD or MECO
	93012D	32	PASS 6X TRAJ Display Enhancement
	93087E	33	RTLS ET Separation Improvements
4.3.3-1. (F)	93087E	33	RTLS ET Separation Improvements
4.3.3-2. (F)	92186A	28	Single Engine RTLS Rolloff Elimination
4.3.4-1. (T)	92186A	28	Single Engine RTLS Rolloff Elimination
	92504G	30	Alleviate ET Recontact for RTLS 2EO Yellow and Orange Regions
	92535B	30	Display Second SSME Failure Velocity
	92950	32	G/C Steer Roll Bias Ramp at PPD or MECO
4.3.4-1.(2) (F)	93087E	33	RTLS ET Separation Improvements
	93012D	32	PASS 6X TRAJ Display Enhancement
	93087E	33	RTLS ET Separation Improvements
4.3.4-2. (T)	92186A	28	Single Engine RTLS Rolloff Elimination
	92504G	30	Alleviate ET Recontact for RTLS 2EO Yellow and Orange Regions
	93087E	33	RTLS ET Separation Improvements
4.3.4-3. (T)	92186A	28	Single Engine RTLS Rolloff Elimination
	93087E	33	RTLS ET Separation Improvements
4.3.4-4.(2) (F)	93087E	33	RTLS ET Separation Improvements
4.3.4-4A.(4) (F)	92504G	30	Alleviate ET Recontact for RTLS 2EO Yellow and Orange Regions
	92504G	30	Alleviate ET Recontact for RTLS 2EO Yellow and Orange Regions
4.3.4-4B.(1) (F)	92504G	30	Alleviate ET Recontact for RTLS 2EO Yellow and Orange Regions
4.3.4-4B.(4) (F)	92504G	30	Alleviate ET Recontact for RTLS 2EO Yellow and Orange Regions
4.3.4-6. (F)	92186A	28	Single Engine RTLS Rolloff Elimination
4.3.4-6.(1) (F)	92950	32	G/C Steer Roll Bias Ramp at PPD or MECO
4.3.4-6.(2) (F)	92535B	30	Display Second SSME Failure Velocity
	92950	32	G/C Steer Roll Bias Ramp at PPD or MECO
4.3.4-7. (F)	92186A	28	Single Engine RTLS Rolloff Elimination
4.3.5-1. (T)	91051K	26B	Streamlined Shuttle GPS Capability

Table R.1-1. CR Reference Summary				
Paragraph	CR No.	OI	CR Title	
4.3.5-3. (T)	92025B	26B	Onorbit TACAN Deletion	
	92067D	27	Three String GPS Capability	
	92144C	27	Three String GPS Documentation Cleanup	
	90704F	28	DAP Hotstick Downmode Alert and Message	
	90914C	28	Delay MOV MPS Dump/FRCS Dump at MM602	
	92186A	28	Single Engine RTLS Rolloff Elimination	
	92353D	29	Automated Alpha-Beta Management During Mated Coast & MM104	
	92355B	29	GPC Major Mode to MEDS	
	92404B	29	Preserve MECO Vi, Altitude, & Altitude Rate in MM104	
	92504G	30	Alleviate ET Recontact for RTLS 2EO Yellow and Orange Regions	
	92522D	30	Overhaul MEDS Composite Flight Instrument Display	
	92535B	30	Display Second SSME Failure Velocity	
	92565A	30	SE RTLS Increased Pitch Authority Using Forward RCS Jets	
	92619A	30	Correction CR for CR 92522D	
	92676B	30	CR 92522D / CR 92619A Correction CR	
	92909A	30/3	ET Camera Power Control Commands	
	92950	32	G/C Steer Roll Bias Ramp at PPD or MECO	
	93012D	32	PASS 6X TRAJ Display Enhancement	
	93025B	32	Single Engine Throttle Back for NPSP Protection	
	93023D	32	OI-32 Remote Control Orbiter Capability	
	93087E	33	RTLS ET Separation Improvements	
	93090E	33	Bearing Displays	
	4.3.5-5. (T)	92186A	28	Single Engine RTLS Rolloff Elimination
		92504G	30	Alleviate ET Recontact for RTLS 2EO Yellow and Orange Regions
		92522D	30	Overhaul MEDS Composite Flight Instrument Display
		93087E	33	RTLS ET Separation Improvements
91051K		26B	Streamlined Shuttle GPS Capability	
92332D		30	Add Theta Limits Bracket to MEDS ADI Displays	
92522D		30	Overhaul MEDS Composite Flight Instrument Display	
92389C	29	Spiral HAC in TAEM Area Navigation		
	93090E	33	Bearing Displays	

Table R.1-1. CR Reference Summary

Paragraph	CR No.	OI	CR Title
4.6.2-1. (T)	91051K	26B	Streamlined Shuttle GPS Capability
	92144C	27	Three String GPS Documentation Cleanup
	92353D	29	Automated Alpha-Beta Management During Mated Coast & MM104
	92332D	30	Add Theta Limits Bracket to MEDS ADI Displays
	92504G	30	Alleviate ET Recontact for RTLS 2EO Yellow and Orange Regions
	92522D	30	Overhaul MEDS Composite Flight Instrument Display
	92619A	30	Correction CR for CR 92522D
	92676B	30	CR 92522D / CR 92619A Correction CR
	93012D	32	PASS 6X TRAJ Display Enhancement
	93023D	32	OI-32 Remote Control Orbiter Capability
4.6.2-2. (T)	91051K	26B	Streamlined Shuttle GPS Capability
4.6.2-3. (T)	92144C	27	Three String GPS Documentation Cleanup
	92619A	30	Correction CR for CR 92522D
4.6.2-7. (T)	91051K	26B	Streamlined Shuttle GPS Capability
4.6.3-1. (F)	92144C	27	Three String GPS Documentation Cleanup
	92504G	30	Alleviate ET Recontact for RTLS 2EO Yellow and Orange Regions
	92522D	30	Overhaul MEDS Composite Flight Instrument Display
	92619A	30	Correction CR for CR 92522D
	93023D	32	OI-32 Remote Control Orbiter Capability
4.6.4.2	91051K	26B	Streamlined Shuttle GPS Capability
	92144C	27	Three String GPS Documentation Cleanup
4.6.4.2-1. (F)	91051K	26B	Streamlined Shuttle GPS Capability
4.6.4.3	93023D	32	OI-32 Remote Control Orbiter Capability
4.6.4.3-1. (F)	93023D	32	OI-32 Remote Control Orbiter Capability
4.6.4.4	91051K	26B	Streamlined Shuttle GPS Capability
	92144C	27	Three String GPS Documentation Cleanup
	92504G	30	Alleviate ET Recontact for RTLS 2EO Yellow and Orange Regions
	92522D	30	Overhaul MEDS Composite Flight Instrument Display
	92619A	30	Correction CR for CR 92522D
	92676B	30	CR 92522D / CR 92619A Correction CR
4.6.4.4-1. (F)	91051K	26B	Streamlined Shuttle GPS Capability

Table R.1-1. CR Reference Summary			
Paragraph	CR No.	OI	CR Title
4.6.5-1. (T)	92144C	27	Three String GPS Documentation Cleanup
	92504G	30	Alleviate ET Recontact for RTLS 2EO Yellow and Orange Regions
	92619A	30	Correction CR for CR 92522D
	92676B	30	CR 92522D / CR 92619A Correction CR
	91051K	26B	Streamlined Shuttle GPS Capability
	92025B	26B	Onorbit TACAN Deletion
	92067D	27	Three String GPS Capability
	92144C	27	Three String GPS Documentation Cleanup
	92297B	27	Delete Erroneous TLM Destinations for NAV
	90704F	28	DAP Hot-Stick Downmode Alert and Message
	90724D	28	OPS 6 Entry ECAL Automation
	90914C	28	Delay MOV MPS Dump/FRCS Dump at MM602
	92329E	29	Onboard Calculation of RNP Matrix
	92353D	29	Automated Alpha-Beta Management During Mated Coast & MM104
	92355B	29	GPC Major Mode to MEDS
	92404B	29	Preserve MECO Vi, Altitude, & Altitude Rate in MM104
	92504G	30	Alleviate ET Recontact for RTLS 2EO Yellow and Orange Regions
	92522D	30	Overhaul MEDS Composite Flight Instrument Display
	92565A	30	SE RTLS Increased Pitch Authority Using Forward RCS Jets
	4.6.5-2. (T)	92950	32
93012D		32	PASS 6X TRAJ Display Enhancement
93023D		32	OI-32 Remote Control Orbiter Capability
93090E		33	Bearing Displays
93100C		33	OI-33 Remote Control Orbiter Capability Enhancement
91051K		26B	Streamlined Shuttle GPS Capability
92144C		27	Three String GPS Documentation Cleanup
92353D		29	Automated Alpha-Beta Management During Mated Coast & MM104
92332D		30	Add Theta Limits Bracket to MEDS ADI Displays
92522D		30	Overhaul MEDS Composite Flight Instrument Display
92619A	30	Correction CR for CR 92522D	
92676B	30	CR 92522D / CR 92619A Correction CR	

Table R.1-1. CR Reference Summary			
Paragraph	CR No.	OI	CR Title
4.6.5-3. (T) 4.6.5-5. (T)	93090E	33	Bearing Displays
	93090E	33	Bearing Displays
	91051K	26B	Streamlined Shuttle GPS Capability
	92389C	29	Spiral HAC in TAEM Area Navigation
	92332D	30	Add Theta Limits Bracket to MEDS ADI Displays
	92522D	30	Overhaul MEDS Composite Flight Instrument Display
4.7.18	93090E	33	Bearing Displays
	92858D	32	Eliminate GPC Error Exposure from QUAT_TO_EULER

R.2 HISTORICAL CHANGE REQUEST SUMMARY

Table R.2-1. is an historical record of approved change requests incorporated since the initial baseline up to OI-25. Change requests commencing with OI-26 are reformatted and listed in the CR Reference Summary.

Table R.2-1. Historical Change Request Summary		
CR No.	OI	CR Title
2265B		Add IMU Align Capability to OPS 3
2313A		Addition of TLM Requirements
2340		Revision to the Processing and Display of Attitude Data Addition of GN&C/SM-PL IF(4.111) to GNC OPS 3 for GNC
2433C		OPS 3/SM OPS 2 Operation
2449D		OFT Contingency Abort Requirements
2492B		Vehicle Mass Definition Inconsistency
2494C		LVL A Downlist Requirements (Entry) (Add PSI to D/L)
2580		Modification to Linear Interpolations (INTERPS)
12000B		Ascent Flight Control FSSR PF I/O Table Update
12001		Addition of Pitch Attitude Tape Scale to Vertical Sit Dipoles
12004		Delete Fader GRTLS in Ascent Flight Control
12005		Statement Level Simulator (SLS). Update of A/E ATT_PROC
12006A		Format Caution, HAL Convention
12019		Standardization of FSSR Principal Function I/O Tables
12025		Statement Level Simulator (SLS) Update of GC_STEER Initialization Requirements

Table R.2-1. Historical Change Request Summary		
CR No.	OI	CR Title
12030		Statement Level Simulator (SLS) Update of GC_STEER and ASC_DAP
12035		Staging INTERPS Change
12056		Ascent/entry attitude processor Formulation Corrections
12058		IMU Gimbal Angle Time Tab
12105		Reinstate Mass and Mass Rate Fill of PEG Output in Second Stage
12106B		Format Caution, HAL Convention, and Make Work Correction of Utility Functions
12177B		Dedicated Display Rate Reductions
12211A		Ascent and Transition DAP Overlap Problem Resolution
12218		Aero Actuator Command SOP Ascent Rate Scrub
12225B		GN&C Level C Uplink Requirements
12227		INTERPS NYREF Simplification
12250A		Delete SRB Vector Limiting
12252A		I-Load for INIT ADI Reference Quaternion
12267A		Quaternion Utility Functions Updated and Made Re-entrant
12269		MSID Corrections to IDD Tables
12311A		Delete Priority Rate Limiting in MM102
12313B		Addition of TLM Requirements
12314B		Attitude Sample Rate Reduction for Ascent
12316		GN&C Switch RM Processing Rate Reduction
12317		A/E ATT PROC Rate for TRANS DAP
12318		Simplify Sideslip Computation
12334		Elimination of Interface Between Deorbit DIP and TRANS DAP
12336		I-Load OFT-1 Baseline
12337		I-Load OFT-1 Baseline
12339		I-Load OFT-1 Baseline
12404A		Proposed FCS 9 and Changes to Ascent FSSR and CR 12030
12407B		Addition of Trans Port Delay Compensation to Antenna Arrangement
12411B		OMS Engine FDI Simplification (Remove ACCUM_DELTA_V0)
12423A		Changes to the Ascent/RTLS and Entry Navigation FSSR's to Obtain Attitude Data for A/E Precise Predictor
12432A		Mods to Area Nav PF per Crew Assessment Working Group (Delete HEADVALID)
12442		Integrated Entry/Navigation, Ascent Navigation, and Orbit Navigation Interface Requirements
12468B		Aeroject DAP Roll/Yaw Update
12474B		Reduce IMU Velocity Processing Rate (Scrub Item I-106)
12490		Attitude Sample Rate Reduction for Ascent and Entry

Table R.2-1. Historical Change Request Summary		
CR No.	OI	CR Title
12499D		Manual Landing SOP
12519		Change From Yaw to Three-Axis Attitude Hold
12521A		Variable IY Targeting (STS-3)
12557		RTLS Mated Coast and -Z Translation Guidance
12570		Rate Command/Attitude Hold Mode for Ascent
12586		Integrated Signal Interfaces for 6.35, 6.46, and Associate Maneuver DIP's
12600C		Integrated MSID Assignment for Uplink, D&C, and GN&C Requirements for OPS 1, 2, 3, 6, and 9
12624		Software Modifications Required to Support MCR 4598 (Flight Control Switch Modification)
12645A		ATT PROC, ADI and HSI Modifications for Ascent Powered Flight
12665		Determination of ASC/Entry ATT PROC ILOAD Value for DTIMU
12683		Replacement of Bank Angle With Body Roll Angle
12689B		Commanded Body Attitude During OMS Burns
12693B		ADI and IMU Quaternion Availability for Telemetry
12770		BF Command RM
12846		Change MPS Gains for RTLS Powered Pitchdown
12896		ET Separation Sequence Cleanup
12899		Ascent FCS FSSR Cleanup
12907		GC-STEER Derived Rate Calculation
12920B		GRTLS DAP Lash-Up (Add GRTLS DAP as destination of ALPHA_N)
12927		Deletion of the Simplification to Sideslip Computation (CR 12318)
12950		Three-Axis RHC Scheduling in Ascent
12972		I-Load Changes for Ascent DAP
12982		ASC DAP ILOAD Update
12983		Last Chance I-Load for 12-11 Drop FCS
12993		I-Loads Version FACI
12994		I-Loads OFT-1 FACI Update
19022		Modifications to 9-4-78 and 12-11-78 MPAD ILOAD Paper Baseline of 9-21-78
19038		Resolution of I-Load Data Base Discrepancies
19039		Ascent/Entry Structural PTI's
19045A		MPAD I-Load Update for Cycle 2
19054		Mods to 9/14/78 & 12/11/78 I-load Paper Baseline of 9/21/78. (Non-MPAD)
19067A		Modifying Attitude Errors With Acceleration Errors for Monitoring Load Relief Performance

Table R.2-1. Historical Change Request Summary		
CR No.	OI	CR Title
19069A		Resolution of I-Load Ambiguities and Errors
19084A		Removal of Crosswind Compensation
19096		Modification to W Bias Computation Logic (CR 12689B)
19097A		Additions to MPAD I-Load Update for Cycle 2
19100		Interim Change Requests for PCN1
19101A		I-Load Corrections for Ascent FCS
19136		Simplify Sideslip Computation
19167B		REL NAV Display Interface Correction
19177A		Extinguish PBI Lamps at Terminations of Ascent DAP
19179		Transition DAP/RCS SOP Rate Reduction
19183A		Fast Separation Attitude Control
19200		Redundant I-Load: TNBBODY
19204		Ascent Flight Control FCS10, Second Stage
19205		GC_STEER and ASC DAP I-Load Corrections
19277		MPS TVC Gravity Initialization
19280		Three-Engine-Out RCS Roll Control
19302		Deletion of Transition Mode in ATT_PROC During RTLS
19326		Modification of GC_STEER Sequencing Requirements
19329		Exempt Interps From "Unscheduled Execution of Low Rate Module" Reqmt. In Para.4.1.3.C
19331		Corrections in the Attitude Processor Inner Loop Processing
19333A		Modifications to IDD Requirements for Ascent Flight Control
19364		FCS10 I-Load Ascent Flt. Control, First & Second Stages
19374		Attitude Error Limit for Manual Guidance
19389A		Attitude Processor I-Load Corrections (STS-1, Cycle 2)
19394C		I-Load Data Tape Corrections
19395		OV-102 IMU/ST I-Load Update for KSC (VU-5)
19397		Incorrect Requirements in an Approved GC-STEERCR
19409A		COAS Mark/ADI PB Interface
19415A		Correct I-Load CR's
19431		Sign Error in Ascent Manual Guidance
19441		Correct ADI Error Needles to "Fly-To" Reference
19448		ADI Error Needles During Ascent
19452B		I-Load Correction Necessary for 3/19 Release
19455		Measurement Attribute Corrections
19465		ADI Error Needles During RTLS
19484A		I-Loads Data Tape Corrections From Community Review

Table R.2-1. Historical Change Request Summary		
CR No.	OI	CR Title
19488A		IMU Rate Change (V_IMU_CURRENT Input at 1.04 Hz)
19536		Corrections to MPS Actuator Rate Limiting
19581B		Corrections to I-Load Paper Baseline – STS1 (2) (Corrections to CR 19394C)
19601		Correction and Clarification of the RGA Prefilter Module in the Ascent/entry attitude processor
19611A		Provide Time Homogeneous Data to NAVDAD SOP
19614A		Corrections to the Rate Bias Estimator Computation of the Ascent/entry attitude processor Inner Loop (STS–2)
19617		Delete GNC/SM Payload Angles From ATT_PROC During OPS 1
19713		Make Work Correction to CR 19280 (3 Eng out RCS Control) and CR 12899A (Ascent FSSR Clear Up–RCS Control)
19882		Additional FRF Unique I-Load Parameter
19888		I-Load Change to Fix Incorrect Implementation of CR 19101A
19900		FSSR Update No. 5
29958A		Ascent Flight Control Documentation Cleanup
19931C		Preserve Uplink ADI Ref. Quats Across OPS Transitions
19989		Documentation Clean-up for the ASCENT/entry attitude processor
29003A		Alpha–Mach Indicator Update Rate Change to the VERT SIT 1 Display (STS–1)
29046B		FCS Switch Nomenclature Change in Compliance With MCR 5949
29067		SRB I-Load Changes
29093E		MPAD I-Load Update No. 1 for STS–1 Cycle 3
29094D		MPAD I-Load Update No. 2 for STS–1 Cycle 3
29096C		Standardized Math Model IMU I-Loads (1)
29102A		Correct MOD A of CR 19958 (STS–1)
29142B		MPAD I-Load Update No. 4 for STS–1 Cycle 3
29149B		Add Program Interrupt, Level A CPDS
29152A		QUAT_TO_ADI Singularity Avoidance
29159A		Ascent FC I-Loads
29172		SSME Start in Null Position
29283A		No Rate Feedback to Ascent DAP for Fast Sep
29294		ATT_PROC Cycle–3 I-Load Correction (STS–1)
29296		Engine Out I-Load Update for STS–1 Cycle 3
29356A		Entry FCS FSL Verification Anomalies Update No.1
29417A		Modification of CR 29356A I-Load Changes
29448A		Spare for IMU 3 in OV–102 (2) (S/N 10 in POS 3) Matrix
29450A		Correct Rate – CAPABILITY – NO FAILS

Table R.2-1. Historical Change Request Summary		
CR No.	OI	CR Title
29500		FSSR Update No. 7
29612A		Opposing RHC Deflections
29620		Mod CR 29560 Quaternion I/L
29655		MSC Constants and I-Loads (1) (Level B Changes)
29800		FSSR Update No. 8
29471B		HFE Overrun Definition
29750A		SRB ATVC FDIR at SRB Ignition
29798		SSME/OMS Clearance Problem
29915		SSME/OMS Interface
39000		FSSR Update No. 9
19988A		Aerosurface Limit Cycle During LOA
29053A		Remove First VREL Breakpoints
29112A		Delete CR 12866A
29114		Delete CR 19448 (ADI Error Needles During Ascent) STS-2
29692B		A/E and ORB ATT PROC Cold Start
29694B		STS-1 Cycle 3.1.1 MPAD Abort I/L
29700		Matching I/L for Standard IMU
29715A		Ascent HSI Moding Change
29762A		ATT_PROC IDD Cleanup
29895B		Update GN&C/SM-PL I/F Requirements
29908B		3.1.1 I/L Changes for RTLS
29938		STS-1 Cycle 3.2.2-AOA to Edwards
29982C		Ascent ADI Reference RELMAT
39085		First-Stage SSME Out Prof I/L
39188		Quat for IMU 21 in Pos 1 (1)
39189		Quat for IMU 21 in Pos 2 (1)
39192		Cycle 3.3.3 I/Loads (1)
39218A		Cycle 3.3.3 MPAD I/L - Abort (1)
39246		Elevon Schedules for Ascent (1)
39276A		IMU S/N 12 I-L/Pos1/VAB, PAD (1)
39277A		IMU S/N 12 I-L/Pos2/VAB, PAD (1)
39278A		IMU S/N 12 I-L/Pos3/VAB, PAD (1)
39280A		STS-2 Cycle I Nom Asc & 10 (1)
39292		IMU S/N 21-Pos 3 I/L - R 18 (1)
39304		IMU 12-Pos 1 - Quaternions (1)
39305		IMU 12-Pos 2 - Quaternions (1)
39306		IMU 12-Pos 3 - Quaternions (1)

Table R.2-1. Historical Change Request Summary		
CR No.	OI	CR Title
39323A		STS-2 Cycle 1 MPAD ABORT I/L (2)
39355		STS-2 Ascent Mass & TRIM I/L (1)
39431A		ADI Error from Q-B-I-CMD (1)
29731A		SSME & SB Posn-Recycle Count
39087A		Head Up Display (HUD)
39163		Ascent ADI Reference Relmat
39365F		HUD PROC I/O Cleanup
39401A		Transatlantic Abort Landing
39467A		DR Closeout-DOC Cleanup
39530F		STS-2 Cycle 2 I-Loads (2)
39543		IMU S/N 20 I/L Pos 3/VAB, DAD(1)
39660		Elevon Load Relief Correction
39950		FSSR Update
29490C		RCS Vernier Leak Detection
59006		Clearing OMS Gimbal Trim CMD
39899		On-Orbit Auto Maneuver
39590B		RUDDER/SB Hinge Interfer - G1 & G3
39983A		Flight Control I/L IUS P/L
59450		FSSR Update
59218		CORR ASC/ENT & Orb ATT_PROC
59095A		First-Stage Engine-2 Out Guidance
59279A		SSME Pitch Parallel Second Stage
39092		Unfreeze ADI Yaw Axis
39875		TAL Abort Wings Level
397731		Delete FCS Downmoding
39640		FSSR Update No. 11/18 and No. 3/19
39950		FSSR Update No. 12/18 and No. 3/19
59267C		Adaptive First Stage Guidance (ref only)
39700D		Ent/GRTLS FCS Gain + Aero Mode (ref only)
39958A		IMU S/N 1 I-Load, Slot 2 (ref only)
59261		STS-5 CY 5 Ascent Abort I-Loads (ref only)
29886G		MVRR EXEC DISP/DPIS UPDT
39803C		Launch Delay Window
59253A		Corrections to CR 39803C
59324A		HUD A/L Monitor Clean-up
39954		IMU S/N 7 I-LOAD, SLOT 1 OV-099 (I-loads only)
59631		STS-9 CY 1 ASC ABORT I-LOADS (STS-9 I-loads only)

Table R.2-1. Historical Change Request Summary		
CR No.	OI	CR Title
59735A		1st STG Roll Rate LIM I/L (I-loads only)
69088		STS 9.3 Option B Ascent IL's (STS-9 only)
29786A		Single ME Control Enhancement
39687		CR 39503 Ascent DAP Correction
59653A		Delete Ascent MSID (Ref only)
59749		Correct CR 29786A – Single SSME
69372		Disable 2nd STG Pitch Parallel (11-only)
69485		Disable 2nd STG Pitch Parallel (13-only)
69519		PRE-IMRB RI I/L Ownership (Ref only)
69528		Parallel Pitch Off Occurrence (IMRB)
69649		Pitch Parallel Early IMPL (16-only) *See Appendix E for Requirements (CR 69441A).
69700		FSSR Update
59245A		Stable ATT-IMU CF, OPS Change
59653A		Delete Ascent MSID (Reference only)
59764E		OPS 101 SSME TVC ACT CMD UTIL
69441A		2nd-Stage Pitch Parallel Mod
69599C		Supplement CR's 59245A/69200A
69717A		Bending Filter for FWC SRB's
69890B		ASC ENT ATT PROC Doc Cleanup (IDD only)
59954		I-Load Scrub: Star Tracker
59955		I-Load Scrub: Power Guidance
69555A		TAL/RTLS Weather Alternate
69833A		LVLH ATT Independent of ADI
79167A		Code Change for FWC SRB's
79209B		FWC SRB Timing (Ref Only)
79377		Ascent Scrub FCS Downmode
79505		Inhibit Inadvertent Roll Reversals in MM 103
79643A		OMS Dump W/3 SSMEs Failed
79705		Ascent HSI Oscillation Correction
79767F		Revision GRTLS DAP Logic, ET SEP
79790A		CR Implementation Baseline – November 1985
79933F		Vent Door SEQ Scrub CR
79935H		SRB RGA Rechannelization
79967G		ZF32, ZF42, I/L to K-Loads
89132D		APU Failure DAP Moding
89165H		MPS Feed DISC Latch Logic

Table R.2-1. Historical Change Request Summary		
CR No.	OI	CR Title
89219B		Auto/Loft First Stage Cont Cleanup
89245D		Post-MECO TAL Declaration
89250B		Bailout Control System
89251B		IMU RM K-Loads to I-Loads
89366B		FSSR Errata STS 83-0008A, Vol. 1
89408A		Scrub EST Beta ATT_PROC
89413B		Dir Check Auto MM601-2 Trans
89461A		FSSR STS 83-0002B/Errata B/L
89474B		AUTO NZ for Contingency Abort
89494A		FSSR 10 Errata Document Cleanup
89495B		FSSR STS 83-0008B Volume 2 8B Errata
89498C		FSSR STS 83-0008B Volume 1 Errata
89545A		STS83-0013B 8B Errata B/L
89553A		Elev Null Position Fader for PRESEP
89598A		OI-8B Sequencing FSSR Errata
89599C		Cleanup Level B GN&C Document
89615		Document change ASC DAP Roll Mix Logic
89622A		I/L Changes STS83-0003B
89655E		First Stage Guidance/Interps Redesign
89662B		FSSR STS 83-0003B Errata Update
89672A		STS 83-0014B Volume 1 PCN-1 Errata
89674E	22	Entry FCS I / L – K / L Conversion
89688B		FSSR STS 83-0008B Volume 1 Errata
89740B		FSSR 7 OI-8B PCN-1 Errata
89741B		Errata STS 83-0010B
89801		Define Local Event/Fade Elevon Before PRESEP
89844B		Correct CR 89655E Fir Stage Guidance/Interps
89865A		Clarify Late Slew Check Requirements
89728B		B/L System Software CPDS
89903B		Add Fuel Dissipation Reference to MM601
89986H	22	OPS-1 IMU Alignment
89990E	21	Single Engine Auto Contingency Abort
90011E	22	Second Stage Engine Out Trim Algorithm
90054A		Entry FCS Errata
90055A		Cleanup to Guidance/Interps CR 89655E
90072	20	UPD Dis Runway Names Upon Runway Sel
90112E	21	EDO WOW Sensing Upgrades

Table R.2-1. Historical Change Request Summary

CR No.	OI	CR Title
90114B	21	Abort Sequencing Redesign
90115		Documentation Cleanup for 510 Level B CPDS
90182	21	SCM Scrub Completion
90185A	20	Add CR Field to FSSR I/O Tables
90221		Change TLAMC From MET to GMT
90243C	22	Second Stage Auto Recognition
90256D	23	Mission Independent First Stage I-Loads
90336	21	Roll Mix Logic Clarification to CR 89990E
90366C	22	Single Engine Cntrl Improvements in MM103
90374C	20	Automated FSSR Constants
90405	22	New Auto Discrete Def for Cont Aborts
90440B	22	Thrust Auto Direction Filter Init Correction
90476F	25	Wraparound Yaw Jet System w/PTI Effector
90517C	24	GRTLS Mated Coast Pitch/Roll Command Update
90543A	22	Doc-Cleanup, Radians to Degrees Conversion for Trim Thrust Angles
90550	22	Correct CR 90122, Inhibit PEG Steering When DROOP CNTL is Active
90576A	21	Clean up of CR 89990E, Single Engine Auto Contingency Abort
90646C	24	Replace S_GDRDY With GUIDANCE_INITIATE on TLM
90650	23	Corrections to CR 90256D
90690A	24	Deletion of EQTN MSID column from K-Load FSSR tables
90705H	25	3 Engines Out Auto Contingency
90714	23	Initialize Q_B_I_CMD Display to Zero at REFS_RDY
90781C	24	Define Parametric Data Nomenclature(s)
90790	24	Add Memory Configuration to the FSSR I-Load Tables
90814C	24	Add Description Of Database Generated FSSR Parameter Tables
90827A	22	Initialize 3-Axis RHC SOP Detent and Softstop Parameters
90887	24	FSSR STS83-0008-1 Documentation Changes
90893C	24	Ascent Flight Control FSSR-8 Vol 1 Corrections
90964	25	Interface Clarification for 3 Engines Out - CR90705H
90966A	24	Deletion of the Qualifier from the FSSR I-Load Tables
91066D	25	Standardize the FSSR Correlation Tables
91072D	24	OI-24 GN&C Doc Issues Cleanup
91091A	24	Cleanup of CR 90243C, Second Stage Auto Recognition of Second Engine Out
91099	25	3 Engines Out Downmode Correction
92027B	25	TDMS 2 Required FSSR Changes