NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

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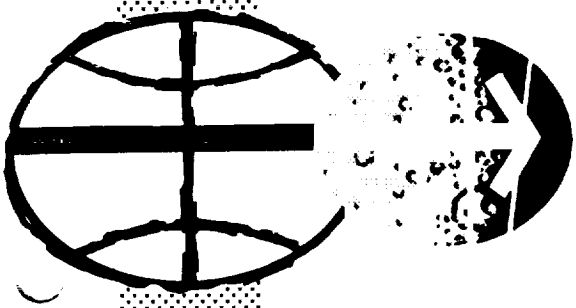
PROGRAMMED GUIDANCE EQUATIONS FOR LUMINARY IC MANNED LM EARTH ORBITAL AND LUNAR PROGRAM

By Flight Software Branch

FLIGHT SUPPORT DIVISION

MANNED SPACECRAFT CENTER
HOUSTON, TEXAS



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PROGRAMMED GUIDANCE EQUATIONS

for

LUMINARY 1C

MANNED LM EARTH ORBITAL

AND LUNAR PROGRAM

Prepared by

Flight Software Branch

FLIGHT SUPPORT DIVISION

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

MANNED SPACECRAFT CENTER

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UNCLASSIFIED

Page Change Record

This document is a complete re-issue of MSC Internal Note No. 69-FS-3, "Programmed Guidance Equations for LUMINARY 1A Manned LM Earth Orbital and Lunar Program," dated May 1969, updated to reflect the information in the LUMINARY 1B program to be flown on the Apollo H1 mission.

Revision A

Revision A to MSC Internal Note No. 69-FS-6, "Programmed Guidance Equations for LUMINARY 1C Manned LM Earth Orbital and Lunar Program," contains the following:

a) Coding changes between LUMINARY 1B and 1C. The coding changes are indicated by a vertical line to the left of the affected area.

b) Editorial changes (e.g., coding rewritten for clarify, reformatting of pages, added comments, corrected mistakes, etc.). These changes are indicated by a vertical dotted line to the left of the affected area.

Pages changed from the original issue of this document are identified by "Revision A" on the same line as the page number. All dashed or dotted lines, on those pages not having Revision A on them, should be ignored as they indicate changes between previous revisions of the LUMINARY program. The pages changed are as follows.

Cover page	106	DATA-21	IMUC-2
Title page	ALIN-6	DATA-36	IMUC-20
i thru v	ALIN-13	DATA-38 thru 42	IMUC-22
	ASCT-5	DATA-44	ORBI-23
1	ASCT-11	DATA-45	ORBI-24
2	ASCT-13	DESC-2	PGSR-1
25	ASCT-15	DESC-4	PGSR-2
26	ASCT-16	DESC-5	PGSR-3
27	ATTM-1	DESC-6	PGSR-6
32	ATTM-2	DESC-9 thru 14	PGSR-12
33	BURN-20	DESC-19 thru 22	PGSR-18
34	BURN-21	DESC-26	RADR-15
	BURN-28		
36	BURN-31	DESC-29	RADR-19
68	DAPA-13	DESC-31	RADR-25
71	DAPA-14	EXVB-2	RADR-31
78	DAPB-2	EXVB-7	RNAV-15
80	DAPB-18	EXVB-26	RNAV-22
87	DAPB-19	EXVB-27	RNAV-32
94	DAPB-24	EXVB-30	RNAV-33
96	DAPB-32	EXVB-34	RNAV-35
100	DATA-19	EXVB-35	SERV-9
102	DATA-20	EXVB-36	SERV-15

SERV-22	TELE-24	W-13	X-24	X-49
SERV-26	TELE-25	X-3	X-32	X-51
SERV-28	TELE-26	X-6	X-34	
TELE-15	TELE-28 thru 34	X-7	X-38	
TELE-16	TELE-37	X-8	X-39	
TELE-17	TELE-38	X-11	X-40	
TELE-19	TELE-39	X-14	X-45	
TELE-20	W-3	X-18	X-47	
TELE-21	W-10	X-19	X-48	

Abstract

The information presented in this document on the LUMINARY 1C guidance program was produced with the intention that it be used together with a symbolic tabulation of the program. The information is divided into a series of separate sections, each of which describes a basic area of guidance computation and contains a list of definitions of variables and constants used in that area of the program. In order to assist the user in finding the computations in which he is interested, summaries of each section have been included, and all routine tags used in this document (generally identical to but a subset of those in the program listing) are indexed at the end of the document along with a list of references to each routine listed. A list of references to flagwords and channels has been included as well, as a supplement to the list of references to variables and constants supplied in the program listing itself.

The program from which this document was prepared is identified "LUMINARY Revision 131" and was released on December 2, 1969 for fabrication of the LM Guidance Computer memory ropes for the Apollo H2 mission.

Because of the purposes for which the information in this document was originally prepared, and the methods used in its production, this material should not be used as definitive information on the LUMINARY 1C program but as an aid in the reading and understanding of the program listing. If definitive information is required, the G&N contractor is the proper source for it.

Table of Contents

Introduction

Under the egis of the Program Development Group, Apollo Guidance Program Section, Flight Software Branch of MSC, in order to facilitate the reading of the detailed symbolic listing, a "Programmed Guidance Equations Document" has been prepared for the "LUMINARY" program. A major purpose of this document has been to provide more effective identification and analysis of various program performance features and to permit more effective review of published computer program documentation.

During reviews of previous programs written for the Apollo Guidance Computers, it was found desirable to assemble a set of working-paper information on the equations actually programmed for these flights. This material has proven to be useful to the various groups associated with these flights, in that it can be used to bridge the gap between the extreme detail of the program listing and the occasional lack of detail available elsewhere on the guidance equations. Consequently, the material on the following pages has been assembled in a fashion similar to that used for previous programs and follows the same general format.

Certain aspects of the program are quite complex, and this programmed guidance equation material should not be considered as a substitute for actual study of the program symbolic listing itself. No complete set of equation information was available from the G&N contractor against which the programmed equations could be validated, and in the interest of timely publication, the review of the assembled document against the program assembly has not been as detailed as would be desired.

The program assembly listing which was used to prepare this programmed equation information bears the heading print:

GAP: ASSEMBLE REVISION 131 OF AGC PROGRAM LUMINARY BY NASA 2021112-091

and is dated December 2, 1969. The functions of virtually all the program

steps of interest to the flight is described either on the following pages, or, for general computer system control, in TRW Working Paper 3420.5-27 (revision 2).

Recipients of this document are cautioned against misusing it as a definitive description of the "LUMINARY" guidance equations. Instead, it might be used to achieve a better understanding of the program assembly listing, since it is intended as an aid in review of the listing, not as a substitute for it. Definitive guidance equation information can be provided only by the G&N contractor through the appropriate MSC channels.

A great deal of credit goes to TRW Systems MTCP Tasks A-90 and A-201 (Support of Apollo Guidance Program and Guidance Document Review) personnel, in particular Mr. William C. Koelsch, who conducted a similar review of the "SUNDANCE" program. This document has drawn heavily upon the results of that review and could not be published at this time without the earlier work done by TRW Systems.

Erasable Memory Initialization

The quantities listed below constitute the "erasable memory load" which supplements the initialization performed by verb 36 (fresh start routine "SLAP1") in order to prepare the LGC erasable memory for the beginning of the mission. The list shows the absolute address of each quantity in the list (single, double or triple precision) in ECADR form (EBANK in bits 11-9; address = 1400_8 + bits 8-1); the tag assigned to that address by this document; the tag assigned to that address by the LUMINARY program if it differs from that used in this document; the scale factor and the units which the program assumes when handling each quantity; and the section of this document in which the quantity is defined.

Following this alphabetical list are the erasable memory quantities listed in order of increasing ECADR.

ECADR	Tag (alternate tag)	Scale	Units	Section
02566 02567	ABTRDOT	B7	meters/centisecond	ASCT
• 01463	ADIAX	B-6	gyro pulses/cm per sec	IMUC
• 01464	ADIAY	B-6	gyro pulses/cm per sec	IMUC
• 01465	ADIAZ	B-6	gyro pulses/cm per sec	IMUC
• 01466	ADSRAX	B-6	gyro pulses/cm per sec	IMUC
• 01467	ADSRAY	B-6	gyro pulses/cm per sec	IMUC
• 01470	ADSRAZ	B-6	gyro pulses/cm per sec	IMUC
	(Because one gyro pulse is equivalent to 2^{-21} revolutions, the above six quantities could also be assumed to be scaled B-26 in units of revolutions.)			
02020 02021	AGSK	B28	centiseconds	EXVB
03404	$AOTAZ_1$ (AOTAZ)	B-1	revolutions (2's comp)	ALIN
03405	$AOTAZ_2$ (AOTAZ+1)	B-1	revolutions (2's comp)	ALIN
03406	$AOTAZ_3$ (AOTAZ+2)	B-1	revolutions (2's comp)	ALIN
03407	$AOTAZ_4$ (AOTAZ+3)	B-1	revolutions (2's comp)	ALIN

ECADR	Tag (alternate tag)	Scale	Units	Section
03410	$AOTAZ_5$ (AOTAZ+4)	B-1	revolutions (2's comp)	ALIN
03411	$AOTAZ_6$ (AOTAZ+5)	B-1	revolutions (2's comp)	ALIN
03412	$AOTEL_1$ (AOTEL)	B-1	revolutions (2's comp)	ALIN
03413	$AOTEL_2$ (AOTEL+1)	B-1	revolutions (2's comp)	ALIN
03414	$AOTEL_3$ (AOTEL+2)	B-1	revolutions (2's comp)	ALIN
03415	$AOTEL_4$ (AOTEL+3)	B-1	revolutions (2's comp)	ALIN
03416	$AOTEL_5$ (AOTEL+4)	B-1	revolutions (2's comp)	ALIN
03417	$AOTEL_6$ (AOTEL+5)	B-1	revolutions (2's comp)	ALIN
	(2's comp indicates that these quantities are stored in two's complement form, not the usual one's complement form)			
03400 03401	ATIGINC	B28	centiseconds	TRGL
03373	AZBIAS	B-1	revolutions	DESC
01711 01712	AZO	B0	revolutions	COOR
02570 02571	COSTHET1	B2	unitless	ASCT
02572 02573	COSTHET2	B2	unitless	ASCT
01327	CSMMASS	B16	kilograms	DAPB
02520 02521	DELQFIX	B24	meters	SERV
03425	DELTTFAP	B17	centiseconds	DESC
02474 02475	DESIGNRX (RIGNX)	B24	meters	DESC
02476 02477	DESIGNRZ (RIGNZ)	B24	meters	DESC
02472 02473	DESIGNV (VIGN)	B10	meters/centisecond	DESC

	ECADR	Tag (alternate tag)	Scale	Units	Section
	02504 02505	DESKIGNV (KIGNV/B4)	B18	centiseconds	DESC
	02500 02501	DESKIGNX (KIGNX/B4)	B4	unitless	DESC
	02502 02503	DESKIGNY (KIGNY/B8)	B-16	meters^{-1}	DESC
*	03011	DKDB	B15	revolutions^{-1}	DAPB *
*	03005	DKKAOSN	B14	unitless	DAPA *
*	03004	DKOMEGAN	B14	unitless	DAPA *
*	03003	DKTRAP	B-3	revolutions/second	DAPA *
	02634 thru 02641	DLAND	B24	meters	DESC
	03113	DOWNTORK$_0$ (POSTORKP)	B5	seconds	DAPA
	03114	DOWNTORK$_1$ (NEGTORKP)	B5	seconds	DAPA
	03115	DOWNTORK$_2$ (POSTORKU)	B5	seconds	DAPA
	03116	DOWNTORK$_3$ (NEGTORKU)	B5	seconds	DAPA
	03117	DOWNTORK$_4$ (POSTORKV)	B5	seconds	DAPA
	03120	DOWNTORK$_5$ (NEGTORKV)	B5	seconds	DAPA
	01350	E32C31RM	B80	meters^6/centisecond^2	ORBI
	01347	E3J22R2M	B58	meters^5/centisecond^2	ORBI
	01356	ELBIAS	B-1	revolutions	DESC
	02432 02433	GAIN$_0$ (GAINBRAK)	B0	unitless	DESC
	02466 02467	GAIN$_{28}$ (GAINAPPR)	B0	unitless	DESC
*	03000	HIASCENT	B16	kilograms	DAPB *
	02507	HIGHCRIT	B14	DPS throttle pulses	DESC
	03012	IGNAOSQ	B-2	revolutions/second^2	BURN
	03013	IGNAOSR	B-2	revolutions/second^2	BURN

	ECADR	Tag (alternate tag)	Scale	Units	Section
	02550 02551	J1PARM	* B23	meters	ASCT
	02552 02553	K1PARM	* B23	meters/revolution	ASCT
	02554 02555	J2PARM	* B23	meters	ASCT
	02556 02557	K2PARM	* B23	meters/revolution	ASCT

* See note on page ASCT-14.

02542 02543	LAGdTAU (LAG/TAU)	B0	unitless	DESC
03426	LEADTIME	B17	centiseconds	DESC
01326	LEMMASS	B16	kilograms	DAPB
02012 thru 02017	LM504 (504LM)	B0	radians	COOR
* 03010	LMKAOSN	B14	unitless	DAPA *
* 03007	LMOMEGAN	B14	unitless	DAPA *
* 03006	LMTRAP	B-3	revolutions/second	DAPA *
02506	LOWCRIT	B14	DPS throttle pulses	DESC
02522	$LRALPHA_1$ (LRALPHA)	B-1	revolutions (2's comp)	SERV
02524	$LRALPHA_2$ (LRALPHA2)	B-1	revolutions (2's comp)	SERV
02523	$LRBETA_1$ (LRBETA1)	B-1	revolutions (2's comp)	SERV
02525	$LRBETA_2$ (LRBETA2)	B-1	revolutions (2's comp)	SERV
03420	LRHMAX	B14	meters	SERV

ECADR	Tag (alternate tag)	Scale	Units	Section
02402 thru 02407	$\underline{T}ARGRDG_0$ (RDG,RBRFG)	B24	meters	DESC
02436 thru 02443	$\underline{T}ARGRDG_{28}$ (RAPFG)	B24	meters	DESC
02410 thru 02415	$\underline{T}ARGVDG_0$ (VDG,VBRFG)	B10	meters/centisecond	DESC
02444 thru 02451	$\underline{T}ARGVDG_{28}$ (VAPFG)	B10	meters/centisecond	DESC
02540 02541	TAUROD	B9	centiseconds	DESC
02516 02517	TAUVERT	B14	centiseconds	DESC
02434	$TCGF_0$ (TCGFBRAK)	B17	centiseconds	DESC
02470	$TCGF_{28}$ (TCGFAPPR)	B17	centiseconds	DESC
02435	$TCGI_0$ (TCGIBRAK)	B17	centiseconds	DESC
02471	$TCGI_{28}$ (TCGIAPPR)	B17	centiseconds	DESC
03423	$TEND_0$ (TENDBRAK)	B17	centiseconds	DESC
03424	$TEND_1$ (TENDAPPR)	B17	centiseconds	DESC
01706 01707 01710	TEPHEM	B42	centiseconds	COOR
01570 01571	TETCSM	B28	centiseconds	ORBI
01642 01643	TETLEM	B28	centiseconds	ORBI
02560 02561	THETCRIT	B0	revolutions	ASCT

ECADR	Tag (alternate tag)	Scale	Units	Section
02400 02401	TLAND	B28	centiseconds	DESC
03431 03432	TNEWA	B28	centiseconds	BURN
02011	TRUNVAR	B-12	radians^2	RNAV
02426 02427	TTFADGZ$_0$ (ABRFG* and ADG2TTF+0)	B-4	meters/centisecond^2	DESC
02462 02463	TTFADGZ$_{28}$ (AAPFG* and ADG2TTF+28)	B-4	meters/centisecond^2	DESC
02430 02431	TTFJDGZ$_0$ (JBRFG* and JDG2TTF+0)	B-21	meters/centisecond^3	DESC
02464 02465	TTFJDGZ$_{28}$ (JAPFG* and (JDG2TTF+28)	B-21	meters/centisecond^3	DESC
02424 02425	TTFVDGZ$_0$ (VBRFG* and VDG2TTF+0	B13	meters/centisecond	DESC
02460 02461	TTFVDGZ$_{28}$ (VAPFG* and VDG2TTF+28	B13	meters/centisecond	DESC
01713 01714	UNITW$_x$ (mAYO)	B0	unitless	COOR
01715 01716	UNITW$_y$ (AXO)	B0	unitless	COOR
02510 thru 02515	V2FG	B10	meters/centisecond	DESC
03371 03372	VELBIAS	B6	meters/centisecond	SERV
02005	VMAX	B7	meters/centisecond	RNAV
01775	VVARMIN	B-12	meters^2/centisecond^2	RNAV
02000	WRENDPOS	B14	meters	RNAV
02001	WRENDVEL	B0	meters/centisecond	RNAV
02002	WSHAFT	B-5	radians	RNAV
02006	WSURFPOS	B14	meters	RNAV

ECADR	Tag (alternate tag)	Scale	Units	Section
02007	WSURFVEL	B0	meters/centisecond	RNAV
02003	WTRUN	B-5	radians	RNAV
01700 thru 01705	X789	*	radians	RNAV
	(*Scaling is B5 for earth and B3 for moon)			
02564 02565	YLIM	B24	meters	ASCT
03422	ZOOMTIME	B14	centiseconds	BURN

* These quantities are also loaded by the fresh start routine entered from verb 36.

In addition to the quantities listed on the previous pages, the indicated bits of the following flagwords must be padloaded as they are not initialized by the fresh start ("SLAP1") routine.

FLAGWRD3	bit 13	(REFSMFLG)
FLAGWRD8	bit 8	(SURFFLAG)
	bit 11	(LMOONFLG)
	bit 12	(CMOONFLG)
FLGWRD10	bit 13	(APSFLAG)

The following pad loaded variables are listed by ascending ECADR. The tag name is that given by this document.

ECADR	Tag	ECADR	Tag
01243-4	MASS	01700-5	X789
01326	LEMMASS	01706-10	TEPHEM
01327	CSMMASS	01711-2	AZO
01347	E3J22R2M	01713-4	$UNITW_x$
01350	E32C31RM	01715-6	$UNITW_y$
01351-2	RADSKAL	01770-1	RANGEVAR
01353	SKALSKAL	01772-3	RATEVAR
01356	ELBIAS	01774	RVARMIN
01452	$PIPABIAS_x$	01775	VVARMIN
01453	$PIPASCF_x$	02000	WRENDPOS
01454	$PIPABIAS_y$	02001	WRENDVEL
01455	$PIPASCF_y$	02002	WSHAFT
01456	$PIPABIAS_z$	02003	WTRUN
01457	$PIPASCF_z$	02004	RMAX
01460	NBDX	02005	VMAX
01461	NBDY	02006	WSURFPOS
01462	NBDZ	02007	WSURFVEL
01463	ADIAX	02010	SHAFTVAR
01464	ADIAY	02011	TRUNVAR
01465	ADIAZ	02012-7	LM504
01466	ADSRAX	02020-1	AGSK
01467	ADSRAY	02022-7	RLS
01470	ADSRAZ	02400-1	TLAND
01570-1	TETCSM	02402-7	$TARGRDG_0$
01642-3	TETLEM		

ECADR	Tag
02410-5	TARGVDG$_0$
02416-23	TARGADG$_0$
02424-5	TTFVDGZ$_0$
02426-7	TTFADGZ$_0$
02430-1	TTFJDGZ$_0$
02432-3	GAIN$_0$
02434	TCGF$_0$
02435	TCGI$_0$
02436-43	TARGRDG$_{28}$
02444-51	TARGVDG$_{28}$
02452-7	TARGADG$_{28}$
02460-1	TTFVDGZ$_{28}$
02462-3	TTFADGZ$_{28}$
02464-5	TTFJDGZ$_{28}$
02466-7	GAIN$_{28}$
02470	TCGF$_{28}$
02471	TCGI$_{28}$
02472-3	DESIGNV
02474-5	DESIGNRX
02476-7	DESIGNRZ
02500-1	DESKIGNX
02502-3	DESKIGNY
02504-5	DESKIGNV
02506	LOWCRIT
02507	HIGHCRIT
02510-5	V2FG

ECADR	Tag
02516-7	TAUVERT
02520-1	DELQFIX
02522	LRALPHA$_1$
02523	LRBETA$_1$
02524	LRALPHA$_2$
02525	LRBETA$_2$
02526	LRVMAX
02527	LRVF
02530	LRWV$_0$
02531	LRWV$_1$
02532	LRWV$_2$
02533	LRWVF$_0$
02534	LRWVF$_1$
02535	LRWVF$_2$
02536	LRWVFF
02537	RODSCALE
02540-1	TAUROD
02542-3	LAGdTAU
02544-5	MINFORCE
02546-7	MAXFORCE
02550-1	J1PARM
02552-3	K1PARM
02554-5	J2PARM
02556-7	K2PARM
02560-1	THETCRIT
02562-3	RAMIN

ECADR	Tag
02564-5	YLIM
02566-7	ABTRDOT
02570-1	COSTHET1
02572-3	COSTHET2
02634-41	DLAND
03000	HIASCENT
03001	ROLLTIME
03002	PITTIME
03003	DKTRAP
03004	DKOMEGAN
03005	DKKAOSN
03006	LMTRAP
03007	LMOMEGAN
03010	LMKAOSN
03011	DKDB
03012	IGNAOSQ
03013	IGNAOSR
03113-20	$DOWNTORK_{0-5}$
03371-2	VELBIAS
03373	AZBIAS
03400-1	ATIGINC
03402-3	PTIGINC
03404-11	$AOTAZ_{1-6}$
03412-7	$AOTEL_{1-6}$
03420	LRHMAX
03421	LRWH

ECADR	Tag
03422	ZOOMTIME
03423	$TEND_0$
03424	$TEND_1$
03425	DELTTFAP
03426	LEADTIME
03427	RPCRTIME
03430	RPCRTQSW
03431-2	TNEWA

Bit and initial value (fresh start)

		Mnemonic	Meaning when 1 and 0
3	(0)	spare	
2	(0)	INITALGN	1 - Initial pass through P57 0 - Second pass through P57
1	(0)	360SW	1 - Transfer angle near 360 degrees 0 - Transfer angle not near 360 degrees

FLAGWRD9

Bit and initial value (fresh start)

	Mnemonic	Meaning when 1 and 0
15 (0)	spare	
14 (0)	FLVR	1 - Vertical rise (ascent guidance) 0 - Non-vertical rise
13 (0)	P7071FLG	1 - P70 or P71 using ascent guidance 0 - P12 using ascent guidance
12 (0)	FLPC	1 - No position control (ascent guidance) 0 - Position control
11 (0)	FLPI	1 - Pre-ignition phase (ascent guidance) 0 - Regular guidance
10 (0)	FLRCS	1 - RCS injection mode (ascent guidance) 0 - Main engine mode
9 (0)	LETABORT	1 - Abort programs are enabled 0 - Abort programs are not enabled
8 (0)	FLAP	1 - APS continued abort after DPS staging (ascent guidance) 0 - APS abort is not a continuation
7 (0)	ABTTGFLG	1 - Abort targeting to use J_2, K_2 0 - Abort targeting to use J_1, K_1
6 (0)	ROTFLAG	1 - P70 and P71 will force vehicle rotation in the preferred direction 0 - P70 and P71 will not force vehicle rotation in the preferred direction
5 (0)	QUITFLAG	1 - Discontinue orbital integration 0 - Continue integration
4 (0)	spare	
3 (0)	MID1FLAG	1 - Integrate to TDEC 0 - Integrate to TIMENOW
2 (0)	MIDAVFLG	1 - Integration entered from one of the drifting flight to powered flight handover routines 0 - Integration not entered as above
1 (0)	AVEMIDSW	1 - AVETOMID calling for W-matrix integration; do not write over RN, VN, PIPTIME 0 - AVETOMID without W-matrix integration; allow set up of RN, VN, PIPTIME

Bit and initial value (fresh start)

	Mnemonic	Meaning when 1 and 0
1 (0)	HFLSHFLG	1 - Landing radar altitude fail lamp should be flashing 0 - Landing radar altitude fail lamp should not be flashing

Bit and initial value (fresh start)

		Mnemonic	Meaning when 1 and 0
15	(0)	PULSES	1 - Minimum impulse command mode 0 - Not minimum impulse
14	(1)	USEQRJTS	1 - Use of gimbal not allowed 0 - Gimbal may be used
13	(0)	CSMDOCKD	1 - CSM attached to LM 0 - CSM not attached
12	(0)	OURRCBIT	1 - Still in rate command mode 0 - Not in rate command mode
11	(0)	ACC4OR2X	1 - 4-jet P-axis translation 0 - 2-jet P-axis translation
10	(1)	AORBTRAN	1 - X translation B system 0 - X translation A system
9	(0)	XOVINHIB	1 - LPD phase; X-axis override disabled 0 - Not in Landing Point Designation Phase
8	(1)	DRIFTBIT	1 - Assume that offset acceleration is zero 0 - Offset acceleration likely
7	(1)	RHCSCALE	1 - Normal RHC scaling 0 - Fine RHC scaling
6	(0)	ULLAGER	1 - Internal ullage request 0 - No program ullage request
5	(1)	DBSL2FLG	
4	(0)	DBSELECT	

N46 Digit "D" Load	DAP Deadband	BIT 5	BIT 4
0	±0.3°	0	0
1	±1.0°	0	1
2	±5.0°	1	0
3	±5.0°	1	1

3	(0)	ACCSOKAY	1 - Computed accelerations probably correct 0 - Computed accelerations probably incorrect
2	(1)	AUTRATE2	Used together to determine index (RATEINDX)
1	(0)	AUTRATE1	which is used to select attitude maneuver rate

Bit	Routines
13	1 - IGNITION GOPROG ABRTJASK 0 - IMUMON ENGINOF3
10	1 - ERROR 0 - STARTSB2
9	1 - READACCS 0 - STARTSB2 AVGEND
7	1 - V37 VBTSTLTS DSPALARM ALMCYCLE CHARALRM UPERROUT UPEND70 P20LEMB7 ALM/END V73UPDAT UPEND73 ABORTALM 0 - STARTSB2 ERROR TSTLTS3
6	1 - FLASHSUB TESTNN VBTSTLTS REQDATZ REQMM 0 - NV50DSP STARTSB2 TSTLTS3 BLANKDSP ENTER GOLOADLV VBRESEQ
5	1 - CHARIN NV50DSP MONDO VBTSTLTS 0 - STARTSB2 WITCHONE RELDSP RELDSP1
4	1 - IMUMON VBTSTLTS 0 - IMUMON STARTSB2 TSTLTS3
3	1 - UPRUPT VBTSTLTS 0 - STARTSB2 TSTLTS3 V73UPDAT UPOUT4 ERROR VBRELDSP
2	1 - ADVAN 0 - STARTSB2 DUMMYJB2
1	1 - SETISSW VBTSTLTS 0 - SETISSW TSTLTS3 test - ENDIMU

Channel 12

15	1 - ENDTNON 0 - STARTSB2 UNZ2 CAGESUB DOFSTRT1 test - IMUMON
14	1 - R23LEM LRS24.1 RO4X DODES R29DODES 0 - R21LEM TRMTRACK RRGIMON STDESIG RO4END R29 DOFSTRT1 P63LM test - R22LEM
13	1 - LRPOS2 0 - STARTSB2 LRPOSCAN DOFSTRT1 test -

Bit Routines

12 1 - ACDT+C12 TRIMGIMB
0 - ACDT+C12 TRIMGIMB SUPERJOB MOREIDLE DOFSTRT1 NEGUSUM
test - SPSCONT

11-9 same as 12

8 1 - LANDISP
0 - STARTSB2 IMUMON DISPRSET DOFSTRT1

6 1 - NEEDLER COARS IMUATTCK GOPROG CA+ECE DOFSTRT1
0 - NEEDLER IMUMON CAGESUB SETCOARS IMUZERO DOFSTRT1
test - NEEDLER

5 1 - IMUZERO ISSZERO CAGESUB
0 - IMUMON UNZ2 IMUZERO2 IMUFINE DOFSTRT1
test - IMUATTCK

4 1 - SETCOARS CAGESUB GOPROG DOFSTRT1
0 - IMUMON UNZ2 IMUZERO IMUFINE DOFSTRT1
test - TNONTEST GLOCKMON IFAILOK IMUATTCK SETCOARS 8192AUG
TSTLTS3

2 1 - SETRRECR INTLZE
0 - STARTSB2 RRAUTCHK RRGIMON DORREPOS TRMTRACK STDESIG RESET22
IMUMON R24END R24LEM3 RRDESDUN RRDESEND POOH RR1AX2 RRDESNB
R29DPAS2 DOFSTRT1 PROG20A R21LEM9 DISPRSET P12LM
test - SETRRECR SPEEDRUN

1 1 - RRZEROSB NORRGMON
0 - STARTSB2 RRZEROSB DOFSTRT1

Channel 13

15 1 - JTLST T6JOBCHK
0 - STARTSB1 DOFSTRT1

14 1 - none
0 - DOFSTRT1

13 1 - none
0 - DOFSTRT1

12 1 - REDESMON STARTP64 STARTSB2
0 - DOFSTRT1

Bit Routines

11 1 - P06
0 - POSTAND STARTSB2 DOFSTRT1

10 1 - VBTSTLTS
0 - ERROR TSTLTS3 STARTSB2 DOFSTRT1

9 1 - ZEROENBL
0 - STARTSB2 DOFSTRT1

8 1 - ZEROENBL
0 - STARTSB2 DOFSTRT1

7 1 - DODOWNTM
0 - DOFSTRT1 WOZERO
test - DODOWNTM

6-5 not set in LUMINARY

4 1 - RADSTART
0 - STARTSB2 DOFSTRT1
test - C13STALL VBTSTLTS

3 1 - RADSTART
0 - STARTSB2 DOFSTRT1
test - RADAREAD

2 1 - RADSTART
0 - STARTSB2 DOFSTRT1
test - RADAREAD

1 1 - RADSTART
0 - STARTSB2 DOFSTRT1
test - RADAREAD RENDRAD

Channel 14

15 1 - COARS2 ATTCK2 NEEDLES
0 - DOFSTRT1 IMUMON STARTSB2

14 1 - COARS2 ATTCK2 NEEDLES
0 - DOFSTRT1 IMUMON STARTSB2

13 1 - COARS2 ATTCK2 NEEDLES
0 - DOFSTRT1 IMUMON STARTSB2

12 1 - RROUT SPEEDRUN
0 - DOFSTRT1 IMUMON STARTSB2

Bit	Routines
11	1 - RROUT SPEEDRUN 0 - IMUMON STARTSB2 DOFSTRT1
10	1 - GYROEXIT 0 - STRTGYRO IMUMON SETCOARS STARTSB2 DOFSTRT1
9	1 - STRTGYR2 0 - STRTGYRO IMUMON STARTSB2 DOFSTRT1
8	1 - STRTGYR2 0 - STRTGYRO IMUMON STARTSB2 DOFSTRT1
7	1 - STRTGYR2 0 - STRTGYRO IMUMON STARTSB2 DOFSTRT1
6	1 - IMUPULSE 0 - IMUMON DOFSTRT1
4	1 - GOPROG DOIT P40ZOOM THROTUP ENGINOF3 0 - STARTSB2 DOFSTRT1
3	1 - ALTROUT1 ALTOUT1 0 - STARTSB2 DOFSTRT1
2	1 - ALTROUT1 0 - ALTOUT1 STARTSB2 DOFSTRT1

Channel 15

Tested in routines KEYRUPT1 and LIGHTSET - 5 LIGHTSET
2 LIGHTSET

Channel 16

7	DESCBITS SOMEKEY MARKRUPT
6	SOMEKEY MARKRUPT
5	LIGHTSET MARKRUPT
4	
3	

FLAGWRD2 (Continued)

Bit	Mnemonic	Routines
5	AVFLAG	1 - P42STAGE S40.9 P34 P35 P32 P33 0 - P74 P75 P72 P73 . . . DOFSTRT1 test - PRECSET, A[illegible]NE
4	PFRATFLG	1 - S40.2,3 0 - R51E GYCOARS REGCOARS DOFSTRT1 test - PROG52
3	CALCMAN3	Not really functional: set in KALCMAN3; reset in DOFSTRT1
2	CALCMAN2	1 - WCALC 0 - NEWANGL DOFSTRT1 test - NEWANGL
1	NODOFLAG	1 - AGSVCALC STATINT1 P06 P76 0 - AGSVCALC STATINT1 POOH POSTAND DOFSTRT1 POODOO P76 test - V37

FLAGWRD3

Bit	Mnemonic	Routines
15	POOHFLAG	1 - STATINT1 0 - CANV37 DOFSTRT1 test - TESTLOOP
14	GLOKFAIL	1 - CALCGA 0 - REDO CANV37 DOFSTRT1 test - REDO
13	REFSMFLG	1 - P51C GYCOARS REGCOARS SURFDISP 0 - RNDREFDR GYCOARS GVDETER test - AGSINIT RO2BOTH VN1645 PACKOPTN DSPOPTN R59
12	LUNAFLAG	1 - LANDJUNK P52LS P57POST P21VSAVE 0 - DOFSTRT1 P21VSAVE test - LAT-LONG LALOTORV
11	NOR29FLG	1 - AVGEND DOFSTRT1 0 - CMPONENT test - COPYCYC1 STARTSB2 R29RDJOB RDRUSECK
10	VFLAG	1 - R56 PIC3 0 - PIC3 DOFSTRT1 test - PIC3 PICEND
9	RO4FLAG	1 - RO4 R61C+LO1 0 - RO4END CANV37 PROG20A DOFSTRT1 R61C+LO1 STARTSB2 test - RO4Z RADAREAD RESAMPLE R77
	READRFLG	1 - R29DPAS2 0 - ENDRRD29 STARTSB2 DOFSTRT1 test - R29READ COPYCYC1
8	PRECIFLG	1 - STATINT1 CSMPREC INTEGRVS LEMPREC 0 - STATINT1 INTEXIT DOFSTRT1 test - TESTLOOP
7	CULTFLAG	1 - OCCULT 0 - OCCULT DOFSTRT1 test - PIC3
6	ORBWFLAG	1 - never set 0 - WMATEND INTWAKEU DOFSTRT1 test - AVETOMID
5	STATEFLG	1 - SETIFLGS WMATEND LSR22.3 LSR22.4 0 - ENDINT TESTLOOP DOFSTRT1 POODOO INTEXIT test - A-PCHK

FLAGWRD5 (CONTINUED)

Bit	Mnemonic	Routines
4	NORMMON	1 - VBCOARK R23LEM R21LEM8 0 - RRDESEND STARTSB2 PROG20A R23LEM R23LEM2 DOFSTRT1 R21LEM1 test - RRGIMON
3	SOLNSW	1 - TIMERAD SOFSCHEK LAMBERT 0 - TIMERAD DOFSTRT1 LAMBERT test - none (telemetry)
2	MGLVFLAG	1 - GET.LVC 0 - GET+MGA DOFSTRT1 test - none (telemetry)
1	REINDWFLG	1 - WLINIT 0 - WMATRING WMATEND INTWAKEU V67CALL DOFSTRT1 ATMAG test - STATINT1 AVETOMID UPPSV ORBCHGO LSR22.3

FLAGWRD6

Bit	Mnemonic	Routines
15	S32.1F1	1 - CSI/B2 0 - CSI/A SCNDSOL DOFSTRT1 test - CSI/B2
14	S32.1F2	1 - CSI/A SCNDSOL 0 - FRSTPAS DOFSTRT1 test - CIRCL
13	S32.1F3A	1 - CIRCL FIFTYFPS 0 - CSI/A SCNDSOL DOFSTRT1 test - CSI/B2 CIRCL SCNDSOL
12	S32.1F3B	1 - CSI/A FIFTYFPS 0 - CIRCL SCNDSOL DOFSTRT1 test - CSI/B2 CIRCL SCNDSOL
11	[illegible]	[illegible]
10	GMBDRVSW	1 - PITCHOFF 0 - TRIMGIMB DOFSTRT1 test - PITCHOFF
9	2PHASE G	[illegible]
8	MUNFLAG	1 - P63LM P12LM 0 - AVGEND DOFSTRT1 CANV37 test - NORMLIZE READACCS AVERAGEG RRGIMON PARISPOT SERVIDLE V83CALL GETRVN
7	POUTFLAG	1 - [illegible] 0 - STARTP64 P65START [illegible] test - [illegible]
6	REDFLAG	1 - P64DISPS 0 - P64DISPS STARTP64 P63LM DOFSTRT1 STRTP66A test - P64DISPS REDESIG
3	NTARGFLG	1 - NTARGCHK 0 - S34/35.5 DOFSTRT1 test - Not shown in document

FLAGWRD6 (Continued)

Bit	Mnemonic	Routines
2	AUXFLAG	1 - AVERAGEG 0 - AVERAGEG DOFSTRT1 test - AVERAGEG
1	ATTFLAG	1 - REFMF 0 - DOFSTRT1 test - PACKOPTN DSPOPTN ATTCHK

FLAGWRD7

Bit	Mnemonic	Routines
15	ITSWICH	1 - P34/P74C P33/P73B 0 - P34/P74C INTLOOP DOFSTRT1 test - INTLOOP ELCALC
13	IGNFLAG	1 - TIG-0 0 TIG-5 P42IGN DOFSTRT1 test - *PROCEED
12	ASTNFLAG	1 - *PROCEED 0 - TIG-5 P42IGN DOFSTRT1 test - TIG-0
11	SWANDISP	1 - P63IGN ABRTIGN 0 - DOFSTRT1 AVGEND test - LANDISP
10	NORMSW	1 - INITVEL2 0 - PARAM DOFSTRT1 HAVEGUES test - S40.1B S40.9 GEOM UPDATEVG RASTRER1
9	RVSW	1 - INTLOOP CSI/B2 VN0611 0 - CDHMVR DOFSTRT1 ORBCHGG test - COMMNOUT
8	V67FLAG	1 - V67CALL 0 - DOFSTRT1 V67CALL test - V67CALL
7	IDLEFLAG	1 - STEERING ENGINOF1 COMFAIL DOFSTRT1 MAINENG SERVIDLE 0 - P42IGN GOABORT COMFAIL4 test - STEERING AVERAGEG MAINENG
6	V37FLAG	1 - PREREAD 0 - DOFSTRT1 AVGEND test - V37 POODOO RDRUSECK
5	AVEGFLAG	1 - PREREAD 0 - V37 DOFSTRT1 test - V82CALL READACCS REV83 RRGIMON P70 P71 R10,R11 V83CALL LRPOS2K
4	UPLOCKFL	1 - UPRUPT 0 - UPRUPT DOFSTRT1 test - UPRUPT

FLAGWRD8 (Continued)

Bit	Mnemonic	Routines
4	COGAFLAG	1 - TIMERAD TIMETHET 0 - COMMNOUT PARAM DOFSTRT1 test - none (telemetry)
2	INITALGN	1 - BYLMATT 0 - DOFSTRT1 ATTCHK test - SURFDISP INITBY SURFLINE
1	360SW	1 - GETX WLOOP 0 - GETX DOFSTRT1 test - POLYCOEF

FLAGWRD9

Bit	Mnemonic	Routines
14	FLVR	1 - P12LM INJTARG 0 - CMPONENT DOFSTRT1 test - CMPONENT
13	P7071FLG	1 - GOABORT 0 - DOFSTRT1 test - ASCENT CMPONENT
12	FLPC	1 - MAINENG 0 - DOFSTRT1 test - MAINENG
11	FLPI	1 - P12LM 0 - P12RET DOFSTRT1 test - CMPONENT
10	FLRCS	1 - CUTOFF 0 - GOABORT DOFSTRT1 test - ASCTERM1 ASCTERM ASCENT ATMAG
9	LETABORT	1 - P63IGN 0 - LANDJUNK TERMASC GOABORT DOFSTRT1 test - P70 P71 R10,R11
8	FLAP	1 - UPTHROT 0 - DOFSTRT1 test - GOABORT P12INIT
7	ABTTGFLG	1 - INJTART 0 - CANV37 test - None
6	ROTFLAG	1 - INJTARG 0 - DOFSTRT1 CMPONENT test - CMPONENT
5	QUITFLAG	1 - VERB96 0 - STATINT1 DOFSTRT1 test - STATINT1 TESTLOOP
3	MID1FLAG	1 - MIDTOAV1 0 - MIDTOAV1 MIDTOAV2 CKMID2 DOFSTRT1 test - CKMID2
2	MIDAVFLG	1 - MIDTOAV2 0 - MIDTOAV2 DOFSTRT1 test - ENDSTATE
1	AVEMIDSW	1 - AVETOMID 0 - INTEXIT DOFSTRT1 test - SVDWN2

FLGWRD10

Bit	Mnemonic	Routines
14	INTFLAG	1 - INTSTALL 0 - INTWAKE1 GOPROG GOPROG2A DOFSTRT1 test - INTSTALL
13	APSFLAG	1 - LANDJUNK DPDAT1 ABRTJASK WANTAPS 0 - DPDAT1 test - P40LM P42LM S40.13 RCS 1/ACCS DAPDATA1 DAPDATA2 SERVICER P40AUTO DVMON AFTERTJ S40.130
7	REINTFLG	1 - ENDSTATE A-PCHK P76 UPJOB INCORP2 0 - GOPROG2A INTWAKE1 DOFSTRT1 POODOO test - INTSTALL INTWAKE

FLGWRD11

Bit	Mnemonic	Routines
15	LRBYPASS	1 - SERVIDLE ABRTJASK CANV37 DOFSTRT1 STARTSB1 0 - P63LM test - MUNRETRN R10,R11 RDRUSECK RADAREAD RESAMPLE
12	VXINH	1 - VMEASCHK 0 - ABRTJASK VMEASCHK DOFSTRT1 CANV37 SERVIDLE test - VMEASCHK
11	PSTHIGAT	1 - MUNRETRN 0 - ABRTJASK DOFSTRT1 CANV37 SERVIDLE test - MUNRETRN UPDATCHK
10	NOLRREAD	1 - MUNRETRN 0 - ABRTJASK POSGOOD DOFSTRT1 CANV37 SERVIDLE P1GHK test - UPDATCHK R10,R11 MUNRETRN
9	XORFLG	1 - MUNRETRN 0 - ABRTJASK DOFSTRT1 CANV37 SERVIDLE test - MUNRETRN
8	LRINH	1 - SET57 0 - ABRTJASK LROFF DOFSTRT1 CANV37 SERVIDLE RESET57 test - NOREASON VMEASCHK
7	VELDATA	1 - LRVJOB 0 - ABRTJASK CONTSERV DOFSTRT1 CANV37 SERVIDLE test - VMEASCHK
6	LRPOS2FLG	1 - POSGOOD 0 - ABRTJASK SERVIDLE DOFSTRT1 CANV37 test -
5	READVEL	1 - VALTCHK 0 - ABRTJASK DOFSTRT1 CANV37 SERVIDLE test - VALTCHK
4	RNGEDATA	1 - LRHJOB 0 - CONTSERV ABRTJASK DOFSTRT1 CANV37 SERVIDLE test - UPDATCHK
3	NO51IFLG	1 - P1CHK 0 - ABRTJASK SERVIDLE DOFSTRT1 CANV37 test - MUNRETRN

Bit	Mnemonic	Routines
5	LRALTFLG	1 - RESAMPLE R77CHECK 0 - ERROR ITURNON2 STARTSUB GOODRAD TSTLTS3 R77CHECK test - RADLITES
4	RRDATAFL	1 - RESAMPLE 0 - ERROR ITURNON2 STARTSUB GOODRAD TSTLTS3 test - SETTRKF
3	RRRSFLAG	1 - SCALCHNG LRS22.1 RO4Z 0 - ITURNON2 STARTSUB SCALCHNG LRS22.1 RO4Z test - RENDRAD RRANGOUT
2	AUTOMODE	1 - ITURNON2 STARTSUB RRAUTCHK 0 - RRAUTCHK test - RRAUTCHK RRCDUCHK RRGIMON SETTRKF RR1AX2 RRZERO COPYCYC1 R29RDJOB NORRGMON
1	TURNONFL	1 - RRAUTCHK 0 - ITURNON2 STARTSUB STARTSB2 RRTURNON RRAUTCHK test - RRZERO

DAPBOOLS

Bit	Mnemonic	Routines
15	PULSES	1 - MINIMP LANDJUNK 0 - NOMINIMP P63IGN DOFSTRT1 IGNITION ABRTJASK TIGTASK test - TSNEXTP TSNEXTS
14	USEQRJTS	1 - ENGINOF3 AVERAGEG DVMON DOFSTRT1 0 - DVMON test - TJLAW4 TRYGTS SPSCONT
13	CSMDOCKD	1 - DPDAT1 0 - DPDAT1 DOFSTRT1 test - PURGENCY TJLAW4 1/ACCS DAPDATA2 DAPDATA1 DPDAT1 BACKP STIKLOAD FINDCDUW P40LM MINRTN
12	OURRCBIT	1 - DETENTCK 0 - DETENTCK DOFSTRT1 test - DETENTCK CHEKSTIK QRAXIS
11	ACC4OR2X	1 - DPDAT1 GOABORT P12LM 0 - DPDAT1 DOFSTRT1 test - DPDAT1 DAPDATA1 +XORULGE
10	AORBTRAN	1 - COMFAIL2 DPDAT1 DOFSTRT1 0 - COMFAIL2 DPDAT1 test - MINRTN DAPDATA1 +XORULGE
9	XOVINHIB	1 - CMPONENT MUNRETRN 0 - DOFSTRT1 P65START CMPONENT ABRTJASK CANV37 GOTOPOOH STRTP66A test - TSNEXTP FINDCDUW
8	DRIFTBIT	1 - ALLCOAST COMFAIL2 DOFSTRT1 0 - P42IGN ABRTJASK test - 1/ACCONT SPSRCS RCS BACKP AFTERTJ
7	RHCSCALE	1 - DPDAT1 DOFSTRT1 0 - DPDAT1 test - DAPDATA1 STIKLOAD
6	ULLAGER	1 - ULLGTASK COMFAIL2 0 - P42IGN ENGINOF1 GOPOST GOTOPOOH GOCUTOFF ABRTJASK DOFSTRT1 STOPCLOK test - RCS

XYMARK = bits 15-7 of AOTCODE shifted right 6 places to bit positions 9-1

If XYMARK $\leq$ 0, proceed to "GETDAT"

If XYMARK = 00007_8: (detent code 7 for COAS)

Proceed to "GOXDSPF" with TS = K:V06N87 (AZ, EL)
(If terminate, proceed to "KILLAOT"; if proceed, continue at next step; if other response, repeat this step)

TSazm = AZ

TSelev = EL

TSsrot = 0

Proceed to "OPTAXIS"

(Otherwise, XYMARK is between 1 and 6 inclusive)

TSelev = $\text{AOTEL}_{\text{XYMARK}}$

TSazm = $\text{AOTAZ}_{\text{XYMARK}}$

TSsrot = AOTAZ_2 - TSazm

OPTAXIS Perform "OANB"

UYP = cosTSsrot UYP' - sinTSsrot UXP'

UXP = cosTSsrot UXP' + sinTSsrot UYP'

STARAD_6 = 0

Proceed to "GETMKS"

OANB TSelev = TSelev converted to one's complement form

TSazm = TSazm converted to one's complement form

$$\text{SCAXIS} = \begin{pmatrix} \text{sinTSelev} & & \\ \text{cosTSelev} & \text{sinTSazm} & \\ \text{cosTSelev} & \text{cosTSazm} & \end{pmatrix}$$

UYP' = unit(SCAXIS * K:UNITX) (= (0, cosTSazm, -sinTSazm))

UXP' = unit(UYP' * SCAXIS)

Return

GETMKS XXMARK = 00000_8

MARKCNTR = 0

Switch bits 15 thru 10 of MARKSTAT to 0

TS = K:V54N71 ("mark X or Y" verb; star code noun)

PASTIT Proceed to "GOMARK4"
(If terminate, proceed to "KILLAOT"; if proceed, proceed to "MARKCHEX"; if other response, proceed to "GETDAT".)

MARKRUPT (Entered on program interrupt initiated by the mark or mark reject buttons or by a commanded change in descent rate.)

TScdu = CDU

TSt = TIMENOW

If bit 6 or 7 of channel 16 = 1:
(Commanded change in rate of descent)

Proceed to "SOMEKEY"

If bit 12 of MARKSTAT = 1, Resume
(Processing of marks inhibited)

If MARKSTAT = 00000_8: (mark program not operating)

Perform "ALARM" with TS = 00112_8

Resume

If bit 5 of channel 16 = 1: (mark reject)

If FLAGWRD8 bit 8 (SURFFLAG) = 1:

If MARKCNTR > 0:

MARKCNTR = MARKCNTR - 1

Resume

Perform "ALARM" with TS = 00115_8

Resume

LOCSAM QMIN = return address

TSIGHT = TSt

Perform "LSPOS"

TDEC1 = TSIGHT

Perform "LEMPREC"

If PBODY = 0: (earth centered)

VMOON = unit(K:RSUBEM VMOON - RATT)

VEARTH = -unitRATT

CEARTH = cos(arcsin(K:RSUBE / |RATT|) + K:5DEGREES)

CMOON = K:CSS5

If PBODY = 2: (moon centered)

VSUN = unit(VSUN - K:ROE VMOON)

VEARTH = - unit(K:RSUBEM VMOON + RATT)

VMOON = - unitRATT

CMOON = cos(arcsin(K:RSUBM / |RATT|) + K:5DEGREES)

CEARTH = K:CSS5

CSUN = K:CSSUN

Return via QMIN

CHKSDATA Switch FLAGWRD0 bit 3 (FREEFLAG) to 1 (R54)

TSang = arccos($\underline{STARAD}_0 \cdot \underline{STARAD}_6$)

Switch FLAGWRD0 bit 3 (FREEFLAG) to 0

THETA = arccos($\underline{TS}_6 \cdot \underline{TS}_{12}$) - TSang

$DSPTEM1_{dp}$ = THETA

Switch FLAGWRD0 bit 3 (FREEFLAG) to 1

Proceed to "GOFLASH" with TS = K:V06N05 (DSPTEM1)
(If terminate, proceed to "GOTOPOOH"; if proceed, skip next step; if other response, continue at next step.)

Switch FLAGWRD0 bit 3 (FREEFLAG) to 0

Return

AXISGEN $\underline{TS1} = \underline{TS}_6$

$\underline{TS2} = \text{unit}(\underline{TS}_6 * \underline{TS}_{12})$

$\underline{TS3} = \underline{TS1} * \underline{TS2}$

$$[\text{RFSTMAT}] = \begin{bmatrix} TS1_x & TS1_y & TS1_z \\ TS2_x & TS2_y & TS2_z \\ TS3_x & TS3_y & TS3_z \end{bmatrix}$$

$\underline{TS1} = \underline{STARAD}_0$

$\underline{TS2} = \text{unit}(\underline{STARAD}_0 * \underline{STARAD}_6)$

$\underline{TS3} = \underline{TS1} * \underline{TS2}$

$$[\text{SMSTMAT}] = \begin{bmatrix} TS1_x & TS1_y & TS1_z \\ TS2_x & TS2_y & TS2_z \\ TS3_x & TS3_y & TS3_z \end{bmatrix}$$

$$[\text{DCMAT}] = [\text{SMSTMAT}]^T [\text{RFSTMAT}]$$

Unitize each of the three rows of DCMAT
(assure that it is orthogonal)

$\underline{STARAD}_0 = [\text{DCMAT}]^T \underline{K}:\text{UNITX}$

$\underline{STARAD}_6 = [\text{DCMAT}]^T \underline{K}:\text{UNITY}$

$\underline{STARAD}_{12} = [\text{DCMAT}]^T \underline{K}:\text{UNITZ}$

Return

PROG52 Perform "RO2BOTH"

If FLAGWRD2 bit 4 (PFRATFLG) = 1:

OPTION2 = 1 and skip next step

OPTION2 = 3 (REFSMMAT option)

(If MODREG = 70:)

Perform "COMMINIT" (initialize ascent targets)

Proceed to "INJTARG"

Switch FLAGWRD9 bit 9 (LETABORT) to 0

DVTHRUSH = K:THRESH2

Perform "P12INIT"

If FLAGWRD9 bit 8 (FLAP) = 1:

TGO1 = 2 TGO

TGO = TGO1

Proceed to the third step of "UPTHROT"

TGO = TIMENOW - TIG

INJTARG RDOTD = ABTRDOT

Y = RCO ($\underline{U}$NITR · $\underline{Q}$AXIS)

TS = |Y| - YLIM

If TS $\geq$ 0, YCO = TS signY

XRANGE = YCO - Y

Switch FLAGWRD9 bit 14 (FLVR) to 1

TS = (unit$\underline{R}$CSM * unit$\underline{R}$) · $\underline{W}$M

TS1 = signTS arccos(unit$\underline{R}$CSM · unit$\underline{R}$)

If TS1 $\geq$ THETCRIT:

Switch FLAGWRD9 bit 7 (ABTTGFLG) to 1

JPARM = J2PARM

KPARM = K2PARM

RP = THETCRIT (this step included only because of coding efficiency)

If TS1 $<$ THETCRIT:

JPARM = J1PARM

KPARM = K1PARM

RP = J2PARM (this step included only because of coding efficiency)

```
          RP = RCO
          Switch FLAGWRD9 bit 6 (ROTFLAG) to 1
UPTHROT   Perform "THROTUP"
          Switch FLAGWRD9 bit 8 (FLAP) to 1
          Perform "P40AUTO"
          Perform "THROTUP"
          Change job priority to 17                    (pr17)
          AVEGEXIT = "ATMAG"
          End job
THROTUP   THRUST = K:MAXTHRUST
          Switch bit 4 of channel 14 to 1
          Return
P12INIT   DV3 = K:DVA
          DV2 = K:DVA
          DV1 = K:DVA
          AT = K:ATA
          TBUP = K:TBUPA
          TTO = - K:ATDECAY
          VE = - K:APSVEX
          If FLAGWRD9 bit 8 (FLAP) = 1, return
COMMINIT  RCO = K:HINJECT + LANDMAG
          TXO = 0
          YCO = 0
          YDOTD = 0
          QAXIS = unit([REFSMMAT] (VRECTCSM * RRECTCSM) )
          Return
```

If FLAGWRD9 bit 6 (ROTFLAG) = 1:

TS = (unitUNFC · XNBPIP) - COSTHET1

If TS < 0:

TS = (XNBPIP · UNITR) - COSTHET2

If TS < 0:

UNFC = UNITR

Proceed to "ASCTERM"

Switch FLAGWRD9 bit 6 (ROTFLAG) to 0

Switch DAPBOOLS bit 9 (XOVINHIB) to 0 (allow x-axis override)

If FLAGWRD9 bit 13 (P7071FLG) = 0:

Switch FLAGWRD3 bit 11 (NOR29FLG) to 0

ASCTERM If FLAGWRD9 bit 10 (FLRCS) = 1:

End job

Perform "FINDCDUW"

ASCTERM1 If FLAGWRD9 bit 10 (FLRCS) = 1:

End job

If FLAGWRD8 bit 10 (FLUNDISP) = 1:

End job

Proceed to "GODSP" with TS = K:VQ6N63 (ABVEL, HDOTDISP, HCALC1)

ENGOFF1 Perform "ENGINOF2"

Establish "CUTOFF" (pr17)

End task

CUTOFF Switch FLAGWRD9 bit 10 (FLRCS) to 1

Proceed to "GOFLASH" with TS = K:V16N63 (ABVEL, HDOTDISP, HCALC1)
(If terminate, proceed to "TERMASC"; if proceed, continue with next step; if other response, repeat this step.)

Inhibit interrupts

Perform "ZATTEROR"

Perform "SETMINDB"

Release interrupt inhibit

Proceed to "GOFLASH" with TS = K:V16N85 (VGBODY)
(If terminate, proceed to "TERMASC"; if proceed, proceed to "TERMASC"; if other response, repeat this step.)

TERMASC Inhibit interrupts

Perform "RESTORDB"

Switch FLAGWRD9 bit 9 (LETABORT) to 0

Release interrupt inhibit

Proceed to "GOTOPOOH"

RPCOMP2 $RP = RMAG + RDOT\ TGO + \frac{PCONS\ TGO^2}{2\ TBUP} + \frac{PRATE\ TGO^3}{6\ TBUP}$

Return

ZDOTDCMP TS = (unitRCSM * unitR) · WM

TS1 = signTS arccos(unitRCSM · unitR)

RA = JPARM + KPARM TS1 - RP

If RA < RAMIN, RA = RAMIN

$ZDOTD = \sqrt{2\ K{:}MUMm37\ RA\ /\ (RA + RP)\ RP}$

Return

Quantities in Computations

ABDVCONV: Double precision magnitude of sensed change in velocity converted to units of meters per centisecond and scaled B5.

ABRTABLE: see WHICH of the BURN section.

ABTRDOT: Double precision erasable memory constant representing the radial rate required at insertion for aborts from powered descent, scaled B7 in units of meters per centisecond.

AH: Double precision intermediate computation, scaled B-9 in units of meters per centisecond squared.

AHMAG: Double precision intermediate computation, scaled B-9 in units of meters per centisecond squared.

AT: Double precision LM thrust acceleration magnitude, scaled B-9 in units of meters per centisecond squared.

ATP: Double precision intermediate computation, scaled B-9 in units of meters per centisecond squared.

ATPSQ: Double precision intermediate computation, scaled B-18 in units of meters squared per centiseconds to the fourth power.

ATR: Double precision required radial acceleration, scaled B-9 in units of meters per centisecond squared.

ATY: Double precision required crossrange acceleration, scaled B-9 in units of meters per centisecond squared.

AVEGEXIT: see SERV section.

COSTHET1: Double precision erasable memory constant, scaled B2 and unitless.

COSTHET2: Double precision erasable memory constant, scaled B2 and unitless.

DB: see DAPB section.

DISPDEX: see BURN section.

DRDOT, DYDOT, DZDOT: Double precision velocity-to-be-gained components in the radial, crossrange, and downrange directions respectively, scaled B7 in units of meters per centisecond.

DVCNTR: see SERV section.

DVTHRUSH: see SERV section.

DVO, DV1, DV2, DV3: Double precision quantities representing the reciprocal of successive PIPA readings, scaled B7 in units of centiseconds per meter; program notation 1/DVO, 1/DV1, 1/DV2, 1/DV3.

D12: Double precision intermediate computation, scaled B17 in units of centiseconds.

D21: Double precision intermediate computation, scaled B17 in units of centiseconds.

ENGOFFDT: Single precision delta time for engine cutoff, scaled B14 in units of centiseconds.

GDT1: see SERV section.

GEFF: Double precision effective gravity, scaled B-9 in units of meters per centiseconds squared.

HCALC1: See DESC section.

HDOTDISP: See SERV section.

JPARM: Double precision parameter used in the calculation of ZDOTD for aborts from the powered descent, scaled B24 in units of meters (see note following K2PARM). JPARM contains J1PARM or J2PARM.

J1PARM: Double precision parameter used in the calculation of ZDOTD for aborts where the LM to CSM phase angle is less than THETCRIT, scaled B24 in units of meters (see note following K2PARM); part of the erasable load.

J2PARM: Double precision parameter used in the calculation of ZDOTD for aborts where the LM to CSM phase angle is greater than or equal to THETCRIT, scaled B24 in units of meters (see note following K2PARM); part of the erasable load.

KPARM: Double precision parameter used in the calculation of ZDOTD for aborts from the powered descent, scaled B24 in units of meters per revolution (see note following K2PARM). KPARM contains K1PARM or K2PARM.

K1PARM: Double precision parameter used in the calculation of ZDOTD for aborts where the LM to CSM phase angle is less than THETCRIT, scaled B24 in units of meters per revolution (see note following K2PARM); part of the erasable load.

K2PARM: Double precision parameter used in the calculation of ZDOTD for aborts where the LM to CSM phase angle is greater than or equal to THETCRIT, scaled B24 in units of meters per revolution (see note below); part of the erasable load.

Note: JPARM and KPARM are considered in this document to be scaled B24; thus the erasable parameters J1PARM, J2PARM, K1PARM, K2PARM are expected to be multiplied by 2 and then scaled B24 (of course this is the same as scaling by B23) in order to introduce a factor of 2 into the equation which calculates RA.

K:APSVEX: Single precision constant stored as - 30.3 X 2^{-5}, scaled B5 in units of meters per centisecond. Equation value: - 30.3

K:ATA: Double precision constant stored as 3.2883 E-4 X 2^{9}, scaled B-9 in units of meters per centisecond squared; program notation (AT)A. Equation value: 3.2883 E-4

K:ATD: Double precision constant stored as 0.02, scaled B-2 in units of reciprocal centiseconds; program notation K(AT). Equation value: 0.005

K:ATDECAY: Double precision constant stored as - 18. X 2^{-28}, scaled B28 in units of centiseconds. Equation value: - 18.

K:ATRCS: Double precision constant stored as 0.785 E-4 X 2^{10}, scaled B-10 in units of meters per centisecond squared; program notation AT/RCS. Equation value: 0.785 E-4

K:DPSVEX: Single precision constant stored as - 29.5588868 X 2^{-5}, scaled B5 in units of meters per centisecond. Equation value: - 29.5588868.

K:DVA: Double precision constant stored as 15.2 X 2^{-7}, scaled B7 in units of centiseconds per meter; program notation (1/DV)A. Equation value: 15.2

K:DVD: Double precision constant stored as 436.7 X 2^{-9}, scaled B9 in units of kilogram-meters per centisecond-second; program notation K(1/DV). Constant corresponds to K:DPSVEX times K:MDOTDPS converted to the units shown above. Equation value: 436.7

K:HINJECT: Double precision constant stored as 18288. X 2^{-24}, scaled B24 in units of meters. Equation value: 18288. (equivalent to 60,000 feet)

K:MAXTHRUST: Single precision constant stored as 10000_8, scaled B14 in units of DPS throttle pulses; program notation BI^8T13. Equation value: 4096. (enough to oversaturate the throttle -- see THRUST)

K:MDOTDPS: Double precision constant stored as 0.148 X 2^{-3}, scaled B3 in units of kilograms per centisecond. Equation value: 0.148 (equivalent to 32.62 pounds mass per second.)

K:MINABDV: Double precision constant stored as 0.0356 X 2^{-5}, scaled B5 in units of meters per centisecond. Equation value: 0.0356

K:MOONRATE: Double precision constant stored as 0.2661699489 E-7 X 2^{19}, scaled B-19 in units of radians per centisecond. Equation value: 0.2661699489 E-7

K:MUMm37: Double precision constant stored as 4.902778 E 8 X 2^{-37}, scaled B37 in units of meters cubed per centisecond squared; program notation MUM(-37). Equation value: 4.902778 E 8

K:ONE: Single precision constant stored as 00004_8, scaled B12 and unitless; program notation BIT3H. Equation value: 1.0.

K:FRLIMIT: Double precision constant stored as - 0.0639, scaled B-21 in units of meters per centisecond cubed. Equation value: -0.3048 E-7.

K:RDOTDNOM: Double precision constant stored as 0.059436×2^{-7}, scaled B7 in units of meters per centisecond. Equation value: 0.059436. (Corresponds to 19.5 feet per second.)

K:TBUPA: Double precision constant stored as $91902. \times 2^{-17}$, scaled B17 in units of centiseconds; program notation (TBUP)A. Equation value: 91902.

K:TGOA: Double precision constant stored as $3.7 \text{ E } 4 \times 2^{-17}$, scaled B17 in units of centiseconds; program notation (TGO)A. Equation value: 3.7 E 4

K:THRESH2: Double precision constant stored as $308. \times 2^{-14}$, scaled B14 in units of centimeters per second. Equation value: 308.

K:T2A: Double precision constant stored as $200. \times 2^{-17}$, scaled B17 in units of centiseconds. Equation value: 200.

K:T3: Double precision constant stored as $1000. \times 2^{-17}$, scaled B17 in units of centiseconds. Equation value: 1000.

K:UNITZ: Double precision constant vector stored as (0, 0, 0.5), scaled B1 and unitless. Equation value: (0, 0, 1)

K:VINJNOM: Double precision constant stored as 16.7924×2^{-7}, scaled B7 in units of meters per centisecond. Equation value: 16.7924. (Equivalent to 5509.5 feet per second.)

K:10SECS: Double precision constant stored as 1000×2^{-28}, scaled B28 in units of centiseconds. Equation value: 1000.

K:100PCTTO: Double precision constant stored as 24×2^{-17}, scaled B17 in units of centiseconds. Equation value: 24.

K:100CS: Double precision constant stored as 200×2^{-18}, scaled B17 in units of centiseconds. Equation value: 100.

K:1DEGDB: Single precision constant stored as 00554_8, scaled B-3 in units of revolutions. Equation value: 0.00277. (Equivalent to 1 degree.)

K:2SEC: Implicit program constant equal to two (2) seconds.

K:2SEC18: Double precision constant stored as $200. \times 2^{-18}$, scaled B18 in units of centiseconds; program notation 2SEC(18). Equation value: 200.

K:2SEC9: Double precision constant stored as $200. \times 2^{-9}$, scaled B9 in units of centiseconds; program notation 2SEC(9). Equation value: 200.

R60LEM TEMPR60 = return address

If FLAGWRD5 bit 6 (3AXISFLG) = 0:

Perform "VECPOINT"

THETAD = TS

Switch FLAGWRD0 bit 4 (NEEDLFLG) to 1

Switch FLAGWRD0 bit 15 (NEED2FLG) to 0

Perform "BALLANGS"

TOBALLA Perform "GOPERF2R" with TS = K:V06N18 (display FDAI angles)
(If terminate, proceed to "R61TEST"; if proceed, proceed to "REDOMANC"; if other response, proceed to "ENDMANU1".)

Perform "CHKLINUS" (make display priority if necessary)

End job

REDOMANC If FLAGWRD5 bit 6 (3AXISFLG) = 0:

Perform "VECPOINT"

THETAD = TS

Perform "BALLANGS"

If bit 10 of channel 30 = 1 (not PGNCS control), or if bit 14 of channel 31 = 1 (not AUTO control mode):

Proceed to "TOBALLA" (not AUTO)

Perform "GODSPR" with TS = K:V06N18 (display FDAI angles)

Perform "CHKLINUS" (make display priority if necessary)

GOMANUR If ATTCADR $\neq$ 0:

$TS1_{dp}$ = address of last display ("TOBALL")

Proceed to "BAILOUT1" with TS = 31210_8

ATTCADR = calling address + 1, in 2CADR format

ATTPRIO = bits 14-10 of PRIORITY (pr37; the priority of calling job

Proceed to "KALCMAN3"

ENDMANUV Proceed to "TOBALLA"

ENDMANU1 Switch FLAGWRD5 bit 6 (3AXISFLG) to 0

Return via TEMPR60

R61TEST If MODREG = 0, proceed to "ENDMANU1"

If FLAGWRD4 bit 12 (PDSPFLAG) = 1, proceed to "TRMTRACK"

Proceed to "GOTOPOOH"

BALLANGS BALLEXIT = return address

Perform "CD*TR*GS" with ANG = THETAD

TS_z = arcsin(- SINOGA COSMGA)

SINTH = SINMGA

COSTH = COSOGA COSMGA

Perform "ARCTAN"

TS_x = THETA

COSTH = COSOGA COSIGA - SINMGA SINOGA SINIGA

SINTH = SINIGA COSOGA + SINMGA SINOGA COSIGA

Perform "ARCTAN"

TS_y = THETA

FDAI = TS converted to two's complement form

Return via BALLEXIT

TSa = TS - (K:K1VAL / MASS)

If TSa < 0:

TSt = (TS MASS + K:K2VAL) / K:K3VAL

Proceed to "S40.132"

TSb = F K:5SECS / (MASS - MDOT K:3.5SEC)

TSc = TSa - TSb

If TSc ≥ 0, proceed to "S40.13D" (TGO ≥ 6 seconds)

TSt = K:1SEC2D + K:5SECS TSa / TSb

Proceed to "S40.132"

S40.13D TS = TS MASS

If FLGWRD10 bit 13 (APSFLAG) = 1:

TSt = TS / K:FAPS

Proceed to second step of "S40.132"

TSt = TS / K:S40.136

Switch FLAGWRD5 bit 12 (NOTHROTL) to 0

If overflow ($TSt \geq 2^{14}$):

TGO = TS MASS / K:S40.136*

End job

If TSt < K:6SEC: (TGO < 6 seconds)

Proceed to "S40.132"

If TSt < (K:6SEC + K:89SECS): (TGO < 95 seconds)

Switch FLAGWRD5 bit 12 (NOTHROTL) to 1

Proceed to the second step of "S40.132"

S40.132 Switch FLAGWRD2 bit 9 (IMPULSW) to 1

TGO = $(0, TSt_{ms})$

End job

INITCDUW OGABIAS = 0

UNFV = K:UNITX

UNWC = K:UNITX

Return

FINDCDUW TSnewthrust = UNFC

QCDUWUSR = return address

NDXCDUW = bit 13 of DAPBOOLS (CSMDOCKD) (1 or 0)

FLPAUTNO = 1

FLAGOODW = bit 9 of DAPBOOLS (XOVINHIB) (1 or 0)

Inhibit interrupts

ANG = CDU

If bit 10 of channel 30 = 0 and bit 14 of channel 31 = 0:
(PGNCS control; DAP in Auto mode)

FLPAUTNO = 0

ANG = CDUD

Release interrupt inhibit

UNX = unitTSnewthrust (argument of unit operation adjusted to prevent overflow)

UNZ = unitUNWC

Perform "QUICTRIG"

If overflow (in either unit operation above), proceed to "NOATTCNT"

TS = unitDELV

If no overflow ($|DELV| \geq 2^{-7}$ cm/sec):

Perform "SMTONB"

TSdv = [SMNBMAT] TS

$TS = (TSdv_y - UNFV_y)\ K{:}GAINFLTR_{NDXCDUW}$

If $|TS| >$ K:DUNFVLIM, TS = K:DUNFVLIM signTS

(If no overflow:)

$UNFV_y = UNFV_y + TS$

If $|UNFV_y| > K{:}UNFVLIM$, $UNFV_y = K{:}UNFVLIM\ signUNFV_y$

$TS = (TSdv_z - UNFV_z)\ K{:}GAINFLTR_{NDXCDUW}$

If $|TS| > K{:}DUNFVLIM$, $TS = K{:}DUNFVLIM\ signTS$

$UNFV_z = UNFV_z + TS$

If $|UNFV_z| > K{:}UNFVLIM$, $UNFV_z = K{:}UNFVLIM\ signUNFV_z$

If FLAGOODW = 1:

If $(\underline{UNZ} \cdot \underline{UNX})^2 < K{:}DOTSWFMX$:

Proceed to "DCMCL"

FLAGOODW = 0

$\underline{UNZ} = \underline{ZNBPIP}$

If $(\underline{UNZ} \cdot \underline{UNX})^2 < K{:}DOTSWFMX$:

Proceed to "DCMCL"

FLAGOODW = 0

$\underline{UNZ} = -\underline{XNBPIP}$

DCMCL $\underline{UNY} = unit(\underline{UNZ} * \underline{UNX})$

$\underline{UNZ} = \underline{UNY} * \underline{UNX}$

$\underline{UNX} = unit(\underline{UNX} + UNFV_z\ \underline{UNZ} - UNFV_y\ \underline{UNY})$

$\underline{UNY} = \underline{UNX} * \underline{UNZ}$

$\underline{UNZ} = -\underline{UNY} * \underline{UNX}$

Perform "NB2CDUSP"

$TScdu_x = TScdu_x + OGABIAS$

If $|TScdu_z| > K{:}CDUZDLIM$:

$TScdu_z = K{:}CDUZDLIM\ signTScdu_z$

Perform "ALARM" with $TS = 00401_8$

Inhibit interrupts

$\underline{T}HETAD = \underline{T}Scdu$

$\underline{m}DELGMB = -(\underline{T}Scdu - \underline{C}DUD)$

If $mDELGMB_y^2 + K{:}HI5 > 0$, FLAGOODW = 0

If $mDELGMB_z^2 + K{:}HI5 > 0$, FLAGOODW = 0

If FLPAUTNO > 0 or if FLAGWRD5 bit 7 (ENGONFLG) = 0:

Proceed to the second step of "NOATTCNT"

i = NDXCDUW

If $|mDELGMB_z| > K{:}DAZMAX_i$, $mDELGMB_z = K{:}DAZMAX_i$ sign($mDELGMB_z$)

$TS = mDELGMB_y$ COSMGA

If $|TS| > K{:}DAYd2MAX_i$, $TS = K{:}DAYd2MAX_i$ signTS

$TSa = mDELGMB_y$

$mDELGMB_y = TS$ / COSMGA

TS = - SINMGA TSa - $mDELGMB_x$

If $|TS| > K{:}DAXMAX_i$, $TS = K{:}DAXMAX_i$ signTS

$mDELGMB_x = -TS$

If FLAGOODW = 0, $mDELGMB_x = 0$

$mDELGMB_x = mDELGMB_x$ - SINMGA $mDELGMB_y$

OMEGAPD = K:dvtoacc (- $mDELGMB_x$ - SINMGA $mDELGMB_y$)

OMEGAQD = K:dvtoacc (- COSOGA COSMGA $mDELGMB_y$ - SINOGA $mDELGMB_z$)

OMEGARD = K:dvtoacc (SINOGA COSMGA $mDELGMB_y$ - COSOGA $mDELGMB_z$)

$\underline{D}ELCDU = K{:}DTdDELT\ \underline{m}DELGMB$ (converted to two's comp. form)

$TS = |OMEGARD|$ OMEGARD K:biascale / 1JACCR

If $|TS| > K{:}DELERLIM$, $TS = K{:}DELERLIM$ signTS

DELRERROR = TS

DISPDEX: Single precision index controlling the function of "CLOKJOB" and "CLOKTASK", scaled B14 and unitless. "CLOKJOB" and "CLOKTASK" operate semi-independently of the guidance programs and the primary interface between them and guidance is DISPDEX.

DVCNTR, DVTHRUSH: See SERV section.

DVTOTAL: See SERV section. (Displayed by nouns 40 and 62 in "CLOKJOB".)

F: Double precision thrust expected during the burn, scaled B7 in units of kilogram meters per centisecond squared.

FLAGOODW: Single precision flag set or reset on every pass through "FINDCDUW" to indicate whether steering is or is not based on the desired window pointing vector; scaled B6 and unitless.

FLPASSO: See DESC section.

FLPAUTNO: Single precision flag set to indicate that the burn is not under automatic control and reset to indicate that the DAP control quantities are to be calculated, scaled B6 and unitless.

GCSM, GDT, GDT1: See SERV section.

GEOMSGN: See TRGL section.

GOBLTIME: Double precision storage for TIG, scaled B28 in units of centiseconds; used to bias the velocity-to-be-gained vector to offset the effect of gravity during an extented Lambert burn.

HCALC1, HDOTDISP: See SERV section. (Displayed by noun 63 in "CLOKJOB".)

IGNAOSQ, IGNAOSR: Single precision initial DAP bias acceleration estimates, scaled B-2 in units of revolutions per second squared; a pad loaded quantity.

K:1SEC2D: Double precision constant stored as 100×2^{-14}, scaled B14 in units of centiseconds. Equation value: 100.

K:200b29: Double precision constant stored as 100×2^{-28}, program notation 100B28, scaled B29 in units of centiseconds. Equation value: 200.

K:2pi+1: Double precision constant stored as $3.141592653 \times 2^{-2}$, scaled B1 in units of radians. Equation value: $\pi / 2$. Program notation: 2PI+3

K:2PI+3: Double precision constant stored as 3.14159653×2^{-2}, scaled B3 in units of radians per revolution. Equation value: 2π.

K:3.5SEC: Double precision constant stored as 350×2^{-13}, scaled B13 in units of centiseconds. Equation value: 350.

K:4SEC: Double precision constant stored as 400×2^{-17}, scaled B17 in units of centiseconds. Equation value: 400.

K:5SECDP: Double precision constant stored as 500×2^{-28}, scaled B28 in units of centiseconds. Equation value: 500.

K:5SECS: Double precision constant stored as 500×2^{-14}, scaled B14 in units of centiseconds. Equation value: 500.

K:6SEC: Double precision constant stored as 600 x 2^{-14}, scaled B14 in units of centiseconds. Equation value: 600.

K:89SECS: Double precision constant stored as 8900 x 2^{-14}, scaled B14 in units of centiseconds. Equation value: 8900.

K:APSVEX: Single precision constant stored as - 30.30 X 2^{-5}, scaled B5 in units of meters per centisecond. Equation value: - 30.30

K:ATDECAY: Double precision constant stored as - 18. X 2^{-28}, scaled B28 in units of centiseconds. Equation value: - 18.

K:biascale: Single precision constant stored as 02000_8, scaled B2 and unitless; program notation BIT11. Equation value: 0.25

K:CDUZDLIM: Single precision constant stored as 0.3888888888, scaled B-1 in units of revolutions. Equation value: 0.1944444444 (Equivalent to 70 degrees.)

K:D29.9SEC: Double precision constant stored as 2990. X 2^{-28}, scaled B28 in units of centiseconds. Equation value: 2990.

K:DAXMAX$_0$: Single precision constant stored as 0.11111111111, scaled B-1 in units of revolutions. Equation value: 0.05555555555 (Equivalent to 20 degrees.)

K:DAXMAX$_1$: Single precision constant stored as 0.01111111111, scaled B-1 in units of revolutions. Equation value: 0.00555555555 (Equivalent to 2 degrees.)

K:DAYd2MAX$_0$: Single precision constant stored as 0.05555555555, scaled B0 in units of revolutions. Equation value: 0.05555555555 (Equivalent to 20 degrees.)

K:DAYd2MAX$_1$: Single precision constant stored as 0.0055555555, scaled B0 in units of revolutions. Equation value: 0.0055555555 (Equivalent to 2 degrees.)

K:DAZMAX$_0$: Single precision constant identical to K:DAXMAX$_0$.

K:DAZMAX$_1$: Single precision constant identical to K:DAXMAX$_1$.

K:DELERLIM: Single precision constant stored as 0.05555555555, scaled B-1 in units of revolutions. Equation value: 0.02777777777 (Equivalent to 10 degrees.)

K:DOTSWFMX: Single precision constant stored as 0.93302 X 2^{-4}, scaled B4 and unitless. Equation value: 0.93302 (Equivalent to the square of the cosine of 15 degrees.)

K:DPSVEX: Single precision constant stored as - 29.5588868 x 2^{-5}, scaled B5 in units of meters per centisecond. Equation value: - 29.5588868.

K:DTdDELT: Single precision constant stored as 0.05, scaled B0 in units of guidance cycles per DAP cycle. Equation value: 0.05

MUdA, MUASTEER: See TRGL section.

MUDEX: see ORBI section.

NDXCDUW: Single precision index (0 or 1) to select the proper steering constants for LM alone or CSM-LM configuration, scaled B14 and unitless.

NVWORD1: Single precision cell used to specify either a V97 or V99 display.

$NVWORD_2$: See DINT section.

OGABIAS: Single precision quantity representing the outer gimbal angle bias for window pointing commands to account for window bending due to cabin pressurization. Set to zero in "INITCDUW" and changed to AZBIAS in P64 ("XNORM"). Scaled B-1 in units of revolutions.

OMEGAPD, OMEGAQD, OMEGARD: See DAPA section.

OUTOFPLN: See DESC section. (Displayed by noun 61 in "CLOKJOB".)

PBODY: See ORBI section.

PIPTIME, PIPTIME1: See SERV section.

PITCH: See ASCT section. (Displayed by noun 74 in "CLOKJOB".)

POINTVSM: See ATTM section.

QCDUWUSR: Single precision octal return address storage.

QTEMP, QTEMP1: Single precision octal return address storage.

RATT, VATT, TAT: See ORBI section.

RCSM, VCSM: See SERV section.

[REFSMMAT]: See COOR section.

RINIT, VINIT: See TRGL section.

RMAG: See ASCT section. Scaled B29 (earth) or B27 (moon) here.

RN, VN: See SERV section.

RTARG: See TRGL section.

RTIG, VTIG: See TRGX section.

RTX1, RTX2: See ORBI section.

SAVET: Double precision temporary storage cell for time information, scaled B28 in units of centiseconds.

SCAXIS: See ATTM section.

SINIGA, SINMGA, SINOGA: See COOR section.

[SMNBMAT]: See COOR section.

TDEC1: See ORBI section.

TDECAY: Double precision thrust decay time added to TGO, scaled B28 in units of centiseconds.

TEVENT: Double precision time-of-event for downlink information, scaled B28 in units of centiseconds.

TGO: Double precision predicted length of burn, scaled B28 in units of centiseconds.

THETAD: See IMUC section.

THRUST: See DESC section.

TIG: Double precision predicted time of ignition input to the burn routines, or predicted cutoff time, scaled B28 in units of centiseconds.

TIGSAVE: Double precision storage for the effective time of the last performance of the Lambert routine; scaled B28 in units of centiseconds.

TIMENOW: See EXVB section.

TNEWA: Double precision pad loaded quantity giving the Lambert cycle period; scaled B28 in units of centiseconds.

TNIT, TNITPREV: Double precision times used to determine the number of navigation cycles between successive entries into "S40.9", scaled B28 in units of centiseconds.

TPASS4: See TRGL section.

TRKMKCNT: See RNAV section

TTFDISP: See DESC section. (Displayed by noun 61 in "CLOKJOB".)

TTOGO: Double precision time until engine ignition (or cutoff), scaled B28 in units of centiseconds.

UNFC: Double precision desired thrust acceleration vector, with variable scaling in units of meters per centisecond squared and expressed in the Platform coordinate system.

UNFV: Double precision filtered value of the sensed thrust direction vector, scaled B1 and unitless, and expressed in what might best be called the "theoretical" body coordinate system. The X component is not used, but the Y and Z components are used to bias the desired thrust vector with respect to the spacecraft so that the desired direction of thrust passes through the center of gravity of the spacecraft.

UNITGOBL: Double precision vector used to bias the velocity-to-be-gained vector to offset the effect of gravity during an extended Lambert burn, scaled B1 and expressed in the Reference coordinate system.

UNITR: See SERV section.

UNWC: Double precision vector along the desired pointing direction of the landing window, scaling and units variable, expressed in the Platform coordinate system.

UT: Double precision unit vector in the direction of velocity to be gained, used to determine initial attitude for burns, scaled B1 and expressed in the Reference coordinate system.

UNX, UNY, UNZ: Double precision unit vectors along the desired directions of the three body axes, scaled B1 and expressed in the Platform coordinate system.

If bit 3 of channel 31 = 0, TJ_0 = K:minimptj (+P)

OLDPMIN = 1

NUMBERT = 4

If FLAGWRD5 bit 5 (AORBSFLG), NUMBERT = 5

Proceed to "PJETSLEC"

ZEROENBL $SAVEHAND_0$ = RHCQ

$SAVEHAND_1$ = RHCR

RHCP, RHCQ, and RHCR = 0

Perform "C13STALL" with interrupts inhibited

Switch bits 8 and 9 of channel 13 to 1
(Start RHC read and enable RHC counters)

Return

DETENTCK TS_{ch31} = channel 31

If TS_{ch31} bit 15 = 1 and DAPBOOLS bit 12 (OURRCBIT) = 0:

Proceed to "PURGENCY"

If TS_{ch31} bit 15 = 0 and DAPBOOLS bit 12 (OURRCBIT) = 1:

Switch RCSFLAGS bit 9 (JUSTIN) to 1

Proceed to "RATERROR"

If TS_{ch31} bit 15 = 0 and DAPBOOLS bit 12 (OURRCBIT) = 0:

Switch RCSFLAGS bit 9 (JUSTIN) to 1

PERROR = 0

Switch DAPBOOLS bit 12 (OURRCBIT) to 1

$DXERROR_{dp}$ = 0

$DYERROR_{dp}$ = 0

$DZERROR_{dp}$ = 0

PLAST = 0

QLAST = 0

RLAST = 0

(If TS_{ch31} bit 15 = 0 and DAPBOOLS bit 12 (OURRCBIT) = 0)

RHCQ = 0

RHCR = 0

Switch RCSFLAGS bits 10 and 11 to 0

Perform "ZEROENBL"

Proceed to "JETSOFF"

If TS_{ch31} bit 15 = 1 and DAPBOOLS bit 12 (OURRCBIT) = 1:

If RCSFLAGS bit 9 (JUSTIN) = 1:

If channel 31 bit 13 = 0, proceed to "RATEDAMP"

Switch RCSFLAGS bits 9 & 11 (JUSTIN & QRBIT) to 0

Proceed to "RATEDAMP"

If RCSFLAGS bit 10 (PBIT) = 1, proceed to "RATEDAMP"

If RCSFLAGS bit 11 (QRBIT) = 1, proceed to "RATEDAMP"

Switch DAPBOOLS bit 12 (OURRCBIT) to 0

If channel 31 bit 13 = 1:

$CDUD_x = CDU_x$

Proceed to "PURGENCY"

Perform "ZATTEROR"

proceed to "PURGENCY"

RATERROR $CDUD_x = CDU_x$

TSp = PLAST

PLAST = STIKSENS (RHCP |RHCP| + K:LINRAT RHCP)

TS1 = PLAST - TSp

Perform "ZEROENBL"

EDOT = OMEGAP - PLAST

DIGITAL AUTOPILOT PHASE PLANE LOGIC

1/ACCSET AOSQ and AOSR = 0 (most significant halves of d.p. words)

ALPHAQ and ALPHAR = 0

1/ACCJOB Perform "1/ACCS"

End Job

1/ACCS DOCKTEMP = bit 13 of DAPBOOLS (CSMDOCKD)

LEMMASS = MASS

If DOCKTEMP = 1, LEMMASS = MASS - CSMMASS

Inhibit interrupts

If FLGWRD10 bit 13 (APSFLAG) = 1: (ascent or lunar surface)

2JETLIM = K:nomaxjts

i = 12

If LEMMASS < K:LOASCENT, LEMMASS = K:LOASCENT

If LEMMASS ≥ HIASCENT, LEMMASS = HIASCENT

If FLGWRD10 bit 13 (APSFLAG) = 0:

2JETLIM = K:2jlimdwn

i = 6

If LEMMASS < K:LODESCNT + HIASCENT:

LEMMASS = K:LODESCNT + HIASCENT

If LEMMASS ≥ K:HIDESCNT, LEMMASS = K:HIDESCNT

MASS = LEMMASS

If DOCKTEMP = 1, MASS = LEMMASS + CSMMASS

Release interrupt inhibit

If DOCKTEMP = 1, proceed to "DOCKED"

i = i - 2

1JACCR = $K:INERCONB_i + K:INERCONA_i/(LEMMASS + K:INERCONC_i)$

i = i - 2

1JACCQ = K:INERCONB$_i$ + K:INERCONA$_i$ / (LEMMASS + K:INERCONC$_i$)

i = i - 2

1JACCP = K:INERCONB$_i$ + K:INERCONA$_i$ / (LEMMASS + K:INERCONC$_i$)

Perform "COMMEQS" (see pg. DAPB - 22)

1JACCU = - COEFFQ 1JACCQ + COEFFR 1JACCR (rescaled to B-2)

If i > 0: (ascent)

ALLOWGTS = 0

INGTS = 0

Proceed to "1/ACCONT"

LPVTARM = K:LconB + K:LconA / (LEMMASS + K:LconC)

MPAC$_0$ = (K:dvtoacc ABDELV MASS / K:GFACTM) LPVTARM (limited)

Inhibit interrupts

ACCDOTR = MPAC$_0$ 1JACCR / K:TORKJET1 (limited)

ACCDOTQ = MPAC$_0$ 1JACCQ / K:TORKJET1 (limited)

Proceed to "SPSCONT"

DOCKED MPAC$_0$ = K:inrtcofC LEMMASS CSMMASS + K:inrtcofF

MPAC$_0$ = MPAC$_0$ + (K:inrtcofA CSMMASS + K:inrtcofD) CSMMASS

MPAC$_0$ = MPAC$_0$ + (K:inrtcofB LEMMASS + K:inrtcofE) LEMMASS

MPAC$_1$ = MPAC$_0$

MPAC$_0$ = K:cgcoefC LEMMASS CSMMASS + K:cgcoefF

MPAC$_0$ = MPAC$_0$ + (K:cgcoefA CSMMASS + K:cgcoefD) CSMMASS

MPAC$_0$ = MPAC$_0$ + (K:cgcoefB LEMMASS + K:cgcoefE) LEMMASS

1JACCP = K:1JACCON / MASS (limited)

1dANET$_{-14}$ = K:posmax

1dANET$_{+2}$ = K:posmax

SPSRCS i = AXISCTR + 1

If $TJ_i = 0$:

OLDSENSE = 0

Proceed to "SPSSTART"

OLDSENSE = 1 signTJ_i

TS_1 = - OLDSENSE EDOT

If DAPBOOLS bit 8 (DRIFTBIT) = 0: (powered flight)

$TS_1 = TS_1$ + K:RATEDB1

If $TS_1 > 0$, proceed to 2nd line of "POSTHRST"

SPSSTART If |EDOT K:RATELIM1| ≥ 1: (check to see if outer rate limit has been exceeded)

TS_t = - 0.5 signEDOT

Proceed to "POSTHRST"

TS_2 = DKDB (K:m3tom1 EDOT + E)

TSt = 0

If $|TS_2| < 1$, proceed to "POSTHRST" (E will be less than the deadband within 4 seconds without firing)

If $TS_2 < 0$ and EDOT ≤ K:RATELIM2, TSt = 0.5

If $TS_2 > 0$ and EDOT >-K:RATELIM2, TSt = - 0.5 (if within the inner rate limit fire toward it)

POSTHRST TJ_i = K:BOtoB10 TSt

```
            If OLDSENSE = 0, proceed to "CTRCHECK"
            If OLDSENSE > 0:
                TS = TJ_i
                Skip next step
            TS = - TJ_i                    (OLDSENSE < 0)
            If TS > 0, return
            PJETCTR_i = K:UTIME_i
            TJ_i = 0
            Return
CTRCHECK    If PJETCTR_i = 0, return
            TJ_i = 0
            Return
RESTORDB    If DAPBOOLS bit 5 (DBSLECT2) = 1, proceed to "SETMAXDB"
            If DAPBOOLS bit 4 (DBSELECT) = 0, proceed to "SETMINDB"
            DB = K:POWERDB
            Proceed to 2nd step of "SETMAXDB"
SETMINDB    DB = K:NARROWDB
            Establish "1/ACCJOB"                                  (pr27)
            Return
SETMAXDB    DB = K:WIDEDB
            Establish "1/ACCJOB"                                  (pr27)
            Return
PFLITEDB    Perform "ZATTEROR"
            DB = K:POWERDB
            Establish "1/ACCJOB"                                  (pr27)
            Return
```

(Entered from a verb 48, this is Routine 03)

DAPDATA1 DAPDATR1 = bits 13, 11, 10, 7, 5, 4, 2 and 1 of DAPBOOLS (CSMDOCKD,ACC4OR2X,AORBTRAN, RHCSCALE, DBSLECT2,DBSELECT, AUTRATE2,AUTRATE1)

If FLGWRD10, bit 13 = 1: DAPDATR1, bit 14 = 0, otherwise DAPDATR1 bit 14 = 1

If DAPDATR1, bits 13 and 14 = 0, set bit 13 of DAPDATR1 = 1

Perform "GOXDSPFR" with TS = K:V01N46 (display DAPDATR1)
(If terminate, proceed to "ENDEXT"; If proceed, proceed to "DPDAT1"; other response, skip next two steps)

Perform "BLANKET" with TS = 00006_8

End job

DAPDATR1 = bits 14, 13, 11, 10, 7, 5, 4, 2 and 1 of DAPDATR1

Proceed to third step of "DAPDATA1"

DPDAT1 Inhibit interrupts

FLGWRD10, bit 13 = complement of DAPDATR1, bit 14

If DAPDATR1, bits 13 and 14 $\neq$ 1, bit 13 of DAPDATR1 = 0

Set bits 13,11,10,7,5,4,2 and 1 of DAPBOOLS = bits 13,11,10,7, 5,4,2 and 1 of DAPDATR1

MASS = LEMMASS

If DAPBOOLS bit 13 = 1, MASS = MASS + CSMMASS

If DAPBOOLS bit 11 = 1, switch FLAGWRD1 bit 15 (NJETSFLG) to 0

If DAPBOOLS bit 11 (ACC4OR2X) = 0:

Switch FLAGWRD1 bit 15 (NJETSFLG) to 1

RATEINDX = bits 2 and 1 of DAPBOOLS

STIKLOAD STIKSENS = K:FINE

If DAPBOOLS bit 7 (RHCSCALE) = 1:

STIKSENS = STIKSENS + K:NORMAL

RATEDB = K:m0.6DdS

If DAPBOOLS bit 13 (CSMDOCKD) = 1:

STIKSENS = K:1d10 STIKSENS

RATEDB = K:m0.3DdS

Release interrupt inhibit

DAPDATA2 Perform "GOXDSPFR" with TS = K:V06N47 (LEMMASS, CSMMASS)
(If terminate, proceed to "ENDR03"; if proceed, skip next two steps; if other response, repeat this step.)

Perform "BLANKET" with TS = 00004_8

End Job

TS = K:MINMINLM (ascent)

If FLGWRD10 bit 13 (APSFLAG) = 0, TS = TS + K:MINLMD (descent)

If LEMMASS ≤ TS, proceed to "DAPDATA2"

MASS = LEMMASS

If DAPBOOLS bit 13 (CSMDOCKD) = 1:

If CSMMASS ≤ K:MINCSM, proceed to "DAPDATA2"

MASS = LEMMASS + CSMMASS

Perform "RESTORDB" with interrupts inhibited

If FLGWRD10 bit 13 (APSFLAG) = 1, proceed to "ENDEXT" (ascent)

Perform "GOXDSPFR" with TS = K:V06N48 (PITTIME, ROLLTIME)
(If terminate, proceed to "ENDEXT"; if proceed, skip next two steps; if other response, repeat this step)

Perform "BLANKET" with TS = 00004_8 (blank R3)

End Job

Call "TRIMGIMB" in 0.01 second

End Job

QUANTITIES IN COMPUTATIONS

$1dACOAST_{-16}$, $1dACOAST_{0}$, $1dACOAST_{16}$, $1dACOSTT_{0}$: Single precision inverse of magnitude of offset acceleration expected to oppose positive jet torques, scaled B8 in units of seconds squared per revolution. Limited to a maximum value. See description of storage sequence below.

$1dACOAST_{-15}$, $1dACOAST_{1}$, $1dACOAST_{17}$, $1dACOSTT_{1}$: Single precision inverse of magnitude of offset acceleration expected to oppose negative jet torques, scaled B8 in units of seconds squared per revolution. Limited to a maximum value. See description of storage sequence below.

$1dANET_{0}$, $1dANET_{16}$, $1dATEM1_{0}$, 1dATEMP: Single precision inverse of the 1-jet, net acceleration expected in a negative sense around an axis, scaled B8 in units of seconds squared per revolution. If this 1-jet acceleration cannot counteract an opposing offset acceleration and the required jets are not failed, the appropriate ACCSW is set to -1 and the inverse of the 2-jet, net acceleration is stored in this cell. See description of storage sequence below.

$1dANET_{1}$, $1dANET_{17}$, $1dATEM1_{1}$, 1dATEMP: Single precision inverse of the 1-jet, net acceleration expected in a positive sense around an axis, scaled B8 in units of seconds squared per revolution. If this 1-jet acceleration cannot counteract an opposing offset acceleration and the required jets are not failed, the appropriate ACCSW is set to 1 and the inverse of the 2-jet, net acceleration is stored in this cell. See description of storage sequence below.

$1dANET_{-14}$, $1dANET_{2}$, $1dANET_{18}$, $1dATEM1_{2}$, 1dATEMP: Single precision inverse of the 2-jet, net acceleration expected in a negative sense around an axis, scaled B8 in units of seconds squared per revolution. If a jet failure is present for the axis in question, the 1-jet, net acceleration is stored in this cell. See description of storage sequence below.

$1dANET_{-13}$, $1dANET_{3}$, $1dANET_{19}$, $1dATEM1_{3}$, 1dATEMP: Single precision inverse of the 2-jet, net acceleration expected in a positive sense around an axis, scaled B8 in units of seconds squared per revolution. If a jet failure is present for the axis in question, the 1-jet, net acceleration is stored in this cell. See description of storage sequence below.

1JACCP, 1JACCQ, 1JACCR: (Program notation also 1JACC, 1JACC +1, and 1JACC +2, respectively). Single precision angular accelerations expected from a single RCS jet fired around the P,Q and R axes, respectively; computed in "1/ACCS" or in "DOCKED" from empirical functions of the mass of the vehicle, scaled B-3 in units of revolutions per second squared.

1JACCU: Single precision angular acceleration expected from a single RCS jet fired around the U or V axes; computed from a function of 1JACCQ and 1JACCR and scaled B-2 in units of revolutions per second squared.

2JETLIM: See DAPA section.

ABDELV: Double precision magnitude of sensed change in velocity, scaled B14 in units of centimeters per second.

ABSAOS: Single precision magnitude of sensed offset acceleration, scaled B-2 in units of revolutions per second squared.

ACCDOTQ, ACCDOTR: Magnitude of rate of change of the offset acceleration; a function of inertia and c.g. position for the DPS whose gimbals are driven at a constant rate; zero for the APS which has no gimbals; scaled B-8 in units of revolutions per second cubed.

$ACCFCT_0$, $ACCFCT_{16}$, $ACFTEM_0$: Single precision function defining the intersection on the phase plane of two parabolic trajectories (paths of constant acceleration), scaled B8 in units of seconds squared per revolution. One trajectory corresponds to the 1-jet, net acceleration expected in a negative sense around an axis, and the other trajectory corresponds to the offset acceleration expected in a positive sense around an axis. If no offset acceleration is expected in a positive sense around the axis, the second parabola is based on a minimum acceleration and defines the minimum limit cycle that can be achieved. See description of storage sequence below.

$ACCFCT_1$, $ACCFCT_{17}$, $ACFTEM_1$: Single precision function defining the intersection on the phase plane of two parabolic trajectories (paths of constant acceleration), scaled B8 in units of seconds squared per revolution. One trajectory corresponds to the 1-jet, net acceleration expected in a positive sense around an axis, and the other trajectory corresponds to the offset acceleration expected in a negative sense around an axis. If no offset acceleration is expected in a negative sense around the axis, the second parabola is based on a minimum acceleration and defines the minimum limit cycle that can be achieved. See description of storage sequence below.

$ACCFCT_{-14}$, $ACCFCT_2$, $ACCFCT_{18}$, $ACFTEM_2$: Single precision function defining the intersection on the phase plane of two parabolic trajectories (paths of constant acceleration), scaled B8 in units of seconds squared per revolution. One trajectory corresponds to the 2-jet, net acceleration expected in a negative sense around an axis, and the other trajectory corresponds to the offset acceleration expected in a positive sense around an axis. If no offset acceleration is expected in a positive sense around the axis, the second parabola is based on a minimum acceleration and defines the minimum limit cycle that can be achieved. See description of storage sequence below.

K:inrtcofA, B, C, D, E and F: Six single precision coefficients of a curve fit of the form $Ax^2 + By^2 + Cxy + Dx + Ey + F$ used to find the approximate moment of inertia around an axis in the Q-R plane of the combined CSM LM.

	Program Notation	Stored Value	Scale Factor	Units	Equation Value
A	COEFF +3	-0.03709	B6	kg cm^2/rad kg^2	-2.37376
B	COEFF +2	-0.17670	B6	kg cm^2/rad kg^2	-1.13088 E1
C	COEFF +0	0.19518	B6	kg cm^2/rad kg^2	1.24915 E1
D	COEFF +5	0.02569	B22	kg cm^2/rad kg	1.07752 E5
E	COEFF +4	0.06974	B22	kg cm^2/rad kg	2.92511 E5
F	COEFF +1	-0.00529	B38	kg cm^2/rad	-1.45410 E9

K:LconA: Double precision constant, program notation INERCONA -2, stored as 0.0410511917, scaled B19 in units of kilograms feet per radian. Equation value: 21522.647

K:LconB: Single precision constant, program notation INERCONB -2, stored as 0.155044, scaled B3 in units of feet per radian. Equation value: 1.240352

K:LconC: Single precision constant, program notation INERCONC -2, stored as -0.025233, scaled B16 in units of kilograms. Equation value: -1653.7

K:LOASCENT: Single precision constant stored as 2200 x 2^{-16}; the lower bound on ascent stage mass, scaled B16 in units of kilograms. Equation value: 2200

K:LODESCNT: Single precision constant stored as 00666_8, scaled B16 in units of kilograms. It plus HIASCENT is the lower bound on the unstaged LM mass. Equation value 1752

K:m.1875: Single precision constant stored as 71777_8, but used in this writeup as though it were positive. Scaled B-2 with units of revs/sec^2. Equation value: 0.04687 (corresponds to 16.87 deg/sec^2)

K:m0.3DdS: Single precision constant stored as 77622_8, program notation -0.3D/S, scaled B-3 in units of revolutions per second. Equation value: 0.00083 (equivalent to 0.3 degrees per second)

K:m0.6DdS: Single precision constant, program notation -0.6D/S, stored as 77445_8, scaled B-3 in units of revolutions per second. Equation value: 0.00166 (equivalent to 0.6 degrees per second)

K:m3deg: Single precision constant stored as 75673_8. Scaled B-3 in units of revolutions. Equation value: -0.00833 (equivalent to -3 degrees)

K:m3toml: Constant implied in combining EDOT, scaled B-3 in units of revolutions per second, with E, scaled B-1 in units of revolutions; scale factor B2, units seconds. This is the inverse of the slope of the switch curves in the docked RCS phase plane. Equation value: 4

K:MINCSM: Single precision constant stored as 02000_8, scaled B16 in units of kilograms. Equation value: 4096

K:miniacc: Single precision constant, program notation -.03R/S2, stored as 77377_8, scaled B-2 in units of revolutions per second squared. Equation value: +0.0039 (corresponds to 0.02454 radians per second squared or $1.406^\circ/sec^2$)

K:minimpt: Single precision constant, stored as 00040_8, program notation BIT6, scaled B2 in units of seconds. Equation value: 2^{-7} (equivalent to 7.8 ms)

K:MINLMD: Single precision constant stored as 76466_8, but used as positive, scaled B16 in units of kilograms. Equation value: 2852.

K:MINMINLM: Single precision constant stored as 76731_8, but used as positive, scaled B16 in units of kilograms. Equation value: 2200.

K:NARROWDB: Single precision constant stored as 00155_8, scaled B-3 in units of revolutions. Equation value: 0.00083 (equivalent to 0.2994°)

K:nomaxjts: Single precision constant stored as 40000_8, scaled B-3 in units of revolutions per second. Equation value: +0.12499 (equivalent to 44.997 degrees per second)

K:NORMAL: Single precision constant stored as 25101_8, scaled B-15 in units of revolutions per second per RHC-count squared. Equation value: 0.000020148. See definition of STIKSENS in the DAPA Section.

K:POWERDB: Single precision constant stored as 00554_8, scaled B-3 in units of revolutions. Equation value: 0.00277 (equivalent to 1 degree)

K:RATEDB1: Single precision constant, stored as 00045_8, scaled B-3 in units of revolutions per second. Equation value: 0.0002823 (equivalent to $0.102^\circ/sec$)

K:RATELIM1: Single precision constant, stored as 00032_8, scaled B17 in units of seconds per revolution. Equation value: 208 or 1.0/0.0048 (equivalent to $1/1.73^\circ/sec$)

ABLOAD Perform "GETCOMP"

TS = low 2 bits of (TS shifted right 10)

If TS < 1, proceed to "DSPALARM" (noun has no 2nd component)

Perform "GETCOMP"

If bit 15 of TS = 1, proceed to "DSPALARM" ("no-load" noun)

VERBREG = K:VB21

Perform "UPDATVB"

Perform "REQDATX" (return is via REQRET after data entry)

VERBREG = K:VB22

Perform "UPDATVB"

Perform "REQDATY"

Bits 5 and 4 of DECBRNCH now indicate whether the numbers loaded were decimal (1) or octal (0). (See routine "BOTHSGN") If both are not the same (one component octal, the other decimal):

Proceed to "ALMCYCLE"

Perform "LODNNTAB"

Perform "PUTCOM" with DECOUNT = 0

Store TS from "PUTCOM" in address specified by NOUNADD

Perform "PUTCOM" with DECOUNT = 1

Store TS from "PUTCOM" in address specified by (1 + NOUNADD)

Proceed to "LOADLV"

ABCLOAD Perform "GETCOMP"

TS = low 2 bits of (TS shifted right 10)

If TS < 2, proceed to "DSPALARM" (noun has no 3rd component)

Perform "GETCOMP"

If bit 15 of TS = 1, proceed to "DSPALARM" ("no-load" noun)

VERBREG = K:VB21

Perform "UPDATVB"

Perform "REQDATX" (return is via REQRET after data entry)

VERBREG = K:VB22

Perform "UPDATVB"

Perform "REQDATY"

VERBREG = K:VB23

Perform "UPDATVB"

Perform "REQDATZ"

Bits 3, 4 and 5 of DECBRNCH now indicate whether the numbers loaded were decimal (1) or octal (0). If the three bits are not all 1 or all 0 (some components octal and some decimal):

Proceed to "ALMCYCLE"

Perform "LODNNTAB"

Perform "PUTCOM" with DECOUNT = 0

Store TS from "PUTCOM" in address specified by NOUNADD

Perform "PUTCOM" with DECOUNT = 1

Store TS from "PUTCOM" in address specified by (1 + NOUNADD)

Perform "PUTCOM" with DECOUNT = 2

Store TS from "PUTCOM" in address specified by (2 + NOUNADD)

If NOUNREG $\neq$ 7, proceed to "LOADLV"

Inhibit interrupts

TS = XREG - 30_8

If TS $\leq$ 0, proceed to "CHANBITS"

EBANK = bits 11-9 of XREG

NOUNADD = 01400_8 + (bits 8-1 of XREG)

Channel 1 = contents of location specified by NOUNADD

XREG = 1 (channel 1 is the computer L register)

TS = 1

CHANBITS If TS + 21_8 = 0, proceed to "BITSOFF2" (channel 7)

If ZREG $\leq$ 0:

Set those bits of $\text{channel}_{\text{XREG}}$ = 0 that are 1 in YREG

Proceed to "BITSOFF1"

Set those bits of $channel_{XREG}$ = 1 that are 1 in YREG

BITSOFF1 If XREG = 1 or XREG < 0, $E_{NOUNADD}$ = Channel 1 (computer L registe

BITSOFF2 Release interrupt inhibit

Proceed to "LOADLV"

GETCOMP If MIXBR = 1, TS = high 5 bits of NNTYPTEM

If MIXBR = 2, TS = high 5 bits of NNADTEM

Return

PUTCOM DECRET = return address

Set overflow indicator to 0

$MPAC_{dp}$ = (XREG + XREGLP), (YREG + YREGLP) or (ZREG + ZREGLP) according to whether DECOUNT = 0, 1 or 2

If MIXBR = 1, proceed to "PUTNORM"

i = DECOUNT + 1

NOUNCADR = low 11 bits of $IDADTEM_i$

EBANK = bits 11-9 of NOUNCADR

NOUNADD = (01400_8 + bits 8-1 of NOUNCADR) - DECOUNT

If DECBRNCH > 0: (decimal)

Perform "GETI" with TS = NNTYPTEM

SFTEMP1 = $K:SFINTAB_i$

Perform "GETI" with TS = RUTMXTEM

Proceed to "PUTDCSF2"

Perform "GETCOMP"

If bit 14 of TS = 1, proceed to "ALMCYCLE" (decimal only)

Perform "GETI" with TS = RUTMXTEM

If i = 4, 5, 7 or 10: (double precision noun)

Set (the more significant half of the double precision register specified by NOUNADD + DECOUNT) = 0

NOUNADD = NOUNADD + 1 (specify minor part)

Proceed to "PUTCOM2"

GETI i = high 5 bits (DECOUNT = 2), mid 5 bits (DECOUNT = 1) or low 5 bits (DECOUNT = 0) of TS shifted right 10, 5 or 0 places according to whether DECOUNT = 2, 1 or 0.

(i is of the form 000 000 000 0xx xxx_2)

Return

PUTNORM EBANK = bits 11-9 of NOUNCADR (NOUNCADR set in "TESTNN")

NOUNADD = 01400_8 + bits 8-1 of NOUNCADR

If DECBRNCH > 0: (decimal)

i = low 5 bits of NNTYPTEM

SFTEMP1 = $K:SFINTAB_i$

i = mid 5 bits of NNTYPTEM shifted right 5

Proceed to "PUTDCSF2"

Perform "GETCOMP"

If bit 14 of TS = 1, proceed to "ALMCYCLE" (decimal only)

i = mid 5 bits of NNTYPTEM shifted right 5

If i = 4, 5, 7 or 10: (double precision noun)

Set (the more significant half of the double precision register specified by NOUNADD) = 0

NOUNADD = NOUNADD + 1

Proceed to "PUTCOM2"

Table 1

Normal Nouns

Noun	K:NNADTAB (addresses are normally positive)	K:NNTYPTAB bits 15-13	bits 12-11	bits 10-6	bits 5-1
0	+0	0 0 0	0	0	0
1	-K:posmaxsp	0 0 0	2	1	0
2	-K:posmaxsp	0 0 0	2	3	0
3	-K:posmaxsp	0 0 0	2	2	2
4	DSPTEM1	0 0 0	0	10	4
5	DSPTEM1	0 0 0	0	10	4
6	OPTION1,OPTION2,OPTION3	0 0 0	2	0	0
7	XREG, YREG, ZREG	0 0 0	2	0	0
8	$ALMCADR_{dp}$, ERCOUNT	0 0 0	2	0	0
9	$FAILREG_{0,1,2}$	0 0 0	2	0	0
10	-1	0 0 0	0	0	0
11	TCSI	0 1 0	2	8	0
12	OPTIONX	0 0 0	1	0	0
13	TCDH	0 1 0	2	8	0
14	$DSPTEMX_{0,1,2}$	0 0 0	2	3	0
15	-0	0 0 0	0	0	0
16	$DSPTEMX_{dp}$	0 1 0	2	8	0
17	+0	0 0 0	0	0	0
18	FDAI	0 0 0	2	2	2
19	+0	0 0 0	0	0	0
20	CDU	0 0 0	2	2	2
21	PIPA	0 0 0	2	3	0
22	THETAD	0 0 0	2	2	2
23	+0	0 0 0	0	0	0
24	$DSPTEMX_{dp}$	0 1 0	2	8	0
25	$DSPTEM1_{0,1,2}$	0 0 0	2	3	0
26	$DSPTEM1_{0,1,2}$	0 0 0	2	0	0
27	SMODE	0 0 0	0	3	0
28	+0	0 0 0	0	0	0
29	+0	0 0 0	0	0	0
30	+0	0 0 0	0	0	0
31	+0	0 0 0	0	0	0
32	mTPER	0 1 0	2	8	0
33	TIG	0 1 0	2	8	0
34	$DSPTEM1_{dp}$	0 1 0	2	8	0
35	TTOGO	0 1 0	2	8	0
36	TIMENOW	0 1 0	2	8	0
37	TTPI	0 1 0	2	8	0
38	TET	0 1 0	2	8	0
39	+0	0 0 0	0	0	0

Table 2

Mixed Nouns

Noun	K:NNADTAB (bits 15,14,13 12-11, 10-1) i	K:IDADTAB $K:IDADTAB_i$ $K:IDADTAB_{i+1}$ $K:IDADTAB_{i+2}$	K:NNTYPTAB (binary)	K:RUTMXTAB (binary)
40	1 1 0 2 0	TTOGO VGDISP	01010 01010 00000	00111 00111 01001
41	1 1 1 1 3	DVTOTAL $DSPTEM1_0$ $DSPTEM1_1$ +0	00000 01011 00010	00000 00011 00010
42	0 1 0 2 6	HAPO HPER	01010 01000 01000	00111 00111 00111
43	0 1 0 2 9	VGDISP LAT LONG	01000 00100 00100	00111 01010 01010
44	1 1 0 2 12	ALT HAPOX HPERX	00000 01000 01000	01001 00111 00111
45	1 1 0 2 15	TFF TRKMKCNT TTOGO	00100 00000 00000	01010 01001 00011
46	0 0 0 0 18	pMGA DAPDATR1 +0	00000 00000 00000	00000 00000 00000
47	0 1 0 1 21	+0 LEMMASS CSMMASS	00000 00110 00110	00000 01011 01011
48	0 1 0 1 24	+0 PITTIME ROLLTIME	00000 10111 10111	00000 00011 00011
49	0 1 0 2 27	+0 R22DISP R22DISP+2	00000 01010 01000	00011 00111 00111
50	0 0 0 0 0	WHCHREAD +0 +0	00000 00000 00000	00000 00000 00000
51	0 1 0 1 33	+0 ALPHASB BETASB	00000 00100 00100	00000 01010 01010
52	0 0 0 0 36	+0 ACTCENT +0	00000 00000 00100	00000 00000 01010
53	0 0 0 0 0	+0 +0 +0 +0 +0	00000 00000 00000	00000 00000 00000

Table 2 continued

Noun	K:NNADTAB	K:IDADTAB	K:NNTYPTAB	K:RUTMXTAB
54	0 1 0 2 42	RANGE RRATE RTHETA	00100 01010 00111	01010 00111 00100
55	0 1 0 2 45	NN ELEV CENTANG	00100 00100 00000	01010 01010 00011
56	0 0 0 1 48	RR-AZ RR-ELEV +0	00000 00100 00100	00000 01010 01010
57	0 0 0 0 0	+0 +0 +0	00000 00000 00000	00000 00000 00000
58	0 1 0 2 54	POSTTPI DELVTPI DELVTPF	01010 01010 01000	00111 00111 00111
59	0 1 0 2 57	$DVLOS_x$ $DVLOS_y$ $DVLOS_z$	01010 01010 01010	00111 00111 00111
60	0 1 0 2 60	FORVEL HDOTDISP HCALC1	11000 01010 10001	00100 00111 00011
61	1 1 0 2 63	TTFDISP TTOGO OUTOFPLN	10110 00000 00000	01010 01001 01001
62	1 1 0 2 66	ABVEL TTOGO DVTOTAL	01010 00000 01010	00111 01001 00111
63	0 1 0 2 69	ABVEL HDOTDISP HCALC1	11000 01010 01010	00100 00111 00111
64	1 1 0 2 72	FUNNYDSP HDOTDISP HCALC	11000 01010 00000	00100 00111 01100
65	0 1 0 2 75	SAMPTIME SAMPTIME SAMPTIME	00000 00000 00000	01000 01000 01000
66	1 1 0 1 78	$RSTACK_6$ LR position bits of channel 33 +0	00000 00000 01110	00000 00110 00100
67	0 0 0 2 81	$RSTACK_0$ $RSTACK_2$ $RSTACK_4$	10101 10100 10011	00100 00100 00100
68	1 1 0 2 84	RANGEDSP TTFDISP DELTAH	11000 00000 10110	00100 01001 01010
69	0 1 0 2 87	DLANDZ DLANDY DLANDZ	11000 11000 11000	00100 00100 00100

Table 2 continued

Noun	K:NNADTAB	K:IDADTAB	K:NNTYPTAB	K:RUTMXTAB
70	0 0 0 2 90	AOTCODE $AOTCODE_1$ $AOTCODE_2$	00000 00000 00000	00000 00000 00000
71	0 0 0 2 93	AOTCODE $AOTCODE_1$ $AOTCODE_2$	00000 00000 00000	00000 00000 00000
72	0 0 0 1 96	CDU_t CDU_s +0	00000 00010 00010	00000 00010 01101
73	0 0 0 1 99	$TANG_0$ $TANG_1$ +0	00000 00010 00010	00000 00010 01101
74	1 1 0 2 102	TTOGO YAW PITCH	00100 00100 00000	01010 01010 01001
75	1 1 0 2 105	DIFFALT T1TOT2 T2TOT3	00000 00000 01000	01001 01001 00111
76	0 1 0 2 108	ZDOTD RDOTD XRANGE	01000 01010 01010	00111 00111 00111
77	1 1 0 1 111	TTOGO YDOT +0	00000 01010 00000	00000 00111 01001
78	**1 1 0 2 114**	**DNRRANGE** **DNRRDOT** **TTOTIG**	00000 01101 01100	**01001 01111 01110**
79	0 1 0 2 117	CURSOR SPIRAL POSCODE	00000 00010 00010	00011 00010 00010
80	0 0 0 1 120	DATAGOOD OMEGDISP +0	00000 00100 00000	00000 01010 00011
81	0 1 0 2 123	$DELVLVC_x$ $DELVLVC_y$ $DELVLVC_z$	01010 01010 01010	00111 00111 00111
82	0 1 0 2 126	$DELVLVC_x$ $DELVLVC_y$ $DELVLVC_z$	01010 01010 01010	00111 00111 00111
83	0 1 0 2 129	$DELVIMU_x$ $DELVIMU_y$ $DELVIMU_z$	01010 01010 01010	00111 00111 00111
84	0 1 0 2 132	$DELVOV_x$ $DELVOV_y$ $DELVOV_z$	01010 01010 01010	00111 00111 00111

Table 2 continued

Noun	K:NNADTAB	K:IDADTAB	K:NNTYPTAB	K:RUTMXTAB
85	0 1 0 2 135	$VGBODY_x$ $VGBODY_y$ $VGBODY_z$	01010 01010 01010	00111 00111 00111
86	0 1 0 2 138	DELVLVCx DELVLVCy DELVLVCz	01010 01010 01010	00111 00111 00111
87	0 0 0 1 141	ΔZ EL +0	00000 00010 00010	00000 00010 00010
88	0 1 0 2 144	$STARAD_{0x}$ $STARAD_{0y}$ $STARAD_{0z}$	00000 00000 00000	00001 00001 00001
89	0 1 0 2 147	LANDLAT LANDLONG LANDALT	00111 00011 00011	00100 00111 00111
90	0 1 0 2 150	RANGE RRATE RTHETA	00100 01010 00111	01010 00111 00100
91	0 0 0 2 153	P21ALT P21VEL P21GAM	00100 01001 01000	01010 01010 00111
92	0 0 0 2 156	THRDISP HDOTDISP HCALC1	11000 01010 00000	00100 00111 00011
93	0 0 0 2 159	OGC IGC MGC	00011 00011 00011	00111 00111 00111
94	0 0 0 0 0	+0 +0 +0	00000 00000 00000	00000 00000 00000
95	0 0 0 0 0	+0 +0 +0	00000 00000 00000	00000 00000 00000
96	0 0 0 0 0	+0 +0 +0	00000 00000 00000	00000 00000 00000
97	0 0 0 2 171	DSPTEM1 $DSPTEM1_1$ $DSPTEM1_2$	00000 00000 00000	00011 00011 00011
98	0 0 0 2 174	DSPTEM2 $DSPTEM2_1$ $DSPTEM2_2$	00000 00000 00000	00011 00001 00011
99	0 1 0 2 177	WWPOS WWVEL WWBIAS	11100 11011 11010	01010 00101 00111

Table 3

Input/Output Scaling

Each description in the table is arranged in the following order:

Equation value
Scale factor and units
Stored value
(comment)

Index	K:SFINTABi	K:SFOUTABi
0	10^5 B28, unitless 000006_8 032408	10^{-5} B-14, unitless 051748 132618
	(used with nouns 2,14,21,25,27,45,49,55,79,80,92,97,98)	
1	+0	+0 (not used)
2	0 B-1, revolutions 0	+0
	(used with nouns 3,18,20,22,41,72,72,79,87)	
3	when used with noun 89	
	$(100 / 360) +2^{-28}$ B0, revolutions per degree 107078 034358	360 / 100 B7, degrees per revolution 007148 314638
3	when used with noun 93	
	$(100 / 360) 2^{-21} +2^{-7}$ B-21, gyro torque pulses/deg 107078 034358	2^{21} 360 / 100 B28 degrees per gyro pulse 007148 314638
4	$(1000 / 360) +2^{-25}$ B3, revolutions per degree 130708 343458	360 / 100 B0, degrees per revolution 134128 075348
	(used with nouns 4,5,43,45,51,52,55,56,74,80,90,91)	
5	1000 / 360 B13, revolutions per degree 000058 216168	360 / 1000 B1, degrees per revolution 056058 036568
	(not used)	

Index	K:SFINTAB$_i$	K:SFOUTAB$_i$
6	10^5 x 0.45359237 B16, kilograms per pound 26113_8 31713_3	2.2046268 / 10^5 B-2, pounds per kilogram 00001_8 16170_8
	(used with noun 47)	
7	1852 x 10^3 B29, meters per nmi 00070_8 20460_8	5.3996 x 10^{-4} / 10^3 B-15, nmi per meter 00441_8 34306_8
	(used with nouns 54,89,90)	
8	1852 x 10^4 B29, meters per nmi 01065_8 05740_8	5.3996 x 10^{-4} / 10^4 B-22, nmi per meter 07176_8 21603_8
	(used with nouns 42, 43, 44, 49, **58, 75, 76, 91**)	
9	(0.3048 / 100) x 10^5 B10, meters/cs per fps 11414_8 31463_8	(100 / 0.3048) x 10^5 B0 , fps per meter/cs 15340_8 15340_8 (equal halves)
	(used with noun 91)	
10	(0.3048 / 100) x 10^4 B7, meters/cs per fps 07475_8 16051_8	(100 / 0.3048) 10^{-4} + 2^{-21} B0, fps per meter/cs 01031_8 21032_8
	(used with nouns 40,42,49,54,58,59,60,62,63,64,76,77,81-86,90,92)	
11	10^2 / 360 B12, revolutions per degree 00001_8 03434_8	360 / 10^2 B2, degrees per revolution 34631_8 23146_8
	(used with noun 41)	
12	10^3 / 2.859026 B28, RR range counts per nmi 00047_8 21135_8	2.859024 / 10^3 B-14 nmi per RR range count 00636_8 14552_8
	(used with noun 78)	
13	-1.59286 x 10^5 B28, RR rate counts per fps 77766_8 50711_8	-0.6278 / 10^5 B-14, fps per RR rate count 74552_8 70307_8
	(used with noun 78)	

Index	K:SFINTAB$_i$	K:SFOUTAB$_i$
14	10^5 / 1.0790 B28, LR alt counts per foot 0.9267840599 E5 x 2^{-28} (used with noun 66)	1.0790 / 10^5 B-14, feet per LR alt count 1.079 E-5 x 2^{14}
15	10^5 / 2.345 B28, bits per foot 00002_8 23224_8 (not used)	2.345 / 10^5 B-14, feet per bit 14226_8 31757_8
16	10^5 / 0.5 B28, bits per fps 00014_8 06500_8 (not used)	0.5 / 10^5 B-14, fps per bit 02476_8 05531_8
17	0.18125 x E5 B28, bits per fps 0.18125 E5 x 2^{-28} (used with noun 60)	5.517 / 10^5 B-14, fps per bit 5.517 E-5 2^{14}
18	10^5 / 360 B-11, rev per deg/sec 04256_8 07071_8 (not used)	360 / 10^5 B-3, deg/sec per rev 00007_8 13734_8
19	-1.55279503 x 10^5 B28, LRVX counts per fps -1.55279503 E5 x 2^{-28} (used with noun 67)	-0.6440 / 10^5 B-14, fps per LRVX count -0.6440 E-5 x 2^{14}
20	0.8250825087 x 10^5 B28, LRVY counts per fps 0.8250825087 E5 x 2^{-28} (used with noun 67)	1.212 / 10^5 B-14, fps per LRVY count 1.212 E-5 x 2^{14}
21	1.153668673 x 10^5 B28, LRVZ counts per fps 1.153668673 E5 x 2^{-28} (used with noun 67)	0.8668 / 10^5 B-14, fps per LRVZ count 0.8668 E-5 x 2^{14}

Index	K:SFINTAB$_i$	K:SFOUTAB$_i$
22	1852×10^4 B27, meters per nmi 043248_8 276008_8	$5.399568 \times 10^{-4} / 10^4$ B-24, nmi per meter 347728_8 070168_8
	(used with nouns 61,68)	
23	$10^3 / 0.002$ B28, centiseconds per deg 00036_8 20440_8	$0.002 / 10^3$ B-14, deg per centisecond 01030_8 33675_8
	(used with noun 48)	
24	0.3048×10^5 B24, meters per foot 00035_8 30400_8	$3.2808399 / 10^5$ B-10, feet per meter 01046_8 15700_8
	(used with nouns 60,63,64,68 ,69,92)	
25	10^4 B14, unitless 23420_8 00000_8	10^{-4} B-7, unitless 00321_8 26706_8
	(not used)	
26	30480 B19, meters per foot 30480×2^{-19}	17.2010499 B7, feet per meter 17.2010499×2^{-7}
	(used with noun 99)	
27	0.003048×10^4 B7, meters/cs per fps 30.48×2^{-7}	$328.08399 / 10^4$ B0, fps per meter 0.032808399
	(used with noun 99)	
28	100 B8, unitless 100×2^{-8}	$2^5 \times 10^{-2}$ B0, unitless 0.32
	(used with noun 99)	

Display Quantities

ABVEL: See SERV section.

ACTCENT: See TRGL section.

ALMCADR: See PGSR section.

ALPHASB: Same as PITCHANG, see EXVB section.

ALT: See COOR section.

AOTCODE: See ALIN section.

APO: See ASCT section.

AZ: See ALIN section.

BETASB: Same as YAWANG, see EXVB section.

CDU: See "Major Variables" section.

CDU_s: See RADR section.

CDU_t: See RADR section.

CENTANG: See TRGL section.

CSMMASS: See DAPB section.

CURSOR: See ALIN section.

DAPDATR1: See DAPB section.

DATAGOOD: See RNAV section.

DELTAH: See SERV section.

$DELVIMU_{x,y,z}$: See BURN section.

$DELVLVC_{x,y,z}$: See TRGX section.

$DELVOV_{x,y,z}$: See ORBI section.

DELVTPF: See TRGL section.

DELVTPI: See TRGL section.

DIFFALT: See TRGX section.

DLANDX,DLANDY,DLANDZ: See DESC section.

DNRRANGE: See RADR section.

DNRRDOT: See RADR section.

DSPTEMX: See DATA section.

DSPTEM1: See DATA section.

DSPTEM2: See DATA section.

$DVLOS_{x,y,z}$: See TRGL section.

DVTOTAL: See SERV section.

EL: See ALIN section.

ELEV: See TRGL section.

ERCOUNT: See TEST section.

FAILREG: See PGSR section.

FDAI: See ATTM section.

FORVEL: See SERV section.

FUNNYDSP: See DESC section.

HAPO: See TRGX section.

HAPOX: See EXVB section.

HCALC: See SERV section.

HCALC1: See SERV section.

HDOTDISP: See SERV section.

HPER: See TRGX section.

HPERX: See EXVB section.

IGC: See COOR section.

LANDALT: See ALIN section.

LANDLAT: See ALIN section.

LANDLONG: See ALIN section.

LAT: See COOR section.

LEMMASS: See DAPB section.

LONG: See COOR section.

MGC: See COOR section.

mTPER: See EXVB section.

NN: See TRGX section.

OGC: See COOR section.

OMEGDISP: See RNAV section.

OPTIONX: See EXVB section.

OPTION1: See DATA section.

OPTION2: See DATA section.

OUTOFPLN: See DESC section.

PIPA: See SERV section.

PITCH: See ASCT section.

PITTIME: See DAPB section.

pMGA: See TRGX section.

POSCODE: See ALIN section.

POSTTPI: See TRGL section.

P21ALT: See RNAV section.

P21GAM: See RNAV section.

P21VEL: See RNAV section.

RANGE: See EXVB section.

RANGEDSP: See DESC section.

RDOTD: See ASCT section.

ROLLTIME: See DAPB section.

RRATE: See EXVB section.

RR-AZ: See RNAV section.

RR-ELEV: See RNAV section.

RSTACK: See RNAV section.

RTHETA: See EXVB section.

R22DISP: See R22DISPR in RNAV section.

R22DISP+2: See R22DISPV in RNAV section.

SAMPTIME: See DSKY section.

SMODE: See TEST section.

SPIRAL: See ALIN section.

STARAD: See ALIN section.

TANG: See RADR section.

TCDH: See TRGX section.

TCSI: See TRGX section.

TET: See ORBI section.

TFF: See EXVB section.

THETAD: See COOR section.

THRDISP: See DESC section.

TIG: See BURN section.

TIMENOW: See EXVB section.

TRKMKCNT: See RNAV section.

TTFDISP: See DESC section.

TTOGO: See BURN section.

TTOTIG: See RADR section.

TTPI: See TRGL section.

T1TOT2: See TRGX section.

T2TOT3: See TRGX section.

VGBODY: See BURN section.

VGDISP: Same as DELVSAB, see BURN section.

WHCHREAD: See RNAV section.

WWBIAS: See RNAV section.

WWPOS: See RNAV section.

WWVEL: See RNAV section.

XRANGE: See ASCT section.

XREG: See DATA section.

YAW: See ASCT section.

YDOT: See ASCT section.

YREG: See DATA section.

ZDOTD: See ASCT section.

ZREG: See DATA section.

-K:posmaxsp: See "Major Variables" section.

Descent Guidance

P63LM

Perform "R02BOTH" (assure that IMU is operating)

WHICH = "P63TABLE"

DVTHRUSH = K:DPSTHRSH

DVCNTR = 4

WCHPHASE = - 1

FLPASSO = 0

Switch bit 14 of channel 12 to 0 (disable RR tracker)

Switch FLAGWRD5 bit 12 (NOTHROTL) to 0

Switch FLAGWRD6 bit 6 (REDFLAG) to 0

Switch FLGWRD11 bit 15 (LRBYPASS) to 0

Switch FLAGWRD6 bit 8 (MUNFLAG) to 1

Switch FLAGWRD0 bit 9 (P25FLAG) to 0

Switch FLAGWRD0 bit 7 (RNDVZFLG) to 0

TPIP = TLAND

TSt = TLAND

Perform "MOONMX"

$\underline{LAND} = [REFSMMAT]\ [MOONMAT]^T\ (\underline{RLS} + \underline{LM504} * \underline{RLS})$

TSt = TIMENOW

Perform "MOONMX"

$\underline{WM} = K{:}MOONRATE\ [REFSMMAT]\ [MOONMAT]^T\ (\underline{K}{:}UNITZ + \underline{LM504} * \underline{K}{:}UNITZ)$

$LANDMAG = |\underline{RLS}|$

TDEC1 = TLAND - K:GUIDDURN

Perform "LEMPREC"

NIGNLOOP = 40

$$[GCMAT] = \begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix}$$

DELTAH = K:99999CON

UNFC = 0

TTF = 0

IGNALOOP PIPTIME1 = TAT

R = [REFSMMAT] RATT

Perform "MUNGRAV" with TSr = R

GDT = GDT1

NGUIDSUB = 2

Proceed to the second step of "GUILDRET" (continues at "EXGSUB" after one iteration of guidance computations)

EXGSUB UNFC = K:TRIMACCL ZOOMTIME unitUNFC (argument of unit operation adjusted to prevent overflow)

If NGUIDSUB > 0:

NGUIDSUB = NGUIDSUB - 1

Proceed to "CALCRGVG"

If NIGNLOOP = 0:

Perform "ALARM" with TS = 01412_8

TS = 3313_8 (S-register portion of address of cell containing alarm pattern)

If NIGNLOOP > 0:

TS = NIGNLOOP - 1

NIGNLOOP = TS

TSden = VGU_z - DESKIGNX VGU_x

TSnum = (DESIGNRZ - RGU_z) + DESKIGNY RGU_y^2 + DESKIGNX (RGU_x - DESIGNRX)

TSv = DESKIGNV (|VGU| - DESIGNV)

TSt = (TSv + TSnum) / TSden

TDEC1 = PIPTIME1 + TSt

If $|TSt| \geq$ K:DDUMCRIT: (reiterate)

Perform "INTSTALL"

Switch FLAGWRD3 bit 4 (INTYPFLG) to 1

Switch FLAGWRD0 bit 12 (MOONFLAG) to 1

TET = PIPTIME1

RCV = RATT

VCV = VATT

Perform "INTEGRVS"

Proceed to "IGNALOOP"

TIG = TDEC1 - ZOOMTIME

OUTOFPLN = unit(V * R) · LAND

R60SAVE = UNFC

DISPDEX = - 21 (enable astronaut branch to "ASTNRET")

Perform "STCLOK3"

End job

ASTNRET Proceed to "GOPERF1" with TS = 00014_8
(If terminate, proceed to "GOTO^{8}POOH"; if proceed, continue at next step; if other response, skip next step.)

Perform "R51"

POINTVSM = unitR60SAVE

SCAXIS = K:UNITX

Perform "PFLITEDB" with interrupts inhibited

Perform "R60LEM"

If bit 6 of channel 33 = 1: (LR not in position #1)

Proceed to "GOPERF1" with TS = 00500_8
(If terminate, proceed to "GOTO^{8}POOH"; if proceed, continue at previous step; if other response, continue at next step.)

Perform "SETPOS1" (Initialize landing radar control)

Proceed to "BURNBABY"
(Standard pre-ignition sequence; initializes average-g navigation at TIG-30 seconds; calls "P63IGN" at time of ignition which sets AVEGEXIT to "LUNLAND" establishing the two-second guidance loop; calls "P63ZOOM" at throttle-up time.)

LUNLAND If FLAGWRD5 bit 8 (ZOOMFLAG) = 0: (R13)

Proceed to "DISPEXIT" (do display only; no throttle-up yet)

If MODREG = 66: (in P66)

If FLAGWRD1 bit 12 (RODFLAG) = 0:

Proceed to "STRTP66A"

Proceed to "VERTGUID"

If bit 13 of channel 31 = 0 and RODCOUNT $\neq$ 0:

Proceed to "STARTP66"

GUILDRET RODCOUNT = 0

TPIPOLD = TPIP

TPIP = PIPTIME1

TTFTMP = TTF

If FLPASSO $>$ 0, proceed to "TTFINCR"

Proceed to K:NEWPHASE$_{WCHPHASE}$
(TTFINCR, TTFINCR, STARTP64, P65START)

STARTP64 MODREG = 64

Establish "DSPMMJOB" (pr30)

TTFTMP = TTFTMP + DELTTFAP

Inhibit interrupts

Perform "C13STALL"

Switch bit 12 of channel 13 to 1 (enable RHC interrupt #10)

DB = K:P64DB

Switch FLAGWRD6 bit 6 (REDFLAG) to 0

Release interrupt inhibit

Proceed to "TTFINCR"

P65START MODREG = 65

Establish "DSPMMJOB" (pr30)

WCHVERT = 0

Switch DAPBOOLS bit 9 (XOVINHIB) to 0 (permit X-axis override)

TTFINCR TSt = TPIP - TPIPOLD (rescaled to B17 centiseconds)

LANDTEMP = LANDMAG unit(LAND - TSt LAND * WM) (argument of unit operation adjusted to prevent overflow)

TTFTMP = TTFTMP + TSt

TTF = TTFTMP

Perform "TDISPSET"

Change job priority to 31 (pr31)

LAND = LANDTEMP + DLAND

LANDMAG = | LAND |

DLAND = 0

Change job priority to 20 (pr20)

Proceed to K:PREGUIDE$_{WCHPHASE}$
(CALCRGVG, RGVGCALC, REDESIG, RGVGCALC)

REDESIG If FLAGWRD6 bit 6 (REDFLAG) or if TREDES = 0:

Proceed to "RGVGCALC"

Inhibit interrupts

$ELINCR_{dp}$ = (ELINCR1, 0)

$AZINCR_{dp}$ = (AZINCR1, 0) (AZINCR1 and ELINCR1 are updated in routines "PITFALL" and "REDESMON" which are called by program interrupt #10)

ELINCR1 = 0

AZINCR1 = 0

Release interrupt inhibit

TS = unit(LAND - R)

TS = TS + AZINCR YNBPIP - ELINCR TS * YNBPIP

If $TS_x \geq$ K:DEPRCRIT, TS_x = K:DEPRCRIT

$\underline{LANDTEMP}$ = LANDMAG unit($\underline{R}$ + $\underline{TS}$ ($LAND_x - R_x$) / TS_x)

$\underline{LAND}$ = $\underline{LANDTEMP}$

Proceed to "RGVGCALC"

CALCRGVG $\underline{V}$ = [REFSMMAT] $\underline{VATT}$ + $\underline{UNFC}$ (VATT used here is VATT1 scaled B5; see VATT of the ORBI section.)

RGVGCALC $\underline{ANGTERM}$ = $\underline{R}$ * $\underline{WM}$ + $\underline{V}$

$\underline{VGU}$ = [GCMAT] $\underline{ANGTERM}$

$\underline{TS}$ = $\underline{R}$ - $\underline{LAND}$

$\underline{RGU}$ = [GCMAT] $\underline{TS}$

RANGEDSP = |$\underline{RGU}$|

LOOKANGL = K:180degs ($arcsin_{sp}$(unit $\underline{TS}$ · $\underline{XNBPIP}$) + K:1d2DEG + ELBIAS)

Proceed to $K:WHATGUID_{WCHPHASE}$
(TTF/8CL, TTF/8CL, TTF/8CL, VERTGUID)

TTF/8CL LUNDEX = $K:TARGTDEX_{WCHPHASE}$ (0, 0, 28)

A_3 = $TTFJDGZ_{LUNDEX}$ (j_{DZG})

A_2 = $TTFADGZ_{LUNDEX}$ (6 a_{DZG})

A_1 = K:ttf6b3 VGU_z + $TTFVDGZ_{LUNDEX}$ (6 VGU_z + 18 v_{DZG})

$\underline{TS}$ = $\underline{TARGRDG}_{LUNDEX}$

A_0 = K:ttf24b6 ($TS_z - RGU_z$)

PREC = 2^{-7}

ROOTPS = TTF

n = 3

Perform "ROOTPSRS"

If PROJ2 $\leq$ 0, PROJ2 = 0

$UNWC_z$ = PROJ1 $GCMAT_{33}$ + PROJ2 $UNWC_z$

$UNWC_y$ = PROJ1 $GCMAT_{32}$ + PROJ2 $UNWC_y$

$UNWC_x$ = PROJ1 $GCMAT_{31}$ + PROJ2 $UNWC_x$

OGABIAS = AZBIAS

STEER? If FLAGWRD2 bit 11 (STEERSW) = 0:

If bit 13 of channel 31 = 1:

Perform "STOPRATE"

Proceed to "DISPEXIT"

EXVERT If overflow occured anywhere above:

Perform "ALARM" with TS = 01410_8

If bit 13 of channel 31 = 1:

Perform "STOPRATE"

Proceed to "DISPEXIT"

Perform "THROTTLE"

Perform "FINDCDUW"

DISPEXIT If FLAGWRD8 bit 10 (FLUNDISP) = 1, end job

Proceed to K:WHATDISP$_{\text{WCHPHOLD}}$
(---, P63DISPS, P64DISPS, VERTDISP)

P63DISPS Proceed to "REGODSP" with TS = K:V06N63 (ABVEL, HDOTDISP, HCALC1)

P64DISPS If TREDES = 0:

Switch FLAGWRD6 bit 6 (REDFLAG) to 0

Proceed to "REGODSP" with TS = K:V06N64

If FLAGWRD6 bit 6 (REDFLAG) = 1:

Proceed to "REGODSP" with TS = K:V06N64

Proceed to "REFLASH" with TS = K:V06N64 (FUNNYDSP, HDOTDISP, HCALC)
(If terminate, proceed to "GOTOPOOH"; if proceed , continue at next step; if other response, proceed to "P64DISPS".)

ELINCR1 = 0

AZINCR1 = 0

Switch FLAGWRD6 bit 6 (REDFLAG) to 1

End job

VERTDISP Proceed to "REFLASH" with TS = K:V06N60 (FORVEL, HDOTDISP, HCALC1)
(If terminate, proceed to "GOTOPOOH"; if proceed, continue at next step; if other response, continue at next step.)

Perform "ZATTEROR" with interrupts inhibited

End job

TDISPSET TTFDISP = K:TSCALINV TTF_{ms}

TSt = K:TREDESCL ($TCGF_{28}$ + TTF_{ms}) - 103

If TSt $\geq$ 0:

TREDES = 99

Return

TSt = TSt + 99

If TSt $\leq$ 0:

TREDES = 0

Return

TREDES = TSt

Return

STARTP66 MODREG = 66

Establish "DSPMMJOB" (pr30)

VDGVERT = HDOTDISP

STRTP66A TS = (PIPABIAS$_x$, PIPABIAS$_y$, PIPABIAS$_z$)

VBIAS = K:BIASFACT TS

Switch FLAGWRD1 bit 12 (RODFLAG) to 1

OLDPIPA = -TEM

DELVROD = 0

RODSCAL1 = RODSCALE

LASTTPIP = PIPTIME

FCOLD$_{sp}$ = 0

FWEIGHT$_{dp}$ = 0

WCHVERT = 2

WCHPHOLD = 2

WCHPHASE = 2

Perform "STOPRATE"

Switch DAPBOOLS bit 9 (XOVINHIB) to 0

Switch FLAGWRD6 bit 6 (REDFLAG) to 0

Proceed to "VERTGUID"

VERTGUID If WCHVERT = 0: (P65)

TSa = (V2FG - VGU) / TAUVERT (desired acceleration)

Proceed to "AFCCALC1"

If WCHVERT > 0: (P66)

Proceed to "P66VERT"

P66VERT Call "RODTASK" in 1.0 second (note that "RODCOMP" will be performed now and again in 1.0 second)

Proceed to "RODCOMP" (pr22)

RODTASK Establish "RODCOMP"

End task

RODCOMP Inhibit interrupts

VDGVERT = VDGVERT + RODCOUNT RODSCAL1 (activation of the R.O.D. switch causes routine "DESCBITS" to be entered which updates RODCOUNT)

RODCOUNT = 0

POLDPIPA = OLDPIPA

OLDPIPA = PIPA

THISTPIP = TIMENOW

TS_{sp} = OLDPIPA + PIPATMP

DELVROD = TEM - OLDPIPA + POLDPIPA

TS_{dp} = TS_{sp} (least significant components set to 0)

TEM = 0

Release interrupt inhibit

TS = K:KPIP1 TS_{dp}

TSdelt = THISTPIP - PIPTIME

$\underline{TSv} = (TSdelt / K{:}4SECb28)\ (\frac{1}{2}\ \underline{GDT} - \frac{1}{2}\ \underline{VBIAS}) + \underline{V} + \underline{TS}$ (updated velocity stored in PDL24-29 at B7 m/cs)

$HDOTDISP = \underline{TSv} \cdot unit\underline{R}$

$HCALC1 = TSdelt\ HDOTDISP + |\underline{R}| - LANDMAG$

$TS1 = (VDGVERT - HDOTDISP) / TAUROD$ (PDLO-1; B-2 m/cs^2)

$TS2 = |\underline{GDT}| / K{:}GSCALE$ (PDL20-21; B-2)

$TS3 = TS2 + TS1$ (PDLO-1; B-2)

Perform "CDUTRIG"

Perform "NBTOSM"

$\underline{TS} = [NBSMMAT]\ \underline{K}{:}UNITX$

$TS4 = \underline{TS} \cdot unit\underline{R}$ (PDL22-23; B2)

$AFCMAG = TS3 / TS4$

$TS1 = |K{:}KPIP1\ \underline{DELVROD} + \frac{1}{2}\ \underline{VBIAS}|$ (PDLO-1; B7)

$TSt3 = THISTPIP - LASTTPIP$ (PDL2-3; B28)

$LASTTPIP = THISTPIP$

$TSacc = TS1 / (TSt3 / K{:}SHFTFACT)$ (measured acceleration in PDLO-1 at B-4 m/cs^2)

$TS5 = (FWEIGHT\ K{:}BIT1H) / (MASS\ K{:}SCALEFAC) + TSacc$ (PDL2-3; B-4)

$AFCMAG = AFCMAG + LAGdTAU\ (\ (\ TS2 / TS4) - TS5)$ (PDL2-3; B-4)

$TSafcmax = MAXFORCE / MASS$ (PDL4-5; B-4)

$TSafcmin = MINFORCE / MASS$ (PDL6-7; B-4)

If $AFCMAG < TSafcmin$, $AFCMAG = TSafcmin$

If $AFCMAG \geq TSafcmax$, $AFCMAG = TSafcmax$

$TSthrot = TSacc$

Perform "THROTTLE" (starting at second step; return will be to the next step.)

Proceed to "DISPEXIT"

THROTTLE TSthrot = K:ABAFCNST ABDELV

RTNHOLD = return address

FP_{dp} = K:SCALEFAC MASS TSthrot

If $FP_{dp} \geq$ K:fmax, FP_{sp} = K:posmaxsp

$FCODD_{dp}$ = K:SCALEFAC MASS AFCMAG

If $FCODD_{dp} \geq$ K:fmax, $FCODD_{sp}$ = K:posmaxsp

FC = FCODD

TS = FC

If TS $\geq 2^{13}$ throttle pulses, truncate bits $\geq 2^{13}$

THRDISP = (TS / K:4FMAXNOM) 400

TSt = (less significant half of TIMENOW) - TTHROT

If TSt $\leq$ 0, TSt = 16384 + TSt

If TSt $<$ K:3SECS:

FP_{dp} = FP + FWEIGHT

PIFPSET = 0

If FCOLD $>$ HIGHCRIT:

If $FCODD_{sp} \leq$ LOWCRIT:

PIFPSET = FP_{sp} - K:FMAXODD

If $FCODD_{sp} >$ LOWCRIT:

FCODD = FP

PIFPSET = K:FEXTRA

If FCOLD $\leq$ HIGHCRIT:

If $FCODD_{sp} >$ HIGHCRIT:

FCODD = K:FMAXPOS

PIFPSET = K:FEXTRA

FCOLD = FCODD

PIF = FCODD - FP

Proceed to "DOIT"

A_i (i = 0,1,2,...): Double precision coefficients of the polynomial input to "ROOTPSRS", unitless and scaled B30, B13, B-4 and B-21 when generated in "TTF/8CL".

ABDELV, ABVEL: See SERV section.

AFCMAG: Double precision magnitude of desired thrust acceleration, program notation /AFC/, scaled B-4 in units of meters per centisecond squared.

ALPHAV: See COOR section.

ANGTERM: Double precision velocity of the LM vehicle relative to the rotating moon, scaled B9 in units of meters per centisecond and expressed in the Platform coordinate system.

AZBIAS: Single precision quantity representing the desired outer gimbal angle bias for window pointing commands in P64 to account for window bending due to cabin pressurization, scaled B-1 in units of revolutions; part of the erasable load.

AZINCR, AZINCR1: Double precision and single precision storage for the desired addition to the landing site azimuth, scaled B0 in units of radians.

DA_i (i = 0,1...): Double precision coefficients of the polynomial derivative of the polynomial input to "ROOTPSRS"; unitless and scaled B13, B-4, and B-21 when generated in response to the polynomial input from "TTF/8CL".

DAPBOOLS: see DAPA section.

DB: see DAPB section.

DELTAH: see SERV section.

DELTTFAP: Single precision time constant added to TTF at the start of P64, scaled B17 in units of centiseconds. DELTTFAP is a negative number and is part of the erasable load.

DELVROD: Double precision sensed-change-in-velocity vector for P66 (R.O.D.) computations, scaled B14 in units of centimeters per second.

DELVS: See SERV section.

DESIGNRX, DESIGNRZ: Double precision components of desired position relative to the landing site (desired crossrange position component is zero), scaled B24 in units of meters and expressed in the Descent Guidance coordinate system; program notations RIGNX and RIGNZ respectively; part of the erasable load.

DESIGNV: Double precision speed desired at ignition, relative to the rotating moon, scaled B10 in units of meters per centisecond; program notation VIGN, part of the erasable load.

DESKIGNV: Double precision speed error scale factor used in the ignition-time test quantity, scaled B18 in units of centiseconds; program notation KIGNV/B4; part of the erasable load.

DESKIGNX: Double precision landing site vertical error scale factor used in the ignition-time test quantity, scaled B4 and unitless; program notation KIGNX/B4; part of the erasable load.

DESKIGNY: Double precision crossrange error scale factor used in the ignition-time test quantity, scaled B-16 in units of meters to the minus one power; program notation KIGNY/B8; part of the erasable load.

DISPDEX: see BURN section.

DLAND: Double precision vector expressed in the Platform coordinate system representing the correction to the Landing site vector LAND, scaled B24 in units of meters. DLAND is padloaded to zero and may be loaded by the crew in Noun 69 in the order $DLAND_z$, $DLAND_y$, $DLAND_x$.

DVCNTR, DVTHRUSH: see SERV section.

DXCRIT: Double precision criterion for the convergence of the iterative calculation in "ROOTPSRS", with scaling and units identical to those of ROOTPS.

ELBIAS: Single precision quantity representing the LPD elevation angle bias used in calculating LOOKANGL to account for window bending due to cabin pressurization, scaled B-1 in units of revolutions; part of the erasable load.

ELINCR, ELINCR1: Double precision and single precision storage for the complement of the desired addition to landing site elevation, scaled B0 in units of radians. (Sign changed to compensate for the inversion of the cross product in "REDESIG".)

ELVIRA: Single precision storage for the status of the landing site redesignation discretes from channel 31.

FC: Single precision storage for the magnitude of desired thrust, scaled B14 in units of DPS throttle pulses.

FCODD: Double precision magnitude of desired thrust, scaled B14 in units of DPS throttle pulses. (The less significant half is not always maintained.)

FCOLD: Single precision magnitude of previous value of desired thrust, scaled B14 in units of DPS throttle pulses.

FLPASSO: Single precision flag set to zero at the beginning of a new guidance phase (except at the beginning of P66 or P67) to initialize guidance quantities for the new guidance phase.

FORVEL: see SERV section.

FP: Double precision estimate of the magnitude of the present thrust, scaled B14 in units of DPS throttle pulses. (The less significant half is not always maintained.)

FUNNYDSP: Special display of LOOKANGL and TREDES in the same display register, both displayed in two digits only.

FWEIGHT: Double precision change in sensed thrust expected to have occurred since the sampling of the accelerometers, scaled B14 in units of DPS throttle pulses.

$GAIN_0$: Double precision gain constant used in the computation of the orientation of the Descent Guidance Coordinate System for the braking phase, scaled B0 and unitless. Program notation: GAINBRAK; part of the erasable load.

$GAIN_{28}$: Double precision gain constant used in the computation of the orientation of the Descent Guidance Coordinate System for the approach phase, scaled B0 and unitless. Program notation: GAINAPPR; part of the erasable load.

[GCMAT]: Double precision, 3X3 transformation matrix defined such that $\underline{A}dgc = [GCMAT]\ \underline{A}smc$, where $\underline{A}$ is a vector expressed in the Descent Guidance and Platform (sm) coordinate systems respectively; scaled B1 and unitless; program notation CG+0 through CG+17.

The Descent Guidance coordinate system is an orthogonal, cartesian system where the X axis is along the radius from the center of the moon through the present landing site, the Y axis is defined such that the velocity, acceleration and jerk vectors at the landing site lie entirely in the X-Z plane, and the Z axis is defined such as to complete the right handed system.

$\underline{G}DT$, $\underline{G}DT1$: See SERV section.

$\underline{G}SAV$: See ALIN section

HCALC, HDOTDISP: See SERV section.

HCALC1: Double precision calculated altitude above the landing site radius for display in Noun 63 and Noun 60, scaled B24 in units of meters. HCALC1 is set to HCALC in the SERV section and is calculated once per second in "RODCOMP".

HIGHCRIT: Single precision upper limit on the variable throttle region in a situation of increasing thrust commands, scaled B14 in units of DPS throttle pulses. If the throttle setting is in the variable region, the throttle setting commanded by the program will correspond directly with the desired thrust until the desired thrust exceeds HIGHCRIT. Then the program will command full throttle. HIGHCRIT is part of the erasable load.

K:180DEGS: Single precision constant stored as 180×2^{-14}, scaled B15 in units of degrees per revolution. Equation value: 360.

K:1d2DEG: Single precision constant stored as 0.00278, scaled B-1 in units of revolutions. Equation value: 0.00139. (Equivalent to one-half of one degree.)

K:2SECS: Single precision constant stored as 200×2^{-14}, scaled B14 in units of centiseconds. Equation value: 200.

K:3SECS: Single precision constant stored as 300 x 2^{-14}, scaled B14 in units of centiseconds. Equation value: 300.

K:4FMAXNOM: Single precision constant stored as 14908 x 2^{-14}, scaled B14 in units of DPS throttle pulses. Corresponds to 4 x 3727 x 2^{-14}. The 3727 corresponds to 10,500 lbf. converted to throttle pulses. Equation value: 14908.

K:4SECb28: Double precision constant stored as 400 x 2^{-28}, scaled B26 in units of centiseconds. Equation value: 100.

K:4SECS: Single precision constant stored as 400 x 2^{-14}, scaled B14 in units of centiseconds. Equation value: 400.

K:99999CON: Double precision constant stored as 30479.7 x 2^{-24}, scaled B24 in units of meters. Equation value: 30479.7. (Equivalent to 99999 feet.)

K:ABAFCNST: Single precision constant stored as 0.13107, program notation /AF/CNST, scaled B-13 in units of meters per centisecond squared / centimeters per second per guidance cycle. Equation value: 5 E-7. (Equivalent to $\frac{1}{2}$ x 0.01 cubed.)

K:AFTRGUID$_i$ (i = -1 thru 2): Table of single precision addresses for branching. Indexed in the order -1 thru 2, they are the addresses of: CGCALC, EXTLOGIC, EXTLOGIC, STEER?.

K:AZEACH: Single precision constant stored as 0.03491, scaled B0 in units of radians. Equation value: 0.03491. (Equivalent to 2 degrees.)

K:BIASFACT: Double precision constant stored as 655.36 x 2^{-26}, scaled B11 in units of seconds meters per centimeter. Equation value: 0.02. (Stored value corresponds to 2 sec x 0.01 m/cm x 2^{-11}.)

K:BIT1H: Single precision constant stored as 1 x 2^{-14}, scaled B14 and unitless. Equation value: 1.0

K:BIT6: Single precision constant stored as 00040_8, scaled B14 in units of DPS throttle pulses per centisecond. Equation value: 32.

K:DDUMCRIT: Double precision constant stored as 8 x 2^{-28}, scaled B28 in units of centiseconds. Equation value: 8.

K:DEPRCRIT: Double precision constant stored as -0.02 x 2^{-1}, scaled B1 and unitless. Equation value: -0.02. (Depression angle criterion.)

K:DPSTHRSH: Single precision constant stored as 36 x 2^{-14}, scaled B14 in units of centimeters per second. Equation value: 36. (Equivalent to K:THRESH1 + K:THRESH2 of the BURN section.)

K:EIEACH: Single precision constant stored as 0.00873, scaled B0 in units of radians. Equation value: 0.00873. (Equivalent to one-half of one degree.)

LAGdTAU: Double precision lag time divided by TAUROD, scaled B0 and unitless. Program notation LAG/TAU; part of the erasable load.

LAND, LANDTEMP: Double precision position vector of the landing site, scaled B24 in units of meters, measured from the center of the moon and expressed in the Platform coordinate system.

LANDMAG: Double precision radius magnitude of the landing site, scaled B24 in units of meters; program notation /LAND/.

LASTTPIP: Double precision storage for the time of the previous PIPA reading during P66 (R.O.D.) computations, scaled B28 in units of centiseconds.

LEADTIME: Single precision negative of the time increment specifying how far the guidance computations are to be projected forward in P63 and P64, scaled B17 in units of centiseconds; part of the erasable load.

LM504: see COOR section.

LOOKANGL: Single precision landing site elevation angle, scaled B14 in units of degrees. LOOKANGL is calculated as the complement of the angle between the LM +X axis and the negative LOS, which is equivalent to the angle between the LM YZ plane and the positive LOS.

LOWCRIT: Single precision upper limit on the variable throttle region in a situation of decreasing thrust commands, scaled B14 in units of DPS throttle pulses. If the throttle is set at maximum thrust, the desired thrust must fall below this limit before the program will command a throttle setting below maximum. LOWCRIT is part of the erasable load.

LUNDEX: Single precision index scaled B14 and unitless.

MASS: See SERV section.

MAXFORCE: Double precision maximum thrust that P66 will command, scaled B12 in units of kilogram meter per centisecond squared; part of the erasable load.

MINFORCE: Double precision minimum thrust that P66 will command, scaled B12 in units of kilogram meter per centisecond squared; part of the erasable load.

MODREG: See DATA section.

[MOONMAT]: See COOR section.

[NBSMMAT]: See COOR section.

NGUIDSUB: Single precision counter scaled B14 and unitless.

NIGNLOOP: Single precision counter scaled B14 and unitless.

OGABIAS: See BURN section.

OLDPIPA: Single precision storage for the accelerometer readings (PIPA) performed at time THISTPIP for P66 computations, scaled B14 in units of centimeters per second. Note that this is different from the normal two second cycle PIPA reading which is made at PIPTIME.

OUTOFPLN: Double precision distance of the landing site from the LM orbital plane at the projected time of ignition, scaled B24 in units of meters. (Positive if the orbital plane is to the right of the landing site, looking in the direction of travel.)

PIF: Double precision change in the desired thrust level, scaled B14 in units of DPS throttle pulses.

PIFPSET: Single precision bias on the throttle command, scaled B14 in units of DPS throttle pulses.

PIPA, PIPATMP: See SERV section.

$PIPABIAS_x$, $PIPABIAS_y$, $PIPABIAS_z$: See IMUC section.

PIPTIME, PIPTIME1: See SERV section.

POINTVSM: See ATTM section.

POLDPIPA: Single precision storage for the previous cycle value of OLDPIPA, scaled B14 in units of centimeters per second; program notation RUPTREG.

PREC: Single precision specification of the precision to which "ROOTPSRS" is to converge, scaled B0 and unitless.

PROJ, PROJ1, PROJ2: Single precision projection of the Y Descent Guidance coordinate system axis onto the unit normal to the plane defined by the X body axis and the line-of-sight vector, and the difference between that projection and its upper and lower bounds; scaled B3 and unitless.

PSEUDO55: Single precision storage for telemetry of the throttle command sent to the descent engine, scaled B14 in units of throttle pulses. (See definition of THRUST.)

R60SAVE: Double precision temporary storage for the UNFC vector, scaled B7 in units of meters per centisecond.

R: Double precision navigated present position vector of the LM, scaled B24 in units of meters, measured from the center of the moon and expressed in the Platform coordinate system.

TDEC1: See ORBI section.

TEM: See SERV section.

$TEND_0$: Single precision quantity representing the time at which the approach phase (P64) is selected (i.e. WCHPHASE goes from 0 to 1 thus selecting P64), scaled B17 in units of centiseconds; program notation TENDBRAK; part of the erasable load.

$TEND_1$: Single precision quantity representing the time at which the vertical phase (P65) is selected (i.e. WCHPHASE goes from 1 to 2 thus selecting P65 provided the Mode Control switch is in the Auto position and RODCOUNT = 0; otherwise P66 is selected), scaled B17 in units of centiseconds; program notation TENDAPPR; part of the erasable load.

TET: See ORBI section.

THISTPIP: Double precision time of PIPA readings for P66 (R.O.D.) computations, scaled B28 in units of centiseconds. Note that this is a different reading than that which is taken at PIPTIME.

THRDISP: Single precision quantity representing the percent that desired thrust is of 10,500 lbf. for display in Noun 92, scaled B14 and unitless.

THRUST: Cell used to provide DPS throttle commands by setting bit 4 of channel 14; scaled B14 in units of DPS throttle pulses. One pulse corresponds to about 12.532 newtons or 2.8173 pounds force (depending on erosion of the DPS nozzle), and the maximum command recognized by the throttle is 3428 pulses or about 42,960 newtons or 9658 pounds force.

TIG: see BURN section.

TIMENOW: see EXVB section.

TLAND: Double precision nominal time of lunar landing, scaled B28 in units of centiseconds; part of the erasable load.

TPIP, TPIPOLD: Double precision storage for consecutive times of entry in the TTF incrementing routine, scaled B28 in units of centiseconds and used to increment TTF.

TREDES: Single precision time remaining to redesignate the landing site, scaled B14 in units of seconds (limited to 99).

TRKMKCNT: See RNAV section.

TTF, TTFTMP: Double precision negative time from the end of the present descent guidance phase, scaled B17 in units of centiseconds.

TTFADGZ$_0$: Double precision Z component of $\underline{T}$ARGADG$_0$ multiplied by 6; scaled B-4 in units of meters per centisecond squared; program notation ABRFG* or ADG2TTF$_0$; part of the erasable load.

TTFADGZ$_{28}$: Double precision Z component of $\underline{T}$ARGADG$_{28}$ multiplied by 6; scaled B-4 in units of meters per centisecond squared; program notation AAPFG* or ADG2TTF$_{28}$; part of the erasable load.

TTFDISP: Double precision storage for TTF for display purposes, scaled B28 in units of centiseconds.

TTFJDGZ$_0$: Double precision Hi-gate jerk aimpoint, Z component only, scaled B-21 in units of meters per centisecond cubed; program notation JBRFG* or JDG2TTF$_0$; part of the erasable load.

TTFJDGZ$_{28}$: Double precision Lo-gate jerk aimpoint, Z component only, scaled B-21 in units of meters per centisecond cubed; program notation JAPFG* or JDG2TTF$_{28}$; part of the erasable load.

TTFVDGZ$_0$: Double precision Z component of $\underline{T}$ARGVDG$_0$ multiplied by 18; scaled B13 in units of meters per centisecond; program notation VBRFG* or VDG2TTF$_0$; part of the erasable load.

TTFVDGZ$_{28}$: Double precision Z component of $\underline{T}$ARGVDG$_{28}$ multiplied by 18; scaled B13 in units of meters per centisecond; program notation VAPFG* or VDG2TTF$_{28}$; part of the erasable load.

TTHROT: Single precision time of the last throttle command, scaled B14 in units of centiseconds.

UNITR: See SERV section.

UNFC: See BURN section. During the pre-ignition phase computations for the powered descent maneuver (P63), UNFC represents the Delta-V vector for the pre-full throttle thrust, scaled B7 in units of meters per centisecond.

UNWC: See BURN section.

V2FG: Double precision vector constant representing the velocity aim conditions for P65 velocity nulling computations, scaled B10 in units of meters per centisecond; part of the erasable load.

V: Double precision present navigated velocity vector of the LM, scaled B7 in units of meters per centisecond and expressed in the Platform coordinate system.

VBIAS: Double precision velocity bias factor based on PIPA bias values for P66 (R.O.D.) computations, scaled B8 in units of meters per centisecond.

VDGVERT: Double precision vertical component of velocity desired in the final (vertical) phase of descent, scaled B7 in units of meters per centisecond; altered in response to astronaut commands during manual descent control.

VGU: Double precision velocity vector of the LM relative to the rotating moon, scaled B10 in units of meters per centisecond and expressed in the Descent Guidance coordinate system.

WCHPHASE: Single precision index scaled B14 and unitless. Set to -1 in the pre-ignition phase ("P63LM"), 0 at ignition ("P63IGN"), 1 when TTF (negative) is greater than minus $TEND_0$ ("EXTLOGIC"), and 2 when TTF is greater than minus $TEND_1$ or when the astronaut switches out of automatic control selecting P66 ("EXTLOGIC" or "LUNLAND").

WCHPHOLD: Single precision storage for WCHPHASE to preserve the present guidance mode through the present guidance cycle when WCHPHASE changes.

WCHVERT: Single precision flag to indicate whether the final (vertical) phase of guidance is under control of P65 (WCHVERT = 0) or P66 (WCHVERT = 2), scaled B14 and unitless.

WHICH: See BURN section.

WM: Double precision mean angular velocity vector of the moon, scaled B-17 in units of radians per centisecond and expressed in the Platform coordinate system.

XNBPIP, YNBPIP, ZNBPIP: See SERV section.

ZERLINA: Single precision counter scaled B14 and unitless.

ZOOMTIME: See BURN section.

GOEXTVB Proceed to routine specified by the contents of TSextfan

TSextfan	(verb)	Starting address of routine	Function
0	40	VBZERO	zero IMU CDU or Rendezvous Radar CDU
1	41	VBCOARK	coarse align (ICDU or RRCDU)
2	42	IMUFINEK	fine align IMU
3	43	IMUATTCK	load IMU attitude error needles
4	44	RRDESEND	terminate continuous designate
5		ALM/END	not defined
6		ALM/END	not defined
7	47	V47TXACT	AGS initialization
8	48	DAPDISP	load autopilot data
9	49	CREWMANU	start automatic attitude maneuver
10	50	GOLOADLV	please perform
11		ALM/END	not defined
12	52	GOLOADLV	please mark X
13	53	GOLOADLV	please mark Y
14	54	GOLOADLV	please mark X or Y
15	55	ALINTIME	align time
16	56	TRMTRACK	terminate tracking
17	57	LRON	permit landing radar updates
18	58	LROFF	inhibit landing radar updates
19	59	LRPOS2K	LR to position 2
20	60	RATEDISP	display DAP estimated rates
21	61	DAPATTER	display DAP attitude error
22	62	TOTATTER	display total attitude error
23	63	R04	sample radar once/second
24	64	VB64	calculate and display S-band ant. angles
25	65	SNUFFOUT	docked U-V control disable
26	66	ATTACHED	attached
27	67	V67	W matrix monitor
28	68	ALM/END	not defined
29	69	VERB69	cause restart
30	70	V70UPDAT	update liftoff time
31	71	V71UPDAT	universal update - block address
32	72	V72UPDAT	universal update - single address
33	73	V73UPDAT	update AGC time (octal)
34	74	DNEDUMP	initialize downlink for erasable dump
35	75	OUTSNUFF	remove U-V control disable
36	76	MINIMP	minimum impulse mode
37	77	NOMINIMP	rate command mode
38	78	R77	start LR spurious return test
39	79	R77END	terminate LR spurious return test

TSextfan	(verb)	Starting address of routine	Function
40	80	LEMVEC	update LM state vector
41	81	CSMVEC	update CSM state vector
42	82	V82PERF	request orbit param display (R30)
43	83	V83PERF	request rend param display (R31)
44		ALM/END	not defined
45	85	VERB85	display RR LOS azimuth and elevation
46		ALM/END	not defined
47		ALM/END	not defined
48		ALM/END	not defined
49	89	V89PERF	align X or Z LM axis along LOS (R63)
50	90	V90PERF	out of plane rend display
51	91	GOSHOSUM	display bank sum
52	92	SYSTEST	operate IMU performance test
53	93	WMATRXNG	clear RENDWFLG
54		ALM/END	not defined
55	95	UPDATOFF	no state vector update allowed
56	96	VERB96	interrupt integration and go to POOH
57	97	GOLOADLV	please verify engine failure
58		ALM/END	not defined
59	99	GOLOADLV	please enable engine

ALM/END Switch bit 7 of channel 11 to 1 (operator error)

Proceed to "PINBRNCH"

TESTXACT If EXTVBACT $>$ 0, proceed to "ALM/END"

If FLAGWRD4 bit 14 (PRIODFLG), 12 (PDSPFLAG) or 7 (PRONVFLG) = 1:

Proceed to "ALM/END"

EXTVBACT = 00025_8 (set bits 1, 3, and 5)

TSvn = -2

Perform "NVSUB" with TSmonopt = 00000_8

Check for new job waiting, and perform it if required

Return

If FLAGWRD1 bit 5 (TRACKFLG) = 0, proceed to "PINBRNCH"

Switch FLAGWRD1 bits 5 (TRACKFLG) and 7 (UPDATFLG) to 0

Switch FLAGWRD0 bit 8 (IMUSE) to 0

Perform "INTSTALL"

Clear P20, P25 restart logic and inhibit interrupts

Perform "STOPRATE"

Perform "RESTORDB"

Switch RADMODES bits 10 (DESIGFLG) and 15 (CDESFLAG) to 0

Switch bits 14 and 2 of channel 12 to 0 (disable tracker and RR error counter)

Proceed to "GOPROG2"

LRON — Perform "TESTXACT" (vb57)

Proceed to "DSP68" (this section)

LROFF — Switch FLGWRD11 bit 8 (LRINH) to 0 (vb58)

Proceed to "PINBRNCH"

LRPOS2K — If FLAGWRD7 bit 5 (AVEGFLAG) = 0: (see Anomaly Report No. L-1C-03) (vb59)

Proceed to "LRPOS2K1"

If MODREG = 63, proceed to "V59GP63"

LRPOS2K1 — Perform "RDRUSECK"

Proceed to "LRP2COMM"

RATEDISP — Switch FLAGWRD0 bit 15 (NEED2FLG) to 1 (vb60)

Proceed to "PINBRNCH"

DAPATTER — Switch FLAGWRD0 bits 4 (NEEDLFLG) and 15 (NEED2FLG) to 0 (vb61)

Proceed to "PINBRNCH"

• TOTATTER — Switch FLAGWRD0 bit 4 (NEEDLFLG) to 1 and bit 15 (NEED2FLG) to 0 (vb62)

Proceed to "PINBRNCH"

R04 — Perform "RDRUSECK" (this section) (vb63)

	Perform "TESTXACT"		
	Switch FLAGWRD3 bit 9 (RO4FLAG) to 1		
	Proceed to "RO4Z"	(RADR section)	
VB64	Perform "TESTXACT"		(vb64)
	Establish "SBANDANT"	(this section)	(pr04)
	End job		
SNUFFOUT	Switch FLAGWRD5 bit 13 (SNUFFER) to 1		(vb65)
	Proceed to "PINBRNCH"		
ATTACHED	If FLAGWRD8 bit 8 (SURFFLAG) = 1:		(vb66)
	Proceed to "ALM/END"	(this section)	
	Establish "ATTACHIT"	(this section)	(pr10)
	End job		
V67	Perform "TESTXACT"	(this section)	(vb67)
	Establish "V67CALL"	(RNAV section)	(pr05)
	End job		
VERB69	Cause a hardware restart	("GOPROG")	(vb69)
V70UPDAT	UPVERBSV = 0		(vb70)
	Skip next five steps		
V71UPDAT	UPVERBSV = 1		(vb71)
	Skip next three steps		
V72UPDAT	UPVERBSV = 2		(vb72)
	Skip next step		
V73UPDAT	UPVERBSV = 3		(vb73)
	Perform "TESTXACT"		

VCV = BASETHV

If FLAGWRD8 bit 11 (LMOONFLG) = 1:

Switch FLAGWRD0 bit 12 (MOONFLAG) to 1

Switch FLAGWRD3 bit 4 (INTYPFLG) to 1

TET = BASETIME

Perform "INTEGRVS"

OTHCONIC RONE = RATT

VONE = VATT

Perform "INTSTALL"

Switch FLAGWRD3 bit 4 (INTYPFLG) to 1

TS = TAT

OTHINT TDEC1 = TS

Switch FLAGWRD0 bit 12 (MOONFLAG) to 0

RCV = BASEOTP

VCV = BASEOTV

If FLAGWRD8 bit 11 (LMOONFLG) = 1:

Switch FLAGWRD0 bit 12 (MOONFLAG) to 1

TET = BASETIME

Perform "INTEGRVS"

COMPDISP RANGE = |RATT - RONE|

RRATE = unit(RATT - RONE) • (VATT - VONE)

Perform "CDUTRIG"

Perform "NBTOSM"

ZNBrf = $[\text{REFSMMAT}]^{T}$ [NBSMMAT] K:UNITZ

TSp = unit(ZNBrf - (ZNBrf • unitRONE) unitRONE)

TSu = ((unitRONE * VONE) * unitRONE) • TSp

RTHETA = arccos(TSp • ZNBrf signTSu)

If unitRONE • ZNBrf < 0, RTHETA = 1 - RTHETA

If bit 5 of EXTVBACT = 0, proceed to "ENDEXT"

Set bit 12 of EXTVBACT to 1

Proceed to "REV83"

GETRVN RONE = RN (change to pr22)

VONE = VN

TS1 = VCSM

TS2 = RCSM

TS = PIPTIME (change to pr03)

If FLAGWRD6 bit 8 (MUNFLAG) = 0:

Perform "INTSTALL"

Switch FLAGWRD3 bit 4 (INTYPFLG) to 0

Proceed to "OTHINT"

RATT = TS2 [REFSMMAT] (note that RATT and VATT are equivalent to locations 0D and 6D, respectively, of the pushdown list)

VATT = TS1 [REFSMMAT]

Proceed to "COMPDISP"

R36 $DSPTEMX_{dp}$ = TIG (vb90)

Proceed to "GOXDSPF" with TS = K:V06N16 (DSPTEMX)
(If terminate, proceed to "ENDEXT"; if proceed, continue at next step; if other response, repeat this step.)

TDEC1 = DSPTEMX

If DSPTEMX = 0, TDEC1 = TIMENOW

Perform "CSMPREC"

RPASS36 = RATT

UNP36 = unit(VATT * unitRATT)

TDEC1 = TAT

Perform "LEMPREC"

TSlos = RPASS36 - RATT

RANGE = $\underline{R}$ATT • $\underline{U}$NP36

RRATE = $\underline{V}$ATT • $\underline{U}$NP36

$\underline{T}$Suf = unit((unit$\underline{R}$ATT * $\underline{V}$ATT) * unit$\underline{R}$ATT)

If overflow, $\underline{T}$Suf = unit(1, $TSuf_y$, $TSuf_z$)

$\underline{T}$Sulos = unit($\underline{T}$Slos - (unit$\underline{R}$ATT • $\underline{T}$Slos) unit$\underline{R}$ATT

If overflow, $\underline{T}$Sulos = unit(1, $TSulos_y$, $TSulos_z$)

RTHETA = arcos($\underline{T}$Sulos • $\underline{T}$Suf)

If ($\underline{T}$Sulos * $\underline{T}$Suf • $\underline{R}$ATT) < 0, RTHETA = 1 - RTHETA

Proceed to "GOXDSPF" with TS = K:V06N90 (RANGE, RRATE, RTHETA)
(If terminate, proceed to "ENDEXT"; if proceed, proceed to "ENDEXT"; if other response, proceed to "R36")

SBANDANT TDEC1 = TIMENOW

Perform "LEMCONIC"

If PBODY = 0: (means earth)

$\underline{T}$S = $\underline{R}$ATT

Skip next three lines

TSt = TAT

Perform "LSPOS"

$\underline{T}$S = (K:REMDIST $\underline{V}$MOON) + $\underline{R}$ATT

$\underline{T}$S = -unit$\underline{T}$S

Perform "CDUTRIG"

$\underline{T}$S = [REFSMMAT] $\underline{T}$S (transform to stable member)

$PITCHANG_{dp}$ = +0

$YAWANG_{dp}$ = +0

Perform "SMTONB"

RLM = [SMNBMAT] TS

RLMTEMP = RLM

RLMYTEMP = RLM_y

RLM_y = (RLM_y - RLM_x) K:1OVSQRT2

RLM_x = (RLMYTEMP + RLM_x) K:1OVSQRT2

TS2 = RLM - (RLM • K:UNITY) K:UNITY

TS2 = unitTS2; if overflow, proceed to "SBANDEX"

RLM = -(TS2 * K:UNITZ)

TS = RLM • K:UNITY

PITCHANG = arcsin(signTS |RLM|)

TS1 = TS2 • K:UNITZ

If TS1 < 0:

PITCHANG = 0.5 - PITCHANG

RLM = unitRLMTEMP * TS2

TS = (K:UNITX cosPITCHANG) - (K:UNITZ sinPITCHANG)

TS = TS • RLM

YAWANG = arcsin(signTS |RLM|)

SBANDEX If bit 5 of EXTVBACT = 0, proceed to "ENDEXT" (change to pr05)

Perform "GOXDSPFR" with TS = K:V06N51 (PITCHANG, YAWANG)
(If terminate or proceed, set bit 5 of EXTVBACT = 0 and end job; if other response, end job.) (change to pr04)

TS = 100_2

Perform "BLANKET"

Proceed to "SBANDANT"

ATTACHIT Perform "INTSTALL"

Switch FLAGWRD8 bit 12 (CMOONFLG) to 1

If FLAGWRD8 bit 11 (LMOONFLG) = 0:

Switch FLAGWRD8 bit 12 (CMOONFLG) to 0

Inhibit interrupts

XKEPCSM = XKEPLEM

TCCSM = TCLEM

VCVCSM = VCVLEM

RCVCSM = RCVLEM

NUVCSM = NUVLEM

DELTACSM = DELTALEM

TETCSM = TETLEM

VRECTCSM = VRECTLEM

RRECTCSM = RRECTLEM

Release interrupt inhibit

If FLAGWRD8 bit 8 (SURFFLAG) = 1, proceed to "USEPIOS"

Perform "MOVEPLEM"

Set FLAGWRD0 bit 12 (MOONFLAG) = FLAGWRD8 bit 11 (LMOONFLG)

PBODY = 0

If FLAGWRD0 bit 12 (MOONFLAG) = 1, PBODY = 2

Perform "SVDWN1" (scaling controled by PBODY)

QPRET = "PINBRNCH"

Proceed to "INTWAKE"

RDRUSECK If FLAGWRD3 bit 11 (NOR29FLG) = 0, proceed to "ALM/END"

If FLAGWRD5 bit 11 (R77FLAG) = 1, proceed to "ALM/END"

If FLAGWRD7 bit 6 (V37FLAG) = 0, skip next line

If FLGWRD11 bit 15 (LRBYPASS) = 0, proceed to "ALM/END"

If FLAGWRD1 bit 5 (TRACKFLG) = 0, return

Proceed to "ALM/END"

DSP68 Perform "GOXDSPFR" with TS = K:V06N68 (RRANGEDSP, TTFDISP, DELTAH)
(If terminate, set bits 5 and 1 of EXTVBACT = 0 and end job;
if proceed, proceed to "SET57"; if other response, end job.)

WAIT68 Delay two seconds

If bit 5 and bit 1 of EXTVBACT = 0, proceed to "ENDEXT"

If bit 5 of EXTVBACT = 1, proceed to "DSP68"

Perform "GOMARK3R" with TS = K:V50N68 (RRANGEDSP, TTFDISP, DELTAH)
(If terminate or proceed, set bits 5 and 1 of EXTVBACT = 0
and end job; if other response, proceed to "RESET57".)
(TS is formed by adding 13000_8 to K:V06N68)

Proceed to "WAIT68"

SET57 Switch FLGWRD11 bit 8 (LRINH) to 1

Set bit 5 of EXTVBACT = 0

End job

RESET57 Switch FLGWRD11 bit 8 (LRINH) to 0

EXTVBACT = 00025_8

End job

LRP2COMM Perform "LRPOS2" (See Anomaly Report No. L-1C-03)

Perform "RADSTALL"

If RADGOOD = 0, perform "ALARM" with TS = 00523_8

Proceed to "PINBRNCH"

V59GP63 RPCRTIME = 37777_8

RPCRTQSW = -1

Proceed to "PINBRNCH"

K:RPAD: Double precision constant stored as 6373338×2^{-29}, scaled B29 in units of meters. Equation value: 6373338.

K:RSCALE: Double precision constant stored as 3.280839×2^{-3}, scaled B3 in units of feet per meter. Equation value: 3.280839.

K:TFF0, K:TFF1, K:TFF2, K:TFF3, K:TFF4, K:TFF5: Six double precision constant coefficients of a polynomial approximation. Scaled B0 and unitless. Equation value:

0.3333333333
-0.1999819135
0.1418148467
-0.101310997
0.05609004986
-0.01536156925

K:TSCALE: Double precision constant stored as 100×2^{-10}, scaled B10 in units of centiseconds per second. Equation value: 100.

K:UNITX, K:UNITZ, K:UNITY: See SERV section.

K:VSCALE: Double precision constant stored as 328.0839×2^{-9}, scaled B9 in units of feet per second/meters per centisecond. Equation value: 328.0839.

MMNUMBER: See PGSR section.

MODREG: See DATA section.

MPAC: See DINT section.

mTPER: Double precision time to perigee, scaled B28 in units of centiseconds.

NEWJOB: See MATX section.

NUVCSM, NUVLEM: See ORBI section.

[NBSMMAT] : See COOR section.

NOUNREG: See DATA section.

$OPTIONX_0$, $OPTIONX_1$: Display registers used by noun 12 with extended verbs. Similar to OPTION1, OPTION2. Same register as DSPTEMX.

PBODY: See ORBI section.

PIPTIME: See SERV section.

PITCHANG: Cell used to contain the pitch gimbal angle required to point the S-band antenna toward the center of the earth. Scaled B0, in units of revolutions.

QPRET: See ORBI section.

QTERM: Double precision product of the cotangent of flight path angle at RTERM and the square root of semi-latus rectum, scaled B16 (earth) or B15 (moon) in units of meters to the one-half power.

RADCADR, RADGOOD, RADMODES: See RADR section.

RANGE, RRATE: Double precision range and range-rate, scaled B29 for range in units of meters and B7 for range-rate in units of meters per centisecond.

RAPO, RPER: Double precision radius at apogee and perigee, scaled B29 (earth) or B27 (moon) in units of meters.

RATT, VATT, TAT: See ORBI section.
RCSM: See SERV section.
RCV, VCV: See CONC section.

RCVCSM, RCVLEM: See ORBI section.

RRECTCSM, RRECTLEM: See ORBI section.

[REFSMMAT] : See COOR section.

RLM: Double precision vector defined by transforming the unit line-of-sight vector (reference coordinates) first into stable member then into navigation base coordinates, and finally rotated and compensated by the orientation of the S-band antenna mount with respect to the navigation base.

RLMTEMP: Temporary storage location for RLM to be used in later calculations.

RLMYTEMP: Temporary storage location for RLM_y.

RLS: See CONC section.

RMAG1: Double precision magnitude of RONE, scaled B29 (earth) or B27 (moon) in units of meters.

RN, VN: See SERV section.

RONE, VONE: Double precision position and velocity vectors at TSTART82; scaled B29 (earth) or B27 (moon) for position, and B7 (earth) or B5 (moon) for velocity. Position is in units of meters, with velocity in units of meters/centisecond.

RPADTEM: Double precision radius of launch site on earth or moon for use as a base for computing altitude, scaled B29 (earth) or B27 (moon) in units of meters.

RPASS36: Double precision vector storage for CSM position vector in routine 36, scaled B29 in units of meters.

RPCRTIME: See SERV section.

RPCRTQSW: See SERV section.

RSAMPDT: See RADR section.

RTERM: Double precision terminal radius for calculation of TFF, scaled B29 (earth) or B27 (moon) in units of meters.

RTHETA: Double precision angle between LM +Z axis and the local horizontal, scaled B0 in units of revolutions.

SAMPTIME: See DSKY section.

[SMNBMAT] : See ORBI section.

TCCSM, TCLEM: See ORBI section.

TDEC1: See ORBI section.

TEPHEM: See COOR section.

TET, TETCSM, TETLEM: See ORBI section.

TFF: Double precision time of free fall to RTERM, scaled B28 in units of centiseconds.

TFF1dALF: Double precision semi-major axis, stored in units of meters with variable scaling.

TFFALFA: Double precision reciprocal of the semi-major axis, stored in units of meters with variable scaling.

TFFDELQ: Double precision difference between -QTERM and TFFQ1, scaled B16 (earth) or B15 (moon).

TFFdRTMU: Double precision reciprocal of the square root of mu of primary body; variable scaling.

TFFNP: Double precision semi-latus rectum, stored in units of meters with variable scaling.

TFFQ1: Intermediate quantity calculated in "CALCTFF", scaled B16 (earth) or B15 (moon).

TFFRTALF: Double precision square root of TFFALFA, stored in meters with variable scaling.

TFFTEM: Double precision intermediate variable used in "CALCTFF", stored in units of meters with variable scaling.

TFFVSQ: Double precision value of the complement of the square of the velocity divided by the root of mu; variable scaling.

TFFX: Double precision universal variable, scaled B0 and unitless.

THETAD: See COOR section.

TIG: See BURN section.

TIMENOW: Double precision current time scaled B28 in units of centiseconds; a computer counter incremented every centisecond automatically, and modified by verbs 55, 70 and 73.

TSTART82: Double precision start time of the verb 82 routines, scaled B28 in centiseconds; used to update TFF from its value at the time of verb 82 initialization to a value corresponding to the time at which it is displayed. Also used to update mTPER.

UNP36: Double precision vector storage for normal to the CSM orbital plane, scaled B1 and unitless.

$UPBUFF_{0-19}$: Single precision buffer cells for P27 updates.

UPCOUNT: Single precision number of components received in a P27 update, scaled B14 and unitless.

UPOLDMOD: Single precision storage for the value of MODREG at the initialization of a P27 update.

UPTEMP: Single precision storage for the number of a P27 update component to be corrected or for an address of a cell to be updated.

UPVERBSV, UPVERB: Single precision indication of the verb that initiated a P27 update, scaled B14 and unitless.

V82FLAGS: Single precision flagword used in verb 82 routines. Bit two is set when only TFF is computed and bit one is set when mTPER is computed.

VMOON: See COOR section.

VONEPR: Double precision value of VONE TFFdRTMU, scaled B-10 (earth) or B-9 (moon).

VCSM: See SERV section.

VCVCSM, VCVIEM: See ORBI section.

VRECTCSM, VRECTIEM: See ORBI section.

IMU Computations

SVCT3 (This task is used as part of the waitlist control and is entered every 81.93 seconds)

If FLAGWRD2 bit 15 (DRIFTFLG) = 1:

If IMUCADR = +0, establish "NBDONLY" (pr35)

If IMUCADR ≠ +0, call "SVCT3" in 5.0 seconds

End task

1/GYRO GCOMP = GCOMP rescaled to B21 pulses (truncated at 2^{-7} pulses)

TS = address of GCOMP

Perform "IMUPULSE"

Perform "IMUSTALL"

If ISSGOOD = 0, End job

GCOMP = fractional part of GCOMP rescaled to B14 pulses

End job

NBDONLY If GCOMPSW < 0, End job

Inhibit interrupts

If FLAGWRD2 bit 15 (DRIFTFLG) = 0, End job

TS = 0

If FLAGWRD8 bit 8 (SURFFLAG) = 1:

TS = 00200_8

Perform "PIPASR" skipping first step

TS1 = 1dPIPADT

1dPIPADT = TIMENOW_{1s} (load present time)

Release interrupt inhibit

TSt = 1dPIPADT - TS1 (present time - previous time)

NBD2 TSt = TSt (corrected for possible overflow of TIMENOW counter)

GCOMPSW = 0

If TS > 0: (SURFFLAG set)

$$\underline{GCOMP} = \underline{GCOMP} + \begin{bmatrix} -ADIAX & ADSRAX & 0 \\ 0 & -ADIAY & ADSRAY \\ 0 & -ADSRAZ & -ADIAZ \end{bmatrix} \underline{DELV}$$

$$\underline{GCOMP} = \underline{GCOMP} - TSt \begin{bmatrix} NBDX \\ NBDY \\ -NBDZ \end{bmatrix}$$

If $|GCOMP_x| > 2$, $GCOMPSW = |GCOMP_x| - 2$

If $|GCOMP_y| > 2$, $GCOMPSW = |GCOMP_y| - 2$

If $|GCOMP_z| > 2$, $GCOMPSW = |GCOMP_z| - 2$

If GCOMPSW > 0, proceed to "1/GYRO"

End job

1/PIPA If GCOMPSW < 0, return

$$\underline{DELV}_{dp} = \underline{DELV}_{sp} + \begin{bmatrix} PIPASCF_x & 0 & 0 \\ 0 & PIPASCF_y & 0 \\ 0 & 0 & PIPASCF_z \end{bmatrix} \underline{DELV}_{sp} - 1dPIPADT \begin{pmatrix} PIPABIAS_x \\ PIPABIAS_y \\ PIPABIAS_z \end{pmatrix}$$

GCOMPSW = 0

$$\underline{GCOMP} = \underline{GCOMP} + \begin{bmatrix} -ADIAX & ADSRAX & 0 \\ 0 & -ADIAY & ADSRAY \\ 0 & -ADSRAZ & -ADIAZ \end{bmatrix} \underline{DELV} - 1dPIPADT \begin{pmatrix} NBDX \\ NBDY \\ -NBDZ \end{pmatrix}$$

If $|GCOMP_x| > 2$, $GCOMPSW = |GCOMP_x| - 2$

If $|GCOMP_y| > 2$, $GCOMPSW = |GCOMP_y| - 2$

LOC = IMUCADR

ISSGOOD = 0

Wake job put to sleep in "IMUSTALL"

IMUCADR = +0

End task

ATTCK2 $CDU_zCMD = THETAD_z$ K:ONETENTH

$CDU_yCMD = THETAD_y$ K:ONETENTH

$CDU_xCMD = THETAD_x$ K:ONETENTH

Switch bits 13, 14 and 15 of channel 14 to 1 (send CDU_iCMD's)

End task

RO2BOTH If FLAGWRD3 bit 13 (REFSMFLG) = 1:

Switch FLAGWRD0 bit 8 (IMUSE) to 1

Return

If bit 9 of IMODES30 = 1: (IMU not operating)

Perform "ALARM" with TS = 00210_8

If bit 9 of IMODES30 = 0: (REFSMMAT invalid)

Perform "ALARM" with TS = 00220_8

Proceed to "GOTOPOOH"

ldPIPADT: Single precision time interval for application of PIPA biases and gyro drift compensation, scaled B8, or storage for present time for the purpose of computing that time interval, scaled B14, in units of centiseconds.

ADIAX: Single precision angular drift of the X gyro around its output axis caused by linear acceleration of the IMU in the direction of the X gyro input axis (+XSM), scaled B-6 in units of gyro pulses / centimeters per second. (One gyro pulse corresponds to 2^{-21} revolutions.)

ADIAY: Single precision angular drift of the Y gyro around its output axis caused by linear acceleration of the IMU in the direction of the Y gyro input axis (+YSM), scaled B-6 in units of gyro pulses / centimeters per second.

ADIAZ: Single precision angular drift of the Z gyro around its output axis caused by linear acceleration of the IMU in the direction of the Z gyro input axis (+ZSM), scaled B-6 in units of gyro pulses / centimeters per second.

ADSRAX: Single precision angular drift of the X gyro around its output axis caused by linear acceleration of the IMU in the direction of the X gyro spin-reference axis (-YSM), scaled B-6 in units of gyro pulses / centimeters per second.

ADSRAY: Single precision angular drift of the Y gyro around its output axis caused by linear acceleration of the IMU in the direction of the Y gyro spin-reference axis (-ZSM), scaled B-6 in units of gyro pulses / centimeters per second.

ADSRAZ: Single precision angular drift of the Z gyro around its output axis caused by linear acceleration of the IMU in the direction of the Z gyro spin-reference axis (+YSM), scaled B-6 in units of gyro pulses / centimeters per second.

CDU (CDU_x,CDU_y,CDU_z): Single precision vector containing the measured values of the IMU gimbal angles (outer, inner and middle gimbal in X, Y, and Z components, respectively), scaled B-1 in units of revolutions and stored in two's complement form. Each component is an LGC input counter incremented directly from the Coupling Data Unit in response to changes in the IMU gimbal angles.

CDU$_i$CMD:(i = x,y or z): Three single precision counters scaled B1 in units of revolutions, gated to the ICDU Error Counters by setting bits 15, 14 and 13 of channel 14. Bits 15-13 reset when respective counters reach -0.

COMMAND: Tempory storage for changes to the three gimbal angles during coarse alignment, scaled B1 in units of revolutions.

DELV: See SERV section.

$DSPTAB_{11}$: See INTR section.

$\underline{E}_{LGYRO}$: Double precision vector containing three desired gyro torque angles whose address is specified at entry to the IMUPULSE routine, scaled B21 in units of revolutions. $\underline{E}_{LGYRO}$ = $\underline{G}$COMP or (OGC,IGC,MGC).

$\underline{G}$COMP: Double precision vector containing required gyro compensation angles, scaled B14 (or B21) in units of gyro pulses (1 gyro pulse = 2^{-21} revolutions).

GCOMPSW: Single precision switch indicating whether gyro compensation is required or inhibited, scaled B14 and unitless.

GYROCMD: Computer cell counted down as torquing pulses are sent to one of the gyros, scaled B14 in units of gyro pulses. Used for commands to all three gyros; the pulse train is initiated by setting bit 10 of Channel 14 and it is routed to the appropriate gyro torque motor by the setting in bits 7 and 8 of Channel 14.

GYRODEX: An index equivalent to that maintained by the program in bits 15-13 of LGYRO; used to indicate which gyro is being torqued and assigned a separate label merely for convenience in functional representation.

i,j: Single precision index registers, scaled B14 and unitless.

IMODES30: Single precision flagword whose individual bits have the following meanings:

Bit 15	(1) IMU temperature not within prescribed limits (0) IMU temperature within limits
Bit 14	(1) ISS turn-on delay not in effect (0) ISS turn-on delay initiated and in effect
Bit 13	(1) IMU good (0) IMU fail
Bit 12	(1) ICDU good (0) ICDU fail
Bit 11	(1) IMU not externally caged (0) IMU caged, externally
Bit 10	(1) PIPA good (0) PIPA fail (identical to bit 13 of IMODES33)
Bit 9	(1) IMU off (0) IMU operating
Bit 8	(1) IMU turn-on delay in progress (0) IMU turn-on delay complete or not initiated
Bit 7	(1) IMU turn-on delay initiate (0) IMU turn-on delay not initiated
Bit 6	(1) IMU caged (Internally) (0) IMU not caged

Bit 5 (1) Secondary PIPA fail monitor inhibited
(0) Secondary PIPA fail monitor enabled

Bit 4 (1) IMU fail monitor inhibited
(0) IMU fail monitor enabled

Bit 3 (1) CDU fail monitor inhibited
(0) CDU fail monitor enabled

Bit 2 (1) ISS turn-on sequence failure
(0) No ISS turn-on sequence failure in effect

Bit 1 (1) Primary PIPA fail monitor inhibited
(0) Primary PIPA fail monitor enabled

IMODES33: See INTR section.

IMUCADR: Single precision octal storage for address to return to program that is making use of the ISS and waiting for a particular operation to be accomplished.

ISSGOOD: Variable introduced as a substitute for variable return address; set to 1 or 0 to indicate whether an IMU mode switch was successfully completed (1) or not (0).

K:70degs: Single precision constant stored as -0.38888, program notation "-70DEGS," scaled B-1 in units of revolutions. Equation value: +0.19444. (Equivalent to +69.9984 degrees).

K:85degs: Single precision constant stored as -0.38888 + -0.08333, scaled B-1 in units of revolutions. Equation value: +0.23610. (Equivalent to +84.99 degrees.)

K:COARSTOL: Single precision constant stored as -0.01111, scaled B-1 in units of revolutions. Equation value: 0.005555. (Equivalent to +1.9998 degrees.)

K:commax: Single precision constant stored as -191×2^{-14} and -192×2^{-14}, program notations "-COMMAX" and "-COMMAX-", scaled B1 in units of revolutions. Equation value: +0.0234375. (Equivalent to +8.4375 degrees or half the mechanical limit of the ICDU Error Counter.)

K:GYROFRAC: Double precision constant stored as 0.215×2^{-21}, scaled B21 in units of gyro torque pulses. Equation value: 0.21875. (The closest approximation to 0.215 with a least increment of 0.0078125.)

K:gyromin: Single precision constant stored as 77601_8, program notation "-GYROMIN," scaled B7 in units of gyro torque pulses. Equation value: 1.0. (1 gyro pulse is equivalent to 2^{-21} revolutions.)

K:gyrtm: Single precision constant stored as 01000_8, program notation "BIT10," scaled B0 in units of seconds per gyro torquing pulse. Equation value: 1 / 3200.

(If UPSVFLAG > 0:)

Set FLAGWRD8 bit 12 (CMOONFLG) = FLAGWRD0 bit 12 (MOONFLAG)

Switch FLAGWRD3 bit 6 (ORBWFLAG) to 0

If UPSVFLAG < 0:

Perform "MOVEALEM"

Switch FLAGWRD8 bit 11 (LMOONFLG) to 1

Perform "SVDWN2"

Set FLAGWRD8 bit 11 (LMOONFLG) = FLAGWRD0 bit 12 (MOONFLAG)

Switch FLAGWRD5 bit 1 (RENDWFLG) to 0

UPSVFLAG = 0

Perform "INTWAKE1"

Return

P76 Switch FLAGWRD1 bit 5 (TRACKFLG) to 1

$\underline{DELVOV} = \underline{DELVLVC}$

Proceed to "GOFLASH" with TS = K:V06N33 (TIG)
(If terminate, proceed to "ENDP76" if proceed, continue at next step; other response, repeat this step.)

Proceed to "GOFLASH" with TS = K:V06N84 ($\underline{DELVOV}$)
(If terminate, proceed to "ENDP76" if proceed, continue at next step; other response, repeat this step.)

Switch FLAGWRD2 bit 1 (NODOFLAG) to 1

TDEC1 = TIG

Perform "CSMPREC"

$$\underline{TSv} = \begin{bmatrix} \text{unit}(\text{unit}\underline{RATT} * \underline{VATT}) * \text{unit}\underline{RATT} \\ \text{unit}(\underline{VATT} * \text{unit}\underline{RATT}) \\ -\ \text{unit}\underline{RATT} \end{bmatrix}^{T} \underline{DELVOV} + \underline{VATT}$$

Perform "INTSTALL"

Set FLAGWRD0 bit 12 (MOONFLAG) = FLAGWRD8 bit 12 (CMOONFLG)

VCV = TSv (scaling controlled by MOONFLAG)

RCV = RATT

TET = TIG

Switch FLAGWRD3 bit 4 (INTYPFLG) to 0

TDEC1 = TETLEM

Perform "INTEGRVS"

Perform "INTSTALL"

RRECT = RATT

RCV = RATT

TET = TAT

VRECT = VATT

VCV = VATT

TDELTAV = 0

TNUV = 0

TC = 0

XPREV = 0

Switch FLGWRD10 bit 7 (REINTFLG) to 1

Perform "MOVEACSM"

Switch FLAGWRD8 bit 12 (CMOONFLG) to 1

Perform "SVDWN1"

Set FLAGWRD8 bit 12 (CMOONFLG) = FLAGWRD0 bit 12 (MOONFLAG)

Perform "INTWAKE1"

Switch FLAGWRD2 bit 1 (NODOFLAG) to 0

SLAP1 Inhibit interrupts

Perform "STARTSUB"

Switch $DSPTAB_{11}$ to 100 000 000 x0x 000_2 (INTR)

ERCOUNT = 0 (TEST)

$FAILREG_i = 0$ for i = 0, 1, 2 (PGSR)

REDOCTR = 0 (PGSR)

DSRUPTSW = -5120 (INTR)

DOFSTART Switch channel 11 bit 14 to 1 (bit 14 is engine off)

THRUST = -0 (DESC)

DOFSTRT1 RCSFLAGS = 00004_8 (DAPA)

ABDELV = 0 (SERV)

NVSAVE and $DSPFLG_2 = 0$ (DINT)

CH5MASK, CH6MASK, and PVALTEST = 0 (DAPA)

ERESTORE = 0 (TEST)

SMODE = +0 (TEST)

DNLSTCOD = 0 (TELE)

AGSWORD = 0 (EXVB)

UPSVFLAG = 0 (ORBI)

Switch channels 5, 6, 12, 13, and 14 to 00000_8

If $DSPTAB_{11}$ bit 4 (no attitude) and bit 6 (gimbal lock warning) both = 1:

Switch channel 12 to 00050_8

Make all restart groups inactive

MODREG = -0

IMODES30 = 37411_8 (IMUC)

DB = K:MAXDB

RATEINDX = 2 (DAPB)

DAPBOOLS = 21322_8 (DAPB)

(DAPA)

EBANK = K:EBANK6

STIKSENS = K:STIKSTRT (DAPA)

RATEDB = K:RATESTRT (DAPA)

HIASCENT = K:FULLAPS (DAPB)

DKTRAP = K:77001OCT (DAPA)

LMTRAP = K:77001OCT (DAPA)

DKKAOSN and LMKAOSN = 60 (DAPA)

LMOMEGAN = 0 (DAPA)

DKOMEGAN = 10 (DAPA)

DKDB = 00200_8 (DAPB)

IMODES33 = 16040_8 (INTR)

Switch $FLAGWRD_i$ to 00000_8 for i = 0, 1, 2, 4, 5, 6, 9

FLAGWRD7 = 00100_8

FLAGWRD8 = $000\ xx0\ 0x0\ 000\ 000_2$ (leave bit 12 (CMOONFLG), bit 11 (LMOONFLG), and bit 8 (SURFFLAG) alone)

FLAGWRD3 = $00x\ 010\ 000\ 000\ 000_2$ (leave bit 13 (REFSMFLG) alone)

FLGWRD10 = $00x\ 000\ 000\ 000\ 000_2$ (leave bit 13 (APSFLAG) alone)

FLGWRD11 = 40000_8 (bit 15 is LRBYPASS)

Proceed to "DUMMYJB2"

STARTSUB DNTMGOTO = "DNPHASE1" (TELE)

RADMODES = 00102_8 + bit 6 of channel 33 (LR pos) (RADR)

STARTSB1 Set TIME3 to cause program interrupt #3 in 10 milliseconds

Set TIME4 to cause program interrupt #4 in 30 milliseconds

Set TIME5 to cause program interrupt #2 in 40 milliseconds

EBANK = K:EBANK6

Switch RCSFLAGS bit 13 to 1 (DAPA)

$T6NEXTTM_0$ = 37777_8 (disable TIME6 clock) (DAPA)

Switch bit 15 of channel 13 to 0

NXT6AXIS = 0 (DAPA)

NEXTP = 00000_8 (DAPA)

Switch DAPBOOLS bit 3 (ACCSOKAY) to 0 (DAPA)

T5ADR = "DAPIDLER" (DAPA)

If FLGWRD11 bit 15 (LRBYPASS) = 1, proceed to "STARTSB2"

If STILBADH > 0, skip next line (SERV)

STILBADH = STILBADH + 1

If STILBADV > 0, proceed to "STARTSB2" (SERV)

STILBADV = STILBADV + 1

STARTSB2 Switch channel 11 to $0xx\ 000\ 000\ 000\ 00x_2$
(leave engine on/off and ISS warning alone)

Switch FLAGWRD3 bit 9 (READRFLG) to 0

If FLAGWRD3 bit 11 (NOR29FLG) ≠ 0:

RADMODES = $x00\ x00\ xxx\ xxx\ xx0_2$

Skip next line

RADMODES = $x00\ x0x\ xxx\ xxx\ xx0_2$

Switch channel 12 to $0x0\ xxx\ x00\ xxx\ 000_2$

Switch FLAGWRD5 bit 4 (NORRMON) and bit 11 (R77FLAG) to 0

Switch channel 13 to $xxx\ 100\ 00x\ xx0\ 000_2$

Switch channel 14 to $000\ 000\ 000\ x00\ 000_2$

EBANK = K:STARTEB

Set all 8 waitlist times to 81.93 seconds (MATX)

Set all 9 waitlist task addresses to "SVCT3" (MATX)

Make all 8 job register sets available (MATX)

DSRUPTSW = -0 (INTR)

NEWJOB = -0 (MATX)

Make all 5 VAC areas available (MATX)

$DSPTAB_i = -04000_8$ for i = 0-10 (negative for output) (DSKY)

$DELAYLOC_i = 0$ for i = 0, 1, 2 (MATX)

R1SAVE = 0 (DINT)

$INLINK = 00000_8$ (TELE)

DSPCNT = 0 (INTR)

CADRSTOR = +0 (DINT)

REQRET = +0 (DSKY)

CLPASS = 0 (DSKY)

DSPLOCK = 0 (DSKY)

MONSAVE and MONSAVE1 = 0 (DATA)

VERBREG and NOUNREG = 0 (DATA)

DSPLIST = +0 (DINT)

MARKSTAT = +0 (ALIN)

EXTVBACT = 0 (EXVB)

IMUCADR = +0 (IMUC)

OPTCADR = +0 (ALIN)

RADCADR = +0 (RADR)

ATTCADR = +0 (ATTM)

LGYRO = +0 (IMUC)

$FLAGWRD4 = 00000_8$ (kill display interface routine action)

NOUT = 11 (INTR)

SAMPLIM = -1 (RADR)

$IMODES33 = 001\ 110\ 000\ x00\ 000_2$ (set PIPA good, downlink good, uplink good bits; leave DAP disable bit alone)

SELFRET = "SELFCHK" (TEST)

DSPCOUNT = -19 (DSKY)

Return

V37 If IMODES30 bit 6 = 1: (IMU caged)

Perform "ALARM" with TS = 01520_8

Proceed to "V37BAD"

If MMNUMBER = 70, proceed to "P70"

If MMNUMBER = 71, proceed to "P71"

If MMNUMBER = 0:

If FLAGWRD7 bit 6 (V37FLAG) = 0, proceed to "CANV37"

(Otherwise, "SERVICER" is running; cause it to exit to "CANV37")

Switch FLAGWRD7 bit 5 (AVEGFLG) to 0

End job

If FLAGWRD2 bit 1 (NODOFLAG) = 1:

Perform "ALARM" with TS = 01520_8

Proceed to "V37BAD"

If MMNUMBER $\neq$ low 7 bits of K:PREMM1$_i$ for some i from 0 to 24

Switch bit 7 of channel 11 to 1 (operator error)

Proceed to "V37BAD"

MINDEX = i for which MMNUMBER = low 7 bits of K:PREMM1$_i$

If FLAGWRD7 bit 6 (V37FLAG) $\neq$ 0, proceed to "CANV37"

Switch FLAGWRD7 bit 5 (AVEGFLAG) to 0

End job

V37BAD Perform "RELDSP"

Proceed to "PINBRNCH" (reinstitute any interrupted display)

CANV37 SUPERBNK = 0

Perform "INTSTALL" (wait until integration is free)

Switch FLAGWRD5 bit 6 (3AXISFLG) to 0

Switch FLAGWRD3 bit 15 (POOHFLAG) to 0

Switch FLGWRD11 to 40000_8

Switch FLAGWRD3 bits 9 (RO4FLAG) and 14 (GLOKFAIL) to 0

Switch FLAGWRD6 bit 8 (MUNFLAG) to 0

Switch FLAGWRD9 bit 7 (ABTTGFLG) to 0

Switch DAPBOOLS bit 9 (XOVINHIB) to 0

If MMNUMBER = 0, proceed to "POOH"

If FLAGWRD0 bit 7 (RNDVZFLG) and 9 (P25FLAG) both = 0:

    Switch FLAGWRD0 bit 8 (IMUSE) to 0

DNLSTCOD = $K:DNLADMM1_{MINDEX}$

Inhibit interrupts

Proceed to "SEUDOPOO"

POOH Perform "RELDSP"

Inhibit interrupts

Switch RADMODES bits 10 (DESIGFLG) and 15 (CDESFLAG) to 0

Switch bit 2 of channel 12 to 0 (disable RR Error counter)

Switch FLAGWRD2 bit 1 (NODOFLAG) to 0

Clear P20, P25 restart logic and cause "GOPROG2" to restart "STATINT1"

Switch FLAGWRD0 bits 7 (RNDVZFLG), 8 (IMUSE) and 9 (P25FLAG) to 0

DNLSTCOD = 0

SEUDOPOO AGSWORD = DNLSTCOD

Perform "ENGINOF1"

Perform "ALLCOAST"

Switch FLAGWRD1 bit 14 (DIDFLAG) to 0

Switch FLAGWRD1 bit 12 (RODFLAG) to 0

Switch FLAGWRD0 bit 11 (P21FLAG) to 0

If all restart groups are inactive:

If bit 15 of MODREG = 1, proceed to "ENDRSTRT"

Proceed to "GOTOPOOH" ("GOFLASH" will put "DSPMMJOB" to sleep, leaving program number blank)

Restart all jobs and tasks indicated by active restart groups

ENDRSTRT Proceed to "DUMMYJB2"

GOTOPOOH Switch DAPBOOLS bit 9 (XOVINHIB) and bit 6 (ULLAGER) to 0

Inhibit interrupts

Switch FLAGWRD4 bit 1 (XDSPFLAG) to 0

Release interrupt inhibit

Proceed to "GOFLASH" with TS = K:V37N99 (noun not processed)
(If terminate, repeat this step; if proceed, repeat this step; if other response, repeat this step.)

ALARM Inhibit interrupts

$ALMCADR_0$ = "calling address + 1" (S-register portion)

ALARM2 $ALMCADR_1$ = BBANK + SUPERBNK (or'ed into bits 7-5)

If $FAILREG_0$ = 0:

$FAILREG_0$ = TS (TS contains alarm code)

Proceed to "PROGLARM"

If $FAILREG_1$ = 0:

$FAILREG_1$ = TS

Proceed to "PROGLARM"

PROGLARM $FAILREG_2$ = TS

Switch bit 9 of $DSPTAB_{11}$ to 1 and flag for output

Release interrupt inhibit

Return

BAILOUT Inhibit interrupts

$ALMCADR_0$ = "calling address + 1" (S-register portion)

Perform "ALARM2"

WHIMPER Resume (after this Resume, return is to next line)

Proceed to "ENEMA"

POODOO Inhibit interrupts

$ALMCADR_0$ = "calling address + 1" (S-register portion)

Perform "ALARM2" (TS contains the alarm code)

Switch FLAGWRD3 bit 5 (STATEFLG) to 0

Switch FLGWRD10 bit 7 (REINTFLG) to 0

Switch FLAGWRD2 bit 1 (NODOFLAG) to 0

If FLAGWRD7 bit 6 (V37FLAG) = 1; proceed to "SERVIDLE"

Make all restart groups inactive

Proceed to "WHIMPER"

CURTAINS Inhibit interrupts

Perform "ALARM2" with TS = 00217_8

Return

BAILOUT1 Inhibit interrupts

$ALMCADR_{dp} = TS1_{dp}$

Perform "ALARM2" starting at second line

Inhibit interrupts

Proceed to "WHIMPER"

POODOO1 Inhibit interrupts

$ALMCADR_{dp} = TS1_{dp}$

AGSWORD: See EXVB section.

ALMCADR: Double precision storage for return address (address in most significant half, bank information in least significant half) of the routine that generated the latest alarm.

BASETEMP: Single precision storage for octal address of program to be started by verb 37.

BBANK: A computer hardware cell containing in bits 15-11 the fixed memory bank (FBANK) currently being used and in bits 3-1 the erasable. memory bank number.

CDU_s, CDU_t: See RADR section.

$DELAYLOC_i$ (i = 0,1,2): See MATX section.

DNLSTCOD: See TELE section.

$DSPFLG_2$: See DINT section.

$DSPTAB_{11}$: See INTR section.

DSPTEM1: See DATA section.

E_i: Single precision memory cell whose address is in i.

EBANK: See MATX section.

ERESTORE: See TEST section.

$FAILREG_i$ (i = 0,1,2): Three single precision registers used for storage of alarm code information. $FAILREG_{0,1}$ are zeroed via an "error reset", $FAILREG_2$ is unaltered. All three registers are zeroed by a Verb 36 (fresh start). $FAILREG_0$ contains the first alarm code generated after the "Error Reset"; $FAILREG_1$ contains the second; and $FAILREG_2$ always contains the most recent.

K:77001OCT: Single precision constant stored as 77001_8, scaled B-3 in units of revolutions per second. Equation value: +0.00389. (Equation value: 1.4 degrees per second.)

K:$DNLADMM1_i$ (i = 0-24): Table of 25 single precision indexes which determine the downlist sent during each major mode. See table below.

K:EBANK6: Single precision constant stored as 03000_8, scaled B6 and unitless. Equation value: 6.

K:$FCADRMM1_i$ (i = 0-24): Table of 25 single precision addresses of the 25 major mode programs. See table below.

K:FULLAPS: Single precision constant stored as 5050×2^{-16}, scaled B16 in units of kilograms. Equation value: 5050.

K:PREMM1$_i$ (i = 0-24): Table of 25 major mode numbers with associated EBANK^{1}settings and priorities.

K:MAXDB: Single precision constant stored as 03434_8; used to initialize the attitude deadband. Corresponds to approximately 5 degrees.

K:RATESTRT: Single precision constant stored as 77445_8, scaled B-3 in units of revolutions/second. Used to initialize location -RATEDB (referred to as RATEDB in DAPA section) in "DOFSTRT1".

K:STARTEB: Single precision constant stored as 01400_8, scaled B6 and unitless. Equation value: 3.

K:STIKSTRT: Single precision constant stored as 32321_8, scaled B-15 in revolutions per second/RHC counts. Used to initialize location STIKSENS in "DOFSTRT1".

MINDEX: Single precision register used to select the appropriate table entries for a V37 selected program change (loaded based upon equality of MMNUMBER and bits 7-1 of K:PREMM1$_i$ with the value of i.)

MODREG: See DATA section.

MMNUMBER: Single precision storage for the desired value of the major mode register, scaled B14 and unitless.

MMTEMP: Single precision storage for the number of the program being started by verb 37 (bits 10-1) and for the priority with which the program is to be started (bits 15-11).

NEWJOB: See MATX section.

NVSAVE: See NVWORD in the DINT section.

RADMODES: See RADR section.

REDOCTR: Single precision counter set to zero in a fresh start and incremented whenever a hardware restart occurs; scaled B14 and unitless.

RSBBQ: Storage for the value of the address where a hardware restart occurred. The most significant part contains the BBANK and SUPERBNK information; the least significant part contains the Q-register information.

SCALSAVE: Double precision value of the standby clock (channels 3 and 4)

at the time program 06 enables standby, scaled B23 in units of centiseconds.

SKEEP5, SKEEP6, SKEEP7: See TEST section.

STILBADH: See SERV section.

STILBADV: See SERV section.

SUPERBNK: See MATX section.

TIME3, TIME4, TIME5: See "Major Variables" section.

TIME2SAV: Double precision value of TIMENOW when program 06 enables standby, scaled B28 in units of centiseconds.

TIMENOW: See EXVB section.

RSAMPDT = K:1SECp1

RTSTLOC = 0

If RTSTBASE = +0, TS = 2

If RTSTBASE > 0, TS = 1

RTSTDEX = TS

Proceed to "RO4X"

RO4END RSAMPDT = +0

Delay 1.28 seconds

Inhibit interrupts

Switch bit 14 of channel 12 to 0 (disable RR tracker)

Switch FLAGWRD3 bit 9 (RO4FLAG) to 0

Proceed to "ENDEXT"

RADSAMP If RSAMPDT = +0, end task

Call "RADSAMP" in (|RSAMPDT| - 1) centiseconds

Establish "DORSAMP" (pr25)

RTSTDEX = RTSTBASE + RTSTLOC / 2

End task

DORSAMP If RTSTDEX = 0, perform "RRRANGE" with TSn = 1

If RTSTDEX = 1, perform "RRRDOT" with TSn = 1

If RTSTDEX = 2, perform "LRVELX" with TSn = 1

If RTSTDEX = 3, perform "LRVELY" with TSn = 1

If RTSTDEX = 4, perform "LRVELZ" with TSn = 1

If RTSTDEX = 5, perform "LRALT" with TSn = 1

Perform "RADSTALL"

If RADGOOD = 0, RFAILCNT = RFAILCNT + 1

Inhibit interrupts

If FLAGWRD5 bit 11 (R77FLAG) = 0:

$RSTACK_{RTSTLOC} = SAMPLSUM_{dp}$

If RADMODES bit 6 (LRPOSFLG) $\neq$ bit 6 of channel 33:

Perform "ALARM" with TS = 00522_8

RFAILCNT = RFAILCNT + 1

If RTSTLOC $\neq$ RTSTMAX:

RTSTLOC = RTSTLOC + 2

End job

RTSTLOC = 0

End job

RRRANGE TSset = 00011_8 (bits 1 and 4 = 1)

Perform "INITREAD" with TSn = 1

Return

: If RADCADR = -0 or RADCADR = -1: (should never be true)

RADCADR = +0

End task

LOC = RADCADR

RADGOOD = 1

Wake job put to sleep in "RADSTALL"

RADCADR = +0

End task

RDBADEND If RADCADR = +0:

RADCADR = -0

End task

: If RADCADR = -0 or RADCADR = -1: (should never be true)

: RADCADR = +0

: End task

LOC = RADCADR

RADGOOD = 0

Wake job put to sleep in "RADSTALL"

RADCADR = +0

End task

RADAREAD (entered on radar interrupt about 85-95 ms after "INITREAD")

TTOTIG = TTOGO

DNINDEX = bits 3-1 of channel 13 (radar selection bits)

If DNINDEX $\neq$ 0: (If radar select bits zero, do not store data for downlist (erasable problems))

$DNRADATA_{DNINDEX}$ = RNRAD (radar data)

If SAMPLIM < 0:

Perform "ALARM" with TS = 00520_8

Resume

If SAMPLIM = 0:

If FLGWRD11 bit 15 (LRBYPASS) = 0, proceed to "BADRAD"

If FLAGWRD3 bit 9 (RO4FLAG) = 0, perform "ALARM"
with TS = 00521_8

Proceed to "BADRAD"

SAMPLIM = SAMPLIM - 1

If bit 3 of channel 13 = 0, proceed to "RENDRAD"

Perform "R77CHECK"

If bits 1 and 2 channel 13 are both 1, proceed to "LRHEIGHT"
(LR range/altitude measurement)

TS_{dp} = RNRAD +K:LVELBIAS

i = 8

Perform "DGCHECK" (returns only if data is good)

If NSAMP > 0:

NSAMP = NSAMP - 1

Proceed to "RESAMPLE"

Proceed to "GOODRAD"

LRHEIGHT i = 5

If bit 9 of RADMODES (ALTSCALE) ≠ bit 9 of channel 33:

Proceed to "SCALCHNG" with j = 9

TS_{dp} = RNRAD

C13STALL If bit 4 of channel 13 = 0, return

TS_4 = LOSCALAR + RADTIME (LOSCALAR may have overflowed once since RADTIME was last loaded, but this occurrance has been compensated for in the coding)

If TS ≥ K:90MSCAIR + RADDEL , return

If TS <(K:mDTSCAIR + K:90MSCAIR + RADDEL), return

Proceed to second step of "C13STALL"

RADLITES If i < 5, proceed to second step of "SETTRKF"

If i = 8: (LR velocity data good)

k = +2

$TS = 00004_8$

j = 3

If i = 5: (LR altitude data good)

k = +1

$TS = 00020_8$

j = 5

If bit i of RADMODES = 1, proceed to "ONLITES"

If bit k of FLGWRD11 = 1, proceed to second step of "SETTRKF"

$TS = 00000_8$

LITIT If bit j of $DSPTAB_{11}$ ≠ bit j of TS: (bit 5 is LR altitude fail lamp)

Set bit j of $DSPTAB_{11}$ = bit j of TS (bit 3 is LR velocity fail lamp)

Switch bit 15 of $DSPTAB_{11}$ to 1

Return

ONLITES Switch bit k of FLGWRD11 to 0

Proceed to "LITIT"

CDU_t, CDU_s: LGC input counters incremented directly from the Coupling Data Unit to maintain LGC knowledge of the RR trunnion and shaft angles, respectively. Single precision angles stored in two's complement form and scaled B-1 in units of revolutions.

CDUSCMD, CDUTCMD: LGC output counters connected to the RR shaft and trunnion channels of the CDU. The contents of each of these counters is a rate command scaled B14 in units of RR pulses (one's complement form) and is sent to its respective CDU Error Counter by setting the appropriate enabling discrete in channel 14. See definition of K:RRSPGAIN.

COSTH: See COOR section.

DESCOUNT: Single precision counter defining the maximum amount of time allowed for an attempt to designate, scaled B14 and unitless.

DESRET: A single precision octal return address storage cell.

DNINDEX: A single precision index for selection of appropriate downlink buffer cell for radar data. DNINDEX = 1, 2, 4, 5, 6 or 7 for RR range, RR range-rate, LR X-velocity, LR Y-velocity, LR Z-velocity and LR altitude data, respectively; scaled B14 and unitless.

$DNRADATA_i$: Special storage for downlink of radar data. i = 1, 2, 4, 5, 6, and 7 to index six single precision cells (consecutive except between i = 2 and 4) alternately labelled DNRRANGE, DNRRDOT, DNLRVELX, DNLRVELY, DNLRVELZ AND DNLRALT, respectively.

$DSPTAB_{11}$: See INTR section.

DSPTEM1: Temporary storage cell used mainly for display interface purposes.

IMODES33: See INTR section.

RADLIMCK: Temporary variable indication which of three return options from "RRDESSM" is taken.

RADMODES: A flagword whose bits have the following significance when set (1):

Bit	Mnemonic	Meaning
15	CDESFLAG	Continuous designate; used in conjunction with bit 10
14	REMODFLG	RR remode required
13	RCDUOFLG	RR zeroing in progress
12	ANTENFLG	RR in Mode II (in Mode I if zero)
11	REPOSMON	RR repositioning in progress; RR was outside of prescribed limits
10	DESIGFLG	RR designation in progress
9	ALTSCALE	LR range high scale (low scale if bit is zero)
8	LRVELFLG	LR velocity data bad (LR vel data good if bit is zero)
7	RCDUFAIL	RR CDU operative (RR CDU failed if bit is zero)
6	LRPOSFLG	LR commanded to and presumed to be in position #2
5	LRALTFLG	LR position data bad (LR pos data good if bit is zero)
4	RRDATAFL	RR data bad (if zero, the RR data is "good"; the RR tracker has acquired a target, hopefully the CSM and hopefully not a side lobe).
3	RRRSFLAG	RR range high scale (low scale if bit is zero)
2	AUTOMODE	RR not turned on or not in automatic mode of operation (if zero, the RR is on and it is in the automatic mode)
1	TURNONFL	RR turn-on in progress

RADTIME: Single precision storage for the complement of the value of LOSCALAR at the time bit 4 of channel 13 was set, scaled B9 in units of centiseconds.

RDES: Desired RR position angle (shaft or trunnion); a single precision variable in two's complement form, scaled B-1 in units of revolutions.

RFAILCNT: Single precision counter scaled B14 and used to keep track of the number of unsuccessful attempts to read the radar data.

RNRAD: Single precision LGC counter advanced directly by whichever radar circuit is enabled for sampling, scaled B14 in units of counts.

Sample Type	Value of 1 count	
RRRDOT	-0.19135344 meters/second	-0.6278 fps
RRRANGE		
low scale	2.859024 meters	9.38 feet
high scale	22.872192 meters	75.04 feet
LRVELX	-0.1962912 meters/second	-0.6440 fps
LRVELY	0.3694176 meters/second	1.212 fps
LRVELZ	0.2642006 meters/second	0.8668 fps
LRALT		
lowscale	0.3288792 meters	1.0790 feet
high scale	1.64440 meters	5.3950 feet

RRINDEX: Single precision index to indicate whether the content of RDES is a desired shaft angle (1) or a desired trunnion angle (0), scaled B14.

RRRET: Single precision octal return address storage.

RRTARGET: Desired line-of-sight vector, a double precision unit vector scaled B1 in stable member or navigation base coordinates (see FLAGWRD0 bit 6).

RSAMPDT: A cell used for storage of the low-speed sampling interval, in centiseconds scaled B14.

$RSTACK_i$: A series of 4 double precision cells loaded with radar sample data for display in nouns 66, 67 and $(i = 0, 2, 4, 6)$.

RTSTBASE: Single precision quantity scaled B14 used to set RTSTDEX for LR or RR sampling in an automatic sampling mode.

RTSTDEX: An option loaded by the astronout or set by the program to designate the specific radar data to be sampled single precision, scaled B14.

```
60TIMES   Perform "LPS20.1"

          Perform "RRDESSM"

          If RADLIMCK = 0:

               If REPOSCNT = 0:    (looked 600 seconds ahead did not find)

                    Perform "PRIOLARM"  with TS = 530g
                        (All responses go to "TRMTRACK")

                    End job

               REPOSCNT = REPOSCNT - 1

               REPOSTM = REPOSTM+K:TENSEC

               TDEC1 = REPOSTM     (old designate time plus 10 seconds)

               Proceed to "60TIMES"

          If RADLIMCK = 1:

               End of job

          If RADLIMCK = 2:

               Remove "BEGDES" from waitlist

               If FLAGWRD0 bit 10 (FSPASFLG) =  0:

                    Proceed to "R21LEM8"

               Switch FLAGWRD0 bit 10 (FSPASFLG) to 0

               REPOSTM = REPOSTM+K:TENSEC

               TDEC1 = REPOSTM     (old designate time plus 10 seconds)

               Proceed to "60TIMES"
```

R21LEM8 TDEC1 = REPOSTM

Perform "UPPSV"

Switch RADMODES bit 15 (CDESFLAG) to 1

Switch FLAGWRD0 bit 5 (LOKONSW) to 0

Switch FLAGWRD5 bit 4 (NORRMON) to 1

Perform "RRDESNB"

Call "R21LEM9" in (REPOSTM-TIMENOW seconds)

End of job

R21LEM9 Remove "STDESIG" from waitlist

Switch RADMODES bit 10 and 15 (DESIGFLG) and (CDESFLAG) = 0

Switch bit 2 of channel 12 = 0

Establish "R21LEM10" (pr26)

End task

R21DISP Perform "GOPERF2R" with TS = K:V06N72 (CDU_t , CDU_s)
(If terminate, proceed to "TRMTRACK"; if proceed, proceed to "P20LEMWT"; other response, repeat this step.)

Perform "BLANKET" with TS = 00100_8

End of job

R22LEM42 If FLAGWRD8 bit 8 (SURFFLAG) = 0:

R65CNTR = 2

Perform "R65LEM"

Proceed to "R22LEM"

Proceed to "R22LEM" in 2 seconds

Proceed to fifth step of "R24IEM"

LRS22.1 Switch FLAGWRD5 bit 10 (RNGSCFLG) to 0

Inhibit interrupts

Set RADMODES bit 3 (RRRSFLAG) = bit 3 of channel 33 (RR range scale)

Release interrupt inhibit

READRDOT Perform "RRRDOT" (read RR range-rate)

Perform "RADSTALL"

If RADGOOD = 0:

    TSerror = 1

    Return

Inhibit interrupts

$TS_{5\&6}$ = TIMEHOLD (Save for downlink storage)

RDOTMSAV = SAMPLSUM

TS_3 = CDUY

TS_4 = CDUZ

TS_2 = CDUX

TS_t = TIMENOW

$TANG_0 = CDU_t$

$TANG_1 = CDU_s$

Release interrupt inhibit

Perform "RRRANGE" (read RR range)

Perform "RADSTALL"

If RADGOOD = 0:

If FLAGWRD5 bit 10 (RNGSCFLG) = 1:

Proceed to "READRDOT"

TSerror = 1

Return

Inhibit interrupts

RANGRDOT = $DNRADATA_{1\&2}$

MKTIME = $TS_{5\&6}$

AIG = TS_3

AMG = TS_4

$TANGNB_0$ = $TANG_0$

$TANGNB_1$ = $TANG_1$

AOG = TS_2

RDOTM = K:RDOTCONV RDOTMSAV(scaled to (meters/centisecond)/2^7)

RRTRUN = $TANG_0$ converted to one's complement form

RRSHAFT = $TANG_1$ simlarly converted

RM = K:RANGCONV SAMPLSUM

Perform "RRNB" (determine actual LOS from radar position angles)

RRBORSIT = TS

TDEC1 = TS_t

Perform "LPS20.1" (get estimate of LOS based on present state vector information)

R29 If RADMODES bit 10 (DESIGFLG) = 1, proceed to "R29.LOS"

Inhibit interrupts (note:"R29" will not work because of the anomaly described under "R29DPAS2" on page RNAV - 35)

Switch RADMODES bit 10 (DESIGFLG) to 1

Switch bit 14 of channel 12 to 0 (disable tracker)

Switch FLAGWRD2 bit 12 (LOSCMFLG) to 0

Switch FLAGWRD0 bit 1 (OLDESFLG) to 0

Perform "SETRRECR"

If RADMODES bit 12 (ANTENFLG)= 1:

Call "PREPOS29" in 0.01 second

Switch RADMODES bit 11 (REPOSMON) to 1

Proceed to "NOR29NOW"

Establish "R29REMOJ" (pr21)

Switch RADMODES bit 10 (DESIGFLG) to 0

Switch RADMODES bit 14 (REMODFLG) to 1

Proceed to "NOR29NOW"

R29.LOS TS_t = TIMENOW - PIPTIME

$\underline{TS} = \underline{RCSM} - \underline{R} + TS_t\ (\underline{VCSM} - \underline{V})$

If FLAGWRD2 bit 12 (LOSCMFLG) = 1, proceed to "NOR29NOW"

Switch FLAGWRD2 bit 12 (LOSCMFLG) to 1

$\underline{LOSSM} = \underline{TS}$

$\underline{LOSVDTd4} = K{:}.5SECB17\ (\underline{VCSM} - \underline{V})$

Switch FLAGWRD2 bit 12 (LOSCMFLG) to 0

If FLAGWRD0 bit 1 (OLDESFLG) = 1, proceed to "NOR29NOW"

Inhibit interrupts

Switch FLAGWRD0 bit 1 (OLDESFLG) to 1

TS = 100

If PIPCTR > 0, TS = 4

Call "BEGDES29" in TS centiseconds

Release interrupt inhibit

Proceed to "NOR29NOW"

R29REMOJ Call "REMODE" in 0.01 second.

Perform "RADSTALL"

End job

PREPOS29 RDES = $-\frac{1}{2}$ (-180^{o})

Perform "RRTONLY"

Switch RADMODES bit 11 (REPOSMON) to 0

End task

R29READ Establish "R29RDJOB" (pr26)

Delay 2 seconds

If FLAGWRD3 bit 9 (READRFLG) = 1, proceed to "R29READ"

End task

R29RDJOB If FLAGWRD3 bit 11 (NOR29FLG) = 1, proceed to "ENDR29RD"

If RADMODES bit 2 (AUTOMODE) = 1, proceed to "ENDRRD29"

Perform "RRRDOT"

Perform "RADSTALL"

If RADGOOD = 0, proceed to "ENDRRD29"

TS_{t} = TIMEHOLD

Inhibit interrupts

$TS_{CDUT} = CDU_{t}$

$TS_{CDUS} = CDU_{s}$

$TS_{CDUy} = CDU_y$

$TS_{CDUz} = CDU_z$

$TS_{CDUx} = CDU_x$

R29RANGE Perform "RRRANGE"

Perform "RADSTALL"

If RADGOOD = 0:

If FLAGWRD5 bit 10 (RNGSCFLG) = 0, proceed to "ENDRRD29"

Switch FLAGWRD5 bit 10 (RNGSCFLG) to 0

Proceed to "R29RANGE"

Inhibit interrupts

$RM_0 = DNRADATA_1$

$RM_1 = DNRADATA_2$

$MKTIME = TS_t$

$TANGNB_0 = TS_{CDUT}$

$TANGNB_1 = TS_{CDUS}$

$AIG = TS_{CDUy}$

$AMG = TS_{CDUz}$

$AOG = TS_{CDUx}$

TRKMKCNT = 1

Release interrupt inhibit

End job

ENDR29RD Switch channel 12 bit 14 to 0

ENDRRD29 TRKMKCNT = 0

Switch FLAGWRD3 bit 9 (READRFLG) to 0

End job

BEGDES29 Establish "R29DODES" (pr21)

Delay 0.5 second

If RADMODES bit 10 (DESIGFLG) = 0, end task

If FLAGWRD2 bit 12 (LOSCMFLG) = 1:

    Delay 0.01 second

    Proceed to third line of "BEGDES29"

Switch FLAGWRD2 bit 12 (LOSCMFLG) to 1

Proceed to "BEGDES29"

R29DODES TANG = 1

If TANG > 0, TSsm = LOSSM

If TANG = 0:

    LOSSM = LOSSM + LOSVDTd4

    TSsm = LOSSM + LOSVDTd4

TS_{LOSSM} = unit TSsm

If TANG > 0:

    Inhibit interrupts

    $TS_{CDUT} = CDU_t$

    $TS_{CDUS} = CDU_s$

    ANG = (CDU_y, CDU_z, CDU_x)

    Perform "QUICTRIG"

Perform "SMTONB"

$\underline{ULOSNB} = [SMNBMAT]\ \underline{TS}_{LOSSM}$

If TANG = 0, proceed to "R29DPAS2"

Inhibit interrupts

TANG = 0

$TS_{cost} = cos_{sp}\ TS_{CDUT}$

$TS_{sint} = sin_{sp}\ TS_{CDUT}$

$TS_{sins} = sin_{sp}\ TS_{CDUS}$

$TS_{coss} = cos_{sp}\ TS_{CDUS}$

$TSm = TS_{coss}\ TS_{cost}\ ULOSNB_z - TS_{sint}\ ULOSNB_y + TS_{cost}\ TS_{sins}\ ULOSNB_x$

TSm = 2 TSm (cosine of angle between actual LOS and radar LOS)

If TS = +1: (TS = +1 for positive overflow of TSm)

Switch bit 14 of channel 12 to 1 (self track enable)

Release interrupt inhibit

Proceed to second step of "R29DODES"

R29DPAS2 $TANG_0 = TS_{coss}\ ULOSNB_x - TS_{sins}\ ULOSNB_z$

$TSm = TS_{sint}\ TS_{sins}\ ULOSNB_x + TS_{cost}\ ULOSNB_y + TS_{coss}\ TS_{sint}\ ULOSNB_z$

SHAFTCMD = K:R29GAIN $TANG_0$

$TRUNNCMD_0$ = K:R29GAIN TSm

If bit 4 of channel 33 = 1: (RR tracker not locked on)

Perform "RROUT"

Switch FLAGWRD2 bit 12 (LOSCMFLG) to 0

End job

Switch RADMODES bit 10 (RRDESFLG) to 0

Switch bit 2 of channel 12 to 0 (disable RRCDU Error Counters)

Switch FLAGWRD3 bit 9 (READRFLG) to 1

TS = 100

If PIPCTR > 0, TS = 4

Call "R29READ" in TS centiseconds

Switch FLAGWRD2 bit 12 (LOSCMFLG) to 0

End job

WLINIT p = WRENDPOS

v = WRENDVEL

If FLAGWRD8 bit 8 (SURFFLAG) = 1:

p = WSURFPOS

v = WSURFVEL

s = WSHAFT

t = WTRUN

$$[W] = \begin{bmatrix} p & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & p & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & p & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & v & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & v & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & v & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & s & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & t & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \end{bmatrix}$$

Switch FLAGWRD5 bit 1 (RENDWFLG) to 1

TRKMKCNT = 0

Return

LGCUPDTE LGRET = return address

Perform "INCORP1"

R22DISPR = $|\underline{\text{DELTAX}}_0|$

R22DISPV = $|\underline{\text{DELTAX}}_1|$

If R22DISPR > RMAX or if R22DISPV > VMAX:

Proceed to "R22LEM96" (get astronaut OK)

If TS $\geq$ 0: (DELTAH too large)

If LRRCTR $\neq$ 0 and LRLCTR - LRRCTR $<$ 4:

Switch FLGWRD11 bit 1 (HFLSHFLG) to 1

LRRCTR = LRLCTR

Proceed to "VMEASCHK"

Switch FLGWRD11 bit 1 (HFLSHFLG) to 0

NOREASON If FLGWRD11 bit 8 (LRINH) = 0, proceed to "VMEASCHK"

If HCALC $\geq$ LRHMAX, proceed to "VMEASCHK"

TS = DELTAH LRWH (LRHMAX - HCALC) / LRHMAX

TSr = R1S + TS UNITR

Perform "MUNGRAV"

R1S = TSr

VMEASCHK If FLGWRD11 bit 7 (VELDATA) = 0, proceed to "VALTCHK"

ANG = LRCDU

Perform "QUICTRIG"

If VSELECT = 0, TSuv = VZBEAMNB

If VSELECT = 1, TSuv = VYBEAMNB

If VSELECT = 2, TSuv = VXBEAMNB

Perform "NBTOSM"

j = 2 VSELECT

VBEAM = [NBSMMAT] TSuv

TSgv = GDT (LRVTIME - PIPTIME) / K:2SECb28

TS = TSgv + V + K:KPIP1 PIPTEM + DELVS

VEST = TS · VBEAM

DELTAV = $K{:}VSCAL_j$ VMEAS - VEST

TS = |DELTAV| - (|TS| / 8 + VELBIAS)

LRMCTR = LRMCTR + 1

If TS $\geq$ 0: (DELTAV too large)

If LRSCTR $\neq$ 0 and LRMCTR - LRSCTR $<$ 4:

Switch FLGWRD11 bit 2 (VFLSHFLG) to 1

LRSCTR = LRMCTR

If VSELECT = 0, switch FLGWRD11 bit 12 (VXINH) to 1

Proceed to "VALTCHK"

Switch FLGWRD11 bit 2 (VFLSHFLG) to 0

If FLGWRD11 bit 12 (VXINH) = 1:

Switch FLGWRD11 bit 12 (VXINH) to 0

If VSELECT = 2, proceed to "VALTCHK"

If FLGWRD11 bit 8 (LRINH) = 0, proceed to "VALTCHK"

If ABVEL $\leq$ LRVF:

TS = $LRWVF_{VSELECT}$

Proceed to "WSTOR"

If LRVMAX $\leq$ ABVEL:

TS = 0

Proceed to "WSTOR"

TS = $LRWV_{VSELECT}$ (LRVMAX - ABVEL) / LRVMAX

WSTOR If MODREG $>$ 64:

TS = LRWVFF

TS_{dp} = (TS, 0)

$\underline{TS}v = \underline{V}1S + TS_{dp}$ DELTAV $\underline{V}$BEAM

$\underline{V}1S = \underline{TS}v$

Proceed to "VALTCHK"

LANDISP PIPCTR = PIPCTR1

If FLAGWRD7 bit 11 (SWANDISP) = 0, proceed to "DISPRSET"

LADQSAVE = "ALTROUT1"

If IMODES33 bit 7 = 1, LADQSAVE = "ALTOUT1"

If bit 6 of channel 30 = 1, proceed to "DISPRSET"
(inertial data display discrete is reset)

If FLAGWRD1 bit 14 (DIDFLAG) = 1, proceed to "SPEEDRUN"

Switch FLAGWRD1 bit 14 (DIDFLAG) to 1

Switch IMODES33 bit 7 to 0 (display rate first)

If FLAGWRD0 bit 2 (R10FLAG) = 1, end task

Switch bit 8 of channel 12 to 1 (set inertial data display moding discrete)

TRAKLATV = 0

TRAKFWDV = 0

LATVMETR = 0

FORVMETR = 0

Call "INTLZE" in 0.08 second

End task

INTLZE Switch bit 2 of channel 12 to 1 (enable RRCDU error counter)

Switch IMODES33 bit 8 to 1

End task

SPEEDRUN DT_{sp} = TIMENOW - PIPTIME

$\underline{V}VECT = \frac{1}{2}\ \underline{G}DT\ DT\ /\ K{:}1SEC$

$\underline{V}VECT_{sp} = \underline{V}VECT + \underline{V} + K{:}KPIP1b5\ (\underline{P}IPA + \underline{P}IPATMP)$

Delay 0.04 second

If FLAGWRD0 bit 2 (R10FLAG) = 1, proceed to LADQSAVE

If bit 2 of channel 12 = 0, proceed to "DISPRSET"

$\underline{T}S = \underline{V}VECT + \underline{D}ELVS_{ms}$

```
VHY = TS · UHYP

VHZ = TS · UHZP

LATVEL = K:VELCONV (M32 VHY + M22 VHZ)

FORVEL = K:VELCONV (M32 VHZ - M22 VHY)

If |FORVEL| < K:MAXVBITS:
     If TRAKFWDV FORVEL ≥ 0:
          TS = FORVEL - FORVMETR
          If TRAKFWDV = 0 and FORVEL FORVMETR < 0:
               If |TS| > K:MAXVBITS, TS = K:MAXVBITS signTS
     If TRAKFWDV FORVEL < 0:
          TS = - FORVMETR
     TRAKFWDV = 0
If |FORVEL| ≥ K:MAXVBITS:
     If TRAKFWDV FORVEL ≥ 0:
          TS = K:MAXVBITS signFORVEL - FORVMETR
          i = 1 signFORVEL
     If TRAKFWDV FORVEL < 0:
          TS = K:MAXVBITS signFORVEL
          i = 0
     TRAKFWDV = i
CDUSCMD = TS

FORVMETR = FORVMETR + TS

If |LATVEL| < K:MAXVBITS:
     If TRAKLATV LATVEL ≥ 0:
          TS = LATVEL - LATVMETR
```

corresponds to an RR drive rate of 10 degrees per second; each bit represents 0.1698 meters per second (0.5571 feet per second) when used to drive the velocity meters.

CDUTEMP: Single precision vector storage for the reading of the ICDU at the time of a PIPA read, scaled B-1 in units of revolutions and stored in twos complement form.

COSIGA, COSMGA, COSOGA: See COOR section.

DALTRATE: Single precision expected rate of change of ALTRATE, scaled BO in units of Analog-altitude-rate-display bits per centisecond.

DAPBOOLS: See flagword definitions.

DELQFIX: Double precision Landing Radar Data reasonableness test parameter, scaled B24 in units of meters; part of the erasable load.

DELTAH: Double precision difference between the calculated altitude and that measured by the Landing Radar, scaled B24 in units of meters.

DELTAV: Double precision difference between the calculated velocity component and that measured by the Landing Radar, scaled B6 in units of meters per centisecond.

DELV: Double precision sensed-change-in-velocity vector, scaled B14 in units of centimeters per second (one PIPA pulse represents one centimeter per second on the LM) and expressed in Platform coordinates.

DELVREF: Double precision sensed-change-in-velocity vector converted to a scaling of B7 in units of meters per centisecond and expressed in the Reference coordinate system.

DELVS: Double precision vector difference between velocity relative to the rotating moon and inertial velocity, scaled B5 in units of meters per centisecond and expressed in the Platform coordinate system.

$DSPTAB_{11}$: See INTR section.

DT: Single precision time interval from beginning of navigation interval to the time of the generation of the display on the tape-drive meters, scaled B14 in units of centiseconds.

DVCNTR: Single precision counter set to determine the length of the thrust monitor, scaled B14 in units of navigation cycles.

DVTHRUSH: Single precision delta-v threshold, scaled B14 in units of centimeters per second; set according to the engine in use.

DVTOTAL: Double precision sum of velocity gained, scaled B7 in units of meters per centisecond.

FORVEL: Single precision forward velocity component (Body coordinates) of the LM relative to the rotating moon, scaled B14 in forward velocity display units.

FORVMETR: Single precision storage for the total value of velocity displayed on the Forward velocity meter, scaled B14 in forward velocity display units (see definition of CDUSCMD)

GCSM: Double precision gravity vector at the CSM, scaled B8 in units of meters per centisecond and expressed in the Platform coordinate system.

GDT, GDT1: Double precision gravity vector at the LM, scaled B8 in units of meters per centisecond and expressed in the Platform coordinate system.

HBEAMNB: Double precision unit vector in the direction of the Landing Radar measurement of altitude, scaled B1 and expressed in the Body coordinate system.

HCALC, HCALC1: Double precision calculated altitude above the landing site radius, scaled B24 in units of meters. HCALC1 is for display purposes.

HDOTDISP: Double precision calculated value of altitude rate, scaled B7 in units of meters per centisecond.

HMEAS: Double precision Landing Radar measurement of altitude, scaled B28 in units of Landing Radar altitude bits.

IMODES33: See INTR section.

K:1SEC: Single precision constant stored as 100×2^{-14}, scaled B14 in units of centiseconds. Equation value: 100.

K:2J: Double precision constant stored as 3.24692010 E-3, scaled B0 and unitless. Equation value: 3 x 0.0010823067.

K:20J: Double precision constant stored as 3.24692010 E-2, scaled B0 and unitless. Equation value: Ten times K:2J.

K:2SECb28: Double precision constant stored as 200×2^{-28}, program notation 2SEC(28), scaled B28 in units of centiseconds. Equation value: 200.

K:30kft: Double precision constant stored as 1.6768072 E7 $\times 2^{-24}$, program notation "1-30KFT", scaled B24 in units of meters. Represents 2^{24} - 9144 meters (K:posmaxdp plus one least increment minus 9144 meters). Used to check current altitude against 9144 meters. Equation value: 9144 (Equivalent to 30,000 feet).

K:6KFTdSEC: Single precision constant stored as 18.288×2^{-7}, scaled B7 in units of meters per centisecond. Equation value: 18.288. (Equivalent to 6000 feet per second.)

LATVEL: Single precision lateral velocity component (Body coordinates; positive to the right when looking forward) of the LM relative to the rotating moon, scaled B14 in forward/lateral velocity units.

LATVMETR: Single precision storage for the total value of velocity displayed on the lateral velocity meter, scaled B14 in forward/lateral velocity display units.

$LRALPHA_1$, $LRALPHA_2$: Single precision angle from the Z spacecraft axis to the Z LR coordinate axis measured in a right hand rotation around the -X spacecraft axis, for LR positions 1 and 2 respectively, scaled B-1 in units of revolutions and stored in twos complement form.

$LRBETA_1$, $LRBETA_2$: Single precision angle from the +X spacecraft axis to the +X LR coordinate axis measured in a right hand rotation around the -Z LR coordinate axis, for LR positions 1 and 2 respectively, scaled B-1 in units of revolutions and stored in twos complement form.

LRCDU, LRCDUDL: Single precision vector storage for the value of the three ICDU angles at the estimated midpoint of an LR velocity reading, scaled B-1 in units of revolutions and stored in twos complement form. LRCDUDL is for downlink purposes.

LRHMAX: Single precision maximum limit for altitude calculations that are allowed to be updated by the Landing Radar measurement, scaled B14 in units of meters.

LRLCTR: Single precision count of the number of comparisons made between HMEAS and HCALC, scaled B14 and unitless.

LRMCTR: Single precision count of the number of comparisons made between measured velocity and calculated velocity, scaled B14 and unitless.

LRRCTR: Single precision counter used in conjunction with LRLCTR to determine if at least four good comparisons between HMEAS and HCALC have been made since the last unreasonable one, scaled B14 and unitless.

LRSCTR: Single precision counter used in conjunction with LRMCTR to determine if at least four good comparisons between measured velocity and calculated velocity have been made since the last unreasonable one, scaled B14 and unitless.

LRVF: Single precision erasable memory constant representing the velocity at which the velocity update coefficients are changed, scaled B7 in units of meters per centisecond.

LRVMAX: Single precision maximum limit for velocity calculations that are allowed to be updated by the LR measurement, scaled B7 in units of meters per centisecond.

LRVTIME, LRVTIMDL: Double precision time at the estimated midpoint of the LR velocity sample, scaled B28 in units of centiseconds. LRVTIMDL is for downlink purposes.

LRWH: Single precision weighting factor for the incorporation of LR altitude measurements into the LM state vector, scaled B0 and unitless.

LRWV$_i$ (i = 0,1,2): Single precision weighting factors for LR Z, Y and X axis velocity updates, scaled BO and unitless.

LRWVF$_i$ (i = 0,1,2): Single precision weighting factors for LR Z, Y and X axis velocity updates, scaled BO and unitless.

LRWVFF: Single precision weighting factor for LR velocity updates for P65 and P66 , scaled BO and unitless.

M22, M32: See DAPA section.

MASS, MASS1: Double precision mass of the vehicle, scaled B16 in units of kilograms. Loaded by the astronaut (routine 03) and updated during average-g navigation.

MKTIME: Double precision time of PIPA readings which are associated with the Landing Radar altitude measurement for downlink purposes, scaled B28 in units of centiseconds.

MODREG: See DATA section.

[NBSMMAT]: See COOR section.

PGUIDE: Double precision length of the navigation-guidance period, scaled B28 in units of centiseconds.

PIPA: Single precision sensed-change-in-velocity vector, scaled B14 in units of centimeters per second and expressed in the Platform coordinate system. The three components are incremented directly from the Pulse-Integrating, Pendulous Accelerometers on the stable member of the Inertial Measurement Unit.

PIPATMP: Single precision vector storage for the current PIPA reading for use by the analog display routines, reset to zero after the current reading is incorporated into the navigation state vector; scaled B14 in units of centimeters per second and expressed in the Platform coordinate system.

PIPCTR: Single precision counter scaled B14 and unitless; used to determine time elapsed from the beginning of the navigation cycle in "R10,R11" and routine 29.

PIPCTR1: Single precision temporary storage for PIPCTR.

PIPTEM: Single precision vector storage for the sensed change in velocity between the beginning of the navigation cycle and the mean time of the LR velocity sample, scaled B14 in units of centimeters per second and expressed in the Platform coordinate system.

PIPTIME: Double precision time of the most recent PIPA read cycle, scaled B28 in units of centiseconds; time at which the average-g state vector is valid.

PIPTIME1: Temporary storage for PIPTIME to avoid changing the downlink state vector until it is updated homogeneously.

R: see DESC section.

R1S: Temporary storage for R to avoid changing the state vector on the downlink until it is updated homogeneously, scaled B24 in units of meters and expressed in the Platform coordinate system.

RADGOOD, RADMODES: See RADR section.

RADSKAL: Double precision erasable memory quantity representing the LR scale information for high scale radar output, scaled B21 in units of low-scale altitude bits per meter per centisecond; part of erasable load.

RCSM: Double precision position vector of the CSM measured from the center of the earth or moon, program notations R-OTHER and R(CSM), scaled B29 or B24 (descent guidance) in units of meters and expressed in the Reference or the Platform (descent) coordinate system.

[REFSMMAT]: see COOR section.

RMAGSQ: Double precision square of the magnitude of the position vector, scaled B58 (CALCGRAV) or B48 (MUNGRAV) in units of meters squared.

RN: Double precision vector position of the LM measured from the center of the earth or moon, scaled B29 in units of meters and expressed in the Reference coordinate system.

RN1: Temporary storage for RN to avoid changing the state vector on the downlink until it is updated homogeneously.

RPCRTQSW: Double precision required X component of the X-body axis in Platform coordinates at the time of LR reposition to position 2, scaled B1 and unitless; part of the erasable load and may be altered by V59.

RPCRTIME: Single precision value of TTF at which the LR may be repositioned to position 2, scaled B17 in units of centiseconds; part of the erasable load and may be altered by V59.

RTX1, RTX2: See TRGL section.

RUNIT: Single precision unit vector along the position vector of the LM with respect to the center of the moon, scaled B1, unitless, and expressed in the Platform coordinate system.

SAMPLSUM: See RADR section.

SINIGA, SINMGA, SINOGA: See COOR section.

SKALSKAL: Single precision erasable memory factor by which the correction to the LR data is reduced if the LR is on low range scale, scaled B0 and unitless; part of the erasable load.

[SMNBMAT]: see COOR section.

STILBADH, STILBADV: Single precision counters, scaled B14 and unitless.

TEM: Single precision storage for -PIPA, scaled B14 in units of centimeters per second. TEM is used in the R.O.D. computations of the DESC section.

TIME5: see DAPA section.

TIMENOW: see EXVB section.

TRAKFWDV: Single precision flag set to 1, 0 or - 1 to indicate whether the previously computed value of FORVEL exceeded K:MAXVBITS or not, scaled B14 and unitless.

TRAKLATV: Single precision flag set to 1, 0 or - 1 to indicate whether the previously computed value of LATVEL exceeded K:MAXVBITS or not, scaled B14 and unitless.

TTF: see DESC section.

UHYP: Double precision unit vector normal to the CSM orbital plane, scaled B1 and unitless.

UHZP: Double precision unit local vertical vector in the forward direction, scaled B1 and unitless.

UNITGOBL: See BURN section.

UNITR: Double precision unit vector along the vector from the center of the moon or the earth to the LM, program notation UNIT/R/, scaled B1, unitless and expressed in the Platform or Reference coordinate system.

V: See DESC section.

V1S: Temporary storage for V to avoid changing state vector on the downlink until it is updated homogeneously, scaled B7 in units of meters per centisecond and expressed in the Platform coordinate system.

VBEAM: Double precision unit vector along one of the three Landing Radar velocity measurement directions, scaled B1 and expressed in Platform coordinates at LRVTIME.

VCSM: Double precision inertial velocity vector of the CSM, program notations V-OTHER and V(CSM), scaled B7 in units of meters per centisecond and expressed in the Reference or the Platform (for Descent) coordinate system.

VELBIAS: Double precision erasable constant representing the Landing Radar velocity reasonability test limit, scaled B6 in units of meters per centisecond; part of the erasable load.

VEST: Double precision projection of calculated velocity onto the particular LR velocity component direction being processed, scaled B6 in units of meters per centisecond.

VHY, VHZ: Single precision lateral and forward components of velocity relative to the rotating moon expressed in the Platform coordinate system (lateral velocity positive to the right when looking forward); scaled B5 in units of meters per centisecond.

VMEAS: Double precision velocity measurement from the LR sampling, scaled B28 in units of Landing Radar velocity bits.

WORD #	FIRST REGISTER	SECOND REGISTER	ERASABLE ADDRESS
25	$DNRADATA_4$ (DNLRVELX)	$DNRADATA_5$ (DNLRVELY)	1333, 1334
26	$DNRADATA_6$ (DNLRVELZ)	$DNRADATA_7$ (DNLRALT)	1335, 1336
27	$VGPREV_0$ (VGTIG-X comp)	$VGPREV_1$ (VGTIG-X comp)	3700 - 3705
28	$VGPREV_2$ (VGTIG-Y comp)	$VGPREV_3$ (VGTIG-Y comp)	
29	$VGPREV_4$ (VGTIG-Z comp)	$VGPREV_5$ (VGTIG-Z comp)	
30	REDOCTR	$THETAD_0$ (X-ANGLE)	0320, 0321
31	$THETAD_1$ (Y-ANGLE)	$THETAD_2$ (Z-ANGLE)	0322, 0323
32	RSBBQ	RSBBQ+1	1432, 1433
33	OMEGAP	OMEGAQ	3021, 3022
34	OMEGAR	ALPHAQ	3023, 3024
35	CDUXD	CDUYD	3234, 3235
36	CDUZD	*DELCDUX	3236, 3237
37	CDUX	CDUY	0032, 0033
38	CDUZ	CDUT	0034, 0035
39	FLAGWRD0	FLAGWRD1	0074 - 0107
40	FLAGWRD2	FLAGWRD3	
41	FLAGWRD4	FLAGWRD5	
42	FLAGWRD6	FLAGWRD7	
43	FLAGWRD8	FLAGWRD9	
44	FLGWRD10	FLGWRD11	
45	$DSPTAB_0$	$DSPTAB_1$	1022 - 1035
46	$DSPTAB_2$	$DSPTAB_3$	
47	$DSPTAB_4$	$DSPTAB_5$	
48	$DSPTAB_6$	$DSPTAB_7$	
49	$DSPTAB_8$	$DSPTAB_9$	
50	$DSPTAB_{10}$	$DSPTAB_{11}$	

WORD #	FIRST REGISTER	SECOND REGISTER	ERASABLE ADDRESS
51	TIMENOW (TIME2)	TIMENOW (TIME1)	0024-5
52	RN_0 (X comp.)	RN_1 (X comp.)	1217 - 1224
53	RN_2 (Y comp.)	RN_3 (Y comp.)	
54	RN_4 (Z comp.)	RN_5 (Z comp.)	
55	VN_0 (X comp.)	VN_1 (X comp.)	1225 - 1232
56	VN_2 (Y comp.)	VN_3 (Y comp.)	
57	VN_4 (Z comp.)	VN_5 (Z comp.)	
58	PIPTIME	PIPTIME	1233-4
59	OMEGAPD	OMEGAQD	3242, 3243
60	OMEGARD	*ECDUW	3244, 3245
61	$CADRFLSH_0$	$CADRFLSH_1$	0372, 0373
62	$CADRFLSH_2$	$FAILREG_0$	0374, 0375
63	$FAILREG_1$	$FAILREG_2$	0376, 0377
64	RADMODES	DAPBOOLS	0110, 0111
65	OGC	OGC	2737 - 2740
66	IGC	IGC	2741-2
67	MGC	MGC	2743-4
68	BESTI (STAR ID 1)	BESTJ (STAR ID 2)	2755, 2756
69	$STARSAV1_0$ (X comp.)	$STARSAV1_1$ (X comp.)	2760 - 2765
70	$STARSAV1_2$ (Y comp.)	$STARSAV1_3$ (Y comp.)	
71	$STARSAV1_4$ (Z comp.)	$STARSAV1_5$ (Z comp.)	
72	$STARSAV2_0$ (X comp.)	$STARSAV2_1$ (X comp.)	2766 - 2773
73	$STARSAV2_2$ (Y comp.)	$STARSAV2_3$ (Y comp.)	
74	$STARSAV2_4$ (Z comp.)	$STARSAV2_5$ (Z comp.)	
75	$DNRADATA_4$ (DNLRVELX)	$DNRADATA_5$ (DNLRVELY)	1333, 1334
76	$DNRADATA_6$ (DNLRVELZ)	$DNRADATA_7$ (DNLRALT)	1335, 1336

WORD #	FIRST REGISTER	SECOND REGISTER	ERASABLE ADDRESS
77	CDUS	PIPA (X)	0036, 0037
78	PIPA (Y)	PIPA (Z)	0040, 0041
79	LASTTCMD (LASTYCMD)	LASTSCMD (LASTXCMD)	0112, 0113
80	LEMMASS	CSMMASS	1326, 1327
81	IMODES30	IMODES33	1277, 1300
82	TIG	TIG	3441-2
83	OMEGAP	OMEGAQ	3021, 3022
84	OMEGAR	ALPHAQ	3023, 3024
85	CDUXD	CDUYD	3234, 3235
86	CDUZD	*DELCDUX	3236, 3237
87	CDUX	CDUY	0032, 0033
88	CDUZ	CDUT	0034, 0035
89	ALPHAQ	ALPHAR	3024, 3025
90	$DOWNTORK_0$ (POSTORKP)	$DOWNTORK_1$ (NEGTORKP)	3113, 3114
91	CHANNEL11	CHANNEL12	
92	CHANNEL13	CHANNEL14	
93	CHANNEL30	CHANNEL31	
94	CHANNEL32	CHANNEL33	
95	$DSPTAB_0$	$DSPTAB_1$	1022 - 1035
96	$DSPTAB_2$	$DSPTAB_3$	
97	$DSPTAB_4$	$DSPTAB_5$	
98	$DSPTAB_6$	$DSPTAB_7$	
99	$DSPTAB_8$	$DSPTAB_9$	
100	$DSPTAB_{10}$	$DSPTAB_{11}$	

AGS INITIALIZATION & UPDATE LIST

WORD #	FIRST REGISTER	SECOND REGISTER	ERASABLE ADDRESS
1	LIST ID (77776_8)	SYNC PATTERN (77340_8)	
2	$AGSBUFF_0$ (LM X POS)	*$AGSBUFF_1$ (not used by AGS)	2200, 2201
3	$AGSBUFF_2$ (LM Y POS)	*$AGSBUFF_3$ (not used by AGS)	2202, 2203
4	$AGSBUFF_4$ (LM Z POS)	*$AGSBUFF_5$ (not used by AGS)	2204, 2205
5	$AGSBUFF_{12}$ (Vector time MSB)	*$AGSBUFF_{13}$ (not used by AGS)	2214, 2215
6	$AGSBUFF_1$ (LM X VEL)	*$AGSBUFF_2$ (not used by AGS)	2201, 2202
7	$AGSUBFF_3$ (LM Y VEL)	*$AGSBUFF_4$ (not used by AGS)	2203, 2204
8	$AGSBUFF_5$ (LM Z VEL)	*$AGSBUFF_6$ (not used by AGS)	2205, 2206
9	$AGSBUFF_{13}$ (Vector time LSB)	*$VONE_2$ (not used by AGS)	2215, 2216
10	$AGSBUFF_6$ (CSM X POS)	*$AGSBUFF_7$ (not used by AGS)	2206, 2207
11	$AGSBUFF_8$ (CSM Y POS)	*$AGSBUFF_9$ (not used by AGS)	2210, 2211
12	$AGSBUFF_{10}$ (CSM Z POS)	*$AGSBUFF_{11}$ (not used by AGS)	2212, 2213
13	$AGSBUFF_{12}$ (Vector time MSB)	*$AGSBUFF_{13}$ (not used by AGS)	2214, 2215
14	$AGSBUFF_7$ (CSM X VEL)	*$AGSBUFF_8$ (not used by AGS)	2207, 2210
15	$AGSBUFF_9$ (CSM Y VEL)	*$AGSBUFF_{10}$ (not used by AGS)	2211, 2212
16	$AGSBUFF_{11}$ (CSM Z VEL)	*$AGSBUFF_{12}$ (not used by AGS)	2213, 2214
17	$AGSBUFF_{13}$ (Vector time LSB)	*$VONE_2$ (not used by AGS)	2215, 2216
18	COMPNUMB	UPOLDMOD	1167, 1170
19	UPVERB	UPCOUNT	1171, 1172

WORD #	FIRST REGISTER	SECOND REGISTER	ERASABLE ADDRESS
20	$UPBUFF_0$	$UPBUFF_1$	1173 - 1216
21	$UPBUFF_2$	$UPBUFF_3$	
22	$UPBUFF_4$	$UPBUFF_5$	
23	$UPBUFF_6$	$UPBUFF_7$	
24	$UPBUFF_8$	$UPBUFF_9$	
25	$UPBUFF_{10}$	$UPBUFF_{11}$	
26	$UPBUFF_{12}$	$UPBUFF_{13}$	
27	$UPBUFF_{14}$	$UPBUFF_{15}$	
28	$UPBUFF_{16}$	$UPBUFF_{17}$	
29	$UPBUFF_{18}$	$UPBUFF_{19}$	
30	REDOCTR	$THETAD_0$ (X-angle)	0320, 0321
31	$THETAD_1$ (Y-angle)	$THETAD_2$ (Z-angle)	0322, 0323
32	RSBBQ	RSBBQ+1	1432, 1433
33	OMEGAP	OMEGAQ	3021, 3022
34	OMEGAR	ALPHAQ	3023, 3024
35	CDUXD	CDUYD	3234, 3235
36	CDUZD	*DELCDUX	3236, 3237
37	CDUX	CDUY	0032, 0033
38	CDUZ	CDUT	0034, 0035
39	FLAGWRD0	FLAGWRD1	0074 - 0107
40	FLAGWRD2	FLAGWRD3	
41	FLAGWRD4	FLAGWRD5	
42	FLAGWRD6	FLAGWRD7	
43	FLAGWRD8	FLAGWRD9	
44	FLGWRD10	FLGWRD11	

WORD #	FIRST REGISTER	SECOND REGISTER	ERASABLE ADDRESS
45	$DSPTAB_0$	$DSPTAB_1$	1022 - 1035
46	$DSPTAB_2$	$DSPTAB_3$	
47	$DSPTAB_4$	$DSPTAB_5$	
48	$DSPTAB_6$	$DSPTAB_7$	
49	$DSPTAB_8$	$DSPTAB_9$	
50	$DSPTAB_{10}$	$DSPTAB_{11}$	
51	TIMENOW (TIME2)	TIMENOW (TIME1)	0024-5
52	RN_0 (X comp.)	RN_1 (X comp.)	1217 - 1224
53	RN_2 (Y comp.)	RN_3 (Y comp.)	
54	RN_4 (Z comp.)	RN_5 (Z comp.)	
55	VN_0 (X comp.)	VN_1 (X comp.)	1225 - 1232
56	VN_2 (Y comp.)	VN_3 (Y comp.)	
57	VN_4 (Z comp.)	VN_5 (Z comp.)	
58	PIPTIME	PIPTIME	1233-4
59	OMEGAPD	OMEGAQD	3242, 3243
60	OMEGARD	*ECDUW	3244, 3245
61	$CADRFLSH_0$	$CADRFLSH_1$	0372, 0373
62	$CADRFLSH_2$	$FAILREG_0$	0374, 0375
63	$FAILREG_1$	$FAILREG_2$	0376, 0377
64	RADMODES	DAPBOOLS	0110, 0111
65	$DOWNTORK_2$ (POSTORKU)	$DOWNTORK_3$ (NEGTORKU)	3115, 3116
66	$DOWNTORK_4$ (POSTORKV)	$DOWNTORK_5$ (NEGTORKV)	3117, 3120
67	SPARE	SPARE	
68	SPARE	SPARE	
69	AGSK (K-FACTOR)	AGSK (K-FACTOR)	2020-1

BINROUND	DATA-24	PUTDCSF2
BITSOFF1	DATA-21	CHANBITS
BITSOFF2	DATA-21	CHANBITS
BLANKDSP	DATA-2	NVSUB
BLANKET	DINT-6	CHKLINUS RO4Z DSPRRLOS V67CALL DISPLAYE VBCOARK SBANDEX V99RECYC DAPDATA1 DAPDATA2 TRIMDONE
BLANKSUB	DSKY-11	PASTEVB NV50DSP
BLOAD	DATA-18	VERBFAN
BOTHAXES	DAPB-5	STMIN-
BOTHPAD	EXVB-18	V82GOFF1
BOTHSGN	DSKY-5	NEGSGN POSGN
BRNCHCTR	CONC-5	KEPLOOP
BURNBABY	BURN-3	P12RET P40IN P41LM ASTNRET
BYLMATT	ALIN-26	DSPOPTN
C13STALL	RADR-25	WOZERO T6JOBCHK JTLST ZEROENBL STARTP64 ERROR DODOWNTM REDESMON C13STALL TSTLTS3 VBTSTLTS
C33TEST	IMUC-7	TNONTEST
CA+ECE	IMUC-9	GLOCKMON
CAGESUB	IMUC-8	TNONTEST
CAGESUB1	IMUC-8	IMUMON
CAGESUB2	IMUC-8	TNONTEST
CAL53A	ALIN-18	REGCOARS
CALCGA	COOR-6	REDO S52.2 INITBY GVDETER
CALCGRAV	SERV-6	NORMLIZE CALCRVG
CALCGTA	COOR-7	GYCOARS R55 INITBY
CALCN83	BURN-13	POSTBURN STARTP47

ATTACHED	EXVB-8	GOEXTVB
ATTACHIT	EXVB-28	ATTACHED
ATTCHK	ALIN-26	GVDETER P57POST SURFDISP
ATTCK2	IMUC-19	IMUATTCK
ATTSTEER	DAPA-23	CHEKSTIK RHCACTIV TSNEXTS
AVEIT	ALIN-10	JUSTOA
AVERAGEG	SERV-3	
AVESTAR	ALIN-10	AVEIT
AVETOMID	ORBI-18	AVGEND
AVGEND	SERV-5	READACCS
AXISGEN	ALIN-14	INITBY R51E P51C
AZEL	ALIN-21	R52
BACKHAND	DAPA-23	BACKHAND FAILOOP FEEDBACK DOROTAT TJLAW4
BACKP	DAPA-7	
BADRAD	RADR-22	RADAREAD RENDRAD RESAMPLE
BAILOUT	PGSR-12	PAXIS MAKEPLAY MAKEPRIO NV50DSP FLASHSUB
BAILOUT1	PGSR-12	FINDVAC2 NOVAC3 GOMANUR IMUSTALL AOTMARK AOTSTALL DELLOOP
BALLANGS	ATTM-2	R60LEM R61C+LO2 REDOMANC V89RECL
BANKCALL	MATX-25	
BANKJUMP	MATX-25	
BEGDES	RADR-9	DORREPOS RR1AX2 STARTDES
BEGDES29	RADR-34	BEGDES29 R29.LOS
BIGIQ	DAPB-22	COMMEQS

ALMCYCLE	DATA-17	TESTNN ABLOAD ABCLOAD PUTCOM PUTNORM PUTDCSF2 BINROUND DPINSF+2 DEGINSF HMSIN MMCHANG
ALMXIT	TRGX-15	CIRCL SCNDSOL
ALOAD	DATA-14	VERBFAN
ALOADED	ORBI-4	INTEGRV
ALTDSPLY	DAPA-3	CHEKBITS
ALTOUT1	SERV-18	LANDISP
ALTROUT1	SERV-17	LANDISP
AOTMARK	ALIN-3	P51C R51E R59OUT
AOTSTALL	ALIN-3	P51C R51E R59OUT
APSIDES	CONC-2	PERIAPO
ARCCOS	MATX-3	
ARCSIN	MATX-3	
ARCSUB	MATX-3	ARCCOS ARCSIN
ARCTAN	COOR-5	LAT-LONG RANGEBQ BALLANGS
ARCTRGSP	BURN-24	NB2CDUSP
ARCTRIG	COOR-6	CALCGA CALCGTA RRANGLES RRLOSDSP
ARTOUTSF	DATA-10	DECDSP3 LRPOSOUT
ASCENT	ASCT-7	ATMAG P12LM
ASCTERM	ASCT-11	CMPONENT
ASCTERM1	ASCT-11	ATMAG
ASTAR	ALIN-33	R59RET
ASTNRET	DESC-3	CLOKJOB
ASTOK	RNAV-37	R29LEM96
ATMAG	ASCT-7	UPTHROT ABRTIGN

ADTIME	TRGL-8	ELCALC
ADVAN	MATX-10	CHECKNJ
ADVANCE	TRGX-7	P32/P72B P33/P73B
AFCCALC1	DESC-7	VERTGUID
AFTERTJ	DAPA-24	BACKHAND MINRTN TJLAW4
AGSDISPK	EXVB-12	AGSDISPK
AGSINIT	EXVB-12	V47TXACT
AGSVCALC	EXVB-12	AGSDISPK
ALARM	PGSR-11	INTLOOP P33/P73B CALCGA WMATEND MIDTOAV1 CKMID2 UPTMFAST DNTMFAST PRIOLARM RRDESK2 LRP2COMM AGSIMT V37 GOPROG3 RADAREAD LRS24.1 RRCDUCHK RRDESNB RRZERO RESAMPLE SOMEKEY YMKRUPT MARKCHEX R51 DSPOPTN R59ALM SETISSW IMUZERO COARS2 IMUCHK MARKRUPT KALCMAN3 PIPFREE IMUMON TNONTEST C33TEST RO2BOTH VGAIN* 1406ALM MUNRETRN P40ALM DCMCL NOATTCNT EXGSUB EXVERT TRYUORV SELECTP +XORULGE FAILOOP PRERRORS SOMEERRR SOMERR2 SURFAGAN DORSAMP
ALARM1	PGSR-14	ARCSUB
ALARM2	PGSR-11	BAILOUT BAILOUT1 CURTAINS POODOO POODOO1 VARALARM ALARM1
ALFLT	TEST-16	ALLOOP
ALGORTHM	DAPA-28	NEGUSUM
ALINTIME	EXVB-6	GOEXTVB
ALLCOAST	DAPA-32	SEUDOPOO COASTSET GOPOST GOCUTOFF
ALLOOP	TEST-15	ESTIMS ALLOOP
ALM/END	EXVB-2	GOEXTVB TESTACT VBZERO IMUFINEK IMUATTCK CREWMANU VB64 R77 V89PERF GOSHOSUM SYSTEST RDRUSECK ATTACHED VBTSTLTS

Noun	Tag	Comp.	Def.	Decimal Display	Comment
97	$DSPTEM1_0$	3	DATA	XXXXX. unitless	
	$DSPTEM1_1$		DATA	XXXXX. unitless	
	$DSPTEM1_2$		DATA	XXXXX. unitless	
	(none)				
98	$DSPTEM2_0$	3	DATA	XXXXX. unitless	
	$DSPTEM2_1$		DATA	.XXXXX unitless	
	$DSPTEM2_2$		DATA	XXXXX. unitless	
	(SHOW)				
99	WWPOS	3	RNAV	XXXXX. feet	Decimal only
	WWVEL		RNAV	XXXX.X fps	
	WWBIAS		RNAV	XX.XXX radians	

(V67CALL, GOTOPOOH - in GOTOPOOH, the noun is not processed)

Noun	Tag	Comp.	Def.	Decimal Display	Comment
82	DELVLVC (P32/P72F)	3	TRGX	XXXX.X fps	Decimal only
83	DELVIMU (P47BODY)	3	BURN	XXXX.X fps	Decimal only
84	DELVOV (P76)	3	ORBI	XXXX.X fps	Decimal only
85	VGBODY (TIGNOW, CUTOFF, P41LM, TIG-30A)	3	BURN	XXXX.X fps	Decimal only
86	DELVLVC (none)	3	TRGX	XXXX.X fps	Decimal only
87	AZ EL (GETDAT, GETAZEL)	2	ALIN ALIN	XXX.XX degrees XXX.XX degrees	
88	STARAD (PLANET)	3	ALIN	.XXXX unitless	Decimal only
89	LANDLAT LANDLONG LANDALT (N89DISP)	3	ALIN ALIN ALIN	XX.XXX degrees XX.XXX degrees XXX.XX nautical miles	Decimal only
90	RANGE RRATE RTHETA (R36)	3	EXVB EXVB EXVB	XXX.XX nautical miles XXXX.X fps XXX.XX degrees	Decimal only
91	P21ALT P21VEL P21GAM	3	RNAV RNAV RNAV	XXXXXB. nautical miles XXXXX. ft/sec XXX.XX degrees	
92	THRDISP HDOTDISP HCALC1	3	DESC SERV SERV	XXXXX. percent XXXX.X fps XXXXX. feet	
93	OGC IGC MGC	3	COOR COOR COOR	XX.XXX degrees XX.XXX degrees XX.XXX degrees	
94	spare				
95	spare				
96	spare				

Noun	Tag	Comp.	Def.	Decimal Display	Comment
51	PITCHANG	2	EXVB	XXX.XX degrees	Decimal only
	YAWANG		EXVB	XXX.XX degrees	
	(SBANDEX)				
52	ACTCENT	1	TRGL	XXX.XX degrees	
	(none)				
53	spare				
54	RANGE	3	EXVB	XXX.XX nautical miles	Decimal only
	RRATE		EXVB	XXXX.X fps	
	RTHETA		EXVB	XXX.XX degrees	
	(DISPN5X)				
55	NN	3	TRGX	XXXXX. unitless	Decimal only
	ELEV		TRGL	XXX.XX degrees	
	CENTANG		TRGL	XXX.XX degrees	
	(DISPLAYE, P32, P72)				
56	RR-AZ	2	RNAV	XXX.XX degrees	
	RR-ELEV		RNAV	XXX.XX degrees	
	(DSPRRLOS)				
57	spare				
58	POSTTPI	3	TRGL	XXXX.X nautical miles	Decimal only
	DELVTPI		TRGL	XXXX.X fps	
	DELVTPF		TRGL	XXXX.X fps	
	(INTLOOP)				
59	DVLOS	3	TRGL	XXXX.X fps	Decimal only
	(S34/35.5. NTARGCHK)				
60	FORVEL	3	DESC	XXXX.X fps	Decimal only
	HDOTDISP		SERV	XXXX.X fps	
	HCALC1		SERV	XXXXX. feet	
	(VERTDISP)				
61	TTFDISP	3	DESC	XX XX min-sec	No load - Decimal only
	TTOGO		BURN	XX XX min-sec	
	OUTOFPLN		DESC	XXXX.X nautical miles	
	(CLOKJOB)				

Noun	Tag	Comp.	Def.	Decimal Display	Comment
40	TTOGO	3	BURN	XX XX min-sec	No load - decimal only
	DELVSAB		TRGX	XXXX.X fps	
	DVTOTAL		BURN	XXXX.X fps	
	(POSTBURN, CLOKJOB, V99RECYC)				
41	$DSPTEM1_0$	2	DATA	XXX.XX degrees	
	$DSPTEM1_1$		DATA	XX.XXX degrees	
	(REDO)				
42	HAPO	3	TRGX	XXXX.X nautical miles	Decimal only
	HPER		TRGX	XXXX.X nautical miles	
	DELVSAB		TRGX	XXXX.X fps	
	(P30)				
43	LAT	3	COOR	XXX.XX degrees	Decimal only
	LONG		COOR	XXX.XX degrees	
	ALT		COOR	XXXX.X nautical miles	
	(P21VSAVE, LANDJUNK)				
44	HAPOX	3	EXVB	XXXX.X nautical miles	No load - decimal only
	HPERX		EXVB	XXXX.X nautical miles	
	TFF		EXVB	XX XX min - sec	
	(V82GOFLP, V82GON)				
45	TRKMKCNT	3	RNAV	XXXXX. unitless	No load - decimal only
	TTOGO		BURN	XX XX min-sec	
	pMGA		TRGX	XXX.XX degrees	
	(VN1645)				
46	DAPDATR1	1	DAPB	Octal only	
	(DAPDATA1)				
47	LEMMASS	2	DAPB	XXXXX. pounds mass	Decimal only
	CSMMASS		DAPB	XXXXX. pounds mass	
	(DAPDATA2)				
48	PITTIME	2	DAPB	XXX.XX degrees	Decimal only
	ROLLTIME		DAPB	XXX.XX degrees	
	(DAPDATA2, TRIMDONE)				
49	R22DISPR	3	RNAV	XXXX.X nautical miles	Decimal only
	R22DISPV		RNAV	XXXX.X fps	
	WHCHREAD		RNAV	XXXXX.	
	(N49DSP (R22LEM96))				
50	spare				

PROGRAM AND ROUTINE LIST

Programs

Routines

The following table gives the downlink parameters, basic scale factors, units, and sections referenced for definitions. The pages following this table contain a list of definitions compiled from the listed references.

Mnemonic	Scale Factor	Units	Definition Reference
$AGSBUFF_{0-13}$ (12SP) (2DP)	Position - B25 (EARTH) B23 (MOON) Velocity - B15 (EARTH) B13 (MOON) Time - B18	feet feet/second seconds	EXVB
AGSK (DP)	B28	centiseconds	EXVB
AIG (SP)	B-1 (2's comp)	revolutions	RNAV
ALPHAQ (SP)	B-2	revolutions/second squared	DAPA
ALPHAR (SP)	B-2	revolutions/second squared	DAPA
AMG (SP)	B-1 (2's comp)	revolutions	RNAV
AOG (SP)	B-1 (2's comp)	revolutions	RNAV
AOTCODE (SP)	OCTAL	optics code	ALIN
AT (DP)	B-9	meters/centisecond squared	ASCT
BESTI (SP)	B14	six times the decimal equivalent of the star IDs	ALIN
BESTJ (SP)	B14		ALIN
$CADRFLSH_{0-2}$ (3SP)	OCTAL	address	DINT
CDUS (SP)	B-1 (2's comp)	revolutions	RADR
CDUT (SP)	B-1 (2's comp)	revolutions	RADR
CDUX (SP)	B-1 (2's comp)	revolutions	IMU COOR DAPA
CDUY (SP)	B-1 (2's comp)	revolutions	IMU COOR DAPA

WORD #	FIRST REGISTER	SECOND REGISTER	ERASABLE ADDRESS
78	AGSK (K-FACTOR)	AGSK (K-FACTOR)	2020-1
79	LASTTCMD (LASTYCMD)	LASTSCMD (LASTXCMD)	0112, 0113
80	LEMMASS	CSMMASS	1326, 1327
81	IMODES30	IMODES33	1277, 1300
82	TIG	TIG	3441-2
83	OMEGAP	OMEGAQ	3021, 3022
84	OMEGAR	ALPHAQ	3023, 3024
85	CDUXD	CDUYD	3234, 3235
86	CDUZD	*DELCDUX	3236, 3237
87	CDUX	CDUY	0032, 0033
88	CDUZ	CDUT	0034, 0035
89	ALPHAQ	ALPHAR	3024, 3025
90	$DOWNTORK_0$ (POSTORKP)	$DOWNTORK_1$ (NEGTORKP)	3113, 3114
91	CHANNEL11	CHANNEL12	
92	CHANNEL13	CHANNEL14	
93	CHANNEL30	CHANNEL31	
94	CHANNEL32	CHANNEL33	
95	PIPTIME1	PIPTIME1	3560-1
96	$DELV_0$ (X comp.)	$DELV_1$ (X comp.)	0324 - 0331
97	$DELV_2$ (Y comp.)	$DELV_3$ (Y comp.)	
98	$DELV_4$ (Z comp.)	$DELV_5$ (Z comp.)	
99	SPARE	SPARE	
100	SPARE	SPARE	

WORD #	FIRST REGISTER	SECOND REGISTER	ERASABLE ADDRESS
51	TIMENOW (TIME2)	TIMENOW (TIME1)	0024-5
52	RN_0 (X comp.)	RN_1 (X comp.)	1217 - 1224
53	RN_2 (Y comp.)	RN_3 (Y comp.)	
54	RN_4 (Z comp.)	RN_5 (Z comp.)	
55	VN_0 (X comp.)	VN_1 (X comp.)	1225 - 1232
56	VN_2 (Y comp.)	VN_3 (Y comp.)	
57	VN_4 (Z comp.)	VN_5 (Z comp.)	
58	PIPTIME	PIPTIME	1233-4
59	OMEGAPD	OMEGAQD	3242, 3243
60	OMEGARD	*ECDUW	3244, 3245
61	$CADRFLSH_0$	$CADRFLSH_1$	0372, 0373
62	$CADRFLSH_2$	$FAILREG_0$	0374, 0375
63	$FAILREG_1$	$FAILREG_2$	0376, 0377
64	RADMODES	DAPBOOLS	0110, 0111
65	OGC	OGC	2737 - 2740
66	IGC	IGC	2741-2
67	MGC	MGC	2743-4
68	BESTI (STAR ID1)	BESTJ (STAR ID2)	2755, 2756
69	$STARSAV1_0$ (X comp.)	$STARSAV1_1$ (X comp.)	2760 - 2765
70	$STARSAV1_2$ (Y comp.)	$STARSAV1_3$ (Y comp.)	
71	$STARSAV1_4$ (Z comp.)	$STARSAV1_5$ (Z comp.)	
72	$STARSAV2_0$ (X comp.)	$STARSAV2_1$ (X comp.)	2766 - 2773
73	$STARSAV2_2$ (Y comp.)	$STARSAV2_3$ (Y comp.)	
74	$STARSAV2_4$ (Z comp.)	$STARSAV2_5$ (Z comp.)	
75	$GSAV_0$ (X comp.)	$GSAV_1$ (X comp.)	2230 - 2235
76	$GSAV_2$ (Y comp.)	$GSAV_3$ (Y comp.)	
77	$GSAV_4$ (Z comp.)	$GSAV_5$ (Z comp.)	

WORD #	FIRST REGISTER	SECOND REGISTER	ERASABLE ADDRESS
24	$ZNBSAV_0$ (X comp.)	$ZNBSAV_1$ (X comp.)	2244 - 2251
25	$ZNBSAV_2$ (Y comp.)	$ZNBSAV_3$ (Y comp.)	
26	$ZNBSAV_4$ (Z comp.)	$ZNBSAV_5$ (Z comp.)	
27	$X789_x$ (RR shaft bias)	$X789_x$ (RR shaft bias)	1700-1
23	$X789_y$ (RR trunnion bias)	$X789_y$ (RR trunnion bias)	1702-3
29	LASTTCMD (LASTYCMD)	LASTSCMD (LASTXCMD)	0112, 0113
30	REDOCTR	$THETAD_0$ (X-angle)	0320, 0321
31	$THETAD_1$ (Y-angle)	$THETAD_2$ (Z-angle)	0322, 0323
32	RSBBQ	RSBBQ+1	1432, 1433
33	OMEGAP	OMEGAQ	3021, 3022
34	OMEGAR	ALPHAQ	3023, 3024
35	CDUXD	CDUYD	3234, 3235
36	CDUZD	*DELCDUX	3236, 3237
37	CDUX	CDUY	0032, 0033
38	CDUZ	CDUT	0034, 0035
39	FLAGWRD0	FLAGWRD1	0074 - 0107
40	FLAGWRD2	FLAGWRD3	
41	FLAGWRD4	FLAGWRD5	
42	FLAGWRD6	FLAGWRD7	
43	FLAGWRD8	FLAGWRD9	
44	FLGWRD10	FLGWRD11	
45	$DSPTAB_0$	$DSPTAB_1$	1022 - 1035
46	$DSPTAB_2$	$DSPTAB_3$	
47	$DSPTAB_4$	$DSPTAB_5$	
48	$DSPTAB_6$	$DSPTAB_7$	
49	$DSPTAB_8$	$DSPTAB_9$	
50	$DSPTAB_{10}$	$DSPTAB_{11}$	

WORD #	FIRST REGISTER	SECOND REGISTER	ERASABLE ADDRESS
73	$LAND_0$ (X comp.)	$LAND_1$ (X comp.)	
74	$LAND_2$ (Y comp.)	$LAND_3$ (Y comp.)	3634 - 3641
75	$LAND_4$ (Z comp.)	$LAND_5$ (Z comp.)	
76	AT	AT	2262-3
77	TLAND	TLAND	2400-1
78	FC	* RDOTV	3615, 3616
79	LASTTCMD (LASTYCMD)	LASTSCMD (LASTXCMD)	0112, 0113
80	LEMMASS	CSMMASS	1326, 1327
81	IMODES30	IMODES33	1277, 1300
82	TIG	TIG	3441-2
83	OMEGAP	OMEGAQ	3021, 3022
84	OMEGAR	ALPHAQ	3023, 3024
85	CDUXD	CDUYD	3234, 3235
86	CDUZD	* DELCDUX	3236, 3237
87	CDUX	CDUY	0032, 0033
88	CDUZ	CDUT	0034, 0035
89	ALPHAQ	ALPHAR	3024, 3025
90	$DOWNTORK_0$ (POSTORKP)	$DOWNTORK_1$ (NEGTORKP)	3113, 3114
91	CHANNEL11	CHANNEL12	
92	CHANNEL13	CHANNEL14	
93	CHANNEL30	CHANNEL31	
94	CHANNEL32	CHANNEL33	
95	PIPTIME1	PIPTIME1	3560-1
96	$DELV_0$ (X comp.)	$DELV_1$ (X comp.)	
97	$DELV_2$ (Y comp.)	$DELV_3$ (Y comp.)	0324 - 0331
98	$DELV_4$ (Z comp.)	$DELV_5$ (Z comp.)	

WORD #	FIRST REGISTER	SECOND REGISTER	ERASABLE ADDRESS
48	$DSPTAB_6$	$DSPTAB_7$	1022 - 1035
49	$DSPTAB_8$	$DSPTAB_9$	
50	$DSPTAB_{10}$	$DSPTAB_{11}$	
51	TIMENOW (TIME2)	TIMENOW (TIME1)	0024-5
52	RN_0 (X comp.)	RN_1 (X comp.)	1217 - 1224
53	RN_2 (Y comp.)	RN_3 (Y comp.)	
54	RN_4 (Z comp.)	RN_5 (Z comp.)	
55	VN_0 (X comp.)	VN_1 (X comp.)	1225 - 1232
56	VN_2 (Y comp.)	VN_3 (Y comp.)	
57	VN_4 (Z comp.)	VN_5 (Z comp.)	
58	PIPTIME	PIPTIME	1233-4
59	OMEGAPD	OMEGAQD	3242, 3243
60	OMEGARD	*ECDUW	3244, 3245
61	$CADRFLSH_0$	$CADRFLSH_1$	0372, 0373
62	$CADRFLSH_2$	$FAILREG_0$	0374, 0375
63	$FAILREG_1$	$FAILREG_2$	0376, 0377
64	RADMODES	DAPBOOLS	0110, 0111
65	$DOWNTORK_2$ (POSTORKU)	$DOWNTORK_3$ (NEGTORKU)	3115, 3116
66	$DOWNTORK_4$ (POSTORKV)	$DOWNTORK_5$ (NEGTORKV)	3117, 3120
67	RGU_0 (X comp.)	RGU_1 (X comp.)	2626 - 2633
68	RGU_2 (Y comp.)	RGU_3 (Y comp.)	
69	RGU_4 (Z comp.)	RGU_5 (Z comp.)	
70	VGU_0 (X comp.)	VGU_1 (X comp.)	3626 - 3633
71	VGU_2 (Y comp.)	VGU_3 (Y comp.)	
72	VGU_4 (Z comp.)	VGU_5 (Z comp.)	

WORD #	FIRST REGISTER	SECOND REGISTER	ERASABLE ADDRESS
23	RLS_0 (X comp.)	RLS_1 (X comp.)	2022 - 2027
24	RLS_2 (Y comp.)	RLS_3 (Y comp.)	
25	RLS_4 (Z comp.)	RLS_5 (Z comp.)	
26	ZDOTD	ZDOTD	2276-7
27	$X789_x$ (RR Shaft bias)	$X789_x$ (RR Shaft bias)	1700-1
28	$X789_y$ (RR Trunnion bias)	$X789_y$ (RR Trunnion bias)	1702-3
29	LASTTCMD (LASTYCMD)	LASTSCMD (LASTXCMD)	0112, 0113
30	REDOCTR	$THETAD_0$ (X-angle)	0320, 0321
31	$THETAD_1$ (Y-angle)	$THETAD_2$ (Z-angle)	0322, 0323
32	RSBBQ	RSBBQ+1	1432, 1433
33	OMEGAP	OMEGAQ	3021, 3022
34	OMEGAR	ALPHAQ	3023, 3024
35	CDUXD	CDUYD	3234, 3235
36	CDUZD	*DELCDUX	3236, 3237
37	CDUX	CDUY	0032, 0033
38	CDUZ	CDUT	0034, 0035
39	FLAGWRD0	FLAGWRD1	0074 - 0107
40	FLAGWRD2	FLAGWRD3	
41	FLAGWRD4	FLAGWRD5	
42	FLAGWRD6	FLAGWRD7	
43	FLAGWRD8	FLAGWRD9	
44	FLGWRD10	FLGWRD11	
45	$DSPTAB_0$	$DSPTAB_1$	1022 - 1035
46	$DSPTAB_2$	$DSPTAB_3$	
47	$DSPTAB_4$	$DSPTAB_5$	

DESCENT AND ASCENT LIST

WORD #	FIRST REGISTER	SECOND REGISTER	ERASABLE ADDRESS
1	LIST ID (77773_8)	SYNC PATTERN (77340_8)	
2	$LRCDUDL_0$ (LRXCDUDL)	$LRCDUDL_1$ (LRYCDUDL)	2334, 2335
3	$LRCDUDL_2$ (LRZCDUDL)	LRVTIME (MSB)	2336, 2337
4	VSELECT	*VMEAS (MSB)	3651, 3652
5	LRVTIMDL	LRVTIMDL	2337 - 2340
6	VMEAS (LR Velocity)	VMEAS (LR Velocity)	3652-3
7	MKTIME	MKTIME	3754-5
8	HMEAS (LR Range)	HMEAS (LR Range)	3654-5
9	RM_0 (RR Range)	RM_1 (RR Range rate)	3756, 3757
10	AIG (Y-angle)	AMG (Z-angle)	3457, 3460
11	AOG (X-angle)	TRKMKCNT	3461, 3462
12	$TANGNB_0$ (RR Trunnion)	$TANGNB_1$ (RR Shaft)	3752, 3753
13	MKTIME	MKTIME	3754-5
14	TEVENT	TEVENT	1341-2
15	$UNFC_0$ (X comp.)	$UNFC_1$ (X comp.)	3252 - 3257
16	$UNFC_2$ (Y comp.)	$UNFC_3$ (Y comp.)	
17	$UNFC_4$ (Z comp.)	$UNFC_5$ (Z comp.)	
18	$VGVECT_0$ (X comp.)	$VGVECT_1$ (X comp.)	3645-3652
19	$VGVECT_2$ (Y comp.)	$VGVECT_3$ (Y comp.)	
20	$VGVECT_4$ (Z comp.)	$VGVECT_5$ (Z comp.)	
21	TTF	TTF	3642-3
22	DELTAH	DELTAH	3664-5

WORD #	FIRST REGISTER	SECOND REGISTER	ERASABLE ADDRESS
77	$DNRADATA_4$ (DNLRVELX)	$DNRADATA_5$ (DNLRVELY)	1333, 1334
78	$DNRADATA_6$ (DNLRVELZ)	$DNRADATA_7$ (DNLRALT)	1335, 1336
79	DIFFALT	DIFFALT	3577 - 3600
80	LEMMASS	CSMMASS	1326, 1327
81	IMODES30	IMODES33	1277 - 1300
82	TIG	TIG	3441-2
83	OMEGAP	OMEGAQ	3021, 3022
84	OMEGAR	ALPHAQ	3023, 3024
85	CDUXD	CDUYD	3234, 3235
86	CDUZD	* DELCDUX	3236, 3237
87	CDUX	CDUY	0032, 0033
88	CDUZ	CDUT	0034, 0035
89	ALPHAQ	ALPHAR	3024, 3025
90	$DOWNTORK_0$ (POSTORKP)	$DOWNTORK_1$ (NEGTORKP)	3113, 3114
91	CHANNEL11	CHANNEL12	
92	CHANNEL13	CHANNEL14	
93	CHANNEL30	CHANNEL31	
94	CHANNEL32	CHANNEL33	
95	PIPTIME1	PIPTIME1	3560-1
96	$DELV_0$ (X comp.)	$DELV_1$ (X comp.)	
97	$DELV_2$ (Y comp.)	$DELV_3$ (Y comp.)	0324 - 0331
98	$DELV_4$ (Z comp.)	$DELV_5$ (Z comp.)	
99	SPARE	SPARE	
100	TGO	TGO	3516-7

WORD #	FIRST REGISTER	SECOND REGISTER	ERASABLE ADDRESS
51	TIMENOW (TIME2)	TIMENOW (TIME1)	0024-5
52	RN_0 (X comp.)	RN_1 (X comp.)	1217 - 1224
53	RN_2 (Y comp.)	RN_3 (Y comp.)	
54	RN_4 (Z comp.)	RN_5 (Z comp.)	
55	VN_0 (X comp.)	VN_1 (X comp.)	1225 - 1232
56	VN_2 (Y comp.)	VN_3 (Y comp.)	
57	VN_4 (Z comp.)	VN_5 (Z comp.)	
58	PIPTIME	PIPTIME	1233-4
59	OMEGAPD	OMEGAQD	3242 - 3243
60	OMEGARD	*ECDUW	3244, 3245
61	$CADRFLSH_0$	$CADRFLSH_1$	0372, 0373
62	$CADRFLSH_2$	$FAILREG_0$	0374, 0375
63	$FAILREG_1$	$FAILREG_2$	0376, 0377
64	RADMODES	DAPBOOLS	0110, 0111
65	$DOWNTORK_2$ (POSTORKU)	$DOWNTORK_3$ (NEGTORKU)	3115, 3116
66	$DOWNTORK_4$ (POSTORKV)	$DOWNTORK_5$ (NEGTORKV)	3117, 3120
67	SPARE	SPARE	
68	TCDH	TCDH	1776-7
69	$DELVEET2_0$ (X comp.)	$DELVEET2_1$ (X comp.)	2274 - 2301
70	$DELVEET2_2$ (Y comp.)	$DELVEET2_3$ (Y comp.)	
71	$DELVEET2_4$ (Z comp.)	$DELVEET2_5$ (Z comp.)	
72	TTPI	TTPI	3635-6
73	$DELVEET3_0$ (X comp.)	$DELVEET3_1$ (X comp.)	2365 - 2372
74	$DELVEET3_2$ (Y comp.)	$DELVEET3_3$ (Y comp.)	
75	$DELVEET3_4$ (Z comp.)	$DELVEET3_5$ (Z comp.)	
76	$DNRADATA_1$ (DNRRANGE)	$DNRADATA_2$ (DNRRDOT)	1330, 1331

WORD #	FIRST REGISTER	SECOND REGISTER	ERASABLE ADDRESS
25	$VGPREV_0$ (VGTIG-X comp.)	$VGPREV_1$ (VGTIG-X comp.)	
26	$VGPREV_2$ (VGTIG-Y comp.)	$VGPREV_3$ (VGTIG-Y comp.)	3700 - 3705
27	$VGPREV_4$ (VGTIG-Z comp.)	$VGPREV_5$ (VGTIG-Z comp.)	
28	$DNRADATA_6$ (DNLRVELZ)	$DNRADATA_7$ (DNLRALT)	1335, 1336
29	TPASS4 (TPF time)	TPASS4 (TPF time)	3630-1
30	REDOCTR	$THETAD_0$ (X-angle)	0320, 0321
31	$THETAD_1$ (Y-angle)	$THETAD_2$ (Z-angle)	0322, 0323
32	RSBBQ	RSBBQ+1	1432, 1433
33	OMEGAP	OMEGAQ	3021, 3022
34	OMEGAR	ALPHAQ	3023, 3024
35	CDUXD	CDUYD	3234, 3235
36	CDUZD	*DELCDUX	3236, 3237
37	CDUX	CDUY	0032, 0033
38	CDUZ	CDUT	0034, 0035
39	FLAGWRD0	FLAGWRD1	
40	FLAGWRD2	FLAGWRD3	
41	FLAGWRD4	FLAGWRD5	
42	FLAGWRD6	FLAGWRD7	0074 - 0107
43	FLAGWRD8	FLAGWRD9	
44	FLGWRD10	FLGWRD11	
45	$DSPTAB_0$	$DSPTAB_1$	
46	$DSPTAB_2$	$DSPTAB_3$	
47	$DSPTAB_4$	$DSPTAB_5$	
48	$DSPTAB_6$	$DSPTAB_7$	1022 - 1035
49	$DSPTAB_8$	$DSPTAB_9$	
50	$DSPTAB_{10}$	$DSPTAB_{11}$	

ORBITAL MANEUVERS LIST

WORD #	FIRST REGISTER	SECOND REGISTER	ERASABLE ADDRESS
1	LIST ID (77774_8)	SYNC PATTERN (77340_8)	
2	$R\text{-}OTHER_0$ (X comp.)	$R\text{-}OTHER_1$ (X comp.)	1717 - 1724
3	$R\text{-}OTHER_2$ (Y comp.)	$R\text{-}OTHER_3$ (Y comp.)	
4	$R\text{-}OTHER_4$ (Z comp.)	$R\text{-}OTHER_5$ (Z comp.)	
5	$V\text{-}OTHER_0$ (X comp.)	$V\text{-}OTHER_1$ (X comp.)	1725 - 1732
6	$V\text{-}OTHER_2$ (Y comp.)	$V\text{-}OTHER_3$ (Y comp.)	
7	$V\text{-}OTHER_4$ (Z comp.)	$V\text{-}OTHER_5$ (Z comp.)	
8	TETCSM	TETCSM	1570-1
9	DELLT4	DELLT4	3451-2
10	$RTARG_0$ (X comp.)	$RTARG_1$ (X comp.)	3443 - 3450
11	$RTARG_2$ (Y comp.)	$RTARG_3$ (Y comp.)	
12	$RTARG_4$ (Z comp.)	$RTARG_5$ (Z comp.)	
13	ELEV	ELEV	2256-7
14	TEVENT	TEVENT	1341-2
15	$REFSMMAT_0$ (R_1C_1)	$REFSMMAT_1$ (R_1C_1)	1733 - 1746
16	$REFSMMAT_2$ (R_1C_2)	$REFSMMAT_3$ (R_1C_2)	
17	$REFSMMAT_4$ (R_1C_3)	$REFSMMAT_5$ (R_1C_3)	
18	$REFSMMAT_6$ (R_2C_1)	$REFSMMAT_7$ (R_2C_1)	
19	$REFSMMAT_8$ (R_2C_2)	$REFSMMAT_9$ (R_2C_2)	
20	$REFSMMAT_{10}$ (R_2C_3)	$REFSMMAT_{11}$ (R_2C_3)	
21	TCSI	TCSI	3633-4
22	$DELVEET1_0$ (X comp.)	$DELVEET1_1$ (X comp.)	2266 - 2273
23	$DELVEET1_2$ (Y comp.)	$DELVEET1_3$ (Y comp.)	
24	$DELVEET1_4$ (Z comp.)	$DELVEET1_5$ (Z comp.)	

WORD #	FIRST REGISTER	SECOND REGISTER	ERASABLE ADDRESS
77	CDUS	PIPA (X)	0036, 0037
78	PIPA (Y)	PIPA (Z)	0040, 0041
79	LASTTCMD (LASTYCMD)	LASTSCMD (LASTXCMD)	0112, 0113
80	LEMMASS	CSMMASS	1326, 1327
81	IMODES30	IMODES33	1277, 1300
82	TIG	TIG	3441-2
83	OMEGAP	OMEGAQ	3021, 3022
84	OMEGAR	ALPHAQ	3023, 3024
85	CDUXD	CDUYD	3234, 3235
86	CDUZD	*DELCDUX	3236, 3237
87	CDUX	CDUY	0032, 0033
88	CDUZ	CDUT	0034, 0035
89	ALPHAQ	ALPHAR	3024, 3025
90	$DOWNTORK_0$ (POSTORKP)	$DOWNTORK_1$ (NEGTORKP)	3113, 3114
91	CHANNEL11	CHANNEL12	
92	CHANNEL13	CHANNEL14	
93	CHANNEL30	CHANNEL31	
94	CHANNEL32	CHANNEL33	
95	SPARE	SPARE	
96	CENTANG	CENTANG	3620-1
97	NN	NN	3466-7
98	DIFFALT	DIFFALT	3577 - 3600
99	DELVTPF	DELVTPF	2347 - 2350
100	SPARE	SPARE	

WORD #	FIRST REGISTER	SECOND REGISTER	ERASABLE ADDRESS
51	TIMENOW (TIME2)	TIMENOW (TIME1)	0024-5
52	RN_0 (X comp.)	RN_1 (X comp.)	1217 - 1224
53	RN_2 (Y comp.)	RN_3 (Y comp.)	
54	RN_4 (Z comp.)	RN_5 (Z comp.)	
55	VN_0 (X comp.)	VN_1 (X comp.)	1225 - 1232
56	VN_2 (Y comp.)	VN_3 (Y comp.)	
57	VN_4 (Z comp.)	VN_5 (Z comp.)	
58	PIPTIME	PIPTIME	1233-4
59	OMEGAPD	OMEGAQD	3242, 3243
60	OMEGARD	*ECDUW	3244, 3245
61	$CADRFLSH_0$	$CADRFLSH_1$	0372, 0373
62	$CADRFLSH_2$	$FAILREG_0$	0374, 0375
63	$FAILREG_1$	$FAILREG_2$	0376, 0377
64	RADMODES	DAPBOOLS	0110, 0111
65	$DOWNTORK_2$ (POSTORKU)	$DOWNTORK_3$ (NEGTORKU)	3115, 3116
66	$DOWNTORK_4$ (POSTORKV)	$DOWNTORK_5$ (NEGTORKV)	3117, 3120
67	SPARE	SPARE	
68	TCDH	TCDH	1776-7
69	$DELVEET2_0$ (X comp.)	$DELVEET2_1$ (X comp.)	2274 - 2301
70	$DELVEET2_2$ (Y comp.)	$DELVEET2_3$ (Y comp.)	
71	$DELVEET2_4$ (Z comp.)	$DELVEET2_5$ (Z comp.)	
72	TTPI	TTPI	3635-6
73	$DELVEET3_0$	$DELVEET3_1$	2365 - 2372
74	$DELVEET3_2$	$DELVEET3_3$	
75	$DELVEET3_4$	$DELVEET3_5$	
76	ELEV	ELEV	2256-7

WORD #	FIRST REGISTER	SECOND REGISTER	ERASABLE ADDRESS
25	SPARE	SPARE	
26	TPASS4 (TPF time)	TPASS4 (TPF time)	3630-1
27	$X789_X$ (RR shaft bias)	$X789_X$ (RR shaft bias)	1700-1
28	$X789_Y$ (RR trunnion bias)	$X789_Y$ (RR trunnion bias)	1702-3
29	LASTTCMD(LASTYCMD)	LASTSCMD (LASTXCMD)	0112 - 0113
30	REDOCTR	$THETAD_0$ (X-angle)	0320, 0321
31	$THETAD_1$ (Y-angle)	$THETAD_2$ (Z-angle)	0322, 0323
32	RSBBQ	RSBBQ+1	1432, 1433
33	OMEGAP	OMEGAQ	3021, 3022
34	OMEGAR	ALPHAQ	3023, 3024
35	CDUXD	CDUYD	3234, 3235
36	CDUZD	*DELCDUX	3236, 3237
37	CDUX	CDUY	0032, 0033
38	CDUZ	CDUT	0034, 0035
39	FLAGWRD0	FLAGWRD1	0074 - 0107
40	FLAGWRD2	FLAGWRD3	
41	FLAGWRD4	FLAGWRD5	
42	FLAGWRD6	FLAGWRD7	
43	FLAGWRD8	FLAGWRD9	
44	FLGWRD10	FLGWRD11	
45	$DSPTAB_0$	$DSPTAB_1$	1022 - 1035
46	$DSPTAB_2$	$DSPTAB_3$	
47	$DSPTAB_4$	$DSPTAB_5$	
48	$DSPTAB_6$	$DSPTAB_7$	
49	$DSPTAB_8$	$DSPTAB_9$	
50	$DSPTAB_{10}$	$DSPTAB_{11}$	

RENDEZVOUS & PRETHRUST LIST

WORD #	FIRST REGISTER	SECOND REGISTER	ERASABLE ADDRESS
1	LIST ID (77775$_8$)	SYNC PATTERN (77340$_8$)	
2	R-OTHER$_0$ (X comp.)	R-OTHER$_1$ (X comp.)	1717 - 1724
3	R-OTHER$_2$ (Y comp.)	R-OTHER$_3$ (Y comp.)	
4	R-OTHER$_4$ (Z comp.)	R-OTHER$_5$ (Z comp.)	
5	V-OTHER$_0$ (X comp.)	V-OTHER$_1$ (X comp.)	1725 - 1732
6	V-OTHER$_2$ (Y comp.)	V-OTHER$_3$ (Y comp.)	
7	V-OTHER$_4$ (Z comp.)	V-OTHER$_5$ (Z comp.)	
8	TETCSM	TETCSM	1570-1
9	RANGRDOT	RANGRDOT+1	3760, 3761
10	AIG	AMG	3457, 3460
11	AOG	TRKMKCNT	3461, 3462
12	TANGNB$_0$ (RR trunnion)	TANGNB$_1$ (RR shaft)	3752, 3753
13	MKTIME	MKTIME	3754-5
14	DELLT4 (T_F Lambert)	DELLT4 (T_F Lambert)	3451-2
15	RTARG$_0$ (X comp.)	RTARG$_1$ (X comp.)	3443 - 3450
16	RTARG$_2$ (Y comp.)	RTARG$_3$ (Y comp.)	
17	RTARG$_4$ (Z comp.)	RTARG$_5$ (Z comp.)	
18	DELVLVC$_0$ (DELVSLV-X)	DELVLVC$_1$ (DELVSLV-X)	3433 - 3440
19	DELVLVC$_2$ (DELVSLV-Y)	DELVLVC$_3$ (DELVSLV-Y)	
20	DELVLVC$_4$ (DELVSLV-Z)	DELVLVC$_5$ (DELVSLV-Z)	
21	TCSI (CSI time)	TCSI (CSI time)	3633-4
22	DELVEET1$_0$ (X comp.)	DELVEET1$_1$ (X comp.)	2266 - 2273
23	DELVEET1$_2$ (Y comp.)	DELVEET1$_3$ (Y comp.)	
24	DELVEET1$_4$ (Z comp.)	DELVEET1$_5$ (Z comp.)	

WORD #	FIRST REGISTER	SECOND REGISTER	ERASABLE ADDRESS
95	$DSPTAB_0$	$DSPTAB_1$	1022. - 1035
96	$DSPTAB_2$	$DSPTAB_3$	
97	$DSPTAB_4$	$DSPTAB_5$	
98	$DSPTAB_6$	$DSPTAB_7$	
99	$DSPTAB_8$	$DSPTAB_9$	
100	$DSPTAB_{10}$	$DSPTAB_{11}$	

WORD #	FIRST REGISTER	SECOND REGISTER	ERASABLE ADDRESS
70	$UPBUFF_0$	$UPBUFF_1$	1173 - 1216
71	$UPBUFF_2$	$UPBUFF_3$	
72	$UPBUFF_4$	$UPBUFF_5$	
73	$UPBUFF_6$	$UPBUFF_7$	
74	$UPBUFF_8$	$UPBUFF_9$	
75	$UPBUFF_{10}$	$UPBUFF_{11}$	
76	$UPBUFF_{12}$	$UPBUFF_{13}$	
77	$UPBUFF_{14}$	$UPBUFF_{15}$	
78	$UPBUFF_{16}$	$UPBUFF_{17}$	
79	$UPBUFF_{18}$	$UPBUFF_{19}$	
80	LEMMASS	CSMMASS	1326, 1327
81	IMODES30	IMODES33	1277, 1300
82	SPARE	SPARE	
83	OMEGAP	OMEGAQ	3021, 3022
84	OMEGAR	ALPHAQ	3023, 3024
85	CDUXD	CDUYD	3234, 3235
86	CDUZD	* DELCDUX	3236, 3237
87	CDUX	CDUY	0032, 0033
88	CDUZ	CDUT	0034, 0035
89	ALPHAQ	ALPHAR	3024, 3025
90	$DOWNTORK_0$ (POSTORKP)	$DOWNTORK_1$ (NEGTORKP)	3113, 3114
91	CHANNEL11	CHANNEL12	
92	CHANNEL13	CHANNEL14	
93	CHANNEL30	CHANNEL31	
94	CHANNEL32	CHANNEL33	

CALCN85	BURN-12	ULLGNOT
CALCPERR	DAPA-16	MOREIDLE PURGENCY
CALCRGVG	DESC-6	EXGSUB TTFINCR
CALCRVG	SERV-5	AVERAGEG
CALCSMSC	COOR-1	INITBY P570PTO P570PT1 R56 REFMF S52.2
CALCTFF	EXVB-22	SR30.1
CALCTPER	EXVB-22	SR30.1
CALLDGCH	RNAV-30	LR24.1 R24END R24LEM3
CANV37	PGSR-6	V37 V37RET
CCSHOLE	PGSR-15	EJSCAN SPECTEST
CD*TR*GS	COOR-1	RANGEBQ READRDOT AVESTAR INITBY JUSTOA BALLANGS P570PT1 P570PT3 SETPOS
CDHMVR	TRGX-9	P33/P73B CIRCL
CDULOGIC	MATX-7	
CDUTODCM	ATTM-9	KALCMAN3 VECPOINT
CDUTRIG	COOR-1	COMPDISP DODES R61C+L02 RRDESSM SBANDANT INITBY ADDGRAV P570PTO P570PT1 R56 R59 S52.2 S41.1 REFMF P57POST RODCOMP
CGCALC	DESC-8	AFCCALC1
CHANBITS	DATA-20	ABCLOAD
CHANG1	MATX-13	DORROUT ADRSCHK
CHANG2	MATX-14	
CHANGEVB	ALIN-9	REMARK
CHANJOB4	MATX-14	ADVAN CHANG1 EJSCAN
CHARALRM	DSKY-2	CHARIN PROCKEY
CHARIN	DSKY-1	KEYRUPT1 UPRUPT
CHECKG	TEST-14	PIPACHK PIPJOBB CHECKG

CHECKNJ	TEST-3	SELFCHK ERASLOOP ADRSCHK
CHEKBITS	DAPA-3	DAPIDLER PAXIS
CHEKSTIK	DAPA-21	TSNEXTS
CHKLINUS	ATTM-12	TOBALLA REDOMANC
CHKSDATA	ALIN-13	P51C R51E SURFLINE
CHKVISFZ	DAPA-11	SUPERJOB
CIRCL	TRGX-12	CSI/B2
CKMID2	ORBI-21	ENDSTATE
CLEAR	DSKY-6	CHARIN
CLEANDSP	DINT-3	P41BLANK V99RECYC
CLOAD	DATA-18	VERBFAN
CLOCPLAY	DINT-18	CLOKJOB V99RECYC
CLOKJOB	BURN-9	CLOKTASK
CLOKTASK	BURN-9	CLOKTASK COMPTGO STCLOK3
CLOSEOUT	DAPA-30	BACKHAND TJLAW4 FEEDBACK XTRANS FAILOOP
CLUPDATE	TRGX-7	VN1645
CMPONENT	ASCT-9	MAINENG
CNTRLOOP	TEST-5	CNTRLOOP
COARS	IMUC-15	IMUCOARS
COARS2	IMUC-15	COARS2
COARSE	ALIN-2	CAL53A INITBY LUNG P51 COARSE
COASTSET	BURN-8	ENGINOF2
COMADRS	TEST-7	ADRS+1 NXTBNK
COMFAIL	BURN-11	DVMON
COMFAIL2	BURN-12	CLOKJOB

DETENTCK	DAPA-13	TSNEXTP
DGCHECK	RADR-21	LRHEIGHT RADAREAD RENDRAD
DIFEQ+2	ORBI-12	NBRANCH
DISPCHNG	BURN-5	TIG-5 P40SJUNK
DISPEXIT	DESC-9	EXVERT STEER? 1406ALM RODCOMP LUNLAND
DISPLAYE	TRGL-3	P34 P74 INTLOOP
DISPN5X	EXVB-24	
DISPRSET	SERV-18	LANDISP SPEEDRUN
DLY2	MATX-20	DELLOOP WAITLIST VARDELAY
DNDUMP	TELE-6	DNDUMP1
DNDUMP1	TELE-5	DNDUMPI3 DNDUMP
DNDUMP2	TELE-6	DNDUMP1 DNDUMP
DNDUMPI	TELE-5	DNDUMP DNEDUMP
DNDUMPI3	TELE-5	DNDUMPI
DNEDUMP	EXVB-9	GOEXTVB
DNPHASE1	TELE-2	STARTSUB DNDUMP DNPHASE2
DNPHASE2	TELE-2	DNPHASE1
DNTMFAST	TELE-1	C33TEST
DOCKED	DAPB-2	1/ACCS
DOCKTEST	DAPB-4	SPSCONT
DOCMBASE	EXVB-24	V83CALL
DODES	RADR-10	MOREDES
DODNCHAN	TELE-3	NEXTINSL DNPHASE2
DODNPTR	TELE-4	NEXTINSL DNPHASE2

DODOWNTM	TELE-2	Called via program interrupt #8
DOFSTART	PGSR-1	LIGHTSET
DOFSTRT1	PGSR-1	GOPROG3
DOIT	DESC-15	THROTTLE
DONEYET2	DAPA-32	TIMQGMBL
DOROTAT	DAPA-24	AFTERTJ
DORREPOS	RADR-3	RRGIMON
DORROUT	RADR-12	DODES
DORSAMP	RADR-16	RADSAMP
DOT6RUPT	DAPA-1	Called via program interrupt #1
DOW..	ORBI-14	INTGRATE NBRANCH
DPDAT1	DAPB-19	
DPINSF+2	DATA-24	PUTDCSF2
DPOUT	DATA-11	DECDSP3
DSP2DEC	DSKY-11	DSPDPDEC
DSP68	EXVB-30	WAIT68 LRON
DSPA	DATA-7	DSPAB VERBFAN
DSPAB	DATA-8	VERBFAN DSPABC
DSPA	DATA-7	DSPAB VERBFAN
DSPAB	DATA-8	VERBFAN DSPABC
DSPABC	DATA-8	VERBFAN
DSPALARM	DATA-5	ENTER NVSUB TESTNN MIXNOUN DSPA DSPB DSPC DSPAB DSPABC DECDSP3 DSPDPDEC BLOAD ABLOAD ABCLOAD PUTDCSF2 VERBFAN CLOAD
DSPB	DATA-7	VERBFAN
DSPC	DATA-7	VERBFAN
DSPCOM2	DATA-8	DSPA DSPC DSPB
DSPDC2NR	DSKY-11	M/SOUT

DSPDCEND	DATA-14	DECDSP3 ARTOUTSF DEGOUTSF M/SOUT 2INTOUT
DSPDCPUT	DATA-9	DSPDCEND
DSPDCWD1	DSKY-9	DSPDCWD1 DSPDC2NR DSPDECVN DSP2DEC
DSPDECVN	DSKY-11	2INTOUT UPDATNN UPDATVB DSPMMJOB
DSPDECWD	DSKY-9	HMSOUT DSPDCEND
DSPDPDEC	DATA-15	VERBFAN
DSPFMEM	DATA-26	VERBFAN
DSPIN	DSKY-13	NUM WDAGAIN DSPDCWD1 5BLANK M/SOUT
DSPIN1	DSKY-13	11DSPIN DSPIN
DSPMMJOB	DATA-17	STARTP66 STARTP67 STARTP64 P65START REDO TSTLTS3 ENDTEST1 UPUPDATE V37XEQ GOPROG3
DSPOCTWD	DSKY-9	TESTNN DSPCOM2 DSPFMEM
DSPOPTN	ALIN-26	DSPOPTN
DSPRRLOS	RNAV-43	VERB85
DSPSCAN	INTR-4	T4RUPT QUIKDSP DSPSCAN
DSPSIGN	DSKY-10	DSPDECWD DSPDC2NR DSP2DEC
DSPV6N79	ALIN-11	YMKRUPT CHANGEVB DSPV6N79 SURFAGAN
DUMMYJB2	MATX-10	DOFSTRT1 ENDRSTRT EJSCAN
DVMON	SERV-3	AVERAGEG
DXCOMP	CONC-4	PERIODCH
DYNMDISP	BURN-12	P41LM DYNMDISP

EARTHMX	COOR-2	LAT-LONG LALOTORV
EARTHR*	TEST-15	PIPACHK PIPJOBB
EJSCAN	MATX-16	PRIOCHNG JOBSLEEP EJSCAN
ELCALC	TRGL-5	V82CALL TICKTEST V82GON2 CALCTFF COMPDISP R36 SBANDEX ADTIME
ENDEXT	DINT-17	R62DISP V89CALL V89RECL AVEIT RO4END V67CALL RRLOSDSP VBCOARK IMUFINEK IMUATTCK ALINTIME V73UPDAT AGSINIT AGSDISPK AGSVCALC UPOUT4 DAPDATA2 DAPDATA1 TRIMDONE SDISPLAY WAIT68 ENDTEST1 ENDRO3
ENDIMU	IMUC-18	IMUZERO2 COARS2 IMUFINED
ENDINT	ORBI-2	STATINT1
ENDLRV	SERV-13	LRVJOB
ENDMANU1	ATTM-2	TOBALLA R61TEST
ENDMANUV	ATTM-2	
ENDOFJOB	MATX-16	DORROUT LRS24.1 OMEGCALC DATDCHK TESTNN DSPCOM2 HMSOUT DSPDPDEC MONITOR ALMCYCLE OKTOPLAY MAKEMARK OKTOCOPY XCHSLEEP NOUN ENTER R61C+L06 DSPDCEND PREREAD
ENDP76	ORBI-25	P76
ENDPRCHG	MATX-15	EJSCAN
ENDRADAR	RADR-18	RADSTALL STDESIG RRZ2
ENDRET	DINT-16	NORMWAKE MARKWAKE
ENDR29RD	RNAV-33	R29RDJOB
ENDRRD29	RNAV-33	R29RDJOB R29RANGE
ENDRO3	DAPB-21	DAPDATA2
ENDRSTRT	PGSR-11	GOPROG3
ENDSTATE	ORBI-13	DIFEQ+2

GET+MGA	TRGX-15	VN1645
GETAZEL	ALIN-21	R52
GETCADR	MATX-24	LONGCYCL
GETCOMP	DATA-21	BLOAD CLOAD ABLOAD ABCLOAD PUTNORM PUTCOM
GETDAT	ALIN-4	AOTMARK GETDAT PASTIT
GETI	DATA-22	PUTCOM DEGINSF
GETINREL	DSKY-4	5BLANK NUM POSGN NEGSN CLEAR +ON -ON
GETLMATT	ALIN-26	DSPOPTN
GETMKS	ALIN-6	MARKCHEX SURFAGAN OPTAXIS
GETRANS	BURN-14	UPDATEVG
GETRVN	EXVB-26	V83CALL REV83
GETX	CONC-10	TIMERAD TIMETHET LAMBLOOP
GLOCKMON	IMUC-8	PROCEEDE
GOABORT	ASCT-4	ABRTJASK
GOBAQUE	ORBI-12	GAMCOMP OBLATE ENDSTATE
GOCUTOFF	BURN-11	*ENTER
GODSP	DINT-1	ASCTERM1
GODSPR	DINT-1	REDOMANC GYCOARS
GODSPRET	DINT-1	P51 P41LM
GODSPRS1	DINT-5	GODSPR GOFLASHR GOPERF1R GOPERF2R GOPERF4R REGODSPR REFLASHR GOXDSPR GOXDSPFR GOMARK2R PRIODSPR
GOESTIMS	TEST-11	REDO
GOEXTVB	EXVB-1	VERBFAN

GOFLASH	DINT-1	R62DISP V89CALL V89RECL PLANET CHKSDATA DISPLAYE P52B R59 GVDETER R59ALM 79DISP INITBY DSPOPTN VN0611 P34 R55 R52 P52D REDO SHOW ORBCHGO PROG21 REP40ALM P12LM CUTOFF LANDJUNK GOTOPOOH P76 N89DISP GETAZEL P74 INTLOOP S34/35.5 P570PT P30 P32 P72 P32/P72F P33 P73 P33/P73B P33/P73F VN1645 ALMXIT NTARGCHK VN0655
GOFLASH2	DINT-5	GODSP GODSPRET GOFLASH GOPERF1 GOPERF2 GOPERF4 REGODSP REFLASH CLEANDSP GOXDSP EXDSPRET GOXDSPF GOMARK2 GOMARK3 GOMARK4 KLEENEX PRIODSP
GOFLASHR	DINT-1	POSTBURN V99RECYC P47BODY
GOLOADV	EXVB-6	GOEXTVB
GOMANUR	ATTM-1	
GOMARK2	DINT-4	
GOMARK2R	DINT-4	
GOMARK3	DINT-4	AGSVCALC
GOMARK3R	DINT-4	TRIMDONE WAIT68
GOMARK4	DINT-5	PASTIT RO4X
GOODMANU	ATTM-8	NOGO
GOODRAD	RADR-22	LRHEIGHT RADAREAD RENDRAD
GOPERF1	DINT-1	P51 P52D R51 R51K P57POST P20LEMB7 R23LEM P40AUTO ASTNRET P06
GOPERF1R	DINT-2	
GOPERF2	DINT-2	
GOPERF2R	DINT-2	TOBALLA R21DSP
GOPERF4	DINT-2	ORBCHGO PROG21
GOPERF4R	DINT-2	P52B P570PT

GOPOST	BURN-11	*ENTER
GOPROG	PGSR-9	Called via program interrupt #11 VERB69
GOPROG2	PGSR-10	TRMTRACK SEUDOP00 V37RET
GOPROG2A	PGSR-10	
GOPROG3	PGSR-10	GOPROG
GOSHOSUM	EXVB-10	GOEXTVB
GOTOPOOH	PGSR-11	TERMASC P12LM TERM40 STOPCLOK P40AUTO P21VSAVE P47BODY SERVIDLE ASTNRET P64DISPS LANDJUNK N89DISP ENDP76 P34 P74 INTLOOP DISPLAYE S34/35.5 GETAZEL DSPLY81 P30 P57OPT KILLAOT P32/P72F P33 P73 P33/P73B P33/P73F VN1645 VN0611 N45PROC ALMXIT NTARGCHK GOPROG3 POSTAND HIGATJOB ORBCHGO PROG21 GVDETER DSPOPTN INITBY REP40ALM P57POST 79DISP R59ALM R59 R55 R52 R51K R51 REGCOARS P52D P52B CHKSDATA DSPV6N79 VN0655 R61TEST R02BOTH P51 P51C IMUCHK GETDAT PASTIT
GOXDSP	DINT-3	
GOXDSPF	DINT-4	SDISPLAY VBCOARK IMUFINEK IMUATTCK AGSDISPK OHWELL1 OHWELL2 UPVERIFY V82CALL V82GOFLP V82GON DISPN5X R36 ALINTIME R04X DSPV6N79 GETDAT
GOXDSPFR	DINT-4	DAPDATA1 DAPDATA2 VBCOARK SBANDEX DSPRRLOS V67CALL R04Z DSP68
GOXDSPR	DINT-3	
GRABGRAV	ALIN-35	GREED
GREED	ALIN-35	ADDGRAV
GTS	DAPA-28	QRAXIS TRYGTS
GTSQRT	DAPA-34	RSTOFGTS
GUILDRET	DESC-4	IGNALOOP
GVDETER	ALIN-33	BYLMATT GVDETER
GYCOARS	ALIN-17	P52D
GYROEXIT	IMUC-13	STRTGYR2 8192AUG

HAVEGUES	TRGL-9	S40.9
HIENERGY	CONC-8	LAMBLOOP
HIGATJOB	SERV-8	MUNRETRN
HMSIN	DATA-25	PUTDCSF2
HMSOUT	DATA-11	DECDSP3
IDLERET3	DINT-15	RECALTST
IFAILOK	IMUC-17	IMUFINE
IGNALOOP	DESC-2	EXGSUB
IGNITION	BURN-5	*PROCEED TIG-0
IMUATTCK	EXVB-5	GOEXTVB
IMUBAD	IMUC-18	ENDTNON STRTGYRO 8192AUG COARS COARS2 IMUZERO2 ENDIMU IMUFINED
IMUCHK	ALIN-36	P51 P57
IMUCOARS	IMUC-14	REDO PIPJOBB VBCOARK COARSE
IMUFINE	IMUC-17	REDO IMUFINEK COARSE
IMUFINED	IMUC-17	STRTGYR2 IMUFINE
IMUFINEK	EXVB-4	GOEXTVB
IMUGOOD	IMUC-18	
IMUMON	IMUC-4	PROCEEDE
IMUPULSE	IMUC-10	EARTHR* PERFERAJ IMUFINEK 1/GYRO STRTGYR2 GYCOARS R55 INITBY
IMUSTALL	IMUC-17	REDO PIPJOBB EARTH* PERFERAS VBCOARK IMUFINEK AGSVCALC VBZERO 1/GYRO COARSE R55 INITBY GYCOARS

KALCMAN3	ATTM-4	GOMANUR
KEPCONVG	CONC-5	KEPLOOP BRNCHCTR
KEPLERN	CONC-3	KEPPREP
KEPLOOP	CONC-4	BRNCHCTR
KEPPREP	ORBI-15	RVCON GOBAQUE NBRANCH
KEYRUPT1	DSKY-1	Called via program interrupt #5
KILLAOT	ALIN-36	GETDAT PASTIT DSPV6N79
KLEENEX	DINT-5	
LALOTORV	COOR-4	N89DISP
LAMBERT	CONC-6	INITVEL2
LAMBLOOP	CONC-7	HIENERGY LAMBLOOP LOENERGY
LAMENTER	CONC-12	INITV
LANDISP	SERV-15	R10,R11
LANDJUNK	DESC-18	
LASTBIAS	IMUC-3	PREREAD
LAT-LONG	COOR-3	PROG21 LANDJUNK N89DISP
LEMCONIC	ORBI-3	S52.3 V89RECL LPS20.1 LRS24.1 SBANDANT
LEMPREC	ORBI-2	LOCSAM P57D PROG21 AGSVCALC V82GOFF1 V83CALL REV83 R36 S30.1 PRECSET P12LM S40.1B P63LM
LEMVEC	EXVB-9	GOEXTVB
LGCUPDTE	RNAV-36	RANGEBQ
LIGHTSET	PGSR-10	GOPROG GOPROG2A

LITIT	RADR-25	ONLITES
LOADLV	DINT-14	ALOAD BLOAD CLOAD ABLOAD ABCLOAD PUTNORM HMSIN GOLOADLV BITSOFF2
LOCSAM	ALIN-13	PLANET R51
LODNNTAB	DATA-4	TESTNN ALOAD BLOAD CLOAD ABLOAD ABCLOAD UPDATNN
LOENERGY	CONC-8	LAMBLOOP
LOGSUB	MATX-6	
LONGCALL	MATX-23	
LONGCYCL	MATX-23	LONGCALL LONGCYCL
LPS20.1	RNAV-8	P20LEM1 R21LEM1 R61C+LO2 READRDOT 60TIMES
LRALT	RADR-17	DORSAMP LRHJOB
LRHEIGHT	RADR-20	RADAREAD
LRHJOB	SERV-12	R10,R11
LROFF	EXVB-7	GOEXTVB
LRON	EXVB-7	GOEXTVB
LRP2COMM	EXVB-30	LRPOS2K1
LRPOS2	RADR-23	LRP2COMM HIGATJOB
LRPOS2K	EXVB-7	GOEXTVB
LRPOS2K1	EXVB-7	LRPOS2K
LRPOSCAN	RADR-23	LRPOS2 LRPOSCAN
LRPOSOUT	DATA-11	DECDSP3
LRS22.1	RNAV-21	R22LEM
LRS24.1	RNAV-28	DATGDCHK R24LEM

P33	TRGX-4	
P33/P73B	TRGX-4	P33/P73F
P33/P73E	TRGX-5	P33/P73E
P33/P73F	TRGX-5	P33/P73F
P34	TRGL-1	
P34/P74C	TRGL-1	INTLOOP
P35	TRGL-4	
P35/P75B	TRGL-4	P35/P75B

P40ALM	BURN-2	P40LM P42LM
P40AUTO	BURN-13	UPTHROT BURNBABY P40AUTO
P40IGN	BURN-6	IGNITION
P40IN	BURN-1	P40LM
P40LM	BURN-1	
P40SJUNK	BURN-4	TIG-5
P40SPOT	BURN-3	BURNBABY
P40ZOOM	BURN-7	
P41BLANK	BURN-4	TIG-35
P41LM	BURN-2	
P41SPOT	BURN-3	BURNBABY
P42IGN	BURN-6	P63IGN ABRTIGN IGNITION
P42LM	BURN-1	
P42STAGE	BURN-1	REP40ALM

P47BODY	BURN-13	STARTP47 P47BODY
P47LM	BURN-13	
P51	ALIN-1	P51 P51C V37
P51B	ALIN-1	P51
P51C	ALIN-1	P51C
P52B	ALIN-15	
P52D	ALIN-16	P52B P52D P52LS
P52LS	ALIN-15	
P57	ALIN-25	
P57D	ALIN-25	P57OPT
P57OPT	ALIN-25	P57OPT
P57OPT0	ALIN-27	ATTCHK
P57OPT1	ALIN-27	ATTCHK
P57OPT2	ALIN-28	ATTCHK
P57OPT3	ALIN-28	ATTCHK
P57POST	ALIN-36	SURFLINE INITBY SURFDISP
P63DISPS	DESC-9	ZOOM DISPEXIT
P63IGN	BURN-6	IGNITION
P63LM	DESC-1	
P63ZOOM	BURN-7	ZOOM
P64DISPS	DESC-9	DISPEXIT P64DISPS
P65START	DESC-5	GUILDRET
P66VERT	DESC-12	VERTGUID

P70	ASCT-3	V37
P70A	ASCT-3	R10,R11
P71	ASCT-3	V37
P71A	ASCT-3	P70A R10,R11
P72	TRGX-2	
P73	TRGX-4	
P74	TRGL-1	
P75	TRGL-4	
P76	ORBI-23	

PACKOPTN	ALIN-26	P57OPT
PARAM	CONC-9	TIMERAD APSIDES TIMETHET
PASTEVB	DATA-16	MONDO DSPALARM
PASTIT	ALIN-6	CHANGEVB
PAXFLIT	DAPA-10	PAXIS
PAXIS	DAPA-6	
PERFERAS	TEST-17	ALFLT
PEGI	DAPA-15	RATERROR
PERIAPO	CONC-13	INTLOOP CSI/B2
PERIAPO1	CONC-13	S30.1 CIRCL
PERIODCH	CONC-3	PERIODCH
PFAILOK	IMUC-10	UNZ2
PFLITEDB	DAPB-18	P12RET P4OIGN ASTNRET

PIC1	ALIN-22	PIC1 PIC3
PIC3	ALIN-22	PIC3
PICEND	ALIN-24	PIC1
PINBRNCH	DINT-17	TSTLTS3 ABORTALM VBRELDSP IDLERET3 ALM/END VBZERO RRDESEND TRMTRACK LRON LROFF LRP2COMM DAPATTER TOTATTER SNUFFOUT CSMVEC DNEDUMP OUTSNUFF MINIMP NOMINIMP R77END WMATRXNG UPDATOFF ATTACHIT V37BAD R04Z RATEDSP V59GP63
PIPACHK	TEST-12	REDO TORQUE
PIPASR	SERV-1	PREREAD READACCS NBDONLY LUNG GRABGRAV
PIPATASK	TEST-12	PIPACHK PIPATASK
PIPFREE	IMUC-3	AVGEND
PIPJOBB	TEST-13	PIPATASK
PIPUSE	IMUC-3	LASTBIAS
PITCHOFF	DAPB-21	TRIMGIMB
PITFALL	DESC -16	Called via program interrupt #10
PJETSLEC	DAPA-16	TSNEXTP PEGI PURGENCY
PLANET	ALIN-12	P51C R51E AZEL R59RET ASTAR
PLAYJUM1	DINT-7	OKTOPLAY XCHSLEEP NV50DSP NORMRET NORMWAKE NORMBNCH
POLYCOEF	CONC-11	WLOOP
POODOO	PGSR-12	AOTMARK 1406P00 DSPALARM POODO01 CCSHOLE GOBAQUE COMMNOUT TIMETHET TIMERAD
POODO01	PGSR-12	SQRT DLY2 LONGCALL
POOH	PGSR-6	CANV37
POSGN	DSKY-4	CHARIN
POSTAND	PGSR-13	POSTAND P06

R23LEM	RNAV -19	P20LEMB7 R23LEM3
R23LEM2	RNAV -20	R23LEM
R23LEM3	RNAV -20	R23LEM
R24END	RNAV -20	R24LEM
R24LEM	RNAV -20	R24LEM3 R21LEM R23LEM1
R24LEM3	RNAV -20	R24LEM
R29	RNAV -31	COPYCYC1
R29.LOS	RNAV -31	R29
R29DODES	RNAV -34	BEGDES29 R29DODES
R29DPAS2	RNAV -35	R29DODES
R29RANGE	RNAV -33	R29RANGE
R29RDJOB	RNAV -32	R29READ
R29READ	RNAV -32	R29DPAS2 R29READ
R29REMOJ	RNAV -32	R29
R31CALL	EXVB-23	V83PERF R31CALL
R36	EXVB-26	V90PERF
R51	ALIN-19	P52B REGCOARS R51 R51K ASTNRET
R51E	ALIN-19	R51 R51E
R51K	ALIN-20	GYCOARS
R52	ALIN-21	R51E R52 AZEL
R55	ALIN-22	R51E
R56	ALIN-22	R51
R59	ALIN-30	79DISP R59ALM R59
R59ALM	ALIN-33	INCAZ
R59OUT	ALIN-33	R59 R59ALM

R59RET	ALIN-33	R59OUT
R60LEM	ATTM-1	R62DISP V89RECL R61C+LO2 P40IN P41LM ASTNRET AZEL
R61C+LO1	RNAV-10	R61C+LO6
R61C+LO2	RNAV-11	R61C+LO1 R61LEM
R61C+LO6	RNAV-12	R61C+LO2
R61LEM	RNAV-10	P20LEMA R24LEM3 R22LEM R23LEM3
R61TEST	ATTM-2	TOBALLA
R62DISP	ATTM-11	CREWMANU
R65LEM	RNAV-10	P25LEM1 R22LEM R22LEM42 RANGEBQ
R77	EXVB-9	GOEXTVB
R77CHECK	RADR-24	RADAREAD
R77END	EXVB-9	GOEXTVB
RADAREAD	RADR-19	Called via program interrupt #9
RADLITES	RADR-25	GOODRAD RESAMPLE
RADSAMP	RADR-15	RO4X RO4Z RADSAMP
RADSTALL	RADR-18	R29RDJOB DORSAMP R29RANGE R22RSTRT R21LEM1 R29REMOJ READRDOT R21LEM VBZERO RRDESK2 LRP2COMM HIGATJOB LRHJOB LRVJOB R61C+LO1
RADSTART	RADR-24	INITREAD RESAMPLE RADSTART
RANGEBQ	RNAV-26	LSR22.3 LSR22.4
RASTEER1	BURN-17	S40.8
RATEDAMP	DAPA-15	DETENTCK
RATEDISP	EXVB-7	GOEXTVB
RATELOOP	DAPA-6	RATELOOP
RATERROR	DAPA-14	DETENTCK RATEDAMP
RCS	DAPA-18	QRAXIS TRYGTS
RCSMONIT	DAPA-33	PROCEEDE
RDBADEND	RADR-19	BADRAD ENDRADAR LRPOSCAN STDESIG
RDGIMS	SERV-13	LRVJOB
RDRUSECK	EXVB-29	VBZERO VBCOARK LRPOS2K1 RO4 R77

READACCS	SERV-1	READACCS
READRDOT	RNAV -21	READRDOT
RECALTST	DINT-15	VBRESEQ LOADLV
RECTEST	ORBI-8	TIMESTEP LUNSPH
RECTIFY	ORBI-5	INTEGRVS RVCON RECTOUT ORIGCHNG RECTEST GOBAQUE FAZC
RECTOUT	ORBI-4	A-PCHK
REDESIG	DESC -5	TFFINCR
REDESMON	DESC -16	PITFALL REDESMON
REDO	TEST-10	SYSTEST
REDOMANC	ATTM-1	TOBALLA
REDOPRIO	DINT-9	NV50DSP
REFLASH	DINT-3	CLOKJOB P64DISPS VERTDISP
REFLASHR	DINT-3	TIGNOW
REFMF	COOR-8	LANDJUNK GETLMATT SURFDISP
REGCOARS	ALIN-35	P52D
REGODSP	DINT-2	TIG-30A CLOKJOB P63DISPS P64DISPS
REGODSPR	DINT-3	
REJECT	ALIN-9	MARKRUPT
RELDSP	DINT-13	TSTLTS3 ABORTALM VBRELDSP VERBFAN VBRESEQ VBRQEXEC LOADLV RECALTST V37BAD POOH V37XEQ VBRQWAIT
RELDSP1	DINT-13	VBRELDSP MONITOR
RELINUS	ATTM-12	SEUDOPOO CHKLINUS
REMARK	ALIN-9	VACSTOR
REMODE	RADR-9	R29REMOJ

RENDRAD	RADR-21	RADAREAD
REP4OALM	BURN-2	REP4OALM
REQDATX	DSKY-5	ALOAD ABLOAD ABCLOAD
REQDATY	DSKY-5	BLOAD ABLOAD ABCLOAD
REQDATZ	DSKY-5	TESTNN CLOAD ABCLOAD
REQMM	DSKY-5	MMCHANG
RESAMPLE	RADR-21	RADAREAD
RESET22	PGSR-7	RESET22
RESET57	EXVB-30	WAIT68
RESTORDB	DAPB-18	ALLCOAST DAPDATA2 ENDRO3 TERMASC TERM4O TRMTRACK R23LEM R61C+LO2
RETURNTJ	DAPB-16	Z123COMP ZONE1 ZONE2 ZONE3 ZONE4 RUFLAW2 RUFLAW12
REV83	EXVB-24	COMPDISP
RGOODEND	RADR-18	GOODRAD LRPOS2 LRPOSCAN R77CHECK REMODE RRZERO
RGVGCALC	DESC-6	TTFINCR REDESIG
RHCACTIV	DAPA-22	CHEKSTIK
RMODINV	RADR-8	LUNDESCH REMODE RRDESNB RRDESSM
RNDREFDR	IMUC-15	P06 IMUMON
RODCOMP	DESC-12	P66VERT RODTASK
RODTASK	DESC-12	P66VERT
ROOTLOOP	DESC-17	ROOTLOOP
ROOTPSRS	DESC-17	TTF/8CL
ROPECHK	TEST-7	SELFCHK CNTRLOOP
RPCOMP2	ASCT-12	ASCENT CMPONENT
RR1AX2	RADR-4	RR1AX2 RRTONLY
RRANGLES	RADR-7	RRDESSM
RRANGOUT	DATA-26	DECDSP3
RRAUTCHK	RADR-1	PROCEEDE
RRCDUCHK	RADR-1	RRAUTCHK
RRDESDUN	RADR-11	DODES
RRDESEND	EXVB-5	GOEXTVB
RRDESK2	EXVB-5	VBCOARK
RRDESNB	RADR-6	RRDESK2 R21LEM R21LEMB

STARTP67	DESC-11	LUNLAND
STARTSB1	PGSR-2	ENEMA
STARTSB2	PGSR-3	GOPROG2 STARTSB1
STARTSUB	PGSR-2	SLAP1 GOPROG LIGHTSET
STATEINT	ORBI-1	ENDINT
STATINT1	ORBI-1	POOH STATEINT
STCLOK3	BURN-9	P40SPOT COMFAIL EXGSUB
STDESIG	RADR-9	BEGDES MOREDES DORROUT CSMINT
STEER?	DESC-9	AFCCALC1 EXBRAK
STEERING	BURN-7	ULLGNOT
STIKLOAD	DAPB-19	
STMIN-	DAPB-8	ACCTHERE
STOPCLOK	BURN-10	CLOKJOB V99RECYC
STOPRATE	DAPA-32	TRMTRACK ALLCOAST STEERING NOATTCNT DVMON STRTP66A EXVERT NOGO T406ALM STEER? ATMAG
STRTGYRO	IMUC-11	IMUPULSE STRTGYR2 8192AUG
STRTGYR2	IMUC-11	STRTGYR2
STRTP66A	DESC-11	LUNLAND
STSHOSUM	TEST-7	SHOWSUM2 NXTBNK
SUFFCHEK	CONC-8	LAMBLOOP HIENERGY LOENERGY
SUPDACAL	MATX-26	C(ADRS
SUPERJOB	DAPA-10	PAXFILT BACKP
SURFAGAN	ALIN-11	DSPV6N79
SURFDISP	ALIN-30	
SURFEND	ALIN-11	DSPV6N79
SURFLINE	ALIN-28	SAMETYP R59RET

SURFSTAR	ALIN-11	AVESTAR
SURFSTOR	ALIN-8	YMKRUPT
SVCT3	IMUC-1	SVCT3 T3RUPT STARTSB2 DLY2 WTLST5
SVDWN1	TELE-6	ENDSTATE A-PCHK INTWAKEU P76 ATTACHIT ORBCHGO FAZAB3
SVDWN2	TELE-6	ENDSTATE A-PCHK INTWAKEU FAZAB3
SWCALL	MATX-25	
SWRETURN	MATX-25	
SYNCT4	INTR-5	QUIKDSP SYNCT4
SYSTEST	EXVB-10	GOEXTVB
T3RUPT	MATX-22	TASKOVER Called via program interrupt #3
T4RUPT	INTR-2	QUIKDSP SYNCT4 T4RUPT Called via program interrupt #4
T5RUPT	DAPA-1	Called via program interrupt #2
T6JOBCHK	DAPA-1	DOT6RUPT
TASKOVER	MATX-22	WAKER LONGCYCL
TCGETCAD	MATX-19	DELLOOP
TDISPSET	DESC-10	TTFINCR TTF/8CL
TERMASC	ASCT-12	CUTOFF
TERMATE	DINT-15	RECALTST
TERM40	BURN-9	POSTBURN TIGNOW
TESTLOOP	ORBI-5	ALOADED GOBAQUE ENDSTATE WMATEND CKMID2
TESTNN	DATA-3	MONDO
TESTXACT	EXVB-2	VBCOARK IMUATTCK V47XACT DAPDISP CREWMANU ALINTIME RO4 VB64 V67 V73UPDAT V82PERF V83PERF VERB85 V90PERF GOSHOSUM SYSTEST IMUFINEK LRON V89PERF

TFFEL1	EXVB-23	CALCTFF
THROTTLE	DESC-14	EXVERT RODCOMP
THROTUP	ASCT-6	UPTHROT
TICKTEST	EXVB-19	V82CALL TICKTEST
TIG-0	BURN-5	TIG-5
TIG-5	BURN-4	TIG-30 COMFAIL2
TIG-30	BURN-4	TIG-35
TIG-30.1	BURN-4	TIG-35
TIG-30A	BURN-4	TIG-30.1
TIG-35	BURN-4	P41SPOT
TIGNOW	BURN-8	TIGTASK
TIGTASK	BURN-5	TIG-0
TIMEDIDL	EXVB-15	UPEND73 UPEND70
TIMEGMBL	DAPA-31	TRYGTS SPSCONT
TIMERAD	CONC-1	VNO611
TIMESTEP	ORBI-6	
TIMETHET	CONC-2	INTLOOP CDHMVR CSI/B2 ORBCHGO
TIMQGMBL	DAPA-31	TIMEGMBL
TJETLAW	DAPB-12	PURGENCY TJLAW4
TJLAW	DAPA-24	
TJLAW4	DAPA-24	
TNONTEST	IMUC-6	IMUMON
TOBALLA	ATTM-1	REDOMANC ENDMANUV
TOPSEUDO	DAPA-23	ENTERUV
TORQUE	TEST-12	PERFERAS
TOTATTER	EXVB-7	GOEXTVB

TRIMDONE	DAPB-21	PITCHOFF
TRIMGIMB	DAPB-21	DAPDATA2
TRMTRACK	EXVB-6	R61TEST GOEXTVB R22LEM R23LEM2 P20LEM1 60TIMES R24LEM R21DISP P20LEMB7 CSMINT R21LEM R21LEM1
TRYGTS	DAPA-27	QRAXIS
TRYUORV	DAPA-11	TRYUORV
TSNEXTP	DAPA-12	CHKVISFZ TRYUORV
TSNEXTS	DAPA-20	RCS +XORULGE
TSTLTS2	TEST-1	VBTSTLTS
TSTLTS3	TEST-1	TSTLTS2
TTFINCR	DESC-5	GUILDRET STARTP64
TTF/8CL	DESC-6	RGVGCALC
TWIDDLE	MATX-19	

ULLGNOT	BURN-4	TIG-30
ULLGTASK	BURN-4	TIG-30 STOPCLOK GOPOST GOCUTOFF
UNZ2	IMUC-9	ISSZERO ENDTNON
UPDATCHK	SERV-8	MUNRETRN
UPDATEVG	BURN-14	STEERING CALCN85
UPDATOFF	EXVB-11	GOEXTVB
UPDATNN	DATA-17	MONDO NVSUB
UPDATVB	DATA-17	CLEAR NVSUB PASTEVB ALMCYCLE ABLOAD ABCLOAD
UPDTCALL	ATTM-8	CONTMANU
UPEND70	EXVB-16	UPJOB
UPEND71	EXVB-16	UPJOB
UPEND72	EXVB-17	UPJOB
UPEND73	EXVB-15	UPSTORE

UPERROUT	EXVB-17	UPEND71 UPEND72
UPJOB	EXVB-16	UPSTORE
UPOUT4	EXVB-17	OHWELL1 OHWELL2 UPVERIFY UPEND73 UPEND70 UPEND71 UPERROUT
UPPSV	RNAV-9	P20LEMC3 R21LEM8
UPPSV4	RNAV-10	UPPSV
UPRUPT	TELE-1	Called via program interrupt #7
UPSTORE	EXVB-15	UPVERIFY
UPTHROT	ASCT-6	GOABORT
UPUPDATE	EXVB-14	V73UPDAT
UPVERIFY	EXVB-15	OHWELL2 UPVERIFY
UPTMFAST	TELE-1	C33TEST
USEPIOS	ORBI-15	INTEGRV ATTACHIT
V1ST02S	MATX-8	
V37	PGSR-5	MMCHANG VERB96 SEUDOP00
V37BAD	PGSR-6	V37
V37RET	PGSR-14	V37
V37XEQ	PGSR-8	SEUDOP00
V47TXACT	EXVB-6	GOEXTVB
V59GP63	EXVB-30	LRPOS2K
V67	EXVB-8	GOEXTVB
V67CALL	RNAV 40	V67
V70UPDAT	EXVB-8	GOEXTVB
V71UPDAT	EXVB-8	GOEXTVB
V72UPDAT	EXVB-8	GOEXTVB
V73UPDAT	EXVB-8	GOEXTVB
V82CALL	EXVB-17	V82PERF

V82GOFF1	EXVB-18	V82GOFLP
V82GOFLP	EXVB-17	V82GOFLP
V82GON	EXVB-19	V82CALL
V82GON1	EXVB-19	V82GON V82GON2
V82GON2	EXVB-20	V82GON1
V82PERF	EXVB-10	GOEXTVB
V83CALL	EXVB-24	R31CALL
V33PERF	EXVB-10	GOEXTVB
V89CALL	ATTM-11	V89PERF
V89PERF	EXVB-10	GOEXTVB
V89RECL	ATTM-11	V89RECL
V90PERF	EXVB-10	GOEXTVB
V99RECYC	BURN-10	*ENTER
VACSTOR	ALIN-8	YMKRUPT
VALMIS	TEST-14	PERFERAS
VALTCHK	SERV-11	VMEASCHK WSTOR
VARALARM	PGSR-14	ALMXIT
VARDELAY	MATX-24	
VB64	EXVB-8	GOEXTVB
VBCOARK	EXVB-3	GOEXTVB
VBPROC	DINT-14	PROCKEY VERBFAN
VBRELDSP	DSKY-8	CHARIN
VBRESEQ	DINT-14	VERBFAN
VBRQEXEC	PGSR-8	VERBFAN
VBRQWAIT	PGSR-8	VERBFAN

VBTERM	DINT-14	VERBFAN JAMTERM
VBTSTLTS	TEST-1	VERBFAN
VBZERO	EXVB-3	GOEXTVB
VECPNT1	ATTM-3	R61C+LO1
VECPOINT	ATTM-3	R61C+LO1 R60LEM REDOMANC V89RECL
VERB	DSKY-2	CHARIN
VERB69	EXVB-8	GOEXTVB
VERB85	EXVB-10	GOEXTVB
VERB96	EXVB-11	GOEXTVB
VERBFAN	DATA-5	ENTPASO TESTNN MIXNOUN
VERTDISP	DESC-10	DISPEXIT
VERTGUID	DESC-12	RGVGCALC LUNLAND STRTP66A
VGAIN*	BURN-14	FIRSTMME
VMEASCHK	SERV-9	UPDATCHK NOREASON
VN0611	TRGX-1	VN0611
VN0655	TRGX-2	VN0611
VN1645	TRGX-6	P34 P74 INTLOOP P35 P75 P35/P75B P31 JUNCTN1 DSPLY81 P39 P79 P30 VN0655 P32/P72F P33 P73 P33/P73F
VOPENED	DAPA-33	RCSMONIT
WAITLIST	MATX-19	
WAKER	MATX-19	DELLOOP
WANTAPS	BURN-4	TIG-30
WCALC	ATTM-6	KALCMAN3
WDAGAIN	DSKY-9	WDAGAIN
WHIMPER	PGSR-12	SERVIDLE POODOO BAILOUT1 ABORT
WITCHONE	DINT-10	OKTOPLAY OKTOCOPY JOBXCHS

VBTERM	DINT-14	VERBFAN JAMTERM
VBTSTLTS	TEST-1	VERBFAN
VBZERO	EXVB-3	GOEXTVB
VECPNT1	ATTM-3	R61C+LO2
VECPOINT	ATTM-3	R60LEM REDOMANC V89RECL
VERB	DSKY-2	CHARIN
VERB69	EXVB-8	GOEXTVB
VERB85	EXVB-10	GOEXTVB
VERB96	EXVB-11	GOEXTVB
VERBFAN	DATA-5	ENTPASO TESTNN MIXNOUN
VERTDISP	DESC-10	DISPEXIT
VERTGUID	DESC-12	RGVGCALC VRTSTART RESTART?
VGAIN*	BURN-14	FIRTTME
VMEASCHK	SERV-9	UPDATCHK NOREASON
VN0611	TRGX-1	VN0611
VN0655	TRGX-2	VN0611
VN1645	TRGX-6	P34 P74 INTLOOP P35 P75 P35/P75B P30 VN0655 P32/P72F P33 P73 P33/P73F
VOPENED	DAPA-33	RCSMONIT
VRSTART	DESC-11	STRTP66A
WAIT68	EXVB-30	WAIT68
WAITLIST	MATX-19	
WAKER	MATX-19	DELLOOP
WANTAPS	BURN-4	TIG-30
WCALC	ATTM-6	KALCMAN3
WDAGAIN	DSKY-9	WDAGAIN
WHIMPER	PGSR-12	SERVIDLE POODOO BAILOUT1 ABORT
WITCHONE	DINT-10	OKTOPLAY OKTOCOPY JOBXCHS