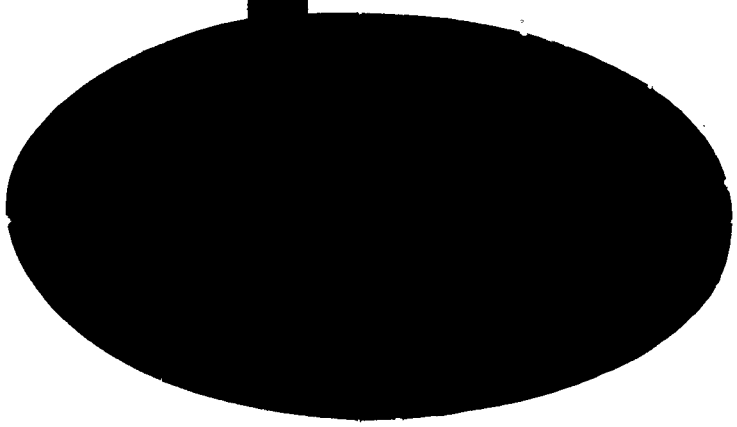
JM6/R. L. PHELPS

MASSACHUSETTS INSTITUTE OF TECHNOLOGY

APOLLO

GUIDANCE, NAVIGATION AND CONTROL

OFFICE OF PRIME RESPONSIBILITY



MIT CHARLES STARK DRAPER LABORATORY

CAMBRIDGE MASSACHUSETTS 02139

MASSACHUSETTS INSTITUTE OF TECHNOLOGY

GUIDANCE, NAVIGATION AND CONTROL

Submitted by: Margaret H. Hamilton Date: 4-12 72
M. H. HAMILTON, DIR., MISSION PROGRAM DEVEL.
APOLLO GUIDANCE AND NAVIGATION PROGRAM

Approved: Stephen L. Copps Date: 4-13-72
S. L. COPPS, SKYLARK PROGRAM MANAGER
APOLLO GUIDANCE AND NAVIGATION PROGRAM

Approved: R. H. Battin Date: 4/13/72
R. H. BATTIN, DIRECTOR, MISSION DEVELOPMENT
APOLLO GUIDANCE AND NAVIGATION PROGRAM

Approved: David G. Hoag Date: 14 Apr 72
D. G. HOAG, DIRECTOR
APOLLO GUIDANCE AND NAVIGATION PROGRAM

Approved: Ralph R. Ragan Date: 18 Apr 72
R. R. RAGAN, DEPUTY DIRECTOR
CHARLES STARK DRAPER LABORATORY

R-693 ✓

GUIDANCE SYSTEM OPERATIONS PLAN FOR MANNED CM EARTH ORBITAL MISSIONS USING PROGRAM SKYLARK 1

NAS9-4065

SECTION 2 DATA LINKS

MARCH 1972

MIT CHARLES STARK DRAPER LABORATORY
CAMBRIDGE, MASSACHUSETTS, 02139

ACKNOWLEDGEMENT

This report was prepared under DSR Project 55-23890, sponsored by the Manned Spacecraft Center of the National Aeronautics and Space Administration through Contract NAS 9-4065.

GUIDANCE SYSTEM OPERATIONS PLAN FOR MANNED CM EARTH ORBITAL MISSIONS USING PROGRAM SKYLARK 1

SECTION 2 DATA LINKS

Signatures appearing on this page designate approval of this document by NASA/MSC.

Approved: _____ Date: 3/20/72
John R. Garman
Section Chief, Guidance Program Section
Manned Spacecraft Center, NASA

Approved: _____ Date: 3/20/72
John E. Williams, Jr.
Chief, Simulation and Flight Software Branch
Manned Spacecraft Center, NASA

Approved: _____ Date: 3/21/72
James C. Stokes, Jr.
Chief, Flight Support Division
Manned Spacecraft Center, NASA

BLANK

FOREWORD

The Guidance System Operations Plan (GSOP) for Program Skylark 1 is published as separate volumes in five sections:

2. Data Links
3. Digital Autopilots
4. Operational Modes
5. Guidance Equations
7. Erasable Programs

Since the information in Section 1 of the Colossus 2E GSOP is also applicable to the Skylark Program, Section 1 will not be republished for Skylark. Therefore, the reader is referred to R577 Colossus 2E GSOP, Section 1, Revision 2, January 1970. Also, Section 6 will not be published for Skylark.

The changes made to the Skylark GSOP Section 2 were enough to warrant its consideration as a new document. Consequently, it is not being treated as a revision of Colossus 3 GSOP 2. Major deletions, additions, and editorial changes have been made to reflect the scope of the new program. The document has undergone extensive editorial and format changes with a view of making it more useful to the reader. Appendix A contains a list of PCR's and PCN's whose implementation is reflected in this issue.

The volume is published as a control document governing the structure of Uplink and Downlink programs in Skylark 1. Revisions constituting changes to the Skylark Program require NASA approval.

BLANK

TABLE OF CONTENTS

TABLE OF CONTENTS (concl'd)

SECTION 2

DATA LINKS

2.0 Introduction

This volume, Section 2 of the Guidance System Operations Plan for Manned CM Earth Orbital Missions using Program SKYLARK describes the GNCS Data Links: Digital Uplink to CMC (P27) and CM Digital Downlink for use on these missions.

The material of Section 2 of this GSOP is arranged:

2.1 Digital Uplink to CMC (P27)
2.2 CMC Digital Downlink
2.3 Downlist Formats
2.4 Description of Telemetered Quantities
2.5 Flagbits
2.6 Effects of Fresh Start (V36) and Hardware Restart on Flagword and Channel Bits

BLANK

2.1 Digital Uplink to CMC (P27)

By means of the CMC UPLINK, ground control can insert data or issue instructions to the CMC in the same manner that these functions are normally performed by the spacecraft crew in using the DSKY keyboard. The CMC is programmed to accept the following UPLINK inputs:

1. LIFTOFF TIME INCREMENT: Provides ground capability to increment or decrement the CMC clock, OWS and CSM state vector times and TEPHEM (time) with a double precision octal time value, scaled centiseconds/2^{28}.

2. CONTIGUOUS BLOCK UPDATE: Provides ground capability to update from 1 to 18 consecutive E memory registers in the same EBANK.

3. SCATTER UPDATE: Provides ground capability to update from 1 to 9 non-consecutive E memory registers in the same or different EBANKs.

4. OCTAL CLOCK INCREMENT: Provides ground capability to increment or decrement the CMC clock with a double precision octal time value scaled centiseconds/2^{28}.

All information received by the CMC from the uplink is in the form of keyboard characters. Each character is assigned an identifying code number called its character code. Each character code transmitted to the CMC is sent as a triply redundant uplink word preceded by a leading "1" bit. Thus, if C is the 5-bit character code, then the 16 bit uplink word has the form:

$$1\ C\ \overline{C}\ C$$

where $\overline{C}$ denotes the bit-by-bit complement of C. (Table 2-1 defines all the legal input keycodes.) To these 16 bits of information the ground adds a 3-bit code specifying the system aboard the spacecraft which is to be the final recipient of the data and a 3-bit code indicating the spacecraft which should receive the information. The 22 total bits are sub-bit encoded (replacing each bit with a 5-bit code for transmission). If the message is received and successfully decoded, the on-board receiver will send back an 8-bit "message accepted pulse" to the ground and shift the original 16 bits of the uplink word to the CMC (1 C $\overline{C}$ C). The leading "1" bit causes an interrupt within the CMC after all 16 bits have been shifted from the uplink receiver. During ground testing the count of UPRUPTS and the sum of the $C\overline{C}C$ codes entering the AGC are accumulated in erasable registers, permitting a count and sum-check on data transmitted UPLINK to the AGC. This feature will not be used in flight because the summing of uplink data is disabled.

Any ground command sequence normally transmitted via the uplink may be duplicated by the astronaut via the keyboard. All reference to uplink words used in

TABLE 2-1

Character	Uplink Word
0	1 10000 01111 10000
1	1 00001 11110 00001
2	1 00010 11101 00010
3	1 00011 11100 00011
4	1 00100 11011 00100
5	1 00101 11010 00101
6	1 00110 11001 00110
7	1 00111 11000 00111
8	1 01000 10111 01000
9	1 01001 10110 01001
VERB	1 10001 01110 10001
NOUN	1 11111 00000 11111
ENTER	1 11100 00011 11100
ERROR RESET	1 10010 01101 10010
CLEAR	1 11110 00001 11110
KEY RELEASE	1 11001 00110 11001
+	1 11010 00101 11010
-	1 11011 00100 11011

NOTE: It is good operational procedure to end every uplink message with a KEY RELEASE.

this section are in the form transmitted from the uplink receiver to the CMC. Therefore, they do not contain the vehicle or subsystem addresses added by the ground facilities.

During update program (P27) execution, the following registers may be monitored via the P27 Downlink List:

1. UPBUFF - Contains all input data, including index value, ECADR value(s) and update parameters. There are 20 (decimal) UPBUFF registers numbered sequentially from UPBUFF + 0 to UPBUFF + 19D where the D indicates decimal notation.

2. UPVERB - Contains second digit of update verb being used, e.g., "0" for Verb 70, "1" for Verb 71, etc.

3. UPOLDMOD - Contains value of program interrupted by P27, e.g., 00, 02, or 20 for programs 00, 02, or 20; program 27 is inhibited from interrupting any other programs.*

4. COMPNUMB - Contains octal value of number of components to be processed by P27. Once set, it remains fixed during complete update operation.

5. UPCOUNT - Used for indexing UPBUFF. The contents of this register may vary from one (1) to the value contained in COMPNUMB. This register always contains the octal identifier of the parameter that is being loaded.

If the CMC received an improperly coded word from the uplink receiver during the load (i.e., not "1 CCC") it sets BIT 4 of FLAGWRD7 to "one", which is transmitted via Downlink to the ground station. When this occurs, the ground station should correct the transmission by sending the following uplink word:

1 00000 00000 00000

(which clears the INLINK register) and follow this by transmitting "ERROR RESET" (which will set BIT 4 of FLAGWRD7 to zero).** If "CLEAR" is transmitted immediately following "ERROR RESET", the ground station then may begin the corrected transmission with the first word of the 5 octal digits that was being sent when the alarm condition occurred. The "CLEAR" button is used after the "ERROR RESET" to blank the data display register (R1). The ground station should then continue the update by using UPCOUNT to indicate the specific parameter being processed and resume the update function by re-transmitting the parameter beginning with the first octal character.

---

* It is possible to update when program lights are blanked by a FRESH START (MODREG is 77777_8).

** "ERROR RESET" must be sent via uplink to set BIT4 of FLAGWRD7 to zero. DSKY "ERROR RESET" has no effect.

If the ground wishes to continue loading without transmitting the "CLEAR" code it must determine which character was in error when failure occurred, and resume uplink transmission from the point of failure. This may be determined by monitoring the display in R1 as well as the contents of UPCOUNT.

This program may be entered only from P00, P02, or P20 Option 1, 2, or 5 for the CM. If the CMC is not in one of the programs indicated above when any update VERB is sent uplink, the "Operator Error" lamp will be illuminated, the uplink activity light will be turned "OFF" and the computer will ignore the request, via the specified update VERB, to transfer control to P27.

2.1.1 CM LIFTOFF TIME INCREMENT

To initiate a double precision LIFTOFF octal time increment the ground station transmits "VERB70ENTER".

2.1.1.1 Program 27 Verification

The ground station should then await confirmation via Downlink that the CMC is in Program 27.

If P27 is entered, the CMC puts the old program number in UPOLDMOD, sets UPCOUNT to "one", selects the P27 Downlink List for Downlink transmission and flashes V21N01 which requests a data load for UPBUFF + 0.

If P27 is entered for a Verb 70 update, 0 is placed in UPVERB and 2 is placed in COMPNUMB. Following P27 verification and confirmation of UPVERB and COMPNUMB sent via Downlink, the ground station should transmit the double precision octal time XXXXX ENTER XXXXX ENTER, where time is in centiseconds scaled 2^{-28}. A negative time value (decrement) should be transmitted in one's complement form. It should be noted that UPCOUNT is incremented by 1 after the ENTER following the most significant part of the double precision time. P27 uses the contents of UPCOUNT to calculate the next UPBUFF location for the V21N01.

2.1.1.2 Data Verification and Termination

After the final ENTER associated with the last update has been transmitted, P27 flashes V21N02 which is a request to the ground station to verify all the update data and to perform one of the following functions:

1. Accept all the update data entered
2. Modify some or all of the update data
3. Reject all of the update data

2.1.1.2.1 Accept All the Update Data Entered

If the ground station verifies that the content of the UPBUFF registers is correct, it should transmit "VERB33ENTER" to signal P27 to process the update data. For the Verb 70 update, P27 inverts BIT 3 of FLAGWRD7 and determines if the State Vector data is being used by the orbital integration routine. If so, further P27 instruction executions are delayed (P27 dormant) until the integration routine is complete. A display of "27" in the program lights, along with a ground verification that BIT3 of FLAGWRD7 has been inverted and that the operator error light is "OFF", should indicate to the operator that the completion of P27 is temporarily being delayed.

After P27 is re-activated or if it initially finds that the integration routine is not in use, it will inhibit other routines from using State Vector data and complete the data verification requirements for the specific update Verb in use. (For each Verb, see appropriate verification section.)

2.1.1.2.1.1 Verb 70 Double Precision Time Verification

Program 27 verifies that the double precision octal time can be subtracted from the CMC clock without causing overflow. (For this operation two of the UPBUFF registers, UPBUFF + 18D and 19D, are used as temporary buffers for TIME2 and TIME1.) If the double precision input time can be subtracted from the CMC clock without causing overflow, P27 proceeds to increment TEPHEM and decrement the CMC clock, the CSM State Vector time, and the OWS StateVector time. Program 27 will then turn the uplink activity light "OFF", replace the downlink list code in DNLSTCOD with the code for the previous program, release the State Vector data for other routines, and reinstate the previous program.

If, on the other hand, an overflow would occur, P27 will leave the CMC clock intact and turn the operator error light "ON". It will then turn the uplink activity light "OFF", replace the downlink list code in DNLSTCOD with the code for the previous program, release the State Vector data, and reinstate the previous program.

2.1.1.2.2 Modify Some or All of the Update Data

If during the verification time some of the UPBUFF registers are found to be in error, the ground station may make corrections by either of the following methods:

a. Individual parameters in UPBUFF + 0 to UPBUFF + 19D may be

changed by sending a two digit octal identifier followed by the ENTER code. For example, if input word 2 (UPBUFF+1) required change, the ground station would transmit "02ENTER". This causes P27 to display the UPBUFF+1 address in R3 and flash V21N01, requesting a new octal data load from the ground. After transmission of the data and its ENTER code, P27 repeats the V21N02 flash to request data acceptance, modification or rejection (section 2.1.1.2). NOTE: If the octal identifier is ≤ 0 or $>$ COMPNUMB, P27 will continue the V21N02 flash and completely disregard the value just entered. It should also be noted that the contents of UPCOUNT is never changed during line by line correction.

b. If several parameters are to be modified, the ground station may change each separately as in step "a" above, or it may choose to terminate and re-initiate the load. To terminate the load the ground must transmit "VERB34ENTER" which will cause the CMC to return to the program it was in before the update was initiated. (P27 turns the uplink activity light "OFF", and switches to the previous Downlink list before returning control to the other program.) To resume its update the ground station would re-transmit the update VERB followed by the complete update load.

2.1.1.2.3. Reject All the Update Data

Update data may be rejected at any time by terminating a load. This is accomplished with the VERB34ENTER sequence described in part "b" of section 2.1.1.2.2.

2.1.1.2.4 Effects and Use of "VERB33ENTER"

1. During data loads and prior to the V21N02 flash, transmission of VERB33ENTER will be ignored by P27.

2. During V21N02 flashing, transmission of VERB33ENTER will initiate the procedure described in section 2.1.1.2.1.

3. If line by line correction is initiated (section 2.1.1.2.2), transmission of VERB33ENTER after the octal identifier has been entered will be ignored by P27.

2.1.2 CM Contiguous Block Update

To initiate a contiguous E memory update the ground station should transmit "VERB71ENTER".

Before sending the update data the ground station should perform Program 27 verification as defined in the first three paragraphs of section 2.1.1.1. If P27 is entered, 1 is placed in UPVERB and in UPCOUNT.

The verb 71 data format is defined in section 2.1.2.1 below and the data load requirements are described in section 2.1.2.2.

2.1.2.1 VERB71 Data Entry Format

The VERB71 update data format is as follows (all Es represent ENTERs):

```
I  I  E
A  A  A  A  E
X  X  X  X  X  E
X  X  X  X  X  E
         .
         .
         .
X  X  X  X  X  E
```

where:

1. $3 \leq II \leq 24$ octal. This is the index value used by P27 to process the update data. The index value represents the total number of numeric quantities to be loaded, including the index value itself, the starting address (ECADR) and the update parameters(s). The minimum value of 3 is for a single update parameter load. A maximum value of 24 octal is allowed since the UPBUFF capacity is a 20 (decimal) register buffer for P27. This value represents a maximum of 18 update parameters in addition to the index count and the starting E memory address.

2. AAAA is the first E memory address (ECADR) of the update block to be processed. Bits 1-8 indicate the relative address ($0\text{-}377_8$) within the selected EBANK and bits 9-11 identify the desired EBANK (0-7). Also, for one data load operation, all update parameters must ultimately be stored in the same EBANK. Therefore, the starting address and the length of the block must be chosen so that the complete load is contained in the same EBANK; i.e., (bits 8 - 1 of AAAA) + II-3 must be $\leq$ 377 octal.

3. X X X X X is octal data which is to be loaded. This data is stored in sequential order in UPBUFF+2 and following, up to UPBUFF+19D. Scaling of the data must be the same as that of the internal CMC registers.

2.1.2.2 Data Load Requirements by Ground Station

Following Program 27 verification (V21N01 flashes with the UPBUFF+0 address displayed in R3) the ground station should enter the update data in the manner described below.

2.1.2.2.1 Index Value

The index value I I should be entered as an octal number and visually verified (displayed in R1) prior to transmitting the ENTER code. This value should be within the specified limits (see part 1 section 2.1.2.1 for format).

If an index value < 3 or > 24 octal is erroneously keyed-in followed by the ENTER code, P27 will reject the value and will continue to flash V21N01 until the ground station enters an index value within the specified limits. (Entry of a legal value is indicated when the UPBUFF+1 address value is displayed in R3 and UPCOUNT contains a 2).

If a legal index value is keyed-in but is found to be in error (displayed in R1) before the ENTER code is transmitted, the operator may correct his error by depressing the "CLEAR" key and re-transmitting the new index value followed by the ENTER code. A legally entered value is stored in UPBUFF+0 and COMPNUMB. UPCOUNT is incremented by 1, the next UPBUFF location is computed and V21N01 continues to flash indicating a request for an ECADR load.

If, however, the ground station operator loads a legal index value followed by the ENTER code and then discovers the numeric value to be incorrect (UPBUFF+0 display), then the only means of recovery is to terminate the load (VERB34ENTER) and re-initiate the update VERB. This procedure is necessary since invalid index values cannot be changed if entered in COMPNUMB and will therefore result in an incorrect update if it is not immediately modified.

2.1.2.2.2 E Memory Address Value

The second octal data word to be entered must be the first E memory address (ECADR) of the update data block.

The ENTER code following the ECADR causes P27 to store this value in UPBUFF+1, increment UPCOUNT by 1, compute the next UPBUFF location and continue the V21N01 flash which requests an update data load.

2.1.2.2.3 Update Data

The update parameters which will be stored in sequential E memory locations beginning with a legitimate E memory address (ECADR), as defined in part 2 of section 2.1.2.1, may be loaded in two separate ways.

1. Each octal value may be individually entered and visually verified (address of data is displayed in R3 and data is displayed in R1) prior to transmitting the ENTER code.

   If data is in error the operator may depress the "CLEAR" key and retransmit the correct octal value followed by the ENTER code. This code causes P27 to store the data in the UPBUFF address specified in R3. If more data follows, UPCOUNT is incremented by 1, the next UPBUFF location is computed and V21N01 continues to flash.

   This method of input allows the ground station to make immediate corrections if data errors are detected and to visually verify that each data word is loaded into its specified E memory location.

2. The second method of input is to transmit all the octal update data as quickly as possible and then perform a visual verification of all the data in the UPBUFF registers as specified in section 2.1.1.2.

2.1.2.3 VERB71 Contiguous Block Update Verification

The last ENTER of the update sequence causes P27 to flash V21N02. This is a request to the ground station to accept, modify or completely reject the data load as specified in 2.1.1.2 sections.

VERB33ENTER also causes P27 to check the validity of the ECADR value stored in UPBUFF+1 (this value must meet the requirements specified in part 2 of section 2.1.2.1). If the ECADR value is illegal, P27 rejects all input data, replaces Program 27 with the previous program value, turns the uplink activity light "OFF", turns the operator error light "ON" and switches to the Downlink list for the previous program.

A valid ECADR causes P27 to transfer all the update data from the UPBUFF registers into the specified E memory registers, replace program 27 with the previous program value, turn the uplink activity light "OFF", switch to the Downlink list for the previous program and release the State Vector data.

2.1.3 CM Scatter Update

To initiate an E memory update in non-contiguous E memory locations the ground station should transmit "VERB72ENTER".

Before sending the update data the ground station should perform Program 27 verification as defined in the first two paragraphs of section 2.1.1.1.

If P27 is entered for a VERB72 update, a 2 is placed in UPVERB and a 1 in UPCOUNT. Following P27 verification the ground station performs this update exactly as described for the VERB71 updates. The differences in these two update verbs are noted in the following section.

2.1.3.1 VERB72 Data Entry Format

The VERB72 update format is defined as follows:

I I E
A A A A E
X X X X X E
A A A A E
X X X X X E
.
.
.
A A A A E
X X X X X E

where:

1. $3 \leq I I \leq 24$ octal. The difference between this index value and the VERB71 index value is that this value must always be odd. This is due to the fact that each update parameter must have its specified E memory address. Thus, the index count includes itself and up to 9 pairs of update words. An even number index value, although accepted at this point in the procedure, will cause rejection of VERB72 data as indicated in section 2.1.3.3. Additionally, Program 27 is replaced with the previous program value, the uplink activity light is turned "OFF", the operator error light is turned "ON", the State Vector data is released and the Downlink list is switched for use by the previous program.

2. All A A A As represent the ECADRs. (Each A A A A is the ECADR of the register to be loaded with the X X X X X immediately following.) Note that update data entered via VERB72 may be loaded into different EBANKs.

3. All X X X X Xs are in octal and scaled the same as the internal CMC registers.

2.1.3.2 Data Load Requirements by Ground Station

The load requirements of VERB72 are identical to VERB71 (see sections 2.1.2.2 and 2.1.2.2.1 through 2.1.2.2.3).

2.1.3.3 VERB72 Scatter Update Verification

The last ENTER of the update sequence will cause P27 to flash V21N02. This is a request to the ground to accept, modify or completely reject the data load as specified in 2.1.1.2 sections.

VERB33ENTER causes P27 to verify that COMPNUMB is odd. If COMPNUMB is even, P27 will not transfer the data into the specified E memory registers; instead it will turn on the Operator Error Light, turn off Uplink Activity Light, transfer to previous program and downlist.

If, however, COMPNUMB is valid P27 will perform exactly as specified in the third paragraph of section 2.1.2.3.

2.1.4 CMC Octal Clock Increment

To initiate a double precision octal time increment the ground station transmits "VERB73ENTER".

The loading procedure for this update is identical to the VERB70 update defined in section 2.1.1 except that 3 is placed in UPVERB instead of 0.

If the update is acceptable, it is immediately used to increment the clock (i.e., positive double precision time is added to the clock). No delay is encountered if the orbital integration routine is in use since the CSM and OWS state vector time registers and the TEPHEM register are not modified.

2.1.5 Use of the Contiguous Block Update VERB

VERB 71, defined in section 2.1.2, can be used to perform the following updates:

1. CMC CSM/OWS STATE VECTOR UPDATE
2. CMC DESIRED REFSMMAT UPDATE
3. CMC REFSMMAT UPDATE
4. CMC EXTERNAL DELTA V UPDATE
5. CMC RETROFIRE EXTERNAL DELTA V UPDATE
6. CMC ENTRY UPDATE

In defining each of these updates, it is assumed that the ground station has transmitted VERB71 ENTER and performed Program 27 verification as required prior to transmittal of the index value, ECADR and update parameters. It is also assumed that final verification of each update will be done as specified in section 2.1.2.3.

2.1.5.1 CMC CSM/OWS STATE VECTOR UPDATE

This data consists of a single precision state vector identifier, three (3) double precision components of position, three (3) double precision components of velocity and a double precision time. The identifier (UPSVFLAG) indicates CSM or OWS*:

1 = CSM
-1 = OWS

The position and velocity components should be in reference coordinates scaled as follows:

Position	meters/2^{29}
Velocity	(meters/centisecond)/2^{7}

The time associated with the state vector should be relative to CMC clock zero. The identifier is scaled units/2^{14}. Time is scaled centiseconds/2^{28}.

The CMC is a fixed point machine with the point just to the left of the most significant bit.

The scaling indicated above will be sufficient to force the 3 components of position and the 3 components of velocity and time to numbers less than one.

To form the double precision quantities ready for coding and transmission, the scaled magnitudes of time and each component of position and velocity should be expressed as two binary words as follows:

---

*A 0 or -0 will update the UPSVFLAG erasable but the CMC will not perform a state vector update. Any positive non-zero quantity is interpreted as a CSM state vector update; any negative non-zero quantity is interpreted as an OWS state vector update.

1st word:

0	X	X	X	X	X	X	X	X	X	X	X	X	X	X
	2^{-1}	2^{-2}	2^{-3}	2^{-4}	2^{-5}	2^{-6}	2^{-7}	2^{-8}	2^{-9}	2^{-10}	2^{-11}	2^{-12}	2^{-13}	2^{-14}

2nd word:

0	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
	2^{-15}	2^{-16}	2^{-17}	2^{-18}	2^{-19}	2^{-20}	2^{-21}	2^{-22}	2^{-23}	2^{-24}	2^{-25}	2^{-26}	2^{-27}	2^{-28}

Each X above represents a binary bit of the appropriate magnitude, the place value of which is indicated below the corresponding X. Once the magnitude of the component is accounted for in the above 28 X's, the sign must be considered.

If the component is positive, the words remain as formed; if the component is negative, the "1s complement" of the 2 words is used (all 1's are replaced by 0's and all 0's by 1's.)

The first word is then transformed into a 5 character octal word. The first character is the octal equivalent of the first three bits, the second character is the octal equivalent of the next three bits, etc. This word is referred to as the "most significant part" of data in the text below. Similarly, the second word is transformed into a 5 character octal word which is the "least significant part" of the data. Table 2-1 lists all the uplink characters with their corresponding binary format.

The CMC CSM/OWS STATE VECTOR UPDATE data must be sent in the following sequence:

Octal Identifier	Data Value	Data Definition
1	21_8	(index value) ENTER
2	(AAAA)*	(ECADR - UPSVFLAG) ENTER
3	XXXXX	(identifier) ENTER
4	XXXXX	(most sig. part of X position) ENTER
5	XXXXX	(least sig. part of X position) ENTER
6	XXXXX	(most sig. part of Y position) ENTER
7	XXXXX	(least sig. part of Y position) ENTER
10_8	XXXXX	(most sig. part of Z position) ENTER
11_8	XXXXX	(least sig. part of Z position) ENTER

* Refer to Paragraph 2.1.6 to obtain the absolute address (ECADR) for this UPDATE.

Octal Identifier	Data Value	Data Definition
12_8	XXXXX	(most sig. part of X velocity) ENTER
13_8	XXXXX	(least sig. part of X velocity) ENTER
14_8	XXXXX	(most sig. part of Y velocity) ENTER
15_8	XXXXX	(least sig. part of Y velocity) ENTER
16_8	XXXXX	(most sig. part of Z velocity) ENTER
17_8	XXXXX	(least sig. part of Z velocity) ENTER
20_8	XXXXX	(most sig. part of time from CMC clock zero) ENTER
21_8	XXXXX	(least sig. part of time from CMC clock zero) ENTER

where each "A", "X" and "ENTER" above represent an uplink word.

2.1.5.2 CMC DESIRED REFSMMAT UPDATE

XSMD - XSMD + 17 is a 3 x 3 double precision matrix which represents the Reference to Stable Member Desired Transformation.

The elements of the matrix are scaled, units/2^1.

The following relations must hold:

1. The inner product of any row with itself must equal 0.25
2. The inner product of any column with itself must equal 0.25
3. The inner product of any row with another row must equal 0
4. The inner product of any column with another column must equal 0

The CMC DESIRED REFSMMAT UPDATE must be sent in the following sequence:

Octal Identifier	Data Value	Data Definition
1	24_8	(index value) ENTER
2	(AAAA)*	(ECADR-XSMD) ENTER
3	XXXXX	(most sig. part of Row 1 Col. 1) ENTER
4	XXXXX	(least sig. part of Row 1 Col. 1) ENTER
5	XXXXX	(most sig. part of Row 1 Col. 2) ENTER
6	XXXXX	(least sig. part of Row 1 Col. 2) ENTER
7	XXXXX	(most sig. part of Row 1 Col. 3) ENTER
10_8	XXXXX	(least sig. part of Row 1 Col. 3) ENTER
11_8	XXXXX	(most sig. part of Row 2 Col. 1) ENTER

* Refer to Paragraph 2.1.6 to obtain the absolute address (ECADR) for this UPDATE.

Octal Identifier	Data Value	Data Definition
12_8	XXXXX	(least sig. part of Row 2 Col. 1) ENTER
13_8	XXXXX	(most sig. part of Row 2 Col. 2) ENTER
14_8	XXXXX	(least sig. part of Row 2 Col. 2) ENTER
15_8	XXXXX	(most sig. part of Row 2 Col. 3) ENTER
16_8	XXXXX	(least sig. part of Row 2 Col. 3) ENTER
17_8	XXXXX	(most sig. part of Row 3 Col. 1) ENTER
20_8	XXXXX	(least sig. part of Row 3 Col. 1) ENTER
21_8	XXXXX	(most sig. part of Row 3 Col. 2) ENTER
22_8	XXXXX	(least sig. part of Row 3 Col. 2) ENTER
23_8	XXXXX	(most sig. part of Row 3 Col. 3) ENTER
24_8	XXXXX	(least sig. part of Row 3 Col. 3) ENTER

2.1.5.3 CMC REFSMMAT UPDATE

REFSMMAT - REFSMMAT + 17D is a 3 × 3 matrix used to convert between reference coordinates and stable member coordinates. The elements of the matrix are scaled, units/2^1.

The CMC REFSMMAT UPDATE must be sent in the following sequence:

Octal Identifier	Data Value	Data Definition
1	24_8	(index value) ENTER
2	(AAAA)*	(ECADR - REFSMMAT) ENTER
3	XXXXX	(most sig. part of Row 1 Col. 1) ENTER
4	XXXXX	(least sig. part of Row 1 Col. 1) ENTER
5	XXXXX	(most sig. part of Row 1 Col. 2) ENTER
6	XXXXX	(least sig. part of Row 1 Col. 2) ENTER
7	XXXXX	(most sig. part of Row 1 Col. 3) ENTER
10_8	XXXXX	(least sig. part of Row 1 Col. 3) ENTER
11_8	XXXXX	(most sig. part of Row 2 Col. 1) ENTER
12_8	XXXXX	(least sig. part of Row 2 Col. 1) ENTER

* Refer to paragraph 2.1.6 to obtain the absolute address(ECADR) for this UPDATE.

Octal Identifier	Data Value	Data Definition
13_8	XXXXX	(most sig. part of Row 2 Col. 2) ENTER
14_8	XXXXX	(least sig. part of Row 2 Col. 2) ENTER
15_8	XXXXX	(most sig. part of Row 2 Col. 3) ENTER
16_8	XXXXX	(least sig. part of Row 2 Col. 3) ENTER
17_8	XXXXX	(most sig. part of Row 3 Col. 1) ENTER
20_8	XXXXX	(least sig. part of Row 3 Col. 1) ENTER
21_8	XXXXX	(most sig. part of Row 3 Col. 2) ENTER
22_8	XXXXX	(least sig. part of Row 3 Col. 2) ENTER
23_8	XXXXX	(most sig. part of Row 3 Col. 3) ENTER
24_8	XXXXX	(least sig. part of Row 3 Col. 3) ENTER

2.1.5.4 CMC EXTERNAL DELTA V UPDATE

This data consists of three velocity components in local vertical coordinates, and the time of ignition. The scale factors are

1. $DELVSLV_{x,y,z}$ (meters/centisecond)/2^7

2. TIG centiseconds/2^{28}

The velocity components sent from the ground must be in the local vertical system defined by the CMC-determined, CSM state vector at TIG-30.

The CMC EXTERNAL DELTA V UPDATE data must be sent in the following sequence:

Octal Identifier	Data Value	Data Definition
1	12_8	(index value) ENTER
2	(AAAA)*	(ECADR - DELVSLV) ENTER
3	XXXXX	(most sig. part of $DELVSLV_x$) ENTER
4	XXXXX	(least sig. part of $DELVSLV_x$) ENTER
5	XXXXX	(most sig. part of $DELVSLV_y$) ENTER
6	XXXXX	(least sig. part of $DELVSLV_y$) ENTER
7	XXXXX	(most sig. part of $DELVSLV_z$) ENTER
10_8	XXXXX	(least sig. part of $DELVSLV_z$) ENTER
11_8	XXXXX	(most sig. part of TIG) ENTER
12_8	XXXXX	(least sig. part of TIG) ENTER

* Refer to paragraph 2.1.6 to obtain the absolute address (ECADR) for this UPDATE.

2.1.5.5 CMC RETROFIRE EXTERNAL DELTA V UPDATE

This data consists of the latitude and longitude of the entry target, three velocity components in local vertical coordinates and the time of ignition. The scale factors are:

1. LAT (SPL) degrees/360 (North positive)
2. LNG (SPL) degrees/360 (East positive)
3. $DELVSLV_{x,y,z}$ (meters/centisecond)/2^7
4. TIG centiseconds/2^{28}

The CMC RETROFIRE EXTERNAL DELTA V UPDATE date must be sent in the following sequence:

Octal Identifier	Data Value	Data Definition
1	16_8	(index value) ENTER
2	(AAAA)*	(ECADR- LAT(SPL)) ENTER
3	XXXXX	(most sig. part of LAT (SPL)) ENTER
4	XXXXX	(least sig. part of LAT (SPL)) ENTER
5	XXXXX	(most sig. part of LNG (SPL)) ENTER
6	XXXXX	(least sig. part of LNG (SPL)) ENTER
7	XXXXX	(most sig. part of $DELVSLV_x$) ENTER
10_8	XXXXX	(least sig. part of $DELVSLV_x$) ENTER
11_8	XXXXX	(most sig. part of $DELVSLV_y$) ENTER
12_8	XXXXX	(least sig. part of $DELVSLV_y$) ENTER
13_8	XXXXX	(most sig. part of $DELVSLV_z$) ENTER
14_8	XXXXX	(least sig. part of $DELVSLV_z$) ENTER
15_8	XXXXX	(most sig. part of TIG) ENTER
16_8	XXXXX	(least sig. part of TIG) ENTER

2.1.5.6 CMC ENTRY UPDATE

This data consists of the latitude and longitude of the entry target. The scale factors are:

1. LAT (SPL) degrees/360 (North positive)
2. LNG (SPL) degrees/360 (East positive)

The CMC ENTRY UPDATE data must be sent in the following sequence:

* Refer to paragraph 2.1.6 to obtain the absolute address (ECADR) for this UPDATE.

Octal Identifier	Data Value	Data Definition
1	06_8	(index value) ENTER
2	(AAAA)*	(ECADR-LAT(SPL)) ENTER
3	XXXXX	(most sig. part of LAT (SPL)) ENTER
4	XXXXX	(least sig. part of LAT (SPL)) ENTER
5	XXXXX	(most sig. part of LNG (SPL)) ENTER
6	XXXXX	(least sig. part of LNG (SPL)) ENTER

2.1.6. Absolute Addresses for UPDATE Program

01501	UPSVFLAG	CSM/OWS State Vector Update
00306	XSMD	DESIRED REFSMMAT UPDATE
01717	REFSMMAT	REFSMMAT UPDATE
03404	DELVSLV	EXTERNAL DELTA-V UPDATE
03400	LAT(SPL)	RETROFIRE EXT DELTA-V OR ENTRY UPDATE

* Refer to paragraph 2.1.6 to obtain the absolute address(ECADR) for this UPDATE.

2.2 CMC Digital Downlink

The downlink format is controlled by a CMC program. This program is entered on an interrupt caused by an "endpulse" from the telemetry system. The program loads the content of the next two 16-bit CMC registers that are to be transmitted into channels 34 and 35. The loading is accomplished according to the format described in the next paragraph.

Each downlist word consists of 33 significant bits plus seven repetition bits. The first bit is a "word order code bit". The next 16 bits comprise the contents of one 16-bit CMC register (15 bits of data followed by an odd parity bit). The final 16 bits are the content of another 16-bit CMC register. Since the spacecraft downlink is organized in 8-bit segments, seven "filler bits" are transmitted to follow the 33 bits outlined above in order to use all the downlink space available. These filler bits are repetitions of the first seven bits of the first CMC register transmitted.

Thus the form in which the content of the two CMC registers is arranged for transmission as a sequence of 40 CMC downlink bits (represented by X) on channels 34 and 35 may be pictured as shown in the table below:

		Channel 34															
Reg #1	X Word Order Code	X 15_1	X 14_1	X 13_1	X 12_1	X 11_1	X 10_1	X 9_1	X 8_1	X 7_1	X 6_1	X 5_1	X 4_1	X 3_1	X 2_1	X 1_1	X P_1	} word
		Channel 35															
	Reg #2	X 15_2	X 14_2	X 13_2	X 12_2	X 11_2	X 10_2	X 9_2	X 8_2	X 7_2	X 6_2	X 5_2	X 4_2	X 3_2	X 2_2	X 1_2	X P_2	} word
		Channel 34															
	Reg #1	X 15_1	X 14_1	X 13_1	X 12_1	X 11_1	X 10_1	X 9_1										} repeat

Table Showing CMC Downlink Bits

The first word in any list contains the "ID" and synchronization registers and has a word order code bit of zero. (All other downlink words have word order code bits of one except word 51 on the standard downlists which has a word order code bit of zero to indicate the mid-point of the standard downlists.) The ID register marks the beginning of a list and identifies the list being transmitted. The synchronization (sync) register always contains the same sixteen bits (111 111 011 100 000 0), which are used to synchronize remote site downlink processing equipment.

The standard CMC downlink lists contain 100 downlink words (200 CMC registers). The CMC digital downlink is transmitted at a rate of 50 words per second at

high bit rate and 10 words at low bit rate. Therefore, transmission of the standard list requires two seconds at high bit rate and ten seconds at the low bit rate.

2.2.1 Erasable Memory Dump Downlist

Upon reception of a Verb 74 Enter from the keyboard or the uplink, the computer will interrupt the nominal downlist being transmitted and start transmitting the erasable memory dump downlist. The first word of the erasable memory dump downlist is an ID word, 01777_8 and the same pattern of synch bits as on the standard list. The word order code for this downlink word will be 0. The next 129 downlink words have word order codes of one and make up the remainder of the 130 word dump downlink list. Word 2 of this list (i.e., the word following the ID word) contains a "packed indicator" code in the first register and the contents of TIME1 in the second register. TIME1 is the least significant clock register and is described later in this section under the standard lists. The "packed indicator" identifies which erasable bank and which pass through that bank is contained in the present list as follows:

Bits 15 & 14 - zero

Bits 13 & 12 - 00 for 1st pass
01 for 2nd pass

Bits 11 thru 9 - gives EBANK number

Bits 8 thru 1 - zeros

The next 128 downlink words (256 registers) are the contents of the erasable bank indicated in the packed indicator.

After transmitting the 130 downlink word list (one ID word, one packed indicator and time word, and 128 data words), the downlink will transmit the ID word again, followed by the packed indicator, followed by the contents of the next erasable bank etc. In this way, one complete pass through erasable memory will require 20.8 seconds for high bit rate, and 104 seconds for low bit rate. The computer will make two complete passes through the complete erasable memory before returning to the standard downlist.

NOTE: After completion of the erasable dump downlist the current downlist will be started at the ID word. Since no programs are interrupted during the transmission of the erasable memory downlist, some of the registers transmitted may have different contents on different passes through the erasable.

2.2.2 Standard Downlists

For this mission there are four standard downlists, each associated with a set of programs, as follows:

A. The Powered List is transmitted during
   - 11 Earth Orbit Insertion (EOI) Monitor
   - 40 SPS Thrust
   - 41 RCS Thrust
   - 47 Thrust Monitor
   - 48 Rendezvous Thrust Monitor
   - 61 Entry Preparation Program

B. The Coast and Align List is transmitted during
   - 00 CMC Idling
   - 01 Prelaunch Initialization
   - 02 Gyro Compassing
   - 03 Optical Verification of Gyro Compassing
   - 06 CMC Power Down
   - 07 System Test
   - 50 ATM Orientation Determination
   - 51 IMU Orientation Determination
   - 52 IMU Realign
   - 53 Backup IMU Orientation Determination
   - 54 Backup IMU Realign
   - 55 ATM Star Tracker Gimbal Angle

C. The Rendezvous and Prethrust List is transmitted during
   - 20 Universal Tracking
   - 21 Ground Track Determination
   - 25 Contingency VHF Range Rate
   - 29 Time of Longitude Program
   - 30 External ΔV Maneuver Guidance
   - 31 NC1 Targeting
   - 32 NC2 Targeting
   - 33 NCC Targeting
   - 34 NSR Targeting

35 TPI Targeting
36 TPM Targeting
37 Rendezvous Final Phase
38 Plane Change Targeting
77 CSM Velocity Vector Update

D. The Entry and Update List is transmitted during
27 CMC Update
62 CM/SM Separation and Pre-entry Maneuver
63 Entry Initialization
64 Post 0.05 G Entry Mode
65 Up Control Entry Mode
66 Ballistic Entry Mode
67 Final Entry Mode

The list switching is accomplished as follows: Whenever a new program is entered, it sets up a request for its list by placing the appropriate code in the register, DNLSTCOD. The downlink program will transmit the complement of this code as the ID and use the code to select the appropriate list. The complete list is then transmitted even if DNLSTCOD is changed during it. This procedure is, of course, not true for the erasable memory dump downlist (see Section 2.2.1), which completes its required number of passes irrespective of other programs. A computer "restart" (hardware), or "fresh start" will immediately cause the telemetry list to start with word #1. A "restart" (hardware) will begin the list whose code is in DNLSTCOD but a "fresh start" will always set DNLSTCOD to transmit the Coast and Align list. An erasable memory dump, if in process, will be interrupted in both cases, and regular downlist transmission resumed.

Since certain data on the standard downlink lists are only meaningful when considered in multiregister arrays and since the programs which compute these arrays are not synchronized with the downlink program, a "snapshot" is taken of these words so that changes in their values will not occur while these arrays are being transmitted to the ground. When a "snapshot" is taken several words are stored at the time the first word is transmitted. The other words in the downlist are read at the time of transmission and therefore the only time homogeneity for them is between the two registers making up a single word. The SKYLARK downlists have the following "snapshots":

Powered List	words 2-8, 9-13, 30-31, 52-58, 59-63
Coast and Align List	words 2-8, 9-13, 52-58, 59-63
Rendezvous and Prethrust List	words 2-8, 9-13, 23-28, 52-58, 59-63
Entry and Update List	words 2-8, 9-13, 52-58, 59-63

2.3 Downlist Formats

The contents of the downlists are listed in this section for reference purposes.

Section 2.3.1 lists by word order each of the four downlists. The E memory address (ECADR) of the downlinked quantities is given.

Section 2.3.2 lists, in alphabetical order by mnemonic, all downlinked items and their ECADR's.

Section 2.3.3 lists, in alphabetical order by mnemonic, all ENTRY shared downlink items and their ECADR's.

Section 2.3.4 is a chart listing all downlinked items in order by ECADR. Each entry contains the mnemonic of the item and the downlist word number(s) in which it appears. The input/output channels and those downlist registers which contain undefined (meaningless) information appear at the end of the chart.

2.3.1 Downlist Word Order

2.3.1.1 Powered List

Word #	Mnemonic	ECADR	
1A	I.D.WORD		(OCTAL 77774)
1B	SYNCH BITS		(OCTAL 77340)
2-4	RN	01021	CSM STATE VECTOR (POSITION)
5-7	VN	01027	CSM STATE VECTOR (VELOCITY)
8	PIPTIME	01035	CSM STATE VECTOR TIME
9A	CDUX	00032	ACTUAL X CDU ANGLE
9B	CDUY	00033	ACTUAL Y CDU ANGLE
10A	CDUZ	00034	ACTUAL Z CDU ANGLE
10B	CDUT	00035	OPTICS TRUNNION
11	ADOT	03162	ADOTS ROLL OR OGARATE
12	ADOT +2	03164	ADOTS PITCH OR OMEGA B PITCH
13	ADOT +4	03166	ADOTS YAW OR OMEGA B YAW
14A	AK	03125	X ATTITUDE ERROR
14B	AK1	03126	Y ATTITUDE ERROR
15A	AK2	03127	Z ATTITUDE ERROR
15B	RCSFLAGS	03130	RCS FLAGS
16A	THETADX	03223	
16B	THETADY	03224	
17A	THETADZ	03225	
17B			GARBAGE

Powered List (Continued)

Word #	Mnemonic	ECADR	
18	TIG	03412	
19A	SLOPE	03305	
19B	ADB	03306	
20A	DAPDATR3	03070	
20B	CH5FAIL	03071	
21A	CH6FAIL	03072	
21B	DKRATE	03073	
22A	DKDB	03074	
22B	WHICHDAP	03075	
23	TGO	03427	
24	PIPTIME1	01076	
25	DELVX	01304	
26	DELVY	01306	
27	DELVZ	01310	
28A	PACTOFF	03010	
28B	YACTOFF	03011	
29A	PCMD	03252	
29B	YCMD	03253	
30A	CSTEER	03662	
30B	RM	03663	
31	MARKTIME	01115	
32	FIXTIME	01333	
33	DVTOTAL	03425	
34-39	REFSMMAT	01717	
40-44	FLAGWRD0	00074	FLAGWORDS 0 THRU 9

Powered List (Continued)

Word #	Mnemonic	ECADR	
45-50	DSPTAB	01216	DSPTAB THRU DSPTAB +11D
51	TIME2	00024	AGC TIME
52-54	R-OTHER	01703	OWS STATE VECTOR (POSITION)
55-57	V-OTHER	01711	OWS STATE VECTOR (VELOCITY)
58	T-OTHER	01642	OWS STATE VECTOR TIME
59A	CDUX	00032	ACTUAL X CDU ANGLE
59B	CDUY	00033	ACTUAL Y CDU ANGLE
60A	CDUZ	00034	ACTUAL Z CDU ANGLE
60B	CDUT	00035	OPTICS TRUNNION
61	ADOT	03162	ADOTS ROLL OR OGARATE
62	ADOT +2	03164	ADOTS PITCH OR OMEGA B PITCH
63	ADOT +4	03166	ADOTS YAW OR OMEGA B YAW
64A	AK	03125	X ATTITUDE ERROR
64B	AK1	03126	Y ATTITUDE ERROR
65A	AK2	03127	Z ATTITUDE ERROR
65B	RCSFLAGS	03130	RCS FLAGS
66A	THETADX	03223	
66B	THETADY	03224	
67A	THETADZ	03225	
67B			GARBAGE
68A	RSBBQ	01432	BBANK AT RESTART
68B	RSBBQ +1	01433	Q AT RESTART
69A			GARBAGE
69B	CHAN77		CHANNEL 77
70A	C31FLWRD	00373	

Powered List (Continued)

Word #	Mnemonic	ECADR	
70B	FAILREG	00374	
71A	FAILREG +1	00375	
71B	FAILREG +2	00376	
72A	CDUS	00036	OPTICS SHAFT
72B	PIPAX	00037	
73A	PIPAY	00040	
73B	PIPAZ	00041	
74	ELEV	03640	ELEVATION ANGLE
75	SVEC +2	03753	
76	TET	01516	
77A	FLGWRD10	00106	
77B	FLGWRD11	00107	
78	TEVENT	01014	
79A	PCMD	03252	
79B	YCMD	03253	
80A	OPTMODES	01327	
80B	HOLDFLAG	01330	
81A	LEMMASS	03121	
81B	CSMMASS	03122	CSM MASS
82A	DAPDATR1	03114	
82B	DAPDATR2	03115	
83A	ERRORX	03220	
83B	ERRORY	03221	
84A	ERRORZ	03222	
84B			GARBAGE

Powered List (Continued)

Word #	Mnemonic	ECADR	
85	WBODY	03154	WBODY OR OMEGAC (ROLL)
86	WBODY +2	03156	WBODY OR OMEGAC (PITCH)
87	WBODY +4	03160	WBODY OR OMEGAC (YAW)
88A	REDOCTR	01276	
88B	THETAD	01277	DESIRED FINAL CDU X
89A	THETAD +1	01300	DESIRED FINAL CDU Y
89B	THETAD +2	01301	DESIRED FINAL CDU Z
90A	IMODES30	01323	
90B	IMODES33	01324	
91A	DSALMOUT		CHANNEL 11
91B	CHAN12		CHANNEL 12
92A	CHAN13		CHANNEL 13
92B	CHAN14		CHANNEL 14
93A	CHAN30		CHANNEL 30
93B	CHAN31		CHANNEL 31
94A	CHAN32		CHANNEL 32
94B	CHAN33		CHANNEL 33
95-97	VGTIG	03771	
98-100	DELVSLV	03404	

2.3.1.2 Coast and Align List

Word #	Mnemonic	ECADR	
1A	I•D•WORD		(OCTAL 77777)
1B	SYNCH BITS		(OCTAL 77340)
2-4	RN	01021	CSM STATE VECTOR (POSITION)
5-7	VN	01027	CSM STATE VECTOR (VELOCITY)
8	PIPTIME	01035	CSM STATE VECTOR TIME
9A	CDUX	00032	ACTUAL X CDU ANGLE
9B	CDUY	00033	ACTUAL Y CDU ANGLE
10A	CDUZ	00034	ACTUAL Z CDU ANGLE
10B	CDUT	00035	OPTICS TRUNNION
11	ADOT	03162	ADOTS ROLL OR OGARATE
12	ADOT +2	03164	ADOTS PITCH OR OMEGA B PITCH
13	ADOT +4	03166	ADOTS YAW OR OMEGA B YAW
14A	AK	03125	X ATTITUDE ERROR
14B	AK1	03126	Y ATTITUDE ERROR
15A	AK2	03127	Z ATTITUDE ERROR
15B	RCSFLAGS	03130	RCS FLAGS
16A	THETADX	03223	
16B	THETADY	03224	
17A	THETADZ	03225	
17B			GARBAGE

Coast and Align List (Continued)

Word #	Mnemonic	ECADR	
18	TIG	03412	
19A	BESTI	00302	STAR I.D. 1
19B	BESTJ	00303	STAR I.D. 2
20	MARKDOWN	03654	OPTICS MARK TIME 1
21A	MARKDOWN +2	03656	Y CDU ANGLE 1
21B	MARKDOWN +3	03657	OPTICS SHAFT ANGLE 1
22A	MARKDOWN +4	03660	Z CDU ANGLE 1
22B	MARKDOWN +5	03661	OPTICS TRUNNION ANGLE 1
23A	MARKDOWN +6	03662	X CDU ANGLE 1
23B			GARBAGE
24	MARK2DWN	03460	OPTICS MARK TIME 2
25A	MARK2DWN +2	03462	Y CDU ANGLE 2
25B	MARK2DWN +3	03463	OPTICS SHAFT ANGLE 2
26A	MARK2DWN +4	03464	Z CDU ANGLE 2
26B	MARK2DWN +5	03465	OPTICS TRUNNION ANGLE 2
27A	MARK2DWN +6	03466	X CDU ANGLE 2
27B			GARBAGE
28	HAPOX	02203	APOGEE
29	HPERX	02205	PERIGEE
30A	PACTOFF	03010	
30B	YACTOFF	03011	
31-33	VGTIG	03771	
34-39	REFSMMAT	01717	
40-44	FLAGWRD0	00074	FLAGWORDS 0 THRU 9
45-50	DSPTAB	01216	DSPTAB THRU DSPTAB +11D

Coast and Align List (Continued)

Word #	Mnemonic	ECADR	
51	TIME2	00024	AGC TIME
52-54	R-OTHER	01703	OWS STATE VECTOR (POSITION)
55-57	V-OTHER	01711	OWS STATE VECTOR (VELOCITY)
58	T-OTHER	01642	OWS STATE VECTOR TIME
59A	CDUX	00032	ACTUAL X CDU ANGLE
59B	CDUY	00033	ACTUAL Y CDU ANGLE
60A	CDUZ	00034	ACTUAL Z CDU ANGLE
60B	CDUT	00035	OPTICS TRUNNION
61	ADOT	03162	ADOTS ROLL OR OGARATE
62	ADOT +2	03164	ADOTS PITCH OR OMEGA B PITCH
63	ADOT +4	03166	ADOTS YAW OR OMEGA B YAW
64A	OPTION1	00770	
64B	OPTION2	00771	
65	TET	01516	
66A	THETADX	03223	
66B	THETADY	03224	
67A	THETADZ	03225	
67B			GARBAGE
68A	RSBBQ	01432	BBANK AT RESTART
68B	RSBBQ +1	01433	Q AT RESTART
69A			GARBAGE
69B	CHAN77		CHANNEL 77
70A	C31FLWRD	00373	
70B	FAILREG	00374	
71A	FAILREG +1	00375	

Coast and Align List (Continued)

Word #	Mnemonic	ECADR	
71B	FAILREG +2	00376	
72A	CDUS	00036	OPTICS SHAFT
72B	PIPAX	00037	
73A	PIPAY	00040	
73B	PIPAZ	00041	
74	OGC	02757	
75	IGC	02761	
76	MGC	02763	
77A	FLGWRD10	00106	
77B	FLGWRD11	00107	
78	TEVENT	01014	
79	LAUNCHAZ	02633	
80A	OPTMODES	01327	
80B	HOLDFLAG	01330	
81A	LEMMASS	03121	
81B	CSMMASS	03122	CSM MASS
82A	DAPDATR1	03114	
82B	DAPDATR2	03115	
83A	ERRORX	03220	
83B	ERRORY	03221	
84A	ERRORZ	03222	
84B			GARBAGE
85	WBODY	03154	WBODY OR OMEGAC (ROLL)
86	WBODY +2	03156	WBODY OR OMEGAC (PITCH)
87	WBODY +4	03160	WBODY OR OMEGAC (YAW)

Coast and Align List (Continued)

Word #	Mnemonic	ECADR	
88A	REDOCTR	01276	
88B	THETAD	01277	DESIRED FINAL CDU X
89A	THETAD +1	01300	DESIRED FINAL CDU Y
89B	THETAD +2	01301	DESIRED FINAL CDU Z
90A	IMODES30	01323	
90B	IMODES33	01324	
91A	DSALMOUT		CHANNEL 11
91B	CHAN12		CHANNEL 12
92A	CHAN13		CHANNEL 13
92B	CHAN14		CHANNEL 14
93A	CHAN30		CHANNEL 30
93B	CHAN31		CHANNEL 31
94A	CHAN32		CHANNEL 32
94B	CHAN33		CHANNEL 33
95-96A	TEPHEM	01700	
96B			GARBAGE
97A	SLOPE	03305	
97B	ADB	03306	
98A	DAPDATR3	03070	
98B	CH5FAIL	03071	
99A	CH6FAIL	03072	
99B	DKRATE	03073	
100A	DKDB	03074	
100B	WHICHDAP	03075	

2.3.1.3 Rendezvous and Prethrust List

Word #	Mnemonic	ECADR	
1A	I.D.WORD		(OCTAL 77775)
1B	SYNCH BITS		(OCTAL 77340)
2-4	RN	01021	CSM STATE VECTOR (POSITION)
5-7	VN	01027	CSM STATE VECTOR (VELOCITY)
8	PIPTIME	01035	CSM STATE VECTOR TIME
9A	CDUX	00032	ACTUAL X CDU ANGLE
9B	CDUY	00033	ACTUAL Y CDU ANGLE
10A	CDUZ	00034	ACTUAL Z CDU ANGLE
10B	CDUT	00035	OPTICS TRUNNION
11	ADOT	03162	ADOTS ROLL OR OGARATE
12	ADOT +2	03164	ADOTS PITCH OR OMEGA B PITCH
13	ADOT +4	03166	ADOTS YAW OR OMEGA B YAW
14A	AK	03125	X ATTITUDE ERROR
14B	AK1	03126	Y ATTITUDE ERROR
15A	AK2	03127	Z ATTITUDE ERROR
15B	RCSFLAGS	03130	RCS FLAGS
16A	THETADX	03223	
16B	THETADY	03224	
17A	THETADZ	03225	
17B			GARBAGE

Rendezvous and Prethrust List (Continued)

Word #	Mnemonic	ECADR	
18	TIG	03412	
19A	SLOPE	03305	
19B	ADB	03306	
20A	DAPDATR3	03070	
20B	CH5FAIL	03071	
21A	CH6FAIL	03072	
21B	DKRATE	03073	
22A	DKDB	03074	
22B	WHICHDAP	03075	
23	VHFTIME	01002	
24	MARKDOWN	03654	OPTICS MARK TIME
25A	MARKDOWN +2	03656	Y CDU ANGLE
25B	MARKDOWN +3	03657	OPTICS SHAFT ANGLE
26A	MARKDOWN +4	03660	Z CDU ANGLE
26B	MARKDOWN +5	03661	OPTICS TRUNNION ANGLE
27A	MARKDOWN +6	03662	X CDU ANGLE
27B	RM	03663	VHF RANGE
28A	VHFCNT	00764	VHF MARKS
28B	TRKMKCNT	00765	OPTICS MARKS
29	TTPI	03642	
30	SVEC +2	03753	
31	DELVTPF	02630	DELTA V MAGNITUDE
32	TNSR	02460	NSR TIME
33	TNCC	02462	NCC TIME
34	TPASS4	03633	TPF TIME

Rendezvous and Prethrust List (Continued)

Word #	Mnemonic	ECADR	
35-37	DELVSLV	03404	
38	RANGE	02201	
39	RRATE	02203	RANGE RATE
40-44	FLAGWRD0	00074	FLAGWORDS 0 THRU 9
45-50	DSPTAB	01216	DSPTAB THRU DSPTAB +11D
51	TIME2	00024	AGC TIME
52-54	R-OTHER	01703	OWS STATE VECTOR (POSITION)
55-57	V-OTHER	01711	OWS STATE VECTOR (VELOCITY)
58	T-OTHER	01642	OWS STATE VECTOR TIME
59A	CDUX	00032	ACTUAL X CDU ANGLE
59B	CDUY	00033	ACTUAL Y CDU ANGLE
60A	CDUZ	00034	ACTUAL Z CDU ANGLE
60B	CDUT	00035	OPTICS TRUNNION
61	ADOT	03162	ADOTS ROLL OR OGARATE
62	ADOT +2	03164	ADOTS PITCH OR OMEGA B PITCH
63	ADOT +4	03166	ADOTS YAW OR OMEGA B YAW
64A	OPTION1	00770	
64B	OPTION2	0C771	
65	TET	01516	
66A	THETADX	03223	
66B	THETADY	03224	
67A	THETADZ	03225	
67B			GARBAGE
68A	RSBBQ	01432	BBANK AT RESTART
68B	RSBBQ +1	01433	Q AT RESTART

Rendezvous and Prethrust List (Continued)

Word #	Mnemonic	ECADR	
69A			GARBAGE
69B	CHAN77		CHANNEL 77
70A	C31FLWRD	00373	
70B	FAILREG	00374	
71A	FAILREG +1	00375	
71B	FAILREG +2	00376	
72A	CDUS	00036	OPTICS SHAFT
72B	PIPAX	00037	
73A	PIPAY	00040	
73B	PIPAZ	00041	
74	NC1TIG	03765	
75	NC2TIG	03767	
76	DHDSP	03547	
77-79	DELVEET3	03623	
80A	OPTMODES	01327	
80B	HOLDFLAG	01330	
81A	LEMMASS	03121	
81B	CSMMASS	03122	CSM MASS
82A	DAPDATR1	03114	
82B	DAPDATR2	03115	
83A	ERRORX	03220	
83B	ERRORY	03221	
84A	ERRORZ	03222	
84B			GARBAGE
85	WBODY	03154	WBODY OR OMEGAC (ROLL)

Rendezvous and Prethrust List (Continued)

Word #	Mnemonic	ECADR	
86	WBODY +2	03156	WBODY OR OMEGAC (PITCH)
87	WBODY +4	03160	WBODY OR OMEGAC (YAW)
88A	REDOCTR	01276	
88B	THETAD	01277	DESIRED FINAL CDU X
89A	THETAD +1	01300	DESIRED FINAL CDU Y
89B	THETAD +2	01301	DESIRED FINAL CDU Z
90A	IMODES30	01323	
90B	IMODES33	01324	
91A	DSALMOUT		CHANNEL 11
91B	CHAN12		CHANNEL 12
92A	CHAN13		CHANNEL 13
92B	CHAN14		CHANNEL 14
93A	CHAN30		CHANNEL 30
93B	CHAN31		CHANNEL 31
94A	CHAN32		CHANNEL 32
94B	CHAN33		CHANNEL 33
95	RTHETA	02205	
96	DVDSP1	03573	
97	DVDSP2	03575	
98	UTPIT	03717	
99	UTYAW	03721	
100A	FLGWRD10	00106	
100B	FLGWRD11	00107	

2.3.1.4 Entry and Update List

Word #	Mnemonic	ECADR	
1A	I.D.WORD		(OCTAL 77776)
1B	SYNCH BITS		(OCTAL 77340)
2-4	RN	01021	CSM STATE VECTOR (POSITION)
5-7	VN	01027	CSM STATE VECTOR (VELOCITY)
8	PIPTIME	01035	CSM STATE VECTOR TIME
9A	CDUX	00032	ACTUAL X CDU ANGLE
9B	CDUY	00033	ACTUAL Y CDU ANGLE
10A	CDUZ	00034	ACTUAL Z CDU ANGLE
10B	CDUT	00035	OPTICS TRUNNION
11	ADOT	03162	ADOTS ROLL OR OGARATE
12	ADOT +2	03164	ADOTS PITCH OR OMEGA B PITCH
13	ADOT +4	03166	ADOTS YAW OR OMEGA B YAW
14A	AK	03125	X ATTITUDE ERROR
14B	AK1	03126	Y ATTITUDE ERROR
15A	AK2	03127	Z ATTITUDE ERROR
15B	RCSFLAGS	03130	RCS FLAGS
16A	THETADX	03223	
16B	THETADY	03224	
17A	THETADZ	03225	
17B		03226	GARBAGE (DURING UPDATE ONLY)

Entry and Update List (Continued)

Word #	Mnemonic	ECADR	
18A	CMDAPMOD	03331	ENTRY DAP MODE
18B	PREL	03332	ROLL RATE
19A	QREL	03333	PITCH RATE
19B	RREL	03334	YAW RATE
20	L/D1	03635	
21-30	UPBUFF	00304	UPBUFF THRU UPBUFF +19D
31A	COMPNUMB	00300	
31B	UPOLDMOD	00301	
32A	UPVERB	00302	
32B	UPCOUNT	00303	
33A	PAXERR1	03344	
33B	ROLLTM	03345	
34	LATANG	03675	
35	RDOT	03677	
36	THETAH	03701	
37	LAT(SPL)	03400	
38	LNG(SPL)	03402	
39A	ALFA/180	03316	ALPHA
39B	BETA/180	03317	BETA
40-44	FLAGWRD0	00074	FLAGWORDS 0 THRU 9
45-50	DSPTAB	01216	DSPTAB THRU DSPTAB +11D
51	TIME2	00024	AGC TIME
52	PIPTIME1	01076	
53	DELVX	01304	
54	DELVY	01306	

Entry and Update List (Continued)

Word #	Mnemonic	ECADR	
55	DELVZ	01310	
56	TTE	03726	
57	VIO	03724	
58	VPRED	03736	
59A	CDUX	00032	ACTUAL X CDU ANGLE
59B	CDUY	00033	ACTUAL Y CDU ANGLE
60A	CDUZ	00034	ACTUAL Z CDU ANGLE
60B	CDUT	00035	OPTICS TRUNNION
61	ADOT	03162	ADOTS ROLL OR OGARATE
62	ADOT +2	03164	ADOTS PITCH OR OMEGA B PITCH
63	ADOT +4	03166	ADOTS YAW OR OMEGA B YAW
64A	OPTION1	00770	
64B	OPTION2	00771	
65	TET	01516	
66A	ERRORX	03220	
66B	ERRORY	03221	
67A	ERRORZ	03222	
67B	THETADX	03223	
68A	THETADY	03224	
68B	THETADZ	03225	
69A	CMDAPMOD	03331	ENTRY DAP MODE
69B	PREL	03332	ROLL RATE
70A	QREL	03333	PITCH RATE
70B	RREL	03334	YAW RATE
71-80	UPBUFF	00304	UPBUFF THRU UPBUFF +19D

Entry and Update List (Continued)

Word #	Mnemonic	ECADR	
81A	LEMMASS	03121	
81B	CSMMASS	03122	CSM MASS
82A	DAPDATR1	03114	
82B	DAPDATR2	03115	
83A	ROLLTM	03345	
83B	ROLLC	03346	
84A	OPTMODES	01327	
84B	HOLDFLAG	01330	
85	WBODY	03154	WBODY OR OMEGAC (ROLL)
86	WBODY +2	03156	WBODY OR OMEGAC (PITCH)
87	WBODY +4	03160	WBODY OR OMEGAC (YAW)
88A	REDOCTR	01276	
88B	THETAD	01277	DESIRED FINAL CDU X
89A	THETAD +1	01300	DESIRED FINAL CDU Y
89B	THETAD +2	01301	DESIRED FINAL CDU Z
90A	IMODES30	01323	
90B	IMODES33	01324	
91A	DSALMOUT		CHANNEL 11
91B	CHAN12		CHANNEL 12
92A	CHAN13		CHANNEL 13
92B	CHAN14		CHANNEL 14
93A	CHAN30		CHANNEL 30
93B	CHAN31		CHANNEL 31
94A	CHAN32		CHANNEL 32
94B	CHAN33		CHANNEL 33

Entry and Update List (Continued)

Word #	Mnemonic	ECADR	
95A	RSBBQ	01432	BBANK AT RESTART
95B	RSBBQ +1	01433	Q AT RESTART
96A			GARBAGE
96B	CHAN77		CHANNEL 77
97A	C31FLWRD	00373	
97B	FAILREG	00374	
98A	FAILREG +1	00375	
98B	FAILREG +2	00376	
99A	FLGWRD10	00106	
99B	FLGWRD11	00107	
100	GAMMAEI	03740	

2.3.2 Alphabetic Reference List

Mnemonic	ECADR
-VT/180E	03221
ADB	03306
ADOT	03162
ADOT +2	03164
ADOT +4	03166
AK	03125
AK1	03126
AK2	03127
ALFA/180	03316
A0	00327
BESTI	00302
BESTJ	00303
BETA/180	03317
CDUS	00036
CDUT	00035
CDUX	00032
CDUY	00033
CDUZ	00034
CHAN12	*
CHAN13	*
CHAN14	*
CHAN30	*
CHAN31	*
CHAN32	*
CHAN33	*
CHAN77	*
CH5FAIL	03071
CH6FAIL	03072
CMDAPMOD	03331
CMTMTIME	00304
COMPNUMB	00300
CSMMASS	03122
CSTEER	03662
C31FLWRD	00373
DAPDATR1	03114
DAPDATR2	03115
DAPDATR3	03070
DELVEET3	03623
DELVSLV	03404
DELVTPF	02630
DELVX	01304
DELVY	01306
DELVZ	01310
DHDSP	03547
DKDB	03074
DKRATE	03073
DSALMOUT	*
DSPTAB	01216

*These mnemonics have no associated ECADRs as they are channels (see E memory Reference List, page 2-54).

Alphabetic Reference List (Continued)

Mnemonic	ECADR	Mnemonic	ECADR
DSPTAB +1	01217	FLAGWRD5	00101
DSPTAB +2	01220	FLAGWRD6	00102
DSPTAB +3	01221	FLAGWRD7	00103
DSPTAB +4	01222	FLAGWRD8	00104
DSPTAB +5	01223	FLAGWRD9	00105
DSPTAB +6	01224	FLGWRD10	00106
DSPTAB +7	01225	FLGWRD11	00107
DSPTAB +8D	01226	GAMMAEI	03740
DSPTAB +9D	10227	GAMMAL	03740
DSPTAB +10D	01230	HAPOX	02203
DSPTAB +11D	01231	HOLDFLAG	01330
DVDSP1	03573	HPERX	02205
DVDSP2	03575	IGC	02761
DVTOTAL	03425	IMODES30	01323
ELEV	03640	IMODES33	01324
ERRORX	03220	JJ	03741
ERRORY	03221	L/DCALC	03726
ERRORZ	03222	L/D1	03635
FAILREG	00374	LAT(SPL)	03400
FAILREG +1	00375	LATANG	03675
FAILREG +2	00376	LAUNCHAZ	02633
FIXTIME	01333	LEMMASS	03121
FLAGWRD0	00074	LEWD	03724
FLAGWRD1	00075	LNG(SPL)	03402
FLAGWRD2	00076	MARKDOWN	03654
FLAGWRD3	00077	MARKDOWN +2	03656
FLAGWRD4	00100	MARKDOWN +3	03657

Alphabetic Reference List (Continued)

Mnemonic	ECADR	Mnemonic	ECADR
MARKDOWN +4	03660	PIPAZ	00041
MARKDOWN +5	03661	PIPTIME	01035
MARKDOWN +6	03662	PIPTIME1	01076
MARKTIME	01115	PREDANG	03740
MARK2DWN	03460	PREL	03332
MARK2DWN +2	03462	QAXERR	03223
MARK2DWN +3	03463	QREL	03333
MARK2DWN +4	03464	Q7	03225
MARK2DWN +5	03465	R-OTHER	01703
MARK2DWN +6	03466	RANGE	02201
MGC	02763	RAXERR	03224
NC1TIG	03765	RCSFLAGS	03130
NC2TIG	03767	RDOT	03677
OGARATE	03162	RDOTREF	01277
OGC	02757	REDOCTR	01276
OMEGAB	03162	REFSMMAT	01717
OMEGAC	03154	RM	03663
OMEGAYB	03164	RN	01021
OMEGAZB	03166	ROLLC	03346
OPTION1	00770	ROLLTM	03345
OPTION2	00771	RRATE	02203
OPTMODES	01327	RRATE2	02205
PACTOFF	03010	RREL	03334
PAXERR1	03344	RSBBQ	01432
PCMD	03252	RSBBQ +1	01433
PIPAX	00037	RTHETA	02205
PIPAY	00040	SLOPE	03305

Alphabetic Reference List (Continued)

Mnemonic	ECADR	Mnemonic	ECADR
SVEC +2	03753	UPVERB	00302
SW/NDX	00305	UTPIT	03717
T-OTHER	01642	UTYAW	03721
TEPHEM	01700	V-OTHER	01711
TET	01516	VDT/180	03220
TEVENT	01014	VGTIG	03771
TGO	03427	VHFCNT	00764
THETAD	01277	VHFTIME	01002
THETAD +1	01300	VIO	03724
THETAD +2	01301	VL	03736
THETADX	03223	VN	01027
THETADY	03224	VPRED	03736
THETADZ	03225	VREF	01301
THETAH	03701	V1	00325
TIG	03412	WBODY	03154
TIME1	00025	WBODY +2	03156
TIME2	00024	WBODY +4	03160
TNCC	02462	WHICHDAP	03075
TNSR	02460	XOLDBUF	03165
TPASS4	03633	XPIPBUF	03162
TRKMKCNT	00765	YACTOFF	03011
TTE	03726	YCMD	03253
TTPI	03642	YOLDBUF	03166
UPBUFF	00304	YPIPBUF	03163
UPCOUNT	00303	ZOLDBUF	03167
UPOLDMOD	00301	ZPIPBUF	03164

2.3.3 Alphabetic Reference List of Entry Shared Registers

The ECADRs listed below do not reflect the actual E memory address of the listed mnemonics, but rather the ECADR shared for downlink. This list is to be used to locate the description of the downlinked quantity in section 2.4.

Mnemonic	ECADR
ASKEP	03154
ASPDWN	03157
ASPUP	03156
ASP1	03155
ASP3	03160
LCX/360	03222
PREL	00306, 00311, 00314, 00317, 00322
QREL	00307, 00312, 00315, 00320, 00323
RREL	00310, 00313, 00316, 00321, 00324

2.3.4 E memory Reference List

ECADR	Mnemonic	Powered	Coast & Align	Rendezvous	Entry/ Update
0024-0025	TIME2,TIME1	51	51	51	51
0032-0034	CDUX,Y,Z	9-10a;59-60a	9-10a;59-60a	9-10a;59-60a	9-10a;59-60a
0035	CDUT	10b;60b	10b;60b	10b;60b	10b;60b
0036	CDUS	72a	72a	72a	
0037-0041	PIPAX,Y,Z	72b-73	72b-73	72b-73	
0074-0105	FLAGWRD0-9	40-44	40-44	40-44	40-44
0106-0107	FLGWRD10-11	77	77	100	99
0300	COMPNUMB				31a
0301	UPOLDMOD				31b
0302	BESTI		19a		
0302	UPVERB				32a
0303	BESTJ		19b		
0303	UPCOUNT				32b
0304-0327	UPBUFF				21-30;71-80
0304	CMTMTIME				21a; 71a
0305	SW/NDX				21b; 71b
0325-0326	V1				29b-30a;79b-80a
0327	A0				30b;80b
0373	C31FLWRD	70a	70a	70a	97a
0374-0376	FAILREG	70b-71	70b-71	70b-71	97b-98
0764	VHFCNT			28a	
0765	TRKMKCNT			28b	
0770	OPTION1		64a	64a	64a
0771	OPTION2		64b	64b	64b
1002-1003	VHFTIME			23	
1014-1015	TEVENT	78	78		
1021-1026	RN	2-4	2-4	2-4	2-4
1027-1034	VN	5-7	5-7	5-7	5-7
1035-1036	PIPTIME	8	8	8	8
1076-1077	PIPTIME1	24			52
1115-1116	MARKTIME	31			
1216-1231	DSPTAB	45-50	45-50	45-50	45-50
1276	REDOCTR	88a	88a	88a	88a
1277-1301	THETAD	88b-89	88b-89	88b-89	88b-89
1277-1300	RDOTREF				88b-89a
1301	VREF				89b
1304-1311	DELVX,Y,Z	25-27			53-55
1323	IMODES30	90a	90a	90a	90a
1324	IMODES33	90b	90b	90b	90b
1327	OPTMODES	80a	80a	80a	84a

E memory Reference List, continued

ECADR	Mnemonic	Powered	Coast & Align	Rendezvous	Entry/ Update
1330	HOLDFLAG	80b	80b	80b	84b
1333-1334	FIXTIME	32			
1432-1433	RSBBQ	68	68	68	95
1516-1517	TET	76	65	65	65
1642-1643	T-OTHER	58	58	58	
1700-1702	TEPHEM		95-96a		
1703-1710	R-OTHER	52-54	52-54	52-54	
1711-1716	V-OTHER	55-57	55-57	55-57	
1717-1732	REFSMMAT	34-39	34-39		
2201-2202	RANGE			38	
2203-2204	HAPOX		28		
2203-2204	RRATE			39	
2205-2206	HPERX		29		
2205-2206	RTHETA			95	
2205-2206	RRATE2			95	
2460-2461	TNSR			32	
2462-2463	TNCC			33	
2630-2631	DELVTPF			31	
2633-2634	LAUNCHAZ		79		
2757-2760	OGC		74		
2761-2762	IGC		75		
2763-2764	MGC		76		
3010	PACTOFF	28a	30a		
3011	YACTOFF	28b	30b		
3070	DAPDATR3	20a	98a	20a	
3071	CH5FAIL	20b	98b	20b	
3072	CH6FAIL	21a	99a	21a	
3073	DKRATE	21b	99b	21b	
3074	DKDB	22a	100a	22a	
3075	WHICHDAP	22b	100b	22b	
3114	DAPDATR1	82a	82a	82a	82a
3115	DAPDATR2	82b	82b	82b	82b
3121	LEMMASS	81a	81a	81a	81a
3122	CSMMASS	81b	81b	81b	81b
3125	AK	14a;64a	14a	14a	14a
3126	AK1	14b;64b	14b	14b	14b
3127	AK2	15a;65a	15a	15a	15a
3130	RCSFLAGS	15b;65b	15b	15b	15b
3154-3161	WBODY	85-87	85-87	85-87	85-87
3154-3161	OMEGAC	85-87			

E memory Reference List, continued

ECADR	Mnemonic	Powered	Coast & Align	Rendezvous	Entry/ Update
3162-3167	ADOT	11-13;61-63	11-13;61-63	11-13;61-63	11-13;61-63
3162-3163	OGARATE	11;61			
3162-3167	OMEGAB	11-13;61-63			
3162	XPIPBUF				11a;61a
3163	YPIPBUF				11b;61b
3164-3165	OMEGAYB	12;62			
3164	ZPIPBUF				12a;62a
3165	XOLDBUF				12b;62b
3166-3167	OMEGAZB	13;63			
3166	YOLDBUF				13a;63a
3167	ZOLDBUF				13b;63b
3220-3222	ERRORX, Y, Z	83-84a	83-84a	83-84a	66-67a
3220	VDT/180				66a
3221	-VT/180E				66b
3223-3225	THETADX, Y, Z	16-17a;66-67a	16-17a;66-67a	16-17a;66-67a	16-17a;67b-68
3223	QAXERR				16a;67b
3224	RAXERR				16b;68a
3225-3226	Q7				17
3252	PCMD	29a;79a			
3253	YCMD	29b;79b			
3305	SLOPE	19a	97a	19a	
3306	ADB	19b	97b	19b	
3316	ALFA/180				39a
3317	BETA/180				39b
3331	CMDAPMOD				18a;69a
3332	PREL				18b;69b
3333	QREL				19a;70a
3334	RREL				19b;70b
3344	PAXERR1				33a
3345	ROLLTM				33b;83a
3346	ROLLC				83b
3400-3401	LAT(SPL)				37
3402-3403	LNG(SPL)				38
3404-3411	DELVSLV	98-100		35-37	
3412-3413	TIG	18	18	18	
3425-3426	DVTOTAL	33			
3427-3420	TGO	23			
3460-3466	MARK2DWN		24-27a		
3547-3550	DHDSP			76	
3573-3574	DVDSP1			96	
3575-3576	DVDSP2			97	
3623-3630	DELVEET3			77-79	
3633-3634	TPASS4			34	
3635-3636	L/D1				20

E memory Reference List, continued

ECADR	Mnemonic	Powered	Coast & Align	Rendezvous	Entry/ Update
3640-3641	ELEV	74			
3642-3643	TTPI			29	
3654-3662	MARKDOWN		20-23a	24-27a	
3662	CSTEER	30a			
3663	RM	30b		27b	
3675-3676	LATANG				34
3677-3700	RDOT				35
3701-3702	THETAH				36
3717-3720	UTPIT			98	
3721-3722	UTYAW			99	
3724-3725	VIO				57
3724-3725	LEWD				57
3726-3727	TTE				56
3726-3727	L/DCALC				56
3736-3737	VPRED				58
3736-3737	VL				58
3740-3741	GAMMAEI				100
3740-3741	GAMMAL				100
3740	PREDANG				100a
3741	JJ				100b
3753-3754	SVEC +2	75		30	
3765-3766	NC1TIG			74	
3767-3770	NC2TIG			75	
3771-3776	VGTIG	95-97	31-33		

CHANNEL	Mnemonic	Powered	Coast & Align	Rendezvous	Entry/ Update
0011	DSALMOUT	91a	91a	91a	91a
0012	CHAN12	91b	91b	91b	91b
0013	CHAN13	92a	92a	92a	92a
0014	CHAN14	92b	92b	92b	92b
0030	CHAN30	93a	93a	93a	93a
0031	CHAN31	93b	93b	93b	93b
0032	CHAN32	94a	94a	94a	94a
0033	CHAN33	94b	94b	94b	94b
0077	CHAN77	69b	69b	69b	96b
	Undefined	17b;67b; 69a;84b	17b;23b; 27b;67b; 69a;84b; 96b	17b;67b; 69a;84b	17b*;96a

*During update only.

C.2

2.4 Description of Telemetered Quantities

This section contains a list of CMC registers making up the various downlists, ordered by erasable memory address, followed by a list of CMC input and output channels. Each entry contains the mnemonic of the register(s) or channel, the downlist word number(s) in which it appears, and a description of its contents.

A register may contain other quantities during programs in which the CMC no longer needs to save the primary downlist quantity.

The following downlist words contain meaningless information:

Powered List: 17b, 67b, 69a, 84b.
Coast and Align List: 17b, 23b, 27b, 67b, 69a, 84b, 96b.
Rendezvous List: 17b, 67b, 69a, 84b.
Entry/Update List: 17b*, 96a.

*during update only

ECADR	Mnemonic	Powered	Coast & Align	Rendezvous	Entry/ Update
0024-0025	TIME2,TIME1	51	51	51	51

A double precision word indicating ground elapsed time. Used for all timing while the CMC is on. Zeroed at liftoff and incremented by one bit per centisecond. It may be updated by Verb 55, Verb 70 (P27) or Verb 73 (P27). Scaled centiseconds/2^{23}.

0032-0034	CDUX,Y,Z	9-10a; 59-60a	9-10a; 59-60a	9-10a; 59-60a	9-10a; 59-60a

CDUX (outer gimbal) CDUY (inner gimbal) CDUZ (middle gimbal): The actual values of the IMU CDU angles. Each register is an unsigned 15-bit fraction, scaled degrees/360, and is updated by counter interrupts. A middle gimbal angle greater than 70 degrees will light the Gimbal Lock lamp on the DSKY. When $|MGA|$ exceeds 75 degrees, automatic maneuvers are inhibited. Whenever $|MGA|$ exceeds 85 degrees the ISS stabilization loop will be disabled except during Average-G when the "config" window of DAPDATR1 indicates Saturn configuration. As a result, the CDUZ register should maintain values that correspond to middle gimbal angles between -70 degrees and +70 degrees.

0035	CDUT	10b;60b	10b;60b	10b;60b	10b;60b

The optics trunnion angle CDU, scaled (degrees-19.7754)/45 (two's complement). The angle measurement varies from -19.775° to 45°, corresponding to a range of 0° to about 65° in actual trunnion.

0036	CDUS	72a	72a	72a

The optics CDU shaft angle. This register is an unsigned 15-bit fraction scaled, degrees/360. The angle varies $\pm 180^{\circ}$.

0037-0041	PIPAX,Y,Z	72b-73	72b-73	72b-73

The accumulation of output pulses from the X, Y, and Z accelerometers (a measure of the velocity changes), scaled (centimeters/second)/(5.85 x 2^{14}). These registers are zeroed by PIPUSE (called by LASTBIAS which is called by PREREAD at the start of Average-G). They are then read and zeroed every two seconds by READACCS (or REREADAC) throughout Average-G.

0074-0105	FLAGWRD0-9	40-44	40-44	40-44	40-44

See Flagword Table, Sec. 2.5 for descriptive material.

ECADR	Mnemonic	Powered	Coast & Align	Rendezvous	Entry/ Update
0106-0107	FLGWRD10-11	77	77	100	99

See Flagword Table, Sec. 2.5 for descriptive material.

0300 COMPNUMB 31a

The total number (octal) of components the update program expects to receive. For a Verb 71 or a Verb 72 update, COMPNUMB will be set equal to the index value.

0301 UPOLDMOD 31b

This is the number of the CMC program which was interrupted by P27, the update program. It will indicate program 0, 2, 20, or Fresh Start (77777_8).

0302 BESTI 19a

The celestial body I. D. associated in P51, P52, P53, and P54 with the optics mark data in words 20-23a of the Coast and Align list. Each star I. D. will be the octal equivalent of the CMC star number multiplied by six; e. g., for Alpha Tauri, catalogue no. 11_8, BESTI = 66_8. Calculated in P50, P51, P52, P53, P54 and P55.

0302 UPVERB 32a

The least significant digit of the verb number which was selected to initiate a desired CMC update.

0303 BESTJ 19b

The celestial body I.D. associated with the optics mark data in words 24-27a of the Coast and Align list. Each star I.D. will be the octal equivalent of the CMC star number multiplied by six; e.g., for Alpha Tauri, catalogue no. 11_8, BESTJ = 66_8. Calculated in P51, P52, P53 and P54.

0303 UPCOUNT 32b

The octal identifier of the next quantity that the update program expects to receive. As each quantity goes into UPBUFF, UPCOUNT will be incremented by one, until it is equal to COMPNUMB. It will not change during a line-by-line correction of the data load.

ECADR	Mnemonic	Powered	Coast & Align	Rendezvous	Entry/ Update
0304-0327	UPBUFF				21-30; 71-80

These twenty registers, UPBUFF through UPBUFF+19D, contain the uplinked octal components in the transmitted order during P27. If the update is composed of less than twenty quantities, the remaining registers may contain Entry values as shown below. Entry programs use these registers as follows:

UPBUFF = CMTMTIME, time at which body-rate list was last initialized. Scaled centiseconds/2^{14}.

UPBUFF+1 = SW/NDX, combined switch and index associated with FDAI display and TM. Scaled 2^{-14}. See SKYLARK GSOP Section 3.

UPBUFF+2,....+16D = body rates in the sequence, PREL, QREL, RREL, PREL, QREL, RREL, etc.
Scaled (degrees/sec)/1800.

UPBUFF+17D, +18D = V1*, initial velocity for UPCONTRL. Scaled (ft/sec)/(2 x 25766.1973).

UPBUFF+19D = A0*, (high order register) initial drag for UPCONTRL. Scaled (ft/sec^2)/805.0.

ECADR	Mnemonic	Powered	Coast & Align	Rendezvous	Entry/ Update
0373	C31FLWRD	70a	70a	70a	97a

A single-precision erasable memory cell used to determine if the channel representations of the CMC mode switch, SC control switch, optics mode switch, or optics zero switch are to be used or if back-up indicators are to be used. The erasable is of the form $AXXDX_8$, where:

*Not expected to be computed for SKYLAB missions.

ECADR	Mnemonic	Powered	Coast & Align	Rendezvous	Entry/ Update
0373	C31FLWRD (Cont.)	70a	70a	70a	97a

A Value

0 or 4	Bits 13, 14, 15 of channel 31 are valid
1	G&N Control FREE
2	G&N Control ATTITUDE HOLD
3	G&N Control AUTO
5	SCS Control FREE
6	SCS Control ATTITUDE HOLD
7	SCS Control AUTO

D Value

0 or 4	Bits 4 and 5 of channel 33 are valid
1 or 5	Optics Mode CMC
2 or 6	Optics Mode ZERO
3 or 7	Optics Mode MANUAL

0374-0376	FAILREG, +1, +2	70b-71	70b-71	70b-71	97b-98

A set of three single-precision cells used to retain alarm pattern code information. They are all reset to zero by a Fresh Start. FAILREG and FAILREG+1 are also reset to zero by use of the "ERROR RESET" keycode. FAILREG contains the first alarm code received after the "ERROR RESET", FAILREG+1 contains the second, and FAILREG+2 will always contain the most recent alarm code. Octal quantities.

0764 VHFCNT 28a

The number of VHF ranging marks incorporated into the state vector since the initialization of P20, scaled 2^{-14}. This item is used in the N45 display (two most significant digits of R1) and has a range in that display of 0 to 99 (modulo 100). VHFCNT is incremented each time a VHF ranging mark is incorporated (approx. 1/min if P20 is operating, VHF ranging is on and VHFRFLAG, UPDATFLG and TRACKFLG are set and SNAPFLAG is not set). Set to 0 by Fresh Start and when the W-matrix is re-initialized.

ECADR	Mnemonic	Powered	Coast & Align	Rendezvous	Entry/ Update

0765 TRKMKCNT 28b

The number of optics marks incorporated into the state vector since the initialization of P20, scaled 2^{-14}. This item is used in the N45 display (two least significant digits of R1) and has a range in that display of 0 to 99 (modulo 100). TRKMKCNT is incremented each time an optics mark is incorporated. The frequency depends upon the astronaut because marking is a manual operation. Set to 0 as in above (VHFCNT).

0770-0771 OPTION1, OPTION2 64 64 64

OPTION1. The option code which is displayed in R1 in conjunction with a flashing V04N06 to request the astronaut to load into R2 the option he desires.

OPTION2. The astronaut-selected option which was loaded into R2 as a result of the displayed OPTION1 code.

The OPTION1 and OPTION2 codes, scaled in octal, are as follows:

OPTION1 Code	Purpose	OPTION2 Code (Astronaut Input)
00001 (during P52, P54)	Specify IMU Orientation	1=Preferred 2=Nominal 3=REFSMMAT
00002 (during P21 & P29)	Specify Vehicle	1=This Vehicle 2=Other Vehicle
00012 (during P50)	Specify ATM Orientation Determination Technique	1=ATM Sun Sensor 2=ATM Sun Sensor & Star Tracker 3=Docking Angles from External Source
00013 (during P55)	Specify tracker angle computation data source	1=Mark on celestial body & IMU Orientation 2=Mark on celestial body & ATM in Solar Inertial Orientation
00024 (during P20)	Specify Tracking Option	0=Rendezvous, VECPOINT 1=Celestial body, VECPOINT 2=Rotation 4=Rendezvous, 3-axis 5=Celestial body, 3-axis

1002-1003 VHFTIME 23

The time (TIME2,TIME1) of the last VHF Range mark that is read by R08 when called by R22. It is scaled centiseconds/2^{28}. When VHFRFLAG is found to be set and at least 60 seconds have expired since the time of the last reading, R22 calls

ECADR	Mnemonic	Powered	Coast & Align	Rendezvous	Entry/ Update
1002-1003	VHFTIME (Cont.)			23	

R08 to read the range and record time of reading. This time is stored in VHFTIME upon return to R22. It is used to determine if one minute has elapsed since the last mark was processed and to integrate the state vector to the mark time. It is assumed, for practical purposes, that the range data is acquired at this time but actually there is a very small time delay.

1014-1015	TEVENT	78	78		

The time of liftoff (P11 clock zeroing), or time of any SPS ignition or shutdown command (P40); whichever occurs last. It is scaled centiseconds/2^{28} and referenced to the computer clock.

1021-1036	RN, VN, PIPTIME	2-8	2-8	2-8	2-8

CSM state vector and time. The CMC'S latest calculated state vector for the CSM. Words 2-4 contain the position components X, Y, Z, scaled meters/2^{29}. Words 5-7 contain the velocity components, X, Y, Z, scaled (meters/centisecond)/2^{7}. Word 8 contains the time associated with the CSM state vector in words 2-7, scaled centiseconds/2^{28}, referenced to the computer clock. These parameters are calculated whenever the CSM state vector is permanently extrapolated or changed, as follows:

P00,P20 option 1, 2, 5 - every four time steps
P20 - upon entry (MINKEY) or after initial displays (non-MINKEY options 0, 4), then extrapolated for each mark; updated by each mark incorporation if CM update option.
P27 - update of state vector
Average-G - every cycle
V47 - state vector transfer
P77 - Impulsive ΔV Program

1076-1077	PIPTIME1	24			52

The time (TIME2, TIME1) at which the PIPAs are read, scaled centiseconds/2^{28}. Integration stores the PREREAD state vector time in anticipation of reading PIPAs at that time. Updated by PIPASR every two seconds during Average-G.

ECADR	Mnemonic	Powered	Coast & Align	Rendezvous	Entry/ Update
1115-1116	MARKTIME	31			

The time (TIME2,TIME1) of the last VHF Range mark that is read by R08 when called by P48. It is scaled centiseconds/2^{28}. It is assumed for practical purposes that the range data is acquired at this time but actually there is a very small time delay.

1216-1231	DSPTAB	45-50	45-50	45-50	45-50

The eleven registers, DSPTAB+0 through DSPTAB+10D, indicate the status of the DSKY displays. If bits 15 through 12 are 0001, the next 11 bits will indicate the actual status of the DSKY displays; if bits 15 through 12 are 1110, the next 11 bits indicate the "ones" complement of the status to which the CMC will command the DSKY display. Bits 11-1 of DSPTAB+0 through DSPTAB+10D are decoded as follows:

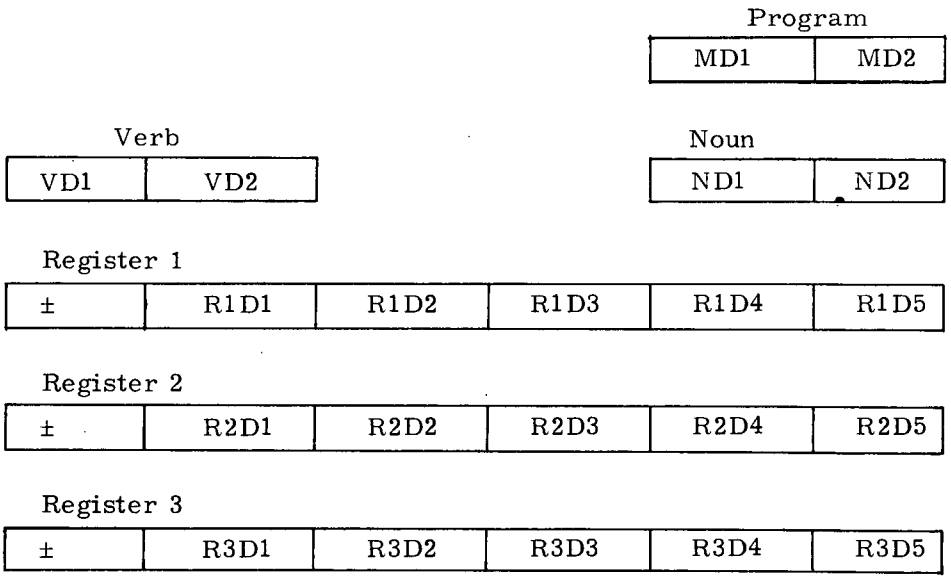
DSPTAB Register	Downlink Word Number	Bit Assignments		
		Bit 11	Bits 10-6	Bits 5-1
DSPTAB+0	45a	-R3S	R3D4	R3D5
DSPTAB+1	45b	+R3S	R3D2	R3D3
DSPTAB+2	46a		R2D5	R3D1
DSPTAB+3	46b	-R2S	R2D3	R2D4
DSPTAB+4	47a	+R2S	R2D1	R2D2
DSPTAB+5	47b	-R1S	R1D4	R1D5
DSPTAB+6	48a	+R1S	R1D2	R1D3
DSPTAB+7	48b			R1D1
DSPTAB+8D	49a		ND1	ND2
DSPTAB+9D	49b		VD1	VD2
DSPTAB+10D	50a		MD1	MD2

R3D1 stands for digit one of the third register and VD1 stands for the first digit of the verb display, etc. For the right character of a pair, bit 5 is the MSB with bit 1 the LSB. For the left character of a pair, the MSB is bit 10 with bit 6 the LSB. Bit 11 of some of the DSPTABs contains discrete information, a one indicating that the discrete is on. For example, a one in bit 11 of DSPTAB+1 indicates that R3 has a plus sign. If the sign bits associated with a given register are both zeros, then the content of that particular register is octal; if either of the bits is set, the register content is decimal data. The five bit codes associated with the digits are as follows:

ECADR	Mnemonic	Powered	Coast & Align	Rendezvous	Entry/ Update
1216-1231	DSPTAB's (Cont.)	45-50	45-50	45-50	45-50

	MSB				LSB
0	1	0	1	0	1
1	0	0	0	1	1
2	1	1	0	0	1
3	1	1	0	1	1
4	0	1	1	1	1
5	1	1	1	1	0
6	1	1	1	0	0
7	1	0	0	1	1
8	1	1	1	0	1
9	1	1	1	1	1
Blank	0	0	0	0	0

The following is a diagram of the DSKY face showing positions of the different digits:



DSPTAB+11D. This register drives relays for display lights. The bit assignments are:

ECADR	Mnemonic	Powered	Coast & Align	Rendezvous	Entry/ Update
1216-1231	DSPTAB's (Cont.)	45-50	45-50	45-50	45-50

Bit	Assignment
1	
2	
3	
4	No Attitude
5	
6	Gimbal Lock
7	
8	Tracker
9	Program Caution
10	
11	

If bits 15 through 12 of DSPTAB+11D are 1000, the next 11 bits indicate the state to which the CMC will command the relays; if bits 15 through 12 are 0000, the next 11 bits indicate the actual state of the relays. A one indicates that the discrete is on. A verb 36 fresh start preserves bits 6 and 4, while a restart preserves bits 9, 6 and 4. All other bits are zeroed. An error reset code preserves bits 6 and 4.

1276	REDOCTR	88a	88a	88a	88a

Counter for hardware restarts. Set to zero by a keyboard fresh start (VERB 36). Incremented once per hardware restart by the restart program (GOPROG) and scaled 2^{-14}.

1277-1301	THETAD	88b-89	88b-89	88b-89	88b-89

The final desired CDU angles, (X, Y, Z) treated as 15-bit unsigned quantities and scaled, degrees/360. THETAD+2 should not be in gimbal lock or near it. These items should not be confused with THETADX, Y, and Z.

During P50, these registers are used as pseudo-docking angles (180 - α, β, γ) and hence THETAD +2 is not restricted as above.

Entry guidance* use these registers as follows:

---

*This portion of ENTRY program not expected to be exercised for SKYLAB missions.

ECADR	Mnemonic	Powered	Coast & Align	Rendezvous	Entry/ Update
1277-1301	THETAD (Cont.)	88b-89	88b-89	88b-89	88b-89

1277-1301 = RDOTREF (double-precision), reference RDOT for UPCONTRL. VREF (high-order register only), reference velocity for UPCONTRL. Both scaled (ft/sec)/(2 x 25766.1973).

1304-1311	DELVX,Y,Z	25-27			53-55

The sampled X, Y, & Z PIPA accumulations (velocity increments) with compensation for PIPA bias and scale factor errors. These quantities are in the stable member coordinate system and are scaled, (cm/sec)/(5.85 x 2^{14}). Calculation takes place every two seconds during Average-G. The variation with time and the range of values depend on the acceleration level and compensation. There is a zeroing of all low-order components and a momentary zeroing of DELVY and DELVZ prior to the loading of PIPA contents into respective high-order words (part of READACCS, or REREADAC task). If no restarts occur the momentary zeroing would not appear on the downlink. PIPA compensation follows in Servicer job (inhinted, so that all or no PIPA compensation shows up).

1323	IMODES30	90a	90a	90a	90a

A cell whose individual bits are used to control the monitoring of IMU functions associated with channel 30 (and in a few cases channel 33). Set to 37411_8 for a fresh start; a restart sets the word to 37000_8 plus the present contents of bits 9, 5, 4, 3, 1 (zeroing bit 15, 8, 7, 6, and 2). Word is updated once every 0.48 seconds based upon the channel sampling controlled by the T4RUPT computations. Discussion below ignores settings performed by verb 35 ("lamp test").

Bit	Meaning
15	Last sampled value of channel 30 bit 15 (0 if IMU temperature within limits). If bit changes, bit 4 (Temperature caution) of channel 11 is set to agree with this bit. Bit set 0 for a fresh start or restart.
14	Last sampled value of channel 30 bit 14 (0 if ISS has been turned on or commanded to be turned on). Bit is used in the control of IMU monitoring logic; set to 1 for a fresh start and restart.

ECADR	Mnemonic	Powered	Coast & Align	Rendezvous	Entry/ Update
1323	IMODES30 (Cont.)	90a	90a	90a	90a

Bit	Meaning
13	Last sampled value of channel 30 bit 13 (0 if an IMU fail indication produced). Set 1 for a fresh start or restart; if bit becomes 0 while bit 4 of this word is also zero, then channel 11 bit 1 (ISS Warning) is set 1.
12	Last sampled value of channel 30 bit 12 (0 if an IMU CDU fail indication produced). Set 1 for a fresh start or restart; if bit becomes 0 while bit 3 of this word is also zero, then channel 11 bit 1 (ISS Warning) is set 1.
11	Last sampled value of channel 30 bit 11 (0 if an IMU cage command produced by crew). Set 1 for a fresh start or restart.
10	Last sampled value of channel 33 bit 13 (0 if a PIPA fail indication produced), having same value as bit 13 of IMODES33. Bit is set 1 for a fresh start or restart, and if an error reset key code is received via DSKY or uplink. If bit becomes 0 while bit 1 of this word is also zero, then channel 11 bit 1 (ISS Warning) is set 1.
9	Last sampled value of channel 30 bit 9 (0 if IMU turned on and operating with no malfunctions). Set 1 for a fresh start. Alarm 0214_8 is generated if bit goes from 0 to 1 while bit 8 (IMUSE) of Flagword 0 is 1.
8	Bit used to control the IMU turn-on sequencing. It is set 1 if bit 7 of this word is sensed as 1, and is reset (with bit 7) to zero 0.48 secs later, before starting the IMU turn-on sequencing. Used to achieve a wait of 0.48 secs before acting on the IMU turn-on information. Set 0 by fresh start or restart.
7	Bit used to control the IMU turn-on sequencing. It is set to 1 based on logic using bits 14, 9, and 2 of this word, and is reset to zero (with bit 8 of this word) 0.48 secs later. Also set 0 by a fresh start or restart. Hence can be set to 1 if ISS initialization requested (bit 14 or bit 9 of this word changing) since last fresh start, turn-off of IMU (change in bit 9 of this word), or turn-on delay complete (change in bit 14 of this word).
6	Bit set 1 to indicate that IMU initialization is being carried out. Set 1 during turn-on sequence, if a cage command (bit 11 of this word) is received, or if

ECADR	Mnemonic	Powered	Coast & Align	Rendezvous	Entry/ Update
1323	IMODES30 (Cont.)	90a	90a	90a	90a

Bit	Meaning

IMU zeroing in T4RUPT is done. Set 0 by a fresh start or restart, about 8.22 seconds after removal of cage command, about 8.22 seconds after start of zeroing in T4RUPT (when bits 8-7 set 0), or about 97.90 seconds after start of turn-on sequence (when bits 8-7 set 0 marks the "start" of sequence). If bit is 1, no verb 37 input is processed and alarm pattern 1520_8 is generated. If bit is 1, an error exit from the internal IMU routines is forced (coarse align, fine align, or gyro torquing).

5 Bit set 1 to inhibit the generation of program alarm 0212_8 if a PIPA fail signal (bit 13 of channel 33) is produced. Set 0 as part of a fresh start, and value retained if a restart. Bit not used unless bit 1 of this word is 1. Bit set to 1 during IMU turn-on sequence (when bit 6 is set 1), and reset 0 about 4.0 seconds after bit 6 is reset 0 (alarm generated when Average-G is stopped, if bit 10 of this word is 0, regardless of the value of this bit 5).

4 Bit set 1 to inhibit generation of an ISS warning based on receipt of an IMU fail signal. Set 1 as part of a fresh start, and value retained if a restart. Bit reset to 0 when bit 6 is set 0 (having been set 1 when bit 6 set 1). Bit also set 1 when coarse align of IMU is started, and is set 0 about 5.12 seconds after mode change to fine align is done. Also set to 1 for 8.22 seconds when IMU CDU zero commanded outside of T4RUPT package.

3 Bit set 1 to inhibit generation of an ISS warning based on receipt of an IMU CDU fail signal. Bit set 0 as part of a fresh start, and value retained if a restart. Bit set 1 when bit 6 of this word set 1, and is set 0 (at end of IMU zeroing sequence) when bit 6 set 0. Bit also set 1 (at the same time as bit 4) for 8.22 seconds when IMU CDU zero is commanded separate from T4RUPT package (via V40E).

2 Bit set 1 to indicate failure of the turn-on delay sequence for IMU turn-on (alarm 0207_8 is also generated). Zeroed by fresh start or restart.

1 Bit set 1 to inhibit generation of an ISS warning based on receipt of a PIPA fail signal (bit 13 of channel 33). Bit set 1 as part of a fresh start, and value retained if a restart. Bit also set 1 when bit 6 of this word is set 1 (but is not subsequently reset in the T4RUPT logic, cf. bit 5 of this word).

ECADR	Mnemonic	Powered	Coast & Align	Rendezvous	Entry/ Update
1324	IMODES33	90b	90b	90b	90b

A cell whose individual bits are used to control the monitoring of functions associated with channel 33 (and other items). Set to 16000_8 as part of a Fresh Start; a restart sets it to 16000_8 + the present contents of bit 6 (other bits set 0); and an error reset key code sets bits 13-11 to 1 (leaving other bits alone). Word is updated once every 0.48 seconds. Discussion below ignores settings performed by verb 35 ("lamp test") except for bit 1.

Bit	Meaning
15	Not assigned, hence expected to remain 0.
14	Last sampled value of channel 32 bit 14 (0 if a Proceed command is given using the old "standby" button). A transition from 1 to 0 causes a job to be established that has same program logic effect as V33E (from a mission program standpoint). Contrary to the other bits of this word, this bit is updated once every 0.12 seconds. It should be noted that in the case of a response to a V21, V22, and V23, the logic for a Proceed is not the same as for a V33E.
13	Last sampled value of channel 33 bit 13 (0 if an accelerometer fail signal, or PIPA fail, produced by hardware). Same quantity loaded into bit 10 of IMODES30 (for program logic control convenience). Fresh start and restart set bit to 1.
12	Last sampled value of channel 33 bit 12 (0 if a telemetry end pulse rejected because downlink rate too fast). When a 1 to 0 transition is sensed, alarm pattern 1105_8 is generated. Fresh start and restart set bit to 1.
11	Last sampled value of channel 33 bit 11 (0 if an uplink bit rejected because uplink rate too fast). When a 1 to 0 transition is sensed, alarm pattern 1106_8 is generated. Fresh start and restart set bit to 1.
10-7	Not assigned, hence expected to remain 0.
6	Bit set to 1 to indicate that IMU use for vehicle attitude information should not be attempted. Bit set 1 the same time as bit 6 of IMODES30 is set 1, and also when bit 4 of IMODES30 is set 1 (for IMU zeroing external to T4RUPT and for IMU coarse align). Bit set 0 if IMU fine align routine is performed. Set 1 if IMU turned off.

ECADR	Mnemonic	Powered	Coast & Align	Rendezvous	Entry/ Update
1324	IMODES33 (Cont.)	90b	90b	90b	90b

Bit	Meaning
5	Bit set 1 in IMU zeroing routine external to T4RUPT while zeroing is taking place (for an interval of about 8.22 seconds, at the same time as bit 6 of this word is set in the routine). This routine is entered via V40E.
4-2	Not assigned, hence expected to remain 0.
1	Bit set to 1 when a verb 35 ("lamp test") is received, and reset to 0 about 5 seconds later. Used to inhibit resetting of lights to 0 in T4RUPT package while the lamp test is being performed.

1327	OPTMODES	80a	80a	80a	84a

A cell whose individual bits are used to control the performance of optics functions within the T4RUPT package. Set to 00130_8 (bits 7, 5, 4 = 1) as part of a fresh start; a restart preserves the present values of the bits 5, 4, while setting bit 7 to 1 and zeroing the remaining bits (15-8, 6, 3-1). Word is updated once every 0.48 seconds, about 0.24 seconds before the interrupt that updates IMODES30 & IMODES33.

Bit	Meaning
15-11	Not assigned, hence expected to remain 0.
10	Bit set 1 to indicate that zeroing of optics completed since last fresh start or restart (both of which set the bit 0). If an attempt is made to drive the optics and this bit is found to be zero, alarm 0120_8 is generated (but computation proceeds).
9-8	Not assigned, hence expected to remain 0.
7	Last sampled value of channel 30 bit 7 (0 if an optics CDU fail indication has been generated by the optics CDU hardware). If bit 2 of this word is 0, a Tracker alarm (bit 8 of DSPTAB+11) is generated if this bit has a 1 to 0 transition. Bit set 1 by a fresh start or restart.
6	Not assigned, hence expected to remain 0.

ECADR	Mnemonic	Powered	Coast & Align	Rendezvous	Entry/ Update
1327	OPTMODES (Cont.)	80a	80a	80a	84a

Bit	Meaning

5 Last sampled value of channel 33 bit 5 or its backup as indicated by C31FLWRD (0 if optics mode switch set to computer control).

4 Last sampled value of channel 33 bit 4 or its backup as indicated by C31FLWRD (0 if optics mode switch set to zero optics). If bits 5-4 = 11_2, this means that optics mode switch set to manual mode.

3 Bit set 1 when optics mode switch changed from manual or computer control mode to zero optics mode, to indicate that zeroing of the optics is in progress. If bit is 1, then a switch out of zero optics mode will cause alarm 0116_8 to be generated (if switched to manual, a "grace period" of about 5.3 seconds is provided before the optics-zeroing time counter is reset, during which time a switch back to optics zeroing can be made). Bit remains 1 for about 16.2 seconds, and is then reset to 0 (at same time that bit 10 of this word is set 1, and bit 2 of this word set 0).

2 Bit set 1 to inhibit generation of Tracker alarm (bit 8 of DSPTAB+11D) if bit 7 of this word goes from 1 to 0. Bit set and reset at the same time as bit 3.

1 Not assigned, hence expected to remain 0.

1330	HOLDFLAG	80b	80b	80b	84b

A multiple purpose switch which is used for establishing the control reference of the autopilot. It has the following three states:

State	Meaning

(+) Sample the CDU angles and store in THETADX, THETADY, and THETADZ before resuming attitude hold and resetting HOLDFLAG to (+0).

(+0) Remain in attitude hold about previously established reference angles, THETADX, THETADY and THETADZ. Set to this state if previously negative by CSM-alone or Docked DAP when $|MGA| > 75^{\circ}$. Also set to this state at termination of automatic maneuver.

(-) Enable automatic steering.

ECADR	Mnemonic	Powered	Coast & Align	Rendezvous	Entry/ Update
1333-1334	FIXTIME	32			

The time for which range and range rate are optimized in R27. Loaded into N72 by astronaut. Automatically incremented by four minutes in R27 after each optimization pass is complete. Scaled centiseconds/2^{28}.

1432-1433	RSBBQ	68	68	68	95

RSBBQ. When a hardware restart occurs, this register is loaded with the setting of the BBANK portion of the calling address +1 and also Superbank information which is in channel 7.

RSBBQ + 1. Loaded with the setting of the Q-register when a hardware restart occurs.

1516-1517	TET	76	65	65	65

The time of state vector being integrated or the time to which the last state vector was integrated. It is stepped by half-time-step increments (plus or minus) whenever integration is being done. It is scaled, centiseconds/2^{28}.

1642-1643	T-OTHER	58	58	58

The time associated with the OWS state vector in words 52 through 57, scaled centiseconds/2^{28}, referenced to the computer clock.

1700-1702	TEPHEM	95-96a

Epoch measured in centiseconds (scaled seconds/2^{42}) from July 1 universal time which is (approximately) the beginning of the Nearest Besselian Year in question (usually the NBY during which launch occurs).

1703-1716	R-OTHER, V-OTHER	52-57	52-57	52-57

OWS state vector. The CMC's latest calculated state vector for the OWS. Words 52-54 contain the position coordinates, X, Y, and Z, scaled meters/2^{29}. Words 55-57 contain the velocity components, X, Y, and Z, scaled (meters/centisecond)/2^{7}. These parameters are calculated whenever the OWS state vector is permanently extrapolated or changed, as follows:

ECADR	Mnemonic	Powered	Coast & Align	Rendezvous	Entry/ Update
1703-1716	R-OTHER, V-OTHER (Cont.)	52-57	52-57	52-57	

P00,P20 option 1,2,5 - every 10 minutes to CM state vector time.

P20 - upon entry (MINKEY) or after initial displays (non-MINKEY options 0, 4), then extrapolated for each mark; updated by each mark incorporation if OWS update option.

P27 - update of state vector.

V66 - state vector transfer.

Termination of Average-G.

1717-1732	REFSMMAT	34-39	34-39

Six elements of REFSMMAT, double precision quantities, transmitted R_1C_1, R_1C_2, R_1C_3, R_2C_1, R_2C_2, and R_2C_3, each scaled 2^{-1}. REFSMMAT is the 3 x 3 matrix used to convert between reference coordinates and stable member coordinates. The remaining three components of REFSMMAT may be computed as follows:

$$R_3C_1 = (R_1C_2)(R_2C_3) - (R_1C_3)(R_2C_2)$$

$$R_3C_2 = (R_1C_3)(R_2C_1) - (R_1C_1)(R_2C_3)$$

$$R_3C_3 = (R_1C_1)(R_2C_2) - (R_1C_2)(R_2C_1),$$ where R = ROW and C = COLUMN.

REFSMMAT is calculated in P11, P51, P52, P53 and P54.

2201-2202	RANGE	38

This parameter is involved in two areas, R31/R34/P37 and R36. In either category it is scaled, meters/2^{29}. In R31/R34/P37, RANGE is the magnitude of the difference between the radius vectors of the two vehicles (CSM-OWS). In R36, RANGE represents the out-of-plane position for the CSM and is computed as $Y = \underline{r}_C \cdot \{\text{UNIT}(\underline{v}_W \times \underline{r}_W)\}$. This item is calculated in P37 or whenever R31, R34 or R36 is selected by the astronaut via V83, V85, or V90. The displayed value can range from 000.00 n.m. to 999.99 n.m. Once the routine is selected, RANGE is recomputed in R31/R34/P37 until program termination ("PROCEED"); in R36 it is necessary to "RECYCLE" in order to have the value recomputed. The update rate in R31/R34/P37 is a function of what other jobs are running.

ECADR	Mnemonic	Powered	Coast & Align	Rendezvous	Entry/ Update

2203-2204 HAPOX 28

The altitude of the apogee above earth reference radius. Scaled meters/2^{29}. Calculated in R30 only.

2203-2204 RRATE 39

This parameter is involved in two areas, R31/R34/P37 and R36. In either category it is scaled (meters/centisecond)/2^7. In R31/R34/P37 it is defined as the range rate between the two vehicles (CSM-OWS) and is computed as $\dot{R} = (\underline{v}_W - \underline{v}_C) \cdot \{UNIT(\underline{r}_W - \underline{r}_C)\}$. A negative quantity indicates closing. In R36, RRATE represents velocity for CSM in the sense of $\dot{Y} = \underline{v}_C \cdot \{UNIT(\underline{v}_W \times \underline{r}_W)\}$. This item is calculated in P37 or whenever R31, R34, or R36 is selected by the astronaut using verbs V83, V85, or V90. The displayed value can range from 0000.0 fps to 9999.9 fps. It is recomputed in R31/R34/P37 until program termination ("PROCEED"). In R36 it is necessary to RECYCLE in order to update the value, which is valid for an astronaut-selected time. The update rate in R31/R34/P37 is a function of what other jobs are running.

2205-2206 HPERX 29

PERIGEE. The altitude of the perigee above earth reference radius. Scaled meters/2^{29}. Calculated in R30 only.

2205-2206 RTHETA 95

This parameter is involved in two areas, RTHETA in R31/R34/P37 and RRATE2 in R36.

RTHETA. In R31/R34/P37 it is the angle from the local horizontal plane to either the CSM X-body axis (Noun 54 flashing) or to the SXT line of sight (Noun 53 flashing). The scaling is in degrees/360. This item is calculated in P37 or whenever R31 or R34 is selected by the astronaut via V83 or V85. It is computed in R31/R34/P37 until program termination ("PROCEED"). The update rate is a function of what other jobs are running.

RRATE2. Same as RRATE for R36 except velocity is for OWS.

2460-2461 TNSR 32

The time of ignition of the NSR maneuver. Input in P34 (N13). Used to initialize state vector for CDHMVR subroutine. Calculated by P31, P32 and P33. Scaled centiseconds/2^{28}, referenced to computer clock.

ECADR	Mnemonic	Powered	Coast & Align	Rendezvous	Entry/ Update
2462-2463	TNCC			33	

The time of ignition for the NCC maneuver. Computed by P31 and P32. Input to P33 in N11. Scaled centiseconds/2^{28}, referenced to computer clock.

2630-2631	DELVTPF			31	

The required impulsive delta V to accomplish the TPF maneuver at time of intercept, scaled (meters/centisecond)/2^{7}. This quantity is calculated by P35.

2633-2634	LAUNCHAZ		79		

The clockwise angle from true north to the IMU stable member X axis, measured in the local horizontal plane and scaled degrees/360. The expected angles will range from $+72^{\circ}$ to $+108^{\circ}$ (approx.). The item is pad loaded and may be reloaded during P02, gyrocompassing program, via Verb 78E.

2757-2764	OGC,IGC,MGC		74-76		

During R55 and during the gyro trim phase of R50, the X, Y, and Z gyro torquing angles. During coarse align, in P52 and P54, the desired gimbal angles (outer, inner & middle), scaled degrees/360. During P50, the pseudo-docking angles ($180-\alpha, \beta, \gamma$).

3010-3011	PACTOFF, YACTOFF	28		30	

The SPS engine gimbal-actuator trim angle estimates in the pitch and yaw planes (used to align the engine with the vehicle cg), scaled (seconds of arc)/(85.41 x 2^{14}). These values are added to the DAP filter output every DAP sample period as part of the engine gimbal servo command. The variation is usually less than ±2 degrees over the course of a burn. These are equivalent to the upper halves of the double-precision registers, PDELOFF and YDELOFF. These items are set initially by astronauts in R03. They change significantly at the CSM "one-shot" correction time, which is about 3.4 seconds after ignition. For the CSM/LM DAP* configuration the "one-shot" occurs at TVC initialization and hence causes no change to PACTOFF or YACTOFF. Incremental changes are made every 0.5 second after the "one-shot" correction and an end-of-burn update is made following the engine shut-down command.

---

* The LM-CSM docked configuration option exists in the SKYLARK program, although it will not be exercised for SKYLAB missions.

ECADR	Mnemonic	Powered	Coast & Align	Rendezvous	Entry/ Update
3070	DAPDATR3	20a	98a	20a	

Information concerning the Docked DAP interfaces.

DAPDATR3 is packed with 5 octal digits of information as follows:

Bits	15-13	12-10	9-7	6-4	3-1
	AC-roll	XTAC	XTBD	PCTRL	YCTRL

(1) AC-roll: Roll jet selection

0 BD preferred
1 AC preferred

(2) XTAC: X-translation using Quads AC

0 No AC
1 Use AC

(3) XTBD: X-translation using Quads BD

0 No BD
1 Use BD

(4) PCTRL: Pitch control

0 Use torque couple control
1 Use Z force control

(5) YCTRL: Yaw control

0 Use torque couple control
1 Use Y force control

If both XTAC and XTBD are loaded 0, no jets will fire in response to ±X THC commands; if both are loaded 1 the autopilot will attempt to use all four quads.

ECADR	Mnemonic	Powered	Coast & Align	Rendezvous	Entry/ Update
3071	CH5FAIL	20b	98b	20b	

Docked DAP channel 5 jet inhibit. Contains octal sum of codes corresponding to channel 5 jets to be inhibited:

Jet	Code no.
C3(1)	00001
C4(4)	00002
A3(3)	00004
A4(2)	00010
D3(5)	00020
D4(8)	00040
B3(7)	00100
B4(6)	00200

3072	CH6FAIL	21a	99a	21a

Docked DAP channel 6 jet inhibit. Contains octal sum of codes corresponding to channel 6 jets to be inhibited:

Jet	Code no.
B1(9)	00001
B2(12)	00002
D1(11)	00004
D2(10)	00010
A1(13)	00020
A2(16)	00040
C1(15)	00100
C2(14)	00200

3073	DKRATE	21b	99b	21b

Docked DAP maneuver rate for both manual rotation and automatic maneuvers scaled (degrees/sec)/(450 x 2^{-6}). For manual rotations it is the per axis rate. For automatic maneuvers it is the total command angular rate. This variable is normally loaded in R04 as R1 of N89.

ECADR	Mnemonic	Powered	Coast & Align	Rendezvous	Entry/ Update
3074	DKDB	22a	100a	22a	

Docked DAP deadband, scaled degrees/180. This variable is normally loaded in R04 as R2 of N89.

3075	WHICHDAP	22b	100b	22b	

Indicates whether CSM-alone or Docked DAP is operating. Set to 0 at start of CSM-alone DAP; set to 1 at start of Docked DAP.

3114-3115	DAPDATR1,2	82	82	82	82

Information concerning the CSM-Alone DAP interfaces:

DAPDATR1 is packed with 5 octal digits of information as follows:

Bits	15-13	12-10	9-7	6-4	3-1
	CONFIG	XTAC	XTBD	DB	RATE

(1) CONFIG: Configuration

0 No DAP or ENTRY DAP
1 CSM
2 CSM/LM*
3 CSM/SIVB
6 CSM/LM ASCENT STAGE ONLY*

(2) XTAC: X-translation using Quads AC

0 No AC
1 Use AC

(3) XTBD: X-translation using Quads BD

0 No BD
1 Use BD

---

* The LM-CSM docked configuration option exists in the SKYLARK program, although it will not be exercised for SKYLAB missions.

ECADR	Mnemonic	Powered	Coast & Align	Rendezvous	Entry/ Update
3114-3115	DAPDATR1,2 (Cont.)	82	82	82	82

(4) DB: Deadband

0 ±0.5 degree
1 ±5.0 degrees

(5) RATE: Response to RHC, Automatic maneuvers

0 0.05 degree/second
1 0.2 degree/second
2 0.5 degree/second
3 2.0 degrees/second

DAPDATR2 is packed with 5 octal digits of information as follows:

Bits	15-13	12-10	9-7	6-4	3-1
	AC-Roll	Quad A	Quad B	Quad C	Quad D

(1) AC-Roll: Roll jet selection

0 Use BD Roll
1 Use AC Roll

(2) A, B, C, D Quad fails

0 Quad Failed
1 Quad OK

3121	LEMMASS	81a	81a	81a	81a

The current mass of the LM vehicle*, scaled kilograms/2^{16}. This is a pad load erasable and is not changed in normal use. The astronaut can change it, however, as part of the normal DAPDATA LOAD (R03, V48).

* The LM-CSM docked configuration option exists in the SKYLARK program, although it will not be exercised for SKYLAB missions.

ECADR	Mnemonic	Powered	Coast & Align	Rendezvous	Entry/ Update
3122	CSMMASS	81b	81b	81b	81b

The current weight of the CSM vehicle, scaled kilograms/2^{16}. It is a pad load erasable which can be altered by the astronaut in R03 (V48). It is changed automatically every 2 seconds during P40 by S40.8 if thrust is OK. This change consists of decrementing the parameter by 200 times the value of the pad-loaded quantity EMDOT, which represents the value of the SPS mass-flow rate in kg/cs.

3125-3127	AK,AK1,AK2	14-15a; 64-65a	14-15a	14-15a	14-15a

The X, Y and Z (roll, pitch and yaw, respectively) attitude errors used to drive the FDAI display, scaled degrees/180. The roll attitude error register (AK) is loaded with one-quarter the "raw" value during P11 and entry programs while Entry DAP is running, to increase the scale by a factor of four. The attitude errors are about the control axes for CSM-alone or Docked DAP and about the body axes for TVC and Entry DAP. Zeros in bits 15,14 and 13 of DAPDATR1 and a one in bit 2 of Flagword 6 indicate that the Entry DAP is active. During CSM-alone or Docked DAP operation the particular error quantities depend upon the display mode selected, as follows: MODE 1 (selected by V61) results in Autopilot phase-plane errors; MODE 2 (selected by V62) results in total attitude errors with respect to the angles in N22; MODE 3 (selected by V63) results in total astronaut attitude errors with respect to the angles in N17. In MODE 1 the errors should generally remain less than the attitude deadband, ADB. The values are calculated every 200 ms during CSM-alone or Docked DAP operation, whereas in TVC DAP operation, AK is updated every 0.5 second in TVC EXECUTIVE with the complement of OGAERR, and AK1 and AK2 are updated every TVC DAP sample period (in PCOPY and YCOPY) with the respective values of ERRBTMP. The error needles themselves, however, are updated with AKs only every one-half second on a call from TVC EXECUTIVE. Also, with TVC DAP, AK will normally have a magnitude of less than 5 degrees but a jet failed-on could produce a diverging roll attitude. AK1 and AK2 will normally have peak values of up to 3 degrees, converging to 0-1 degrees with time.

3130	RCSFLAGS	15b;65b	15b	15b	15b

A cell whose individual bits are used in monitoring the CSM-alone or Docked DAP.

Bit	Meaning
15	Bit set to 1 during R60 or R67 auto maneuver if high rate (2 deg/sec) has been specified in R03. Bit is reset to 0 at termination of auto maneuver.

ECADR	Mnemonic	Powered	Coast & Align	Rendezvous	Entry/ Update
3130	RCSFLAGS (Cont.)	15b; 65b	15b	15b	15b

Bit	Meaning

14 Bit is set to 1 if rate estimates are not good and a repeat of the rate filter initialization is required. Bit is reset to 0 if the G&N is in control and the IMU data is usable. Approximately 1 second after bit is reset to 0 the rate filter initialization is complete.

13 Bit set 1 if the rate damping has not been completed on the roll axis. Bit is reset to 0 if the rate damping has been completed on the roll axis.

12 Bit set 1 if the rate damping has not been completed on the pitch axis. Bit is reset to 0 if the rate damping has been completed on the pitch axis.

11 Bit set 1 if the rate damping has not been completed on the yaw axis. Bit reset to 0 if the rate damping has been completed on the yaw axis.

10,9 Either or both bits are set to 1 when there has been a change in RHC roll command since the last DAP cycle. Additionally, the Docked DAP sets bit 9 to 1 to indicate the beginning or end of an automatic maneuver.

8,7 Either or both bits are set to 1 when there has been a change in RHC yaw command since the last DAP cycle. Additionally, the Docked DAP sets bit 7 to 1 to indicate the beginning or end of an automatic maneuver.

6,5 Either or both bits are set to 1 when there has been a change in the RHC pitch command since the last DAP cycle. Additionally, the Docked DAP sets bit 5 to 1 to indicate the beginning or end of an automatic maneuver.

4 Bit set 1 indicates that the AK values should be updated. Bit is reset to 0 to indicate that the NEEDLE DRIVE routine should be processed with the AK values which have been previously acquired.

3,2 If Bit 3, Bit 2 = 11_2 or 10_2, it is necessary to follow the initialization path of the NEEDLE DRIVE routine.

If Bit 3, Bit 2 = 01_2, it is necessary to follow pass 2 of the NEEDLE DRIVE routine.

ECADR	Mnemonic	Powered	Coast & Align	Rendezvous	Entry/ Update
3130	RCSFLAGS (Cont.)	15b;65b	15b	15b	15b

Bit	Meaning
	If Bit 3, Bit 2 = 00_2, it is necessary to follow pass 3 and greater paths of the NEEDLE DRIVE routine.
1	Bit is set 1 to indicate that the initial pass path in the T6 program should not be followed. Bit is reset to 0 if the T6 program should be initialized.

ECADR	Mnemonic	Powered	Coast & Align	Rendezvous	Entry/ Update
3154-3161	WBODY	85-87	85-87	85-87	85-87

WBODYs (when CSM-alone or Docked DAP is on) or OMEGACs (when TVC DAP is on). WBODYs are the desired angular body rates (roll, pitch, yaw) about the control axes scaled (degrees/second)/450. The control axes are rotated w.r.t body axes by -7.25 degrees about +X. OMEGACs are body axis rate commands in roll, pitch and yaw generated by cross-product steering (Roll is ignored by TVC).

Bits 15 and 14 of Flagword 6 indicate which parameter is being sent. Bits 15, 14 and 13 of DAPDATR1 indicate the correct scaling for OMEGAC.

Bits 15, 14 Flagword 6	Bits 15, 14, 13 DAPDATR1	
01	XXX	WBODYs
10	001	OMEGACs for CSM-alone DAP scaled (rev/sec)/12.5
10	010	OMEGACs for CSM/LM DAP. Scaled
	110	(rev/sec)/6.25.

Entry guidance* stores the following values into these registers (all scaled deg/360):

3154 = ASKEP, Kepler range angle.
3155 = ASP1, final phase range angle.
3156 = ASPUP, Up-range angle.
3157 = ASPDWN, range angle down to PULL-UP.
3160-61 = ASP3 (double-precision) gamma correction range angle.

ECADR	Mnemonic	Powered	Coast & Align	Rendezvous	Entry/ Update
3162-3167	ADOT	11-13; 61-63	11-13; 61-63	11-13; 61-63	11-13; 61-63

ADOTs (if CSM-alone or Docked DAP on) or OGARATE and OMEGABs (if TVC DAP on). ADOTs are DAP - measured vehicle body rates (i.e. the outputs from the CSM-alone or Docked DAP rate filter), roll, pitch and yaw, about the control axes. These axes are aligned with the RCS jet quads and, consequently, are rotated,

* This portion of Entry programs not expected to be exercised for SKYLAB missions.

ECADR	Mnemonic	Powered	Coast & Align	Rendezvous	Entry/ Update
3162-3167	ADOT (Cont.)	11-13; 61-63	11-13; 61-63	11-13; 61-63	11-13; 61-63

with respect to the NAV BASE axes, -7.25 degrees about +X. ADOTs are scaled (degrees/second)/450. OGARATE is the measured roll rate obtained by back-differencing the outer gimbal angle (OGA) measurements every 0.5 second, scaled (rev/sec)/2^{-4}. This quantity will normally be near zero magnitude but a roll jet failed-on could produce 2-3°/sec rates. OMEGABs are the measured attitude rates about the pitch and yaw body axes, obtained by transforming the back-differenced CDU readings taken each DAP sample period. OMEGAYB is computed each pitch DAP pass; OMEGAZB is computed each yaw DAP pass. The first OMEGAZB value when the TVC DAP is started (or after a hardware restart) is measured over 1.5 DAP sample periods. The time sharing and scaling for OMEGABs are the same as for the OMEGACs. The maximum OMEGAB rate will be less than 5 deg/sec.

NOTE: Even though OGARATE is computed and stored as a single precision quantity, it can be considered a double precision word in which the least significant half is always zero. This is insured by the TVC zeroing loop.

Entry powered flight uses these registers as follows scaled (centimeters/second)/ (5.85 x 2^{14}):

3162	= XPIPBUF	PIPA Buffers for TM during Entry. PIPs filed here every 0.5 second.
3163	= YPIPBUF	
3164	= ZPIPBUF	
3165	= XOLDBUF	Contain PIPA value previously in PIPBUF.
3166	= YOLDBUF	
3167	= ZOLDBUF	

3220-3222	ERRORX, Y, Z	83-84a	83-84a	83-84a	66-67a

The CSM-alone or Docked DAP phase plane (roll, pitch, yaw) attitude errors scaled degrees/180. During steady state operation the magnitude of ERRORX, Y, and Z should be less than the attitude deadband, ADB. The RCS control axes, with which these errors are concerned, are rotated, with respect to the body axes, by -7.25 degrees about the +X axis. The error values are calculated:

1. During CSM-alone or Docked DAP operation with CMC MODE switch in AUTO or HOLD, every 100 millisecs.

2. During CSM-alone or Docked DAP operation with CMC MODE switch in FREE, not updated.

ECADR	Mnemonic	Powered	Coast & Align	Rendezvous	Entry/ Update
3220-3222	ERRORX, Y, Z (Cont.)	83-84a	83-84a	83-84a	66-67a

Entry Roll DAP uses these registers as follows:

3220 = VDT/180, preselected drifting rate used by Roll DAP (0 = DAP in dead zone). Scaled (deg/sec)/90.

3221 = -VT/180E, minus roll rate used by the Roll DAP update cycle. Scaled (-deg/sec)/90.

3222 = LCX/360, the roll error (prior to reflection, if any) used by two second Roll DAP update cycle. Scaled deg/360.
The value in this cell is used to initialize PAXERR1 (word 33a of Entry/Update list); however, PAXERR1 is updated each 0.1 second.

3223-3225	THETADX, Y,Z	16-17a; 66-67a	16-17a; 66-67a	16-17a; 66-67a	16-17a; 67b-68

During normal CSM-alone or docked DAP operation, when the CMC Mode switch is in AUTO or HOLD and there are no RHC commands, these registers contain the desired current, (i.e., of this DAP cycle opposed to final) roll, pitch, and yaw CDU angles, treated as 15-bit unsigned fractions and scaled degrees/360. These quantities are used in the computation of phase plane attitude errors and are calculated as follows:

1. During automatic maneuvers they are updated every 100 milliseconds.
2. During attitude hold they are constants (the desired CDU angles to be held).
3. At the end of manual rate maneuvers, after rate damping is complete, THETADX, Y & Z are set to the current CDU angles.
4. During manual rate maneuvers and when in FREE mode the registers are not updated.

Entry programs use these registers as follows:

3223 = QAXERR, Pitch attitude error. Scaled degrees/180.
3224 = RAXERR, Yaw attitude error. Scaled degrees/180.
3225 = Q7,* high order register
3226 = Q7,* low order register (in word 17b)
} Minimum drag for UPCONTRL, scaled $(ft/sec^2)/805$.

* Not expected to be computed for SKYLAB missions.

ECADR	Mnemonic	Powered	Coast & Align	Rendezvous	Entry/ Update
3252-3253	PCMD, YCMD	29;79			

The pitch and yaw SPS engine gimbal-actuator position commands from the respective TVC DAPs, scaled (seconds of arc)/(85.41 x 2^{14}). The expected range of values is between ±1 degree, while the maximum possible values are ±6 degrees. They are calculated at every TVC DAP sample period: 40 ms for CSM, 80 ms for CSM/LM.*

3305	SLOPE	19a	97a	19a	

A DAP quantity specifying the slope of the phase plane boundaries, scaled ((degrees/second)/degree)/2.5.

3306	ADB	19b	97b	19b	

The DAP deadband, scaled degrees/180. If the CSM-alone RCS DAP or the Docked DAP is actively in control and if the CMC MODE switch is in HOLD or AUTO, ADB is the deadband value being currently used by the DAP.

3316	ALFA/180				39a

The pitch attitude angle, used by Entry DAP and scaled, degrees/180. It is the third rotation of the CM body triad in the Euler sequence R, β, α, and is about UBY. The value range is ±180° and is calculated each 0.1 second after the DAP is turned on in P62. Operation of such is indicated by a non-zero value in bit 12, flagword 6. (Bits 1 and 2 are also non-zero.)

3317	BETA/180				39b

The yaw attitude angle, used by Entry DAP and scaled degrees/180. It is the second rotation of the CM body triad in the Euler sequence R, β, α, and is about UBZ. The range is ±90° and is calculated each 0.1 second after the DAP is turned on in P62. This state is indicated by a non-zero value in bit 12, flagword 6. (Bits 1 and 2 are also non-zero.)

3331	CMDAPMOD				18a; 69a

ENTRY DAP MODE. A 4-position switch specifying branching in Entry DAP, scaled 2^{-14}.

Set to "-1" (77776_8) if entry equations sense drag in excess of 0.05 g.

* The LM-CSM docked configuration option exists in the SKYLARK program, although it will not be exercised for SKYLAB missions.

ECADR	Mnemonic	Powered	Coast & Align	Rendezvous	Entry/ Update
3331	CMDAPMOD (Cont.)				18a; 69a

Set to "-0" (77777_8) if the ALFA angle (pitch attitude) magnitude is greater than 135^o.

Set to "+1" (00001_8) if the ALFA angle magnitude is in the range 45^o to 135^o.

Set to "+0" (00000_8) if the ALFA angle is less than 45^o.

The expected value sequence would be $+1 \rightarrow +0 \rightarrow -1$. The value -0, is not generally expected. This item is calculated each 0.1 second after the DAP is turned on in P62. Flagword 6, bits 12 and 2, indicates an active DAP.

3332-3334	PREL,QREL, RREL	18b-19; 69b-70

The single-precision roll, pitch and yaw rates, components of the CM angular velocity vector along the body X, Y, and Z axes and scaled (degrees/sec)/1800. All are corrected for $\dot{\gamma}_E$ if $|\dot{\gamma}_E| \geq \dot{\gamma}_E$ min. The expected range of values would be: PREL $\pm 20^o$/sec, QREL $\pm 4^o$/sec, RREL $\approx \pm 17^o$/sec. These quantities are calculated each 0.1 sec after the DAP is turned on in P62.

Calculation of above rates is indicated by non-zero values in both bit 1 and bit 2 of flagword 6.

3344	PAXERR1	33a

The CM roll attitude error in body axes generated by the DAP and displayed on the FDAI needle, scaled degrees/360. The error is integrated each 0.1 sec between 2-second DAP updates. This quantity is the same as the item, AK, except for the scale factor, and is active only after the DAP is turned on in P62. A one in bit 12 of flagword 6 indicates such activity.

3345	ROLLTM	33b; 83a

The roll attitude angle used by Entry DAP, scaled degrees/180. It is the first Euler rotation of the CM body triad about the negative relative velocity vector -UVA, along which UBX points. The value ranges $\pm 180^o$, is calculated after the DAP is turned on in P62 and is updated each 0.1 second during its operating period. Operation is indicated by a non-zero in bit 12 of flagword 6.

ECADR	Mnemonic	Powered	Coast & Align	Rendezvous	Entry/ Update
3346	ROLLC				83b

The most significant half of roll attitude command issued by Entry Guidance equations and used by the Entry DAP, scaled degrees/360. The angle is defined as a rotation about the negative relative velocity vector, $-\underline{v}_{REL}$. The value will range $\pm 180^{o}$ and is initially set in P62, based on HEADSUP, and holds until the drag exceeds 0.05g. The quantity will be computed each 2 seconds after P64 until the velocity becomes less than 1000 ft/sec in P67.

3400-3401	LAT(SPL)				37

The geodetic latitude of the entry target, scaled degrees/360. A positive quantity denotes North while a negative quantity indicates South. This parameter is pad loaded or DSKY loaded when P61 or P62 is in progress.

3402-3403	LNG(SPL)				38

The longitude of the entry target, scaled degrees/360. A positive quantity indicates East while a negative quantity denotes West. This parameter is pad loaded or DSKY loaded when P61 or P62 is in progress.

3404-3411	DELVSLV	98-100		35-37	

Impulsive delta V of the CSM in local vertical coordinates at the time of ignition. Vector, scaled (meters/centisecond)/2^{7}, is specified by the astronaut (V06N81), uplink, or one of the targeting programs.

3412-3413	TIG	18	18	18	

The time of ignition (prethrust) or time of cutoff (while thrusting). The changeover in definition for P40 occurs at ignition if an impulsive burn and at first TGOCALC (nominal TIG+2) if steering. This item is scaled, centiseconds/2^{28}. This parameter is calculated by P31, P32, P33, P34, P35, P36, and P38. P30 and P77 require TIG as an input. In P77, TIG is loaded with targeted ignition time. If the ignition time must be slipped (alarm 1703_{8}), P40 or P41 loads this word with the new ignition time. After ignition for an impulsive burn, TIG is loaded with predicted cutoff time, and after the first TGO calculation (long burn) TIG is loaded with the state vector time plus TGO. After the enter response to the flashing verb 97 (engine fail), the most significant half of TIG is set to -24_{8} and the least significant half remains unchanged.

ECADR	Mnemonic	Powered	Coast & Align	Rendezvous	Entry/ Update
3425-3426	DVTOTAL	33			

Magnitude of the delta V accumulated since the start of Average-G. Scaled (meters/centisecond)/2^7.

3427-3430 TGO 23

The time to go until engine cutoff, scaled centiseconds/2^{28}. At TIG-5 for an impulsive burn (TGO < 6) it is calculated once to represent the time from ignition to engine cutoff. If the estimated maneuver time is greater than six seconds and active steering has been initiated, TGO becomes the length of the time from the last PIPA reading to engine cutoff. During a burn in which steering is used, TGO is calculated every two seconds from the start of steering until steering is stopped.

NOTE: TGO +1 is also set to the Δt to cutoff when the call to ENGINOFF is set up by the steering logic or by the computer short burn logic.

3460-3466 MARK2DWN 24-27a

These seven registers contain, the time of the mark (TIME2, TIME1), scaled centiseconds/2^{28}, YCDU angle, optics shaft angle, ZCDU angle, optics trunnion angle and XCDU angle. This data is associated with the star indexed by BESTJ. XCDU, YCDU, ZCDU and the optics shaft angle are treated as unsigned 15-bit fractions, scaled degrees/360. The optics trunnion angle is scaled (degrees-19.7754)/45. The bias, 19.7754, is programmed-in.

When mark data is obtained using ATM star tracker, optics shaft and trunnion angles are replaced by tracker azimuth and elevation angles, respectively, also treated as unsigned 15-bit fractions, scaled degrees/360.

3547-3550 DHDSP 76

In P31, the computed altitude between the CSM and OWS orbits at NC2 time, scaled meters/2^{29}. In P32, the desired altitude (pad loaded erasable DHNCC) between the CSM and OWS orbits at NCC time, scaled meters/2^{29}.

3573-3574 DVDSP1 96

In P31, the computed delta V magnitude at NC2 time, scaled (m/csec)/2^7. In P32, the computed delta V magnitude at NCC time, scaled (m/csec)/2^7.

ECADR	Mnemonic	Powered	Coast & Align	Rendezvous	Entry/ Update
3575-3576	DVDSP2			97	

In P31, the computed delta V magnitude at NCC time, scaled $(m/csec)/2^7$. In P32, the computed delta V magnitude at NSR time, scaled $(m/csec)/2^7$.

3623-3630 DELVEET3 77-79

The impulsive delta V (X, Y, Z) calculated via the LAMBERT routine, scaled $(meters/centisecond)/2^7$. These quantities are based on the target vector, time of ignition, and transfer time.

3633-3634 TPASS4 34

The time of arrival, scaled centiseconds/2^{28}, associated with the target vector, RTARG. It is one of the variables used in the determination of the required delta velocity for a rendezvous maneuver. It is calculated in P33 and P35 and is input to the midcourse program P36. It is used in the powered flight programs for Lambert burns.

3635-3636 L/D1 20

The commanded value of lift-to-drag ratio used in Reentry Steering to provide Roll Command, scaled 2^0. It is computed whenever lateral logic is exercised, normally each 2 seconds after the initiation of P64 until the velocity becomes less than 1000 ft/sec in P67. The value range should be equal to, or less than, 1.0. The computation is omitted in P66.

3640-3641 ELEV 74

The angle between the local horizontal plane of the CSM and the line of sight vector to the OWS at TPI. The scaling is degrees/360. This parameter is an input (N55) to P35 also to P31, P32, P33 and P34 (padloaded). Also set to 0 on final pass through P35 (computed TPI time option) in MINKEY if a new time was loaded in N37. The angle is measured in a counter clockwise rotation from the forward-direction path of the CSM (determined by the positive direction of the CSM's velocity vector) to the CSM-OWS line of sight vector. See Fig. 4.1-1 of Section 5 of this GSOP.

3642-3643 TTPI 29

The time of TPI ignition for the rendezvous programs, scaled centiseconds/2^{28}. It is an input to P31, P32, P33, P34, and P35. It can be updated by P34 and will be computed by P35 if elevation angle is provided.

ECADR	Mnemonic	Powered	Coast & Align	Rendezvous	Entry/ Update
3654-3662	MARKDOWN		20-23a	24-27a	

These seven registers contain, in the following order: the time of the mark (TIME2, TIME1), scaled centiseconds/2^{28}, YCDU angle, optics shaft angle, ZCDU angle, optics trunnion angle and XCDU angle. This data is valid at the time an optics mark is taken in alignment or rendezvous programs. XCDU, YCDU, ZCDU and the optics shaft angle are treated as unsigned 15-bit fractions, scaled degrees/360. The optics trunnion angle is scaled (degrees-19.7754)/45. The bias, 19.7754, is programmed-in.

For P51, P52, P53, and P54, this data is associated with the star indexed by BESTI. When mark data is obtained using ATM star tracker, optics shaft and trunnion angles are replaced by tracker azimuth and elevation angles, respectively, also treated as unsigned 15-bit fractions, scaled degrees/360.

3662	CSTEER		30a		

The Cross Product Steering Constant, "c", used by P40/P41 in the equation $\Delta\underline{m} = c\underline{b}\Delta t - \Delta\underline{v}$ and certain prethrust computations. It is scaled "c"/4. The value range will be from -4 to +4 (less one bit). It is set by P40 prethrust to 1 if a Lambert burn. It will be zeroed by P40 prethrust if an external ΔV burn and also by P41 prethrust.

3663	RM		30b	27b	

The range (raw data), from the CSM to the OWS as measured by the VHF range link, using the VHF Range Read Routine (R08). This quantity is a 15-bit integer with the least significant bit equal to 0.01 nmi (multiply by 18.52 to obtain meters). This quantity is modulo 327.68 n.m. Set to zero by P40 and P41.

3675-3676	LATANG				34

The lateral range expressed as an angle, scaled radians/4. It will range at less than 200 n.mi. and is calculated each 2 seconds after the initiation of P63 until the end of P67.

3677-3700	RDOT				35

Altitude rate. The radial component of velocity (negative if descending), scaled (feet/sec)/(2 x 25766.1973). This is a scalar component calculated in earth-centered reference coordinates. If bit 9, flagword 6 (RELVELSW) is zero, the velocity used is inertial. If bit 9, flagword 6 is a one, a velocity relative to air mass is used. The expected range of values runs from less than -7000 ft/sec to +1000 ft/sec and is calculated each 2 seconds after P63 until the end of P67.

ECADR	Mnemonic	Powered	Coast & Align	Rendezvous	Entry/ Update
3701-3702	THETAH				36

The range between the present position and the estimated landing site, expressed as an angle and scaled, degrees/360. The expected value is less than 180^{o}. It is calculated each 2 seconds after start of P63 until the end of P67. It is used in P61 for computing EMS display but is not on the Powered downlist.

3717-3722	UTPIT, UTYAW				98-99

Angles specifying the desired spacecraft axis (SCAXIS) for P20, scaled degrees/360.

3724-3725	VIO				57

These registers have two functions:

P61: VIO, the predicted entry velocity at the EMS altitude above the Fischer radius along a conic path from the present position, scaled (meters/centi-second)/2^{7}. The value will be approximately 26,000 ft/sec. (See Note 1 below.)

P64: LEWD,* UPCONTRL reference L/D. Scaled 2^{0} (max. value of 1.0).

3726-3727	TTE				56

These registers have two functions:

P61-P63: TTE, the time required to traverse the conic path from the present position to the specified EMS altitude above the Fischer ellipsoid, expressed as a negative number, counting down and scaled, centiseconds/2^{28}. The value is calculated in P61. It will be decremented every two seconds thru P63 and displayed via N63. (See Note 1 below.)

P64 through P67: L/DCALC, onboard estimate of L/D ratio. Scaled 2^{0} (max. value of 1.0). Exception: garbage if .05GSW = 0 (bit 3 of Flagword 6). This will occur in P66 if a ballistic trajectory is flown. (P66 not expected for Skylab missions.)

---

*Not expected to be computed for SKYLAB missions.

ECADR	Mnemonic	Powered	Coast & Align	Rendezvous	Entry/ Update
3736-3737	VPRED				58

These registers have two functions:

P61: VPRED, the predicted entry velocity at 400K feet above the Fischer radius along a conic path from the present position, scaled (meters/centisecond)/2^7. The value will be approximately 26,000 ft/sec. (See Note 1 below.)

P64: VL*, exit velocity for UPCONTRL. Scaled (ft/sec)/(2 x 25766.1973).

ECADR	Mnemonic	Powered	Coast & Align	Rendezvous	Entry/ Update
3740-3741	GAMMAEI				100

These registers have three functions:

P61: GAMMAEI (single precision), the conic flight path angle between the inertial velocity and the local horizontal at the entry interface altitude of 400,000 ft above the Fischer ellipsoid, scaled degrees/360. A minus quantity indicates that the flight path is below the horizontal plane. (See Note 1 below.)

GAMMAEI +1(RTGO, single precision), the predicted range angle from the EMS altitude above Fischer radius to target along conic from present position, scaled degrees/360. (See Note 1 below.)

P64: GAMMAL* (double-precision), flight-path angle at VL. Scaled 2^0 radians.

P67: PREDANG (single-precision), predicted range angle, final phase. Scaled revolutions/2^{-3}, where a revolution is 21600 n.m.

JJ (single-precision), index in final phase, table look-up. Scaled 2^{-14}.

(Note 1: If the Recycle option (V32E) of N63 in P61 is exercised, this quantity is recalculated using the current state vector. However, only the result of the final calculation will appear on the Entry and Update list).

---

*Not expected to be computed for SKYLAB missions.

ECADR	Mnemonic	Powered	Coast & Align	Rendezvous	Entry/ Update
3753-3754	SVEC +2	75		30	

The R27 range rate, either current or (during an optimization) converging, scaled (meters/centisecond)/2^6.

3765-3766	NC1TIG			74	

The time of ignition for the NC1 Rendezvous maneuver, scaled centiseconds/2^{28}. It is an input to P31.

3767-3770	NC2TIG			75	

The time of ignition for the NC2 Rendezvous maneuver, scaled centiseconds/2^{28}. It is computed in P31 and is an input to P32.

3771-3776	VGTIG	95-97		31-33	

The predicted velocity (X, Y, Z) to be gained at TIG in reference coordinates, scaled (meters/centisecond)/2^7. During Lambert burns, the DELVEET3s from pre-thrust targeting are picked up and stored in VGTIG. External ΔV burns compute and store a rotated VG. It is calculated in burn programs: S40.1 computes (X-DELV) or copies (LAMBERT) as part of pre-thrust computations.

Channel	Mnemonic	Powered	Coast & Align	Rendezvous	Entry/ Update
0011	DSALMOUT	91a	91a	91a	91a

Channel 11. A computer output channel whose individual bits are used for display parameter quantities and engine on-off control. A fresh start sets all bits to 0. Processing of a verb 37 and a software restart both set bits 7-3 to 0. V37 also sets bits 10 and 9 to 0. A hardware restart sets all bits to 0 unless bit 7 of flagword 5 = 1 in which case, bit 13 of this word will be set to 1.

Bit	Meaning

15-14 Not assigned.

13 SPS Engine on (set 1 in P40 to turn on SPS engine, set 0 to turn it off). Also set 0 if caging command received.

12-11 Not assigned.

10 Caution Reset signal (for display system lights). Set to 1 when an error reset key code (from uplink or DSKY) is received.

9 Test connector Outbit. Set 1 in accelerometer reading subroutine (READACCS, entered about 2 seconds after Average-G is "started" and each two seconds thereafter until bit 1 of Flagword 1 = 0) and set 0 when Average-G is terminated (shortly after bit 6 of Flagword 7 is set 0).

8 Not assigned.

7 Operator error light (FLASH). Set 0 when an error reset key code (from uplink or DSKY) is received; set 1 if various procedural items (most of which are related to the DSKY, such as illegal noun/verb combinations) are not performed properly.

6 Flash verb and noun lights. Bit is set when an operator action is required (by program means, as a clue to the operator that a response is needed). See discussion of Flagword 4.

Channel	Mnemonic	Powered	Coast & Align	Rendezvous	Entry/ Update
0011	DSALMOUT (Cont.)	91a	91a	91a	91a

Bit	Meaning

5 Key Release light (FLASH). Set 1 if program desires to use display system but external (DSKY or uplink) use of it is being made. Also would be set 1 if an internal or externally initiated monitor display had been started and then some DSKY button was depressed. It is lit if a request for operator response has been initiated and crew does not respond directly to it, but instead displays something else. Set 0 by key release keyboard input, and upon other instances (such as processing of an extended verb) when display system is released by the internal program.

4 Temperature Caution light. See bit 15 of IMODES30.

3 Uplink activity light. Set when an uplink interrupt is received; reset when an error reset key code is received, a key release key code, or at the termination of P27 (based on receipt of a proceed or terminate response). Bit is also set to 1 in R61 if an R60 maneuver is desired, but the maneuver is inhibited.

2 Computer activity light. Set 0 if no active Jobs are to be performed. During P00 probably will be 0 except during the periodic state vector update or gyro drift compensation. It will also be set to one intermittently during P00 if the CSM-alone or Docked DAP is active. Bit is not set 1 if a Task is performed, but instead left at its previous value.

1 ISS Warning light. See bits 13, 12, and 10 of IMODES30.

0012	CHAN12	91b	91b	91b	91b

Channel 12. A computer output channel whose individual bits are used for control of optics/TVC and IMU hardware, and for control of the ISS. A fresh start zeroes all bits and then sets bits 6 and 4 to 1 if bits 6 and 4 of DSPTAB + 11D are both 1. A hardware restart sets all bits to zero. A verb 37 clears bits 2, 3, 8, 10, 11, 13, and 14. A software restart does not change this channel, IMU caging zeros bits 8, 6, 5, 4, and 2.

Bit	Meaning

15 ISS turn-on delay complete. Reset to 0 7.90 seconds after being set 1 at end of 90 second ISS turn-on delay.

Channel	Mnemonic	Powered	Coast & Align	Rendezvous	Entry/ Update
0012	CHAN12 (Cont.)	91b	91b	91b	91b

Bit	Meaning

14 S4B Cutoff command. Bit set in P40 for backup of S4B cutoff whenever SPS cutoff is commanded.

13 S4B Injection Sequence Start. Not set by the program.

12 Not assigned.

11 Disengage optics Digital-to-Analog Converter. Bit set in TVC DAP preparations (S40.6) at the start of the gimbal drive test or trim to avoid driving the optics system with TVC commands if optics had been left in the computer control mode. Set to 0 when the TVC DAP is terminated.

10 Zero Optics. Not set by the program.

9 S4B Takeover Enable. Set to 1 following a V46E with bits 14-13 of DAPDATR1 = 1 (for Saturn attitude control using RHC). Bit also set to 1 if bit 10 of Channel 30 is sensed as 0 in P11, meaning the Saturn control given to CMC.

8 TVC Enable. Set to 1 in P40 shortly after the response to checklist 0204_8 code, in order to connect the output of the "optics" CDU digital-to-analog converters to the SPS gimbal servo amplifiers. Bit set 0 about 2.5 seconds after engine cutoff command (bit 13 of channel 11 set 0) in the following cases: normal cutoff, an enter or terminate response to a flashing V99N40 initiated at nominal ignition-5 seconds, an enter or terminate response to a flashing V97 initiated by thrust fail routine. Set to 1 in T4RUPT when optics mode is changed to manual and computer-driving of the optics is requested (OPTIND = 0 or 1). Set to 0, if present value is 1, when leaving the manual mode or when terminating computer control of optics (OPTIND = -0 or -1).

7 Not assigned.

6 Enable IMU error counters. Set 1 during coarse align of IMU, and in order to permit output of error information to the FDAI attitude error needles (bit is set 0 on initialization pass, then set 1; the third pass is the first one with output to needles).

Channel	Mnemonic	Powered	Coast & Align	Rendezvous	Entry/ Update
0012	CHAN12 (Cont.)	91b	91b	91b	91b

Bit	Meaning

5 Zero IMU CDU's. Set to 1 to zero IMU CDU's. Set and reset in T4RUPT or V40E.

4 Enable coarse align of IMU. Set 1 to specify coarse align of IMU (cf. bit 6), and also if middle gimbal angle (i.e. CDUZ) exceeds 85°, except during Average-G when the "config" window of DAPDATR1 indicates Saturn configuration.

3 Not assigned.

2 Enable Optics CDU Error Counters. Set to 0 at start of SPS gimbal trim subroutine, then set 1 about 0.06 seconds after TVC Enable (bit 8 of this channel) set 1, for TVC control; and set 0 at the same time TVC Enable is zeroed, (approximately 2.5 seconds after SPS engine shutdown). In OPTMON routine (entered every 0.48 sec) it is set to 0, then set to 1 about 0.06 sec later, whenever optics mode is changed to manual or CMC and computer driving of the optics is requested (OPTIND = 0 or 1). Set to 0, if present value is 1, when optics mode is changed to zero or when terminating computer control of optics (OPTIND = -0 or -1).

1 Zero Optics CDU's. Set 1 for about 0.2 seconds at the end of the optics zeroing sequence (cf. OPTMODES). Not needed for TVC purposes, of course, since these CDU's are optics inputs and TVC merely takes advantage of the digital-to-analog outputs assigned to "optics".

0013	CHAN13	92a	92a	92a	92a

Channel 13. A computer output channel whose outputs are used for miscellaneous purposes. Set to 0 by a fresh start or hardware restart. Processing of a verb 37 first clears bits 8 and 9 in DUMMYAD and then clears bits 10 and 11 in STARTSB2, retaining the value of the remaining bits. A software restart clears bits 11 and 10 to zero and retains the value of the other bits.

Channel	Mnemonic	Powered	Coast &Align	Rendezvous	Entry/ Update
0013	CHAN13 (Cont.)	92a	92a	92a	92a

Bit	Meaning
15	Bit set 1 to permit an internal computer clock (TIME6) to be counted down at a 1600 pps rate. This clock is used for control of jet on-times in CSM-alone DAP, Docked DAP, and the TVC Roll DAP, but is not used for the Entry DAP. When clock has counted down, bit is reset to 0, and the desired program interrupt action initiated.
14	Reset input trap circuit 32, concerned with bits 10-1 of channel 32. Bit not set in program.
13	Reset input trap circuit 31B, concerned with bits 12-7 of channel 31. Bit not set in program.
12	Reset input trap circuit 31A, concerned with bits 6-1 of channel 31. Bit not set in program.
11	Enable Standby. Set to 1 in P06 after the clock has been read and reset to 0 by powering up the computer after the standby operation.
10	Test DSKY lights. Set 0 by an error reset keycode input; set 1 for about 5 seconds if a verb 35 input is received.
9	Not assigned.
8	Not used (assigned to "BMAG output enable").
7	Telemetry word order code bit. When channel is telemetered, should have a value of 1 (bit 0 only for words 1 and 51).
6	Block inputs to uplink cell. Not set by program.
5	Not used (connects an alternate input to uplink cell).
4	Range Unit activity.
3	Range Unit Select a.

Channel	Mnemonic	Powered	Coast & Align	Rendezvous	Entry/ Update
0013	CHAN13 (Cont.)	92a	92a	92a	92a

Bit	Meaning
2	Range Unit Select b.
1	Range Unit Select c.

Note: Bits 1 through 4 are assigned control functions for sampling of the VHF Range link to establish quantity fed to cell 0046_8 (RNRAD). These bits must contain the quantity, 1001_2 in order to obtain this control.

0014	CHAN14	92b	92b	92b	92b

Channel 14. A computer output channel whose outputs are used for control of computer counter cells. Set 0 by a fresh start or hardware restart. Processing of a verb 37 or software restart does not change this channel setting. An IMU cage command zeros bit 15-6.

Bit	Meaning
15	Bit set to 1 to cause output pulses from cell used to drive X-axis IMU CDU error counter (IMU X-axis coarse align or error needle for roll axis). Bit reset to 0 after counter cell reduced to 0 (3200 pps): bit 6 of channel 12 must be set to load error counter.
14	Same as bit 15, but for Y-axis (pitch).
13	Same as bit 15, but for Z-axis (yaw).
12	Bit set to 1 to cause output pulses from cell used to drive optics trunnion or TVC yaw axis. Bit reset to 0 after counter cell reduced to 0 (3200 pps): bit 2 of channel 12 must be set to load error counter.
11	Same as bit 12, but for optics shaft or TVC pitch axis.
10	Bit set 1 to generate gyro torquing pulses, and reset to 0 when required number produced. Is set when pulse torquing of gyros performed (for IMU compensation or for pulse torquing in P52 or P54 following acceptance of V06N93 display) or during gyro trim phase of R50. Bit also set to 1 in GYCRS (pulse torque coarse aligning in P52/P54).

Channel	Mnemonic	Powered	Coast & Align	Rendezvous	Entry/ Update
0014	CHAN14 (Cont.)	92b	92b	92b	92b

Bit	Meaning

9 Bit set 1 to indicate negative gyro torquing required (otherwise, torquing is positive). Bit reset to 0 after completion of routine.

8-7 Bits used to specify axis for gyro compensation (sequence is Y, Z, X for inner, middle, outer). Program resets to 00_2 when done.

00_2	No axis
01_2	X-axis
10_2	Y-axis
11_2	Z-axis

6 Bit set 1 (at beginning of routine to generate gyro torquing pulses) to enable gyro torquing power supply, and left at 1 (unless a fresh start done or a caging command).

5 Not used (assigned to entry monitoring function).

4-2 Not assigned.

1 Not used (assigned to "outlink activity").

0030	CHAN30	93a	93a	93a	93a

Channel 30. A computer input channel for miscellaneous functions.

Bit	Meaning

15 Bit sensed as 0 if stable member temperature within design limits (see bit 15 of IMODES30).

14 Bit sensed as 0 if ISS has been turned on or commanded to be turned on (see bit 14 of IMODES30).

13 Bit sensed as 0 if an IMU fail indication produced (see bit 13 of IMODES30).

12 Bit sensed as 0 if an IMU CDU fail indication produced (see bit 12 of IMODES30).

Channel	Mnemonic	Powered	Coast & Align	Rendezvous	Entry/ Update
0030	CHAN30 (Cont.)	93a	93a	93a	93a

Bit	Meaning
11	Bit sensed as 0 if an IMU cage command generated by the crew (see bit 11 of IMODES30).
10	Bit sensed as 0 if control of Saturn given to computer.
9	Bit sensed as 0 if IMU turned on and operating with no malfunctions (see bit 9 of IMODES30).
8	Not assigned.
7	Bit sensed as 0 if an optics CDU fail indication produced (see bit 7 of OPTMODES).
6	Bit sensed as 0 if guidance reference release signal produced: bit not sensed by program.
5	Bit sensed as 0 if liftoff signal produced (used to cause termination of P02 and initiation of P11, a function that can alternatively be initiated by V75E).
4	Bit sensed as 0 if S4B separation/abort signal produced: bit not sensed by program.
3	Bit sensed as 0 when preparations for use of the SPS engine ("SPSready") is complete. This bit is not sensed by the flight program.
2	Bit sensed as 0 if CM/SM separation signal produced: bit not sensed by program.
1	Bit sensed as 0 if "ullage thrust present" (from Saturn): bit not sensed by program.

0031	CHAN31	93b	93b	93b	93b

Channel 31. A computer input from crew control devices, used by CSM-alone or Docked DAP.

Channel	Mnemonic	Powered	Coast & Align	Rendezvous	Entry/ Update.
0031	CHAN31 (Cont.)	93b	93b	93b	93b

Bit	Meaning
15	Bit sensed as 0 if computer in control of spacecraft ("G&N autopilot control"). Bit also becomes 1 if IMU turned off, SCS spacecraft control, or translation hand controller twisted in clockwise direction.
14	Bit sensed as 0 if "Free" mode selected.
13	Bit sensed as 0 if "Hold" mode selected. If bits 14-13 are 11_2, this indicates that "Automatic" mode selected.
12	Bit sensed as 0 if translation in -Z direction commanded.
11	Bit sensed as 0 if translation in +Z direction commanded.
10	Bit sensed as 0 if translation in -Y direction commanded.
9	Bit sensed as 0 if translation in +Y direction commanded.
8	Bit sensed as 0 if translation in -X direction commanded.
7	Bit sensed as 0 if translation in +X direction commanded.
6	Bit sensed as 0 if rotation in negative roll direction commanded.
5	Bit sensed as 0 if rotation in positive roll direction commanded.
4	Bit sensed as 0 if rotation in negative yaw direction commanded.
3	Bit sensed as 0 if rotation in positive yaw direction commanded.
2	Bit sensed as 0 if rotation in negative pitch direction commanded.
1	Bit sensed as 0 if rotation in positive pitch direction commanded.

Channel	Mnemonic	Powered	Coast & Align	Rendezvous	Entry/ Update
0032	CHAN32	94a	94a	94a	94a

Channel 32. A computer input channel for additional crew input to CSM-alone or Docked DAP, etc.

Bit	Meaning
15	Not assigned.
14	Bit sensed as 0 if "proceed key" (formerly standby button) is depressed (see bit 14 of IMODES33).
13-7	Not assigned.
6	Bit sensed as 0 if negative roll commanded by minimum impulse controller.
5	Bit sensed as 0 if positive roll commanded by minimum impulse controller.
4	Bit sensed as 0 if negative yaw commanded by minimum impulse controller.
3	Bit sensed as 0 if positive yaw commanded by minimum impulse controller.
2	Bit sensed as 0 if negative pitch commanded by minimum impulse controller.
1	Bit sensed as 0 if positive pitch commanded by minimum impulse controller.

Channel	Mnemonic	Powered	Coast & Align	Rendezvous	Entry/ Update
0033	CHAN33	94b	94b	94b	94b

Channel 33. A computer input channel for hardware status and command information. Bits 15-11 are flip-flop bits (which are reset by a channel "write" command) that are also reset when a restart is encountered.

Bit	Meaning
15	Bit sensed as 0 if the computer oscillator has stopped.
14	Bit sensed as 0 if a computer warning is produced. If bits 15-14 = 10_2, it is concluded that a restart loop exists and a fresh start is done.

Channel	Mnemonic	Powered	Coast & Align	Rendezvous	Entry/ Update
0033	CHAN33 (Cont.)	94b	94b	94b	94b

Bit	Meaning
13	Bit sensed as 0 if an accelerometer fail indication produced (PIPA fail). (See bit 13 of IMODES33).
12	Bit sensed as 0 if a telemetry end pulse rejected (downlink interrupt rate excessive). (See bit 12 of IMODES33).
11	Bit sensed as 0 if an uplink input bit is rejected, indicating an excessive uplink rate. (See bit 11 of IMODES33).
10	Bit sensed as 0 if spacecraft switches set by crew so as to inhibit uplink inputs from being loaded into erasable memory (and subsequently generating an uplink interrupt). The bit reads a binary 1 when the "accept uplink" signal is present at the interface.
9-6	Not assigned.
5	Bit sensed as 0 if computer control of optics is set. (See bit 5 of OPTMODES).
4	Bit sensed as 0 if zero mode is set. If bits 5-4 are both 1, the manual mode is selected. (See bit 4 of OPTMODES.)
3	Not assigned.
2	Bit sensed as zero if the Range Unit data is good.
1	Not assigned.

0077	CHAN77	69b	69b	69b	96b

Channel 77. A computer output channel, the individual bits of which are used to indicate the source of a hardware restart and/or AGC warning. The channel is initialized to 0 by a V36E (request fresh start). The channel will be zeroed by the final V33E on a P27 state vector uplink and also by a crew or ground V21N10E77EE. Should a hardware restart occur, one of the bits in the channel would be set to 1 indicating the source. If multiple restarts occur, more than one bit could possibly

Channel	Mnemonic	Powered	Coast & Align	Rendezvous	Entry/ Update
0077	CHAN77 (Cont.)	69b	69b	69b	96b

be left set afterwards (i.e., if they were different types). Many restarts of the same type would leave just one bit set with the register REDOCTR indicating the number. The bit definitions are:

Bit	Restart (and/or AGC warning) Cause
15-10	Spare
9	Scalar double frequency
8	Scalar fail
7	Counter fail
6	Voltage fail
5	Night Watchman
4	Rupt Lock
3	TC Trap
2	E-memory parity fail
1	E or F-memory parity fail

Note: A restart due to oscillator fail is not shown in this channel.

2.5 Flagbits

2.5.1 Alphabetic Listing of Flagbits and Locations

The following table is taken directly from the current program listing.

Flag name	Bit and Flag	Flag name	Bit and Flag	Flag name	Bit and Flag
.05GSW	BIT 3 FLAG 6	INFINFLG	BIT 7 FLAG 8	PRIODFLG	BIT 14 FLAG 4
360SW	BIT 1 FLAG 8	INRLSW	BIT 5 FLAG 6	PRONVFLG	BIT 7 FLAG 4
3AXISFLG	BIT 6 FLAG 5	INTFLAG	BIT 14 FLAG 10	PTV93FLG	BIT 4 FLAG 10
45/46FLG	BIT 6 FLAG 3	INTYPFLG	BIT 4 FLAG 3	QUITFLAG	BIT 5 FLAG 9
500**FLG	BIT 12 FLAG 3	ITERFLG	BIT 13 FLAG 2	R21MARK	BIT 14 FLAG 2
501**FLG	BIT 11 FLAG 3	ITSWICH	BIT 14 FLAG 7	R22CAFLG	BIT 7 FLAG 9
APSESW	BIT 5 FLAG 8	JSWITCH	BIT 14 FLAG 0	R27FLAG	BIT 12 FLAG 11
ASTNFLAG	BIT 12 FLAG 7	LATSW	BIT 4 FLAG 6	R27UP1	BIT 1 FLAG 11
ATMFLAG	BIT 11 FLAG 0	MANEUFLG	BIT 5 FLAG 10	R27UP2	BIT 2 FLAG 11
ATTCHFLG	BIT 2 FLAG 7	MARKFLG	BIT 4 FLAG 1	R31FLAG	BIT 4 FLAG 9
AUTOSEQ	BIT 7 FLAG 10	MAXDBFLG	BIT 12 FLAG 9	R53FLAG	BIT 6 FLAG 0
AVEGFLAG	BIT 1 FLAG 1	MID1FLAG	BIT 3 FLAG 9	R67FLAG	BIT 2 FLAG 8
AVEMIDSW	BIT 1 FLAG 9	MIDAVFLG	BIT 2 FLAG 9	REFSMFLG	BIT 13 FLAG 3
AZIMFLAG	BIT 8 FLAG 11	MKOVFLAG	BIT 3 FLAG 4	REINTFLG	BIT 13 FLAG 10
CALCMAN2	BIT 2 FLAG 2	MRKIDFLG	BIT 15 FLAG 4	REJCTFLG	BIT 12 FLAG 10
CMDAPARM	BIT 12 FLAG 6	MRKNVFLG	BIT 9 FLAG 4	RELVFLSW	BIT 9 FLAG 6
CM/DSTBY	BIT 2 FLAG 6	MRUPTFLG	BIT 5 FLAG 4	RENDWFLG	BIT 1 FLAG 5
COGAFLAG	BIT 4 FLAG 8	MWAITFLG	BIT 11 FLAG 4	REVFLAG	BIT 5 FLAG 2
CULTFLAG	BIT 7 FLAG 3	N22ORN17	BIT 6 FLAG 9	RNDVZFLG	BIT 7 FLAG 0
CYCLFLAG	BIT 11 FLAG 11	N77FLAG	BIT 9 FLAG 11	RVSW	BIT 9 FLAG 7
CYC61FLG	BIT 4 FLAG 0	NC12FLG	BIT 5 FLAG 0	SBFLAG	BIT 3 FLAG 2
DAPBIT1	BIT 15 FLAG 6	NCINTFLG	BIT 2 FLAG 0	SKIPVHF	BIT 10 FLAG 2
DAPBIT2	BIT 14 FLAG 6	NCLPFLG	BIT 9 FLAG 1	SLOPESW	BIT 3 FLAG 1
DIMOFLAG	BIT 1 FLAG 3	NEEDLFLG	BIT 9 FLAG 0	SNAPFLAG	BIT 6 FLAG 11
DRIFTFLG	BIT 15 FLAG 2	NEWIFLG	BIT 13 FLAG 8	SOLNSW	BIT 3 FLAG 5
DSKYFLAG	BIT 15 FLAG 5	NEWTFLAG	BIT 10 FLAG 5	SOURCFLG	BIT 8 FLAG 9
EGSW	BIT 8 FLAG 6	NJETSFLG	BIT 15 FLAG 1	STATEFLG	BIT 5 FLAG 3
ENG2FLAG	BIT 11 FLAG 1	NODOFLAG	BIT 1 FLAG 2	STEERSW	BIT 11 FLAG 2
ENGONFLG	BIT 7 FLAG 5	NODOP01	BIT 12 FLAG 1	STIKFLAG	BIT 14 FLAG 1
ENTRYDSP	BIT 13 FLAG 6	NORMSW	BIT 10 FLAG 7	STRULLSW	BIT 13 FLAG 6
ERADFLAG	BIT 13 FLAG 1	NOSWITCH	BIT 7 FLAG 6	SWTOVER	BIT 15 FLAG 9
ETPIFLAG	BIT 7 FLAG 2	NOUNFLG	BIT 10 FLAG 11	TARG1FLG	BIT 10 FLAG 1
EXTRANGE	BIT 9 FLAG 10	NRMIDFLG	BIT 13 FLAG 4	TCOMPFLG	BIT 6 FLAG 10
FINALFLG	BIT 6 FLAG 2	NRMNVFLG	BIT 8 FLAG 4	TDFLAG	BIT 3 FLAG 11
FIRSTFLG	BIT 7 FLAG 2	NRUPTFLG	BIT 4 FLAG 4	TERMIFLG	BIT 15 FLAG 7
FIXFLAG	BIT 7 FLAG 11	NWAITFLG	BIT 10 FLAG 4	TFFSW	BIT 1 FLAG 7
FREEFLAG	BIT 3 FLAG 0	ORDERSW	BIT 6 FLAG 8	TIMRFLAG	BIT 11 FLAG 7
FULTKFLG	BIT 2 FLAG 10	P21FLAG	BIT 12 FLAG 2	TPIMNFLG	BIT 3 FLAG 10
GAMDIFSW	BIT 11 FLAG 6	P25FLAG	BIT 4 FLAG 11	TRACKFLG	BIT 5 FLAG 1
GLOKFAIL	BIT 14 FLAG 3	P29FLAG	BIT 1 FLAG 0	UPDATFLG	BIT 7 FLAG 1
GONEBY	BIT 8 FLAG 7	P35FLAG	BIT 8 FLAG 10	UPLOCKFL	BIT 4 FLAG 7
GONEPAST	BIT 10 FLAG 6	P48FLAG	BIT 5 FLAG 11	UTFLAG	BIT 9 FLAG 8
GRRBKFLG	BIT 5 FLAG 5	P50FLAG	BIT 10 FLAG 0	V37FLAG	BIT 6 FLAG 7
GUESSW	BIT 2 FLAG 1	P50.1FLG	BIT 12 FLAG 0	V50N18FL	BIT 15 FLAG 3
GYMDIFSW	BIT 1 FLAG 6	P55.1FLG	BIT 13 FLAG 0	V96ONFLG	BIT 3 FLAG 8
HDSUPFLG	BIT 11 FLAG 10	PCFLAG	BIT 1 FLAG 10	VEHUPFLG	BIT 8 FLAG 1
HIND	BIT 6 FLAG 6	PCMANFLG	BIT 15 FLAG 10	VERIFLAG	BIT 3 FLAG 7
IDLEFAIL	BIT 6 FLAG 1	PDSPFLAG	BIT 12 FLAG 4	VFLAG	BIT 10 FLAG 3
IGNFLAG	BIT 13 FLAG 7	PFRATFLG	BIT 4 FLAG 2	VHFRFLAG	BIT 9 FLAG 9
IMPULSW	BIT 9 FLAG 2	PINBRFLG	BIT 6 FLAG 4	VINTFLAG	BIT 3 FLAG 3
IMUSE	BIT 8 FLAG 0	POOFLAG	BIT 9 FLAG 3	VNFLAG	BIT 2 FLAG 4
INCORFLG	BIT 11 FLAG 5	PRECIFLG	BIT 8 FLAG 3	XDELVFLG	BIT 8 FLAG 2
				XDSPFLAG	BIT 1 FLAG 4

2.5.2 Flagbit Definitions

FLAG	BIT	AGC MNEMONIC	SET 1 BY	1 INDICATES	CONDITIONS, COMMENTS	SET 0 BY	0 INDICATES	CONDITIONS, COMMENTS
0	15	Not Used						Should always be 0
0	14	JSWITCH	Orbital Integration	W-matrix is being integrated	Set only if DIM0FLAG (flag 3 bit 1) is 1	Orbital Integration	In integration, state vector is being integrated	
0	13	P55.1FLG	P55	P55 option 1 is operating		R00	P55 option 1 is not operating	
0	12	P50.1FLG	P50	P50 option 1 is operating		R00	P50 option 1 is not operating	
0	11	ATMFLAG	SXTSM	SXTSM should check digit C of STARCODE	Set at SXTSM when called by P51, P52, P53, P54	SXTSM R00	SXTSM should ignore digit C of STARCODE	
0	10	P50FLAG	P50	Inhibit gimbal lock alarm (401) in CALCGA during P50		CALCGA R00	Allow 401 alarm	
0	9	NEEDLFLG	V62 V63	CSM-alone or Docked DAP is to compute "total attitude error" and display it on FDAI error needles	N22ORN17 (flag 9 bit 6) determines whether the "total attitude error" is with respect to N22 or N17	V61	CSM-alone or Docked DAP is to display Mode I errors ("autopilot following errors") on FDAI error needles	
0	8	IMUSE	R02 P51 P53	IMU in use	R02 is performed by P20, P40, P41, P47, P48, P50, P52, P54, P55, P61, P62, R63	P06 Syst.Test V56 (or any other P20 termi-nation) V37 (with P20 off) R00 IMU Turnoff	IMU not in use	

FLAG	BIT	AGC MNEMONIC	SET 1 BY	1 INDICATES	CONDITIONS, COMMENTS	SET 0 BY	0 INDICATES	CONDITIONS, COMMENTS
0	7	RNDVZFLG	P20 (option 0,4)	Rendezvous navigation and tracking are enabled		P20 (option 1,2,5) P00 P06 P25 P48 V56 (or any other P20 termination) POODOO IMU Turnoff	Rendezvous navigation and tracking are not enabled	
0	6	R53FLAG	R53	R53 has been started		R52	R53 has not been started	
0	5	NC12FLG	P32	P32 (NC2) targeting computations to be performed		P31	P31 (NC1) targeting computations to be performed	
0	4	CYC61FLG	R61	First KALCMANU call from R61; indicates KALCMANU to return to R61		R61 STARTSB2	2nd KALCMANU call from R61; indicates KALCMANU to issue commands	
0	3	FREEFLAG	R54	Astronaut accepts star data test		R54	Astronaut rejects star data test	
0	2	NCINTFLG	P31 P32	Program to use conic integration of state vectors		P31 P32 P33	Program to use precision integration of state vectors	
0	1	P29FLAG	P29	P29 running, 1st pass of P29 logic is in progress		P29 R00	P21 running or P29 is finished with first pass	Reset after first pass of P29

FLAG	BIT	AGC MNEMONIC	SET 1 BY	1 INDICATES	CONDITIONS, COMMENTS	SET 0 BY	0 INDICATES	CONDITIONS, COMMENTS
1	15	NJETSFLG	R03 FRESHDAP	CSM-alone DAP X-translation will be 2 jet	Bit 10 of DAPDATR1 not = bit 7 of DAPDATR1	R03 FRESHDAP	CSM-alone DAP X-translation will be 4 jet	Bit 10 of DAPDATR1 = bit 7 of DAPDATR1
1	14	STIKFLAG	CSM-alone or Docked DAP	P20 automatic tracking to be inhibited because astronaut has deflected RHC; or |MGA| > 75 degrees		V58 V37	Neither condition that sets STIKFLAG has occurred	
1	13	ERADFLAG		Use Fischer ellipsoid to determine earth radius	This bit is never set to 1 in the SKYLARK program	P11 P21 P29 P67 R30	Use fixed earth radius	
1	12	NODOP01	P11	Prelaunch phase completed; selection of P01 and summing of uplink key codes prohibited	This bit is unchanged by Fresh Start	Pad load	Prelaunch phase in progress; P01 and summing of uplink codes permitted	
1	11	ENG2FLAG	P41	Thrusting will be done by RCS	For branching in common P40/P41 code and for proper thrust levels in preburn attitude computations	P40	Thrusting will be done by SPS	
1	10	TARG1FLG	P20(option 0,4) RELINUS (option 0,4)	R52 to track OWS		V37	R52 to track star	
1	9	NCLPFLG	P31 P32	Computing delta altitude error at NSR time in P31/P32		P31	Computing delta altitude error at NCC time in P31	
1	8	VEHUPFLG	P20 V81	CSM state vector is to be updated by rendezvous navigation measurements		V80	OWS state vector is to be updated by rendezvous navigation measurements	

FLAG	BIT	AGC MNEMONIC	SET 1 BY	1 INDICATES	CONDITIONS, COMMENTS	SET 0 BY	0 INDICATES	CONDITIONS, COMMENTS
1	7	UPDATFLG	P20 (option 0,4) P30 P31 P32 P33 P34 P35 P36 P37 P38 V37	Updating of state vector in P20 (by optics or VHF marks) is allowed		P30 P31 P32 P33 P34 P35 P36 P38 P52 P54 V37 V56 (or any other P20 termination)	Updating of state vector in P20 not allowed; the performance of the optics pointing computations in P52 for P20 is omitted and the performance of P22 computations is suppressed	Reset by targeting programs during comp cycle in order to avoid erasable conflict
1	6	IDLEFAIL	R40	Inhibit thrust fail monitor routine for 2 seconds	Set after PRO to V97	R00 R40	Allow thrust fail monitor routine	Reset after a 2-second delay from the time it was set.
1	5	TRACKFLG	P20 P21 P29 P30 P31 P32 P33 P34 P35 P36 P37 P38 V37 P52 P54	P20 permitted	 If P20 option 2 is active	P00D00 IMU Turnoff IMUCAGE IMUCOARS V56 (or any other P20 termination) V37	P20 inhibited	
1	4	MARKFLG	MARKRUPT	A mark exists which can be rejected	Set when new mark received	MRKREJCT MKRELEAS STARTSB2	No mark exists which can be rejected	Reset when current mark rejected, end of marking, or software or hardware restart
1	3	SLOPESW	LAMBERT	LAMBERT iterations have not started	Set only on first pass in LAMBERT; this bit is equivalent to the switch f(3) of Section 5.5 of this GSOP	ITERATOR	LAMBERT iterations have been started	Not reset if first pass results are satisfactory

FLAG	BIT	AGC MNEMONIC	SET 1 BY	1 INDICATES	CONDITIONS, COMMENTS	SET 0 BY	0 INDICATES	CONDITIONS, COMMENTS
1	2	GUESSW	INITVEL	No guess of COGA is available	Set in INITVEL only when called by P33, P35, P36 or LAMBERT Aimpoint Maneuver Prethrust Routine; this bit is equivalent to the switch f(1) of Section 5.5 of this GSOP	INITVEL S40.9	A guess of COGA is to be used by LAMBERT	
1	1	AVEGFLAG	PREREAD	Average-G is to cycle at 2 second intervals		V37	Average-G cycle is to be terminated	

FLAG	BIT	AGC MNEMONIC	SET 1 BY	1 INDICATES	CONDITIONS, COMMENTS	SET 0 BY	0 INDICATES	CONDITIONS, COMMENTS
2	15	DRIFTFLG	AVGEND P51 P52 P53 P54	Free flight gyro drift compensation enabled	Set in P52/P54 after pulse torquing; set in P51/P53 after PRO to V50N25 (R1 = 00015)	Coarse align PREREAD P06 P52 P54 IMU Turnoff IMUCAGE	Free flight gyro drift compensation disabled	
2	14	R21MARK	P20 (option 0,4) R23	Optics mark taken is for rendezvous navigation R23 marking is complete, resume regular optics marking	Set at PIKUP20 and PELINUS restart points Set at response to V53N45 or at terminate response to V06N94 in R23	P20 (option 1,2,5) V37 V54 V56 (or any other P20 termination) STARTSB2	Optics mark taken is not for rendezvous navigation Mark being processed by R22 is a backup mark (R23)	Reset at initiation of R23 (backup marking)
2	13	ITERFIG	P31 P32 P33	15 iterations have occurred in the subroutine ITER; non-convergence of a computational loop in P31, P32 or P33		P31 P32 P33	15 iterations have not occurred in subroutine ITER; computation loops in P31,P32 or P33 have converged	
2	12	P21FLAG	P21	Use base vector for calculation in P21	Set after base vectors computed.	STARTSB2 R00	Calculate base vector in P21	
2	11	STEERSW	P40	Cross-product steering, check for low thrust and time-to-engine cutoff computations to be made	Set 2 seconds after ignition if burn is not impulsive; set on a PRO to V97	R00 P40	Bypass steering computations	Reset if measured acceleration is less than an erasable constant or if time-to-go < 4 sec
2	10	SKIPVHF	STARTSB2	Restart (software, hardware, or V37) has occurred; VHF read routine disregards mark if it finds this bit on		R08	VHF read routine may process mark; no restart has occurred during read cycle	
2	9	IMPULSW	P40	Burn time <= 6 seconds	Set after completion of S40.13 at TIG-5	R00 P40	Burn time > 6 seconds	

FLAG	BIT	AGC MNEMONIC	SET 1 BY	1 INDICATES	CONDITIONS, COMMENTS	SET 0 BY	0 INDICATES	CONDITIONS, COMMENTS
2	8	XDELVFLG	P30 P31 P32 P34 P38	External delta-V targeting/guidance		P33 P35 P36	LAMBERT targeting/guidance	
2	7	FIRSTFLG	P40 P41	First pass through LAMBERT computations not completed	Set at start of S40.1	P40 P41	First pass through LAMBERT computations completed	Reset after first pass through LAMBERT computations completed
2	7	ETPIFLAG	P35	Elevation angle has been input to P35 and TPI time is to be computed	Set on PRO response to the initial V06N55 display in P35 if the elevation angle input in R2 was non-zero; this bit is equivalent to COMPE FLAG of Section 4 (P35) of this GSOP	P35	TPI time is input and an elevation angle is to be computed	Reset on PRO response to the initial V06N55 display in P35; reset on final pass in P35 during MINKEY if computed TPI time option was initially selected and a new time was manually loaded into N37
2	6	FINALFLG	P31 P32 P33 P34 P35 P36 P38	The final pass through rendezvous targeting program is to be performed	Set at first PRO response to V16N45	P31 P32 P33 P34 P35 P36 P38	The final pass through rendezvous targeting program has not been requested	Reset before first V16N45 display; controls setting of UPDATFLG (flag 1 bit 7), and controls program performance for response to the V16N45 display
2	5	REVFLAG	P33	GET.LVC is only to compute matrix	Set after PRO on V06N81	GET.LVC STARTSB2	GET.LVC is to compute matrix and rotate velocity vector	Reset before leaving GET.LVC
2	4	PFRATFLG	P40 P41 P52	XSMD contains a preferred orientation		P52 P54 P40 P41	XSMD does not contain a preferred orientation	Reset at TIG-30 in P40/P41
2	3	SBFLAG	P40	Complex Short Burn Routine has been requested - Average-G routine will accumulate the PIPAs	Set at start of P40 and at ENTR response to V97	P00 P40	Complex Short Burn Routine is not to be used	Reset at TIG-5 if predicted burn time < 1 second or > 6 seconds

FLAG	BIT	AGC MNEMONIC	SET 1 BY	1 INDICATES	CONDITIONS, COMMENTS	SET 0 BY	0 INDICATES	CONDITIONS, COMMENTS
2	2	CALCMAN2	R67RSTRT WCALCEND	Attitude maneuver calculations are complete, information is ready to be communicated to DAP for start of maneuver	Setting the bit causes the maneuver steering code to perform initialization	NEWDELHI	The maneuver start branch should not be taken in the steering logic	
2	1	NODOFLAG	Periodic P00-type integration P06 P62 P77	V37 selection of any program other than P00 is prohibited		POODOO Periodic P00-type integration V37 selection of P00 P06 (after clock reset) P77	Normal V37 selection of new program is permitted	

FLAG	BIT	AGC MNEMONIC	SET 1 BY	1 INDICATES	CONDITIONS, COMMENTS	SET 0 BY	0 INDICATES	CONDITIONS, COMMENTS
3	15	V50N18FL	P20 V58 V37	Allow R60 attitude maneuver in P20	Set during P20 initialization Set by extended verb to enable automatic maneuver in P20 Set by any major mode change except P00	R61CSM	Inhibit R60 attitude maneuver in P20	
3	14	GLOKFAIL	CALCGA	Desired MGA >60 degrees results in a code 401 program alarm	CALCGA called by P50, P52, P54, P62, P64, P66, IMU Performance Test; however, if P50 is the caller, CALCGA will not set bit	R00 IMU Perform-ance Test		
3	13	REFSMFLG	P11 P51 P52 P53 P54	REFSMMAT is valid (alignment of IMU in inertial space is known)	This bit unchanged by Fresh Start	Coarse Align IMUCAGE P06 P51 P52 P53 P54 IMU Turnoff	REFSMMAT is not valid	Reset temporarily in P51/P53, P52/P54
3	12	500**FLG	Docked DAP	There has been a 500 alarm since R04	500 alarm means not enough jets enabled for some pitch or yaw command	R04	There has not been a 500 alarm since R04	Reset on PRO response to V05N87 display in R04; reset on data ENTR response to V06N89 display in R04
3	11	501**FLG	Docked DAP	There has been a 501 alarm since R04	501 alarm means not enough jets enabled for some roll command	R04	There has not been a 501 alarm since R04	Reset on PRO response to V05N87 display in R04; reset on data ENTR response to V06N89 display in R04
3	10	VFLAG	P52 P54	Suitable star pair has not been found		P52 P54	Suitable star pair has been found	
3	9	POOFLAG	STATINT1	Periodic integration is being done	Set for P00 or P20 (option 1,2,5)	P00	Periodic integration is not being done	

FLAG	BIT	AGC MNEMONIC	SET 1 BY	1 INDICATES	CONDITIONS, COMMENTS	SET 0 BY	0 INDICATES	CONDITIONS, COMMENTS
3	8	PRECIFLG	Orbital Integration STATINT1	Do normal integration although POOFLAG (flag 3 bit 9) is set	Enables extended verb integration in P00 or P20 (options 1,2,5) Set by CSMPREC, LEMPREC, INTEGRVS and STATINT1 when integrating OWS state vector	Orbital Integration	Engage periodic integration logic	Tested only if POOFLAG (flag 3 bit 9) is set Reset at exit from Orbital Integration
3	7	CULTFLAG	P52 P54 R52	Star being examined is occulted by sun or earth; or, in R52, required sextant trunnion angle >90 deg		P52 P54 R52	Star is not occulted; or, in R52, required sextant trunnion angle < or = 90 deg	
3	6	45/46FLG	V45	V45 was last DAP turn-on extended verb	Used to determine correct setting of WHICHDAP	V46	V46 was last DAP turn-on extended verb	
3	5	STATEFLG	Orbital Integration (if W-matrix overflows) SETIFLGS SETINTG	Permanent state vector is to be updated by Orbital Integration	Setting of this bit for permanent integration is done by P20 (options 0,4) upon entry and for marking, by AVETOMID (for OWS state vector only), and by periodic integration in P00 and P20 (options 1,2, and 5)	Orbital Integration POODOO ENDINT	Permanent state vector not to be updated	Reset by Orbital Integration if QUITFLAG (flag 9 bit 5) is set and upon completion of integration
3	4	INTYPFLG	CSMCONIC LEMCONIC INTINT QRDTPI NC12INT R31 R34	Conic state vector extrapolation to be done in Orbital Integration		CSMPREC LEMPREC MIDTOAVE SETIFLGS INITVEL INTINT QRDTPI NC12INT SETINTG R31 R34 P21 P29 P33 P77	Precision state vector extrapolation is to be done in Orbital Integration	

FLAG	BIT	AGC MNEMONIC	SET 1 BY	1 INDICATES	CONDITIONS, COMMENTS	SET 0 BY	0 INDICATES	CONDITIONS, COMMENTS
3	3	VINTFLAG	AVETOMID CSMCONIC CSMPREC SETINTG R22 P21 P29 STATEUP R41	Extrapolate CSM state vector		AVETOMID LEMCONIC LEMPREC R22 P21 P29 STATEUP	Extrapolate OWS state vector	
3	2	Not Used						Should always be 0
3	1	DIMOFLAG	AVETOMID P20 R22 STATEUP	W-matrix to be integrated	Set if RENDWFLG (flag 5 bit 1) is set	Orbital Integration MIDTOAVE INTEGRVS CSMCONIC LEMCONIC CSMPREC LEMPREC SETIFLGS SETINTG P21 P29	W-matrix not to be integrated	Orbital Integration (if W-matrix overflows)

FLAG	BIT	AGC MNEMONIC	SET 1 BY	1 INDICATES	CONDITIONS, COMMENTS	SET 0 BY	0 INDICATES	CONDITIONS, COMMENTS
4	15	MRKIDFLG	Display interface routines	Mark or extended verb display is in ENDIDLE		Display interface routines STARTSB2	No mark or extended verb display is in ENDIDLE	
4	14	PRIODFLG	Display interface routines	Priority display is in ENDIDLE		Display interface routines STARTSB2	No priority display is in ENDIDLE	
4	13	NRMIDFLG	Display interface routines	Normal display is in ENDIDLE		Display interface routines STARTSB2	No normal display is in ENDIDLE	
4	12	PDSPFLAG	P20	Priority display status exists		P20 STARTSB2	Priority display status does not exist	
4	11	MWAITFLG	Display interface routines	Higher priority display operating when mark or extended verb display initiated		Display interface routines STARTSB2	No higher priority display operating when mark or extended verb display initiated	
4	10	NWAITFLG	Display interface routines	Higher priority display operating when normal display initiated		Display interface routines STARTSB2	No higher priority display operating when normal display initiated	
4	9	MRKNVFLG	Display interface routines	Astronaut using keyboard when mark or extended verb display initiated		Display interface routines STARTSB2	Astronaut not using keyboard when mark or extended verb display initiated	
4	8	NRMNVFLG	Display interface routines	Astronaut using keyboard when normal display initiated		Display interface routines STARTSB2	Astronaut not using keyboard when normal display initiated	
4	7	PRONVFLG	Display interface routines	Astronaut using keyboard when priority display initiated		Display interface routines STARTSB2	Astronaut not using keyboard when priority display initiated	
4	6	PINBRFLG	Display interface routines	Astronaut has interfered with existing display; or mark/extended verb display terminated while bit 13 or 14 is set to 1		Display interface routines STARTSB2	Astronaut has not interfered with existing displays	

FLAG	BIT	AGC MNEMONIC	SET 1 BY	1 INDICATES	CONDITIONS, COMMENTS	SET 0 BY	0 INDICATES	CONDITIONS, COMMENTS
4	5	MRUPTFLG	Display interface routines	Mark/extended verb display interrupted by priority display		Display interface routines STARTSB2	Mark/extended verb display not interrupted by priority display	
4	4	NRUPTFLG	Display interface routines	Normal display interrupted by priority or mark/extended verb display		Display interface routines STARTSB2	Normal display not interrupted by priority or mark/extended verb display	
4	3	MKOVFLAG	Display interface routines	Mark/extended verb display over normal display		Display interface routines STARTSB2	No mark/extended verb display over normal display	
4	2	VNFLAG	VNFLASH VNFLASHR	Display is a VNFLASH display		Response to display STARTSB2	Display is not a VNFLASH display	
4	1	XDSPFLAG	Display interface routines	Mark/extended verb display status exists		Display interface routines STARTSB2	No special mark/extended verb information	

FLAG	BIT	AGC MNEMONIC	SET 1 BY	1 INDICATES	CONDITIONS, COMMENTS	SET 0 BY	0 INDICATES	CONDITIONS, COMMENTS
5	15	DSKYFLAG	KEYRUPT	A DSKY key has been depressed; DSKY data should be displayed	Not set 1 by Uplink		Leave DSKY blank	Not set to 0 except by Fresh Start
5	14	Not Used						Should always be 0
5	13	Not Used						Should always be 0
5	12	Not Used						Should always be 0
5	11	INCORFLG	R22	1st incorporation computation of observation data into the state vector is in progress	Enable magnitude checks leading to a possible V06N49 display in R22	R22	1st incorporation computation of observation data into the state vector is complete	
5	10	NEWTFLAG	P29	Set temporarily in P29 to indicate new iteration of longitude calculation		R00 P29	Normal operation of P29	
5	9	Not Used						Should always be 0
5	8	Not Used						Should always be 0
5	7	ENGONFLG	P40	SPS engine on command has been generated (Chan 11 bit 13 set to 1)		P40 IMUCAGE R00	Chan 11 bit 13 has been set to 0 by the program	
5	6	3AXISFLG	P20 (option 4,5) V49 (R62)	R60 is to perform a 3-axis maneuver		P40/P41 V89 (R63) P20 (option 0,1)	R60 is to perform a VECPOINT maneuver	
5	5	GRRBKFLG	V75	Backup liftoff has been requested to initiate P11 from P02			Backup liftoff has not been requested	Not set to 0 except by Fresh Start
5	4	Not Used						Should always be 0

FLAG	BIT	AGC MNEMONIC	SET 1 BY	1 INDICATES	CONDITIONS, COMMENTS	SET 0 BY	0 INDICATES	CONDITIONS, COMMENTS
5	3	SOLNSW	Time-radius LAMBERT SUFFCHEK	Required parameters not computed by conic subroutines due to non-convergence to the transfer time or if angle between the two input position vectors was less than about 1/2 minute of arc	This bit is never tested by the program; time-radius subroutine is not used in the SKYLARK program; this bit is equivalent to the switch f(5) + f(9) of Section 5.5 of this GSOP	Time-radius LAMBERT	Required parameters have been computed by conic subroutines	
5	2	Not Used						Should always be 0
5	1	RENDWFLG	R22	W-matrix is considered valid for rendezvous navigation in R22; W-matrix to be integrated in AVETOMID and in periodic P00-type integration	Set in R22 after processing of a set of mark information has been started	Orbital Integration P27 V93	W-matrix is not valid; W-matrix is not to be integrated	Reset by Orbital Integration if W-matrix integration overflows. Reset by P27 on state vector update

FLAG	BIT	AGC MNEMONIC	SET 1 BY	1 INDICATES	CONDITIONS, COMMENTS	SET 0 BY	0 INDICATES	CONDITIONS, COMMENTS
6	15 14	DAPBIT1 DAPBIT2		These bits are used as a pair to indicate which DAP configuration has been selected: 11 Saturn DAP 10 TVC DAP 01 RCS DAP 00 None (or Entry)	Set to 11 in SATSTKON (V46 when bits 14-13 of DAPDATR1 = 11) Set to 10 at 0.4 seconds after ignition (P40) Set to 01 in RCSDAPON (V45 and V46 when bits 14-13 of DAPDATR1 unequal; or P40 after TVC shutdown) Set to 00 at EXDAPOFF (V46 when bits 14-13 of DAPDATR1 = 00), ignition (P40), CM/DAPON (P62)			These bits are unchanged by V46 during TVC DAP.
6	13	STRULLSW	P40	Non-impulsive burn	Set STEERSW (flag 2 bit 11) at ignition + 2 seconds to permit steering and time-to-cutoff calculations	P40 R00	Impulsive burn	Do not set STEERSW (flag 2 bit 11) at ignition + 2 seconds
6	13	ENTRYDSP	P62.1 STARTENT P65.1 P66END	Actuates Entry current display nouns when Entry exit code sequence is used	Set after response to N61 Set after PRO to N69	P65.1 P62 R00	Suppresses display	Reset before N69 is displayed
6	12	CMDAPARM	CM/DAPON	Entry DAP "armed" (allow Entry firings and calculations)	Set shortly after GAMDIFSW (flag 6 bit 11) becomes 1 (within 0.5 seconds)	P62	Inhibit Entry firings and calculations; Entry DAP computations halted after computation of vehicle body rates	Reset shortly before start of V50N25(R1= 41) display

FLAG	BIT	AGC MNEMONIC	SET 1 BY	1 INDICATES	CONDITIONS, COMMENTS	SET 0 BY	0 INDICATES	CONDITIONS, COMMENTS
6	11	GAMDIFSW	P62	Initialization of Entry DAP computations permitted; Entry DAP quantity to be computed as the first difference of the present and previous values of a cell	Set within 2 seconds of the Average-G cycle following reset	P62	Initialization of Entry DAP computations inhibited	Reset shortly before start of V50N25(R1= 41) display
6	10	GONEPAST	P63 P67	Prevent lateral control before drag > 0.05g; No lateral control computations; desired lift set to maximum down provided no g-limiter constraints are violated	Set in P67 if bit 8 of flag 7 is sensed as 1 (hence is a latched version of bit 8 of flag 7)	P63	0.05g sensed - allow lateral control calculations	Reset near start of P63
6	9	RELVELSW	Entry targeting	Earth relative velocity to be used for Entry targeting and computations	Set if EGSW (flag 6 bit 8) is 1 and Average-G output indicates VMAG < 12883.1 FPS	P63	Inertial velocity to be used for Entry targeting and computations	Reset near start of P63
6	8	EGSW	P67	Final phase of the Entry computations	Used by targeting for range prediction	P63	Not final phase of Entry calculations	
6	7	NOSWITCH	P65	Lateral reversal of roll command during present steering cycle inhibited	If drag > 140 ft/sec/sec	P63 LIMITL/D	Lateral reversal of roll command during present steering cycle permitted	Reset after start of P63
6	6	HIND	Entry DAP	HUNTEST iteration calculations are to be performed	Set after range prediction	P63 PREHUNT	HUNTEST iteration calculations are not to be performed	Reset near start of P63 This bit expected to remain 0 for the SKYLARK Program
6	5	INRLSW	P63	Sensed drag > 0.05g	Set first time drag > 0.05g	P63	Not yet sensed drag > 0.05g	Reset near start of P63
6	4	LATSW	P62 P63	No roll "over the top" required (downlift not inhibited)	Set shortly before start of V50N25(R1= 41) display Set near the start of P63 and after roll "over the top"	NEGTESTS	Enforce a roll "over the top" (downlift inhibited)	

FLAG	BIT	AGC MNEMONIC	SET 1 BY	1 INDICATES	CONDITIONS, COMMENTS	SET 0 BY	0 INDICATES	CONDITIONS, COMMENTS
6	3	.05GSW	Entry targeting	Sensed drag > 0.05g	Controls nature of computations to be performed Bit set to 1 by Fresh Start	P61 P62 P63 Entry targeting	Sensed drag < 0.05g	
6	2	CM/DSTBY	P62	Entry DAP not to be in standby (i.e., it is activated)	Set shortly before start of V50N25(R1=41) display	P67.1 AVGEND	Entry DAP not activated	Reset after response to V16N67
6	1	GYMDIPSW	READGYMB	CDU differences and body rates can be computed and computations continued subject to other bits such as CMDAPARM (flag 6 bit 12)	Set if CMDSTBY (flag 6 bit 2) is 1 and bit 6 of IMODES33 is 0	P62 P67.1 READGYMB	Neither CDU differences nor body rates can be computed nor computations continued	Reset shortly before start of V50N25(R1= 41) display Reset if bit 6 of IMODES33 is 1 Reset after response to V16N67 display

FLAG	BIT	AGC MNEMONIC	SET 1 BY	1 INDICATES	CONDITIONS, COMMENTS	SET 0 BY	0 INDICATES	CONDITIONS, COMMENTS
7	15	TERMIFLG	R53	R53 has been completed		R52	R53 not complete	
7	14	ITSWICH	P34 P35	A solution for TPI time has not yet been reached		P35	A solution for TPI time has been reached	Reset at response to V06N55 if only TPI time is input (N37) and elevation angle is to be computed (R2 of N55 = 0)
7	13	IGNFLAG	P40	Nominal ignition time has arrived; ignition to be performed on PRO response to V99	Set at TIG-0 and at ENTR response to V97	R00	Nominal ignition time has not arrived	
7	12	ASTMFLAG	P40	SPS engine-on has been authorized by the crew; ignition to be performed when nominal ignition time occurs	Set at PRO response to V99	R00 P40	SPS engine-on has not been authorized by the crew	Reset at ENTR response to V97
7	11	TIMRFLAG	P30 P31 P32 P33 P34 P35 P36 P38 P40 P41	Permit time-to-go calculations (in CLOKTASK) to continue		R00 P30 P31 P32 P33 P34 P35 P36 P38 P40 P41	Terminate time-to-go calculations (in CLOKTASK)	

FLAG	BIT	AGC MNEMONIC	SET 1 BY	1 INDICATES	CONDITIONS, COMMENTS	SET 0 BY	0 INDICATES	CONDITIONS, COMMENTS
7	10	NORMSW	INITVEL	Unit normal vector is input to LAMBERT routine	Set when target vector lies inside "the cone", ("the cone" is a mathematically-defined cone whose vertex is the origin of coordinates, whose axis is the 180 deg transfer direction, and whose semi-cone angle is specified to INITVEL); this bit is equivalent to the switch f(2) of Section 5.5 of this GSOP ; this bit is equivalent to the switch S(R) of Section 5.3.3 of this GSOP	INITVEL PARAM	LAMBERT is to compute its own unit normal vector	Reset when target vector lies outside "the cone"
7	9	RVSW	P31 P32 P35 P38	Time-theta and Time-radius routines are to compute only the time required to transfer through the specified transfer angle or to the specified radius respectively	This bit is equivalent to the switch f(6) of Section 5.5 of this GSOP	P29 P31 P32 P34	Time-theta and Time-radius are to compute the state vector at the terminal point in addition to the transfer time	
7	8	GONEBY	Entry targeting	Vehicle has passed target; R3 of N64 and R1 of N67 are positive		Entry targeting	Vehicle approaching target; R3 of N64 and R1 of N67 are negative	
7	7	Not used						Should always be 0
7	6	V37FLAG	PRERAD	Average-G is operating		AVGEND	Average-G is not operating	Reset at completion of final Average-G cycle after orbital state vector has been updated
7	5	Not Used						Should always be 0

FLAG	BIT	AGC MNEMONIC	SET 1 BY	1 INDICATES	CONDITIONS, COMMENTS	SET 0 BY	0 INDICATES	CONDITIONS, COMMENTS
7	4	UPLOCKFL	UPRUPT	Failure of the CCC data check has been detected in processing an input from the uplink receiver	While this bit is 1, all uplink information except "error reset" code is rejected by the uplink program	UPRUPT	No CCC data check failure has occurred	This bit is reset when "error reset" code is received via uplink; the DSKY RSET key does not reset this bit
7	3	VERIFLAG	P27		Value of this bit is complemented when final V33 entry received in P27; indicates uplink information will be used to update erasable memory	P27		
7	2	ATTCHFLG	S41.2	Bits 14,13 of DAPDATR1 = 10 (LM attached)	This bit is not tested by the program	S41.2	Bits 14,13 of DAPDATR1 not = 10	
7	1	TPFSW	CALCTPER	Calculate time of perigee for R30	Set if perigee altitude > or = 300,000 ft.	CALCTPF	Calculate time of free fall to interface altitude for R30 or time to EMS altitude for P61	

FLAG	BIT	AGC MNEMONIC	SET 1 BY	1 INDICATES	CONDITIONS, COMMENTS	SET 0 BY	0 INDICATES	CONDITIONS, COMMENTS
8	15	Not Used						Should always be 0
8	14	Not Used						Should always be 0
8	13	NEWIFLG	Orbital Integration	1st time step in Orbital Integration; do 4 time-step logic	Tested only if POOFLAG is set and PRECIFLG is reset	Orbital Integration	Not 1st time step in Orbital Integration	
8	12	Not Used						Should always be 0
8	11	Not Used						Should always be 0
8	10	Not Used						Should always be 0
8	9	UTFLAG	P20 (option 1,2,5)	P20 option 1, 2, or 5 is operating		P00 P06 P20 (option 0,4) V56 (or any other P20 termination) POODOO IMU Turnoff	P20 option 1, 2, or 5 not operating	
8	8	Not Used						Should always be 0
8	7	INFINFLG	Time-theta Time-radius	No solution can be computed (transfer required past a hyperbolic asymptote)	Time-radius subroutine is not used in the SKYLARK program; this bit is equivalent to the switch f(7) of Section 5.5 of this GSOP	Time-theta Time-radius	Physical solution has been obtained or has not yet been attempted	
8	6	ORDERSW			Never set to 1; this bit is equivalent to the switch f(4) of Section 5.5 of this GSOP		ITERATOR uses 1st order standard mode	

FLAG	BIT	AGC MNEMONIC	SET 1 BY	1 INDICATES	CONDITIONS, COMMENTS	SET 0 BY	0 INDICATES	CONDITIONS, COMMENTS
8	5	APSESW	Time-radius	Desired radius was greater than radius of apocenter or less than radius of pericenter	Time-radius subroutine is not used in the SKYLARK program; this bit is equivalent to the switch f(8) of Section 5.5 of this GSOP	Time-radius	Desired radius was between pericenter and apocenter radii	
8	4	COGAFLAG	Time-theta Time-radius	No solution exists (flight path angle < 1 deg 47.5 min or > 178 deg 12.5 min.)	Time-radius subroutine is not used in the SKYLARK program	Time-theta Time-radius	Solution is possible	
8	3	V96ONFLG	V96	P00 integration is inhibited		Periodic P00-type integration	P00 integration is enabled	
8	2	R67FLAG	R67	R67 is active		V37 R67 V56 (or any other P20 termi-nation)	R67 is not active	Reset in R67 if TRACKFLG = 0
8	1	360SW	Time-theta Time-radius LAMBERT	Transfer angle near 360 degrees	Time-radius subroutine is not used by the SKYLARK program; this bit is equivalent to the switch f(w) of Section 5.5, fig 5.10-4 of this GSOP	Time-theta Time-radius LAMBERT	Transfer angle not near 360 degrees	

FLAG	BIT	AGC MNEMONIC	SET 1 BY	1 INDICATES	CONDITIONS, COMMENTS	SET 0 BY	0 INDICATES	CONDITIONS, COMMENTS
9	15	SWTOVER	SWICHOVR	Switch-over to low bandwidth CSM/LM DAP filter has occurred	Set in V46 if bits 14,13 of DAPDATR1 = 10	R00 TVCINIT	No switch-over has occurred	"0" is normal state
9	14	Not Used						Should always be 0
9	13	Not Used						Should always be 0
9	12	MAXDBFLG	R03	5-degree deadband was selected in R03		R03	0.5-degree deadband was selected in R03	
9	11	Not Used						Should always be 0
9	10	Not Used						Should always be 0
9	9	VHFRFLAG	V87	R22 permitted to accept range data		V37 V88	R22 inhibited from accepting range data	Will not be reset when changing major mode during MINKEY sequence
9	8	SOURCFLG	R22	Source of input data is VHF radar		R22	Source of input data is optics	
9	7	R22CAFLG	R22	Optics mark is being processed	When set, a MARK REJ or V86 will prevent mark incorporation into the state vector	R22	Optics mark is not being processed	
9	6	N22ORN17	V62	Use angles stored in N22 to compute "total attitude error" for FDAI display		V63	Use angles stored in N17 to compute "total attitude error" for FDAI display	
9	5	QUITFLAG	V96	V96 has been selected, causing integration (if any) to be terminated and program to transfer to P00, with periodic integration inhibited	P00 integration is inhibited until a new program (except P27) is selected	P00	V96 has not been selected; or V96 has been selected and has been processed	
9	4	R31FLAG	P37 V83	R31 selected		V85	R34 selected	
9	3	MID1FLAG	MIDTOAV1	MIDTOAV1 called integration		MIDTOAV2 NOTIME	MIDTOAV2 called integration; or TIG-30 < 12.5 seconds in the future	

FLAG	BIT	AGC MNEMONIC	SET 1 BY	1 INDICATES	CONDITIONS, COMMENTS	SET 0 BY	0 INDICATES	CONDITIONS, COMMENTS
9	2	MIDAVFLG	R41 (MID TO AVE)	Integration was called by R41		INTEXIT	Integration was not called by R41	
9	1	AVEMIDSW	AVETOMID	Writing of CSM state vector into downlink registers is inhibited	Purpose of current integration is to synchronize W-matrix	INTEXIT	Writing of CSM state vector into downlink registers is permitted	

FLAG	BIT	AGC MNEMONIC	SET 1 BY	1 INDICATES	CONDITIONS, COMMENTS	SET 0 BY	0 INDICATES	CONDITIONS, COMMENTS
10	15	PCMANFLG	R07	P20 is to exit after plane change attitude maneuver	Set before call to P20 after plane change burn	R07 V37	P20 may operate normally	Reset upon completion of attitude maneuver; will not be reset when changing major mode in a MINKEY sequence
10	14	INTPLAG	INTSTALL	Some program or routine has called INTSTALL and is in the process of integrating; other users desiring to use integration must wait	INTSTALL is a subroutine called by all programs and routines prior to using integration, in order to avoid sharing of integration erasable registers	INTWAKE GOPROG GOPROG2 ENEMA	No program or routine is currently using integration; the integration routines are free to be used by the next caller of INTSTAIL, unless REINTFLG (flag 10 bit 13) is 1	
10	13	REINTFLG	All programs having restart points during integration	Integration currently in progress is to be restarted		INTWAKE POODOO	Current integration, if any, is not restartable	
10	12	REJCTFLG	MARK REJ V86	Optics mark currently being processed by R22 has been rejected		R22	Optics mark being processed by R22 has not been rejected	
10	11	HDSUPFLG		"Heads Up" tracking attitude (AZIMANGL initialized to 0 degrees)	This bit is unchanged by Fresh Start; this bit is normally pad loaded as "1"		"Heads Down" tracking attitude (AZIMANGL initialized to 180 degrees)	This bit is set or reset by ground or crew action
10	10	Not Used						Should always be 0
10	9	EXTRANGE	R61	R63RANGE (computed in R61) is valid	R63RANGE is used by R08 to determine if range > 327.68 n.m.	V37	R63RANGE is invalid	
10	8	P35FLAG	P36	TPM targeting has been completed	Set on final pass through P36	R22	TPM targeting has not been completed	Reset after W-matrix is initialized

FLAG	BIT	AGC MNEMONIC	SET 1 BY	1 INDICATES	CONDITIONS, COMMENTS	SET 0 BY	0 INDICATES	CONDITIONS, COMMENTS
10	7	AUTOSEQ	R00	MINKEY automatic sequence operating	Set temporarily at selection of all rendezvous targeting programs for purpose of P20 initialization	R00 V56 (or any other P20 termination) P00D00	MINKEY not operating	
			R07		Set on PRO response to V50N25 (R1 = 17)	R07		Reset on ENTR response to V50N25 (R1 = 17)
						V37		V37 DSKY selection of any program
10	6	TCOMPFLG	P52	During MINKEY plane change pulse torquing, the Z-gyro will be torqued -45 degrees the first time and +45 degrees the second time	Set in P52 when COS(CDUY) and delta V(Y local vertical) have different signs	P52	During MINKEY plane change pulse torquing, the Z-gyro will be torqued +45 degrees and then -45 degrees	Reset when COS(CDUY) and delta V(Y local vertical) have the same sign
10	5	MANEUFLG	P31 P32 P33 P34 P35 P36 R07	No mark has been incorporated since the last final computation cycle of rendezvous targeting program	Set after second PRO response to V16N45 display and on PRO response to V50N25 (R1 = 17) if RENDWFLG (flag 5 bit 1) = 0	R22		Reset after mark incorporation
10	4	PTV93FLG	R22	W-matrix initialization to be performed after the next burn	Set if age of W-matrix and other criteria indicate W-matrix initialization is desired after next burn	R22		Reset when W-matrix initialized
			R07		Set in R07 on PRO response to V50N25 (R1=17) if RENDWFLG (flag 5 bit 1) = 0			
10	3	TPIMNFLG	P35	TPI targeting has been completed	Set on final pass in P35	P35	TPI targeting has not been completed	Reset on entrance to P35
			P36		Set on entrance to P36	V37		This bit will not be reset when changing major mode in an automatic MINKEY sequence

FLAG	BIT	AGC MNEMONIC	SET 1 BY	1 INDICATES	CONDITIONS, COMMENTS	SET 0 BY	0 INDICATES	CONDITIONS, COMMENTS
10	2	FULTKFLG	V57	Only one type of marking (optics or VHF) is being performed for rendezvous navigation	Crew option (load)	V57	Both optics and VHF are being used for rendezvous navigation	Crew option (load)
10	1	PCFLAG	P38	Plane change targeting (P38) and first entrance to P52 for MINKEY plane change pulse torquing	Set on selection of P38	P31 P32 P33 P34 P35 P36 P37 P52 R07	Not plane change targeting	Reset by selection of P31 - P37; at PRO response to V50N25 (R1 = 17); Reset when pulse torquing done in P52 in first MINKEY selection

FLAG	BIT	AGC MNEMONIC	SET 1 BY	1 INDICATES	CONDITIONS, COMMENTS	SET 0 BY	0 INDICATES	CONDITIONS, COMMENTS
11	15	Not Used						Should always be 0
11	14	Not Used						Should always be 0
11	13	Not Used						Should always be 0
11	12	R27FLAG	V76	Allow R27 to be called from R22		P20 V77	Inhibit R27 in R22	Reset on entrance to P20
11	11	CYCLFLAG	P48	R27 in P48 has not yet finished its mark processing		V37 P48	R27 in P48 has completed its mark processing	
11	10	NOUNFLG	R27	Display N77 in P25 and P48		R27	Display N76 in P25 and P48	
11	9	N77FLAG	R27	R1 and R2 of N77 remain static	N77 holds either last current or optimized range and range rate	R27	R1 and R2 of N77 are being updated	
11	8	AZIMFLAG	P20 (option 4,5) R07	P20 (option 4 or 5) operating; R61 attitude maneuvers to be 3-axis		P20 (option 0,1,2) V89	R61 attitude maneuvers to be VECPOINT	
11	7	FIXFLAG	R27	R27 is optimizing range and range rate for a given time	Optimizing interval is optimization time +/- 95 seconds	R27	R27 is updating range and range rate for the current time	
11	6	SNAPFLAG	R27	Optimization time is 20 seconds or less in the future	R27 inhibits R22 state vector updates; R3 of N77 remains static at -00001	R27 V37	Optimization time is in the past or >20 seconds in the future	R27 does not inhibit R22 state vector updates
11	5	P48FLAG	P48	Program is P48		V37 P47	Program not P48	
11	4	P25FLAG	P25	Program is P25		V37	Program not P25	
11	3	TDFLAG	R27	Either Phi or Theta at the time of optimization has been computed	R3 of N77 remains static at value computed at optimization time	V37 R27	Angle at time of optimization not yet computed	R3 of N77 is updated (except in P25)
11	2	R27UP2	R27	Second initialization pass in R27 complete	Set after first estimate of range state vector	V37 V76	Second pass in R27 not yet complete	
11	1	R27UP1	R27	First initialization pass in R27 complete	Set after first mark has been stored	V37 V76	First pass in R27 not yet complete	

2.6 Effects of Fresh Start (V36) and Hardware Restart on Flagword and Channel Bits

Flagword	Downlist Word	Fresh Start (V36)					Hardware Restart				
		15-13	12-10	9 8 7	6 5 4	3 2 1	15-13	12-10	9 8 7	6 5 4	3 2 1
0	40	000	000	000	000	000	UUU	UUU	UUU	UU0	UUU
1	40	000	U00	000	000	000	UUU	UUU	UUU	UC0	UUU
2	41	000	000	000	000	000	C0U	0U1	UUU	U0U	UUU
3	41	00U	000	000	000	000	UUC	UUU	UUU	UUU	UUU
4	42	000	000	000	000	000	000	000	000	000	000
5	42	000	000	000	000	000	UUU	UUU	UUU	UUU	UUU
6	43	000	000	000	000	100	UUU	UUU	UUU	UUU	UUU
7	43	000	000	000	000	000	UUU	UUU	UUU	UUU	UUU
8	44	000	000	000	000	000	UUU	UUU	UUU	UUU	UUU
9	44	000	000	000	000	000	UUU	UUU	UUU	UUU	UUU
10	(varies)	000	0U0	000	000	000	U0U	UUU	UUU	UUU	UUU
11	(varies)	000	000	000	000	000	UUU	UUU	UUU	UUU	UUU
Channel	Downlist Word	Fresh Start (V36)					Hardware Restart				
11	91	000	000	000	000	000	00+	000	000	000	00U
12	91	000	000	000	*0*	000	000	000	000	*0*	000
13	92	000	000	000	000	000	000	000	000	000	000
14	92	000	000	000	000	000	000	000	000	000	000
30	93	UUU	UUU	UUU	UUU	UUU	UUU	UUU	UUU	UUU	UUU
31	93	UUU	UUU	UUU	UUU	UUU	UUU	UUU	UUU	UUU	UUU
32	94	UUU	UUU	UUU	UUU	UUU	UUU	UUU	UUU	UUU	UUU
33	94	UUU	UUU	UUU	UUU	UUU	111	11U	UUU	UUU	UUU
77	(varies)	000	000	000	000	000	UUU	UUU	RRR	RRR	RRR

KEY:
- 0 - Bit set to 0
- 1 - Bit set to 1
- U - Bit unchanged
- * - If IMU was in Coarse Align, set bits 4 and 6, otherwise reset to 0
- + - Set to 1 if ENGONFLG is on, otherwise reset to 0
- C - Bit set to 0 if IMU was in Coarse Align otherwise unchanged.
- R - Set 1 if this bit indicates cause of restart, otherwise unchanged

BLANK

Appendix A
PCR-PCN Checklist

The preparation of this issue of GSOP Section 2 reflects the implementation of the Skylark Program PCRs and PCNs listed below.

PCR/PCN	Title
003	Improved Short Burn Logic
004	Deletion of Verb 94
005	Deletion of Verb 59
006	Deletion of Verb 52
007	Deletion of Verbs 44 and 45
008	Routine 57 Deletion
010	Routine 05 Deletion
011	Programs 72-79 Deletion
013	Deletion of Lunar Surface Alignment Option
014	Program 39 Deletion
015	Program 38 Deletion
016	Program 37 Deletion
017	Program 23 Deletion
018	Program 22 Deletion
019	Program 24 Deletion
021	Program 32 Deletion
022	Lock Out Moon Midcourse Perturbations
025	Extended Range Capability
030	Addition of NCC Maneuver Computation Capability
032	VHF Range Rate Computation and Display
035	Add TEPHEM to the Coast and Align Downlist
036	Compute ATM Star Tracker Gimbal Angles
040	Skylab Digital Autopilot
042	Skylab Four Maneuver DKI Sequence
048	Conversion of RCS DAP Phase Plane Fixed Memory Constants to Erasable Load
051 REV 1	Skylark Downlist Changes
400	Program 15 Deletion
402	Eliminate 481 day TEPHEM limitation in Lunar-Solar Ephemerides Routine
405	Transform Optics Angles to Tracking Angles
409*	Modification to PCR SL022

*PCN

PCR/PCN	Title
410*	Delete Lunar Capability
411*	Delete HAM Targetting Program
412*	Delete ECSTEER
413	ATM Orientation Determination Program (P50)
414	Docked Alignment Capability in P51
415	Docked Alignment Capability in P52
416	Add Gyro Trim to R50
417*	Deletion of 9 Dimensional Capability
422*	Initialize Rendezvous Navigation to Update the CSM State Vector
423	Change Conic to Precision Integration in All Rendezvous Targetting Programs
424	Improve Minkey Gyro Torquing Logic
428	Modification of Skylark Memo #14: Preliminary Skylab Rendezvous Targeting Plan for the Skylab GSOP
431	R04 Roll Preference Specification
434	Correct α_{ATM} in P50
435*	Do Not Automatically Take VHF in P20
436*	Nominal Use of ATM Sources in P52 and P54
438*	Incorrect Star Tracker Angle in P55
439 REV 1	VHF Range Rate Filter Enable/Disable by Extended Verb
442*	Modification to R22
448	Modification No. 4 to Skylark Memo No. 14
449	Forced firings for docked DAP auto maneuvers
452	Precision Integration for V90
454	Docked DAP Alarm Codes
455*	Change to P35, P36 and R00 to Fix Anomaly ART 07
456*	Zeroing HOLDFLAG
459	VHFṘ Changes
464	Set NN = 0 in P35
467*	Change VHFTIME to MARKTIME on the Powered Downlist

*PCN

SKYLARK 1 (GSOP)

R693

Internal Distribution List

Group 23A	D. Lutkevich	DL7-211	(9)
		Phillips	
	Brand	Pu	
	Higgins	Reber	
	Levine	Robertson	
	Muller	Tempelman	
Group 23B	C. Flynn	DL7-221L	(12)
	Klawsnik	Reed	
	Nayar (10)		
Group 23B	C. Taylor	DL7-221L	(11)
	Barnert	Lollar	
		McCoy	
	Brodeur		
	Cramer	Ostanek	
	Goode	Rye	
	Hamilton	Whittredge	
	Haslam		
Group 23B	J. Flaherty	DL7-238A	(5)
	Albert	Millard	
	Berman	Schulenberg	
	Engel		
Group 23C	M. Erickson	DL7-215J	(12)
	Bairnsfather	Penchuk	
	Basile	Potter	
	Croopnick	Schlundt	
	Fraser	Turnbull	
	Jones	Womble	
	Kalan	Work	
Group 23D	N. Auker	DL7-213	(8)
	Drake	Larson	
	Dunbar	Metzinger	
	Groome	Walsh	
	Johnson		
	Kiburz		

Group 23H	R. Shane	DL7-272	(3)
	Cook	O'Connor	
	Kossuth		
Group 23N	G. Grover	DL11-201	(4)
	Blanchard	Ogletree	
	Johnson	Parr	
Group 23P	E. Talbot	DL7-252	(2)
	Greene	Stubbs	
Group 23P	B. Hwoschinsky	DL7-203	(2)
	Battin	Copps	
Group 23S	P. Amsler	DL7-240	(18)
	Adams	McOuat	
	Edmonds	Megna	
	Felleman	O'Donnell	
	Goodwin	Sheridan	
	Grace	Silver	
	Heinemann	St. Amand	
	Kido	Werner	
	Lawrence	White	
	Lones	Woolsey	
Group 23	D. Farrell	DL7-283	(1)
	Lawrence		
Group 33	F. Harding	DL7-111	(3)
	Drane	Mimno	
	Glick		
APOLLO Library			(2)
CSDL Technical Documentation Center			(2)

External Distribution List

SKYLARK 1

Charles Stark Draper Laboratory (5)
P.O. Box 21025
Kennedy Space Center
Attn: Mr. R. O'Donnell

Charles Stark Draper Laboratory (3)
Code EG/MIT Building 16
NASA Manned Spacecraft Center
Houston, Texas 77058
Attn: Mr. G. Silver

NASA MSC HW (10)
Building M7-409
Kennedy Space Center
Florida 32815
Attn: Mr. F. Hughes

Delco Electronics Division (2)
Milwaukee, Wisconsin 53201
Attn: Mr. J. Stridde, Dept. 42-02
Mr. W. Siarnicki, Dept: 94-02
Building 2-C

Delco Electronics Division (2)
P.O. Box 21027
Kennedy Space Center
Florida 32815
Attn: Mr. J. Kaiser

Delco Electronics Division (1)
P.O. Box 265
Bethpage, Long Island
New York 11714
Attn: Mr. D. Dettmann

Delco Electronics Division (1)
P.O. Box 734
Downey, California 90241
Attn: Mr. D. Karstedt

Kollsman Instrument Corporation (1)
575 Underhill Boulevard
Syosset, Long Island
New York
Attn: Mr. F. McCoy

	Raytheon Company Boston Post Road Sudbury, Mass. 01776	(6)
NASA/MSFC	National Aeronautics and Space Administration George C. Marshall Space Flight Center Huntsville, Alabama 35812 Attn: J. Mack R-ASTR-5 (1) V. Buckelew S&E-AERO-MFG (1) A. Deaton R-AERO-DG (1) F. Moore R-ASTR-N (1) H. Hosenthien R-ASTR-F (1) D. Germany I-I/IB-E (1) R. Barraza I-V-E (1) W. Chubb R-ASTR/NG (1) J. McCullough I-VE/T (1)	(10)
NASA/MSC	National Aeronautics and Space Administration Manned Spacecraft Center APOLLO Document Control Group (BM86) Houston, Texas 77058 Attn: Mr. J. Garman, FS6 (letter of transmittal only)	(180+1R)
LINK	LINK Group, GPSI SIMCOM 1740 A NASA Boulevard Houston, Texas 77058 Attn: Mr. D. Klingbell	(3)
NASA/GSFC	National Aeronautics and Space Administration Goddard Space Flight Center Greenbelt, Maryland 70771 Attn: Mr. P. Pashby, Code 813	(2)
NASA/RASPO NAR	National Aeronautics and Space Administration Resident APOLLO Spacecraft Program Office North American Rockwell, Inc. Space and Information Systems Division CSM Data Management D/096-704 AE99 12214 Lakewood Boulevard Downey, California 90241 Attn: T. Watson (1)	(2+1R)
NASA/KSC	National Aeronautics and Space Administration Kennedy Space Center Florida 32899 Attn: Technical Document Control Office	(3)
NASA/RASPO	General Electric Company APOLLO Systems P.O. Box 2500 Daytona Beach, Florida 32015 Attn: Mr. E. P. Padgett, Jr./Unit 509	(1)

NASA/HDQ	NASA Headquarters 600 Independence Avenue SW Washington, D.C. 20546 Attn: Mission Director, Code MA (1) Robert Aller, Code MAO (1)	(2)
NASA/LEWIS	National Aeronautics and Space Administration Lewis Research Center Cleveland, Ohio 44135 Attn: Library	(2)
NASA/FRC	National Aeronautics and Space Administration Flight Research Center Edwards AFB, California 93523 Attn: Research Library	(1)
NASA/LRC	National Aeronautics and Space Administration Langley Research Center Langley AFB, Virginia 23365 Attn: Mr. A. T. Mattson	(2)
NAR/KSC	Kennedy Space Center Florida 32815 M.S.O.B. North American Mail Station ZK69 Attn: Mr. D. Matteson	(1)
NASA/RASPO GAC	National Aeronautics and Space Administration Resident APOLLO Spacecraft Program Officer Grumman Aerospace Corporation Bethpage, Long Island New York 11714	(1)
NASA/WSMR	National Aeronautics and Space Administration Post Office Drawer MM Las Cruces, New Mexico 88001 Attn: RH4 Documentation	(2)