

# APOLLO

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E-1905

## KEYBOARD AND DISPLAY PROGRAM AND OPERATION

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# MIT

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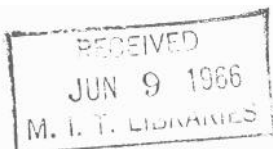
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E- 1905

KEYBOARD AND DISPLAY  
PROGRAM AND OPERATION

ABSTRACT

The Keyboard and Display Program described in ~~this~~ report is included in the Flight 202 Program (originally called CORONA). This report brings E-1574 up to date.

by Alan I. Green  
January 1966

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## INTRODUCTION

The Keyboard and Display System Program processes digital information exchanged between the Apollo Guidance Computer (AGC) and the computer operator. The initiation for these exchanges can be caused by operator action or by internal computer programs.

The modes of operation are as follows:

1. Display of Internal Data. Both a one-shot display and a periodically updating display (called monitor) are provided.
2. Loading External Data. As each numerical character is punched in, it is displayed in the appropriate Display Panel location.

The data involved in both loading and display can be presented in either octal or decimal form, as the operator indicates. If decimal is chosen, the appropriate scale factors are supplied by the program.

3. Program Calling and Control. The Keyboard System is used to initiate a class of routines which are concerned with neither loading nor display. Typical of this class are test routines and system routines. Certain of these require instructions from the operator to determine whether to stop or continue at a given point.
4. Changing Major Mode. The initiation of large scale mission phases can be commanded by the operator.

The inputs to the Keyboard and Display Program are from the

direct-wire keyboard and the remote keyboard which transmits via Uplink. Both of these inputs are accomplished character-by-character. In addition, there are internal machine program requests of the Keyboard and Display Program.



## CHAPTER 1

### INPUT/OUTPUT INTERFACES OF THE KEYBOARD AND DISPLAY SYSTEM PROGRAM

The external inputs to the Keyboard and Display System Program are the direct wire Keyboard and the Uplink. The output is the Electroluminescent Display Panel.

#### 1. 1 Direct -wire Keyboard.

The Keyboard contains the following characters: VERB, NOUN, +, -, the numerical characters from 0 through 9, CLEAR, ENTER, ERROR LIGHT RESET, and KEY RELEASE. Each of the characters is represented by a 5 bit binary code (see Appendix I). The Keyboard code is transmitted to the computer over a 5 wire link and is placed into bits 1-5 of the input register IN0.

Each depression of a Keyboard button activates INTERRUPT #4 (KEYRUPT), as well as places the key code into IN0. This KEYRUPT program picks up the key code and enters a request to the Executive Routine for the program which decodes and digests the key code (CHARIN). Then a RESUME is executed, terminating the KEYRUPT.

#### 1. 2 UPLINK Inputs.

The Uplink is the digital telemetry system which sends information from the ground to the airborne computer. Each time a word is received by the Uplink, INTERRUPT #5 (UPRUPT) is activated. UPRUPT picks up the transmitted code (these codes are the same as key codes) and enters a request to the Executive Routine for the program which decodes and digests the key code (CHARIN). (See Appendix VI. ) Then a RESUME is executed,

terminating the UPRUPT. Note that CHARIN makes no distinction between inputs from the Keyboard and inputs from the Uplink.

There is a toggle switch which is used either to accept Uplink inputs, or to block the Uplink. In the blocked position, the operator has chosen not to accept any keyboard type of input from the ground.

### 1. 3 The MARK Button.

When the MARK button is depressed, a "1" is placed in bit 15 of IN0 and KEYRUPT is activated. The MARK part of KEYRUPT picks up and stores seven quantities: three IMU angles, two Optics angles, and double precision time. The KEYRUPT is then terminated with a RESUME.

### 1. 4 The Display Panel.

#### 1. 4. 1 Description.

The Display Panel consists of 24 electroluminescent sections arranged as in Fig. 1- 1. Each section is capable of displaying any decimal character or remaining blank, except the 3 sign sections (R1S, R2S, R3S). These display a plus sign, a minus sign, or a blank. The numerical sections are grouped to form 3 data display registers, each of 5 numerical characters; and 3 control display registers, each of 2 numerical characters. The data display registers are referred to as R1, R2, R3. The control display registers are known as Verb, Noun, and Major Mode.

The Major Mode display register is used to indicate which phase of the mission or large system program is operating. The Verb and Noun display registers are used to indicate the activity of a smaller class of programs, such as displays, loads, etc. These may be initiated by keyboard action, or from within the computer by program action.

#### 1.4.2 Activation.

Each Display Panel character is controlled by a group of 5 latching relays. Once these relays are activated, the appropriate character remains visible on the Display Panel until the state of these relays is changed. The 5-bit relay codes for each numerical character are listed in Appendix I.

All the information necessary to operate the Display Panel is transmitted from the computer through the output register OUT0. Two Display Panel characters are activated by OUT0 at a time. Bits 1-5 (bit 1 is the low order bit) of OUT0 operate the right character of the selected pair; bits 6-10 operate the left character of the pair. Bit 11 is used for special one-bit functions, such as signs, flash, etc. Bits 12-15 (bit 15 is the high order bit), which are known as the Relayword code, select the appropriate pair of Display Panel characters. See Appendix I for details.

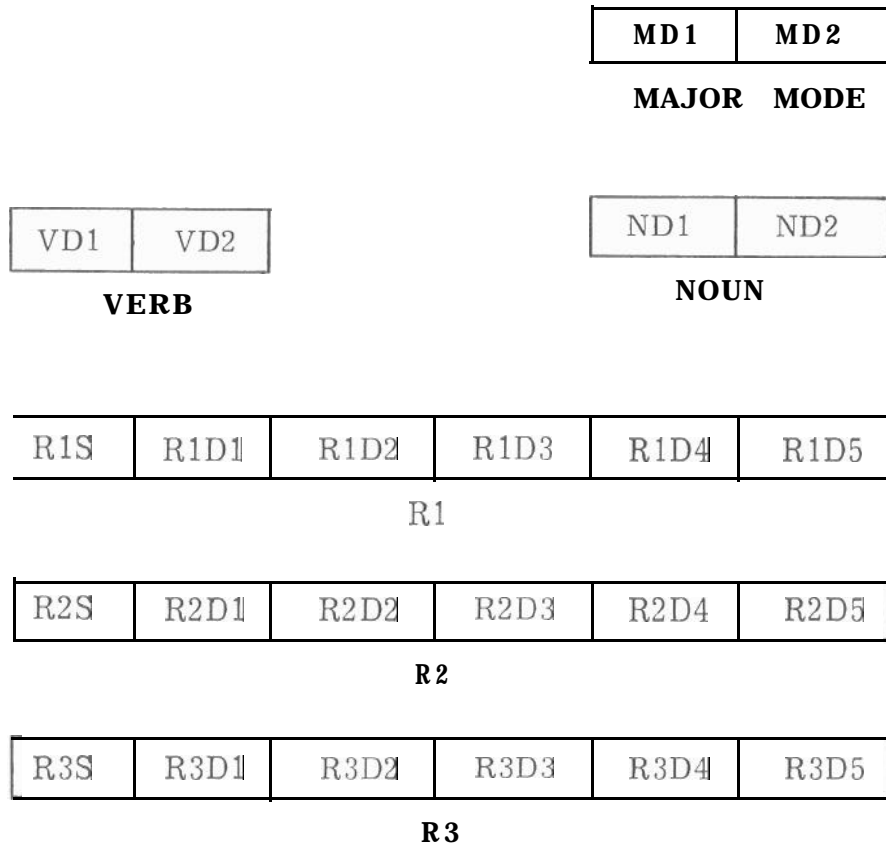
#### 1.4.3 Timing.

The 15-bit word which activates a pair of characters in the Display Panel is placed into OUT0 by DSPOUT, a program operating in the Interrupt mode. DSPOUT is part of a larger Interrupt program called T4RUPT (INTERRUPT #3). T4RUPT is activated approximately once every 60 milliseconds. Every second T4RUPT (or approximately 120 milliseconds) calls DSPOUT. Thus, at maximum activity, two numerical characters and a sign may be updated on the Display Panel every .12 seconds.

#### 1.4.4 Display Panel Buffer.

DSPOUT obtains the 15-bit word to be placed in OUT0 from an 11-register buffer called DSPTAB. Each DSPTAB register contains the information to activate a pair of numerical characters (and perhaps a special single bit function, such as

sign) in the Display Panel. By retaining this information, the DSPTAB reflects the present state of the entire Display Panel. Thus it is possible to compare new information with that already displayed and to place new data in `OUT0` only when they differ.



**Fig. I -1. Display Panel**

## CHAPTER 2

### KEYBOARD USE OF THE KEYBOARD AND DISPLAY SYSTEM

The Keyboard and Display System Program can be initiated either by external manipulation of the Keyboard or by internal computer program action.

#### 2.1 Functions of Keyboard Buttons and Display Panel Lights

The numerical buttons 0 through 9 and + and - are obvious.

The VERB button indicates that the next 2 numerical characters punched in are to be interpreted as the Verb Code.

The NOUN button indicates that the next 2 numerical characters punched in are to be interpreted as the Noun Code.

The ERROR RESET button turns off the alarm lights on the DSKY panel. If any of these alarm lights remains on, it indicates that the condition causing the alarm persists.

The ENTER button is used two ways:

1. to execute the Verb /Noun combination appearing in the Verb and Noun lights.
2. to accept the data word just loaded.

The CLEAR button is used during a data loading sequence to blank the data display register (R1, R2, or R3) being used. It allows the operator to begin loading the data word again.

The KEY RELEASE button gives the operator's permission for internal programs to use the Keyboard and Display Panel Program.

The KEY RELEASE light is turned on when an internal program attempts to use the Keyboard and Display Panel but finds that the operator has not released it for internal use. Pressing the KEY RELEASE button performs this release.

The CHECK FAIL light is turned on when the operator performs some improper sequence of key depressions. A common example is an attempt to execute an undefined (spare) Verb or Noun Code.

The Verb/Noun Flash turns the Verb and Noun lights on and off about once per second. It is used to indicate that some action is required of the operator (usually the loading of data).

## 2.2 Keyboard Operating Format

The basic language of communication between the operator and the Keyboard and Display System is a pair of words known as Verb and Noun. Each of these is represented by a 2 character octal number. The Verb code indicates what action is to be taken (operation); the Noun code indicates to what this action is applied (operand). Typical Verbs are those for displaying, loading, etc. Nouns usually refer to a group of erasable registers within the computer memory. The Verb codes are listed in Appendix II; the Noun codes in Appendix III.

### 2.2.1 Standard Verb-Noun Activation Procedure

The standard procedure for the execution of a keyboard operation consists of a sequence of 7 key depressions.



The VERB key depression blanks the Verb lights on the Display Panel ( $VD_1$  and  $VD_2$ ) and clears the Verb code register within the computer. The next two numerical characters punched in are interpreted as the Verb code ( $V_1, V_2$  in octal). Each of these characters is displayed in the Verb lights on the Display

Panel as it is punched in. The NOUN key operates similarly for the NOUN lights and Noun code register.

The depression of the ENTER key causes the performance of the Verb-Noun combination appearing in the lights at the time of depression. Thus it is not necessary to follow any order in punching in the Verb or Noun code. They may be done in reverse order, or an old Verb or old Noun may be used without repunching it.

No action is ever taken in performing the Verb-Noun combination until ENTER is pressed. If an error is noticed in either the Verb code or the Noun code before the ENTER is pressed, correction is simple. Merely press the VERB or NOUN key and repunch the originally intended code, without necessarily changing the other. Only when the operator has verified that the desired Verb and Noun codes are in the lights should he press the ENTER key and execute the Verb-Noun combination.

## 2. 2. 2 Further Procedure for Data Loading.

If the Verb-Noun combination being executed requires data to be loaded by the operator, the flash will be turned on after the Enter which initiated the Verb-Noun execution. This flash turns the Verb and Noun lights off and on about once per second. Data is loaded in 5-character words and is displayed character-by-character in one of the 5-position data display registers R1, R2, or R3 as it is keyed in. Numerical data is assumed to be octal, unless the 5-character data word is preceded by a plus or minus sign, in which case it is considered decimal. Decimal data must be loaded in full 5-numerical-character words (no zeros may be suppressed); octal data may be loaded with high order zeros suppressed. If decimal is used for any component of a multi-component Load Verb, it must be used for all components of that Verb. No mixing of octal and



decimal data is permitted for different components of the same Load Verb. (If this is violated, the Check Fail Alarm is turned on. )

The ENTER key must be pressed after each data word. This tells the program that the numerical word being punched in is complete. The flash is turned off after the last ENTER of a loading sequence is pressed.

### 2| 2. 3 Acceptance of Keys.

The numerical keys, the CLEAR key, and the sign keys are rejected if struck after completion (final ENTER) of a data display or data load Verb. At such time, only the Verb, Noun, Enter, Error Light Reset, or Key Release are accepted. Thus the data keys are accepted only after the control keys have instructed the program to accept them.

Similarly the plus (+) and minus (-) keys are accepted just before the first numerical character of R1, R2, or R3 is punched in, and at no other time.

The 8 or 9 key is accepted only while loading a data word into R1, R2, or R3 which was preceded by a plus or minus sign. (If this is violated, the Check Fail Alarm is turned on. )

If more than two numerical characters are punched in while loading the Verb, Noun, or Major Mode code, or more than five numerical characters, while loading a data word, the excess characters are not accepted.

### 2. 2.4 Release of Keyboard and Display System.

The Keyboard and Display System Program can be used by internal computer programs as a subroutine (see Chapter 3). However, any operator keyboard action (except Error Light Reset) makes the Keyboard and Display System Program busy to internal routines. The operator has control of the Keyboard and Display System until he wishes to release it. Thus he is assured that data he wishes to observe will not be replaced by internally

initiated displays. In general, it is recommended that the operator release the Keyboard and Display System for internal use when he has temporarily finished with it. This is done by pressing the Key Release button. (Verb 35, Release Display System, is included for early Display Panels which had no Key Release button. ) For more details, see Chapter 3.

If an internal program attempts to use the Keyboard and Display System, but finds that the operator has used it and not yet released it, the Key Release light is turned on. When the operator finds it convenient, he should strike the Key Release button to allow the internal program to use the Keyboard and Display Panel.

### 2.3 General Verb, Noun Conventions.

#### 2.3. 1 Noun Conventions

A Noun code can refer to a device, a group of computer erasable registers, a group of counter registers, or may serve merely as a label. A label Noun refers to no particular computer register, but conveys information by its Noun code number only. The group of registers to which a Noun code refers may be a group of 1, 2, or 3 members. These are generally referred to as 1-, 2-, or 3-component Nouns. The component is understood as a component member of the register group to which the Noun refers. The machine addresses for the registers to which a Noun refers are stored within the computer in Noun Tables. This will be described in more detail in Chapter 4.

There are two classes of Nouns: Normal and Mixed. A Normal Noun is one whose component members refer to computer registers which have consecutive addresses, and whose component members all use the same scale factor when converted to decimal. A Mixed Noun is one whose component members refer to non-consecutive machine addresses, or whose component members require different scale factors when converted to decimal, or both.

The Nouns which refer to counter registers are primarily intended to be used with Display Verbs. They are not normally loaded, but the capability exists and may be useful in special applications. Some Nouns refer to registers intended for command numbers (i. e., a desired new angle command). These are intended primarily to be used with Load Verbs, but may be displayed if desired.

### 2. 3.2 Verb Conventions.

As discussed in Section 2. 3. 1, a single Noun code refers to a group of 1-, 2-, or S-component members. It is the Verb code that determines which component member of the Noun group is operated on. Thus, for instance, there are 5 different Load Verbs (see Appendix II). Verb 21 is required for loading the first component of whatever Noun is used therewith; Verb 22 loads the second component of the Noun; Verb 23, the third component; Verb 24, the first and second components of the Noun; and Verb 25 loads all three components of the Noun. A similar component format is used in the Display and Monitor Verbs.

### 2. 3. 3 Decimal Conversion.

When decimal is used in loading or displaying data, conversion is done by interpreting the number as a fraction. For other than fractional representations, scale factors are applied after the fractional conversion to binary when loading and before the fractional conversion to decimal when displaying. The scale factors for Nouns that are to handle decimal data are kept in Noun Tables within the computer. These Noun Tables also keep information on how many component members are associated with each Noun that handles decimal data. The details for these Noun Tables are found in Appendix IV.

When the Decimal Display Verb is employed, all the component members of the Noun being used are scaled as appropriate, converted to decimal, and displayed in the data display registers. This Decimal Display Verb is the only exception to the component selection feature of Verbs.

If decimal is used for loading data of any component of a multi-component Load Verb, it must be used for all components of that Verb. Thus no mixture of decimal and octal data is permitted for different components of the same Load Verb. (If this is violated, the Check Fail Alarm is turned on.)

#### 2.4 Data Loading.

Whenever any data is to be loaded by the operator, the Verb and Noun lights flash. This flashing occurs when the loading of data is required by procedures initiated either by operator keyboard action or by internal program action. Also, the appropriate data display register (R1, R2, or R3) is blanked, and the internal computer storage register is cleared in anticipation of data loading. Each numerical character is displayed in the proper data display register position as it is punched in. Each of the data display registers (R1, R2, R3) can handle 5 numerical characters (sign is optional). If an attempt is made to key in more than 5 numerical characters in sequence, the sixth and subsequent characters are simply rejected. They do not write over the last valid character.

The plus (+) and minus (-) keys are accepted only when they precede the first numerical character of R1, R2, or R3. The signs are simply rejected if punched at any other time. If the 8 or 9 key is punched at any time other than while loading a data word which was preceded by a plus or minus sign, it is rejected and the Check Fail Light is turned on.

As data is loaded, it is temporarily stored in intermediate buffers. It is not placed into its final destination, as spec-

ified by the Noun code, until the final ENTER of the load sequence is punched in.

#### 2.4. 1 The CLEAR Button

The CLEAR Button is used during data loading to remove errors in R1, R2, or R3. It allows the operator to begin loading the data word again. It does nothing to the Major Mode, Noun, or Verb lights. (The Noun lights are blanked by the NOUN key; the Verb lights, by the VERB key. ) In the following discussions, the term Clearing Function will be used to mean: blanking the data display register of interest and placing +0 into the internal storage register associated with that display register.

For single component Load Verbs or "Machine Address to be Specified " Nouns, the CLEAR button depression performs the Clearing Function on whichever register is being loaded, provided that the CLEAR is punched before the data ENTER. Once the ENTER is depressed, the CLEAR does nothing. The only way to correct an error after the data ENTER for a single component Load Verb is to begin the Load Verb again.

For the 2- or 3-component Load Verbs, there is a backing-up feature of CLEAR. The first depression of the CLEAR key performs the Clearing Function on whichever register is being loaded. (The CLEAR may be pressed after any character, but before its ENTER. ) Consecutive depressions of CLEAR perform the Clearing Function on the data display register above the current one, until R1 is cleared. Any attempts to back-up beyond R1 are simply ignored.

The backing-up function of CLEAR operates only on whatever data is pertinent to the Load Verb which initiated the loading sequence. For example, if the initiating Load Verb was a load second component only, no backing-up action is possible.

## 2. 4. 2 Loading Sequence.

The normal use of the flash is with a Load Verb. In multi-component load situations, the appropriate single component Load Verbs are flashed one at a time. Thus the computer always instructs the operator through a loading sequence. For example, consider a three-component loading sequence. The operator (or the internal program, for that matter) initiates the sequence by punching in VERB = 25, "load 3 components of:" (any noun will do). The Verb code is changed to 21, "load first component of," and the flash is turned on. Verb 21 continues to be flashed as the operator punches in the first word of data. When the ENTER is pressed, the Verb code is changed to 22. Flashing continues while the operator punches in the second data word. When ENTER is pressed, the Verb code is changed to 23, "load third component of," and again the flash continues while the third data word is punched in. When ENTER is pressed, the flash is turned off, and all three data words are placed in the locations specified by the Noun. Notice that throughout the changing of the Verb codes, the Noun code was left unchanged.

There are two special cases when the flash is used with Verbs other than Load Verbs.

### Case I. Machine Address to be Specified.

There is a class of Noun available to allow any machine address to be used. These are called "Machine Address to be Specified" Nouns. When the ENTER which causes the Verb+Noun combination to be executed senses a Noun of this type, the flash is immediately turned on. The Verb code is left unchanged. The operator should load the 5-octal-character complete machine address of interest. It is displayed in R3 as it is punched in. If an error is made in loading the address, the CLEAR may be used to remove it. Pressing ENTER causes continuation in executing the Verb.

## Case II. Change Major Mode

To change Major Mode, the sequence is: VERB 37 ENTER.  
This causes the Noun display register to be blanked and the Verb code to be flashed. The 2-octal-character Major Mode Code should then be loaded. For verification purposes, it is displayed as it is loaded in the Noun display register. The ENTER causes 1) the flash to be turned off, 2) a request for the new Major Mode to be entered, and 3) a new Major Mode Code to be displayed in the Major Mode display register. See Mission Plan for further details.

### 2.4.3 Conclusion of Loading

During data loading sequences, the flash is turned off only by three events: 1) the final ENTER of a load sequence, 2) the VERB = Terminate, 3) the VERB = Proceed Without Data. It is important to conclude every Load Verb by one of the above three, especially if the load was initiated by program action within the computer. If an internally initiated load is not concluded validly, the program that initiated it may never be recalled.

The "Proceed Without Data" Verb is used to indicate that the operator is unable or wishes not to supply the data requested, but wishes the initiating program to continue as best it can with old data. The "Terminate" Verb is used to indicate that the operator chooses not to load the requested data, and also wishes the requesting routine to cease operation. See Chapter 3 for further explanation. The decision for what to do is left to the internal program.

## 2.5 Program Initiation.

There is a class of programs of larger scope that the data loading and display programs which the Keyboard can call.

This class is typically concerned with system testing and operation. Of course, some of these programs will need to display data or request the loading of data or commands by means of the Keyboard and Display Program. The details of this will be described in Chapter 3.

The group of Verbs that perform this general program calling is called the Extended Verbs. Their Verb codes are in the range 40-77. The pertinent programs are called directly upon ENTER as part of the Keyboard and Display Program Executive Job, and with its same priority. The Verbs that call programs of relatively short duration should be executed directly and then should end the Keyboard and Display Program with a TC ENTRET. Those of longer duration should place a request to the Executive Routine for the main body of the program and end the Keyboard and Display Program with a TC ENTRET. The Keyboard and Display System is released before the Extended Verbs (codes 40-77) are called, so that they may use the Keyboard and Display System Program.

## 2. 6 Data Monitor.

There is a class of Verbs called Monitor Verbs which displays data every one second. Once a Monitor Verb is executed, the data in the Display Panel continues to be updated until the Monitor is turned off.

The Monitor is turned off by: Verb 34 (Terminate), an internal program initiation of the Keyboard and Display System Program (a NVSUB call that finds the Keyboard and Display System available), and by Fresh Start.

Monitor action is suspended (but not ended) by the depression of any key, except Error Reset. Monitor action continues after the Keyboard and Display System is released. Thus it is possible to suspend a monitor while the operator loads some



data, or requests another display; and to return to the original monitor when his intervention is concluded.

If a second monitor is requested by the operator while an earlier monitor is still active, the second monitor takes over the first, which ends. Thus multiple monitors cannot occur.

## 2.7 Miscellaneous Restrictions and Cautions in Loads and Displays

This section contains certain important restrictions to operation and facts about loading and displaying, some of which have not been discussed elsewhere. Familiarity with them is necessary for proper understanding of operation.

A) In octal display and monitor verbs and `allload` verbs, the component number of the verb must not exceed the number of components in the noun. If this condition is violated, the Check Fail light is turned on when the ENTER is pressed to execute the verb/noun combination.

This feature is included to prevent the situation in which the operator attempts to load too many data words for the noun he has selected and changes registers that do not belong to that noun. Since it seems wise to make displays consistent with loads, display verbs are similarly restricted.

All "machine address to be specified" nouns are considered 1 component, except noun 01, which may be used with any verb.

B) The scale factoring for seconds, hours, gyro degrees, position, velocity, and time in weeks is handled so that the full range of 5 decimal characters may be used. This makes it necessary to treat these quantities as greater than single precision in octal; that is, two consecutive erasable registers are involved in the decimal scale factoring. The

numerically greater address is treated as the minor part; the numerically smaller address is treated as the major part. Note that this is not a full double precision operation where 10 decimal characters would have to be handled.

Octal load verbs place +0 into the major part register, and place the octal data word loaded into the minor part register. Octal display verbs show only the minor part.

The above is also true of "machine address to be specified" nouns with these scales. To get at both the major and minor parts in octal, noun 0 1 must be used.

C) In multi-component load verbs, no mixing of octal and decimal data is permitted. The data words loaded must be either all octal or all decimal. If not, the Check Fail light is turned on when the final ENTER of the set is pressed. No data is loaded into the final destinations. At this point, the flash is already turned off. Therefore to effect the correct load, it is necessary to key in VERB XX ENTER and begin the loading process again.

D) In loading decimal data, it is necessary to supply 5 numerical characters (and sign, of course) for each data word before its ENTER. If not, the Check Fail light is turned on when the ENTER is pressed for the offending word. The Flash is left on and ~~the~~ Verb Code is not advanced. Thus it is possible to supply the missing numerical characters and press the ENTER again for the same data word. Or the CLEAR key may be used if the operator wishes to begin loading the offending data word again.

E) Machine addresses loaded by the operator must be octal. If a machine address is loaded in decimal, the Check Fail light is turned on when the address is entered.

At this point the flash is off. In order to correct the address, it is necessary to strike the ENTER again to re-execute the Verb -Noun combination.

F) If the decimal display or decimal monitor verb is used with an "octal only"<sup>1</sup> noun, the Check Fail light is turned on. If any attempt is made to load decimal data with an "octal only" noun, the Check Fail light is turned on.

When the Check Fail light is turned on during the loading of data, the state of the flash indicates whether it is necessary to begin the loading sequence again (by re-executing the Verb-Noun combination) or if it is possible to use the CLEAR key to remove the offending data word and simply continue with the rest of the data load. If the flash is off when the Check Fail light comes on, it is necessary to strike the VERB key again and supply the Verb Code to begin the execution of the loading sequence again.

## 2.8 Required Operator Responses to Internally Requested Action

Whenever an internal program requests operator action, the flash is turned on to indicate this fact. It is very important that the operator perform one of the legitimate responses, for the internal program may be in an idling condition while awaiting the operator's response. If he does not respond properly, the internal program may never be recalled.

### 2.8. 1 Response to Internally Initiated Load Request

This is the most usual event in this class. It has been thoroughly discussed in Section 2.4. 3. The load verb situation is the model upon which the other situations in this section have been based.

### 2. 8. 2 Response to Internally Initiated Display with Flash

The initiating program wishes the operator to indicate his acceptance of the displayed data. The operator may:

- A) Correct the data. He performs the appropriate load verb sequence. Upon the final ENTER, the requesting program is recalled.
- B) Perform V33E (Proceed Without Data). This indicates his acceptance of the displayed data, and his desire for the initiating program to continue without further information from him.
- C) Perform V34E (Terminate). The operator wishes the requesting program to cease operation. The decision for what to do is left to the requesting program.

### 2. 8. 3 Response to Internally Initiated "Please Perform" with Flash

This is usually used with the Noun "Checklist" and a coded number for the requested action is displayed in register R11

- A) Striking ENTER indicates that the requested action has been performed (similar to data in, under a load situation).
- B) V33E (Proceed Without Data). The operator chooses not to perform the requested action, but desires the requesting program to proceed as best it can without further activity from him.
- C) V34E (Terminate). The operator chooses not to perform the requested action and desires the requesting program to cease operation. The decision for what to do is left to the requesting program.

#### 2.8.4 Response to Internally Initiated "Please Mark" with Flash

This is very similar to the "Please Perform" case. If the operator wishes the requesting program to get by with fewer than the requested number of MARKS, he presses ENTER (under the "Please Mark" Verb). If he has supplied the proper number of MARKS, the requesting program displays "Please Perform" and he indicates complete acceptance by ENTER (under the "Please Perform").

The "Mark Reject" Verb (or button, when available) merely cancels the last MARK.

V33E, or V34E (under "Please Mark") have similar meanings as described in Section 2.8.3.

More detail on MARK and "Please Mark" Verb is best obtained from the Mission Plan.

## CHAPTER 3

### INTERNAL USE OF KEYBOARD AND DISPLAY SYSTEM PROGRAM

The Keyboard and Display System Program is available to other internal computer programs in its entirety for subroutine use. Use is limited to routines operating under Executive Routine control. Routines operating in the Interrupt Mode may not use the Keyboard and Display Program as a subroutine.

The Verb and Noun Codes themselves are used as the language for communicating between other internal programs and the Keyboard and Display System Program. Any Verb-Noun combination available to the Keyboard can be called by internal routines.

#### 3.1 Interlocks for Internal Use of Keyboard and Display Program

It is necessary to place certain limits on when an internal routine may use the Keyboard and Display Program. This is necessary to prevent the situation in which an internally initiated procedure might write over data in the Display Panel that the operator has not had time to digest.

The two interlocks are: an operator/internal interlock, and an internal/internal interlock.

The operator/internal interlock (called DSPLOCK) is made busy to internal routines by any keyboard activity (except Error Light Reset). It remains busy until it is "released" by the Key Release button or by certain special Verbs. See Section 3.3.2.

The internal/internal interlock (called GRABLOCK) is made busy to other internal routines once any internal routine has "grabbed" the Display System. It remains busy until 10 seconds\* after the grabbing routine has "freed" it. These procedures will be described in detail in Section 3.3.

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\*This time has been shortened to 1.75 seconds for flight 202.

### 3.2 Typical Calling Sequence for Internal Use of Keyboard and Display System

A complete calling sequence for typical internal use of the Keyboard and Display System Program is:

L, TC GRABDSP

L+1, Return here if Display System is already grabbed.

L+2, Return here means you have Display System grabbed.

-----  
-----  
-----

M, TC NVSUB (with Verb-Noun code in A register)

M+1, Return here if Display System is busy (operator).

M+2, Return here after execution of Verb/Noun.

-----  
-----  
-----

NVSUB may be used more than once while Display System is grabbed.

-----  
-----  
-----

TC FREEDSP

### 3.3 Details of Calling Keyboard and Display Program for Internal Use

The details of the Calling Sequence shown in Section 3.2 will be described here. Also the formats and return option will be explained.

### 3.3.1 "GRABBING" the Display System (GRABDSP)

Any internal routine that wishes to use the Keyboard and Display Program must first "GRAB" the Display System by executing a TC GRABDSP. (This routine is in directly accessible fixed memory.) If the TC GRABDSP was done at location L, the return is to L+1 if the System is already grabbed (GRABLOCK is busy). If GRABLOCK shows that the Keyboard and Display System is free, the return is to L+2, indicating that the calling routine now has the System "grabbed."

The decision for what to do if the Keyboard and Display System is found already grabbed is left to the calling routine. It may use an optional routine called GRABUSY, which enters it into a list waiting for the Keyboard and Display System to be freed, or it may prefer to continue and attempt the TC GRABDSP again later.

The calling sequence for the optional GRABUSY is:

```
CAF WAKECADR
TC GRABUSY
```

GRABUSY is in directly accessible fixed memory. It puts the calling JOB to sleep, and enters the specified CADR into a waiting list. This CADR is the location at which you wish your JOB to wake up when the Display System is freed. The list is searched and the CADR's are called in the sequence they were inserted according to the following convention. After a TC FREEDSP, the internal/internal interlock (GRABLOCK) is kept busy for 10 seconds,\* after which a CADR is called from the list and the JOB waked up. This 10-second\*delay insures that all internally initiated information for display will be visible.

There is a special entrance to GRABUSY called PREGBSY for routines in banks that wish the CADR of 1+ (Location from which the TC PREGBSY was done) to be entered in the list.

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\*This time has been shortened to 1.75 seconds for flight 202



### 3.3.2 Internal Calling of a Verb/Noun Combination (NVSUB)

The communicator for calling the Keyboard and Display Program is called NVSUB. It is in directly accessible fixed memory. Any Verb-Noun combination available to the Keyboard can be called by NVSUB. The format is to place a word in the A register with the 6-bit Verb code in bits 7-12 and the 6-bit Noun code in bits 1-6. The TC NVSUB causes the Verb code to be displayed in the Verb lights, the Noun code to be displayed in the Noun lights, and the Verb-Noun combination to be executed. Notice that the Verb 00 and Noun 00 are both illegal codes, if punched in by the operator. Advantage is made of this fact in the following situation. If the program calling NVSUB wishes to display a Verb code without executing it, or to display a Noun code without executing it, the contents of A should be set so that the other 6 bits are all zero. Thus to display the Verb code only, bits 1-6 are set to 0, and the Verb code is placed into bits 7-12. To display the Noun code only, bits 7-12 are set to 0, and the Noun code is placed into bits 1-6. The entire action of NVSUB is taken as a subroutine of the program that called NVSUB. Thus NVSUB is run as part of the same Executive Job that called NVSUB, and with the same priority.

If the calling routine wishes to use one of the "Machine Address to be Specified" Nouns, it is necessary only to preload MPAC +2 with the appropriate Machine Address before the TC NVSUB.

The Keyboard and Display System is made busy (DSPLOCK) to internal users when there is any Keyboard activity (except Error Light Reset). It remains busy until it is released by the Key Release button or by the following Verbs: Release Display System (35), which is included for early versions of the Keyboard which have no Key Release button; Proceed Without Data (33); Terminate (34); Fresh Start (36); Request Executive (20); Request Waitlist (10); also by all the Verbs with codes 40-77 (these

are the so-called Extended Verbs)

If the TC NVSUB was done at location M, the return is to M + 1 if the Keyboard and Display System is busy (DSPLOCK is busy). If DSPLOCK shows that the System is available, the return is to M + 2, after the Verb-Noun combination has been executed. If the Keyboard and Display System is available, but in the execution of the Verb-Noun combination some alarm condition is found (such as use of an undefined Verb or Noun code, or certain other situations impossible during normal operation - see Section 5. 1), then an ABORT is caused (with code 01501 displayed).

The decision for what to do if the Keyboard and Display System is found busy is left to the calling routine. It may use an optional routine called NVSUBUSY, which enters it into a list waiting for the Keyboard and Display System to be released. Or it may prefer to continue and attempt the TC NVSUB again later.

The calling sequence for the optional NVSUBUSY is:

CAF WAKECADR

TC NVSUBUSY

NVUBUSY is indirectly accessible fixed memory. It puts the calling JOB to sleep, enters the specified CADR on the top of the waiting list, and turns on the "Key Release" light, telling the operator to release the Display System for internal use. This CADR is the location at which you wish your JOB to wake up when the Display System is released.

The waiting list is searched by all internal occurrences of the "Free" Display System but only by those external occurrences of the "Release" Display System which are in response to use of the NVUBUSY routine.

There is a special entrance to NVSUBUSY called PRENVBSY for routines in banks that wish the CADR of (location from which the TC PRENVBSY was done) - 2 to be entered in the list.

### 3.3.3 "FREEING" the Display System (FREEDSP)

An internal routine that has successfully "grabbed" the Keyboard and Display System may execute an unlimited number of calls to NVSUB before "freeing" the System to other internal users by executing a TC FREEDSP. (This routine is in directly accessible fixed memory.) If the TC FREEDSP was done at location N, the return is to N+1.

After a TC FREEDSP, GRABLOCK is kept busy for 10 seconds\*, after which a CADR is called from the list and the corresponding JOB waked up. The CADR's are called in the order they were inserted, except that any CADR that may have been placed in the list by NVSUBUSY is called first. This is done to ensure that a routine which has "grabbed" the System, but has found NVSUB busy (due to keyboard action by the operator) and has used NVSUBUSY will be called before other routines that find the system already grabbed.

### 3.4 Keyboard and Display System Release

The "Key Release" Light (also known as Release Display System) is turned on to indicate to the operator that some internal program has attempted to use NVSUB, and found the Keyboard and Display System busy. Thus the operator should release the Keyboard and Display System by pressing the Key Release button (or by performing Verb 35 on those early keyboards which have no Key Release button).

Note that the waiting list associated with GRABUSY and NVSUBUSY is searched by those occurrences of the "Release" Display System which are in response to the use of the NVSUBUSY routine. If the Display System is released at any time other than

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\*This time has been shortened to 1.75 seconds for flight 202.

following an internal use of NVSUBBUSY, the list is not searched even if there are some CADR's in the list due to the use of GRABUSY. These will be called after the routine that has the System grabbed performs a Free Display System.

### 3.5 Internally Initiated Loads

If a loading operation is called by NVSUB, some additional facts should be pointed out. If the Keyboard and Display System is available, the Load Verb is displayed along with the Noun and the flash is turned on. When everything is set up to receive data from the operator, NVSUB returns to M+2 of the calling routine. Now there is a relatively long time until the completion of the load. The option of what to do at this point is left to the calling routine. There are essentially two courses of action.

#### 3.5.1 Initiating Programs that Keep Control

Some programs that place requests through NVSUB for data to be loaded will wish to retain control of the computer while the operator loads the data. These can inspect the contents of an erasable register called LOADSTAT to determine when the data is complete. The conditions of LOADSTAT are:

- + 0        Waiting for data.
- + NZ      The Verb "Proceed Without Data" has been keyed in.
- NZ      The Verb "Terminate" has been keyed in.
- 0        The data load has been completed.

#### 3.5.2 Initiating Programs that Relinquish Control

Some programs that place requests through NVSUB for data to be loaded will desire to give up control of the computer until the data has been loaded. These will be recalled as soon as the data load is completed, if they follow the procedure outlined below.

A routine called ENDDIDLE is provided in directly accessible fixed storage. It puts the current Executive Job to sleep,

and stores away the location from which the initiating routine did a TC ENDIDLE (call this location P). It also makes NVSUB busy to other internal programs. Use of ENDIDLE allows other Executive Jobs to be run while the actual data loading is taking place.

Recall to the routine that called ENDIDLE is made at the end of the loading sequence, when the Verb "Terminate" is keyed in, or when the Verb "Proceed Without Data" is keyed in. The recall is to:

P + 1	For "Terminate."
P + 2	For "Proceed Without Data."
P + 3	For Data In.

The recall is made by way of an Executive Routine request to wake up the routine that did the TC ENDIDLE. NVSUB is made available just before recall.

### 3.6 Other Uses of ENDIDLE

As discussed in Section 3.5.2, the primary use of ENDIDLE is while an internal program is waiting for data that it requested to be loaded (with an actual load verb). Experience has shown that there are several situations in which internal programs wish to wait for certain operator actions before continuing in their solution. These programs may use ENDIDLE, but they must turn the flash on to indicate to the operator that he must respond.

#### 3.6.1 Use of ENDIDLE with Display Verbs

A routine going to NVSUB with a display verb may then turn on the flash, and go to ENDIDLE. This is done when the program wishes the operator to indicate his acceptance of the displayed data.

- A) If the operator wishes to correct the data, he may perform the appropriate load verb sequence. Upon the final ENTER, the requesting program is recalled at P + 3.

- B) If the operator wishes to accept the displayed data, he strikes V33E (Proceed Without Data). This indicates his desire for the initiating program to continue without further information from him. The requesting program is recalled at  $P + 2$ .
- C) If the operator may wish the requesting program to cease operation, he strikes V34E (Terminate). The requesting program is recalled at  $P + 1$ . Whether or not it ceases to operate is decided by the program itself at this point.

### 3.6.2 Use of ENDIDLE with "Please Perform"

A routine may display the Please Perform Verb usually with the Noun "Checklist" and a coded number for the action it wishes to be performed in Register R1. The flash must be turned on. Operator responses are:

- A) ENTER to indicate the requested action has been taken. Recall is to  $P + 3$  (similar to data in, under a load situation).
- B) V33E (Proceed Without Data). The operator chooses not to perform requested action, but wishes the requesting program to continue as best it can without further activity from him.
- C) V34E (Terminate). The operator chooses not to perform the requested action, and wishes the requesting program to cease operation. The decision for what to do is left to the requesting program.

### 3.6.3 Use of ENDIDLE with "Please Mark"

This is very similar to the "Please Perform" case. If the operator wishes the requesting program to get by with fewer than the requested number of MARKS, he presses ENTER (under the



## CHAPTER 4

### PROGRAM DESCRIPTION

The AGC Keyboard and Display Program, as currently implemented, comprises nearly 2,000 words and occupies the majority of two banks of AGC fixed memory. The listing of the program contains a significant amount of documentary information and is regarded as the prime reference for the program's description. This chapter attempts to give a broad functional description of the program flow and logic to aid in the understanding and use of the routine.

Figure V-1 gives a functional block diagram and illustrates the three principle divisions of the program:

1. Input Character Processing.
2. Command Execution.
3. Display.

#### 4.1 Input Character Processing.

The parts of the program which process input characters are:

1. KEYRUPT. The routine triggered by the Keyboard Interrupt which reads the input character and activates the Executive Routine part of the Keyboard Routine (CHARIN).
2. NUM. The part of the routine which processes numerical characters.
3. The various control character processors including: NOUN, VERB, CLEAR, ERROR RESET, +, -, and KEY RELEASE.



Descriptively the NOUN and VERB keys indicate that new command parameters are to be entered and the program initializes the proper registers to accept these parameters.

The + and - keys are used to set register DECBRNCH, which directs NUM how to accept input numerical characters.

The function of CLEAR has been described in Chapter 2. This function is implemented by using the state of register CLPASS as a one-pass gate. Initially CLPASS is +0, as set by an ENTER. When CLEAR is actuated, the "blank current register" path is taken and CLPASS is incremented. A second CLEAR then will take the other branch (CLPASSHI) and do the backing up. If, however, a sign or numeric character intervened, CLPASS would have been reset to +0. A special case is required for the single-component loads since these can not be allowed to back up. These verbs then set CLPASS to a large negative number which prevents the backing up path from being entered.

The function of ERROR RESET is clear from the flow chart.

The ENTER key is used in two distinct ways:

1. As an execute signal implying that the operator wants the current noun-verb command to be executed. This occurs when REQRET is positive and is the normal ENTER function.
2. As a data-entered signal implying that the operator has completed a numerical input word. This occurs when REQRET is negative. Since data is entered only in response to a data request, the routines which do this requesting (e. g. , REQDATZ) set REQRET negative. The Enter routine, when it takes the "data in" path (ENTPASSHI), leaves REQRET positive so

that succeeding ENTER's will be interpreted in the first category unless another load request has occurred.

Numerical input is processed by the NUM routine, which assembles input characters in one of 5 possible buffer registers, NOUNREG, VERBREG, X, Y, or ZREG, depending on the previous control characters or the load command. The buffer register used is determined by the state of DSPCOUNT, so that there is a 1-1 correspondence between the input buffers and the displays. As numerical data is accepted, it is also displayed via the DSPIN subroutine. NUM accepts either octal or decimal input. Octal input is assembled by cycling so that leading zeros are not required. Decimal input is accepted as if the decimal point were to the far right until overflow or the fifth character is in; this is then converted to fractional form and stored to double precision. Five characters must be punched in for decimal.

#### 4.2 Command Execution.

Whenever an "execute Verb-Noun" ENTER occurs, the particular command routine implied by the Verb-Noun codes is executed. This process takes place in two stages:

1. Noun Translation.
2. Verb Execution.

The Noun translation phase decides whether the Noun is Normal or Mixed, looks up the machine address for the given Noun and stores it in NOUNADD, tests if the Noun address is to be entered or incremented, and does as much preliminary processing as possible before branching on the Verb code.

After the Noun translation phase, a full fan on the Verb code is executed and a particular Verb routine is entered. These fall into three general categories:

1. Display and Monitor Commands.
2. Load Commands.

### 3. "Go To" Commands (or Routine Initialization)

#### 4.2.1 Display and Monitor Verbs.

The basic flow of control for decimal display is:

1. All component data pick up from referenced registers into a temporary buffer.
2. For each component in turn:
  - a. Scale factor look up.
  - b. Scaling routine look up.
  - c. Scale and display.

The logic is complicated by the difference between Mixed and Normal Nouns, since the Noun Tables for each are of different formats (Appendix IV).

The monitoring function is implemented by providing a Monitor Verb corresponding to each Display Verb. The Monitor execution consists of three basic parts:

1. The MONITOR routine, entered via the verbplan, saves the Noun and Verb codes and the machine address corresponding to the Noun (in case it was a "Machine Address to be Specified" Noun) and makes a Waitlist request for MONREQ.
2. The MONREQ routine is merely a scheduling routine which produces an Executive call to MONDO every 1 sec.
3. The MONDO routine causes execution of the equivalent Display Verb and Noun combination whenever it is called. It first tests DSPLOCK (the operator/internal interlock) to enable keyboard activity to suspend (but not end) monitoring action.

The ability to handle externally specified addresses is gained by always preloading the address register NOUNADD. For other than "Machine Address to be Specified" Nouns, this register is reloaded from the Noun Tables by the TESTNOUN routine.

#### 4.2.2 Load Verbs.

The flow of control for a Load Verb is:

1. Input data for each component is requested in turn by the display of the proper "load single component" Verb and the flash. When all input data is received, signified by the last ENTER, then the following occurs for each component in turn:
  - a. Address look up.
  - b. Octal or Decimal Test.
  - c. Store if octal; scale factor look up if decimal
  - d. Scaling routine look up if decimal.
  - e. Scale and store if decimal.

#### 4.2.3. "Go To" Verbs.

The "Go To" Verbs provide a means of calling specialized routines from the Keyboard. These have been provided for such functions as testing and facilitating the running of programs to be loaded into erasable memory. The called routines have the option of using the Noun code as a parameter if desired.

#### 4.2.4. Miscellaneous Verbs.

There are several miscellaneous verbs such as Bump, Proceed, Terminate, etc. These programs are straightforward and will not be described in detail here.

#### 4.3 Subroutine Use.

An entry routine NVSUB has been provided to make the routines of the Keyboard and Display System available to programs as well as the Keyboard. The use and philosophy has been previously described. The structure of the program is straightforward and, in effect, depends on having an erasable register ENTRET as the exit instruction for all Keyboard and Display routines. When they are initiated by the Keyboard, this register is preset to TC ENDOFJOB; when they are initiated by NVSUB, it is set to NVSUBEND where a return is made to the calling routine.

The mechanism for handling internally requested loads has been previously described.

#### 4.4 Display Output Routines.

The electroluminescent Display Panel is periodically updated by INTERRUPT #3 (T4RUPT) to the DSPOUT routine. This routine (Fig. V-2) maintains a correspondence between an internal buffer (DSPTAB) and the lights by driving the controlling relays via OUT0 whenever the states of the buffer and lights differ.

To conserve Interrupt time, the programs which make entries to the DSPTAB (e. g. , DSPIN) always test that:

1. The new entry represents a change from the previous entry.
2. The previous entry had already been displayed (as opposed to awaiting display).

Only if both conditions are satisfied is the DSPOUT counter (NOUT) incremented. Hence  $c(NOUT)$  is the number of DSPTAB entries which must be sent out to make the Display Panel correspond to the buffer.

The differentiation between a DSPTAB entry which has been

displayed and one waiting to be displayed is maintained by the sign of the entry. Positive entries have already been displayed, while their complements represent new information waiting to be displayed. When DSPOUT sends a word to OUT0, it changes the DSPTAB entry sign from negative to positive to indicate this.

As can be seen by following the flow chart, a safety play is incorporated to guard against looping. When the counter (DSPCNT) which is used to step through the display table reaches zero the second time, then there must be no negative entries in DSPTAB so NOUT is set to zero and the program exits.

#### 4.5 Interlock Control.

Interlock between external (keyboard) and internal routine use of the Keyboard and Display System is controlled by the following routines:

1. GRABDSP, GRABUSY
2. NVSUBUSY
3. FREEDSP, FREEWAIT, FREDSPDO
4. RELDSP

The effect and use of these programs has been described in Chapter 3.

Logically the interlocking is accomplished by controlling the states of 2 registers. DSPLOCK is the operator/internal interlock and has 2 states: external activity or no external activity. GRABLOCK is the internal/internal interlock and has 3 states:

1. +0 no internal control (system is available).
2. +1 internal control assumed by some routine. Others must wait.
3. +2 internal control assumed by some routine, but pre-empted by external activity. When external user releases the Display System, the internal routine is re-activated (JOBWAKE) and GRABLOCK is reset to +1.

## CHAPTER 5

### ALARMS AND SPECIAL CONTROLS

The Keyboard and Display System Program makes use of the Program Check Fail Light (also known as Illegal Order). It is also concerned with the Key Release Light (also known as Release Display System), the Flash, and the Error Light Reset Button. This chapter will describe the way the Keyboard and Display System Program makes use of these alarms and controls.

#### 5.1 Program Check Fail Light (Illegal Order).

The Program Check Fail Light is turned on by the Keyboard and Display Program when it encounters some improper operating condition. If the Keyboard was the initiator, it does a TC ENDOFJOB; if some internal program was the initiator, an ABORT is caused (with code 01501 displayed).

The conditions which cause the Keyboard and Display Program to turn on the Program Check Fail Light are:

1. An input code other than those listed in Appendix I is received from the Keyboard.
2. The contents of the register used to determine which Display Panel character is to be lighted has exceeded its limit.
3. An 8 or 9 was punched in while loading a word that was not preceded by a plus or minus sign.
4. An undefined Verb or Noun code has been used. The Verb 00 or Noun 00 are always illegal if punched into the Keyboard.

5. A decimal number which is numerically too large for the scale factor assigned to the current Noun has been loaded through the Keyboard.
6. The dp decimal display Verb has been used with a Mixed Noun.
7. The component number of the verb exceeds the number of components in the noun (see Section 2.7).
8. Octal and decimal data is mixed while performing a multi-component load verb (see Section 2.7).
9. Fewer than 5 numerical characters are supplied in loading decimal data (see Section 2.7).
10. A machine address is loaded in decimal (see Section 2.7).
11. A decimal display or decimal monitor verb is used with an "octal only" noun. Decimal data is loaded into an "octal only" noun (see Section 2.7).

## 5.2 Key Release (Release Display System).

The illumination of the Key Release light indicates that some internal program has attempted to use the Keyboard and Display System Program and found it busy due to operator action. The operator should press the Key Release button (or execute Verb 35 in those keyboards which have no Key Release button) when convenient.

## 5.3 The Verb, Noun Flash.

The Verb and Noun lights are flashed to indicate that some action is required of the operator (usually the loading of data). It is turned off by any of the usual load sequence conclusions:

1. Finishing the load sequence (for non-load situations, see Section 2.8).
2. Punching in Verb 33, Proceed Without Data.
3. Punching in Verb 34, Terminate.



#### 5.4 Error Light Reset.

The Error Light Reset button serves two functions. By direct wire, it turns off the non-program computer alarm lights on the Display Panel. By program action, it takes the following action related to the Display Panel: the Program Check Fail light is turned off, the UPLINK Activity light is turned off, the Telemetry Fail light is turned off, the Program Alarm light is turned off, the DSPTAB buffer is checked for proper format and corrected if necessary. Also, the following program action not related to the Display Panel is taken: Endpulses are unblocked; the Errrupt lock is reset; the C Relays corresponding to IMU Fail, CDU Fail, and PIPA Fail are reset.

#### 5.5 Fresh Start.

The Fresh Start Program is initiated either by the automatic restart circuitry or by Verb 36. It takes the following action in regard to the Keyboard and Display System: turns off the Display Panel Alarm lights, turns off the Key Release light, blanks the Display Panel Data and Control Registers, releases the Display System (DSPLOCK), frees the Display System (GRABLOCK), and terminates the Monitor. It also initializes much of the program control software.

APPENDIX I  
INPUT/OUTPUT CODES

I.1 Keyboard Input Codes.

These codes enter the computer through bits 1-5 of IN0. The MSB is placed in bit 5; the LSB, in bit 1.

	MSB	LSB
0	1	0 0 0 0
1	0	0 0 0 1
2	0	0 0 1 0
3	0	0 0 1 1
4	0	0 1 0 0
5	0	0 1 0 1
6	0	0 1 1 0
7	0	0 1 1 1
8	0	1 0 0 0
9	0	1 0 0 1
VERB	1	0 0 0 1
ERROR RESET	1	0 0 1 0
ABORT	1	0 0 1 1
KEY RELEASE	1	1 0 0 1
+	1	1 0 1 0
	1	1 0 1 1
ENTER	1	1 1 0 0
CLEAR	1	1 1 1 0
NOUN	1	1 1 1 1

## 1.2 5 Bit Relay Output Codes for Display Panel.

These codes are placed in OUT0. There are two possible orientations. For the right character of a pair, the MSB is placed in bit 5; the LSB, in bit 1. For the left character of a pair, the MSB is placed in bit 10; the LSB, in bit 6.

	MSB	LSB
Blank	0 0 0 0 0	
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	

### I.3 Relayword Format for OUT0.

<u>Bits 15-12</u>	<u>Bit 11</u>	<u>Bits 10-6</u>	<u>Bits 5-1</u>
1 0 1 1		MD1	MD2
1 0 1 0	FLASH	VD1	VD2
1 0 0 1		ND1	ND2
1 0 0 0	UPACT		R1D1
0 1 1 1	+R1S	R1D2	R1D3
0 1 1 0	-R1S	R1D4	R1D5
0 1 0 1	+R2S	R2D1	R2D2
0 1 0 0	-R2S	R2D3	R2D4
0 0 1 1		R2D5	R3D1
0 0 1 0	+R3S	R3D2	R3D3
0 0 0 1	-R3S	R3D4	R3D5

The Display Panel Output Buffer (DSPTAB) follows this same format with respect to the low order 11 bits.

## APPENDIX II

### VERBS

#### II.1 Verb List

##### II.1.1 Ordinary Verbs

<u>Verb Code</u>	<u>Function</u>	<u>Display Location</u>
00	Illegal	
01	Display (in octal) 1st component of;	R1
02	Display (in octal) 2nd component of;	R1
03	Display (in octal) 3rd component of;	R1
04	Display (in octal) 1st and 2nd components of;	R1, R2
05	Display (in octal) 1st, 2nd, and 3rd components of;	R1, R2, R3
06	Display (in decimal) all component(s) of;	As appropriate
07	DP decimal display	R1, R2
10	Enter Request to Waitlist	
11	Monitor (in octal) 1st component of;	R1
12	Monitor (in octal) 2nd component of;	R1
13	Monitor (in octal) 3rd component of;	R1
14	Monitor (in octal) 1st and 2nd components of;	R1, R2
15	Monitor (in octal) 1st, 2nd, and 3rd components of;	R1, R2, R3
16	Monitor (in decimal) all component(s) of;	As appropriate
17	Monitor DP Decimal	R1, R2
20	Enter Request to Executive	
21	Load 1st component of;	R1

<u>Verb Code</u>	<u>Function</u>	<u>Display Location</u>
22	Load 2nd component of:	R2
23	Load 3rd component of:	R3
24	Load 1st and 2nd components of:	R1, R2
25	Load 1st, 2nd, and 3rd components of:	R1, R2, R3
26	Spare	
27	Spare	
30	Spare	
31	Bank Display	R1
32	Bump displays [c(R2) into R3, c(R1) into R2]	
33	Proceed without Data	
34	Terminate	
35	Release Display System	
36	Fresh Start	
37	Change Major Mode to:	

IL 1.2	<u>Extended Verbs</u>
40	Zero (used with noun ICDU or OCDU only)
41	Coarse Align (used with noun ICDU or OCDU only)
42	Fine align IMU
43	Lock IMU
44	Set IMU to Attitude Control
45	Set IMU to Re-entry Control
46	Return IMU to Coarse Align
47	Turn Optical Tracker On (not in use yet)
50	Please Perform
51	Please Mark
52	MARK Reject (until button is available)
53	Free (used with Noun ICDU or OCDU only)
54	Pulse Torque GYRO's
55	Align Time
56	Perform Banksum
57	Perform System Test
60	Prepare for Standby
61	Recover from Standby
62	Spare
63	Spare
64	Spare
65	Spare
66	Spare
67	Spare
70	Spare
71	Spare
72	Spare
73	Spare

74	Spare
75	Perform I/O Operation
76	Update State Vector
77	Abort Boost



## II. 2 Verb Descriptions.

### II. 2.1 Ordinary Verbs

Verbs 01-05 Perform octal displays of data.

Verb 06 Performs decimal display of data. The scale factors, types of scale factor routines, and component information are stored within the machine for each Noun which is required to display in decimal.

Verb 07 Performs a double precision decimal display of data. It does no scale factoring. It merely performs a 10 character fractional decimal conversion of two consecutive erasable registers using R1 and R2 (the sign is placed in the R1 sign position; the R2 sign position is blank). It cannot be used with Mixed Nouns. Its intended use is primarily with "Machine Address to be Specified" Nouns.

Verb 10 Enters request to Waitlist Routine for any machine address with any delay. This Verb assumes that the desired number of 10 millisecond units of delay has been loaded into the low order bits of the Prio/Delay register (Noun 26). This Verb is used with the "Machine Address to be Specified" Noun. The complete address of the desired location is then punched in. See Section 2.4.2, Case I.

Verbs 11-17 Update data displays every second.

Verb 20	Enters request to Executive Routine for any machine address with any priority. This Verb assumes that the desired priority has been loaded into bits 10-14 of the Prio/Delay register (Noun 26). This Verb is used with the Noun "Machine Address to be Specified." The complete address of the desired location is then punched in. See Section 2.4.2, Case I.
Verbs 21-25	Perform data load. Octal quantities are unsigned. Decimal quantities are preceded by a + or - sign.
Verb 31	Bank Display. This Verb is included to permit displaying the contents of fixed memory in any bank. Its intended use is for checking program ropes and the BANK position of program ropes.
Verb 32	Display Shift. Useful for preserving an existing display of a quantity while displaying another quantity.
Verb 33	Proceed Without Data. Informs routine requesting data to be loaded that the operator chooses not to load fresh data, but wishes the routine to continue as best it can with old data. Final decision for what action should be taken is left to requesting routine.
Verb 34	Terminate. Informs routine requesting data to be loaded that the operator chooses not to load fresh data, and wishes the routine

to terminate. Final decision for what action should be taken is left to requesting routine. If Monitor is on, it is turned off.

Verb 35 Releases Keyboard and Display System for internally initiated use. Performs the same function as the Key Release button. It is included for use with those early keyboards which have no Key Release button.

Verb 36 Initializes the program control software and the Keyboard and Display System Program. See Section 5.5 for details.

Verb 37 Changes to New Major Mode. See Section 2.4.2, Case II for details.

## II. 2. 2 Extended Verbs

Verb 40	Must be used with Noun 20 (ICDU) or Noun 55 (OCDU) only.
Verb 41	Must be used with Noun 20 (ICDU) or Noun 55 (OCDU) only.
Verbs 42-47	Call programs that perform the indicated G&N System procedure.
Verb 50	<p>This verb is used only by internal routines that wish the operator to perform a certain task. It should never be keyed in by the operator. It is usually used with Noun 25 (Checklist). The coded number for the Checklist Item to be performed is displayed in register R1 by the requesting routine.</p> <p>Once the operator has performed the requested action, he should press ENTER to indicate that the Checklist Item has been performed. If he wishes not to perform the requested action, he should key in the Verb "Proceed Without Data." (see Section 2. 8. 3)</p>
Verbs 51, 52	Verb 51 is used only by internal routines that wish the operator to MARK. It should never be keyed in by the operator. The operator can reject the last MARK by Verb 52 (Mark Reject) or by pressing the Mark Reject button when it is available. (see Section 2. 7. 4)
Verbs 53-54	Call programs that perform the indicated G&N System procedure.

Verb 55

Requests the loading of  $\Delta T$  (in seconds). When this data has been entered, the contents of the time counters are updated.

In order to align time, it is necessary to be able to display time as of a given command with a minimum of uncertainty in fetching the time counters. Noun 65 has been altered so that it displays a Sampled Time. The time counters are sampled for this noun in Keyrupt, Uprupt, and in the interrupt section of the monitor.

Verb 56

Causes the Self Check Program to perform the sum check of the fixed memory

Verb 57

Calls the program that performs the G&N System Test.

Verbs 60, 61

Are included to correct TIME1 and TIME2 after a period of low power operation when the AGC clocks are not running, but IN1 (the 24 hour time counter) is maintained.

At least 1.5 seconds before the computer is put in standby mode, the operator punches in:

V 60 E (Prepare for standby)

After the computer is put back in the full power mode, the operator punches in:

V 61 E (Recover from standby).

TIME1 and TIME2 are corrected to 10 milliseconds within 1.5 seconds after the ENTER is punched in.

Verb 75	Calls program that performs certain manual input/output options.
Verb 76	Calls program that allows the State Vector to be updated.
Verb 77	Calls Boost Abort program

APPENDIX III  
NOUNS

III. 1 Noun List

NORMAL NOUNS

SCALE AND DECIMAL POINT

00	NOT IN USE	
01	SPECIFY MACHINE ADDRESS (FRACTIONAL)	(. XXXXX)
02	SPECIFY MACHINE ADDRESS (WHOLE)	(XXXXX.)
03	SPECIFY MACHINE ADDRESS (DEGREES)	(XXX. XX DEGREES)
04	SPECIFY MACHINE ADDRESS (HOURS)	(XXX. XX HOURS)
05	SPECIFY MACHINE ADDRESS (SECONDS)	(XXX. XX SECONDS)
06	SPECIFY MACHINE ADDRESS (GYRO DEGREES)	(XX. XXX DEGREES)
07	SPECIFY MACHINE ADDRESS (Y OPT DEGREES)	(XXX. XX DEGREES OR XX. XXX DEGREES)
10	SPARE	
11	SPARE	
12	SPARE	
13	SPARE	
14	SPARE	
15	INCREMENT MACHINE ADDRESS	(OCTAL ONLY)
16	TIME SECONDS	(XXX. XX SECONDS)
17	TIME HOURS	(XXX. XX HOURS)
20	ICDU	(XXX. XX DEGREES)
21	PIPAS	(XXXXX. PULSES)
22	NEW ANGLES I	(XXX. XX DEGREES)
23	DELTA ANGLES I	(XXX. XX DEGREES)

NORMAL NOUNS

24 DELTA TIME (SECONDS)  
25 CHECKLIST  
26 PRIO/DELAY  
27 SELF TEST ON/OFF SWITCH  
30 STAR NUMBERS  
31 FAILREG, SFAIL, ERCOUNT  
32 DECISION TIME (MIDCOURSE)  
33 EPHEMERIS TIME (MIDCOURSE)  
34 MEASURED QUANTITY (MIDCOURSE)  
35 ROLL, PITCH, YAW  
36 LANDMARK DATA 1  
37 LANDMARK DATA 2  
40 Vg for 202  
41 SPARE  
42 SPARE  
43 SPARE  
44 SPARE  
45 SPARE  
46 SPARE  
47 SPARE  
50 SPARE  
51 SPARE  
52 GYRO BIAS DRIFT  
53 GYRO INPUT AXIS ACCELERATION DRIFT  
54 GYRO SPIN AXIS ACCELERATION DRIFT

SCALE AND DECIMAL POINT

(XXX.XX SECONDS)  
(XXXXX.)  
(XXXXX.)  
(XXXXX.)  
(XXXXX.)  
(OCTAL ONLY)  
(XXX.XX HOURS [INTERNAL UNITS = WEEKS])  
(XXX.XX HOURS [INTERNAL UNITS = WEEKS])  
(XXXX.X KILOMETERS)  
(XXX.XX DEGREES)  
(OCTAL ONLY)  
(OCTAL ONLY)  
(XXXX.X meters/sec)  
  
(.BBBBXXX MILLIRAD/SEC)  
(.BBBBXXX [MILLIRAD/SEC] / [CM/SEC SEC])  
(.BBBBXXX [MILLIRAD/SEC] / [CM/SEC SEC])

NOTE: B indicates blank.



MIXED NOUNS

SCALE AND DECIMAL POINT

55	OCDU	(XXX.XX DEGREES, XXX.XX DEGREES OR XX.XXX DEGREES)
56	UNCALLED MARK DATA (OCDU & TIME [SECONDS])	(XXX.XX DEGREES, XXX.XX DEGREES OR XX.XXX DEGREES, XXX.XX SECONDS)
57	NEW ANGLES OCDU	(XXX.XX DEGREES, XXX.XX DEGREES OR XX.XXX DEGREES)
60	IMU MODE STATUS (IN3, WASKSET, OLDERR)	(OCTAL ONLY)
61	TARGET AZIMUTH AND ELEVATION	(XXX.XX DEGREES, XX.XXX DEGREES)
62	ICDUZ AND TIME	(XXX.XX DEGREES, XXX.XX SECONDS)
63	OCDEX AND TIME	(XXX.XX DEGREES, XXX.XX SECONDS)
64	OCDUY AND TIME	(XXX.XX DEGREES OR XX.XXX DEGREES, XXX.XX SECONDS)
65	SAMPLED TIME (HOURS AND SECONDS) (FETCHED IN INTERRUPT)	(XXX.XX HOURS, XXX.XX SECONDS)
66	SYSTEM TEST RESULTS	(XXXXX., .XXXXX, XXXXX.)
67	DELTA GYRO ANGLES	(XX.XXX DEGREES FOR EACH)
70	PIPA BIAS	(X.XXXX CM/SEC SEC FOR EACH)
71	PIPA SCALE FACTOR ERROR	(XXXXX. PARTS/MILLION FOR EACH)
72	DELTA POSITION	(XXXX.X KILOMETERS FOR EACH)
73	DELTA VELOCITY	(XXXX.X METERS/SEC FOR EACH)
74	MEASUREMENT DATA (MIDCOURSE)	(XXX.XX HOURS [INTERNAL UNITS = WEEKS], XXXX.X KILOMETERS, XXXXX.)
75	MEASUREMENT DEVIATIONS (MIDCOURSE)	(XXXX.X KILOMETERS, XXXX.X METERS/SEC XXXX.X KILOMETERS)
76	POSITION VECTOR	(XXXX.X KILOMETERS FOR EACH)
77	VELOCITY VECTOR	(XXXX.X METERS/SEC FOR EACH)

### III. 2 Noun Scale Factors

	<u>Decimal Format</u>	<u>AGC Format</u>
1) FRACTIONAL	.XXXXXX	bit 1 = $2^{-14}$ units
2) WHOLE	XXXXXX. (max 16383.)	bit 1 = 1 unit
3) DEGREES	XXX.XX degrees (max 359.99)	bit 1 = $360/2^{15}$ degrees (uses 15 bits for magnitude and 2's com)
4) TIME (SEC)	XXX.XX sec	bit 1 of low register = $10^{-2}$ sec
5) TIME (HOURS)	XXX.XX hours (max 745.65)	bit 1 of low register = $10^{-2}$ sec
6) GYRO DEGREES	XX.XXX degrees	bit 1 of low register = $360/2^{20}$ degrees
7) Y OPTICS DEGREES	There are two different ranges, selected according to bit 13 of register WASOPSET. BIT 13 = 0 for Range I; BIT 13 = 1, for Range II.	
RANGE I	XXX.XX degrees (max 179.99)	bit 1 = $180/2^{15}$ degrees uses 15 bits for magnitude and 2's com
RANGE II	XX.XXX degrees (bias of 19.775 degrees added for display; subtracted for load)	bit 1 = $90/2^{15}$ degrees uses 15 bits for magnitude and 2's com
8) GYRO BIAS DRIFT	.BBXXXXX millirad/sec	fractional part of $\frac{\text{gyro pulses}}{64 \text{ centi-sec}}$
9) GYRO AXIS ACCELERATION SENSITIVE DRIFT	.BBXXXXX $\frac{\text{millirad/sec}}{\text{cm/sec}^2}$	fractional part of $\frac{\text{gyro pulses}}{\text{PIPA pulse}}$
10) PIPA BIAS	X.XXXX cm/sec <sup>2</sup>	fractional part of $\frac{\text{PIPA pulses}}{256 \text{ centi-sec}}$

NOTE: BB states blank positions out of the DSKY range

	Decimal Format	AGC Format
11) PIPA SCALE FACTOR ERROR	XXXXXX. parts/millior	fractional part of $\frac{\text{parts}}{\text{million}} \times \frac{10^6}{2048}$
12) POSITION	XXXX.X kilometers	low order bit of high order word = 1 kilometer
13) VELOCITY	XXXX.X meters/sec	low order bit of high order word = $\frac{631,304.11}{64}$ 2-14 m/sec
14) TIME (WEEKS)	XXX.XX hours	fractional part of weeks
15) ELEVATION DEGREES	XX.XXX degrees (max 89,999)	low order bit = $\frac{90}{2^{14}}$ degrees
16) Vg	XXXX.X meters/sec	bit 14 = 1600 meters/sec

### III. 3 Noun Descriptions

#### III. 3.1 Normal Nouns

Noun 00        Not in use

Nouns 01-07    The machine address for these nouns is not stored within the machine, but is supplied by the operator. This allows any address to be loaded, displayed, or monitored. When ENTER is pressed with one of these nouns, the Flash is activated, but the Verb is left unchanged. This indicates to the operator that he should type in the 5 character OCTAL address, followed by an ENTER. It is displayed in R3, and the Flash is turned off. Thereafter, the execution of the Verb continues, just as in the case of any other noun. Seven different "Machine Address to be Specified" nouns are provided so that any of the decimal scale factors may be applied to the contents of any machine address.

Noun 15        This is used to increment the machine address already specified. It is useful for loading or displaying a group of consecutive addresses. OCTAL only.

Nouns 16-17    These nouns refer to the time counters TIME1, TIME2, and are not normally loaded. If decimal is desired, Noun 16 gives seconds modulo 1000 (maximum +999.99 seconds); Noun 17 gives hours up to a machine maximum of 745.65 hours.\*

---

\* Since this noun refers to counter registers, it is not normally loaded. However, the capability exists and loading may be useful in special applications.

Noun 20	This refers to the 3 ICDU counters. They are not normally loaded. If decimal is desired, the form is XXX.XX degrees (maximum of $\pm 359.99$ ). *
Noun 21	This refers to the 3 PIPA counters, and is not normally loaded. In decimal, register contents are presented as whole decimal, representing the number of PIPA counts (maximum $\pm 16,383$ ). *
Noun 22	This refers to the desired platform angle registers (THETAD). (Decimal scale, $\pm 359.99$ degrees maximum.)
Noun 23	This refers to the Temporary Data Buffer. (Decimal scale $\pm 359.99$ degrees maximum.)
Noun 24	This refers to the Temporary Data Buffer. (Decimal scale, $\pm 999.99$ seconds maximum.)
Noun 25	Usually used with Verb 50, described in Section II. 2. 2. Refers to Temporary Data Buffer. (If decimal is desired, whole scale is used.)
Noun 26	This Noun is to be preloaded with the desired PRIORITY for use with VERB 20 (REQUEST EXECUTIVE); with the desired DELAY, when used with VERB 10 (REQUEST WAITLIST). OCTAL is to be used for the PRIORITY; decimal whole scaling is provided for the DELAY.

---

\* Since this noun refers to counter registers, it is not normally loaded. However, the capability exists and loading may be useful in special applications.

Noun 27	<p>+0 loaded into this Noun causes the idle job to be done for Executive Backup.</p> <p>-NZ loaded into this Noun causes the AGC Self Check routine to be done for the Executive Backup indefinitely.</p> <p>+NZ loaded into this Noun causes the AGC Self Check routine to be done for the Executive Backup N times, where N is the Number loaded. (If decimal is used, whole number scale.)</p>
Noun 30	<p>Refers to the Temporary Data Buffer. Intended for star identification numbers. The decimal scale for each is whole. This Noun is usually used with Verb 51, described in Section II. 2. 2.</p>
Noun 31	<p>Used to display system failure conditions. A coded number to identify the failure is displayed in R1. The address of the last malfunction detected by the Self-Check program (if appropriate) is displayed in R2. The number of times the Self-Check program has detected a malfunction (if appropriate) is displayed in R3 (Octal only).</p>
Noun 32	<p>Refers to TDEC. Scale is time in weeks.</p>
Noun 33	<p>Refers to TET. Scale is time in weeks.</p>
Noun 34	<p>Refers to MEASQ. Scale is position.</p>
Noun 35	<p>Refers to ROLL, PITCH, YAW. Scale is regular degrees.</p>
Noun 36, 37	<p>Landmark data. Octal only.</p>
Noun 40	<p>Refers to the temporary data buffer. Scale is Vg.</p>

- Noun 52 Refers to GBIAS registers. Scale is Gyro Bias Drift
- Noun 53 Refers to ADIAX registers. Scale is Gyro Axis Acceleration Drift.
- Noun 54 Refers to ADSRAX registers. Scale is Gyro Axis Acceleration Drift.

### III. 3. 2 Mixed Nouns

Mixed Nouns are those whose components refer to non-consecutive addresses or have different scale factors.

- Noun 55 Refers to the OCDU counters. (Decimal scale: X OPTICS scale is +359.99 degrees maximum. Y OPTICS scale is either +179.99 degrees maximum, or t-89.999 degrees maximum. See Section III. 2)<sup>‡</sup>
- Noun 56 Refers to Temporary Data Buffer. Noun is used by internal routines to display the OCDU angles and time (seconds) when an unrequested Mark is performed. (Optics decimal scale is same as Noun 55. )
- Noun 57 Refers to the desired optics angle registers (DESOPTX, DESOPTY) (Optics decimal scale is same as Noun 55. )
- Noun 60 Refers to IN3, WASKSET, OLDERR
- Noun 61 Refers to Temporary Data Buffer. Scales are elevation in degrees, degrees.

---

<sup>‡</sup> Since this noun refers to counter registers, it is not normally loaded. However, the capability exists and loading may be useful in special applications.

Nouns 62-64	Refers to each of the ICDU and OCDU counters separately, and time counter (in seconds). The ICDU decimal scales are $\pm 359.99$ degrees maximum. (Optics decimal scales are same as Noun 55. ) <sup>‡</sup>
Noun 65	Refers to TIME1, TIME2 counters. (Decimal scales: hours scale, +745.65 maximum; seconds scale, +999.99 maximum. ) <sup>‡</sup>
Noun 66	Refers to Temporary Data Buffer. Decimal scales are whole, fractional, whole.
Noun 67	Refers to the desired delta GYRO angle registers (OGC). Decimal scale is XX. XXX degrees.
Noun 70	Refers to the PBIAS registers. Scale is PIPA bias.
Noun 71	Refers to the PIPASCF registers. Scale is PIPA scale factor error.
Noun 72	Refers to the DELR registers. Scale is position.
Noun 73	Refers to the DELVEL registers. Scale is velocity.
Noun 74	Refers to TDEC, MEASQ, MEASMODE. Scales are time in weeks, position, whole.
Noun 75	Refers to the Temporary Data Buffer, and DELTAQ. Scales are position, velocity, position.

---

<sup>‡</sup> Since this noun refers to counter registers, it is not normally loaded. However, the capability exists and loading may be useful in special application.



Noun 76            Refers to the Temporary Data Buffer.  
Scale is position.

Noun 77            Refers to the Temporary Data Buffer.  
Scale is velocity.

APPENDIX IV  
NOUN TABLE FORMAT

IV. 1 Code Numbers.

The Noun Tables contain the information necessary to perform scale factoring of decimal data in loading and display. There is a Component Code Number, which indicates how many component members belong to the given Noun; a Scale Factor Routine Code Number, which indicates what Scale Factoring Routine should be used with this Noun; and a Scale Factor Constant Code Number, which indicates what scaling constant should be applied for this Noun. Of course, Mixed Nouns require a separate Scale Factor Routine Code and a separate Scale Factor Constant Code for each component.

Component Code Number

0 0 0 0 0	1 component
0 0 0 0 1	2 components
0 0 0 1 0	3 components

Scale Factor Routine Code Number

0 0 0 0 0	Octal only
0 0 0 0 1	Fractional
0 0 0 1 0	Degrees (XXX. XX)
0 0 0 1 1	Arithmetic Scale Factor
0 0 1 0 0	Arithmetic Double Precision (multiplies by $2^{14}$ at end)
0 0 1 0 1	Arithmetic Double Precision
0 0 1 1 0	Y Optics Degrees
0 0 1 1 1	Arithmetic Double Precision (shifts left by 7 at end)

Scale Factor Constant Code Number

0 0 0 0 0	Whole Time in Seconds (XXX. XX)
0 0 0 0 1	Time in Hours (XXX. XX)
0 0 0 1 0	Degrees
0 0 0 1 1	Gyro Degrees
0 0 1 0 0	Gyro Bias Drift
0 0 1 0 1	Gyro Axis Acceleration Drift
0 0 1 1 0	PIPA Bias
0 0 1 1 1	PIPA Scale Factor Error
0 1 0 0 0	Position
0 1 0 0 1	Velocity
0 1 0 1 0	Time in weeks
0 1 0 1 1	Elevation degrees
0 1 1 0 0	Vg for 202

These Code Numbers, together with the machine addresses pertinent to each Noun, are combined in the Noun Tables: NNADTAB, NNTYPTAB, and IDADDTAB (necessary for Mixed Nouns only).

IV. 2 Noun Tables--Normal Nouns.

<u>NNADTAB</u>	15	11	10	1		
	/ / / / / / / / / /		E			
	+0, Not in use					
	-NZ, Specify Machine Address					
	- 0, Increment Machine Address					
<u>NNTYPTAB</u>	15	11	10	6	5	1
	COMP#		S. F. ROUT#		S. F. CON#	

IV. 3 Noun Tables--Mixed Nouns.

<u>NNADTAB</u>	15	11	10	1
	COMP #		IDADDREL	
	+0, Not in use			

**NNTYPTAB**



or



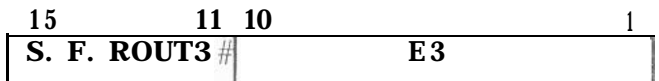
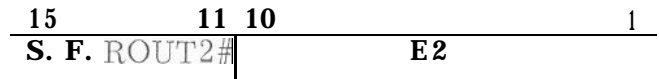
or



**IDADDTAB**



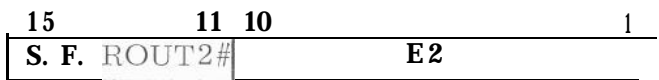
**3-component**



or



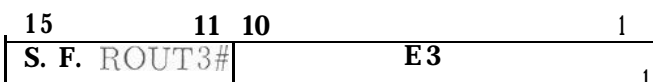
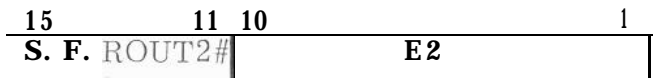
**2-component**



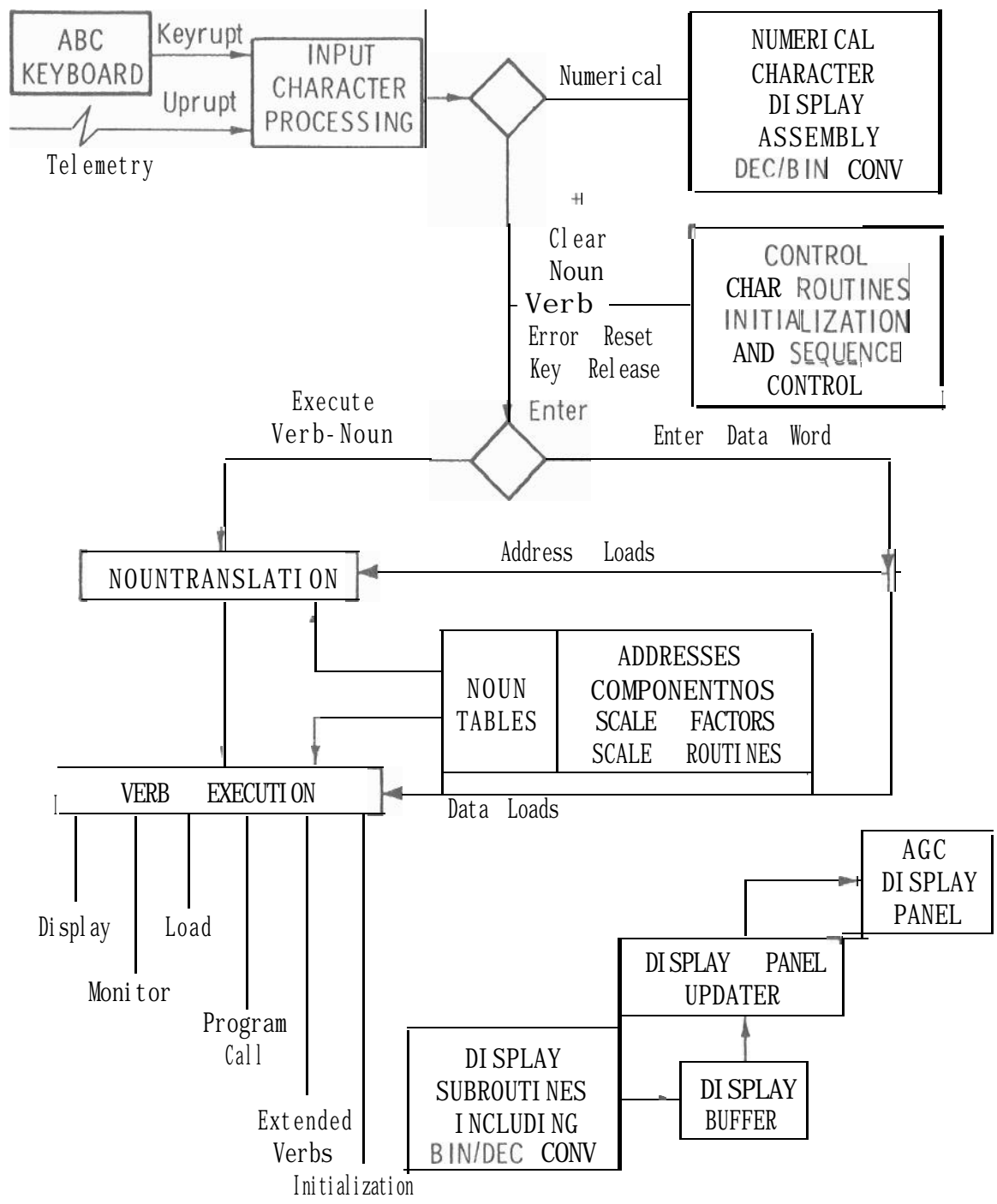
or



**3-component**



**APPENDIX V**  
**PROGRAM FLOW DIAGRAMS**



**Fig. V-1 Keyboard and display block diagram.**

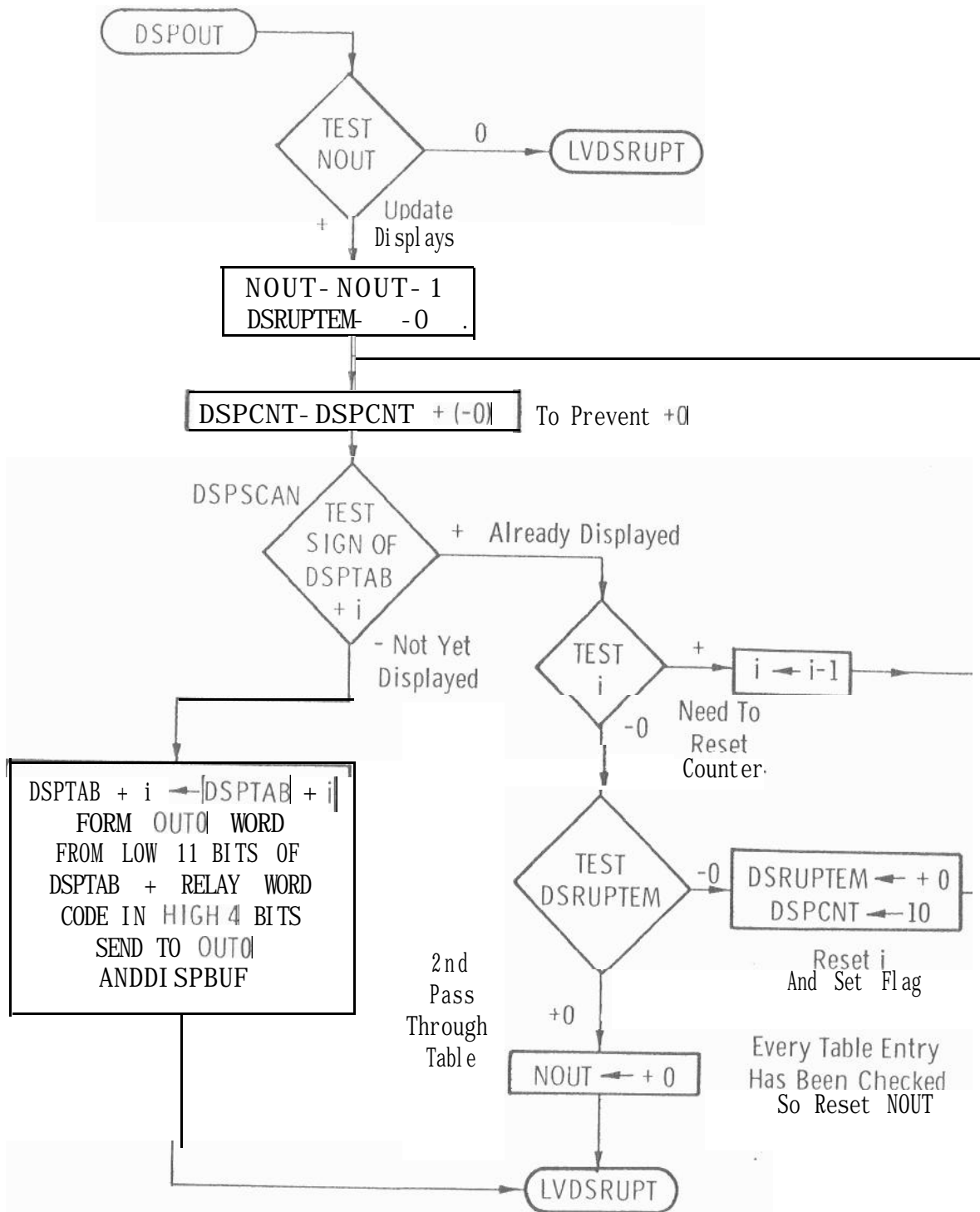


Fig. V-2 DSPOUT flow diagram.

## APPENDIX VI

### UPRUPT OPERATION

An UPRUPT is executed when a 15 bit Uplink message is assembled in register UPLINK. The UPRUPT program reads this 15 bit word and tests for  $W\bar{W}W$  format. (This is a 5 bit keycode message, its complement in the middle 5 bits, and the original in the high 5 bits. )

If the  $W\bar{W}W$  test is passed, an executive request is placed for CHARIN to digest the 5 bit key code. If the  $W\bar{W}W$  test is failed, the TM Fail light is turned on and a program interlock is activated to block further acceptance of Uplink messages. This interlock is freed by sending the Error Light Reset code through the UPLINK. It is important to send a string of at least 15 zeroes before the Error Light Reset to clear out any "ones" that might be left in UPLINK due to falling out of synch.

The UPLINK ACTIVITY light is turned on by all UPRUPT's. It is turned off by Key Release. Therefore, it is good practice to send the Key Release code at the end of a sequence of UPLINK transmissions.



## E-1905

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