

AGC INFORMATION SERIES
ERRATA SHEET 15-8
1 June 1965

1. Remove title page and insert new title pages which is attached.
2. Remove pages iii/iv and v/vi and insert new pages iii/iv and v/vi which are attached.
3. Remove pages 15-3/15-4 and insert new pages 15-3/15-4 which are attached.
4. Remove pages 15-8A/15-8B through pages 15-8GG/15-HH and insert new pages 15-8A/15-8B which are attached.
5. Remove pages 15-63/15-64 through 15-87/15-88 and insert new pages 15-63/15-64 through 15-85/15-86 which are attached.
6. Add Appendix A (pages A-1/A-2 through A-29/A-30) and Appendix B (pages B-1/B-2 through B-19/B-20) to the end of the issue.

APOLLO GUIDANCE COMPUTER
Information Series
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SUBSYSTEM
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Number

- A AGC Subsystem Input and Output Signals
- B E Register Assignment II for Sunrise Programs

15-6. THE BLOCK I AGC SUBSYSTEM

15-6A. The Block I AGC subsystem consists of one Apollo guidance computer (AGC), one Navigation Panel DSKY, and one Main Panel DSKY. The AGC consists of one Tray A, one Tray B, one Tray C, an end connector assembly, and a coldplate (figure 15-1). Space is also provided for two spare trays. Tray A contains logic modules A1 through A40 (figure 15-2A) and Tray B contains modules B1 through B33 (figure 15-2B). Trays A and B are plugged into end connectors 05A4J4 and 05A4J3 respectively which are interconnected with end connector 05A4J5 that provides the AGC input and output connections.

15-6B. Tray C contains two harnesses (figure 15-3). Harness A interconnects plug 05A3P3, which plugs into end connector 05A4J5, with plug 05A3P1 and receptical 05A3J1. (No connections between plug 05A3P1 and receptical 05A3J1 are provided.) Plug 05A3P1 provides AGC connections to and from other subsystems of the G&N system (PSA, IMU, Optics, etc.) and the Navigation Panel DSKY. Harness B interconnects plug 05A3P2 and receptical 05A3J2. Plug 05A3P2 provides connections to and from G&N subsystems which are not connected to the AGC but to other spacecraft systems. A third harness, which is mounted to the Connector Cover Plate, connects plugs 05A5P1 and 05A5P2 with plug 05A5P3. Plugs 05A5P1 and 05A5P2 mate with recepticals 05A3J1 and 05A3J2 respectively. (No connections are provided between plugs 05A5P1 and 05A5P2.) Plug 05A5P3 provides connections to and from various spacecraft systems (the Downlink equipment, the Uplink equipment, SCS, etc.) and the Main Panel DSKY.

15-6C. The Block I DSKY's are shown in figures 15-4 through 15-6. The jack on the back of the Navigation Panel is designated 05A6J1, the jack on the back of the Main Panel DSKY, 05A8J1.

15-6D. All input and output connections of the AGC and both DSKY's are listed in Appendix A. This table has been derived from NASA Drawings 1006079, 1006080, 1006164, 1006165, 1006166, 1006167, 1006181, 1006183, 1006251, 1006252; and from Digital Development Memo No. 75 (Revision 3), all generated by MIT/IL. Column one of the table contains identification numbers of the input and output lines or signals. The letter S indicates a signal line, the letter R, a return line. Columns two through seven contain the pin number of the AGC and DSKY connectors to which the various signal lines are connected. Refer to figures 15-3 through 15-5 for the plug and jack numbers. Columns

eight and nine contain the signal names used in the drawings and in Digital Development Memo 75 respectively. The last column contains a short description of the signals.

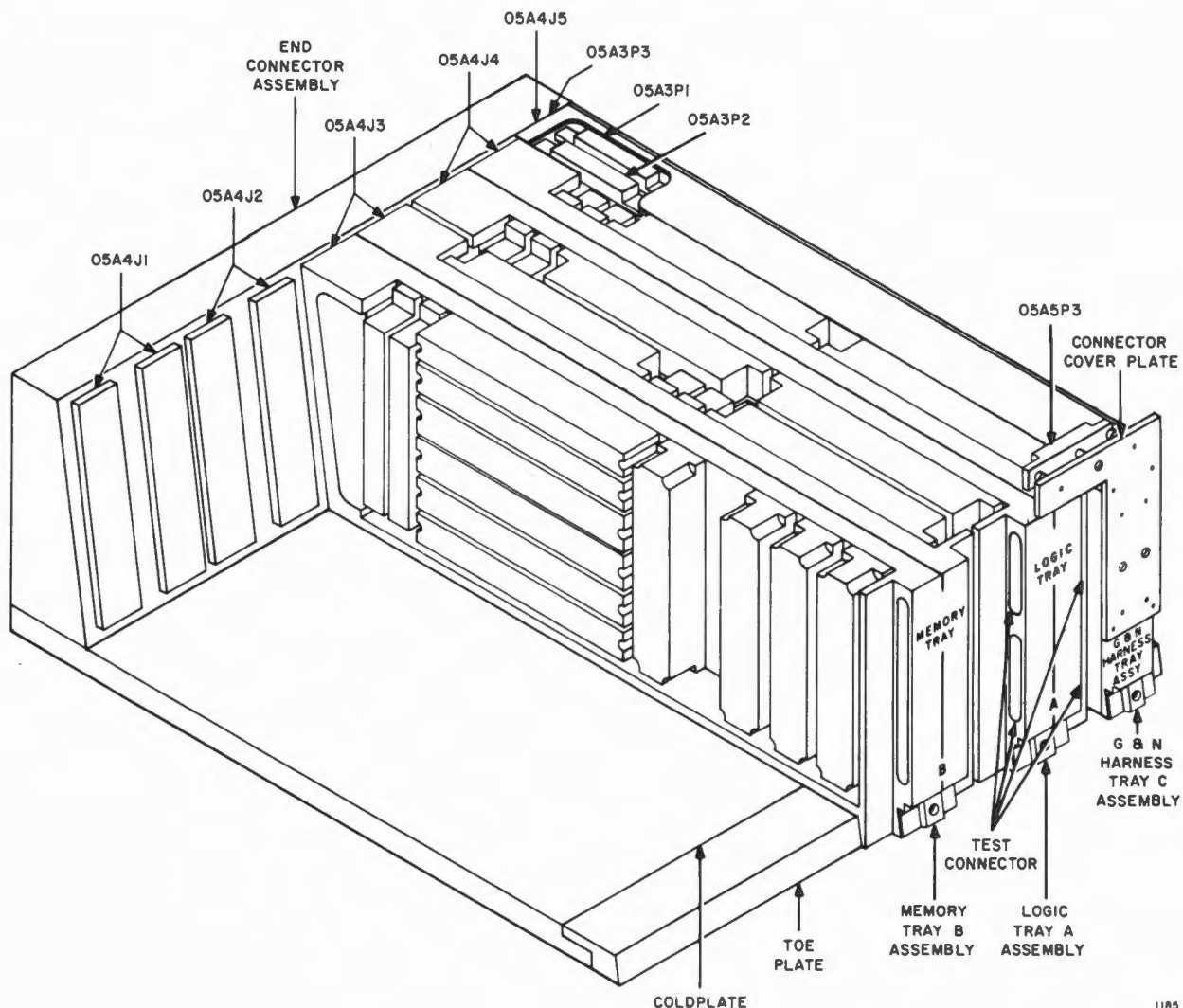
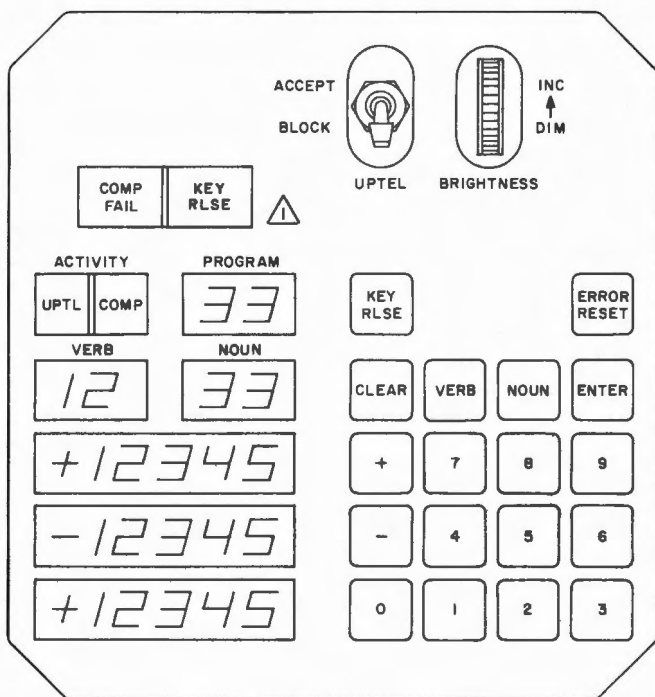


Figure 15-1. Block I AGC

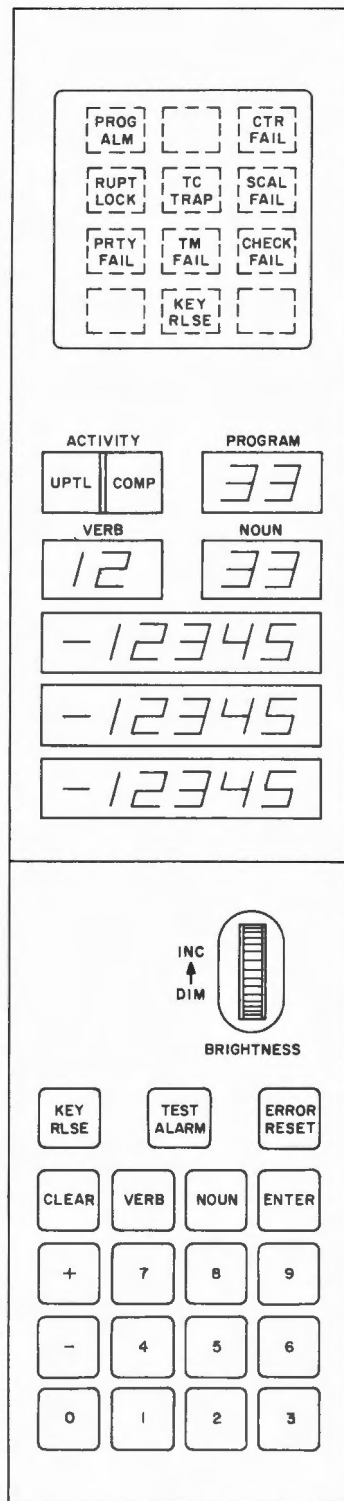
15-6E. All logic of the Block I AGC is built from solid state silicon integrated NOR gates with three inputs. Refer to figure 15-6A. If one input of a NOR gate is connected to a positive potential of about 1 volt, the output potential of the NOR gate is about 0.2 volts. If all inputs used are connected to a positive potential of about 0.2 volts or less,



MAIN PANEL DSKY



INDICATOR CHECK FAIL FOR SYSTEM AGE 5

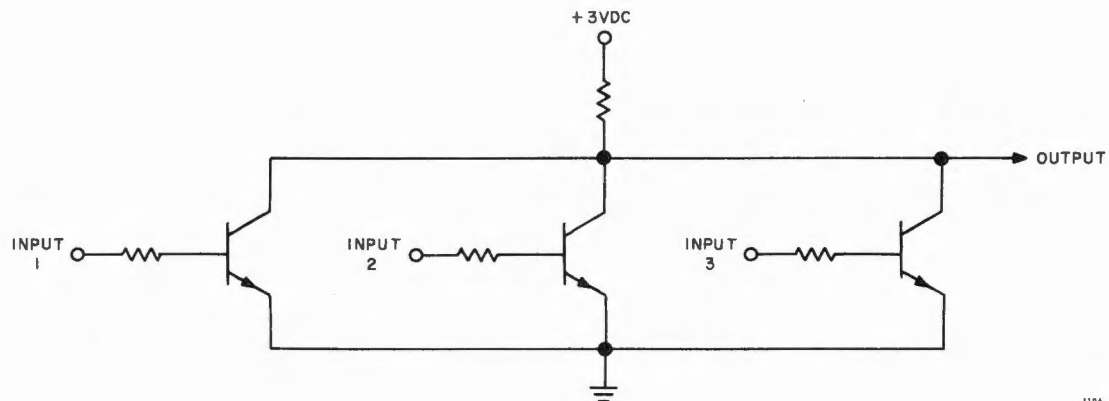


NAVIGATION PANEL DSKY

1116 B

Figure 15-6. Front View of DSKY's

the output potential is about 1 volt. Thus, a logical ONE is represented by a positive potential of approximately 1 volt and a logical ZERO by a positive potential of about 0.2 volt. Since each NOR gate inverts voltage levels, a logical ZERO can represent either a data ZERO or a data ONE dependent on the operational location of a gate, and a logical ONE can represent a data ONE or a data ZERO. A data ONE is represented by a logical ONE (positive potential of approximately 1 volt) at the input of the write amplifiers, and a logical ZERO (positive potential of about 0.2 volt). At the output of the Write Amplifiers, a logical ONE (positive potential of approximately 1 volt) represents a data ZERO, and a logical ZERO (positive potential of approximately 0.2 volt) represents a data ONE.



1184

Figure 15-6A. NOR Gate

15-98. AGC PROGRAMS

15-99. An AGC program performs such functions as solving guidance and navigation problems, testing the operation of the Guidance and Navigation (G&N) System, and monitoring the operation of the Spacecraft. Such a program consists of a group of program sections that are classified according to the function they perform. These classifications are Mission Functions, Auxiliary Functions, and Utility Functions.

15-100. Mission Functions are performed by program sections that implement operations directly concerned with the major functions of the Apollo G&N System. These operations include erecting the IMU stable member and aligning it to a desired azimuth while the Spacecraft is situated on the ground. The Mission Functions also include realignment of the stable member each time the Inertial Subsystem is reenergized during a flight. Other Mission Functions include the computation of Spacecraft position and velocity during coasting periods of the flight by solution of second-order differential equations which describe the motions of a body subject to the forces of gravity. In addition the Mission Functions test other elements of the G&N System.

15-101. Auxiliary Functions are executed at the occurrence of certain events, requests, or commands to implement many and varied operations in support of the Mission Functions. These operations include:

- a. Starting and restarting most program sections in response to a keyboard entry via the DSKY's or as the result of a hardware failure.
- b. Accepting and processing keyboard and uplink information.
- c. Supplying data to the telemetry system.
- d. Servicing devices outside the Computer Subsystem which require high-frequency attention.
- e. Selecting the various modes of the IMU and Optics and controlling the use of these units.
- f. Providing the means for aligning the IMU in flight.
- g. Testing the Computer Subsystem.
- h. Displaying alarm messages on the DSKY's to notify the operator of failure conditions within the G&N System.

15-102. Utility Functions are performed by program sections that coordinate and synchronize AGC activity to guarantee orderly and timely

execution of required operations. These functions control the operation of the Mission Functions and the Auxiliary Functions by scheduling AGC operations on either a priority or a real-time basis. The Utility Functions also translate interpretive language to basic machine language which allows complex mathematical operations such as matrix multiplication, vector and multiprecision computations to be performed within the framework of compact routines at the expense of computing time. In addition, the Utility Functions supervise interrupt conditions and enable data retrieval and control transfer between isolated banks in the fixed-switchable portion of Fixed Memory.

15-103. The programs which have been wired into rope memory modules for field use with the AGC form a family of programs called the Sunrise programs. Program Sunrise 33 was the first program to be wired into the core ropes; it was superseded by programs Sunrise 38, and Sunrise 45 which were essentially the same as Sunrise 33 with minor changes. Program Sunrise 69, which is the current program, adds to Sunrise 45 certain IMU and AGC tests in three additional program sections. Program Sunrise 69 consists of 23 program sections as listed in table 15-14. The program sections are listed as they appear in the program listing, NASA Drawing 1021103-C. The table identifies the program sections as to the function they perform: M for Mission Function, A for Auxiliary Function, and U for Utility Function. The table also indicates where the program sections are located in Fixed Memory.

15-104. The following paragraphs contain descriptions of each program section organized by functional group.[△] However, before describing the program sections, several terms must be introduced and defined so that they may be used to describe the program sections. These terms are: Phase, Routine, Job, and Task.

15-105. A Phase is an identifiable portion of a Mission Function that serves as a "milestone" at which a Mission Function may be reentered following the occurrence of an error during the execution of the Mission Function. Thus it is not necessary to restart at the beginning of the Mission Function.

15-106. A Routine is a sequence of machine instructions which requires a request from a source outside of itself to set it into operation.

15-107. A Job is a Routine which is executed according to an assigned priority based on the relative importance of the Job to the overall accomplishment of the Apollo Mission.


15-108. A Task is a Routine which is to be executed at an assigned future time counting ahead from the present time.


[△] Descriptions of program sections AGC Self-Check 2 and IMU Performance Tests 1 and 2 will be supplied later.

TABLE 15-14
PROGRAM SUNRISE -- PROGRAM SECTIONS

Rope Module B28				Rope Module B29			
Bank 04	Bank 01	Bank 24	Bank 21	Bank 02	Bank 03	Bank 22	Bank 23
6000	2000 Interrupt (RPT and GO) Transfer Routines	6000	6000	4000	6000	6000	6000 Orbital Integration
Executive (Job Control)	2036 U	Pinball (Keyboard and Display)	Pinball (Keyboard and Display)	Interpreter	Interpreter	Orbital Integration	6107 M
	2037 Executive (Job Control)						6110
	2123 U						Prelaunch Alignment
	2124 Waitlist (Task Control)						
2216 U							
2217 Progress (Master) Control							
6351 U	2300 U						
6352	2301 Telemetry (DOWNRUPT) Processor						
Waitlist (Task Control)	2426 A						
	2427 T4RUPT Output Control						
6501 U	2466 A						
6502	2467 Mode Switching and Mark						
Progress (Master) Control	2515 A						
	2516 Interbank Communication						
6743 U	2604 U						
6744	2605 Alarm and Display Processor						
Fresh Start and Restart	2667 A						
	2670						
	Pinball (Keyboard and Display)						
							3200 Interrupt (RPT and GO) Transfer Routines
							3203 U
	7264 A	3204					
	7265 KEYRUPT and UPRUPT Processor						
7375 A							
7376							
7630 A		7621 A					
7631		7622					
5652 U		5653					
7743		7744					
7777		7777					
7777		7777					
7777		7777					
7777		7777					
7777		7777					
7777		7777					
7777		7777					
7777		7777					

TABLE 15-14
PROGRAM SUNRISE -- PROGRAM SECTIONS (cont)

Rope Module B21				Rope Module B22 			
Bank 10	Bank 05	Bank 30	Bank 25	Bank 06	Bank 07	Bank 26	Bank 27
6000	6000	6000	6000	6000	6000	6000	6000
T4RUPT Output Control	Mode Switching and Mark	System Test	Inflight (IMU) Alignment Routines	AGC Self-Check Number Two		IMU Performance Tests 1	IMU Performance Tests 2
	6675 A		6626 A				
	6676		6627				
	AGC Self-Check						
7053 A							
7054	7344 A						
Mode Switching and Mark	7345 Mode Switching and Mark						
	7416 A						
	7417	7357 M					
		7400		7344			
		System Test		7345			
	7633	7402 M					
	7634 Alarm and Display Processor	7403					
7732 A	7642 A						
	7643						
7740	7737					7732 A	
Mode Switching and Mark						7733	
7765 A	7740 Mode Switching and Mark						7760 A
	7777 A	7777	7777	7777	7777	7777	7761
							7777

 Locations used only by Program Sunrise 69

15-109. MISSION FUNCTIONS

15-110. Three program sections are classified as Mission Functions: Prelaunch Alignment, Orbital Integration, and System Test. Program section System Test differs from the other two Mission Functions, in that it has no Phases. This difference exists because System Test is utilized only during computer checkout and not during an actual flight. If an error occurs during the execution of System Test, the program section is terminated and corrective action is initiated. If an error occurs during any other Mission Function, a fresh start or a restart is initiated depending upon the nature of the error.

15-111. PRELAUNCH ALIGNMENT

15-112. Prelaunch Alignment aligns the IMU so that the X axis points along the local vertical and the Z axis points along a specified azimuth in the plane of the desired vehicle trajectory. During vertical erection both the Y and Z PIPA input channels are handled identically; during gyrocompassing the Z channel is maintained as in erection and the Y channel performs the azimuth alignment and holds the vertical orientation of the X axis.

15-113. ORBITAL INTEGRATION

15-114. Orbital Integration computes position and velocity of the Spacecraft during coasting periods of the Apollo mission. Position and velocity are maintained in the computer in non-rotating rectangular coordinates and referenced to either the earth or the moon. An earth-centered coordinate system is used when the spacecraft is outside the gravitational field of the moon. Inside this field, the center of coordinates coincides with the center of the moon.

15-115. SYSTEM TEST

15-116. System Test measures various parameters of the G&N System and presents the results of these measurements for verification that system performance criteria are within given specifications.

15-117. AUXILIARY FUNCTIONS

15-118. Nine program sections are termed Auxiliary Functions:

- a. Fresh Start and Restart
- b. T4RUPT Output Control
- c. Telemetry Processor

- d. KEYRUPT and UPRUPT Processor
- e. Pinball
- f. Mode Switching and Mark
- g. AGC Self-Check
- h. Alarm and Display Processor
- i. In-Flight Alignment.

These program sections perform various operations in support of the Mission Functions to facilitate accomplishment of the overall mission.

15-119. FRESH START AND RESTART

15-120. A fresh start initiates most program sections in response to a keyboard entry from the DSKY's, when the computer is turned on or when a serious error condition exists, or after a GO sequence if there is a disagreement between the phase tables. A restart initiates most program sections after a GO sequence when the phase tables agree. A restart returns program control to the beginning of the appropriate Phase of that Mission Function which was interrupted by the error.

15-121. T4RUPT OUTPUT CONTROL

15-122. T4RUPT Output Control, which is activated when the TIME4 counter overflows, serves as a connection between the Mission Functions and devices external to the computer. The operations performed by this program section include:

- a. Driving the IMU CDU's and the Optics CDU's
- b. Updating the DSKY displays and discrete relay outputs
- c. Monitoring the IMU and Optics
- d. Monitoring the downlink transmission rate to ensure that it is not too slow
- e. Checking for IMU, PIPA, and CDU failures.

15-123. TELEMETRY PROCESSOR

15-124. The Telemetry Processor, which is initiated on receipt of an end pulse from the NAA Programmer, provides data for downlink transmission and checks the transmission rate to ensure that it is not too fast. The transmitted data may represent a DSKY or UPLINK keycode, a DSKY relay word, a display character word, an identification word or a data word.

15-125. KEYRUPT AND UPRUPT PROCESSOR

15-126. Program section KEYRUPT and UPRUPT Processor accepts data from the DSKY's, the Optics, and uplink. KEYRUPT is initiated each time a DSKY key is depressed or when the Optics MARK button is depressed. UPRUPT is initiated whenever data is received via uplink. After the data has been accepted, KEYRUPT and UPRUPT Processor requests the execution of program section Pinball which processes the data.

15-127. PINBALL

15-128. Program section Pinball processes information exchanged between the computer and the astronaut. These exchanges are initiated primarily by keyboard action; however, exchanges can also be initiated under internal computer program control. Various functions are performed in response to requests from the keyboard; information resulting from these keyboard requests or internal requests from other program sections are displayed on the DSKY's.

15-129. MODE SWITCHING AND MARK

15-130. Mode Switching and Mark selects the IMU and the Optics modes of operation and controls the use of these units. The selection and control is requested automatically by the Mission Functions or manually via keyboard entries. Mode Switching and Mark also supervises the input-output operations performed by T4RUPT Output Control which relate to IMU and Optics moding.

15-131. AGC SELF-CHECK

15-132. AGC Self-Check exercises most of the control pulses in the computer to check performance of the computer. This is accomplished by initiating various program instructions. Most of the control pulses in an instruction are used every time that particular instruction is executed; however, the functions that some of these pulses perform are not utilized until some time later. Therefore, a systematic method is used to exercise those pulses not used immediately. Program section AGC Self-Check is requested via the DSKY's and executed only when the computer is idle, that is, when there is no Job waiting to be performed. AGC Self-Check also has the duty of maintaining the COMP (Computer) ACTIVITY indicator on the DSKY's. These indicators are illuminated only when a genuine Job is being processed by the computer.

15-133. ALARM AND DISPLAY PROCESSOR

15-134. The Alarm and Display Processor causes the display of certain failure messages on the DSKY's. These failures are defined as being either an alarm or an abort. Except for repeated alarms, an alarm is a failure which does not require a computer fresh start or re-start. In the case of repeated alarms, the astronaut may initiate a manual fresh start via a keyboard entry. An abort is a failure which requires a computer fresh start. Both failure conditions are displayed on the DSKY's in a five-character code of the form AAANN where AAA identifies the program section or routine in which the failure occurred and NN identifies the specific error which has occurred.

15-135. IN-FLIGHT ALIGNMENT

15-136. Program section In-Flight Alignment provides the framework for aligning the IMU. The program section consists of a set of routines written in interpretive language which are used for geometric transformation of the many coordinate axes needed in the in-flight alignment process.

15-137. UTILITY FUNCTIONS

15-138. Utility Functions perform the "housekeeping" activities for the computer. These activities include recording the progress of Mission Functions, supervising the execution of Jobs, scheduling Tasks, decoding and executing interpretive instructions, servicing interrupts, and transferring control between banks in Fixed Memory. The program sections classified as Utility Functions are:

- a. Progress Control
- b. Executive
- c. Waitlist
- d. Interrupt Transfer Routines
- e. Interbank Communications
- f. Interpreter
- g. RTB Op Codes

15-139. PROGRESS CONTROL

15-140. Progress Control consists of routines which initiate, terminate, change, and supervise the restart of all Mission Functions except System Test. In addition, Progress Control maintains the PROGRAM indicators on the DSKY's.

15-141. The capability to start, stop and change the Mission Functions manually is provided by Progress Control in conjunction with Pinball via a keyboard entry. A restart is initiated following the detection of a hardware failure or an abort both of which cause a GO sequence. To implement restart, Progress Control maintains a phase table which indicates the status of all the Mission Functions. The Phases stored in the table provide a point at which an interrupted Mission Function may be restarted. The phase table is stored in triplicate and the Mission Functions are restarted only if all three copies agree. If the copies do not agree, a fresh start is executed with no restart of the Mission Functions.

15-142. EXECUTIVE

15-143. The Executive supervises the execution of all requested Jobs according to an assigned priority scheme. The Job having the highest priority is allowed to operate until displaced by another Job of higher priority; up to eight Jobs may be in various stages of completion within the program. Each Job is assigned a Job Area which is a group of locations in Erasable Memory into which information relating to the Job can be stored. When the Job having the highest priority is completed, the Executive initiates the execution of that Job having the next highest priority. If no Job is awaiting execution, a dummy Job is executed which keeps the computer idling until the next Job request. While the computer is idling, program section AGC Self-Check may be executed in response to a manual request from the DSKY's.

15-144. In addition, the Executive places Jobs into a dormant state when they require the occurrence of certain external events before proceeding. The Executive then must reactivate these Jobs when the external events have been completed.

15-145. WAITLIST

15-146. Program section Waitlist schedules the execution of Tasks which must be executed at a specific time. Waitlist derives its timing from the TIME3 counter and whenever this counter overflows, program control is transferred to that Task which must be executed next. Waitlist maintains a list of Tasks to be performed; up to six Tasks may be simultaneously under its control. If there are less than six Tasks awaiting execution, dummy Tasks are used to fill the list. The dummy Tasks are scheduled to be executed 81.93 sec apart. A dummy Task performs the same function for Waitlist as the dummy Job performs for the Executive.

15-147. INTERRUPT TRANSFER ROUTINES

15-148. The Interrupt Transfer Routines save the contents of registers A (accumulator) and Q (return address) and transfers program control to the Routine that must be executed when an interrupt transfer request is recognized. The Interrupt Transfer Routines transfer program control to Routines T3RUPT, T4RUPT, KEYRUPT, UPRUPT, and DOWNRUPT. The contents of the registers mentioned are saved so that program control can return to the instruction following that instruction which was being executed when the interrupt occurred and so that the data in the accumulator is not destroyed.

15-149. INTERBANK COMMUNICATION

15-150. Interbank Communication allows the transfer of information and/or control between banks in the fixed switchable portion of Fixed Memory. This transfer is accomplished by transferring program control to fixed-fixed memory where the bank address can conveniently be changed. Then register S is set to address the desired location within the proper bank. Program control is then transferred to the correct location in fixed-switchable memory.

15-151. INTERPRETER

15-152. The Interpreter translates into basic machine language and executes that part of the AGC program written in interpretive language. This allows for complex operations to be prepared in a compact form at the sacrifice of computer operational speed. Routines written in interpretive language contain explicit double precision, vector, and matrix operations.

15-153. RTB OP CODES

15-154. The RTB Op Codes serve as an appendage to the Interpreter to increase its effectiveness. The RTB Op Codes provide a convenient link between basic and interpretive language and make possible the execution of subroutines in basic language while operating in the interpretive mode.

15-155. PROGRAM OPERATION

15-156. The interplay between the various program sections during the operation of an AGC program is quite complex. Therefore, to facilitate the explanation of an AGC program, program operation is discussed in terms of interrupt, idle, normal, and abnormal conditions.

15-157. INTERRUPT CONDITIONS

15-158. During program operation, five possible interrupts can occur: some occur at specific intervals; others at random. These interrupts enable the execution of Tasks and the processing of input-output data. All interrupts suspend the execution of the current program section; save the contents of registers A and Q (the contents of registers B and Z are saved by hardware action) and return program control to the interrupted program section when the required interrupt operations have been completed. The interrupts initiate the execution of corresponding Routines in program section Interrupt Transfer Routines (figure 15-13). The five Interrupt Transfer Routines transfer program control to Routines: T3RUPT, T4RUPT, KEYRUPT, UPRUPT, and DOWNRUPT.

15-159. Routine T3RUPT

15-160. Tasks are executed at specific times subject to the overflow of the TIME3 counter. This counter is preset within Routine T3RUPT to some value less than 163.84 sec (overflow condition) and incremented every 10 msec until overflow occurs. When the counter overflows, the Interrupt Transfer Routine associated with Routine T3RUPT is initiated which interrupts the current program section; saves the contents of registers A and Q; and transfers program control to Routine T3RUPT of program section Waitlist. Routine T3RUPT initiates the execution of the Task due and sets the TIME3 counter so it will overflow when the next Task is due. Upon completion of the initiated Task, program control is returned to the interrupted program section with the content of registers A and Q restored to the values present at the time the interrupt occurred.

15-161. Routine T4RUPT

15-162. Various input-output operations must be performed periodically during the operation of an AGC program. These operations are initiated subject to the overflow of the TIME4 counter which is preset in Routine T4RUPT to overflow every 60 msec to perpetuate its execution.

15-163. When the TIME4 counter overflows, the Interrupt Transfer Routine associated with Routine T4RUPT is initiated which interrupts the current program section, saves the contents of registers A and Q, and transfers program control to Routine T4RUPT of program section T4RUPT Output Control. The execution of T4RUPT Output Control must be initiated periodically to perform the following operations:

- a. Transfer new information to DSKY's; one relay bank may be switched each 120 msec
- b. Drive the IMU CDU's and the Optics CDU's; one IMU CDU may be driven every 60 msec, all three every 180 msec and one Optics CDU every 480 msec, all three every 960 msec
- c. Sample the IMU mode and Optics mode settings; both may be sampled every 120 msec
- d. Check the downlink rate to ensure that it is not too slow; the rate is checked every 120 msec
- e. Test for IMU, CDU, and PIPA failures; the test is made every 480 msec.

Upon completion of the required input-output operation, T4RUPT Output Control returns program control to the interrupted program section.

15-164. Routine KEYRUPT

15-165. Whenever DSKY or MARK data is entered into the AGC, the current program section must be interrupted so the data can be accepted and processed. Therefore, each time a DSKY key (except key TEST ALARM) or the MARK button on the G&N Indicator Control Panel is depressed, the Interrupt Transfer Routine associated with Routine KEYRUPT is initiated which interrupts the current program section; saves the contents of registers A and Q; and transfers program control to KEYRUPT and UPRUPT Processor.

15-166. KEYRUPT and UPRUPT Processor accepts the input data and requests the Executive to initiate the execution of Pinball which decodes the data. After completing these operations, program control is returned to the interrupted program section.

15-167. Routine UPRUPT

15-168. The AGC will accept uplink data from the ground only when the ACCEPT/BLOCK UPTL switch on the Main Panel DSKY is in the ACCEPT position. When uplink data is received, the current program section must be interrupted so the uplink data can be accepted and processed by the AGC. Therefore, upon the reception of each uplink word, the Interrupt Transfer Routine associated with Routine UPRUPT is initiated which interrupts the current program section; saves the contents of registers A and Q; and transfers program control to KEYRUPT and UPRUPT Processor. Since uplink data is in a coded form similar to the DSKY keycodes except that the code is transmitted three times for verification, KEYRUPT and UPRUPT Processor performs the same operations described for Routine KEYRUPT.

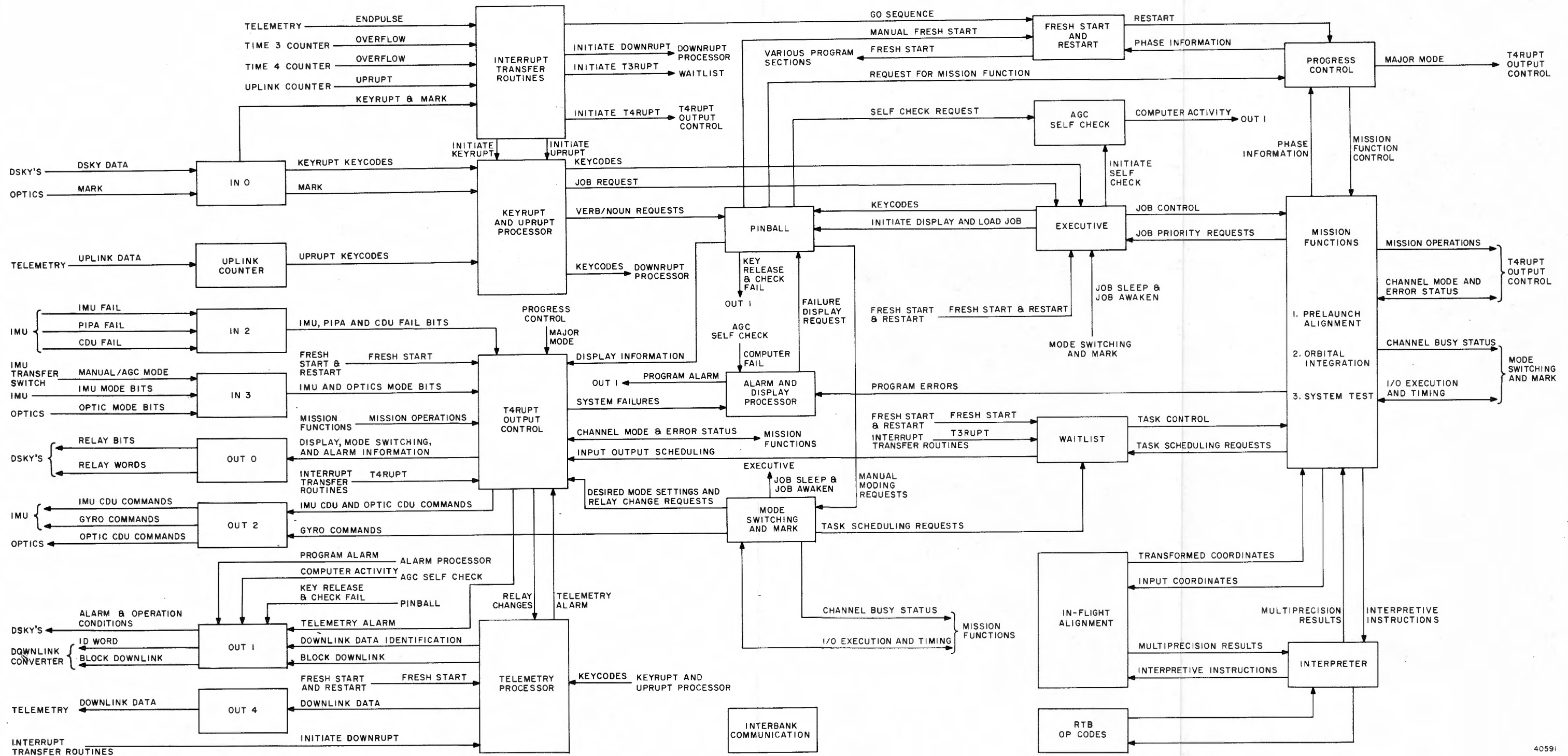


Figure 15-13. Program Sunrise

15-169. Routine DOWNRUPT

15-170. The AGC provides data for transmission downlink at a rate of one to seven times each 120 msec time period. At the end of each transmission, the current program section must be interrupted to allow the AGC to prepare for the next transmission. Therefore, each time a transmission has been completed, the Telemetry System sends an END pulse to the AGC which initiates the Interrupt Transfer Routine associated with Routine DOWNRUPT in program section Telemetry Processor. This Routine interrupts the current program section; saves the contents of registers A and Q; and transfers program control to the Telemetry Processor. The Telemetry Processor checks to ensure the downlink rate is not too fast and, if the rate is not too fast, loads register OUT4 with the data to be sent downlink during the next transmission. Then the Telemetry Processor returns program control to the interrupted program. If the downlink rate is too fast, a telemetry alarm is generated and displayed on the Navigation Panel DSKY and the downlink transmission is blocked.

15-171. Inhibiting and Releasing Interrupts

15-172. There are occasions during program operation when it is inconvenient to recognize and process an interrupt. Thus, an interrupt inhibit (INHINT) instruction is programmed into various program sections which inhibits the processing of interrupts while an operation is being performed which should not be interrupted (e.g., displaying information on the DSKY's). Upon the completion of the operation, an interrupt release (RELINT) instruction is used to release the INHINT instruction and allow interrupts to be processed when they occur. Interrupt requests received between the execution of instructions INHINT and RELINT are not lost, but are stored for processing after the RELINT is executed.

15-173. IDLE CONDITIONS

15-174. When power is first applied to the Computer Subsystem, the hardware automatically initiates the GO Sequence (GOJAM) and program control is transferred to program section Fresh Start and Restart. Fresh Start and Restart initializes certain locations (registers) in Erasable Memory which results in the following:

- a. The Executive has no Jobs awaiting execution except the dummy Job.
- b. The Waitlist has no Tasks scheduled to be executed except the dummy Task.

- c. The three phase tables in Progress Control are set to agree.
- d. All relays under computer control are deenergized which clears the displays on both DSKY's and places the G&N System in the Attitude Control mode. (In this mode power is removed from the IMU.)
- e. The TIME3 and TIME4 counters are preset to overflow in 10 msec.

Program control is then transferred to program section AGC Self-Check where the dummy Job is executed.

15-175. The dummy Job continually searches for a genuine Job of higher priority. However, since power has just been applied, no Jobs have been requested and the dummy Job is continually executed to keep the computer idling until the execution of a genuine Job is requested via a keyboard entry or uplink. Until a genuine Job is requested, the computer continues operating in a loop and can only be interrupted by an Interrupt Transfer Routine.

15-176. While the computer is idling awaiting a KEYRUPT or UPRUPT, only those Interrupt Transfer Routines associated with T3RUPT, T4RUPT, and DOWNRUPT are intermittently active. Every 81.93 sec the TIME3 counter overflows, the dummy Job is interrupted and suspended and program control is transferred to the Waitlist at routine T3RUPT. Routine T3RUPT initiates the execution of the dummy Task since no genuine Tasks are scheduled. When the dummy Task has been completed, program control is returned to the interrupted Job which is in this instance the dummy Job. The dummy Task continues to be executed every 81.93 sec until the idling condition is terminated.

15-177. Within the 81.93 sec intervals the TIME4 counter overflows every 60 msec, interrupting the execution of the dummy Job and causing program control to be transferred to program section T4RUPT Output Control. There are no operations to be performed by this program section while the computer is idling; therefore, program control returns to the dummy Job.

15-178. Routine DOWNRUPT in the Telemetry Processor is also intermittently active at this time because END pulses are received one to seven times every 120 msec. When an END pulse is received, the execution of the dummy Job is interrupted, program control is transferred to the Telemetry Processor which loads register OUT4, and program control is returned to the dummy Job.

15-179. Routines UPRUPT and KEYRUPT are inactive because the computer receives no inputs from uplink or the DSKY's during the idling condition.

15-180. Thus, in the idle condition, the program executes only the dummy Job in program section AGC Self-Check, Routine T3RUPT in program section Waitlist, the T4RUPT Output Control, and the Telemetry Processor. The dummy Job is executed most of the time with brief moments taken by program sections Waitlist, T4RUPT Output Control, and Telemetry Processor.

15-181. NORMAL CONDITIONS

15-182. The following discussion of the AGC program in normal operation assumes the computer has been turned on recently, is presently idling, and has received no Job requests. It is further assumed that the TRANSFER switch on the IMU Control Panel is in the COMPUTER position. Several of the initial operations performed during Mission Function Prelaunch Alignment are described to illustrate the interplay between the program sections to accomplish these operations. However, before discussing the AGC program in normal operation, the overall purpose of Prelaunch Alignment is discussed.

15-183. Prelaunch Alignment is designed to align the IMU prior to launch. This is necessary to ensure that the thrust acceleration will be in the plane of trajectory, to prevent gimbal lock during launch, and to monitor the boost phase for failures. Prelaunch Alignment is performed in four steps: initialization, IMU moding, vertical erection, and gyrocompassing. The discussion of the AGC program in normal operation is confined to only the initialization and the Zero Encoder portion of the IMU moding. These are sufficient for adequate understanding of the interplay between program sections.

15-184. Mission Function Prelaunch Alignment is initiated through either DSKY keyboard by depressing keys VERB, 3, 7, ENTER, D_1 , D_2 , and ENTER where D_1 is key 0 and D_2 can be any of the digit keys between 0 and 7. Verb 37 is a request to change the major mode (Mission Function) to that specified by digits D_1 and D_2 . In this discussion, D_1 is key 0 designating Mission Function Prelaunch Alignment and D_2 is key 1 designating manual phase 1. The manual phases should not be confused with the internal Phases described previously. A manual phase is a keyed-in code used at the keyboard to gain access to an internal Phase (or combination of internal Phases) of the Mission Function.

15-185. When the VERB key is depressed, the computer generates a KEYRUPT which interrupts the dummy Job and initiates the appropriate Interrupt Transfer Routine. Program control is then transferred to KEYRUPT and UPRUPT Processor which accepts the five-bit keycode representing key VERB and requests the Executive to schedule the Job CHARIN in Pinball. When the request has been processed by the Executive, KEYRUPT and UPRUPT Processor stores the keycode in a register of the Job Area assigned to the requested Job CHARIN. Program control returns to the dummy Job which checks for a genuine Job and finds there is one, Job CHARIN. Program control is then transferred via the Executive to Pinball where Job CHARIN decodes the key-code. When the decoding is complete, program control returns to the Executive which terminates Job CHARIN and reinitiates the dummy Job. The dummy Job remains active until another keyboard entry is received.

15-186. The sequence of operations is repeated for each keyboard entry; however, the specific action taken by Job CHARIN is dependent upon the particular keycode received. When key VERB is depressed, Job CHARIN requests that the VERB indicators be blanked and conditions the computer to accept the next two entries (digits 3 and 7) as a Verb code. As keys 3 and 7 are depressed, Job CHARIN, which is executed twice, once per key, requests the display of digits 3 and 7 in the VERB indicators, and preserves the Verb code for later use. When key ENTER is depressed, Job CHARIN requests that the VERB indicators flash to alert the astronaut that additional information must be keyed in. Then the astronaut keys in digits 0 and 1 and Job CHARIN (again executed twice) requests the display of the digits in the NOUN indicators as they are entered. Upon depressing key ENTER the second time, Job CHARIN blanks the NOUN indicators and decodes the two digits 0 and 1. Program control is then transferred to program section Progress Control.

15-187. Each time Job CHARIN makes a display request, program section T4RUPT Output Control honors the request within 120 msec during a T4RUPT. The requested display information is supplied to the DSKY's via register OUT0. In addition, the keycodes (from Job CHARIN) and the resulting relay changes (from T4RUPT Output Control) are sent downlink by program section Telemetry Processor subject to DOWNRUPT's.

15-188. When the last entry has been processed and program control has been transferred to Progress Control, the Mission Function code 0 is used to determine the proper place (cell) in the phase table. The

Phase presently contained in the cell is replaced with the manual phase (1) just keyed in. Program control is then transferred to the Executive to request the execution of Prelaunch Alignment. Program control returns to Progress Control and is passed on to Pinball to update the PROGRAM indicators on the DSKY's which will display digits 0 and 1. (The digits 0 and 1 which are displayed on the DSKY's are not the same digits that were keyed in but rather a two-digit code representing Prelaunch Alignment.) The Executive then assumes program control, terminates Job CHARIN, and searches for the Job having the highest priority.

15-189. At this time, Prelaunch Alignment, which is now considered a Job, has the highest priority; therefore, program control is transferred to it. Prelaunch Alignment immediately utilizes Progress Control to change the content of the phase table cell from the manual phase to the internal Phase. Program control is returned to Prelaunch Alignment and its execution is continued.

15-190. As a result of keying in manual phase 1, Prelaunch Alignment sets the azimuth angle to a desired value, zeros the initial gimbal angles, zeros the gyro drift rates, and sets the latitude angle. Program control is then transferred to Mode Switching and Mark to initiate the Zero Encoding sequence. This initiation includes requesting the Zero Encode mode and the scheduling of a Task by the Waitlist which is to be executed 40 sec hence. (The 40-sec delay is required to allow the CDU shafts to reach the zero position.) This is the first of five Tasks required to complete the Zero Encoding sequence which equates the reading of the CDU dials with the actual gimbal angles. (The five Tasks are scheduled to be executed by transferring program control to the Waitlist where each Task, when executed, requests the scheduling of the following Task. Thus, the first Task schedules the second, the second the third, etc.)

15-191. Program control is transferred from the Waitlist back to Mode Switching and Mark and on to Prelaunch Alignment where further initialization is performed which consists of setting up a five-minute period for vertical erection, setting the nominal gain for driving the CDU's and clearing the gyro command registers. This initialization requires only a very small part of the 40-sec waiting period until the first Task is executed. Thus program control is transferred to Mode Switching and Mark which requests the Executive to put Prelaunch Alignment into a dormant state (made inactive) until all five Tasks have been completed. Between each Task the Executive then searches for the Job having the next highest priority which is the dummy Job.

Program control is transferred to AGC Self-Check where the dummy Job keeps the computer operating in a loop while checking for the existence of a genuine Job.

15-192. This operation continues until the 40-sec waiting period has elapsed when a T3RUPT occurs which transfers control to the Waitlist and the Task is executed. However, during the waiting period, T4RUPT Output Control is initiated between 600 and 700 times. The first and second (or second and third) times that T4RUPT Output Control is executed, the mode switching that was requested is accomplished and register IN3 is tested to verify that the mode switching has in fact been accomplished. In addition, the TIME3 counter might overflow before the 40-sec waiting period elapses due to a request for the dummy Task which occurs every 81.93 sec.

15-193. When the 40-sec period is over, program control is transferred from AGC Self-Check to the Waitlist by means of a T3RUPT. Program control is then transferred to Mode Switching and Mark where the scheduled Task is executed. During the execution of the Task, a request is made to the Waitlist for the scheduling of the next Task and program control goes to the dummy Job until the Task comes due. (The dummy Job is interrupted by T3RUPT's, T4RUPT's, and DOWNRUPT's and the mode switching is verified during the initial T4RUPT's.) This sequence of operations is repeated until all five Tasks have been requested and successfully completed. During the execution of the last Task, Mode Switching and Mark requests the Executive to make Prelaunch Alignment active once again. When Prelaunch Alignment is again executed, it completes the remaining IMU moding and further initialization before entering the vertical portion of its operation.

15-194. ABNORMAL CONDITIONS

15-195. During program operation, several abnormal conditions may occur which are classified as hardware failures, aborts, or alarms. A hardware failure occurs as the result of such conditions as incorrect parity, a counter failure, an interrupt lock or a TC (transfer control) trap. An abort occurs when a serious program failure exists such as an excessive number of Jobs or Tasks. An alarm occurs when a program failure exists which is not too serious such as the reception of unrequested Mark information. Hardware failures and aborts result in a computer restart while alarms may (or may not) result in a computer fresh start subject to the discretion of the astronaut. It is assumed in the following paragraphs that Mission Function Prelaunch Alignment is operating when the abnormal conditions occur.

15-196. Hardware Failures

15-197. When a hardware failure occurs, the appropriate failure indicator is illuminated on the Navigation Panel DSKY, the COMPUTER FAIL indicator is illuminated on the Main Panel DSKY, and a GO sequence is initiated automatically which transfers program control to program section Fresh Start and Restart. A restart is initiated and the phase tables are checked for agreement. Assuming the phase tables agree, program control is transferred to program section Progress Control which determines the Phase of Mission Function Orbital Integration and examines this Phase to determine if Orbital Integration is active. Since (by definition) no Mission Function is active except Prelaunch Alignment at this time the code for Orbital Integration is not displayed on the DSKY's and the Executive does not request its execution. Next, the Phase of Prelaunch Alignment is determined and examined to ascertain if Prelaunch Alignment is active. Being active, program control is transferred to Fresh Start and Restart where the mission function code is made available for display. Program control is then transferred to Prelaunch Alignment where a request is made to the Executive to execute Prelaunch Alignment (Prelaunch Alignment requests the execution of itself). Program control is transferred from the Executive to Fresh Start and Restart via Prelaunch Alignment. Since there are no other Mission Functions to examine at this time, program control is transferred to the Executive to request the execution of Job DOALARM in the Alarm and Display Processor. Pinball then assumes program control via Fresh Start and Restart and requests the display of the current (active) Mission Function code which is 01 for Prelaunch Alignment. Program control is transferred to AGC Self-Check where the dummy Job is initiated.

15-198. During the routine check for a genuine Job, Job DOALARM is found to have the highest priority and program control is transferred to it via the Executive. Since a hardware failure does not have a display code and no aborts or alarms have occurred previously, Job DOALARM has no failure code to display. However, since Pinball has requested a display, five zeros are prepared for display in display register R1; digits 0, 1 are displayed in the VERB indicators; and digits 3, 1 are displayed in the NOUN indicators on both DSKY's. These displays are performed subject to T4RUPT Output Control within 120 msec.

15-199. Program control passes from Job DOALARM to the Executive which terminates Job DOALARM; searches for the next highest priority Job which is Prelaunch Alignment; and transfers program control to Prelaunch Alignment. Program control is transferred to Progress

Control to obtain the Phase that Prelaunch Alignment was in when the hardware failure occurred. Program control returns to Prelaunch Alignment examines the Phase just obtained to determine if a manual phase was recently keyed in and assuming no manual phase, it commences execution at the beginning of the internal Phase. Thus the hardware failure operation is completed.

15-200. Aborts

15-201. When an abort occurs, program control goes to the Alarm and Display Processor which causes the PROG ALM (Program Alarm) indicator on the Navigation Panel DSKY to be illuminated via an entry into register OUT1. The Alarm and Display Processor then sets up a display code indicating where the abort occurred and the type of abort that exists. Then the Alarm and Display Processor enters a loop that results in a TC trap which causes a GOJAM. The sequence of operation from this point on is similar to that of a hardware failure except that Job DOALARM displays a failure code via program sections Pinball and T4RUPT Output Control.

15-202. Alarms

15-203. When an alarm occurs, program control goes to the Alarm and Display Processor which causes the PROG ALM indicator on the Navigation Panel DSKY to be illuminated, requests the execution of Job DOALARM, and returns program control to location $L + 2$ (where location L is the location at which the alarm occurred and $L + 1$ is the location at which the failure code is stored). At the next break point (place where a current Job can be superceded by a higher priority Job), the Executive executes Job DOALARM to display the failure code. If the alarm condition repeats, the astronaut has the option of manually initiating a fresh start by a keyboard entry. A fresh start results in the computer entering an idle state similar to that previously discussed.

ISSUE 15
APPENDIX A

This appendix contains a list of the AGC Subsystem input and output signals. The list contains the line, the connector pins, names(s) and description of each input and output signal.

AGC SUBSYSTEM INPUT AND OUTPUT SIGNALS

Line	Connecting Pin of						Name Used on Drawing	Name Used on DD Memo 75	Signal Description
	05A4J5 05A3P3	05A3P1	05A3J1 05A5P1	05A5P3	05A6P1	05A8P1			
001 S R	4302 4303		224 226	224 226			MASTER CLOCK (1024KCPS)	MASTER CLOCK	1.024 mpps pulses generated by AGC Clock for CM master timing.
011 S R	4228 4328		034 035	094 095			ENG. ON	ENGINE ON	102.4 kpps pulse trains generated by AGC to turn on SM engine.
014 S R	4224 4324		190 191	190 191			DLNK START	DLNK START	AGC words (16-bit) to be sent to ground stations are entered into register OUT 4 and transferred serially to the NAA Telemetry Programmer. These words are under the control of signals (pulses) DLNK START, DLNK END, and DLNK SYNC which are generated by the NAA equipment. Serial DLNK DATA signals (pulses) are generated by the Downlink Converter within the AGC.
015 S R	4424 4524		192 193	192 193			DLNK END	DLNK END	
016 S R	4225 4325		194 195	194 195			DLNK SYNC	DLNK SYNC	
017 S R	4625 4626		098 099	090 091			DLNK DATA	DLNK DATA	
024 S R	4425 4525		123 124	123 124			ULNK 0	ULNK 0	Uplink information is received by uplink equipment in the spacecraft and forwarded in serial form (pulses ULNK 0 and ULNK 1) to the AGC. The AGC enters the serial information into counter UP-LINK and converts it into 15-bit AGC words.
025 S R	4226 4326		125 126	125 126			ULNK 1	ULNK 1	
026 S R	4612 4613		100 101	092 062			POWER FAIL	AGC POWER FAIL	In case of a failure in the AGC power supply, relay K1 in the power supply closes a contact which turns on indicator COMP PWR FAIL on the Main Display and Control Panel.
101 S R	4607 4611	119 120					SWITCH COMMON	COMMON	Refer to signal description for lines 105 through 107.
102 S R	4708 4611	086 087					MARK	MARK	
103 S R	4808 4611	088 089					MARK	MARK	
104 S R	4908 4611	054 055					ZERO ENCODER	ZERO OPT	

AGC SUBSYSTEM INPUT AND OUTPUT SIGNALS (cont)

Line	Connecting Pin of						Name Used on Drawing	Name Used on DD Memo 75	Signal Description
	05A4J5 05A3P3	05A3P1	05A3J1 05A5P1	05A5P3	05A6P1	05A8P1			
105 S R	5008 4611	016 017					OPTMS 1	OPT MODE SW 1	
106 S R	4709 4611	018 019					OPTMS 2	OPT MODE SW 2	
107 S R	4809 4611	020 021					OPTMS 3	OPT MODE SW 3	
108 S R	4419 4519	156 157					X+	OPT +X	
109 S R	4220 4320	123 124					X-	OPT -X	Incremental pulses received from Optics CDU X encoder and CDU Y encoder. Pulses 108 and 109 are used to increment and decrement the content of counter OPT X, and pulses 110 and 111 to increment and decrement the content of counter OPT Y.
110 S R	4420 4520	230 231					Y+	OPT +Y	
111 S R	4221 4321	190 191					Y-	OPT -Y	
114 S R	4706 4806	163 164					X+	+X OPT CDU	
115 S R	4906 5006	130 131					X-	-X OPT CDU	Bursts of 3.2 kpps generated in the AGC to drive the Optics CDU's. The Optics CDU X (shaft angle CDU) is driven by signal 114 in the positive direction and by signal 115 in the negative direction. The Optics CDU Y (trunnion angle CDU) is driven by signal 116 in the positive direction and by signal 117 in the negative direction.
116 S R	4707 4807	235 236					Y+	+Y OPT CDU	
117 S R	4907 5007	197 198					Y-	-Y OPT CDU	

AGC SUBSYSTEM INPUT AND OUTPUT SIGNALS (cont)

Line	Connecting Pin of						Name Used on Drawing	Name Used on DD Memo 75	Signal Description
	05A4J5 05A3P3	05A3P1	05A3J1 05A5P1	05A5P3	05A6P1	05A8P1			
118 S R	4212 4312	056 057					X+	+X CDU	Incremental pulses received from IMU CDU X, IMU CDU Y, and IMU CDU Z encoders. Pulses 118 and 119 are used to increment and decrement the content of counter CDU X, pulses 120 and 121 to increment and decrement the content of counter CDU Y, and pulses 122 and 123 to increment and decrement the content of counter CDU Z.
119 S R	4412 4512	058 059					X-	-X CDU	
120 S R	4213 4313	024 025					Y+	+Y CDU	
121 S R	4413 4513	026 027					Y-	-Y CDU	
122 S R	4214 4314	232 233					Z+	+Z CDU	
123 S R	4414 4514	192 193					Z-	-Z CDU	
124 S R	4215 4315	158 159					FAIL	CDU FAIL	In case of a CDU failure, a 102.4 kpps pulse train is supplied by the CDU's which sets bit position 10 of register IN2.
126 S R	4402 4502	064 065					X+	CDU X+	Bursts of 3.2 kpps generated in the AGC to drive the IMU CDU's. The IMU X is driven by signal 126 in the position direction and by signal 127 in the negative direction. The IMU CDU Y and the IMU CDU Z are driven in a similar way by signals 128 through 131.
127 S R	4403 4503	030 031					X-	CDU X-	
128 S R	4404 4504	237 238					Y+	CDU Y+	
129 S R	4405 4505	199 200					Y-	CDU Y-	
130 S R	4406 4506	165 166					Z+	CDU Z+	
131 S R	4407 4507	097 098					Z-	CDU Z-	
132 S R	4415 4515	125 126					ΔV_{X+}	+DV _X	Refer to signal description for lines 134 through 137.
133 S R	4216 4316	092 093					ΔV_{X-}	-DV _X	

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AGC SUBSYSTEM INPUT AND OUTPUT SIGNALS (cont)

Line	Connecting Pin of						Name Used on Drawing	Name Used on DD Memo 75	Signal Description
	05A4J5 05A3P3	05A3P1	05A3J1 05A5P1	05A5P3	05A6P1	05A8P1			
134 S R	4416 4516	194 195					$\Delta V_Y +$	+DV _Y	Incremental pulses received from PIPA X, PIPA Y, and PIPA Z. Pulses 132 and 133 are used to increment and decrement the content of counter PIPA X, pulses 134 and 135 to increment and decrement the content of counter PIPA Y, and pulses 136 and 137 to increment and decrement the content of counter PIPA Z.
135 S R	4217 4317	160 161					$\Delta V_Y -$	-DV _Y	
136 S R	4417 4517	127 128					$\Delta V_Z +$	+DV _Z	
137 S R	4218 4318	094 095					$\Delta V_Z -$	-DV _Z	
138 S R	4418 4518	060 061					PIPA FAIL	PIPA FAIL	In case of a PIPA failure, a 102.4 kpps pulse train is supplied by the PIPA's which sets bit position 11 of register IN2.
139 S R	4207 4307	132 133					PIPA INTERROGATE	PIPA INTERROGATE	Continuous 3.2 kpps pulse trains generated by the AGC to Interrogate the PIPA's.
140 S R	4208 4308	099 100					PIPA CLOCK	PIPA SWITCHING	
141 S R	4219 4319	028 029					IMU FAIL	IMU FAIL	In case of an IMU failure, a 102.4 kpps pulse train is supplied by the IMU which sets bit position 12 of register IN2.
142 S R	4209 4309	066 067					X+	+DX	Bursts of 3.2 kpps generated in the AGC to drive the IMU gyros. The X gyro is driven by signal 142 in the positive direction and by signal 143 in the negative direction. The Y and the Z gyro are driven in a similar way by signals 144 through 147.
143 S R	4210 4310	032 033					X-	-DX	
144 S R	4211 4311	239 240					Y+	+DY	
145 S R	4408 4508	201 202					Y-	-DY	
146 S R	4409 4509	167 168					Z+	+DZ	
147 S R	4410 4510	134 135					Z-	-DZ	

AGC SUBSYSTEM INPUT AND OUTPUT SIGNALS (cont)

Line	Connecting Pin of						Name Used on Drawing	Name Used on DD Memo 75	Signal Description
	05A4J5 05A3P3	05A3P1	05A3J1 05A5P1	05A5P3	05A6P1	05A8P1			
148 S R	4411 4511	101 102					GYRO RESET	GYRO RESET	3.2 kpps pulse train is generated in the AGC to reset the IMU gyros.
149 S R	4702 4802	068 069					800 CPS SET	800 PPS SET	Continuous pulse trains generated in the AGC and transmitted to the PSA.
150 S R	4902 5002	034 035					800 CPS RESET	800 PPS RESET	
151 S R	4703 4803	241 242					3.2 KC SET	3.2K PPS SET	
152 S R	4903 5003	203 204					3.2 KC RESET	3.2K PPS RESET	
153 S R	4704 4804	169 170					25.6 KC SET	25.6K PPS SET	
154 S R	4904 5004	136 137					25.6 KC RESET	25.6K PPS RESET	
155 S R	4705 4805	103 104					CONVERTER SYNC (12.8KC)	12.8K PPS	
156 S R	4905 5005	070 071					DISCRET SIG CARRIER (102.4KC)	DISCRET SIGNAL CARRIER	
157 S R	4616 4617	036 037					AGC POWER FAIL NAV PANEL LIGHT	AGC POWER FAIL	In case of a failure in the AGC power supply, relay K1 in the power supply is energized which turns an indicator COMP PWR FAIL on the Navigation Display and Control Panel and is also sent to the telemetry system.
158 S R	4909 4611	152 153					K1	K1	DC signals supplied by relays K1, K2, K3, K4, K12, and K5 in the IMU. Signal 158 indicates mode ZERO ENCODER and sets bit position 1 of register IN3. Signal 159 indicates mode COARSE ALIGNMENT and sets bit position 2. Signal 160 indicates mode LOCK CDU's and sets bit position 3. Signal 161 indicates mode FINE ALIGNMENT
159 S R	5009 4611	154 155					K2	K2	
160 S R	4700 4611	188 189					K3	K3	

(Continued on next page)

AGC SUBSYSTEM INPUT AND OUTPUT SIGNALS (cont)

Line	Connecting Pin of						Name Used on Drawing	Name Used on DD Memo 75	Signal Description
	05A4J5 05A3P3	05A3P1	05A3J1 05A5P1	05A5P3	05A6P1	05A8P1			
161 S R	4810 4611	222 223					K4	K4	and sets bit position 4. Signal 162 indicates mode ATTITUDE CONTROL and sets bit position 5. Signal 163 indicates mode ROLL RE-ENTRY and sets bit position 7 of register IN3. Refer to signals 307 through 315.
162 S R	4910 4611	224 225					K12	K12	
163 S R	5010 4611	226 227					K5	K5	
164 S R	4608 4611	228 229					TR SWITCH	TRN SW	DC signal supplied by Transfer Switch of IMU. Signal indicates that AGC has control over relays K1 through K5, and K12 in IMU, and sets bit position 6 of register IN3.
165 S R	4610 4611	121 122					COMMON	COMMON	+VDC supplied by AGC to IMU for the generation of signals 158 through 164. Refer to signals 307 through 315.
166	4603	234					BACK UP SIGNAL	BACK UP SIGNAL	+28VDC test point.
167 S R	4301 4201	001 073					28 VDC- A-Bus	+28V Bus A	+28VDC Bus A from PSA Junction Box to AGC Power Supply
168 S R	5001 4901	139 207					28 VDC- B-Bus	+28V Bus B	+28VDC Bus B from PSA Junction Box to AGC Power Supply
169 S R	4501 4401	002 074					0 VDC- A-Bus	0V Bus A	0VDC Bus A from PSA Junction Box to AGC Power Supply
170 S R	4701 4801	208 140					0 VDC- B-Bus	0V Bus B	0VDC Bus B from PSA Junction Box to AGC Power Supply
171	4304	196					TEMP MON 1	TEMP MON 1	Not used
172	4305	162					TEMP MON 2	TEMP MON 2	
173	4306	129					TEMP MON 3	TEMP MON 3	
175	4604	096					+3V A	3V A	Not used
176	4605	062					+13V A	13V A	

AGC SUBSYSTEM INPUT AND OUTPUT SIGNALS (cont)

Line	Connecting Pin of						Name Used on Drawing	Name Used on DD Memo 75	Signal Description
	05A4J5 05A3P3	05A3P1	05A3J1 05A5P1	05A5P3	05A6P1	05A8P1			
177	4606	063					0V	0V	Not used
178	4609	053					SHLD GRD	SHIELD GROUND GROUP IV	
179	4615	022 023 156 157 158 159 160					SHLD GRD	SHIELD GROUND GROUP V	
181	4611								Common signal return for signals 101 through 107, 158 through 165, 201 through 205, and 207 through 210.
183 S R	4724 4824	205 206					STAR PRES		Not used
201 S R	4718 4611	218 219	218 219	218 219	034 069	006 007, 003	KEY CODE 1	KEY CODE 1	+13VDC signals supplied by DSKY's which set bit positions 1 through 5 of register INO.
202 S R	4818 4611	183 184	183 184	183 184	035 069	008 009, 003	KEY CODE 2	KEY CODE 2	
203 S R	4918 4611	150 151	150 151	150 151	036 069	010 011, 003	KEY CODE 3	KEY CODE 3	
204 S R	5018 4611	117 118	117 118	117 118	037 069	012 013, 003	KEY CODE 4	KEY CODE 4	
205 S R	4719 4611	084 085	084 085	084 085	038 069	014 015, 003	KEY CODE 5	KEY CODE 5	
206 S R	4819		049 050	049 050		016 017, 003	KEY RESET	KYBD RESET	+13VDC signals supplied by DSKY's. Signals 206 and 209 control the Interrupt Priority Control. Signals 207 and 208 control the Alarm Control.
207 S R	4919 4611	014 015			039 069		TEST ALARM	TEST ALARM	
208 S R	5019 4611	220 221	220 221	220 221	048 069	018 019, 003	ERROR RESET	ERR LGHT RESET	

AGC SUBSYSTEM INPUT AND OUTPUT SIGNALS (cont)

Line	Connecting Pin of						Name Used on Drawing	Name Used on DD Memo 75	Signal Description
	05A4J5 05A3P3	05A3P1	05A3J1 05A5P1	05A5P3	05A6P1	05A8P1			
209 S R	4720 4611	012 013			049 069		KEY RESET	KYBD RESET	Refer to signal description for lines 206 through 208.
210 S R	4720 4611	185 186	185 186	185 186	047 069	020 021, 003	OR OF C1 → C22 (NAV DSKY) OR OF C23 → C33 (MAIN DSKY)	OR OF RELAYS C1 - C22 (NAV DSKY) OR OF RELAYS C23 - C33 (MAIN DSKY)	
211	5020	003	003	003	070	209	SPARE	SPARE	
212	4717	075	075	075	071	211	POWER SYNC N	POWER SUPPLY SYNC N	800 pps sync signal generated in AGC and supplied to Navigation Panel DSKY power supply.
213	4621	141	141	141	072	213	SPARE	SPARE	
214 S R	4711 4618, 4620	210 211	210 211	210 211	073 082	215 216, 208	OUT 0 1	OUT 0 1	Refer to signal description for lines 220 through 228.
215 S R	4811 4618, 4620	175 176	175 176	175 176	074 082	217 218, 208	OUT 0 2	OUT 0 2	
216 S R	4911 4618, 4620	142 143	142 143	142 143	060 082	219 220, 208	OUT 0 3	OUT 0 3	
217 S R	5011 4618, 4620	109 110	109 110	109 110	028 082	221 222, 208	OUT 0 4	OUT 0 4	
218 S R	4712 4618, 4620	076 077	076 077	076 077	029 082	223 224, 208	OUT 0 5	OUT 0 5	
219 S R	4812 4618, 4620	041 042	041 042	041 042	030 082	225 226, 208	OUT 0 6	OUT 0 6	

AGC SUBSYSTEM INPUT AND OUTPUT SIGNALS (cont)

Line	Connecting Pin of						Name Used on Drawing	Name Used on DD Memo 75	Signal Description
	05A4J5 05A3P3	05A3P1	05A3J1 05A5P1	05A5P3	05A6P1	05A8P1			
220 S R	4912 4618, 4620	004 005	004 005	004 005	031 082	227 228, 208	OUT 0 7	OUT 0 7	+ VDC signals supplied by bit positions 1 through 15 of register OUT0. These signals control the latched relays in the DSKY, which in turn control displays on the DSKY and other subsystems of the AGE.
221 S R	5012 4618, 4620	212 213	212 213	212 213	061 082	229 230, 208	OUT 0 8	OUT 0 8	
222 S R	4713 4618, 4620	177 178	177 178	177 178	062 082	231 232, 208	OUT 0 9	OUT 0 9	
223 S R	4813 4618, 4620	144 145	144 145	144 145	063 082	233 234, 208	OUT 0 10	OUT 0 10	
224 S R	4913 4618, 4620	111 112	111 112	111 112	014 082	235 236, 208	OUT 0 11	OUT 0 11	
225 S R	5013 4618, 4620	078 079	078 079	078 079	015 082	237 238, 208	OUT 0 12	OUT 0 12	
226 S R	4714 4618, 4620	043 044	043 044	043 044	016 080	239 240, 208	OUT 0 13	OUT 0 13	
227 S R	4814 4618, 4620	006 007	006 007	006 007	017 082	241 242, 208	OUT 0 14	OUT 0 14	
228 S R	4914 4618, 4620	214 215	214 215	214 215	018 082	176 177, 208	OUT 0 15	OUT 0 15	
229 S R	5014 4618, 4620	179 180	179 180	179 180	040 082	178 179, 208	PROGRAM ALARM	PROGRAM ALARM	Refer to signal description for lines 235 through 238.
230 S R	4715 4618, 4620	146 147	146 147	146 147	041 082	180 181, 208	COMPUTER ACTIVITY	COMPUTER ACTIVITY	
231 S R	4815 4618, 4620	113 114	113 114	113 114	019 082	182 183, 208	TL FAIL ALARM	TELEMETRY ALARM	
232 S R	4915 4618, 4620	080 081	080 081	080 081	032 082	184 185, 208	CHECK FAIL ALARM	PROGRAM CHECK FAILURE ALARM	
233 S R	5015 4618, 4620	045 046	045 046	045 046	033 082	186 187, 208	SCALER FAIL ALARM	SCALER FAIL ALARM	
234 S R	4716 4618, 4620	008 009	008 009	008 009	044 082	188 189, 208	PARITY FAIL ALARM	PARITY FAIL ALARM	

AGC SUBSYSTEM INPUT AND OUTPUT SIGNALS (cont)

Line	Connecting Pin of						Name Used on Drawing	Name Used on DD Memo 75	Signal Description
	05A4J5 05A3P3	05A3P1	05A3J1 05A5P1	05A5P3	05A6P1	05A8P1			
235 S R	4816 4618, 4620	216 217	216 217	216 217	043 082	190 191, 208	COUNTER FAIL ALARM	COUNTER FAIL ALARM	+VDC signals generated in the AGC. Signals 229, 230, 236, 231, and 232 are provided by bit positions 1 through 5 of register OUT 1 respectively. Signals 233, 234, 235, 237, and 238 are provided by various circuits. All Signals control non-latched relays in the DSKY's which in turn control indicators on the DSKY's.
236 S R	4916 4618, 4620	181 182	181 182	181 182	053 082	192 193, 208	KEY RLSE	KEY RELEASE	
237 S R	5016 4618, 4620	148 149	148 149	148 149	051 082	194 195, 208	RUPT LOCK ALARM	RUPT LOCK ALARM	
238 S R	4817 4618, 4620	115 116	115 116	115 116	064 082	196 197, 208	TC TRAP ALARM	TC TRAP ALARM	
239	4203	173	173	173	056	207	SIGNAL GRD	GND	Signals supplied by the AGC for the DSKY's.
240	4204	174	174	174	055	001	+3V B	+3V B	
241	4205	108	108	108	057	139	+13V B	+13V B	
242 S R	4917 4620	082 083	082 083	082 083	020 082	198 199, 208	POWER SYNC (800CPS)	POWER SUPPLY SYNC M	800 cps sync signal generated in AGC and supplied to Main Panel DSKY power supply.
243	4206	040	040	040	059	073	+28V COMPUTER	28V COMP	+28VDC supplied by the AGC for the DSKY's.
244 S R	5017 4618, 4620	047 048	047 048	047 048	042 082	200 201, 208	TIMING (1.5CPS)	TIMING	Action Request signal supplied by Timer to DSKY's for flasing of VERB and NOUN displays.
245					001	173			SHIELD
246 S R	4920 4611		051 052	051 052		004 005, 003	BLOCK UP LINK	BLOCK UPLNK	+VDC signal supplied by switch UPTTEL on the Main Panel DSKY if in position ACCEPT. The signal sets bit position 6 of Register INO.
247	4624	209	209	209	075	202	SPARE	SPARE	SHIELD
248	4627	010	010	010	045	022	SPARE	SPARE	
249	4630	011	011	011	046	024	SPARE	SPARE	
250					027	027		SHLD GND GP III	
251	4202	039	039	039	058	002	SIGNAL GRD (KEYBOARD)	KEY BD GND	

(See page 15-8EE for line 252)

Line	Connecting Pin of						Name Used on Drawing	Name Used on DD Memo 75	Signal Description
	05A4J5 05A3P3	05A3P1	05A3J1 05A5P1	05A5P3	05A6P1	05A8P1			
301					003		ENCODER ZEROING	C5	
302					004		CDU FAIL	C6	
303					005		PIPA FAIL	C7	
304					006		IMU FAIL	C8	
305					007		SPARE	C9	
306					008		COMMON	COMMON	
307					021		ZERO ENCODER	C1	
308					022		COARSE ALIGN	C2	
309					023		LOCK CDU'S	C3	
310					024		FINE ALIGN	C4	
311					025		ROLL REENTRY	C11	
312					026		COMMON	COMMON	
313					011		LAMP TEST SW		

(Continued on next page)

AGC SUBSYSTEM INPUT AND OUTPUT SIGNALS (cont)

Line	Connecting Pin of						Name Used on Drawing	Name Used on DD Memo 75	Signal Description
	05A4J5 05A3P3	05A3P1	05A3J1 05A5P1	05A5P3	05A6P1	05A8P1			
314					012		LAMP HIGH	C10 ATT CONTROL HI	
315					013		COMMON ATTITUDE CONTROL LAMP	COMMON ATT CONTROL	
316					065		ZERO OPT	C12	
317					066		STAR TRACKER ON	C13	
318							SPARE		
319							SPARE		
320							SPARE		
321							SPARE		
322							SPARE		
323							SPARE		
324							SPARE		
325							SPARE		

Line	Connecting Pin of						Name Used on Drawing	Name Used on DD Memo 75	Signal Description
	05A4J5 05A3P3	05A3P1	05A3J1 05A5P1	05A5P3	05A6P1	05A8P1			
326					009		OR OF ALARMS	OR OF ALARMS	<p>NONLATCHING RELAYS IN NAV PANEL DSKY</p> <p>PSA</p> <p>SIGNAL 326 — +28VDC</p> <p>SIGNAL 327 — 0VDC</p> <p>REFER TO SIGNALS 229 THRU 238</p> <p>THESE RELAYS ALSO TURN ON THE FOLLOWING INDICATORS IN THE DSKY:</p> <ul style="list-style-type: none">TC TRAPRUPT LOCKCTR FAILPRY FAILSCAL FAILCHECK FAILTM FAILPROG ALM
327					010		ALARM COMMON	COMMON	
328					002		CONDITION LAMP TEST	COND. LAMP TEST	Refer to signals 301 through 306
329									
330					082		GROUP II RETURN GROUND	COMMON RETURNS (SHIELD)	
331					067		OPT COMMON	COMMON (SHIELD)	
401									DC signals supplied by relays in the Main Panel DSKY to turn on indicators CDU FAIL, ACCEL FAIL, OR IMU FAIL respectively on the Main Display and Control Panel.
402					080		CDU FAIL	C6	
403					081		PIPA FAIL	C7	
404					082		IMU FAIL	C8	
405					083		SPARE	C9	Spare connection
406					084		COMMON	COMMON	Returns for signals 402 through 405

AGC SUBSYSTEM INPUT AND OUTPUT SIGNALS (cont)

Line	Connecting Pin of						Name Used on Drawing	Name Used on DD Memo 75	Signal Description
	05A4J5 05A3P3	05A3P1	05A3J1 05A5P1	05A5P3	05A6P1	05A8P1			
407									
408									
409									
410									
411									
412						085	PROGRAM ALARM	PROGRAM ALARM	+VDC signals supplied by relays in the Main Panel DSKY and sent to the NAA Telemetry Programmer, which collects information for downlink transmission. Similar signals are generated by relays in the Navigation Panel DSKY and used to turn on indicators PROG ALM, COMP ACTIVITY, TM FAIL, CHECK FAIL, SCAL FAIL, PRTY FAIL, CTR FAIL, KEY RLSE, RUPT LOCK, and TC TRAP. Thus, the signals sent to ground via the Main Panel DSKY contain the same information as is displayed on the Navigation Panel DSKY.
413						086	COMPUTER ACTIVITY	COMPUTER ACTIVITY	
414						087	TL FAIL ALARM	TELEMETRY ALARM	
415						088	CHECK FAIL ALARM	PROGRAM CHECK FAILURE ALARM	
416						089	SCALER FAIL ALARM	SCALER FAIL ALARM	
417						090	PARITY FAIL ALARM	PARITY FAIL ALARM	
418						091	COUNTER FAIL ALARM	COUNTER FAIL ALARM	
419						092	KEY RLSE	KEY RELEASE	
420						093	RUPT LOCK ALARM	RUPT LOCK ALARM	
421						094	TC TRAP ALARM	TC TRAP ALARM	
422						099	CRC GND	CRC COMMON	0V line from NAA Telemetry Programmer
423 S R						078 079	BLOCK UPLNK	BLOCK UPLNK	+VDC signal supplied by switch UPTL on the Main Panel DSKY if in position ACCEPT.
424						095	ENCODER ZEROING	C5	Refer to signal description for lines 425 through 427.

AGC SUBSYSTEM INPUT AND OUTPUT SIGNALS (cont)

Line	Connecting Pin of						Name Used on Drawing	Name Used on DD Memo 75	Signal Description
	05A4J5 05A3P3	05A3P1	05A3J1 05A5P1	05A5P3	05A6P1	05A8P1			
425						096	CDU FAIL	C6	+VDC signals supplied by relays in Main Panel DSKY and sent to the NAA Telemetry Programmer, which collects information for telemetry transmission. Signal 424 indicates that IMU CDU's are being zeroed. Signals 425 through 427 are similar to signals 402 through 404 except they are used as downlink information instead of turning on indicators CDU FAIL, ACCEL FAIL, or IMU FAIL.
426						097	PIPA FAIL	C7	
427						098	IMU FAIL	C8	
428						100	CRC SUPPLY	CRC +5V	
429								COMMON D RETURNS	
708	4126		235				CNTRL 1		Test signals from the Computer Test Set to test the AGC Power Supply.
709	4127		236				CNTRL 2		
713	4130		239				MT LO		
714	4129		238				MT HI		
	4125		234				CNSHLD		
	4128		237				MTSHLD		
	4619		187	187			SHLD GRD		
			107	107			SHLD GRN		
252					069	003	GROUP III RETURN GROUND		

ISSUE 15
APPENDIX B

This appendix contains a list of registers in Erasable Memory that are used by program sections Interpreter, Interbank Communication, and Pinball. The list contains the octal address, mnemonic name, and purpose of the registers.

E REGISTER ASSIGNMENT II FOR SUNRISE PROGRAMS

Octal Address	Initials △	Name and Purpose
The following registers are used by program sections Interpreter, Interbank Communication, and Pinball.		
0060	BANKSET	Holds complemented number of the bank in which the interpretive routine currently executed is stored.
0061	ADDR (ADDRWD)	Holds any 9-bit address referring to a Work Area; holds any 10-bit address referring to E memory; holds any 12-bit address for addressing F memory by means of register S; holds first Interpretive Address Word of a string in its true form temporarily; holds number N after decoding an Interpretive Address Word.
0062	ORDER	Holds Interpretive Instruction Word (in its true form) to be decoded; holds second order code of a decoded Interpretive Instruction Word; holds 00000 if no second order code exists or processing of it has been started.
	UPDATRET	Holds return address entered by subroutines UPDATNN and UPDATVB of Pinball.
	CHAR	Temporary storage used by subroutine CHARIN of Pinball.
	ERCNT	Error light reset counter, used by Pinball.
0063	DECOUNT	Scaling and display counter, used by Pinball.
	TEM11 SGNON	Temporary storage used by routines DOT2 and INCRT4 of Interpreter. Sign On indicator, used by Pinball.

△ Symbols in () are used in MIT/IL listings.

E REGISTER ASSIGNMENT II FOR SUNRISE PROGRAMS (cont)

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Octal Address	Initials △	Name and Purpose
0063	NOUNTEM DISTEM DECTEM DECTEM1	Counter for mixed noun fetch, used by Pinball. Counter for octal display verbs, used by Pinball. Counter for decimal display verbs, used by Pinball. Temporary storage for numbers, used by Pinball.
0064	MODE ENTRET	Holds 77776 when Interpreter is in DP mode; holds 77775 when Interpreter is in TP mode; holds 77777 when Interpreter is in Vector mode. Temporary storage used by subroutine ENTER of Pinball.
0065	LOADIND (NEWEQIND) MONTEM	Holds 00001 if MPAC or VAC has to be reloaded by the Interpreter; holds 00000 if the present content of MPAC or VAC is to be operated with. Also used as temporary storage by Interpreter. Temporary storage used by subroutine MONITOR of Pinball.
0066	WORKLOC (FIXLOC)	Holds address of Work Area currently used by the Interpreter. One out of five addresses is entered by the Job Control.
0067	VACLOC	Holds address of VAC currently used by the Interpreter. VACLOC = WORKLOC + 32D. One out of five addresses is entered by the Job Control.
0070-0075	VBUF	Temporary storage (6 locations) for vector operations of Interpreter.
0070	TEMQS	Temporary storage used by subroutine SWCALL of Interbank Communication.

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Changed 1 June 1965

E REGISTER ASSIGNMENT II FOR SUNRISE PROGRAMS (cont)

Octal Address	Initials ⚠	Name and Purpose
0071	BANKTEM	Temporary storage used by subroutine SWCALL of Interbank Communication.
0072	TEMB (B) SIGNRET	Argument storage used by subroutine ARCCOS of Interpreter. Holds return address entered by subroutine ON of Pinball.
0072-0073	PROGREG MIXTEMP	Temporary storage for program codes, used by Pinball. Temporary storage for mixed noun data, used by Pinball.
0074	ESCAPE2 TAG1	Negative Argument Switch. Contains a TC K instruction during execution of Interpretive Instruction ARCCOS. Holds address of Work Area currently used by the Interpreter, plus zero or one dependent upon whether Index Register X1 or X2 is to be used, or plus two or three dependent upon whether Step Register S1 or S2 is to be used.
0075	AWORD (POLISH) TEMQ3 WDCNT INREL	Holds an Address Word in its true form; holds 10-bit E address of Store Code Address Word. Holds return addresses entered by subroutines DDV K and SQRTDIV. Character Counter, used by subroutine DSPWP of Pinball. Input buffer selector (X, Y, Z, display register) of Pinball.

E REGISTER ASSIGNMENT II FOR SUNRISE PROGRAMS (cont)

FR-2-115

Octal Address	Initials △	Name and Purpose
0076-0100	BUF	Temporary storage (3 locations) for DP and TP operations of Interpreter. Registers BUF+1 and BUF+2 used as temporary storage by LOAD routine.
0100	SGNDMAX TEM3	Temporary storage used by subroutine TPAGREE of Interpreter. Temporary storage used by subroutine TPAGREE of Interpreter.
0101	TEM2 DSREL	Temporary storage used by subroutines TRAD, DAD1, STD2, DMP1, DDV, DOT2, INCRT2, STB, and CROSS of Interpreter. Temporary storage used by subroutine DAD1 of Interpreter.
0102	TEM4 TEMQ DSMG 1DADDTM	Temporary storage used by routines DMP1, INCRT4, and CROSS1 of Interpreter. Holds return address entered by routine TPAGREE of Interpreter. Temporary storage used by subroutine DSPIN of Pinball. Mixed noun indirect address storage, used by Pinball.
0103	TEM5 TEMQ2 BASE COUNT	Temporary storage used by routines TRAD, DMP, DAD, and VACCOM of Interpreter. Holds return address entered by subroutine SQRT3 of Interpreter. Temporary storage used by subroutine CROSS1 of Interpreter. Temporary storage used by subroutine DSPIN of Pinball.

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Changed 1 June 1965

E REGISTER ASSIGNMENT II FOR SUNRISE PROGRAMS (cont)

Octal Address	Initials △	Name and Purpose
0104	TEM6 TEM8	Temporary storage used by subroutine CROSS1 of Interpreter. Temporary storage used by subroutines ST02, DOT2, and ROUND of Interpreter.
0105	TEM9 WRDRET WDRET DECRET 21/22REG	Temporary storage used by subroutines POLY, MXV, and VXM of Interpreter. Holds return address entered by subroutine 5 BLANK of Pinball. Holds return address entered by subroutine DSPWP of Pinball. Holds return address entered by subroutine PUTCOM of Pinball. Temporary storage used by routine CHARIN of Pinball.
0106	TEM10 IND MIXBR	Temporary storage used by subroutine POLY, MXV, and VXM of Interpreter. Temporary storage used by subroutine CROSS1 of Interpreter. Indicator for mixed and normal noun, used by Pinball.
0107	DVSW SGNOFF NVTEMP SFTEMP1	Divide Switch, holds 0000 for normal divide or any other quantity for backward divide of Interpreter. Temporary storage used by subroutine ON of Pinball. Temporary storage used by subroutine NVSUB of Pinball. Holds high order part of SF constant for Pinball.

E REGISTER ASSIGNMENT II FOR SUNRISE PROGRAMS (cont)

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Octal Address	Initials △	Name and Purpose
0107	DECTEM2	Temporary storage for numeric used by Pinball.
0110	BRANCHQ CODE SFTEMP2	Holds the return address for a branch operation of the Interpreter. Temporary storage used by routine DSPIN of Pinball. Holds low order part of SF constant for Pinball.
0111	COMPON DSEXIT EXITEM BLANKRET	Component counter for UNIT operation of Interpreter, also used as temporary storage by Interpreter. Holds return address entered by subroutine DSPIN of Pinball. Holds return address entered by scale factor select routine of Pinball. Holds return address entered by subroutine 2BLANK of Pinball.
0112	ARETURN LSTPTR RELRET FREERET	Holds return address during the execution of Interpretive Instructions ASIN and ACOS. List pointer for routine GRABUSY of Pinball. Holds return address entered by subroutine RELDSP of Pinball. Holds return address entered by subroutine FREEDSP of Pinball.
0113	ESCAPE CADRTEM	Return Address Switch contains a TC instruction during the execution of Interpretive Instructions ASIN and ACOS. Temporary storage used by GRAB subroutines of Pinball.

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Changed 1 June 1965

E REGISTER ASSIGNMENT II FOR SUNRISE PROGRAMS (cont)

Octal Address	Initials 1	Name and Purpose
The following registers are used by program sections Interpreter and Job Control.		
0114-0123	Job Area 1	Defined by the following 8 locations.
0114-0116	MPAC	Multiprecision Accumulator (MPAC, 3 locations).
0117	IWLOC (LOC)	Holds 12-bit address of Interpretive Instruction Word to be decoded.
0120	AWLOC (ADRLOC)	Holds 12-bit address of last TC INTPRET; holds address of last Interpretive Instruction Word in string currently executed; holds address of any Interpretive Address Word in current string.
0121	OVFIND	Overflow Indicator. Normally holds 00000; holds 00001 or 77776 in case of overflow or underflow.
0122	PUSHLOC	Holds address of next available Pushlist location in bit positions 10 through 1. (Register PUSHLOC of other Job Areas also holds the bank code of the Job occupying that Job Area in bit positions 15 through 11).
0123	PRIORITY	Holds 77777 when this Job Area is available. When this Job Area is in use, the register holds a ZERO in bit position 15 and the priority code of the Job using this Job Area in bit positions 14 through 10. (Register PRIORITY of other Job Areas also holds the address of the assigned Work Area in bit positions 9 through 1) The register may contain this information in noncomplemented form (all Job Areas) or complemented form (Job Areas 2 through 8 only), dependent whether the Job is in the active or dormant state.

E REGISTER ASSIGNMENT II FOR SUNRISE PROGRAMS (cont)

Octal Address	Initials △	Name and Purpose
0124-0133	Job Area 2	Similar to Job Area 1.
0134-0143	Job Area 3	Similar to Job Area 1.
0144-0153	Job Area 4	Similar to Job Area 1.
0154-0163	Job Area 5	Similar to Job Area 1.
0164-0173	Job Area 6	Similar to Job Area 1.
0174-0203	Job Area 7	Similar to Job Area 1.
0204-0213	Job Area 8	Similar to Job Area 1.
0214	VAC1USE	Holds 00000 when Work Area 1 is in use; holds 00214 when Work Area 1 is available.
0215-0267	Work Area 1	Defined by the following 43 locations.
0215-0254	PUSHLIST	Modified pushlist (32 locations), Work Area addresses 0000 through 0037.
0255-0262	VAC	Vector Accumulator (VAC, 6 locations), Work Area address 0040.
0263-0264	X1, X2	Index Registers 1 and 2, Work Area addresses 0046 and 0047.
0265-0266	S1, S2	Step Registers 1 and 2, Work Area addresses 0050 and 0051.
(continued next page)		

E REGISTER ASSIGNMENT II FOR SUNRISE PROGRAMS (cont)

Octal Address	Initials △	Name and Purpose
0267	QPRET	Holds return address, Work Area address 0052.
0270	VAC2USE	Holds 00000 when Work Area 2 is in use; holds 00270 when Work Area 2 is available.
0271-0343	Work Area 2	Similar to Work Area 1.
0344	VAC3USE	Holds 00000 if Work Area 3 is in use; holds 00344 if Work Area 3 is available.
0245-0417	Work Area 3	Similar to Work Area 1.
0420	VAC4USE	Holds 00000 if Work Area 4 is in use; holds 00420 if Work Area 4 is available.
0421-0473	Work Area 4	Similar to Work Area 1.
0474	VAC5USE	Holds 00000 if Work Area 5 is in use; holds 00474 if Work Area 5 is available.
0475-0547	Work Area 5	Similar to Work Area 1.
0550	NEWJOB	A multiple of eight is entered by the Job Control to indicate that the execution of a Job of higher priority has been requested. The tag specifies in which Job Area the active Job of highest priority is located.

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E REGISTER ASSIGNMENT II FOR SUNRISE PROGRAMS (cont)

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Octal Address	Initials △	Name and Purpose
The following registers are used by program section Task Control only.		
0551-0555	LST1 through LST1+4	Timelist (5 locations), holds times at which executions of Tasks have to be initiated.
0556-0563	LST2 through LST2+5	Addresslist (6 locations), holds addresses of Task to be executed.
The following registers are used by program sections Job Control, Task Control, Function Control, and interrupted or interrupting routines.		
0564	RUPTAGN	Contains 77777 if program control is to return to the interrupted Job upon the completion of a Task; contains 00001 if the next Task is to be executed immediately.
	KEYTEM2	Temporary storage used by KEYRUPT and UPRUPT.
0565	EXECTEM1	Holds back number of the requesting routine, used by Job Control.
	RUPTSTOR	Temporary storage used by Job Control.
	PHASE	Temporary storage used by Function Control.
0566	EXECTEM2	Holds the complete starting or reactivating address of the Job to be executed; used by Job Control.
	PROG	Temporary storage used by Function Control.

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E REGISTER ASSIGNMENT II FOR SUNRISE PROGRAMS (cont)

Octal Address	Initials △	Name and Purpose
0567	EXECTEM3 PHASEDIG ITEMP3 SRRUPT	Holds the address of a Pushlist register, used by Job Control. Temporary storage used by Function Control. Temporary storage used by T4RUPT. Temporary storage used by T4RUPT.
0570	EXECTEM4 PHASELP	Temporary storage used by Function Control. Temporary storage used by Function Control.
0571	EXECTEM5	Temporary storage used by Function Control.
0572	NEWPRIO PHASEWD NVAL DELT ITEMP1	Holds the priority of the active Job of highest priority in bit positions 14 through 10, and the address of a Work Area in bit positions 9 through 1, used by Job Control. Temporary storage used by Function Control. Holds Δt_R of the requested Task. Holds the tag specifying into which place of the Waitinglist the requested Task is to be entered, used by routine WAITLIST. Temporary storage used by routine T3RUPT.
0573	WTEXTIT ITEMP2	Holds the address used for computing the return address of the requesting routine, used by Load and WAITLIST routine. Temporary storage used by Function Control.

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E REGISTER ASSIGNMENT II FOR SUNRISE PROGRAMS (cont)

FR-2-115

Octal Address	Initials ⚠	Name and Purpose
0573	KEYTEMP1 DSRUPTM	Temporary storage used by KEYRUPT and UPRUPT. Temporary storage used by subroutine DSPOUT of T4RUPT.
0574	LOCCTR PHASDATA	Holds the tag specifying the Job Area used by the Job recently requested or reactivated, used by Job Control. Also used as temporary storage by program section Keyboard And Display. Temporary storage used by Function Control.
0575	BANKRUPT	Holds bank code of interrupted program section entered by interrupting program section.
0576	OVRUPT	Holds the quantity contained in counter OUTCR during a program interruption.
0577	LPRUPT	Holds the quantity contained in register LP during a program interruption.
0600	RUPTREG1 KSAMPTM	Long term storage used by various program sections during an interrupt. Holds current IMU mode setting.
0601	RUPTREG2 OSAMPTM	Long term storage used by various program sections during an interrupt. Holds current Optics mode setting.

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E REGISTER ASSIGNMENT II FOR SUNRISE PROGRAMS (cont)

Octal Address	Initials △	Name and Purpose
0602	RUPTREG3	Long term storage used by various program sections during an interrupt.
0603-0611		Not assigned.
0612	VERBREG	Verb Buffer. Holds the two octal characters punched in after depressing the VERB key.
0613	NOUNREG	Noun Buffer. Holds the two octal characters punched in after depressing the NOUN key.
0614	XREG	R ₁ Input Buffer. Holds numerical characters entered in response to Verb 21, 24, or 25. After decimal data has been scaled, this register holds the high order part of the data.
0615	YREG	R ₂ Input Buffer. Holds numerical characters entered in response to Verb 22, 24, or 25. After decimal data has been scaled, this register holds the high order part of the data.
0616	ZREG	R ₃ Input Buffer. Holds numerical characters entered in response to Verb 23 or 25. After decimal data has been scaled, the register holds the high order part of the data.
0617	XREGLP	Holds low order part of scaled decimal data entered in response to Verb 21, 24, or 25.

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E REGISTER ASSIGNMENT II FOR SUNRISE PROGRAMS (cont)

Octal Address	Initials △ 1	Name and Purpose
0620	YREGLP	Holds low order part of scaled decimal data entered in response to Verb 22, 24, or 25.
0621	ZREGLP	Holds low order part of scaled decimal data entered in response to Verb 23 or 25.
0622	MODREG	Mode Buffer. Holds the two octal characters that represent a Mission Function to be executed.
0623	DSPLOCK	Operator/Internal Interlock. Holds the quantity 00001 if the operator has control over program section Keyboard And Display or the quantity 00000 if program section Keyboard And Display is available for internal use.
0624	REGRET	Holds the return address during the execution of a load request entered in response to Verbs 21 through 25.
0625	DSPCOUNT	Holds a code in bit positions 6 through 1 which refers to a display position on the DSKY's to be illuminated.
0626	DECBRNCH	Holds the quantity 00001 if the + key has been depressed, the quantity 00002 if the - key has been depressed, or the quantity 00000 if no sign key has been depressed.
0627-0631	DSPTEM1	Temporary storage used to hold information defined by the Noun.

E REGISTER ASSIGNMENT II FOR SUNRISE PROGRAMS (cont)

Octal Address	Initials ⚠	Name and Purpose
0632-0634	DSPTEM2	Temporary storage used to hold information defined by the Noun.
0635	NOUNADD	Holds the address of the Object specified by the Noun.
0636	MONSAVE	Holds the Verb code in bit positions 12 through 7 and the Noun code in bit positions 6 through 1 during monitoring. Contains a ONE in bit position 15 if monitoring is to be terminated.
0637	MONSAVE1	Holds the address of the Object specified by NOUNS 01 through 07 for monitoring activity.
0640	CADRSTOR	Holds the complete address of the location where a Job, that has been put to sleep by routine ENDIDLE, will be reactivated after requested data has been entered.
0641	GRABLOCK	Internal/Internal interlock. Holds the quantity 00001 if an internal program has already "grabbed" program section Keyboard And Display, or the quantity 00000 if the section has not already been "grabbed" by an internal program.
0642	NVBNKTEM	Holds the 5-bit bank number of the routine that called routine NVSUB.
0643	IN0WORD	Temporary storage for bits 5 through 1 of register IN0.
0644	NVQTEM	Holds the 12 bit address of the instruction that called routine NVSUB.

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E REGISTER ASSIGNMENT II FOR SUNRISE PROGRAMS (cont)

FR-2-115

Octal Address	Initials ①	Name and Purpose
0645	LOADSTAT	Holds the quantity 00001 if Verb 33 punched in, the quantity 77776 if Verb 34 has been punched in, the quantity 00000 if the job is in the dormant state and waiting for data, or the quantity 77777 if all requested data has been entered.
0646	CLPASS	Pass indicator for routine CLEAR. Holds a quantity smaller than zero, or equal to 77777, if only one input buffer (0614 through 0621) and its corresponding display register (R_1 , R_2 , or R_3) is to be cleared. Holds the quantity 00000 before the CLEAR key has been depressed once and successive clearings of buffer registers and display positions are allowed. Holds a quantity larger than zero if the CLEAR key has been depressed once and successive depressions of the CLEAR key are allowed.
0647-0651	DSPLIST	Waiting list. Holds the complete reactivating address of internal jobs that have attempted to use program section Keyboard And Display but found it either already "grabbed" or under operator control.
0652-0654	STATE	45 bit positions. Used as switches by program section Interbuster.
0655-0660	PHASETAB through PHASETAB +3	Phase Table 1. Each location contains three five-bit phase codes entered by program section Function Control.
0661-0664	BACHPHASE through BACHPHASE+3	Phase Table 2 is identical to Phase Table 1.

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E REGISTER ASSIGNMENT II FOR SUNRISE PROGRAMS (cont)

Octal Address	Initials △	Name and Purpose
0665-0670	PHASEBAR through PHASEBAR+3	Phase Table 3 is identical to Phase Table 1 except the codes are stored in complement form.
0671 0672	PWT PROG PWT PROG+1	Each contains the code of a Mission Function being terminated by program section Function Control.
0673 0674	PWTCADR PWTCADR+1	Each contains the complete address of the first Job of the Mission Function to be executed upon the termination of the Mission Function whose code is contained in PWT PROG (PWT PROG+1).
0675	TELCOUNT	Used by program sections T4RUPT Output Control and DOWNRUPT Processor to govern the rate of AGC downlink words supplied for downlink transmission.
0676	DISPBUF	Contains next relay word (entered by T4RUPT Output Control) to be sent downlink.
0677	DNLSTADR	Contains address of last location of TM list.
0700	IDPLACER	Used to count the four words to be sent with each ID word.
0701	TMINDEX	Used for stepping through the downlist (DNLST1).
0702	TMKEYBUF	Contains next character word to be sent downlink (entered by routine KEYRUPT or UPRUPT).
0703	DSRUPTSW	Stage Counter. Used by T4RUPT Output Control.

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E REGISTER ASSIGNMENT II FOR SUNRISE PROGRAMS (cont)

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Octal Address	Initials △	Name and Purpose
0704	CDUIND	IMU CDU status indicator.
0705	THETAD	Stores desired IMU CDU X angles.
0706	THETAD +1	Stores desired IMU CDU Y angles.
0707	THETAD +2	Stores desired IMU CDU Z angles.
0710	COMMAND	Stores last command to CDU X.
0711	COMMAND+1	Stores last command to CDU Y.
0712	COMMAND+2	Stores last command to CDU Z.
0713	KG	Contains CDU driving constant KG.
0714	KH	Contains CDU driving constant KH.
0715-0722	GYROD through GYROD +5	Contain gyro pulse train commands.
0723	OPTIND	Optics CDU status indicator.
0724	DESOPTX	Stores desired Optics CDU X angles.
0725	DESOPTX+1	Stores desired Optics CDU Y angles.

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E REGISTER ASSIGNMENT II FOR SUNRISE PROGRAMS (cont)

Octal Address	Initials △	Name and Purpose
0726	DSPCNT	Used for stepping through registers DSPTAB +12 through DSPTAB.
0727	NOUT	Contains the number of relay words to be transferred to the DSKY's and downlink.
0730-0745	DSPTAB through DSPTAB +15	DSPTAB registers contain information to be transferred to the DSKY's and downlink. (Refer to table 18-1.)
0746	OLDERR	Contains last sampled system error bits.
0747	WASKSET	Holds previous IMU mode setting.
0750	WASOPSET	Holds previous Optics mode setting.
0751	DESKSET	Holds desired IMU mode setting.
0752	DESOPSET	Holds desired Optics mode setting.
0753	IMUCADR	Indicates whether or not the IMU mode switching was completed by program section Modeswitching and Mark.
0753	MODECADR	This address, when indexed by 00000 or 00001, is the address of IMUCADR or OPTCADR.
0754	OPTCADR	Used by program section Modeswitching and Mark to indicate whether or not the Optics mode switching was completed.

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E REGISTER ASSIGNMENT II FOR SUNRISE PROGRAMS (cont)

Octal Address	Initials △	Name and Purpose
0755	MARKSTAT	Holds the quantity 00000 if no MARK operations have been requested or a positive quantity if MARK operations have been requested. (Refer to paragraph 17-).
0756	FAILREG	Holds a 14-bit failure code if routines ALARM or ABORT have been executed or a negative quantity if multiple failures have occurred.

Information concerning additional E register assignments will be supplied later.

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AGC INFORMATION SERIES ERRATA SHEET 15-2 29 May 1964

1. Remove and replace title page and page iii/iv attached.
2. PAGE 15-5/15-6: Remove and replace with reprinted page 15-5/15-6 attached.
3. PAGE 15-9/15-10: Remove and replace with reprinted page 15-9/15-10 attached.
4. PAGE 15-13/15-14: Remove and replace with reprinted page 15-13/15-14 attached.
5. PAGE 15-17/15-18: Remove and replace with reprinted page 15-17/15-18 attached.
6. PAGE 15-21/15-22: Remove and replace with reprinted page 15-21/15-22 attached.
7. PAGE 15-37/15-38: Remove and replace with reprinted page 15-37/15-38 attached.
8. PAGE 15-41/15-42: Remove and replace with reprinted page 15-41/15-42 attached.
9. PAGE 15-57/15-58: Remove and replace with reprinted page 15-57/15-58 attached.
10. PAGE 15-59/15-60: Remove and replace with reprinted page 15-59/15-60 attached.
11. PAGE 15-75/15-76: Remove and replace with reprinted page 15-75/15-76 attached.
12. Add "Changed 17 April 1964", as contained on page 15-1, to the lower left hand corner of the following pages: 15-3, 31, 47, 53, 55, ~~57~~, 63, 65, 67, 69, 71, 73, 77, and 79.

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when it is detached from the enclosures.

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