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IMPROVED CORONA COMMAND SYSTEM

J-1 CONFIGURATION

J-34 AND UP

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1.0 INTRODUCTION

This document presents a functional description of the improved Corona command system for purposes of familiarization. Wiring schematics and detailed descriptions of hardware components are omitted.

The improved command system was developed to improve efficiency of the Corona mission and to increase command system flexibility. Both of these objectives were attained with a minimum of hardware changes. Hardware changes were effected in the payload command box only with no additional Real Time Commands (RTC) required.

The primary feature of the improved command system is operations selection capability; i.e., the ability to delete undesired programmed operations on an individual basis rather than an orbit rev basis. This feature coupled with other factors has established the feasibility of programming Corona missions through the use of digital computers. Commanding and programming concepts are covered briefly; the emphasis is placed on the functional description.

2.0 FUNCTIONAL DESCRIPTION

2.1 SUMMARY

The command system can be divided into two groups of commands: i.e., real time commands (RTC) and stored program commands (SPC). SPC's are provided by a pre-launch loaded programmer which operates through use of a punched mylar tape and 52 brushes. The tape speed is governed by a timer which is adjusted by RTC to maintain sync with the orbit. A brush falling through a punch in the tape creates a command. RTC's are issued by ground command stations during satellite acquisition. The command network is comprised of command stations [redacted]

The SPC's provide control functions for both the orbit vehicle and payload system. Included are 18 SPC's (numbered 30 thru 47) which define 9 camera programs. Each camera program consists of 2 SPC's, one to turn the cameras on and the other to turn the cameras off. In flight, one of the 9 camera programs is selected for control of the cameras. This selection is effected by means of a stepper switch, each position on the switch being wired to select a specific program. The stepper switch is positioned by RTC to select the desired program.

An operations selection unit is used to provide the flexibility of selecting or deleting each programmed operation of the selected program: i.e., operations selection provides the capability of deleting any or all of the programmed operations on an individual operation by operation basis. This feature allows the take/not take decision to be based upon weather and other real time flight operations factors.

The camera operation mode (stereo, mono) is selected through RTC by positioning a stepper switch. Camera cycle rate (which controls forward motion compensation) is controlled by a V/H programmer. This programmer generates an analog sine-type command signal. The programmer is started once each orbit rev and runs for 3840 seconds. The command signal function can be modified through selection of reference level, amplitude, and start time. The 3 control factors are selected by RTC; there are 11 choices available for each factor for a total of 11^3 or 1331 V/H profiles.

The orbit vehicle guidance system is commanded by a yaw programmer, the purpose of which is to compensate for cross track motion due to earth rotation. This programmer is started each orbit rev by SPC. In addition, the yaw programmer can be disabled in case of failure by RTC.

Figure 2.1-A presents a functional diagram of the command system as described above.

SIMPLIFIED FUNCTIONAL DIAGRAM

IMPROVED COMMAND SYSTEM

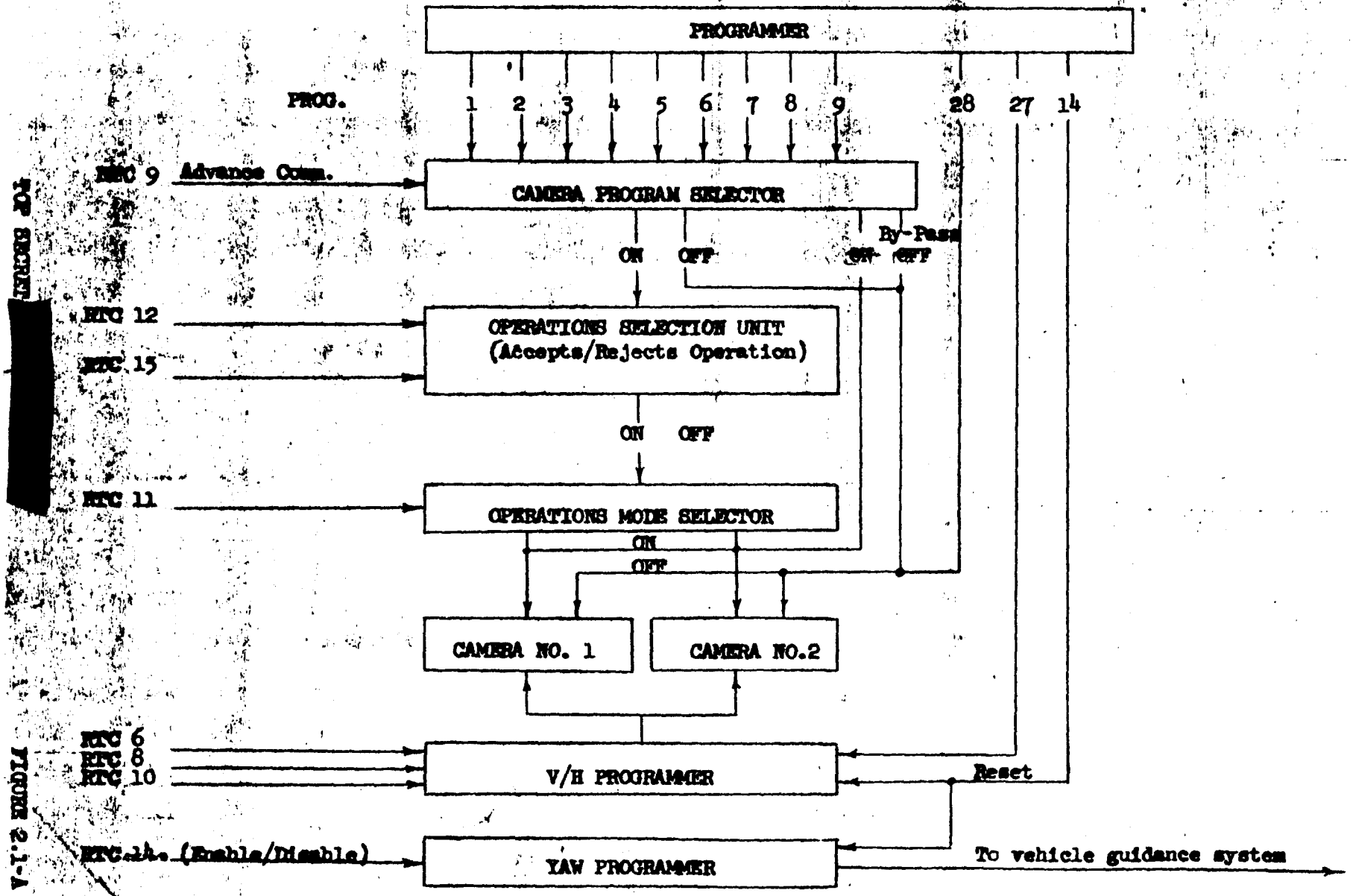

FIGURE 2.1-A

2.2 PROGRAM SELECTOR

Figure 2.2-A presents a detailed functional description of the program selector. It should be noted that the program selector is an 11 position stepper switch. The switch advances one position each time it receives an RTC 9 command. The switch is cyclic: i.e., position 1 follows position 11. Positions 10 and 11 are wired to take programs 1 and 4 respectively and route them directly to the camera system bypassing the other components of the command system. This feature provides a failure mode of operation.

PROGRAM SELECTOR-FUNCTIONAL DIAGRAM

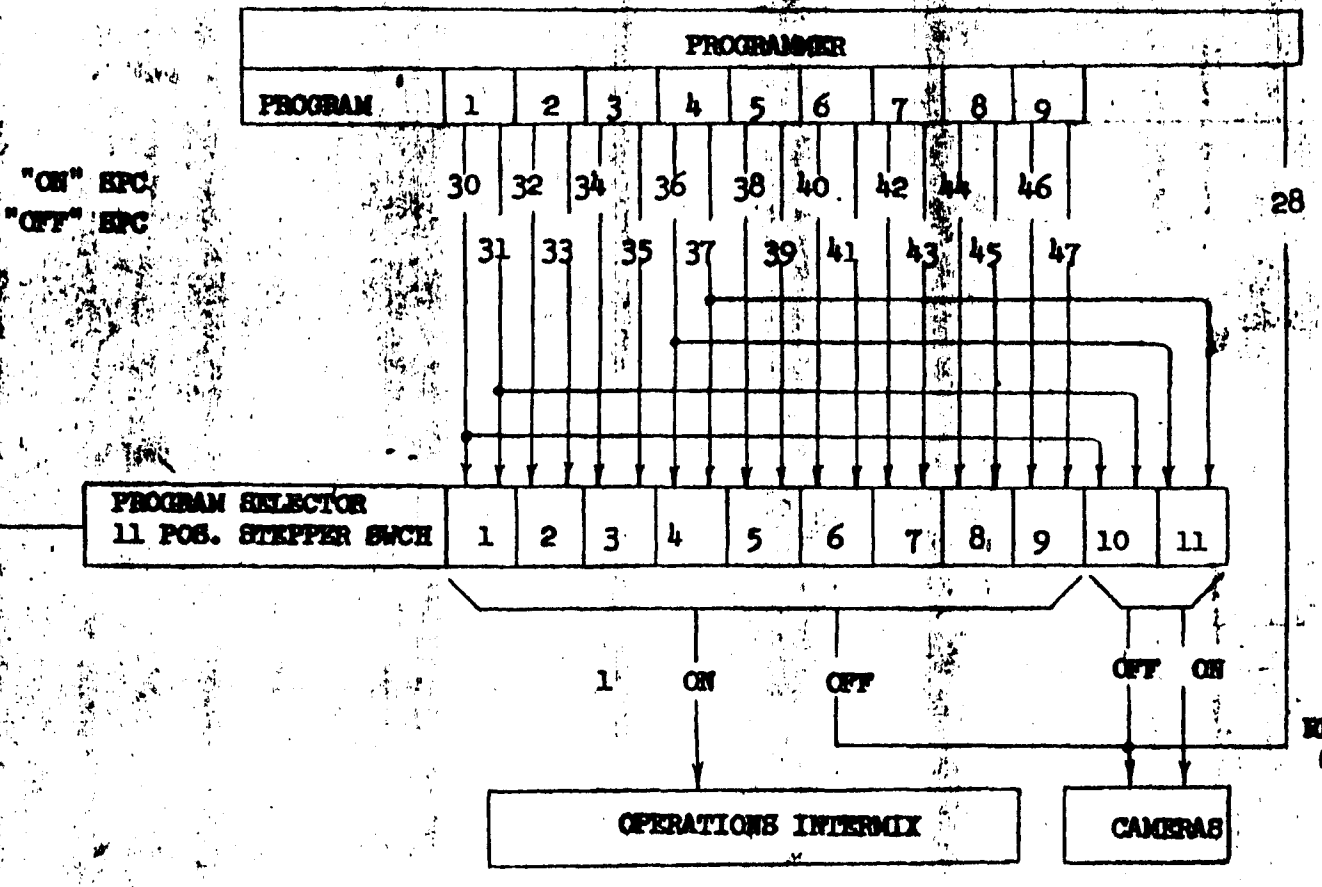

Figure 2.2-1

2.3 OPERATIONS SELECTION

The purpose of the operations selection unit is to provide the capability of deleting undesired programmed operations through use of RTC's. This feature assures efficiency of film utilization. Operations selection has the capability of controlling a sequence of 8 programmed operations: i.e., any individual operation or operations in the sequence can be deleted. This capability normally exceeds the number of programmed operations between command acquisitions.

The command logic required to control a sequence of 8 functionally can be described by considering a binary sequence of eight digits: i.e., 01101110 where a "1" digit means "on", select, or operate, and a "0" digit means "off" or delete the operation. Two 16 position stepper switches are used to set up the binary sequence of 8. Each switch is capable of any sequence of 4. A counter and stepper switch select relay allows adding the two sequences to form a total sequence of 8. Table 2.3-1 illustrates the wiring or digit arrangement of the 16 position stepper switches.

Figure 2.3-1 is a functional diagram of the operations selection unit. Two RTC's (12 and 15) are used to set up thedesired control sequence during an acquisition. RTC 12 positions stepper switch No. 1 and RTC 15 positions stepper switch No. 2. Both RTC 12 and 15 reset the counter and the stepper switch select relay thus placing control in stepper switch No. 1. Following the acquisition when an "on" command is received from the program selector, the command is either passed through the operations selection unit or the "on" command is converted into an "off" command, dependent upon the digit condition ("0" to "1") of the stepper switch No. 1 position. Approximately 23 seconds later (sufficient time for the "on"

TABLE 2.3-1

POS.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
BIT	1	1	1	0	0	1	0	1	0	0	0	0	1	1	0	1

Enable or select - Bit = 1

Disable or delete - Bit = 0

Switch homes in Position 16: i.e., only RTC can move switch from Position 16.

SEQUENCE	START POSITION
0000	9
0001	10
0010	4
0011	11
0100	7
0101	5
0110	12
0111	15
1000	8
1001	3
1010	6
1011	14
1100	2
1101	13
1110	1
1111	16

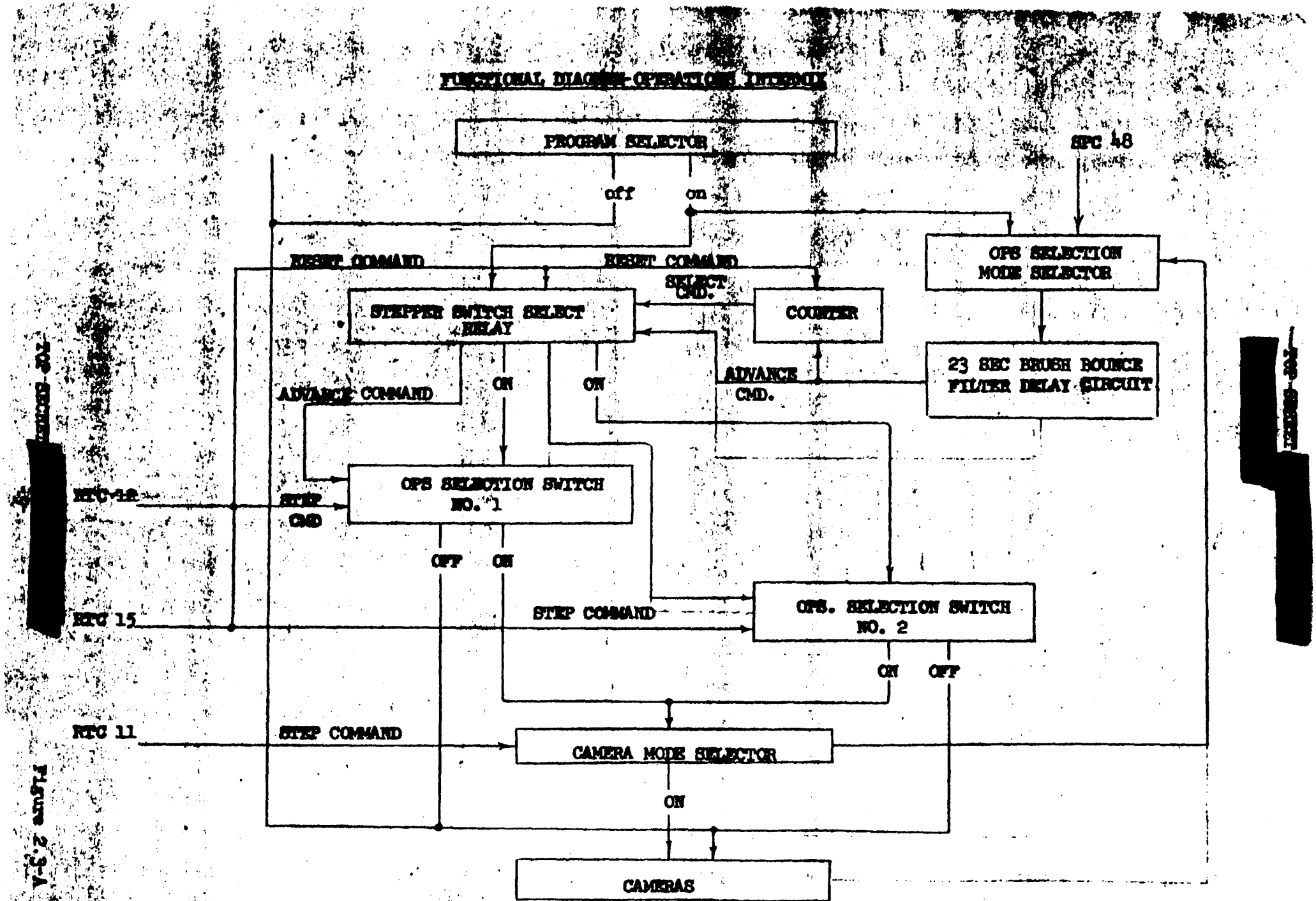
PROGRAM SELECTOR
SPC 48
off
on
RESET COMMAND
RESET COMMAND
SELECT CMD.
STEPPER SWITCH SELECT RELAY
COUNTER
OPS SELECTION MODE SELECTOR
23 SEC BRUSH BOUNCE FILTER DELAY CIRCUIT
ADVANCE CMD.
ADVANCE COMMAND
ON
ON
OPS SELECTION SWITCH NO. 1
RTC 12
STEP CMD
OFF
ON
STEP COMMAND
OPS. SELECTION SWITCH NO. 2
RTC 15
ON
OFF
RTC 11
STEP COMMAND
CAMERA MODE SELECTOR
ON
CAMERAS

Figure 2.3-A

command to be terminated) a stepper switch position advance command is generated by a filter circuit. The filter delay circuit command is initiated by the "on" command. The stepper switch position advance command causes the counter to count 1 and also passes through the stepper switch select relay and commands the stepper switch No. 1 to advance to the next position. When the counter accumulates a count of 4 the intermix select relay is switched placing stepper switch No. 2 in control. From this point stepper switch No. 1 does not step and exercises no control functions until receipt of RTC 12 or 15. Stepper switch No. 2 now functions as previously described for stepper switch No. 1. However, intermix No. 2 will continue advancing as advance commands occur without reference to the counter. Both stepper switches No. 1 and No. 2 home in position 16. This means that advance commands cannot move the stepper switch; only RTC's can make the stepper switch move from position 16. It should be noted that the bit condition of position 16 is "on" for both stepper switches, thus providing a fail safe condition to assure execution of the selected camera program should RTC command capability be lost. Upon receipt of either RTC 12 or 15 at the following acquisition, the counter is reset and the stepper switch select relay is switched to stepper switch No. 1.

2.4 CAMERA OPERATIONS MODE SELECTOR

Camera operations mode (mono, stereo) is controlled by an 11 position stepper switch. The stepper switch is stepped by RTC 11. Table 2.4-1 presents the control modes for each position of the stepper switch. Effectively, the switch provides 5 camera operating modes multiplexed with two operations selection control modes accounting for 10 of the 11 positions. The eleventh position disables the cameras and disables the advance commands to the ops. selection stepper switches. This feature provides the capability of commanding the system off without continually commanding RTC's 12 and 15 to obtain sequences of "0" bits. Table 2.4-1 generally is self explanatory. It should be noted, however, that positions 5, 6, 9 and 10 result in all programmed operations of the selected program being taken by one camera while the other camera is controlled by the operations selection unit.

TABLE 2.4-1

CAMERA OPERATIONS MODE SELECTOR

STEPPER SWITCH POSITION	FUNCTION	
1	Stereo	Ops. Selection Stepper Switch Advanced by "ON" SPC of Selected Program
2	Mono #1	
3	Mono #2	
4	#1 By-pass Ops Selection, #2 Ops Selection	
5	#2 By-pass Ops Selection, #1 Ops Selection	
6	Stereo	Ops. Selection Stepper Switch Advanced by SPC 48 Command
7	Mono #1	
8	Mono #2	
9	#1 By-pass Ops Selection, #2 Ops Selection	
10	#2 By-pass Ops Selection, #1 Ops Selection	
11	Camera Disabled or OFF	

2.5 V/H PROGRAMMER CONTROL

The V/H programmer generates a sine type analog command voltage. The output function has a fixed period of 3840 seconds. The reference level, amplitude, and start time of the output function are controlled by RTC's 6, 8, and 10. RTC 6 positions an 11 position stepper switch which controls the function reference level. RTC 8 positions an 11 position stepper switch which controls the function amplitude. The start time for the V/H programmer is controlled through the use of RTC 10 coupled with the SPC 27 and SPC 14 programs. In general reference level and amplitude define the orbit profile and start time syncronizes the function with perigee location. RTC 10 positions an 11 position stepper switch. Once each rev SPC 14 homes a second 11 position stepper switch to position 1. SPC 14 normally is programmed to occur about the south tangent point each rev. SPC 27 is programmed generally at equal time intervals for a total of 12 commands each rev. SPC 27 steps the second stepper switch. When the two stepper switch positions are coincident a V/H programmer start command is generated. The programming of SPC 27 is such that the program is centered about the optimum start time for the nominal or planned perigee location as a function of time.

The time interval between SPC 27 commands is based upon expected perigee location dispersions. This assures the ability to sync the V/H programmer function with actual perigee location. SPC 27 is programmed 12 times each rev to assure the occurrence of a V/H programmer start pulse. When the stored programmer is synced with the orbit, the brushes are raised and the mylar tape repositioned. When this occurs it is possible that an SPC 27 command may be missed, therefore, SPC 27 is programmed for 12 commands each rev.

2.6 UNUSUAL CONDITIONS AND RESULTS

During ground testing and flight operations, several conditions may occur which are unusual. In order to preclude confusion, a list of such conditions and the normal result of such conditions are listed below:

1. Power interruption or power shutdown. The counter counts one but the stepper switch does not advance.

2. H-timer (stored programmer) is stopped with brush in "on" command hole. Brush bounce filter circuit times out and advances ops selection stepper switch one position. If the new position bit is "0" the system is given an "off" command. If the new position bit is a "1" the system is given an "on" command. The cameras can be shut down by placing the mode selector switch in position 11 or by selecting a camera program that has no "on" punch at that time.

3. RTC 12 and/or 15 given while the brush bounce filter circuit is engaged as a result of an SPC 48 or SPC "on". The counter and stepper switch select relay are reset in the normal manner. The stepper switch advance result depends upon the RTC given and the selected stepper switch at the time:

a. RTC 12/switch No. 1 selected. Neither stepper switch advances. Switch No. 1 advances one position when filter circuit times out. Repeated RTC 12 will have no effect.

b. RTC 12/switch No. 2 selected. Upon switching of the stepper switch select relay to reset position (select No. 1), stepper switch No. 2 advances one position. Stepper switch No. 1 also advances one position when the brush bounce filter circuit times out. Repeat RTC 12 commands have no effect.

c. RTC 15/switch No. 1 selected. Same as a. above. Repeated RTC 15 have no effect.

d. RTC 15/switch No. 2 selected. Same as b. above. Repeated RTC 15 have no effect.

4. Under SPC 48 control the brush bounce filter circuit times out while the "on" SPC is engaged. The stepper switch advances one position. If the bit condition of the old and new stepper switch positions are different the command to the operate relay will be changed.

5. Mode selector switch in position 11 (cameras off). The brush bounce filter circuits are disabled, therefore, no stepper switch advance commands by SPC will be executed and no counts will be accumulated. RTC 12 and 15 will step the stepper switches and reset the counter and switch select relay in the normal manner. SPC "on" commands pass through the ops selection unit and control the operate relay, but the operate relay cirucit is interrupted by the mode selector switch. Should the operate relay be in the operate condition when the mode selector is moved from position 11, the cameras will be turned on. Note that the operate relay is controlled at all times by the selected program, redundant off SPC and the operations selection bit condition except when the program selector is in positions 10 or 11.

3.0 COMMANDING CONCEPTS

3.1 NORMAL OPERATIONS

Normal flight operations will be conducted in the stereo camera operations mode with operations selection. The operations selection capability of a sequence of 8 normally will not be exceeded.

3.2 UNUSUAL OPERATIONS

1. Mono and stereo/mono intermix camera operations modes seldom are used.

2. More than 8 programmed operations between acquisitions may occur on rare occasions. Should this situation occur, operations efficiency may or may not be compromised depending upon the specific desired operations selection sequence. Tables are available which define the minimum possible compromise command settings. There are three tables available based upon the following logic:

a. All desired ops are to be taken and the maximum number of undesired ops are to be deleted.

b. All undesired ops are to be deleted and the maximum number of desired ops are to be taken.

c. Sequence compromises for take and delete are considered of equal value; therefore, the minimum number of sequence compromises are to be effected.

The SPC 48 program defines another choice for consideration in this case, however, it is improbable that use of SPC 48 will improve the available options using operations selection.

3. One or more programs can be used to sub-divide the total denied area into eight segments between command acquisitions. Use of one of these programs provides the capability of effectively adding an operation not included in any of the regular programs.

3.3 FAILURE MODES

1. Loss of RTC 12 and 15 will result in the operations selection switch No. 2 homing in position 16 which is an enable position. The result will be the loss of operations selection and all programmed operations of the selected program will be taken.

2. Should the cameras not shut down, position 11 of the mode selector switch can be used to disable the cameras.

3. Loss of operations selection and/or mode select can be circumvented by stepping the program selector to positions 10 or 11. In this case, program 1 or 4 can be executed without operations selection.

4.0 PROGRAMMING CONCEPTS

4.1 TARGET REQUIREMENTS

Targets defining possible operations can be defined as follows:

1. Point targets - high priority
2. Point targets - general
3. Holiday area targets
4. Mapping area targets
5. New targets defined after the program is cut.

The various required targets may be superimposed: i.e., point targets may fall within Holiday or mapping area targets, and holiday and mapping area targets may overlap. The command system has the capability of controlling segments of a large area target if the program consists of a series of "on" commands terminated by an "off". This means that it is possible to program an area target containing a point target such that the area is broken into 3 operations which can be controlled by operations selection. New targets can be handled by a universal program which simply divides the total denied area into 8 programmed operations between acquisitions.

4.2 PROGRAM DEFINITION

Program definition is to be effected through use of a digital computer program. Input will consist of orbit elements, target definition, and control cards defining types of targets and longitude dispersions to be considered. Each of the 9 generated programs will be based upon the criteria defined by the control cards. The SPC 48 program will be designed such that commands will occur only when there are no operations programmed in any of the 9 camera programs. The programming system provides the capability of manually modifying any of the computer generated programs.