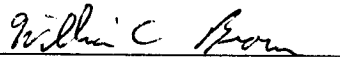
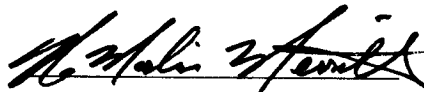


Commanding 1102

March, 1988



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How To Use This Workbook

This book is organized in sections. Begin each section by reading the objectives and learning material. If you are already familiar with the subject matter, skip to the section tests. If the material is new to you, be sure to read all the text carefully before taking the tests.

Before progressing to another section you should understand the correct answers to each of the test questions. The answers and feedback items explain the correct responses to each question and how your performance should be evaluated.

All the acronyms and abbreviations used in this workbook are defined when first used and listed in appendix A.

This workbook is provided for your use. You may take notes or write comments anywhere you like.

Study this document to the level of detailed comprehension specified by the requirements for the certification you are seeking. Requirements for all certified positions within MOD can be found in the Flight Operations Support Personnel Training Guides (Blue Books).

Section 1: Basic Concepts of Commanding

Performance Objectives

The student should be prepared to accomplish the following tasks as a result of studying this section of the workbook:

- Explain purpose of commands uplinked to the Orbiter.
- Describe the path commands take from an MCC console to an Orbiter subsystem.
- Explain how two-stage commands and single stage commands are verified in the MOC.

Introduction

There are many functions that must be controlled (that is, configured and updated) during a Space Shuttle Mission. Commands provide a means for this control. Commands can be executed by the Orbiter crew through keystrokes on the display keyboard or panel switches. However, to reduce the crew workload, most functions are controlled by ground commands transmitted and executed from the Mission Control Center (MCC). Commands are transmitted to the Orbiter through an RF link, demodulated in a receiver, and routed to the onboard General Purpose Computers (GPCs) through a Network Signal Processor (NSP) and multiplexer/demultiplexer (MDM). Instructive commands which control configuration of Orbiter functions are processed by GPCs and distributed to the addressed subsystems through an MDM interface. See figure 1-1.

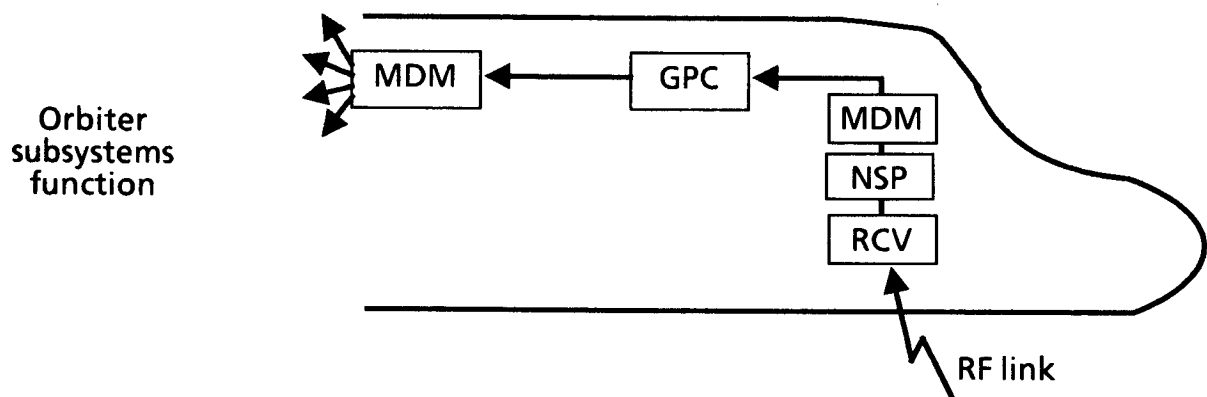


Figure 1-1. – Command flow.

Real time commands (RTCs) are commands which are routed to Orbiter subsystems. Other commands are processed in the GPCs to update GPC software. GPC software updates are called command loads.

Orbiter commands are transmitted (initiated) from MCC console positions, which for purposes of this instruction will be called the "uplink positions." Uplink position persons include:

- Instrumentation Communications Officer (INCO)
- Radio Frequency Communications (RF COMM)
- Data Communications (DATA COMM)
- Instrumentation (INST)
- Payload Officer (P/LO)
- Payload Operations Control Center (POCC)

All of the above positions transmit commands from console modules. All commands are transmitted either by or under the authority of the INCO.

In addition commands may be sent from the command position as a backup to INCO. In this lesson this position will be called COMMAND (CMD).

Command Response Verification

The Orbiter responds to a command in one of two ways, depending on whether the command sent is single-stage or two-stage.

A single-stage command is executed immediately after completion of GPC validation. The end item response verifies the effectiveness of the command through Orbiter telemetry. See figure 1-3. In other words, the only verification returned to the source is the telemetry response the Orbiter sends as a result of the execution of the command. The source is defined as the Mission Operations Computer (MOC) in the Mission Control Center (MCC) Shuttle Data Processing Complex (SDPC).

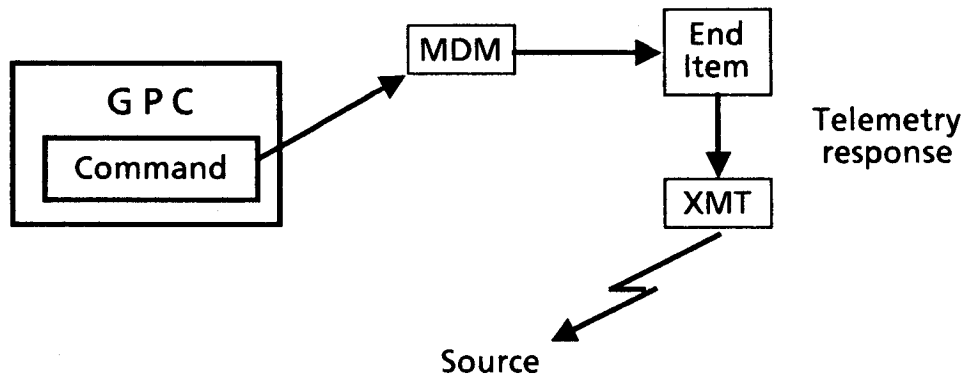


Figure 1-2. – End item telemetry response.

A two-stage command is verified by an explicit response from the Orbiter. Before execution the two-stage command is stored in the GPC command buffer. The Orbiter transmits the GPC-stored command back to the source by way of an RF downlink, where it is validated by comparing the returned command code with the original command code, either automatically by a computer program or by visual inspection as seen on figure 1-2. If validated, the command is executed automatically or manually from the source. The results of the command are monitored through the telemetry as an end item response. Refer to figure 1-3.

Propagation and Routing

Prebuilt Orbiter commands are stored in the Mission Operations Computer (MOC) in the Mission Control Center (MCC). These commands are selected and initiated manually from MCC console switch panels. The commands are transmitted from the MOC by way of a Domestic Satellite (DOMSAT) to White Sands, New Mexico. From there they are retransmitted through the East or West Tracking and Data Relay Satellite (TDRS) to an Orbiter receiver. Figure 1-4 illustrates a TDRS link. The TDRS-to-Orbiter RF link may be either S-Band or Ku-Band.

Commands may also be routed to the Orbiter through the Space Shuttle Orbiter Ground Network (GN). GN commands out of the MOC are transmitted to the Goddard Space Flight Center (GSFC), where they are routed to a GN ground station and then transmitted the Orbiter. The GN RF link is on one of two Orbiter-compatible S-Band frequencies. See figure 1-5.

In addition to the GN stations, NASA also has access to DOD remote tracking stations (RTS) for command and telemetry support. The RTS sites operate through the Satellite Test Center (STC) in Sunnyvale, California. The STC is linked to the

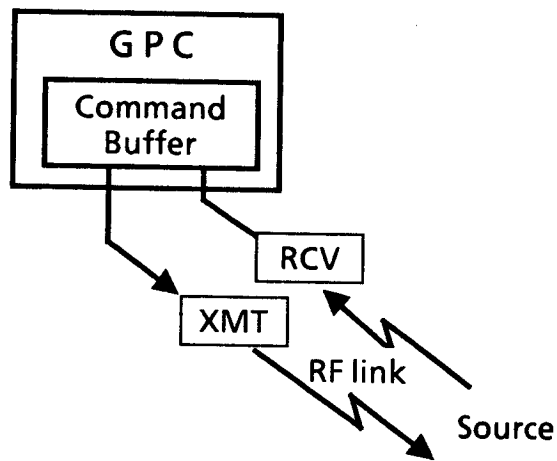
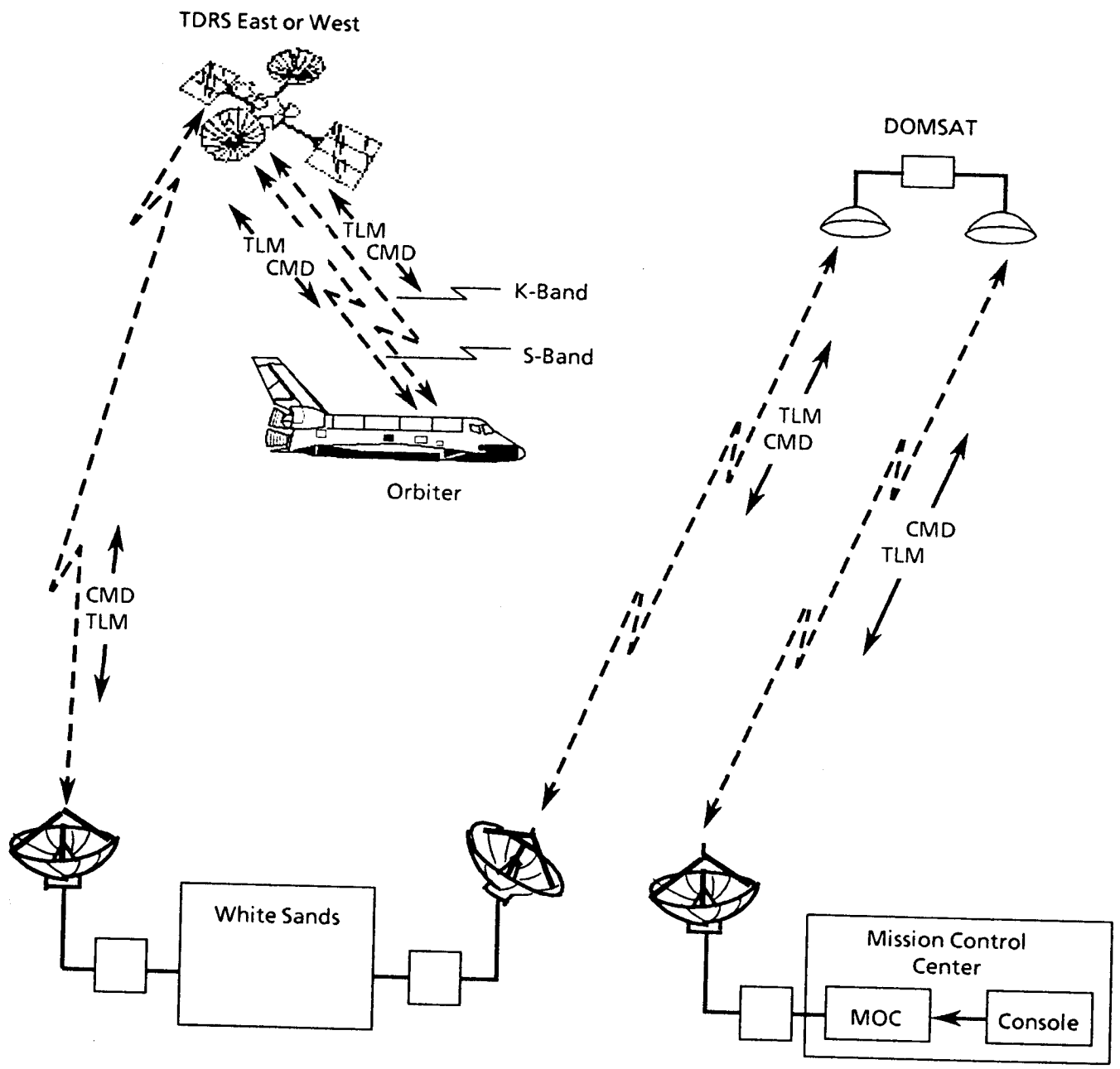


Figure 1-3. – Two-stage command verification.

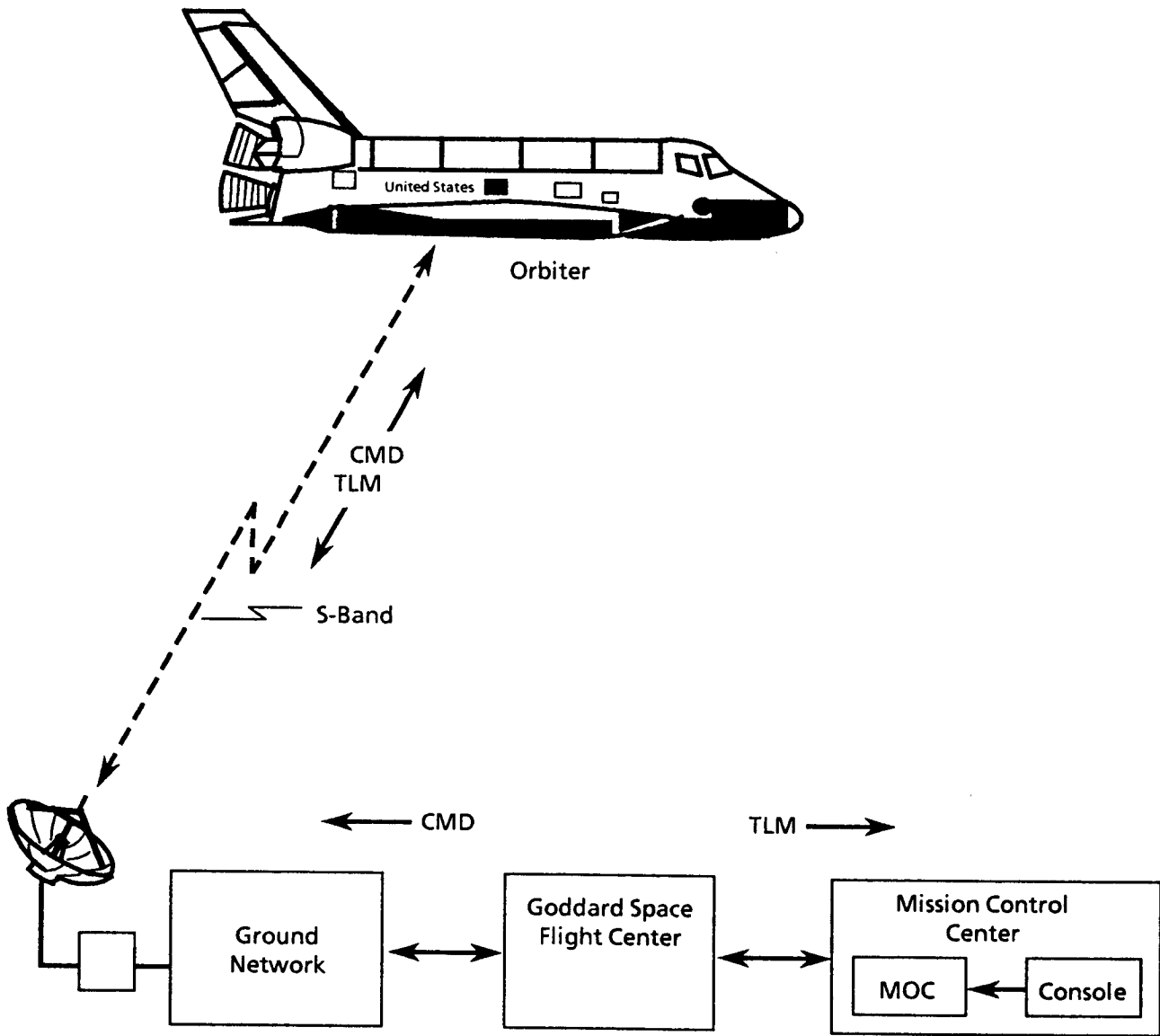
MCC through a domestic satellite. In the Orbiter, the RTS link is called the Shuttle Ground Link System (SGLS).

All Orbiter telemetry (TLM), including command verification information, is routed back to the MCC through the same links used by the command system.



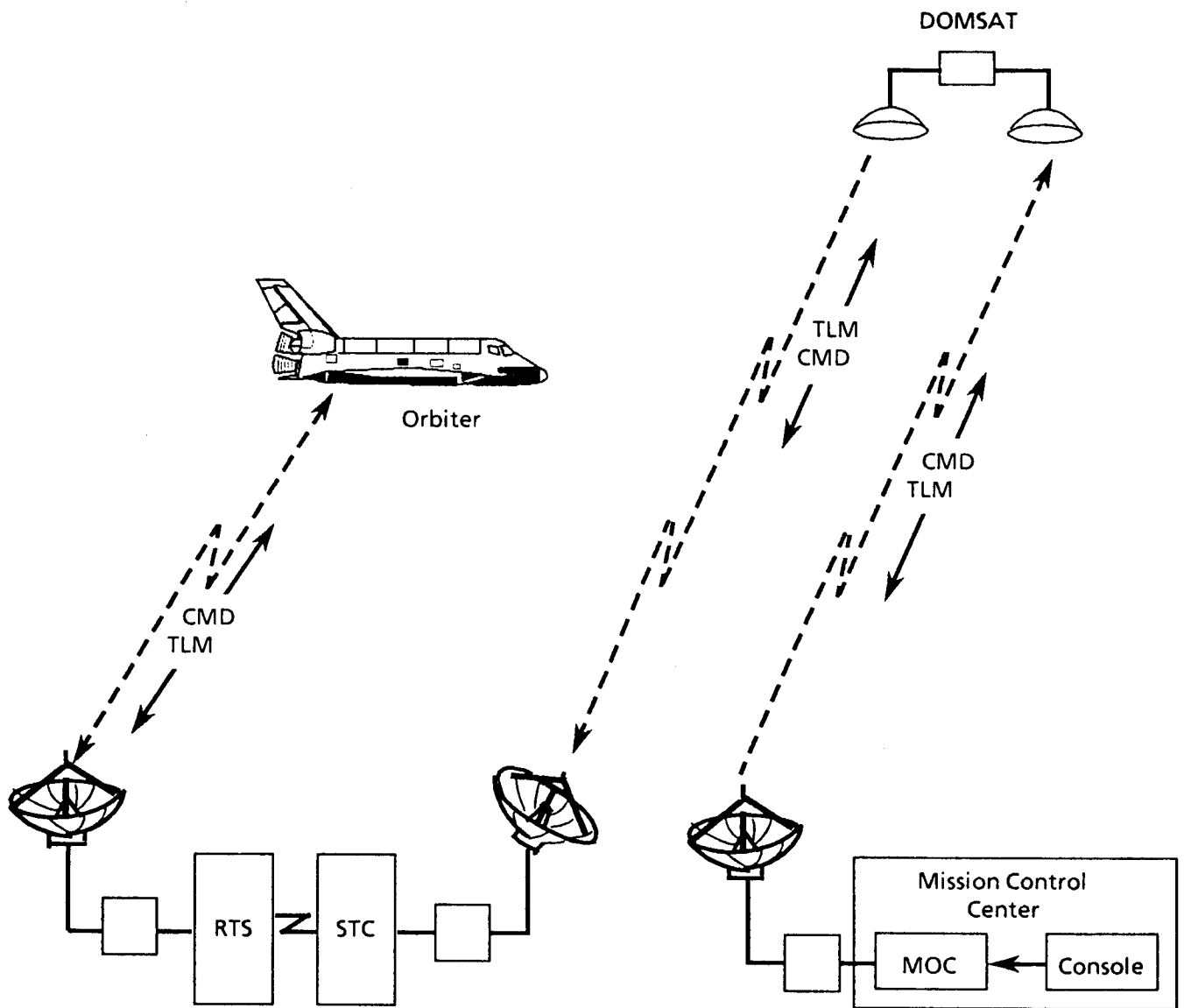
TD1004*001

Figure 1-4. - Space Network link.



TD1004*002

Figure 1-5. – GN link.



TD1004*016

Figure 1-6. - SGLS link.

Summary

Command instructions are formatted and transmitted from the MCC MOC under the control of an INCO or Payload console operator. Commands transmitted from the MOC enter the Orbiter General Purpose Computer through the Space Network (TDRS), GN, or Satellite Test Center/RTS links. The GPC processes the command by either entering the instruction into the GPC as a program update, or routing the instruction to the appropriate subsystem through a multiplexer/demultiplexer (MDM).

In the case of a single-stage command, the command is executed after the GPC has processed the routing instructions.

Two-stage commands are first loaded into the two-stage buffer. Then the contents of the buffer are transmitted back to the MOC for verification by comparison. A second command is sent to execute the buffered command.

Questions

1. a. How is a two-stage command verified?

b. How is a single-stage command verified?
2. Through what three networks can the MCC transmit commands to the Orbiter?
3. Where are preexisting commands stored?

Answers

1. a. A two-stage command is stored in a GPC buffer and retransmitted back to its source, where its accuracy can be verified automatically or manually.
b. A one-stage command is verified by observing through telemetry whether or not the intended result of the command was produced.
2. The Space Network (TDRS), the Ground Network (GN), or the Satellite Test Center/Remote Tracking Station (STC/RTS) link.
3. Preexisting commands are stored in the MCC MOC (Mission Operations Computer).

Feedback

Total your score by adding 25 points for each part of questions 1 and 2 and for question 3.

For every question answered incorrectly, reread the pertinent material from this section. If more than one question was answered incorrectly, carefully reread the entire section.

Section 2: Command Structure

Performance Objectives

After studying this section, the student should be able to perform the following:

- Outline the structure of a 48-bit command word.
- Describe the routing of command data from the MCC MOC to a destination in an Orbiter subsystem.
- Identify the various types of commands that can be sent.
- Briefly state who can build new commands to uplink to the Orbiter.

Command Coding

Orbiter commands are pulse coded in the MCC MOC. Each command is coded in a 48-bit word format. The first 16 bits of the command word form the header. Each header contains the following information:

- Vehicle ID (the Orbiter being commanded)
- Major function (which GPC is to process the command)
- Operation code (type of command)
- First command word/last command word

Bits 17 through 48 contain the command code data.

Figure 2-1 and the accompanying tables describe the structure of the command word format.

Header																Command data							
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	<.....>	32	33	<.....>	48		
Veh Add			Maj Func/ GPC			OP Code						F C W	L C W	Command Data				Command Data					

Figure 2-1. – Command word structure.

Vehicle Address: Bits 1-3

Vehicle address is represented by a three bit code identifying the Orbiter by serial number. Table 2-1 contains the bit codes that are used. Figure 2-2 shows command word bits 1 through 3.

Table 2-1. Vehicle Address

000 - Illegal
001 - Vehicle 099
010 - Vehicle 102 (Columbia)
011 - Vehicle 103 (Discovery)
100 - Vehicle 104 (Atlantis)
101 - Vehicle 105
110 - Vehicle 106
111 - Vehicle 107

1	2	3
Veh Add		
		

Figure 2-2. - Vehicle address: Command word bits 1-3.

Major Function: Bits 4-7

Major Function is represented by a four bit code (4 through 7) of the command word. Major Function identifies the GPC or major function to which the command is being addressed. Table 2-2 contains the four-bit codes used to identify the GPCs. Figure 2-3 shows command word bits 4 through 7.

Table 2-2. Major function codes.

0000 - Illegal
0001 - GPC 1
0010 - GPC 2
0011 - GPC 3
0100 - GPC 4
0101 - GPC 5
0110 - All active GPCs
0111 - GN&C (Guidance, Navigation, and Control)
1000 - SM (Systems Management)
1001 - PL (Payload)
1010 - BFS (Backup Flight System)
1011 - 1111 - Illegal

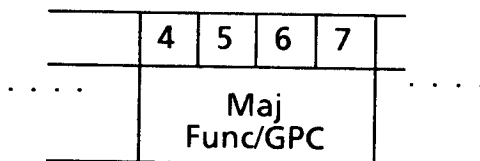


Figure 2-3. – Major function: command word bits 4-7.

Codes 0001 through 0101 are illegal if the GPCs are in a redundant set.

Operation Code (OP Code): Bits 8-14

The OP code bits (8 through 14) of the command word identify the type of command being sent. Bit 8 indicates whether the command sent is a two-stage or a single-stage command. "0" indicates two-stage and a "1" indicates single-stage. Table 2-3 contains the two-stage command OP codes. Table 2-4 contains the single stage command OP codes.

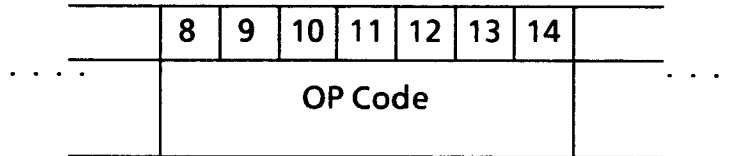


Figure 2-4. – OP code: Command word bits 8-14.

Table 2-3. Two-stage command OP codes (Bit 8 = 0).

8	9	10	11	12	13	14	
0	0	0	0	0	0	0	ILLEGAL
0	0	0	0	0	0	1	GMEM CONTIGUOUS
0	0	0	0	0	1	0	GMEM SCATTER
0	0	0	0	0	1	1	MDM MULTIPLE (TWO-STAGE MRTC)
0	0	0	0	1	0	0	MDM SPC MULTIPLE
0	0	0	0	1	0	1	EQUIVALENT DEU
0	0	0	0	1	1	0	GPC MM READ
0	0	0	0	1	1	0	GPC MM MERGE
0	0	0	0	1	1	0	GPC MM WRITE
0	0	0	0	1	1	0	TEXT BUFFER 01-40
0	0	0	0	1	1	1	KU BAND ANTENNA CONTROL
0	0	0	1	0	0	0	IMU REFSMMAT
0	0	0	1	0	0	1	ORBITER STATE VECTOR
0	0	0	1	0	1	0	RENDEZVOUS VEHICLE STATE VECTOR
0	0	0	1	0	1	1	GUIDANCE POLYNOMIAL-PPOLY
0	0	0	1	1	0	0	GUIDANCE POLYNOMIAL-PSI
0	0	0	1	1	0	1	GUIDANCE POLYNOMIAL -THETA I, 1
0	0	0	1	1	1	0	SPARE
0	0	1	0	0	0	0	ON-ORBIT GUIDANCE TARGET-PEG7
0	0	0	1	1	1	1	LAUNCH TARGETING
0	0	1	0	0	0	1	DEORBIT GUIDANCE TARGET-PEG7
0	0	1	0	0	1	0	IMU GYRO BIAS
0	0	1	0	0	1	1	IMU ACCELEROMETER BIAS
0	0	1	0	1	0	0	DEORBIT GUIDANCE-PEG4
0	0	1	0	1	0	1	STS1-4 DEORBIT LANDING SITE PARAMETERS
0	0	1	0	1	0	1	STS-5 DEORBIT LANDING SITE PARAMETERS
0	0	1	0	1	1	0	TDRS STATE VECTOR
0	0	1	0	1	1	1	KU-BAND ANTENNA BIAS MATRIX
0	0	1	1	0	0	0	ADI INERTIAL QUATERNION
0	0	1	1	0	0	1	SPARE
0	0	1	1	0	1	0	PAYLOAD
0	0	1	1	0	1	1	PSP CONFIGURATION MESSAGE
0	0	1	1	1	0	0	VEHICLE INERTIA MATRIX
0	0	1	1	1	0	1	ADI REFERENCE QUATERNION
0	0	1	1	1	1	0	ADI BIAS LVLH QUATERNION

Table 2-3. Two-stage command OP codes (Bit 8 = 0). (Concluded)

8	9	0	1	2	3	4	
0	0	1	1	1	1	1	STS1-4 DEORBIT TACAN PARAMETERS
0	0	1	1	1	1	1	STS-5DEORBIT TACAN PARAMETER
0	1	0	0	0	0	0	DELTA NAV
0	1	0	0	0	0	1	TABLE MAINTENANCE BLOCK UPDATE
0	1	0	0	0	1	0	TACAN SITE TABLE LOAD
0	1	0	0	0	1	1	TACAN CHANNEL LOAD
0	1	0	0	1	0	0	TACAN ANTENNA LOAD
0	1	0	0	1	0	1	SPARE
0	1	0	0	1	1	0	SPARE
0	1	0	0	1	1	1	SPARE
0	1	0	1	0	0	0	GUIDANCE POLYNOMIAL-PHI I
0	1	0	1	0	0	1	VENT/RCS BODY FORCE VECTOR
0	1	0	1	0	1	0	DRAG MODEL PARAMETERS
0	1	0	1	0	1	1	COVARIANCE MATRIX
0	1	0	1	1	0	0	RESERVED FOR ORBIT TARGETING
0	1	0	1	1	0	1	INSERTION GUIDANCE TARGET - PEG 4
0	1	0	1	1	1	0	TIME EXECUTED SIO (TEC)
0	1	0	1	1	1	1	SPARE
0	1	1	0	0	0	0	SPARE
0	1	1	0	0	0	1	SPARE
0	1	1	0	0	1	0	RCS QUANTITY MONITOR
0	1	1	0	0	1	1	SPARE
0	1	1	0	1	0	0	SPARE
0	1	1	0	1	0	1	SPARE
0	1	1	0	1	1	0	PCMMU TFL/DFL
0	1	1	0	1	1	1	VARIABLE DOWNLIST SELECT
0	1	1	1	0	0	0	TIME EXECUTE BUFFER CLEAR
0	1	1	1	0	0	1	SPARE
0	1	1	1	0	1	0	SPARE
0	1	1	1	0	1	1	SPARE
0	1	1	1	1	0	0	SPARE
0	1	1	1	1	0	1	PAYLOAD THROUGHPUT (SINGLE STAGE)
0	1	1	1	1	1	0	SPARE
0	1	1	1	1	1	1	SPARE

Table 2-4. Single-stage and interactive command OP codes (Bit 8 = 1).

8	9	0	1	2	3	4	
1	0	0	0	0	0	0	SPARE
1	0	0	0	0	0	1	TWO STAGE BUFFER CLEAR
1	0	0	0	0	1	0	SPC BUFFER CLEAR
1	0	0	0	0	1	1	TWO-STAGE BUFFER EXECUTE
1	0	0	0	1	0	0	WORD-BY-WORD CORRECTION
1	0	0	0	1	0	1	MDM SINGLE STAGE (RTC)
1	0	0	0	0	0	1	MDM MULTIPLE RTC (MRTC)
1	0	0	0	1	1	0	UPLINK ACTIVITY OFF
1	0	0	0	1	1	1	UPLINK ACTIVITY ON
1	0	0	1	0	0	0	MEMORY OVERLAP UPLINK
1	0	0	1	0	0	1	RESERVED FOR SINGLE STAGE GROWTH
1	0	0	1	0	1	0	0
1	0	0	1	0	1	1	0
1	0	0	1	1	0	0	0
1	0	0	1	1	0	1	0
1	0	0	1	1	1	0	0
1	0	0	1	1	1	1	0
1	0	1	0	0	0	0	RESERVED FOR SINGLE STAGE GROWTH
1	0	1	0	0	0	1	SPARE
1	1	1	1	1	1	0	SPARE
1	1	1	1	1	1	1	ILLEGAL

First Command Word/Last Command Word: Bits 15-16

The First Command Word (FCW)/Last Command Word (LCW) bits (15 and 16) contain a two-bit code which identifies the first command word, the last command word, and intermediate command words in a series of two-stage commands. These bits all have the same vehicle address, major function, and op code. Figure 2-5 contains the FCW/LCW codes.

- 10 - The first command word in a multiword command sequence.
- 00 - All command words between the first and last commands words in a multiword sequence.
- 01 - The last command word in a multiword command sequence

- 11 - A single command word

	15	16	
.....	F	L
	C	C	
	W	W	

Figure 2-5.- FCW/LCW: Command word bits 15-16.

Command Data: Bits 17-48

The command data bits are divided into 16-bit groups. The coding of these bits identifies such functions as

- Control of an end item
- Command routing to an end item
- Command execution time
- Set and Reset command
- GPC software entries.

Interactive RTC

An interactive RTC controls an end item. Command word bits 17 through 32 the routing of an interactive RTC from the GPC to the end item through an MDM.

The contents of bits 17 through 32 will be discussed in which they route the command, rather than in the order in which they appear in the command word. The bits are discussed in the following order:

- Bits 26-32 - Identify MDM
- Bits 17-20 - Identify MDM IOM
- Bits 24-25 - Identify IOM channel
- Bit 21 - Identifies reset or set command

Figure 2-7 shows schematically the selection of PL1 MDM / IOM 5 / Channel 3.

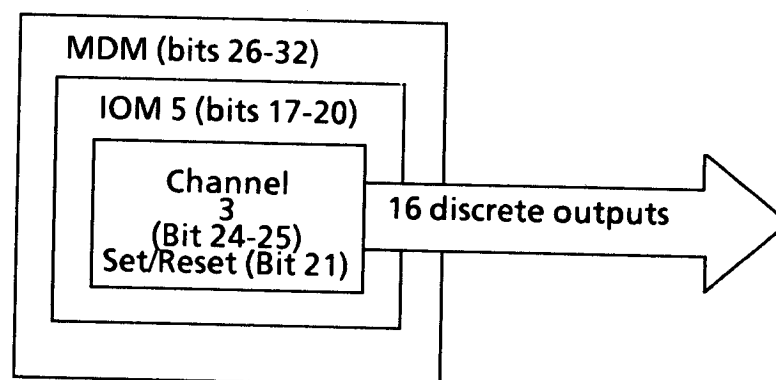


Figure 2-6. – Example: Selection of PL1 MDM / IOM5 / Channel 3.

Bits 26-32: MDM Select : There are ten permanent MDMs through which commands may be routed after launch. Two are used only for prelaunch, and one to six may be added for Spacelab or payload support. Bits 26 through 32 identify which MDM is selected. See figure 2-8. The ten permanent and six flexible MDMs are illustrated in figure 2-9. MDM select codes are shown in Table 2-6..

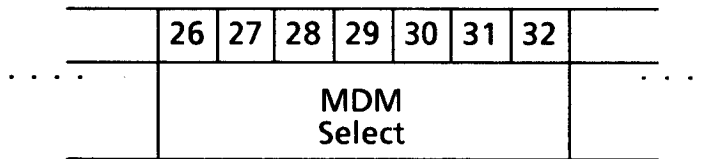


Figure 2-8. – MDM select: command word bits 26-32.

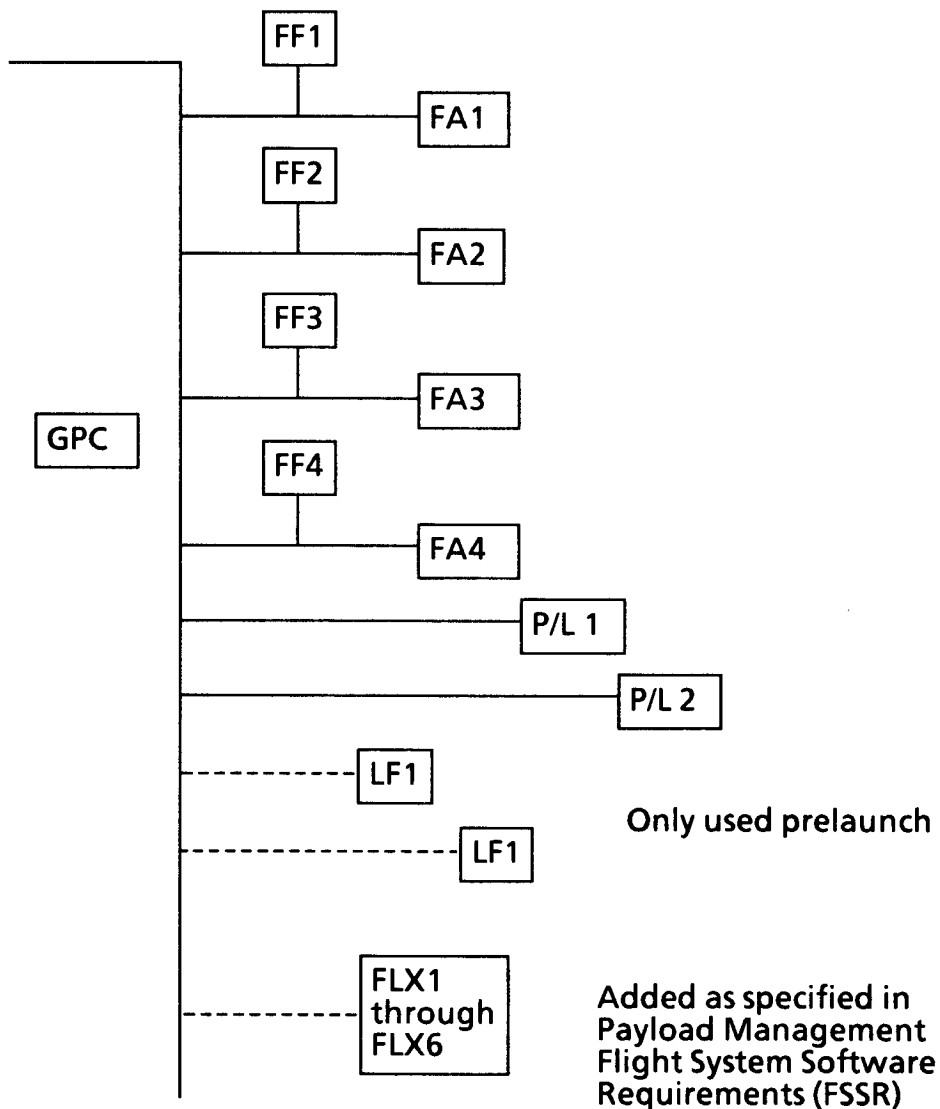


Figure 2-9. – Permanent MDMs.

Table 2-6. MDM Select Codes

0000000	Illegal
0000001	FF1
0000010	FF2
0000011	FF3
0000100	FF4
0000101	FA1
0000110	FF2
0000111	FA3
0001000	FA4
0001001	P/L 1
0001010	P/L2
0001011	LF1
0001100	LA1
0001101	FLX1
0001110	FLX2
0001111	FLX3
0010000	FLX4
0010001	FLX5
0010010	FLX6
0010011	
through	Illegal
1111111	

Bits 17 - 20: IOM Select: Each MDM is equipped with connections for 16 input/output modules (IOMs) which are numbered 0 to 15. Each IOM is a circuit card that has been assigned to provide circuit margins compatible with the interface. Refer to figures 2-10 and 2-11.

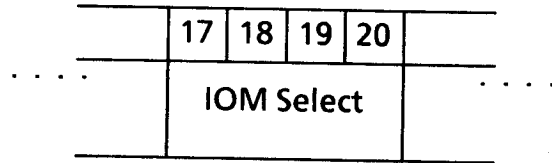


Figure 2-10. – IOM select: command word bits 17-20.

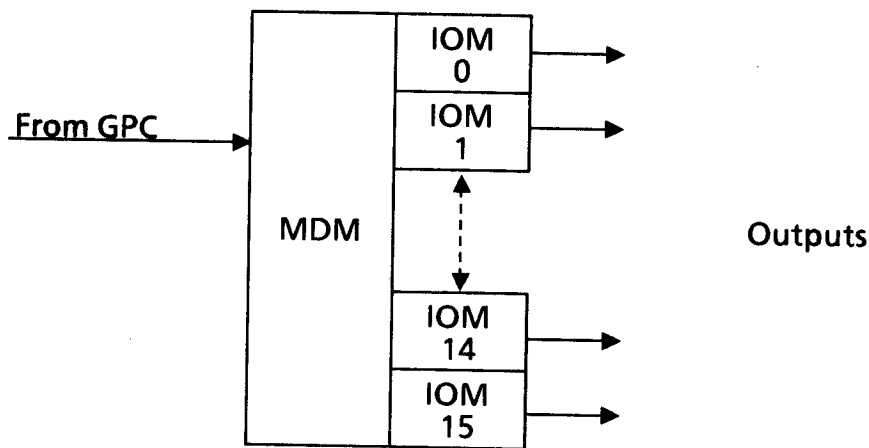


Figure 2-11. – Command data: command word bits 17-48.

There are nine different types of IOM circuit cards. Commands are routed through output type circuit cards. The four types of IOM used for commanding are listed below.

- Analog output differential (AOD) -

The output of an AOD card is -5.12 to + 5.11 volts DC. Output is continuously variable between these two limits. AOD output is used to provide analog control of an end item device.

- Discrete output low (DOL) -

The output of a DOL card is bilevel, 0 to + 5 volts DC. It has two possible functions.

Discrete (on/off) control of an end item device

Provide coded bits to control a device requiring a coded parallel interface when used with other DOL outputs.

- Discrete output high (DOH) -
A DOH card is the same as a DOL card, except that the output ranges from 0 to +25 volts DC.
- Serial input/output (SIO) -
The output of an SIO card is a serial data stream with a high and low voltage per bit of +5 and -5 volts DC, respectively.

Bits 17 through 20 are coded to identify the output card connector to which the command is to be routed. Table 2-7 identifies the type of card that is connected to each IOM location and each MDM. Table 2-8 contains the routing code for each connector.

Table 2-7. Type of IOM by Location and MDM

MOM	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
FF 1-FF 3	TAC	AID	DOH	SIO	DIH	DOL	DIL	AIS	AOD	DIH	DOL	SIO	DIH	DOL	AID	DIL
FF 4	TAC +	AIDX	DOH	SIO +	DIH	DOL	DIL	AIS	AOD	DIH	DOL	SIO	DIH	DOL	AID	DIL
FA A-FA 4	AOD	AID	DOL	DIH	AOD	DIL	AIS	DOH	DIH	AID	DOL	DIH	DOH	DIL	AIS	DOH
LF 1	DOH	DIL	DOH	AIS	AOD	DOH	DIH	DOL	DOL	DOH	DIH	DOH	AID	DIH	DOH	DIL
LA 1	DOH	DIL	DOH	AIS	AOD	DOH	DIH	DOL	DOL	DOH	DIH	DOH	AID	DIH	DOH	DIL
PF 1	DOL	AID	DOH	DIH	AIDX	DIL	DIH	DOM	SIO	DIH	DOL	AID	ADD	DIL	DOH	SIO
PF 2	DOL	AID	DOH	DIH	AIDX	DIL	DIH	DOM	SIO	DIH	DOL	AID	ADD	DIL	DOH	SIO
FLX 1																
FLX 2																

Table 2-8. IOM Routing Codes

0000	connector	0
0001	connector	1
0010	connector	2
0011	connector	3
0100	connector	4
0101	connector	5
0110	connector	6
0111	connector	7
1000	connector	8
1001	connector	9
1010	connector	10
1011	connector	11
1100	connector	12
1101	connector	12
1110	connector	14
1111	connector	15

Bits 22-25: MDM/IOM Channel Address: After the IOM is selected, IOM commands are routed through one of three IOM channels. Bits 24 and 25 identify the MDM channel address. (Bits 22 and 23 are spares.) Refer to figure 2-12. Table 2-9 illustrates the MDM channel address system.

Table 2-9. MDM Channel Address

Bits 22 - 23 - Spare
Bits 24 - 25 - Channel 0
01 - Channel 1
10 - Channel 2
11 - Illegal

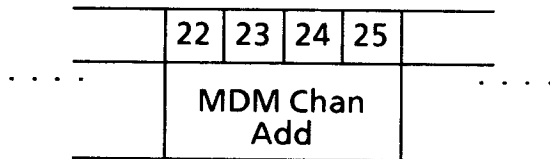


Figure 2-12. – MDM Channel Address: Bits 22-25.

Bits 33-48: Command Data: The command data bits (bits 33-48) in each part of the RESET/SET command word control each of the 16 discrete outputs from the MDM/IOM/channel selected by bits 17 through 32. Discrete outputs may be DOL cards, which produce discrete outputs of 0 or + 5 volts DC, or DOH cards, which produce discrete outputs of 0 or + 25 volts DC.

Bit 21: RESET/SET: All commands routed though an MDM are sent in two parts: one 48 bit RESET command word followed by one 48 bit SET command word. The RESET and SET parts are stored together in the MOC as a single command group. The MOC sends the RESET command and then the SET command in response to keystrokes initiated from a console module.

For a RESET command word bit 21 = 0. For a set command word bit 21 = 1.

Reset (Bit 21 = 0)

The MOC sends the RESET part of the command first. A 1 in any of the bits 33 through 48 of the RESET command will cause the associated discrete output to RESET to 0. In other words, if a discrete output is 1, then 1 in the RESET word will change the output to 0. If an output is already 0, it will not be changed. A 0 in the

RESET word will leave the output unchanged. An example of this process is shown in table 2-10.

Table 2-10. Example of RESET Command Word

Discrete Outputs	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
	1	1	0	0	1	0	1	1	1	1	0	1	0	1	1	1
Reset CMD Word	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48
	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0
New discrete Outputs	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
	1	1	0	0	1	0	1	0	1	1	0	1	0	1	1	1

In the example, the RESET command word contains a one in bit 40 and a zero in bits 42 and 45. These locations are associated with discrete outputs 7, 9, and 12, respectively. After the RESET is sent, output 7 changes from 1 to 0. Output discrete 12 remains unchanged. All other output discrettes remained unchanged.

Set (Bit 21 = 1)

After the RESET command is sent, the SET command is sent by the MOC. A 1 in any of bits 33-48 of the SET command will cause the associated discrete output to SET to 1. In other words, if a discrete output is 0, then 1 in the controlling bit for that output will change the discrete output to 1. If an output is already 1, it will not be changed. A 0 in the controlling bit of an output will leave the discrete output unchanged. An example of this is shown in table 2-11.

Table 2-11. Example of the SET Command Word

Discrete Outputs	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
	1	1	0	0	1	0	1	0	1	0	0	1	0	1	1	1
Set CMD Word	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48
	0	0	0	0	0	0	0	1	0	1	0	0	1	0	0	0
New discrete Outputs	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
	1	1	0	0	1	0	1	1	1	1	0	1	1	1	1	1

In the example, the SET command word contains a 1 in bits 40, 42, and 45. These locations are associated with discrete outputs 7, 9, and 12, respectively. Discrete outputs 7, 9 and 12 are changed from 0 to 1 as a result. All other outputs remained unchanged since the SET bits are zeros

To summarize, bits 33 through 48 of the RESET/SET command words control the 16 discrete outputs of a given MDM/IOM/Channel selection. The RESET part which is identified by a 0 in bit 21, resets selected outputs to 0, leaving others unchanged. The SET part which is identified by a 1 in bit 21, sets selected outputs to 1, leaving others unchanged.

Discrete outputs: Discrete outputs may be used two ways;

- Each of the 16 outputs may be used individually as a discrete output to control an end item function. Examples: Change a mode, control a relay, open a valve, or close a door.
- The outputs may be used together to provide a coded parallel interface to an end item function. Examples: Orbiter communication, Ground Command Interface Logic (GCIL), or Orbiter operation recorder control.
- DOH and DOL IOMs provide this type of interface.

Summary of Example: MDM-routed commands are the most common type of command sent to the Orbiter, so this example has wide applicability. The following is a list of routing information contained in the command word:

- Bits 17 through 32 contain routing information.
- Bits 26 through 32 identify the MDM through which the command is routed.
- Bits 17 through 20 identify one of 16 IOMs connected to the MDM.
- Bits 24 and 25 identify one of three channels per IOM.
- Bit 21 identifies the command word as a reset or set command word.
- Bits 33 through 48 control the 16 discrete outputs of each channel.

In the reset part of a command, a 1 in bits 33-48 will reset the output to 0. In the set part, a 1 in bits 33-48 will set the outputs to 1. Every command sent is divided into a reset part and a set part by the MOC and sent to the Orbiter in that order. Unexpected end item responses may be observed if an improper sector reset comand is loaded and executed.

Types of Commands

There are basically two types of commands: single-stage commands (SSC) and two-stage commands (TSC).

Single-Stage Commands (SSC)

An SSC is a real-time command (RTC) initiated at an MCC console by the INCO/INST/COMM/PLO. The transmitted reset and set command words are momentarily stored in the GPC single-stage buffer (SSB) and are automatically executed after the destination data has been decoded. An SSC is usually verified by observing the telemetry response of the action it initiates in the end item. Table 2-12 illustrates the bit structure of a typical SSC.

Table 2-12. Typical SSC Bit Structure

Veh Add	Maj Func	Op Code	F L W	L C W	Data			Data
					IOM Add	Chan Add	MDM No	
1 2 3	4 5 6 7	8 9 10 11 12 13 14	15	16	17 18 19 20	21 22 23 24 25	26 27 28 29 30 31 32	33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48
		Discrete Mask 1 RST						Discrete Mask 1 RST
0 0 1	1 0 0 0	1 0 0 0 1 0 1	1	1	1 0 1 0	0 0 0 0 1	0 0 0 1 0 1 0	1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
		Discrete Mask 2 SET						Discrete Mask 2 SET
0 0 1	1 0 0 0	1 0 0 0 1 0 1	1	1	1 0 1 0	1 0 0 0 1	0 0 0 1 0 1 0	0 0 0 0 0 0 0 0 0 0 0 0 1 0 0 0 0

- Veh Add = 001 - Vehicle 099
- Maj Func = 1000 - System Management
- Op Code = 1000101 - MDM Single Stage (RTC)
- FCW/LCW = 11 - Single command word
- MDM (26-32) = 0001010 - P/L 2
- IOM (17-20) = 1010 - Connector 10
- Channel (24-25) = 01 - Channel 1

Two-Stage Commands (TSC)

There are five types of TSCs:

- Real-time commands (RTC)
- Multiple real-time commands (MRTC)
- Stored program commands (SPC)
- Uplink Modifications Loads, such as Table Maintenance Block Update (TMBU), GPC Memory Uplink (G-MEM), and so on
- Single stage payload throughput commands which use the two-stage buffer

TSCs are stored in the GPC two-stage buffer (TSB). The stored command or load is executed after verification by the command controller, and in some cases after a designated time has been reached.

Real-time command

A two-stage RTC is initiated at an MCC console by the INCO/INST/COMM/PLO.

The set and reset command words entering the Orbiter GPC are stored in the TSB, along with an additional 48-bit word. The additional word is added by the MOC and precedes the reset word. It identifies the number of groups of commands in a sequence. One reset and set word together constitute a group. Bits 28 through 32 of this word indicate the number of groups from zero to ten. See table 2-13.

**Table 2-13. Bits 28-32 of Group Number Command Word:
Number of Groups in a TSC RTC.**

28	29	30	31	32	# of groups
0	0	0	0	0	Illegal
0	0	0	0	1	1
0	0	0	1	0	2
0	0	0	1	1	3
0	0	1	0	0	4
0	0	1	0	1	5
0	0	1	1	0	6
0	0	1	1	1	7
0	1	0	0	0	8
0	1	0	0	1	9
0	1	0	1	0	10
0	1	0	1	1	
through					Illegal
1	1	1	1	1	

Table 2-14 illustrates the coding for a typical TSC as it is stored in the Orbiter GPC.

Table 2-14. Typical TSC Bit Structure.

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48												
VEH ADD		MAJ FUNC			OP CODE								F C W	L C W	DATA												DATA																																
															SPARE												NO. OF GROUPS				SPARE																												
1	0	0	1	0	0	0	0	0	0	0	0	0	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0						
(104)		(SM)			(MDM MULTIPLE)								(1ST CMD WORD MULTI-WORD TWO-STAGE CMD)		(SPARE)												(1 GROUP)				(SPARE)																												
															IOM ADD	CHAN ADD	MDM NO.																																										
1	0	0	1	0	0	0	0	0	0	0	0	1	1	0	0	1	0	1	0	0	0	0	0	1	0	0	0	1	0	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1					
(104)		(SM)			(MDM MULTIPLE)								(INTERMEDIATE CMD WORD)		(IOM 11)	(RESET CHAN 1)	(P/L MDM 2)				(RESET ALL 16 DISCRETE OUTPUTS TO 0)																																						
																					DISCRETE MASK 2 RESET																																						
1	0	0	1	0	0	1	0	0	0	0	0	1	1	0	1	1	0	1	0	1	0	0	0	1	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
(104)		(SM)			(MDM MULTIPLE)								(LAST CMD WORD)		(IOM 11)	(SET CHAN 1)	(P/L MDM 2)				(SET DISCRETE OUTPUT 12 TO 1)																																						

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Manual Verification. A TSC is manually verified by comparing the uplink (UP) to the downlink (DN) command word on the GNC/SM UPLINK VERIFY display, RR 1321 of 1322. See figure 2-15. As previously stated, the MOC will flag errors. However, it should be noted that the command can be manually executed as stored in the TSB. The MOC does not protect against the manual execution of an improperly stored.

2		5		9		DAY 3		5		1			
F/V 126/103				GNC/SM UPLINK VERIFY				RR1321TCH062					
RGHT 49:17:49:25				U/L ACT				01 103					
GNC/SM NR				GNC				SM 7					
GPC/MP CHK				GPC ID				1					
ILLEGAL OP				CMD SITE VM1				NSP 0000000000000000					
VEN ADD ER				U/L SKIP				GPC 1111111110000000					
UP				FM/LN ERR				0000000000000000					
1	DN	15	UP	DN	UP	DN	UP	DN	UP	DN	UP		
1	0000	15	UP	0000	29	UP	0000	43	UP	0000	57	UP	0000
2	0000	16	UP	0000	30	UP	0000	44	UP	0000	58	UP	0000
3	0000	17	UP	0000	31	UP	0000	45	UP	0000	59	UP	0000
4	0000	18	UP	0000	32	UP	0000	46	UP	0000	60	UP	0000
5	0000	19	UP	0000	33	UP	0000	47	UP	0000	61	UP	0000
6	0000	20	UP	0000	34	UP	0000	48	UP	0000	62	UP	0000
7	0000	21	UP	0000	35	UP	0000	49	UP	0000	63	UP	0000
8	0000	22	UP	0000	36	UP	0000	50	UP	0000	64	UP	0000
9	0000	23	UP	0000	37	UP	0000	51	UP	0000	65	UP	0000
10	0000	24	UP	0000	38	UP	0000	52	UP	0000	66	UP	0000
11	0000	25	UP	0000	39	UP	0000	53	UP	0000	67	UP	0000
12	0000	26	UP	0000	40	UP	0000	54	UP	0000			0000
13	0000	27	UP	0000	41	UP	0000	55	UP	0000			0000
14	0000	28	UP	0000	42	UP	0000	56	UP	0000			0000

2		5		9		DAY 3		5		1			
F/V 126/103				GNC/SM UPLINK VERIFY				RR1321TCH062					
RGHT 49:17:49:25				U/L ACT				01 103					
GNC/SM NR				GNC				SM 7					
GPC/MP CHK				GPC ID				1					
ILLEGAL OP				CMD SITE VM1				NSP 0000000000000000					
VEN ADD ER				U/L SKIP				GPC 1111111110000000					
UP				FM/LN ERR				0000000000000000					
1	DN	15	UP	DN	UP	DN	UP	DN	UP	DN	UP		
1	710F	7012	UP	9F0A	29	UP	01FF	43	UP	007F	57	UP	0000
2	FEF0	0000	UP	7109	30	UP	7909	44	UP	0041	58	UP	0000
3	0000	0000	UP	01FF	31	UP	00F3	45	UP	AC34	59	UP	0000
4	7109	18	UP	7909	32	UP	0041	46	UP	710A	60	UP	0000
5	01FF	19	UP	00F1	33	UP	AC30	47	UP	01FF	61	UP	0000
6	7909	20	UP	0041	34	UP	710A	48	UP	790A	62	UP	0000
7	00F3	21	UP	A942	35	UP	01FF	49	UP	007F	63	UP	0000
8	0041	22	UP	7109	36	UP	790A	50	UP	0041	64	UP	0000
9	9F0A	23	UP	01FF	37	UP	00F3	51	UP	AC36	65	UP	0000
10	7109	24	UP	7909	38	UP	0041	52	UP	0000	66	UP	0000
11	01FF	25	UP	00F3	39	UP	AC32	53	UP	0000	67	UP	0000
12	7909	26	UP	0041	40	UP	7109	54	UP	0000			0000
13	007F	27	UP	A944	41	UP	01FF	55	UP	0000			0000
14	0041	28	UP	7109	42	UP	7909	56	UP	0000			0000

Figure 2-15. – GNC/SM Uplink Verify display (RR 1321).

Command words are displayed in a hexadecimal format. Each hexadecimal character represents four bits in the command word. The example in table 2-15 shows the hexadecimal code for a two-stage set command word. Only the code for the data bits is shown on the MSK display.

Table 2-15. Example of Console Display Format

Command word:

Veh Add	Maj Func	Op Code	FLW	LCW	Data								Data							
1 2 3	4 5 6 7	8 9 10 11 12 13 14	15	16	17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32	33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48														
1 0 0	1 0 0 0	0 0 0 0 1 0 1	0	1	1 0 1 0 1 0 0 0 1 0 0 0 1 0 1 0	0 0 0 0 0 0 0 0 0 0 0 0 1 0 0 0 0														
9	0	1	5		A 8 8 A	0 0 1 0														
					(Data bits 17-32)	(Data bits 33-48)														

A complete two-stage command group contains the group number command word plus the reset and set command words. Each group has a common header contained in bits 1-14. Bits 15 and 16 indicate the FCW and LCW. See table 2-16 for an example of the hexadecimal display of a complete two-stage command group.

Table 2-16. Example of Two-stage Command Group Display Format

Command word group:

Veh Add	Maj Func	Op Code	FLW	LCW	Data								Data							
1 2 3	4 5 6 7	8 9 10 11 12 13 14	15	16	17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32	33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48														
1 0 0	1 0 0 0	0 0 0 0 1 0 1	1	0	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0														
1 0 0	1 0 0 0	0 0 0 0 1 0 1	0	0	1 1 1 1 1 1 1 0 1 1 1 1 0 0 0 0	1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1														
1 0 0	1 0 0 0	0 0 0 0 1 0 1	0	1	1 0 1 0 1 0 0 0 1 0 0 0 1 0 1 0	0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 0 0														
9	0	1	6		0 0 0 1	0 0 0 0														
9	0	1	4		A 0 8 A	F F F F														
9	0	1	5		A 8 8 A	0 0 1 0														
					(Data bits 17-32)	(Data bits 32-48)														

Compare the coding of figure 2-16 with display MSK1321 in figure 2-18.

Multiple Real-Time Commands (MRTC).

MRTCs are transmitted as a set of commands with a single initiation by the INCO. MRTCs may be transmitted in the SSC mode, but are normally sent in the TSC mode. Figure 2-16 illustrates the structure of a two-stage set of MRTC commands. The first word in the set defines the number of word groups in the set.

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48			
VEH ADD			MAJ FUNC				OP CODE				F C M	L C N	DATA															DATA																						
X	X	X	Y	Y	Y	Y	0	0	0	0	0	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
											0	0	MOD ADD	CHAN ADD		HOM NO.	DISCRETE MASK 1 RST																																	
														0	0																	0	X	X																
											0	0	1	1		1	1																																	
														0			2 SET																																	
											1	0	1	0		2	1 RST																																	
														1			2 SET																																	
											0	1	1	0		3	1 RST																																	
														1			2 SET																																	
											1	0	1	0		4	1 RST																																	
														1			2 SET																																	

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Figure 2-16. - MRTC command group format.

Stored Program Command (SPC).

A stored program command (SPC) contains the same words as an MRTC, with the addition of a time word to each group.

The time word shares the same header (bits 1-16) as the other words in the group. Bits 17 through 48 of the time word define the Greenwich Mean Time (GMT) at which the stored command is executed. These 32 bits contain the time in seconds. The format is binary, where bit 48 is the least significant bit and bit 17 is the most significant bit. Figure 2-17 illustrates the format of a typical SPC command word set. Note the OP code.

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48				
VEH ADD			MAJ FUNC				OP CODE								F C W	L C W	DATA																DATA																		
X	X	X	Y	Y	Y	Y	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
															0	0	MOD ADD	CHAN ADD				MDM NO.	DISCRETE MASK 1 RST																												
																	MOD ADD	1 0 0 X X				MDM NO.	DISCRETE MASK 2 SET																												
																		TIME WORD (MSS)																TIME WORD (LSS)																L S B	
																	MOD ADD	0 0 0 X X				MDM NO.	DISCRETE MASK 1 RST																												
																	MOD ADD	1 0 0 X X				MDM NO.	DISCRETE MASK 2 SET																												
																		TIME WORD (MSS)																TIME WORD (LSS)																L S B	

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Figure 2-17. – SPC command group format.

The time word for an SPC is displayed after the associated set word on MOCR display RR1321. See figure 2-18.

		2	5	9	DAY 3	5	1	
F/V 126/103		GNC/SM UPLINK VERIFY					RR1321TCH062	
RGMT 49:17:49:28							01 103	
MSG		DGM NR		DGMT		U/L ACT		
GPC/MP CHK		EX PAR BUF		TBC ERROR		DNC		
ILLEGAL OP		SPC FULL		U/L SKIP		SM ?		
VEN ADD ER		MDM ADD ER		FM/LM ERR		DNC ID 1		
UP		UP		UP		CMD SITE VM1		
						TLM SITE TDR		
						DNC 862		
						NSP 0000000000000000		
						1111111111000000		
						GPC 1111100000100000		
						0000000000000000		
1	0000	16	0000	29	UP	DN	DN	
2	0000	16	0000	30	UP	DN	DN	
3	0000	17	0000	31	UP	DN	DN	
4	0000	18	0000	32	UP	DN	DN	
5	0000	19	0000	33	UP	DN	DN	
6	0000	20	0000	34	UP	DN	DN	
7	0000	21	0000	35	UP	DN	DN	
8	0000	22	0000	36	UP	DN	DN	
9	0000	23	0000	37	UP	DN	DN	
10	0000	24	0000	38	UP	DN	DN	
11	0000	25	0000	39	UP	DN	DN	
12	0000	26	0000	40	UP	DN	DN	
13	0000	27	0000	41	UP	DN	DN	
14	0000	28	0000	42	UP	DN	DN	
MSG		DGM NR		DGMT		U/L ACT		
GPC/MP CHK		EX PAR BUF		TBC ERROR		DNC		
ILLEGAL OP		SPC FULL		TEC FULL		SM ?		
VEN ADD ER		MDM ADD ER		FM/LM ERR		DNC ID 4		
UP		UP		UP		TMBU REJ 8		
						PL UL INV		
						SM 864		
						NSP 0000000000000000		
						0000000000000010		
						GPC 0000000000000000		
						0000000000000000		
1	710F	16	9F08	29	UP	DN	DN	
2	FEF0	16	7109	30	UP	DN	DN	
3	0000	17	01FF	31	UP	DN	DN	
4		18	7909	32	UP	DN	DN	
5	01FF	19	08F1	33	UP	DN	DN	
6	7909	20	0841	34	UP	DN	DN	
7	08F3	21	A942	35	UP	DN	DN	
8	0841	22	7109	36	UP	DN	DN	
9	9F08	23	01FF	37	UP	DN	DN	
10	7109	24	7909	38	UP	DN	DN	
11	01FF	25	08E3	39	UP	DN	DN	
12	7909	26	0841	40	UP	DN	DN	
13	087F	27	A944	41	UP	DN	DN	
14	0841	28	7109	42	UP	DN	DN	

Figure 2-18. - MOCR display MSK 1321: GNC/SM uplink verify.

Time Executed Command (TEC)

A TEC is essentially the same as an SPC, except that commands are routed to serial I/O (SIO) MDM channels. For example, payload commands are routed through P/L MDM SIOs. Figure 2-19 illustrates a TEC load format. (Note the OP code.)

BIT NUMBER																																															
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48
VEH ADD			MAJ FUNC			OP CODE						F C W	L C W	DATA																DATA																	
X	X	X	1	0	0	0	0	1	0	1	1	1	0	1	0	GMT TIME OF EXECUTION																															
/			/			/						0	0	1	0	0	0	0	DEST. DEP.	DATA WORD COUNT	DATA WORD 1																										
														DATA WORD 2																DATA WORD 3																	
														DATA WORD 4																DATA WORD 5																	
														DATA WORD 6																DATA WORD 7																	
														DATA WORD 8																DATA WORD 9																	
														DATA WORD 10																DATA WORD 11																	
														DATA WORD 12																DATA WORD 13																	
														DATA WORD 14																DATA WORD 15																	
														DATA WORD 16																DATA WORD 17																	
														DATA WORD 18																DATA WORD 19																	
														DATA WORD 20																DATA WORD 21																	
														DATA WORD 22																DATA WORD 23																	
														DATA WORD 24																DATA WORD 25																	
												0	0	DATA WORD 26																DATA WORD 27																	
X	X	X	1	0	0	0	0	1	0	1	1	1	0	0	1	DATA WORD 28																DATA WORD 29															

TD1004*024

Figure 2-19. – TEC command group format.

Bits 1 through 16 of each word constitute the header information.

Bits 17 through 48 of the first word in the group represent the binary code for the designated GMT of execution, where bit 48 is the LSB, representing one second.

Bits 17 through 21 of the second word indicate the destination of the data leaving the GPC as follows:

1 0 0 0 - Payload command via Payload Signal Processor (PSP)

0 1 0 0 - Standard SIO

0 0 1 1 - Spacelab SIO

All other combinations are illegal.

The contents of bits 22 through 25 of the second word depend on the which destination is specified in bits 17 through 21.

PSP Commands. The PSP requires a configuration message to be loaded for each command or group of commands sent to a payload. The configuration message is stored in the GPC and identified by a number 1 through 5. Bits 22 through 25 identify this number, as follows:

0 0 0 1 1

0 0 1 0 2

0 0 1 1 3

0 1 0 0 4

0 1 0 1 5

All other codes are illegal.

Standard SIO Commands. MDM serial interfaces are designated numbers 1 through 8 in bits 22-25 of the second word:

0111 - 1 1011 - 5

1000 - 2 1100 - 6

1001 - 3 1101 - 7

1010 - 4 1111 - 8

All other codes are illegal.

Spacelab SIO Commands. Spacelab serial data may be sent to one of two Spacelab computers, identified in bits 22-25 as follows:

1 1 0 0 Subsystem computer

0 1 0 0 Experiment computer

All other codes are illegal.

Bits 26 through 32 of the second TEC word define the number of words to be transferred in the group. The maximum number differs for each destination defined by bits 17 through 21, as follows:

PSP commands

0 0 0 0 0 0 -0

0 0 0 0 0 1 -1

⋮

0 1 1 1 1 0 -62

0 1 1 1 1 1 -63

Standard SIO

0000000 - Illegal

0000001 - 1

0000010 - 2

⋮

0011111 - 31

0100000 - 32

All others are illegal.

Spacelab SIO

0000000 - 0

0000001 - 1

⋮

0011110 - 30

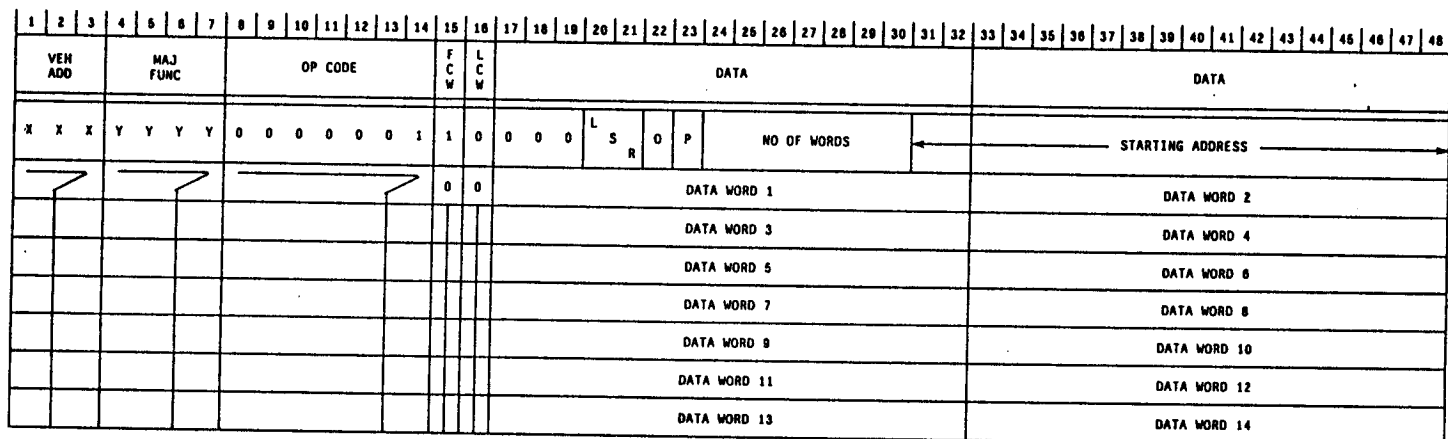
0011111 - 31

All others are illegal.

Command Loads

A command load is always a two-stage command which is used to control data in the GPC main memory or GPC mass memory unit (MMU).

G-MEM. GPC Memory loads (G-MEMs) update data in memory by GPC memory address. Figure 2-20 illustrates the command word structure for a contiguous G-MEM update. Note the OP code.



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Figure 2-20.- Contiguous G-MEM update format.

The first word of a contiguous G-MEM update identifies the following:

- The effect that the command data word will have on the data stored in the specified address (Bits 20 and 21)
- Whether the memory storage is protected or unprotected (Bit 23)
- The number of command words (Bits 24 through 30)
- Starting address for a series of consecutive addresses (Bits 31 through 48).

Bits 20 and 21 contain a coded instruction that determines the effect of the command data word on the data stored in a specific address as shown:

- 00 -Illegal
- 01 -Set bits in memory
- 10 -Reset bits in memory
- 11 -Load data directly into memory location

Bit 23 determines whether memory storage will be protected or unprotected, where 1 indicates protected and 0 indicates unprotected.

Bits 24 through 30 define the number of data words to follow in the command load. The command load can contain up to 64 sixteen-bit words. The number of data words is indicated as follows:

- 0 0 0 0 0 0 -zero words
- 0 0 0 0 0 1-one word
- ⋮
- 1 0 0 0 0 0 -64 words

All other codes are illegal.

Bits 31 through 48 identify the starting address for a series of data words. The addresses are incremented upward from the starting address for each successive data word.

The second word and all successive words of the G-MEM command possess a common sixteen-bit header. Bits 17 through 48 of these words are divided into two sixteen-bit data words. Each successive sixteen-bit data word contains the load update for a successive memory address.

Besides the G-MEM contiguous command loads, there are the G-MEM scatter command loads. The main difference between a G-MEM contiguous and a G-MEM scatter command load is that each data word is accompanied by a unique address in bits 17 through 32. Figure 2-21 illustrates the format of G-MEM scatter command load. Note the OP code.

0000 0010	TM ALERT LIMIT SET 1 - LO LIMIT/STATE
0000 0011	TM ALERT LIMIT SET 1 - HI LIMIT/STATE
0000 0100	TM ALERT LIMIT SET 2 - LO LIMIT/STATE
0000 0101	TM ALERT LIMIT SET 2 - HI LIMIT/STATE
0000 0110	TM ALERT LIMIT SET 3 - LO LIMIT/STATE
0000 0111	TM ALERT LIMIT SET 3 - HI LIMIT/STATE
0000 1011	TM BU C&W LIMIT SET - LO LIMIT/STATE
0000 1100	TM BU C&W LIMIT SET - HI LIMIT/STATE
0001 0001	TM CONSTANT VALUE

Figure 2-23. – Sample TMBUs.

Digital Matrix Numbers

Commands are tagged in the MOC with digital select matrix (DSM) numbers for identification and software accountability. RTCs are identified by four-digit numbers and command loads are identified by five-digit numbers.

DSM numbers are used by the Instrumentation (INST), Communication (COMM), and Payload Officer (PLO) uplink position through console modules, to select commands stored in the MOC. Most commands are prebuilt and prenumbered. However, the INCO may build and assign DSM numbers to RTC or command loads. Figure 2-24 shows a sample DSM list.

DSM	M/S ID	OPS NOMENCLATURE	MDM	RESET	SET
4321	F V75K6114U	OPS 1 DELAY TIME 1	PF1	A0890180	A8890100
4322	F V75K6115U	OPS 1 DELAY TIME 2	PF1	A0890180	A8890080
4323	F V75K6116U	OPS 1 DELAY TIME 3	PF1	A0890180	A8890180
4324	F V75K6107U	OPS 1 CHANGE DIR ON	PF1	A0891000	A8891010
4325	F V75K6108U	OPS 1 CHANGE DIR OFF	PF1	A0891000	A8890000
4326	F V75K6109U	OPS 1 SPEED 24 IPS	PF1	A0890600	A8890000
4327	F V75K6110U	OPS 1 SPEED 120 IPS	PF1	A0890600	A8890400

Figure 2-24. – Sample DSM list.

Command Building

RTCs and command loads can be built or changed by console operators of several disciplines, including the flight dynamics officer (FDO), the data processing system engineer (DPS), and the guidance officer (GDO). These operators may build or change loads with a manual entry device (MED) called a Megadata or work station. A Megadata consists of a keyboard display, a disk drive, and a printer. Refer to figure 2-25.

The transmission of all MCC commands is the responsibility of INCO and PLO. However, console operators who generate loads are responsible for the content. For the purposes of this lesson, they are called load generators.

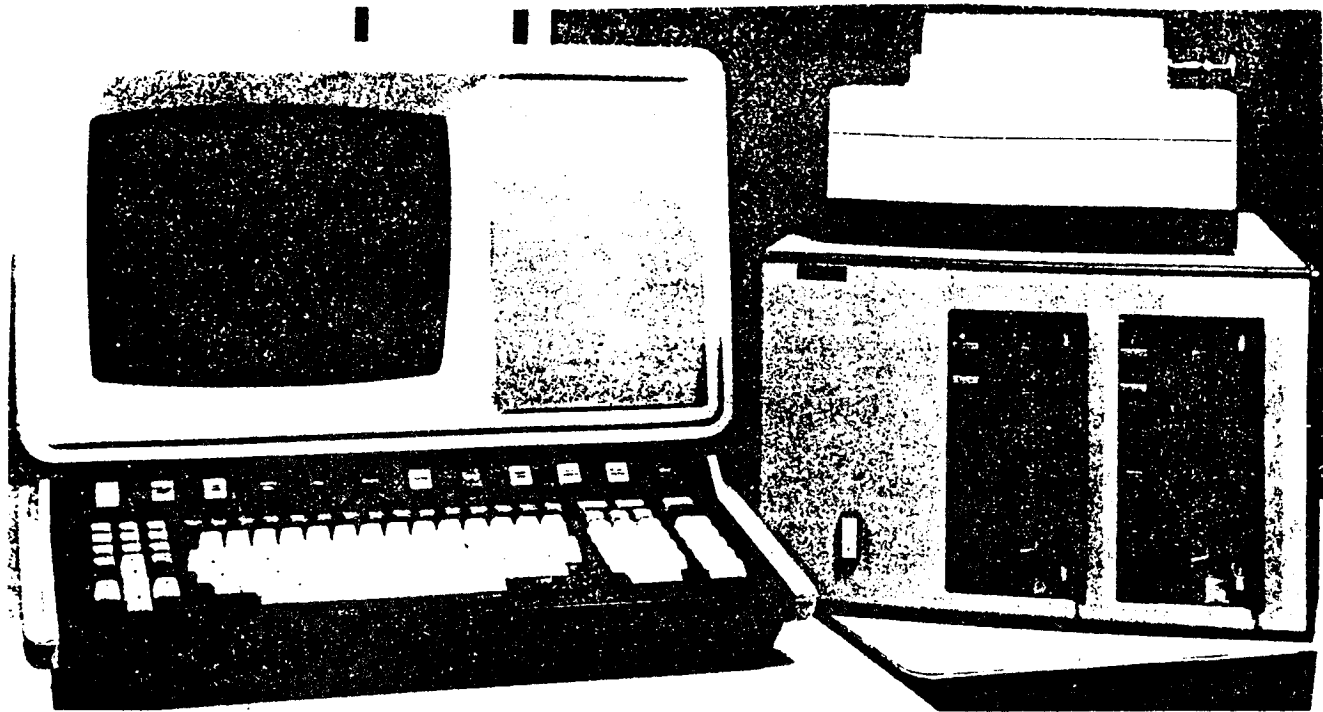


Figure 2-25. – Megadata terminal.

The load generators can perform the following operations with the Megadata:

- Build an RTC or command load not prebuilt in the MOC
- Assemble a group of RTCs under a unique DSM
- Change the command data structure of a prebuilt RTC or command load
- Build an SPC or TEC and specify the execution time
- Redefine the limits of TMBU loads.

Figure 2-26 shows a sample Megadata display.

```

C40#          002/RT SPARE RTC BUILD
ORB VEH ID _____ DSM NUMBER _____ TITLE 'SPARE RTC BUILD'
                                           OPTION BINARY=J,HEX=2
                                           MDM
                                           ADD DATA
RESET COMMAND(HEX) _____
SET COMMAND(HEX)  _____

                BITS 1   2       2       3           4
                7MOD 1 SP CH 6MDM NO 3DISCRETE MASK 8
RESET COMMAND(BINARY) _____
SET COMMAND(BINARY)  _____

BITS 17-20 = MODULE ADDRESS
21         = 0=RESET/1=SET
22-23     = SPARE, SET TO ZERO
24-25     = CHANNEL ADDRESS
26-32     = MDM NUMBER
33-48     = DISCRETE MASK

NOTE: IF NO SET COMMAND IS INPUT,
      THE COMMAND IS ASSUMED TO BE
      A SINGLE WORD RTC AND WILL BE
      FLAGGED AS INVALID FOR MRTC
      AND (M)SPC UPLINK

```

Figure 2-26.— Sample megadata display.

The load generators may call up this format with a keyboard entry, then use it to enter data defining the desired parameter and the upper and lower limits on that parameter. Once entered on the display, the selections are entered into the MOC command program under a DSM number. The data may then be uplinked to the Orbiter as a command load under the assigned DSM number.

The display may also be recorded on a floppy disk for future reference, or it may be assigned an MSK number in the MOC for access through the digital television equipment (DTE).

Hazardous Commands

Some commands are considered hazardous commands. Hazardous commands are commands that could result in a dangerous or destructive situation. Hazardous commands from a remote POCC only are inhibited by the MOC unless enabled by the command controller. In order to arrange for hazardous commands to be enabled, the uplink position must make a voice call to the command controller.

Questions

1.
 - a. What information is contained in bits 1 through 3 of a 48-bit command word?
 - b. What information is contained in bits 4 through 7 of a 48-bit command word?
 - c. What information is contained in bits 8 through 14 of a 48-bit command word?
 - d. What information is contained in bits 15 and 16 of a 48-bit command word?
 - f. What information is contained in bits 26 through 32 of a 48-bit command word?
2. How can a single-stage command be distinguished from a two-stage command?
3. Through which MDM would a command be routed if bits 26 through 32 contain 0000110?
4.
 - a. A 48-bit command is displayed on a MCC console in a hexadecimal format. Translate the following 48-bit command from hexadecimal to binary:
9117A88A001
 - b. Fill in the appropriate binary code from the above example for each of the following:
Vehicle address =
Major function =
OP code =
FCW/LCW =
MDM =
IOM =
Channel =
Reset/Set =

- c. Fill in the appropriate English equivalent from the above example for each of the following:

Vehicle address =

Major function =

Op code =

FCW/LOW =

MDM =

IOM =

Channel =

Reset/Set =

5. What are the four basic types of two stage commands?
6. a. What kind of terminal is used to build or change command loads and RTCs?
b. Who can build or change command loads and RTCs?

Multiple Choice. For questions 7 through 13 circle the letter of the correct answer.

7. The vehicle address as defined in a command word
- a. is selected by the Orbiter crew.
 - b. is added to the command word by the MOC.
 - c. is selected by the INCO by MSK keystrokes.
 - d. requires no action by INCO.
8. The Major Function bits in the command word determine
- a. which MDM the command instruction will be routed.
 - b. two-stage or single-stage command selection.
 - c. which GPC will process the command.
 - d. which payload is to receive the command instruction.

9. Manual verification of a two stage command is done on MSK display
 - a. 0910, 2659.
 - b. 0911.
 - c. 2659, 1320, 0911.
 - d. 1321, 1320, 1322.

10. A TMBU command load
 - a. is used to select telemetry parameters to be downlinked.
 - b. is routed through the P/L MDM.
 - c. is used to change limit sensing for some telemetry points.
 - d. applies only to payload commands.

Answers

1.
 - a. Vehicle address.
 - b. Major function, that is, the GPC to which the command is sent.
 - c. The program to which the command is addressed.
 - d. Identifies the command as the first, last, or an intermediate command in a multiple command string, or as a single command.
 - e. Command data.
 - f. Routing information to guide the command to the proper subsystem.
2. The MSB of a two-stage command's OP code (bit 8) is 0; the MSB of a single stage command's op code is 1.
3. FF2, or forward flight-critical MDM #2.
4.
 - a. 1001 0001 0001 0111 1010 1000 1000 1010 0000 0000 0001 0000
 - b.

Vehicle address	=	100
Major function	=	1000
Op code	=	1000101
FCW/LCW	=	11
MDM	=	0001010
IOM	=	1010
Channel	=	0001
Reset/Set	=	1
 - c.

Vehicle address	=	Vehicle 104 (Atlantis)
Major function	=	SM (Systems management)
Op code	=	MDM Single Stage
FCW/LCW	=	Single command word
MDM	=	P/L2 (payload MDM #2)
IOM	=	IOM #10
Channel	=	Channel 1
Reset/Set	=	Set
5. Real-time commands, multiple real-time commands, stored program commands, and uplink modification loads.
6.
 - a. A megadata terminal.
 - b. The FDO, DPS, and GDO.
7. a: The vehicle address is added by the MOC.

8. c: The GPC will process the command.
9. d: MSK displays 1321, 1320, and 1322.
10. c: It changes limit sensing for some telemetry points.

Feedback

Total your score as follows:

question 1 = 3 points for each item

questions 2, 3, 5, 7, 8, 9, and 10 = 8 points each

question 4 = 6 points for each part

question 6 = 4 points for each part

For each question missed, reread the pertinent material. If your score less than 80 points, carefully reread the entire section.

Section 3: MCC Command Equipment

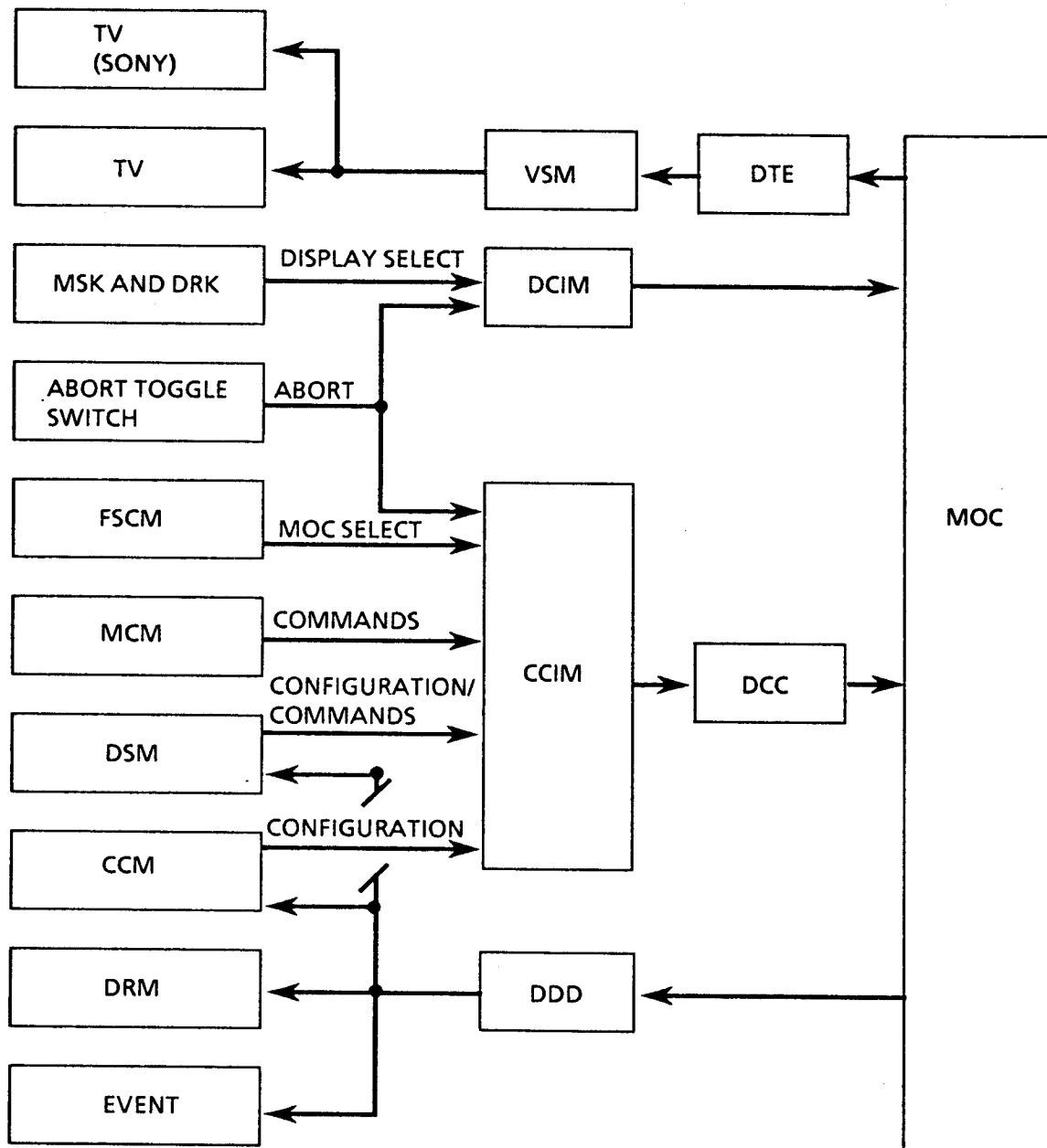
Performance Objectives

After studying this section, the student should be able to identify and describe the following MCC commanding equipment:

- Multiple select keyboard (MSK)
- Abort toggle switch
- Function code select module (FCSM)
- Multiple command module (MCM)
- Digital select module (DSM)
- Configuration control module (CCM)
- Digital readout module (DRM)
- Display electronics unit (DEU)

Console Modules

MCC console uplink position controllers select, initiate, execute, and build commands with keyboards and monitor the status of the commands on console displays. Figure 3-1 illustrates the interfaces between MOC and these console modules.

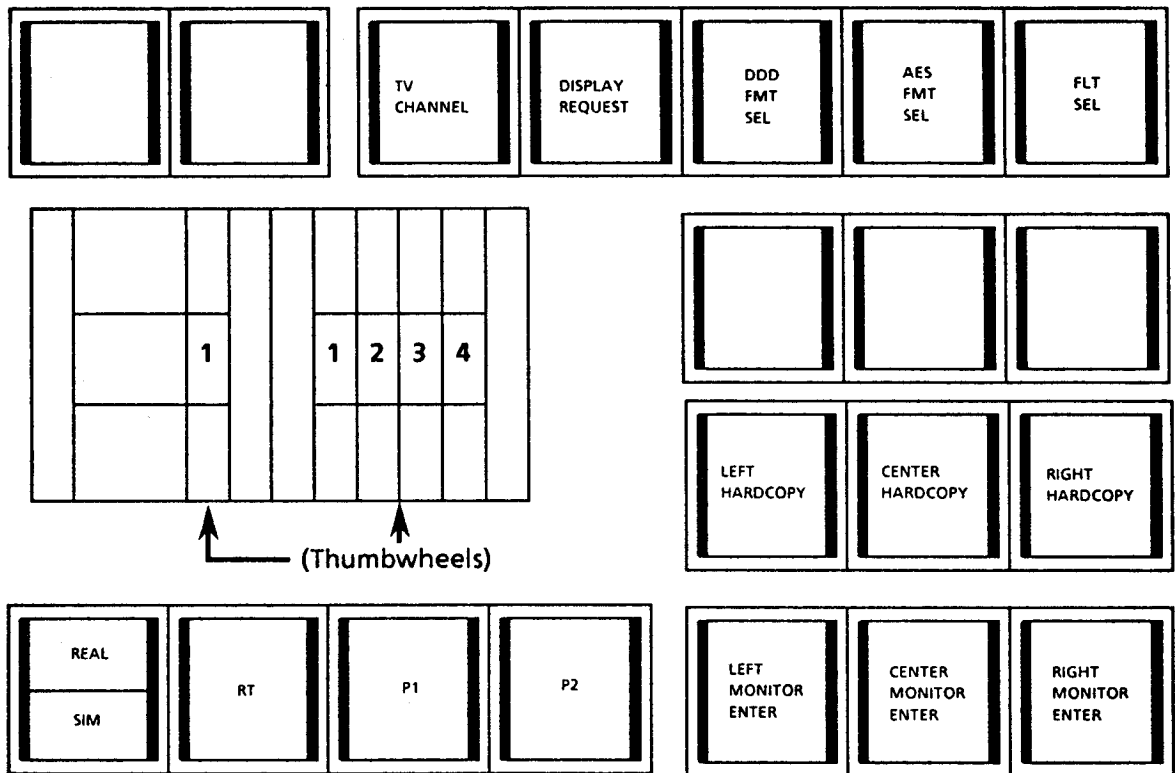


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Figure 3-1. - Console module interface to MOC.

Manual Select Keyboard

The manual select keyboard (MSK) is used to select displays that appear on console TV monitors. See figure 3-2. The TV CHANNEL or DISPLAY REQUEST function will be active for TV display selection.



TD1004*004

Figure 3-2. – Multiple Select Keyboard (MSK).

Functions on the MSK are also used to initialize consoles for command operations. Command activity initialization procedures include the following:

- **DDD FMT SEL**

When the digital display drives (DDD) Format Select function is selected, the operator can use the MSK thumbwheels to select a numerical code. This code is entered by depressing either LEFT or RIGHT MONITOR ENTER PBI (push button indicator). When entered, the code activates the DDD for the associated console. The DDDs drive the indicators on the DSM, CCM, DRM, and console event indicators.

- **FLT SEL**

When the Flight Select (FLT SEL) function is selected, the operator can use the MSK thumbwheels to select the flight number, which is on the top row of the DRM indicators.

- REAL/SIM

This PBI will be configured to either real time (REAL) or simulation (SIM) mode. This is normally configured to REAL, even during simulations.

- RT/P1/P2

These three PBIs are used to determine the source of the telemetry data that is driving the console displays. Selections are for real time (RT), or playback (P1 or P2) of recorded data. The RT function will be selected during commanding so that real time command response may be viewed.

Television Displays

The TV screens on the uplink position console display command the operation information shown in figure 3-3.

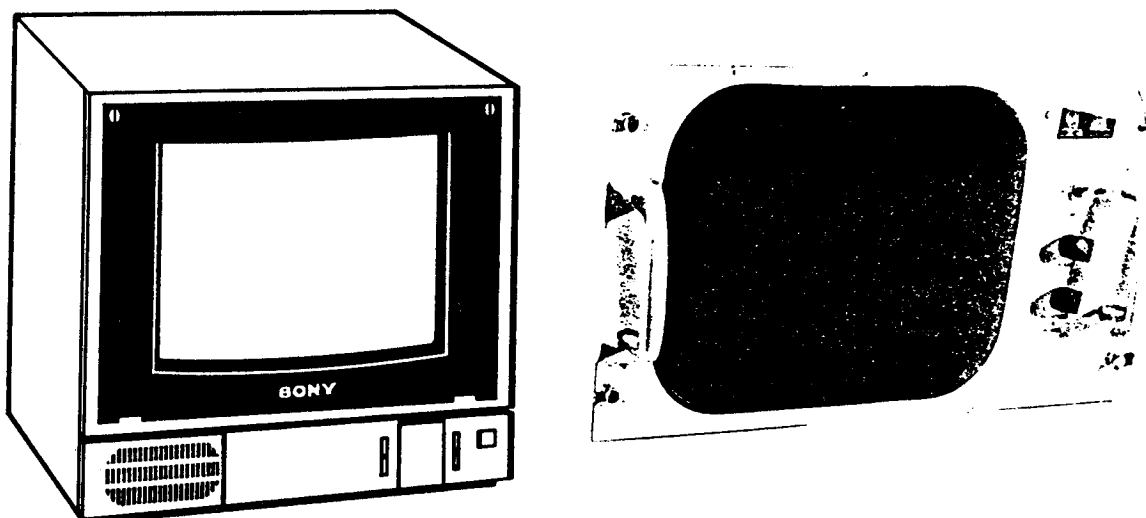


Figure 3-3. – INCO television displays.

- 3540 SL RTC Safing
- 3541 SL Group Safing
- 3602 SSPC Buffer
- 3603 SSPC History
- 3604 SSPC Single
- 3605 SSPC Load
- 3606 SL Inventory
- 3607 SL Load Inventory

The displays used most commonly are as follows:

- 0910 Command Tracking
- 0911 SPC Command History
- 1320 BFS/GNC Uplink Verify
- 1321 SM/GNC Uplink Verify
- 2663 Console Monitor

The displays will be explained in detail in the following sections.

MSK 0910 Command (CMD) Tracking Display

MSK 0910 is a six-page display showing a cumulative listing of all payload and Orbiter commands initiated.

DATE 03/18/87 TIME 20:07 SUNS DTE DISPLAY DESCRIPTION REPORT PAGE 01
 DISPLAY 0910G TV GUIDE TITLE-CMD TRACKING OWNER J

CMD TRACKING PG 1/6 0910G									
GHT	CSL SRC	STA	M F	DSH LOAD	COMMAND TITLE	COMP RSLT	CAP	CMD IDX	

Figure 3-4. – MSK 0910 CMD tracking display.

The following information is available on the CMD Tracking display.

GMT - The Greenwich Mean Time that the command was initiated.

CSL SRC - The console from which the command was initiated.

STA - The station from which the command was initiated.

MF - The major function, or computer, to which the command was addressed.

DSM LOAD - The one, two, three, four, or five character DSM number:

3 character - POCC

4 character - RTC

5 character - LOAD

COMMAND TITLE - The English title of the initiated RTC or command load

COMP RSLT - Compare results for the initiated command. The following codes may appear in this column:

- COMP - Uplink and downlink compared.
- DREJ - Data reject: Uplink and downlink did not compare word by word.
- TMRJ - Telemetry reject: Uplink and downlink did not compare due to telemetry dropouts or because telemetry data was unavailable.
- TSLO - Two-stage lockout of an attempted two-stage execute.
- SNGL - Command was sent in single stage.
- TWO - Command was sent in two stage. When a two-stage command is executed, a "two" will appear in the COMP RSLT column and subsequent buffer compare results will overlay the "two" entry.
- SAFE - Attempted uplink of a safed command.
- ABRT - Priority command in progress when another uplink is attempted.
- CAP - This column is not used
- CMD IDX - Command index, represented as a number from 0 to 255, identifying the sequence of commands sent.

MSK 1320 BFS/GNC Uplink Verify/ MSK 1321 GNC/SM Uplink Verify

The uplink verification displays, BFS/GNC Uplink Verify and GNC/SM Uplink Verify, display the two-stage words initiated under a single DSM number.

F/V 126/103		GNC/SM UPLINK VERIFY				RR1321TCH062			
RGMT 49:17:49:25		U/L ACT				OI 103			
DSM NR	OPC/MF	CHK	EX PAR	BUF	TBC ERROR	GNC	SM ?	NSP	0000000000000000
ILLEGAL OP	SPC FULL	U/L SKIP	FM/LN	ERR	UP	DN	UP	DN	UP
VEN ADD	ERR	MDM ADD	ERR	UP	DN	UP	DN	UP	DN
1	0000	15	0000	29	0000	43	0000	57	0000
2	0000	16	0000	30	0000	44	0000	58	0000
3	0000	17	0000	31	0000	45	0000	59	0000
4	0000	18	0000	32	0000	46	0000	60	0000
5	0000	19	0000	33	0000	47	0000	61	0000
6	0000	20	0000	34	0000	48	0000	62	0000
7	0000	21	0000	35	0000	49	0000	63	0000
8	0000	22	0000	36	0000	50	0000	64	0000
9	0000	23	0000	37	0000	51	0000	65	0000
10	0000	24	0000	38	0000	52	0000	66	0000
11	0000	25	0000	39	0000	53	0000	67	0000
12	0000	26	0000	40	0000	54	0000		
13	0000	27	0000	41	0000	55	0000		
14	0000	28	0000	42	0000	56	0000		

DSM NR	OPC/MF	CHK	EX PAR	BUF	TBC ERROR	GNC	SM ?	NSP	0000000000000000	
ILLEGAL OP	SPC FULL	U/L SKIP	FM/LN	ERR	UP	DN	UP	DN	UP	
VEN ADD	ERR	MDM ADD	ERR	UP	DN	UP	DN	UP	DN	
1	710F	7812	15	9F8A	29	01FF	43	087F	57	0000
2	FEF0	0800	16	7109	30	7909	44	0841	58	0000
3	0000	0800	17	01FF	31	08F3	45	AC34	59	0000
4		7109	18	7909	32	0841	46	710A	60	0000
5		01FF	19	08F1	33	AC30	47	01FF	61	0000
6		7909	20	0841	34	710A	48	790A	62	0000
7		08F3	21	A942	35	01FF	49	087F	63	0000
8		0841	22	7109	36	790A	50	0841	64	0000
9		9F80	23	01FF	37	08F3	51	AC36	65	0000
10		7109	24	7909	38	0841	52	0800	66	0000
11		01FF	25	08E3	39	AC32	53	0800	67	0000
12		7909	26	0841	40	7109	54	0800		
13		087F	27	A944	41	01FF	55	0800		
14		0841	28	7109	42	7909	56	0800		

Figure 3-5. – GNC/SM Uplink Verify display.

Verification of a two-stage command is accomplished on these displays by comparing the UP and DN (down) listings for the command. (The listings are displayed in a hexadecimal format.) If the listings do not match, the command will not be autoexecuted. The listing will be under the major function (MF) to which the command was addressed.

MSK 1320 and MSK 1321 contain similar information, so they are discussed together here. The following information is continued on the display templates.

BFS/GNC

DSM NR

This is the DSM number of the two-stage command being uplinked.

GPC/MF CHECK

An "*" indicates that an uplink command failed to pass the major function check and was rejected.

ILLEGAL OP

An "*" indicates that an illegal OP code was detected and the command was rejected.

VEH ADD ERR

An "*" indicates that an error was detected in the vehicle address and the command was rejected.

GGMT

This parameter indicates current ground GMT in days: hours: minutes: seconds.

EX PAR BUF (Execute partial two-stage buffer)

An "*" indicates that an attempt was made to execute a two-stage buffer load without a valid last command word and the load was rejected.

SPC FULL

An "*" indicates that an attempt was made to store a command in a full SPC buffer and the command was rejected. NO used with the GNC MF.

MDM ADDER

An "*" indicates MDM address is not valid and the command is therefore rejected.

U/L ACT GNC

An "*" indicates the GNC GPC uplink activity flag is set high.

U/L ACT SM

An "*" indicates the SM GPC uplink activity flag was set high.

TSC ERROR

An "*" indicates that a two-stage command error was detected.

U/L SKIP

An "*" indicates that the previous cycle of the uplink process was skipped or not completed and a previously uplinked command may not have been processed.

FW/LW ERR

An "*" indicates that a first word/last word error was detected and a command or command load was rejected.

GPC ID

Numbers 1 to 5 indicate which GPC is in use.

CMD SITE

This three-letter identifier names the ground site through which commands are being sent.

TLM SITE

This three-letter identifier names the site through which telemetry is being received.

GNC

The first three positions specify downlist format selected.

The next position indicates a "G" if the data are suspect and blank if the data are good.

The last position indicates an "*" if the data are static and blank for live data.

NSP

This is a 16-bit binary NSP validity word driven directly from the telemetry.

First 10 BITS - Status of the NSP validation check on 48-bit command words.

1 = VALID CMD 0 = NONVALID

BIT 11 - First/Last word error

1 = ERROR 0 = OK

BIT 12 - MDM code out of bounds

1 = ERROR 0 = OK

BIT 13 - EXEC partical buffer error

1 = ERROR 0 = OK

BIT 14 - Number out of bounds

1 = ERROR 0 = OK

BIT 15 - Vehicle address error

1 = ERROR 0 = OK

BIT 16 - Software uplink block

1 = BLOCK 0 = NOT BLOCKED

Output of the NSP validity word special computer displays the previous change to the 16-bit NSP validity word.

GPC

A 16-bit binary GPC validity word driven directly from telemetry.

First 10 BITS - Status of GPC validation checks on 48 bit command words.

BIT 11 - Major function/GPC code

1 = ERROR 0 = OK

BIT 12 - Uplink processor skipped

1 = cycle skipped 0 = OK

BIT 13 - SPC buffer full

1 = 10 SPCs in buffer 0 = 9 or less

BIT 14 - Uplink OP code error

1 = ERROR 0 = OK

BIT 15 - Two-stage command type error

1 = ERROR 0 = OK

BIT 16 - Spare

Output of the GPC validity word special computer displays the previous change to the 16-bit GPC validity word.

UP

The uplink column contains a hexadecimal code, listed four characters at a time, that indicates the command initiated under the DSM number in the upper left hand corner of the display. Information contained in the uplink column comes from the MOC command processor program.

DN

The downlink column contains a hexadecimal code representing the initiated command code as it is loaded into the GPC TSB. The information for the downlink (DN) column comes from the telemetry processor.

Each line in the uplink and downlink columns should match. If they do not, a double asterisk ("**") will appear in left column next to the number (1 through 67). Retransmission of the miscompared command words may be initiated from the CCM W-B-W (word-by-word) PBI. All data in these columns is removed if the indicated DSM is executed or cleared.

Caution

W-B-W commands should not be sent to the BFS major function.

GNC/SM

The SM part of the display is the same as the BFS/GNC except for the following items.

TEC FULL

An asterisk ("*") in this column indicates that an attempt was made to store a time execute load in a full TEC buffer and the load was rejected.

TMBU REJ

This parameter indicates the TMBU load status is in SM OPS 2 and is displayed in decimal digits as follows:

0 - Last load received by SM OPS 2 was executed with no errors.

1 through 10 - Last data set which was rejected for one of the following reasons:

- a. If class 2 limit change is requested and no class 2 limit set is defined for FDA parameter.
- b. If Class 0, 3, 4 limit change is requested and no Class 0, 3, 4 limits are defined for FDA parameter.

- c. If Class 0, 3, 4 limit change is requested and specified limit set does not exist.
- d. If requested change is a high limit and changed parameter is a discrete.
- e. If parameter of a limit change is not processed by FDA.
- f. If analog or EU limit value exceeds allowable range.
- g. If parameter of a constant change is not a constant parameter.

11 - Entire load was rejected for either of the following reasons:

- a. If TM spec is active when the load reaches the application.
- b. If the number of data sets is less than 1 or greater than 10.

PL UL INV

This column contains an asterisk ("*") if a payload uplink (UL) is invalid (rejected). An invalid payload uplink may be the result of

- a. a payload data load field error
- b. a throughput payload command error
- c. a busy destination interface (PSP, SSI, SCOS, or ECOS)

SM

The first three digits in this column specify to SM downlist format selected.

The next position will contain an asterisk ("*") if the data are static, and a blank (" ") if the data are live.

The last position contains a "G" if the data are suspect and a blank if the data are good.

MSK 1322 GPC Uplink Verify

The MSK 1322 GPC uplink verify display is shown in figure 3-6.

F/V	/	GP	UPLINK	VERIFY	1322P	CH118
DSM NR	0000	GGMT	00:00:00	00	NSP	0000000000000000
DATA READY	B	SS ERROR	B	CMD SITE	000	0000000000000000
GPC/MF CHK	B	SPC FULL	B	TLM SITE	000	0000000000000000
ILLEGAL OP	B	TSC ERROR	B	OP	000 00	0000000000000000
BLK	000 000	U/L ACT	B	GPC ID	B	
		UP	DN	UP	DN	
1	000 0000	0000	2300	0000	4500	0000
2		0000	24	0000	46	0000
3		0000	25	0000	47	0000
4		0000	26	0000	48	0000
5		0000	27	0000	49	0000
6		0000	28	0000	50	0000
7		0000	29	0000	51	0000
8		0000	30	0000	52	0000
9		0000	31	0000	53	0000
10		0000	32	0000	54	0000
11		0000	33	0000	55	0000
12		0000	34	0000	56	0000
13		0000	35	0000	57	0000
14		0000	36	0000	58	0000
15		0000	37	0000	59	0000
16		0000	38	0000	60	0000
17		0000	39	0000	61	0000
18		0000	40	0000	62	0000
19		0000	41	0000	63	0000
20		0000	42	0000	64	0000
21		0000	43	0000	65	0000
22		0000	44	0000	66	0000

Figure 3-6. – GPC Uplink Verify display.

MSK 2663 Console Monitor Display

This display provides a quick look advisory of the status of all MCC consoles that have been activated for commanding. Some of the information is duplicated on console panels such as the DRM, CCM, or MCM. The last command transmitted (such as MCC VAL is also listed. Parts of this display are viewed on MSK 2667.

System Mode

There are two Mission Control Center modes:

- Operate Indicates that enabled consoles may send commands.
- MCC Safe Indicates no commands may be sent from the MCC.

Test Site Sel

The text for this function may represent either the TDRS or ground site through which commands are sent. The text may also represent a ground site in which commands are sent by the command console operator.

GMT

This section displays the present GMT.

Con ACRM

The acronyms indicated on this line identify a console. The data listed below the acronym displays the configuration of the command modules on that console and the processing status of the last command transmitted from the console.

The acronyms are:

STS FCR1 (2nd floor)	STS FCR2 (3rd floor)	SECURE (Red) FCR2 (3rd floor)	POSITION NAME
INC	IC2	IC2	INCO
COM	COM	-	COMM SUPT
CO1	CO1	CO2	COMM SUPT
IN1	IN1	-	INSTRUMENTATION
IN3	IN3	IN2	INSTRUMENTATION
PLO	PL2	PL2	PAYLOAD OFFICERS
ST1	ST1	ST2	PAYLOAD SYSTEMS
PLD	PLD	-	PAYLOAD DATA
STD	STD	-	PAYLOAD SYSTEMS
POC	PO2	PO2	POCC
DAT	DAT	DA2	PAYLOAD DATA
PCR	PCR	-	
FDO	FO2	FO2	FLIGHT DYNAMICS
FD	FD2	FD2	FLIGHT DIRECTOR

Con FLT ENB

This line displays the condition of the console relative to the flight ENB (enabled)/DSB (disabled) status;

This status is established by the command console operator.

CCM ENB/DSB

This line displays the ENB (enabled)/DSB (disabled) status of the CCM panel on the associated console.

VEH Selected

This line displays the vehicle number to which the processed command is sent.

For payload console commands this line will display the identification number of the payload being commanded.

VEH Class

The vehicle class differentiates between Orbiter (ORB) or Payload (PL) as the recipient of commands from the indicated console.

LD/RTC Mode

This line displays the mode selected on the CCM module relative to the command load (LOAD MODE) or real time command (RTC Mode). If a remote POCC command is being represented the line will display "CMD".

DSM Number

This line display the DSM number of the command transmitted by the associated console.

For uplink position commands this will be a four digit number for realtime commands and a five digit number for command loads.

Commands sent from the payload console will be represented by the MCC index number displayed on MSK 3434.

Remote POCC commands will be represented by an index number form 1-999.

DSM FNC SEL

The information indicated on this line represents the last function initiated from the associated DSM module.

- RTC Initiate
- Load Initiate
- Word-By-Word Initiate
- SPC Buffer Clear Execute
- Command Terminate
- Two Stage Clear Execute
- Compare Initiate
- Two State Buffer Execute

AUTO/MAN EXEC

The indication on this line represents auto execute or manual execute selection made on the associated CCM module

AUTO - Auto Execute
MAN - Manual Execute

Single/2 STG

The indication on this line represents the SINGLE STAGE or TWO STAGE selection made on the associated CCM module.

1 - Single Stage
2 - Two State

CLM GPC/FNC

The indication on this line represents the GPC Major function selected on the associated CCM.

SM - SM GPC
GNC - GNC GPC
BFS - BFS GPC

MDM ID SEL

The indication on this line represents the MDM through which the command is to be routed. The selection is made on the associated CCM module.

MCM1 PBI/FLD
MCM2 PBI FLD

The indications on this line represent the last field selected on the associated MCM panels.

MCC VAL/NVL

The indication on this line represents the status of the last command relative to the compare (VAL) or no compare (NVL) condition of a two-stage command.

G-STDN CAP

No longer used.

Comp Status

The indication on this line shows the status of a two-stage command. The following entries will appear.

TWO - two stage command
COMP - Valid compare, replaced "Two"
DREJ - Data reject
TREJ - Telemetry reject

POCC Source

The indication on this line is an acronym representing the last remote POCC station initiating a command.

POCC AUTO RTX

The indication on this line represents the selection mode for POCC AUTO RETRANS (retransmit) on the Payload command console CCM module.

POCC CAP STAT

The indication on this line represents the validation status of a command initiated from a remote POCC station.

Site Selected

The indications on this line is an acronym representing the STD site or TDRS selected as a command link.

Site Status

The indication on this line represents the GO or NOGO status of the selected site.

The table at the bottom of the display represents abort information.

Abort Toggle Switch

There are two consoles in the MCC that have an abort toggle switch: Flight Director and Flight Dynamics Officer (FDO).

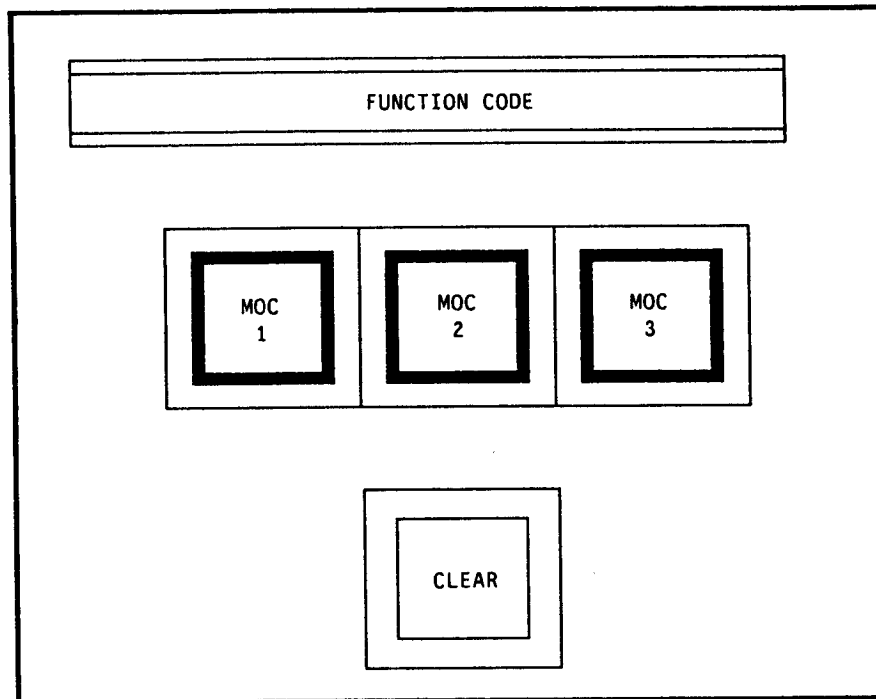
Both switches are interfaced to the MOC through the CCIM and DCIM equipment. An abort toggle switch is a safed lever-lock switch that is used to signal the crew of an ABORT condition during ascent. Through this switch, the Flight Director and/or the FDO can access the abort command resident in the MOC. Once initiated, the command overrides all other commands and is sent 50 times per second until the switch is released. After being processed by the GPC, the abort command causes an "ABORT" indicator visible to the Commander to illuminate. (At the same time, the CAPCOM should make a verbal announcement of the abort to the crew on the air-to-ground links.) The crew responds by performing the appropriate abort procedure.

Function Code Select Module (FCSM)

This module has three function-select PBIs (MOC 1, 2, or 3) and one function-clear PBI.

This module is used to select the MOC that has been designated for the flight being supported for command. This function was primarily designed for use during the STS Operations phase (multiple vehicle support). Functionally, this module puts a generic code in all command inputs for acceptance by the MOC selected. MOC 1 and 3 may be used for non-secure operations; only MOC 2 is used for secure operations.

The interface for this module is through the CCIM. If the proper selection is not made on this module, commands cannot be initiated. Refer to figure 3-7.



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Figure 3-7.- Function code select module.

Multiple Command Module (MCM)

This module allows its user to select one of twelve fields, each of which provides 32 PBIs for RTC or command load transmission. A total of $32 \times 12 = 384$ RTCs or command loads may be selected. Ordinarily, load fields are broken up into predefined load types and RTC fields are separated into categories related to subsystems. However, loads and RTCs can be combined on the same module and in the same field. The functions are defined premission. The module pictured in figure 3-8 is an example of a field of Ku-Band commands.

		S-BAND ANT, PA PREAMP FM SYS	S-BAND NSP XPHDR	CCTV HARDWARE	CCTV SELECTS	CCTV FUNCTION
CLEAR	Ku BAND	OPS 1 RECORDER	OPS 2 RECORDER	PAYLOAD RECORDER	PAYLOAD PSP INTGR	PAYLOAD FREQ SELECT

KU A COMM PWR ON 4102	KU A COMM PWR STBY 4103	KU A COMM PWR OFF 4101	KU UL DATA COMM A 4110		KU A ANT GPC ACQ 4104	KU A ANT GPC DESIG 4105	KU A ANT AUTO 4106
KU B COMM PWR ON 4112	KU B COMM PWR STBY 4113	KU B COMM PWR OFF 4111	KU UL DATA COMM B 4120		KU B ANT GPC ACQ 4114	KU B ANT GPC DESIG 4115	KU B ANT AUTO 4116
HDR OFF 4121	HDR PL MAX 4122	HDR PL INT 4123	HDR PL ANLG 4124	HDR PL DIG 4125	HDR TV 4126		KU/S FAIL- SAFE ENABLE 4140
LDR OFF 4131	LDR RCDR 4132	LDR OPS RCDR 4133	LDR PL DIGI 4134	LDR PL INIT 4135			KU/S FAIL- SAFE ENABLE 4141



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Figure 3-8.- Example of MCM PBI field.

In order to transmit commands from this module, the following configuration must exist:

- a. Console must be flight-enabled.
- b. Proper vehicle must be selected.
- c. CCM must be in the enable mode.
- d. Proper field on the MCM must be selected.
- e. Desired PBI must be pressed.

Neither RTC mode nor the load mode need to be selected on the CCM to transmit a command from the MCM.

If two-stage is selected on the CCM, an RTC or command load transmitted from the MCM will be uplinked two-stage. If single-stage is selected on the CCM, an RT transmitted from the MCM will be uplinked single-stage. The single-stage/two-stage PBI on the CCM is usually left in single-stage so that RTCs can be sent single-stage from the MCM. (Command loads transmitted from the MCM are always two-stage.)

Digital Select Module (DSM)

The DSM is an 18-PBI module used to select DSM numbers for commands. Its operator can initiate a command that is selected on the DSM and initiate any of the six special command functions on the DSM panel. All loads are assigned a five-digit DSM code. RTCs are assigned a four-digit DSM code. The vehicle address is assigned a three-digit DSM code.

The DSM PBIs interface with the MOC through the CCIM. The indicators in the PBIs are controlled by the DDDs. The functions of the DSM PBIs follow figure 3-9.

RTC INITIATE	LOAD INITIATE	W-B-W INITIATE	SPC BUFFER CLEAR EXECUTE	COMMAND TERMINATE	TWO STAGE CLEAR EXECUTE
0	1	2	3	4	COMPARE INITIATE
5	6	7	8	9	TWO STAGE BUFFER EXECUTE

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Figure 3-9.- Digital select module.

RTC Initiate PBI

This PBI will be illuminated if the console is flight selected, command enabled, and if the CCM is in the RTC mode and enabled. The depression of the RTC initiate PBI initiates RTCs or MRTCs that have been selected on the DSM.

Load Initiate PBI

This PBI will be illuminated if the console is flight selected, command enabled, and if the CCM is in the load mode and enabled. The depression of the load initiate PBI initiates command loads that have been selected on the DSM.

W-B-W Initiate PBI

CAUTION

Do not uplink a W-B-W initiate to the BFS MF. Worst case condition may cause an unidentified memory location to be modified without an error condition being annunciated.

This PBI will be illuminated if

- the console is flight-enabled,
- the CCM is enabled,
- a TSC command has been transmitted,
- command word number 1 is good,
- and there is a miscompare in the TSB.

The depression of this illuminated PBI will retransmit those words that did not compare. This function is not valid for buffer clear or buffer execute commands that did not compare. The operator may repeat as many W-B-W corrections as necessary to obtain a valid compare. The miscompares can be identified by viewing the appropriate UPLINK VERIFY display. Ground software is incapable of generating a W-B-W command for payload throughput commands (TPCs). (See the payload section of this book for an explanation of TPCs.)

Compare Initiate PBI

This PBI will be illuminated when the console is flight selected, command enabled, and if the CCM is enabled. If the compare initiate PBI is illuminated, the depression of this PBI from the same console will reinitiate only the ground software comparison routine. If there was a miscompare due to a dropout in the downlink telemetry and the reinitiated compare is successful, the load may be executed either automatically or manually. Neither the command nor any of the words in the command will be retransmitted as a result of depressing the compare initiate PBI. This function is only valid from the console that initiated the command.

Command Terminate PBI

The command terminate indicator is illuminated when the console is flight-enabled and the console CCM is in the enable mode. The command terminate initiate PBI only terminates the ground two-stage processing and terminates any ground processing associated with a TSC initiated from the same console, that is, auto compare. Command terminate will stop an auto execute from being transmitted if it is initiated before the ground TSB compare routine is complete.

CAUTION

If a command has been loaded into the Orbiter TSB, the command terminate will not clear the buffer. Therefore, caution must be used. Example: Another console could manually execute a TSB which has a miscompare in the MOC.

TSB Clear Execute PBI

This TSB clear execute indicator is illuminated when the console is flight selected, command enabled, and the CCM is in the enable mode. The TSB clear execute PBI initiates a command to the Orbiter which clears the contents of the TSB of the addressed onboard computer. Another command console cannot clear or command to an active TSB unless the console that initiated the TSC executes the TSB, clears the TSB, or does a command terminate.

SPC Buffer Clear Execute PBI

The SPC buffer clear execute indicator is illuminated when the console is flight selected, command enabled, and the CCM is in the enable mode. The SPC buffer clear execute PBI initiates a command which clears the Orbiter SPC buffer of the MF/computer that is addressed. This command will clear out all commands in the buffer that are awaiting execution.

TSB Execute PBI

The TSB execute indicator is illuminated when the console is flight selected, command enabled, and the CCM is in the enable mode. The TSB execute PBI initiates a command that transmits the contents of the Orbiter TSB to the vehicle system addressed by the TSC.

DSM Numerical PBIs (10)

These PBIs (0 through 9) are used to call up the required DSM code numbers for either the RTC, load, or vehicle ID desired. The readout of this code appears on the DRM and on MSK 2663 upon depressing these PBIs.

Configuration Control Module (CCM)

The CCM is an 18-PBI module that is used to configure the mode of command operation that will be used. The following is the functional description of the PBIs on the CCM.

The CCM PBIs interface with the MOC through the CCIM. The indicators in the PBIs are controlled by the DDDs. See figure 3-10.

ENABLE	LOAD MODE	VEH SEL MODE	AUTO EXECUTE	SINGLE STAGE	
DISABLE	RTC MODE		MANUAL EXECUTE	TWO STAGE	AUTO RETRAN
MF SM	MF G&C	GPC 1	GPC 3	GPC 5	TEC BUFFER CLEAR
MF PL	MF BFS	GPC 2	GPC 4	GPC ALL	
MDM 1	DEU 1	DEU 3		DSM SELECT	VERIFY CLEAR
MDM 2	DEU 2	DEU 4		DSM CLEAR	

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Figure 3-10.- Configuration control module.

CCM Enable/Disable PBI

This PBI controls all command initiation devices on the console, that is DSM, MCM, and so on.

When in the disable mode, any attempt to initiate a command uplink will result in the request being discarded. All configurations and selected functions are valid in the disable mode.

Uplink initiates are valid only in the enable mode.

CCM Load/RTC Mode Control PBI

This load/RTC mode control PBI controls the types of execute requests that are made from the DSM. The load mode position of the PBI allows the operator to select a five-digit number from the DSM. This mode also illuminates the valid functions of the DSM that are legal when in the load mode. These functions are load initiate, command terminate, TSB execute, TSB clear, and SPC buffer clear.

The RTC mode position of the PBI allows the operator to select a four-digit RTC number from the DSM. Selection of RTC also illuminates the only other valid functions on the DSM, which are the RTC initiate and the SPC buffer clear.

CCM Vehicle Select Mode Control PBI

This PBI selects the vehicle ID. The vehicle ID is a section of the command structure that is to be uplinked. The depression of this PBI will deselect the RTC or load mode and clear any previously selected vehicle ID. After depressing vehicle ID, the desired vehicle is selected on the DSM with a three-digit code. This PBI only functions in the CCM disable state.

If the vehicle code selected on the DSM is incorrect, the DSM select indicator will illuminate red. This means the vehicle code selected does not match the vehicle supported by the MOC. If the operator ignores the red indicator, a command can still be initiated. However, an INVALID error message will occur and the command will not be transmitted.

CCM Auto Execute/Manual Execute Modes

This PBI selects the TSC uplink mode.

TSCs transmitted in the auto execute or manual execute mode will be verified by the ground by comparing the transmitted command data and the downlisted telemetry of the contents of the TSB. If the auto execute mode is selected and the

uplink and downlink compare, the ground command application software in the MOC will automatically transmit the TSB EXECUTE command. If manual execute mode is selected, the operator must transmit the BUFFER EXECUTE command by depressing the TSB execute PBI.

Multicommand (chained) loads being transmitted in the auto execute mode will be automatically compared. If the compare is valid, the BUFFER EXECUTE command will be automatically transmitted. When the BUFFER EXECUTE command is verified, the next command in the chained load will be automatically uplinked, and the sequence will continue until all the commands in the chain are transmitted. In the manual execute mode, the operator must transmit another command, such as TWO-STAGE BUFFER EXECUTE or TWO-STAGE BUFFER CLEAR, to complete/continue the sequence.

The two-stage uplink buffer/downlink telemetry (TLM) verification time delay is fixed at three seconds at the initialization of the MOC command application software. This means that a 3-second time delay between the two-stage uplink initiate and downlink TLM verification is established before a count of five compare cycles starts. This time delay is variable from one to nine seconds. INCO can request COMMAND to adjust the delay time if required.

CCM Single-Stage/Two-Stage Mode PBI

This mode control PBI is applicable to any command that is prestored as a single-stage command. It is normally only applicable to RTCs and MRTCs. This PBI should normally be left in the single-stage position until the operator desires to uplink an RTC two-stage.

The selection of this PBI identifies to the ground software the mode in which the command is to be uplinked, single-stage or two-stage. The ground software attaches the applicable OP code identifier to the uplinked command. The OP code identifier routes the command to either the SSB or TSB as applicable.

Auto Retransmission Select PBI (POCC)

While in two-stage mode, automatic retransmission is valid for either the manual or auto execute mode. When the automatic retransmission mode has been selected for the POCC command uplink, the software shall automatically retransmit the entire command a maximum of three times should the downlink verification indicate a noncompare, that is, data reject. A TWO-STAGE BUFFER CLEAR command is automatically uplinked after each noncompare prior to retransmission. This PBI is only valid for POCC commands.

CCM MF ID PBIs

These PBIs are used to select the data content of the MF field of the uplink format. The major functions selectable by INCO/COMM SUPPORT/INST are SM-MF, GNC-MF, BFS-MF, and P/L-MF.

GPC 1-5 and GPC ALL ID PBIs

These PBIs are used to select the GPC (1, 2, 3, 4, or 5) that is to receive the transmitted command. The GPC ALL PBI transmits all commands to all active GPCs. To use these GPC select functions the operator must use the manual compare routine. GPC ALL is the only method of commanding to a redundant set. GPC ALL must be used when commanding to a computer in OPS ZERO since there is no MF in OPS ZERO.

CAUTION

Selection of a single GPC number can result in a redundant set split.
Selection of a single GPC is illegal if it is a member of a redundant set.
The onboard uplink software tests GPC number codes versus redundant status. Coordinate with the data processing system (DPS) flight controller prior to uplink to a single GPC.

TEC Buffer Clear Execute PBI

The TEC buffer clear execute indicator is illuminated when the console is flight enabled and the CCM is in the enable mode. The TEC buffer clear execute PBI initiates a command which clears the TEC buffer of the computer that is addressed.

CCM MDM Address Select PBI

This PBI is used to select either the primary or secondary RTC data set field in the MOC RTC inventory. Each RTC/DSM has two data fields. Procedurally, MDM PF1 data are located in the MDM 1 field and MDM PF2 data located in the MDM 2 field. If no data are stored in the MDM 2 location, the MDM1 data field is used for both the MDM1 and MDM2 PBI positions. Presently, only the Orbiter ground control interface logic (GCIL) commands have two data sets. The GCIL commands have location 1 loaded with the MDM PF1 address and location 2 with the MDM PF2 address. All other RTCs have data stored only in the MDM 1 location.

CCM Display Electronic Unit (DEU) Address Select PBIs

These PBIs are used to select the DEU address ID of the DEU that is being commanded. This is addressing information that is required in the uplink command format for all DEU equivalent loads. The ground is prohibited procedurally from uplinking DEU equivalents which would cause OPS transitions or major mode changes. DEU equivalent loads always require crew coordination.

The DEU equivalent command capability allows the MCC to emulate any DEU command available to the crew through the DEU. The DEU equivalent load is of fixed length, consisting of six 48-bit command words. They are valid to the GNC, SM, and OP 0. There is no DEU equivalent command capability to the BFS. Serious errors can result from incorrect DEU uplink configuration or procedures. Refer to the INCO Onboard Command System Brief for idiosyncracies concerning DEU equivalents.

CCM DSM Select/Clear PBI

The function of this PBI is to clear selected DSM numbers which appear in the readout windows on the DRM. If DRM inputs are valid, the upper half of this PBI (DSM select) will illuminate. If the inputs are invalid, for

- an invalid vehicle code,
- an invalid or nonexistent command number, or
- a safed command,

the lower half of the PBI (DSM clear) will illuminate red. The depression of this PBI will also clear the DSM logic and all of the DSM select windows on the DRM.

CCM Verify Clear PBI

This PBI is used to clear all verification indicator logic on the command modules. The type of indicators that are reset after a depression of this PBI are MCC VAL/INVAL, COMPARE/NO COMPARE, and STDN VAL/INVAL, and so on.

Digital Readout Module (DRM)

The DRM is a display-only device that provides status and configuration information. See figure 3-11.

RT SIM	FLT 0-9	FLT 0-9	FLT 0-9		SITES	SITES
ORBITER IUS P/L	VEH 0-9	VEH 0-9	VEH 0-9	TDRS GO	GO CMD NGO CMD	VAL STDN NVL STDN GRD STDN
MCC SAFE MCC OPR	CCM ENBL CCM DSBL	CON DSBL	VAL INV CONFIG INV VALIDITY INV TSLO INV SAFE CMD INV CCIM ERR	BUFF COMP DATA RJ TLM RJ		
LOAD MODE RTC MODE VEH SEL	0-9	0-9	0-9	0-9	0-9	

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Figure 3-11.- Digital readout module (DRM).

R/T or SIM

This display indicates whether the console has been selected to support a Realtime (R/T) flight or a simulation (sim).

Flt 001-255

These three indicators display the MOC flight number to which the console operator enabled the console.

Site ID

These two indicators display the site or TDRS command stream ID selected by COMMAND through which the console will command to the vehicle.

Orbiter/IUS/Payload

The MCC software will display which of these vehicles has been selected as the command destination from a particular console. The software determines this by checking the vehicle ID selected on the console.

VEH ID 001-255

These three indicators display the ID of the vehicle selected by the CCM such as 002-102 for Columbia or 003-103 for Discovery.

TDRS GO

This indicator shows that the TDRS network and MCC are properly configured and ready for commands.

GO/NO-GO (for command)

This indicator shows the status of the GN station selected for commanding. The criteria for GO are:

- the station is in operate mode
- it has antenna load
- the spacecraft command encoder (SCE) interface is good
- the appropriate exciter mode has been selected
- there is a command ready from the station.

In addition to the above criteria, the GO/NO-GO indication on the DSM requires a vehicle ID from the DSM and a site ID from the site select matrix (SSM) on the command console. COMMAND must have the flight control console flight selected (enabled). This status is invalid when commanding through TDRSS. The status indicator will always show NO-GO when the ground is configured for the throughput mode.

Note: A "go for command" voice announcement from COMMAND indicates:

- A valid uplink mode
- modulated command carrier on
- operational station command system
- equipment configured for uplink
- bit sync lock for NSP
- frame sync lock for NSP

An "UNABLE TO UPLINK" announcement indicates the station is configured for uplink as instructed but unable to uplink because of an equipment problem or loss of lock.

STDN

This indicator will no longer be valid except in the GN nonthroughput mode. In the GN throughput mode there are no GN validity checks (VAL/NVAL) or ground data rejects (GDRs). In the nonthroughput mode, it provides one of the following three indications on the command status of the GN station in use: VAL

The uplinked command passed the GN station validity check.

NVL

The command was rejected because it did not pass the GN station validity check for source, destination, flight ID, or message type.

GDR

The GN station detected a Bose-Chaudhuri-Hocquenghen (BCH) error or verify error on the command but the command was uplinked.

MCC SAFE/OPER

This indicator shows the state of the MCC command software. MCC safe indicates that the software system is not configured to uplink commands. MCC OPER (operate) indicates that the MCC command software is properly configured to uplink commands (armed).

The MCC should be safed by COMMAND whenever no commanding is required in order to prevent erroneous commands from being sent to the Orbiter. Operationally, COMMAND only safes/unsafes the command system when instructed to do so by INCO or Flight Director (through GC).

CCM ENBL/CCM DSBL

This indicator provides the status of the CCM.

CCM ENBL

Indicates the CCM panel is enabled.

CCM DSBL

Indicates the CCM panel is disabled. The console CCM disable should be selected during extended periods between commanding.

CON DSBL

Indicates that the COMMAND controller has not enabled the console. All software logic power is disabled; therefore, the CCM, DSM, and DRM will be blank, with the exception of this console disable (CON DSBL) indicator and the MCC SAFE/OPER indicator. The CON DSBL function should be used if the console is left unattended, console maintenance is in progress, or during extended loss of signal (LOS) periods in order to prevent accidental or inadvertent commanding from the console.

MCC VAL/INVAL

This indicator has a series of different indications in relation to the checks provided by the MCC software or commands. They are as follows:

MCC VAL

The MCC software has validly accepted and is processing the command initiated.

MCC INVAL

The MCC software will not accept and process the command for any one of the following reasons:

- INVC - Invalid configuration.
- INVV - Invalid validity.
- INVL - Invalid load.
- TSLO - Two-stage lockout.
- SAFE - A command that may be hazardous and that the flight controllers negate has therefore been loaded in the safed table. The command may be unsafed by the COMMAND console operator at the request of the flight controller. Individual safed commands may be viewed on MSK 2665, and safed groups may be viewed on MSK 2666.
- CCIM - The CCIM has checked the command for its validity checks and it failed.

COMP/NCOMP

These indications show whether a TSB compare was successful or unsuccessful. The indications are as follows:

COMP

The TSC has passed all compare processing in the MCC software. Allow for about a four-second delay before this indication appears; one second for network processing and approximately three seconds delay for Orbiter loop processing.

NCOMP

The TSC has failed to pass compare processing in the MCC software. The two-stage compare processing runs for up to 16 seconds before issuing a no compare.

- **TM RJ** - Indicates a failure of the compare routine due to telemetry dropouts or an absence of telemetry from the GPC MF. SM downlist is an example. TLM reject is defined as follows:
 - Two-stage uplink command initiated and downlink TLM data is not available or suspect as invalid for comparison.
 - Compare or word-by-word initiate when downlink TLM data is not available.
 - Two-stage buffer execute when downlink TLM data is not available.
 - Two-stage buffer clear when downlink TLM data is not available.
- **DATA RJ** - Indicates a failure of the compare routine because the uplinked command did not compare with the downlinked command. This is an indication of a data content error that does not result from TLM dropouts. Data reject is defined as follows:
 - Two-stage uplink command initiate and one or more 16-bit words failed to compare.
 - Compare or word-by-word initiate and one or more 16-bit words failed to compare.
 - Initiating two-stage buffer clear and one or more words in the onboard downlink buffer failed to clear (reset to zero).
 - Initiating two-stage buffer execute and one or more words in the onboard downlink buffer failed to clear (reset to zero).

CAUTION

Do not execute a two-stage buffer with a DATA RJ unless the DATA RJ occurred on the buffer execute command (b4 above). Use W-B-W correction (except with BFS) or clear the buffer and retransmit the command when this indication is received.

Load, RTC, Vehicle Mode

This indicator displays which of the three modes has been selected on the CCM.

RTC and Load DSM Indicators (0 through 9)

These indicators display the digits the operator selects on the DSM for the desired command and load. When transmitting RTCs through the DSM, the system uses a four-digit DSM number and a five-digit DSM number when transmitting loads.

Event Panels

Event panels are usually called DDD. This references the digital display drives that serve as the source of the indicators. The indicators are configured and labeled to annunciate specific events which are detected in the MOC. See figure 3-12.

PDI MSTR FRM LK 1 G L	PDI MSTR FRM LK 2 G L	PDI MSTR FRM LK 3 G L	PDI MSTR FRM LK 4 G L	TOG BUF PARITY A R	PDI 1 IN DATA INVL A R
PDI WD LK 1 G	PDI WD LK 2 G	PDI WD LK 3 G	PDI WD LK 4 G	DATA RAM PARITY A R	PDI 2 IN DATA INVL A R
PDI BIT LK 1 G	PDI BIT LK 2 G	PDI BIT LK 3 G	PDI BIT LK 4 G	FAM PARITY A R	PDI 3 IN DATA INVL A R
PDI BR ACCRCY 1 G	PDI BR ACCRCY 2 G	PDI BR ACCRCY 3 G	PDI BR ACCRCY 4 G	PCM 1.152 MHZ A R	PDI NO RSPONSE 1 A R
DCM 1 PARITY A R	DCM 2 PARITY A R	DCM 3 PARITY A R	DCM 4 PARITY A R	MTU IRIG A R	PDI NO RSPONSE 2 A R
PDI PWR ON G R	PDI SW BYPASS R	PDI WRAP R L		TMBU REJECT R	PDI NO RSPONSE 3 A R

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Figure 3-12.— Typical event panel.

Payload

Payloads onboard the Orbiter are controlled, command loaded, and monitored through the Orbiter communications system. Figure 3-13 illustrates command flow through the Payload Signal Processor (PSP) hardline or RF links.

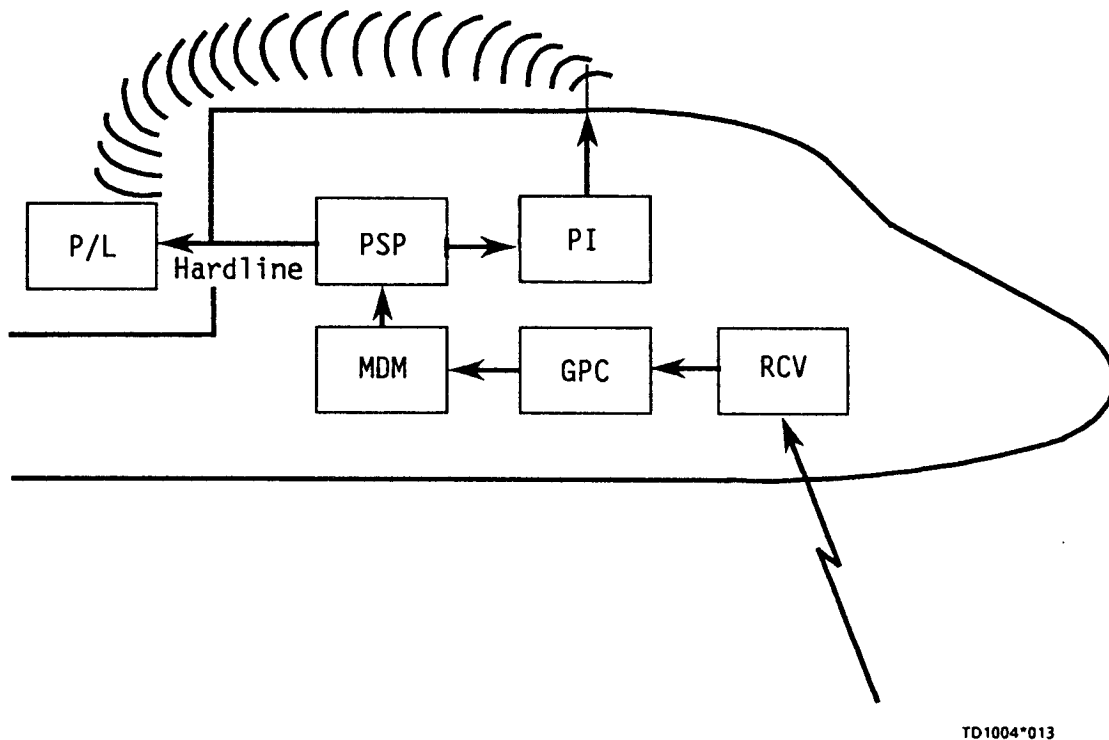
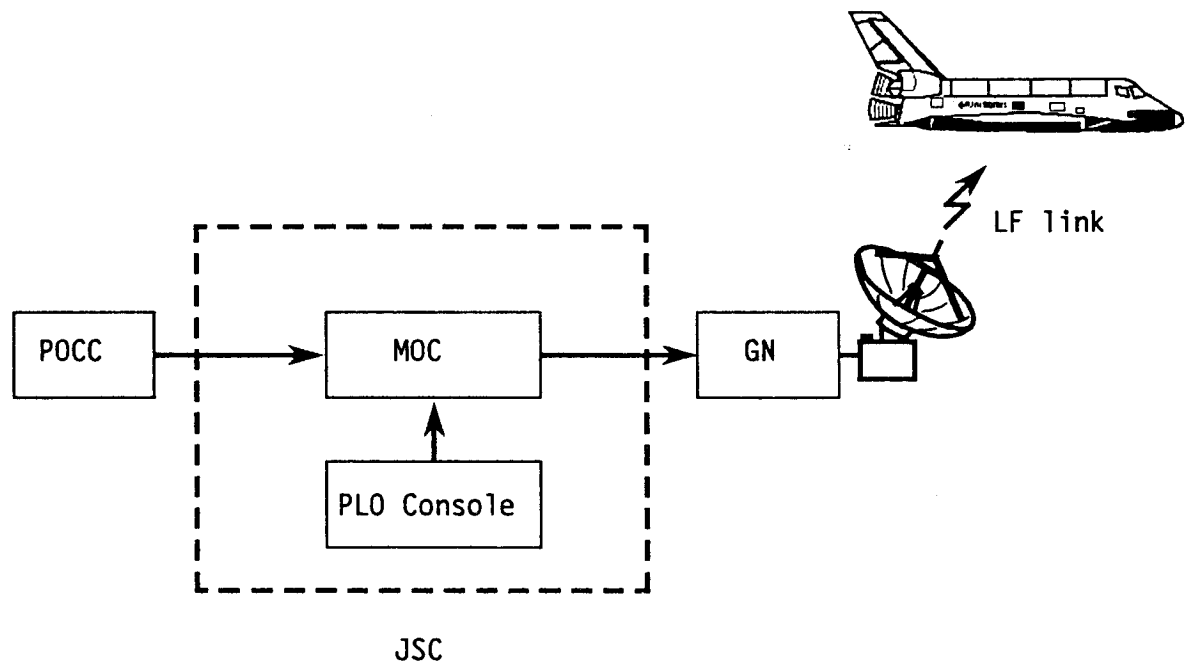


Figure 3-13.— Command flow through the payload signal processor.

Payload commands are sent from the MOC to the Orbiter in the same manner as Orbiter commands. While Orbiter commands and some payload commands are built and stored in the MOC, many payload commands are sent from a remote facility and then processed in the MOC for retransmission to the Orbiter. The remote facility is called the Payload Operations Control Center (POCC). Typical POCC locations are the Marshall Space Flight Center (MSFC) or the White Sands Ground Terminal (WSGT).

POCC commands are initiated at the remote facility and sent to the JSC MOC in standard NASCOM 48-bit blocks. (See figure 3-14). POCC commands are retransmitted by the MOC within seconds of initiation. A decimal number between 0 and 999 is assigned to the POCC facility to identify each command in the NASCOM block. This number appears on the JSC Payload Officer's (PLO) displays for reference.



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Figure 3-14. – Remote POCC command data flow.

POCC Command Processing

Refer to figure 3-15 for the following discussion of POCC command processing.

The MCC MOC command program checks the POCC command message validity and configuration. A valid message is processed by the MOC and a validation (VAL) command acceptance pattern (CAP) is automatically transmitted back to the initiating POCC station. The command message is assembled in the MOC and retransmitted to the Orbiter GPC.

An invalid command message is rejected and a MCC Ground Reject (GDR) command acceptance pattern (CAP) is transmitted back to the POCC station. The GDR CAP contains a diagnostic statement which indicates the invalid condition. Payload command processing may be done in three modes:

- Single stage
- Payload Throughput (single stage)
- Two stage

Single-Stage

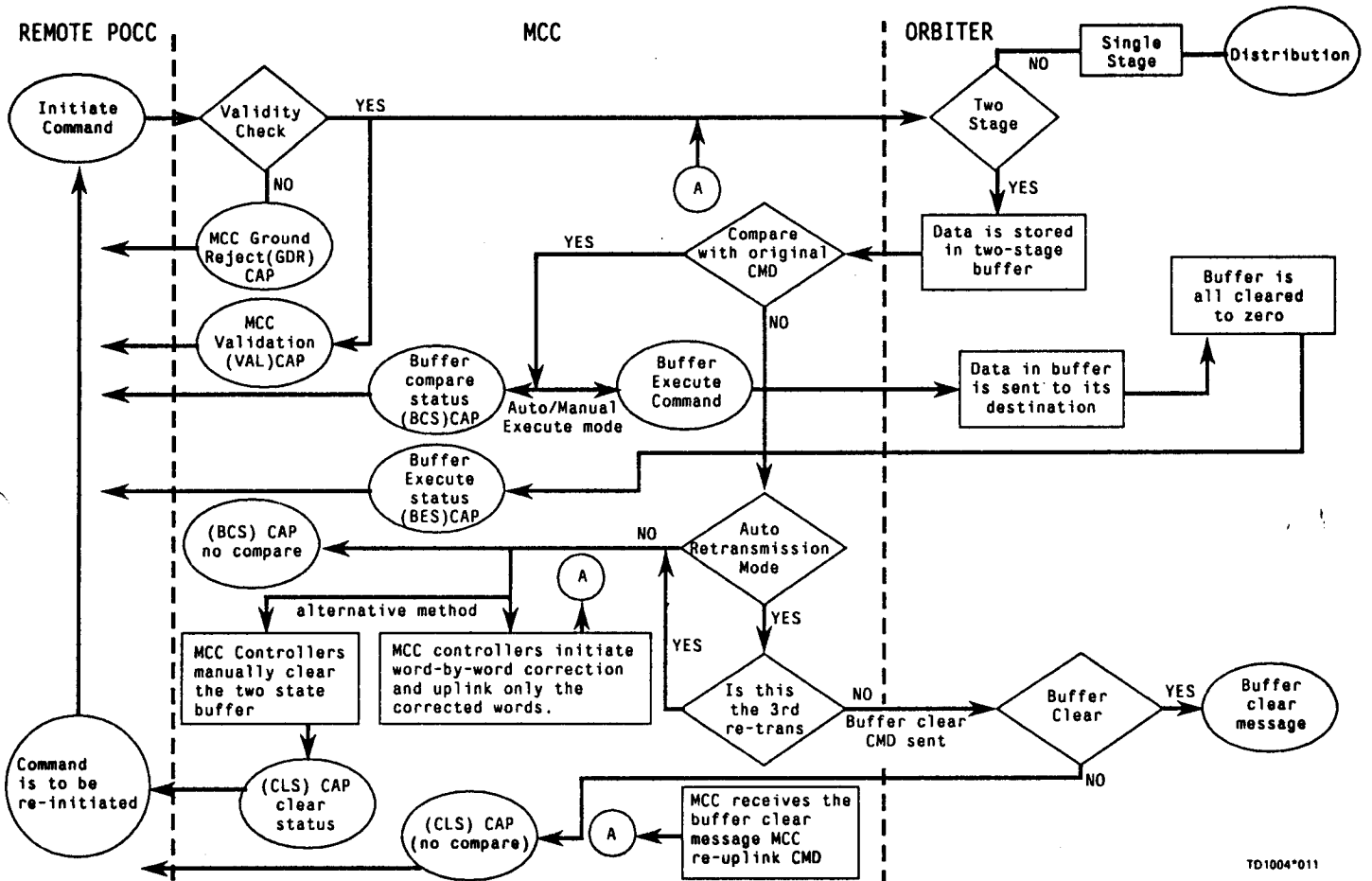
Valid single stage command messages are executed by the GPC after the destination data has been decoded. Orbiter single stage commands are executed in the same manner.

Payload Throughput (Single-Stage)

A payload throughput command uses the GPC two-stage buffer to momentarily store the command word. The throughput command is identified by the Op code which instructs the GPC to execute the accompanying command upon receipt of the last word in a sequence. Refer again to Table 2-3 in section 2 of this workbook. The last word is identified by a 0 in bit 15 and a 1 in bit 16 of the 48 bit command word.

Two-Stage

A valid two-stage command is uplinked, received by the GPC, and stored in the two-stage buffer. The GPC downlinks the command message to the MOC for comparison with the original command message. The comparison process can take up to 16 seconds. During this time if a valid comparison is found, the MOC sends a Buffer Compare Status (BCS) CAP to the POCC. If no comparison is found after 16 seconds, the MCC sends a BCS CAP (NO COMPARE) to the POCC.



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Figure 3-15. - POCC command processing functional flow.

If an uplink command fails the comparison process, the MCC Payload Officer (PLO) may respond by executing a BUFFER CLEAR or a word-by-word correction of the discrepant word.

The PLO console is normally configured for automatic BUFFER EXECUTE of POCC commands but has the option to configure for manual BUFFER EXECUTE. If the latter is chosen the command cannot be executed by the POCC controller. The command must be executed by the PLO.

The PLO has the capability to manually cancel any payload command that has not been executed.

Automatic Retransmission Capability

The MOC may be configured to automatically re-uplink, up to three times, command messages that failed the comparison check.

A command block is uplinked, and the downlink telemetry is compared as described earlier. However, if a valid comparison is not detected after 16 seconds, no BCS CAP is sent to the remote POCC. Instead, a BUFFER CLEAR command is automatically uplinked. After a buffer clear is detected in the downlink, the command is retransmitted and compared as before. If the comparison is still invalid, the process will continue.

- Until a valid comparison is detected. A BCS CAP (COMPARE) is sent to the initiating station.
- Until a single BUFFER CLEAR command fails. The command processing is terminated and a CLS CAP (NO COMPARE) is sent to the remote POCC.
- Until three retransmissions have failed. The word-by-word correction logic is manually enabled, and a BCS CAP (NO COMPARE) is sent to the remote POCC.

During the word-by-word correction process, only the 16-bit command words which did not compare are uplinked. These words overlay the words which were originally uplinked to the two-stage buffer. Therefore, a BUFFER CLEAR command is not uplinked prior to word-by-word corrections during automatic retransmissions. If the incorrect words in the two-stage buffer are not corrected by the initial word-by-word correction uplink, the uplink is retransmitted up to three times. A single valid comparison of the entire command stops the process and causes an BCS CAP (COMPARE) to be sent to the initiating station. Otherwise, a BCS CAP (NO COMPARE) is sent.

Two-Stage Lockout

From the time a valid two-stage command is received by the MOC from an initiating station until it is executed or cleared from the two-stage buffer, all other two-stage commands are rejected by the MOC. This condition is called two-stage lockout. This prevents an incoming message from destroying a message awaiting two-stage verification in the buffer. If a two-stage command is sent during two-stage lockout, a GDR CAP message will indicate the reason for rejection.

Hazardous Commands

The existing MOC system checks for hazardous commands by comparing the incoming command message, embedded in the NASCOM 4800-bit block from the remote POCC, with a table of twenty prestored hazardous command messages. If a comparison is found, the entire NASCOM block is discarded. The constraint to this system is that only one hazardous command is allowed per NASCOM block.

Parallel to the above system check is an upgraded package of capabilities such that the remote POCC can send multiple hazardous command of the same length or multiple hazardous commands of different lengths in the same command message.

Command Acceptance Pattern (CAP) Messages

Throughout the command sequence, the MOC transmits CAP messages to the remote POCC for validating and tracking remote-POCC-initiated commands through the STS system. As previously described four events can cause a CAP message transmission from the MOC to the POCC. These are:

- MOC validation processing, which is the arrival of the command message at the MOC (VAL CAP or GDR CAP)
- Two-stage verification processing, which verifies the command message in the Orbiter two-stage buffer (BES CAP).
- Two-stage buffer execute processing, which transmits the command message from the Orbiter two-stage buffer (BCS CAP)
- Two-stage buffer clear processing, which clears the command message from the Orbiter two-stage buffer as the result of manual intervention by the MCC controller (CLS CAP).

Verification of Payload Command Execution

The command system can only validate the command process through the MOC and the Orbiter. You must examine your payload telemetry for confirmation that the command was executed.

Payload Real-Time Command History

The MOC can provide a real-time command history to support POCC in command reviews. A remote POCC real-time command history summarizes up to 75 entries of the most recent payload command activities available to the MCC real-time mission program. Transmission of a real-time command history to a remote POCC is initiated manually by the MCC command console. It is normally provided within 15 minutes of a voice request from POCC. If a complete history is desired and consists of more than 75 entries, POCC is responsible for requesting the appropriate number of transmissions at regular time intervals to ensure completeness.

Command Testing

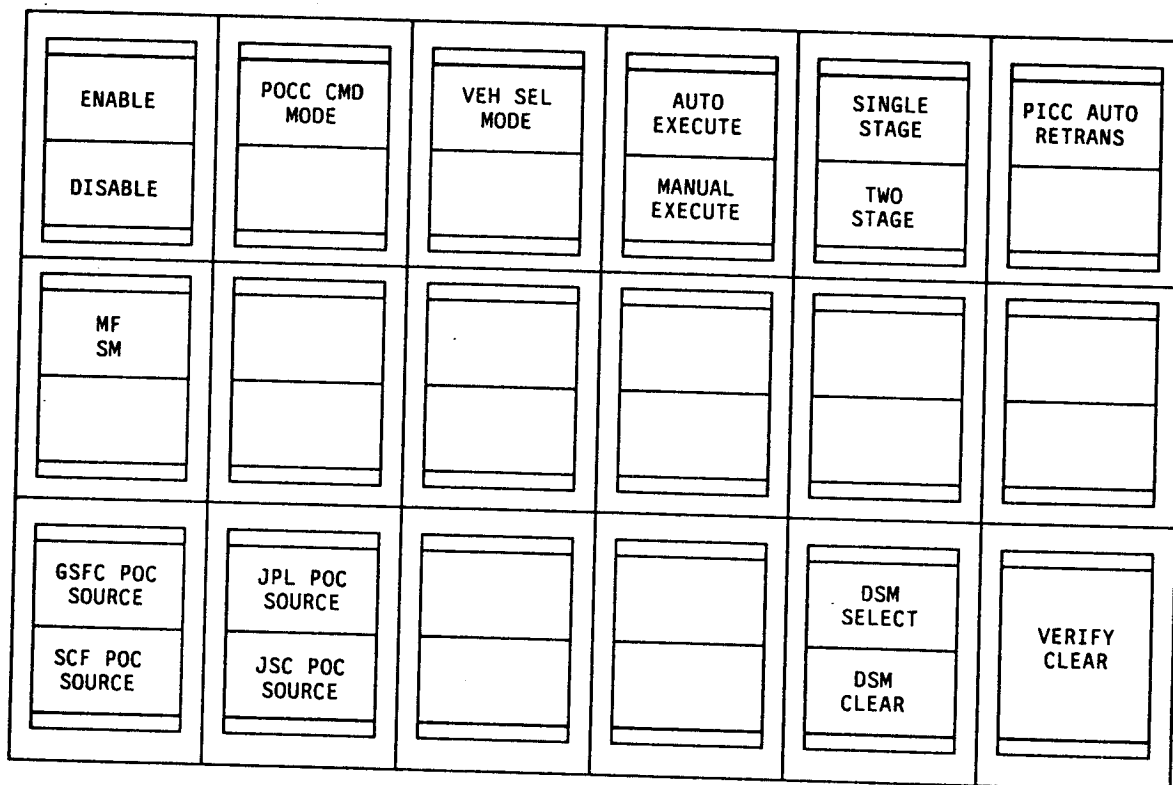
To verify the MCC/POCC command interface, a test command is transmitted from the POCC to the MCC. The MCC does not uplink these test commands to the Orbiter but will respond to the POCC with a CAP message. This test command is used during prepass interface validation.

POCC Panels and Displays

The panels used by the PLO are similar to those used by the INCO, except that they control payloads only. The following explains some of the features of the payload panel differences.

Configuration Control Module (CCM)

The payload officer (PLO) configuration control module (CCM) is shown in figure 3-16.



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Figure 3-16. – Payload officer configuration control module.

POCC CMD MODE/VEH SEL MODE

The POCC command mode and vehicle select mode PBIs are mutually exclusive.

If POCC CMD MODE is selected, the associated console (if enabled) is configured to select and transmit payload RTC command loads. The lower left indicator on the digital readout module (DRM) will also display POCC CMD MODE.

If VEH SEL MODE is selected, the PLO console is configured to select the payload to be commanded. The payload is identified by a three-digit decimal number which is entered on the digital select module (DSM) panel. The selected number is displayed on the DRM VEH ID indicators. This selection will appear in the command word for routing purposes when the command is processed in the GPC.

POCC AUTO RETRANS

The POCC Automatic Retransmit PBI controls the activation or deactivation of the automatic retransmission capability discussed earlier. If this PBI is illuminated, the MOC will retransmit an invalidated command three times automatically unless terminated by the PLO.

POCC SOURCE

The four split PBIs in the lower left corner of the CCM are used by the PLO to select the POCC station from which the MOC will accept payload commands.

Refer again to figure 3-18. Examples of POCC stations are shown. However, the actual station represented by the PBI half is selected with a MED entry by the INCO. POCC CRT display MSK 2662 identifies these selections. Since there may be more than one console under the responsibility of the PLO, the configuration for each console is represented.

The POCC station selection is visible on the DRM POCC SOURCE indicator (second row from the bottom, second from the right.)

Digital Select Module (DSM)

All selections on this panel are the same as INCO, except that they pertain to payload commands only. See figure 3-17.

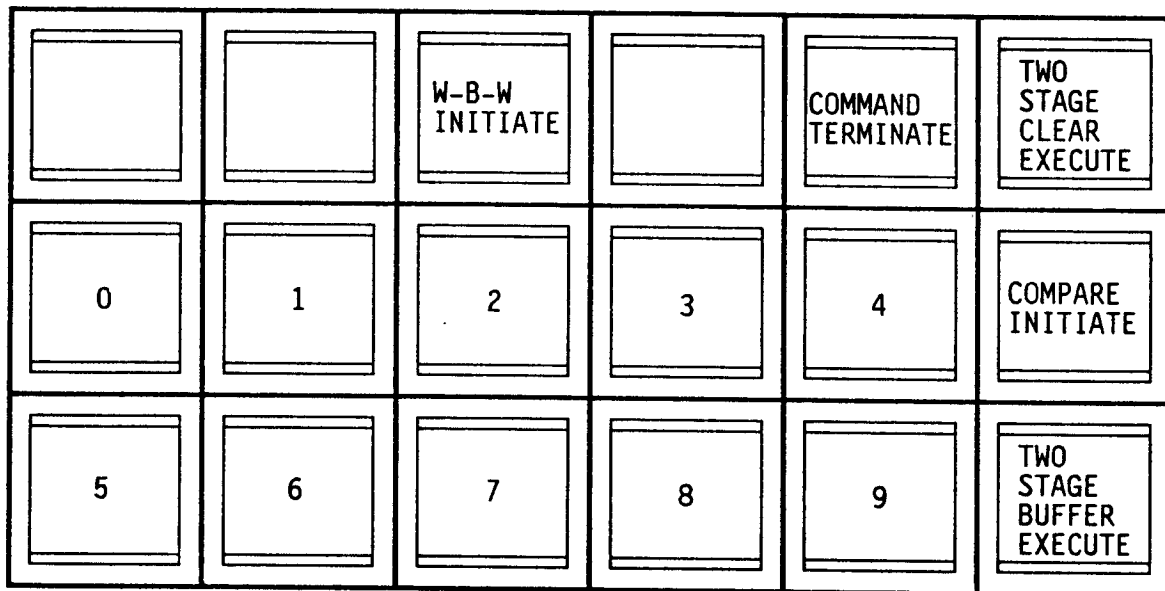


Figure 3-17. – Digital select module.

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Digital Readout Module (DRM)

The digital readout module is shown in figure 3-18.

RT SM	FLT 0-9	FLT 0-9	FLT 0-9		MIL IOS BDA MAD ORR	GWM HAW GDS QUI PDL	AGO ETC ACN BUC TDRS VEH 1 TDRS VEH 2
IUS PAYLOAD	VEH ID 0-9	VEH ID 0-9	VEH ID 0-9		GO NGO	STDN: VAL NVL GDR	
MCC SAFE MCC OPER	CCM ENBL CCM DSBL	CON FLT DSBL	INVC CCIM INVV MCC VAL TSLO SAFE	TWO STAGE COMP DATA RJ TM RJ	POC SOURCE GSFC JPL JSC SCF	POC CAP VAL GDR BCS CLS BES	
POC CMD MODE VEH SEL MODE	0-9	0-9	0-9	-0-9	-0-9		

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Figure 3-18. – Digital readout module.

The top row of indicators is identical to that of the INCO DRM.

The IUS/PAYLOAD indicator on the second row normally indicates "PAYLOAD". The VEH ID numbers to the right indicate the specific payload.

The third row right and indicator displays the Command Acceptance Pattern (CAP) information which is sent back to the POCC station after command initiation.

The indicator second from the right on the third row shows the POCC station identification.

All other indicators in row three are the same as INCO, except that they relate to payload commands.

Row four indicators display the the POCC command number or the payload number depending on the indication displayed on the left most indicator.

If POCC CMD MODE is selected on the CCM the left most indicator displays POC CMD MODE and the numbers to the right indicate the payload command which has been selected on the on the DSM.

If VEH SEL MODE is selected on the CCM the left most indicator displays VEH SEL MODE and the numbers to the right represent the payload being commanded.

MSK Displays

The PLO has several MSK displays that provide status information. Illustrated are seven of these displays and an explanation of each.

POCC History MSK 3434. The POCC history display lists payload commands as they are transmitted. The last command sent is at the top of the list. See figure 3-19.

GMT

The GMT column displays the Greenwich Mean Time at which the command was initiated.

CON SRC

The Console/source column lists the payload console or POCC station from which the command was initiated.

STA

The station column lists the ground station or satellite through which the command was routed. VEH1 represents the East TDRS.

ORB/CMPT

The Orbiter Computer column lists the major function to which the command was addressed.

S = SM

G = GNC

P/L VEH

The Payload Vehicle column lists the payload to which the command is directed. This number is selected on the PLO DSM in the vehicle select mode. This number is also visible on the DRM bottom row.

CMD NR

The command number identifies the command sent by the POCC station.

F/V 126/103

POCC HISTORY

RR3434A CH063

PAGE 1 OF 3

GMT	CON SRC	STA	ORB/ CMPT	P/L VEH	CMD NR	1 2	NR WD	FUNC	AR M	POC CAP	MCC COMP	MCC NDX
49:17:14:35	WSGT	VH1	S	10	11	1	50	CMD	M	VAL	TWO	172
49:17:13:26	WSGT	VH1	S	10	10	1	50	HAZ	M	GDR		0
49:17:02:19	PLD	VH1	S	10	9			TERM	M			0
49:16:55:05	WSGT	VH1	S	10	9	1	50	CMD	M	BCS	TMRJ	122
49:16:45:59	WSGT	VH1	S	10	8	1	50	CMD	A	VAL	THRU	118
49:16:45:15	WSGT	VH1	S	10	7	1	50	CMD	A	VAL	THRU	116
49:16:42:39	PLD	VH1	S	10	6			EXEC	M	BES	COMP	111
49:16:42:20	WSGT	VH1	S	10	6	2	50	CMD	M	BCS	COMP	109
49:16:40:57	PLD	VH1	S	10	5			EXEC	A	BES	COMP	105
49:16:40:51	WSGT	VH1	S	10	5	2	50	CMD	A	BCS	COMP	103
49:16:37:55	WSGT	VH1	S	10	4	1	50	CMD	A	VAL	THRU	98
49:16:34:49	WSGT	VH1	S	10	3	1	50	CMD	A	VAL	THRU	95
1:02:55:49	WSGT	VH1	S	10	2			TEST	M	GDR		0
1:02:54:15	WSGT	VH1	S	10	1	1	25	CMD	M	GDR		0

Figure 3-19. - POCC history.

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This column indicates either a single stage (1) or two-stage (2) command initiation.

NR WD

The decimal number in this column identifies the number of 16-bit command words in an incoming POCC block.

FUNC

The code listed in this column identifies the function being performed by the initiated command. The text for each code is listed below.

CMD	-	Payload uplink command
TEST	-	Test message
EXEC	-	Two-stage buffer execute command uplink
CLCR	-	Two-stage buffer clear execute command uplink
WBW	-	Word-by-word uplink execute
TERM	-	Command terminate function
COMP	-	Two-stage buffer compare function
HAZ	-	Hazardous command or discrete detected
XCES	-	Command rejected due to excessive input rate
RI	-	Command rejected due to RI code enable/disable checks
User	-	Command rejected due to user record validation of RIW or NRIW

ARM

The code listed in this column identifies the execution mode (A = auto, M = manual) under which the associated command was initiated. The selection is made on the PLO console CCM.

POC CAP

The codes listed in this column identify the command acceptance pattern responses which have been transmitted to the initiating POCC station (See also figure function flow). The text for each code is listed.

VAL	-	indicates the incoming POCC command has passed the MCC validity check.
BCS	-	indicates the MOC has detected a successful compare of a two-stage command. This code will overlay the VAL code when it occurs.
CLS	-	indicates that a two-stage buffer clear command was executed.
BES	-	indicates that a two-stage buffer execute was transmitted
GDR	-	indicates that a ground data request message has been sent to the POCC station

MCC COMP

The codes listed in this column indicate the results of the MCC two-stage buffer compare or that a single-stage command was transmitted.

- COMP – indicates a successful two-stage compare.
- DRJ – indicates a command data reject due to a two-stage buffer mismatch.
- TMRJ – indicates a command data reject due to loss of telemetry
- THRU – indicates a payload single-stage throughput command was executed.
- SNGL – indicates a single-stage command was transmitted

MCC NDX

The MCC command index column displays a three-digit decimal number which identifies the associated command in the POCC NASCOM block.

CMD Tracking MSK 0910.

CMD tracking MSK0910 is shown in figure 3-20.

This display is described in detail in the INCO section. Only the POCC entries on this display are described in this section.

CSL/SRC

EW 26/99 CMD TRACKING RDD910004017
 PG 1/4

GMT	CSL SRC	STA	M	DSM F	LOAD	COMMAND TITLE	COMP RSLT	CAP	CMD IDX
22:03:16:28	COM	VH2	S	4060		BUFFER EXECUTE	COMP		207
22:03:16:23	COM	VH2	S	12105		STDN */TDRS */STDN	COMP		208
22:03:16:17	PLD	VH2	S	4060		BUFFER EXECUTE	COMP		209
22:03:16:01	COM	VH2	S	4063		SPC BUFFER CLEAR	SNGL		205
22:03:15:39	COM	VH2	S	12105		STDN */TDRS */STDN	TSLO		0
22:03:15:12	WSGT	VH2	S	1		POCC COMMAND	COMP		203
22:03:15:09	COM	VH2	S	4063		SPC BUFFER CLEAR	SNGL		201
22:03:07:16	COM	VH2	S	4415		DPS 2 RCD SERIAL A	SNGL		199
22:03:06:04	COM	VH2	S	4781		FM SYSTEM 1/2 - OFF	SNGL		198
22:03:05:46	COM	VH2	S	4451		DPS 2 STOP	SNGL		197
22:03:01:14	IN1	VH2	S	4060		BUFFER EXECUTE	COMP		196
22:03:01:10	IN1	VH2	S	12543		PDI DCM3 FDA ENA/INH	COMP		195
22:03:00:58	COM	VH2	S	4417		DPS 2 PLBK SERIAL	SNGL		194
22:03:00:58	COM	VH2	S	4427		DPS 2 SPEED 120 IPS	SNGL		193
22:03:00:36	COM	VH2	S	4451		DPS 2 STOP	SNGL		192
22:03:00:34	COM	VH2	S	4315		DPS 1 RCD SERIAL A	SNGL		191
22:03:21:44	COM	VH2	S	4351		DPS 1 STOP	SNGL		189
22:03:21:33	COM	VH2	S	4415		DPS 2 RCD SERIAL A	SNGL		188
22:03:04:04	COM	VH2	S	4451		DPS 2 STOP	SNGL		186
22:03:03:56	COM	VH2	S	4415		DPS 2 RCD SERIAL A	SNGL		185
22:03:03:55	COM	VH2	S	4401		DPS 2 TRACK 1 - SEL	SNGL		184
22:03:03:52	COM	VH2	S	4451		DPS 2 STOP	SNGL		183
22:03:03:26	COM	VH2	S	4515		P/L RCD SERIAL A	SNGL		182
22:03:03:25	COM	VH2	S	4527		P/L SPEED 2 - SEL	SNGL		181
22:03:03:24	COM	VH2	S	4501		P/L TRACK 1 - SEL	SNGL		180
22:03:03:16	COM	VH2	S	4551		P/L STOP	SNGL		179
22:03:03:00	COM	VH2	S	4556		P/L REWIND EOT	SNGL		178

Figure 3-20. – Payload uplink command tracking.

This column (CSL) displays a three digit console number or a four character source (SRC) identification to show where the listed command was initiated.

DSM LOAD

For payload commands a 1 to 3 digit number is listed to identify the POCC command in the MOC.

COMMAND TITLE

When a payload command is initiated, the acronym "POCC" will appear in this column.

CMD IDX

For POCC commands the NASCOM output block index number is displayed.

Command System Monitor Display MSK 2667.

This display is a summary of information on MSK 0910, MSK 2669, and MSK 2663. The top listing on this display is shown in figure 3-22. It represents the nine most recent entries on MSK 0910.

The application advisory listing represents the six most recent entries on MSK 2669. These entries are generated when a command fails an MCC check. They provide a quick-look advisory of why it failed.

FN

"F" is a three-digit decimal number representing the flight number.

"V" is a three-digit decimal number representing the vehicle number.

CCIM FNC CD

The CCIM function code is a single digit decimal number CCIM software function derived from display MSK 2668.

PROG VER/DATE

The program version and data indication is derived from display MSK 2668.

F/V 116/104 CMD SYSTEM MONITOR RR2667BCH042
 CCIM FNC CD: 4 TOT CCIM CT: 2691
 SDP NO.: 2 TEST SITE SEL: VH2
 PROG VER/DATE: 72.19 87251 SYSTEM MODE: OPERATE

GMT	CSL	STA	F	DSM	COMMAND TITLE	RSLT	CAP	IDX
50:18:06:01	COM	VH2	S	4415	OPS 2 RCD SERIAL A	SNGL		130
50:18:06:01	COM	VH2	S	4429	OPS 2 SPEED 15 IPS	SNGL		129
50:18:06:00	COM	VH2	S	4407	OPS 2 TRACK 71 - SEL	SNGL		128
50:18:05:50	COM	VH2	S	4451	OPS 2 STOP	SNGL		127
50:18:05:48	ST1	VH2	S	4060	BUFFER EXECUTE	COMP		126
50:18:05:38	ST1	VH2	S	80310	BATT 1 K1 OPEN A PRI	COMP		125
50:18:05:26	COM	VH2	S	4456	OPS 2 REWIND EOT	SNGL		124
50:18:05:16	COM	VH2	S	4451	OPS 2 STOP	SNGL		123
50:18:04:12	COM	VH2	S	4457	OPS 2 REWIND BOT	SNGL		122

APPLICATION ADVISORY

18:05:13	116R	ST1	DSM	002	INV LD NR	RJ	
17:58:26	116R	RTC	ADVS	016	UNASSIGNED PBI	FC4	AC0100008
17:42:08	116R	ST1	02903		DSM CMD TERM		
17:41:51	116R	ST1	02903		DATA REJECT	RJ	
17:23:02	116R	RTC	ADVS	016	UNASSIGNED PBI	FC4	AC0100008
17:04:22	116R	IC2	12110		DSM CMD TERM		

CONSOLE STATUS

IC2	COM	CO1	IN1	IN3	PL2	ST1	PLD	STD	PO2	DAT				FO2	PO2
ENB	ENB	DSB	ENB	DSB	ENB	ENB	DSB	ENB	DSB	DSB				DSB	DSB

TDRS HARDWARE STATUS

TDRS	SAT	HDR	LDR	TAGS	SEL	KU	MOD	S	MOD	CONTROL
TDRS VH1	EAST	72K	32K	JSC	1A	ON		ON		CNSL1
TDRS VH2	EAST	72K	32K	JSC	1B	ON		ON		NOM 1
TDRS SIM	SPARE	72K	72K	JSC	2A	ON		OFF		CNSL1

STREAM ID

VH1	VH2	VH3	VH4	VH5	VH6	VH7	VH8	FLT	TYPE	TIME	ENCODE
1	104	0	0	0	10	0	0	0	114	RR	ENB

Figure 3-21. - Command System Monitor display.

TEST SITE SEL

The test site select indication displays a four character acronym identifying the remote site selected for testing. This indication is derived from display MSK 2663.

SYSTEM MODE

The text here indicates SAFE or OPERATE. CMD console controls this function with a console switch.

GMT

The Greenwich Mean Time indication displays the time the associated command was initiated.

POC SRCIFSM STATUS MSK 2662

For payload operation this display shows the POCC remote site assignments for each POCC source on the payload consoles CCM. The assignments are made by MED entries from the Command operator's console.

F/V / POC SRC/FSM STATUS 2662B CH120

FSM ASSIGNMENT:		01 /		07 /		13 /		GMT	
		02 /		08 /		14 /			
		03 /		09 /		15 /			
		04 /		10 /		16 /			
		05 /		11 /		17 /			
		06 /		12 /		18 /			

CONSOLE		CONSOLE		CONSOLE		CONSOLE		CONSOLE	
PBI	SOURCE	PBI	SOURCE	PBI	SOURCE	PBI	SOURCE	PBI	SOURCE
13U	/	13U	/	13U	/	13U	/	13U	/
13L	/	13L	/	13L	/	13L	/	13L	/
14U	/	14U	/	14U	/	14U	/	14U	/
14L	/	14L	/	14L	/	14L	/	14L	/
15U	/	15U	/	15U	/	15U	/	15U	/
15L	/	15L	/	15L	/	15L	/	15L	/
16U	/	16U	/	16U	/	16U	/	16U	/
16L	/	16L	/	16L	/	16L	/	16L	/

Figure 3-22 – POC SRC/FSM status display.

Questions

1. Which console module provides the capability to select between the various MCC ground command support displays available on the TV displays at the uplink position consoles?
2. Which console module allows the selection of the MOC to be used for a flight?
3. What is the maximum possible number of RTCs or command loads that may be selected at the MCM?
4. What does the DRM control?
5. True or False: Commands may be initiated from a DSM with a failed DDD.
6. Through what devices does the CCM communicate with the MOC?
7. The MSK panel is used to:
 - a. select console CRT displays
 - b. select the flight number
 - c. enter the DDD format
 - d. all of the above.
8. The Abort Toggle Switch is present on which of the following consoles?
 - a. Flight Dynamics Officer and Flight Director
 - b. Flight Director and Cap Com.
 - c. INCO and Flight Director
 - d. INCO and Booster.
9. The MCM panel
 - a. is used to establish vehicle select identified in the command word
 - b. is used to establish the end item to which a command is addressed.
 - c. is used only for single-stage commands.
 - d. is used only for command loads.
10. An SPC buffer clear command is initiated from the:
 - a. DSM module panel
 - b. DRM module panel
 - c. CCM module panel
 - d. MSK module panel

11. Which of the following may be selected on the CCM module panel.

- a. SSC, TEC BUFFER CLEAR, P/L MDM 1, and TSB CLEAR
- b. SSC, MANUAL EXECUTE, CCM ENABLE, and SM major function
- c. TSC, TEC BUFFER CLEAR, P/L MDM 2, and vehicle number.
- d. SSC, SPC BUFFER CLEAR, vehicle number, and flight number.

Answers

1. Multiple select keyboard (MSK)
2. Function code select module (FSCM)
3. 384
4. Nothing. It is a display unit only.
5. True.
6. Inputs to the MOC through the command computer input multiplexer (CCIM) to the data computation complex (DCC) to the MOC. Receives output from the MOC through the digital display drivers (DDD).
7. d: All of the above.
8. a: Flight Dynamics Officer and Flight Director
9. b: Establishes an end item to which a command is addressed.
10. a: DSM module panel
11. b: SSC, Manual Execute, CCM Enable, and SM Major Function

Feedback

Score your performance on the test by adding 9 points for every question answered correctly. If more than three questions were answered incorrectly, reread this section of the document.

Section 4: Summary

Orbiter commanding began in the MCC MOC with stored, coded words that identify the function and routing of the commands reaching the Orbiter and payloads. The INCO determines the routing, type of command, and command function by console entries. Figure 4-1 shows an overview of the commanding process.

Routing information includes

- Vehicle address
- Computer address (major function)
- MDM selection.

Type of command can be

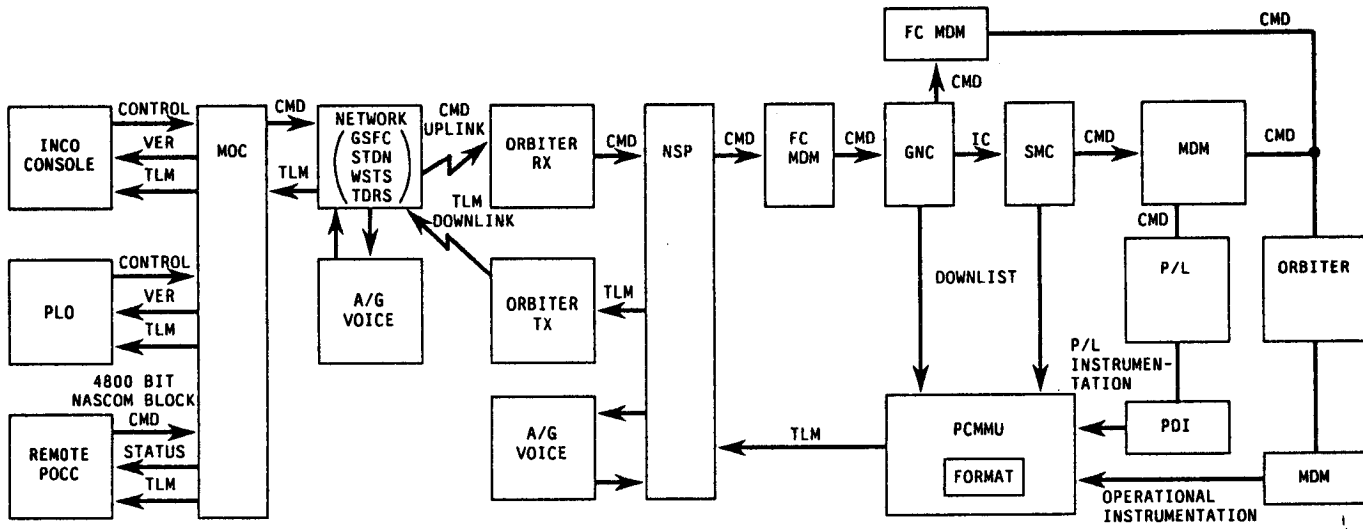
- Single-stage command
- Two-stage command
- Stored program command

Command function is a selection of a command by DSM number. When the DSM number has been selected, the MOC adds

- Op code
- MDM IOM select
- MDM IOM channel select

After the command is selected and initiated from the console, the MOC transmits to the NETWORK in a standard 4800 bit NASCOM block. (The NETWORK includes Goddard Space Flight Center and associated STDN sites, or White Sands and associated TDRS.)

The network RF uplink is processed by the Orbiter receiver and routed to the Network Signal Processor (NSP), where the commands are separated from digitized A/G voice. The command data is sent to the GNC through a flight critical MDM. The major function selection made by the INCO determines which GNC GPC will process the commands. SM commands are routed to the SM GPC by an inter-computer bus.



Header																	Command Data										
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	<	CH AN NE L	>	32	33	<.....>	48				
Veh Add			Maj Func				OP Code						FCW	LCW	IOM	MDM		Command Data									

TD1004*010

Figure 4-1.- Commanding overview.

A single-stage command is executed immediately. The subsystem response is sensed by the Operational Instrumentation (OI) system. This response is telemetered back to the MOC in a Pulse Coded Modulation Master Unit (PCMMU) format through the Orbiter NSP and transmitter and the NASCOM Network. The results are viewed on console displays.

A two-stage command initiated by INCO is routed to the selected GPC, where it is stored in the two-stage buffer and monitored. The contents of the buffer are transmitted back to the MOC by the DOWNLIST input to the PCMMU. The MOC verifies or invalidates the command by comparing the return command code to the transmitted command code. If the result is invalid, the INCO is informed by the MOC through console display indications. If the command is verified, the MOC (auto mode) or the INCO (manual mode) will transmit an EXECUTE command by the same process. An executed command proceeds from GPC buffer storage to the prescribed subsystem.

Although some payload commands may be stored in the MOC for access by the PLO (payload officer), most payload commands are transmitted to the MOC from a remote POCC station in a NASCOM block format. Transmission from the MOC automatically follows a verification process.

There are two basic command categories, as follows:

- Real time commands (RTC), which pass through an Orbiter GPC to control or configure an Orbiter or payload subsystem.
- Command loads which enter the Orbiter GPC or payload computers and effect charges in software.

Appendix A: Abbreviations and Acronyms

ABRT	abort
AC	alternating current
ACRM	acronym
Add	address
AOD	analog output differential
BCS	buffer compare status
BES	buffer execute status
BFS	backup flight system
BU	backup
BUF	buffer
C&W	caution and warning
CAP	command acceptance pattern
CAPCOM	capsule communicator
CCM	configuration control module
Chan	channel
CLR	clear
CMD	command
CMD IDX	command index
CLS	clear status
Comp	compare
CON	console
DC	direct current
DCIM	display system computer interface module
DDD	digital display driver
DEU	display electronics unit
DN	downlink
DOH	discrete output high
DOL	discrete output low
DOMSAT	domestic satellite
DPS	data processing system

DSIM	display select interface MUX
DSK	display request keyboard
DREJ	data reject
DRM	digital readout module
DSB	disabled
DSM	disital select module
DTE	digital television equipment
EECOM	Electrical, Environmental, and Consumables officer
ENB	enabled
ERR	error
EX	execute
EXEC	execute
FA	flight critical aft
FCSM	function code select module
FCW	first command word
FDA	fast detection annunciation
FDO	flight dynamics officer
FF	flight critical forward
FLT SEL	flight select
FLX	flexible
FNC	function
FSM	
FW/LW	first word/last word
G-MEM	GPC memory uplink
GCIL	ground control interface logic
GDO	Guidance Officer
GDR	ground reject
	ground data request
GGMT	ground Greenwich Mean Time
GMT	Greenwich Mean Time
GN	ground network
GNC	Guidance, Navigation, and Control
GPC	general purpose computer
GSFC	Goddard Spaceflight Center (Greenbelt, MD)

HAZ	hazardous
HI	high
I/O	input/output
ID	identification
INCO	Instrumentation and Communication Officer
INST	Instrumentation
INVC	invalid configuration
IOM	input/output module
JSC	Johnson Space Center
KU-Band	15.25 to 17.25 MHz
LCW	last command word
LF	left forward
LO	low
LSB	least significant bit
Maj Func	major function
MAN	manual
MCC	Mission Control Center
MCC OPER	MCC operations
MCC OPER	MCC operator
MCM	multiple command module
MDM	multiplexer/demultiplexer
MED	manual entry device
MF	major function
MMU	mass memory unit
MOC	Mission Operations Computer
MOCR	Mission Operations Control Room
MOD	Mission Operations Directorate
MRTC	multiple real time command
MSB	most significant bit
MSFC	Marshall Spaceflight Center
MSK	manual select keyboard
MUX	multiplexer

NASA	National Aeronautics and Space Administration
NASCOM	NASA communications
NCOMP	No compare
NDX	index
NR WD	number of words
NRIW	
NSP	Network Signal Processor
NVL	no valid comparison
OI	operational instrumentation
OP	operation
Op code	operation code
ORB	Orbiter
P1	playback 1
P2	playback 2
P/L	payload
PA	payload aft
PAR	partial
PBI	pushbutton indicator
PCMMU	pulse coded modulation master unit
PF	payload forward
PL	payload
PLO	Payload Officer
POCC	Payloac Operations Control Center
PSP	payload signal processor
RCV	receiver
REAL	real time mode
RETRANS	retransmit
RF	radio frequency RF communications
RIW	
RJ	reject
RST	reset
RT	real time
RTC	real time command

RTC DSM	RTC digital select module
RTX	retransmit
S-Band	1500 to 5200 MHz
SAFE	safed command
SDPC	Shuttle Data Processing Complex
SIM	simulation
SIO	serial input/output
SM	systems management
SNGL	single
SPC	stored program command
SRC	source
SSB	single-stage buffer
SSC	single-stage command
STA	station
STD	
STDN	Satellite Tracking and Data Network
STG	stage
TDRS	Tracking and Data Relay Satellite
TEC	time executed command
TERM	terminate
TEST	test message
TLM	telemetry
TM	table maintenance
TMBU	table maintenance block update
TMRJ	telemetry reject
TPC	throughput command
TSB	two-stage buffer
TSC	two-stage command
TSLO	two-stage lockout
TWO	two-stage command
U/L	uplink
UP	uplink
VAL	valid comparison

Veh	vehicle
VSM	video switching matrix
WBW	word-by-word
WSGT	White Sands Ground Terminal
XCES	excessive
XMT	transmitter