APOLLO

GUIDANCE AND NAVIGATION

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E-1142 (Rev. 23)

(UNCLASSIFIED TITLE)

SYSTEM STATUS REPORT

August 15, 1964

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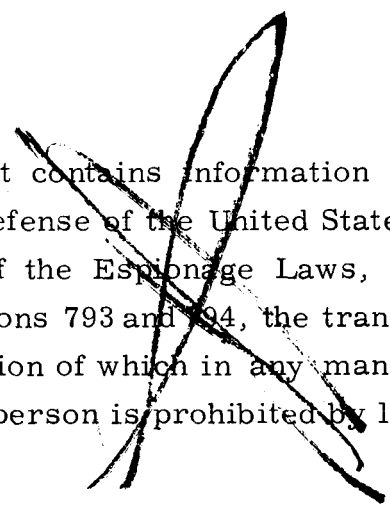

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ABSTRACT

The System Status Report is distributed monthly on the 15th. This month's revision of E-1142 (Rev. 23) contains, in general, the following information for the Block I (100 series) and Block II Command Module and LEM equipment configurations: weights, centers of gravity, moments of inertia, power requirements, status of computer programs, and reliability figures.

Section 1

INTRODUCTION

1-1 INTRODUCTION

The definition of what constitutes Block I (100 series) and Block II Command Module and LEM hardware is contained in the Glossary, section 5 of this report.

The following information is included in this month's report:

(1) Command Module, Block I (100 series): weights. Also included for reference are the following Block I (0 series) parameters: centers of gravity, moments of inertia, and power requirements.

(2) Command Module, Block II: weights, power requirements, status of computer programs, and reliability figures.

(3) LEM: weights, power requirements, and reliability figures.

1-2 ACCURACY

The accuracy of numerical values reported in this revision should not be considered to be within the tolerances implied by the significant figures quoted. The reported values, although based upon the most current information, are subject to normal changes as design and development phases approach completion.

BLOCK I
COMMAND MODULE

Section 2

BLOCK I COMMAND MODULE DATA

2-1 WEIGHTS

Table 2-I presents the weights of all Block I flight systems (100 series systems) equipment, grouped according to specific location within the Command Module. Weights are reported to the component level and to the nearest tenth of a pound.

Given component weights are identified as estimated, calculated, and measured in the order of increasing accuracy. These terms are defined by North American Aviation as follows.

Estimated weights (E) are based on rough calculations. Calculated weights (C) are based on detailed calculations made from final production drawings that will be used to build flyable equipment. Measured weights (M) are the actual weights of equipment built to the production drawings.

North American Aviation will provide and be responsible for cold plate weights that are not integral with guidance and navigation equipment.

2-1.1 WEIGHTS STATUS REPORTING. Table 2-I also offers a comparison of present 100 series component weight values with the zero series components listed in System Status Report, E-1142 (Rev. 22) July 15, 1964. All weight changes are explained in paragraph 2-2.

2-1.2 CONTROL WEIGHT (ZERO SERIES). Column (a) in Table 2-I contains the February 15, 1964 weight status of Apollo G&N zero series equipment. Column (a) adds up to approximately the total control weight specified in letter PG-64-113 (March 6, 1964) from Mr. D. Gilbert, ASPO, to Mr. M. Trageser, MIT/IL.

2-1.3 DESIGN LOAD WEIGHT (ZERO SERIES). At NASA Coordination Meeting No. 15A, MIT agreed to assign "not-to-exceed" design load weights for individual Block I G&N zero series sybsystems. These weights were assigned by MIT in MIT letter AG 594-64, 18 May 1964, and are shown in column (d) of Table 2-I. The total design load weight represents a secure maximum, since it is unlikely that the largest increases in each subsystem will occur simultaneously. The design loads listed recognize possible individual increases to account for changes accepted by NASA for the 100 series systems.

Table 2-I. Current Weight Status of Block I (100 Series) Command Module (lbs at 1 g)

Item	0 Series Status 2/64 (a)	(b-a)	0 Series Status 7/64 (b)	(c-b)	100 Series Status 8/64 (c)	Design Load Wt. 5/64 (d)**
G&N SYSTEMS						
CDU Assy	14.5 (M)	-0.9	13.6 (M)	0.0	13.6 (C)	18.0
Optical Subsystem						
SXT	14.6 (C)				18.7 (C)	
SCT	13.8 (C)	+1.1	46.2 (M)	+3.8	14.3 (C)	
Optical Base & Gearing	16.7 (E)				17.0 (E)	
Optical Eyepieces						
SXT	1.3 (E)	+0.3	1.6 (M)	0.0	1.6 (C)	100.0
SCT	2.3 (E)	+0.3	2.6 (M)	0.0	2.6 (C)	
NVB & Resilient Mounts	25.0 (E)	+0.7	25.7 (M)	0.0	25.7 (C)	
Bellows Assy	13.5 (M)	-0.8	12.7 (M)	0.0	12.7 (C)	
IMU	60.2 (M)	0.0	60.2 (M)	+0.3	60.5 (C)	65.0
Coolant Hoses (two)	1.0 (E)	-0.3	0.7 (E)	+0.1	0.8 (E)	
Power Servo Assy	59.4 (C)	-0.3	59.1 (C)	-0.2	58.9 (C)	75.0
G&N Interconnection Assy	35.2 (E)	-5.2	30.0 (C)	0.0	30.0 (C)	45.0
G&N tp S/C Interface Assy	8.0 (E)	0.0	8.0 (E)	+5.0	83.0 (E)	100.0
AGC (no spares)	70.0 (E)	0.0	70.0 (E)			
Optical Shroud	3.5 (M)	-0.4	3.1 (M)	0.0	3.1 (C)	4.5
LOWER EQUIPMENT BAY						
D&C						
D&C Electronics	2.9 (M)	0.0	2.9 (M)	0.0	2.9 (C)	
Control Electronics	2.9 (E)	-0.9	2.0 (M)	0.0	2.0 (C)	
G&N Ind Cont Panel	9.5 (M)	+0.4	9.9 (M)	0.0	9.9 (C)	
IMU Control Panel	2.4 (M)	+0.2	2.6 (M)	0.0	2.6 (C)	70.0
MDV (includes 1 film)	7.7 (C)	+1.3	9.0 (M)	+0.6	9.6 (C)	
D&C/AGC	20.6 (M)	+0.8	21.4 (C)	0.0	21.4 (C)	
Horiz. Photo. Elect.	0.0	0.0	0.0	+3.3	3.3 (E)	0.0
Signal Conditioner Assy	0.0	+4.6	4.6 (E)	0.0	4.6 (E)	8.0

Table 2-I. Current Weight Status of Block I (100 Series) Command Module (lbs at 1 g) (cont)

Item	0 Series Status 2/64 (a)	(b-a)	0 Series Status 7/64 (b)	(c-b)	100 Series Status 8/64 (c)	Design Load Wt. 5/64 (d)**
MAIN PANEL AREA						
D&C/AGC	20.5 (M)	+0.9	21.4 (C)	0.0	21.4 (C)	26.0
LOOSE STORED ITEMS						
Eye Relief Eyepieces	1.5 (E)	0.0	1.5 (E)	0.0	1.5 (E)	3.0
Film Cartridges (4)	2.4 (E)	+0.1	2.5 (M)	0.0	2.5 (C)	5.0
Horizon Photometer	3.6 (E)	-3.6	0.0	0.0	0.0	0.0
Optics Cover	1.7 (M)	-0.1	1.6 (M)	0.0	1.6 (C)	2.5
TOTAL	415.0*	-2.1	412.9	+12.9	425.8	522.0

*Control weight specified in letter PG-64-114 (March 6, 1964) from Mr. D. Gilbert, ASPO, to Mr. M. Trageser, MIT/IL. See paragraph 2-1.2. Applies to zero series only.

**Design Load Weights are taken from MIT letter AG 594-64 (May 18, 1964). See paragraph 2-1.3. Applies to zero series only.

2-2 REPORTED 100 SERIES WEIGHT CHANGES

The weight changes shown in column (c-b) of Table 2-I are explained below. These changes represent the differences between the current zero series and 100 series systems weight estimates. The identification of the 100 series systems (previously called Block IF) is the result of a series of modifications to the basic zero series systems. These modifications were approved by NASA (Ref: MSC TWX No. E G04-17-64-208).

2-2.1 OPTICAL SUBSYSTEM (+3.8 lbs). The Block II Optical Subsystem has been incorporated into the 100 series systems. This subsystem contains the horizon photometer and star tracker.

2-2.2 IMU (+0.3 lbs). Three friction vibration dampers have been added, one to each of the one-speed axis ends, to eliminate high vibration magnification (+0.1 lbs). Insulation has been added to the IMU heat exchanger area only (0.2 lbs).

2-2.3 COOLANT HOSES (+0.1 lb). The aluminum flex hoses were changed to steel for strength and manufacturability.

2-2.4 POWER SERVO ASSY (-0.2 lbs). The toe plate has been changed to beryllium for increased stiffness and for better thermal contact with the cold plate (-2.3).

Ten plastic covers, gaskets, and mounting screws have been added to each tray of the PSA for moisture proofing (+0.5 lbs).

Additional electronics have been added to trays 8, 9, and 10 as a result of the following changes (+0.8 lbs):

(1) Optics changes for compatability with star tracker and horizon photometer, (2) component value change in 2-speed switch, (3) component value change in compensation module, (4) change to new motor drive amplifiers with SCT rate feed forward, and (5) change to relay module.

A module has been added to tray 10 for photometer peak and amplifier/star presence (+0.77 lbs).

2-2.5 G&N TO S/C INTERFACE ASSEMBLY AND AGC (+5.0 lbs). A different thermal configuration requires a heavier case. This weight increase will be partially offset by the incorporation of the AGC end connector into the case and by the elimination of the toe cap.

2-2.6 MDV (0.6 lbs). Sealed covers have been added to protect the electric and optical elements from moisture (+0.4 lbs) and the MDV frame has been strengthened (+0.2 lbs).

2-2.7 HORIZ. PHOTO. ELECT. (+3.3 lbs). Additional horizon photometer and star tracker electronics will be located on an auxiliary header attached to the right-hand wall behind the MDV.

2-2.8 LIST OF POSSIBLE SPARES. The need for spares has been eliminated.

2-3 CENTERS OF GRAVITY (ZERO SERIES)

Table 2-II presents the centers of gravity of each zero series weight component or packaged assembly, determined with respect to the basic X, Y, Z axes of the Command Module. Center of gravity values are given to the nearest tenth of an inch.

2-4 MOMENTS OF INERTIA (ZERO SERIES)

Table 2-II also presents the moment of the inertia of each zero series weight component or packaged assembly, determined about each of the component axes which (1) run through the center of gravity of the component and (2) are parallel to the basic X, Y, Z axes of the Command Module. The total center of gravity and moments of inertia of all G&N equipment (excluding loose stored items) have been calculated about the basic X, Y, Z axes also.

2-5 COMMAND MODULE POWER REQUIREMENTS (ZERO SERIES)

The power requirements of the Command Module G&N zero series equipment on the primary +28 VDC power supply are shown in figure 2-1, which presents the magnitude and location of dissipated power values on a subassembly level. This chart assumes a 14-day lunar mission as defined by S&ID for power profile computation (Ref: S&ID letter 63 MA 7332).

Table 2-III shows the magnitude and location of power dissipation for the established G&N activities, each of which consists of various power levels of operation.

Table 2-IV shows the energy requirements for each G&N activity on a power level basis. The table is based upon MIT letter AG 679-6, "G&N Power Profile Status," dated August 14, 1963. The vertical column to the left indicates the various G&N activities (phases of operation) for the model 14-day mission submitted by S&ID in S&ID letter 63 MA 7332. The column also indicates the power requirement and operating time for each specific activity. The top row indicates the power requirement and operating time of each G&N power consuming equipment. The table sums up the energy consumptions for each G&N activity and each G&N power consuming equipment.

Table 2-II. Block I (Zero Series) Command Module Center of Gravity and Moment of Inertia Data

Item	Weight (lbs)	Centers of Gravity (inches)			Moments of Inertia ($lb\text{-}in^2$)		
		X	Y	Z	Ixx	Iyy	Izz
LOWER EQUIPMENT BAY							
CDU Assy	13.6	63.5	-14.4	35.8	73	144	131
Optical Subsystem							
SXT							
SCT							
Opt. Base & Gearing	50.4	69.6	0.5	31.1	1468	992	1737
Optical Eyepieces							
SXT							
SCT							
IMU	60.2	56.6	0.0	41.7	1186	1450	1498
NVB & Resilient Mounts	25.7	64.3	-0.1	41.3	3270	4050	5210
Bellows Assy	12.7						
G&N Interconnection Assy	30.0	53.1	-1.1	46.8	3610	3110	4860
G&N to S/C Interface Assy	8.0	37.8	8.9	44.8	378	403	32
D&C/NAV Station							
IMU Cont Panel	2.6	74.0	-15.4	30.9	15	22	24
D&C Electronics	2.9	49.5	-9.6	39.6	20	22	9
Control Electronics Assy	2.0	63.1	10.7	34.9	9	15	8
Optical Shroud & Cover	4.7	66.8	0.0	28.9	387	108	413
G&N Ind. Control Panel	9.9	54.1	0.1	33.9	455	110	560
D&C/AGC	21.4	63.5	14.8	36.3	294	1114	780
MDV (Includes 1 film)	9.0	73.5	-4.5	31.0	518	92	531
AGC (no spares)	70.0	37.8	1.3	46.1	4980	3990	1710
PSA	59.1	45.0	-1.1	41.5	3940	1460	2620
Signal Conditioner Assy	4.6	49.8	9.5	40.5	28	29	14
Coolant Hoses	0.7	64.8	6.5	34.9	7	8	15

(cont)

Table 2-II. Block I (Zero Series) Command Module Center of Gravity and Moment of Inertia Data (cont)

Item	Weight (lbs)	Centers of Gravity (inches)			Moments of Inertia ($lb\text{-}in^2$)		
		X	Y	Z	Ixx	Iyy	Izz
MAIN PANEL AREA							
D&C/AGC	21.4	67.8	-12.5	-20.4	283	256	317
Total Moments of Inertia About the Basix X, Y, Z Axes of the Command Module	408.9	55.1	-0.3	37.3	681,030	1,939,064	1,308,074
LOOSE STORED ITEMS							
Eye Relief Eyepieces	1.5	(SCT, 4-5/8" x 2-1/2" dia. SXT, 3" x 2-1/4" dia.)					
Film Cartridges (4)	2.5	(Each cartridge, 1-1/2 x 3 x 6 inches)					

BLOCK I

COMMAND MODULE

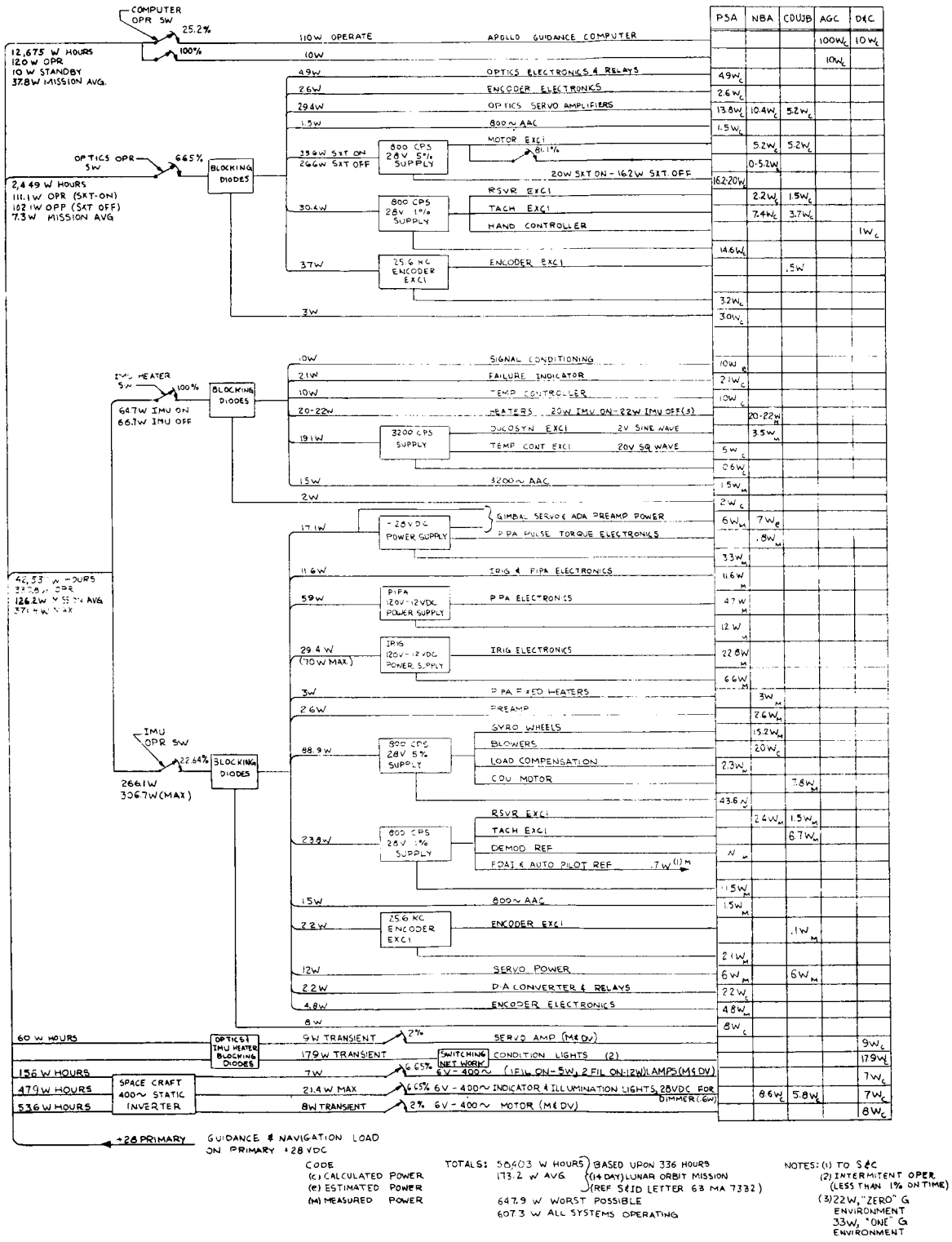

Figure 2-1. Electrical Load on Primary +28 VDC Power Supply
Block I (Zero Series) Systems

Table 2-III. Nominal Power Dissipation (watts) vs G&N Activity for Block I (Zero Series) Systems

MODE	G&N Activity (power levels)	NBA		CDU JB	PSA		AGC	Thermal Load On S/C Coolant	D&C and S&C	Electrical Load
		IMU	OBA		IMU	OBA				
A	IMU & AGC Operate (1,4)	74.5	0	22.1	233.5	0	110	440.1	10.7	450.8
B	IMU Alignment (1,2,4,6)	74.5	39	44	233.5	63.6	110	564.6	42.7	607.3
C	Low-Orbit Navigation (1,3,4,6)	74.5	33.8	44	233.5	59.8	110	555.6	42.7	598.3
D	Standby & Computing (1,5)	25.5	0	0	41.2	0	110	176.7	10	186.7
E	Midcourse Navigation (1,2,5,6)	25.5	39	21.9	41.2	63.6	110	301.2	42	343.2
F	IMU & AGC Standby (5,7)	25.5	0	0	41.2	0	10	76.7	0	76.7
G	IMU Operate and AGC Standby (4,7)	74.5	0	22.1	233.5	0	10	340.1	0.7	340.8

1. AGC 120 watts
2. Optics, SXT on 111.1 watts
3. Optics, SXT off 102.1 watts
4. IMU Operate 330.8 watts
5. IMU Standby 66.7 watts
6. Display and Control 45.4 watts
7. AGC Standby 10 watts

Table 2-IV. Block I (Zero Series) Command Module Profile for 14-Day Lunar Orbit Mission

MODE	G&N Activity	Energy Consumption (kwh)							
		(1) AGC Operate 120 watts 84.67 hrs	(2) Optics SXT on 111.1 watts 18.53 hrs	(3) Optics SXT off 102.1 watts 3.83 hrs	(4) IMU Operate 330.8 watts 76.09 hrs	(5) IMU Standby 66.7 watts 260.32 hrs	(6) Display & Controls 45.4 watts 22.36 hrs	(7) AGC Standby 10.0 watts 251.74 hrs	Total
A	IMU & AGC Operate 450.8 watts, 56.71 hrs	6.805	--	--	18.759	--	--	--	25.564
B	IMU Alignment 607.3 watts, 8.20 hrs	0.984	0.911	--	2.712	--	0.372	--	4.979
C	Low-Orbit Navigation 598.3 watts, 3.83 hrs	0.459	--	0.391	1.266	--	0.173	--	2.289
D	Standby & Computing 186.7 watts, 5.60 hrs	0.672	--	--	--	0.373	--	--	1.045
E	Midcourse Navigation 343.2 watts, 10.33 hrs	1.239	1.147	--	--	0.689	0.468	--	3.543
F	IMU & AGC Standby 76.7 watts, 244.39 hrs	--	--	--	--	16.300	--	2.443	18.743
G	IMU Operate & AGC Standby 340.8 watts, 7.35 hrs	--	--	--	2.431	--	--	0.073	2.504
	TOTAL	10.159	2.058	0.391	25.168	17.362	1.013	2.516	58.667

Section 3

BLOCK II COMMAND MODULE DATA

3-1 INTRODUCTION

The Block II Command Module G&N System reported in this section is the system concept planned until June 4, 1964. On this date, MSC reoriented the Block II G&N System to include spacecraft powered and free fall stabilization and control functions (Ref: minutes of meeting, S&ID, MIT/IL, and MSC Implementation Meeting No. 1, June 4, 1964, MSC, Houston, Texas). These changes are still being defined. The results of a final configuration decision, planned for August 17, 1964, will be reported in the September revision of this report.

3-2 WEIGHTS

Table 3-I presents the weights of the Block II Command Module concept defined in paragraph 3-1. Refer to paragraph 2-1 for a general explanation of weight reporting. No weight changes were reported this month.

3-3 RELIABILITY

The reliability numbers shown in table 3-II do not assume the use of in-flight spares or repair but do include the use of a redundant computer. Estimated Command Module G&N reliability is based on the 138-hour mission as defined in the Lunar Landing Mission Design Plan.

Table 3-II. Reliability (as of 8/15/64)

Subsystem	Operation Time (hrs) Full Power	Probability of Mission Success
IMU	31	0.99576
AGC (2)	19*	0.99996
DSKY	19	0.99995
PSA	31*	0.99421
CDU (5)	31	0.99426
Optics	18	0.99804
Total G&N System		0.98229

*Certain assemblies function continuously.

Table 3-I. Current Weight Status of Block II Command Module (lbs at 1 g)

Item	Status 2/64 (a)	(b-a)	Status 7/64 (b)	(c-b)	Status 8/64 (c)	Design Load Wt. 5/64 (d)
G&N SYSTEMS						
CDU Assy	15.0 (E)	+7.9	22.9 (E)	0.0	22.9 (E)	
Optical Subsystem						
SXT	18.2 (C)	+0.5	18.7 (C)	0.0	18.7 (C)	
SCT	13.8 (C)	+0.5	14.3 (C)	0.0	14.3 (C)	
Optical Base & Gearing	16.7 (E)	+0.3	17.0 (E)	0.0	17.0 (E)	
Optical Eyepieces						
SXT	1.3 (E)	+0.3	1.6 (E)	0.0	1.6 (E)	
SCT	2.3 (E)	+0.3	2.6 (E)	0.0	2.6 (E)	
NVB & Resilient Mounts	22.0 (E)	-4.0	18.0 (E)	0.0	18.0 (E)	
Bellows Assy	13.5 (C)	-0.8	12.7 (C)	0.0	12.7 (C)	
IMU	42.0 (E)	0.0	42.0 (E)	0.0	42.0 (E)	
Coolant Hoses (two)	1.0 (E)	-0.3	0.7 (E)	0.0	0.7 (E)	
Power Servo Assy	41.6 (E)	0.0	41.6 (E)	0.0	41.6 (E)	
G&N Interconnection Assy	35.2 (E)	-5.2	30.0 (E)	0.0	30.0 (E)	
G&N to S/C Interface Assy	8.0 (E)	0.0	8.0 (E)	0.0	8.0 (E)	
AGC (2 complete computers)	84.0 (E)	+4.0	88.0 (E)	0.0	88.0 (E)	
Optical Shroud	3.5 (C)	-0.4	3.1 (E)	0.0	3.1 (E)	
LOWER EQUIPMENT BAY						
D&C						
D&C Electronics	1.5 (E)	0.0	1.5 (E)	0.0	1.5 (E)	
Control Electronics	2.9 (E)	-0.9	2.0 (E)	0.0	2.0 (E)	
G&N Ind Cont Panel	11.1 (E)	0.0	11.1 (E)	0.0	11.1 (E)	
MDV (includes 2 films)	8.3 (E)	+1.3	9.6 (E)	0.0	9.6 (E)	
D&C/AGC	20.6 (E)	-5.6	15.0 (E)	0.0	15.0 (E)	

(cont)

Table 3-I. Current Weight Status of Block II Command Module (lbs) (cont)

Item	Status 2/64 (a)	(b-a)	Status 7/64 (b)	(c-b)	Status 8/64 (c)	Design Load Wt. 5/64 (d)
MAIN PANEL AREA						
D&C/AGC	20.5 (E)	-5.5	15.0 (E)	0.0	15.0 (E)	
LOOSE STORED ITEMS						
Eye Relief Eyepieces	1.5 (E)	0.0	1.5 (E)	0.0	1.5 (E)	
Film Cartridges (3)	1.8 (E)	+0.1	1.9 (E)	0.0	1.9 (E)	
AGC Covers (2)	8.5 (E)	-4.0	4.5 (E)	0.0	4.5 (E)	
PSA Cover	3.5 (E)	0.0	3.5 (E)	0.0	3.5 (E)	
Optics Cover	1.7 (E)	-0.1	1.6 (C)	0.0	1.6 (C)	
TOTAL	400.0* Control Weight	-11.6	388.4	0.0	388.4**	492.6**

*Control Weight specified in letter (PG-64-113, March 6, 1964) from Mr. D. Gilbert, ASPO, to Mr. M. Trageser, MIT/IL. See paragraph 2-1.2.

**Design Load Weight taken from S&ID letter 63 MA 2032, February 11, 1964. Does not include loose stored items.

3-4 POWER REQUIREMENTS

The power requirements of the Block II Command Module G&N equipment on the primary +28 VDC power supply are shown in figure 3-1, which presents the magnitude and location of dissipated power values on a subassembly level. This chart assumes a 14-day lunar orbit mission as defined by S&ID for power profile computation (Ref: S&ID letter 64 MA 3540).

Table 3-III shows the energy consumptions on a G&N activity and G&N equipment basis. The vertical column to the left indicates the various G&N activities (phases of operation). This column also indicates the power requirement and operating time for each specific activity. The top row indicates the power requirement and operating time of each G&N power-consuming equipment.

COMMAND MODULE

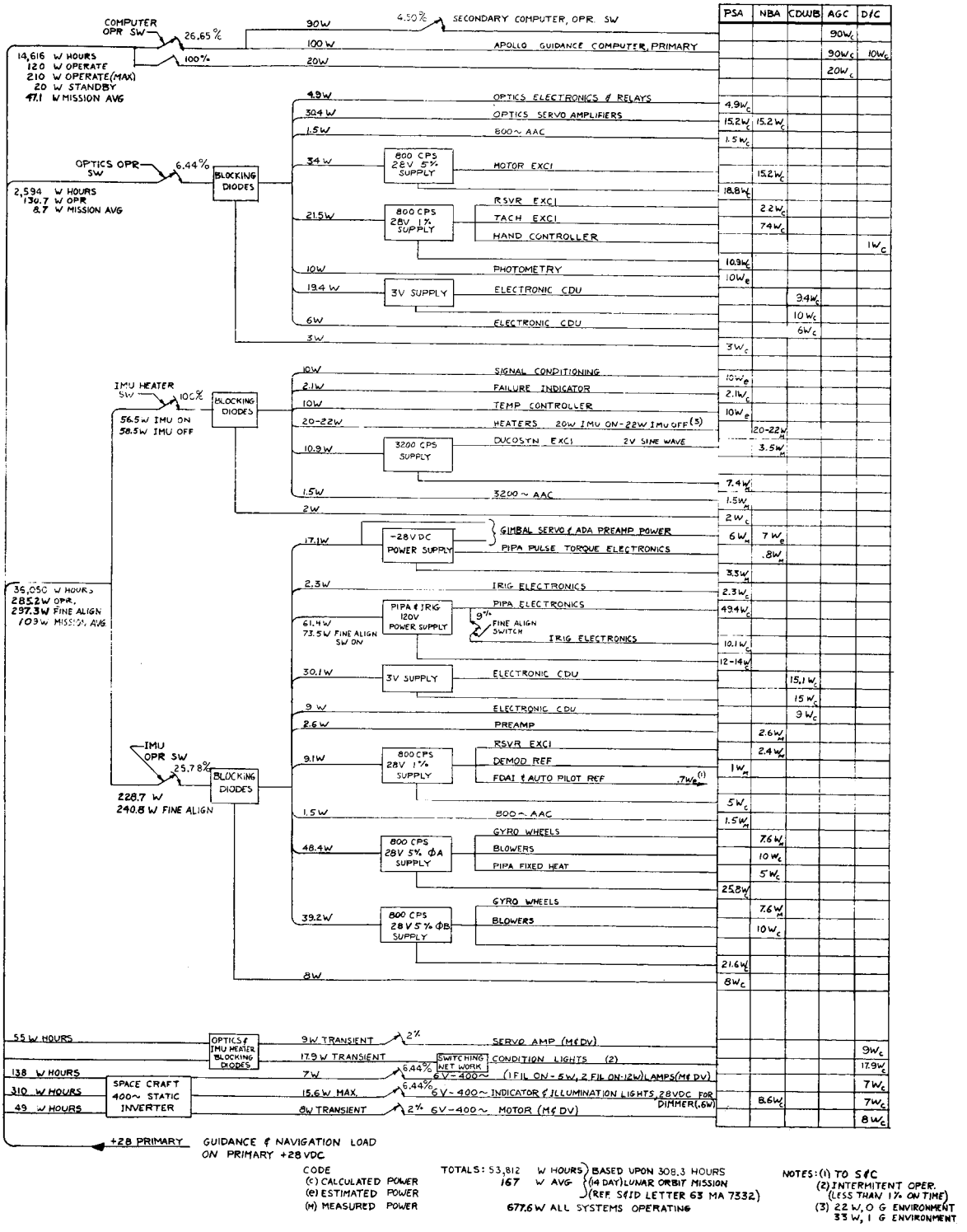

Figure 3-1. Electrical Load on Primary +28 VDC Power Supply

Section 4

LUNAR EXCURSION MODULE DATA

4-1 RELIABILITY

The numbers in table 4-I do not assume the use of in-flight spares or repair. Estimated reliabilities are based on MIT/IL's Guidance Monitor System Note No. 3, dated January 23, 1964.

Table 4-I. Reliability (as of 8/15/64)

Subsystem	Operating Time (hrs)	Probability of Mission Success
IMU	6.25	0.99914
AGC	6.25	0.99768
PSA	6.25	0.99928
CDU (5)	6.25	0.99897
OMU	0.75	0.99997
Total G&N System		0.99505

4-2 WEIGHTS FOR LEM

Lunar Excursion Module weights are presented in table 4-II. In general the data conform to the information contained in paragraphs 2-1, 2-1.1, and 2-1.2.

The row labeled "Bare Guidance System" is inserted to provide for comparisons with similarly specified systems.

4-3 REPORTED WEIGHT CHANGES

4-3.1 NVB (+6.0 lbs.). The navigation base has been identified as an MIT/IL designed item. It will be hard (ball) mounted as a result of GAEC lowering its estimate of the flight vibration environment (by a factor of 5) at NASA Coordination Meeting L7A thereby eliminating the need for vibration isolation.

Table 4-II. Estimated Weights of LEM G&N Components (lbs at 1 g)

Item	Status 2/64 (a)	(b-a)	Status 7/64 (b)	(c-b)	Status 8/64 (c)	Design Load Wt. 7/64 (d)
CDU's	15.0 (E)	+7.9	22.9 (E)	0.0	22.9 (E)	**
Telescope and All Eyepieces	24.5 (E)	0.0	24.5 (E)	0.0	24.5 (E)	
Eye Register for Reticule	2.0 (E)	0.0	2.0 (E)	0.0	2.0 (E)	
Two-Digit Readout for Reticule	5.0 (E)	0.0	5.0 (E)	0.0	5.0 (E)	
IMU	42.0 (E)	0.0	42.0 (E)	0.0	42.0 (E)	
AGC/PSA Interconnection Assy	10.0 (E)	0.0	10.0 (E)	0.0	10.0 (E)	
AGC Display and Controls	19.5 (E)	-4.5	15.0 (E)	0.0	15.0 (E)	
Other Display and Controls	15.0 (E)	0.0	15.0 (E)	0.0	15.0 (E)	
Book of Procedures, etc.	2.0 (E)	0.0	2.0 (E)	0.0	2.0 (E)	
AGC	41.5 (E)	-2.5	44.0 (E)	0.0	44.0 (E)	
AGC Cover	4.3 (E)	-2.0	2.3 (E)	0.0	2.3 (E)	
PSA	24.8 (E)	0.0	24.8 (E)	0.0	24.8 (E)	
PSA Cover	2.4 (E)	0.0	2.4 (E)	0.0	2.4 (E)	
NVB	0.0	0.0	0.0	+6.0	6.0 (E)	
TOTAL	210.0* Control Weight	+1.9	211.9	+6.0	217.9	
Bare Guidance System (IMU, PSA, and computer)	108.3	+2.5	110.8	0.0	110.8	

*Control Weight specified in Letter PG-64-113 (March 6, 1964) from Mr. D. Gilbert, ASPO, to Mr. M. Trageser, MIT/IL. See section 2-1.2.

**No design load weight has been assigned.

4-4 POWER REQUIREMENTS

The estimate for LEM power and energy consumption shown in figure 4-1 is based upon Command Module G&N Block II Data and Preliminary ICD LIS-390-2, LEM Electrical Load Analysis Form.

Table 4-III shows the energy requirements for each G&N activity on a power level basis. The table is also based upon LEM ICD LIS-390-2. The vertical column to the left indicates the various G&N activities (phases of operation). The column also indicates the power requirement and operating time for each specific activity. The top row indicates the power requirement and operating time of each G&N power consuming equipment. The table sums up the energy consumption for power consuming equipment.

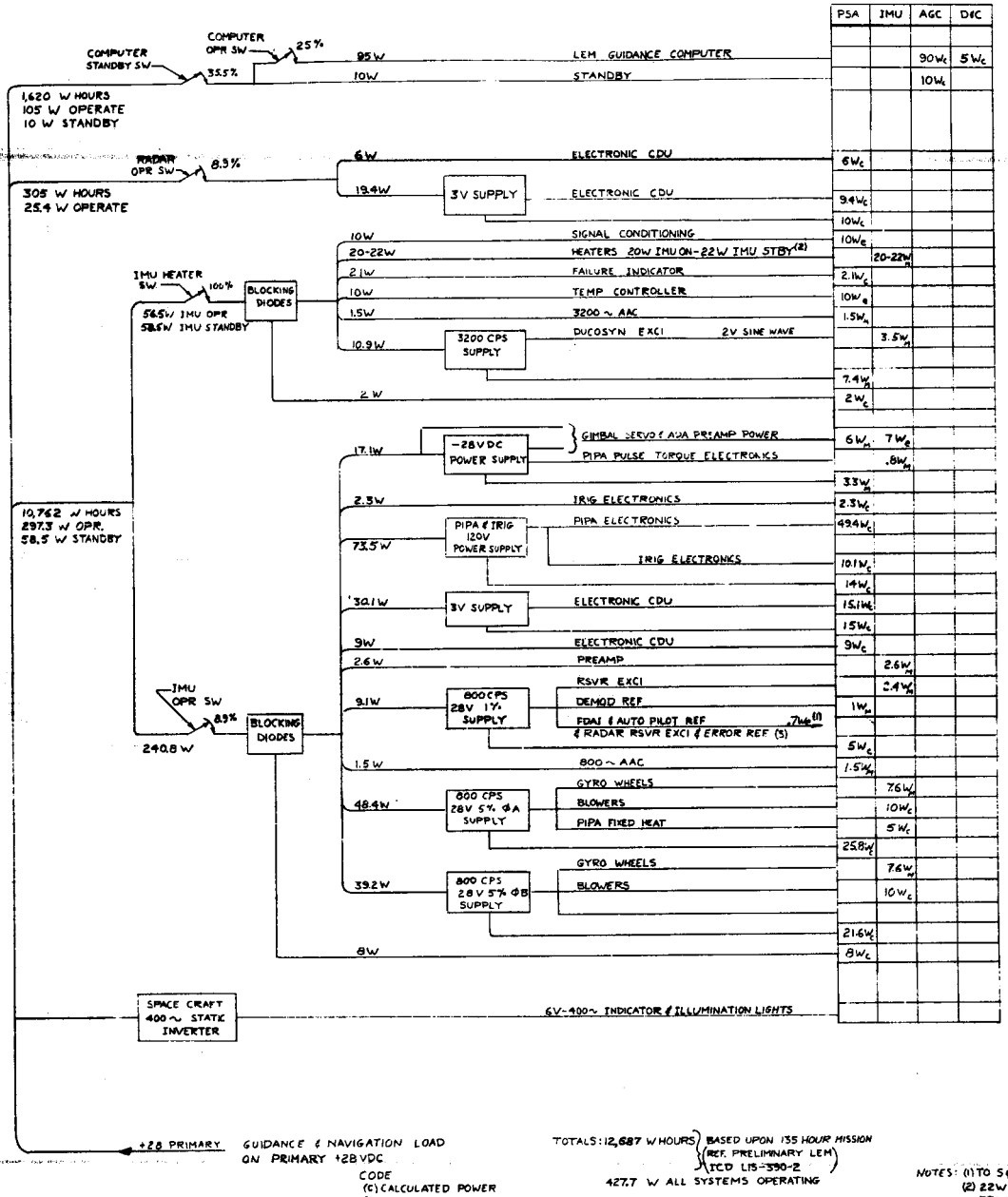

Figure 4-4. Electrical Load on Primary +28 VDC Power Supply

Table 4-III. LEM Power Profile Based on LEM ICD LIS-390-3

Summary of Lunar Excursion Module Energy Consumption in Kilowatt Hours									
		1	2	3	4	5	6	7	
Mode	LEM G&N Activity	AGC Off 0.0 watts	AGC Operate 105.0 watts 11.91 hours	AGC Standby 10.0 watts 35.75 hours	IMU Operate 297.3 watts 11.91 hours	IMU Standby 58.5 watts 123.15 hours	Two Radar CDU Operate 25.4 watts 11.91 hours	OMU (A.O.T.) Operate Negligible 27.42 hours	Total
I	Inactivity 87.40 hours 58.5 watts	0.000	—	—	—	5.113	—	—	5.113
II	Inactivity Alignment Midcourse Measurements 11.72 hours 427.7 watts	—	1.231	—	3.484	—	0.298	Negligible	5.013
III	Guidance During Major Event 0.20 hours 427.7 watts	—	0.021	—	0.059	—	0.005	—	0.085
IV	Inactivity 20.05 hours 68.5 watts	—	—	0.20	—	1.173	—	—	1.373
V	Inactivity 15.70 hours 68.5 watts	—	—	0.157	—	0.918	—	Negligible	1.075
	Total Hours	0.000	1.252	0.357	3.543	7.204	0.303	Negligible	12.659

Section 5

GLOSSARY AND SYSTEM DEFINITION

The following definitions apply to: (1) the Block I 100 series systems and (2) the Block II and LEM systems defined prior to the recognition of the additional functions of spacecraft stabilization and control.

Apollo Guidance Computer (AGC)

CM BLOCK I A single complete flight computer containing all logic, memory, associated power supplies, and all interface circuits except those identified with the CDU's. Does not contain the associated displays and controls.

Consists of one case containing factory replaceable electronic modules. Includes cover for moisture proofing, but does not include the necessary cold plate or the G&N to S/C Interface Assembly which is located in the adjacent area.

CM BLOCK II Two complete and active computers each having the same functions as the Block I AGC. Consists of two wiring matrix headers mounted on each side of the cold plate. This cold plate is not included in this accounting and must be moved up from the Block I configuration location. The modules of the "X" computer mount on one of these headers, those of the "Y" computer on the other.

Block I and Block II AGC's are not interchangeable.

LEM A single complete flight computer having the same functions as one of the Block II computers. Unless installation constraints yet to be determined prevent it, the LEM computer will be physically identical with the Block II computers.

AGC Covers

CM BLOCK I Required for moisture-proofing.

CM BLOCK II Two covers, one for each computer, may be required if it becomes necessary to seal the Malco connectors against moisture.

LEM Same as Block II except that there is only one cover.

Alignment Optical Telescope (AOT)

CM BLOCK I AND BLOCK II Not in CM; see Optical Subsystem.

LEM A 3-position periscope with single-degree-of-freedom manually read reticule for alignment of the IMU. Includes the weight of the bellows assembly and the long-eye-relief eyepiece.

Bellows Assembly

CM BLOCK I AND CM BLOCK II Flexible pressure seal between CM structure and optical subsystem for penetration of pressure hull with optics.

LEM One bellows with a double convoluted wall and two seals providing a flexible seal for pressure penetration of the AOT in the spacecraft. This weight is included in the AOT value.

Book of Procedures

CM Not in CM; see MDV.

LEM Book or other form of maps, charts, procedures, instructions, and the like, needed for lunar operations.

Coupling Data Unit (CDU) Assembly

The CDU provides the necessary signal interfaces among the IMU gimbal angles, optics gimbal angles, radar gimbal angles, angle registers in the AGC, the spacecraft autopilot attitude error signals, and the tracking radar command error signals.

CM BLOCK I Five interchangeable gear boxes each with necessary motor tachometer, resolver synchros, and encoder with mounting frame work. Does not include associated electronics which are located in the PSA.

CM BLOCK II Functionally identical to Block I except the instrumentation is all electronic. Includes all support electronics (including special power supply) and header; is located in same volume as Block I CDU's. Changes in resolver synchro characteristics and mode controls make Block I and II CDU's noninterchangeable.

LEM Interchangeable with CM Block I and II CDU's except for the headers.

Cold Plates

CM BLOCK I, BLOCK II, AND LEM Cold plates for the IMU are built into the IMU. Necessary cold plates for electronics are part of the equipment supplied by the spacecraft manufacturer. All cold surfaces otherwise open to the cabin environment will probably by insulated to prevent moisture condensation.

Control Electronics Assembly

CM BLOCK I Consists of one power transformer, one relay and diode module, and a bracket end connector. Used to support display and control functions. Includes moisture-proofing.

CM BLOCK II May be relocated with other similar functions.

LEM Not defined in LEM.

Cooland Hoses

CM BLOCK I AND CM BLOCK II Consists of (1) two steel flex coolant hoses, one between IMU and spacecraft and one between optics and spacecraft, (2) bracket assembly screws and clamp, and (3) entrapped coolant. Note that a third steel flex coolant hose between the optics and the IMU is considered as part of the weight of the optics base.

LEM Not identified as part of LEM.

Display and Control/Apollo Guidance Computer (D&C/AGC)

CM BLOCK I Number displays and keyboard control associated with the operation of the AGC. Two functionally identical and parallel operation units: one in lower equipment bay and one on main panel between left and center couches.

CM BLOCK II Functionally identical to Block I but smaller configuration because of smaller relays.

LEM Identical to Block II except only a single unit is required.

D&C Electronics Assembly

CM BLOCK I Consists of a chassis, a relay and diode module, a demod. elect. module, a saturable reactor, a time delay module, a connector, and wiring. Used to support display and control functions. Connectors will be moisture-proofed.

CM BLOCK II Not defined at this time.

LEM Not defined in LEM at this time.

Eye Register for Reticule

CM Not in CM.

LEM Device or equipment not yet defined in detail, to position the LEM pilot's eye to use the window marking reticule pattern for landing point observation and selection during the constant flight path phase of landing.

Film Cartridges

CM BLOCK I AND CLOCK II Consists of film cartridges and film for map and data viewer.

LEM Does not exist in LEM.

G&N Indicator Control Panel

CM BLOCK I AND BLOCK II Consists primarily of controls and displays for the operation of the optics, MDV, IMU temperature control, panel brightness control, and attitude impulse control. It includes display and control elements, panel, panel wiring, supporting hardware, and moisture-proofing.

LEM Not defined at this time for LEM.

G&N Interconnection Assembly

CM BLOCK I Consists of PSA End Connector Assembly and interconnect wiring harness, which electrically ties together the assemblies that constitute a completely integrated system. This term does not include the G&N to S/C Interface Assembly weight or the weights of harness support brackets which are an NAA responsibility.

CM BLOCK II Similar to Block I but not interchangeable with Block I.

LEM Not clearly defined but at present is called the AGC/PSA Interconnection Assy. Because of the wide separation of G&N components, most interconnection will be accomplished as part of spacecraft wiring.

G&N to S/C Interface Assembly

CM BLOCK I Cable interconnections between the spacecraft wiring channel, the computer end connector, and the PSA end connector. Contains no active electronics.

CM BLOCK II Similar in function to Block I except the configuration is much different and not interchangeable with Block I.

LEM Not identified yet as a separate item in LEM.

Horizon Photometer

CM BLOCK I AND BLOCK II An earth horizon brightness photometer and automatic star tracker for navigation measurements against the earth's illuminated limb. The sensors are incorporated into the head of the SXT, the weight of which includes this function. The PSA includes all support electronics for Block II and some of the support electronics for Block I.

LEM Not a part of LEM.

Horizon Photometer Electronics

CM BLOCK I Additional horizon photometer and star tracker electronics located on an auxiliary header attached to the right-hand wall behind the MDV.

CM BLOCK II AND LEM Not required.

Inertial Measurement Unit (IMU)

CM BLOCK I Size 14 IMU (14-inch case diameter) gimbal assembly including all parts inside hermetic case, entrapped coolant, and heat exchanger insulation.

CM BLOCK II Size 12.5 IMU functionally interchangeable with Block I unit, but not physically interchangeable with Block I.

LEM Size 12.5 IMU as described above.

IMU Control Panel

CM BLOCK I Consists of panel, wiring, attitude error meter, CDU transfer switch, manual alignment switch, CDU mode control switches, connector, supporting hardware, and associated moisture-proofing.

CM BLOCK II Does not exist in Block II. Moding is done by AGC program and AGC push buttons.

LEM Not defined at this time for LEM.

Long-Eye-Relief Eyepieces

CM BLOCK I AND BLOCK II Consists of a SXT and a SCT eyepiece to provide eye relief of at least 1.6 inches for closed-visor operation. Used in place of normal eyepieces of SXT and SCT.

LEM Long-eye-relief eyepiece is included as part of the AOT.

Map and Data Viewer (MDV)

CM BLOCK I AND BLOCK II Film viewer for display of maps, charts, procedures, and the like. Weight includes one film cartridge for Block I MDV and tentatively two for Block II MDV. An MDV cover is included in the Block I weight only.

LEM Not in LEM; see Book of Procedures.

NVB and Resilient Mounts

CM BLOCK I Rigid beryllium structure supporting the IMU and the optical subsystem with its associated hardware. The NVB is attached to the spacecraft using flexible resilient mounts to prevent spacecraft strains from distorting the NVB and the alignment between the IMU and optics. These mounts also provide shock and vibration attenuation.

CM BLOCK II Functionally similar to Block I but will be lighter and provide for mounting the size 12.5 IMU.

LEM A toroidal aluminum ring with: (1) four tubular aluminum posts to provide for IMU mounting, (2) four tubular aluminum posts for AOT mounting, and (3) three aluminum inserts to provide strain isolation ball mounting to the GAEC structure.

Optical Eyepieces

CM BLOCK I AND BLOCK II Removable SXT eyepiece and SCT eyepiece.

LEM Included as part of the AOT.

Optical Subsystem

CM BLOCK I AND BLOCK II Consists of SXT and SCT, Optical Base, and associated hardware defined as follows:

SXT:	Sextant. A two-line-of-sight, narrow-field, two-degree-of-freedom sextant and its attached gearing. The horizon photometer and automatic star tracker sensors are incorporated into the SXT head.
SCT:	Scanning Telescope. A single-line-of-sight, wide-field-of-view, two-degree-of-freedom articulation optical instrument and its attached gearing.
Optical Base:	Base for SXT and SCT with associated gearing and internal cooling. Includes the weight of the coolant hose between the IMU and Optical Base.

LEM Not in LEM; see AOT.

Optical Shroud & Cover Assembly

CM BLOCK I AND BLOCK II Consists of the optical shroud and protective cover.

LEM Does not exist in LEM.

Power Servo Assembly (PSA)

CM BLOCK I Includes most of the support electronics: power supplies; IMU, Optics, and CDU servos; IMU temperature control; accelerometer and gyro pulse torquing; and horizon photometer and automatic star tracker electronics. Consists of 10 trays with replaceable modules which plug into the PSA end connector assembly. Includes front toe plate but not the cold plate.

CM BLOCK II Similar in function to Block I but does not contain the CDU servos needed in Block I. Consists of a single plane matrix header to mount onto the cold plate with the modules plugging onto the top.

LEM Consists of electronics similar to those identified in the Block II PSA minus various electronics modules. Does not include optics and photometry electronics associated with the Block I and II PSA's.

PSA End Connector Assembly

CM BLOCK I Electrical interconnection between the PSA trays, the G&N Interconnection Assy, and the G&N to S/C Interface Assy. The End Connector weight is reported in the G&N Interconnection Assembly weight.

CM BLOCK II AND LEM Not identified as a separate item; will be part of the PSA matrix header.

PSA Covers

CM BLOCK I Not required.

CM BLOCK II Cover to protect the PSA module connections from moisture during flight.

LEM Same as Block II except lighter in weight.

Signal Conditioner Assembly

CM BLOCK I AND BLOCK II AND LEM Conditions signals for telemetry.

Two-Digit Readout for Reticle

CM Not in CM.

LEM A 2-digit readout driven by the AGC from 00 to 99 to indicate range component of landing point using fixed numbered scale on window reticule.

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