

APOLLO LOGISTICS TRAINING



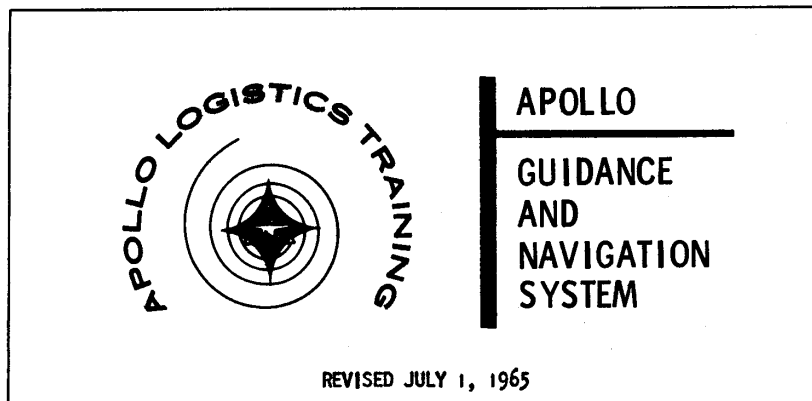
APOLLO

GUIDANCE
AND
NAVIGATION
SYSTEM

REVISED JULY 1, 1965



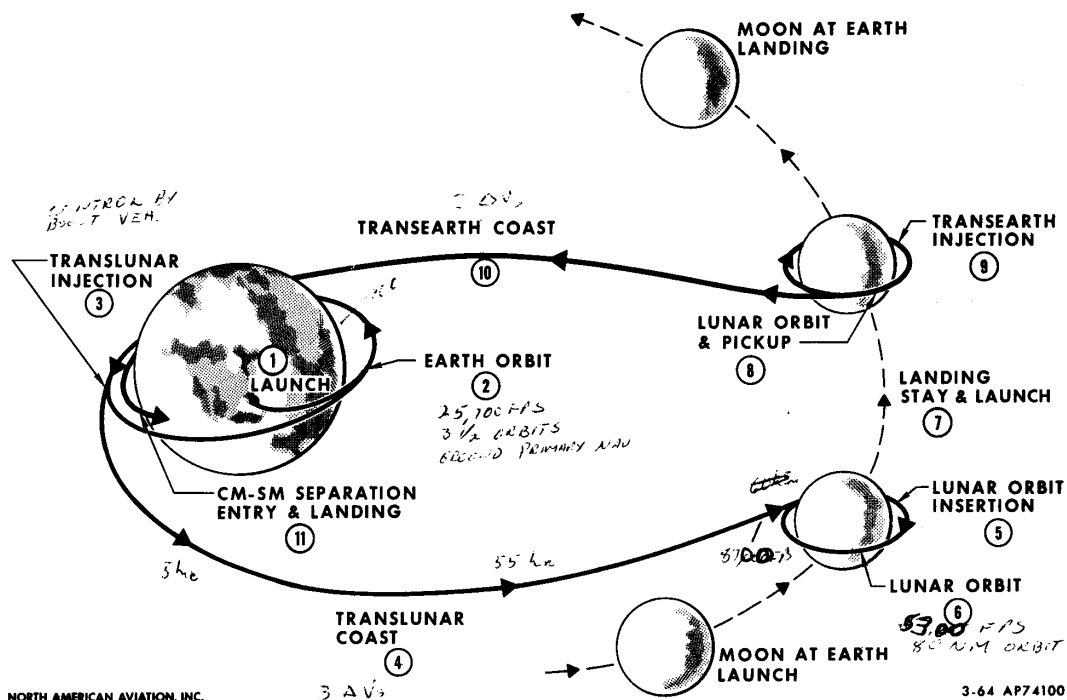
NORTH AMERICAN AVIATION, INC.
SPACE AND INFORMATION SYSTEMS DIVISION



NORTH AMERICAN AVIATION, INC.
SPACE and INFORMATION SYSTEMS DIVISION

GN-0000

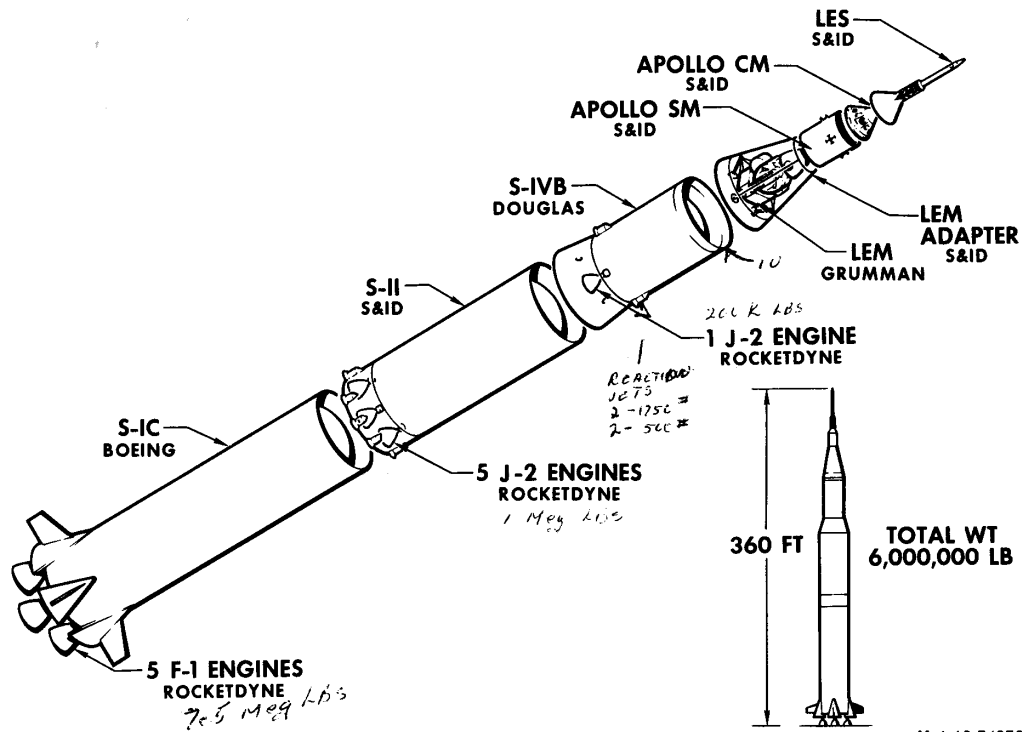
MISSION PLAN - LUNAR ORBITAL RENDEZVOUS MODE



NORTH AMERICAN AVIATION, INC.
SPACE AND INFORMATION SYSTEMS DIVISION

3-64 AP74100

SATURN V

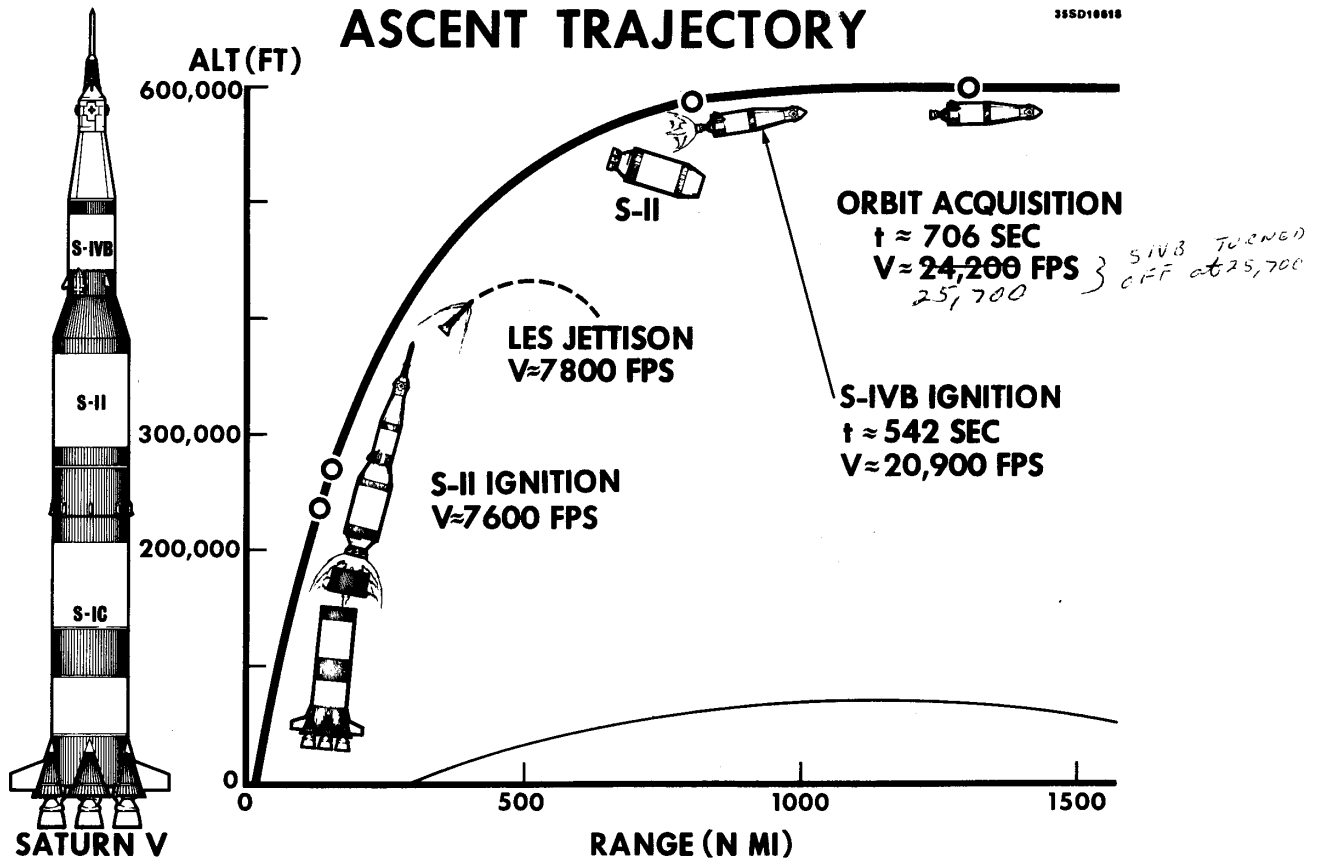


NORTH AMERICAN AVIATION, INC.
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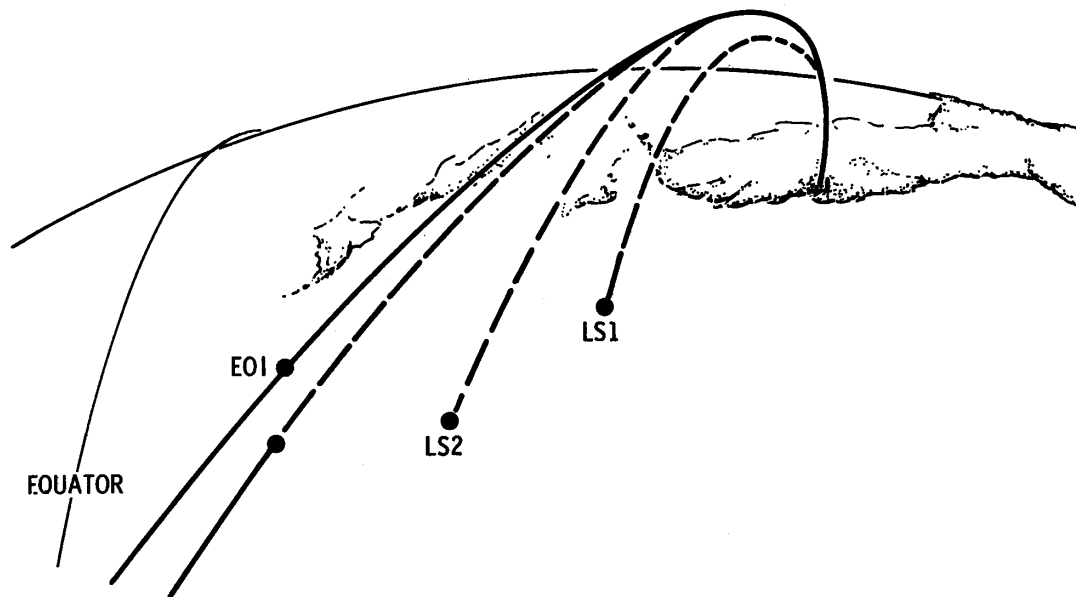
11-4 AP 74372A

ASCENT TRAJECTORY

38SD10018

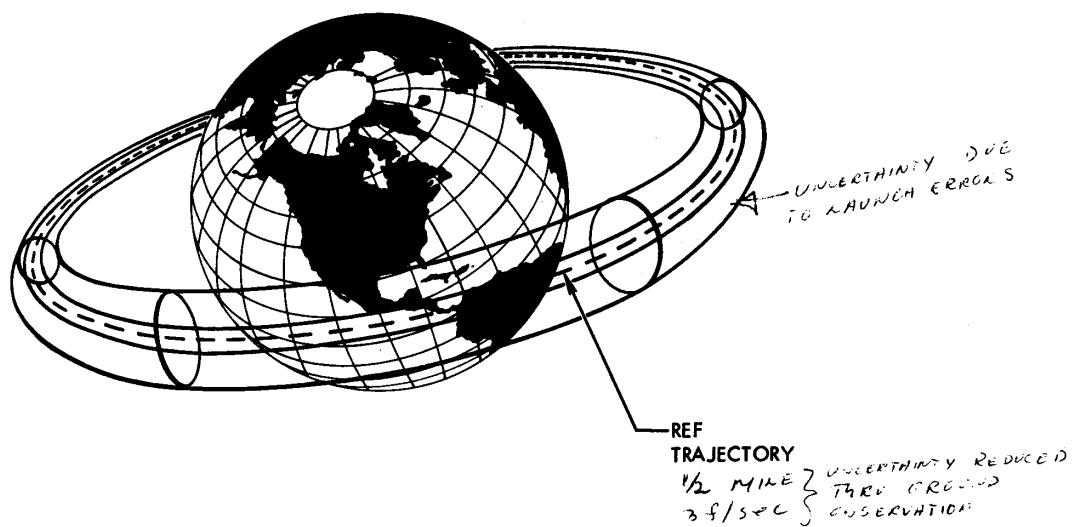


ASCENT PHASE



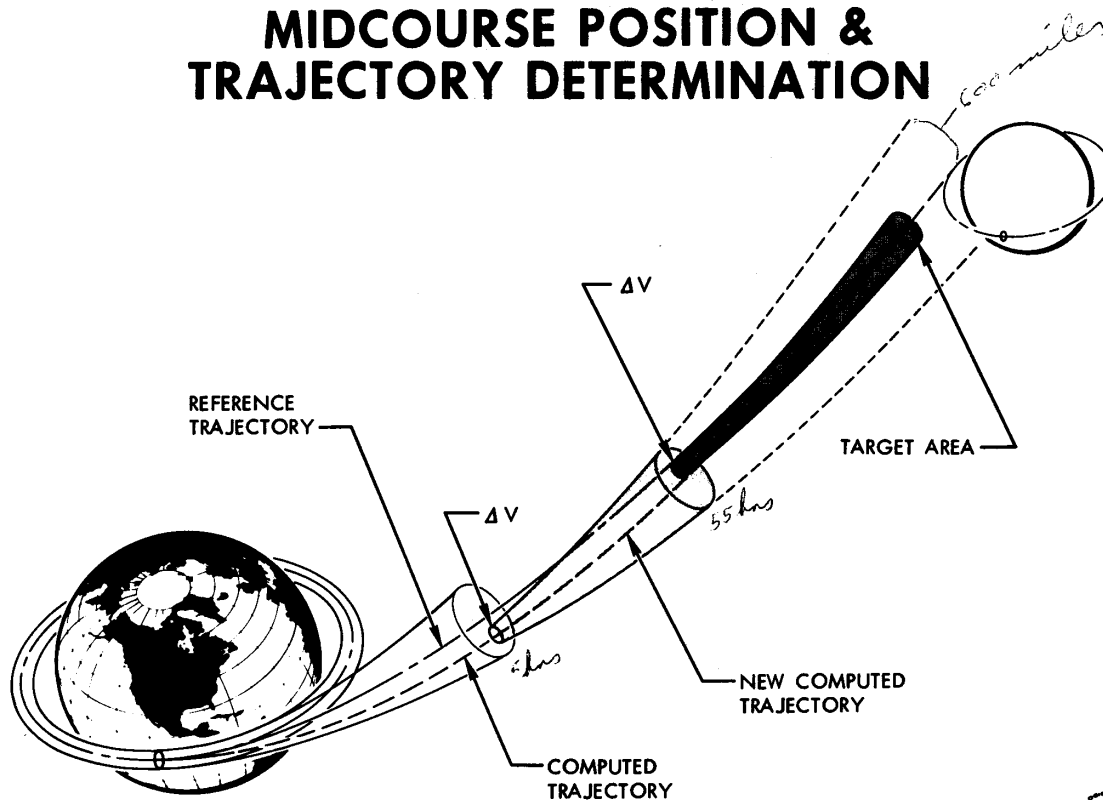
GN-211

EARTH ORBIT POSITION & TRAJECTORY DETERMINATION



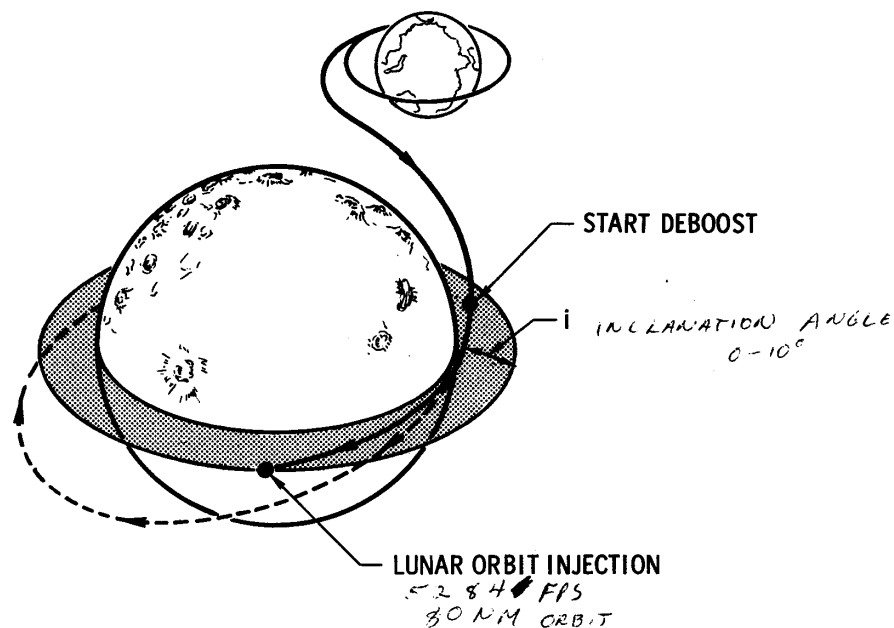
GN-180

MIDCOURSE POSITION & TRAJECTORY DETERMINATION



GN-182 

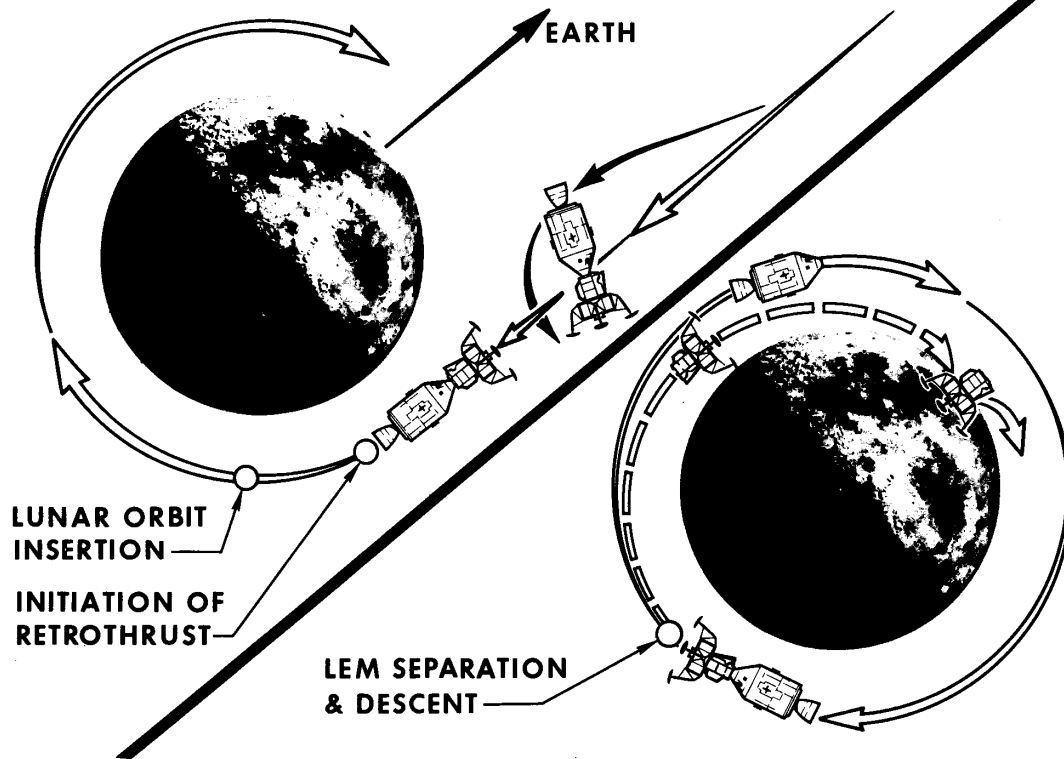
LUNAR ORBIT INJECTION



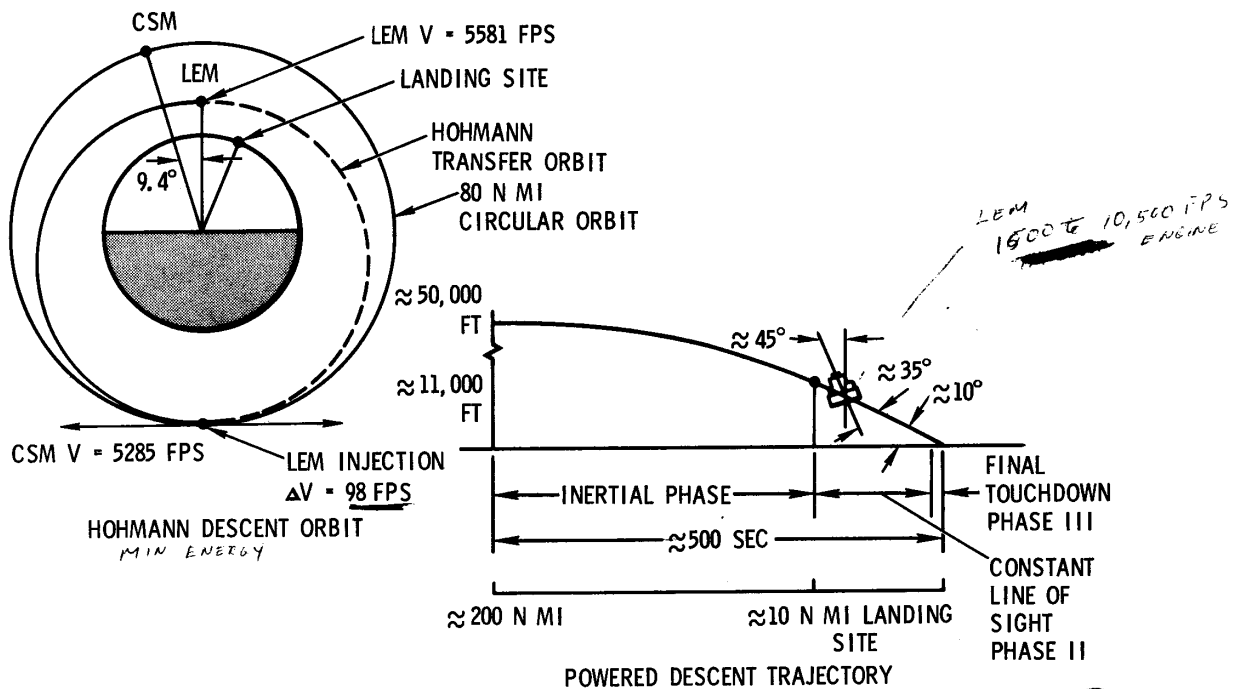
GN-206A 

LUNAR ORBIT & LEM DESCENT

124SD10439

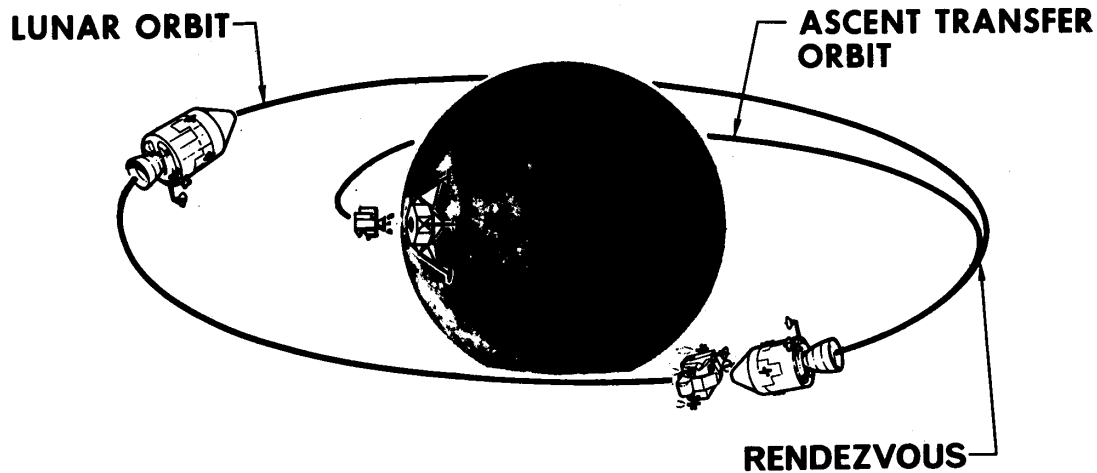


LEM DESCENT TRAJECTORY



GN-241

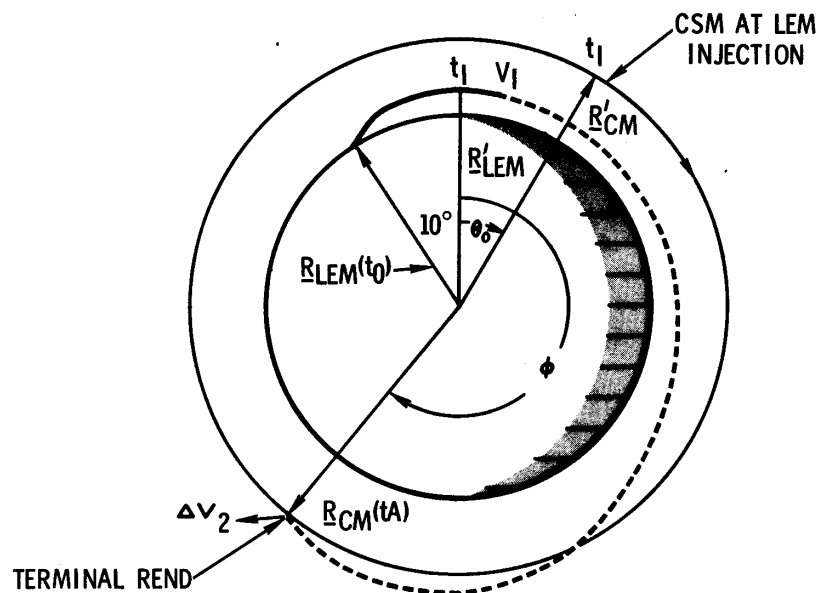
LEM ASCENT & LUNAR ORBITAL RENDEZVOUS



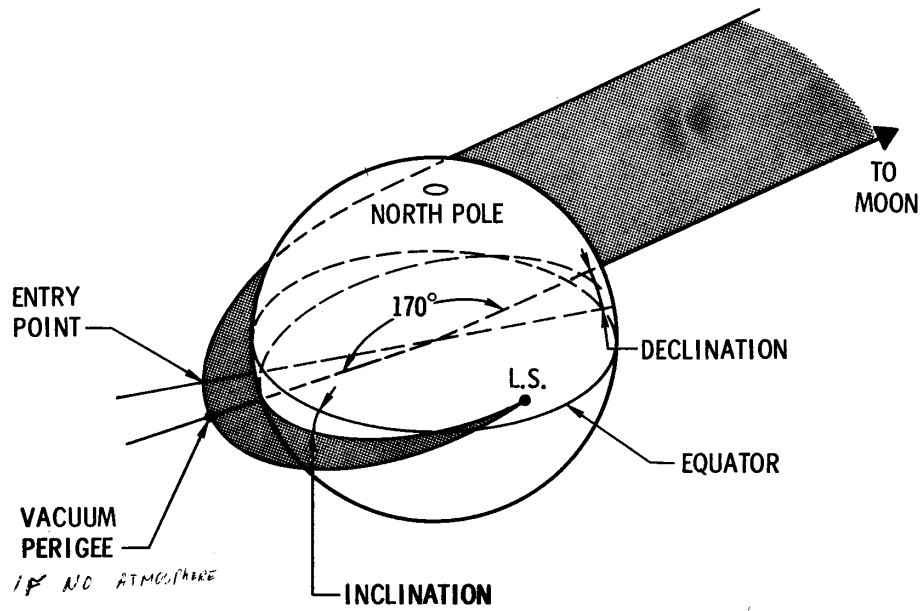
FAM-1006 

64 AP76945

LAUNCH AIM POINT DETERMINATION

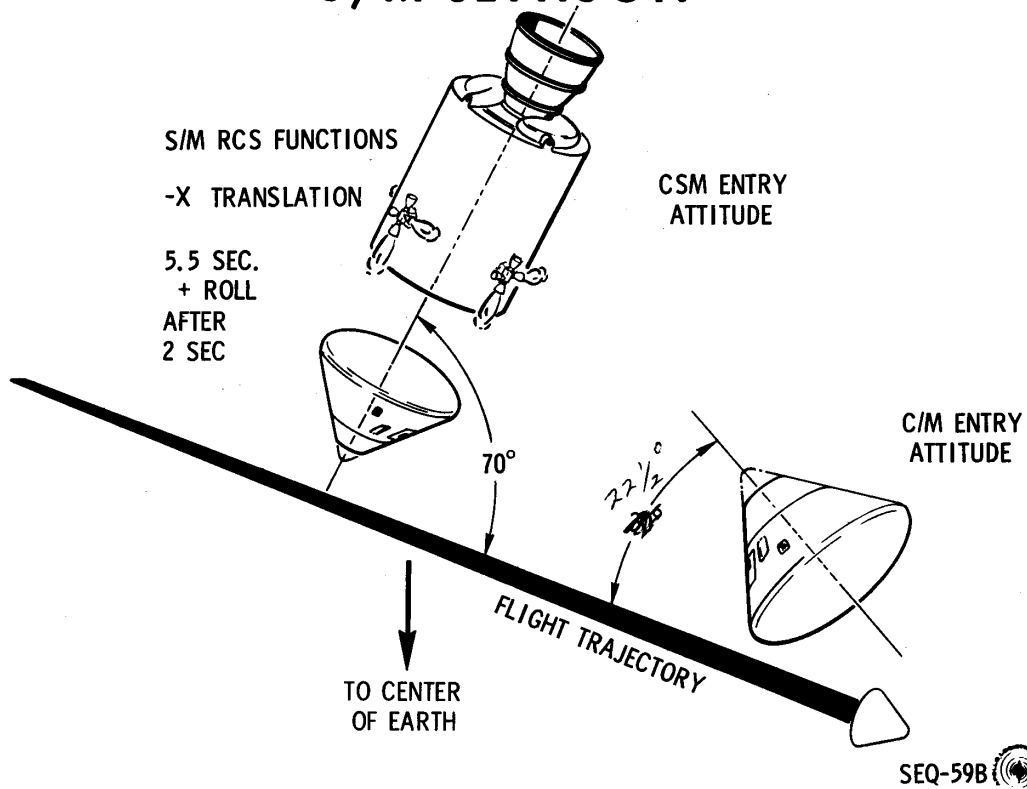


RETURN GEOMETRY

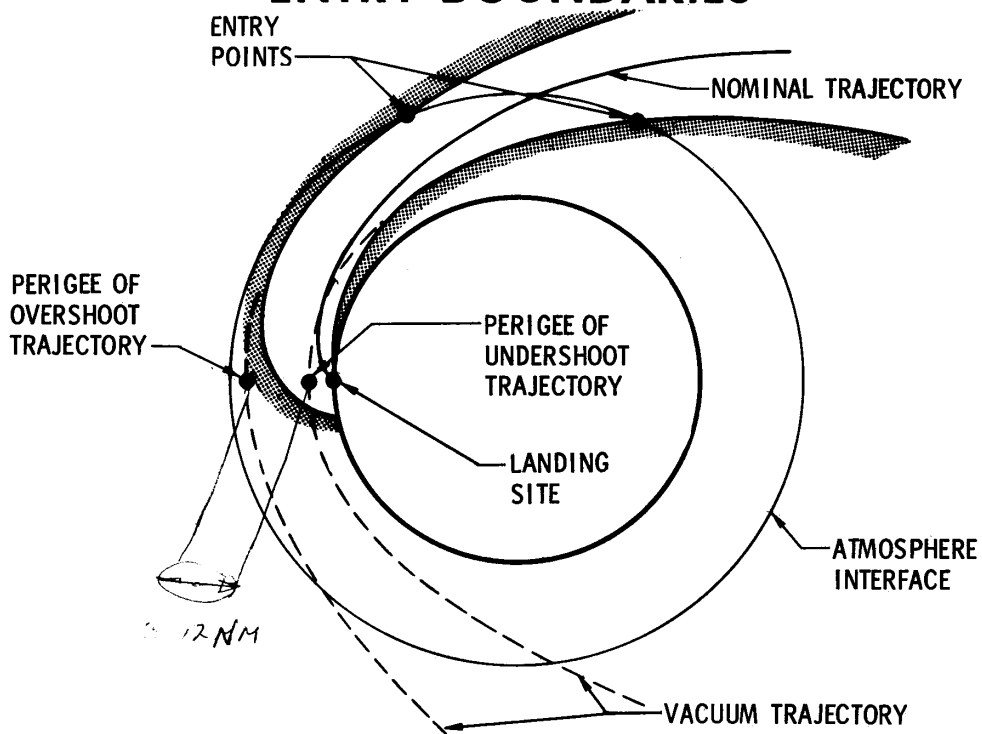


CN-204

S/M JETTISON



ENTRY BOUNDARIES

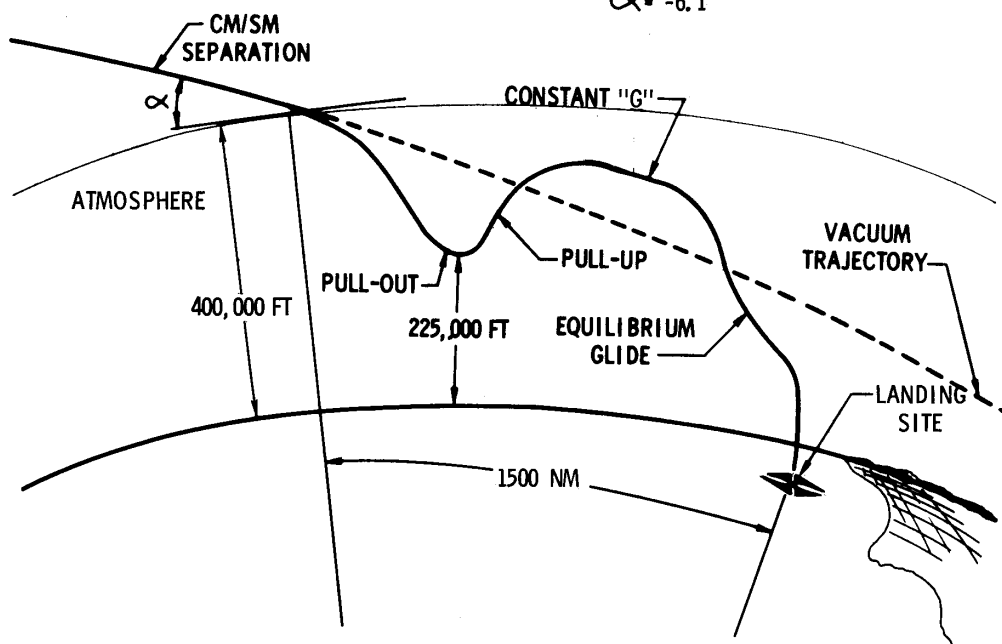


GN-205 A

ENTRY PROFILE

0 - 15 minutes

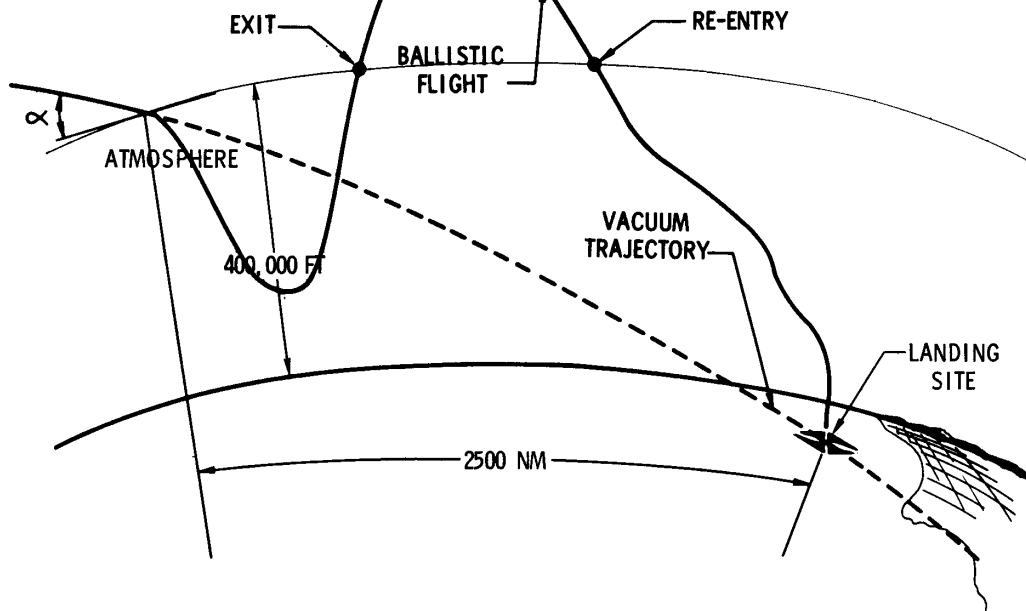
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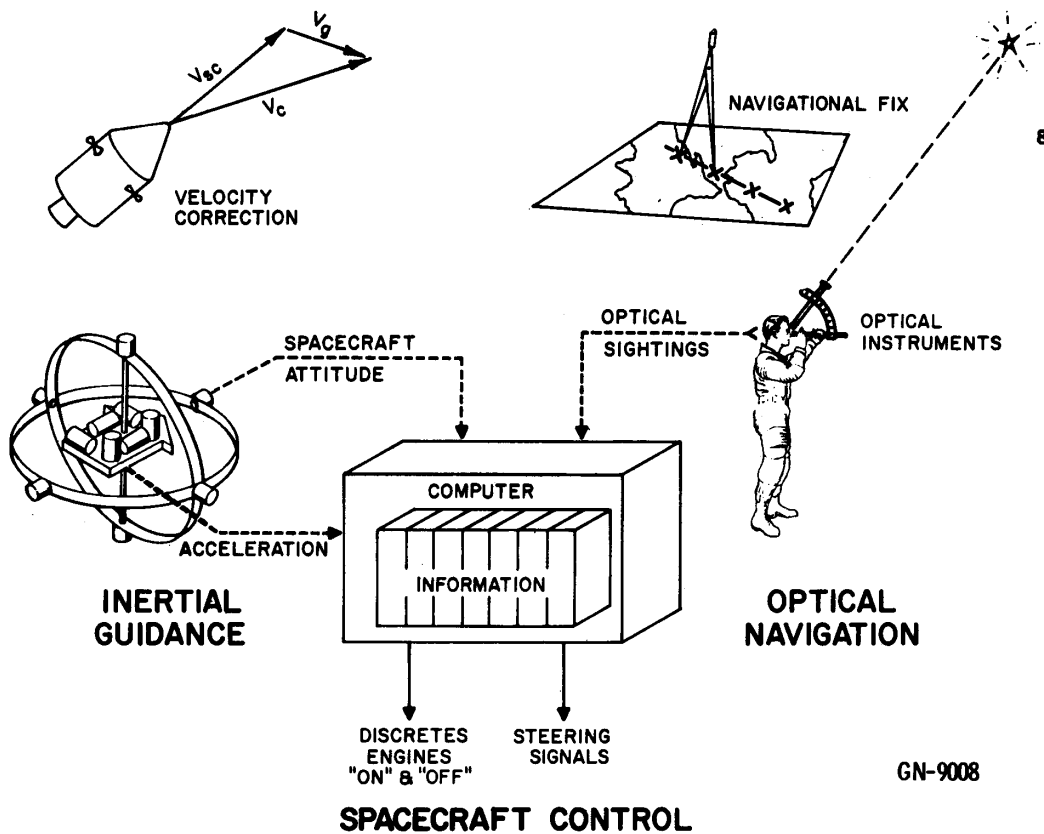
GN-197B-1

ENTRY PROFILE

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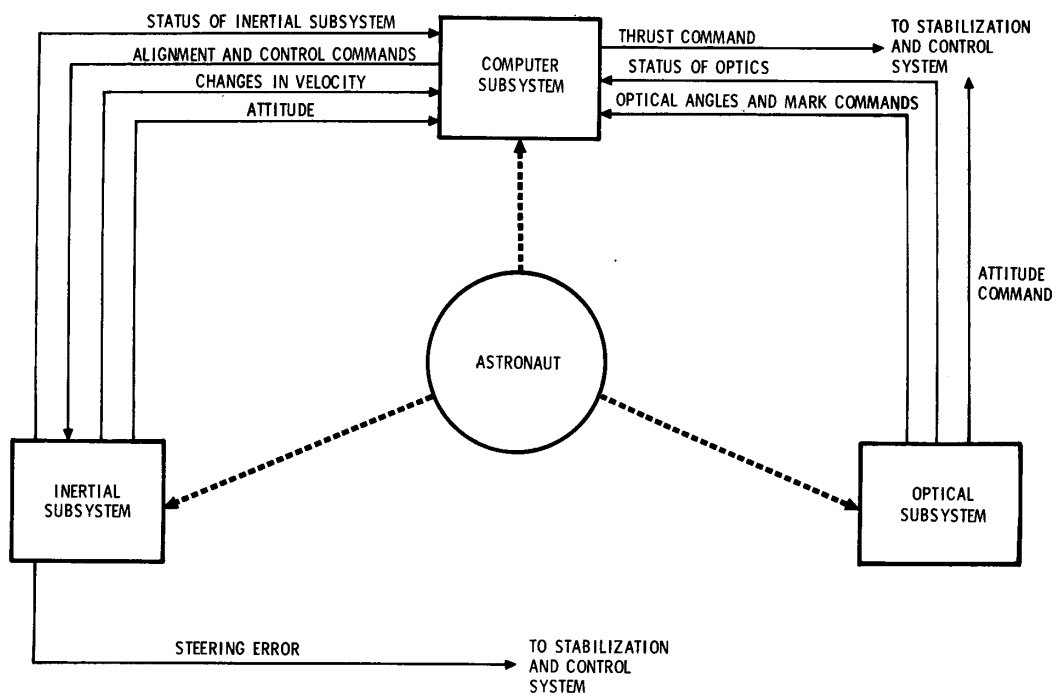


GN-197B-2



GN-9008

INTERFACE OF G AND N SUBSYSTEMS

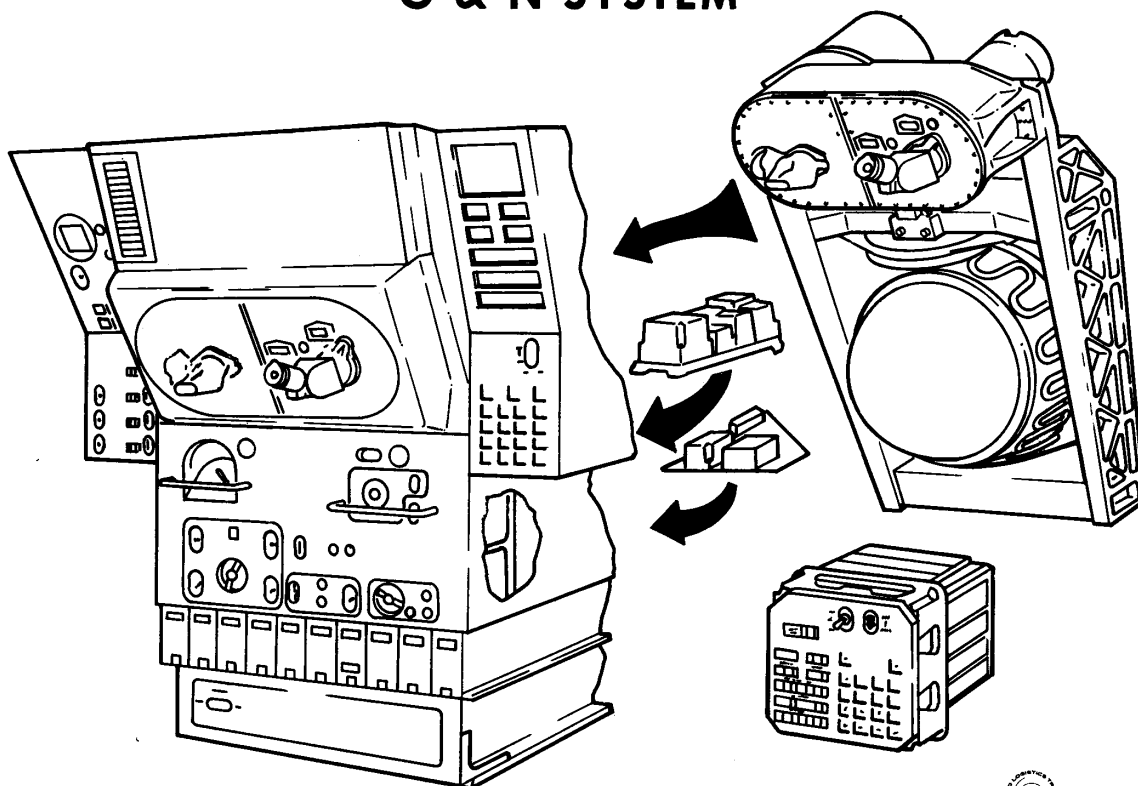


GN-9088A 

G&N HARDWARE

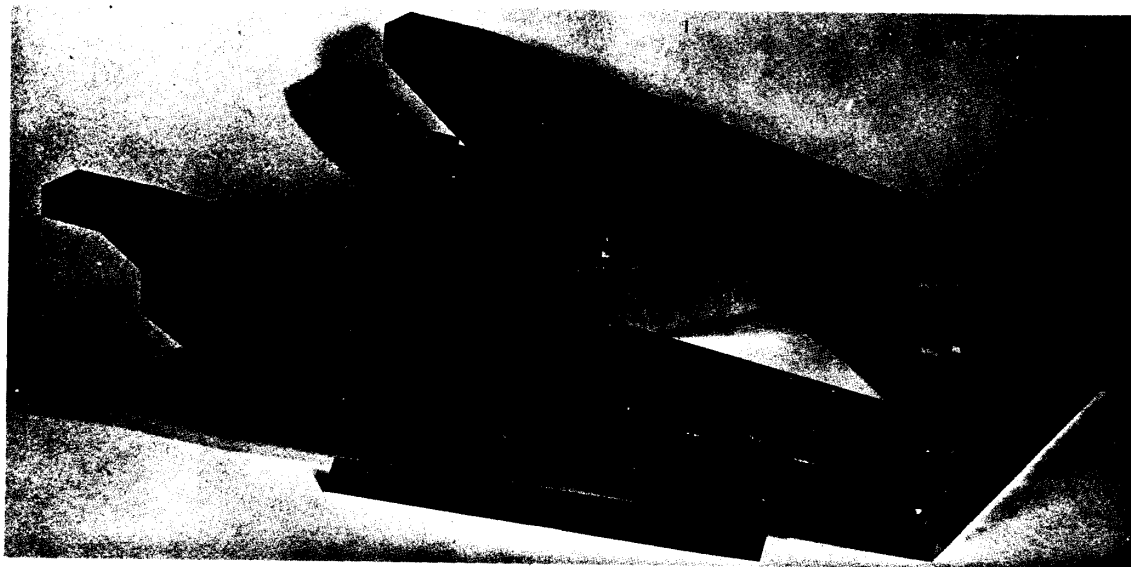
GN-223 

G & N SYSTEM



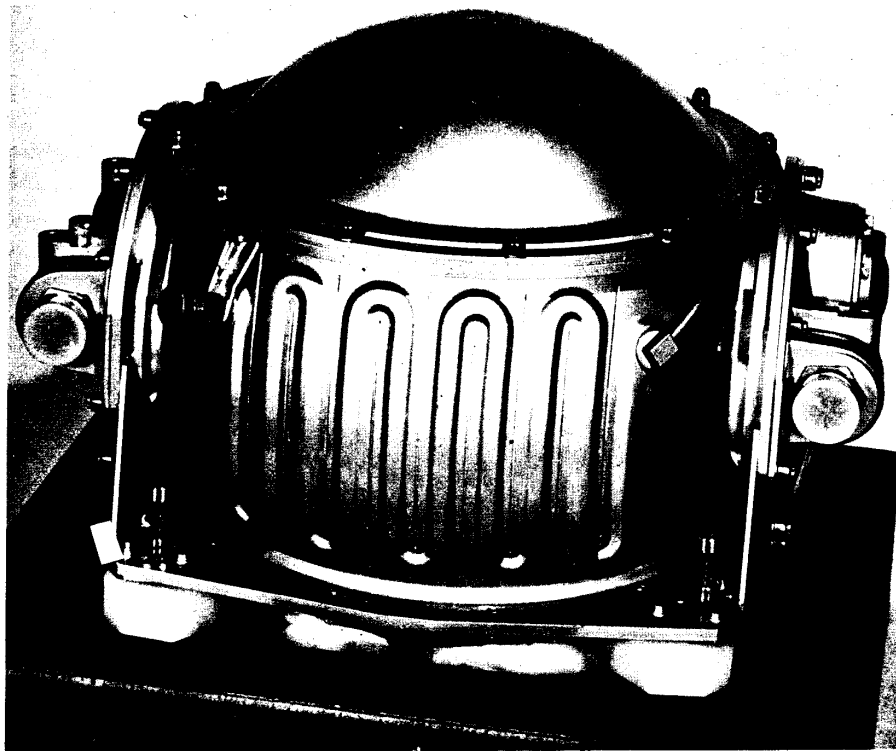
GN-235

NVB



GN-190

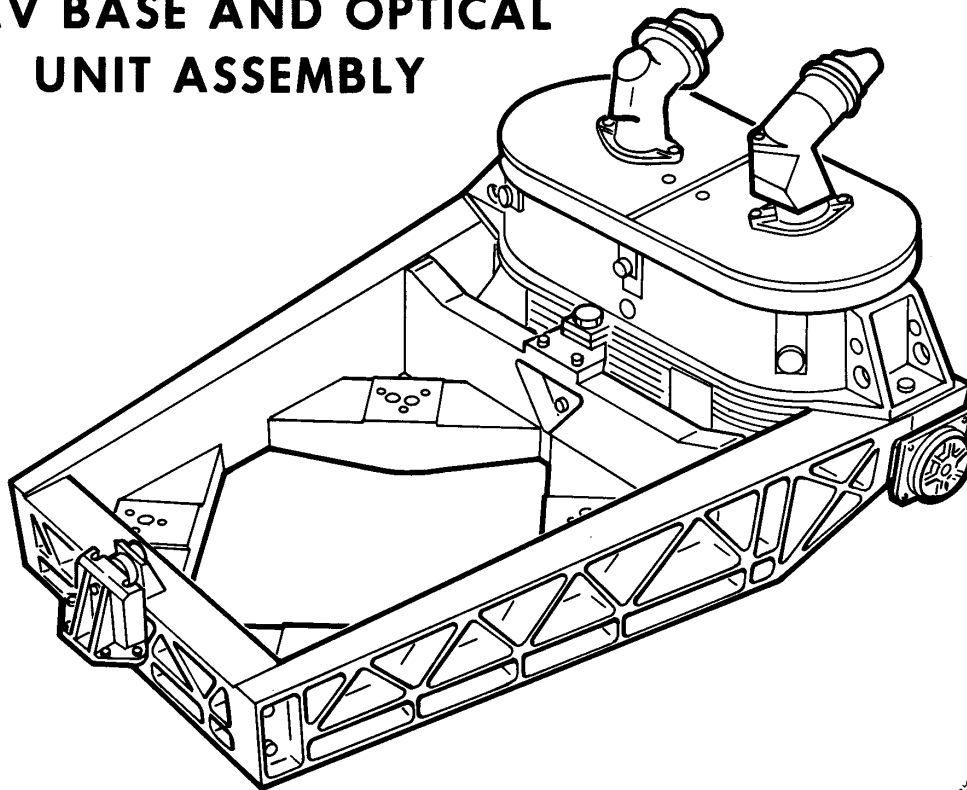
IMU



GN-189



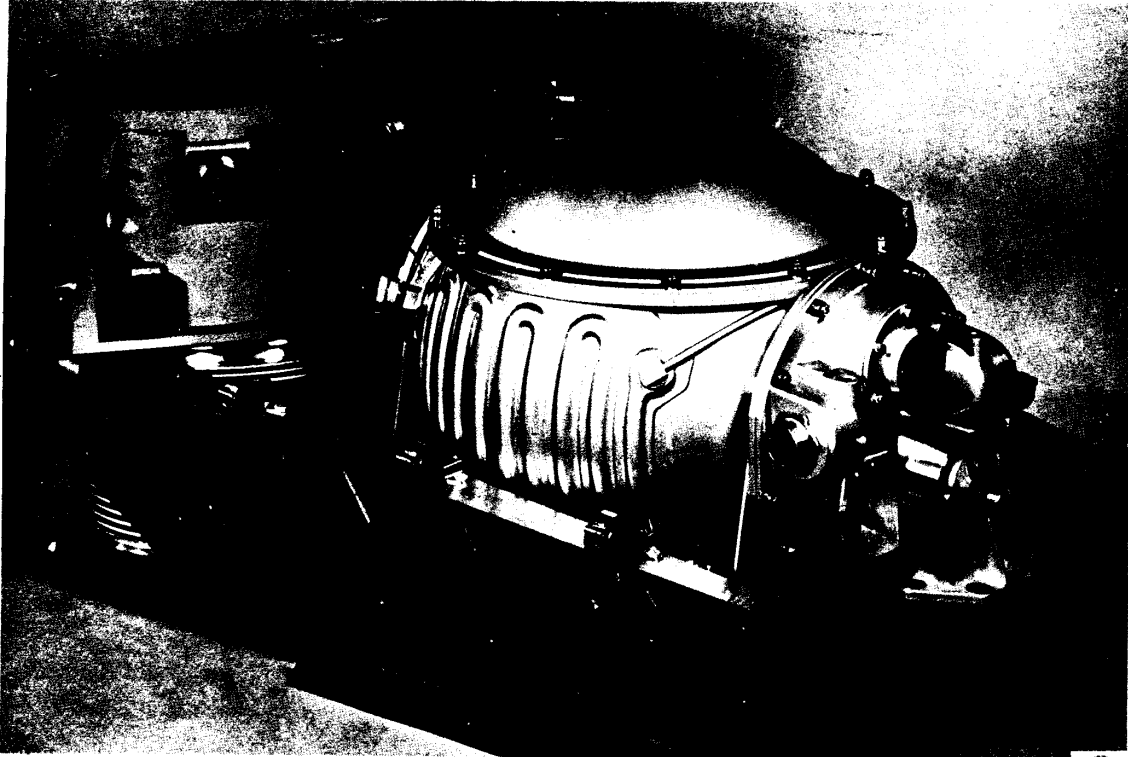
NAV BASE AND OPTICAL UNIT ASSEMBLY



GN-236

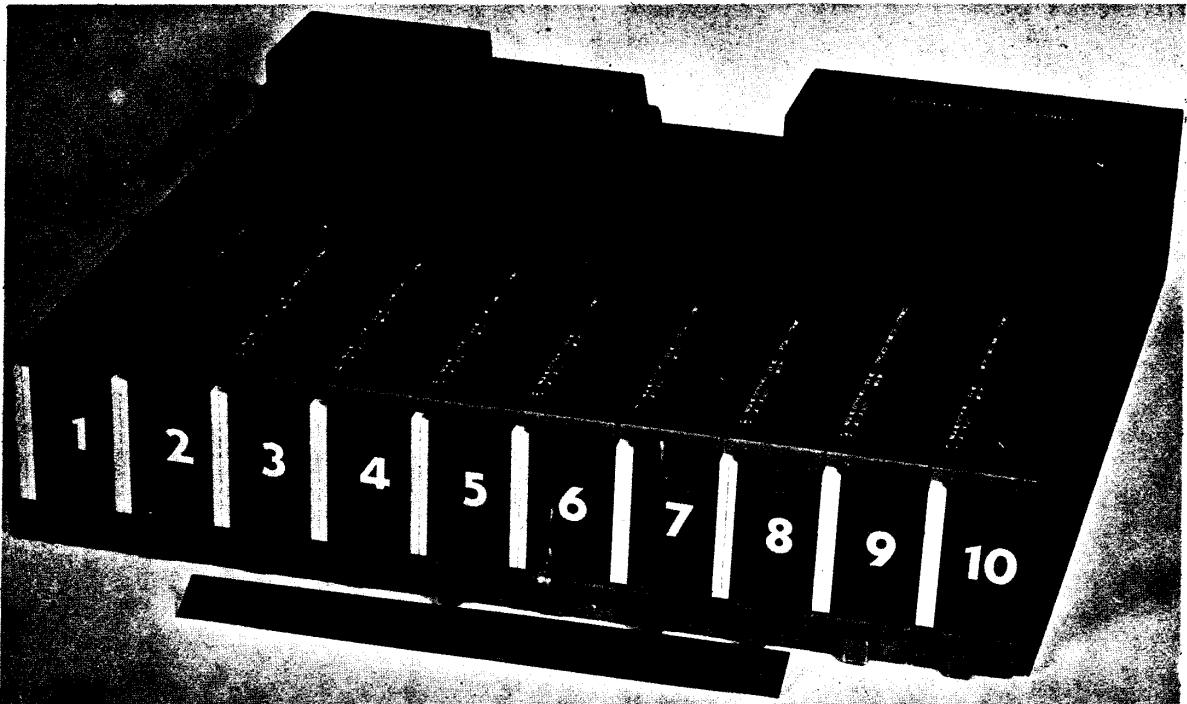


OPTICS-INERTIAL ASSEMBLY



GN-195 

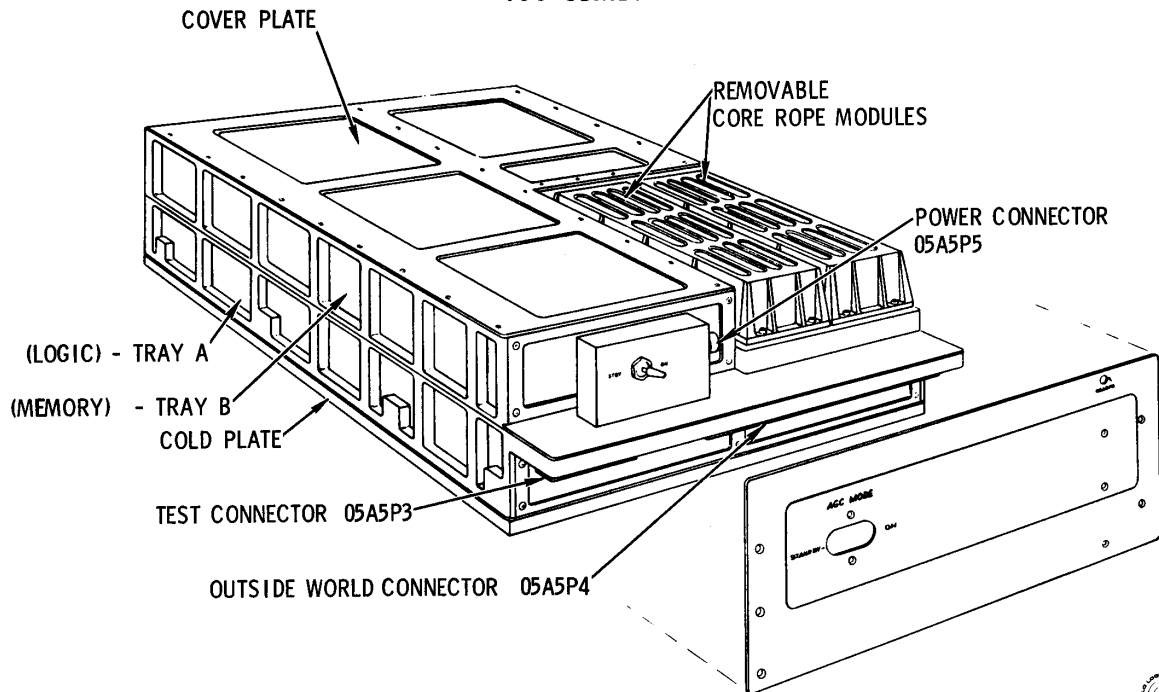
PSA



GN-192 

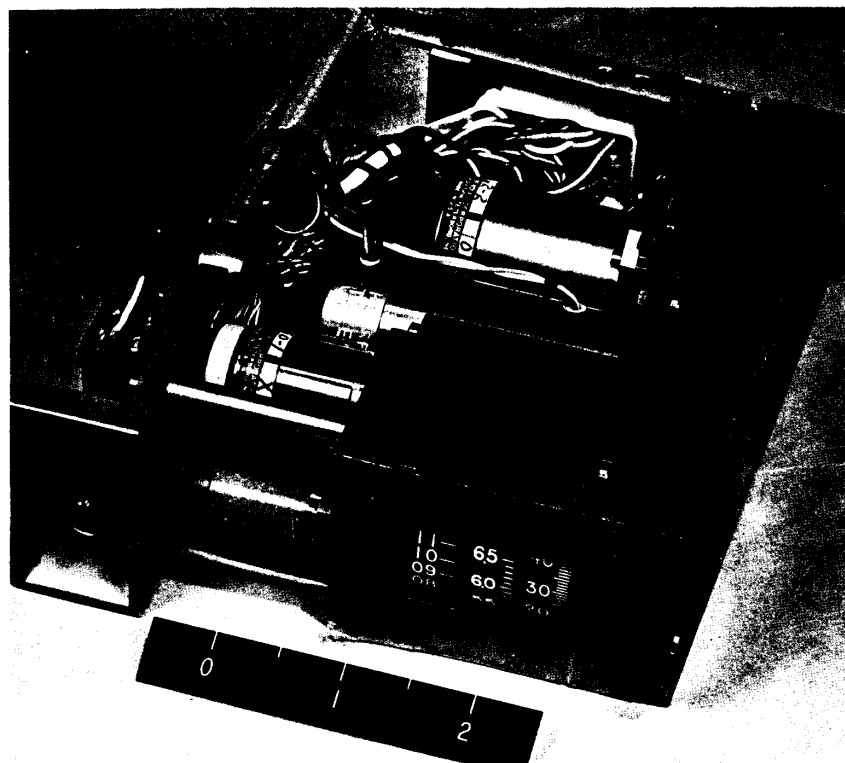
BLOCK I COMPUTER

100 SERIES

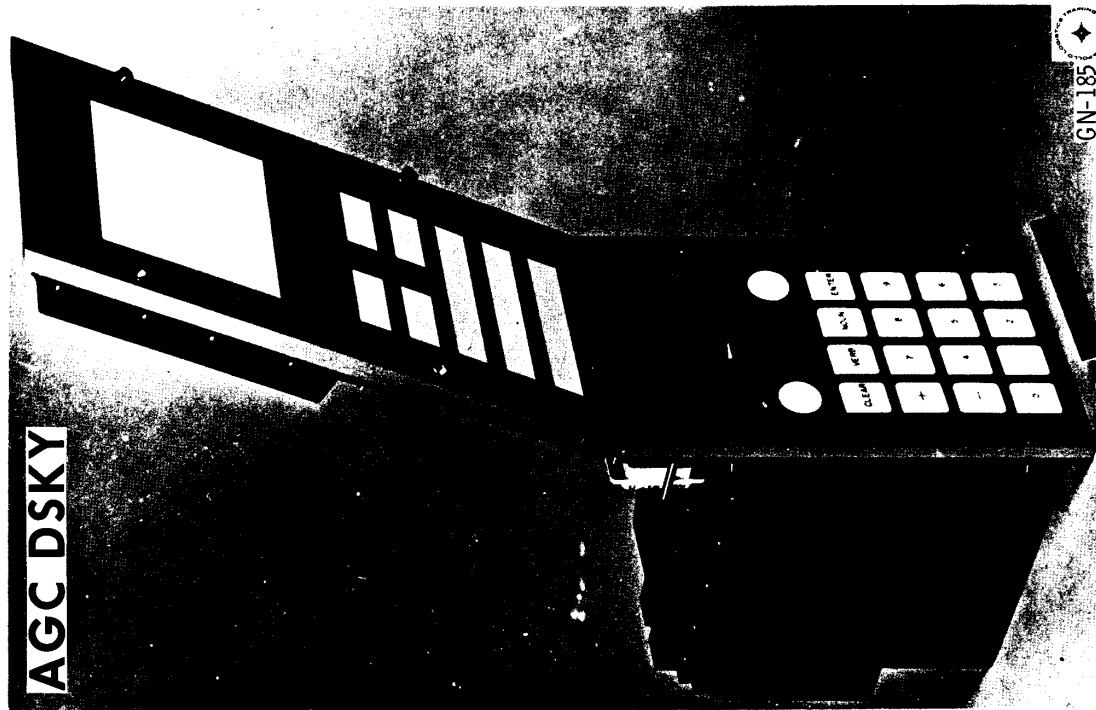


GN-229A

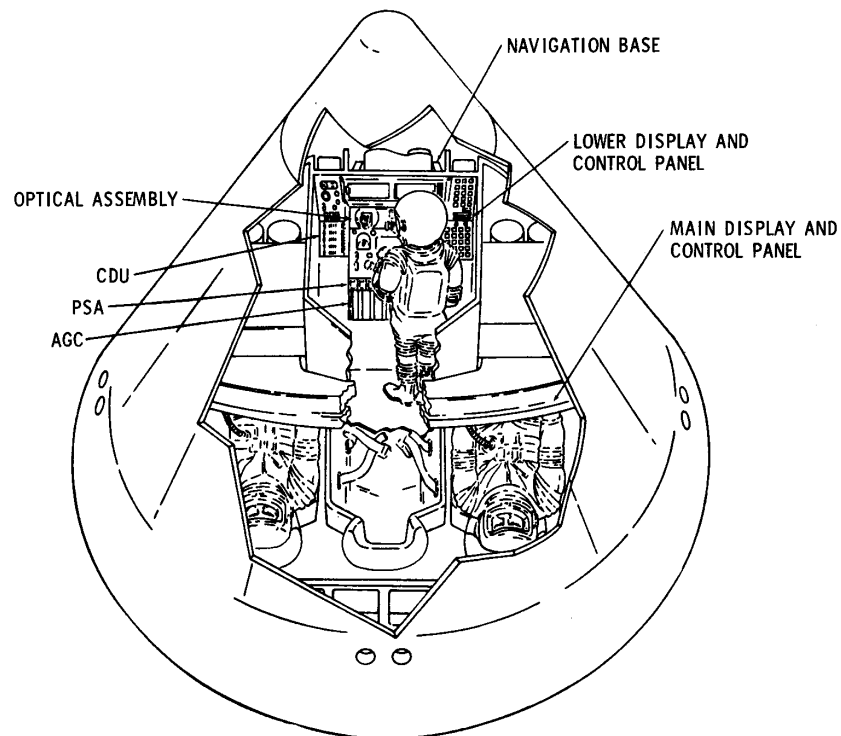
CDU

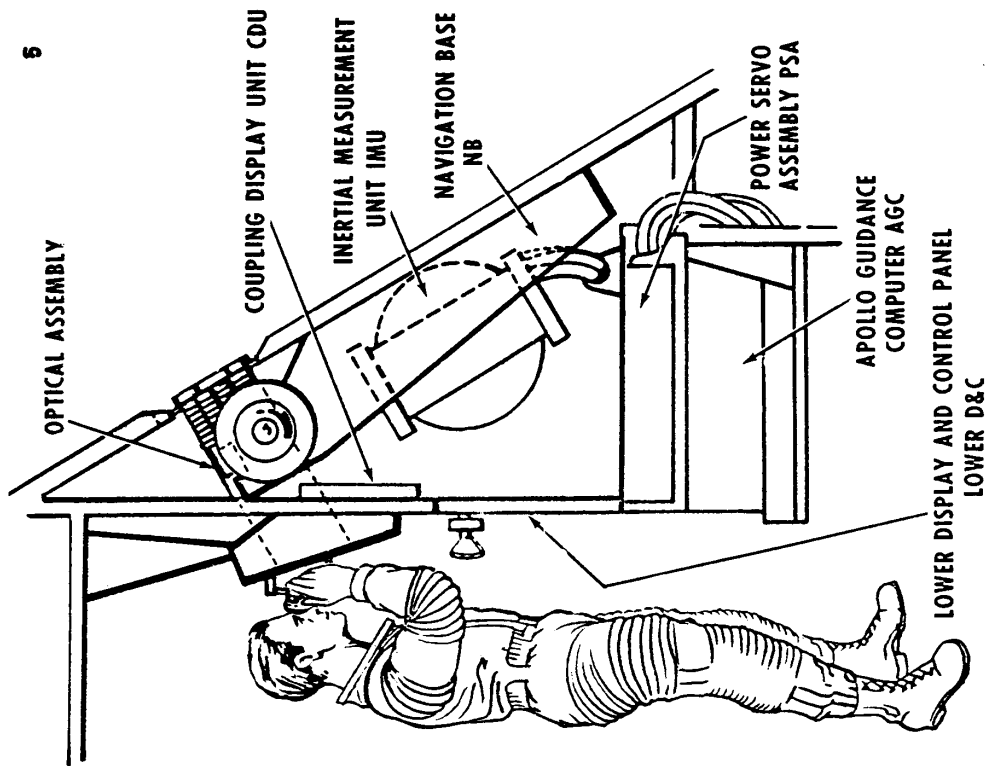


GN-191



G&N SYSTEM EQUIPMENT LOCATION

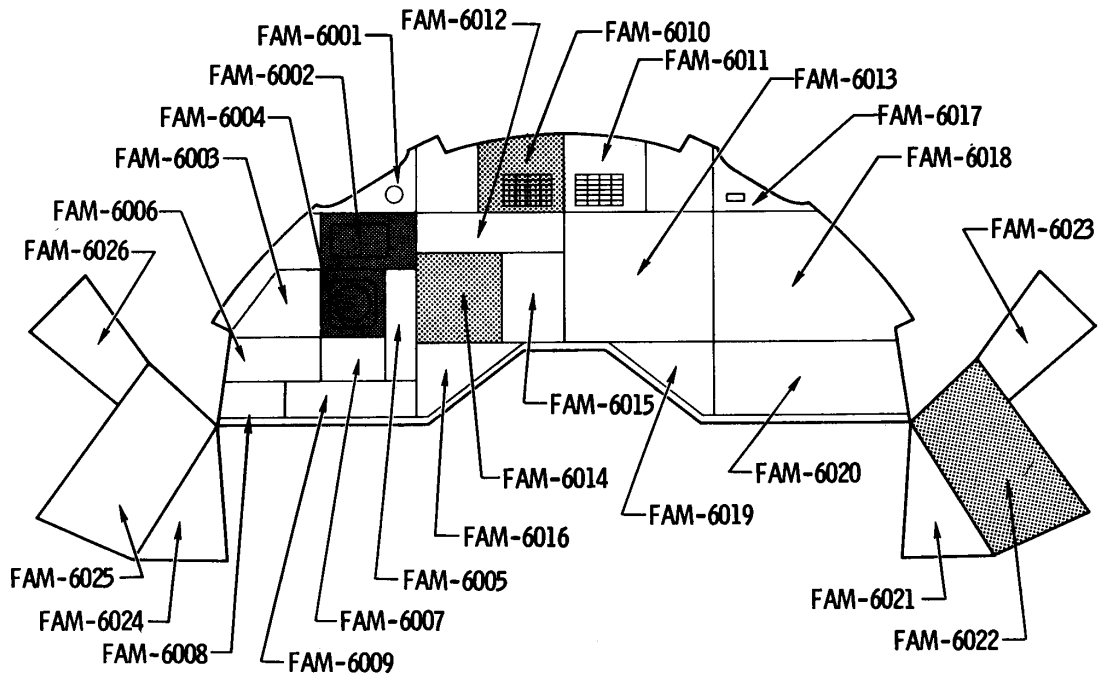




LOCATION OF GUIDANCE AND NAVIGATION
EQUIPMENT IN SPACECRAFT GN-9005

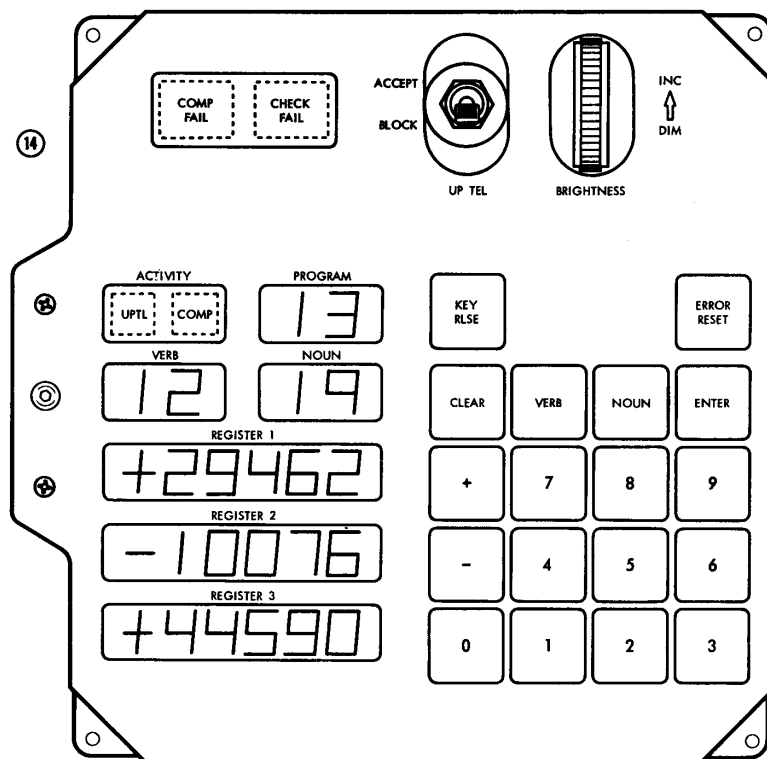
G&N CONTROL & DISPLAYS

MAIN DISPLAY CONSOLE LOCATOR



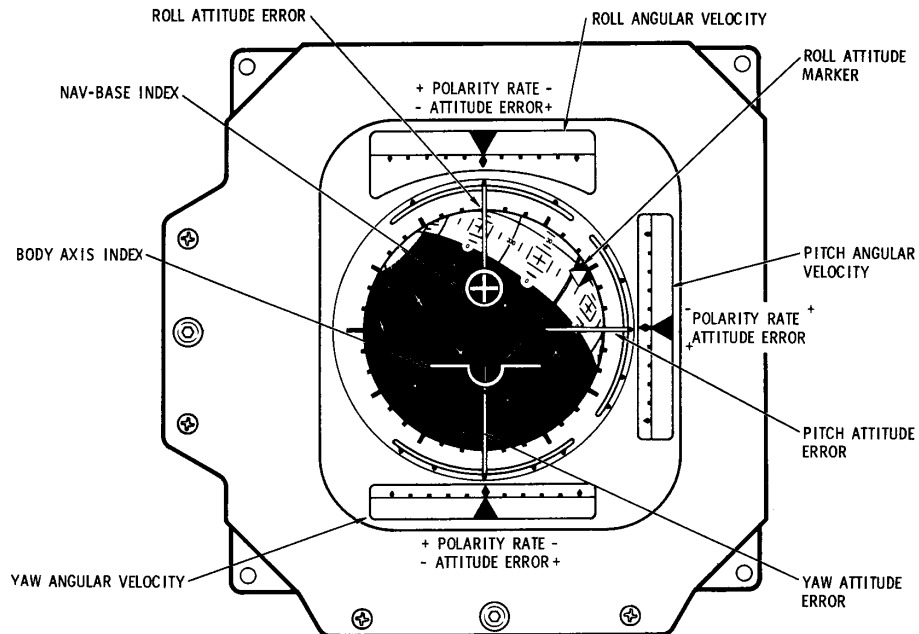
GN-207A 

G & N COMPUTER CONTROL



FAM-6014 

FLIGHT DIRECTOR ATTITUDE INDICATOR



NOTES:

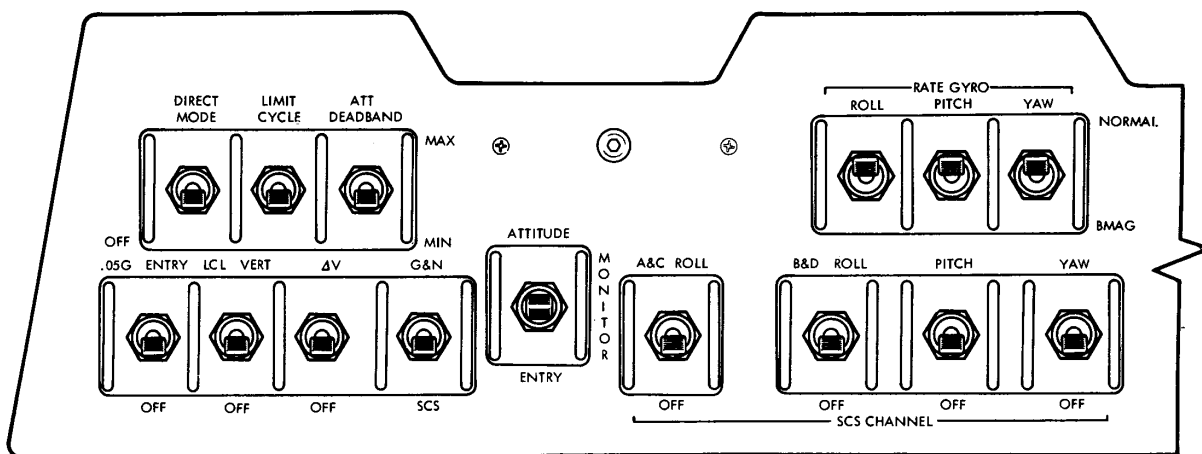
1. ATTITUDE ERROR = ATTITUDE DESIRED - ACTUAL ATTITUDE.
2. THE BALL IS OF THE INSIDE-OUT CONVENTION.
3. EULER ANGLE CONVENTION IS PITCH, YAW, ROLL.
4. THE BALL ATTITUDE SHOWN IS PITCH 345°, YAW 335°, AND ROLL 300°, WITH RESPECT TO THE NAVIGATION BASE INDEX.

SCS-100B



SCS CONTROL PANEL

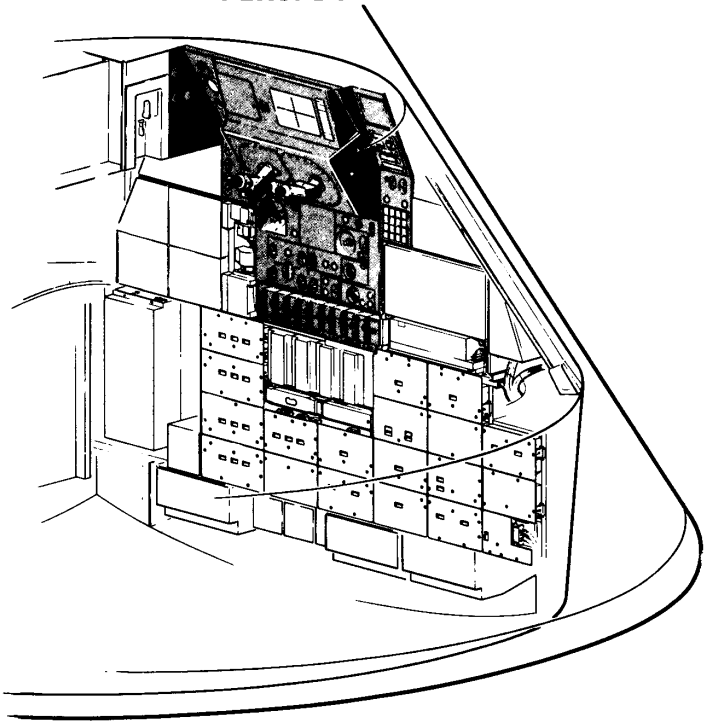
8



SCS-106B



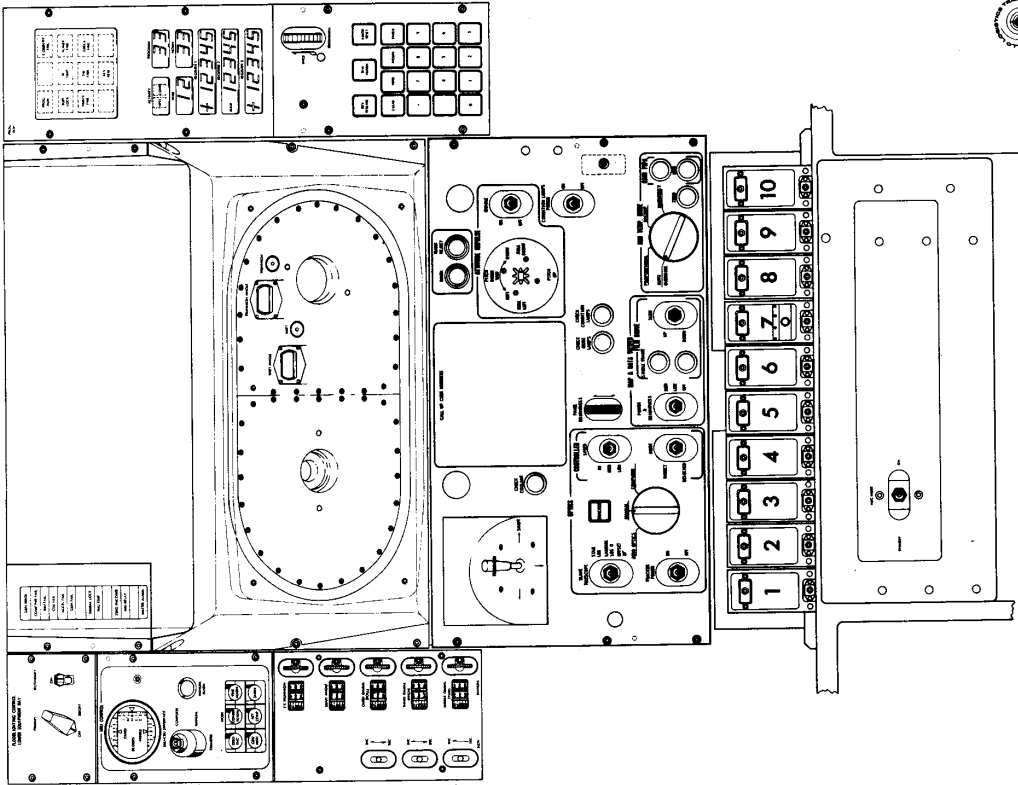
LOWER EQUIPMENT BAY PERSPECTIVE



F-204A

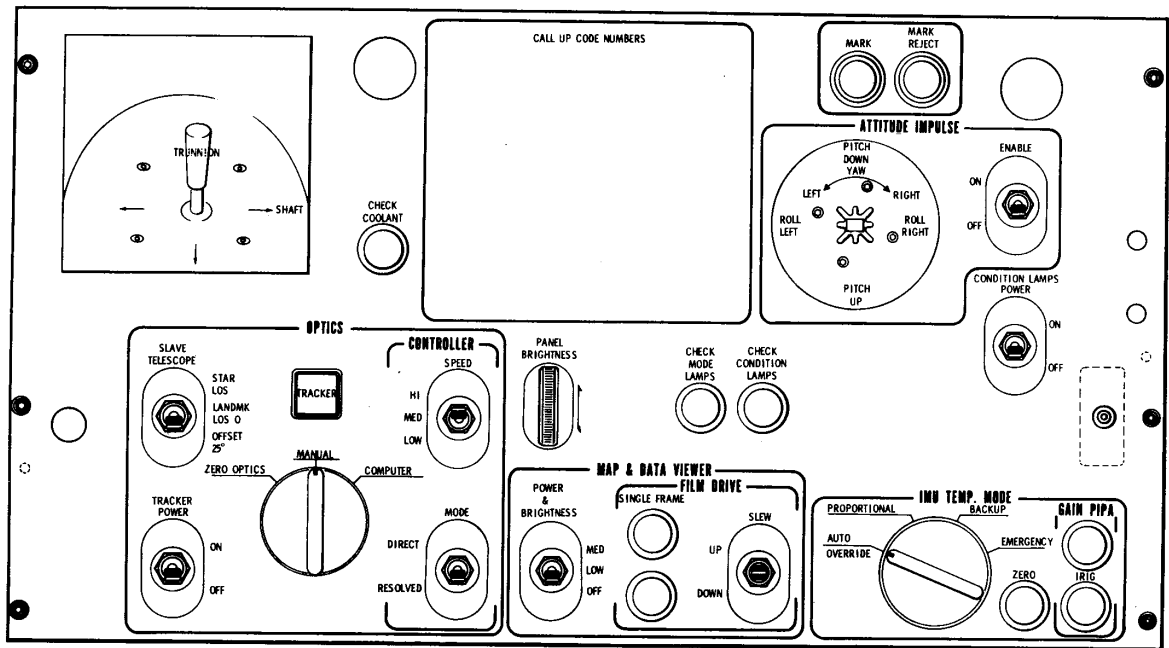
GN-224A

G/N LOWER EQUIPMENT BAY BLOCK I (100 SERIES)



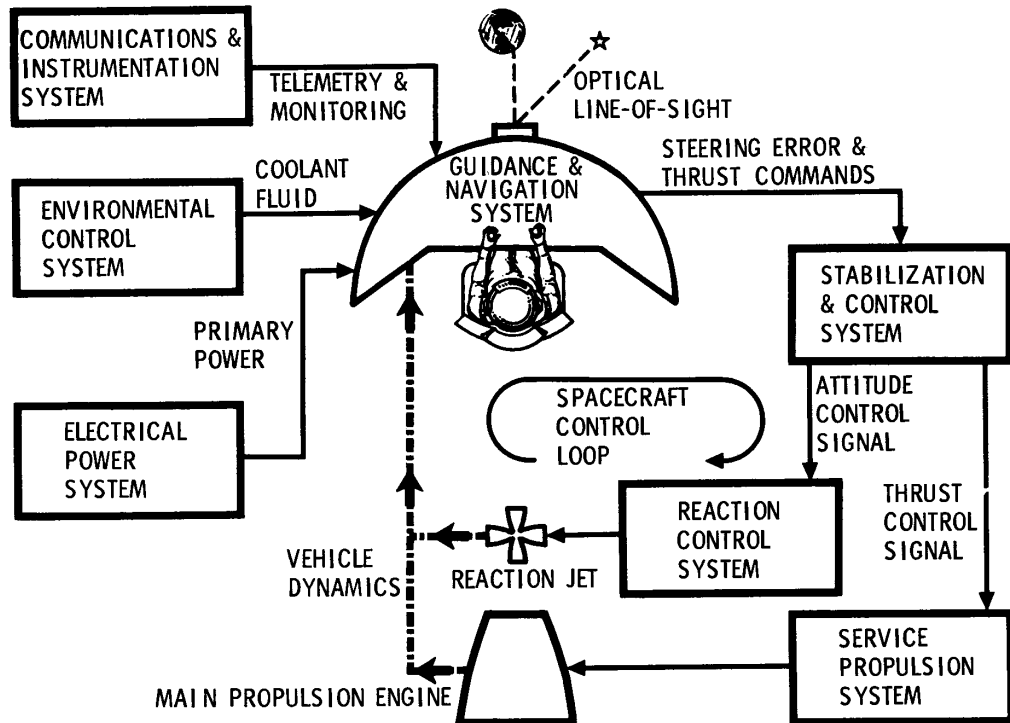
G&N OPTICS CONTROL PANEL

100 SERIES



GN-100A-1

G&N INTERFACE SYSTEMS

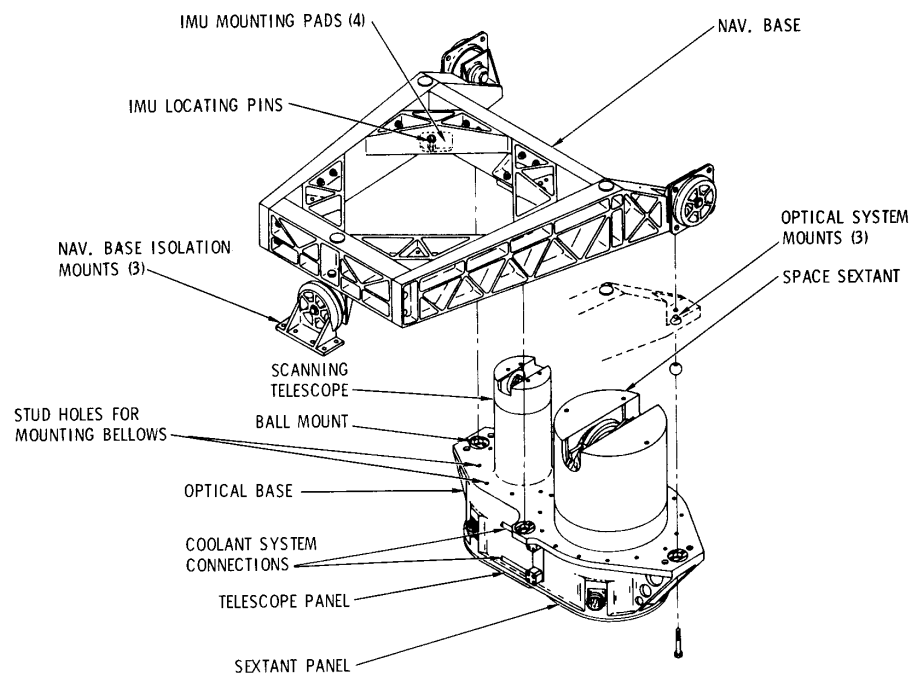


GN-500A

OPTICS SUBSYSTEM

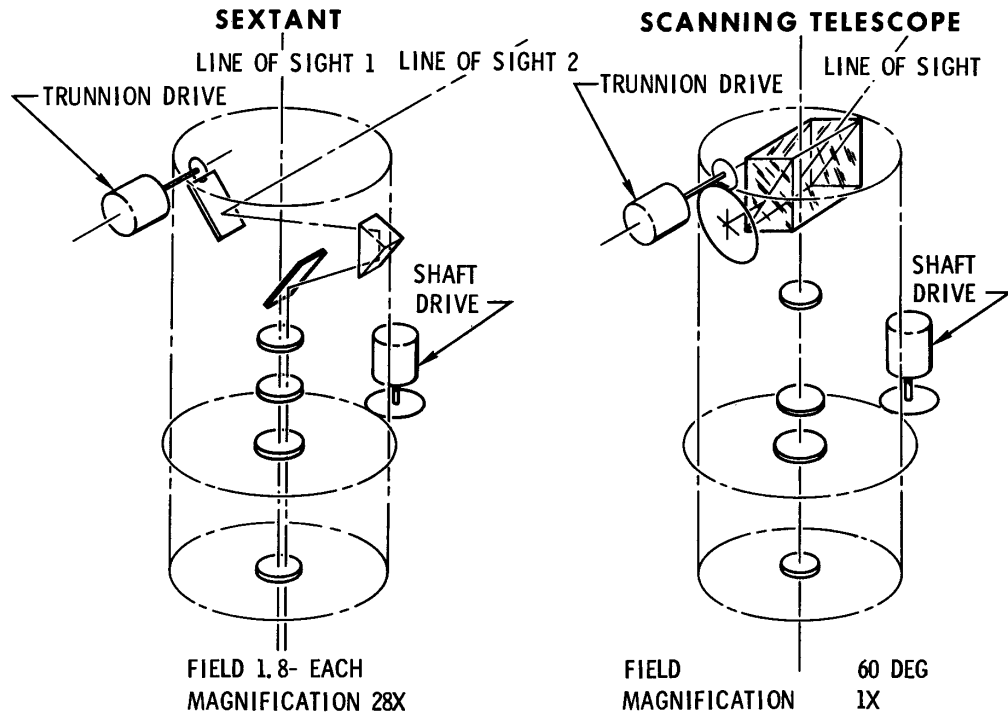
GN-220 

OPTICAL SUBSYSTEM AND NAV. BASE



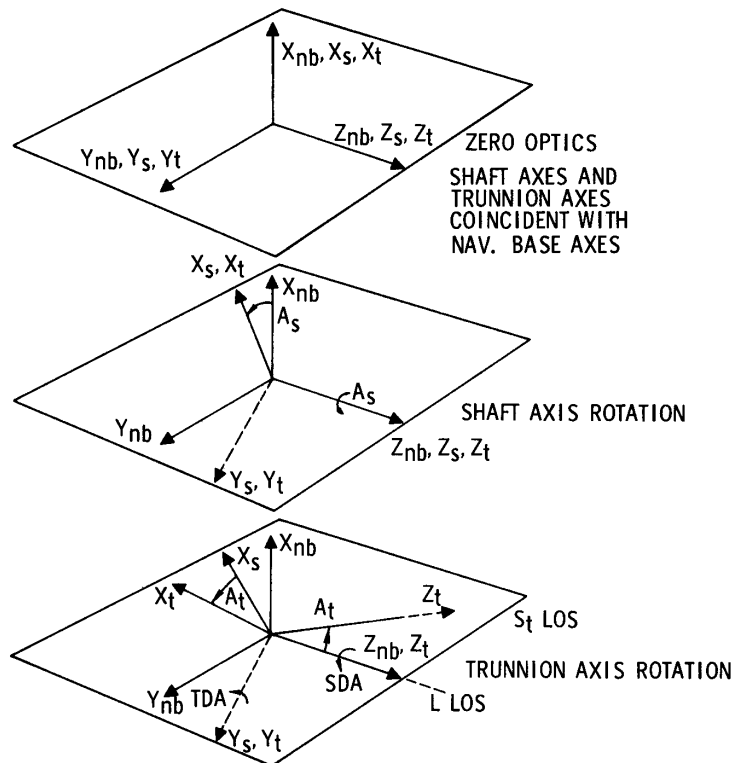
GN-9120A 

OPTICAL SCHEMATIC



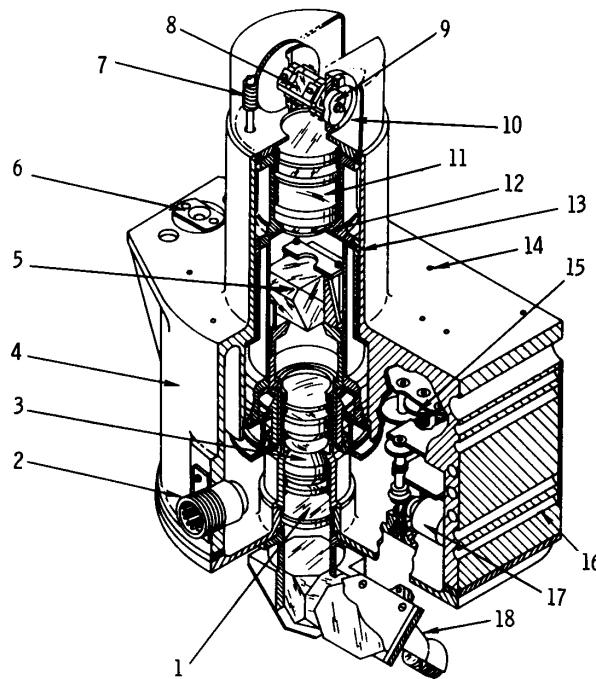
GN-176 A

OPTICAL SYSTEM AXES



GN-9175A

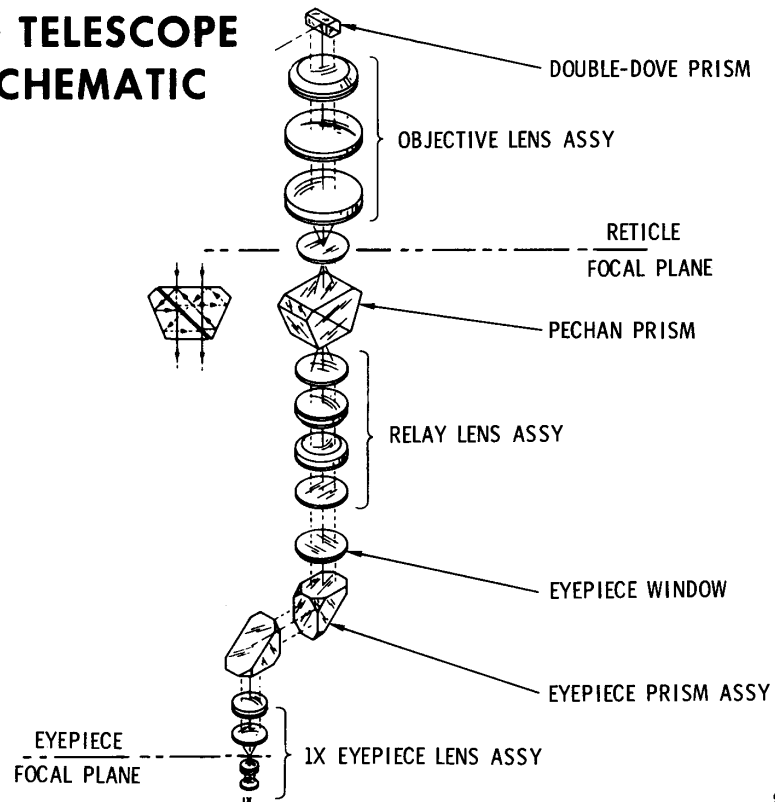
SCANNING TELESCOPE CUTAWAY



1. WINDOW
2. ELECTRICAL CONNECTOR
3. RELAY LENS ASSEMBLY
4. OPTICAL BASE
5. PECHAN PRISM
6. BALL MOUNT
7. TRUNNION DRIVE WORMSHAFT
8. PRISM & MOUNT ASSEMBLY
9. CAM
10. SPRING & CAMFOLLOWER (ANTIBACKLASH)
11. OBJECTIVE LENS ASSEMBLY
12. RETICLE
13. RETICLE ILLUMINATION
14. STUD HOLES FOR BELLOW COVER
15. SHAFT DRIVE GEAR BOX
16. HEAT EXCHANGER CHANNELS
17. COUNTER (SHAFT AXIS)
18. EYEPIECE ASSEMBLY

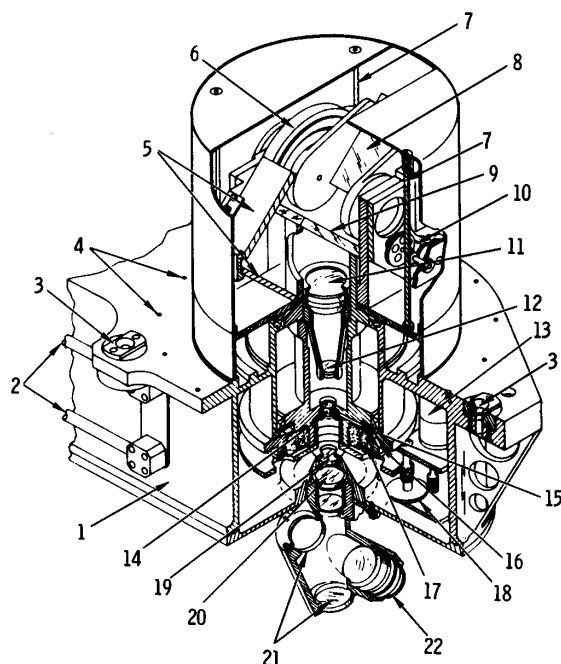
GN-9121A 

SCANNING TELESCOPE OPTICAL SCHEMATIC



GN-9122 A 

SEXTANT CUTAWAY

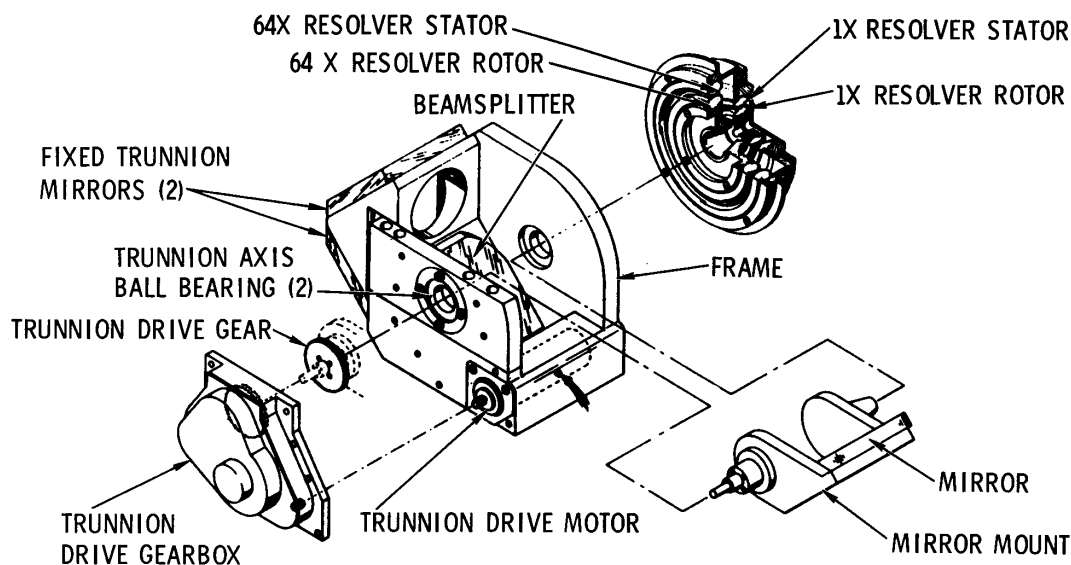


1. OPTICAL BASE
2. COOLANT CONNECTIONS
3. BALL MOUNT
4. STUD HOLES FOR MOUNTING BELLOWS COVER
5. FIXED RIGHT-ANGLE MIRRORS
6. TRUNNION AXIS RESOLVER (64X)
7. COVER-FASTENING ROD
8. INDEXING MIRROR
9. BEAM SPLITTER
10. TRUNNION DRIVE GEAR BOX
11. OBJECTIVE LENS ASSEMBLY
12. INTERMEDIATE LENS ASSEMBLY
13. SHAFT AXIS DRIVE MOTOR
14. RETICLE
15. LIGHT-TRANSMITTING ROD
16. RETICLE LAMP
17. SHAFT-AXIS RESOLVER (16X)
18. SHAFT DRIVE GEAR BOX
19. EYEPIECE SOCKET & SEAL
20. EYEPIECE OBJECTIVE LENS
21. EYEPIECE MIRRORS
22. EYEPIECE OCULAR

GN-9124 A



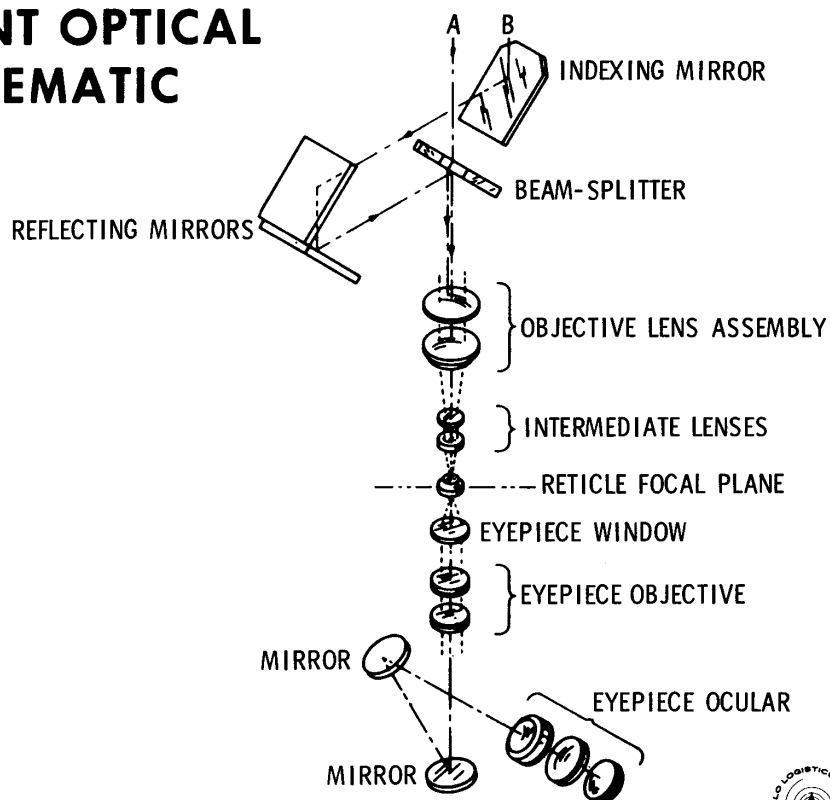
SEXTANT TRUNNION AXIS ASSEMBLY



GN-9125A

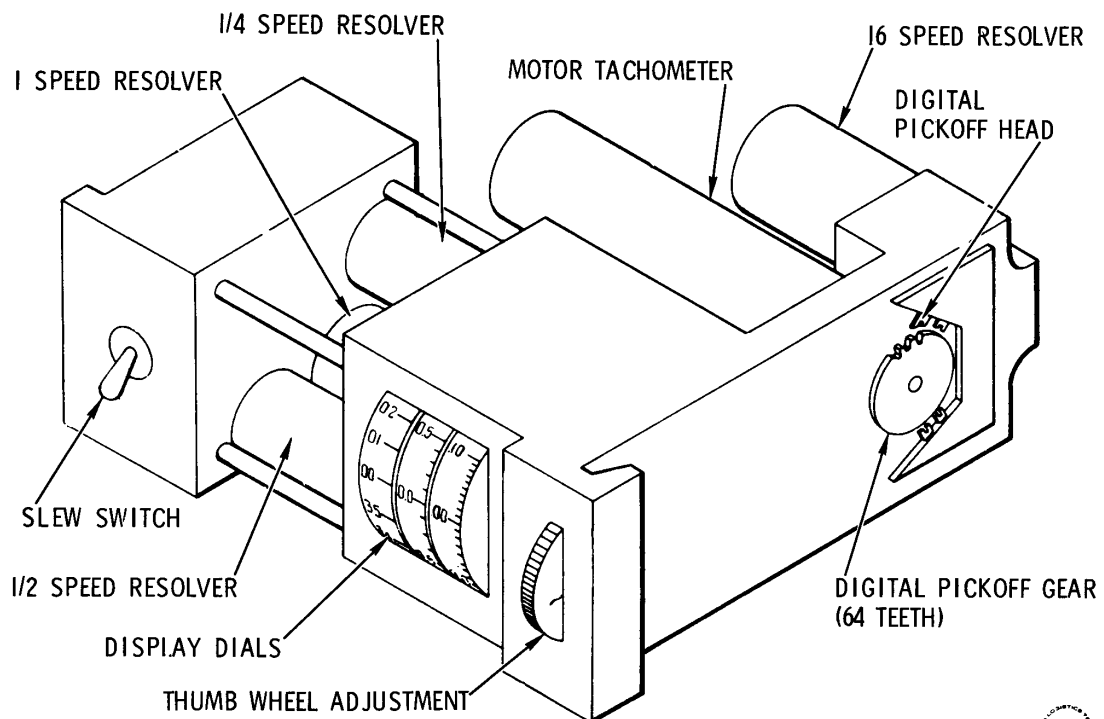


SEXTANT OPTICAL SCHEMATIC

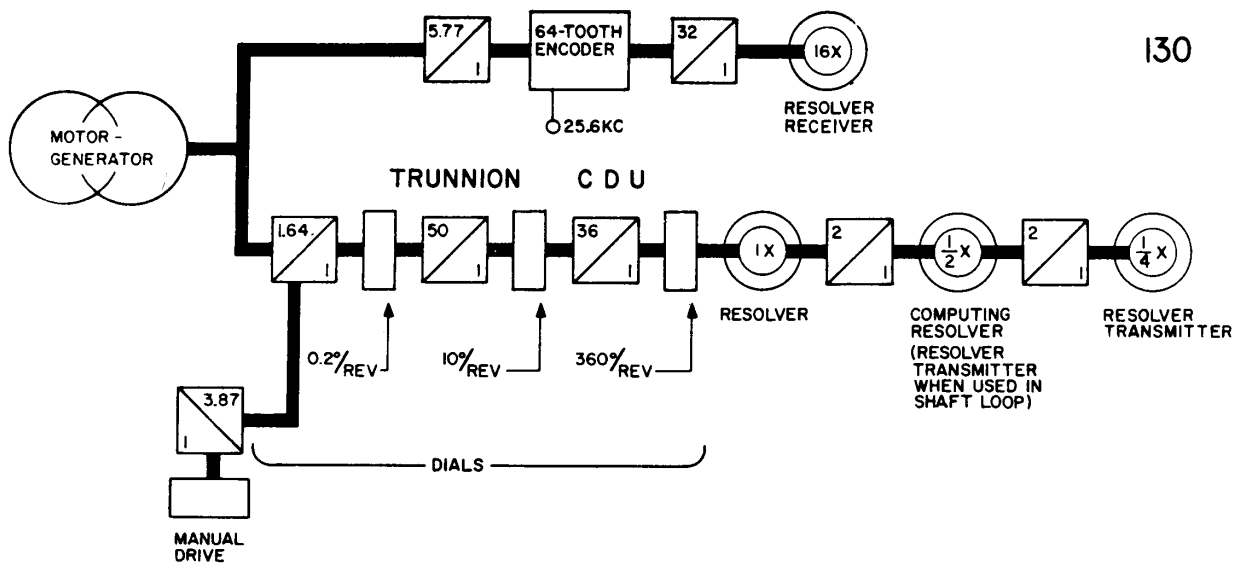


GN-9126A

COUPLING DISPLAY UNIT



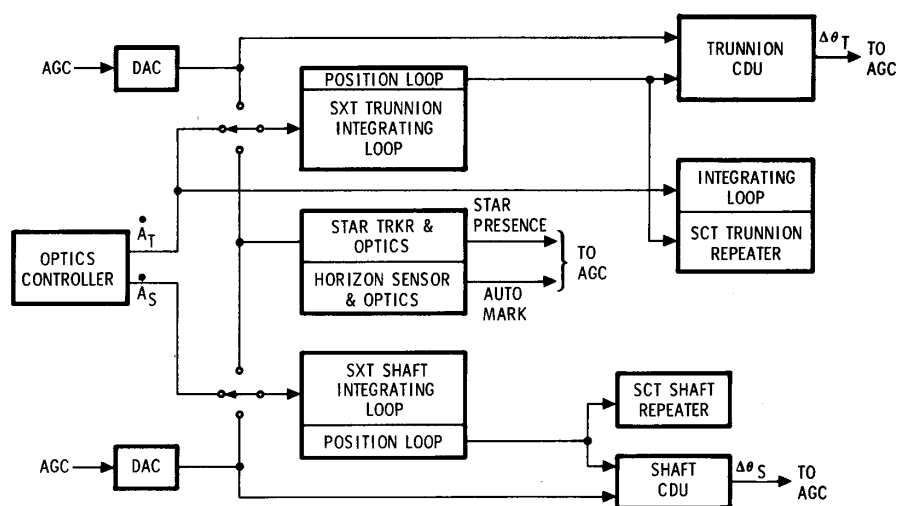
GN-9073A



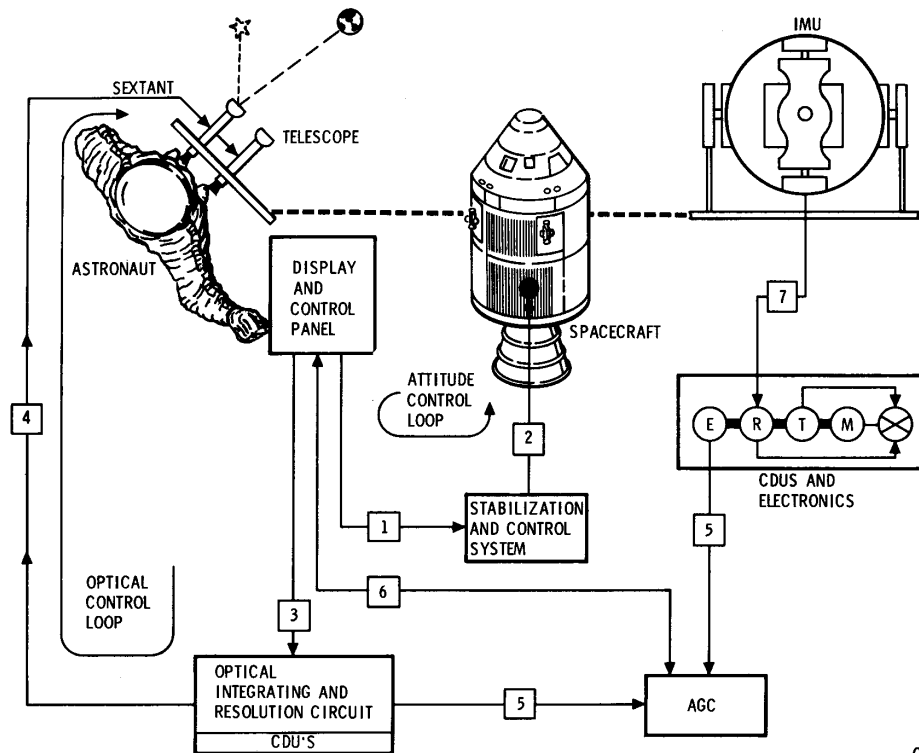
GN-9130

OPTICS MECHANIZATION

BLOCK 1 100SERIES

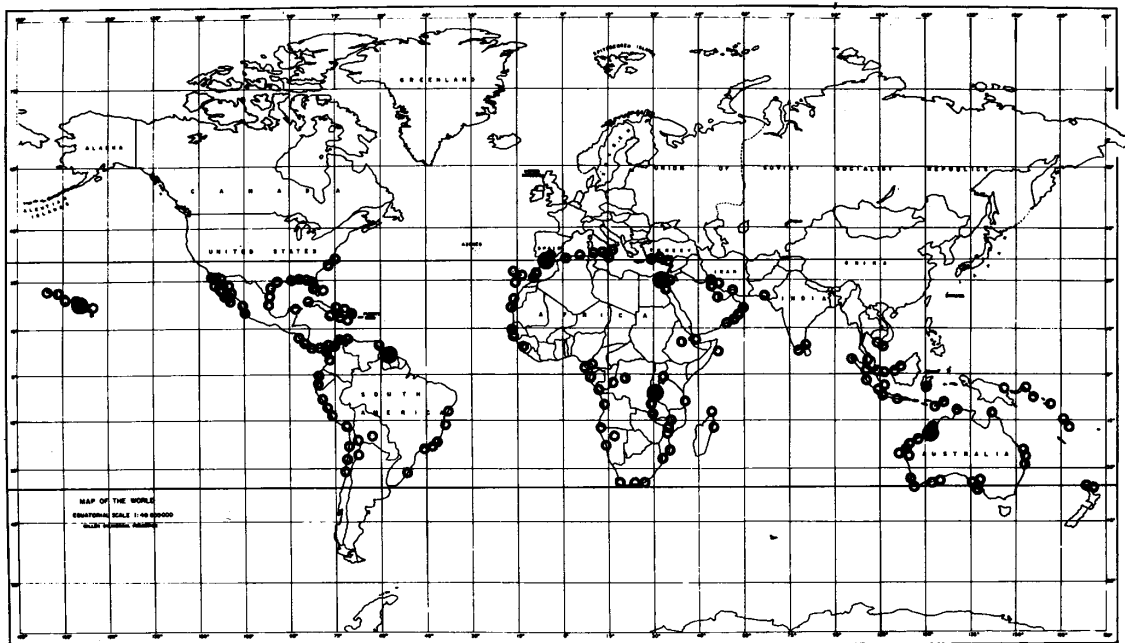


OPTICAL MEASUREMENT



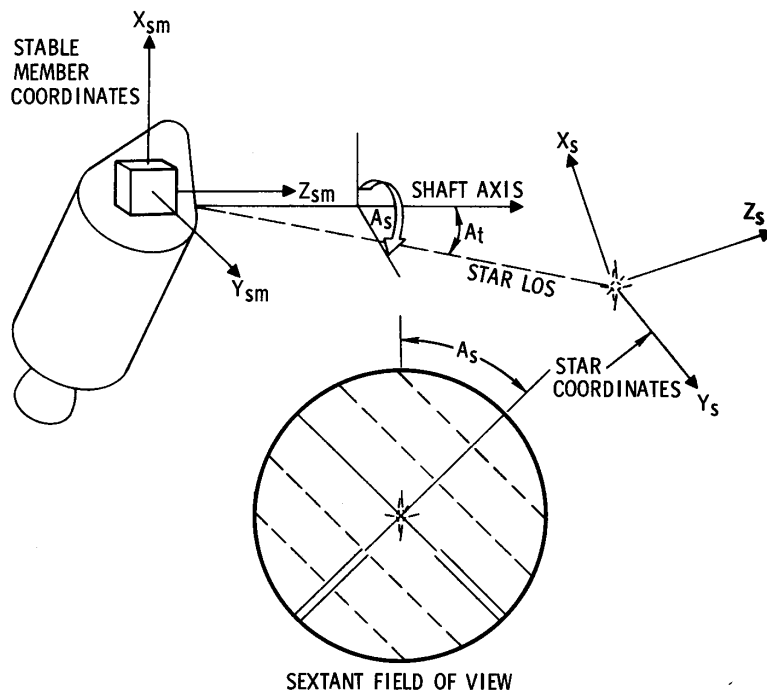
GN-9146A 

LAND MARKS



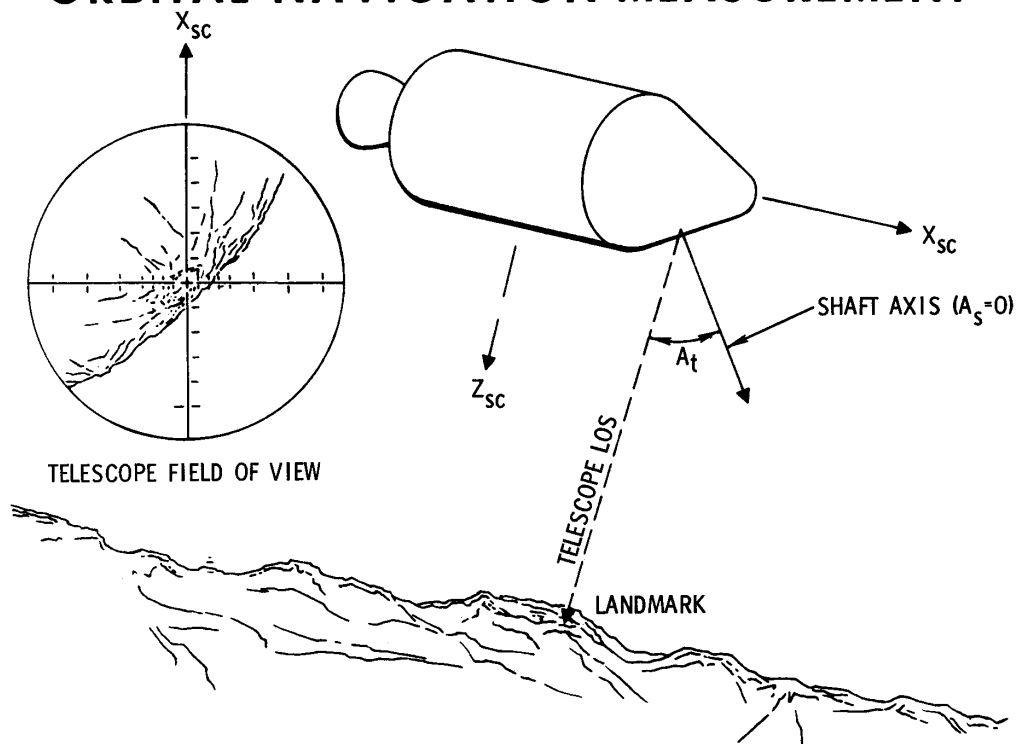
GN-198 

IMU ALIGNMENT MEASUREMENT



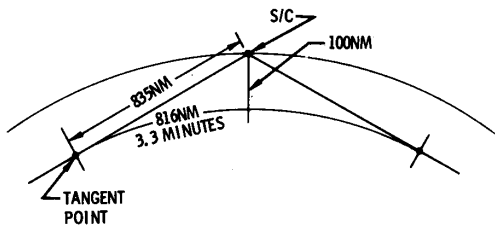
GN-9100A (◆)

ORBITAL NAVIGATION MEASUREMENT

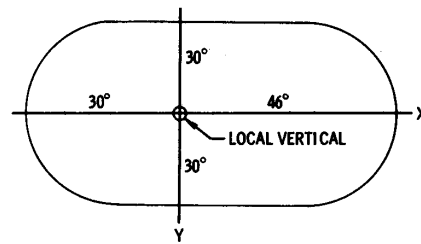


GN-9102A (◆)

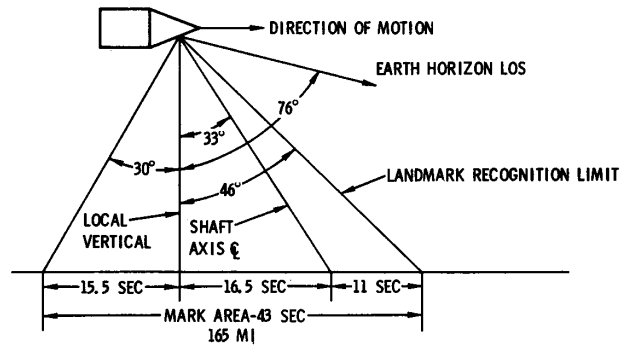
EARTH ORBIT NAVIGATION



EARTH ORBIT GEOMETRY FIGURE 1



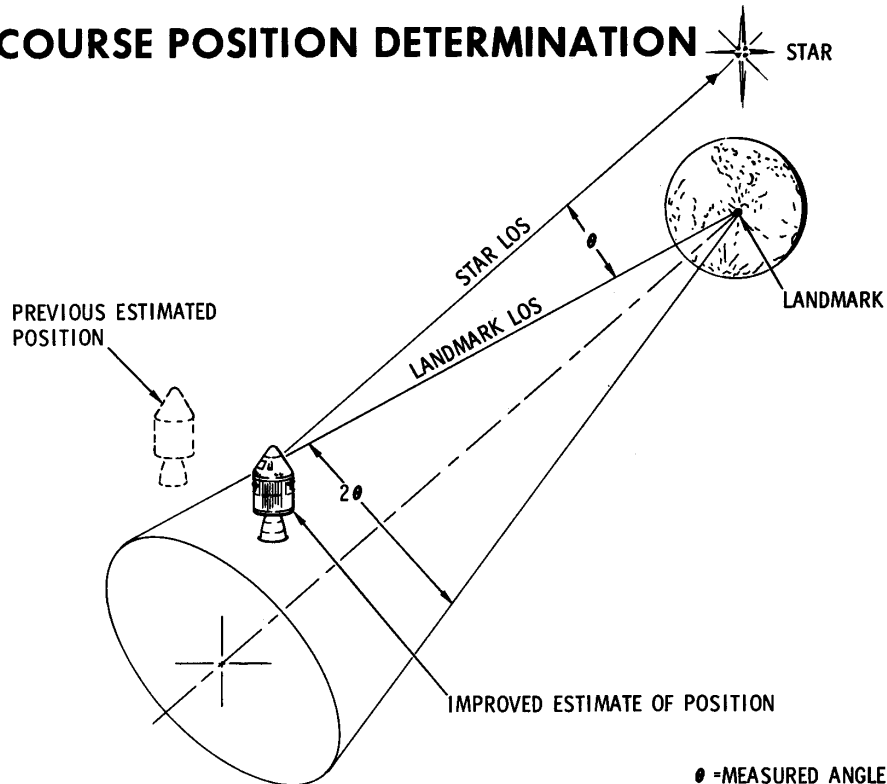
VIEW ON SURFACE FIGURE 3



COVERAGE ON SURFACE FIGURE 2

GN-183A

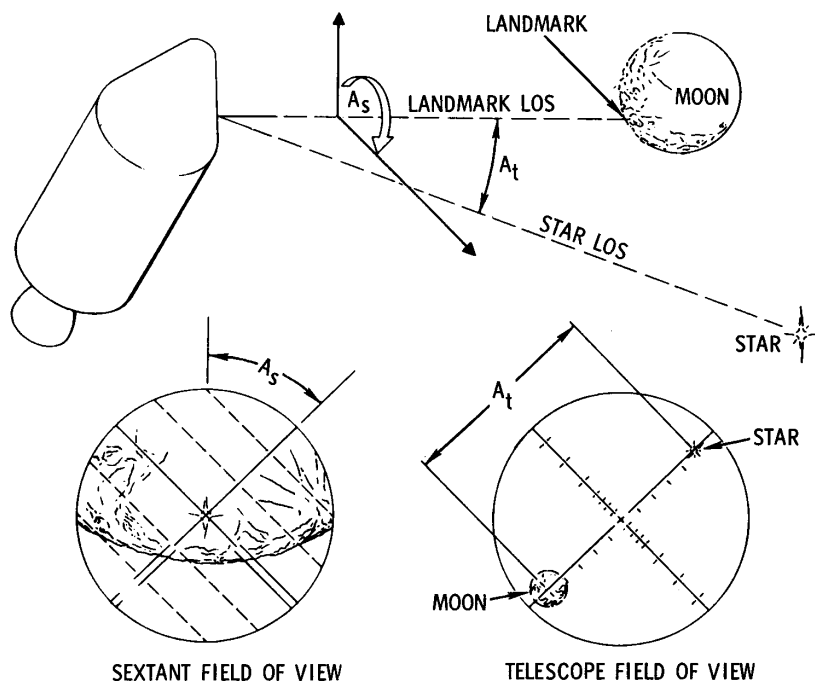
MIDCOURSE POSITION DETERMINATION



● - MEASURED ANGLE

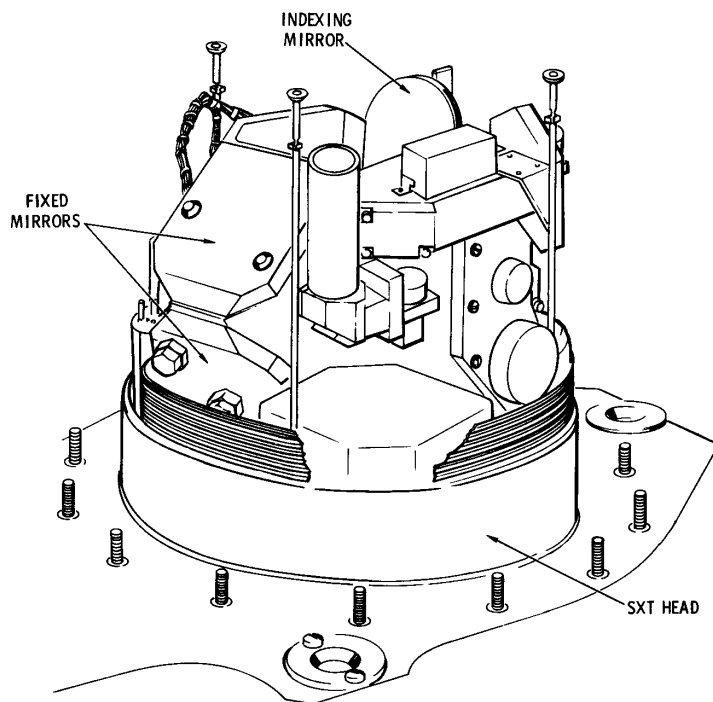
GN-9101A

MIDCOURSE NAVIGATIONAL MEASUREMENT



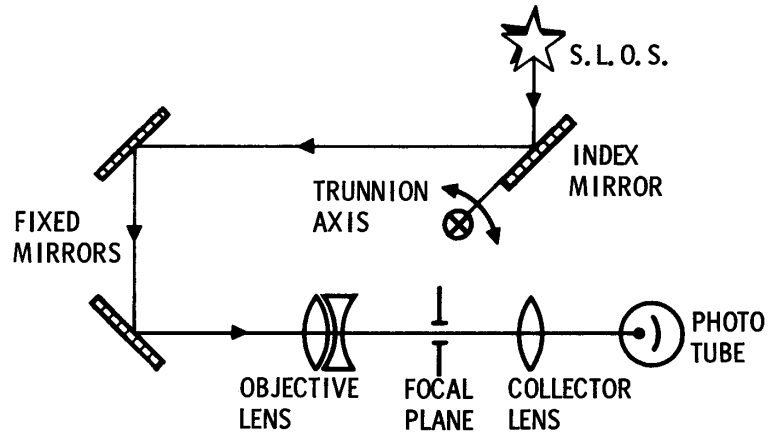
GN-9103A 

TRACKER & HORIZON SENSOR LOCATION

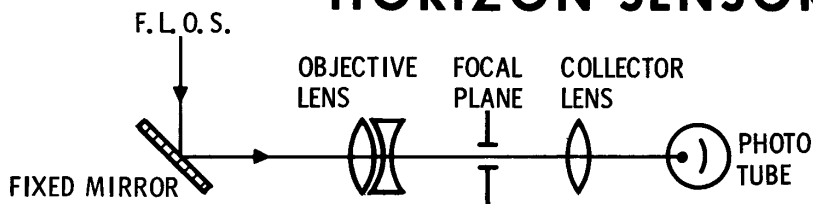


GN-212 

TRACKER LINE OF SIGHT

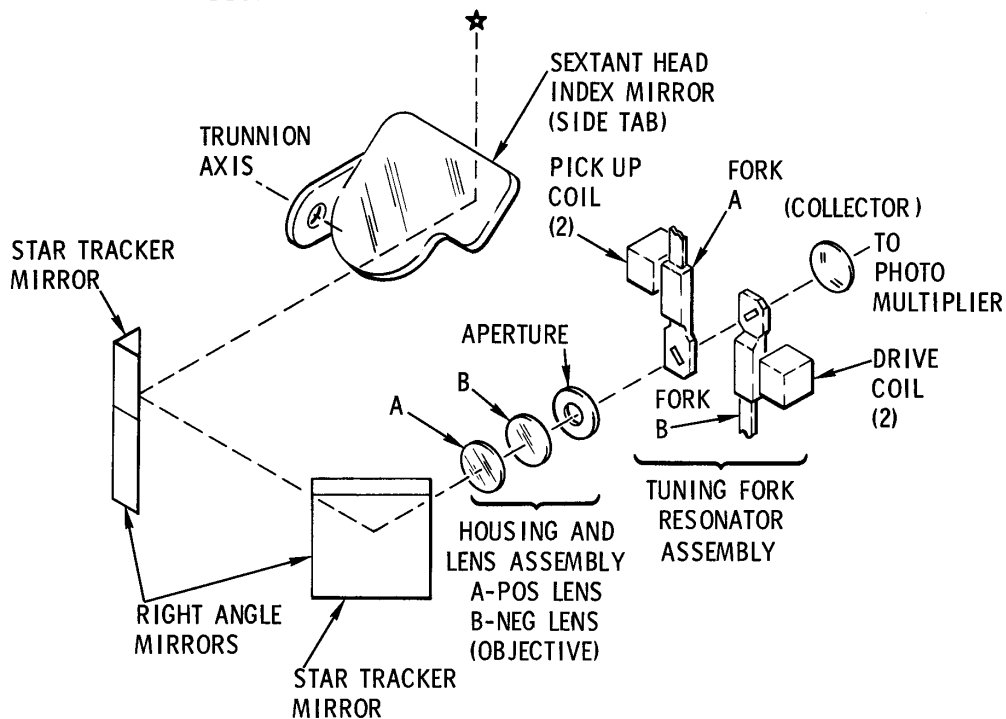


HORIZON SENSOR



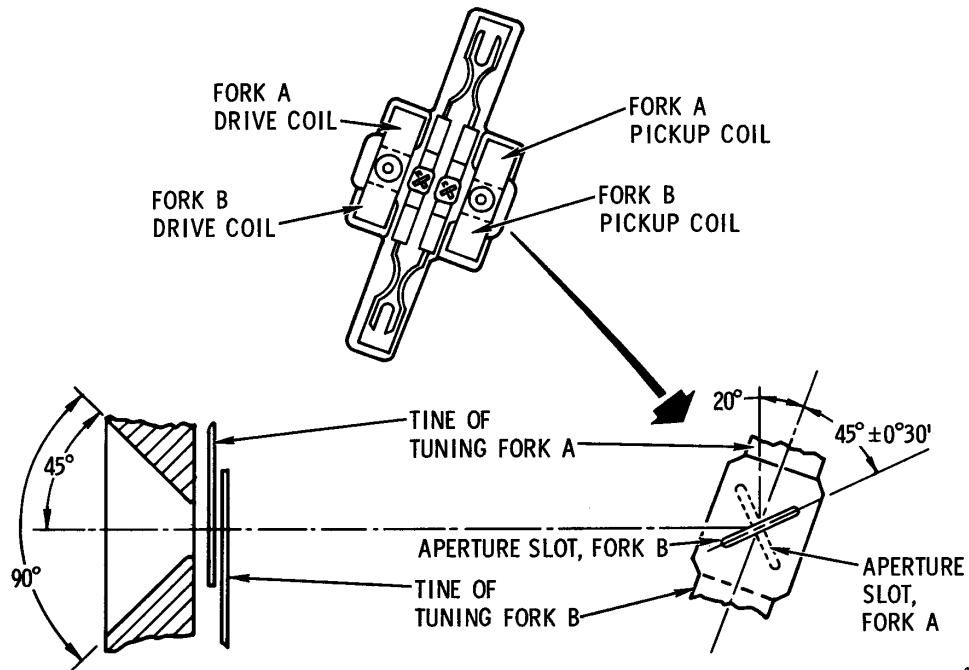
GN-214

TRACKER OPTICAL SYSTEM



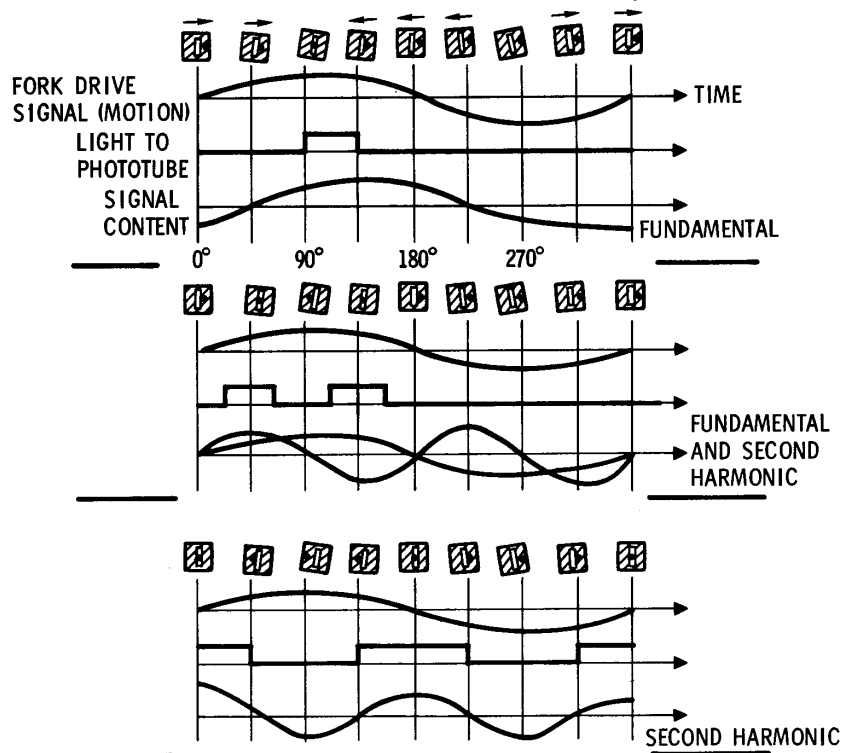
GN-230

TRACKER SCANNING MECHANISM



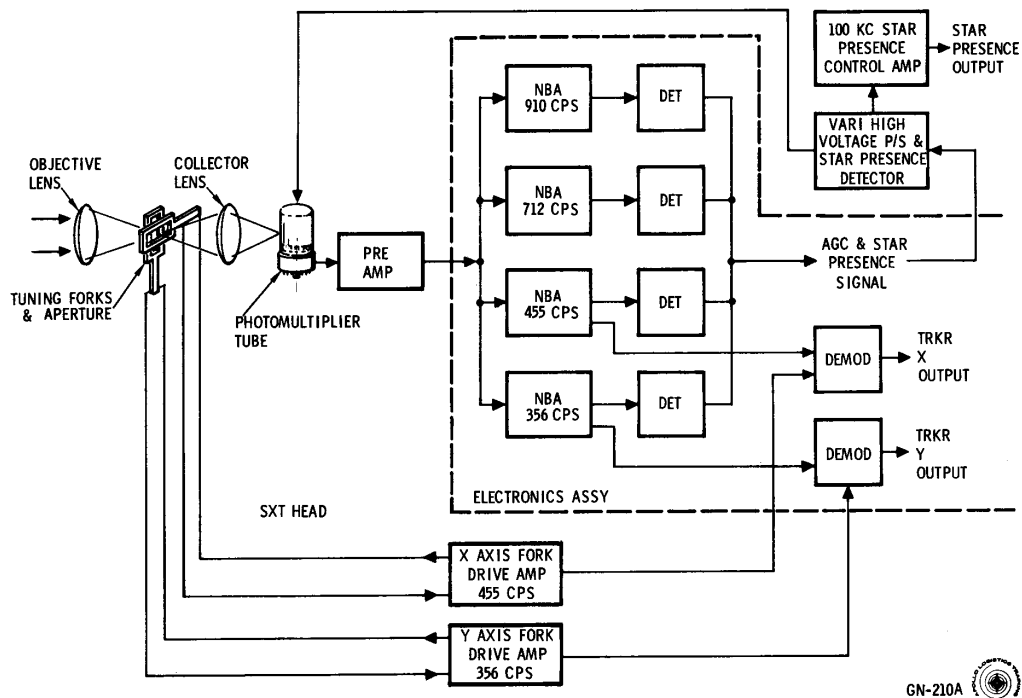
GN-213A

STAR SIGNAL WAVEFORMS

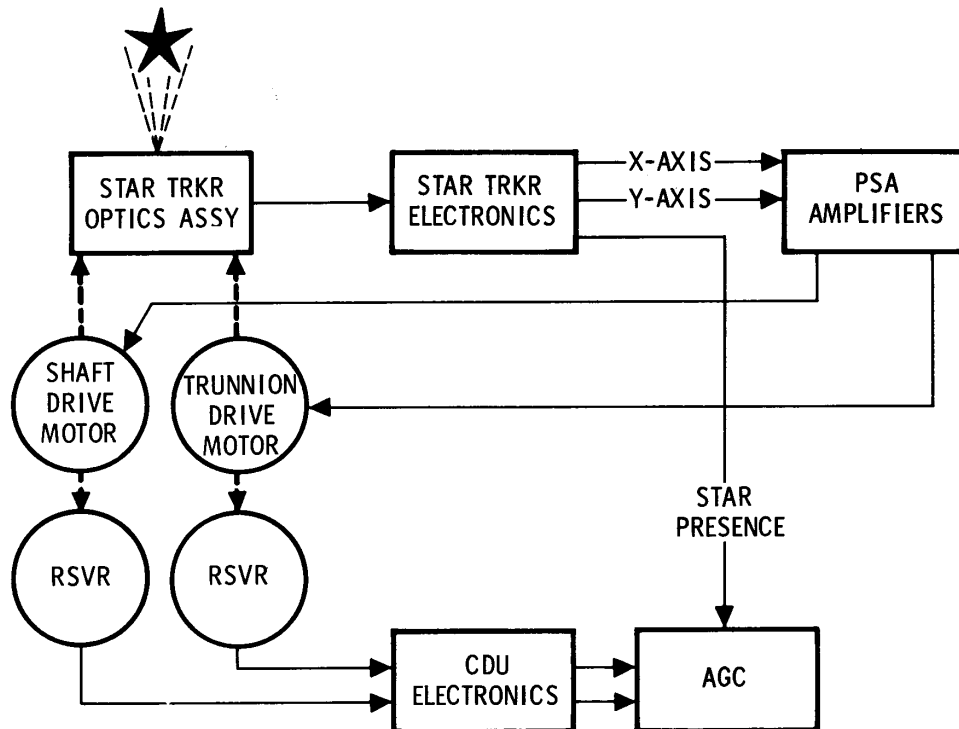


GN-217

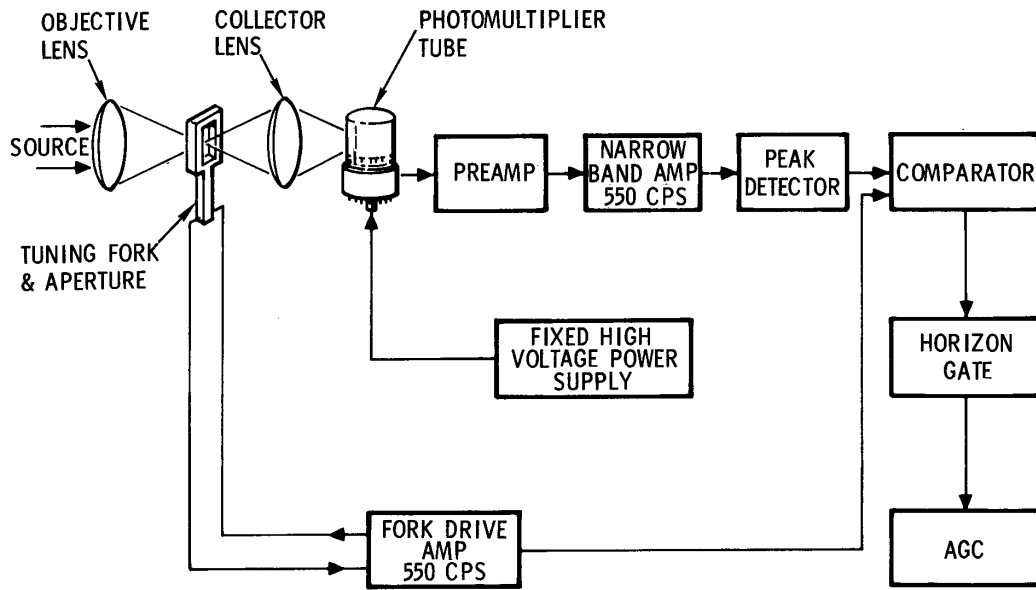
STAR TRACKER



STAR TRACKER MECHANIZATION

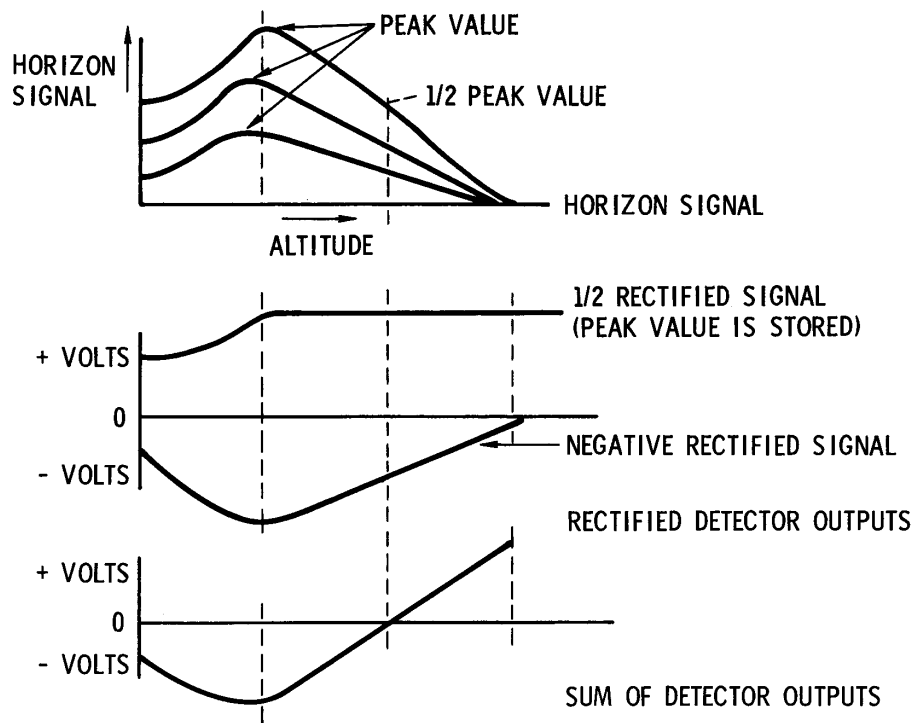


HORIZON SENSOR



GN-209A

HORIZON SENSOR WAVEFORMS

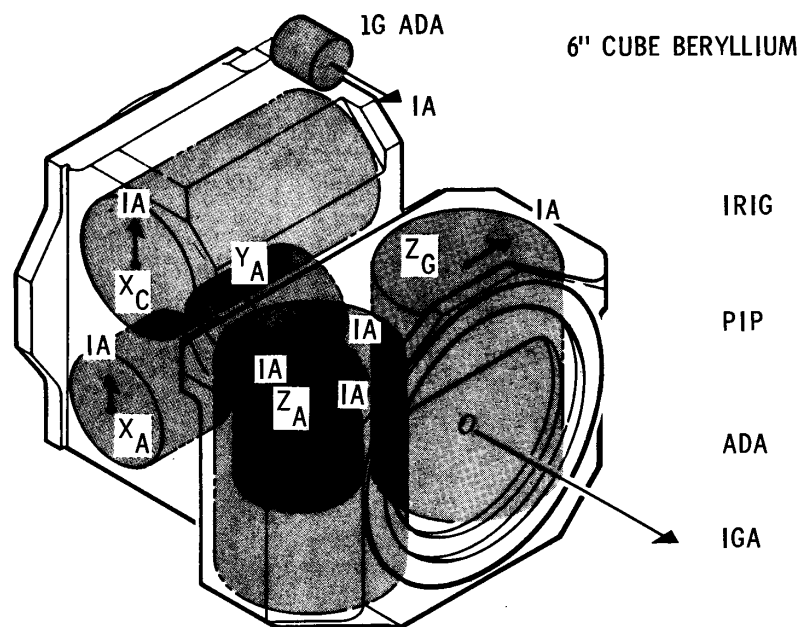


GN-218

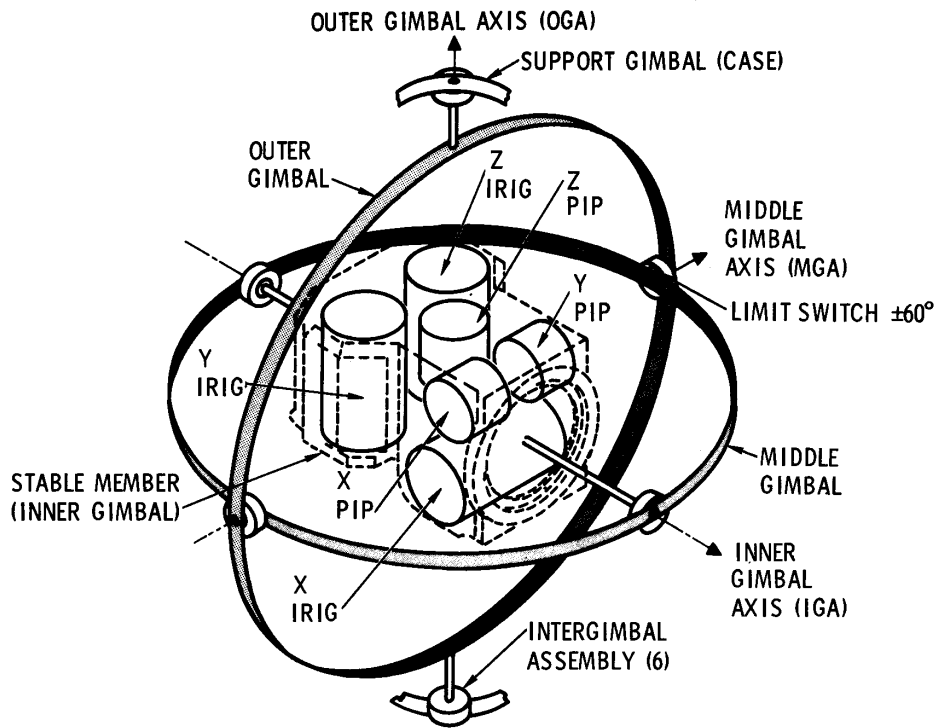
INERTIAL SUBSYSTEM

GN-221 

APOLLO STABLE MEMBER CONFIGURATION

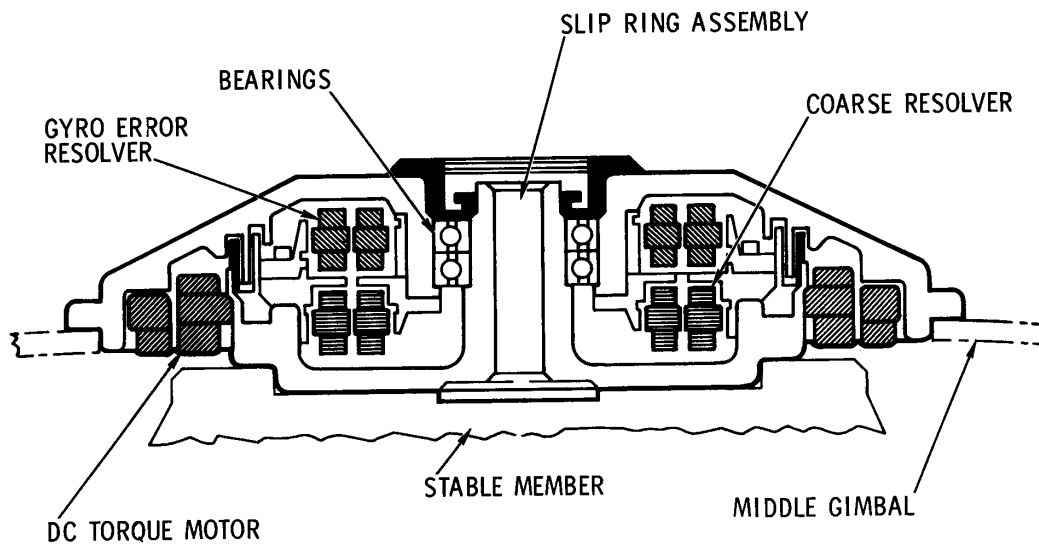
GN-9007A 

IMU GIMBAL ASSEMBLY



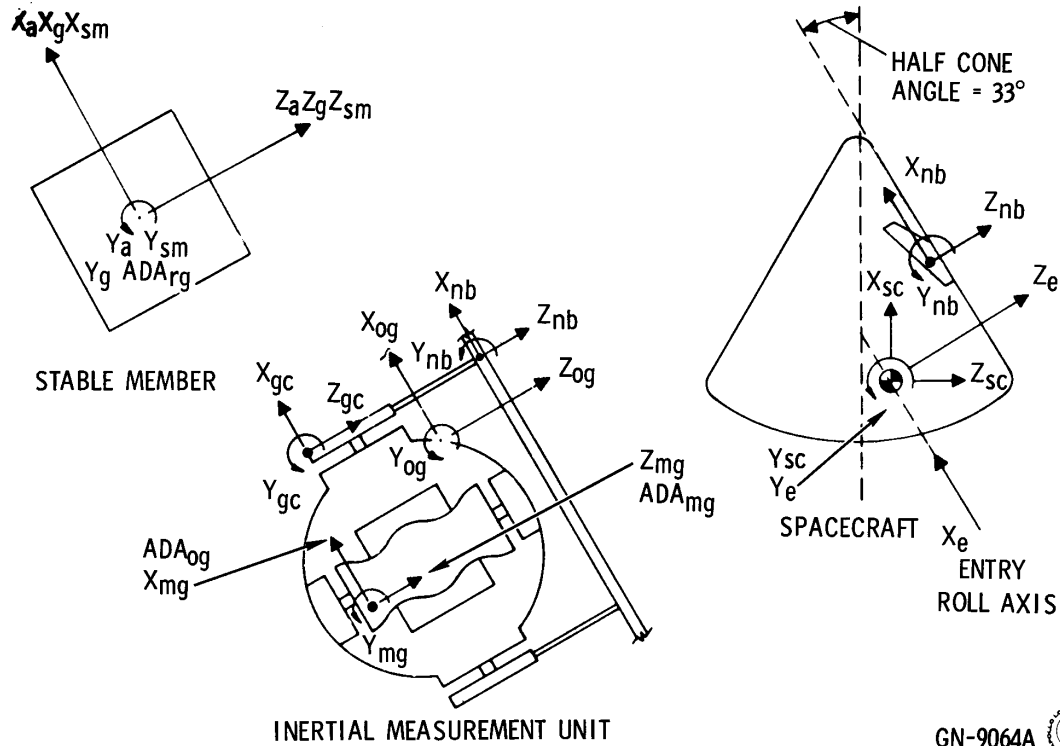
GN-9155A (◆)

INTERGIMBAL ASSEMBLY



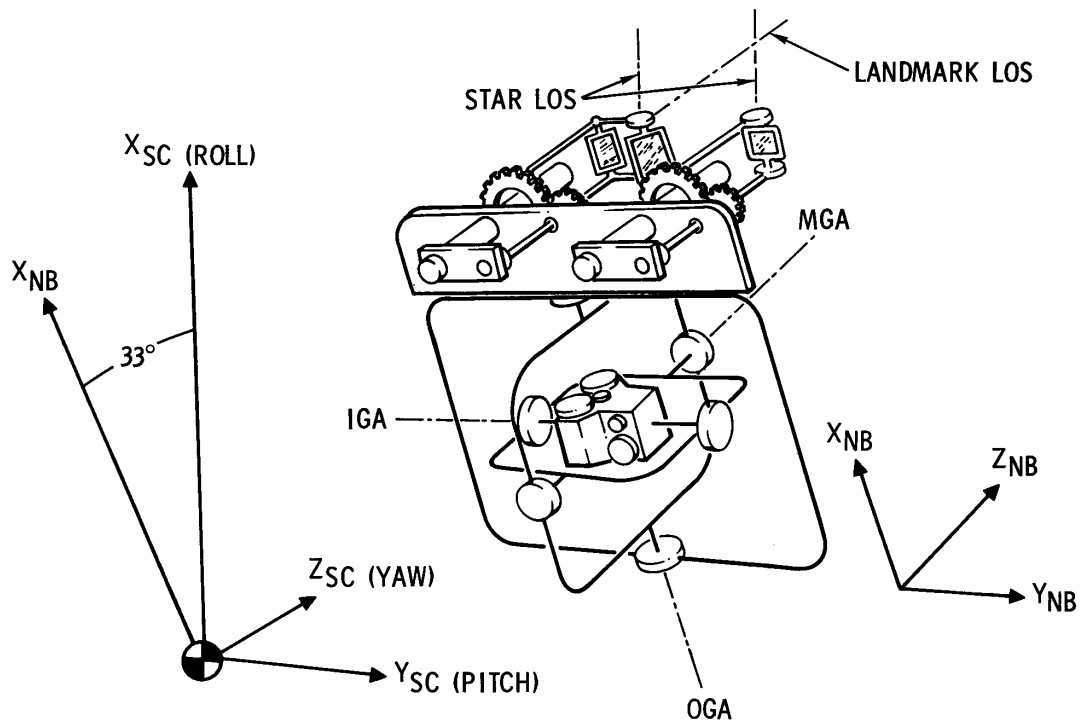
GN-9038A (◆)

ZERO AXIS ALIGNMENT



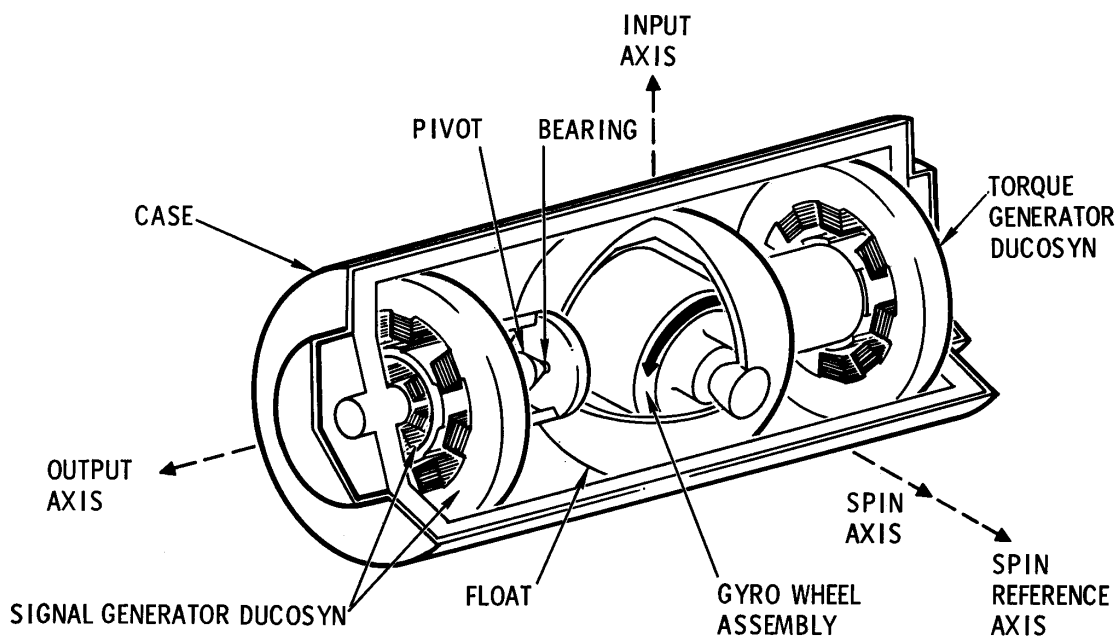
GN-9064A 

G&N FUNCTIONAL SCHEMATIC



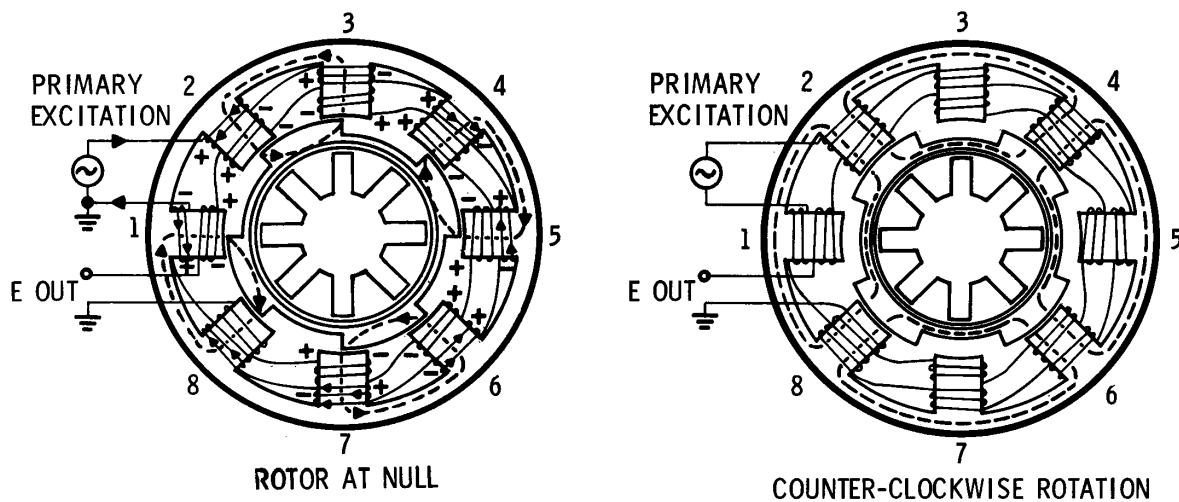
GN-196A 

25 IRIG, SIMPLIFIED CUTAWAY VIEW



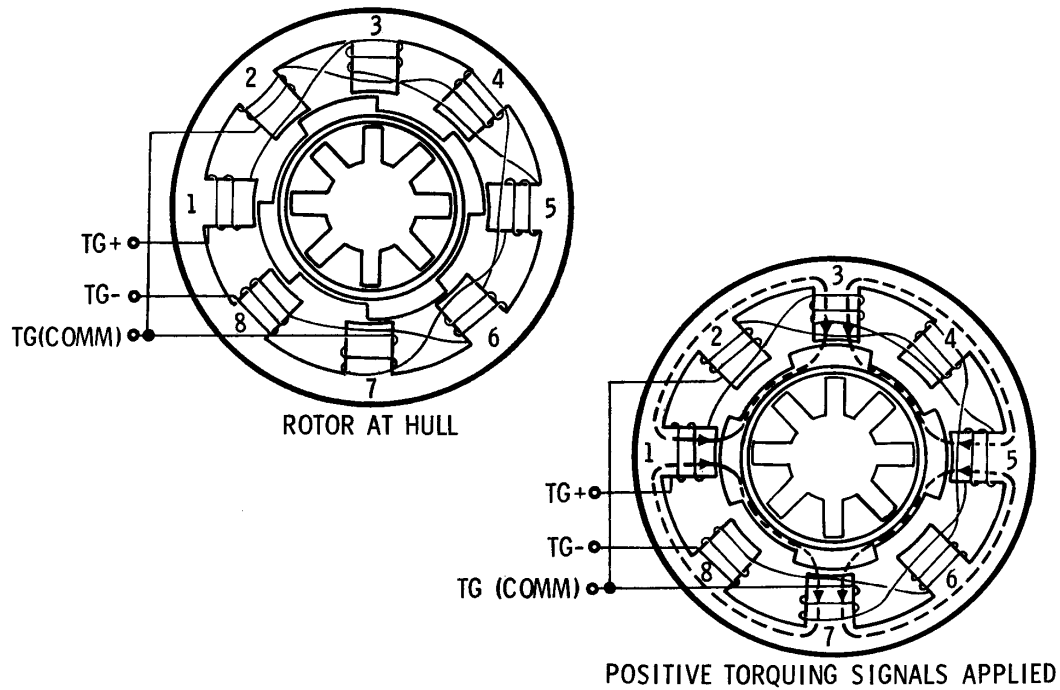
GN-240 

DUCOSYN SIGNAL GENERATOR OPERATION



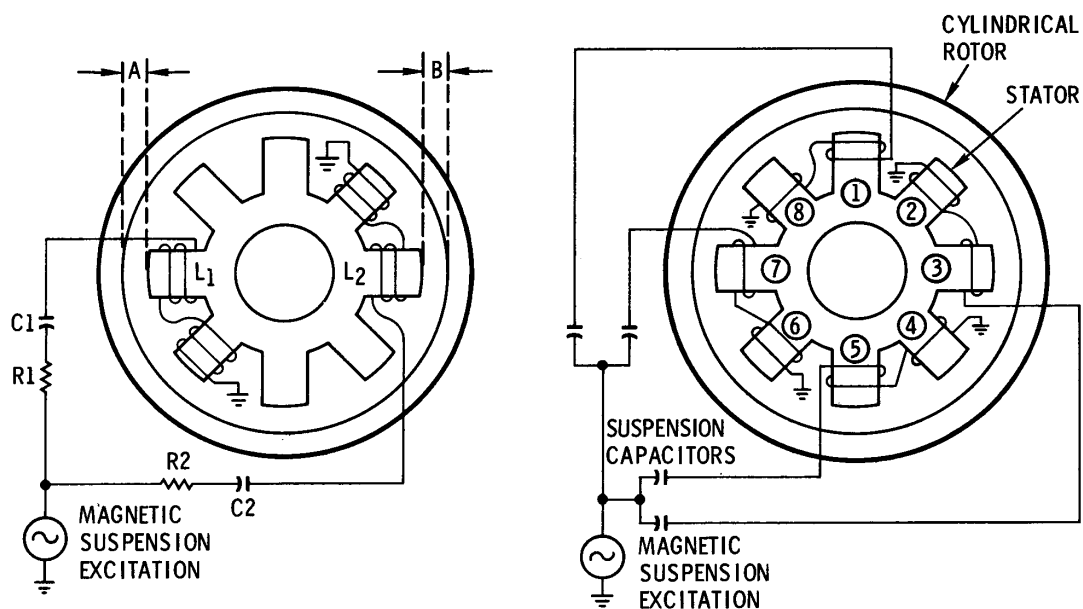
GN-239 

DUCOSYN TORQUE GENERATOR OPERATION



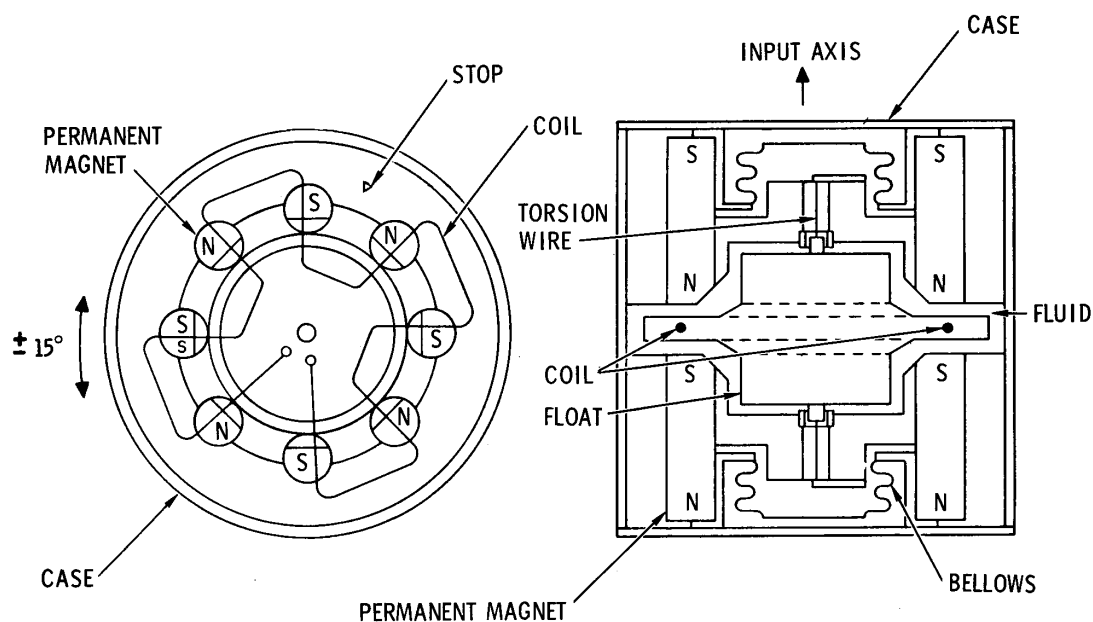
GN-238

MAGNETIC SUSPENSION



GN-237

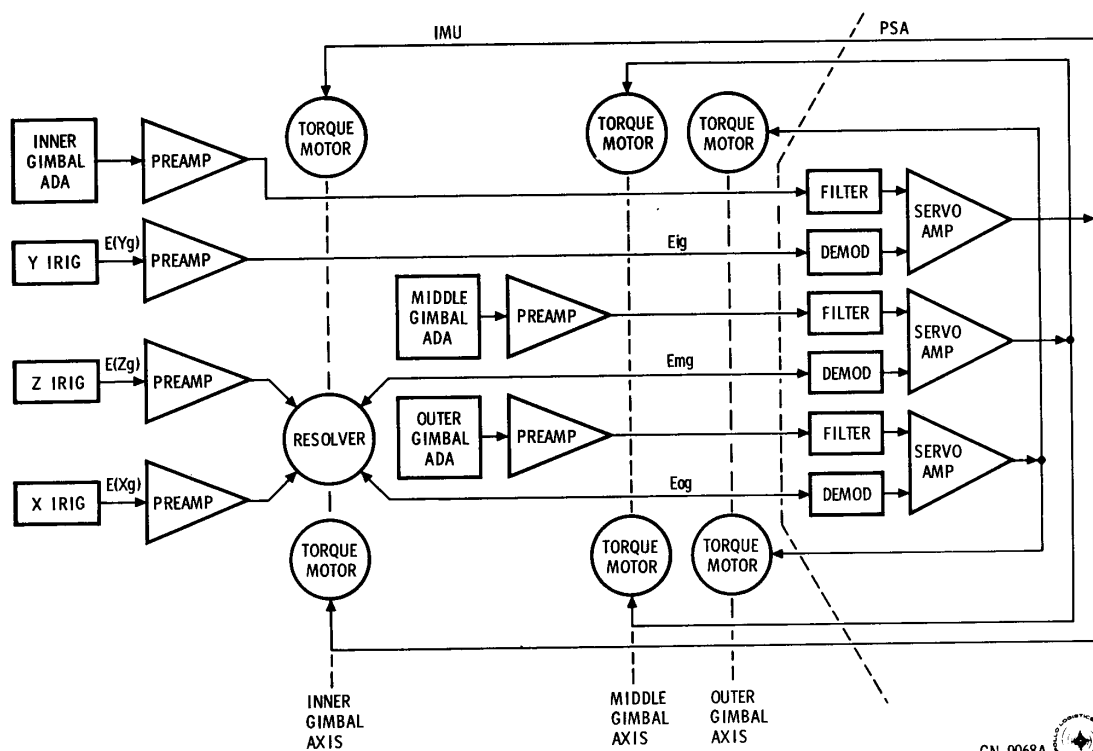
ANGULAR DIFFERENTIATING ACCELEROMETER



GN-9048A

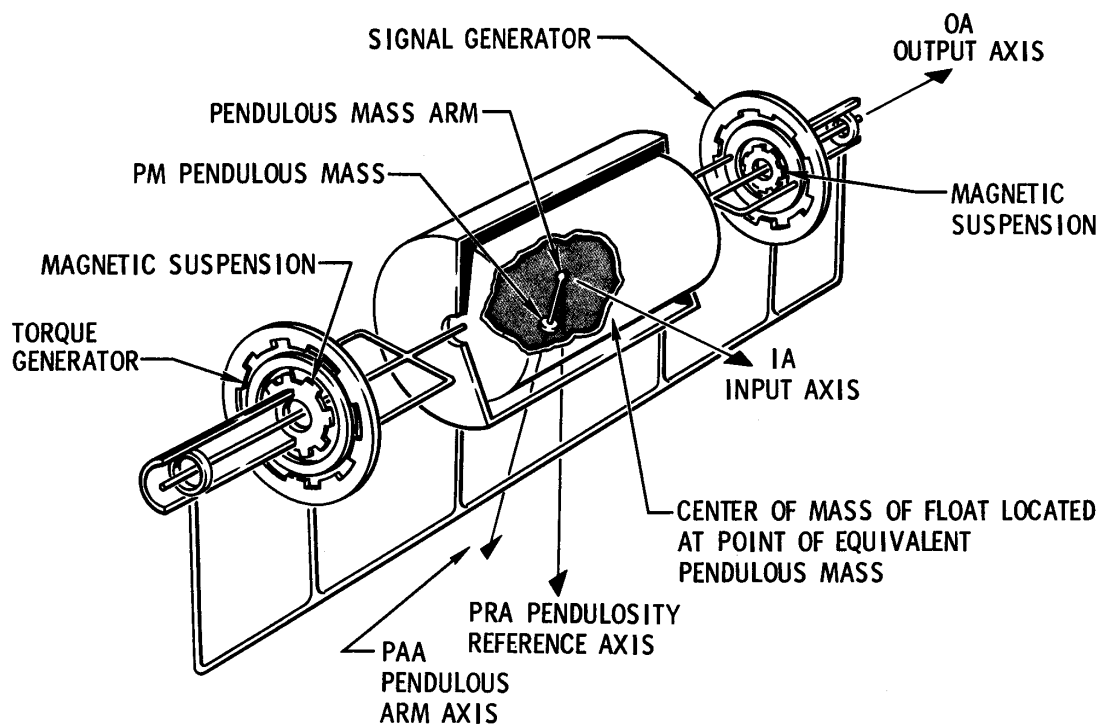


STABILIZATION LOOP



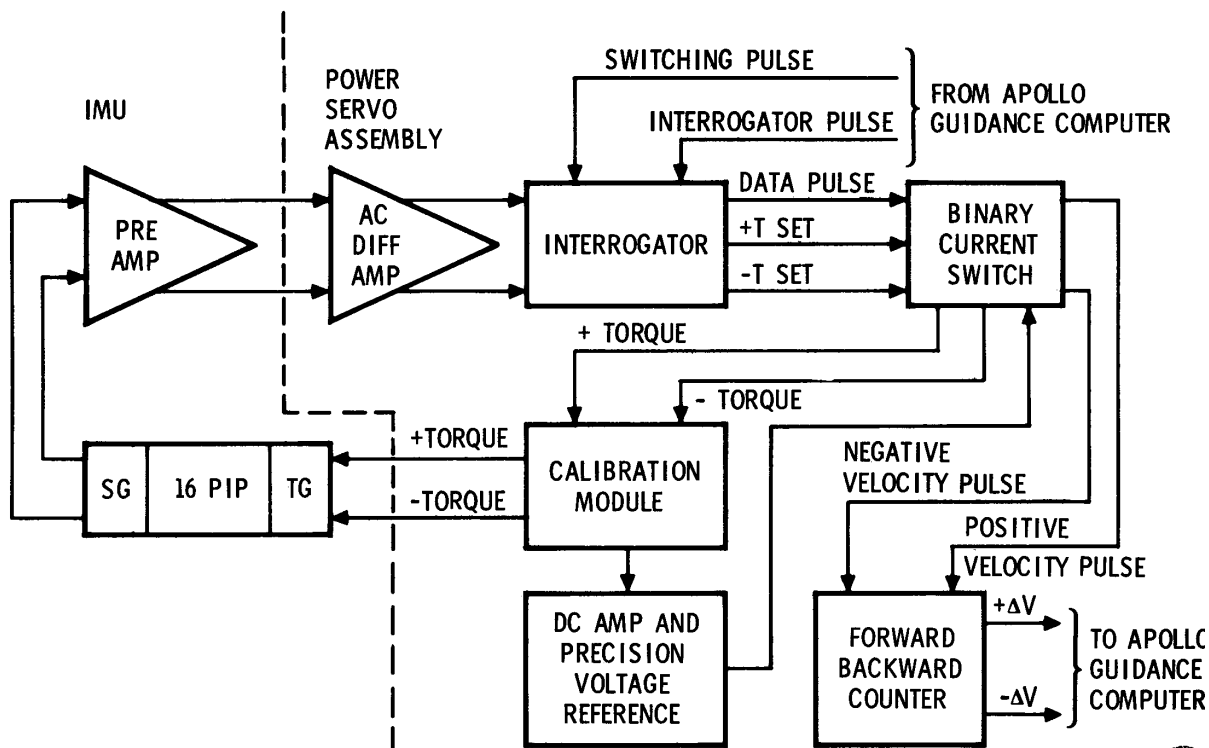
GN-9068A

FLOATED PENDULUM UNIT



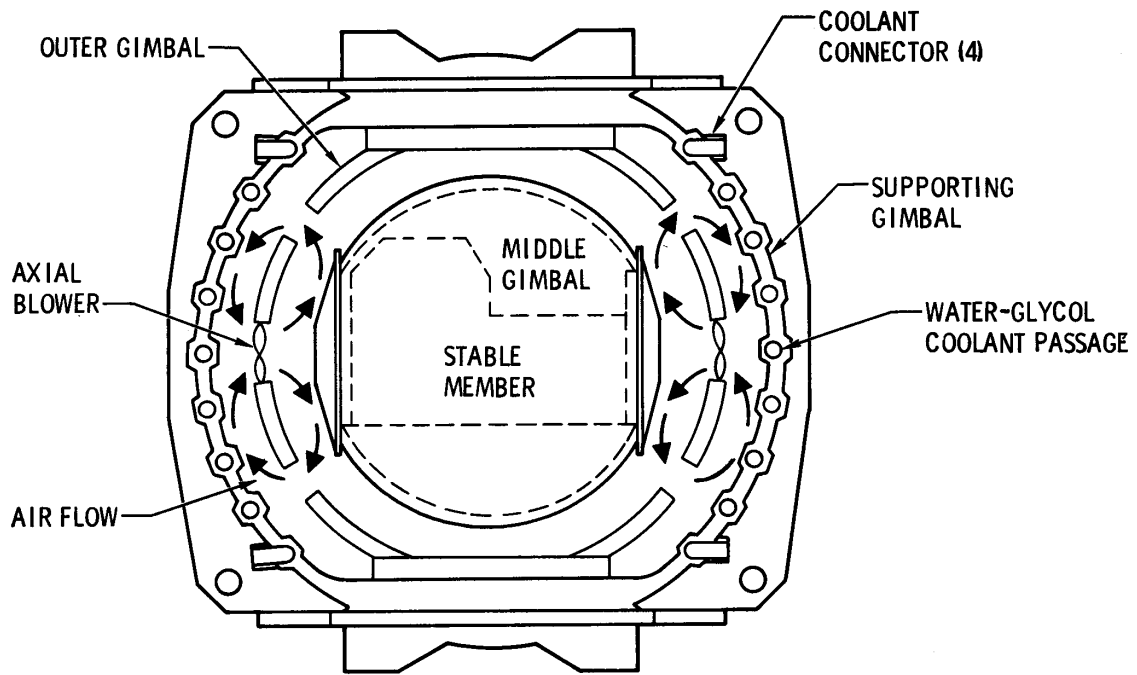
GN-179

ACCELEROMETER LOOP



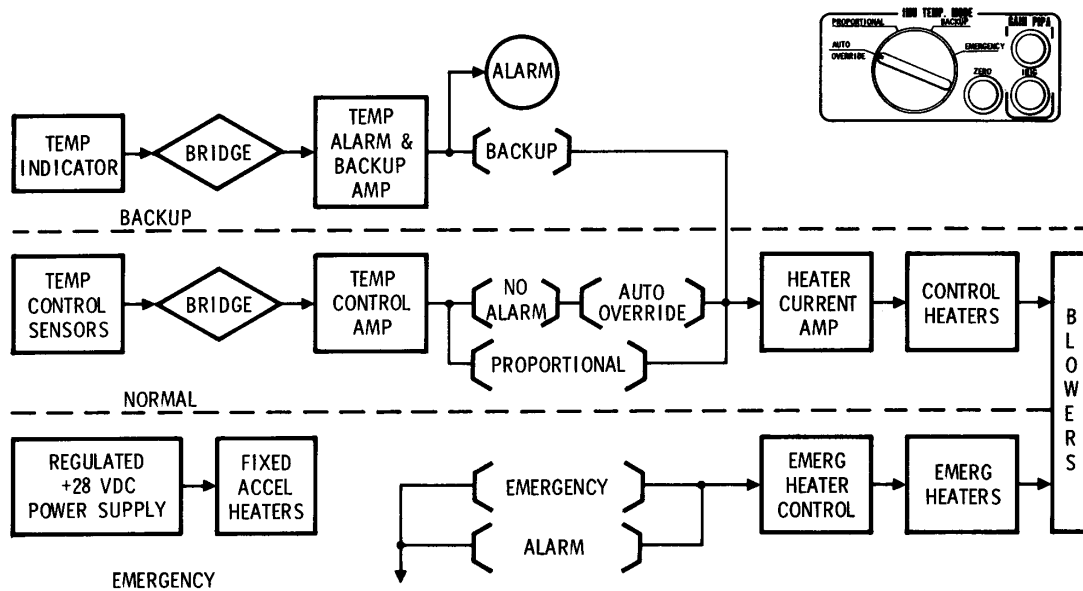
GN-9039A

FORCED CONVECTION IN IMU



GN-9033

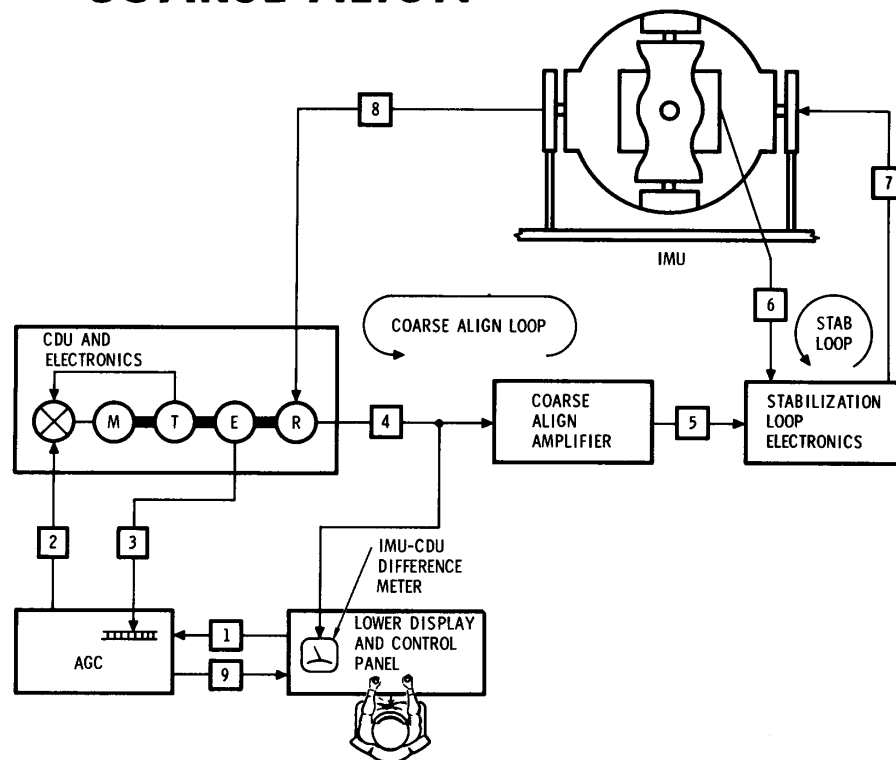
IMU TEMPERATURE CONTROL



GN-219

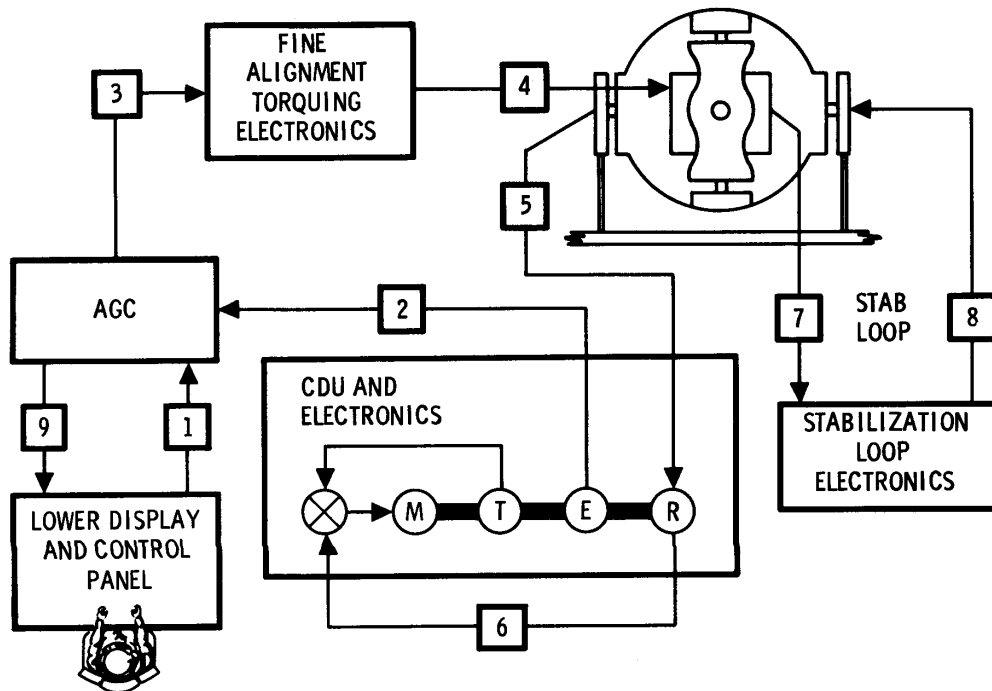


COARSE ALIGN



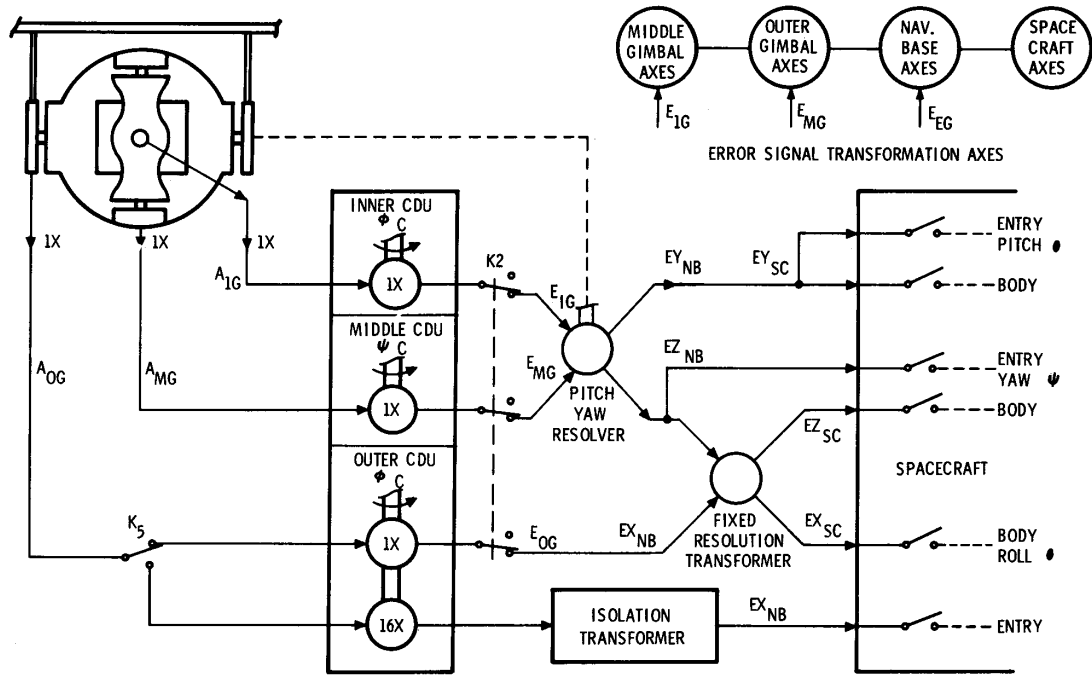
GN-9099A

FINE ALIGN



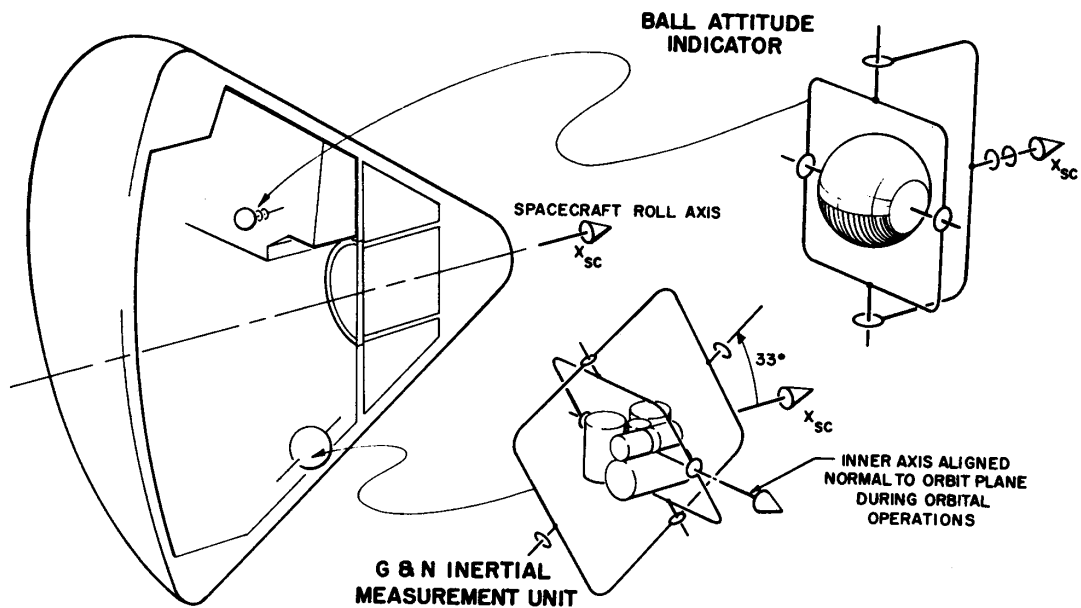
GN-9104

ATTITUDE ERROR TRANSFORMATION



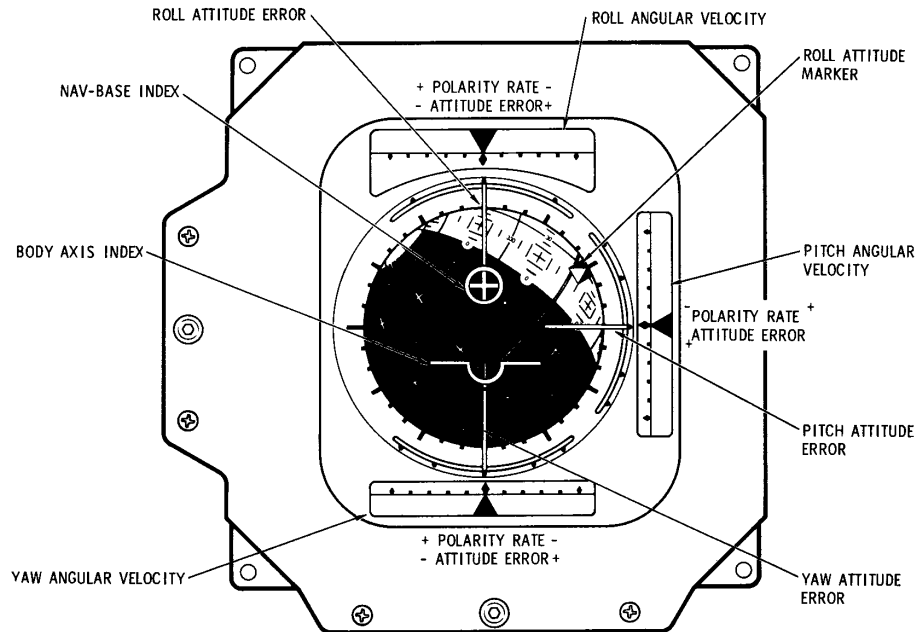
GN-9144A

RELATIONSHIP OF BALL INDICATOR AND IMU



GN-184

FLIGHT DIRECTOR ATTITUDE INDICATOR



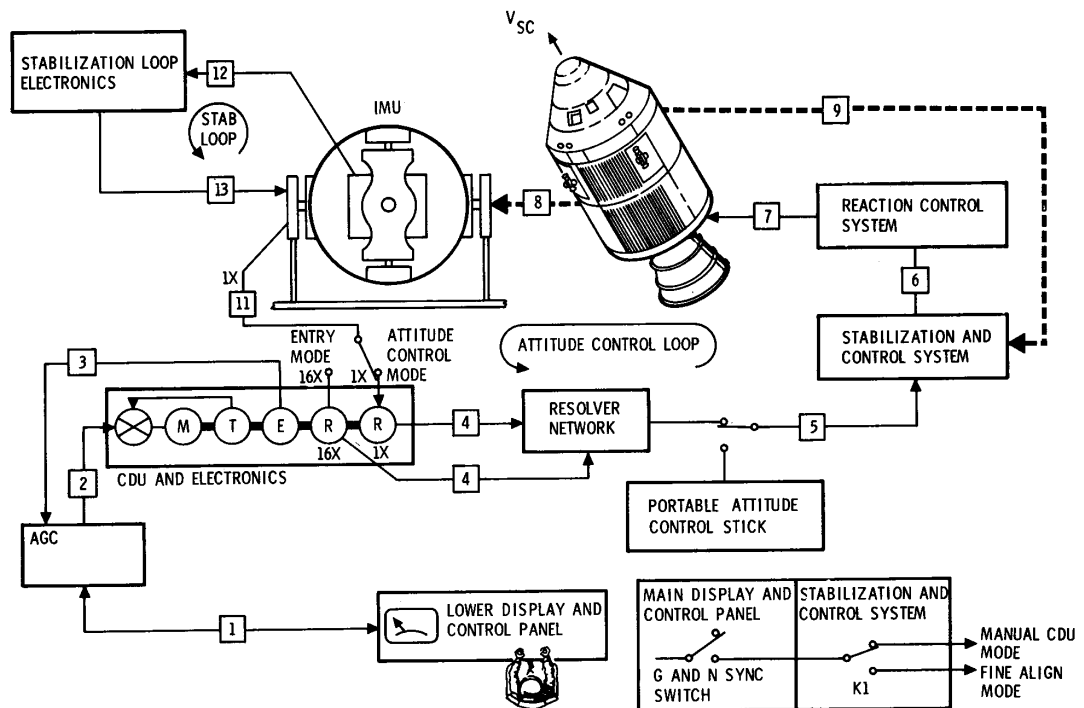
NOTES:

1. ATTITUDE ERROR = ATTITUDE DESIRED - ACTUAL ATTITUDE.
2. THE BALL IS OF THE INSIDE-OUT CONVENTION.
3. EULER ANGLE CONVENTION IS PITCH, YAW, ROLL.
4. THE BALL ATTITUDE SHOWN IS PITCH 345°, YAW 335°, AND ROLL 300°, WITH RESPECT TO THE NAVIGATION BASE INDEX.

SCS-100B



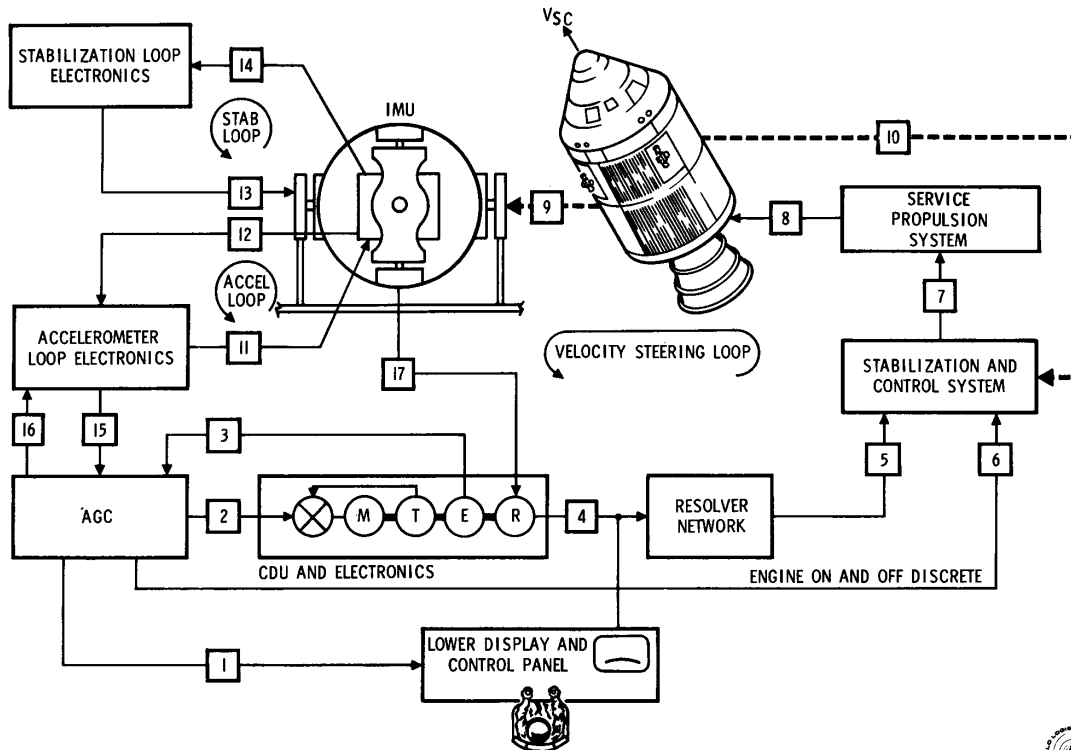
SPACECRAFT ATTITUDE CONTROL



GN-9150A

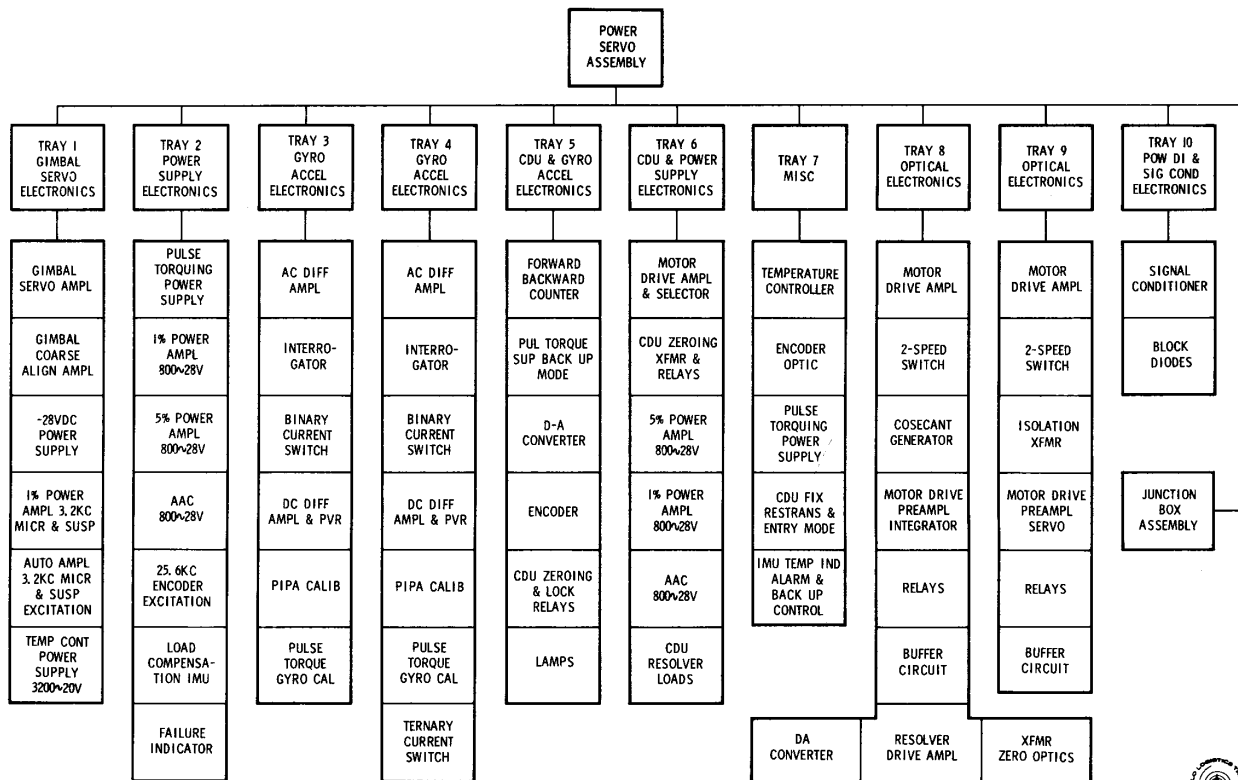


SPACECRAFT THRUST VECTOR CONTROL



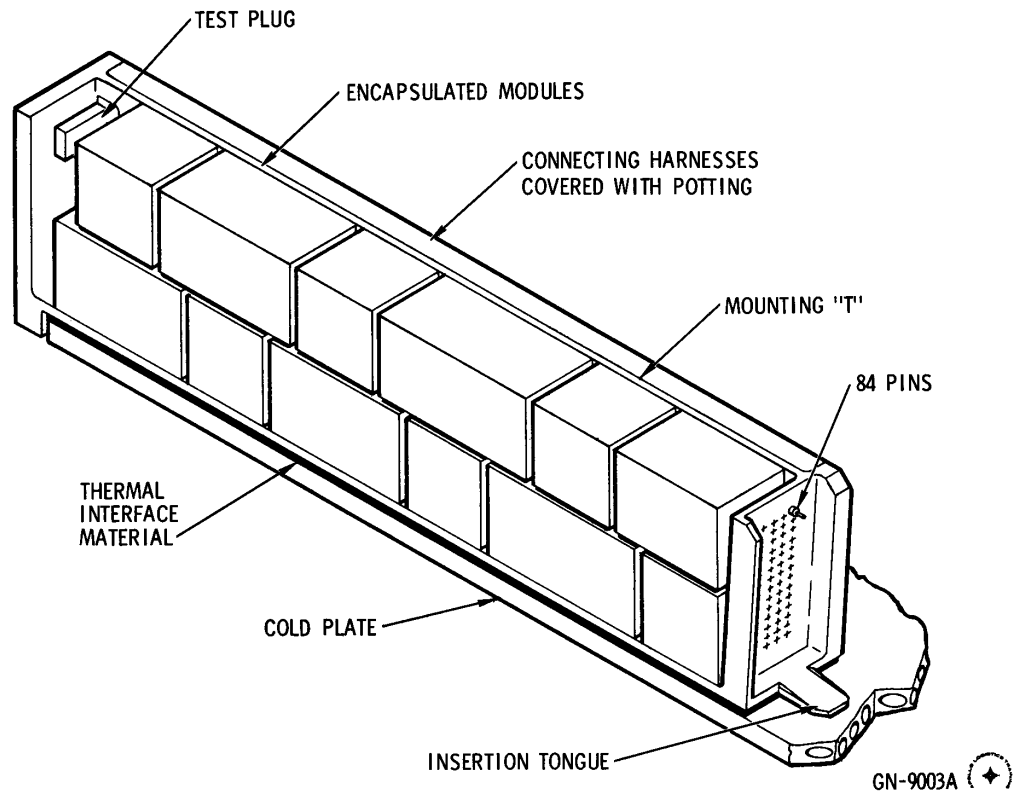
GN-9149A 

PSA FAMILY TREE



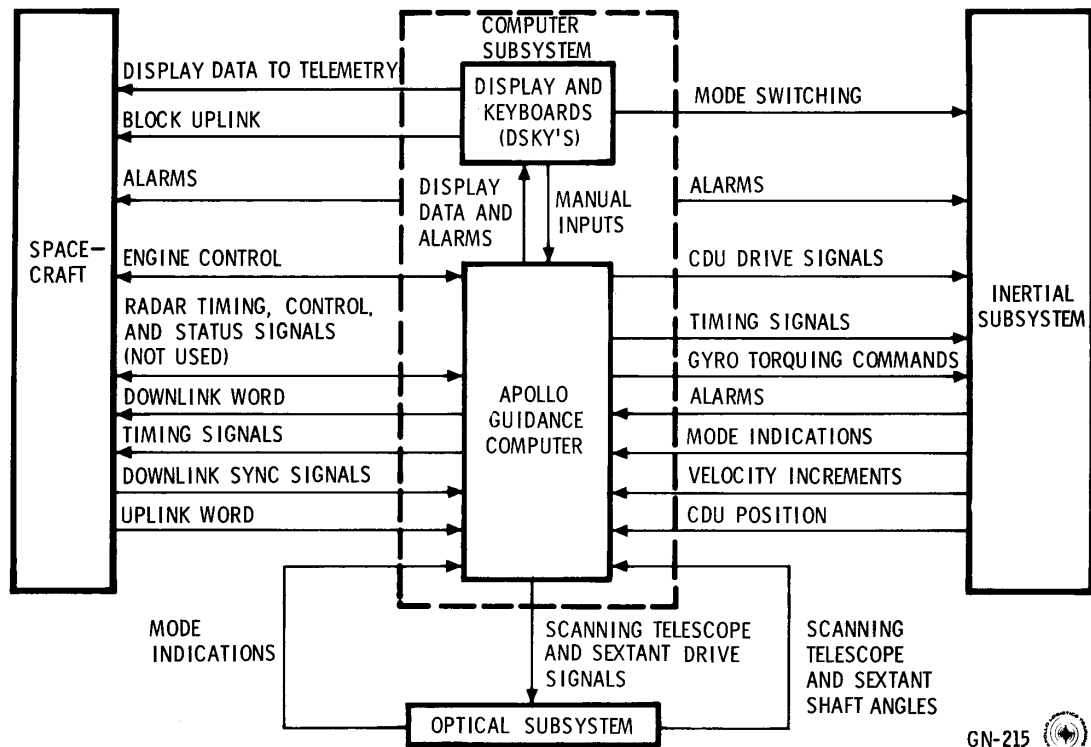
GN-9044A 

PSA TRAY

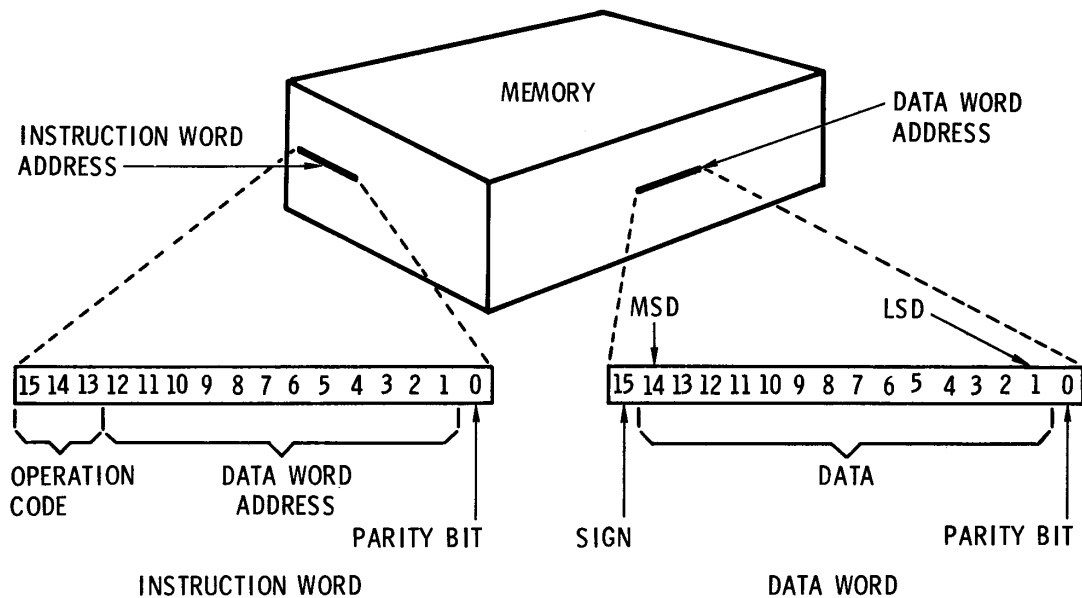


COMPUTER SUBSYSTEM

COMPUTER SUBSYSTEM, GENERAL INTERFACE

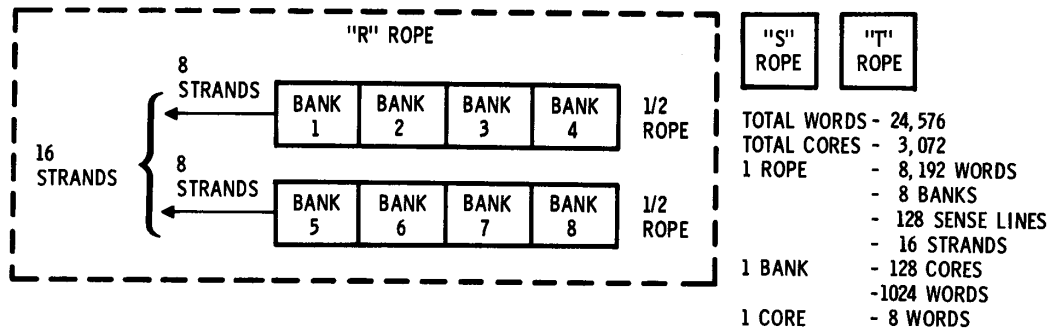


AGC WORD FORMAT



NOTE:
EACH INSTRUCTION AND DATA
WORD HAS ITS OWN ADDRESS
WHICH DEFINES WHERE IT IS
LOCATED IN THE MEMORY.

FIXED MEMORY ORGANIZATION

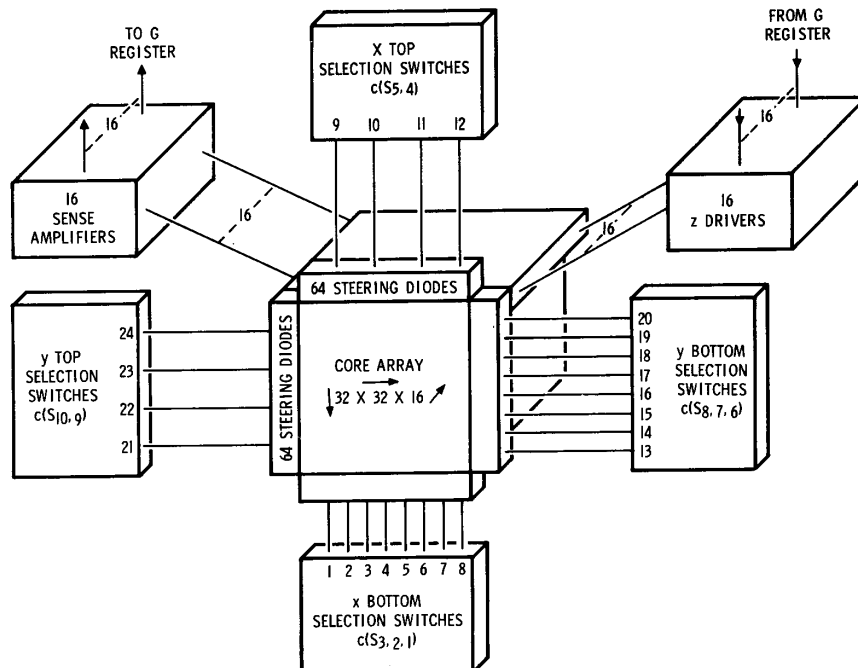


WORD SELECTION

1. SELECT 1 OF 3 ROPES (8,192 WDS OF 24,576 WDS)
2. SELECT 2 OF 8 BANKS (2,048 WDS OF 8,192 WDS)
3. SELECT 2 OF 256 CORES (16 WDS OF 2,048 WDS)
4. SELECT 1 OF 16 STRANDS (1 WD OF 16 WDS)

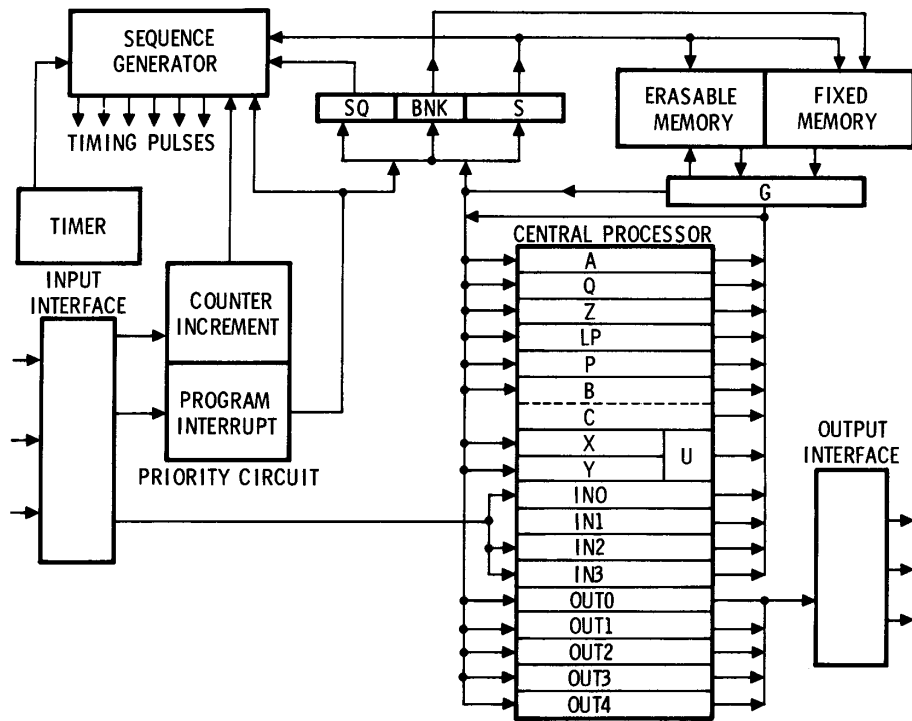
GN-9021B

ADDRESSING, READING, AND WRITING INTO CORE ARRAY



GN-9020A

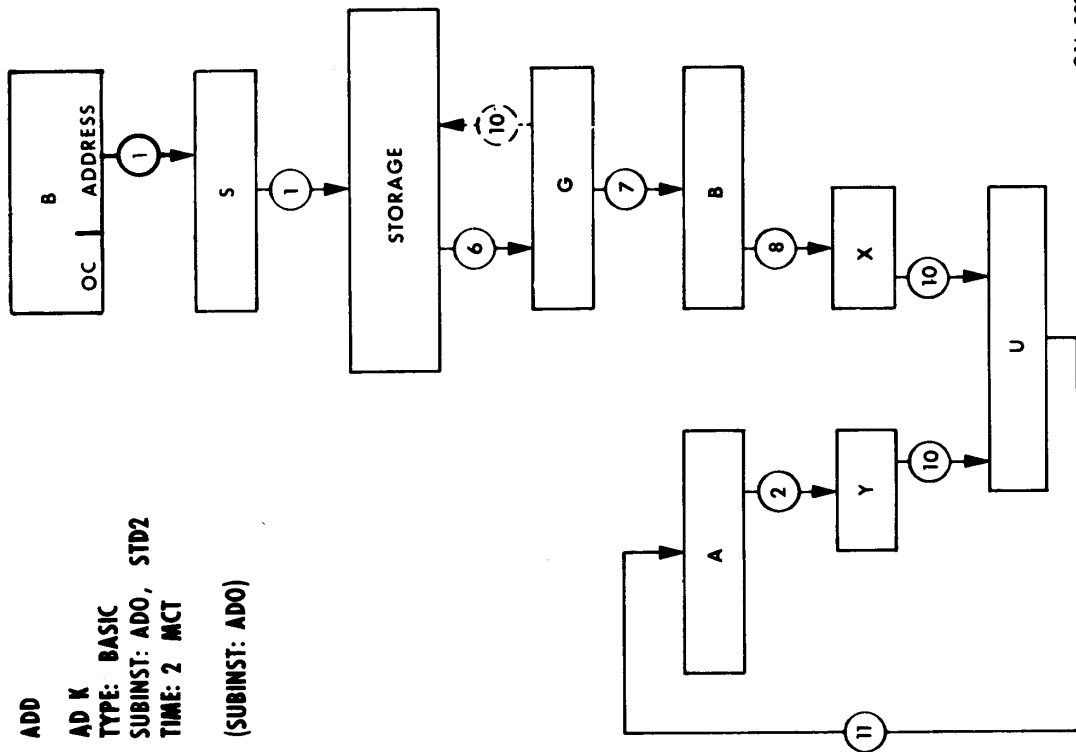
AGC GENERAL BLOCK DIAGRAM



GN-9026A

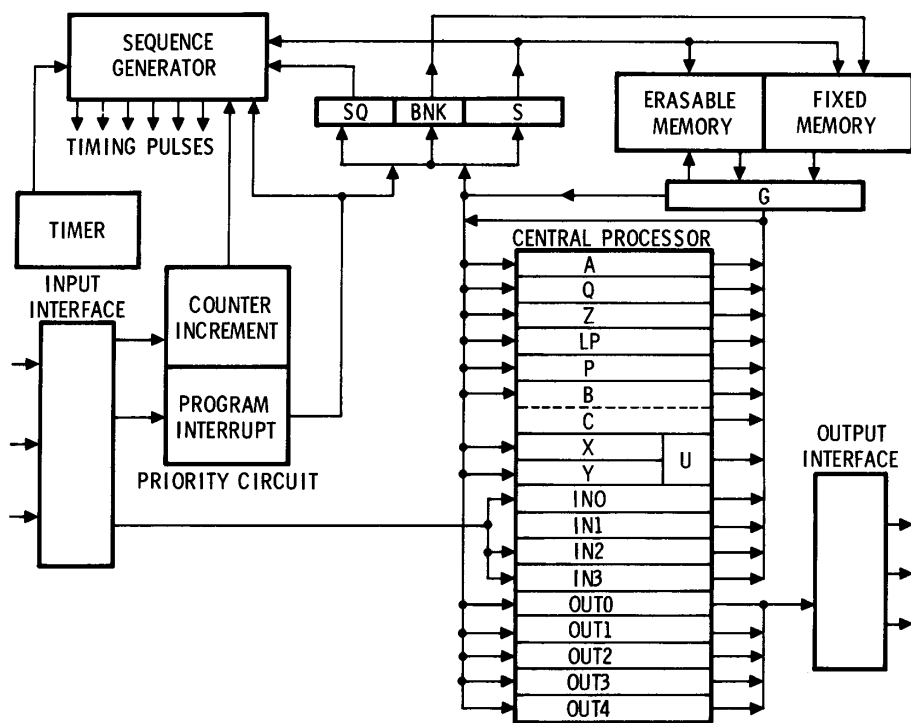


30



GN-9030

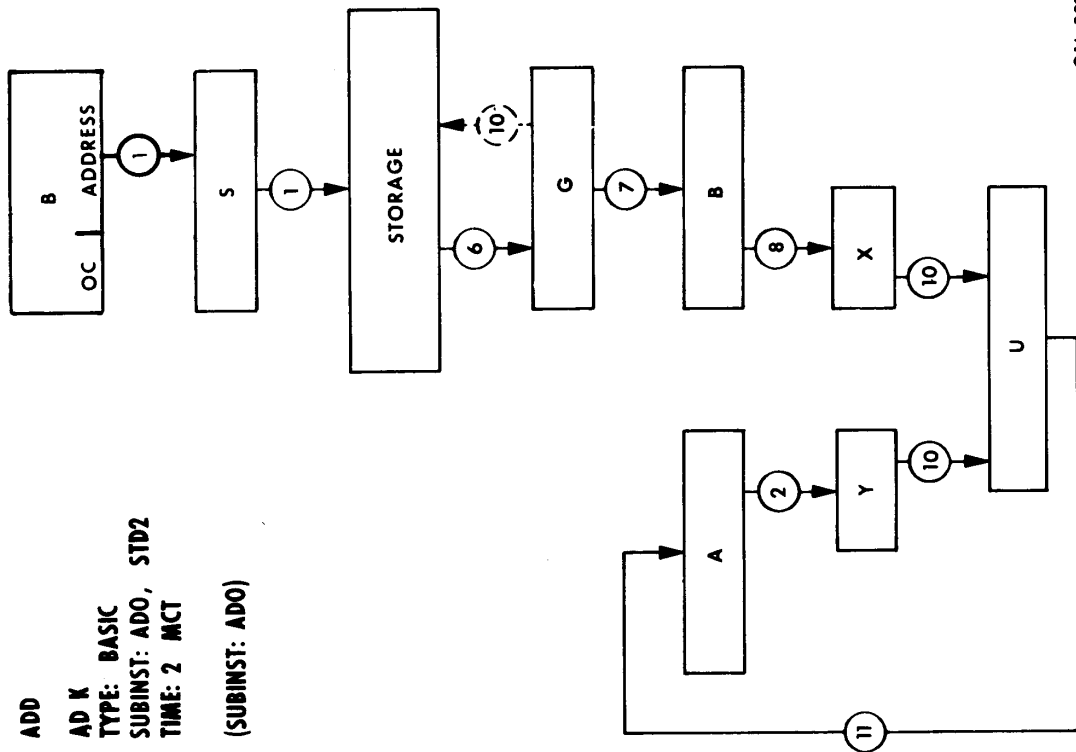
AGC GENERAL BLOCK DIAGRAM



GN-9026A

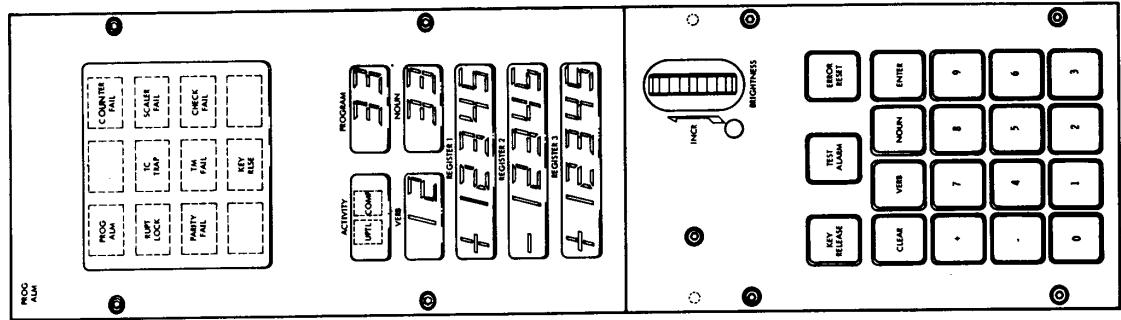


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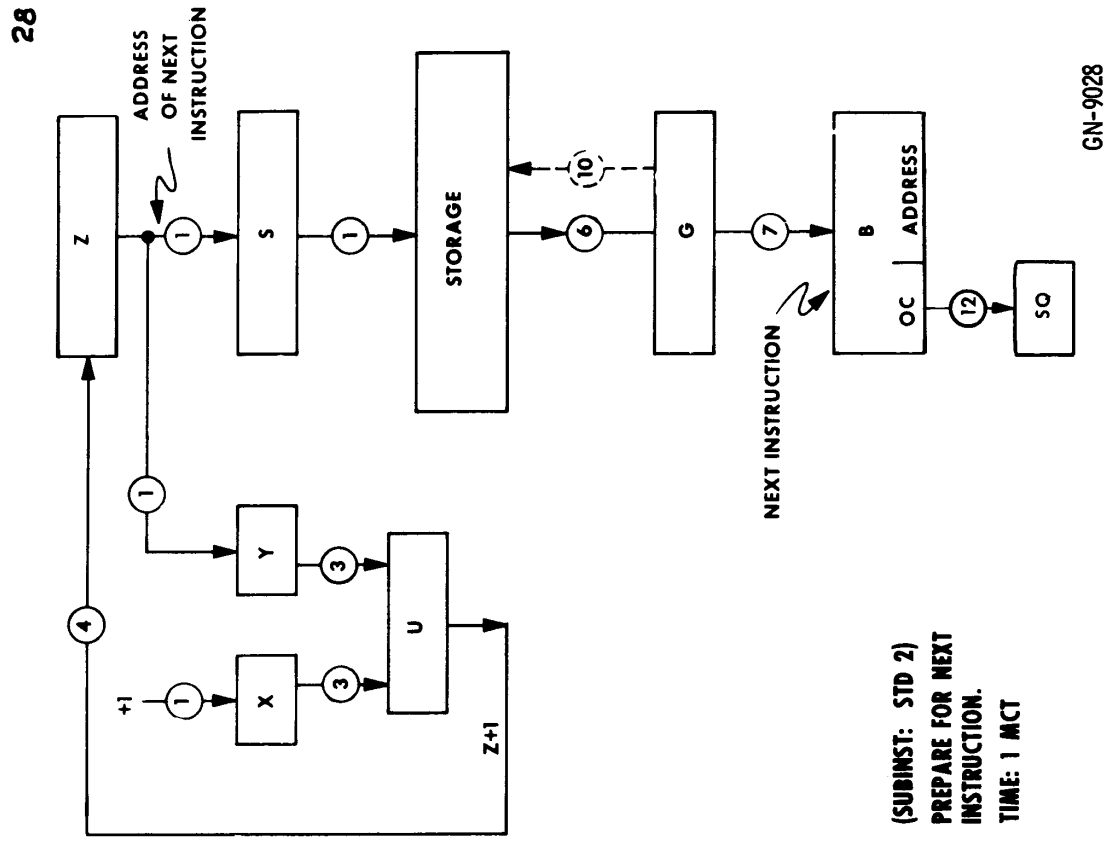


GN-9030

AGC DISPLAY & KEYBOARD



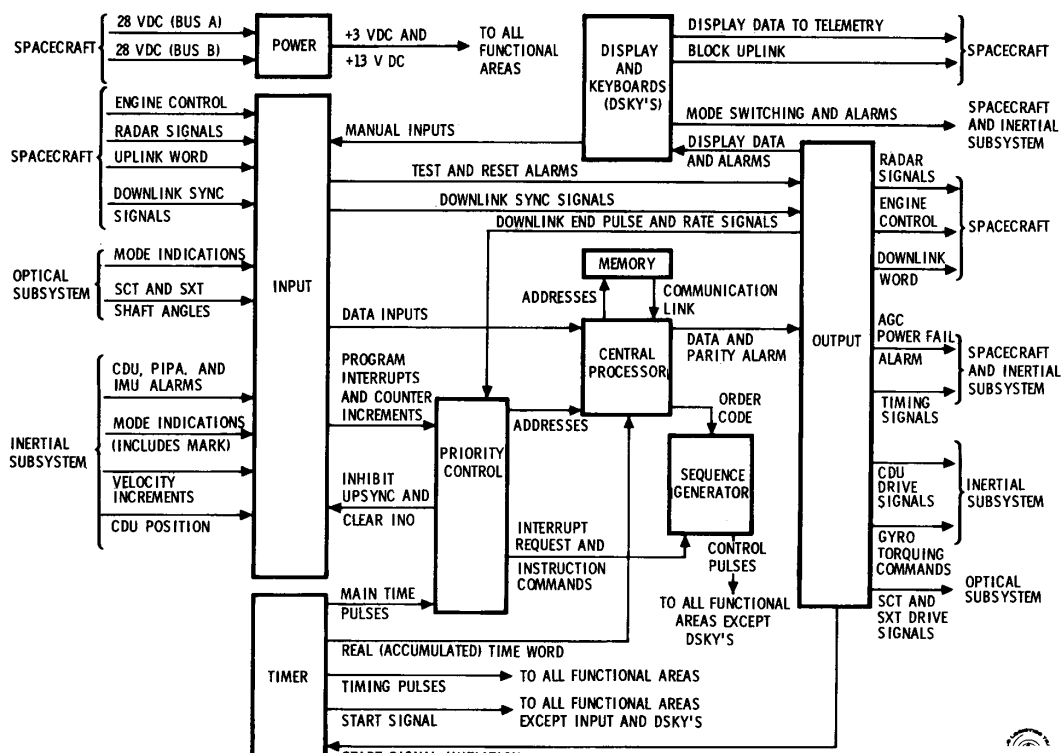
CU-1021C



**(SUBINST: STD 2)
PREPARE FOR NEXT
INSTRUCTION.
TIME: 1 MCT**

GN-9028

COMPUTER SUBSYSTEM



GUIDANCE & NAVIGATION ABBREVIATIONS

ACSP	A.C. SPARK PLUG	LOS	LINE OF SIGHT
ADA	ANGULAR DIFFERENTIATING ACCELEROMETER	LLOS	LANDMARK LINE OF SIGHT
AGC	APOLLO GUIDANCE COMPUTER	LSB	LEAST SIGNIFICANT BIT
AGE	APOLLO GUIDANCE EQUIPMENT	MGA	MIDDLE GIMBAL AXIS
AMR	ATLANTIC MISSILE RANGE	MIT	MASSACHUSETTS INSTITUTE OF TECHNOLOGY
CDU	COUPLING DISPLAY UNIT	MAG AMP	MAGNETIC AMPLIFIER
C.G.	CENTER OF GRAVITY	MSB	MOST SIGNIFICANT BIT
CSS	COMPUTER SUB SYSTEM	M&DV	MAP & DATA VIEWER
DNLK	DOWNLINK	NVB OR NB	NAVIGATION BASE
DSPY	DISPLAY	OGA	OUTER GIMBAL AXIS
DSKY	DISPLAY & KEYBOARD	OA	OUTPUT AXIS
ECS	ENVIRONMENT CONTROL SYSTEM	OSS	OPTICAL SUB SYSTEM
E/M	ERASABLE MEMORY	PIP OR	PULSED INTEGRATING PENDULOUS
EOI	EARTH ORBIT INJECTION	PIPA	ACCELEROMETER
EPS	ELECTRICAL POWER SYSTEM	PSA	POWER SERVO ASSEMBLY
FDAI	FLIGHT DIRECTOR ATTITUDE INDICATOR	PRA	PENDULOSITY REFERENCE AXIS
F/M	FIXED MEMORY	RCS	REACTION CONTROL SYSTEM
G.C.	GIMBAL CASE	RSVR	RESOLVER
IA	INPUT AXIS	SA	SPIN AXIS
IRIG	INERTIAL REFERENCE INTEGRATING GYRO	S/C	SPACECRAFT
IGA	INNER GIMBAL AXIS	SLOS	STAR LINE OF SIGHT
IMU	INERTIAL MEASUREMENT UNIT	SCT	SCANNING TELESCOPE
ISS	INERTIAL SUB SYSTEM	SCS	STABILIZATION & CONTROL SYSTEM
IU	INSTRUMENT UNIT	SDOF	SINGLE DEGREE OF FREEDOM
G&N	GUIDANCE & NAVIGATION	SM	STABLE MEMBER
KYBD	KEYBOARD	SRA	SPIN REFERENCE AXIS
LNDMK	LANDMARK	SPS	SERVICE PROPULSION SYSTEM
LOI	LUNAR ORBIT INJECTION	SXT	SPACE SEXTANT

TEI	TRANS EARTH INJECTION
TACH	TACHOMETER
TLI	TRANS LUNAR INJECTION
TRKR	TRACKER
TVC	THRUST VECTOR CONTROL
T/M	TELEMETRY
UPLK	UPDATE LINK
V OR	CHANGE IN VELOCITY
DELTA V	