

APOLLO TRAINING

GUIDANCE AND CONTROL

SYSTEMS - BLOCK II

S/C 101

15 SEPTEMBER 1967

FOR TRAINING PURPOSES ONLY



Box 015-011



APOLLO TRAINING

GUIDANCE AND CONTROL

SYSTEMS - BLOCK II

S/C 101

15 SEPTEMBER 1967

FOR TRAINING PURPOSES ONLY



QUESTIONS RELATIVE TO THE CONTENTS OF THIS
DOCUMENT SHOULD BE DIRECTED TO:

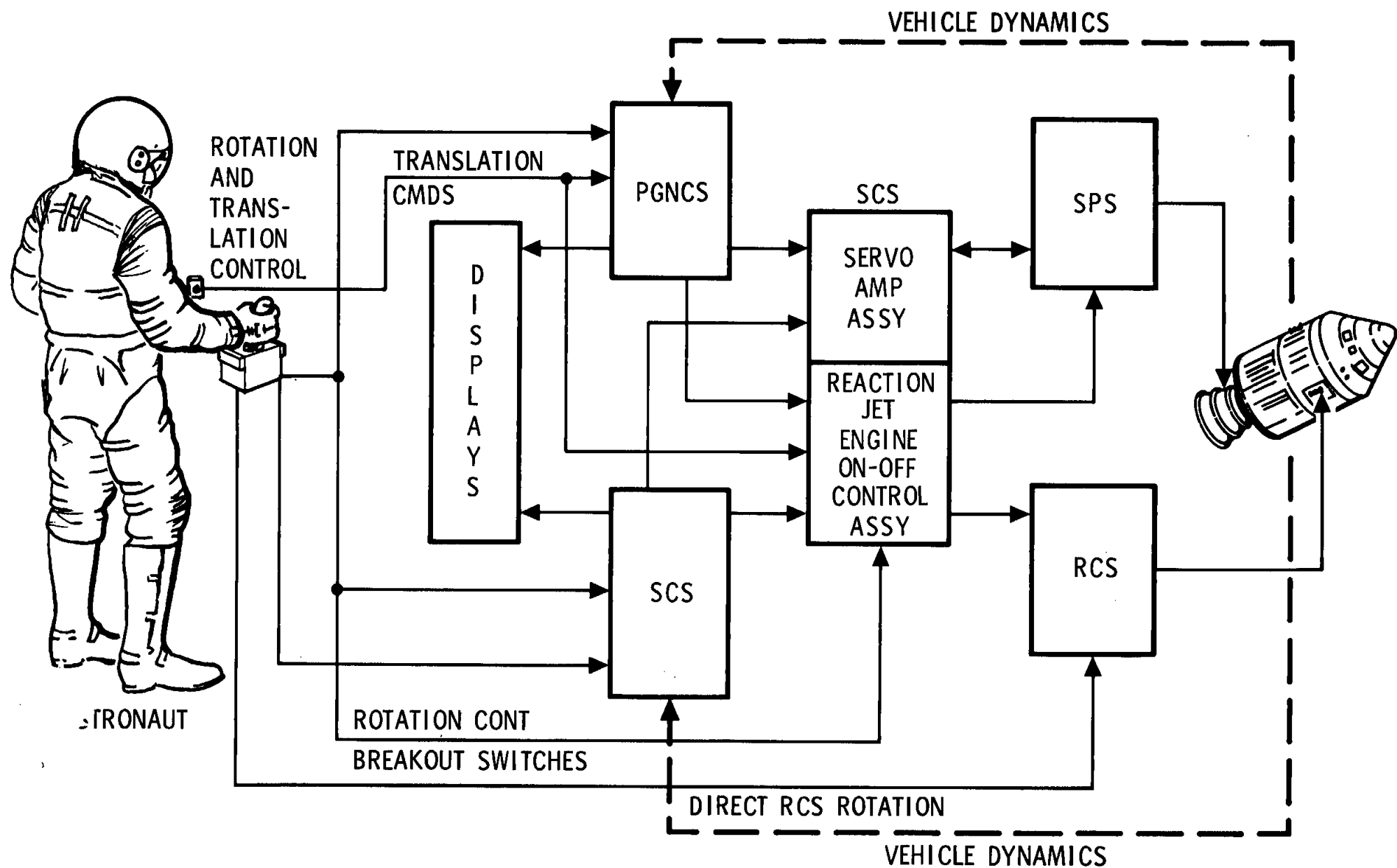
D.P. BENNETT
A.R. PAYNE
W.O. RUFFIN
A.H. SOHLER

NAA, SD
DOWNEY, CALIFORNIA
Extension 4325, 6, or 7

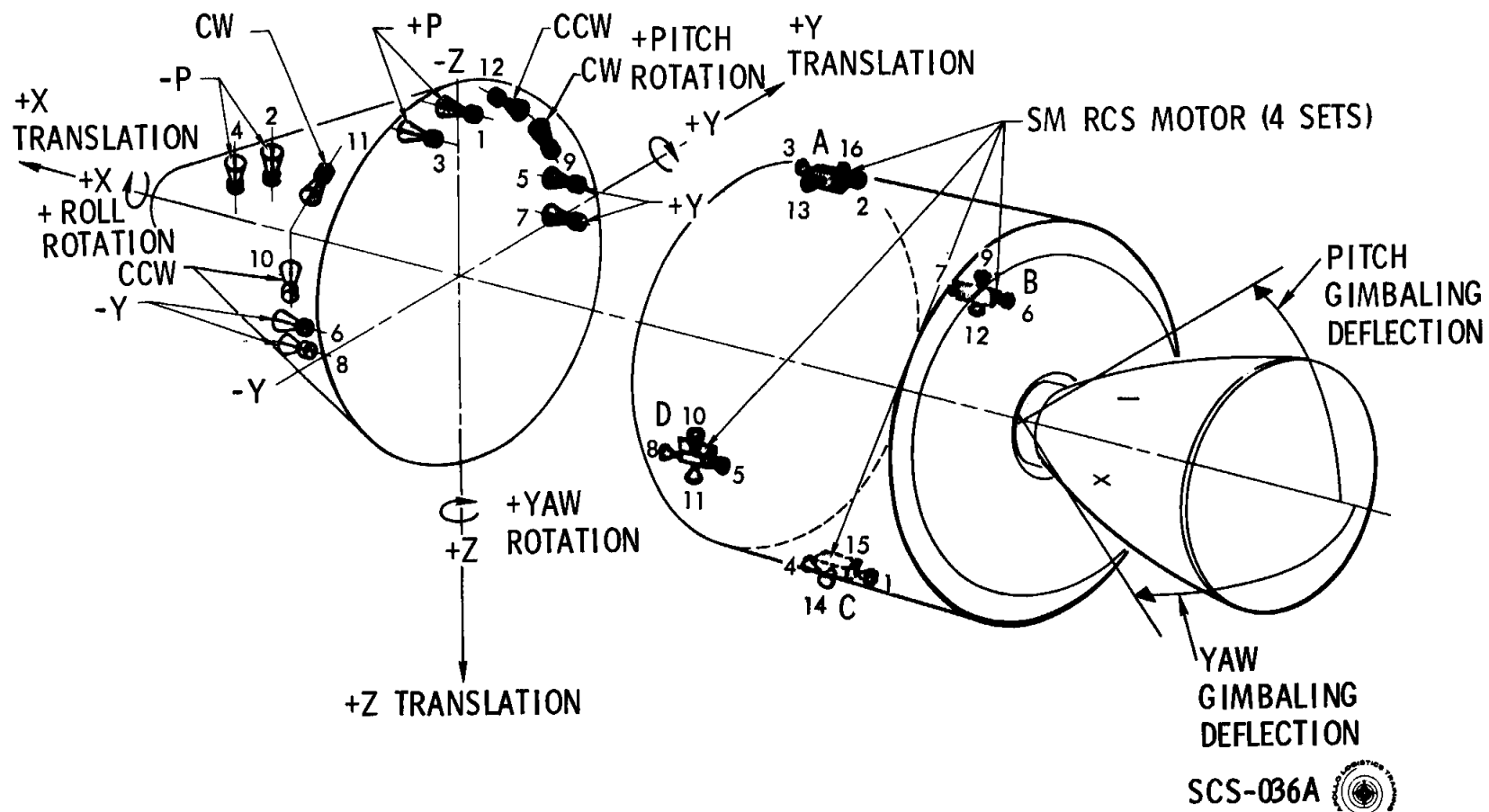
TABLE OF CONTENTS

Section		Page
I	INTRODUCTION	1
II	COMPUTER AND COUPLING DATA UNITS	9
III	OPTICAL AND INERTIAL SUBSYSTEMS	29
IV	ATTITUDE CONTROL SUBSYSTEMS	48
V	ATTITUDE REFERENCE SUBSYSTEMS	70
VI	NAVIGATION	87
VII	THRUST VECTOR CONTROL SUBSYSTEMS AND SIVB TAKEOVER	94
VIII	ENTRY CONTROL AND DISPLAY (EMS)	110
IX	POWER DISTRIBUTION, ABBREVIATIONS AND ACRONYMS	126

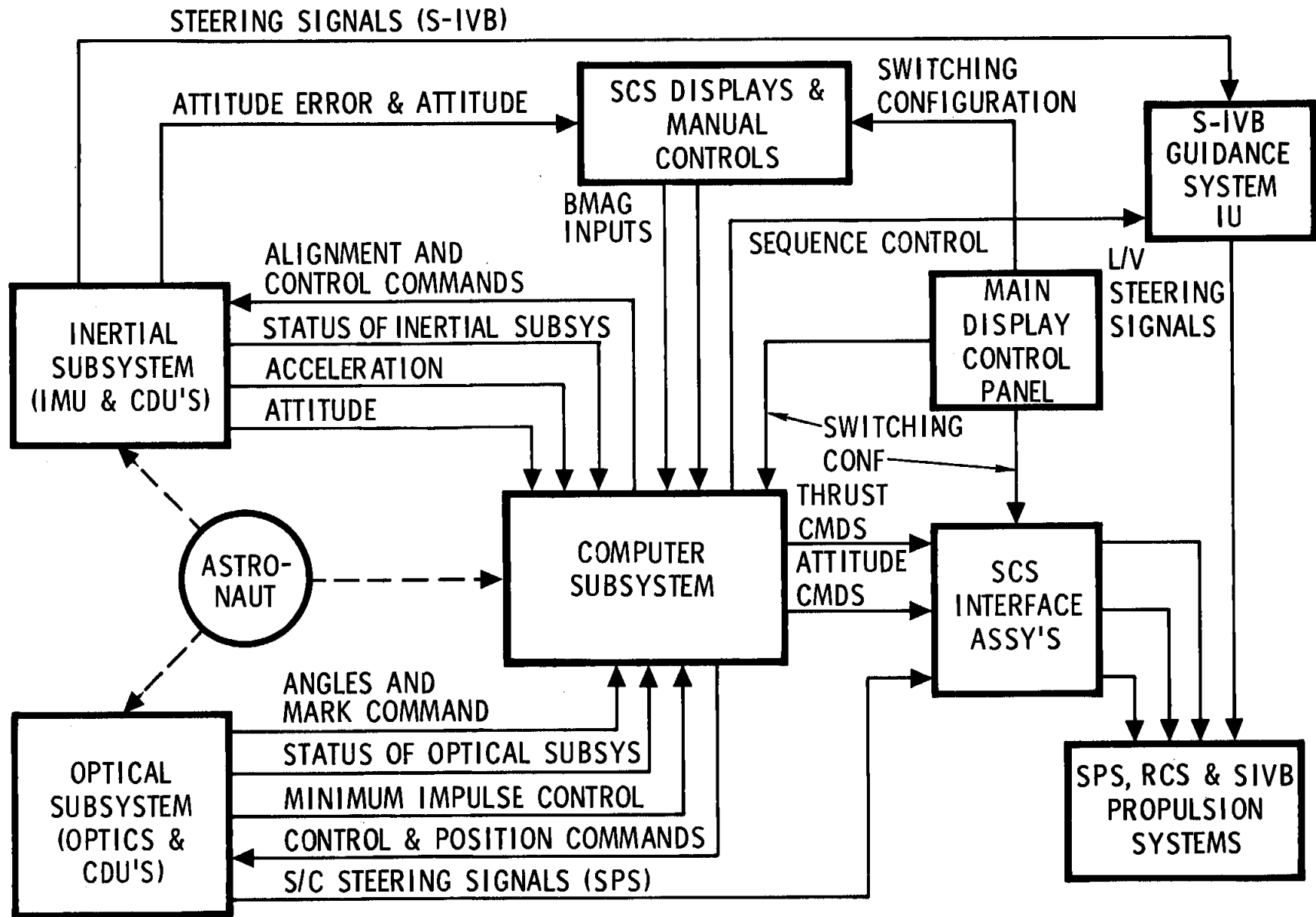
CSM GUIDANCE & CONTROL



PROPULSION TORQUE AND FORCE INPUTS TO THE S/C

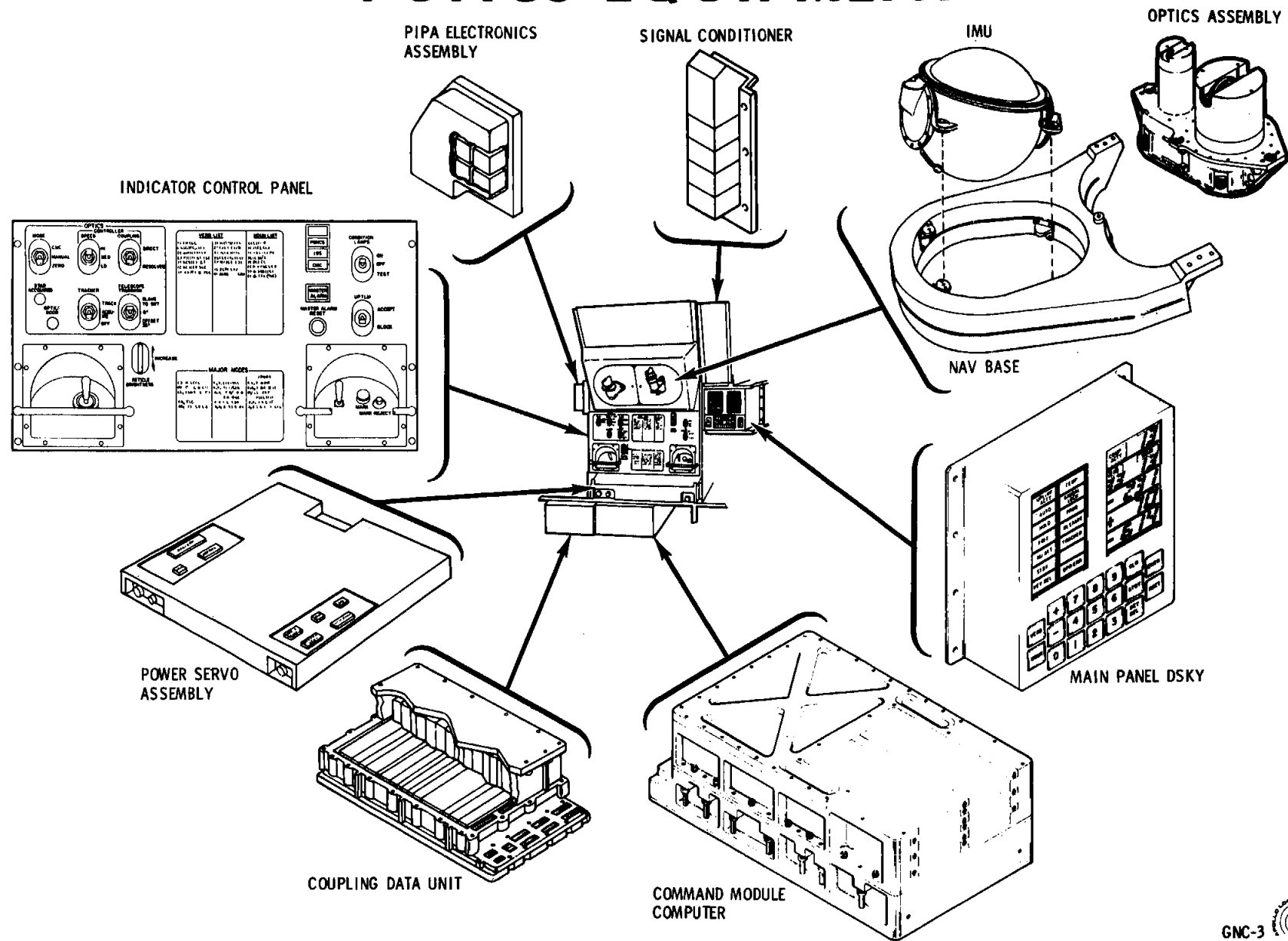


PGNCS DATA FLOW



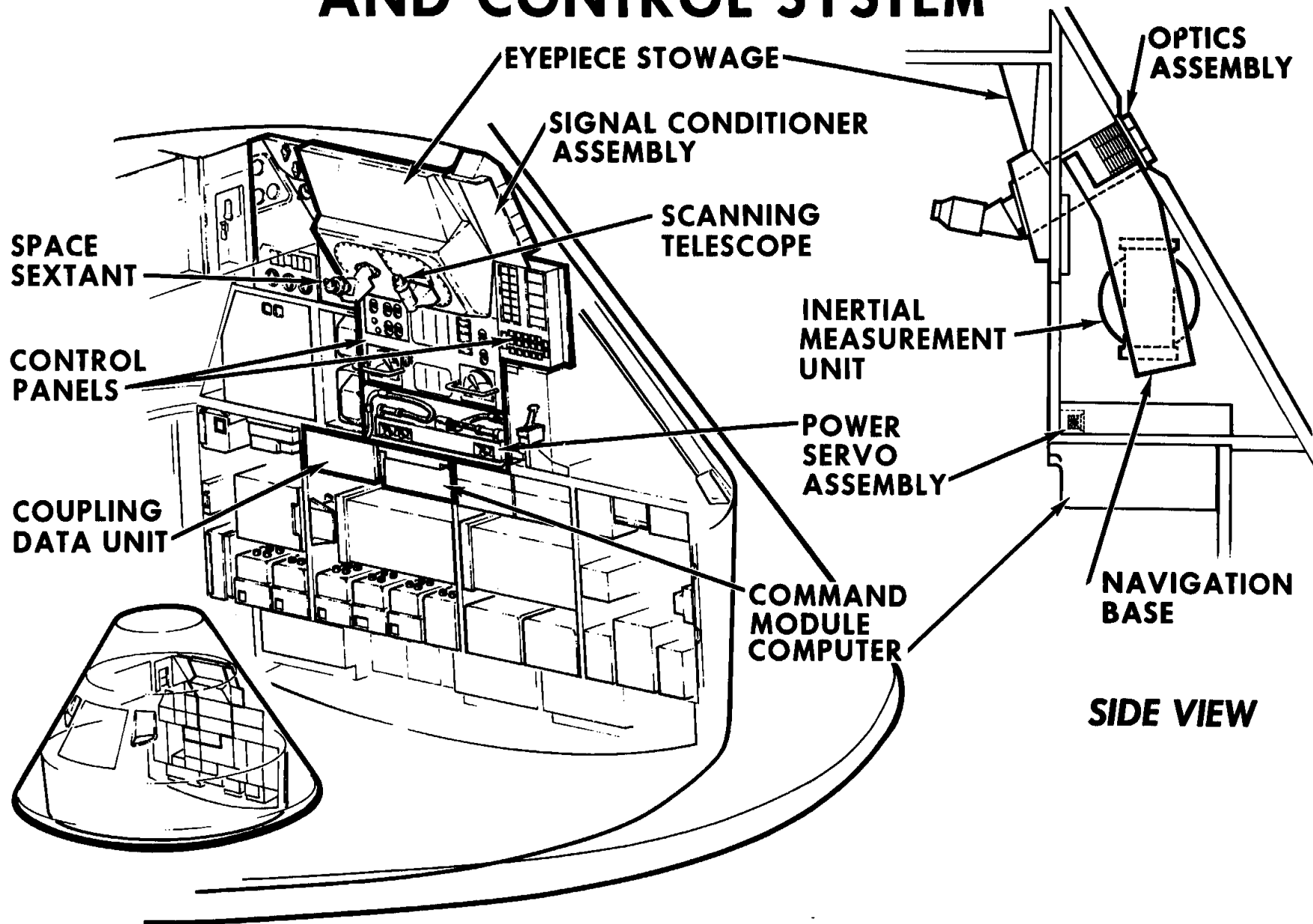
GNC-5D 

PGNCS EQUIPMENT



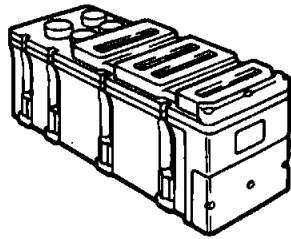
GUIDANCE, NAVIGATION, AND CONTROL SYSTEM

S86SD10793B

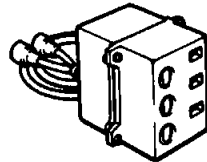


SCS FLIGHT HARDWARE

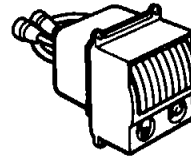
BLOCK II



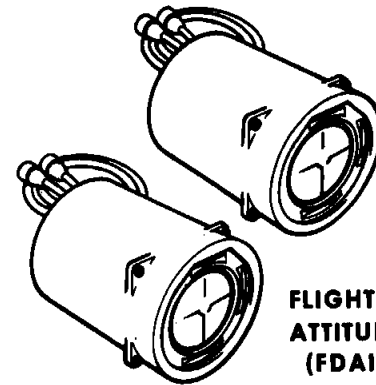
**ELECTRONIC CONTROL ASSEMBLY
(ECA)**



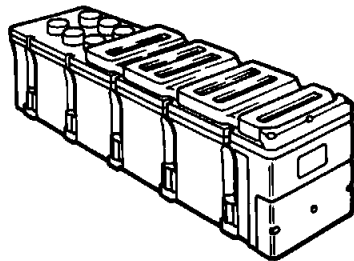
**ATTITUDE SET CONTROL PANEL
(ASCP)**



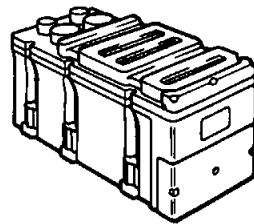
**GIMBAL POSITION/
FUEL PRESSURE INDICATOR
(GP/FPI)**



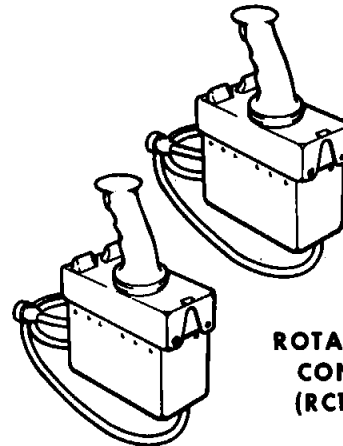
**FLIGHT DIRECTOR
ATTITUDE INDICATOR
(FDAI 1, FDAI 2)**



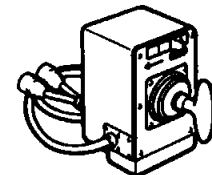
**REACTION JET AND ENGINE
ON-OFF CONTROL
(RJ/EC)**



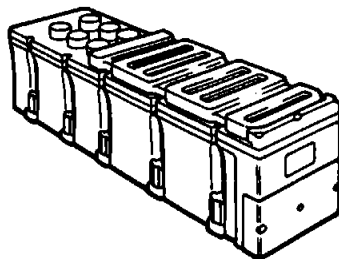
**THRUST VECTOR POSITION
SERVO AMPLIFIER
(TVSA)**



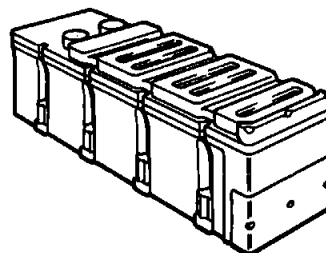
**ROTATION
CONTROL
(RC1, RC2)**



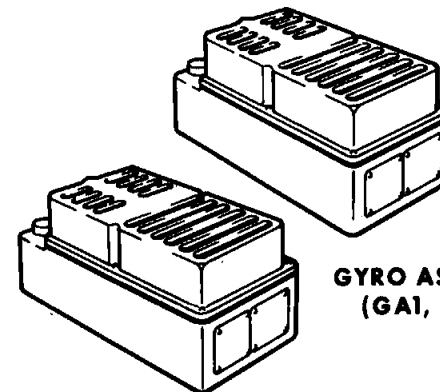
**TRANSLATION CONTROL
(TC)**



**ELECTRONIC DISPLAY ASSEMBLY
(EDA)**

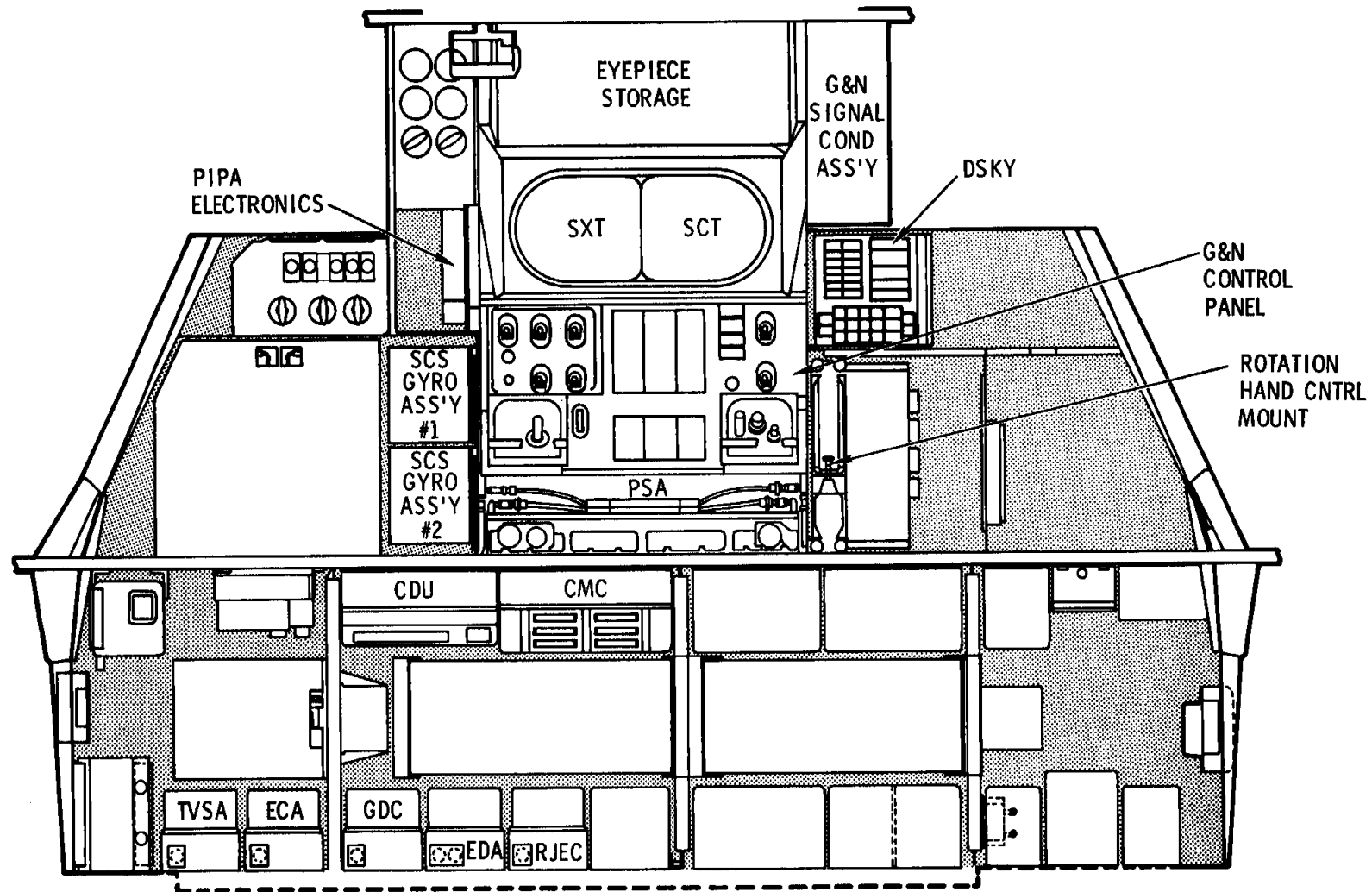


**GYRO DISPLAY COUPLER
(GDC)**

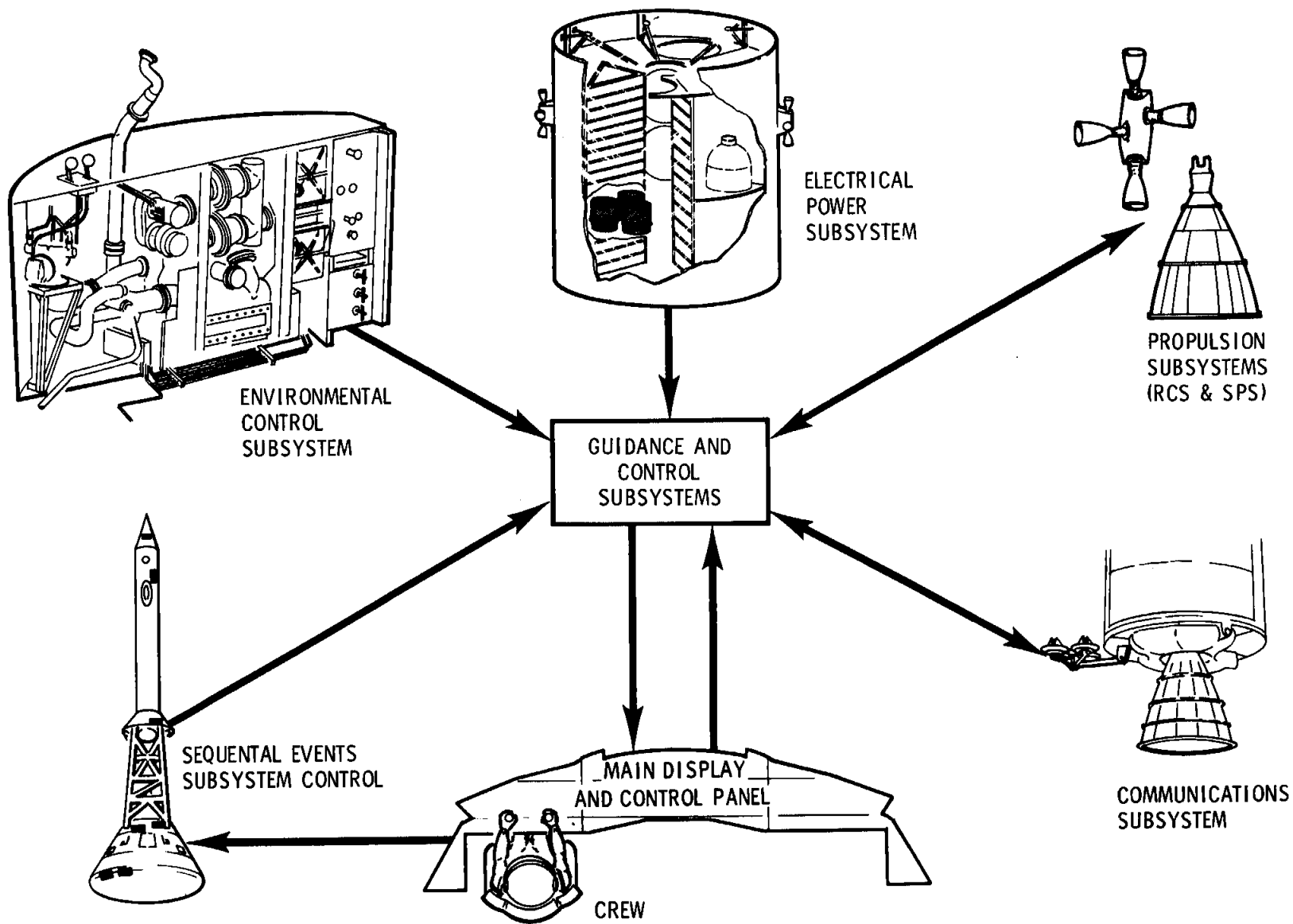


**GYRO ASSEMBLY
(GA1, GA2)**

G&C EQUIPMENT LOCATION

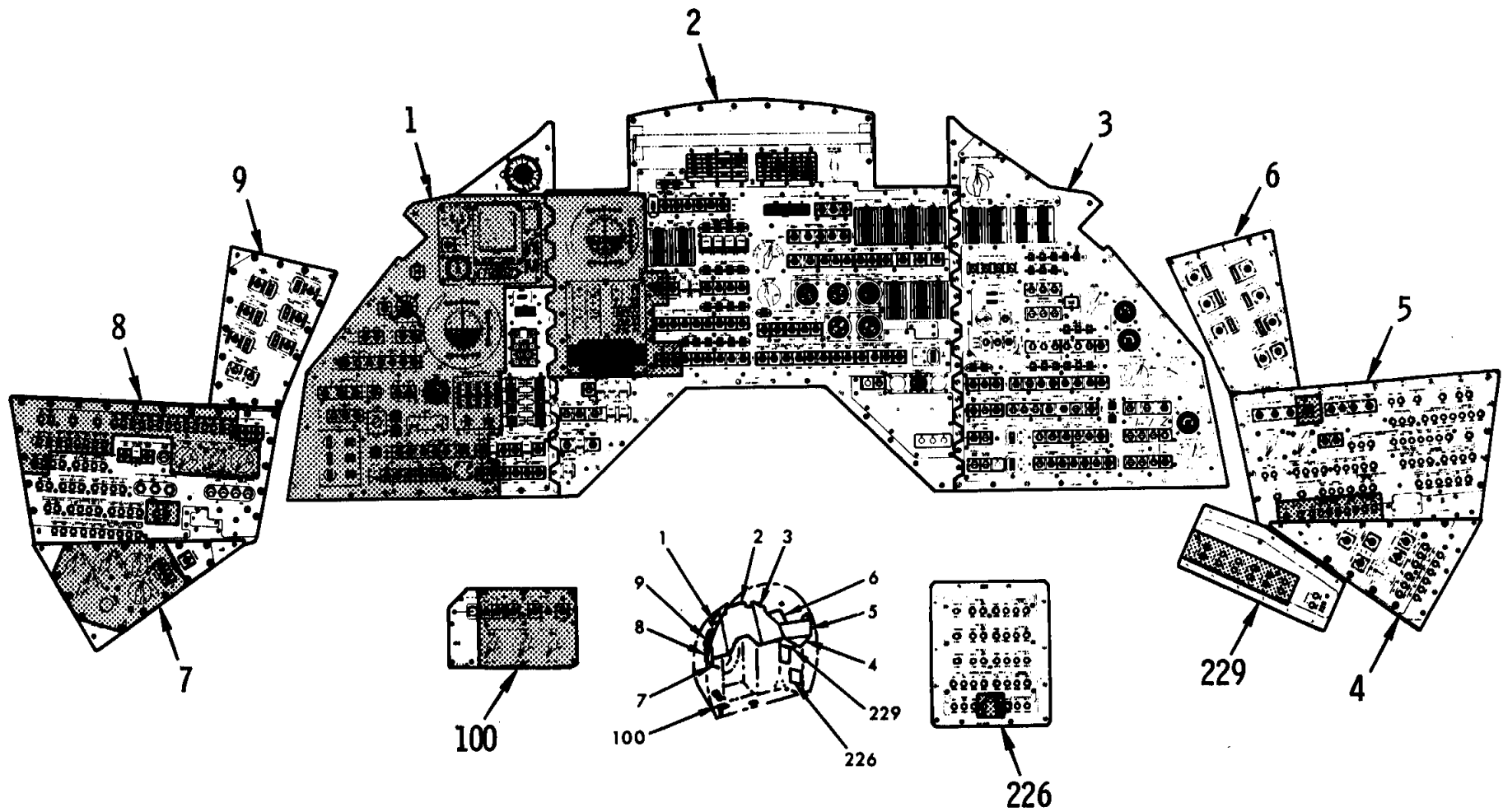


G&C AND APOLLO SUBSYSTEMS INTERFACE

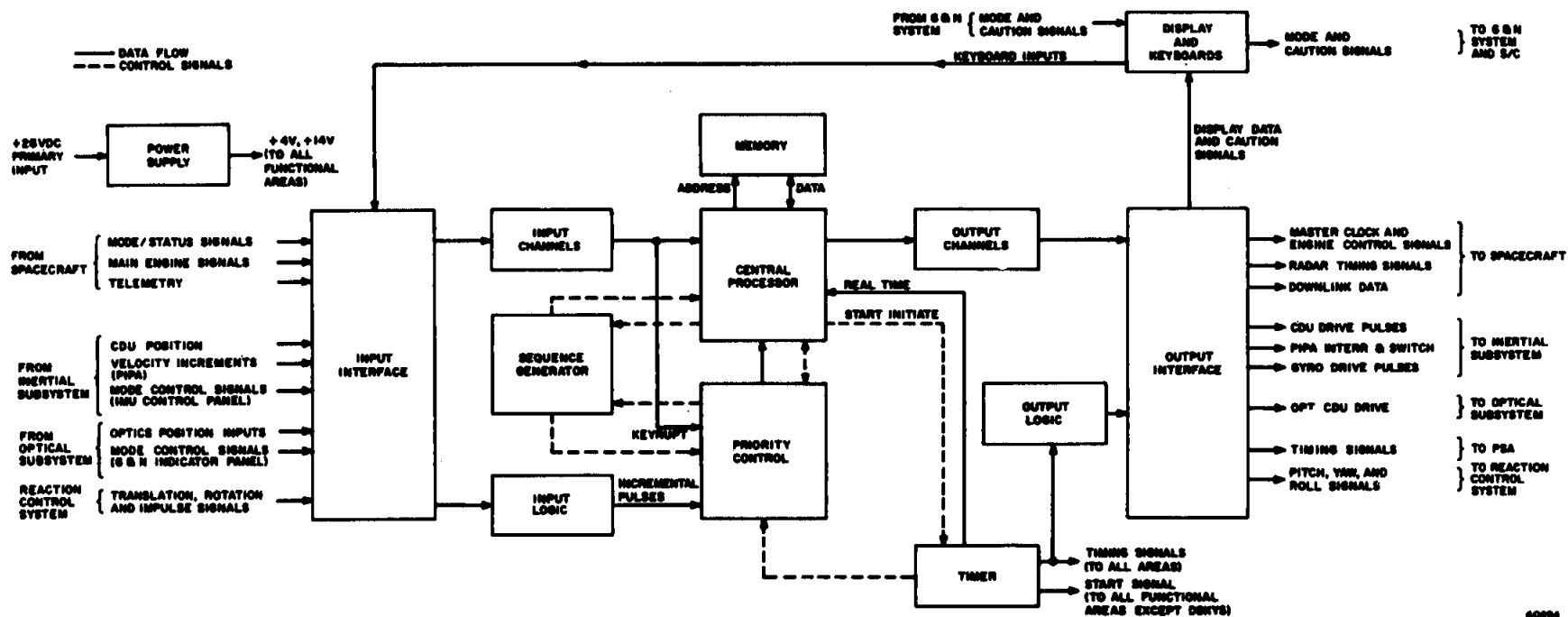


MAIN DISPLAY CONSOLE

G&C SWITCHING LOCATOR

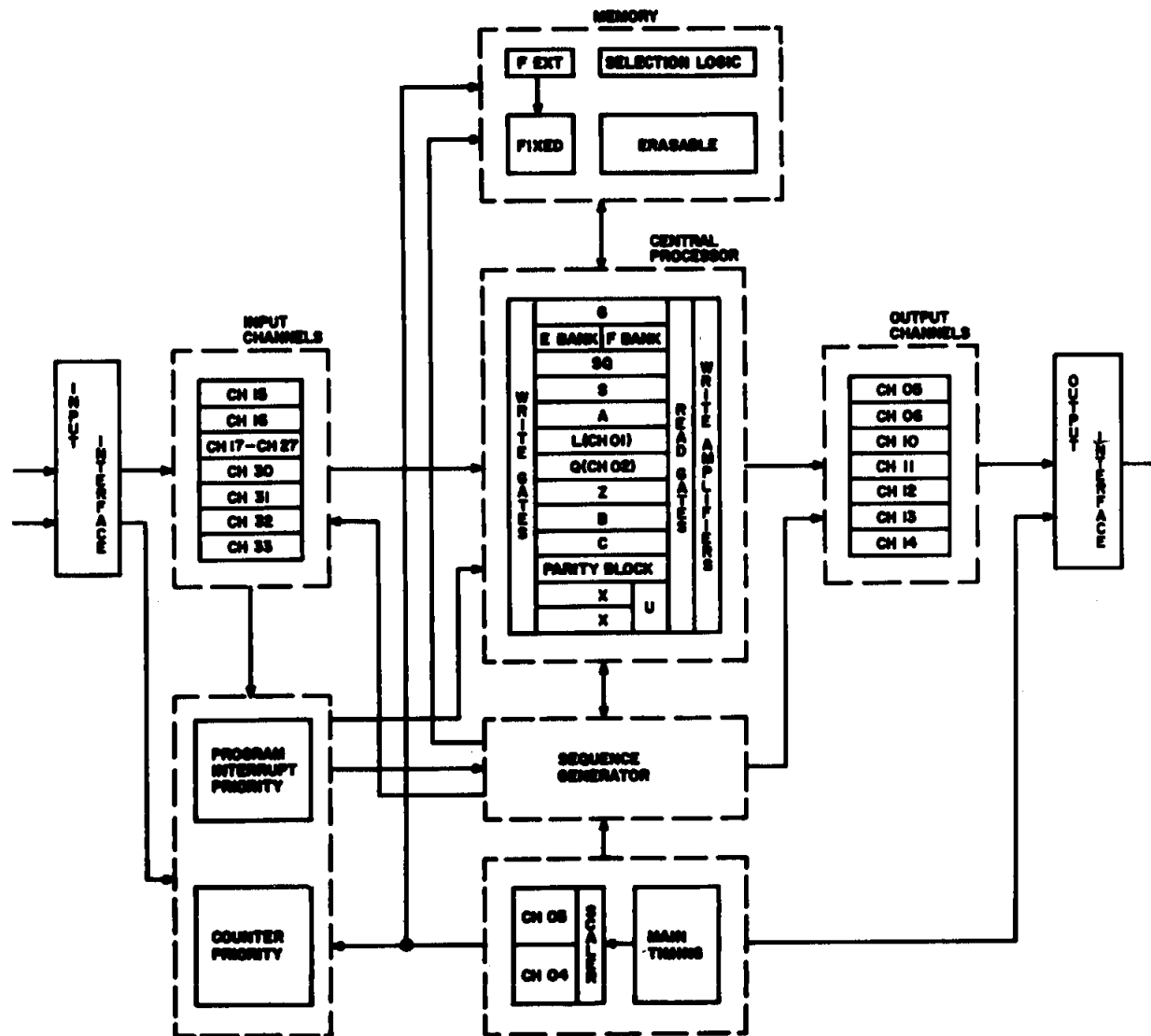


CSS BASIC FLOW



GNC-143

CSS BASIC FLOW DIAGRAM



BIT CHANNEL	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
0 (VACANT)																
1				IDENTICAL TO (8) REGISTER												
2				IDENTICAL TO (10) REGISTER												
3			HIGH 25.3 HRS MAX	ORDER	SCALER											5.12 SEC
4			LOW 5.12 SEC MAX	ORDER	SCALER											1/3200 SEC
OUTBITS 5 RCS (P&V)									+X -Y -YW -X +P	+X +Y +YW -X +P	-X -Y -YW -X +P	+X +Y +YW -X +P	+X -P -P +Z	-X +P +P -X -YW	-X -P -P +Z	+X +P +P -X -YW
OUTBITS 6 RCS (ROLL)									+Y -R -Y +R	+Y +R -Y -R	-Y -R -Y +R	+Y +R -Y -R	+Z -R -Z +R	-Z +R -Z -R	+Z +R -Z -R	+Z +R -Z -R
PHS 7									*** FIXED PE7	*** EXTENSION PE6	*** BITS PE5					C/M LEM
OUTBITS 10 "R" RELAYS		4 RELAY ADDRESS	3	2	1	11	10	9	8	7	6	5	4	3	2	1
OUTBITS 11 "A" RELAYS		4 RELAY ADDRESS	3	2	1	11	10	9	8	7	6	5	4	3	2	1
OUTBITS 12 GNBC		ISS TURN ON DELAY COMPLETE	SVB CUTOFF RELAY	SVB INJ SEQ START RELAY	DISENGAGE OPTICS DAC	ZERO OPTICS	SVB TAKE OVER ENABLE	TVC ENABLE	ENABLE IMU ERROR COUNTER	ZERO IMU CDUPS	COARSE ALINE ENABLE	—	ENABLE OPTICS ERROR COUNTER	ZERO OPTICS CDUPS	—	ZERO OPTICS CDUPS
OUTBITS 13 RADAR & AGC		ENABLE T6 RUPT	RESET TRAP 32	RESET TRAP 31-B	ENABLE STANDBY	TEST ALARMS	START RHC READ	DOWNLINK WORD ORDER	BLOCK INLINK	—	BADAR ACTIVITY	BADAR SELECTION A*	BADAR SELECTION B*	BADAR SELECTION C*	—	BADAR SELECTION C*
OUTBITS 14 IMU		DRIVE CDU X	DRIVE CDU Y	DRIVE CDU Z	DRIVE CDU T	DRIVE CDU S	GYRO ACTIVITY	GYRO SIGN MINUS	GYRO SELECT A**	GYRO SELECT B**	GYRO ENABLE	—	—	—	—	—
INBITS 15 MAIN KEYBOARD																
INBITS 16 NAV KEYBOARD																
INBITS 17 & 20 thru 27 VACANT																
INBITS 30 GNBC		TEMP OUT OF LIMITS	I.S.S. TURN-ON REQUEST	IMU FAIL	IMU CDU FAIL	IMU CAGE	S/C CONTROL OF SATURN Q&N CONTROL OF S/C	IMU OPERATE	OPTICS CDU FAIL	GUID REF RELEASE	LIFTOFF	SVB SEPARATE ABORT	SPS READY	SM SEPARATE STAGE VERIFY	—	—
INBITS 31 TRANS & ROT		OSC ALARM	FREE FUNCTION	HOLD FUNCTION	-Z TRANSLATION	+Z TRANSLATION	-Y TRANSLATION	+Y TRANSLATION	-X TRANSLATION	+X TRANSLATION	-ROLL MAN ROT	+ROLL MAN ROT	-YAW MAN ROT	+YAW MAN ROT	-PITCH MAN ROT	+PITCH MAN ROT
INBITS 32 IMPULSE		—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
INBITS 33 OPTICS & AGC		OSC ALARM	CNC WARNING	PWA FAIL	DOWNLINK TOO FAST	URLINK TOO FAST	BLOCK URLINK INFLUX	—	—	—	—	—	—	—	—	—
34																
35																

RADAR SELECTION			FUNCTION
0	0	0	—
0	0	1	R.R. RANGE
0	1	0	R.R. RANGE RATE
0	1	1	—
1	0	0	L.R. X VELOCITY
1	0	1	L.R. Y VELOCITY
1	1	0	L.R. Z VELOCITY
1	1	1	L.R. RANGE

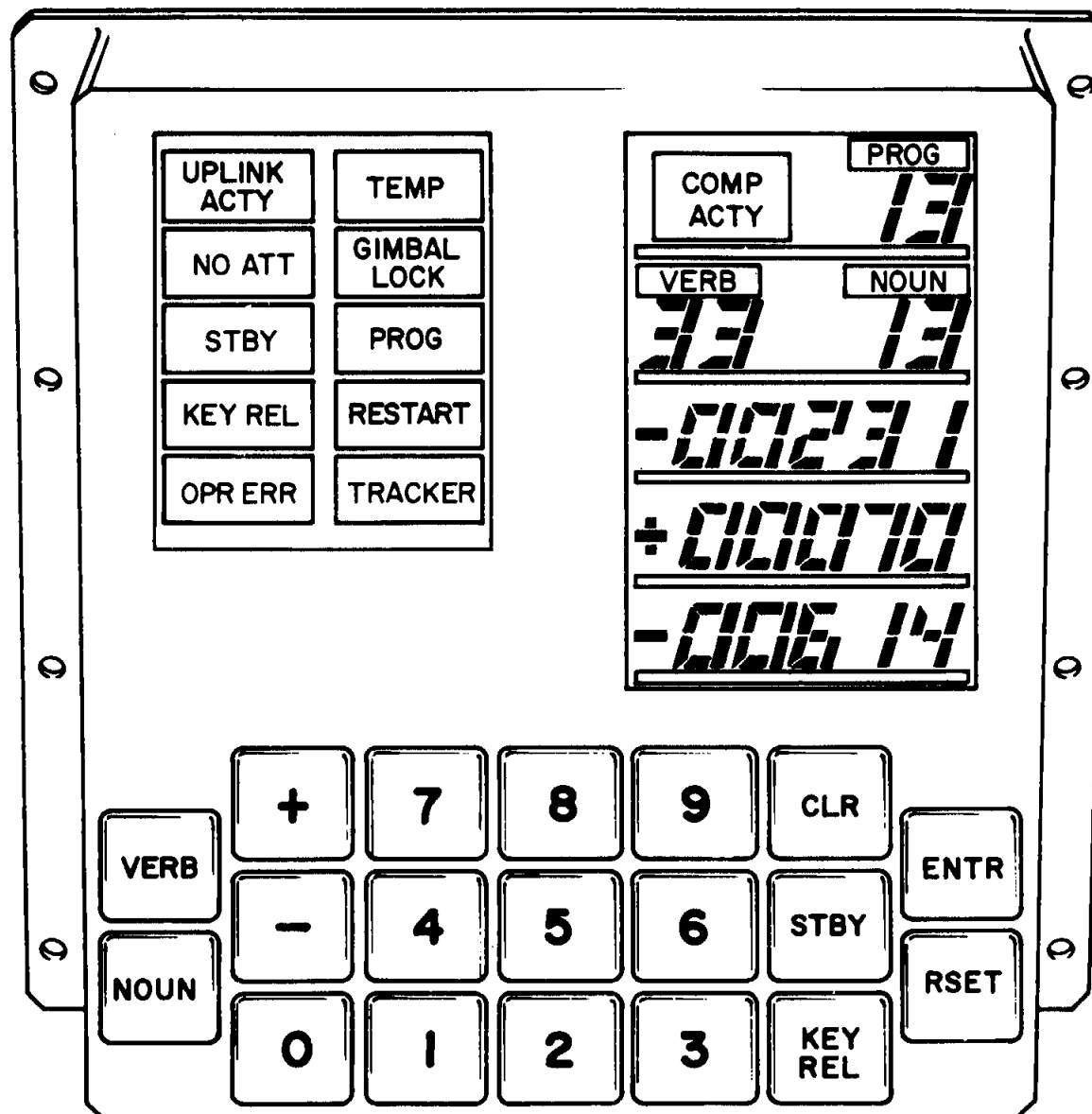
GYRO SELECT			GYRO
0	0	0	—
0	0	1	X
0	1	0	Y
0	1	1	Z

PE7	PE6	PE5	HIGH BANKS
0	X	X	30-37
1	0	0	40-43
1	0	1	EMPTY
1	1	0	EMPTY
1	1	1	EMPTY

BLOCK II CMC & LGC CHANNEL-BIT ASSIGNMENTS

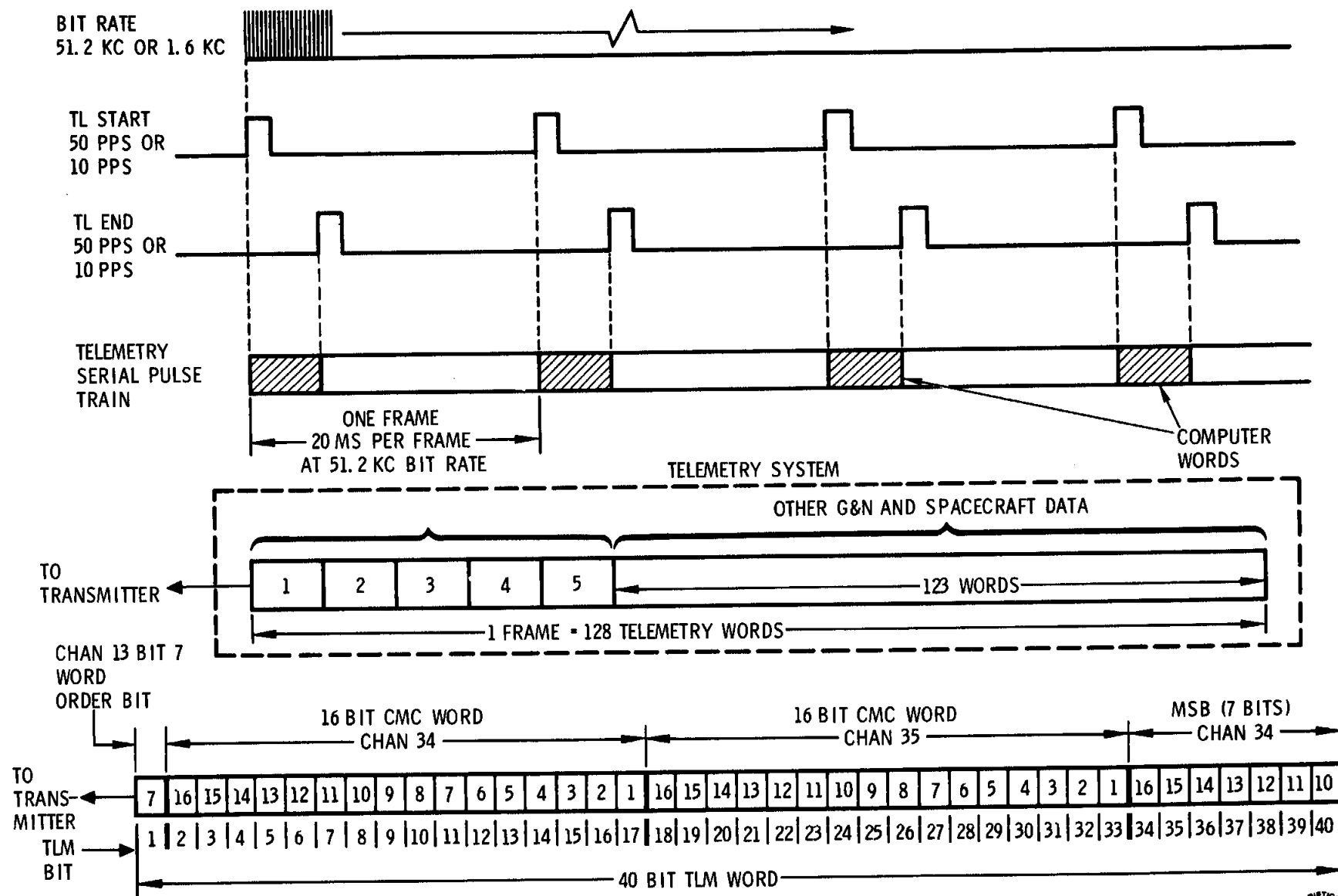


DISPLAY AND KEYBOARD (DSKY)

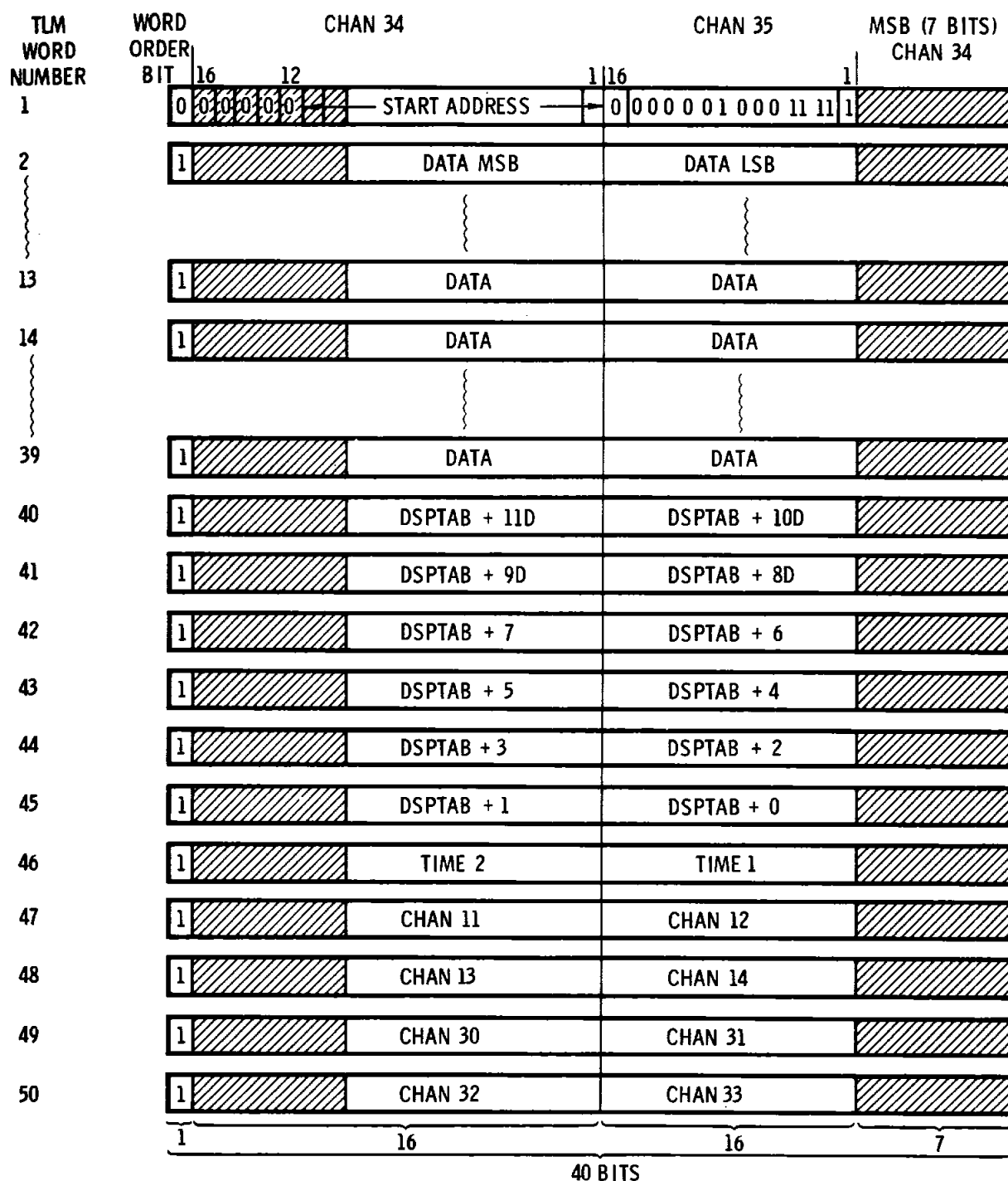


GNC-33 A 

DWN TLM FORMAT

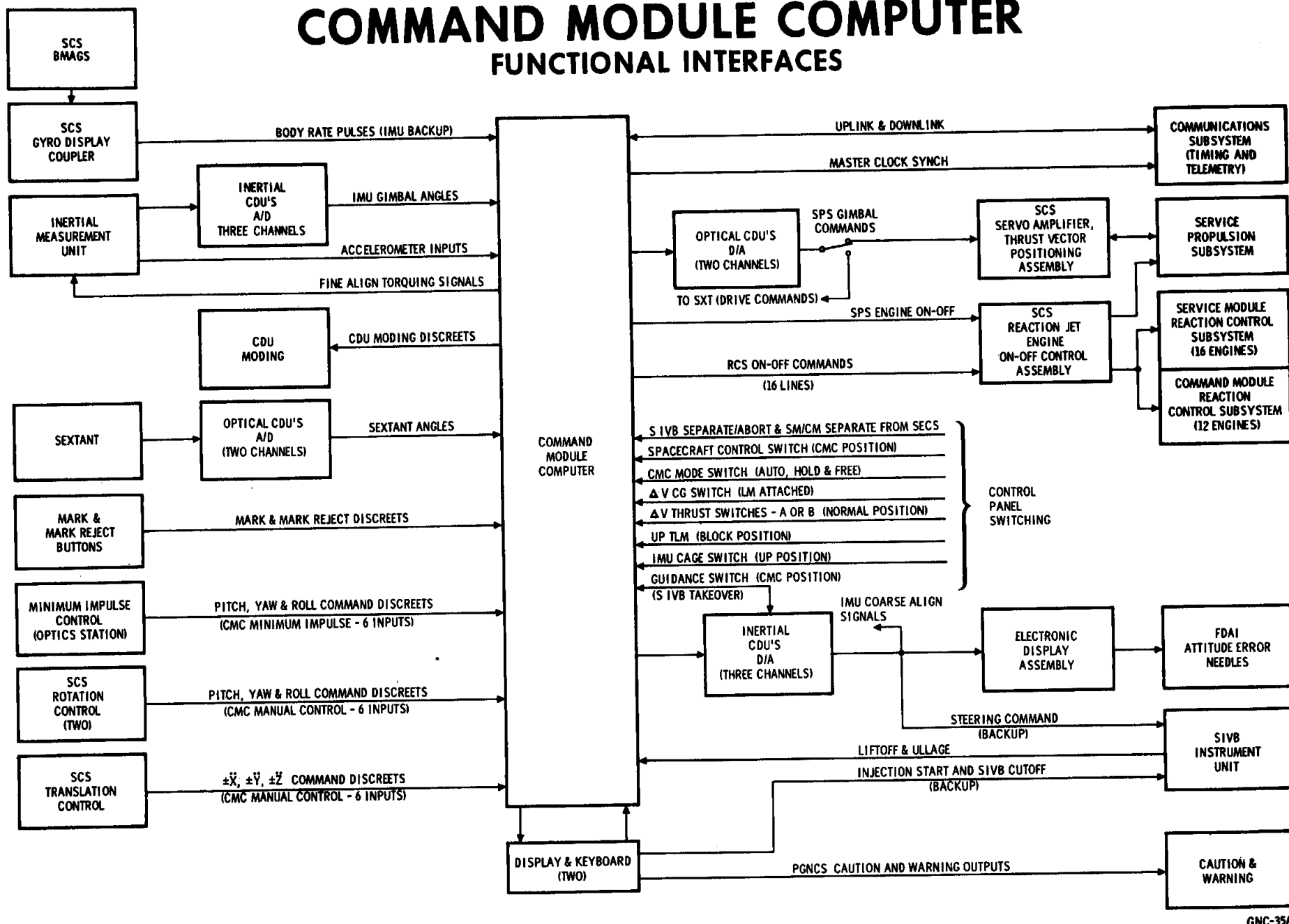


50 WORD DWNTLM LIST



COMMAND MODULE COMPUTER

FUNCTIONAL INTERFACES



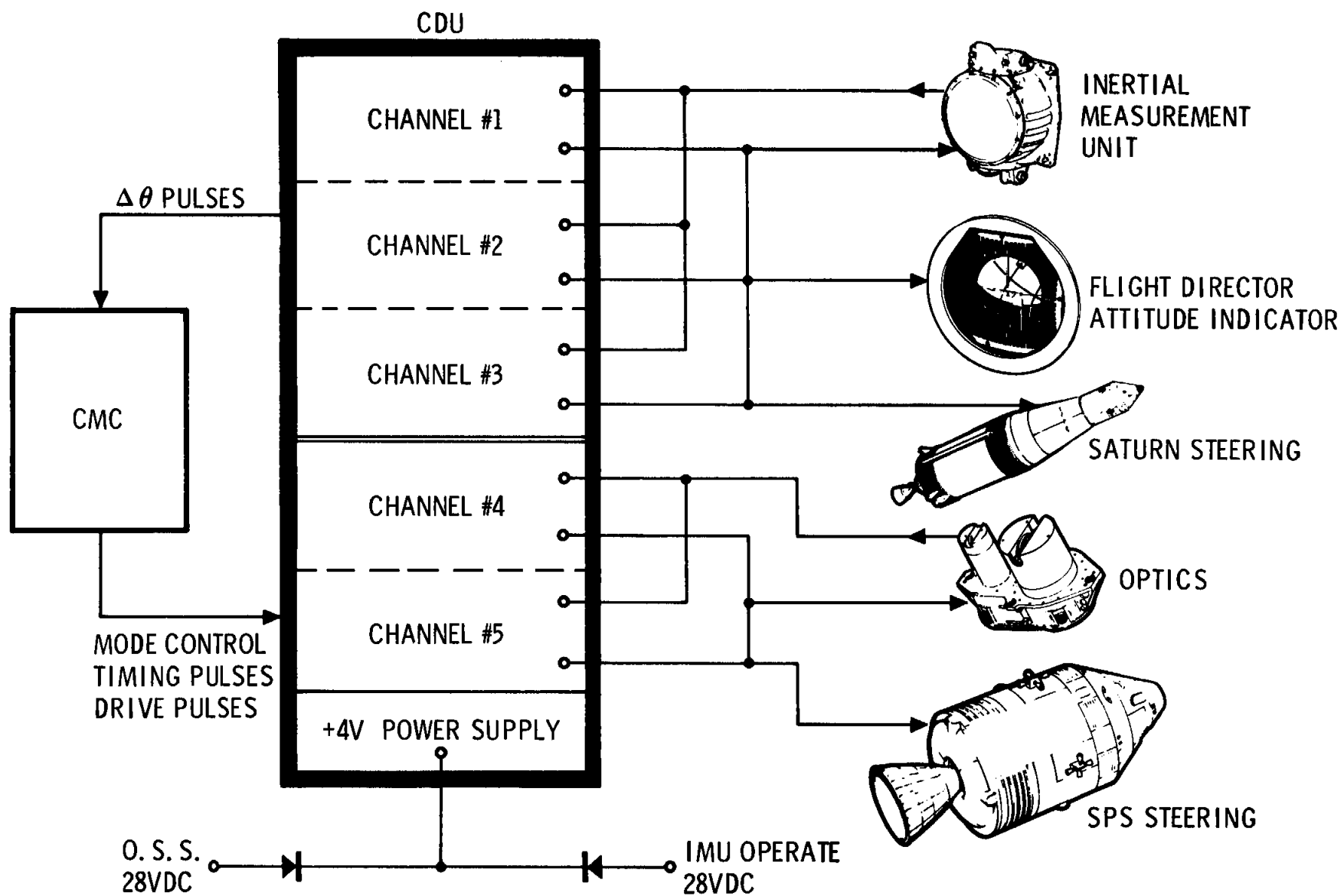
GNC-35A



CSM GUIDANCE COMPUTER MISSION PROGRAMS

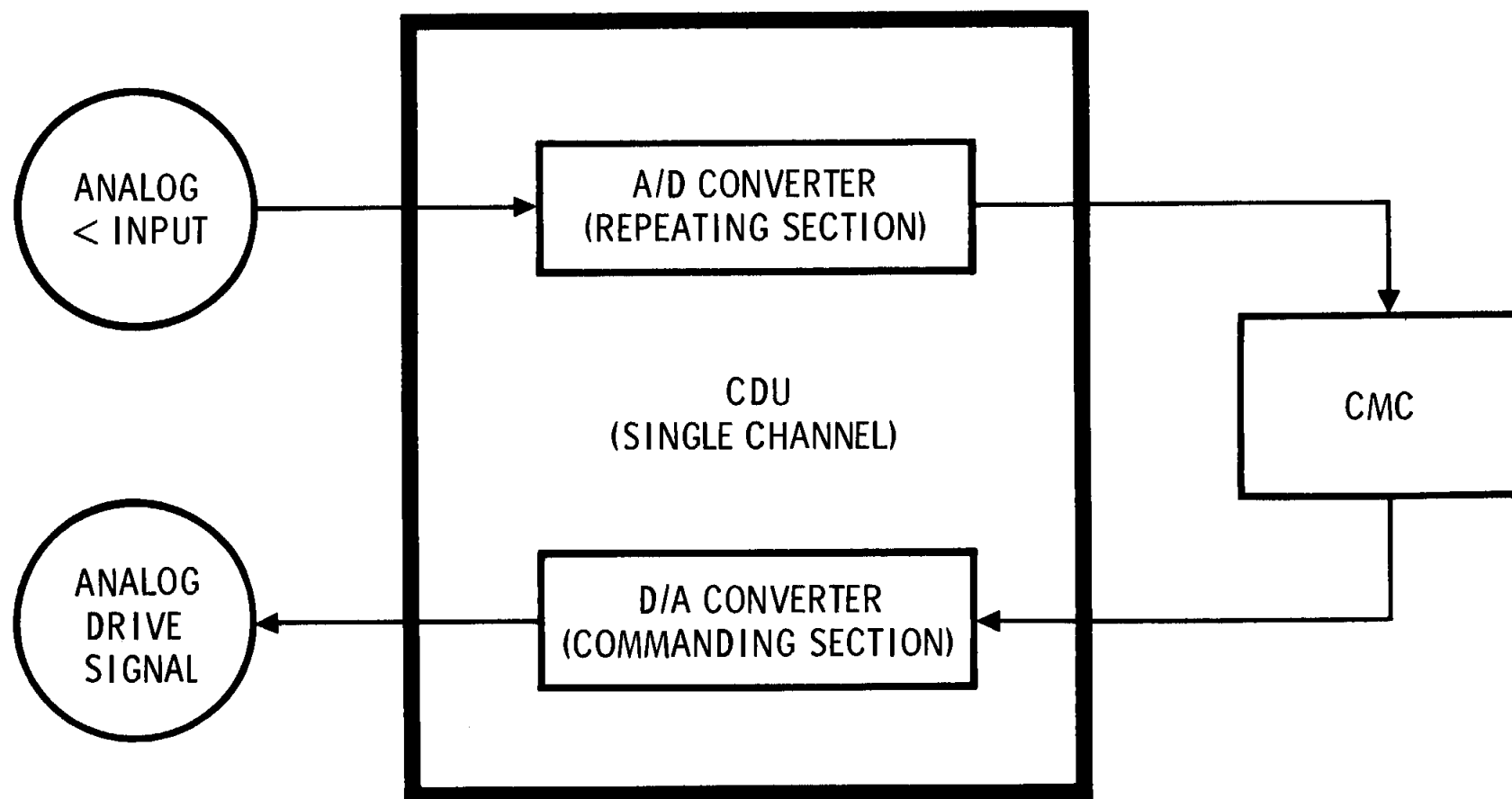
1. Prelaunch & Service
 - P00 CMC Idling
 - P01 Prelaunch Initialization
 - P02 Gyro Compassing
 - P03 Optical Verification of Azimuth
 - P05 GNCS Startup
 - P06 GNCS Power down
 - P27 CMC Update
2. Boost
 - P11 Earth Orbit Insertion Monitor
3. Coast
 - P20 Rendezvous Navigation
 - P21 Ground Track Determination
 - P22 Orbital Navigation
 - P23 Cislunar Midcourse Navigation
4. Prethrust
 - P30 External Delta V
 - P34 Transfer Phase Initiation (TPI)
 - P35 Transfer Phase Initiation (Midcourse)
5. Thrust
 - P40 SPS
 - P41 RCS
 - P47 Thrust Monitor
6. Alignment
 - P51 IMU Orientation Determination
 - P52 IMU Realign
 - P53 Backup IMU Orientation Determination
 - P54 Backup IMU Realign
7. Entry
 - P61 Entry Maneuver to CM/SM Separation Attitude
 - P62 CM/SM Separation & Pre entry maneuver
 - P63 Entry - Initialization
 - P64 Post .05 G
 - P67 Entry Final Phase
8. Abort
 - P74 LM Transfer Phase Initiation (TPI)
 - P75 LM Transfer Phase Initiation Midcourse
9. Astronaut Service Routines
 - R00 Final Automatic Request Termination
 - R02 IMU Status Check
 - R03 DAP Data Load ---- V48E
 - R21 Rendezvous Tracking Data Processing ---- V57E
 - R22 Rendezvous Tracking Sighting Mark
 - R30 Orbit Parameter Display ---- V82E
 - R31 Rendezvous Parameter Display --- V83E
 - R32 Target Delta V ---- V84E
 - R34 Rendezvous Parameter Display ---- V85E
 - R50 Coarse Align
 - R51 Fine Alignment
 - R52 Automatic Optics Positioning
 - R53 Sighting Mark
 - R54 Star Data Test
 - R55 Gyro Torquing
 - R56 Alternate LOS Sighting Mark
 - R60 Attitude Maneuver
 - R61 Preferred Tracking Attitude
 - R62 Crew Defined Maneuver ---- V49E
 - R63 Rendezvous Final Attitude ---- V89E

CDU FUNCTIONAL INTERFACES

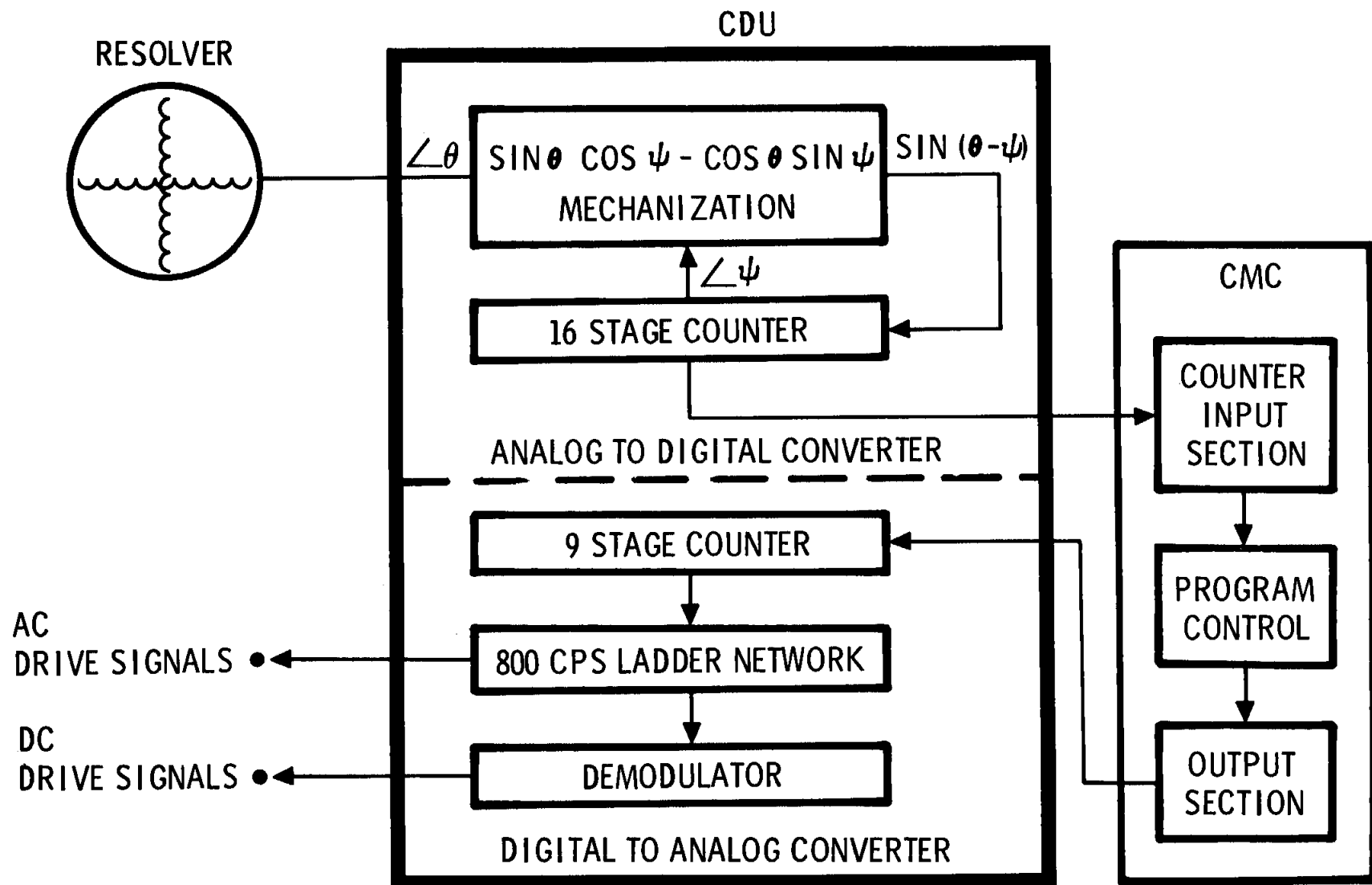


CDU

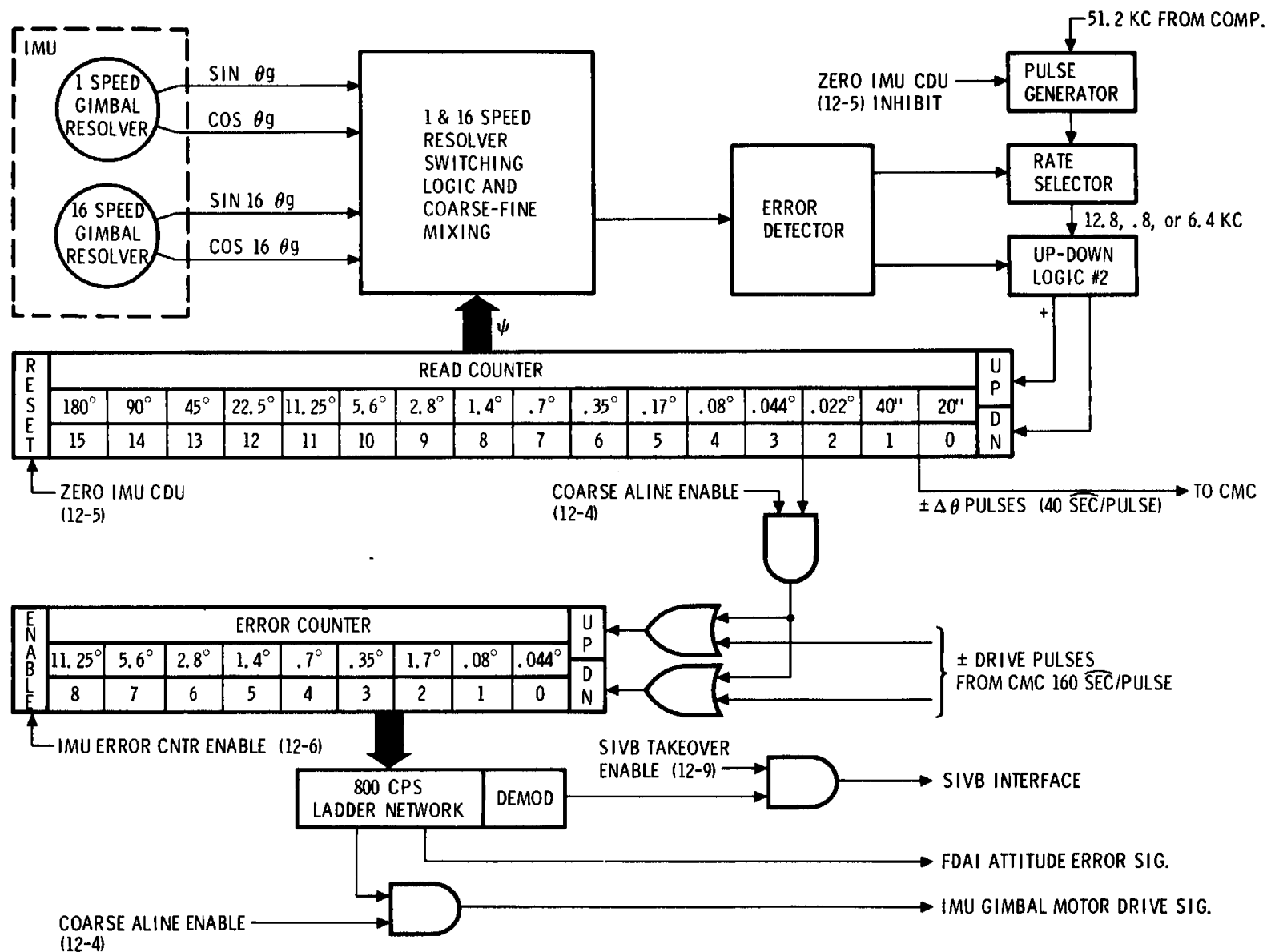
SINGLE CHANNEL SIMPLIFIED



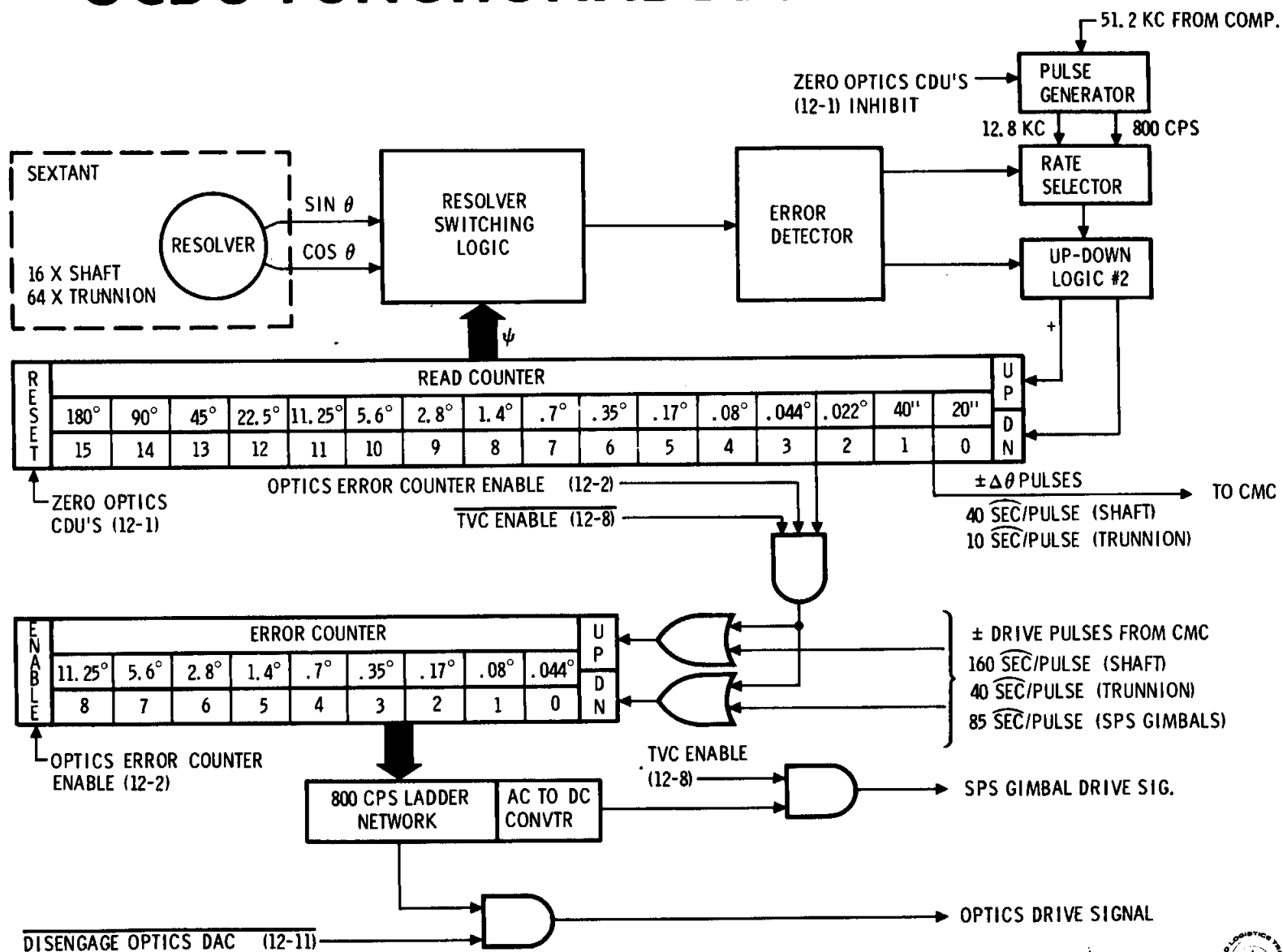
CDU SINGLE CHANNEL



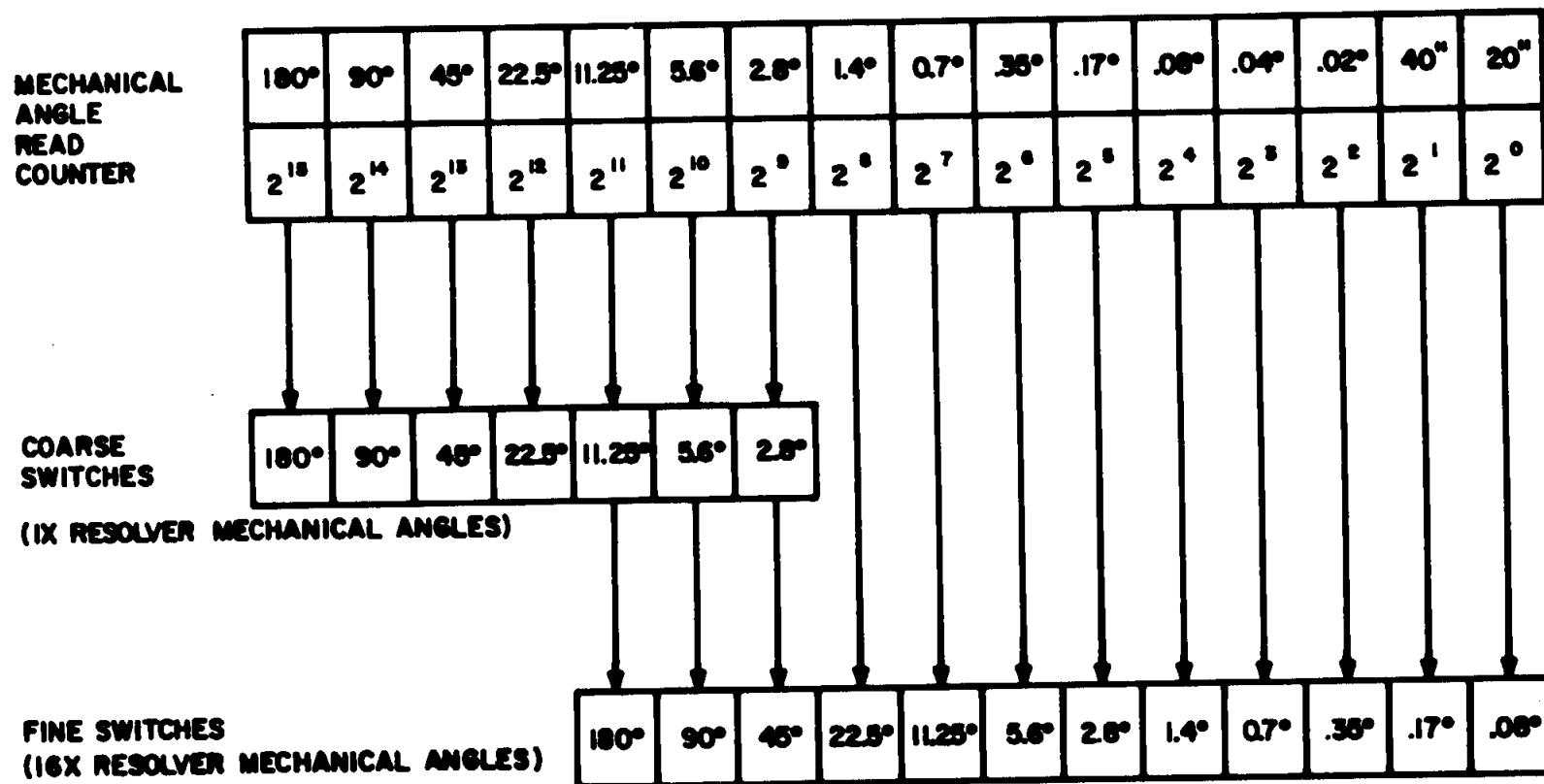
ICDU FUNCTIONAL BLOCK DIAGRAM



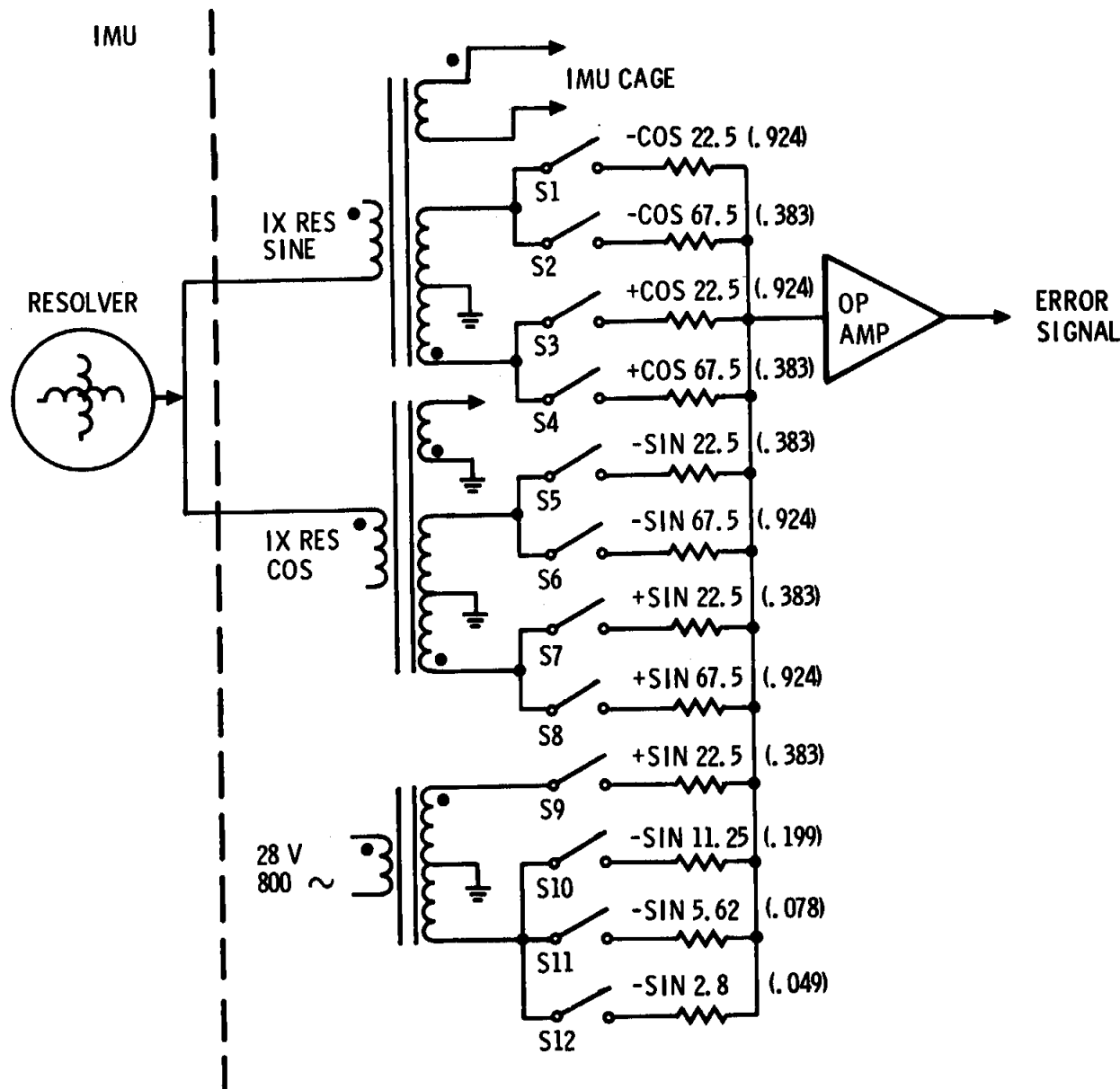
OCDU FUNCTIONAL BLOCK DIAGRAM



READ COUNTER RELATIONSHIP TO COARSE FINE SWITCHING



CDU COARSE MODULE BLOCK DIAGRAM



COARSE SWITCH LOGIC EQUATIONS

$$DC 1 = 2^{15} 2^{14} 2^{13} + 2^{15} 2^{14} 2^{13}$$

$$DC 2 = 2^{15} 2^{14} 2^{13} + 2^{15} 2^{14} 2^{13}$$

$$DC 3 = 2^{15} 2^{14} 2^{13} + 2^{15} 2^{14} 2^{13}$$

$$DC 4 = 2^{15} 2^{14} 2^{13} + 2^{15} 2^{14} 2^{13}$$

$$DC 5 = 2^{15} [2^{14} 2^{13} + 2^{14} 2^{13}]$$

$$DC 6 = 2^{15} [2^{14} 2^{13} + 2^{14} 2^{13}]$$

$$DC 7 = 2^{15} [2^{14} 2^{13} + 2^{14} 2^{13}]$$

$$DC 8 = 2^{15} [2^{14} 2^{13} + 2^{14} 2^{13}]$$

$$DC 9 = 2^{12}$$

$$DC 10 = 2^{11}$$

$$DC 11 = 2^{10}$$

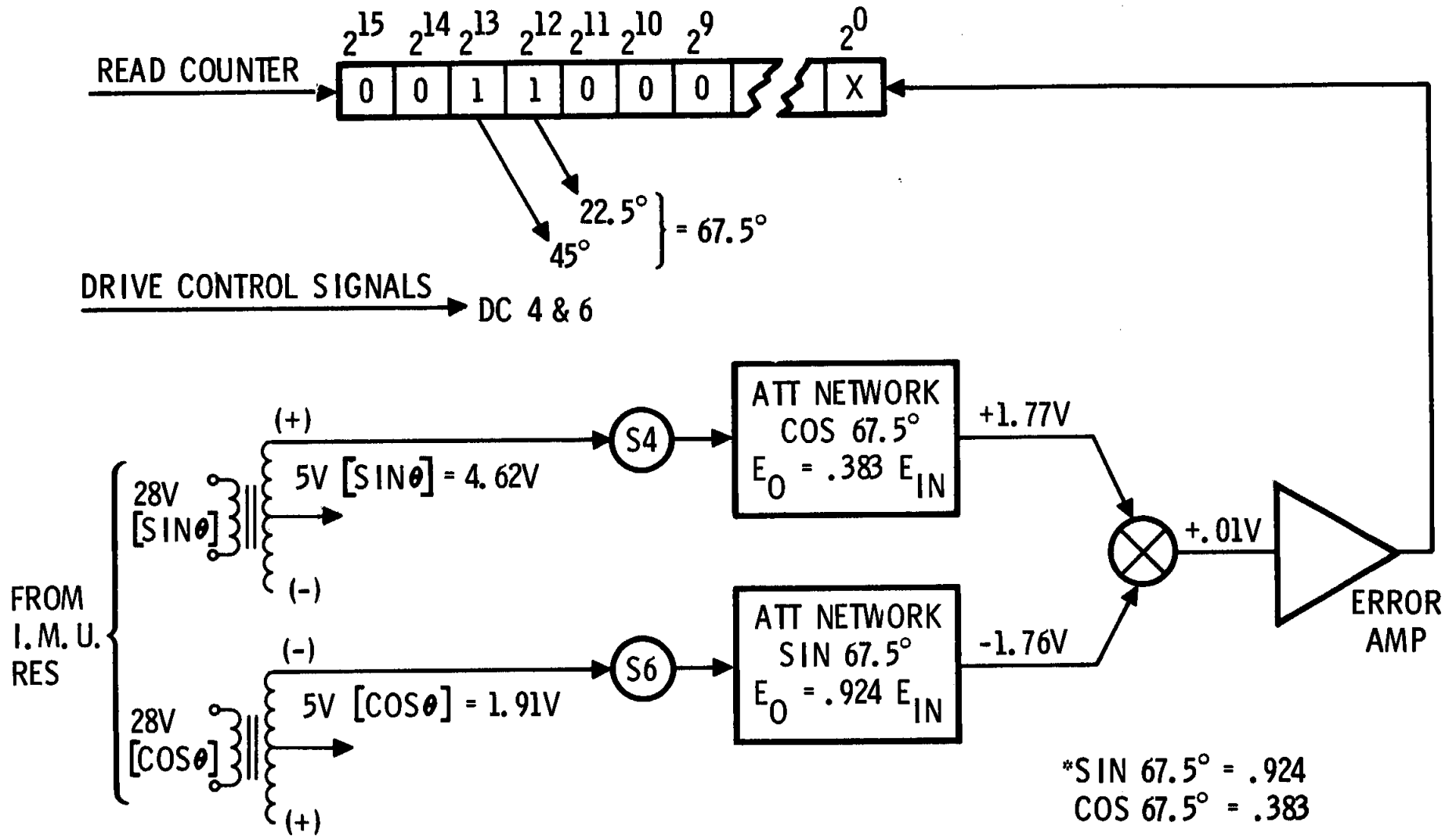
$$DC 12 = 2^9$$

* 2^N = "N" REFERS TO BIT IN THE READ COUNTER

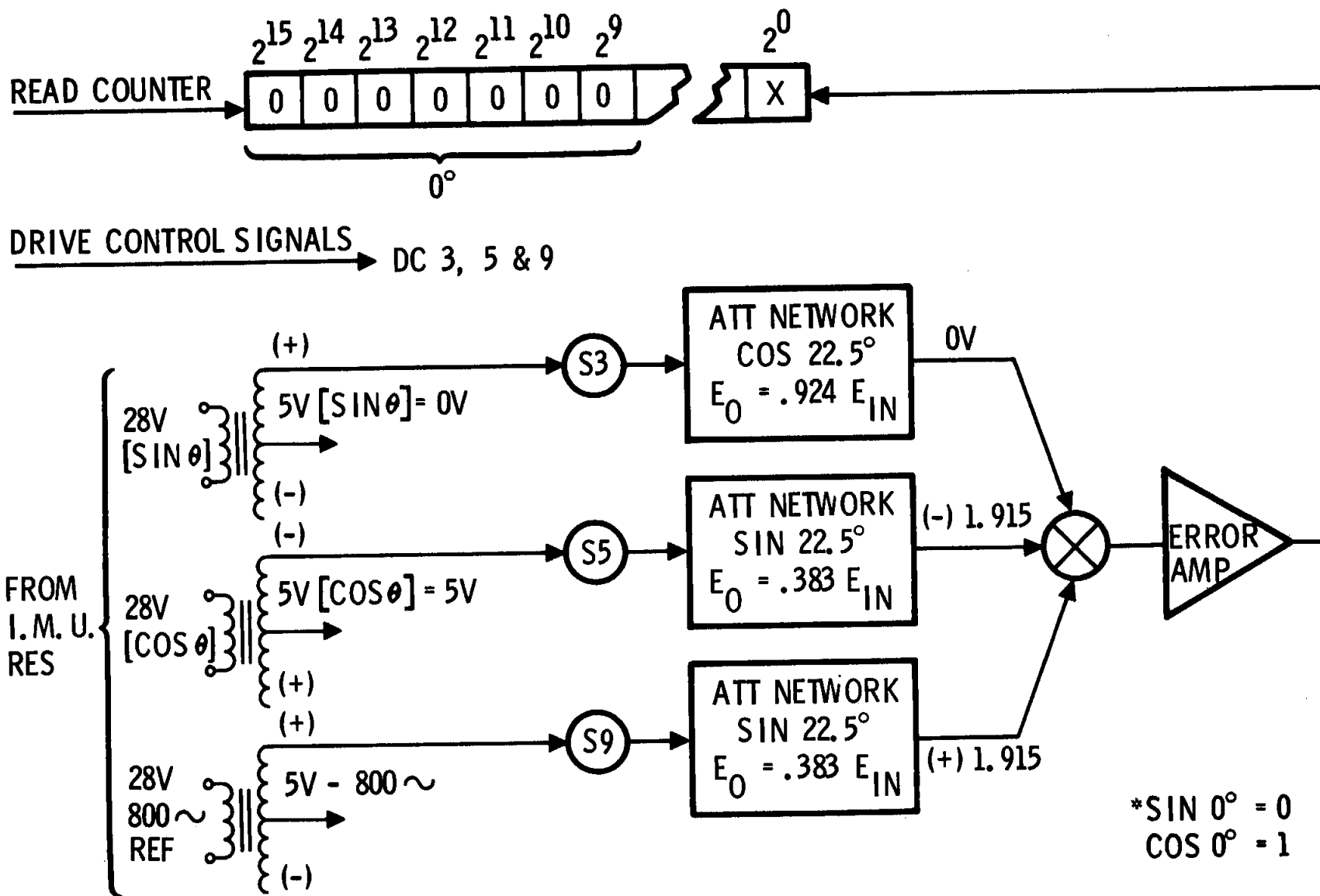
*DC "X" CLOSES SWITCH "X"



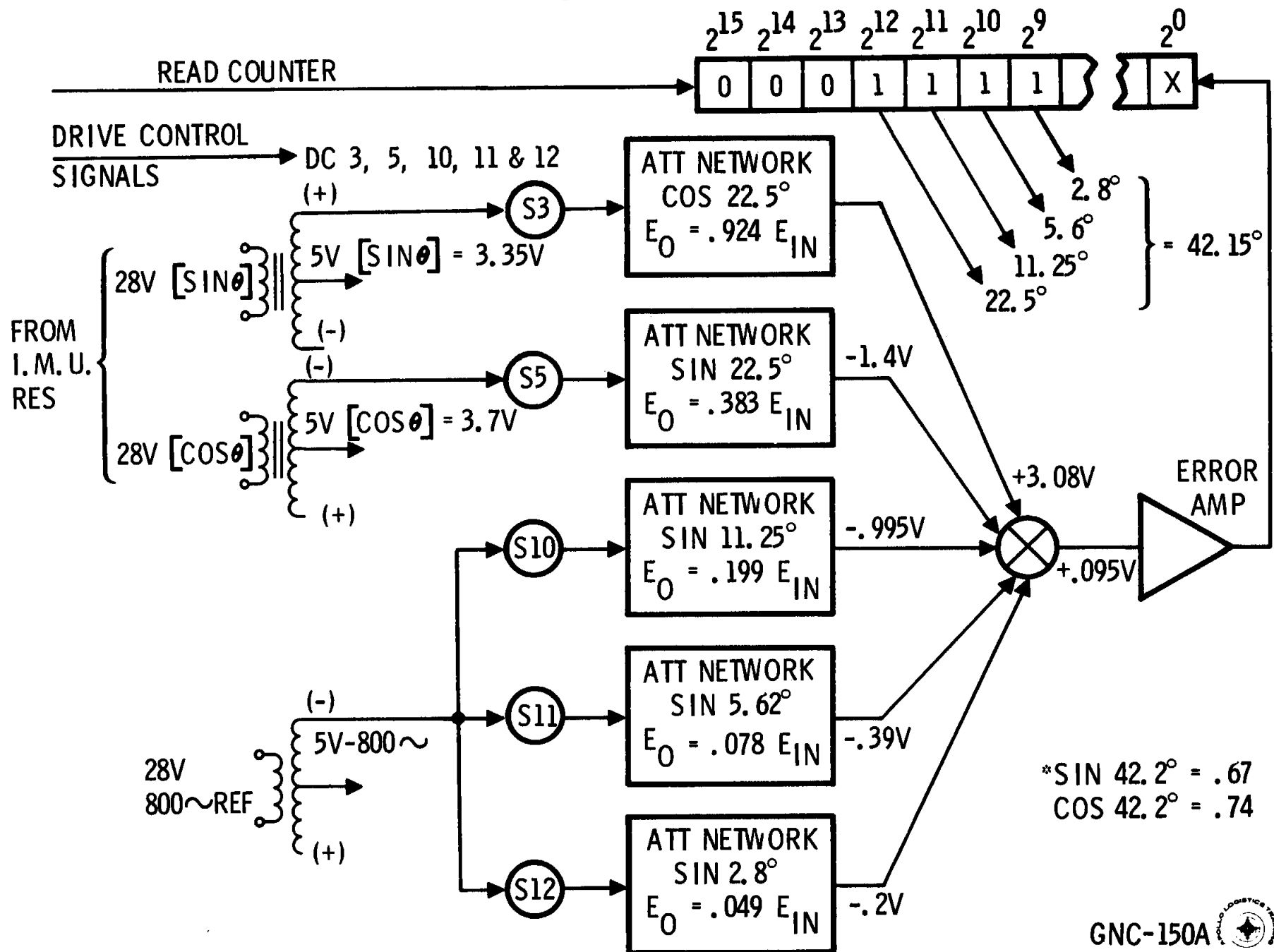
$$\theta = 67.5$$



$$\theta = 0^\circ$$

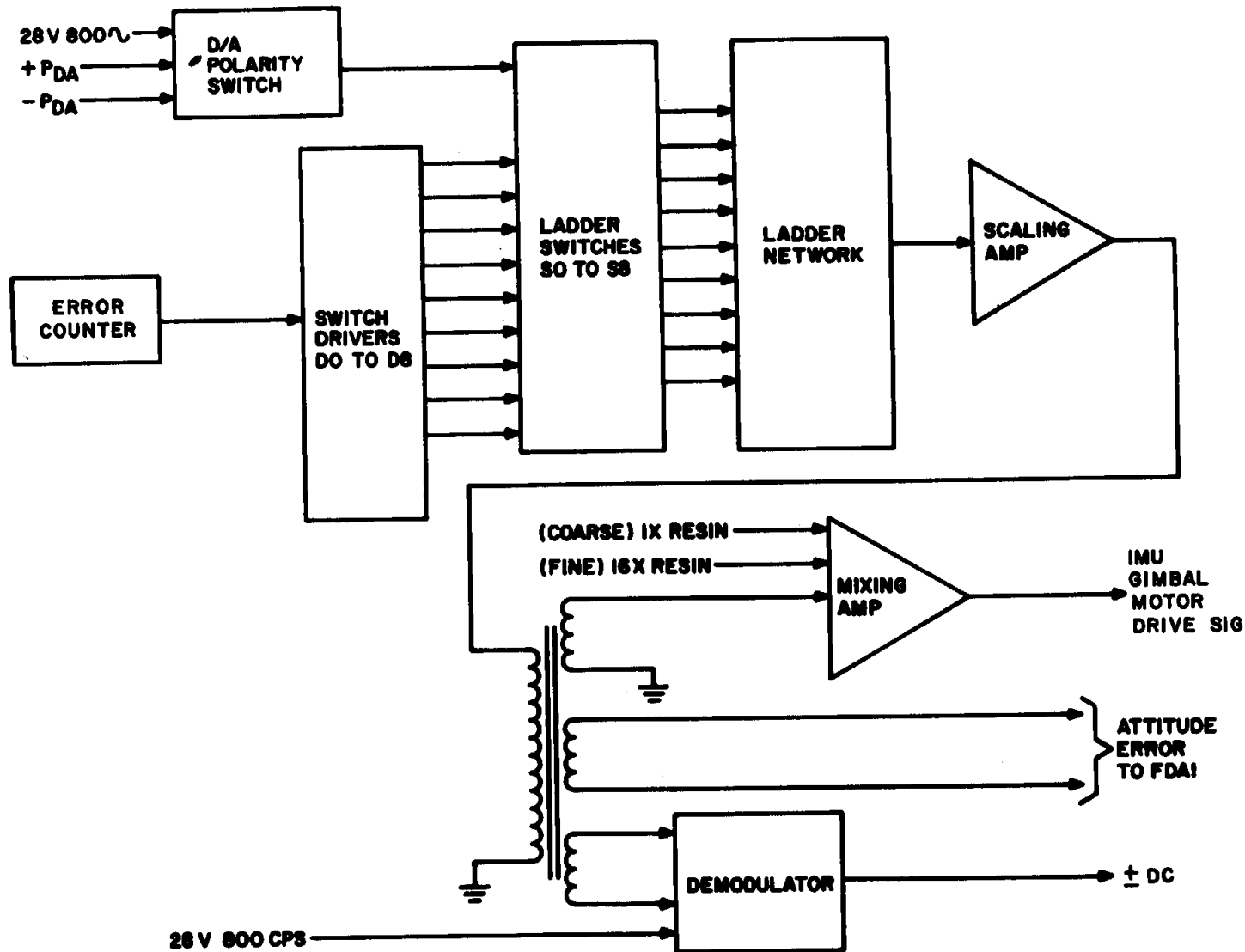


$$\theta = 42.2^\circ$$



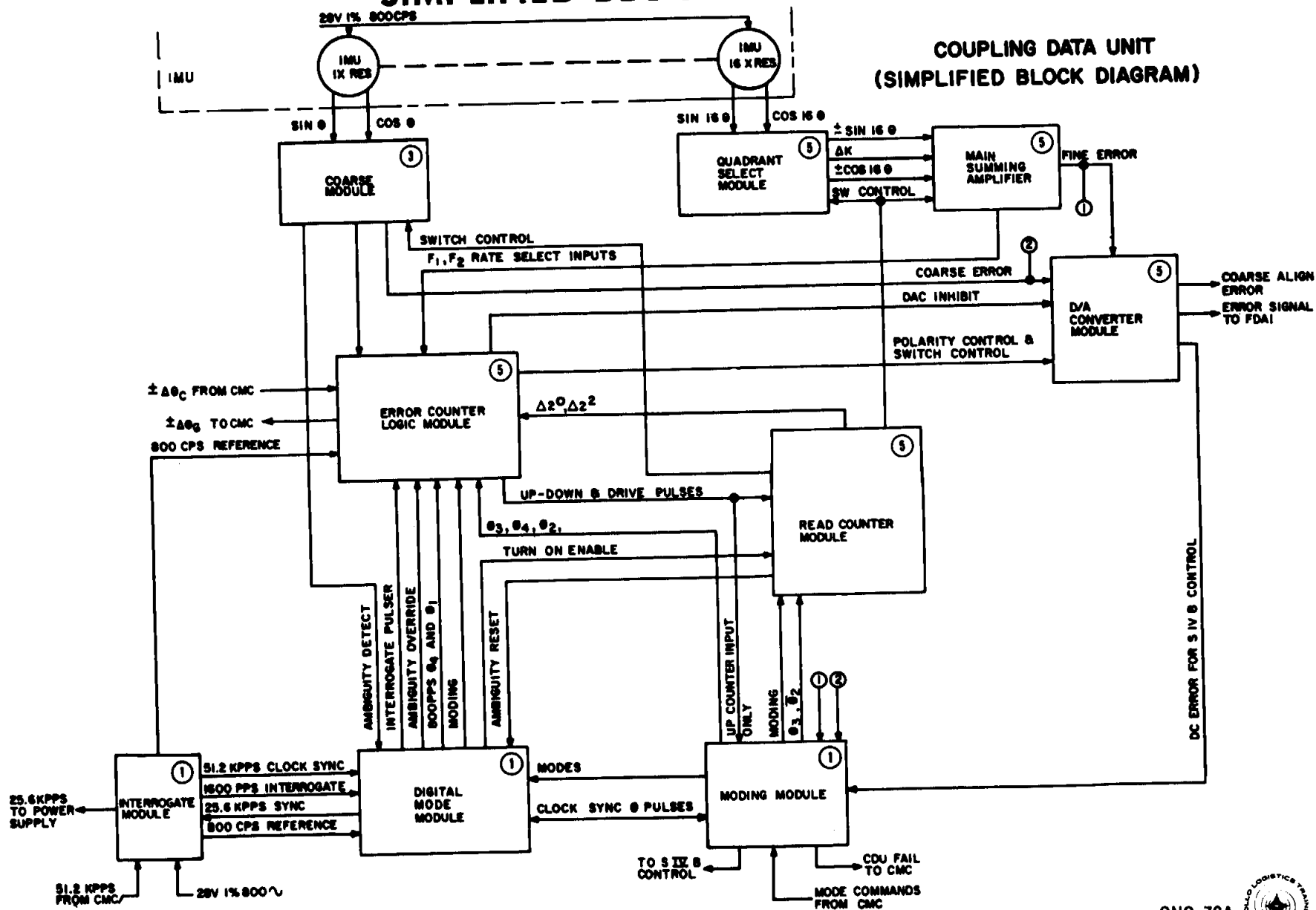
DIGITAL TO ANALOG CONVERTER MODULE BLOCK DIAGRAM

TYPICAL ICDU CHANNEL

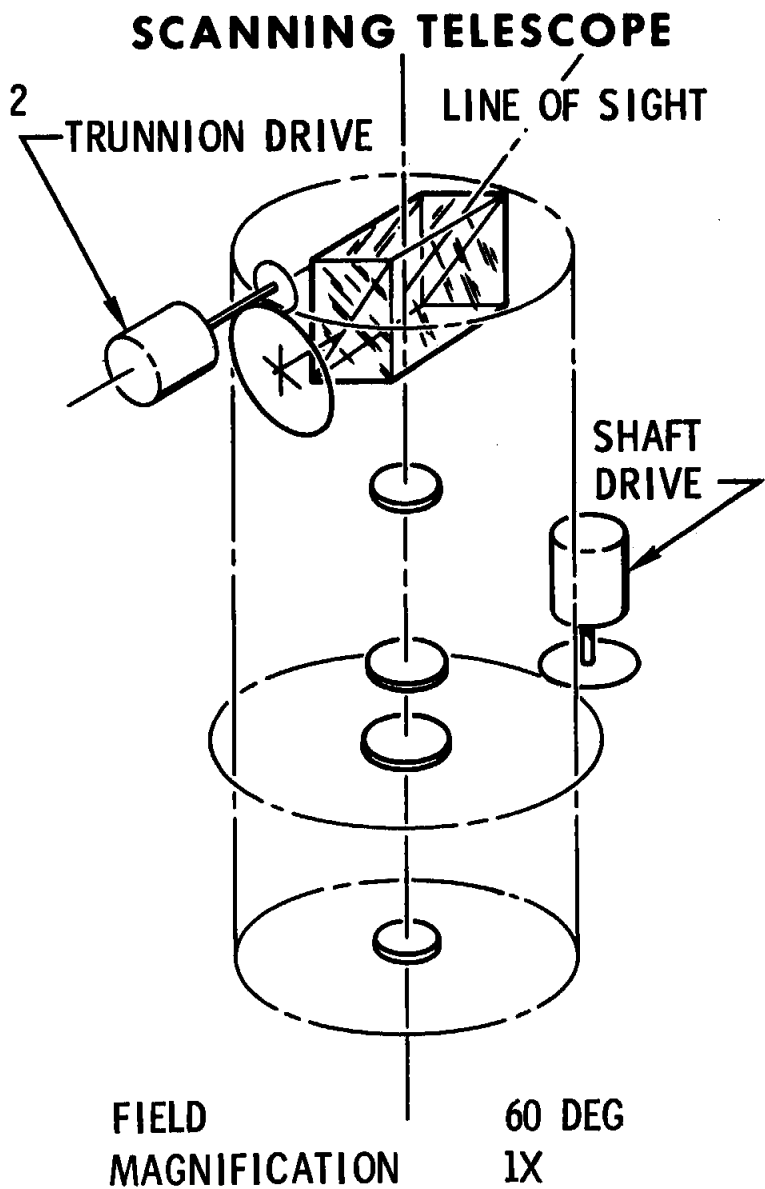
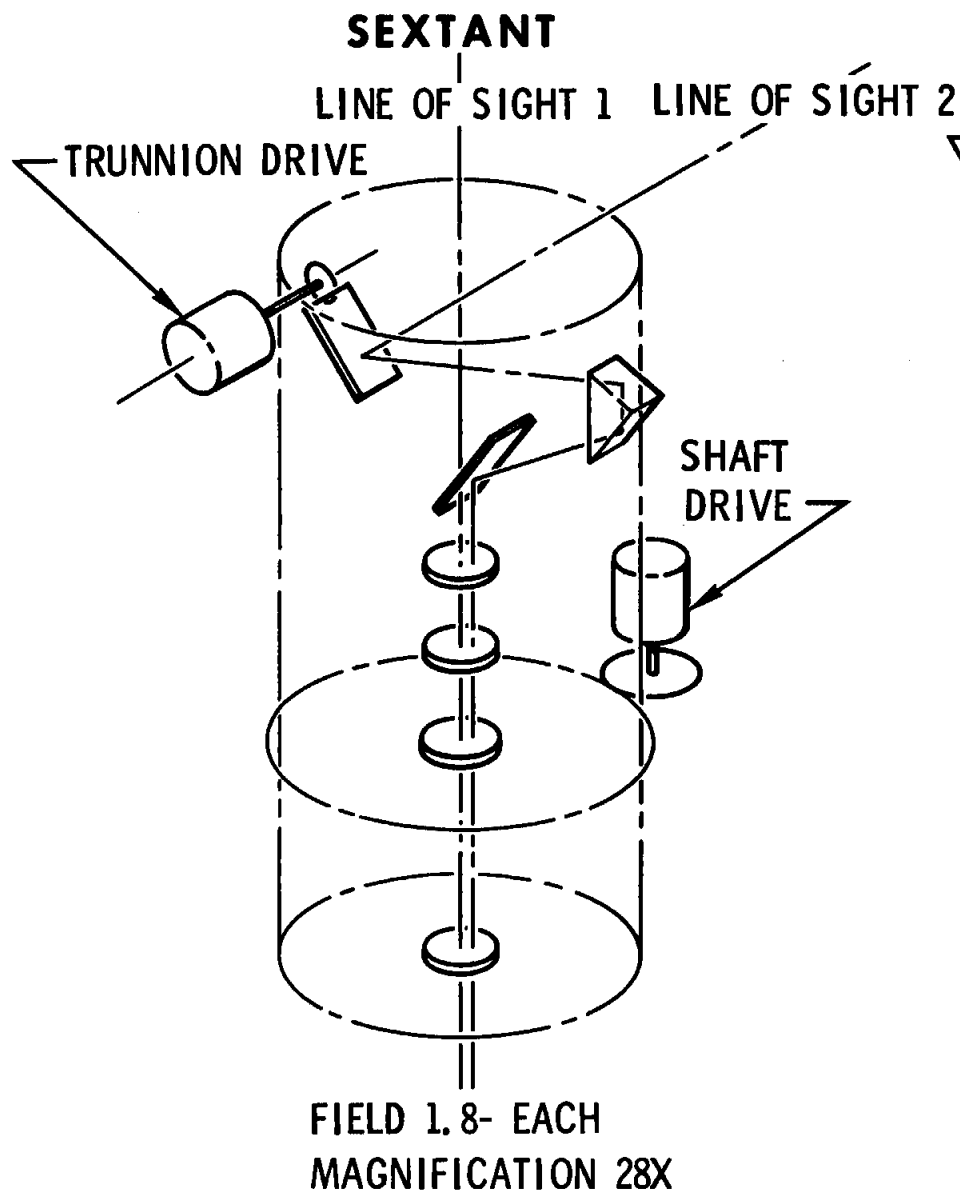


COUPLING DATA UNIT

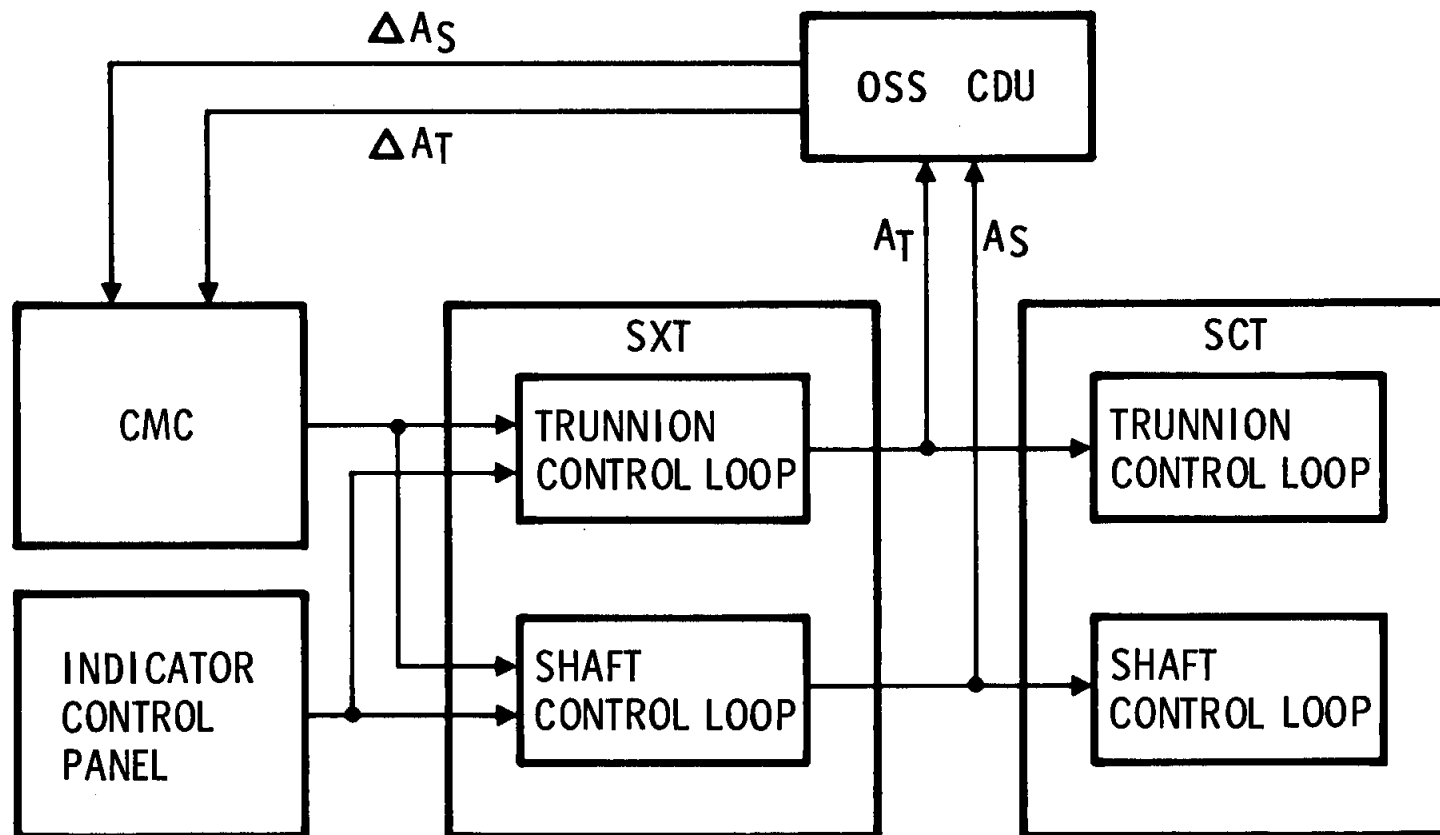
SIMPLIFIED BLOCK DIAGRAM



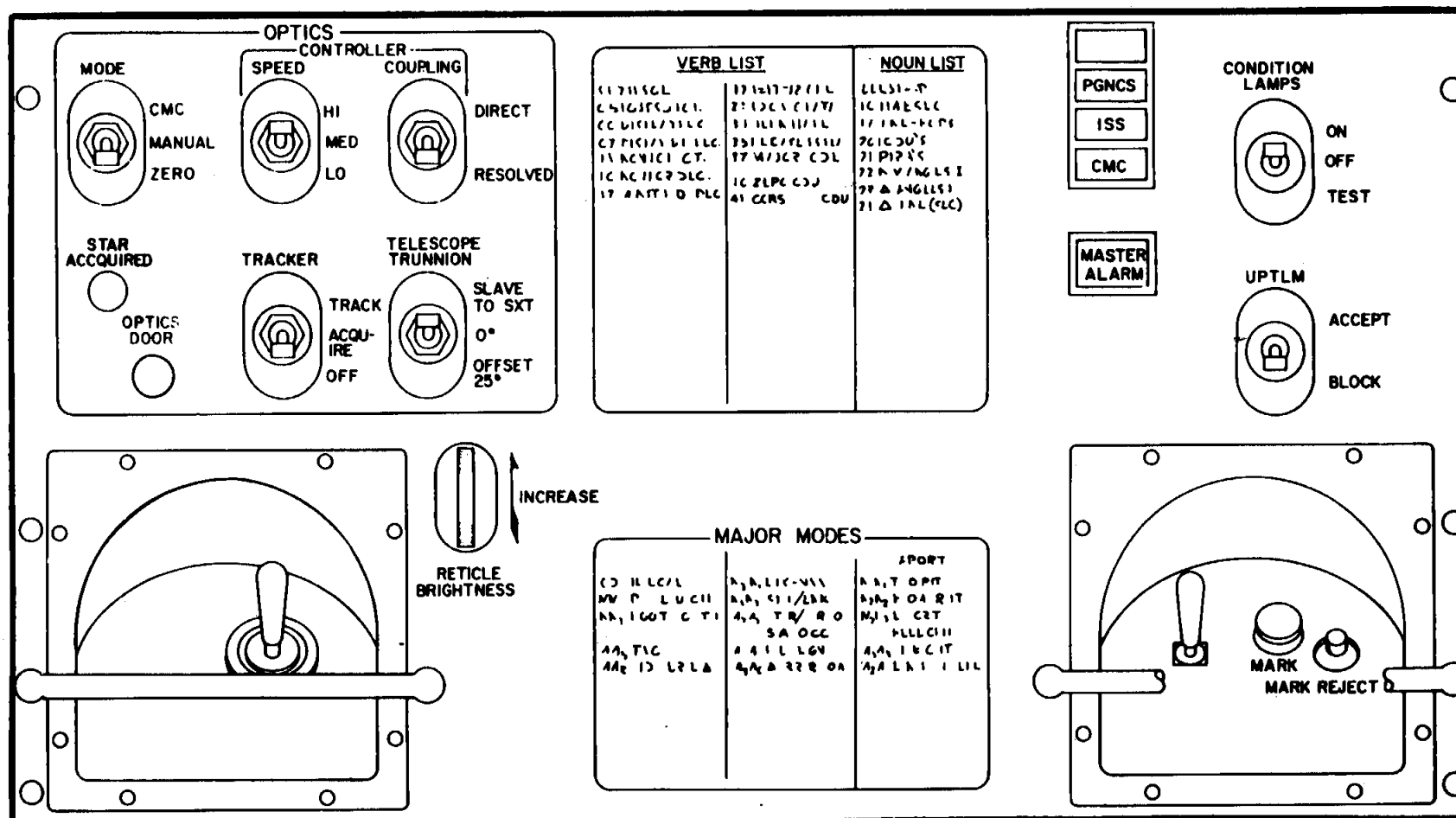
OPTICAL SCHEMATIC



OPTICAL SUBSYSTEM

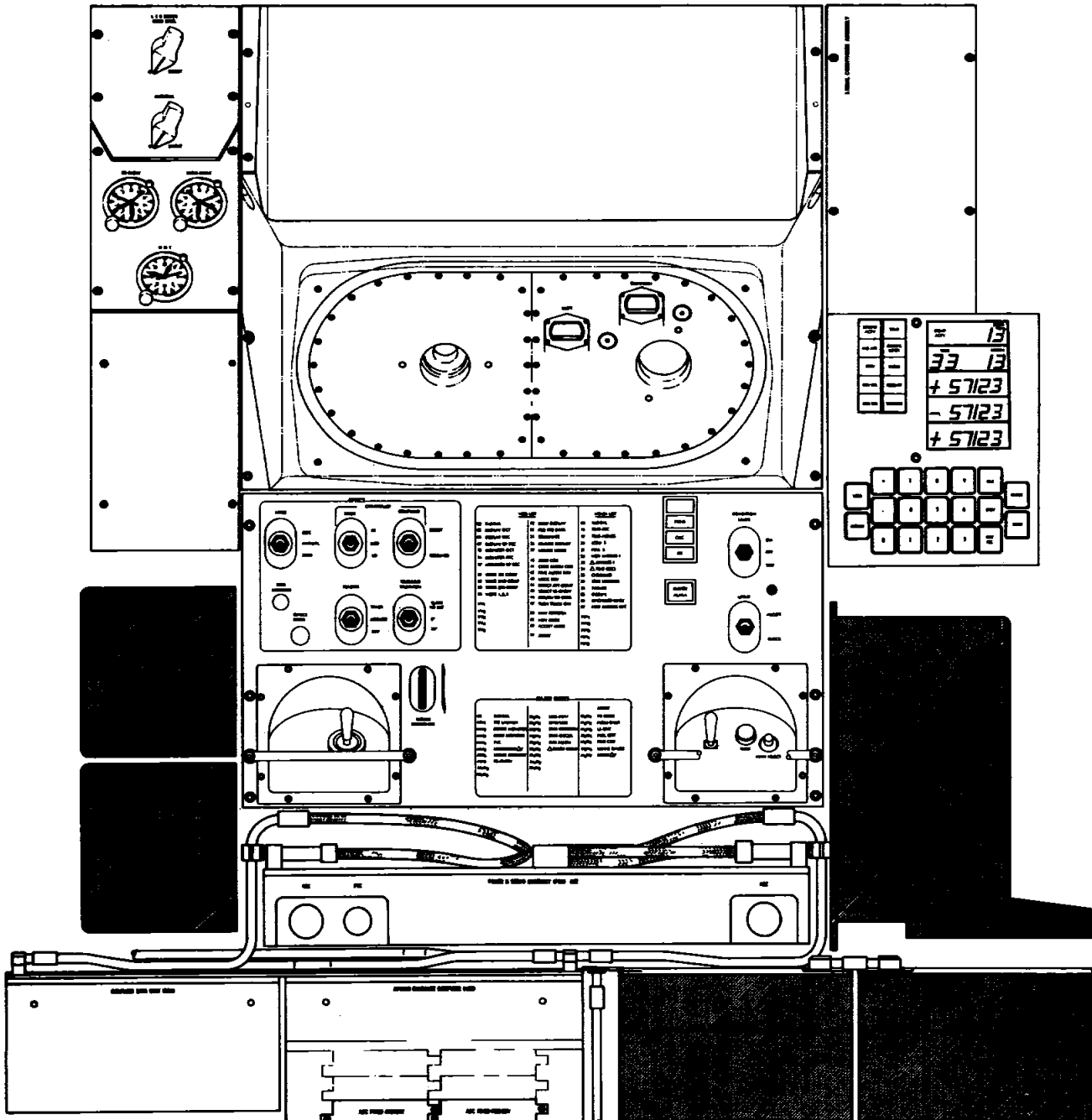


INDICATOR CONTROL PANEL

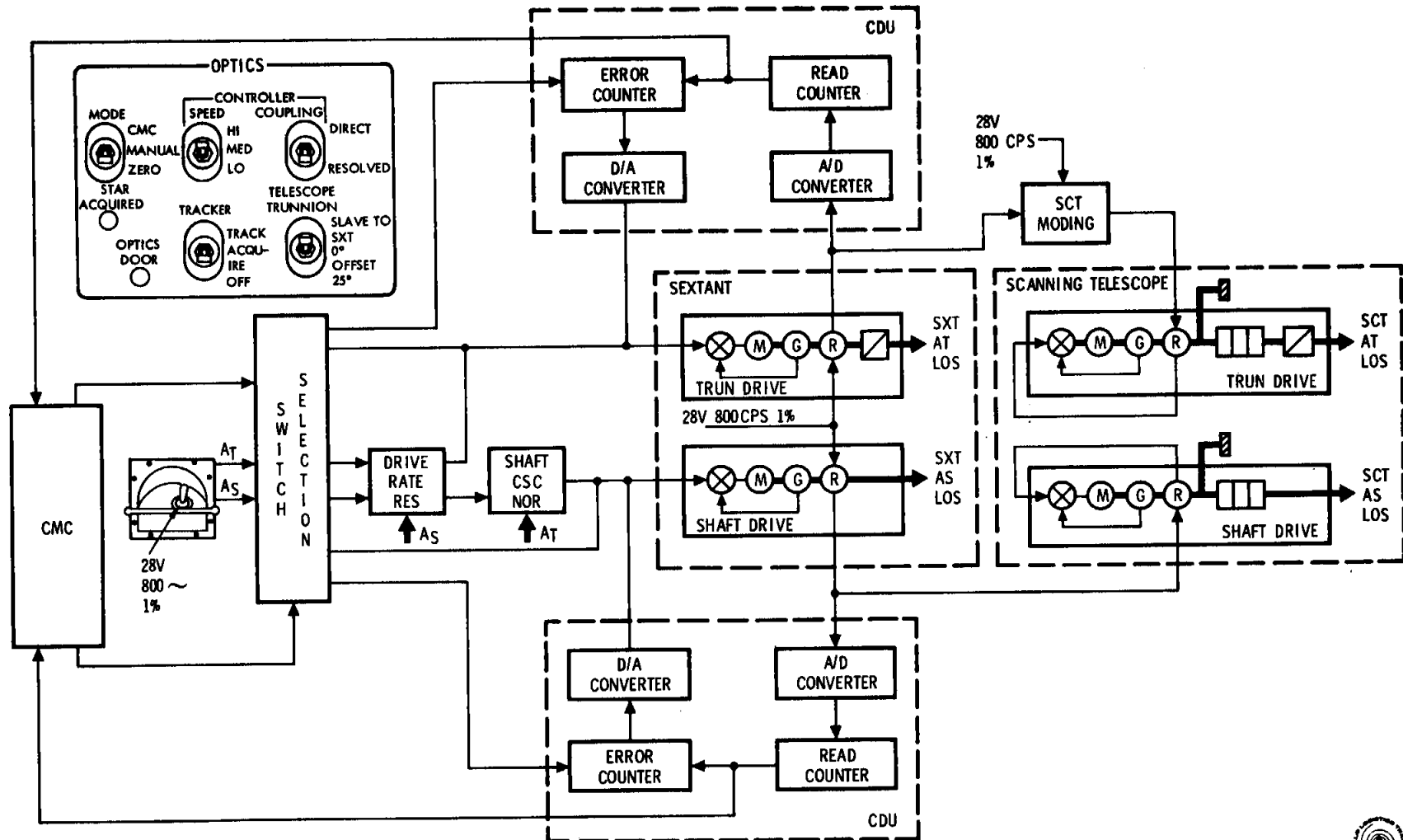


G&N LOWER EQUIPMENT BAY

BLOCK II



OPTICS MODES



GNC-186

MODE CMC MANUAL ZERO

SPEED HI MED LO

DIRECT DIRECT REVERSED

STAR ACCUMULATED

OPTICS DOOR

TRACKER TRACK

TELESCOPE TRUNNION SLAVE TO EXT 0° OFFSET 25°

TRUNNION SHAFT

25V 500~ 1%

25VDC 1% 5K

MODE ZERO OPTICS (MANUAL) MANUAL

COMPUTER COUPLING DIRECT

REVERSED

TO CMC

COMPUTER TO CMC

PSA RELAYS OPERATED BY CMC

CG3722V

CG3011V

CG3160V

CG3140V

CG3021V

CG3170V

CG3160V

CG3011V - TRUNNION CDU FIN ERROR

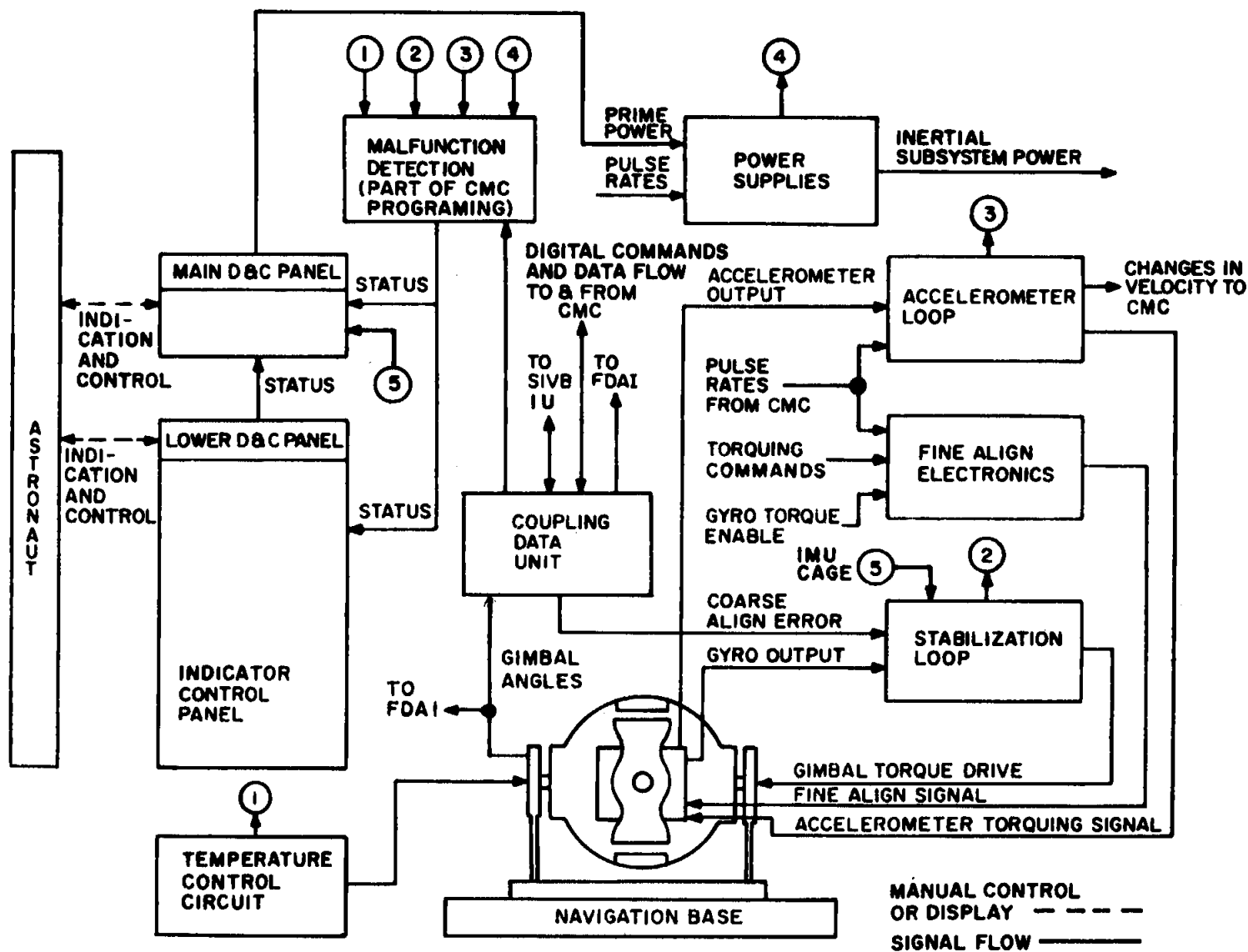
CG3170V - SCT TRUNNION TACHOMETER OUTPUT

- CG3011V - TRUNNION CDU FIN ERROR
CG3170V - SCT TRUNNION TACHOMETER OUTPUT
CG3021V - SHAFT CDU FIN ERROR
CG3160V - SCT SHAFT TACHOMETER OUTPUT
CG3722V - TRUNNION CDU DAC OUTPUT
CG3150V - SXT TRUNNION TACHOMETER OUTPUT
CG3140V - SXT SHAFT TACHOMETER OUTPUT
CG3721V - SHAFT CDU DAC OUTPUT

GNC-129C

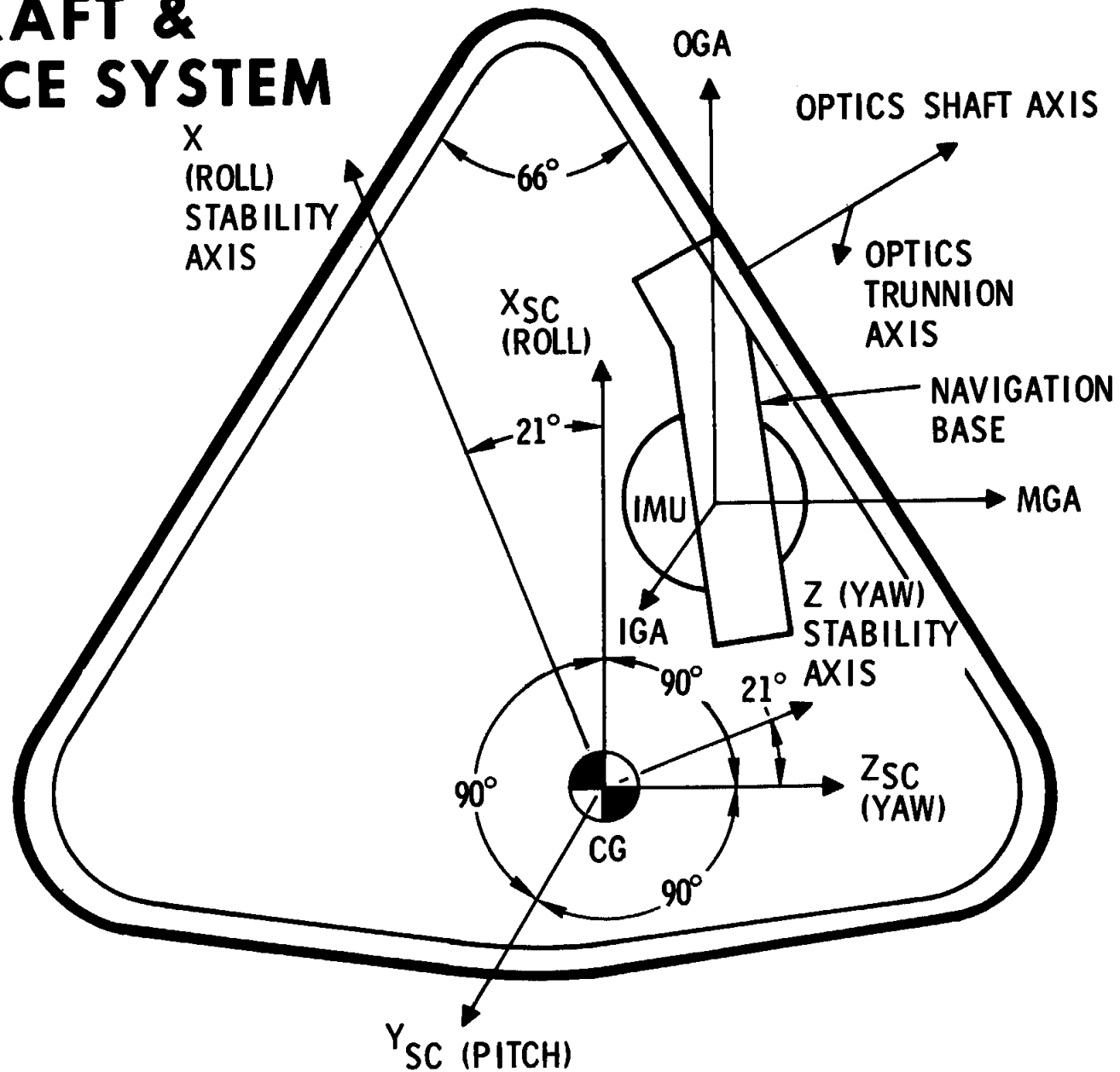


INERTIAL SUBSYSTEM INTERFACE

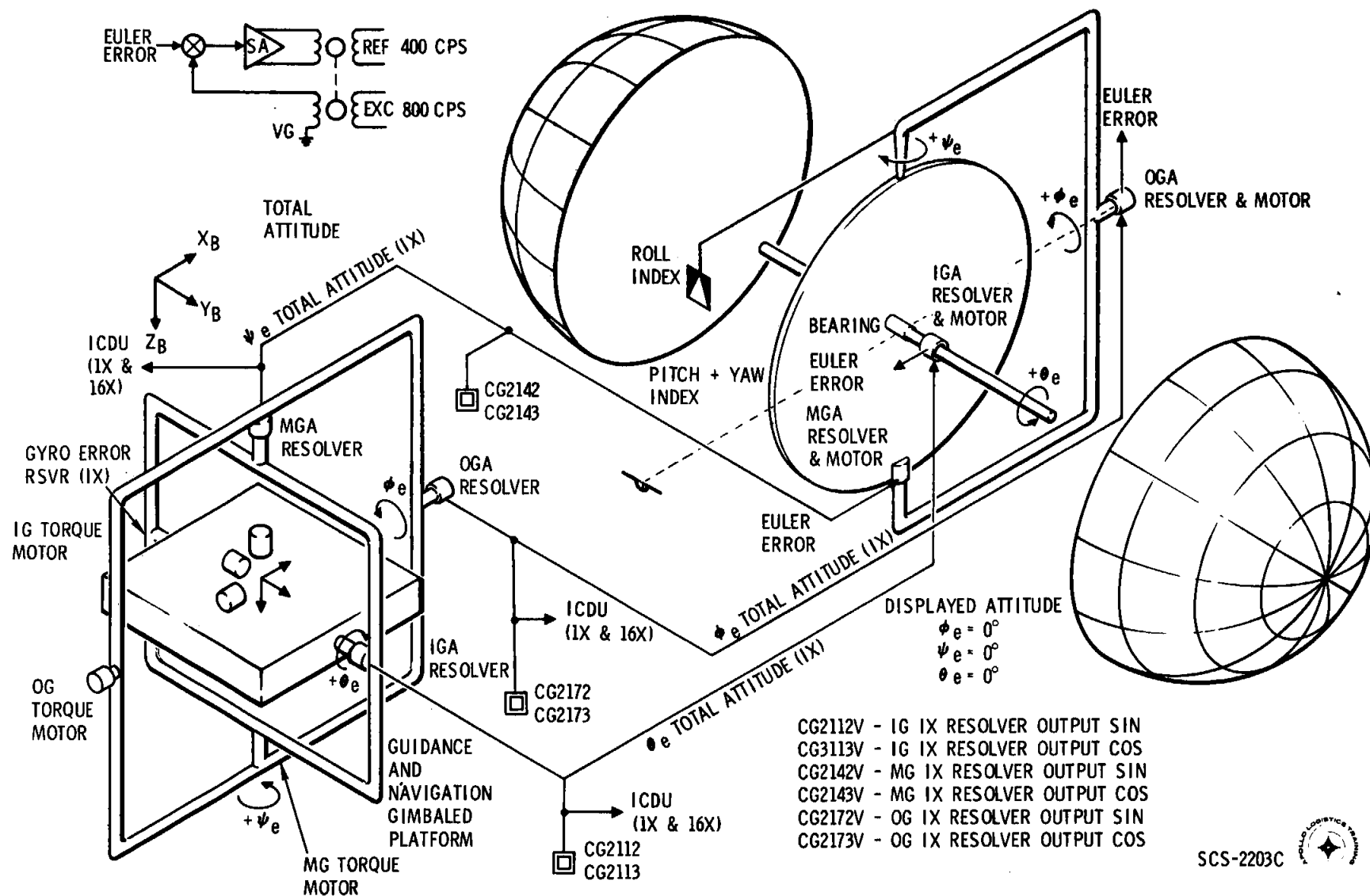


GNC-8 

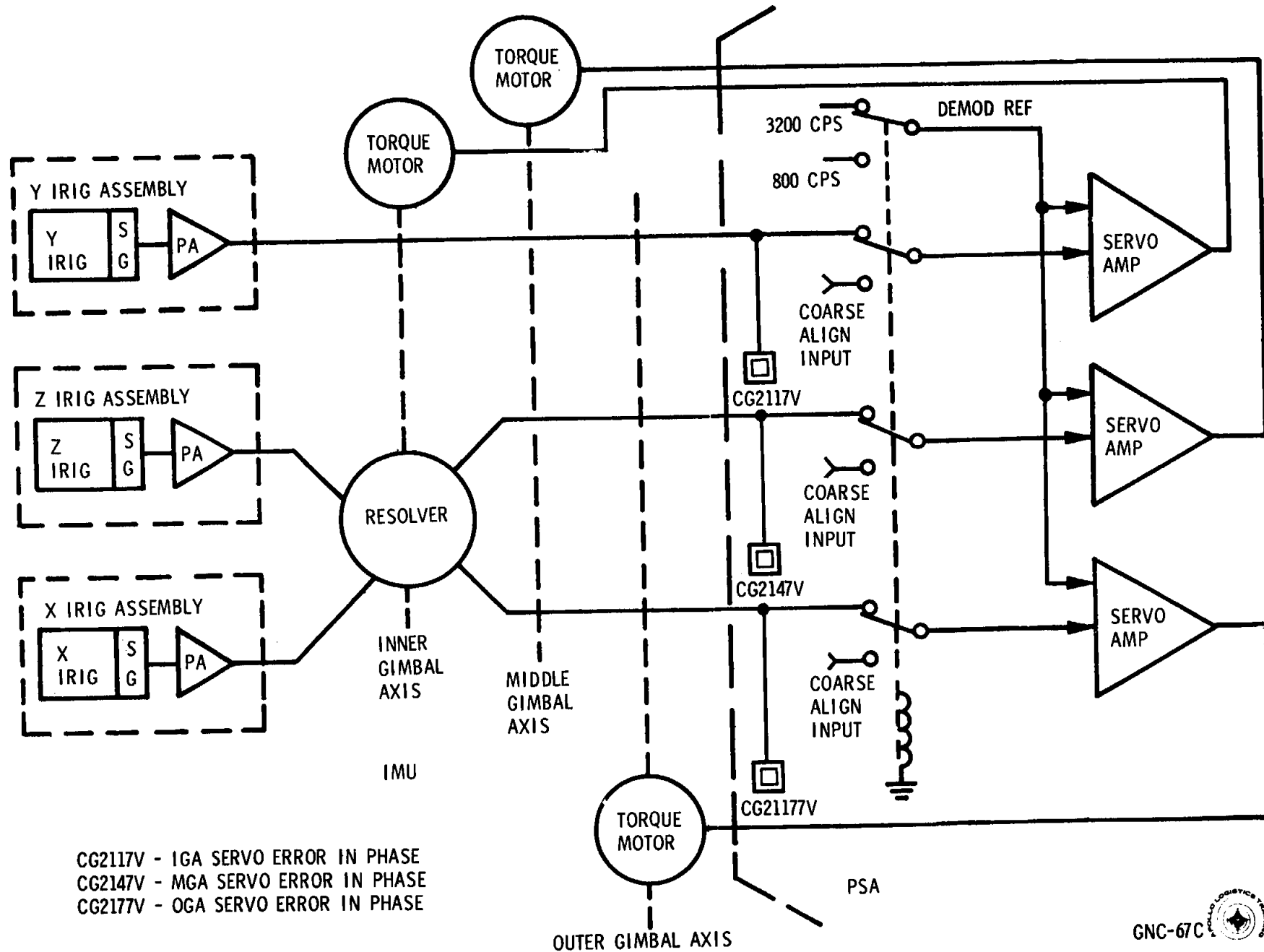
SPACECRAFT & GUIDANCE SYSTEM AXES



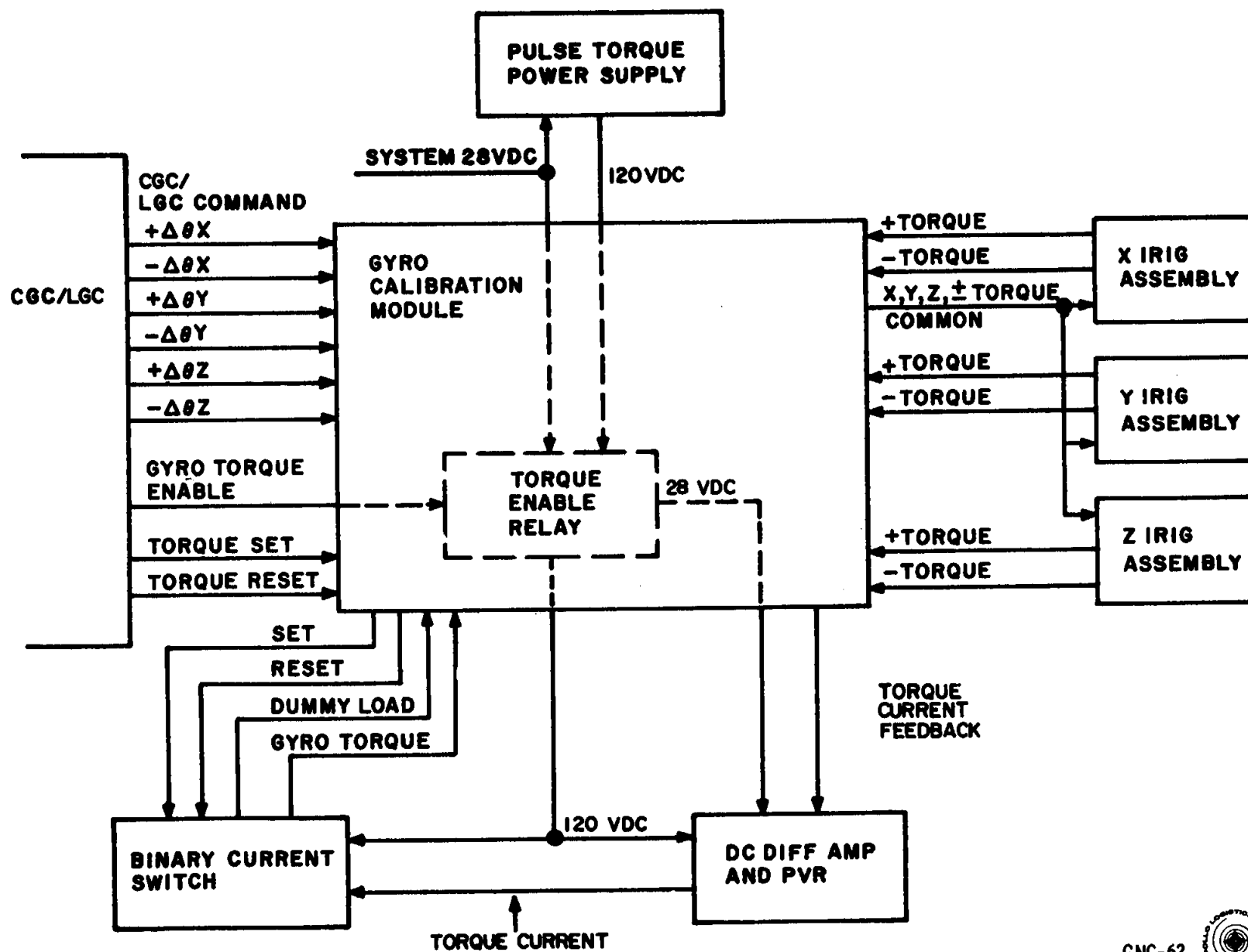
FDAI/IMU GIMBAL RELATIONSHIP



BLOCK II STABILIZATION LOOPS



FINE ALIGN ELECTRONICS

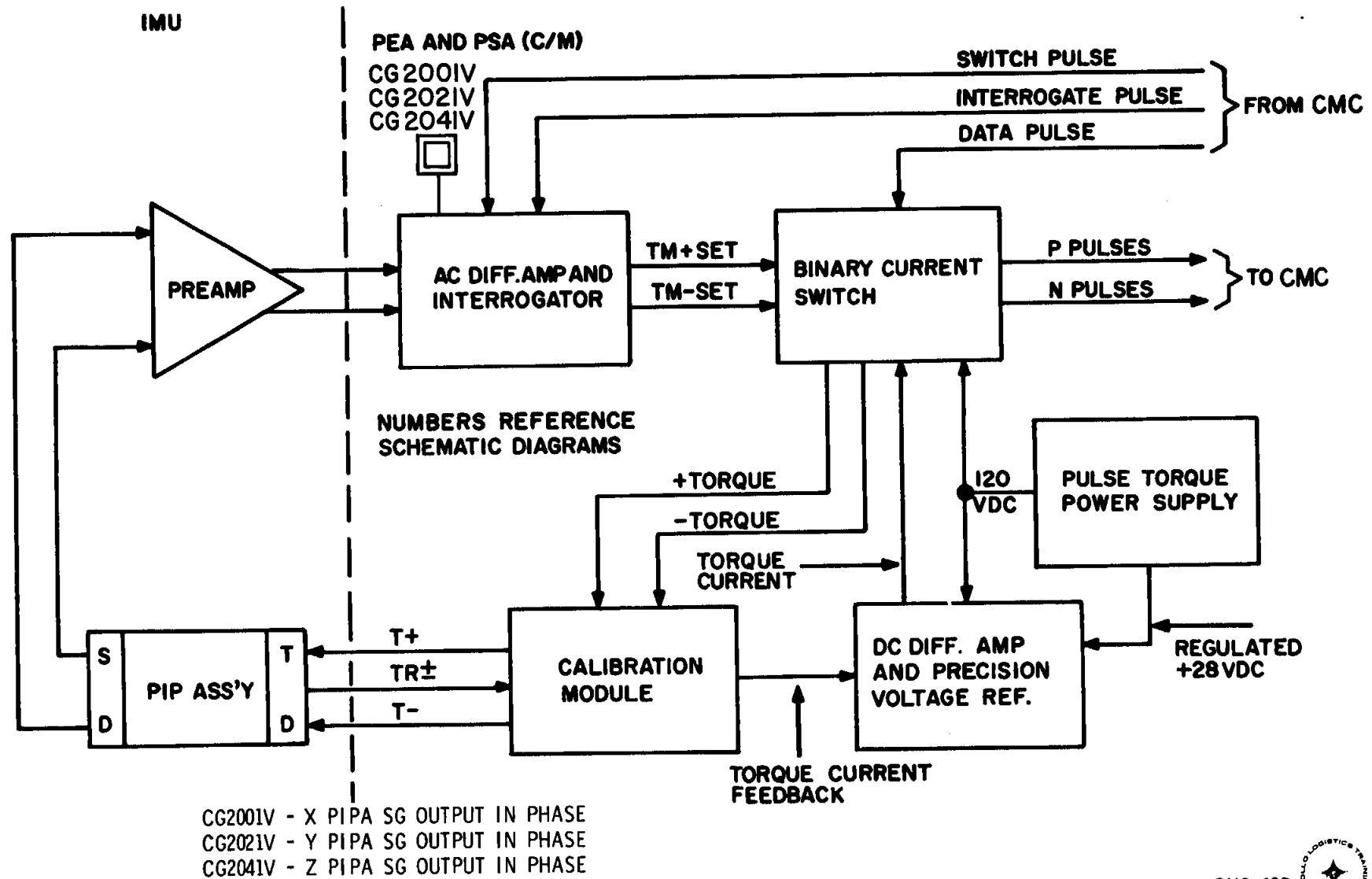


GNC-62

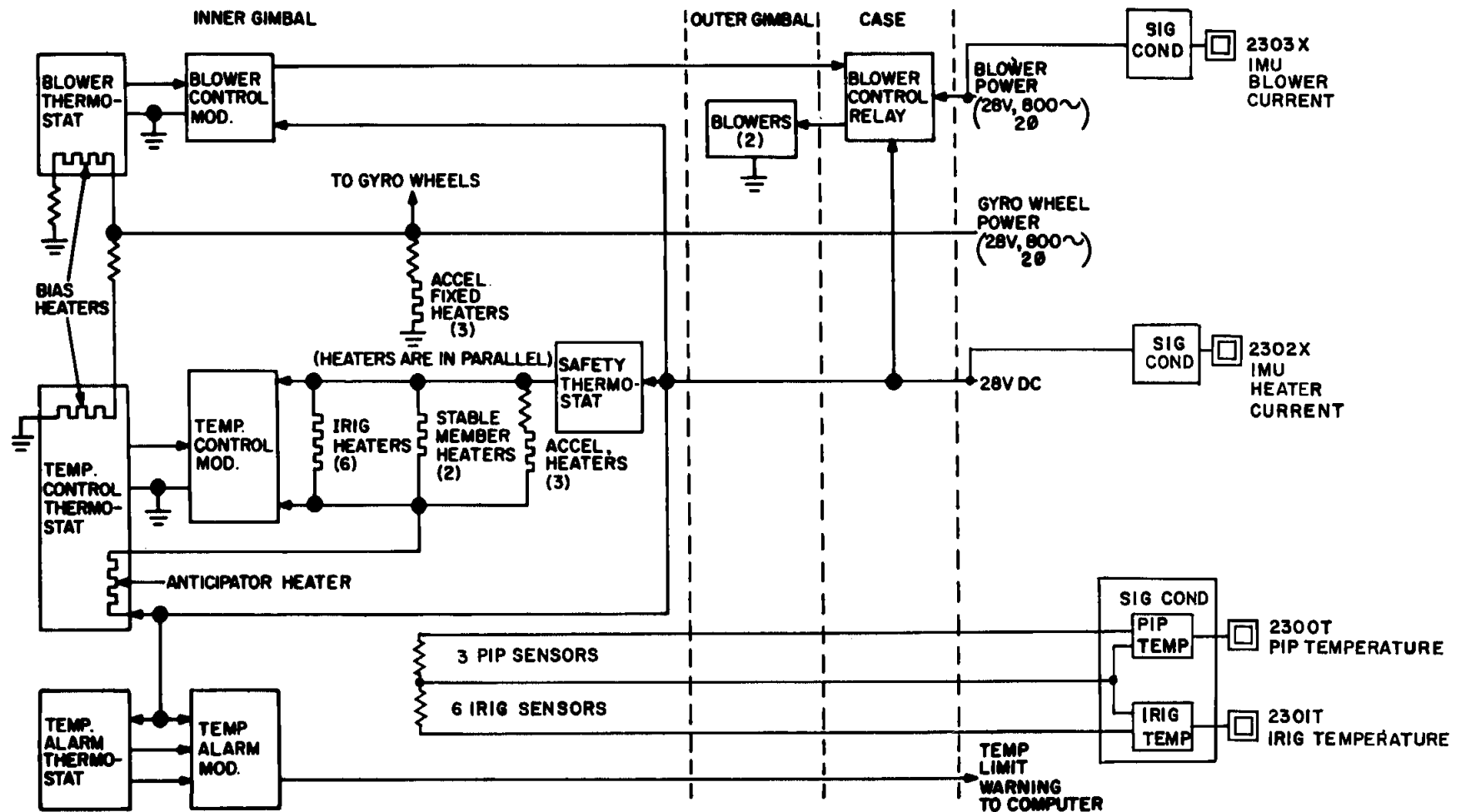


ACCELEROMETER LOOP

BLOCK II



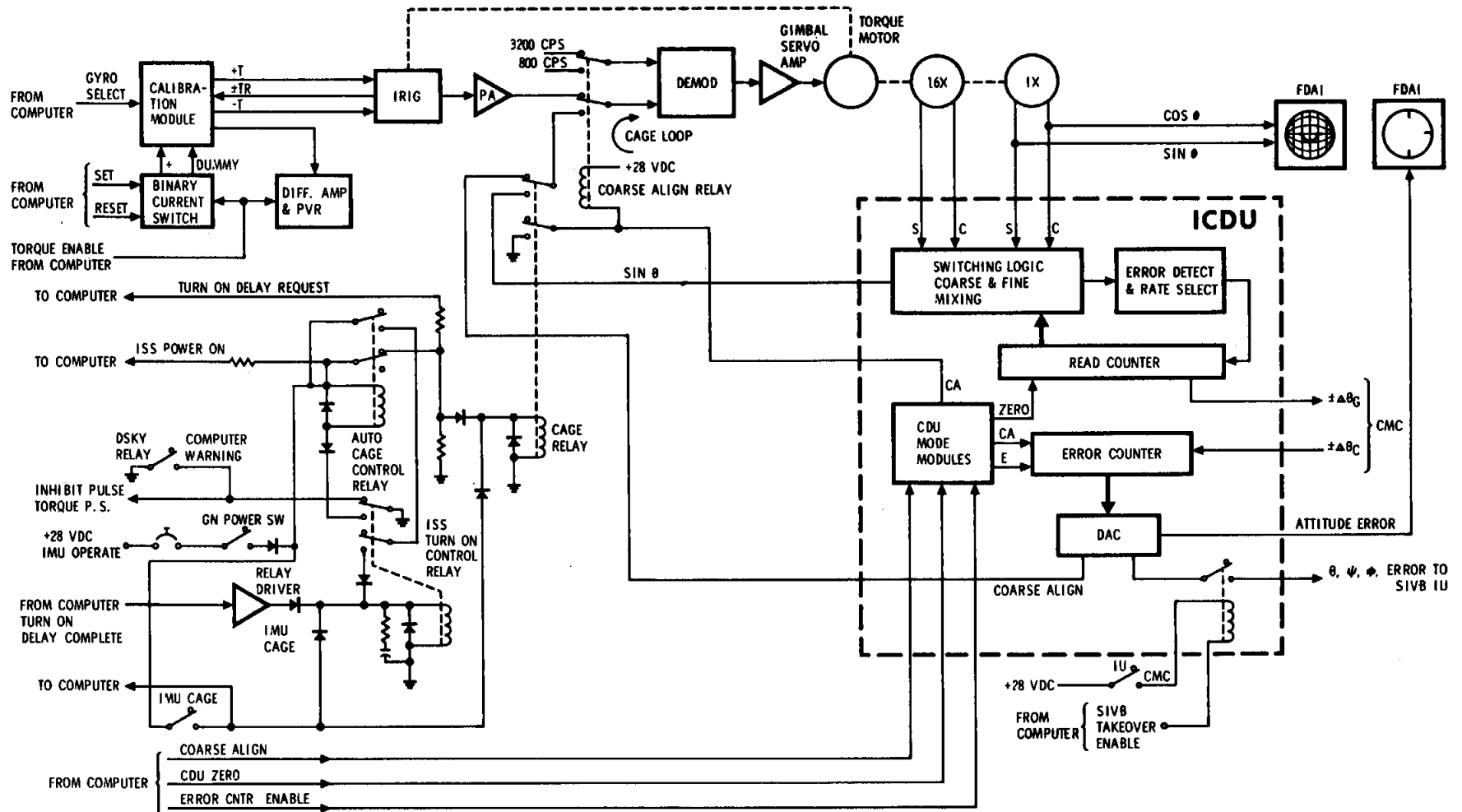
TEMPERATURE CONTROL SYSTEM



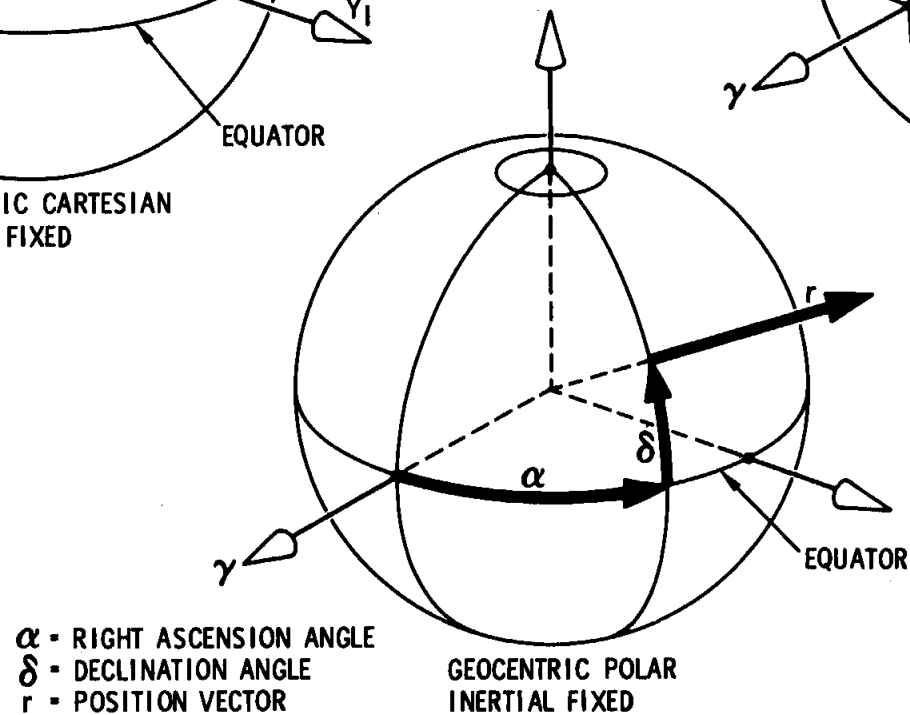
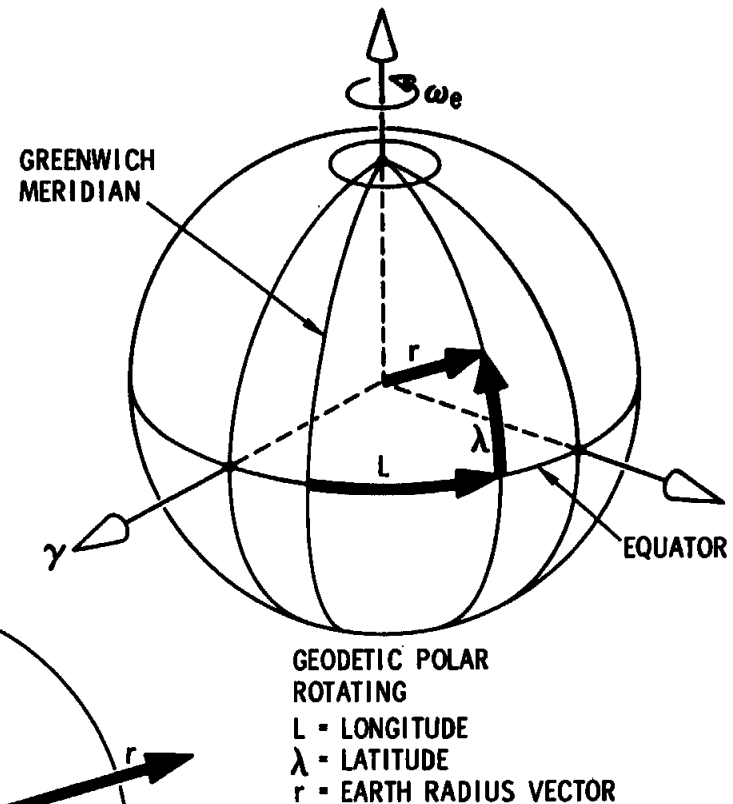
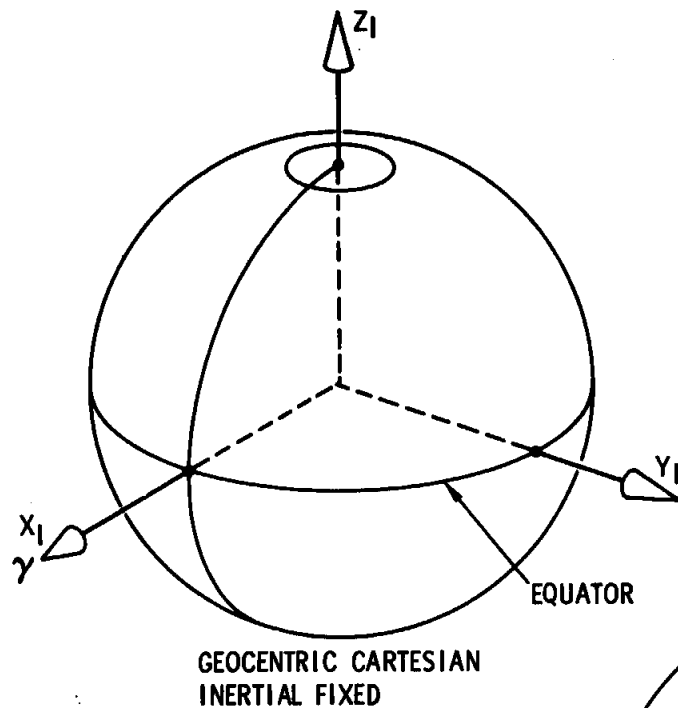
GNC-81B



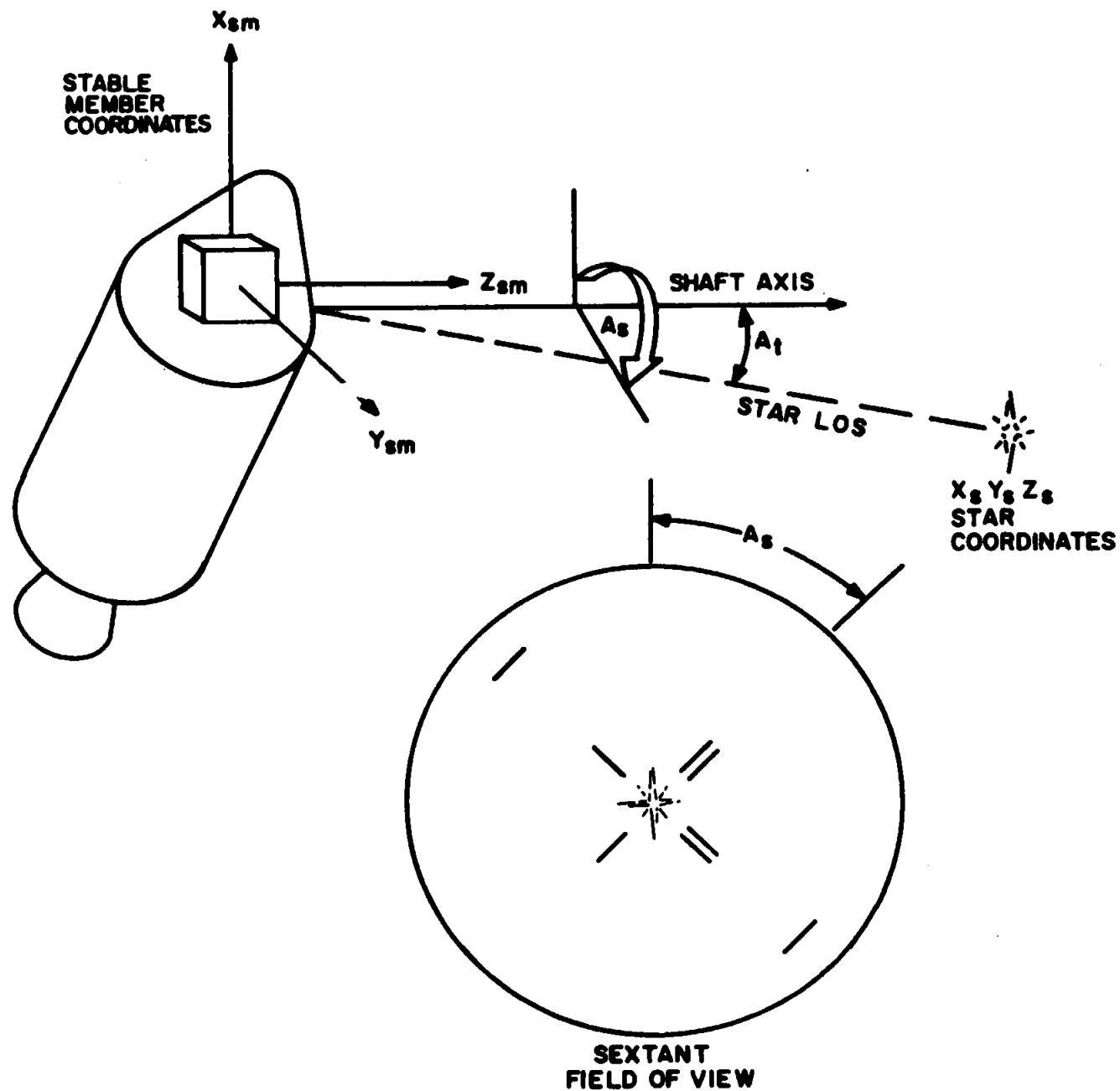
ISS MODES



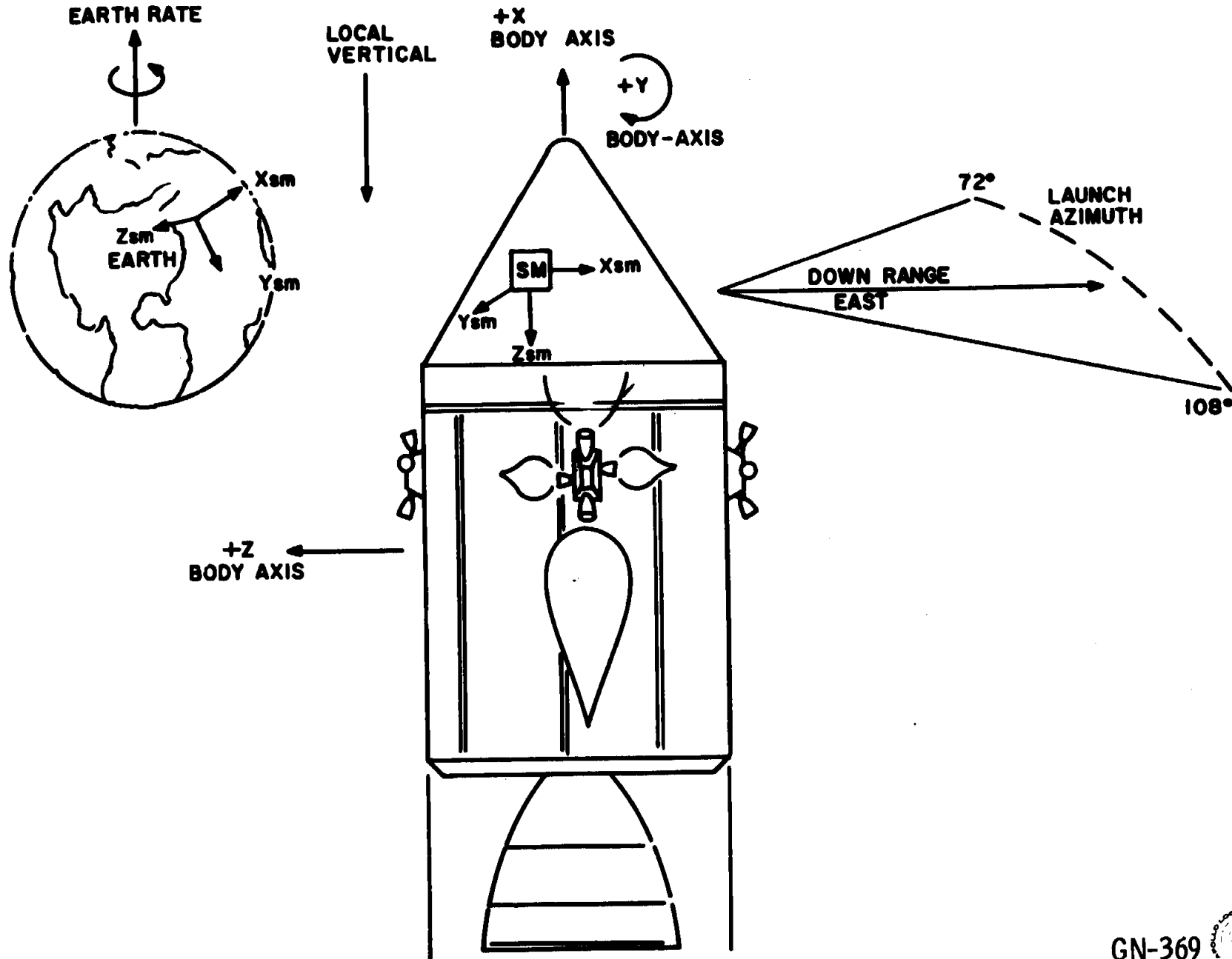
REFERENCE COORDINATE SYSTEMS

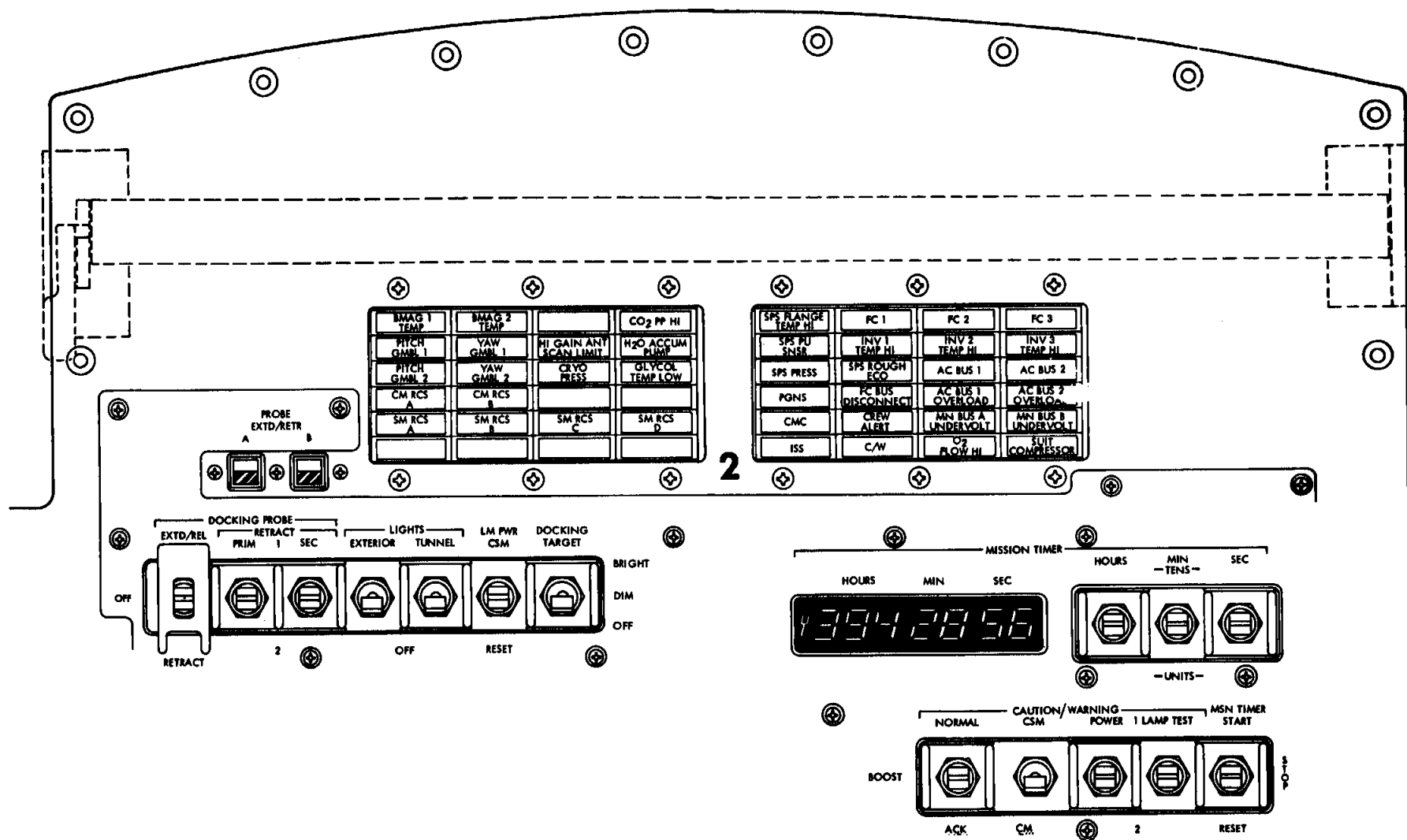


IMU ALIGNMENT MEASUREMENT



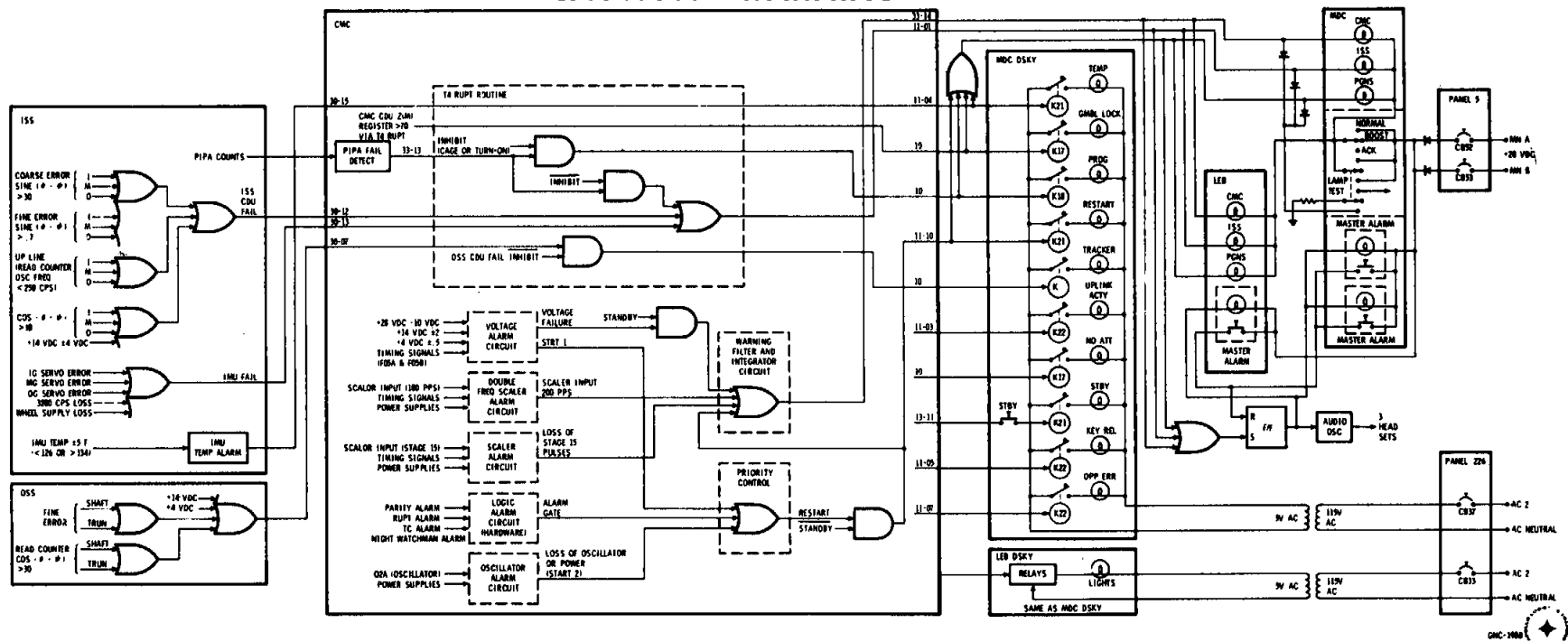
PRELAUNCH ALIGNMENT



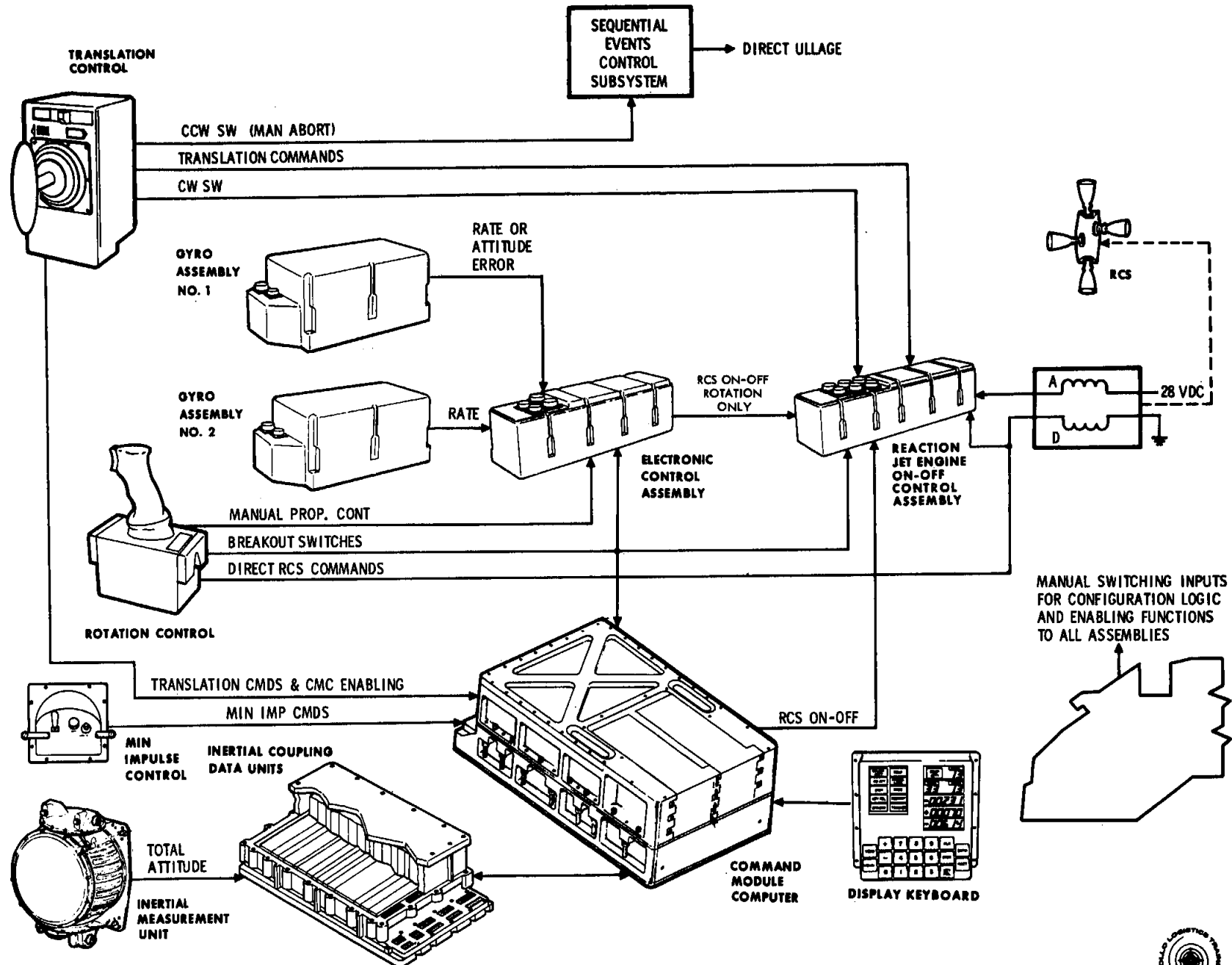


PN-2C-1

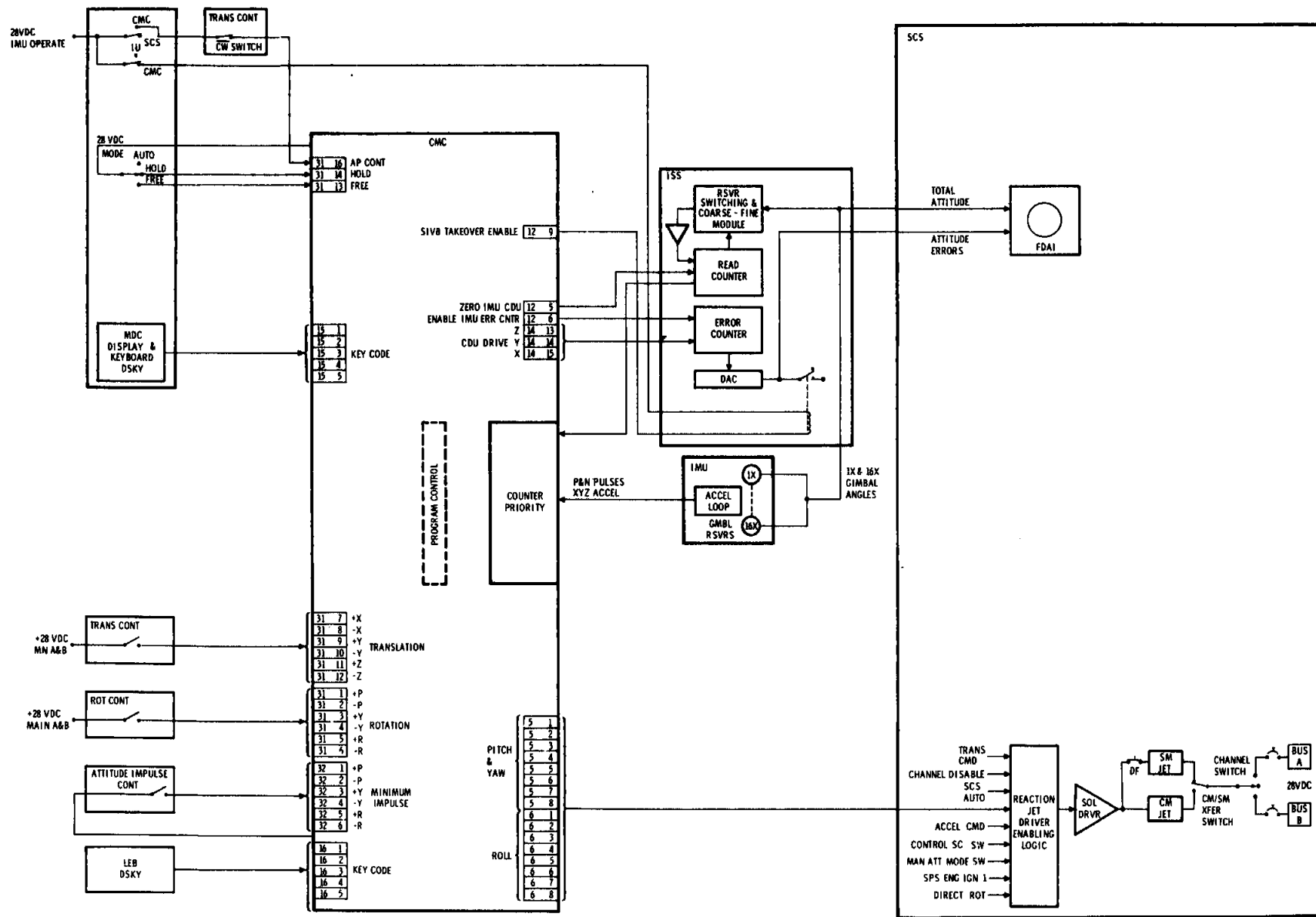
CAUTION & WARNING



G&C ATTITUDE CONTROL

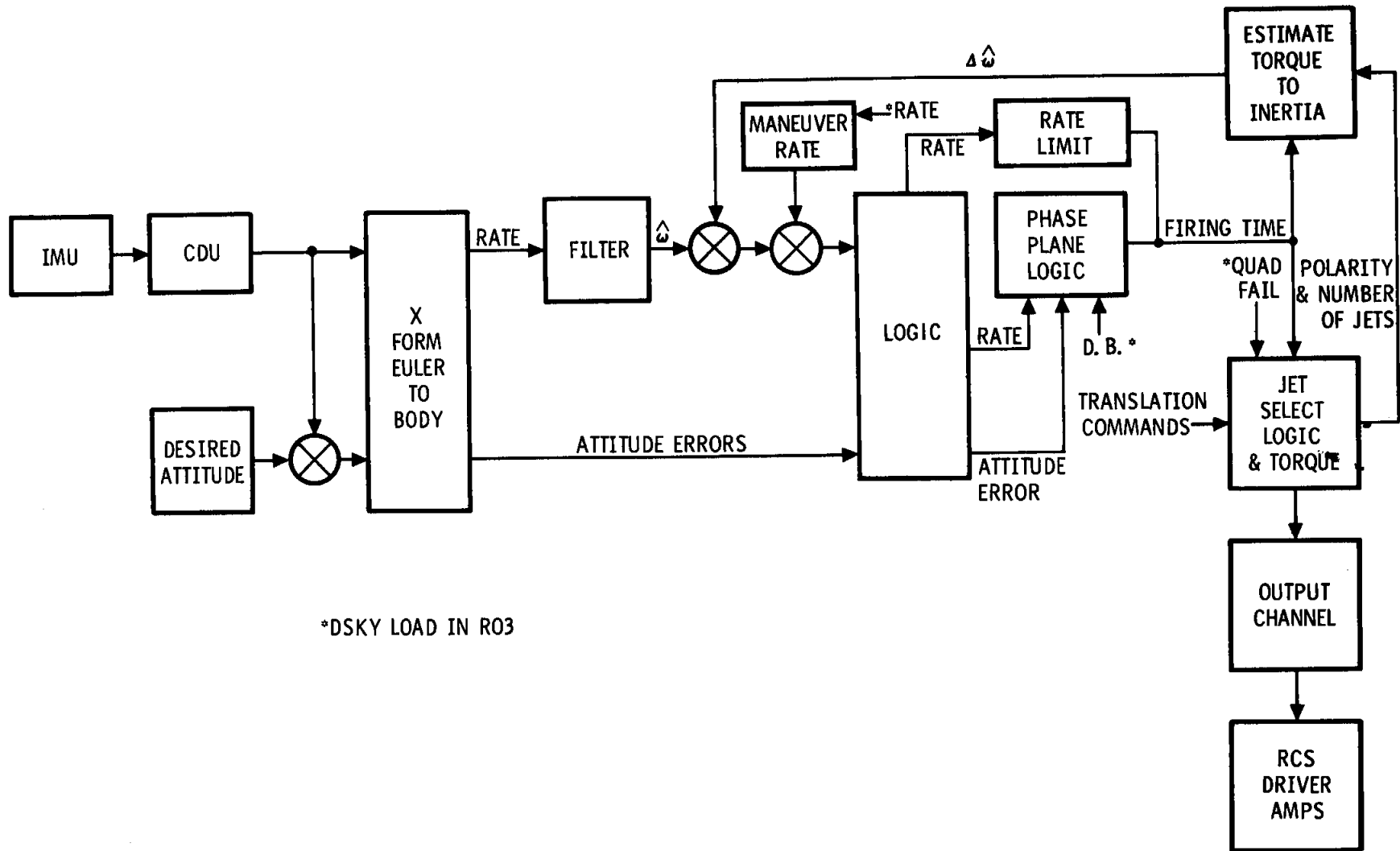


ATTITUDE CONTROL FUNCTIONAL BLOCK DIAGRAM



RCS DAP

SIMPLIFIED BLOCK DIAGRAM



*DSKY LOAD IN R03

DAP DATA LOAD PROCEDURE (RO3)

1. V48E
2. DAP DATA 1 (Specify A/P configuration)
FLV04 N46 (Request data load)
Load data

R1	Vehicle Config.	Quad A/C for $\ddot{X}$	Quad B/D for $\ddot{X}$	Err Deadband	Rate Select
	0 = CM 1 = CSM 2 = CSM & LM 3 = CSM & SIVB	0 = No A/C 1 = A/C	0 = No B/D 1 = B/D	0 = $\pm 0.5^\circ$ 1 = $\pm 5.0^\circ$	0 = 0.05°/sec 1 = 0.2°/sec 2 = 0.5°/sec 3 = 4.0°/sec
R2	Roll Quad Select	Quad A Fail	Quad B Fail	Quad C Fail	Quad D Fail
	0 = A/C 1 = B/D	0 = Fail 1 = No Fail	0 = Fail 1 = NoFail	0 = Fail 1 = No Fail	0 = Fail 1 = No Fail

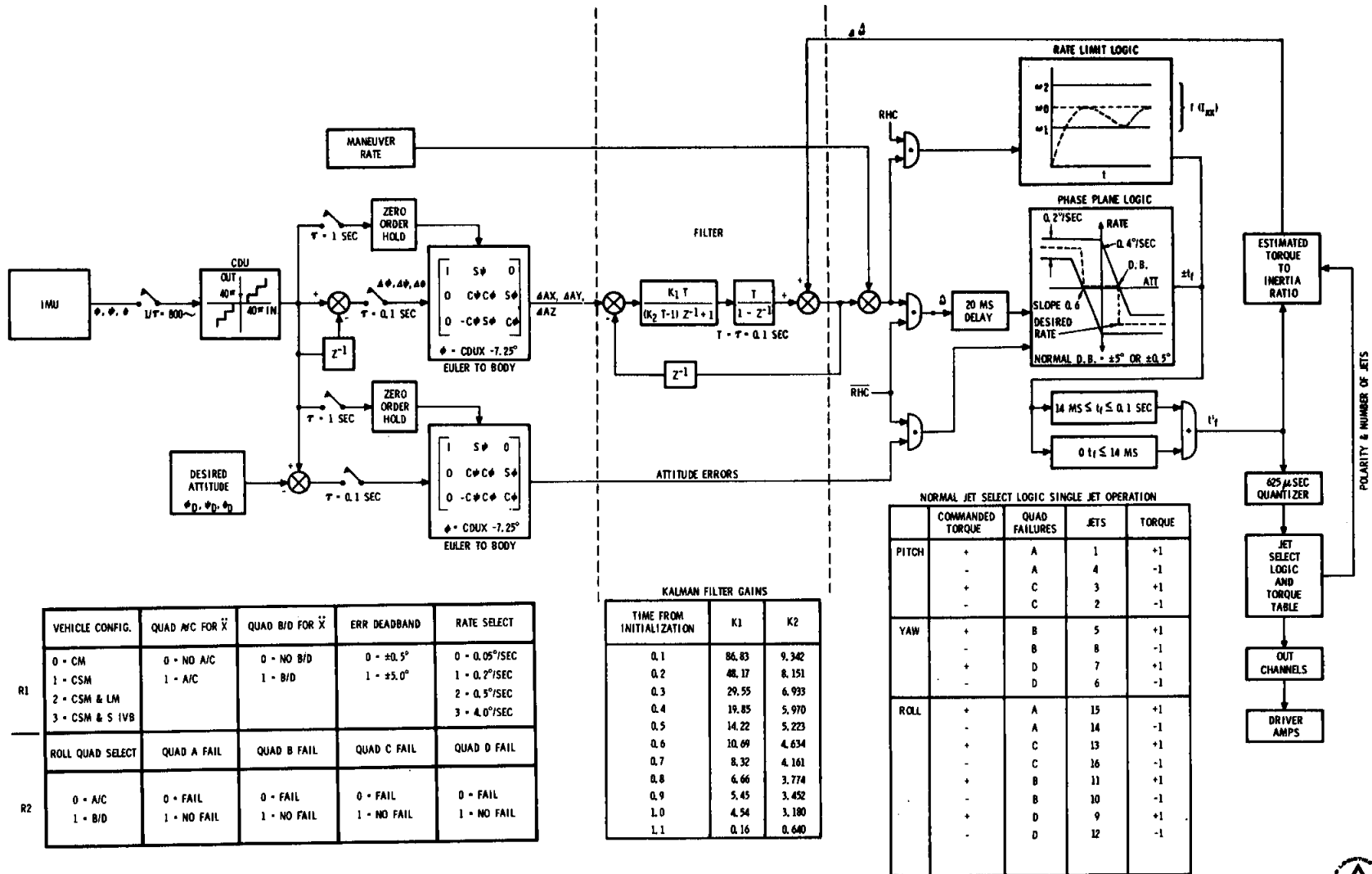
Accept V33E
Reject V24E (Reload data)

3. DAP DATA 2 (Mass parameters)
FLV06 N47 $\overline{[X, 1/2 (IY+IZ), W]}$
Accept V33E
Reject V25E (Reload data)
4. DAP DATA 3 (Mass/propulsion parameters)
FLV06 N48 (P trim, Y trim, TLX)
Accept V33E
Reject V25E (Reload data)
5. V46E $\overline{[Establish G/C control (DAP active)]}$

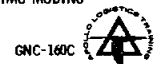
NOTE:
EXTENDED VERB 48 PROGRAMS
AND CALLS DAP DATA 1, 2, & 3 IN
SEQUENTIAL ORDER. DAP DATA 1 OR 2
OR 3 MAY ALSO BE CALLED AND/OR
LOADED INDIVIDUALLY BY USING
THE RESPECTIVE VERB, NOUN
COMBINATIONS. I.E. V04 N46,
V06 N47 OR V06 N48.

SM-2A-1305A

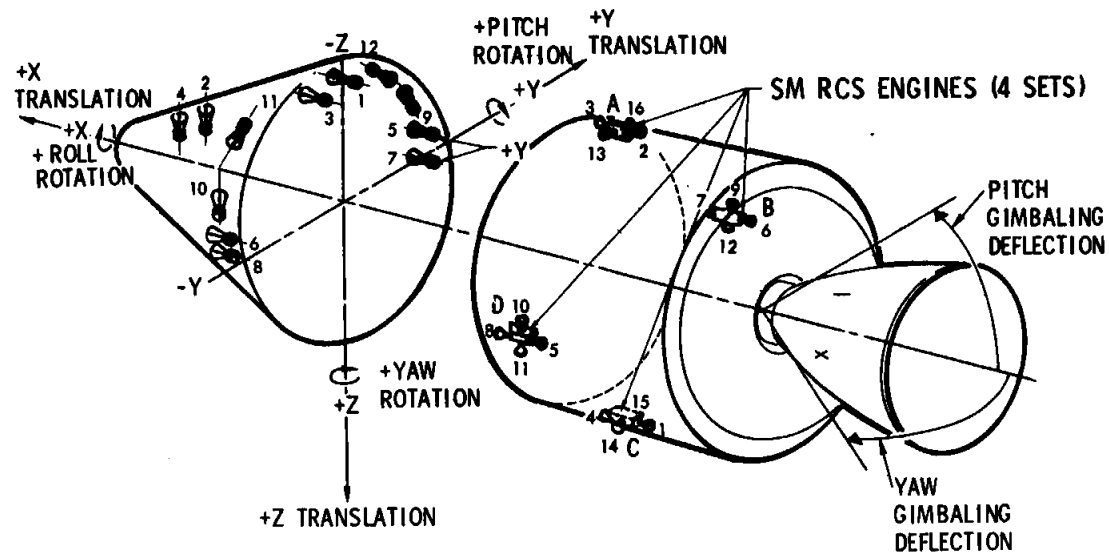
RCS DAP MODEL



3



RCS ENGINE FUNCTIONS



RCS ENG NO.	COMMANDS	QUAD	CHANNEL	CHANNEL SWITCH A POSITION B
1	+X + θ	C	PITCH	A CB'S B
2	+X - θ	A	PITCH	A CB'S B
3	-X + θ	A	PITCH	B CB'S A
4	-X - θ	C	PITCH	B CB'S A
5*	+X + ψ	D	YAW	B CB'S A
6	+X - ψ	B	YAW	B CB'S A
7*	-X + ψ	B	YAW	A CB'S B
8	-X - ψ	D	YAW	A CB'S B
9	+Z + ϕ	B	ROLL	A BD ROLL 1 CB'S B

RCS ENG NO.	COMMANDS	QUAD	CHANNEL	CHANNEL SWITCH A POSITION B
10	+Z - ϕ	D	ROLL	A B BD ROLL 2 CB'S
11	-Z + ϕ	D	ROLL	A B BD ROLL 2 CB'S
12	-Z - ϕ	B	ROLL	A B BD ROLL 1 CB'S
13	+Y + ϕ	A	ROLL	A B AC ROLL 1 CB'S
14	+Y - ϕ	C	ROLL	A B AC ROLL 2 CB'S
15	-Y + ϕ	C	ROLL	A B AC ROLL 2 CB'S
16	-Y - ϕ	A	ROLL	A B AC ROLL 1 CB'S

* SM ONLY

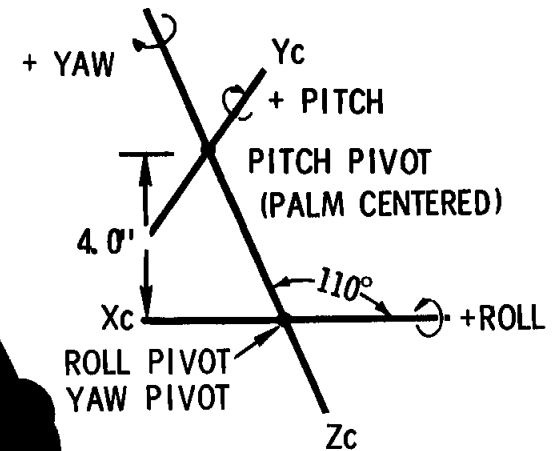
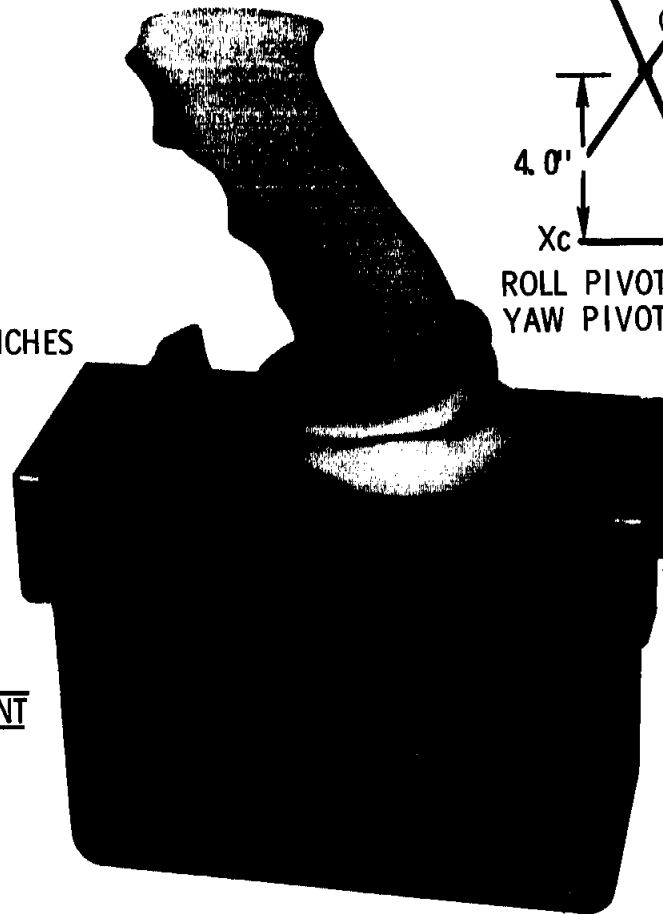
ROTATION CONTROL

PUSH TO TALK SWITCH PARAMETERS

TRAVEL PRIOR TO SWITCH ACTUATION	8.0° MIN
TRAVEL TO HARDSTOP	25.0° MAX
MAXIMUM TORQUE	1.0 POUND INCHES

ROTATION CONTROL PARAMETERS

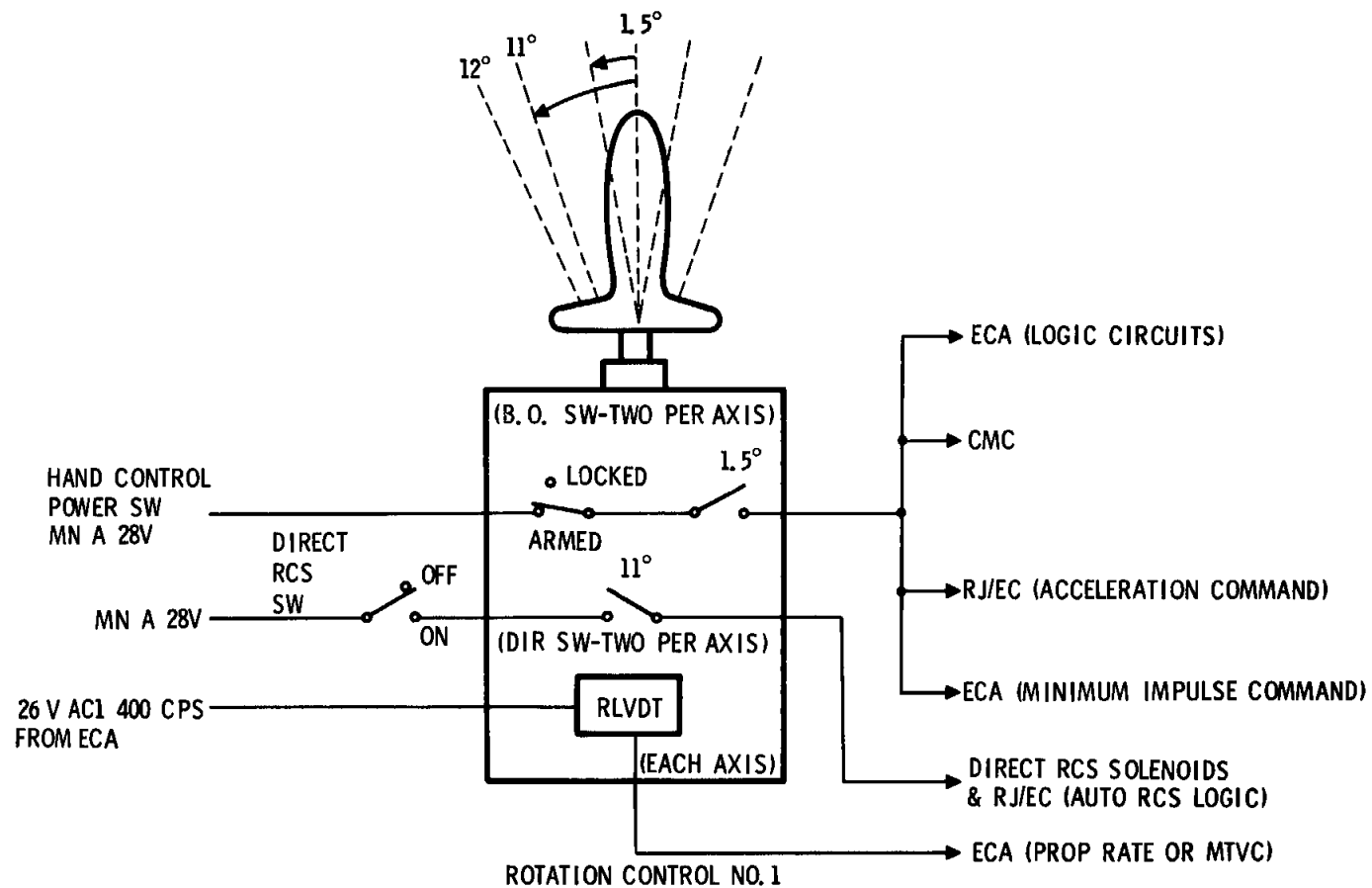
	<u>DISPLACEMENT</u>
HARD STOP	11.5±0.50
DIRECT SWITCH ACTUATION	≈11.0°
SOFT STOP	10±1°
BREAKOUT SWITCH ACTUATION	1.5± 0.5°
CONTROLLER LOCK TO ARM	50.0°



SCS-2002B



ROTATION CONTROL INTERFACES



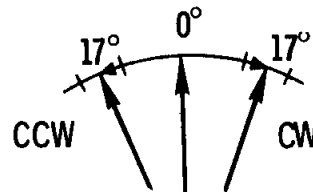
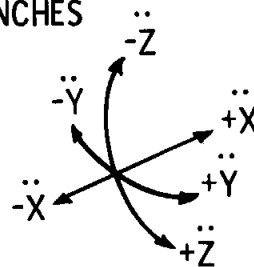
TRANSLATION CONTROL

CW & CCW CONTROL MOTION LIMITS

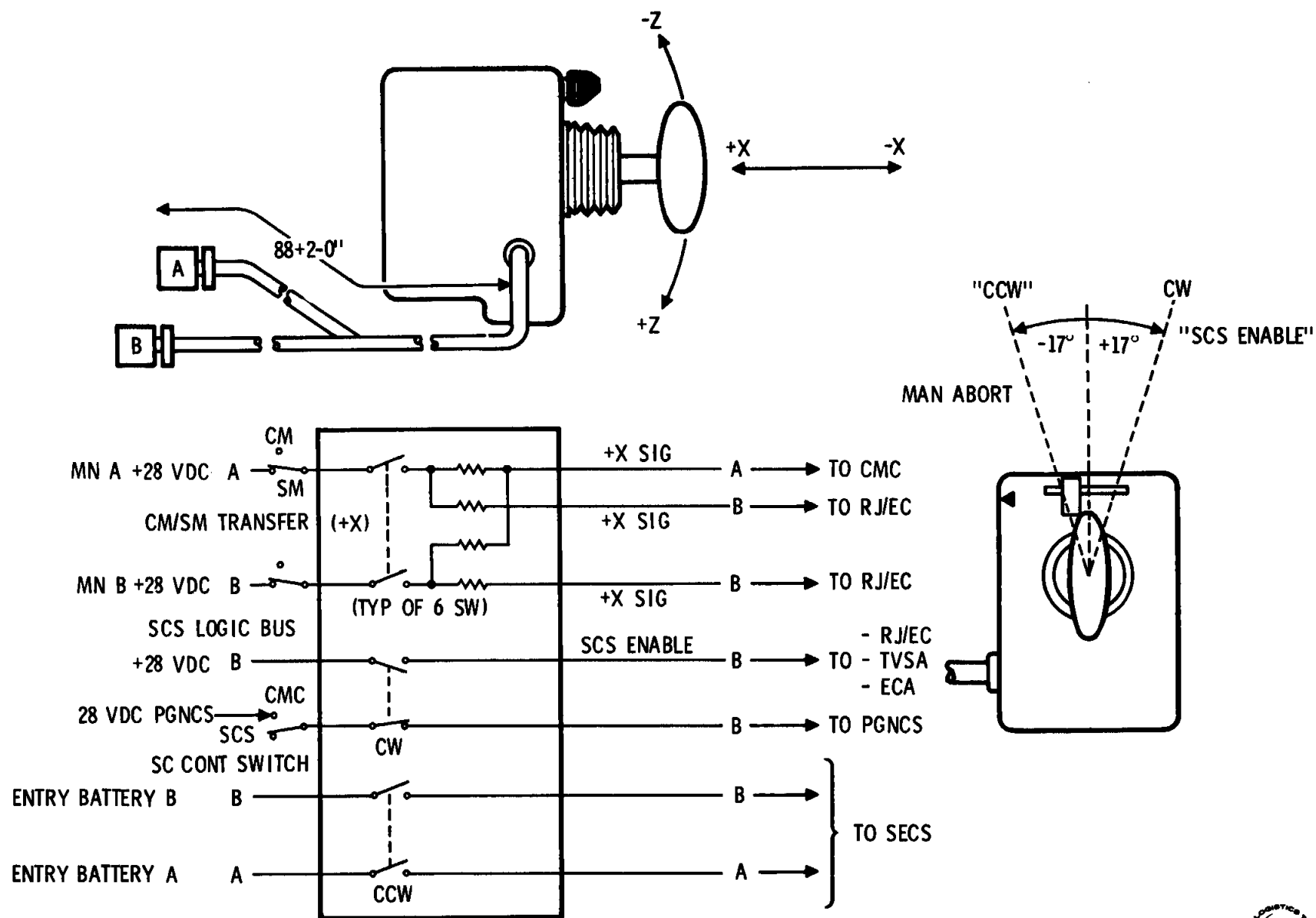
HARD STOP, DETENT & SWITCH CLOSURE	$17^{\circ} \pm 2^{\circ}$
FORCE INTO DETENT	15 ± 5.0 LB INCHES
OUT OF DETENT	6 LB INCHES MIN

TRANSLATION CONTROL MOTION LIMITS (+ OR - COMMANDS)

MECHANICAL STOP	- 0.5 ± 0.075 ARC INCHES
SWITCH CLOSURE	- $0.375 \begin{matrix} +0.025 \\ -0.075 \end{matrix}$ ARC INCHES
FORCE	- 1.5 ± 0.33 POUNDS

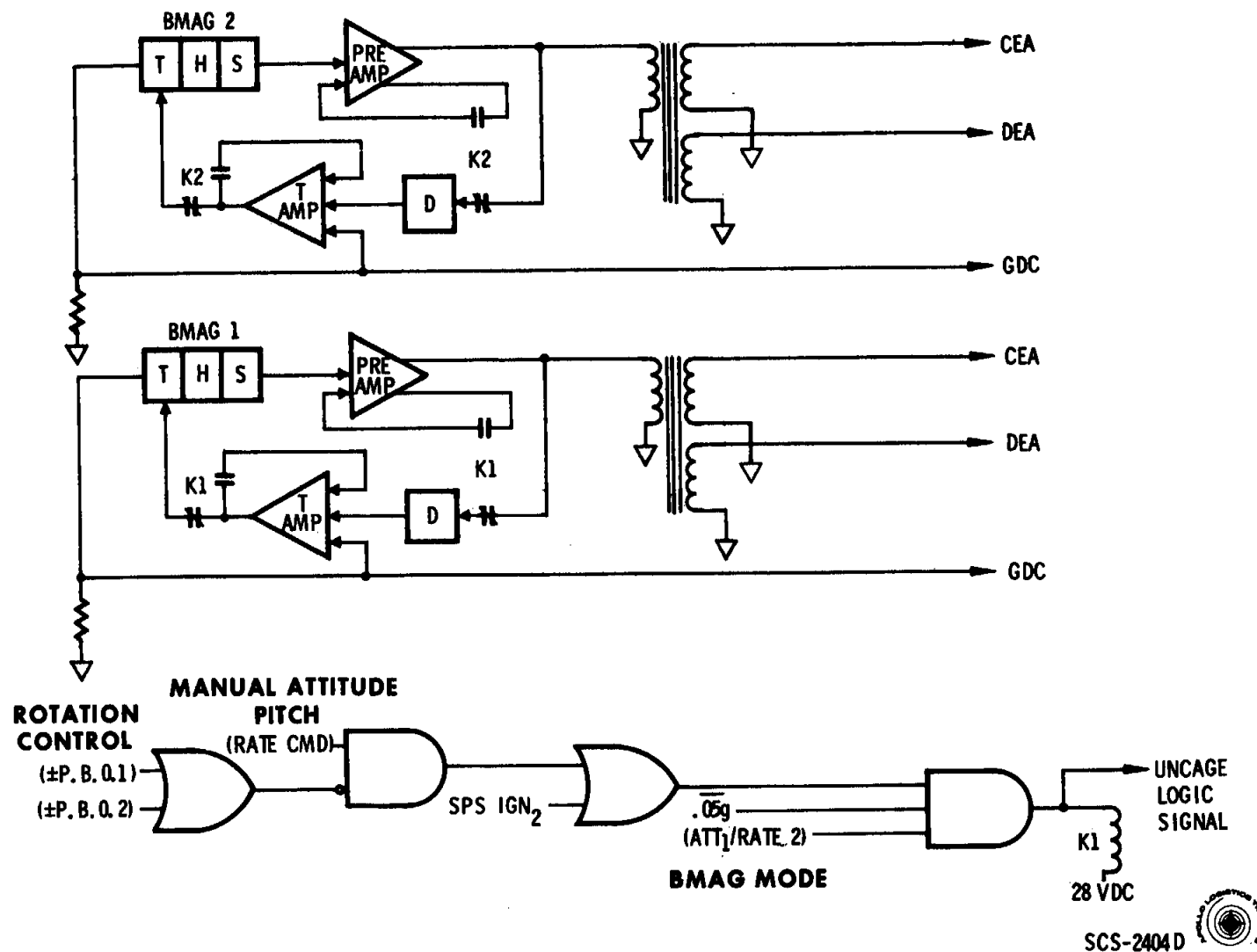


TRANSLATION CONTROL INTERFACES



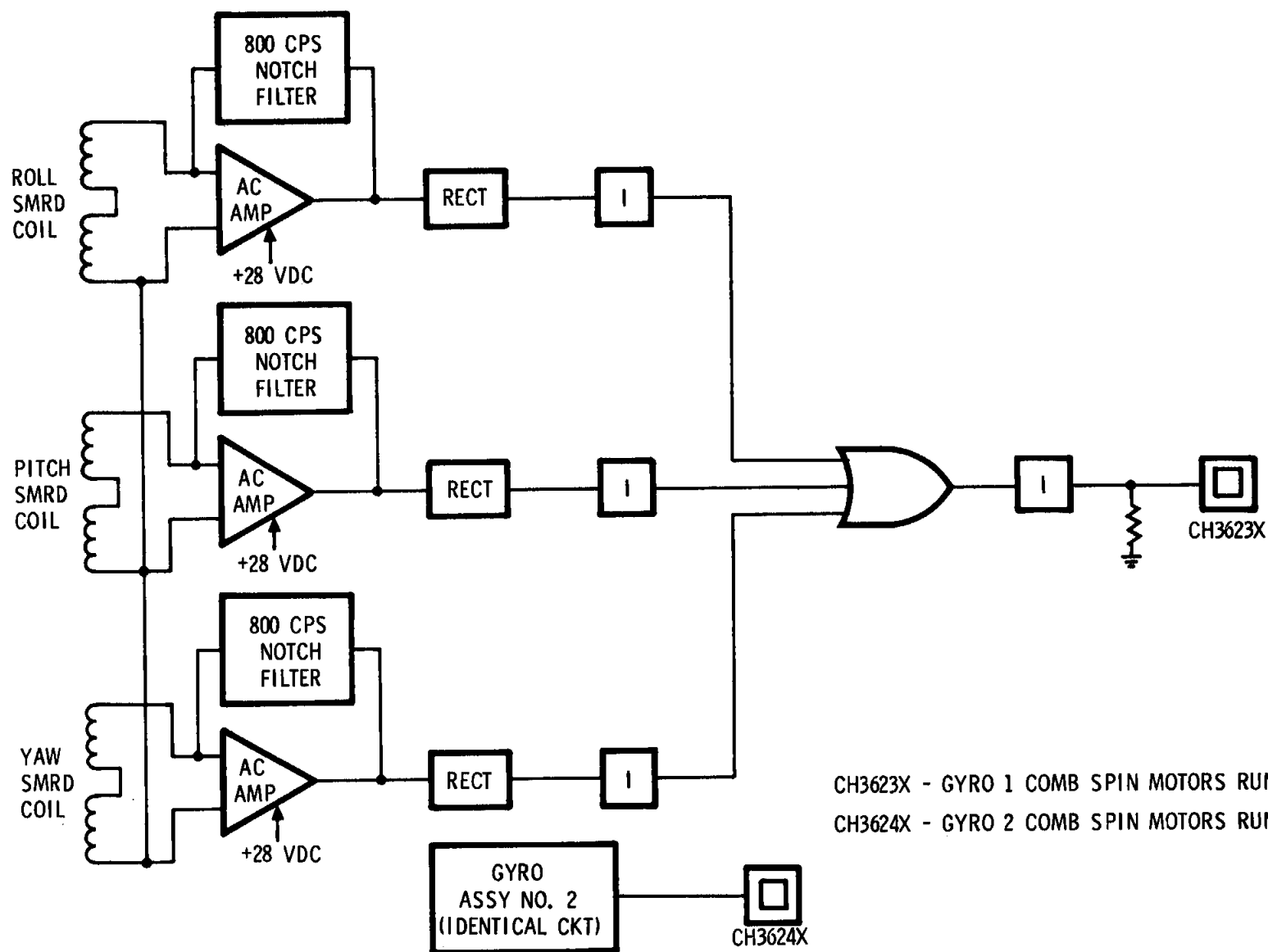
SCS-2401E

PITCH BMAG LOGIC AND OUTPUTS



SCS GYRO ASSEMBLY NO.1

SMRD TM



CH3623X - GYRO 1 COMB SPIN MOTORS RUN DET

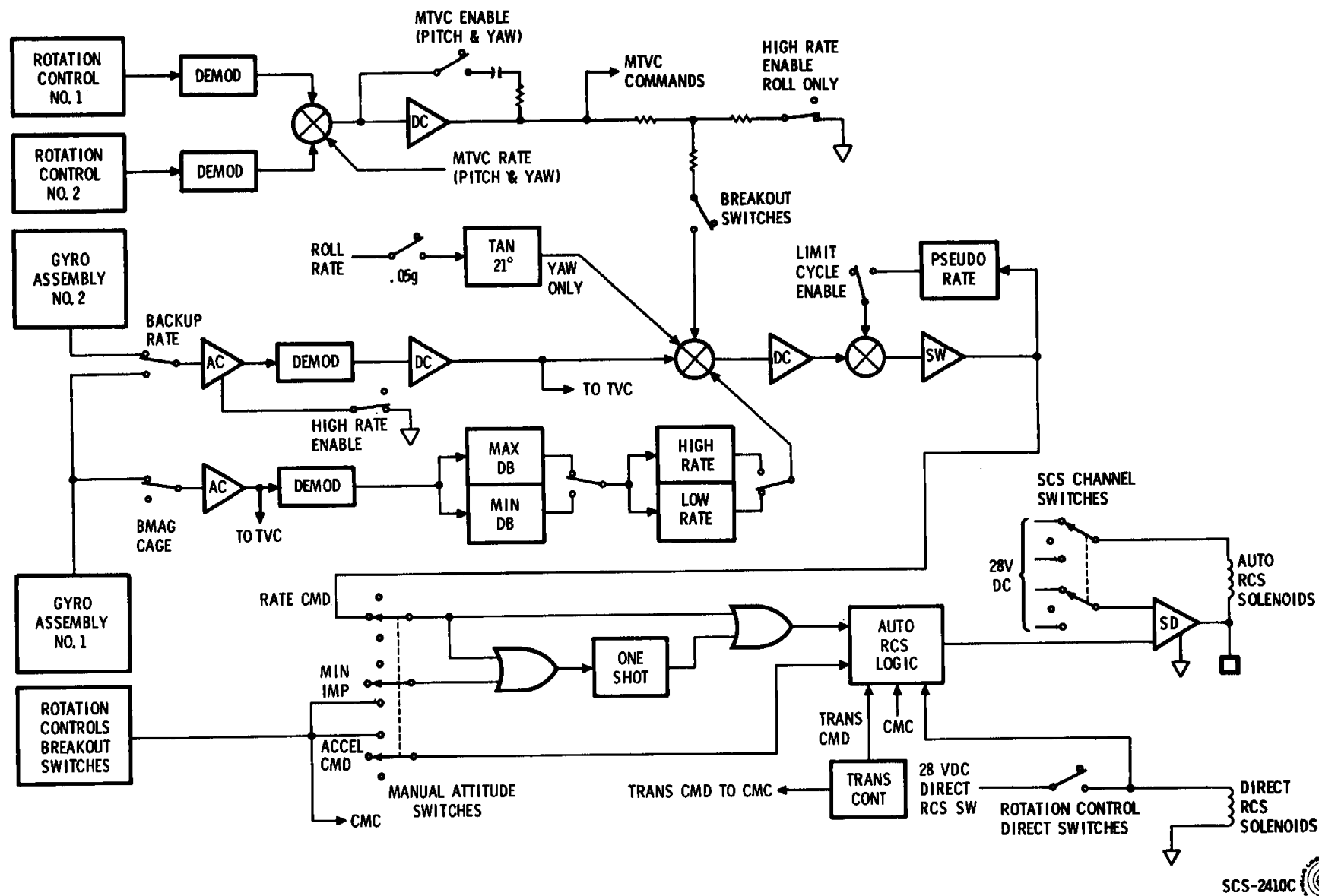
CH3624X - GYRO 2 COMB SPIN MOTORS RUN DET

SCS-2601A



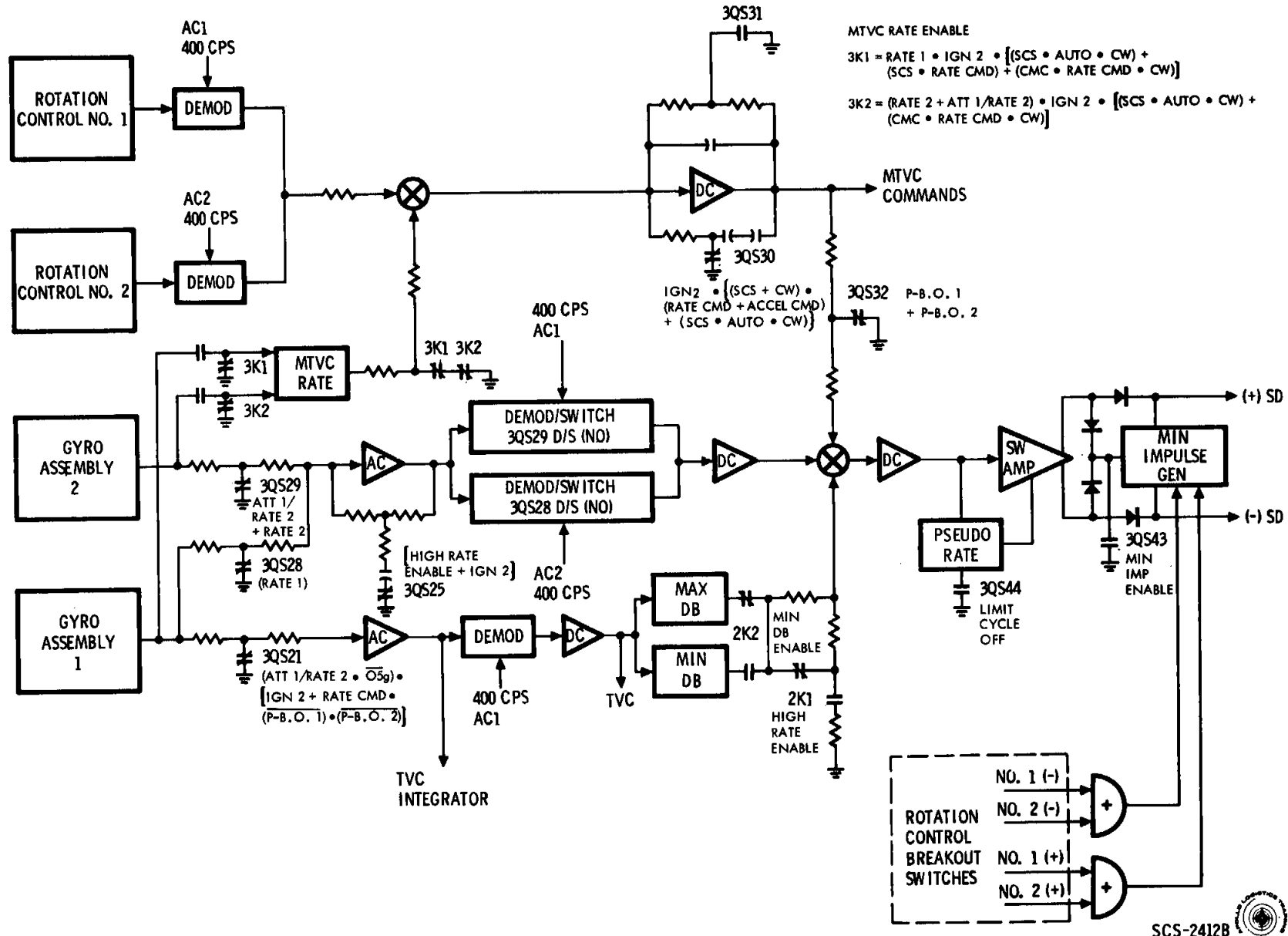
SCS ATTITUDE CONTROL

FUNCTIONAL OPERATION

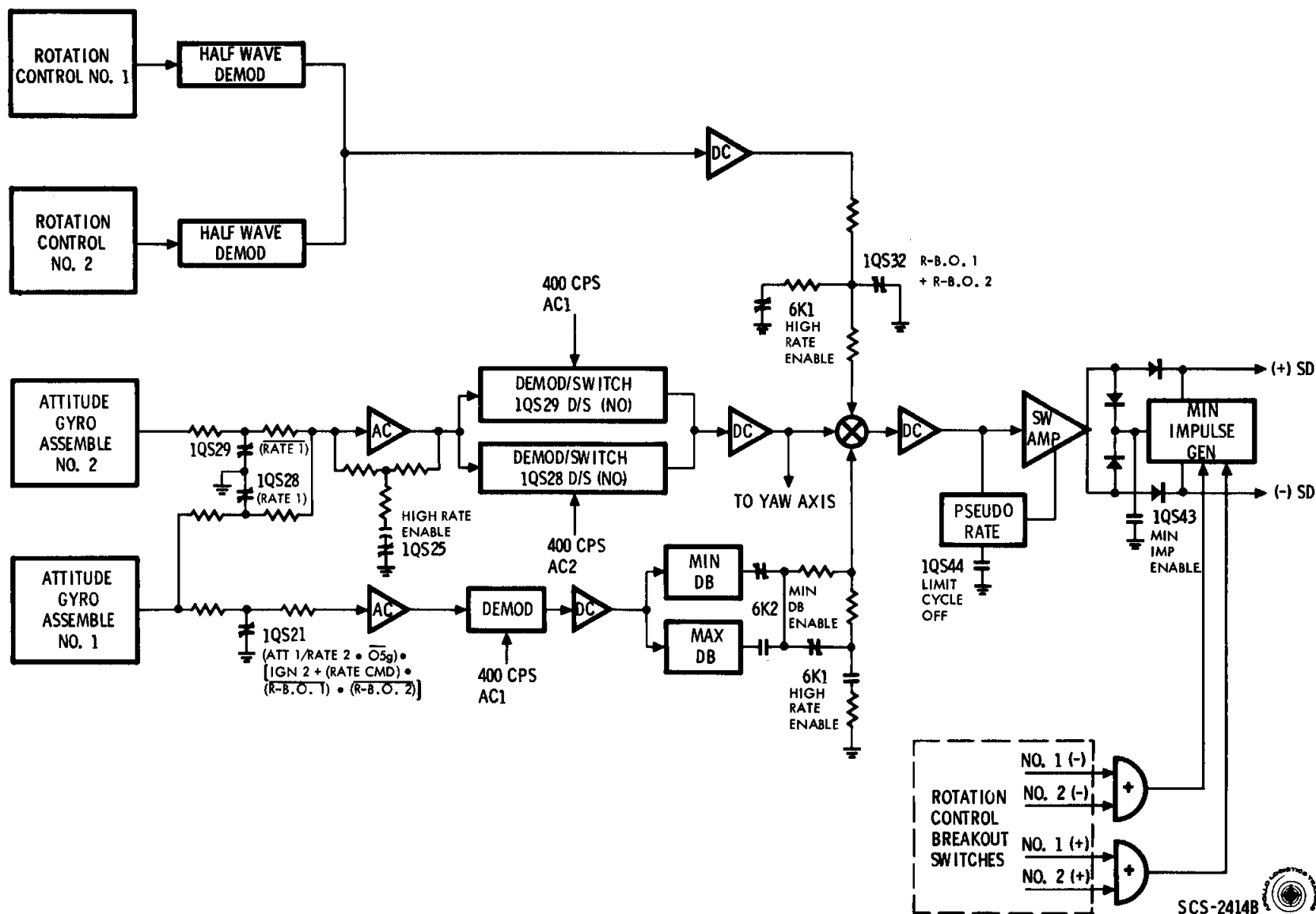


SCS-2410C

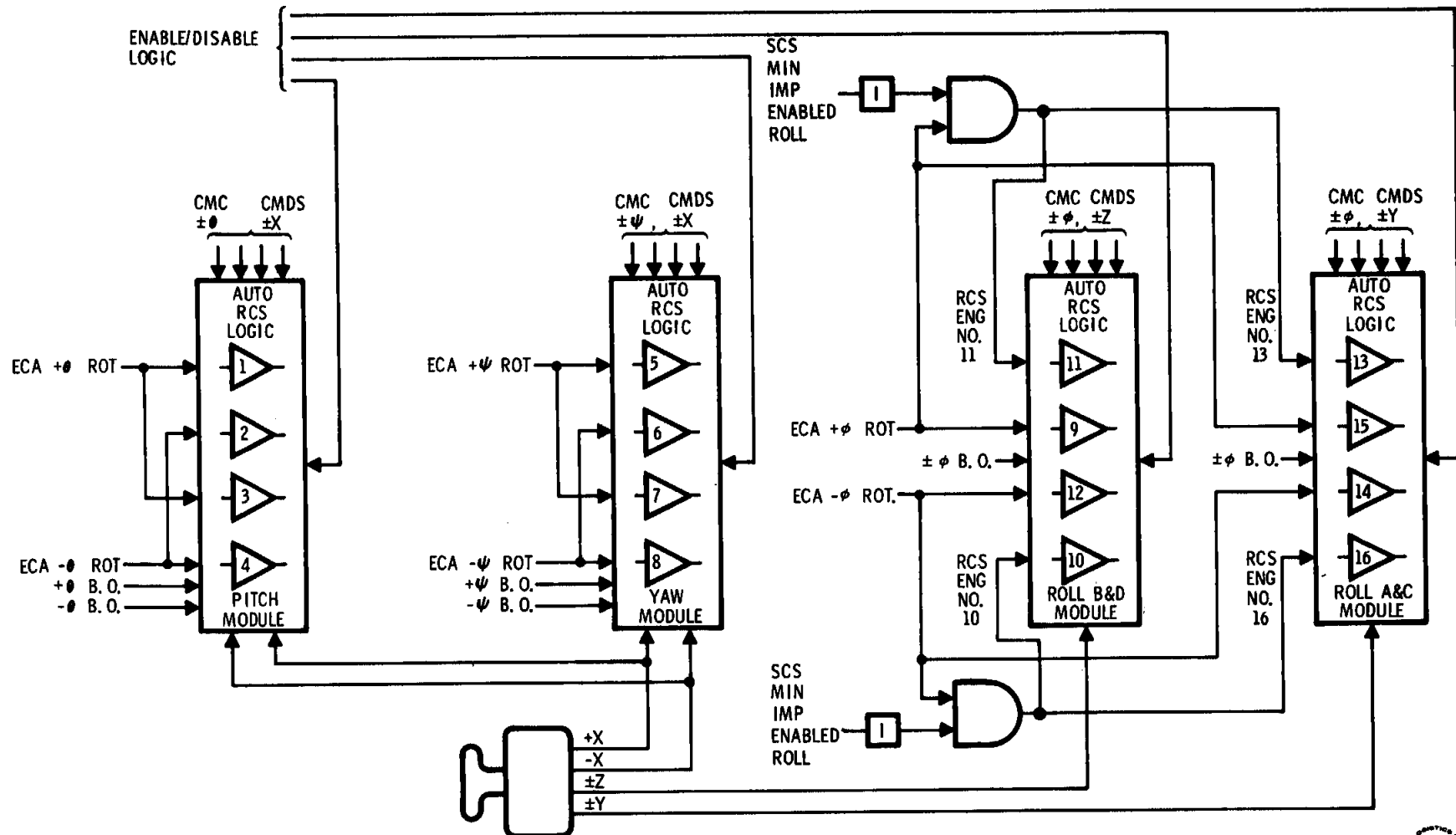
SCS ATTITUDE CONTROL PITCH CHANNEL



SCS ATTITUDE CONTROL ROLL CHANNEL

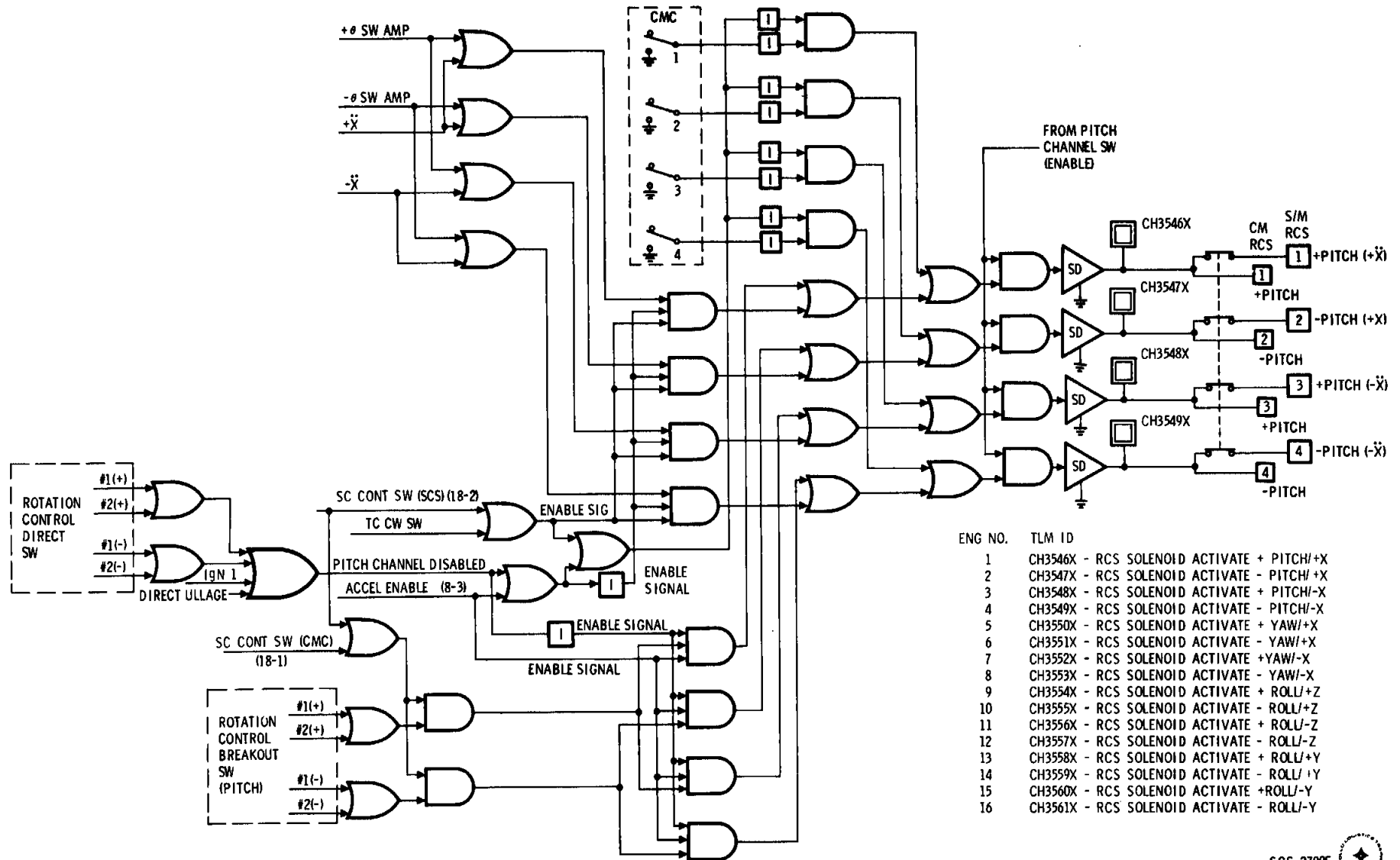


AUTO RCS LOGIC SIG FLOW

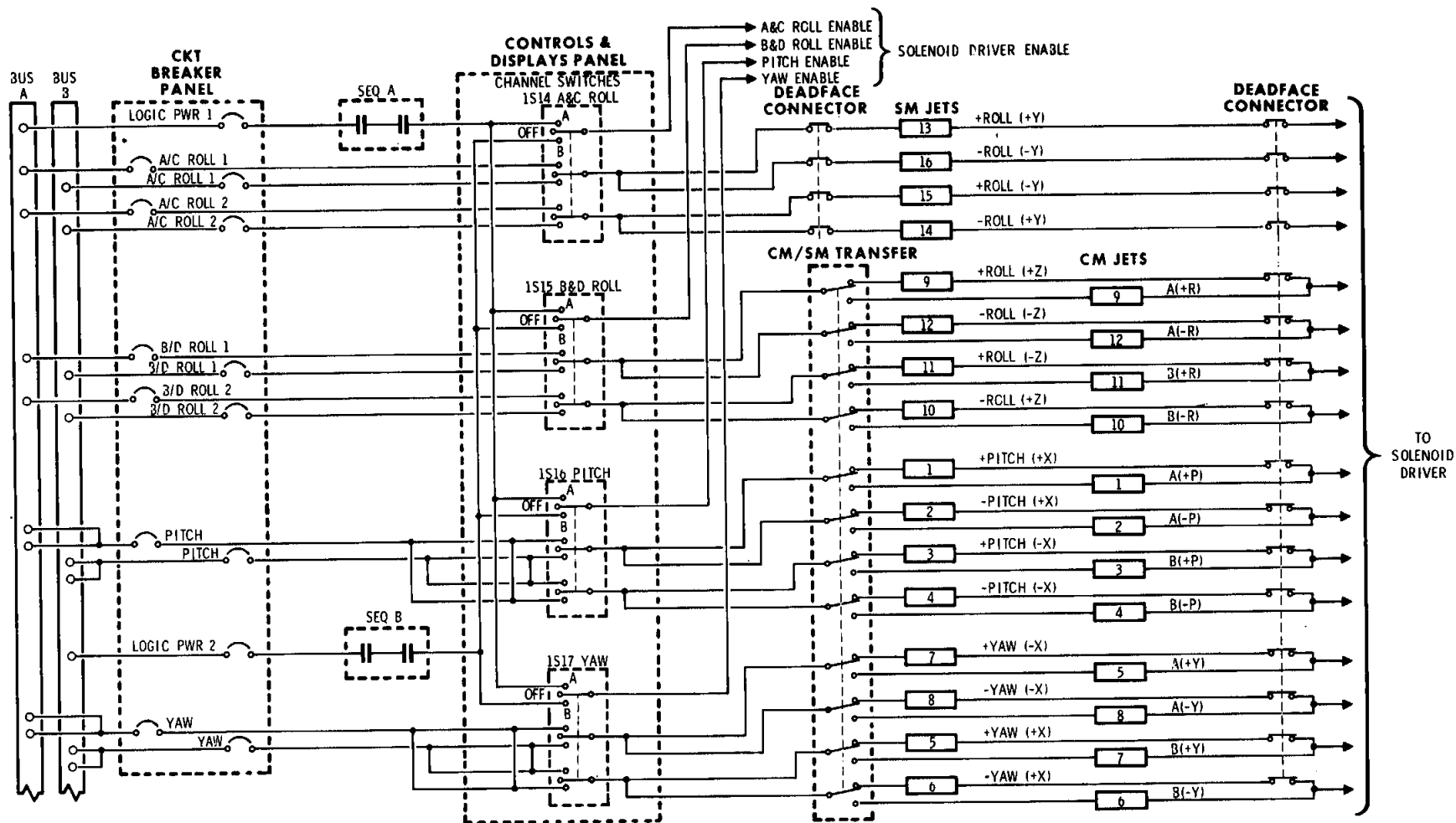


SCS-2415C 

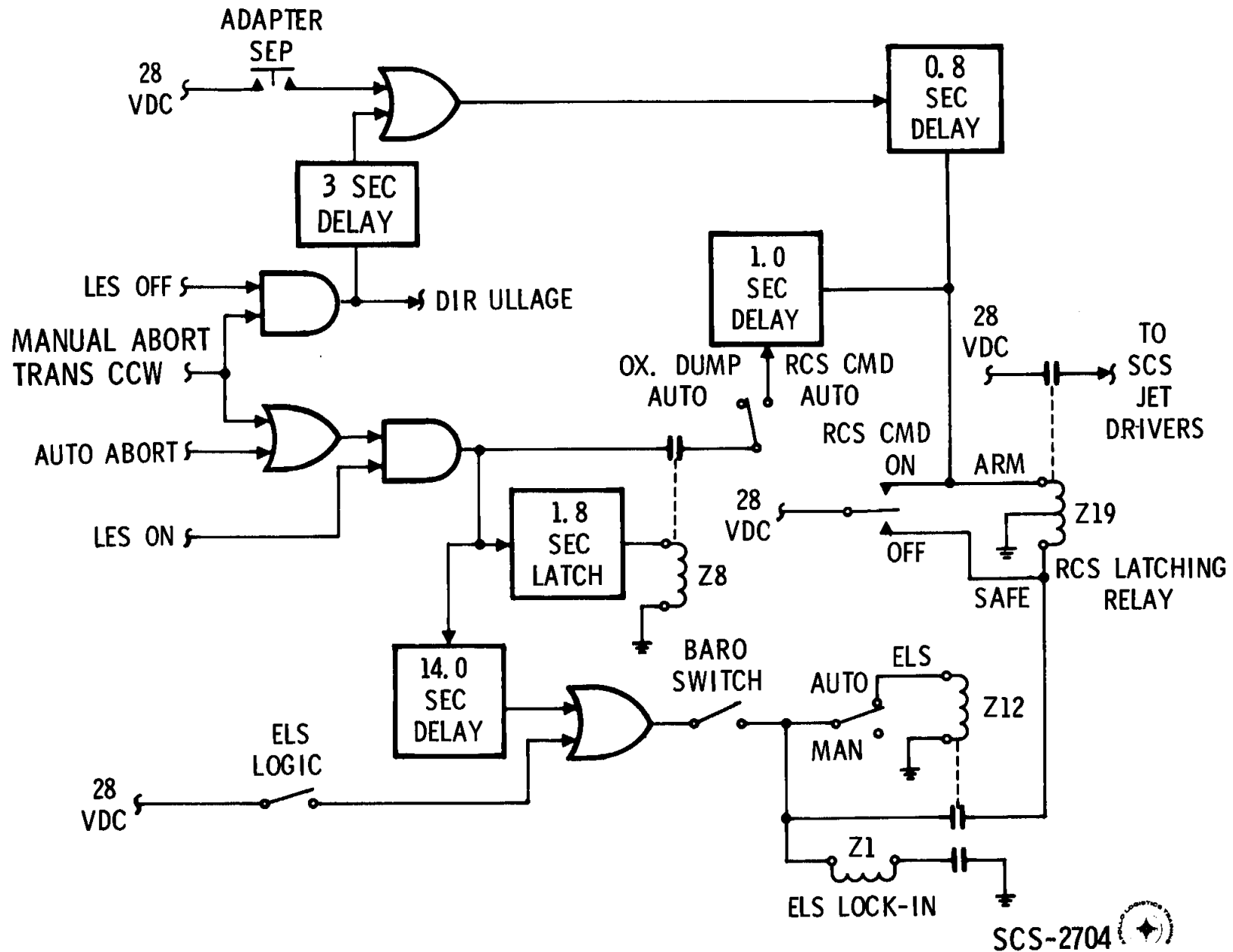
AUTO RCS LOGIC TYPICAL CHANNEL (PITCH)



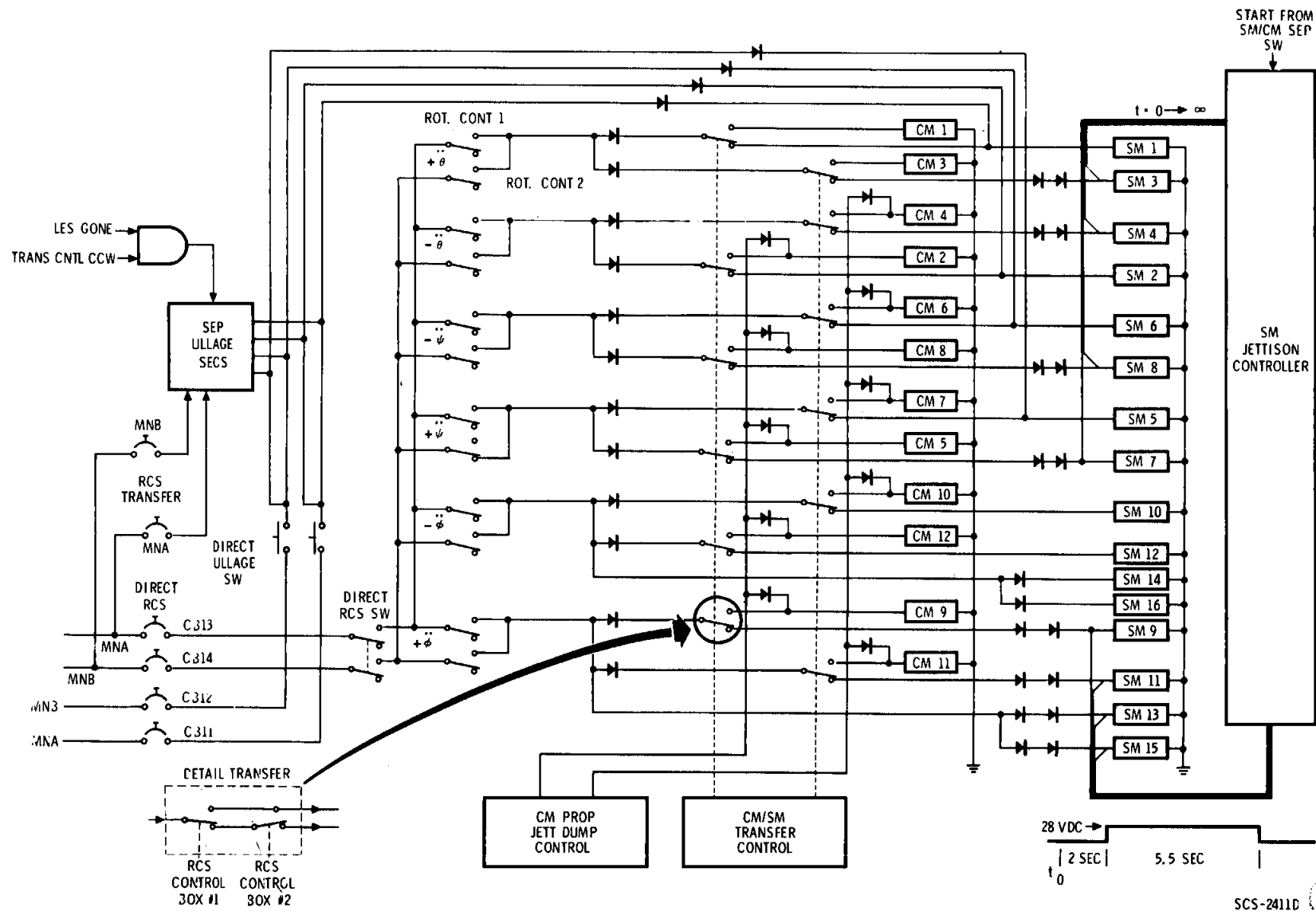
ENABLING POWER - AUTO RCS



RCS LATCHING RELAY LOGIC



DIRECT CONTROL LOOP



SCS-2411D

ACS CONTROL CAPABILITIES

			MANUAL					AUTOMATIC			
			DIRECT	ACCELERATION CMD	TRANSLATION	MINIMUM IMPULSE		PROPORTIONAL RATE (4)	RATE DAMPING	ATTITUDE HOLD	
MANUAL ATTITUDE	ROLL	ACCEL CMD		✓							
		RATE CMD			✓			✓	✓		✓
		MIN IMP			✓	✓					
	PITCH	ACCEL CMD		✓							
		RATE CMD			✓			✓	✓		✓
		MIN IMP			✓	✓					
	YAW	ACCEL CMD		✓							
		RATE CMD			✓			✓	✓		✓
		MIN IMP			✓	✓					
BMAG MODE	ROLL	RATE 2							✓		
		ATT 1/RATE 2									✓
		RATE 1							✓		
	PITCH	RATE 2							✓		
		ATT 1/RATE 2									✓
		RATE 1							✓		
	YAW	RATE 2							✓		
		ATT 1/RATE 2									✓
		RATE 1							✓		
SC CONT	CMC	SCS			✓	✓	✓	✓	✓	✓	✓
		NEUTRAL									
TRANS CONTROL	CW	NEUTRAL									
		UP	✓	(3)	(3)	(3)	(3)	(3)	(3)	(3)	(3)
ROT CONTROL	B.O. SW	OFF									
		DIRECT SW	CLOSE	CLOSE (2)		CLOSE (2)	CLOSE	OPEN	OPEN	OPEN	OPEN
LIMIT (1) CYCLE	UP	OFF						✓	✓		✓
		05G									
ENTRY	OFF	OFF									✓

- (1) NOT REQUIRED TO ENABLE A PARTICULAR FUNCTION.
INDICATES DESIRED POSITION FOR RCS PROPELLANT CONSERVATION.
- (2) IF B.O. SW IS OPEN THE S/C WILL BE IN FREE DRIFT.
- (3) IF "ON", DIRECT SW IN ROTATION CONTROL MUST BE "OPEN".
- (4) MAXIMUM RATE ATTAINABLE IS FUNCTION OF RATE-HIGH/LOW SWITCH

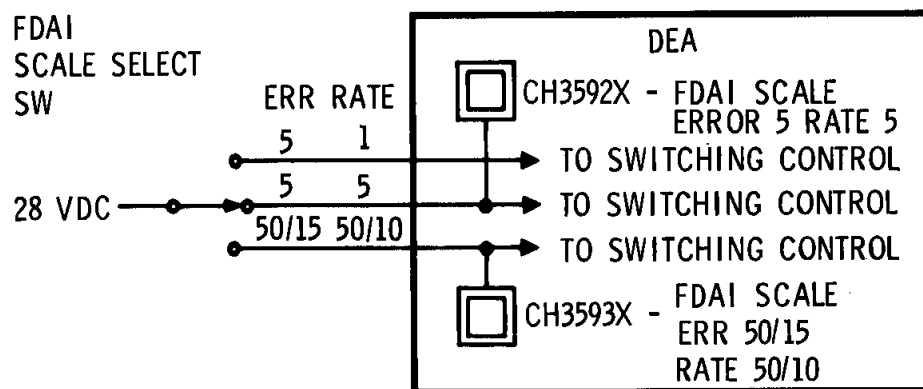
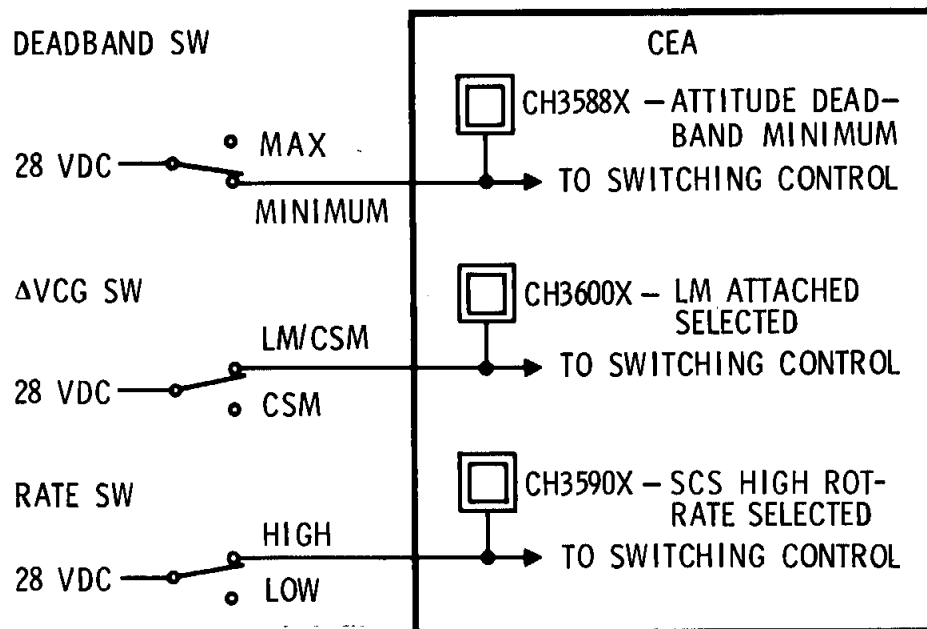
GENERAL COMMENTS:

- A. THE CAPABILITIES, IN GENERAL, ARE LISTED IN ORDER OF THEIR PRIORITY.
- B. WHEN MORE THAN ONE SWITCH POSITION IS CHECKED (✓) THE CAPABILITY WILL BE ENABLED IN EITHER POSITION.

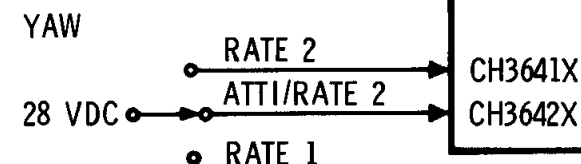
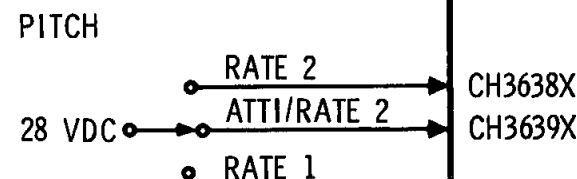
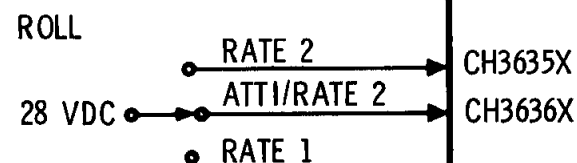
SCS-2803C



SCS CONTROL PANEL SWITCHING TM



BMAG MODE SWITCHES



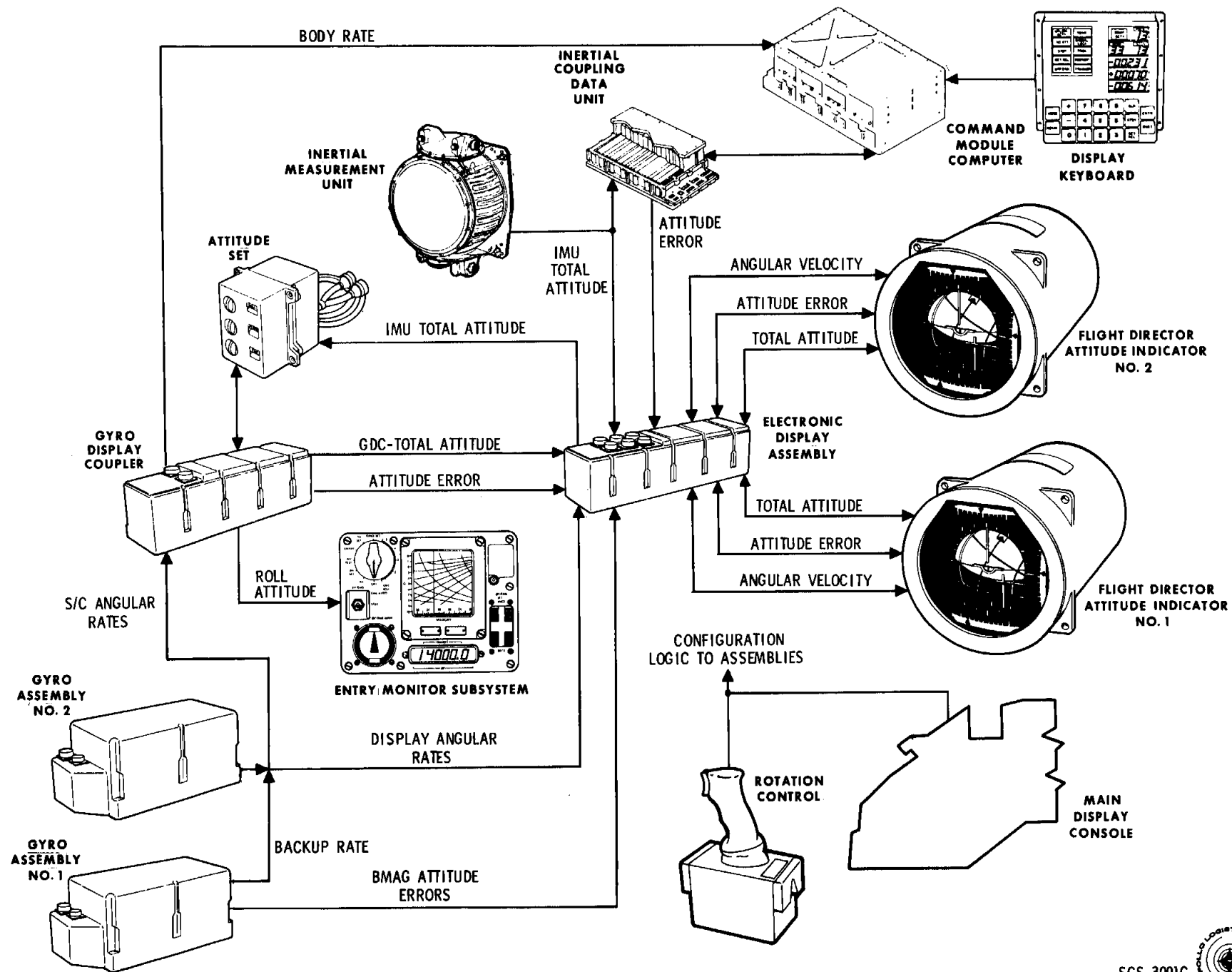
C13-1A106 SIGNAL CONDITIONER

CH3635X - BMAG MODE SW ROLL ATTI/RATE 2
CH3636X - BMAG MODE SW - ROLL RATE 2
CH3638X - BMAG MODE SW - PITCH ATTI/RATE 2
CH3639X - BMAG MODE SW - PITCH RATE 2
CH3641X - BMAG MODE SW - YAW ATT 1/RATE 2
CH3642X - BMAG MODE SW - YAW RATE 2

SCS-2600A



G & C ATTITUDE REFERENCE

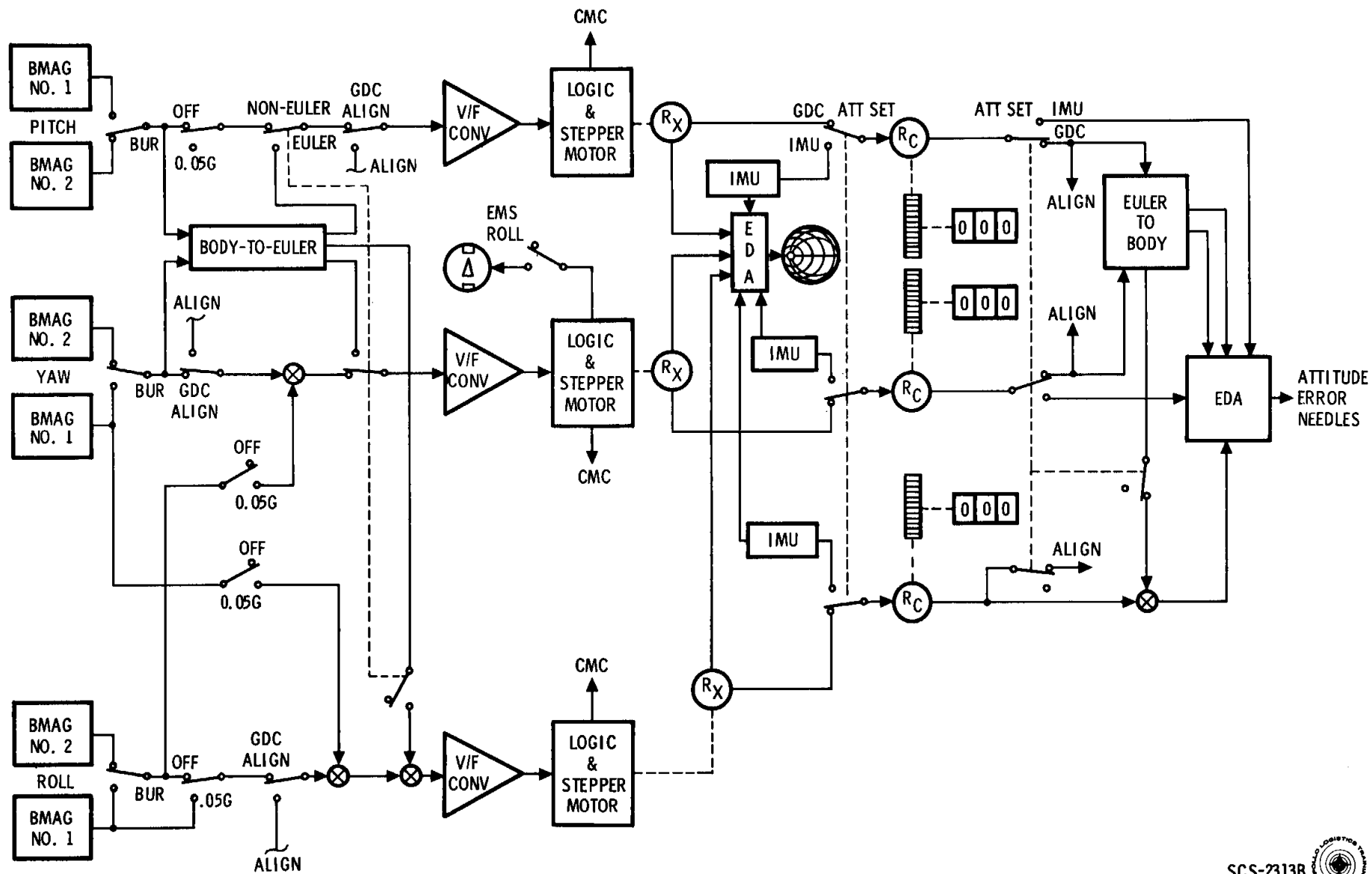


SCS-3001C

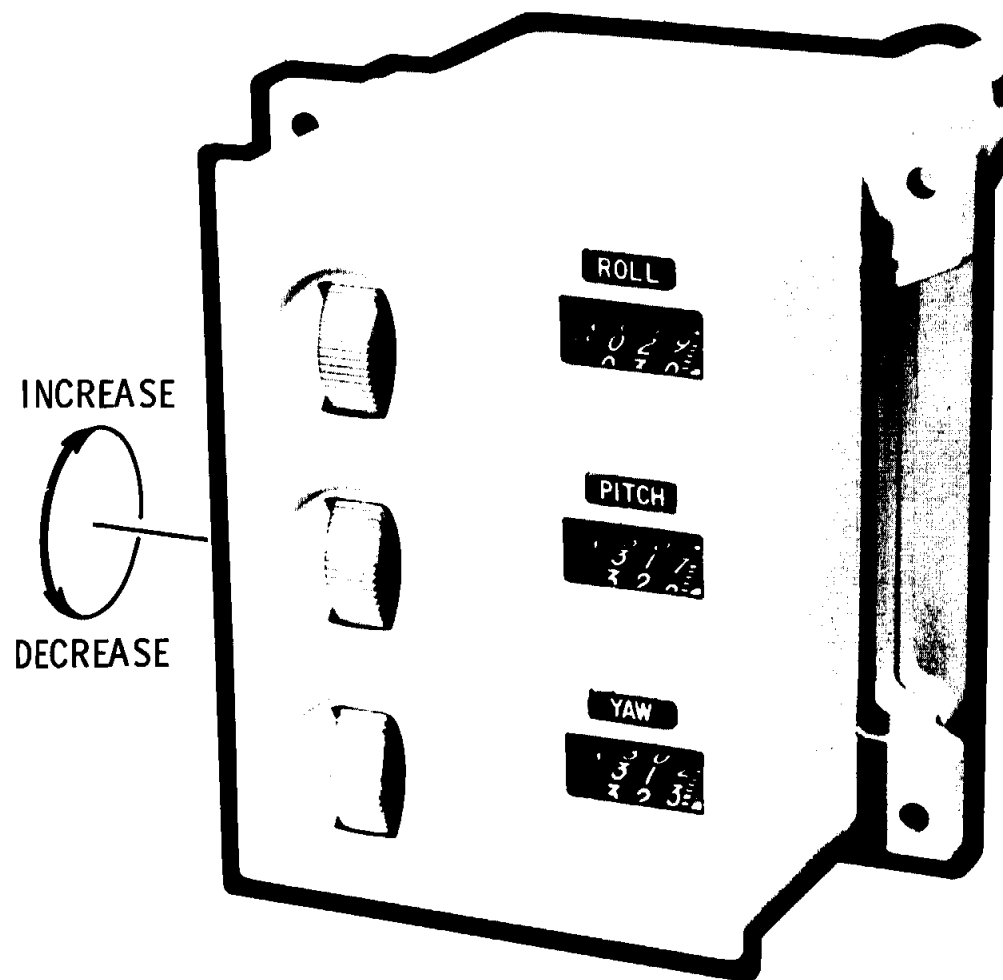


ATTITUDE REFERENCE SUBSYSTEM

FUNCTIONAL OPERATION



ATTITUDE SET DISPLAY

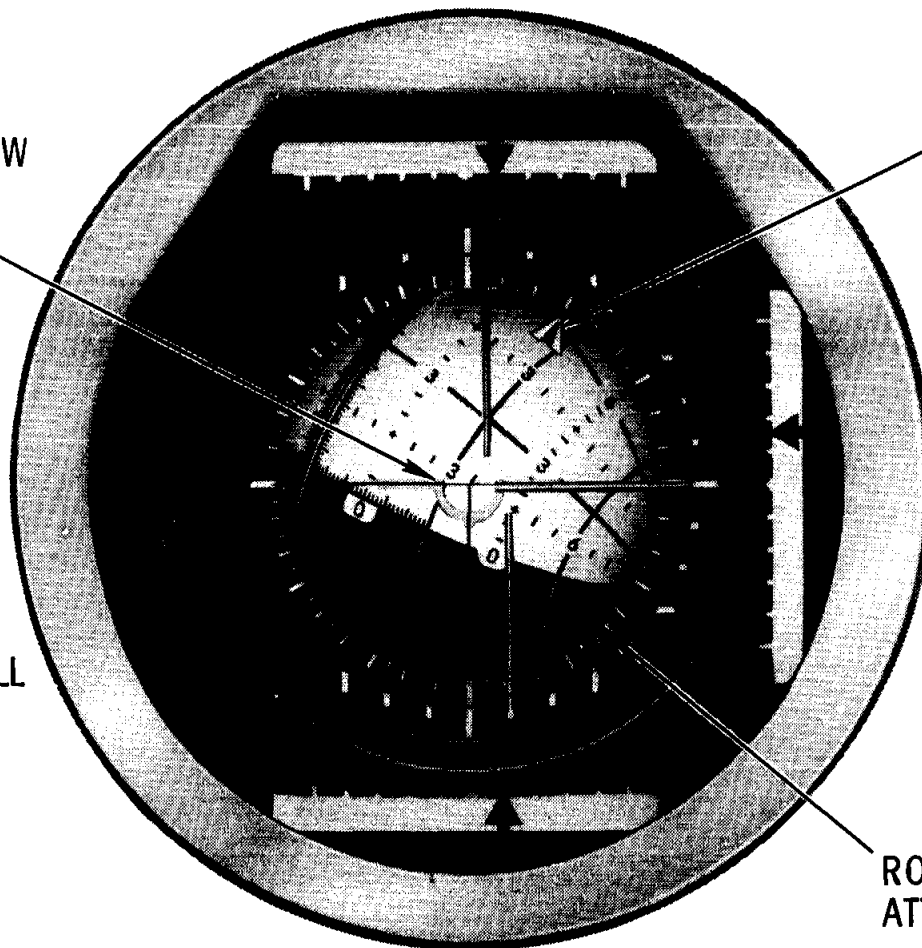


FLIGHT DIRECTOR ATTITUDE INDICATOR

ROLL
+ANGULAR VELOCITY-
+ATTITUDE ERROR-

PITCH & YAW
INDEX

ROLL INDEX



-	P	-
ATTITUDE	I	ANGULAR
ERROR	T	VELOCITY
+	C	
	H	+

EULER ATTITUDE ON BALL
PITCH - θ = 014°
YAW - ψ = 034°
ROLL - ϕ = 330°

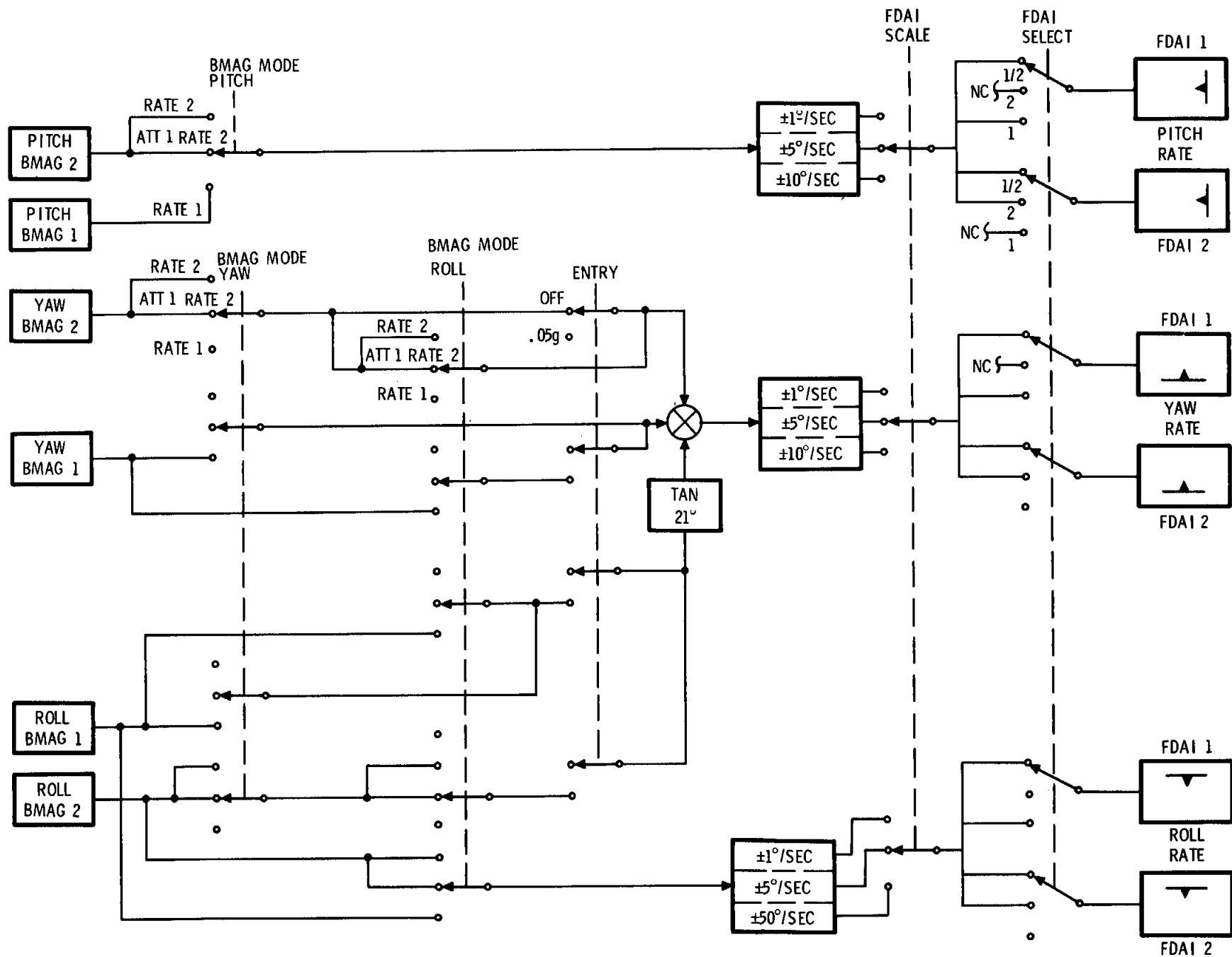
NOTE:

ALL POLARITIES INDICATE
VEHICLE DYNAMICS

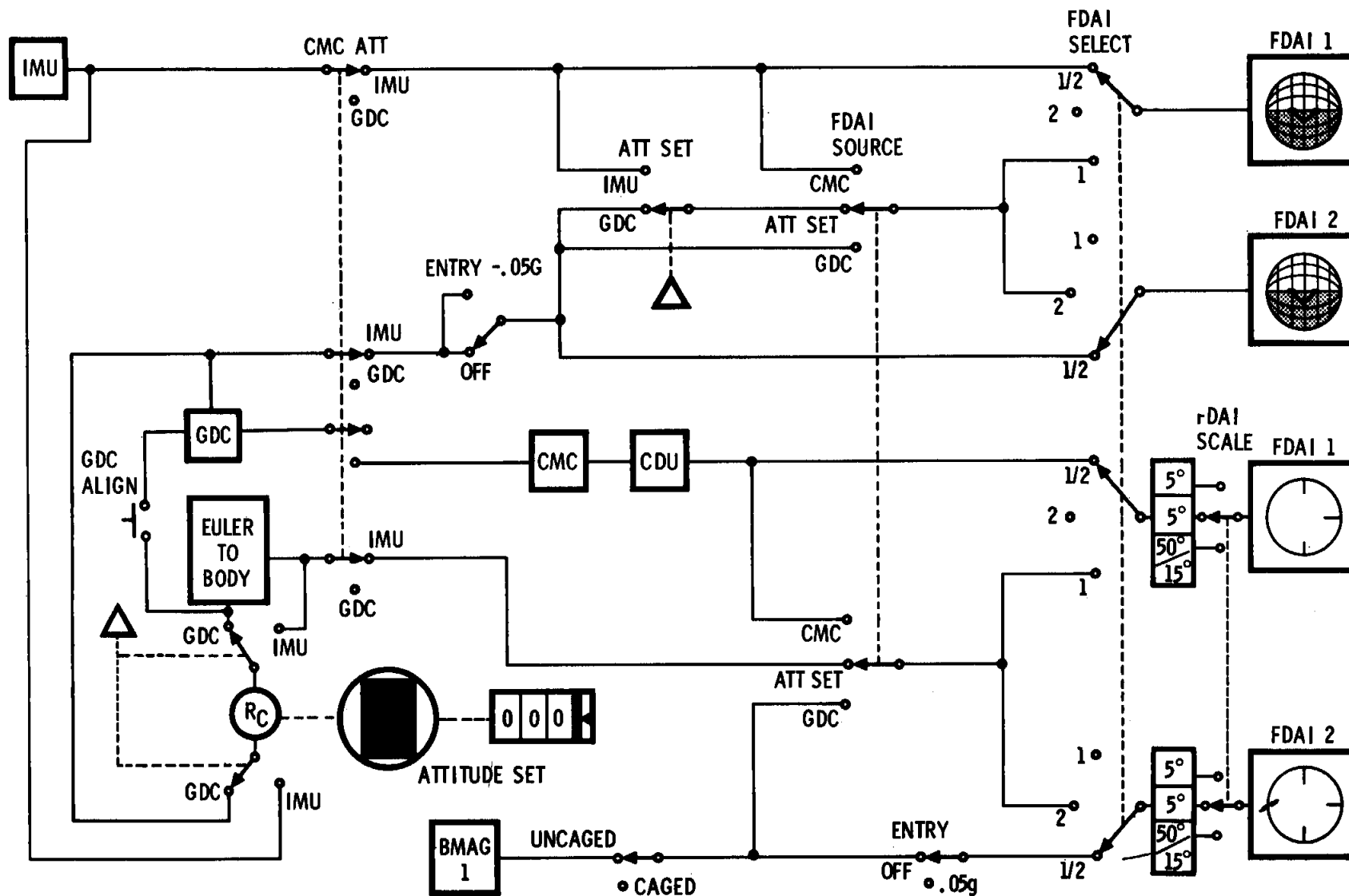
YAW
+ATTITUDE ERROR-
+ANGULAR VELOCITY-

ROLL TOTAL
ATTITUDE SCALE

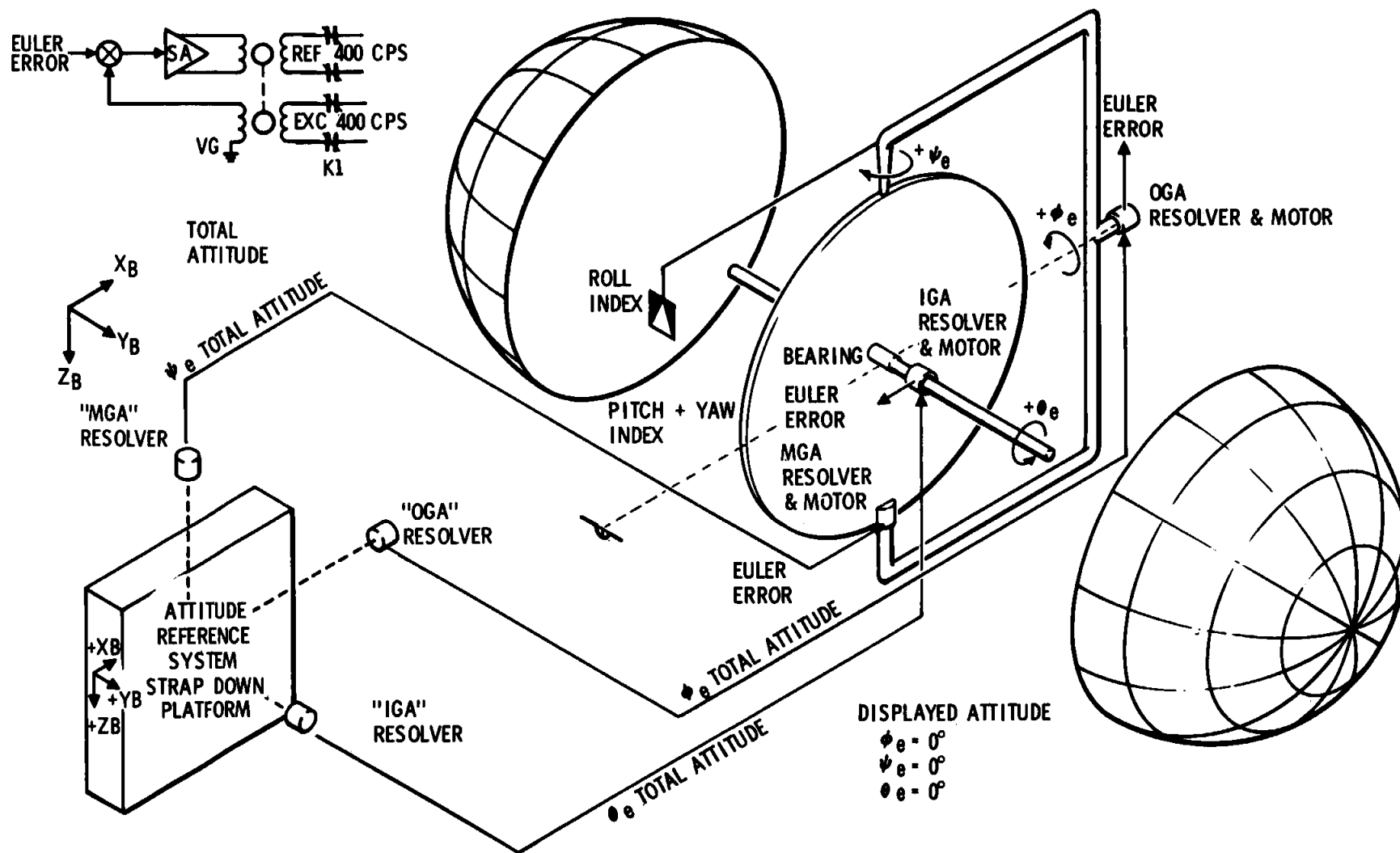
FDAI RATE SELECT LOGIC



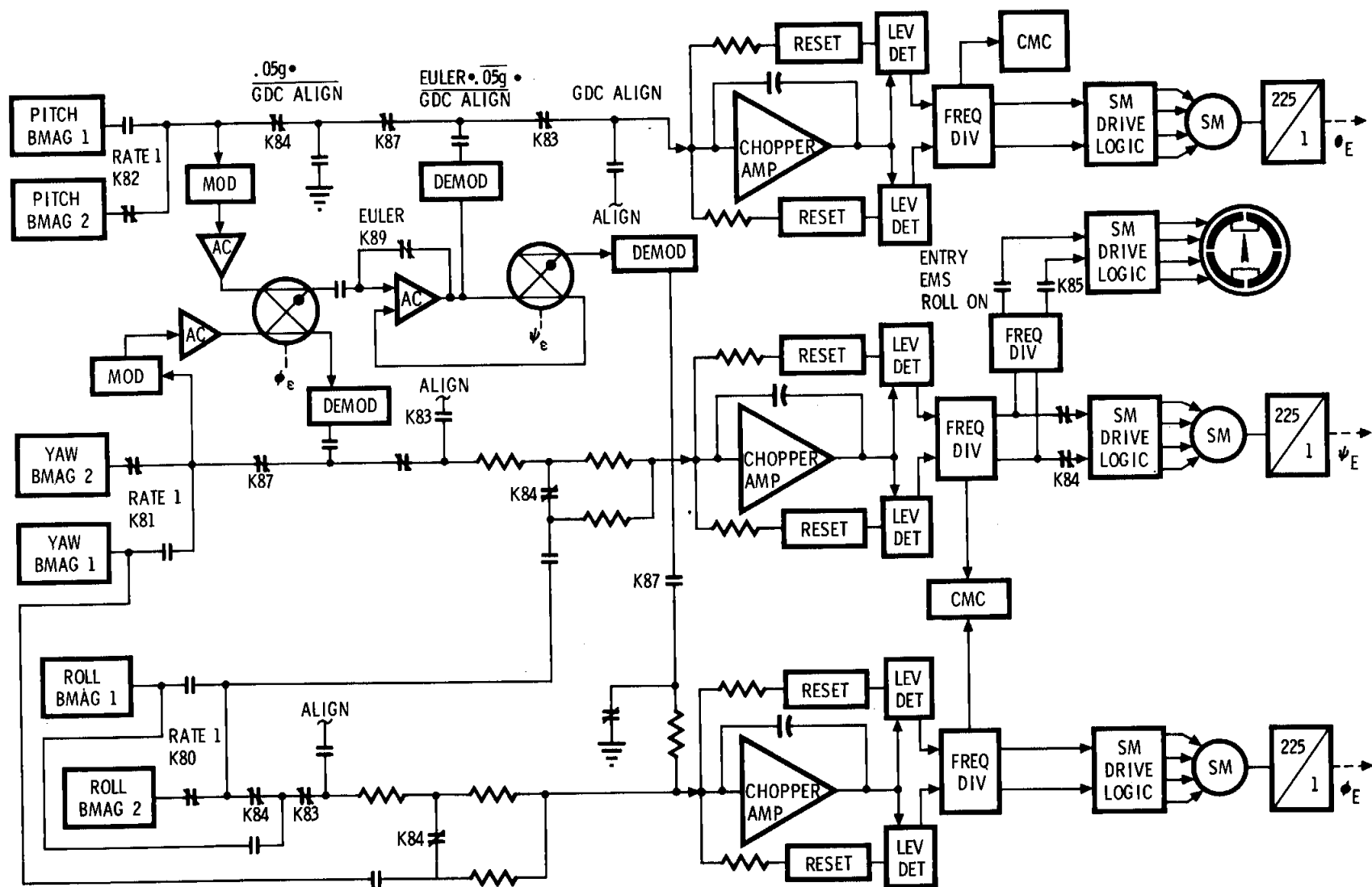
FDAI ATTITUDE SELECT LOGIC



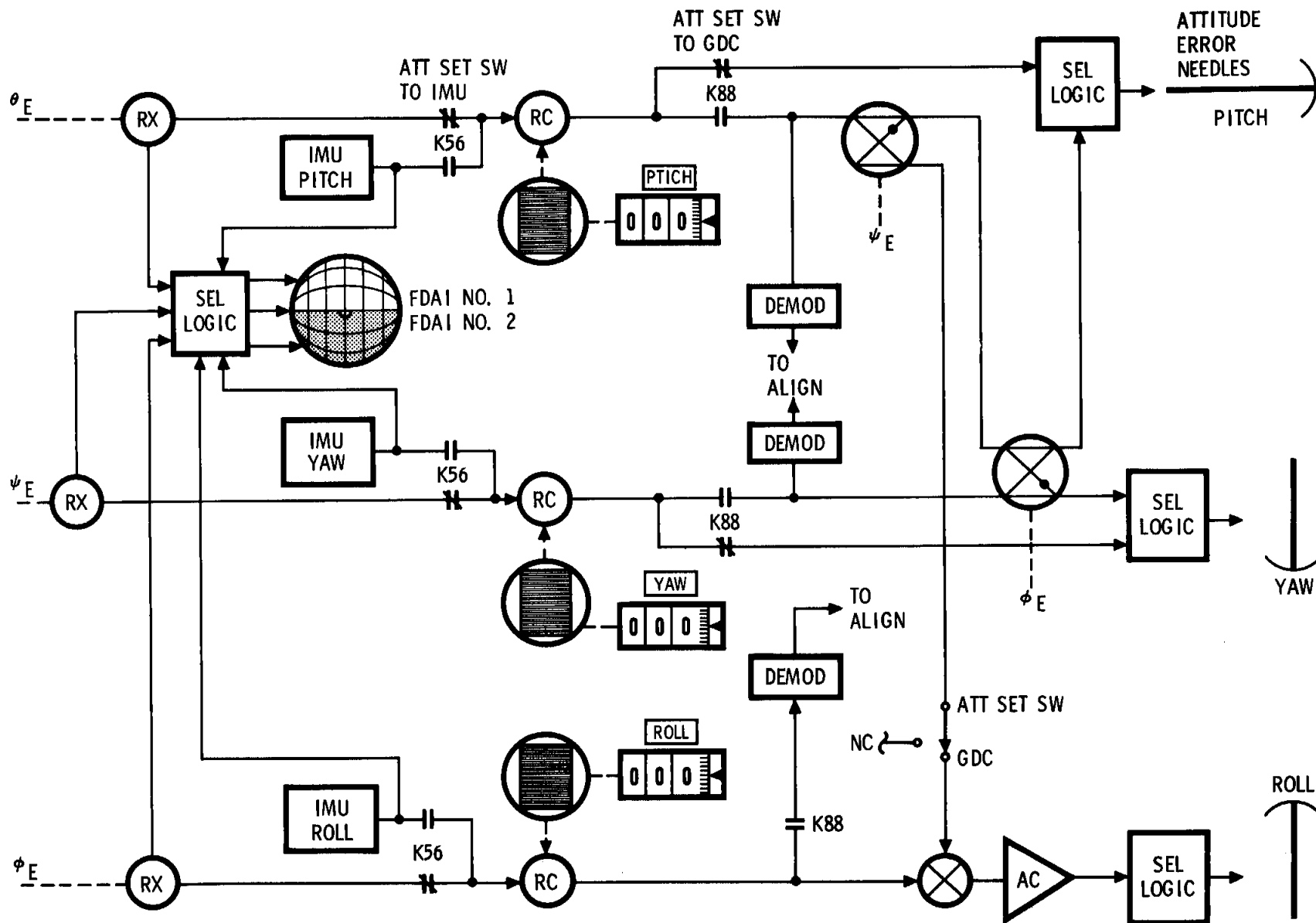
FDAI/GDC SHAFT RELATIONSHIP



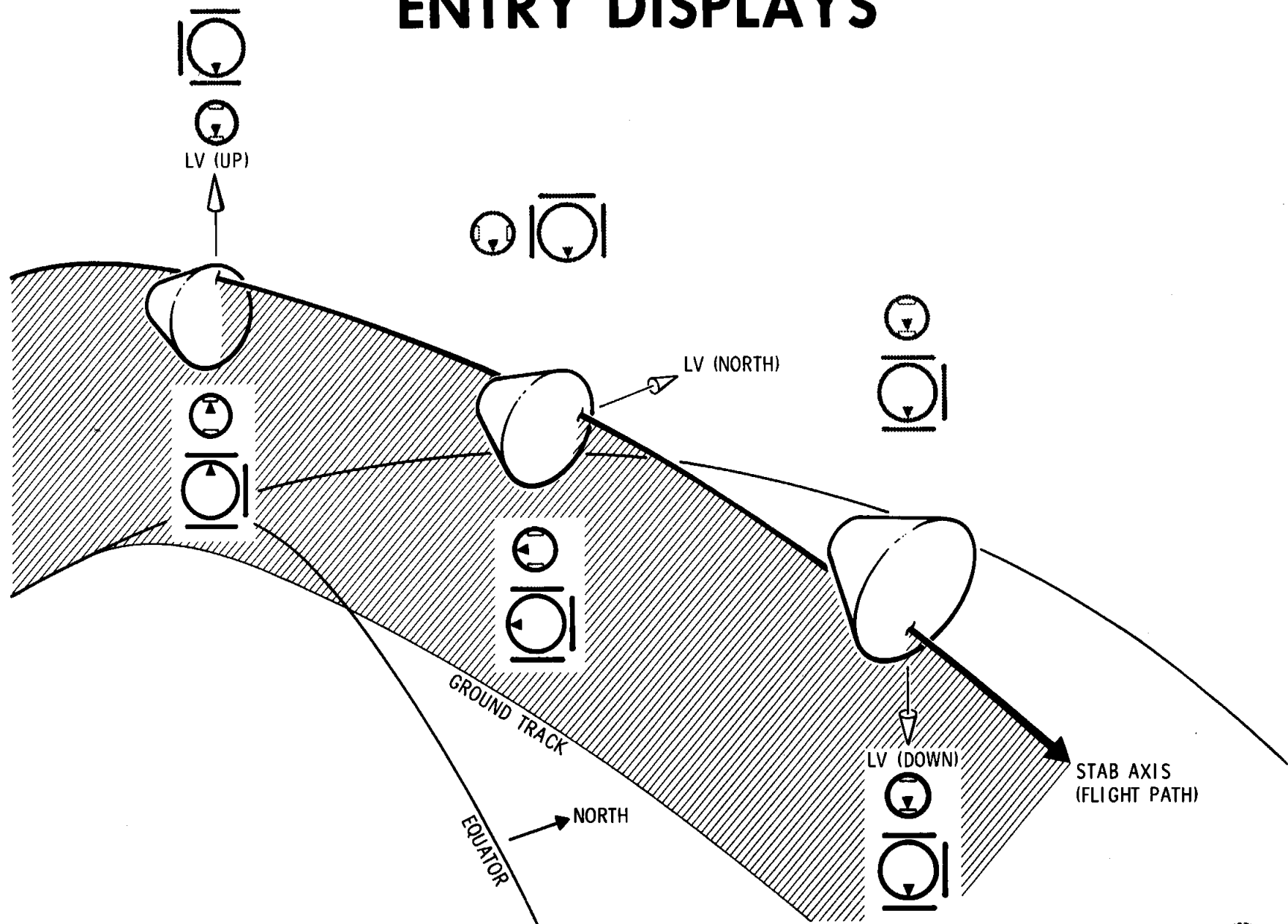
GYRO DISPLAY COUPLER



FDAI SIGNAL FLOW



ENTRY DISPLAYS



SCS-2207B



ARS SWITCHING

		ARS CONFIGURATIONS					TOTAL ATTITUDE DISP SOURCES			ERROR DISP SOURCES (4)			RATE DISP SOURCES	
		GDC ALIGN	EULER	NON-EULER	ENTRY ≥ .05G	IMU	GDC (2)	BMAG #1 (3)	GDC-ATT SET DIFF	IMU-ATT SET DIFF	CDU	BMAG #2	BMAG #1	
B M A G M O D E	PITCH	RATE 2									✓			
		ATT 1/ RATE 2					✓				✓			
		RATE 1											✓	
	YAW	RATE 2										✓		
		ATT 1/ RATE 2						✓				✓		
		RATE 1												✓
	ROLL	RATE 2										✓		
		ATT 1/ RATE 2						✓				✓		
		RATE 1												✓
E N T R Y	.05G	05G			✓		✓ (2)							
		OFF		✓	✓		✓	✓			✓ (4)	✓ (4)		
	EMS ROLL	EMS ROLL					✓ (2)							
	OFF													
	FDAI SELECT	(1) 1/2				✓	✓	✓			✓			
		2				✓	✓	✓	✓	✓	✓			
		1				✓	✓	✓	✓	✓	✓			
	FDAI SOURCE	CMC				✓					✓			
		ATT SET				✓		✓	✓	✓				
		GDC					✓	✓						
	ATT SET	IMU				✓			✓					
		GDC	✓					✓						
	CMC ATT	IMU		✓		✓	✓							
		GDC			✓									
	GDC ALIGN	PRESS	✓											
		OFF		✓	✓	✓								
	ATTITUDE SET CONT PANEL	3 THUMB- WHEELS	✓					✓	✓					

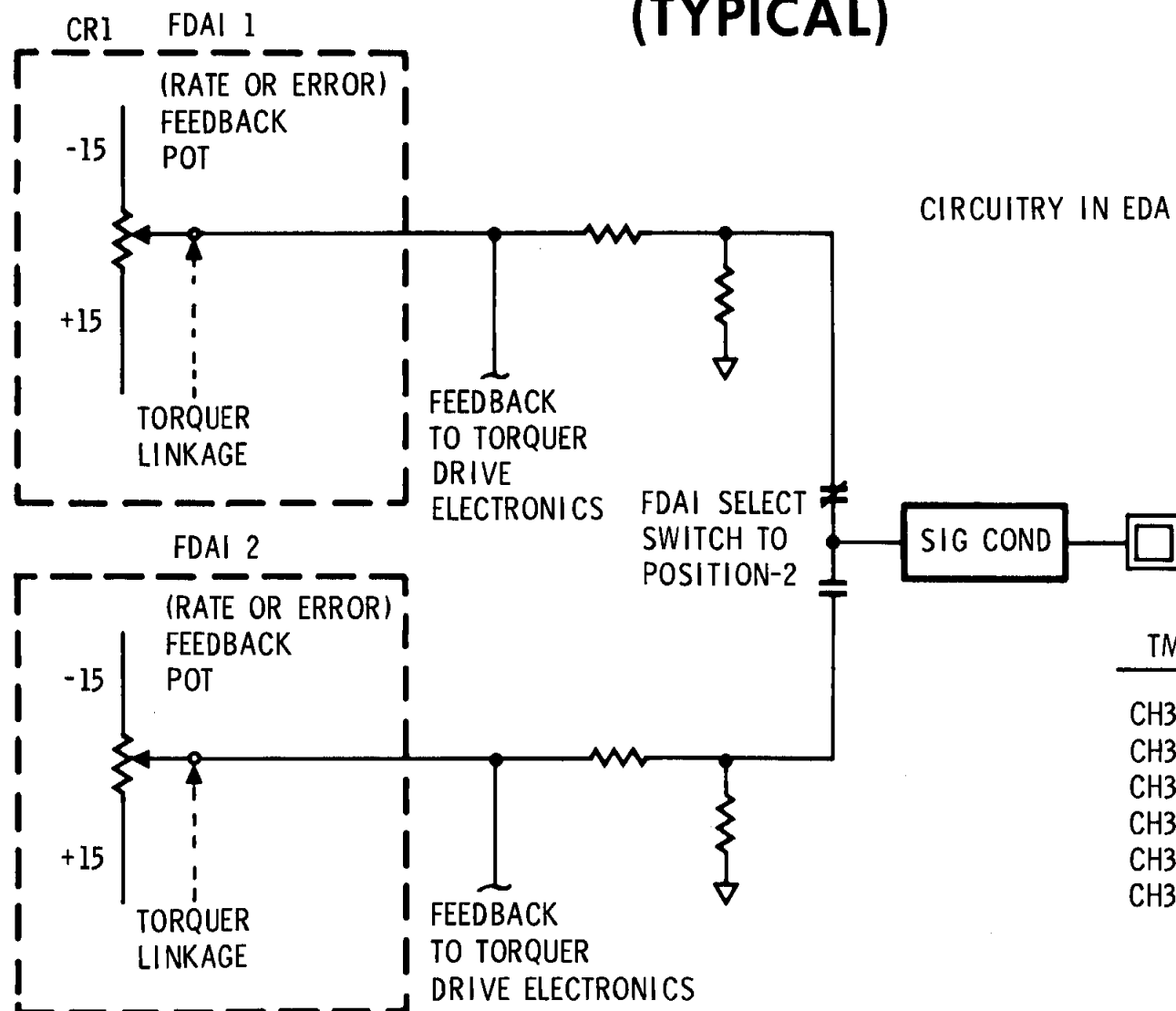
- (1) ATTITUDE AND ATTITUDE ERROR TO FDAI #1 FROM G&N AND TO FDAI #2 FROM THE SCS
 (2) DURING ENTRY, STABILITY ROLL ONLY IS SUPPLIED TO THE FDAI SELECTED AND TO THE ROLL STABILITY INDICATOR ON THE ENTRY MONITOR SYSTEM.
 (3) BMAG UNCAGE LOGIC MUST ALSO BE SATISFIED IN ADDITION TO SWITCHES SHOWN.
 (4) NECESSARY FOR CORRECT YAW DISPLAY DURING NON ENTRY MISSION PHASES.

CHART 1

SCS-2804B



RATE AND ATTITUDE ERROR TELEMETRY PICKOFF (TYPICAL)

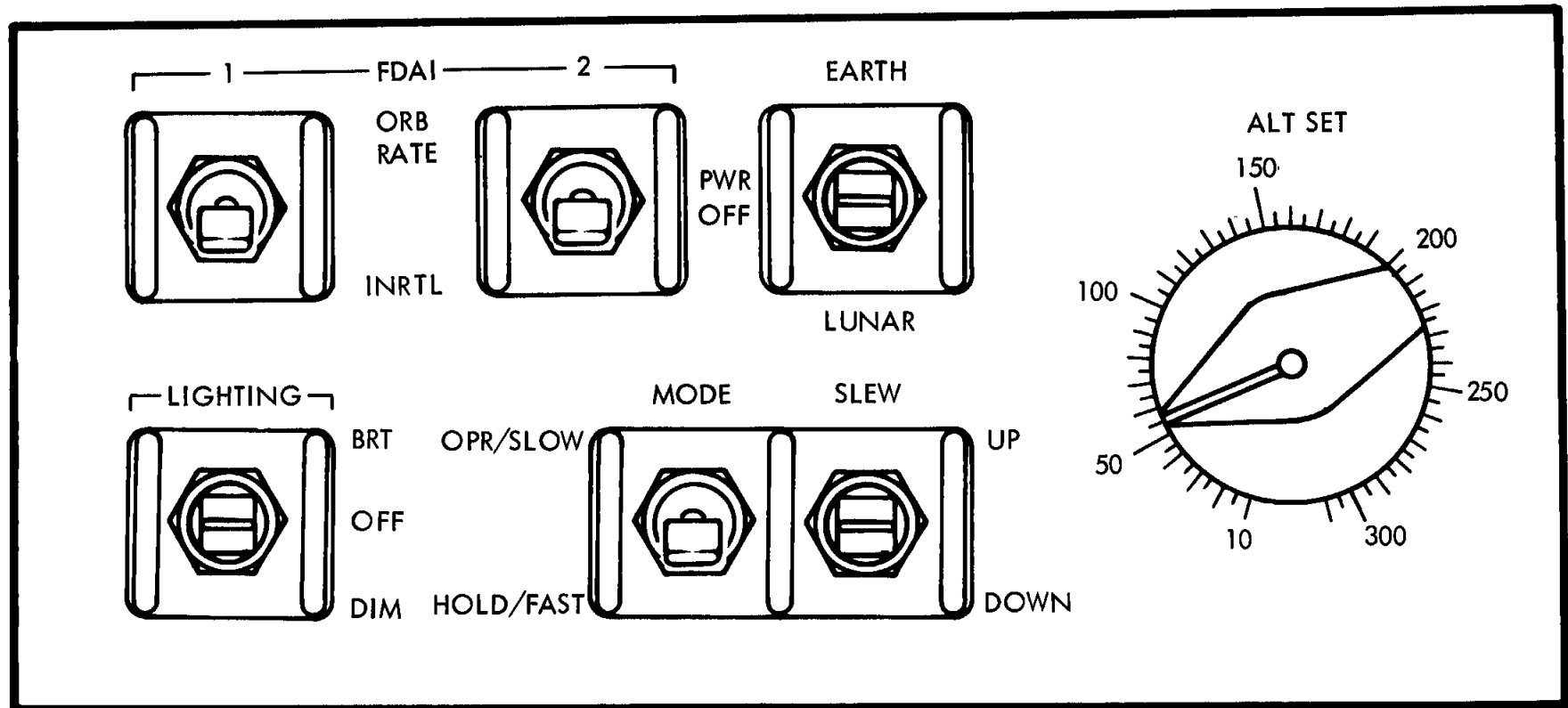


TM ID	S/C PARAMETER
CH3500V	ATTITUDE ERROR PITCH
CH3501V	ATTITUDE ERROR YAW
CH3502V	ATTITUDE ERROR ROLL
CH3503R	SCS BODY RATE PITCH
CH3504R	SCS BODY RATE YAW
CH3505R	SCS BODY RATE ROLL

SCS-2212A

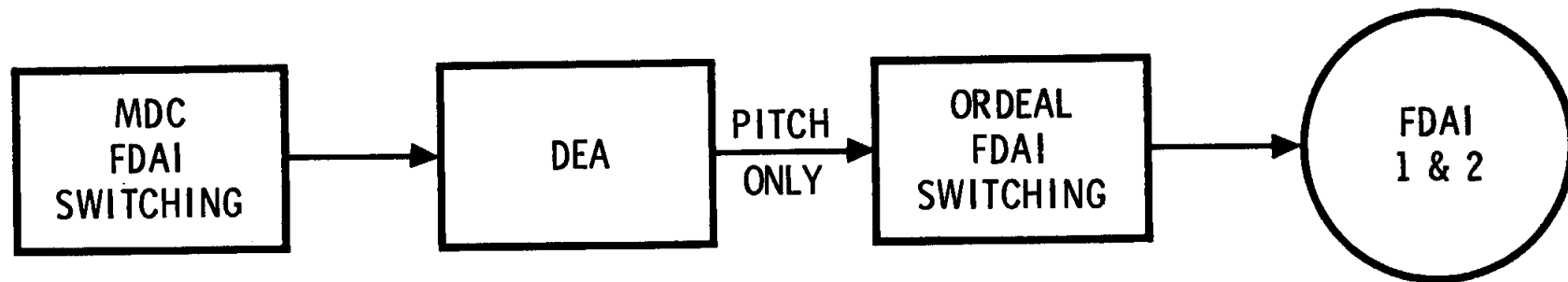


ORDEAL PANEL

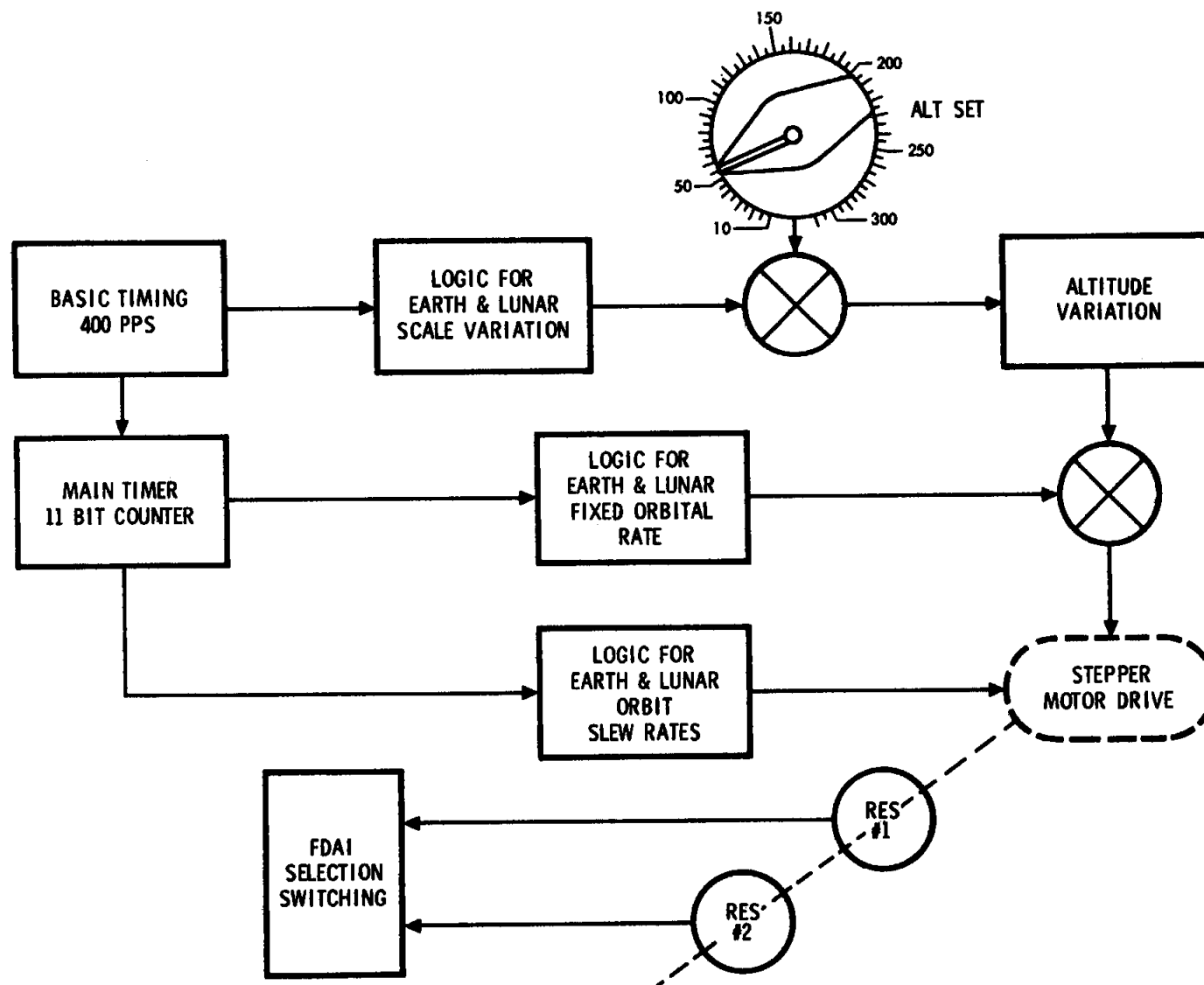


SCS-4000A 

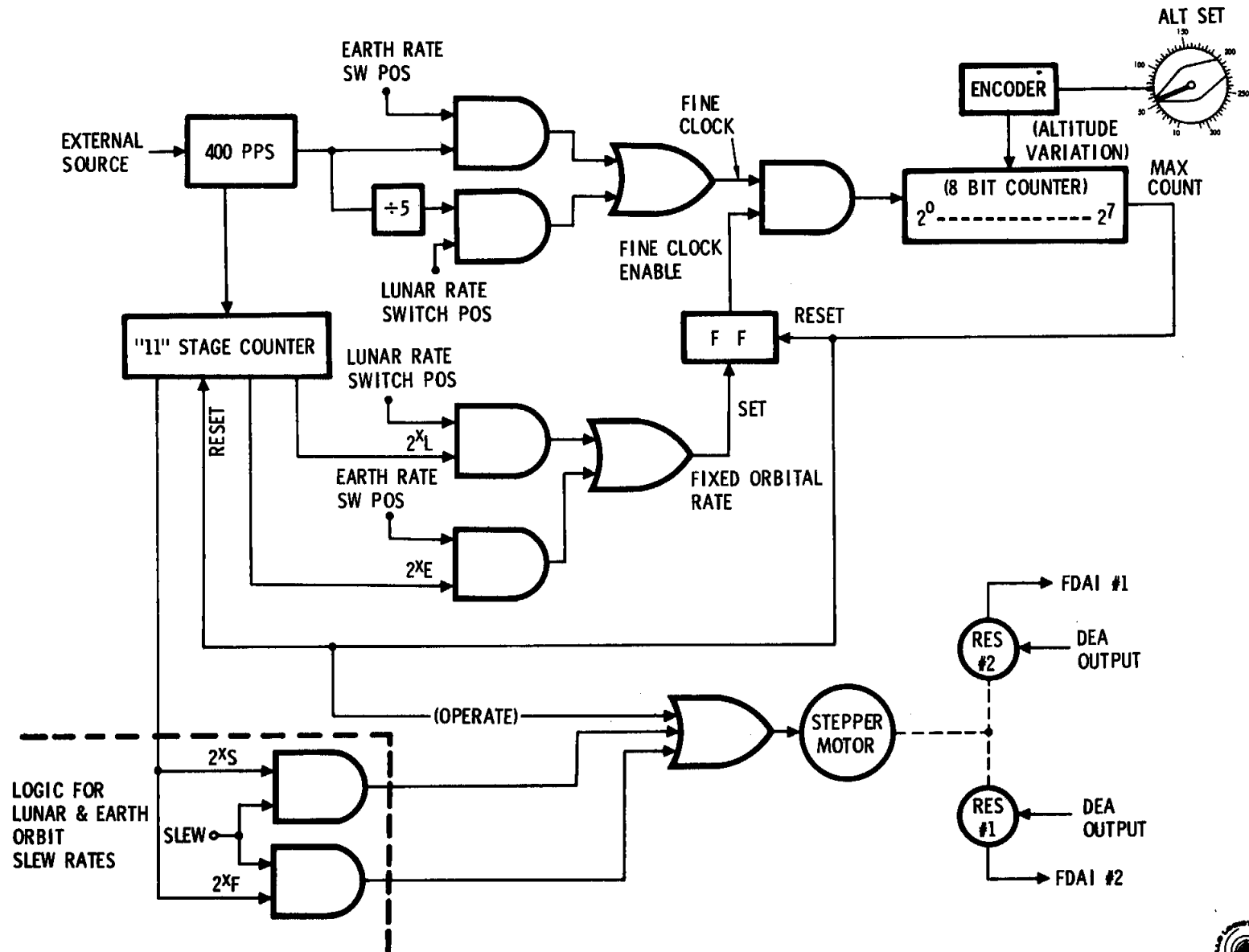
ORDEAL INTERFACE



ORDEAL FUNCTIONAL BLOCK DIAGRAM



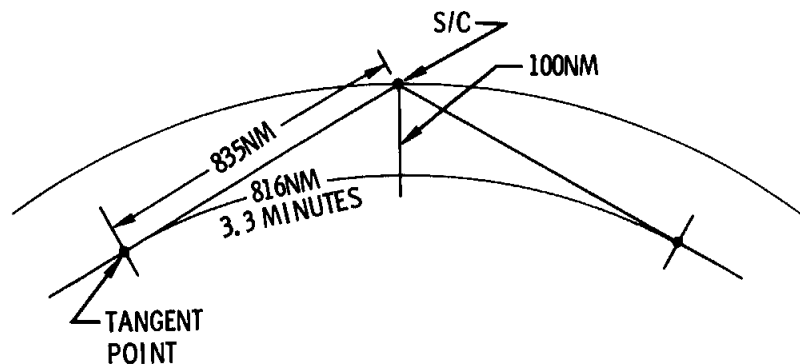
ORDEAL SIGNAL FLOW DIAGRAM



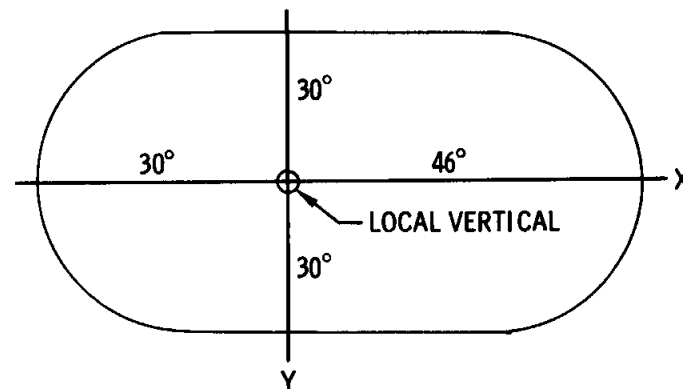
The diagram shows a sphere with several coordinate systems and trajectories. A vertical axis is labeled Z_I . A horizontal axis is labeled X_I . A third axis, pointing towards the bottom right, is labeled Y_I . A dashed line from the center to the sphere's surface is labeled YE . A shaded, curved band on the sphere's surface is labeled $CSM AT T_0$. Another shaded, curved band, slightly higher and further to the right, is labeled $CSM AT T_1$. A line from the center to the $CSM AT T_1$ band is labeled $LAT \& LONG$. A line from the center to the $CSM AT T_0$ band is labeled LAT . A line from the center to the $CSM AT T_1$ band is labeled $LONG$. A line from the center to the $CSM AT T_0$ band is labeled AZ . A line from the center to the $CSM AT T_1$ band is labeled YE . A line from the center to the $CSM AT T_0$ band is labeled Y_I . A line from the center to the $CSM AT T_1$ band is labeled XE . A line from the center to the $CSM AT T_0$ band is labeled $GREENWICH MERIDIAN$.

GNC-170 

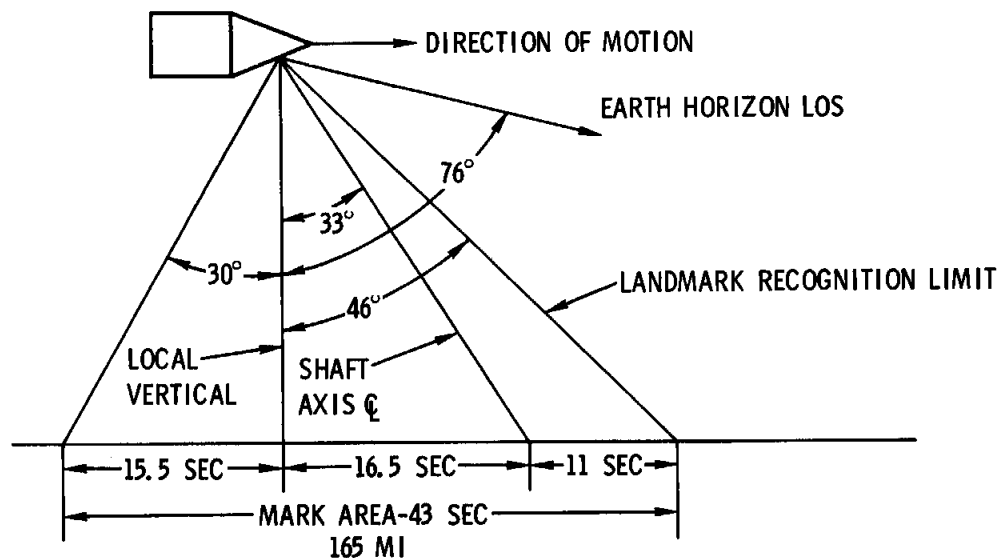
EARTH ORBIT NAVIGATION



EARTH ORBIT GEOMETRY FIGURE 1



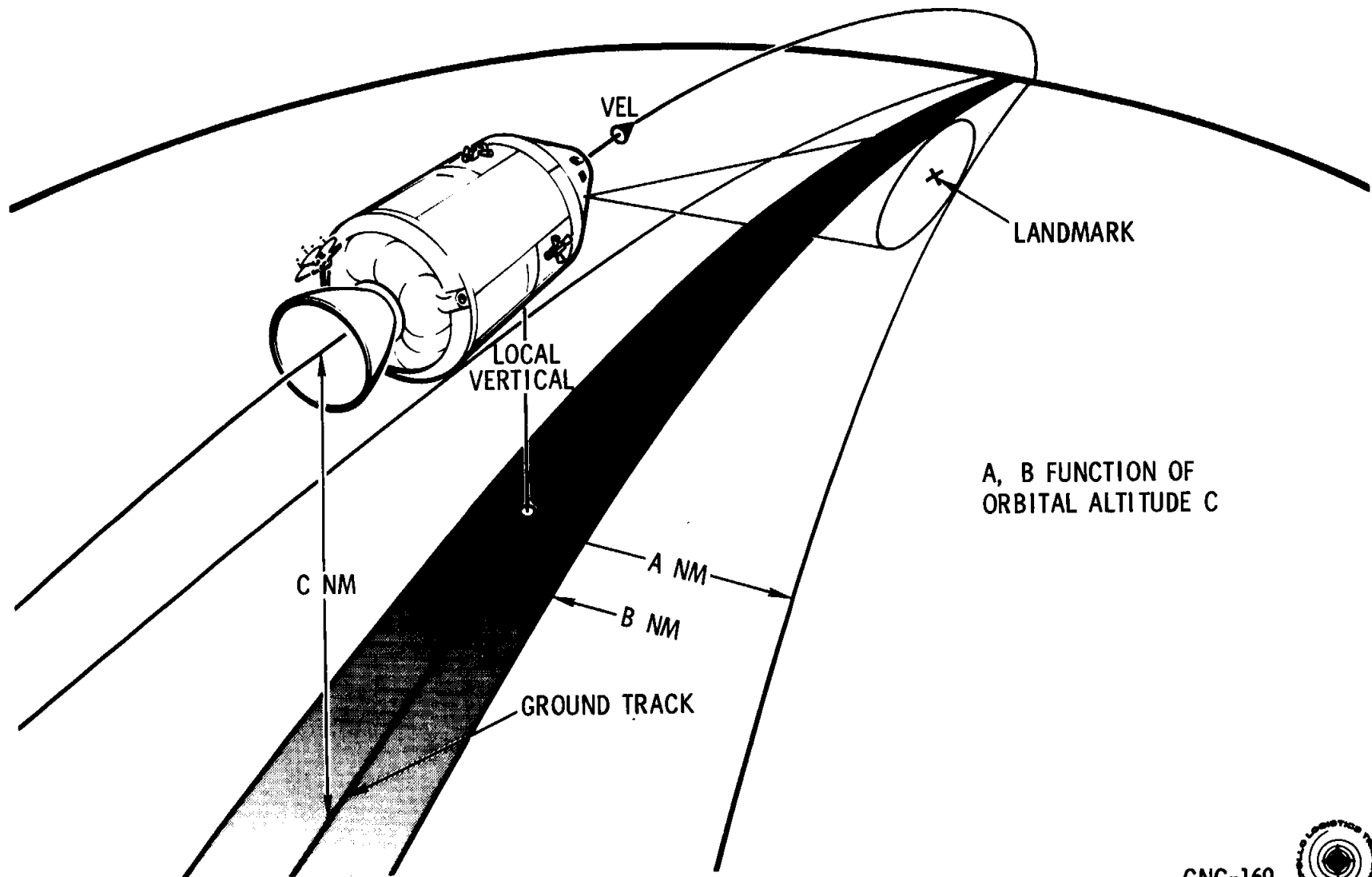
VIEW ON SURFACE FIGURE 3



COVERAGE ON SURFACE FIGURE 2



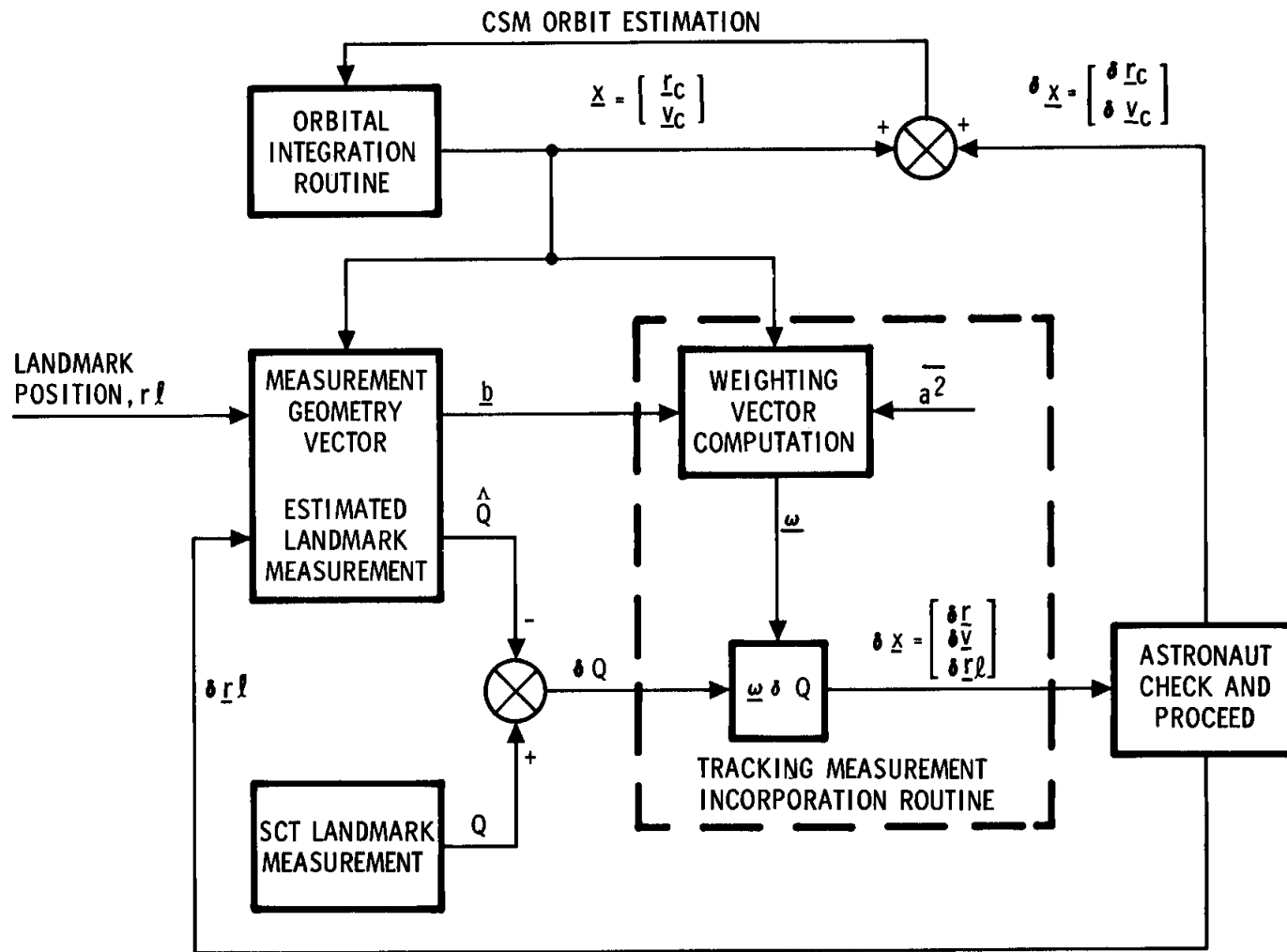
ORBITAL LANDMARK TRACKING



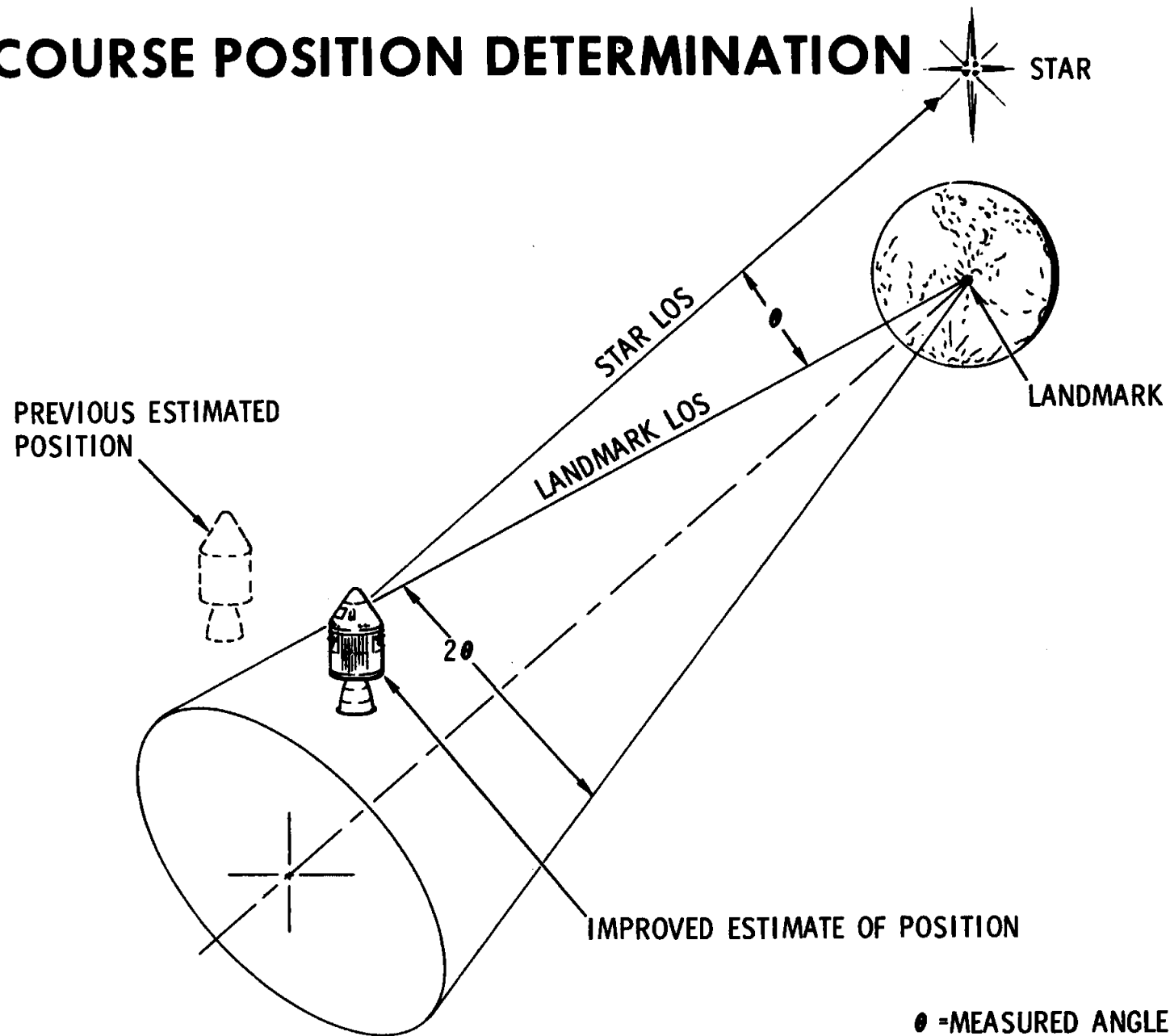
GNC-169



SIMPLIFIED ORBITAL NAVIGATION FUNCTIONAL DIAGRAM



MIDCOURSE POSITION DETERMINATION

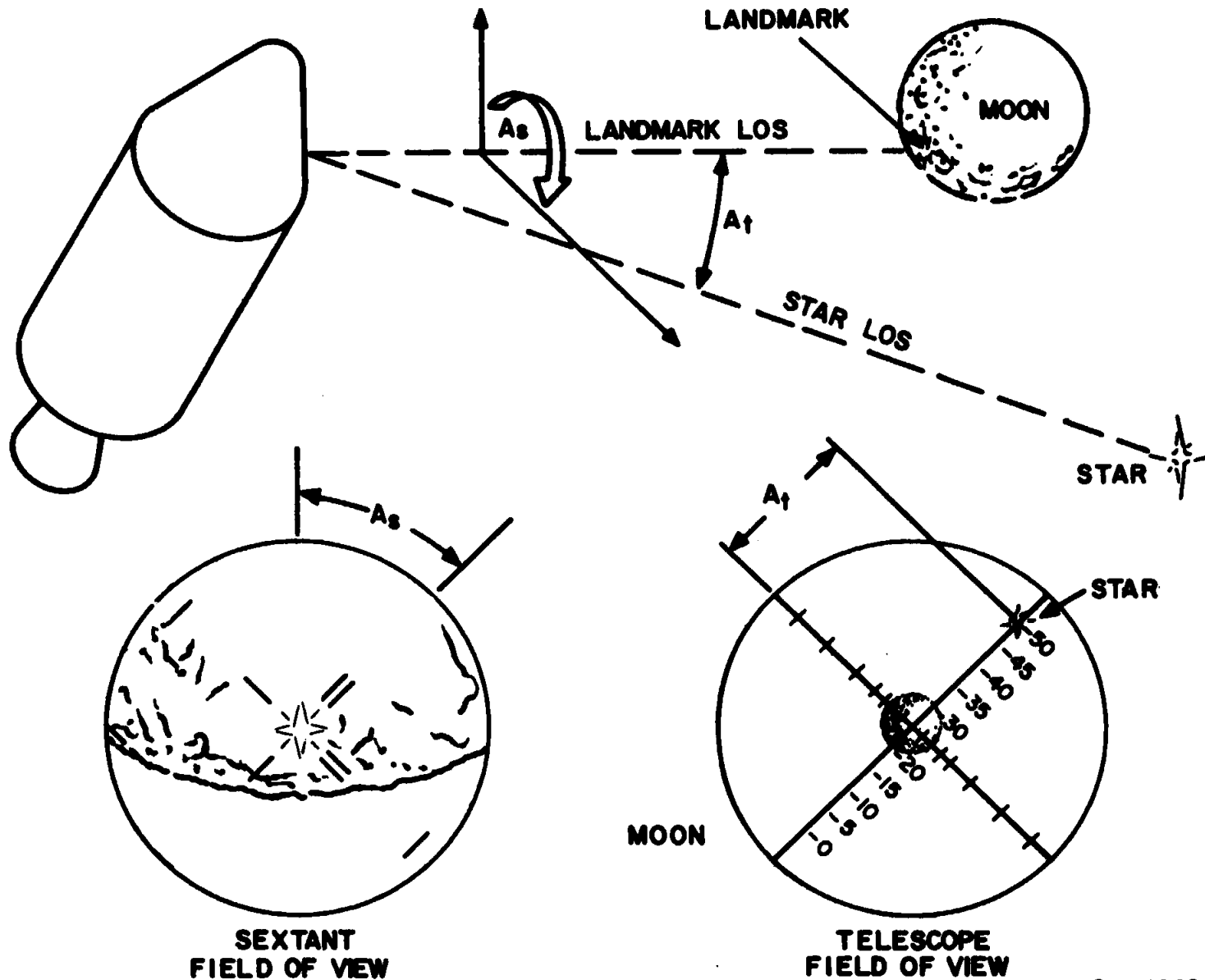


θ - MEASURED ANGLE

GN-9101A

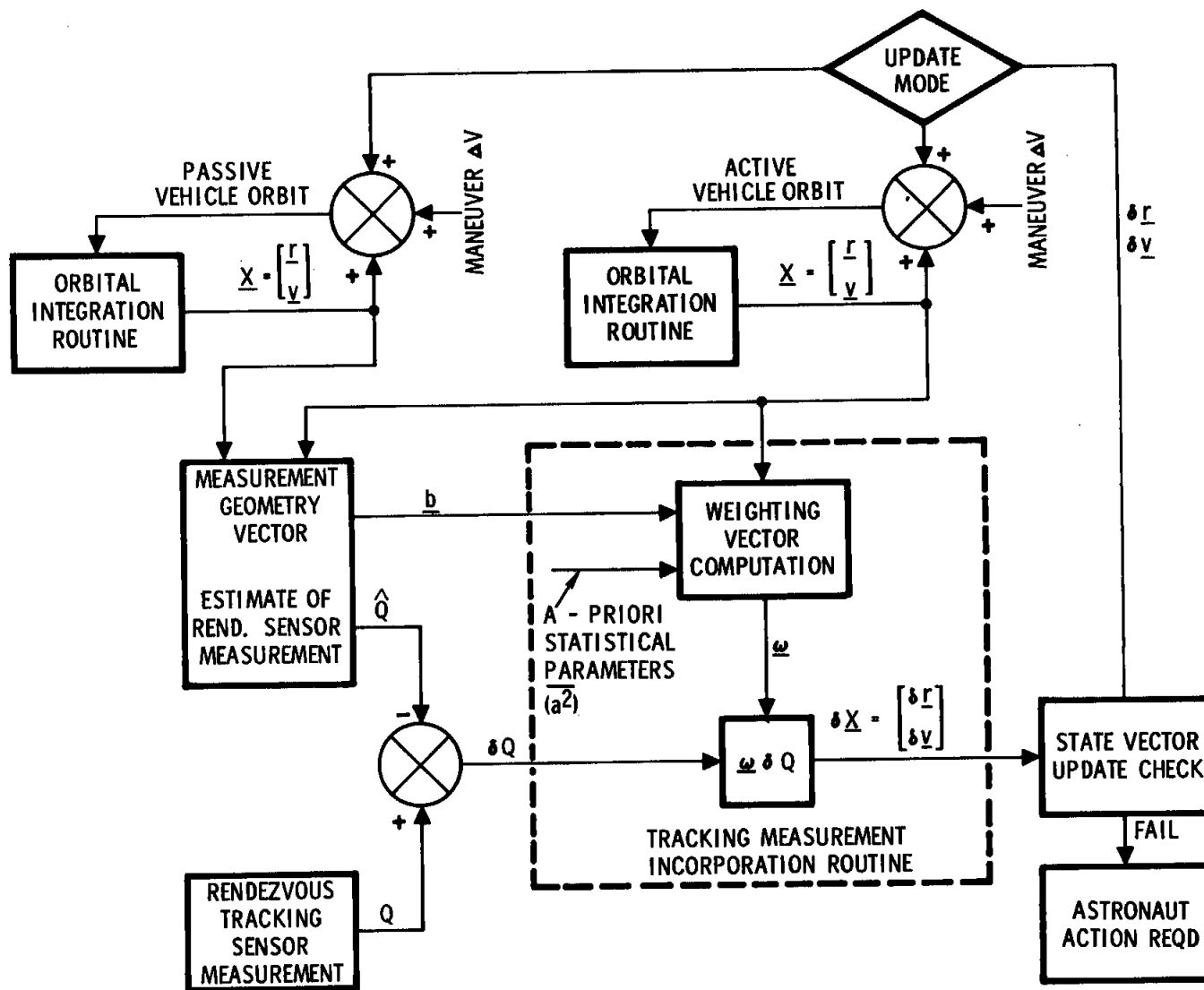


NAVIGATIONAL MEASUREMENT

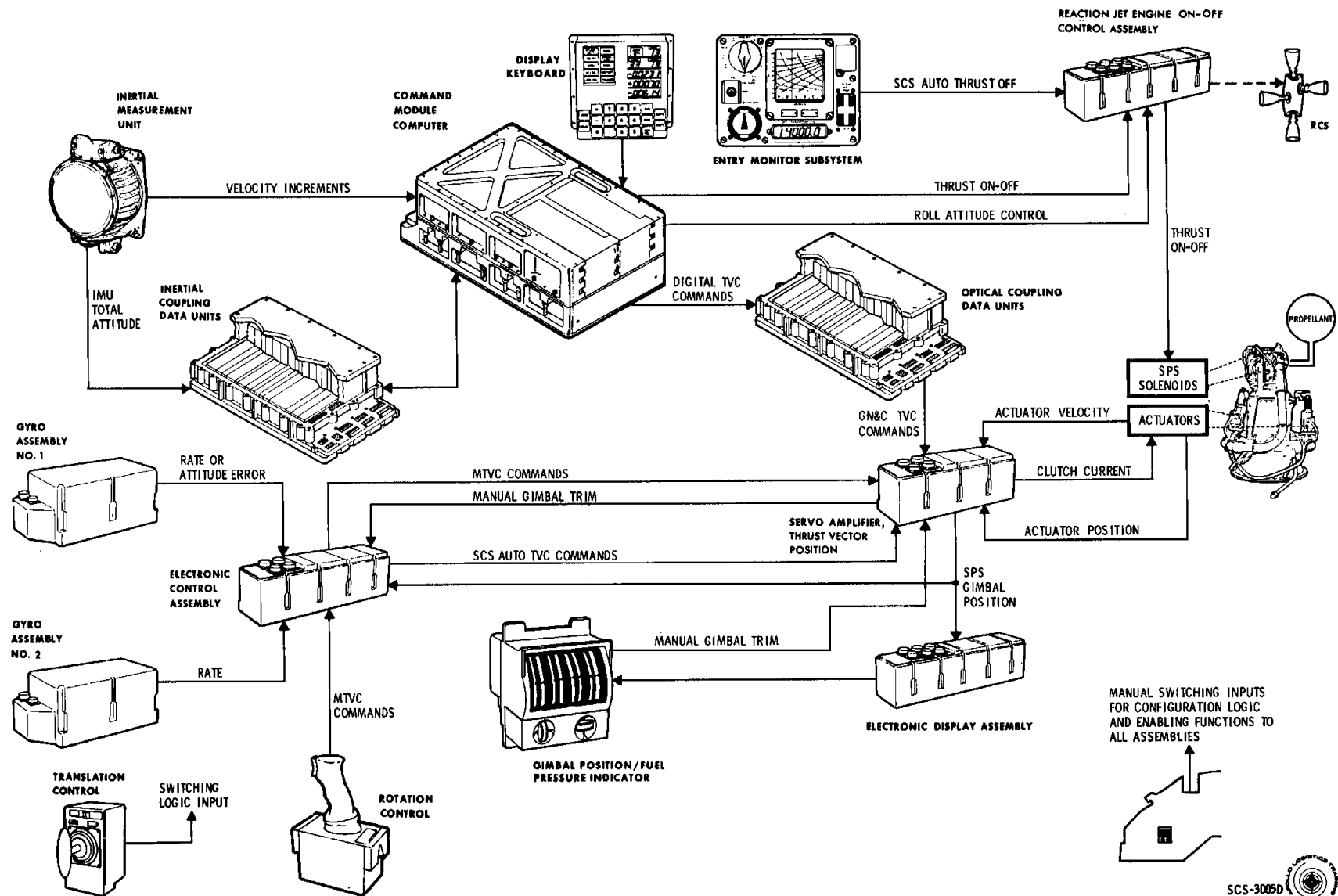


GN-9103B 

SIMPLIFIED CMC RENDEZVOUS NAVIGATIONAL FUNCTIONAL DIAGRAM

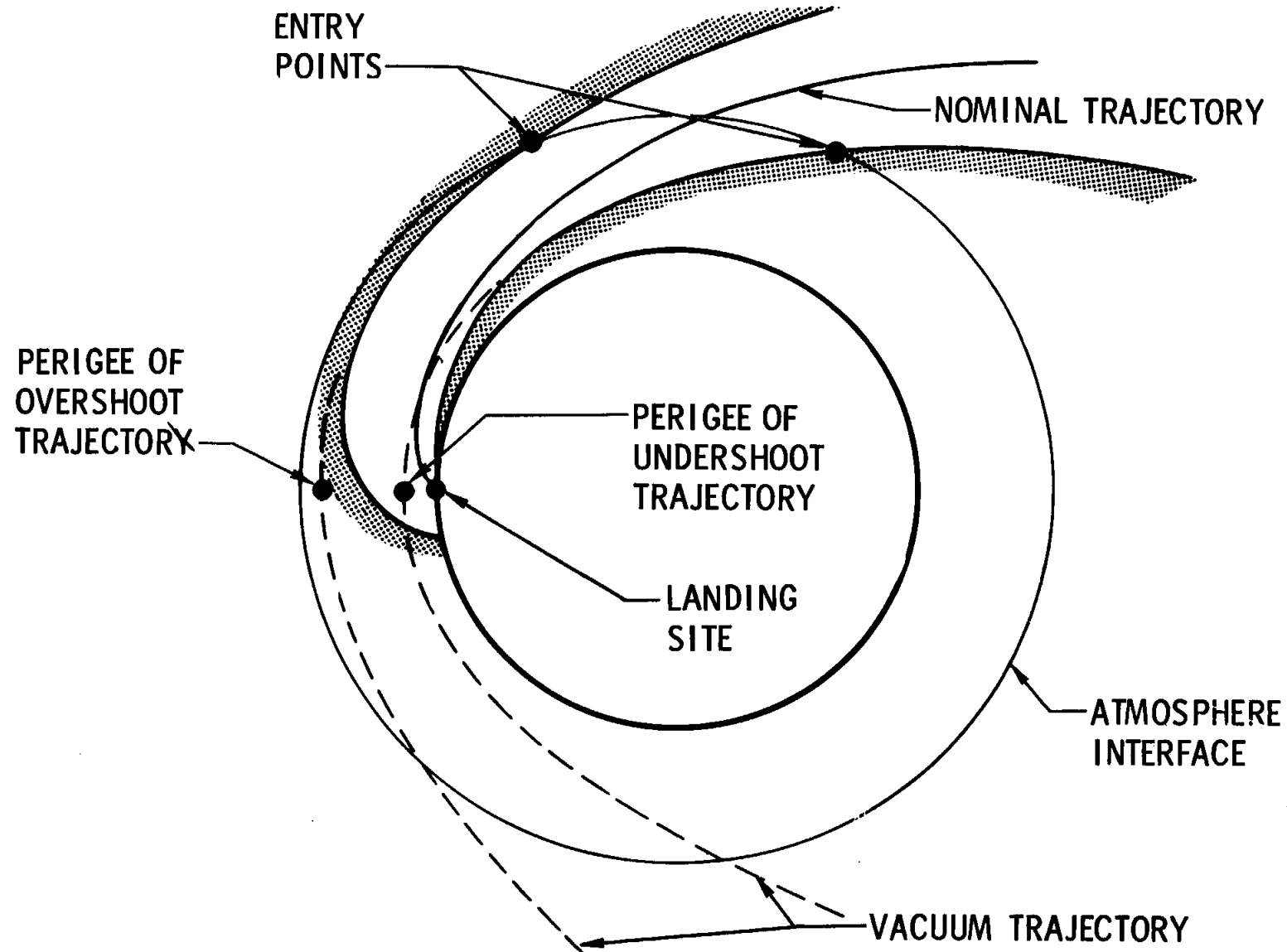


G & C THRUST VECTOR CONTROL



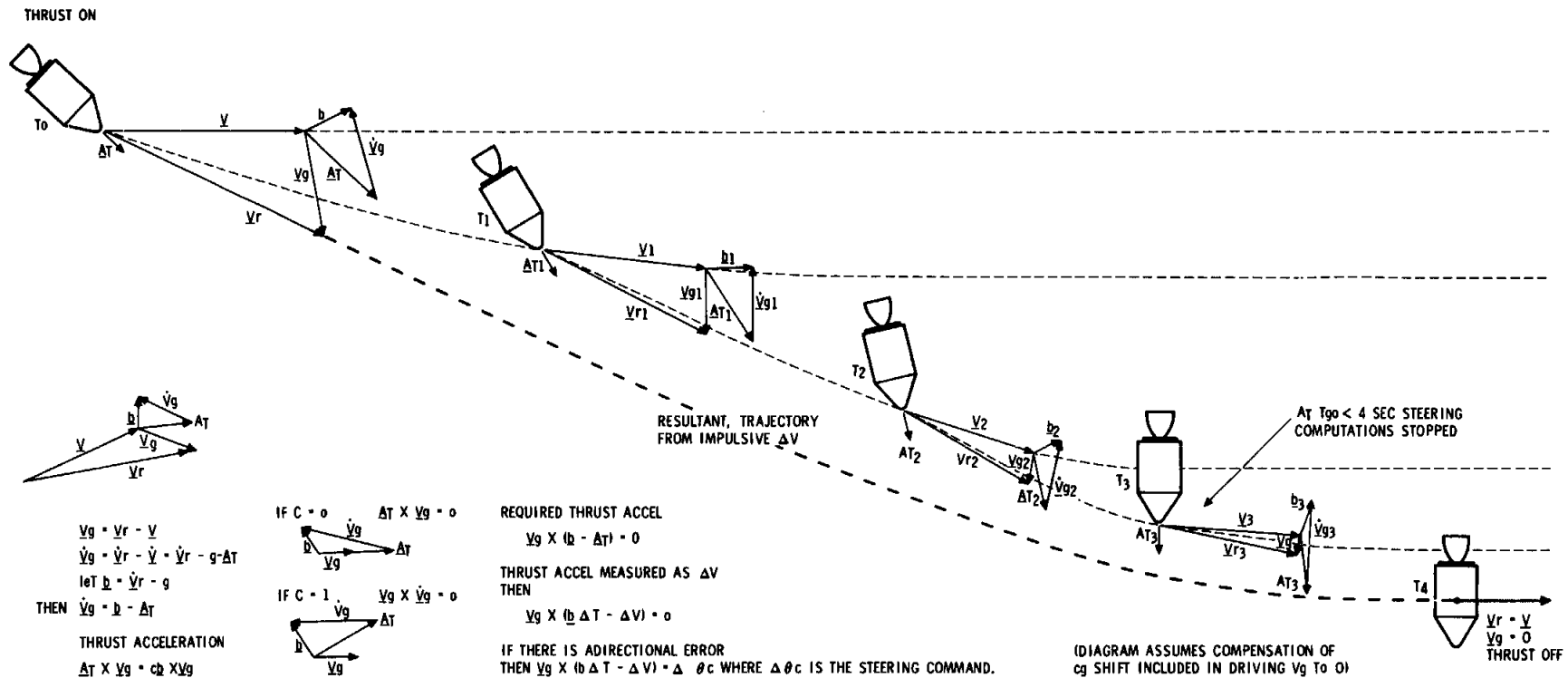
SCS-3005D

ENTRY BOUNDARIES

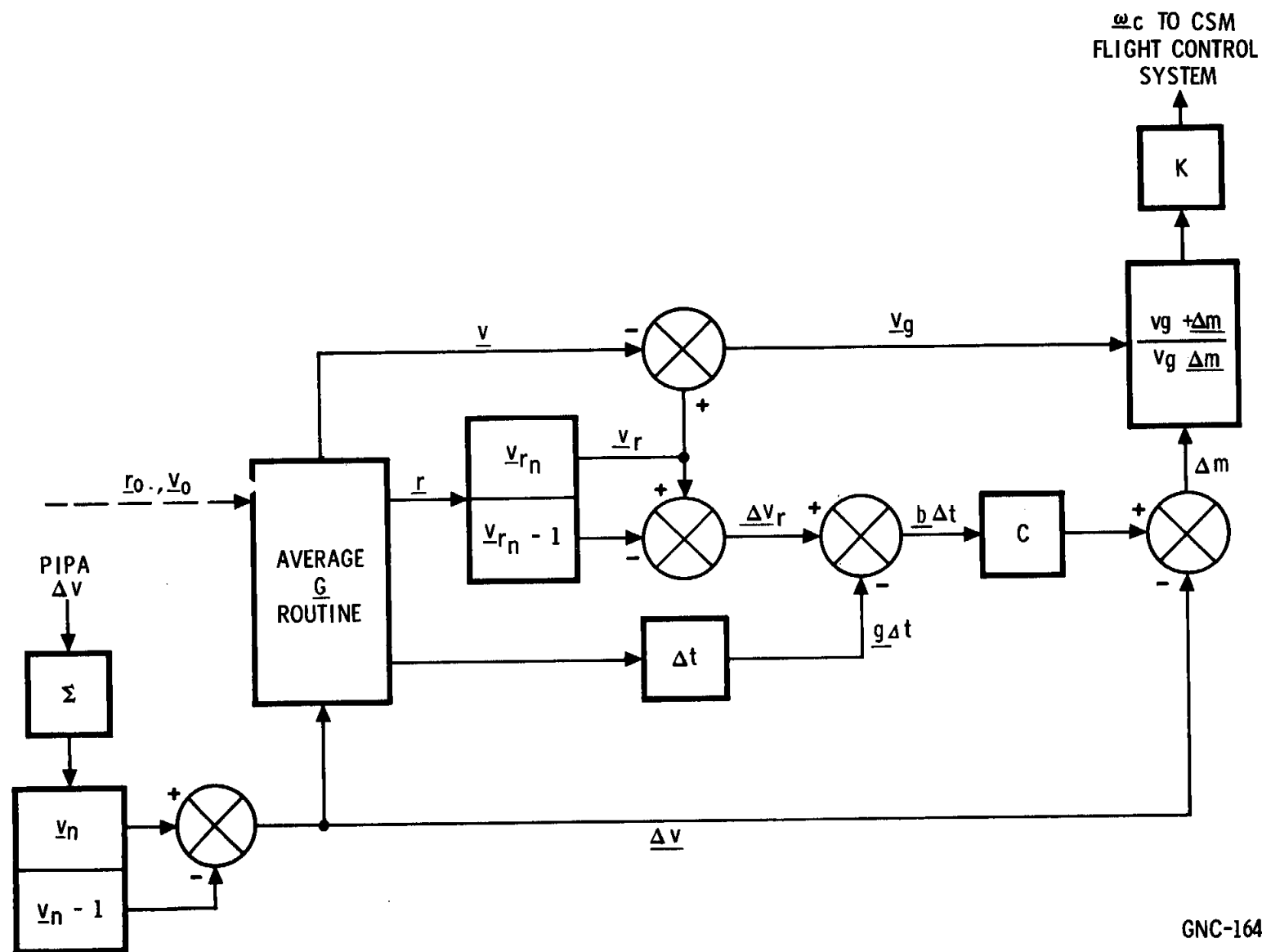


GN-205 A 

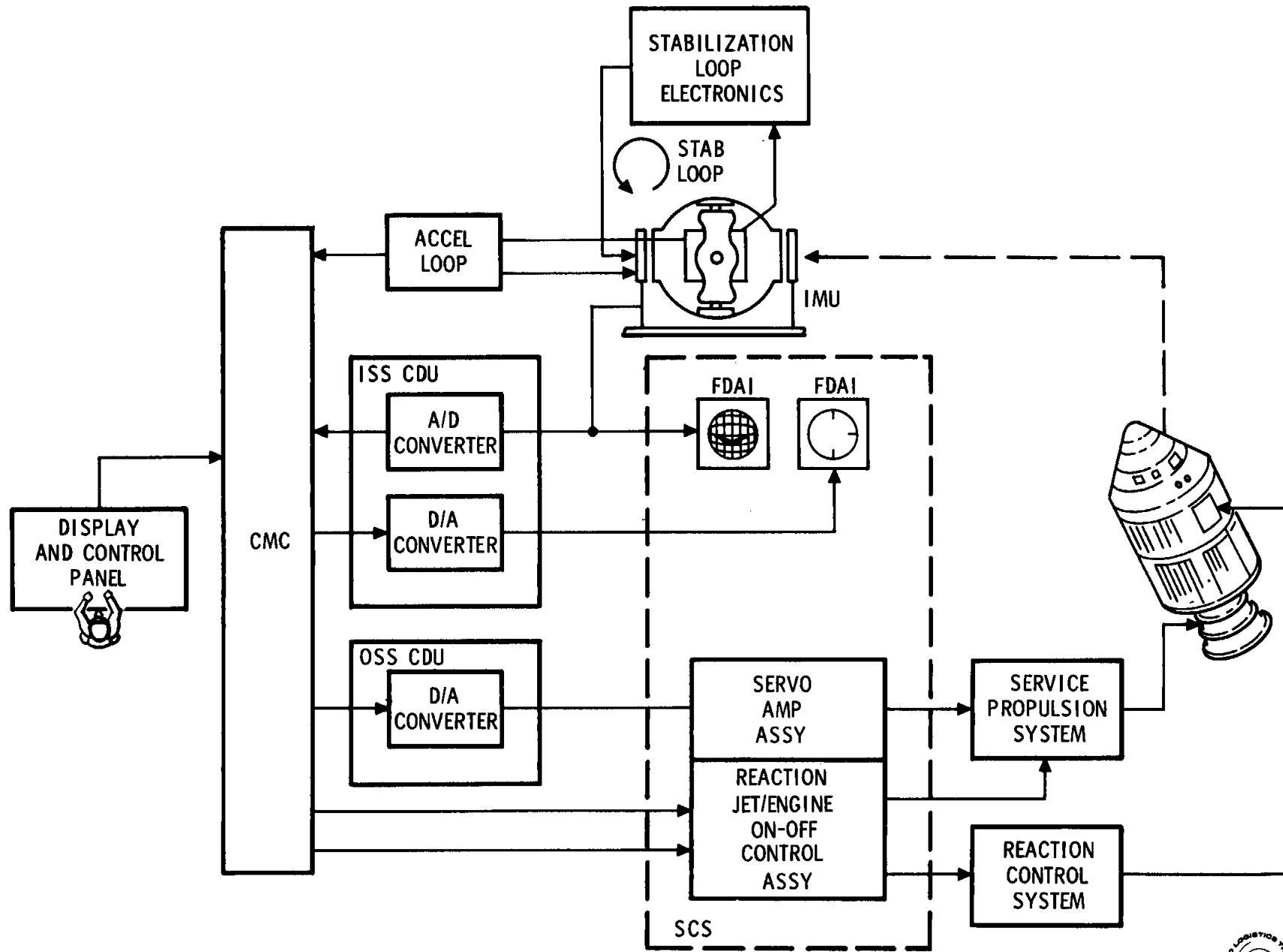
STEERING FOR ORBITAL MANUEVERS



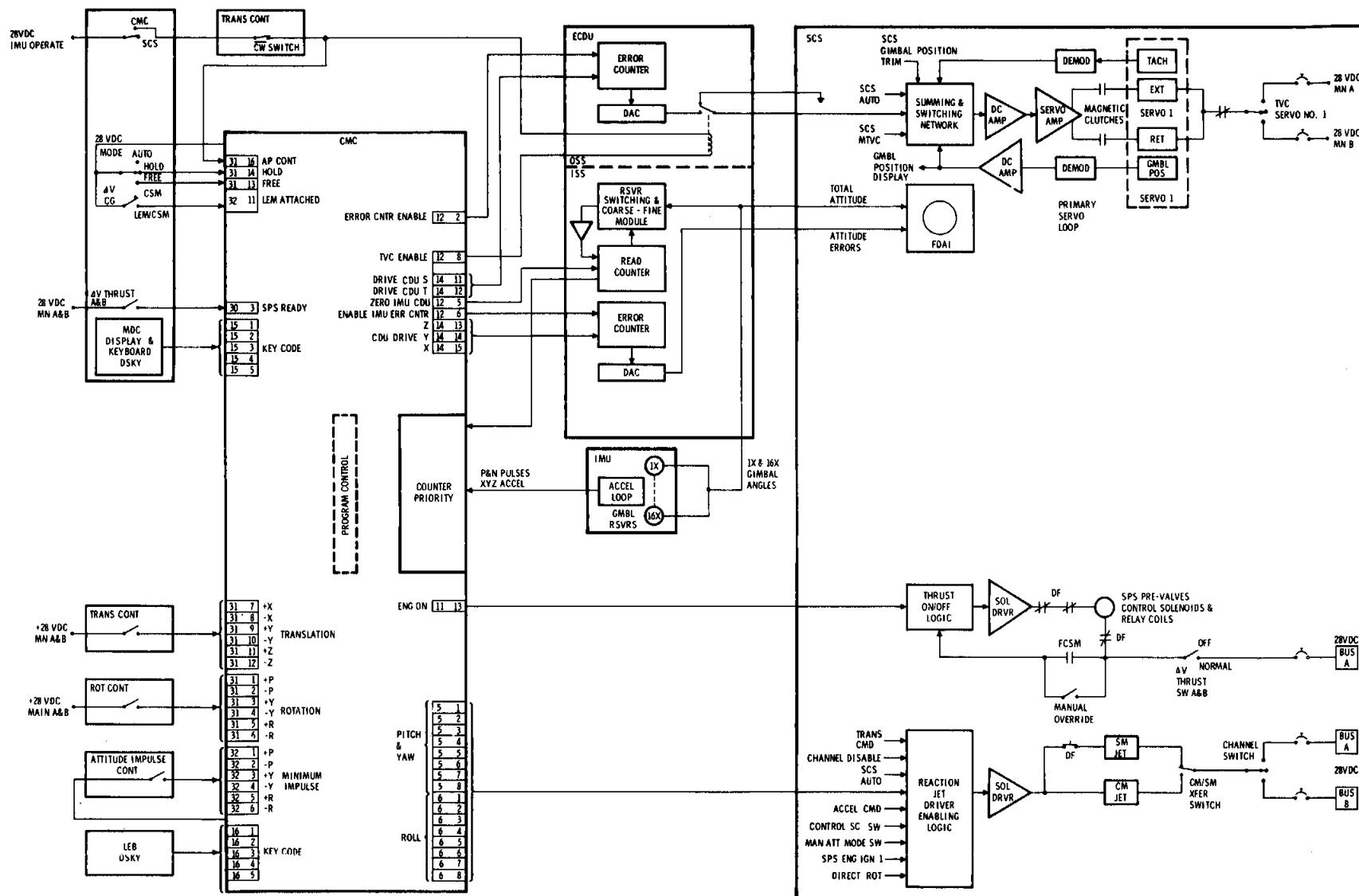
CMC POWERED FLIGHT STEERING BLOCK DIAGRAM



THRUST VECTOR CONTROL



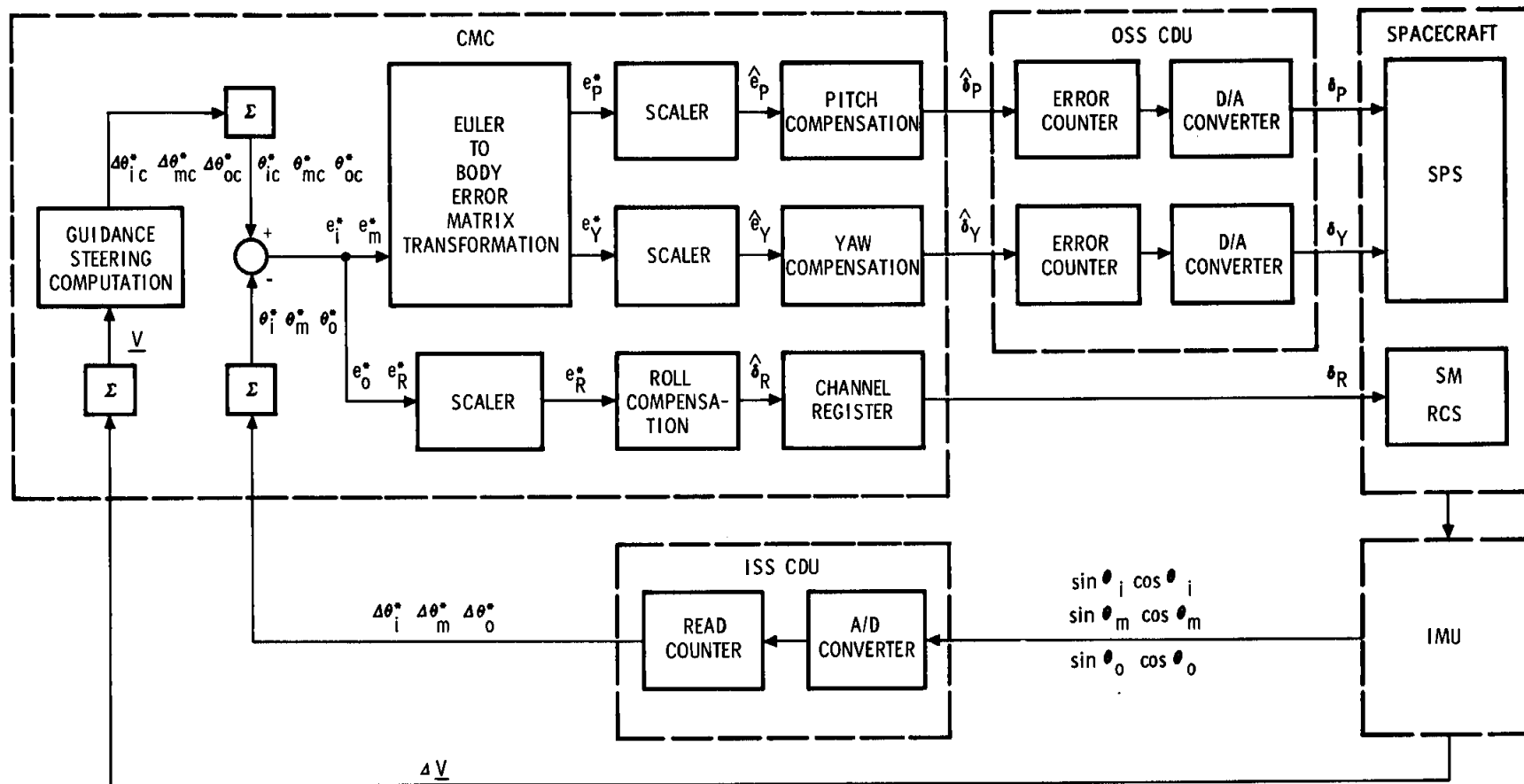
TVC FUNCTIONAL BLOCK DIAGRAM



GNC-187

TVC DAP

SIMPLIFIED BLOCK DIAGRAM



LEGEND:

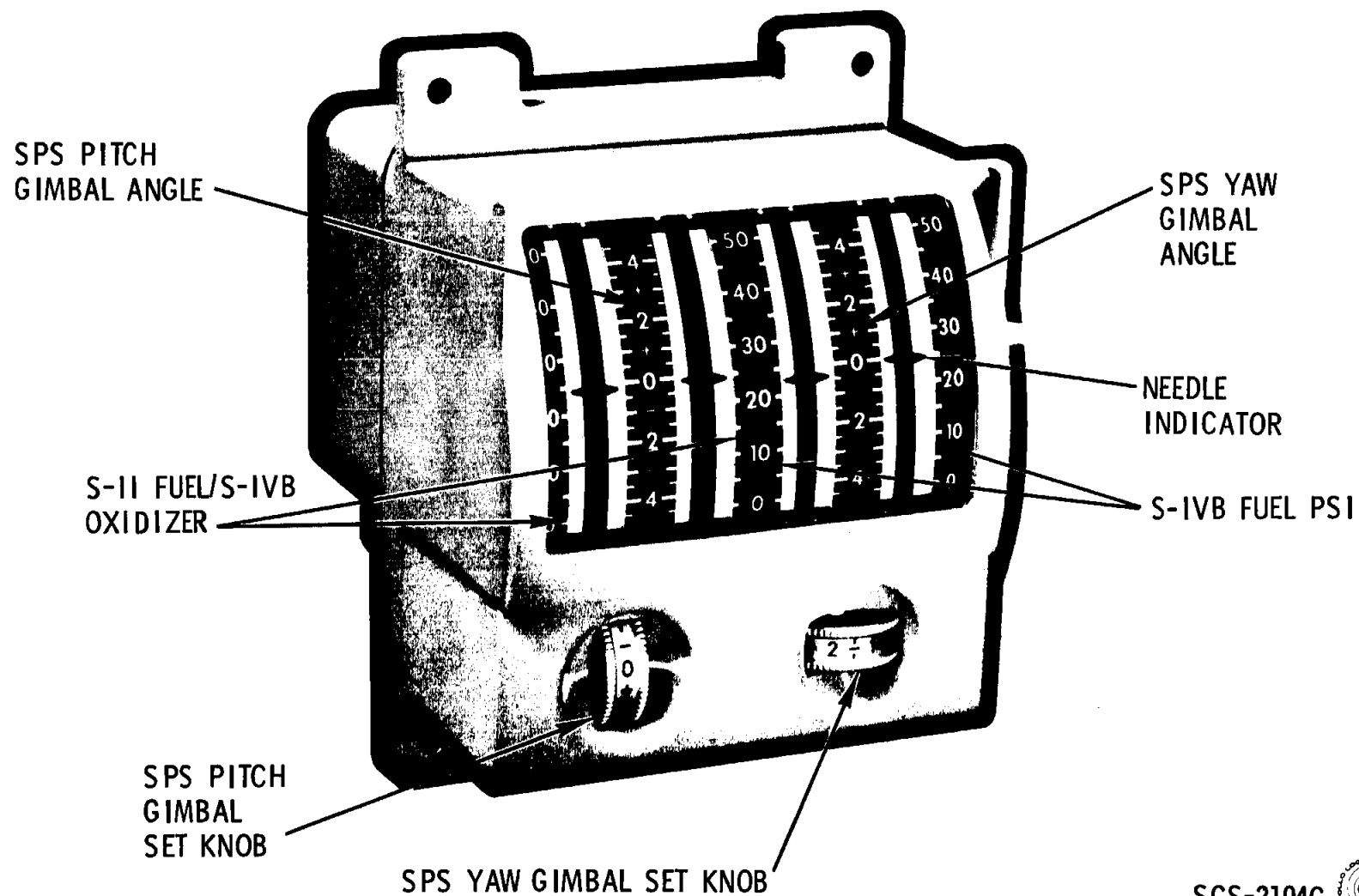
$\theta_i \ \theta_m \ \theta_o$ IMU GIMBAL ANGLES: INNER, MIDDLE AND OUTER.
 $\theta_{ic} \ \theta_{mc} \ \theta_{oc}$ IMU GIMBAL-ANGLE COMMANDS: INNER, MIDDLE AND OUTER.
 $e_i \ e_m \ e_o$ GIMBAL-ANGLE ERRORS: INNER, MIDDLE AND OUTER.

$e_p \ e_y \ e_R$ SPACECRAFT ATTITUDE ERRORS: PITCH, YAW AND ROLL.
 $\delta_p \ \delta_y$ PITCH-AND YAW-CHANNEL SPS GIMBAL-ANGLE COMMANDS.
 δ_R ROLL-CHANNEL SM RCS ENGINE "ON-OFF" COMMANDS.

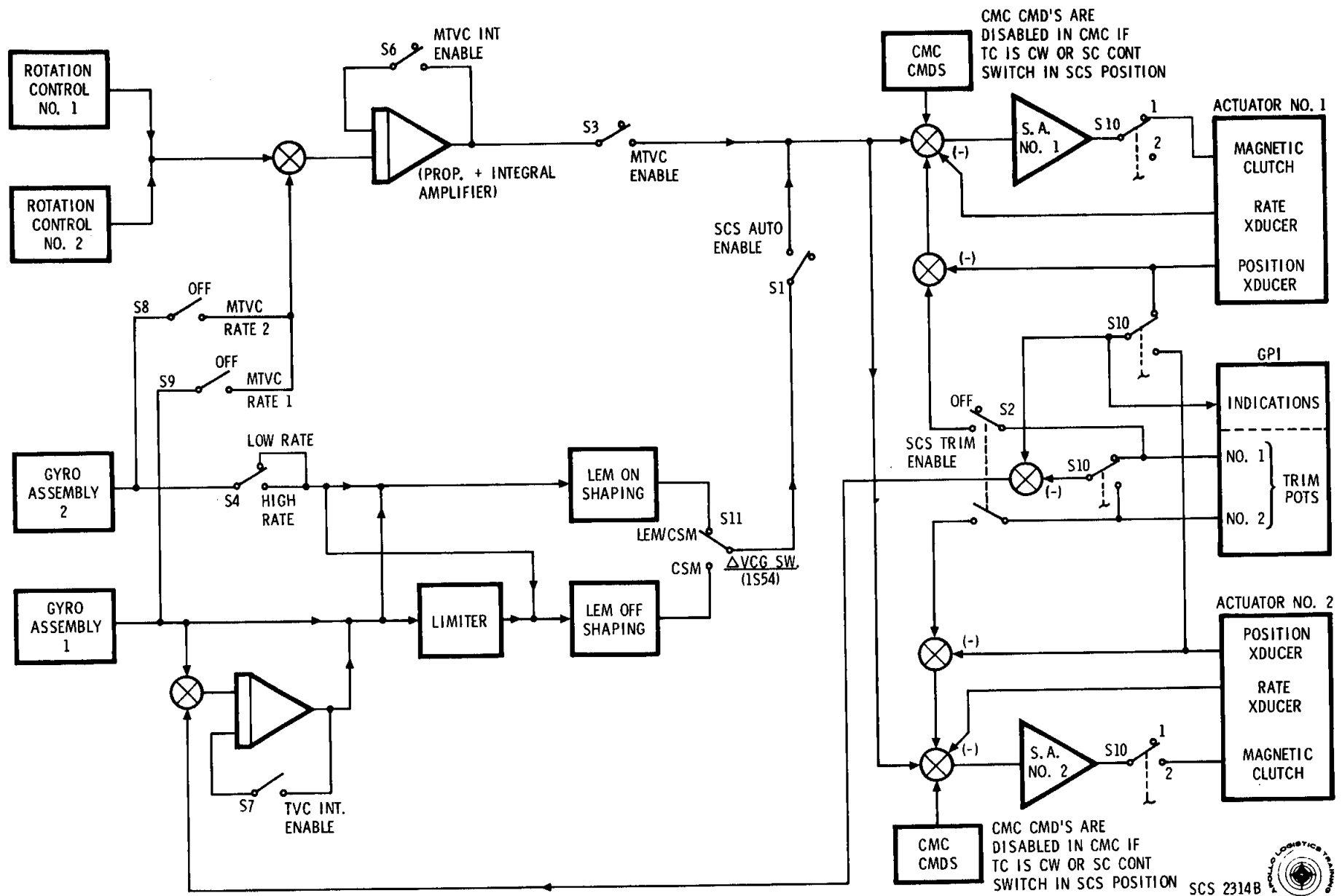
GNC-161B



FUEL PRESSURE/GIMBAL POSITION INDICATOR



THRUST VECTOR CONTROL-SIGNAL FLOW

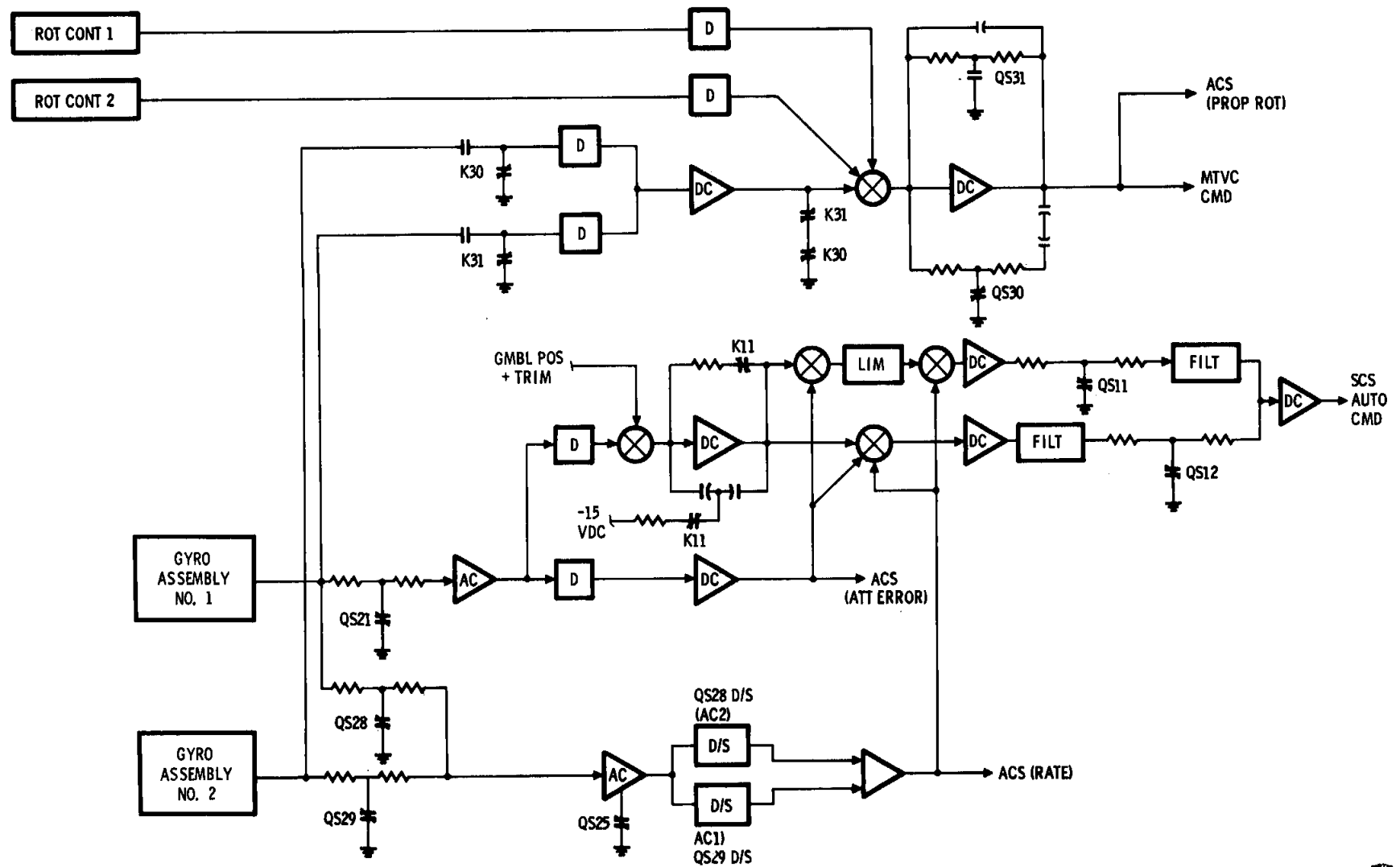


TVC FUNCTION ENABLING LOGIC

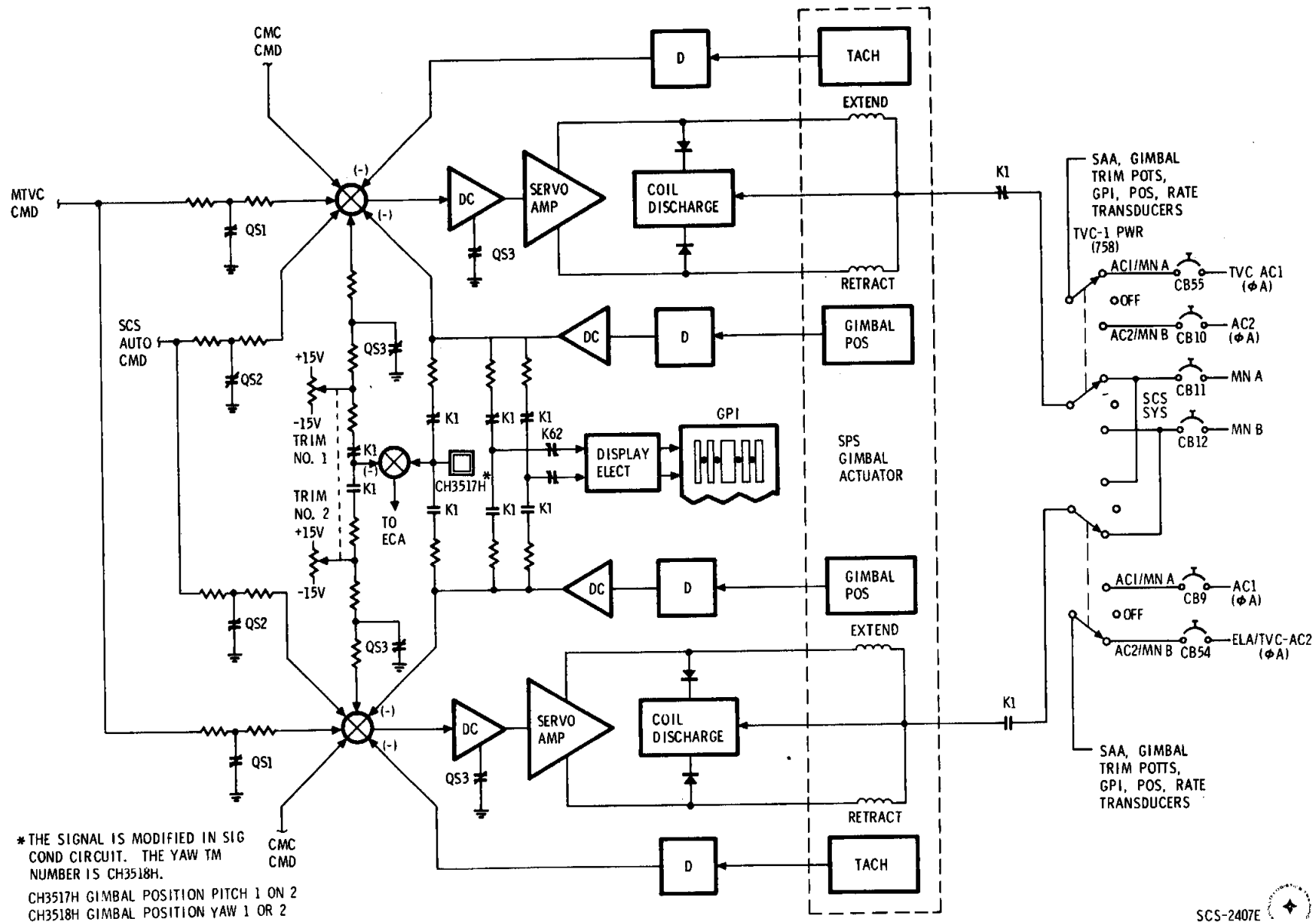
SYSTEM CONFIGU- RATION	FUNCT SW. /POSITION SWITCH POS.		PANEL SWITCHING AND LOGIC FOR ENABLING FUNCTIONAL SWITCH POSITION															
			SC CONT (1S18)		BMAG MODE (1S21 OR 1S22)		SPSTVC (1S38 OR 1S39)		TVC GMBL DR (1S27 OR 1S28)			XLATION CONTROL		FAIL SENSE (P OR Y)				
			SCS	CMC	RATE 2	ATT 1/ RATE 2	RATE 1	AUTO	RATE CMD	ACCEL CMD	1	AUTO	2	CW	CW	FS	FS	IGN 2
SCS AUTO TVC (1)	S1	SCS AUTO ENABLE	X			(2)		X						X				X
				X				X						X			X	
		S2	SCS TRIM ENABLE	X											X			
				X														
		S4 (3)	HIGH RATE															X(3)
	S7	TVC INT. ENABLE	X															X
				X										X			X	
COMMON FUNCTION	S3	MTVC ENABLE	X						X OR X									
			X					X						X				
				X					X OR X					X				
	S6	MTVC INT. ENABLE	SWITCH POSITIONS ARE SAME AS FOR S3 BUT LOGIC REQUIRES 'IGN 2' SIGNAL															
M T V C RATE CMD	S8 OR S9	MTVC RATE 2	X		X OR X				X									X
			X		X OR X			X						X			X	
				X	X OR X				X					X			X	
		MTVC RATE 1	SWITCH POSITIONS ARE SAME AS FOR S8 EXCEPT BMAG MODE SWITCH MUST BE IN RATE 1 POSITION															
	ACCEL CMD	S8 AND S9 OFF								X								
SERVO NO. 1	S10	1									X							
SERVO NO. 2	S10	2																
												X			X			
												X						X

- (1). FUNCTIONAL SWITCH -S11- REPRESENTS Δ VCG SW. (1S54). SELECTS LEM ON OR LEM OFF SHAPING CIRCUITS.
- (2). FOR SCS AUTO BMAG MODE SWITCH MUST BE IN ATT 1/RATE 2 POSITION, HOWEVER, ENABLING LOGIC DOES NOT REQUIRE THIS.
- (3). SWITCH S4 POSITION IS ALSO CONTROLLED BY RATE SWITCH (1S12). IF (1S12) IS IN "LOW" POSITION, THEN, PRIOR TO IGN 2 RATE SIGNALS ARE SHAPED THROUGH HIGH GAIN CIRCUITRY, (THIS IS NOT SHOWN IN SCS 2314 DWG BECAUSE THE SIGNALS ARE NOT SWITCHED (FCT SW S1) INTO SERVO AMP UNTIL IGN 2).

SCS TVC ELECTRONICS (PITCH)

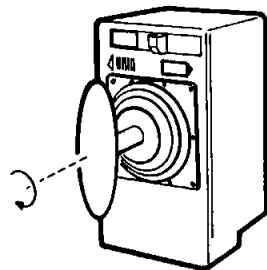
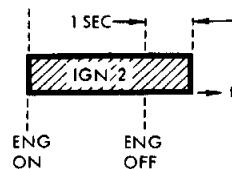
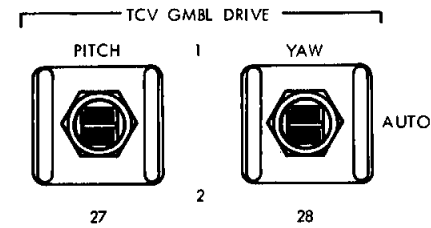
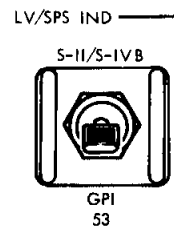
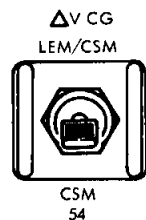
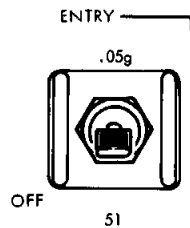
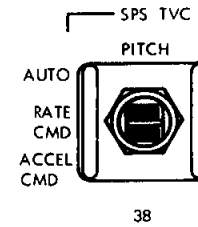
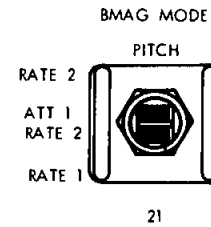
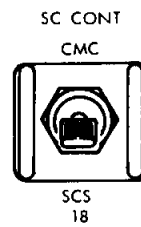
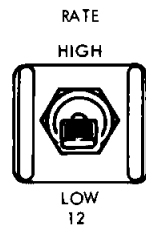
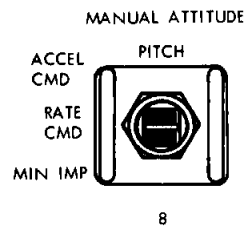


SPS SERVO ELECTRONICS (PITCH)



TVC LOGIC

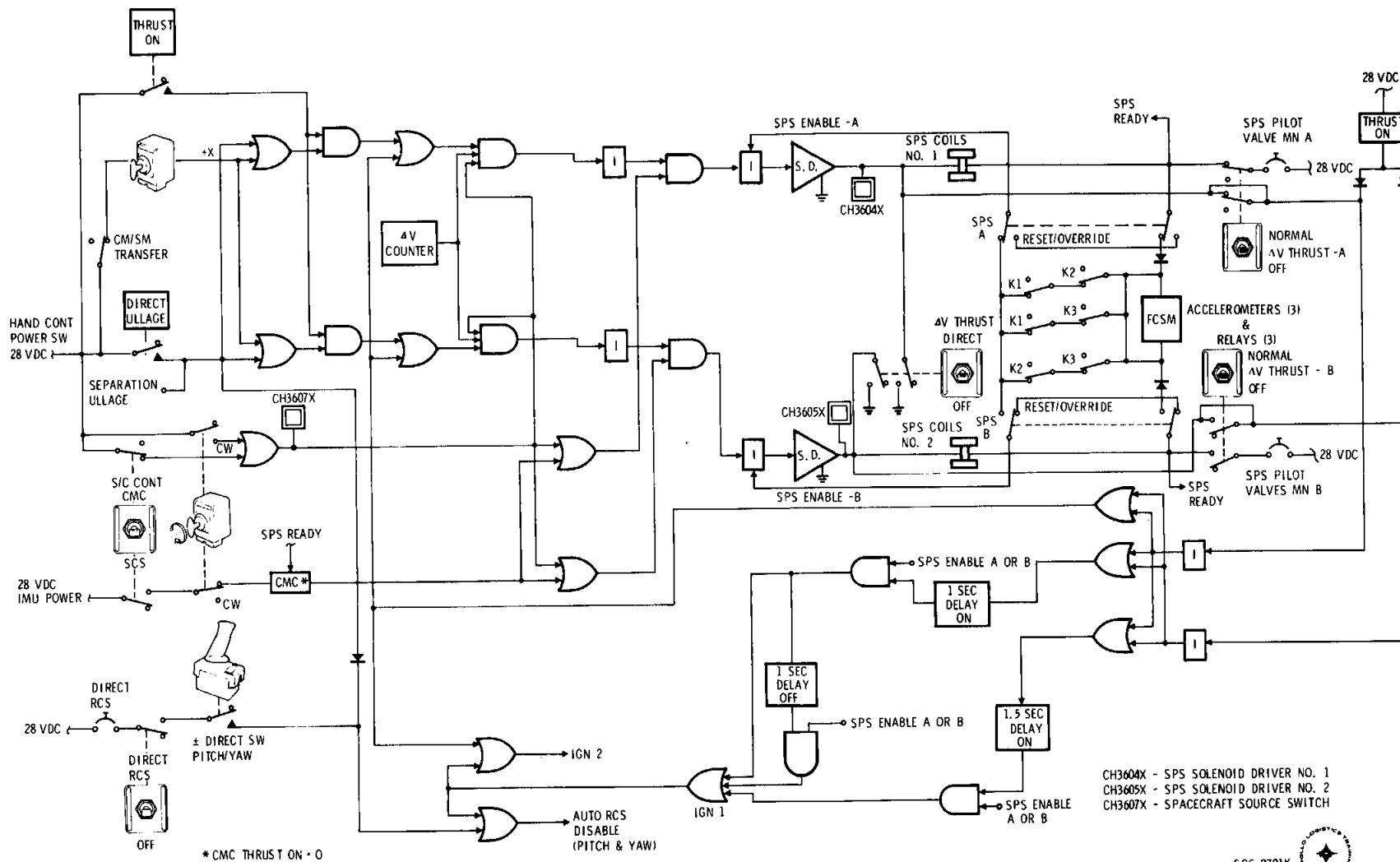
(SCS TVC ELECTRONICS)



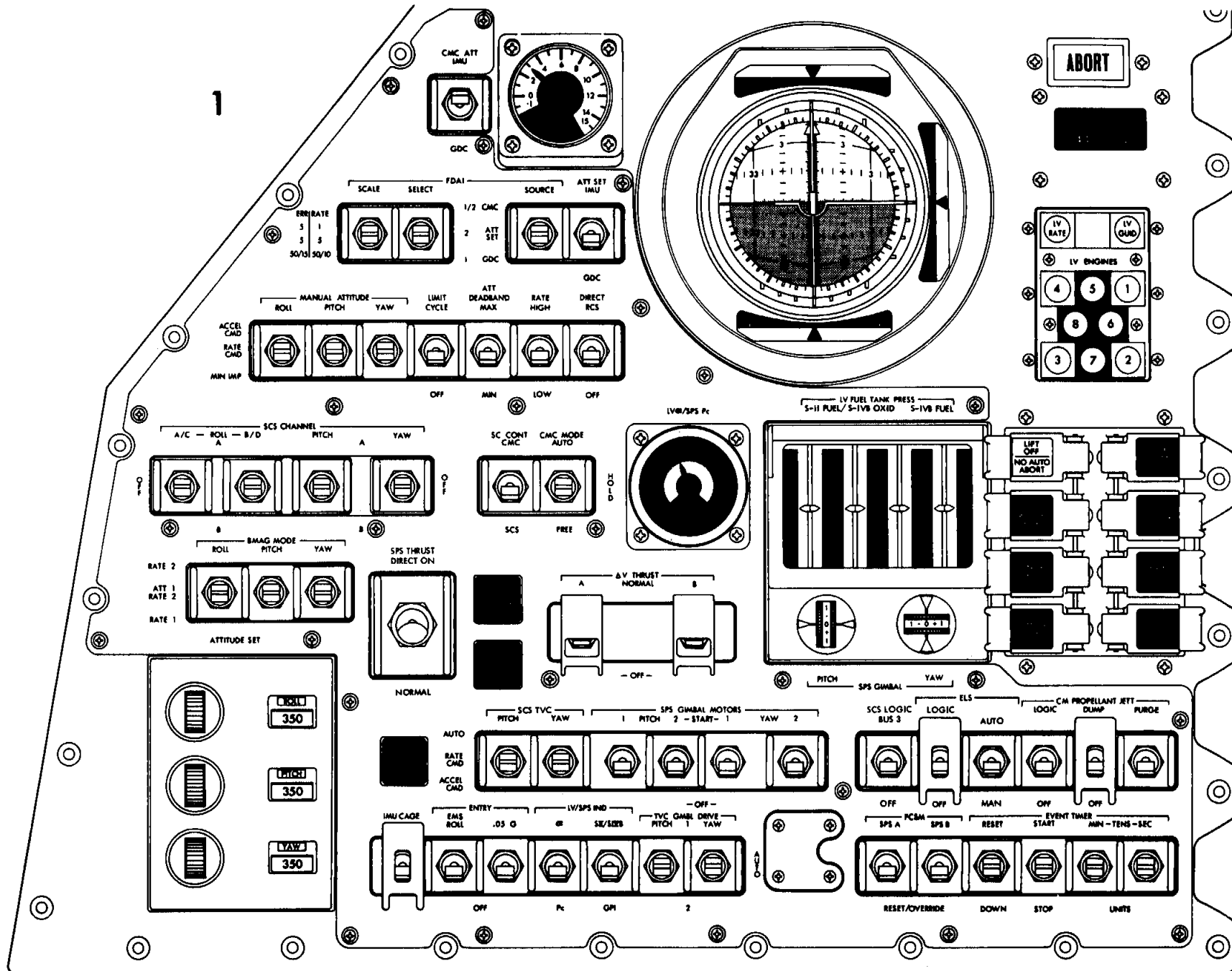
TC

- 3QS28 = RATE 1
- 3QS29 = (RATE 2) + (ATT 1/RATE 2)
- 3QS25 = (HIGH RATE) + IGN 2
- 3QS11 = LEM OFF
- 3QS12 = LEM ON
- 3QS31 = $\{ \text{IGN}_2 [(\text{SCS} + \text{CW}) \cdot (\text{RATE CMD} + \text{ACCEL}) + \text{SCS} \cdot \text{AUTO} \cdot \text{CW}] \}$
- 3K11 = (IGN 2) (SCS + CW)
- 121A5K1 = (ATT 1/RATE 2) (0.05g)' [IGN 2 + (RATE CMD MAN. ATT) ($\pm$ BO P)']
- 3QS21 = 121A5K1
- 3QS30 = $\text{IGN}_2 [(\text{SCS} + \text{CW}) \cdot (\text{RATE CMD} + \text{ACCEL}) + \text{SCS} \cdot \text{AUTO} \cdot \text{CW}]$
- 3K30 = $[(\text{RATE 2}) + (\text{ATT 1/RATE 2})]$ (RATE DAMPED MTVC)
- 3K31 = (RATE 1) (RATE DAMPED MTVC)
- 3QS1 = $\text{SCS} \cdot (\text{SCS AUTO})' + \text{CW} \cdot (\text{SCS AUTO})' + \text{CW} \cdot \text{SCS}$
- 3QS2 = (SCS AUTO) (IGN 2) $[\text{SCS} \cdot \overline{\text{CW}} + \text{CMC} \cdot \text{CW}]$
- 3QS3 = SCS + CW
- K1 = GIM DR 2 + GIM DR AUTO (F. S. + CW)
- K62 = GPI

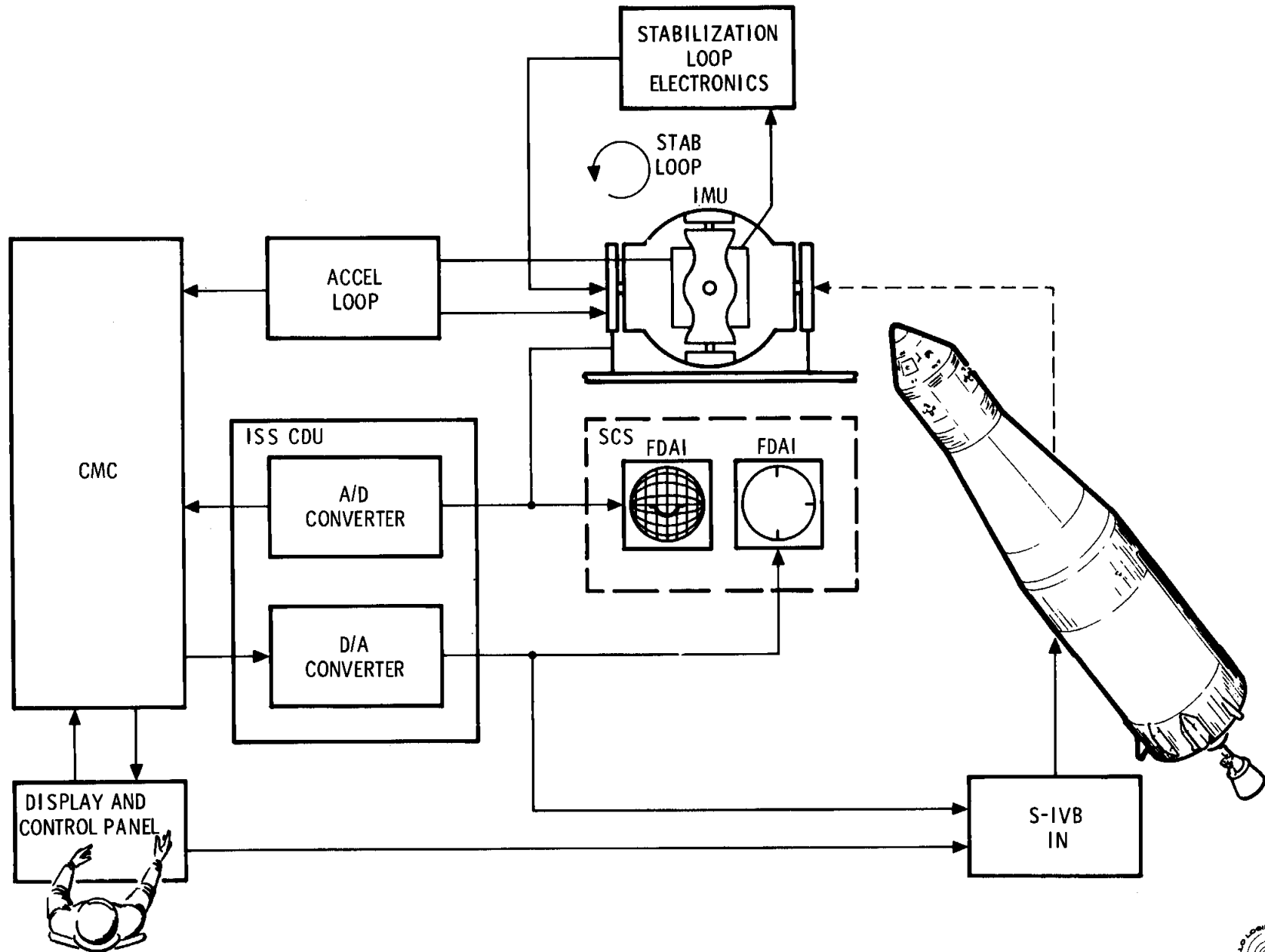
SPS ENGINE ON-OFF LOGIC



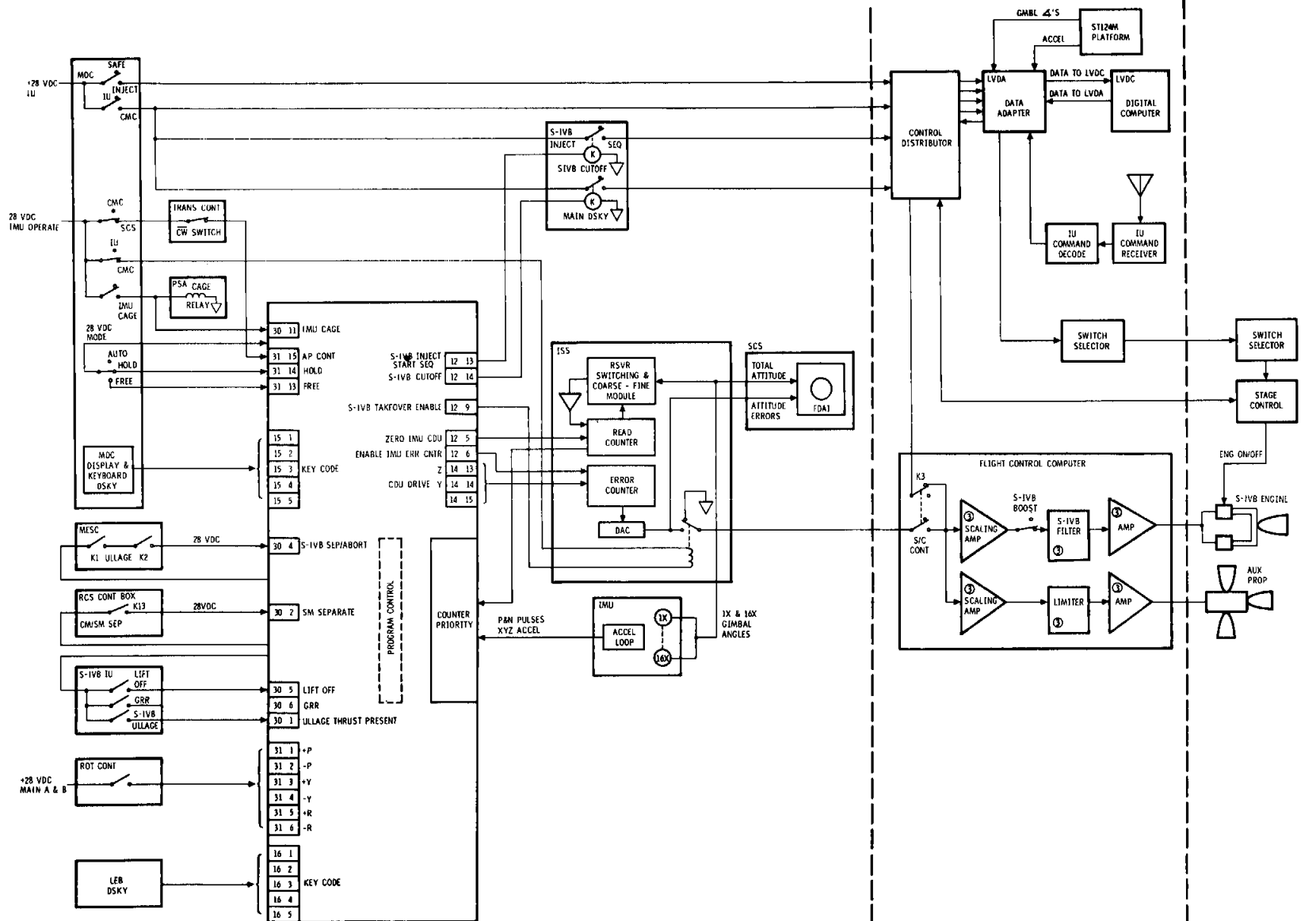
SCS-2701K

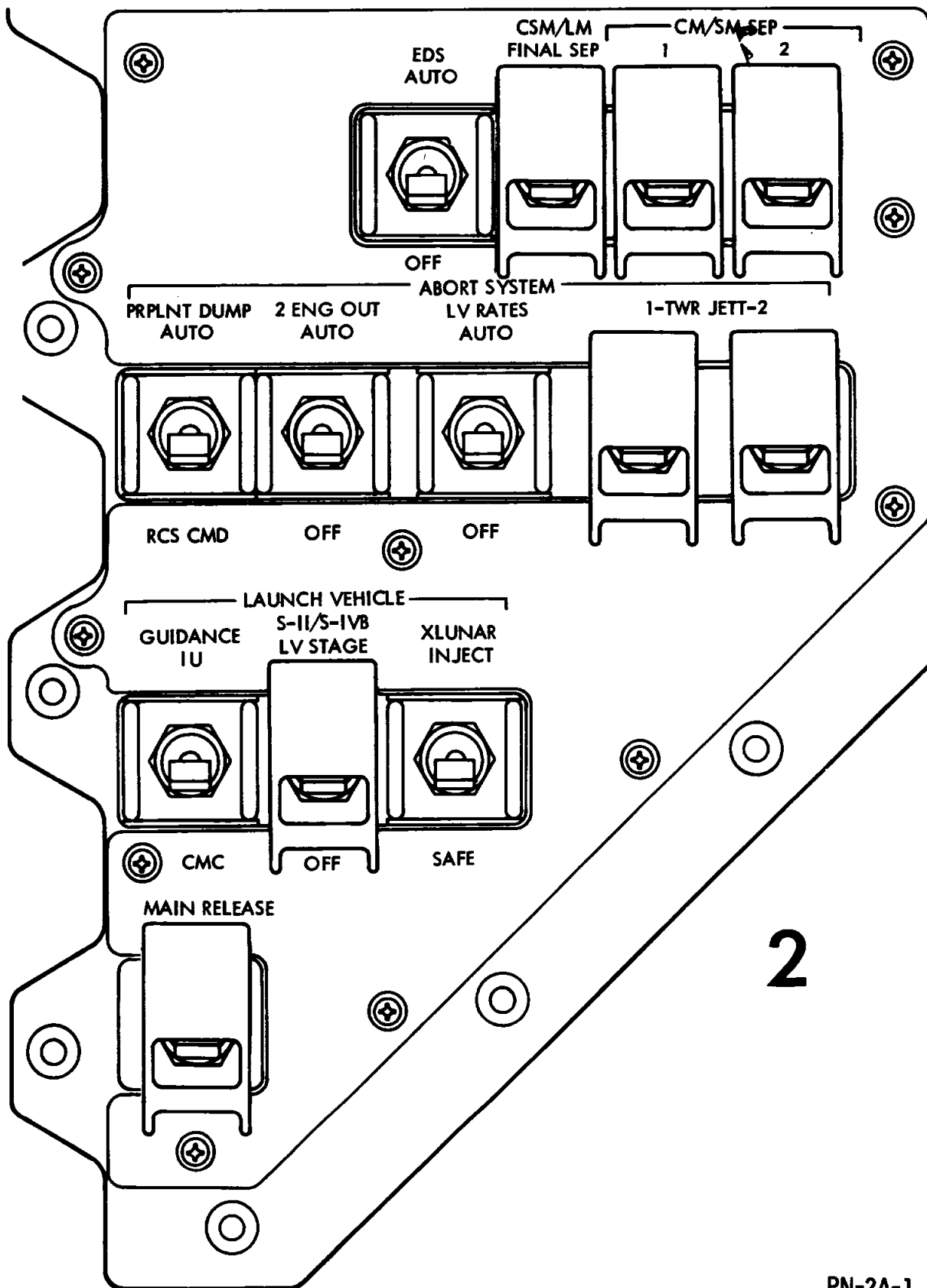


SC CONTROL OF SATURN

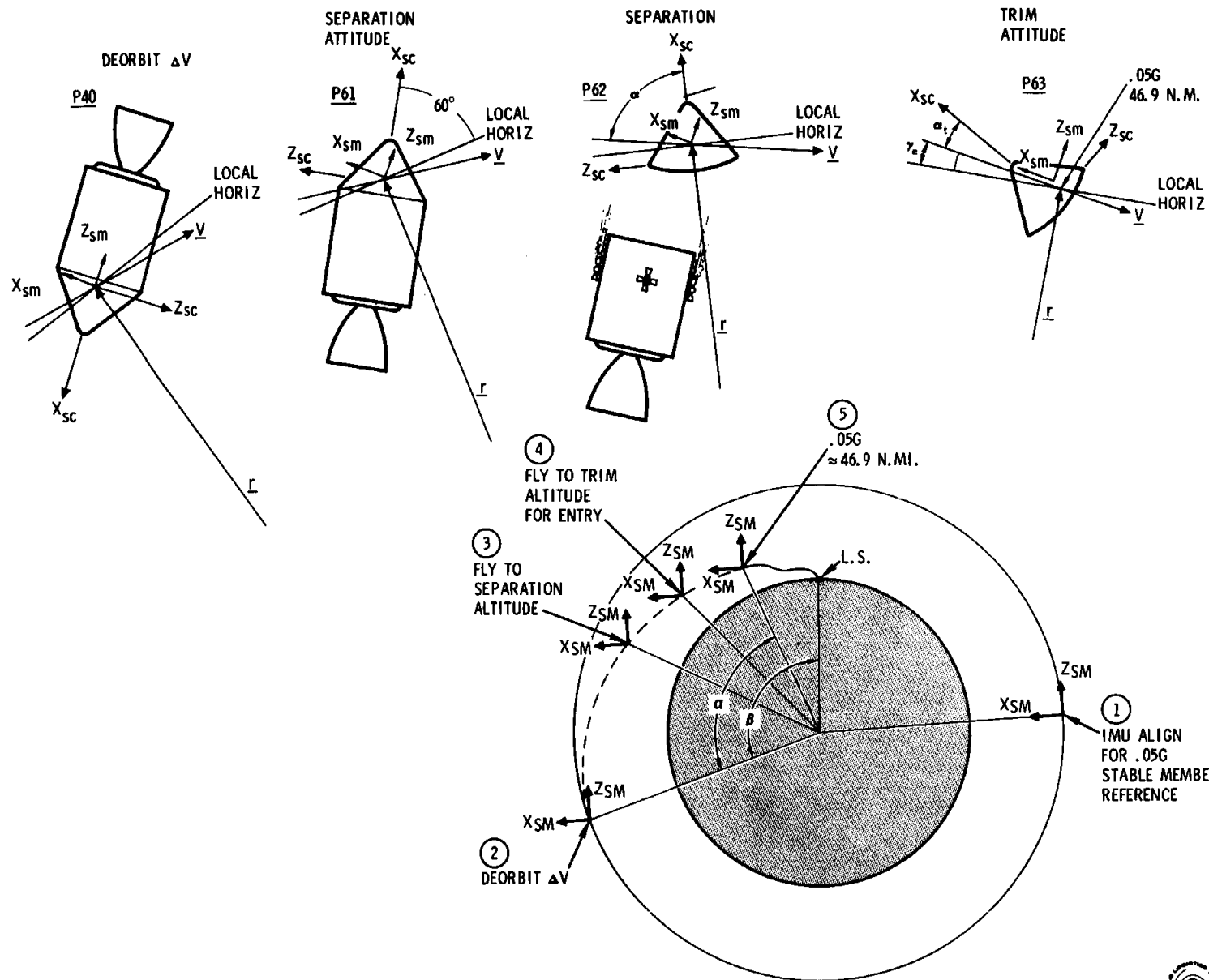


CSM

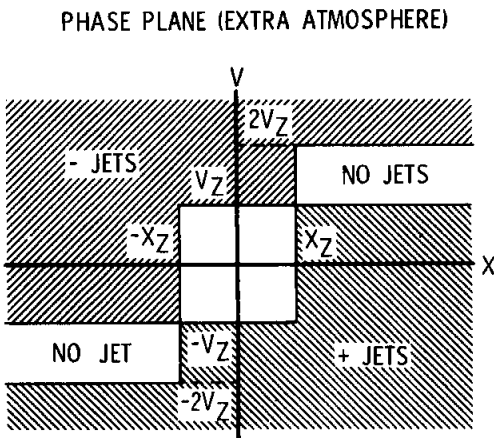
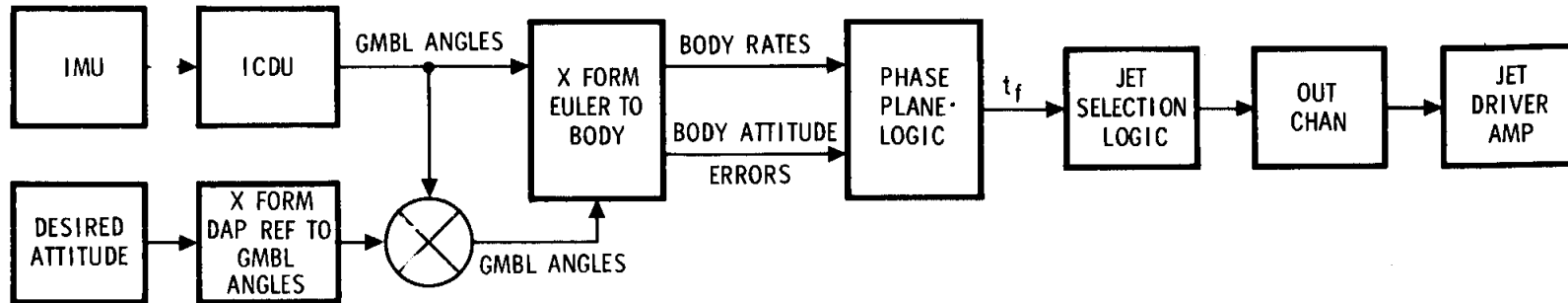




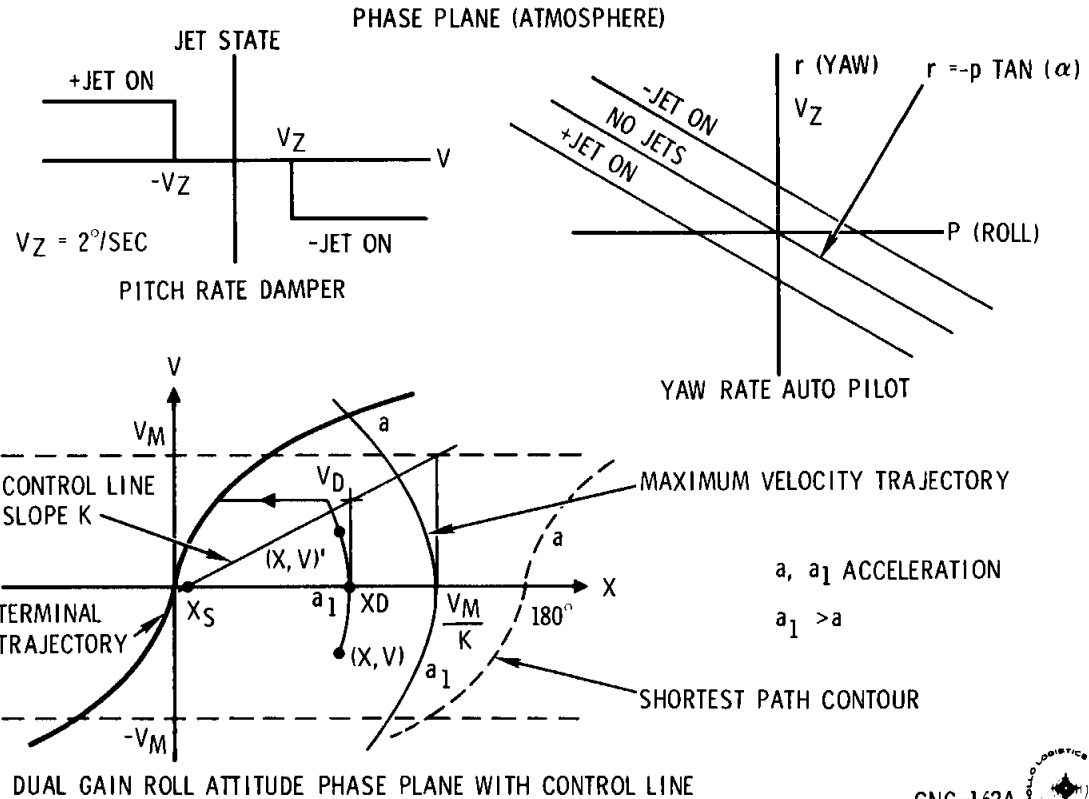
PREPARATION FOR ENTRY

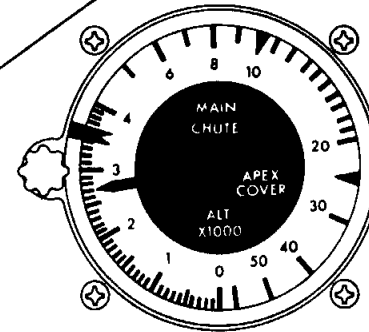


ENTRY DAP

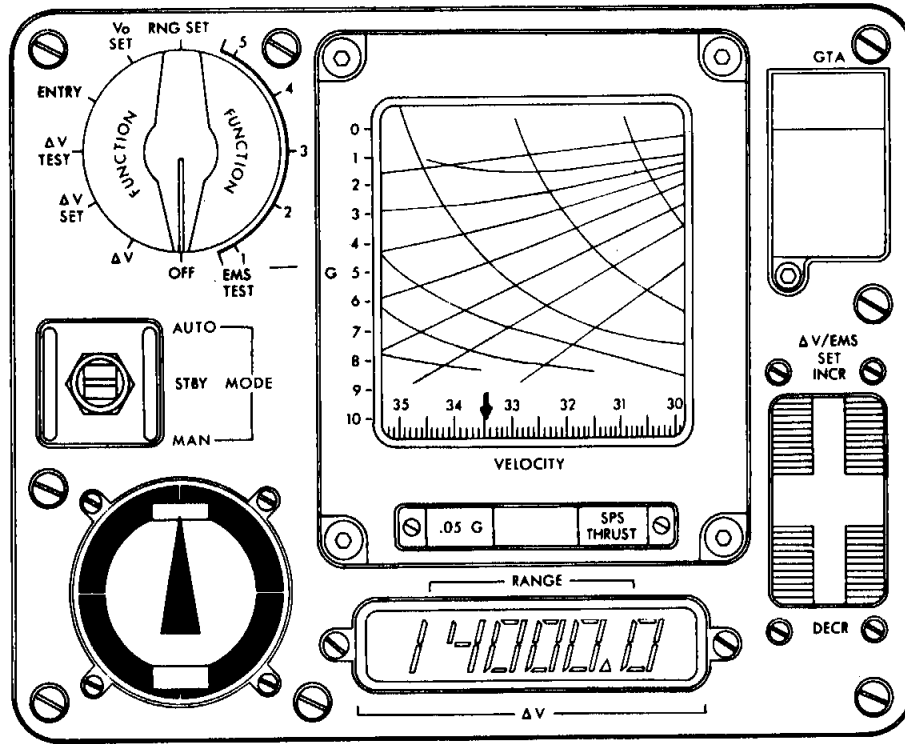


$XZ = 3^\circ$
 $VZ = 2^\circ/\text{SEC}$
 ATTITUDE CONTROL

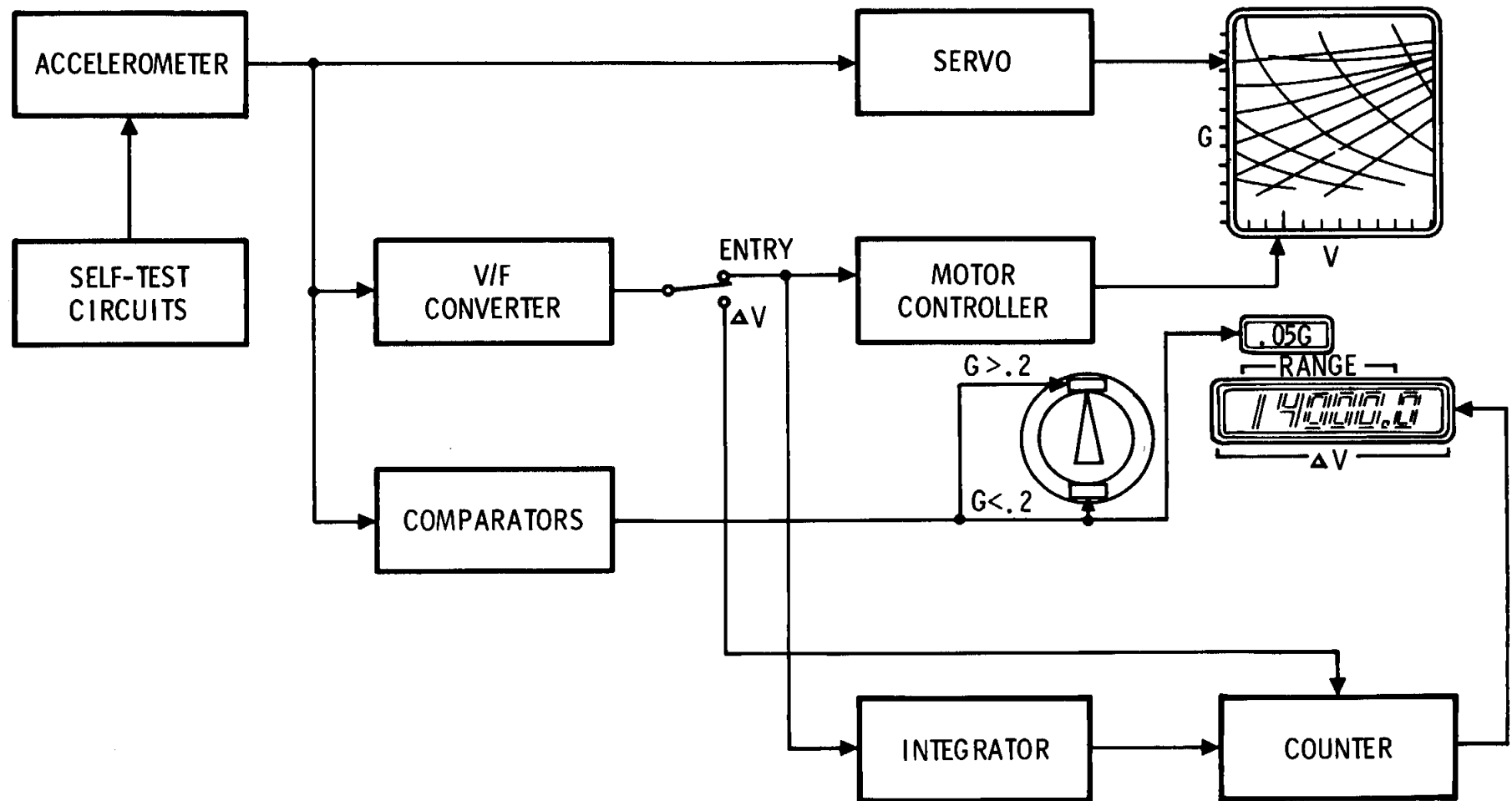




1



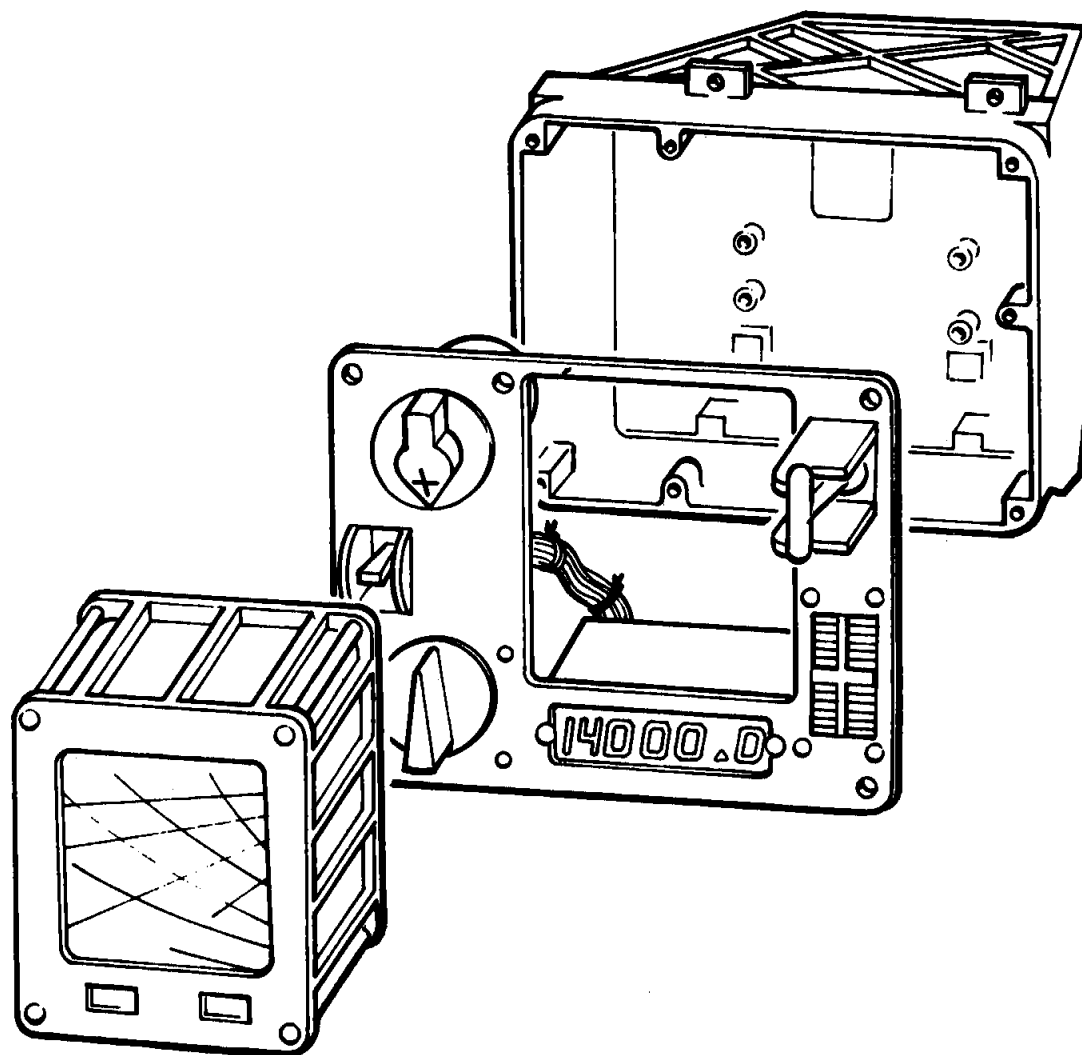
EMS BLOCK DIAGRAM



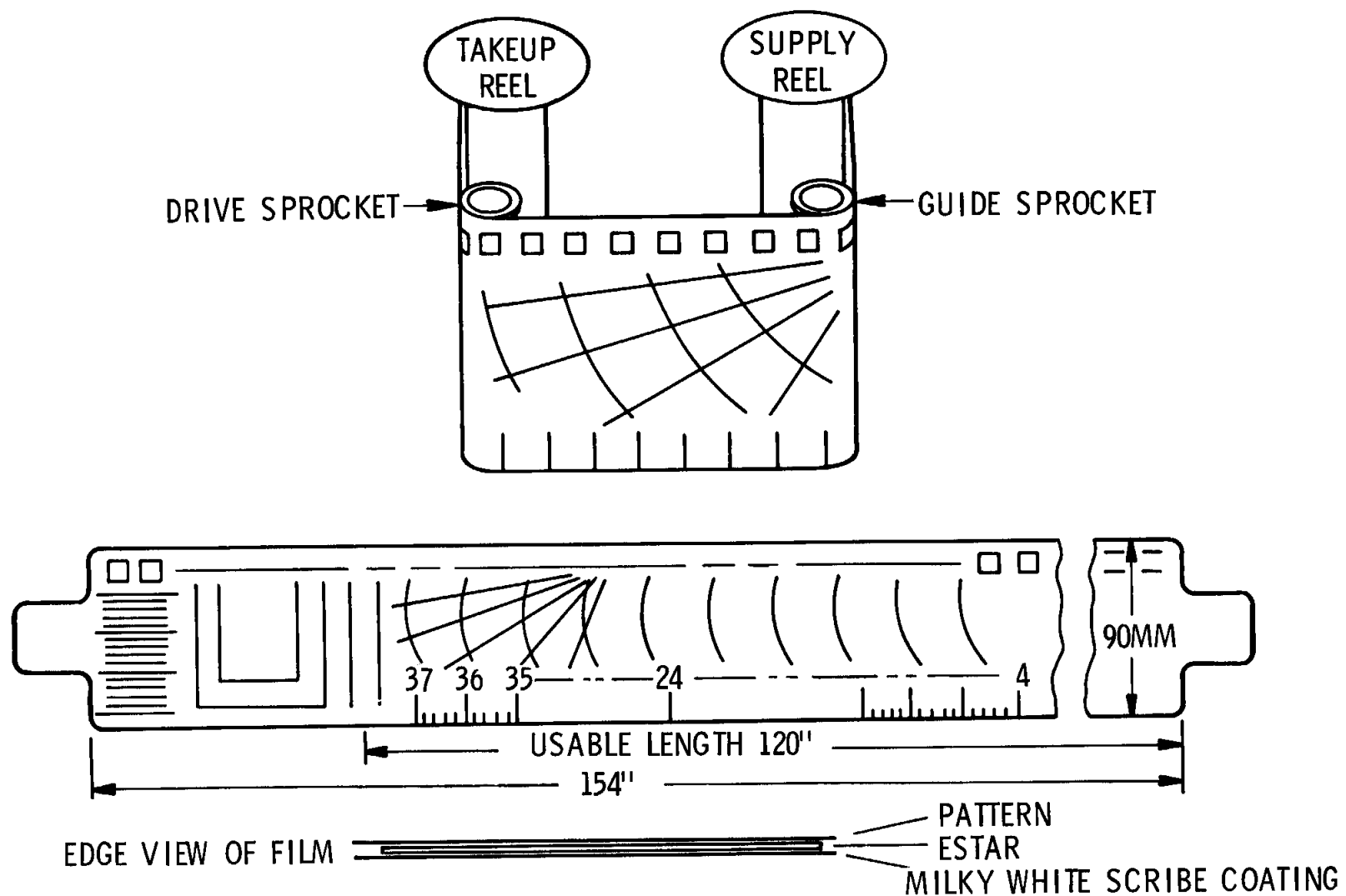
SCS-2205



EMS HOUSING FRONT PANEL



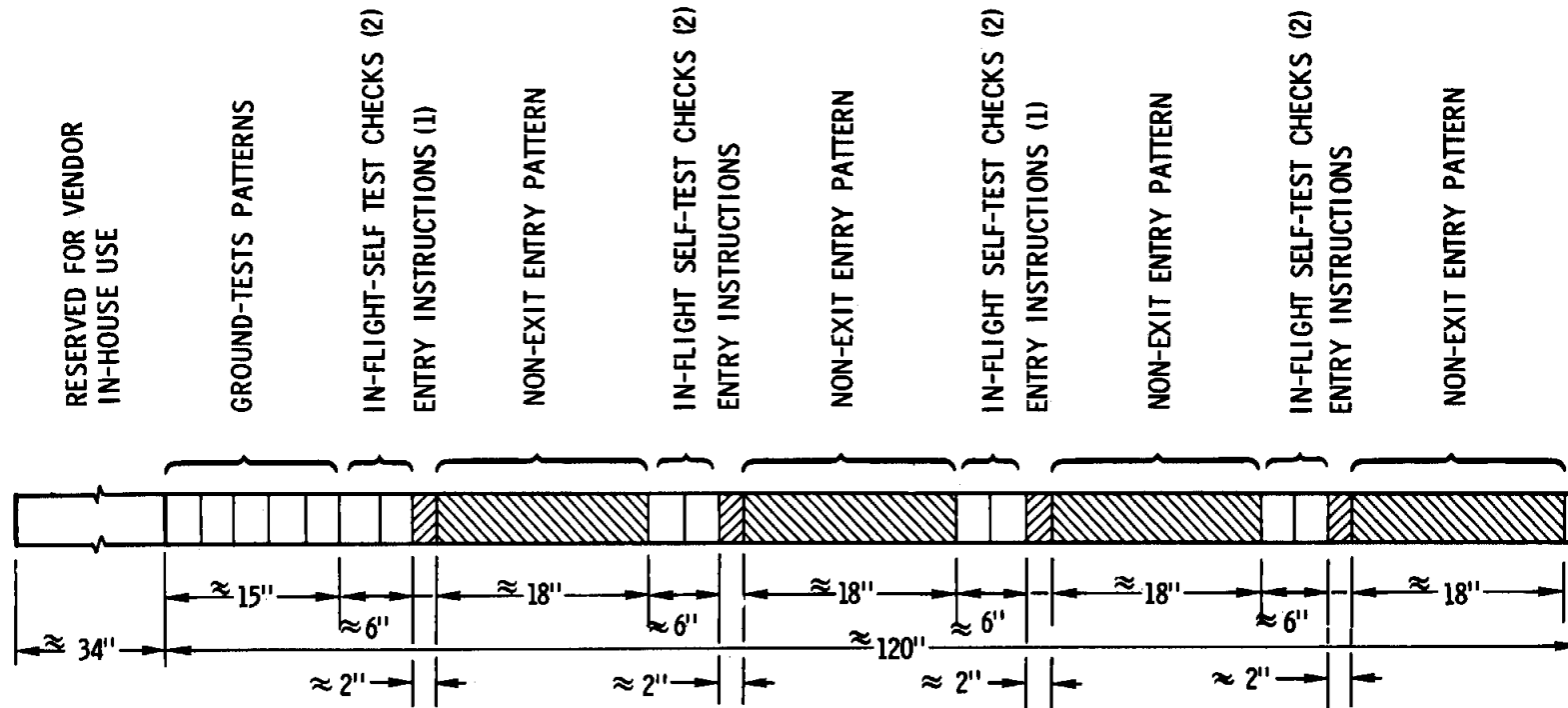
EMS SCROLL & SCRIBE



SCS-2014



EMS SCROLL FORMAT



EMS FLIGHT SCROLL

SELF TEST & ENTRY PREPARATION

STBY
1
AUTO
SET SCROLL
2
.05G LT
3
.05G LT
DOWN LT
SET 58.0
4
.05G LT
RNG 0±.2
5
.05G LT
UP LT

SET
SCROLL
37,000

STBY
1
AUTO
SET SCROLL
2
.05G LT
3
.05G LT
DOWN LT
SET 58.0
4
.05G LT
RNG 0±.2
5
.05G LT
UP LT

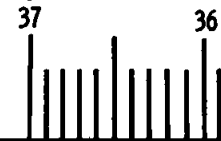
SET
SCROLL
37,000

(DEORBIT)
RNG SET
1586.8
ΔV TEST
SPS LT ON
SPS LT OFF
AT $\Delta V < 0$
-20.8±20.7

STBY
ΔV SET
ΔV - AUTO

(ENTRY)
STBY
RNG SET
VO SET

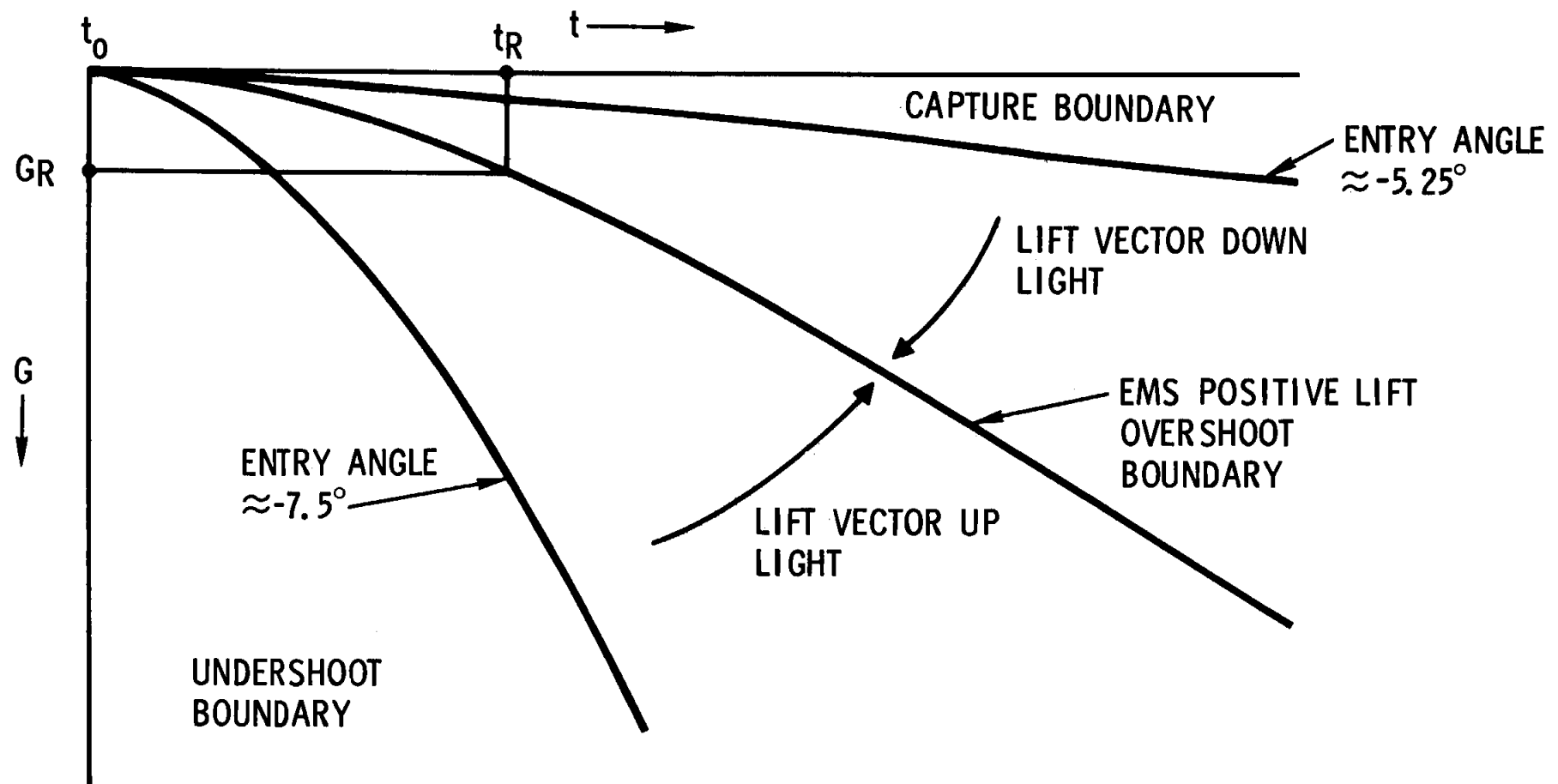
SET
SCROLL
ENTRY
AUTO



SCS-2209



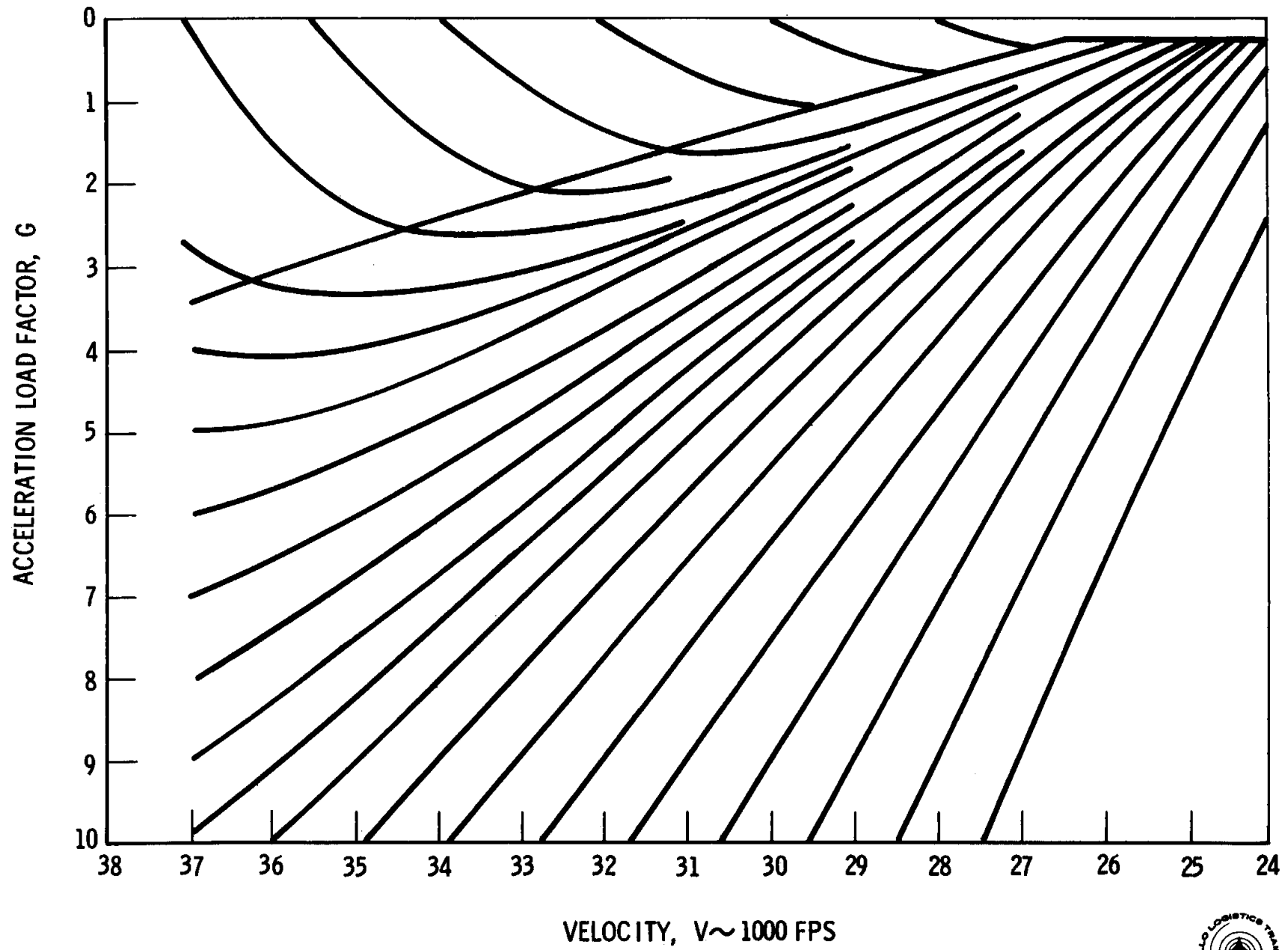
EMS CORRIDOR EVALUATION



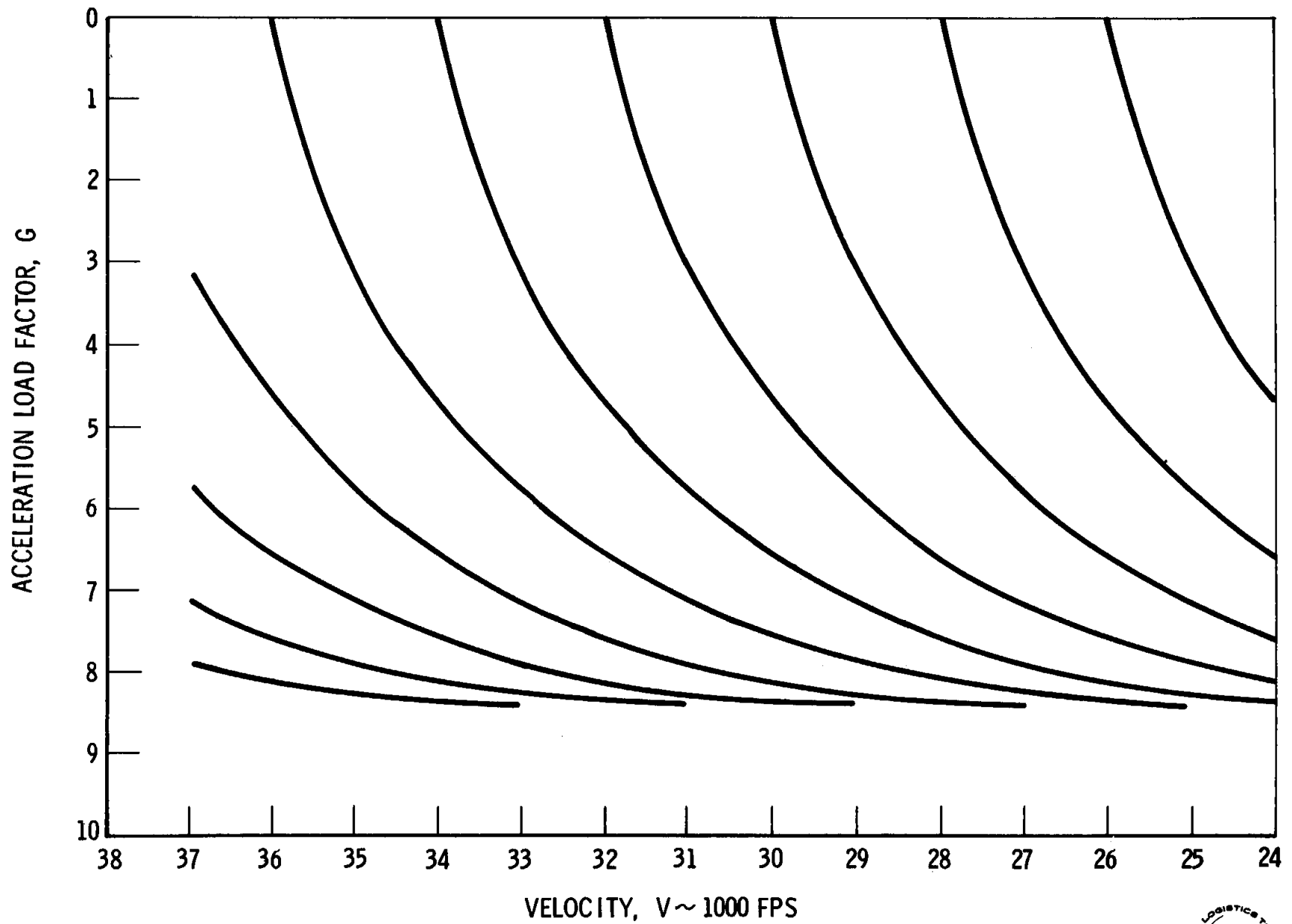
$GR = .2G$
 $t_R = 10 \text{ SEC AFTER } t_0$
 $t_0 = \text{TIME AT } .05G$

FOR LUNAR
 ENTRY VELOCITY
 AND ENTRY ANGLES ONLY

OFF-SET FLIGHT LIMITS



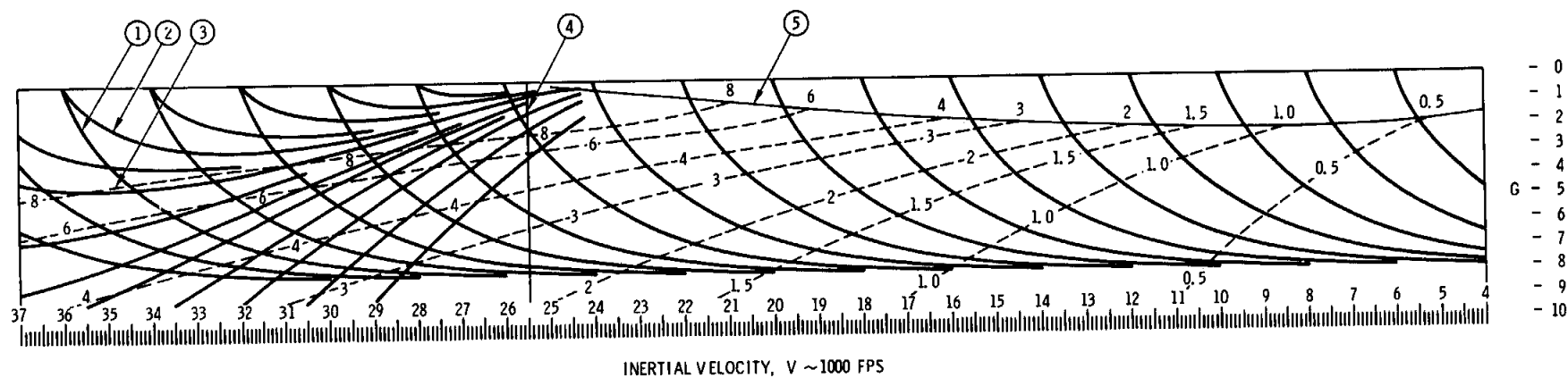
ON-SET FLIGHT LIMITS



SCS-2312

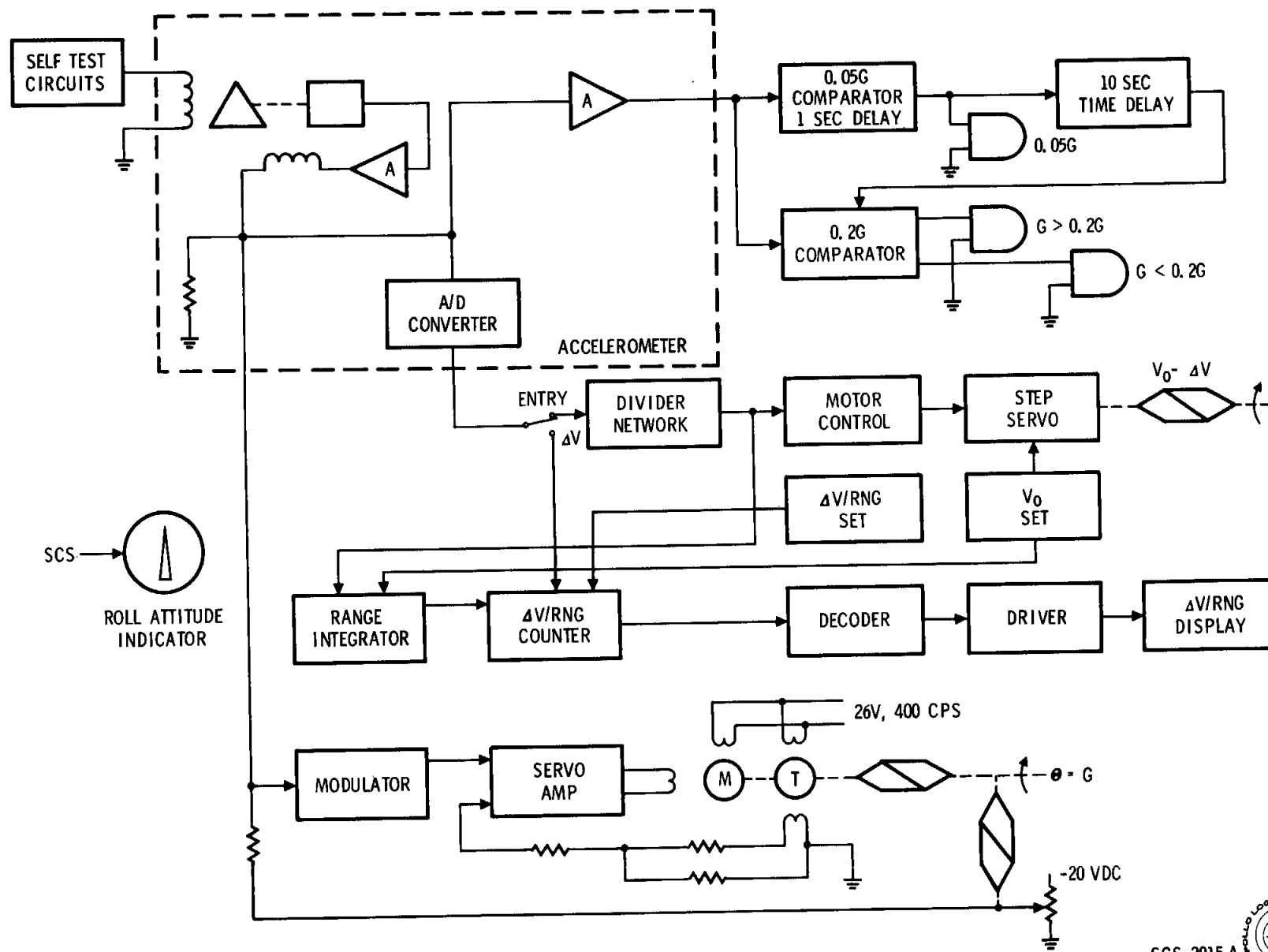


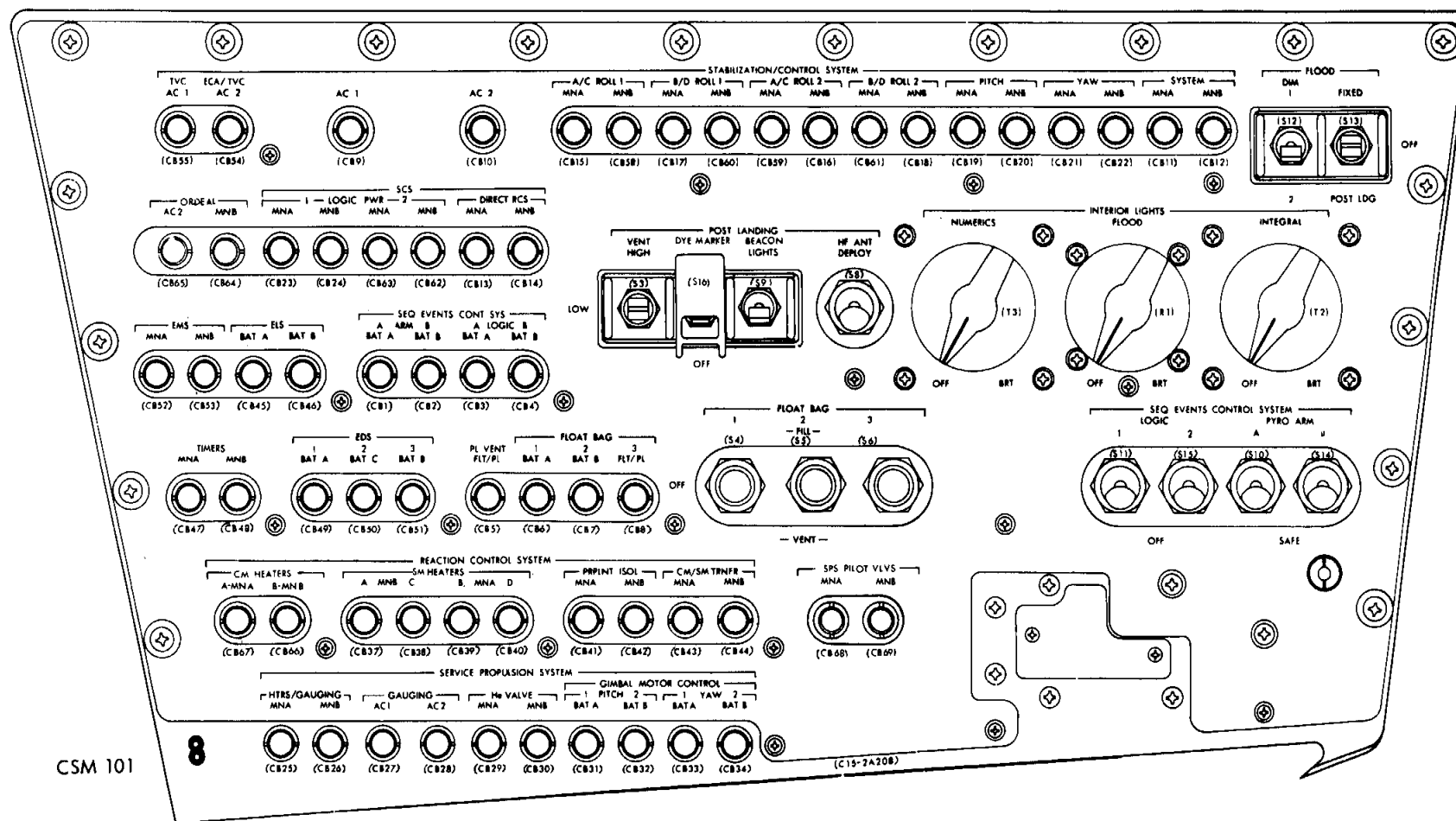
NON-EXIT ENTRY PATTERN FOR EMS ORBITAL MISSION



SCS-2211 (◆)

EMS FUNCTIONAL BLOCK DIAGRAM





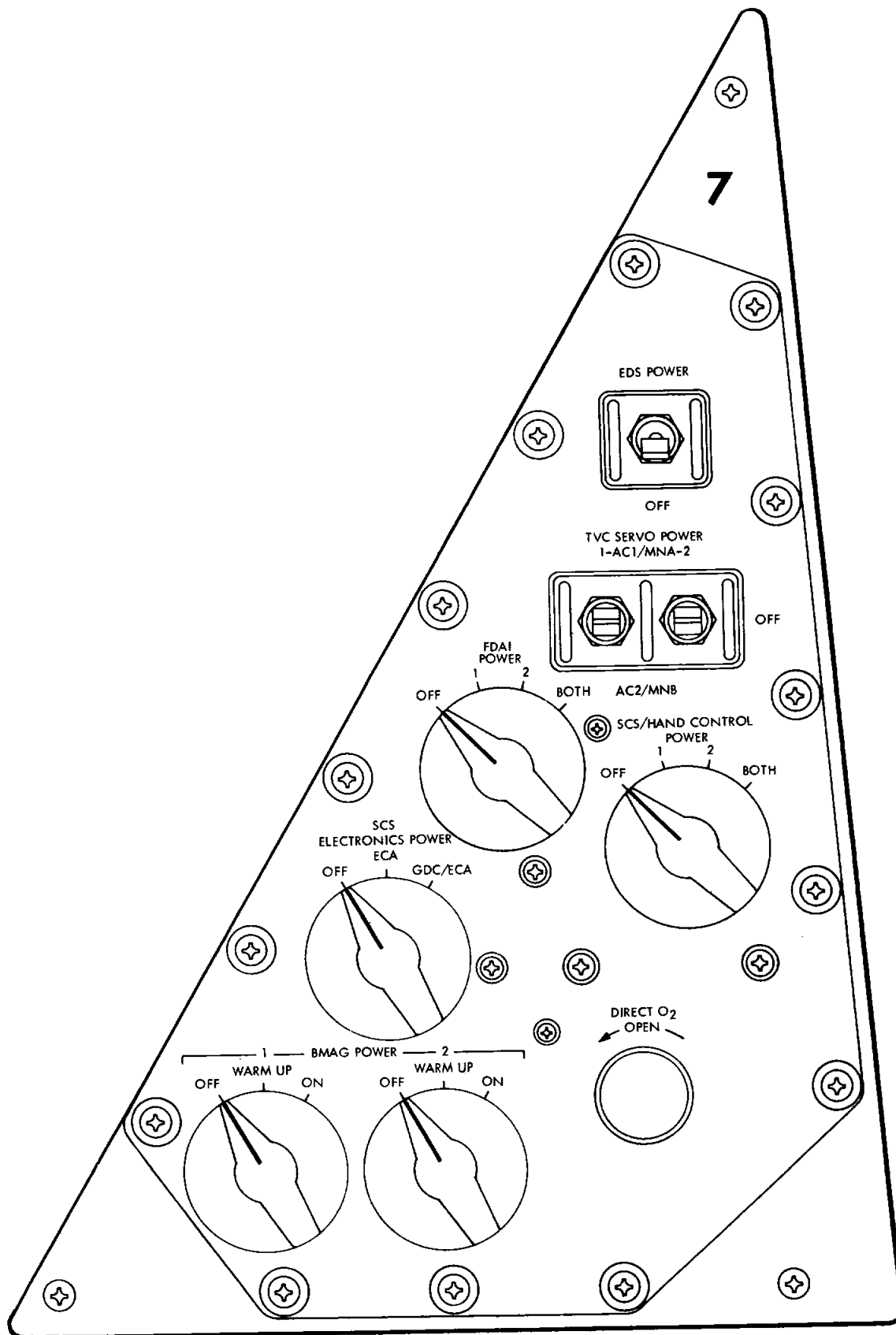
CSM 101

8

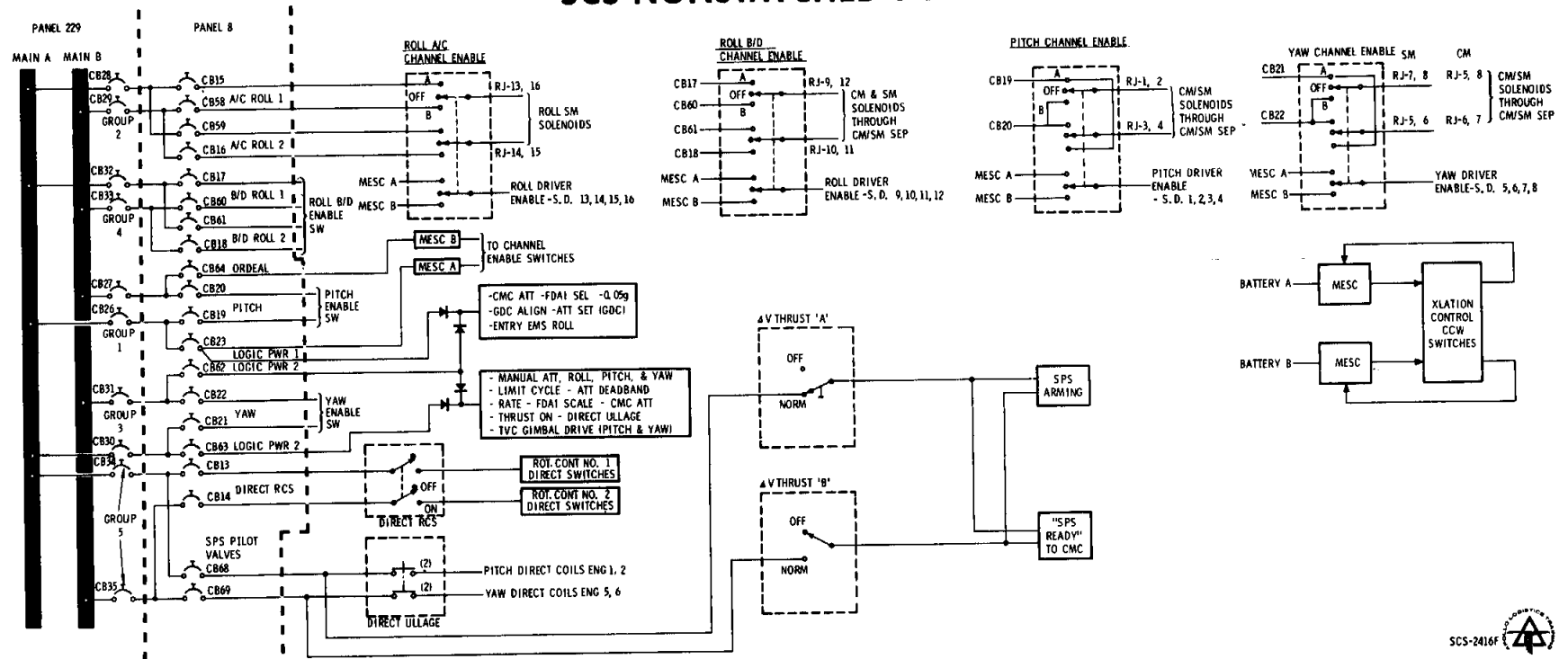
(C15-2A208)

PN-8-1

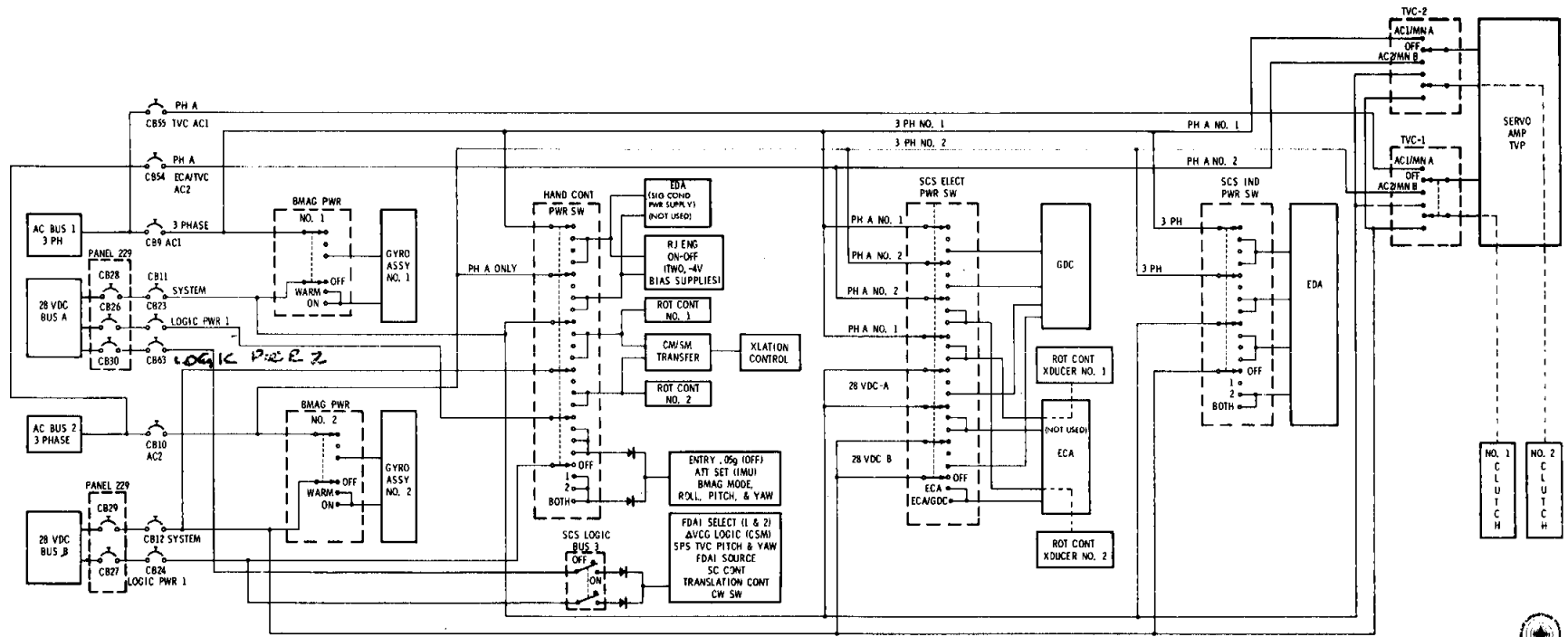




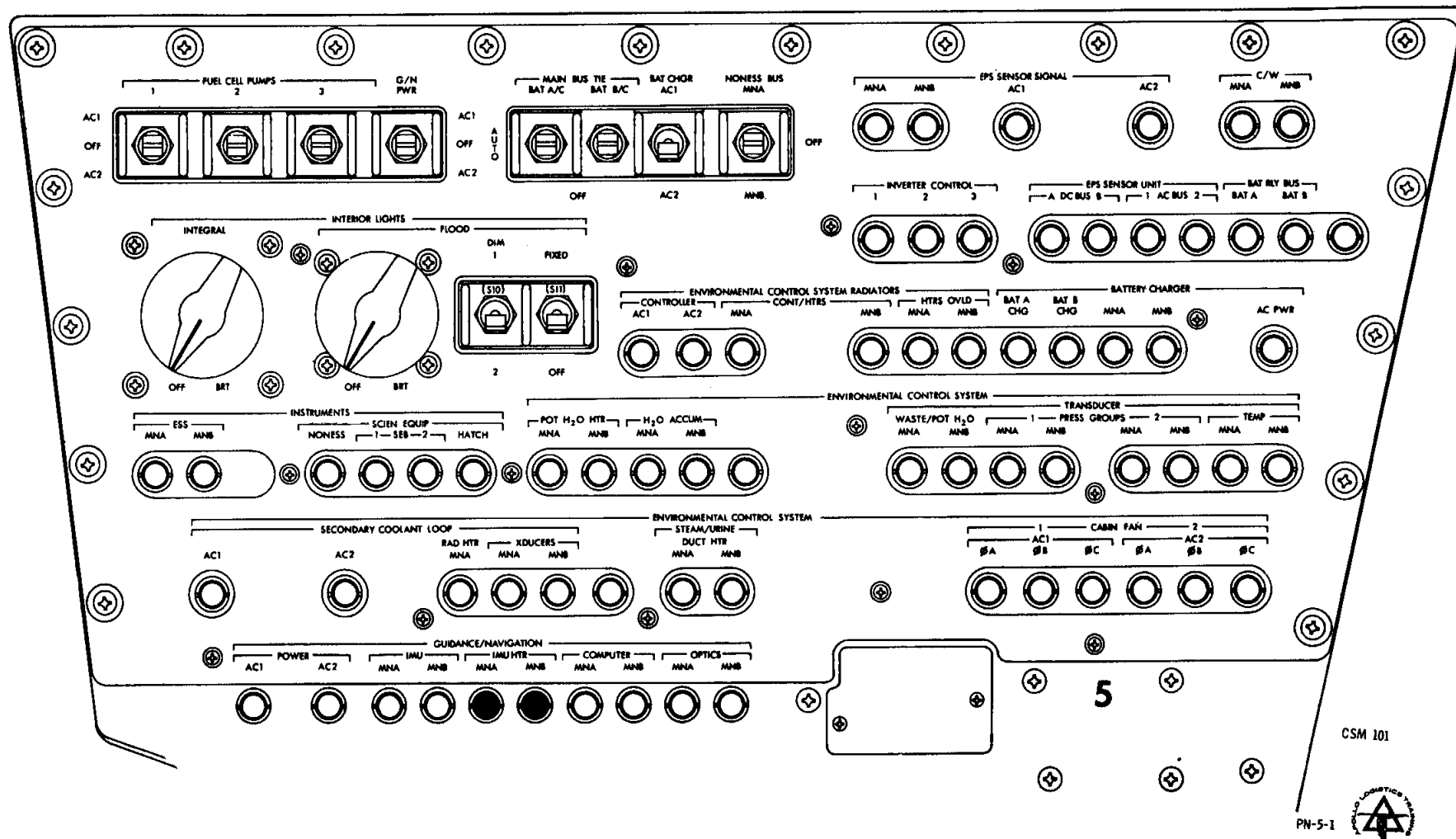
SCS NONSWITCHED POWER



SCS SWITCHED POWER DISTRIBUTION



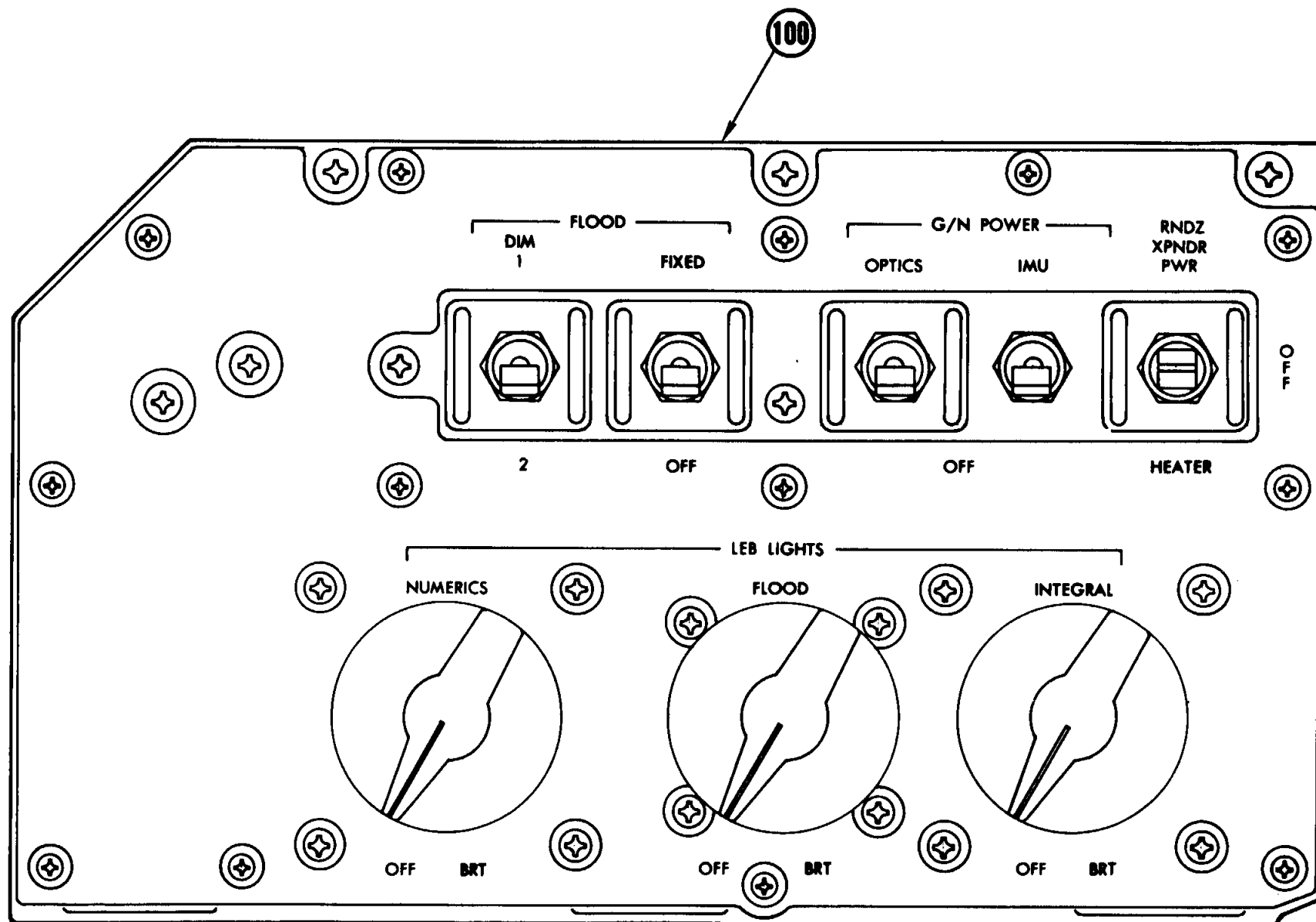
SCS-24171



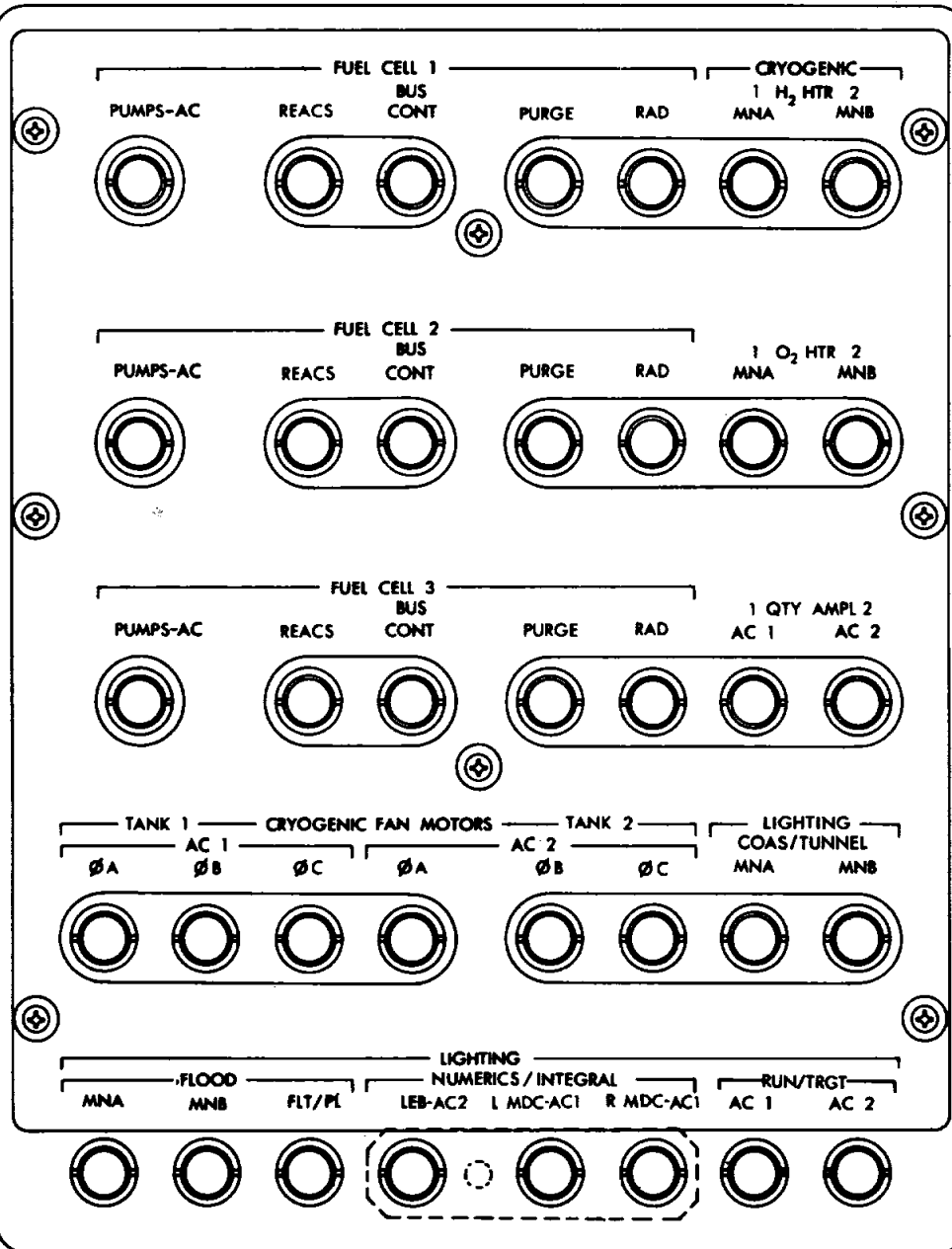
CSM 101

PN-5-1

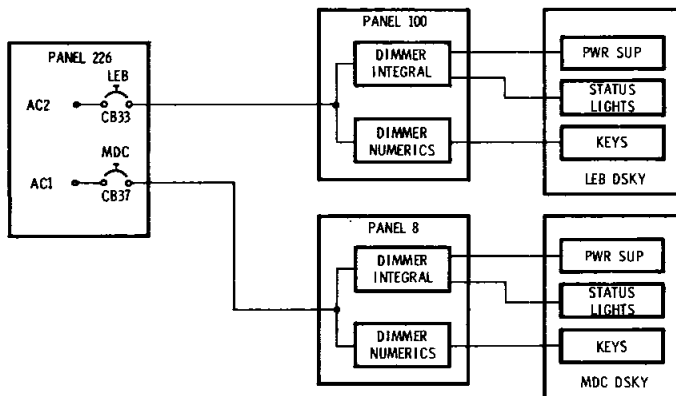
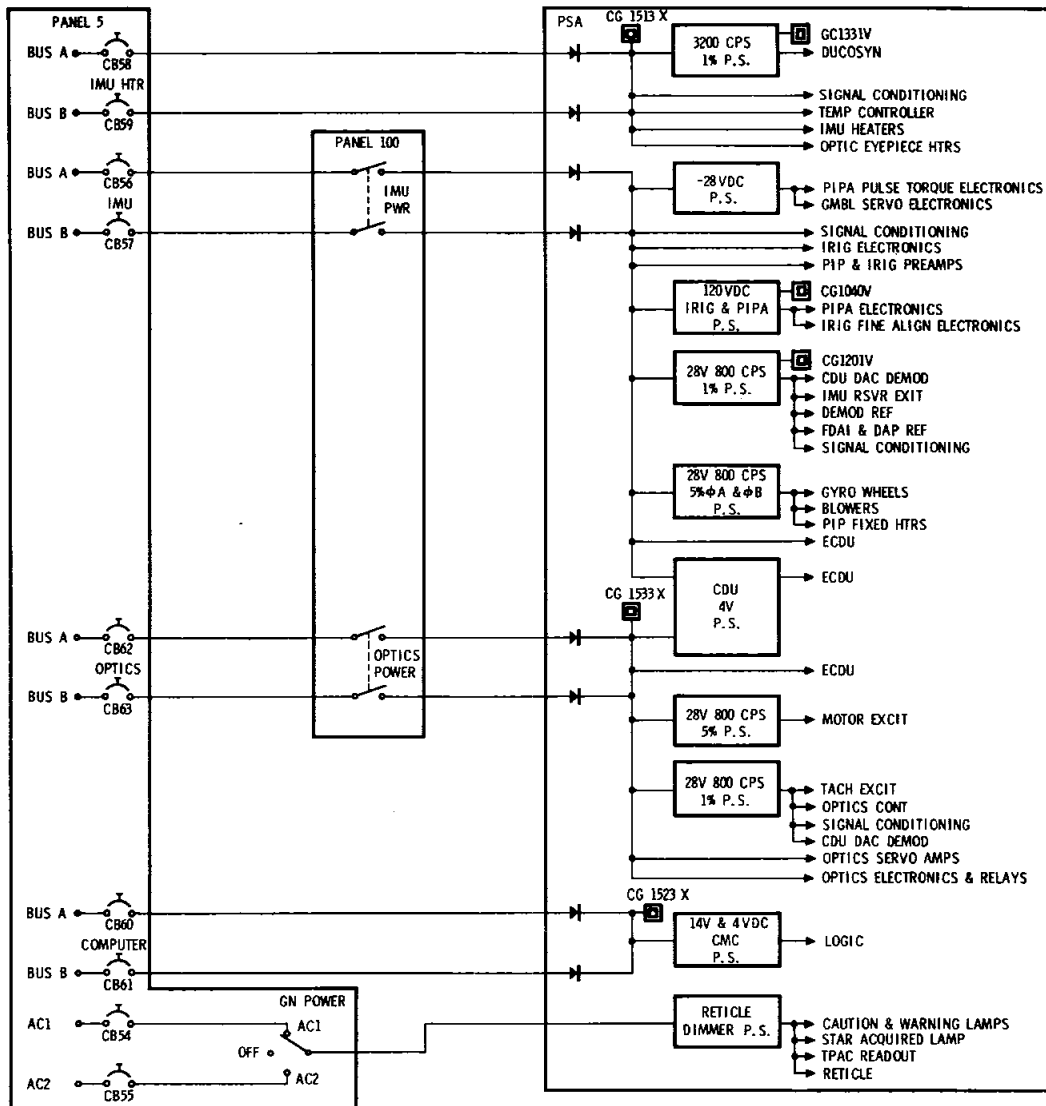




226



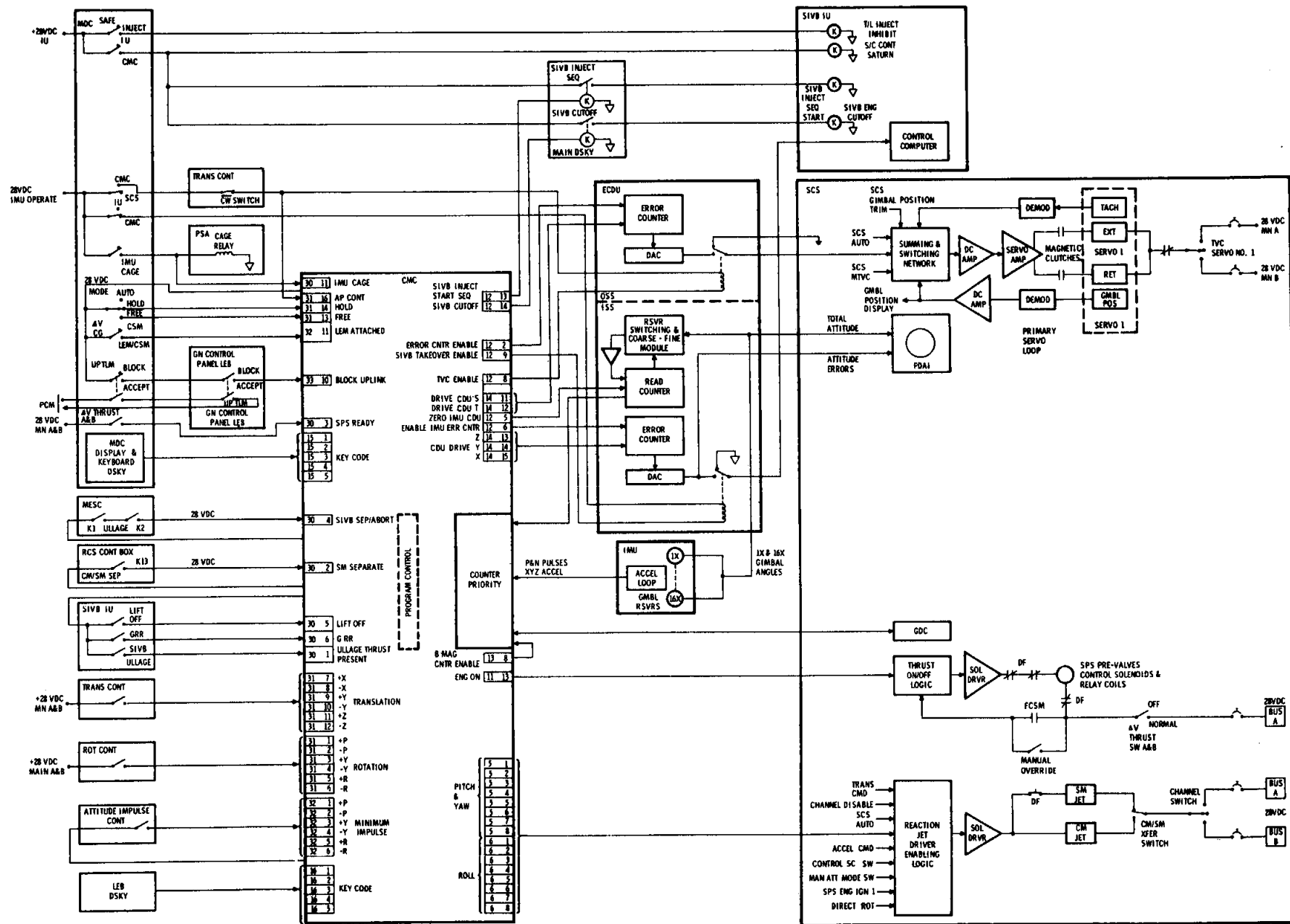
GNC POWER DISTRIBUTION



CG1513X - IMU +28 VDC STANDBY
 CG1331V - 3.2KC 28V SUPPLY
 CG1040V - 120 VDC PIPA SUPPLY DC LEVEL
 CG1201V - IMU 28V .8KC 1 PCT °DEG SUP RMS
 CG1533X - OPTICS OPERATE +28 VDC
 CG1523X - +28 V CMC OPERATE



G & C FUNCTIONAL FLOW



PCM

<u>Measurement No.</u>	<u>Measurement Description</u>	<u>Channel Code</u>	<u>S/S</u>
CG 0001V	COMPUTER DIGITAL DATA 40 BITS	51DS1	50
CG 1040V	+120 VDC PIPA SUPPLY DC LEVEL	10A83	1
CG 1110V	2.5 VDC TM BIAS	10A138	1
CG 1201V	IMU 28V .8KC 1 PCT 0 DEG SUP RMS	10A91	1
CG 1211V	OPTX 28V .8KC 1 PCT 0 DEG RMS	10A146	1
CG 1331V	3.2KC 28V SUPPLY	10A85	1
CG 1513X	IMU +28 VDC STANDBY	11E15-2	10
CG 1523X	+28V CMC OPERATE	11E15-3	10
CG 1533X	OPTX OPERATE +28 VDC	11E15-4	10
CG 2001V	X PIPA SG OUTPUT IN PHASE	51A2	50
CG 2021V	Y PIPA SG OUTPUT IN PHASE	51A3	50
CG 2041V	Z PIPA SG OUTPUT IN PHASE	51A4	50
CG 2112V	IG IX RESOLVER OUTPUT SIN	11A54	10
CG 2113V	IG IX RESOLVER OUTPUT COS	11A59	10
CG 2117V	IGA SERVO ERROR IN PHASE	12A2	100
CG 2142V	MG IX RESOLVER OUTPUT SIN	11A60	10
CG 2143V	MG IX RESOLVER OUTPUT COS	11A61	10
CG 2147V	MGA SERVO ERROR IN PHASE	12A1	100
CG 2172V	OG IX RESOLVER OUTPUT SIN	11A62	10
CG 2173V	OG IX RESOLVER OUTPUT COS	11A63	10
CG 2177V	OGA SERVO ERROR IN PHASE	12A3	100
CG 2219V	PITCH ATT ERROR - CDU DAC OUT	11A64	10
CG 2249V	YAW ATT ERROR - CDU DAC OUT	11A65	10
CG 2279V	ROLL ATT ERROR - CDU DAC OUT	11A16	10
CG 2300T	PIPA TEMPERATURE	10A96	1
CG 2301T	IRIG TEMPERATURE	10A1	1
CG 2302X	IMU HEATER CURRENT	10A5	1
CG 2303X	IMU BLOWER CURRENT	10A7	1
CG 3011V	TRUNNION CDU FINE ERROR	11A171	10
CG 3021V	SHAFT CDU FINE ERROR	11A180	10

PGNCS A/B TLM LIST

PCM

<u>Measurement No.</u>	<u>Measurement Description</u>	<u>Channel Code</u>	<u>S/S</u>
CG 3140V	SXT SHAFT TACHOMETER OUTPUT	11A172	10
CG 3150V	SXT TRUNNION TACHOMETER OUTPUT	11A173	10
CG 3160V	SCT SHAFT TACHOMETER OUTPUT	10A13	1
CG 3170V	SCT TRUNNION TACHOMETER OUTPUT	10A14	1
CG 3721V	SHAFT CDU DAC OUTPUT	11A52	10
CG 3722V	TRUNNION CDU DAC OUTPUT	11A53	10
CG 5040X	CMC WARNING	11E19-1	10

SCS TM List

<u>Measurement ID</u>	<u>Measurement Description</u>	<u>Response Rate</u>	<u>Sensor Range</u> <u>Low</u> <u>High</u>	<u>Display Readout</u>	<u>Channel Code</u>
CH3500V	Attitude Error Pitch	50 S/S	-5/5/15 +5/5/15 Deg	FDAI	51A5
CH3501V	Attitude Error Yaw	50 S/S	-5/5/15 +5/5/15 Deg	FDAI	51A6
CH3502V	Attitude Error Roll	100 S/S	-5/5/50 +5/5/50 Deg	FDAI	12A4
CH3503R	SCS Body Rate Pitch	100 S/S	-1/5/10 +1/5/10 Deg/sec	FDAI	12A5
CH3504R	SCS Body Rate Yaw	100 S/S	-1/5/10 +1/5/10 Deg/sec	FDAI	12A6
CH3505R	SCS Body Rate Roll	100 S/S	-1/5/50 +1/5/50 Deg/sec	FDAI	12A7
CH3517H	GIMBAL POSITION Pitch 1 or 2	100 S/S	-5 +5 Deg	FP/GPI	12A8
CH3518H	GIMBAL POSITION Yaw 1 or 2	100 S/S	-5 +5 Deg	FP/GPI	12A10
CH3546X	RCS Solenoid Activate +Pitch/+X	200 S/S	Event	None	22E1-1
CH3547X	RCS Solenoid Activate -Pitch/+X	200 S/S	Event	None	22E2-2
CH3548X	RCS Solenoid Activate +Pitch/-X	200 S/S	Event	None	22E3-3
CH3549X	RCS Solenoid Activate -Pitch/-X	200 S/S	Event	None	22E4-4
CH3550X	RCS Solenoid Activate +Yaw/+X	200 S/S	Event	None	22E5-5
CH3551X	RCS Solenoid Activate -Yaw/+X	200 S/S	Event	None	22E6-6
CH3552X	RCS Solenoid Activate +Yaw/-X	200 S/S	Event	None	22E7-7
CH3553X	RCS Solenoid Activate -Yaw/-X	200 S/S	Event	None	22E8-8
CH3554X	RCS Solenoid Activate +Roll/+Z	200 S/S	Event	None	22E9-1
CH3555X	RCS Solenoid Activate -Roll/+Z	200 S/S	Event	None	22E13-5
CH3556X	RCS Solenoid Activate +Roll/-Z	200 S/S	Event	None	22E14-6
CH3557X	RCS Solenoid Activate -Roll/-Z	200 S/S	Event	None	22E10-2

SCS TM List

<u>Measurement ID</u>	<u>Measurement Description</u>	<u>Response Rate</u>	<u>Sensor Range</u> <u>Low</u> <u>High</u>	<u>Display Readout</u>	<u>Channel Code</u>
CH3558X	RCS Solenoid Activate +Roll/+Y	200 S/S	Event	None	22E15-7
CH3559X	RCS Solenoid Activate -Roll/+Y	200 S/S	Event	None	22E11-3
CH3560X	RCS Solenoid Activate +Roll/-Y	200 S/S	Event	None	22E12-4
CH3561X	RCS Solenoid Activate -Roll/-Y	200 S/S	Event	None	22E16-8
CH3588X	Attitude Deadband Minimum	10 S/S	Event	Panel Switch	11E8-2
CH3590X	SCS High Rot-Rate Selected	10 S/S	Event	Panel Switch	11E8-4
CH3592X	FDAI Scale Error 5, Rates 5	10 S/S	Event	Panel Switch	11E8-5
CH3593X	FDAI Scale ERR50/15, Rate 50/10	10 S/S	Event	Panel Switch	11E8-6
CH3600X	LM ATTACHED Selected	10 S/S	Event	Panel Switch	11E9-3
CH3604X	SPS Solenoid Driver No. 1	10 S/S	Event	EMS	11E4-4
CH3605X	SPS Solenoid Driver No. 2	10 S/S	Event	EMS	11E9-4
CH3607X	Spacecraft Control Source Switch	10 S/S	Event	Panel Switch	11E9-5
CH3623X	Gyro 1 Comb. SPIN MOTORS Run Det	10 S/S	Event	None	11E8-7
CH3624X	Gyro 2 Comb. SPIN MOTORS Run Det	10 S/S	Event	None	11E8-8
CH3635X	BMAG Mode SW-Roll Att 1/Rate 2	10 S/S	Event	Panel Switch	11E33-1
CH3636X	BMAG Mode Sw-Roll Rate 2	10 S/S	Event	Panel Switch	11E33-2
CH3638X	BMAG Mode Sw-Pitch Att 1/ Rate 2	10 S/S	Event	Panel Switch	11E33-3

SCS TM List

<u>Measurement ID</u>	<u>Measurement Description</u>	<u>Response Rate</u>	<u>Sensor</u> <u>Range</u> <u>Low</u> <u>High</u>	<u>Display Readout</u>	<u>Channel Code</u>
CH3639X	BMAG Mode SW - Pitch Rate 2	10 S/S	Event	Panel Switch	11E33-4
CH3641X	BMAG Mode Sw-Yaw Att 1/ Rate 2	10 S/S	Event	Panel Switch	11E33-5
CH3642X	BMAG Mode Sw - Yaw Rate 2	10 S/S	Event	Panel Switch	11E33-6

ACCEL	Accelerometer/Acceleration
ACS	Attitude Control Subsystem
AC	Alternating Current
A/C	RCS Quads A and C
A/D	Analog to Digital
ALT	Attitude
AMP	Amplifier
ARS	Attitude Reference Subsystem
ASCP	Attitude Set Control Panel
ATT	Attitude/Attenuation
ATT SET	Attitude Set
AUTO	Automatic
B/D	RCS Quads B and D
BMAG	Body Mounted Attitude Gyro
B.O.	Break Out Switch
bps	Bits Per Second
BUR	Backup Rate
BURR	Backup Rate Roll
BURP	Backup Rate Pitch
BURY	Backup Rate Yaw
CB	Circuit Breaker
CCW	Counterclockwise
C&D	Controls and Displays
CDH	Constant Delta Height
CDU	Coupling Data Unit
CFP	Concentric Flight Plan
CG	Center of Gravity
CHAN	Channel
CM	Command Module
CMC	Command Module Computer
CMD	Command
COAS	Crew Optical Alignment Sight
CONT	Control
CPS	Cycles Per Second
CSC	Cosecant Computing Amplifier

CSM	Command and Service Module
CSS	Computer Subsystem
CTE	Central Timing Equipment
CW	Clockwise/Continuous Wave
CW	Not Clockwise
C/W	Caution and Warning
D/A	Digital - to - Analog
DAC	Digital to Analog Converter
DAP	Digital Autopilot
DB or d.b.	Deadband
DECR	Decrease
DC	Direct Current
DEM0D	Demodulator
DSKY	Display and Keyboard
E	Elevation Angle
ECA	Electronic Control Assembly
ECO	Engine Combustion/Engine Cut OFF
EDA	Electronic Display Assembly
ELECT	Electronic
ELS	Earth Landing System
EMS	Entry Monitor System
ENC	Encode
ENG	Engine
ERR	Error
FCSD	Flight Crew Support Division (MSC)
FCSM	Flight Combustion Stability Monitor
FDAI	Flight Director Attitude Indicator
FUNCT	Functional
GA	Gyro Assembly
G&C	Guidance and Control
GET	Ground Elapse Time
G&N	Guidance and Navigation

GNCS	Guidance Navigation and Control System
GDC	Gyro Display Coupler
GMBL	Gimbal
GP/FPI	Gimbal Position and Fuel Pressure Indicator
GPI	Gimbal Position Display
GSOP	Guidance System Operations Plan

ha	Apogee Altitude
HI	High/Hello
hp	Perigee Altitude
HTRS	Heaters

ICDU	Inertial Coupling Data Unit
IGA	Inner Gimbal Angle
IGN	Ignition
IND	Indicator
IMP	Impulse
IMU	Inertial Measurement Unit
INCR	Increase
IRIG	Inertial Rate Integrating Gyro
ISS	Inertial Subsystem
IU	Instrument Unit

KC	Kilo Cycles
----	-------------

LAT	Latitude
LEB	Lower Equipment Bay
LES	Launch Escape System
LET	Launch Escape Tower
LM	Lunar Module
LMK	Landmark
LOR	Lunar Orbit Rendezvous
LOS	Line of Sight
LV	Launch Vehicle/Lift Vector

MAN	Manual
MAX	Maximum
MDC	Main Display Console
MERU	Milli Earth Rate Unit
MESC	Mission Events Sequence Control
MIN	Minimum
MGA	Middle Gimbal Angle
MMH	Monomethylhydrozene
MNA	Main Buss A
MNB	Main Buss B
MSB	Most Significant Bit
MTVC	Manual Thrust Vector Control

NAV	Navigation
NB	Navigation Base
NORM	Normal
NRZ	Non-return to Zero

OCDU	Optics Coupling Data Unit
OGA	Outer Gimbal Angle
OPT	Optics
OSS	Optics Subsystem
ORDEAL	Orbit Rate Drive Electronics Apollo LM
OXID	Oxidizer

P	Pitch Axis of Control/Program
PA	Power Amplifier
PB	Push Button
PCM	Pulse Code Modulation
PGNCS	Primary Guidance, Navigation and Control System
PH	Phase
PIPA	Pulsed Integrating Pendulous Accelerometer
PSA	Power Servo Assembly
PPS	Pulse Per Second
PTT	Push to Talk

PWR	Power	TIGN	Time of Ignition
R	Roll Axis of Control/Routine or DSKY Display Register	TLC	Translunar Coast
RC	Rotation Control	TM	Telemetry
RCS	Reaction Control System	TPAC	Telescope Pointing Angle Counter
REL	Release	TFF	Time of Freefall
REV	Reverse	TPF	Transfer Phase Final
RGA	Rate Gyro Assembly	TPI	Transfer Phase Initiation
RJD	Reaction Jet Driver	TTINT	Time to Intercept
RJ/EC	Reaction Jet and Engine ON-OFF Control	TRNFR	Transfer
RLVDT	Rotary Linear Variable Differential Transformer	TTE	Time - to Events
RNG	Range	TVC	Thrust Vector Control
ROT	Rotation	TVSA	Thrust Vector Position Servo Amplifier
RSI	Roll Stability Indicator	UDL	Up Data Link
RTC	Real Time Commands	UPTLM	Up-Link Telemetry
RUPT	Interrupt	V	Velocity
S/C	Spacecraft	VM	Velocity Measured
SCT	Scanning Telescope	Vc	Circular Velocity
SCS	Stabilization and Control System	Vo	Initial Velocity at .05g
SIG	Signal	XLATION	Translation
SLOS	Star Line of Sight	XLUNAR	Translunar
SM	Service Module	ΔV	Differential Velocity
SMJC	Service Module Jettison Controller	ϕ	Roll Control Axis Designation/Phase
SMRD	Spin Motor Rotation Detector	ψ	Yaw Control Axis Designation
SPS	Service Propulsion System/Samples per Second	θ	Pitch Control Axis Designation
STBY	Standby		
SW	Switch		
SXT	Sextant		
SYNC	Synchronize		
SYS	System		
TC	Translation Control		
TEC	Transearch Coast		
TEMP	Temperature		
TFL	Time - From - Launch		