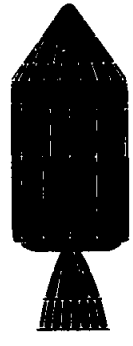
Hyle
3/13/67



APOLLO TRAINING

GUIDANCE AND CONTROL SYSTEMS BLOCK II

FEBRUARY 10, 1967

FOR TRAINING PURPOSES ONLY

APOLLO LOGISTICS TRAINING

BOX 0[illegible]

Hl. to Hughes

Don Bennett

Hl Schuler

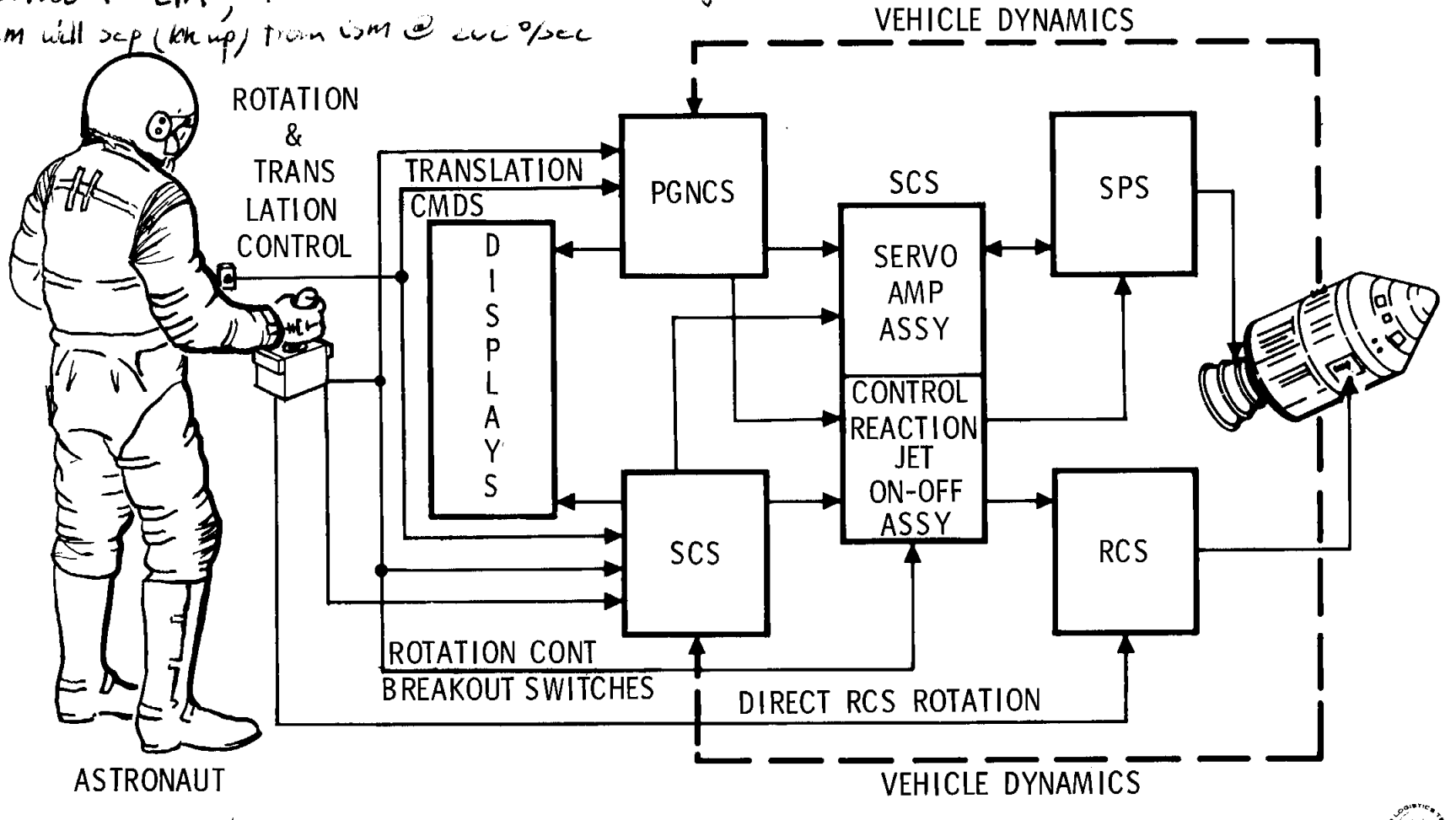
Martin Marietta

* If G&N system isn't working
  ∴ LOI, jett. LM & return to earth.

* SCS is parallel with PGNCS
  ∴ it is a back up. control system

CSM GUIDANCE & CONTROL

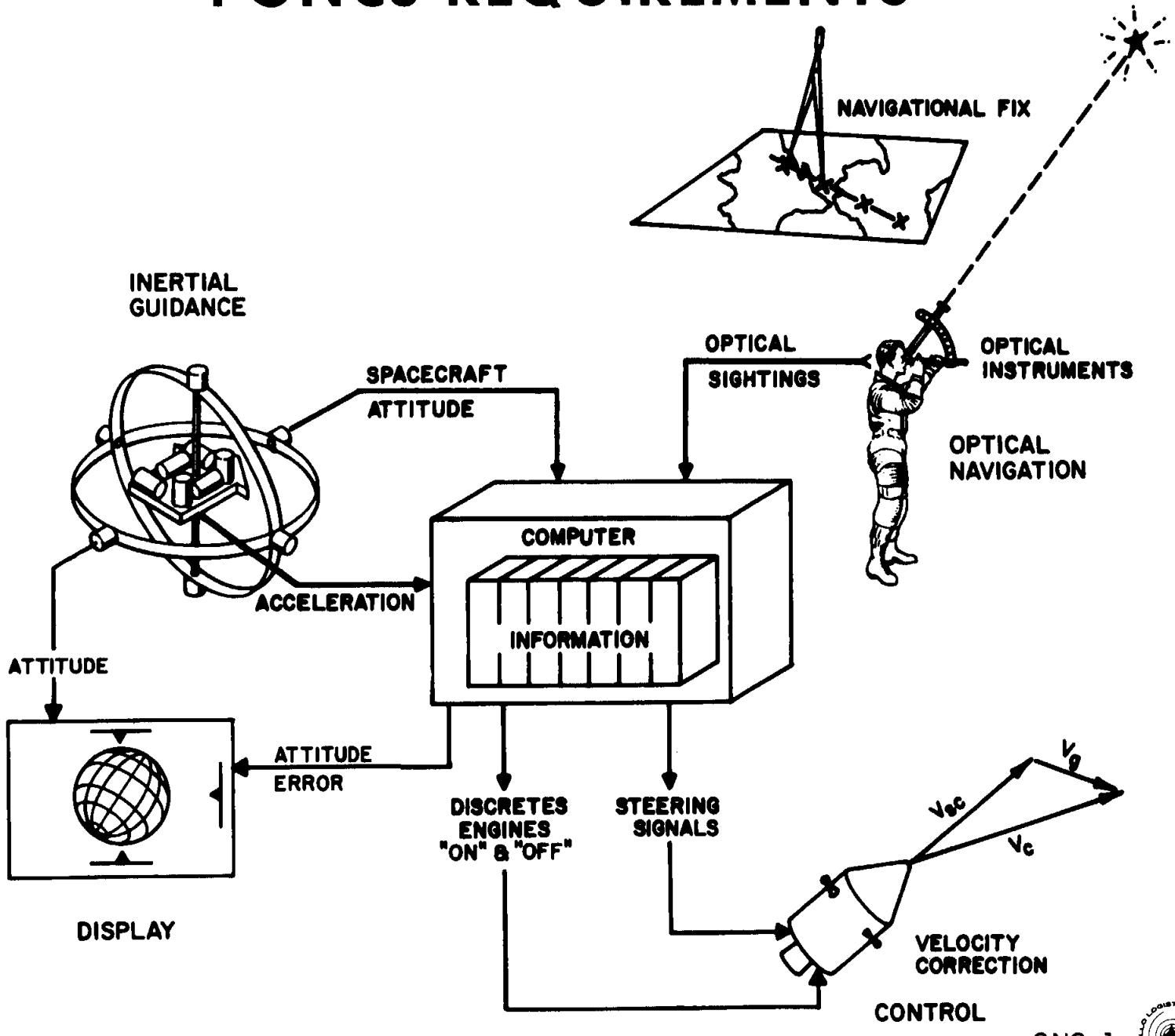
* With LM attached cg position is a good cue --- because att. control is sluggish
* Without LM, the limiter in the TVC logic becomes a good rate cue.
* CM will sep (blow up) from ISM @ ccc °/sec



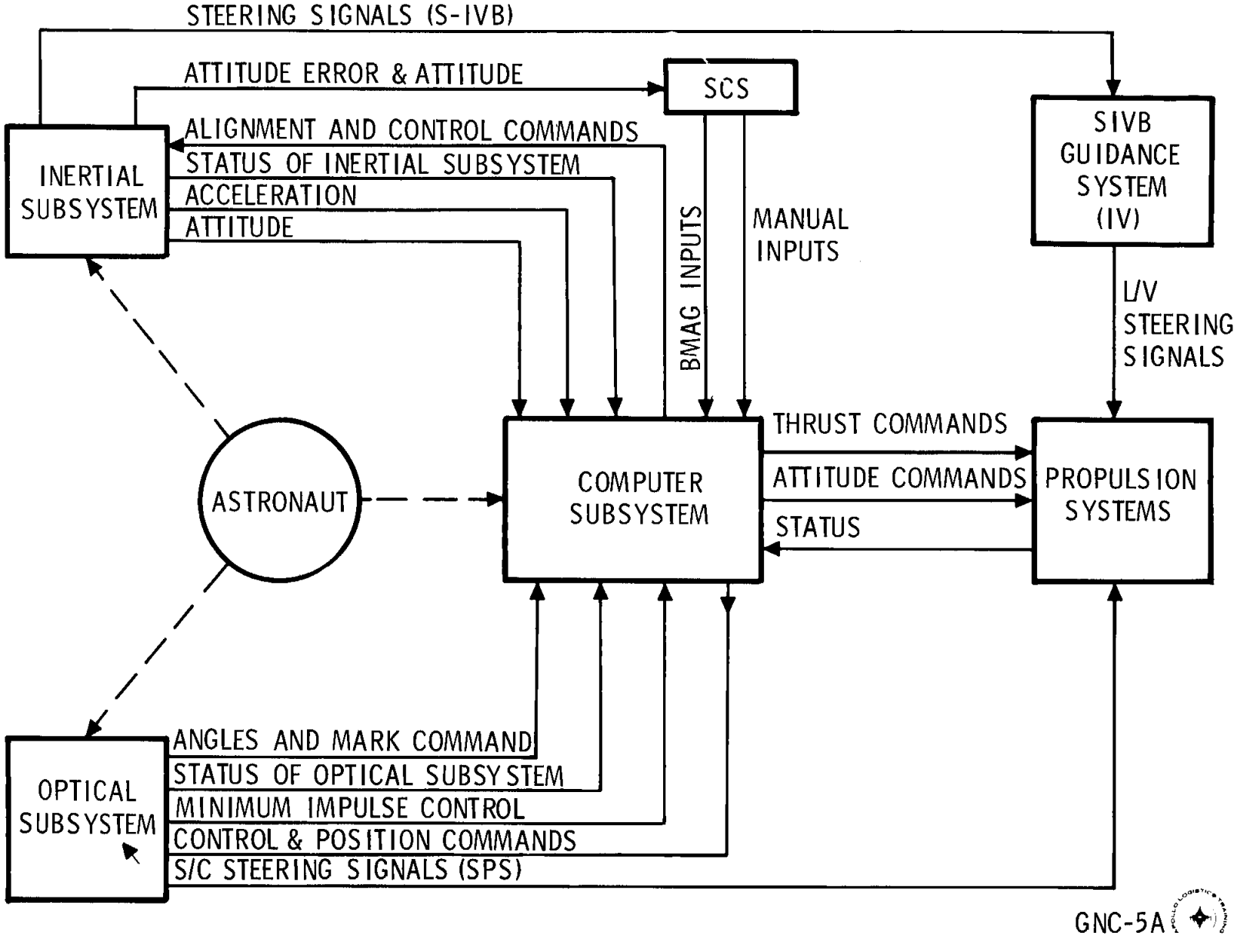
SCS-3002A

→ Backup actuator ∴ if you have actuator Hardover, 2nd one takes over & you can use it to control

PGNCS REQUIREMENTS

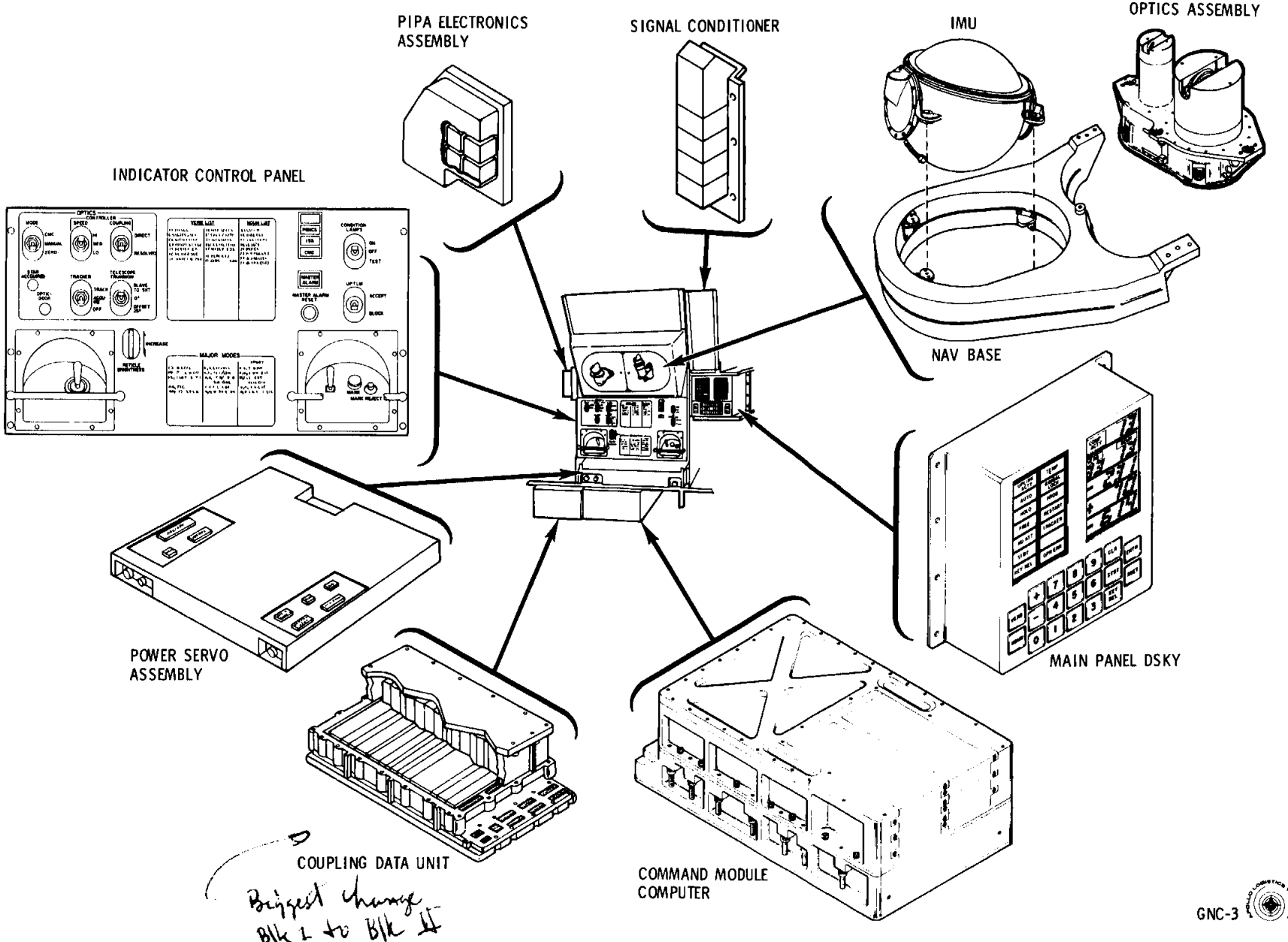


PGNCS DATA FLOW



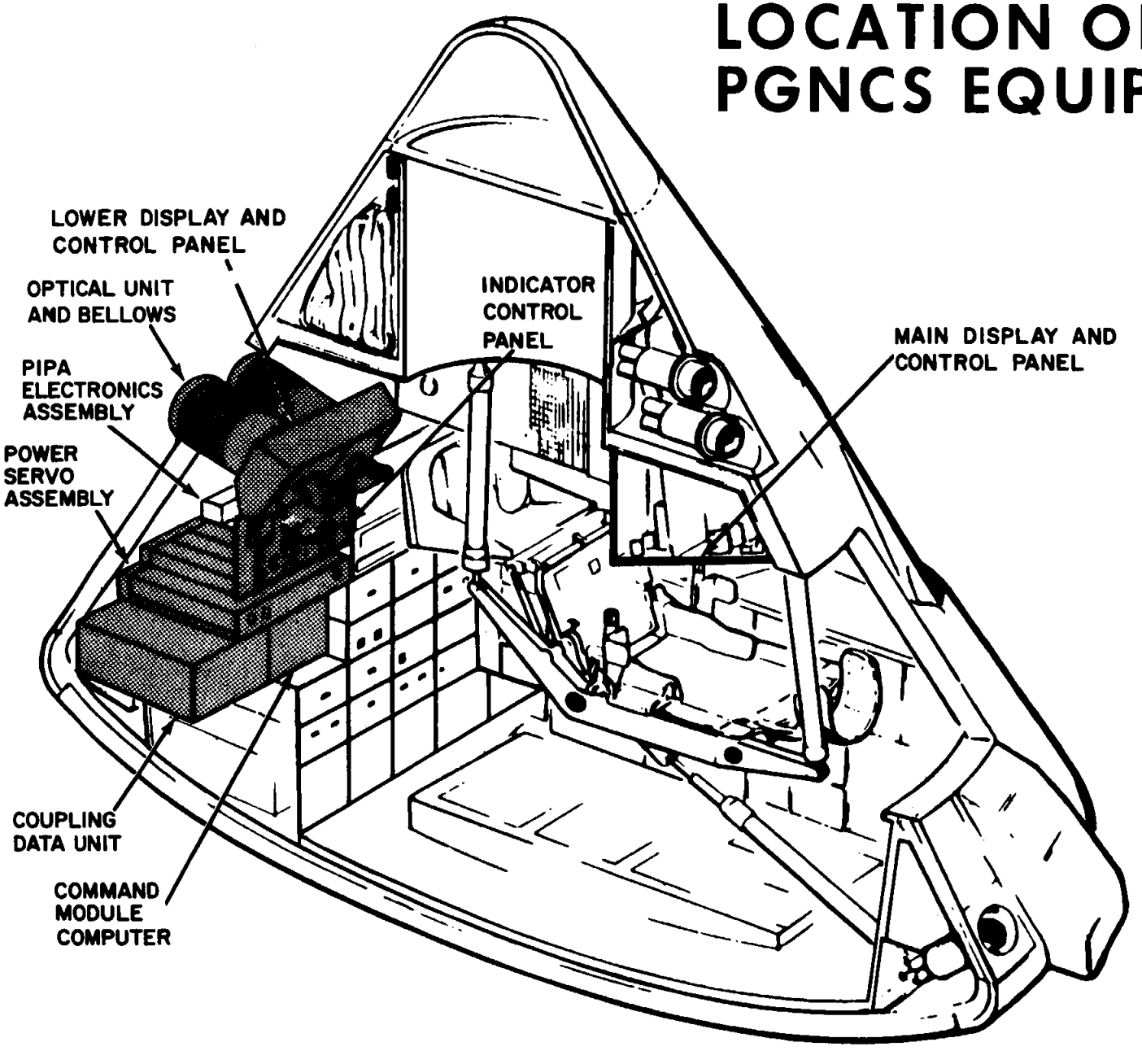
GNC-5A

PGNCS EQUIPMENT



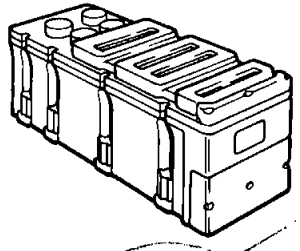
Biggest change
Blk I to Blk II
No display in Blk II
(extensive use of comp)

LOCATION OF PGNCS EQUIPMENT

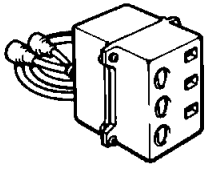


SCS FLIGHT HARDWARE

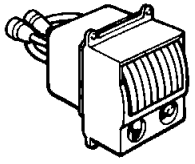
BLOCK II



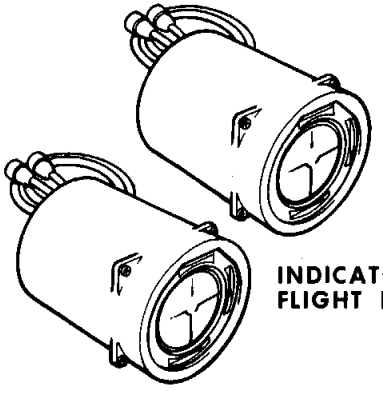
ELECTRONIC CONTROL ASSEMBLY



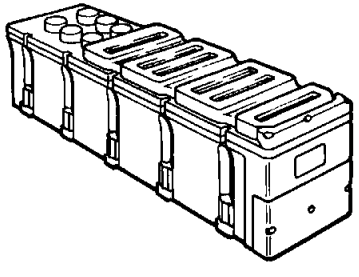
CONTROL PANEL, ATTITUDE SET



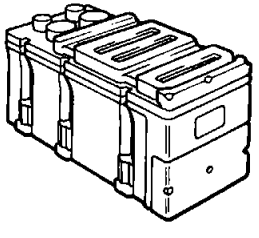
INDICATOR, GIMBAL POSITION AND FUEL PRESSURE



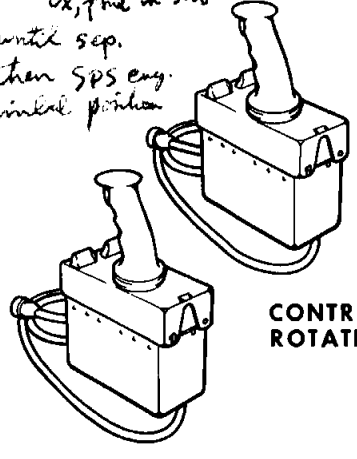
INDICATOR, ATTITUDE, FLIGHT DIRECTOR (2)



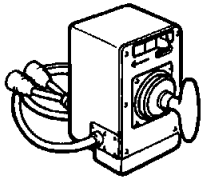
REACTION JET AND ENGINE ON-OFF CONTROL



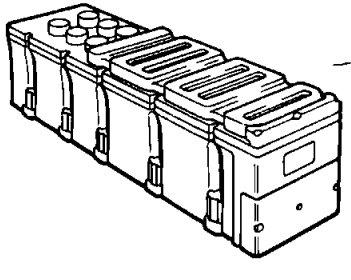
SERVO AMPLIFIER, THRUST VECTOR POSITION



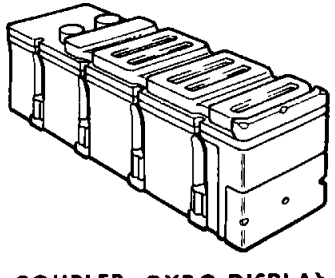
CONTROL, ROTATION (2)



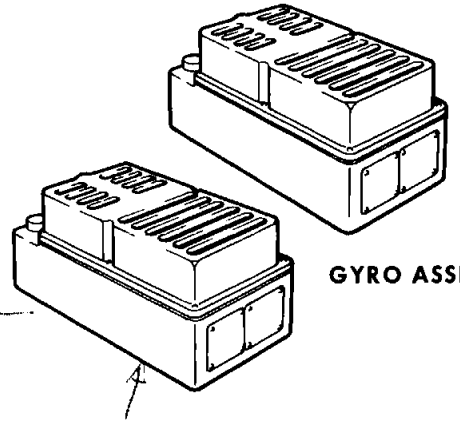
CONTROL, TRANSLATION



ELECTRONIC DISPLAY ASSEMBLY



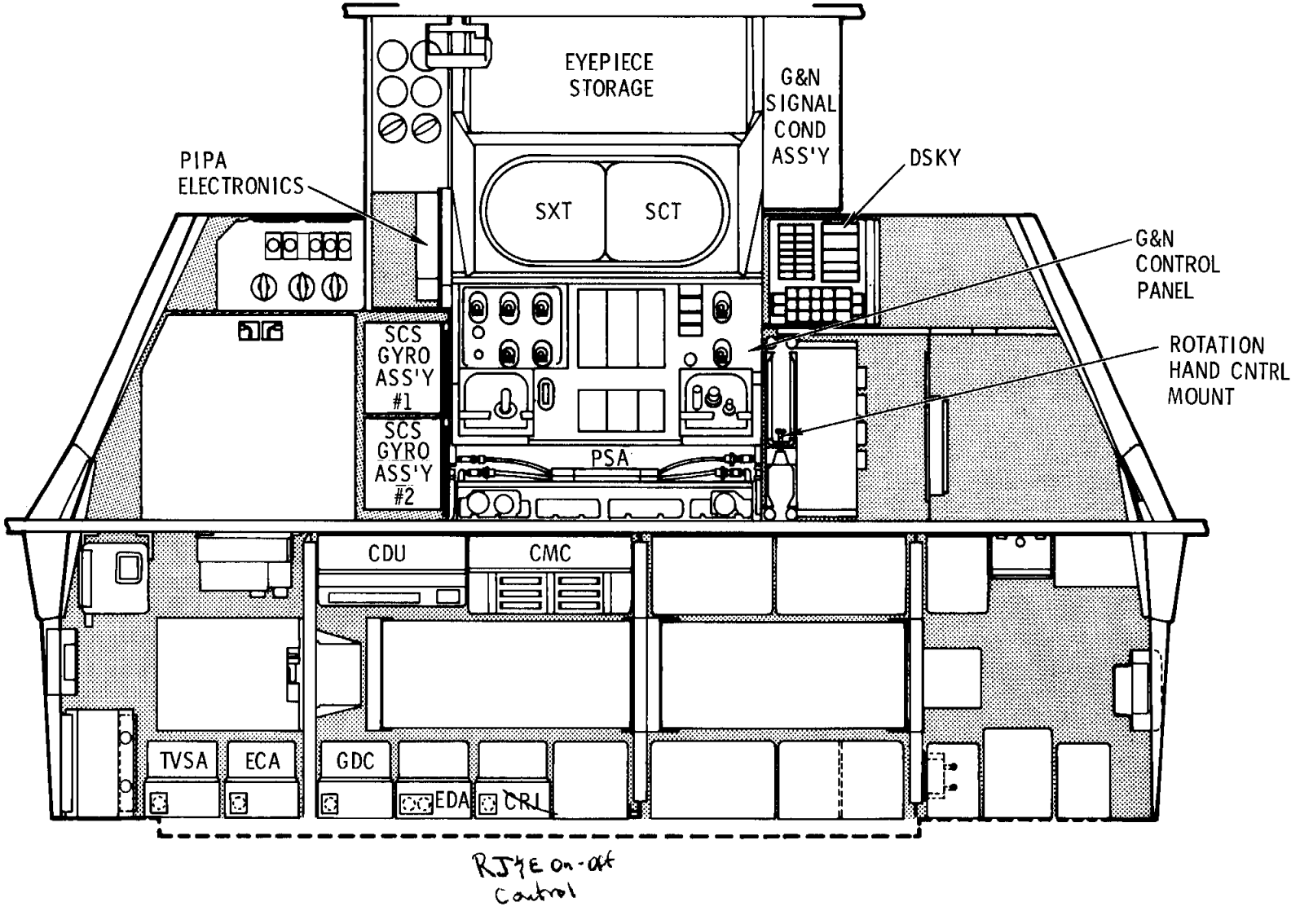
COUPLER, GYRO DISPLAY



GYRO ASSEMBLY (2)

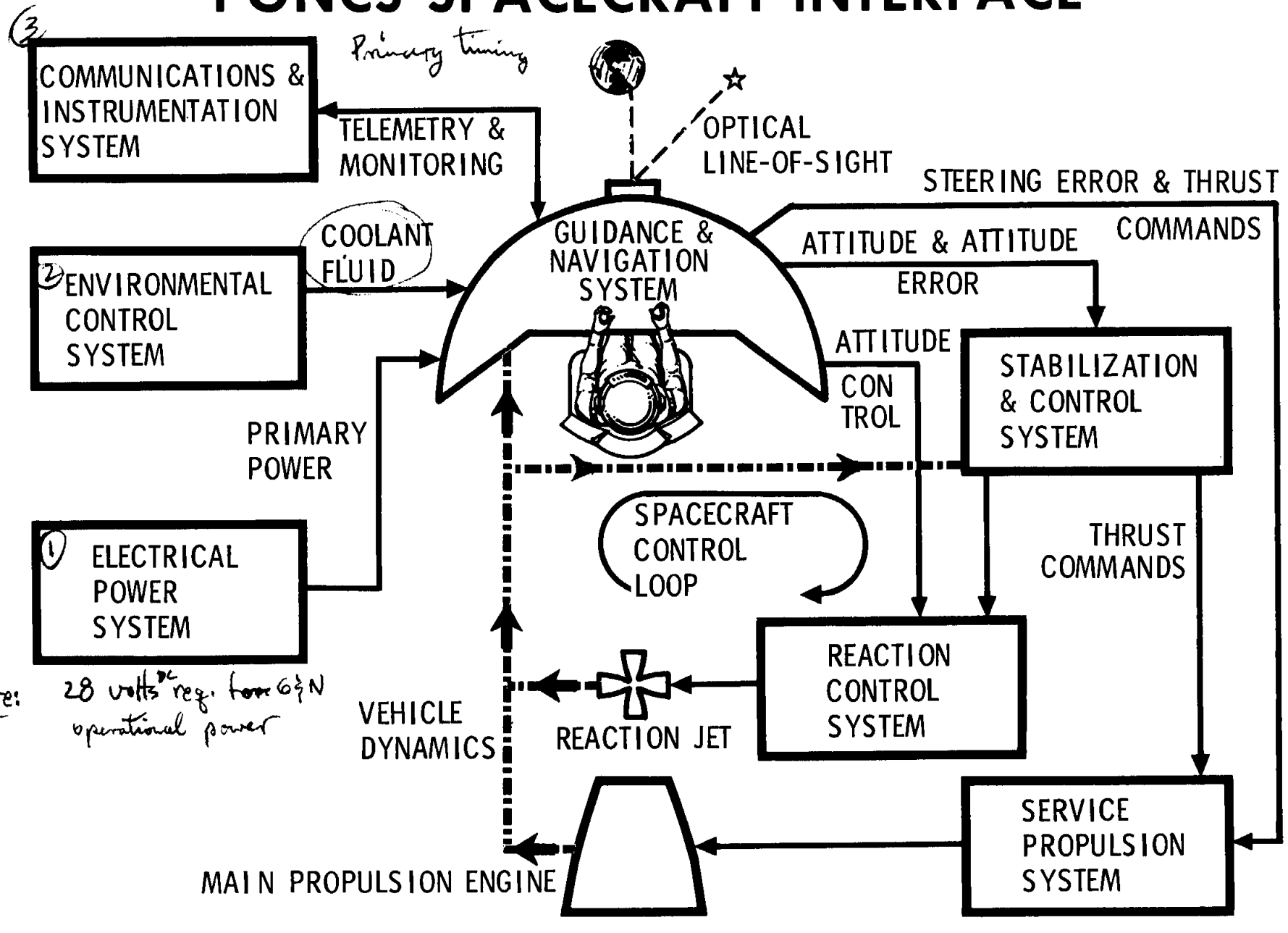
SCS-2010B

G&C EQUIPMENT LOCATION

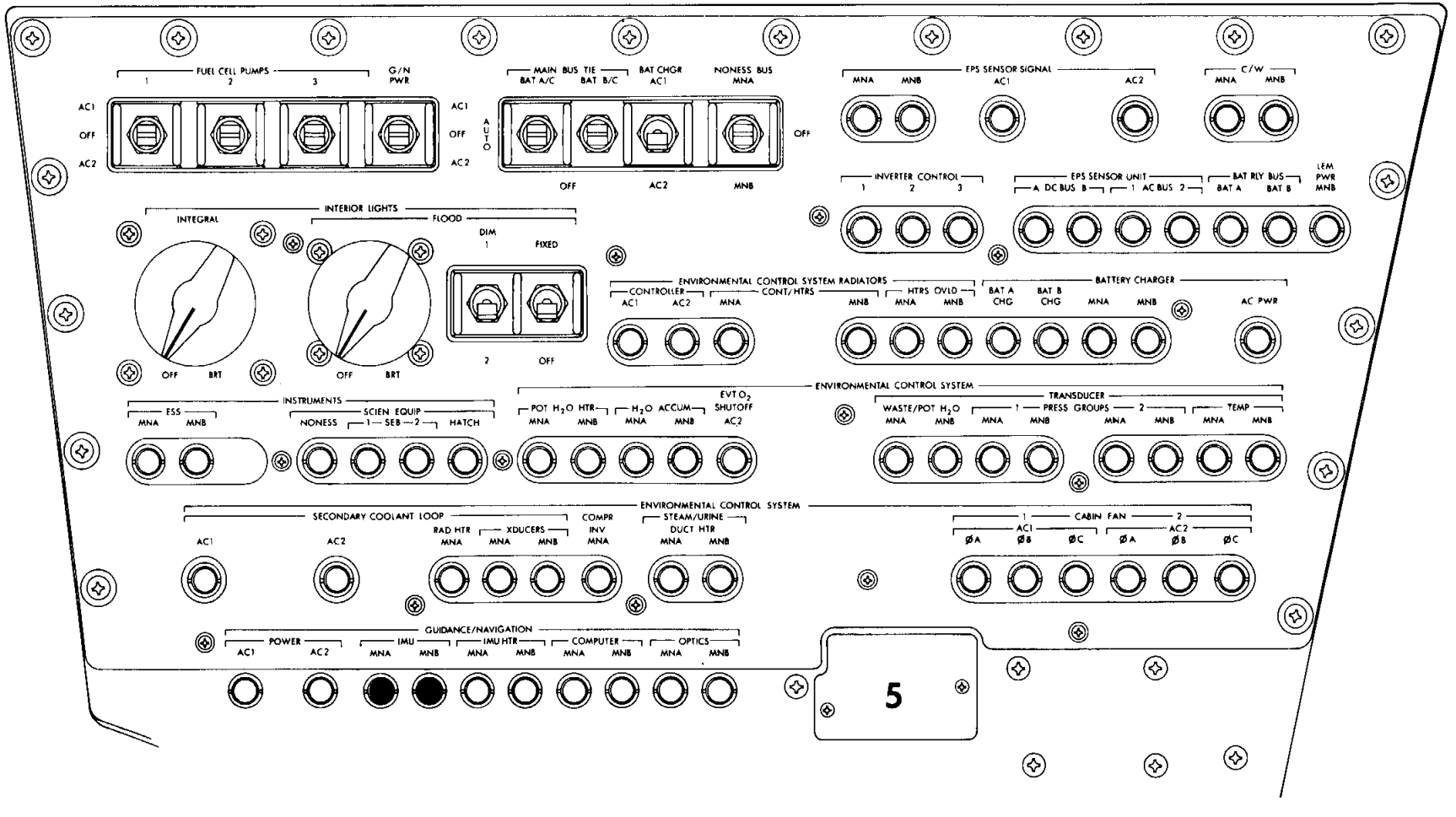


SCS-3004A

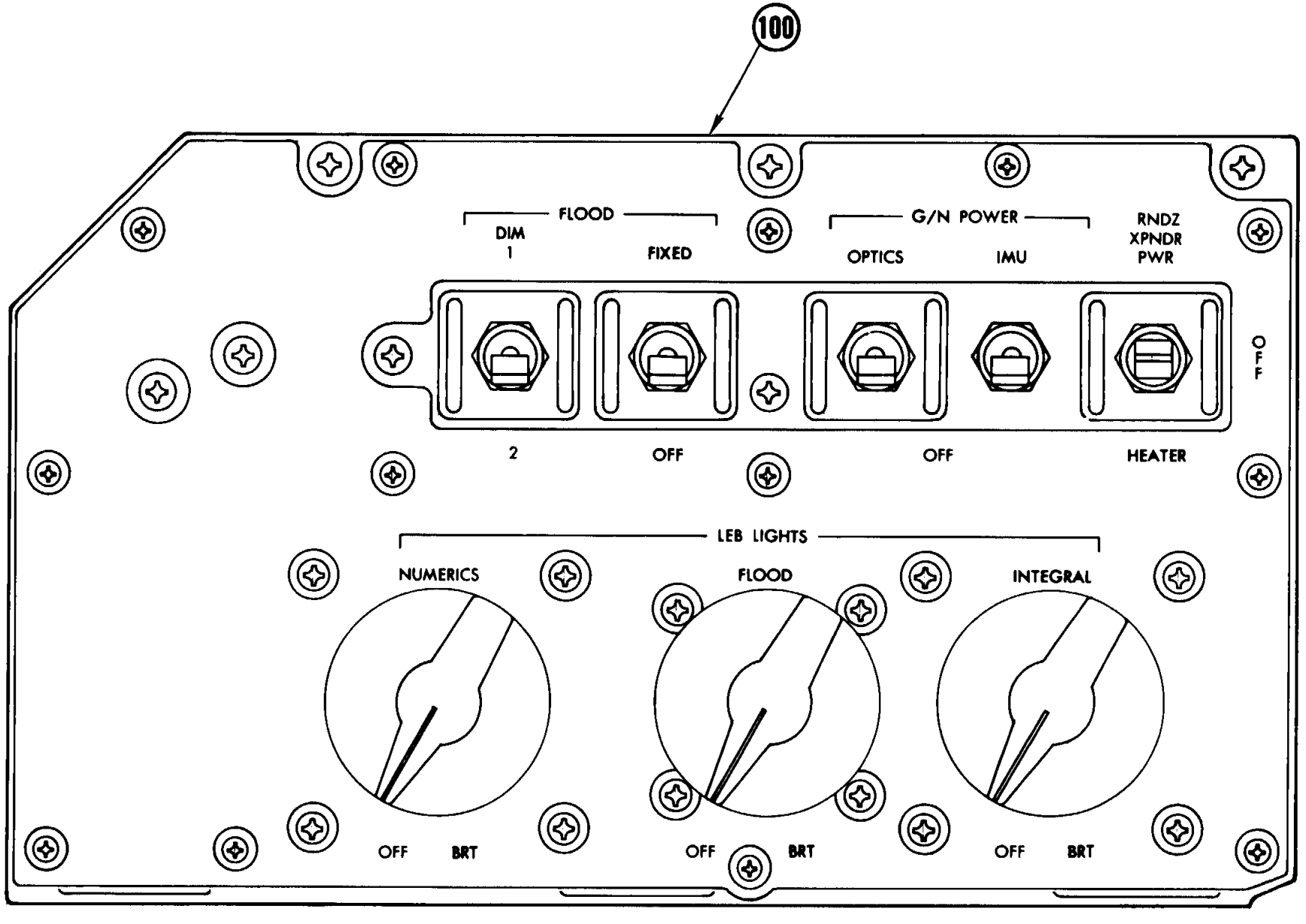
PGNCS SPACECRAFT INTERFACE



Note: 28 volts DC reg. from O2 & N operational power

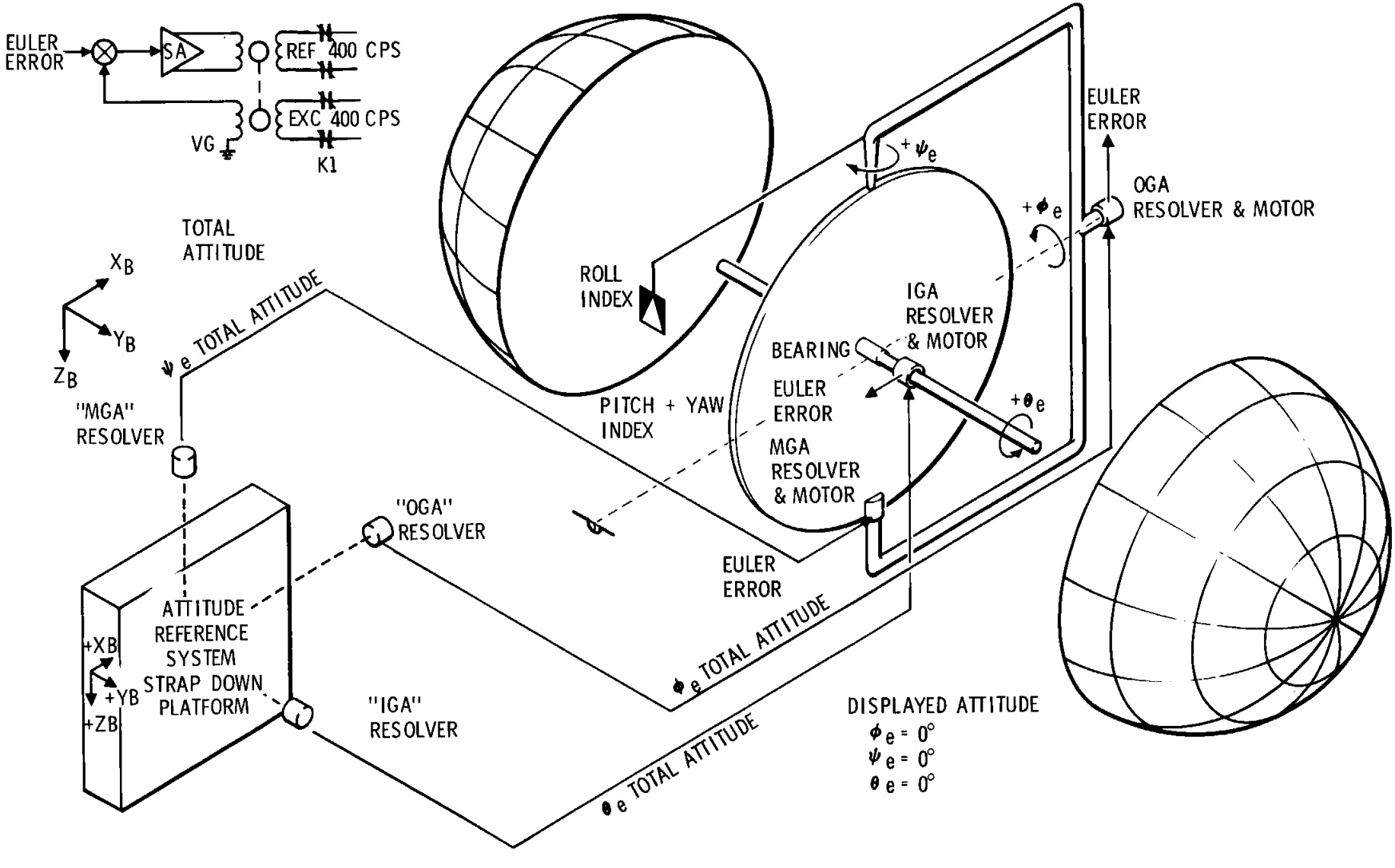

FUEL CELL PUMPS
1
2
3
G/N PWR
AC1
OFF
AC2
MAIN BUS TIE
BAT A/C
BAT B/C
BAT CHGR
AC1
NONESS BUS
MNA
AUTO
OFF
AC2
MNB
EPS SENSOR SIGNAL
MNA
MNB
AC1
AC2
C/W
MNA
MNB
INVERTER CONTROL
1
2
3
EPS SENSOR UNIT
A DC BUS B
1 AC BUS 2
BAT RLY BUS
BAT A
BAT B
LEM PWR
MNB
INTERIOR LIGHTS
INTEGRAL
OFF
BRT
FLOOD
OFF
BRT
DIM
1
FIXED
2
OFF
ENVIRONMENTAL CONTROL SYSTEM RADIATORS
CONTROLLER
AC1
AC2
CONT/HTRS
MNA
MNB
HTRS OVLO
MNA
MNB
BATTERY CHARGER
BAT A CHG
BAT B CHG
MNA
MNB
AC PWR
INSTRUMENTS
ESS
MNA
MNB
SCIEN EQUIP
NONESS
1
SEB
2
HATCH
ENVIRONMENTAL CONTROL SYSTEM
POT H_2O HTR
MNA
MNB
H_2O ACCUM
MNA
MNB
EVT O_2 SHUTOFF
AC2
TRANSDUCER
WASTE/POT H_2O
MNA
MNB
PRESS GROUPS
1
MNA
MNB
2
MNA
MNB
TEMP
MNA
MNB
ENVIRONMENTAL CONTROL SYSTEM
SECONDARY COOLANT LOOP
AC1
AC2
RAD HTR
MNA
XDUCERS
MNA
MNB
COMPR
INV
MNA
STEAM/URINE
DUCT HTR
MNA
MNB
CABIN FAN
1
AC1
ØA
ØB
ØC
2
AC2
ØA
ØB
ØC
GUIDANCE/NAVIGATION
POWER
AC1
AC2
IMU
MNA
MNB
IMU HTR
MNA
MNB
COMPUTER
MNA
MNB
OPTICS
MNA
MNB
5

FAM-6350 B


100
FLOOD
DIM
1
FIXED
G/N POWER
OPTICS
IMU
RNDZ
XPNDR
PWR
OFF
2
OFF
OFF
HEATER
LEB LIGHTS
NUMERICS
FLOOD
INTEGRAL
OFF
BRT
OFF
BRT
OFF
BRT

FAM-6301

FDAI/GDC SHAFT RELATIONSHIP



SCS-2206

(Euler Angles (P,Y,R seq.)

FLIGHT DIRECTOR ATTITUDE INDICATOR

This shows total att. wrt to ball

ROLL
+ANGULAR VELOCITY-
+ATTITUDE ERROR-

Inside out system

PITCH & YAW INDEX

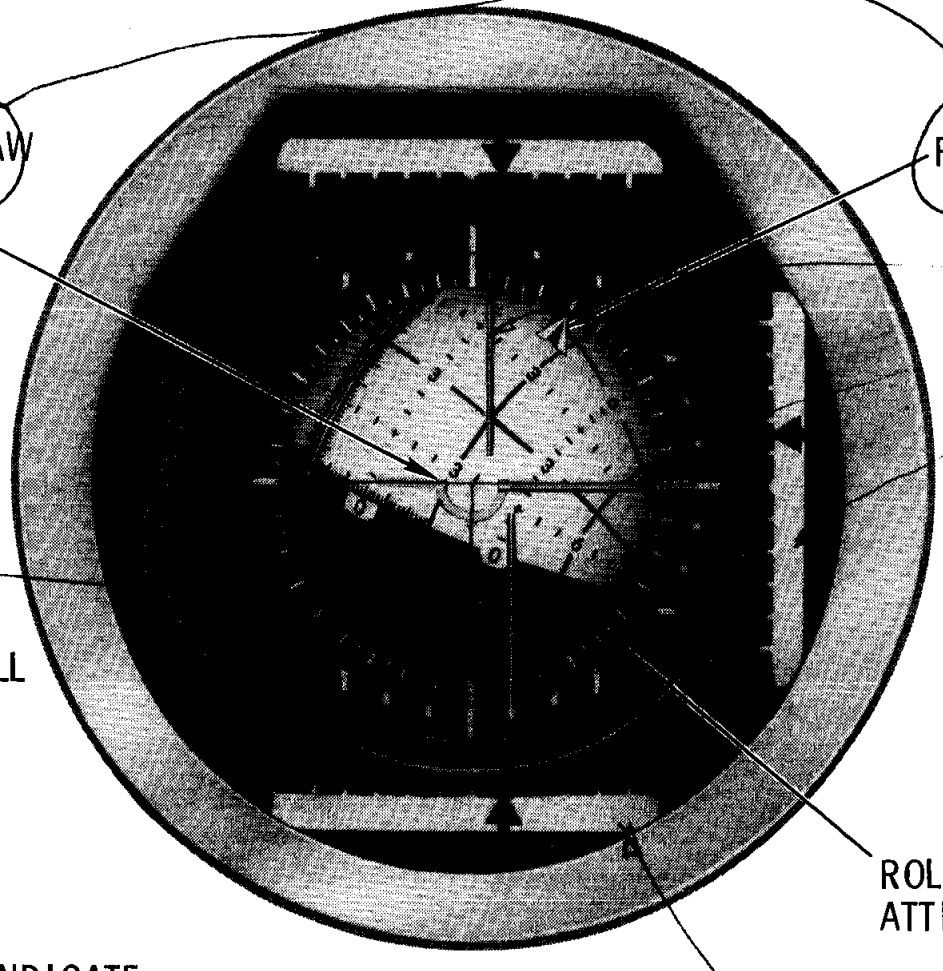
ROLL INDEX

I) Airplane wings & roll bug give total att. ... wings fixed, ball moves

II Att Error ... 3 att. indicators

III Rates: ... Outside gages

If s/c yaws rt, needle moves left (Att. error)



- PITCH +

ATTITUDE ERROR + ANGULAR VELOCITY +

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

ROLL TOTAL ATTITUDE SCALE

NOTE:

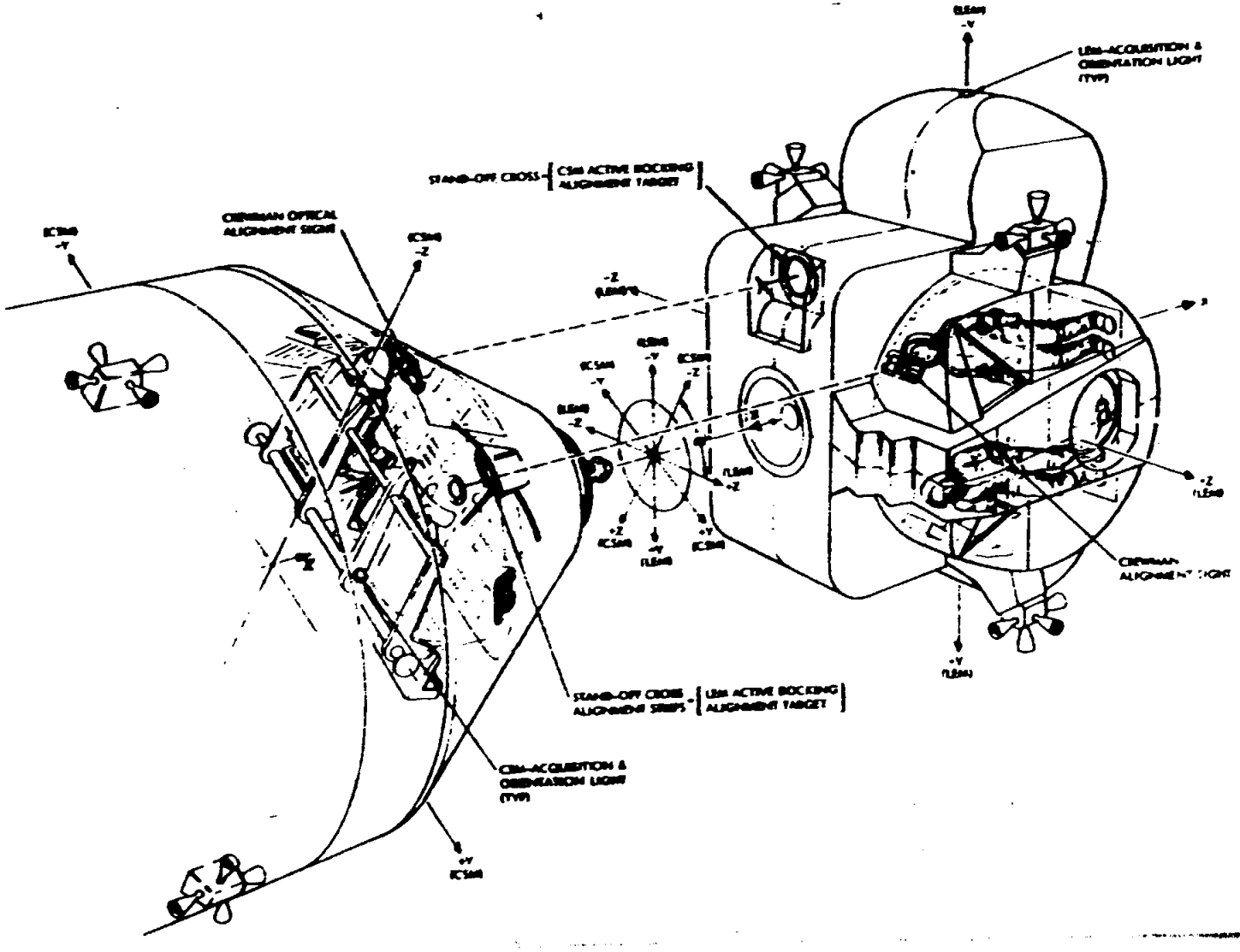
ALL POLARITIES INDICATE VEHICLE DYNAMICS

YAW
+ATTITUDE ERROR-
+ANGULAR VELOCITY-

Fly to Commands

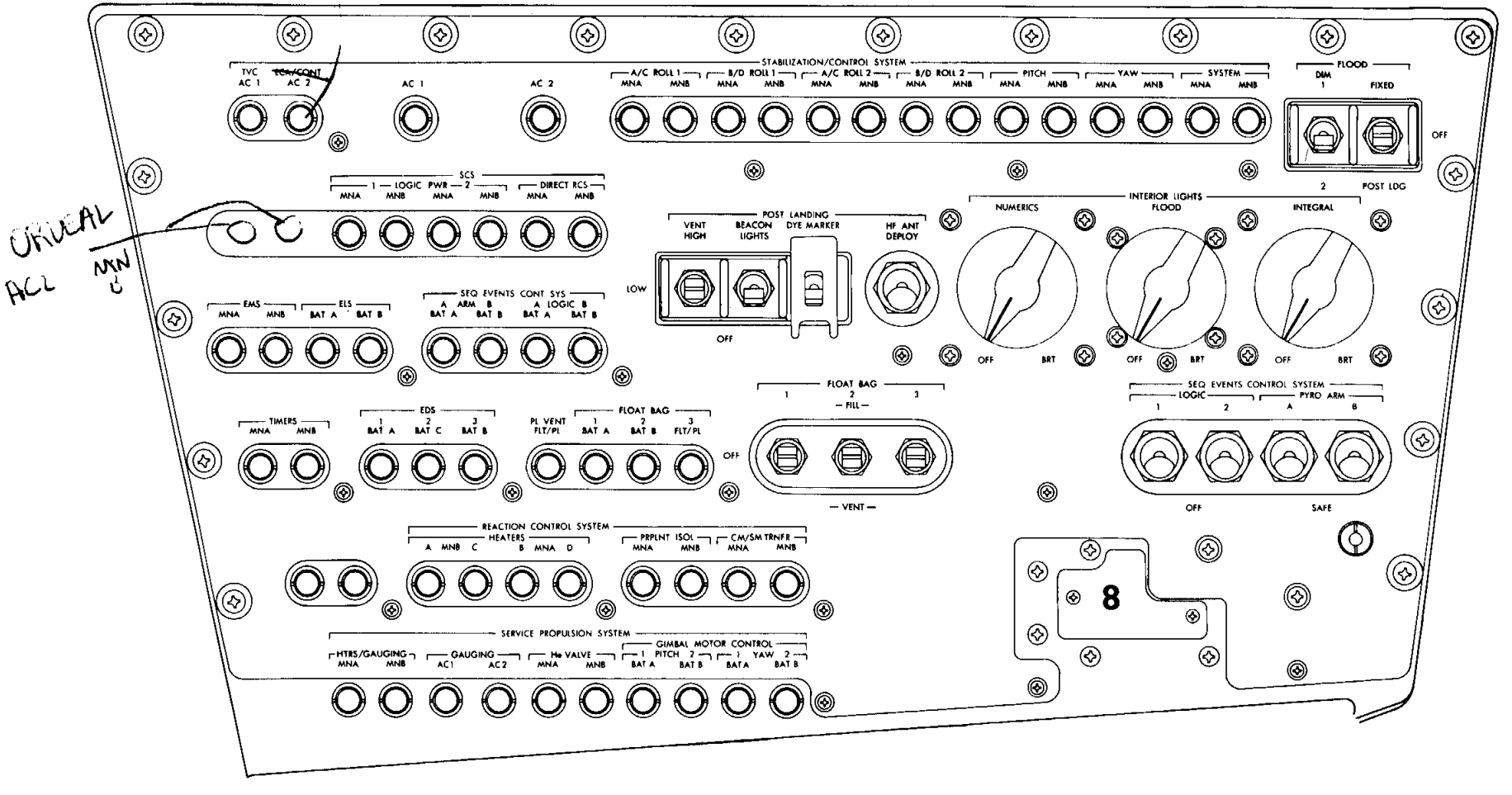
If s/c yaw rt, thee yaw rate needle moves left. To correct pilot moves rot. cont. in dir. of needle (left) & rt. firing thrusters fire & rotate s/c c.c.w.

SCS-2100D

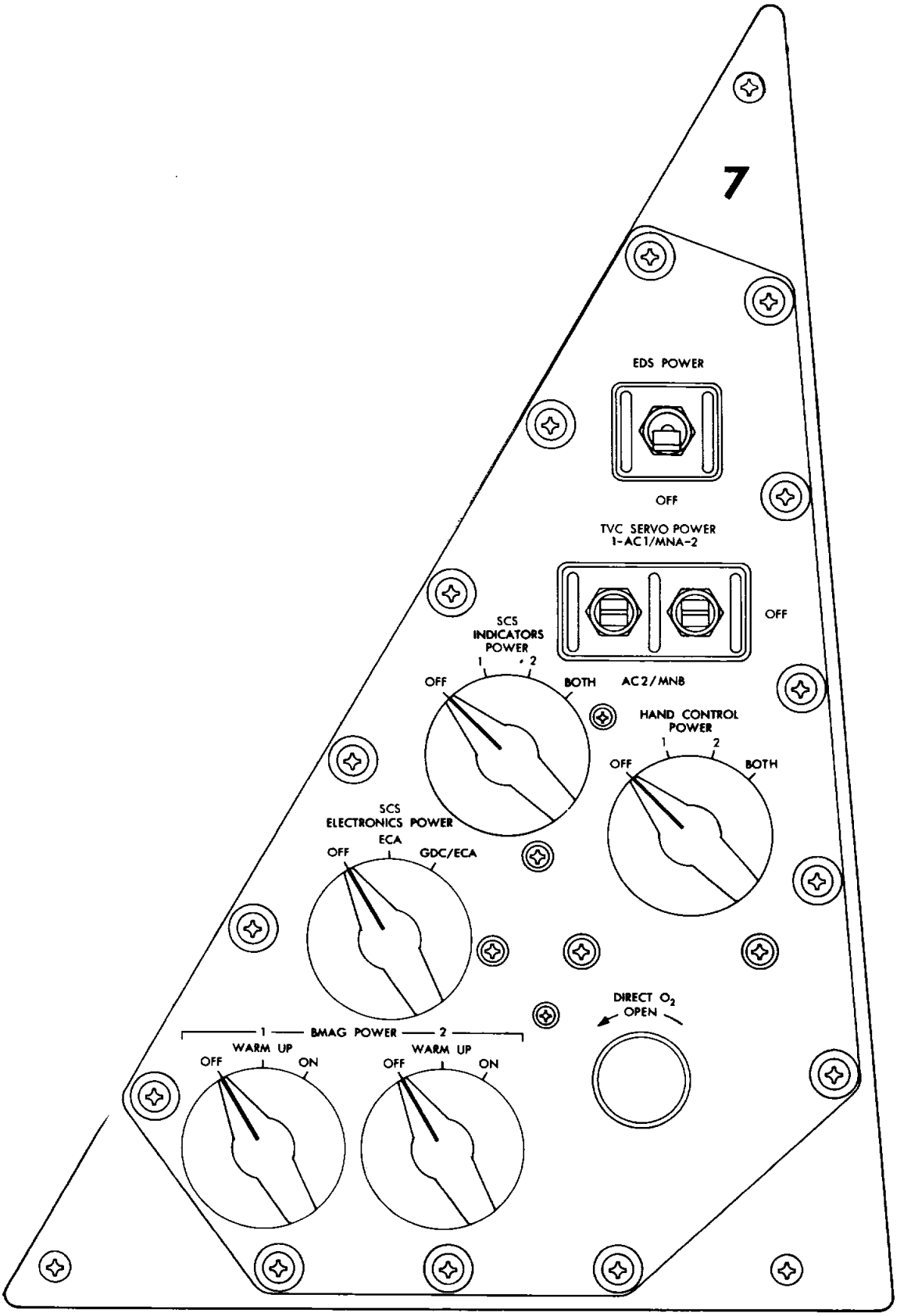

CSM-ACQUISITION & ORIENTATION LIGHT (TYP)
STAND-OFF CROSS
CSM ACTIVE DOCKING ALIGNMENT TARGET
CREWMAN OPTICAL ALIGNMENT SIGHT
STAND-OFF CROSS ALIGNMENT STRIPS
LEM ACTIVE DOCKING ALIGNMENT TARGET
CREWMAN ALIGNMENT SIGHT

SCS Panel

ECA/TVC

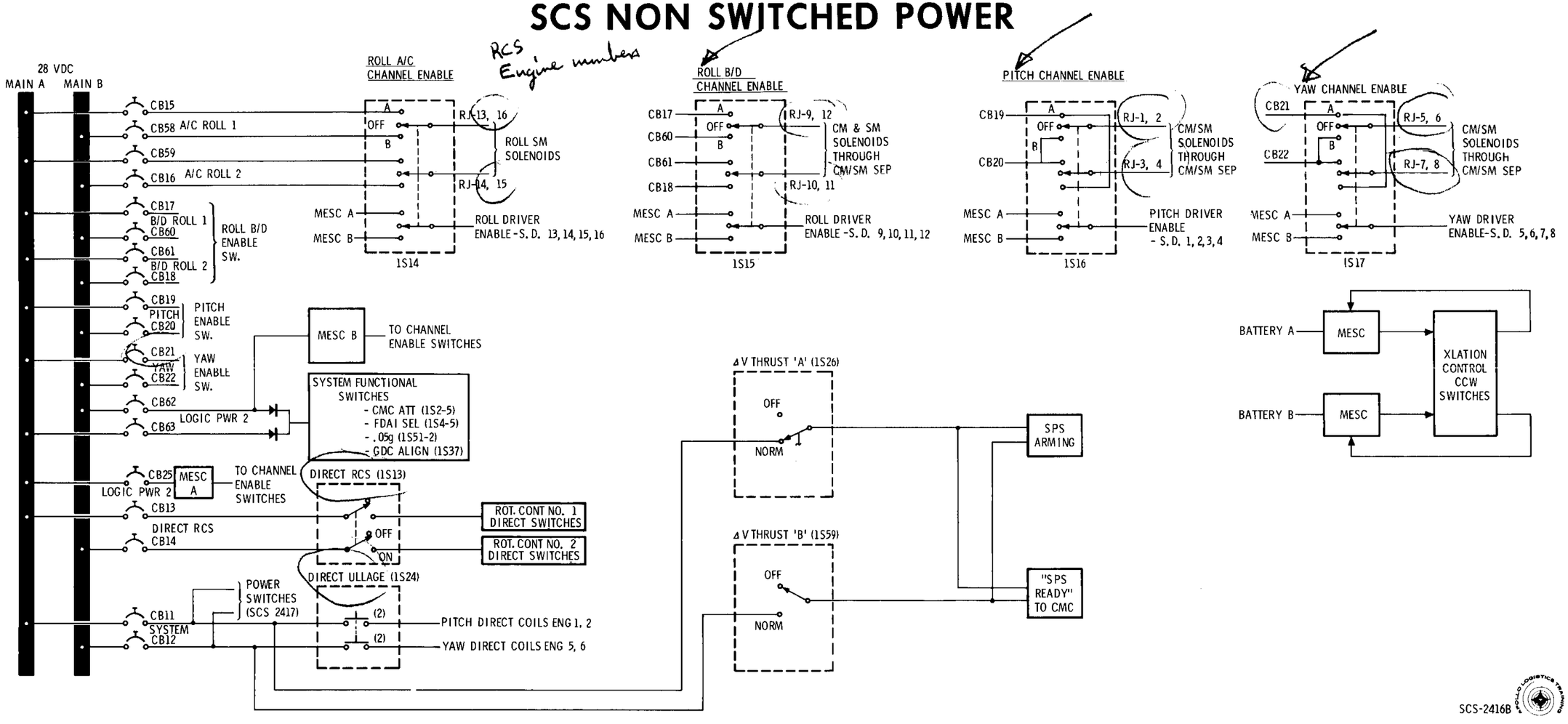


FAM-6380C


7
EDS POWER
OFF
TVC SERVO POWER
1-AC1/MNA-2
OFF
SCS
INDICATORS
POWER
1
2
OFF
BOTH
AC2/MNB
HAND CONTROL
POWER
1
2
OFF
BOTH
SCS
ELECTRONICS POWER
ECA
OFF
GDC/ECA
DIRECT O2
OPEN
1
BMAG POWER
2
WARM UP
OFF
ON
WARM UP
OFF
ON

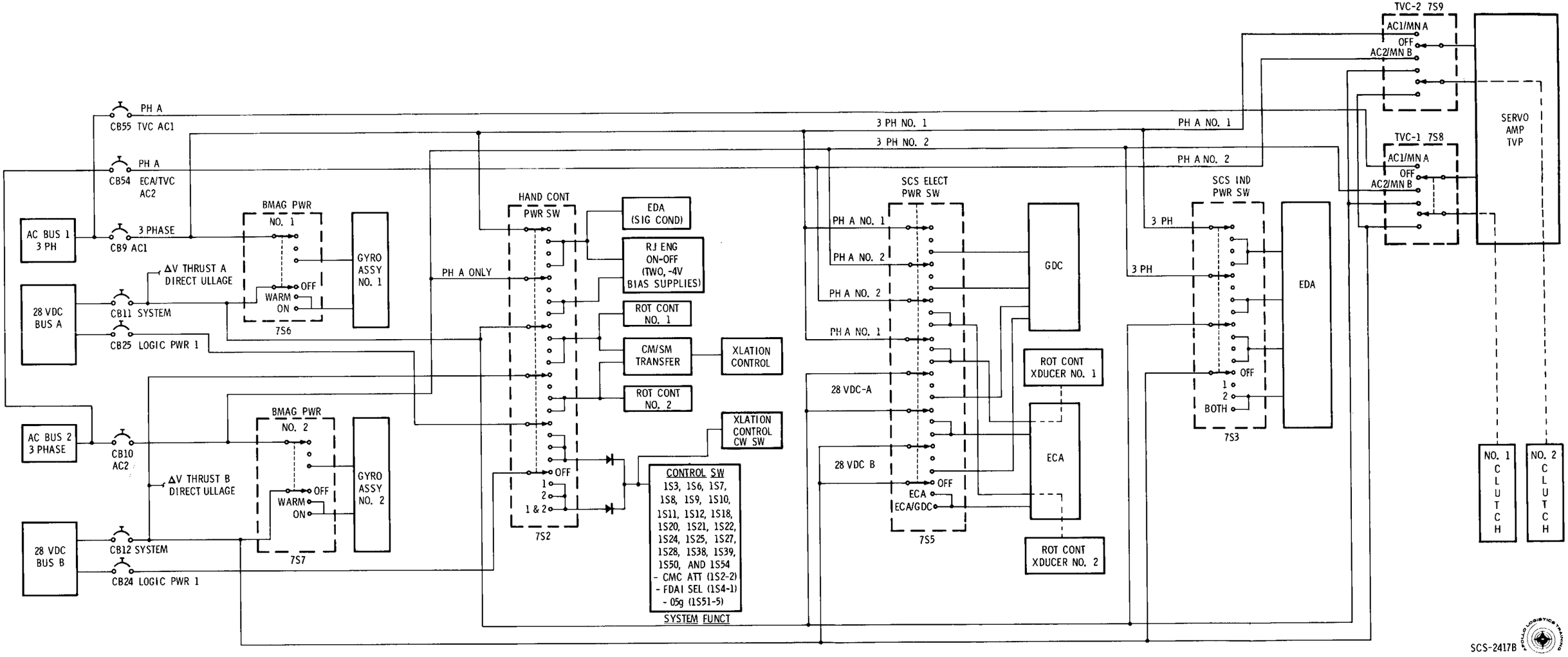
FAM-6370A

SCS NON SWITCHED POWER



SCS-2416B

SCS SWITCHED POWER DISTRIBUTION

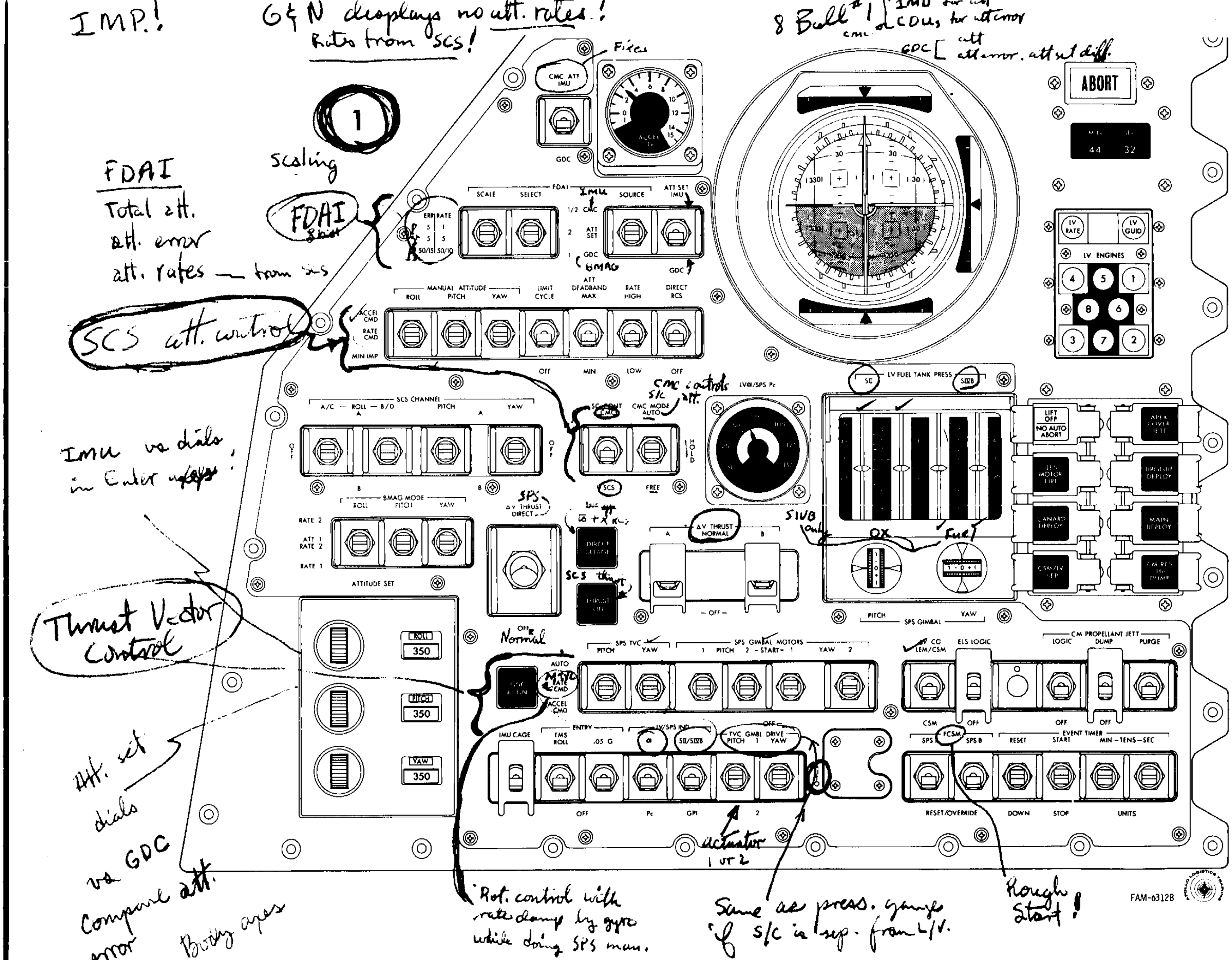


SCS-2417B

(X) TVC

If a G & N burn was initiated and the CMC light came on, the burn could be completed immed. if before starting burn you put SPS TVC S/C control switch is in CMC into ~~auto~~ [or rate cmd] ↓ then when you get CMC light ~~put SC cont switch to SCS.~~ = fixed att.

turn the translation control cw. (rotation)?



IMP!
G&N displays no att. rates!
Rates from SCS!
8 Ball #1
IMU for att
CMC CDUs for att error
GDC att
att error, att set diff.
ABORT
Fixes
CMC ATT
IMU
GDC
ACCEL
G
1
Scaling
FDAI
Total att.
att. error
att. rates — from SCS
FDAI
SCALE
SELECT
SOURCE
ATT SET
IMU
ERR RATE
50/15
50/10
1/2 CMC
ATT SET
GDC
BMAG
MANUAL ATTITUDE
ROLL
PITCH
YAW
LIMIT CYCLE
ATT DEADBAND MAX
RATE HIGH
DIRECT RCS
ACCEL CMD
RATE CMD
MIN IMP
OFF
MIN
LOW
SCS att. control
SCS CHANNEL
A/C
ROLL
B/D
CMC controls S/C att.
SC CONT
CMC
CMC MODE
AUTO
HOLD
FREE
SCS
LV/SPS Pc
LV FUEL TANK PRESS
SII
SIVB
IMU vs dials in Euler angles!
BMAG MODE
RATE 2
ATT 1 RATE 2
RATE 1
ATTITUDE SET
SPS
ΔV THRUST DIRECT
DIRECT ULLAGE
THRUST ON
ΔV THRUST NORMAL
SIVB only
OX
Fuel
LV RATE
LV GUID
LV ENGINES
LIFT OFF NO AUTO ABORT
PITCH
SPS GIMBAL
YAW
Thrust Vector control
ROLL 350
PITCH 350
YAW 350
Normal
AUTO
RATE CMD
ACCEL CMD
SPS TVC
SPS GIMBAL MOTORS
START
CG
LEM/CSM
ELS LOGIC
CM PROPELLANT JETT
LOGIC
DUMP
PURGE
CSM
IMU CAGE
ENTRY
EMS ROLL
.05 G
LV/SPS IND
SII/SIVB
TVC GMBL DRIVE
PITCH
YAW
Pc
GPI
SPS
FCSM
SPS B
EVENT TIMER
RESET
START
MIN — TENS — SEC
RESET/OVERRIDE
DOWN
STOP
UNITS
Att. set dials vs GDC
Compare att. error
Body axes
actuator 1 or 2
Rot. control with rate damp by gyro while doing SPS man.
Same as press. gauge if S/C is sep. from L/V.
Rough Start!
FAM-6312B

Entry Monitor Display

EMS

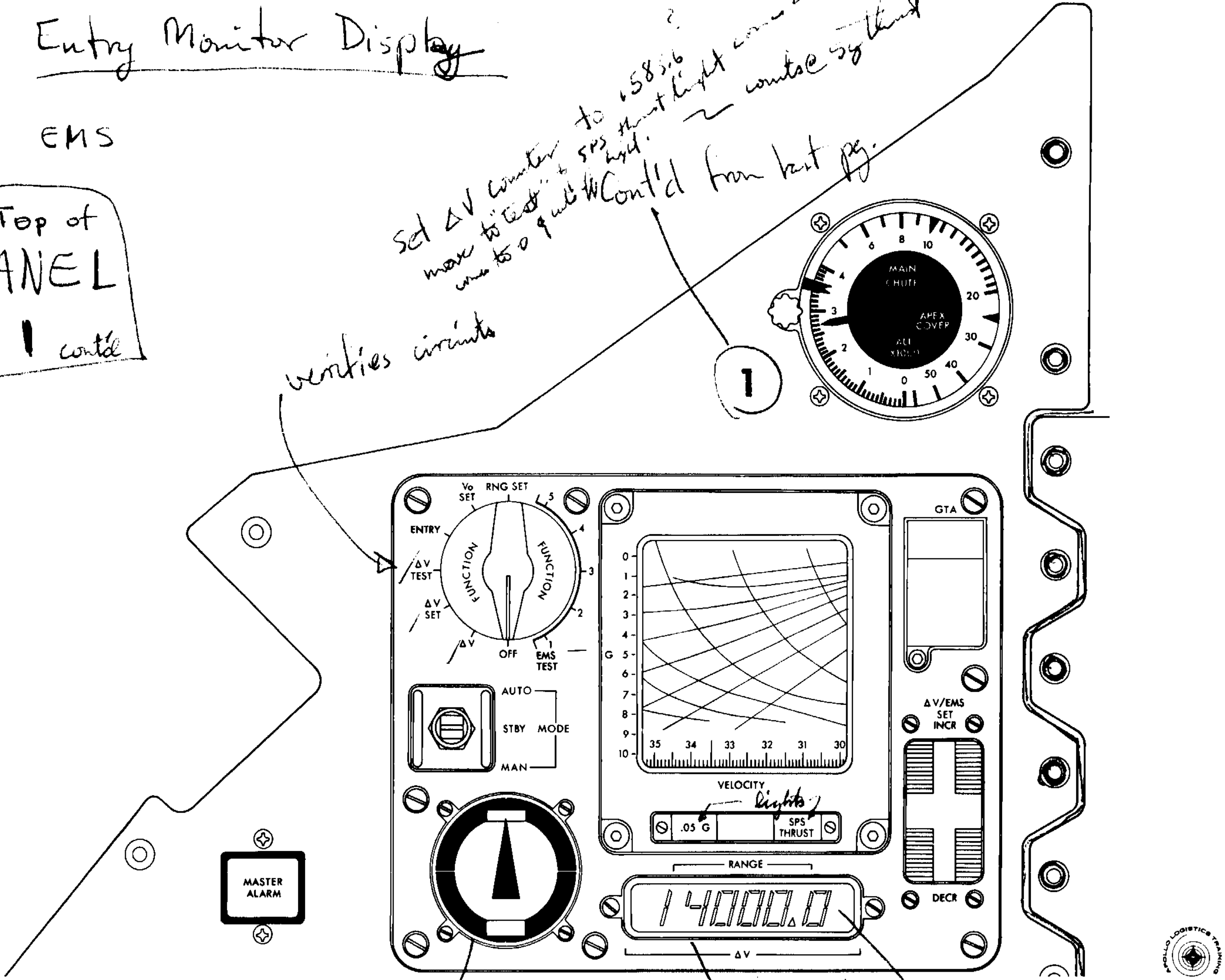
Top of PANEL 1 cont'd

Set ΔV counter to 1585.6 ? move to "test" & SPS thrust light comes on counts to 0 & will ~ counts @ sg thrust light. ~ counts @ sg thrust gun.

Cont'd from last pg.

verifies circuits

lights

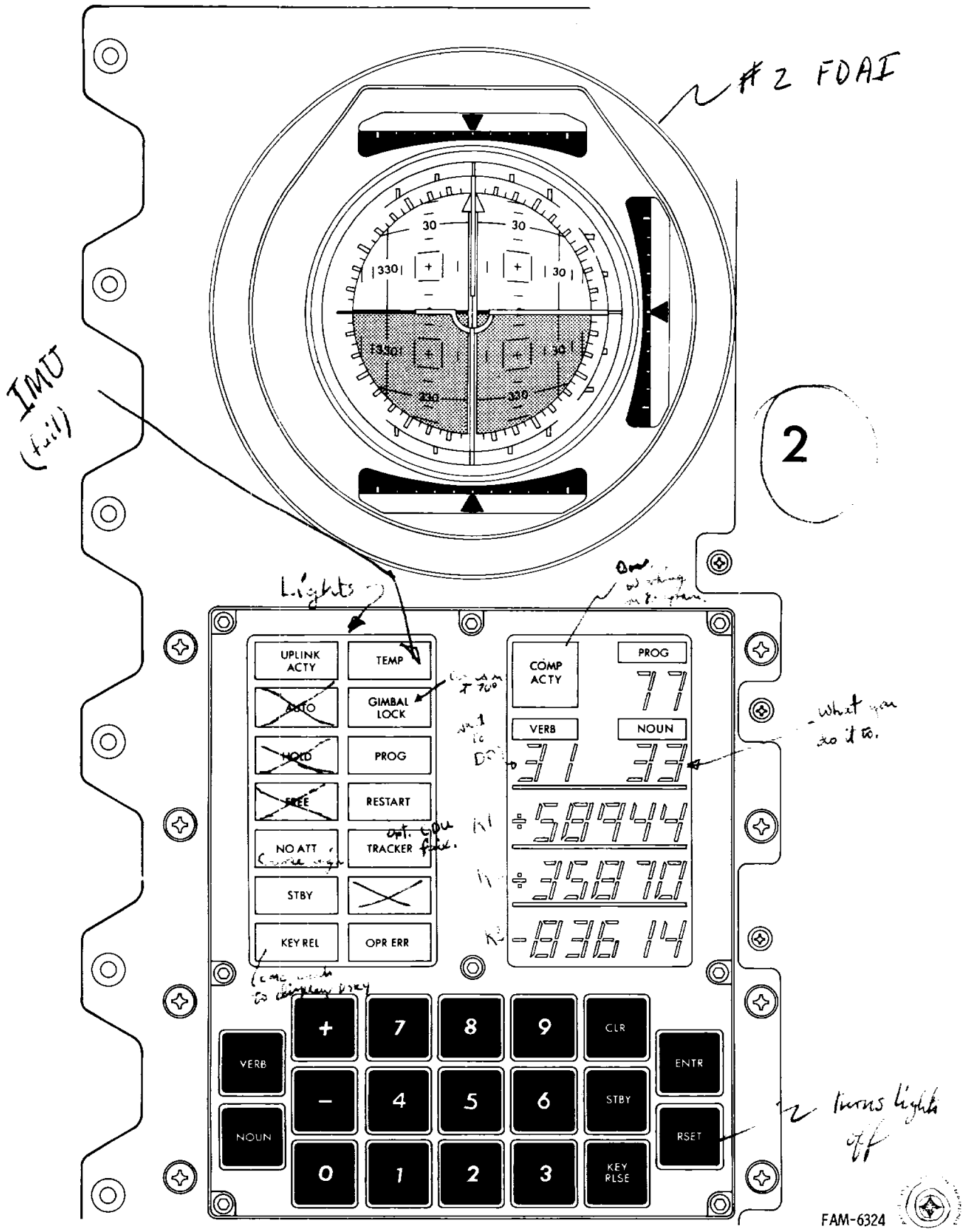


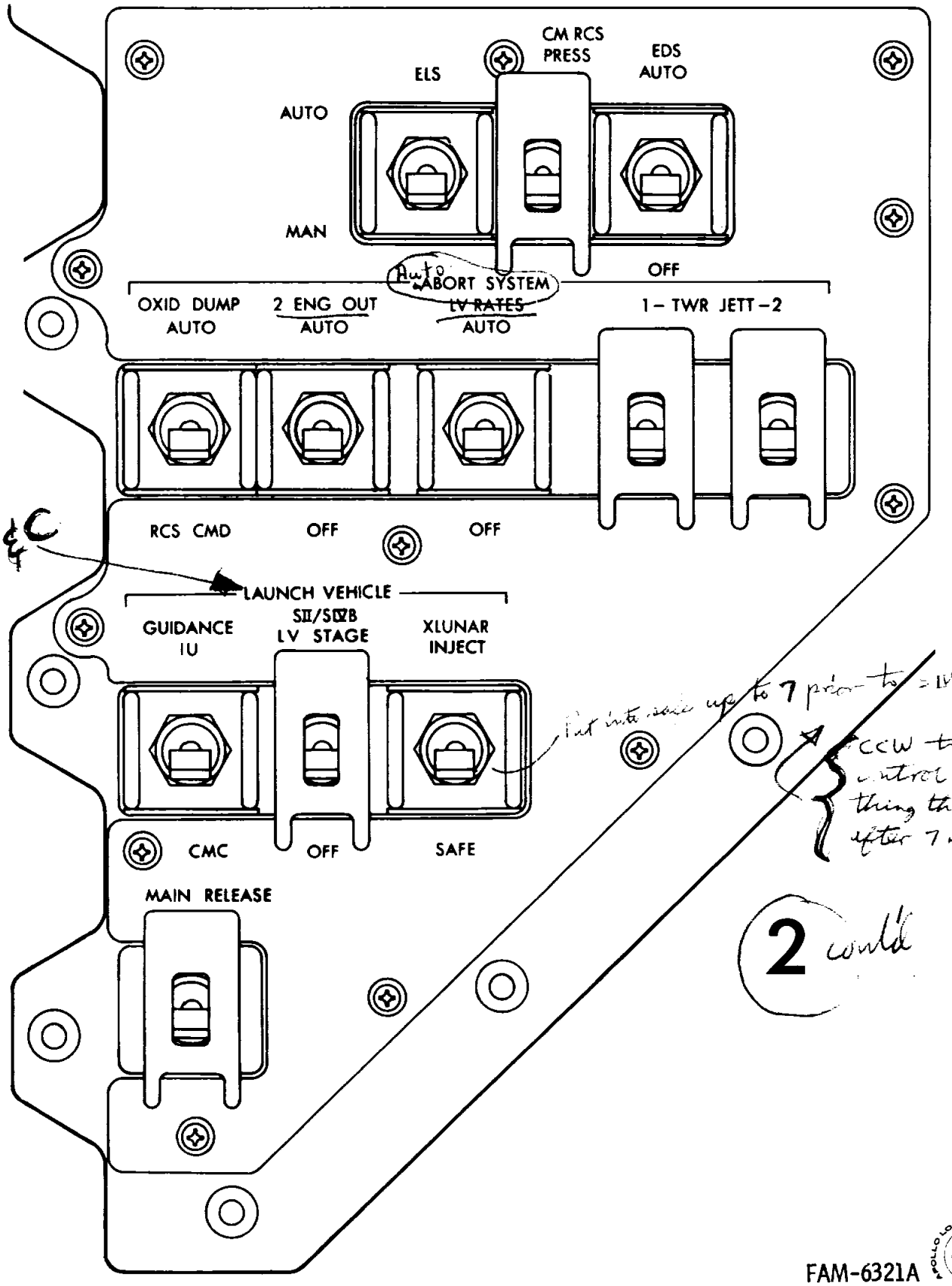
FAM-6311C

roll stab indicator From SCS

down to −1000

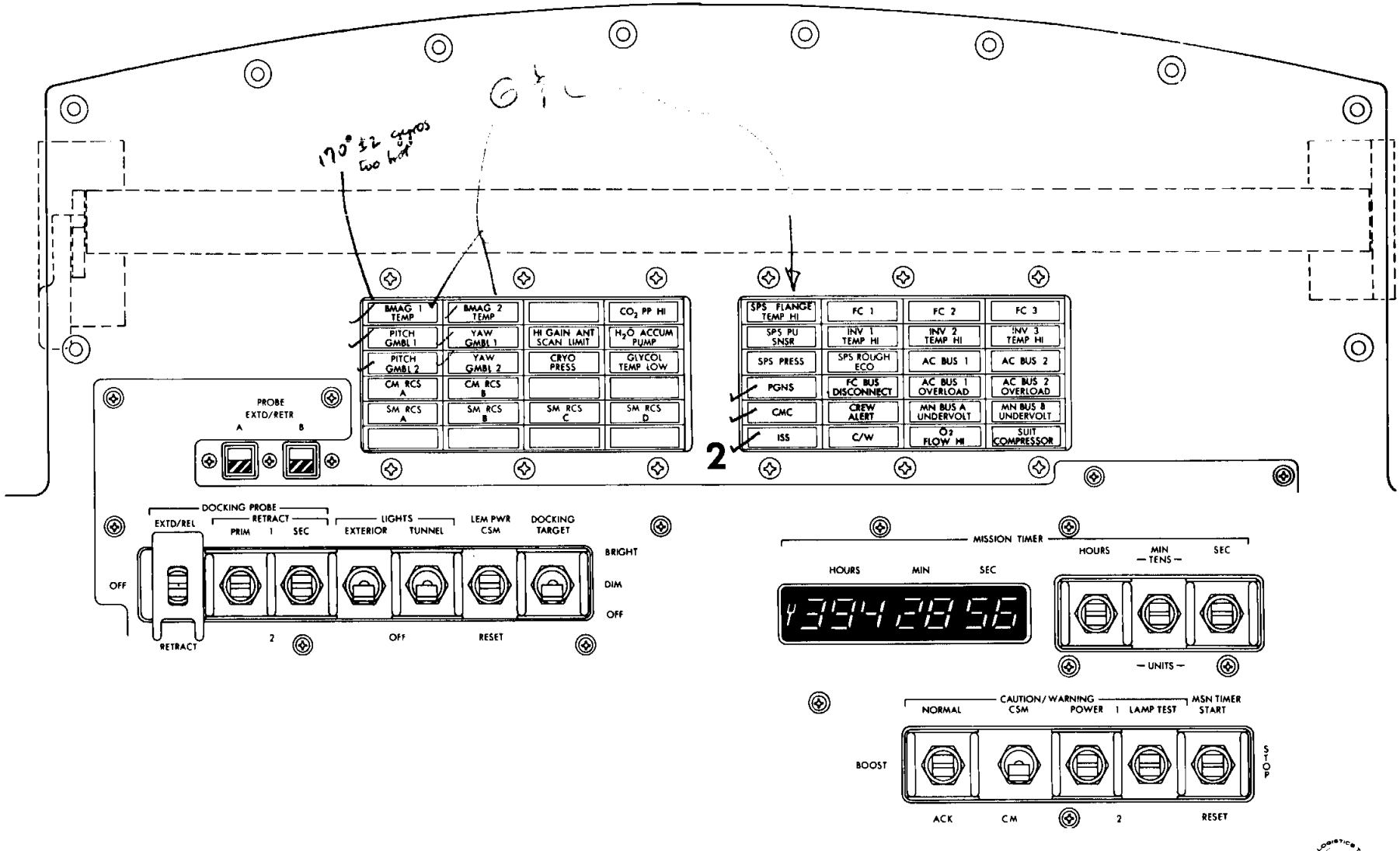
.1 fps


#2 FDAI
IMU (tilt)
2
Lights
UPLINK ACTY
TEMP
GIMBAL LOCK
PROG
RESTART
TRACKER
STBY
KEY REL
OPR ERR
COMP ACTY
PROG
VERB
NOUN
+
7
8
9
CLR
ENTR
VERB
−
4
5
6
STBY
NOUN
RSET
0
1
2
3
KEY RLSE
- what you do it to.
turns lights off
FAM-6324

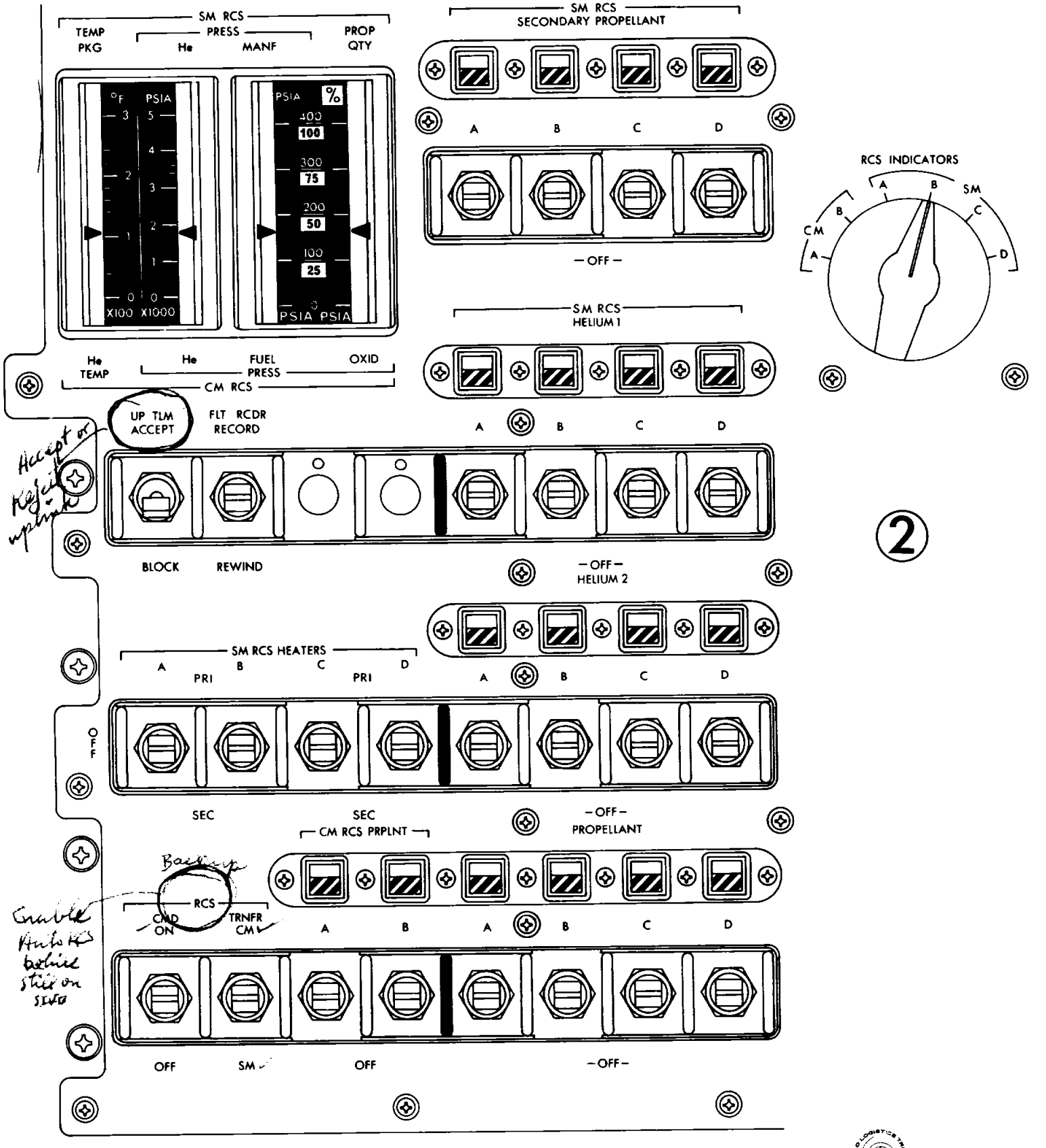

CM RCS PRESS
ELS
EDS AUTO
AUTO
MAN
OFF
Auto ABORT SYSTEM
OXID DUMP AUTO
2 ENG OUT AUTO
LV RATES AUTO
1 – TWR JETT – 2
RCS CMD
OFF
OFF
G&C
LAUNCH VEHICLE
GUIDANCE IU
SII/SIVB LV STAGE
XLUNAR INJECT
CMC
OFF
SAFE
MAIN RELEASE
Put into servo up to 7 prior to = IVB 2nd burn
CCW translation control is only thing that stops TEL after 7 min
2 would

FAM-6321A

Caution & Warning Lights



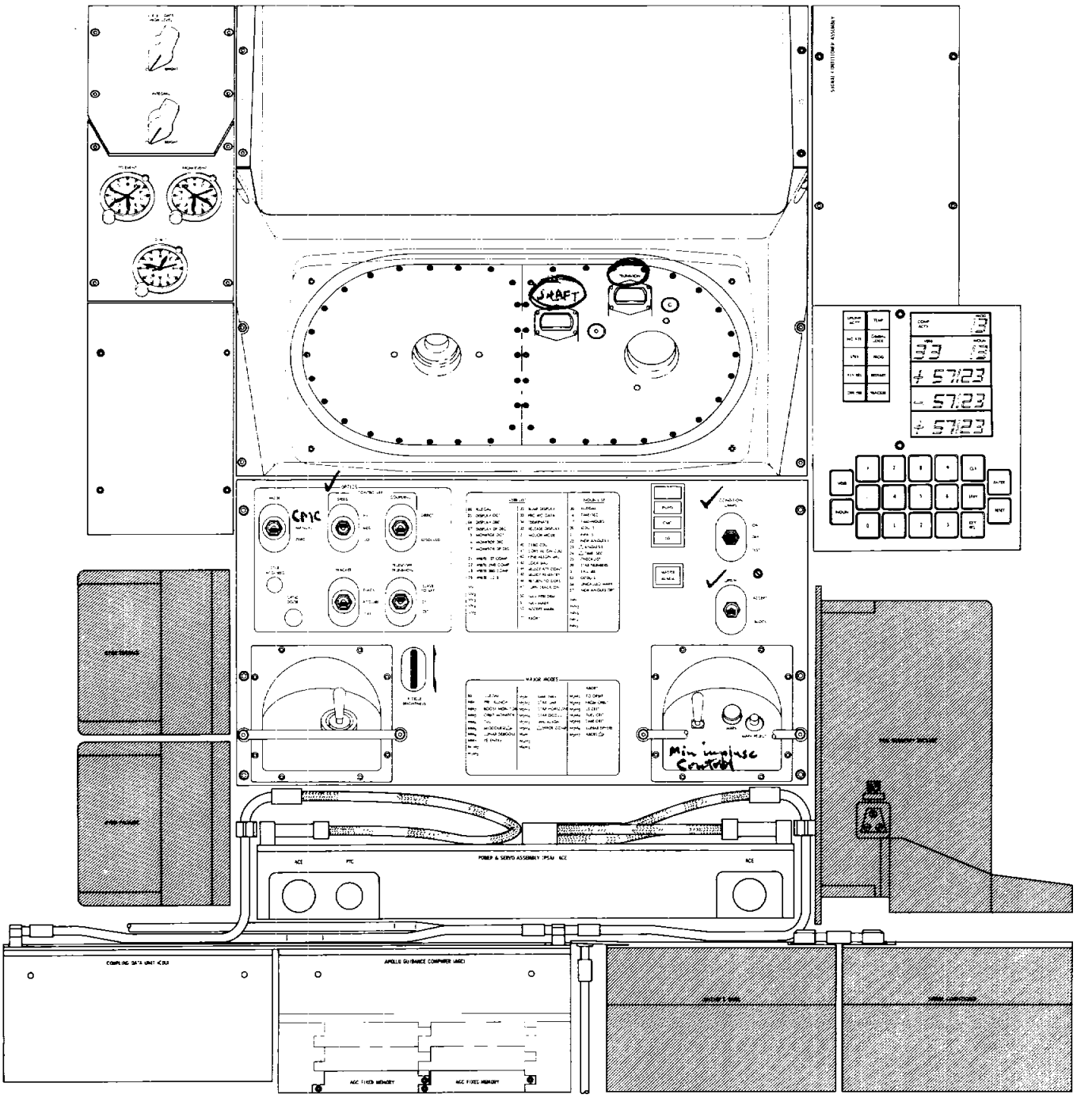
FAM-6323A


SM RCS
TEMP PKG
PRESS
He
MANF
PROP QTY
°F
PSIA
X100 X1000
PSIA %
PSIA PSIA
He TEMP
He PRESS
FUEL PRESS
OXID
CM RCS
SM RCS
SECONDARY PROPELLANT
A B C D
— OFF —
RCS INDICATORS
SM RCS
HELIUM 1
UP TLM ACCEPT
FLT RCDR RECORD
BLOCK
REWIND
— OFF —
HELIUM 2
SM RCS HEATERS
PRI
SEC
CM RCS PRPLNT
— OFF —
PROPELLANT
RCS
CMD ON
TRNFR CM
OFF
SM
2

FAM-6322B

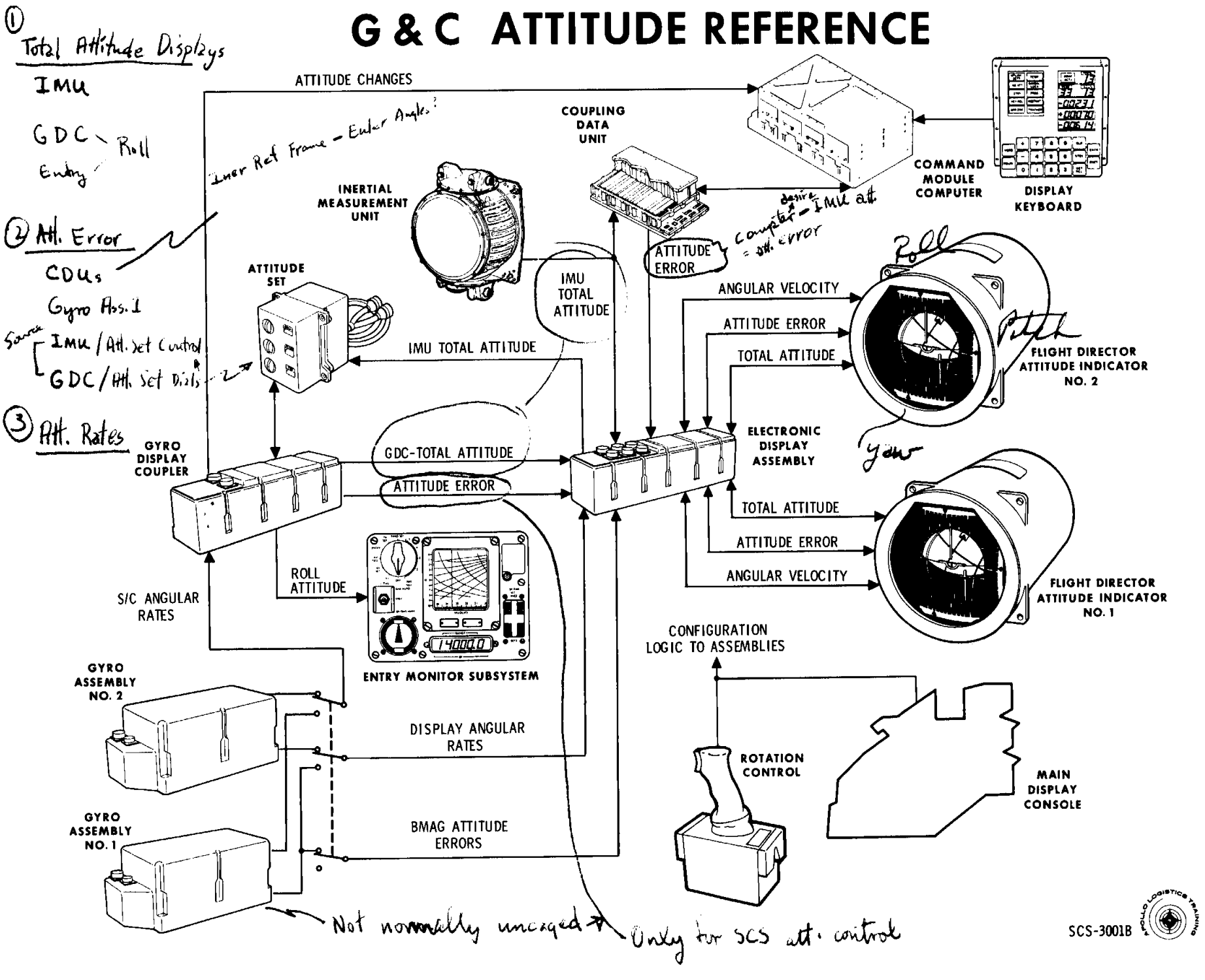
G&N LOWER EQUIPMENT BAY

BLOCK II



GN-228B

G & C ATTITUDE REFERENCE



SCS-3001B

3.) Accel. Cmd.
a) free drift
b) Rot. accel.

G&C ATTITUDE CONTROL

CMC

Auto

Hold

Free

SCS

1.) Rate CMD
a) Hold attitude
b) Rate damping
c) Prop. man. rate
d) Translation

2.) Min Impulse
a) Free drift
b) Min Imp.
3) Translation

SEQUENTIAL EVENTS CONTROL SUBSYSTEM

DIRECT ULLAGE

TRANSLATION CONTROL

CCW SW (MAN ABORT)

TRANSLATION COMMANDS

CW SW (SCS MANUAL TAKE OVER)

GYRO ASSEMBLY NO. 1

GYRO ASSEMBLY NO. 2

RATE OR ATTITUDE ERROR

RATE

RCS ON-OFF

ROTATION ONLY

ELECTRONIC CONTROL ASSEMBLY

CONTROL REATION JET ON-OFF ASSEMBLY

RCS

A

D

28 VDC

MANUAL PROP. CONT

BREAKOUT SWITCHES

DIRECT RCS COMMANDS

ROTATION CONTROL

MANUAL SWITCHING INPUTS FOR CONFIGURATION LOGIC AND ENABLING FUNCTIONS TO ALL ASSEMBLIES

TRANSLATION CMDS & CMC ENABLING

RCS ON-OFF

INERTIAL COUPLING DATA UNITS

TOTAL ATTITUDE

INERTIAL MEASUREMENT UNIT

COMMAND MODULE COMPUTER

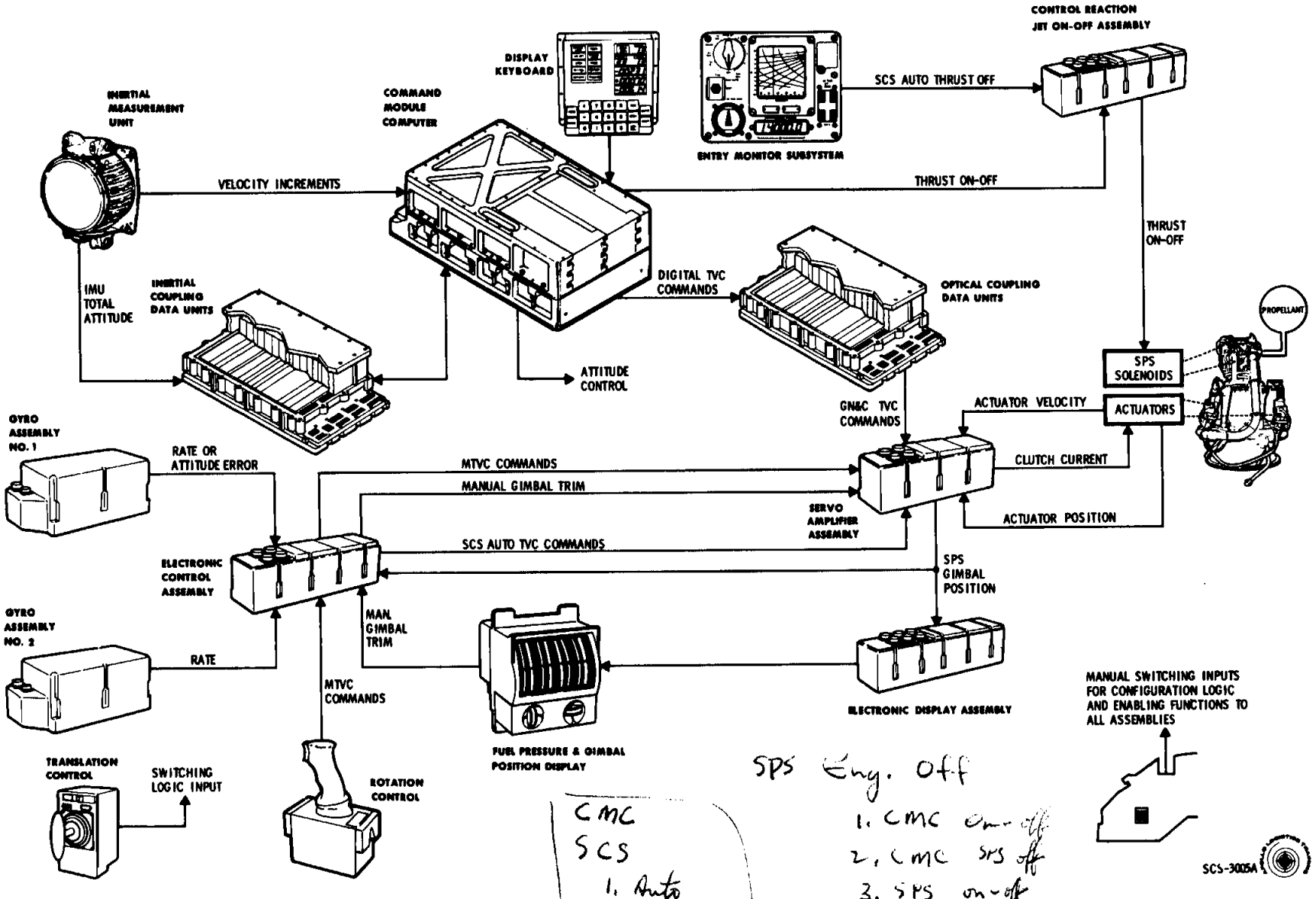
DISPLAY KEYBOARD

SCS-3006A

TVC
Actuator (eng off)
SPS on-off

Sec V Panel (1)
Display

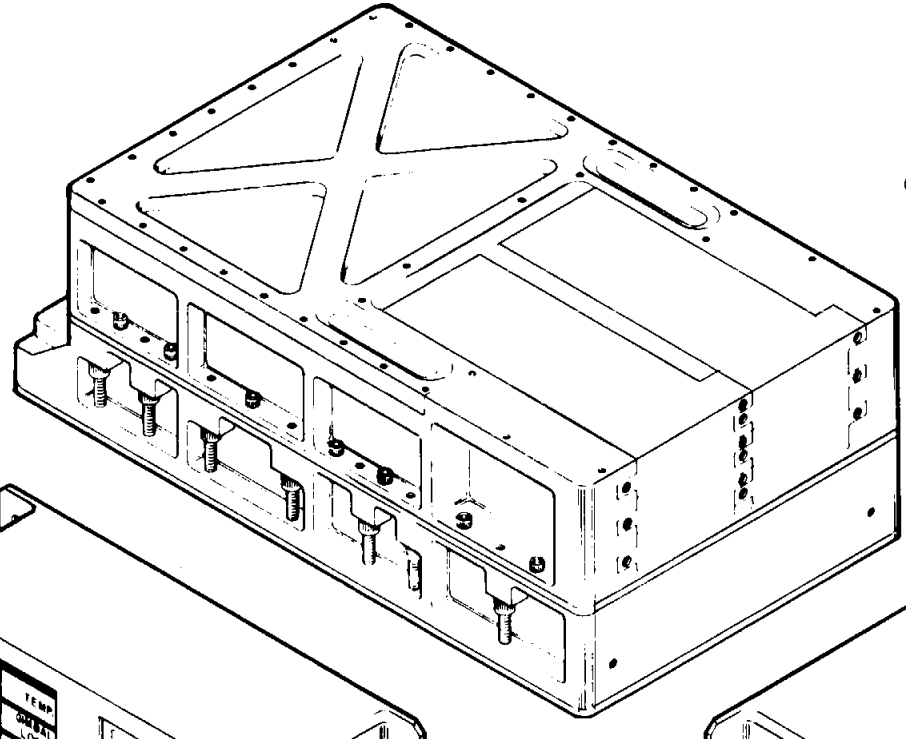
G & C THRUST VECTOR CONTROL



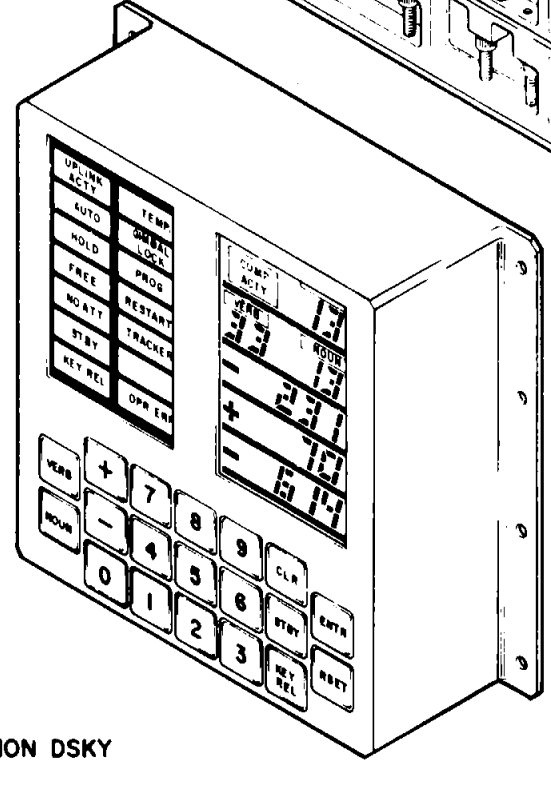
CMC
SCS
1. Auto
2. Rate Cmd
3. Accel. Cmd

SPS Eng. Off
1. CMC on-off
2. CMC SPS off
3. SPS on-off
4. Deviation off

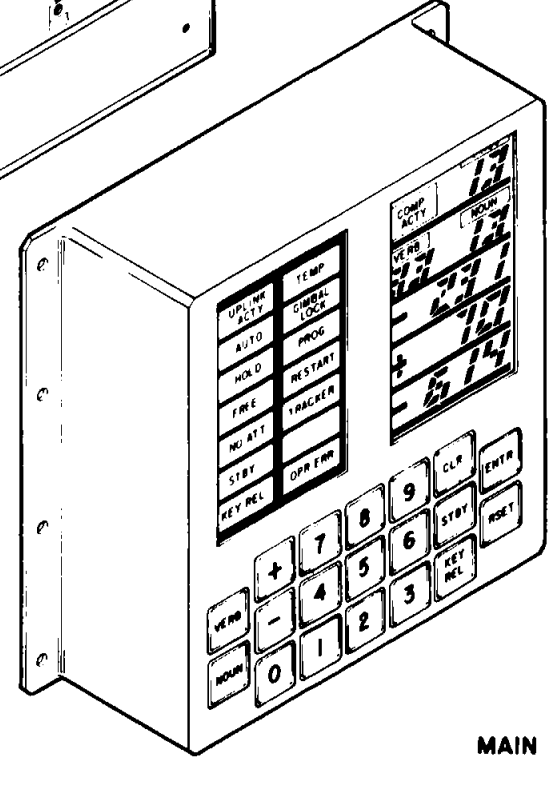
CSS EQUIPMENT



COMMAND MODULE COMPUTER

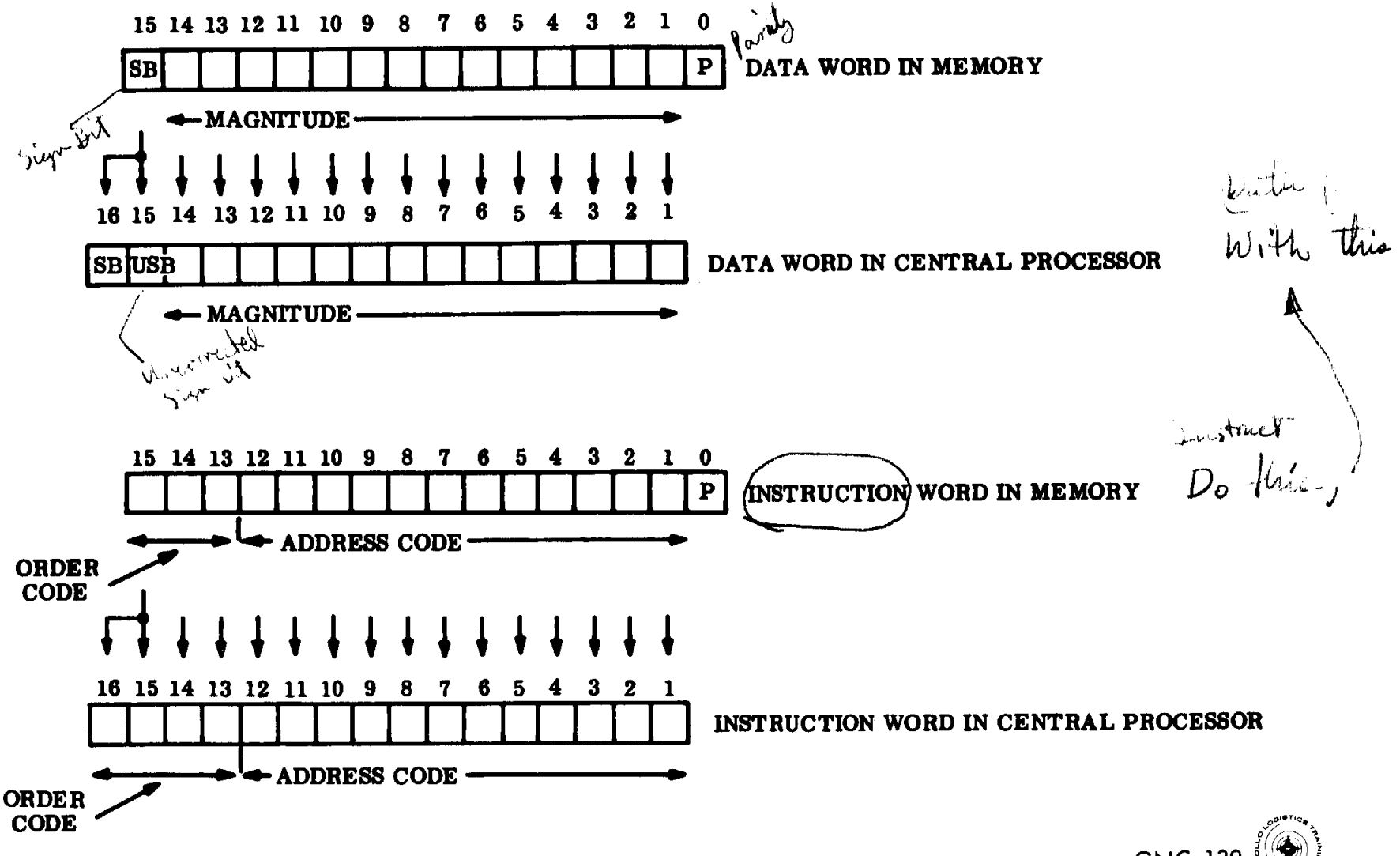


NAVIGATION DSKY



MAIN DSKY

WORD FORMATS IN MEMORY AND CENTRAL PROCESSOR



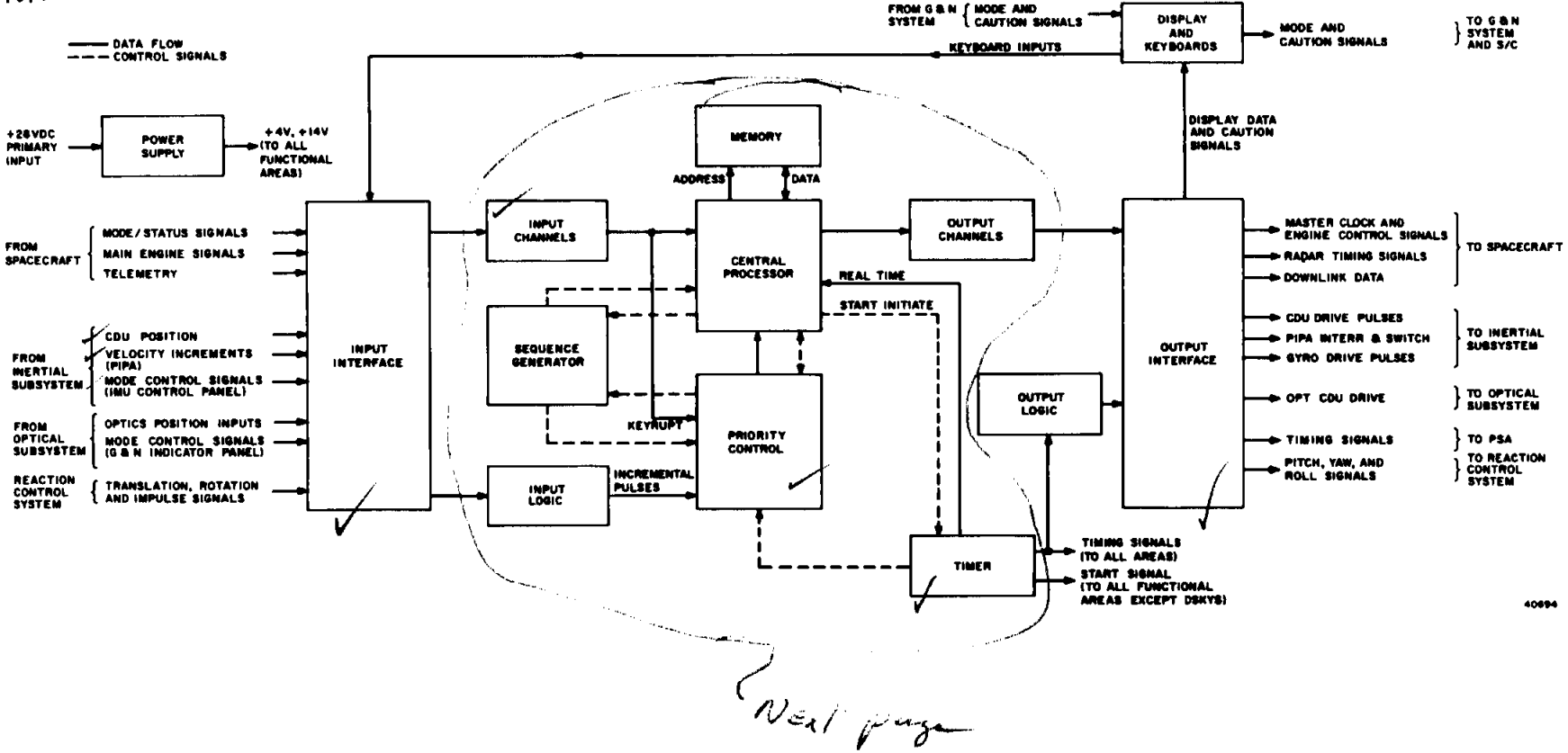
101 = 5

1 = 1

10 = 2
11 = 3
100 = 4
101 = 5
110 = 6
111 = 7
1000 = 8
1001 = 9
1010 = 10

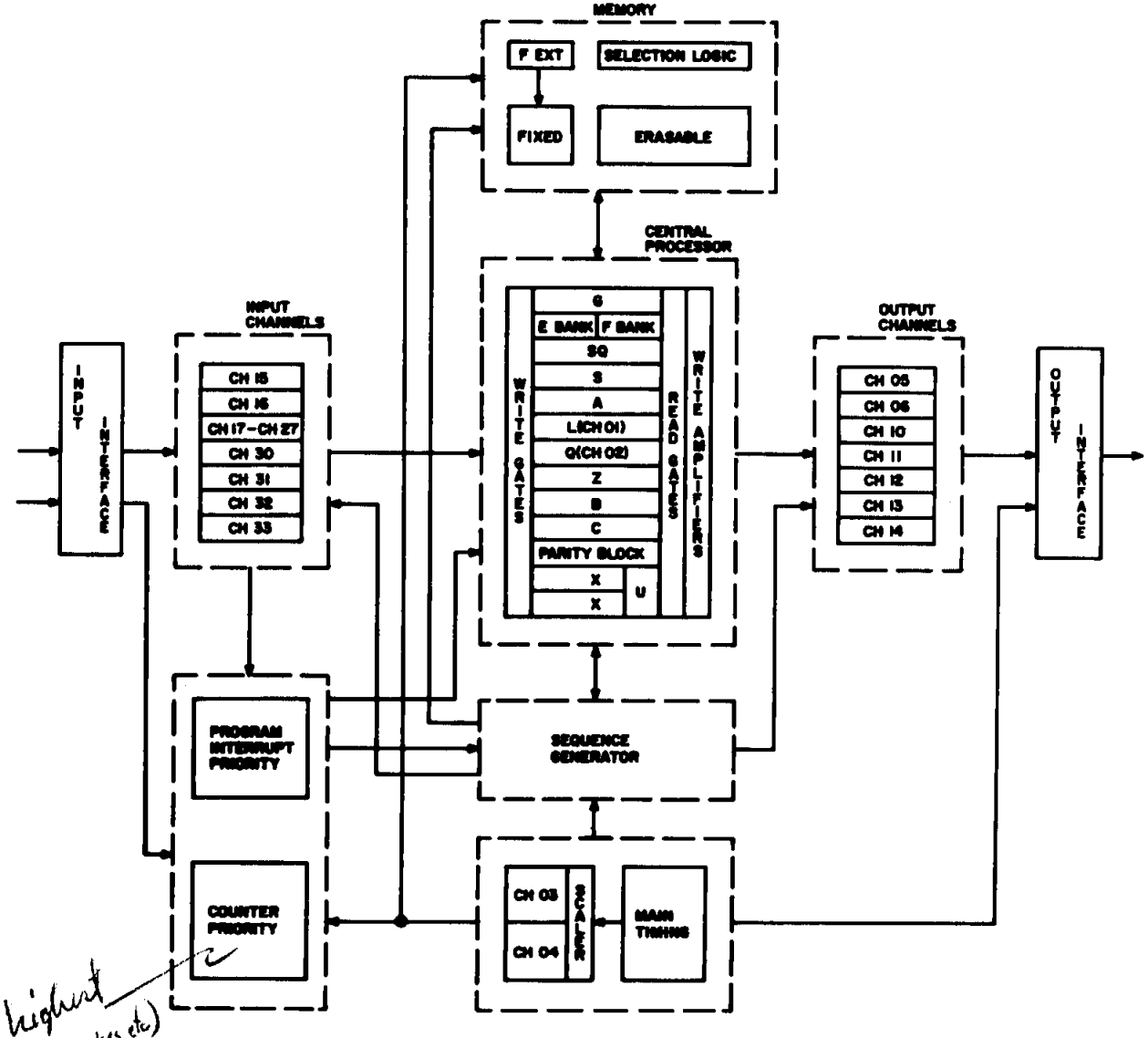
101 Ones compliment → 7 — 111 comp → 000
010 ✗ 9 -5 101 add → 010
Enables comp. to subtract
010 which is = 2.
check

CSS BASIC FLOW



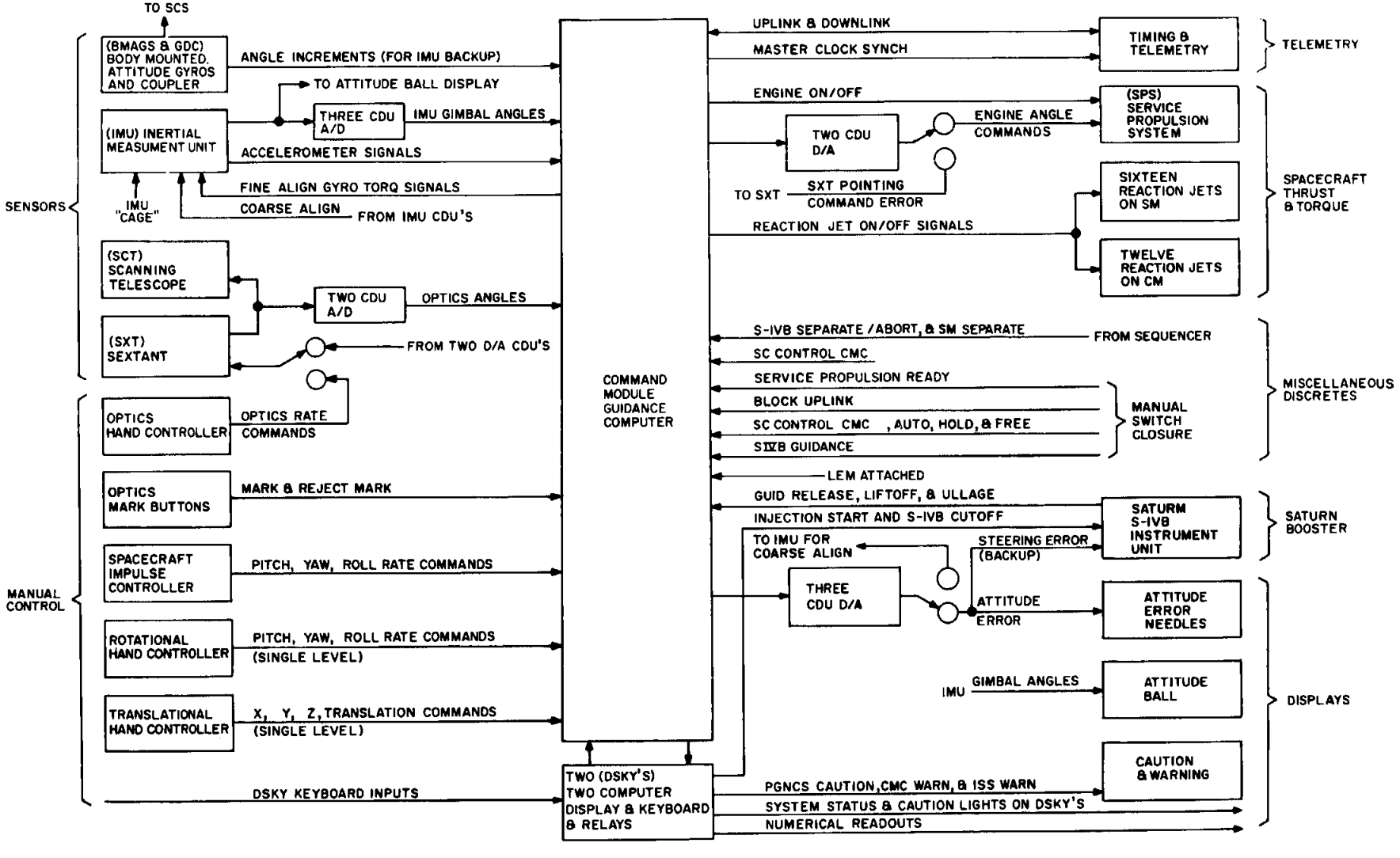
Next page

CSS BASIC FLOW DIAGRAM

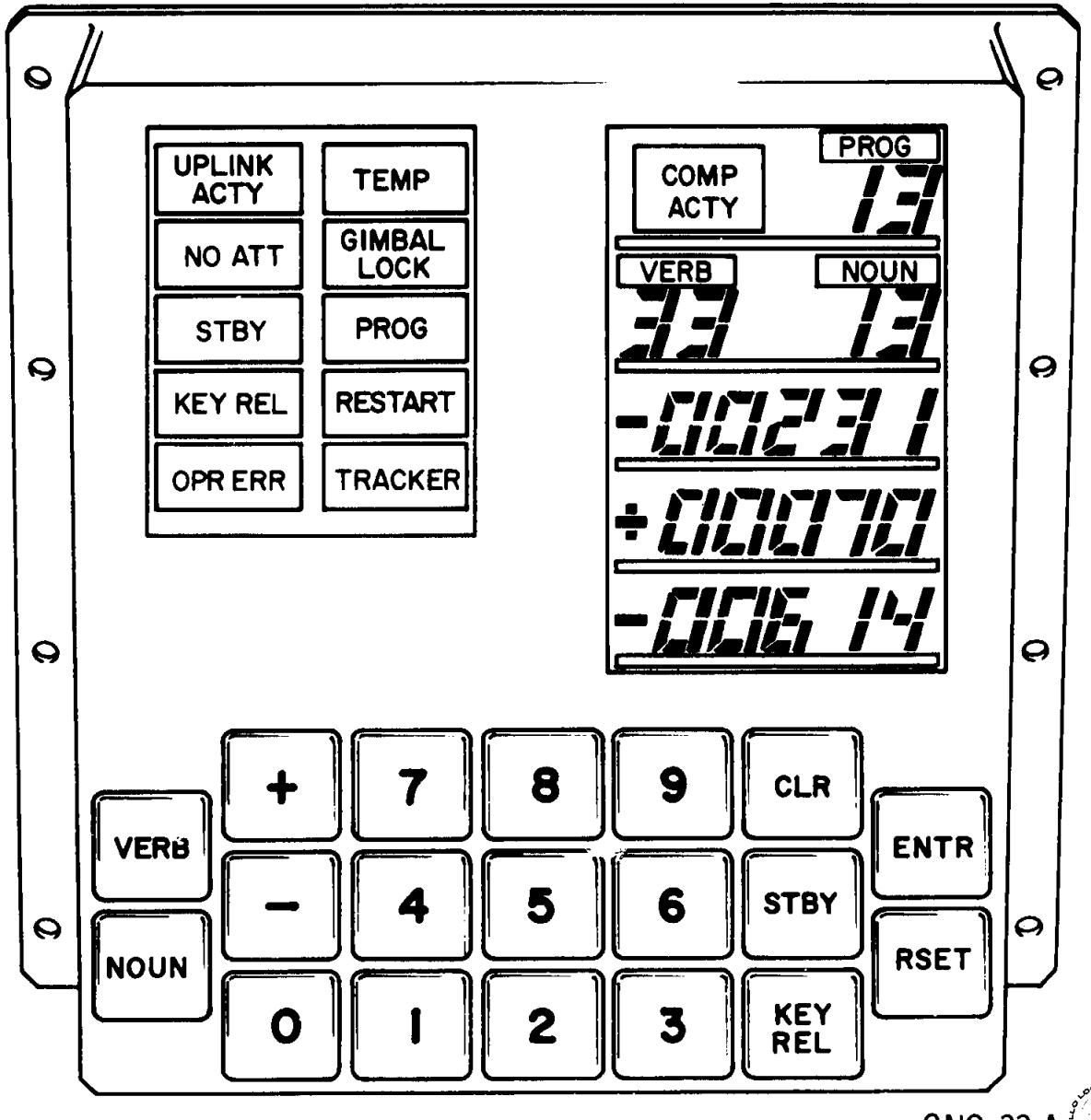


highest
(A.V pulses, etc)

PGNCS - BLOCK II FUNCTIONAL INTERFACE

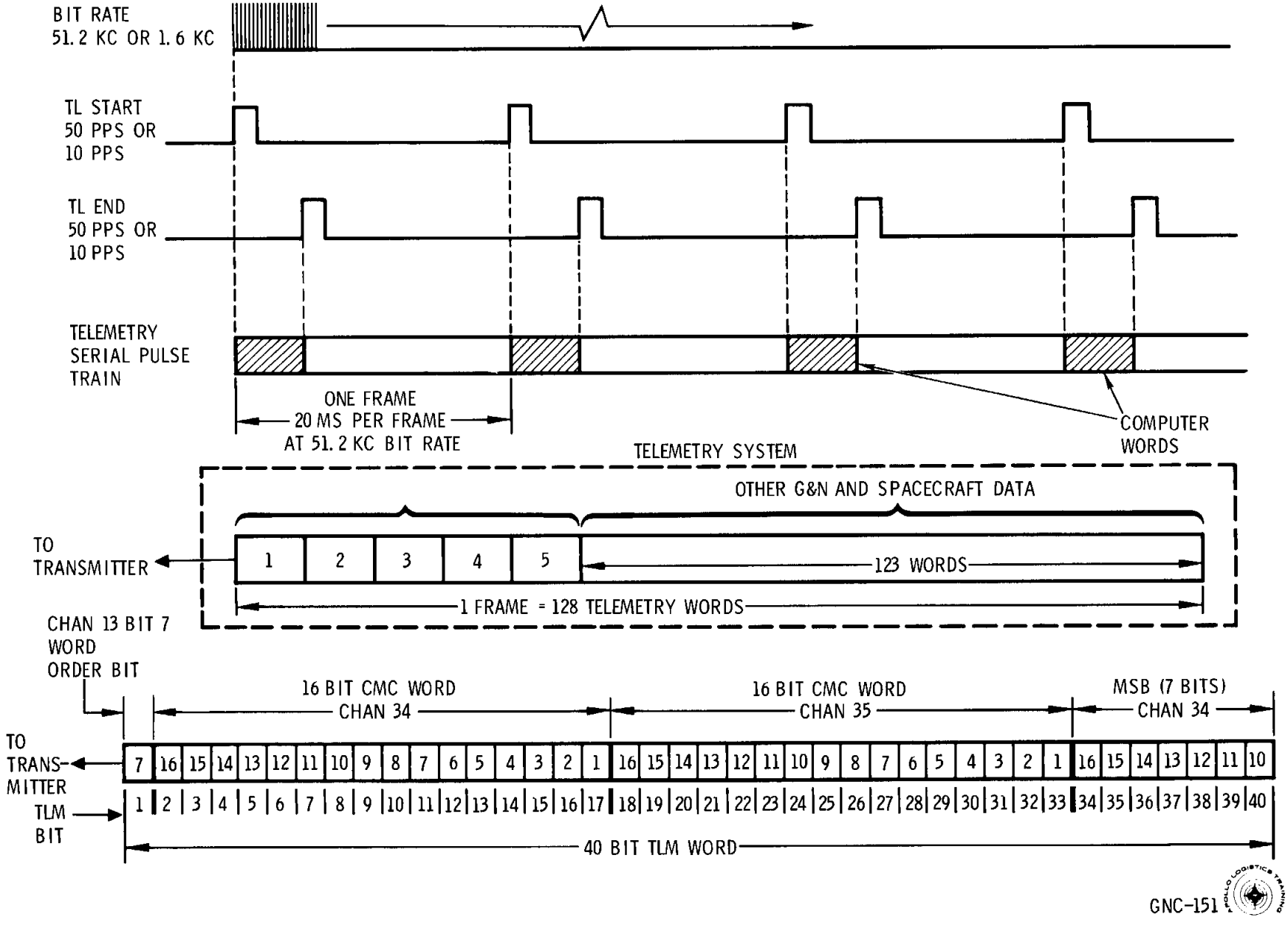


DISPLAY AND KEYBOARD (DSKY)



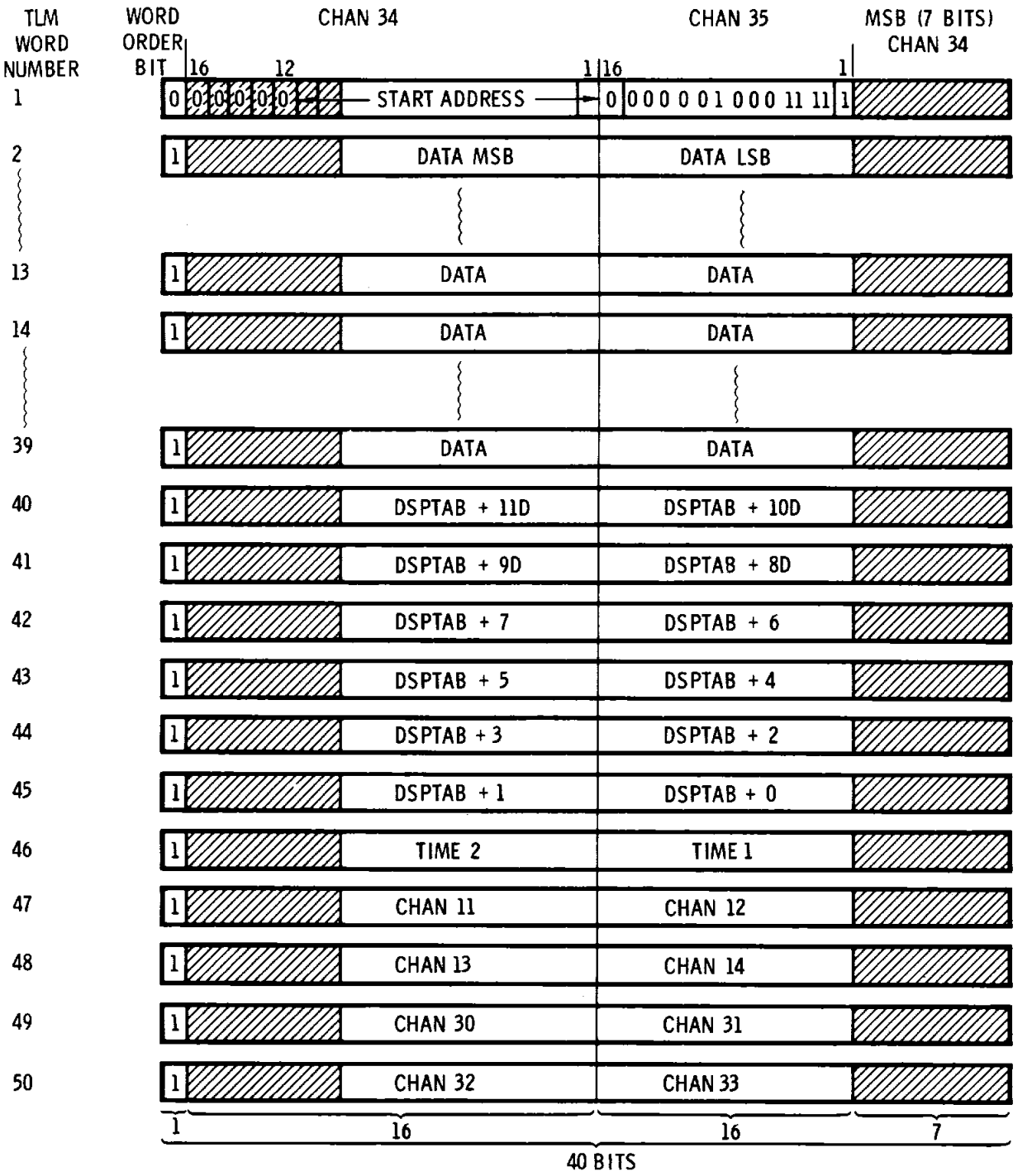
GNC-33 A

DWN TLM FORMAT



GNC-151

50 WORD DWNTLM LIST



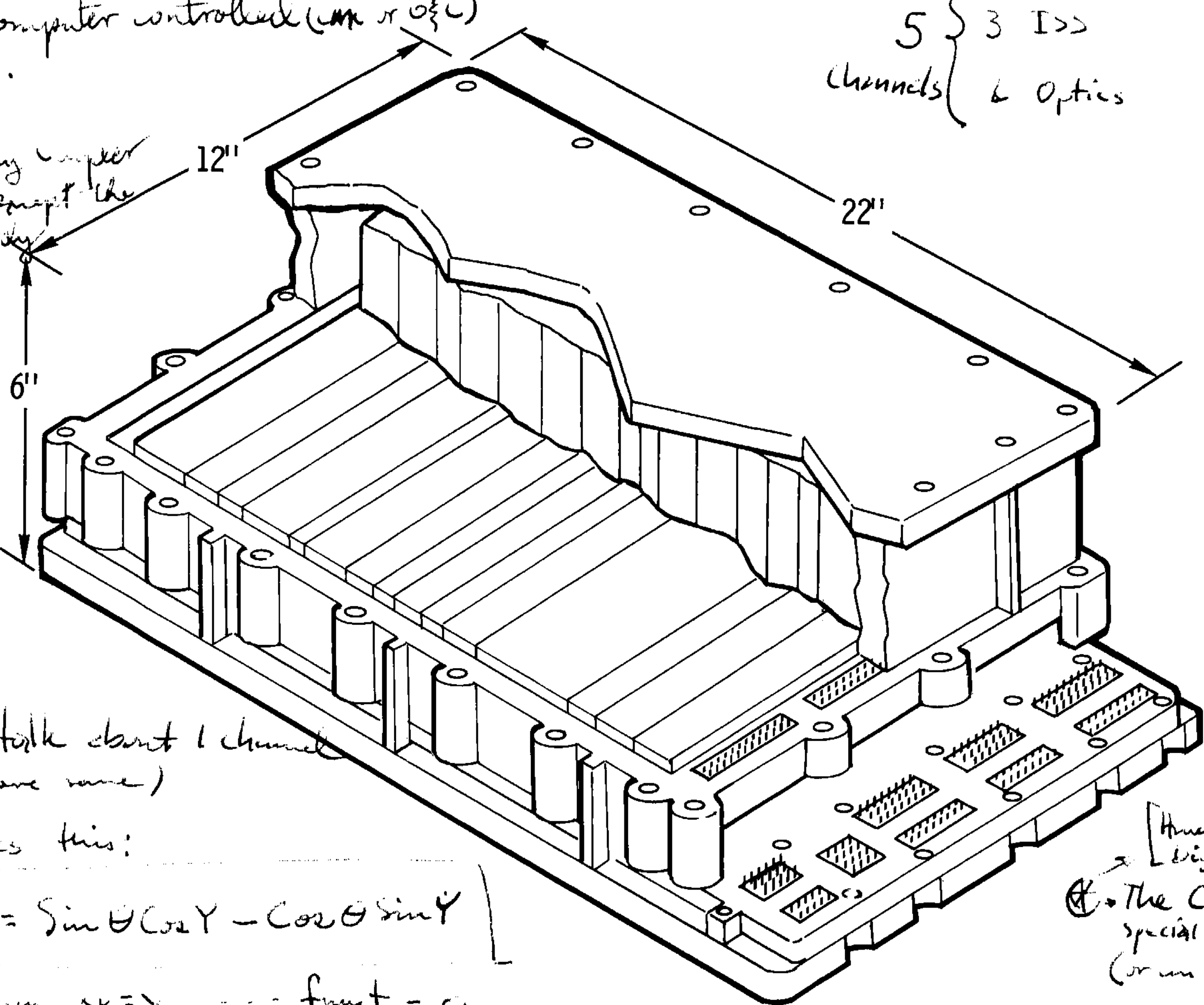
COUPLING DATA UNIT

O&C
Relates s/c attitude to the IMU ref. frame for the computer controlled (LM or O&C) operations.

Analog to Digital converter
Digital to Analog Converter

5 Channels { 3 IMU, 2 Optics }

O&C display coupler does same except the [illegible] is a [illegible] at the time you initiate the operation. No [illegible] goes to CMC



We'll only talk about 1 channel (others are same)

CDU does this:

$\sin(\theta - \Upsilon) = \sin\theta\cos\Upsilon - \cos\theta\sin\Upsilon$

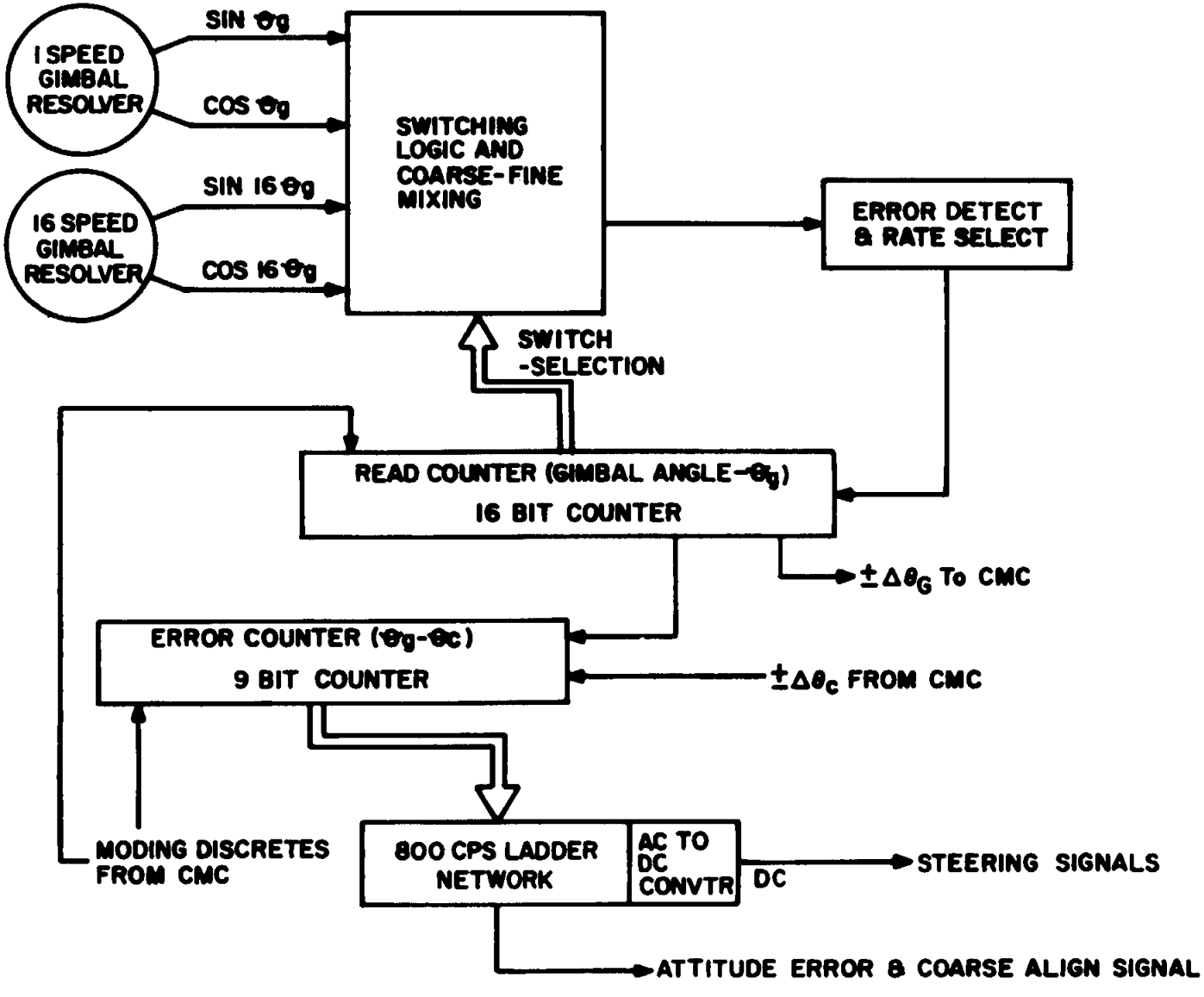
when $\theta = \Upsilon$ --- funct = 0

[Ana to Dig & Dig to Ana]

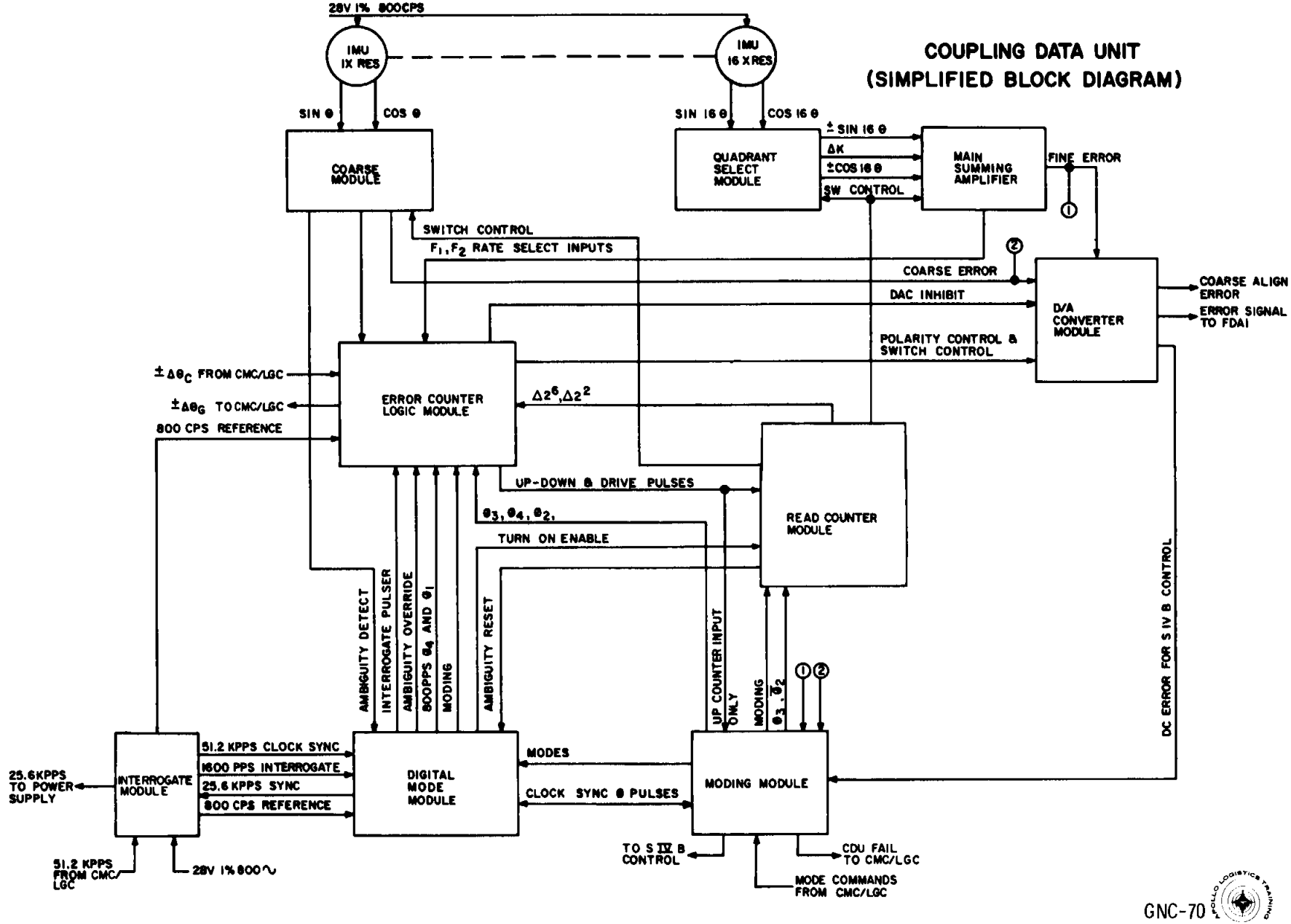
The CDU is a special purpose computer (or an extension of the CMC)

GNC-11
CDU

COUPLING DATA UNIT BLOCK DIAGRAM



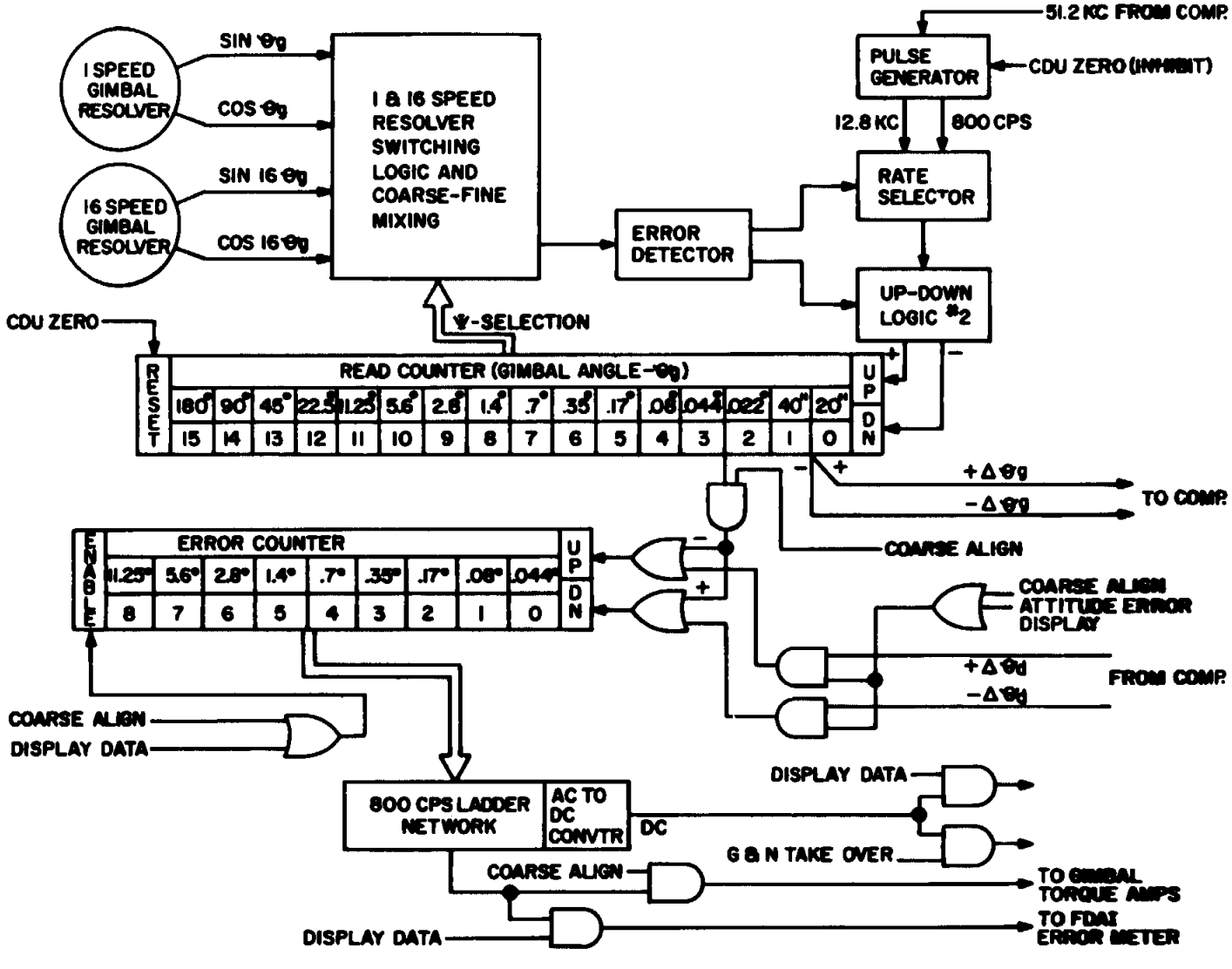
COUPLING DATA UNIT
SIMPLIFIED BLOCK DIAGRAM



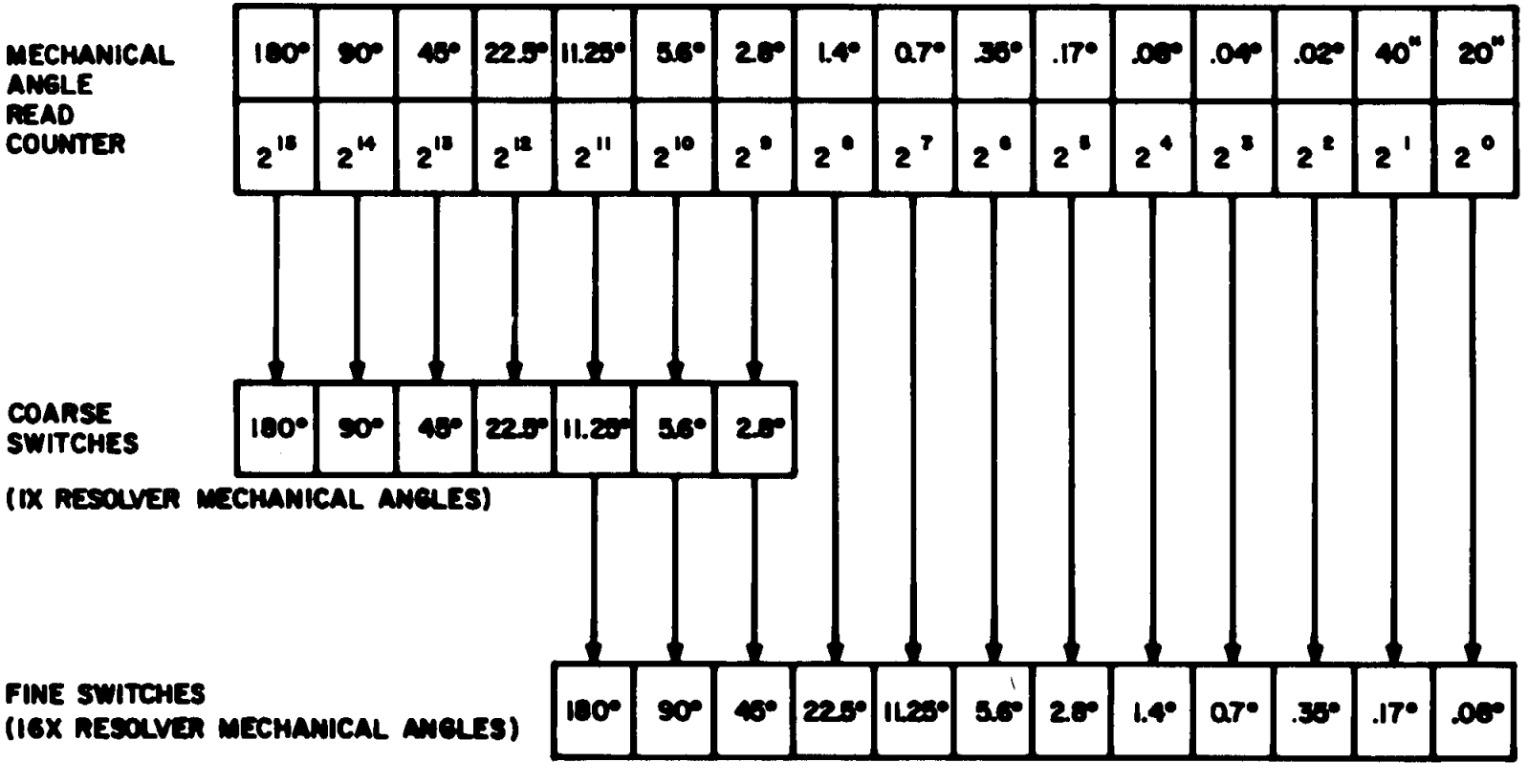
GNC-70

CDU

CDU FUNCTIONAL BLOCK DIAGRAM

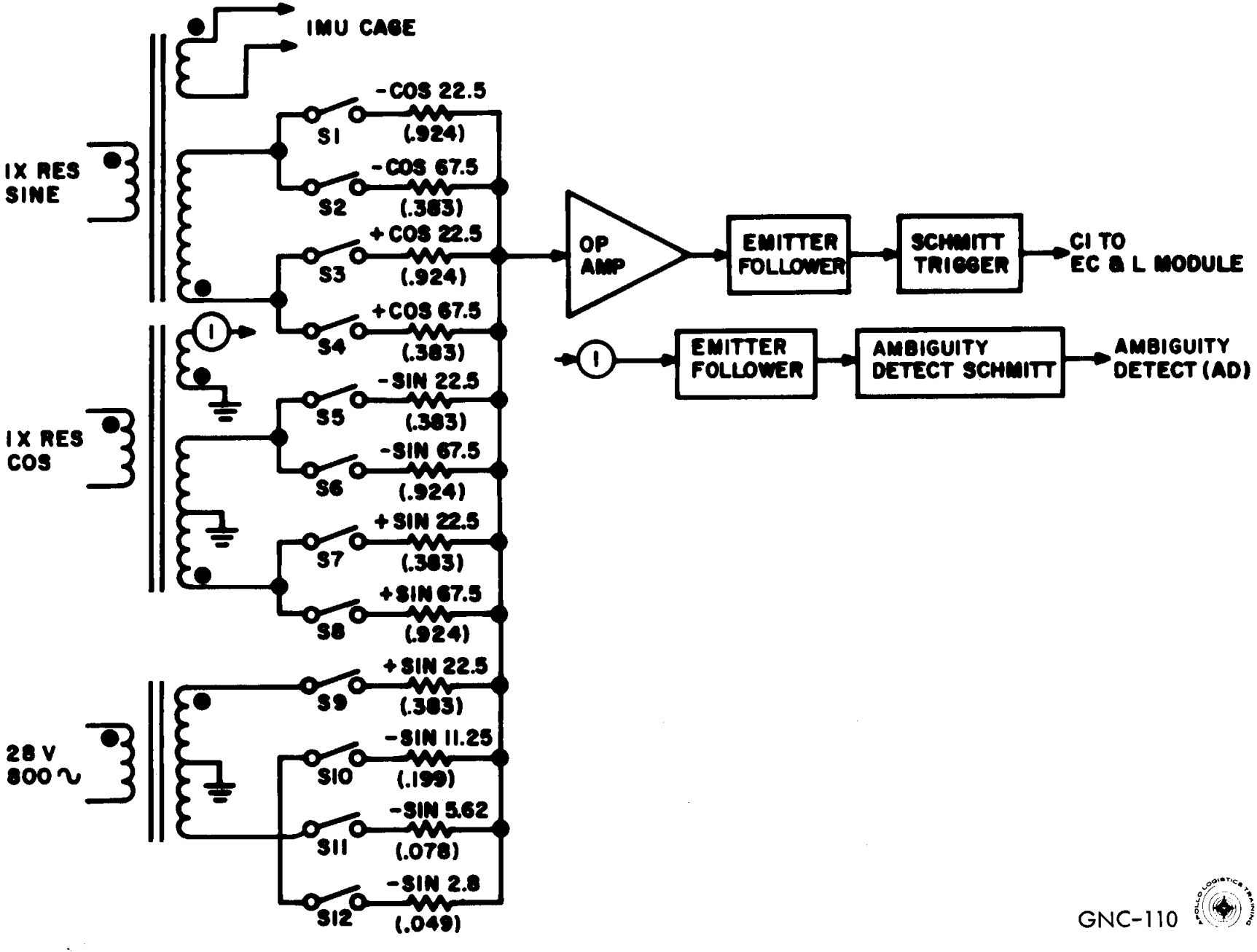


READ COUNTER RELATIONSHIP TO COARSE FINE SWITCHING



CDU

CDU COARSE MODULE BLOCK DIAGRAM



COARSE SWITCH LOGIC EQUATIONS

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

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

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

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

$$DC\ 5 = \overline{2^{15}}\left(2^{14}\ 2^{13} + \overline{2^{14}}\ \overline{2^{13}}\right)$$

$$DC\ 6 = \overline{2^{15}}\left(\overline{2^{14}}\ 2^{13} + 2^{14}\ \overline{2^{13}}\right)$$

$$DC\ 7 = 2^{15}\left(2^{14}\ 2^{13} + \overline{2^{14}}\ \overline{2^{13}}\right)$$

$$DC\ 8 = 2^{15}\left(\overline{2^{14}}\ 2^{13} + 2^{14}\ \overline{2^{13}}\right)$$

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

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

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

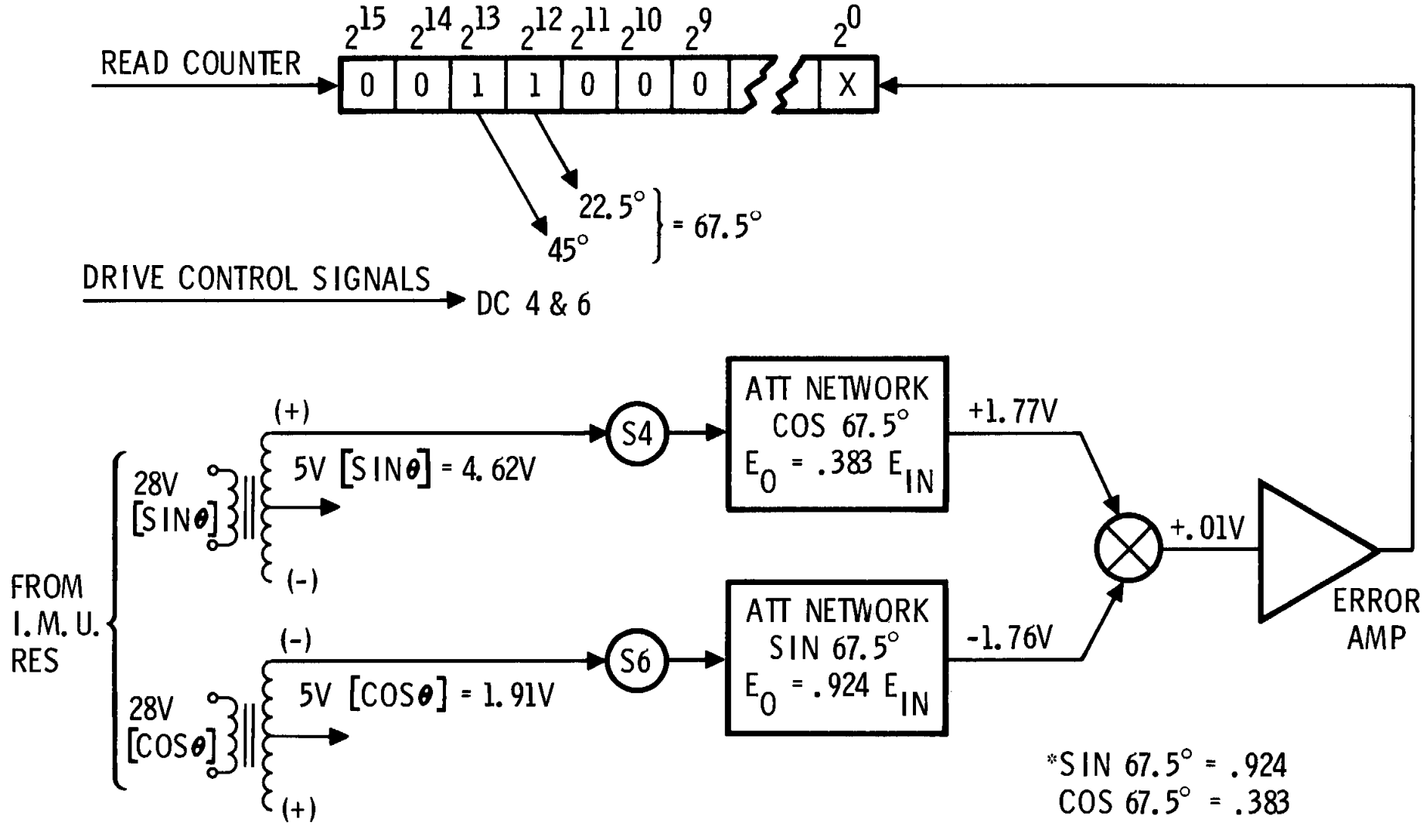
$$DC\ 12 = 2^{9}$$

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

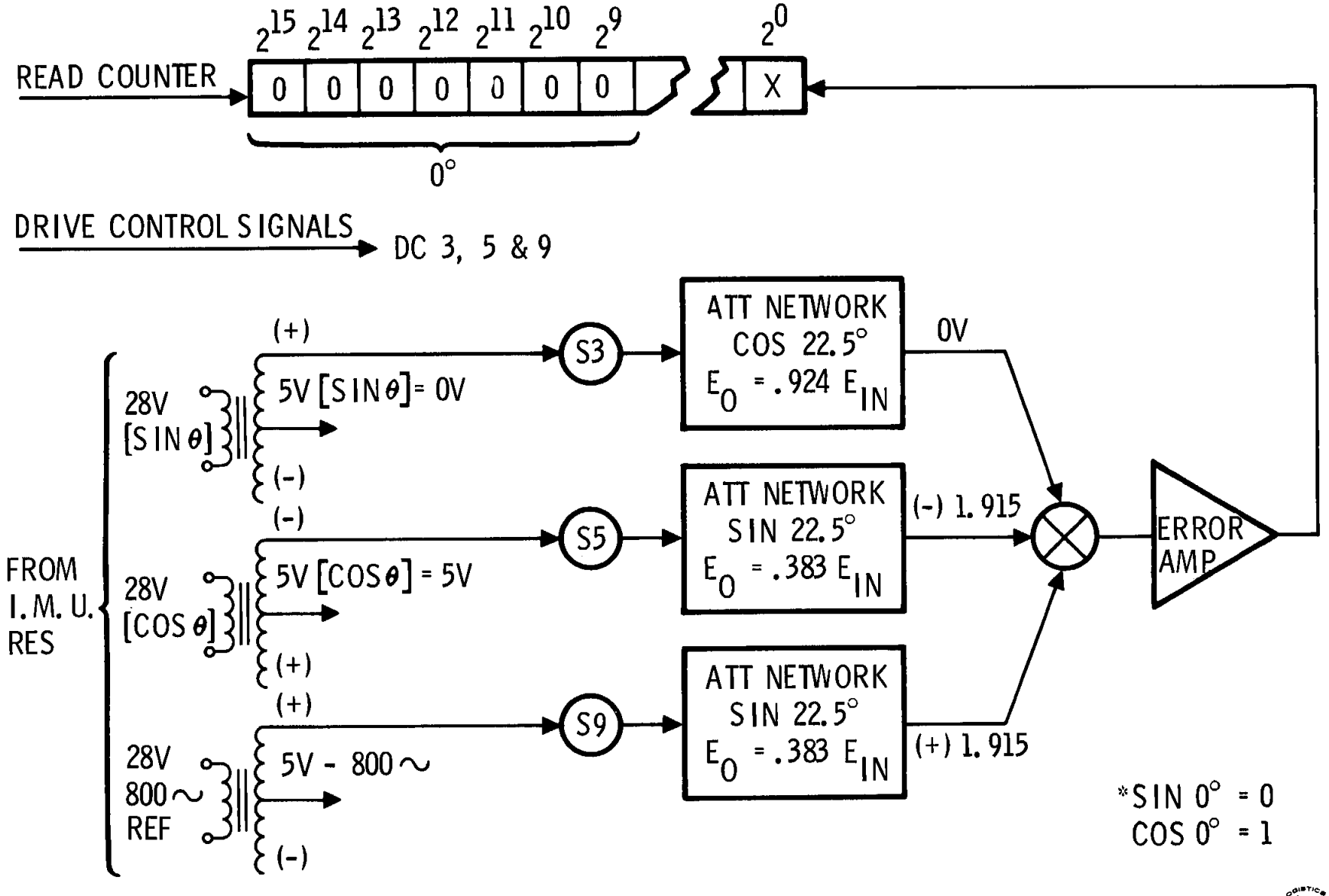
*DC "X" CLOSES SWITCH "X"

CDU

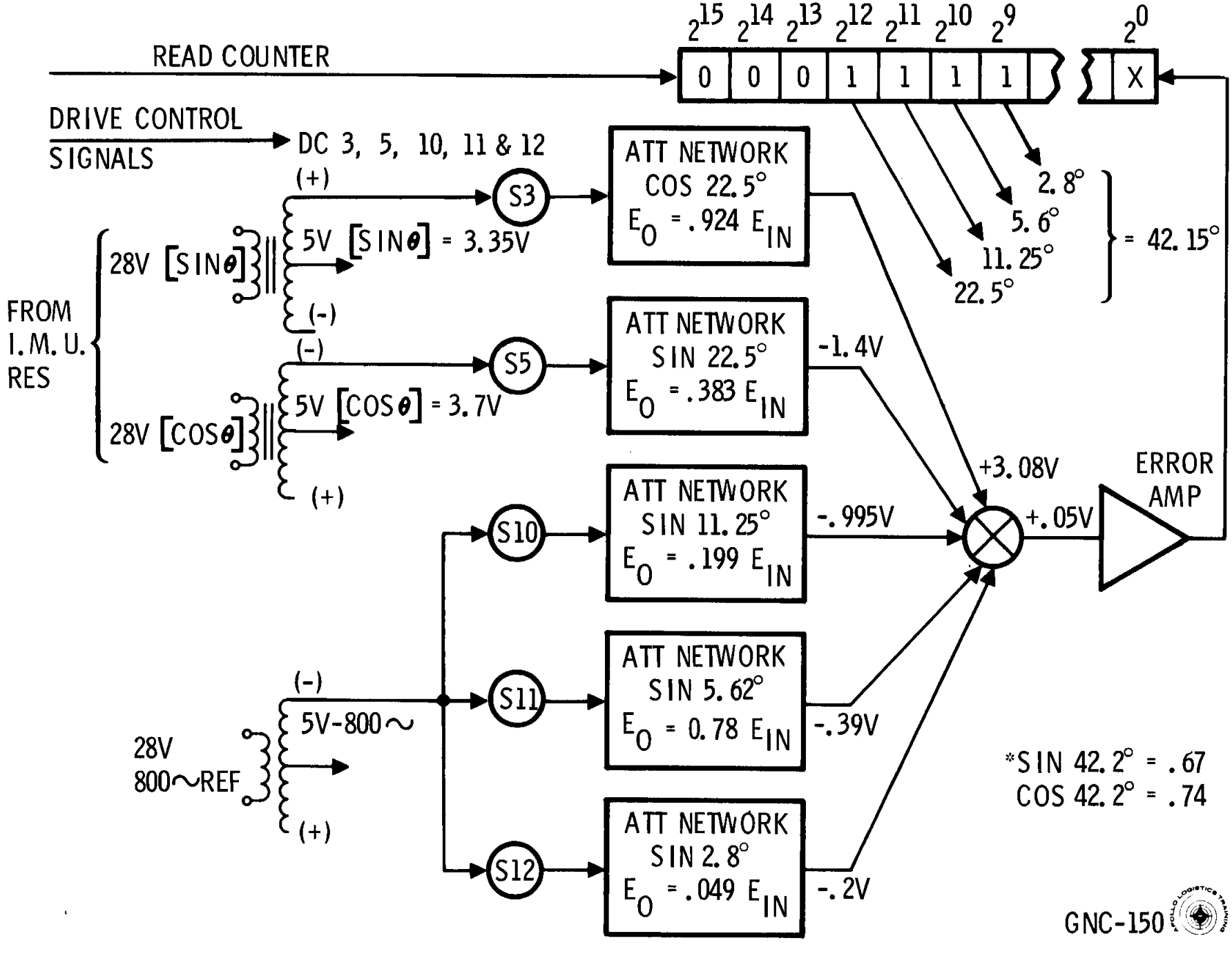
θ=67.5


READ COUNTER
2^{15} 2^{14} 2^{13} 2^{12} 2^{11} 2^{10} 2^{9} 2^{0}
0 0 1 1 0 0 0 X
22.5°
45°
= 67.5°
DRIVE CONTROL SIGNALS
DC 4 & 6
FROM I.M.U. RES
28V [SINθ]
28V [COSθ]
(+)
5V [SINθ] = 4.62V
(-)
(-)
5V [COSθ] = 1.91V
(+)
S4
S6
ATT NETWORK COS 67.5° E_0 = .383 E_{IN}
ATT NETWORK SIN 67.5° E_0 = .924 E_{IN}
+1.77V
-1.76V
+.01V
ERROR AMP
*SIN 67.5° = .924
COS 67.5° = .383

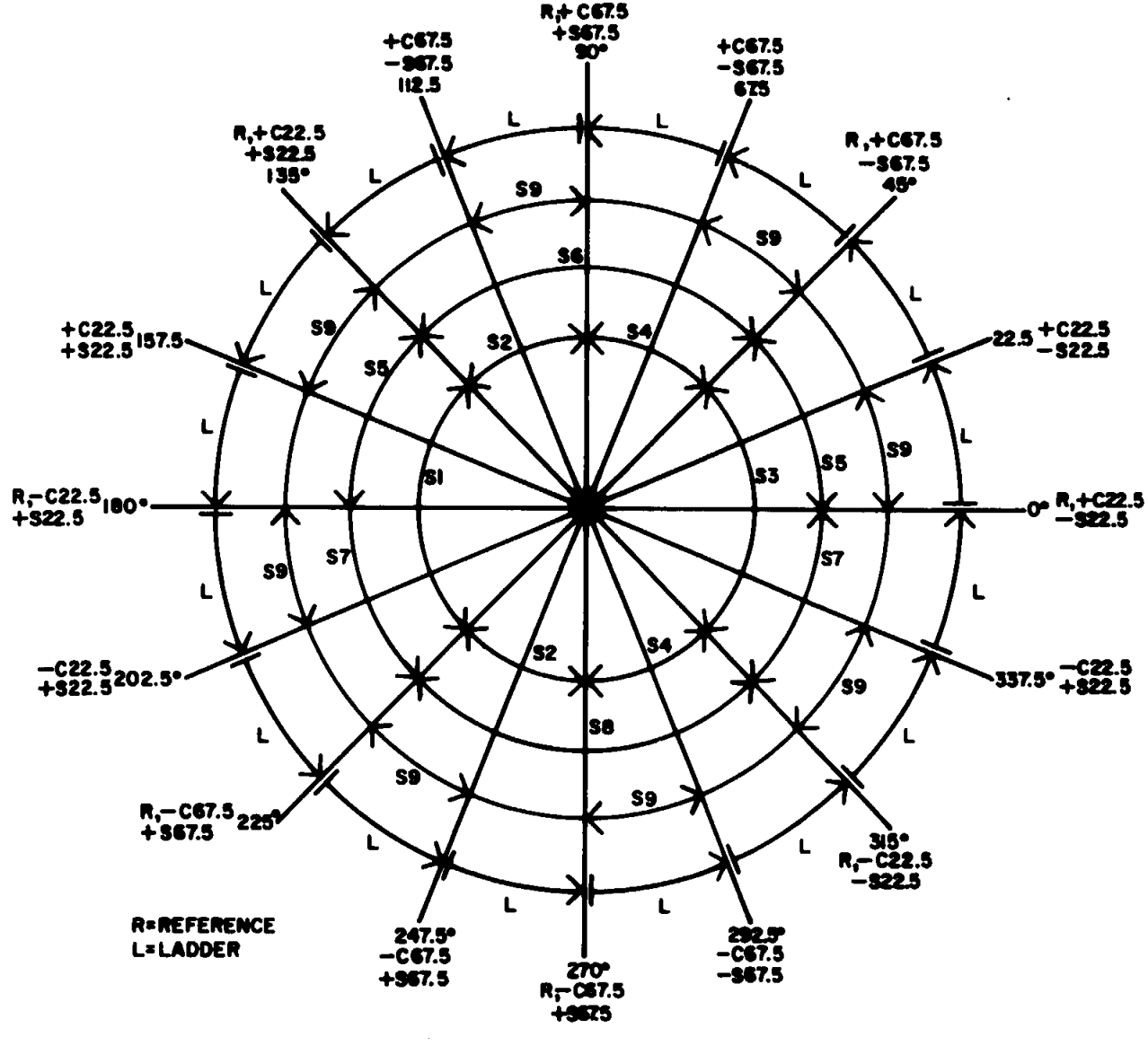
θ = 0°


2^{15} 2^{14} 2^{13} 2^{12} 2^{11} 2^{10} 2^{9} 2^{0}
READ COUNTER
0 0 0 0 0 0 0 X
0°
DRIVE CONTROL SIGNALS
DC 3, 5 & 9
FROM I.M.U. RES
28V [SIN θ]
28V [COS θ]
28V 800 ~ REF
(+)
(-)
5V [SIN θ] = 0V
5V [COS θ] = 5V
5V - 800 ~
S3
S5
S9
ATT NETWORK COS 22.5° E_O = .924 E_{IN}
ATT NETWORK SIN 22.5° E_O = .383 E_{IN}
ATT NETWORK SIN 22.5° E_O = .383 E_{IN}
0V
(-) 1.915
(+) 1.915
ERROR AMP
*SIN 0° = 0
COS 0° = 1

θ=42.2°


READ COUNTER
2^{15} 2^{14} 2^{13} 2^{12} 2^{11} 2^{10} 2^{9} 2^{0}
0 0 0 1 1 1 1 X
DRIVE CONTROL SIGNALS
DC 3, 5, 10, 11 & 12
FROM I.M.U. RES
28V [SINθ]
28V [COSθ]
5V [SINθ] = 3.35V
5V [COSθ] = 3.7V
(+)
(-)
S3
S5
S10
S11
S12
ATT NETWORK COS 22.5° E_O = .924 E_{IN}
ATT NETWORK SIN 22.5° E_O = .383 E_{IN}
ATT NETWORK SIN 11.25° E_O = .199 E_{IN}
ATT NETWORK SIN 5.62° E_O = 0.78 E_{IN}
ATT NETWORK SIN 2.8° E_O = .049 E_{IN}
2.8°
5.6°
11.25°
22.5°
= 42.15°
-1.4V
-.995V
-.39V
-.2V
+3.08V
+.05V
ERROR AMP
28V 800~REF
5V-800~
*SIN 42.2° = .67
COS 42.2° = .74
GNC-150

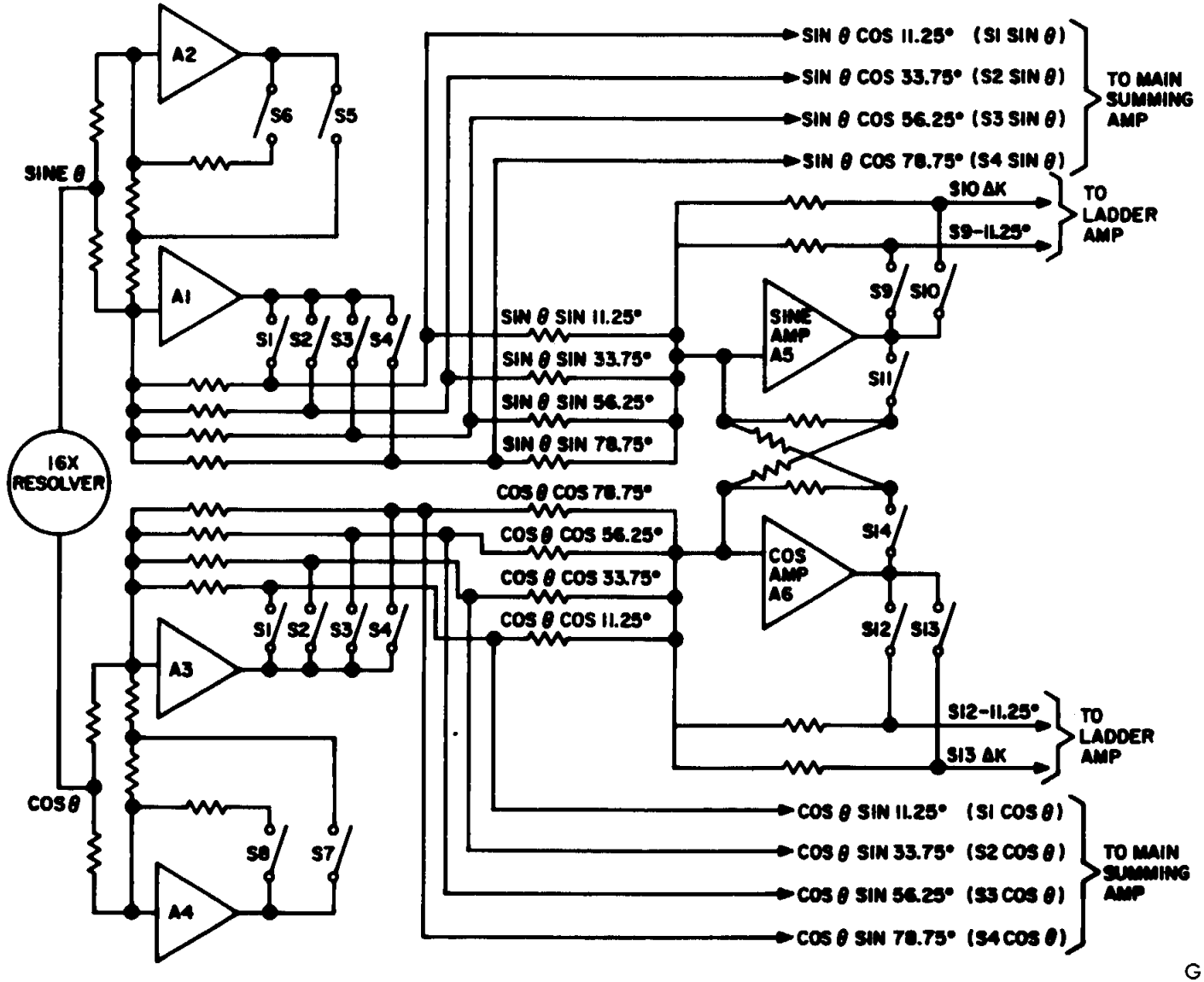
COARSE SWITCHING DIAGRAM



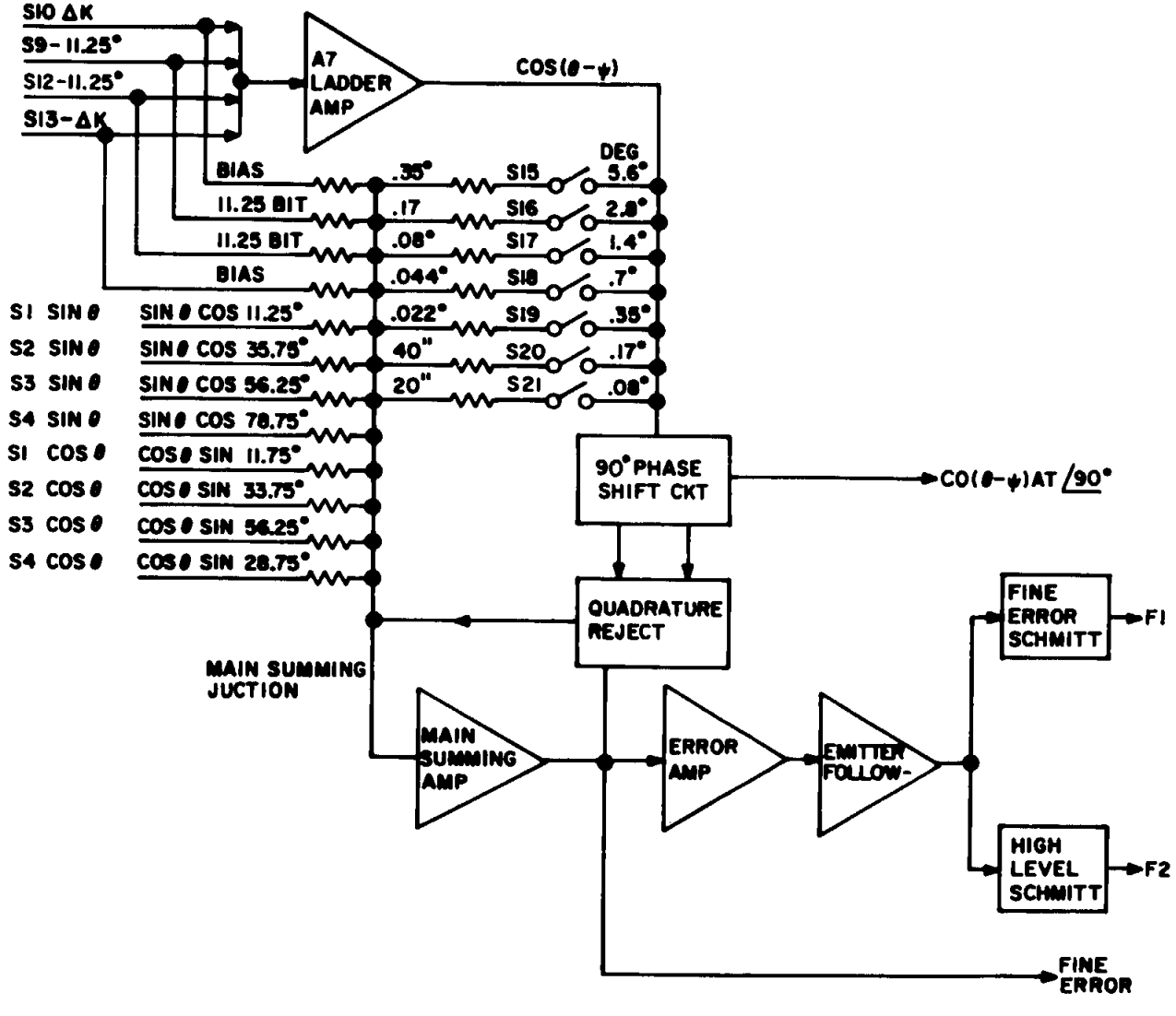
GNC-113

CDH

QUADRANT SELECT MODULE BLOCK DIAGRAM



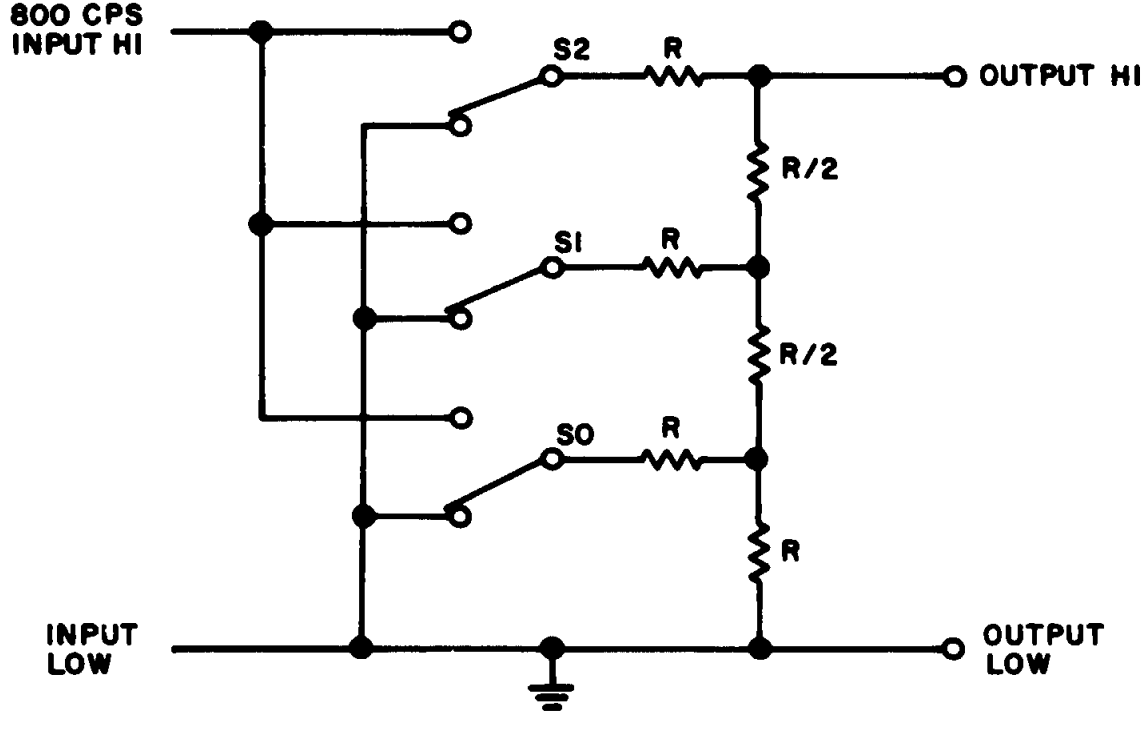
MAIN SUMMING AMPLIFIER QUADRATURE REJECT MODULE BLOCK DIAGRAM



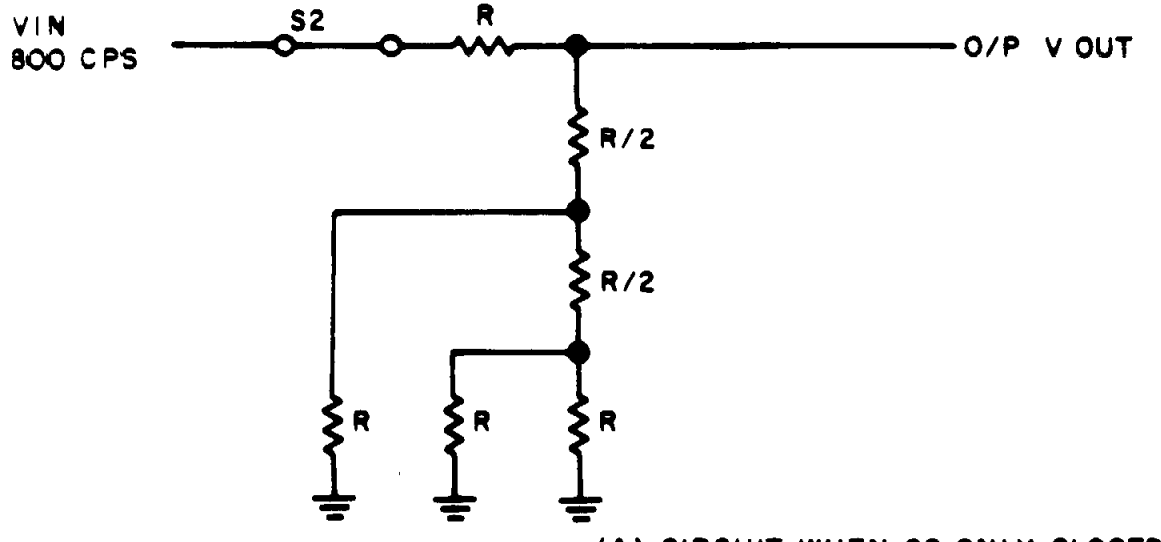
GNC-116

CDU

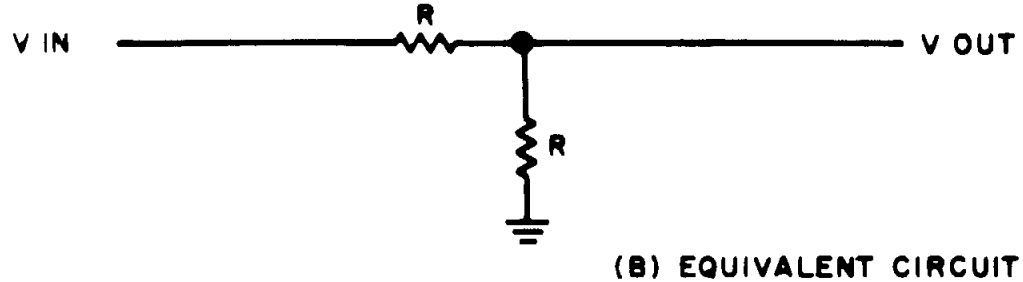
LADDER DECODER-SIMPLIFIED



LADDER CIRCUIT WITH S2 CLOSED



(A) CIRCUIT WHEN S2 ONLY CLOSED



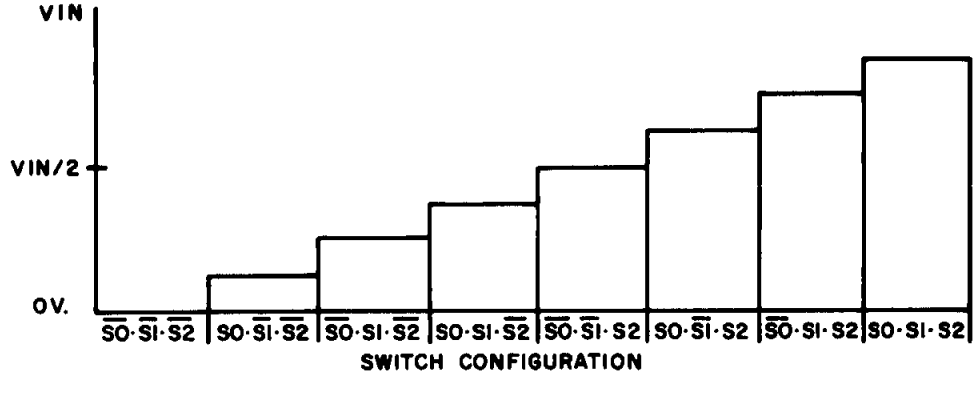
(B) EQUIVALENT CIRCUIT

CDU

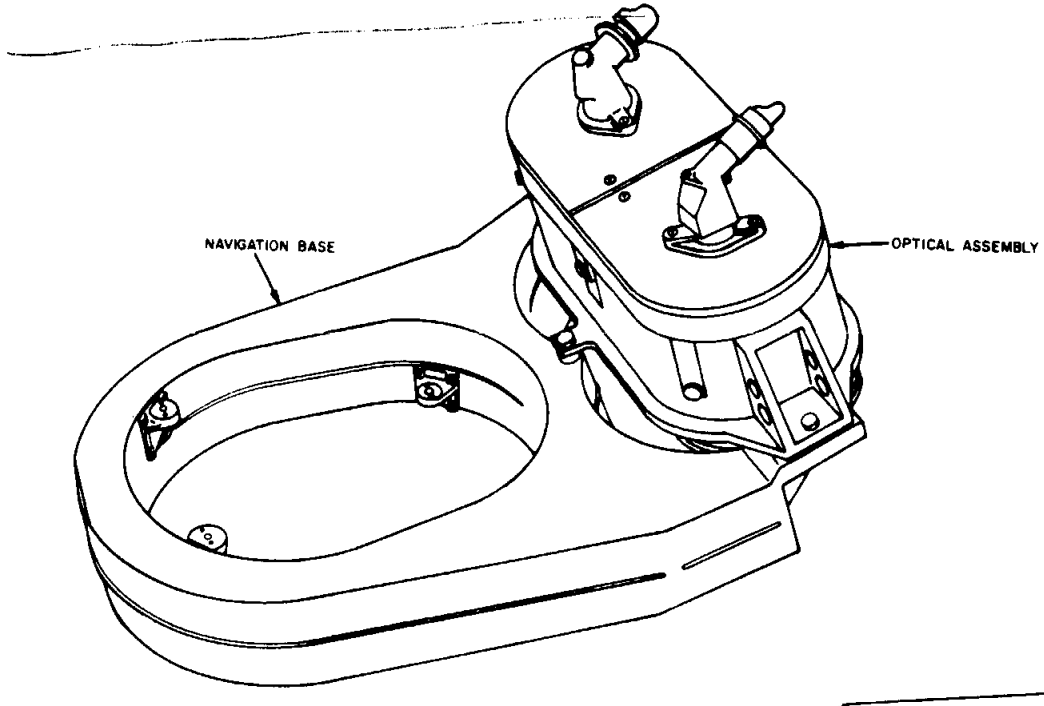
LADDER OUTPUT VOLTAGE

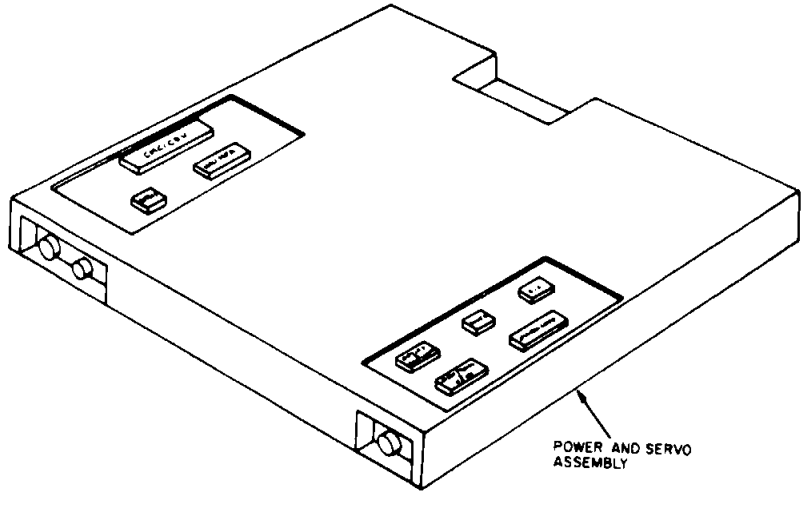
S0	S1	S2	V OUT
0	0	0	0
1	0	0	VIN/8
0	1	0	VIN/4
1	1	0	3/8 VIN
0	0	1	VIN/2
1	0	1	5/8 VIN
0	1	1	3/4 VIN
1	1	1	7/8 VIN

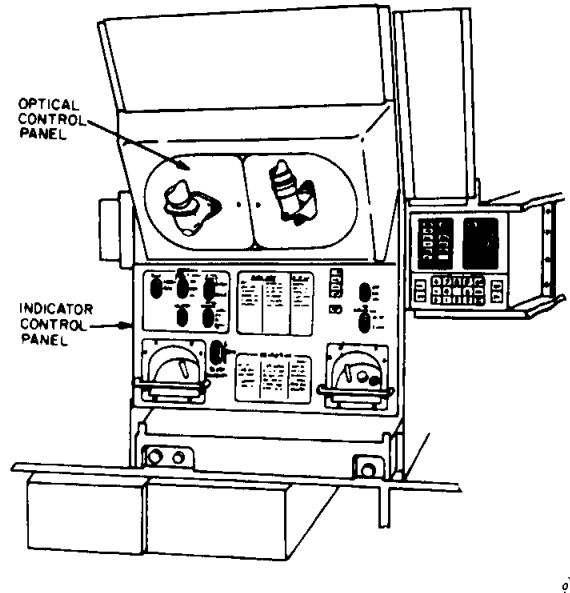
Table 4-4. Ladder Decoder Truth Table



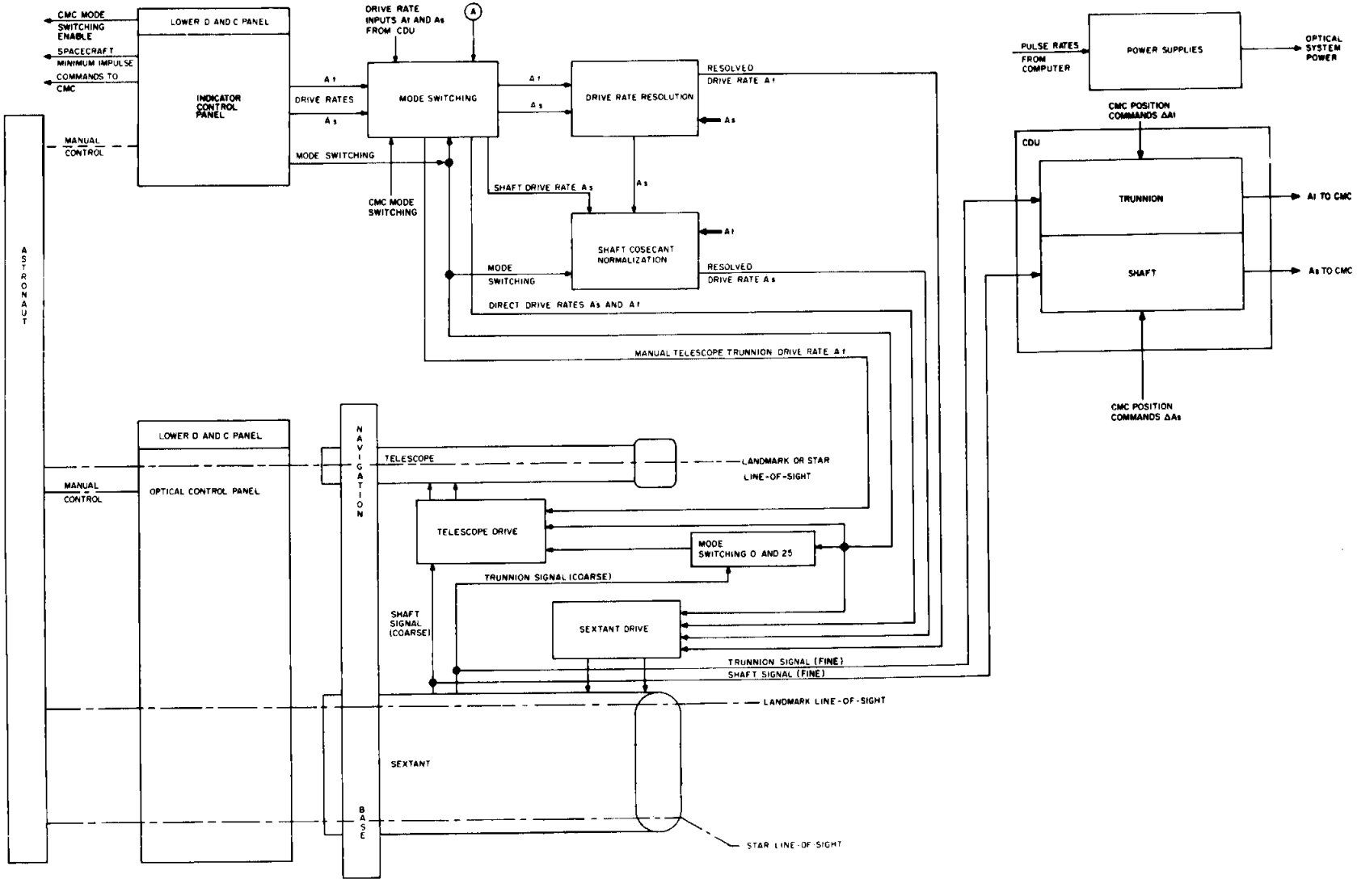
OPTICAL SUBSYSTEM EQUIPMENT



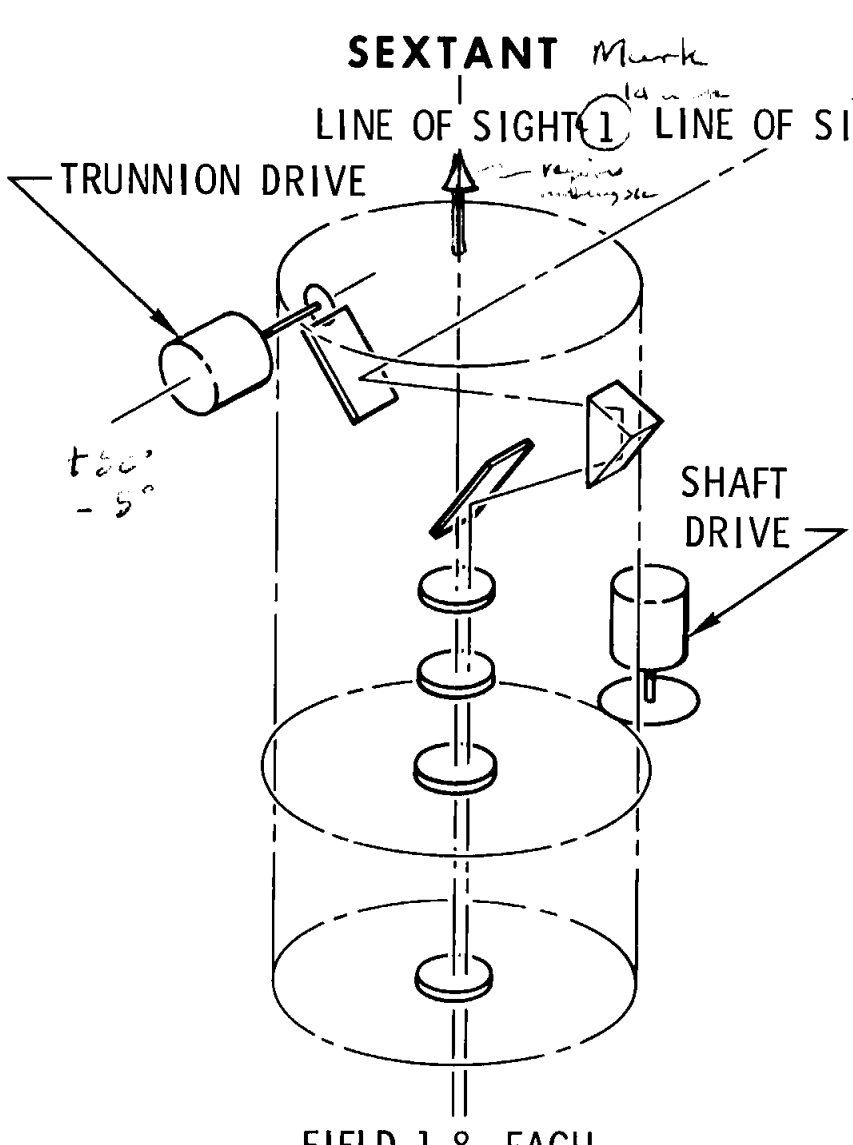


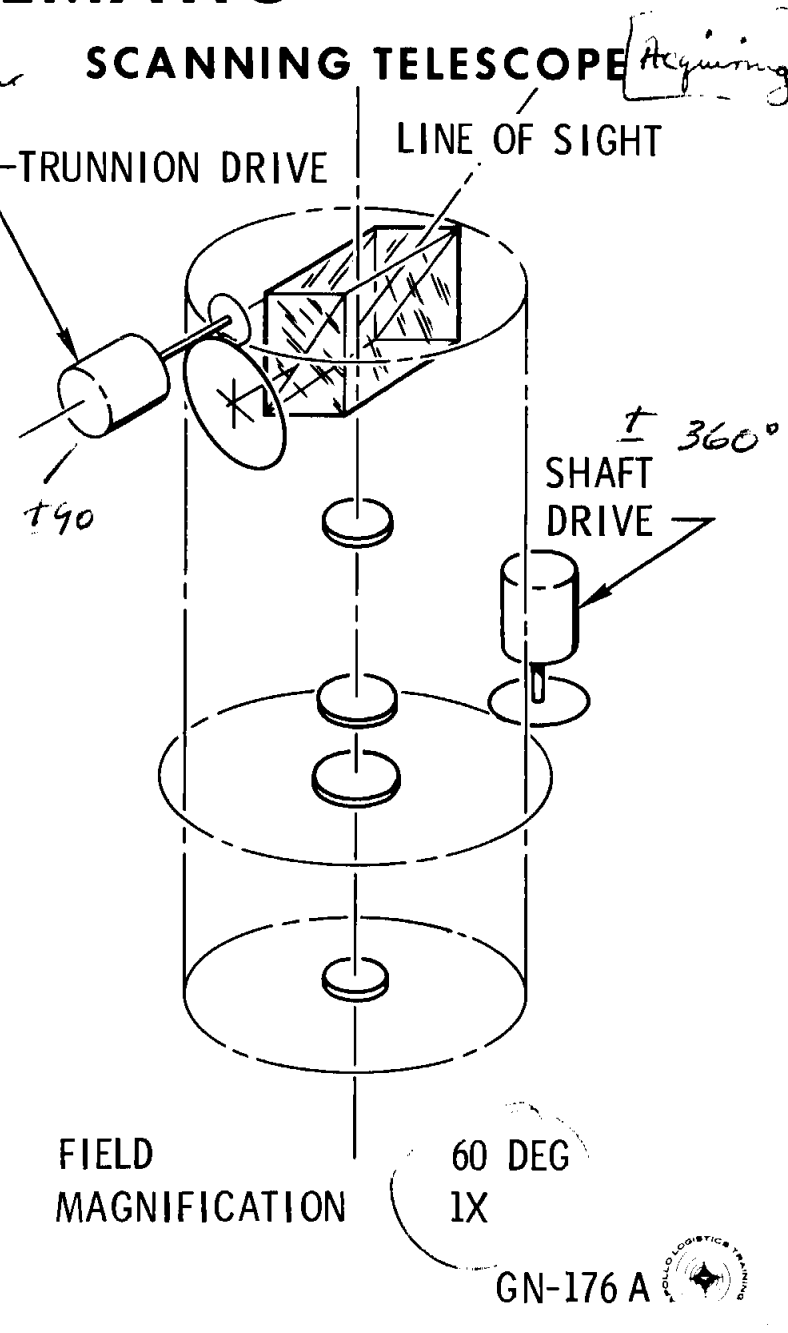


OPTICAL SUBSYSTEM INTERFACE

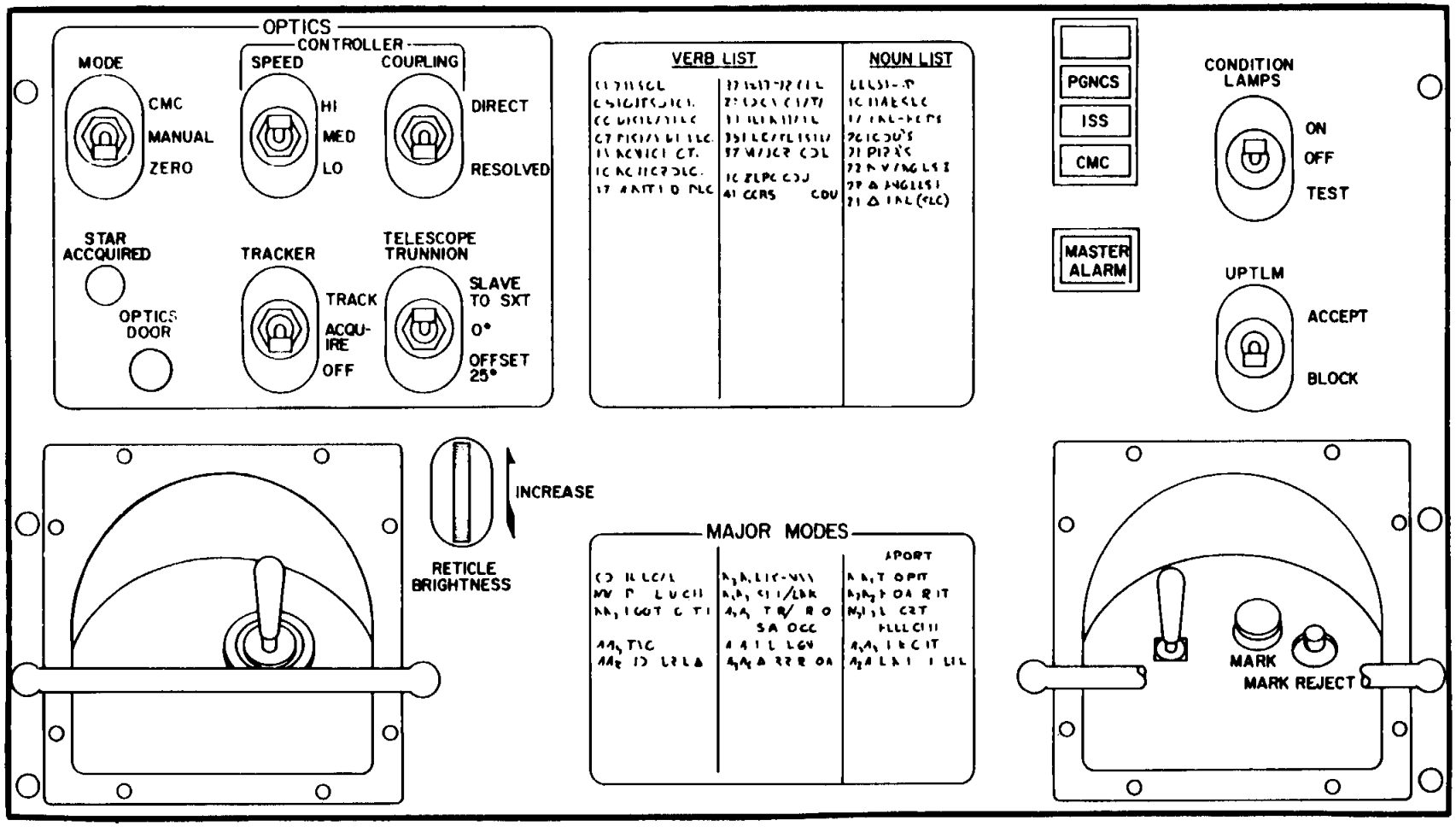


OPTICAL SCHEMATIC

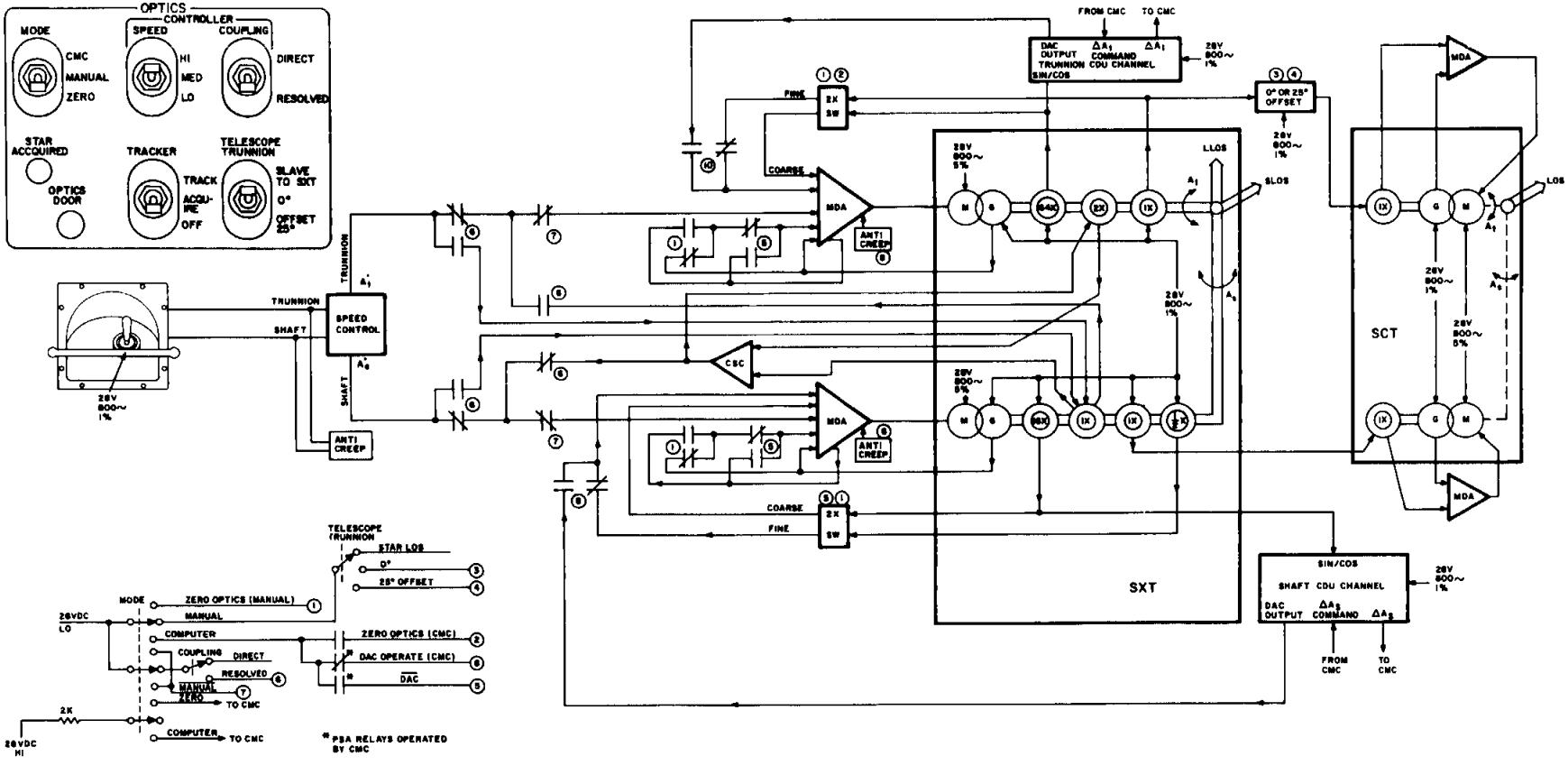




INDICATOR CONTROL PANEL



OPTICS MECHANIZATION



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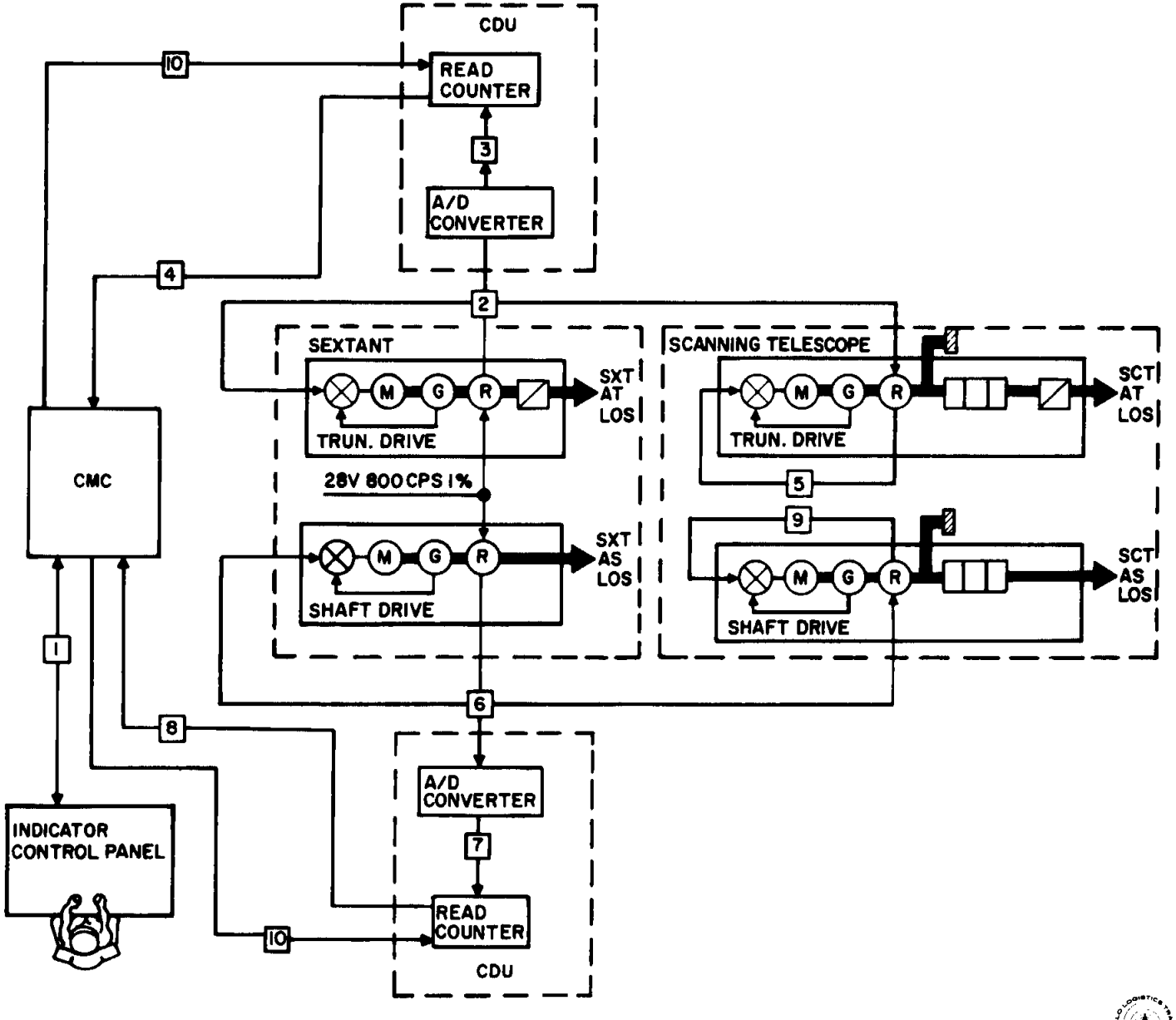
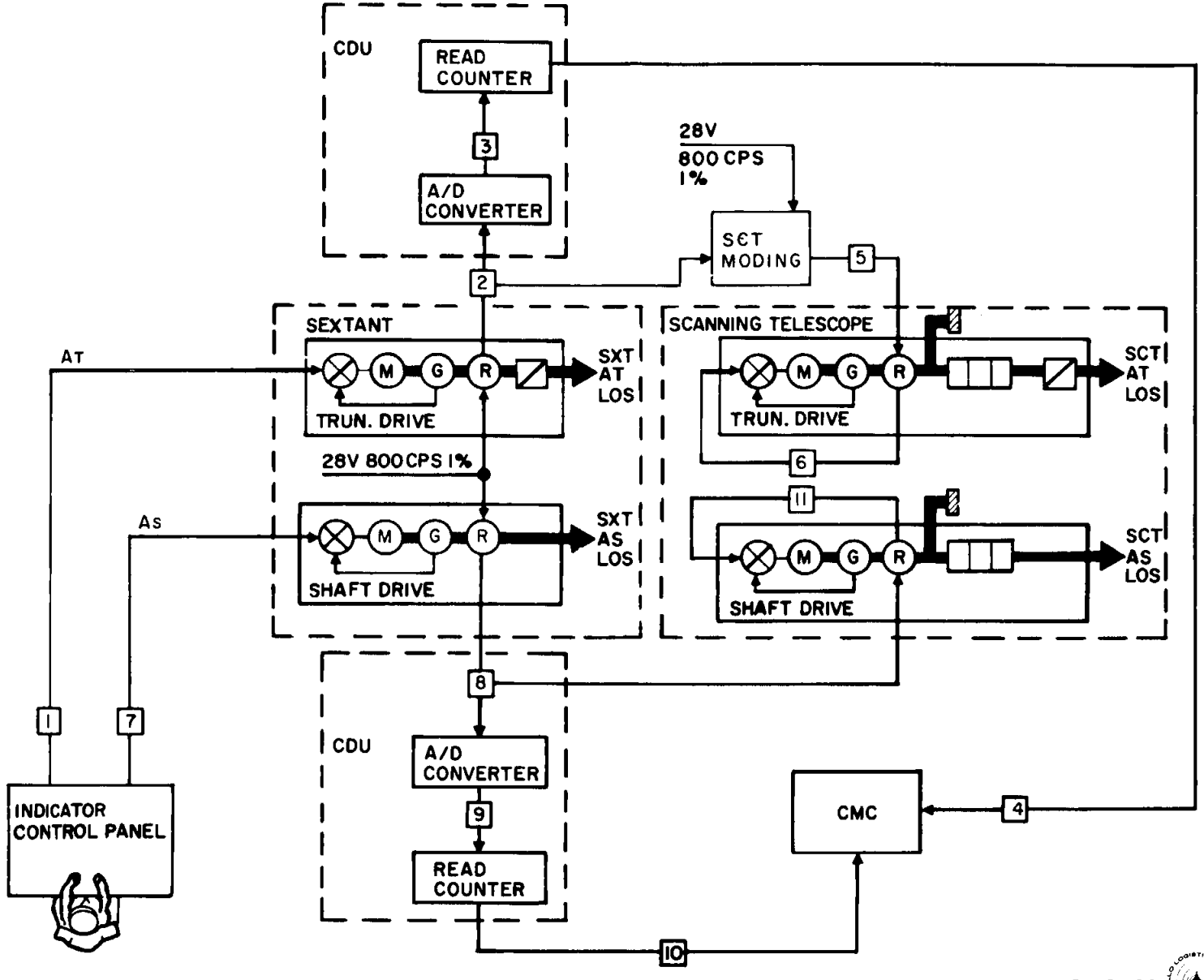
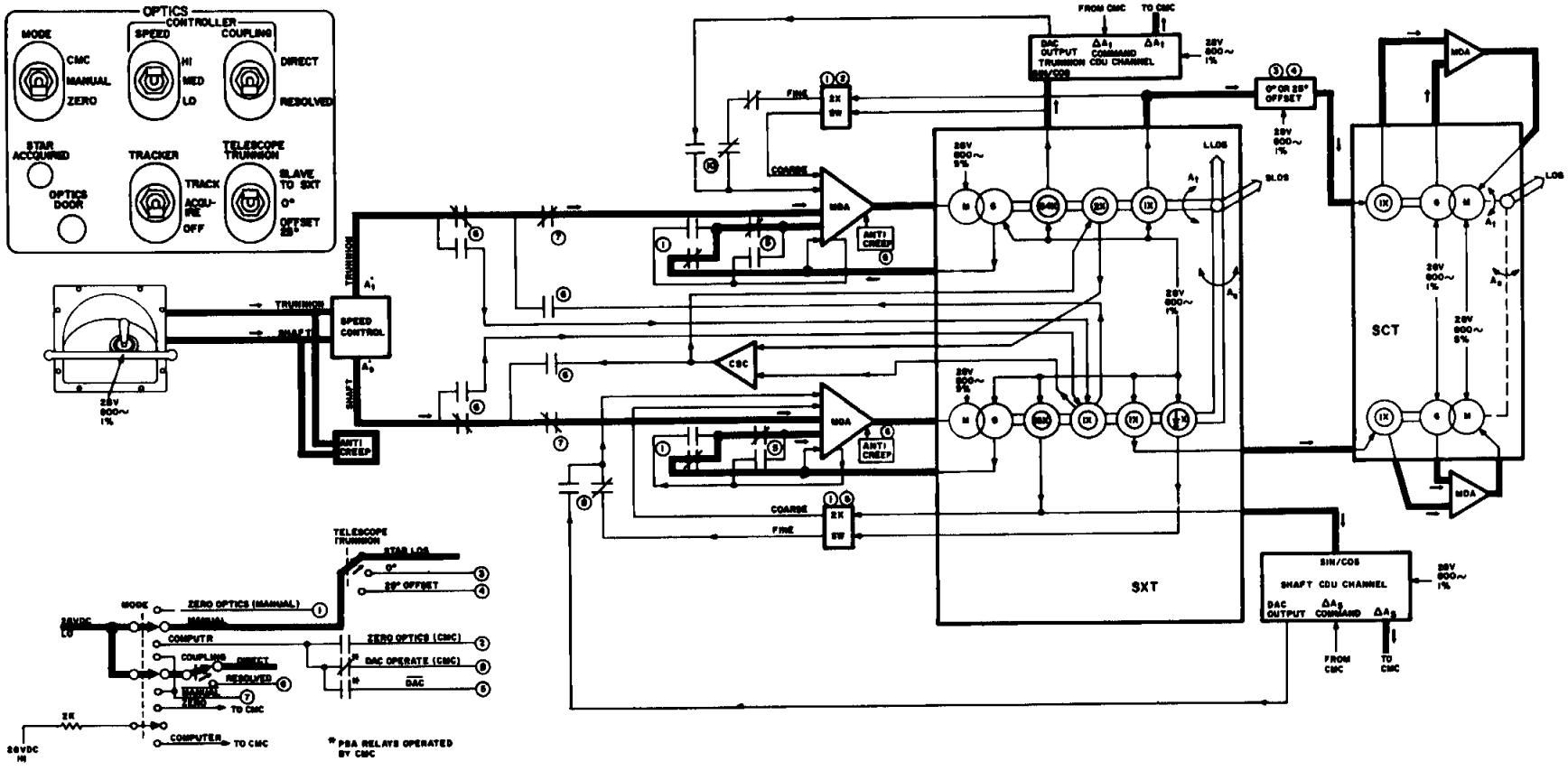
ZERO OPTICS MODE



MANUAL DIRECT MODE

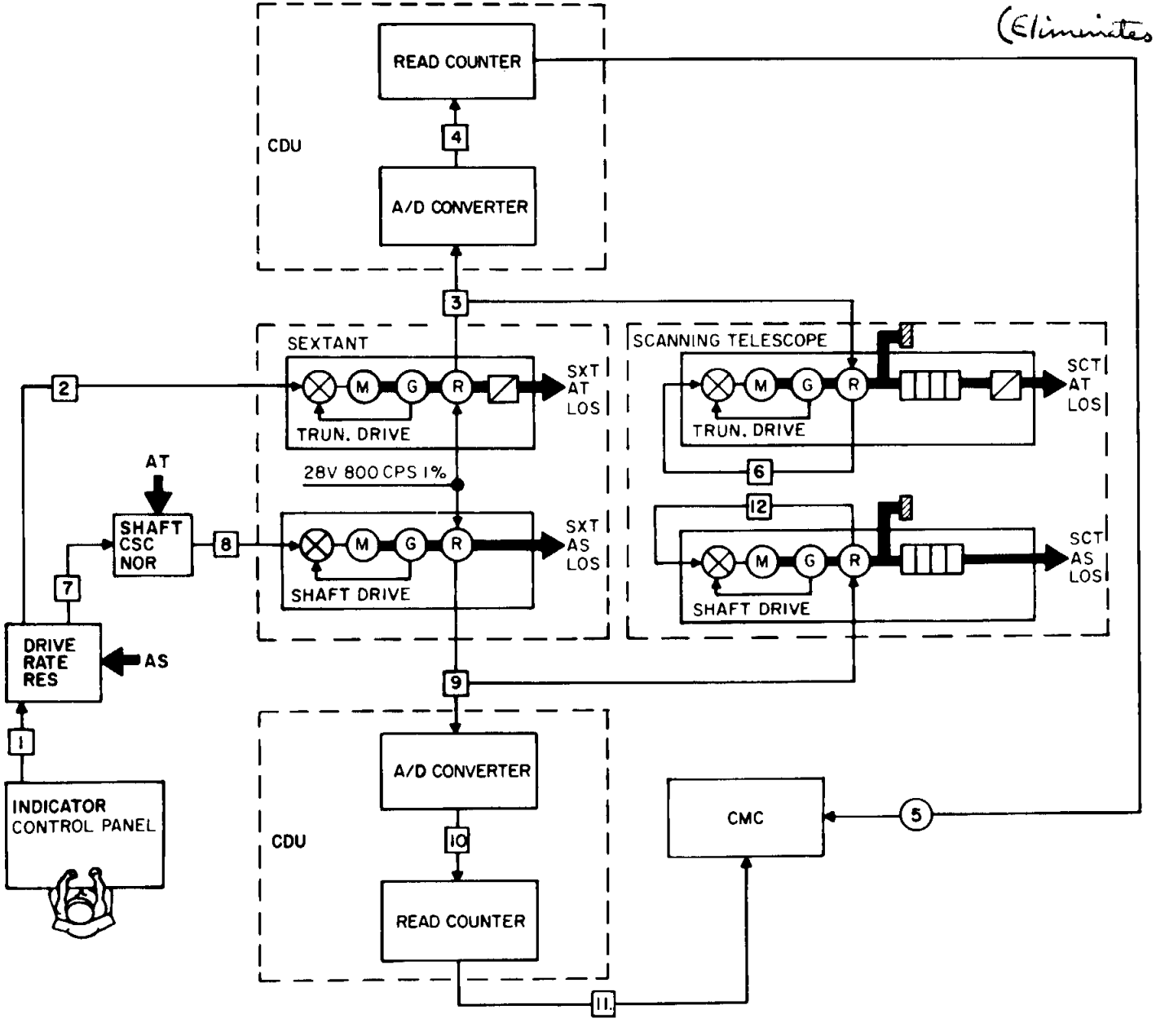


MANUAL DIRECT MODE

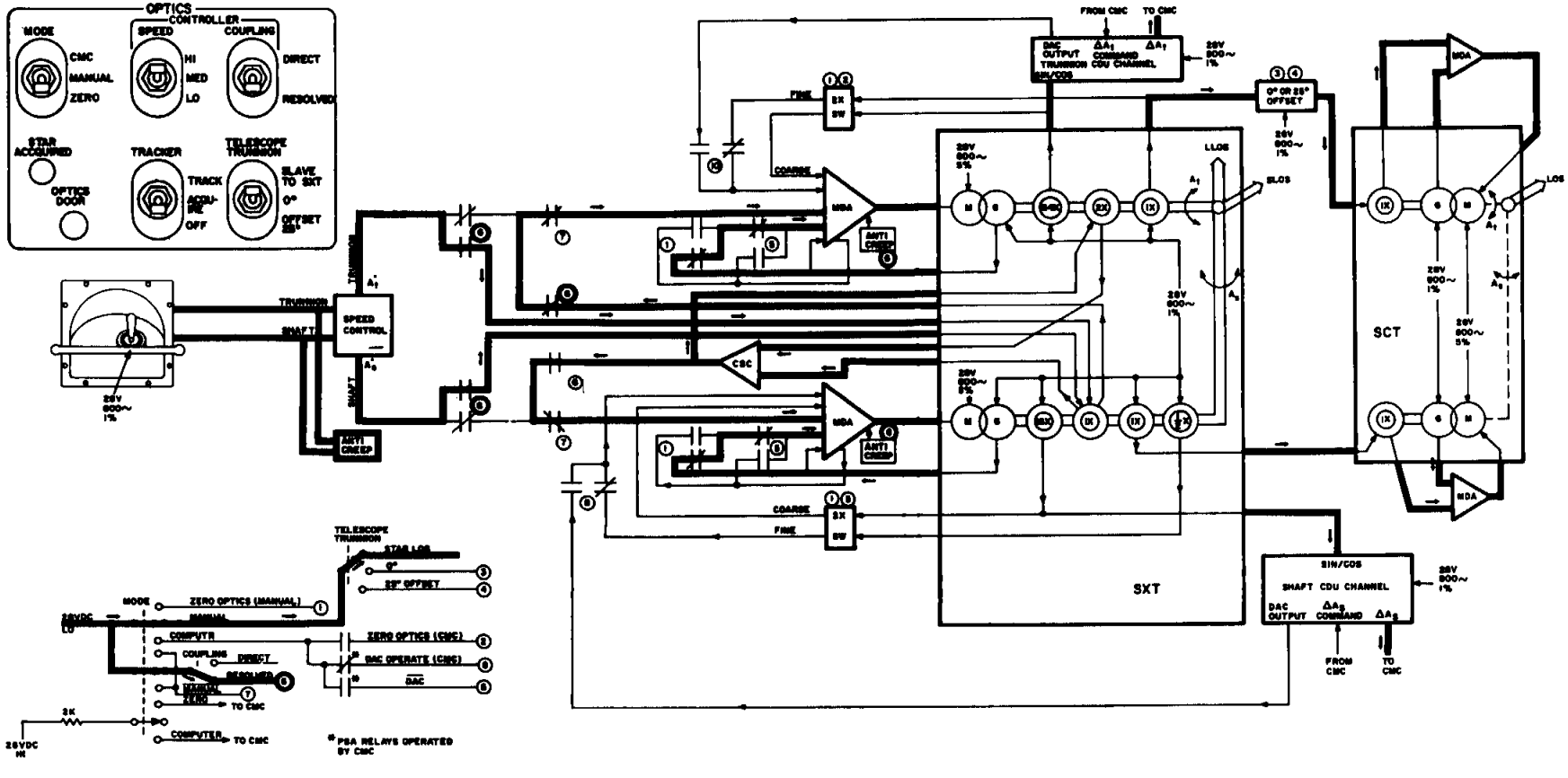


MANUAL RESOLVED MODE

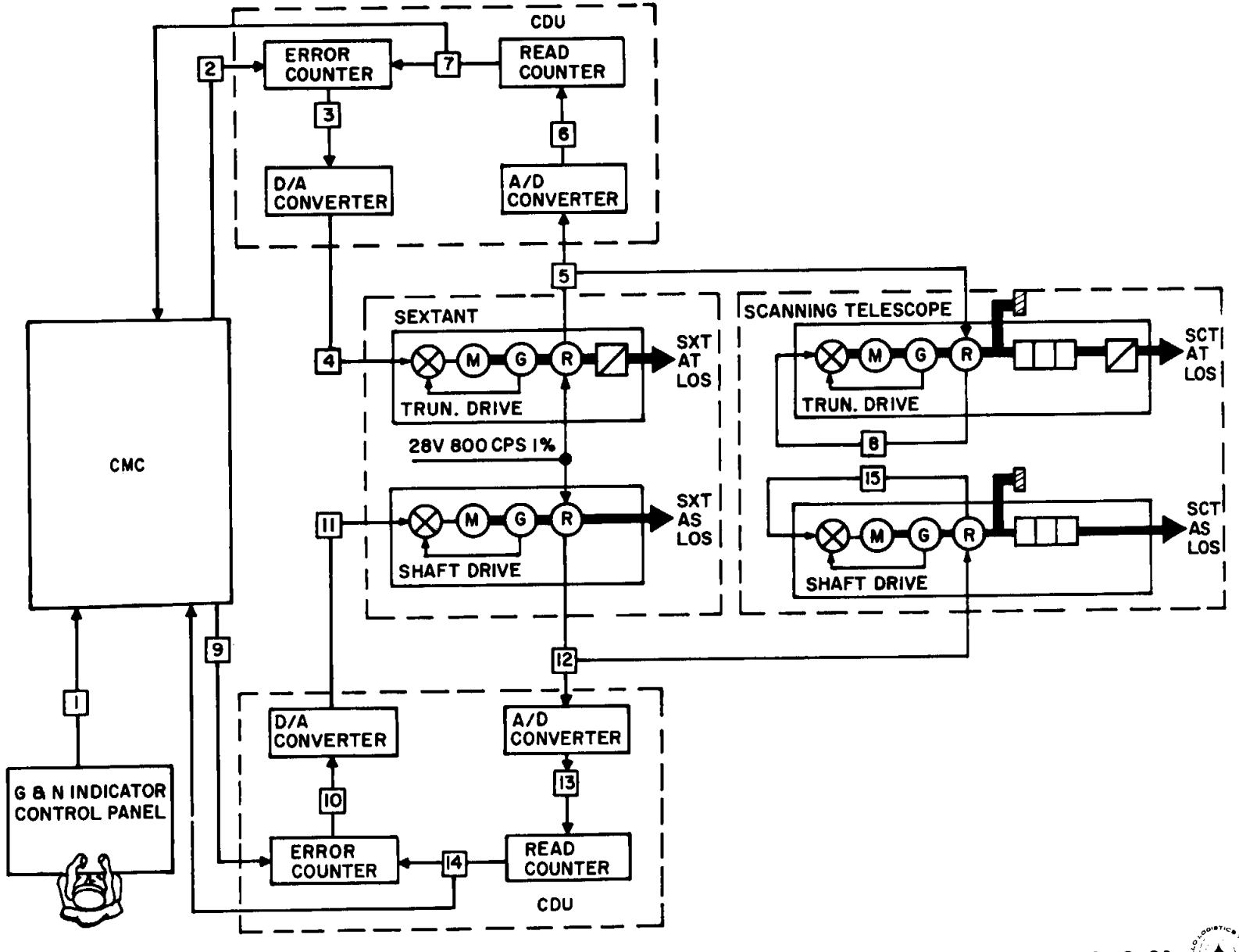
Object moves wrt viewer (Eliminates shaft angle)



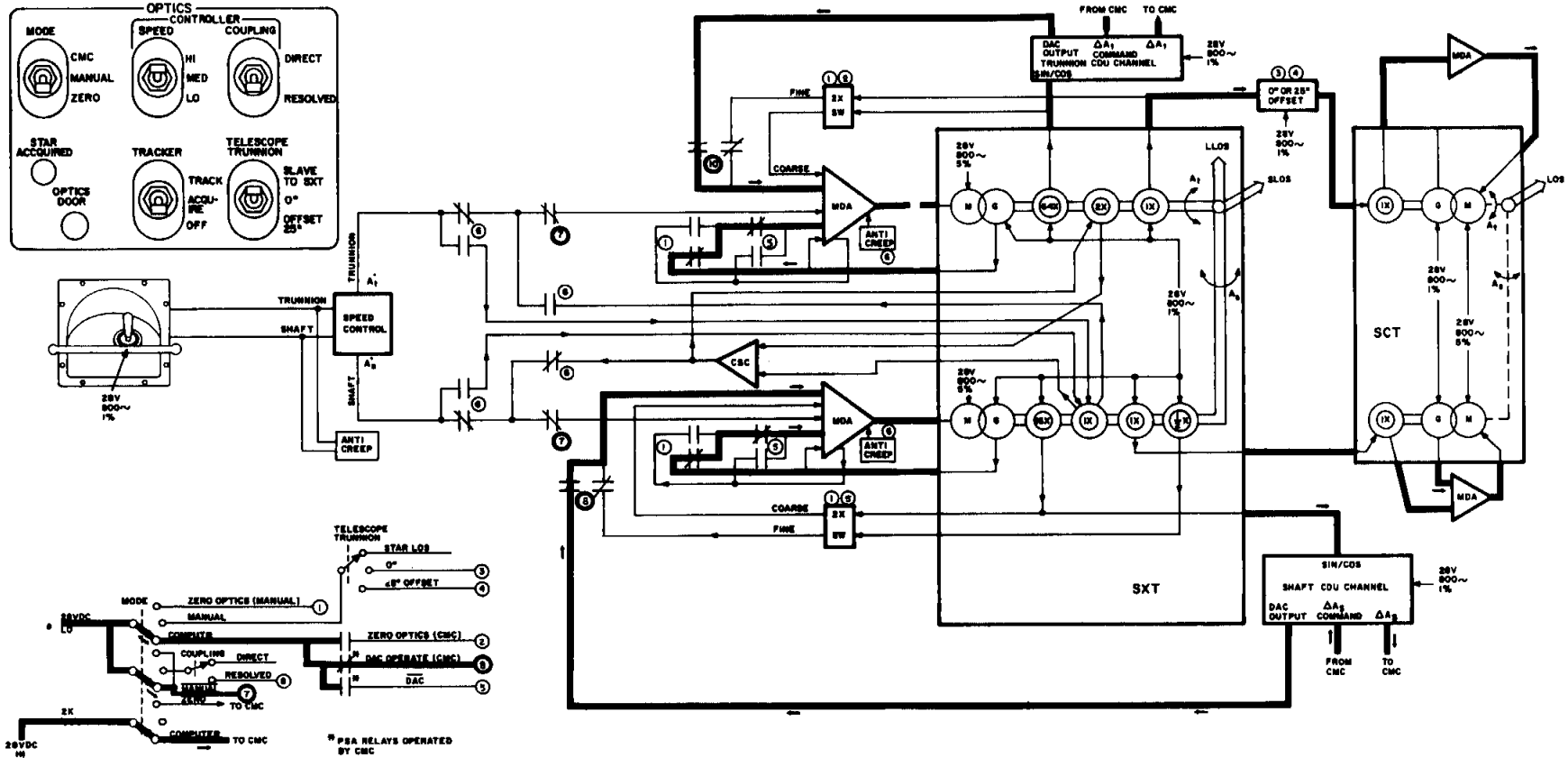
MANUAL RESOLVED MODE



COMPUTER MODE



COMPUTER MODE



GNC-136A

Al Sohler
Martin Murray } Instructors (NAA)

Program 21

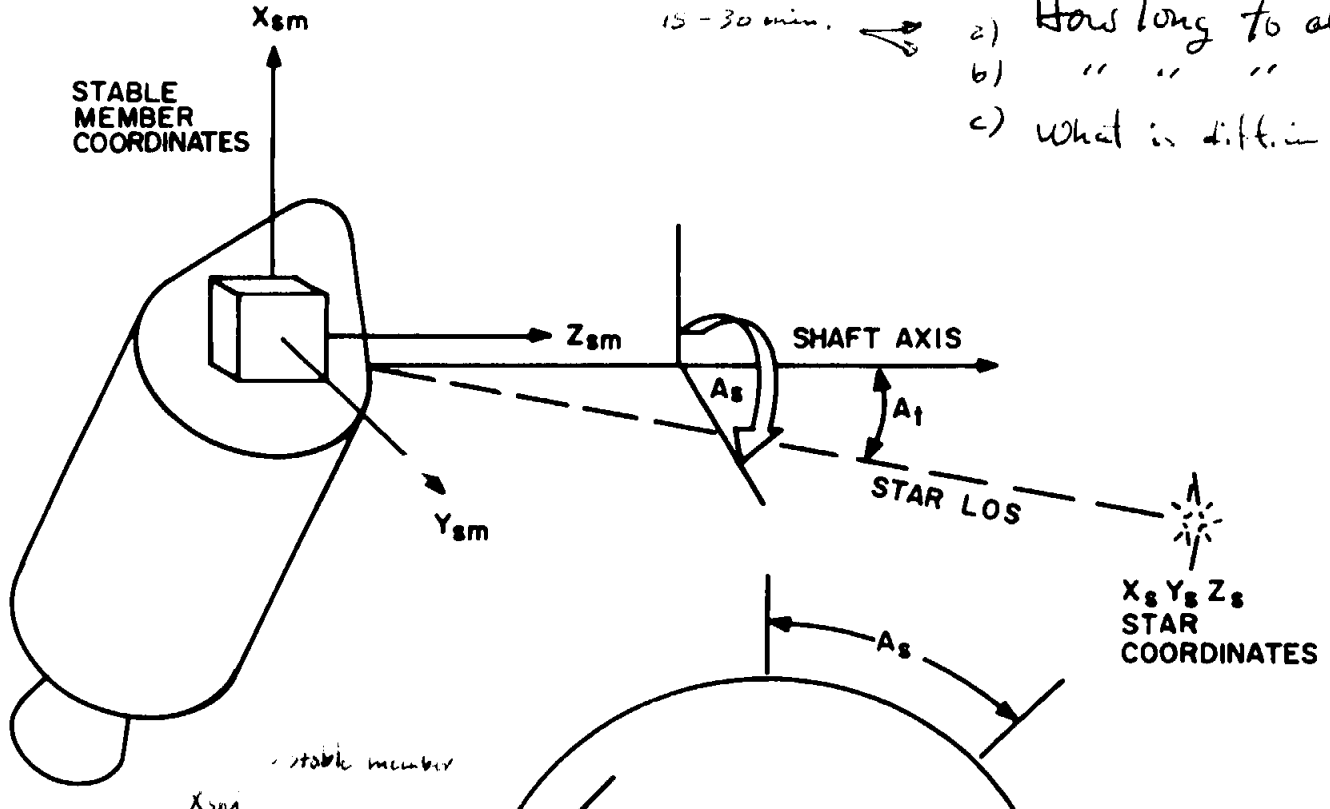
IMU ALIGNMENT MEASUREMENT

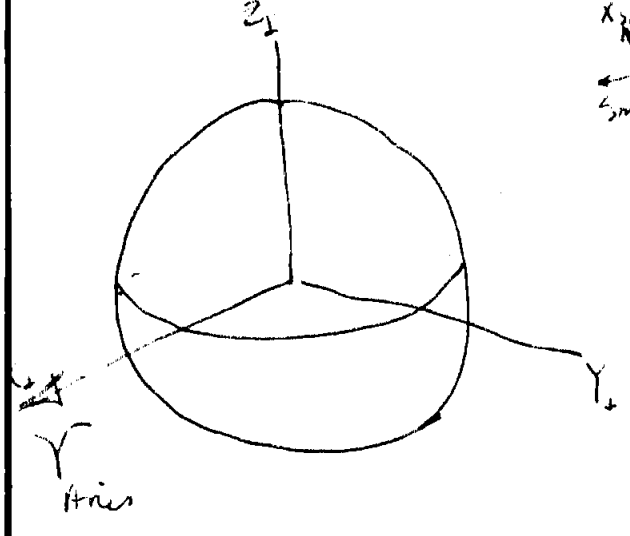
15 - 30 min.

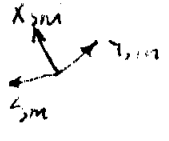
a) How long to align the platform
b) " " " " Det. REFSMMAT
c) What is diff. in time & compare chg

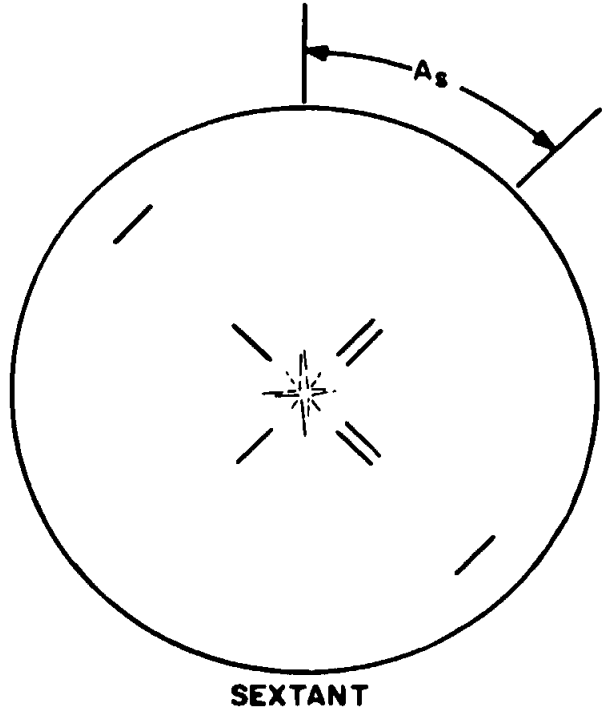
7-8 min

1. Pos

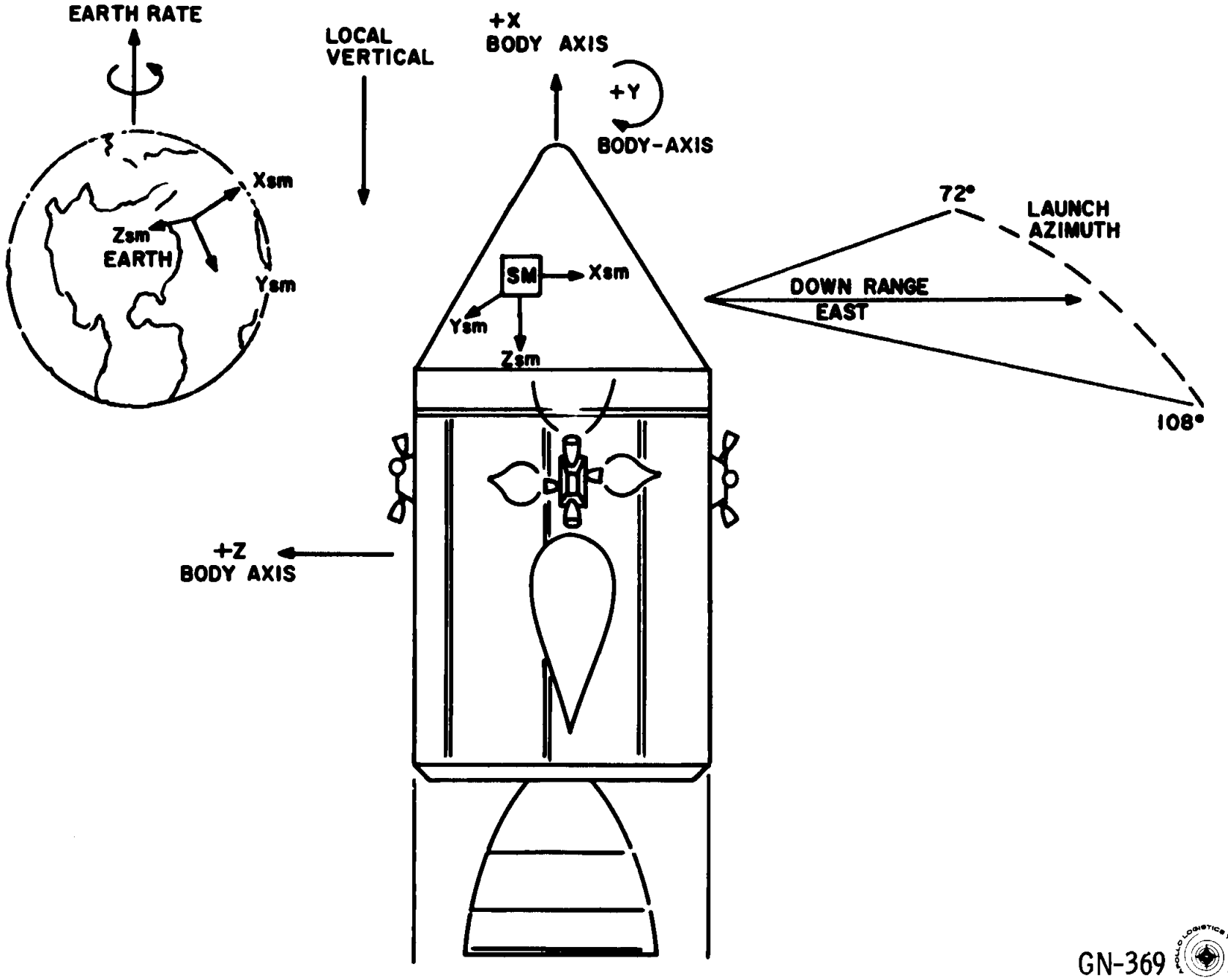






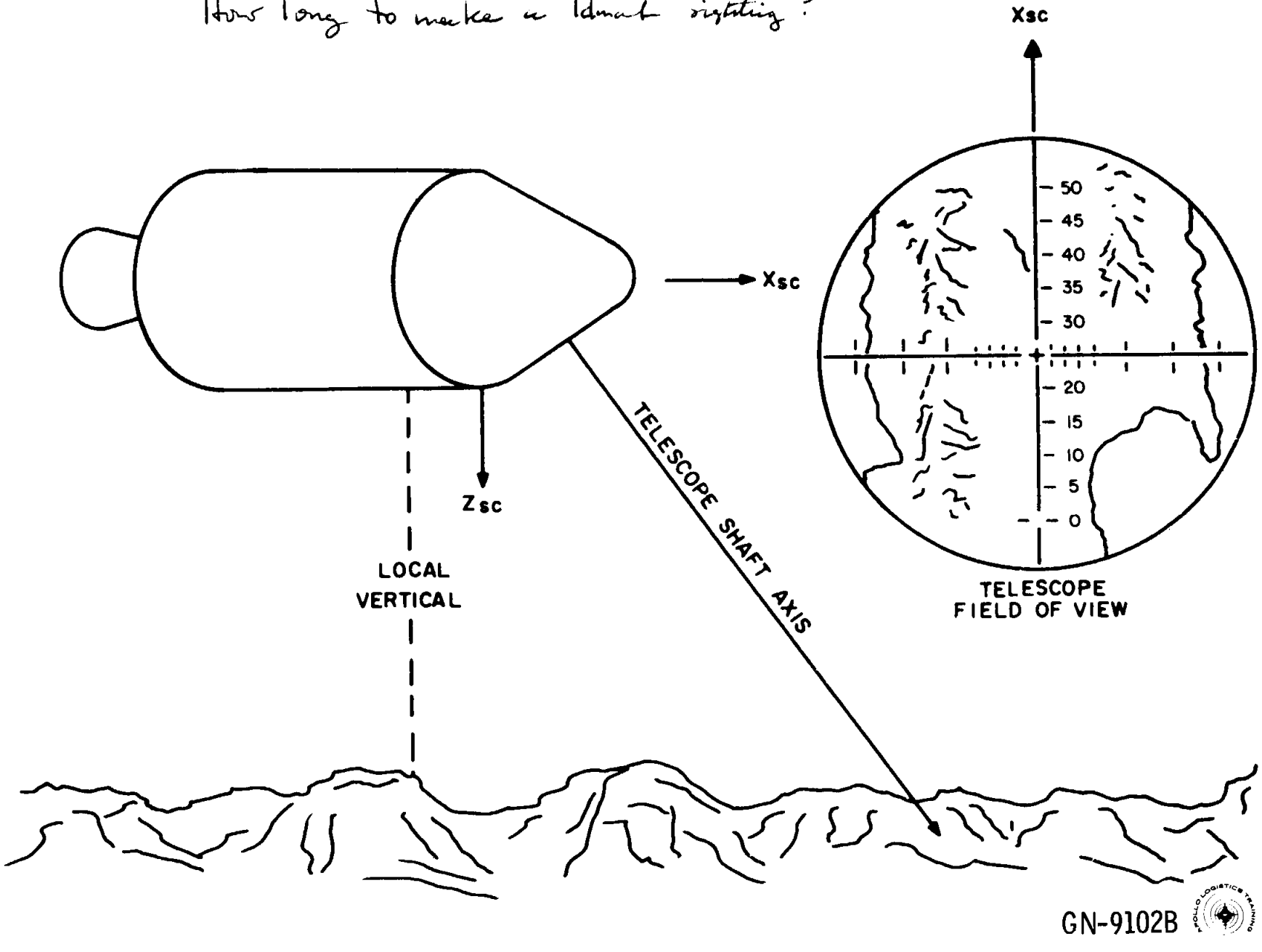


PRELAUNCH ALIGNMENT



GN-369

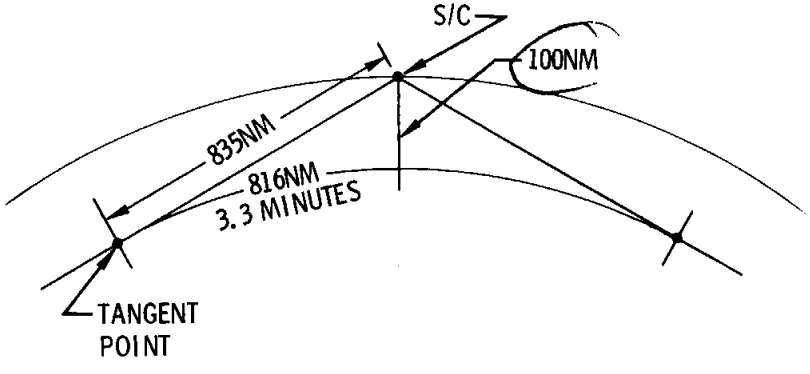
ORBITAL NAVIGATION SIGHTING



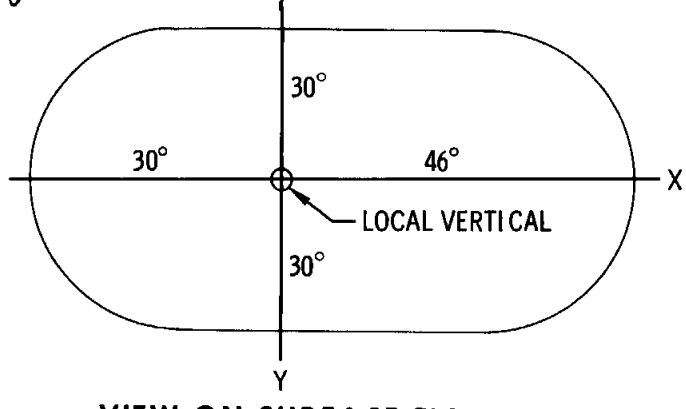
P 21
22

EARTH ORBIT NAVIGATION

How do you get valid update data from an unknown landmark

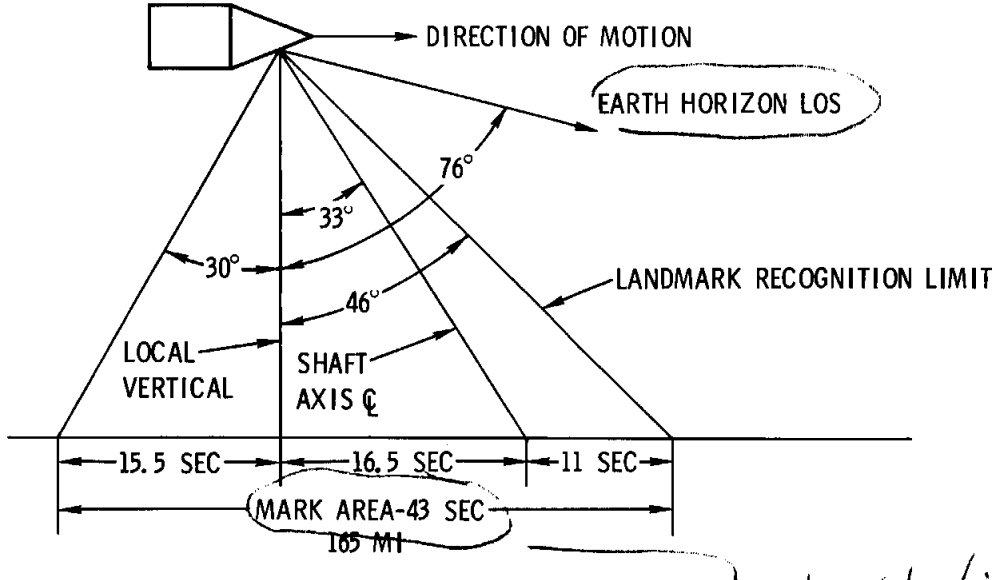


EARTH ORBIT GEOMETRY FIGURE 1



VIEW ON SURFACE FIGURE 3

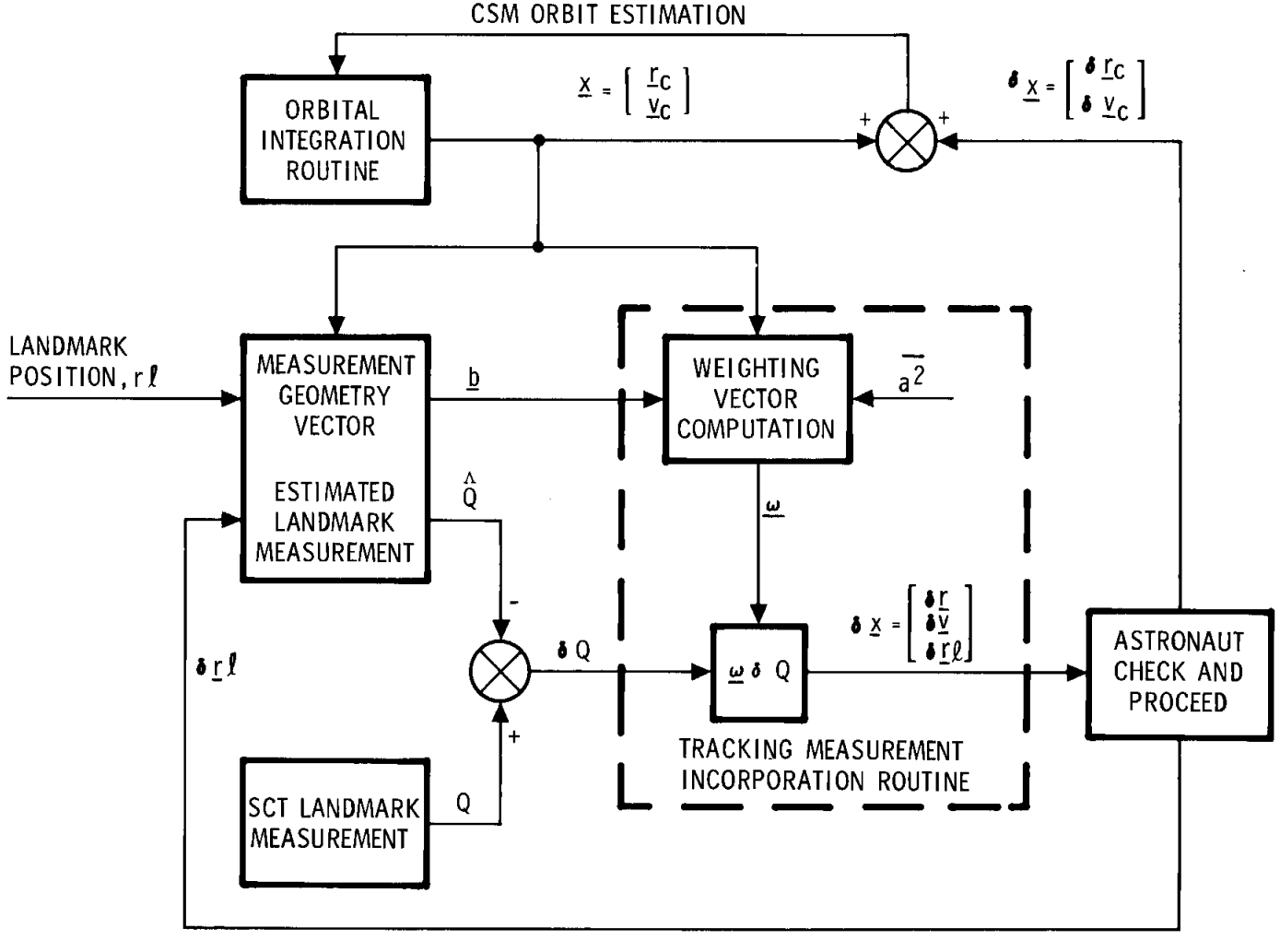
R1 ΔPos (umi)
R2 ΔV (5 ft/sec)
R3 00135
1 processing 3rd mark



COVERAGE ON SURFACE FIGURE 2

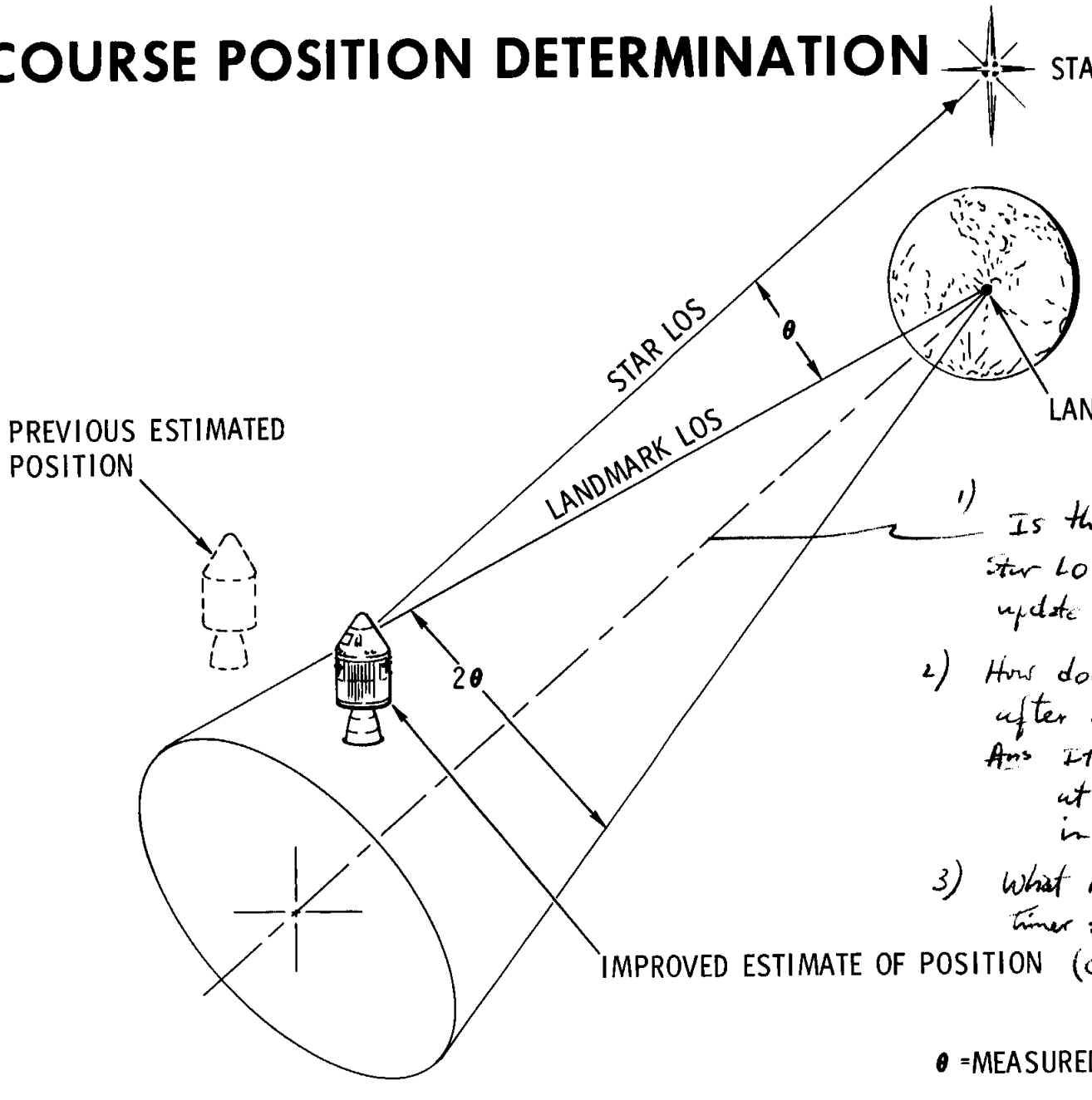
Would like to have 5 sightings (in 43 sec?)

SIMPLIFIED ORBITAL NAVIGATION FUNCTIONAL DIAGRAM



MIDCOURSE POSITION DETERMINATION

Program 23



1) Is this ~~path~~ parallel to star LOS? - Must be to update s/c position

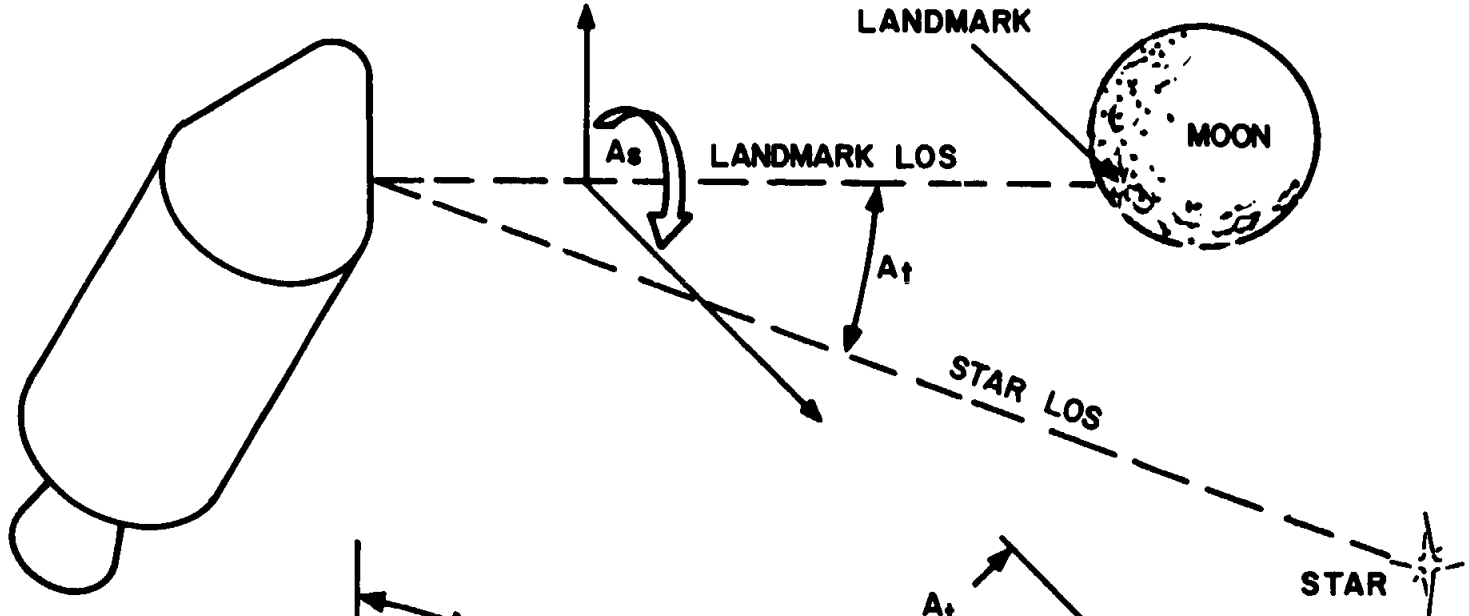
2) How does comp. update itself after being in standby?
Ans It does based on St. vect at ~~start~~ standby time & th in standby

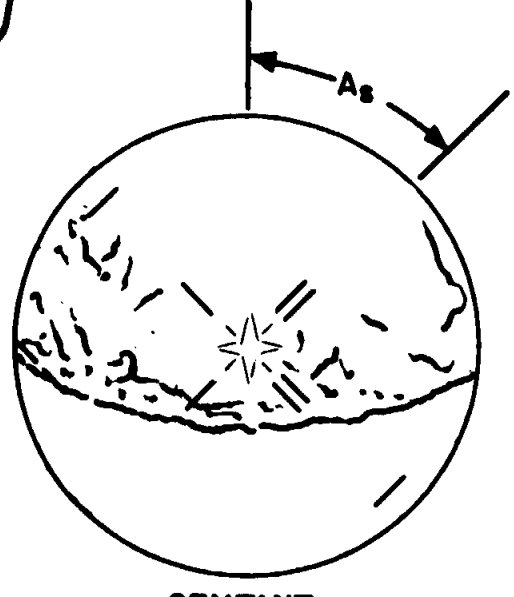
3) What is diff. in mission event timer & ~~computer~~ time?

(CMC in standby can only ~~take~~ hold up to 2 hrs ... it then loses time ∴ state up update.

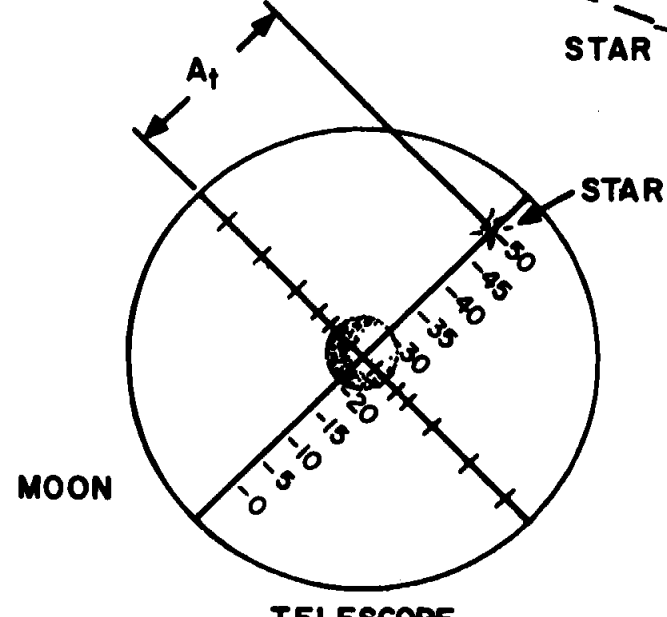
GN-9101A

NAVIGATIONAL MEASUREMENT





SEXTANT
FIELD OF VIEW

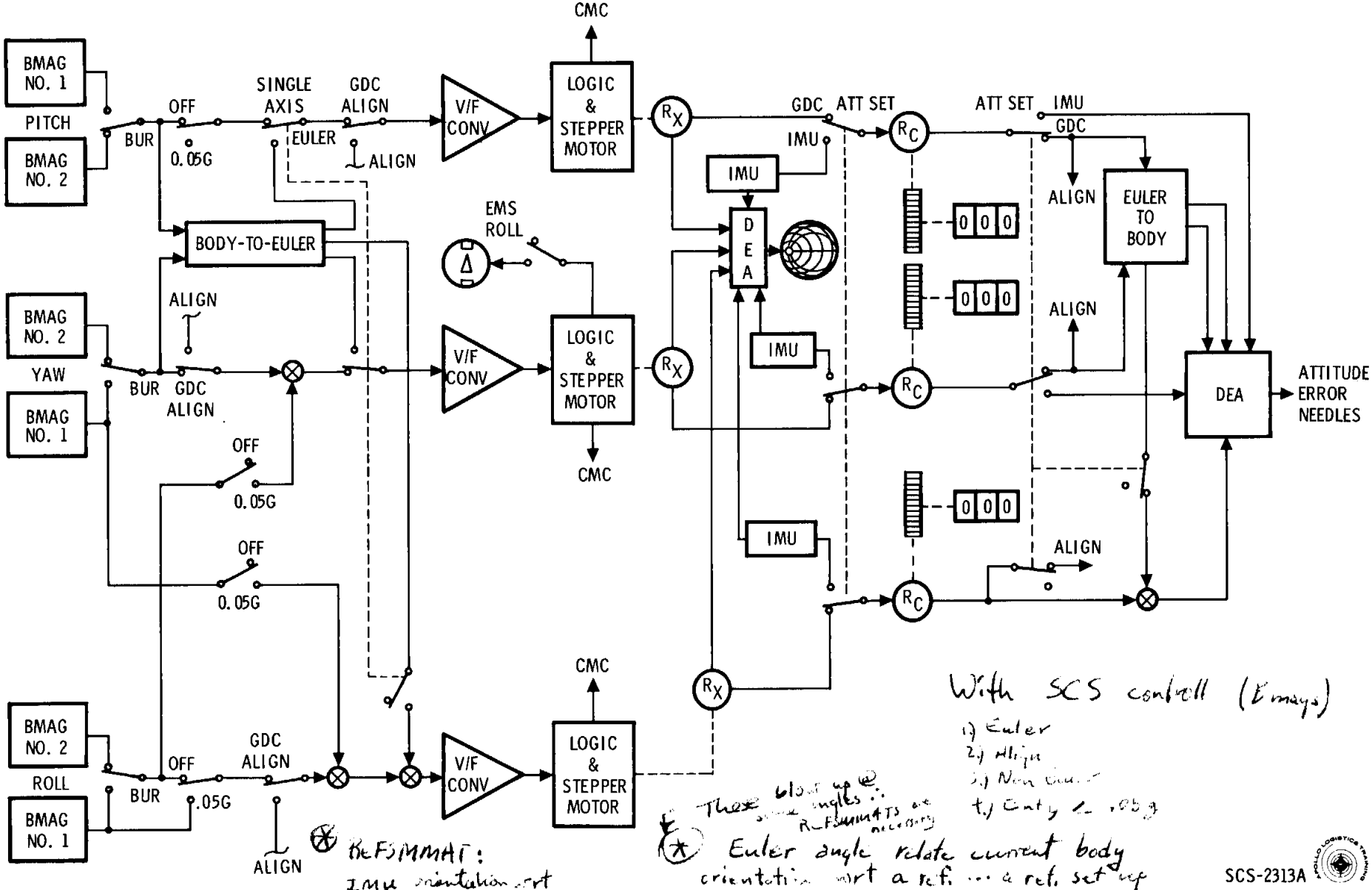


TELESCOPE
FIELD OF VIEW

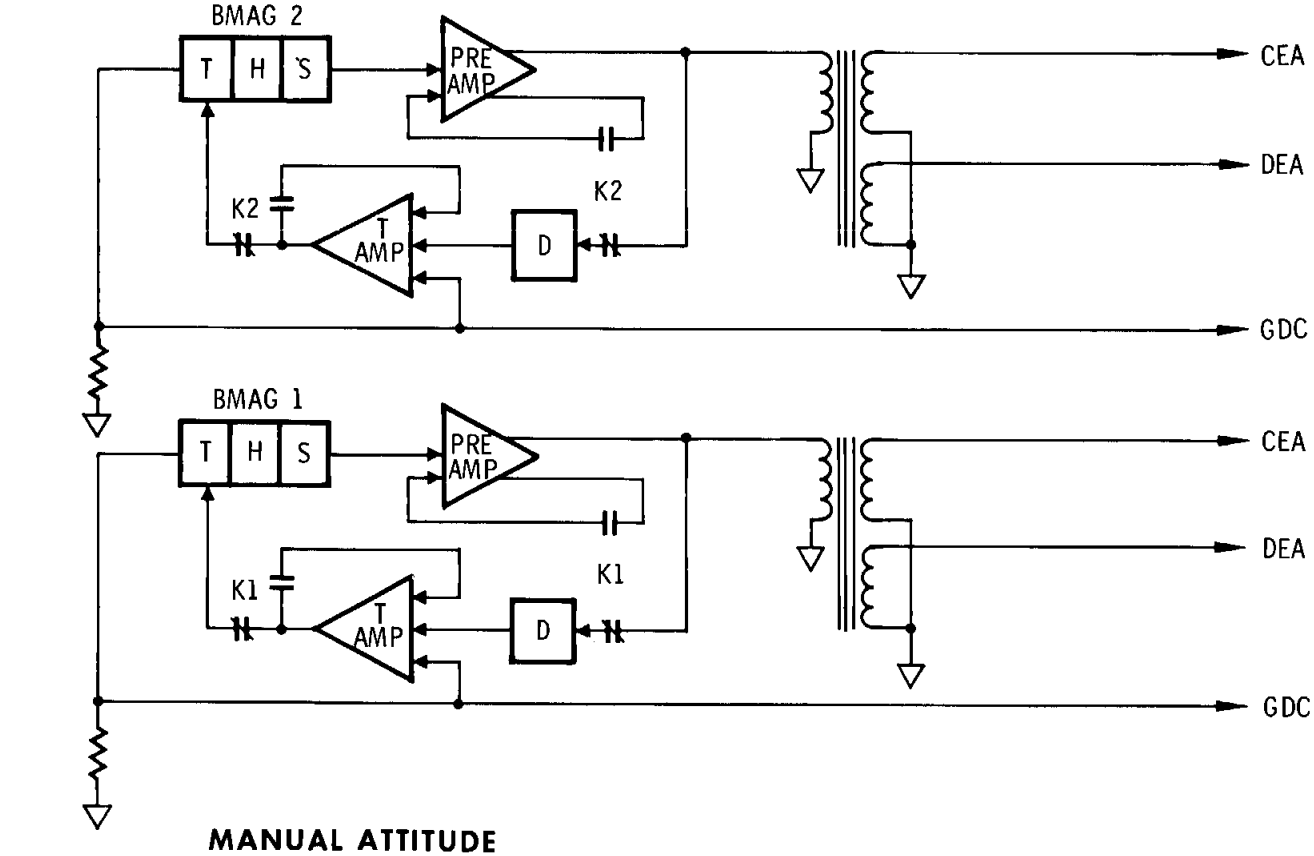
GN-9103B

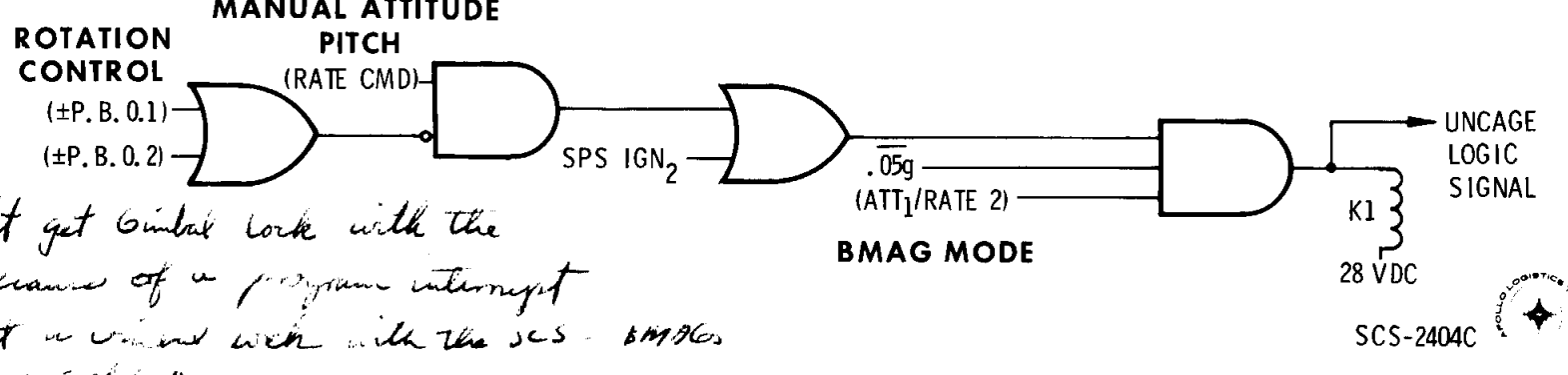
ATTITUDE REFERENCE SUBSYSTEM SCS

FUNCTIONAL OPERATION



PITCH BMAG LOGIC AND OUTPUTS

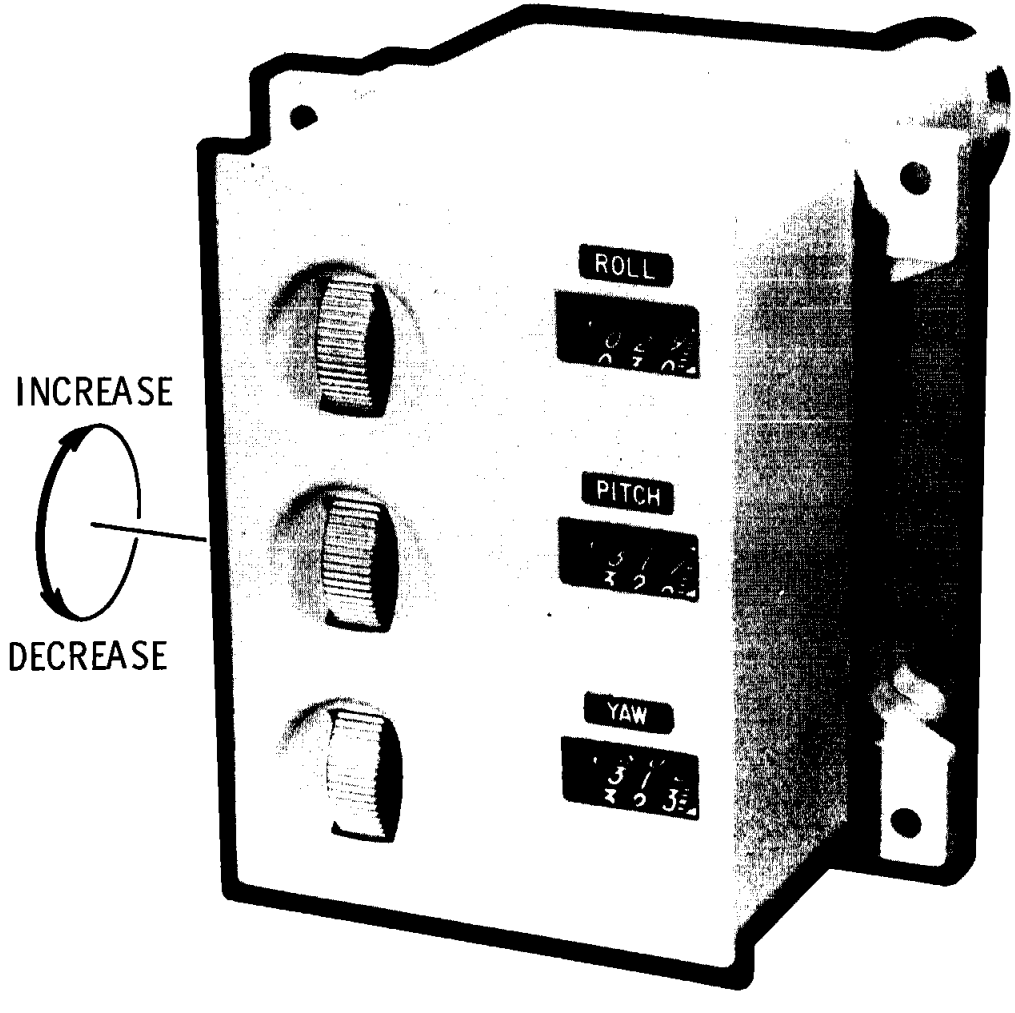




Temp. limit of 170° ±1° on BMAGs
If temp goes up to 175° the att. error goes to pos, but the rate meas. is still good. Also the rate signal is the main use of the BMAGs, ... is MTVC (controls att. while ...) this

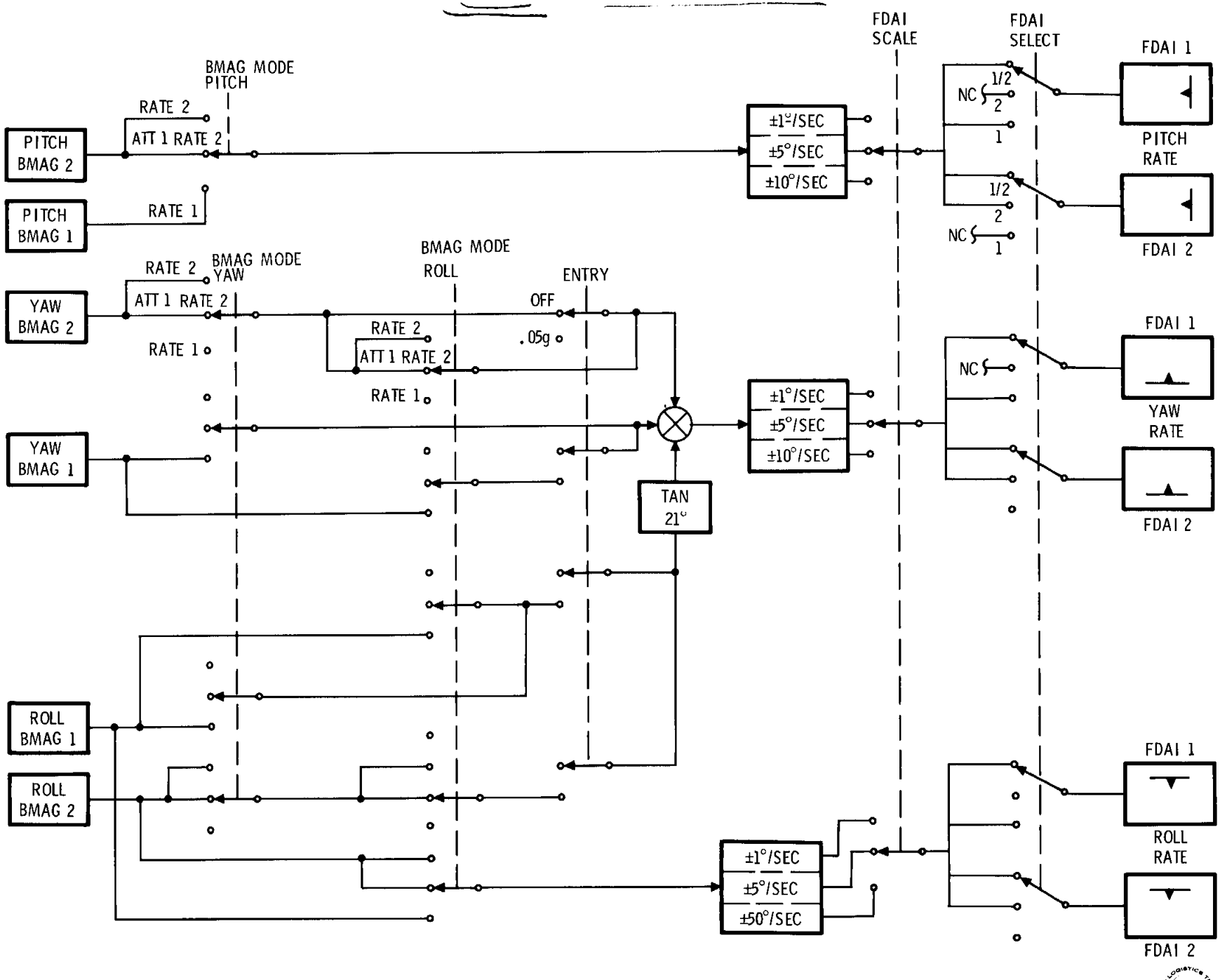
You can't get Gimbal Lock with the 3 gyros because of a program interrupt. You get a warning with the SCS - BMAGs at a pitch of 90°

ATTITUDE SET DISPLAY

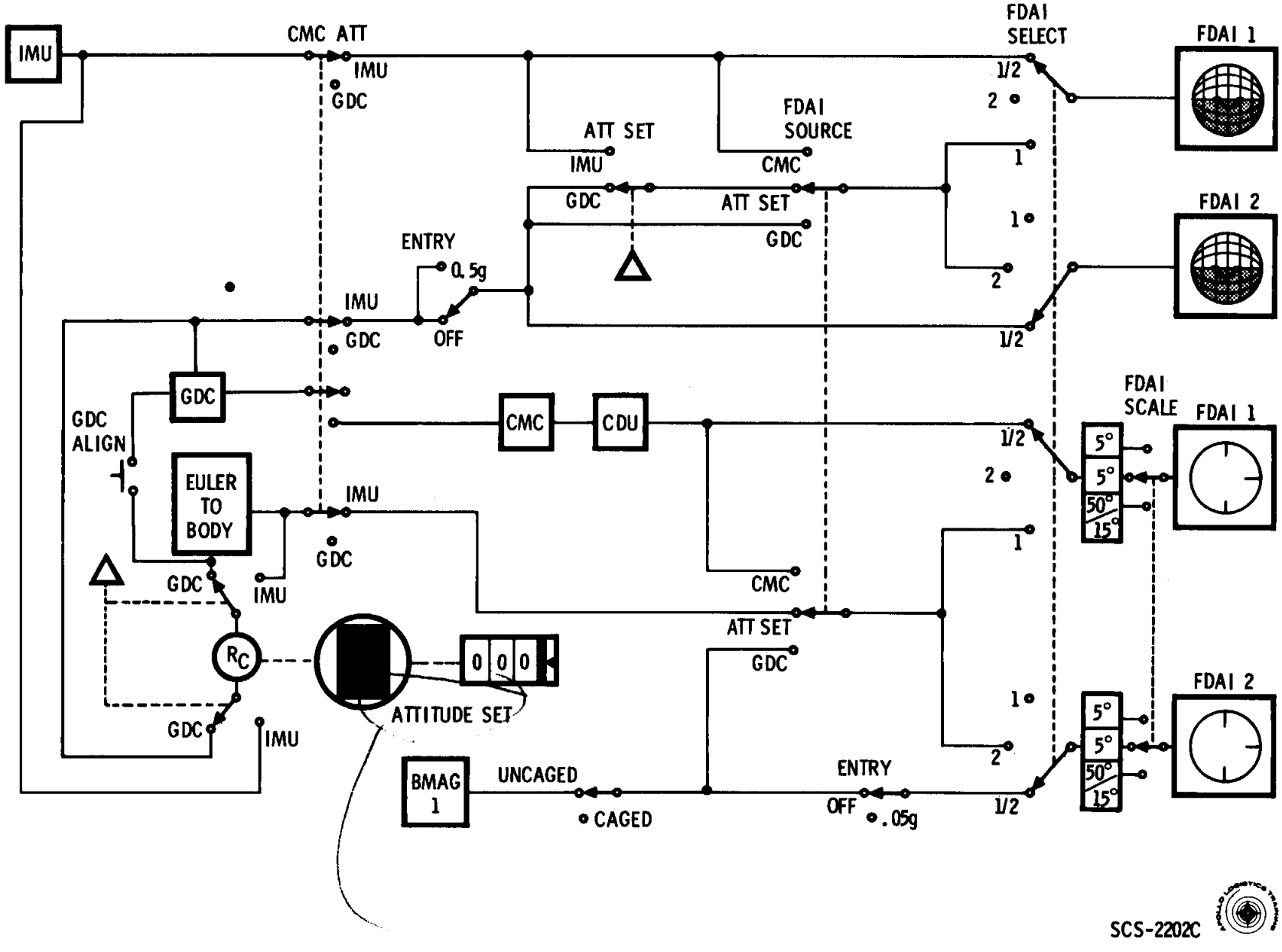


SCS-2102A

FDAI RATE SELECT LOGIC

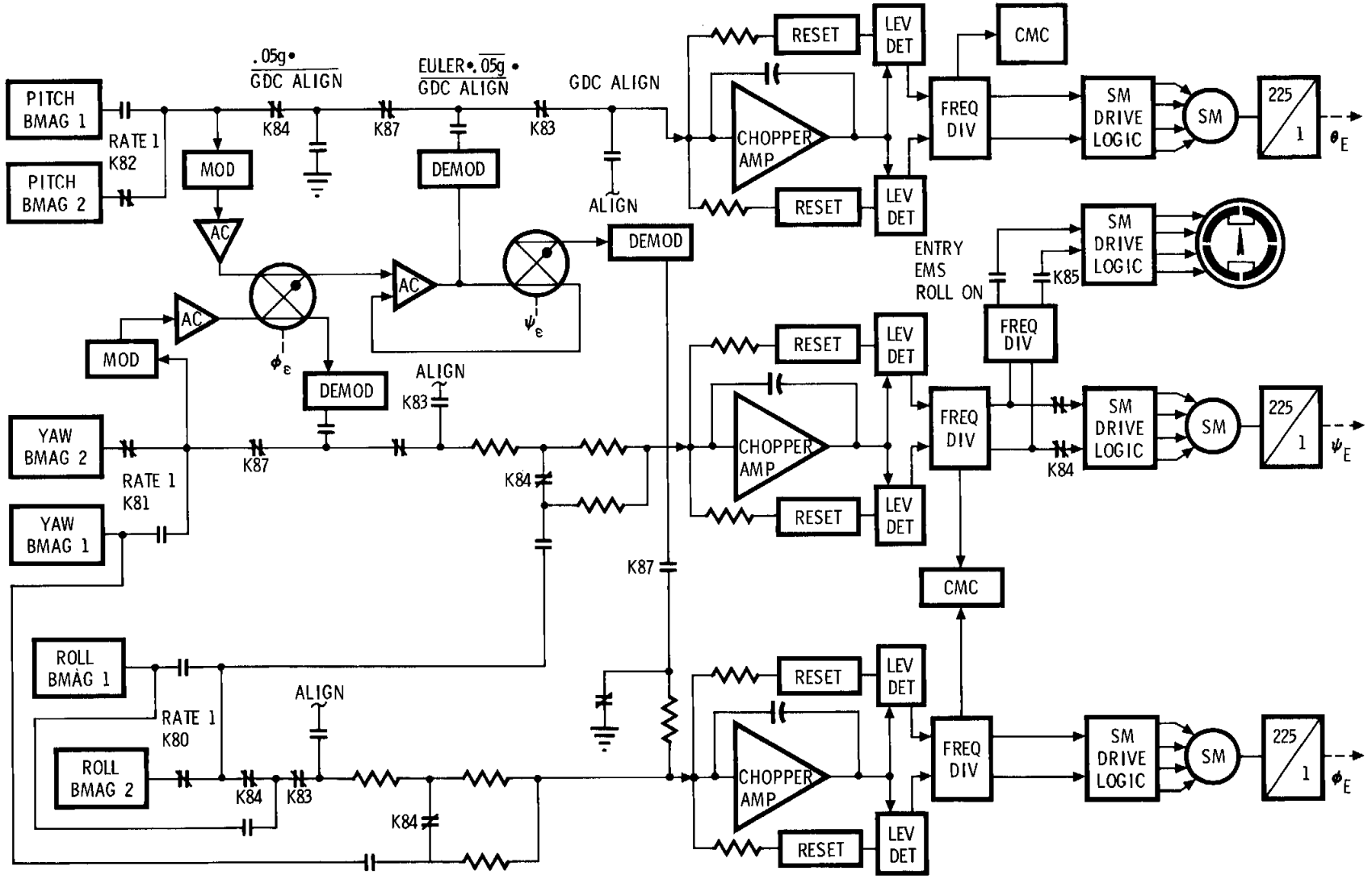


FDAI ATTITUDE SELECT LOGIC



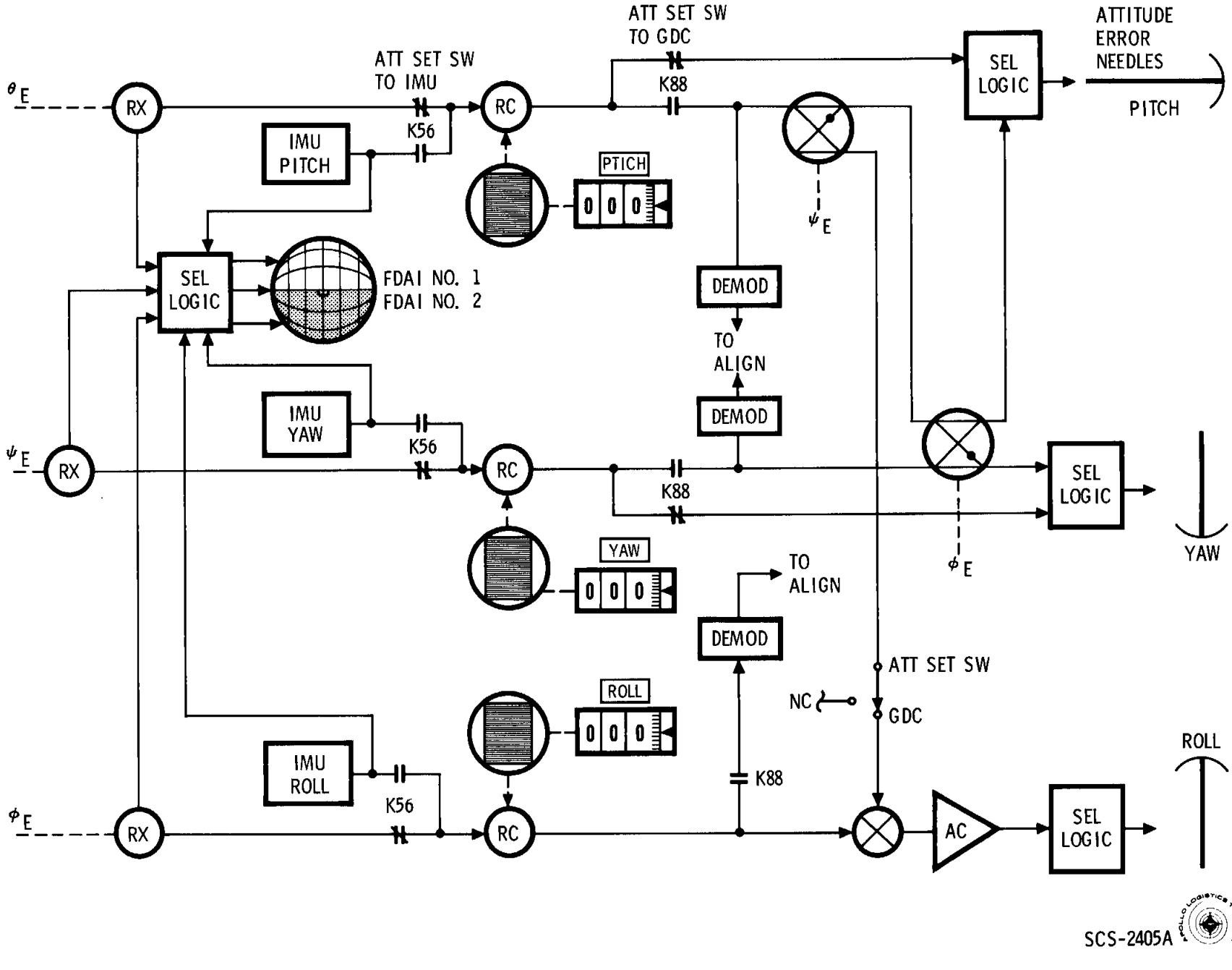
SCS-2202C

GYRO DISPLAY COUPLER



SCS-2406A

FDAI SIGNAL FLOW



Att. Ref Sys

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
BMAG MODE	PITCH RATE 2											✓	
	PITCH ATT 1/ RATE 2							✓				✓	
	PITCH RATE 1												✓
	YAW RATE 2											✓	
	YAW ATT 1/ RATE 2							✓				✓	
	YAW RATE 1												✓
	ROLL RATE 2											✓	
	ROLL ATT 1/ RATE 2							✓				✓	
	ROLL RATE 1												✓
ENTRY	.05G .05G				✓		✓ (2)						
	.05G OFF		✓	✓			✓	✓				✓ (4)	✓ (4)
	EMS ROLL EMS ROLL						✓ (2)						
	EMS ROLL OFF												
	FDAI SELECT (1) 1/2					✓	✓	✓			✓		
	FDAI SELECT 2					✓ ✓	✓ ✓	✓	✓	✓	✓		
	FDAI SELECT 1					✓ ✓	✓ ✓	✓	✓	✓	✓		
	FDAI SOURCE CMC					✓					✓		
	FDAI SOURCE ATT SET					✓	✓		✓	✓			
	FDAI SOURCE GDC						✓	✓					
	ATT SET IMU					✓			✓				
	ATT SET GDC	✓				✓	✓		✓				
	CMC ATT IMU		✓			✓	✓						
	CMC ATT GDC			✓									
	GDC ALIGN PRESS	✓											
	GDC ALIGN 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.

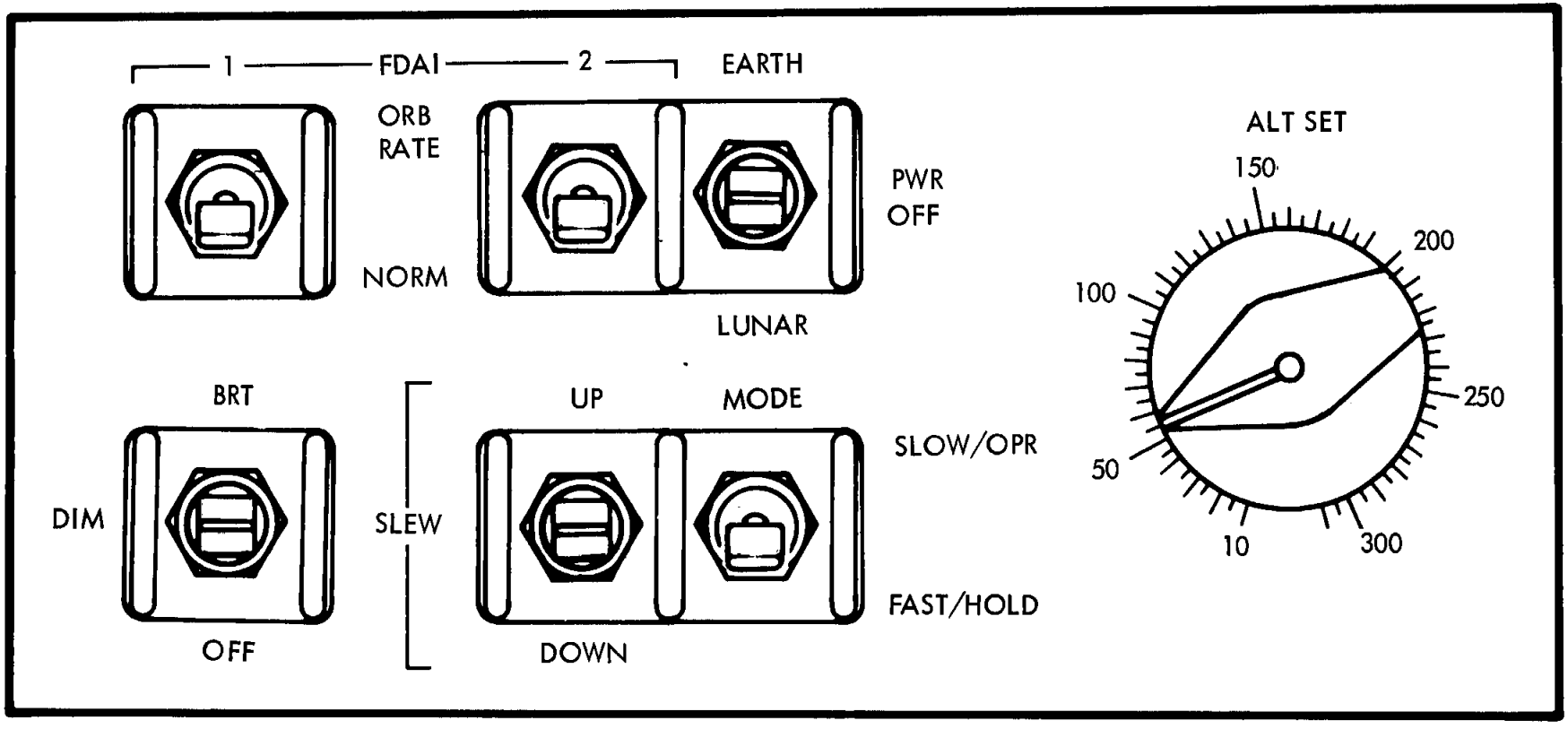
(3) BMAG UNCAGE LOGIC MUST ALSO BE SATISFIED IN ADDITION TO SWITCHES SHOWN.

(4) NECESSARY FOR CORRECT YAW DISPLAY DURING NON ENTRY MISSION PHASES.

CHART 1

SCS-2804B

ORDEAL PANEL



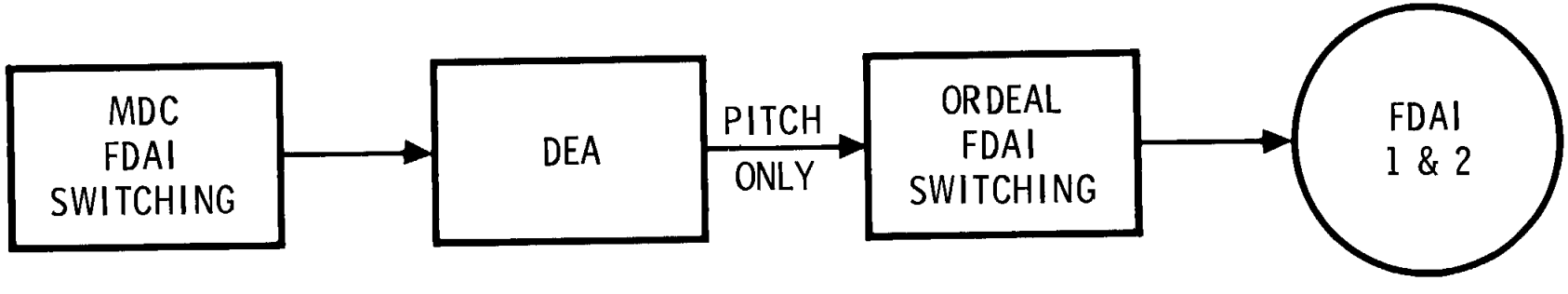
SCS-4000

Orbital Rate drive electronics Apollo LM

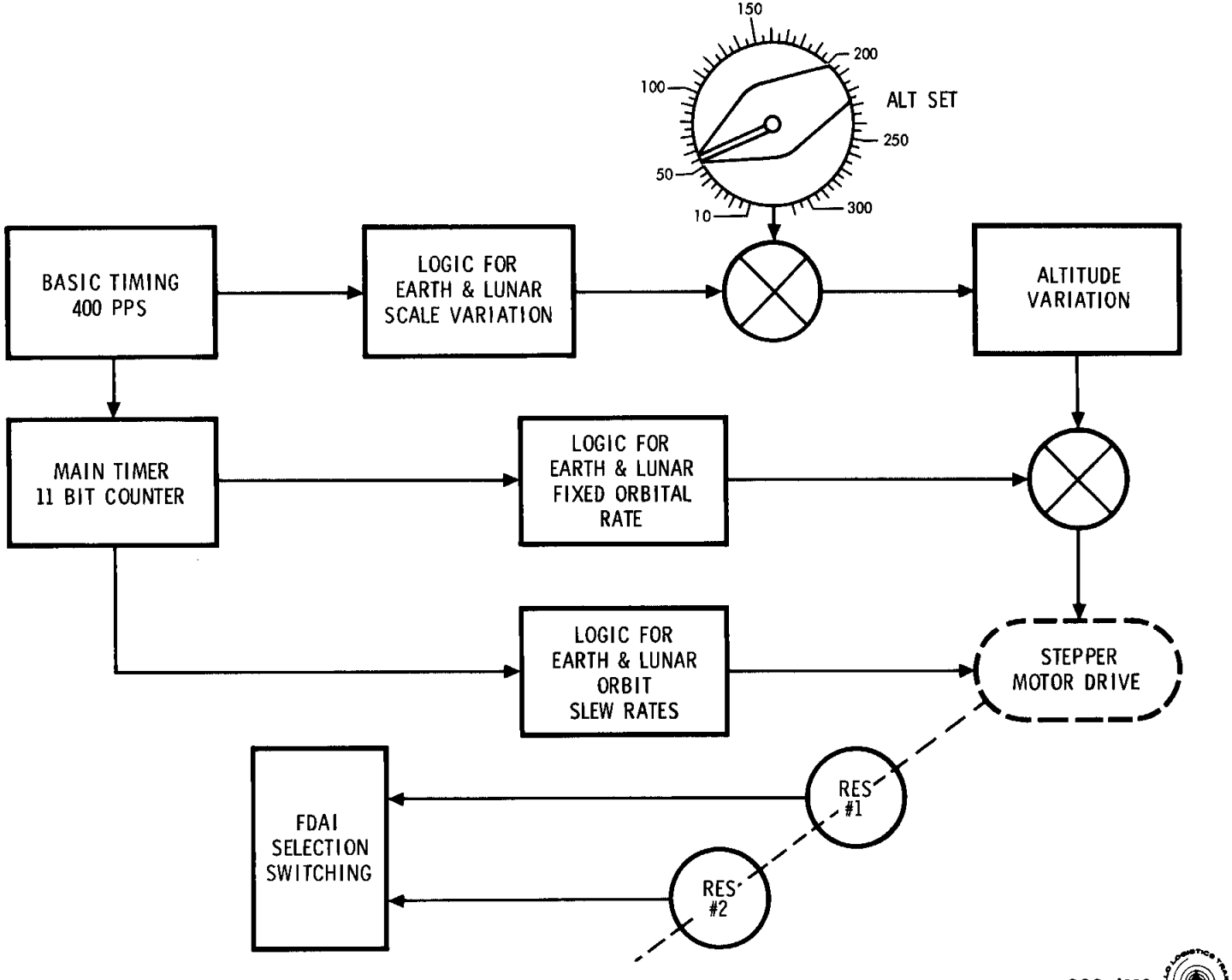
ORDEAL INTERFACE

Provide Astro. with visual indication of local vertical (pitch only) in plane

1°

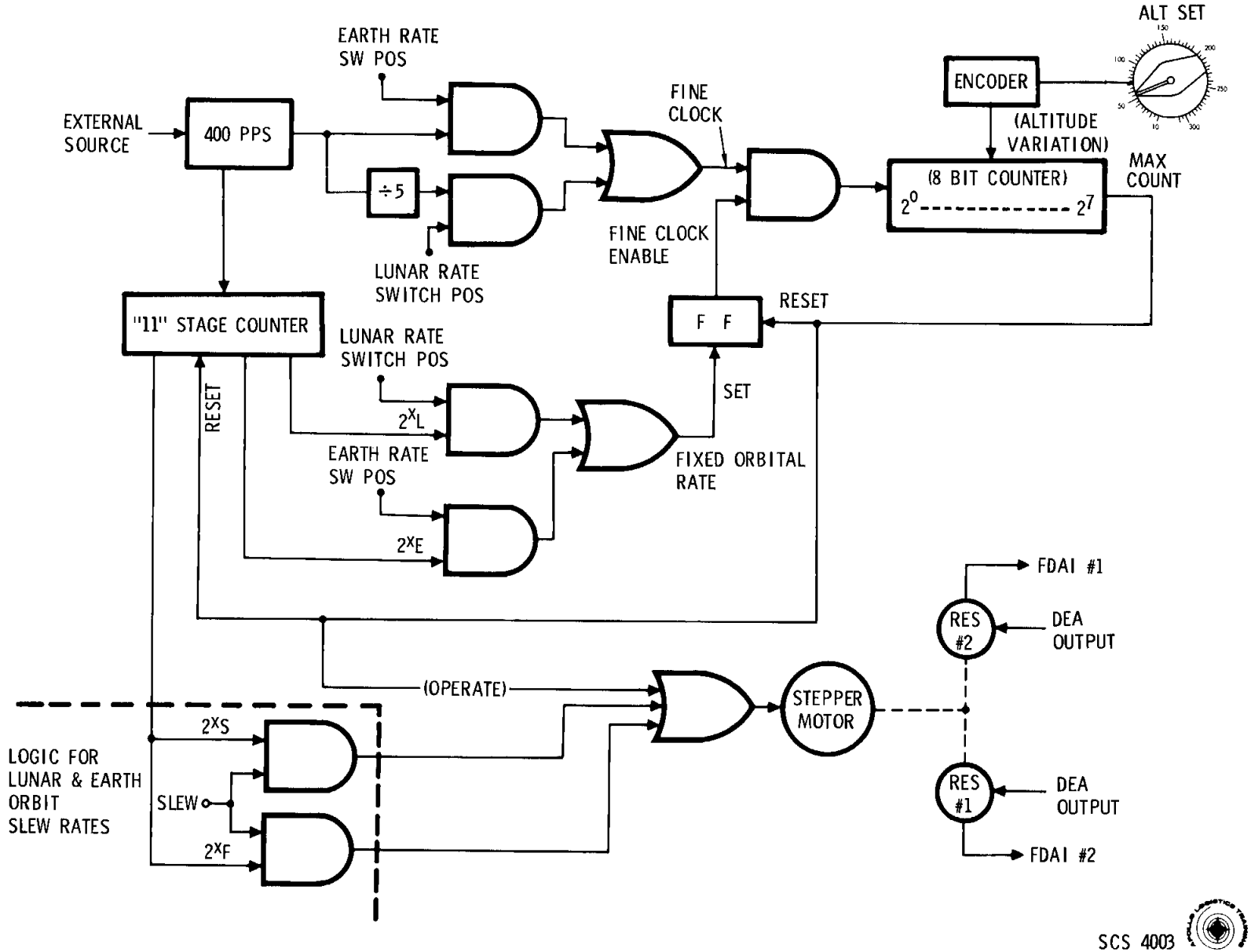


ORDEAL FUNCTIONAL BLOCK DIAGRAM



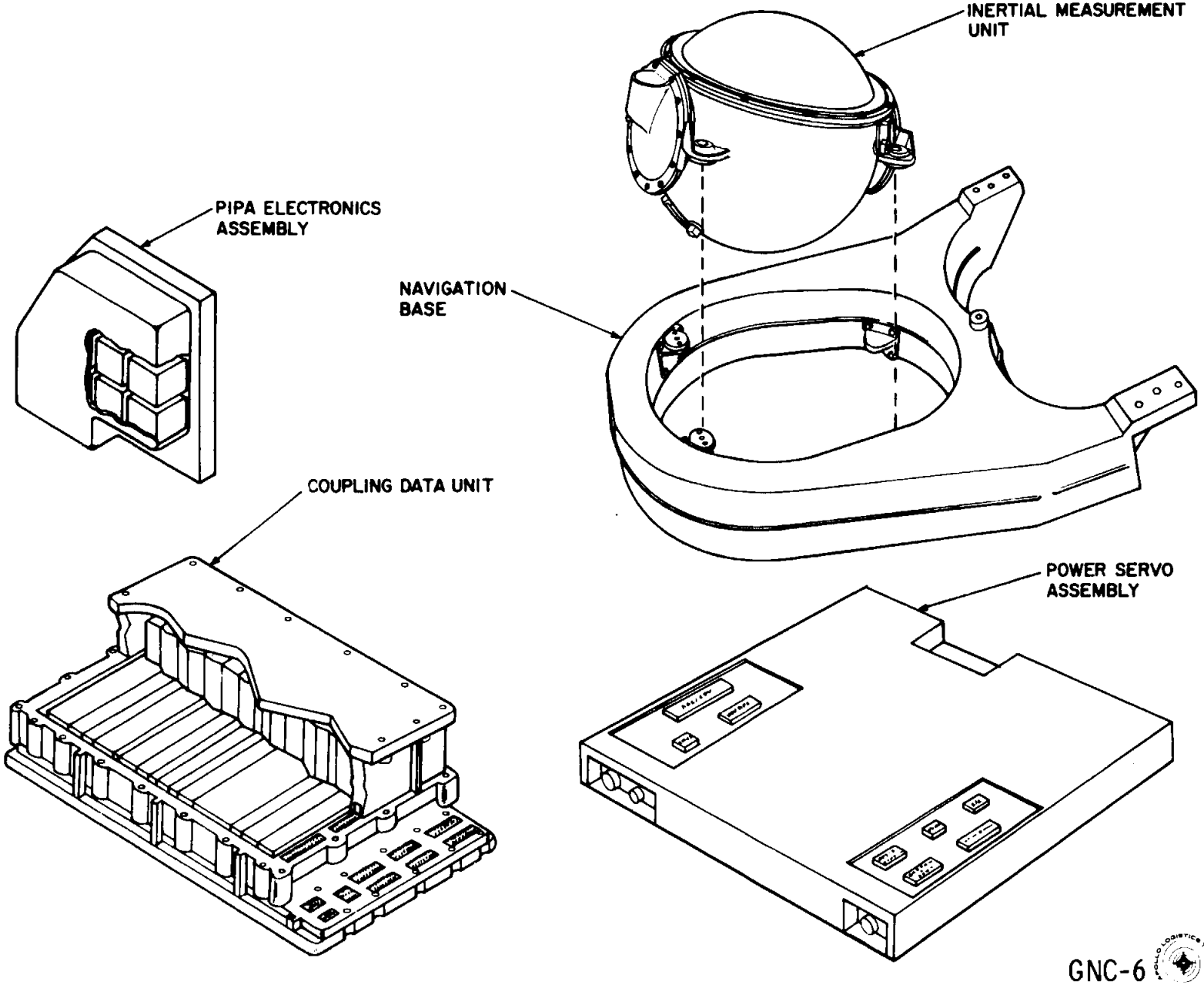
SCS 4002

ORDEAL SIGNAL FLOW DIAGRAM



SCS 4003

ISS EQUIPMENT

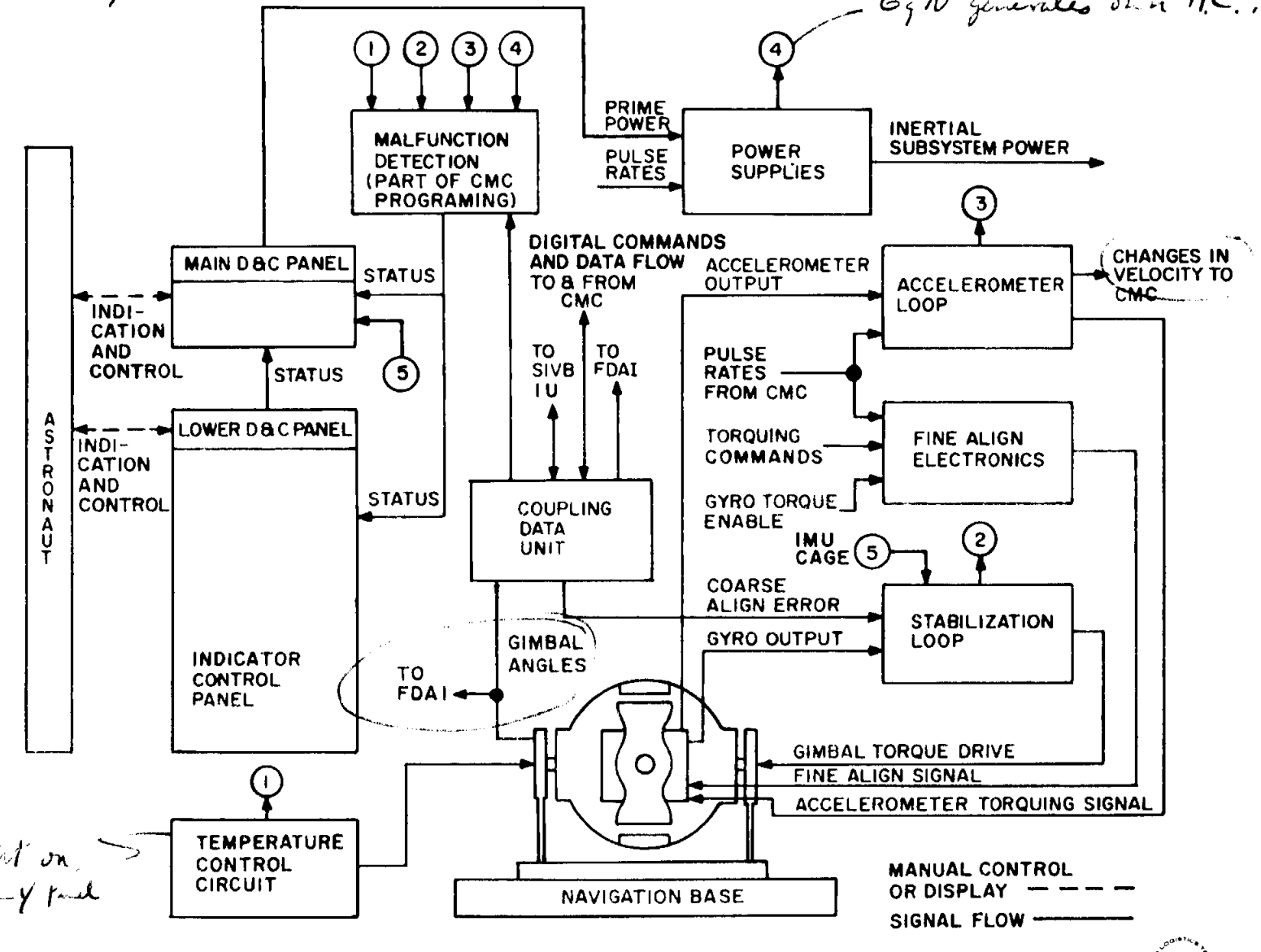


GNC-6

Course Align: (1°-1.5°)

Fine Align: (80 Arc sec)

INERTIAL SUBSYSTEM INTERFACE



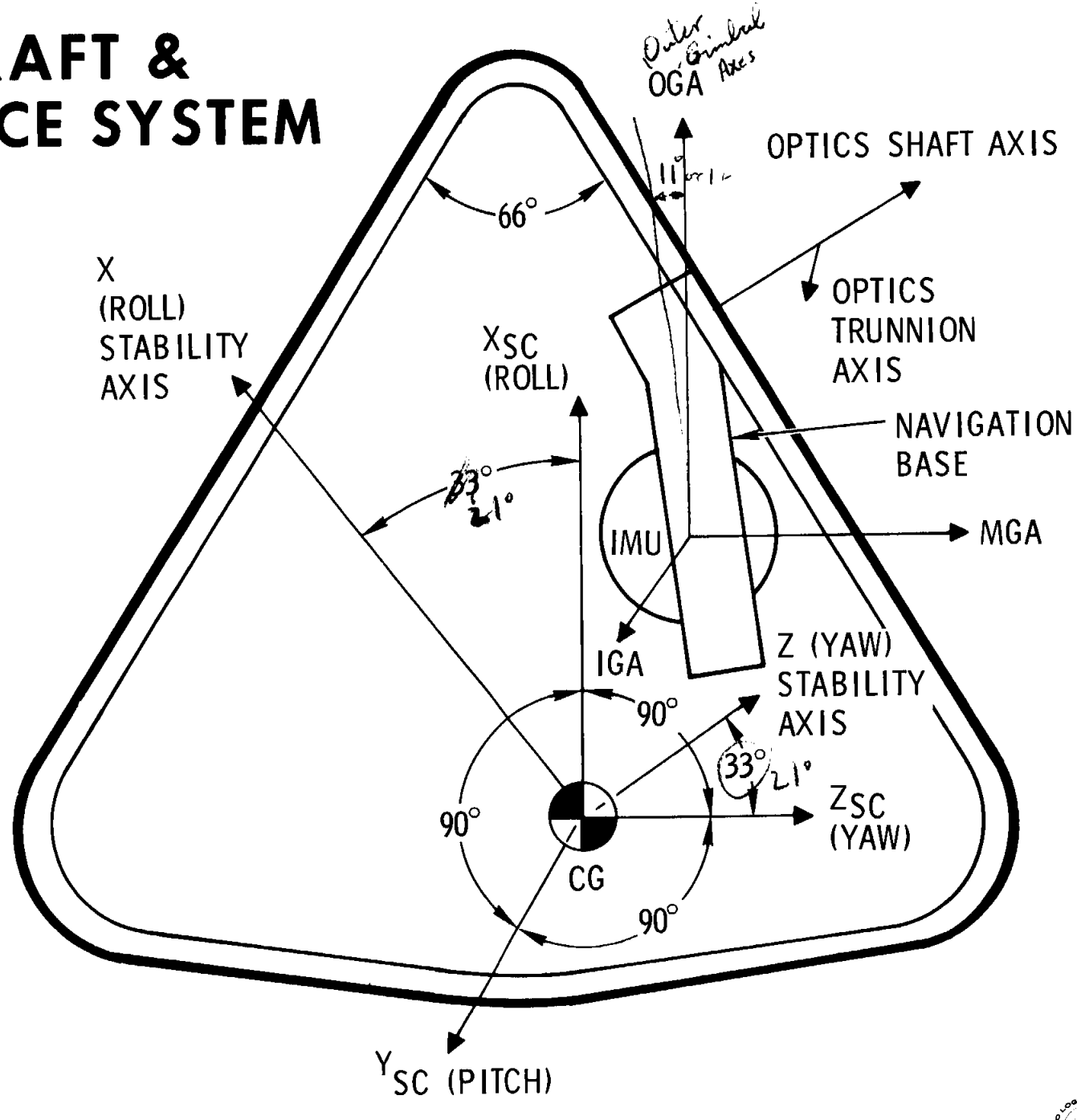
Light on LGC-Y panel

GNC-8

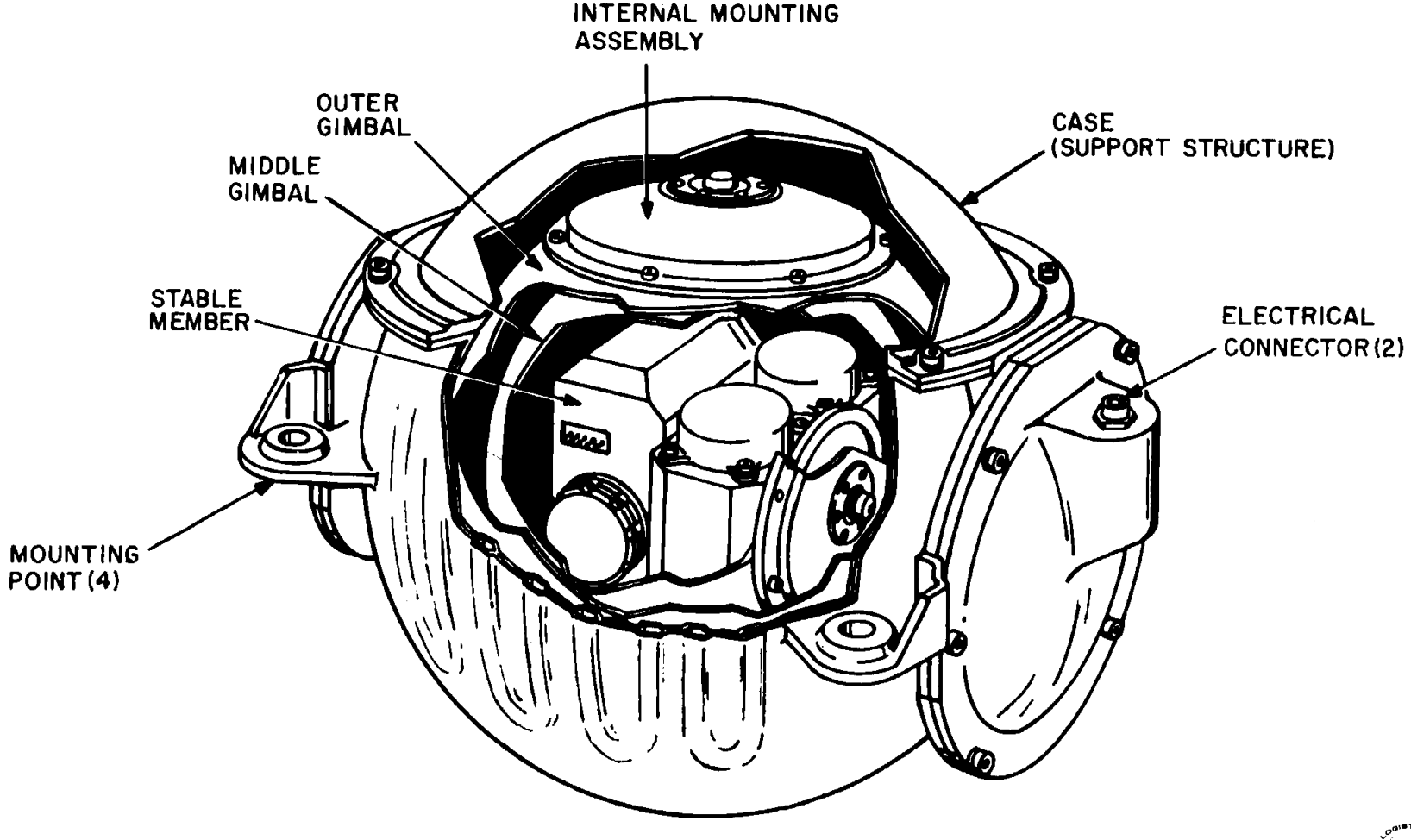
Uncaged means platform is providing an inertial ref. frame & measures s/c motion wrt this ref.

Coarse means moving s/c doesn't get output from IMU --- Gimbal angle driven to zero.

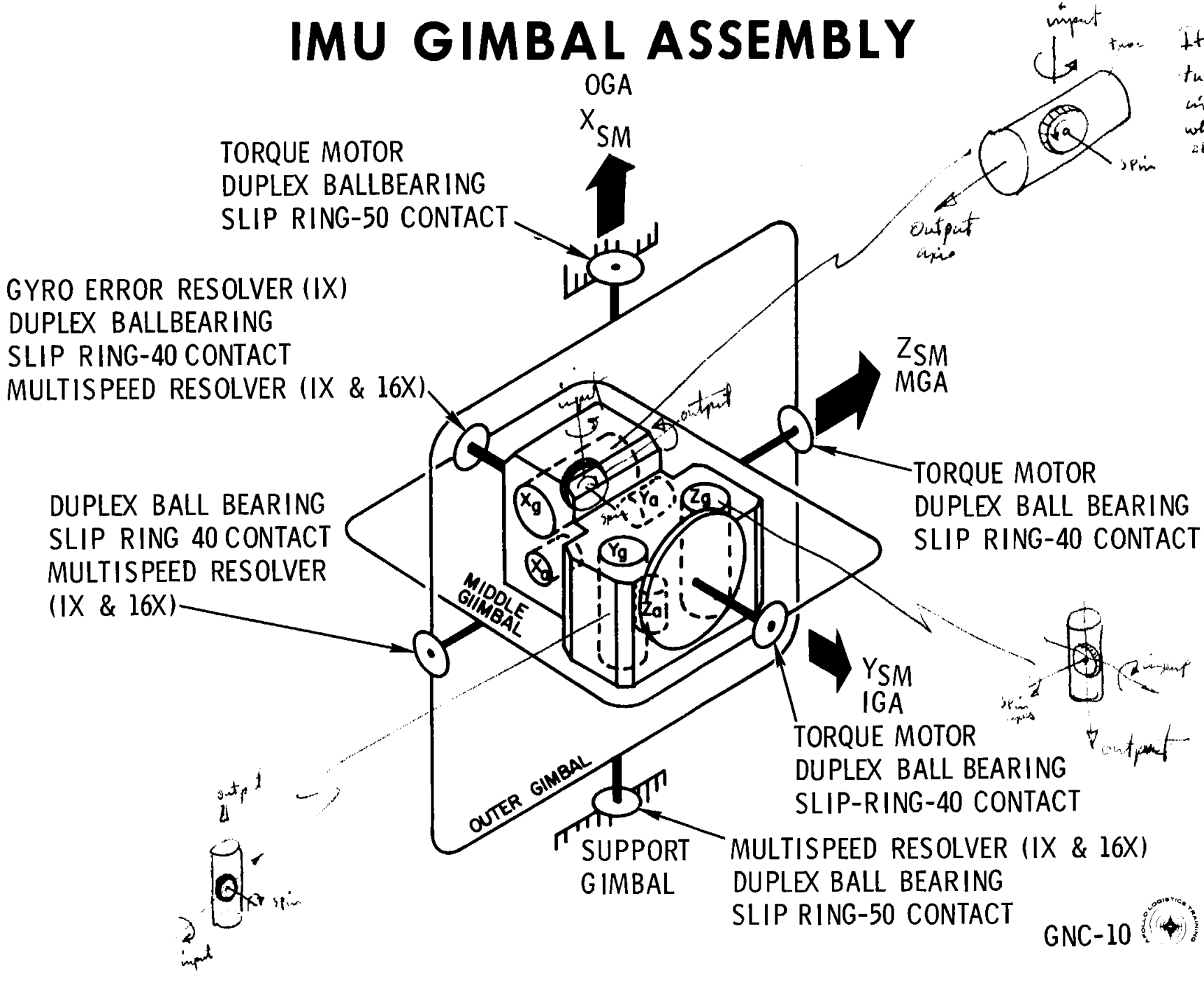
SPACECRAFT & GUIDANCE SYSTEM AXES



INERTIAL MEASUREMENT UNIT

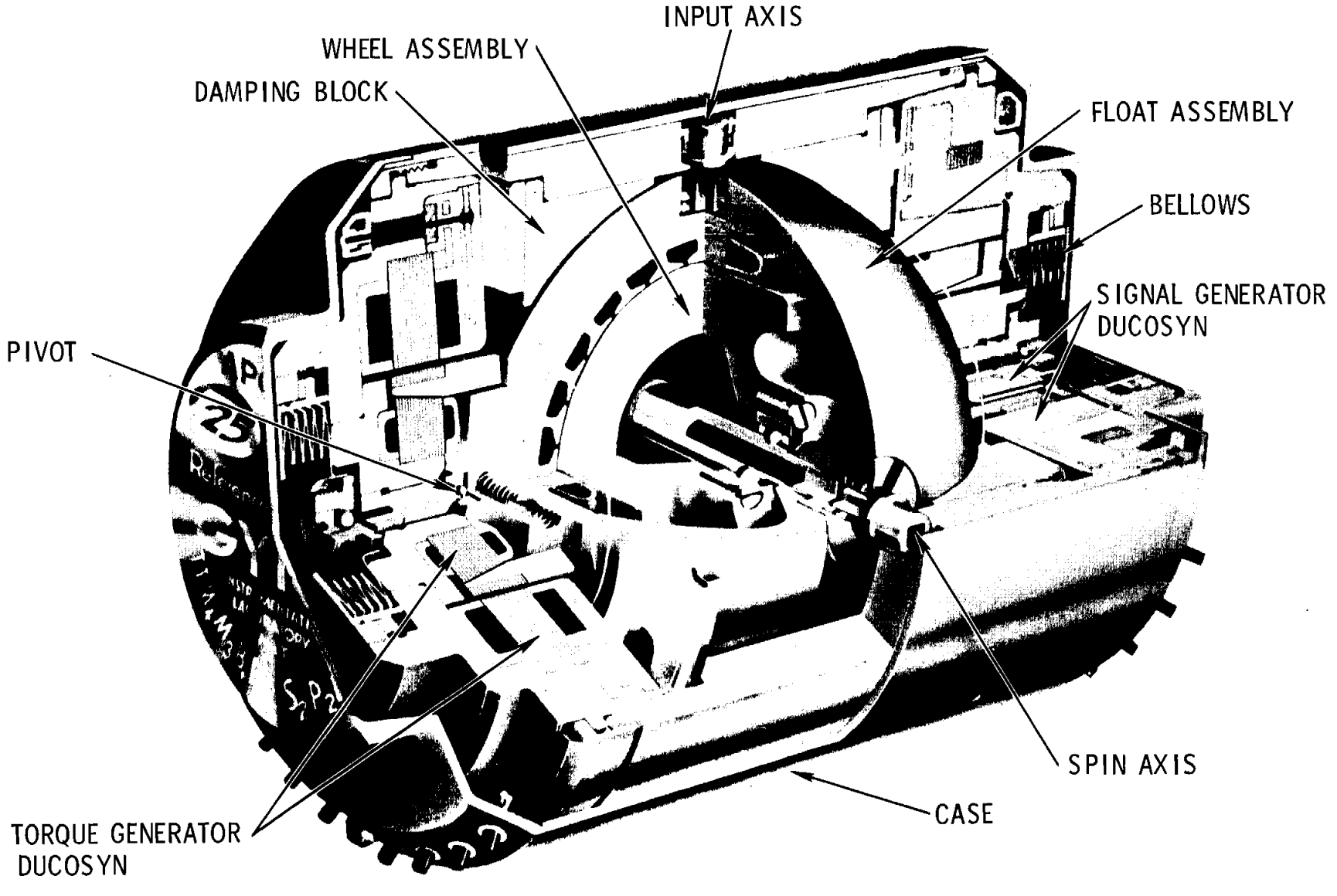


IMU GIMBAL ASSEMBLY



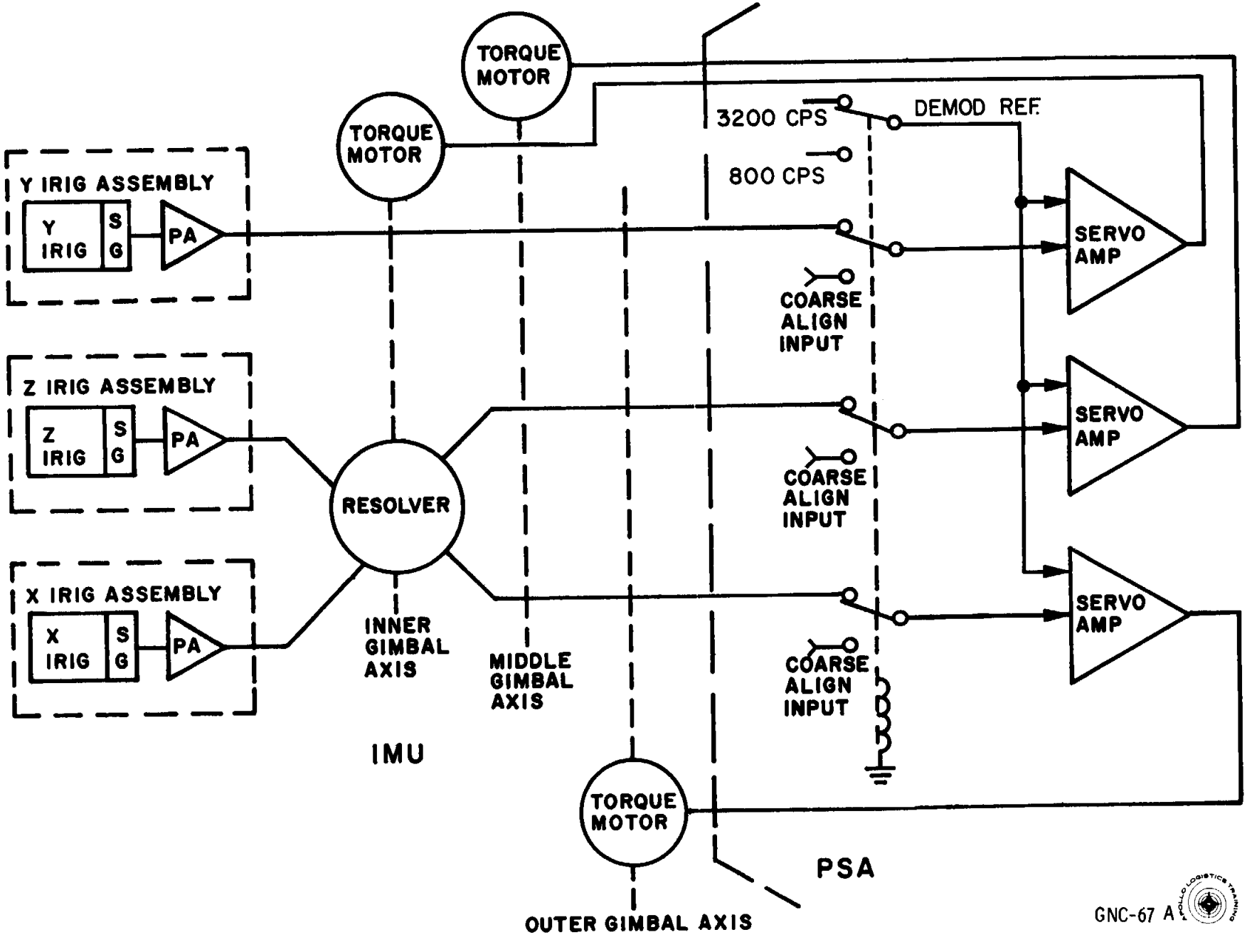
GNC-10

25 IRIG



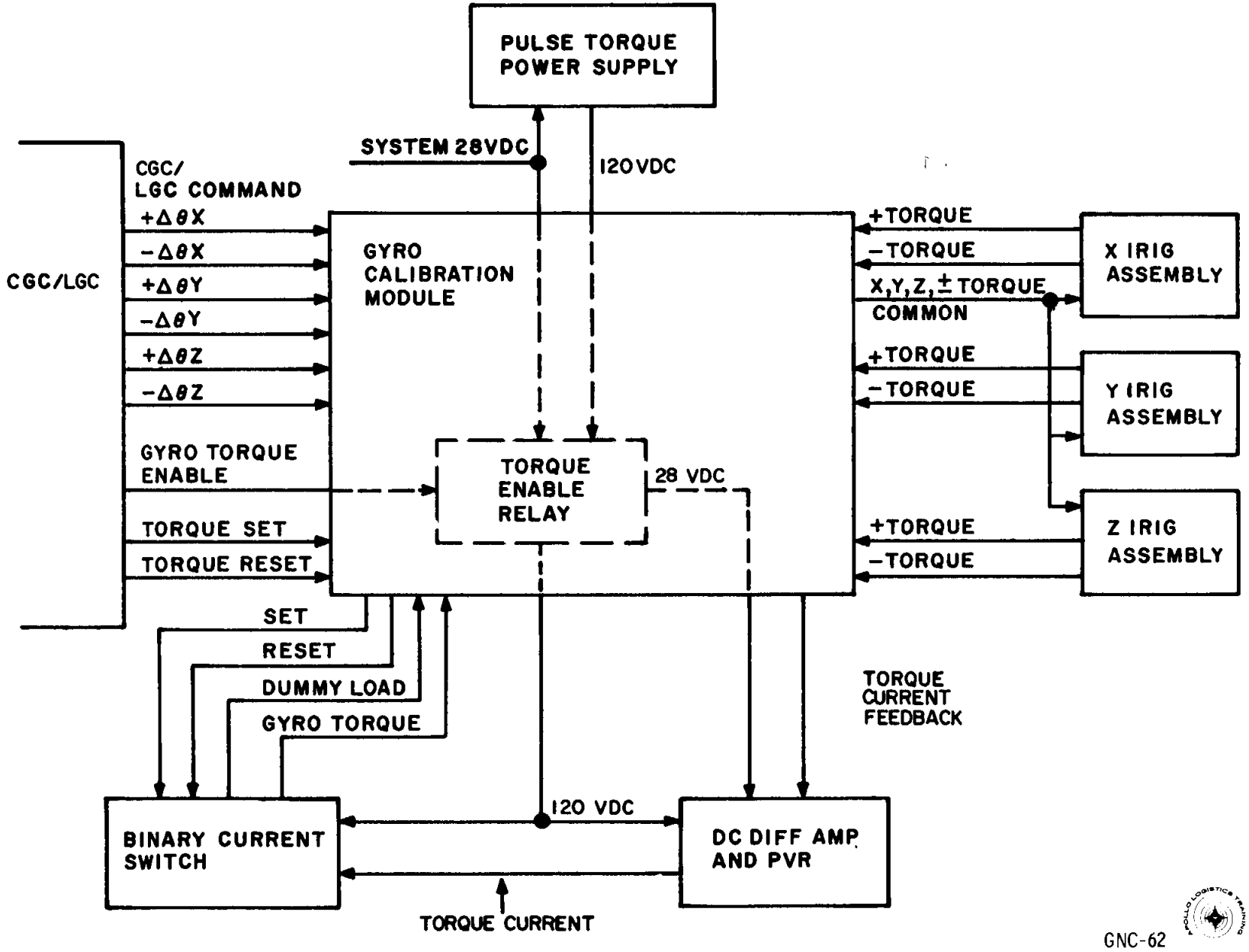
GN-264A

BLOCK II STABILIZATION LOOPS

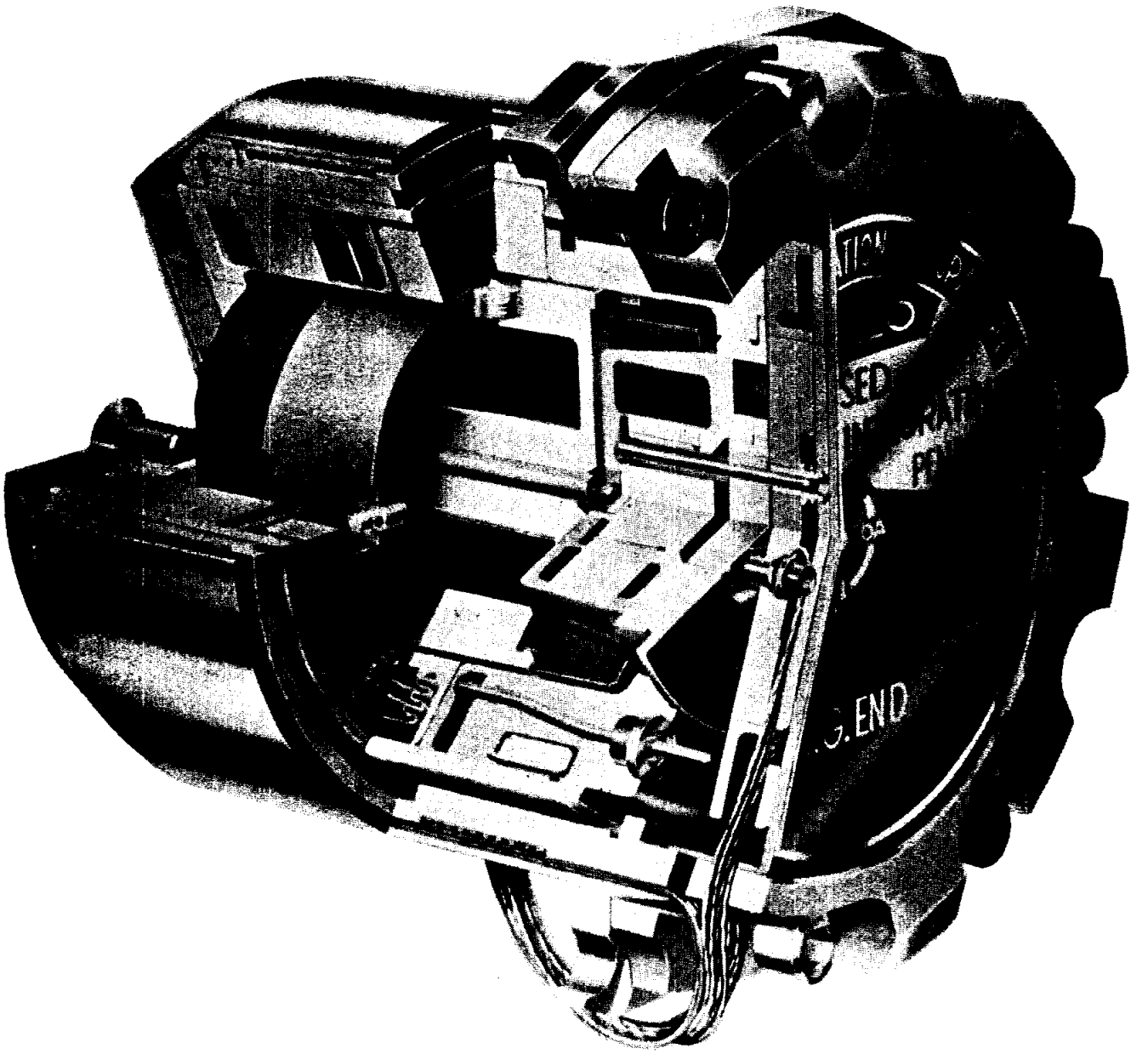


GNC-67 A

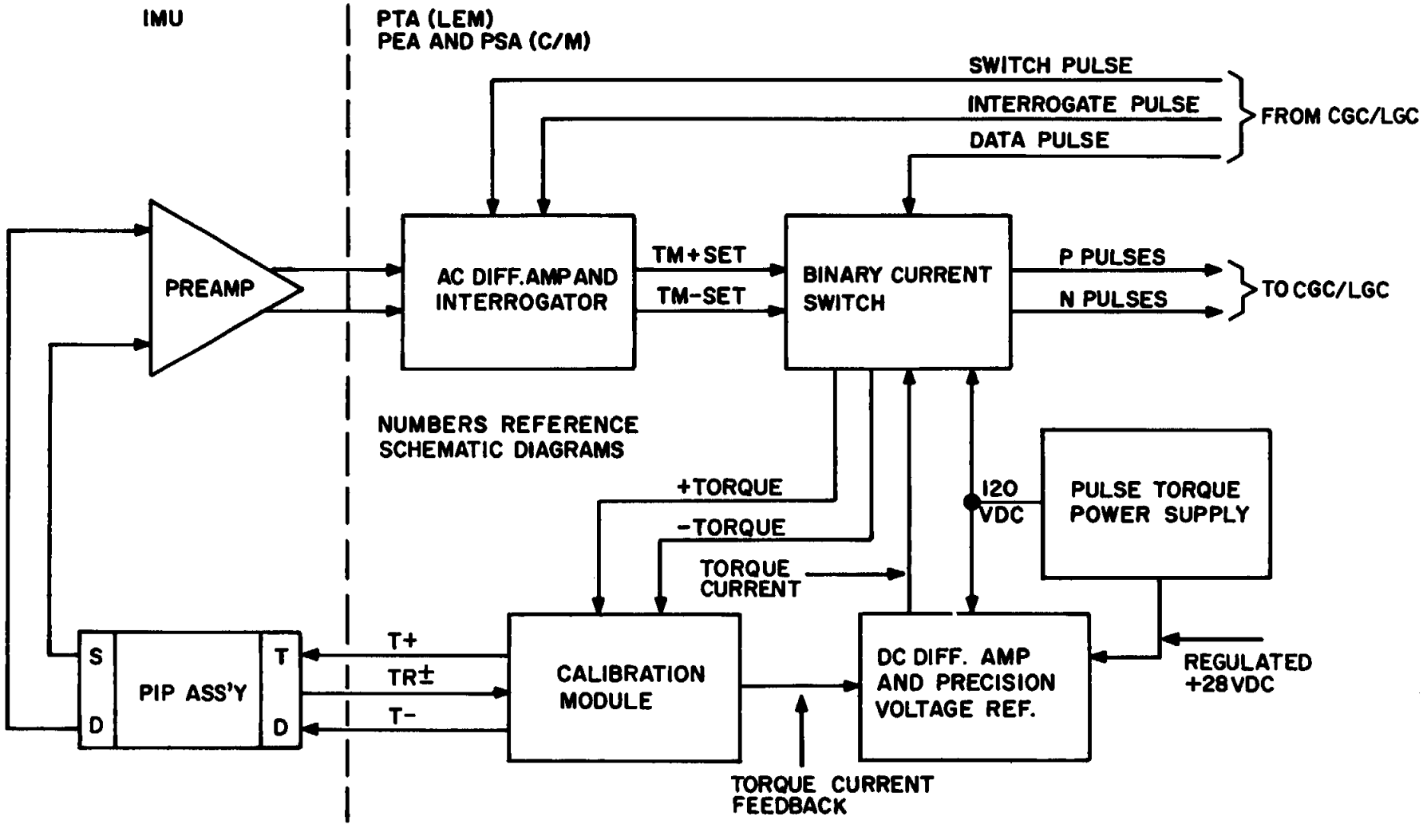
FINE ALIGN ELECTRONICS



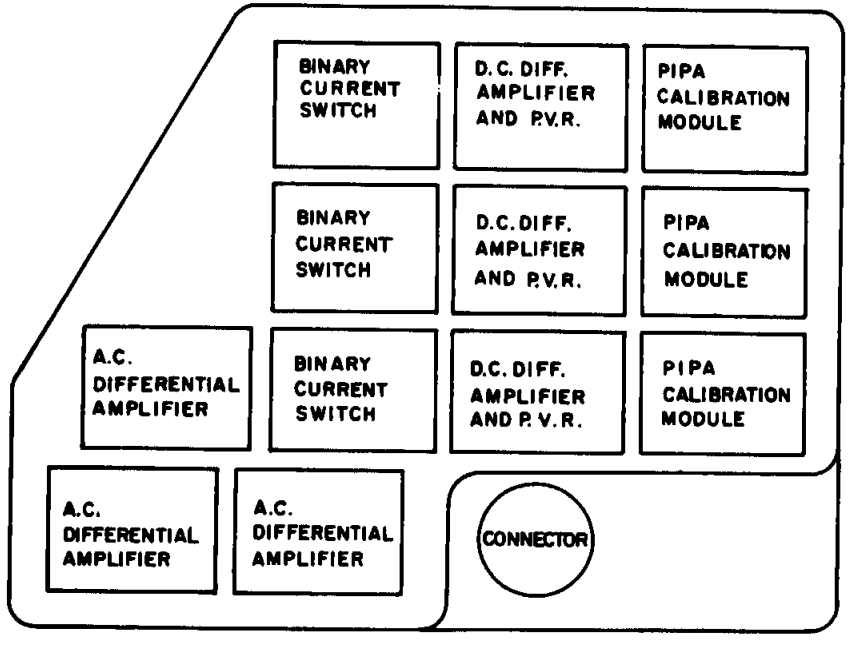
PIP

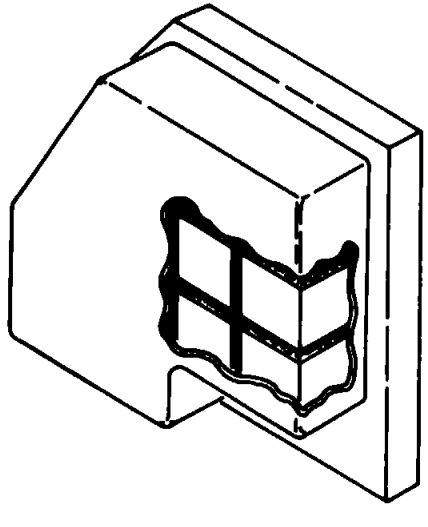


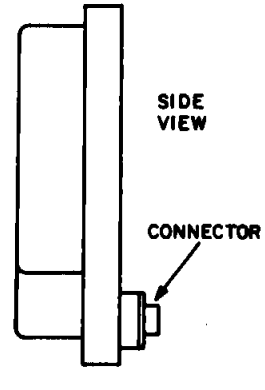
BLOCK II ACCELEROMETER LOOP



PIP. ELECTRONICS ASSEMBLY



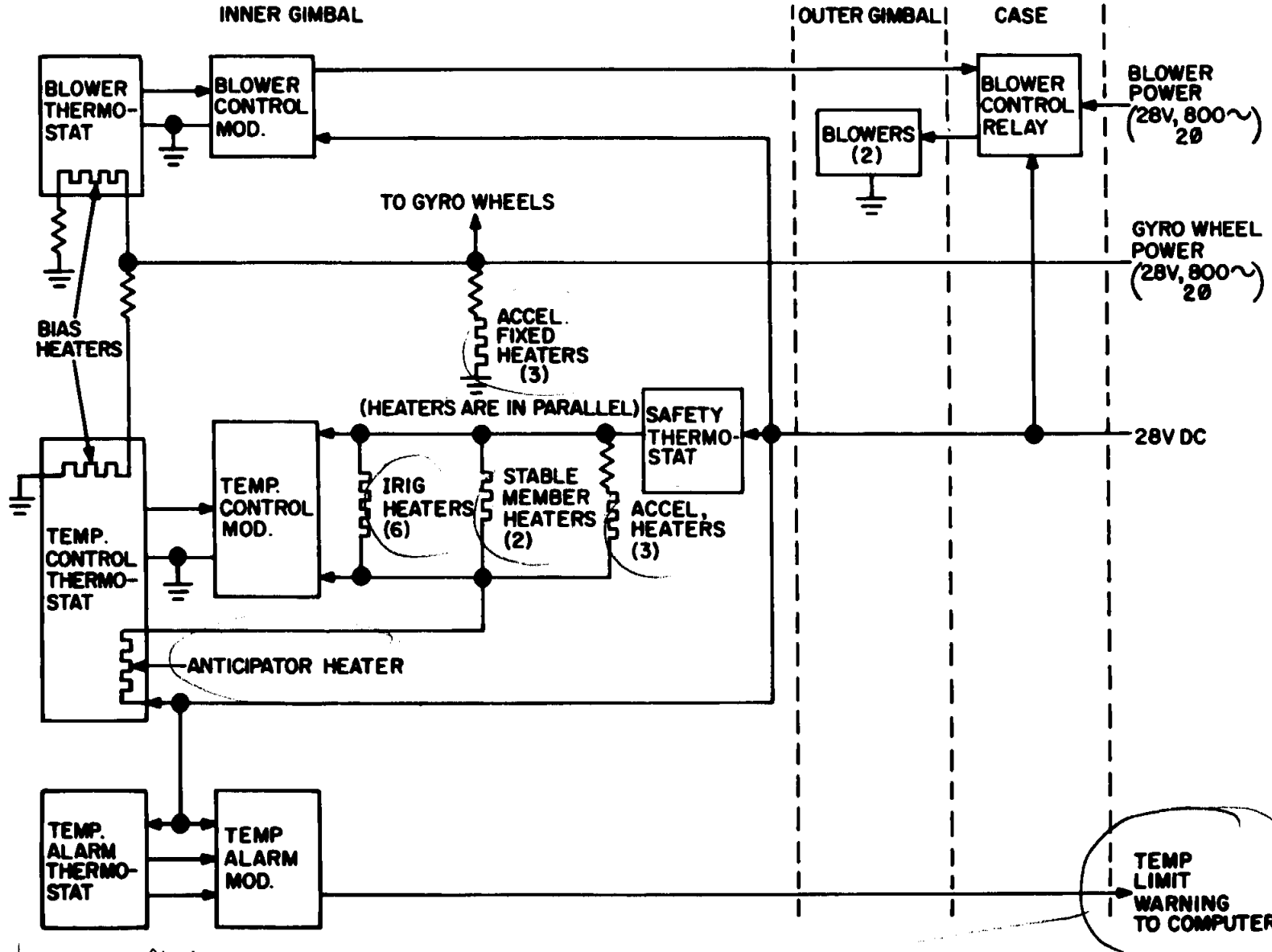




6 heaters

TEMPERATURE CONTROL SYSTEM

located on IMU



GNC-81

(X) Normal temp 158°

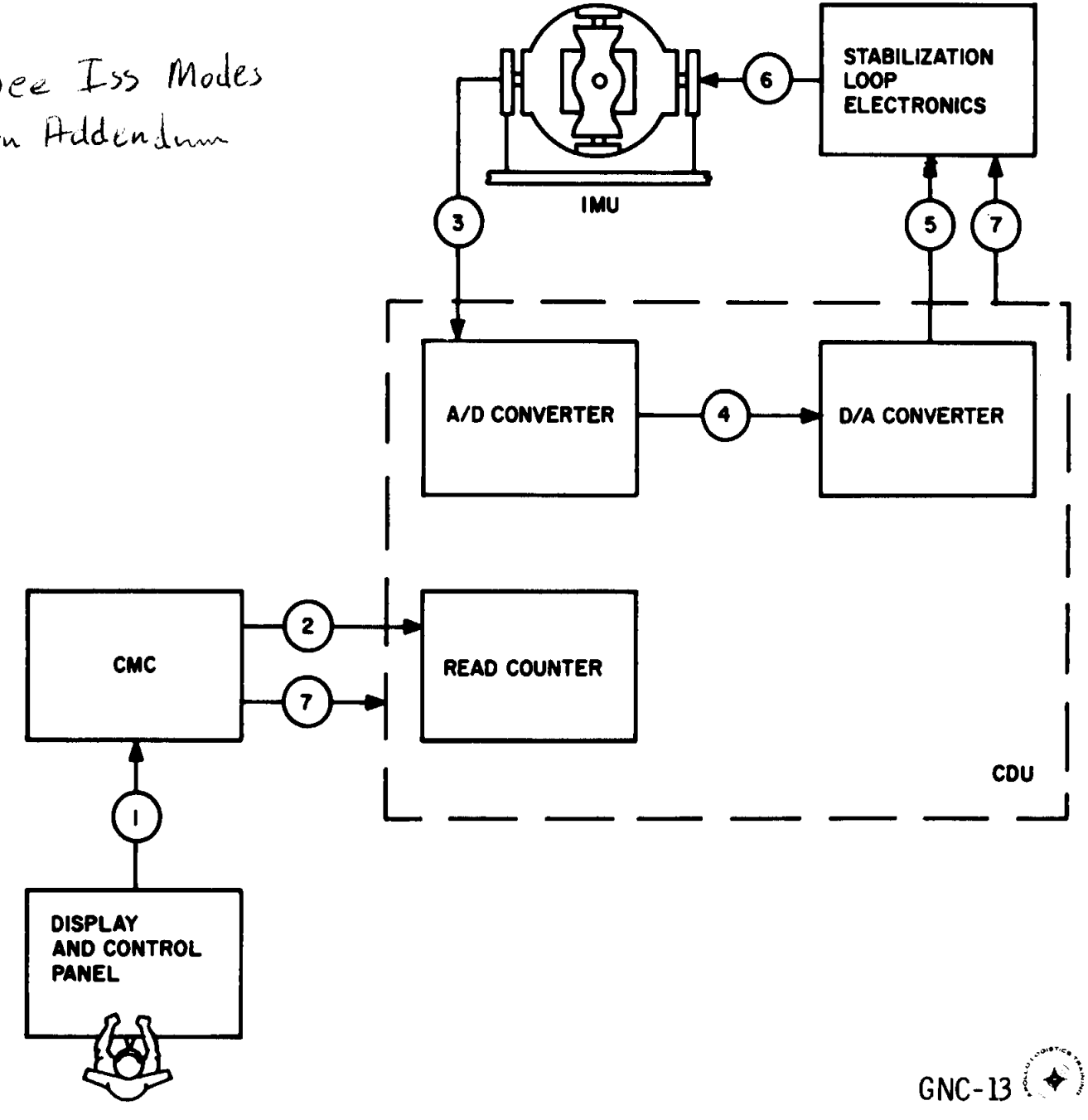
Headleramter deteriorates with temps.

(X) What limits (temp) before you wouldn't use it?

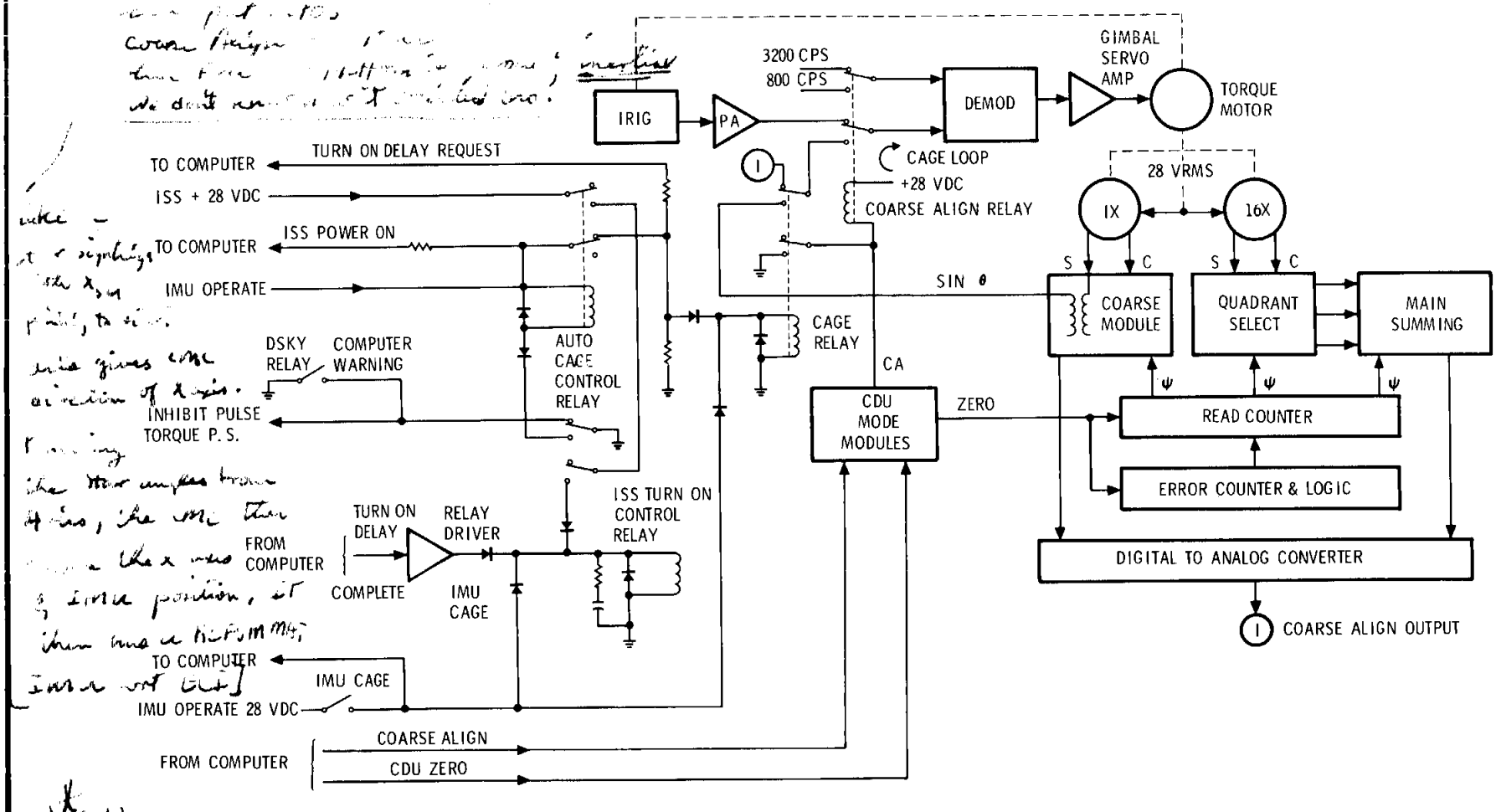
No control over this.

IMU TURN-ON

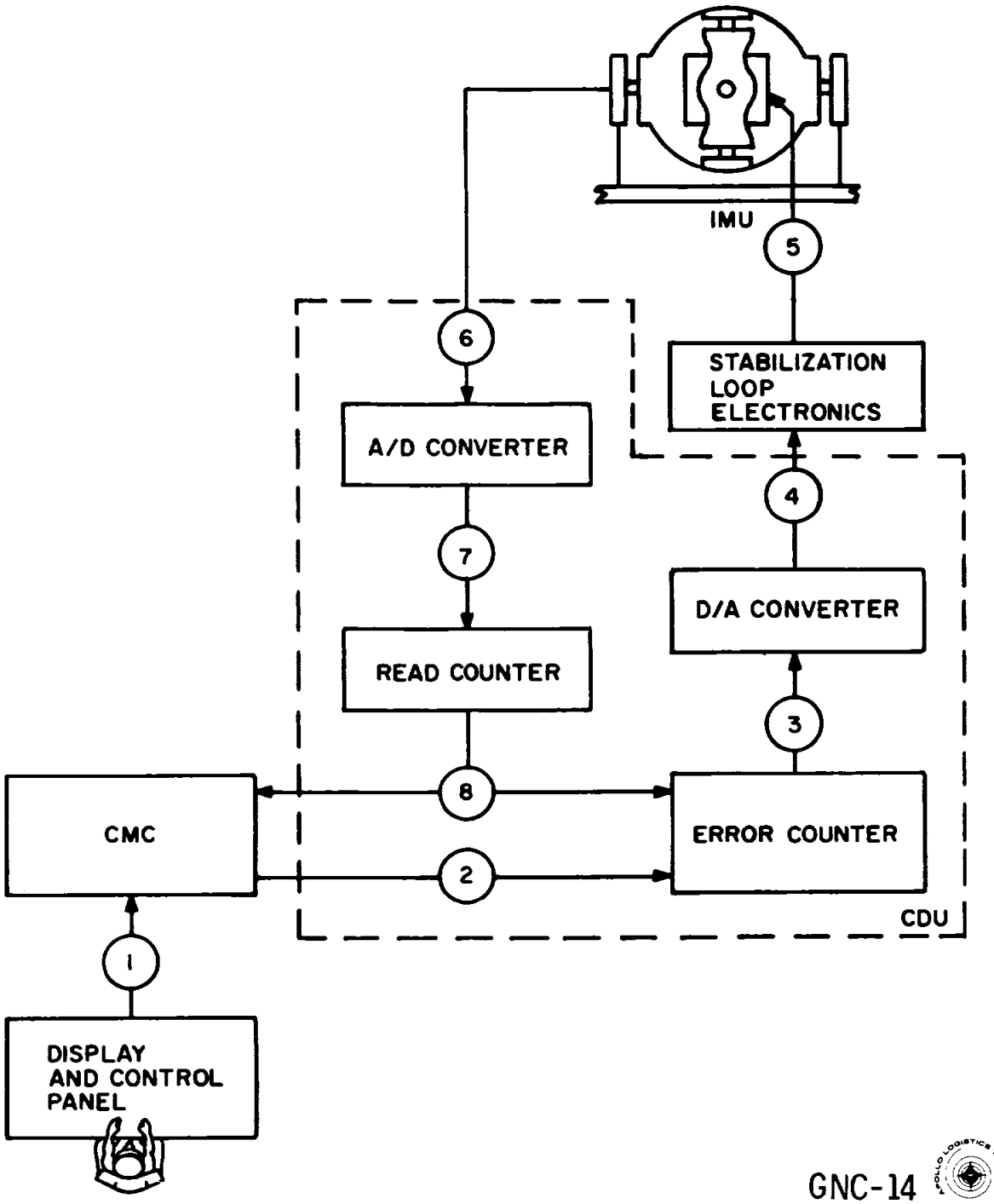
(A) See Iss Modes on Addendum



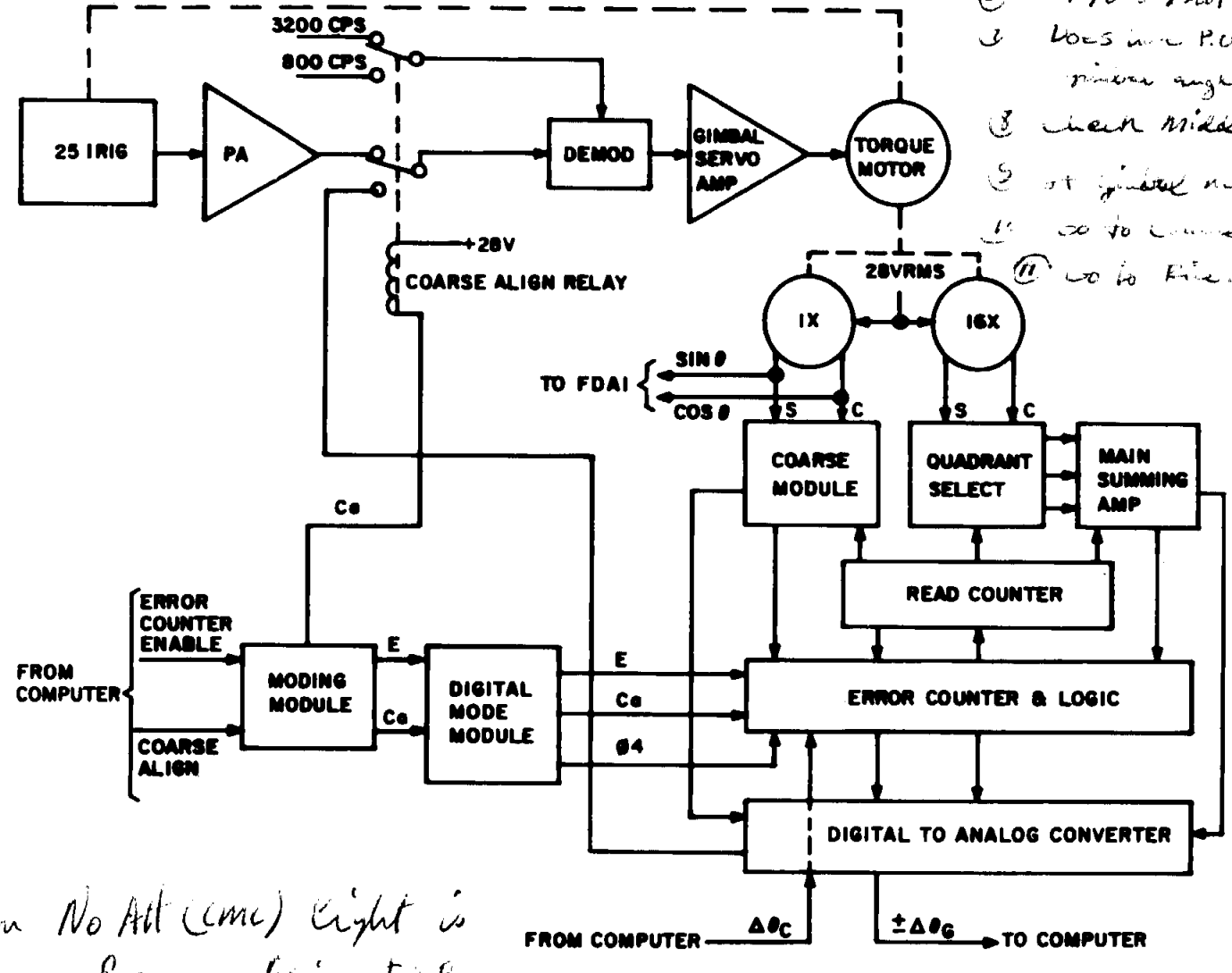
IMU TURN-ON MODE



COARSE ALIGN MODE

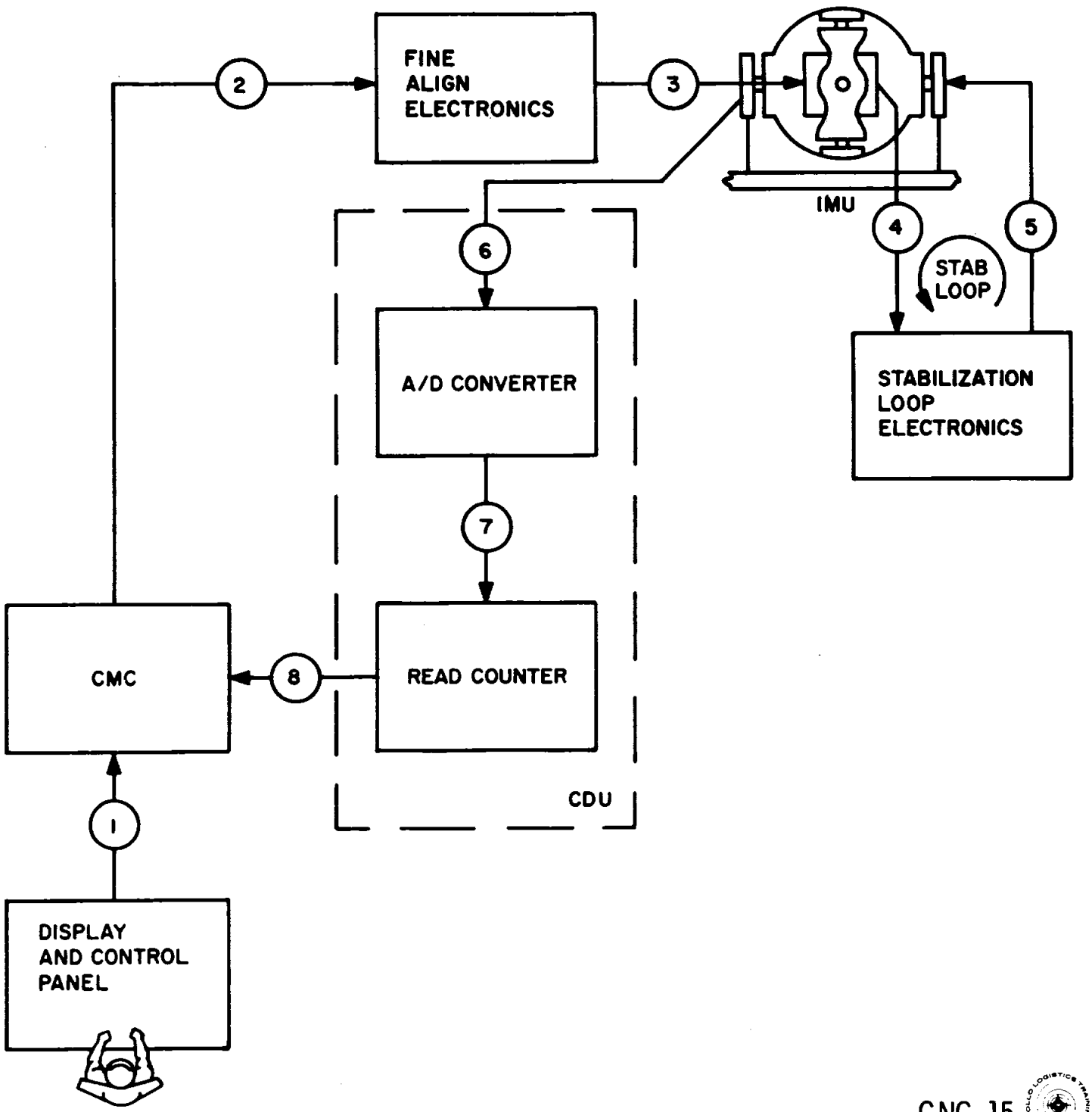


COARSE ALIGN MODE

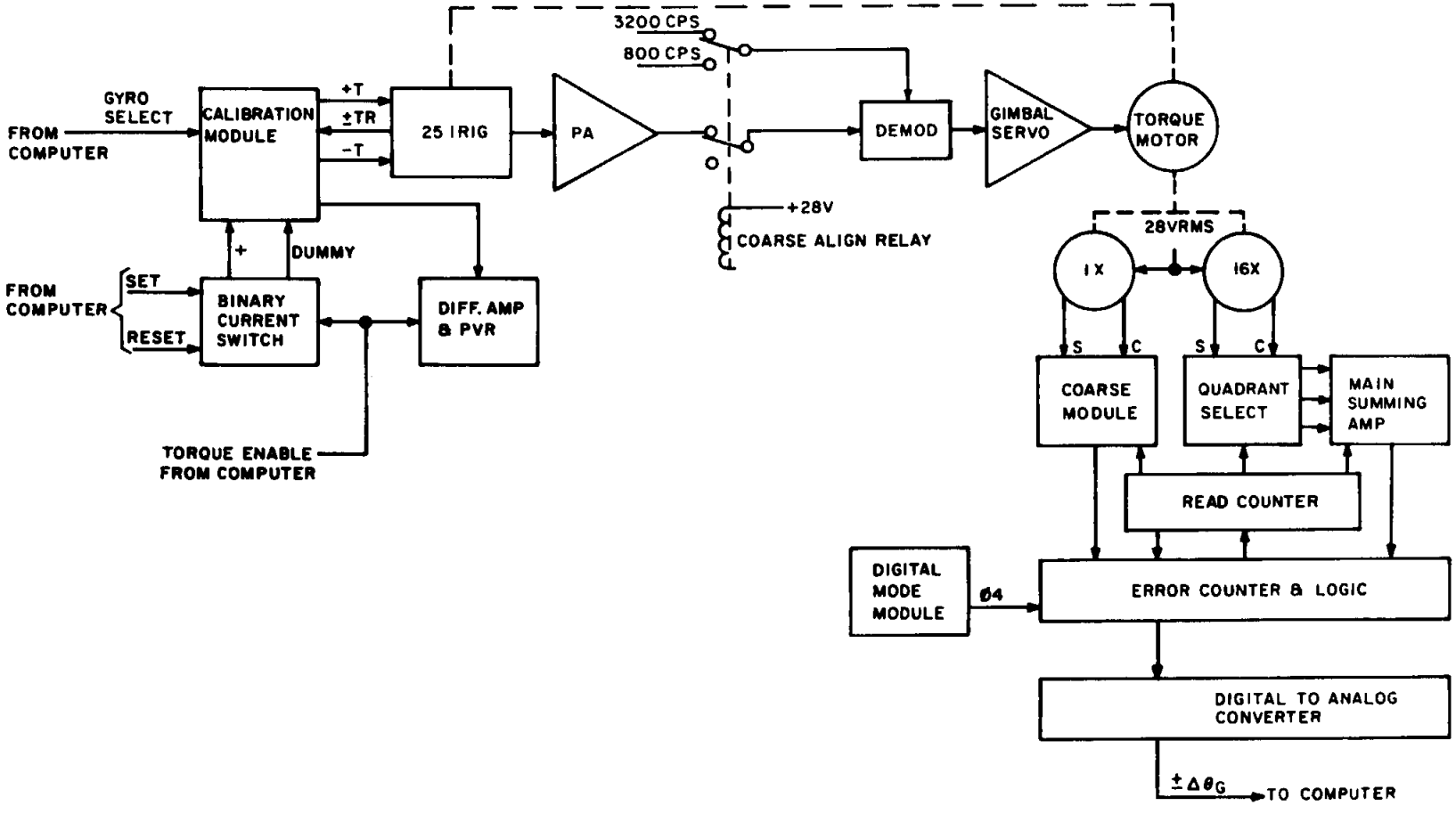


GNC-118

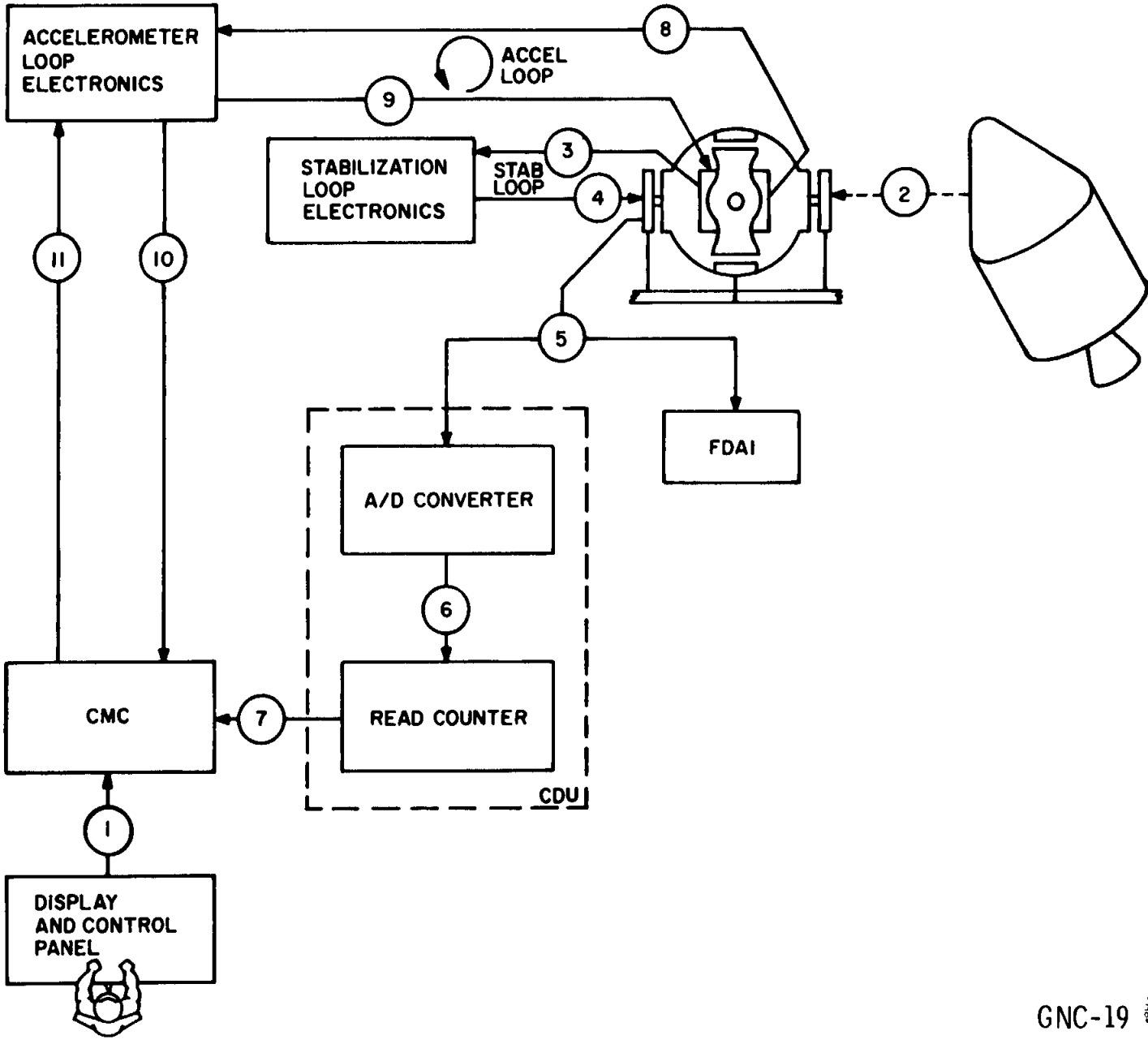
FINE ALIGN


FINE
ALIGN
ELECTRONICS
2
3
IMU
4
5
STAB
LOOP
STABILIZATION
LOOP
ELECTRONICS
6
A/D CONVERTER
7
CMC
8
READ COUNTER
CDU
1
DISPLAY
AND CONTROL
PANEL

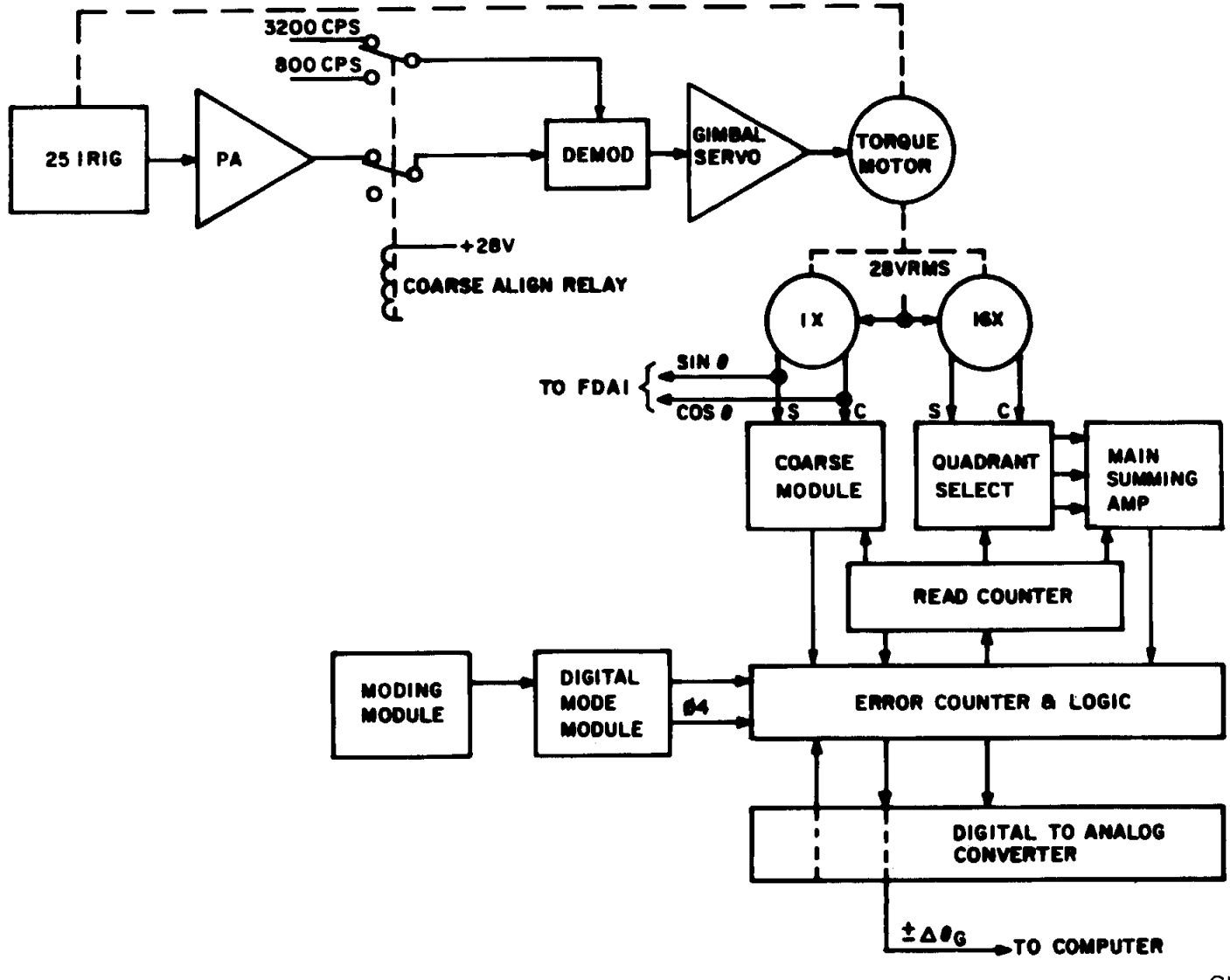
FINE ALIGN MODE



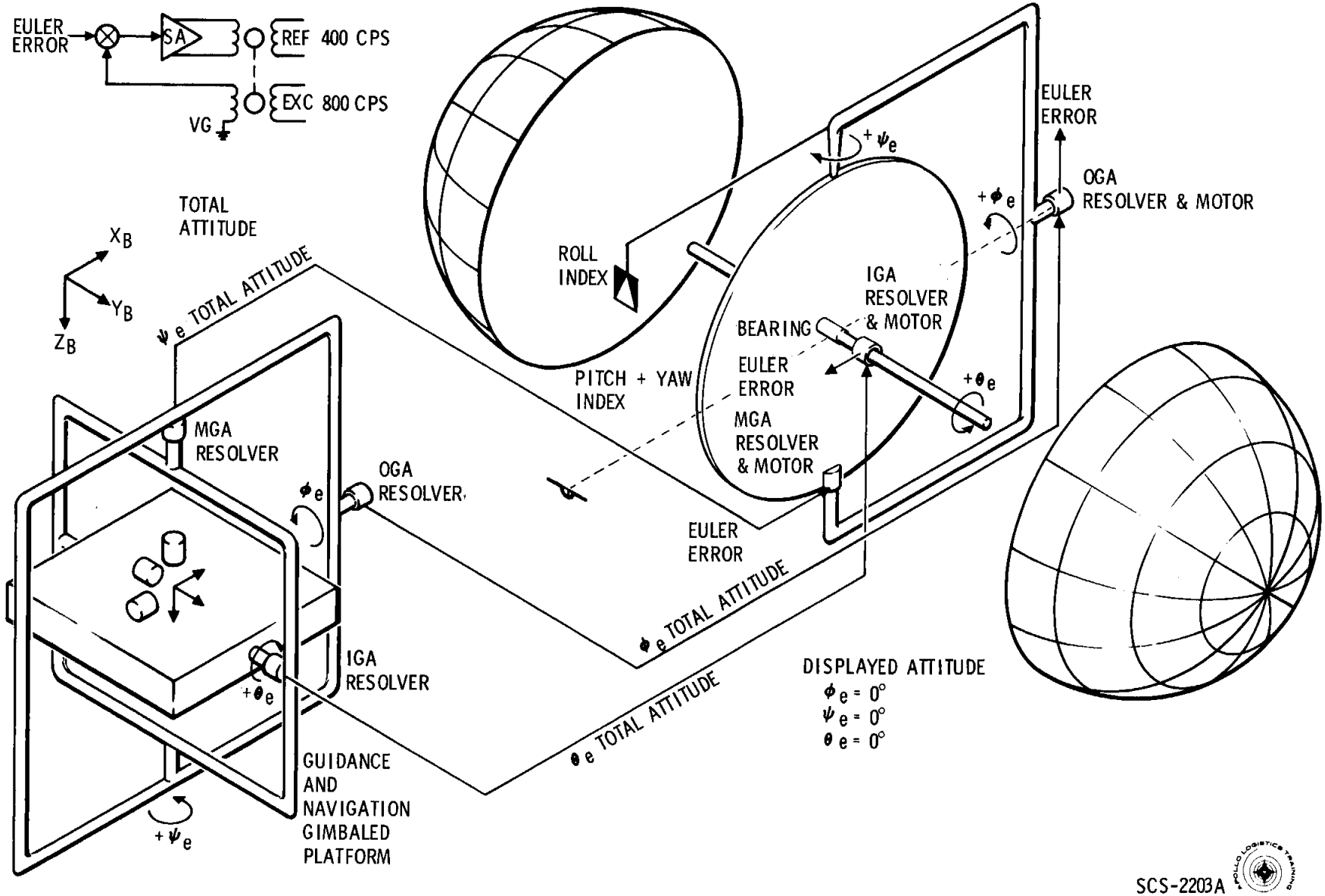
INERTIAL REFERENCE MODE



INERTIAL REFERENCE MODE



FDAI/IMU GIMBAL RELATIONSHIP



SCS-2203A

Encl 5

PREPARED BY: T.F.W.

NORTH AMERICAN AVIATION, INC.
SPACE & INFORMATION SYSTEMS DIVISION

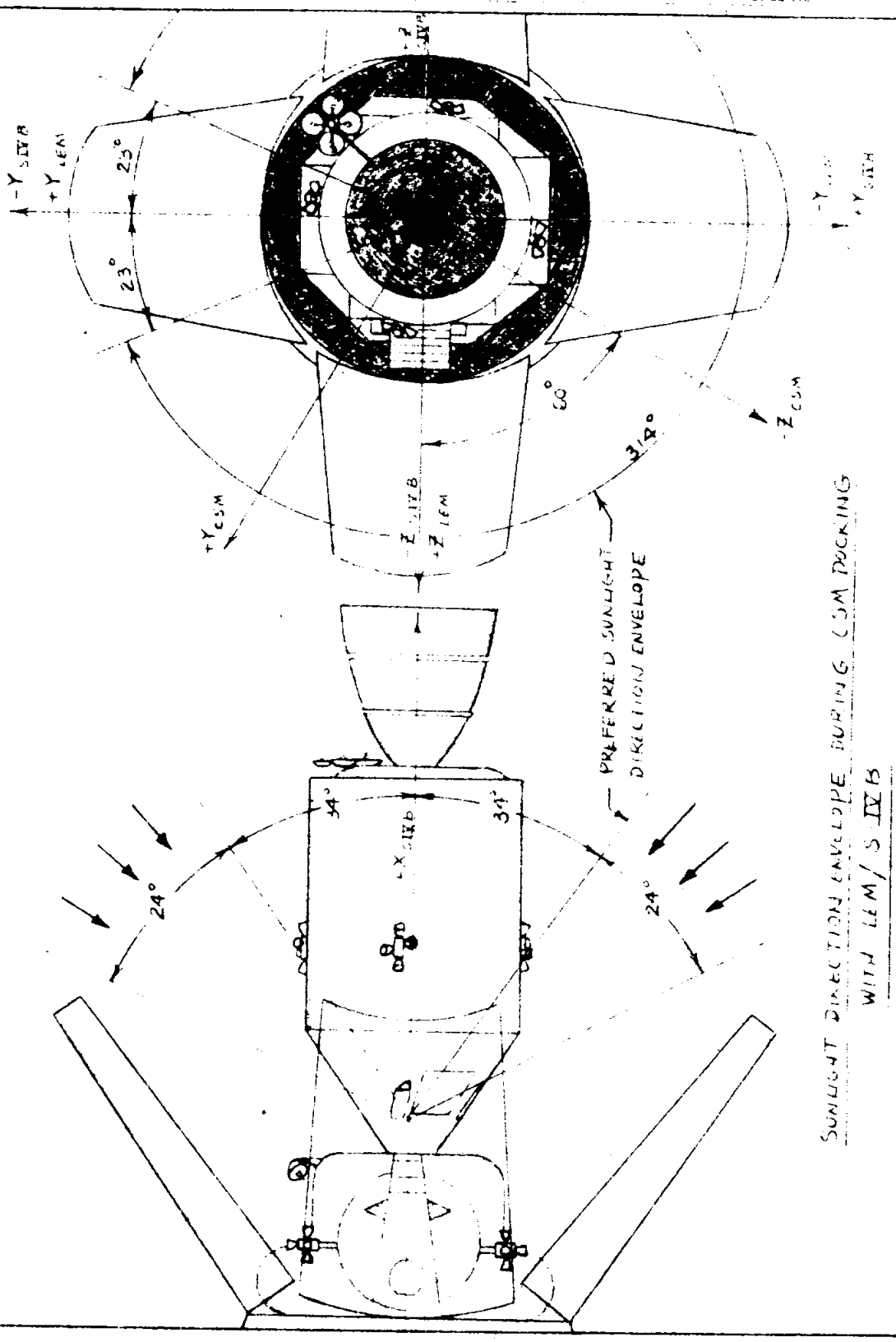
CHECKED BY:

DATE: 5-17-67

PAGE NO 2-9

REPORT NO.

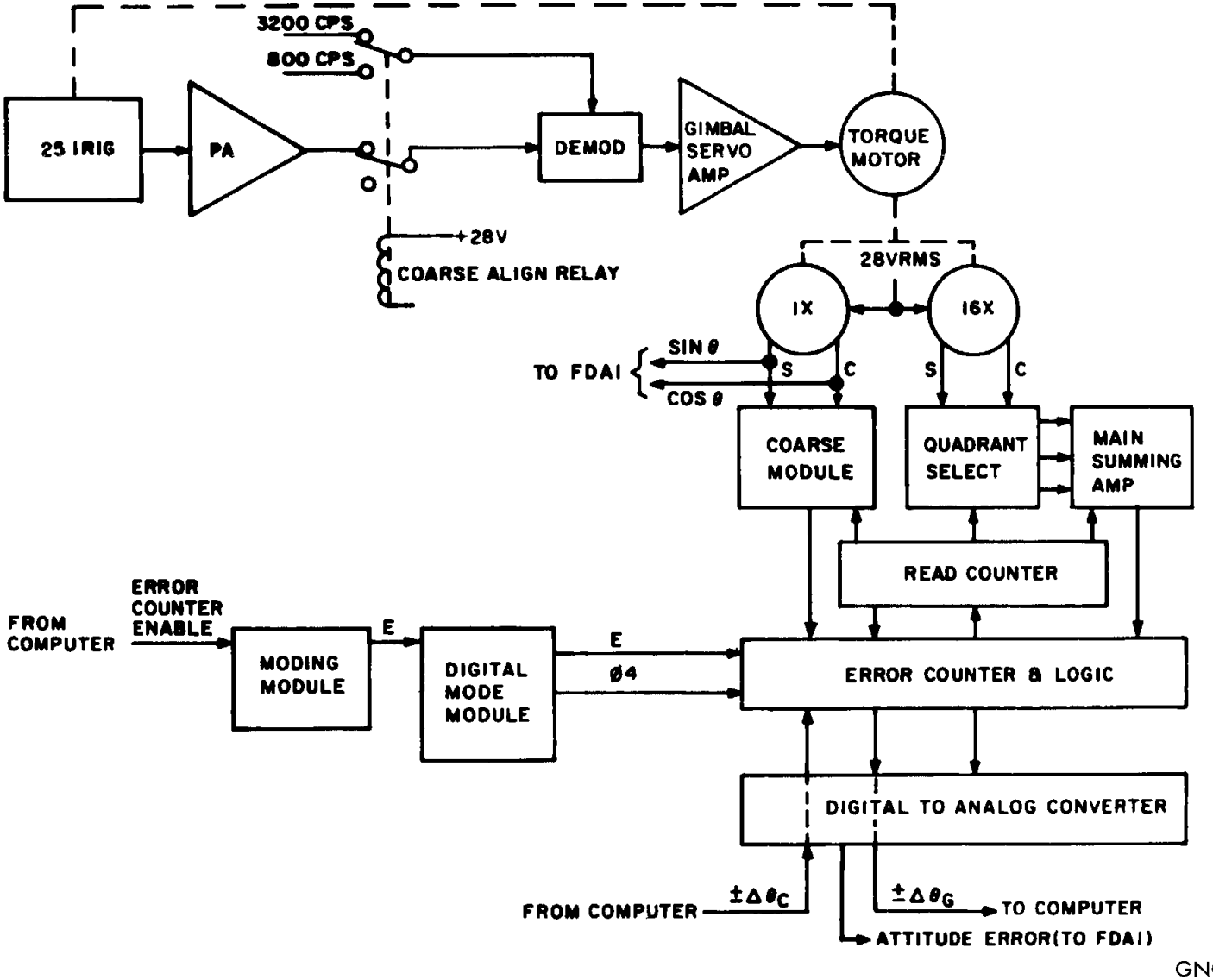
MODEL NO.



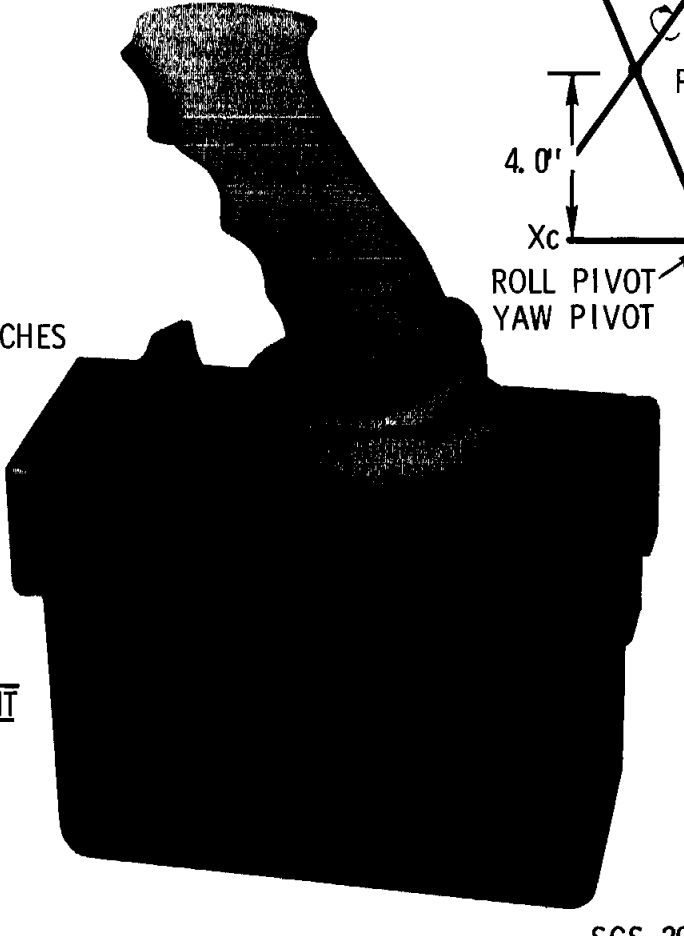
SUNLIGHT DIRECTION ENVELOPE DURING CSM DOCKING WITH LEM/S IVB

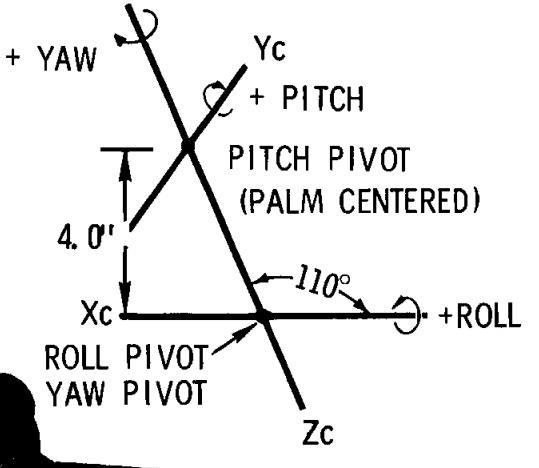
FIGURE 1

ATTITUDE ERROR DISPLAY



ROTATION CONTROL





PUSH TO TALK SWITCH PARAMETERS

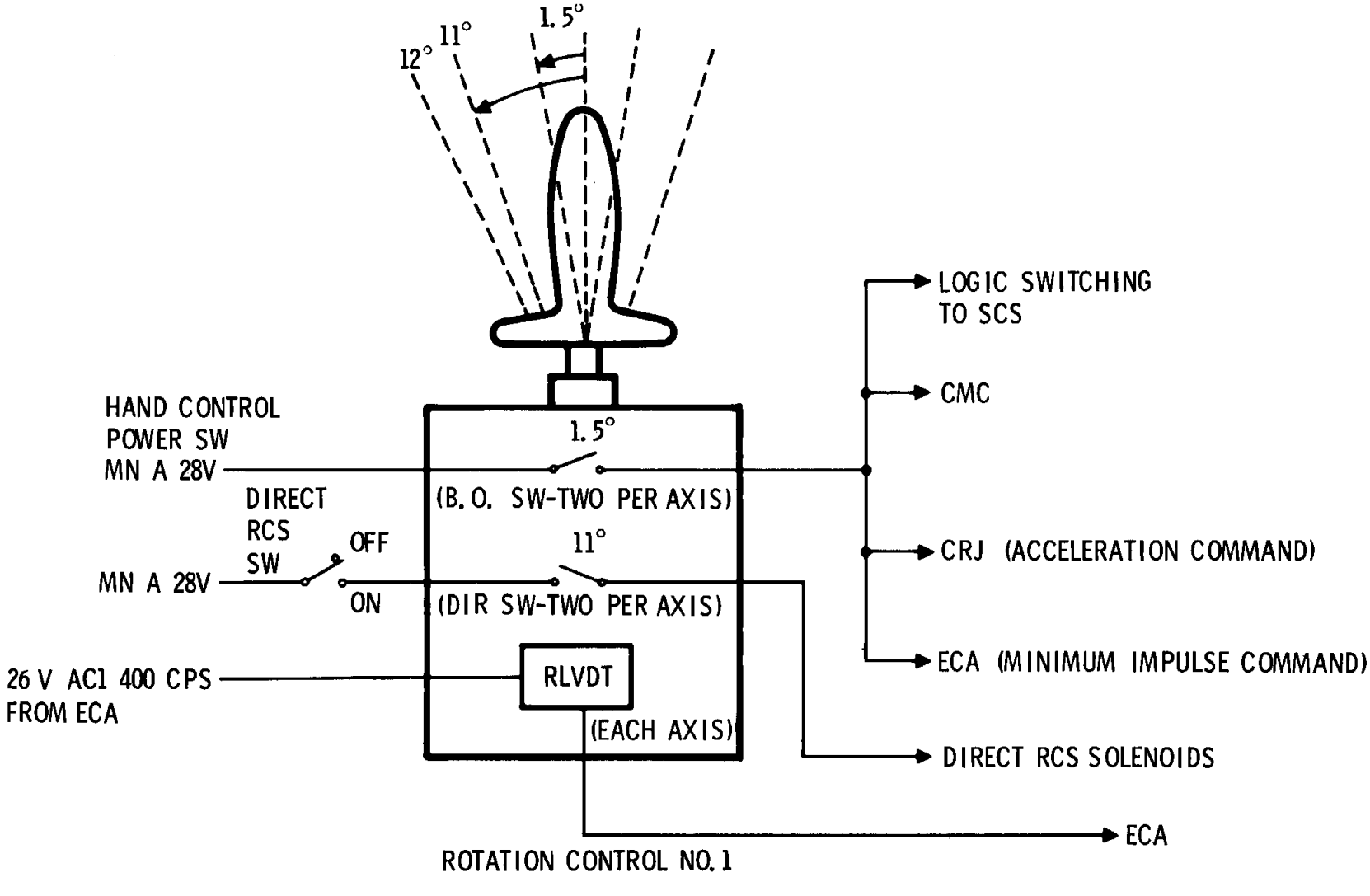
TRAVEL PRIOR TO SWITCH ACTUATION	8.0° MIN
TRAVEL TO HARDSTOP	25.0° MAX
MAXIMUM TORQUE	1.0 POUND INCHES

ROTATION CONTROL PARAMETERS

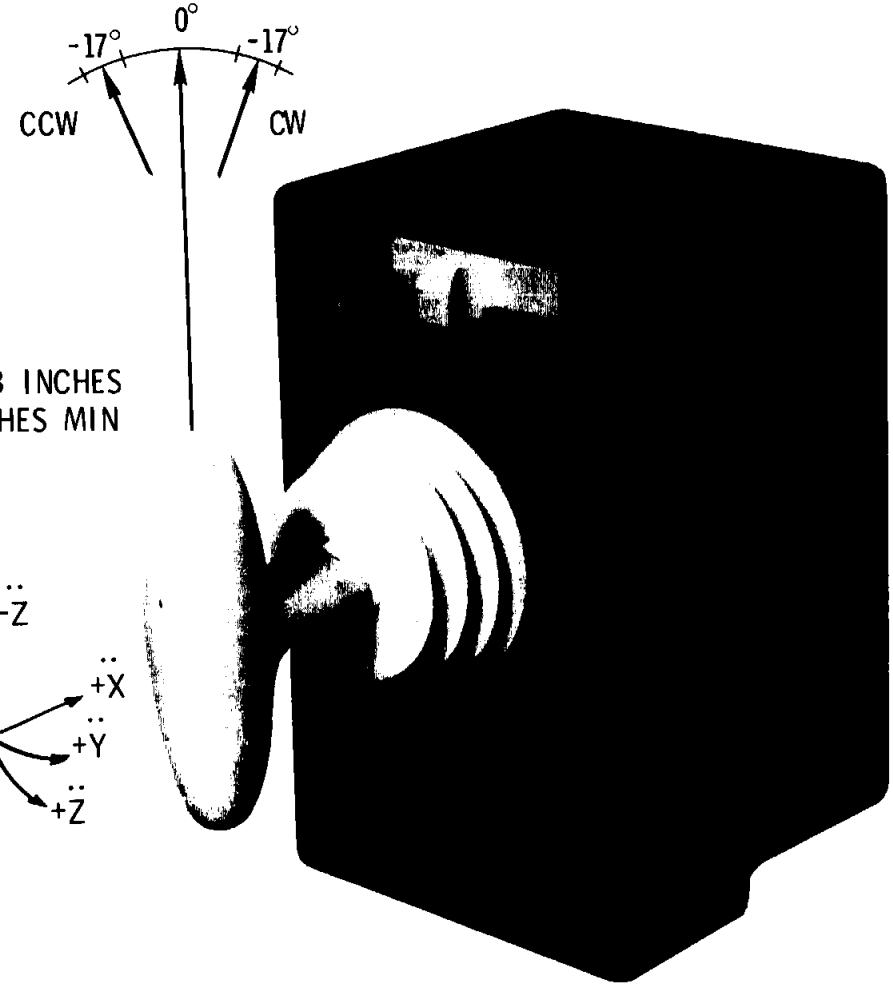
	DISPLACEMENT
HARD STOP	11.5±0.50
DIRECT SWITCH ACTUATION	≈11.0°
SOFT STOP	10±1°
BREAKOUT SWITCH ACTUATION	1.5± 0.5°
CONTROLLER LOCK TO ARM	50.0°

SCS-2002B

ROTATION CONTROL INTERFACES



TRANSLATION CONTROL



CW & CCW CONTROL MOTION LIMITS

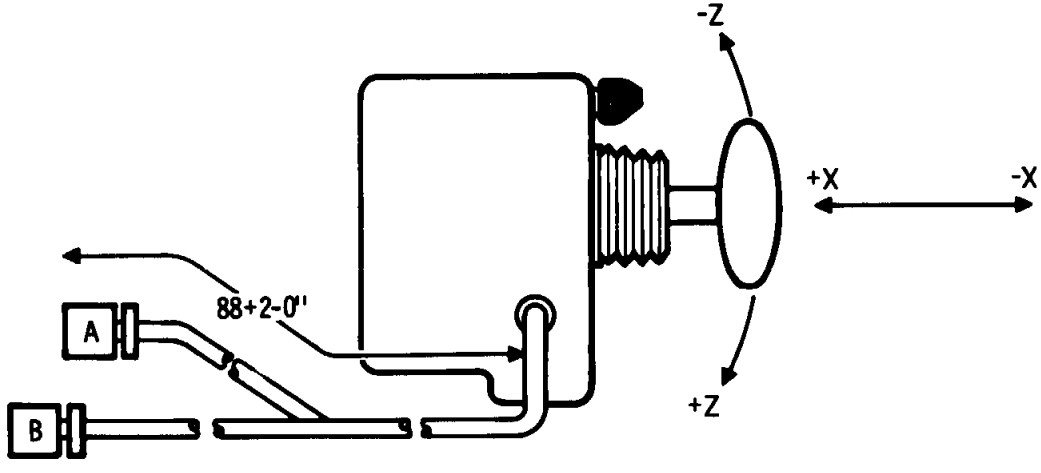
HARD STOP, DETENT & SWITCH CLOSURE	17°±2°
FORCE INTO DETENT	15±5.0 LB INCHES
OUT OF DETENT	6 LB INCHES MIN

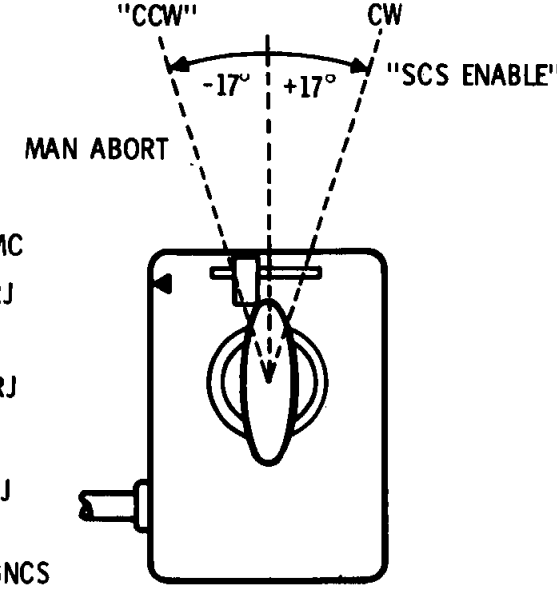
TRANSLATION CONTROL MOTION LIMITS

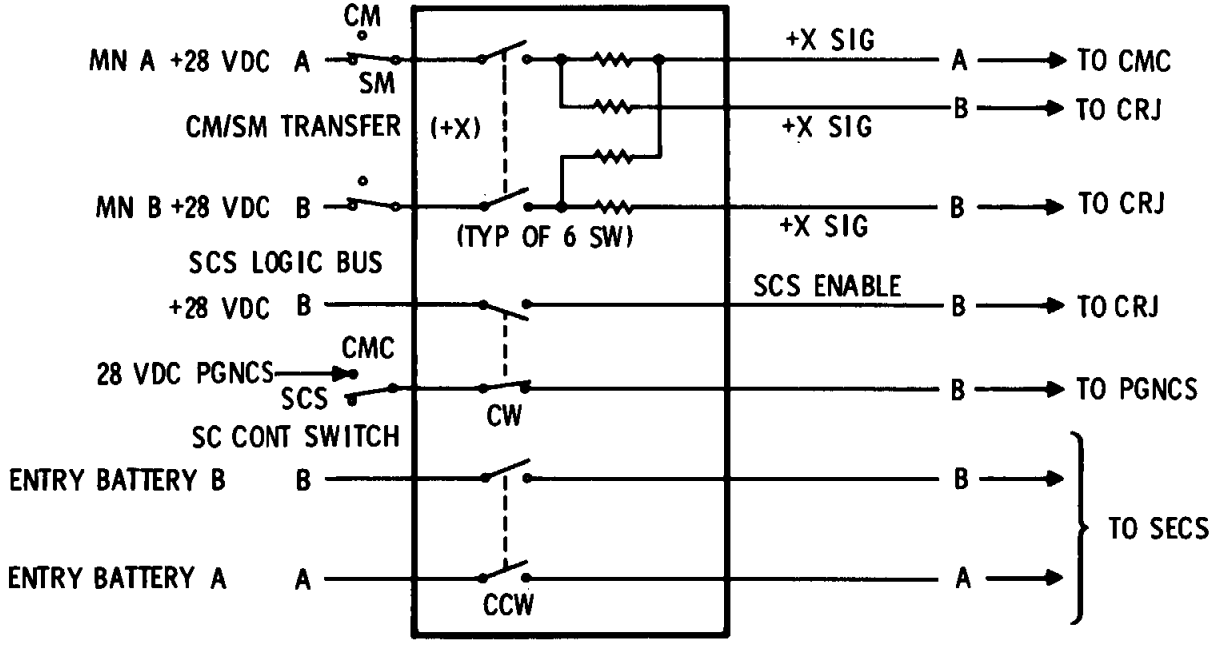
MAXIMUM	±0.5 INCHES
SWITCH CLOSURE	$\pm 0.375\ ^{+0.025}_{-0.075}$
FORCE	2.1±0.3 POUNDS

SCS-2003

TRANSLATION CONTROL INTERFACES



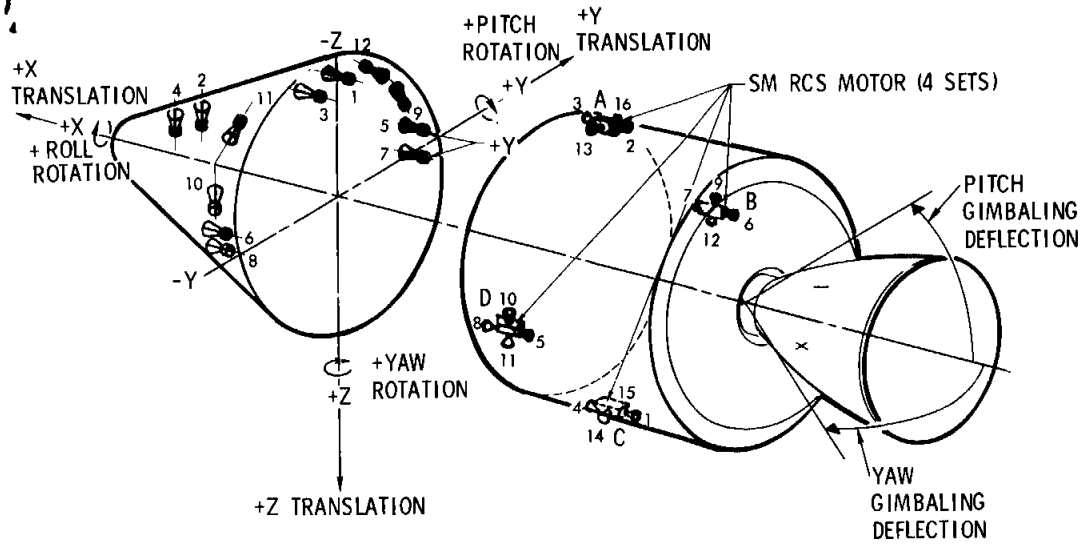


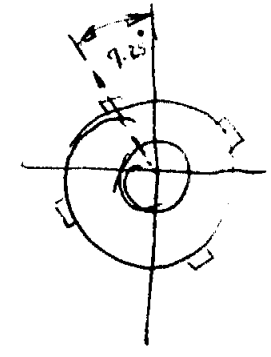


SCS-2401C

SM JET FUNCTIONS

(*) Could deorbit with the CM RCS only!





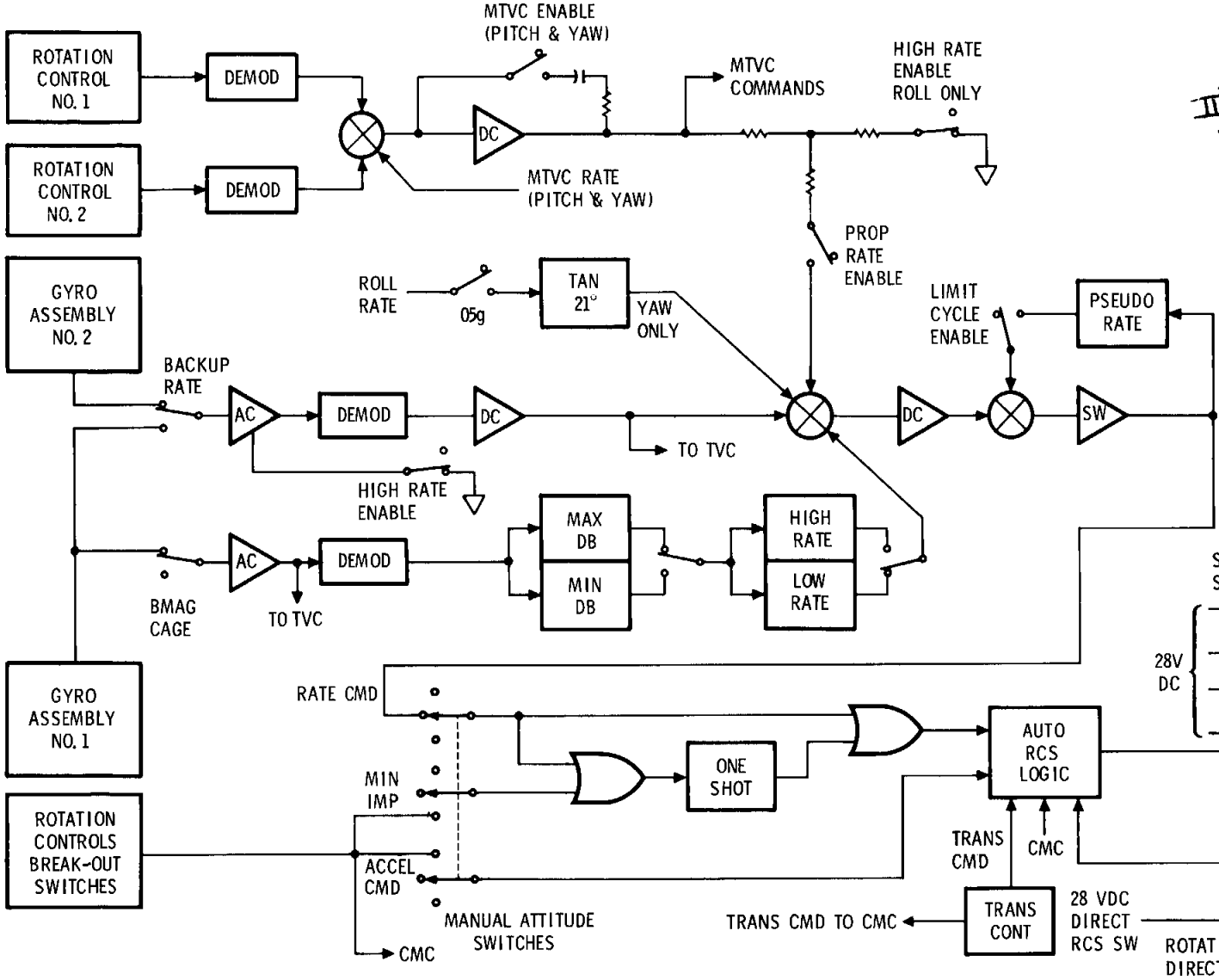
RCS ENG NO.	COMMANDS	QUAD	CHANNEL	CHANNEL SWITCH A POSITION B
1	+X +θ	C	PITCH	A CB'S B
2	+X -θ	A	PITCH	A CB'S B
3	-X +θ	A	PITCH	B CB'S A
4	-X -θ	C	PITCH	B CB'S A
5*	+X +ψ	D	YAW	B CB'S A
6	+X -ψ	B	YAW	B CB'S A
7*	-X +ψ	B	YAW	A CB'S B
8	-X -ψ	D	YAW	A CB'S B
9	+Z +φ	B	ROLL	A BD ROLL 1 CB'S B

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

SCS ATTITUDE CONTROL

FUNCTIONAL OPERATION



SCS-2410B

SCS Att. Control

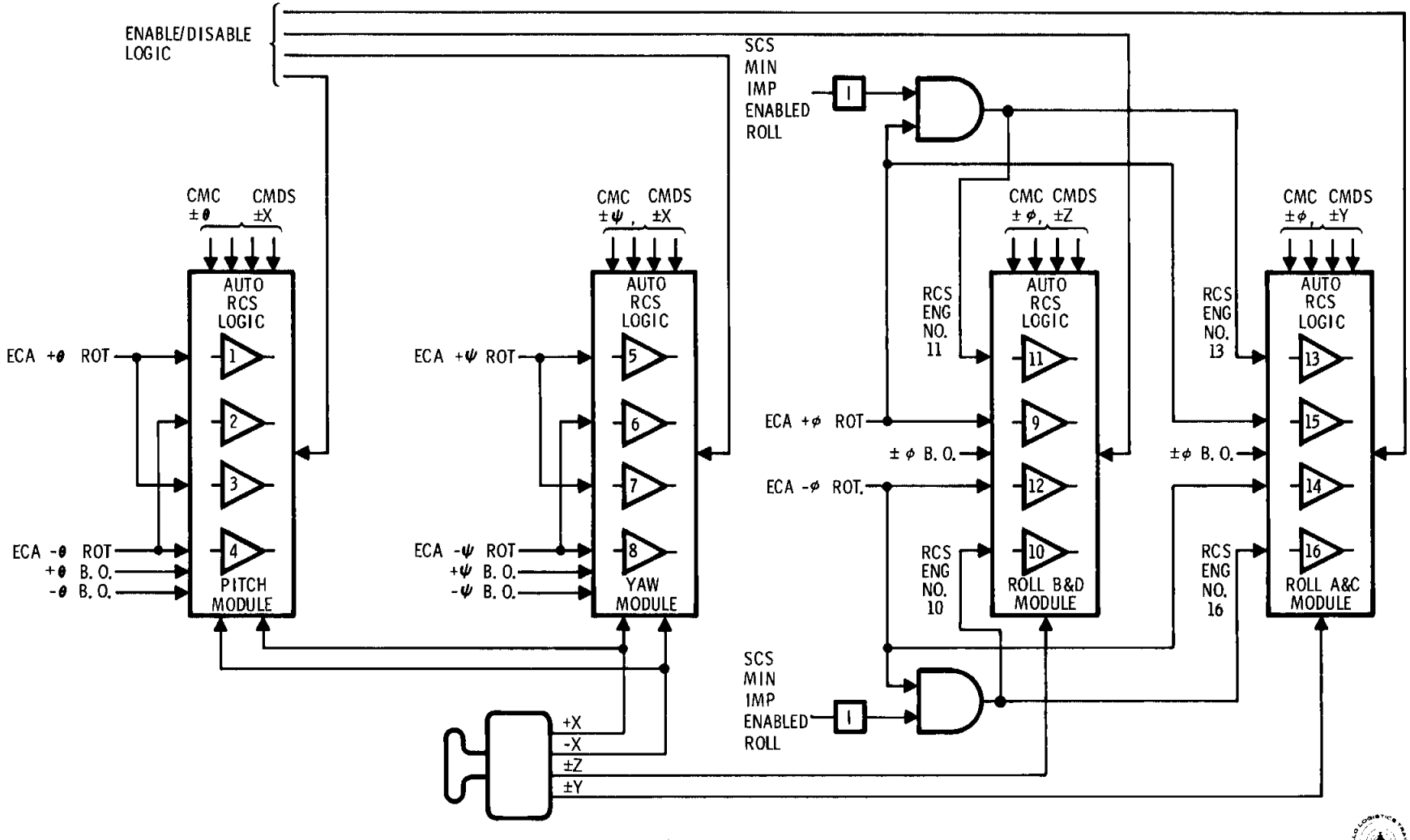
I) Auto
1. Att. hold
2. Rate Damping

II) Manual
1. Prop. Rate
2. Accel. Cmd
3. Min Imp.
4. Trans.

CMC Att. Control (G&N)

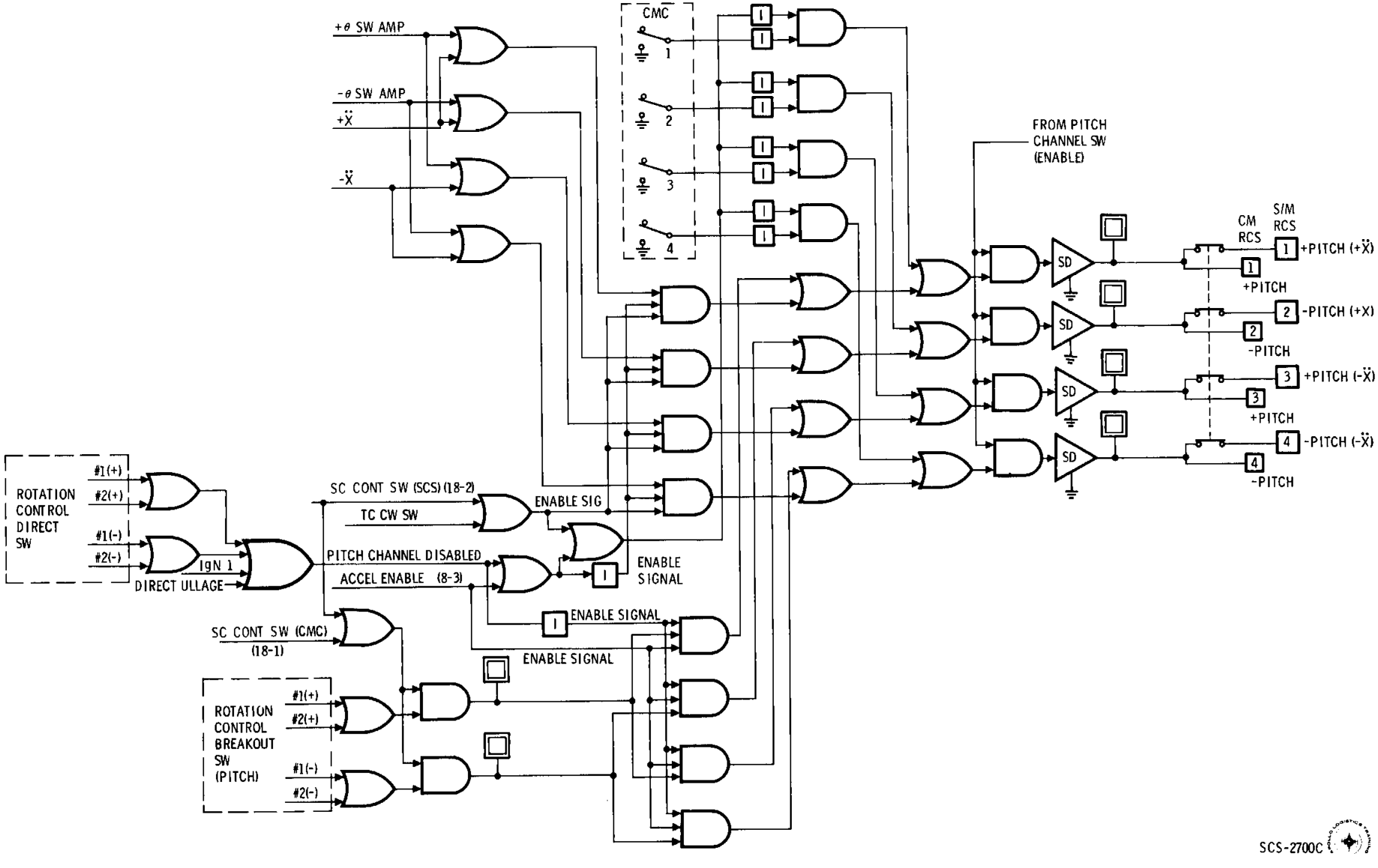
I Auto (G&C does a att. maneu) → Rotation Control & Translation Control OVERRIDE
II Hold → Rotation Control & Translation Control OVERRIDE
III Free .... Min Imp. - use this with star sightings & alignments (No deadband firings)

AUTO RCS LOGIC SIG FLOW



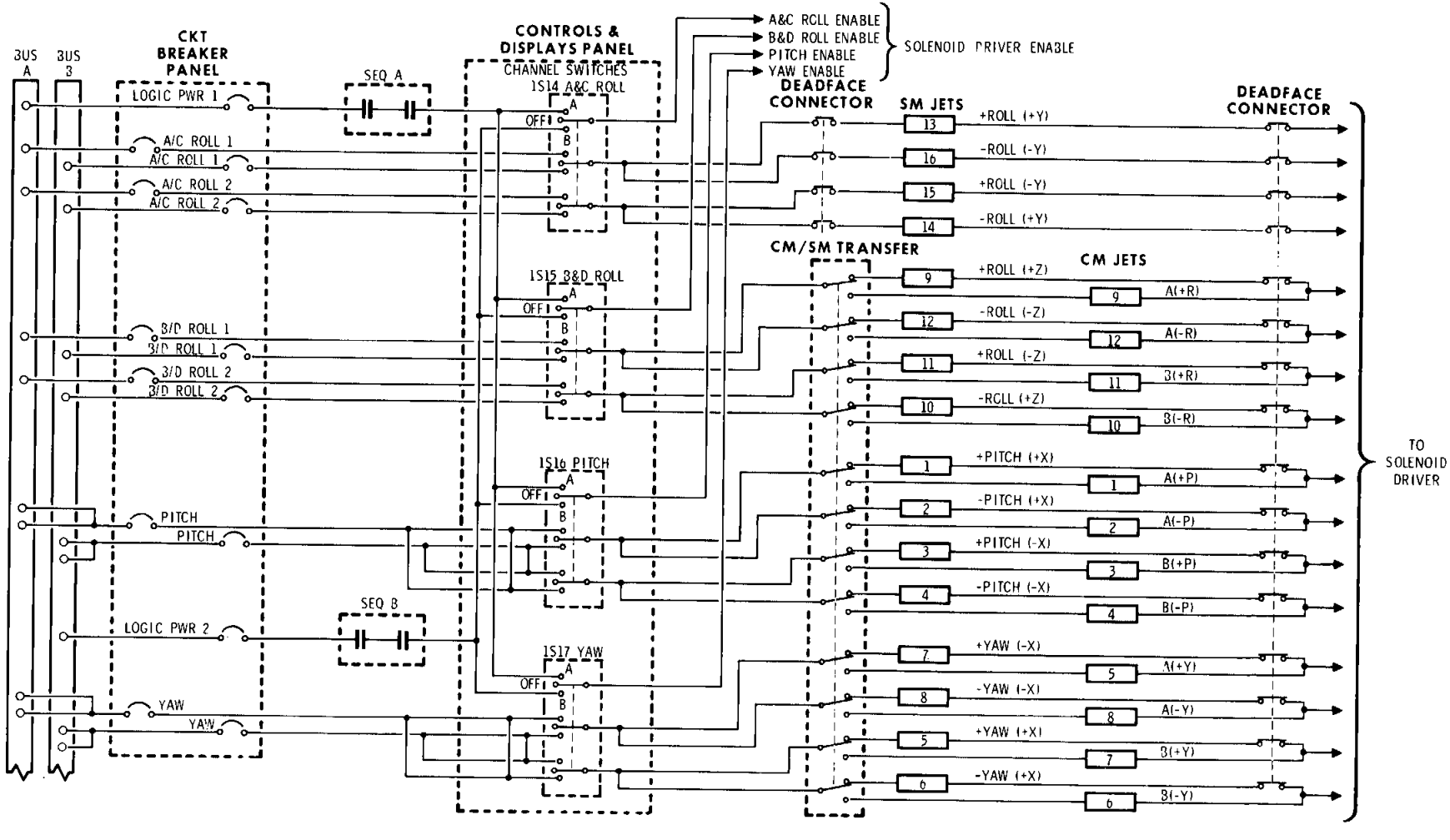
SCS-2415C

AUTO RCS LOGIC
TYPICAL CHANNEL (PITCH)



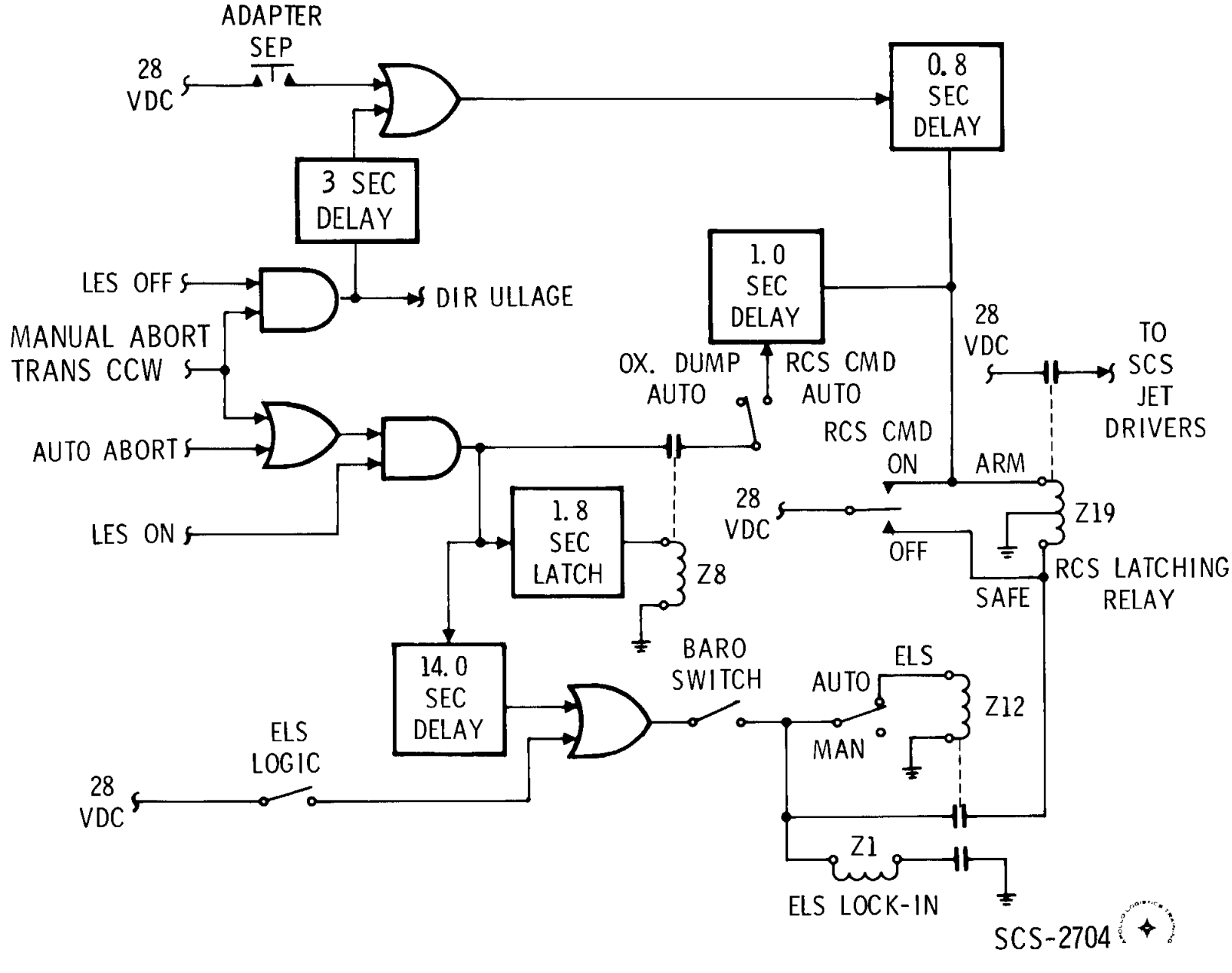
SCS-2700C

ENABLING POWER - AUTO RCS

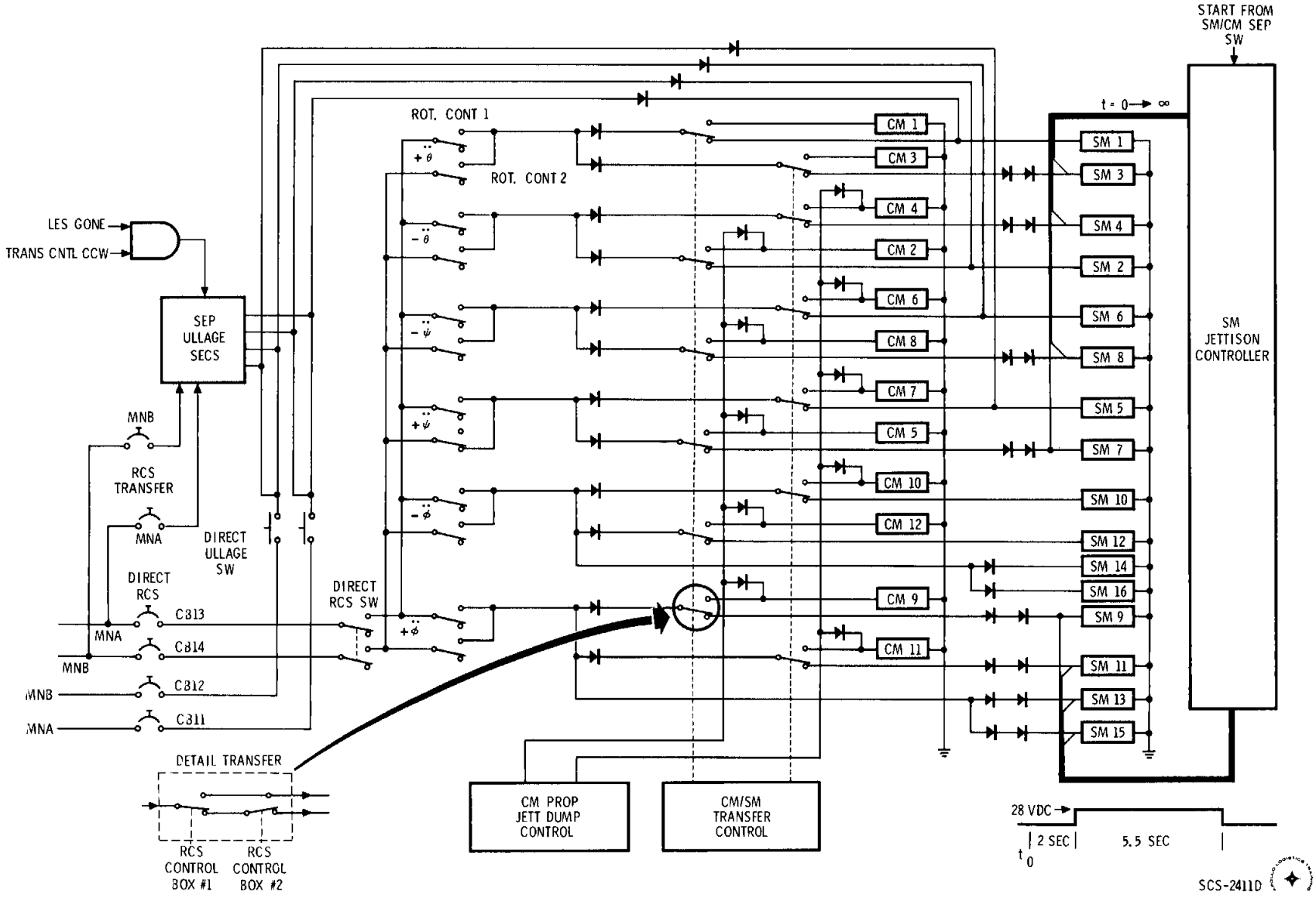


SCS-2413 3

RCS LATCHING RELAY LOGIC



DIRECT CONTROL LOOP



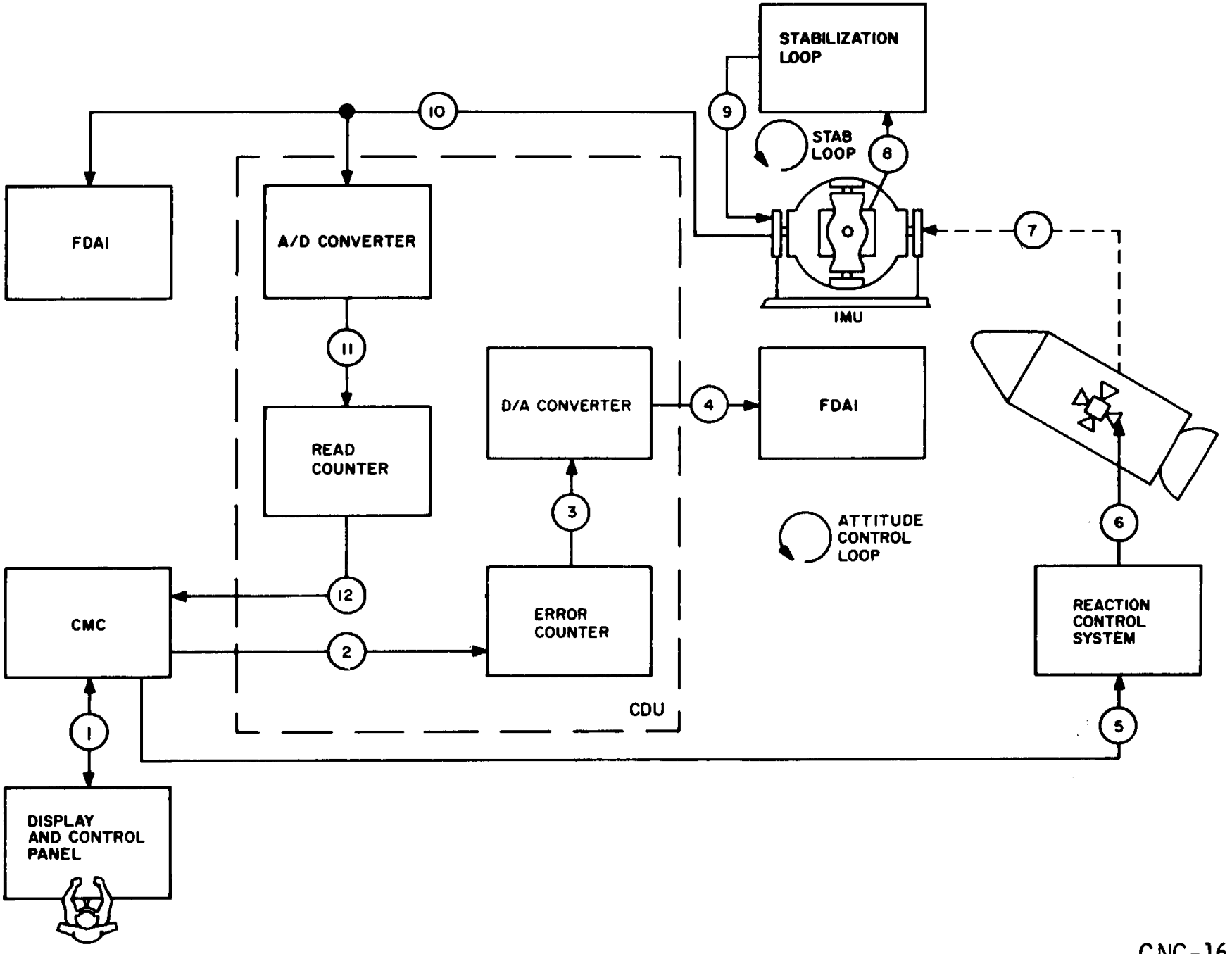
ACS CONTROL CAPABILITIES

			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			✓	✓	✓	✓	✓
TRANS CONTROL		CW			✓	✓	✓	✓	✓
		NEUTRAL							
DIRECT RCS		UP	✓	(3)	(3)	(3)	(3)	(3)	(3)
		OFF							
ROT CONTROL		B.O. SW		CLOSE(2)		CLOSE(2)	CLOSE	OPEN	OPEN
		DIRECT SW	CLOSE						
LIMIT CYCLE (1)		UP							✓
		OFF					✓	✓	
ENTRY		.05G							
		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

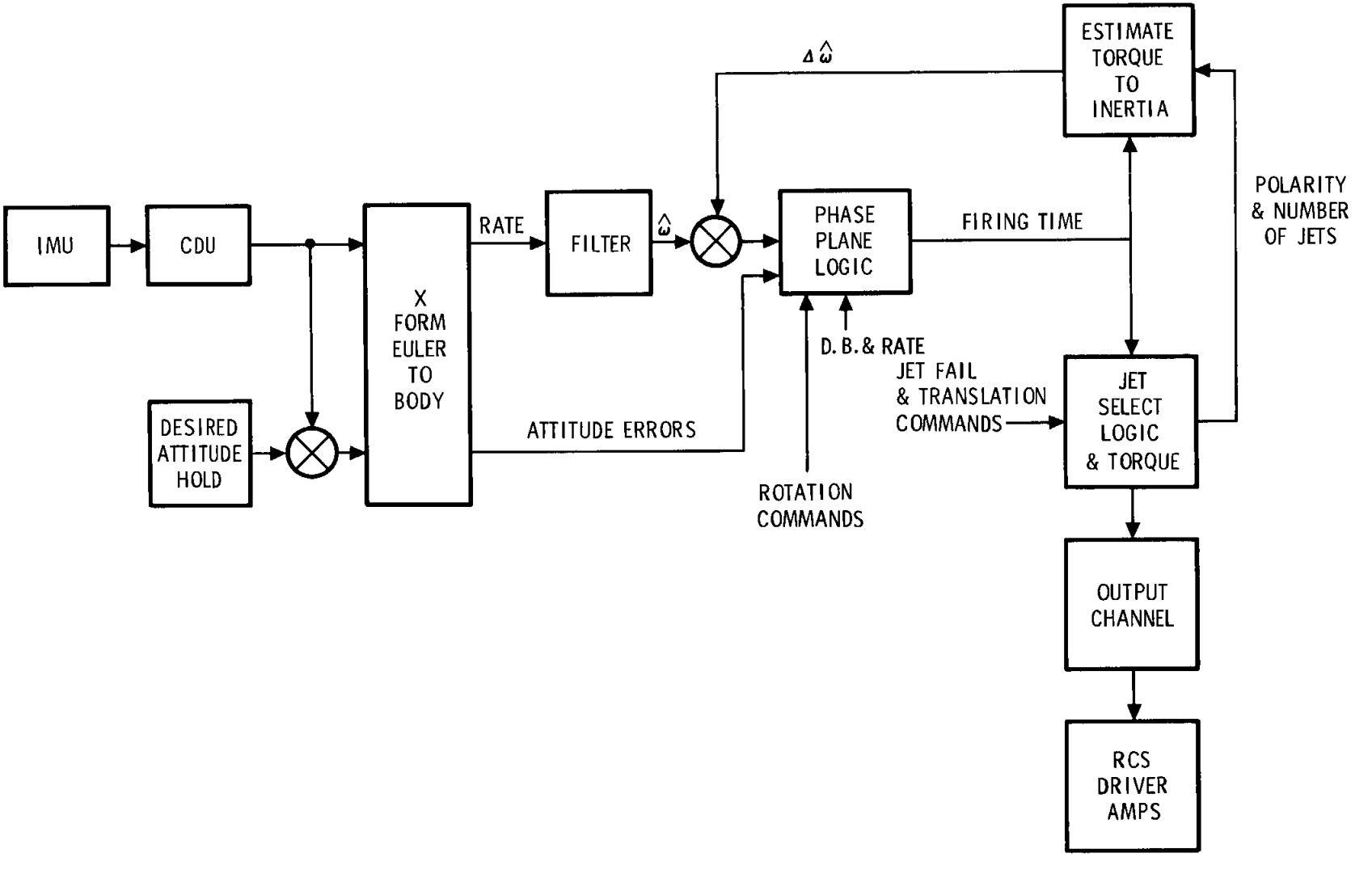
GENERAL COMMENTS:
A. THE CAPABILITIES, IN GENERAL, ARE LISTED IN ORDER OF THEIR PRIORITY.
B. WHEN MORE THAN ONE SWITCH POSITION IS CHECKED (✓) THE CAPABILITY WILL BE ENABLED IN EITHER POSITION.

ATTITUDE CONTROL MODE

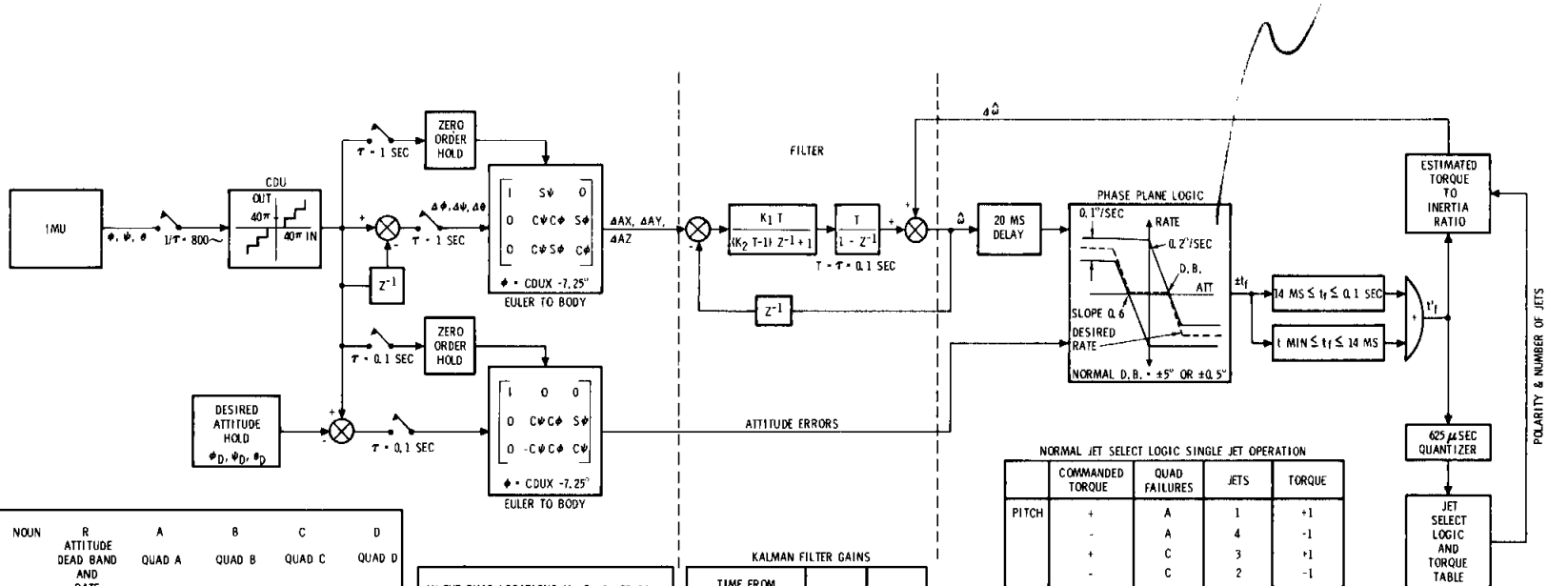


RCS DAP

SIMPLIFIED BLOCK DIAGRAM



RCS DAP MODEL



NOUN	R ATTITUDE DEAD BAND AND RATE	A QUAD A	B QUAD B	C QUAD C	D QUAD D
OCTAL DIGIT (R)		MANEUVER RATE (°/SEC)		ATTITUDE DEG DEADBAND	
0		0.05		0.5	
1		0.05		5.0	
2		0.2		0.5	
3		0.2		5.0	
4		0.5		0.5	
5		0.5		5.0	
6		4.0		0.5	
7		4.0		5.0	

IN THE QUAD LOCATIONS (A, B, C, OR D):

OCTAL DIGIT	PURPOSE
0	NO FAIL
1	PSEUDO FAIL
2	HARD FAIL
3	ILLEGAL
4	COMMANDS B & D ROLL
5	ILLEGAL
6	ILLEGAL
7	ILLEGAL

KALMAN FILTER GAINS

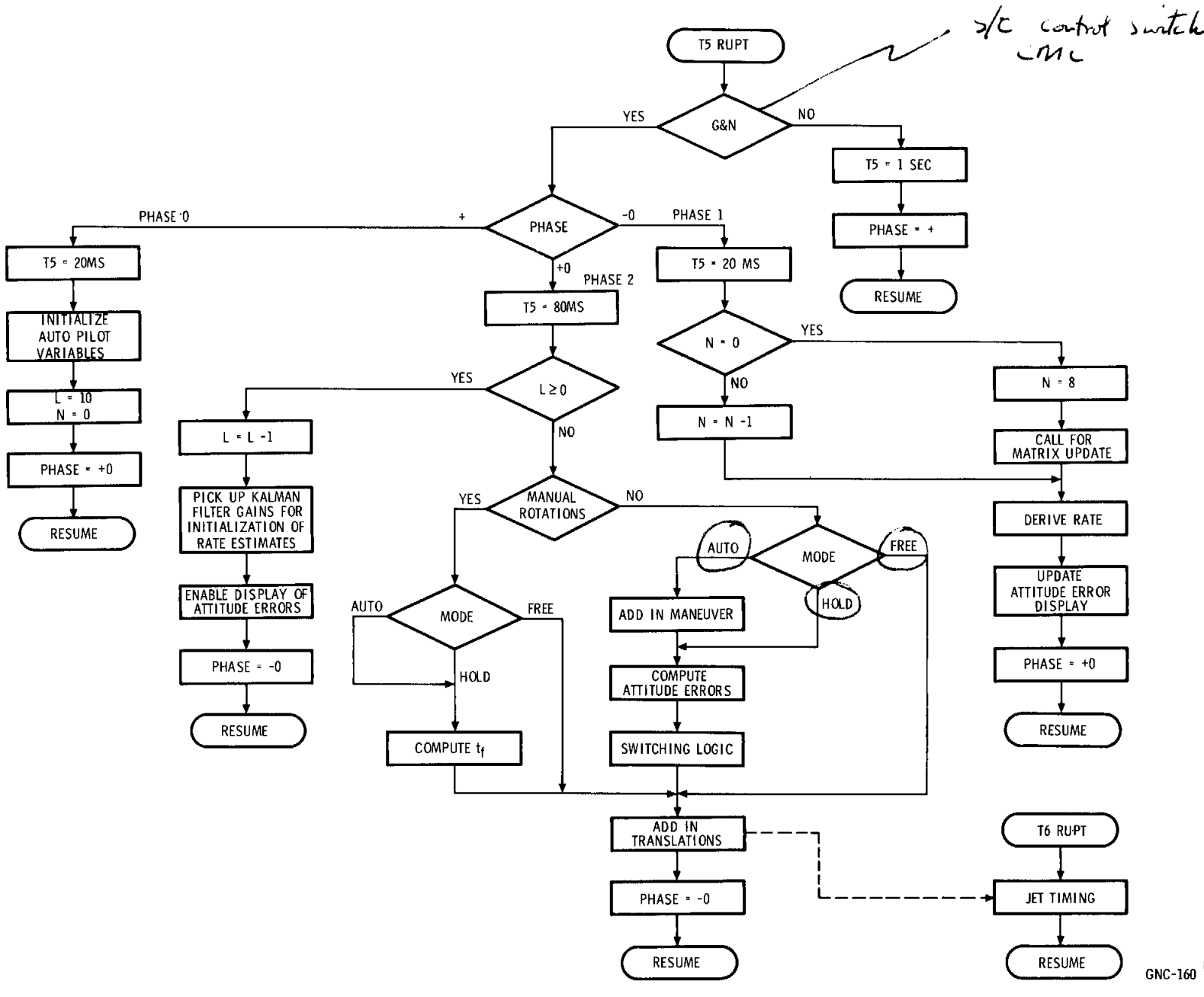
TIME FROM INITIALIZATION	K1	K2
0.1	86.83	9.342
0.2	48.17	8.151
0.3	29.55	6.933
0.4	19.85	5.970
0.5	14.22	5.223
0.6	10.69	4.634
0.7	8.32	4.161
0.8	6.66	3.774
0.9	5.45	3.452
1.0	4.54	3.180
1.1	0.16	0.640

NORMAL JET SELECT LOGIC SINGLE JET OPERATION

	COMMANDED TORQUE	QUAD FAILURES	JETS	TORQUE
PITCH	+	A	1	+1
	-	A	4	-1
	+	C	3	+1
	-	C	2	-1
YAW	+	B	5	+1
	-	B	8	-1
	+	D	7	+1
	-	D	6	-1
ROLL	+	A	15	+1
	-	A	14	-1
	+	C	13	+1
	-	C	16	-1
	+	B	11	+1
	-	B	10	-1
	+	D	9	+1
	-	D	12	-1

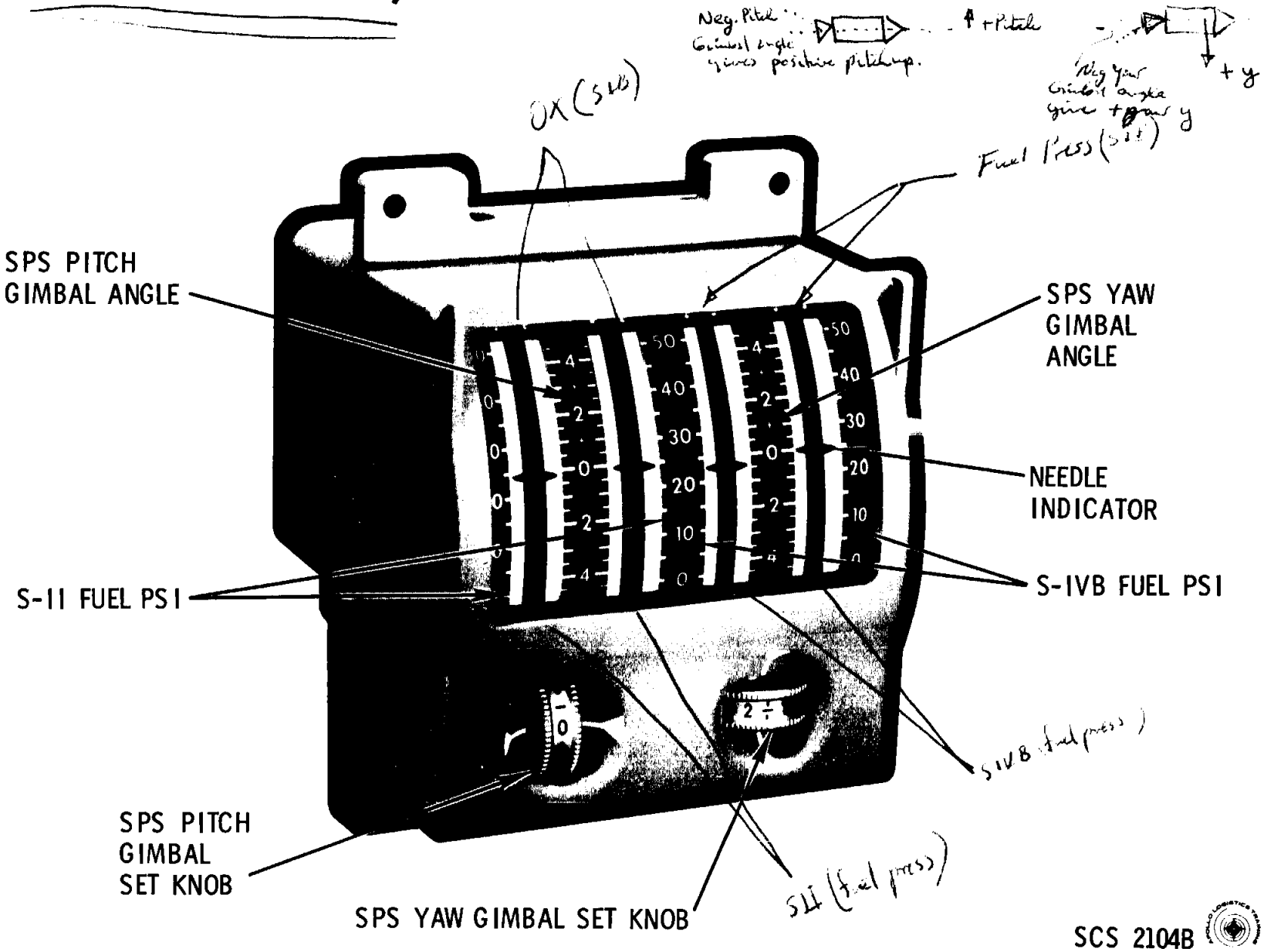
GNC-159

PROGRAM LOGIC FLOW RCS DAP



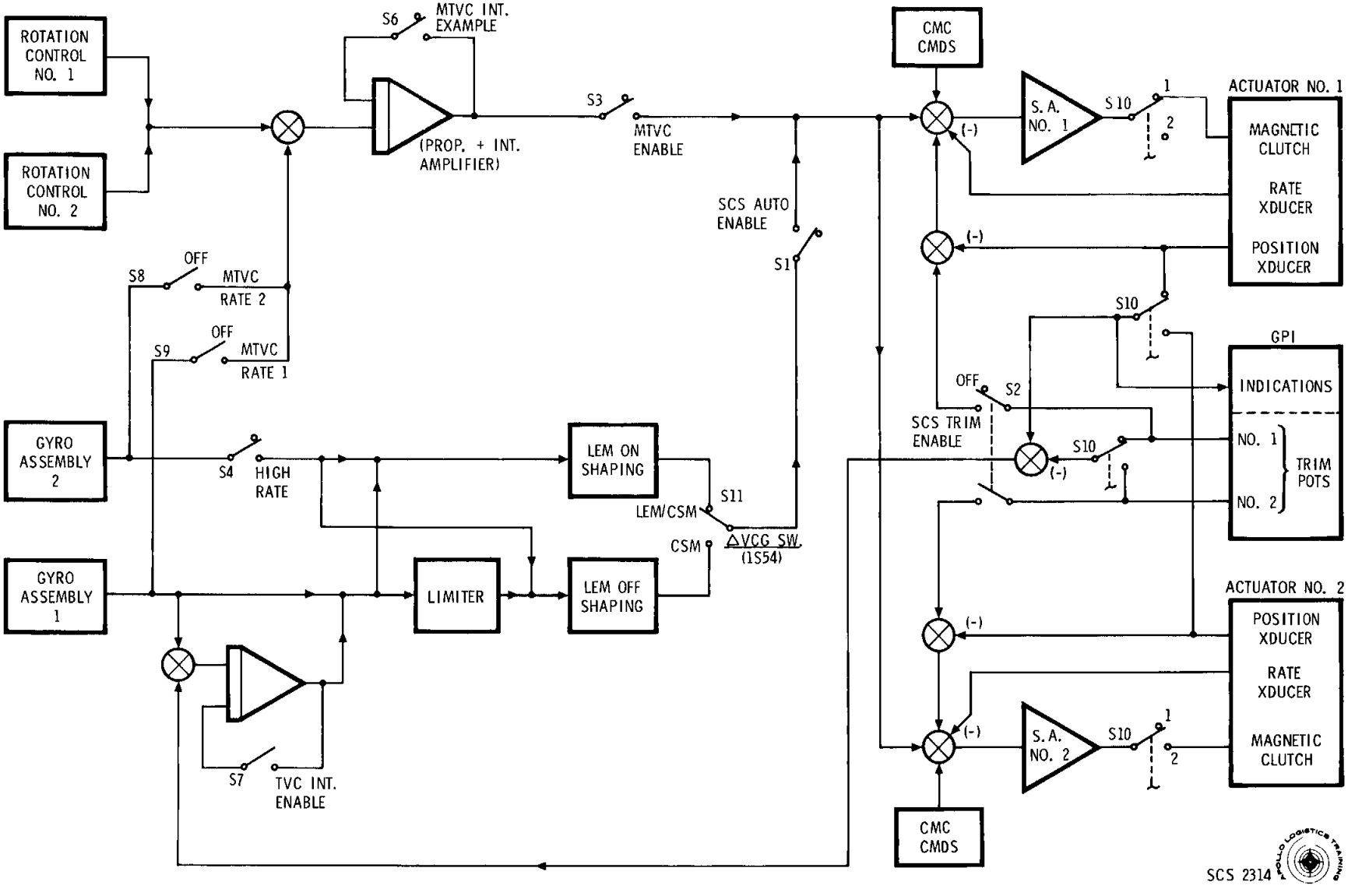
GNC-160

FUEL PRESSURE/GIMBAL POSITION INDICATOR



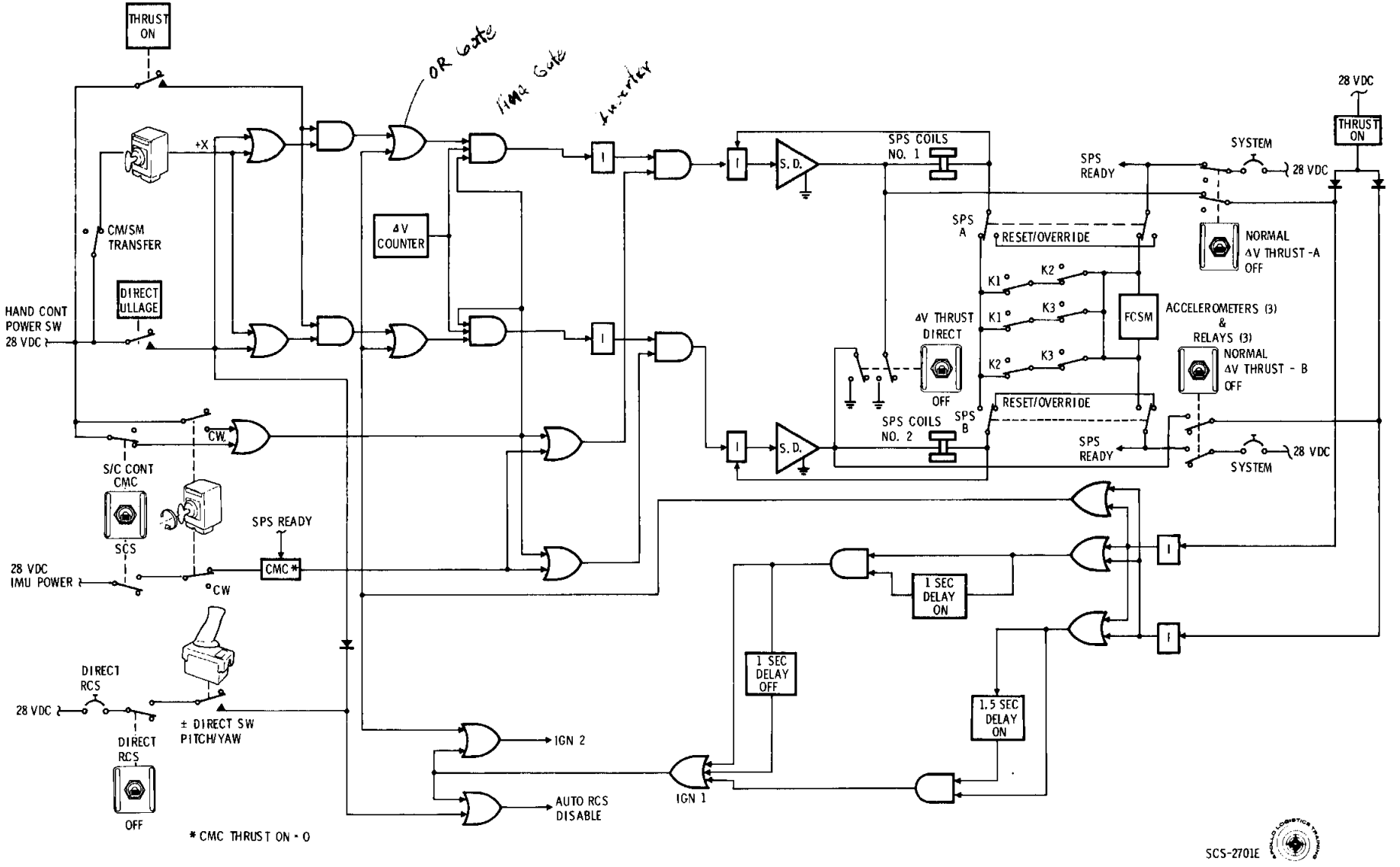
SCS 2104B

THRUST VECTOR CONTROL-SIGNAL FLOW



SCS 2314

SPS ENGINE ON-OFF LOGIC



TVC FUNCTION ENABLING LOGIC

SYSTEM CONFIGURATION	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	$\overline{CW}$	CW	$\overline{FS}$	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			
MTVC	S6	MTVC INT. ENABLE	SWITCH POSITIONS ARE SAME AS FOR S3 BUT LOGIC REQUIRES 'IGN 2' SIGNAL															
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							
												X		X		X		
SERVO NO. 2	S10	2											X					
												X			X			
												X					X	

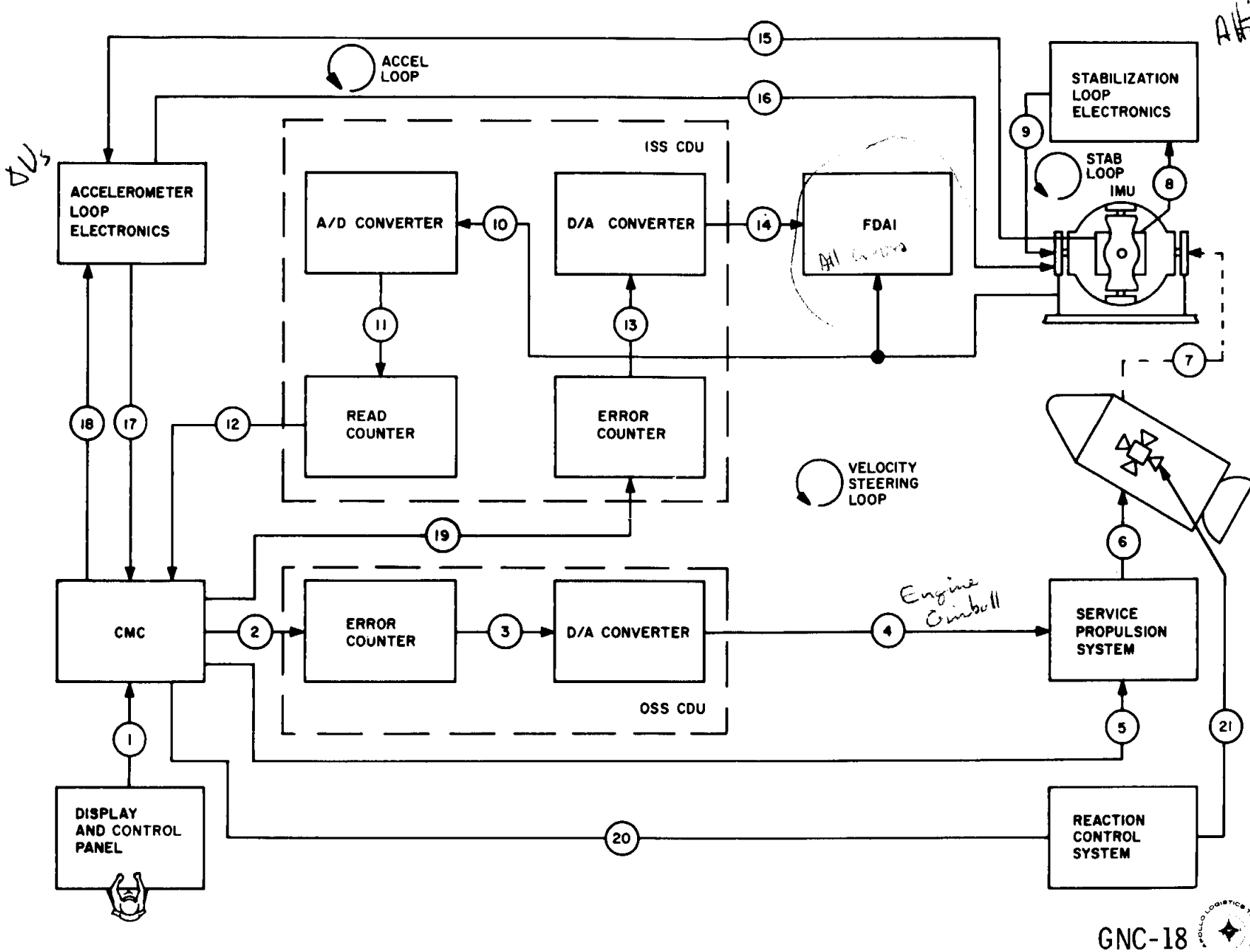
(1). FUNCTIONAL SWITCH -S11- REPRESENTS ΔVCG SW. (1S54). SELECTS LEM ON OR LEM OFF SHAPING CIRCUITS.

(2). FOR SCS AUTO BMAG MODE SWITCH MUST BE IN ATT 1/RATE 2 POSITION, HOWEVER, ENABLING LOGIC DOES NOT REQUIRE THIS.

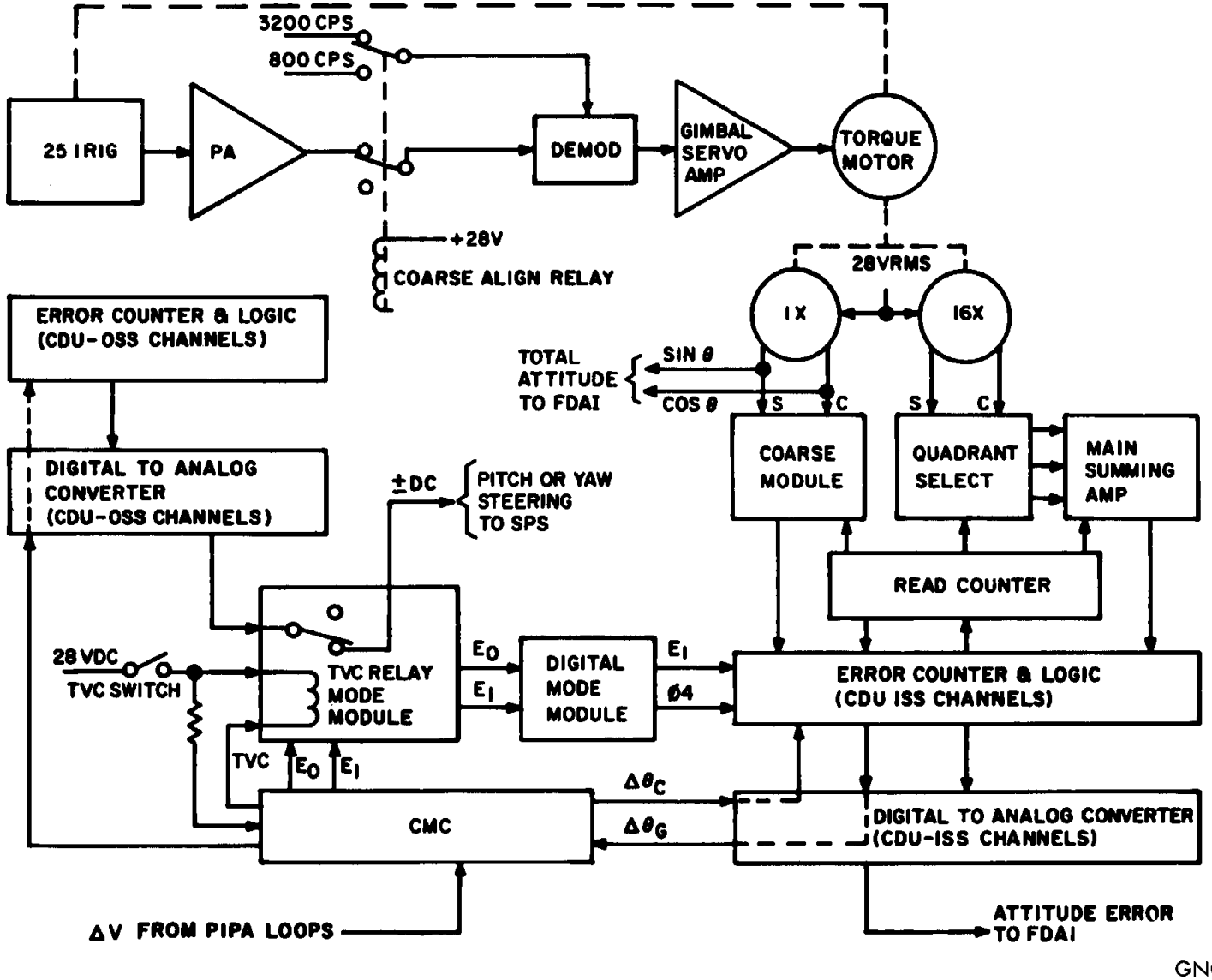
(3). SWITCH S4 POSITION IS ALSO CONTROLLED BY RATE SWITCH (1S12). IF (1S12) IS IN "LOW" POSITION, THEN, PRIOR TO IGN 2 RATE SIGNALS ARE SHAPED THROUGH HIGH GAIN CIRCUITRY, (THIS IS NOT SHOWN IN SCS 2314 DWG BECAUSE THE SIGNALS ARE NOT SWITCHED (FCT SW S1) INTO SERVO AMP UNTIL IGN 2).

SCS-2802A

THRUST VECTOR CONTROL



THRUST VECTOR CONTROL



P40 – SPS thrusting program

t_{ig} → t_B left

V_G left

V_m veh. accel so far

Sundisc program

TVC DAP

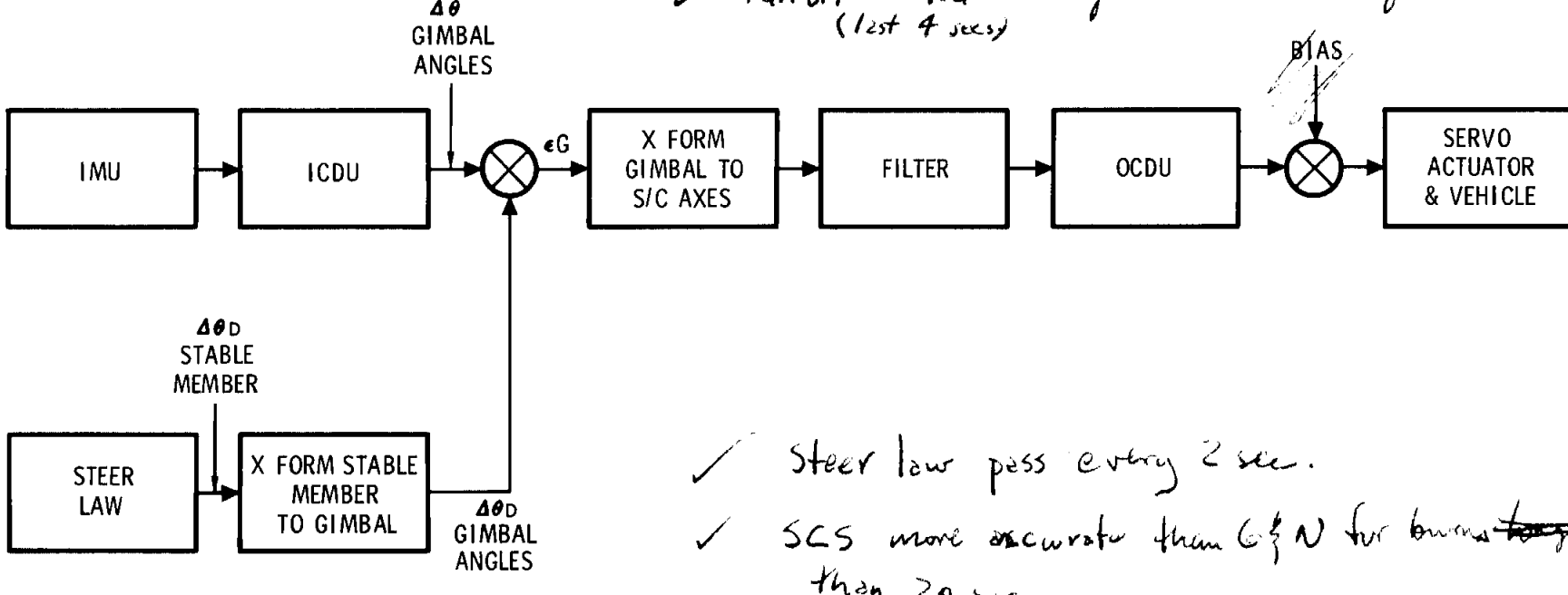
SIMPLIFIED BLOCK DIAGRAM

(*) ✓ No steering cmds until after 4 sec of burn

✓ If burn is less than 4 sec – no steering.

✓ No steering in last 4 sec --- cutoff based on predicted cutoff time.

✓ Tailoff added into eqns when .995 of ΔV achieved (last 4 secs)



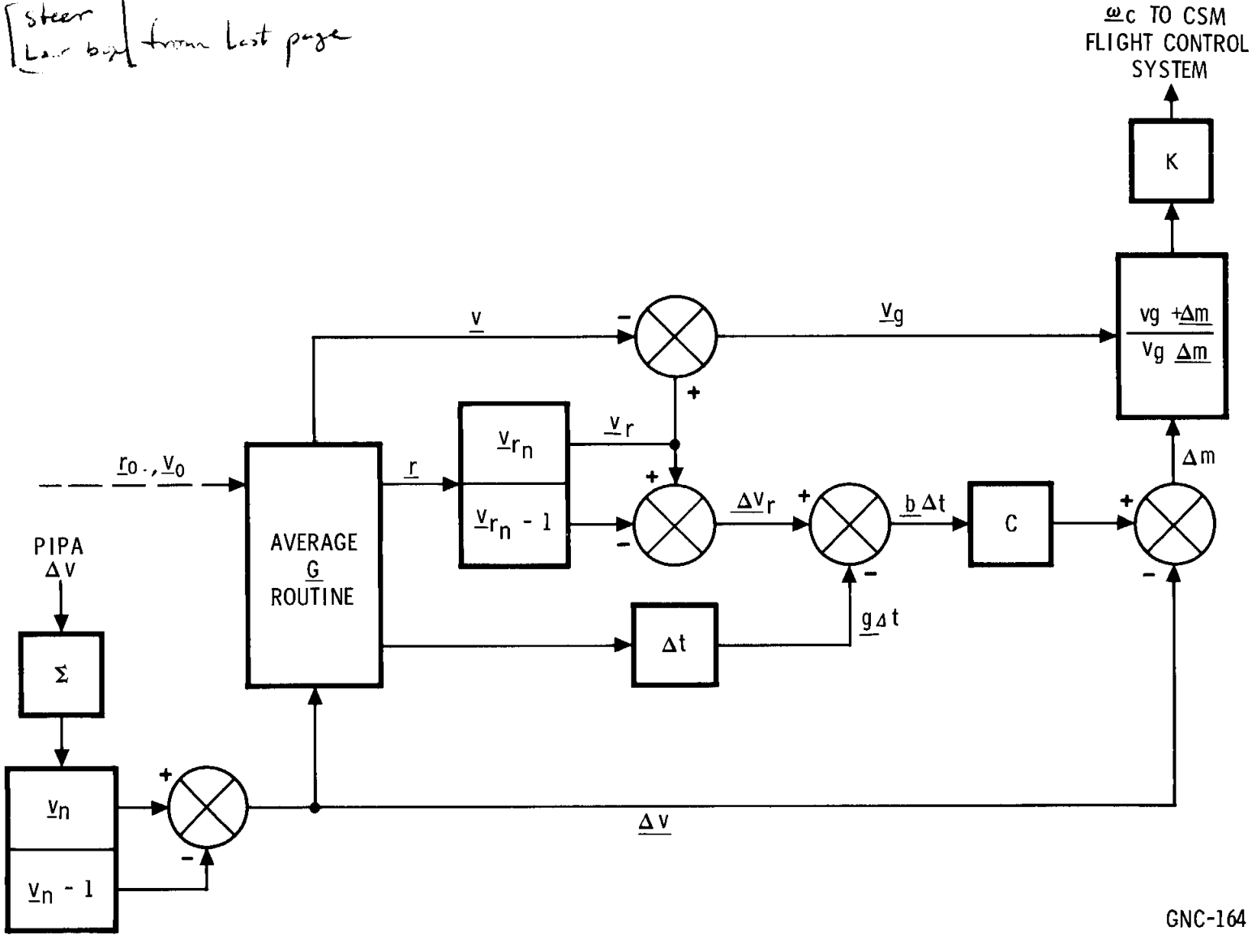
✓ Steer law pass every 2 sec.

✓ SCS more accurate than G&N for burns ~~less~~ shorter than 20 sec.

G&N only! can do a "straight" burn (fixed inert. $ curved burn) — SPS backup — TEI

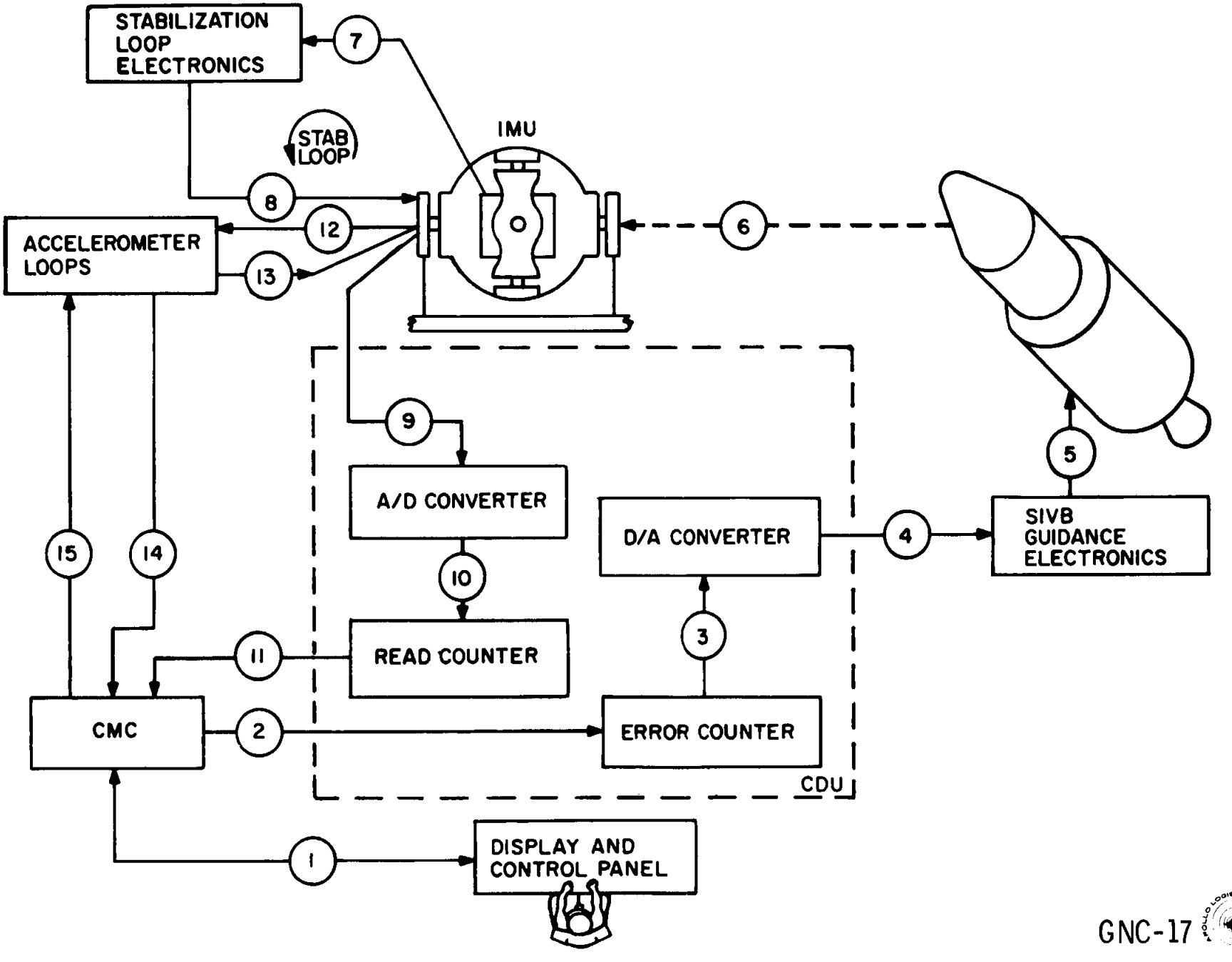
~~SCS~~ can't do the more efficient (fixed) curved burn

CMC POWERED FLIGHT STEERING BLOCK DIAGRAM

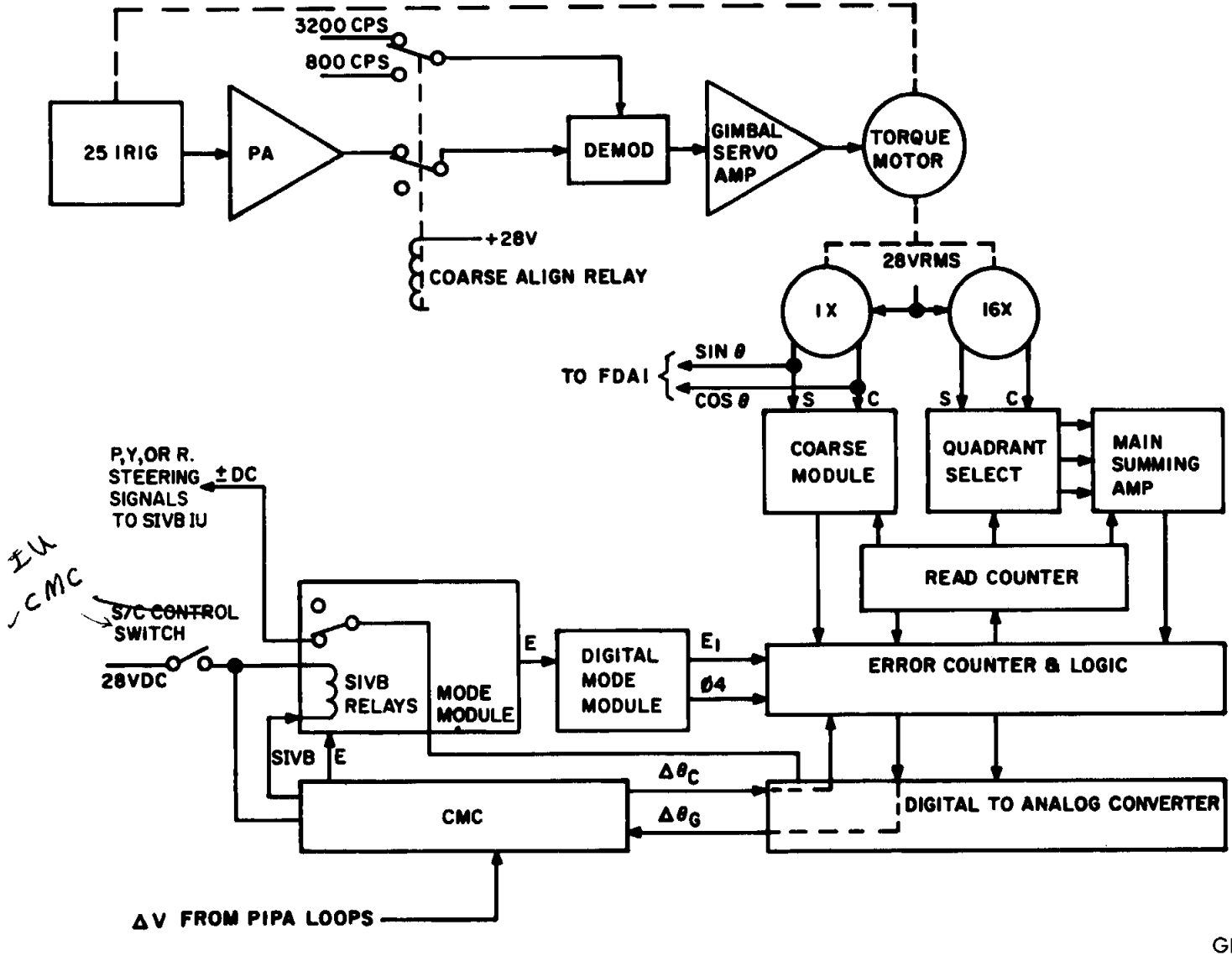


GNC-164

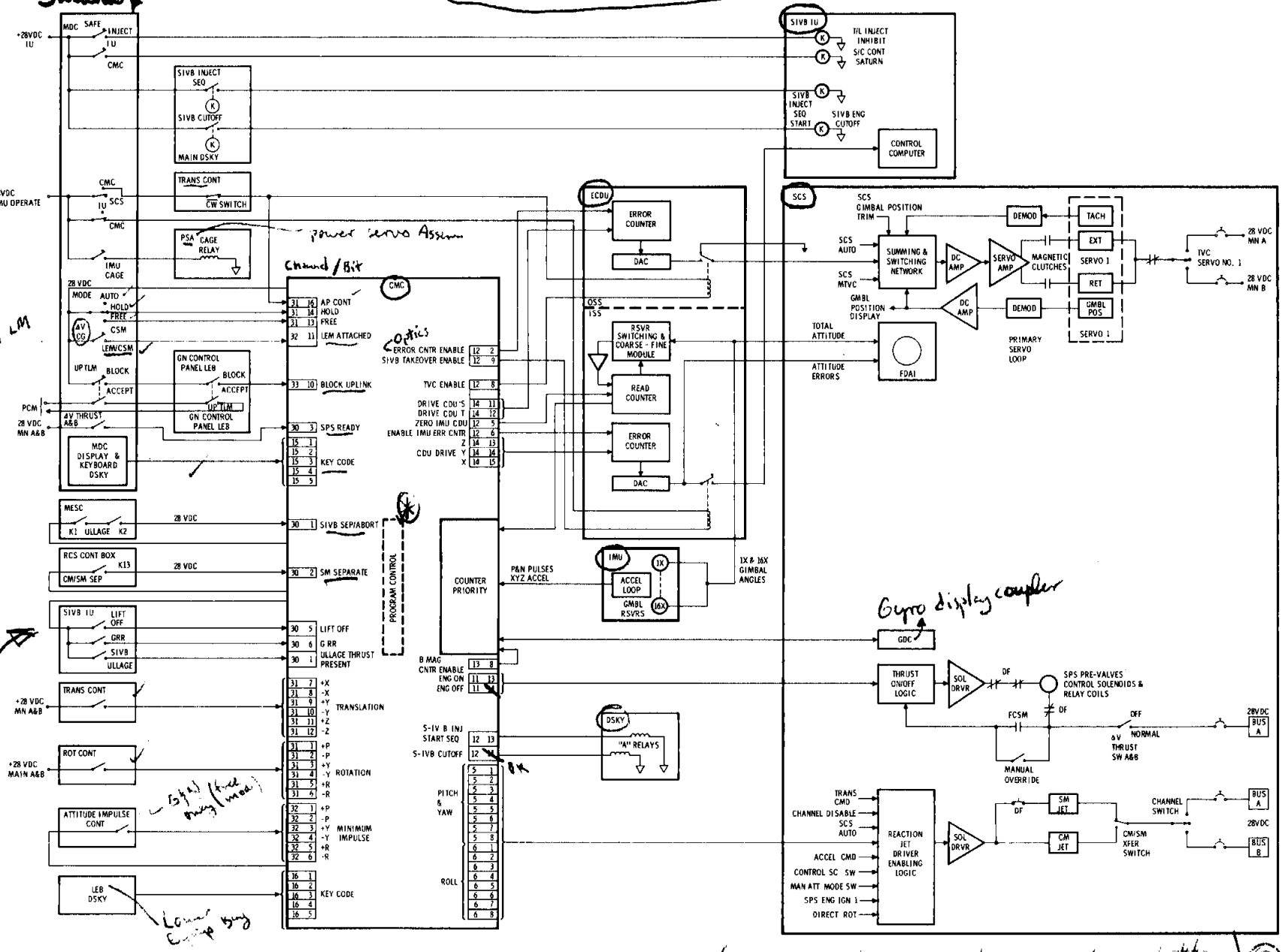
S/C CONTROL OF SATURN MODE



SIV B TAKEOVER



G&C FUNCTIONAL FLOW



with or without LM

for Lg

Gyro display coupler

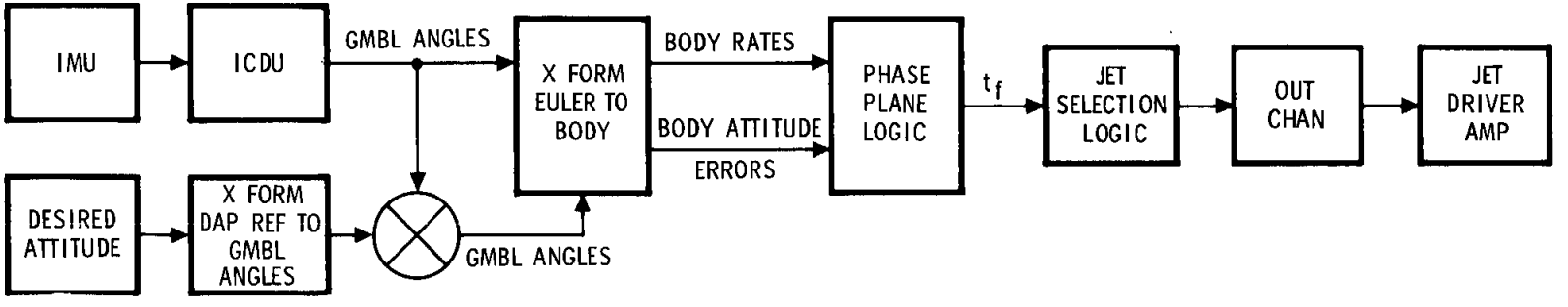
S/C platform goes inertial at IU Lift Off signal (L/V sends L.O. to computer & platform)

L/V platform goes inertial @ Lift

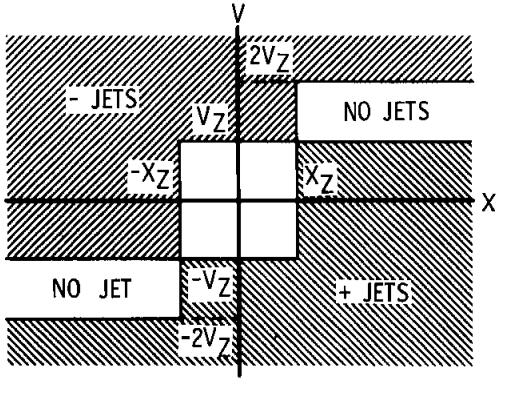
During Program 62 the Entry DAP is entered

SCS has rate damp
No att. hold.
(you can hold Lift vector with ROT control)
G;N has att hold

ENTRY DAP

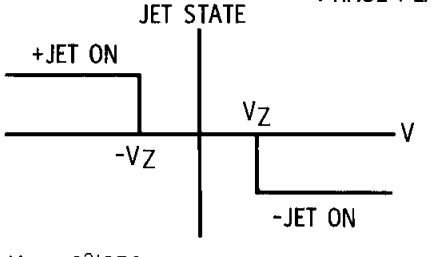


PHASE PLANE (EXTRA ATMOSPHERE)



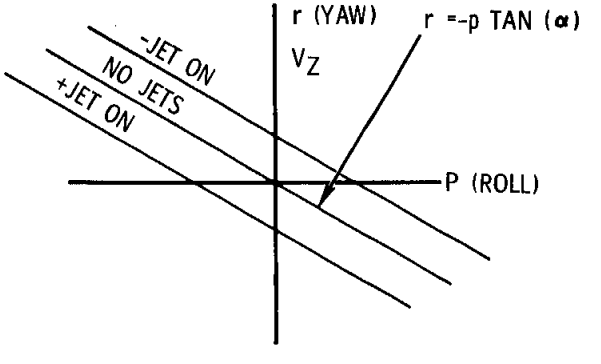
$X_Z = 3°$
$V_Z = 2°/SEC$
ATTITUDE CONTROL

PHASE PLANE (ATMOSPHERE)

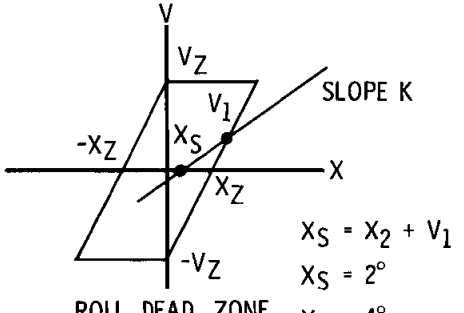


$V_Z = 2°/SEC$

PITCH RATE DAMPER



YAW RATE AUTO PILOT

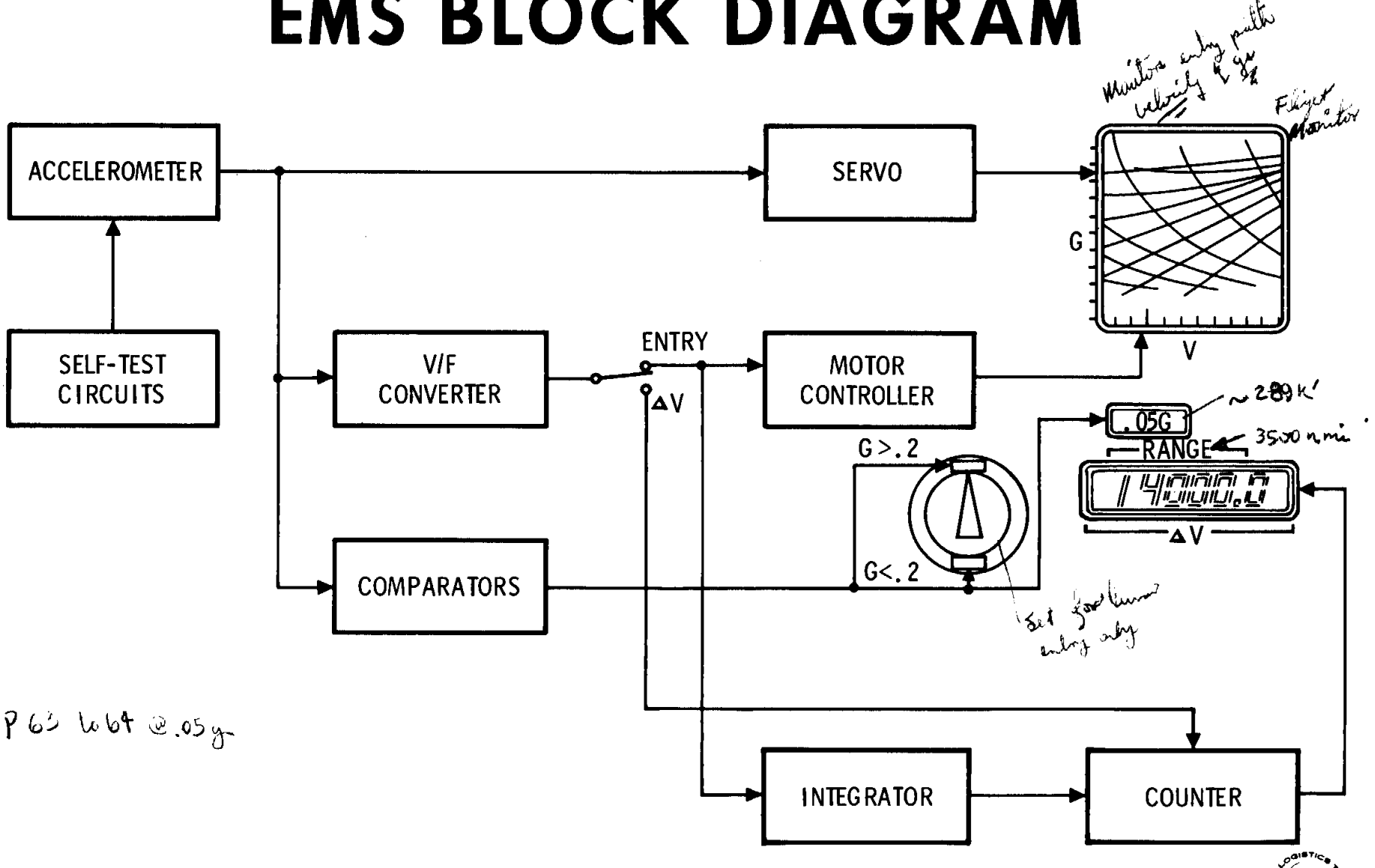


ROLL DEAD ZONE

$X_S = X_2 + V_1$
$X_S = 2°$
$X_Z = 4°$
$V_Z = 2°/SEC$

— Independent of G&N and SCS

EMS BLOCK DIAGRAM



P63 to 64 @ .05g

SCS-2205

EMS HOUSING FRONT PANEL

P40 Deorbit ΔV
P61 sep att.
P62 sep to UAF
P63

G_{max}
?
γ

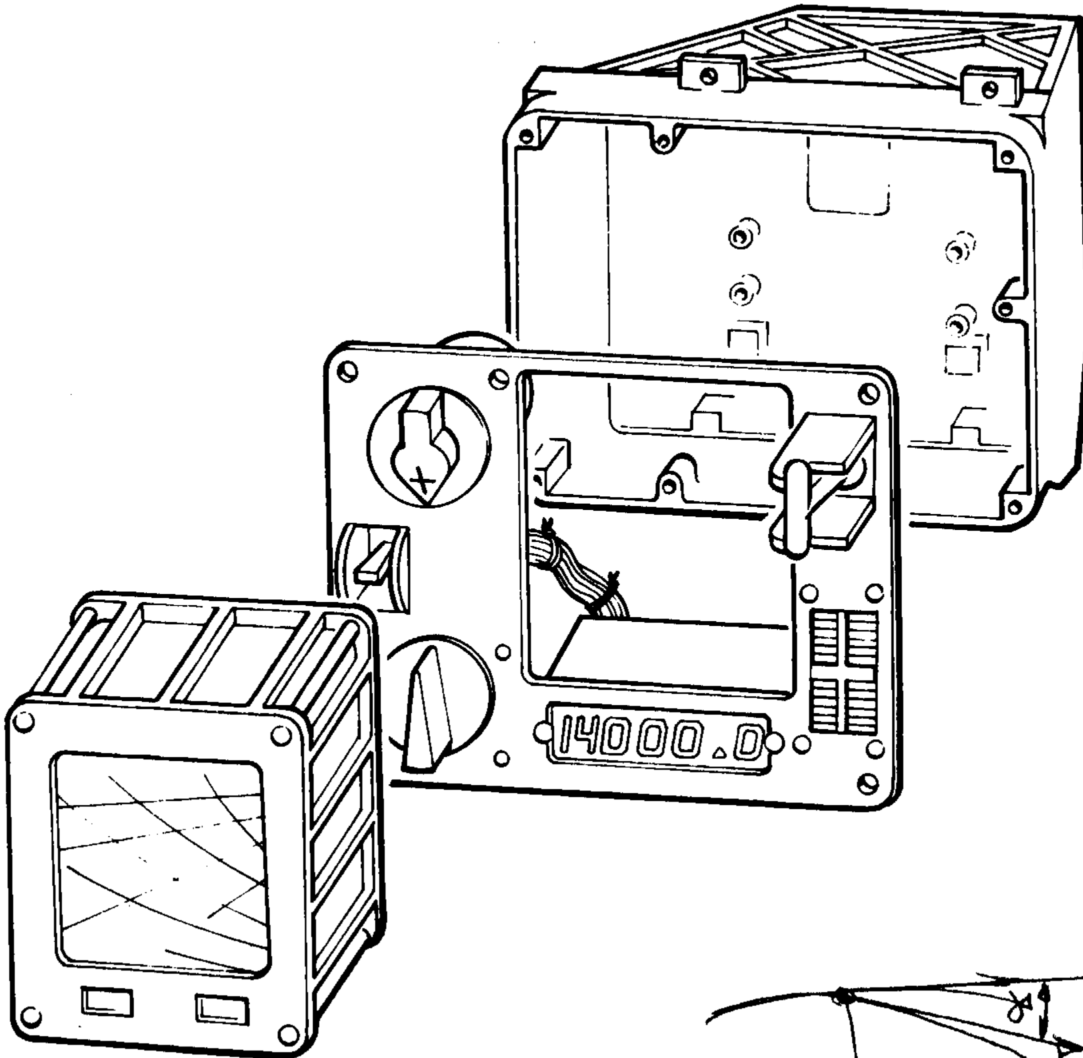
400K
$R_{TO GO}$
V_I
t_{to} .05 g

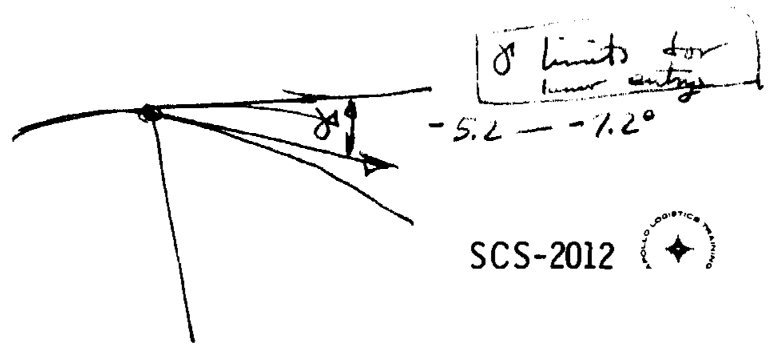
ψ
λ
lift vect. ...

G
V
$\dot{h}$

G_{max}
Known range
... range

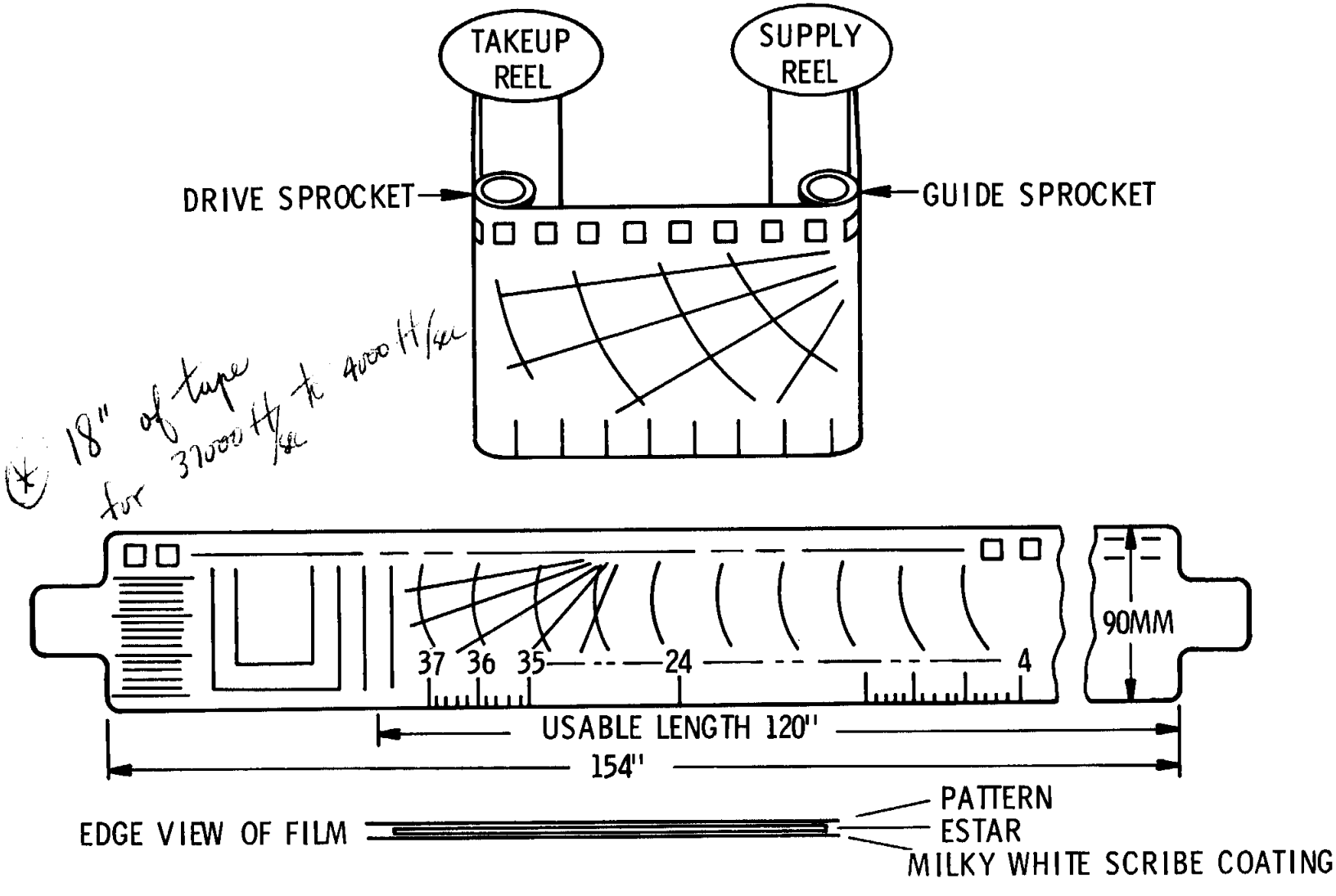
range to target
ψ ...
λ



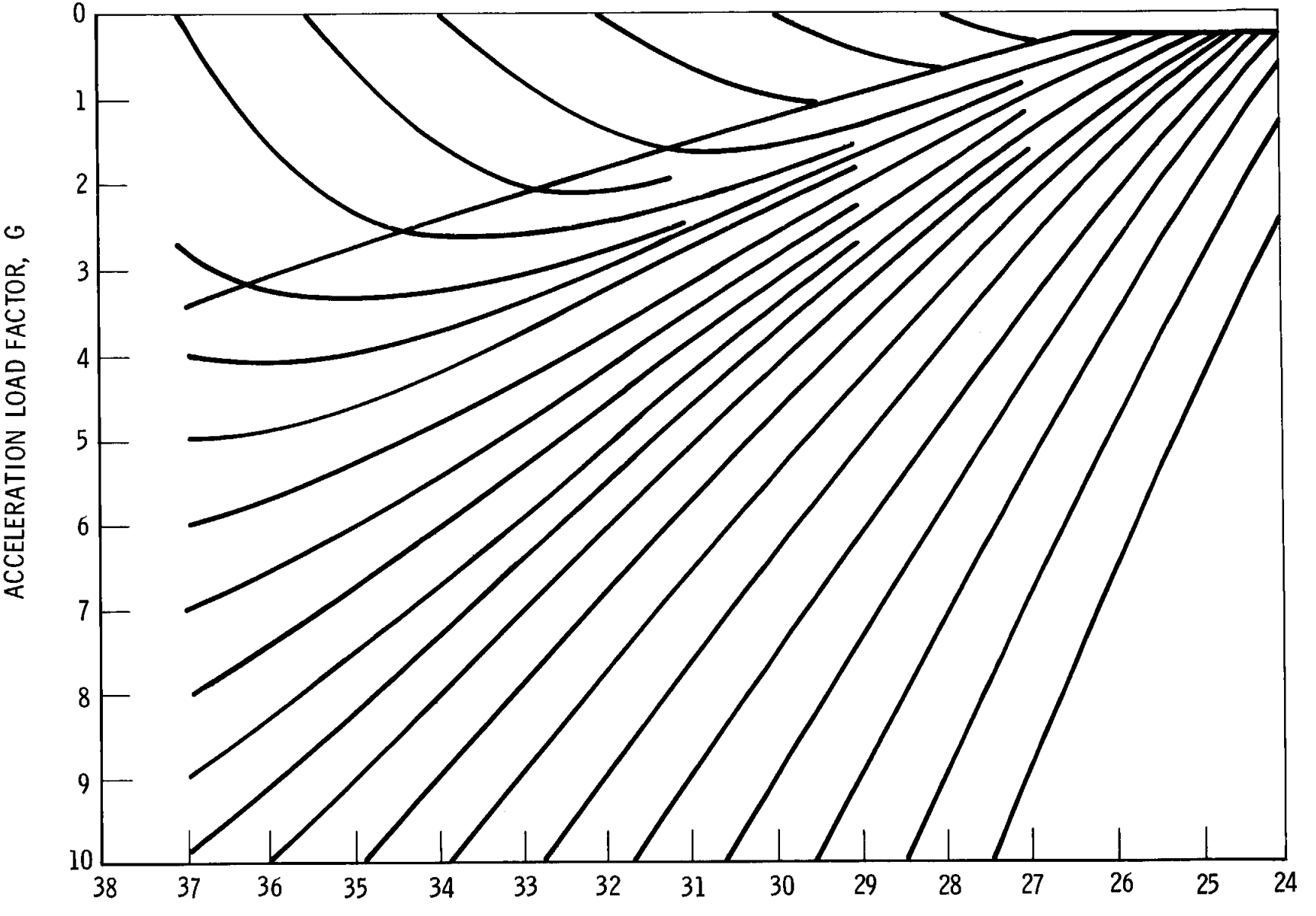


SCS-2012

EMS SCROLL & SCRIBE

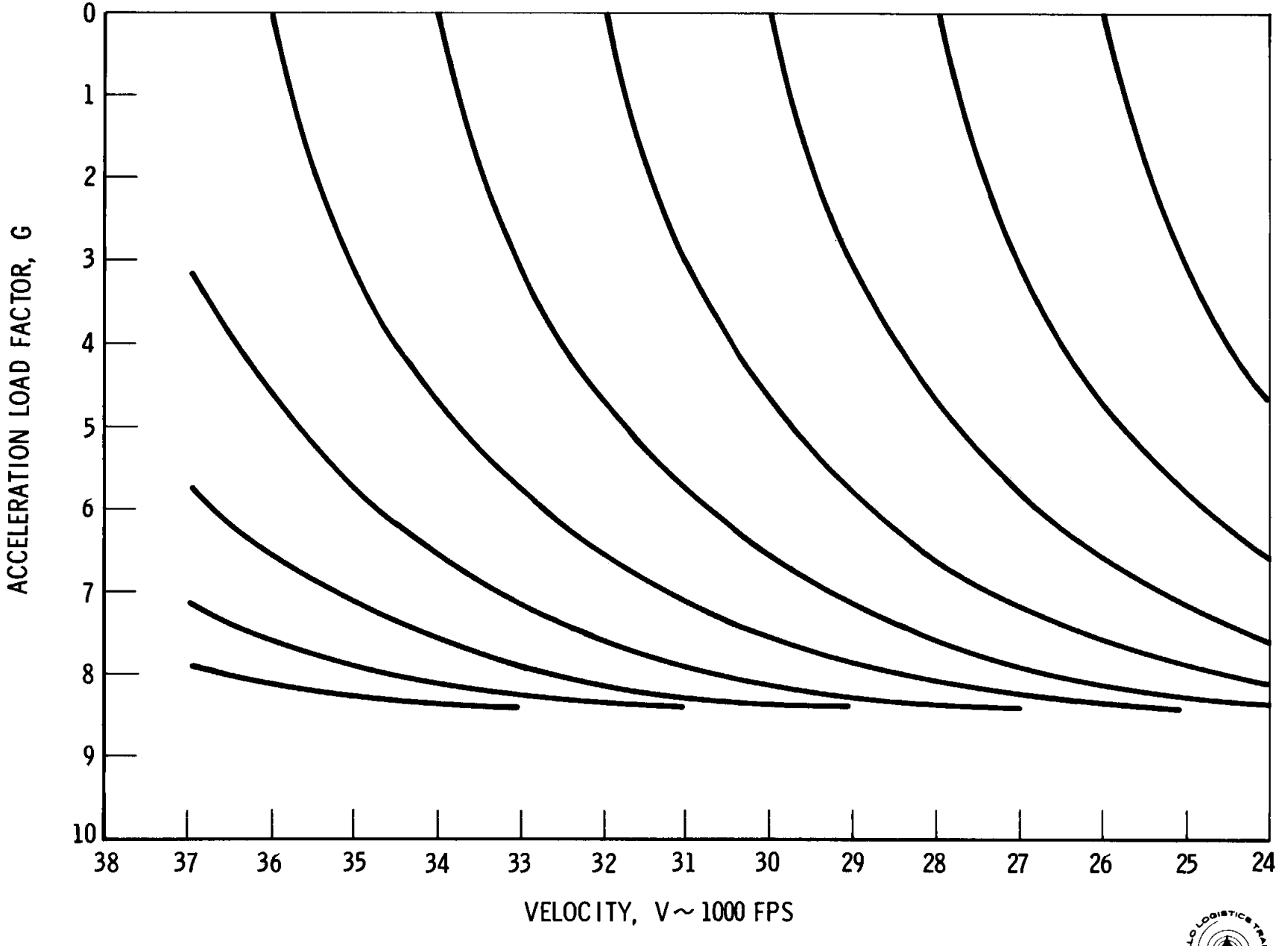


OFF-SET FLIGHT LIMITS

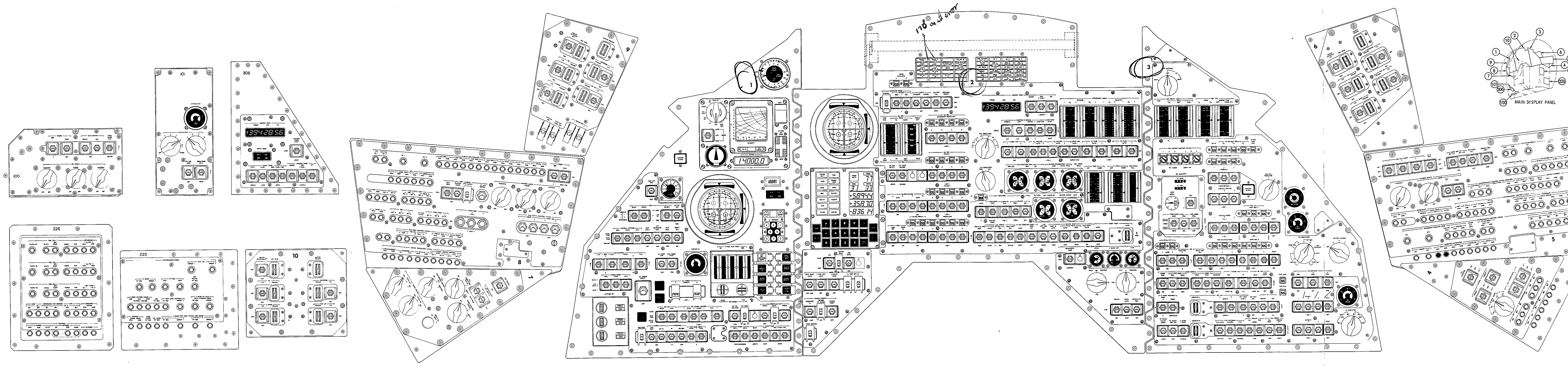


SCS-2309

ON-SET FLIGHT LIMITS

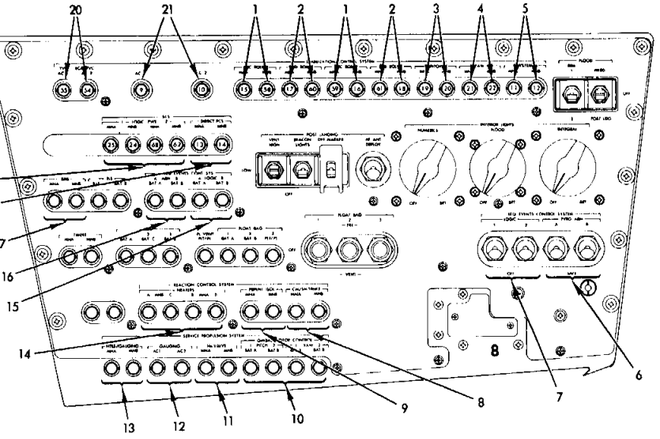


SCS-2312



100
226
225
306
10
8
9
5
MAIN DISPLAY PANEL
APOLLO LOGISTICS TRAINING

M-6300A



(11)

- SYS H_e VLV-2 SW → THRUST ON/OFF RELAY K2 & K3 CONTACTS OR DIRECT TO H_e ISOL VLV NO. 2 (BYPASSES K2 & K3) → SPS H_e ISOLATION VALVE NO. 2
- SPS H_e ISOLATION VLV NO. 2 POS SWITCH CONTACTS → SPS H_e TB NO. 2
- SPS H_e VLV-1 SW → THRUST ON/OFF RELAY K1 & K4 CONTACTS OR DIRECT TO H_e ISOL VLV NO. 1 (BYPASSES K1 & K4) → SPS H_e ISOLATION VALVE NO. 1
- H_e ISOLATION VLV NO. 1 POS SWITCH CONTACTS → SPS H_e TB NO. 1

(12)

- SPS GAUGING SW (PANEL 4) → SPS CONTROL BOX (K1, K2, K3, & K4 CONTACTS) → PUGS 115 VAC NORMAL & REDUNDANT CKTS

(13)

- SPS CONTROL BOX (K1 & K4 CONTACTS)
- SPS LINE HTRS SW (PANEL 3)
- SPS CONTROL BOX (K2 & K3 CONTACTS)
- SPS LINE HTRS SW (PANEL 3)

→ PUGS SYSTEM

(14)

- CB RCS-HEATERS-MNA-D → SM RCS HEATERS D SW (PANEL 2)
- CB RCS-HEATERS-MNA-B → SM RCS HEATERS B SW (PANEL 2)
- CM RCS HTR CKTRY A RELAY K15 & K17 CONTACTS
- CM RCS ENG DIRECT F & OX COILS → SYS A +P NO. 1, SYS A -P NO. 2, SYS A -Y NO. 8, SYS A +Y NO. 5, SYS A -R NO. 12, SYS A +R NO. 9

- CB RCS-HEATERS-MNB-C → SM RCS HEATERS C SW (PANEL 2)
- CB RCS-HEATERS-MNB-A → SM RCS HEATERS A SW (PANEL 2)
- CM RCS HTR CKTRY B RELAY K16 & K17 CONTACTS
- CM RCS ENG DIRECT F & OX COILS → SYS B +P NO. 3, SYS B -P NO. 4, SYS B -Y NO. 6, SYS B +Y NO. 7, SYS B -R NO. 10, SYS B +R NO. 11

(15)

- CB SECS-LOGIC A-BAT A → SECS LOGIC-1 SW
- CB SECS-LOGIC B-BAT B → SECS LOGIC-2 SW

(16)

BAT A → SECS A
BAT B → SECS B
SECS A, SECS B → XLATION CONT CCW SW'S (ABORT)

- CSM/LV SEP PB (PANEL 1) → SECS A & B (AUTO ARM OF RCS LATCH RELAY Z19)
- RCS CMD SW (PANEL 2) → SECS A & B (DIRECT ARM OF RCS LATCH RELAY Z19)
- SECS PYRO ARM-A & B SW (PANEL 8)
- CM RCS PRESS SW (PANEL 2)
- CM SM SEP SW (PANEL 9)

(17)

- EMS PANEL (SPS THRUST LT) → EMS INTERNAL PWR SUPPLIES

(18)

- DIRECT RCS (1513) AND
  - MNA (CB13) → ROT CONT NO. 1 DIRECT SW'S
  - MNB (CB14) → ROT CONT NO. 2 DIRECT SW'S

(19)

- LOGIC PWR 1 MNA (CB 25) → HAND CONT PWR (752); SECS A (RCS LATCHING RELAY CONTACTS) → CHANNEL ENABLE SW'S → RCS SOL DVR ENABLE
- LOGIC PWR 1 MNB (CB 24) → HAND CONT PWR (752)

- LOGIC PWR 2 MNA (CB 63) → CMC ATT (152), FDAI SEL (154), .05G (1551), GDC ALIGN (1537)
- LOGIC PWR 2 MNB (CB 62) → CMC ATT (152), FDAI SEL (154), .05G (1551), GDC ALIGN (1537)

THIS PWR IS DIODE COUPLED FROM CB'S DIRECTLY TO SWITCHES

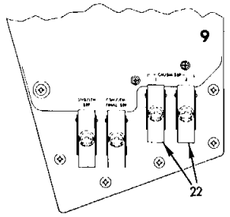
- LOGIC PWR 2 MNB (CB 62) → SECS B (RCS LATCHING RELAY CONTACTS) → CHANNEL ENABLE SW'S → RCS SOL DVR ENABLE

(20)

TVC SERVO POWER 1 (1758) & 2 (759) & SCS ELECT PWR SW 755

(21)

- BMAG PWR NO. 1 (756) - HAND CONTROL PWR (752) - SCS ELECT PWR (755) - SCS IND PWR (753) - TVC SVO PWR 2 (759)	- BMAG PWR NO. 2 (757) - HAND CONTROL PWR (752) - SCS ELECT PWR (755) - SCS IND PWR (753) - TVC SVO PWR 1 (758)

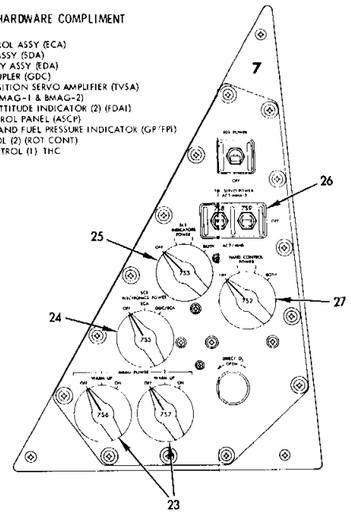


(22)

CM/SM SEP SW	ON	SAME FUNCTION AS CM RCS PRESS SW (PANEL 2) PLUS INITIATES SEPARATION SEQUENCE

SCS HARDWARE COMPLIMENT

ELECTRONIC CONTROL ASSY (ECA)
SOLENOID DRIVER ASSY (SDA)
ELECTRONIC DISPLAY ASSY (EDA)
GYRO DISPLAY COUPLER (GDC)
THRUST VECTOR POSITION SERVO AMPLIFIER (TVSA)
GYRO ASSY'S (2) (BMAG-1 & BMAG-2)
FLIGHT DIRECTOR ATTITUDE INDICATOR (2) (FDAI)
ATTITUDE SET CONTROL PANEL (ASCP)
GIMBAL POSITION AND FUEL PRESSURE INDICATOR (GP'FPI)
ROTATION CONTROL (2) (ROT CONT)
TRANSLATION CONTROL (1) THC



(23)

- AC 2 (CB 10), MNB (CB 12), SYSTEM-MNB (CB 12) → ON / WARM UP → GYRO ASSY NO. 2
- PANEL 8 CB'S
- AC 1 (CB 9), MNA (CB 11), SYSTEM-MNA (CB 11) → ON / WARM UP → GYRO ASSY NO. 1

NOTE: KEEP BMAG PWR SW'S AT WARM UP UNTIL BMAG TEMP LTS (PANEL 2) ARE OUT = (NO INTERLOCK TO KEEP MOTORS FROM SPINNING UP AND DAMAGING GYRO'S

C/W CB MNA &/OR MNB ON PANELS 5 ARE CLOSED

(24)

ECA → ECA/TVC AC 2 (CB 54), AC 1 (CB 9), SYSTEM MNA (CB 11), SYSTEM MNB (CB 12)

- ECA 400 ~ / 28 VDC → ROT CONT XDUCER NO. 2, ROT CONT XDUCER NO. 1
- GDC
- ECA 400 ~ → ROT CONT XDUCER NO. 2, ROT CONT XDUCER NO. 2
- GDC 28V, ECA 28V
- GDC 28V, ECA 28V

AC 1 (CB 9), AC 2 (CB 10), ECA/TVC AC 2 (CB 54), AC 1 (CB 9), SYSTEM MNA (CB 11), SYSTEM MNB (CB 12)

GDC/ECA

PANEL 8 CB'S

(25)

PANEL 8 CB'S → AC 1 (CB 9) MNA (CB 11); AC 2 (CB 10) MNB (CB 12); AC 1 (CB 9), AC 2 (CB 10), MNA (CB 11), MNB (CB 12) → 1 / 2 / BOTH → TO EDA

(26)

PANEL 8 CB'S → 758 - UP - (CB 55) & (CB 11), DN - (CB 10) & (CB 12); 759 - UP - (CB 9) & (CB 11), DN - (CB 54) & (CB 12) → AC2/MNB, AC1/MNA

- SERVO AMP PRIM TVP & TVY → QUIESCENT CURRENT TO NO. 1 CLUTCH
- SERVO AMP SEC) TVP & TVY → QUIESCENT CURRENT TO NO. 2 CLUTCH

(27)

PANEL 8 CB'S → AC 1 (CB 9), SYSTEM MNA (CB 11), LOGIC PWR 1 MNA (CB 25), LOGIC PWR 1 MNB (CB 24); AC 2 (CB 10), SYSTEM MNB (CB 12), LOGIC PWR 1 MNA (CB 25), LOGIC PWR 1 MNB (CB 24); AC 1 (CB 9), AC 2 (CB 10), SYSTEM MNA (CB 11), SYSTEM MNB (CB 12), LOGIC PWR 1 MNA (CB 25), LOGIC PWR 1 MNB (CB 24) → 1 / 2 / BOTH

- TO 1, 3, 5
- TO 2,4,5
- TO 1, 2, 3, 4, 5

1. AC 1 (CB 9) → EDA (SIG COND), RJ ENG (ON/OFF), TWO -4V BIAS
2. AC 2 (CB 10) → RJ ENG (ON/OFF), TWO -4V BIAS
3. SYSTEM MNA (CB 11) → ROT CONT NO. 1 B.O. SW'S, CM/SM TRANS SW'S (MTR DRIVEN) → XLATION CONT
4. SYSTEM MNB (CB 12) → ROT CONT NO. 2 B.O. SW'S, CM/SM TRANS SW'S (MTR DRIVEN) → XLATION CONT
5. LOGIC PWR 1 MNA (CB 25), LOGIC PWR 1 MNB (CB 24) →
   - CMC ATT (152), FDAI SEL (154), .05G (1551), DIRECT ULLAGE (1524), FDAI SCALE (153), FDAI SOURCE (155), ATT SET (156)
   - MANUAL ATTITUDE → ROLL (157), PITCH (158), YAW (159)
   - LIMIT CYCLE (1510), ATT DEADBAND (1511), RATE (1512), S/C CONT (1518)
   - BMAG MODE → ROLL (1520), PITCH (1521), YAW (1522)
   - THRUST ON PB (1525)
   - TVC GMBL DRIVE → PITCH (1527), YAW (1528)
   - SPS TVC → PITCH (1538), YAW (1539)
   - ENTRY EMS ROLL (1550), ΔV CG (1554)

GUIDANCE AND CONTROL FUNCTIONAL SWITCHING DIAGRAM (SHEET 1 OF 4)

SCS-3008

(1)

GIMBAL MOTOR CONTROL PITCH 1 & 2 & YAW - 1 & 2 SW (1540) (1541) (1542) (1543) NOTE - MOTORS ARE STARTED BY SETTING SWITCHES TO START (MOMENTARILY), AND THEN TO ON AT ≈ 1 SEC INTERVALS	OFF	GIMBAL MOTORS DEACTIVATED
	START	MOMENTARY POSITION - APPLIES POWER TO MOTOR DRIVEN SWITCH WHICH DRIVES CONTACTS CLOSED AND IN TURN CONNECTS POWER THROUGH CONTACTS FROM MNA & B TO MOTORS. SETS UP OVERCURRENT SENSING CIRCUITS
	ON	NORMAL POSITION (MOTORS RUNNING). ALLOWS MOTORS TO CONTINUE RUNNING AND MONITOR FOR OVERCURRENT

(2)

CM RCS PRESS SW		CAUSE CM RCS He SQUIB ISOLATION VALVES TO FIRE
	ON	ENERGIZES RELAYS IN SECS WHICH DIRECT POWER THROUGH ITS RELAY CONTACTS FROM SECS PYRO BUS A & B TO THE H_e SQUIBS. PYRO BUS A WILL FIRE ONE SYSTEM A AND ONE SYSTEM B SQUIB. PYRO BUS B WILL ALSO FIRE ONE SYSTEM A AND ONE SYSTEM B SQUIB

(3)

ABORT SYSTEM—OXID DUMP AUTO/RCS CMD SW	OXID DUMP AUTO	NORMALLY SET AT THIS POSITION TILL AFTER LAUNCH T + 42 SEC. ALLOWS AUTO OX DUMP IF MISSION ABORT
	RCS CMD (AUTO)	SET AT T + 42 SEC. ALLOWS AUTO ENABLING OF RCS LATCHING RELAY Z19 (SECS)

(4)

CM RCS HE DUMP PB	PRESSED	BACKS-UP AND INITIATES HE PURGE SEQUENCE

(5)

LV - XLUNAR SW	INJECT	FIRES S-IVB FOR SECOND IGNITION AFTER EARTH ORBIT INSERTION
	SAFE	INHIBITS SECOND IGNITION OF S-IVB STAGE. NORMALLY SET TO SAFE 7 MINUTES PRIOR TO IGNITION

(6)

LV-SII/S-IVB SW	ON	SHUTS DOWN S-II STAGE AND FIRES S-IVB STAGE DURING ASCENT

(7)

LV - GUIDANCE SW	IU	NORMAL LAUNCH POSITION. LAUNCH VEHICLE GUIDANCE CONTROL THROUGH INSTRUMENT UNIT
	CMC	ALLOW MANUAL GUIDANCE OVERRIDE OF LAUNCH VEHICLE THROUGH INSTRUMENT UNIT

(8)

CM PROP JETT PURGE SW	ON	INITIATES PROPELLANT PURGE SEQUENCE

(9)

CM PROP JETT DUMP SW	ON	INITIATES PROPELLANT DUMP & BURN SEQUENCE

(10)

CM PROP JETT LOGIC SW	ON POWERS	• CM PROP JETT DUMP SW • CM RCS HEATERS SW • CIRCUITRY FOR RCS TRANSFER SWITCH MOTORS FOR ABORTS & SEP SEQUENCES

(11)

FCSM - SPS A & B SW (1561) (1562)	ENABLES OR OVERRIDES FCSM FOR MONITORING ROUGH SPS COMBUSTION. IF ΔV THRUST - A SWITCH IS SET ON, THEN FCSM - SPS A SWITCH IS USED AND FCSM - SPS B SWITCH IS LEFT AT RESET/OVERRIDE AND VISE VERSA

(12)

ΔV CG SW (S54)		TVC (LEM ON OR OFF)
	CSM	NORMAL CSM TVC
	LEM/CSM	ENGAGES BODY BENDING FILTERS IN TVC SIGNAL FLOW PATH

(13)

TVC GMBL DRIVE SW PITCH (S27) YAW (S28)	1	SELECTS GMBL SERVO DRIVE NO. 1 BUT ALLOWS NO AUTO SWITCH FUNCTION
	AUTO	SELECTS GMBL SERVO DRIVE ELECTRONICS NO. 1 AND ALLOWS AUTO SWITCH FROM GMBL DRIVE NO. 1 TO GMBL DRIVE NO. 2, IF OVER CURRENT SENSING, NO. 1 OFF, OR THC-CW
	2	SELECTS GMBL SERVO DRIVE ELECTRONICS NO. 2 BUT ALLOWS NO AUTO SWITCH FUNCTION

(14)

LV/SPS IND (S53)	SII/SIVB	SELECTS SII/S-IVB FUEL TANK PRESS IND'S
	GPI	ENABLES GPI DISPLAY OF GIMBAL ACTUATOR POSITION

(15)

NORMALLY SW FROM α TO PC AT LAUNCH TWR JETT

(16)

SPS TVC PITCH (S38) YAW (S39)	AUTO	NORMAL AUTO TVC
	RATE CMD	MAN TVC WITH RATE DAMPING
	ACCEL CMD	MAN TVC WITH NO RATE DAMPING

(17)

ENTRY .05 G (S51)	(CONFIGURES SCS FOR ENTRY)
	1. ALL BMAGS CAGED (RATE INFO ONLY) 2. R TO Y COUPLING (Y CHAN) 3. R TO Y COUPLING ENGAGE IN DEA (Y CHAN) 4. ATT HOLD DISABLED • RATE DAMPING • MANUAL CONTROL } ONLY 5. IN GDC • PITCH CHAN DISABLED • STABILITY ROLL ATT CHANGES COMPUTED IN R & Y CHAN'S • YAW CHAN SUPPLIES STABILITY ROLL ATT TO RSI ON EMS • ROLL CHAN SUPPLIES STABILITY ROLL ATT INFO TO FDAI SELECTED (ROLL ONLY)

(18) ENABLES ROLL STABILITY INDICATOR ON EMS PANEL SEE (35)

(19) [SETS CAGE RELAY IN POWER SERVO ASSY (PSA)] ELECTRONICALLY CAGES (TORQUES IMU GIMBALS TO NULL).

(20)

GDC ALIGN (S37)	USED WITH S4,S5,S6 AND ATT SET DIALS TO ALIGN TO A IMU, OR OTHER DESIRED REFERENCE

(21)

ATT SET PANEL	USED WITH S4, S5, S6 & S37 TO ALIGN GDC OR TO DISPLAY FLY-TO CMDS ON ATT ERR NEEDLES

(22) PROVIDES SPS IGNITION WHEN IN SCS. THRUST ON LT. ON EMS PANEL

(23) POWERS RCS DIRECT COILS FOR ULLAGE

(24)

ΔV THRUST DIRECT SW	THRUST	= (S23 - DIRECT) • (S26 • / + S59 - NORMAL)

(25)

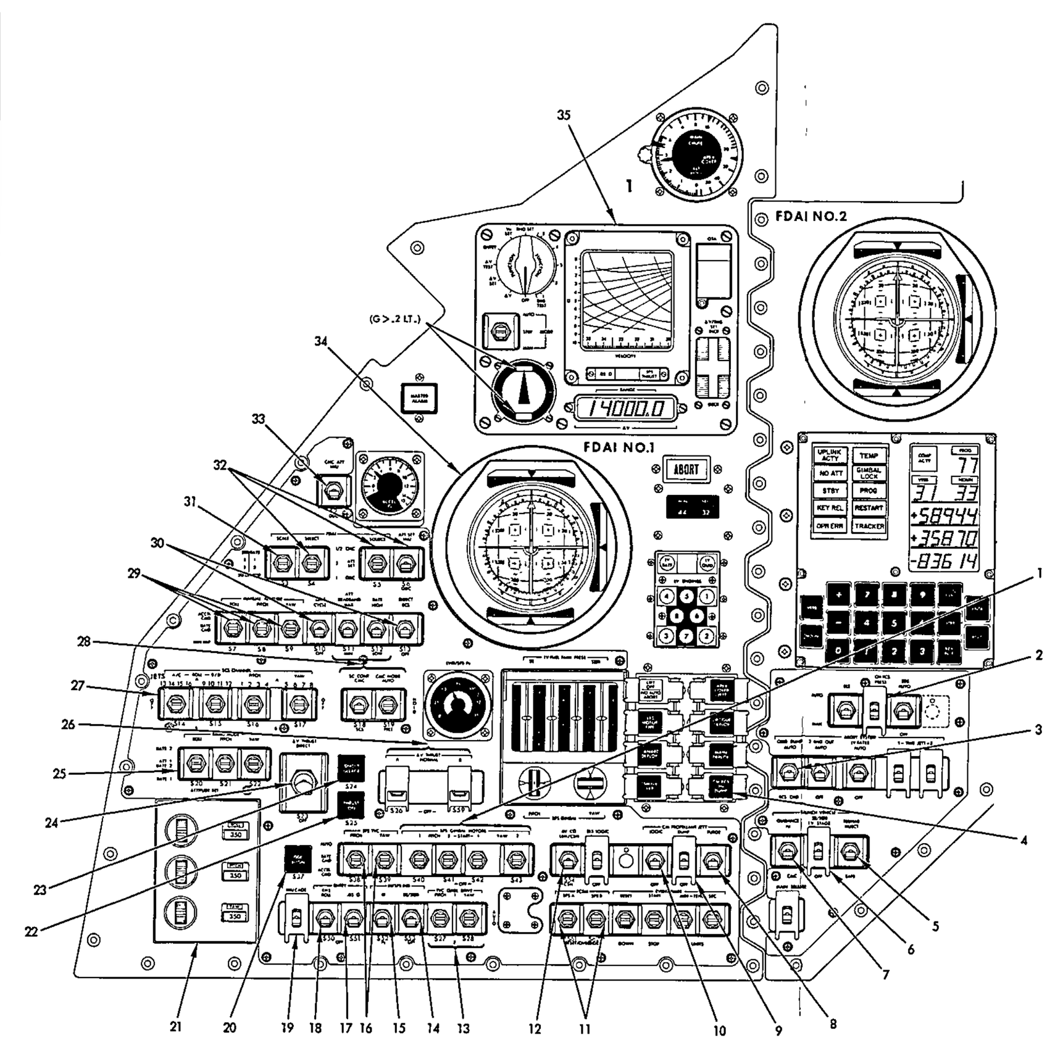
BMAG MODE ROLL (S20) PITCH (S21) YAW (S22)		PERMIT ALTERNATE SELECTION OF RATE AND/OR ATTITUDE SENSORS
	RATE 2	BMAG 2 USED AS SOURCE OF RATE FOR DISPLAY & S/C CONTROL. BMAG 1 IS CAGED BUT IS NOT USED. (RATE DAMPING ONLY OR PROP RATE CMD) IF MAN ATT SW'S IN RATE CMD.
	ATT 1 RATE 2	NORMAL OPERATING POSITION. RATE FROM BMAG -2 (NORMAL RATE SOURCE) AND ATT ERROR FROM BMAG - 1 AUTO TVC & DISPLAYS
	RATE 1	BMAG -1 CAGED FOR B/U RATE IN DESIRED CHANNEL. NO ATT HOLD FOR SELECTED CHANNEL(S). PROVIDES • RATE DAMPING • PROP RATE CMDS • RATES FOR DISPLAY • INPUT TO GDC TO COMPUTE TOTAL ATT

(26)

V THRUST A & B SW (1526) (1559) NOTE - EITHER A OR B SWITCH IS SET TO ON FOR THRUSTING, NOT BOTH. A & B = DC PWR SOURCE FOR PRIM AND SEC THRUST ON-OFF LOGIC	• SUPPLIES (SPS READY) DISCRETE TO CMC FOR TVC • POWER TO FCSM SWITCHES & ELECTRONICS (IF SELECTED) • ENABLES THRUST ON/OFF LOGIC (NORMAL) • USED WITH DIRECT THRUST-SWITCH 1S23 FOR DIRECT SPS IGNITION • ENERGIZES INJECTOR PREVALVES • SUPPLIES POWER TO TWO ENGINE SOLENOID CONTROL VALVES

(27)

SCS CHANNEL S14, S15, S16, S17	ENABLES RCS JETS (AUTO COILS). ALL ARE COMMON TO BOTH CMC OR SCS CONTROL



(28)

ATT DEADBAND (S11)		CONTROLS ATTITUDE DEADBAND EXCURSION
RATE (S12)		AFFECTS ATT DEADBANDS AND SETS AUTO RATE LIMITS. CONTROLS MAX PROPORTIONAL RATES AVAILABLE FROM ROT CONT WITH S/C UNDER SCS CONTROL
SC CONT (S18)		DETERMINES WHETHER CMC OR SCS IS IN CONTROL OF S/C
	CMC	CMC (THC-CW) • (S7, S8, S9 - $\overline{\text{ACCEL CMD}}$)
	SCS	(S7, S8, S9 - $\overline{\text{ACCEL CMD}}$)
CMC MODE (S19)		SELECTS MODE OF OPERATION FOR THE CMC. FOR THIS SWITCH TO FUNCTION, (S18) MUST BE AT CMC. CMC MODE = (S19) • (S18 - CMC) • [(THC - $\overline{\text{CW}}$) • (S7, S8, S9 - $\overline{\text{ACCEL CMD}}$)]
	AUTO	PROVIDES CONTROL BY COMPUTER PROGRAM PLUS DSKY ENTRY FOR MANEUVER RATES, TVC PROGRAMS, OR OTHER CAPABILITIES PROGRAMMED IN THE COMPUTER
	HOLD	CONFIGURES CMC IN ATT HOLD CONFIGURATION. MAINTAINS ERROR & RATE DEADBANDS WITH CSS COMMAND CAPABILITY. CSS COMMANDS ARE INPUTTED TO COMPUTER, COMPUTER THEN COMMANDS ATTITUDE CHANGES.
	FREE	PREVENTS COMPUTER FROM GENERATING COMMANDS. ALLOWS NO ATT HOLD BUT ALLOWS CONTROL OF A DRIFT RATE. ENABLES (MIN IMP CONT) • (XLATION CONT) • (ROT CONT) TO COMMAND DISCRETES TO CMC FOR RCS ACCEL CMDS.

ERROR AND RATE DEADBAND CONTROL
(S11, S12, S18)

ERROR DB (AUTO CONTROL)	
MAX-LOW RATE	±5 0° (S18 - SCS) • (S11 - MAX) • (S12 - LOW)
MIN-LOW RATE	±0.5° (S18 - SCS) • (S11 - MIN) • (S12 - LOW)
MAX-HIGH RATE	±8 0° (S18-SCS) • (S11-MAX) • (S12-HIGH)
MIN-HIGH RATE	±4 0° (S18 - SCS) • (S11 - MIN) • (S12 - HIGH)
RATE DB (AUTO CONTROL)	
S12-HIGH	R, P, Y = ±2 0°/SEC
S12-LOW	R, P, Y = ±0.2°/SEC
ROT CONT MAX PROPORTIONAL COMMANDED RATES	
(S18 - SCS) • (S7 + S8 + S9 + ALL - RATE CMD) THEN	
S12-HIGH	R = 20°/SEC P & Y = 7°/SEC
S12-LOW	R, P & Y = 0.65°/SEC

(29)

MANUAL ATTITUDE ROLL (S7) PITCH (S8) YAW (S9)	ACCEL CMD	FREE DRIFT WITH ACCEL CMD CAPABILITY THROUGH ROT CONT B.O. SW'S.
	RATE CMD	RATE DAMPING, PROPORTIONAL RATE AND ATTITUDE HOLD
	MIN IMP	FREE DRIFT WITH MIN IMP CAPABILITY THROUGH ROT CONT B.O. SW'S

(30)

LIMIT CYCLE (S10)	SWITCHES IN PSEUDO RATE FEEDBACK IN ACS. (SCS MODES ONLY)
DIRECT RCS (S13)	APPLIES 28 VDC TO DIRECT SWS IN ROT. CONT.

(31)

FDAI SCALE (S3)		SETS FDAI ERROR AND RATE FULL SCALE DEFLECTION
ERR	RATE	FULL SCALE DEFLECTION
5	1	[ERROR 5°, RATE 1°/SEC] (R, P, Y)
5	5	[ERROR 5°, RATE 5°/SEC] (R, P, Y)
50/15	50/10	[ERROR 50° (R), ERROR 15° (P, Y)] [RATE 50°/SEC (R), RATE 10°/SEC (P, Y)]

(32)

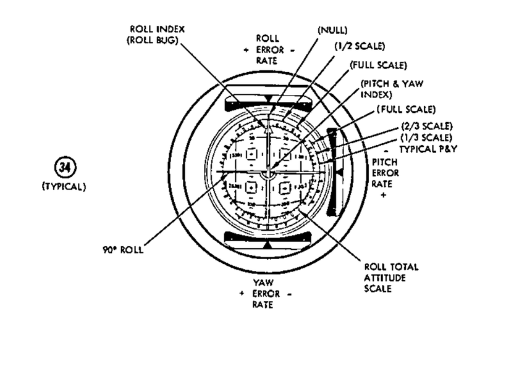
SWITCH	SWITCH POSITION	FDAI SELECTED	BALL (SIGNAL SOURCE)	ERROR (SIGNAL SOURCE)	RATE (SIGNAL SOURCE)
FDAI SELECT (S4) DETERMINES WHETHER FDAI NO. 1, NO. 2, OR BOTH WILL DISPLAY SELECTED INPUTS. NOTE WHEN THIS SWITCH (S4) IS AT 1/2 POSITION, (S5) & (S6) WILL NOT FUNCTION FOR DISPLAY SWITCHING FUNCTIONS	1/2	1 • 2	IMU / GDC	CMC (CDU) / BMAG - 1	BMAG - 2 (NORM) / BMAG - 1 (BUR)
	2	2 (ONLY)	IMU + ATT SET + GDC } SELECTED BY S5, S6	CMC + ATT SET + BMAG -1	BMAG -2 (NORM) + BMAG - 1 (BUR)
	1	1 (ONLY)	IMU + ATT SET + GDC } SELECTED BY S5, S6	CMC + ATT SET + BMAG -1	BMAG - 2 (NORM) + BMAG - 1 (BUR)
FDAI SOURCE (S5) SELECTS FDAI DISPLAY INPUT SIGNAL SOURCE. HAS NO ACTIVE DISPLAY FUNCTION WHEN (S4) IS AT 1/2 POSITION. NOTE WHEN AT CMC POSITION, BOTH ERROR & TOTAL ATTITUDE INFO IS DERIVED FROM G&N SYSTEM.	CMC	1 + 2	IMU	(CMC (PROGRAM)	BMAG -2 (NORM) + BMAG - 1 (BUR)
	ATT SET	1 + 2	IMU [S6 - IMU] • [S4 - 1 + 2] + GDC [S6 - GDC] • [S4 - 1 + 2]	IMU/ATT SET - DIFF [S6 - IMU] • [S4 - 1 + 2] GDC/ATT SET - DIFF [S6 - GDC] • [S4 - 1 + 2]	BMAG - 2 (NORM) + BMAG -1 (BUR)
	GDC	1 + 2	GDC	BMAG -1	BMAG - 2 (NORM) + BMAG -1 (BUR)
ATT SET (S6) USED TO ALIGN FDAI'S TO EITHER IMU REF OR GDC REF IN CONJUNCTION WITH ATT SET DIALS. NOTE FUNCTIONS FOR ERROR NEEDLE DISPLAY WHEN [S5 - ATT SET] • [S4 - 1 + 2]	IMU	1 + 2	IMU	DIFFERENCE ATT SET CONT RSLVR / IMU GIMBAL ANGLES	BMAG - 2 (NORM) + BMAG - 1 (BUR)
	GDC	1 + 2	GDC	DIFFERENCE ATT SET CONT RSLVR / GDC TOTAL ANGLE RSLVR	BMAG - 2 (NORM + BMAG - 1 (BUR)

(33)

CMC ATT (S2) (SET TO GDC ONLY IF IMU FAILS EXCEPT DURING ENTRY)	IMU	POSITION FOR NORMAL G&N OPERATION AND CONROL FUNCTIONS
	GDC	ENABLES BODY RATE PULSES FROM GDC TO CMC FOR ATTITUDE INFO NORMALLY OBTAINED FROM IMU. SCS CONTROLS S/C. ALSO LOSE FDAI ATTITUDE DISPLAY. ERRORS AND RATES ONLY DISPLAYED.

NOTE POLARITIES INDICATE VEHICLE DYNAMICS

(34) (TYPICAL)



(35)

ENTRY MONITOR SYSTEM (EMS)

- PROVIDES DISPLAY OF LOAD FACTOR (G) VERSUS VELOCITY (V)
- DIGITAL DISPLAY OF ΔV ANY RANGE TO GO
- ENABLES CREW TO MONITOR ENTRY PERFORMANCE, MIDCOURSE ΔV MANEUVERS WHILE UNDER AUTOMATIC CONTROL (CMC), AND FURNISHES INFORMATION REQUIRED FOR MANUAL CONTROL IF G/N FAILS.
- PROVIDES ENTRY THRESHOLD INDICATOR, CORRIDOR INDICATORS, AND ROLL STABILITY INDICATOR (LIFT VECTOR ORIENTATION IND) FOR EVALUATION OF SAFE ENTRY.
- CONTAINS SELF TEST PROVISIONS

EMS CONTAINS

- MANUAL CONTROLS
- INDICATORS
- SCROLL ASSY
- ACCELEROMETER
- ELECTRONICS
- GROUND TEST FUNCTION

FUNCTION SWITCH

OFF	ALL EMS POWER OFF EXCEPT • 28 VDC TO SPS THRUST LAMP CIRCUITRY ACTIVE AT ALL TIMES. • 400 CPS EL LINE TO NOMENCLATURE DISPLAY REMAIN ON AT ALL TIMES
EMS TEST 1	TESTS LOWER TRIP POINT OF .05GT THRESHOLD COMPARATOR
EMS TEST 2	TESTS HIGH TRIP POINT OF .05GT THRESHOLD COMPARATOR
EMS TEST 3	TEST TRIP POINT OF LOWER G<.2 LAMP
EMS TEST 4	TEST VELOCITY INTEGRATION CIRCUITRY, G SERVO CIRCUITRY, G-V PLOTTER AND RANGE (RANGE TO GO)
EMS TEST 5	TESTS TRIP POINT OF UPPER G>.2 LAMP
RNG SET	CONFIGURES CIRCUITRY FOR SLEWING RANGE COUNTER FOR ENTRY MODE
V_0 SET	CONFIGURES CIRCUITRY FOR SLEWING G-V PLOTTER SCROLL PRIOR TO ENTRY MODE
ENTRY	OPERATIONAL MODE FOR MONITORING S/C EARTH ENTRY MODE
ΔV TEST	OPERATIONAL MODE FOR SELF-TEST OF ΔV CIRCUITRY
ΔV SET	CONFIGURES CIRCUITRY FOR SLEWING ΔV COUNTER FOR OPERATIONAL MODES AND SELF-TEST
ΔV	OPERATIONAL MODE FOR MONITORING ΔV MANEUVERS

MODE SWITCH

EMS AUTO	EMS ELECTRONICS ON, INTEGRATORS INHIBITED UNTIL .05GT
STBY	EMS ELECTRONICS ON, COMPARATORS, INTEGRATORS, AND G SERVO INHIBITED
V/EMS MAN	ELS ELECTRONICS ON, COMPARATORS DEACTIVATED, INTEGRATORS AND G SERVO ON

ΔV/EMS SET SWITCH

SLEWS FLIGHT MONITOR SCROLL AND ΔV/RANGE COUNTER

SPS THRUST LT		LIGHTS WHEN GROUND IS ON LOW SIDE OF SPS SOLENOIDS & ΔV THRUST SW "A" OR "B" IN NORMAL POSITION
ΔV RANGE/COUNTER		DURING ΔV, DISPLAYS ΔV REMAINING DURING ENTRY, DISPLAYS (RANGE TO GO) 0 - 3500 NM
THRESHOLD INDICATOR .05G LT		PROVIDES FIRST VISUAL INDICATION OF DECELERATION SENSED (300K FT.) LIGHTS WHEN .05G SENSED FOR ONE SECOND PERIOD
CORRIDOR VERIFICATION LIGHTS G>.2 G<.2		ANGLE BETWEEN S/C VELOCITY VECTOR AND LOCAL HORIZONTAL DETERMINED BY SENSING G FORCE BUILD UP OVER GIVEN TIME INTERVAL
	G >.2	INDICATES LIFT VECTOR SHOULD BE UP AT THIS POINT ON ENTRY AND A CONTROLLED ENTRY CAN BE PERFORMED. LIGHTS 10 SEC AFTER .05G IF G FORCE AT END OF 10 SEC PERIOD IS 0.2G OR GREATER. STAYS ON UNTIL 2 G.
	G <.2	INDICATES SHALLOW ENTRY ANGLE AND LIFT VECTOR SHOULD BE DOWN FOR CONTROLLED ENTRY. LIGHTS IF g FORCE < 2g (IMPENDING SKIPOUT).
ROLL STABILITY INDICATOR		MONITORS ROLL ATTITUDE ABOUT STABILITY AXIS WITH RESPECT TO LINE PERPENDICULAR TO EARTHS HORIZON AT ENTRY
	UP	= MAX + (UPWARD) LIFT
	DOWN	= MAX - (DOWNWARD) LIFT
		• ENABLED BY EMS ROLL SW (1550). DRIVEN BY INPUTS GENERATED IN GDC • VALID ROLL = (1550 - EMS ROLL) • (GDC - ENTRY CONFIG) • (.05G - 1551)

FLIGHT MONITOR		RECTILINEAR DISPLAY OF G VERSUS V FOR MONITORING AUTOMATIC (CMC) CONTROLLED ENTRY OR FOR PERFORMING SAFE MANUAL ENTRY
	VELOCITY SCALE	MOVING MYLAR SCROLL (RIGHT TO LEFT) CALIBRATED FOR 37,000 FT/SEC MAX VELOCITY TO SUBCIRCULAR VELOCITY OF 4,000 FT/SEC
	G LEVEL SCALE	VERTICAL SCALE CALIBRATED FROM 0 - 10G TOP TO BOTTOM
		• FAMILY OF CURVES FOR MONITORING ENTRY PROFILE. SLOPES INDICATE MAXIMUM RATES AT WHICH G FORCES CAN INCREASE WITH RESPECT TO VELOCITY WITHOUT EXCEEDING MAXIMUM NOMINAL LOAD FACTOR OF ≈8G DURING DECELERATION TO 4,000 FT/SEC

ACCELEROMETER		GENERATES HIGH AND LOW LEVEL ANALOG AND DIGITAL OUTPUTS TO DRIVE SCROLL, SCRIBE AND ΔV/RANGE COUNTER
	LOW LEVEL ANALOG	(RANGE ±.4G) LIGHTS .05G LT AND ACTIVATES 10 SEC TIMER. ENABLES 0.2G CIRCUITRY WHEN 10 SEC TO TIMES OUT AND LIGHTS ONE OF THE 0 2G LTS.
	HIGH LEVEL ANALOG	(RANGE 0 - 17G) DRIVES SCRIBE ON G-V DISPLAY. AS SCRIBE DRIVES PAST 2G MARK, SIGNAL IN SCROLL ASSY DISABLES 0.2G LTS.
	DIGITAL OUTPUT	PULSES AT RATE OF 321.74 PULSES/SEC/G AND SCALED. IN ΔV MODE, SCALED OUTPUT IS APPLIED TO COUNTER FOR ΔV AND CUTOFF AT ZERO. IN ENTRY MODE, SCALED OUTPUT DRIVES SCROLL STEP SERVO AT ≈33 FT/SEC/PULSE

GUIDANCE AND CONTROL FUNCTIONAL SWITCHING DIAGRAM (SHEET 2 OF 4)

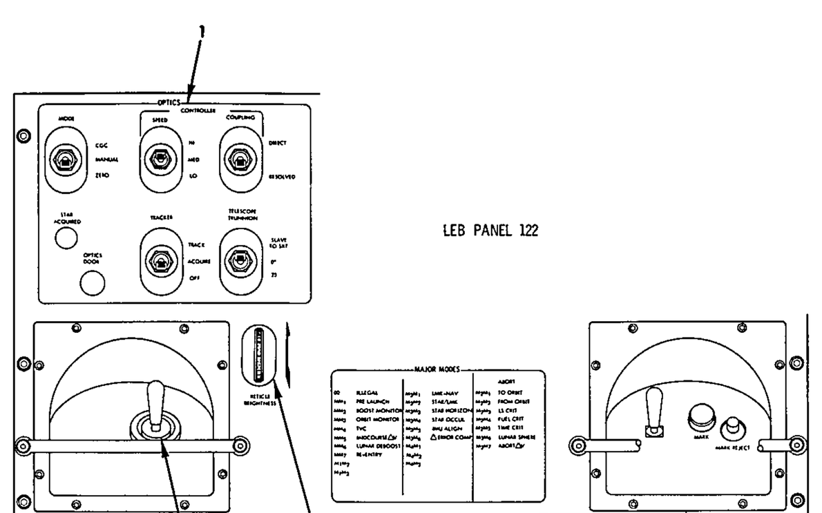
SCS-3008-1

①	OPTICS CONTROLS	
OPTICS-MODE SW	CMC	COMPUTER CONTROLS AND DRIVES SCT AND SXT SHAFTS AND TRUNNIONS
	MANUAL	SCT AND SXT SHAFTS AND TRUNNIONS ARE DRIVEN MANUALLY
	ZERO	SCT AND SXT SHAFTS AND TRUNNIONS ARE DRIVEN TO THEIR ZERO POSITIONS. ZERO MODE CAN BE SELECTED MANUALLY, OR BY THE CMC
OPTICS CONTROLLER-SPEED SW		PROVIDES DRIVE SPEED OPTION FOR SCT AND SXT
OPTICS CONTROLLER-COUPLING SW	DIRECT	PROVIDES MANUAL DIRECT DRIVE OF SCT AND SXT. FORWARD AND BACK MOTION DRIVES TRUNNIONS, AND RIGHT AND LEFT MOTION DRIVES SHAFTS. TARGET IMAGE MOTION IS IN R-M COORDINATE SYSTEM AND IMAGE POSITION DEPENDS ON POSITION OF SXT SHAFT
	RESOLVED	IN RESOLVED MODE, IMAGE MOTION IS IN X-Y S/C COORDINATE SYSTEM. MOTION CORRESPONDS DIRECTLY TO HAND CONTROLLER MOTION
TELESCOPE TRUNNION SW	SLAVE TO SXT	SLAVES SCT TRUNNION TO THE SXT
	0°	ZEROS SCT TRUNNION TO ITS ZERO POSITION
	OFFSET 25°	INCREASES SCT FIELD OF VIEW

②	
MARK PB	WHEN PRESSED, ISSUES DISCRETE MARK COMMAND TO CMC IN CHANNEL 16 BIT POSITION 6, TO DEFINE TIME OF MEASUREMENT AND TO RECORD OPTICAL SHAFT AND TRUNNION ANGLES AT TIME OF THE MARK DISCRETE
MARK REJECT PB	ISSUES MARK REJECT DISCRETE TO CMC IN CHANNEL 16 BIT POSITION 7, TO REJECT TIME AND ANGLE INFORMATION WHICH WAS RECORDED AS A RESULT OF A MARK COMMAND
MIN IMPULSE CONTROLLER	WHEN ENABLED BY MDC SWITCHING, GENERATES MIN IMPULSE COMMANDS TO RCS VIA THE CMC TO ALIGN OPTICS FOR FINER OPTICAL MEASUREMENTS

③	
RETICLE BIRGHTNESS	ADJUSTS SCT AND SXT RETICLE BRIGHTNESS

④	
OPTICS HAND CONTROL	USED TO MANUALLY DRIVE THE SCT AND SXT SHAFTS AND TRUNNIONS

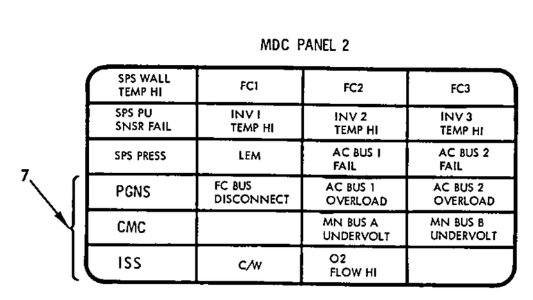


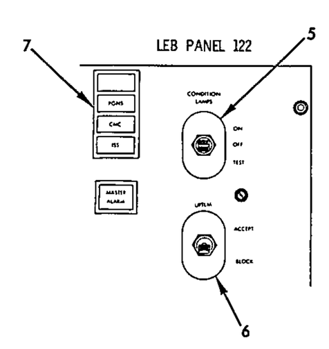
⑤ APPLIES POWER TO CONDITION LAMPS AND PROVIDES LAMP TEST CAPABILITY

⑥ IN SERIES WITH UPTLM SWITCH ON PANEL 2. EITHER INHIBITS OR ALLOWS CMC TO ACCEPT UPLINK TELEMETRY. BOTH SWITCHES MUST BE IN ACCEPT POSITION IN ORDER FOR CMC TO ACCEPT DATA

⑦ FAILURE DETECTION

PGNS ERROR SIGNAL		CAUT/WARN INDICATION	
SUB SYSTEM	ERROR	MDC & LEB LAMPS	DSKY LAMPS
ISS	CDU FAIL DUE TO POWER LOSS, HIGH ERROR, LOSS OF READ COUNTER DATA	ISS (WARNING)	NONE
ISS	GIMBAL SERVO ERROR	PGNS (CAUTION)	NONE
ISS	LOSS OF 3200 CPS POWER	PGNS	NONE
ISS	LOSS OF 800 CPS POWER	PGNS	NONE
ISS	IMU TEMP OUT OF SPEC BY MORE THAN ±5°F	PGNS	IMU TEMP
ISS	GIMBAL LOCK, MGA >±70°	PGNS	GIMBAL LOCK
ISS	PIPA FAIL DUE TO NEITHER OR BOTH P&N PULSES DURING A CLOCK PERIOD-NO THRUSTING	PGNS	NONE
ISS	PIPA FAIL - NEITHER OR BOTH P&N PULSES DURING A CLOCK PERIOD - THRUSTING	ISS (WARNING)	NONE
OSS	CDU FAIL (AS IN ISS)	PGNS	NONE
CMC	POWER LOSS +4 +14	CMC	NONE
CMC	CMC CIRCUIT ALARM	CMC	NONE
CMC	PROGRAM ALARM	PGNS	PROG
CMC	RESTART OF CMC	PGNS	RESTART
CMC	STANDBY POWER CONDITION	NONE	STBY
CMC	ISS NOT IN USABLE MODE	NONE	NO ATT
CMC	CMC DESIRES DSKY DISPLAY BUT KEYBOARD IS IN USE	NONE	KEY RLSE
CMC	OPERATOR HAS USED ILLEGAL KEY BOARD CODE	NONE	OPP ERR





⑧

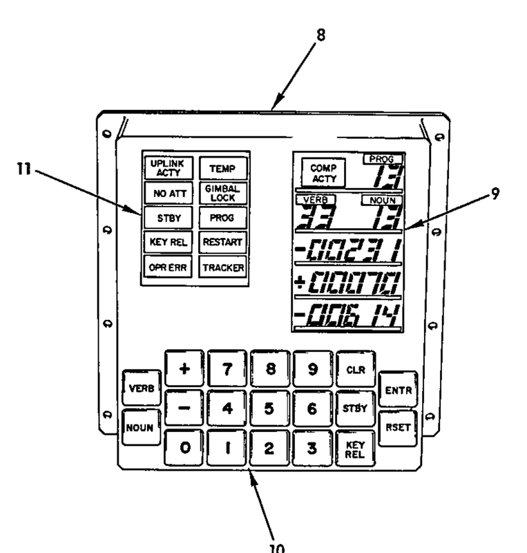
DISPLAY AND KEYBOARD (DSKY) MDC PANEL 2 & LEB PANEL 140	
KEYBOARD	KEYBOARD CONSISTS OF A NUMBER OF KEYS (PB'S). WHEN A KEY IS PRESSED A UNIQUE 5-BIT CODE IS GENERATED AND DIRECTED TO THE CMC INPUT CHANNELS. THIS IS TRUE FOR ALL KEYS EXCEPT THE STBY KEY WHERE NO 5-BIT CODE IS ASSOCIATED (DISCRETE). FOR THE MAIN PANEL DSKY, THE KEY CODES ARE DIRECTED TO CMC INPUT CHANNEL 15, BITS 1 THROUGH 5. FOR THE LEB DSKY, KEY CODES ARE DIRECTED TO INPUT CHANNEL 16, BITS 1 THROUGH 5.
DISPLAY IND	THERE ARE 24 DISPLAY INDICATORS ON THE DSKY; 21 DIGIT DISPLAYS AND 3 SIGN DISPLAY INDICATORS
CONDITION IND	THERE ARE TEN CONDITION INDICATIONS DISPLAYED ON THE DSKY'S

⑨

DISPLAY IND	FUNCTION
PROGRAM IND'S	INDICATE PROGRAM BEING PROCESSED BY CMC
VERB IND'S	INDICATE VERB CODE ENTERED AT KEY-BOARD OR COMMANDED BY CMC
NOUN IND'S	INDICATE NOUN CODE ENTERED AT KEY-BOARD OR COMMANDED BY CMC
DATA DISPLAY IND'S REGISTER 1 (R1) REGISTER 2 (R2) REGISTER 3 (R3)	INDICATE NUMERICAL DATA ENTERED AT KEYBOARD OR COMMANDED BY CMC AND SIGN ASSOCIATED WITH THIS NUMERICAL DATA IF IT IS IN DECIMAL

⑪

CONDITION INDICATOR	FUNCTION
UPLINK ACTY	INDICATES INFO IS BEING RECEIVED VIA UPLINK. LIGHTS IF BIT 3 OF OUT CHAN CONTAINS LOGIC 1.
TEMP	INDICATES STABLE MEMBER TEMP IS BEYOND DESIGN TEMP BY +5°F. LIGHTS IF BIT 15 IN CHAN 30 IS LOGIC 1.
GIMBAL LOCK	INDICATES MG ANGLE >±70° FROM ZERO. LIGHTS IS BIT 6 OF OUT CHAN 10 IS LOGIC 1 AND BITS 15-12 OF SAME CHAN ARE 1100 RESPECTIVELY
PROG	INDICATES THAT PROGRAM CHECK HAS FAILED. LIGHTS IF BIT 9 OF OUT CHAN 10 IS LOGIC 1 and BITS 15-12 OF SAME CHAN ARE 1100 RESPECTIVELY
RESTART	INDICATES· GOJAM SIGNAL GENERATED • WORD INCORRECTLY TRANSFERRED FROM MEMORY PARITY FAIL • TOO MANY CONSECUTIVE TC OR TCF INSTRUCTIONS HAVE OCCURRED, OR HAVE OCCURRED TOO INFREQUENTLY • INTERRUPTS ARE TOO LONG OR TOO INFREQUENT. (RUPT LOCK) • CMC HAS NOT ACCOMPLISHED NEW JOB WITHIN PERIOD WHOSE DURATION IS PROGRAM DEPENDENT AND VARIES FROM .64 TO 1.92 SECONDS (NIGHT WATCHMAN) • TEST ALARM GENERATED BY PROGRAM CONTROL
NO ATT	INDICATES ISS NOT SUITABLE AS ATTITUDE REFERENCE. LIGHTS IF BIT 4 OF OUT CHAN 10 IS LOGIC 1 AND BITS 15-12 OF SAME CHAN ARE 1100 RESPECTIVELY
STBY	INDICATES CMC IS IN STANDBY CONDITION. WILL ALSO LIGHT IF LIGHT TEST IS PERFORMED.
KEY REL	INDICATES CMC PROGRAM ATTEMPTED TO USE DSKY AND FOUND IT BUSY. PRESSING KEY RLSE PB WILL RELEASE DSKY TO CMC. LIGHTS IF BIT 5 OF OUT CHAN 11 IS LOGIC 1. (INDICATOR MODULATED BY FLASH SIGNAL)
OPP ERR	INDICATES ILLEGAL KEYBOARD OPERATION HAS BEEN PERFORMED. LIGHTS IF BIT 7 OF OUT CHAN 11 IS LOGIC 1. (INDICATOR MODULATED BY FLASH SIGNAL)
COMP ACTY	INDICATES CMC IS IN PROGRAM OTHER THAN DUMMY JOB AND CMC IS NOT IN STANDBY MODE. LIGHTS IF BIT 2 OF OUT CHAN 11 IS LOGIC 1.
TRACKER	LIGHTS WHEN CDU FAIL



⑩

KEY	FUNCTION
0-9 KEYS	ENTER NUMERICAL DATA, NOUN CODES AND VERB CODES INTO THE CMC
+ AND - KEYS	INFORM THE CMC THAT FOLLOWING NUMERICAL DATA IS DECIMAL AND INDICATE SIGN OF DATA
NOUN KEY	CONDITIONS CMC TO INTERPRET NEXT TWO NUMERICAL CHARACTERS AS A NOUN CODE AND CAUSES NOUN DISPLAY TO BE BLANKED
VERB KEY	CONDITIONS CMC TO INTERPRET NEXT TWO NUMERICAL CHARACTERS AS A VERB CODE AND CAUSES VERB DISPLAY TO BE BLANKED
CLR KEY	CLEARS DATA CONTAINED IN DATA DISPLAYS. PRESSING KEY CLEARS DATA DISPLAY CURRENTLY BEING USED. SUCCESSIVE DEPRESSIONS CLEAR OTHER TWO DATA DISPLAYS
STBY KEY	COMMANDS CMC TO STANDBY MODE AFTER CMC IS CONDITIONED BY INSERTION OF V60 (PREPARE FOR STANDBY). AN ADDITIONAL DEPRESSION COMMANDS THE CMC TO RESUME REGULAR OPERATION
KEY RLSE	RELEASES DSKY DISPLAYS INITIATED BY KEYBOARD ACTIONS SO THAT INFORMATION SUPPLIED BY THE CMC PROGRAM MAY BE DISPLAYED
ENTR	INFORMS CMC THAT ASSEMBLED DATA IS COMPLETE AND THAT THE REQUESTED FUNCTION IS TO BE EXECUTED
RSET	EXTINGUISHES LAMPS CONTROLLED BY THE CMC

No.	SWITCH	POSITION	FUNCTION
⑫	CAUT/WARN-CSM/CM SW	CSM	ALLOWS CAUT/WARN FUNCTIONS RELATIVE TO CSM CONFIGURATION. PREVENTS CM RCS SYS A & B CAUT/WARN LIGHTS FROM ILLUMINATING DURING CSM MISSION PERIOD.
		CM	ENABLES CM CAUT/WARN FUNCTIONS FOR CM OPERATIONS
⑬	RCS INDICATORS SELECTOR SW		USED IN CONJUNCTION WITH SM RCS AND CM RCS TEMP, PRESS, AND PROP QTY INDICATORS. SWITCH SELECTS DESIRED SYSTEMS TO BE MONITORED
⑭	SM RCS PROPELLANT PRI SW A, B, C, D, (4) AND TB FLAGS	ON	ENERGIZES AND MAGNETIC LATCHES SM RCS PRIMARY FUEL AND OXIDIZER ISOLATION VALVES OPEN. EACH SWITCH SETS 2 VALVES (ONE PRIM FUEL AND ONE PRIM OXIDIZER). SETS TB FLAGS GRAY IF BOTH VALVES OPEN. INDICATES POSITIVE OPEN CONDITION
		OFF	DELATCHES AND ALLOWS SM RCS PRIMARY FUEL AND OXIDIZER ISOLATION VALVES TO SPRING-LOAD CLOSED. SETS TB FLAGS STRIPED IF 1 OR BOTH VALVES CLOSE
⑮	CM RCS PRPLNT SW A, B (2) AND TB FLAGS	ON	ENERGIZES AND MAGNETIC LATCHES CM RCS SYSTEM A & B FUEL AND OXIDIZER SHUTOFF VALVES OPEN. EACH SWITCH SETS 2 VALVES. SETS TB FLAGS GRAY IF BOTH VALVES OPEN. INDICATES POSITIVE OPEN CONDITION
		OFF	DELATCHES AND ALLOWS CM RCS SYSTEM A & B FUEL AND OXIDIZER SHUTOFF VALVES TO SPRING-LOAD CLOSED. SETS TB FLAGS STRIPED IF 1 OR BOTH VALVES CLOSE
⑯	RCS TRNFR SW	CM	APPLIES POWER DIRECTLY TO RCS TRANSFER SWITCH MOTORS WHEN TRANSFERRING TO CM RCS
		SM	APPLIES POWER DIRECTLY TO RCS TRANSFER SWITCH MOTORS WHEN TRANSFERRING TO SM RCS
⑰	RCS CMD SW	ON	DIRECTLY ENABLES RCS LATCHING RELAY Z19 (SECS)
⑱	SM RCS HEATERS SW A, B, C, D (4)	PRI	POWERS HI TEMP THERMAL SWITCHES AND SM RCS HEATERS
		SEC	POWERS LO TEMP THERMAL SWITCHES AND SM RCS HEATERS
⑲	UP TLM SW NOTE - SWITCH ON PANEL 2 IS IN SERIES WITH UP TLM SWITCH ON PANEL 122 (LEB). BOTH MUST BE IN ACCEPT POSITION FOR CMC TO ACCEPT UPLINK DATA	ACCEPT	ENABLES CMC TO ACCEPT UPLINK TELEMETRY
		BLOCK	INHIBITS CMC FROM ACCEPTING UPLINK TELEMETRY
⑳	SM RCS HELIUM-1 & 2 SW A, B, C, D (8) AND TB FLAGS	ON	ENERGIZES AND MAGNETIC LATCHES SM RCS HELIUM ISOLATION VALVES OPEN (8 TOTAL), ONE SWITCH PER VALVE. SETS TB FLAGS GRAY
		OFF	DELATCHES AND ALLOWS SM RCS HELIUM ISOLATION VALVES TO SPRING-LOAD CLOSED. SETS TB FLAGS STRIPED
㉑	SM RCS SECONDARY PROP SW A, B, C, D (4) AND TB FLAGS	ON	ENERGIZES AND MAGNETIC LATCHES SM RCS SECONDARY FUEL AND OXIDIZER ISOLATION VALVES OPEN. EACH SWITCH SETS 2 VALVES (ONE SEC FUEL AND ONE SEC OXIDIZER). SETS TB FLAGS GRAY IF ONE OR BOTH VALVES OPEN.
		OFF	DELATCHES AND ALLOWS SM RCS SECONDARY FUEL AND OXIDIZER ISOLATION VALVES TO SPRING-LOAD CLOSED. SETS TB FLAGS STRIPED IF BOTH VALVES CLOSE. INDICATES POSITIVE CLOSED CONDITION

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BMAG 1 & 2 TEMP	INDICATES BMAGS ARE NOT WITHIN TEMP LIMITS
PITCH GMBL 1 & 2 YAW GMBL 1 & 2	INDICATES GIMBAL MOTORS FAILED BECAUSE OF OVERCURRENT
CM RCS A & B	INDICATES CM RCS OVERUNDER PRESS
SM RCS A, B, C, D	INDICATES SM RCS He OVERUNDER PRESS

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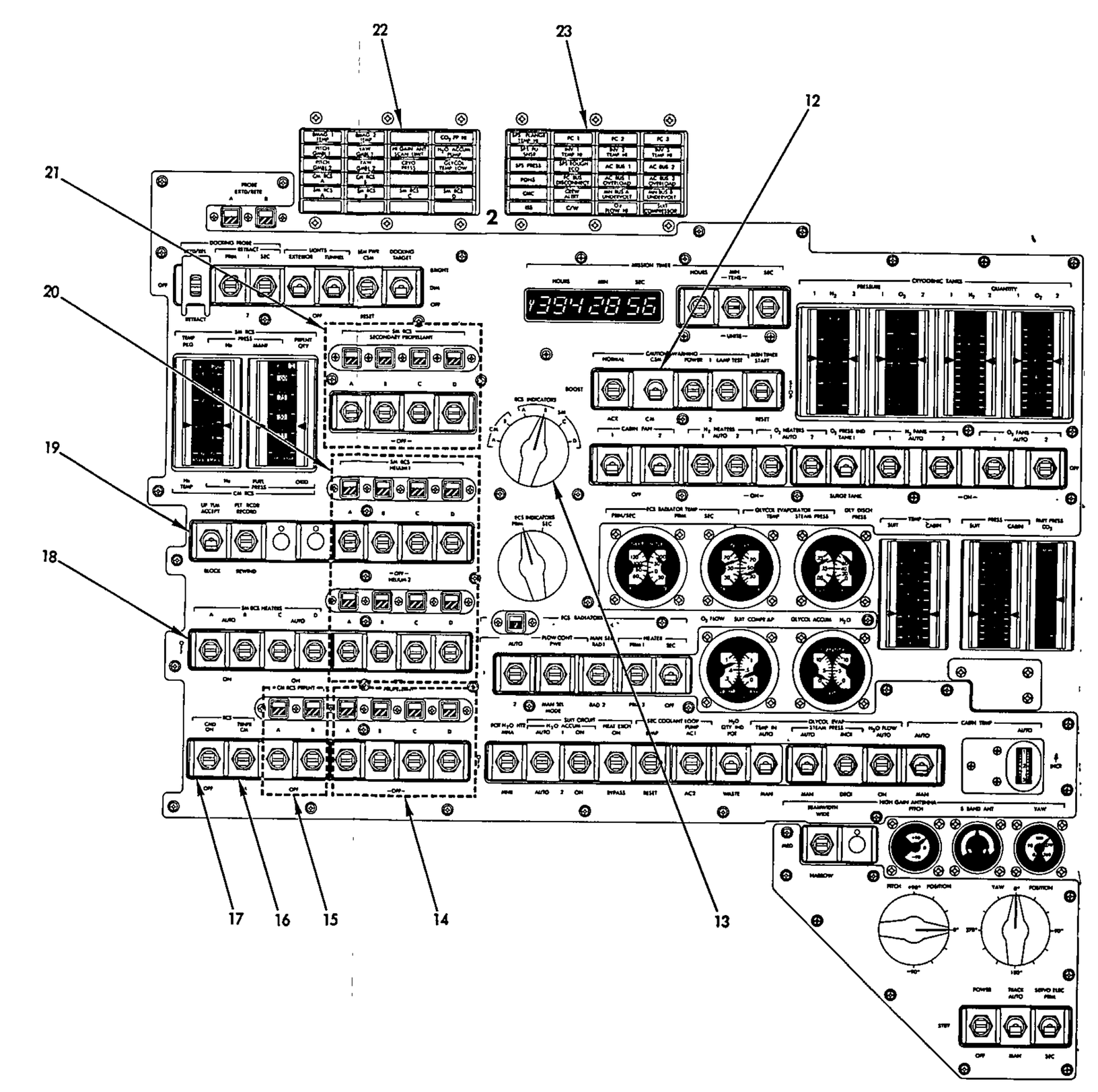
SPS FLANGE TEMP HI	LIGHTS WHEN TEMP +450°F
SPS PU SNSR	INDICATES MALFUNCTION OR TRUE UNBALANCE
SPS PRESS	SPS OVERUNDER PRESS 200 PSIA = OVER PRESS; 160 PSIA = UNDER PRESS
PGNS	INDICATES PROBLEM WITHIN PGNS (SEE FAILURE DETECTION ⑦)
CMC	INDICATES PROBLEM WITHIN CMC (SEE FAILURE DETECTION ⑦)
ISS	INDICATES PROBLEM WITHIN ISS (SEE FAILURE DETECTION ⑦)
SPS ROUGH ECO	LIGHTS WHEN FCSM SENSES ROUGH COMBUSTION AND TERMINATES THRUST



GUIDANCE AND CONTROL FUNCTIONAL SWITCHING DIAGRAM (SHEET 3 OF 4)

SCS-3008-2

① OXID FLOW VALVE-FLOW SW	INCR	INCREASES VALVE AREA OF PU VALVE SELECTED (PRIM OR SEC) THEREFORE INCREASING OXIDIZER FLOW RATE
	NORM	NORMAL POSITION - ASSUMES NOMINAL PU VALVE AREA FOR CORRECT OXIDIZER FLOW TO MAINTAIN BALANCE (PROPER FUEL AND OXIDIZER RATIO)
	DECR	DECREASES VALVE AREA OF PU VALVE SELECTED, THEREBY DECREASING OXIDIZER FLOW RATE
② OXID FLOW VALVE-PRIM/SEC SW	PRIM	SELECTS PRIMARY PU VALVE FOR ADJUSTING FLOW
	SEC	SELECTS SECONDARY PU VALVE FOR ADJUSTING FLOW
③ PUG MODE SW	PRIM	SELECTS PRIMARY PUGS SYSTEM FOR MONITORING
	NORMAL	SELECTS PRIMARY PUGS SYSTEM AND IS THE NORMAL MONITORING POSITION
	AUX	SELECTS AUXILIARY PUG SYSTEM FOR MONITORING
④ SPS-PRESS IND SW		THIS SWITCH TIME-SHARES SPS PRPLNT TANKS-PRESS INDICATOR BETWEEN H_e PRESSURE AND N_2 PRESSURE
	H_e	SELECTS H_e PRESS PORTION OF PRESSURE INDICATOR
	N_2	A OR B SELECTS N_2 PRESS PORTION OF PRESSURE INDICATOR
⑤ SPS-LINE HTRS SW	A	SELECTS AND POWERS SPS A SYSTEM HEATER ELEMENTS (12) ONLY
	AB	SELECTS AND POWERS ALL SPS A & B SYSTEM HEATER ELEMENTS (24)
⑥ SPS H_e VLV-1 & 2 SW	AUTO	NORMAL POSITION FOR THRUSTING; H_e PRESSURIZING SW'S FOR SPS H_e ISOLATION VALVES. APPLIES POWER TO CONTACTS OF SPS THRUST ON/OFF RELAYS. AT THRUST ON, POWER IS DIRECTED TO SPS H_e ISOLATION VALVES 1 & 2 PRESSURIZING PROP SYSTEMS A & B
	ON	BYPASSES AUTOMATIC FUNCTION AND ENERGIZES SPS H_e ISOLATION VALVES DIRECT, THEREBY PRESSURIZING THE PROP SYSTEMS
	OFF	INHIBITS OPERATE POWER TO H_e ISOLATION VALVES.
⑦ SPS H_e VLV-1 & 2 TB	STRIPED	INDICATES SPS H_e ISOLATION VALVES CLOSED; PROPELLANTS NOT PRESSURIZED
	GRAY	INDICATES SPS H_e ISOLATION VALVES OPEN (PROPELLANTS PRESSURIZED) BY AUTOMATIC OR DIRECT THRUST ON
⑧ OXID FLOW VALVE-MAX-MIN TB	MAX	INDICATES PU VALVE AT MAX FLOW POSITION
	MIN	INDICATES PU VALVE AT MIN FLOW POSITION
	GRAY	INDICATES OXID FLOW VALVE-FLOW SW IS AT NORM POSITION AND HAVE NOMINAL FLOW
⑨ OXID UNBAL IND NOTE - THESE INDICATIONS OCCUR ONLY WHILE THRUSTING OR TESTING	0	INDICATES BALANCED FUEL/OXID FLOW
	INCR	INDICATES OXIDIZER FLOW SHOULD BE INCREASED
	DECR	INDICATES OXIDIZER FLOW SHOULD BE DECREASED
⑩ PUGS TEST SW		ENABLES TEST OF PUGS
⑪ % OXID, % FUEL IND		INDICATES % QUANTITY OF FUEL AND OXIDIZER

⑫ SPS ENGINE INJECTOR VALVES INDICATORS NOTE-(A) WOULD NORMALLY BE SET, THEN (B) IF (A) FAILS	A	IF OPEN, INDICATES (A) PORTION OF SPS BI-PROPELLANT VALVE IS OPEN TO PROPELLANTS
	B	IF OPEN, INDICATES (B) PORTION OF SPS BI-PROPELLANT VALVE IS OPEN TO PROPELLANTS

⑬ [SUPPLIES PWR FOR G/N LIGHTING]

⑭ [G/N POWER-OPTICS SW (PANEL 100)] → [OPTICS SYSTEM]

⑮ [COMPUTER (CMC) & INTERNAL PWR SUPPLIES]

⑯ [IMU & HEATER CKTS]

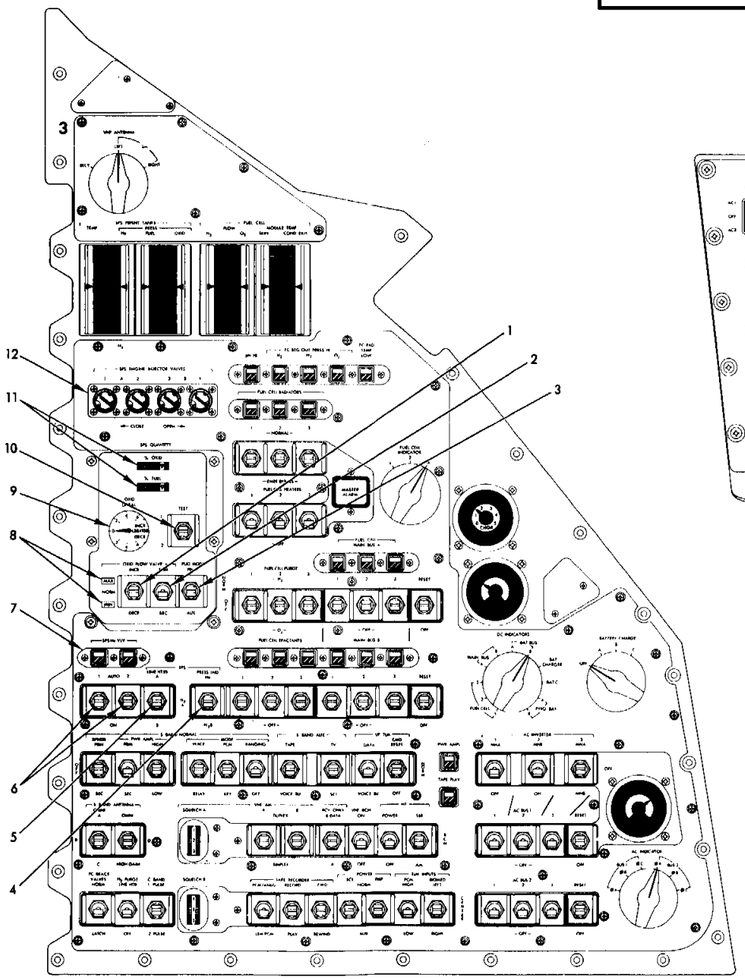
⑰ [G/N POWER-IMU SW (PANEL 100)] → [IMU]
[SC CONT SW (151B) CMC POSITION CONTACT]

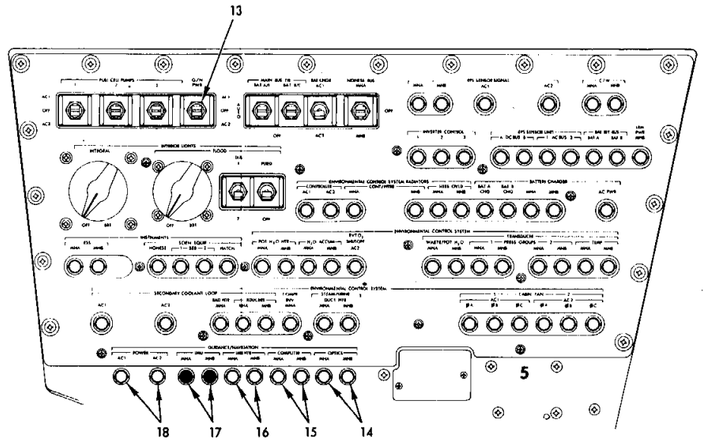
⑱ [G/N PWR SW (PANEL 5)] → [G/N LIGHTING]

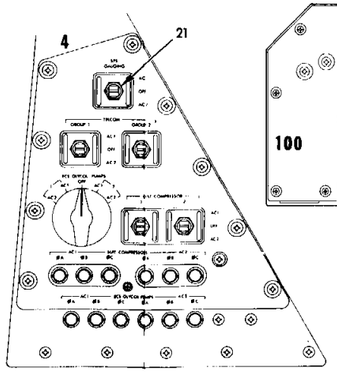
⑲ [APPLIES DC POWER TO OPTICS SYSTEM]

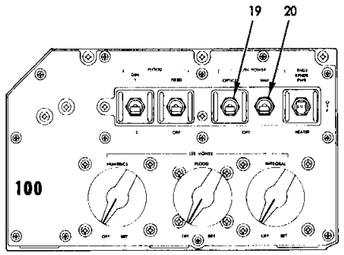
⑳ [APPLIES OPERATE POWER TO IMU]

㉑ [APPLIES AC POWER TO SPS GAUGING SYSTEM]









GUIDANCE AND CONTROL FUNCTIONAL SWITCHING DIAGRAM (SHEET 4 OF 4)

SCS-3008-3

Block II Computer Programs

Idling

P00 – – – housekeeping (orbital mfg, docking)

Prelaunch Servicing

P05 Power up
P06 " down

Boost

P11 Boost monitor
(alt & alterror)

Coast

P20 Rendezvous
P21 Ground Track Det.
P22 Orbital Nav. . . . check state vector
P23 Midcourse NAV.
P27 CMC Update . . targeting for ext. ΔV
CM state
LM state
CMC time
} 4 types of updates,

Pre Thrusting

P30 External ΔV (ΔV required & t_ig)
KCS or SPS
P34 Transfer Phase Initiation (TPI) time (burn to radar) & time of light to burn
P35 TPI - Midcourse . . . redoes
P36 TPF Final

Thrusting

P40 SPS burn (both fixed att & curved burn)
P41 RCS burn

Entry

P61 Fly to CM/SM sep. att.
P62 sep & fly to trim
P64 .2G

BIT / CHANNEL	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	
0 (VACANT)																	
1			IDENTICAL TO REGISTER #1 (L)														
2			IDENTICAL TO REGISTER #2 (Q)														
3			HIGH 23.3 HRS	ORDER	SCALER		14	BIT	POS #							5.12 SEC	
4			LOW 5.12 SEC	ORDER	SCALER		14	BIT	POS #							1/3200 SEC	
OUTBITS 5 RCS (P&Y)					takes 2 jets] translation effect +X rotation effect -Y				6 +X -X -YW -X +P 1D	7 -X +Y 5 +YW -X +P 1U	8 -X -Y -YW -X +P 2D	5 +X +Y 7 +YW -X +P 2U	2 +X -P -P +Z 3D	3 -X +P +P -X -YW 3U	4 -X -P -P +Z 4D	Jet 1 +X +P +P -X -YW 4U	S/M (CM/LM) C/M LEM
OUTBITS 6 RCS (ROLL) ✓									+Y -R 14 - 1S	-Y +R 15 - 4S	-Y -R 16 - 3S	+Y +R 13 - 2S	+Z -R 10 -R -Y +Z 2F	-Z +R 11 +R +Y -Z 1F	-Z -R 12 -R -Y -Z 4F	+Z +R 9 +R +Y +Z 3F	S/M C/M LEM
FMA 7										*** FIXED FE7	*** EXTENSION FE6	*** BITS FE5					C/M LEM
DSKY OUTBITS 10 "R" RELAYS	4	4	3	2	1	11	10	9	8	7	6	5	4	3	2	1	C/M
	RELAY ADDRESS					RELAY BITS (OUTBITS, "R" RELAYS)											
	4	4	3	2	1	11	10	9	8	7	6	5	4	3	2	1	LEM
OUTBITS 11 "A" RELAYS	SPARE	SPARE	ENGINE OFF	SPS ENGINE ON	SPARE	SPARE	CAUTION RESET	TEST CONNECTOR OUTBIT	SPARE	OPERATOR ERROR FLASH	VERB-NOUN FLASH	KEY RELEASE FLASH	TEMP CAUTION	UPLINK ACTIVITY	COMPUTER ACTIVITY	I.S.S. WARNING	C/M LEM
OUTBITS 12 GN&C	ISS TURN ON DELAY COMPLETE	ISS TURN ON DELAY COMPLETE	SIVB CUTOFF ("A" RELAY) R.R. ENABLE RELAY	SIVB INJ SEQ START L.R. POS COMMAND	— -ROLL GIMBAL TRIM	DISENGAGE OPTICS DAC +ROLL GIMBAL TRIM	ZERO OPTICS -PITCH GIMBAL TRIM	SIVB TAKE OVER ENABLE +PITCH GIMBAL TRIM	TVC ENABLE DISPLAY INERTIAL DATA	SPARE	ENABLE IMU ERROR COUNTER	ZERO IMU CDU'S	COARSE ALINE ENABLE	STAR TRACKER ON HORIZONTAL VELOCITY LO-SCALE	ENABLE OPTICS ERROR COUNTER ENABLE R.R. ERROR COUNTER	ZERO OPTICS CDU'S ZERO R.R. CDU'S	C/M LEM
OUTBITS 13 RADAR & AGC	ENABLE T6 RUPT	ENABLE T6 RUPT	RESET TRAP 32	RESET TRAP 31-B	RESET TRAP 31-A	ENABLE STANDBY	TEST ALARMS	— START RHC READ	BMAG COUNTER ENABLE RHC COUNTER ENABLE	DOWNLINK WORD ORDER	BLOCK INLINK	INHIBIT UPLINK, ENABLE CROSS-LINK	RADAR ACTIVITY	RADAR SELECTION A*	RADAR SELECTION B*	RADAR SELECTION C*	C/M LEM
OUTBITS 14 IMU	DRIVE CDU X	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	ENTRY VEL DRIVE MONITOR INCR DRIVE	— THRUST DRIVE	— ALTITUDE METER ACTIVITY	— ALTITUDE RATE SELECT	OUTLINK ACTIVITY	C/M LEM
INBITS 15 MAIN KEYBOARD									Keyrupt is priority 5			(TRAP #15 - RUPT 5) KEY 5M	KEY 4M	KEY 3M	KEY 2M	KEY 1M	C/M LEM
INBITS 16 NAV KEYBOARD ✓										MARK REJECT (TRAP 16B-RUPT 6) (-) DESCENT	MARK (+) DESCENT	KEY 5N MARK REJECT	KEY 4N (TRAP 16A-RUPT 6) MARK Y	KEY 3N MARK X	KEY 2N —	KEY 1N —	C/M LEM
17 & 20 THRU 27 VACANT																	
INBITS 30 GN&C	TEMP IN LIMITS	TEMP IN LIMITS	I.S.S. TURN-ON REQUEST	IMU FAIL	IMU CDU FAIL	IMU CAGE	S/C CONTROL OF SATURN G&N CONTROL OF S/C	IMU OPERATE	SPARE	OPTICS CDU FAIL R.R. CDU FAIL	GUID REF RELEASE DISPLAY INERTIAL DATA	LIFTOFF AUTO THROTTLE	SIVB SEPARATE, ABORT ABORT STAGE	SPS READY ENGINE ARMED	SM SEPARATE STAGE VERIFY	ULLAGE THRUST PRESENT ABORT	C/M LEM
INBITS 31 TRANS & ROT	G&C A/P CONTROL G&N CONTROL OF S/C	G&C A/P CONTROL G&N CONTROL OF S/C	FREE FUNCTION AUTO STABILIZATION	HOLD FUNCTION ATTITUDE HOLD	-Z TRANSLATION	+Z TRANSLATION	-Y TRANSLATION (TRAP 31B - RUPT 10)	+Y TRANSLATION	-X TRANSLATION	+X TRANSLATION	-ROLL MAN ROT -AZ (LPD) -RMI	+ROLL MAN ROT +AZ (LPD) +RMI	-YAW MAN ROT (TRAP 31A - RUPT 10) -YMI	+YAW MAN ROT +YMI	-PITCH MAN ROT -EL (LPD) -PMI	+PITCH MAN ROT +EL (LPD) +PMI	C/M LEM
INBITS 32 IMPULSE	(SPARE)					LEM ATTACHED SPARE	— (TRAP 32 RUPT 10) ROLL GIMBAL OFF	— PITCH GIMBAL OFF	— THRUSTER 10 & 11 FAIL	— THRUSTER 9 & 12 FAIL	-ROLL MIN IMPULSE THRUSTER 13 & 15 FAIL	+ROLL MIN IMPULSE THRUSTER 14 & 16 FAIL	-YAW MIN IMPULSE THRUSTER 6 & 7 FAIL	+YAW MIN IMPULSE THRUSTER 1 & 3 FAIL	-PITCH MIN IMPULSE THRUSTER 5 & 8 FAIL	+PITCH MIN IMPULSE THRUSTER 2 & 4 FAIL	C/M LEM
INBITS 33 OPTICS & AGC	OSC ALARM	OSC ALARM	WARNING	PIPA FAIL	DOWNLINK TOO FAST	UPLINK TOO FAST	BLOCK UPLINK INPUT	— LR RANGE LOW SCALE	— LANDING VEL DATA GOOD	STAR PRESENT LR POS #2	STAR TRACKER ON LR POS #1	AGC CONTROL LR DATA GOOD	ZERO OPTICS RR DATA GOOD	— RR RANGE LOW SCALE	— RR POWER ON/AUTO	SPARE	C/M LEM
	(FLIP-FLOPS)																
34	DOWNLINK #1 FIRST OF TWO WORDS SERIALIZED																C/M LEM
35	DOWNLINK #2 SECOND OF TWO WORDS SERIALIZED																C/M LEM

ALL SIGNALS INVERTED

* RADAR SELECTION

A	B	C	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

A	B	GYRO
0	0	-
0	1	X
1	0	Y
1	1	Z

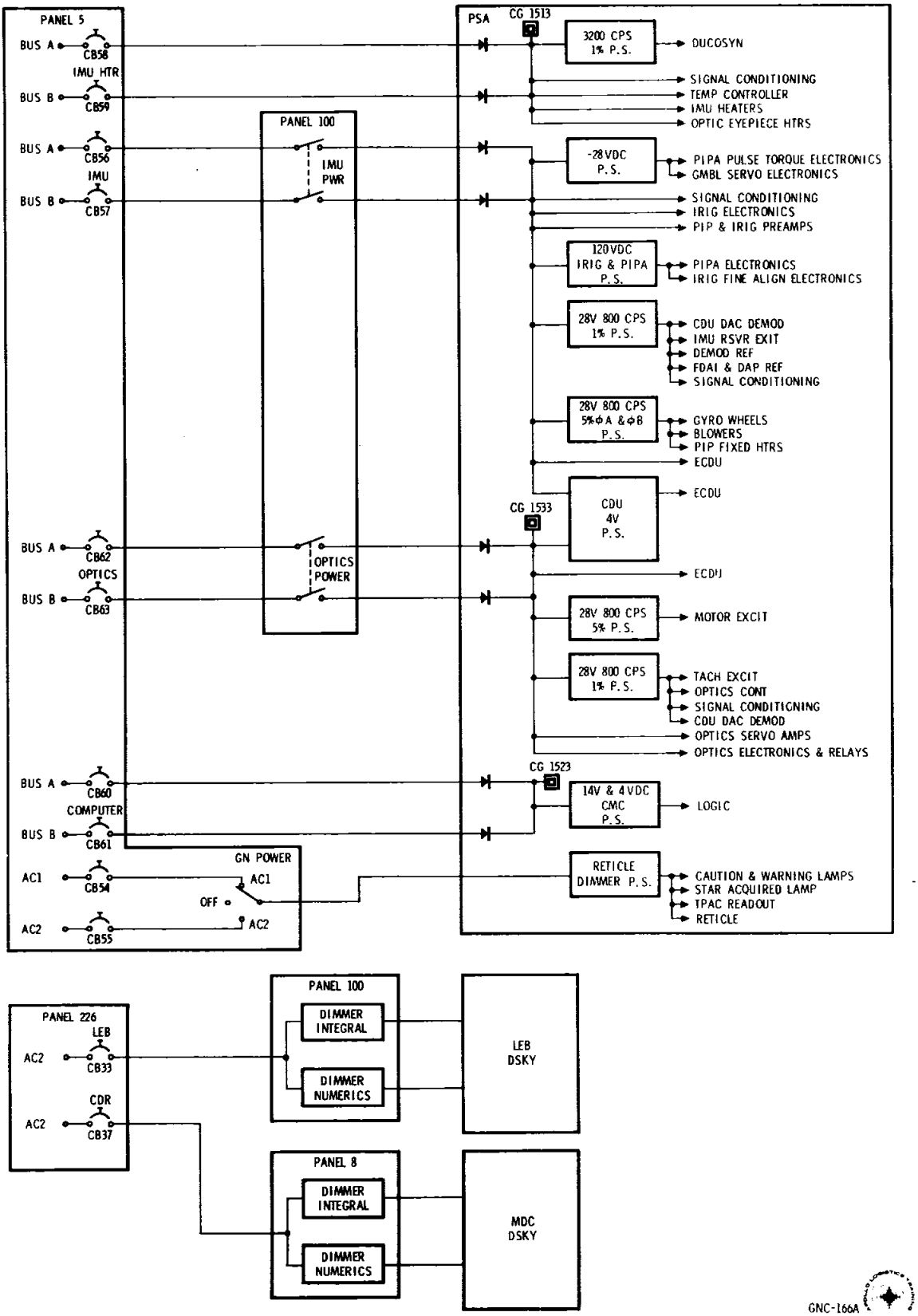
***

FE7	FE6	FE5	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

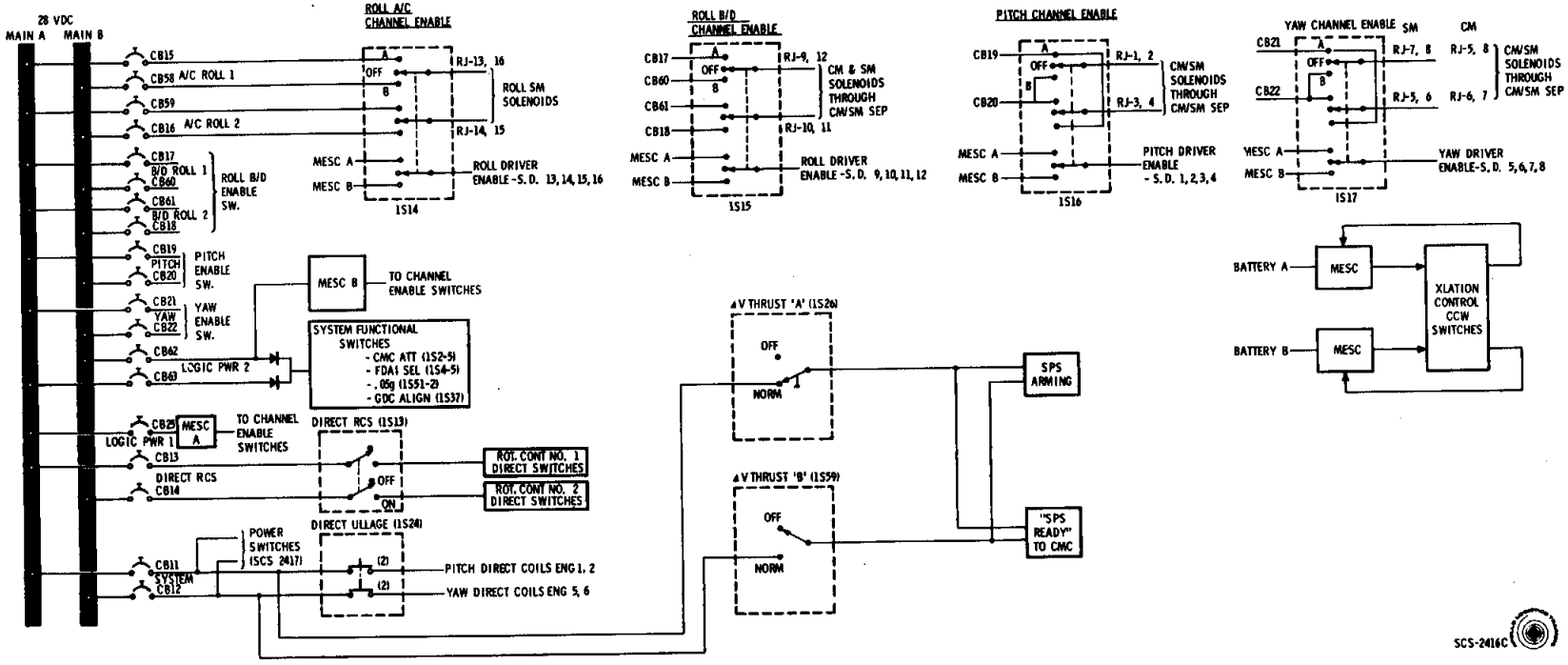
CHANNEL-BIT ASSIGNMENTS

GNC POWER DISTRIBUTION



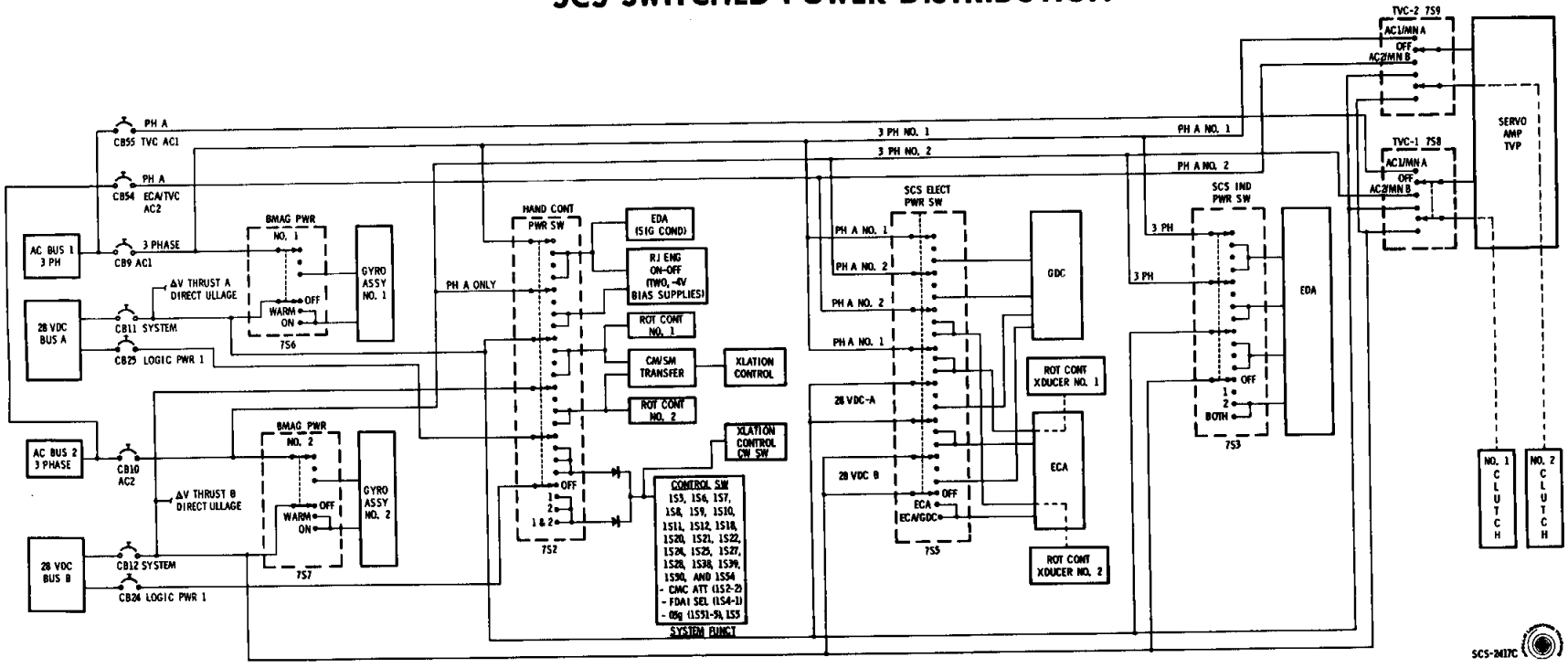
GNC-166A

SCS NON SWITCHED POWER

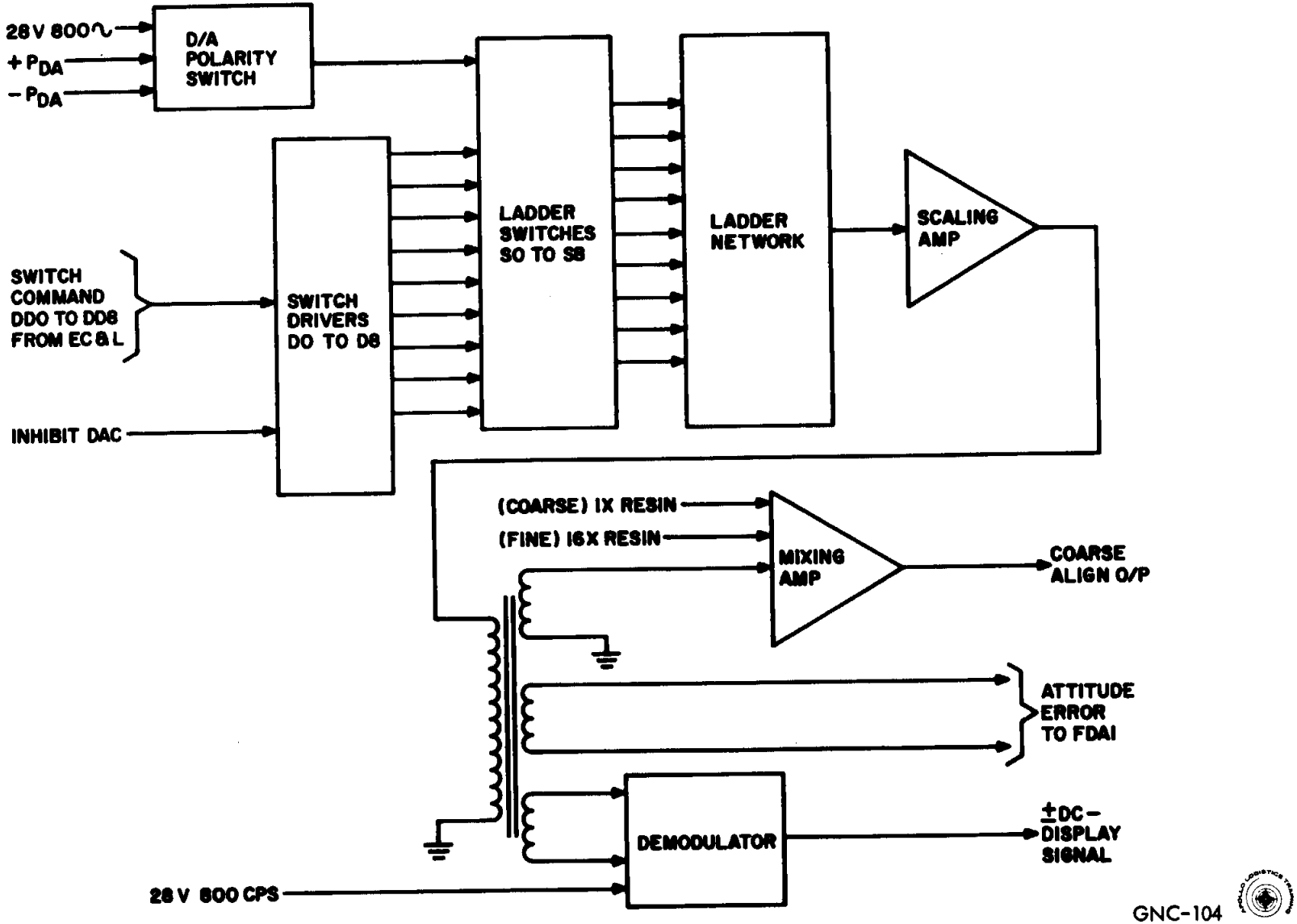


SCS-2416C

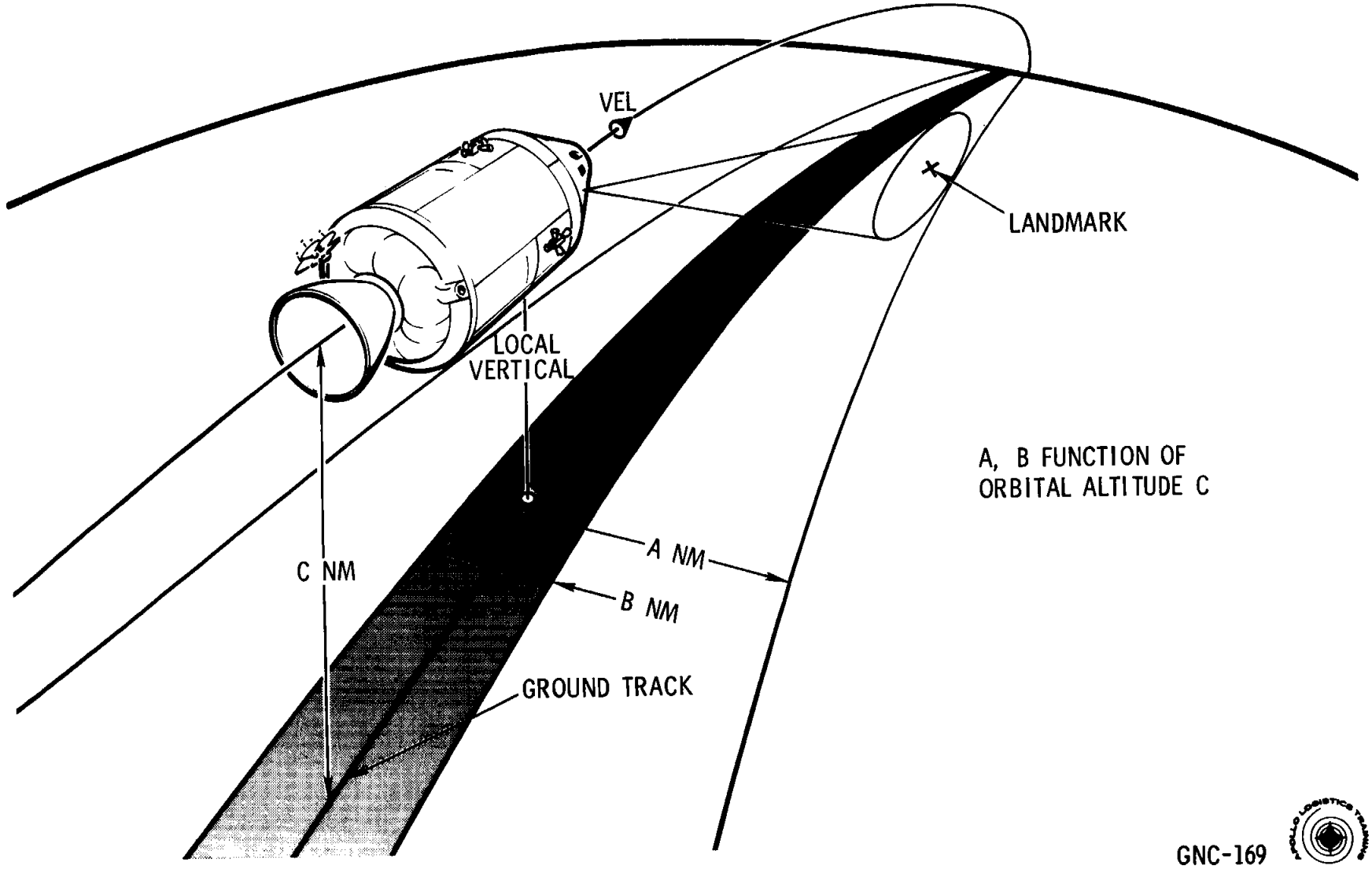
SCS SWITCHED POWER DISTRIBUTION



DIGITAL TO ANALOG CONVERTER MODULE BLOCK DIAGRAM



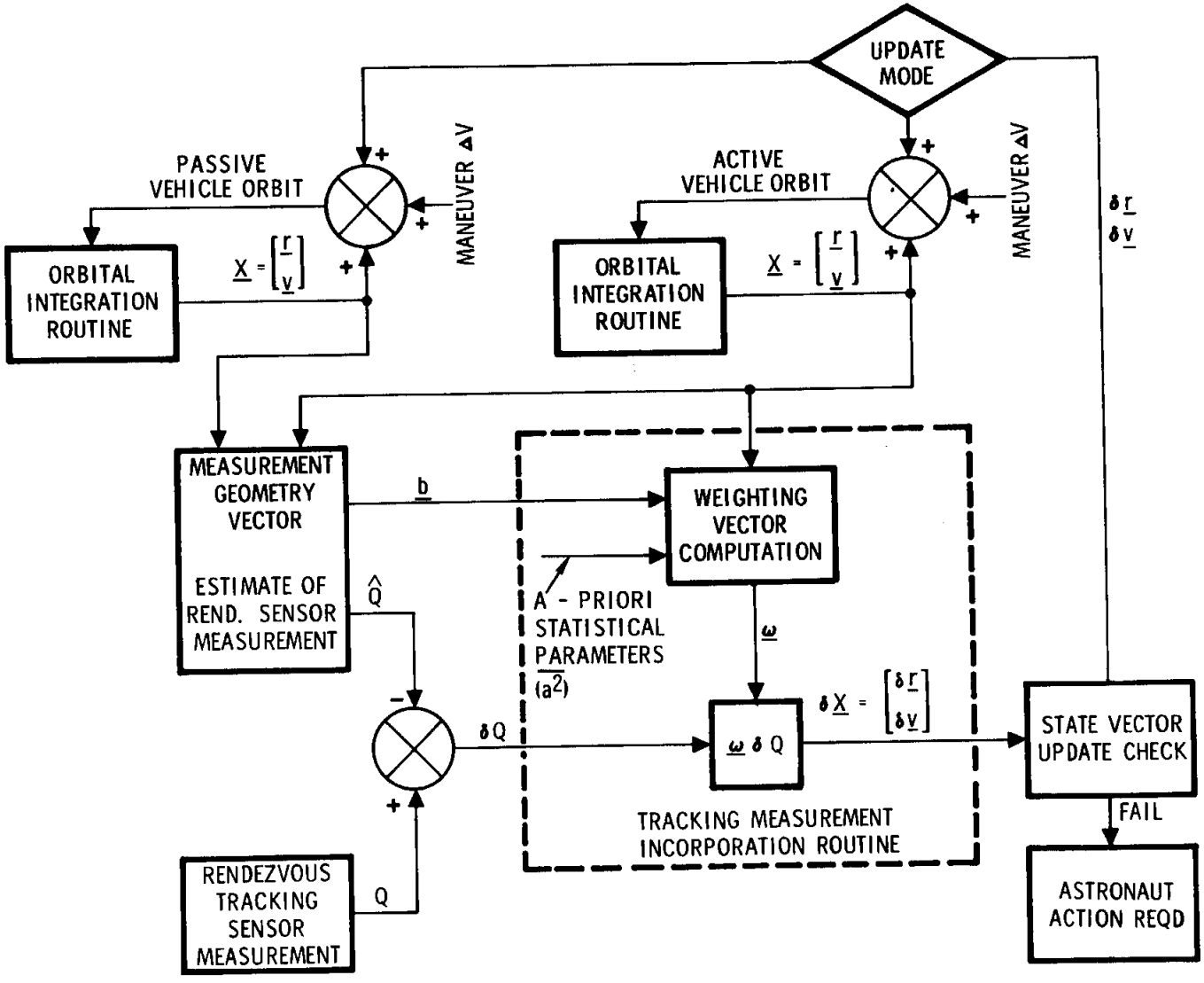
ORBITAL LANDMARK TRACKING



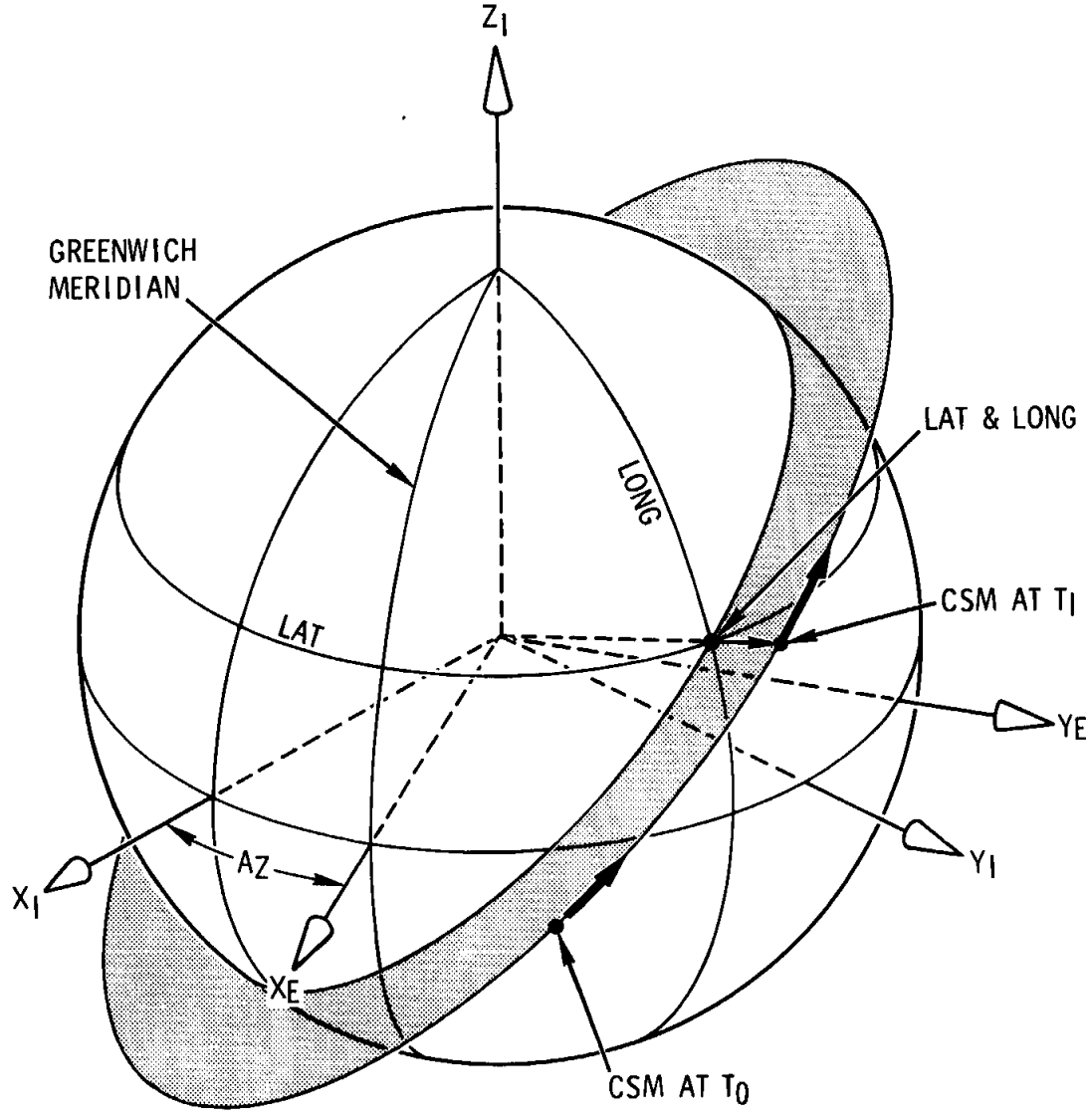
A, B FUNCTION OF
ORBITAL ALTITUDE C

GNC-169

SIMPLIFIED CMC RENDEZOUS NAVIGATIONAL FUNCTIONAL DIAGRAM

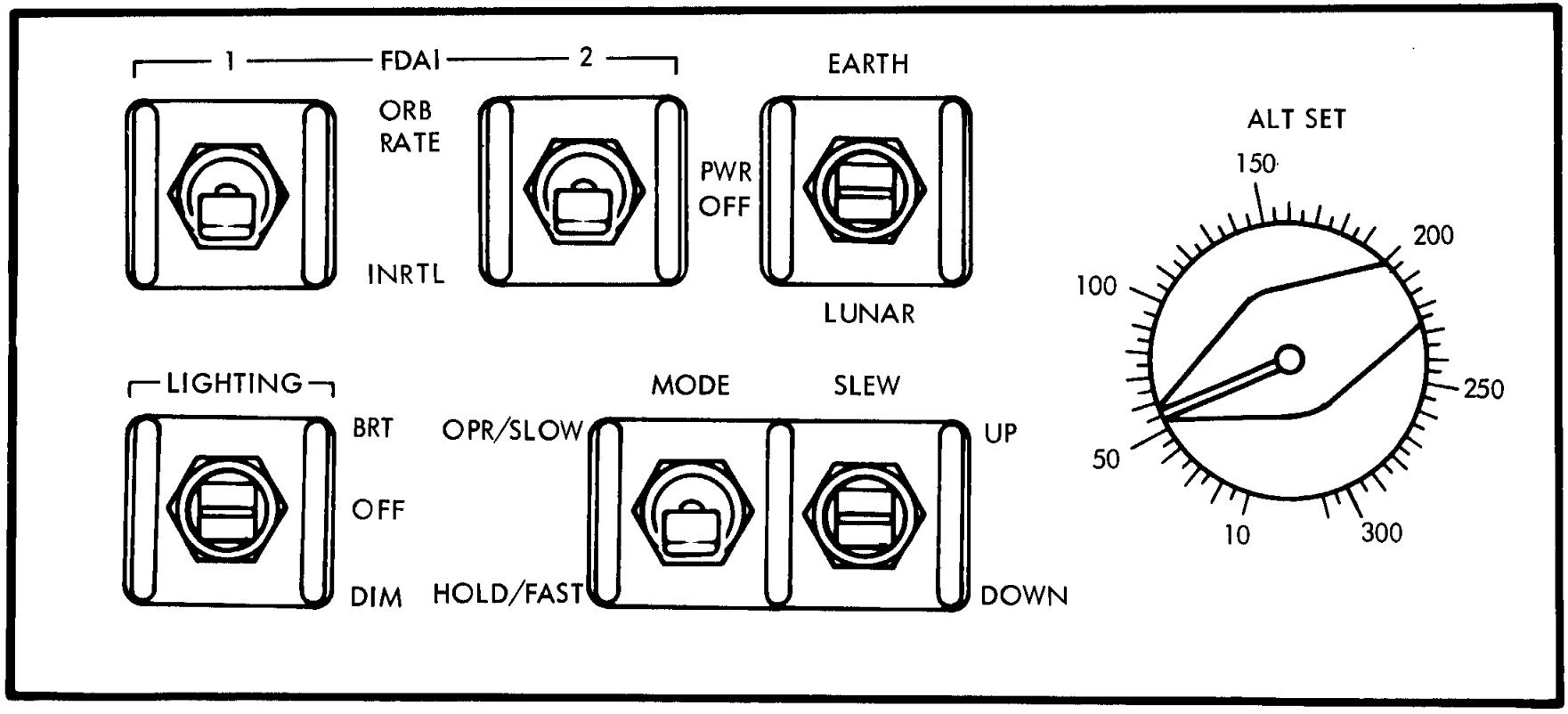


LONGITUDE-LATITUDE DETERMINATION



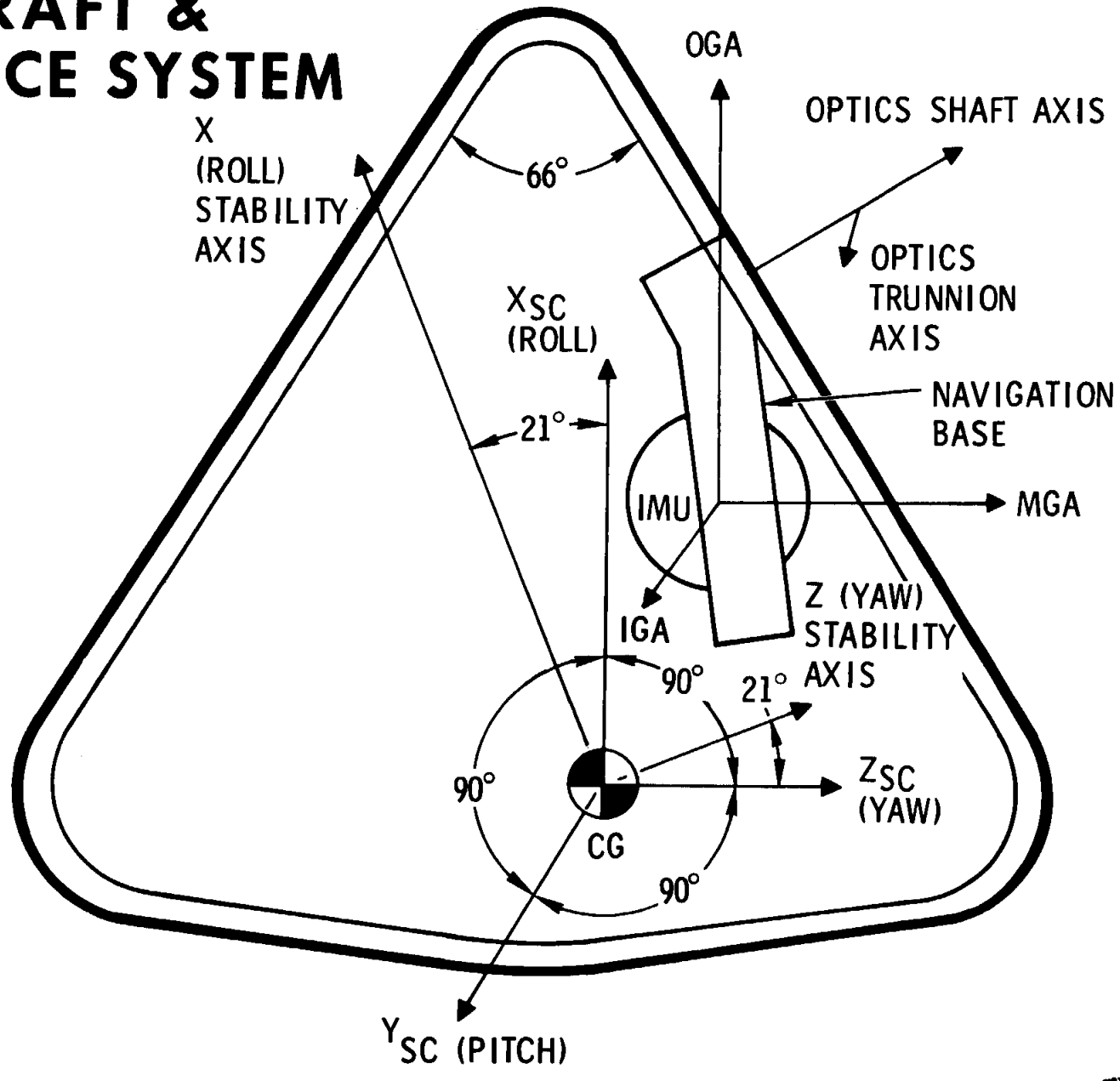
$$A_Z = A_{Z0} + \omega\,(t + t\ \text{ephem})$$

ORDEAL PANEL

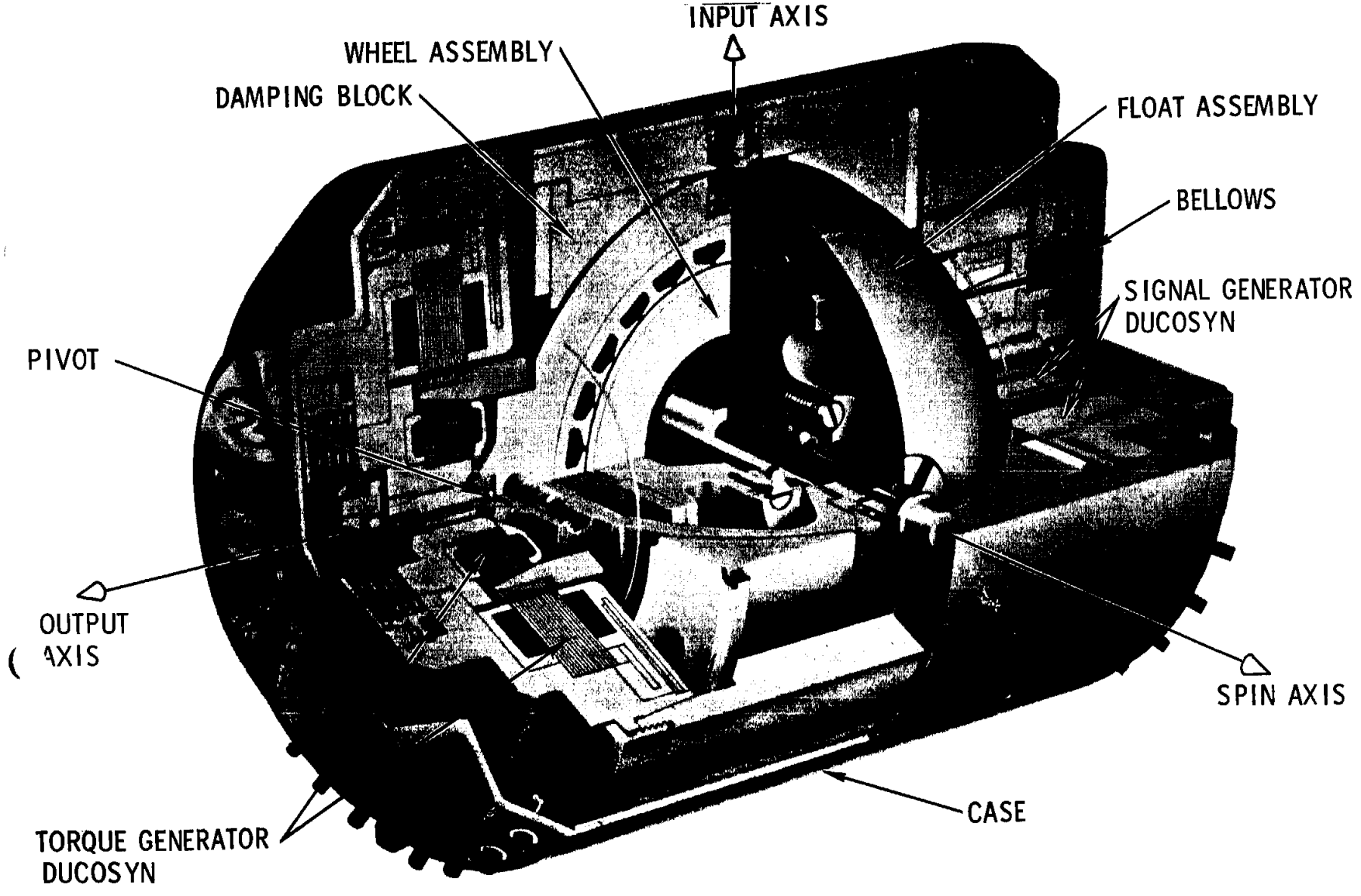


SCS-4000A

SPACECRAFT & GUIDANCE SYSTEM AXES

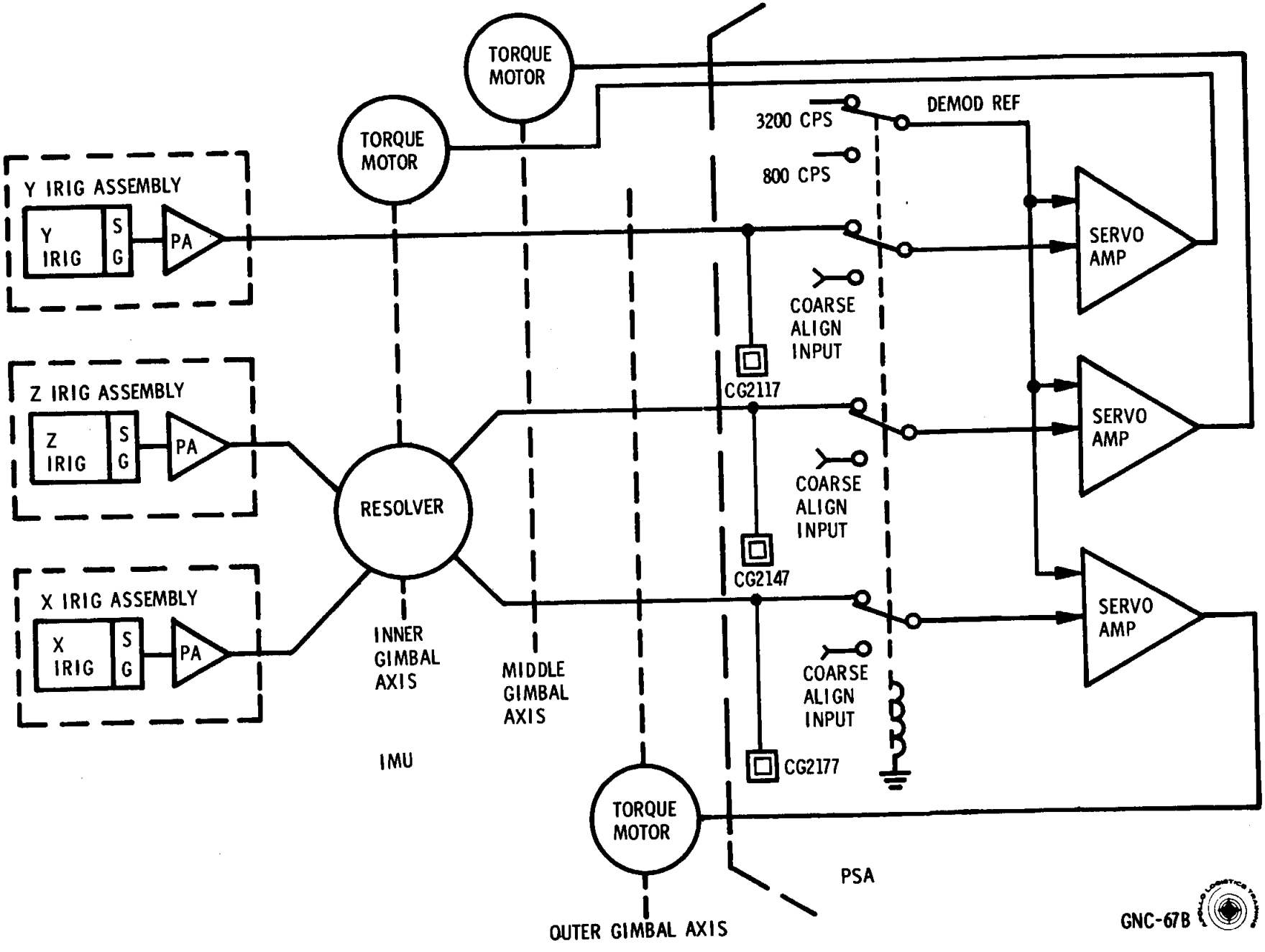


25 IRIG

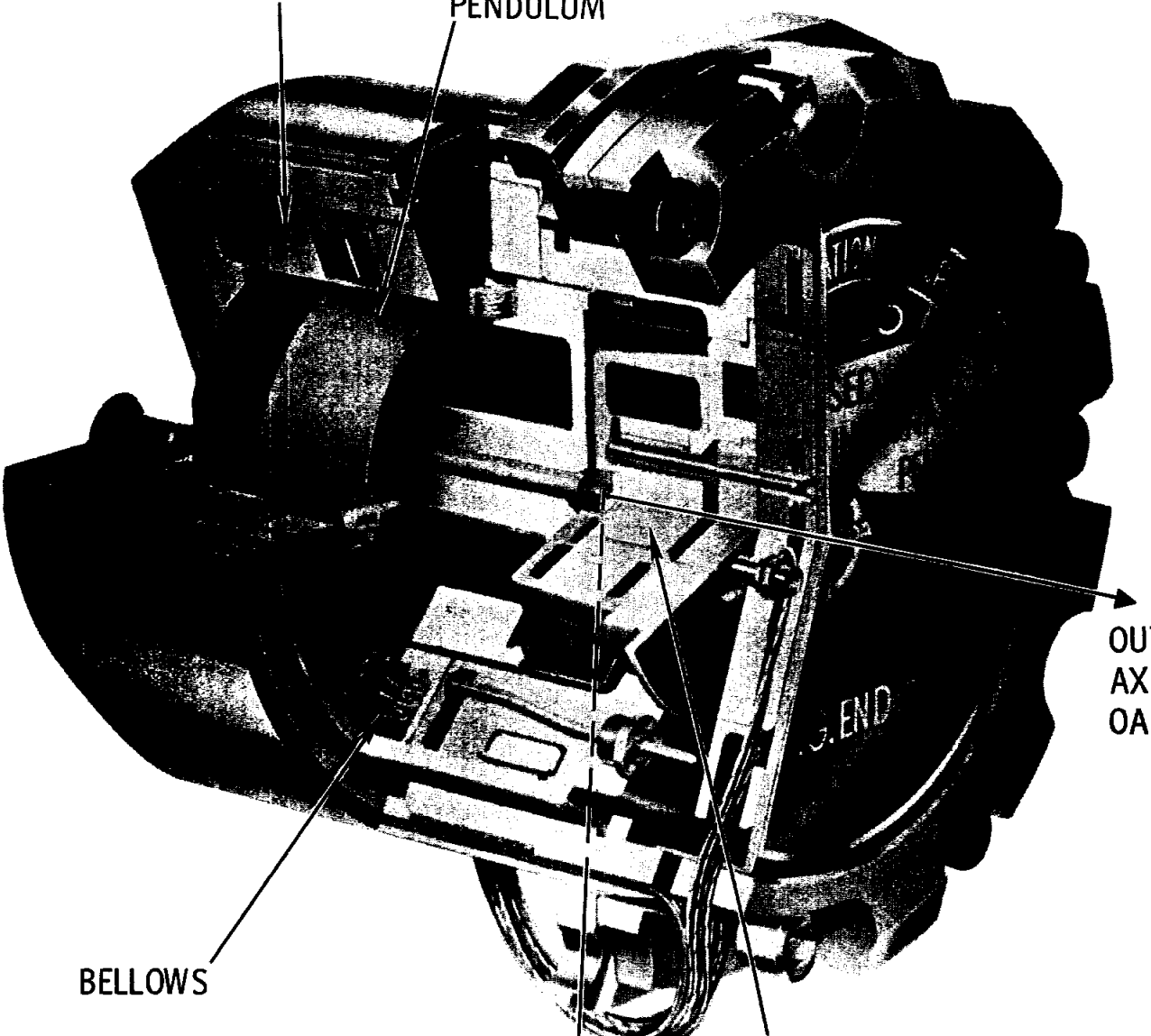


GN-264B

BLOCK II STABILIZATION LOOPS

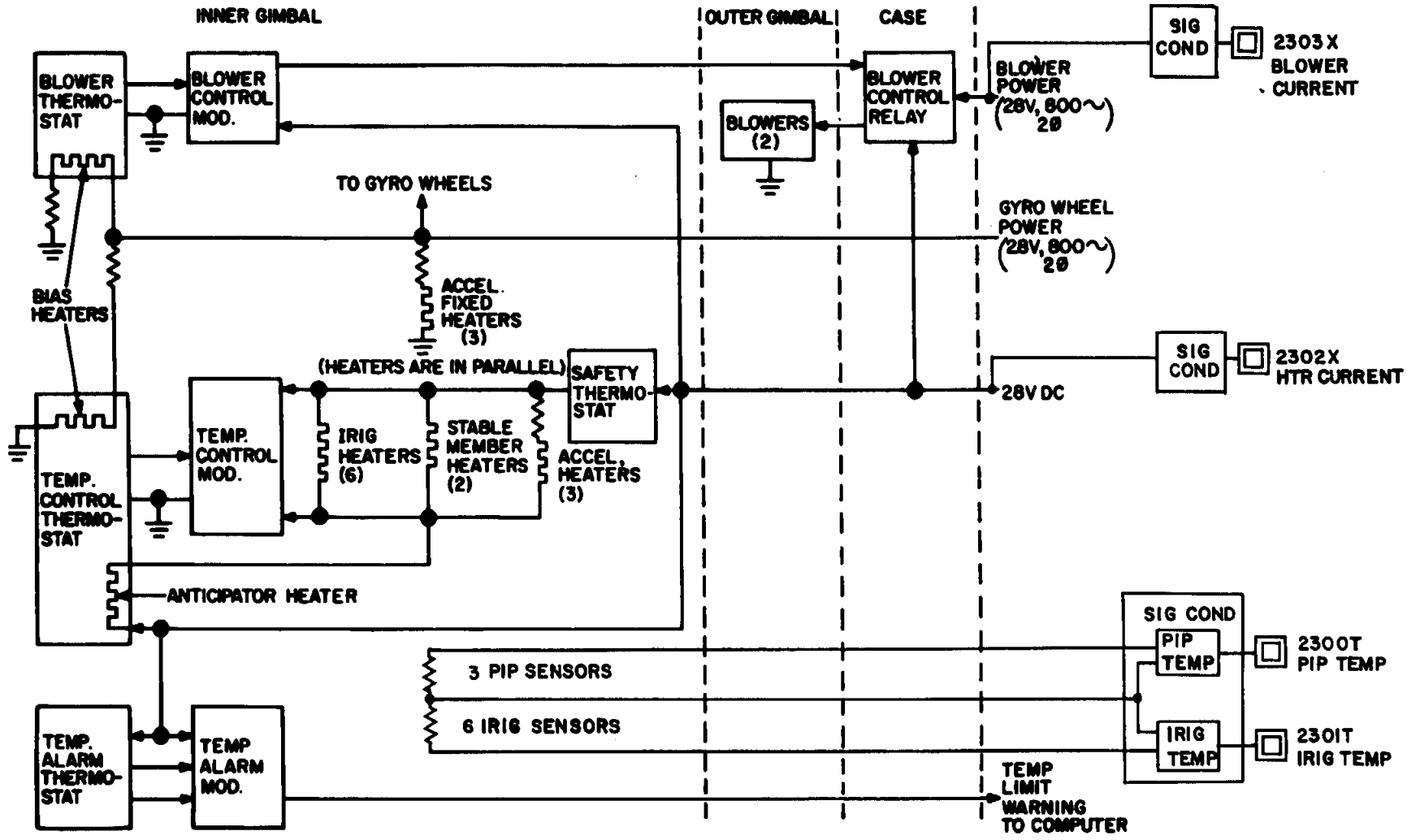


PIP


SIGNAL
GENERATOR
DUCOSYN
PENDULUM
OUTPUT
AXIS
OA
BELLOWS
TORQUE
GENERATOR
DUCOSYN
INPUT AXIS
IA

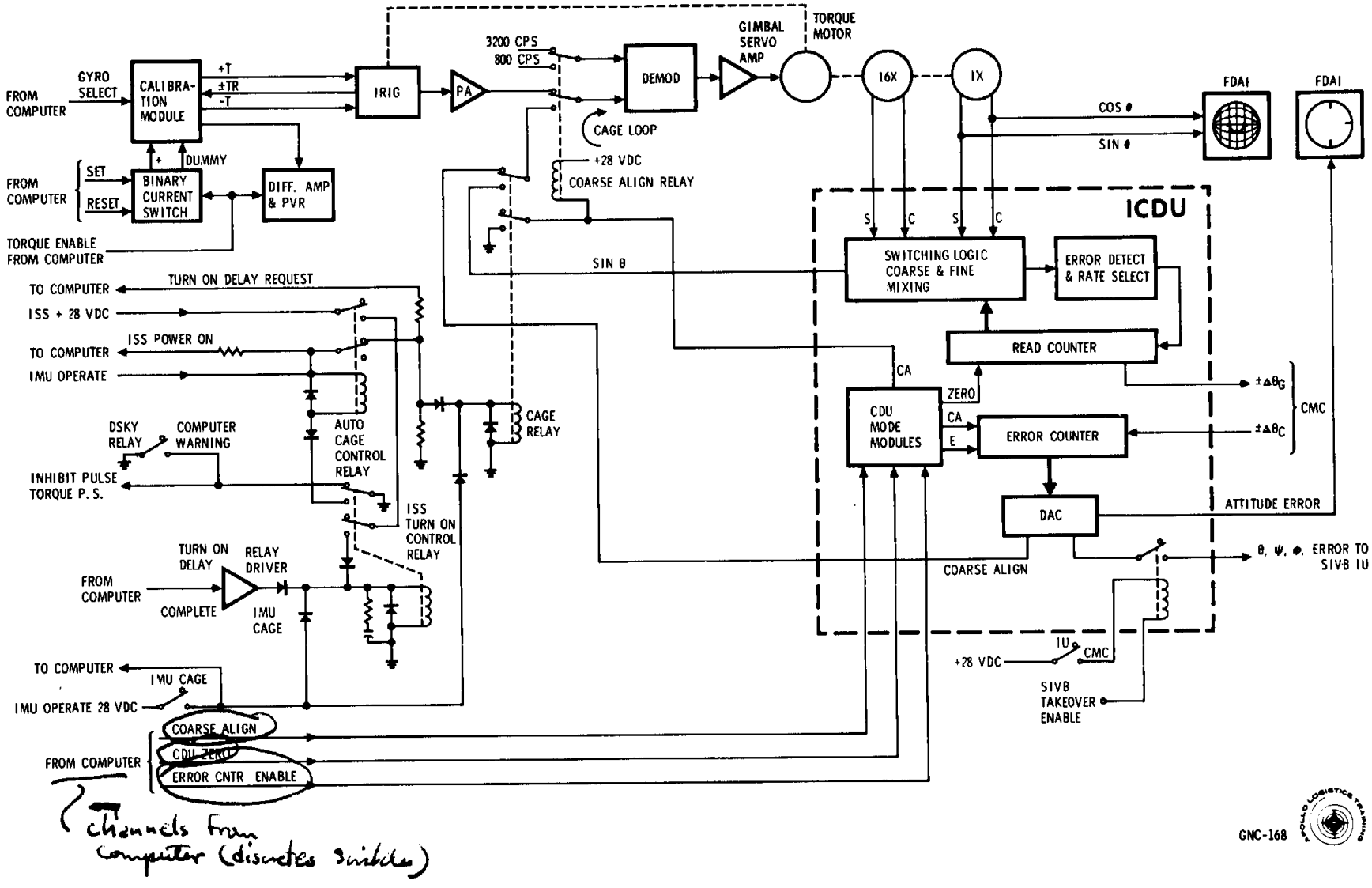
GN-263A

TEMPERATURE CONTROL SYSTEM



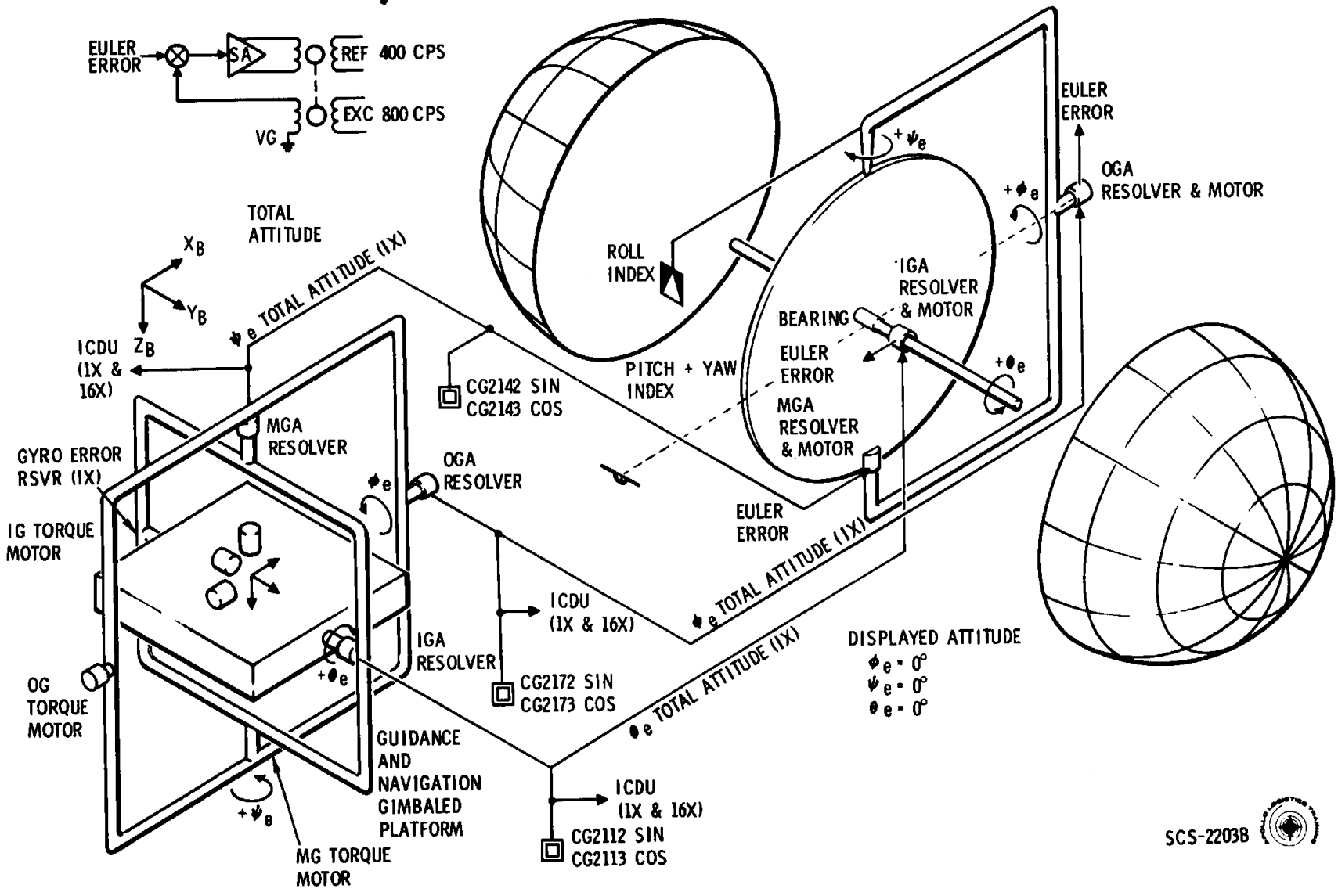
GNC-81A

ISS MODES



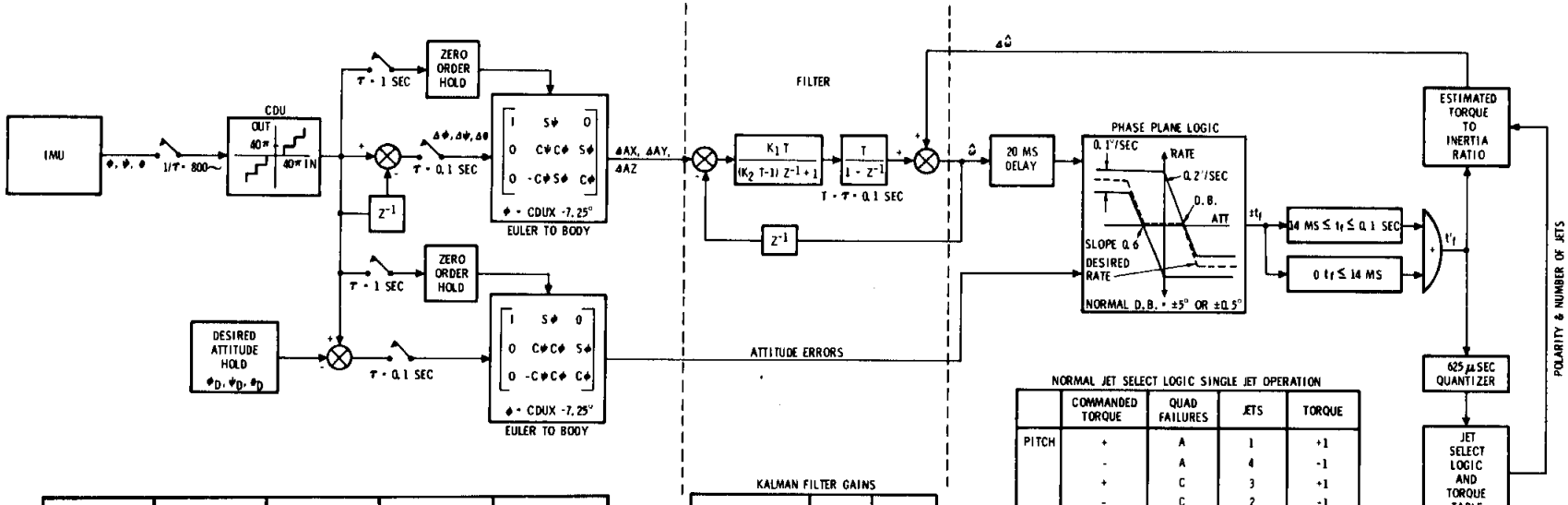
GNC-168

FDAI/IMU GIMBAL RELATIONSHIP



SCS-2203B

RCS DAP MODEL



	VEHICLE CONFIG.	QUAD A/C FOR + $\ddot{X}$	QUAD B/D FOR + $\ddot{X}$	ERR DEADBAND	RATE SELECT
R1	0 = CM 1 = CSM 2 = CSM & LM 3 = CSM & S IVB	0 = NO A/C 1 = A/C	0 = NO B/D 1 = B/D	0 = ±0.5° 1 = ±5.0°	0 = 0.05°/SEC 1 = 0.2°/SEC 2 = 0.5°/SEC 3 = 4.0°/SEC
	ROLL QUAD SELECT	QUAD A FAIL	QUAD B FAIL	QUAD C FAIL	QUAD D FAIL
R2	0 = A/C 1 = B/D	0 = FAIL 1 = NO FAIL	0 = FAIL 1 = NO FAIL	0 = FAIL 1 = NO FAIL	0 = FAIL 1 = NO FAIL

KALMAN FILTER GAINS

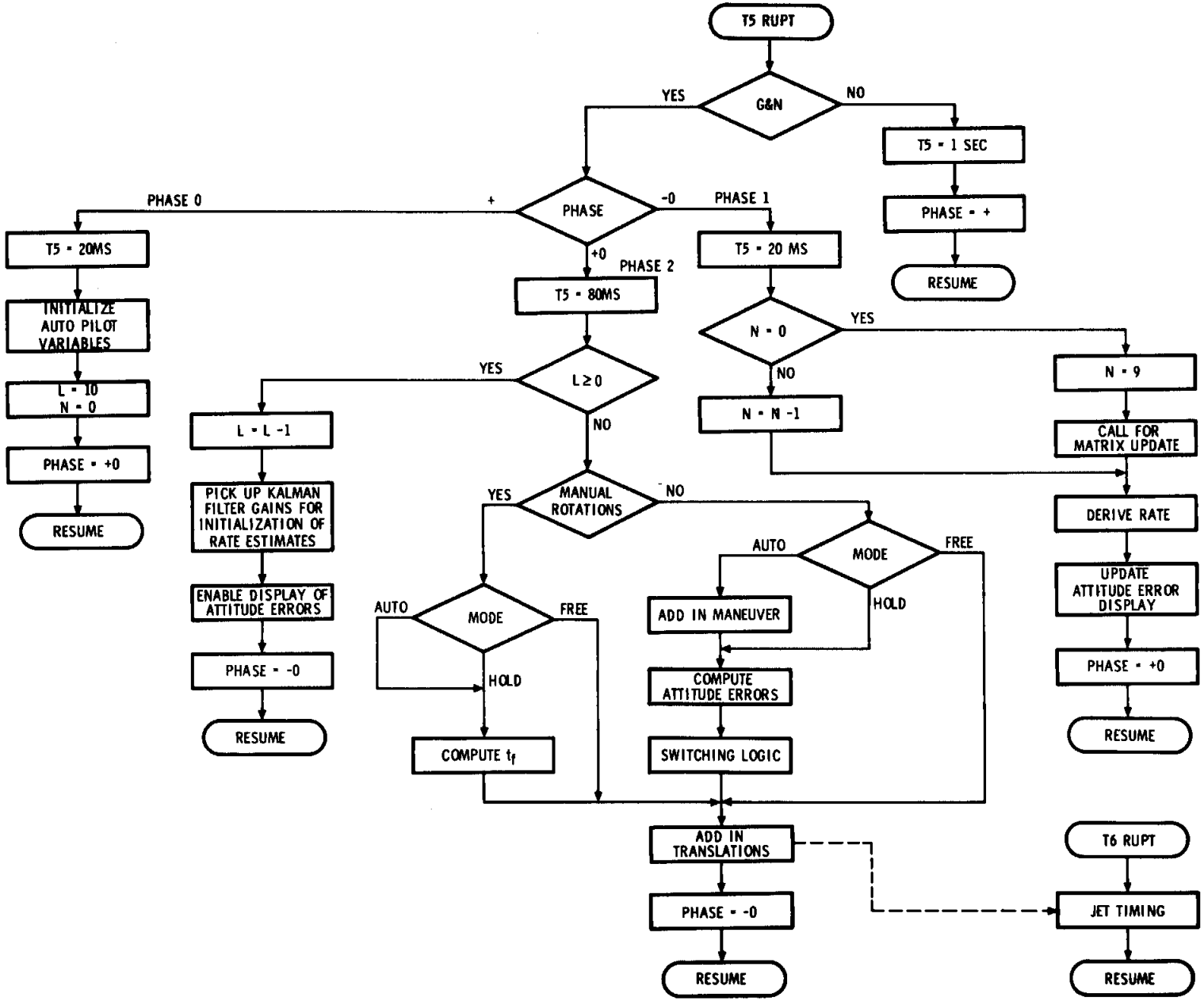
TIME FROM INITIALIZATION	K1	K2
0.1	86.83	9.342
0.2	48.17	8.151
0.3	29.55	6.933
0.4	19.85	5.970
0.5	14.22	5.223
0.6	10.69	4.634
0.7	8.32	4.161
0.8	6.66	3.774
0.9	5.45	3.452
1.0	4.54	3.180
1.1	0.16	0.640

NORMAL JET SELECT LOGIC SINGLE JET OPERATION

	COMMANDED TORQUE	QUAD FAILURES	JETS	TORQUE
PITCH	+	A	1	+1
	-	A	4	-1
	+	C	3	+1
	-	C	2	-1
YAW	+	B	5	+1
	-	B	8	-1
	+	D	7	+1
	-	D	6	-1
ROLL	+	A	15	+1
	-	A	14	-1
	+	C	13	+1
	-	C	16	-1
	+	B	11	+1
	-	B	10	-1
	+	D	9	+1
	-	D	12	-1

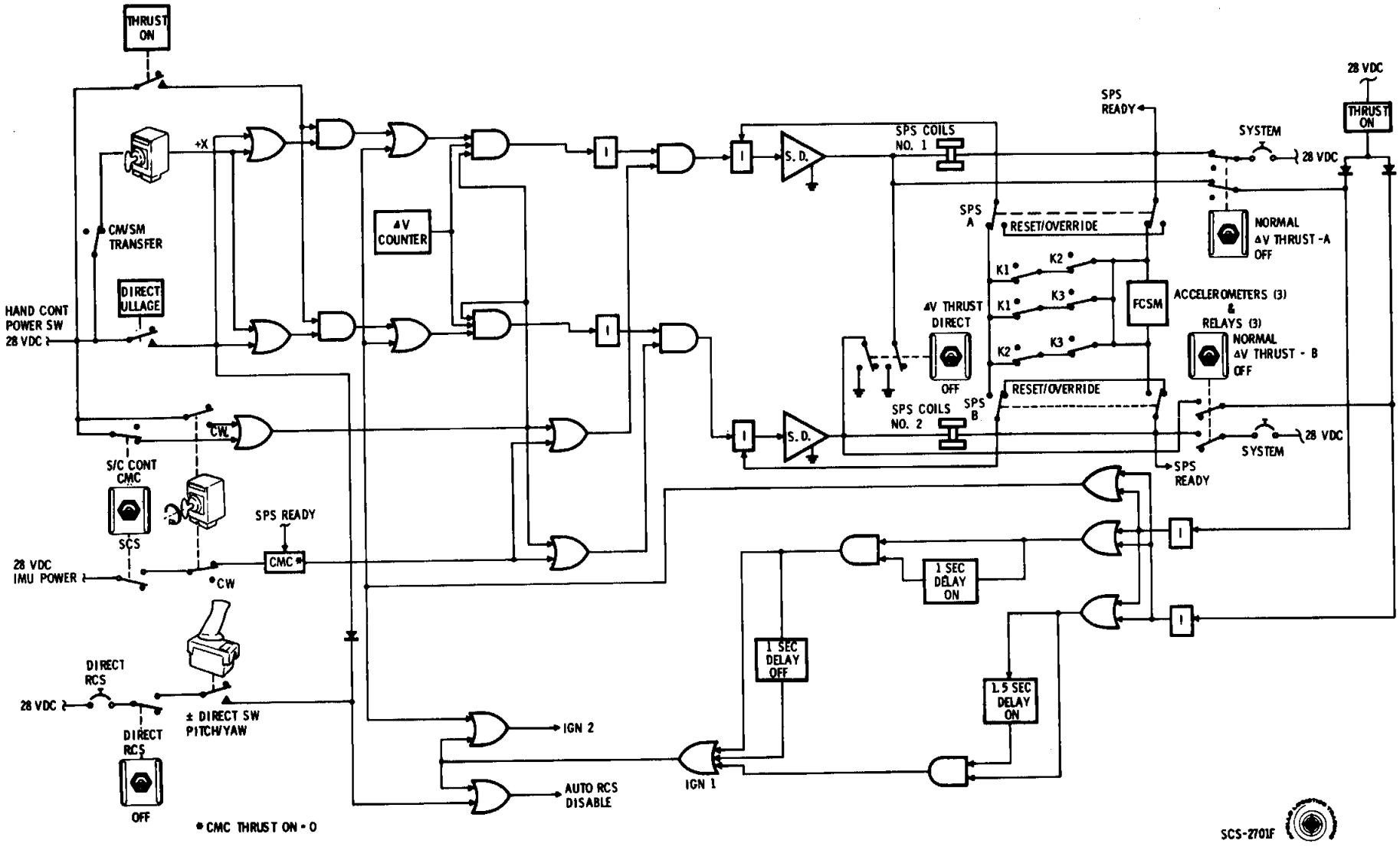
GNC-159A

PROGRAM LOGIC FLOW RCS DAP



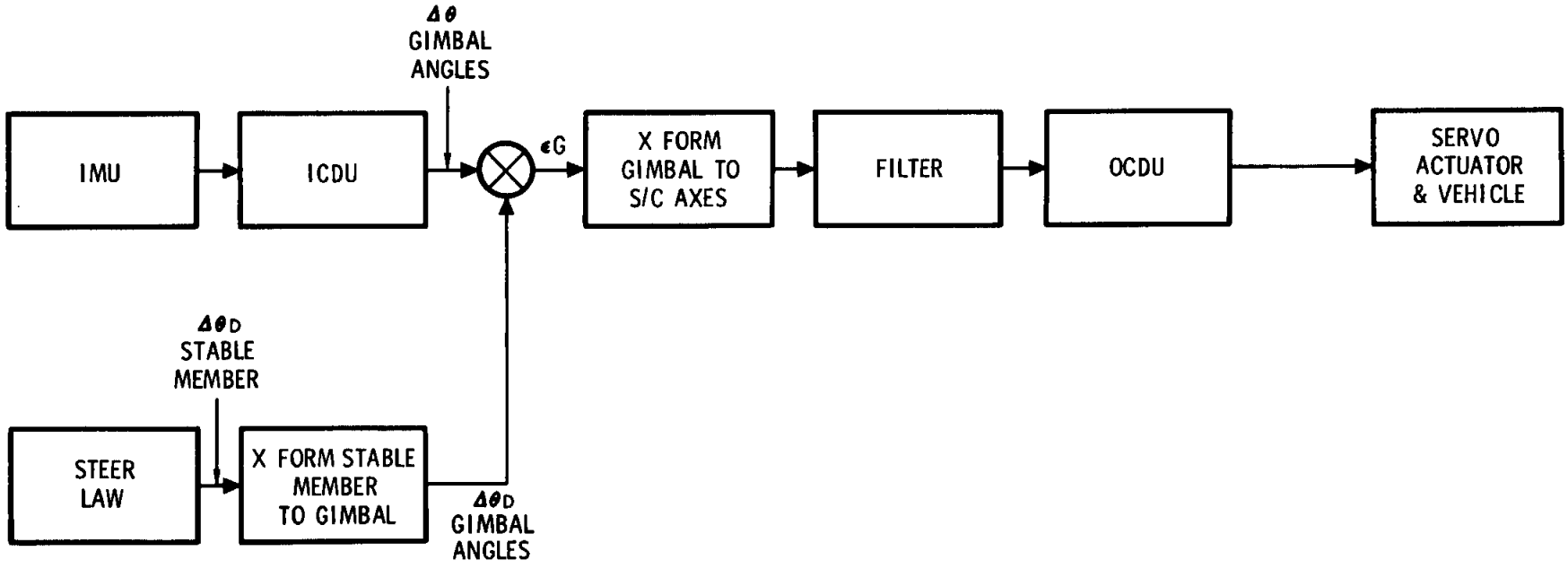
GNC-160A

SPS ENGINE ON-OFF LOGIC



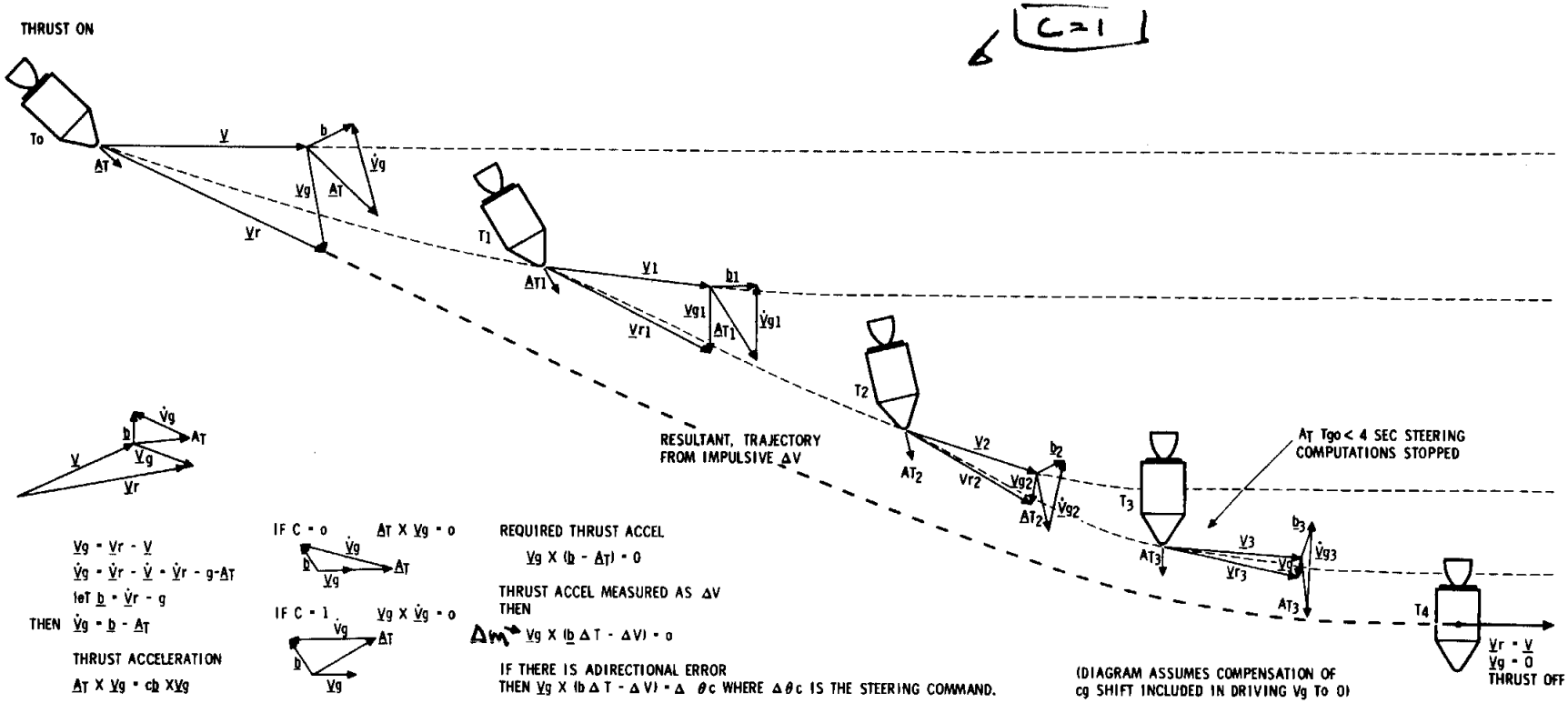
TVC DAP

SIMPLIFIED BLOCK DIAGRAM



STEERING FOR ORBITAL MANUEVERS

C=1



$\dot{V}g = \dot{V}r - \dot{V}$

$\dot{V}g = \dot{V}r - \dot{V} = \dot{V}r - g - \Delta T$

let $\underline{b} = \dot{V}r - g$

THEN $\dot{V}g = \underline{b} - \Delta T$

THRUST ACCELERATION

$\Delta T \times Vg = c\underline{b} \times Vg$

IF C = o $\quad \Delta T \times Vg = o$

IF C = 1 $\quad Vg \times \dot{V}g = o$

REQUIRED THRUST ACCEL

$Vg \times (\underline{b} - \Delta T) = 0$

THRUST ACCEL MEASURED AS ΔV

THEN

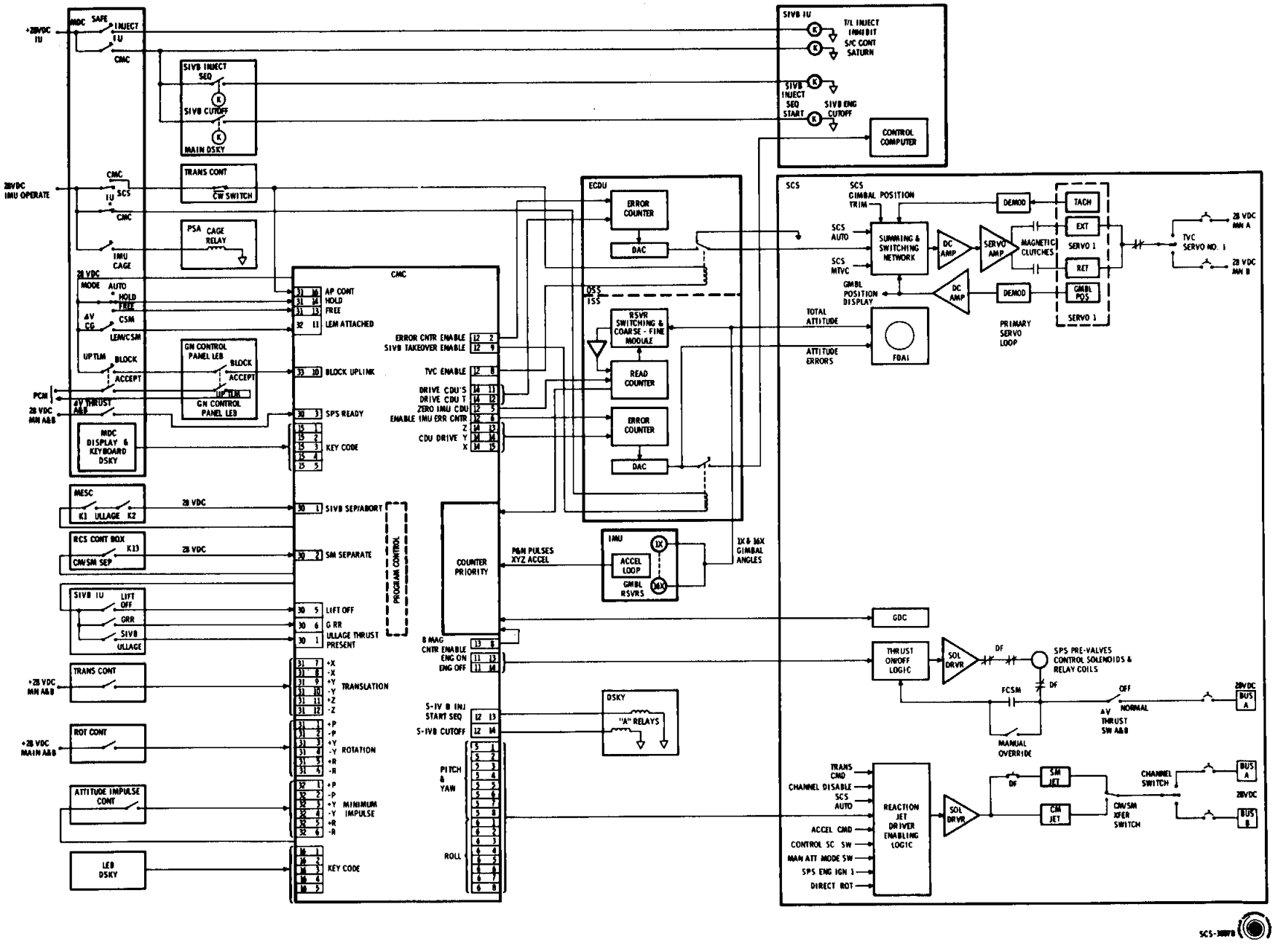
$\Delta m \rightarrow Vg \times (\underline{b}\,\Delta T - \Delta V) = o$

IF THERE IS ADIRECTIONAL ERROR

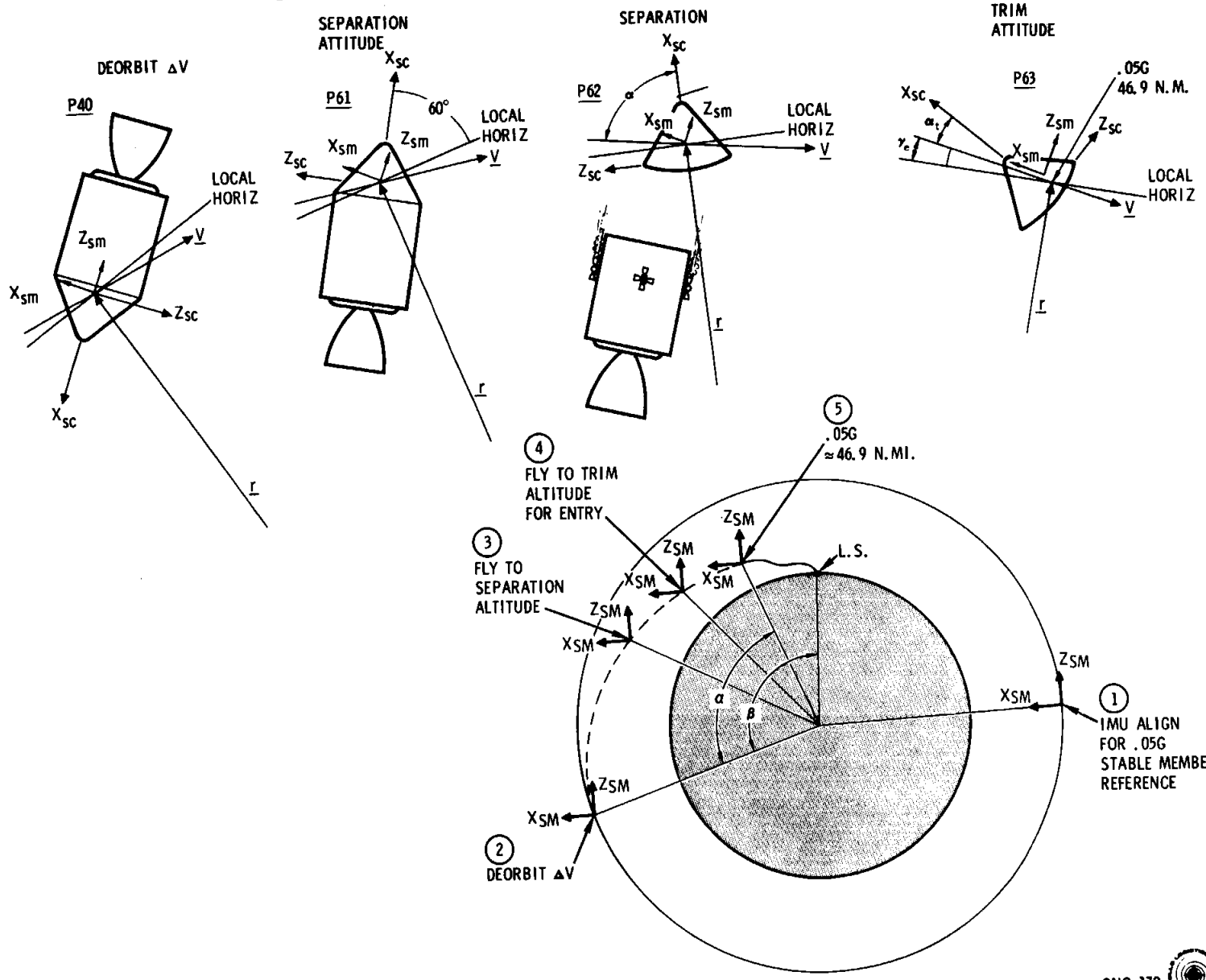
THEN $Vg \times (\underline{b}\,\Delta T - \Delta V) = \Delta\ \theta c$ WHERE $\Delta\theta c$ IS THE STEERING COMMAND.

(DIAGRAM ASSUMES COMPENSATION OF cg SHIFT INCLUDED IN DRIVING Vg To 0)

G & C FUNCTIONAL FLOW



PREPARATION FOR ENTRY



GNC-172

PGNCS A/B TLM LIST

PCM

Measurement No.	Measurement Description	Channel Code	S/S
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 20018	X PIPA SG OUTPUT IN PHASE	51A2	50
CG 20218	Y PIPA SG OUTPUT IN PHASE	51A3	50
CG 20418	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

Measurement No.	Measurement Description	Channel Code	S/S
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

Measurement ID	Measurement Description	Response Rate	Sensor Range Low	Sensor Range High	Display Readout	Channel Code
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

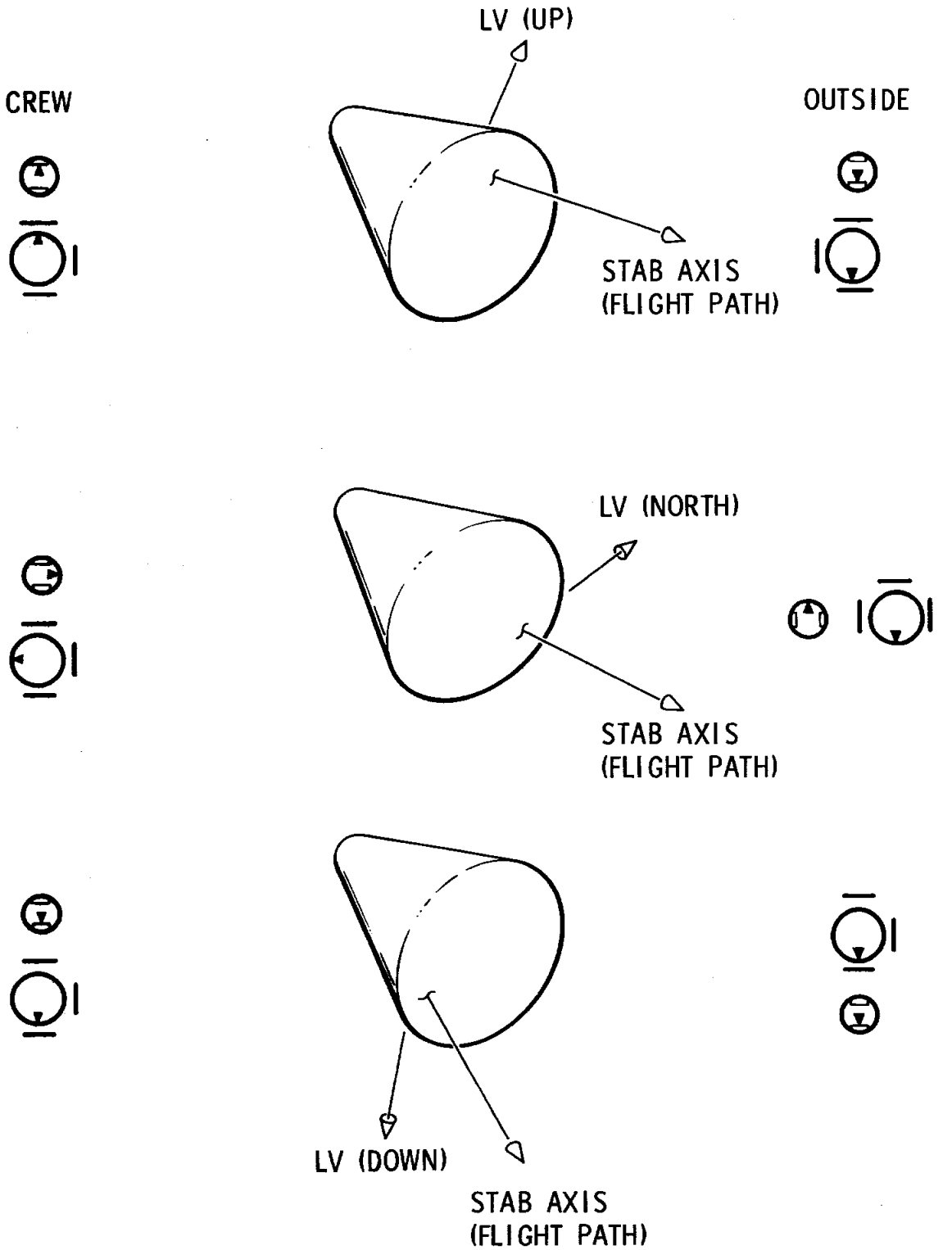
SCS TM List

Measurement ID	Measurement Description	Response Rate	Sensor Range Low	Sensor Range High	Display Readout	Channel Code
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

Measurement ID	Measurement Description	Response Rate	Sensor Range Low	Sensor Range High	Display Readout	Channel Code
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

ENTRY DISPLAYS



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