



APOLLO
CSM LOGISTICS TRAINING
TELECOMMUNICATION
SUBSYSTEM
BLOCK II

JUNE 3, 1969 FOR TRAINING PURPOSES ONLY

SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION

QUESTIONS RELATIVE TO THE CONTENTS OF THIS
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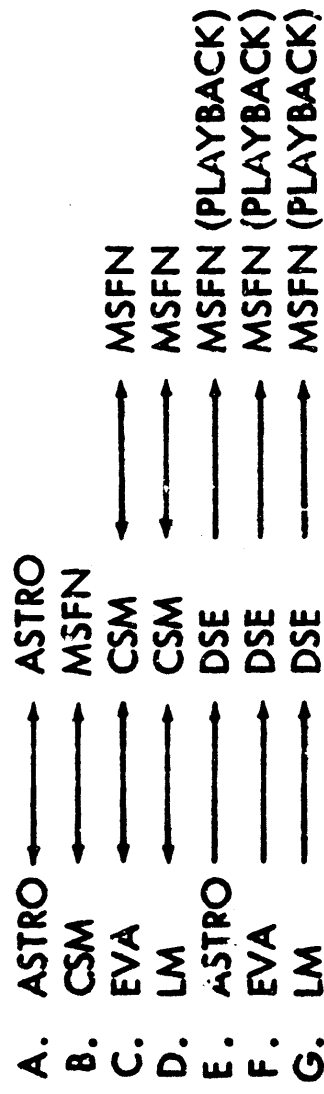
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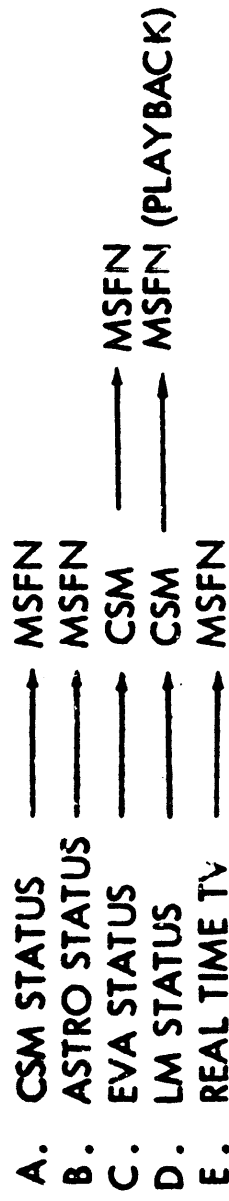
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BLOCK II TELECOMMUNICATION SYSTEM FUNCTIONS

I VOICE COMMUNICATIONS



II DOWN DATA



III UP DATA

- A. REAL TIME COMMANDS (RTC) RELAY CLOSURES
- B. COMMAND MODULE COMPUTER (CMC) UPDATING
- C. CENTRAL TIMING EQUIPMENT (CTE) UPDATING

IV TRACKING

- A. TRANS LUNAR (DOUBLE DOPPLER AND PSEUDO RANDOM NOISE RANGING)
- B. CSM/LM RENDEZVOUS

V RECOVERY

- A. CM VOICE ↔ RECOVERY FORCES
- B. VHF BEACON ↔ RECOVERY FORCES

TELECOMMUNICATIONS EQUIPMENT

AUDIO

PERSONNEL COMMUNICATIONS ASSEMBLY
AUDIO CONTROL PANELS
AUDIO CENTER

DATA

TELEVISION CAMERA (TV)
CENTRAL TIMING EQUIPMENT (CTE)
SIGNAL CONDITIONING EQUIPMENT (SCE)
PULSE CODE MODULATION TELEMETRY (PCM)
DATA STORAGE EQUIPMENT (DSE)
UP DATA LINK (UDL)

RF

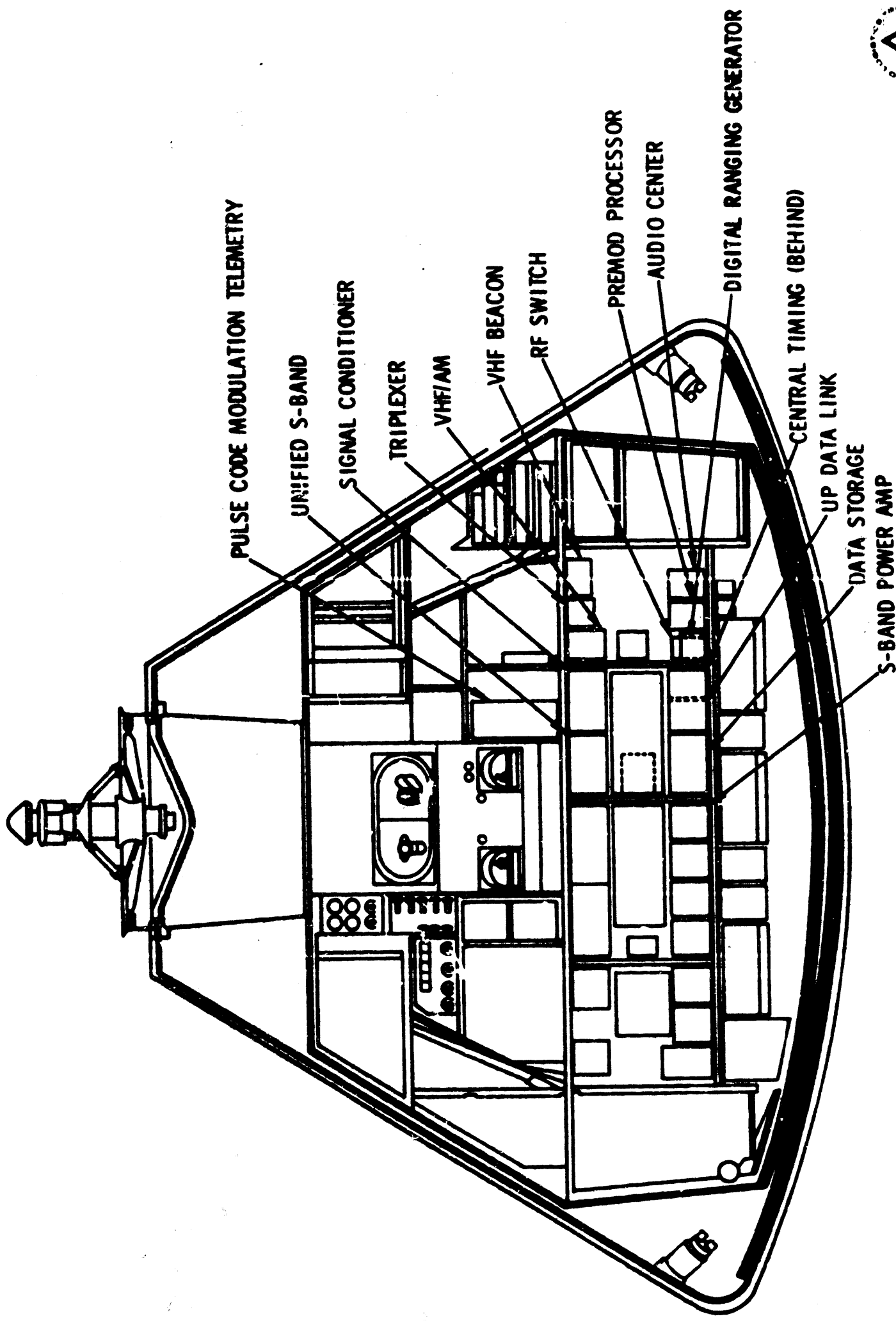
PREMODULATION PROCESSOR (PMP)
UNIFIED S BAND EQUIPMENT (USBE)
VHF/AM TRANSCEIVERS
DIGITAL RANGING GENERATOR
VHF RECOVERY BEACON
RENDEZVOUS RADAR TRANSPONDER (RRT)

ANTENNA (PRESENTED WITH ASSOCIATED RF EQUIPMENT)

S BAND FLUSH MOUNTED
S BAND HIGH GAIN
VHF SCIMITARS
VHF RECOVERY
RENDEZVOUS RADAR TRANSPONDER (RRT) BEAM SPLITTER

TELECOMMUNICATIONS EQUIPMENT

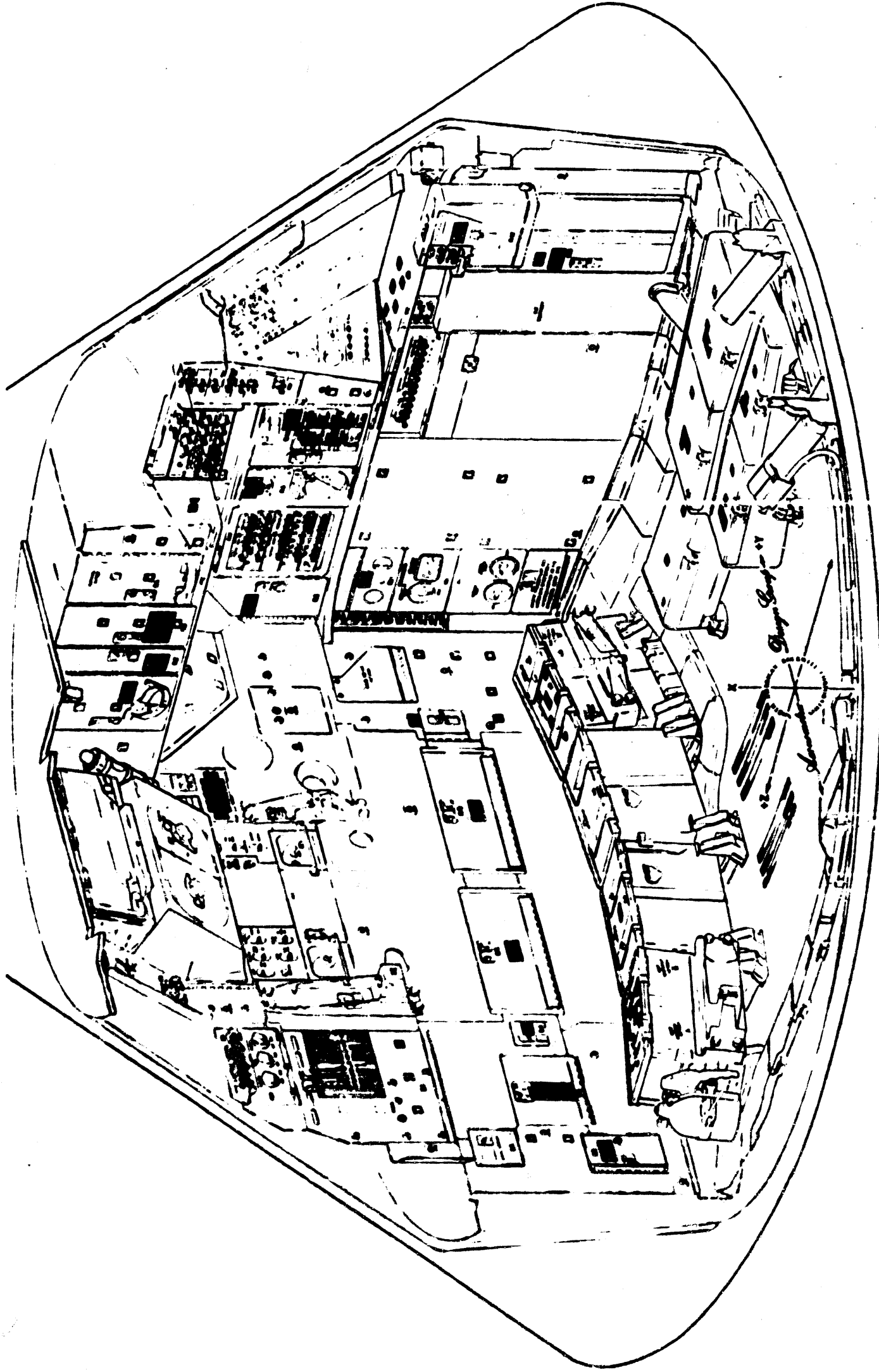
LOWER EQUIPMENT BAY BLOCK II



CD-2006 B

APOLLO CM INTERIOR CONFIGURATION

LES, RHFEB, RHIES, RHES & AS

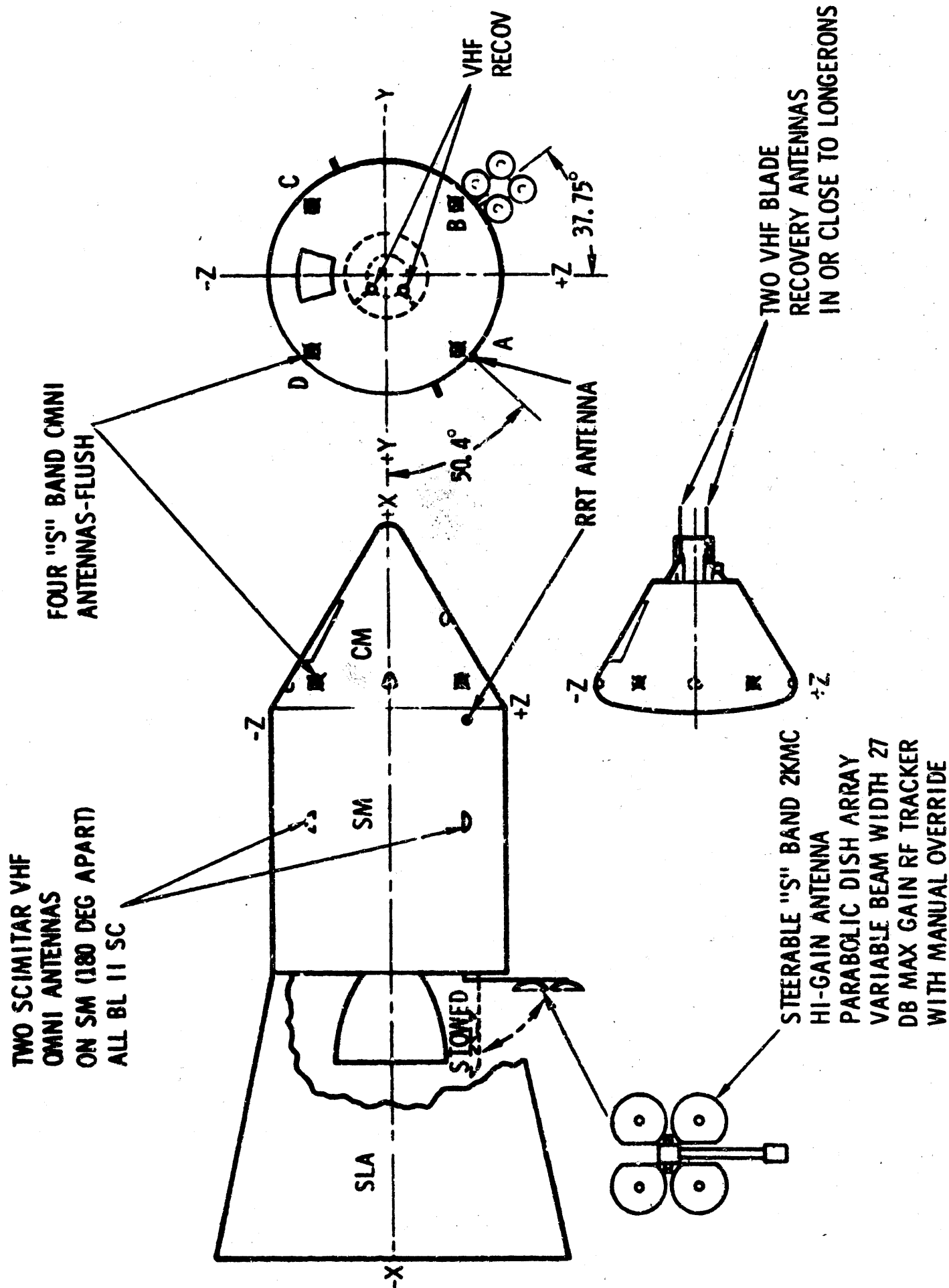


VIEW LOOKING DOWN & OUTBOARD

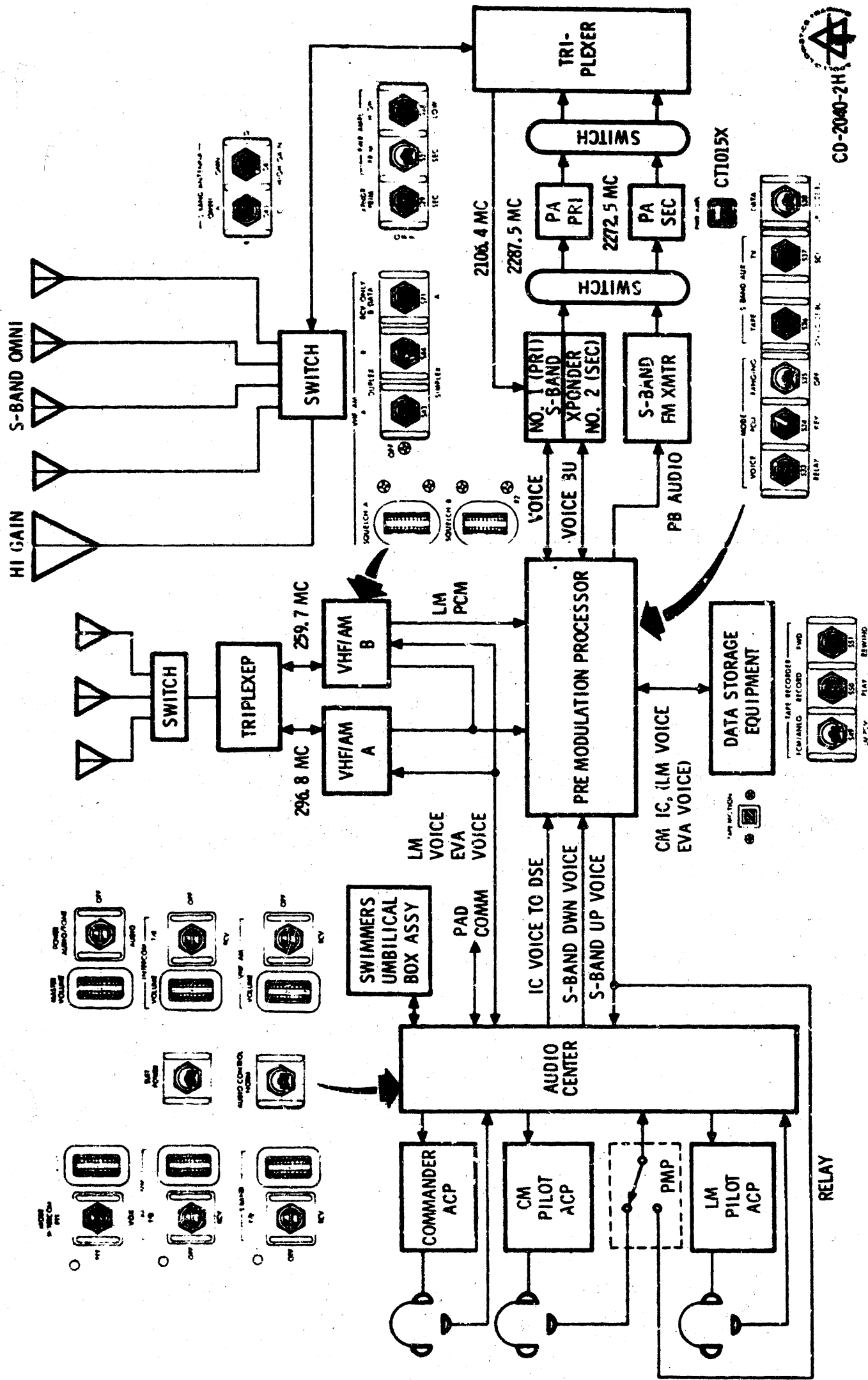
CS-001 (A)

FEB 69

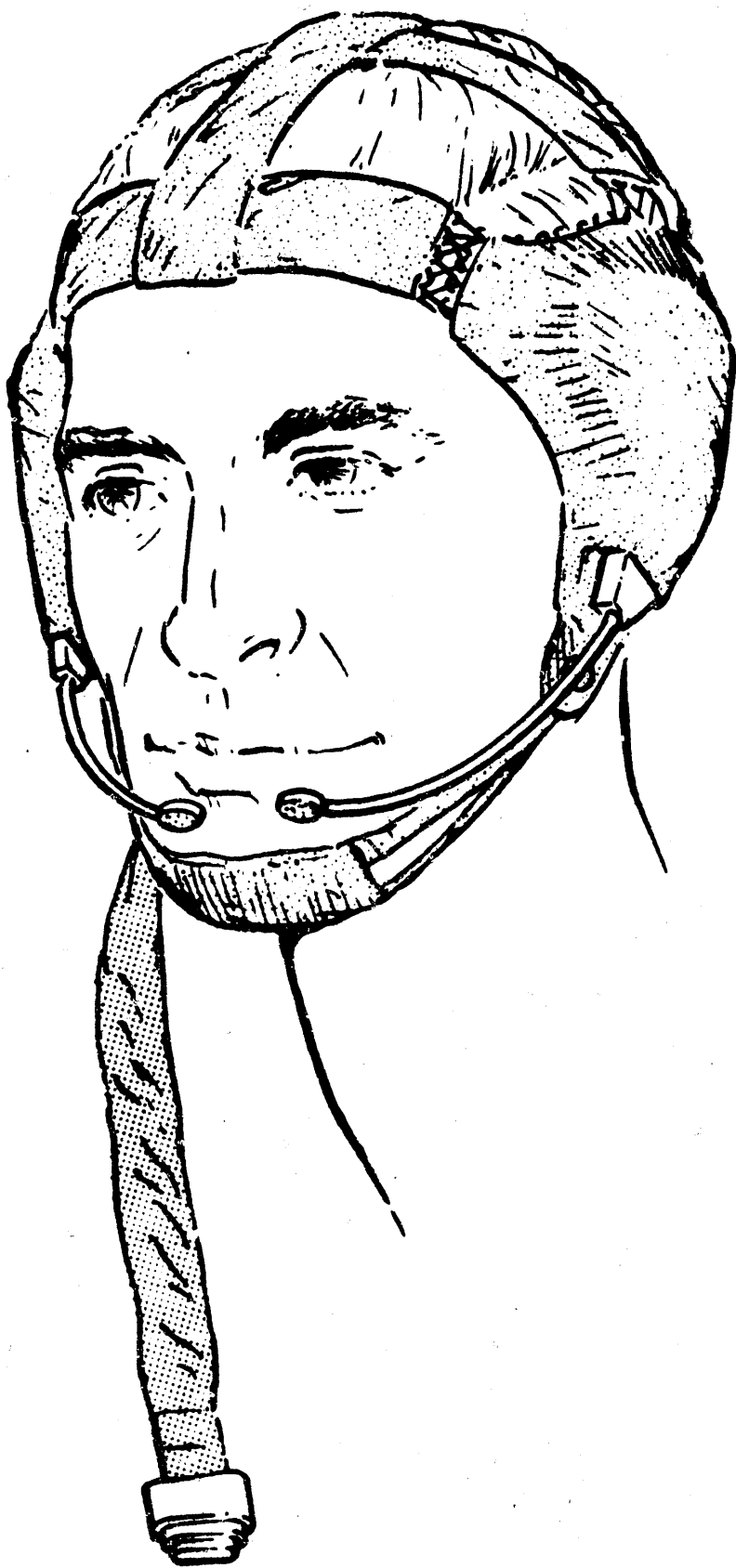
ANTENNA



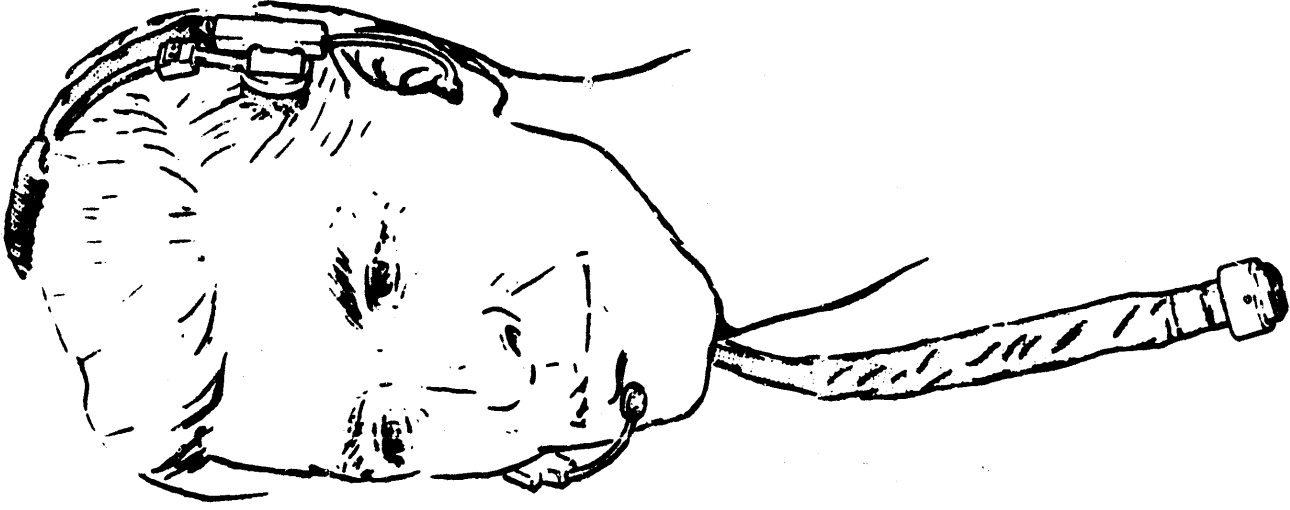
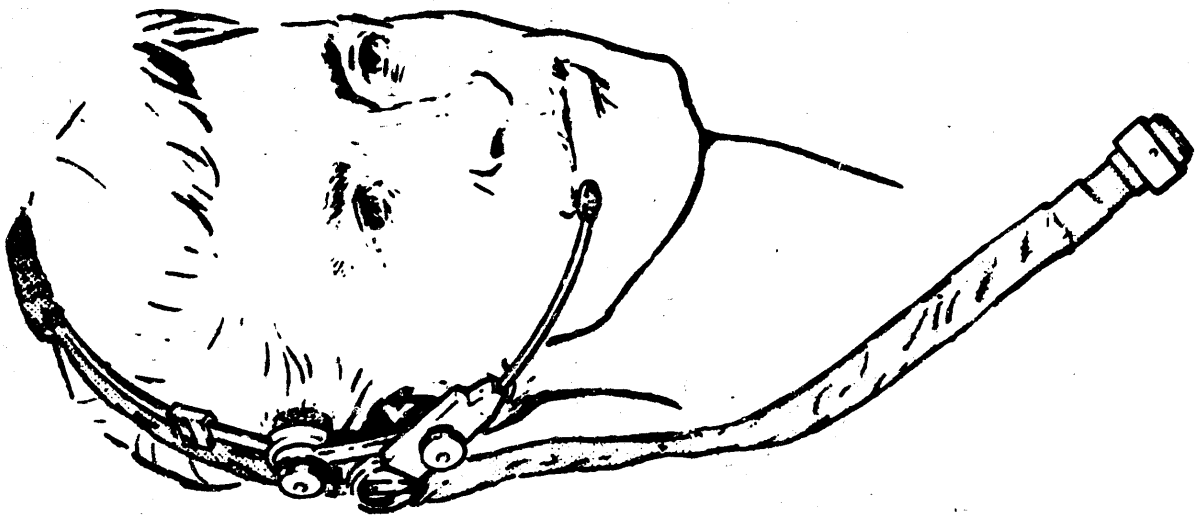
AUDIO INTERFACES



PERSONAL COMMUNICATIONS ASSEMBLY (SOFT HAT)

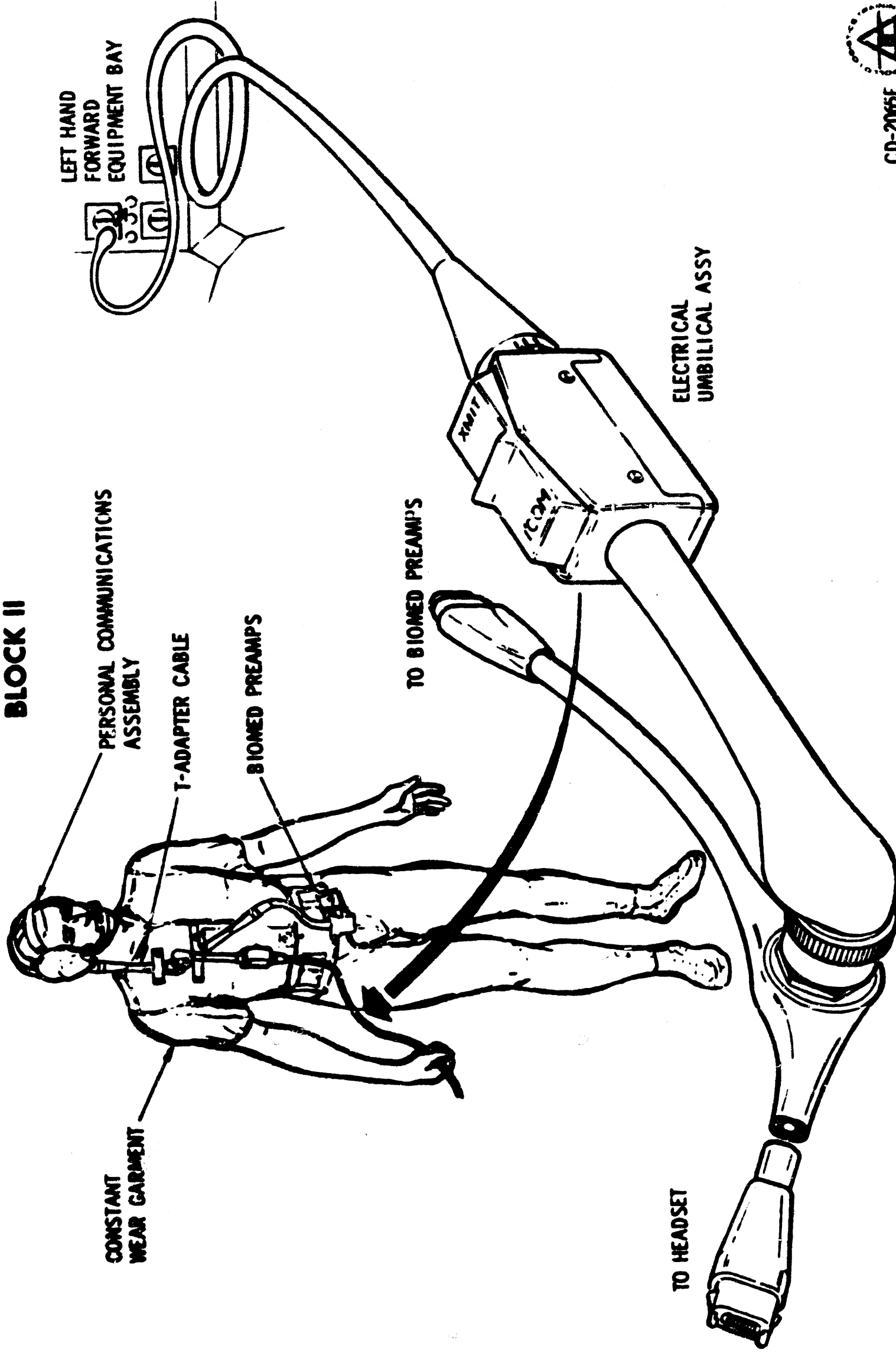


LIGHT WEIGHT HEADSET



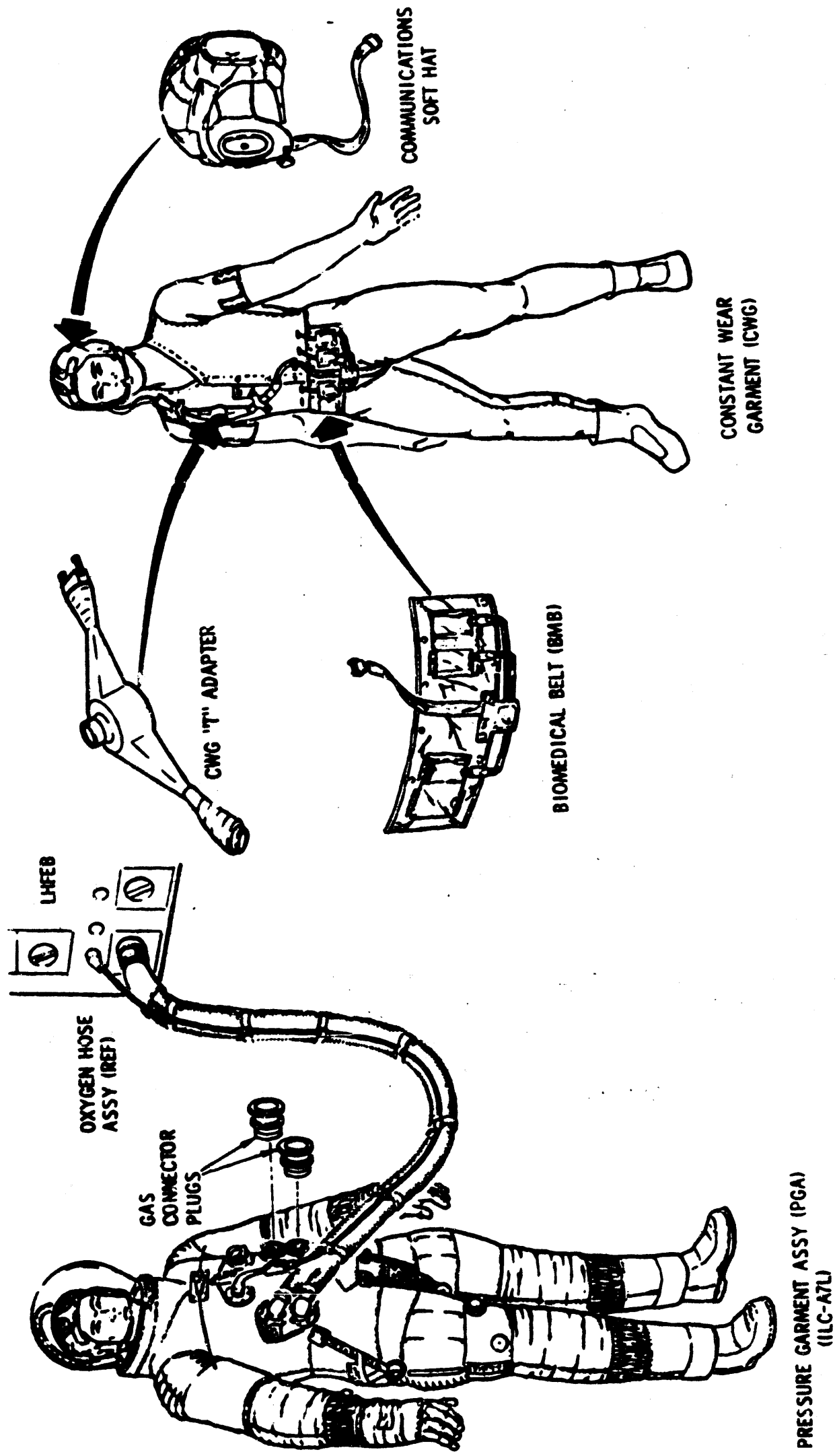
ELECTRICAL UMBILICAL (COMM CABLE)

BLOCK II



CD-2065E

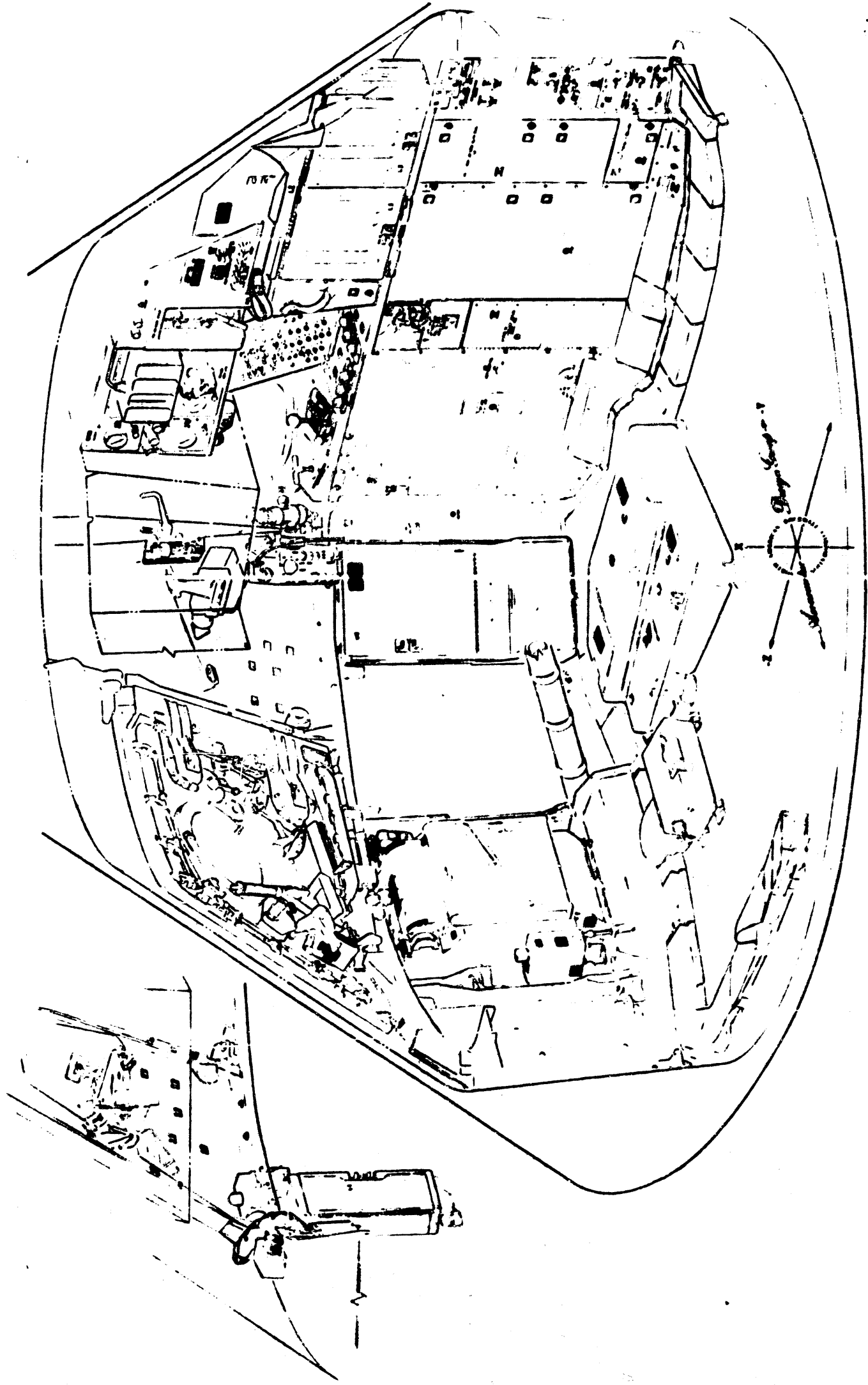
SPACESUIT ASSEMBLY



CD-2147

APOLLO CM INTERIOR CONFIGURATION

LHFB, LHFB, LHFB, UEB & AB

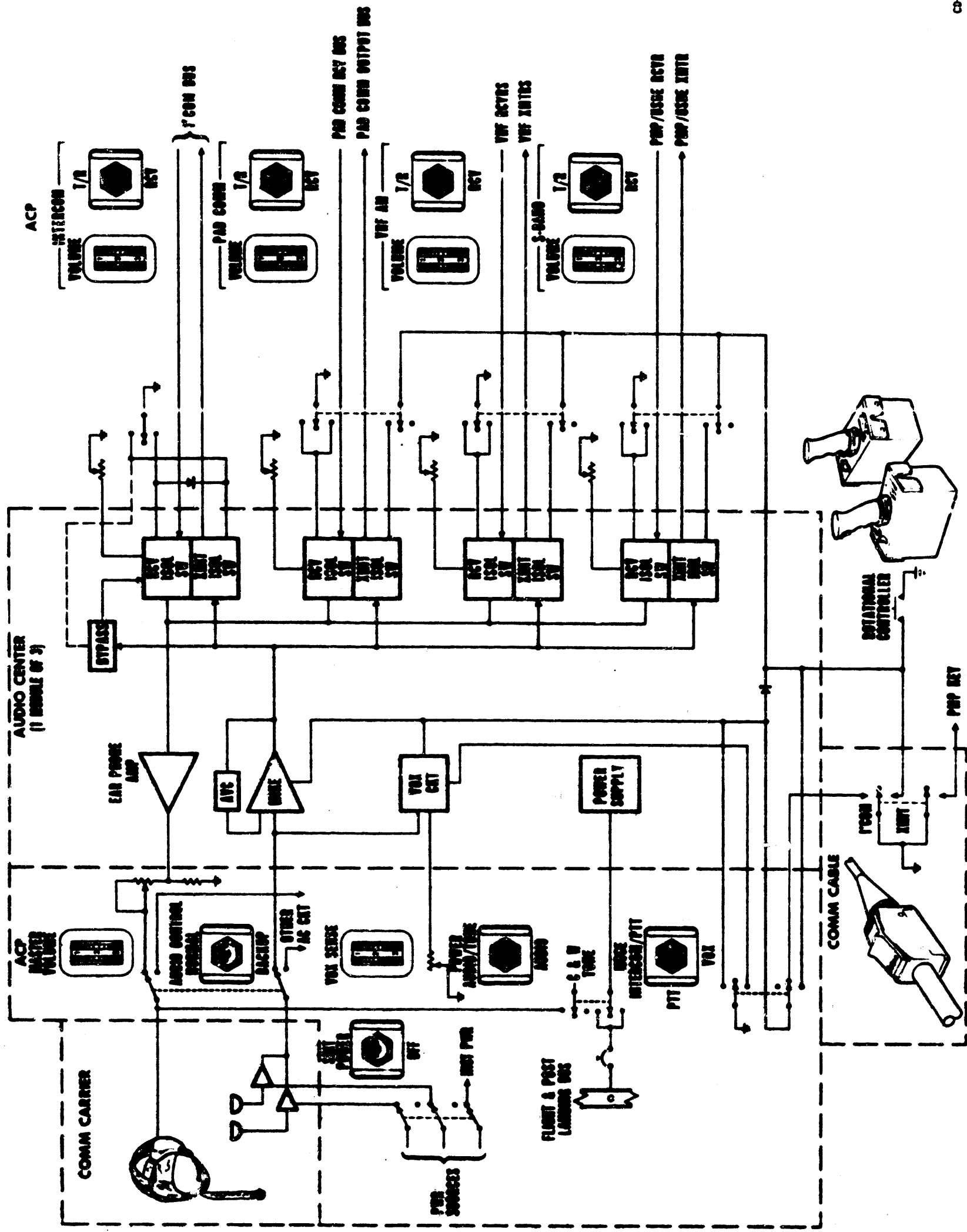


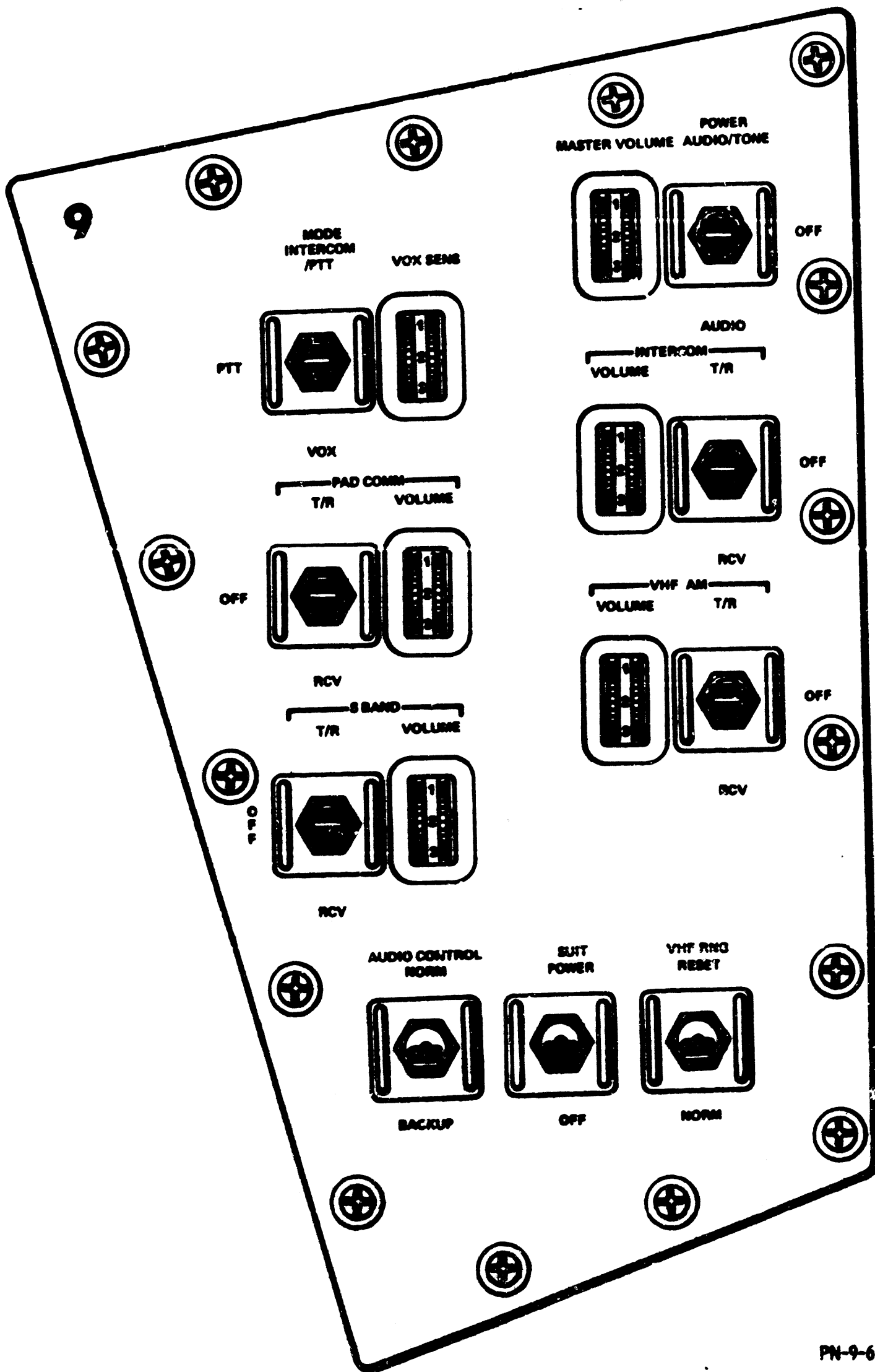
VIEW LOOKING DOWN & OUTBOARD

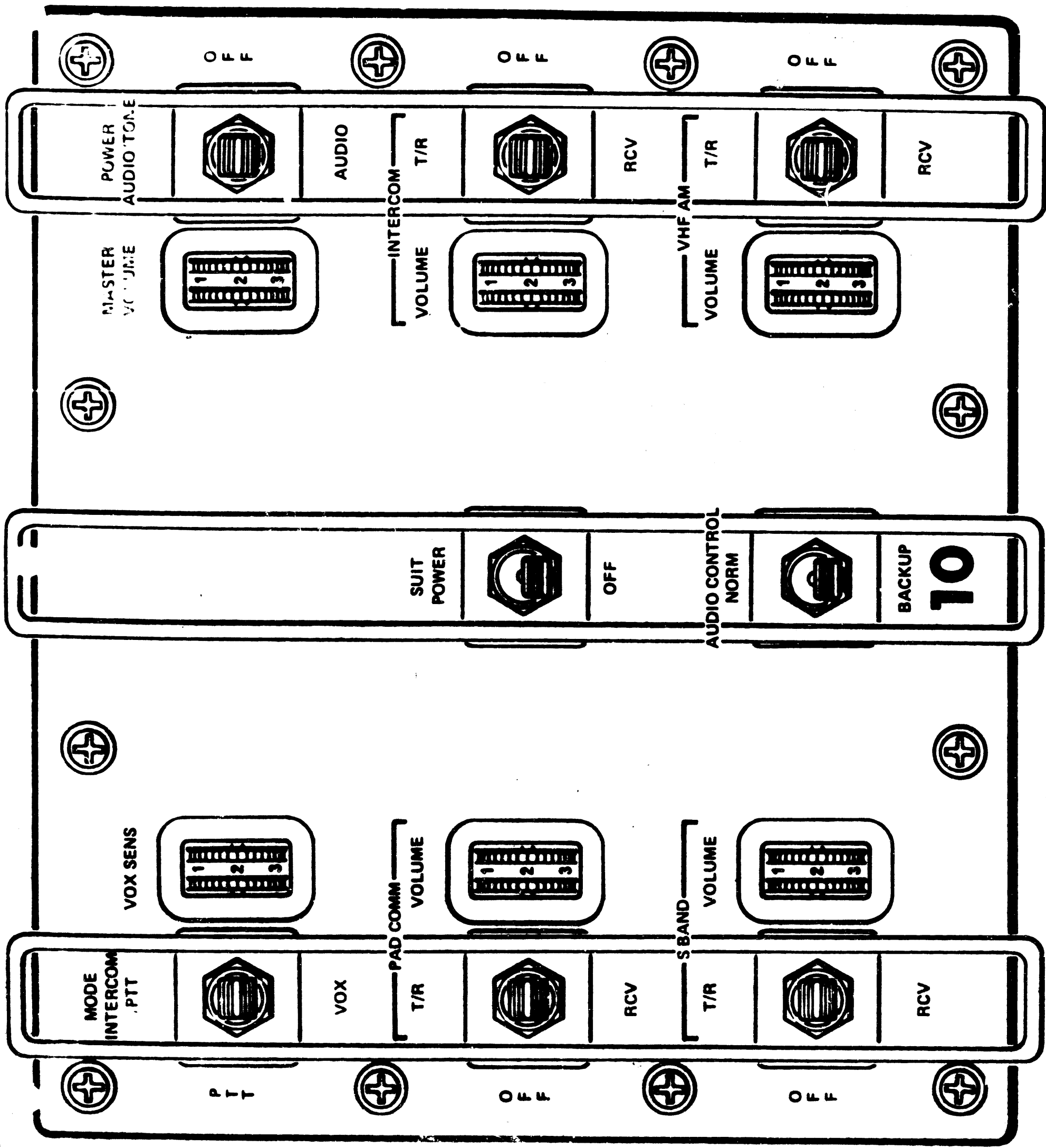
FIG. 60

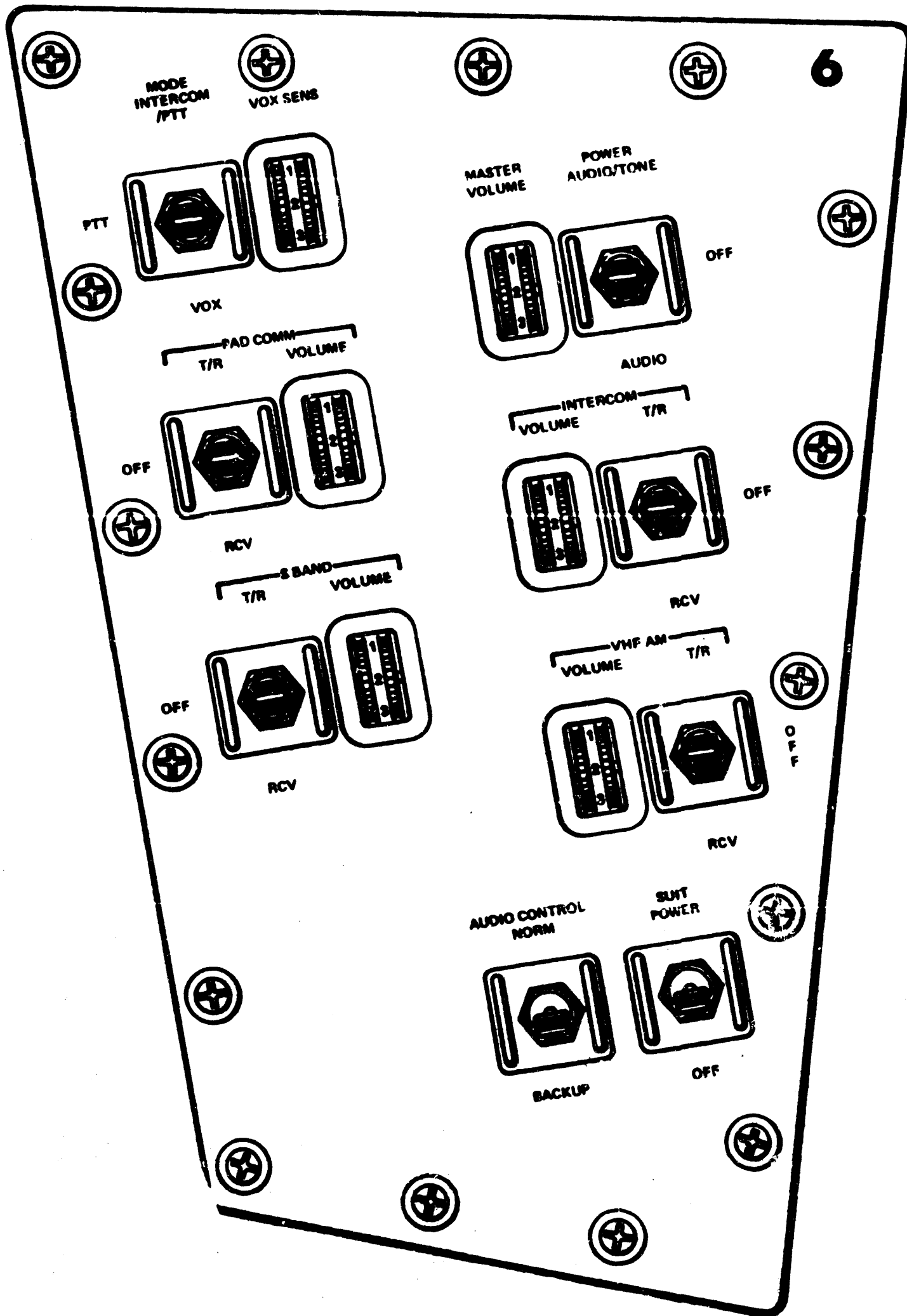
CS-0017 4

AUDIO CENTER BLOCK & SWITCHING DIAGRAM

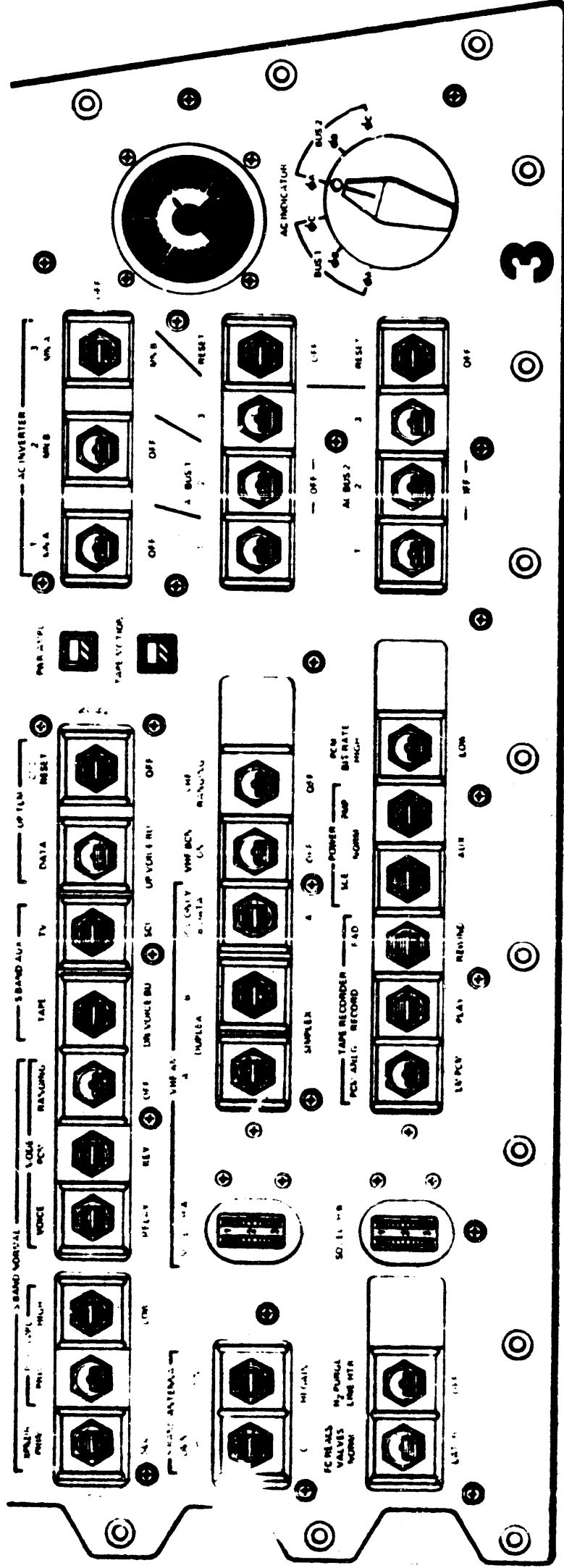








CSM 106 AND 107



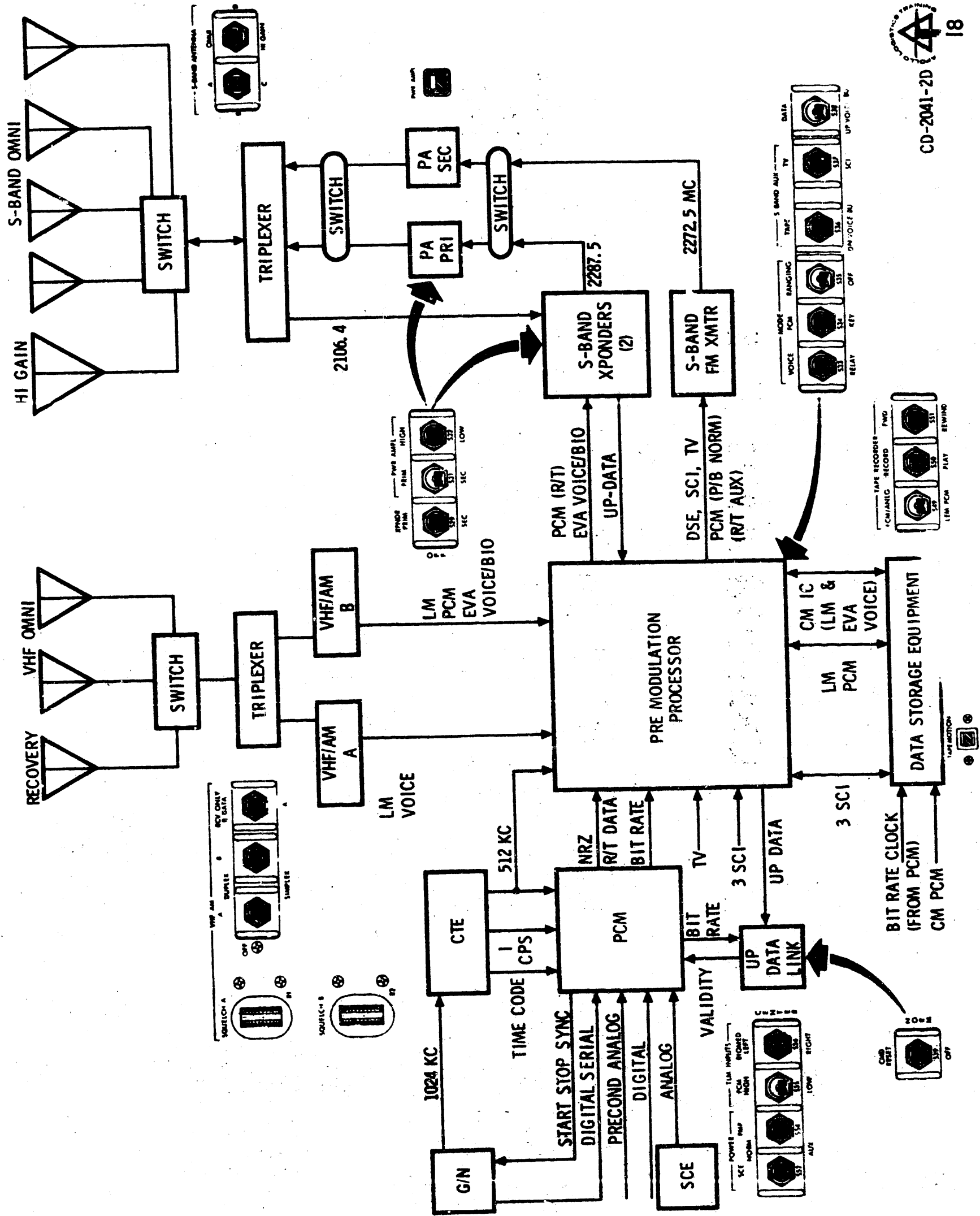
PN-3C-6A



PN-3C-8A

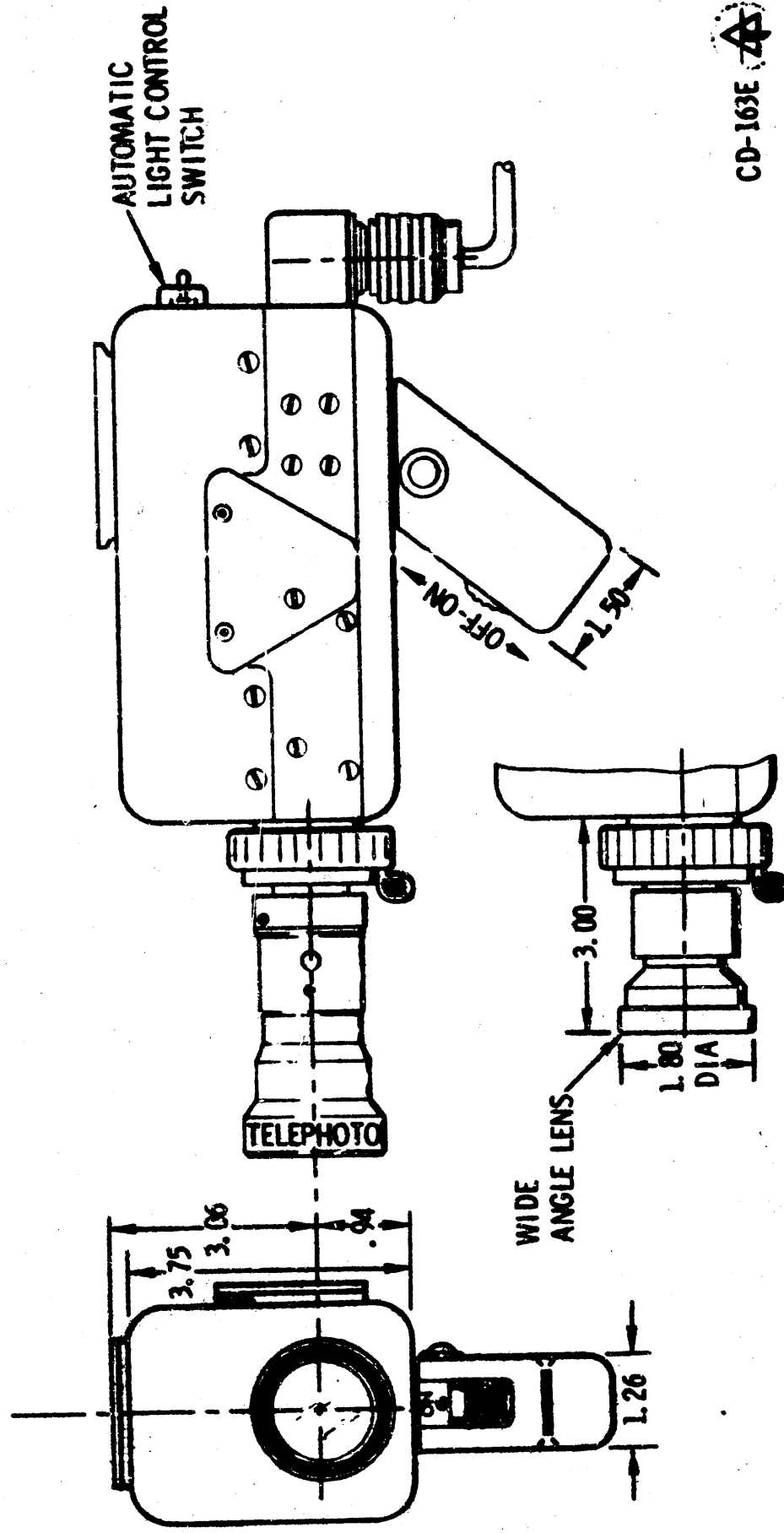
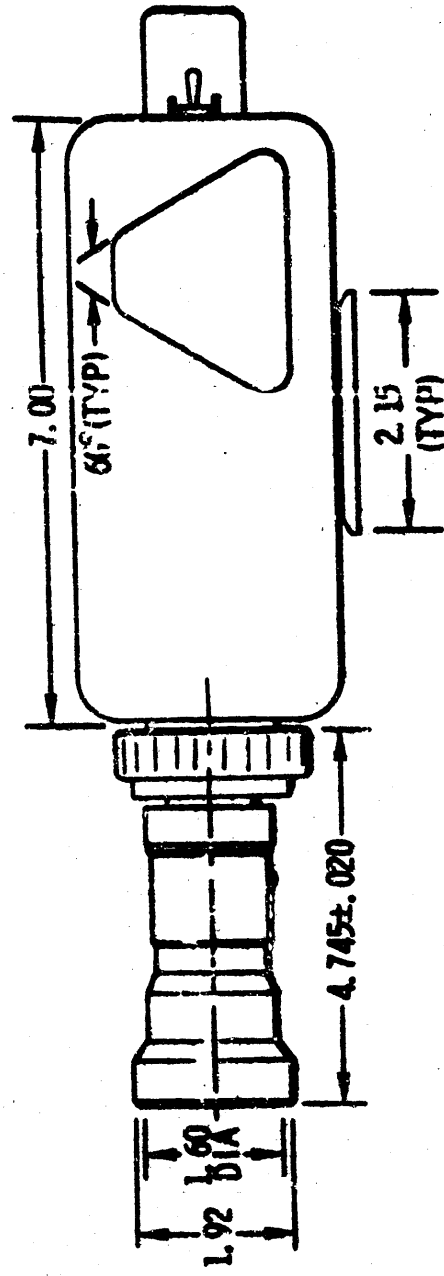
DATA INTERFACES

BLOCK II



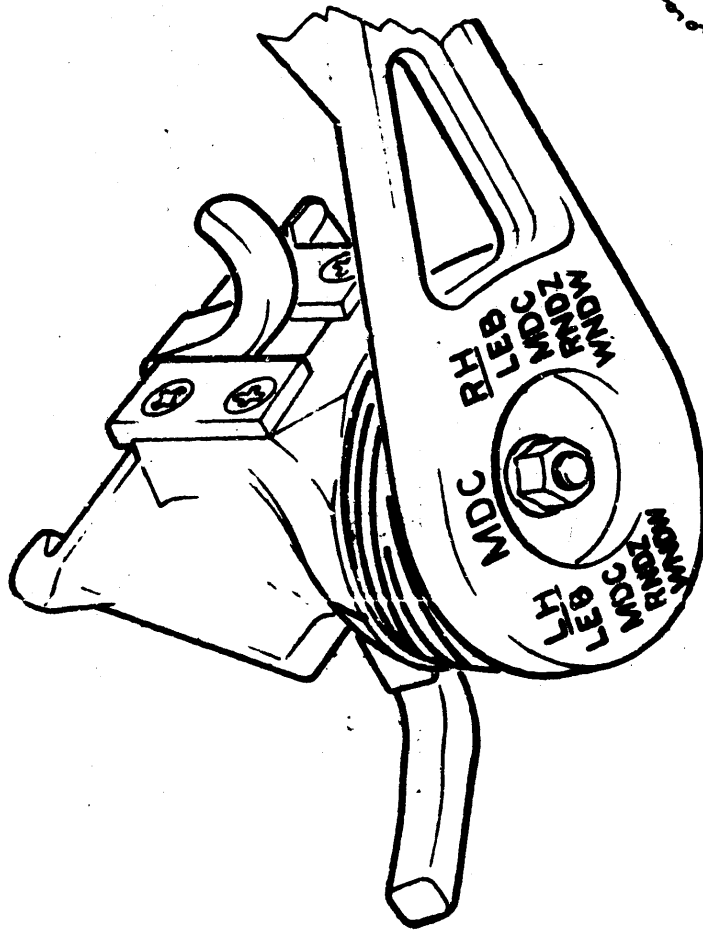
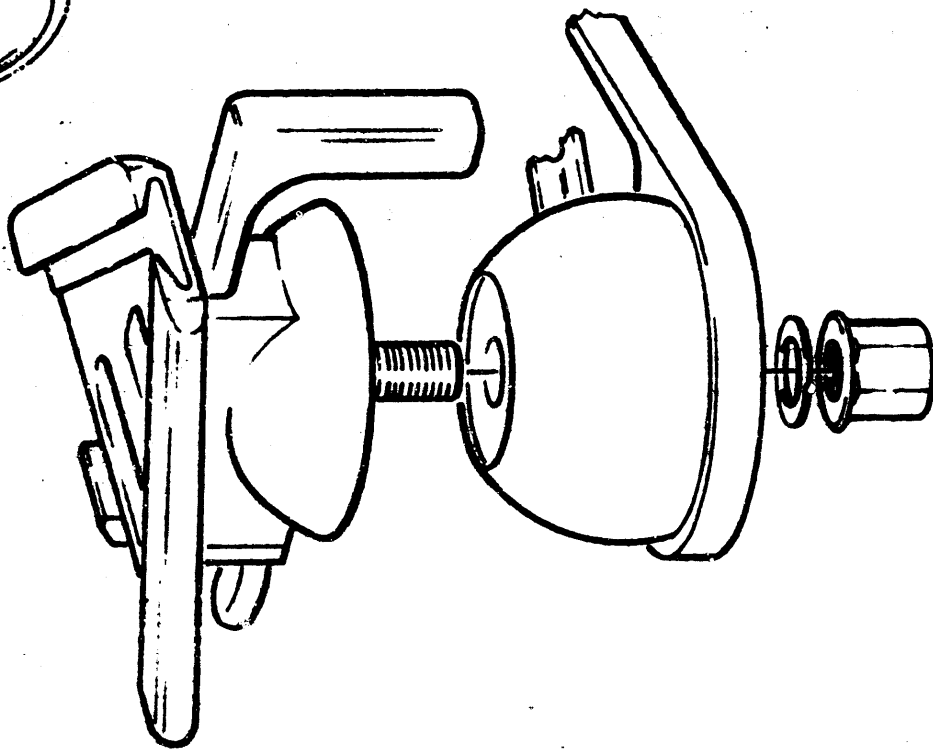
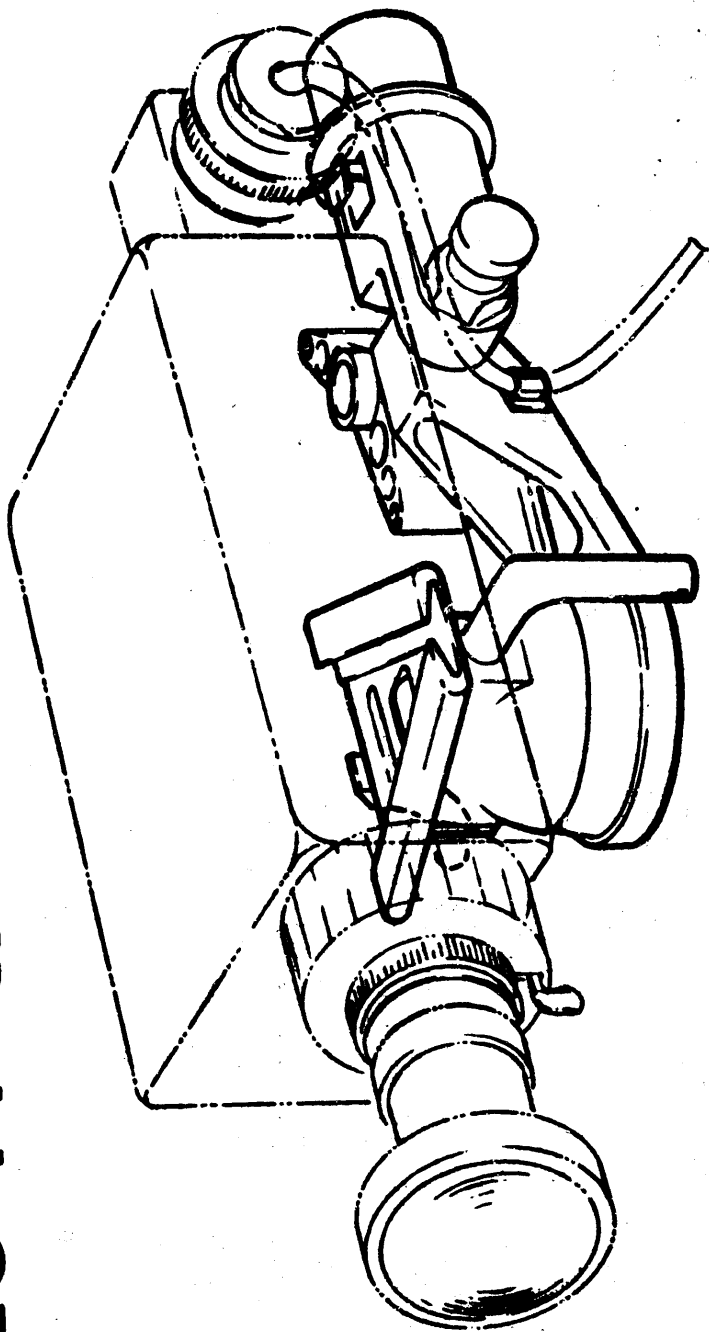
CD-2041-2D

APOLLO TV CAMERA



CD-163E 

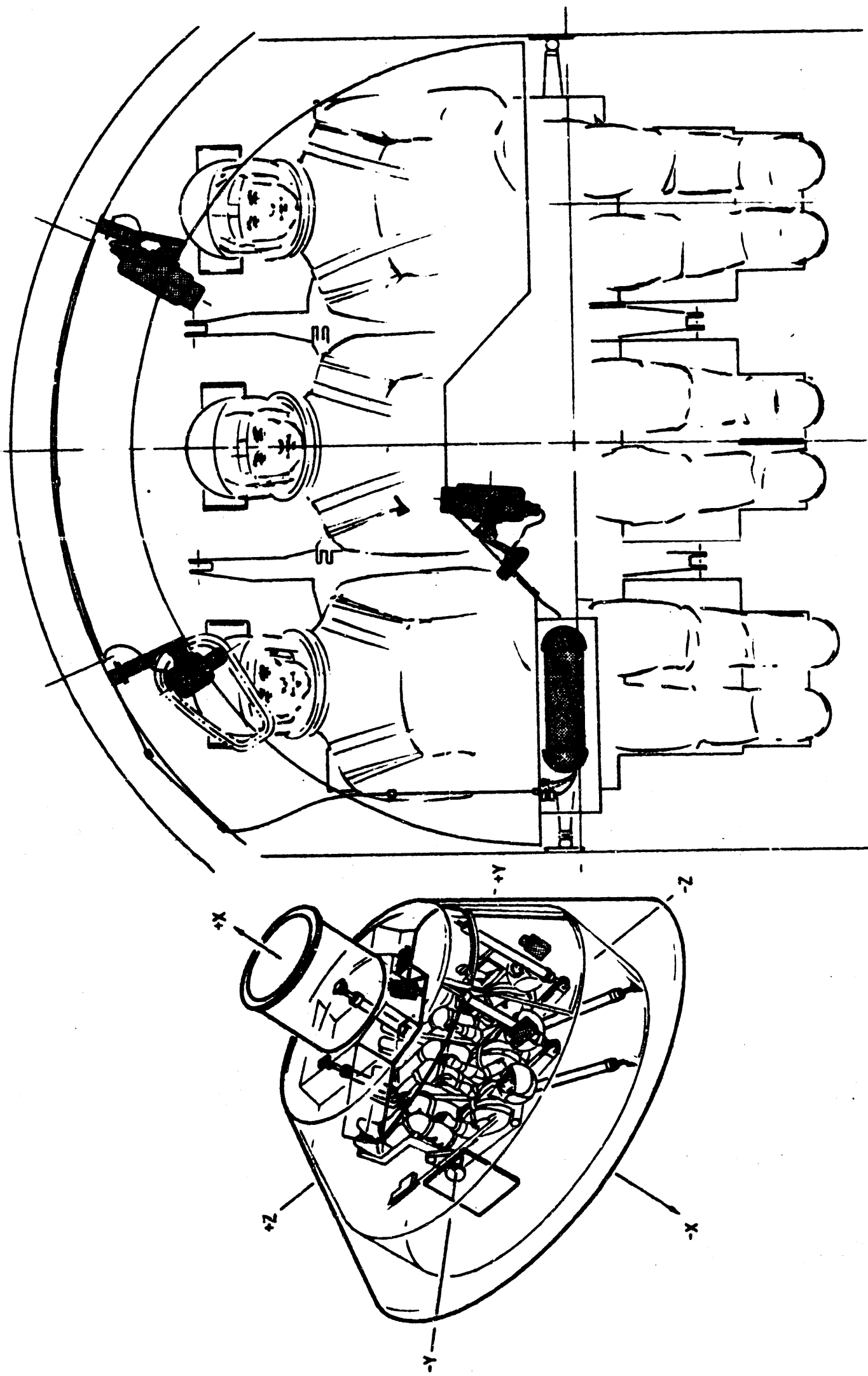
APOLLO TV CAMERA MOUNT



CD-2013D

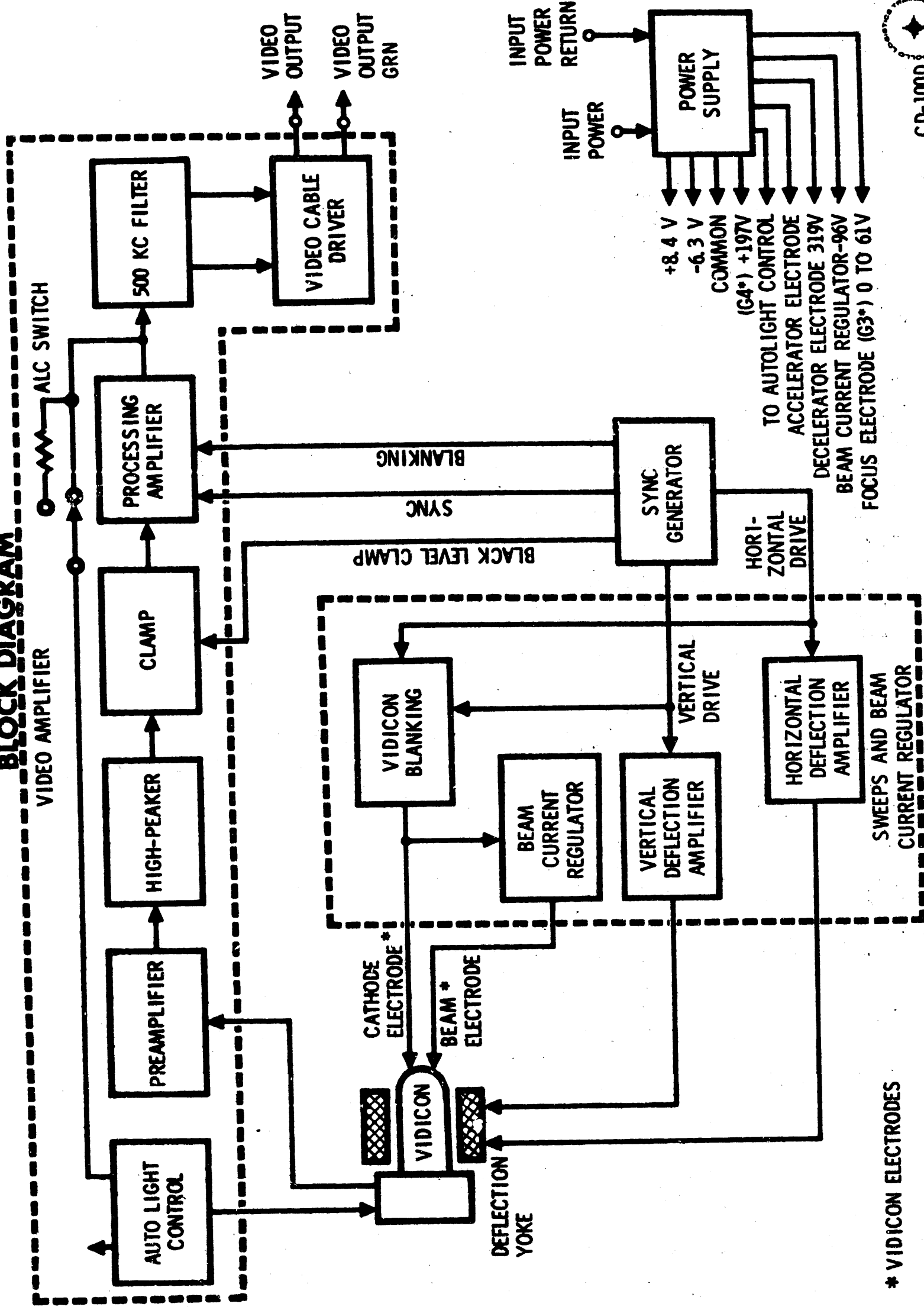


TV CAMERA LOCATIONS



APOLLO TELEVISION CAMERA

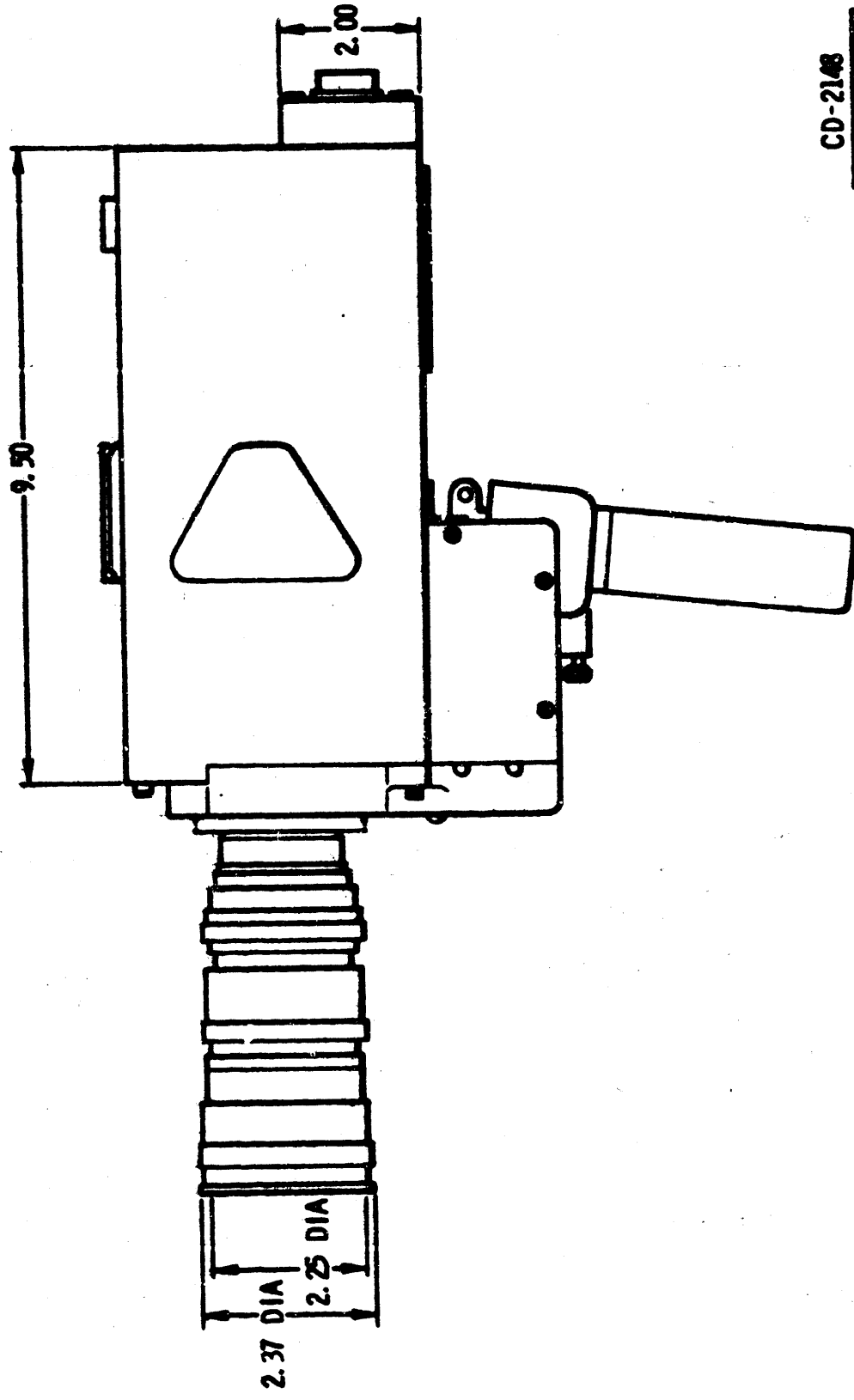
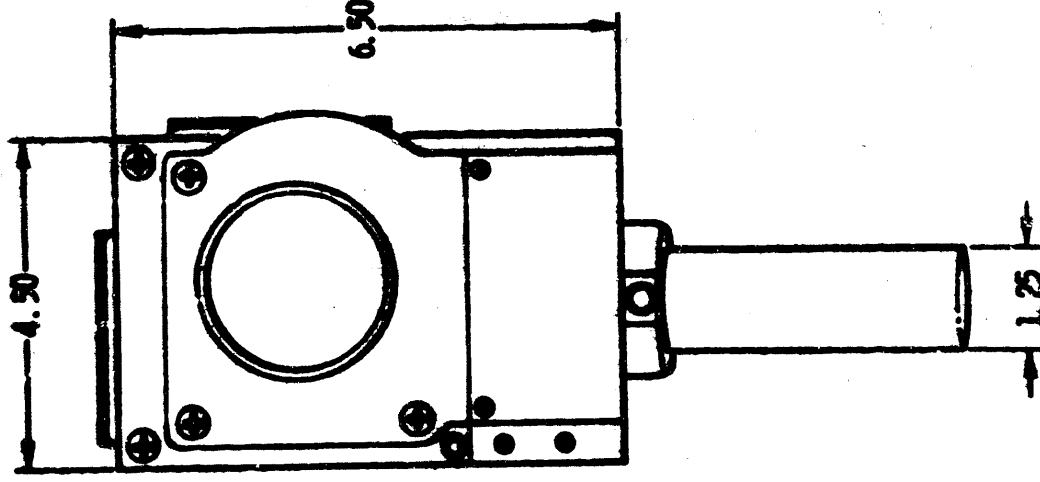
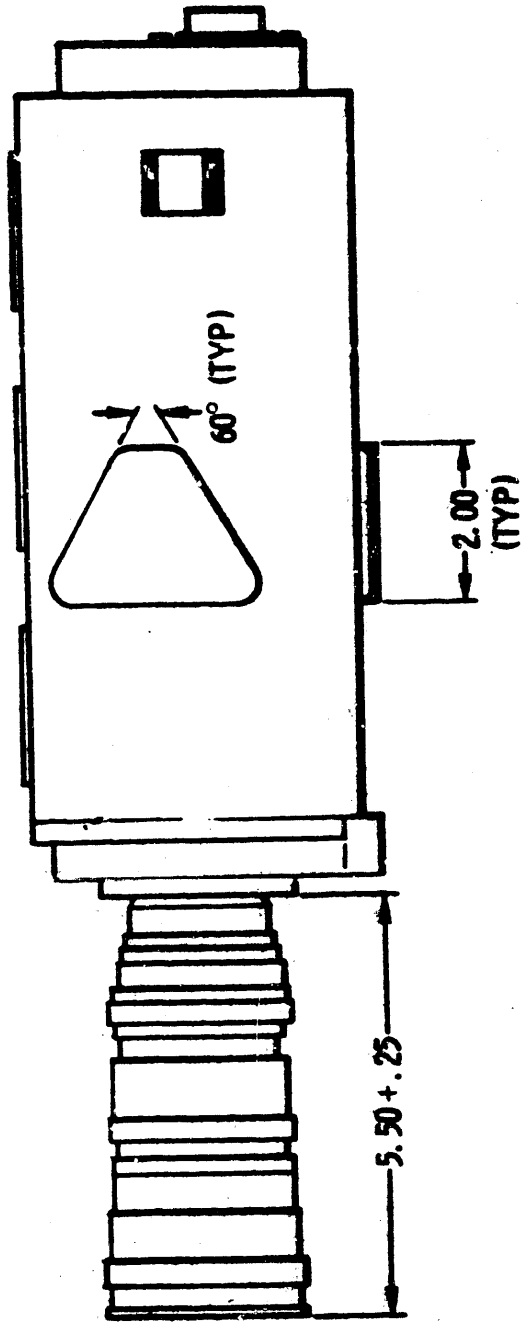
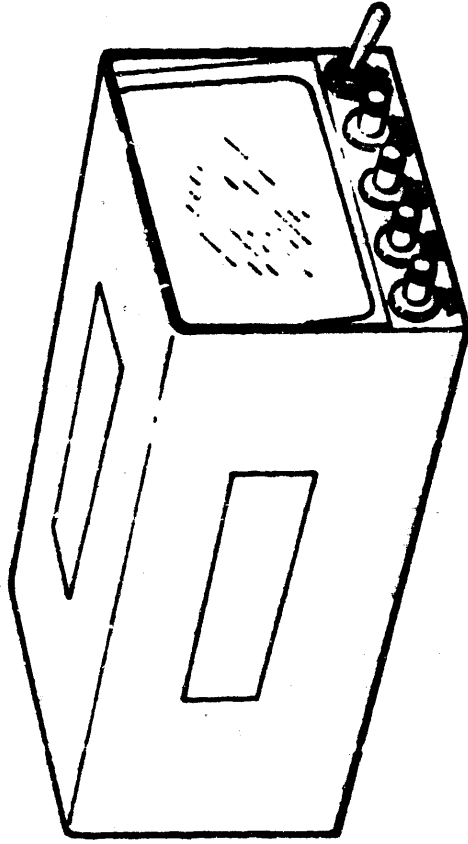
BLOCK DIAGRAM



* VIDICON ELECTRODES

CD-100D

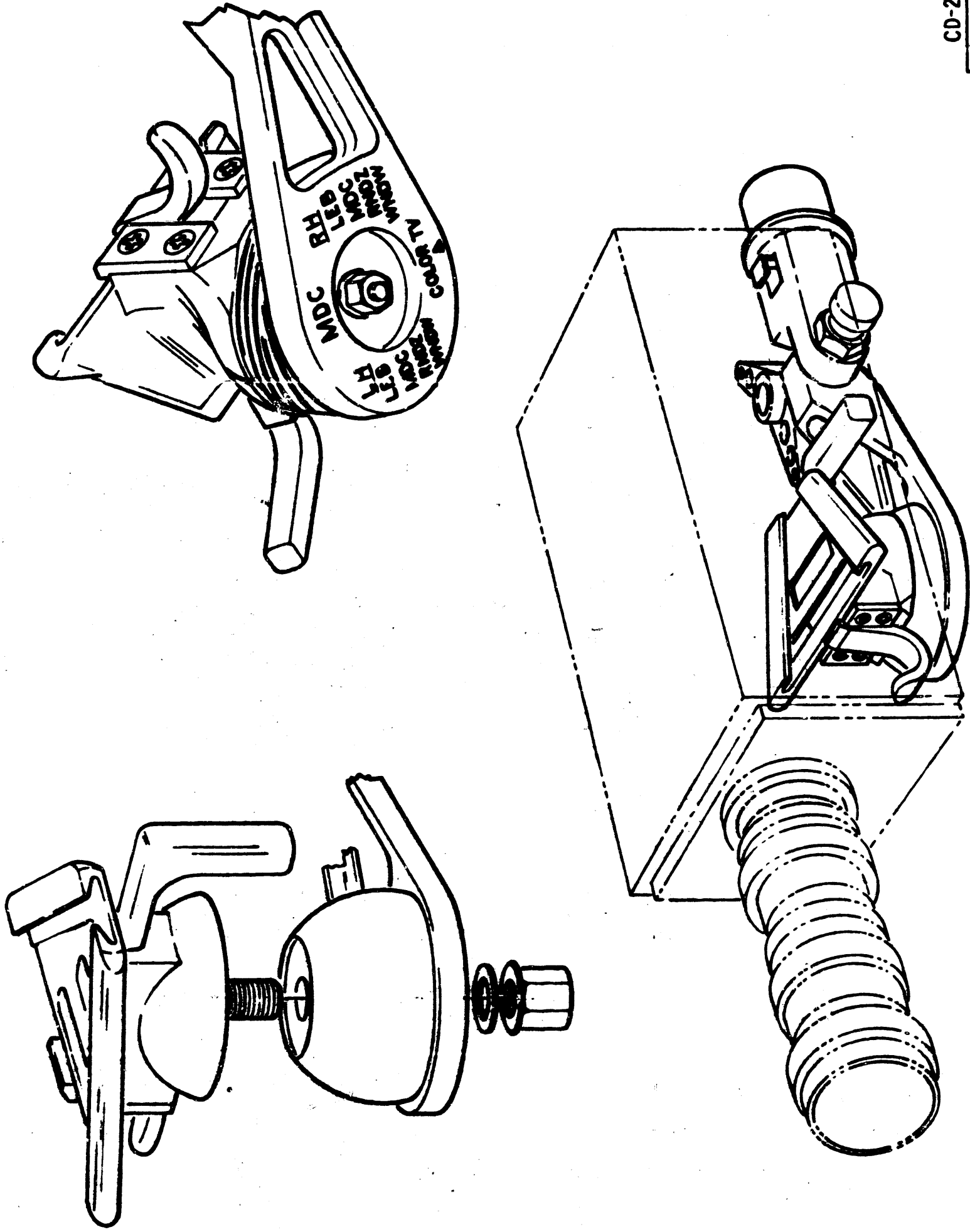
APOLLO COLOR TV CAMERA & MONITOR



CD-2148

CSM LOGISTICS
TRAINING

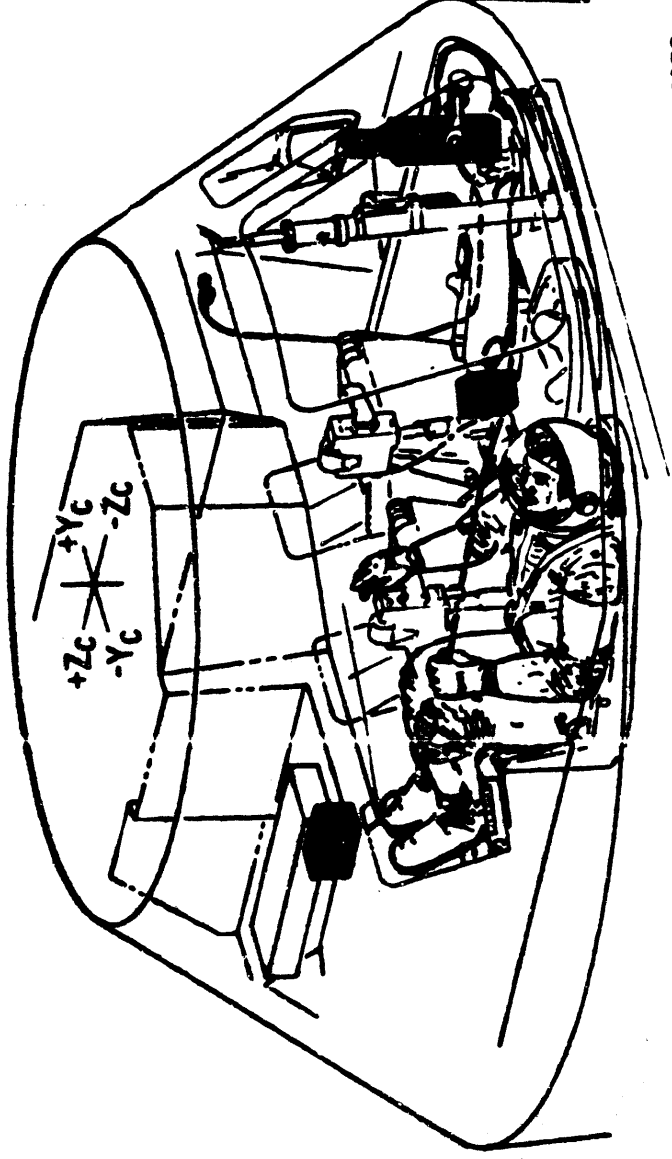
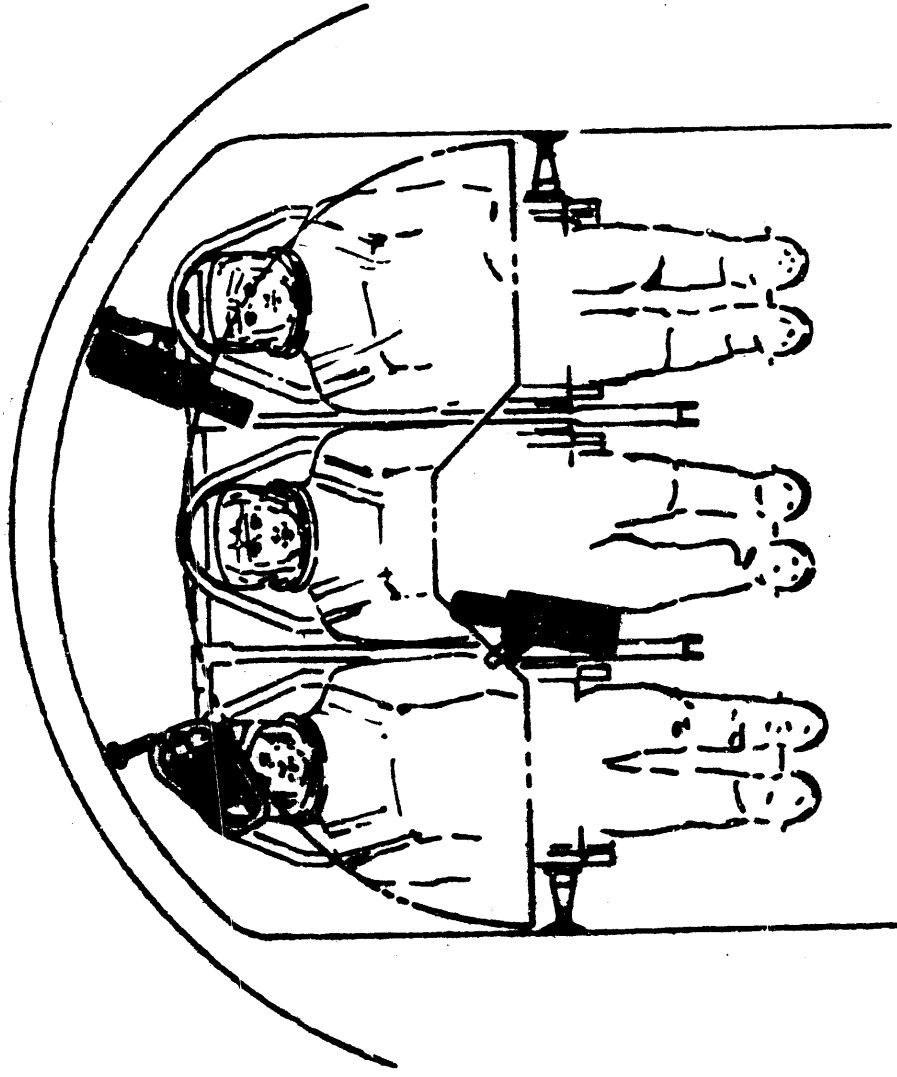
APOLLO COLOR TV CAMERA MOUNT



CD-2149

CSM LOGISTICS TRAINING

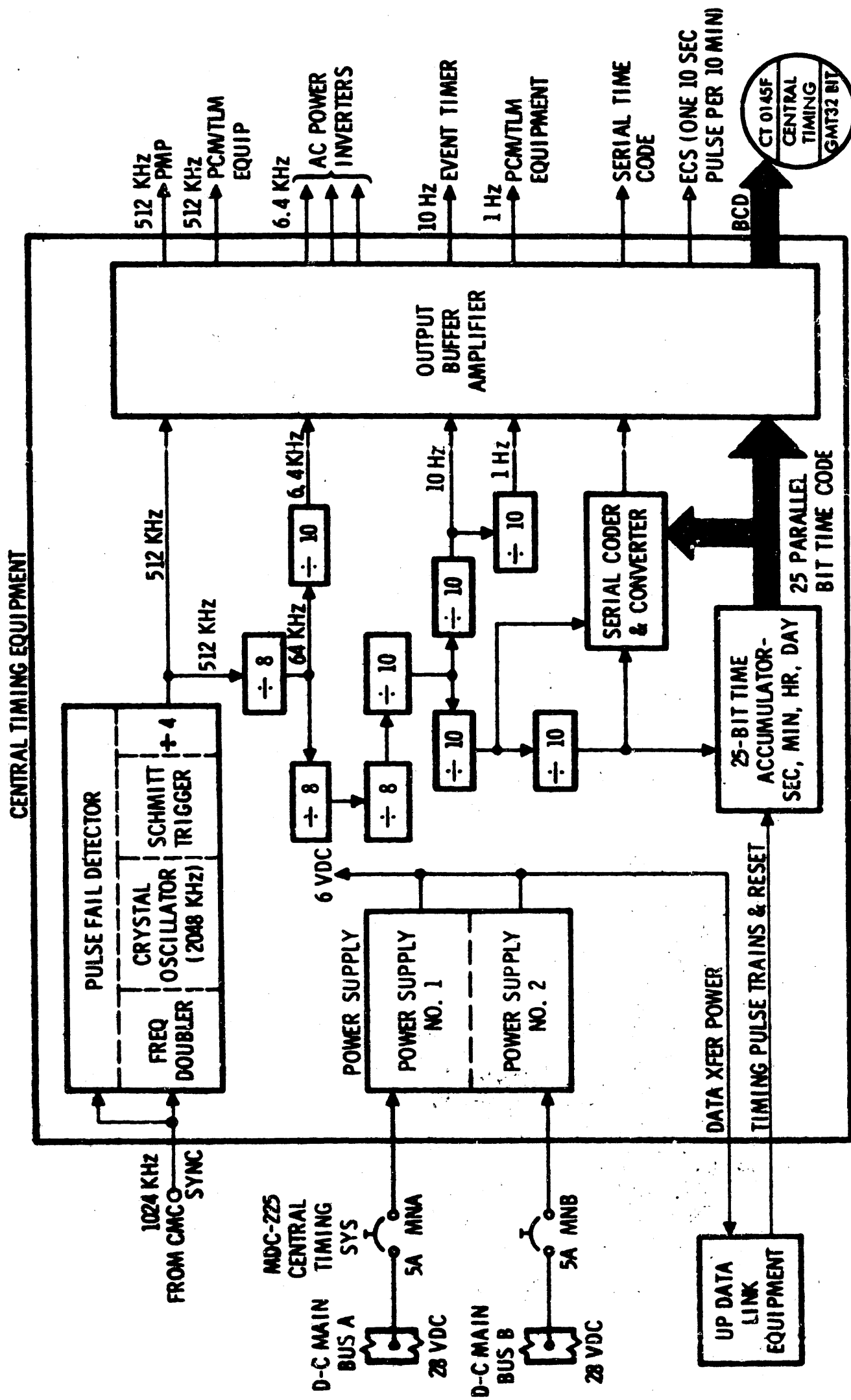
APOLLO COLOR TV & MONITOR LOCATIONS



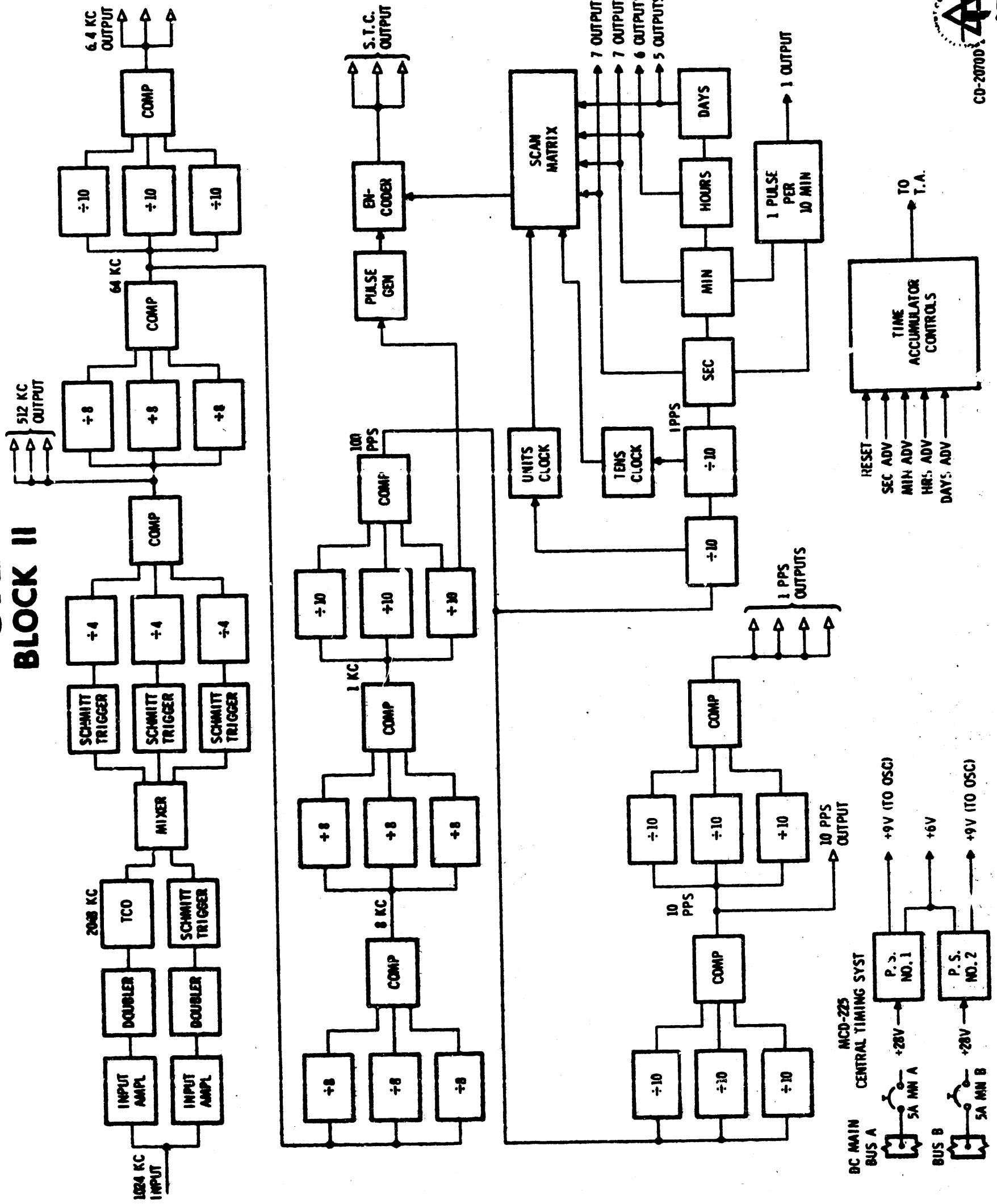
CD-2150

CSM LOGISTICS
TRAINING

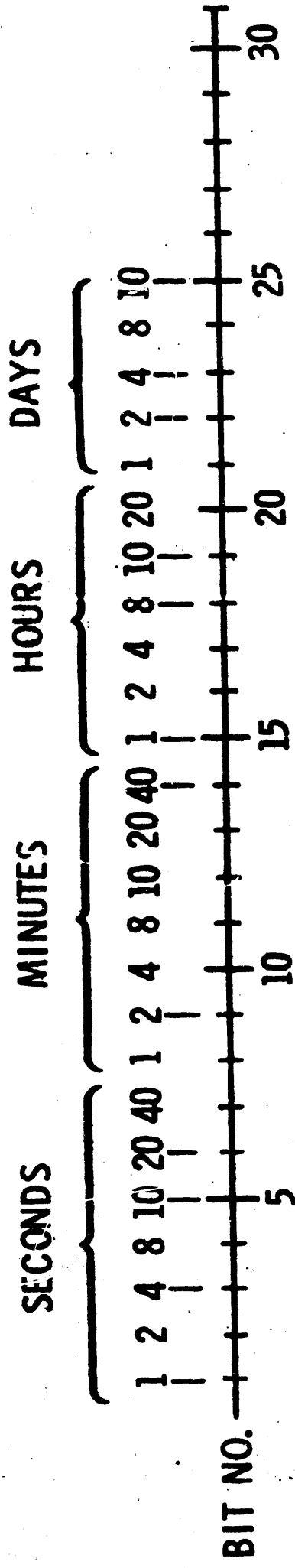
CENTRAL TIMING EQUIPMENT



CIE BLOCK II

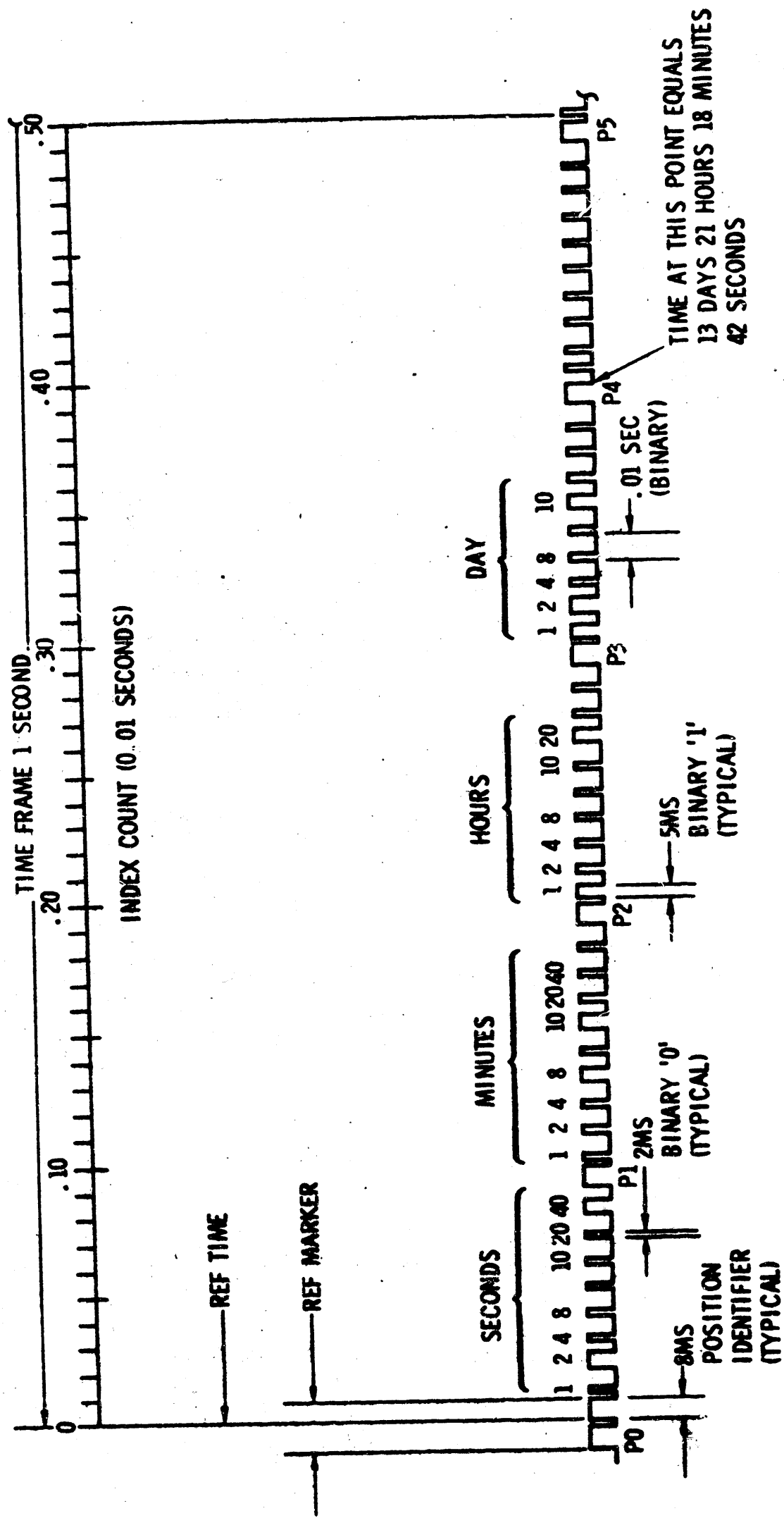


BLK II CTE 25 BIT PARALLEL TIME CODE



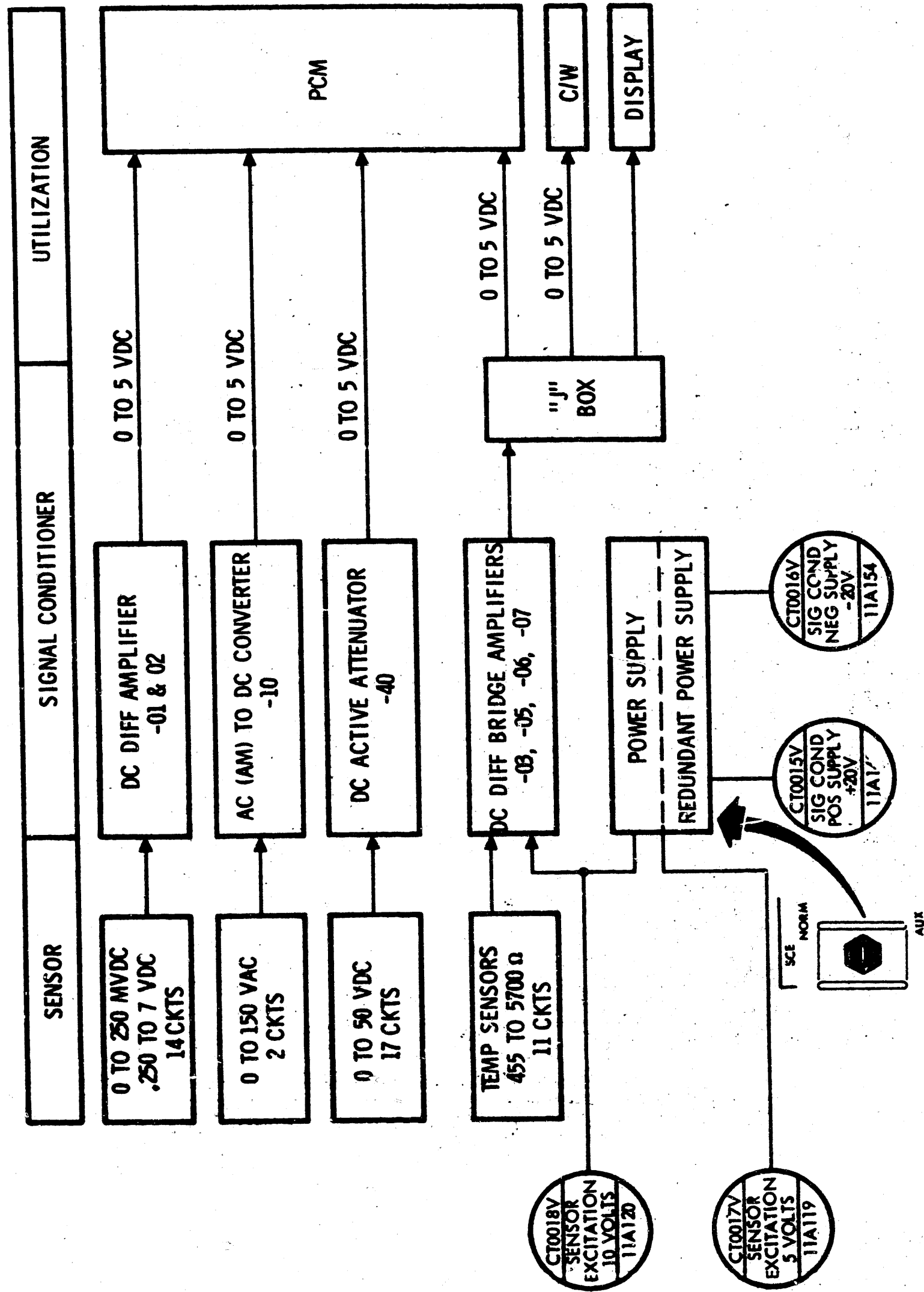
EXAMPLE: 16 DAYS 19 HOURS 42 MINUTES 35 SECONDS

CTE SERIAL OUTPUT

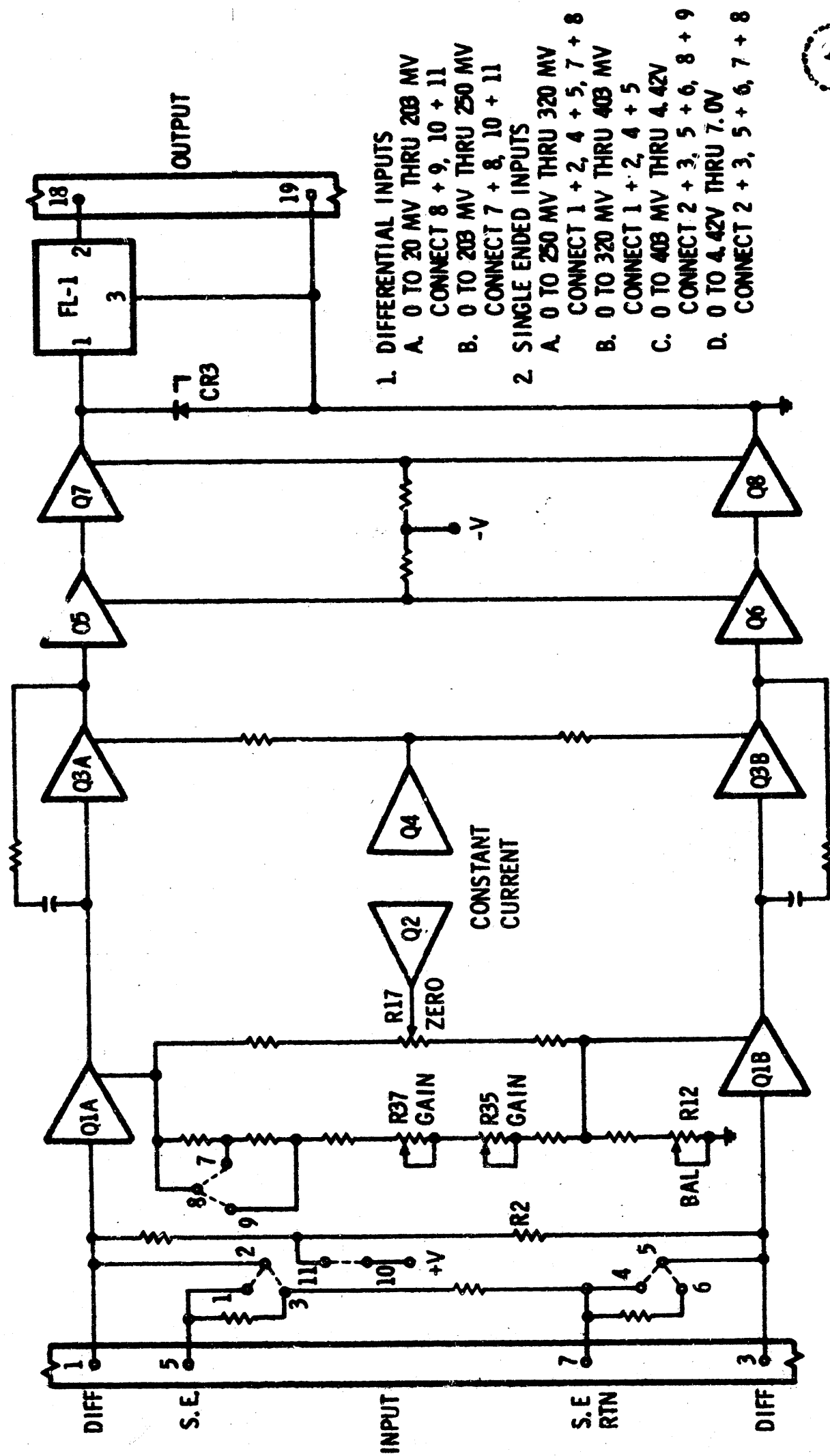


CD-2106A

SCE BLOCK DIAGRAM



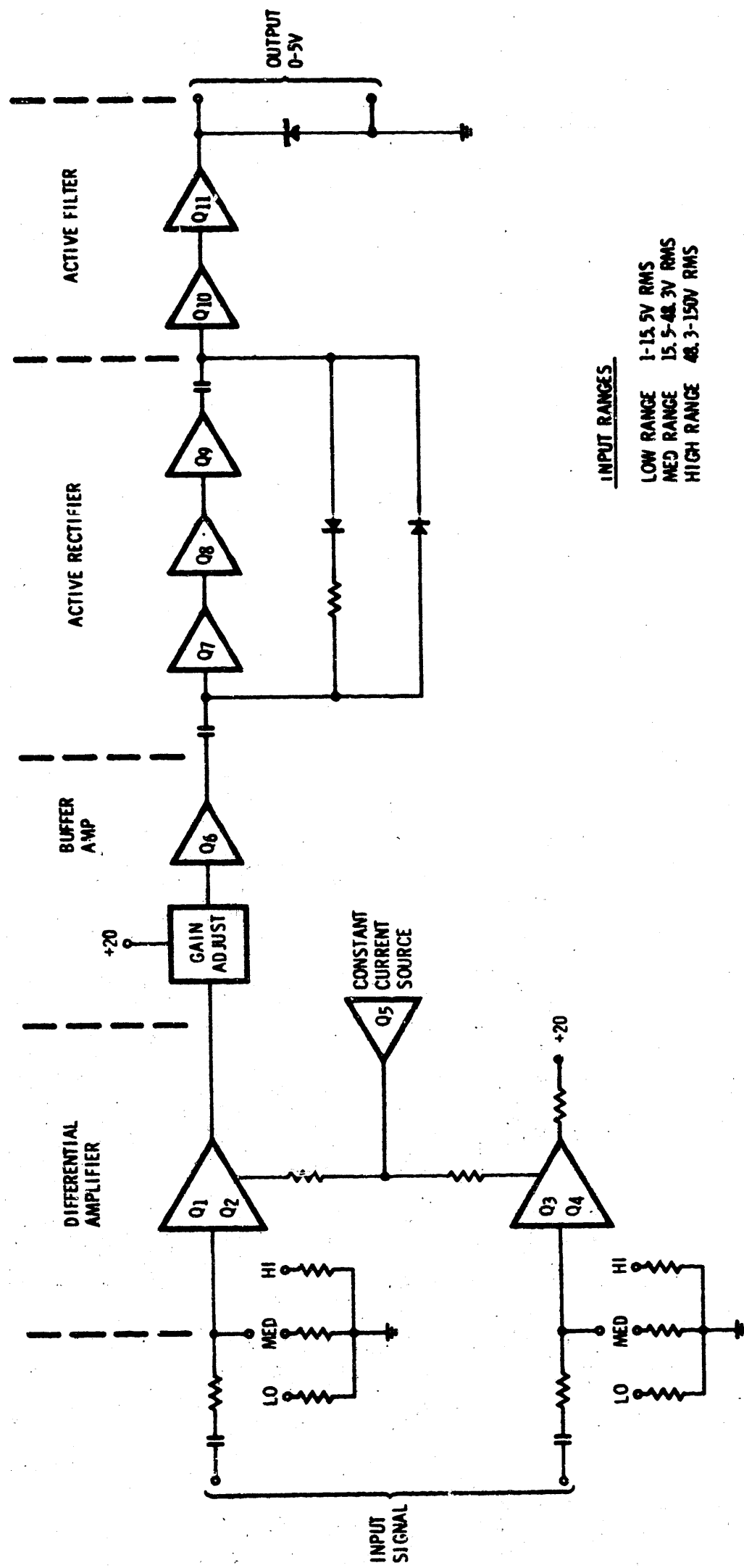
DC DIFFERENTIAL AMPLIFIER



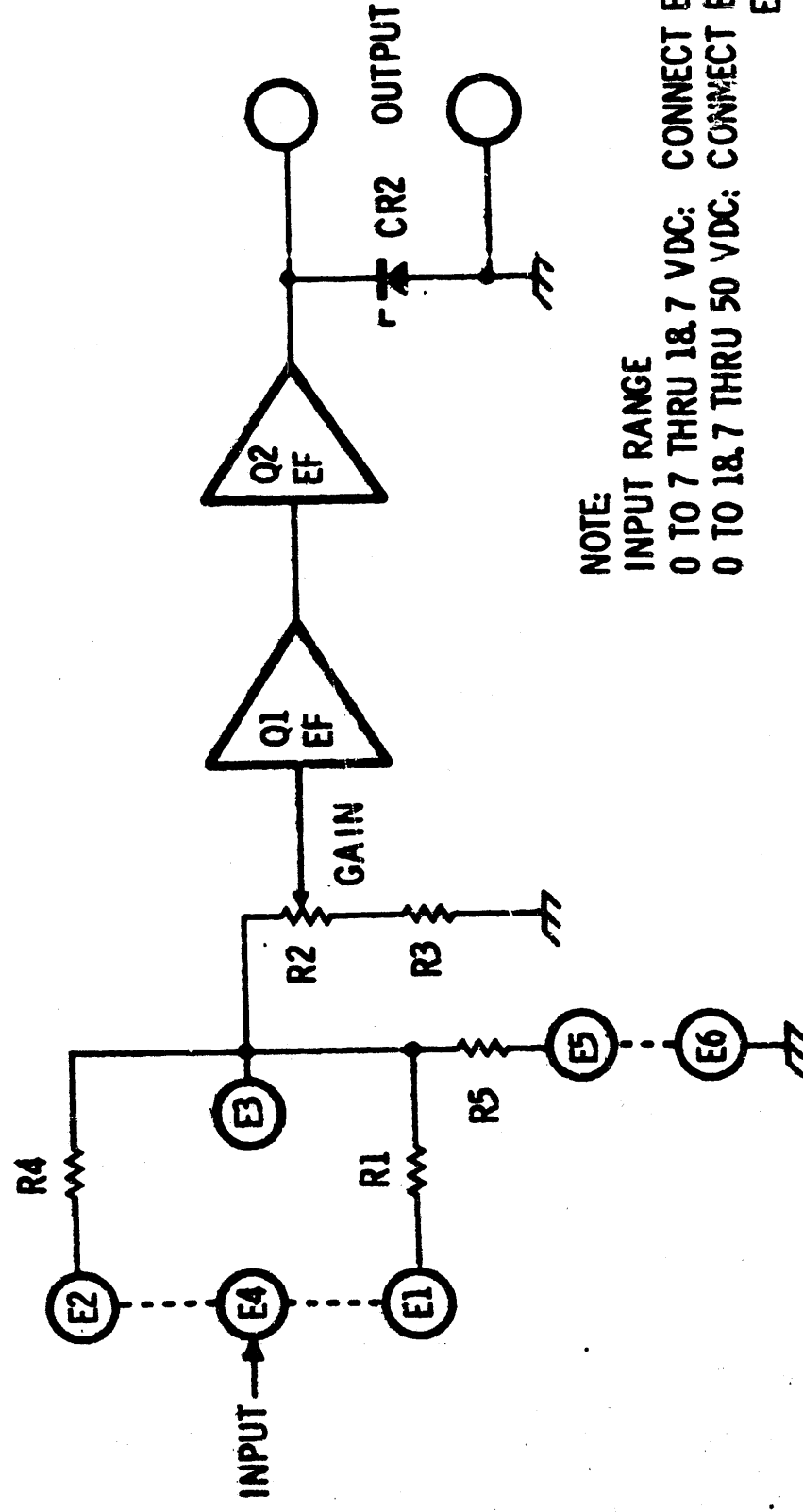
CD-177E

S.C.E. AC TO DC CONVERTER

BLOCK II



DC ACTIVE ATTENUATOR MODULE



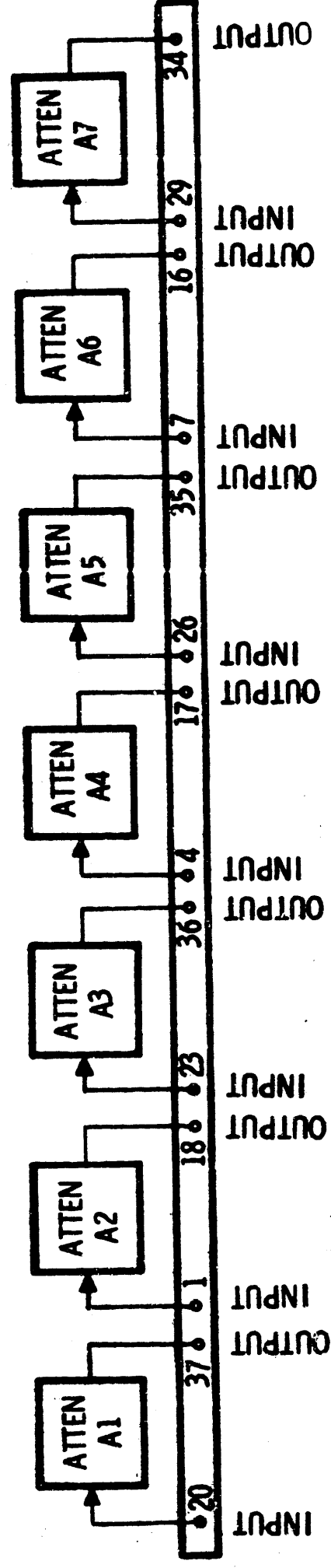
NOTE:

INPUT RANGE

0 TO 7 THRU 18.7 VDC: CONNECT E4 TO E1 (E2 & E5 FLOAT)

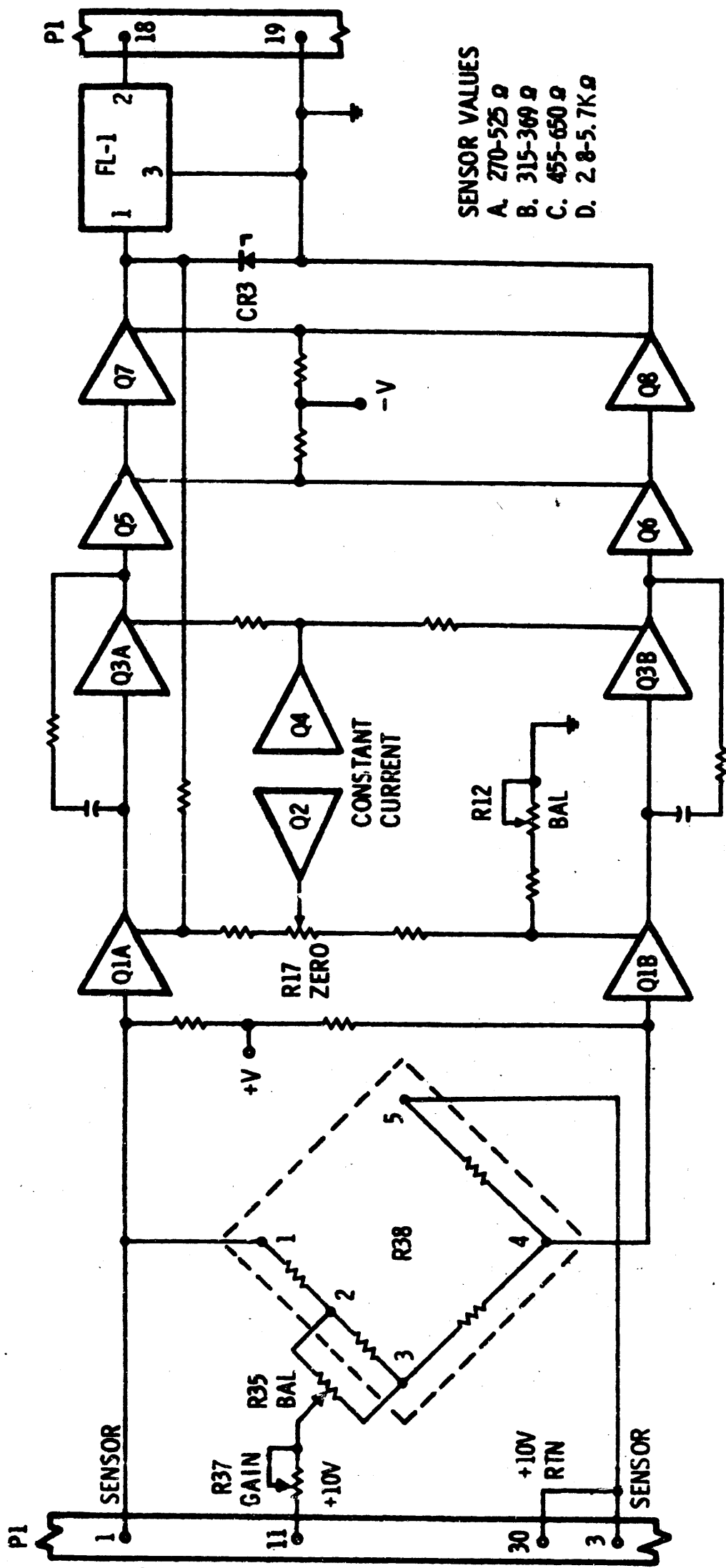
0 TO 18.7 THRU 50 VDC: CONNECT E4 TO E2 (E1 FLOATS)

E5 TO E6

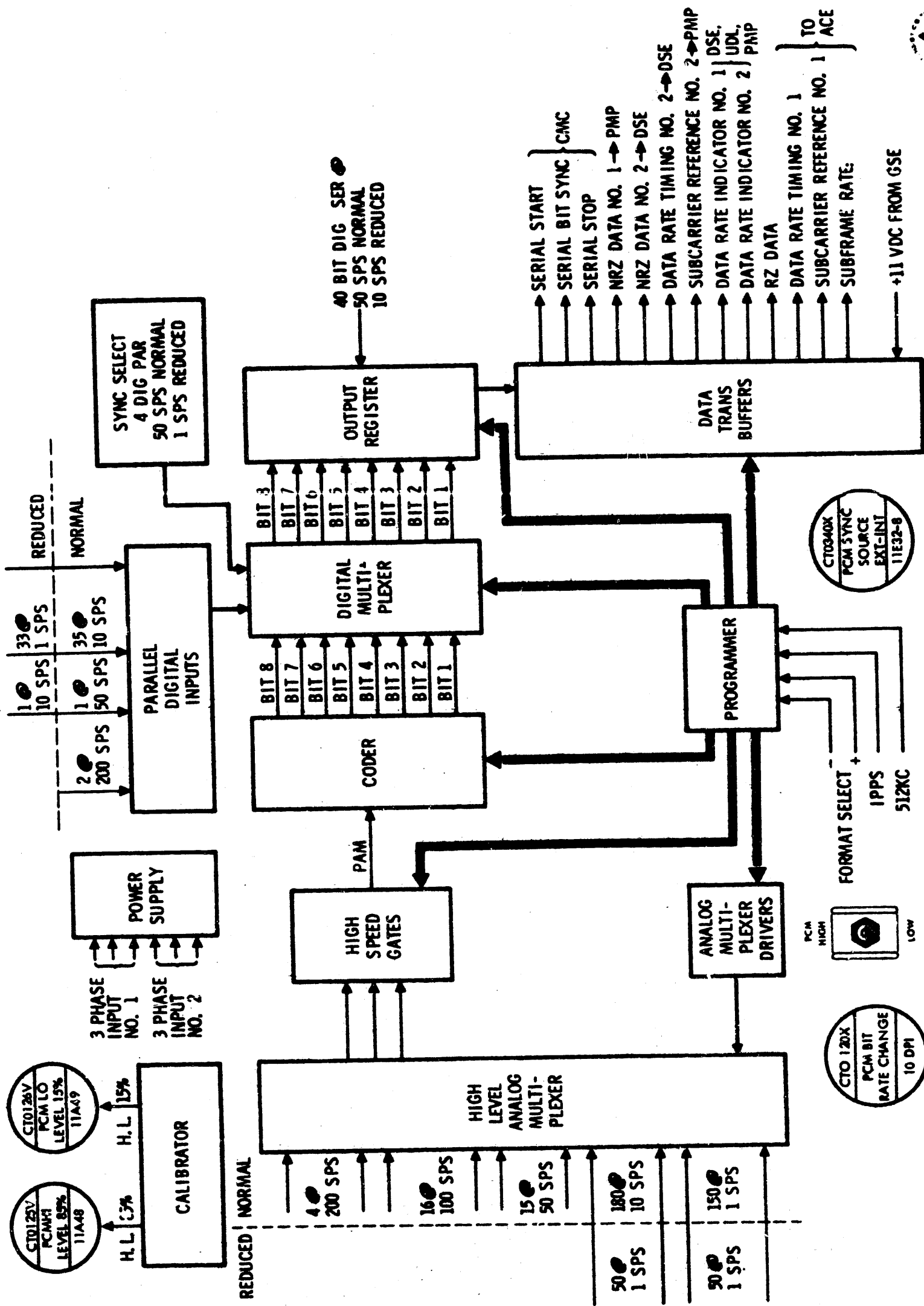


0-173C

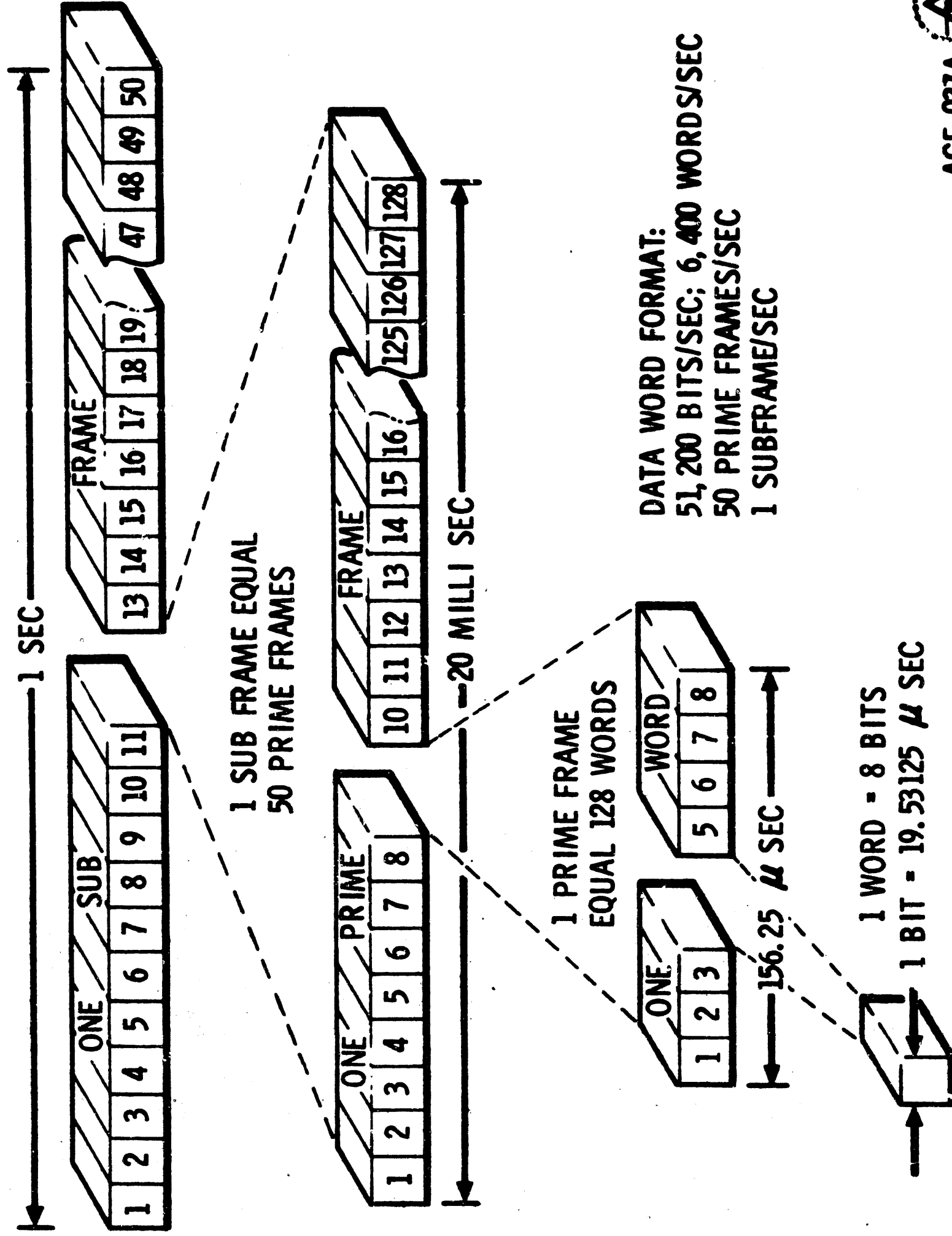
DC DIFFERENTIAL BRIDGE AMPLIFIER



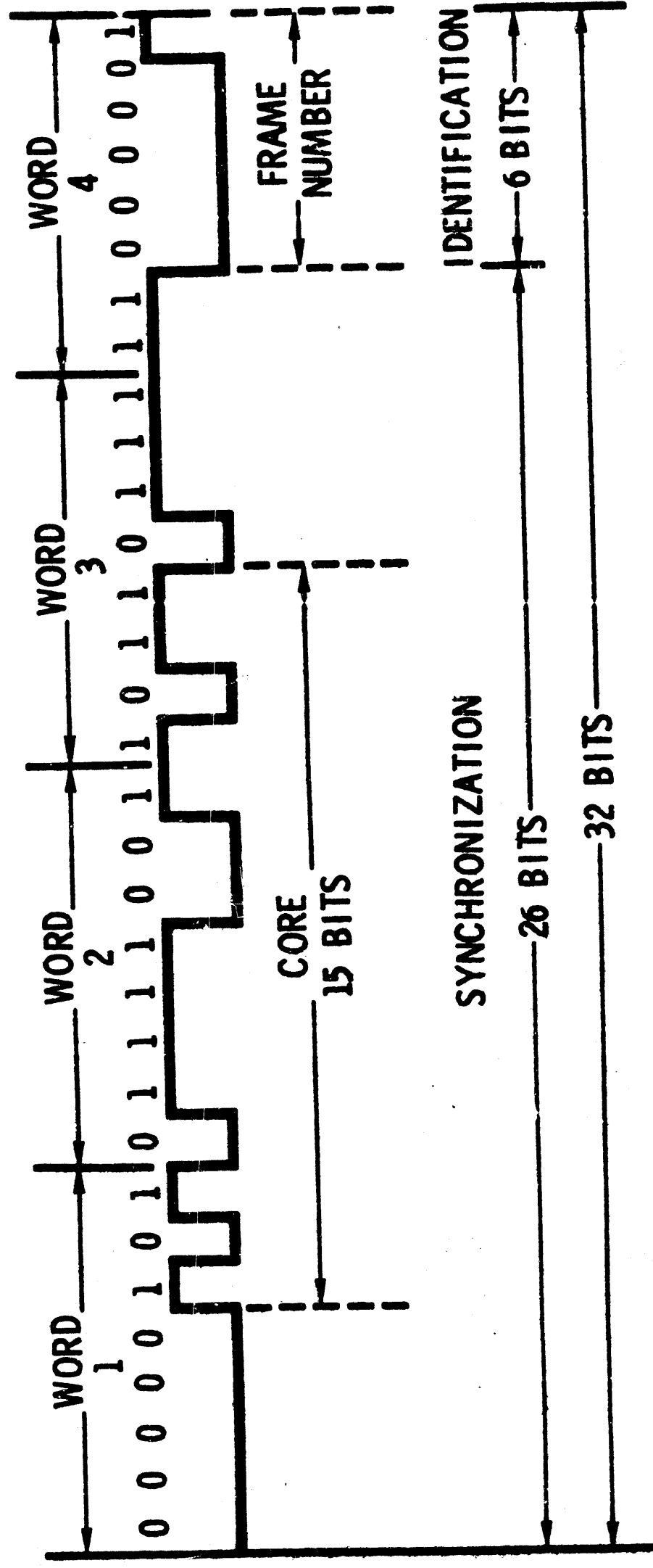
PCM BLOCK DIAGRAM



PCM NORMAL FORMAT



PCM PRIME FRAME SYNCHRONIZATION



PRIME FRAME NUMBER IN BINARY FORM

EXAMPLE: 1 0 0 0 0 1 = PRIME FRAME 1 EXAMPLE: 2 1 1 0 0 1 0 = PRIME FRAME 50

$$\begin{aligned}
 & \uparrow 2^0 = 1 \\
 & \uparrow 2^1 = 2 \\
 & \uparrow 2^4 = 16 \\
 & \uparrow 2^5 = 32 \\
 & \hline
 & 50
 \end{aligned}$$

PCM NORMAL FORMAT PRIME FRAME NO. 1

BLOCK II

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	SIGNIFICANT DIGIT	NO. OF ZEROS
22A				22A	22A	22A	22A	11A	11A	11A	11A	12A	12A	12A	12A		
1				2	2	3	4	1	2	3	4	1	2	3	4		
17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32		
11A	22D	22D	10D	12A	12A	12A	12A	11A	11A	11A	11A	51A	51A	51A	51A	51A	51A
5	1	2	1	5	6	7	8	6	7	8	9	1	2	3	1		
33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48		
51DS	51DS	51DS	51DS	22A	22A	22A	22A	11A	11A	11A	11A	12A	12A	12A	12A		
2	3	4	5	1	2	3	4	10	11	12	13	9	10	11	12		
49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64		
11A	22D	22D	10A	12A	12A	12A	12A	11A	11A	11A	11A	51A	51A	51A	51A		
14	1	2	1	13	14	15	16	15	16	17	18	4	5	6	7		
65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80		
11D	11D	11D	11D	22A	22A	22A	22A	11A	11A	11A	11A	12A	12A	12A	12A		
2	2	2	2	1	2	3	4	19	20	21	22	1	2	3	4		
81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96		
11A	22D	22D	10A	12A	12A	12A	12A	11A	11A	11A	11A	51A	51A	51A	51A		
23	1	2	2	5	6	7	8	24	25	26	27	8	9	10	11		
97	98	99	100	101	102	103	104	105	106	107	108	109	110	111	112		
11D	11D	11D	51D	22A	22A	22A	22A	11A	11A	11A	11A	12A	12A	12A	12A		
3	4	5	2	1	2	3	4	28	29	30	31	9	10	11	12		
113	114	115	116	117	118	119	120	121	122	123	124	125	126	127	128		
11A	22D	22D	10A	12A	12A	12A	12A	11A	11A	11A	11A	51A	51A	51A	51A		
32	1	2	3	13	14	15	16	33	34	35	36	12	13	14	15		

22A
1

CHANNEL

A - ANALOG

DS-DIGITAL SERIAL

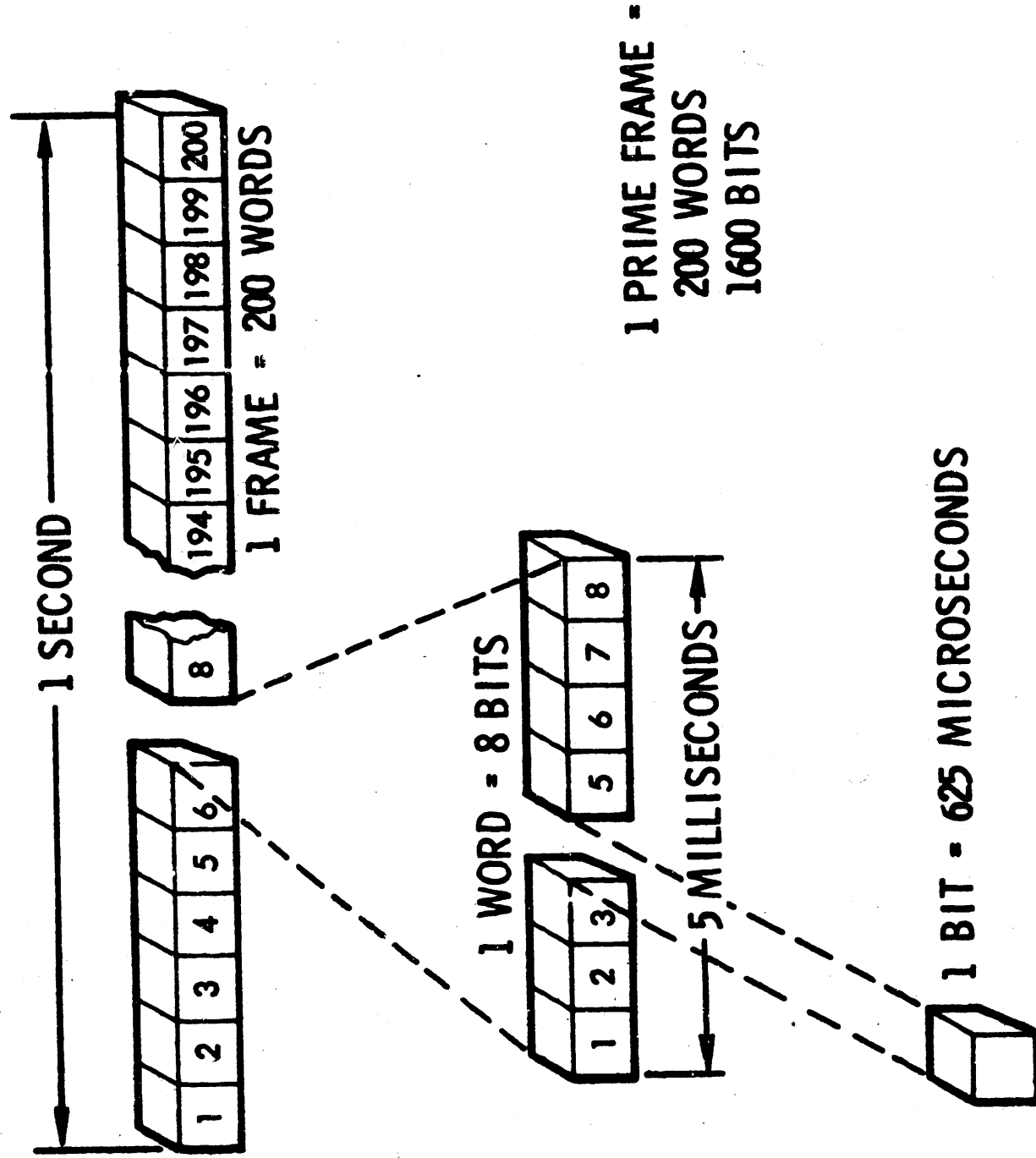
DP-DIGITAL PARALLEL



PCM

3

PCM REDUCED FORMAT



REDUCED PCM FORMAT

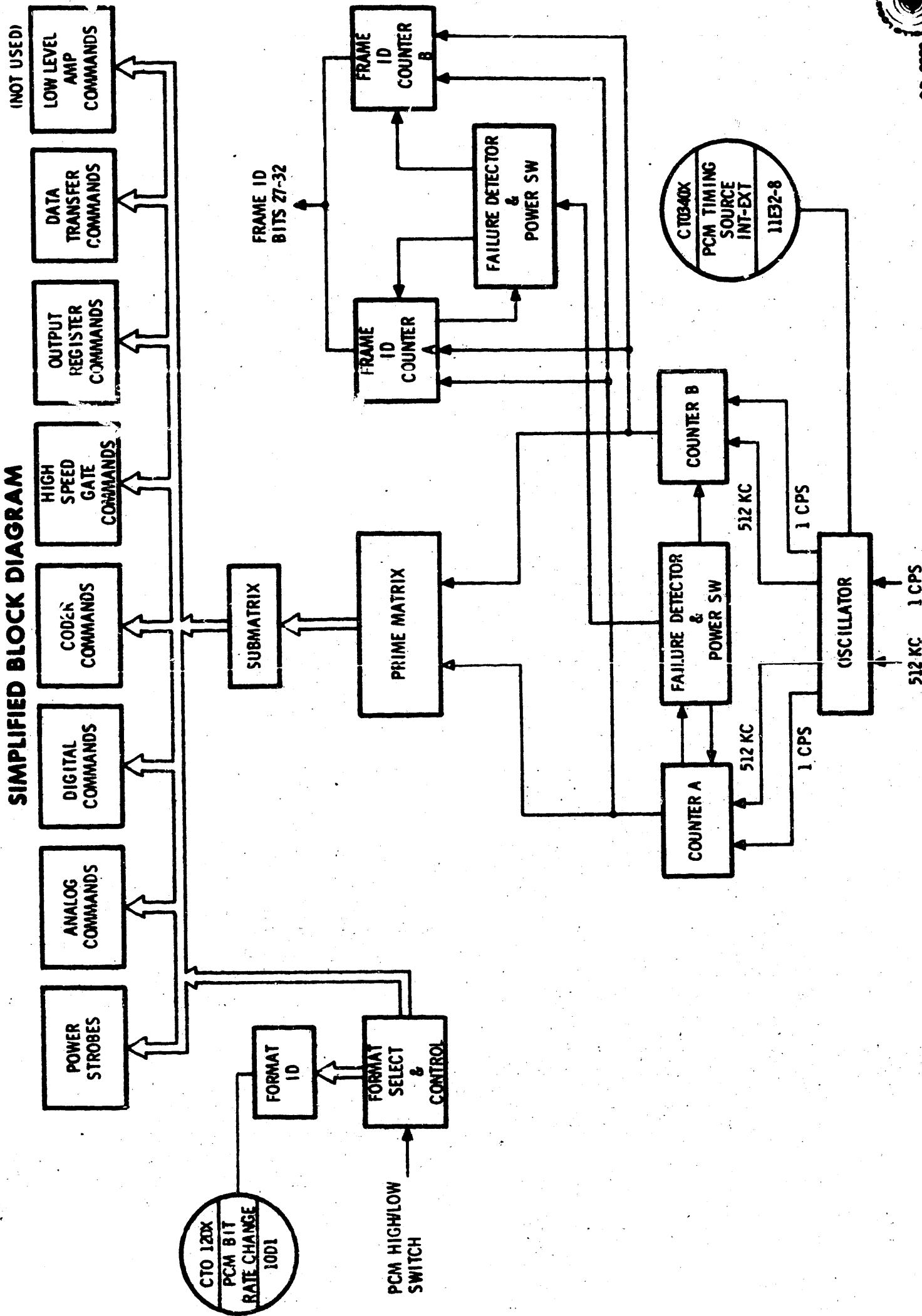
REDUCED FORMAT

WORD	CHANNEL	WORD	CHANNEL	WORD	CHANNEL	WORD	CHANNEL	WORD	CHANNEL
1	SYNC 51/10 DPA	41	11/10 DP4	81	11/10 DP26	121	11/10 DP2A	161	11/10 DP18
2	SYNC 51/10 DPB	42	11/10 DP5	82	11/10 DP10	122	11/10 DP2B	162	11/10 DP19
3	SYNC 51/10 DPC	43	11/10 DP24	83	11/10 DP11	123	11/10 DP2C	163	11/10 DP20
4	SYNC & FRAMES TO 51/10 DPA	44	11/10 DP25	84	11/10 DP12	124	11/10 DP2D	164	11/10 DP21
5	11/10 A1	45	11/10 A109	85	11/10 A46	125	11/10 A154	165	11/10 A91
6	11/10 A2	46	11/10 A110	86	11/10 A47	126	11/10 A155	166	11/10 A92
7	11/10 A3	47	11/10 A111	87	11/10 A48	127	11/10 A156	167	11/10 A93
8	11/10 A4	48	11/10 A112	88	11/10 A49	128	11/10 A157	168	11/10 A94
9	51/11 DSA	49	51/11 DSA	89	51/11 DSA	129	51/11 DSA	169	51/11 DSA
10	51/11 DSB	50	51/11 DSB	90	51/11 DSB	130	51/11 DSB	170	51/11 DSB
11	51/11 DSC	51	51/11 DSC	91	51/11 DSC	131	51/11 DSC	171	51/11 DSC
12	51/11 DSD	52	51/11 DSD	92	51/11 DSD	132	51/11 DSD	172	51/11 DSD
13	51/11 DSE	53	51/11 DSE	93	51/11 DSE	133	51/11 DSE	173	51/11 DSE
14	51/11 DPF	54	51/11 DPF	94	51/11 DPF	134	51/11 DPF	174	51/11 DPF
15	10/10 A123	55	10/10 A126	95	10/10 A129	135	10/10 A132	175	10/10 A135
16	10/10 A128	56	10/10 A141	96	10/10 A144	136	10/10 A147	176	10/10 A150
17	10/10 A3	57	10/10 A6	97	10/10 A9	137	10/10 A12	177	10/10 A15
18	10/10 A18	58	10/10 A21	98	10/10 A24	138	10/10 A27	178	10/10 A30
19	10/10 A33	59	10/10 A36	99	10/10 A39	139	10/10 A42	179	10/10 A45
20	10/10 A48	60	10/10 A51	100	10/10 A54	140	10/10 A57	180	10/10 A60
21	10/10 DPA (FORMAT ID)	61	11/10 DP6	101	11/10 DP27	141	11/10 DP15	181	11/10 DP20
22	SRC "b"	62	11/10 DP7	102	11/10 DP28	142	11/10 DP16	182	11/10 DP21
23	11/10 A39	63	11/10 A147	103	11/10 A84	143	11/10 A21	183	11/10 A129
24	11/10 A40	64	11/10 A148	104	11/10 A85	144	11/10 A22	184	11/10 A130
25	11/10 A73	65	11/10 A10	105	11/10 A118	145	11/10 A55	185	11/10 A163
26	11/10 A74	66	11/10 A11	106	11/10 A119	146	11/10 A56	186	11/10 A164
27	11/10 A75	67	11/10 A12	107	11/10 A120	147	11/10 A57	187	11/10 A165
28	11/10 A76	68	11/10 A13	108	11/10 A121	148	11/10 A58	188	11/10 A166
29	51/11 DSA	69	51/11 DSA	109	51/11 DSA	149	51/11 DSA	189	51/11 DSA
30	51/11 DSB	70	51/11 DSB	110	51/11 DSB	150	51/11 DSB	190	51/11 DSB
31	51/11 DSC	71	51/11 DSC	111	51/11 DSC	151	51/11 DSC	191	51/11 DSC
32	51/11 DSD	72	51/11 DSD	112	51/11 DSD	152	51/11 DSD	192	51/11 DSD
33	51/11 DSE	73	51/11 DSE	113	51/11 DSE	153	51/11 DSE	193	51/11 DSE
34	51/11 DPF	74	51/11 DPF	114	51/11 DPF	154	51/11 DPF	194	51/11 DPF
35	11/10 DP3	75	11/10 DP6	115	11/10 DP13	155	11/10 DP29	195	11/10 DP22
36	SRC "i"	76	11/10 DP9	116	11/10 DP14	156	11/10 DP17	196	11/10 DP23
37	10/10 A63	77	10/10 A66	117	10/10 A69	157	10/10 A72	197	10/10 A75
38	10/10 A78	78	10/10 A81	118	10/10 A84	158	10/10 A87	198	10/10 A90
39	10/10 A93	79	10/10 A96	119	10/10 A99	159	10/10 A102	199	10/10 A105
40	10/10 A108	80	10/10 A111	120	10/10 A114	160	10/10 A117	200	10/10 A120

CD-2026A

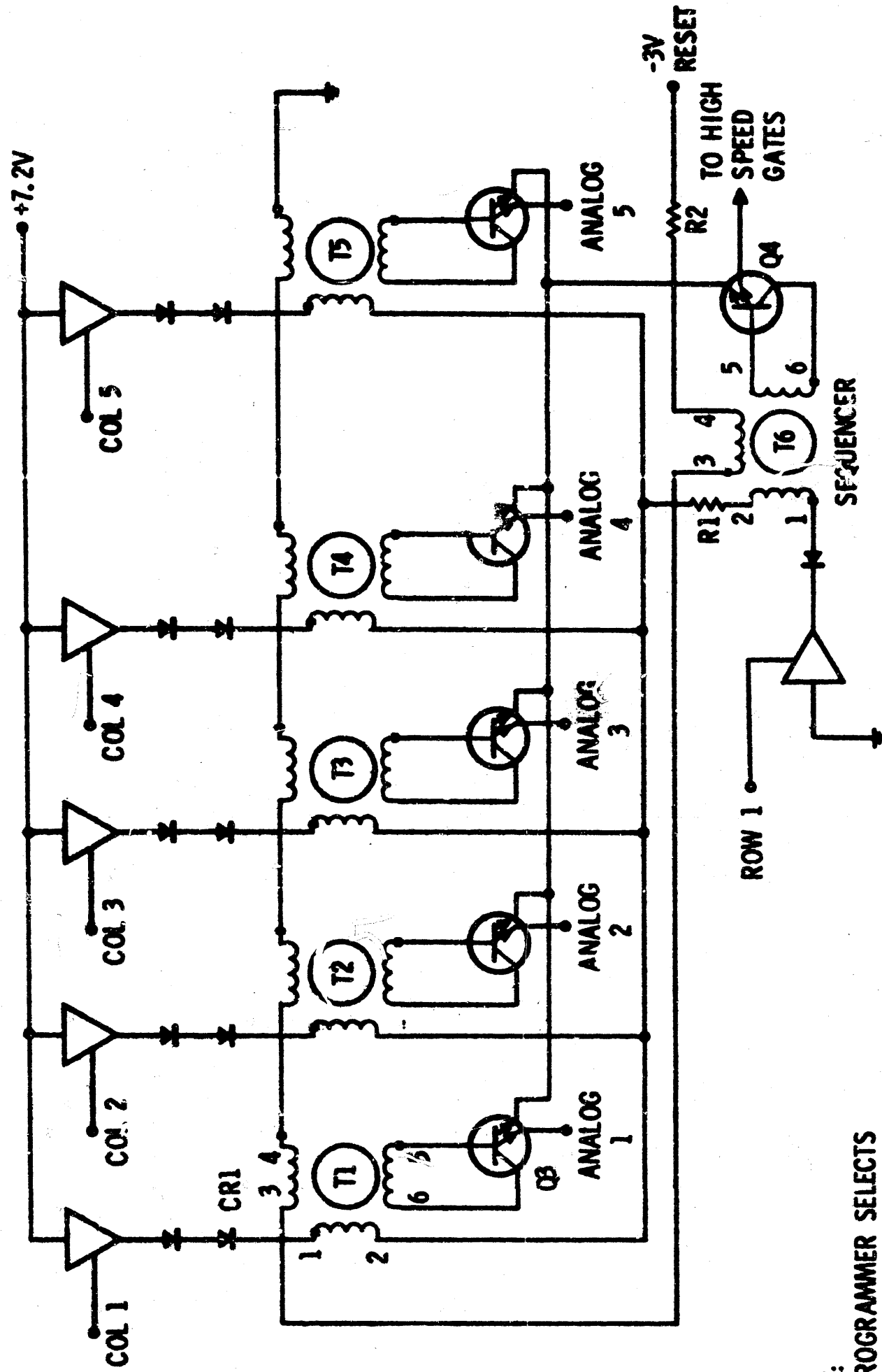
BLOCK II PCM PROGRAMMER

SIMPLIFIED BLOCK DIAGRAM



CD-2029

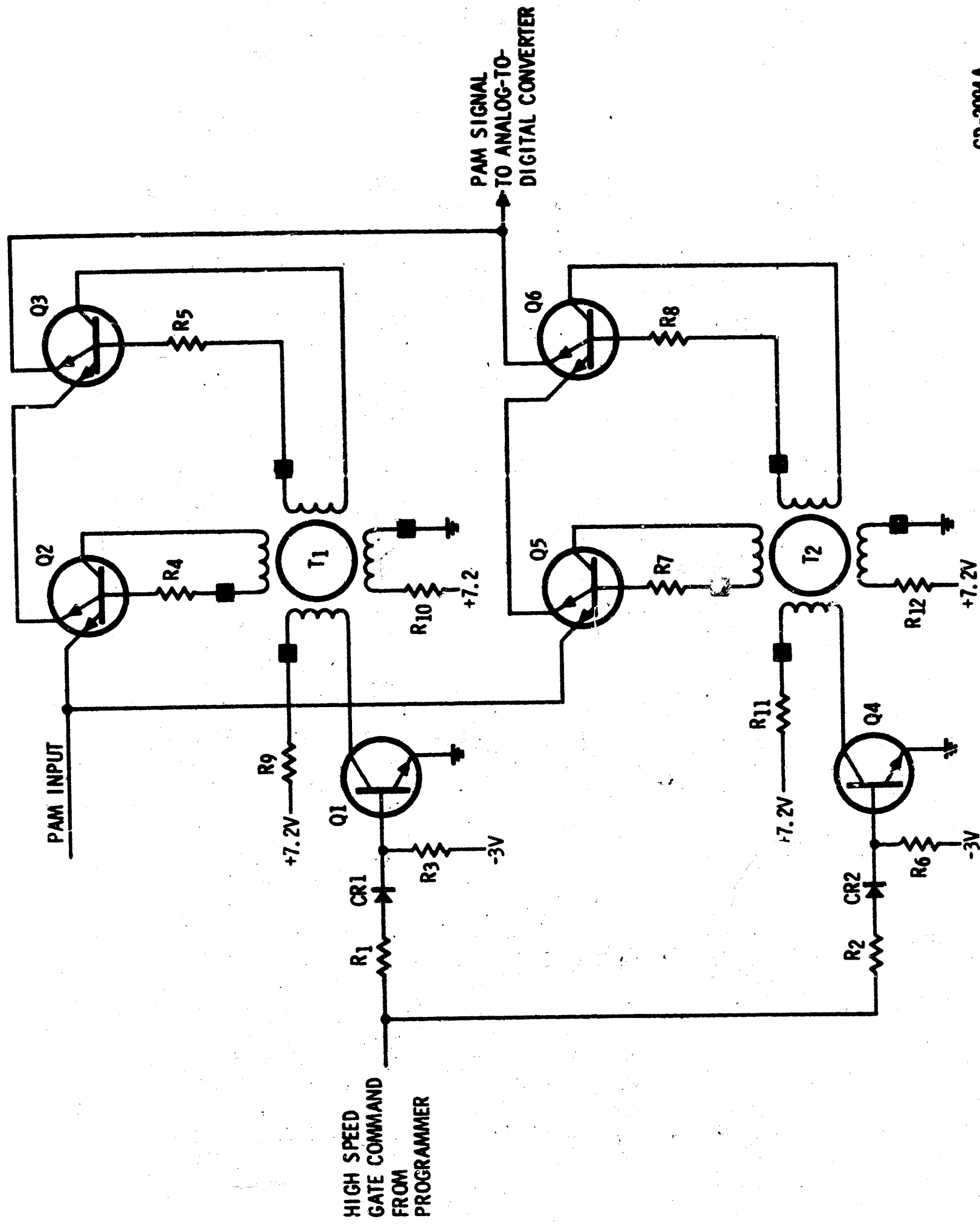
PCM PRIMARY MULTIPLEXER GATES



NOTE:
PROGRAMMER SELECTS
ROW AND COLUMN.

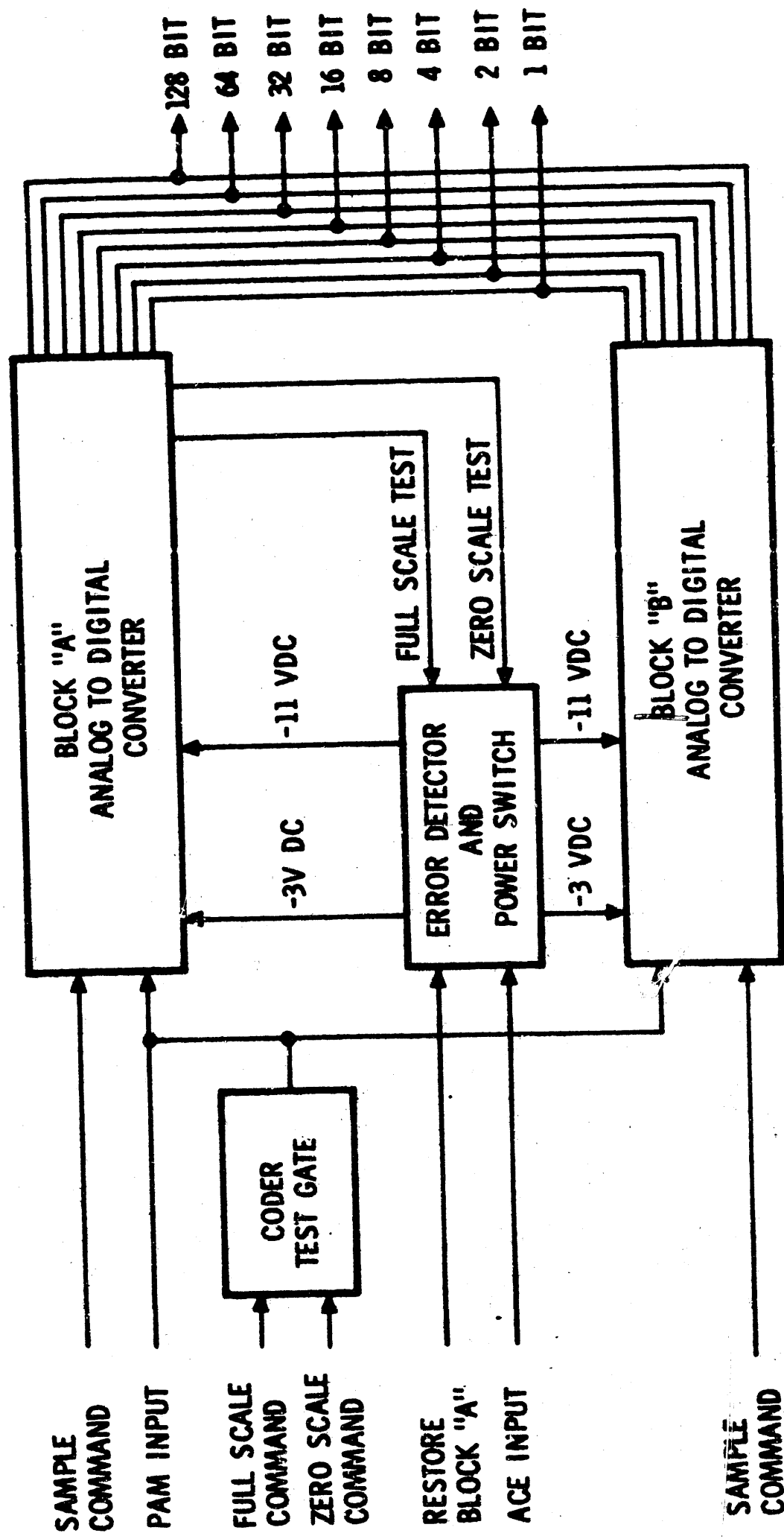
PCM HIGH SPEED GATES

BLOCK II

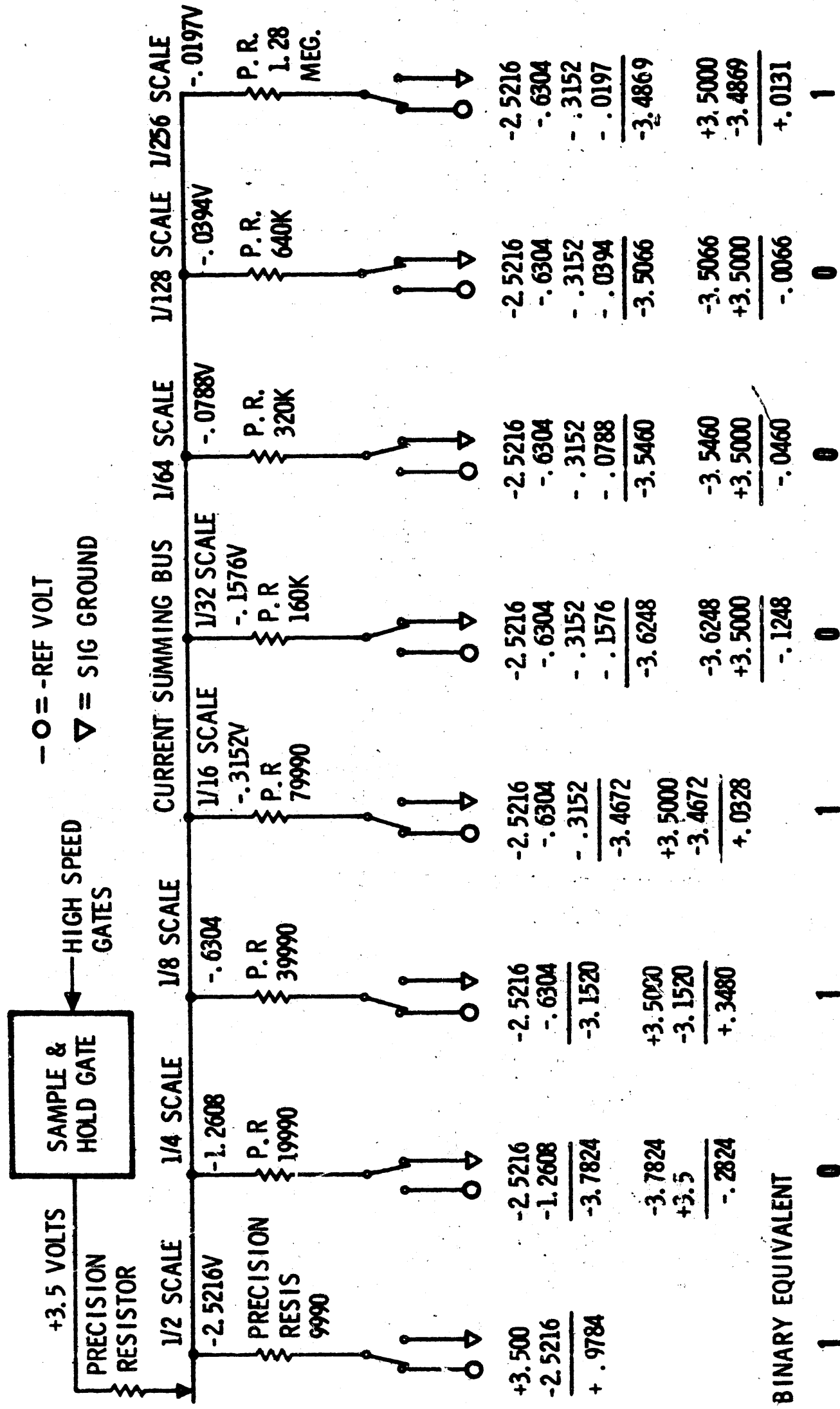


PCM CODER BLOCK DIAGRAM

BLOCK II

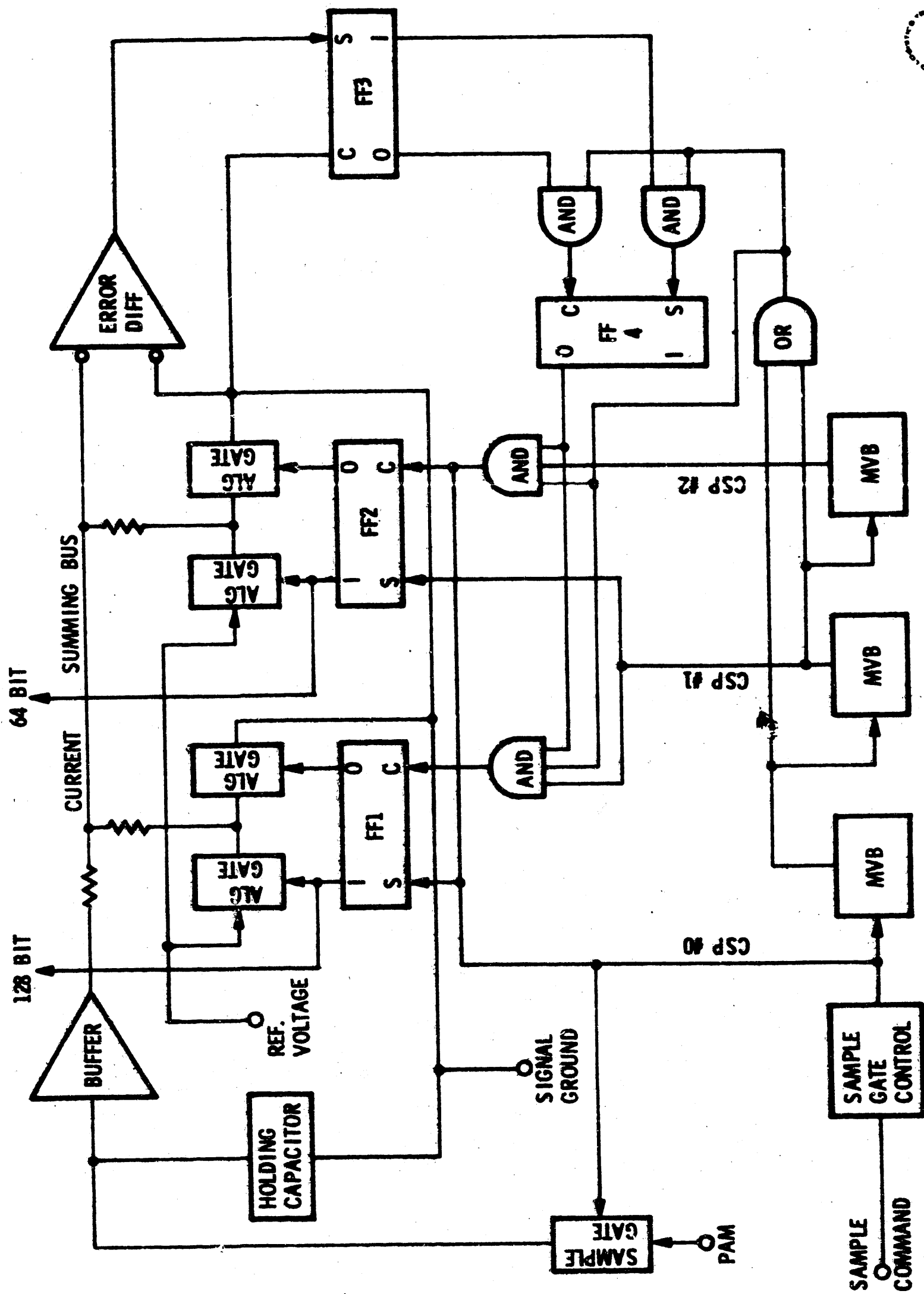


EXAMPLE CODING OF 3.5 VOLT ANALOG SIGNAL



CD-322C (A)

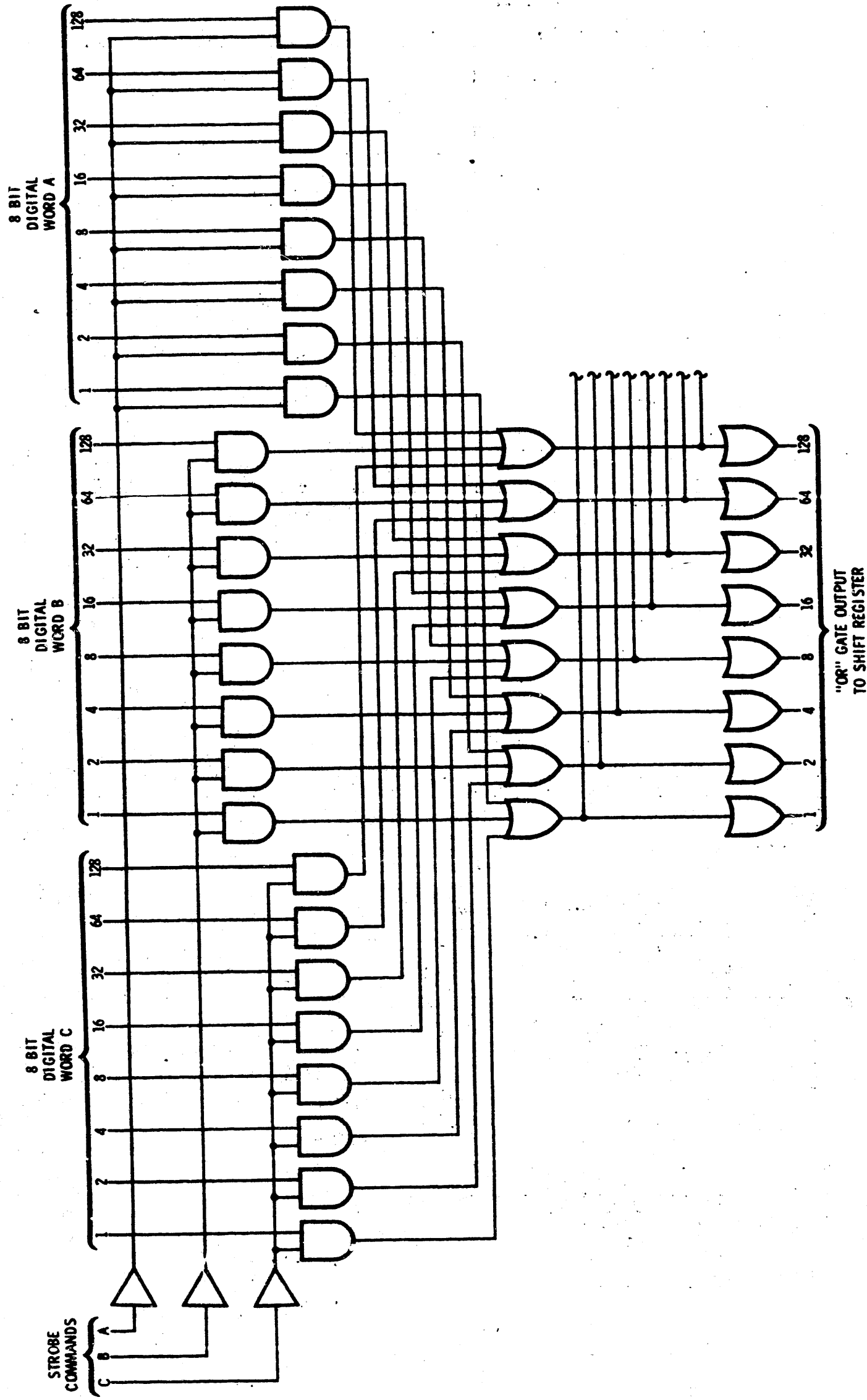
PCM COVER LOGIC



CD-166A

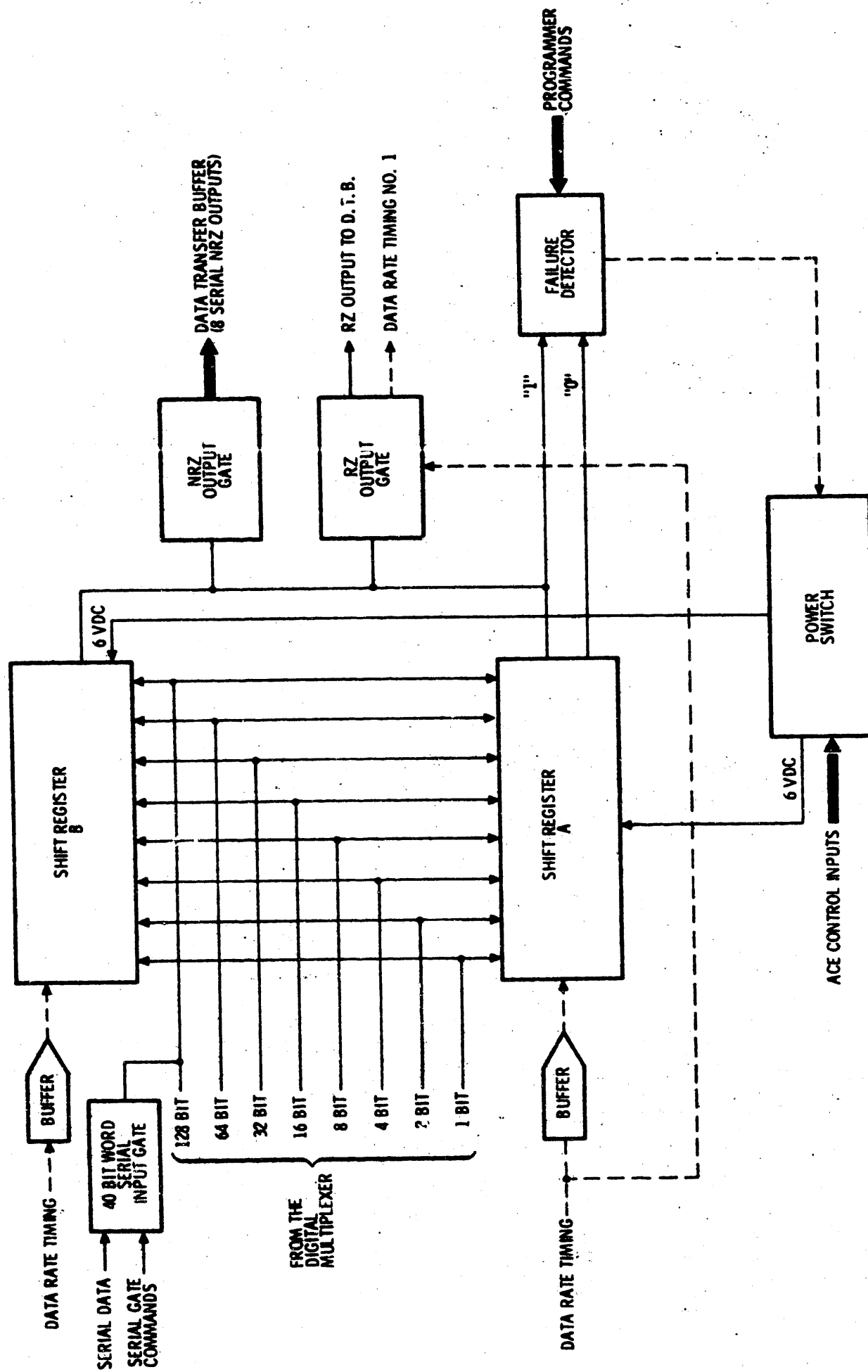
DIGITAL MULTIPLEXER GATES

BLOCK II

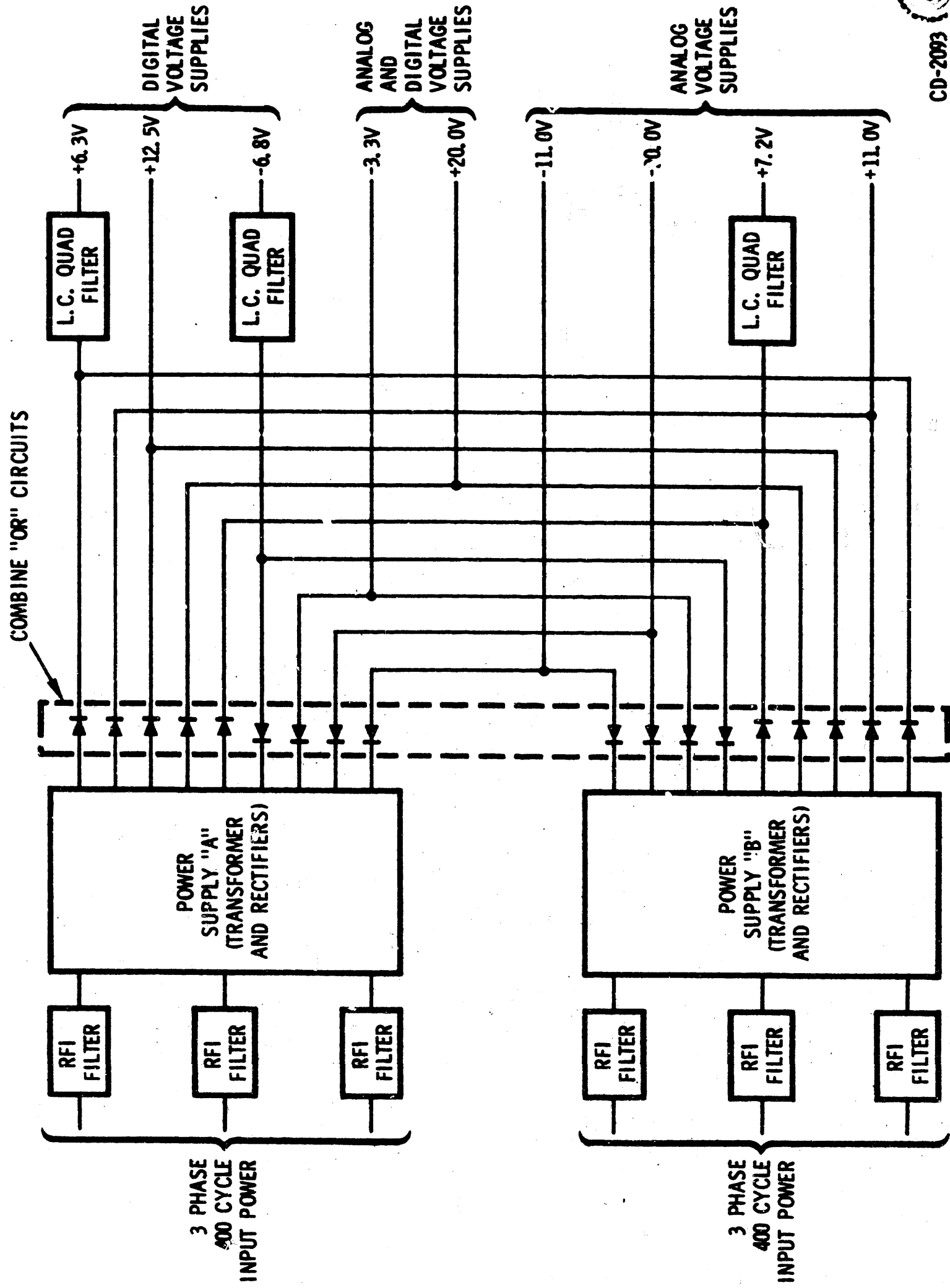


OUTPUT REGISTER BLOCK DIAGRAM

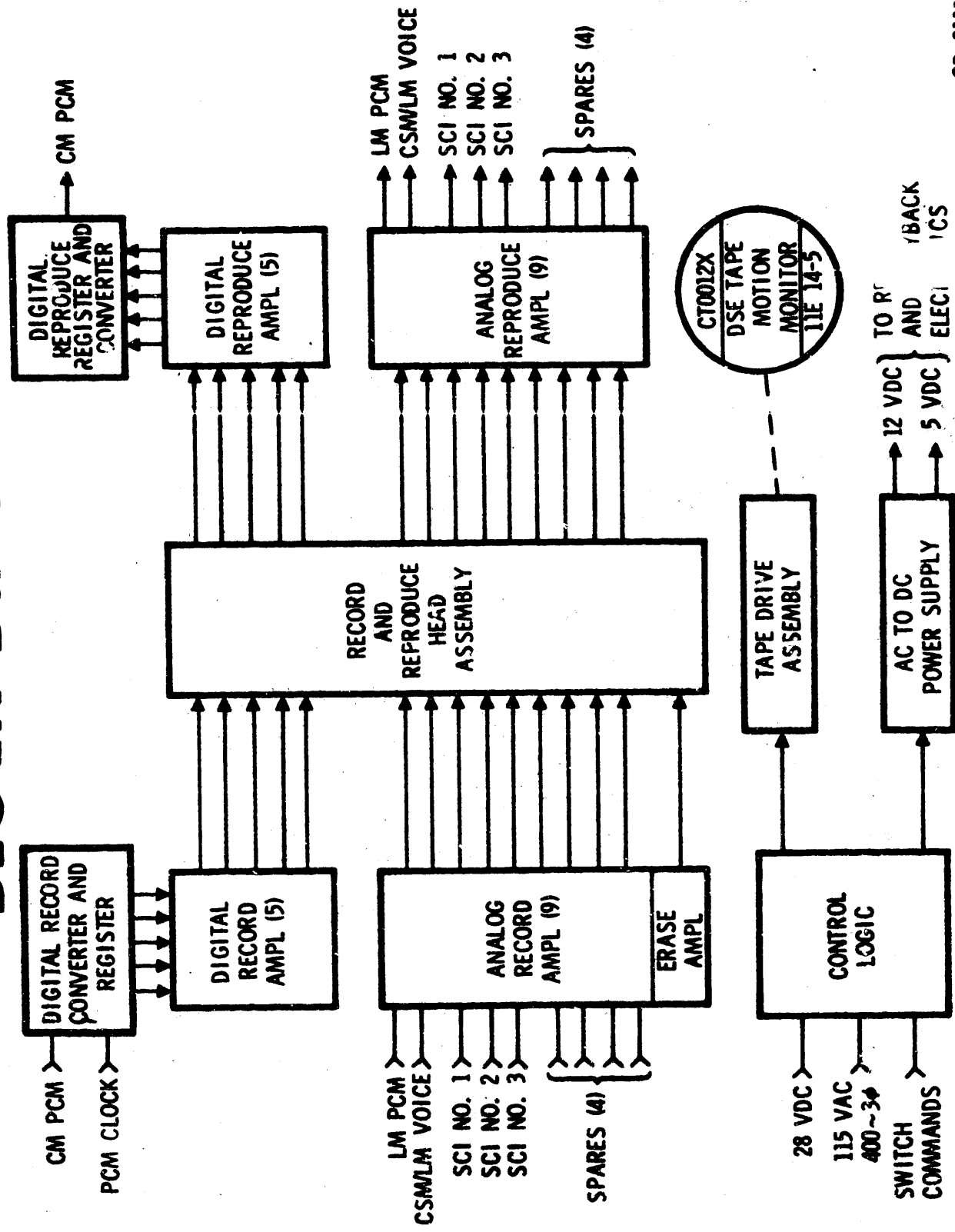
BLOCK II



PCM POWER SUPPLY BLOCK II



DATA STORAGE EQUIPMENT BLOCK DIAGRAM

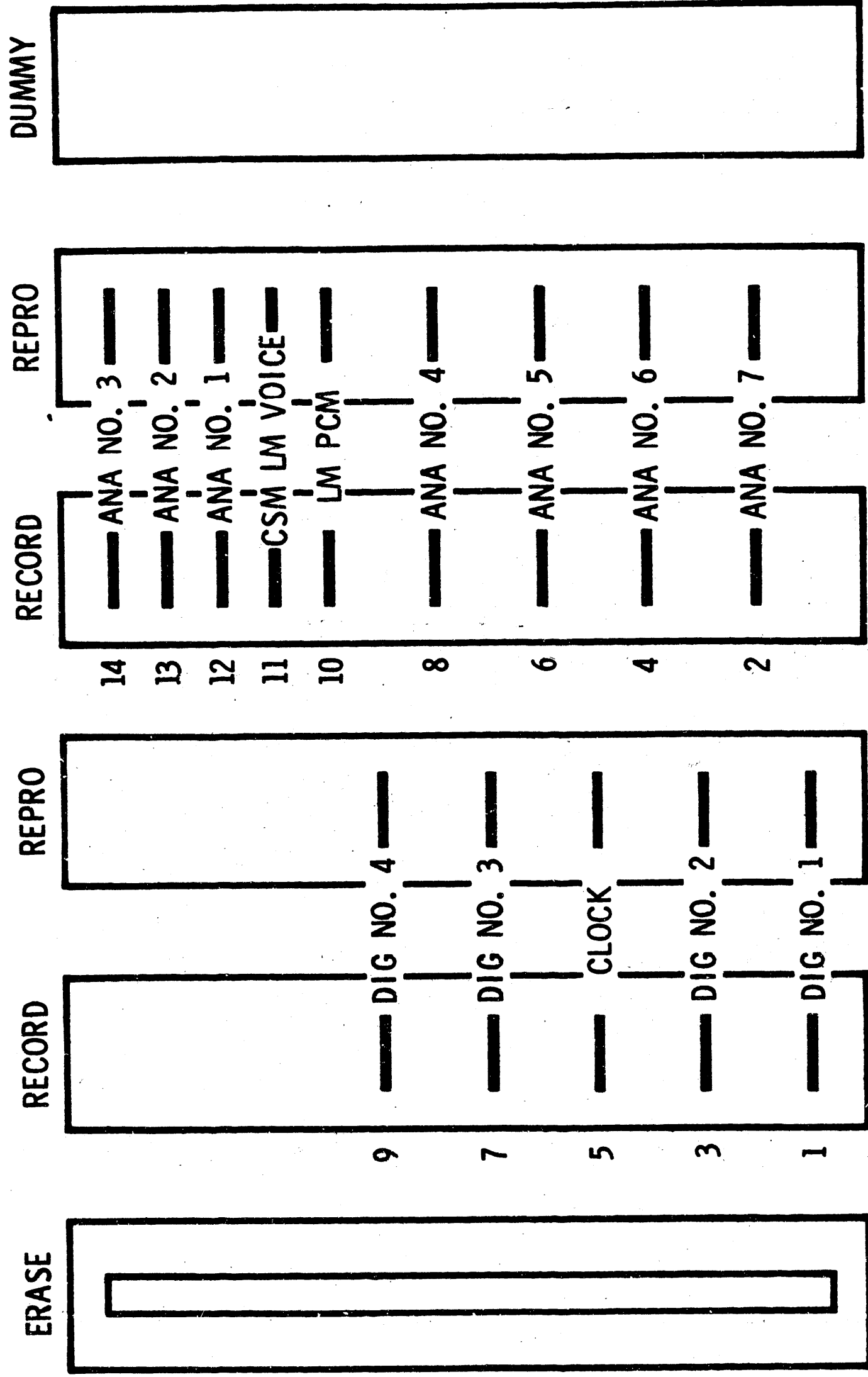


CD-2111A

DSE HEAD LAYOUT

DIGITAL

ANALOG



CD-2097 A

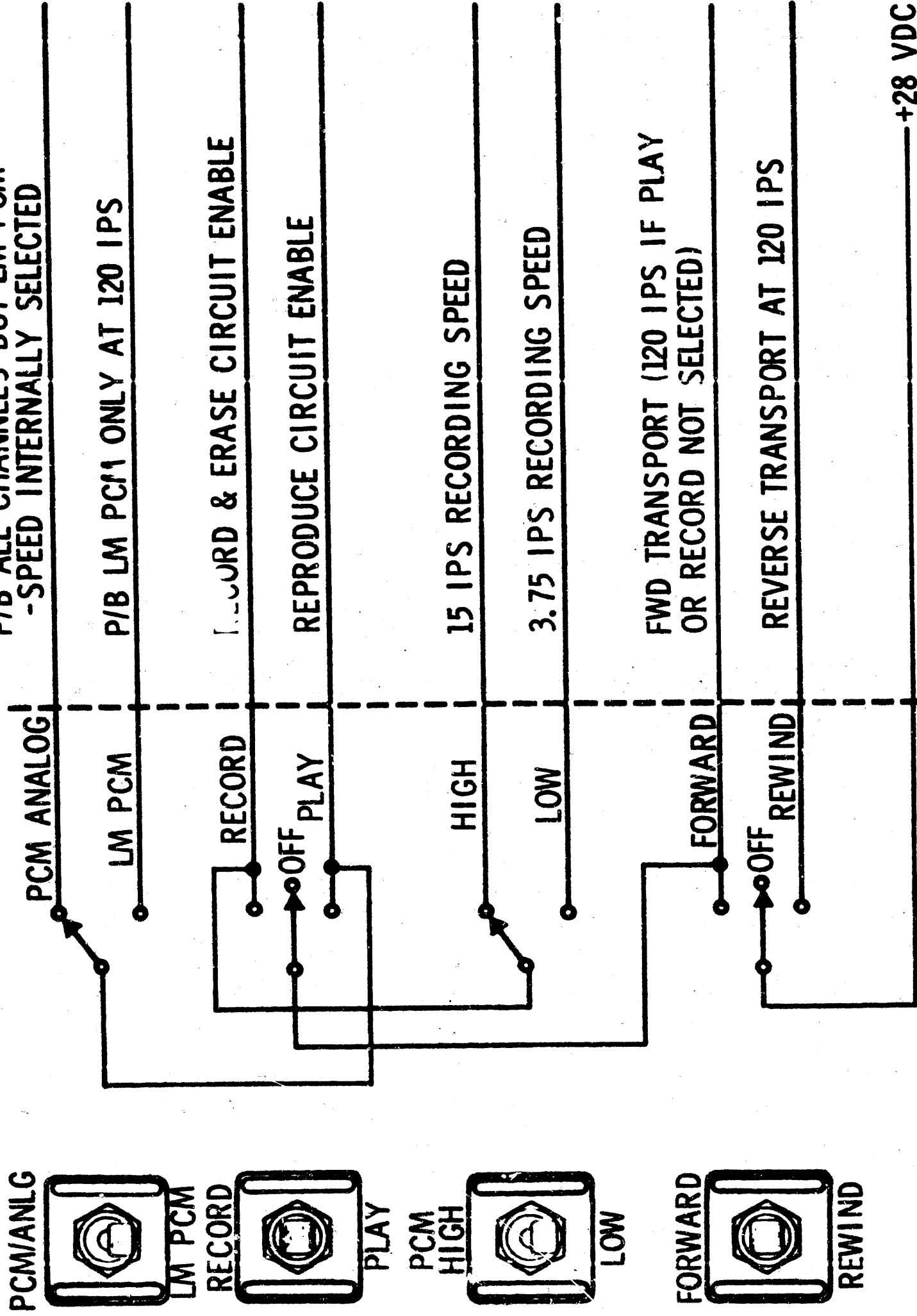


DSE SIMPLIFIED SWITCHING CIRCUITS

SPACECRAFT CONTROL PANEL

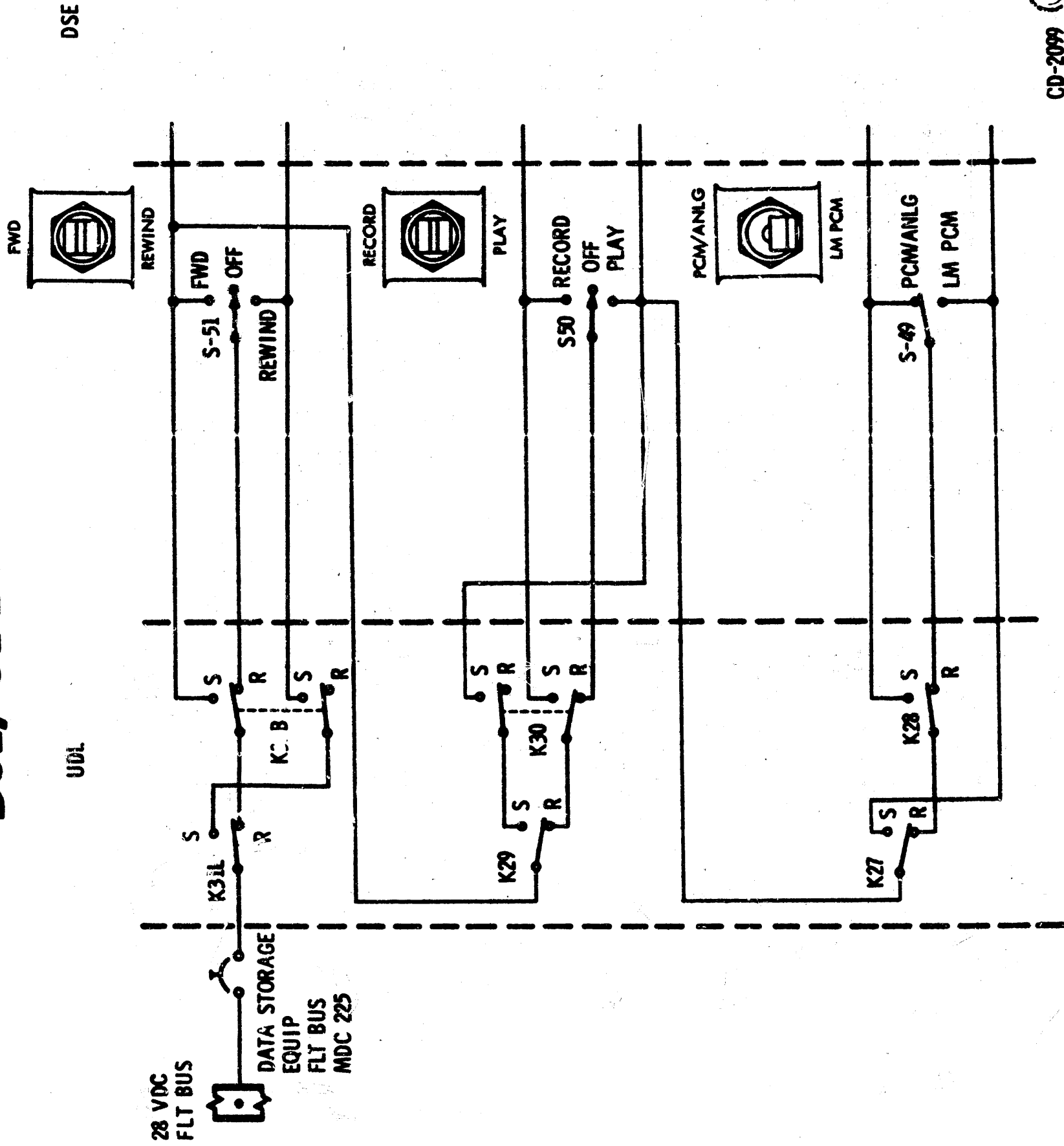
DSE LOGIC CIRCUITS

P/B ALL CHANNELS BUT LM PCM
-SPEED INTERNALLY SELECTED



CD-2109A

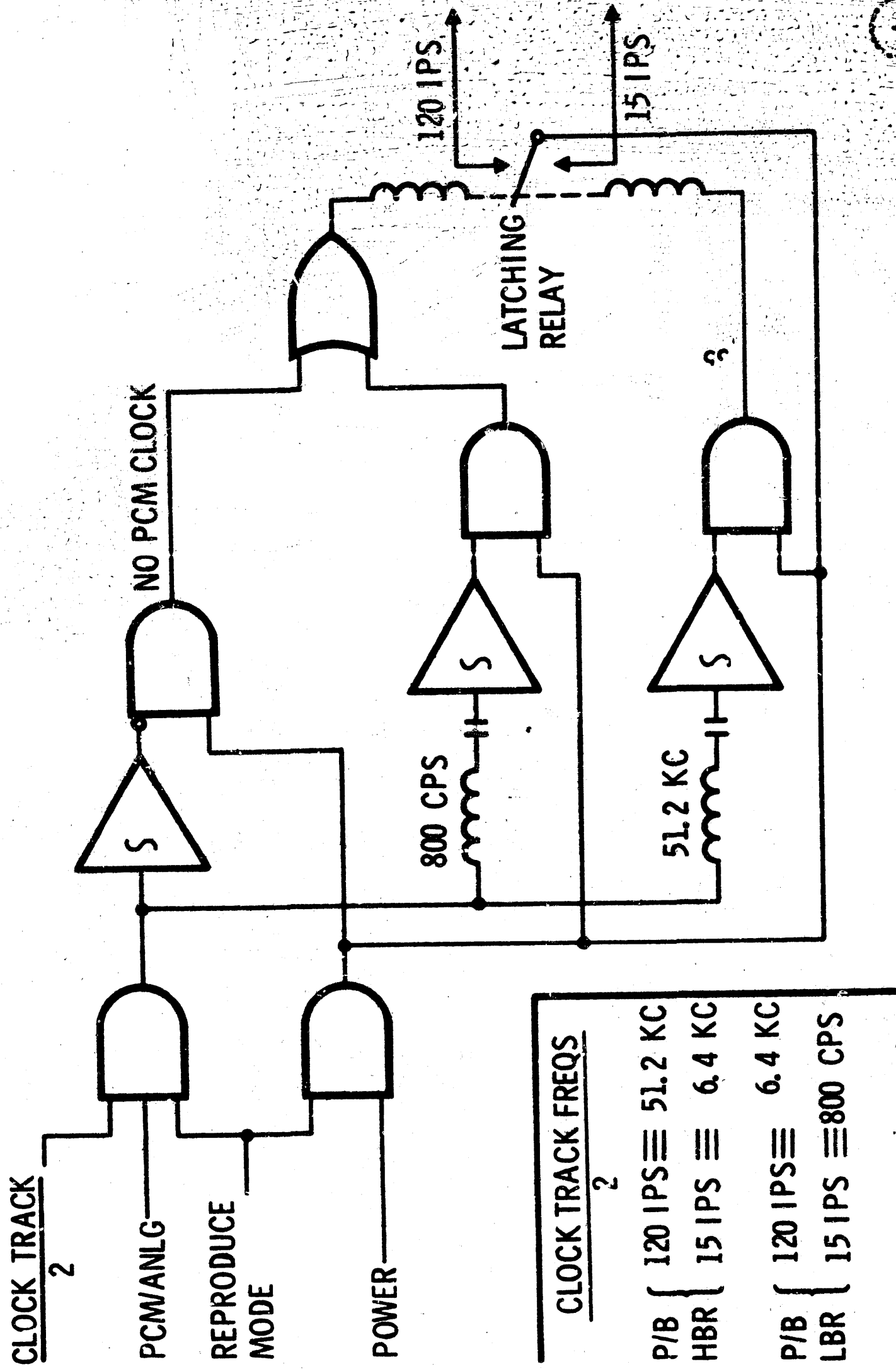
DSE/UDL INTERFACE



D.S.E. TAPE SPEED

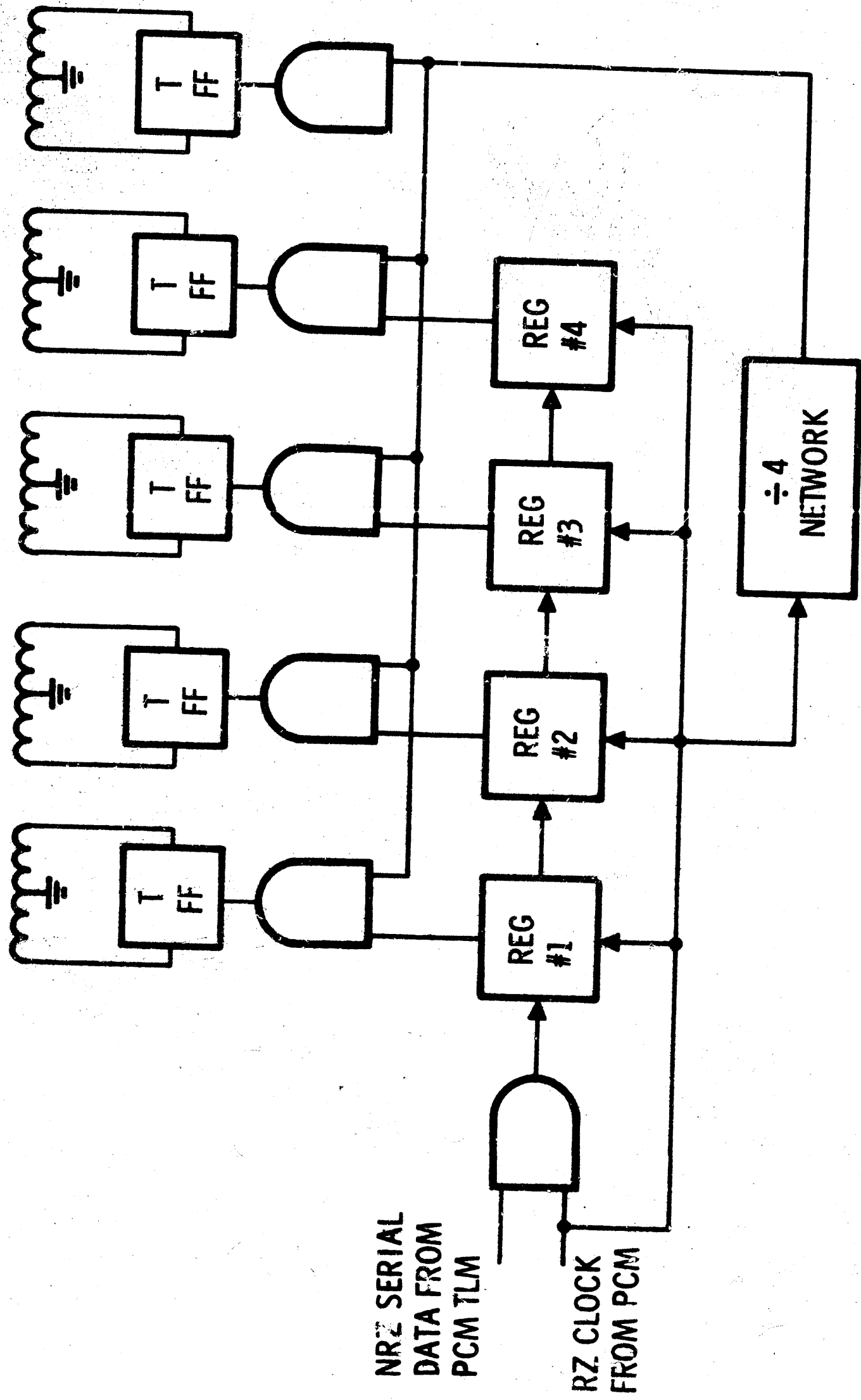
RECORD		PLAYBACK			
DETERMINED BY	PCM BIT-RATE SWITCH (S55)	PCM BIT-RATE SWITCH (S55)	DATA CLOCK TRACK	DATA CLOCK TRACK	TAPE PLAYBACK MODE SWITCH (S49)
	HIGH	LOW	MISSING (FAILURE)	$400 \frac{\text{BIT}}{\text{SEC}}$ OR $107 \frac{\text{BIT}}{\text{IN}}$	$12,800 \frac{\text{BIT}}{\text{SEC}}$ OR $854 \frac{\text{BIT}}{\text{IN}}$
TAPE SPEED	15 IPS	3.75 IPS	120 IPS	120 IPS	120 IPS

D.S.E. AUTO SPEED SELECT



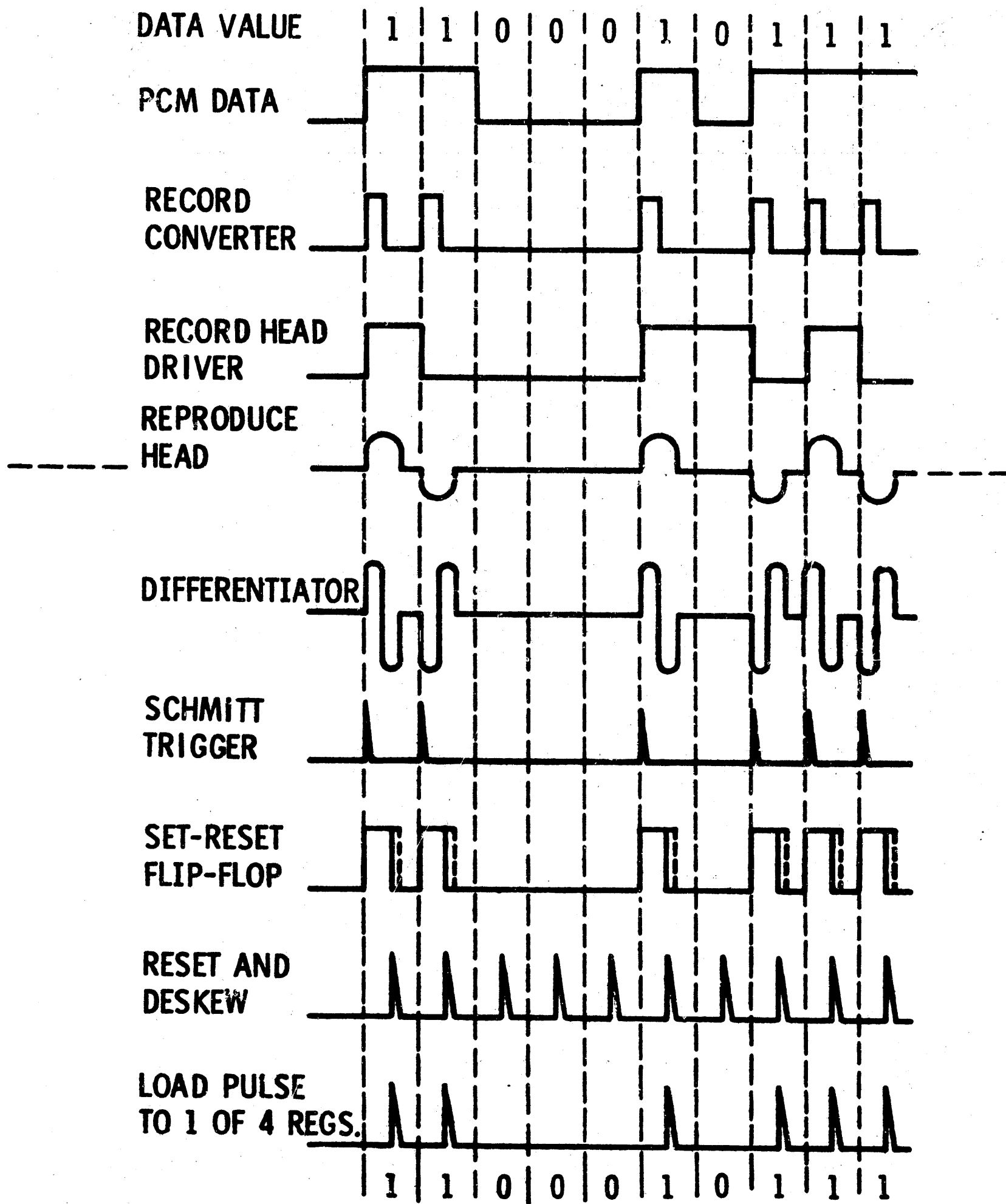
CD-2074A

D.S.E. DIGITAL RECORD CONVERTER



D.S.E. WAVE FORMS

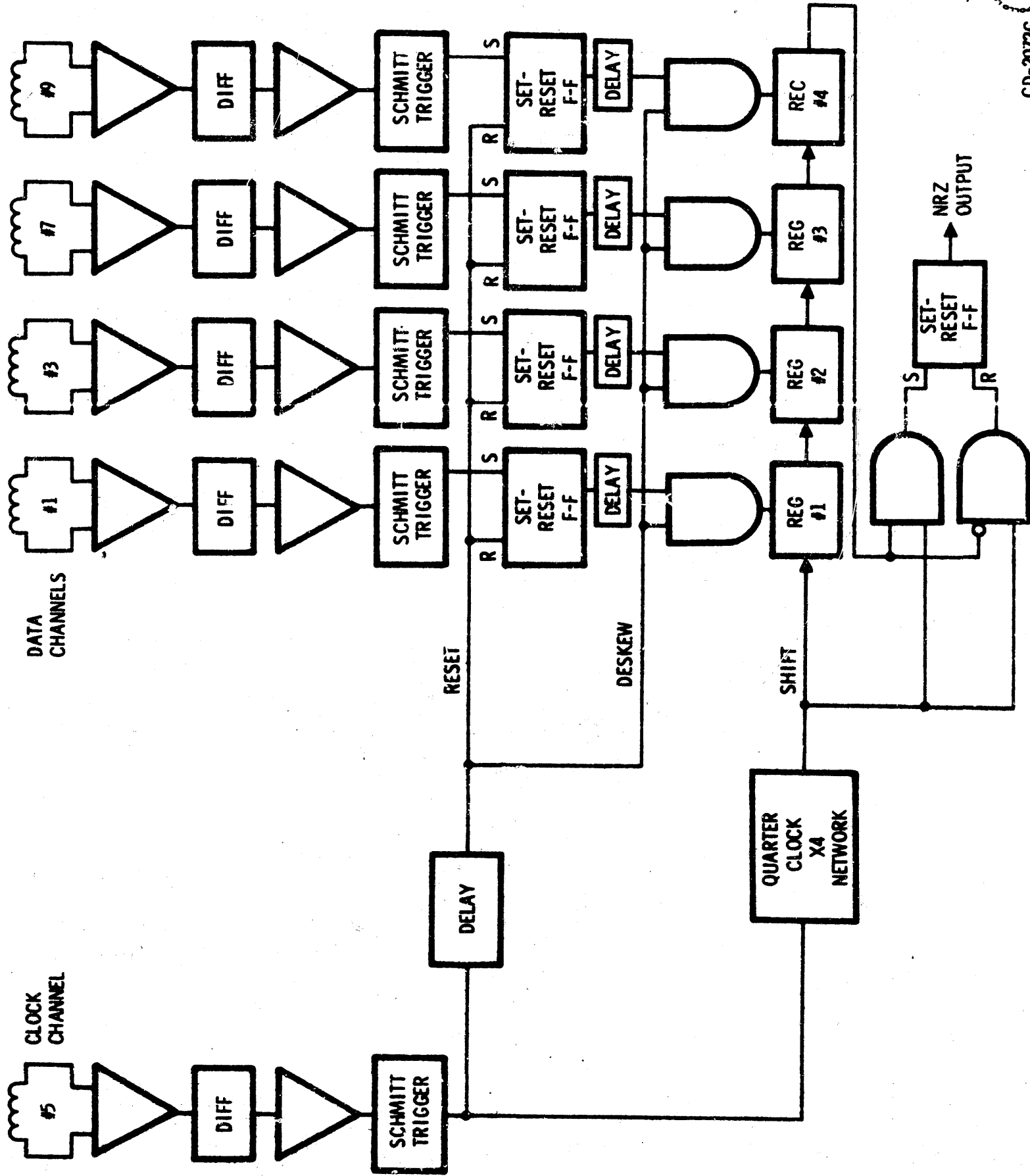
59



CD-2071C

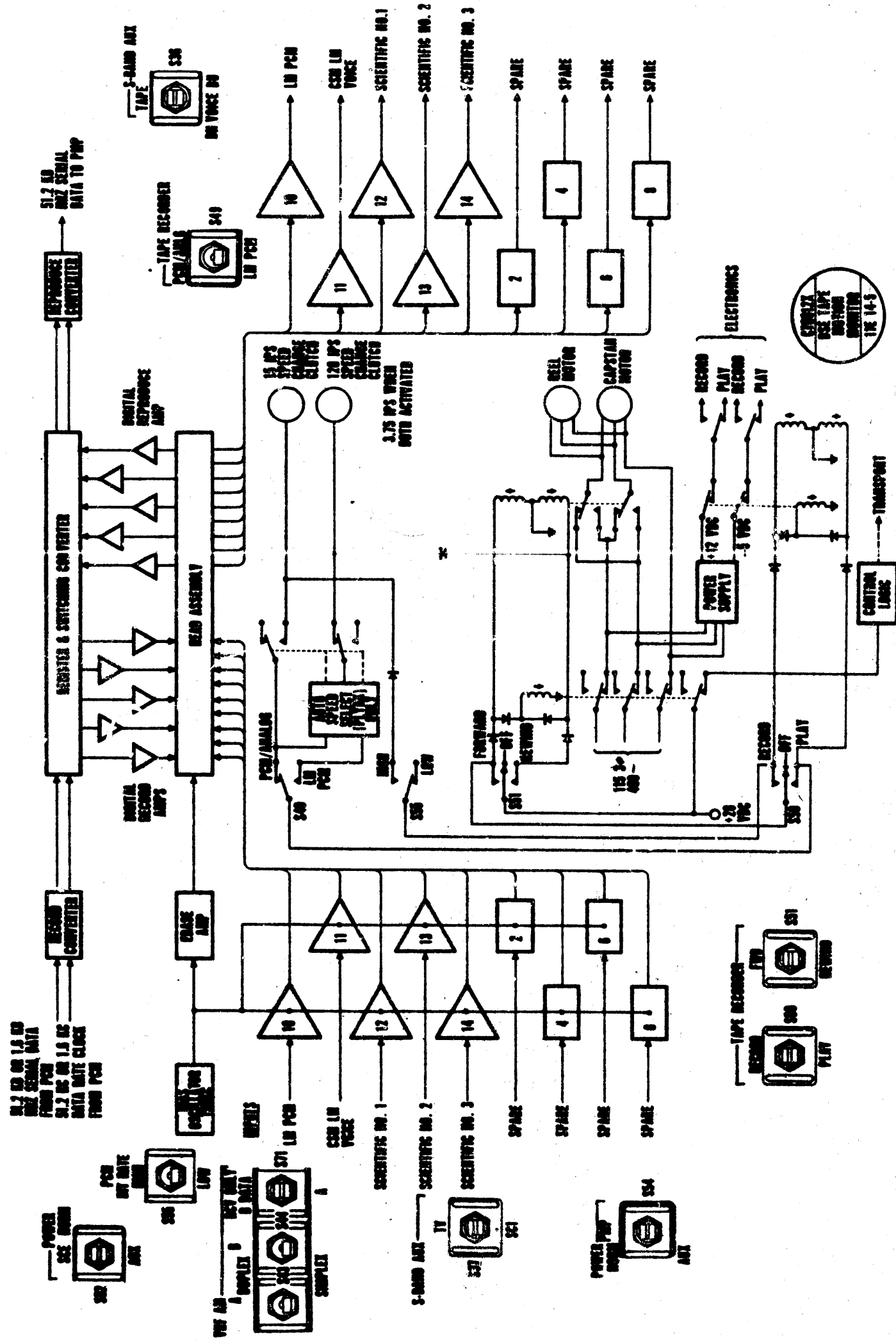


D.S.E. DATA REPRODUCE CIRCUITRY

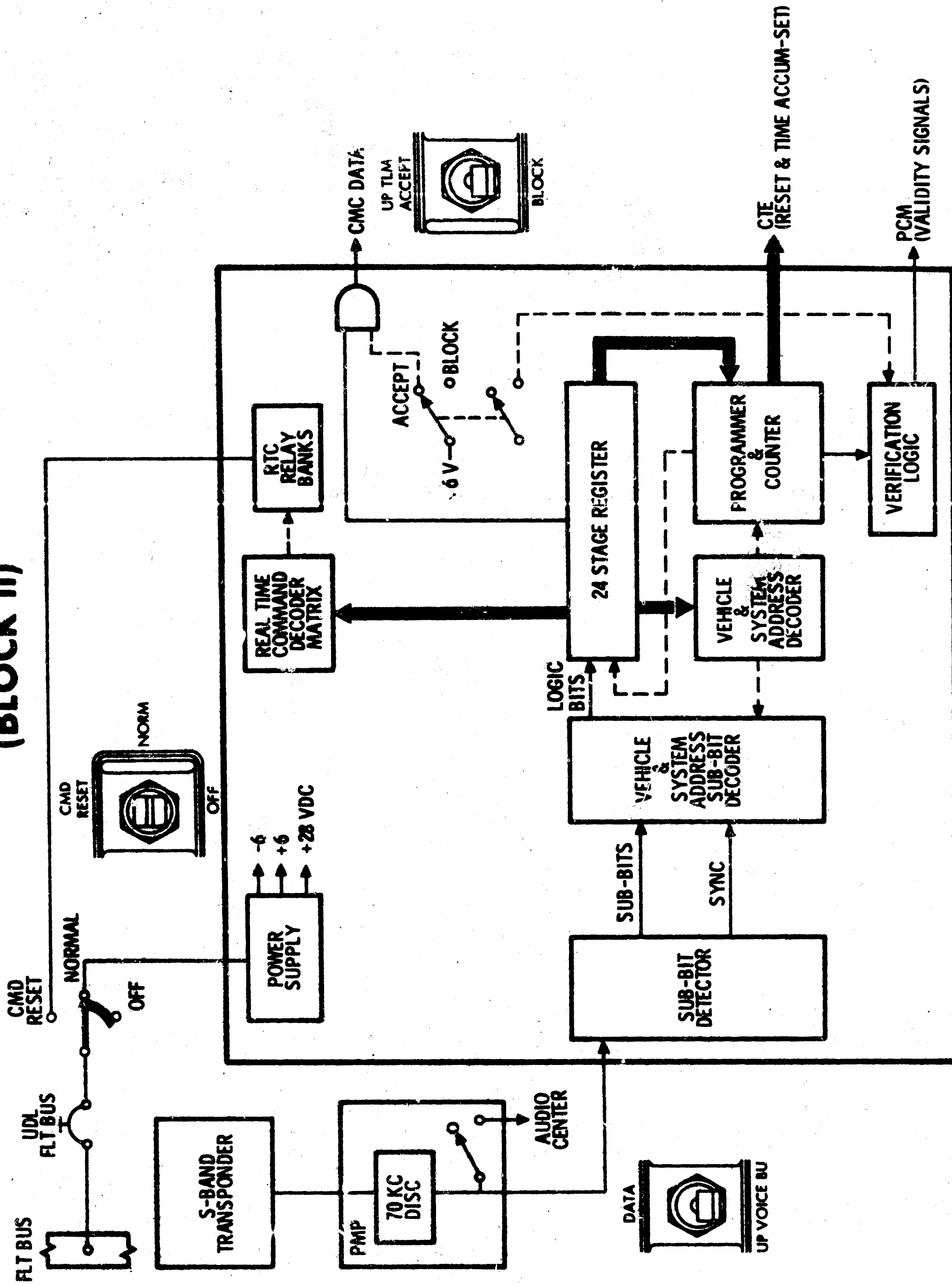


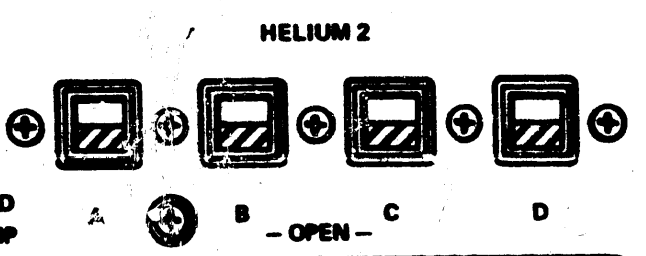
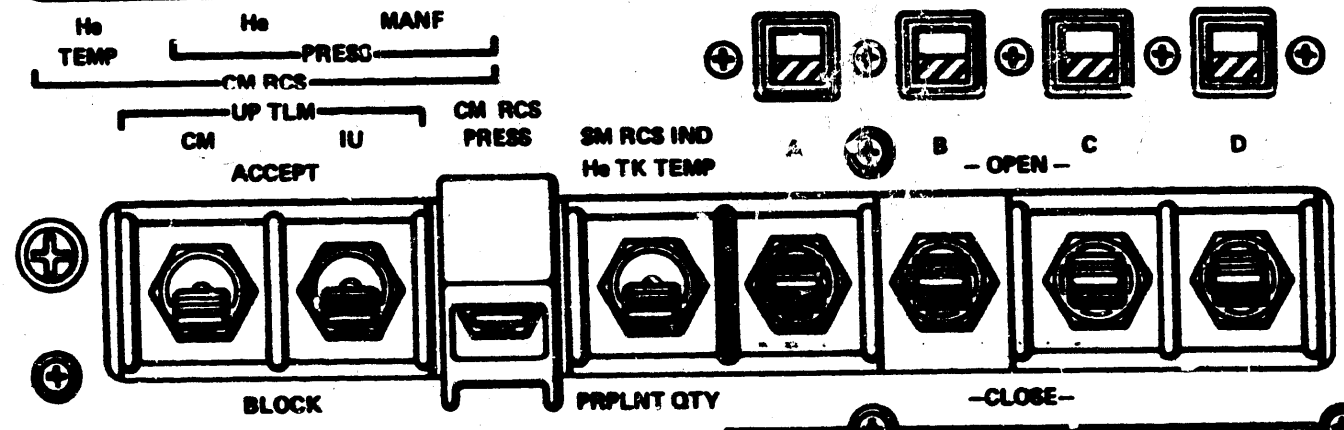
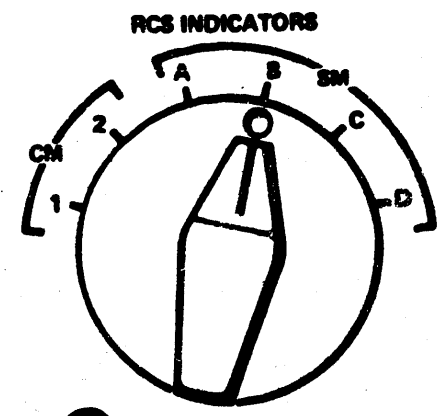
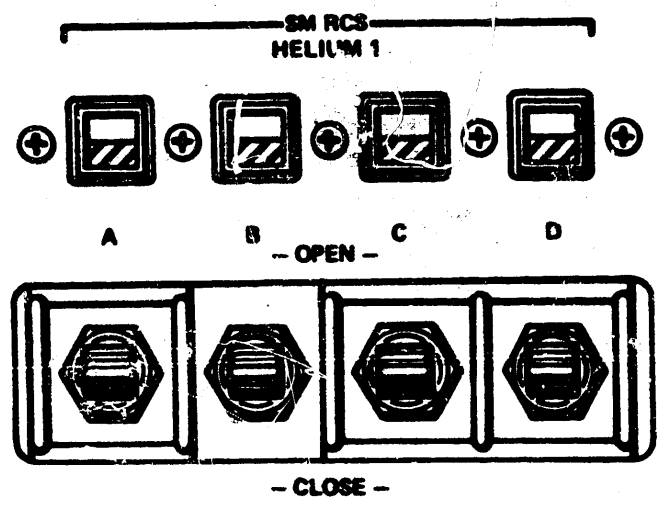
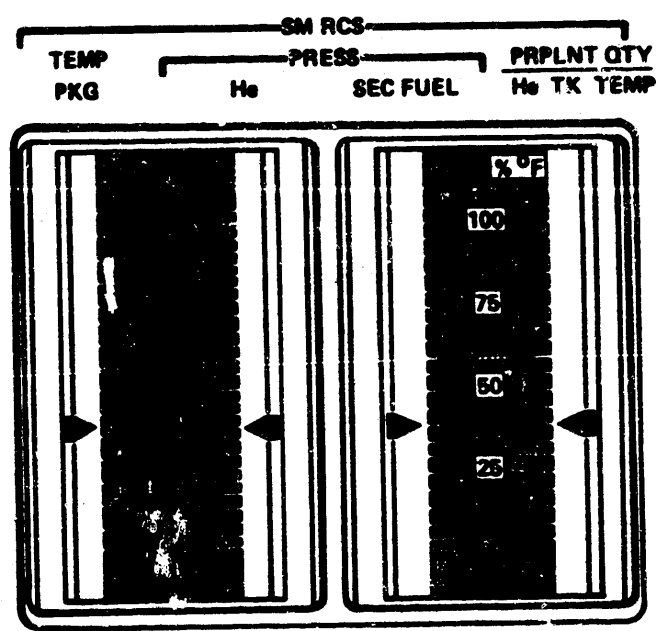
CD-2072C

DATA STORAGE EQUIPMENT BLOCK DIAGRAM

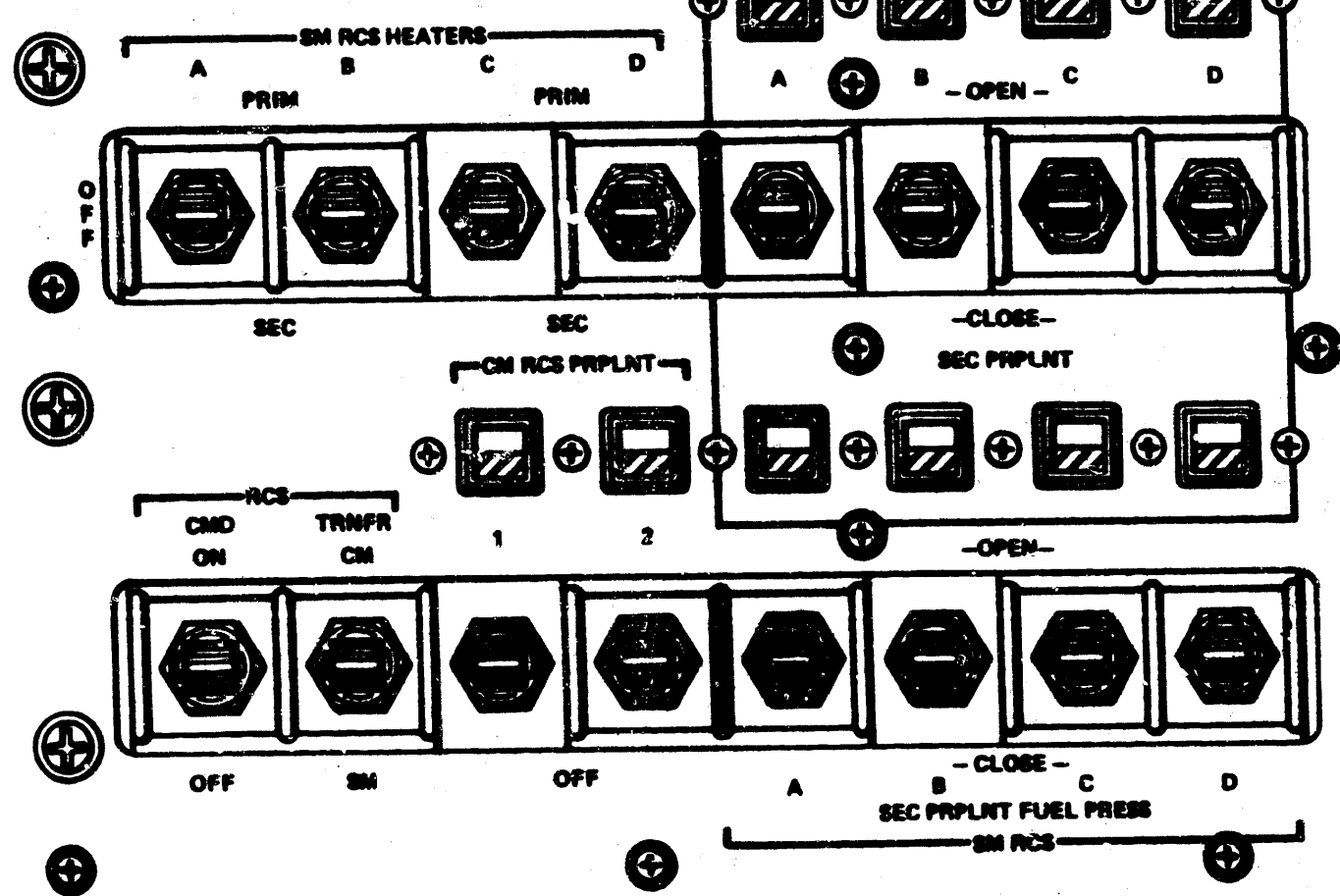


UP-DATA LINK (BLOCK II)

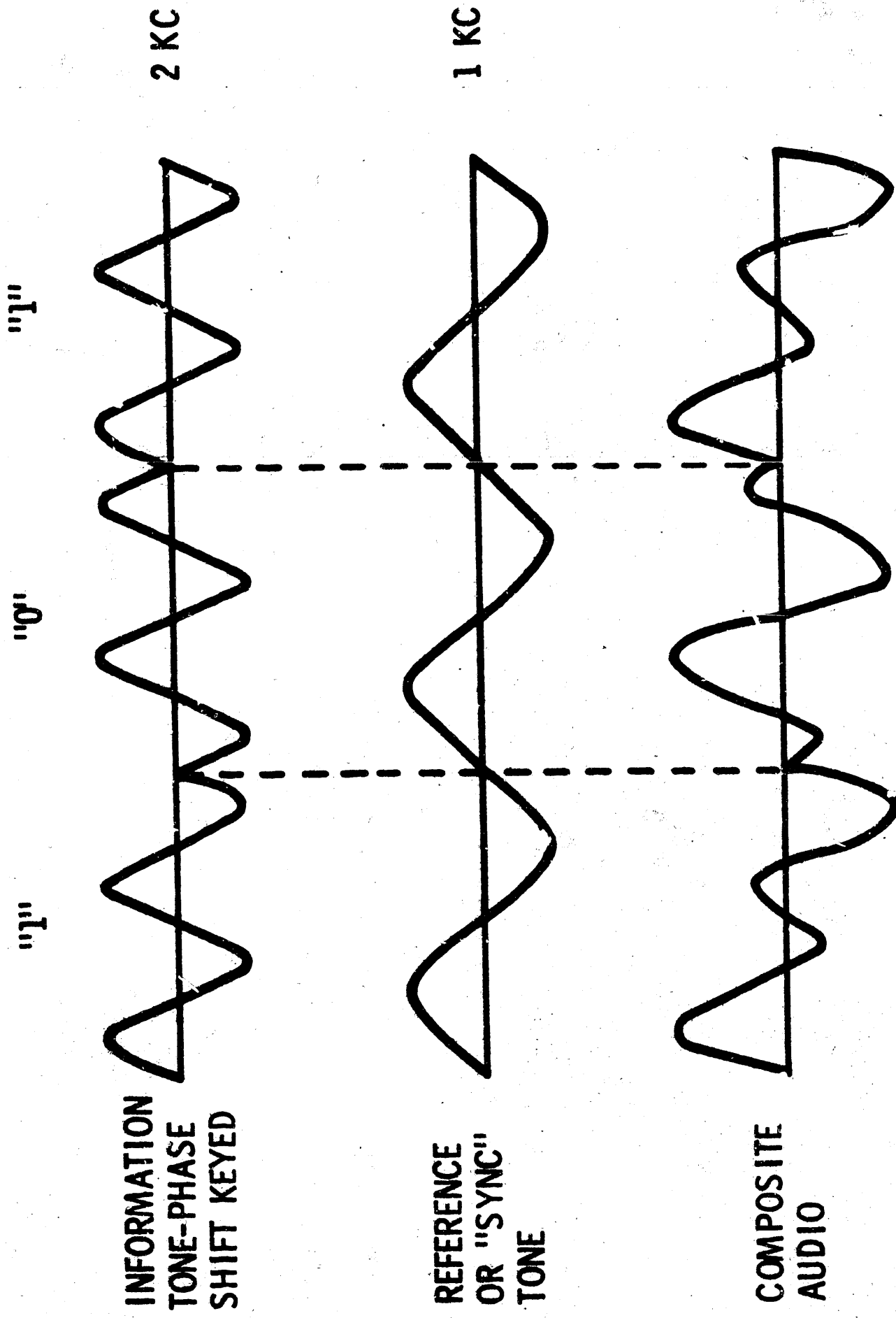




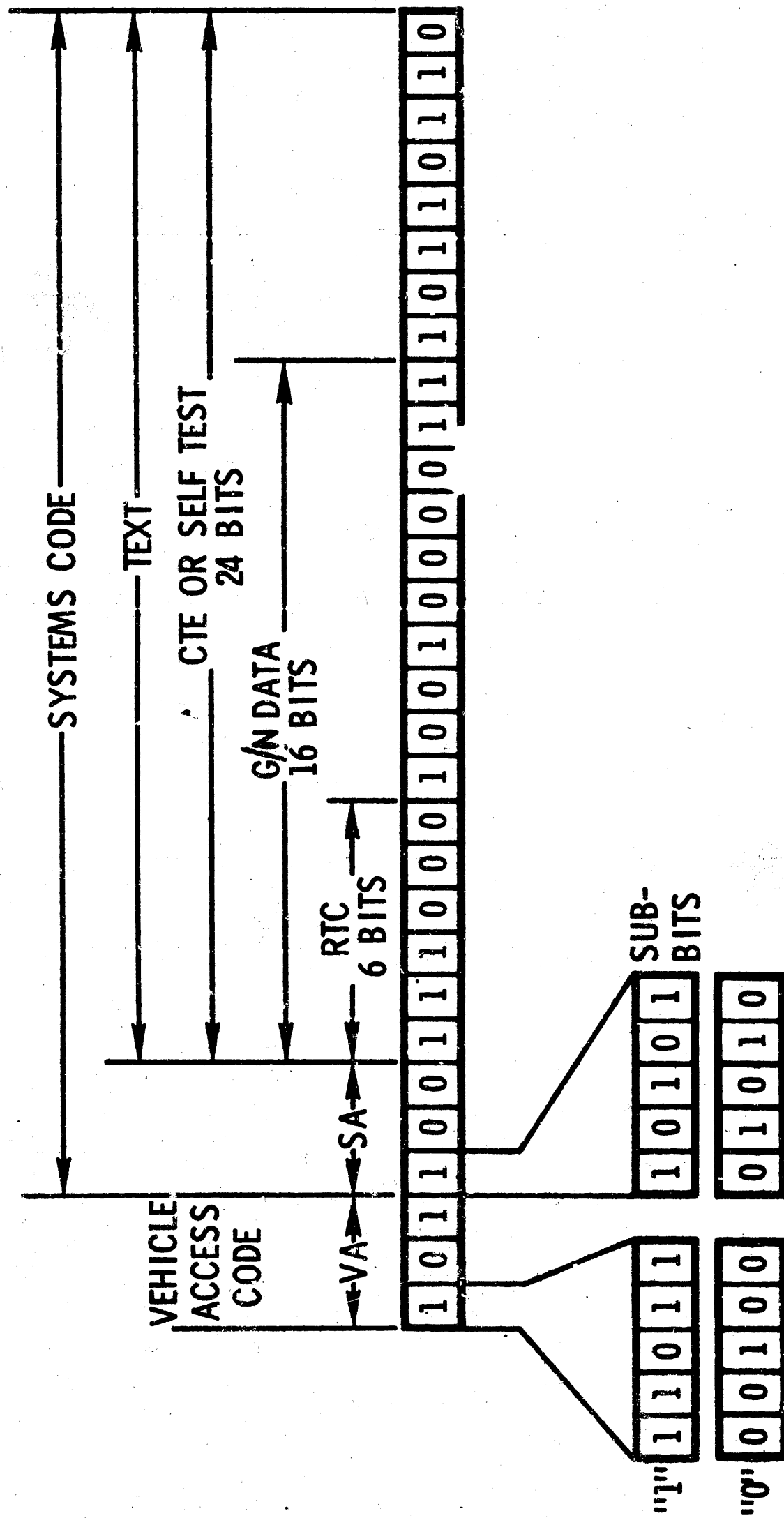
2



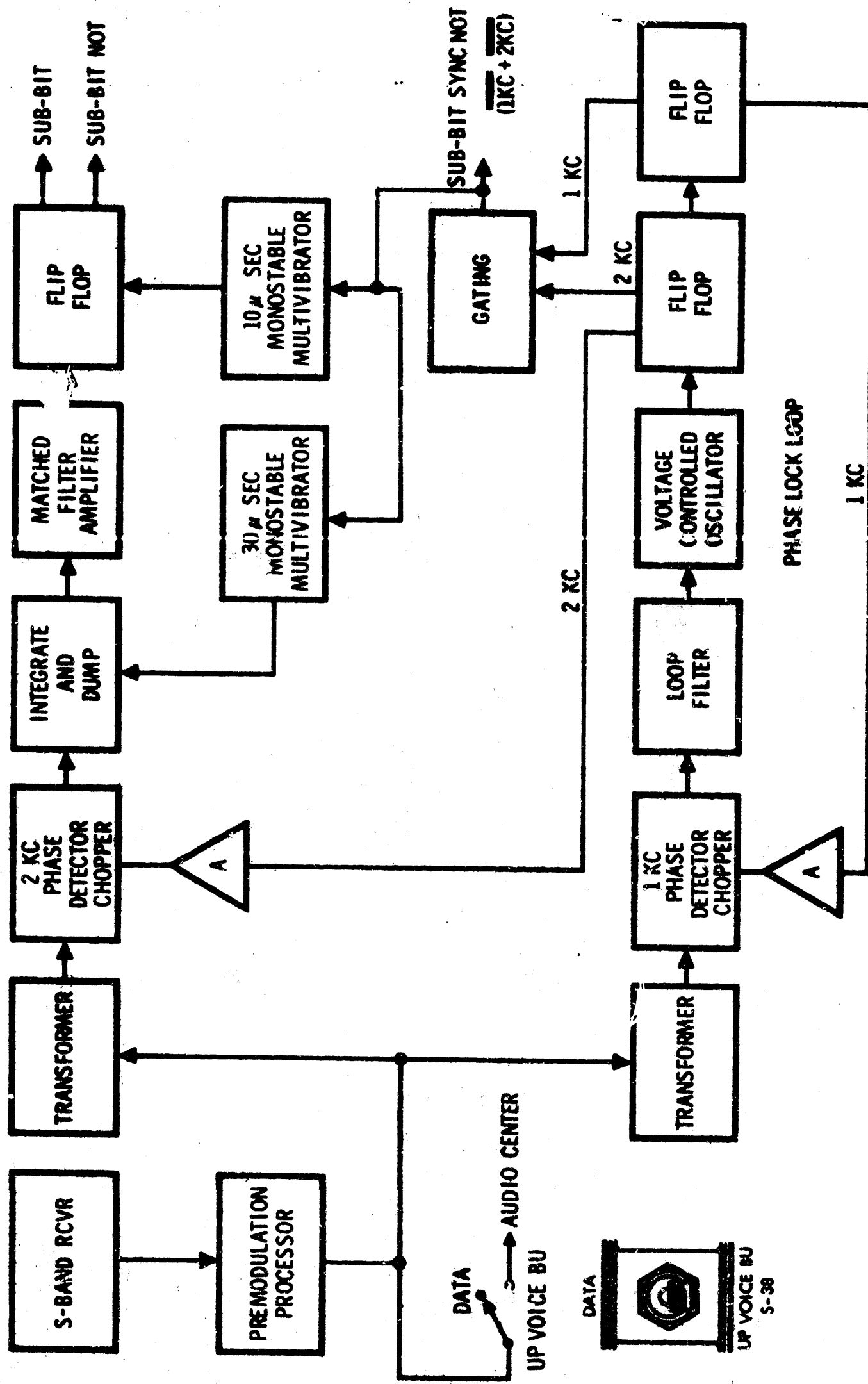
UP-DATA LINK MODULATION



UP-DATA LINK MESSAGE FORMAT

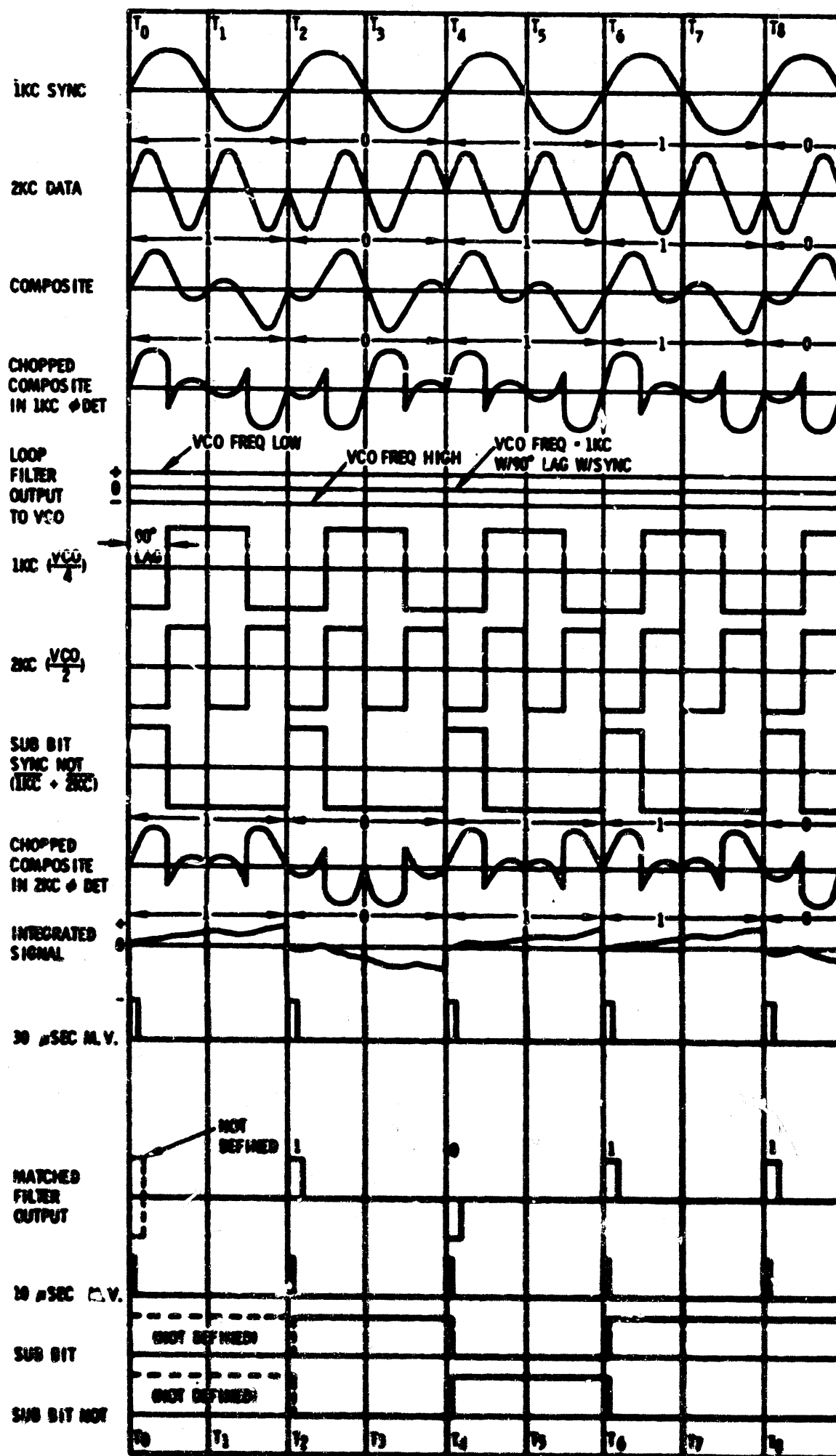


SUB-BIT DETECTOR

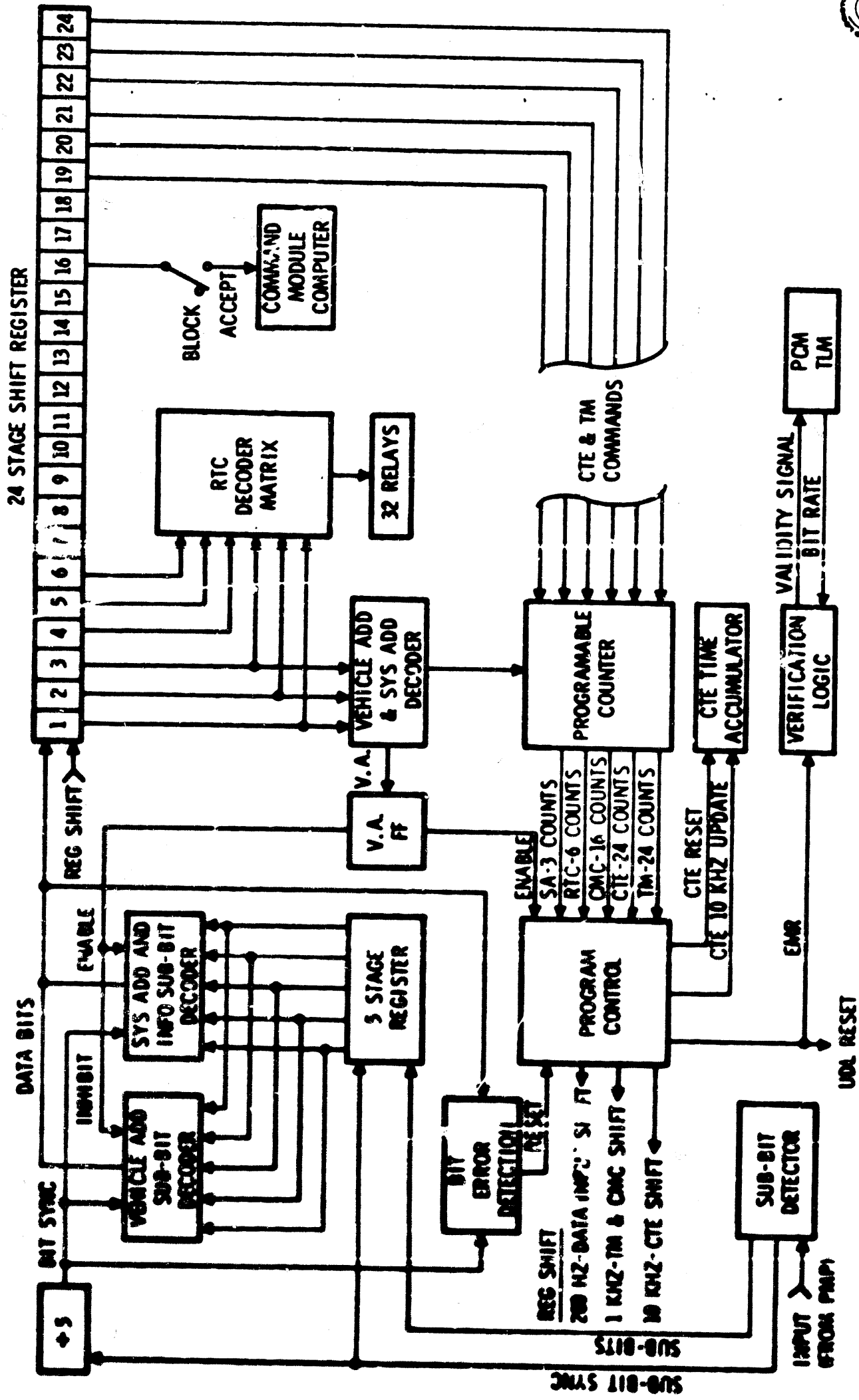


CD-101E

WAVEFORMS OF SUB-BIT DETECTOR



UDL DECODER



UDL RTC MESSAGE FORMAT

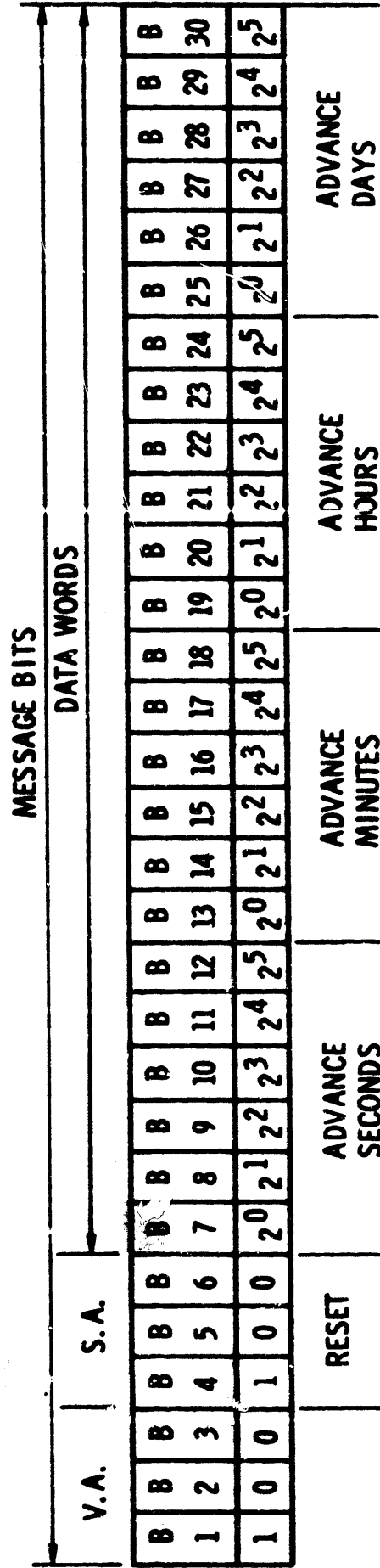
MESSAGE BITS																NOT TRANSMITTED													
V.A.				S.A.				DATA WORD																					
B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B										
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
1	0	0	1	1	0	2 ²	2 ¹	2 ⁰	2 ²	2 ¹	2 ⁰									(REAL TIME COMMANDS-INTERNAL RELAYS)									
1	0	0	1	0	1	0	1	1	0	0	0									(SALVO RESET RTC'S 00, 04, 10, 14, 20)									
1	0	0	1	0	1	1	1	1	0	0	0									(SALVO RESET RTC'S 40, 44, 50, 54, 60, 64, 70, 74)									
1	0	0	1	0	1	0	1	1	0	1	0									(SALVO RESET RTC'S 02, 06, 12, 16, 22, 26, 32, 36)									
1	0	0	1	0	1	1	1	1	0	1	0									(SALVO RESET RTC'S 42, 46, 52, 56, 62, 66, 72, 76)									

1. RTC BITS B7 THRU B10 GROUNDS ONE OF 16 SELECT LINES WHILE BITS B11 AND B12 PROVIDES A 28 VDC PULSE FOR 30 MILLISECONDS ON ONE OF THE SET OR RESET LINES
2. RTC DATA WORD BIT CONFIGURATION CAN BE DETERMINED BY TRANSFORMING THE RTC OCTAL NUMBER TO A 6 BIT BINARY NUMBER
3. TOTAL TIME FROM MESSAGE ENTRY TO VERIFICATION IS 90 MILLISECONDS



CD-2114

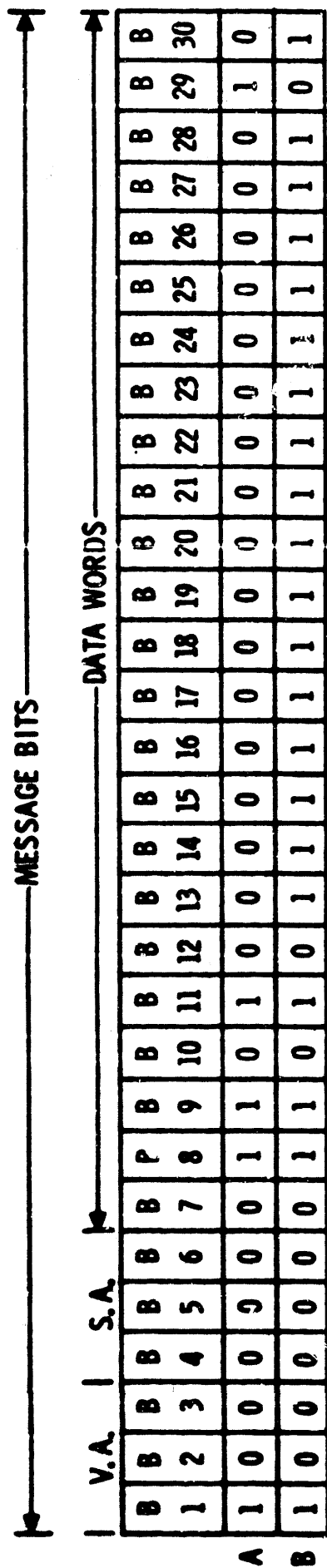
UDL CTE MESSAGE FORMAT



1. SYSTEM ADDRESS (S.A.) GENERATES 24 PULSES (ONLY ONE PULSE REQUIRED) TO RESET CTE, PULSE WIDTH IS 50 MICROSECONDS AND PULSE RATE IS 200 HZ
2. CTE COUNTUP PULSES ARE GENERATED TO SECONDS LINE FIRST, MINUTES LINE NEXT, HOURS LINE NEXT, AND DAYS LINE LAST AT 10 KHZ RATE
3. NUMBER OF COUNTUP PULSES IS THE DECIMAL EQUIVALENT OF A SIX-BIT BINARY NUMBER
4. MAXIMUM TIME INPUT IS 19 DAYS, 23 HOURS, 59 MINUTES AND 59 SECONDS
5. TOTAL TIME FROM MESSAGE ENTRY TO VERIFICATION IS 169 MILLISECONDS MAXIMUM

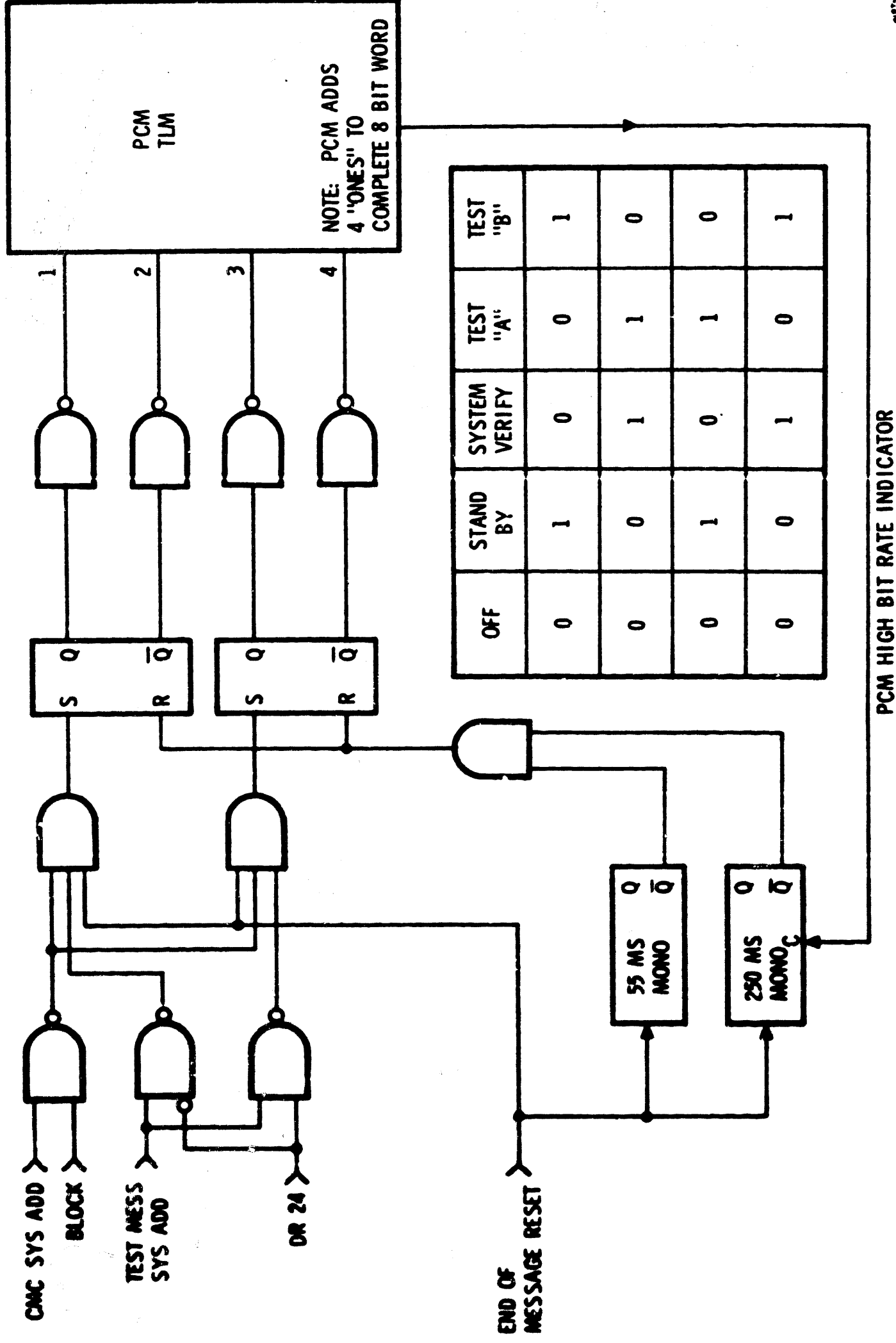


UDL TEST MESSAGE FORMATS



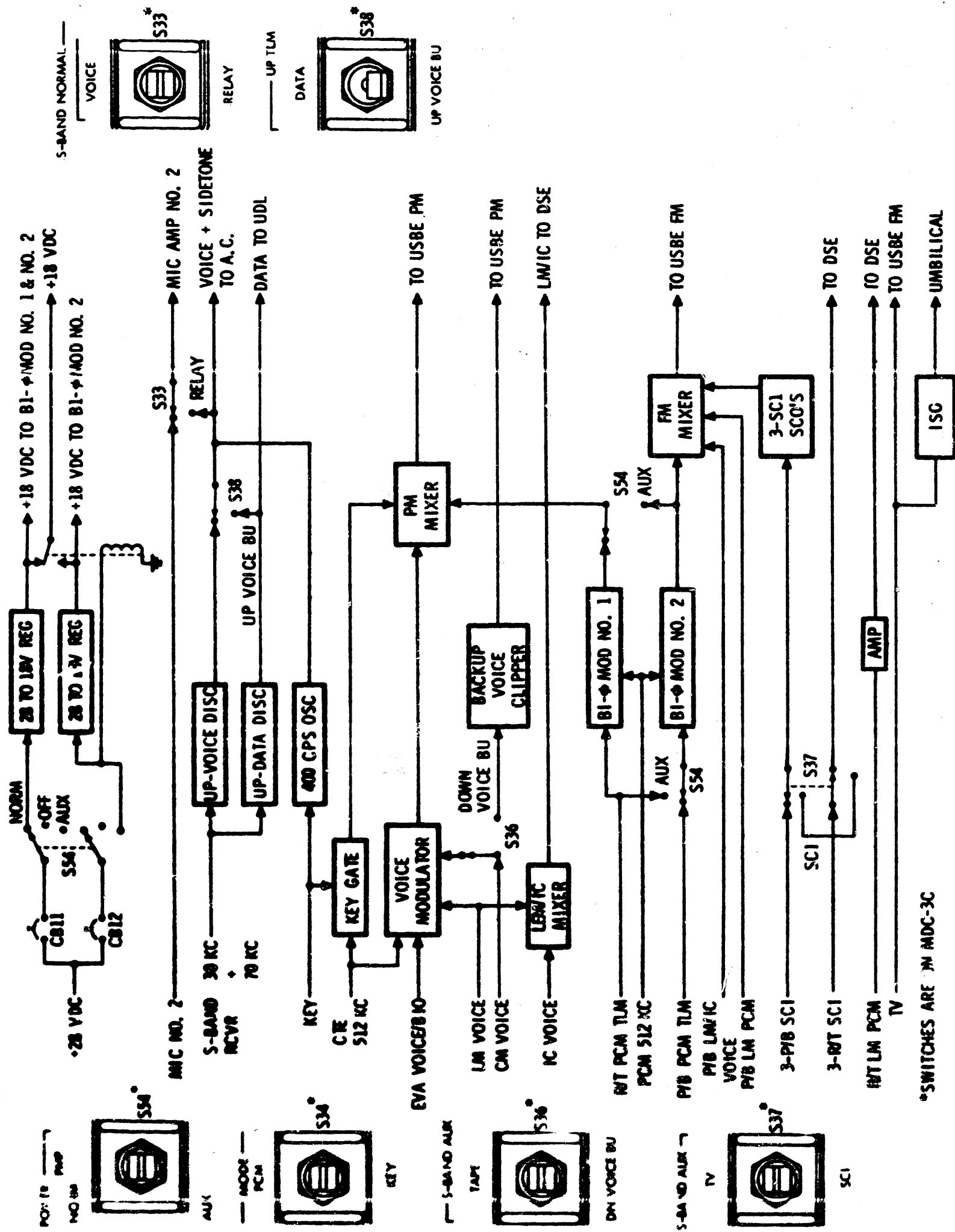
1. TEST MESSAGES A & B EXERCISE ALL PROCESS, TRANSFER AND PROGRAM CONTROL LOGIC AND IF NO ERRORS OCCUR, MAIN REGISTER POSITION 24 WILL CONTAIN BIT 29 INFORMATION FOR A TEST A OR TEST B VERIFICATION SIGNAL
2. TOTAL TIME FROM MESSAGE ENTRY TO VERIFICATION IS 172 MILLISECONDS MAXIMUM

UDL VERIFICATION LOGIC



CD-2115A

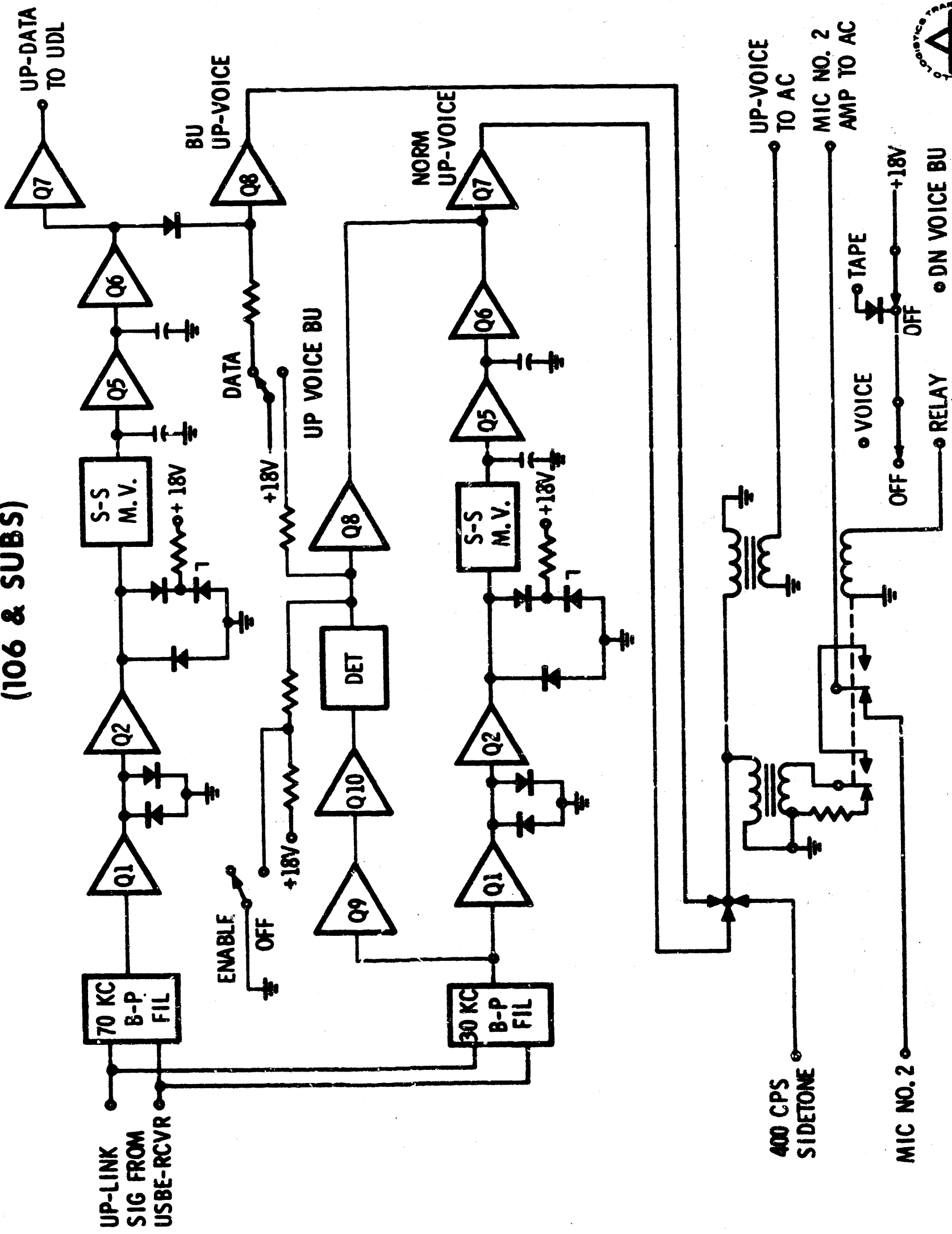
PMP BLOCK DIAGRAM



*SWITCHES ARE IN MDC-3C

PMP UP-LINK DETECTORS

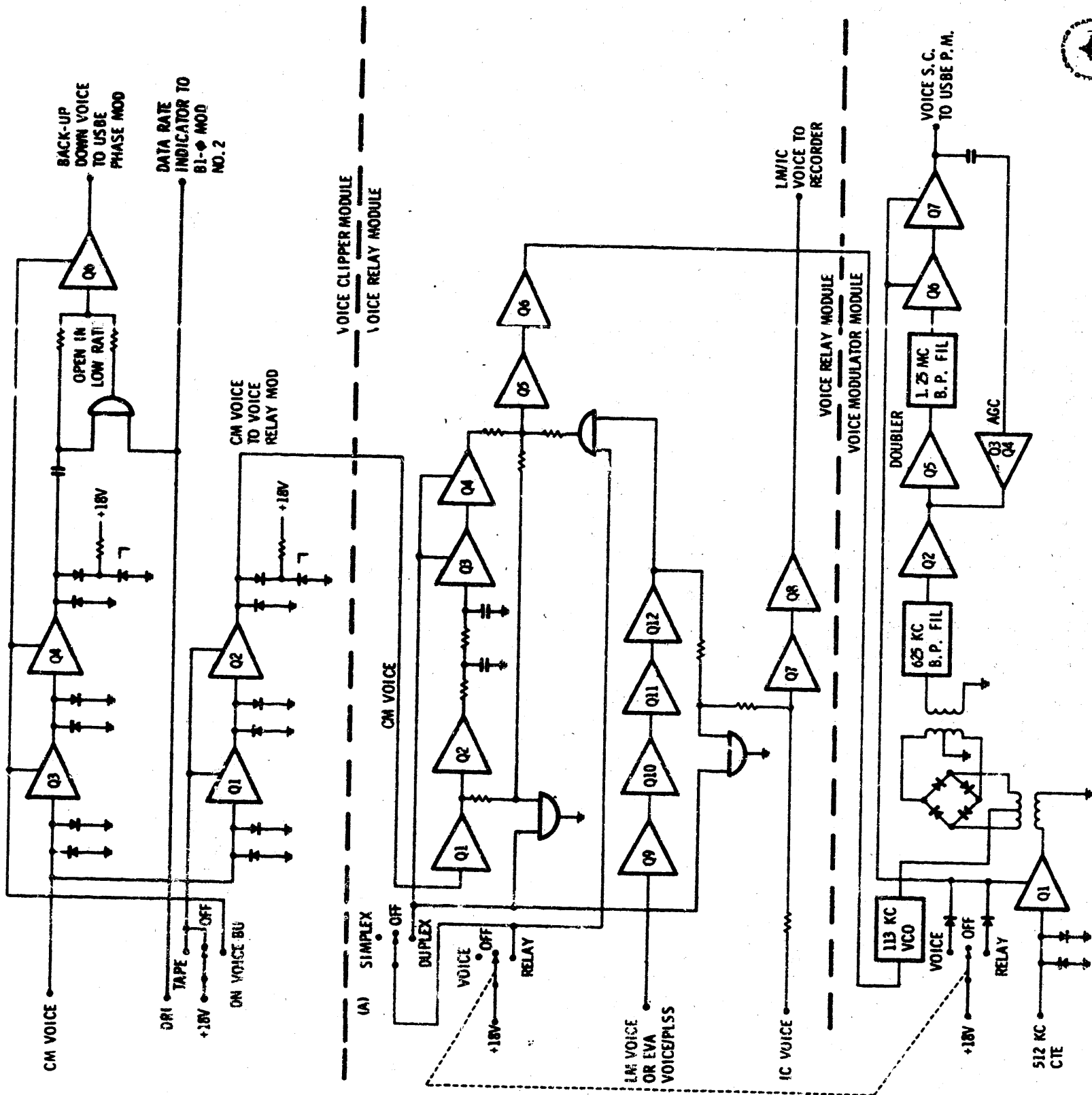
(106 & SUBS)



CD-2142

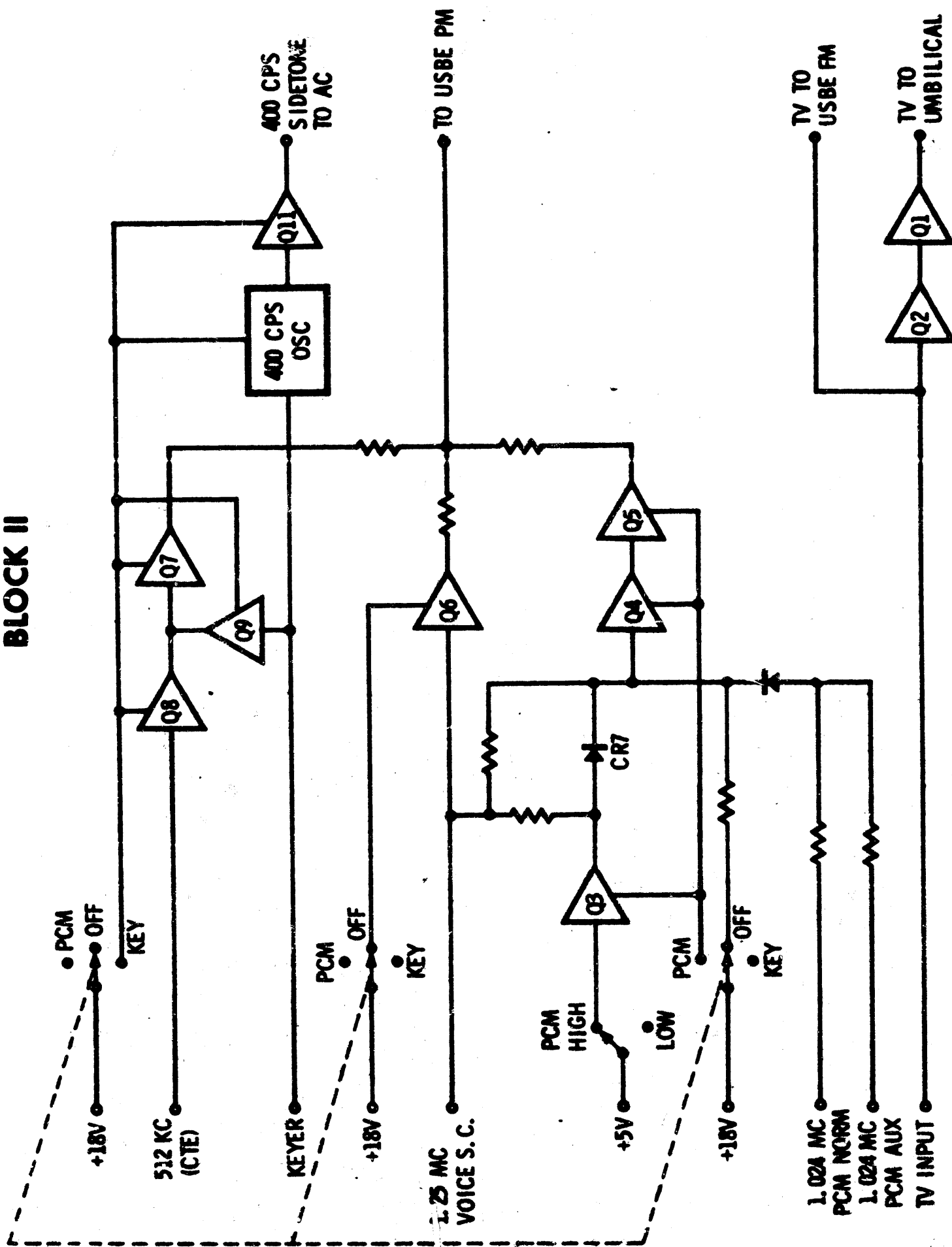
PMP VOICE MODULATOR

BLOCK II



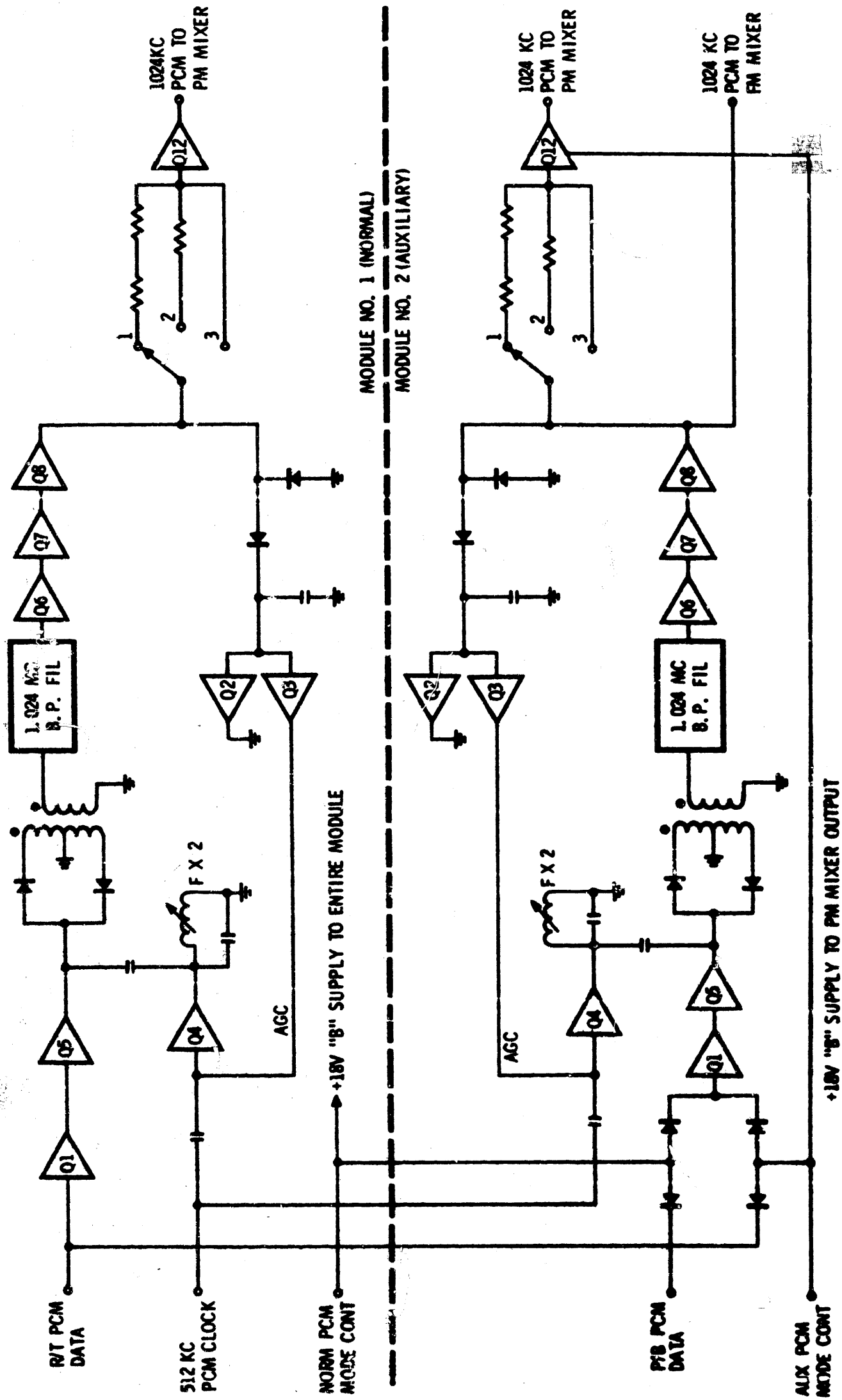
CD-2034 D

PMP PM MIXER BLOCK II



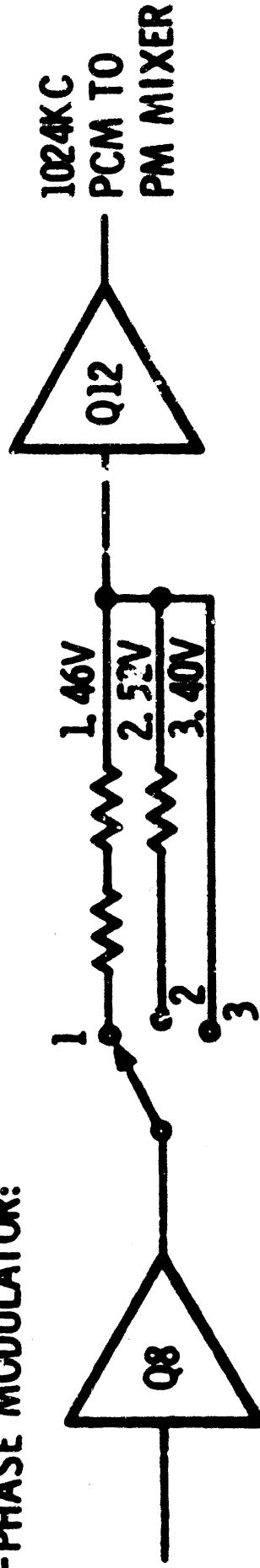
CD-2033A

PMP BI-PHASE MODULATORS

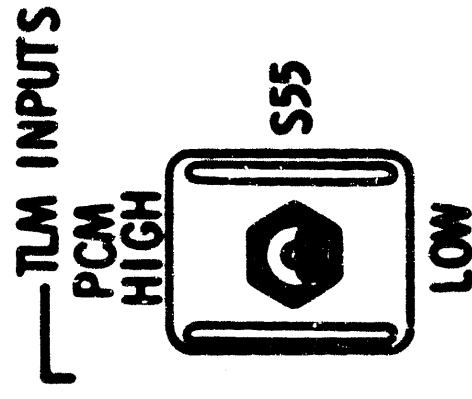
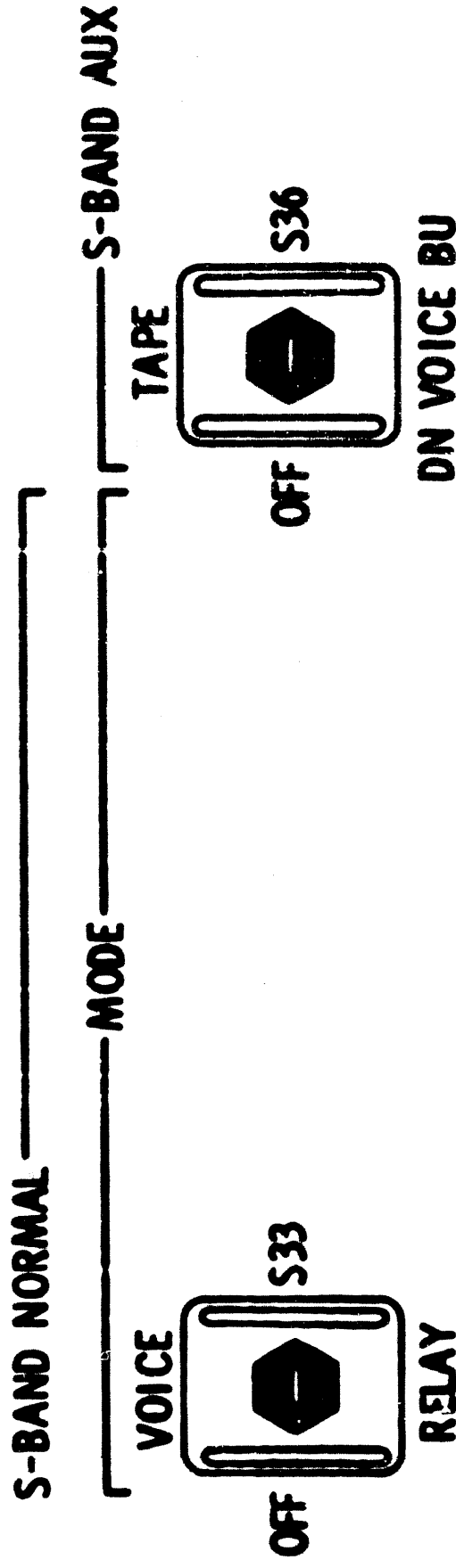


DATA MODULATION LEVELS

BI-PHASE MODULATOR:



PANEL 3:

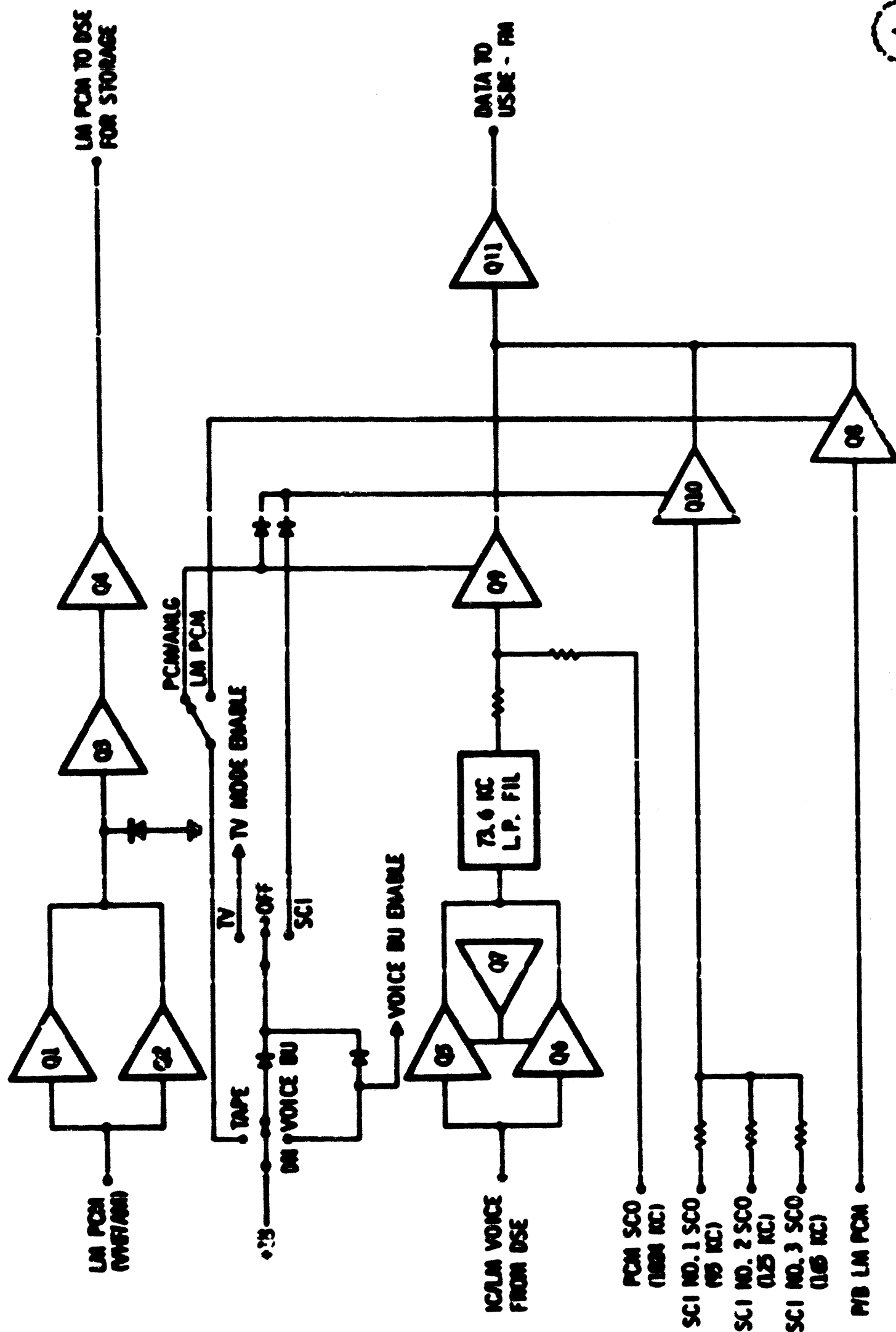


1. LOW BIT RATE W/CM VOICE)
S33 - VOICE, S36 - OFF/TAPE, S55 - LOW
2. LOW BIT RATE W/DN VOICE BU, OR HIGH BIT RATE W/CM OR RELAY VOICE)
S33 - X, S36 - DN VOICE BU, S55 - LOW, OR
S33 - VOICE/RELAY, S36 - OFF/TAPE, S55 - HIGH
3. (NO VOICE CALLED FOR)
S33 - OFF, S36 - OFF/TAPE, S55 - X

CD-2054D (◆)

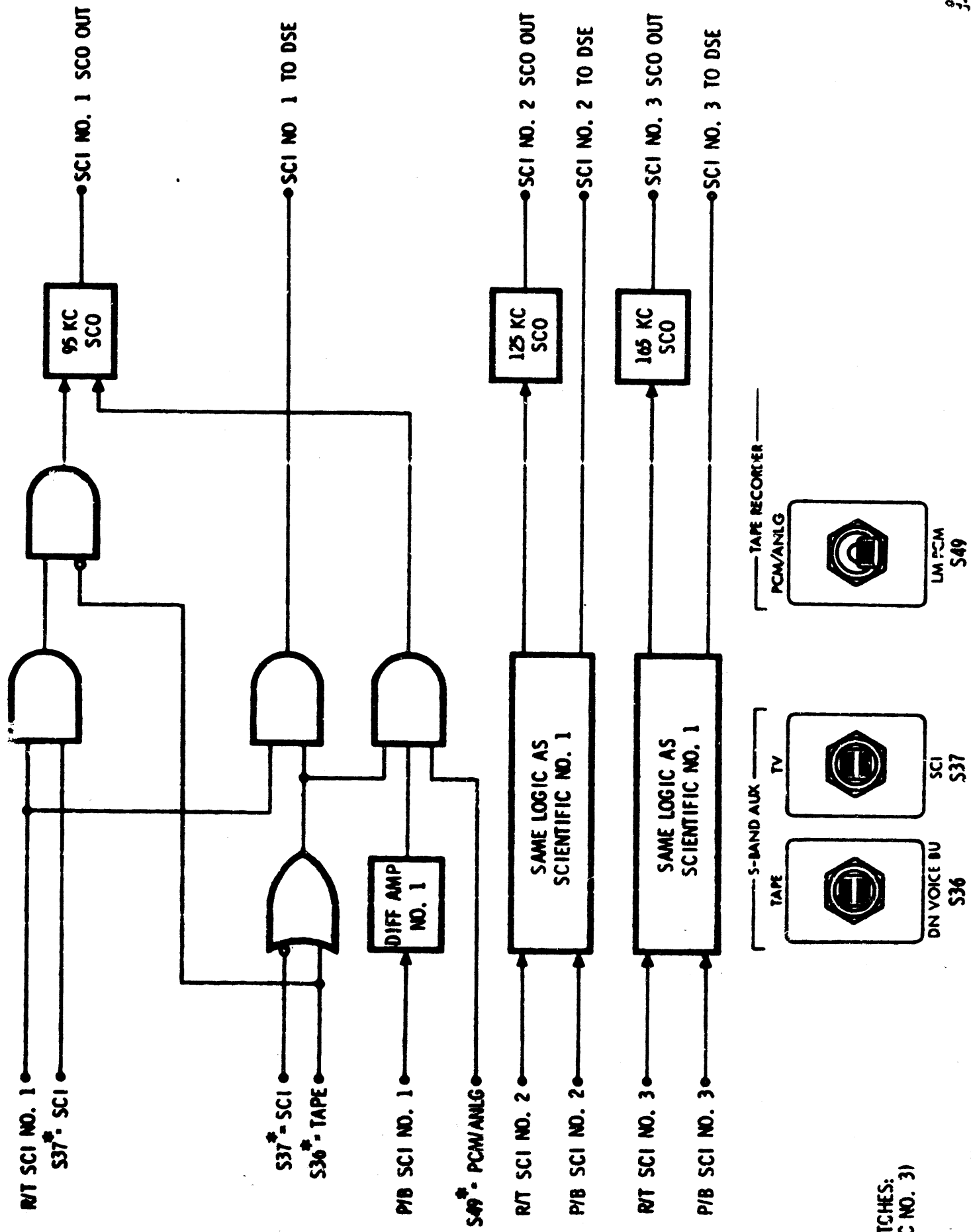
PMP FM MIXER

BLOCK II



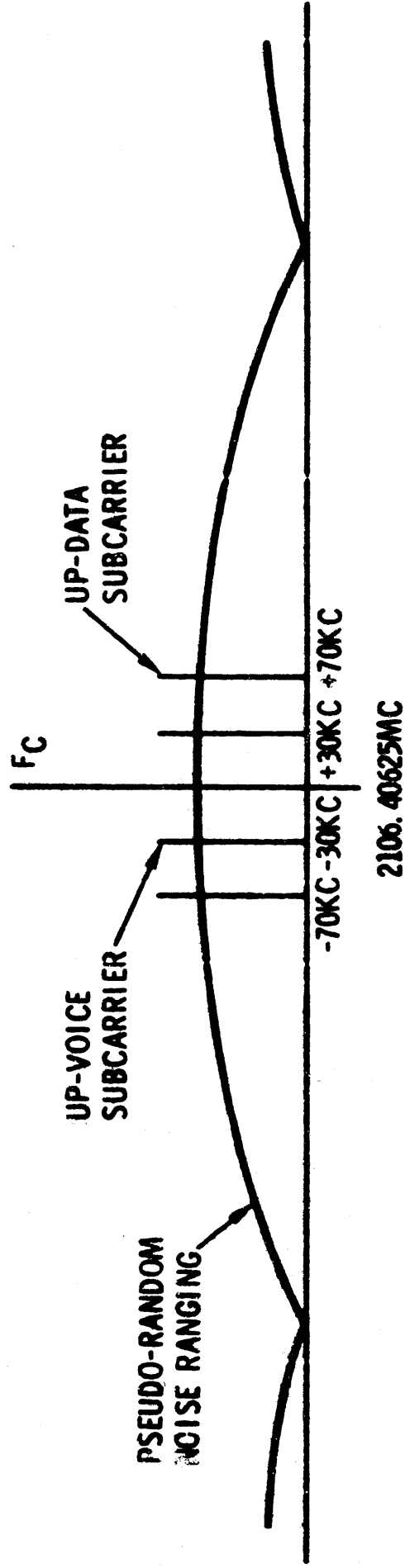
CD-2035 C

PMP SCIENTIFIC SCO'S

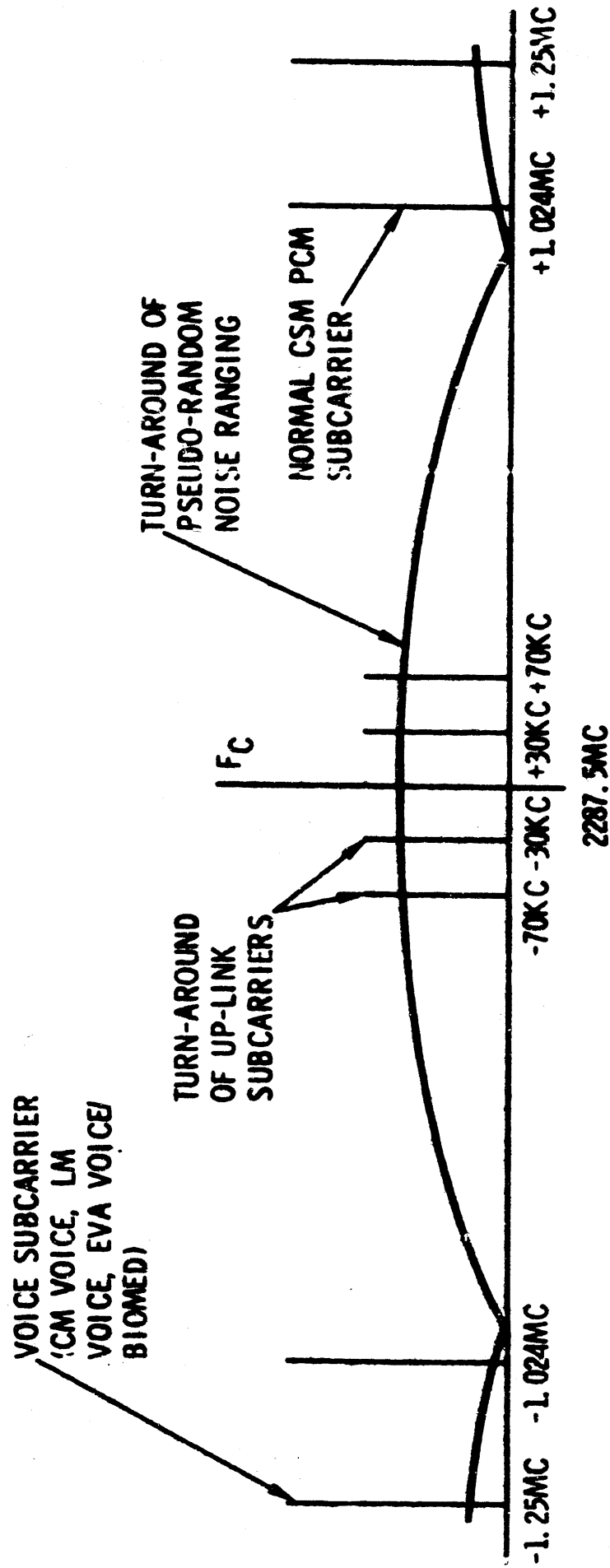


*SWITCHES:
(MDC NO. 3)

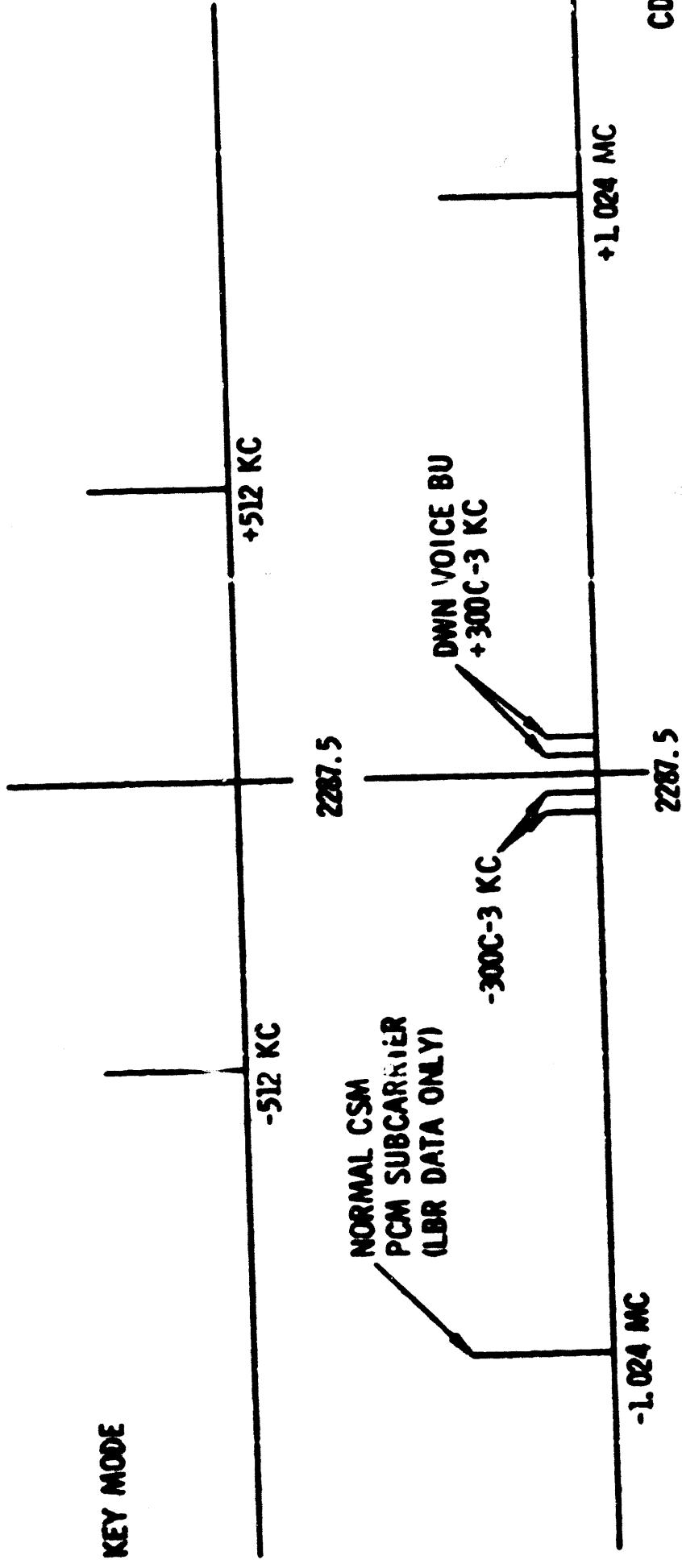
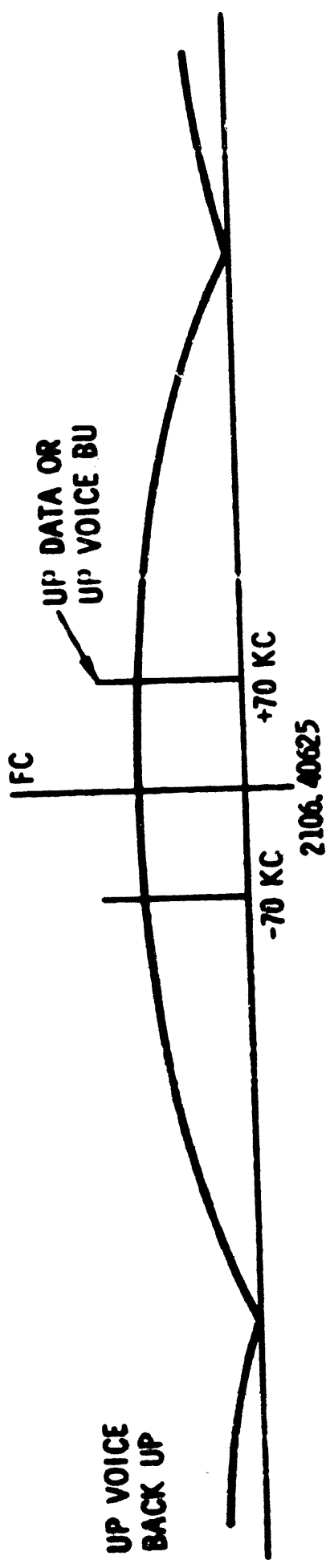
S-BAND UP-LINK SPECTRUM



S-BAND PM DOWN-LINK SPECTRUM

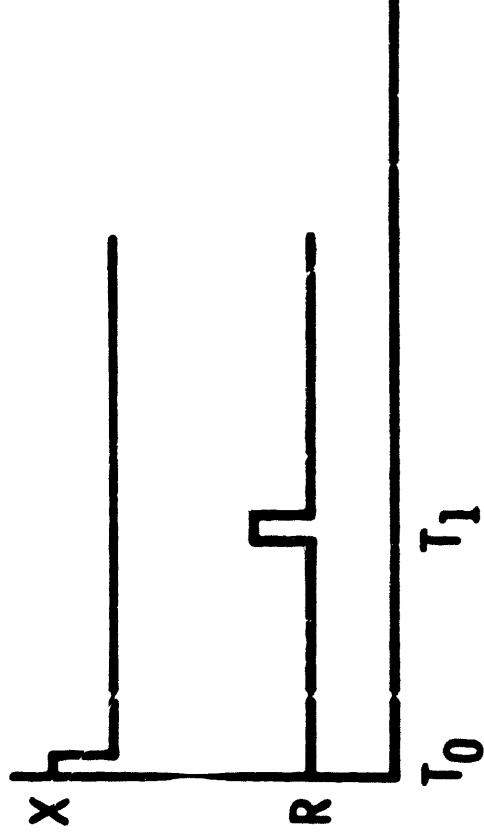
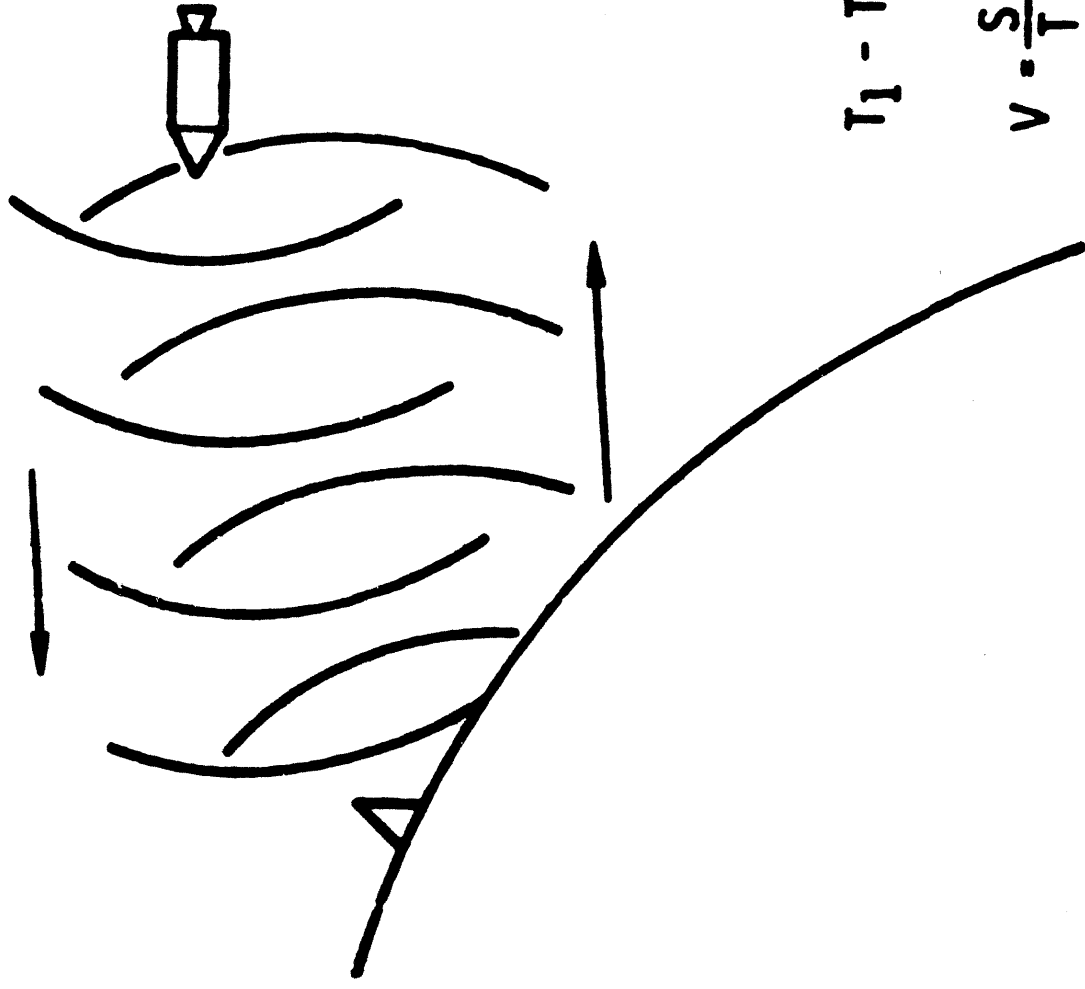


S-BAND BACK-UP SPECTRUM



CD-2098D

PSEUDO RANDOM NOISE RANGING



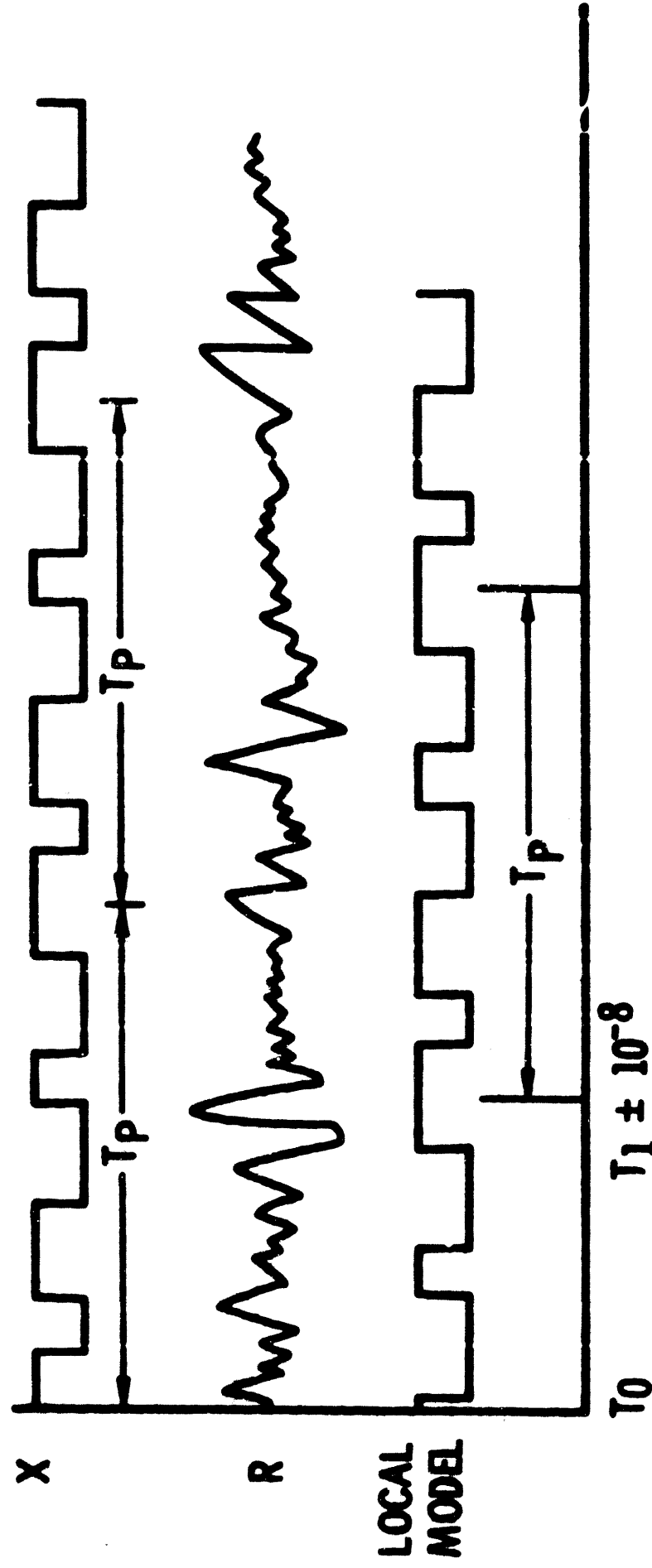
$$T_1 - T_0 = T_{TOT} - 2 T_{PROP} + T_{EQUIP}$$

$$V = \frac{S}{T} = C, \quad S = CT, \quad S = C T_{PROP} = C \left[\frac{T_{TOT} - T_{EQUIP}}{2} \right]$$

$$S, \frac{ds}{dt} = V, \frac{ds^2}{dt^2} = \frac{dV}{dt} = A$$

CD-2079 A (◆)

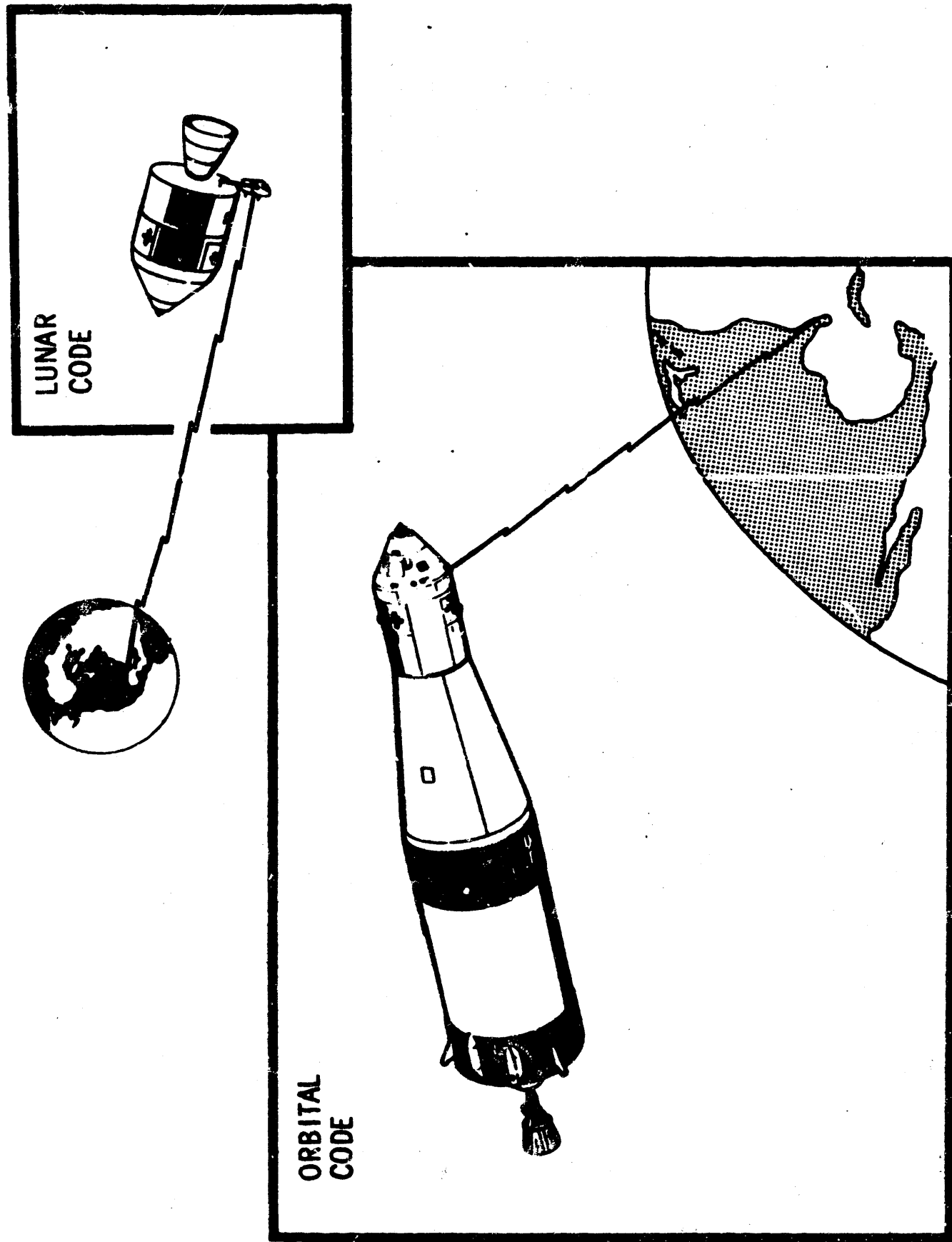
P.R.N. CODE USE



$$T_1 - T_0 = T_{TOT} < T_P$$

CD-2080 A (A)

P.R.N. CODE



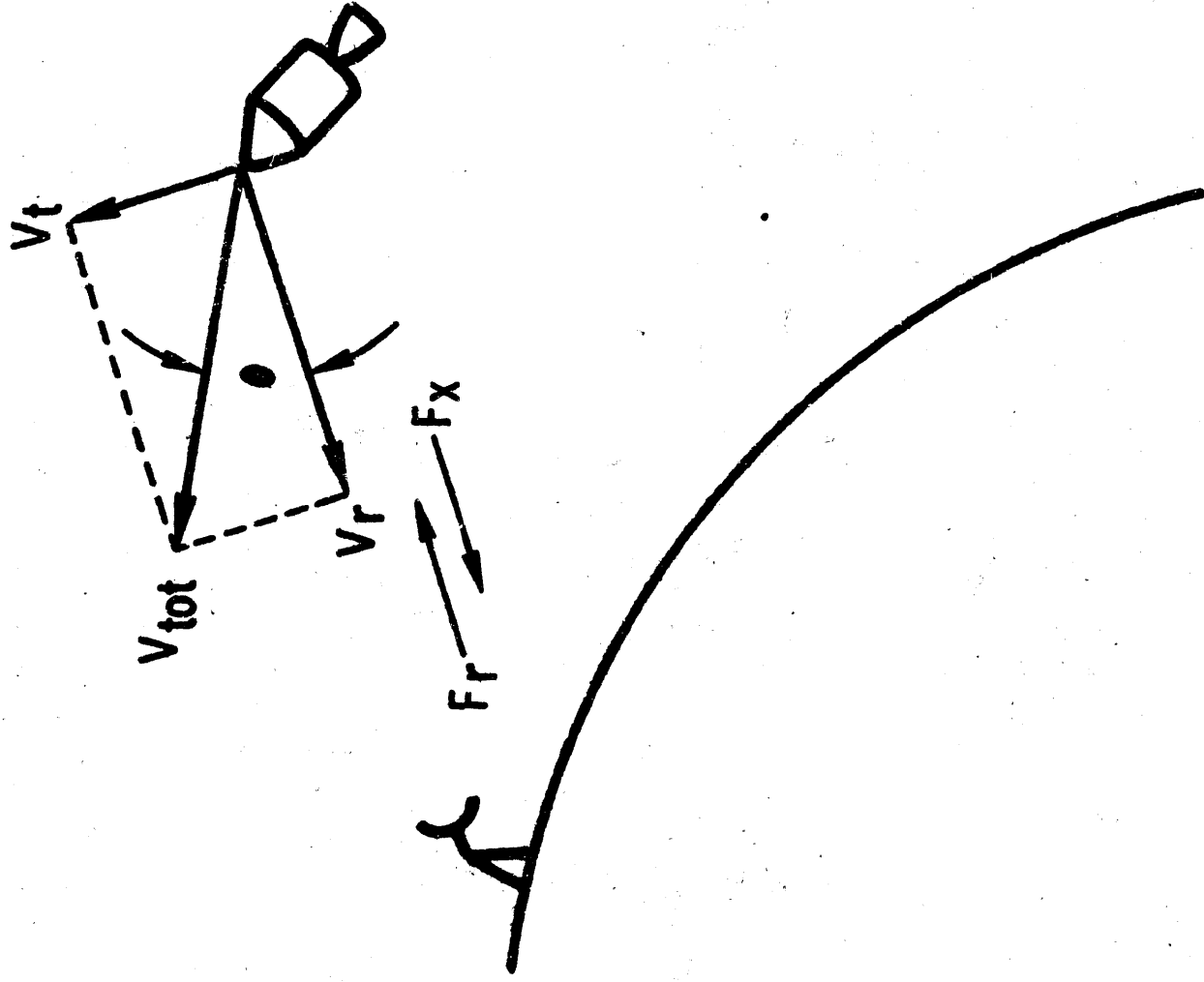
$$T_1 - T_0 - T_{TOT} < T_P \text{ BASIC BIT TIME } \approx 1.042 \text{ } \mu \text{ SEC}$$

$$CL \oplus X \oplus A \oplus B \oplus C$$

$$2 \times 11 \times 31 \times 7 \times 15 = 71,610 \text{ BITS } \approx .075 \text{ SEC } \approx 6.8 \text{ K MILE}$$

$$2 \times 11 \times 31 \times 63 \times 127 = 5,155,000 \text{ BITS } \approx 5.68 \text{ SEC } \approx 528 \text{ K MILE}$$

DOUBLE DOPPLER RANGING



$$F = \frac{C}{\lambda}$$

$$F_a = F_0 \left(1 \pm \frac{V_{tot} \cos \theta}{C} \right)$$

$$V_{tot} = \frac{(F_a - F_0) C}{F_0 \cos \theta}$$

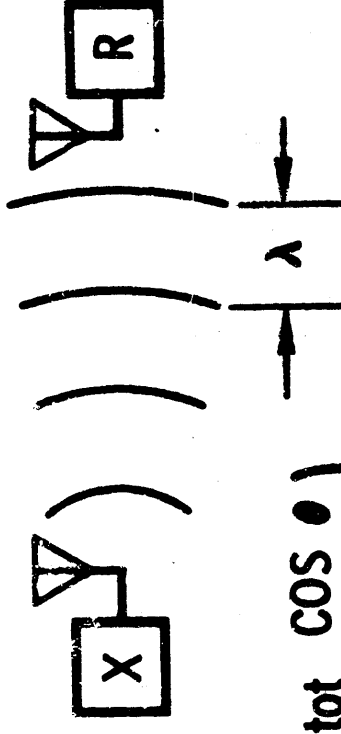
$$S_{tot} = \frac{1}{2} \int (V dt) + S_{INITIAL}$$

$$A = \frac{dv}{dt}$$

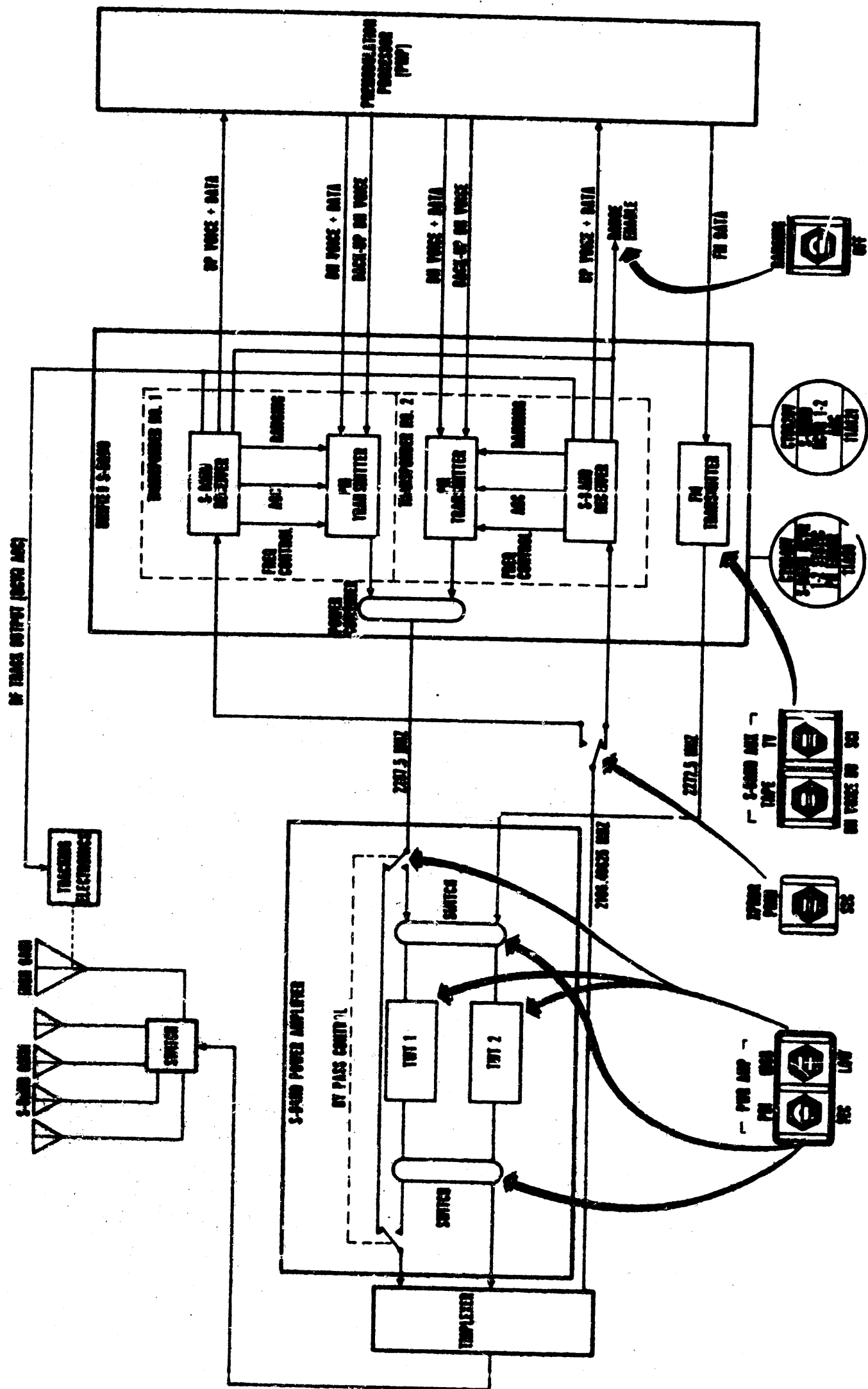
$$\frac{F_r}{F_x} = \frac{2106.40625}{2287.5} = \frac{108 \text{ VCO} + 1^{st} \text{ IF}}{120 \text{ VCO}}$$

$$\frac{(108 + 2) \text{ VCO} + 2^{nd} \text{ IF}}{120 \text{ VCO}} = \frac{(108 + 2 + 1/2) \text{ VCO}}{120 \text{ VCO}}$$

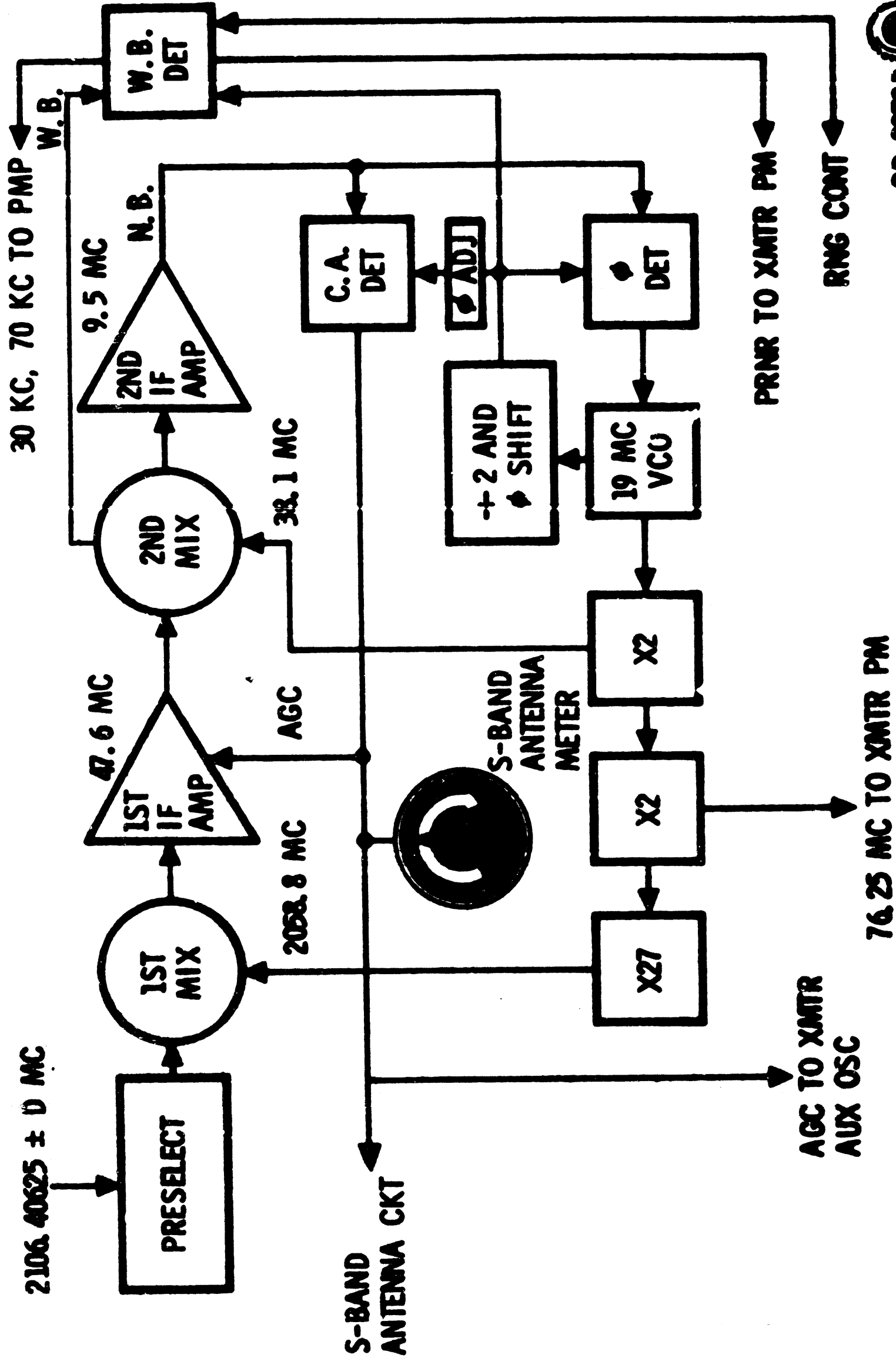
$$= \frac{110.5}{120} = \underline{\underline{\frac{221}{240}}}$$



S-BAND BLOCK DIAGRAM

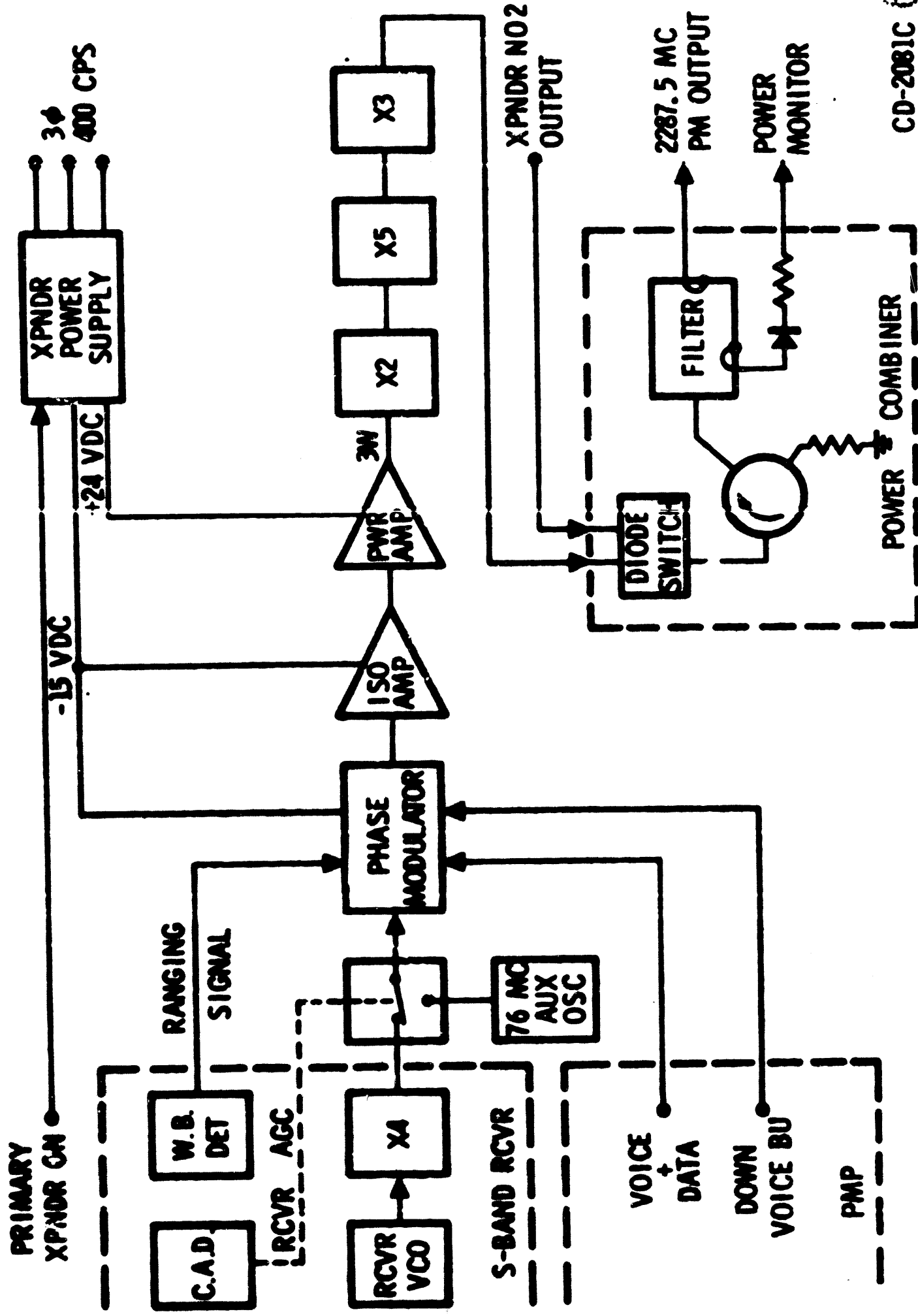


S-BAND RECEIVER



CD-2078 B (C)

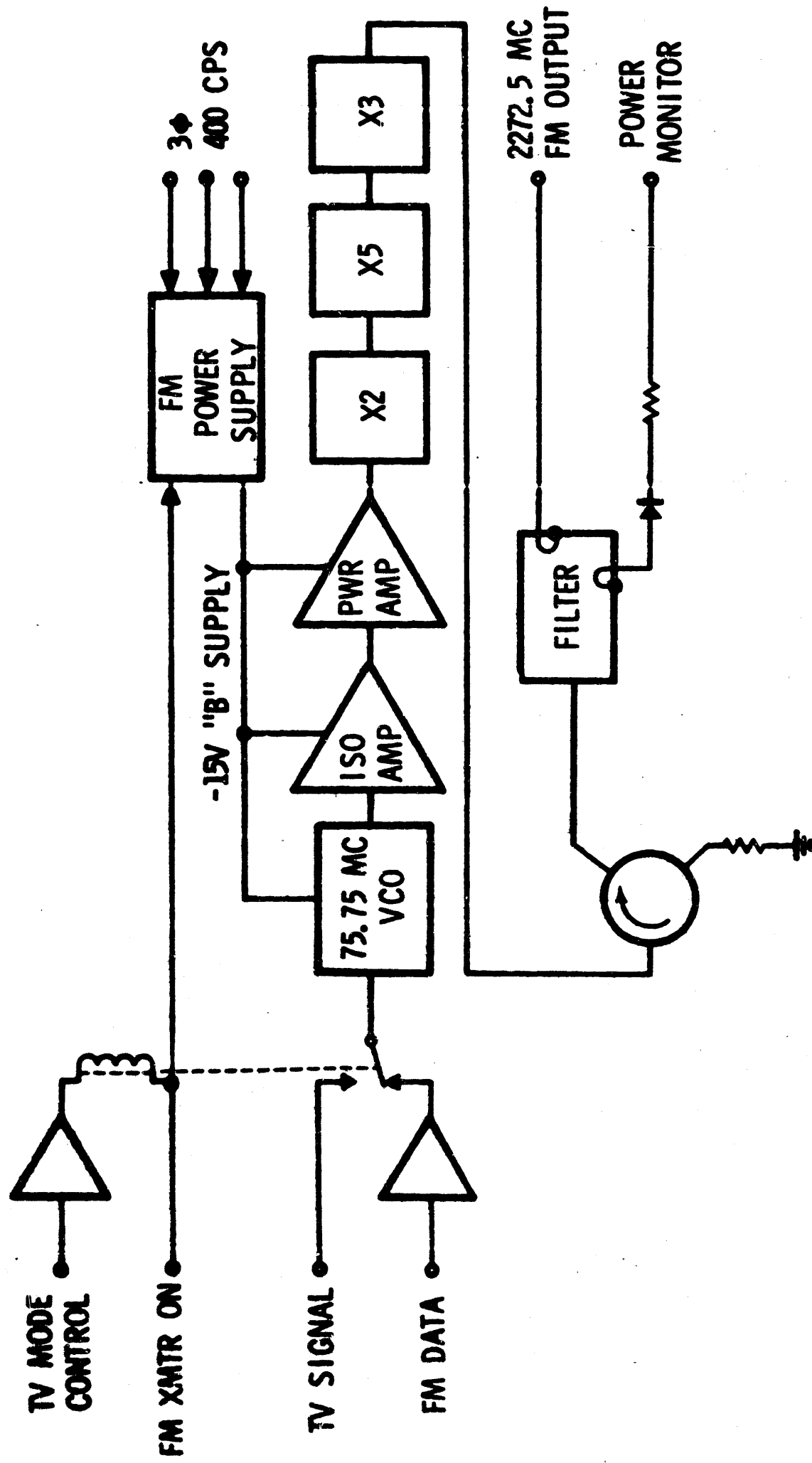
S-BAND PM TRANSMITTER



CD-2081C (A)

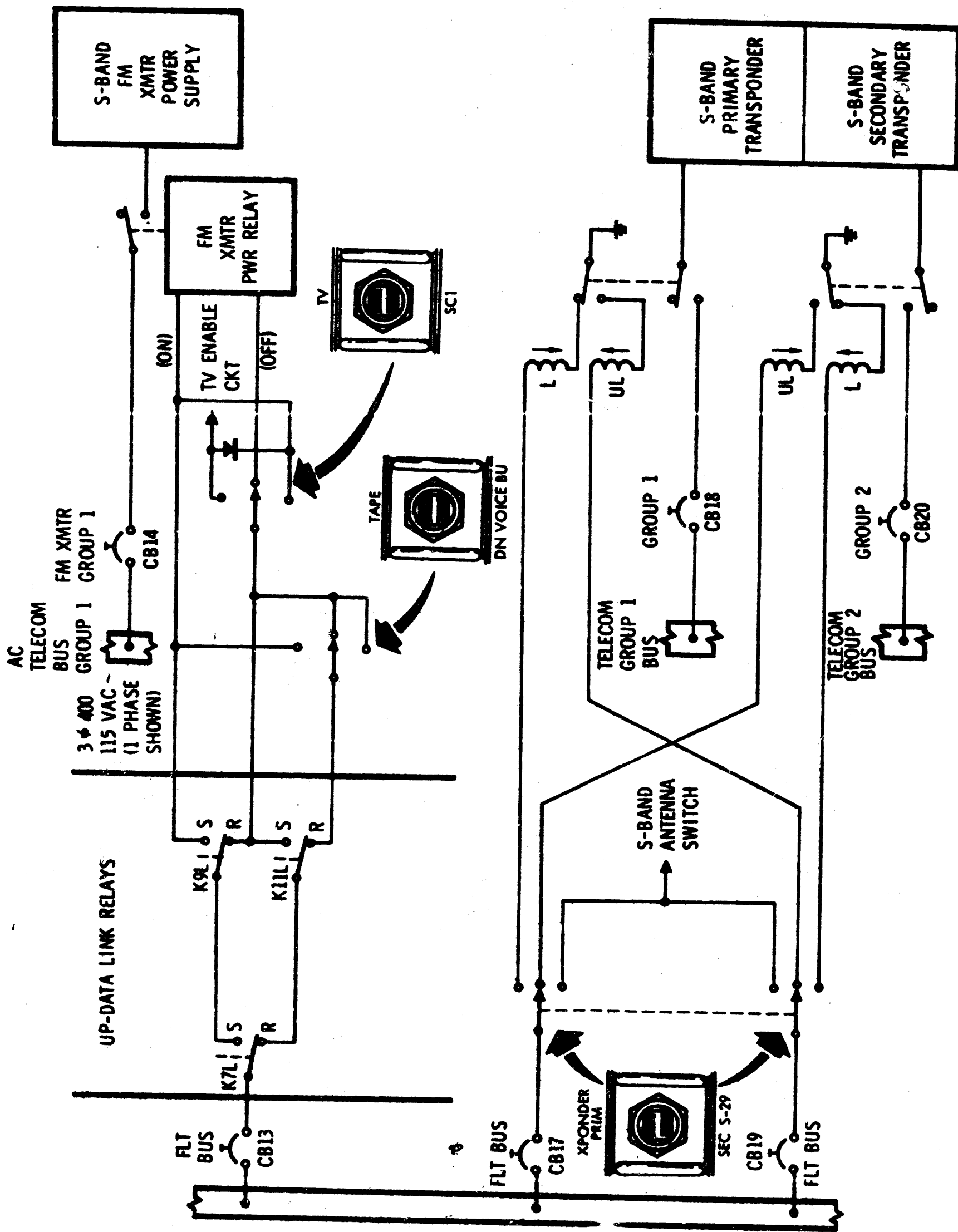
S-BAND FM TRANSMITTER

BLOCK II



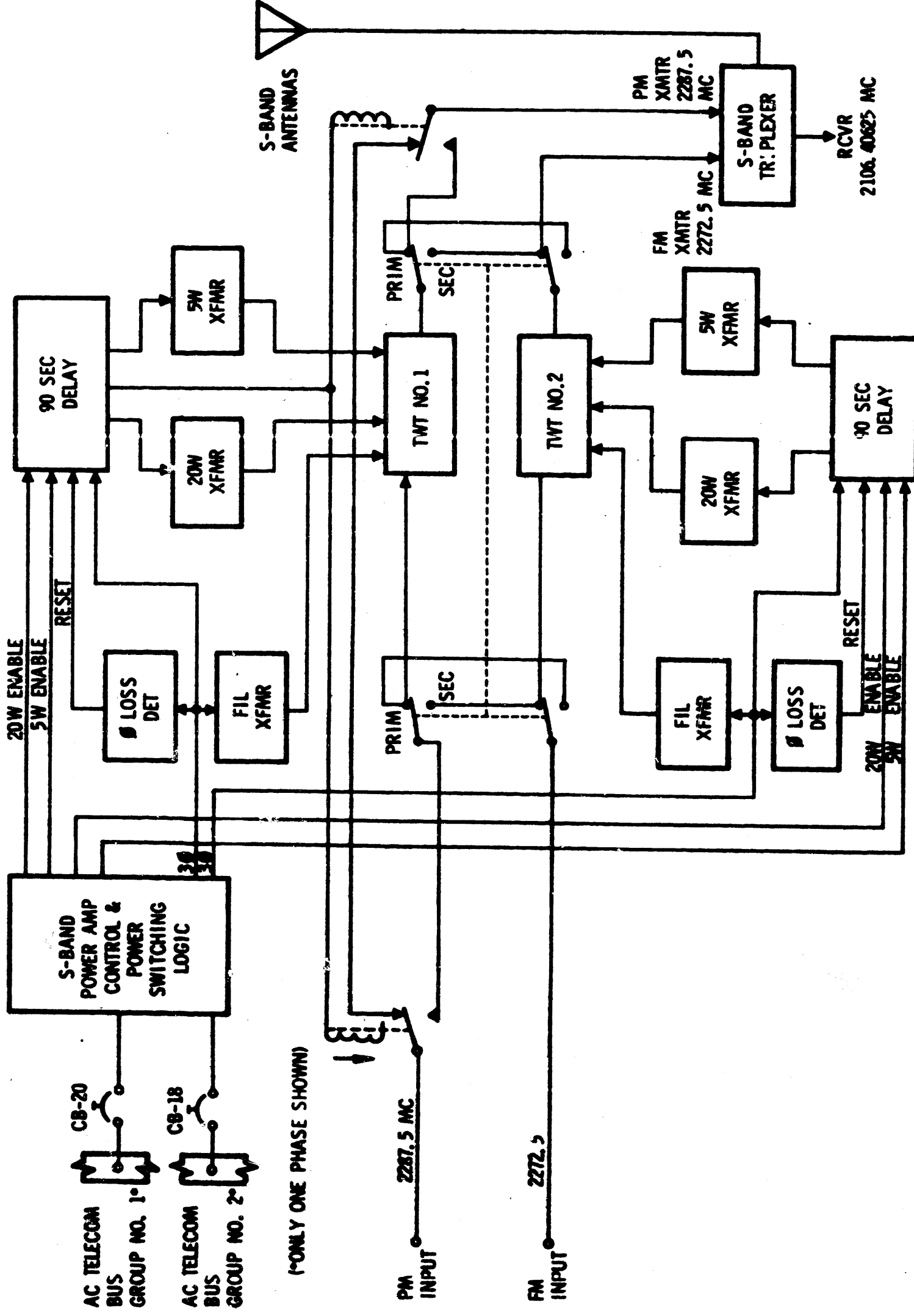
CD-2037A

USBE SWITCHING & POWER CONTROL



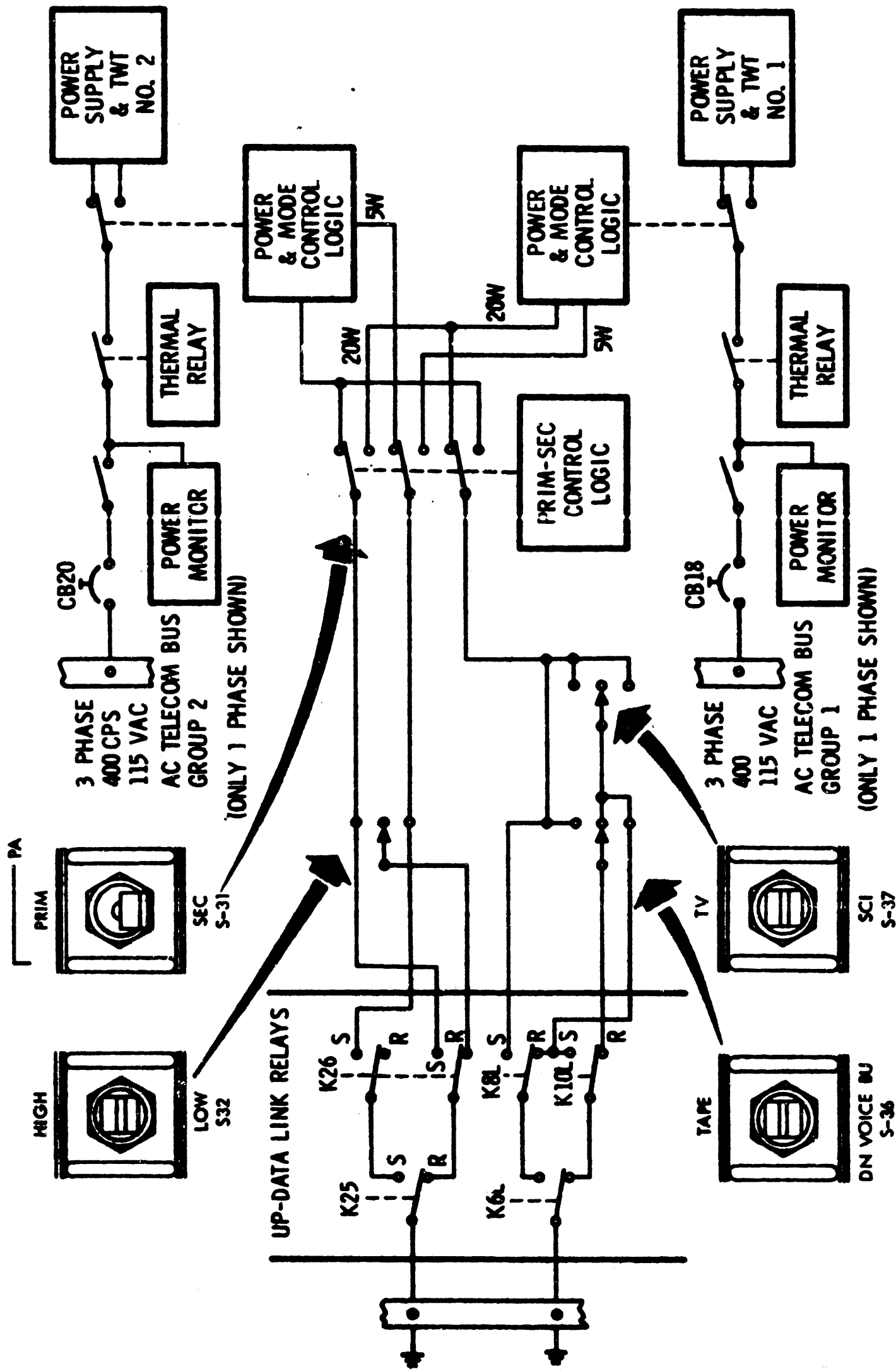
S-BAND POWER AMPLIFIER

BLOCK II



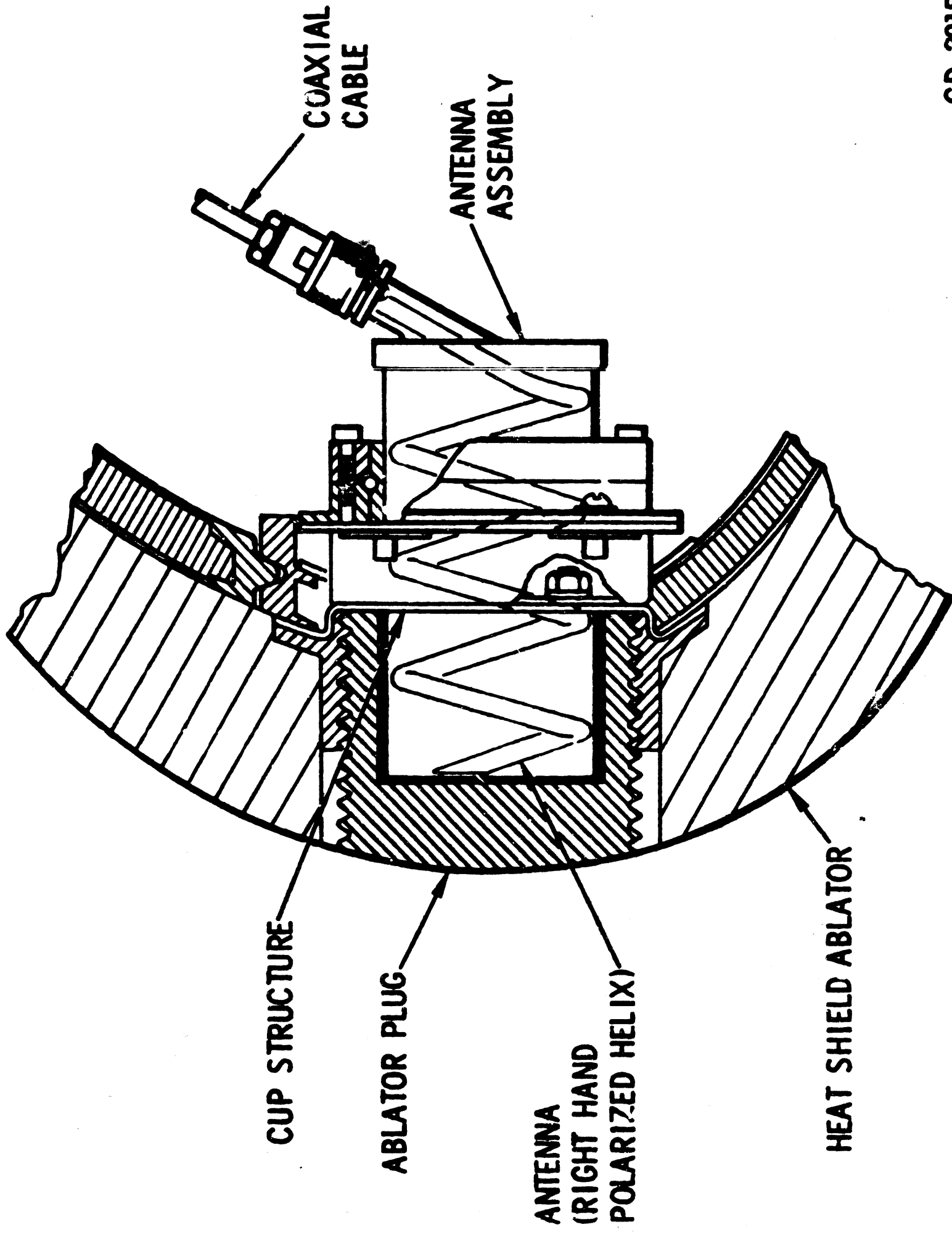
CD-2002D

S-BAND POWER AMPLIFIER CONTROL & POWER SWITCHING



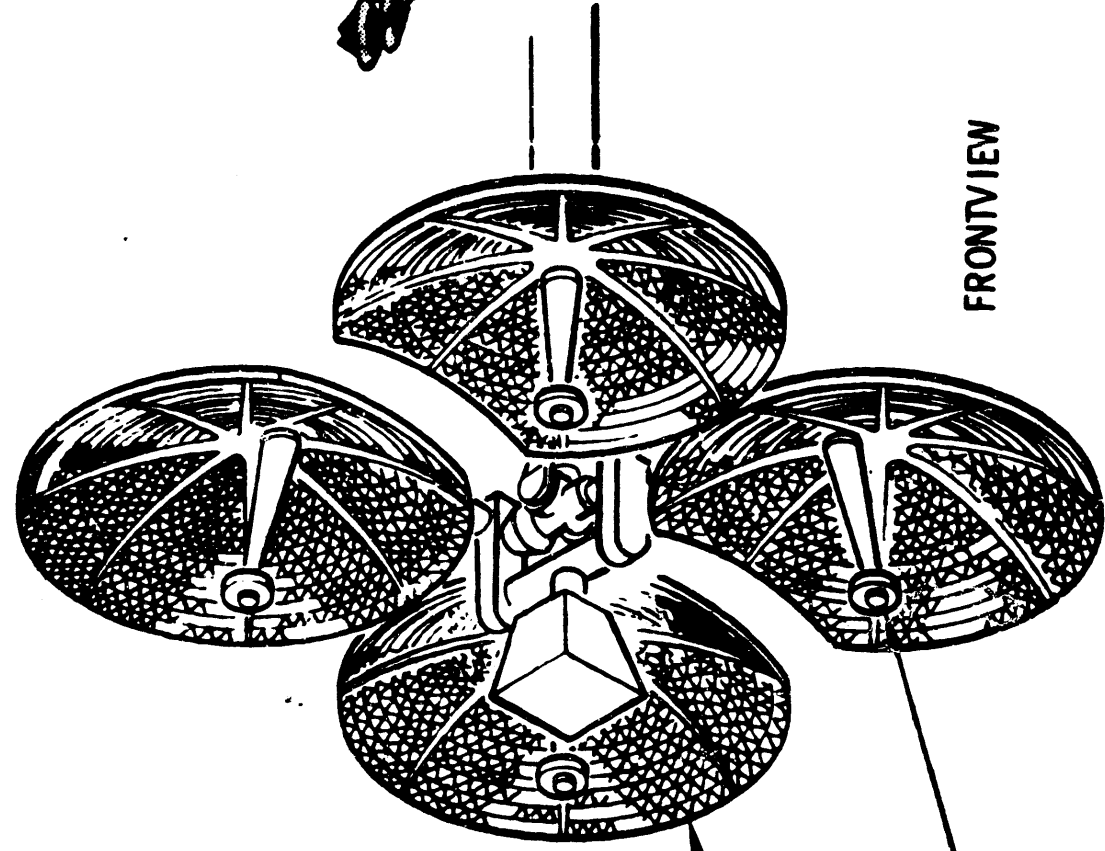
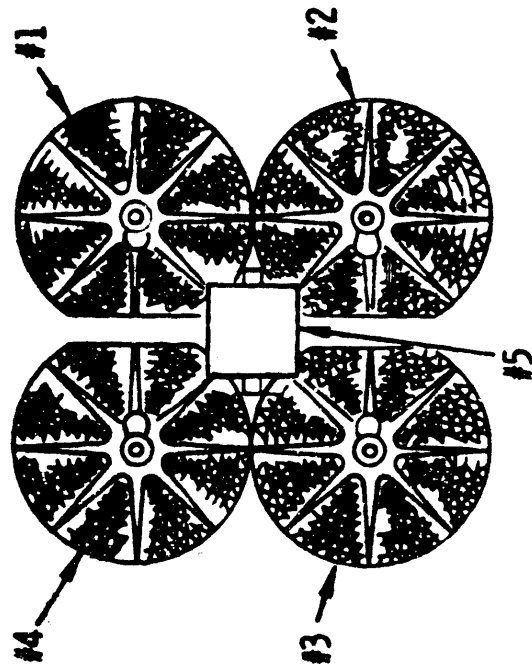
CD-2058C

S-BAND FLUSH MOUNTED ANTENNA

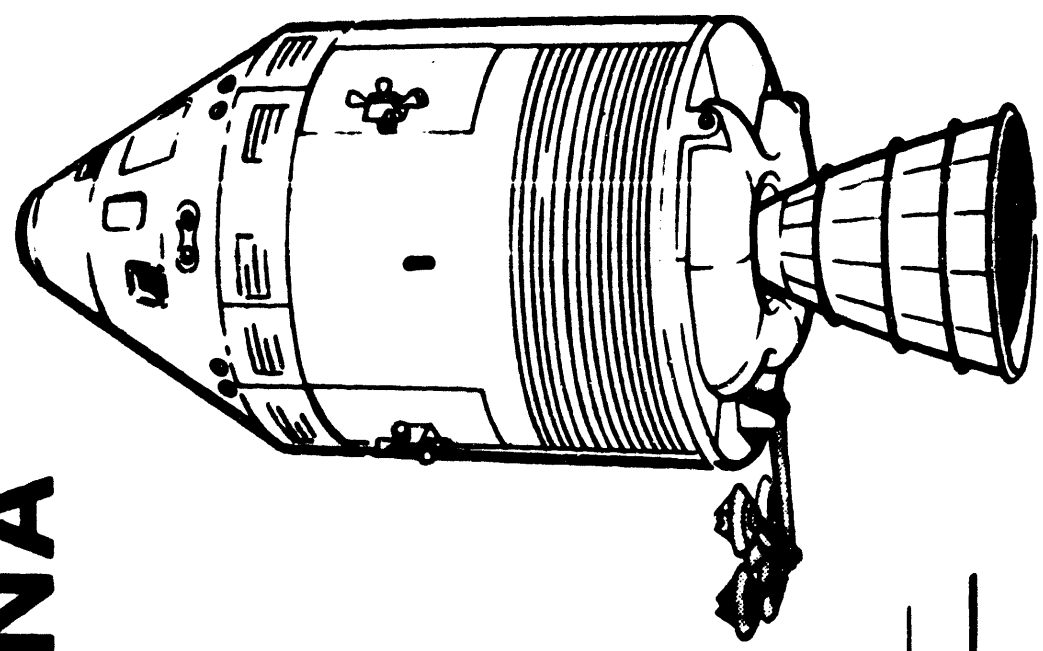


CD-2015 (◆)

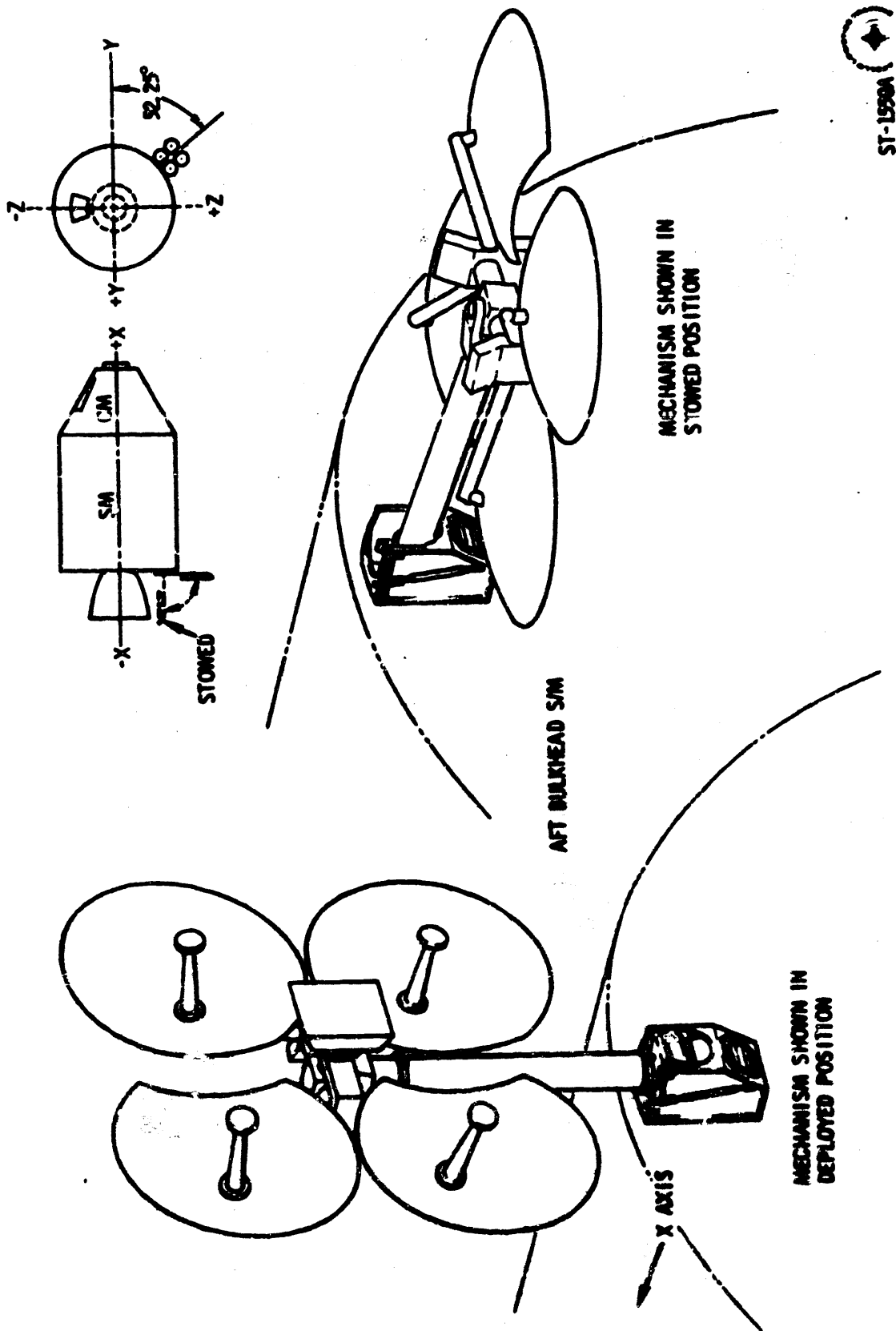
BLOCK II S-BAND HI GAIN ANTENNA

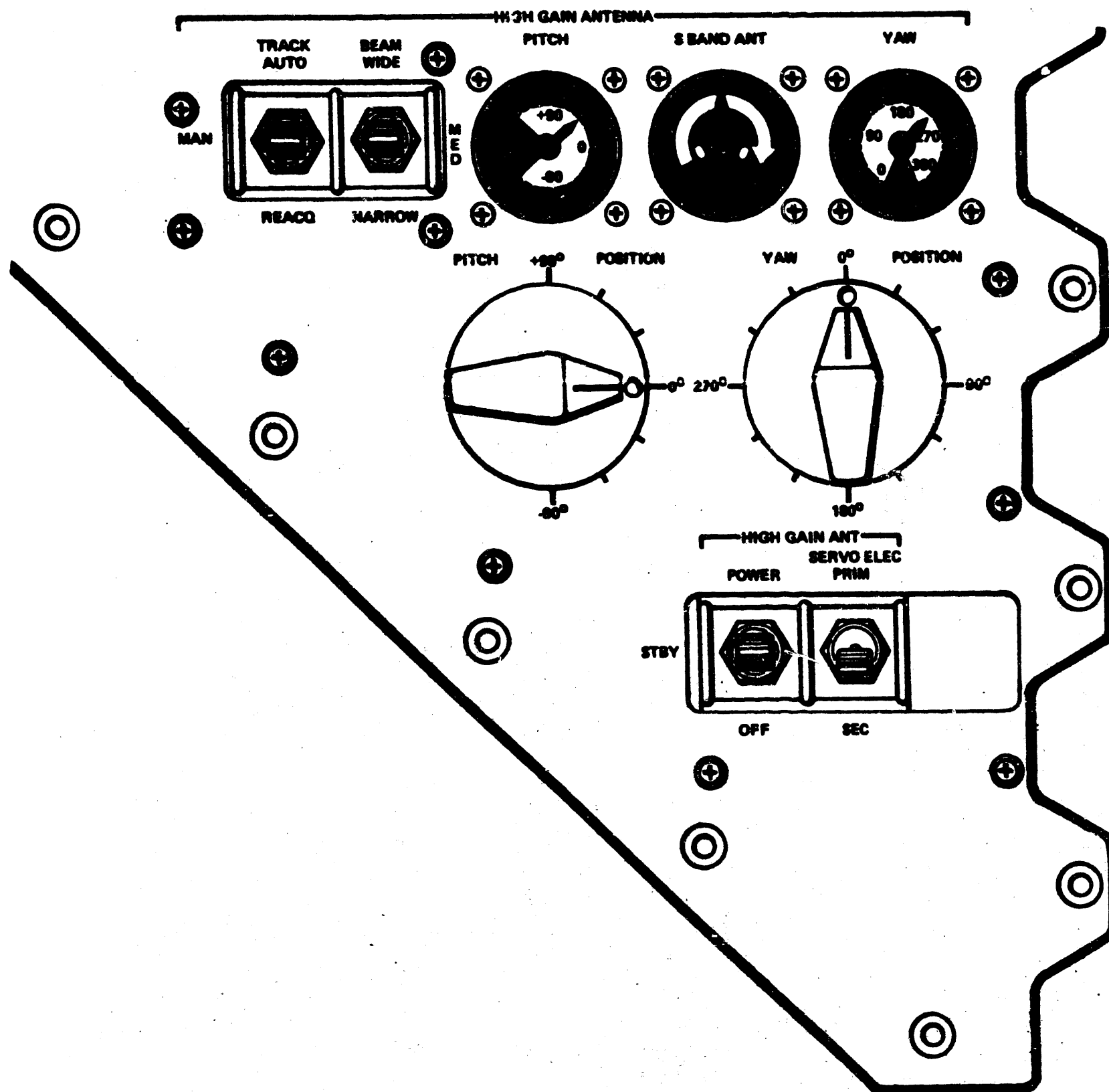


FRONTVIEW



HIGH GAIN ANTENNA



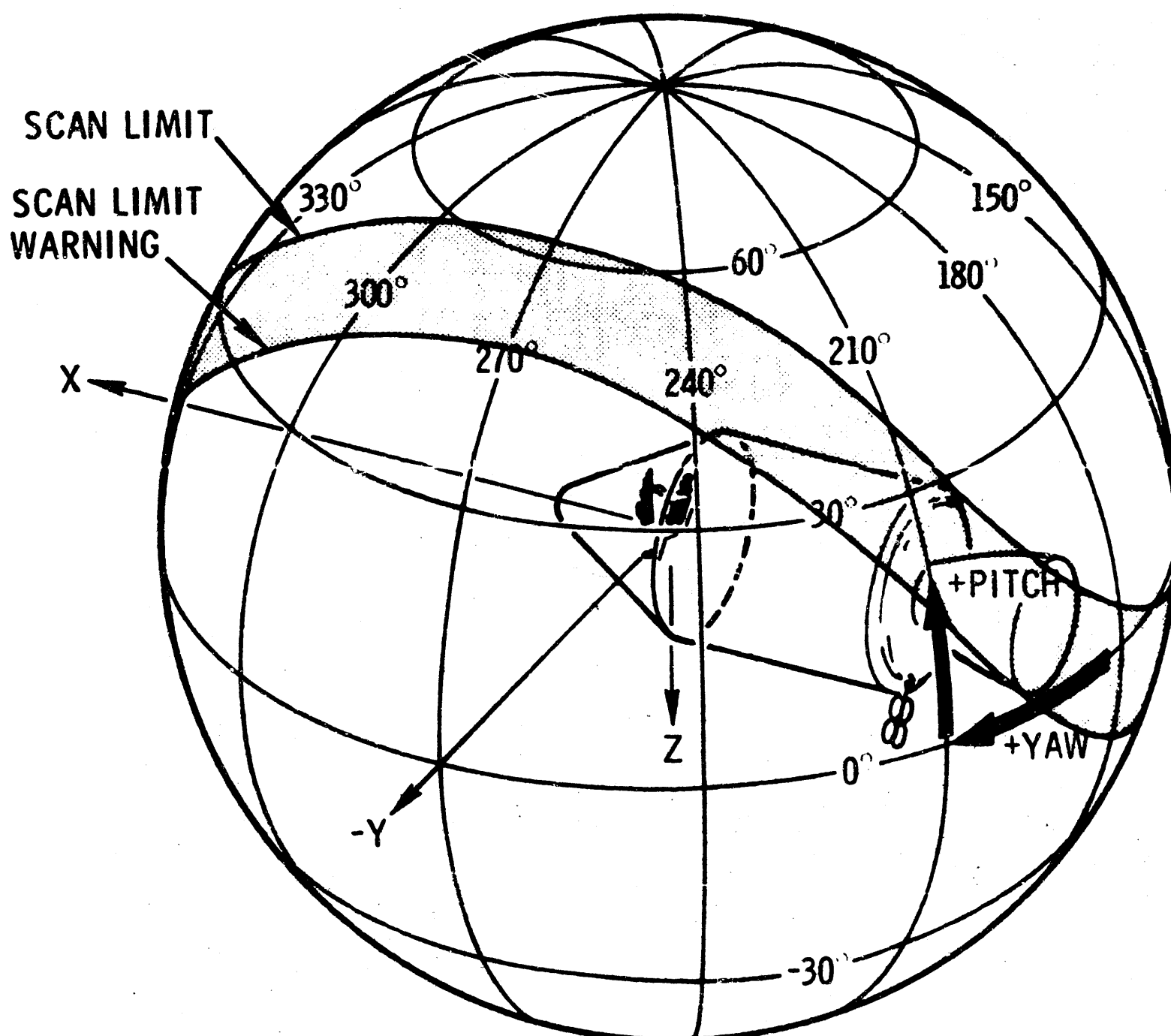


PN-2F-6



HIGH GAIN ANTENNA YAW-PITCH COORDINATE SYSTEM

101



YAW - MEASURED IN XY PLANE,
FROM +X TOWARD +Y, 0 TO 360 DEGREES
(SIMILAR TO LONGITUDE)

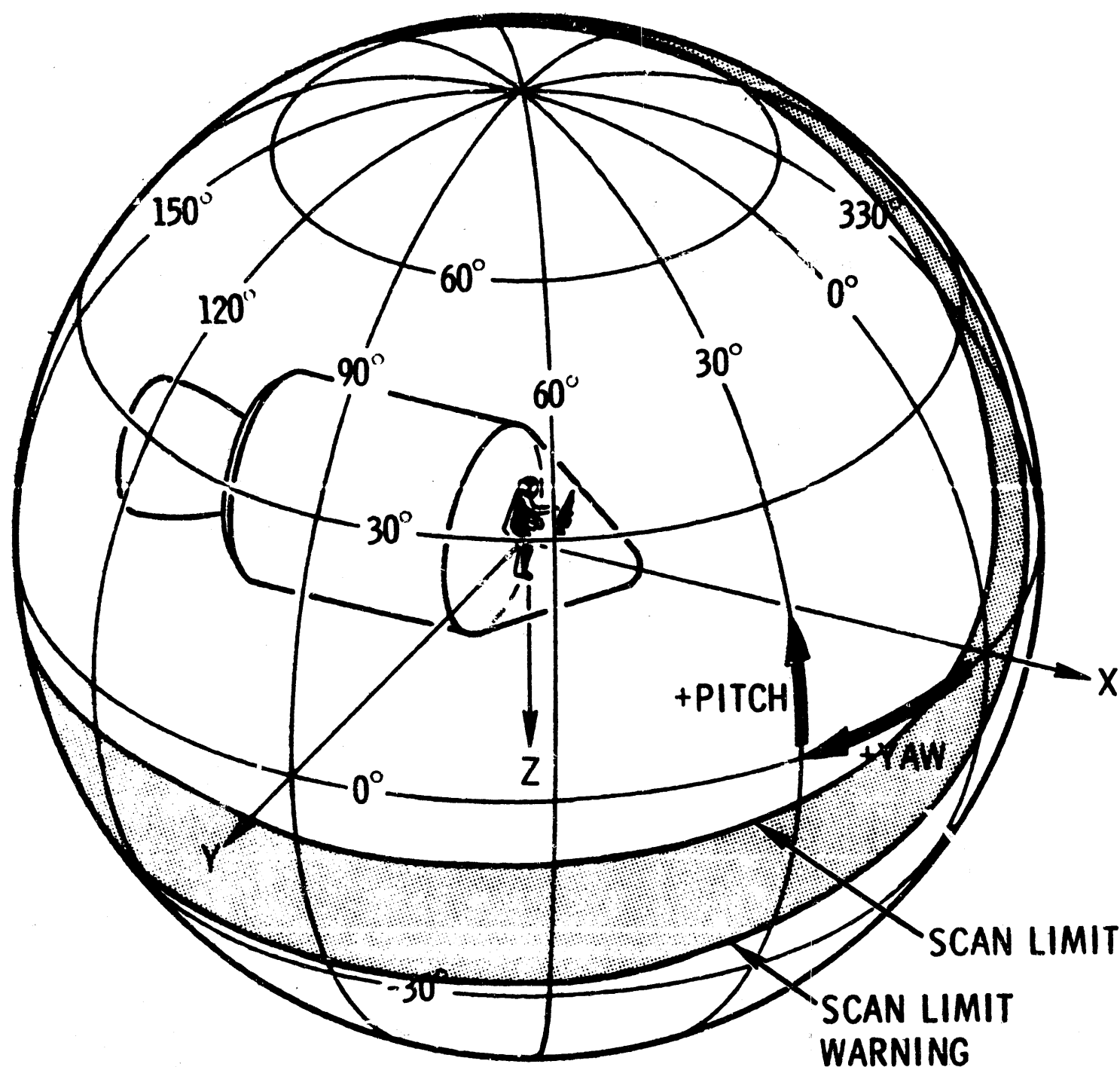
PITCH - MEASURED ABOVE XY PLANE, 0 TO 90 DEGREES
OR BELOW XY PLANE 0 TO -90 DEGREES,
(SIMILAR TO LATITUDE)

NOTE: ORDER TO ROTATION MUST BE YAW FIRST,
THEN PITCH

CD-2102A
CD-2102-1



HIGH GAIN ANTENNA YAW-PITCH COORDINATE SYSTEM



YAW - MEASURED IN XY PLANE,
FROM +X TOWARD +Y, 0 TO 360 DEGREES
(SIMILAR TO LONGITUDE)

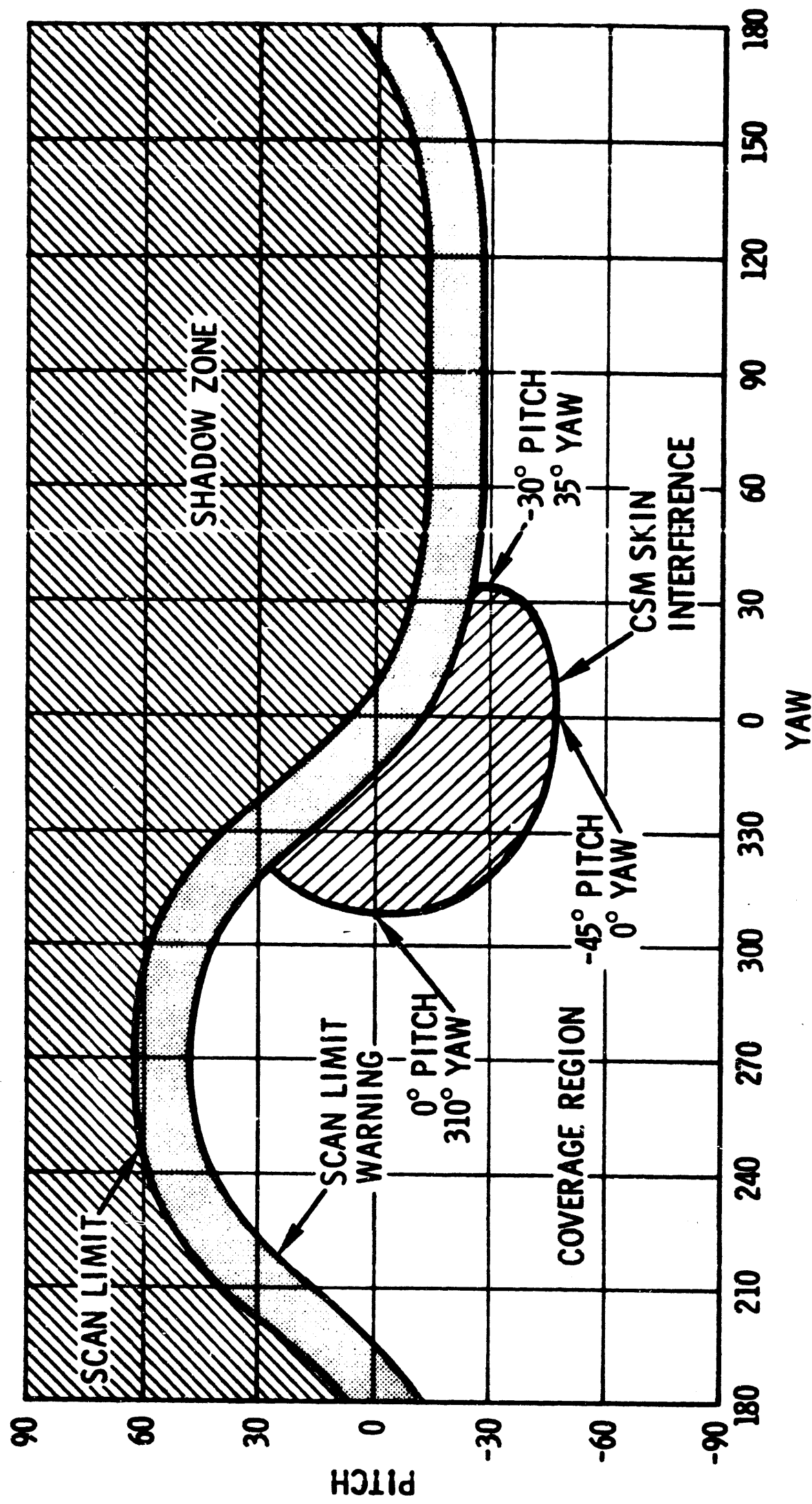
PITCH - MEASURED ABOVE XY PLANE, 0 TO 90 DEGREES
OR BELOW XY PLANE 0 TO -90 DEGREES,
(SIMILAR TO LATITUDE)

NOTE: ORDER OF ROTATION MUST BE YAW FIRST.
THEN PITCH

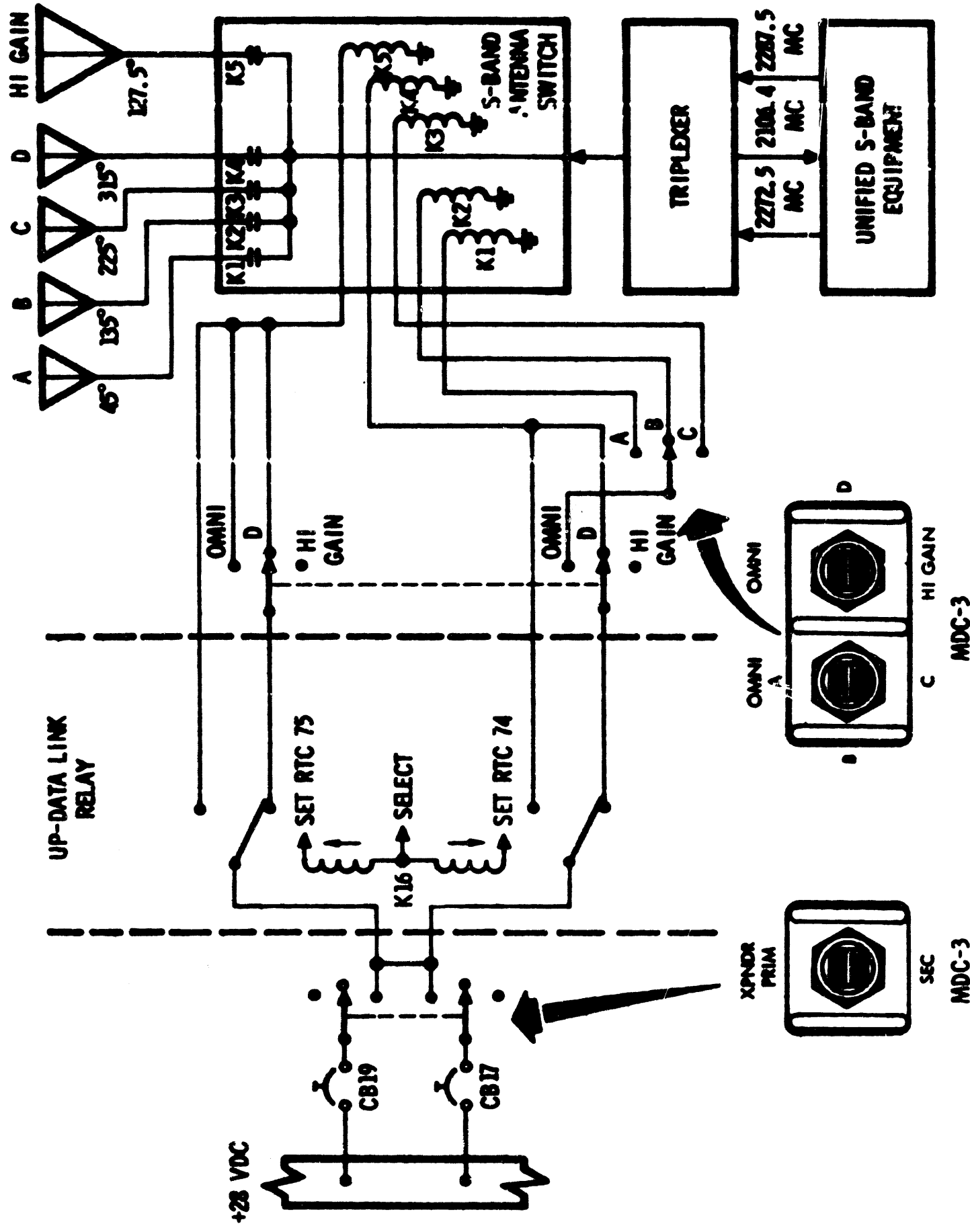
CD-2101A
CD-2101-1



HIGH GAIN ANTENNA SHADOW ZONE



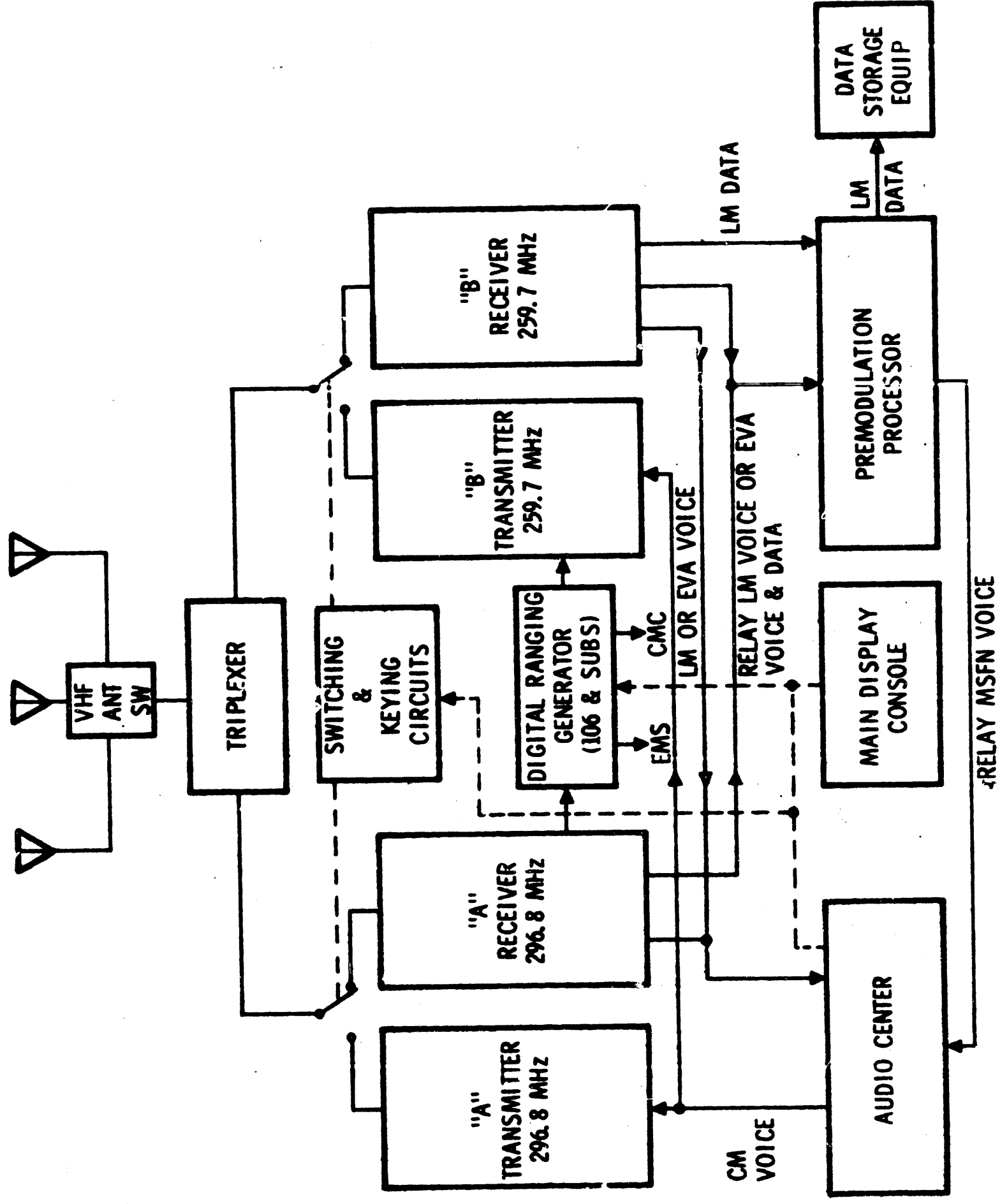
S-BAND ANTENNA INTERFACES



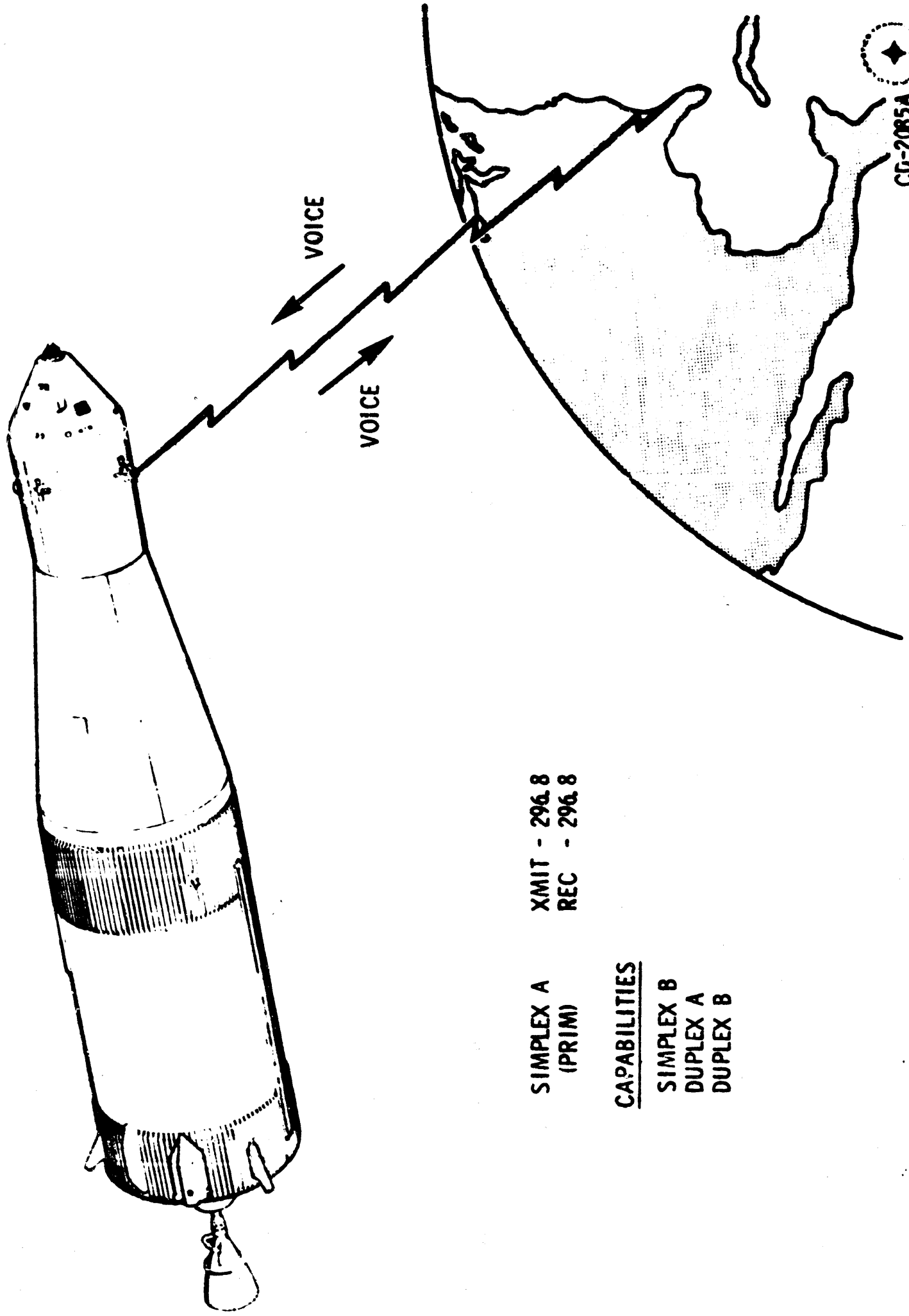
CD-2135



VHF/AM BLOCK DIAGRAM



CSM-MSFN VHF/AM COMM MODE

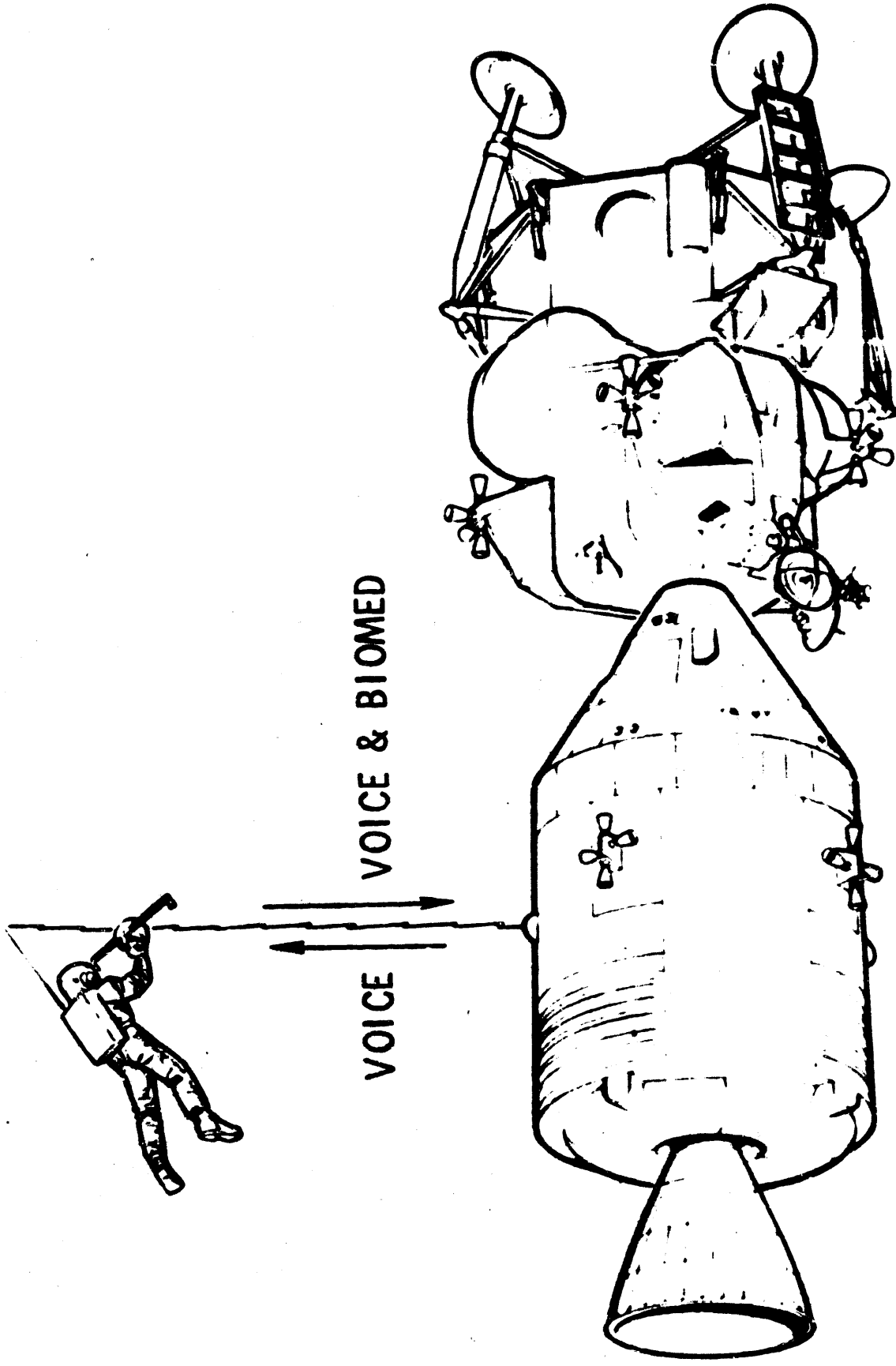


SIMPLEX A XMIT - 296.8
(PRIM) REC - 296.8

CAPABILITIES

SIMPLEX B
DUPLEX A
DUPLEX B

CSM-EVA VHF/AM COMM MODE



DUPLEX A (PRIM)	XMIT - 296.8 REC - 259.7
DUPLEX B (BACK-UP)	XMIT - 259.7 REC - 296.8

NOTE: NO BIOMED IN BACK-UP MODE

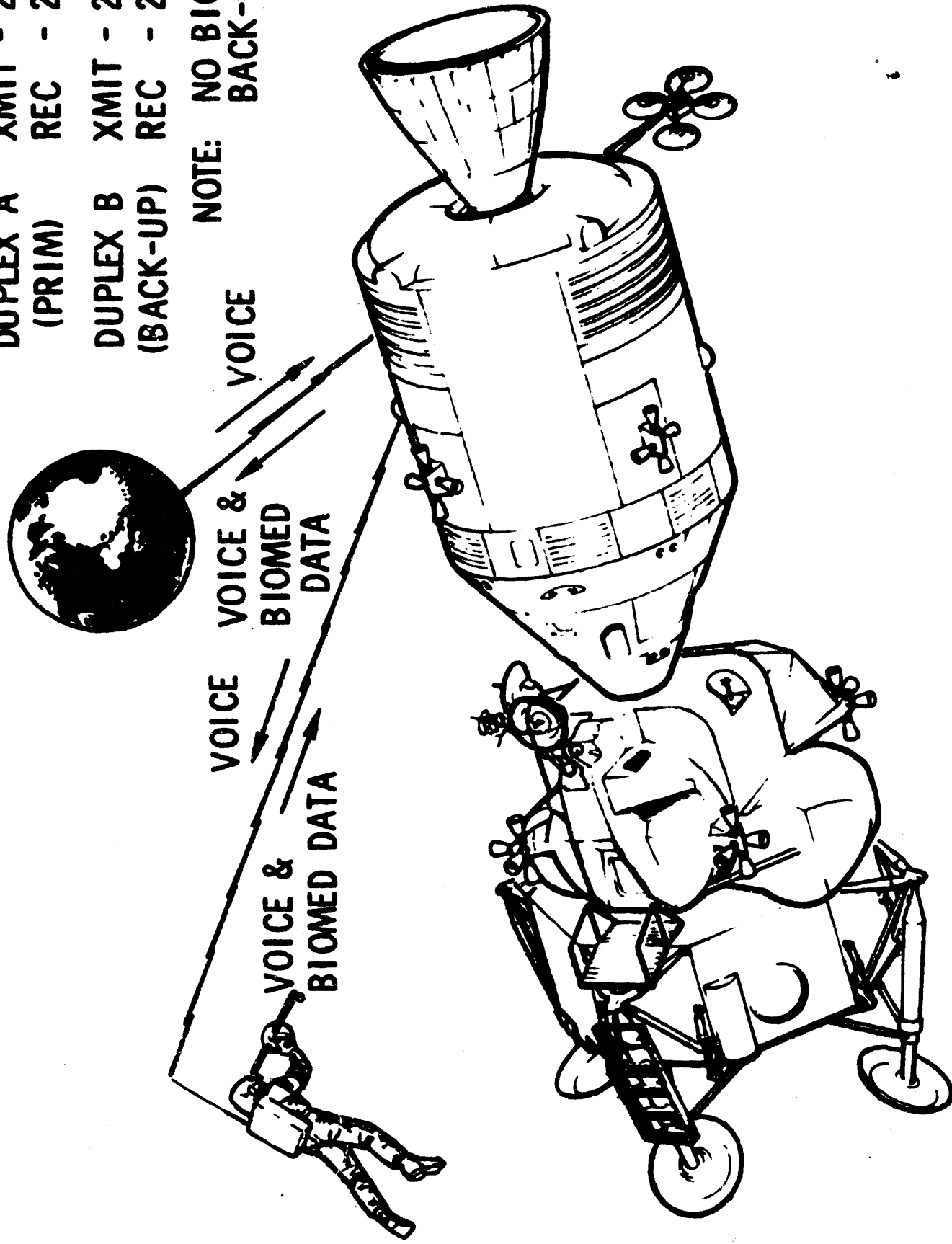
CD-2084A ♦

MSFN-CSM-EVA RELAY MODE

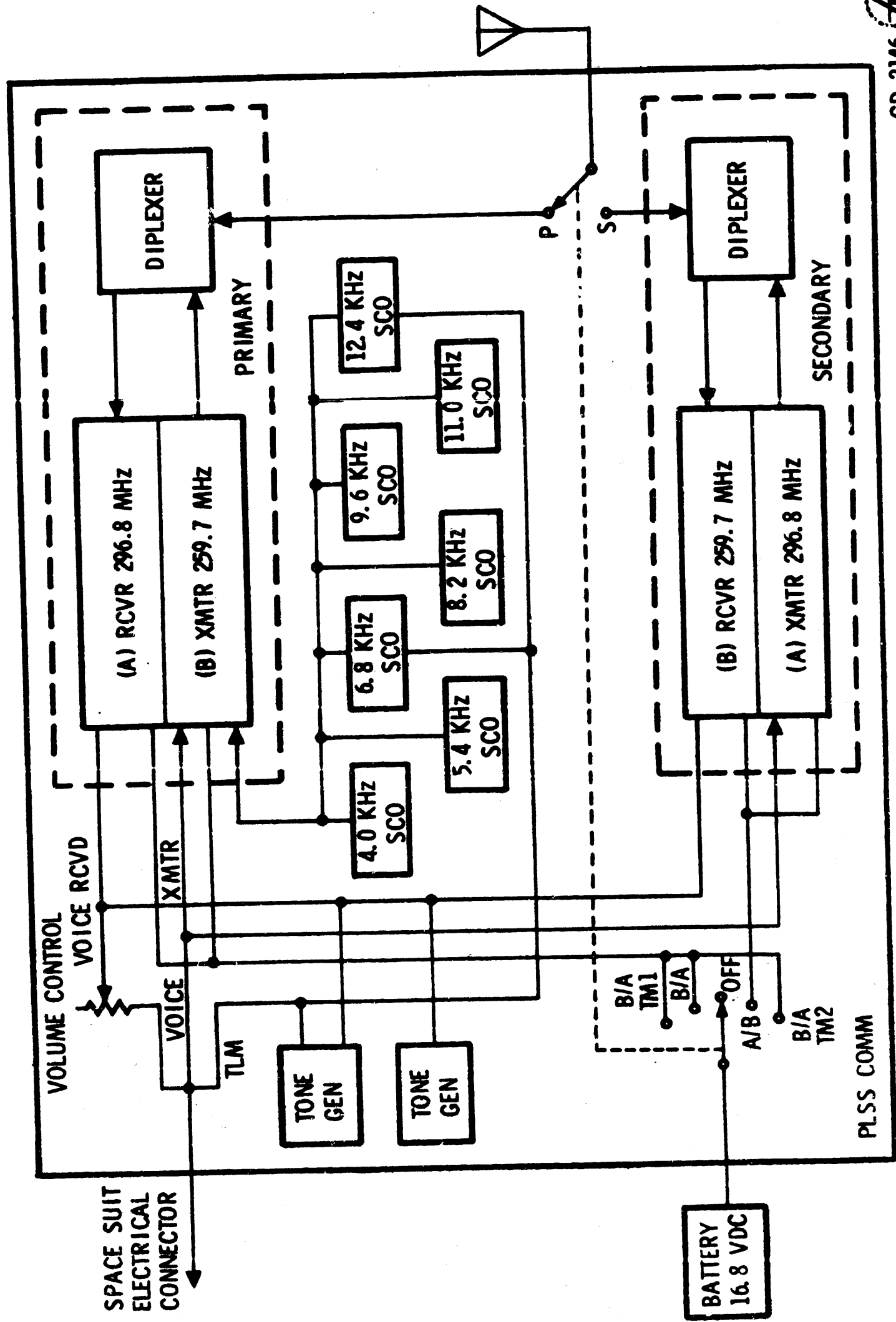
DUPLEX A XMIT - 296.8
(PRIM) REC - 259.7

DUPLEX B XMIT - 259.7
(BACK-UP) REC - 296.8

NOTE: NO BIOMED IN
BACK-UP MODE

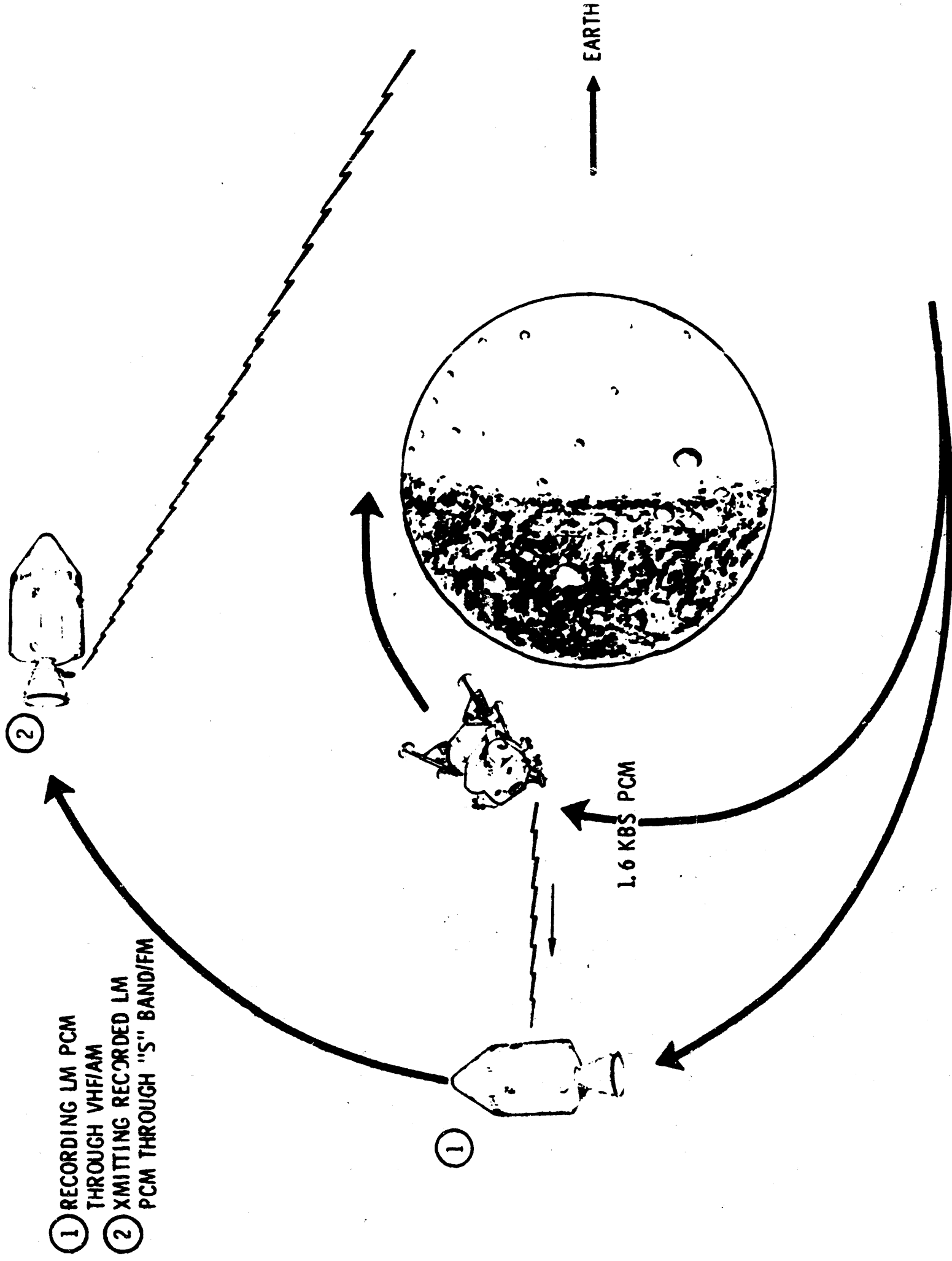


SPACE SUIT COMMUNICATION

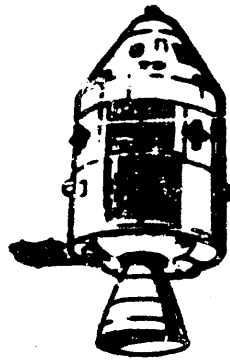


CD-2146 (A)

LM-CSM VHF/AM DATA REC



CSM-LM VHF/AM COMM MODE



VOICE

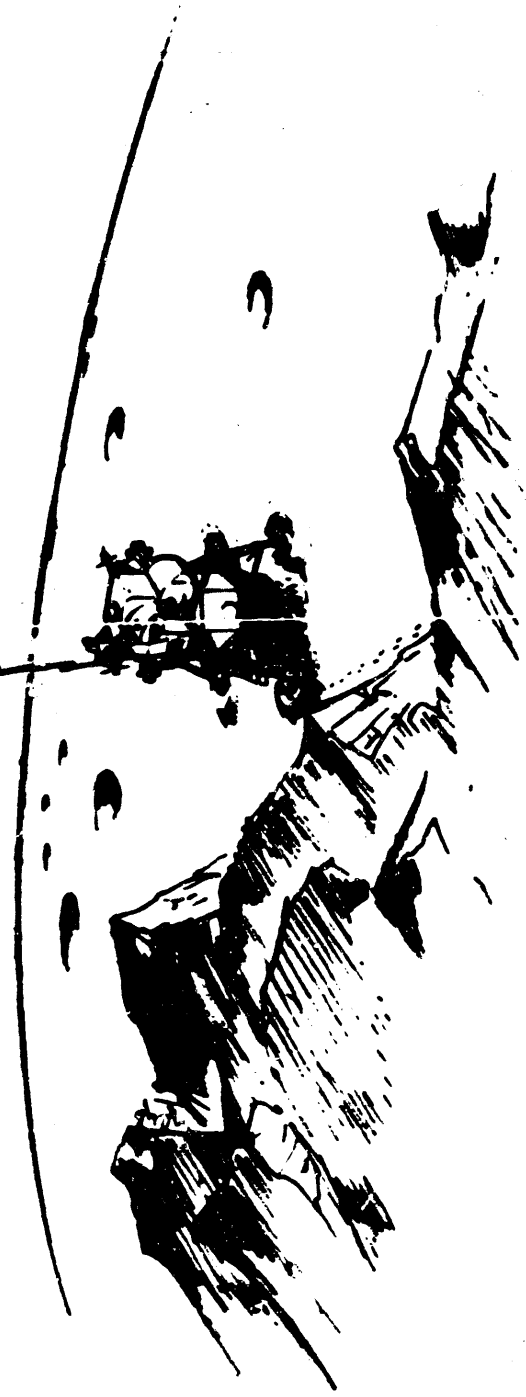
VOICE

SIMPLEX A
(PRIM)

XMIT - 296.8
REC - 296.8

SIMPLEX B
(BACK-UP)

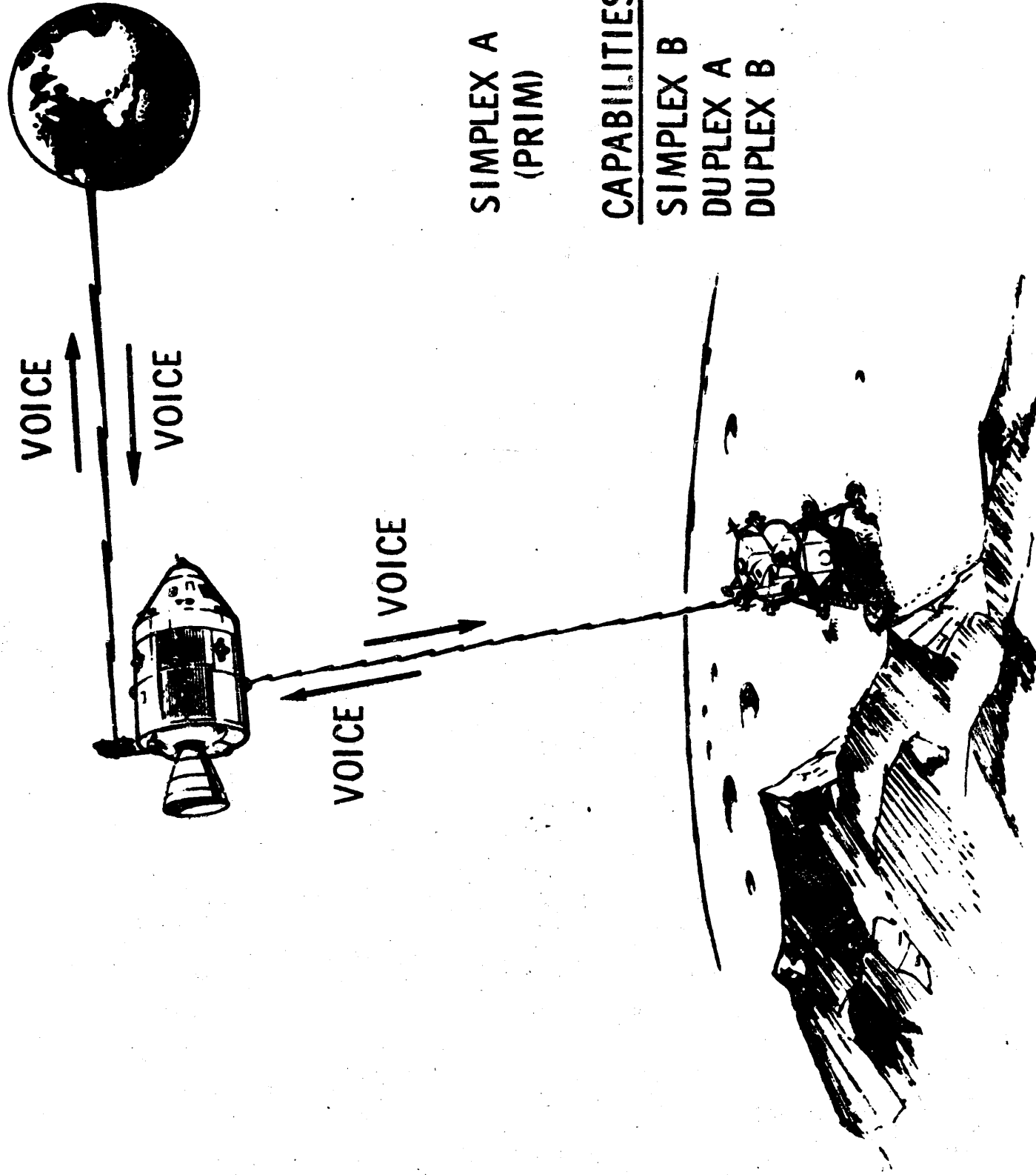
XMIT - 259.7
REC - 259.7



CD-2086 B



MSFN-CSM-LM RELAY MODE

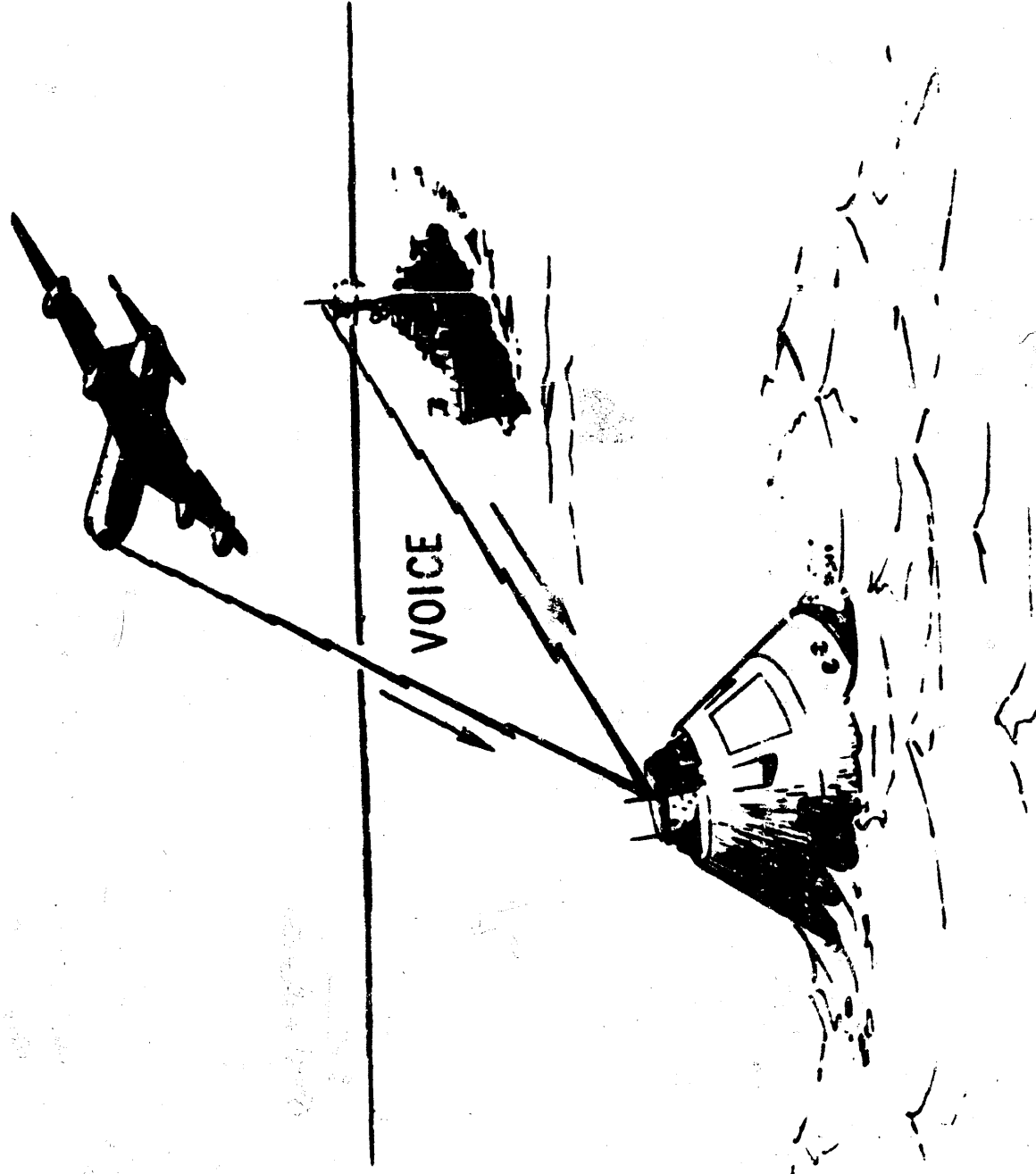


SIMPLEX A
(PRIM) XMIT - 296.8
REC - 296.8

CAPABILITIES

SIMPLEX B
DUPLEX A
DUPLEX B

RECOVERY-CSM VHF/AM REC MODE



REC A REC-296.8

CD-2090B 

VHF/AM COMM MODES

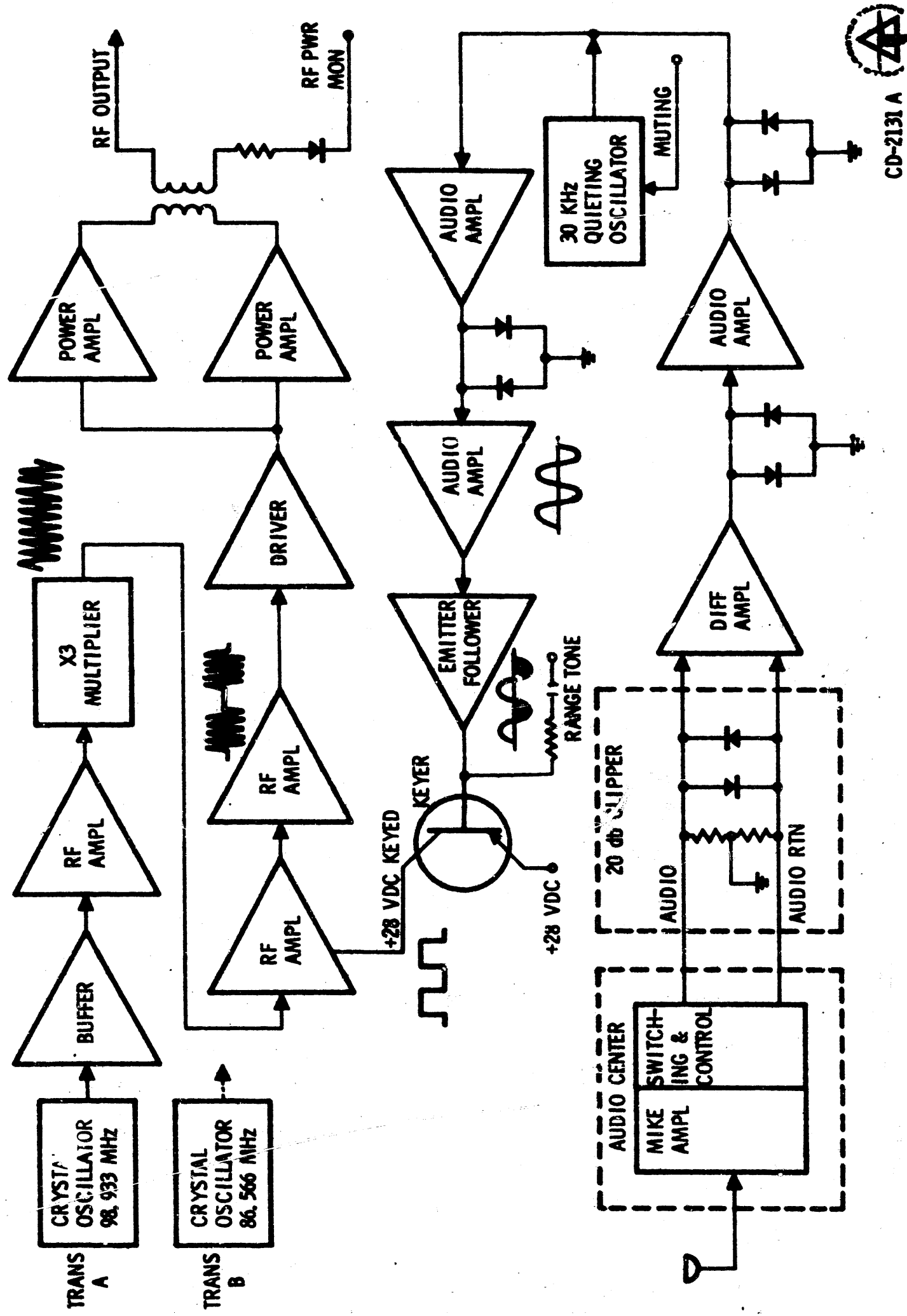
FROM-TO-FROM	VHF MODE	INFORMATION	FREQUENCY (MHZ)	
			XMIT	REC
CSM EVA	DUP A	VOICE	296.8	259.7
EVA CSM	DUP A	VOICE & BIO MED DATA	296.8	259.7
CSM EVA (BU)	DUP B	VOICE	259.7	296.8
EVA CSM (BU)	DUP B	VOICE	259.7	296.8
CSM MSFN	SIM A	VOICE	296.8	296.8
MSFN CSM	SIM A	VOICE	296.8	296.8
CSM LM	SIM A	VOICE	296.8	296.8
LM CSM	SIM A	VOICE	296.8	296.8
CSM LM (BU)	SIM B	VOICE	259.7	259.7
LM CSM (BU)	SIM B	VOICE	259.7	259.7
MSFN CSM-LM	SIM A	VOICE	296.8	296.8*
MSFN CSM-EVA	DUP A	VOICE	296.8	259.7*
MSFN CSM-EV/I	DUP A	VOICE & DATA	296.8	259.7*
LM CSM	REC B	1.6 KBS-PCM		259.7
RECOVERY CSM	REC A	VOICE		296.8

*S-BAND RELAY MODE

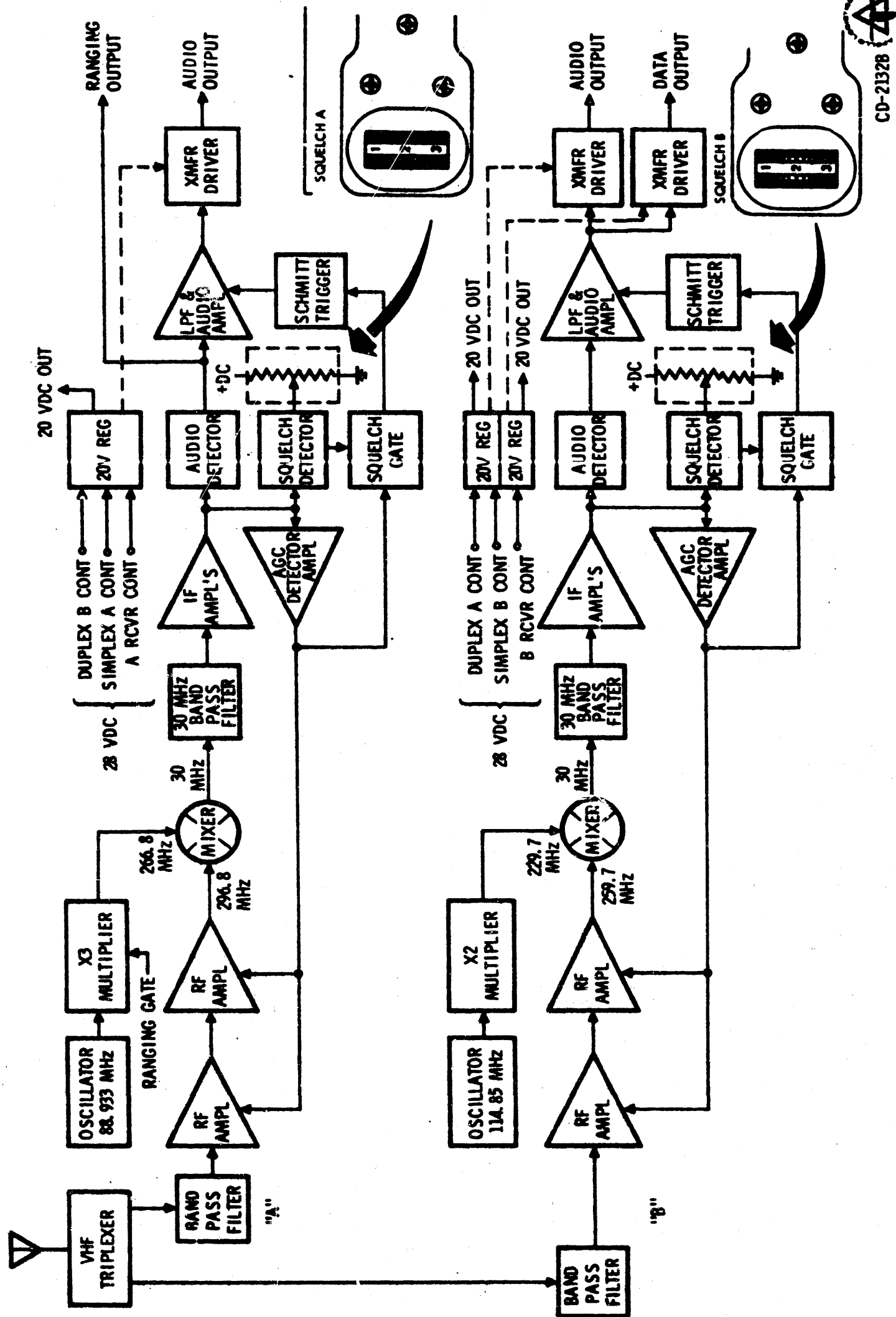


CD-2069C

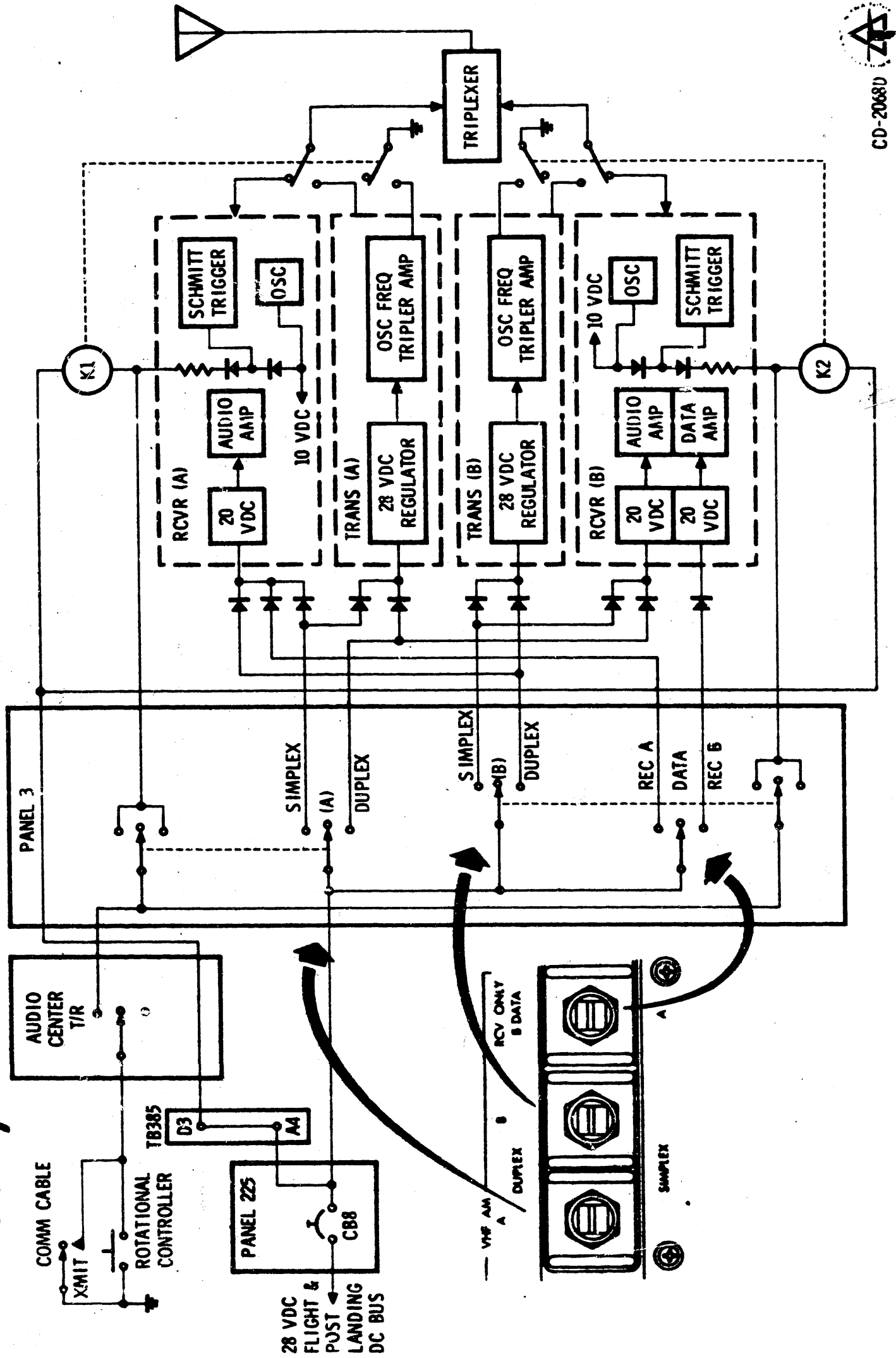
115



VHF/AM RECEIVER



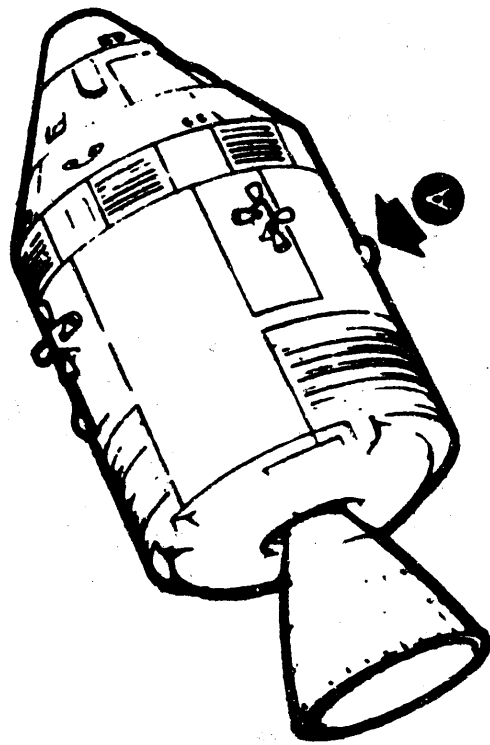
VHF/AM CONTROL & POWER SWITCHING



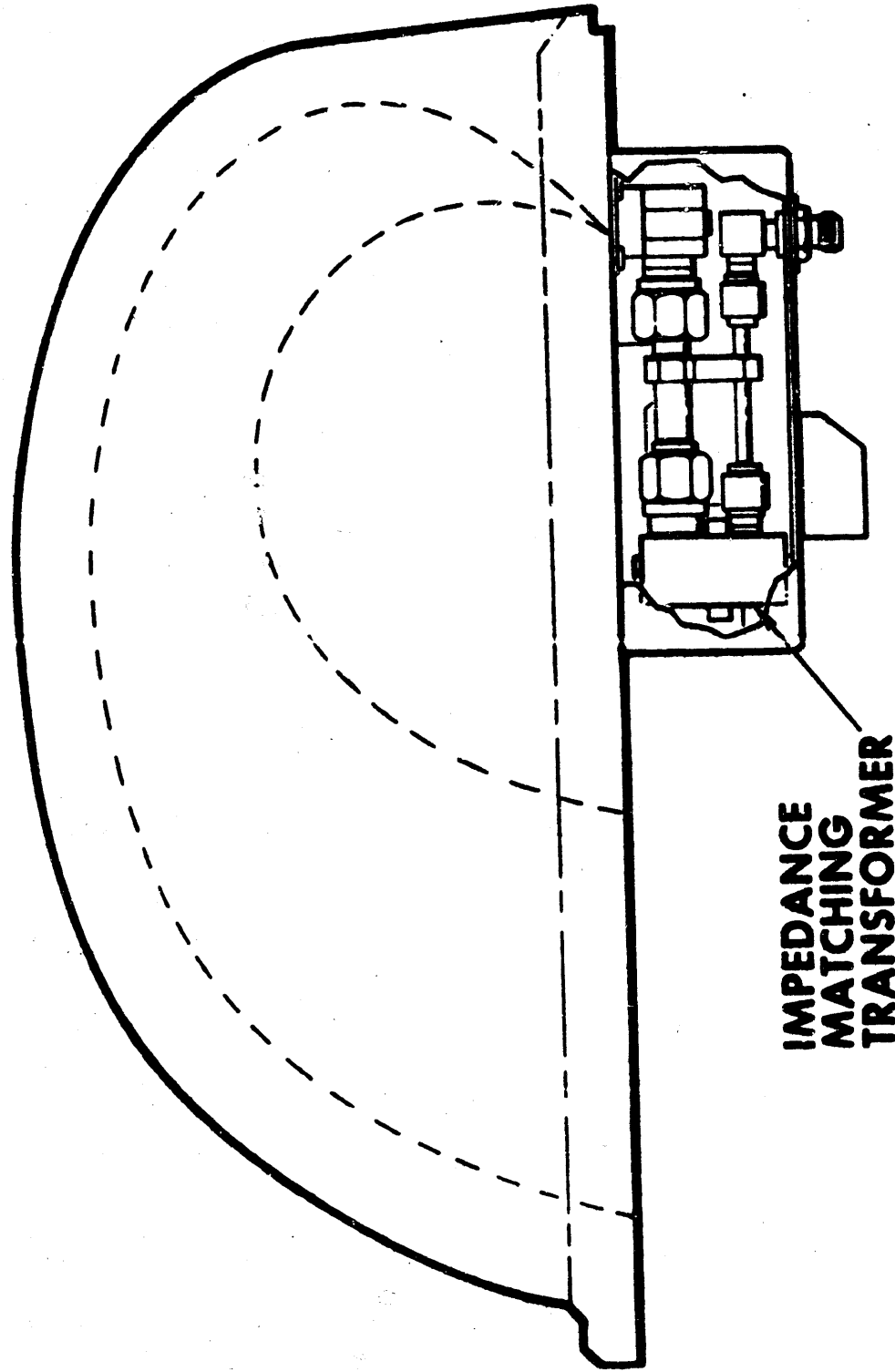
CD-2068D

SCIMITAR ANTENNA

BLOCK II

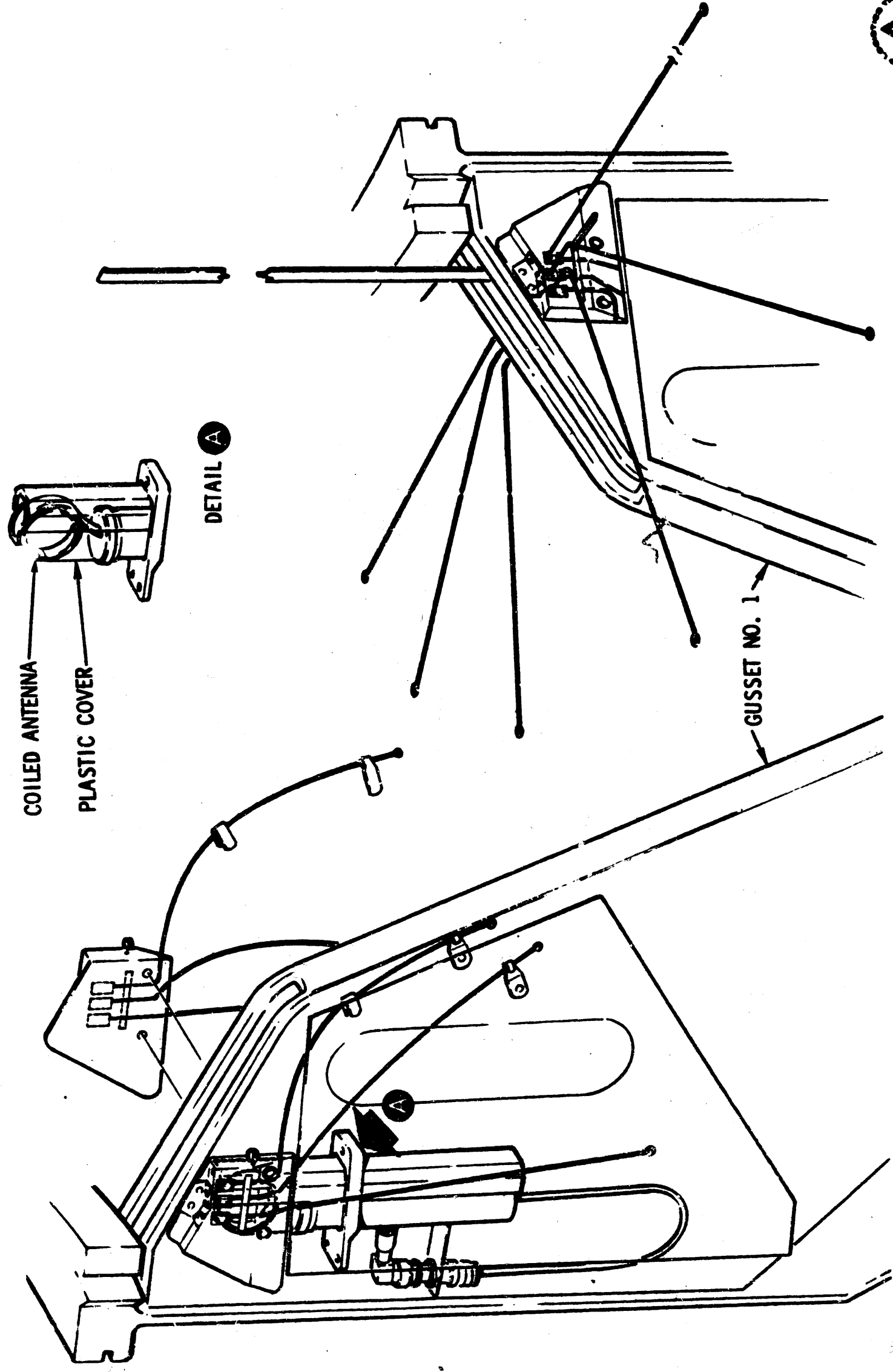


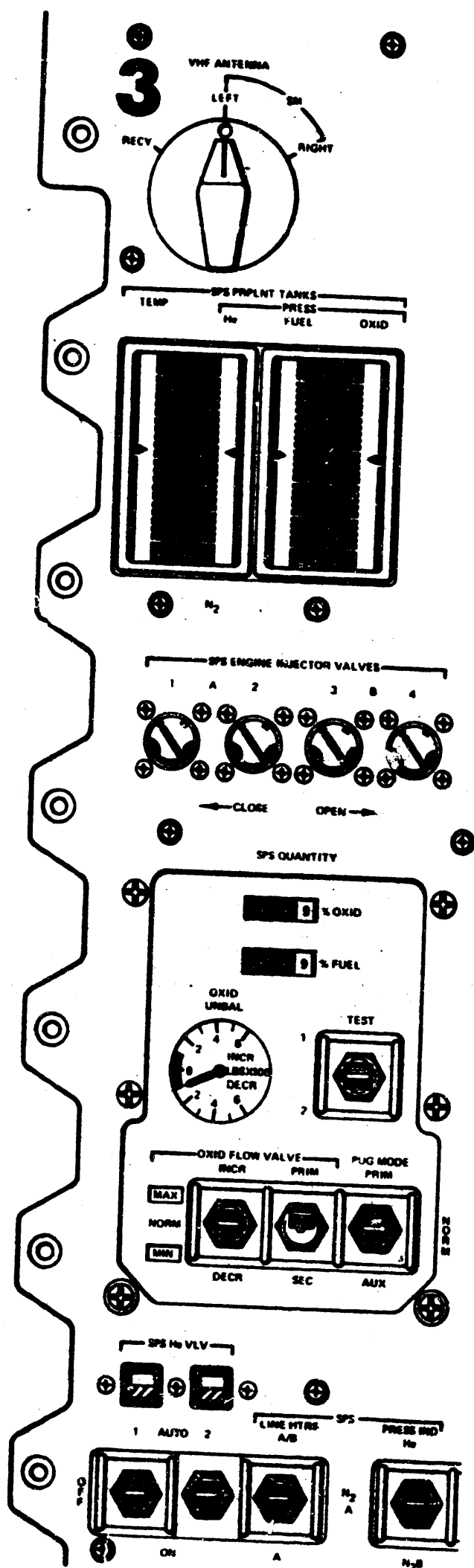
DETAIL A



CD-2004A

VHF RECOVERY ANTENNA NO. 2

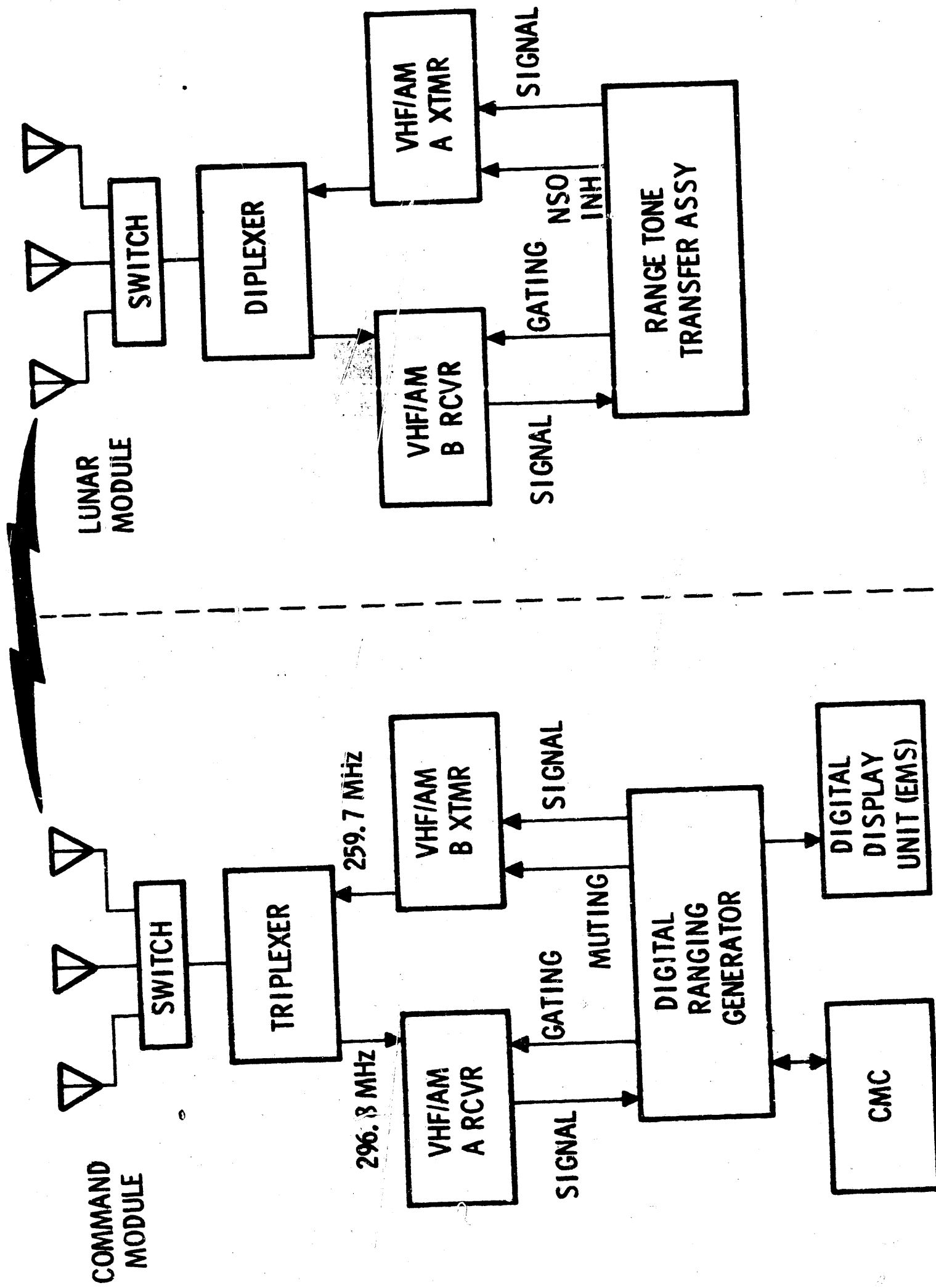




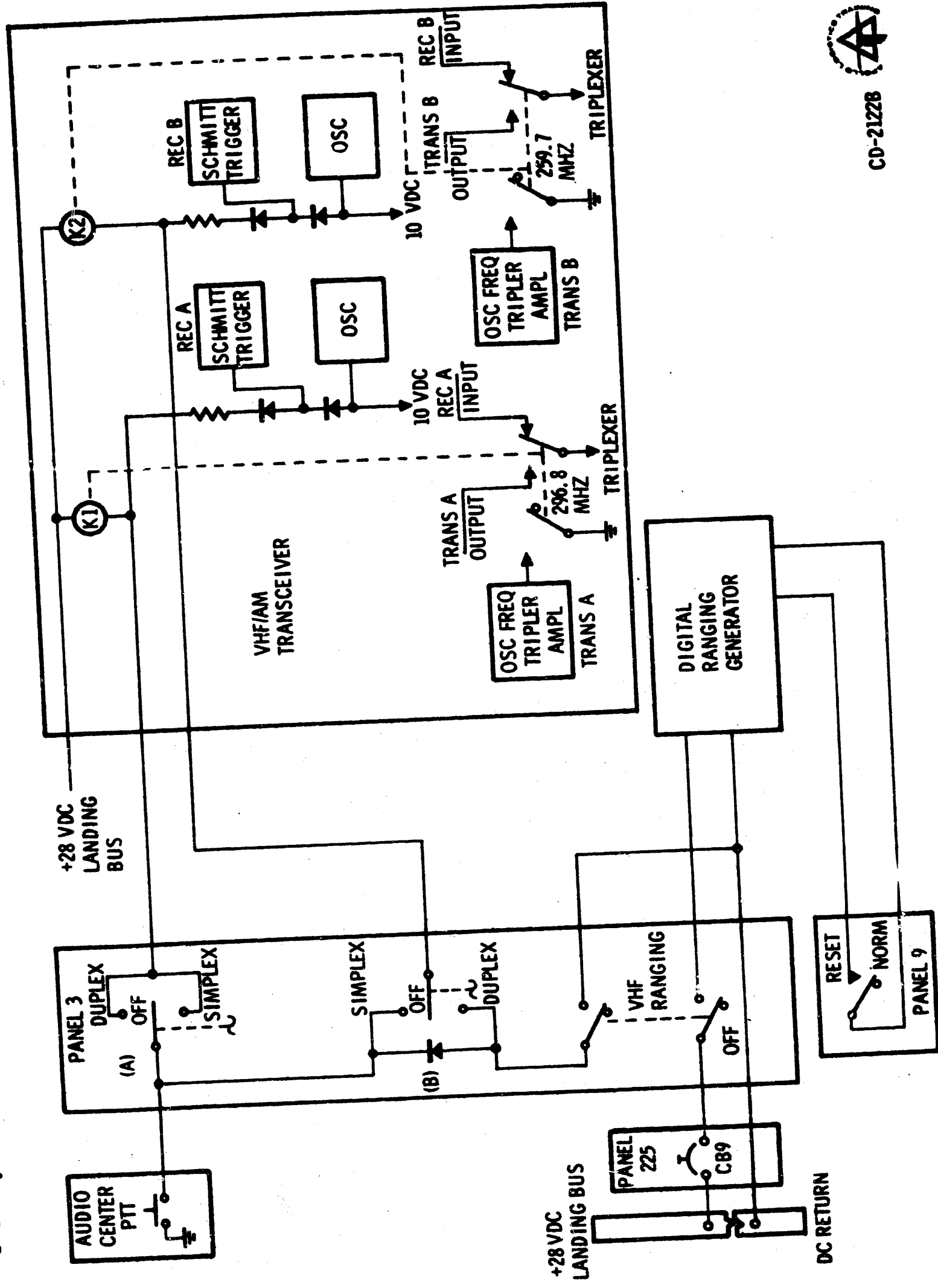
PN-3A-6



VHF RANGING BLOCK DIAGRAM

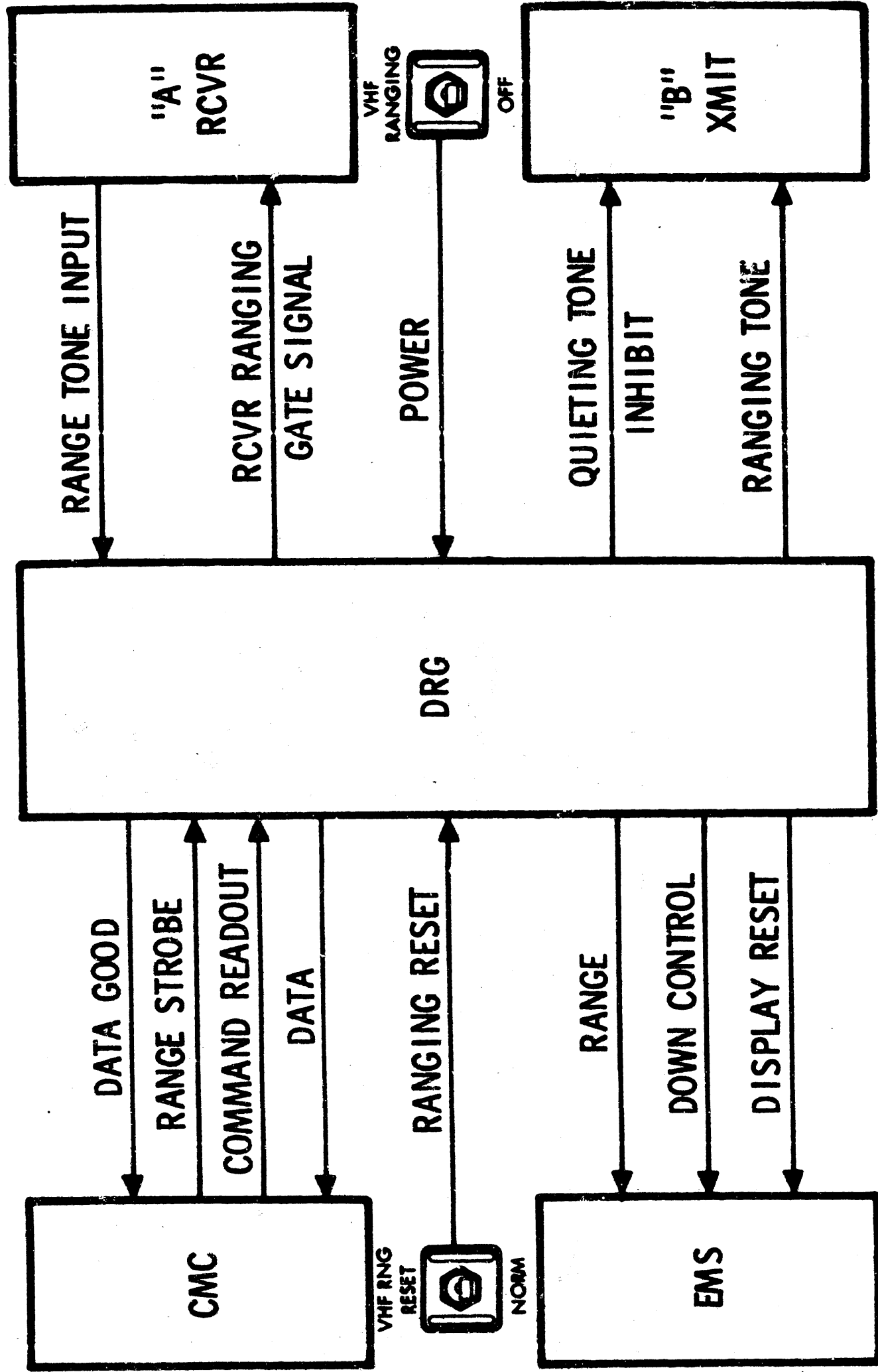


VHF/AM RANGING CONTROL & POWER SWITCHING

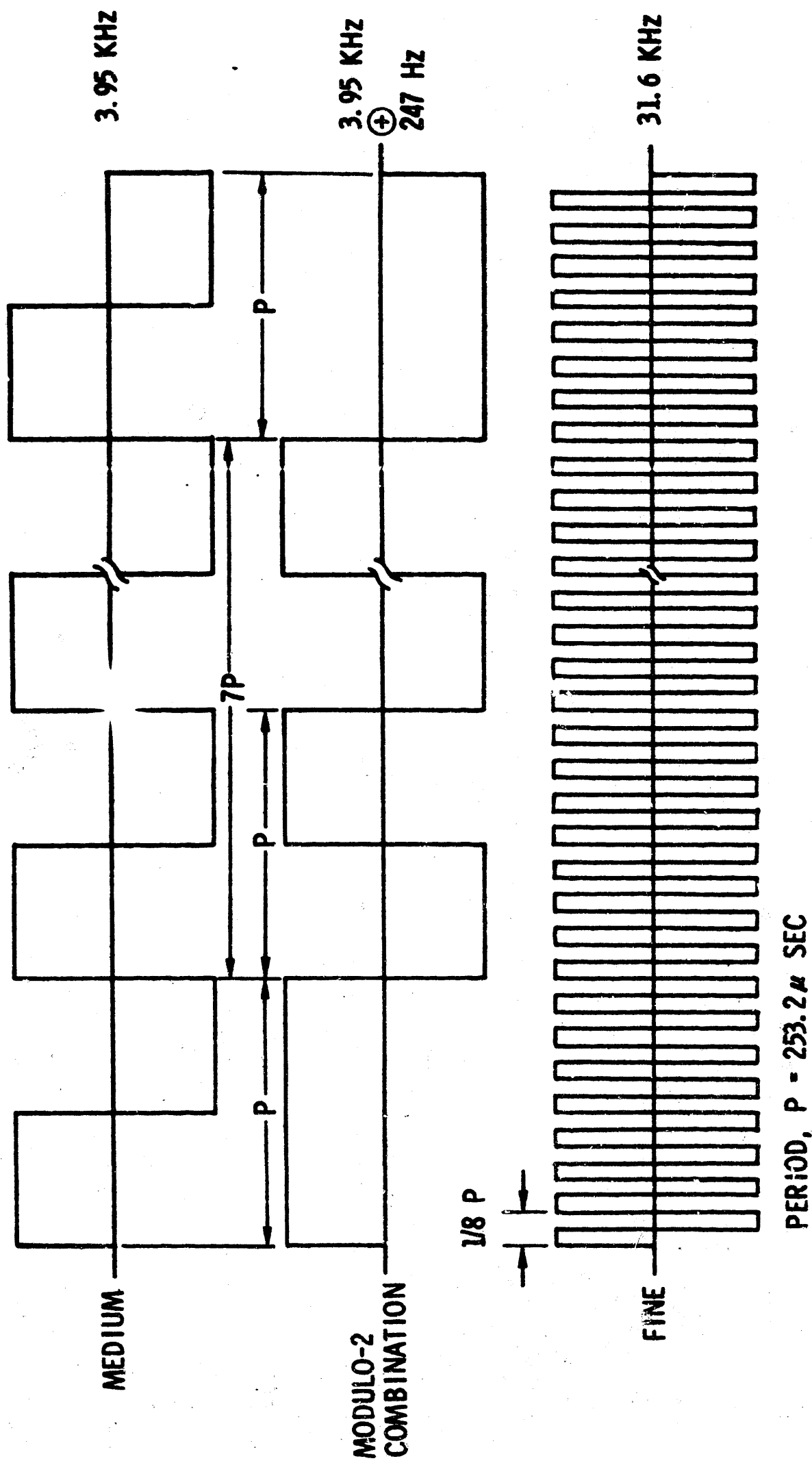


CD-2122B

DRG INTERFACE



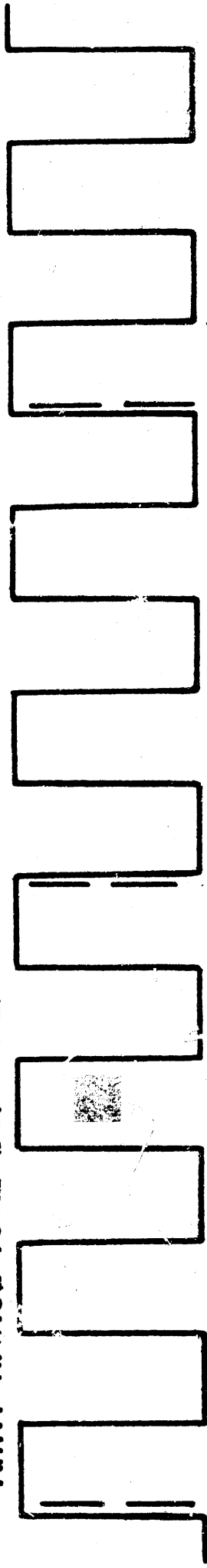
VHF RANGING TONES



CD-2139A (A)

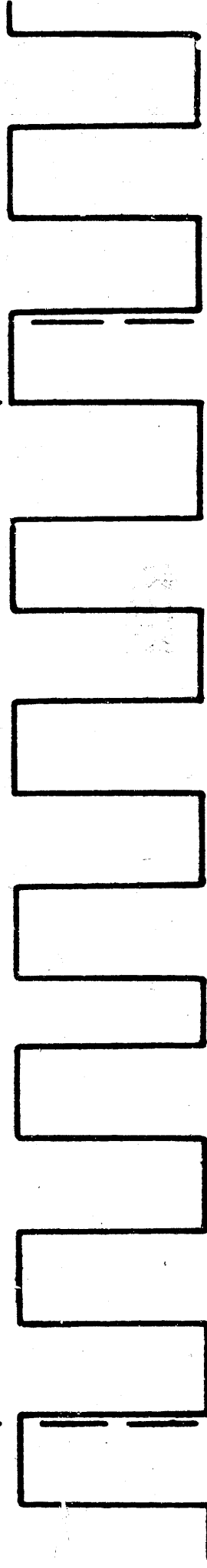
VHF RECEIVER GATING

XMIT RANGE TONE (31.6 KHz)

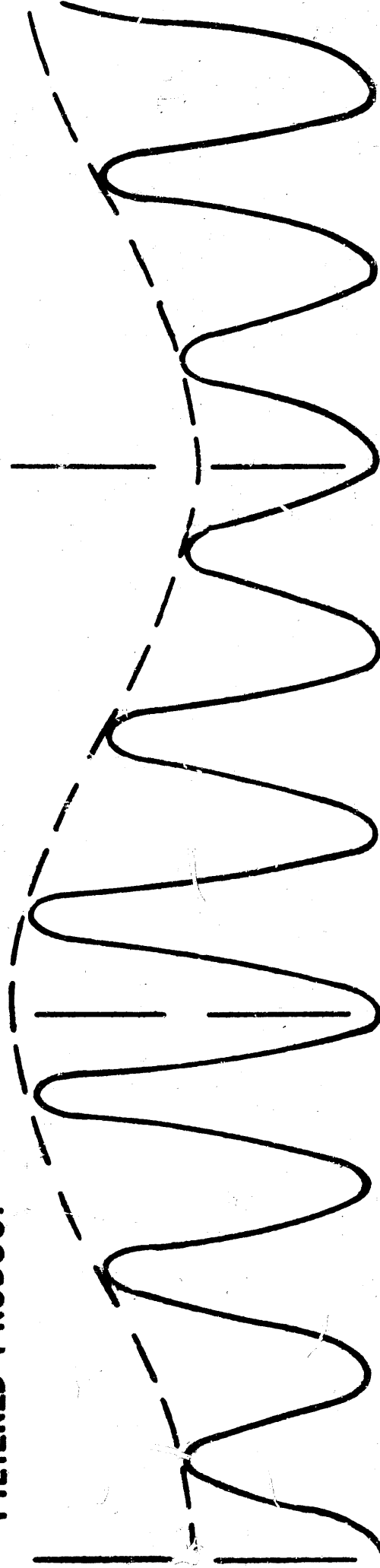


RCVR RANGE GATE

(31.6 KHz / 5.27 KHz)



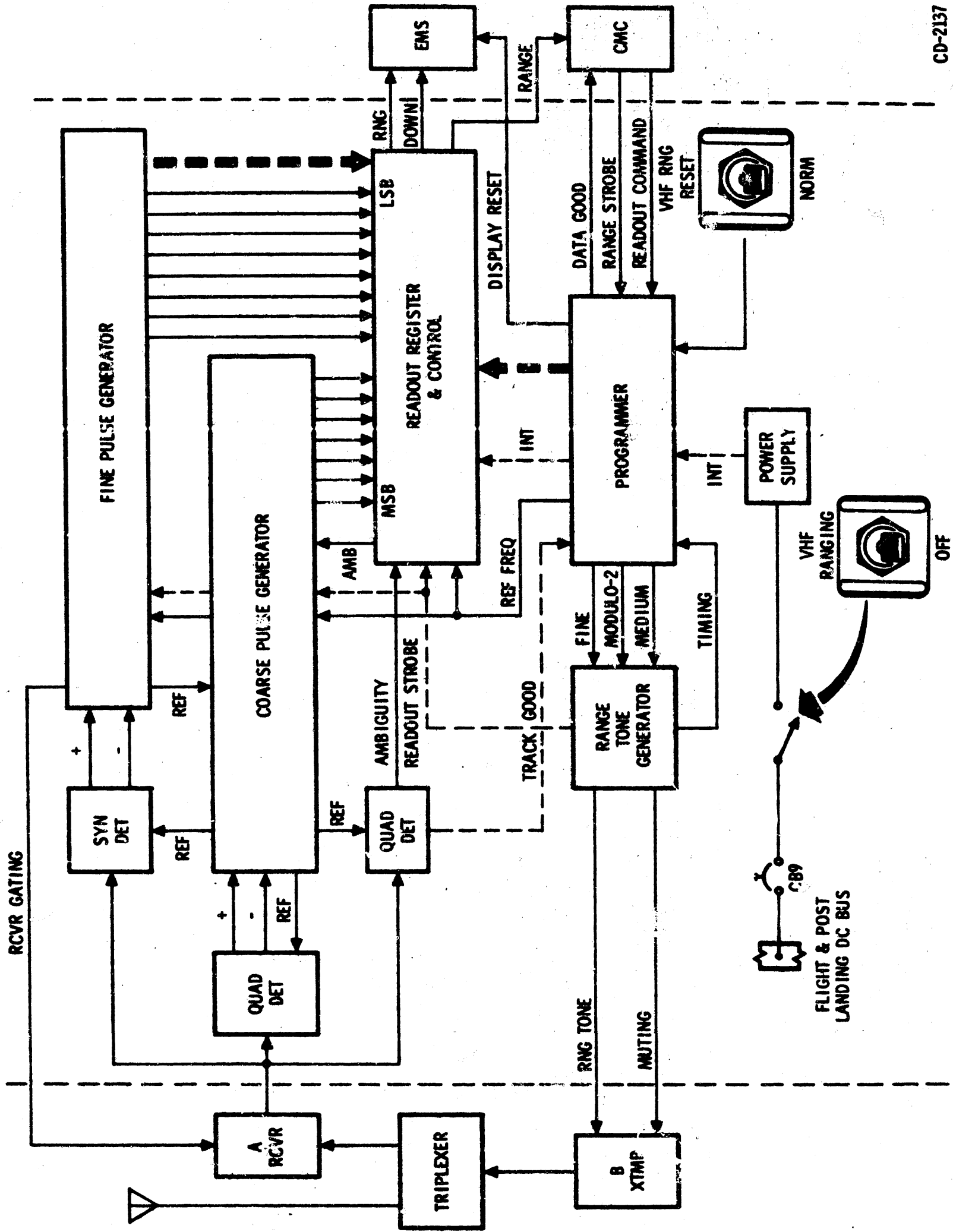
FILTERED PRODUCT



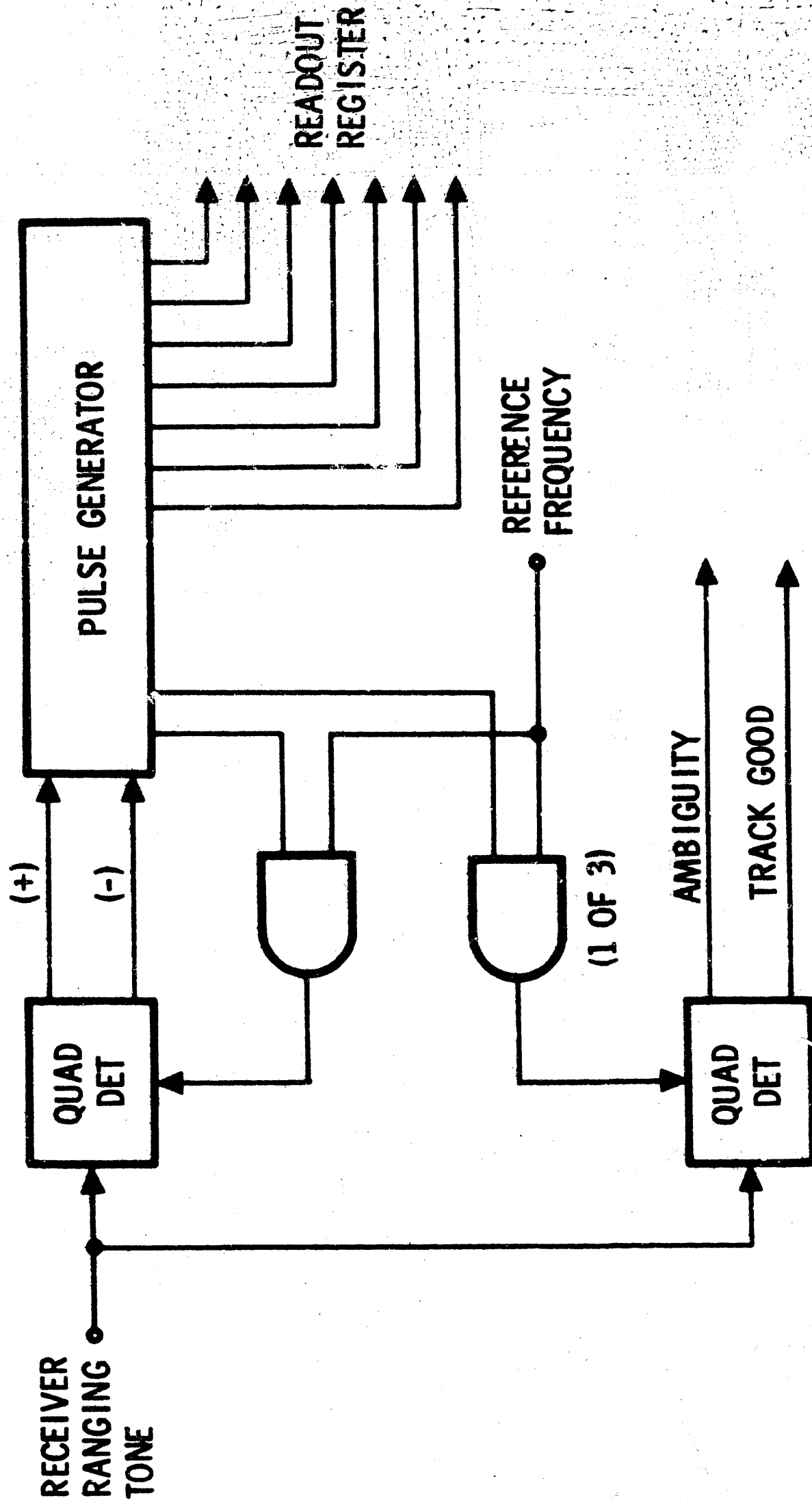
CD-2140

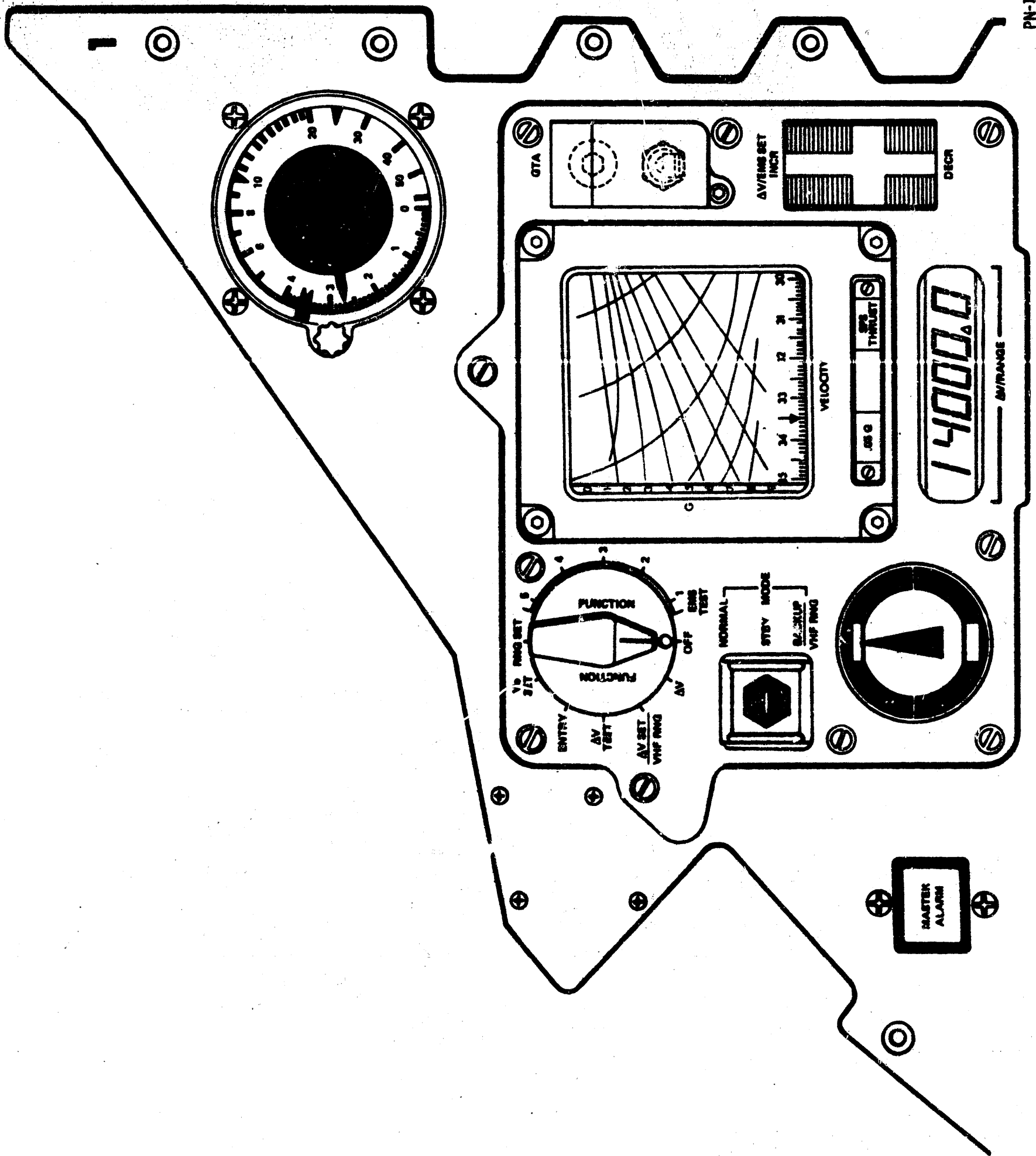


DRG SIMPLIFIED BLOCK DIAGRAM



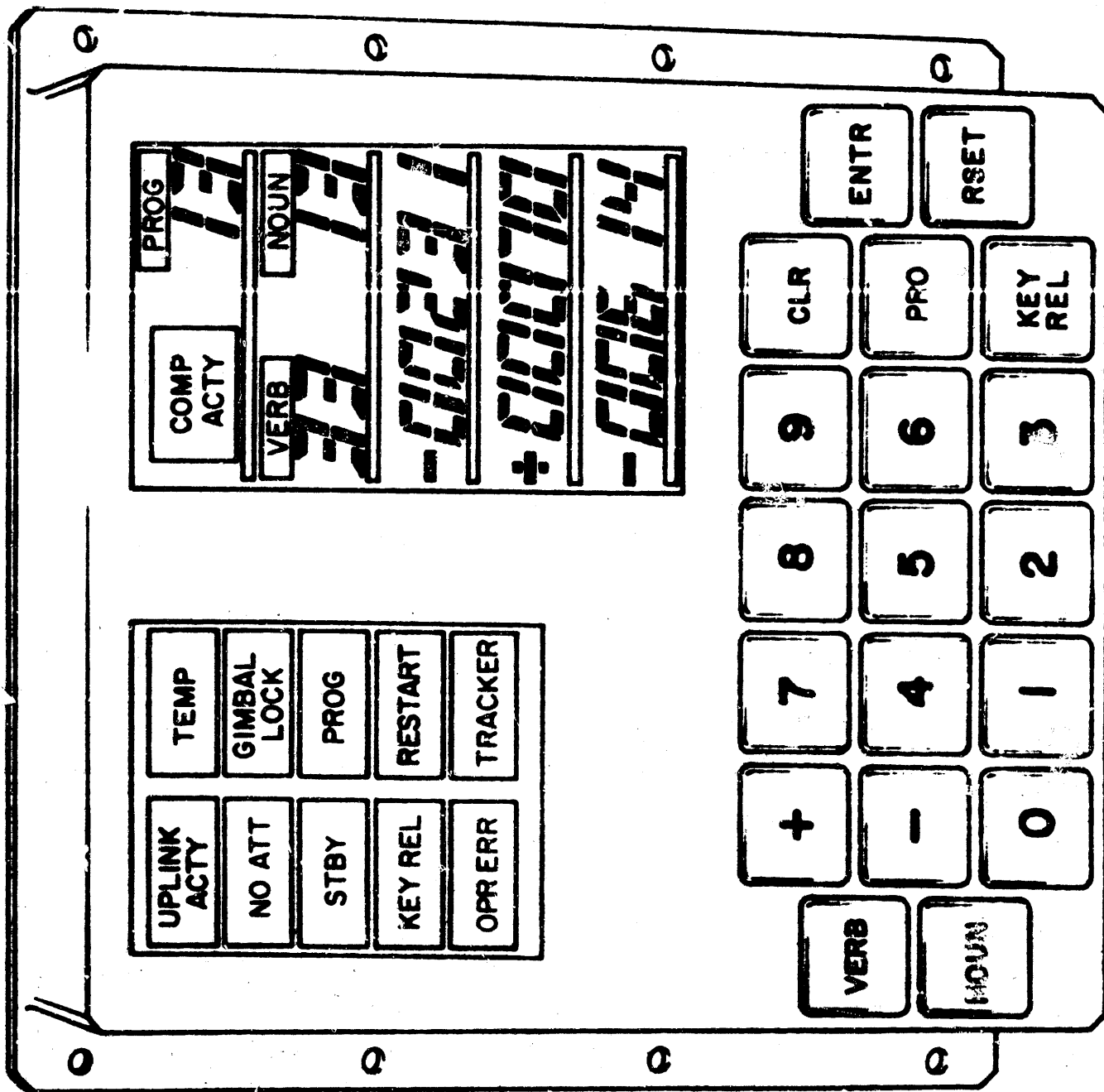
LOCKUP LOOP





PN-1A-6A (A)

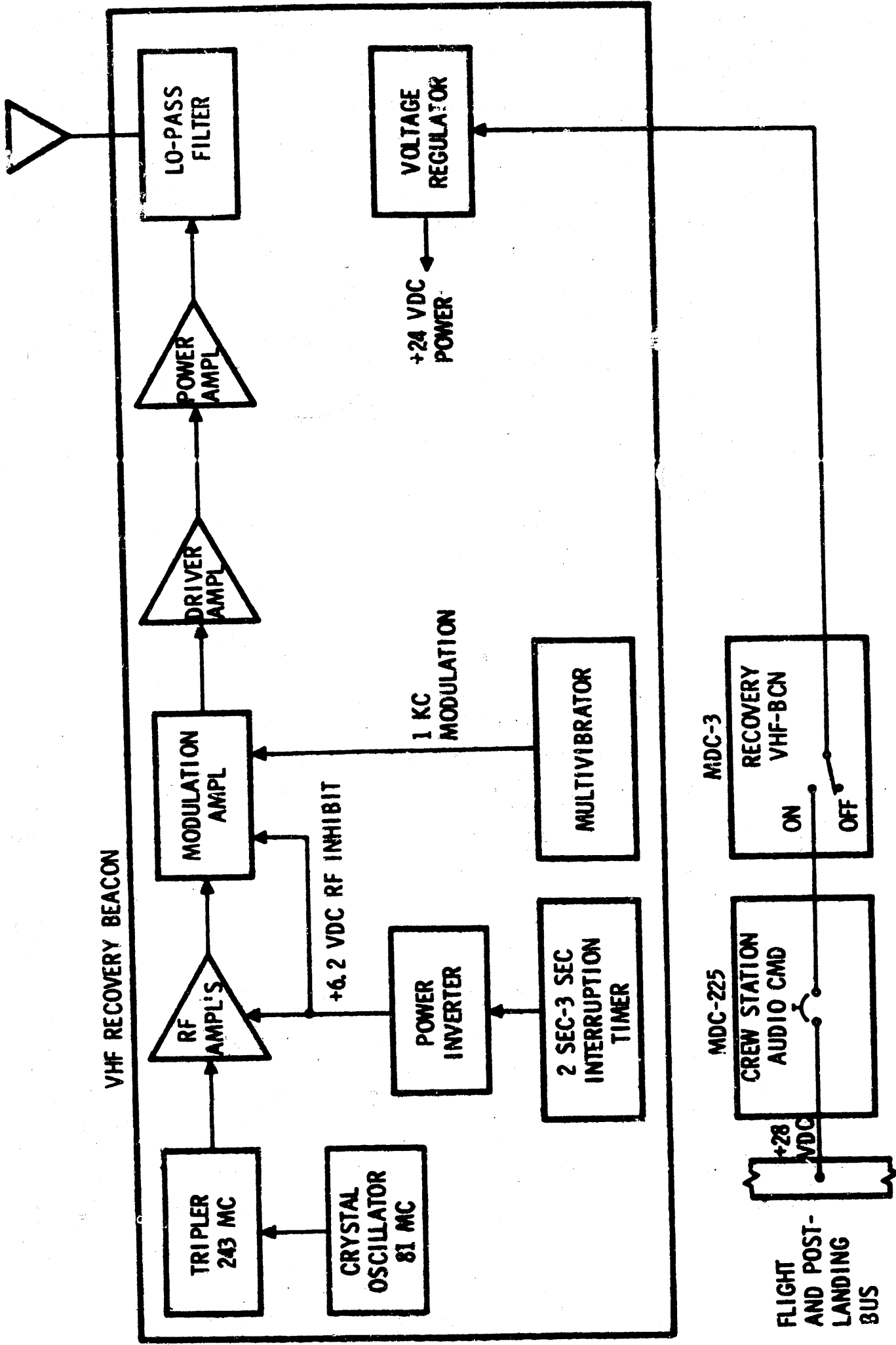
DISPLAY AND KEYBOARD (DSKY)



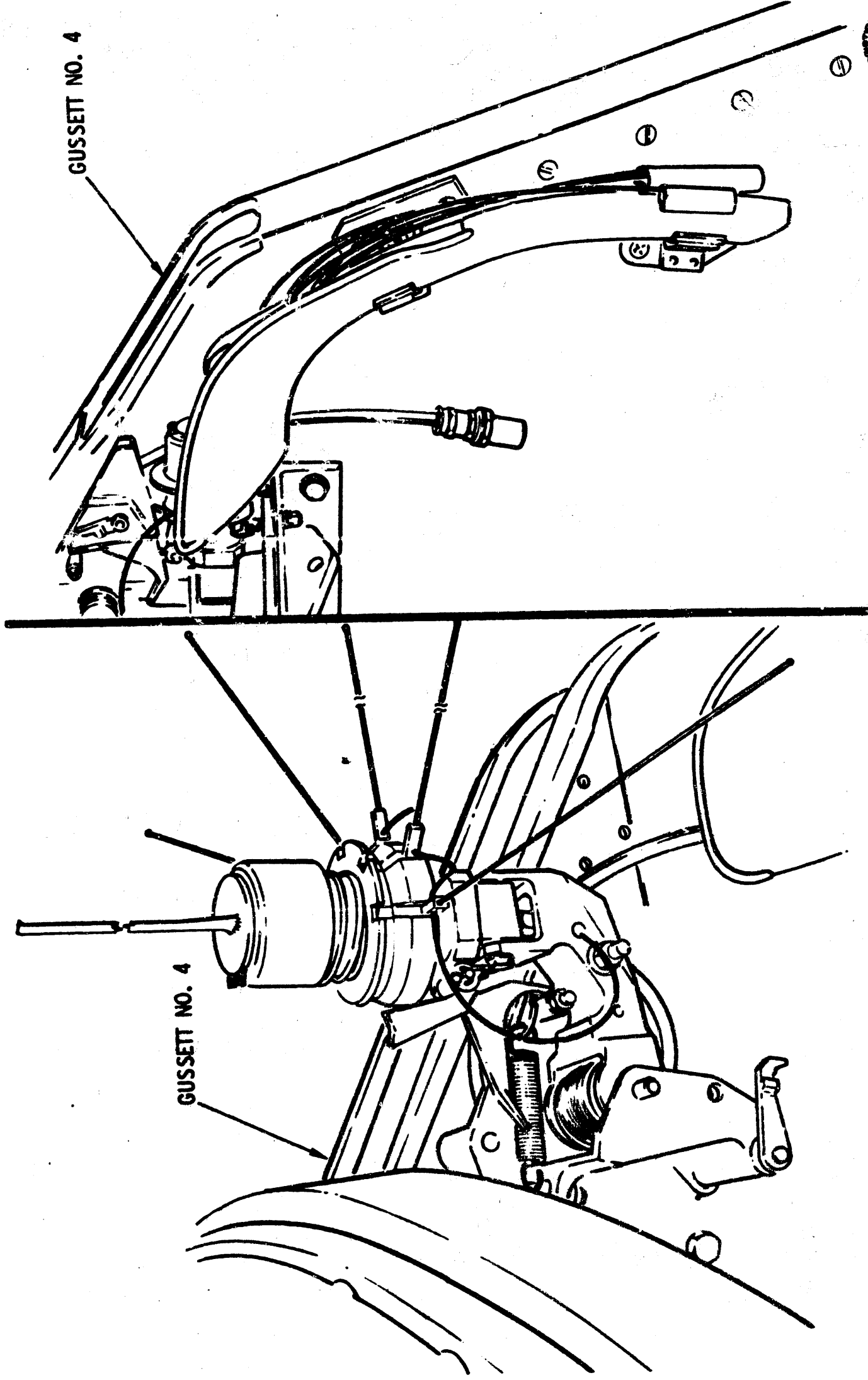
GNC-33B 

VHF RECOVERY BEACON EQUIPMENT

VHF RECOVERY
ANTENNA NO. 1

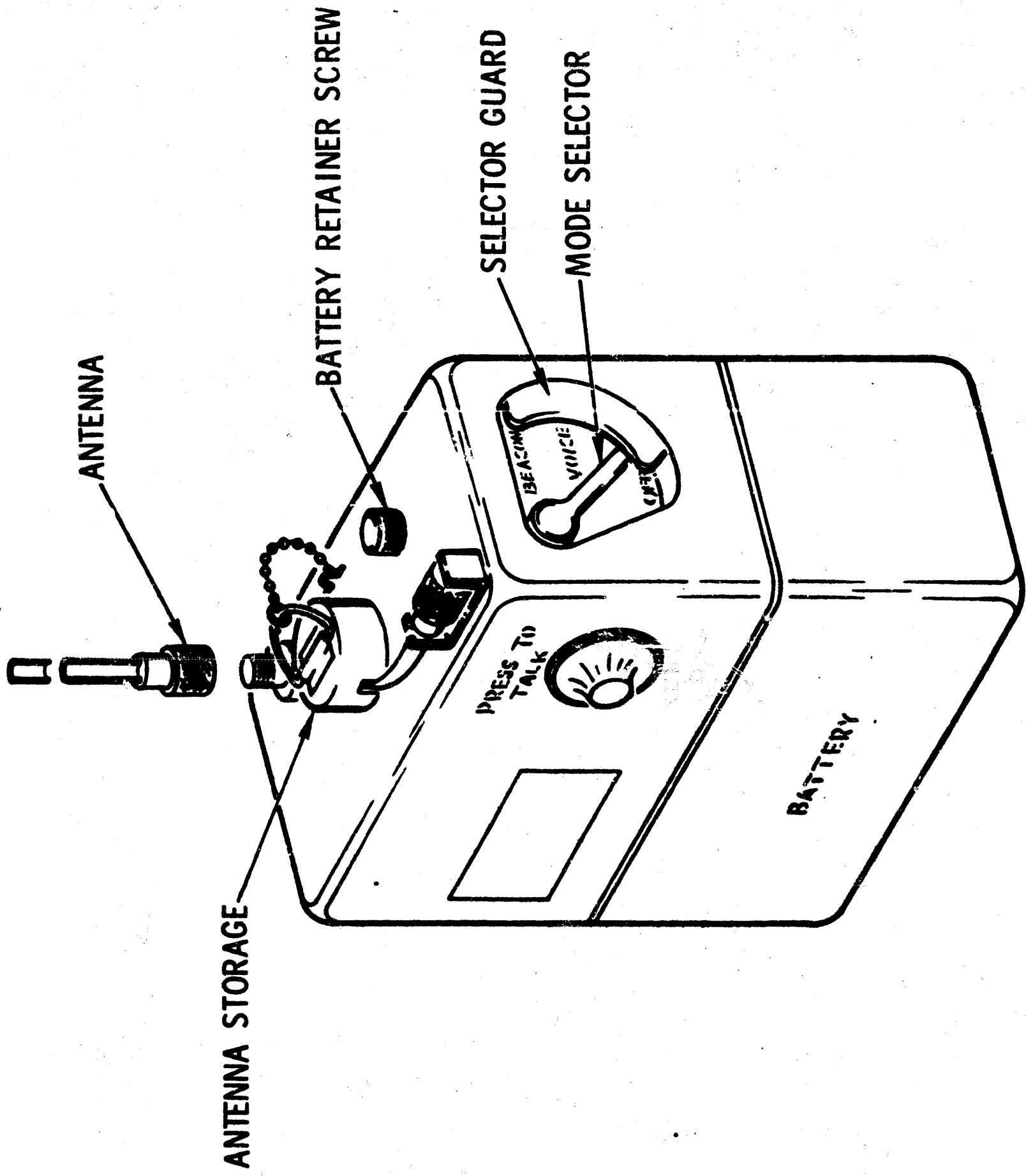


VHF RECOVERY ANTENNA NO. 1



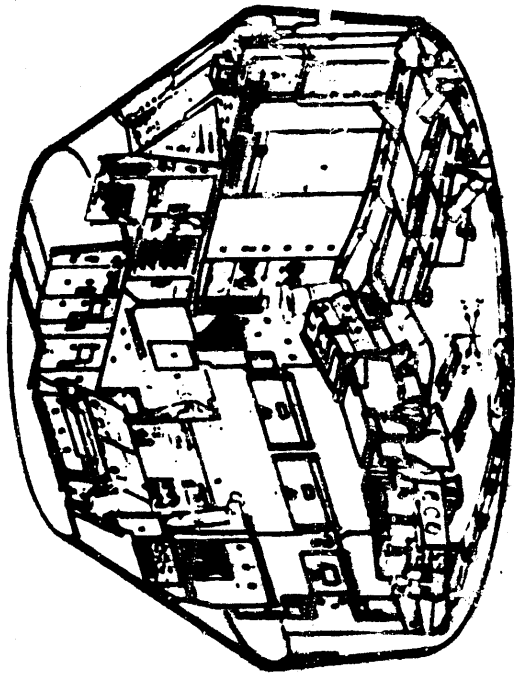
CD2117A (A)

SURVIVAL BEACON/TRANSCIVER RADIO



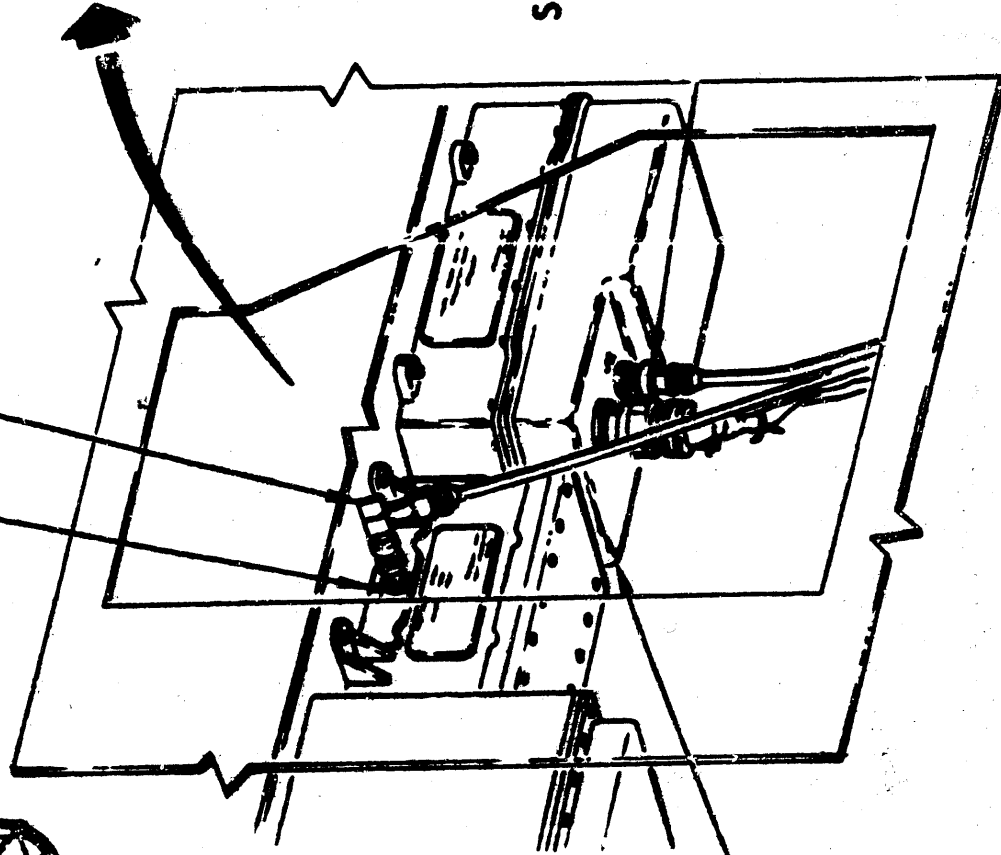
CS-7025

SURVIVAL BEACON ACCESS



VIEW LOOKING DOWN AND OUTBD

VHF TRIPLEXER
TO VHF ANT SW



ACCESS TO THE VHF
TRIPLEXER

S-BAND SQUELCH
ENABLE



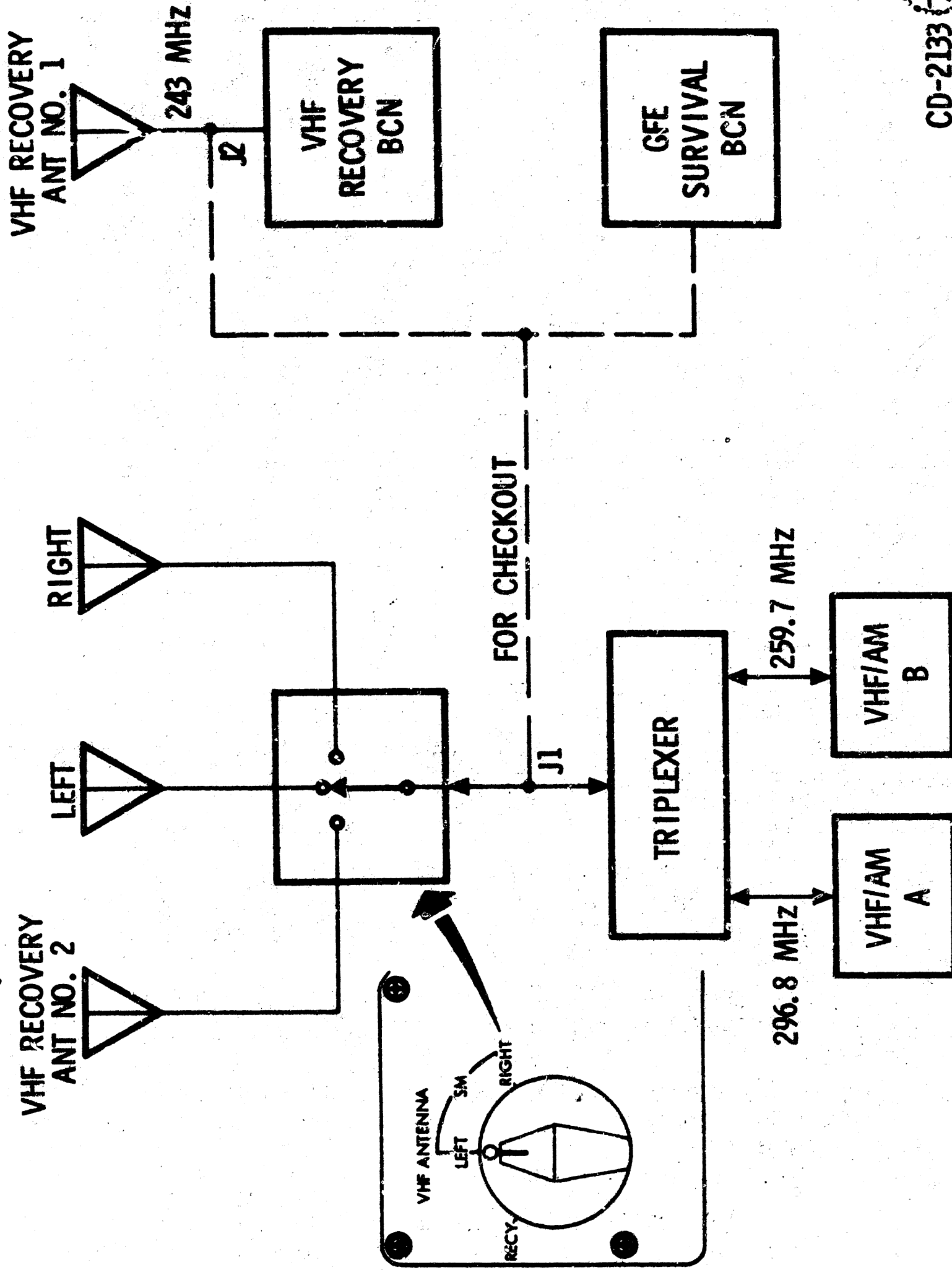
OFF
180

CSM 107

CD-2128

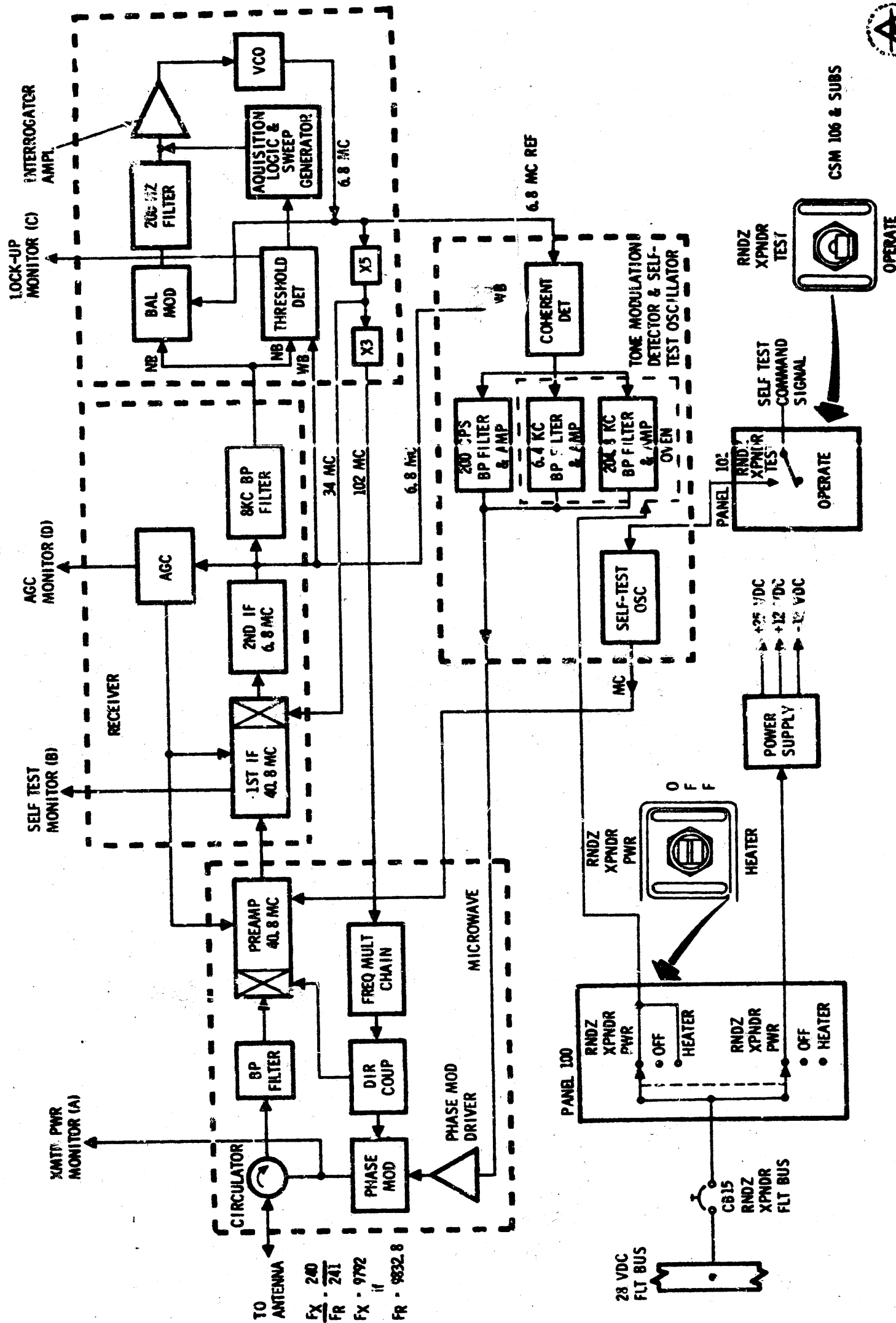


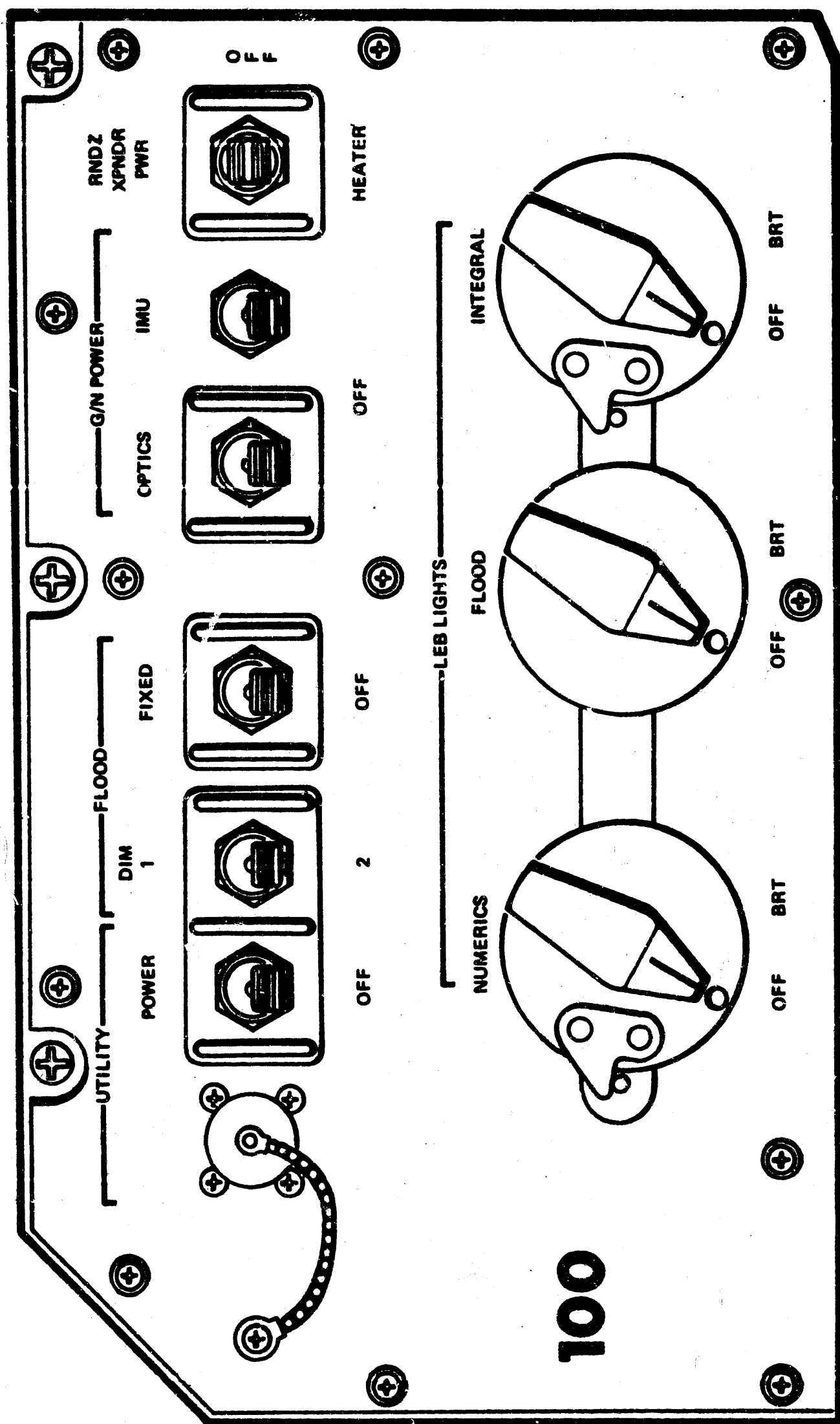
VHF/AM ANTENNA INTERFACES



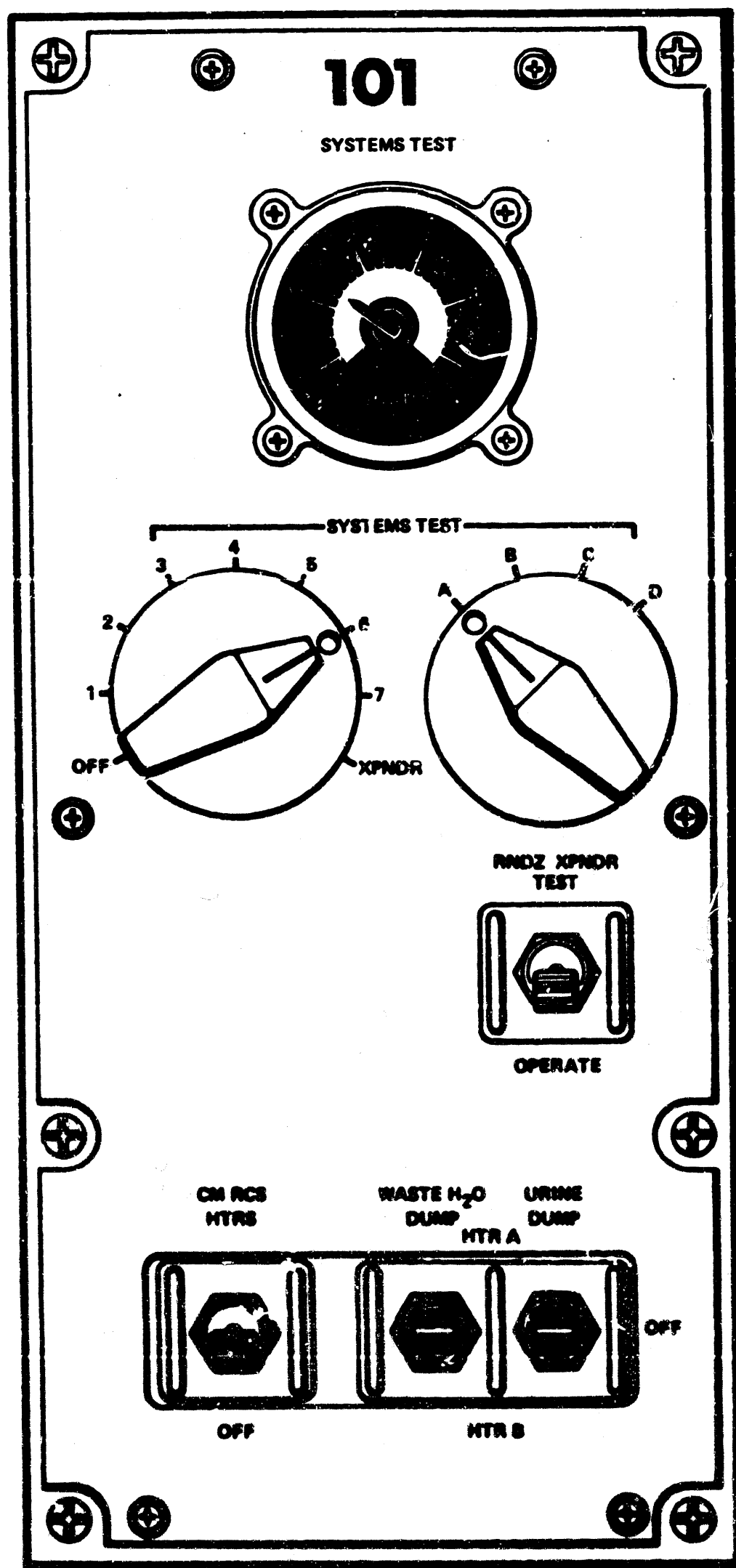
CD-2133 (A)

RRT FUNCTIONAL BLOCK DIAGRAM

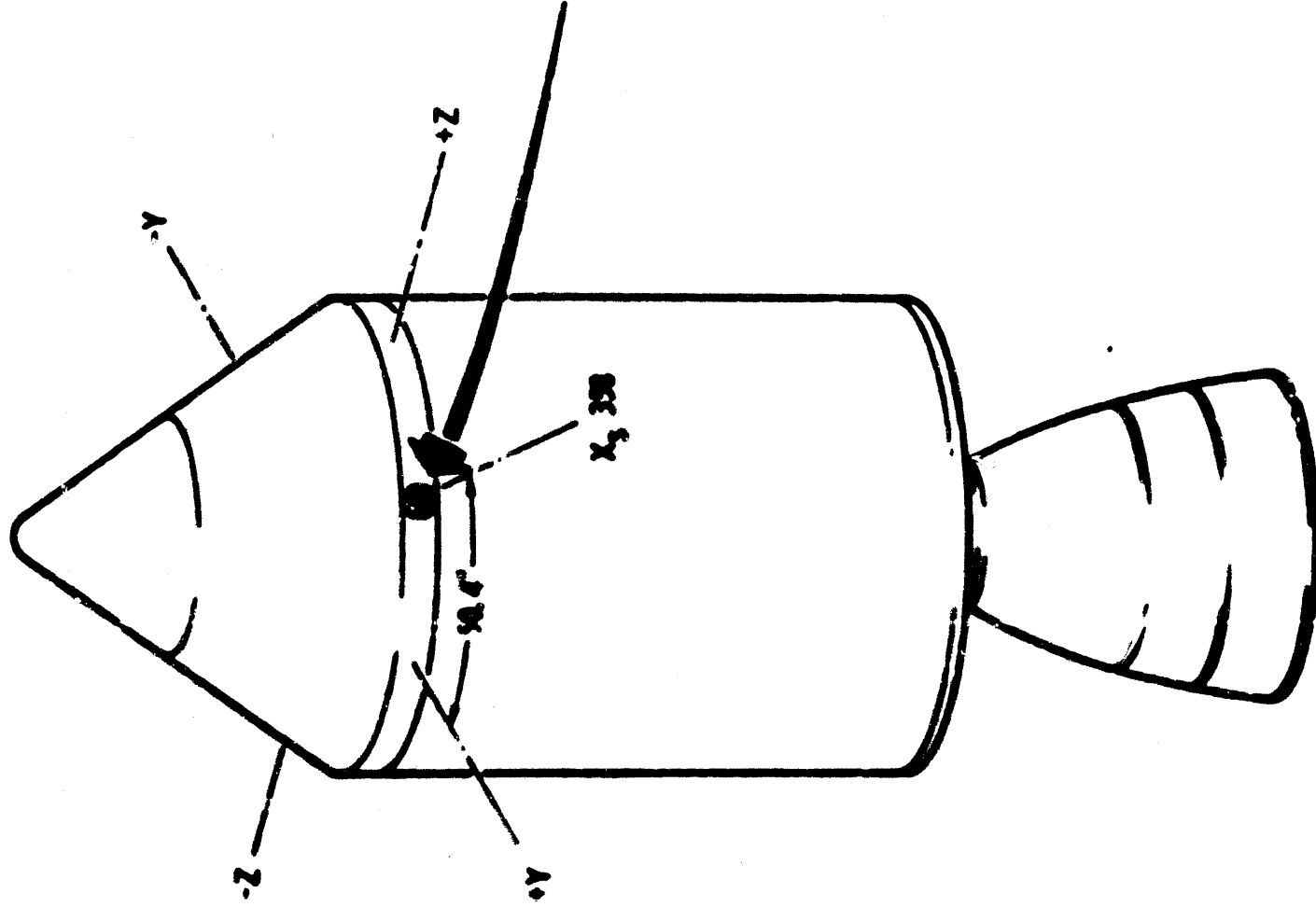




PN-100-6

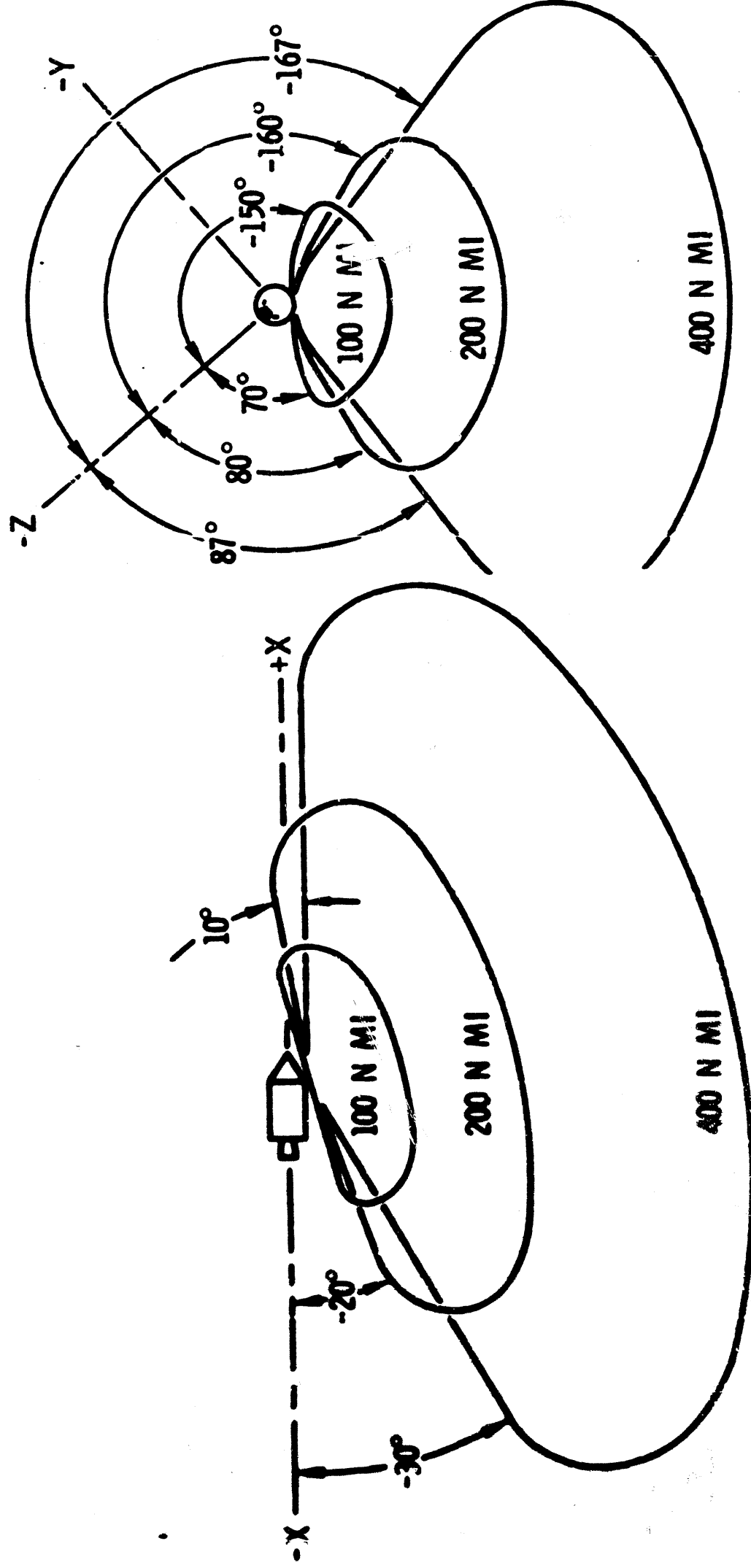


RRT ANTENNA



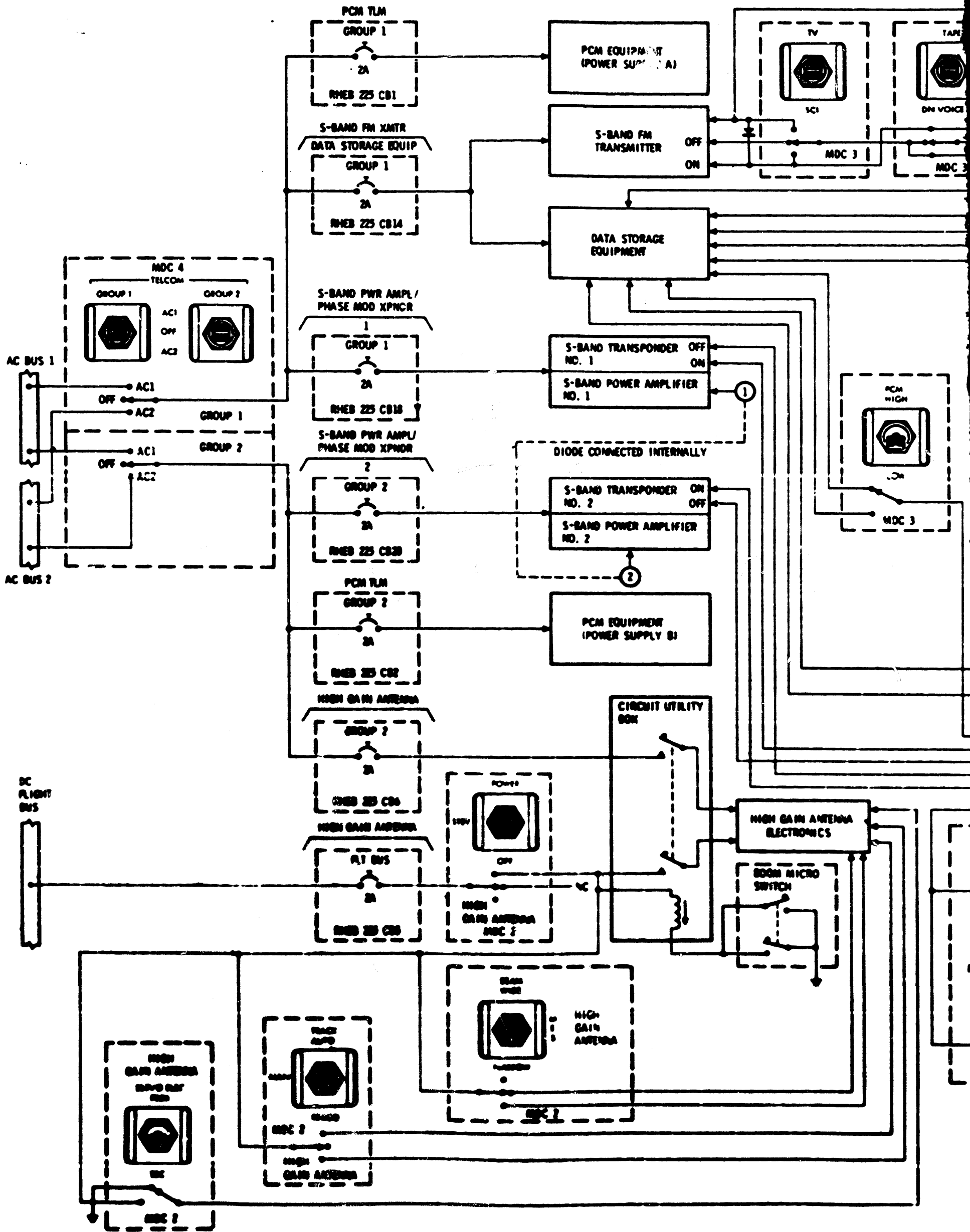
CD-2067A

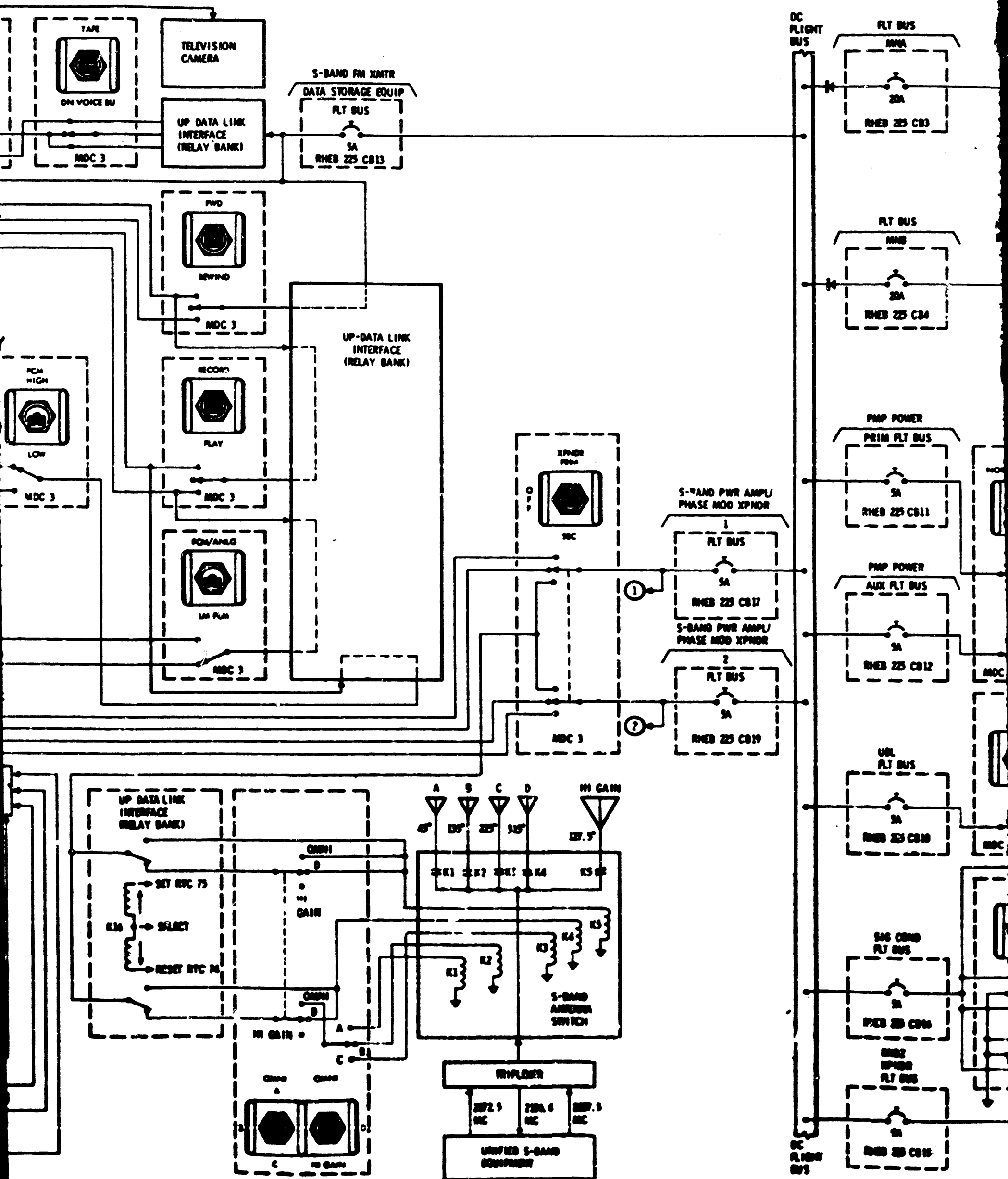
RRT ANTENNA COVERAGE

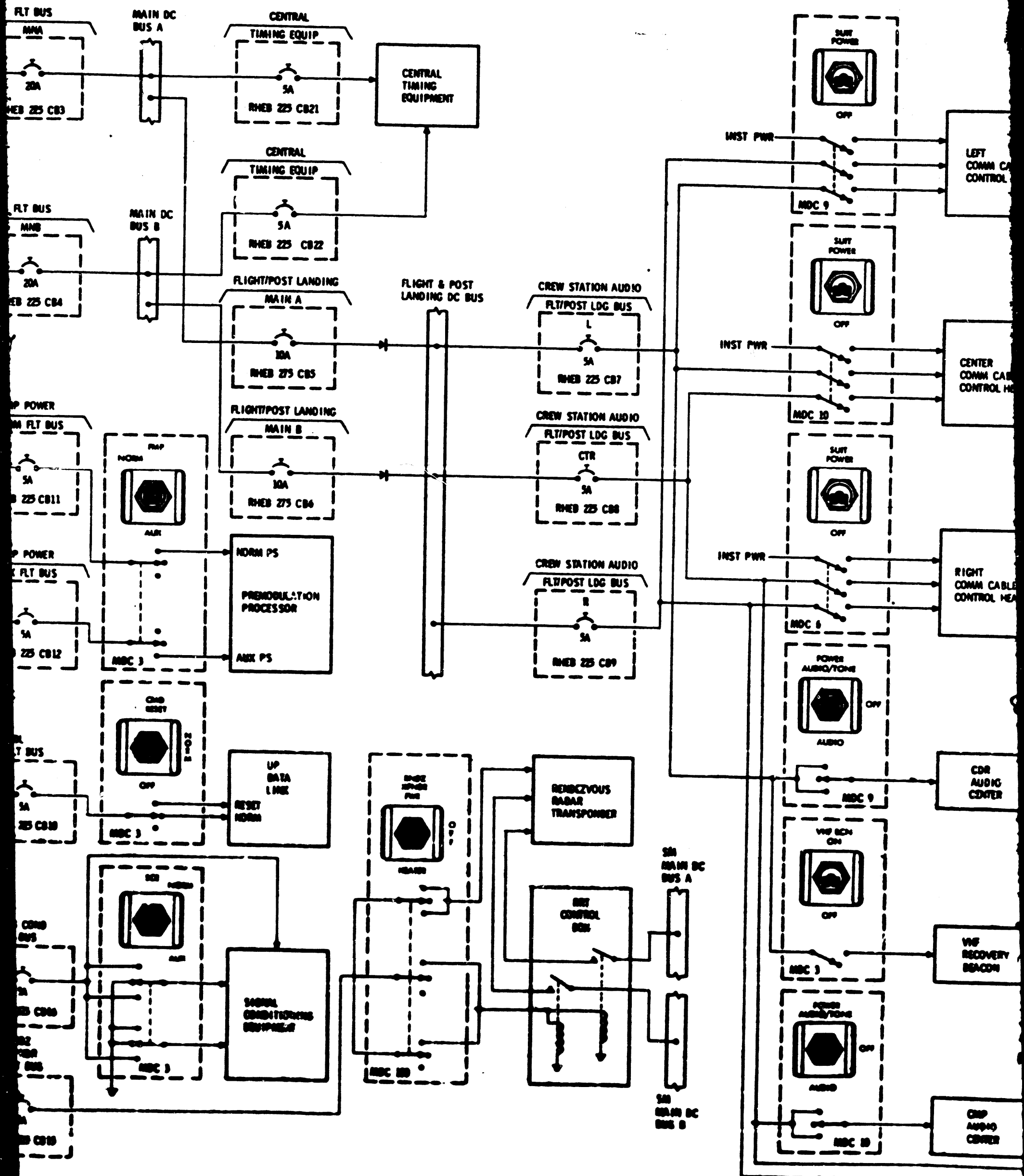


CD-2117

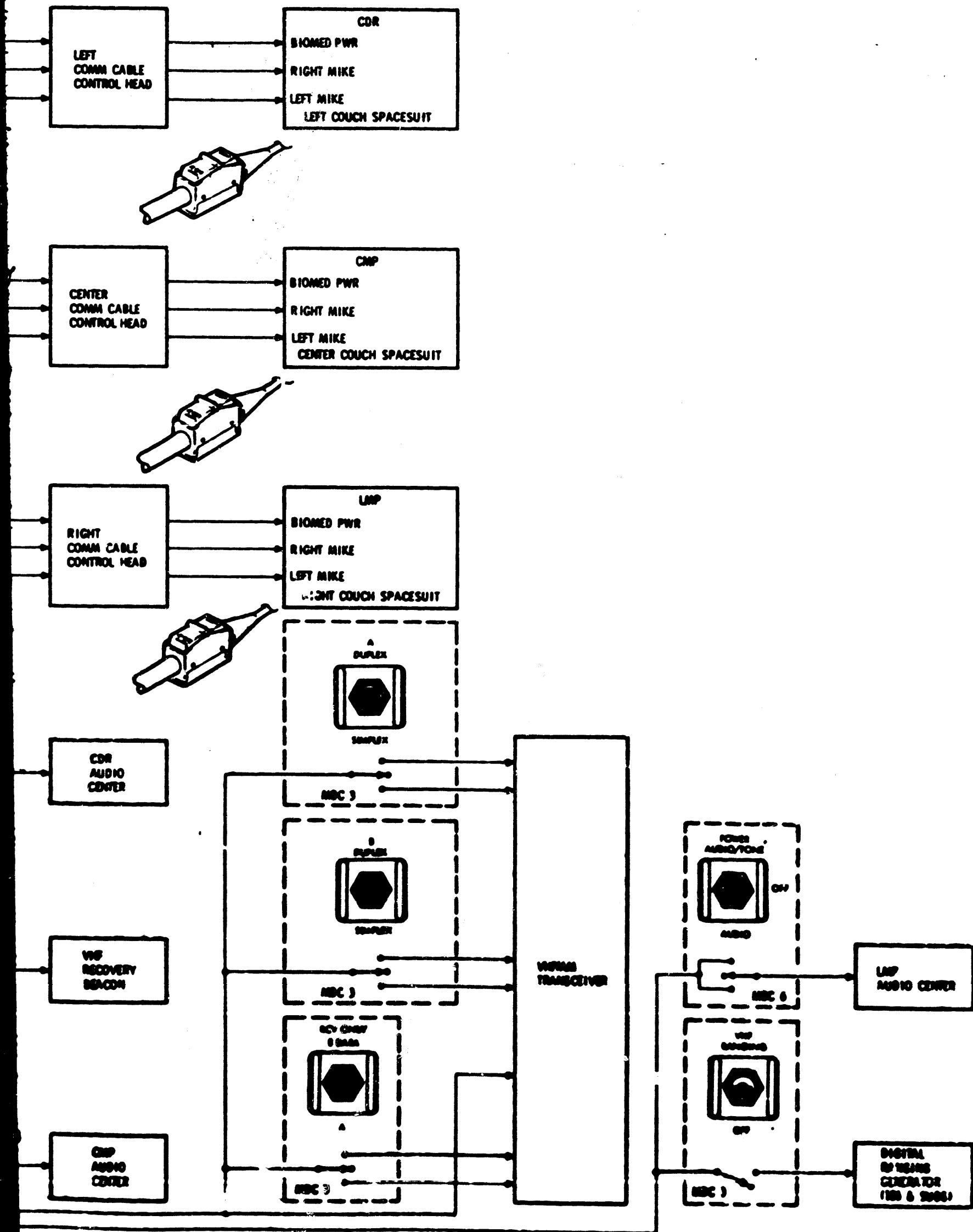


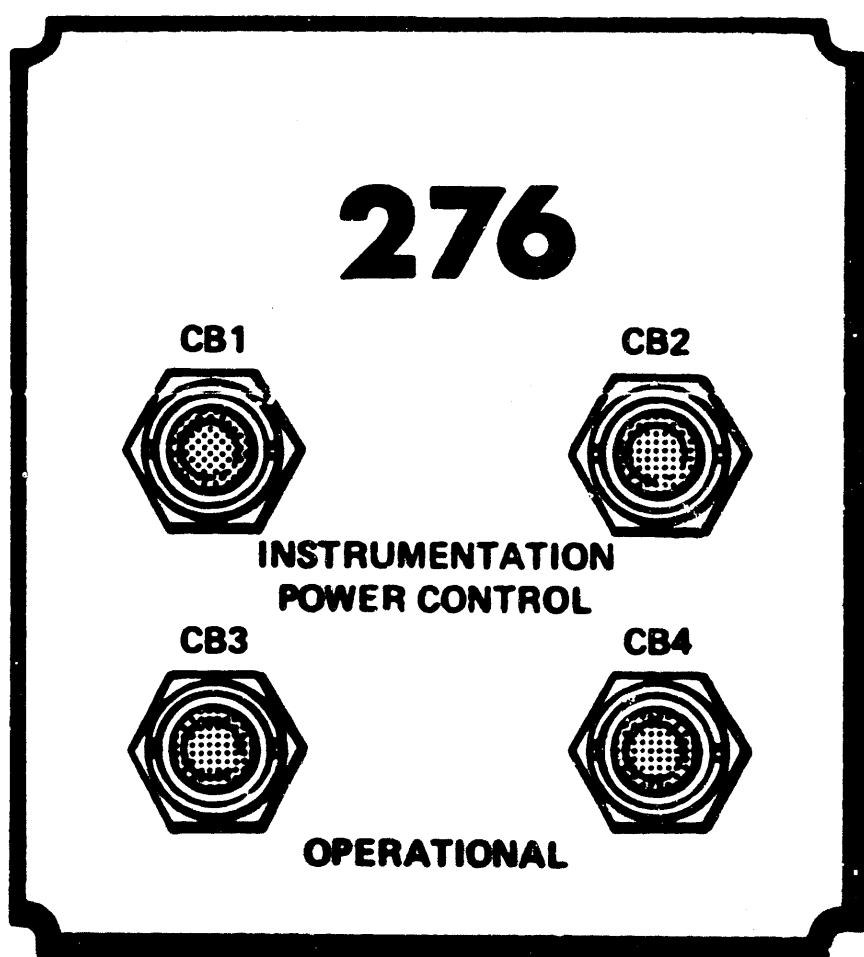






TELECOMM POWER DISTRIBUTION







PN-275-6

225

TELECOMMUNICATIONS

GROUP 1 PCM TLM GROUP 2



PMP POWER

PRIM FLT BUS AUX FLT BUS



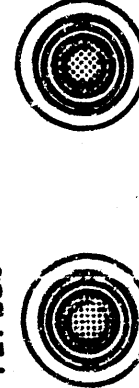
FLT BUS

MNA MNB



S BAND FM XMTR

DATA STORAGE EQUIP FLT BUS GROUP 1



VHF/CREW STATION AUDIO

L CTR R UD L FLT/POST LDG BUS FLT BUS



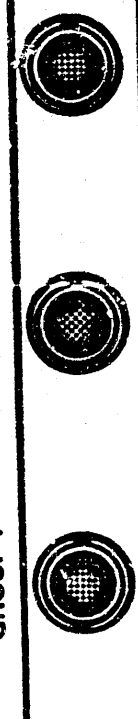
HIGH GAIN ANTENNA

GROUP 2



S BAND PWR AMPL / PHASE MOD XPDR

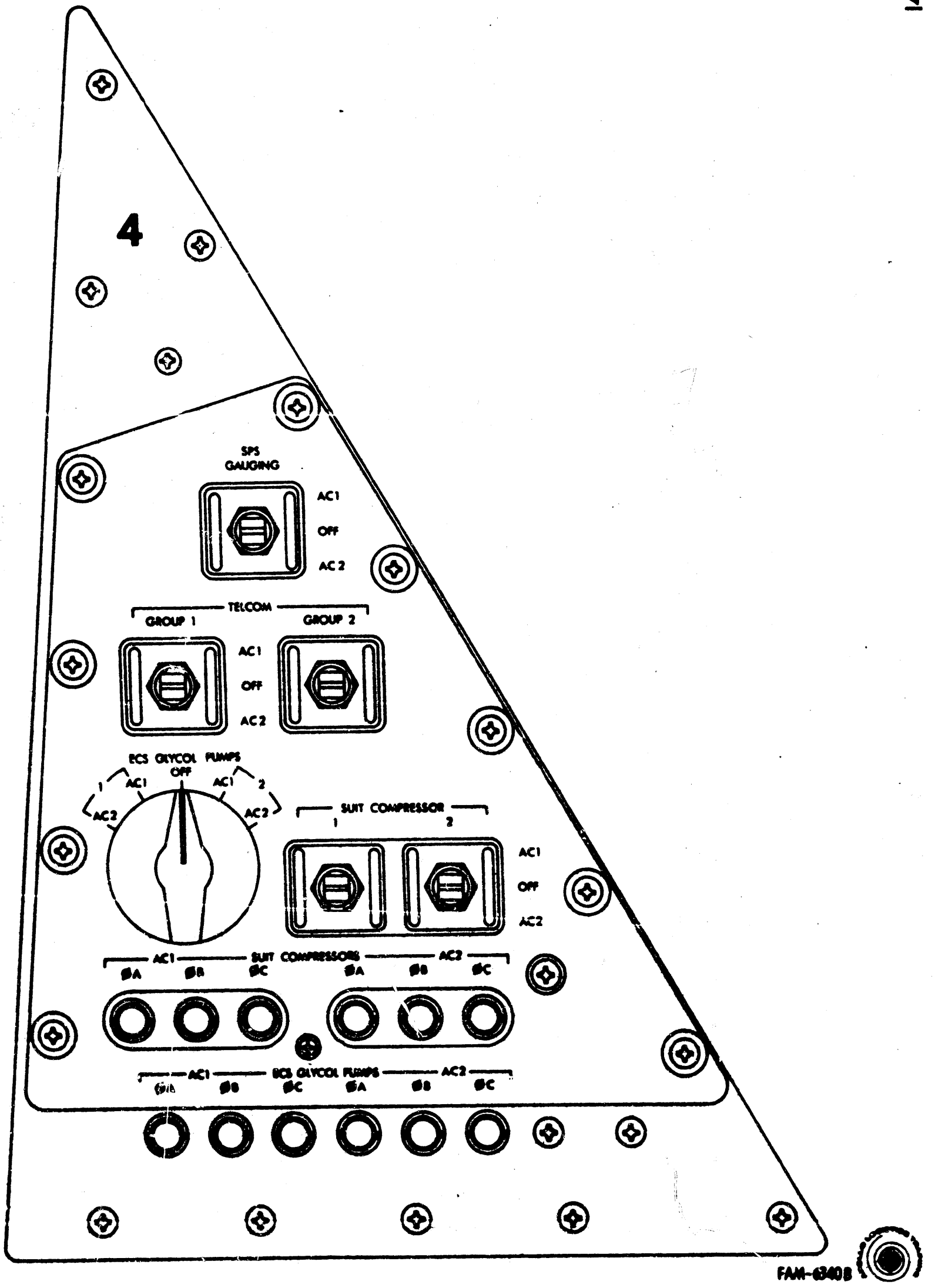
GROUP 1 GROUP 2



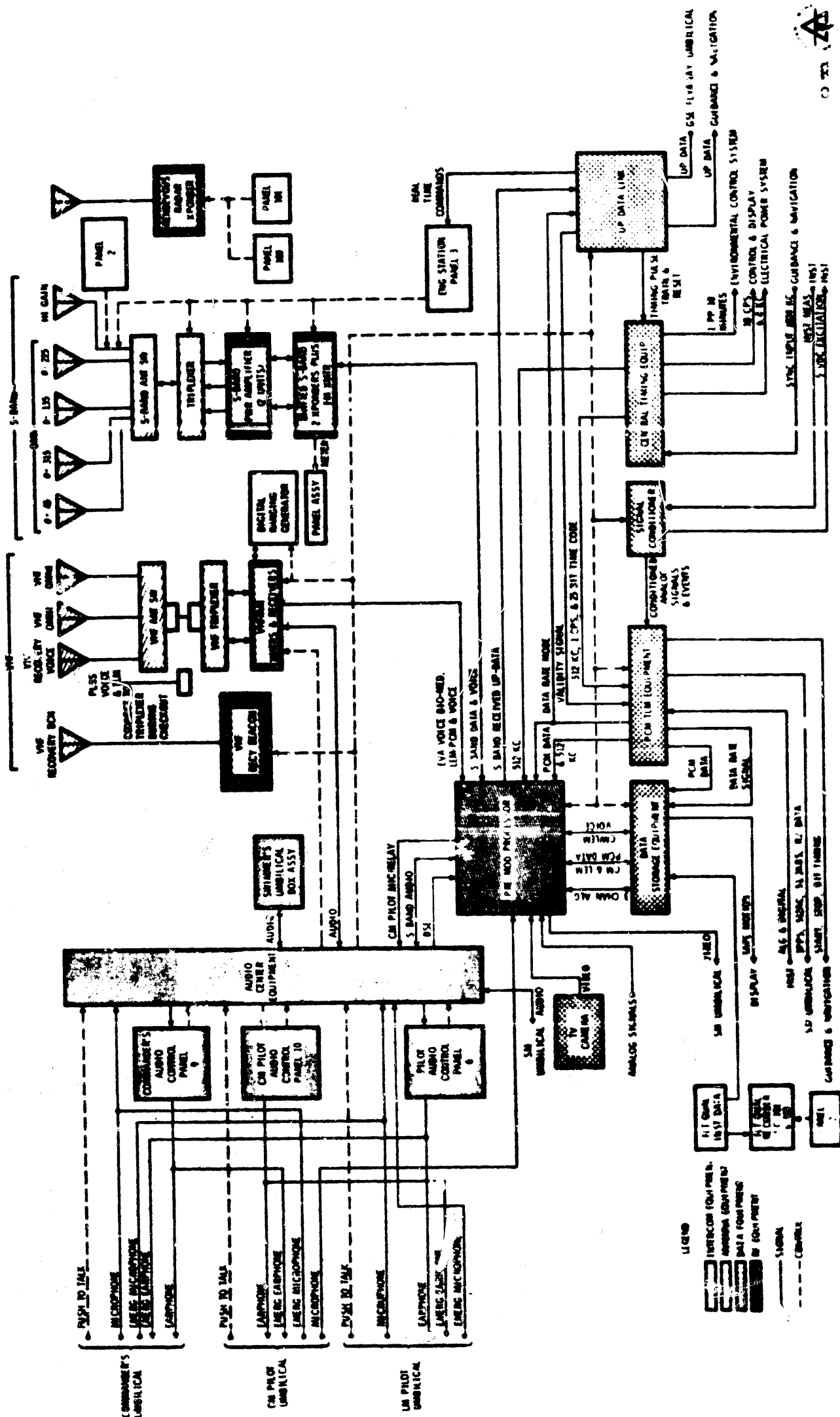
CENTRAL TIMING EQUIP

MNA MNB RNOZ XPDR SIG CONDR FLT BUS

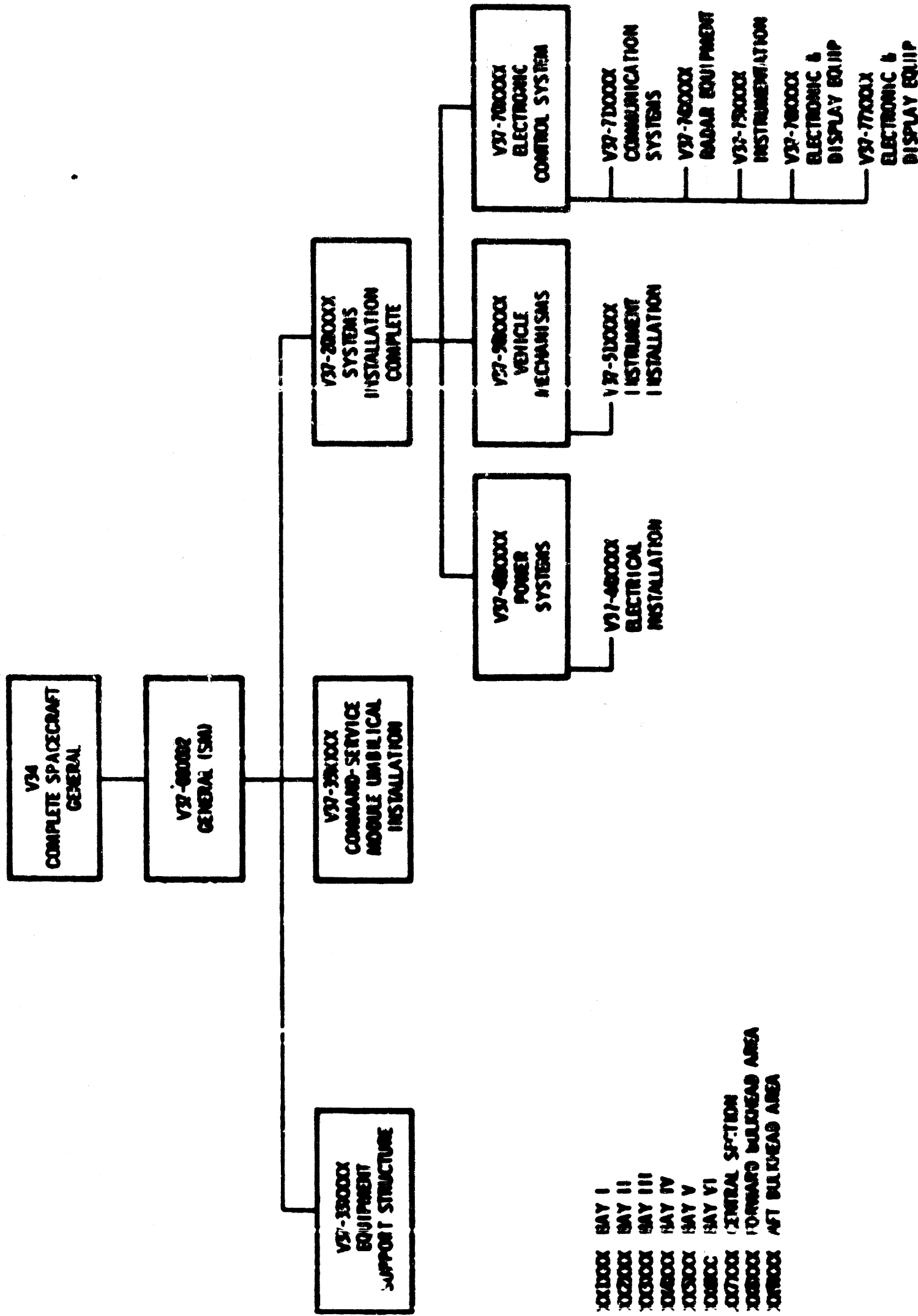




BLOCK II TELECOMMUNICATIONS SYSTEM



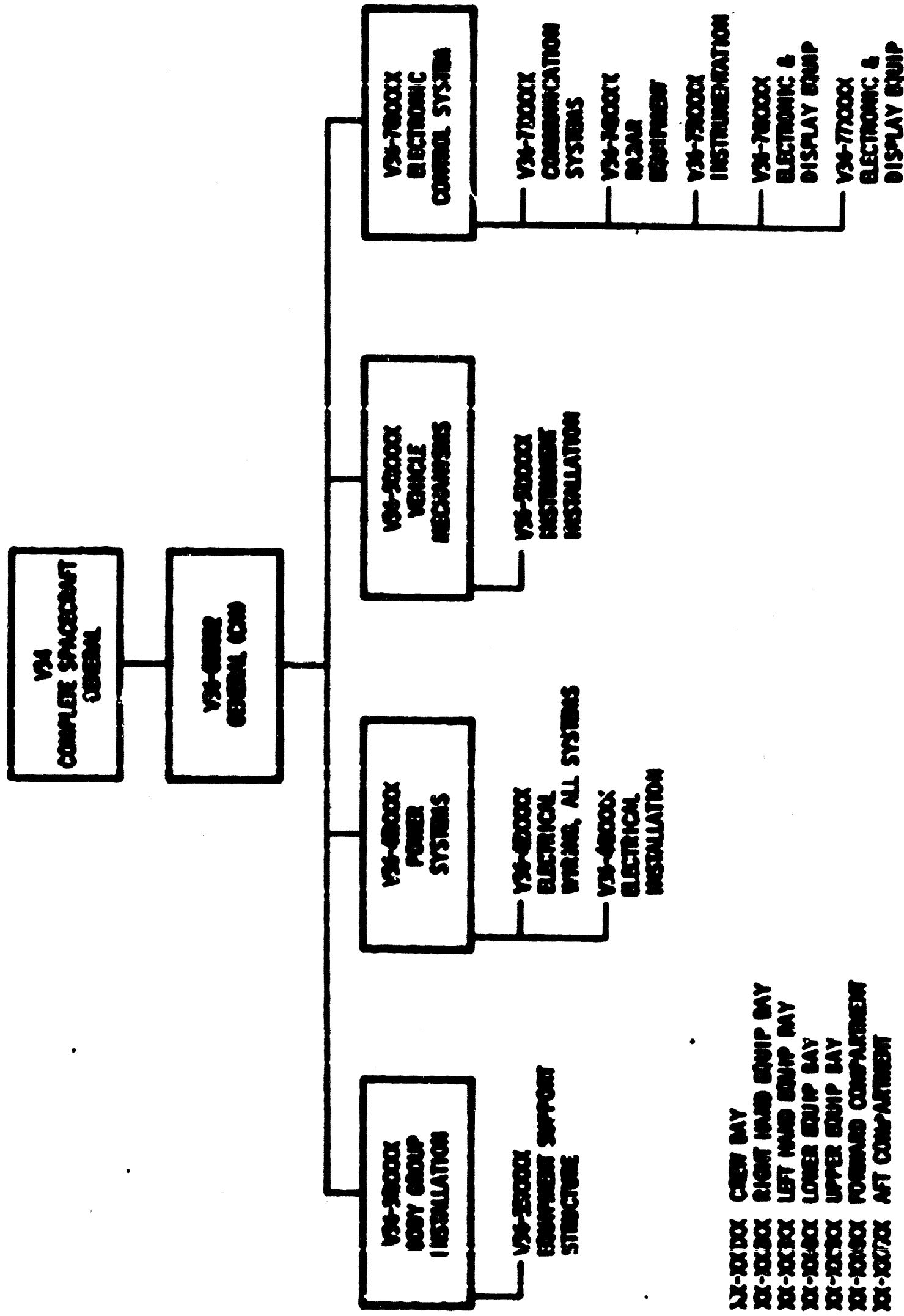
APOLLO SERVICE MODULE DRAWING SYSTEM (V37-) SERVICE MODULE TELECOMMUNICATIONS SYSTEM



X0100X BAY I
 X0200X BAY II
 X0300X BAY III
 X0400X BAY IV
 X0500X BAY V
 X0600X BAY VI
 X0700X CENTRAL SECTION
 X0800X FORWARD BULKHEAD AREA
 X0900X AFT BULKHEAD AREA



APOLLO COMMAND MODULE DRAWING SYSTEM (V36-) COMMAND MODULE TELECOMMUNICATIONS SYSTEM



XI-XI10X CREW BAY
 XI-XI20X RIGHT HAND EQUIP BAY
 XI-XI30X LEFT HAND EQUIP BAY
 XI-XI40X LOWER EQUIP BAY
 XI-XI50X UPPER EQUIP BAY
 XI-XI60X FORWARD COMPARTMENT
 XI-XI70X AFT COMPARTMENT

TELECOMMUNICATIONS SYSTEM

A-1

Abbreviations and Acronyms.

ac	- alternating current (noun)
a-c	- alternating current (adj)
ACE	- Automatic Checkout Equipment
ACP	- Audio Control Panel
AGC	- Apollo Guidance Equipment
AOC	- Automatic Gain Control
AGE	- Aerospace Ground Equipment
AIC	- Automatic Load Control
AM	- Amplitude Modulation
AMP	- Ampere or Amplifier
AMPL	- Amplifier
AMR	- Atlantic Missile Range
ANL	
ANLG or	- Analog
Auto	- Automatic
AVC	- Automatic Volume Control
BCD	- Binary Coded Decimal
BCN	- Beacon (Transmitter only; (no receiver)
Biomed	- Biomedical
bps	- bits per second
BU	- Backup
CI	- Communications Instrumentation
CCTV	- Closed Circuit Television
CLM	- Core Logic Module
CM	- Command Module
C/O	- Checkout
Coax	- Coaxial
COMM	- Communications
Compen	- Compensator
Cont	- Control or Continued
CPLR	- Coupler
CRC	- Collins Radio Company
CSM	- Command and Service Modules
CTE	- Central Timing Equipment
CW	- Continuous Wave
db	- decibel
dbm	- decibels with respect to one milliwatt
dbw	- decibels with respect to one watt
dc	- direct current (Noun)
d-c	- direct current (Adj)
Deg	- degree
DET	- Detector
DISCR	- Discriminator
DRI	- Data Rate Indicator
DRM	- Drafting Room Manual
DS	- Data Storage
DSE	- Data Storage Equipment
DSIP	- Deep Space Instrumentation Facility

EKC	- Emergency Key Communications
EMER	- emergency
EMI	- Electromagnetic Interference
EU	- electronic unit
EVA	- Extra Vehicular Activity
EVC	- Extra Vehicular Crewman
EVSTC	- Extra Vehicle Spacecraft Telemetry & Communications
f_c	- center frequency
FDT	- Full Duplex Teletype Circuit
FM	- Frequency Modulation
FOV	- Field of Vision
FQ	- Flight Qualification
f_s	- full scale
FSK	- Frequency Shift Keyed
FWD	- Forward
gc	- gigacycles
GFE	- Government Furnished Equipment
GMT	- Greenwich Mean Time
GNAV	- Guidance and Navigation Subsystem
GND	- Ground
GSE	- Ground Support Equipment
GSFC	- Goddard Space Flight Center
HF	- High Frequency
HGA	- High Gain Antenna
H1	- high
HSD	- High Speed Data
Hz	- Hertz (cycles per second)
IC	- Intercom
IF	- Intermediate Frequency
IFM	- In-Flight Maintenance
in.	- inch
IPS	- Instrumentation Power System
ips	- inches per second
IRIG	- Inter-Range Instrumentation Group
IRIG	- Inertial Rate Integrating Gyro
k	- kilo (1000)
kbs	- kilobits per sec
kHs	- kilohertz (kilocycle)
kmHs	- kilomegahertz (kilomegacycles)
LAD	- Los Angeles Division
lb	- pound(s)
LCC	- Launch Control Center
LEB	- Lower Equipment Bay
LEM	- Lunar Excursion Module
LF	- Low Frequency
LOS	- Line of Sight
LSB	- Lower Side Band
LSB	- Least Significant Bit
MAX.	- maximum
MCC	- Mission Control Center
MDC	- Main Display Console

MDP	- Main Display Panel
MED	- medium
MHz	- megaHertz
mi	- microphone
mil	- 1/1000 of a measure (e.g. milliradian)
min	- minimum
MOD	- Modulator
MSFN	- Manned Spacecraft Flight Network
mV	- millivolt
mW	- milliwatt
NAND	- negative AND (Norian)
nb	- narrow band
NEG	- negative
NLT	- not less than
nmi	- nautical miles
NMT	- no more than
NRZ	- non return to zero
NSIF	- Near Space Instrumentation Facility
OMNI	- omnidirectional
OSC	- oscillator
PA	- Power Amplifier
PAM	- Pulse Amplitude Modulation
PCM	- Pulse Code Modulation
PDM	- Pulse Duration Modulation
PEP	- Peak Envelope Power
pf	- picofarad
pf	- pulse frequency
PLEK	- playback
PLSS	- Portable Life Support System
PM	- Phase Modulation
PP	- Premodulation Processor
PR	- Pacific Missile Range
POT	- Potentiometer
p-p	- peak-to-peak
PPM	- Pulse Position Modulation
pps	- pulses per second
prf	- pulse repetition frequency
PRIN	- Primary
PRN	- Pseudo-Random Noise
PSK	- Phase Shift Keyed
PTT	- Push-to-Talk
PWR	- Power
R	- Range
RC	- Radio Command
RCDR	- Recorder
RCS	- Reaction Control Subsystem
RCV	- Receive
RCVR	- Receiver
R&D	- Research and Development
REC	- Receive
REG	- Regulated
RF	- Radio Frequency

RFI	- Radio Frequency Interference
RMS	- Root Mean Square
RNDZ	- Rendezvous
RNG	- Ranging
RTTV	- Real Time Television
RZ	- Return to Zero
S-Band	- 1550 to 4000 MHz
SC	- Signal Conditioning
SC	- Spacecraft
SCE	- Signal Conditioning Equipment
SCI	- Scientific
SCIN	- Combined Scimitar and Notch Antennas
sco	- subcarrier oscillator
SCS	- Stabilization and Control Subsystem; Spacesuit Com-
SEC	- Secondary
SENS	- Sensitivity
SEP	- Spacecraft Electronic Package
SIG	- Signal
SITE	- Spacecraft Instrumentation Test Equipment
CLA	- Spacecraft LEM Adapter
SM	- Service Module
S+N/N	-
SPCS	- Spacecraft Personal Communications System
SPDT	- Single Pole, Double Throw
SP3T	- Single Pole, Triple Throw
sps	- samples per second
SSB	- Single Sideband
STEY	- Standby
SYNC	- Synchronization
SW	- Switch
Temp	- Temperature
TLM	- Telemetry
T/M	- Telemeter
TR	- Transmit-Receive
TV	- Television
TWT	- Traveling Wave Tube
UDL	- Up-Data Link
UHF	- Ultra High Frequency (300 to 3000 MHz)
USEE	- Unified S-Band Equipment
uv	- microvolt
uw	- microwatt
V	- Voice
v	- volt
vac	- volts, alternating current
VCO	- Voltage-Controlled Oscillator
vdc	- volts, direct current
VGP	- Vehicle Ground Point
VHF	- Very High Frequency (30 to 300 MHz)
VHF/AM	- VHF/audio modulated
vol	- volume
VOX	- voice-operated relay
VSWR	- Voltage Standing Wave Ratio
W	- word

wpm	- words per minute
X-Band	- 7000 to 10,900 MHz
XCVR	- Transceiver
AFMR	- Transformer
XMIT	- Transmit
XMTR	- Transmitter
XPONDER	- Transponder
XSTR	- Transistor
XTAL	- Crystal

Definitions

Biphase modulation	- An RF modulation technique where PCM wave-form modulates a carrier or sub-carrier by switching its phase positively when the wave-form is positive, and negatively when the wave-form is zero or negative.
Closed Circuit Television	- A television system which does not include an RF link between the camera and monitor.
Coherent Transponder	- The phase of the transmitted signal has a definite, known relationship to the phase of the received signal.
Commulator	- As used herein, an electronic switch which converts a group of parallel signals, each on a separate parallel channel, to a serial train of signals on a single serial channel.
Decommulator	- As used herein, an electronic switch which converts a serial train of signals on a single serial channel to a group of parallel signals each on a separate parallel channel.
Near Earth	- Altitudes up to 8000 nautical miles.
Operational Instrumentation	- Instrumentation used to obtain information for assessment of crew status, spacecraft performance, and environmental conditions.
Predetection Recorder	- Magnetic tape recorder which records the received signal at the receiver IF output before demodulation.

Pseudo-Random Noise Ranging	- A JPL-developed technique of determining range of the spacecraft from a DSIF station utilizing pseudo-random noise modulation.
R&D Instrumentation	- Instrumentation used for the development and qualification of the spacecraft and its systems.
Real Time TV Transmission	- TV information is transmitted as it is obtained with no appreciable delay; as opposed to tape-stored or slow scan techniques.
Scientific Instrumentation	- Instrumentation used for scientific observation, measurement or experimentation not related to spacecraft system operation.
Signal Conditioner	- Circuitry required to change the form of the electrical signal furnished by the sensor or data source to a form suitable for use by the telemetry coder.
Slant Range	- Range directly to the object.
Television Frame Transceiver Transponder	- A single complete TV picture. - Transmitter and receiver combination. - Transmitter and receiver: transmits reply to proper received signal or transmitter output is some function of the received signal.
Triplexer	- Frequency-shares a single antenna by three or more units of equipment.
Video Signal	- Television signal containing picture information before coding or modulation; may or may not contain sweep synchronization information.