

MASSACHUSETTS INSTITUTE OF TECHNOLOGY

APOLLO

GUIDANCE AND NAVIGATION

APOLLO BLOCK II
COMMAND MODULE AND LEM
GUIDANCE NAVIGATION AND
CONTROL SYSTEM

MECHANIZATION AND
BLOCK DIAGRAMS

G. Libon

November 1965

MIT

CAMBRIDGE 39, MASSACHUSETTS

**INSTRUMENTATION
LABORATORY**

MASSACHUSETTS INSTITUTE OF TECHNOLOGY

Geo. Silver
127-146

APOLLO

GUIDANCE AND NAVIGATION

APOLLO BLOCK II
COMMAND MODULE AND LEM
GUIDANCE NAVIGATION AND
CONTROL SYSTEM

MECHANIZATION AND
BLOCK DIAGRAMS

G. Silver

November 1965

MIT

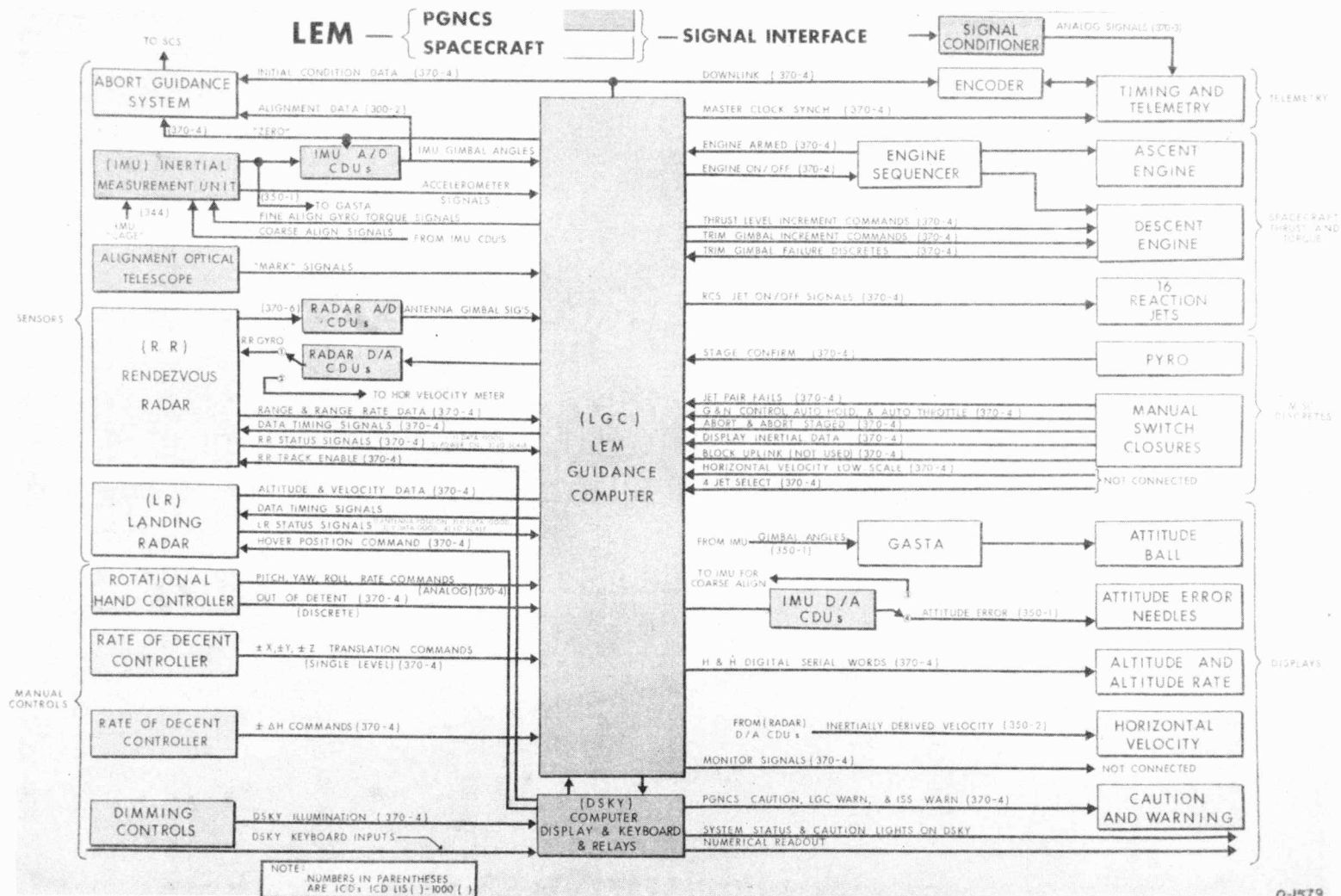
**INSTRUMENTATION
LABORATORY**

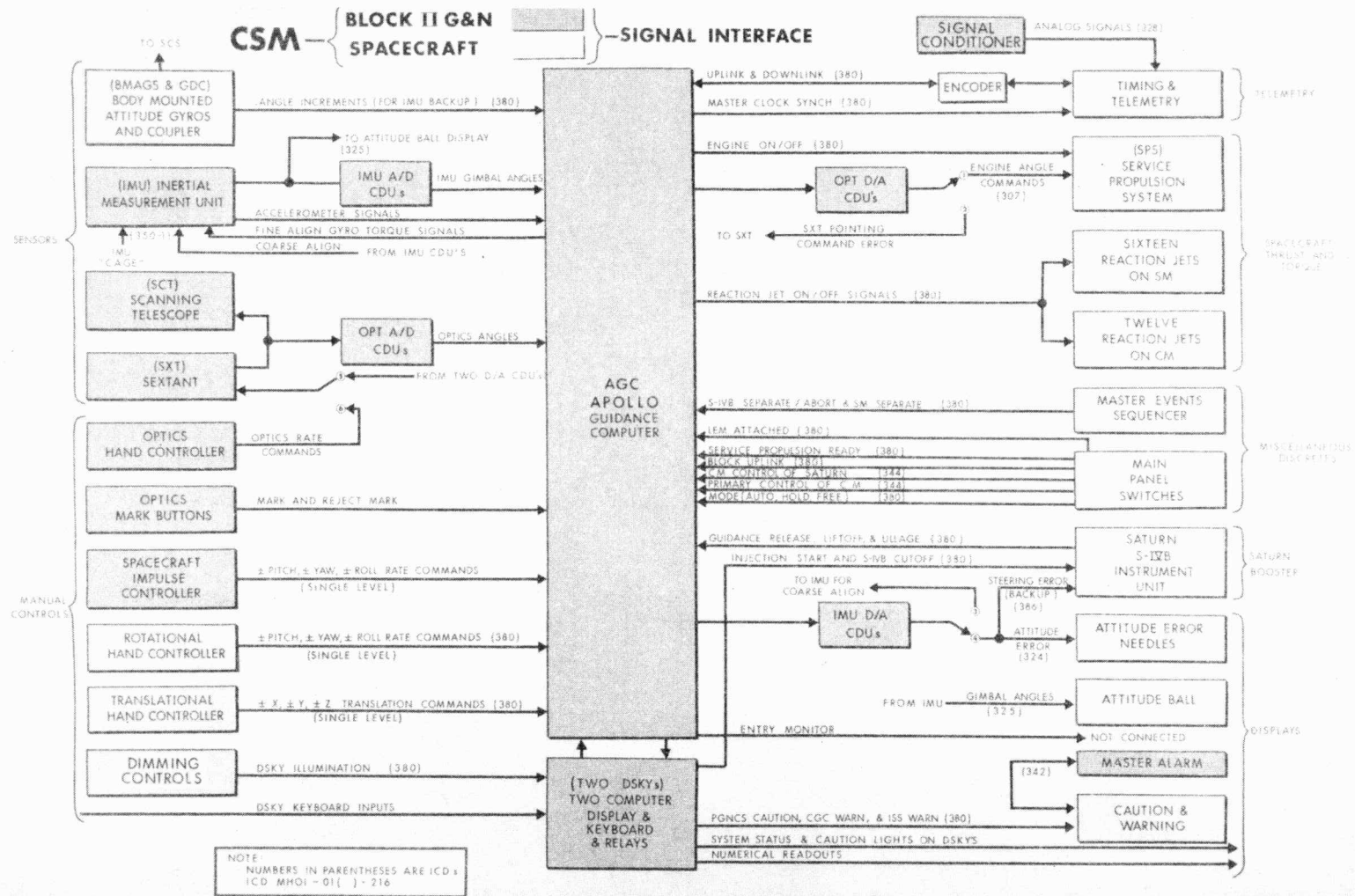
CAMBRIDGE 39, MASSACHUSETTS

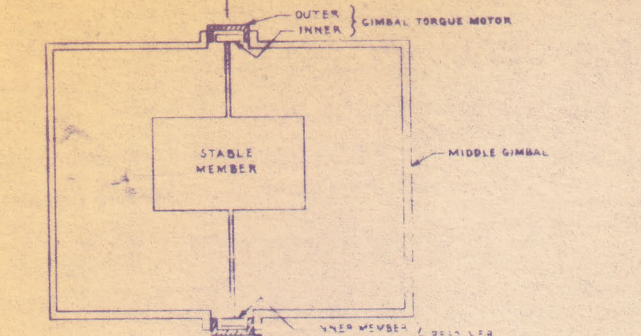
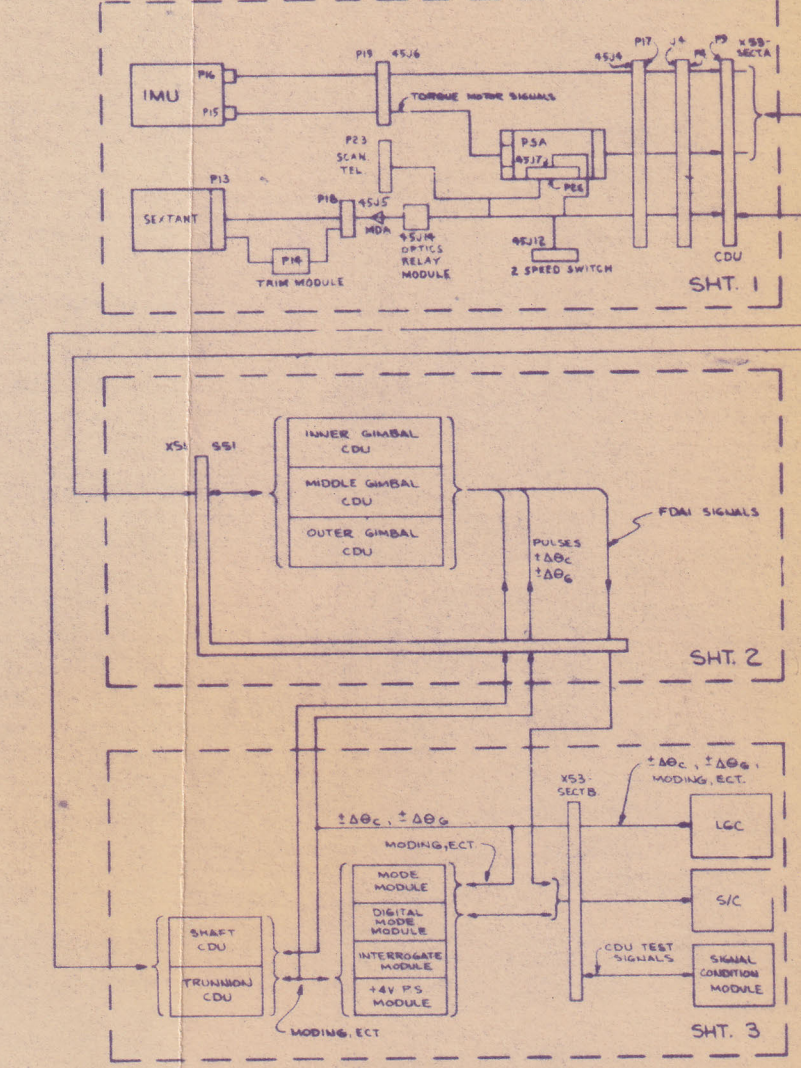
COPY # _____

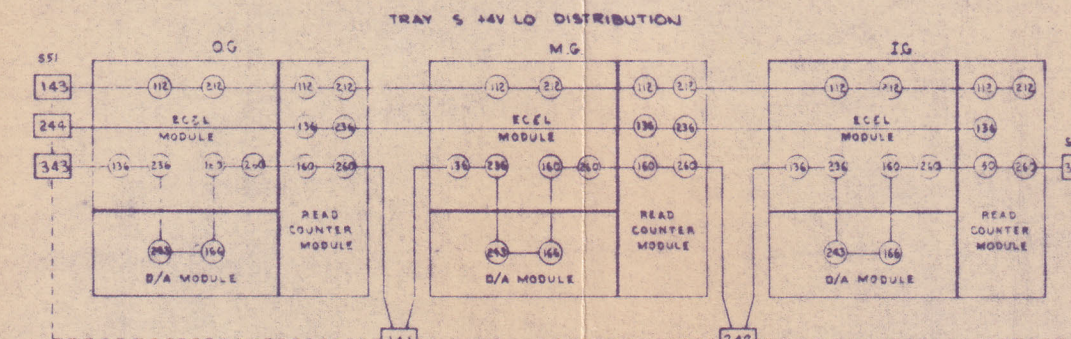
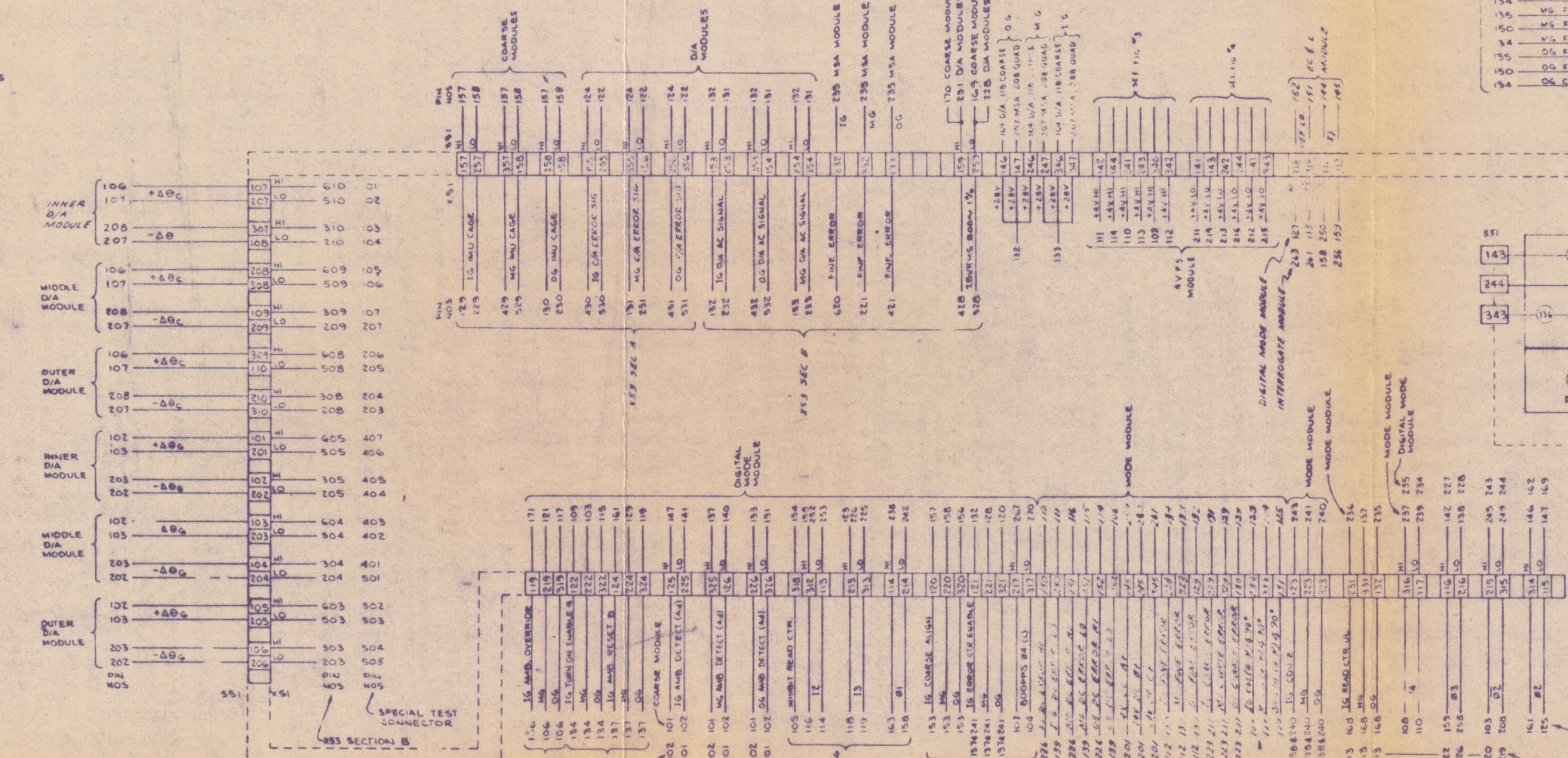
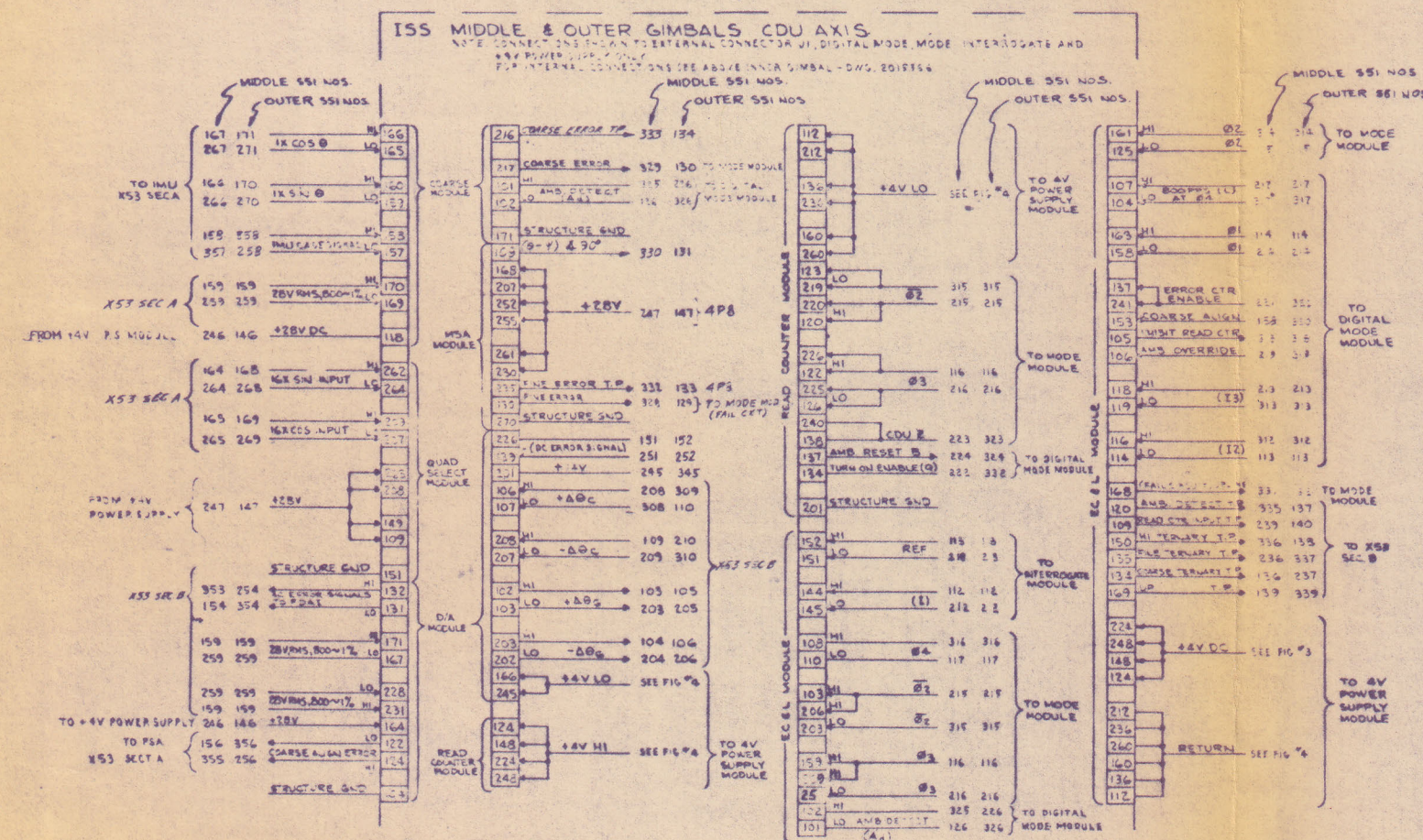
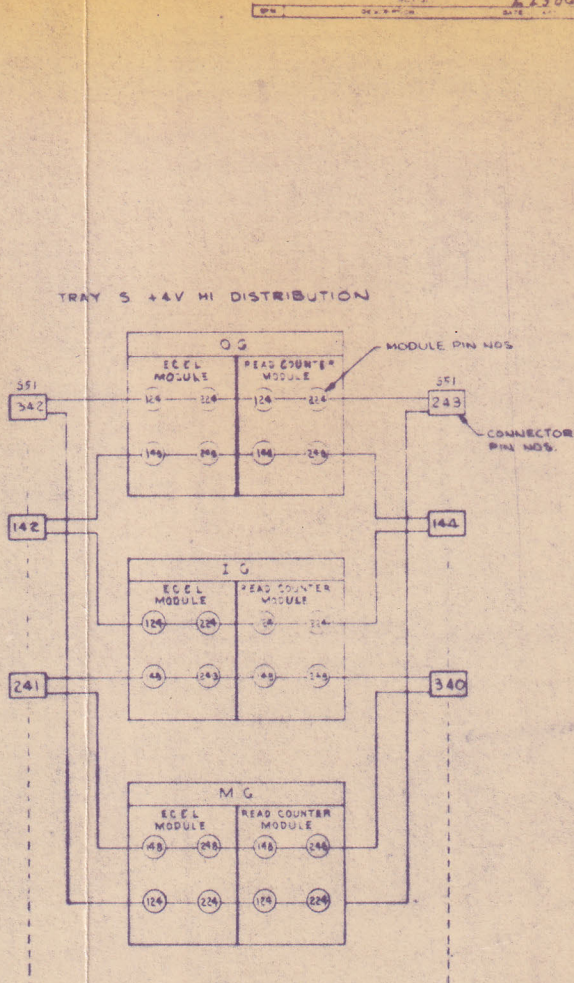
APOLLO BLOCK II COMMAND MODULE
AND LEM
GUIDANCE NAVIGATION AND CONTROL SYSTEM
MECHANIZATION AND BLOCK DIAGRAMS

<u>Drawing Number</u>	<u>Title</u>	<u>Number of Sheets</u>
	CSM Block II G&N/Spacecraft Signal Interface	1
	LEM PGNCS/Spacecraft Signal Interface	1
2015562	CSM 5-Axis Moding	3
2015563	Two Wire Mechanization of Apollo PIPA Loops	1
2015564	Two Wire Mechanization of Apollo Stabilization Loops	1
2015568	IMU CDU One Line Mech Block II	1
2015500	Functional Diagram Optics Subsystem Block II	1
	Apollo Block II Optics 2 Wire Mech	1
2015567	Optics Trunnion & Shaft CDU Block Diagram Block II (2 Line Mech)	3
	+28Y DC Standby Power Distribution Block II C/M	1
	+28V DC IMU Operate Distribution Block II C/M	1
	OVDC IMU Distribution Block II C/M	1
	800~ 1% & 5% IMU Power Distribution Block II CSM	1
	Pulse Torque Power Supply Output Distribution Block II C/M	1
	28V DC Optics Operate Distribution Block II C/M	1
	OVDC Optics Distribution Block II C/M	1
	+28V 800~ 1% & 5% Optics Power Distribution Block II C/M	1
6015562	LEM 5-Axis Moding	3
6015564	Two Wire Mechanization of Apollo Stabilization Loops (LEM)	1
6015563	Two Wire Mechanization of Apollo PIPA Loops (LEM)	1
2015566	IMU-Rend. Radar CDU Block Diagram Block II (2 Line Mech)	2
	LEM +28V DC IMU Operate Distr.	1
	LEM OV DC Distribution	1
	LEM +28V 800~ Power Distr.	1





[illegible][illegible]



FLOW DIAGRAM ON SHEET 1 OUTLINES
COMPONENT LOCATION & SIGNAL FLOW ON
EACH SHEET OF THIS DRAWING.

		USE OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES		SITE INSTRUMENTATION LAB CONSTRUCTION AREA		MANNED SPACECRAFT CENTER NEWTON MASS	
		TOLERANCES ON DIMENSIONS DECIMALS INCHES		DRAWN BY <u>KLS</u> DATE <u>12/2/82</u> CHECKED APPROVAL <u>[Signature]</u> APPROVAL <u>[Signature]</u>		CSM 5 AXIS MOUNTING	
		DO NOT SCALE THIS DRAWING MATERIAL		MADE APPROXIMATE N354 P2 NOT APPROVAL <u>[Signature]</u>		CODE IDENT NO SIZE 2015562 1 1/2" x 11"	
NEXT ASSY USED ON		FINAL FINISH				Make Drawing No 2015562	
APPLICATION						SHEET 2	

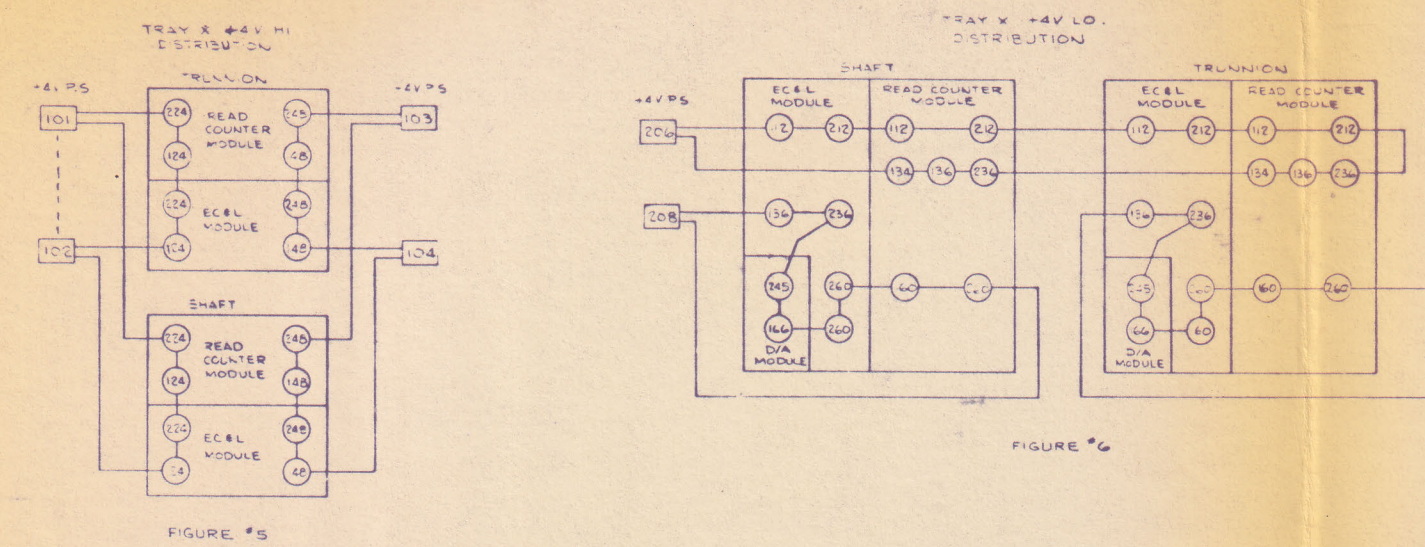


FIGURE 5

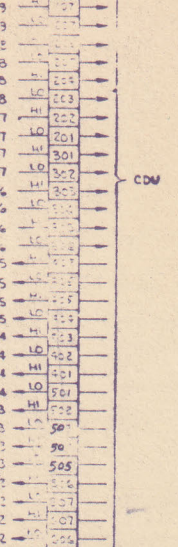


FIGURE 6

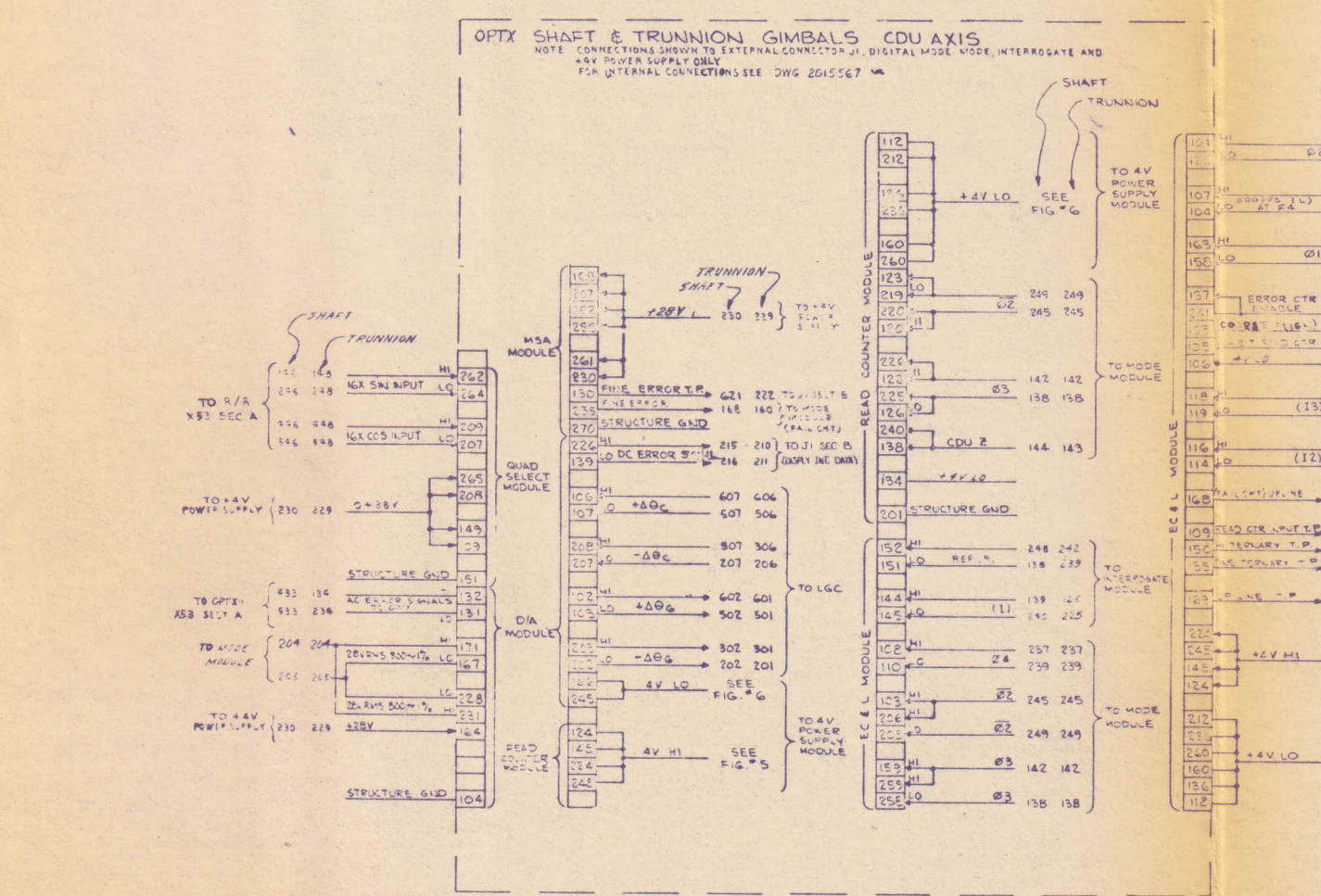


FIGURE 7



FIGURE 8

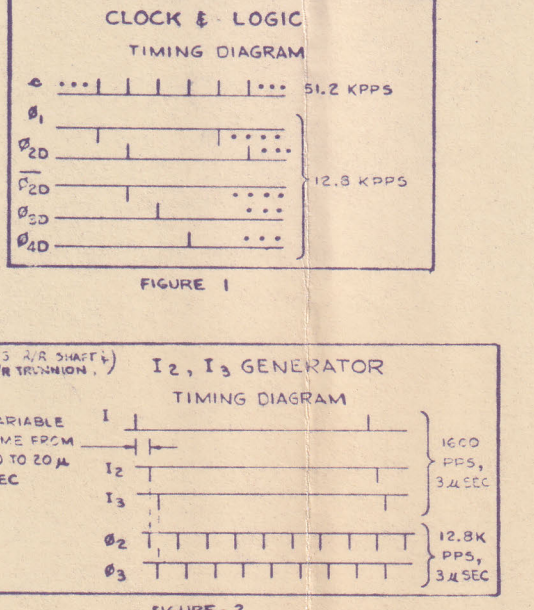


FIGURE 1

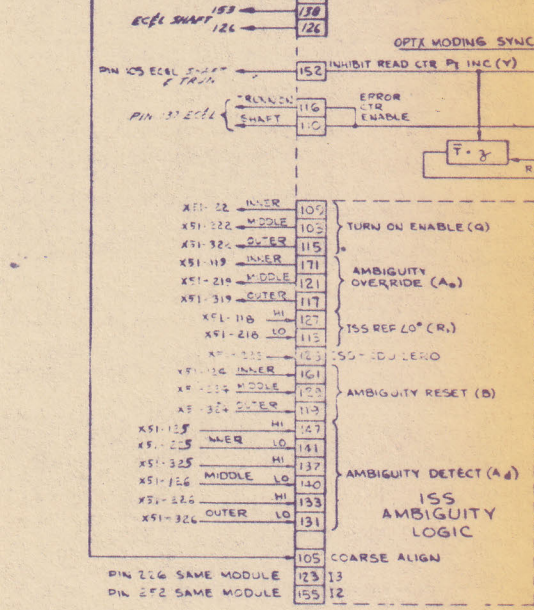


FIGURE 2

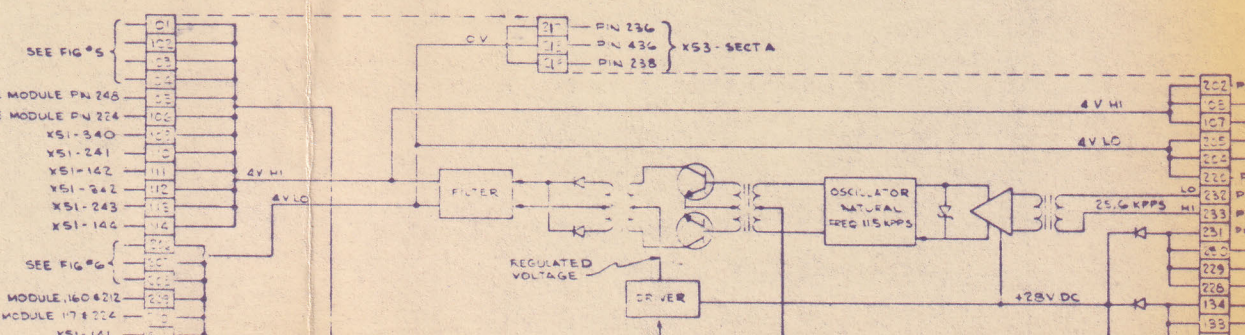


FIGURE 3

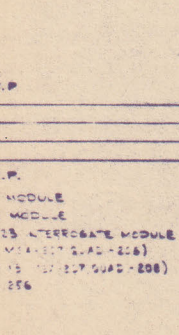


FIGURE 4

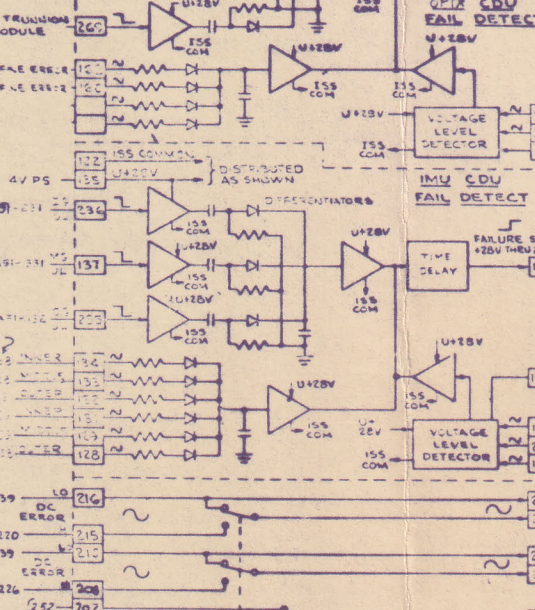


FIGURE 5

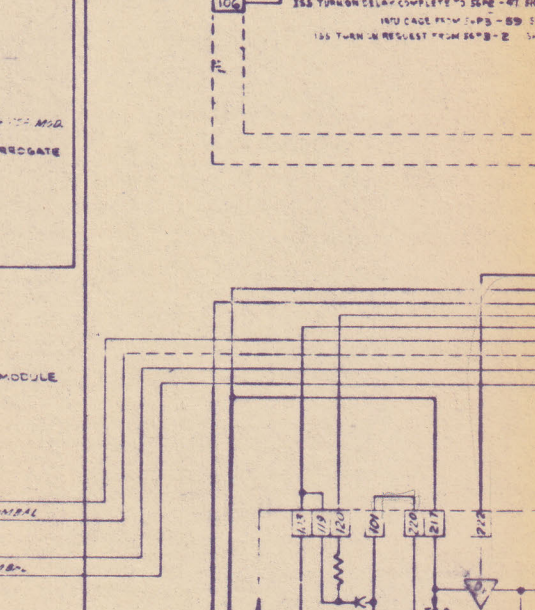


FIGURE 6

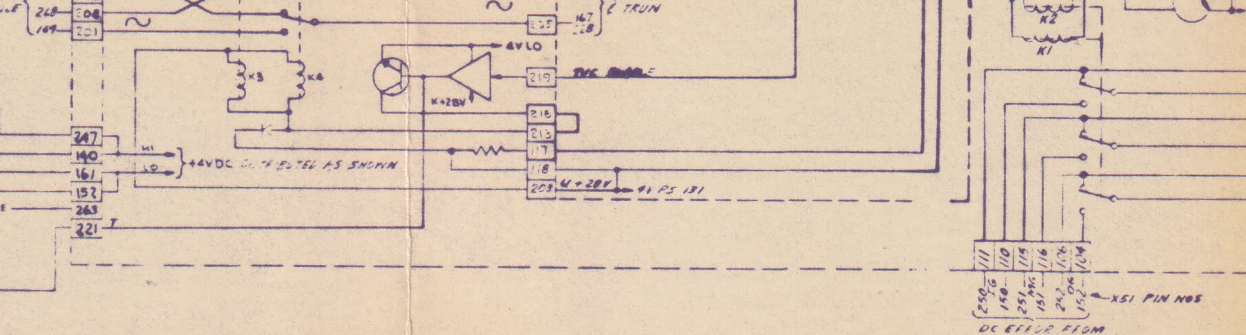


FIGURE 7

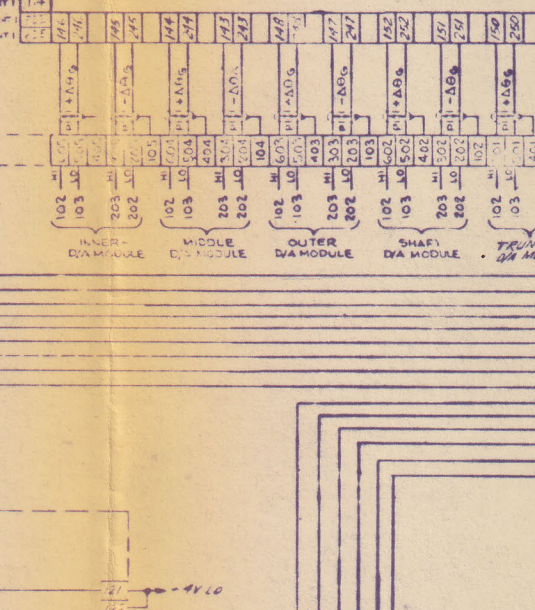


FIGURE 8

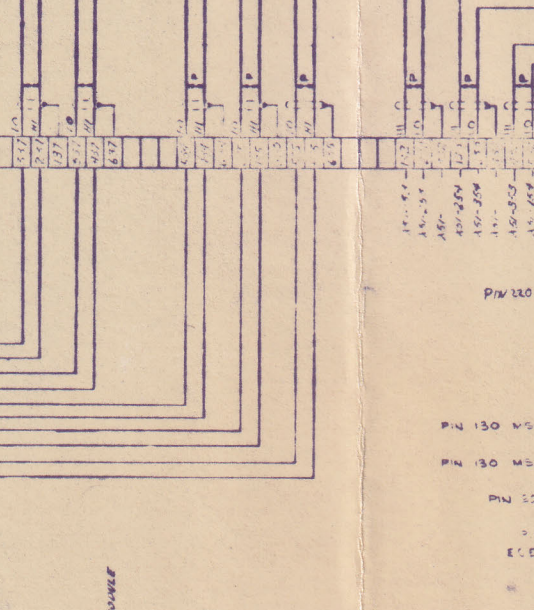


FIGURE 9

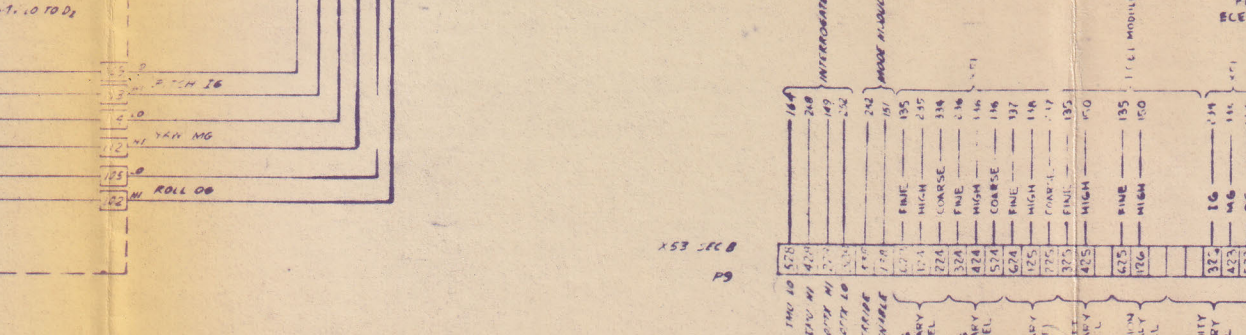


FIGURE 10

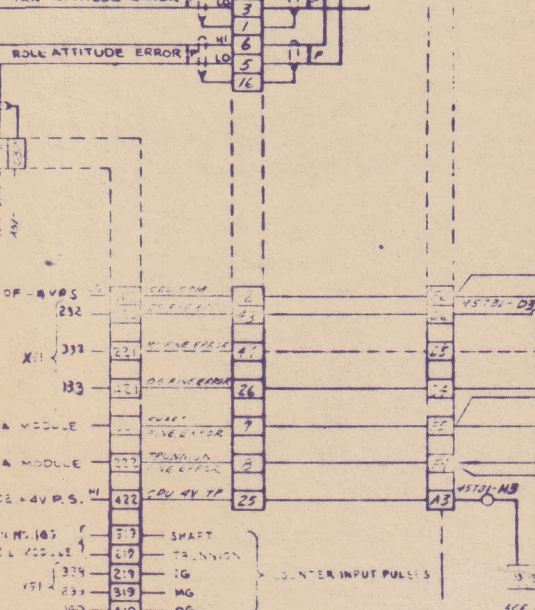


FIGURE 11

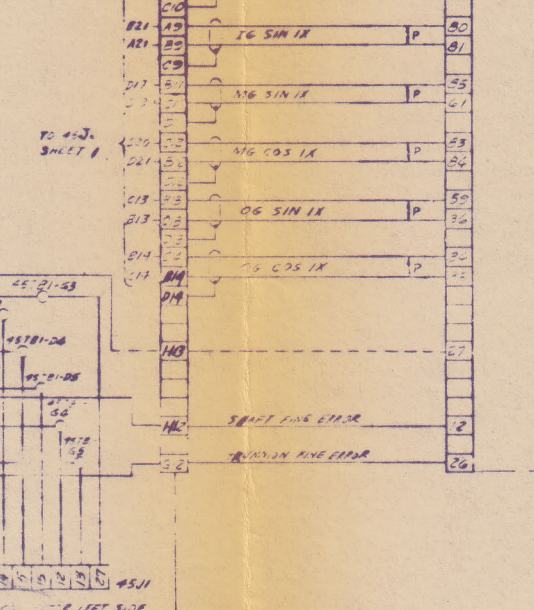


FIGURE 12

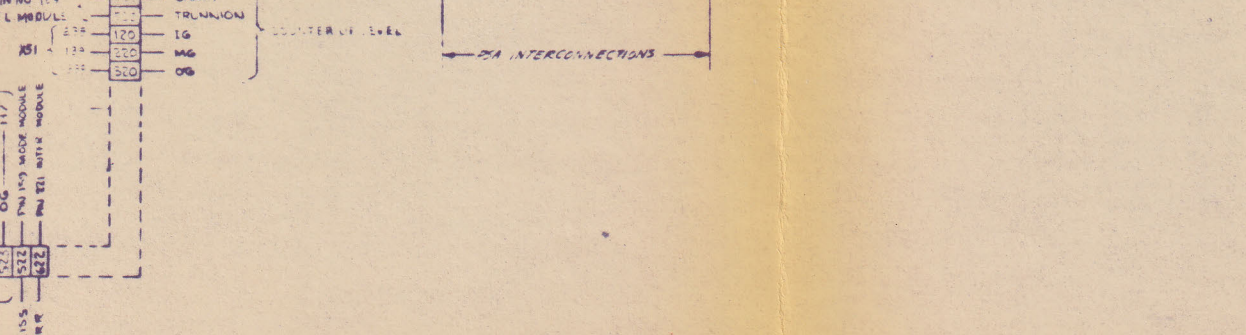


FIGURE 13

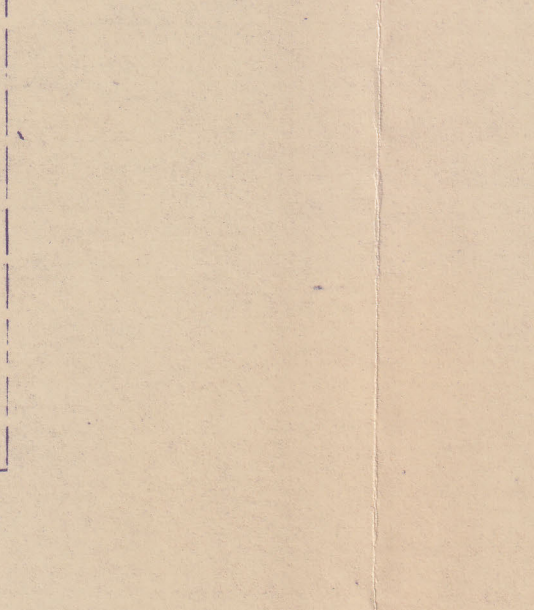


FIGURE 14

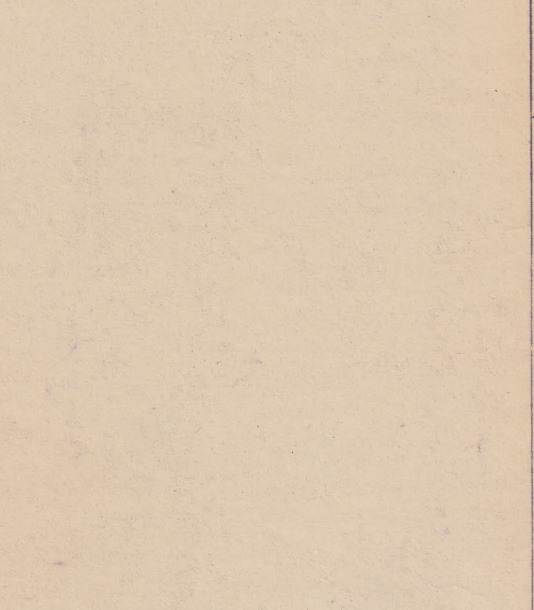
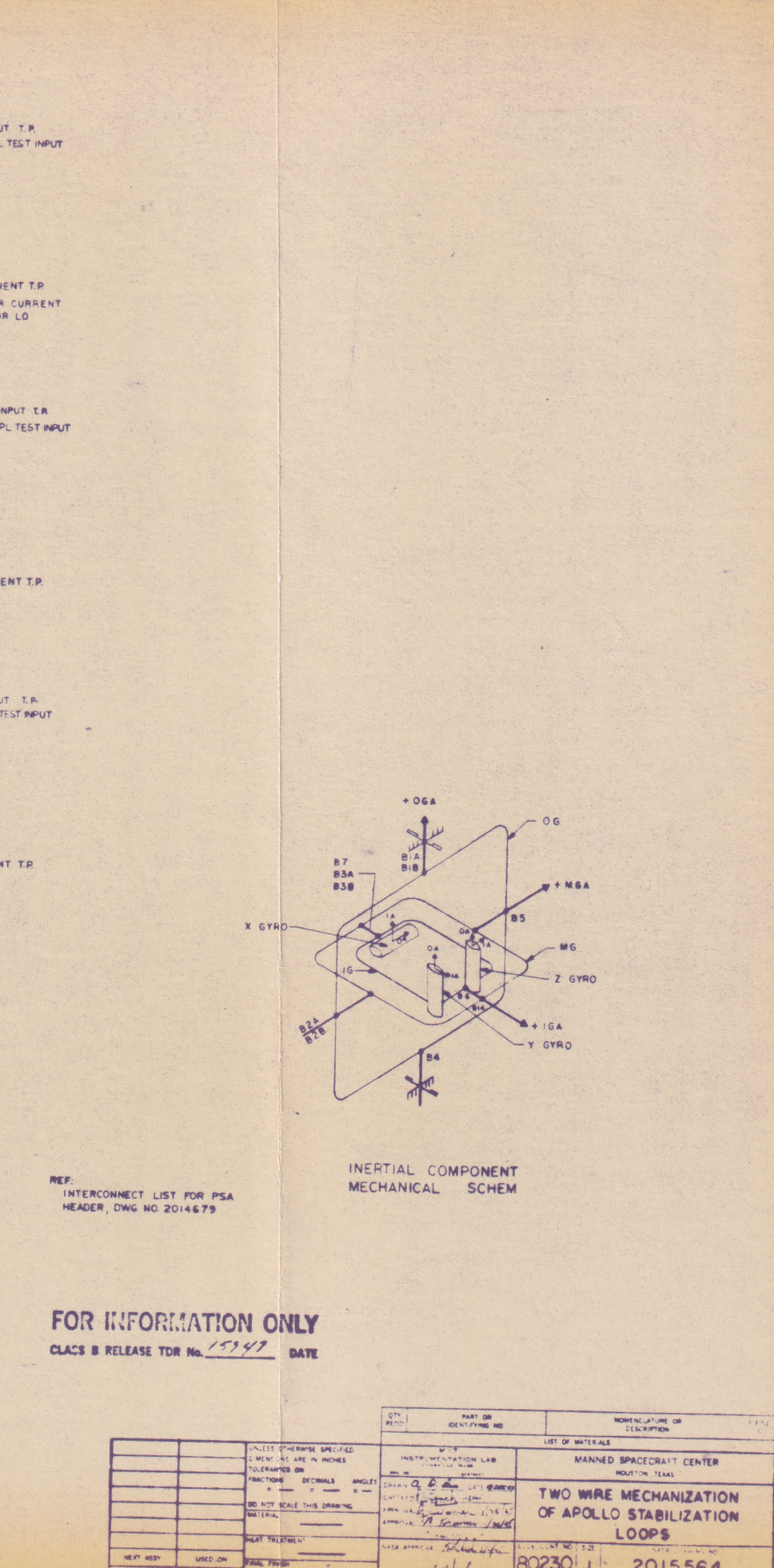
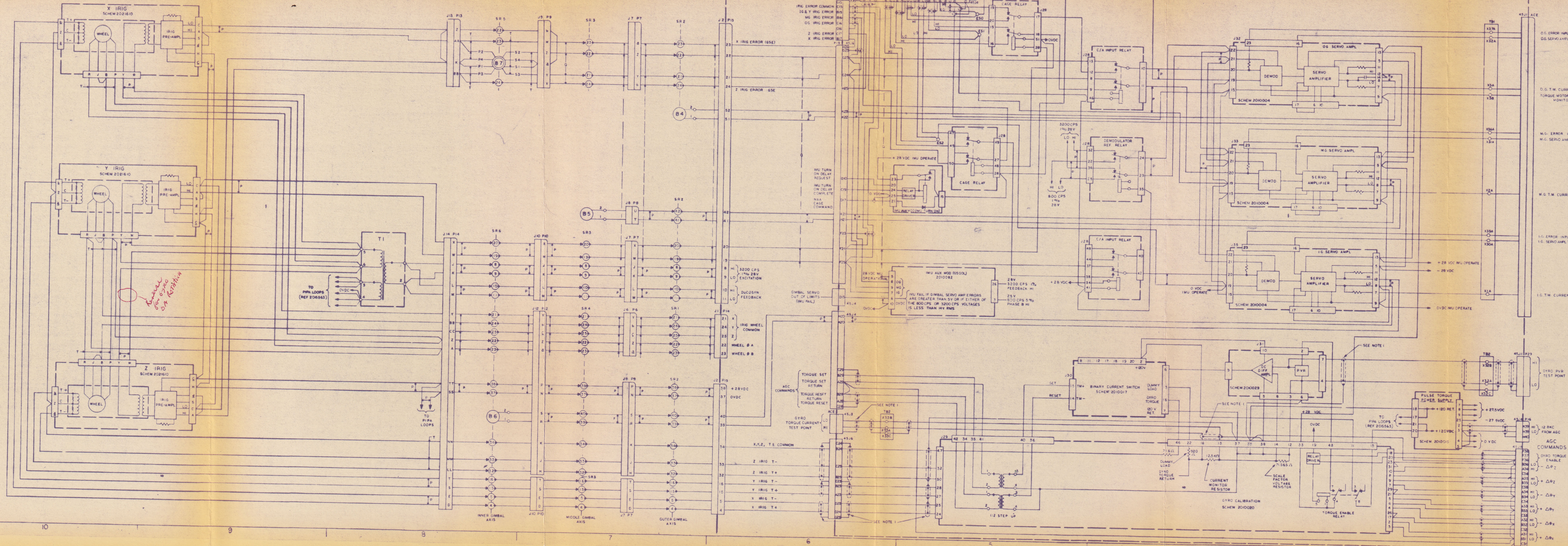


FIGURE 15



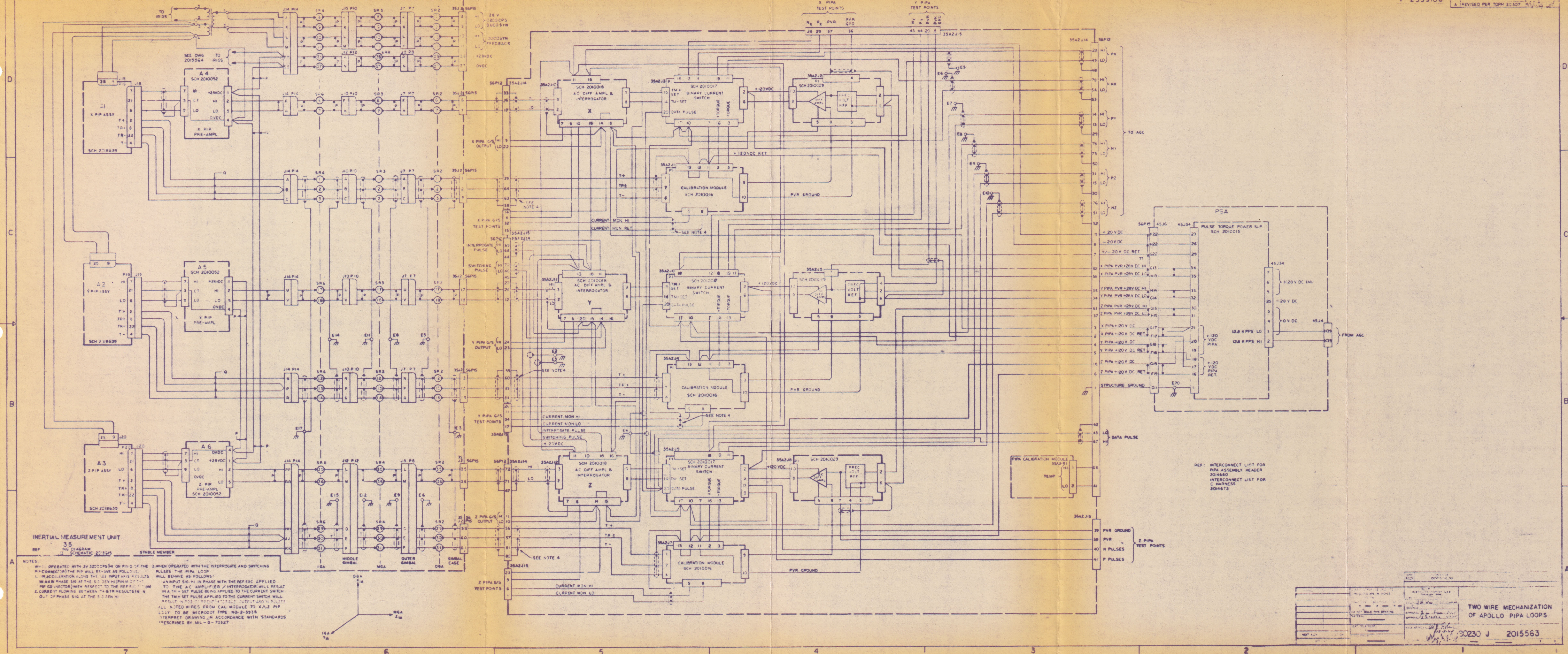
FIGURE 16

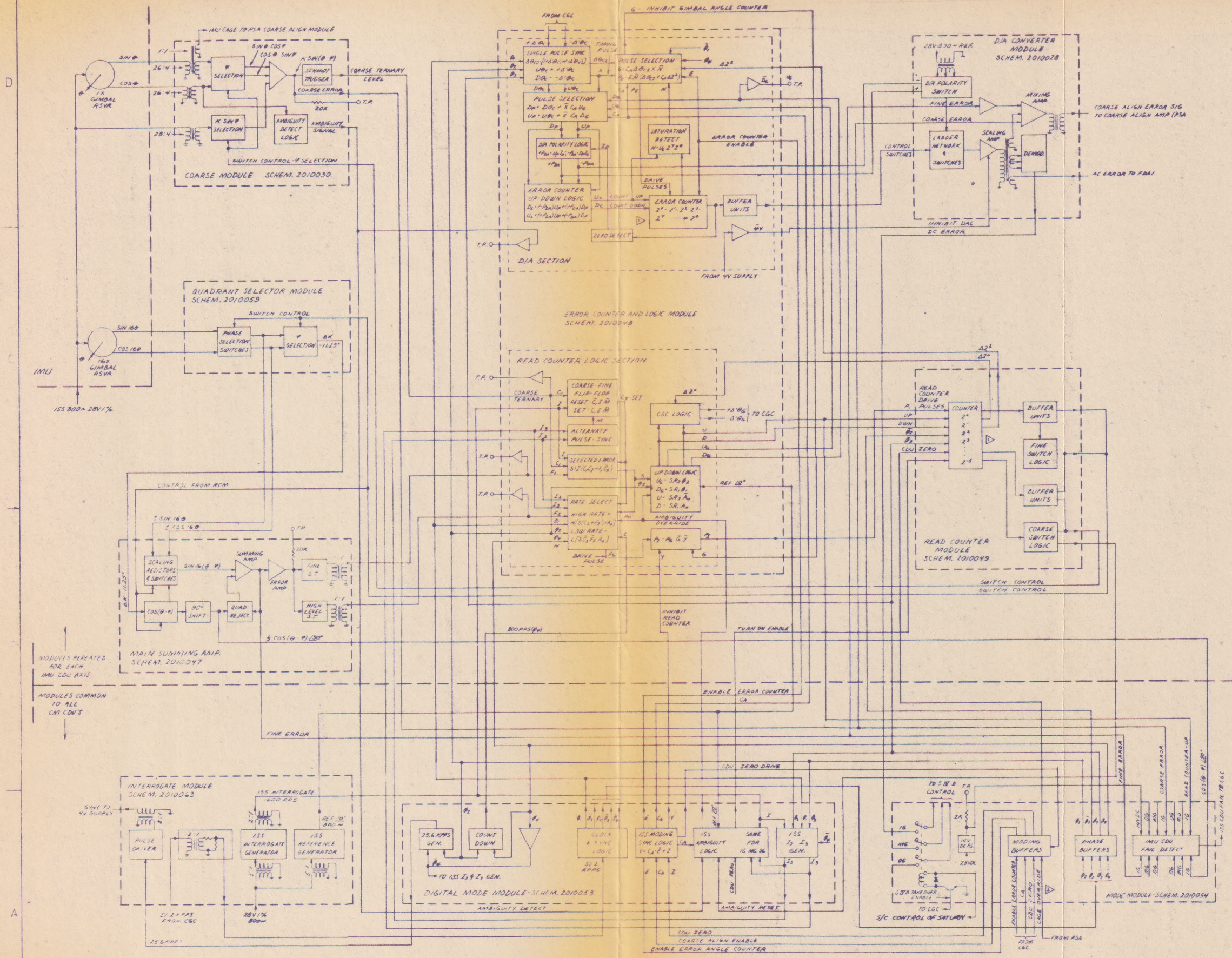


FOR INFORMATION ONLY
CLASS B RELEASE TDR No. 17147 DATE

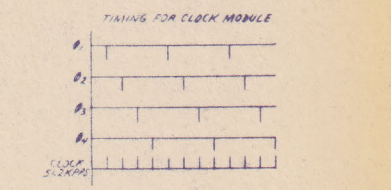
REV	DATE	DESCRIPTION	BY	CHKD
1	10/1/68	INITIAL ISSUE	J. E. HARRIS	J. E. HARRIS
2	10/1/68	REVISION	J. E. HARRIS	J. E. HARRIS
3	10/1/68	REVISION	J. E. HARRIS	J. E. HARRIS
4	10/1/68	REVISION	J. E. HARRIS	J. E. HARRIS
5	10/1/68	REVISION	J. E. HARRIS	J. E. HARRIS
6	10/1/68	REVISION	J. E. HARRIS	J. E. HARRIS
7	10/1/68	REVISION	J. E. HARRIS	J. E. HARRIS
8	10/1/68	REVISION	J. E. HARRIS	J. E. HARRIS
9	10/1/68	REVISION	J. E. HARRIS	J. E. HARRIS
10	10/1/68	REVISION	J. E. HARRIS	J. E. HARRIS

201564 J-1
201564



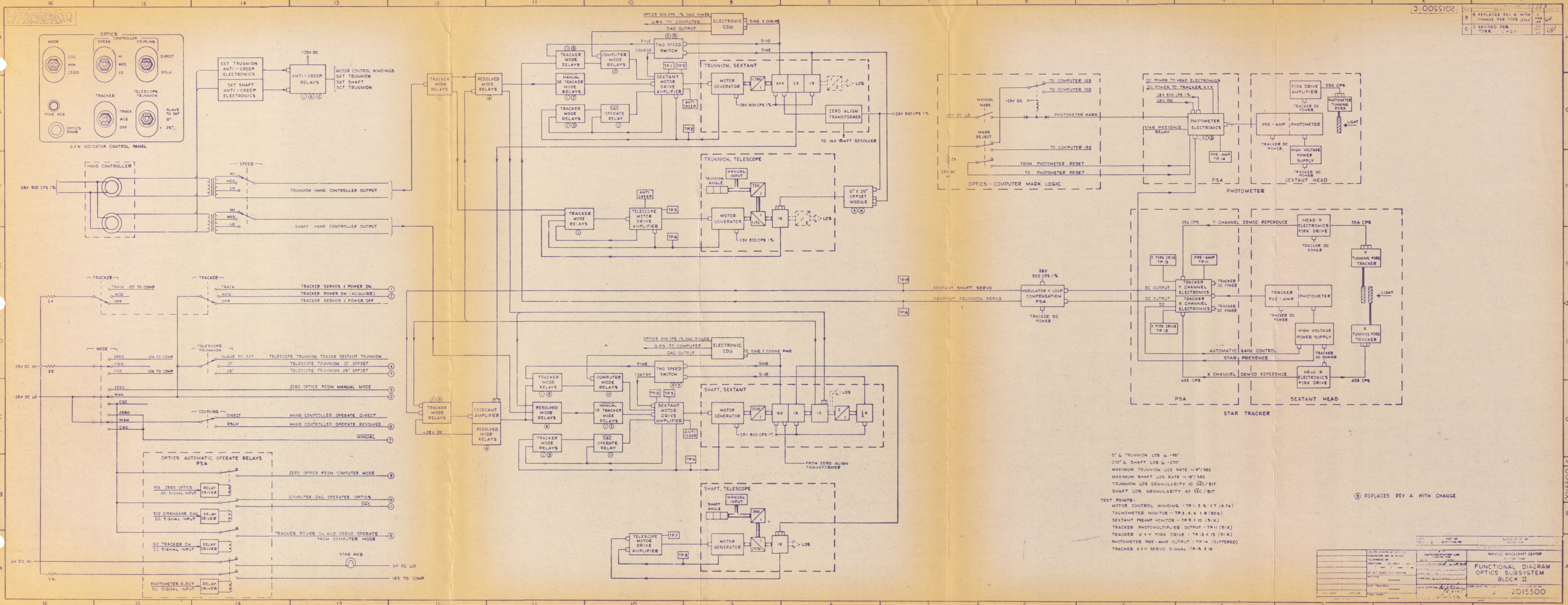


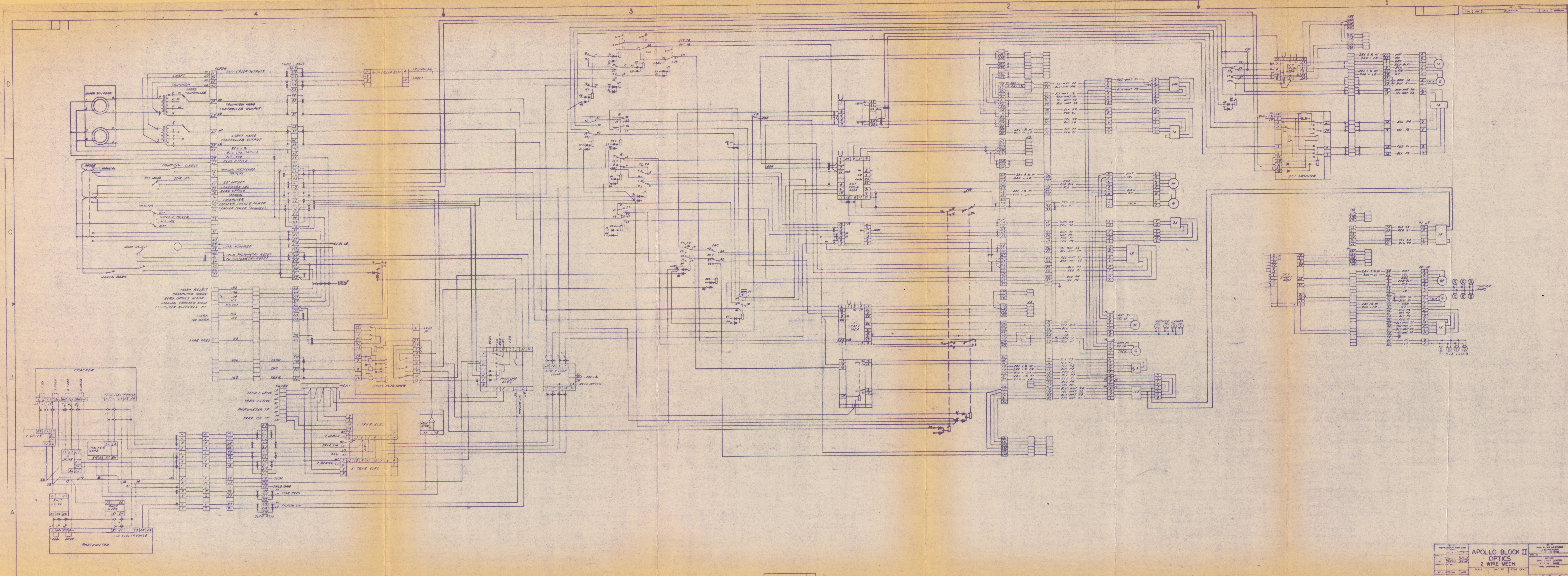
NOTES:
1. 2° DOES NOT INDICATE 2 DEGREES. IT INDICATES 2 RAISED TO THE ZERO POWER CASE OVERIDE IS PRESENT WHEN IMU CASE IS COMMANDED. THIS INHIBITS THE ERROR ANGLE COUNTER AND PROVIDES A LO FOR THE COARSE ALIGN RELAYS IN THE PSA.

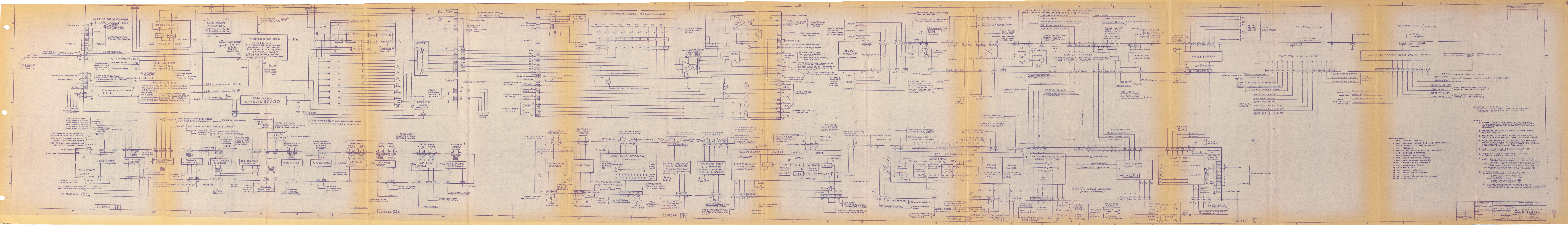


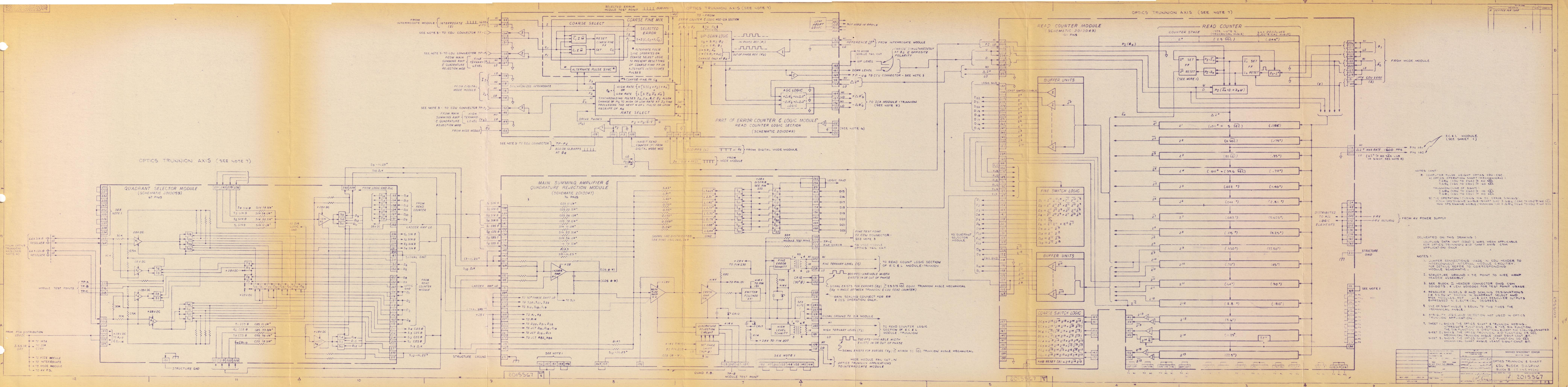
COMMAND MODULE MODING					
CGC COMMANDS TO CDU					
ISS MODES	ISS CDU ZERO	COARSE ALIGN	ENABLE ERROR COUNTER	5.2K TRKDR ENABLER	TVC # ENABLER
INITIAL TURN ON	X	X			
CDU ZERO	X				
COARSE ALIGN		X	X		
ATTITUDE CONTROL				X	
FINE ALIGN					
INERTIAL REFERENCE					
SE CONTROL OF SATURN			X	X	
THRUST VECTOR CONTROL			X		X

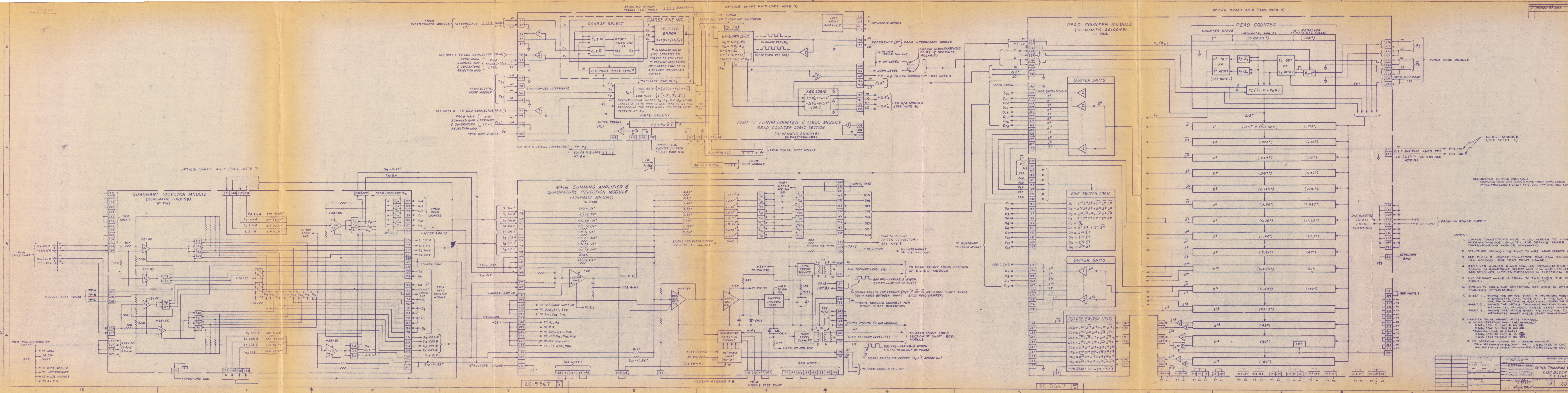
* THRUST VECTOR CONTROL MODE USES THE DIA CONVERSION CAPABILITY OF THE OPTICS CDU'S TO CONTROL THE SPD ENGINE GIMBAL POSITION. DESIRED ENGINE POSITION IS CALCULATED FROM THE IMU GIMBAL READOUT INFORMATION. OPTICS DIA'S ARE NOT SHOWN ON THIS DWE





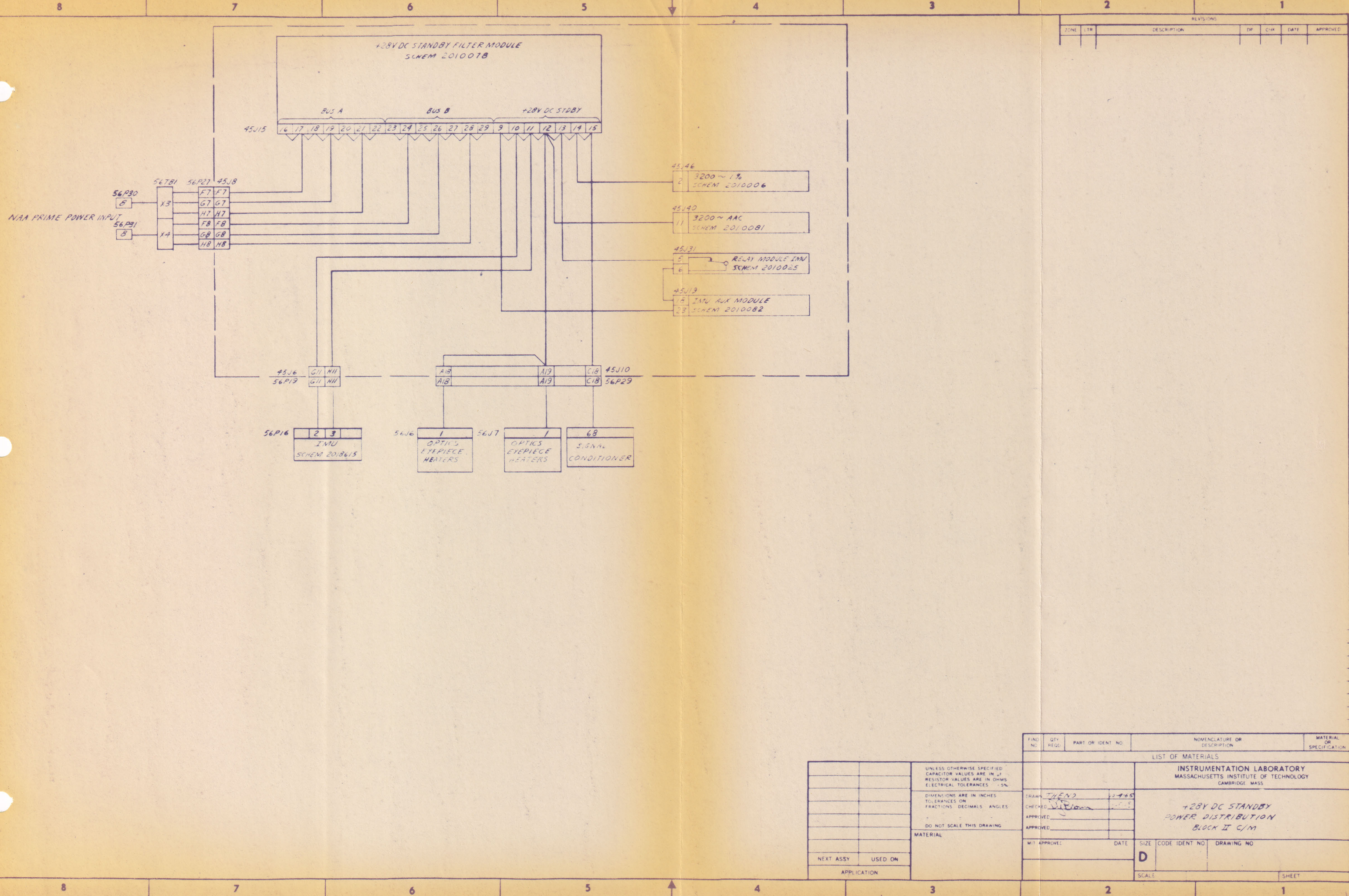


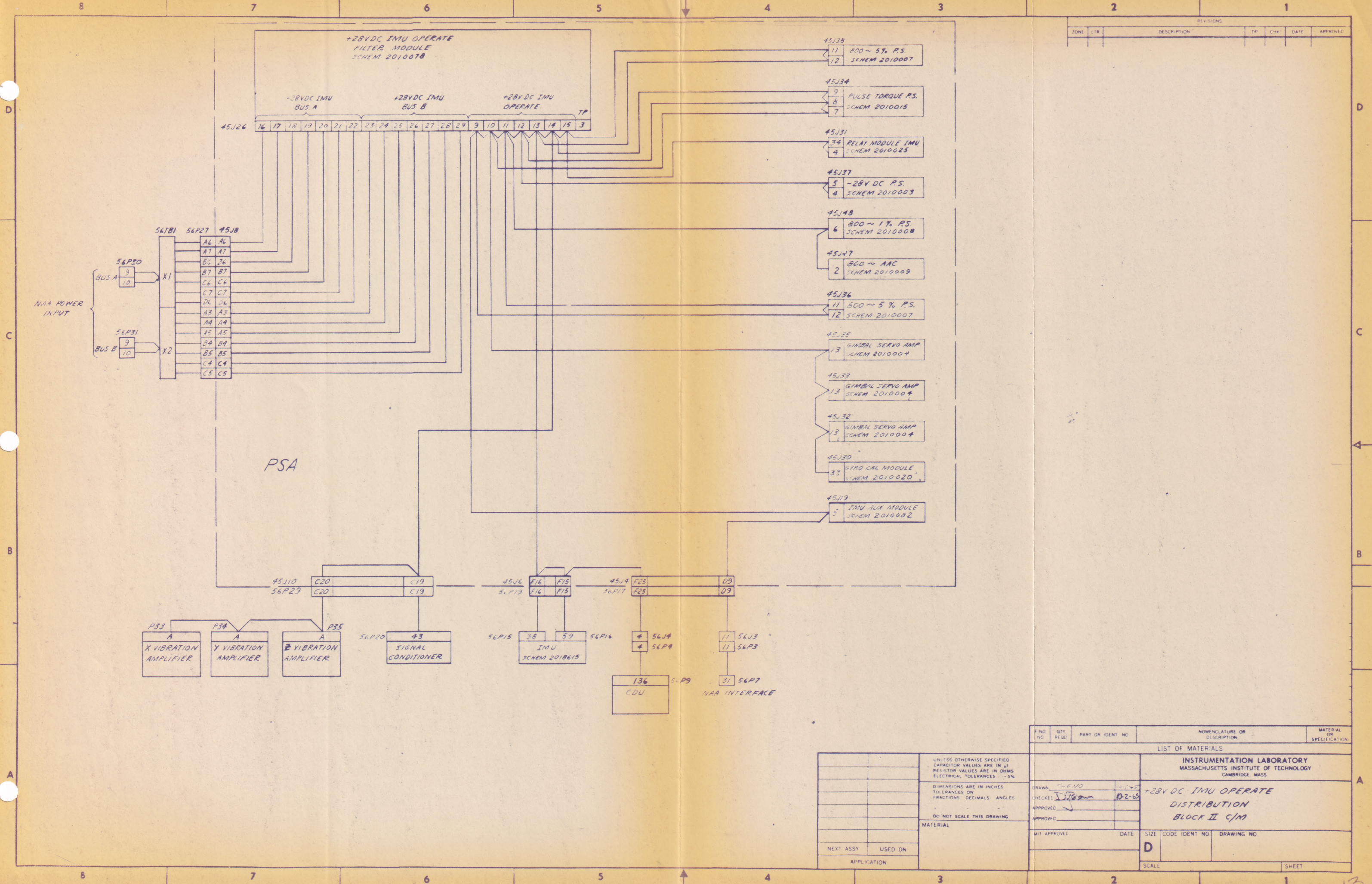


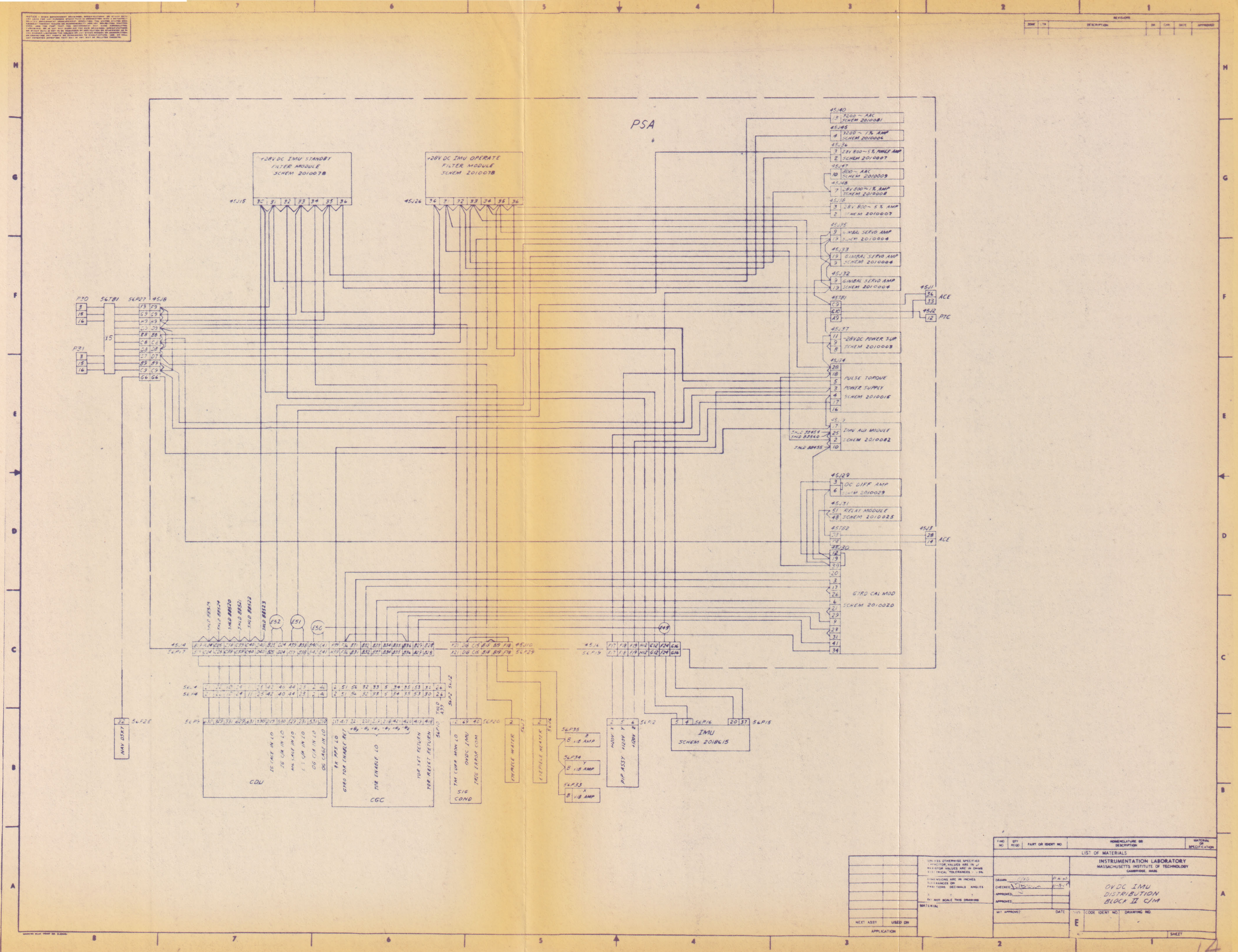


- NOTES:
1. JUMPER CONNECTIONS MADE IN CDU HEADER TO INTERCONNECT INTERNAL MODULE CIRCUITRY. FOR DETAILS REFER TO CORRESPONDING MODULE SCHEMATIC.
 2. STRUCTURE GROUND - TIE POINT TO WIRE WRAP HEADER ASSEMBLY.
 3. SEE BLOCK 2 HEADER CONNECTOR DWG. CSN 2010075, & LEM 6010001 FOR TEST POINT USAGE.
 4. RESOLVER ANGLES & SCALING DESIGNATIONS (E.G. SIN 54.6°) SHOWN IN QUADRANT SELECT AND MSA MODULES, REPRESENT 16x8 RESOLVER OUTPUTS EXPRESSED IN ELECTRICAL DEGREES.
 5. LINE OF SIGHT ANGLE IS EQUAL TO TWO TIMES THE MECHANICAL ANGLE.
 6. AMBIGUITY LOGIC AND DETECTION NOT USED IN OPTICS TRUNNION APPLICATION.
 7. SHEET 1, SHOWS THE OPTICS SHAFT & TRUNNION MOUNTING. INTERMEDIATE FUNCTIONS, ETC. & THE DIA FUNCTION. THE DIA FUNCTION IS IDENTICAL EXCEPT FOR SCALING. SHEET 2, SHOWS THE OPTICS TRUNNION AND FUNCTION 1.5 SEC MECHANICAL TRUNNION ANGLE. SHEET 3, SHOWS THE OPTICS SHAFT AND FUNCTION 2.5 SEC MECHANICAL TRUNNION ANGLE. SHEET 4, SHOWS THE OPTICS SHAFT AND FUNCTION 4.5 SEC MECHANICAL TRUNNION ANGLE.
 8. COMPUTER PULSE WEIGHT OPTICS CDU - C&C:
A) OPTICS OPERATION SHAFT (MECHANICAL) 1.5 SEC (CDU TO C&C) @ 40 SEC.
2.0 SEC (C&C TO CDU) @ 40 SEC.
B) DIA OPERATION (USING DIA ERROR SIGNALS) 1.5 SEC (CDU TO C&C) @ 40 SEC.
2.0 SEC (C&C TO CDU) @ 40 SEC.
C) DIA OPERATION (USING DIA ERROR SIGNALS) 1.5 SEC (CDU TO C&C) @ 40 SEC.
2.0 SEC (C&C TO CDU) @ 40 SEC.

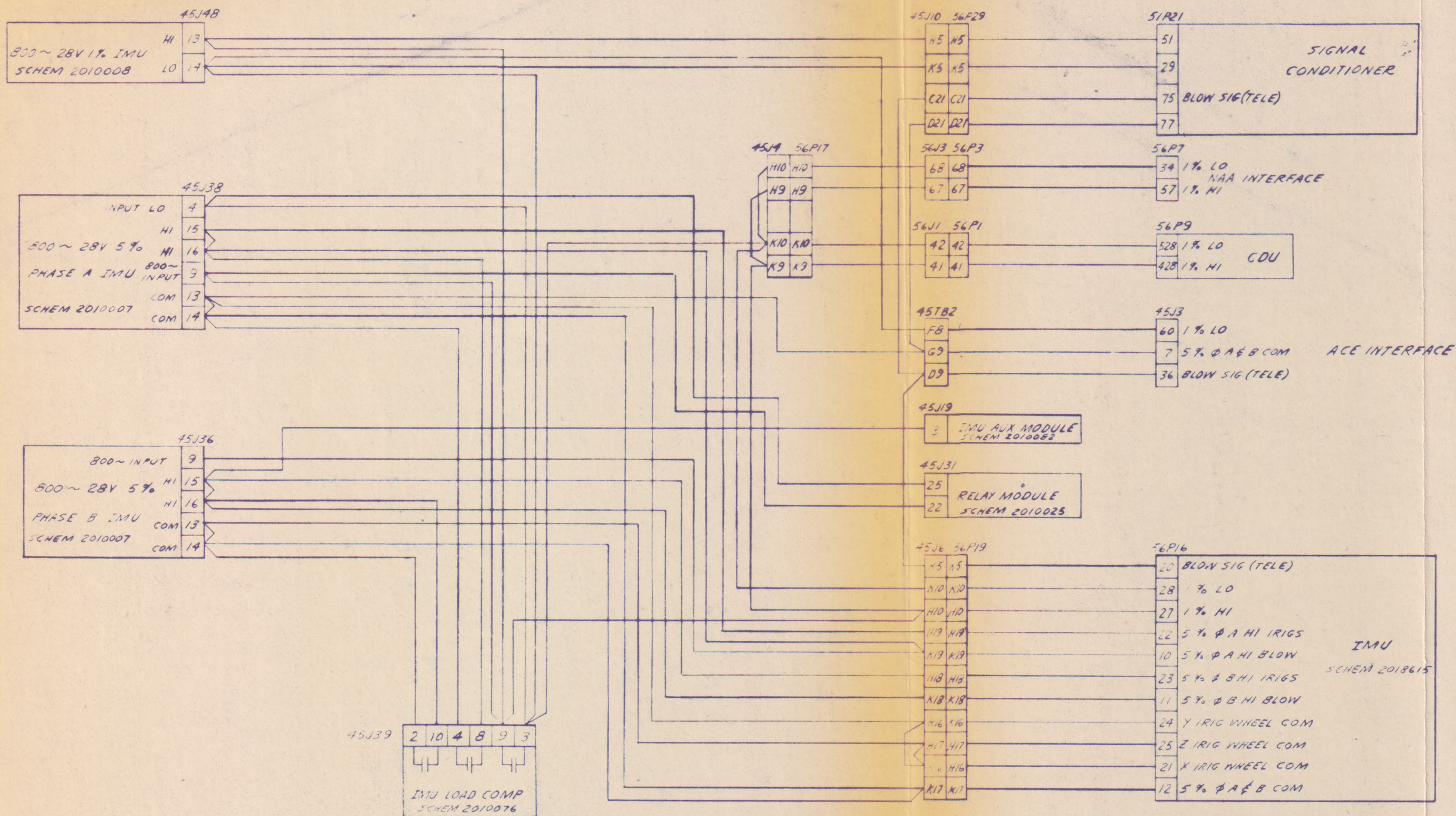
QUADRANT SELECTOR MODULE		MAIN SUMMING AMPLIFIER & QUADRATURE REJECTION MODULE		READ COUNTER MODULE	
1	2	3	4	5	6
7	8	9	10	11	12
13	14	15	16	17	18
19	20	21	22	23	24
25	26	27	28	29	30
31	32	33	34	35	36
37	38	39	40	41	42
43	44	45	46	47	48
49	50	51	52	53	54
55	56	57	58	59	60
61	62	63	64	65	66
67	68	69	70	71	72
73	74	75	76	77	78
79	80	81	82	83	84
85	86	87	88	89	90
91	92	93	94	95	96
97	98	99	100	101	102







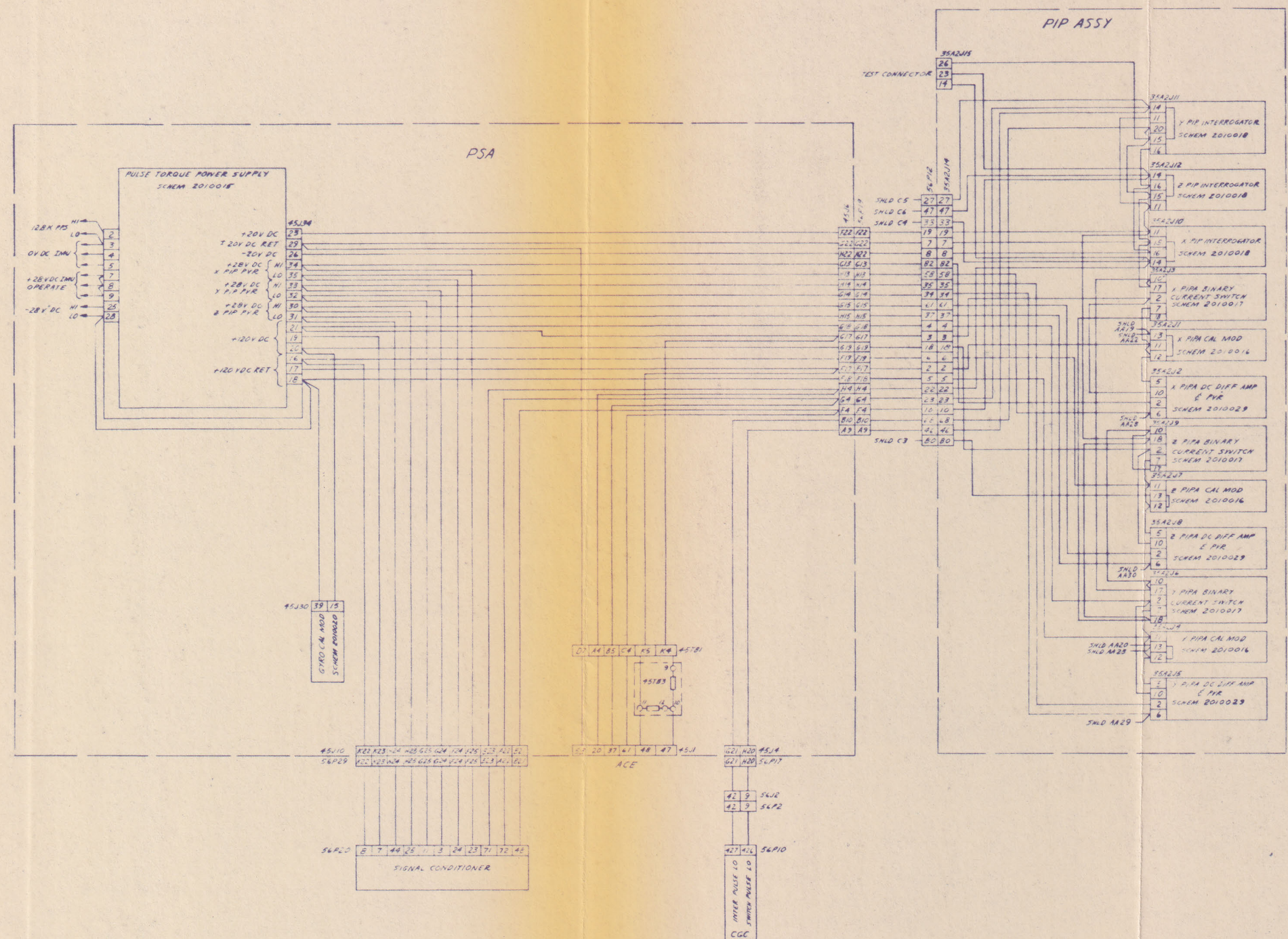
NOTICE - WHEN GOVERNMENT DRAWINGS, SPECIFICATIONS, OR OTHER DATA ARE USED FOR ANY PURPOSE OTHER THAN IN CONNECTION WITH A GOVERNMENT CONTRACT, THE USER SHALL BE RESPONSIBLE FOR OBTAINING ALL NECESSARY RIGHTS, PERMISSIONS, AND CLEARANCES FROM THE APPROPRIATE AGENCIES. THE GOVERNMENT MAKES NO WARRANTY, REPRESENTATION, OR GUARANTEE, EXPRESS OR IMPLIED, AS TO THE ACCURACY, COMPLETENESS, OR SUITABILITY OF THE INFORMATION FURNISHED HEREIN FOR ANY PURPOSE OTHER THAN THAT FOR WHICH IT WAS ORIGINALLY INTENDED. THE USER SHALL BE RESPONSIBLE FOR OBTAINING ALL NECESSARY RIGHTS, PERMISSIONS, AND CLEARANCES FROM THE APPROPRIATE AGENCIES. THE GOVERNMENT MAKES NO WARRANTY, REPRESENTATION, OR GUARANTEE, EXPRESS OR IMPLIED, AS TO THE ACCURACY, COMPLETENESS, OR SUITABILITY OF THE INFORMATION FURNISHED HEREIN FOR ANY PURPOSE OTHER THAN THAT FOR WHICH IT WAS ORIGINALLY INTENDED.



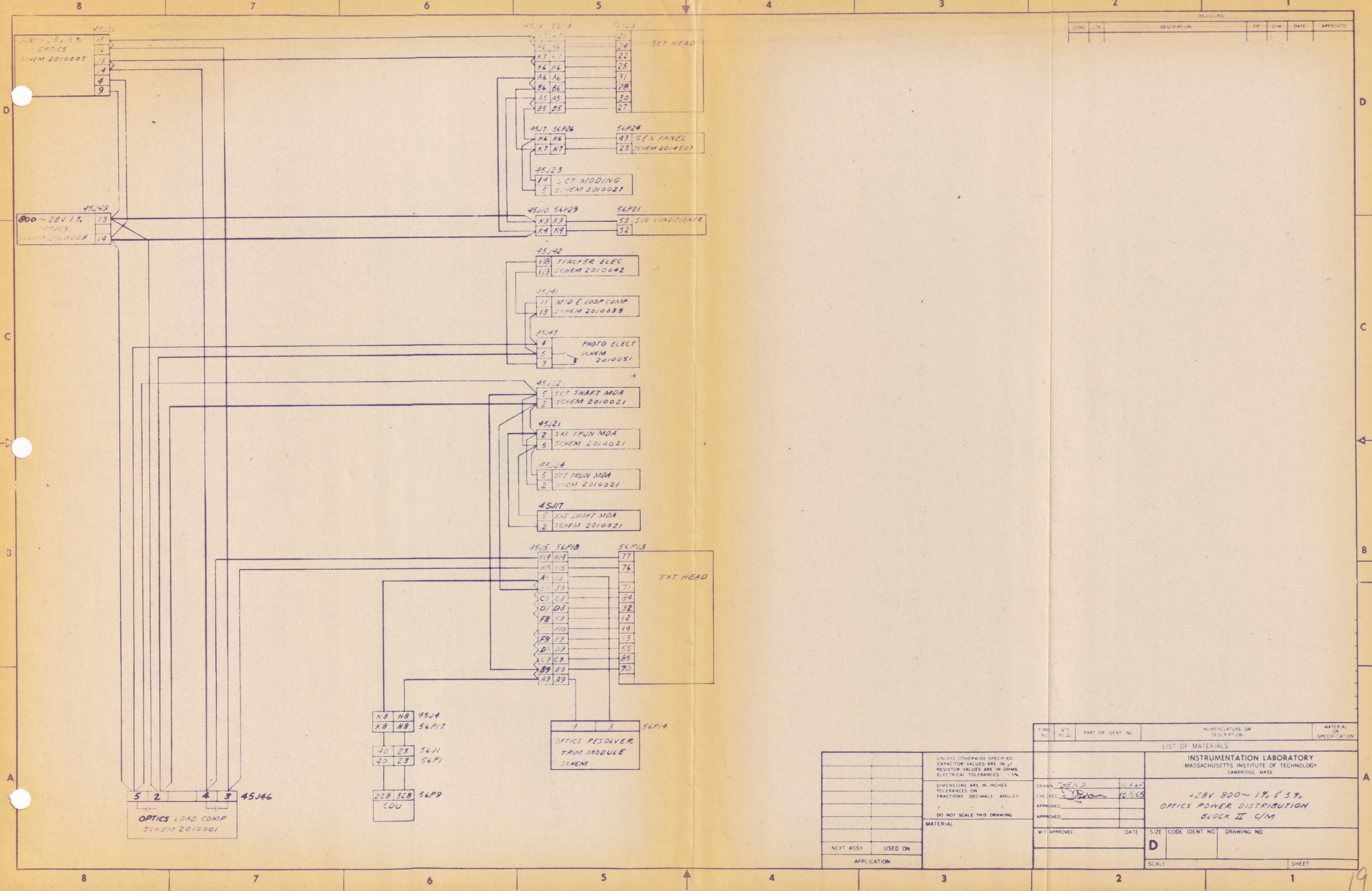
QTY REQD		PART OR IDENTIFYING NO		NOMENCLATURE OR DESCRIPTION		FIND NO	
LIST OF MATERIALS							
MIT INSTRUMENTATION LAB CAMBRIDGE MASS				MANNED SPACECRAFT CENTER HOUSTON, TEXAS			
DRAWN <i>T. F. Y.</i> DATE <i>1-15-65</i>				800 ~ 1% & 5% IMU			
CHECKED <i>S. F. Y.</i> DATE <i>11-1-65</i>				POWER DISTRIBUTION			
APPROVAL				BLOCK II CSM			
HEAT TREATMENT				NASA APPROVAL			
FINA FINISH				CODE IDENT NO SIZE			
NEXT ASSY USED ON				NASA DRAWING NO			
APPLICATION				SCALE WT			
				SHEET 1 OF 1			

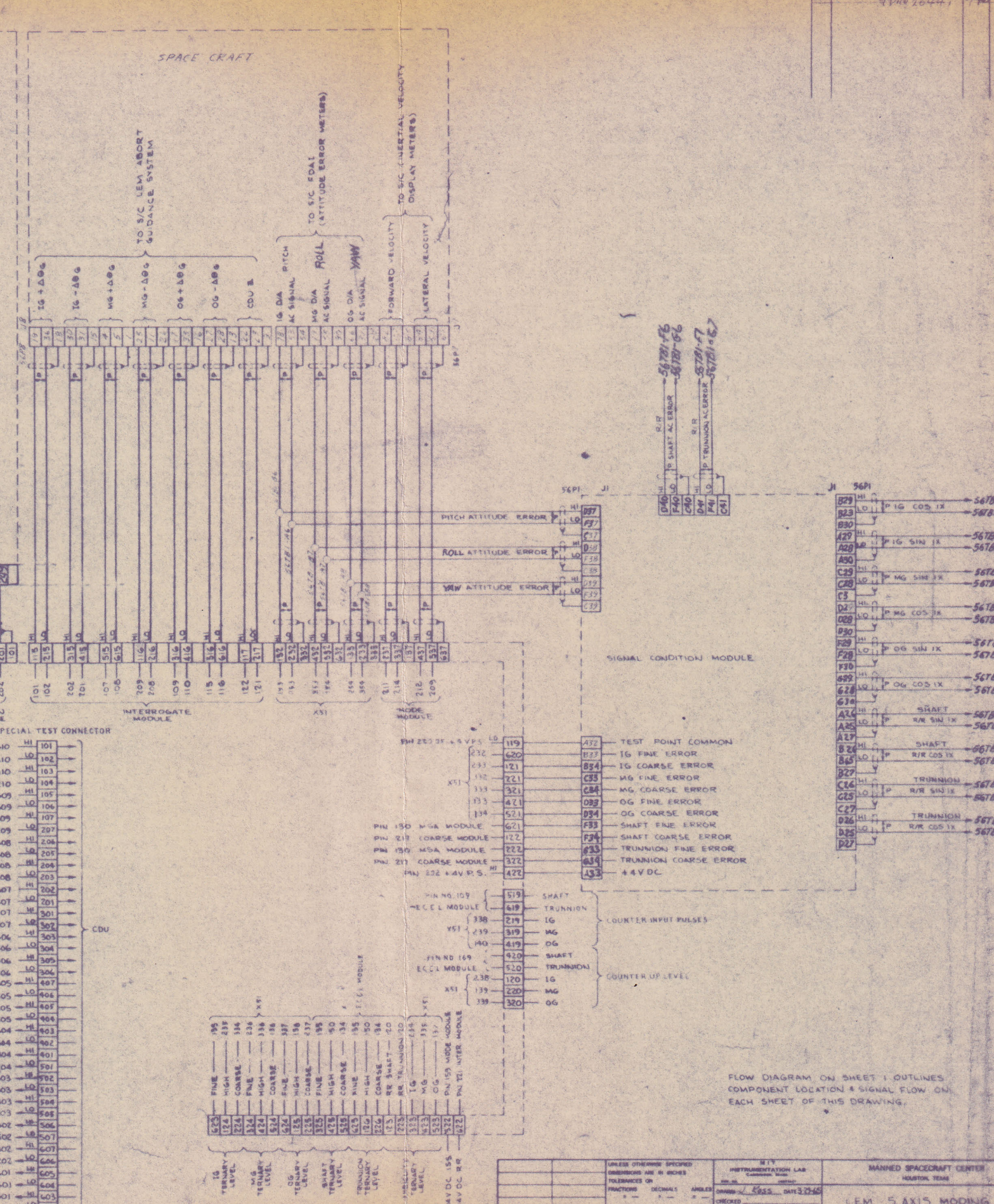
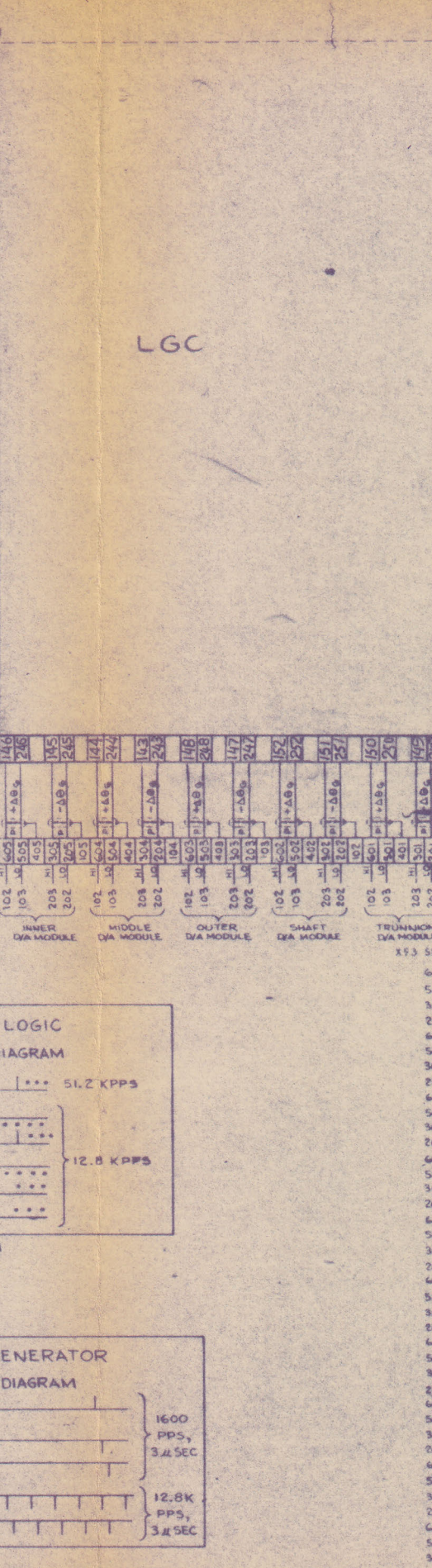
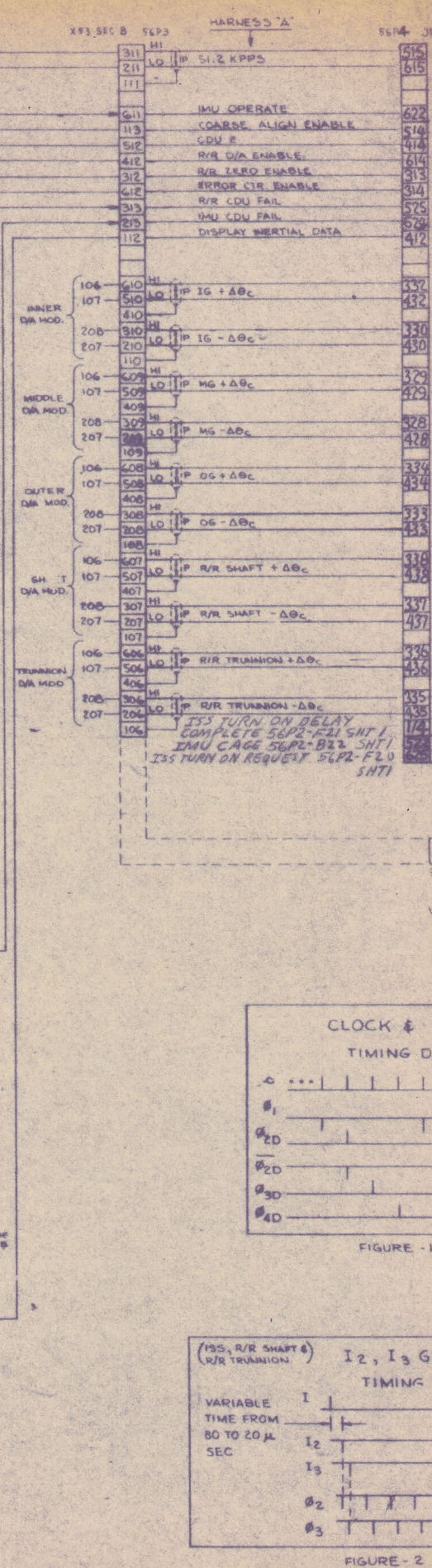
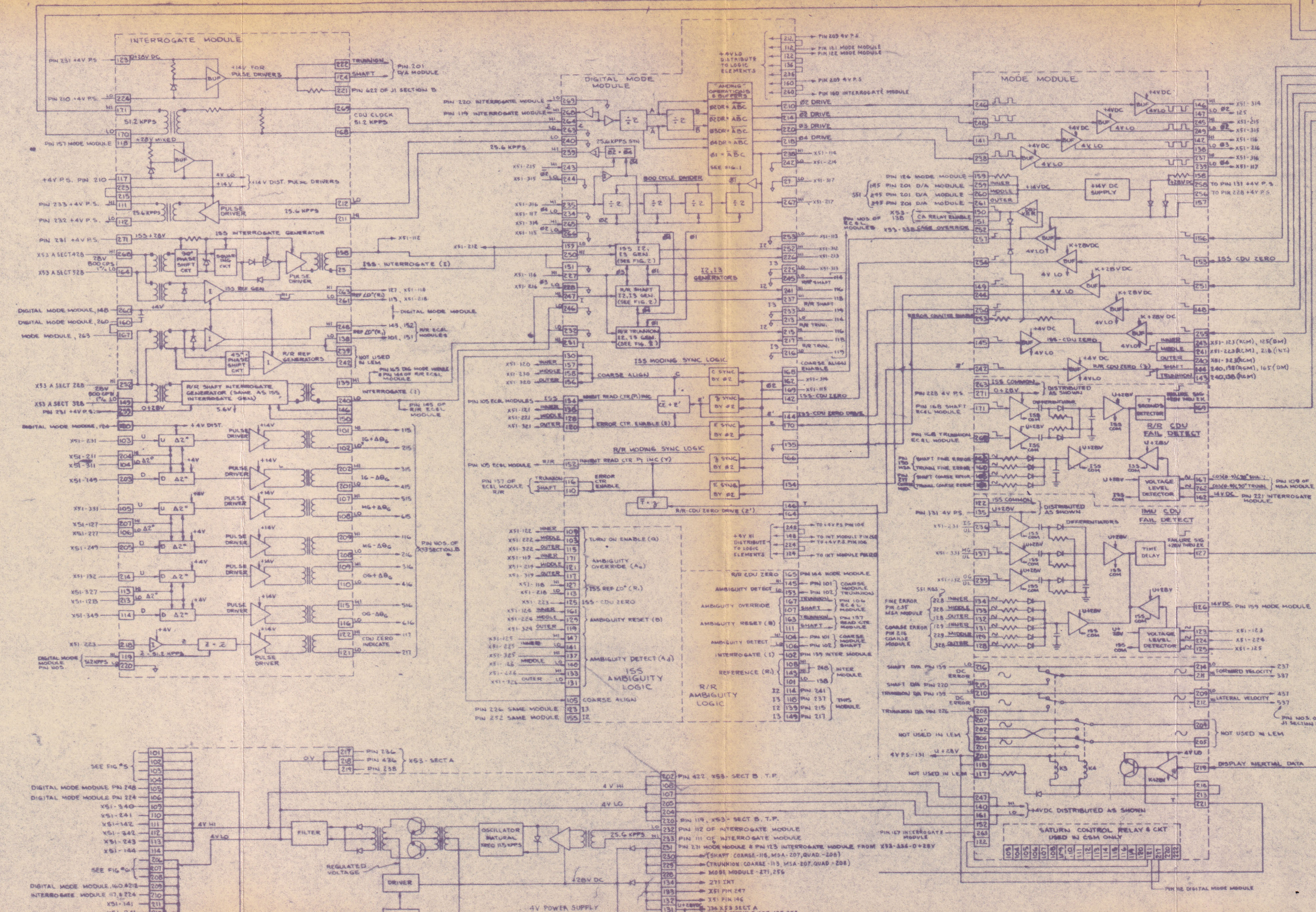
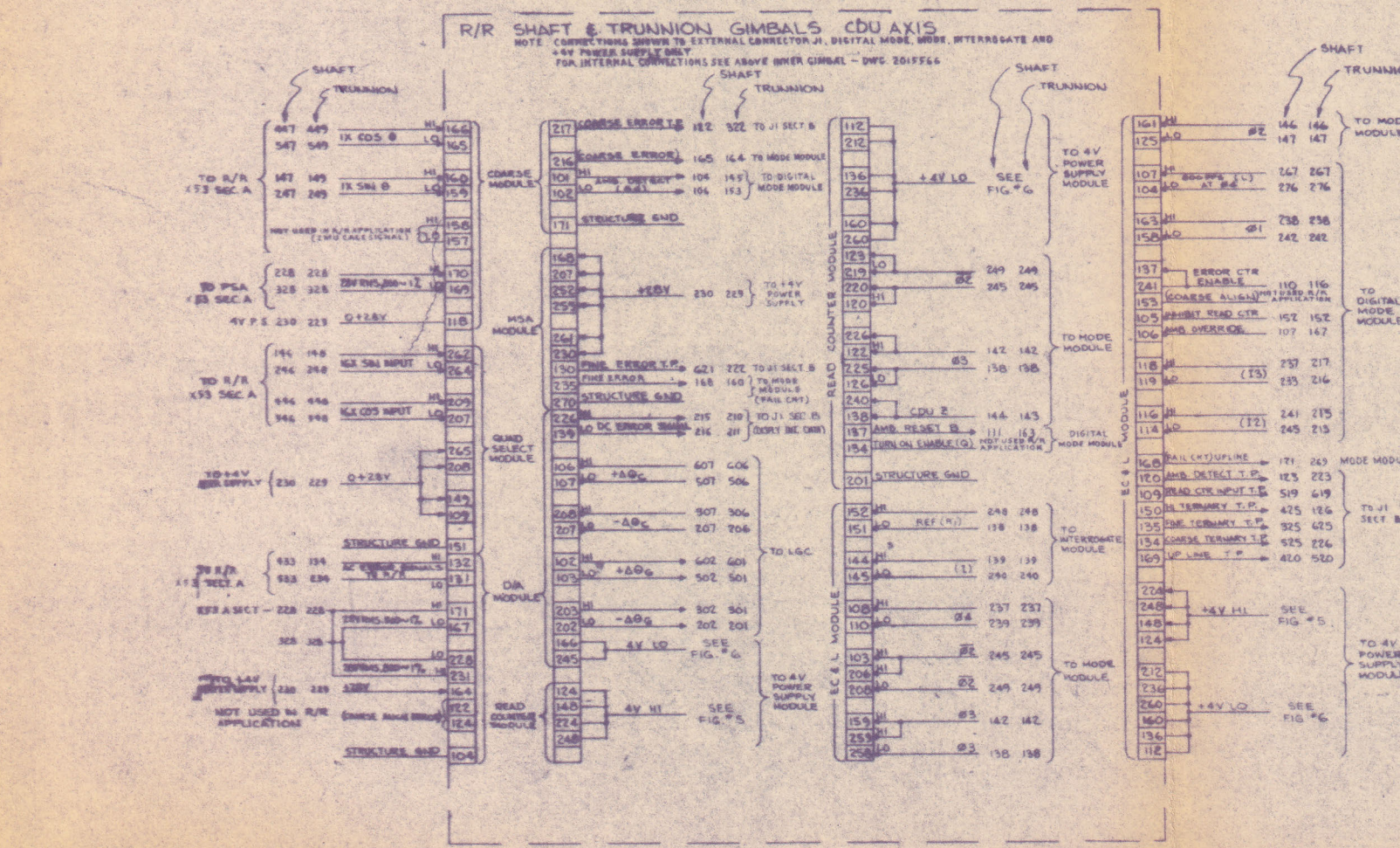
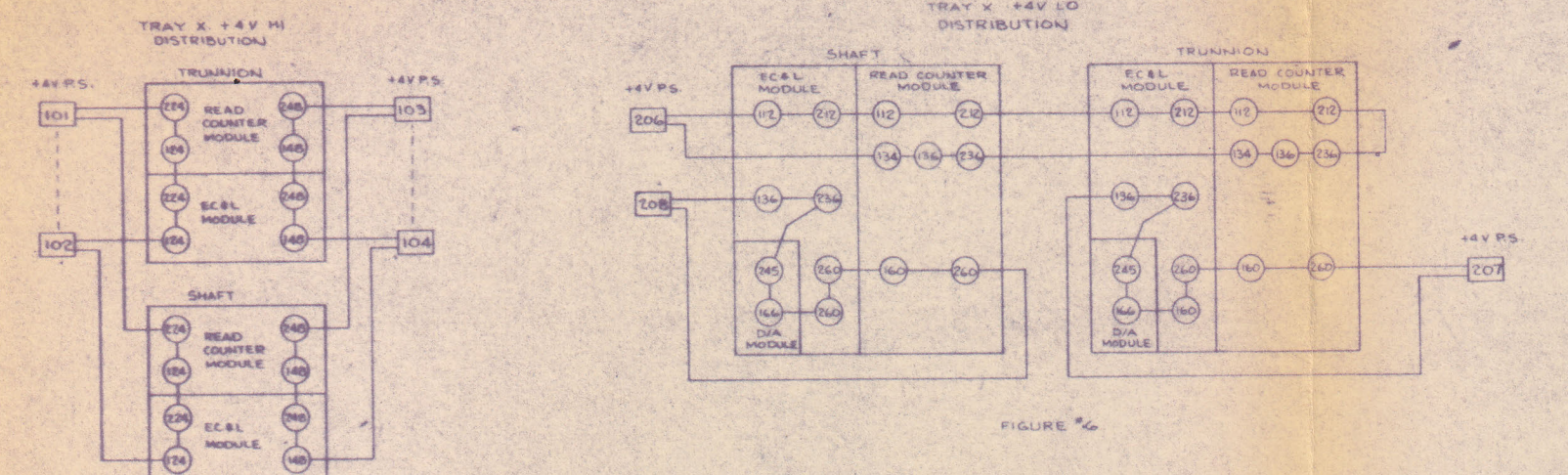
NOTES: 1. THIS DRAWING IS A WORKING DRAWING. IT IS NOT TO BE USED FOR FABRICATION. 2. THE DRAWING IS THE PROPERTY OF THE MASSACHUSETTS INSTITUTE OF TECHNOLOGY. IT IS NOT TO BE REPRODUCED OR TRANSMITTED IN ANY FORM OR BY ANY MEANS, ELECTRONIC OR MECHANICAL, INCLUDING PHOTOCOPYING, RECORDING, OR BY ANY INFORMATION STORAGE AND RETRIEVAL SYSTEM. 3. THE DRAWING IS THE PROPERTY OF THE MASSACHUSETTS INSTITUTE OF TECHNOLOGY. IT IS NOT TO BE REPRODUCED OR TRANSMITTED IN ANY FORM OR BY ANY MEANS, ELECTRONIC OR MECHANICAL, INCLUDING PHOTOCOPYING, RECORDING, OR BY ANY INFORMATION STORAGE AND RETRIEVAL SYSTEM.

REVISIONS				
NO.	DATE	DESCRIPTION	BY	APP.
1				

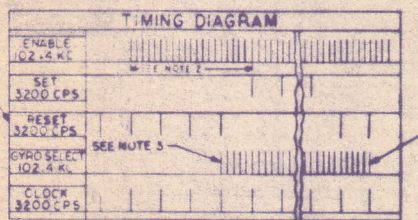
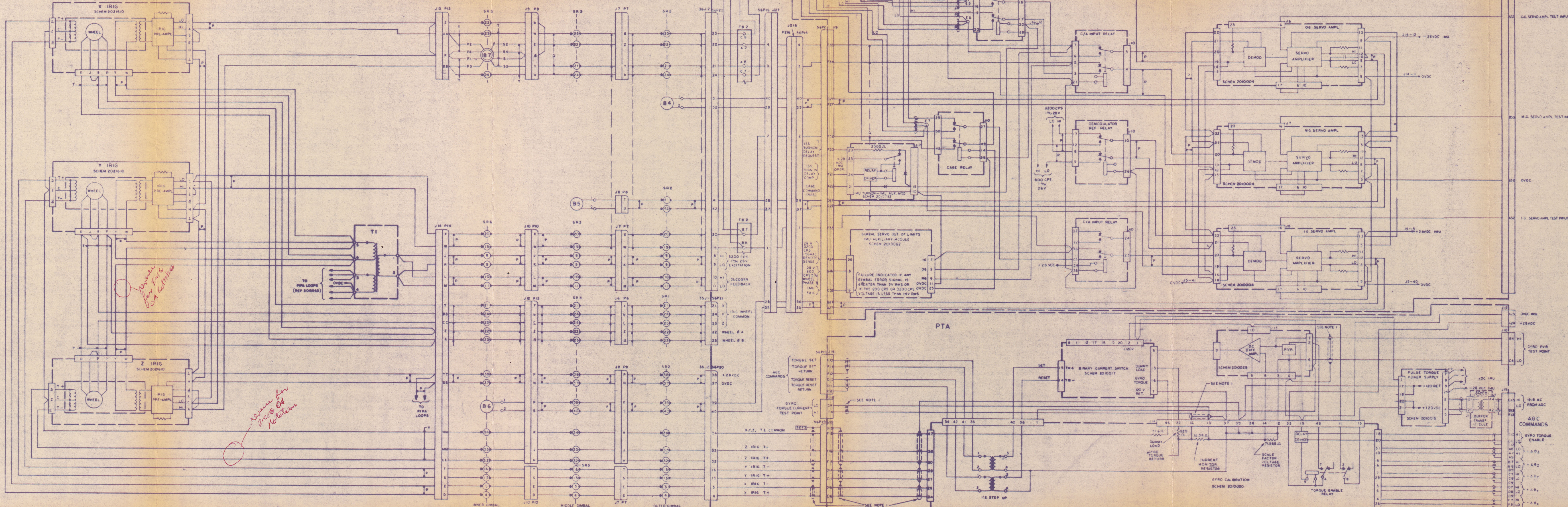


TIME	QTY	PART OR IDENT NO	NOMENCLATURE OR DESCRIPTION	MATERIAL SPECIFICATION
LIST OF MATERIALS				
INSTRUMENTATION LABORATORY MASSACHUSETTS INSTITUTE OF TECHNOLOGY CAMBRIDGE, MASS				
PULSE TORQUE POWER SUPPLY OUTPUT DISTRIBUTION BLOCK II C/M				
DRAWN: [Signature] CHECKED: [Signature] APPROVED: [Signature] DATE: [Date] SCALE: [Scale] SHEET: 16				





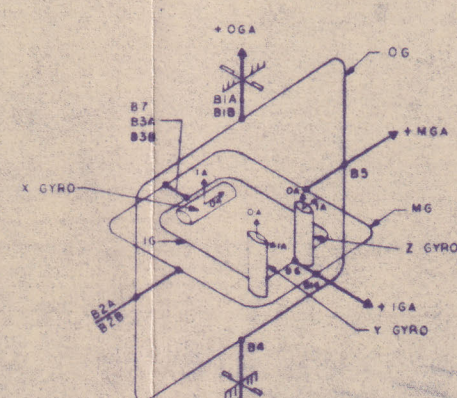
IMU SCHEM 2018610



- NOTES
1. ALL NOTED WIRES TO BE MICRODOT TYPE 2-3558
 2. 24V TORQUE ENABLE SIGNAL MUST BE RECEIVED AT LEAST 20 MILLISECONDS PRIOR TO ANY TORQUE SET PULSE
 3. GYRO SELECT SIGNAL MUST BE RECEIVED AT LEAST ONE CLOCK TIME (3200 CPS) PRIOR TO ANY TORQUE SET PULSES
 4. GYRO RESET PULSE MUST BE GIVEN AT LEAST ONE CLOCK TIME (3200 CPS) PRIOR TO CE-ENERGIZING THE GYRO SELECT SIGNAL LINE
 5. ALL INPUTS FROM THE COMPUTER ARE TO BE TWISTED SHIELDED PAIRS
 6. CURRENT SWITCH MUST BE IN RESET CONDITION PRIOR TO RECEIVING GYRO TORQUE ENABLE SIGNAL FROM THE COMPUTER
 7. 24V TORQUE COMMAND (+24V) SIGNAL PRODUCES TORQUE IN THE "M" WINDING OF THE GYRO RESULTING IN A POSITIVE ACCELERATION ABOUT THE GYRO INPUT AXIS
 8. NO EXTERNAL LEADS SHALL BE CONNECTED TO EITHER THE +20VDC TERMINAL (PIN NO. 10) OR TO THE -12VDC RETURN TERMINAL (PIN NO. 17) ON THE BINARY CURRENT SWITCH
 9. ERROR SIGNAL IN PHASE WITH DEMODULATOR REFERENCE RESULTS IN A POSITIVE TORQUE MOTOR VOLTAGE
 10. INTERPRET DRAWING IN ACCORDANCE WITH STANDARDS PRESCRIBED BY MIL-STD-20327

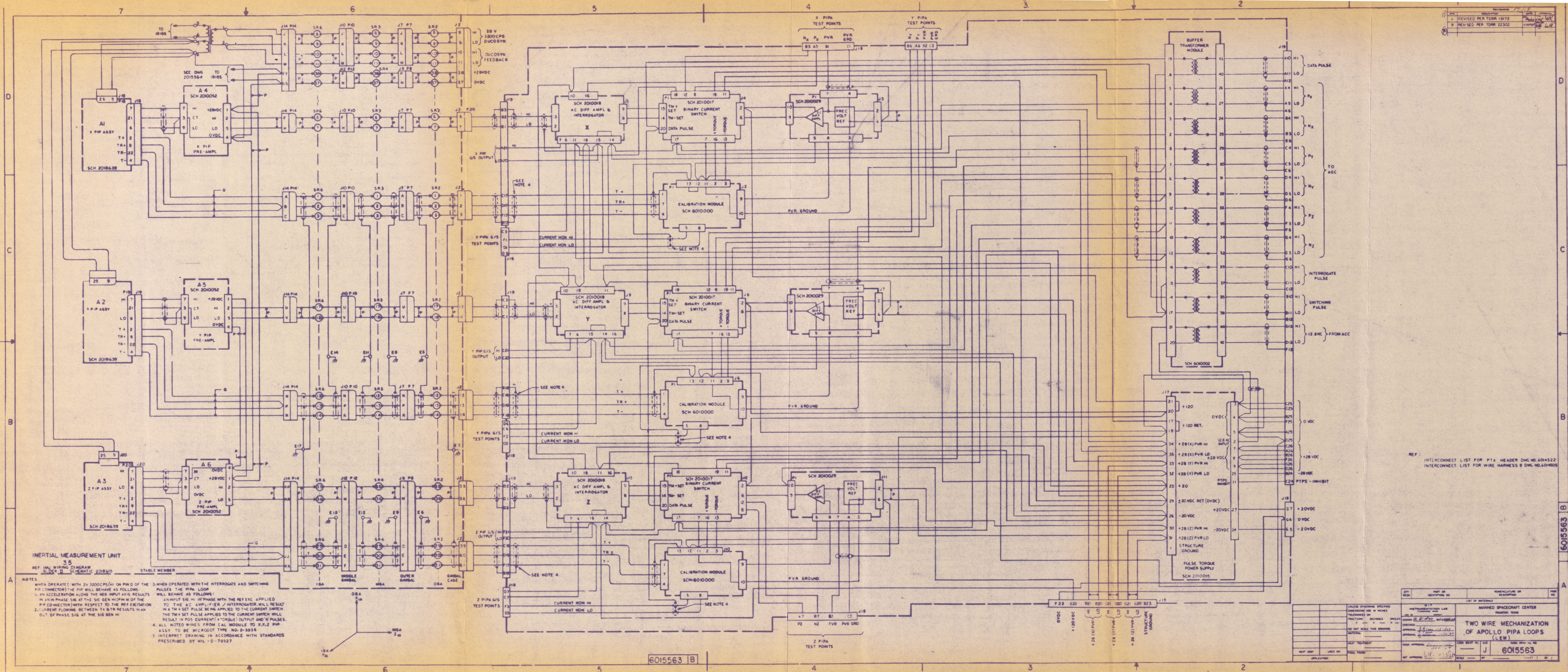
Power for test & on station

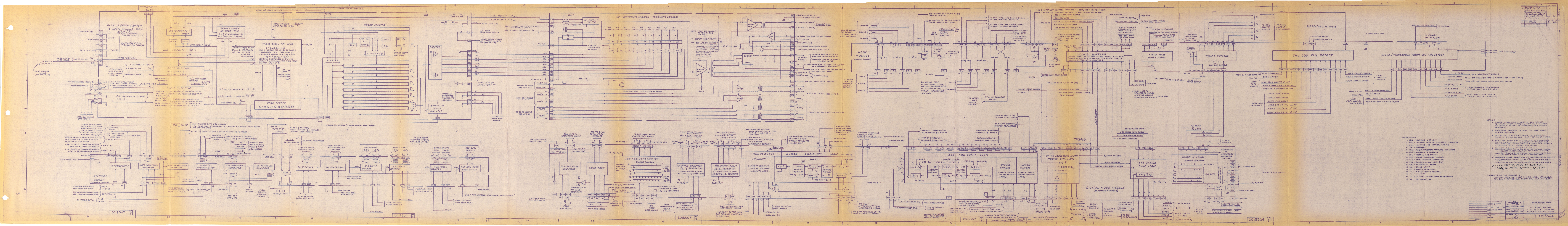
Power for test & on station

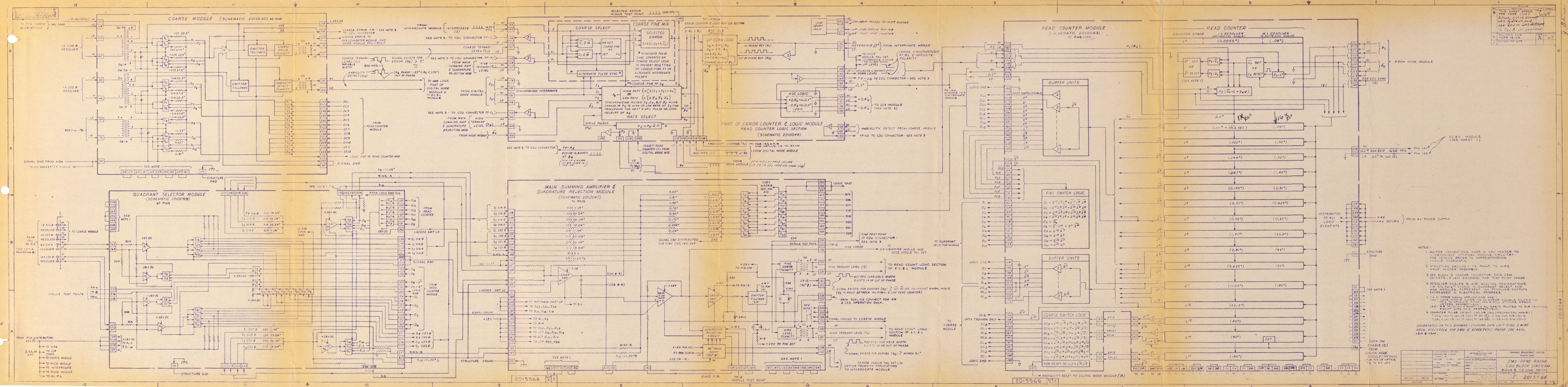


REF: INTERCONNECT LISTS
FOR PTA HEADER 6014582
FOR PSA HEADER 6014581
FOR WIRE HARNESS A 6014504
FOR WIRE HARNESS B 6014505

DATE: 10/1/64 DRAWN BY: [Signature] CHECKED BY: [Signature] APPROVED BY: [Signature]		DATE: 10/1/64 DRAWN BY: [Signature] CHECKED BY: [Signature] APPROVED BY: [Signature]	
6015564		6015564	

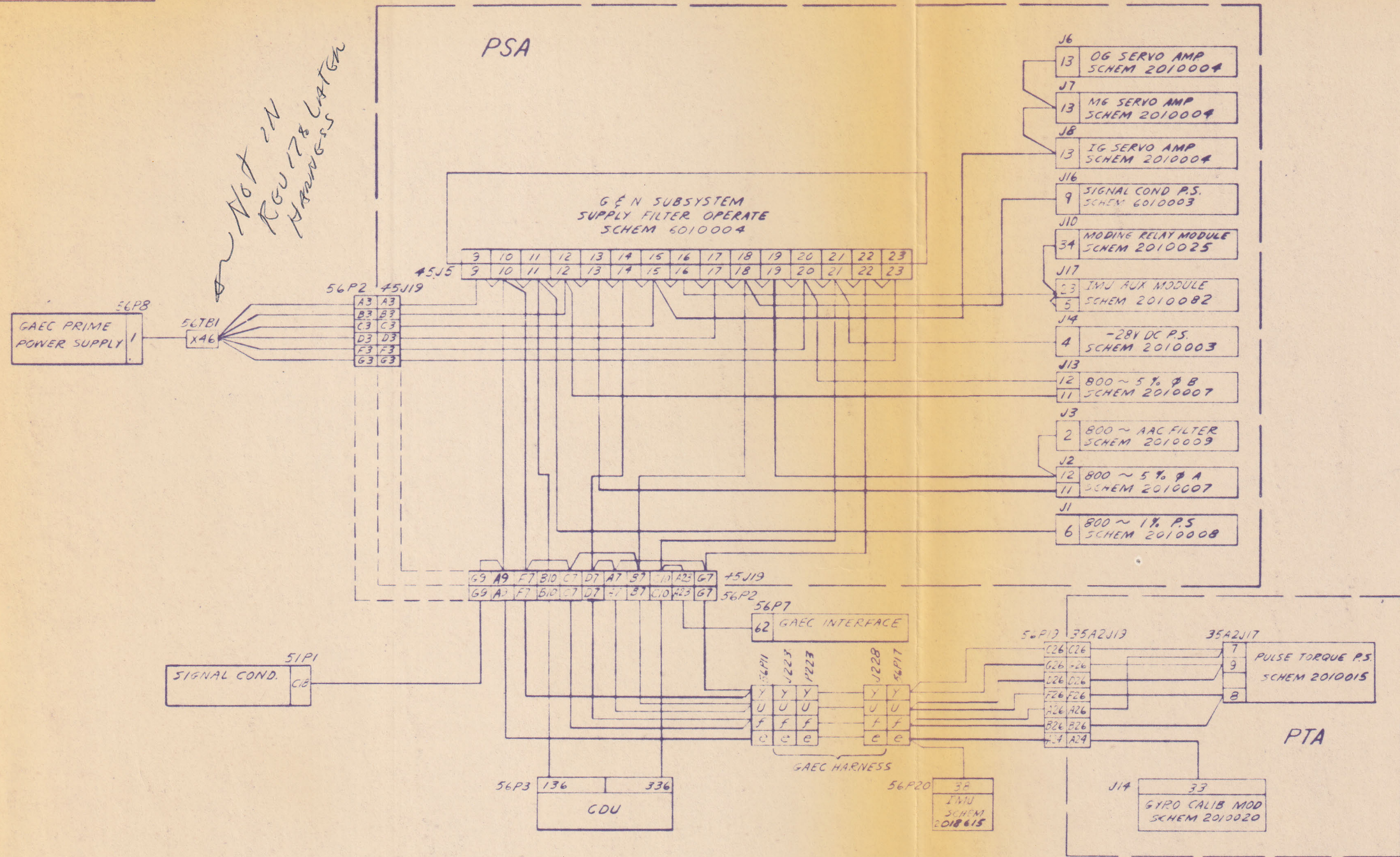




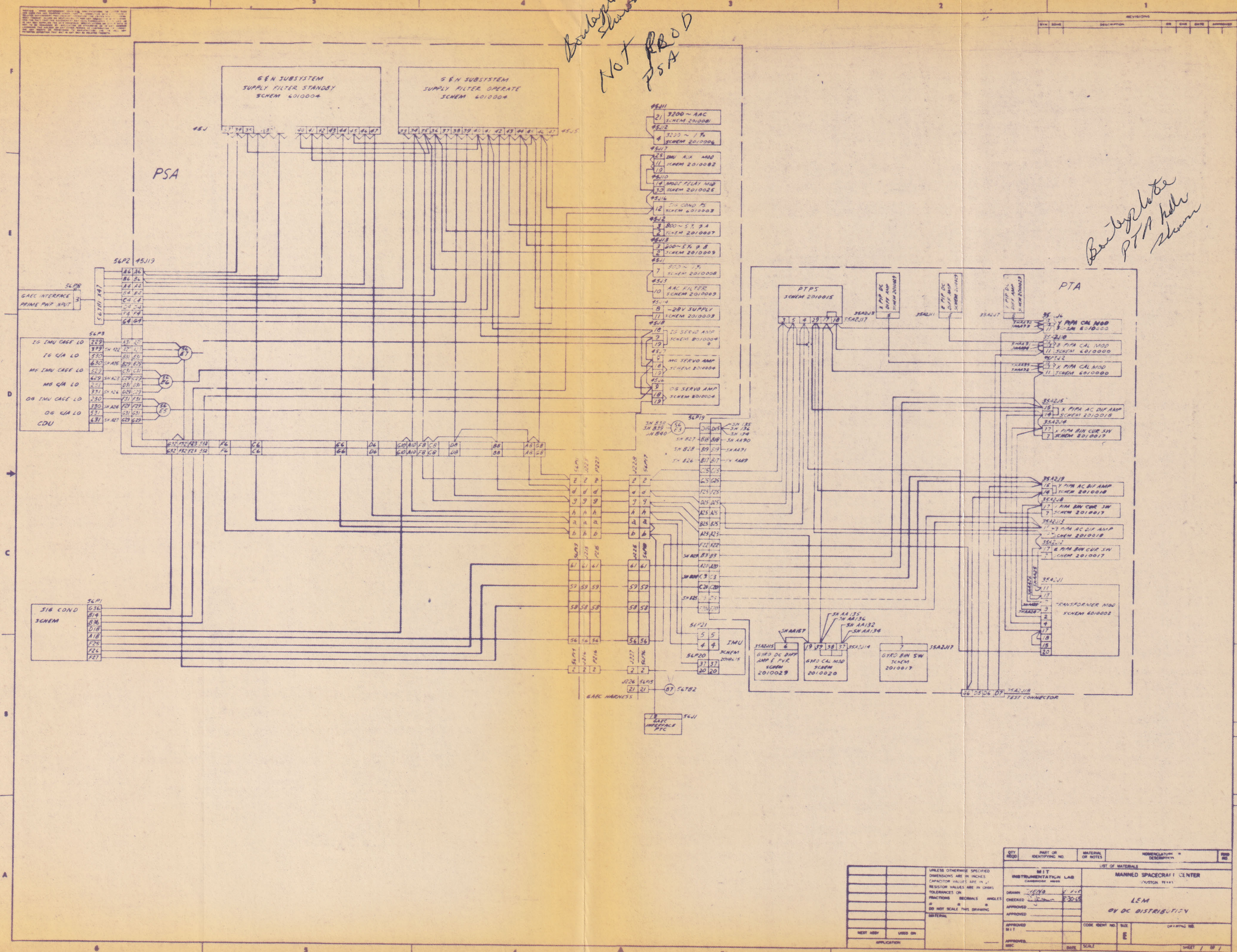


NOTICE: WHEN GOVERNMENT DRAWINGS, SPECIFICATIONS OR OTHER DATA ARE USED FOR ANY PURPOSE OTHER THAN IN CONNECTION WITH A SPECIFICALLY RELATED GOVERNMENT PROCUREMENT OPERATION, THE UNITED STATES GOVERNMENT TAKES NO RESPONSIBILITY FOR THE USE AND/OR REPRODUCTION OF SUCH DATA OR THE FACT THAT THE GOVERNMENT MAY HAVE FORMULATED, EXAMINED OR IN ANY WAY SUPPLIED THE BASIC DRAWINGS, SPECIFICATIONS OR OTHER DATA IS NOT TO BE REGARDED BY IMPLICATION OR OTHERWISE AS IN ANY MANNER ENDORSING THE HOLDER OR ANY OTHER PERSON OR CORPORATION OR CONFIRMING THE ANY RIGHTS OR PERMISSION TO MANUFACTURE, USE OR SELL ANY PATENTED INVENTION THAT MAY IN ANY WAY BE RELATED THEREIN.

REVISIONS				
SYM	ZONE	DESCRIPTION	DR	CHK



QTY REQD	PART OR IDENTIFYING NO.	MATERIAL OR NOTES	NOMENCLATURE OR DESCRIPTION	FIND NO.
LIST OF MATERIALS				
MIT INSTRUMENTATION LAB CAMBRIDGE MASS		MANNED SPACECRAFT CENTER HOUSTON, TEXAS		
DRAWN <u>THEND</u> 8-5-65		LEM +20. DC		
CHECKED <u>WILSON</u> 8-10-65		IMU OPERATE DISTR.		
APPROVED _____		CODE IDENT. NO. <u>D</u>		
APPROVED MIT _____		DRAWING NO. _____		
APPROVED MSC _____		DATE _____ SCALE _____ SHEET / OF /		



Boulogne station
NOT READ PSA

Boulogne station
PTA kable shown

QTY	PART OR IDENTIFYING NO.	MATERIAL OR NOTES	NOMENCLATURE OR DESCRIPTION
LIST OF MATERIALS			
INSTRUMENTATION LAB			
MANNED SPACECRAFT CENTER			
LEA			
OV DC DISTRIBUTION			
APPROVED	CODE IDENT NO.	DATE	SCALE
APPROVED	DATE	SCALE	SHEET 1 OF 1

