APOLLO 15	
LM SYSTEMS DATA	
PART NO.	S/N
SKB32100116-385	1001

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LM TELMU GO CRITERIA
~~5/3/71~~ 7/7/71

GO/NO-GO ITEM		UNDOCK	CIRC	POWERED DESCENT: PDI	POWERED DESCENT: PDI TO PDI + 6:10	POWERED DESCENT: PDI + 6:10 TO HI GATE	POWERED DESCENT: HI GATE TO T/D	LUNAR STAY: STAY W/O EVA	LUNAR STAY: 2-MAN EVA	LUNAR STAY: 1-MAN EVA	RENDEZVOUS LM ACTIVE: LM ACTIVE		DOCKING
PYRO													
1. BAT VOLT > ~~TBD~~ 25 VDC, AND NOT DEGRADING		BOTH				⑨	⑨						
2. ARMING RELAY (K1) INTEGRITY ⑤		BOTH ABLE TO ARM AND DE-ARM				⑩	⑩	BOTH ABLE TO ARM					
3. STAGING RELAYS (K2-K6) INTEGRITY		BOTH			⑪	⑪	⑪						
ELECTRICAL													
1. CDR AND LMP BUS ①		BOTH		BOTH								1 OF 2	
2. DC FEEDERS ① ② **** ****	DESCENT	BOTH		BOTH									
	ASCENT	BOTH		BOTH								1 OF 2	
3. BATTERIES ③ **** ****	DESCENT	2 OF 5		2 OF 5				2 OF 5					
	ASCENT	BOTH		BOTH			⑧	BOTH				1 OF 2	
4. INVERTERS		1 OF 2		1 OF 2									
5. AC BUSES		BUS A OR B ⑦											
ENVIRONMENTAL													
1. SUIT/CABIN INTEGRITY		SUIT AND CABIN					SUIT	SUIT AND CABIN					
2. SUIT FANS **** ****		1 OF 2		1 OF 2				1 OF 2					
3. O_2 DEMAND REGS **** ****		1 OF 2						④	1 OF 2				
4. H_2O SEPARATORS **** ****		1 OF 2 H_2O SEPARATORS						1 OF 2 H_2O SEPS					
5. O2 TANKS ③ **** ****	DESCENT	1 OF 2						1 OF 2					
	ASCENT	1 OF 2							1 OF 2				
6. COOLANT LOOPS **** ****	PRIMARY	BOTH			⑥			BOTH					
	SECONDARY												
7. H_2O FEED PATHS		BOTH			⑥			BOTH					
8. H_2O TANKS ③ **** ****	DESCENT	1 OF 2						1 OF 2					
	ASCENT	1 OF 2						1 OF 2 ③					
9. NO FIRE, SMOKE OR GLYCOL IN SUIT OR CABIN													
10. OPERATIONAL EMU		2 EVA XFER SYS							2	1			

① DURING POWERED DESCENT WHEN TIME IS NOT AVAILABLE TO TROUBLESHOOT, A SHORT ON EITHER AN ASCENT OR DESCENT FEEDER WILL BE CONSIDERED LOSS OF A BUS AND THUS REQUIRE AN ABORT

② A SHORTED DC FEEDER WILL ALWAYS BE REASON FOR ABORTING THE LANDING MISSION. ONE OPEN DESCENT FEEDER WILL NOT BE REASON FOR ABORTING THE LANDING MISSION

③ FUNCTIONAL CAPABILITY ONLY - SEE REDLINES FOR CONSUMABLES REQUIREMENTS

④ DO NOT DEPRESS CABIN

⑤ ABORT FOR ARMED SYSTEM THAT CAN NOT BE DEARMED

⑥ CONSIDERATION WILL BE GIVEN TO CONTINUING DESCENT UNTIL THE SHORTER RDZ IS ACHIEVED AND THEN ABORT

⑦ BUS A REQUIRED IF RR REQUIRED

⑧ AFTER HI GATE WHERE TIME DOES NOT PERMIT TROUBLESHOOTING, CONFIG. FOR SINGLE BATT. 2 BUS ABORT BUT LAND AND TROUBLESHOOT

⑨ LAND, MANUALLY STAGE AND L/O NEXT BEST OPPORTUNITY

⑩ IF UNABLE TO ARM, LAND, MANUALLY STAGE, AND L/O NEXT BEST OPPORTUNITY

⑪ WILL CONTINUE POWERED DESCENT SINCE CANNOT CONFIRM FAILURE WITHOUT STAGING

LEGEND: **** **** RETAIN DESCENT STAGE ALAP

NO REQUIREMENT

NOTE:

1. T_1 NO STAY CONDITIONS:
   - LOSS OF 1 ASC BATT
   - LOSS OF BOTH COOLANT LOOPS
2. T_2 NO STAY CONDITIONS:
   - ~~NONE~~ LOSS OF ONE ASCENT BATTERY

LM CONTROL GO CRITERIA
5/3/71

ITEM	UNDOCKING	CIRC	PDI	PDI TO PDI+6:10	PDI+6:10 TO HI GATE	HI GATE TO LDG	STAY W/O EVA	2-MAN EVA	1-MAN EVA	LM ACT RNDZ	DOCKING
GNC											
1. GUID STEER — PGNS	←				→		← PGNS	⑥ OR	⑥	← PGNS OR	
1. GUID STEER — AGS ③							⑥		AGS →	AGS →	
2. 3-AXIS ATT CONT — PGNS RATE CMD OR PGNS AUTO	←		BOTH			②	→			← PGNS OR	
2. 3-AXIS ATT CONT — AGS RATE CMD ①										AGS →	
3. 3-AXIS TRANS ⑧	← 3-AXIS →		+X							← 1 AXIS →	← 3 AXIS →
4. FDAI-ATT/RATE/ERR	←		CREW OPTION		→						
5. T/D 40 SEC OF 57% GTC					←						
6. VHF RNG/CSM OPTICS	←	2 OF 3	→								
7. RR											
8. AOT											
9. LR	←				→						
10. DPS AUTO ON ⑧											
11. REDNT APS ON ⑤	←		→								
12. P&R GDA TRIM			← NO IMPINGEMENT CONSTRAINT →								
13. MAN THTL ⑦ (1 TTCA)	←		1 OF 2		→						
14. AUTO THTL											
DPS											
1. FU OR OX INLET/ ULLAGE PRESS PSI — < 65%	←	≥30/≥30	→								
1. FU OR OX INLET/ ULLAGE PRESS PSI — > 65%		NA		←	> 150/> 160 →						
2. ΔP OX AND FU	←	FU/OX ≤ 50	→	← ⑩	⑩ ≤ 25	⑩ →					
3. PROP TEMP >50° <90°	←		→								
4. PROP ΔT <10°F	←		→								
5. PROP QTY > BINGO/2%						←					
6. FTP BLOWDOWN CAPABILITY	←		<33% PQGS		→						
7. FU/OX PQGS ΔQ < 10% ④				←		→					
8. 35% EROSION EXCEEDED				←		→					
APS											
1. NO PROP LEAKS	←					→	← IMMEDIATE LIFTOFF →				
2. FU/OX INLET PRESS > 62 & < 220	←								→		
3. FU/OX ΔP (EITHER HIGH) < 90	←								→	APS NOT REQ FOR RNDZ	
4. PROP TEMP > 50° & < 90°	←								→		
5. PROP ΔT < 10°F	←								→		
6. NO HE LEAKS/REDUNDANT PRESS PATH	←					→	← ⑨ →				
RCS											
1. RCS LEAKS	←	NO HE/PROP LEAKS →		← NO PROP LEAK →		NO PROP LK A OR B	← NO PROP LEAKS →				
2. FU/OX MANIF PRESS >100	←		A AND B →			A OR B	← A AND B →			← A OR B →	← A & B →
3. PROP TEMP (>40°F<100°F)	←		A AND B →			A OR B	← A AND B →			← A OR B →	← A & B →
4. NO IMPINGEMENT LIMITS EXCEEDED	←					→					

① AGS RATE CMD MAY CONSIST OF 2 AXIS RATE CMD AND ONE DIRECT, I.E. ONE RATE GYRO FAILED
② FOR SINGLE CONTROL MODE LANDING IS CREW OPTION
③ LOSS OF AGS GUID STEERING IS ACCEPTABLE PROVIDED RDNT 3-AXIS ATTITUDE CONTROL EXISTS
④ MSFN WILL EVALUATE CAPABILITY TO LAND WITH RESPECT TO PROPELLANT REMAINING
⑤ MANUAL IS MANDATORY PLUS EITHER PNGS AUTO OR AGS AUTO
⑥ LOSS OF PGNS GUID STEERING IS ACCEPTABLE PROVIDED RDNT 3-AXIS ATT CONTROL EXISTS
⑦ WORK AROUND PROCEDURE EXISTS FOR MAXIMUM THRUST
⑧ NO AUTO ULLAGE PLUS NO AUTO START - PDI NO GO
⑨ APS HELIUM SOURCE LEAK AFTER PRESSURIZATION REQUIRES IMMEDIATE LIFTOFF
⑩ MUST BE CONFIRMED BY OTHER CUES

NOTE:
1 T_1 NO STAY CONDITIONS:
- APS PROP LEAK
- RCS PROP LEAK (BOTH SYS)

2 T_2 NO STAY CONDITIONS:
- APS PROP LEAK
- RCS LEAK (BOTH SYS)

LEGEND: NO REQUIREMENT

COMMUNICATIONS / INSTRUMENTATION GO CRITERIA
7/1/71

GO/NO-GO ITEM	EARTH ORBIT		TLC			LUNAR ORBIT (BEFORE UNDOCKING)			UNDOCKING	CIRC	POWERED DESCENT				LUNAR STAY			RENDEZVOUS LM ACTIVE		LUNAR ORBIT POST REND	POST DOCK	TEC
	CONT BOOST	CONT E.O.	TLI	TD&E	CONT TLC	LOI	CONT LOI	CONT L.O./DOI	NOMINAL MISSION		PDI	PDI TO PDI + 6:10	PDI + 6:10 TO HI GATE	HI GATE TO T/D	STAY W/O EVA	2-MAN EVA	1-MAN EVA			CONT L.O.	LM JETT	CSM EVA
USB 2-WAY VOICE COMM		①	CSM			CSM OR LM		CSM ⑤ OR LM	CSM & LM	CSM	CSM AND LM				CSM ③ & LM	CSM ③ & LM	CSM ③ & LM			CSM	CSM	
VHF COMM LM/CSM									SIMPLEX OR ← DUPLEX	→												
VHF COMM LM (LCRU)/EVA																SIMP ⑥	SIMP ⑥					
VHF COMM EVA/EVA																						
MSFN/EVA VOICE																⑧	⑧					
CRITICAL INSTRUMENTATION		← CSM →				CSM		CSM ⑦	LM & CSM	CSM AND LM	CSM AND LM	← ④ — LM — ④	— ④ →		← LM AND CSM →			← LM →		CSM		
LM TELEMETRY									LBR OR HBR	LBR OR HBR	LBR OR HBR				← LBR OR HBR →							
CSM TELEMETRY		← HBR OR LBR →																				
CSM SCE			SCE																			

① VHF IS ACCEPTABLE
② DELETED
③ LM RELAY TO CSM IS ACCEPTABLE
④ ADEQUATE DATA TO MAKE FINAL GO/NO GO TO CONTINUE POWERED DESCENT (TM OR ONBOARD DISPLAY)
⑤ CSM AND LM COMM REQUIRED FOR DOI
⑥ IF LM PROBLEM IS DEFINED CONTINUE EVA
PREP AND ACTIVATE LCRU ASAP
⑦ CSM AND LM CRITICAL INSTR REQUIRED FOR DOI
⑧ VOICE UPLINK TO EITHER CREWMAN, VOICE DOWNLINK FROM ONE CREWMAN OR TV

LEGEND: NO REQUIREMENT

...OT ...MP	RNDZ RDR	DECA GMBL	INTGL LTG
...r to ...ecticle	A-C pwr to RR pwr supply for generation of 400 cps 2 Ø used for slewing RR ant	A-C pwr to DECA for GDA drive pwr Aux DC to man throttle CKTS & DECA "ATCA pwr monitor" CKTS	A-C pwr to integral ltg (e.g. tb ind, & panels)
...S B ...ail	Loss of RR ant slew & track capability	GDA freezes at last position Man throttle range limited to ≈75% Cannot monitor ATCA DC pwr in DECA	Loss of tb & ind ltg

Legend

Designates DUAL POWER to function

Designates SIMILAR functions

Designates DIFFERENT functions

...GHT DISPLAYS					AC BUS A		
...RNG RT ...ALT RT	GASTA	CDR FDAI	COAS	ORDEAL	RNG/RNG RT ALT/ALT RT	GASTA	CDR FDAI
RNG, RNG ALT, ALT ind motor	Pwr to GASTA	Pwr to CDR FDAI Pwr to aux switching relay box thru RATE/ ERR MON & ATTITUDE MON sw	Pwr to fwd or ovhd COAS mount thru COAS sw	Pwr to ORDEAL stepper motor thru EARTH/ LUNAR sw	Pwr to RNG, RNG RATE ALT, ALT RATE ind logic	Pwr to GASTA resolvers	Pwr to CDR FDAI sphere drive
...f RNG, ...ATE, ALT, ...ATE ind	Loss of GASTA Computer servo Loss of IMU att data to FDAI's	Loss of CDR FDAI. Loss of switching relays	Loss of COAS reticle lt	Loss of ORDEAL stepper motor Loss of local horiz reference	Loss of RNG, RNG RATE ALT & ALT RATE ind	Loss of PGNS gimbal angle display Loss of PGNS att display	Loss of CDR FDAI att display Error & rate needles still avail LMP FDAI att display avail

DATE ~~4/27/71~~ 7/2/71

LM CONTROL

PNL 11 A&B

11 A

	AC BUS B										AC BUS A								
									BUS TIE		BUS TIE								
	SE WIND HTR	He/PQGS PROPUL DISP	S-BD ANT	ORDEAL	AGS	AOT LAMP	SE FDAI	NUM LTG	INV 2	INV 1	INV 2	INV 1	AC BUS VOLT	CDR WIND HTR	TAPE RCDR	AOT LAMP	RNDZ RDR	DECA GMBL	INTGL LTG
FUNCTIONS POWERED THRU CB	A-C pwr to LMP window htr	A-C pwr to helium, fuel, & oxid digital ind	A-C pwr to S-BD steerable ant mech drive assy	A-C pwr to ORDEAL resolvers A-C pwr to ORDEAL pnl ltg	A-C pwr to AEA outputs for FDAI & ORDEAL drive signals	A-C pwr to AOT reticle lamps	A-C pwr to LMP FDAI sphere drive	A-C pwr to all num displays	Connects inv 2 output to AC BUS B thru INVERTER sw	Connects inv 1 output to AC BUS B thru INVERTER sw	Connects inv 2 output to AC BUS A thru INVERTER sw	Connects inv 1 output to AC BUS A thru INVERTER sw	AC BUS A signal characteristics to IS for TM	A-C pwr to CDR window htr	A-C pwr to DSEA tape transport motors	A-C pwr to AOT reticle lamps	A-C pwr to RR pwr supply for generation of 400 cps 2 ø used for slewing RR ant	A-C pwr to DECA for GDA drive pwr Aux DC to man throttle CKTS & DECA "ATCA pwr monitor" CKTS	A-C pwr to integral ltg (e.g. tb ind, & panels)
EFFECT OF CB OPENING (LOSS OF/OR REMAINING FUNCTION)	Loss of LMP window defogging	Loss of onboard DPS fuel & oxid qty monitoring Loss of onboard APS helium temp & press monitoring and DPS helium press monitoring (displays blank out)	Loss of S-BD steerable ant S-BD in-flight ant avail thru S-BAND sel	Loss of ORDEAL	Loss of monitoring of AEA outputs with FDAI & ORDEAL	AC BUS A pwr avail	Loss of LMP FDAI att display Error & rate needles still avail CDR FDAI att display avail	Loss of all num displays (including DEDA readout) Loss of RCS PRESS & RNG, RNG RATE ALT, ALT RATE IND, & X-PNTR scales	AC BUS A bus tie inv 2 pwr avail	AC BUS A bus tie inv 1 pwr avail	AC BUS B bus tie inv 2 pwr avail	AC BUS B bus tie inv 1 pwr avail	Loss of onboard monitoring of a-c characteristics Loss of a-c characteristics TM	Loss of CDR window defogging	Loss of recording capability	AC BUS B pwr avail	Loss of RR ant slew & track capability	GDA freezes at last position Man throttle range limited to ≈75% Cannot monitor ATCA DC pwr in DECA	Loss of tb & ind ltg

Legend

- Designates DUAL POWER to function
- Designates SIMILAR functions
- Designates DIFFERENT functions

11 B

	RCS SYS A								FLIGHT DISPLAYS								AC BUS A		
	MAIN SOV	QUAD 4 TCA	QUAD 3 TCA	QUAD 2 TCA	QUAD 1 TCA		ASC FEED 2	ASC FEED 1	THRUST	MISSION TIMER	CDR X-PNTR	RNG/RNG RT ALT/ALT RT	GASTA	CDR FDAI	COAS	ORDEAL	RNG/RNG RT ALT/ALT RT	GASTA	CDR FDAI
FUNCTIONS POWERED THRU CB	Pwr to sys A main fuel & oxid sov thru SYS A MAIN SOV sw	Pwr to prplnt vlvs prim coils of sys A quad 4 TCA (A4D & A4R)	Pwr to prplnt vlvs prim coils of sys A quad 3 TCA (A3R & A3U)	Pwr to prplnt vlvs prim coils of sys A quad 2 TCA (A2D & A2A)	Pwr to prplnt vlvs prim coils of sys A quad 1 TCA (A1U & A1F)		Pwr to sys A sec APS prplnt interconnect vlvs thru SYS A ASC FEED 2 sw	Pwr to sys A prim APS prplnt interconnect vlvs thru SYS A ASC FEED 1 sw	Pwr to eng THRUST ind Pwr to aux switching relay box thru ENG THRUST CONT THR CONT sw	Pwr to MISSION TIMER ind	Pwr to CDR X-pointer ind Pwr to aux switching relay box thru MODE SEL & RATE/ERR MON sw	Pwr to RNG, RNG RATE, ALT, ALT RATE ind drive motor	Pwr to GASTA	Pwr to CDR FDAI Pwr to aux switching relay box thru RATE/ ERR MON & ATTITUDE MON sw	Pwr to fwd or ovhd COAS mount thru COAS sw	Pwr to ORDEAL stepper motor thru EARTH/ LUNAR sw	Pwr to RNG, RNG RATE ALT, ALT RATE ind logic	Pwr to GASTA resolvers	Pwr to CDR FDAI sphere drive
EFFECT OF CB OPENING (LOSS OF/OR REMAINING FUNCTION)	Cannot change sys A main sov status (Normally Open) Note RCS sys A will not use APS prplnts if sov are open	Loss of prim auto & man cont of sys A quad 4 TCA's (hardover, AGS direct, & +X-transl cont avail thru sec coils)	Loss of prim auto & man cont of sys A quad 3 TCA's (hardover, AGS direct, & +X-transl cont avail thru sec coils)	Loss of prim auto & man cont of sys A quad 2 TCA's (hardover, AGS direct, & +X-transl cont avail thru sec coils)	Loss of prim auto & man cont of sys A quad 1 TCA's (hardover, AGS direct, & +X-transl cont avail thru sec coils)		Cannot change status of sec pair of sys A APS interconnect vlvs (ASC feed 2 vlv Normally Closed)	Cannot change status of prim pair of sys A APS interconnect vlvs (ASC feed 1 vlv Normally Open)	Loss of eng THRUST ind Loss of switching relays	Loss of MISSION TIMER ind	Loss of CDR X-pointer ind Loss of switching relays Loss of AEA & LDG RDR lat vel & LDG RDR fwd vel on LMP X-pntr also ~~LDG RDR alt data on RNG/ALT ind~~ LDG RADAR AND AGS ALT DATA ON RNG/ALT IND	Loss of RNG, RNG RATE, ALT, ALT RATE ind	Loss of GASTA Computer servo Loss of IMU att data to FDAI's	Loss of CDR FDAI Loss of switching relays	Loss of COAS reticle lt	Loss of ORDEAL stepper motor Loss of local horiz reference	Loss of RNG, RNG RATE ALT & ALT RATE ind	Loss of PGNS gimbal angle display Loss of PGNS att display	Loss of CDR FDAI att display Error & rate needles still avail LMP FDAI att display avail

DATE 4/27/77 7/2/71

LM CONTROL

	ECA PWR	ED: LDG GEAR FLAG	ED: LOGIC PWR A	LTG: UTIL	LTG: ANUN/DOCK/ COMPNT
	des ont	Pwr to LDG GEAR DEPLOY tb	Pwr to EDS sys A	Pwr to portable util lts thru CDR & LMP UTILITY LIGHTS sw	Pwr to caut & warn anun, eng START & STOP, comp caut, pwr fail, & DSKY status lts Pwr to docking lts thru EXTERIOR LTG & LM/ SLA press sw Pwr to DEDA OPR ERR lt
	f des eng ing & ng ity f AGS in dead- election om DES VRD cb start eng thrust) f GDA ind	Loss of LDG GEAR DEPLOY tb	Loss of EDS sys A EDS sys B avail	Loss of portable util lts	Loss of docking lts (During TD & E, no backup) Loss of Anun lighting LMP's ANUN/DOCK/ COMPNT cb avail after TD & E Loss of DEDA OPR ERR lt

LEGEND

Designates DUAL POWER to function

Designates SIMILAR functions

Designates DIFFERENT functions

	HF A CVR	CDR AUDIO	PGNS: SIG STR DISP	PGNS: LDG RDR	PGNS: RNDZ RDR	PGNS: LGC/ DSKY	PGNS: IMU STBY	PGNS: IMU OPR
F P T	VHF A ru RCVR sw	Pwr to CDR audio center	Pwr to SIGNAL STRENGTH ind	Pwr to LR pwr supply Interrupts pwr to htr cont ckt	Pwr to RR electronics assy	Pwr to LGC & PSA pwr supplies	Pwr to IMU temp cont ckt	Pwr to IMU, PSA, CDU, & PTA
E C (L O R F	rcvr	Loss of relay capability CDR must use LMP audio center Loss of all VHF B xmtr voice	Loss of onboard LR & RR monitoring	Loss of LR	Loss of RR	Loss of PGNS Loss of 1.024-mc clock AGS avail	Loss of PIPA & IRIG htrs, temp alarm thermostat IMU accuracy degraded	Loss of IMU, PSA, CDU, & PTA Loss of ISS & att data to LGC & ind LGC avail, but cannot perform all functions Loss of manual throttle in PGNS mode

11 C

	HEATERS						INST	STAB/CONT								ED		LTG	
		RNDZ RDR																	
	URINE LINE	STDBY	OPR	LDG RDR	DOCK WINDOW	AOT	SIG CONDR 1	AEA	ABORT STAGE	ATCA (PGNS)	AELD	ENG CONT	ATT DIR CONT	ENG START OVRD	DECA PWR	LDG GEAR FLAG	LOGIC PWR A	UTIL	ANUN/DOCK/ COMPNT
FUNCTIONS POWERED THRU CB	Pwr to urine line htr to prevent freeze-up of vent tube valve	Pwr to RR ant htr cont ckt to maintain ant above min survival temp	Pwr to RR htr cont ckt for ant & electronics assy	Pwr to LR htr cont ckt to maintain ant above min survival temp	Pwr to docking window htr	Pwr to AOT htrs	Pwr to ERA 1 in SCEA	Pwr to AEA pwr supply for internal use & DEDA pwr	Pwr to abort stage electronics thru ABORT STAGE sw	Pwr to enable prim preamps Redundant bias to jet drivers under PGNS & ATCA control Pwr to S&C cont assy for guid cont switching	Pwr to S&C cont assy No. 1 for asc eng on cmd, AGS auto deadband selection, & staging cmd during abort stage to ED SYS A	Pwr to disable auto thr cont Pwr to des eng stop when asc eng armed or when staging Redundant feed to des eng arm ckts Pwr to reset man eng start relays Pwr for man des eng start Pwr to LUNAR CONTACT lt on pnl 1	Pwr to ACA for direct firing of RCS Pwr to +X TRANSL pb Enabling voltage for AGS pulse mode cmds	Pwr to eng START sw Redundant pwr to ENG ARM sw	Pwr to des eng & cont logic of DECA	Pwr to LDG GEAR DEPLOY tb	Pwr to EDS sys A	Pwr to portable util lts thru CDR & LMP UTILITY LIGHTS sw	Pwr to caut & warn anun, eng START & STOP, comp caut, pwr fail, & DSKY status lts Pwr to docking lts thru EXTERIOR LTG & LM/SLA press sw Pwr to DEDA OPR ERR lt
EFFECT OF CB OPENING (LOSS OF/OR REMAINING FUNCTION)	Loss of htrs causes gradual degradation of urine collection capability	If RR temp below min survival temp, permanent degradation results CB not essential when RR OPR cb is closed	Loss of RR, or degradation of response	If LR temp below min survival temp, permanent degradation results CB not required when cb PGNS; LDG RDR is closed	Loss of window defrosting & defogging	Loss of AOT defrosting	Loss of ERA 1 (approx half oper data)	LMP AEA cb avail	STAGE sw avail Note If ABORT STAGE pb is pushed, des eng will shut down if thrusting, ASC eng will not ignite until ENG ARM sw - ASC	Loss of PGNS cont Prim pwr provided with LMP ATCA cb Cannot switch from AGS to PGNS RCS firings not affected in AGS	LMP AELD cb avail Loss of engine on signal to ED SYS A	Loss of redundant feed to des eng arm Loss of man des eng start & stop Loss of man thrust cont (remains in auto mode) Loss of eng gimbal off, if DPS is armed Under AGS cont: loss of analog gimbal trim cmds & auto min deadband selection when starting des eng Loss of LUNAR CONTACT lt on pnl 1	Loss of AGS direct & pulse modes, hardover, & + X-TRANSL pb (sec TCA coils not avail) Man att cont avail via Att Hold/Rate cmd & PGNS min impulse modes	Prim pwr avail for ENG ARM sw from LMP DISP/ ENG OVRD LOGIC cb Loss of man des & asc eng start Auto eng start avail	Loss of des eng gimbaling & throttling capability Loss of AGS auto min deadband selection Pwr from DES ENG OVRD cb avail to start eng (at max thrust) Loss of GDA caution ind	Loss of LDG GEAR DEPLOY tb	Loss of EDS sys A EDS sys B avail	Loss of portable util lts	Loss of docking lts (During TD & E, no backup) Loss of Anun lighting LMP's ANUN/DOCK/ COMPNT cb avail after TD & E Loss of DEDA OPR ERR lt

LEGEND
- ——— Designates DUAL POWER to function
- - - - - Designates SIMILAR functions
- ═══ Designates DIFFERENT functions

11 D

	HEATER RCS SYS A/B-1				ECS					COMM						PGNS					
							GLYCOL PUMP				SEC S-BD										
	QUAD 4	QUAD 3	QUAD 2	QUAD 1	SUIT FAN 1	CABIN FAN	2	1	AUTO TRNFR	UP DATA LINK	XMTR/RCVR	PWR AMPL	VHF B XMTR	VHF A RCVR	CDR AUDIO	SIG STR DISP	LDG RDR	RNDZ RDR	LGC/ DSKY	IMU STBY	IMU OPR
FUNCTIONS POWERED THRU CB	Pwr to sys A/B-1 htr for each TCA of cluster 4	Pwr to sys A/B-1 htr for each TCA of cluster 3	Pwr to sys A/B-1 htr for each TCA of cluster 2	Pwr to sys A/B-1 htr for each TCA of cluster 1	Pwr to suit fan No. 1 (suit ckt assy) thru SUIT FAN sel	Pwr to cabin fan thru ECS relay box	Pwr to glycol pump No. 2 thru GLYCOL sel	Pwr to glycol pump No. 1 thru GLYCOL sel	Energizes transfer relay to auto switch to pump No. 2 when pump No. 1 ΔP drops below preset value	Pwr to DUA pwr supply	Pwr to sec pwr supply in S-BD xcvr thru XMTR/RCVR sw Pwr to PMP for emer key and VOICE BU functions	Pwr to sec pwr supply in S-BD pwr ampl thru PWR AMPL sw	Pwr to VHF B xmtr voice & data ckts thru VHF B XMTR sw	Pwr to VHF A rcvr thru VHF A RCVR sw	Pwr to CDR audio center	Pwr to SIGNAL STRENGTH ind	Pwr to LR pwr supply Interrupts pwr to htr cont ckt	Pwr to RR electronics assy	Pwr to LGC & PSA pwr supplies	Pwr to IMU temp cont ckt	Pwr to IMU, PSA, CDU, & PTA
EFFECT OF CB OPENING (LOSS OF/OR REMAINING FUNCTION)	Loss of set of htrs in cluster 4 (sys A/B-2 htrs avail, longer warmup required)	Loss of set of htrs in cluster 3 (sys A/B-2 htrs avail, longer warmup required)	Loss of set of htrs in cluster 2 (sys A/B-2 htrs avail, longer warmup required)	Loss of set of htrs in cluster 1 (sys A/B-2 htrs avail, longer warmup required)	Life support system degraded Backup is SUIT FAN sel - 2	Loss of cabin fan	Loss of prim loop redundancy To activate sec loop, WATER TANK SELECTOR vlv - SEC, GLYCOL sel - INST (SEC), SEC EVAP FLOW vlv-OPEN, GLYCOL PUMP SEC cb - close, PRIM EVAP FLOW #1 - closed	Loss of glycol pump No. 1 (if AUTO TRNFR cb closed, glycol pump No. 2 auto activated) Auto transfer relay switch to pump No. 2 (To disable GLYCOL comp caut lt, manually switch GLYCOL sel - PUMP 2)	Loss of auto transfer Manually select pump: GLYCOL sel - PUMP 1 or PUMP 2	Loss of digital uplink capability Loss of received S-bd backup voice Prime voice avail	Prim S-BD xcvr avail Loss of sec S-BD xcvr	Loss of sec S-BD pwr ampl Prim pwr ampl avail	VHF A xmtr voice ckts avail Loss of data & voice transmission via VHF B	VHF B rcvr avail	Loss of relay capability CDR must use LMP audio center Loss of all VHF B xmtr voice	Loss of onboard LR & RR monitoring	Loss of LR	Loss of RR	Loss of PGNS Loss of 1.024-mc clock AGS avail	Loss of PIPA & IRIG htrs, temp alarm thermostat IMU accuracy degraded	Loss of IMU, PSA, CDU, & PTA Loss of ISS & att data to LGC & ind LGC avail, but cannot perform all functions Loss of manual throttle in PGNS mode

LM CONTROL

		PROPUL
:V 1	DC BUS VOLT	DES HE REG/VENT
om CDR inv No. 1 eration /, s, a-c hru TER sw	Pwr from CDR bus to IS, & to monitor bus voltage for telemetry & warn lt Pwr to PCM/TE, sig sensors & sig condrs via relay 4K6 for prelaunch telemetry	Pwr to DPS helium solenoid vlvs thru DES He REG 1 & 2 sw Pwr to DPS prplnt vent solenoid vlvs thru DES FUEL & OXID VENT sw
2 avail VERTER r from us to 2)	Loss of monitoring of CDR bus Loss of prelaunch telemetry	Cannot change status of helium solenoid vlv (Prim: Normally Open, Sec: Normally Closed during normal mission operation) Cannot change status of solenoid vent vlvs

LEGEND

Designates DUAL POWER to function

Designates SIMILAR functions

Designates DIFFERENT functions

11 E

DATE 4/21/71

	EPS											PROPUL
	BAT FEED TIE		CROSS TIE: BAL LOADS	CROSS TIE: BUS	XLUNAR BUS TIE	DES ECA CONT	DES ECA	ASC ECA CONT	ASC ECA	INV 1	DC BUS VOLT	DES HE REG/VENT
FUNCTIONS POWERED THRU CB	Connects bat No. 3 or lunar bat, & bat No. 4 & 6 to CDR d-c bus During bat No. 5 backup, also connects bat No. 5 to CDR d-c bus	Redundant cb	Supplies redundant pwr to CWEA, EPS disp, sig sensor, sig cond #2, & PCM/TE Connects CDR bus to LMP bus thru LMP CROSS TIE cb	Backup cb	Connects CDR neg bus to neg xlunar bus for LM ground	Pwr from CDR bus to low- and high-voltage coils in ECA No. 1 & 2 thru HI VOLTAGE & LOW VOLTAGE sw Pwr to des bats lv/hv off & deadface relay reset for abort stage	Pwr from CDR bus to pwr supplies of both des ECA's for current & reverse current ind & O/C protection Pwr to relays for abort stage	Pwr from CDR bus to norm & backup main feed contactor coils in ECA No. 3 & 4 thru NORMAL FEED & BACK UP FEED sw to switch off asc bats Pwr to DES BATS sw	Pwr from CDR bus to pwr supplies of both asc ECA's for current & reverse current ind & O/C protection	Pwr from CDR bus to inv No. 1 for generation of 115V, 400-cps, a-c pwr, thru INVERTER sw	Pwr from CDR bus to IS, & to monitor bus voltage for telemetry & warn lt Pwr to PCM/TE, sig sensors & sig condrs via relay 4K6 for prelaunch telemetry	Pwr to DPS helium solenoid vlvs thru DES He REG 1 & 2 sw Pwr to DPS prplnt vent solenoid vlvs thru DES FUEL & OXID VENT sw
EFFECT OF CB OPENING (LOSS OF/OR REMAINING FUNCTION)	Adjacent cb avail	Adjacent cb avail	Loss of LMP bus when CSM powers LM results in loss of AGS & possible loss of S-bd steerable ant	Only closed in event of feeder short when powering LMP bus thru CDR bus, or vice versa	No loss of function; relay contacts in parallel with cb	Redundant cb on LMP panel supplies pwr from LMP bus	Redundant cb on LMP panel supplies pwr from LMP bus	Redundant cb on LMP panel supplies pwr from LMP bus	Redundant cb on LM panel supplies pwr from LMP bus	Inv No. 2 avail thru INVERTER sw (pwr from LMP bus to inv No. 2)	Loss of monitoring of CDR bus Loss of prelaunch telemetry	Cannot change status of helium solenoid vlv (Prim: Normally Open, Sec: Normally Closed during normal mission operation) Cannot change status of solenoid vent vlvs

LEGEND

- ——— Designates DUAL POWER to function
- - - - Designates SIMILAR functions
- ═══ Designates DIFFERENT functions

END 11 E

LM CONTROL

	PROPUL		
AIN OV	DISP/ENG OVRD LOGIC	PQGS	ASC He REG
sys B el & thru MAIN	Pwr to MPS: FUEL & OXID TEMP & PRESS ind thru PRPLNT TEMP/PRESS MON sw & to all MPS tb Redundant pwr to eng arm circuits for manual asc eng arm & des cmd ovrd	Pwr to DPS prplnt qty gaging sys cont unit thru PRPLNT QTY MON sw	Pwr to APS helium solenoid vlv thru ASC He REG 1 & 2 sw
change ain sov Normally ote B will APS if sov n	Loss of onboard monitoring of MPS prplnt temp & press (Pwr fail light above PRESS ind goes on) Loss of monitoring of MPS vlv status (tb indicates pwr off) Loss of redundant pwr	Loss of onboard monitoring of DPS prplnt qty	Cannot change status of helium solenoid vlvs (Normally Open)

LEGEND

Designates DUAL POWER to function

Designates SIMILAR functions

Designates DIFFERENT functions

	INST					ECS
TCA AGS)	DES ENG OVRD	CWEA	SIG SENSOR	PCM/TE	SIG CONDR 2	SUIT FLOW CONT
able abort able both C cont uid cont gyro test pwr	Redundant pwr to actuator isol & pilot vlvs of des eng Note Eng fires at full throttle only	Pwr to CWEA	Pwr to all subsys sensors	Pwr to PCMTEA	Pwr to ERA 2 in SCEA	Pwr to suit isol vlv solenoid for auto closure
to AGS provided ATCA cb from GS unaffected t be tested	Loss of des eng override	Loss of CWEA Most malfunctions are monitored by MSFN via telemetry: some are monitored on cabin ind	Loss of approx 40 subsys sensors MSFN & vehicle: DES & ASC oxygen, oxid manifold, suit, cabin, & all DPS, APS, RCS pressure	Loss of telemetry to MSFN Loss of voice & data S-bd sub-carriers, Rng/Alt ind, emer key, inv timing, DSEA ind, & ATCA	Loss of ERA 2: (approx-half oper data)	Loss of torn suit protection

DATE 4/21/71

LIGHTING
PYRO
DC EPS DESCENT
DC EPS ASCENT
AC EPS
PNL 16 A&B
PNL 16 C&D

16 A

	FLT DISP		RCS SYS B										PROPUL		
	EVENT TIMER/ SE FDAI	SE X-PNTR	ASC FEED 1	ASC FEED 2		QUAD 1 TCA	QUAD 2 TCA	QUAD 3 TCA	QUAD 4 TCA	CRSFD	TEMP/PRESS DISP - FLAGS	PQGS/ DISP	MAIN SOV	DISP/ENG OVRD LOGIC	PQGS	ASC He REG
FUNCTIONS POWERED THRU CB	Pwr to EVENT TMR ind Pwr to LMP FDAI Pwr to aux switching relay box thru RATE/ ERR MON & ATTITUDE MON sw	Pwr to LMP X pointer ind PWR to aux switching relay box thru RATE/ ERR MON sw	Pwr to sys B prim APS prplnt interconnect vlvs thru SYS B ASC FEED 1 sw	Pwr to sys B sec APS prplnt interconnect vlvs thru SYS B ASC FEED 2 sw		Pwr to prplnt vlvs prim coils of sys B quad 1 TCA (B1L & B1D)	Pwr to prplnt vlvs prim coils of sys B quad 2 TCA (B2L & B2U)	Pwr to prplnt vlvs prim coils of sys B quad 3 TCA (B3A & B3D)	Pwr to prplnt vlvs prim coils of sys B quad 4 TCA (B4F & B4U)	Pwr to prplnt crossfeed vlvs thru CRSFD sw	Pwr to RCS TEMP & PRESS ind thru TEMP/PRESS MON sel & to all RCS tb	Pwr to RCS sys A & sys B prplnt qty computers & QUANTITY ind	Pwr to sys B main fuel & oxid sov thru SYS B MAIN SOV sw	Pwr to MPS: FUEL & OXID TEMP & PRESS ind thru PRPLNT TEMP/PRESS MON sw & to all MPS tb Redundant pwr to eng arm circuits for manual asc eng arm & des cmd ovrd	Pwr to DPS prplnt qty gaging sys cont unit thru PRPLNT QTY MON sw	Pwr to APS helium solenoid vlv thru ASC He REG 1 & 2 sw
EFFECT OF CB OPENING (LOSS OF/OR REMAINING FUNCTION)	Loss of EVENT TIMER ind Loss of LMP FDAI Loss of switching relays	Loss of LMP X pointer ind Loss of switching relays	Cannot change status of prim pair of APS interconnect vlvs (ASC FEED 1 vlv Normally Open)	Cannot change status of sec pair of APS interconnect vlvs (ASC FEED 2 vlv Normally Closed)		Loss of prim auto & man cont of sys B quad 1 TCA's (hardover, AGS direct, & +X-transl cont avail thru sec coils)	Loss of prim auto & man cont of sys B quad 2 TCA's (hardover, AGS direct, & +X-transl cont avail thru sec coils)	Loss of prim auto & man cont of sys B quad 3 TCA's (hardover, AGS direct, & +X-transl cont avail thru sec coils)	Loss of prim auto & man cont of sys B quad 4 TCA's (hardover, AGS direct, & +X-transl cont avail thru sec coils)	Cannot change status of crsfd vlvs (Normally Closed)	Loss of onboard monitoring of RCS prplnt temp & press, & helium press (Pwr fail light above PRESS ind goes on) Loss of monitoring of RCS vlv status (tb indicates pwr off)	Loss of onboard monitoring of RCS sys A & sys B prplnt qty (Pwr fail light above ind goes on)	Cannot change sys B main sov status (Normally Open) Note RCS sys B will not use APS prplnts if sov are open	Loss of onboard monitoring of MPS prplnt temp & press (Pwr fail light above PRESS ind goes on) Loss of monitoring of MPS vlv status (tb indicates pwr off) Loss of redundant pwr	Loss of onboard monitoring of DPS prplnt qty	Cannot change status of helium solenoid vlvs (Normally Open)

LEGEND

- Designates DUAL POWER to function
- Designates SIMILAR functions
- Designates DIFFERENT functions

16 B

	LTG				ED	STAB/CONT								INST				ECS
	FLOOD	TRACK	ANUN/DOCK/ COMPNT	MASTER ALARM	LOGIC PWR B	AEA	ENG ARM	ASA	AELD	ATCA	ABORT STAGE	ATCA (AGS)	DES ENG OVRD	CWEA	SIG SENSOR	PCM/TE	SIG CONDR 2	SUIT FLOW CONT
FUNCTIONS POWERED THRU CB	Pwr to cabin pnl, fwd & ovhd flood lts thru FLOOD sw Pwr to cabin fwd & ovhd lt thru docking hatch sw	Pwr to tracking lt thru EXTERIOR LTG sw & tracking lt electronics assy	Pwr to caut & warn anun, eng START & STOP, docking thru EXTERIOR LTG sw, comp caut, ind pwr fail, & DSKY status lts Pwr to DEDA OPR ERR lt	Pwr to MASTER ALARM lt & tone gen	Pwr to EDS sys B	Pwr to AEA pwr supply for internal use & DEDA pwr	(ENG ARM sw - DES) Pwr to des eng actuator isol vlvs thru DECA relays (ENG ARM sw - ASC) Pwr to AELD to enable asc eng ignition Pwr to relay drivers for auto APS & DPS cont logic	Pwr to ASA pwr supply & ASA heaters	Pwr to S&C cont assy No. 1 for asc eng on cmd & AGS auto dead band selection & abort stage signal to ED sys B stage relay	Pwr to ATCA pwr supply for ATCA & DECA pwr Pwr to LUNAR CONTACT lt on pnl 3	Pwr to abort stage electronics thru ABORT STAGE sw	Pwr to enable abort preamps Pwr to enable both TTCA's Pwr to S&C cont assy for guid cont switching Provides gyro test pwr	Redundant pwr to actuator isol & pilot vlvs of des eng Note Eng fires at full throttle only	Pwr to CWEA	Pwr to all subsys sensors	Pwr to PCMTEA	Pwr to ERA 2 in SCEA	Pwr to suit isol vlv solenoid for auto closure
EFFECT OF CB OPENING (LOSS OF/OR REMAINING FUNCTION)	Loss of flood lts	Loss of tracking lt	Loss of caut & warn anun, eng START & STOP, docking, comp caut, ind pwr fail, & DSKY status lts Alternative is CDR CB LTG: ANUN/DOCK/ COMPNT Loss of DEDA OPR ERR lt	Loss of MASTER ALARM lt and audio tone	Loss of EDS sys B EDS sys A avail	CDR AEA cb avail	Pwr for ENG ARM sw avail with CDR CB S/C: ENG START OVRD Arming des eng with ABORT pb avail Arming asc eng with ABORT STAGE pb avail Loss of auto eng start for APS & DPS. (START pb avail)	Loss of AGS att cont Man att cont avail	CDR CB S/C: AELD avail Loss of engine on signal to ED sys B	Loss of AGS auto & att hold/ rate cmd cont modes Loss of FDAI rate indication & error ref Loss of RR auto track & slew modes (loss of slewing pwr): LGC mode avail Loss of gimbal & throttle capability (DPS start at max thrust) Loss of APS auto on Loss of LUNAR CONTACT Lt on pnl 3	Abort staging avail with CDR CB S/C: ABORT STAGE Note Des eng will shut down, but asc eng will not ignite until ENG ARM sw - ASC Loss of asc eng arm enable (ENG ARM sw avail) & time delay Loss of des eng override	Loss of auto AGS RCS firing Prim pwr provided with LMP ATCA cb Cannot sw from PGNS to AGS RCS firing unaffected in PGNS RGA cannot be tested	Loss of des eng override	Loss of CWEA Most malfunctions are monitored by MSFN via telemetry; some are monitored on cabin ind	Loss of approx 40 subsys sensors MSFN & vehicle: DES & ASC oxygen, oxid manifold, suit, cabin, & all DPS, APS, RCS pressure	Loss of telemetry to MSFN Loss of voice & data S-bd sub-carriers, Rng/Alt ind, emer key, inv timing, DSEA ind, & ATCA	Loss of ERA 2; (approx-half oper data)	Loss of torn suit protection

DATE 4/21/71

PNL 16 A&B

LM CONTROL

SUIT FAN 2	SUIT FAN ΔP	DIVERT VLV	CO_2 SENSOR
Pwr to suit fan No. 2 (suit ckt assy) thru SUIT FAN sel	Pwr to fan ΔP sensor (ind function only)	Pwr to SUIT GAS DIVERTER vlv for auto closure caused by low cabin press or by PRESS REG A or B vlv - EGRESS	Pwr to CO_2 sensor
Loss of suit fan No. 2 In cabin mode, remove helmet & breath cabin air. After period of time, flush cabin air In egress mode PRESS REG A & B vlv - DIRECT O_2	Loss of indication for failure of suit fan No. 1 or 2 SELECT SUIT FAN No. 1, IF OPERATIONAL - IF NOT	Loss of auto vlv closure; manual mode avail	Loss of CO_2 ind. CO_2 comp caut lt, & TM

LEGEND

Designates DUAL POWER to functio

Designates SIMILAR functions

Designates DIFFERENT functions

		CROSS TIE			BAT FEED TIE
ES CONT	XLUNAR BUS TIE	BUS	BAL LOADS		
us to low & in ECA No. 1 TAGE & LOW v/hv off & deadface ort stage	Connects LMP neg bus to neg xlunar bus for LM ground	Backup cb	Connects LMP bus to CDR bus thru CDR CROSS TIE cb	Connects bat No. 2 or lunar bat, & bat No. 1 & 5 to LMP d-c bus During bat 6 backup also connects bat No. 6 to LMP d-c bus	Redundant cb
CDR panel supplies s	No loss of function; relay contacts in parallel with cb	Only closed in event of feeder short when powering LMP bus thru CDR bus, or vice versa	BUS CROSS TIE cb avail	Adjacent cb avail	Adjacent cb avail

DATE ~~4/27/71~~ 7/2/71

LIGHTING
PYRO
EPS
DC EPS DESCENT
DC EPS ASCENT
AC EPS
O_2 SUPPLY SUIT LOOP
PNL 16 C&D

16 C

	PRIM S-BD									ECS								
	DISP	SE AUDIO	VHF A XMTR	VHF B RCVR	PWR AMPL	XMTR/RCVR	S-BD ANT	PMP	TV	DISP	GLYCOL PUMP SEC		LCG PUMP	CABIN FAN CONT	CABIN REPRESS	SUIT FAN 2	SUIT FAN ΔP	DIVERT VLV	CO_2 SENSOR
FUNCTIONS POWERED THRU CB	Pwr to COMM ANT: PITCH, YAW, & SIGNAL STRENGTH ind	Pwr to LMP audio center	Pwr to VHF A xmtr pwr supply	Pwr to VHF B rcvr	Pwr to prim pwr supply in S-bd pwr ampl thru PWR AMPL sw	Pwr to prim pwr supply in S-bd xcvr thru XMTR/RCVR sw Pwr to PMP for emergency key & voice backup functions thru XMTR/ RCVR and PCM sw	Pwr to S-bd steerable ant	Pwr to PMP pwr supply Pwr to spacesuit biomed ckts thru BIOMED sw & umbilicals	Pwr to TV camera pwr supply	Pwr to all ECS ind	Pwr to backup glycol pump in coolant recirculation assy (Not normally used in flight, except in emergency or checkout modes)		Pwr to LCG pump	Turns off cabin fans when PRESS REG A or B in EGRESS	Pwr to CABIN REPRESS vlv & CABIN warn lt	Pwr to suit fan No. 2 (suit ckt assy) thru SUIT FAN sel	Pwr to fan ΔP sensor (ind function only)	Pwr to SUIT GAS DIVERTER vlv for auto closure caused by low cabin press or by PRESS REG A or B vlv - EGRESS	Pwr to CO_2 sensor
EFFECT OF CB OPENING (LOSS OF/OR REMAINING FUNCTION)	Loss of S-bd ant pitch & yaw position indications & S-bd received signal strength indication	Loss of relay mode LMP must use CDR audio center Loss of DSEA and VHF-A XMTR	Loss of VHF ranging & VHF A voice	Loss of VHF ranging Loss of EVA data Loss of VHF B received voice	Loss of prim S-bd pwr ampl See pwr ampl avail	Loss of prim S-BD XCVR See S-BD xcvr avail See pwr to PMP avail	Loss of S-BD steerable ant S-BD comm thru omni ant avail	Loss of S-BD biomed, PCM, downlink voice, & EMU data, except emergency key & backup voice	Loss of TV camera	Loss of all ECS cabin ind	Loss of sec coolant loop		Loss of circulation thru LCG from LM	Loss of cabin fan auto shutoff Turn off fan by opening fan cb	Loss of auto cabin repress mode; manual mode avail Loss of indication of low cabin press (CABIN warn lt), CABIN PRESS ind avail	Loss of suit fan No. 2 In cabin mode, remove helmet & breath cabin air. After period of time, flush cabin air In egress mode PRESS REG A & B vlv - DIRECT O_2	Loss of indication for failure of suit fan No. 1 or 2 SELECT SUIT FAN No. 1, IF OPERATIONAL - IF NOT	Loss of auto vlv closure; manual mode avail	Loss of CO_2 ind. CO_2 comp caut lt, & TM

LEGEND
- Designates DUAL POWER to functio
- Designates SIMILAR functions
- Designates DIFFERENT functions

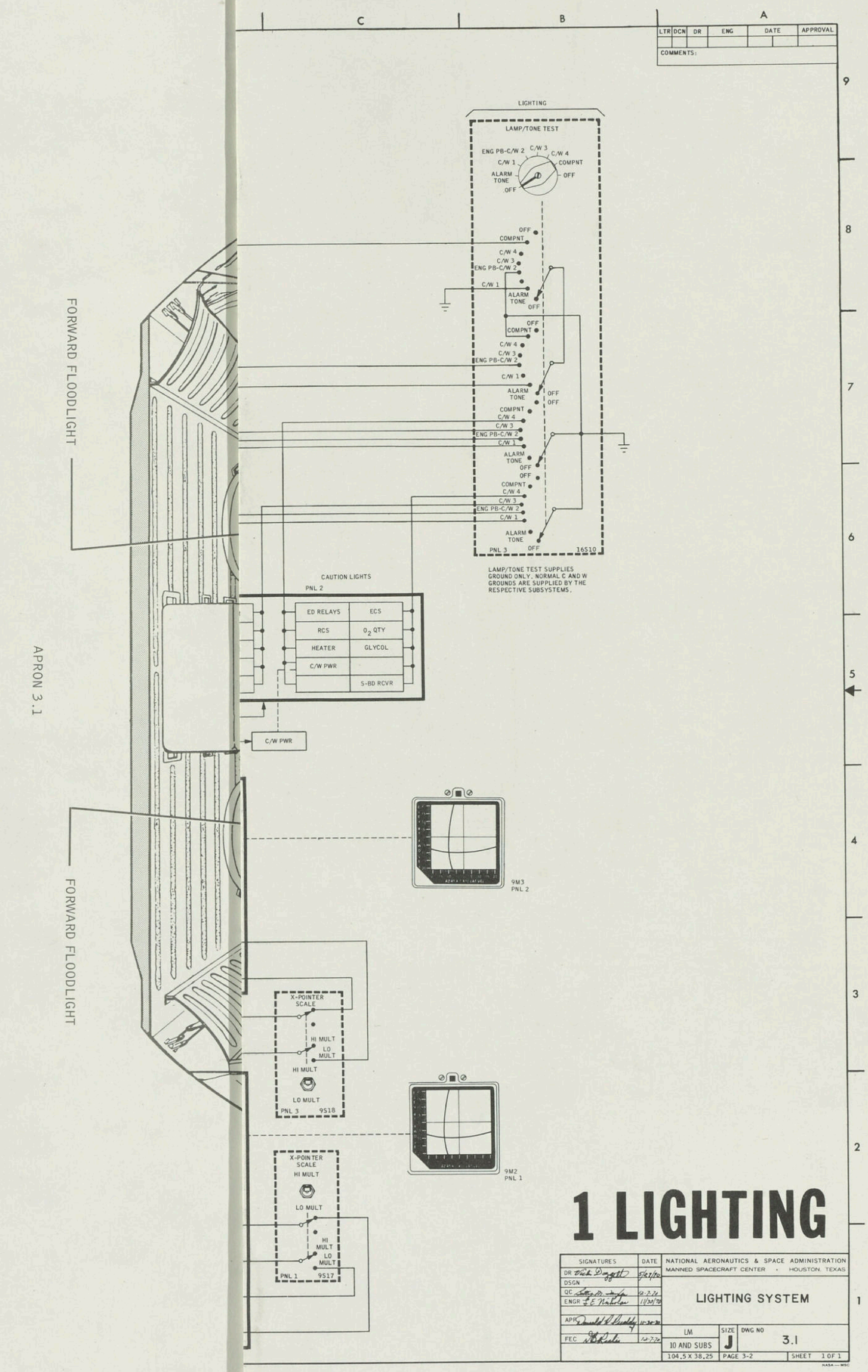
16 D

	HEATERS								EPS											
		RCS SYS A/B-2						CAMR SEQ									CROSS TIE		BAT FEED TIE	
	MESA	QUAD 1	QUAD 2	QUAD 3	QUAD 4	DISP	S-BD ANT		DISP	DC BUS VOLT	INV 2	ASC ECA	ASC ECA CONT	DES ECA	DES ECA CONT	XLUNAR BUS TIE	BUS	BAL LOADS		
FUNCTIONS POWERED THRU CB	Pwr to six htrs on MESA	Pwr to sys A/B-2 htr for each TCA of cluster 1 thru HTR CONT: RCS SYS A/B 2 QUAD 1 sw	Pwr to sys A/B-2 htr for each TCA of cluster 2 thru HTR CONT: RCS SYS A/B 2 QUAD 2 sw	Pwr to sys A/B-2 htr for each TCA of cluster 3 thru HTR CONT: RCS SYS A/B 2 QUAD 3 sw	Pwr to sys A/B-2 htr for each TCA of cluster 4 thru HTR CONT: RCS SYS A/B 2 QUAD 4 sw	Pwr to HTR CONT: TEMP ind	Pwr to S-bd ant htrs	Pwr to sequence camera	Pwr from LMP bus to AMPS & VOLTS ind, & to th	Pwr from LMP bus to IS, to DC BUS FAULT comp caut lt, & to monitor bus voltage for TM & warn lt	Pwr from LMP to inv No. 2 for generation of 115V, 400-cps, a-c pwr, thru INVERTER sw	Pwr from LMP bus to pwr supplies of both asc ECA's for current & reverse current ind & O/C protection	PWR from LMP bus to norm & backup main feed contactor coils in ECA No. 3 & 4 thru NORMAL FEED & BACK UP FEED sw to switch off asc bats Pwr to DES BATS sw	Pwr from LMP bus to pwr supplies of both des ECA'S for current & reverse current ind & O/C protection Pwr to relays for abort stage	Pwr from LMP bus to low & high voltage coils in ECA No. 1 & 2 thru HI VOLTAGE & LOW VOLTAGE sw Pwr to des bats lv/hv off & deadface relay reset for abort stage	Connects LMP neg bus to neg xlunar bus for LM ground	Backup cb	Connects LMP bus to CDR bus thru CDR CROSS TIE cb	Connects bat No. 2 or lunar bat, & bat No. 1 & 5 to LMP d-c bus During bat 6 backup also connects bat No. 6 to LMP d-c bus	Redundant cb
EFFECT OF CB OPENING (LOSS OF/OR REMAINING FUNCTION)	Loss of htrs with possible degradation of items requiring temp stabilization	Loss of set of htrs in cluster 1 (sys A/B-1 htrs avail; longer warmup required)	Loss of set of htrs in cluster 2 (sys A/B-1 htrs avail; warmup required)	Loss of set of htrs in cluster 3 (sys A/B-1 htrs avail; longer warmup required)	Loss of set of htrs in cluster 4 (sys A/B-1 htrs avail; longer warmup required)	Loss of onboard monitoring of temp of RCS cluster, LR, RR temp, & S-BD ant	If S-bd ant temp below min survival temp, permanent degradation results	Loss of sequence camera	Loss of onboard bus & bat monitoring	Loss of monitoring of LMP bus	Inv No. 1 avail thru INVERTER sw (Pwr from CDR bus to inv No. 1)	Redundant cb on CDR panel supplies pwr from CDR bus	Redundant cb on CDR panel supplies pwr from CDR bus	Redundant cb on CDR panel supplies pwr from CDR bus	Redundant cb on CDR panel supplies pwr from CDR bus	No loss of function; relay contacts in parallel with cb	Only closed in event of feeder short when powering LMP bus thru CDR bus, or vice versa	BUS CROSS TIE cb avail	Adjacent cb avail	Adjacent cb avail

DATE 4/21/71 7/2/71

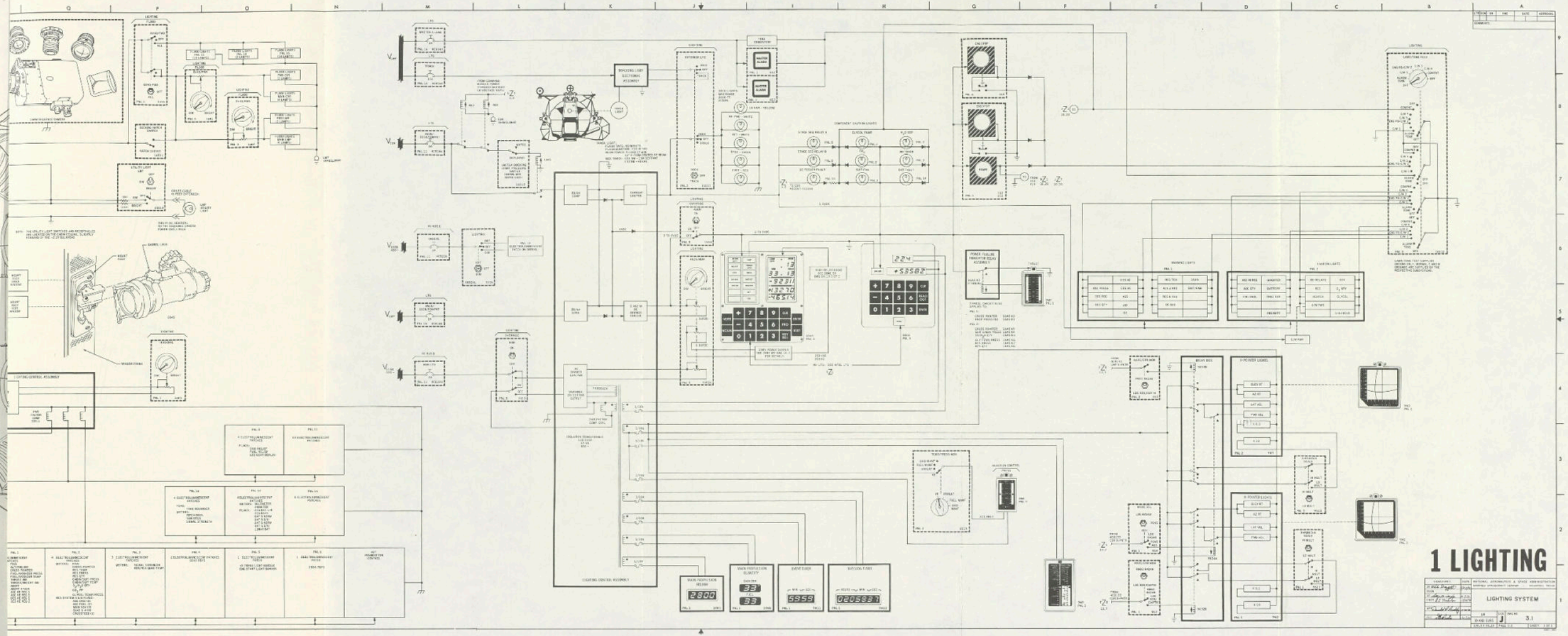
PNL 16 C&D

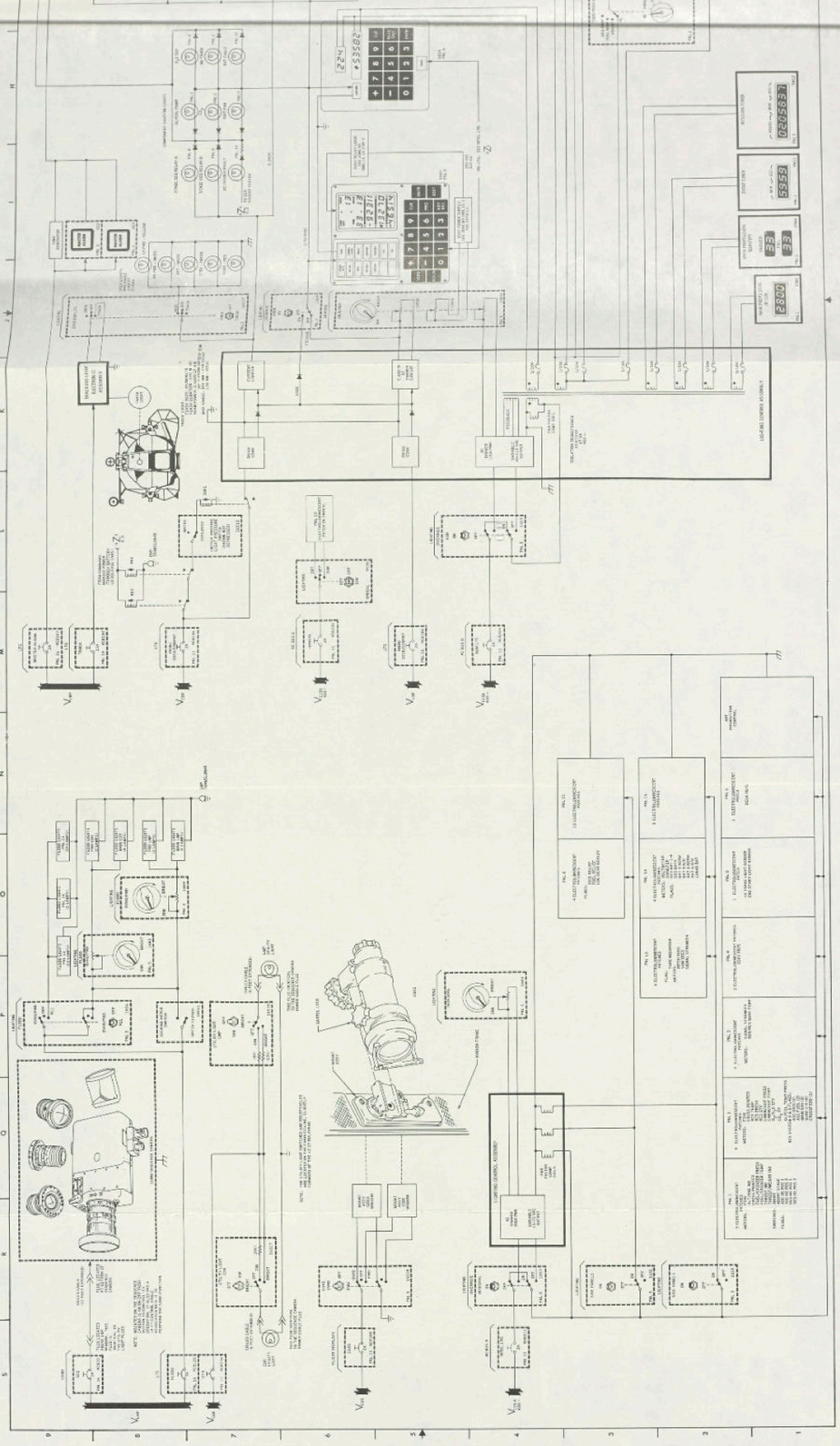
LM CONTROL

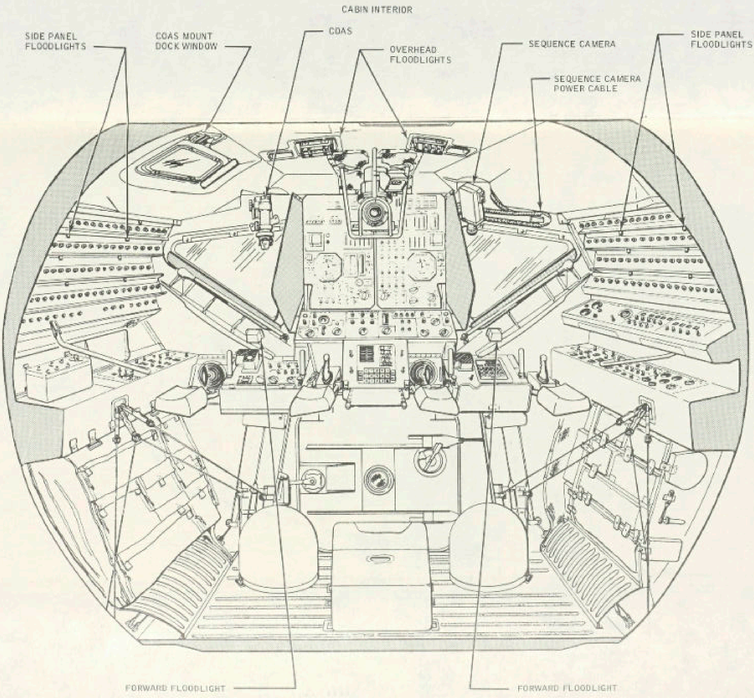


1 LIGHTING

LIGHTING
PYRO
DC EPS DESCENT
DC EPS ASCENT
AC EPS
O_2 SUPPLY SUIT LOOP
H_2O GLYCOL


1 LIGHTING
LIGHTING SYSTEM
NATIONAL AERONAUTICS & SPACE ADMINISTRATION
3.1
FORWARD FLOODLIGHT
ARROW 3.3
LIGHTING




CABIN INTERIOR
SIDE PANEL FLOODLIGHTS
COAS MOUNT DOCK WINDOW
COAS
OVERHEAD FLOODLIGHTS
SEQUENCE CAMERA
SEQUENCE CAMERA POWER CABLE
SIDE PANEL FLOODLIGHTS
FORWARD FLOODLIGHT
FORWARD FLOODLIGHT

1. THE LM PYRO ELECTRICAL SYSTEM IS A SHIELDED FLOATING GROUND SYS
2. THE PYRO SYSTEM HAS TWO 37.1 VOLT DC BATTERIES RATED AT 0.75 AMP I STAGE, AND PYRO BAT B IS LOCATED IN THE ASCENT STAGE
3. THE DESCENT WATER LINE AND ALL INTERSTAGE CABLES ARE ROUTED THROI AND ARE NOT PYROTECHNIC IN NATURE

PYRC

NO.	FUNCTION	COMPONENTS	SYSTEM A INITIATORS	SYSTEM B INITIATORS
1	STAGING			
	EXPLOSIVE NUTS	FOUR NUTS	0	4
	EXPLOSIVE BOLTS	FOUR BOLTS	4	0
	ELECTRICAL CIRCUIT INTERRUPTERS	TWO INTERRUPTERS	2	2
	GUILLOTINE	ONE CUTTER	1	1
2	RCS HE PRESSURIZE			
	RCS SYSTEM A	TWO VALVES IN PARALLEL	1	1
	RCS SYSTEM B	TWO VALVES IN PARALLEL	1	1
3	DESCENT ENGINE PRESSURIZE			
	SUPER CRITICAL HE, PRESS	ONE VALVE	1	1
	START TNK HE PRESS	ONE VALVE	1	1
	OX COMP VALVE	ONE VALVE	1	1
	FUEL COMP VALVE	ONE VALVE	1	1
	FUEL VENT VALVE	ONE VALVE	1	1
	OX VENT VALVE	ONE VALVE	1	1
4	ASCENT ENGINE PRESSURIZE			
	HE PRESS TANK 1	ONE VALVE	1	1
	HE PRESS TANK 2	ONE VALVE	1	1
	OX COMP VALVES	TWO VALVES IN PARALLEL	1	2
	FUEL COMP VALVES	TWO VALVES IN PARALLEL	1	2
5	LAND GEAR CUTTERS	FOUR CUTTERS	4	4

DESCENT STAGE F

ALL INTERSTAGE CURRENT CARRYING CABLES AND ALL INTERSTAGE CABLES WH INTERSTAGE ELECTRICAL CIRCUIT INTERRUPTERS AS FOLLOWS:

ELECTRICAL CIRCUIT INTERRUPTER NO. 1 (P 174)

1. POWER FEEDER FROM ECA 2
* 2. ECA 1 AND 2 POWER
3. DESCENT ENGINE CONTROL ASSY (DECA)
4. GIMBAL DRIVE ACTUATORS (PITCH AND ROLL)
5. DESCENT ENGINE FUNCTIONS
6. PYROTECHNIC SYSTEM A CONTROL
7. LUNAR PROBES

8. OPERATIONAL TELEMETRY

GC0201V	BAT 1 VOLTS	GC4365X	BAT 3 HI
GC0203V	BAT 3 VOLTS	GC4366X	BAT L CDR
GC0204V	BAT 4 VOLTS	GC4367X	BAT 4 HI
GC1201C	BAT 1 CUR	GC4368X	BAT 4 LO
GC1203C	BAT 3 CUR	GC9961U	BAT 1 MAL
GC1204C	BAT 4 CUR	GC9963U	BAT 3/L MAL
GC1207C	BAT L CUR	GC9964U	BAT 4 MAL
GC4361X	BAT 1 HI	GF0500P	DES 2 H_2O P
GC4362X	BAT 1 LO	GF0584P	DES 2 O_2 P
		GF3584P	DES 1 O_2 P
		GF4500P	DES 1 H_2O P

ELECTRICAL CIRCUIT INTERRUPTER NO 2 (P173)

1. POWER FEEDER FROM ECA 1
* 2. ECA 1 AND 2 POWER
3. TV CAMERA
4. DESCENT ENGINE FUNCTIONS
5. LANDING RADAR ELECTRICAL ASSY
6. OPERATIONAL TELEMETRY:

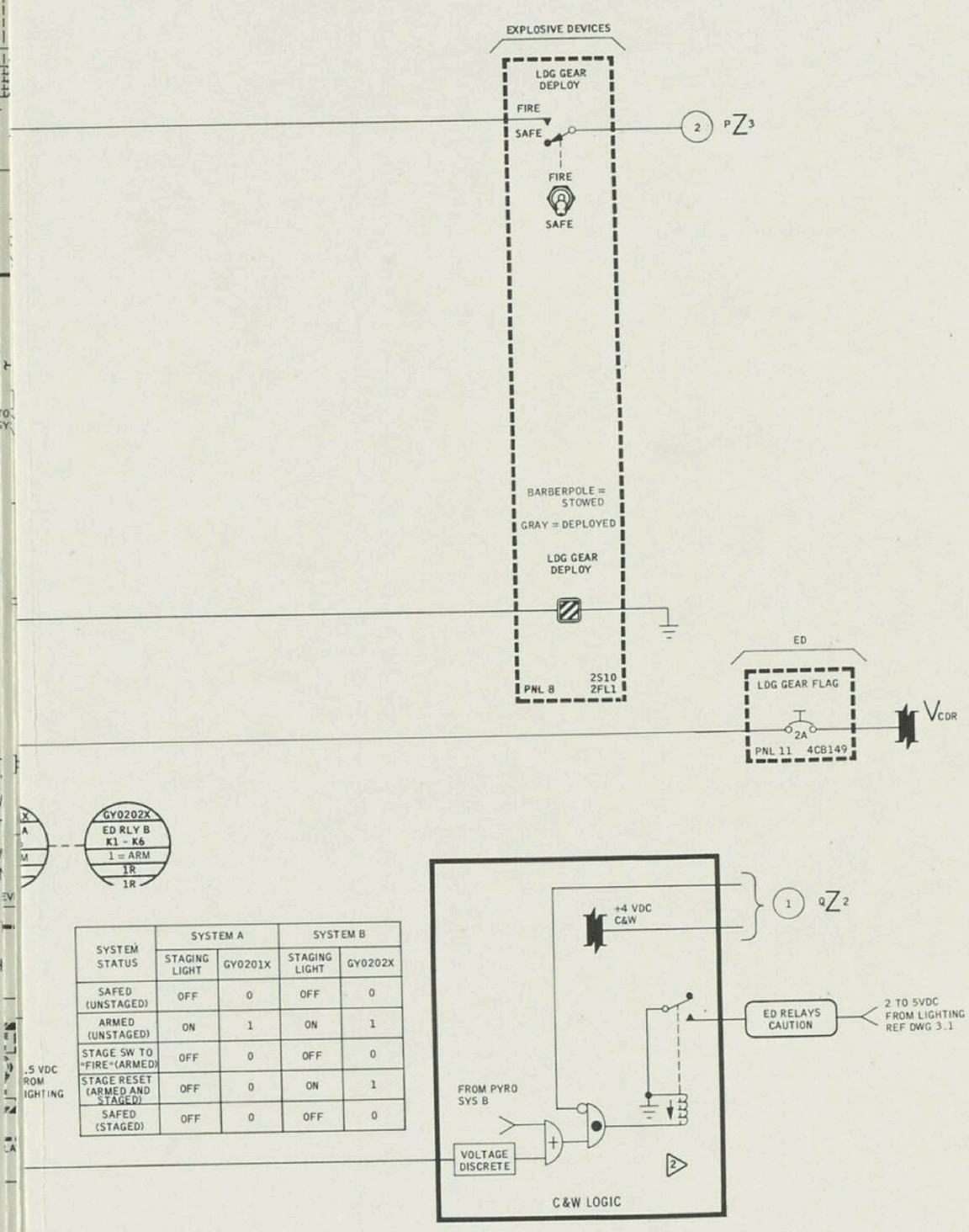
GB0541T	MESA TEMP 1	GC0202V	BAT 2 VOLTS
GB0542T	MESA TEMP 2	GC0207V	BAT L VOLTS
GB0543T	MESA TEMP 3	GC1202C	BAT 2 CUR
		GC4363X	BAT 2 HI
		GC4364X	BAT L LMP
		GC9962U	BAT 2/L MAL

* POWER IN PARALLEL TO BOTH DESCENT ECA'S THROUGH ECI'S 1 AND 2

O INSTRUMENTATION

LTR	PCN	DR	ENG	DATE		APPROVAL
	1			4-15-71	4-15-71	

COMMENTS:



SYSTEM STATUS	SYSTEM A		SYSTEM B	
	STAGING LIGHT	GY0201X	STAGING LIGHT	GY0202X
SAFED (UNSTAGED)	OFF	0	OFF	0
ARMED (UNSTAGED)	ON	1	ON	1
STAGE SW TO "FIRE" (ARMED)	OFF	0	OFF	0
STAGE RESET (ARMED AND STAGED)	OFF	0	ON	1
SAFED (STAGED)	OFF	0	OFF	0

7. TIME DELAY MINIMUM OF 10 MS MAXIMUM OF 45 MS

6. POWER FOR THIS SIGNAL IS SUPPLIED BY 4CB40 FOR PYRO SYSTEM A AND 4CB41 FOR PYRO SYSTEM B

5. IN ADDITION TO RELAY K12A, K12 IS CONTROLLED BY THE ASCENT HE PRESS SWITCH IN PYRO SYSTEM B WHICH PROVIDES REDUNDANT PYRO POWER TO THE ASCENT FUEL AND OX COMP VALVES

4. THIS RELAY IS THE SAME RELAY SHOWN IN ZONE R 8

3. PYRO SYSTEM B BATTERY AND RELAY BOX ARE LOCATED IN THE ASCENT STAGE AND ARE CONTROLLED BY ANOTHER SET OF CONTACTS ON THE SWITCHES SHOWN IN PYRO SYSTEM A

2. BOTH PYRO SYSTEM A AND B PROVIDE INPUTS TO THE C&W LOGIC. AN INADVERTANT CLOSURE OF ANY RELAY K1 THROUGH K6 FROM EITHER SYSTEM A OR B WILL GIVE AN ED RELAY CAUTION LIGHT. HOWEVER, WHEN THE MASTER ARM SWITCH IS CLOSED OR THE SYSTEM IS ARMED THROUGH THE ABORT SW THIS CAUTION LIGHT IS INHIBITED FOR BOTH PYRO SYSTEM A AND B

NOTES: 1. RELAY K12 IS A SPARE RELAY IN SYSTEM A ONLY. IT IS USED IN SYSTEM B (SEE NOTE 5).

1 PYRO

SIGNATURES	DATE
DR	4/28/70
DSGN	
QC	12-7-70
ENGR	11/30/70
APP	11/30/70
FEC	12-7-70

NATIONAL AERONAUTICS & SPACE ADMINISTRATION
MANNED SPACECRAFT CENTER · HOUSTON, TEXAS

PYROTECHNIC SYSTEM

LM 10 AND SUBS | SIZE J | DWG NO 4.1
121 X 38.25 | PAGE 4-1 | SHEET 1 OF 1

EMU
PYRO
DC EPS DESCENT
DC EPS ASCENT
DC EPS
AC
O_2 SUPPLY
SUIT LOOP
H_2O GLYCOL

1. THE LM PYRO ELECTRICAL SYSTEM IS A SHORTED FLOATING GROUND SYS
2. THE PYRO SYSTEM HAS TWO 28 VOLT DC BATTERIES RATED AT 4.35 AMP
STAGE, AND PYRO BAT B IS LOCATED IN THE ASCENT STAGE
3. THE DESCENT WIRER LINE AND ALL EXPLOSIVE CABLES ARE SHORTED THRO
AND ARE NOT PYROTECHNIC IN NATURE

NO.	FUNCTION	COMPONENTS	SYSTEM A INITIATORS	SYSTEM B INITIATORS
1	STAGING			
	EXPLOSIVE NUTS	FOUR NUTS	8	8
	EXPLOSIVE BOLTS	FOUR BOLTS	4	4
	ELECTRICAL CIRCUIT INTERRUPTERS	TWO INTERRUPTERS	2	2
	GUILLOTINE	ONE CUTTER	1	1
2	RCS HE PRESSURIZE			
	RCS SYSTEM A	TWO VALVES IN PARALLEL	1	
	RCS SYSTEM B	TWO VALVES IN PARALLEL		1
3	DESCENT ENGINE PRESSURIZE			
	SUPER CRITICAL HE PRESS	ONE VALVE	1	
	START TANK HE PRESS	ONE VALVE	1	
	OX COMP VALVE	ONE VALVE	1	
	FUEL COMP VALVE	ONE VALVE	1	
	FUEL VENT VALVE	ONE VALVE	1	
	OX VENT VALVE	ONE VALVE	1	
4	ASCENT ENGINE PRESSURIZE			
	HE PRESS TANK 1	ONE VALVE	1	
	HE PRESS TANK 2	ONE VALVE		1
	OX COMP VALVES	TWO VALVES IN PARALLEL	1	2
	FUEL COMP VALVES	TWO VALVES IN PARALLEL	1	2
5	LAND GEAR CUTTERS	FOUR CUTTERS	4	

ALL INTERSTAGE CURRENT CARRYING CABLES AND ALL INTERSTAGE CABLES W
INTERSTAGE ELECTRICAL CIRCUIT INTERRUPTERS AS FOLLOWS

ELECTRICAL CIRCUIT INTERRUPTER NO. 1 (P 1341)

1. POWER FEEDER FROM ECA 2
2. ECA 1 AND 2 POWER
3. DESCENT ENGINE CONTROL ASSY (DECA)
4. GIMBAL DRIVE ACTUATORS (PITCH AND ROLL)
5. DESCENT ENGINE FUNCTIONS
6. PYROTECHNIC SYSTEM A CONTROL
7. LINAK PROBES
8. OPERATIONAL TELEMETRY

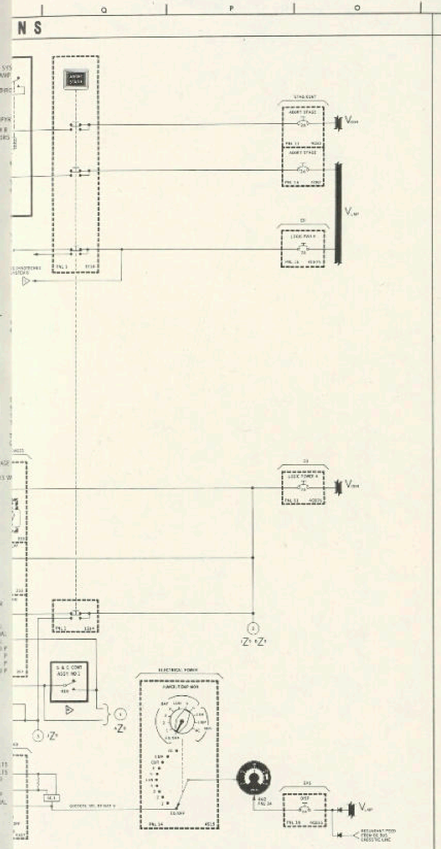
GC0001V	BAT 1 VOLTS	GC0A001	BAT 1 HI
GC0002V	BAT 2 VOLTS	GC0A002	BAT 1 COM
GC0003V	BAT 3 VOLTS	GC0A003	BAT 2 HI
GC0004V	BAT 4 VOLTS	GC0A004	BAT 2 COM
GC0001C	BAT 1 CUR	GC0A005	BAT 3 HI
GC0002C	BAT 2 CUR	GC0A006	BAT 3 COM
GC0003C	BAT 3 CUR	GC0A007	BAT 4 HI
GC0004C	BAT 4 CUR	GC0A008	BAT 4 COM
GC0A001	BAT 1 CUR	GC0A009	BAT 5 HI
GC0A002	BAT 1 HI	GC0A010	BAT 5 COM
GC0A003	BAT 1 LO	GC0A011	BAT 6 HI
		GC0A012	BAT 6 COM

ELECTRICAL CIRCUIT INTERRUPTER NO 2 (P1341)

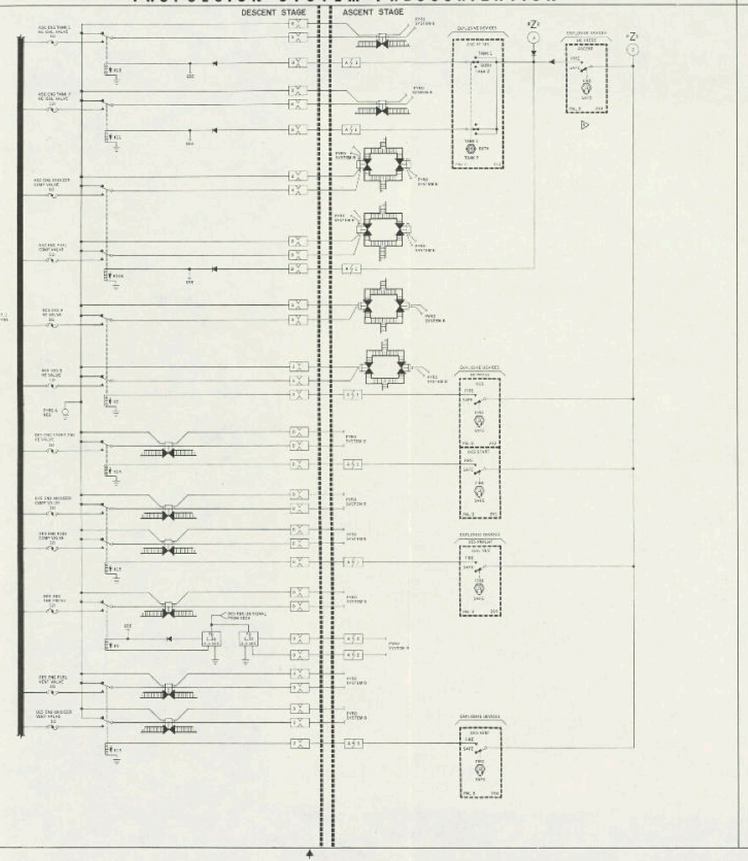
1. POWER FEEDER FROM ECA 1
2. ECA 1 AND 2 POWER
3. TV CAMERA
4. DESCENT ENGINE FUNCTIONS
5. LANDING RADAR ELECTRICAL ASSY
6. OPERATIONAL TELEMETRY

GC0004T	RCSA TEMP 1	GC0D001V	BAT 2 VOLTS
GC0005T	RCSA TEMP 2	GC0D002V	BAT 1 VOLTS
GC0006T	RCSA TEMP 3	GC0D003C	BAT 2 CUR
		GC0D004C	BAT 2 HI
		GC0D005C	BAT 1 CUR
		GC0D006C	BAT 2 LOW

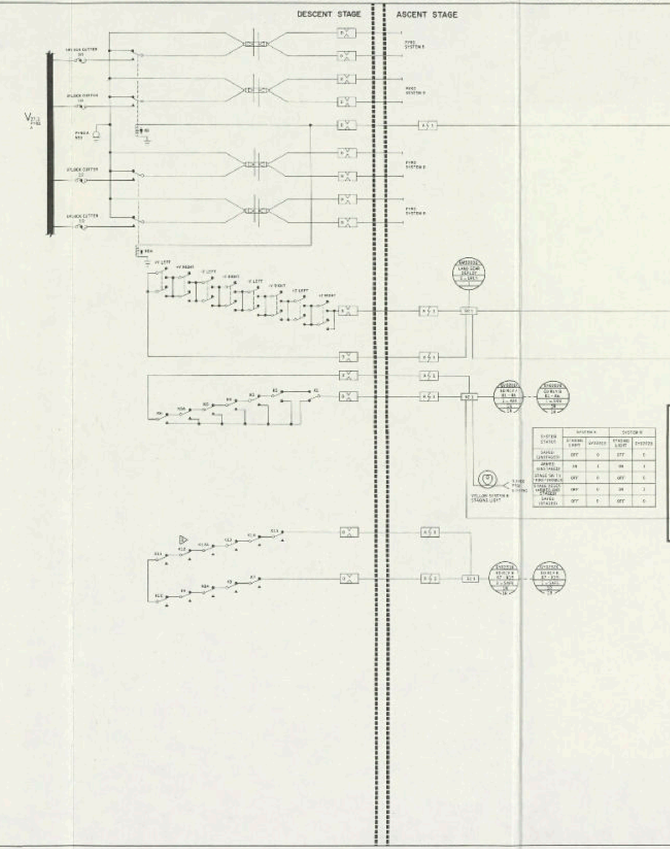
* POWER IN PARALLEL TO BOTH DESCENT ECA'S THROUGH ECA'S 1 AND 2



PROPULSION SYSTEM PRESSURIZATION



LAND GEAR DEPLOYMENT AND PYRO INSTRUMENTATION



SYSTEM STATUS	SYSTEM A		SYSTEM B	
	STANDBY LIGHT	UPDATED	STANDBY LIGHT	UPDATED
SYSTEM CONFIGURED	OFF	0	OFF	0
ARMED (ENGINEER)	ON	1	ON	1
ARMED (ENGINEER)	OFF	0	OFF	0
SYSTEM CONFIGURED (ENGINEER)	OFF	0	ON	1
SYSTEM CONFIGURED	OFF	0	OFF	0

1 PYRO

CONTRACTOR	DATE	NATIONAL AERONAUTICS & SPACE ADMINISTRATION
		PYROTECHNIC SYSTEM
		SIZE J
		4.1

PYRO SYSTEM NOTES

1. THE LM PYRO ELECTRICAL SYSTEM IS A SHIELDED FLOATING GROUND SYSTEM
2. THE PYRO SYSTEM HAS TWO 37.5 VOLT DC BATTERIES RATED AT 0.75 AMP HOURS, ONE FOR SYSTEM A AND ONE FOR SYSTEM B. PYRO BAT A IS LOCATED IN THE DESCENT STAGE, AND PYRO BAT B IS LOCATED IN THE ASCENT STAGE
3. THE DESCENT WATER LINE AND ALL INTERSTAGE CABLES ARE ROUTED THROUGH THE EQUILIBRIUM. THE OXYGEN AND GLYCOL LINES HAVE QUICK DISCONNECTS AND ARE NOT PYROTECHNIC IN NATURE

PYROTECHNIC FUNCTIONS AND COMPONENTS

NO.	FUNCTION	COMPONENTS	SYSTEM A INITIATORS	SYSTEM B INITIATORS	
1	STAGING				
	EXPLOSIVE NUTS	FOUR NUTS	0	4	ONE INITIATOR PER NUT OR BOLT
	EXPLOSIVE BOLTS	FOUR BOLTS	4	0	
	ELECTRICAL CIRCUIT INTERRUPTERS	TWO INTERRUPTERS	2	2	TWO INITIATORS PER INTERRUPTER, ONE FROM SYSTEM A AND ONE FROM SYSTEM B. ONE INITIATOR CAN OPERATE THE INTERRUPTER
	GUILLOTINE	ONE CUTTER	1	1	TWO OPPOSING BLADES, ONE POWERED BY SYSTEM A AND ONE POWERED BY SYSTEM B, TWO TUBES INTERCONNECT THE CHARGES BEHIND EACH BLADE SUCH THAT ONE INITIATOR CAN FIRE BOTH CHARGES BEHIND BOTH BLADES. ONE BLADE CAN SEVER THE INTERSTAGE UMBILICAL
2	RCS HE PRESSURIZE				
	RCS SYSTEM A	TWO VALVES IN PARALLEL	1	1	VALVES ARE THE SINGLE INITIATOR TYPE PLACED IN PARALLEL; ONE VALVE WILL PRESSURIZE THE SYSTEM
	RCS SYSTEM B	TWO VALVES IN PARALLEL	1	1	
3	DESCENT ENGINE PRESSURIZE				
	SUPER CRITICAL HE PRESS	ONE VALVE	1	1	VALVE IS DUAL INITIATOR TYPE, ONE POWERED FROM SYSTEM A AND ONE FROM SYSTEM B. ONE INITIATOR WILL OPERATE THE VALVE
	START TANK HE PRESS	ONE VALVE	1	1	
	OX CORP VALVE	ONE VALVE	1	1	
	FUEL CORP VALVE	ONE VALVE	1	1	
	FUEL VENT VALVE	ONE VALVE	1	1	
	OX VENT VALVE	ONE VALVE	1	1	
4	ASCENT ENGINE PRESSURIZE				
	HE PRESS TANK 1	ONE VALVE	1	1	
	HE PRESS TANK 2	ONE VALVE	1	1	
	OX CORP VALVES	TWO VALVES IN PARALLEL	1	2	THE VALVES ARE DUAL INITIATOR TYPE. ONE OX VALVE AND ONE FUEL VALVE IS FIRED FROM SYSTEM B ALONE. THE OTHER INITIATOR PORTS IN THESE VALVES ARE PLUGGED. THE OTHER TWO OX AND FUEL VALVES ARE DUAL INITIATOR TYPE WITH ONE FIRED FROM SYSTEM A AND THE OTHER FIRED FROM SYSTEM B
	FUEL CORP VALVES	TWO VALVES IN PARALLEL	1	2	
5	LAND GEAR CUTTERS	FOUR CUTTERS	4	4	TWO INITIATORS PER CUTTER. ONE FROM SYSTEM A AND ONE FROM SYSTEM B. ONE INITIATOR WILL FIRE CUTTER

DESCENT STAGE FUNCTIONS LOST AT STAGING

ALL INTERSTAGE CURRENT CARRYING CABLES AND ALL INTERSTAGE CABLES WHICH WOULD AFFECT THE ASCENT STAGE BY BEING GROUNDED ARE ROUTED THROUGH THE INTERSTAGE ELECTRICAL CIRCUIT INTERRUPTERS AS FOLLOWS:

ELECTRICAL CIRCUIT INTERRUPTER NO. 1 (P 124)

1. POWER FEEDER FROM ECA 2
* 2. ECA 1 AND 2 POWER
3. DESCENT ENGINE CONTROL ASSY (DECA)
4. GIMBAL DRIVE ACTUATORS (PITCH AND ROLL)
5. DESCENT ENGINE FUNCTIONS
6. PYROTECHNIC SYSTEM A CONTROL
7. LUNAR PROBES
8. OPERATIONAL TELEMETRY

GG0200V	BAT 1 VOLTS	GG0400X	BAT 1 HI	GH0101V	MAN THRUST CMD	GQ3600Q	DPS FU 1 QTY
GG0201V	BAT 3 VOLTS	GG0400X	BAT 1 CUR	GH0102V	PITCH GIM POS	GQ3601Q	DPS FU 2 QTY
GG0202V	BAT 4 VOLTS	GG0401X	BAT 4 HI	GH0103V	ROLL GIM POS	GQ3611P	DPS FU PRESS
GG1200C	BAT 1 CUR	GT0400X	BAT 4 LO	GH0105X	P TRIM FAIL	GQ4000Q	OPS OX 1 QTY
GG1201C	BAT 3 CUR	GC0402X	BAT 1 NOM	GH0106X	R TRIM FAIL	GQ4010Q	OPS OX 2 QTY
GG1204C	BAT 4 CUR	GC0401X	BAT 3L NOM	GH0107V	AUTO THRUST CMD	GQ4011P	OPS OX PRESS
GC1201C	BAT 1 CUR	GC0402	BAT 4 NOM	GH0108X	DPS ACK	GQ4005Q	OPS PROP LO
GC0401X	BAT 1 HI	GT0500P	DES 2 HI P	GH0000L	LAND GEAR DPY	GQ6100P	DPS SCP
GC0402X	BAT 1 LO	GT0501P	DES 2 LO P	GQ1010P	DPS HE REG P	GQ6000Q	DPS VAR ACT
		GT 0100P	DES 1 LO P	GQ1020P	DPS HE REG P	GH0200X	ED RLY A K1-K6
		GT0401P	DES 1 HI P	GQ3020P	DPS HE PRESS	GH0210X	ED RLY A K7-K13

ELECTRICAL CIRCUIT INTERRUPTER NO 2 (P 127)

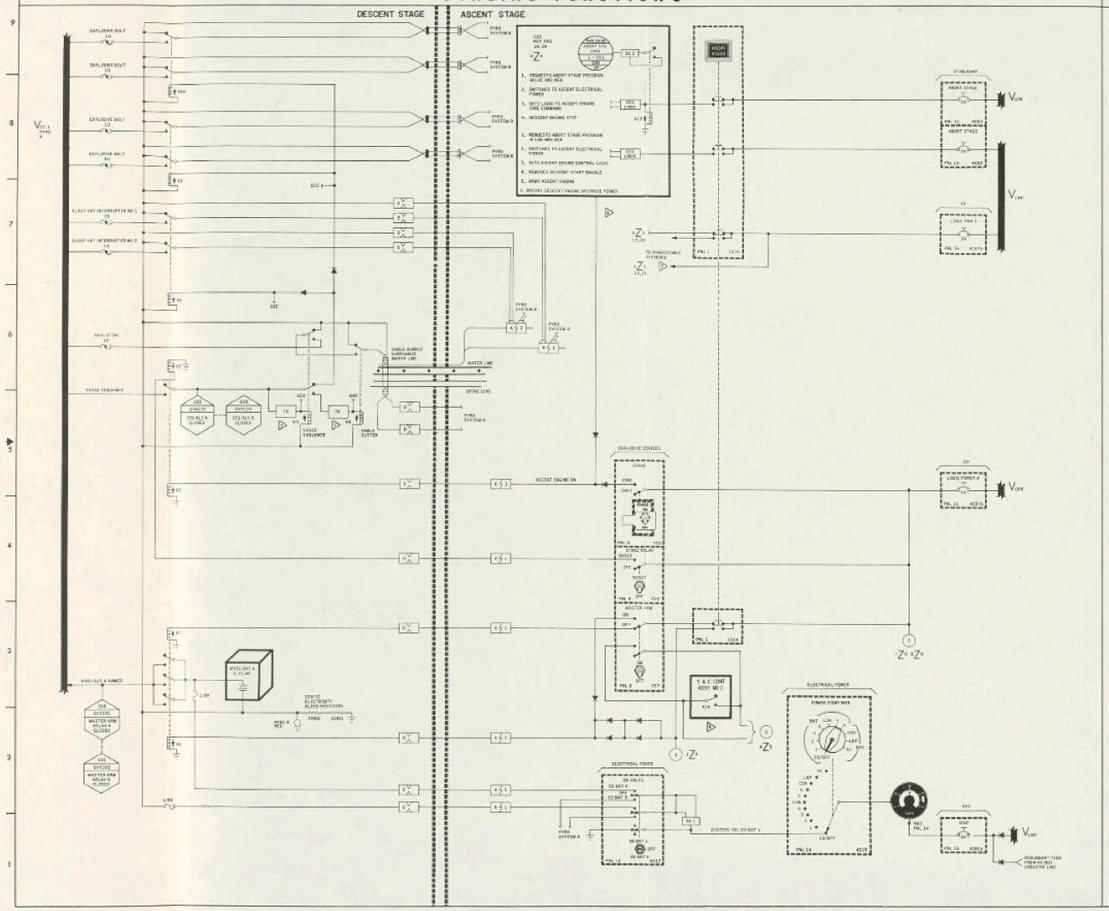
1. POWER FEEDER FROM ECA 1
* 2. ECA 1 AND 2 POWER
3. TV CAMERA
4. DESCENT ENGINE FUNCTIONS
5. LANDING RADAR (ELECTRICAL ASSY)
6. OPERATIONAL TELEMETRY

GB0401	MESA TEMP 1	GG0200V	BAT 2 VOLTS	GL0025T	RTG CASK TEMP	GQ 1011P	DPS START TNK P
GB0402	MESA TEMP 2	GG0202V	BAT 4 VOLTS	GV0102X	LR RNG RAD	GQ3701T	DPS 1 FU T
GB0403	MESA TEMP 3	GG1202C	BAT 1 CUR	GV0103X	LR VEL RAD	GQ3711	DPS 2 FU T
		GG1204C	BAT 3 CUR	GV2603T	LR ANT TEMP	GQ4021MT	DPS 1 OXT
		GC0400X	BAT 1 LMT			GQ4031MT	DPS 2 OXT
		GC0402X	BAT 3L NOM				

* POWER IN PARALLEL TO BOTH DESCENT ECA'S THROUGH ECA'S 1 AND 2

APRON 4.1

STAGING FUNCTIONS


DESCENT STAGE
ASCENT STAGE
EXPLOSIVE BOLT
EXPLOSIVE NUT
ELECTRICAL CIRCUIT INTERRUPTER NO 1
ELECTRICAL CIRCUIT INTERRUPTER NO 2
GUILLOTINE
LANDING GEAR
ONLY SINGLE SUBMERGED WATER LINE
WATER LINE
BRINE LINE
ASCENT ENGINE ON
EXPLOSIVE DEVICES
STAGE RELAY
MASTER ARM
ELECTRICAL POWER
POWER FUNCTIONS
ABORT ASSY
STAGE RELAY
ABORT STAGE
LOGIC POWER
DPS
ASCENT ENGINE CONTROL ASSY
ASCENT ENGINE CONTROL ASSY
ASCENT ENGINE CONTROL ASSY

EMU

COMM

EPS

DC EPS DESCENT

ASCENT

AC EPS

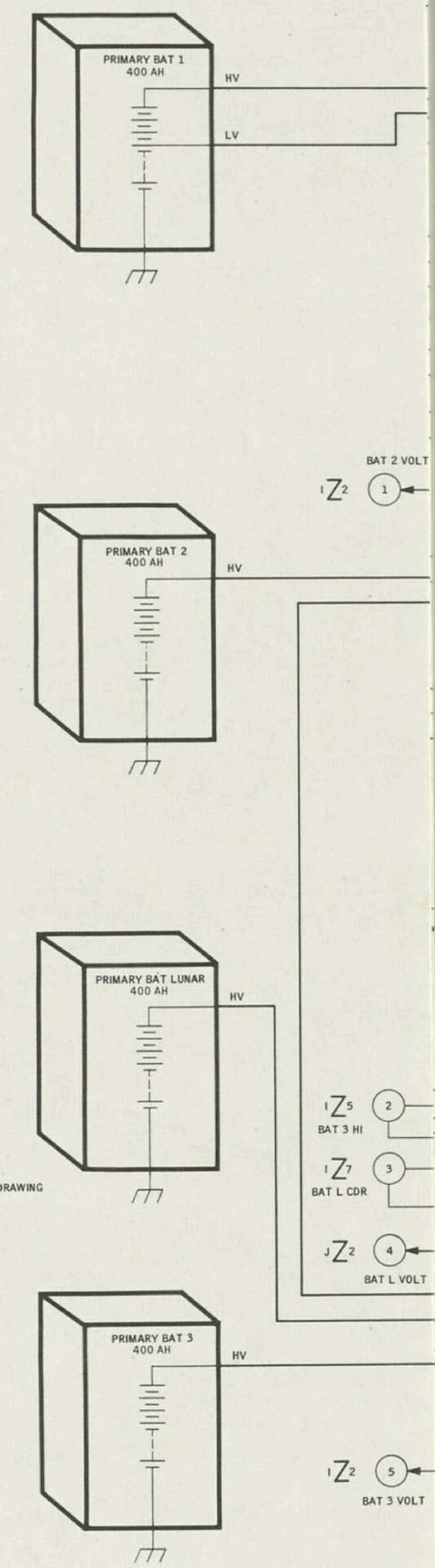
O_2 SUPPLY

SUIT LOOP

H_2O GLYCOL

LTR	PCN	DR	ENG	DATE	APPROVAL
	1			4-15-71	4-15-71

COMMENTS:



9 LIMITATION OF MALFUNCTION INDICATION:
A DESCENT BATTERY OVERTEMPERATURE WILL NOT INDICATE UNLESS THE BATTERY IS ON

8 MALFUNCTION INDICATION LIMITS:
A. OVERTEMPERATURE: > 145° ± 5° F (RESETS AT 125° ± 5° F)
B. OVERCURRENT: > 150-200A
C. REVERSE CURRENT: > -10 AMPS FOR MORE THAN 5 ± 1 SEC (RESETS AT -4 AMPS)

7 ONBOARD BATTERY CURRENT READINGS:
DIVIDE PANEL METER READING BY 2 WHEN MEASURING INDIVIDUAL DESCENT BATTERY CURRENTS

6 DESCENT BATTERY CAPACITY:
400 AMP-HRS AT A TERMINAL VOLTAGE OF 28.0 TO 32.5VDC

5 THE FOLLOWING INSTRUMENTATION IS NOT SHOWN ON THIS DRAWING BECAUSE THE ELECTRICAL CIRCUITS ARE NOT SHOWN

MEASUREMENT

NUMBER	TITLE	RANGE	SAMPLE RATE
GC0201	BAT 1 VOLT	0-40V	1
GC0204	BAT 4 VOLT	0-40V	1
GC1201	BAT 1 CUR	0-60A	1R/1R
GC1204	BAT 4 CUR	0-60A	1R/1R
GC4361	BAT 1 HI	1 = HI	1
GC4362	BAT 1 LO	1 = LO	1
GC4367	BAT 4 HI	1 = HI	1
GC4368	BAT 4 LO	1 = LO	1
GC9961	BAT 1 MAL	1 = MAL	1
GC9964	BAT 4 MAL	1 = MAL	1

4 CDR = LUNAR BAT ON CDR BUS
LMP = LUNAR BAT ON LMP BUS
BARBER POLE = OFF

3 BARBER POLE = OFF
GREY = ON

2 BARBER POLE = OFF
GREY = HI TAP ON
LO = LO TAP ON

NOTES: 1 THIS CIRCUIT IS COMPLETED WHEN INTERRUPTER IS FIRED

2 DES

NATIONAL AERONAUTICS & SPACE ADMINISTRATION
MANNED SPACECRAFT CENTER • HOUSTON, TEXAS

DESCENT ELECTRICAL
DC POWER

SIGNATURES	DATE
DR Linda S. Drouin	6-9-70
DSGN	
QC Betty M. Jenkins	12-7-70
ENGR William L. Patton	11/30/70
APR Donald K. Hindley	11/30/70
FEC D. B. Kelly	12-7-70

DWG NO	SIZE	
5.2	J	LM 10 AND SUBS
SHEET 1 OF 1	PAGE 5-2	104.5 X 34

CHG NO	DR	ENG	DATE	APPROVAL
1	[illegible]	[illegible]	[illegible]	[illegible]

COMMENTS:

PRIMARY BAT 1 400 AH

PRIMARY BAT 2 400 AH

PRIMARY BAT LUNAR 400 AH

PRIMARY BAT 3 400 AH

PRIMARY BAT 4 400 AH

ECA 1A — CURRENT MONITOR — THIS ECA CIRCUIT IS NOT COMPLETE FOR TYPICAL CIRCUIT SEE ECA 2A

ECA 1B — CURRENT MONITOR — TO BAT 2 MAL CIRCUIT — THIS ECA CIRCUIT IS NOT COMPLETE FOR TYPICAL CIRCUIT SEE ECA 2A

ECA 2A — CURRENT MONITOR — LMP XLINKAR BUS

ECA 2B — LMP XLINKAR BUS

BAT 2 OT

BAT L OT

BAT 3 OT

ECBA

BAT 2 HI

BAT L COR

BAT 3/L OFF/RESET

BAT L LMP

BAT 3 HI

BAT 3/L OFF/RESET

BAT L C

BAT 3 C

BAT 2 C

BAT L V

BAT 3V

BAT 2V

ECBA

BAT LV

DESCENT

ASCENT

FROM ECA 1B HV RELAY — BAT 2 HI

FROM ECA 1B LV RELAY — BAT L LMP — BAT L COR

BAT 3 HI

FROM BAT 2/L MAL ECA 1B

BAT 3/L MAL

COR XLINKAR BUS

TO ABORT STAGE

LMP FEEDER

FROM RJB LV ON

FROM RJB LV/AV OFF

FROM RJB DES BAT OFF

BAT 2 HI

BAT L LMP

BAT L COR

BAT 3 HI

FROM BAT 1,4,5,6 MAL SC

FROM BAT 2,4,5,A MAL SC

BATTERY CAUTION

2 TO 5VDC FROM LIGHTING REF DWG 5.1

BAT FAULT PNL 14

BAT 2 VOLTS

BAT 3 VOLTS

BAT L VOLTS

BAT 2 CUR

BAT 3 CUR

BAT L CUR

COR FEEDER

10 AK3 AND AK9

FROM CSM PWR

TO ABORT STAGE

LMP XLINKAR BUS

PNL 14

1. LIMITATION OF MALFUNCTION INDICATION:
   A DESCENT BATTERY OVERTEMPERATURE WILL NOT INDICATE UNLESS THE BATTERY IS ON

2. MALFUNCTION INDICATION LIMITS:
   A. OVERTEMPERATURE: > 145° ± 5° F RESETS AT 125° ± 3° F
   B. OVERCURRENT: > 170-200A
   C. REVERSE CURRENT: > 1 AMPS FOR MORE THAN 1 SEC (RESETS AT -1 AMPS)

3. ONBOARD BATTERY CURRENT READING: 20VDC PANEL METER READING BY 2 WHEN MEASURING INDIVIDUAL DESCENT BATTERY CURRENTS

4. DESCENT BATTERY CAPACITY: 400 AMP-HRS AT A TERMINAL VOLTAGE OF 26.0 TO 32.3VDC

5. THE FOLLOWING INSTRUMENTATION IS NOT SHOWN ON THIS DRAWING BECAUSE THE ELECTRICAL CIRCUITS ARE NOT SHOWN

MEASUREMENT

NUMBER	TITLE	RANGE	SAMPLE RATE
ECB201	BAT 1 VOLT	0-40V	1
ECB204	BAT 4 VOLT	0-40V	1
ECC201	BAT 1 CUR	0-60A	1K/1K
ECC204	BAT 4 CUR	0-60A	1K/1K
ECE201	BAT 1 LD	1 = LD	1
ECE202	BAT 1 LD	1 = LD	1
ECE207	BAT 4 HI	1 = HI	1
ECE208	BAT 4 LD	1 = LD	1
ECF011	BAT 1 MAL	1 = MAL	1
ECF048	BAT 4 MAL	1 = MAL	1

CDR = LUNAR BAT ON CDR BUS
LMP = LUNAR BAT ON LMP BUS
BARRIER POLE = OFF

BARRIER POLE = ON

BARRIER POLE = OFF
GREY = ON

BARRIER POLE = OFF
GREY = HI TAP ON
LO = LO TAP ON

NOTE: THIS CIRCUIT IS COMPLETED WHEN INTERRUPTER IS FIXED

2DES

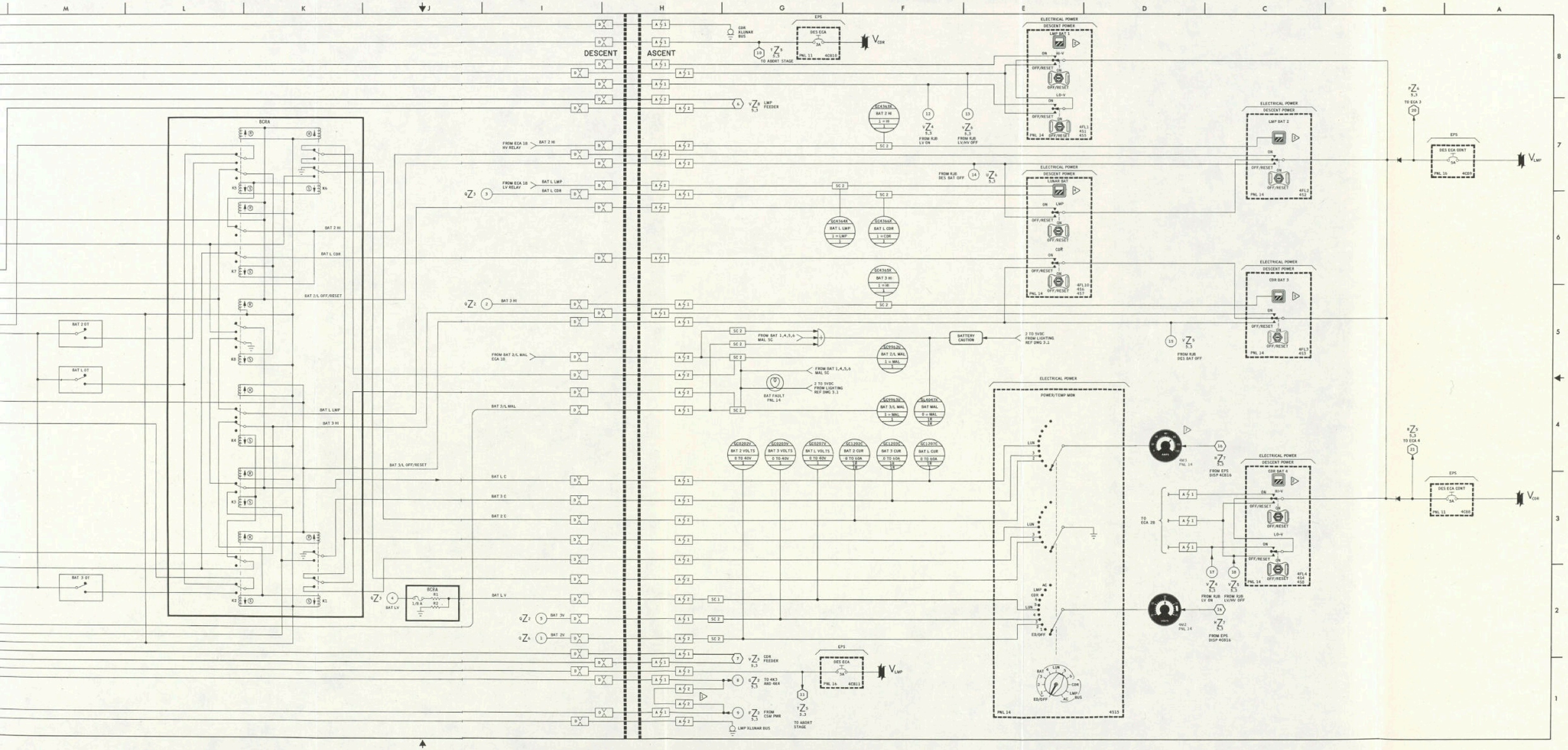
NATIONAL AERONAUTICS & SPACE ADMINISTRATION MANNED SPACECRAFT CENTER HOUSTON, TEXAS	SIGNATURES	DATE
	DSGN [illegible]	[illegible]
	CHK [illegible]	[illegible]
	PROJ [illegible]	[illegible]
	REL [illegible]	[illegible]

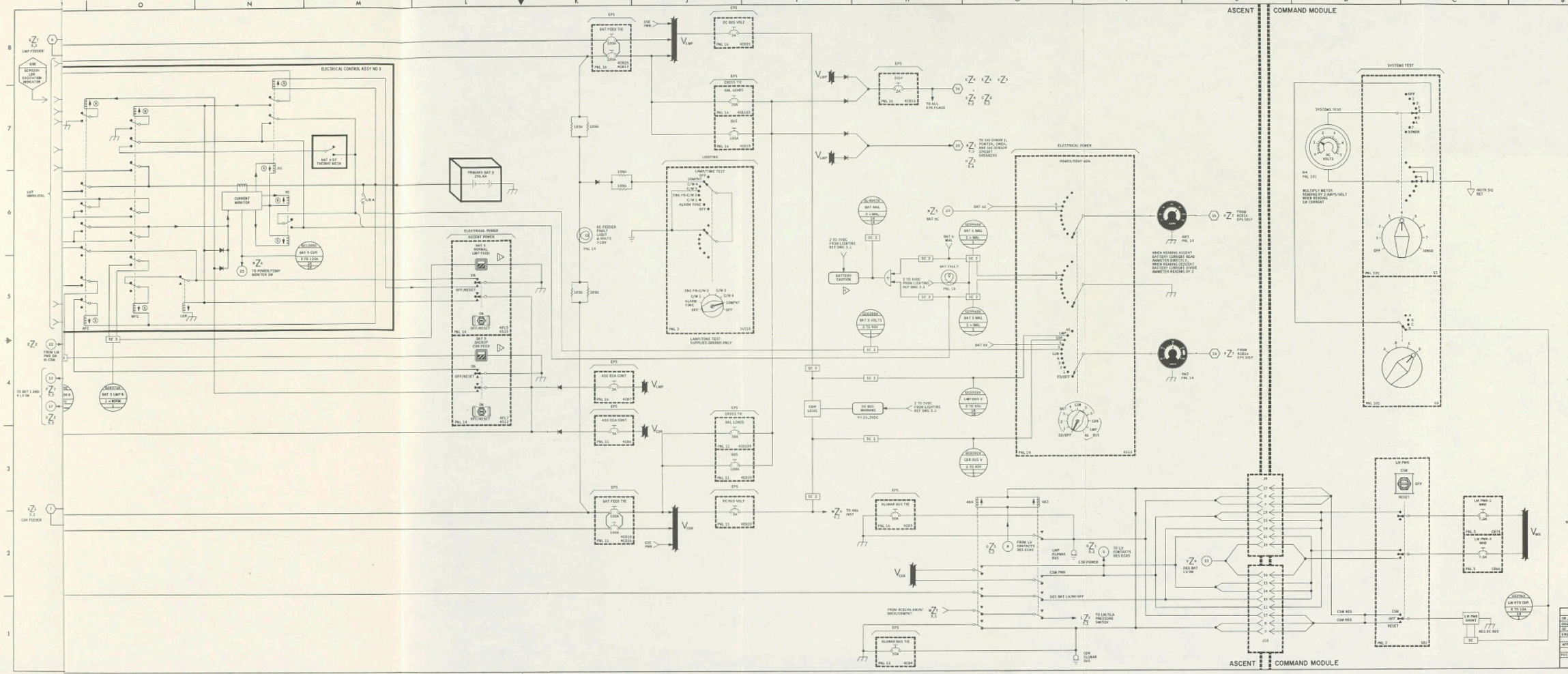
DESCENT ELECTRICAL DC POWER

DWG NO	SIZE	CODE
5.2	J	LM 32 AND SUBS

SHEET 1 OF 1 PAGE 5-2

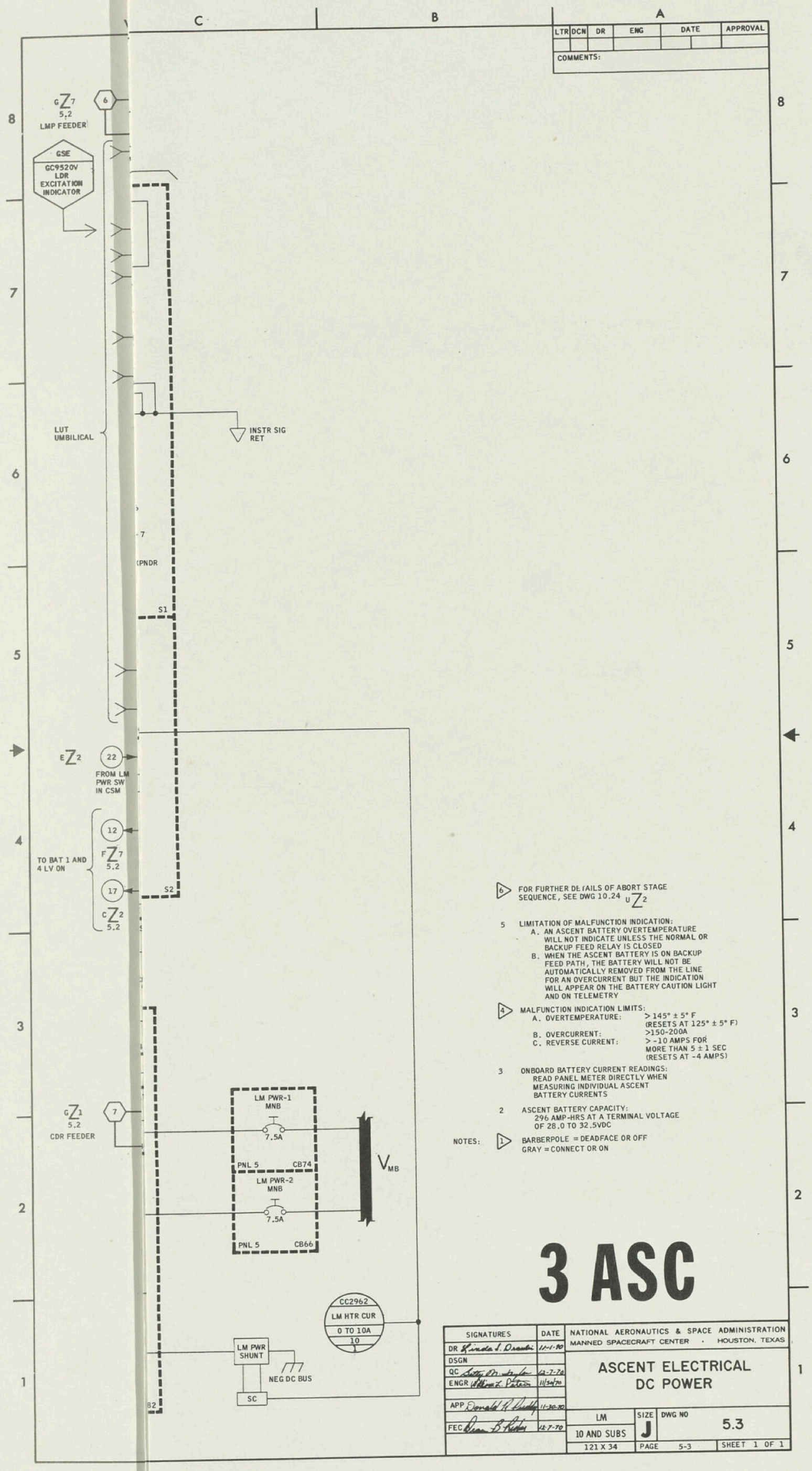
CONTROL NO


DESCENT
ASCENT
BCRA
BAT 2 OT
BAT L OT
BAT 3 OT
BAT 2 HI
BAT L CDR
BAT 2/L OFF/RESET
BAT 3 HI
BAT L LMP
BAT 3/L OFF/RESET
BAT L C
BAT 3 C
BAT 2 C
BAT L V
BAT 3V
BAT 2V
BAT LV
FROM ECA 1B HV RELAY
FROM ECA 1B LV RELAY
BAT L LMP
BAT L CDR
FROM BAT 2/L MAL ECA 1B
BAT 3/L MAL
CDR XLUNAR BUS
TO ABORT STAGE
LMP FEEDER
FROM RJB LV ON
FROM RJB LV/HV OFF
FROM RJB DES BAT OFF
FROM BAT 1,4,5,6 MAL SC
2 TO 5VDC FROM LIGHTING REF DWG 3.1
BAT FAULT PNL 14
BATTERY CAUTION
CDR FEEDER
TO 4K3 AND 4K4
FROM CSM PWR
LMP XLUNAR BUS
TO ECA 2B
FROM EPS DISP 4CB16
TO ECA 3
TO ECA 4
EPS
DES ECA
DES ECA CONT
ELECTRICAL POWER
DESCENT POWER
LMP BAT 1
LMP BAT 2
LUNAR BAT
CDR BAT 3
CDR BAT 4
POWER/TEMP MON
PNL 14
PNL 11
PNL 16
4CB10
4CB11
4CB12
4CB13
4CB14
4CB15
4CB16
4315


ASCENT
COMMAND MODULE
ELECTRICAL CONTROL ASSY NO 3
CURRENT MONITOR
BAT 5 OUT THERMO MECH
PRIMARY BAT 5 ZYLAN
ELECTRICAL POWER
ASCENT POWER
BAT 5 NORMAL LMP FEED
BAT 5 BACKUP COM FEED
LIGHTING
LAMP/TONE TEST
LAMP/TONE TEST SUPPLIES GROUND ONLY
BAT FEED TIE
DC BUS VOLT
DIM LIGHT
CROSS TIE
SWL LOADS
ASC EDA CONT
ALUMAR BUS TIE
DISP
TO ALL EPS FLAGS
TO SAS CONAR 2, POINTER, OMEGA, AND SIG SENSOR CIRCUIT BREAKERS
BATTERY CAUTION
DC BUS WARNING
LMP LOGIC
CDR LOGIC
POWER/TEMP MON
SYSTEMS TEST
MULTIPLY METER READING BY 2 AMPS/VOLT WHEN READING LM CURRENT
WHEN READING ASCENT BATTERY CURRENT READ DIRECTLY ON AMMETER WHEN READING DESCENT BATTERY CURRENT DIVIDE AMMETER READING BY 2
LM PWR SHUNT
NEG DC BUS
LM RTN CUR
CSM RES
CSM PWR
DES BAT LV/MV OFF
LMP ALUMAR BUS
CDR ALUMAR BUS
TO LM/SLA PRESSURE SWITCH
FROM ASCENT AMUN/ DMUX/COMPUT
FOR FURTHER DETAILS OF ABORT STAGE SEQUENCE, SEE DWG 10.34
LIMITATION OF MALFUNCTION INDICATION:
A. AN ASCENT BATTERY OVERTEMPERATURE WILL NOT INDICATE UNLESS THE NORMAL OR BACKUP FEED PATH IS ENERGIZED
B. WHEN THE ASCENT BAT-TERY IS ON BACKUP FEED PATH, THE BATTERY WILL NOT BE AUTOMATICALLY REMOVED FROM THE LINE FOR AN OVERCURRENT BUT THE INDICATION WILL APPEAR ON THE BATTERY CAUTION LIGHT AND ON THE
MALFUNCTION INDICATION LIMITS:
A. OVERTEMPERATURE: >149° ± 5° F (RESETS AT 120° ± 5° F)
B. OVERCURRENT: 1.5-10.0AMP
C. REVERSE CURRENT: >-10 AMPS FOR ABORT TIME 5.1 SEC (RESETS AT -4 AMPS)
3 ONBOARD BATTERY CURRENT READINGS: READ PANEL METER DIRECTLY WHEN MEASURING INDIVIDUAL ASCENT BATTERY CURRENTS
2 ASCENT BATTERY CAPACITY: 20% AMP-HRS AT A TERMINAL VOLTAGE OF 20.0 TO 32.0VDC
NOTES:
WIRE/CABLE - RESISTANCE OR OFF
GRAY = CONNECT ON ON
3 ASC
ASCENT ELECTRICAL DC POWER
NATIONAL AERONAUTICS & SPACE ADMINISTRATION
MANNED SPACECRAFT CENTER HOUSTON, TEXAS
LM 10 AND SUBS
SIZE J
DWG NO 5.3
SHEET 1 OF 3

LTR	DCN	DR	ENG	DATE	APPROVAL

COMMENTS:



6 FOR FURTHER DETAILS OF ABORT STAGE SEQUENCE, SEE DWG 10.24 U Z2

5 LIMITATION OF MALFUNCTION INDICATION:
- A. AN ASCENT BATTERY OVERTEMPERATURE WILL NOT INDICATE UNLESS THE NORMAL OR BACKUP FEED RELAY IS CLOSED
- B. WHEN THE ASCENT BATTERY IS ON BACKUP FEED PATH, THE BATTERY WILL NOT BE AUTOMATICALLY REMOVED FROM THE LINE FOR AN OVERCURRENT BUT THE INDICATION WILL APPEAR ON THE BATTERY CAUTION LIGHT AND ON TELEMETRY

4 MALFUNCTION INDICATION LIMITS:
- A. OVERTEMPERATURE: > 145° ± 5° F (RESETS AT 125° ± 5° F)
- B. OVERCURRENT: >150-200A
- C. REVERSE CURRENT: > -10 AMPS FOR MORE THAN 5 ± 1 SEC (RESETS AT -4 AMPS)

3 ONBOARD BATTERY CURRENT READINGS: READ PANEL METER DIRECTLY WHEN MEASURING INDIVIDUAL ASCENT BATTERY CURRENTS

2 ASCENT BATTERY CAPACITY: 296 AMP-HRS AT A TERMINAL VOLTAGE OF 28.0 TO 32.5VDC

NOTES: 1 BARBERPOLE = DEADFACE OR OFF
GRAY = CONNECT OR ON

3 ASC

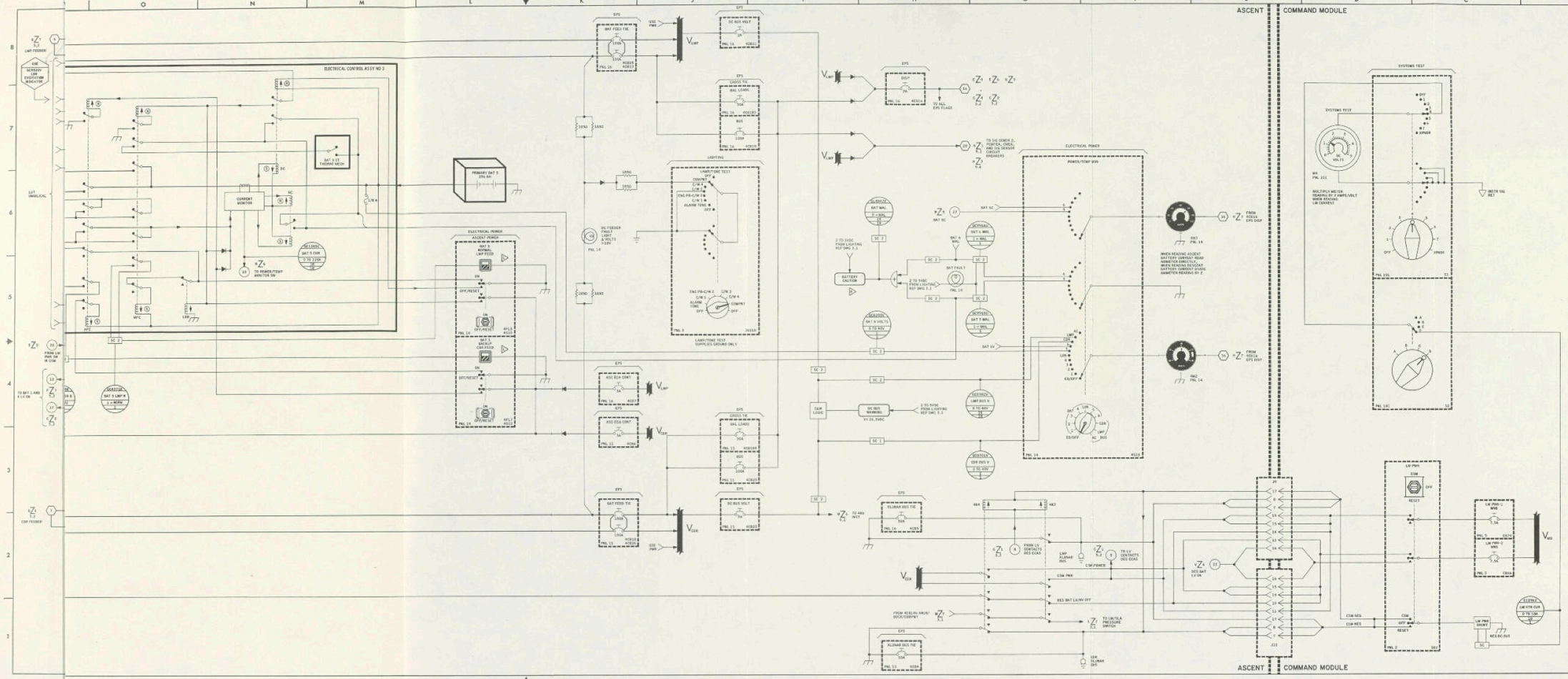
SIGNATURES	DATE
DR Linda L. Dreesbi	11-1-70
DSGN	
QC Jerry D. Taylor	12-7-70
ENGR William L. Patton	11/30/70
APP Donald R. Cuddy	11-30-70
FEC Dean B. Ritter	12-7-70

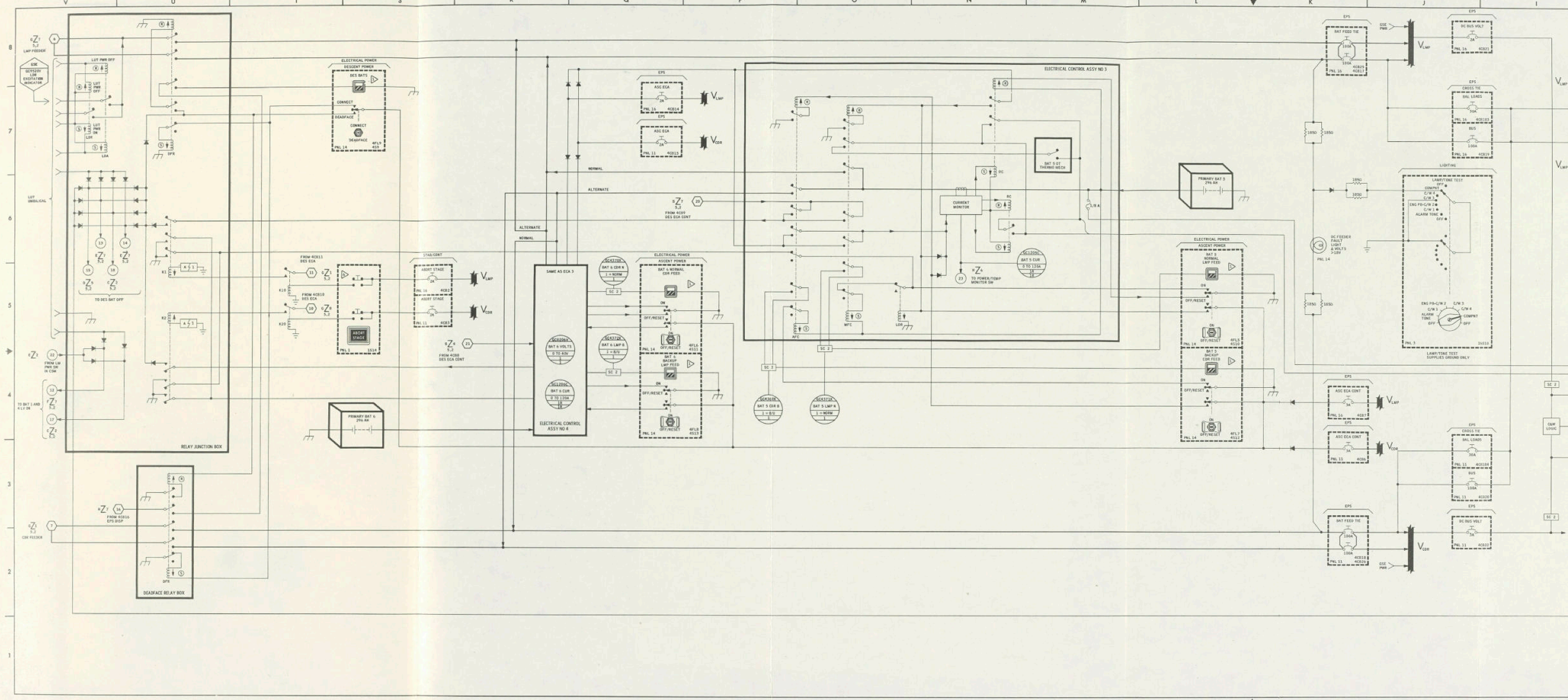
NATIONAL AERONAUTICS & SPACE ADMINISTRATION
MANNED SPACECRAFT CENTER · HOUSTON, TEXAS

ASCENT ELECTRICAL DC POWER

LM	SIZE	DWG NO
10 AND SUBS	J	5.3
121 X 34	PAGE 5-3	SHEET 1 OF 1

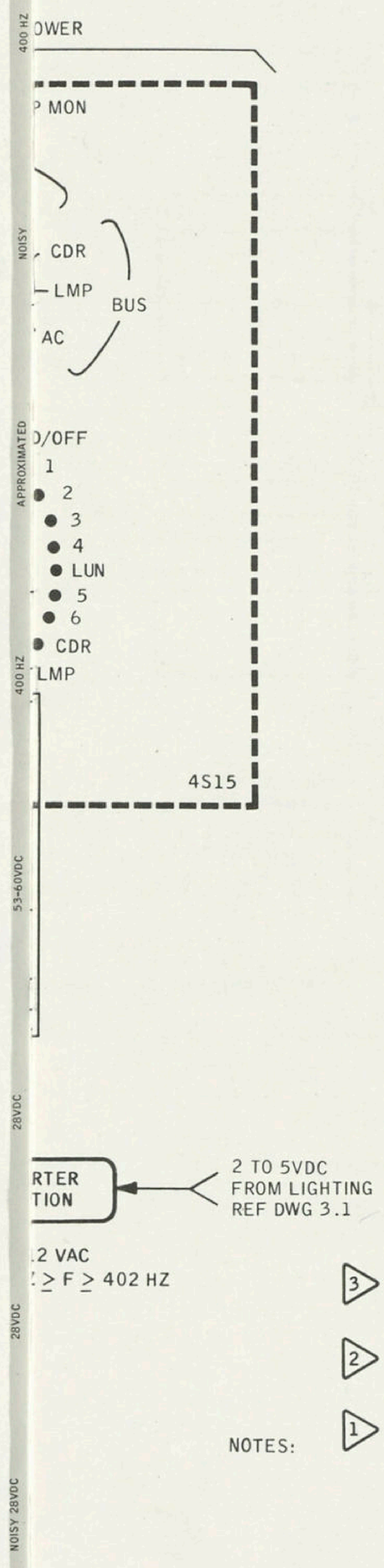
EMU
COMM
RF COMM
DC EPS ASCENT
AC EPS
O_2 SUPPLY
SUIT LOOP
H_2O GLYCOL


ASCENT
COMMAND MODULE
ELECTRICAL CONTROL ASSY NO 2
PRIMARY BAT 5 270 AH
ELECTRICAL POWER
ASCENT POWER
LIGHTING
LAMP/TONE TEST
SYSTEMS TEST
ELECTRICAL POWER
POWER/TEMP MON
CURRENT MONITOR
BATTERY CAUTION
DC BUS WARNING
CSM/LM
LM PWR-2 MAIN
LM PWR-2 MNR
LM PWR SHUNT
NCS DC BUS
LM VTR CUR
TO TB 108
TO LM/TELA PRESSURE SWITCH
TO ALL EPS FLAGS
TO DS SOURCE 2, PORTSA, CNGS, AND DS SENSOR CIRCUIT BREAKERS
FROM ASCENT BATTERY CURRENT READ AMMETER DIRECTLY. FROM CM BATTERY CURRENT BATTERY CURRENT SHUNT AMMETER READING BY 2
WHEN READING ASCENT BATTERY CURRENT READ AMMETER DIRECTLY. FROM CM BATTERY CURRENT BATTERY CURRENT SHUNT AMMETER READING BY 2
MULTIPLY METER READING BY 1 AMPS/VOLT WHEN READING LM CURRENT
FROM ASCENT BATTERY CURRENT
FROM LM PWR ON IN CSM
TO BAT 1 AND 4 LP ON
LMP FEEDER
CSM FEEDER
LGT UMBILICAL
DC FEEDER FAULT DETECT ≥ 30 VOLTS ≥ 2.5V
TO POWER/TEMP MONITOR ON
TO AKS INST
FROM ASCENT ARM/DISCH/CHRNT
LMP ALUMAR DIS
CSM ALUMAR DIS
CSM PWR
DES BAT LK/NV OFF
CSM/POWER
FROM LV CONTACTS DES ECAS
TO LV CONTACTS DES ECAS
DES BAT 1 ON
DES BAT 2 ON
DES BAT 3 ON
DES BAT 4 ON
DES BAT 5 ON
DES BAT 6 ON
DES BAT 7 ON
DES BAT 8 ON
DES BAT 9 ON
DES BAT 10 ON
DES BAT


RELAY JUNCTION BOX
DEADFACE RELAY BOX
ELECTRICAL CONTROL ASSY NO 3
ELECTRICAL CONTROL ASSY NO 4
SAME AS ECA 3
ELECTRICAL POWER
DESCENT POWER
ASCENT POWER
EPS
STAB/CONT
LIGHTING
CROSS TIE
PRIMARY BAT 5 296 AH
PRIMARY BAT 6 296 AH
CURRENT MONITOR
BAT 5 OVT THERMO MECH
LUT PWR OFF
LUT PWR ON
LUT UMBILICAL
TO DES BAT OFF
ABORT STAGE
NORMAL
ALTERNATE
DC FEEDER FAULT LIGHT & VOLTS >18V
LAMP/TONE TEST SUPPLIES GROUNDS ONLY
C&W LOGIC

LTR	DCN	DR	ENG	DATE		APPROVAL

COMMENTS:



NOTES:

(3) THE AOT LAMP IS UNIQUE IN THAT IT CAN BE POWERED FROM EITHER AC BUS. THIS IS THE ONLY PIECE OF AC EQUIPMENT THAT IS POWERED THIS WAY

(2) THE DC INPUT GROUND AND AC OUTPUT GROUND ARE TIED TO TWO SEPARATE NEGATIVE BUSES WHICH ARE BOTH TIED TO STRUCTURE GROUND

(1) INVERTER FREQ = 400 ± 0.4 HZ WITH SYNC FROM INSTR
= 400 ± 10 HZ WITHOUT SYNC FROM INSTR
INVERTER VOLTAGE = 115 ± 2.5VAC

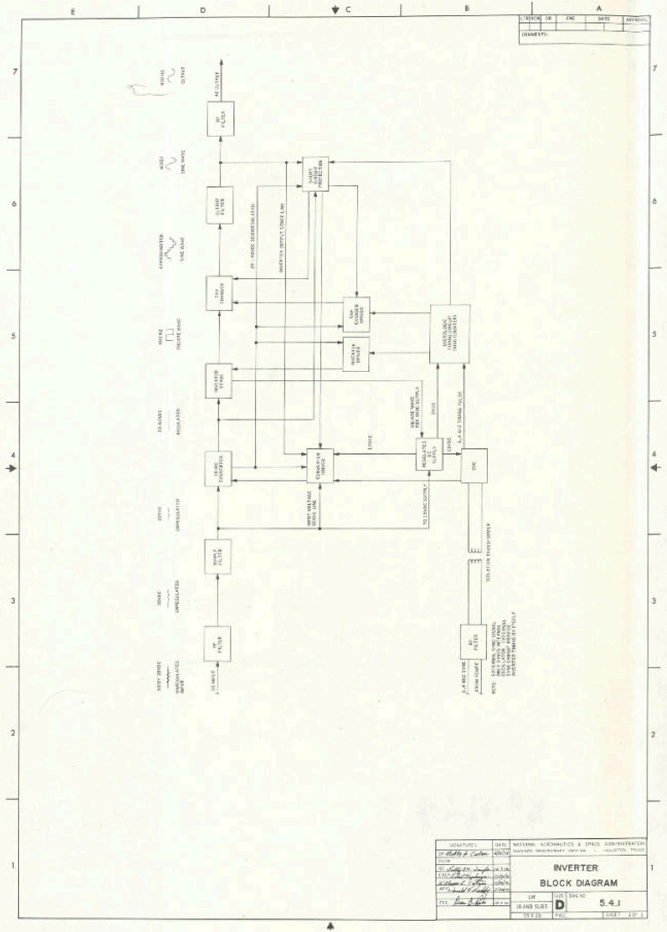
4 AC

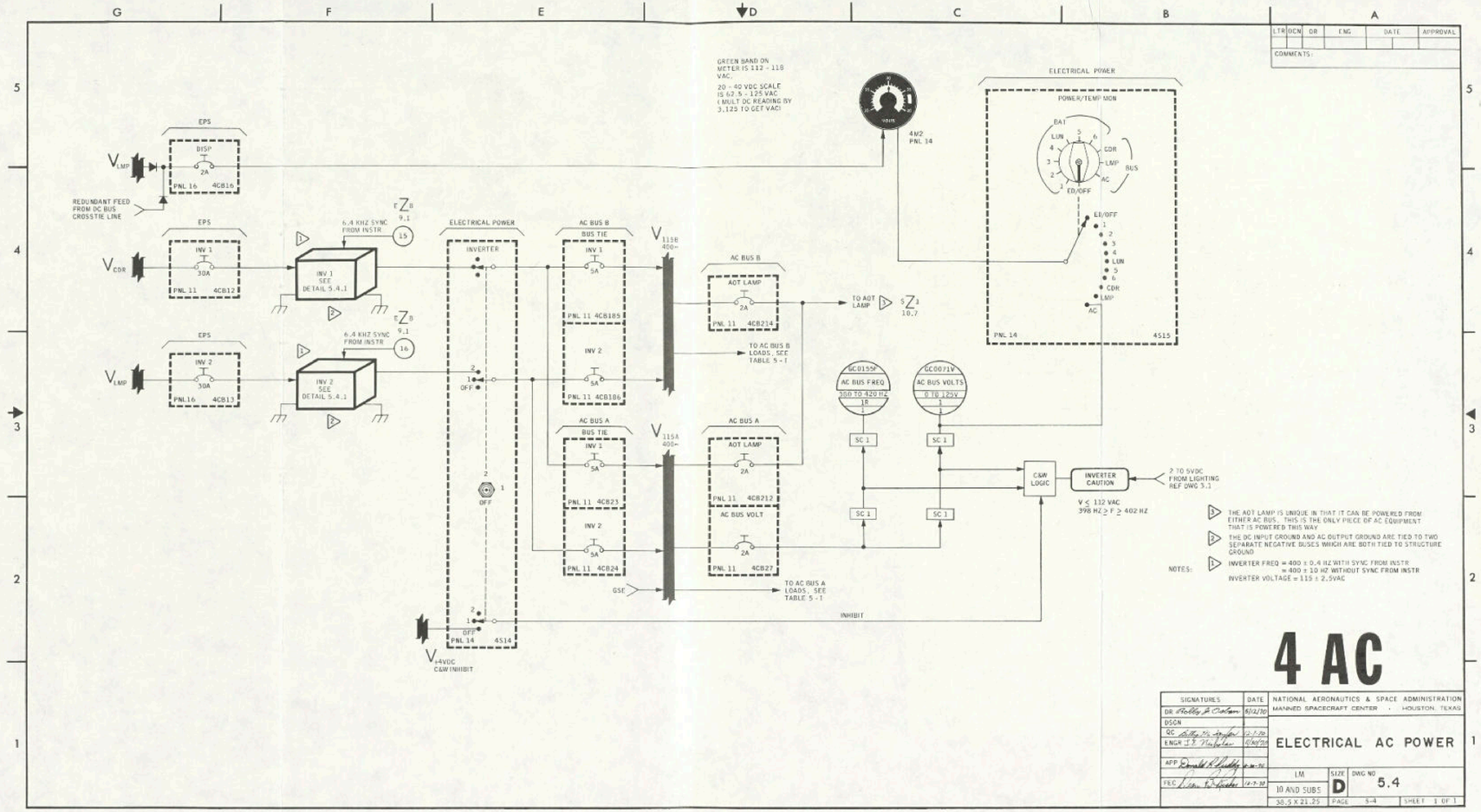
SIGNATURES	DATE
DR Bobby J. Osborn	5/12/70
DSGN	
QC Betty M. Taylor	12-7-70
ENGR L.E. Nicholas	11/30/70
APP Donald R. Puddy	11-30-70
FEC Dean B. Fisher	12-7-70

NATIONAL AERONAUTICS & SPACE ADMINISTRATION
MANNED SPACECRAFT CENTER · HOUSTON, TEXAS

ELECTRICAL AC POWER

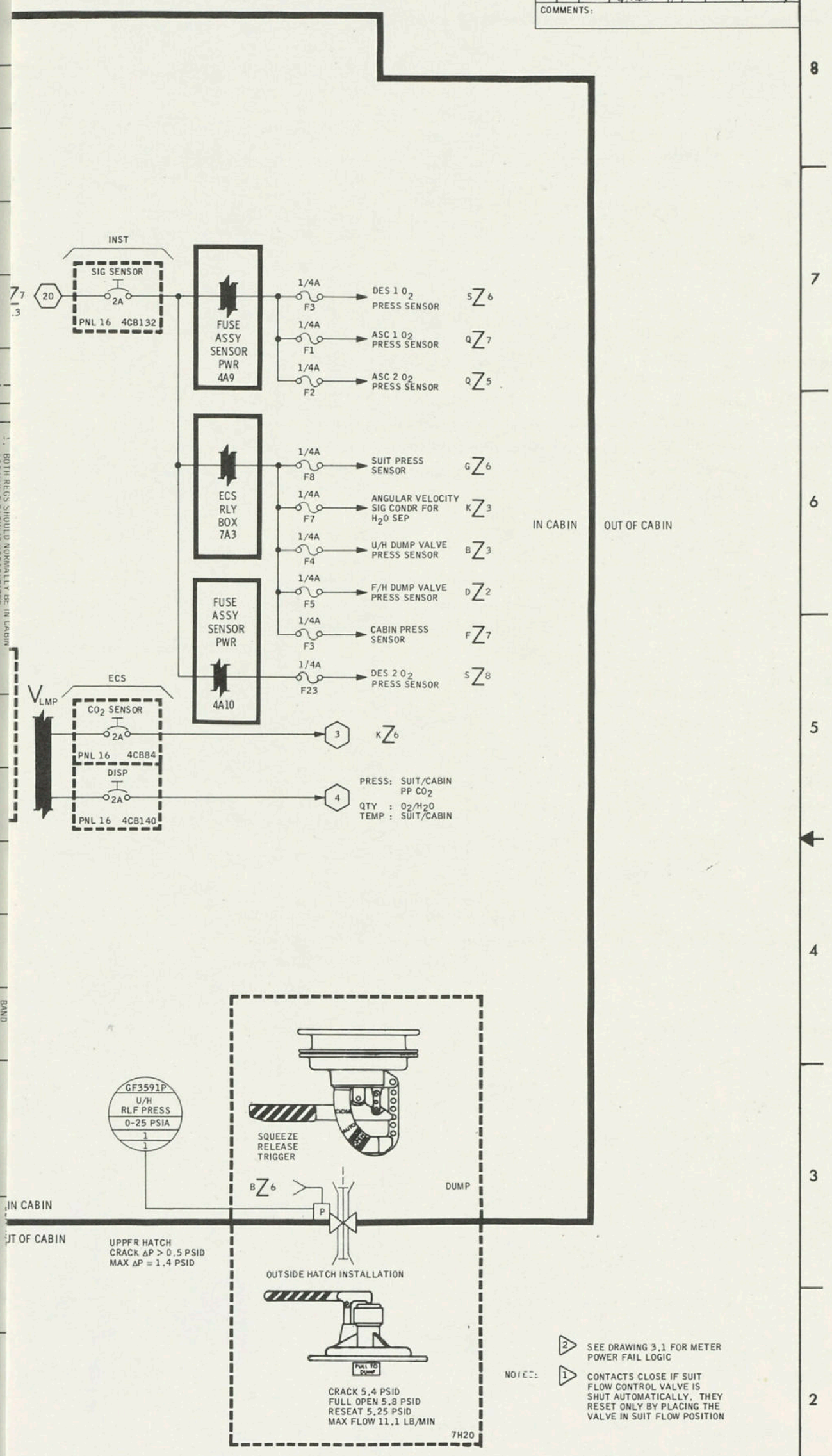
LM	SIZE	DWG NO
10 AND SUBS	D	5.4
38.5 X 21.25	PAGE 5-4	SHEET 1 OF 1


INVERTER
BLOCK DIAGRAM
5.4.1
D


GREEN BAND ON METER IS 112 - 118 VAC.
20 - 40 VDC SCALE IS 62.5 - 125 VAC (MULT DC READING BY 3.125 TO GET VAC)
ELECTRICAL POWER
POWER/TEMP MON
BAT
LUN
CDR
LMP
AC
BUS
EB/OFF
PNL 14
4S15
EPS
DISP
2A
PNL 16 4CB16
REDUNDANT FEED FROM DC BUS CROSSTIE LINE
INV 1
30A
PNL 11 4CB12
INV 2
30A
PNL16 4CB13
6.4 KHZ SYNC FROM INSTR
INV 1 SEE DETAIL 5.4.1
INV 2 SEE DETAIL 5.4.1
ELECTRICAL POWER
INVERTER
OFF
PNL 14 4S14
V +4VDC C&W INHIBIT
AC BUS B
BUS TIE
INV 1
5A
PNL 11 4CB185
INV 2
PNL 11 4CB186
AC BUS A
BUS TIE
INV 1
5A
PNL 11 4CB23
INV 2
PNL 11 4CB24
115B 400~
115A 400~
GSE
AC BUS B
AOT LAMP
2A
PNL 11 4CB214
TO AOT LAMP
TO AC BUS B LOADS, SEE TABLE 5-1
AC BUS A
AOT LAMP
2A
PNL 11 4CB212
AC BUS VOLT
2A
PNL 11 4CB22
TO AC BUS A LOADS, SEE TABLE 5-1
INHIBIT
GC0155P
AC BUS FREQ
350 TO 420 HZ
GC0071V
AC BUS VOLTS
0 TO 125V
SC 1
C&W LOGIC
INVERTER CAUTION
2 TO 5VDC FROM LIGHTING REF DWG 3.1
V ≤ 112 VAC
398 HZ ≥ F ≥ 402 HZ
NOTES:
THE AOT LAMP IS UNIQUE IN THAT IT CAN BE POWERED FROM EITHER AC BUS. THIS IS THE ONLY PIECE OF AC EQUIPMENT THAT IS POWERED THIS WAY.
THE DC INPUT GROUND AND AC OUTPUT GROUND ARE TIED TO TWO SEPARATE NEGATIVE BUSES WHICH ARE BOTH TIED TO STRUCTURE GROUND
INVERTER FREQ = 400 ± 0.4 HZ WITH SYNC FROM INSTR
= 400 ± 10 HZ WITHOUT SYNC FROM INSTR
INVERTER VOLTAGE = 115 ± 2.5VAC
4 AC
NATIONAL AERONAUTICS & SPACE ADMINISTRATION
MANNED SPACECRAFT CENTER · HOUSTON, TEXAS
ELECTRICAL AC POWER
LM
10 AND SUBS
D
DWG NO 5.4
38.5 X 21.25
PAGE 5-4
SHEET 1 OF 1

LTR	PCN	DR	ENG	DATE		APPROVAL
	1		J. Knight for G. Parker	4/13/71	4-8-71	

COMMENTS:



NOTES:
2. SEE DRAWING 3.1 FOR METER POWER FAIL LOGIC
1. CONTACTS CLOSE IF SUIT FLOW CONTROL VALVE IS SHUT AUTOMATICALLY. THEY RESET ONLY BY PLACING THE VALVE IN SUIT FLOW POSITION

SUIT GAS DIVERTER (-112)		
SUIT RELIEF VALVE (-117)		
CABIN PRESS SWITCH (-323)		
CABIN REPRS VALVE (-309)		
SUIT RELIEF VALVE (-117)		
SUIT ISOL VALVES (-138)	INCREASING PRESS WILL NOT RETURN VLV TO SUIT FLOW (OPEN) POSITION	
CABIN REPRS VALVE (-309)		
CABIN DUMP VALVE 307		
SUIT LOOP PRESS SWITCH		BAND 0.1 PSIA

1. BOTH REGS SHOULD NORMALLY BE IN CABIN POS WHILE CABIN IS PRESSURIZED.
2. BOTH REGS SHOULD NORMALLY BE IN EGRESS WHILE CABIN IS DEPRESSURIZED.
3. CABIN WILL BE AT HIGHER PRESS AND CABIN REPRESS VLV WILL OPERATE AT 3.7 TO 4.44 PSIA.

SUIT LOOP MODES

MODE	SWITCH/VALVE POSITION														
	DES O_2	ASC 1 O_2	ASC 2 O_2	CABIN REPRESS	PLSS FILL (HIGH)	PLSS FILL (LOW)	DMD REG A	DMD REG B	SUIT RELIEF	SUIT DIVERTER	CABIN RETURN	CANISTER SEL	SUIT FAN SEL	WATER SEP SEL	(BOTH) CABIN DUMP VALVES	SUIT ISOL VALVES
CABIN (DES)	OPEN	CLOSE	CLOSE	AUTO	CLOSE	CLOSE	CABIN	CABIN	AUTO	CABIN	AUTO	PRIM	1	SEP 1	AUTO	SUIT FLOW (BOTH)
CABIN (ASC)	CLOSE	OPEN	CLOSE	CLOSE	CLOSE	CLOSE	CABIN	CABIN	AUTO	CABIN	AUTO	PRIM	1	SEP 1	AUTO	SUIT FLOW (BOTH)
EGRESS (DES)	OPEN	CLOSE	CLOSE	CLOSE	CLOSE	CLOSE	EGRESS	EGRESS	AUTO	EGRESS	EGRESS	PRIM	1	SEP 1	AUTO	SUIT FLOW (BOTH)
EGRESS (ASC)	CLOSE	OPEN	CLOSE	CLOSE	CLOSE	CLOSE	EGRESS	EGRESS	AUTO	EGRESS	EGRESS	PRIM	1	SEP 1	AUTO	SUIT FLOW (BOTH)

NOTES:
1. THE FOLLOWING C/B'S ARE CLOSED DURING ALL MANNED MODES: 4CB140 - ECS DISP; 4CB113 - CABIN REPRESS; 4CB112 - DIVERT VLV; 4CB138 - SUIT FAN 1 4CB119 - SUIT FAN 2; 4CB120 - SUIT FAN ΔP; 4CB84 - CO2 SENSOR; 4CB234 - SUIT FLOW CONTROL

H_2O SEPARATORS	AT 4.8 PSIA: 1200 TO 3600 RPM AND 5.4 TO 6.5 PSIA H_2O AT 3.8 PSIA: 850 TO 2600 RPM AND 4.4 TO 5.4 PSIA H_2O
CABIN	
CABIN PRESS SWITCHES	CLOSE: 3.70 TO 4.44 PSIA (DECREASING) OPEN: 4.40 TO 5.0 PSIA (INCREASING)
REPRESS VALVE	FLOW RATE = 6.6 LBS/MIN MAX FLOW (AUTO) AT 950 PSIA
DUMP VALVE(S)	5.0 TO 0.08 PSIA IN 310 SEC (ONE VALVE WITH FILTER) 5.0 TO 0.08 PSIA IN 180 SEC (ONE VALVE WITHOUT FILTER)

O_2 CONSUMABLES

TANK	VOLUME FT3	CAPACITY QUANTITY LBS	CAPACITY QUANTITY %	CAPACITY PRESSURE PSIA	CAPACITY TEMPERATURE °F	RESIDUALS QUANTITY LBS	RESIDUALS QUANTITY %	RESIDUALS PRESSURE PSIA	RESIDUALS TEMPERATURE °F
DES 1 O_2	2.985	48.00	100	2730	70	0.84	1.8	50	70
DES 2 O_2	2.985	48.00	100	2730	70	0.84	1.8	50	70
A/1 O_2	0.495	2.43	100	854	70	0.14	5.9	50	70
A/2 O_2	0.495	2.43	100	854	70	0.14	5.9	50	70

OXYGEN USAGE (EXCEPT METABOLIC)
1. SPEC CABIN LEAK RATE 0.2 LB/HR (5 PSIA; 75° F)
2. EXPERIENCED CABIN LEAK RATE ≈ 0.06 LB/HR (4.8 PSIA; 70° F)
3. SUIT LOOP LEAK RATE (WITHOUT SUITS) 0.01 LB/HR (3.7 PSIA; 70° F)
4. CABIN REPRESSURIZATION (TO 5.0 PSIA) 5.51 LB AT 75° F
5. PLSS FILL (HIGH PRESS) 1.5 LB AT 1445 PSIA
PLSS FILL (LOW PRESS) 0.91 LB AT 850 PSIA

METABOLIC LOADS*
1. OXYGEN = 0.082 TO 0.124 $\frac{LB}{MAN\text{-}HR}$
2. HEAT = 400 TO 760 $\frac{BTU}{MAN\text{-}HR}$
3. CO_2 PRODUCTION = 0.096 TO 0.146 $\frac{LB}{MAN\text{-}HR}$

* THESE LOADS ASSUME ASTRONAUT WORKS IN THE LM WHILE IN THE "CABIN" MODE.

1 OXYGEN

SIGNATURES	DATE
DR Linda S. Drouin	4-16-70
DSGN	
QC Betty M. Taylor	12-7-70
ENGR Clarence J. Sales	11/30/70
APPR Ronald K. Priddy	11/30/70
FEC Dean B. Fisher	12-7-70

NATIONAL AERONAUTICS & SPACE ADMINISTRATION
MANNED SPACECRAFT CENTER • HOUSTON, TEXAS

ENVIRONMENTAL O_2 SUPPLY SUIT LOOP

LM	SIZE	DWG NO
10 AND SUBS	J	6.1
104.5 X 34	PAGE 6-1	SHEET 1 OF 1

1 OXYGEN

NATIONAL AERONAUTICS & SPACE ADMINISTRATION
MANNED SPACECRAFT CENTER - HOUSTON, TEXAS

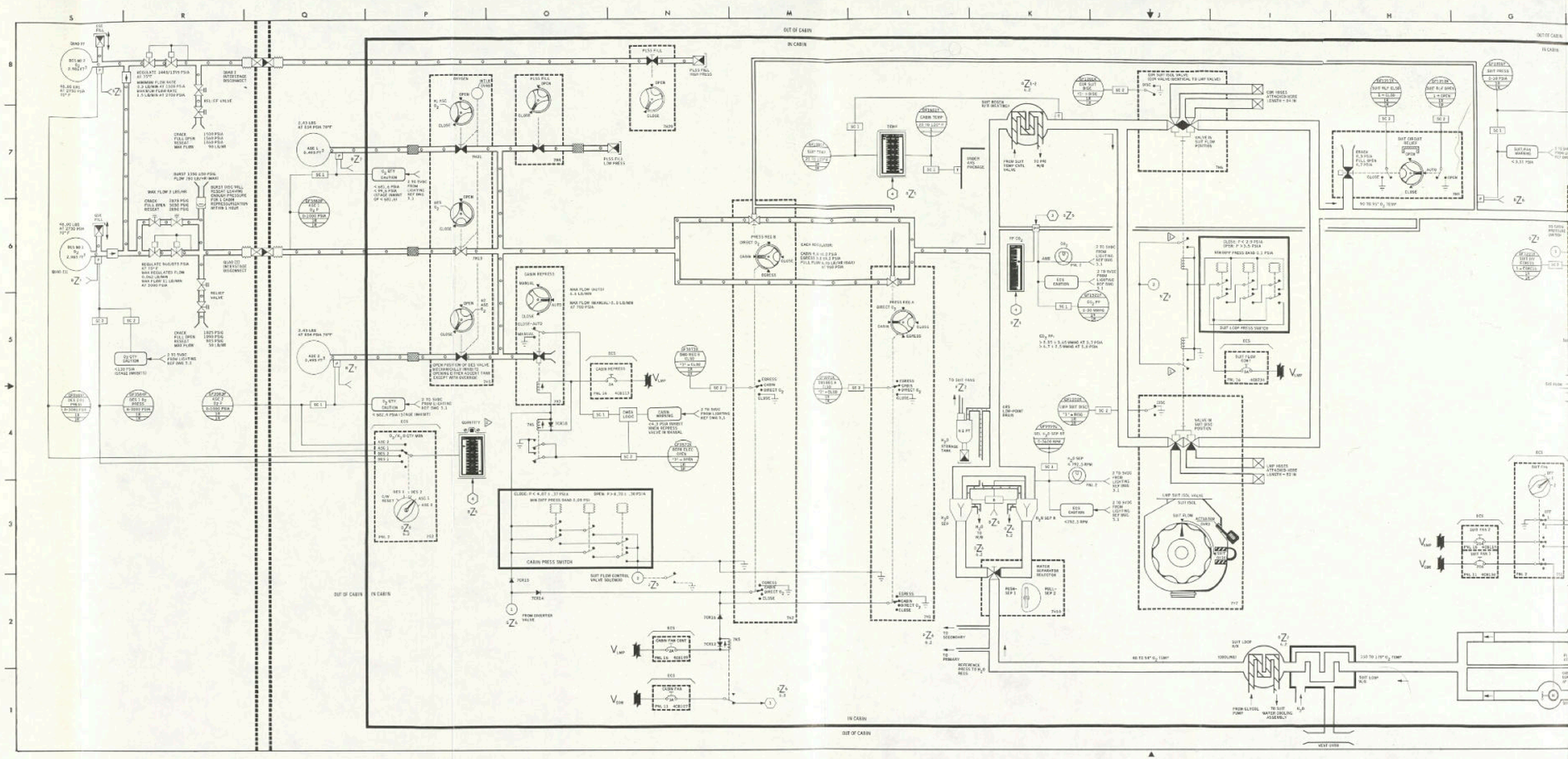
ENVIRONMENTAL O_2 SUPPLY SUIT LOOP

SIZE: D | CODE IDENT NO: 17 | DWG NO: 6.1

D 490 SUBS 1

SCALE: NONE | SHEET 1 OF 1

O_2 SUPPLY SUIT LOOP


OUT OF CABIN
IN CABIN
SUIT PRESSURE
CABIN PRESSURE
CABIN PRESS SWITCH
SUIT FLOW CONTROL VALVE SOLENOID
FROM DIVERTER VALVE
SUIT LOOP PRESS SWITCH
SUIT FLOW
ACTUATOR
SUIT LOOP VALVE
SUIT LOOP
GROUND
FROM GLYCOL PUMP
TO SUIT WATER DRIVING ASSEMBLY
HEAT EXCH
TO SECONDARY
TO PRIMARY
REFERENCE PRESS TO H_2O REG
FROM SUIT TEMP CNTL VALVE
SUIT BOOST AIR (RESTRICT)
UNDER AIR PACKAGE
CO_2 RM.
O_2 STORAGE TANK
WATER SEPARATOR REGULATOR
REGULATOR
SUIT PRESS
SUIT DROOP SENSOR
SUIT FLOW PRESS
SUIT FLOW SUIT
SUIT FLOW SUIT
SUIT FLOW SUIT

H_2O/GLYCOL DATA

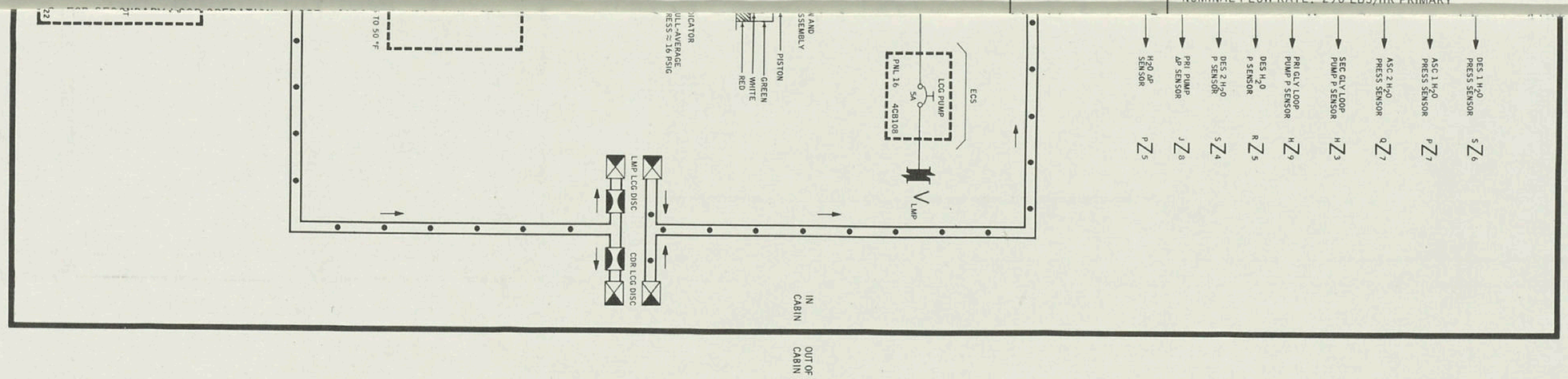
GLYCOL LOOP MODES

MODE	SWITCH/VALVE POSITION								
	WATER TANK SEL	DES H_2O	ASC H_2O	PRI EVAP FLOW NO 1	PRI EVAP FLOW NO 2	SEC EVAP FLOW	GLY PUMP SEL	LIQUID GARMENT COOLING CONTROL	SUIT TEMP CONTROL
NORMAL (DES)	DES	OPEN	CLOSE	OPEN	CLOSE	CLOSE	1	HOT	COLD
NORMAL (ASC)	ASC	CLOSE	OPEN	OPEN	CLOSE	CLOSE	1	HOT	COLD
SECONDARY	SEC	CLOSE	OPEN	CLOSE	CLOSE	OPEN	INST SEC	N/A	N/A

NOTES: 1. THE FOLLOWING C/B'S ARE CLOSED DURING NOMINAL OPERATION: 4CB108 - LCG PUMP; 4CB117 - GLYCOL PUMP 1; 4CB141 - GLYCOL PUMP 2; 4CB217 - GLYCOL PUMP AUTO TRNFR (LUNAR SURFACE ONLY)

ECS SYSTEMS DATA

EQUIPMENT	DATA
SUIT WATER COOLING ASSEMBLY	LIQUID GARMENT COOLING: 40° TO 60°F
CABIN FAN	5 LBS O_2/MIN AT 13,000 ± 250 RPM
GLYCOL LOOPS	
COOLANT	35% ETHYLENE GLYCOL AND 65% H_2O QUANTITY PRIME LOOP = 25 LBS ± 10% QUANTITY SEC LOOP = 5.0 LBS ± 10% NOMINAL FLOW RATE: 290 LBS/HR PRIMARY



NOTES:

1. SEE DWG 3.1 FOR METER POWER FAIL LOGIC
2. DELETED
3. ONE CAUTION LIGHT FOR BOTH FUNCTIONS. SEE DWG 9.6 B_{Z_9} FOR LOGIC
4. ONE CAUTION LIGHT FOR LOW GLYCOL ΔP AND FUNCTIONS IN DWG 6.1. SEE DWG 9.6 F_{Z_3} FOR LOGIC
5. THESE TEMPERATURES ARE EXPECTED OPERATING RANGES. THE NUMBERS ARE NOT TEMPERATURE LIMITS. HIGHER NUMBER OF TWO OCCURS DURING W/B DRYOUT
6. SOLID STATE SWITCH CLOSURE IN SIGNAL CONDITIONER MAINTAINS GLYCOL COMPONENT CAUTION LIGHT ON SO LONG AS $7K_9$ IS CLOSED

2 COOLING

SIGNATURES	DATE	NATIONAL AERONAUTICS & SPACE ADMINISTRATION MANNED SPACECRAFT CENTER - HOUSTON, TEXAS
DR DSGN		
QC		
ENGR		
APR		
FEC		

ENVIRONMENTAL H_2O SUPPLY / GLYCOL LOOP

LM — 10 AND SUBS — SIZE J — DWG NO 6.2

104.5 X 38.25 — PAGE 6-2 — SHEET 1 OF 1

LTR	DCN	DR	ENG	DATE	APPROVAL

COMMENTS:

H2O GLYCOL | C&W WARN | C&W | COMM | COMM | EMU

EQUIPMENT	DATA
SLC PRI LOOP CONTROL ASSEMBLY	LIQUID GARMENT COOLING, 40°F TO 60°F
CABIN FAN	5.185 ft^3/min AT 13.0SE + 2.90 IPGW

GLYCOL LOOPS

COOLANT: 35% ETHYLENE GLYCOL AND 65% H_2O
QUANTITY PRIME LOOP = 25.1 LBS + 13%.
QUANTITY SEC LOOP = 6.3 LBS ± 10%.
NOMINAL FLOW RATE: 290 LBS/HR PRIMARY

SCS SYSTEMS DATA

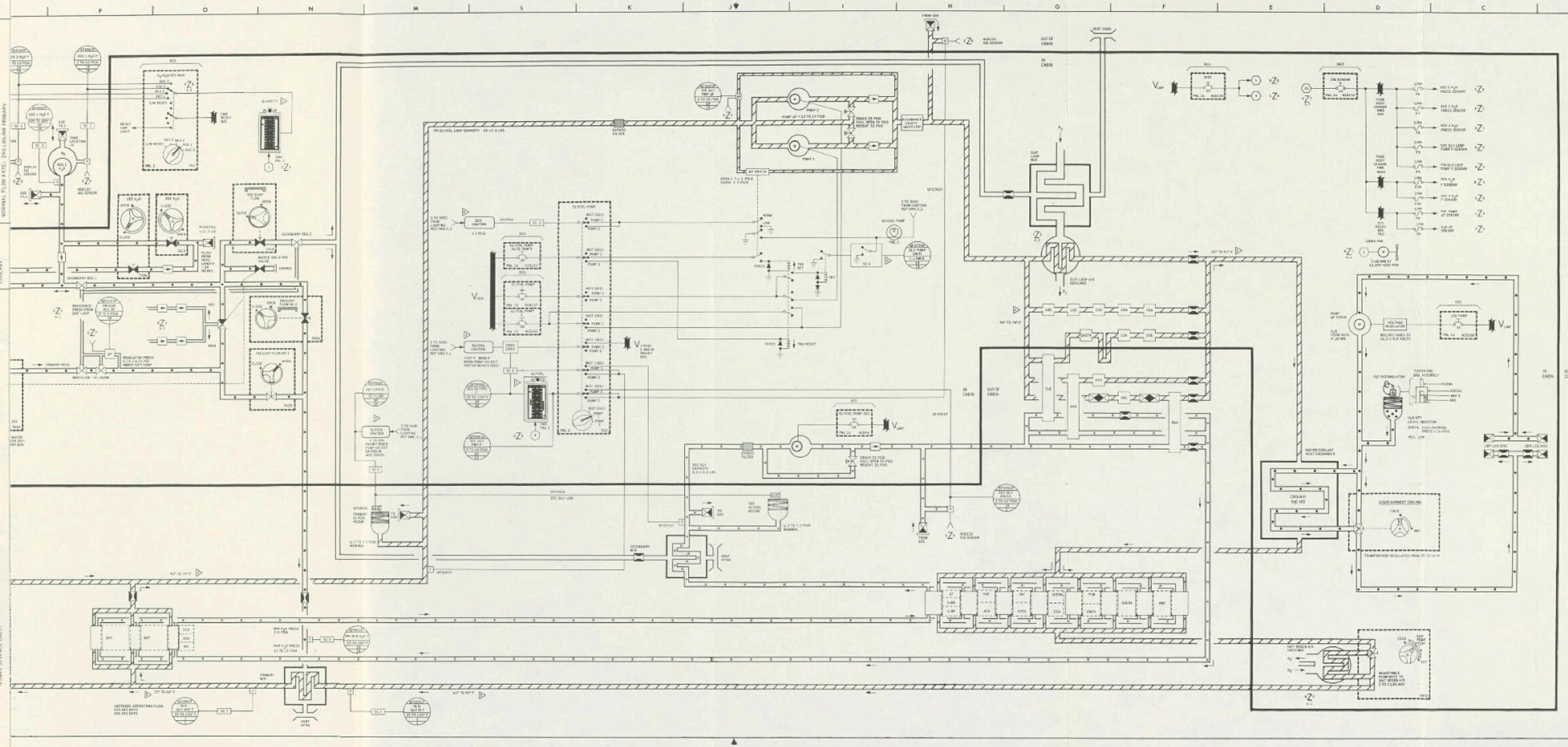
MODE	WATER TANK SEL	IBS. PGD	ASC H_2O	PRI EVAP FLOW SEL	PRI EVAP FLOW SEL	SEC EVAP FLOW SEL	SLV PUMP SEL	LIQUID GARMENT COOLING CONTROL	SLV TEMP CONTROL
NORMAL (DES)	SES	OPEN	CLOSE	OPEN	CLOSE	CLOSE	1	HOT	COLD
NORMAL (ASC)	ASC	CLOSE	OPEN	OPEN	CLOSE	CLOSE	1	HOT	COLD
SECONDARY	SEC	CLOSE	OPEN	CLOSE	CLOSE	OPEN	INTL SEC	OPEN	N/A

SWITCH/VALVE POSITION

GLYCOL LOOP MODES

H2O/GLYCOL DATA

NOTES: 1. THE FOLLOWING C/O'S ARE CLOSED DURING NORMAL OPERATION: HC8115 - LCG PUMP; HC8117 - CLYCOL PUMP 1; HC8142 - GLYCOL PUMP 2; HC8127 - GLYCOL LAND AUTO TIMER (LIMA SERVICE ONLY)



1. SOLID STATE SWITCH CLOSURE IN SIGNAL CONDITIONER MAINTAINS CLOSED, CONTINUOUS CAUTION LIGHT ON 10 LONG AS TEMP IS CLOSED.
2. THESE TEMPERATURES ARE EXPECTED OPERATING RANGES. THE NUMBERS ARE NOT TEMPERATURE LIMITS. HIGHER NUMBER OF TWO SQUARES CARRIES NO OPTION.
3. ONE CAUTION LIGHT FOR LOW GLYCOL AT PRI FUNCTIONS (SEE DWG 7.1) ΔZ_1 FOR LOGIC.
4. ONE CAUTION LIGHT FOR BOTH FUNCTIONS. SEE DWG 7.1 ΔZ_2 FOR LOGIC.
5. DELETED
6. SEE DWG 2.2 FOR WATER POWERED FAN LOGIC

NOTES:

2 COOLING

SUBMITTED:	DATE	NATIONAL AERONAUTICS & SPACE ADMINISTRATION	
		MANNED SPACECRAFT CENTER HOUSTON, TEXAS	
		ENVIRONMENTAL H_2O SUPPLY / GLYCOL LOOP	
		SIZE J	PART NO. 6.2
		20 AND 10B3	
		SCALE NONE	SHEET 1 OF 1

H2O GLYCOL

H_2O/GLYCOL DATA

GLYCOL LOOP MODES

MODE	SWITCH/VALVE POSITION								
	WATER TANK SEL	DES H_2O	ASC H_2O	PRI EVAP FLOW NO 1	PRI EVAP FLOW NO 2	SEC EVAP FLOW	GLY PUMP SEL	LIQUID GARMENT COOLING CONTROL	BUS TEMP CONTROL
NORMAL (DES)	DES	OPEN	CLOSE	OPEN	CLOSE	CLOSE	1	HOT	COLD
NORMAL (ASC)	ASC	CLOSE	OPEN	OPEN	CLOSE	CLOSE	1	HOT	COLD
SECONDARY	SEC	CLOSE	OPEN	CLOSE	CLOSE	OPEN	BOTH SEC	N/A	N/A

NOTES:
1. THE FOLLOWING C/B'S ARE CLOSED DURING NORMAL OPERATION: 4CB106 - LCG PUMP, 4CB117 - GLYCOL PUMP 1, 4CB143 - GLYCOL PUMP 2, 4CB217 - GLYCOL PUMP AUTO TRNFR (LUNAR SURFACE ONLY)
2. FOR SECONDARY LOOP OPERATION: CLOSE - 4CB96 - GLYCOL PUMP SEC
   OPEN - 4CB117 - GLYCOL PUMP 1, 4CB143 - GLYCOL PUMP 2,
   4CB217 - GLYCOL PUMP AUTO TRNFR
   4CB106 - LCG PUMP

H_2O CONSUMABLES

TANK	VOLUME FT^3	CAPACITY			MISSIONS		
		QUANTITY LBS	PRESSURE PSIA	TEMPERATURE °F	QUANTITY LBS	PRESSURE PSIA	TEMPERATURE °F
DES 1 H_2O	7.130*	333**	47.3	75	6.66	11.4***	50
DES 2 H_2O	7.130*	333**	47.3	75	6.66	11.4***	50
ASC 1 H_2O	6.918*	42.5**	47.3	75	0.85	11.4	50
ASC 2 H_2O	6.918*	42.5**	47.3	75	0.85	11.4	50

WATER USAGE
1. PLSS FILL = 9.15 LB
2. NORMAL USAGE FOR HEAT REJECTION
   (METAL COAST - 5.5 TO 7.5 LBS/HR
   LUNAR SURFACE - 5.0 TO 6.5 LBS/HR

HEAT CONVERSION
1. 1 KWH = 3413 BTU
2. 1 LB H_2O REJECTS = 1040 BTU
3. AT 28 VOLTS, 1 AMP TO THE GLYCOL LOOP CORRESPONDS TO 0.096 LBS/HR H_2O

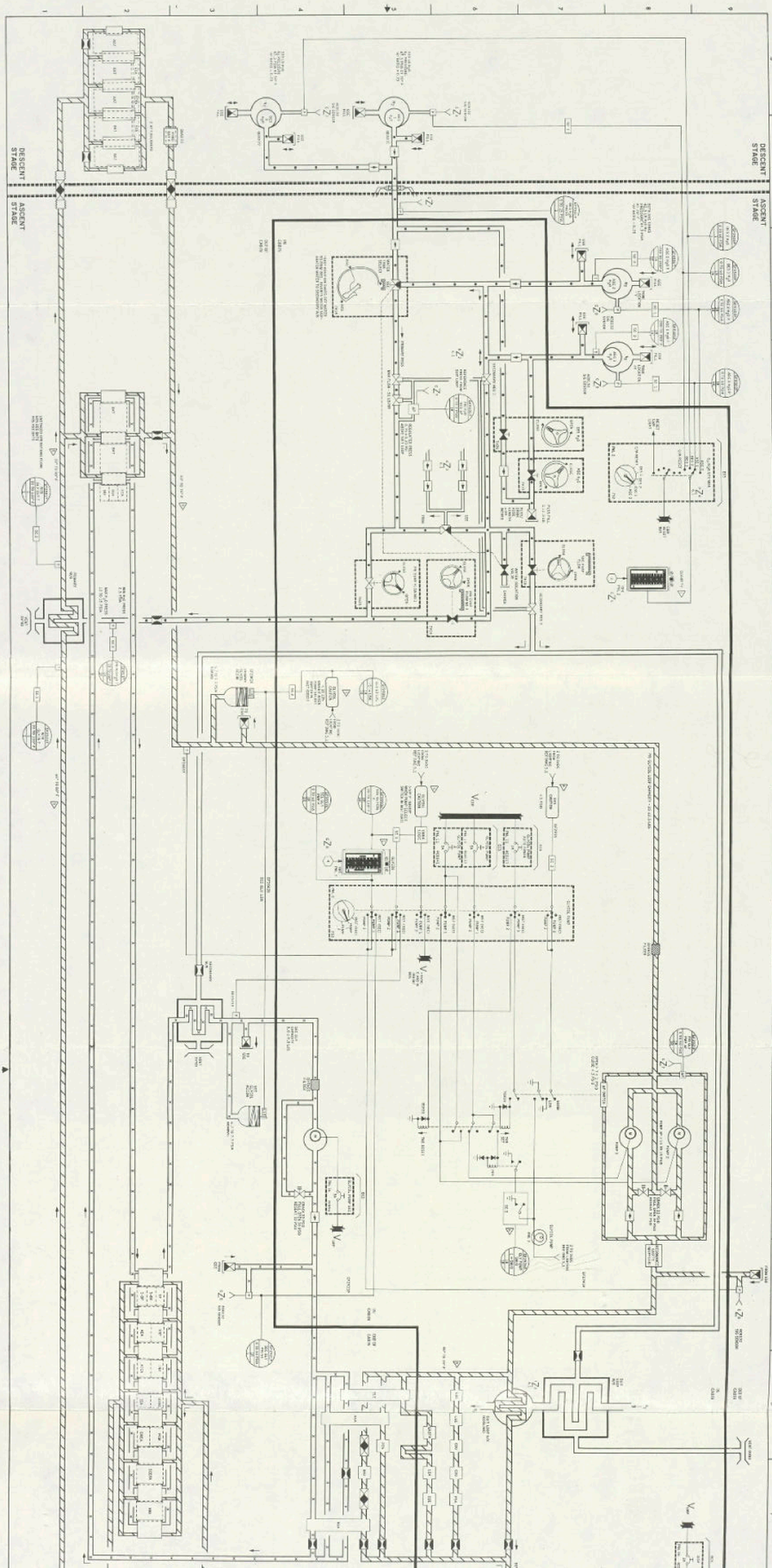
* THIS INCLUDES GAS (N_2) + WATER VOLUME

** INITIAL WATER LOADING MAY VARY BETWEEN 155 LBS AND 333 LBS FOR EACH DESCENT TANK, AND BETWEEN 19.3 LBS AND 42.5 LBS FOR THE ASCENT TANKS.

*** CORRESPONDS TO LOADED RATIO (WATER VOLUME LOADED/TOTAL TANK VOLUME) OF 0.75.

LCS SYSTEMS DATA

EQUIPMENT	DATA
SUIT WATER COOLING ASSEMBLY	LIQUID GARMENT COOLING: 40° TO 60°F
CABIN FAN	5 LBS O_2/MIN AT 13,000 = 250 RPM
GLYCOL LOOPS	
COOLANT	35% ETHYLENE GLYCOL AND 65% H_2O QUANTITY PRIME LOOP = 25 LBS ± 10% QUANTITY SEC LOOP = 5.3 LBS ± 10% NOMINAL FLOW RATE: 290 LBS/HR PRIMARY 300 LBS/HR SECONDARY SPECIFIC HEAT = 0.866 BTU/LB AT 55°F SLUSH POINT = -3°F
PUMP(S)	4.0 LBS/MIN AT 40°F AND INLET PRESS OF 7 PSIA AND ΔP = 19 PSID SPEED = 5500 - 6500 RPM AT 28 - 30 VDC DISCHARGE PRESS = 26 PSIA PRI LOOP = 21 PSIA SEC LOOP
PUMP RELIEF VALVES	CRACK = 33 PSID, FULL OPEN = 39 PSID, RESEAT = 32 PSID
20% H/B	ESTIMATED NOMINAL IN/OUT TEMP RANGES (°F) HIGH: IN 81, OUT 35 LOW: IN 45, OUT 33 MAXIMUM CAPACITY = 23,450 BTU/HR MINIMUM LOAD TO PREVENT FREEZE-UP = 800 BTU/HR BREAKTHROUGH OCCURS IF: 1. INLET TEMP > 150° F (WATER TEMPERATURE DEPENDENT), OR 2. H_2O PRESS > APPROXIMATELY 10.0 PSIA FOR MORE THAN 5 MINUTES MINIMUM ALLOWABLE H_2O PRESS = 2.5 PSIA AT 70° F (TEMP DEPENDENT)



LTR	PCN	DR	ENG	DATE	APPROVAL
	2			6-25-71	6-25-71

COMMENTS:

OPS CONSTRAINT:

PLSS ANTENNA PERMANENTLY MOUNTED ON OPS. ABSENCE OF OPS RESULTS IN LOSS OF COMMUNICATIONS

PLSS VHF ANTENNA

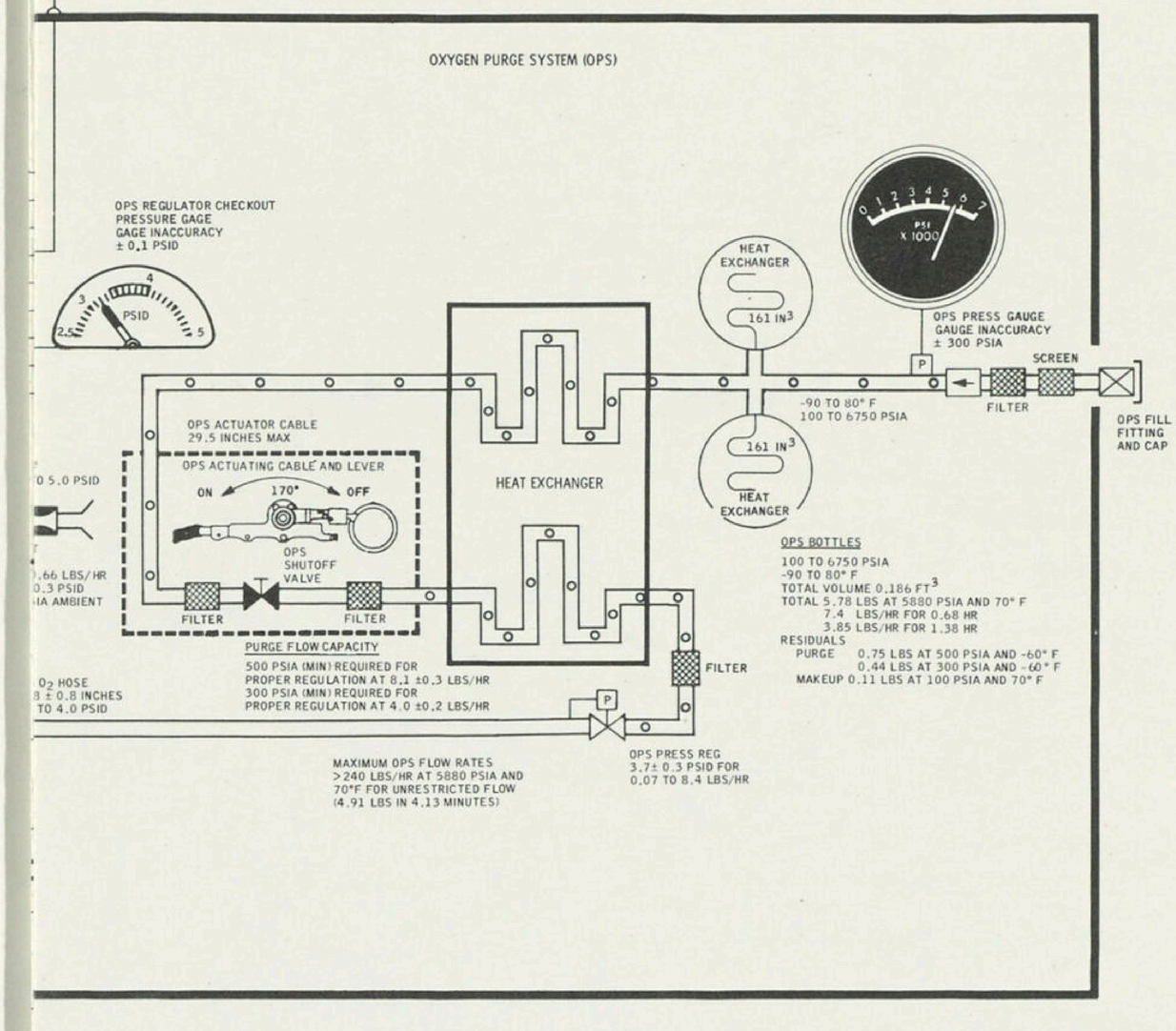


TABLE 1

SUBLIMATOR	STARTUP	MAX HEAT LOAD	MIN HEAT LOAD
INLET TEMP	50 TO 130° F	130° F	72° F
DEWPOINT	50 TO 84° F		
FLOW RATE	7.00 LBS/HR	7.707 LBS/HR	7.707 LBS/HR (0.23 LBS/HR H_2O)
OUTLET TEMP		51° F	>32° F
HEAT LOAD			140 BTU/HR
INLET TEMP	35 TO 109° F	54° F	78 TO 80° F
FLOW RATE	0.06 LBS/HR	4.4 LBS/MIN	0.01 LBS/MIN
OUTLET TEMP		45° F	>32° F
HEAT LOAD			150 BTU/HR
TEMP	35 TO 109° F		
AMBIENT PRESS	<1000 MICRON (0.0193 PSIA)		
FEED H_2O PRESSURE	<6.0 PSIA		
HEAT LOAD		8750 BTU/HR	

NOTES:
1. SUBLIMATOR (SEE TABLE 1)
2. PWR TO FM RCVR IN MODE AR ONLY
3. EKG VCO IS 5.4 KHZ (IRIG 10) IN EVC-1, 3.9 KHZ (IRIG 9) IN EVC-2
4. PAM VCO IS 10.5 KHZ (IRIG 12) IN EVC-1, 7.35 KHZ (IRIG 11) IN EVC-2

1 EMU

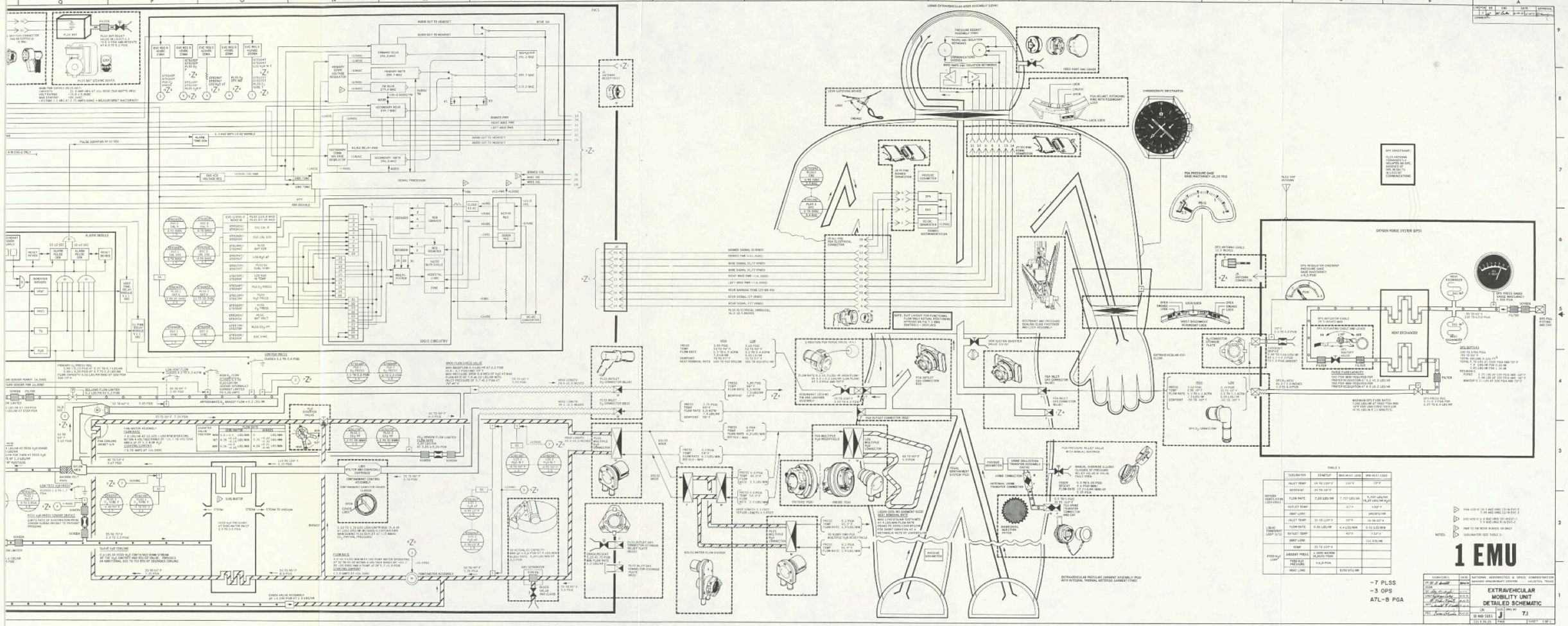
-7 PLSS
-3 OPS
A7L-B PGA

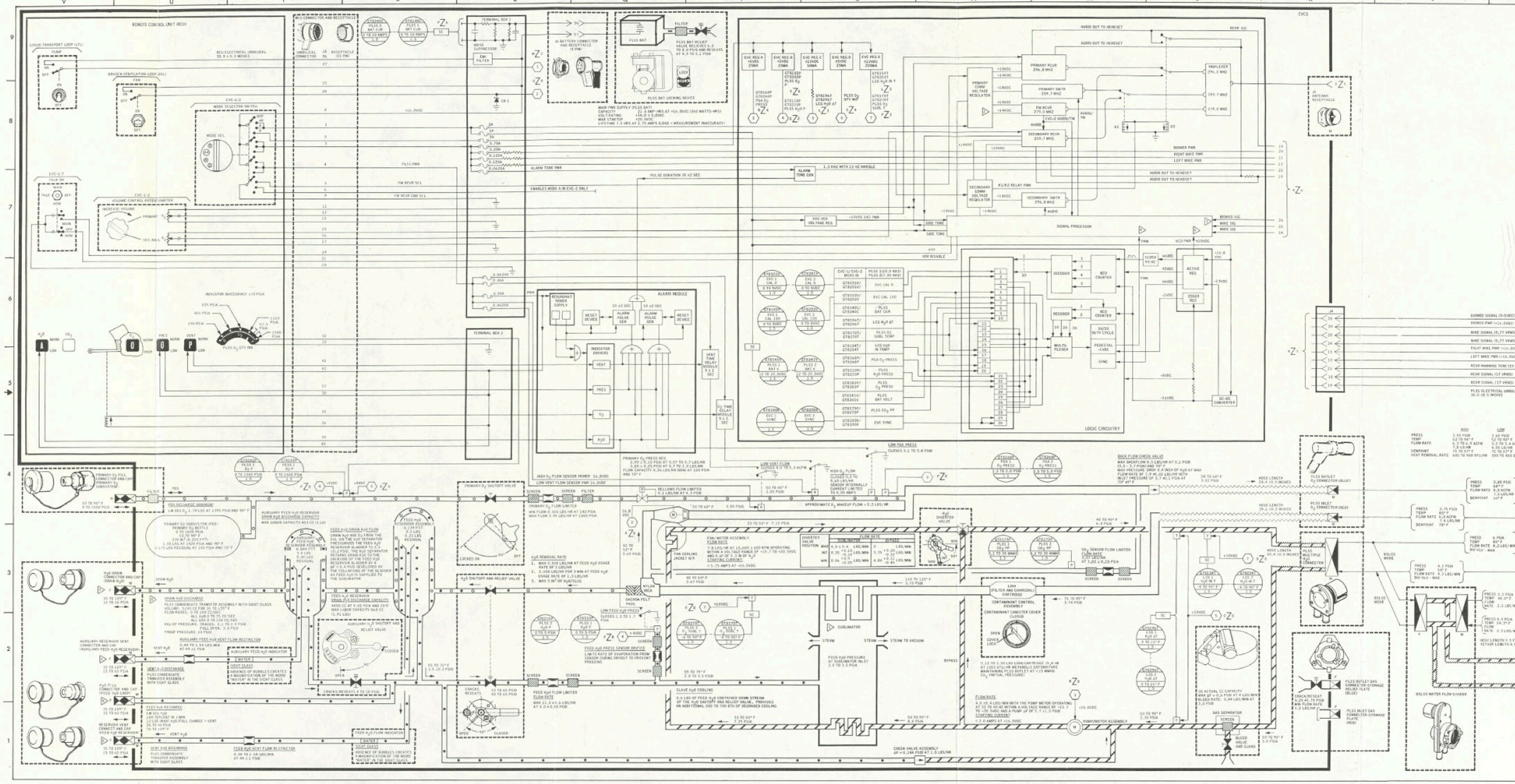
SIGNATURES	DATE
DR	8/24/70
DSGN	
QC	4-15-71
ENGR	4-15-71
	4-15-71
APP	4-15-71
FEC	4-15-71

NATIONAL AERONAUTICS & SPACE ADMINISTRATION
MANNED SPACECRAFT CENTER · HOUSTON, TEXAS

EXTRAVEHICULAR MOBILITY UNIT DETAILED SCHEMATIC

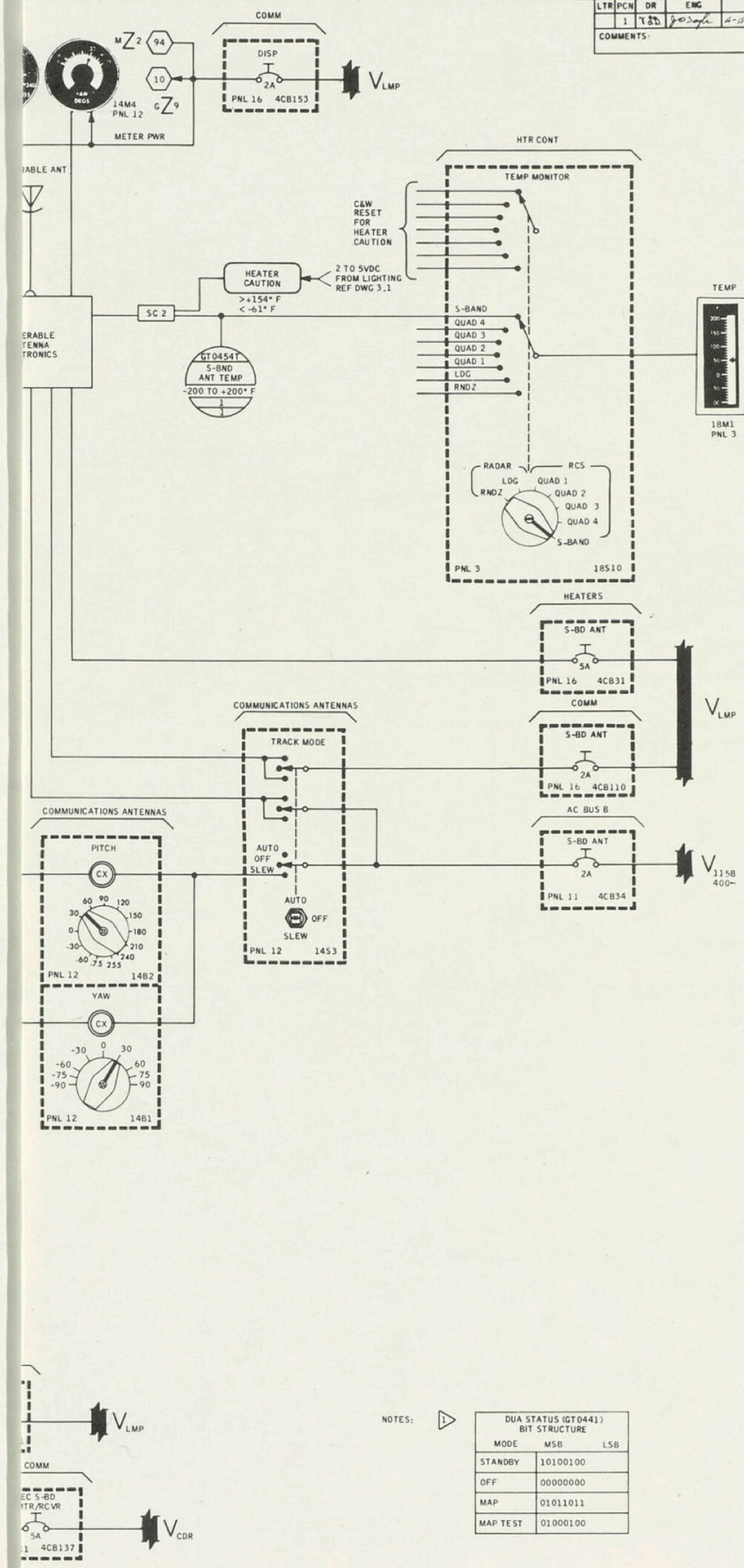
LM	SIZE	DWG NO
10 AND SUBS	J	7.1
121 X 38.25	PAGE	SHEET 1 OF 1


LUNAR EXTRAVEHICULAR UNIT ASSEMBLY (LEVA)
PRESSURE SEALING ASSEMBLY (PSA)
REMOVE AND ISOLATION MECHANISMS
COMMUNICATIONS CARRIER
WATER SHUT-OFF/ISOLATION MECHANISMS
FEED PORT AND COVER
PSA HELMET ATTACHING RING WITH FLEXIBLE LOCK
LOCK/LOCK
CHRONOMETER (ROTATABLE)
PSA PRESSURE GAGE GAGE (NACTOMACH) (0-10 PSI)
OXYGEN PURGE SYSTEM (OPS)
OPS ANTENNA (PLSS VHF ANTENNA)
OPS CONSTRAINT: PLSS ANTENNA MUST BE ROTATED 90 DEG. AWAY FROM OPS ANTENNA TO ELIMINATE COMMUNICATIONS
OPS ANTENNA CABLE
OPS REGULATOR CHECKOUT PRESSURE GAGE (NACTOMACH) (0-6.5 PSI)
OPS INDICATOR CABLE
OPS INDICATOR (OPS SCRATCHING CHECK-OUT LEVER)
HEAT EXCHANGER
OPS PRESS GAGE GAGE (NACTOMACH) (0-300 PSI)
FILTER
SCREEN
OPS PLSS INTERFACE AND CAP
OPS-SUITLEG
LOW PSI (250 PSIA)
-20 TO 100° F
TOTAL 6.75 LBS IN 0.151 FT³
TOTAL 6.75 LBS IN 0.151 FT³ (300 PSIA AND 70° F
7.8 LBS OR 7.04 CU IN
7.8 LBS OR 7.04 CU IN
PRESSURE 0.25 (80.6) 300 PSIA (400 - 60)° F
1.54 LBS OR 2.50 (300 PSIA AND 70° F
WEIGHT 0.31 LBS AT 100 PSIA AND 70° F
MAXIMUM OPS FLOW RATES
0.25 TO 0.4 LBS/HR (300 AND 100 PSIA)
0.25 TO 0.4 LBS/HR
(0 TO 0.25 IN 0.1 MINUTES)
OPS PRESS REG
0.3 TO 0.5 PSIA FOR
0.25 TO 0.4 LBS/HR
PLSS VHF ANTENNA
PLSS ANTENNA CABLE
PLSS ANTENNA CONNECTOR
PLSS ANTENNA CONNECTOR
PLSS ANTENNA CONNECTOR


REMOTE CONTROL UNIT (RCU)
LIQUID TRANSPORT LOOP (LTL)
OXYGEN VENTILATION LOOP (OVL)
RCU ELECTRICAL UMBILICAL 30.9 ± 5.3 INCHES
MODE SELECTOR SWITCH
MODE SEL
EVC-1/2 TALK ON MAIN
VOLUME CONTROL POTENTIOMETER INCREASE VOLUME
PRIMARY
SEC. RADIO
INDICATOR INACCURACY ±1.0 PSIA
PLSS O_2 QTY IND
H_2O MONIT
CO_2
PRES
VENT
UMBILICAL CONNECTOR J9
RECEPTACLE (55 PIN)
PLSS BAT CUR
TERMINAL BOX 1
NOISE SUPPRESSOR
EMI FILTER
CR 1
+10.0VDC
PLSS PWR
FM RCVR SQ L
FM RCVR SQ L
ALARM TONE PWR
ENABLES MODE A IN EVC-2 ONLY
PULSE DURATION 10 ±2 SEC
TERMINAL BOX 2
BATTERY CONNECTOR AND RECEPTACLE (9 PIN)
PLSS BAT
FILTER
PLSS BAT RELIEF VALVE RELIEVES 6.5 TO 8.0 PSID AND RESEALS AT 4.9 TO 5.2 PSID
PLSS BAT LOCKING DEVICE
MAIN PWR SUPPLY (PLSS BAT)
CAPACITY 2.4 AMP-HRS AT +16.8VDC (360 WATTS-HRS)
VOLT RATING 4.8A,8.4 0.0VDC
MAX STARTUP 420 WATTS
LIFETIME 7.5 HRS AT 2.75 AMPS (LOAD + MEASUREMENT INACCURACY)
EVCS
AUDIO OUT TO HEADSET
RCVR SQ
PRIMARY COMM VOLTAGE REGULATOR
PRIMARY RCVR 296.8 MHZ
PRIMARY XMTR 259.7 MHZ
FM RCVR 279.0 MHZ
SECONDARY RCVR 259.7 MHZ
TRIPLEXER 296.8 MHZ
259.7 MHZ
279.0 MHZ
ANTENNA RECEPTACLE
BONNED PWR
RIGHT MIKE PWR
LEFT MIKE PWR
AUDIO OUT TO HEADSET
SECONDARY COMM VOLTAGE REGULATOR
SECONDARY XMTR 296.8 MHZ
K1/K2 RELAY PWR
1.0 KHZ MTR 15 HZ WARBLE
ALARM TONE GEN
EVC VCO VOLTAGE REG
SIDE TONE
SIGNAL PROCESSOR
BONNED SIG
MIKE SIG
VCO PWR
VOX DISABLE
DECODER
BCD COUNTER
ACTIVE REG
ZENER REG
MULTI-PLEXER
50/50 DUTY CYCLE
PEDESTAL
SYNC
DC-DC CONVERTER
LOGIC CIRCUITRY
ALARM MODULE
BOUNDARY POWER SUPPLY
RESET DEVICE
ALARM PULSE GEN
INDICATOR DRIVERS
VENT
PRES
O_2
H_2O
VENT TIME DELAY MODULE 5 ± 2 SEC
O_2 TIME DELAY MODULE 5 ± 2 SEC
PRIMARY O_2 FILL AND CAP (PRIMARY O_2 SUBSYSTEM)
PRIMARY O_2 SUBSYSTEM (POS)
PRIMARY O_2 BOTTLE
0 TO 1000 PSIA
O_2 QTY 0 TO 100 %
O_2 DISCHARGE (WARNING)
AUXILIARY FEED H2O RESERVOIR DRAIN O_2 DISCHARGE CAPACITY
FEED H_2O DRAIN O_2 FLOW
FEED H_2O RESERVOIR ASSEMBLY
H_2O DRAIN AND CAP (FEED H_2O)
H_2O DRAIN CONNECTOR AND CAP
H_2O DISCHARGE
PLSS CONDENSATE TRANSFER ASSEMBLY WITH SIGHT GLASS
AUXILIARY H_2O SHUTOFF AND RELIEF VALVE
AUXILIARY FEED H_2O RESERVOIR
AUXILIARY FEED H_2O VENT FLOW RESTRICTOR
VENT H_2O DISCHARGE
PLSS CONDENSATE TRANSFER ASSEMBLY WITH SIGHT GLASS
VENT GLASS
A BANDS OF BUBBLES CREATES A MAGNIFICATION OF THE WORD "WATER" IN THE SIGHT GLASS
FEED H_2O RECHARGE
FEED H_2O VENT FLOW RESTRICTOR
FEED H_2O FLOW INDICATOR
SIGHT GLASS
A BANDS OF BUBBLES CREATES A MAGNIFICATION OF THE WORD "WATER" IN THE SIGHT GLASS
PRIMARY O_2 SHUTOFF VALVE
H_2O REMOVAL RATE
FEED H_2O RESERVOIR ASSEMBLY
H_2O SHUTOFF AND RELIEF VALVE
FEED H_2O FLOW LIMITER
FEED H_2O PRESS SENSOR ORIFICE
SLAVE H_2O COOLING
PRIMARY O_2 PRESS REG
PRIMARY O_2 FLOW LIMITER
HIGH O_2 FLOW SENSOR POWER 16.0VDC
LOW VENT FLOW SENSOR PWR 16.0VDC
BELLOWS FLOW LIMITER
LOW VENT FLOW
LOW PGA PRESS
HIGH O_2 FLOW
APPROXIMATE O_2 MAKEUP FLOW = 0.2 LBS/HR
FAN/MOTOR ASSEMBLY
FAN COOLING JACKET N/A
DIVERTER VALVE POSITION
FLOW RATE
BYPASS
LOW O_2 DIVERTED VALVE
O_2 SENSOR FLOW LIMITER
LIOH (FILTER AND CHARCOAL) CARTRIDGE
CONTAMINANT CONTROL ASSEMBLY
CONTAMINANT CANISTER COVER CLOSED
COVER LOCK
SUBLIMATOR
STEAM
STEAM TO VACUUM
FEED H_2O PRESSURE AT SUBLIMATOR INLET
PUMP/MOTOR ASSEMBLY
CHECK VALVE ASSEMBLY
GAS SEPARATOR
SCREEN
BACK FLOW CHECK VALVE
HOSE LENGTH
PLSS OUTLET O_2 CONNECTOR (BLUE)
PLSS INLET O_2 CONNECTOR (RED)
PLSS MULTIPLE RED CONNECTOR
BOLLS WATER FLOW DIVIDER
PLSS OUTLET GAS CONNECTOR-STOWAGE RELIEF PLATE (BLUE)
PLSS INLET GAS CONNECTOR-STOWAGE PLATE (RED)
BOLLS MODE
BOLLS WATER
BONNED SIGNAL (0-5VDC)
BONNED PWR (+16.0VDC)
MIKE SIGNAL (0.77 VRMS)
MIKE SIGNAL (0.77 VRMS)
RIGHT MIKE PWR (+16.0VDC)
LEFT MIKE PWR (+16.0VDC)
RCVR WARNING TONE (23 VRMS)
RCVR SIGNAL (17 VRMS)
RCVR SIGNAL (17 VRMS)
PLSS ELECTRICAL UMBILICAL 36.0 ±0.5 INCHES

LTR	PCN	DR	ENG	DATE	APPROVAL
	1			4-13-71	9/24/71

COMMENTS:



NOTES: 1

DUA STATUS (GT0441) BIT STRUCTURE		
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STANDBY	10100100	
OFF	00000000	
MAP	01011011	
MAP TEST	01000100	

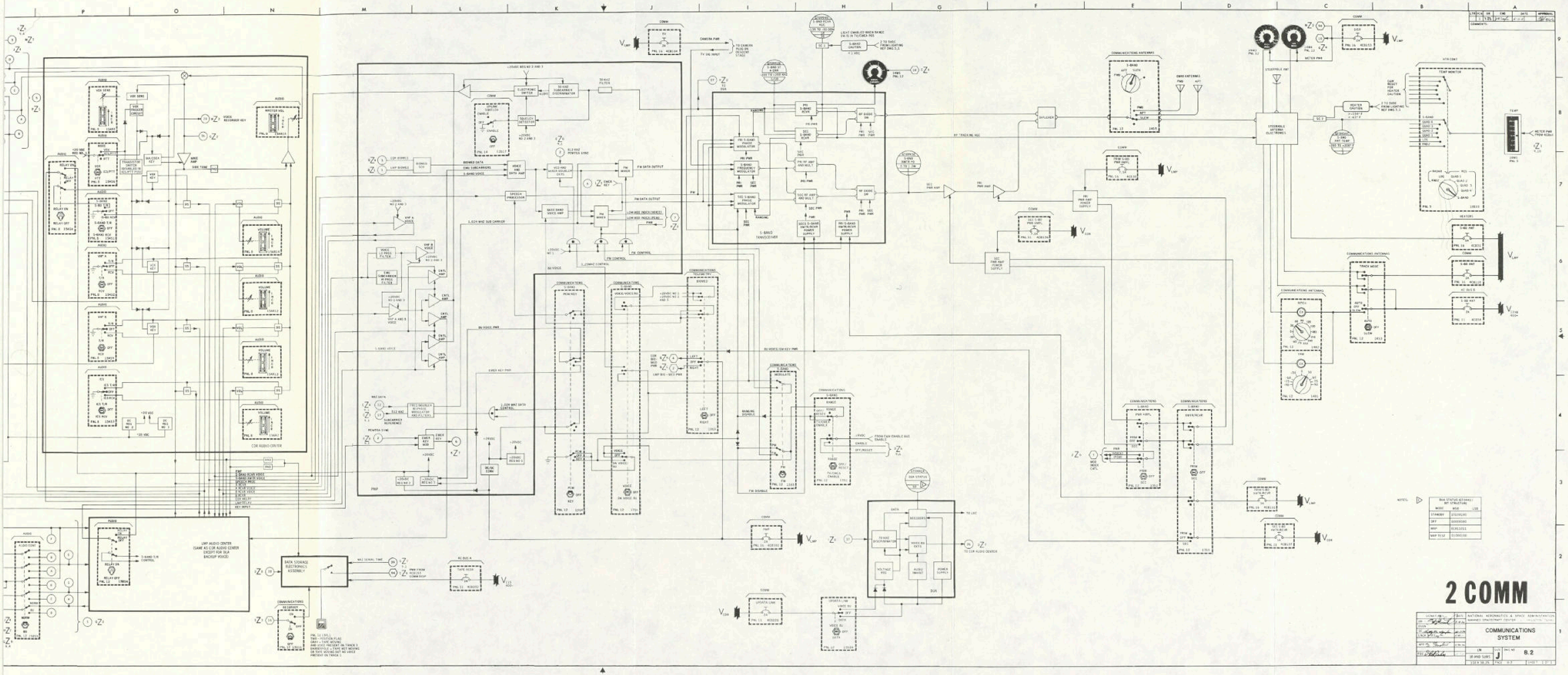
2 COMM

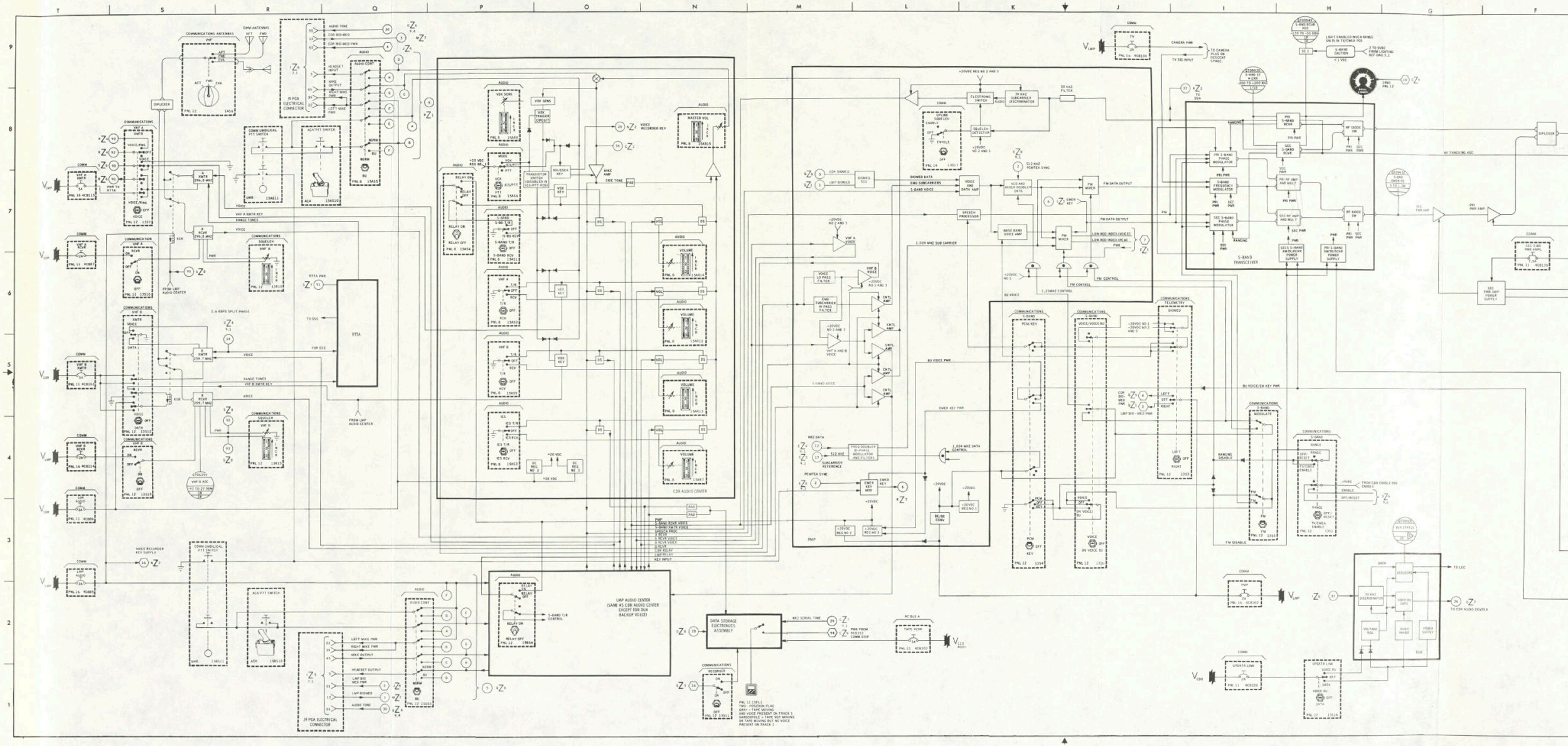
SIGNATURES	DATE
DR	5-9-70
DSGN	
QC	11-2-70
ENGR	11-30-70
APP	11-30-70
FEC	

NATIONAL AERONAUTICS & SPACE ADMINISTRATION
MANNED SPACECRAFT CENTER · HOUSTON, TEXAS

COMMUNICATIONS SYSTEM

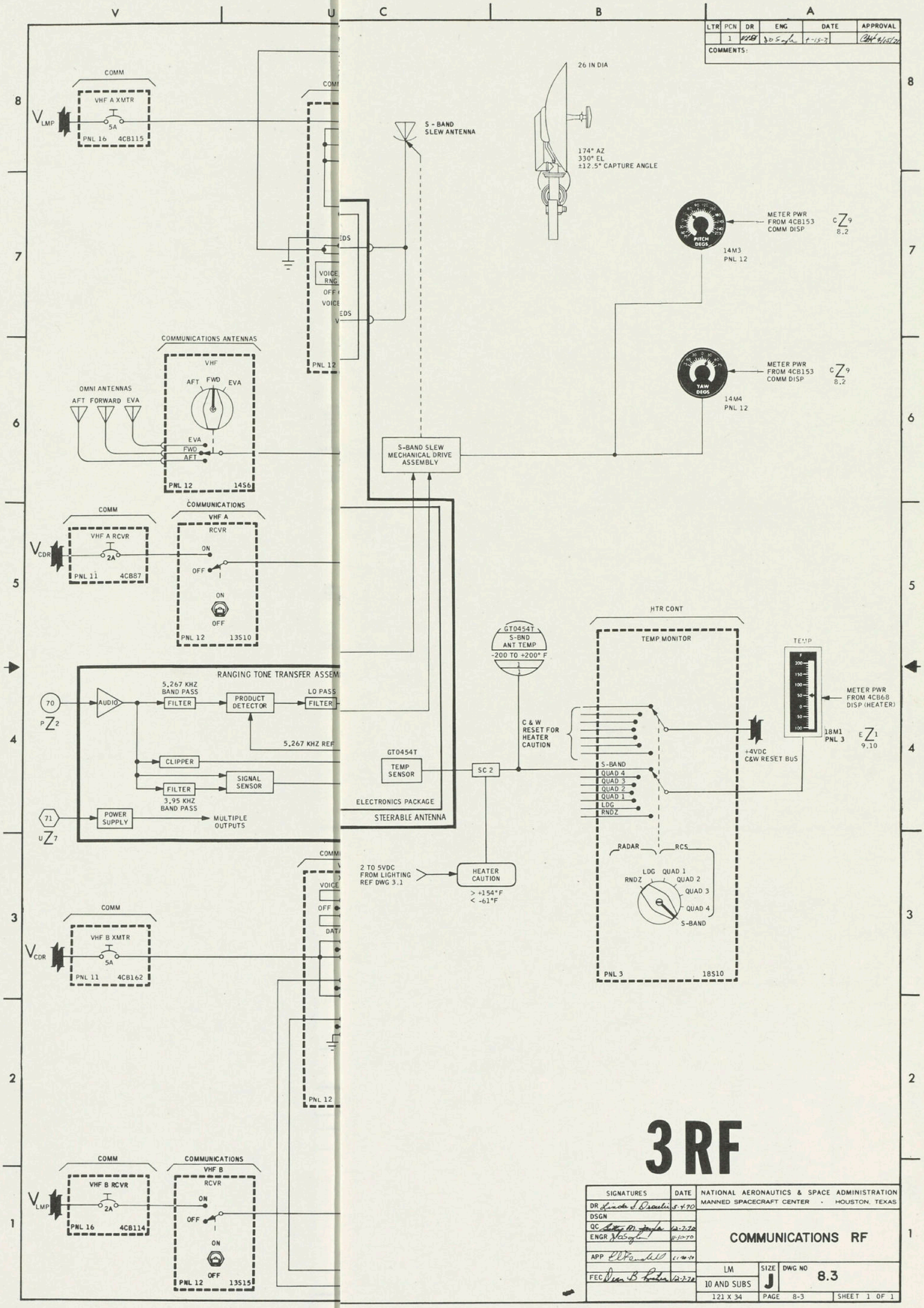
LM	SIZE	DWG NO
10 AND SUBS	J	8.2
110 X 38.25	PAGE 8-2	SHEET 1 OF 1


2 COMM
COMMUNICATIONS SYSTEM
NATIONAL AERONAUTICS & SPACE ADMINISTRATION
MANNED SPACEFLIGHT CENTER
Hhouston, Texas
8.2
COMM
S-BAND TRANSCEIVER
COM AUDIO CENTER
LMP AUDIO CENTER (SAME AS COM AUDIO CENTER EXCEPT FOR DUA BACKUP VOICE)
DATA STORAGE ELECTRONICS ASSEMBLY
DUA
COMMUNICATIONS ANTENNAS
STEERABLE ANTENNA ELECTRONICS
HTR CONT
TEMP
HEATERS
TRACK MODE
NOTES:
DUA STATUS (STORAGE) BIT STRUCTURE
MODE
USB
STANDBY
1111000100
OFF
0000000000
MAP
0000000111
MAP TEST
0100000100


COMMUNICATIONS ANTENNAS
OMNI ANTENNAS
DIPLEXER
COMMUNICATIONS
COMM
COMM UMBILICAL PTT SWITCH
ACA PTT SWITCH
JB PGA ELECTRICAL CONNECTOR
AUDIO CONT
AUDIO
VOX SENS
VOX TRIGGER CIRCUIT
MASTER VOL
VOX KEY
MIC/SIDE KEY
SIDE TONE
VOICE RECORDER KEY
RELAY ON
RELAY OFF
VOLUME
CDR AUDIO CENTER
RTTA
TO GSE
FROM LMP AUDIO CENTER
VOICE RECORDER KEY SUPPLY
LMP AUDIO CENTER (SAME AS CDR AUDIO CENTER EXCEPT FOR DUA BACKUP VOICE)
S-BAND T/R CONTROL
DATA STORAGE ELECTRONICS ASSEMBLY
MK2 SERIAL TIME
AC BUS A
TAPE RCDR
RECORDER
ELECTRONIC SWITCH
30 KHZ SUBCARRIER DISCRIMINATOR
30 KHZ FILTER
SQUELCH DETECTOR
BIOMED SCG
VOICE AND DATA AMP
VCO AND MIXER DOUBLER CKTS
FM MIXER
FM DATA OUTPUT
SPEECH PROCESSOR
BASE BAND VOICE AMP
1.024 MHZ SUB CARRIER
1.25MHZ CONTROL
FM CONTROL
BU VOICE
BU VOICE PWR
EMER KEY PWR
1.024 MHZ DATA CONTROL
FREQ DOUBLER (FOR FM/FM MODULATOR AND FILTER)
EMER KEY MOD
DC/DC CONV
PCM KEY
VOICE/VOICE BU
COMMUNICATIONS TELEMETRY BIOMED
S-BAND TRANSCEIVER
PRI S-BAND RCVR
SEC S-BAND RCVR
PRI S-BAND PHASE MODULATOR
PRI S-BAND FREQUENCY MODULATOR
SEC S-BAND PHASE MODULATOR
PRI RF AMP AND MULT
SEC RF AMP AND MULT
RF DIODE SW
SEC S-BAND XMTR/RCVR POWER SUPPLY
PRI S-BAND XMTR/RCVR POWER SUPPLY
RANGING
RANGING DISABLE
FM DISABLE
S-BAND MODULATOR
S-BAND RANGE
TV/CAMERA ENABLE
TV SIG INPUT
TO CAMERA PLUG ON DESCENT STAGE
LIGHT ENABLED WHEN RANGE SW IS IN TV/CMSA POS
S-BAND CAUTION
TO GSE
TO LGC
TO CDR AUDIO CENTER
DATA
DECODER
TO KIAI DISCRIMINATOR
VOICE BU DATA
VOLTAGE REG
AUDIO INVERT
POWER SUPPLY
DUA
UPDATA LINK
VOICE BU
DATA
PRI PWR AMP
SEC PWR AMP
SEC PWR AMP POWER SUPPLY
PRI PWR AMP POWER SUPPLY
DATA STORAGE ELECTRONICS ASSEMBLY
PNL 12 (SPELL) TWO - POSITION FLAG: ON TAPE MOVING AND VOICE PRESENT ON TRACK 3 SABCERFOLE = TAPE NOT MOVING ON TAPE MOVING BUT NO VOICE PRESENT ON TRACK 3

LTR	PCN	DR	ENG	DATE	APPROVAL
	1			1-15-71	

COMMENTS:



3RF

SIGNATURES	DATE
DR Linda J. Draulin	5-4-70
DSGN	
QC	12-7-70
ENGR	11-10-70
APP	11-10-70
FEC	12-7-70

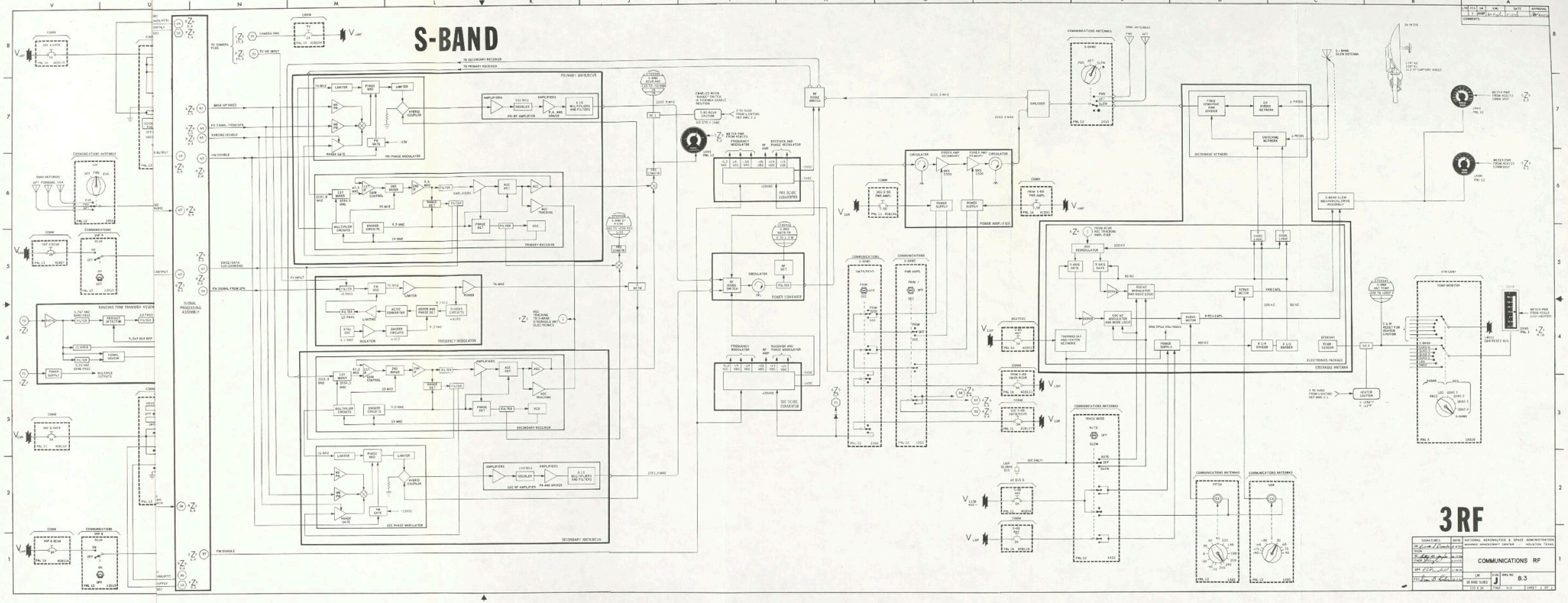
NATIONAL AERONAUTICS & SPACE ADMINISTRATION
MANNED SPACECRAFT CENTER · HOUSTON, TEXAS

COMMUNICATIONS RF

LM 10 AND SUBS | SIZE J | DWG NO 8.3

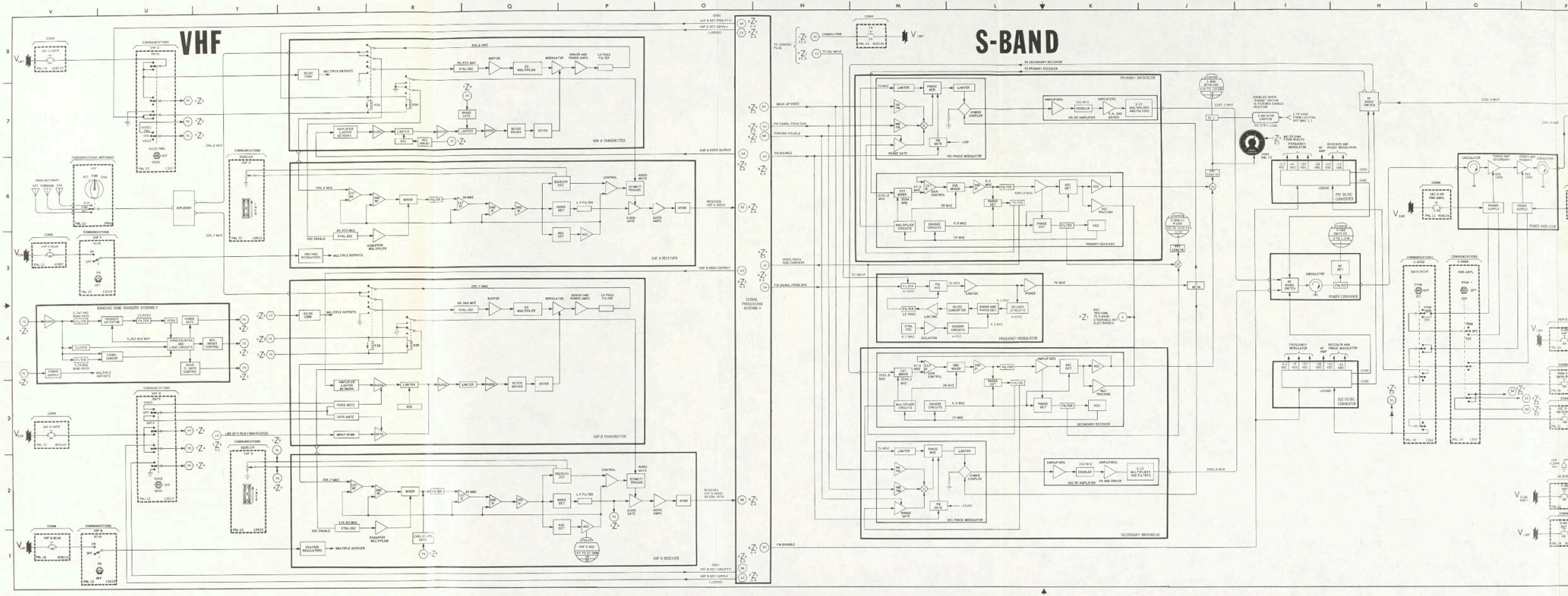
121 X 34 | PAGE 8-3 | SHEET 1 OF 1

S-BAND



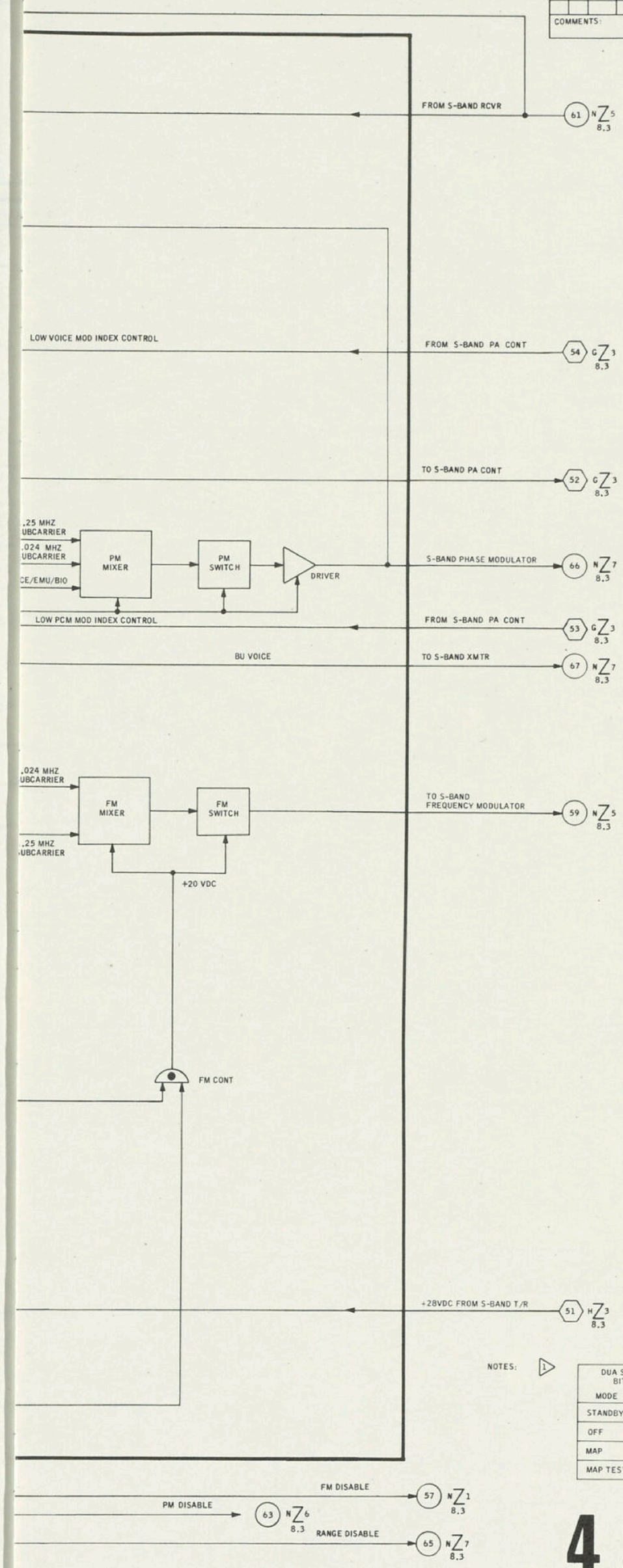
3RF

SIGNATURES	DATE	NATIONAL AERONAUTICS & SPACE ADMINISTRATION MANNED SPACECRAFT CENTER HOUSTON, TEXAS
DR		COMMUNICATIONS RF
CHKD		
ENGR		
APP		
APP		
APP


VHF
S-BAND
VHF A TRANSMITTER
VHF A RECEIVER
VHF B TRANSMITTER
VHF B RECEIVER
RANGING TONE TRANSFER ASSEMBLY
SIGNAL PROCESSING ASSEMBLY
PRIMARY XMTR/RCVR
SECONDARY XMTR/RCVR
PRIMARY RECEIVER
SECONDARY RECEIVER
FREQUENCY MODULATOR
POWER AMPLIFIER
POWER COMBINER
PRI DC/DC CONVERTER
SEC DC/DC CONVERTER
PRI PHASE MODULATOR
SEC PHASE MODULATOR
PRI RF AMPLIFIER
SEC RF AMPLIFIER
PA AND DRIVER
COMMUNICATIONS
COMM
TO CAMERA PLUG
TV SIG INPUT
TO SECONDARY RECEIVER
TO PRIMARY RECEIVER
BACK UP VOICE
PRI SIGNAL FROM SPA
RANGING DISABLE
PRI DISABLE
VOICE/DATA SUB-CARRIERS
TV INPUT
SEC SIGNAL FROM SPA
SEC DISABLE
VHF A VOICE OUTPUT
VHF B VIDEO OUTPUT
RECEIVED VHF A AUDIO
RECEIVED VHF B AUDIO DB ENG DATA
VHF A KEY INPUT
VHF B KEY INPUT
CAMERA PWR
ENABLED WHEN PRIMARY SWITCH IS POWERED ENABLE POSITION
S-BAND RCVR CAPTURE
+28 VDC FROM LIGHTING REF (NO. 3.)
METERING FROM RCVRS
FREQUENCY MODULATOR
RF AMP
RECEIVER AND PHASE MODULATOR AMP
RF DIODE SWITCH
CIRCULATOR
POWER AMP SECONDARY
POWER AMP PRIMARY
POWER SUPPLY
SEC S-BAND PWR AMPL
PRI S-BAND PWR AMPL
WRITE/RCVR
PRIM
SEC
OFF
ON
PRI DC/DC CONVERTER
SEC DC/DC CONVERTER
POWER COMBINER
FILTER
RF DIODE SWITCH
RF DET
LIMITER
PHASE MOD
HYBRID COUPLER
RANGE GATE
PRI GATE
SEC GATE
AMPLIFIERS
X 2 DOUBLER
X 15 MULTIPLIERS AND FILTERS
X 12 MULTIPLIERS AND FILTERS
PRI RF AMPLIFIER
SEC RF AMPLIFIER
PA AND DRIVER
PRI DISABLE
SEC DISABLE
ALC TRACKING TO S-BAND ELECTRONICS
ALC TRACKING
AGC DET
AGC TRACKING
PHASE DET
VCO
MULTIPLIER CIRCUITS
DIVIDER CIRCUITS
GAIN CONTROL
2ND MIXER
1ST MIXER
1ST IF
2ND IF
RANGE DET
FREQUENCY MODULATOR
XTAL OSC
ISOLATION
ADDER AND PHASE DET
DIVIDER CIRCUITS
LO PASS
FM VCO
PRI PHASE MODULATOR
SEC PHASE MODULATOR
FM DISABLE
COMMUNICATIONS
VHF A
VHF B
VOICE
DATA
VOICE MUTE
DATA MUTE
INPUT XFMR
SQUELCH
VHF B AGC
VHF A AGC
SQUELCH DET
AUDIO DET
AGC DET
L P FILTER
SCHMITT TRIGGER
AUDIO GATE
AUDIO AMPS
XFMR
MULTIPLE OUTPUTS
VOLTAGE REGULATORS
BIPLEXER
DIPOLE ANTENNAS
COMMUNICATIONS ANTENNAS
AFT FORWARD
VHF 2 RCVR
VHF 2 XMTR
VHF B RCVR
VHF B XMTR
VHF A RCVR
VHF A XMTR
VHF 2 XMTR
VHF B XMTR
VHF B RCVR
VHF A RCVR
VHF A XMTR
VHF 2 RCVR
VHF B RCVR
VHF B XMTR
VHF A RCVR
VHF A XMTR
VHF 2 XMTR
VHF B XMTR
VHF B RCV

LTR	DCN	OR	ENG	DATE	APPROVAL

COMMENTS:



NOTES: 1

DUA STATUS (GT0441X) BIT STRUCTURE	
MODE	MSB LSB
STANDBY	10100100
OFF	00000000
MAP	01011011
MAP TEST	01000100

4 SPA

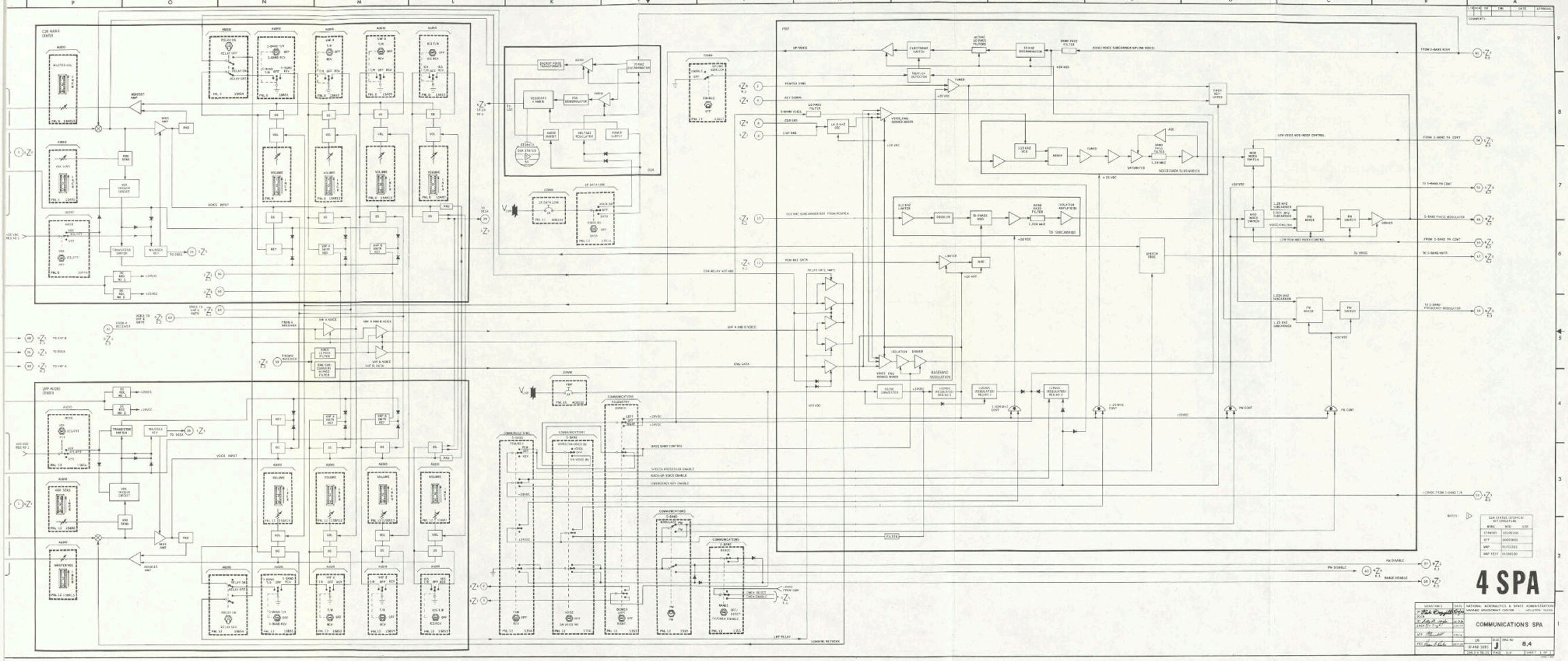
SIGNATURES	DATE
DR Mel Doggett	5/4/70
DSGN	
QC Betty M. Sayler	12-3-70
ENGR Jo Sagl	12-30-70
APP Brandell	12-30-70
FEC Dean B. Parker	12-7-70

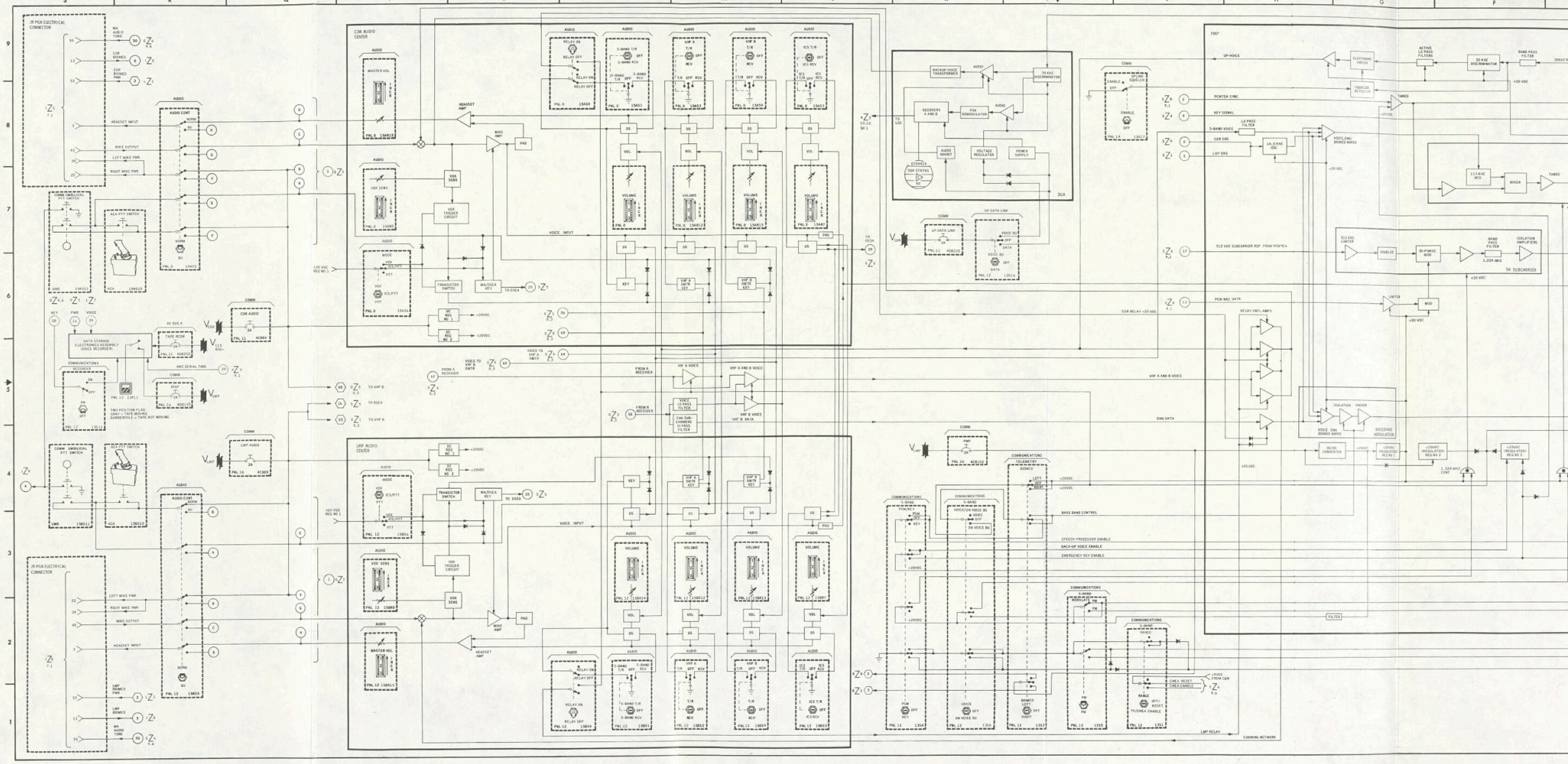
NATIONAL AERONAUTICS & SPACE ADMINISTRATION
MANNED SPACECRAFT CENTER · HOUSTON TEXAS

COMMUNICATIONS SPA

LM	SIZE	DWG NO
10 AND SUBS	J	8.4
104.5 X 38.25	PAGE 8-4	SHEET 1 OF 1

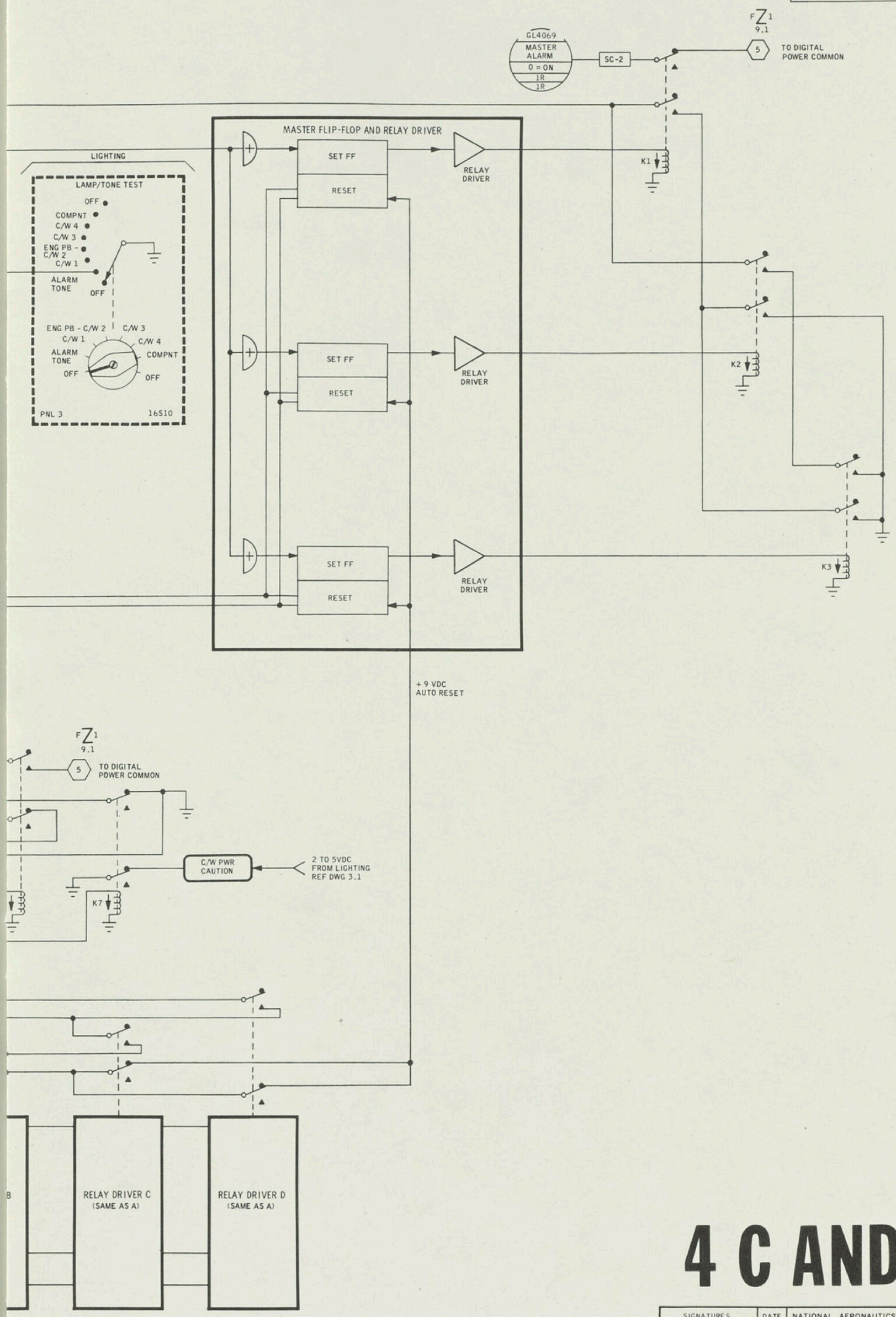
NASA — MSC


4 SPA
COMMUNICATIONS SPA
NATIONAL AERONAUTICS & SPACE ADMINISTRATION
MANNED SPACECRAFT CENTER
HOUSTON, TEXAS
8.4
CSM AUDIO CENTER
LMP AUDIO CENTER
VOICE INPUT
VOICE TO VHF A XMTR
VHF A AND B VOICE
ENG DATA
PCM MAT DATA
FROM S-BAND RCVR
FROM S-BAND PA CONT
TO S-BAND PA CONT
S-BAND PHASE MODULATOR
TO S-BAND FREQUENCY MODULATOR
PM DISABLE
RANGE DISABLE
COMM
COMMUNICATIONS
VOICE ENG
BASEBAND MODULATOR
VOICE ENG DEMOD MIXER
SUBCARRIER
TO SUBCARRIER
SATURATED
UNSATURATED SUBCARRIER
LOW VOICE MOD INDEX CONTROL
LOW PCM MOD INDEX CONTROL
1.25 MHZ CONT
PM CONT
LOWING RETRACTION
LMP RELAY
FILTER


J9 PCA ELECTRICAL CONNECTOR
CDR AUDIO CENTER
LMP AUDIO CENTER
AUDIO CONT
COMM UMBILICAL PTT SWITCH
ACA PTT SWITCH
DATA STORAGE ELECTRONICS ASSEMBLY VOICE RECORDER
COMMUNICATIONS
TWO POSITION FLAG GRAY = TAPE MOVING BARBERPOLE = TAPE NOT MOVING
BACKUP VOICE TRANSFORMER
70 KHZ DISCRIMINATOR
DECODERS A AND B
PSK DEMODULATOR
AUDIO INVERT
VOLTAGE REGULATOR
POWER SUPPLY
DUA
UP DATA LINK
PRP
ELECTRONIC SWITCH
ACTIVE LO PASS FILTERS
30 KHZ DISCRIMINATOR
BAND PASS FILTER
TONE DETECTOR
TUNED
PCM/TEA SYNC
KEY SIGNAL
S-BAND VOICE
CDR EKG
LMP EKG
LO PASS FILTER
VOICE,EMU BIONED MIXER
113 KHZ VCO
MIXER
512 KHZ SUBCARRIER REF FROM PCM/TEA
512 KHZ LIMITER
DOUBLER
BI-PHASE MOD
BAND PASS FILTER
ISOLATION AMPLIFIERS
TM SUBCARRIER
PCM MKE DATA
RELAY CNTL AMPS
LIMITER
MOD
ISOLATION DRIVER
VOICE EMU BIONED MIXER
BASEBAND MODULATION
DC/DC CONVERTER
+20VDC (REGULATED) REG NO 1
+20VDC (REGULATED) REG NO 2
+20VDC (REGULATED) REG NO 3
1.024 MHZ CONT
FILTER
VIF A AND B VOICE
EMU DATA
BASE BAND CONTROL
SPEECH PROCESSOR ENABLE
BACK-UP VOICE ENABLE
EMERGENCY KEY ENABLE
LMP RELAY
SUMMING NETWORK
MASTER VOL
HEADSET AMP
MIKE AMP
VOX SENS
VOX TRIGGER CIRCUIT
TRANSISTOR SWITCH
MA/DSEA KEY
VOICE INPUT
VOLUME
VOL
KEY
VHF A XMTR KEY
VHF B XMTR KEY
RELAY ON
RELAY OFF
S-BAND T/R
S-BAND RCV
VHF A T/R
VHF B T/R
ICS T/R
ICS RCV
FROM A RECEIVER
FROM B RECEIVER
VHF A VOICE
VHF A AND B VOICE
VOICE LO PASS FILTER
EMU SUB-CARRIER HI PASS FILTER
VHF B VOICE
VHF B DATA
TO VHF B
TO DSEA
TO VHF A
+20 VDC REG NO 1
+20VDC REG NO 2
+20VDC REG NO 3
+20 VDC
CDR RELAY +20 VDC
TO DSEA
TO LGC
TO DSEA
VOICE TO VHF B XMTR
VOICE TO VHF A XMTR
AC BUS A
TAPE RCDR
NRZ SERIAL TIME
CDR AUDIO
LMP AUDIO
PCM
VOICE
ON VOICE BU
BIONED LEFT
BIONED RIGHT
FM
RANGE
OFF/RESET
TV/CMEA ENABLE
CMEA RESET
CMEA ENABLE
+5VDC FROM C&W
COMMUNICATIONS
S-BAND POWER
S-BAND VOICE/ON VOICE BU
TELEMETRY BIONED
S-BAND MODULATE
S-BAND RANGE
+28VDC
+24VDC
+20VDC
+5VDC
ST0441X
DOA STATUS
SO
UP-VOICE
PCM/TEA SYNC
KEY SIGNAL
S-BAND VOICE
CDR EKG
LMP EKG
512 KHZ SUBCARRIER REF FROM PCM/TEA
PCM MKE DATA
VIF A AND B VOICE
EMU DATA
BASE BAND CONTROL
SPEECH PROCESSOR ENABLE
BACK-UP VOICE ENABLE
EMERGENCY KEY ENABLE
LMP RELAY
SUMMING NETWORK

LTR	DCN	DR	ENG	DATE	APPROVAL

COMMENTS:



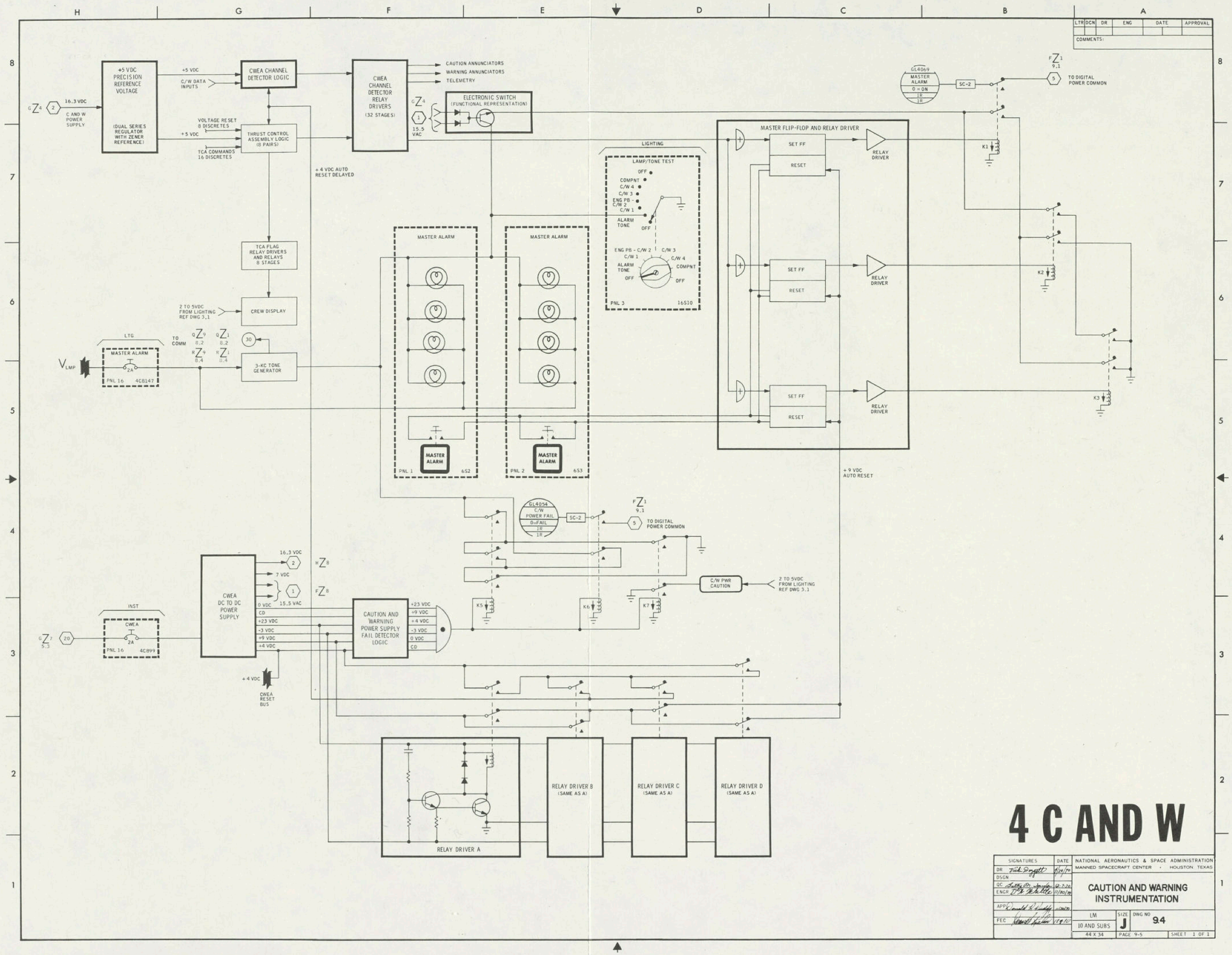
4 C AND W

SIGNATURES	DATE
DR Nick Doggett	4/24/70
DSGN	
QC Betty M. Jordan	12-7-70
ENGR D.H. Whittle	11/30/70
APP Donald R. Dudley	11/30/70
FEC Robert Fuller	12-9-70

NATIONAL AERONAUTICS & SPACE ADMINISTRATION
MANNED SPACECRAFT CENTER · HOUSTON, TEXAS

CAUTION AND WARNING INSTRUMENTATION

LM	SIZE	DWG NO
10 AND SUBS	J	9.4
44 X 34	PAGE 9-5	SHEET 1 OF 1



4 C AND W

SIGNATURES	DATE
DR Dick Doggett	4/24/70
DSGN	
QC	12-2-70
ENGR	11/20/70
APP	11/20/70
FEC	12/9/70

NATIONAL AERONAUTICS & SPACE ADMINISTRATION
MANNED SPACECRAFT CENTER · HOUSTON, TEXAS

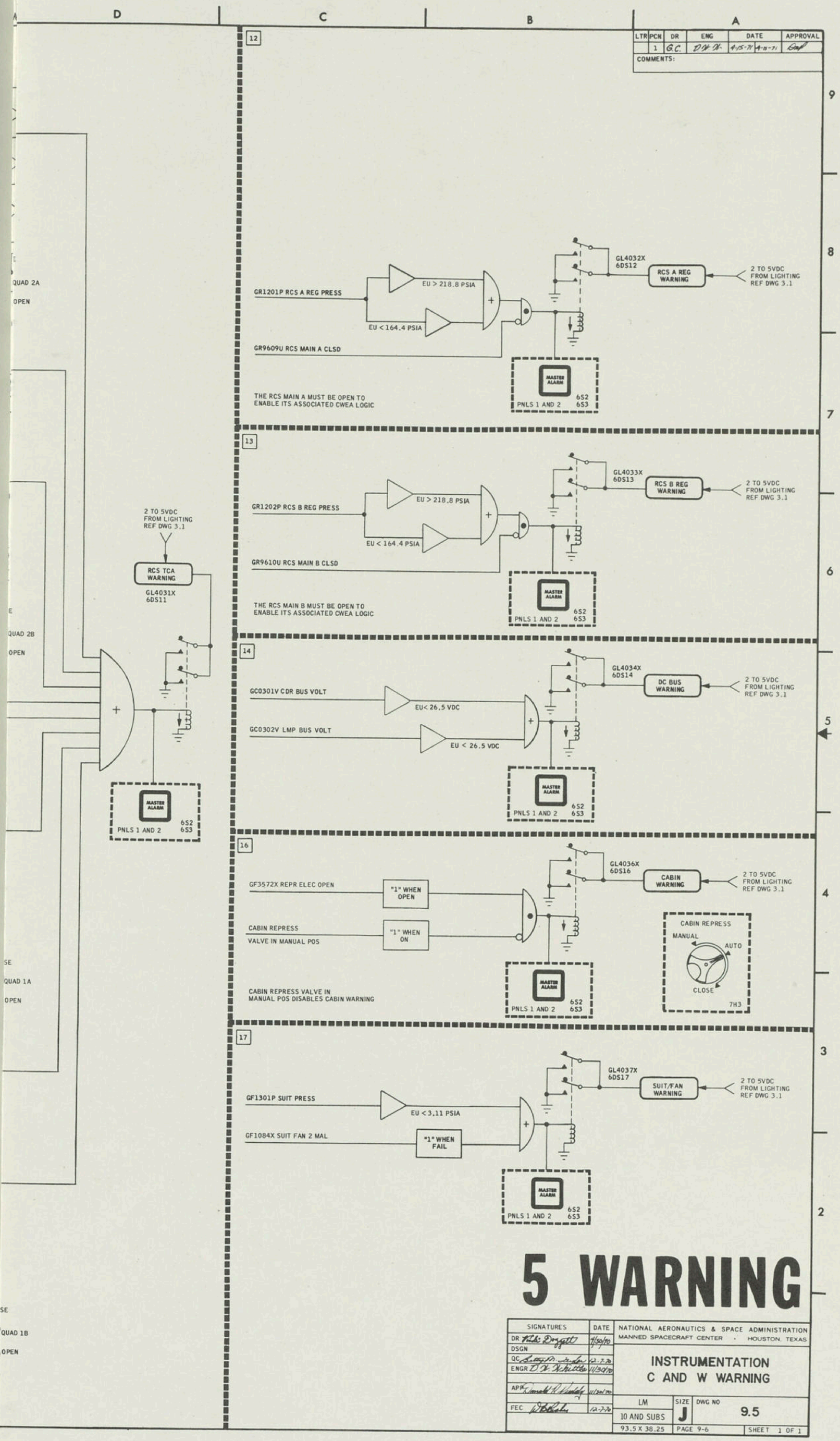
CAUTION AND WARNING INSTRUMENTATION

LM 10 AND SUBS | SIZE J | DWG NO 94

44 X 34 | PAGE 9-5 | SHEET 1 OF 1

LTR	PCN	DR	ENG	DATE	APPROVAL
	1	G.C.	D.N.D.	4-15-71	4-15-71

COMMENTS:



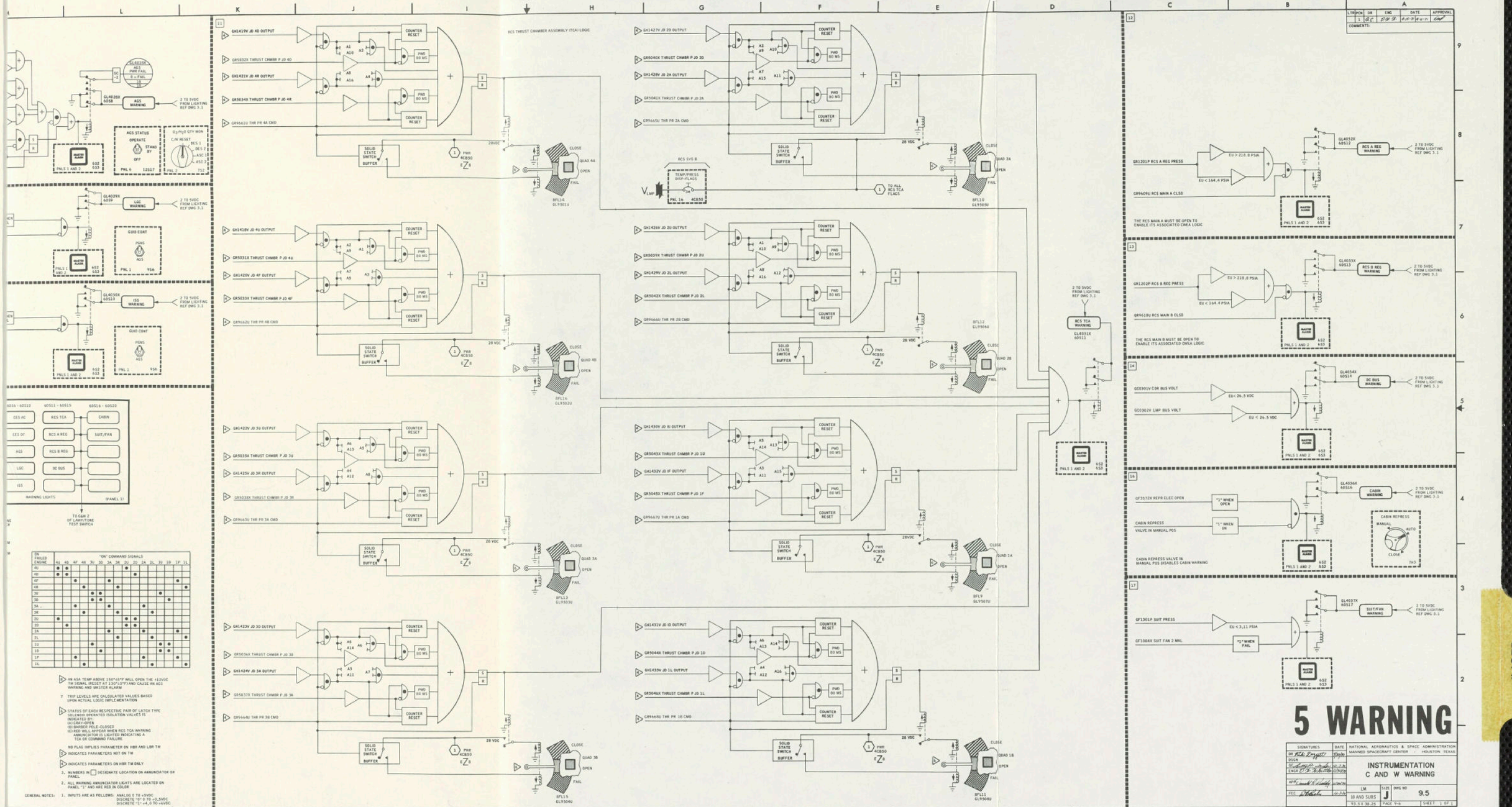
5 WARNING

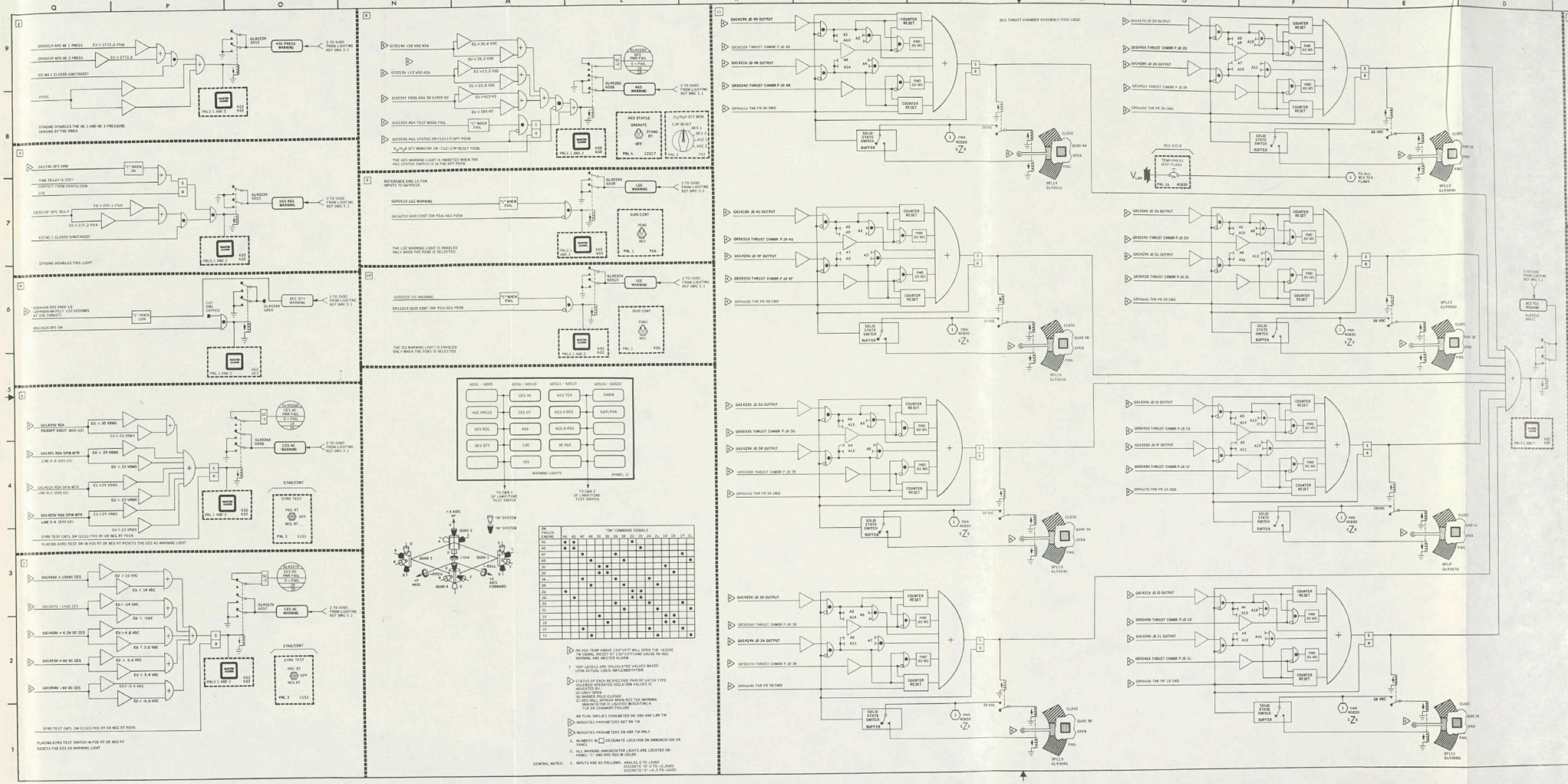
SIGNATURES	DATE
DR	4/30/70
DSGN	
QC	12-7-70
ENGR	11/30/70
APR	11/30/70
FEC	12-7-70

NATIONAL AERONAUTICS & SPACE ADMINISTRATION
MANNED SPACECRAFT CENTER · HOUSTON, TEXAS

INSTRUMENTATION
C AND W WARNING

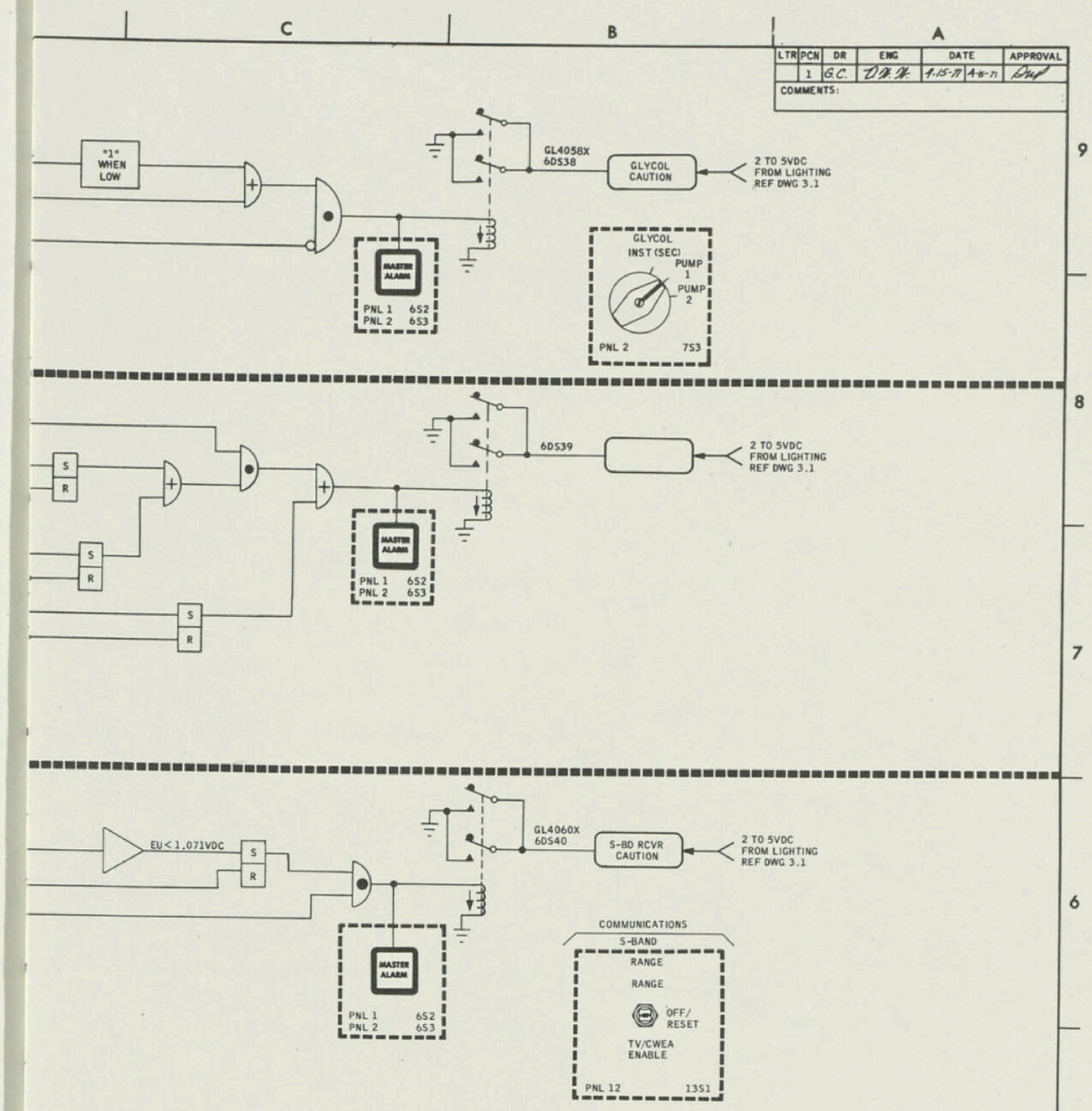
LM	SIZE	DWG NO
10 AND SUBS	J	9.5
93.5 X 38.25	PAGE 9-6	SHEET 1 OF 1

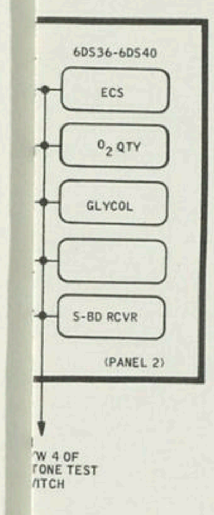

RCS THRUST CHAMBER ASSEMBLY (TCA) LOGIC
COUNTER RESET
PWD 80 MS
SOLID STATE SWITCH BUFFER
PWR 4CB50
CLOSE
QUAD 4A
QUAD 4B
QUAD 3A
QUAD 3B
QUAD 2A
QUAD 2B
QUAD 1A
QUAD 1B
OPEN
FAIL
RCS SYS B
TEMP/PRESS DISP-FLAGS
TO ALL RCS TCA FLAGS
RCS TCA WARNING
MASTER ALARM
AGS WARNING
LGC WARNING
ISS WARNING
RCS A REG WARNING
RCS B REG WARNING
DC BUS WARNING
CABIN WARNING
SUIT/FAN WARNING
2 TO 5VDC FROM LIGHTING REF DWG 3.1
GR1201P RCS A REG PRESS
GR9609U RCS MAIN A CLSD
THE RCS MAIN A MUST BE OPEN TO ENABLE ITS ASSOCIATED CMEA LOGIC
GR1202P RCS B REG PRESS
GR9610U RCS MAIN B CLSD
THE RCS MAIN B MUST BE OPEN TO ENABLE ITS ASSOCIATED CMEA LOGIC
GD0301V CDR BUS VOLT
GD0302V LMP BUS VOLT
GF3572X REPR ELEC OPEN
CABIN REPRESS VALVE IN MANUAL POS
CABIN REPRESS VALVE IN MANUAL POS DISABLES CABIN WARNING
GF1301P SUIT PRESS
GF1084X SUIT FAN 2 MAL
CABIN REPRESS
MANUAL
AUTO
CLOSE
WARNING LIGHTS
TO CWW 2 OF LAMP/TONE TEST SWITCH
GENERAL NOTES:
1. INPUTS ARE AS FOLLOWS: ANALOG 0 TO +5VDC
DISCRETE "0" 0 TO +0.5VDC
DISCRETE "1" +4.0 TO +6VDC
2. ALL WARNING ANNUNCIATOR LIGHTS ARE LOCATED ON PANEL "2" AND ARE RED IN COLOR
3. NUMBERS IN ☐ DESIGNATE LOCATION ON ANNUNCIATOR OR PANEL
7 TRIP LEVELS ARE CALCULATED VALUES BASED UPON ACTUAL LOGIC IMPLEMENTATION
AN ASA TEMP ABOVE 150°±5°F WILL OPEN THE +12VDC TM SIGNAL (RESET AT 130°±5°F) AND CAUSE AN AGS WARNING AND MASTER ALARM
STATUS OF EACH RESPECTIVE PAIR OF LATCH TYPE SOLENOID OPERATED ISOLATION VALVES IS INDICATED BY:
(A) GRAY-OPEN
(B) BARBER POLE-CLOSED
(C) RED WILL APPEAR WHEN RCS TCA WARNING ANNUNCIATOR IS LIGHTED INDICATING A TCA OR COMMAND FAILURE
NO FLAG IMPLIES PARAMETER ON HBR AND LBR TM
INDICATES PARAMETERS NOT ON TM
INDICATES PARAMETERS ON HBR TM ONLY
ON FAILED ENGINE
"ON" COMMAND SIGNALS
5 WARNING
INSTRUMENTATION C AND W WARNING
NATIONAL AERONAUTICS & SPACE ADMINISTRATION
MANNED SPACECRAFT CENTER · HOUSTON, TEXAS
LM 10 AND SUBS
SIZE J
DWG NO 9.5
SHEET 1 OF 1
INSTR C&W WARN


ASC PRESS WARNING
AGS WARNING
DES REG WARNING
LGC WARNING
DES QTY WARNING
ISS WARNING
CES AC WARNING
CES DC WARNING
MASTER ALARM
COUNTER RESET
SOLID STATE SWITCH BUFFER
RCS THRUST CHAMBER ASSEMBLY (TCA) LOGIC
WARNING LIGHTS
(PANEL 1)
STAB/CONT
GYRO TEST
POS RT
NEG RT
OFF
TO CSM 1 OF LAMP/TONE TEST SWITCH
TO CSM 2 OF LAMP/TONE TEST SWITCH
"ON" COMMAND SIGNALS
GENERAL NOTES:
1. INPUTS ARE AS FOLLOWS: ANALOG 0 TO +5VDC
DISCRETE "0" 0 TO +0.5VDC
DISCRETE "1" +4.0 TO +5VDC

LTR	PCN	DR	ENG	DATE	APPROVAL
	1	G.C.	D.W.W.	4-15-71	4-16-71

COMMENTS:





NOTES:

1. ALL CAUTION ANNUNCIATOR LIGHTS ARE LOCATED ON PANEL 2 AND ARE YELLOW IN COLOR
2. NUMBER IN ☐ DESIGNATES LOCATION OF ANNUNCIATOR ON PANEL
3. CAUTION LOGIC MALFUNCTION LEVELS ARE GIVEN IN ENGINEERING UNITS (EU). THE EU'S ARE APPROXIMATE AND WILL VARY DEPENDANT UPON THE ACTUAL TRANSDUCER UTILIZED FOR EACH INPUT PARAMETER. REFER TO CALIBRATION CURVE FOR EACH TRANSDUCER TO ASCERTAIN EXACT EU
4. PARAMETERS NOT ON TM
5. ON HBR TM ONLY
6. TRIP LEVELS ARE CALCULATED VALUES BASED UPON ACTUAL LOGIC IMPLEMENTATION

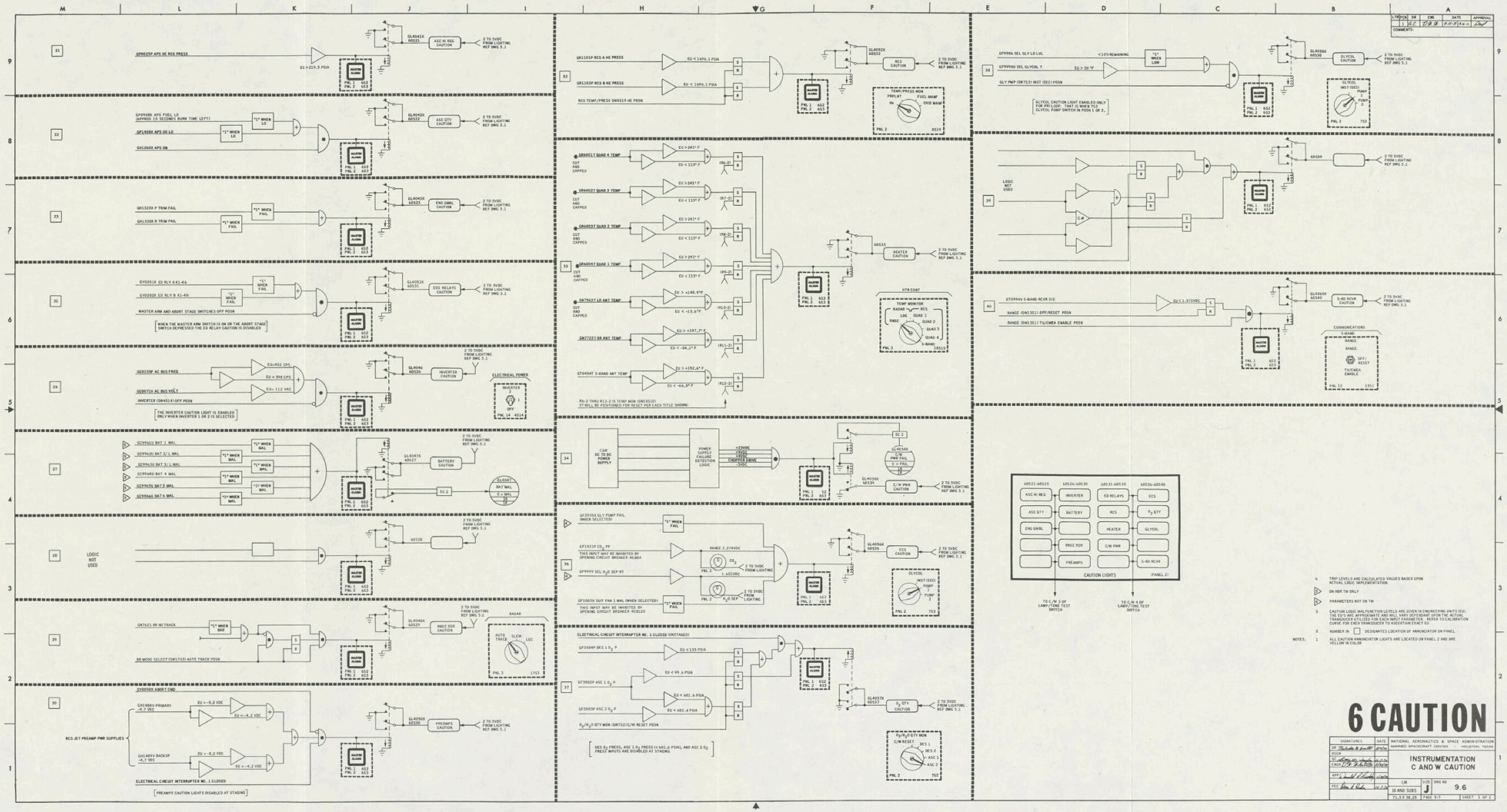
6 CAUTION

SIGNATURES	DATE
DR Malcolm H. Smith	5/19/70
DSGN	
QC Gary M. Taylor	12-7-70
ENGR D.W. Whittle	11/30/70
APP Donald R. Puddy	11/30/70
FEC Dean A. Rieder	12-7-70

NATIONAL AERONAUTICS & SPACE ADMINISTRATION
MANNED SPACECRAFT CENTER · HOUSTON, TEXAS

INSTRUMENTATION
C AND W CAUTION

LM	SIZE	DWG NO
10 AND SUBS	J	9.6
71.5 X 38.25	PAGE 9-7	SHEET 1 OF 1


GP0025P APS HE REG PRESS
EU > 219.5 PSIA
GL4041X 60531
ASC HI REG CAUTION
2 TO 5VDC FROM LIGHTING REF DWG 3.1
GP0928X APS FUEL LO (APPROX 10 SECOND BURN TIME LEFT)
GP1400X APS OX LO
GX1240X APS OX
"1" WHEN LO
GL4042X 60532
ASC QTY CAUTION
GX1323X P TRIM FAIL
GX1330X R TRIM FAIL
"1" WHEN FAIL
GL4043X 60533
ENG GMBL CAUTION
GV0201X ED RLY A K1-K6
GV0202X ED RLY B K1-K6
MASTER ARM AND ABORT STAGE SWITCHES OFF POSN
WHEN THE MASTER ARM SWITCH IS ON OR THE ABORT STAGE SWITCH IS PRESSED THE ED RELAY CAUTION IS DISABLED
GL4051X 60531
EDS RELAYS CAUTION
GC0155P AC BUS FREQ
GC0072V AC BUS VOLT
INVERTER (SW4514) OFF POSN
EU=402 CPS
EU = 398 CPS
EU= 112 VAC
THE INVERTER CAUTION LIGHT IS ENABLED ONLY WHEN INVERTER 1 OR 2 IS SELECTED
GL4046 60526
INVERTER CAUTION
ELECTRICAL POWER
INVERTER 2 1 OFF
PNL 14 4514
GC9961U BAT 1 MAL
GC9962U BAT 2/L MAL
GC9963U BAT 3/L MAL
GC9964U BAT 4 MAL
GC9965U BAT 3 MAL
GC9966U BAT 4 MAL
"1" WHEN MAL
GL4047X 60527
BATTERY CAUTION
SC 2
GL4047 BAT MAL
0 = MAL
LOGIC NOT USED
60528
GR7621 RR NO TRACK
RR MODE SELECT (SW1755) AUTO TRACK POSN
"1" WHEN BAD
GL4048X 60529
RNDZ RDR CAUTION
RADAR
AUTO TRACK SLEW LGC
PNL 3 1753
CV00501 ABORT CMD
CH1488V PRIMARY -4.7 VDC
CH1489V BACKUP -4.7 VDC
EU = -5.2 VDC
EU = -4.2 VDC
RCS JET PREAMP PWR SUPPLIES
ELECTRICAL CIRCUIT INTERRUPTER NO. 1 CLOSED
PREAMPS CAUTION LIGHTS DISABLED AT STAGING
GL4050X 60530
PREAMPS CAUTION
GR1101P RCS A HE PRESS
GR1102P RCS B HE PRESS
RCS TEMP/PRESS SW8519 HE POSN
EU < 1696.1 PSIA
GL4052X 60532
RCS CAUTION
TEMP/PRESS MON
PRPLNT FUEL MANF
IN OXID MANF
PNL 2 8519
GR6001T QUAD 4 TEMP
GR6002T QUAD 3 TEMP
GR6003T QUAD 2 TEMP
GR6004T QUAD 1 TEMP
GN7563T LR ANT TEMP
GN7723T RR ANT TEMP
GT0454T S-BAND ANT TEMP
CUT AND CAPPED
EU > 241° F
EU < 113° F
EU > 148.9°F
EU < -15.6°F
EU > +147.7° F
EU < -54.1° F
EU > +152.6° F
EU < -46.8° F
R6-2 THRU R12-2 IS TEMP MON (SW8519) ST WILL BE POSITIONED FOR RESET PER EACH TITLE SHOWN)
60533
HEATER CAUTION
HTR CONT
TEMP MONITOR
RADAR RCS
LOG QUAD 1
RNDZ QUAD 2
QUAD 3
QUAD 4
S-BAND
PNL 3 8510
CDR DC TO DC POWER SUPPLY
POWER SUPPLY FAILURE DETECTION LOGIC
+22VDC
+22VDC
+22VDC
CHOPPER DRIVE
-22VDC
GL4054X 60534
C/W PWR FAIL
0 = FAIL
C/W PWR CAUTION
GF2935X GLY PUMP FAIL (WHEN SELECTED)
GF1523P CO2 PP
THIS INPUT MAY BE INHIBITED BY OPENING CIRCUIT BREAKER 4C884
GF9999 SEL H2O SEP RT
GF1063X SUIT FAN 1 MAL (WHEN SELECTED)
THIS INPUT MAY BE INHIBITED BY OPENING CIRCUIT BREAKER 4C8120
RANGE 2.274VDC
1.651VDC
2 TO 5VDC FROM LIGHTING
GL4056X 60536
ECS CAUTION
INST (SEC) PUMP 1 PUMP 2
PNL 2 753
ELECTRICAL CIRCUIT INTERRUPTER NO. 1 CLOSED (UNSTAGED)
GF3564P DES 1 O2 P
GF3582P ASC 1 O2 P
GF3583P ASC 2 O2 P
O2/N2O QTY MON (SW7512) C/W RESET POSN
EU < 135 PSIA
EU < 99.6 PSIA
EU < 681.6 PSIA
EU < 682.4 PSIA
DES O2 PRESS, ASC 1 O2 PRESS (< 681.6 PSIA), AND ASC 2 O2 PRESS INPUTS ARE DISABLED AT STAGING
GL4057X 60537
O2 QTY CAUTION
O2/N2O QTY MON C/W RESET
DES 1 DES 2 ASC 1 ASC 2
GP0986 SEL GLY LD LVL
GP9998U SEL GLYCOL T
GLY PMP (SW7531) INST (SEC) POSN
<10% REMAINING
EU > 50 °F
GLYCOL CAUTION LIGHT ENABLED ONLY FOR PRELOOP. THAT IS WHEN 753 GLYCOL PUMP SWITCH IN POSN 1 OR 2.
GL4058X 60538
GLYCOL CAUTION
GLYCOL INST (SEC) PUMP 1 PUMP 2
LOGIC NOT USED
60539
CT0944V S-BAND RCVR SIG
RANGE (SW1351) OFF/RESET POSN
RANGE (SW1351) TV/CMEA ENABLE POSN
EU < 1.073VDC
GL4060X 60540
S-BD RCVR CAUTION
COMMUNICATIONS S-BAND RANGE
OFF/ RESET
TV/CMEA ENABLE
PNL 12 1351
60521-60525
60526-60530
60531-60535
60536-60540
ASC HI REG
ASC QTY
ENG GMBL
INVERTER
BATTERY
RNDZ RDR
PREAMPS
ED RELAYS
RCS
HEATER
C/W PWR
ECS
O2 QTY
GLYCOL
S-BD RCVR
CAUTION LIGHTS
(PANEL 2)
TO C/W 3 OF LAMP/TONE TEST SWITCH
TO C/W 4 OF LAMP/TONE TEST SWITCH
6 TRIP LEVELS ARE CALCULATED VALUES BASED UPON ACTUAL LOGIC IMPLEMENTATION
ON HBR TM ONLY
PARAMETERS NOT ON TM
3 CAUTION LOGIC MALFUNCTION LEVELS ARE GIVEN IN ENGINEERING UNITS (EU). THE EU'S ARE APPROXIMATE AND WILL VARY DEPENDANT UPON THE ACTUAL TRANSDUCER UTILIZED FOR EACH INPUT PARAMETER. REFER TO CALIBRATION CURVE FOR EACH TRANSDUCER TO ASCERTAIN EXACT EU
2 NUMBER IN DESIGNATES LOCATION OF ANNUNCIATOR ON PANEL
NOTES: 1 ALL CAUTION ANNUNCIATOR LIGHTS ARE LOCATED ON PANEL 2 AND ARE YELLOW IN COLOR
6 CAUTION
SIGNATURES
DATE
NATIONAL AERONAUTICS & SPACE ADMINISTRATION
MANNED SPACECRAFT CENTER HOUSTON, TEXAS
INSTRUMENTATION C AND W CAUTION
LM
SIZE J
DWG NO 9.6
10 AND SUBS
71.5 X 30.25
PAGE 9-7
SHEET 1 OF 3
INSTR C&W CAUT

OVERVIEW G&N

OVERVIEW SCS

ASC ENG SI

SIG FLOW

RCS

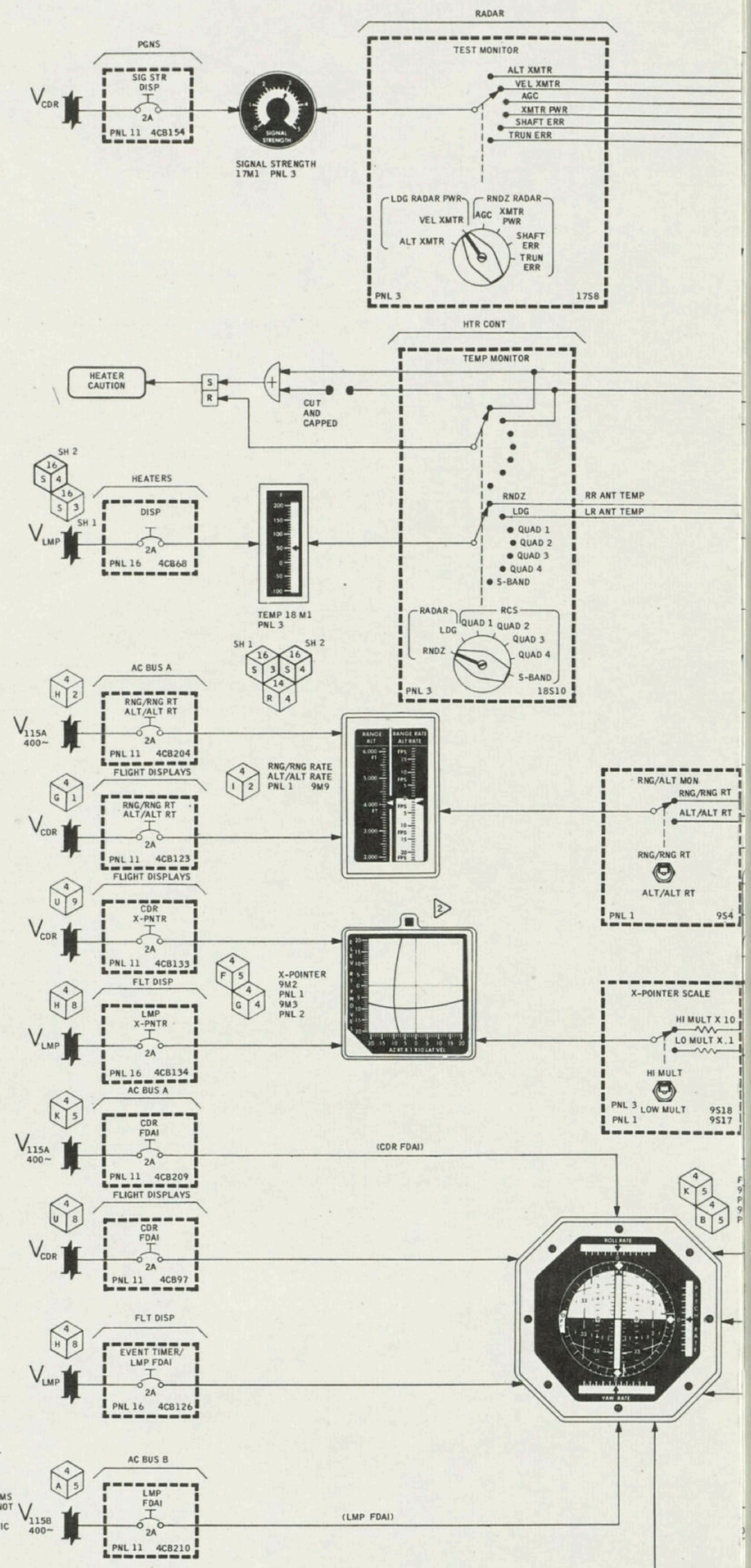
RCS MECH

DES ENG

SIG FLOW

LTR	DCN	DR	ENGR	DATE	APPROVAL

COMMENTS:

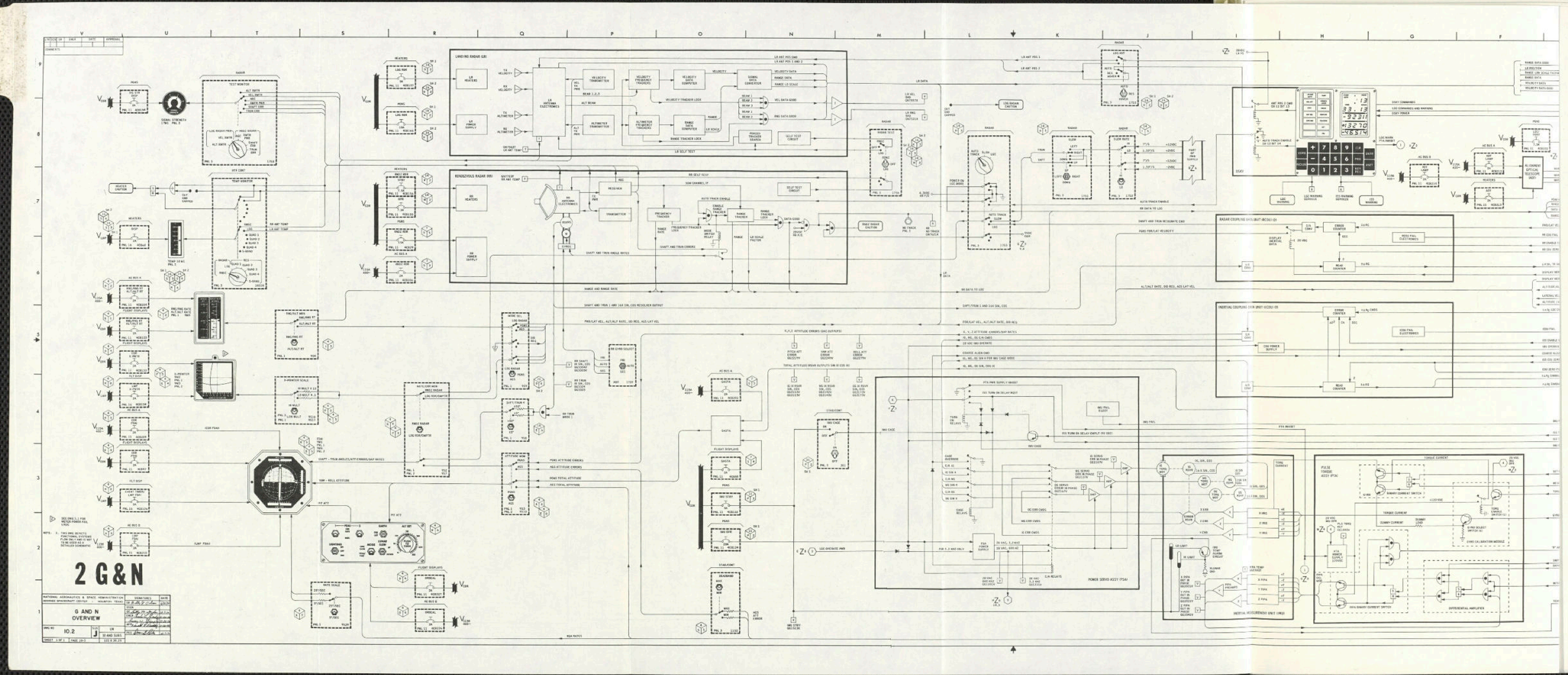


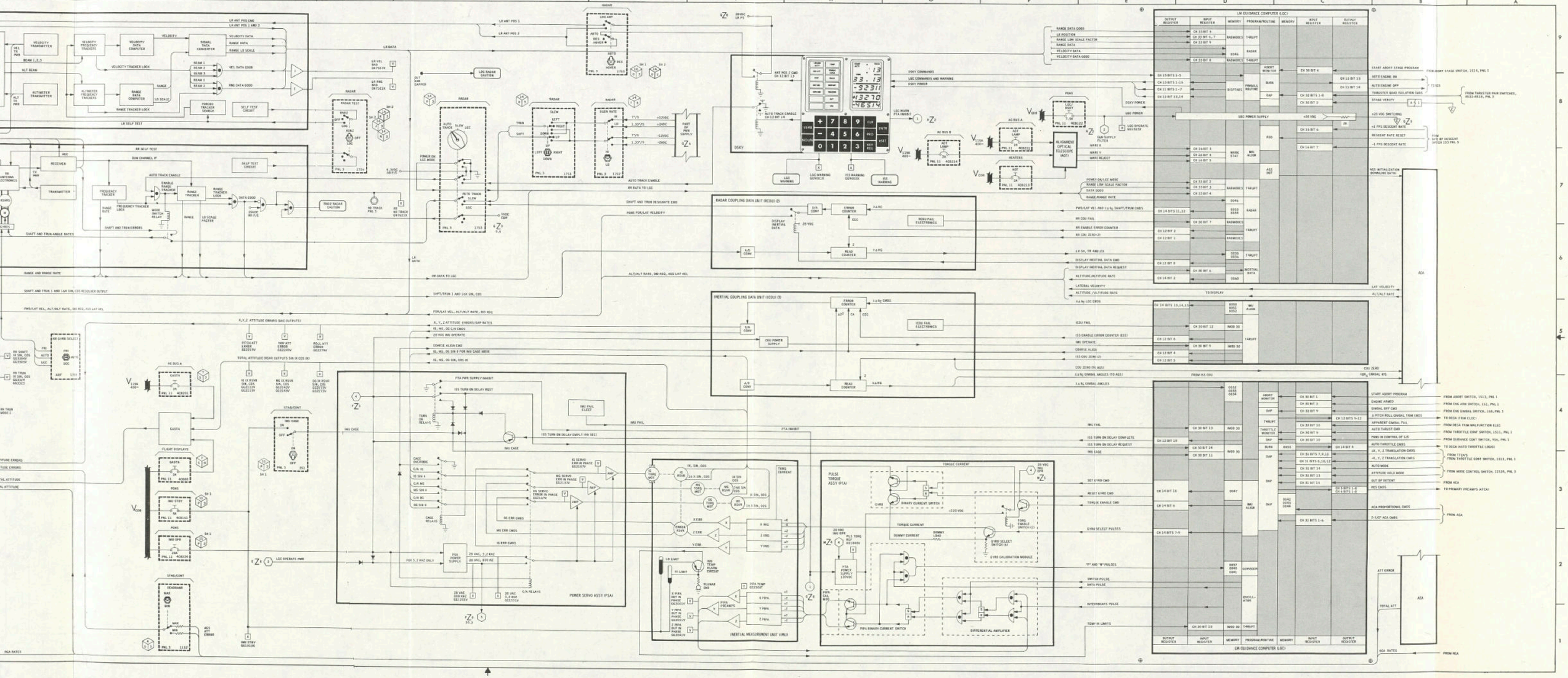
SEE DWG 3.1 FOR METER POWER FAIL LOGIC

NOTE: 1. THIS DWG DEPICTS FUNCTIONAL SYSTEMS FLOW ONLY AND IS NOT TO BE USED AS A DETAILED SCHEMATIC

2 G&N

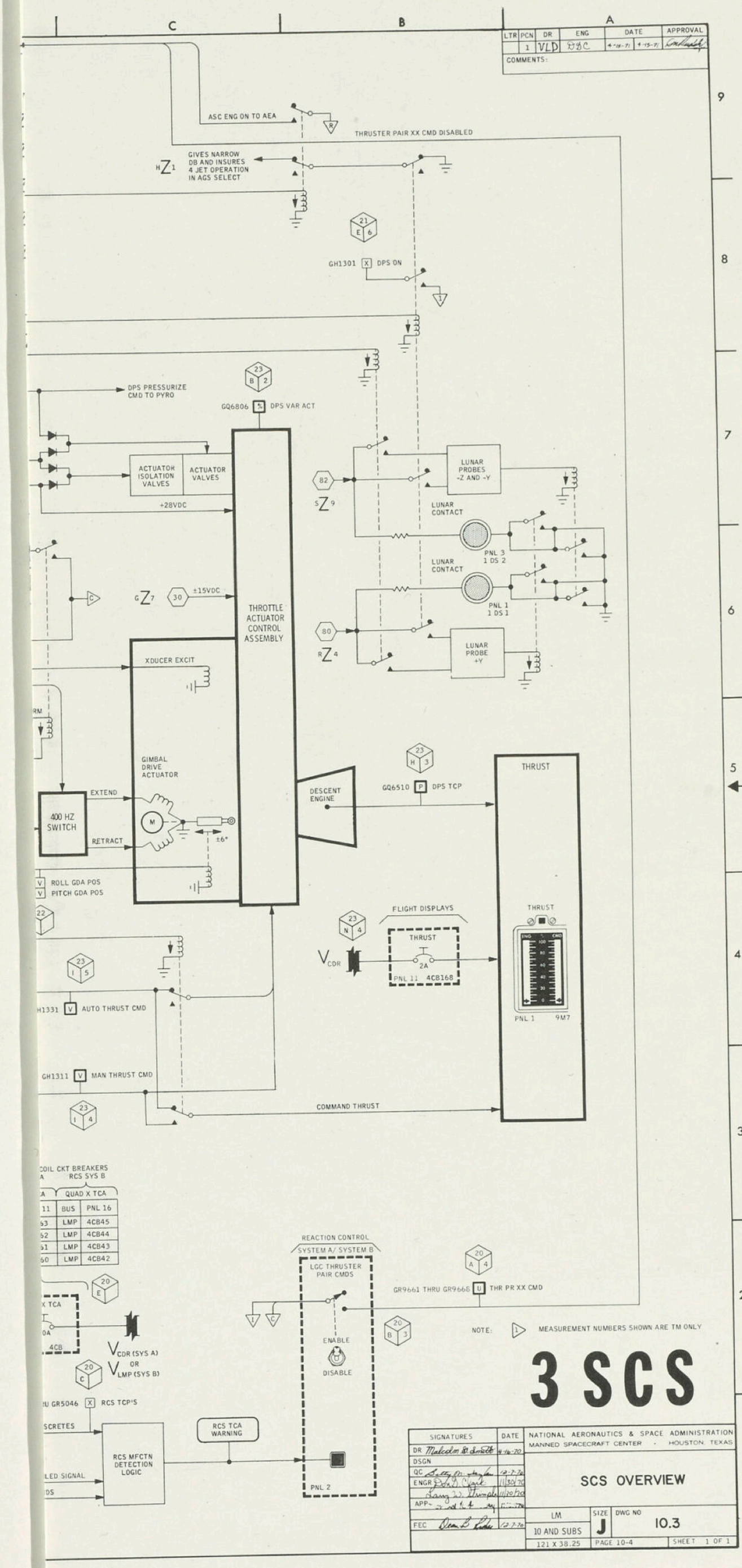
NATIONAL AERONAUTICS & SPACE ADMINISTRATION MANNED SPACECRAFT CENTER · HOUSTON, TEXAS	SIGNATURES	DATE
G AND N OVERVIEW	DR Bobby G. Osborn	6/22/70
	DSGN	
	QC Betty M. Taylor	12-7-70
	ENGR Charles L. Leady	11-30-70
	Harry W. Stimpfig	11-20-70
	APP Robert E. Wadley	11-30-70
	FEC Dean B. Baker	12-7-70
DWG NO 10.2 · SIZE J · LM 10 AND SUBS		
SHEET 1 OF 1 · PAGE 10-3 · 121 X 38.25		


2 G&N
G AND N OVERVIEW
NATIONAL AERONAUTICS & SPACE ADMINISTRATION
MANNED SPACECRAFT CENTER - HOUSTON, TEXAS
DWG NO 10.2
SHEET 1 OF 1
LANDING RADAR (LR)
RENDEZVOUS RADAR (RR)
RADAR COUPLING DATA UNIT (RCDU)
INERTIAL COUPLING DATA UNIT (ICDU)
POWER SERVO ASSY (PSA)
INERTIAL MEASUREMENT UNIT (IMU)
PULSE TORQUE ASSY (PTA)
DSKY
TEST MONITOR
SIGNAL STRENGTH
ATT DISP
FLIGHT DISPLAYS
HEATERS
RATE SCALE
DIFFERENTIAL AMPLIFIER


LM GUIDANCE COMPUTER (LGC)
DSKY
RADAR COUPLING DATA UNIT (RCDU) (2)
INERTIAL COUPLING DATA UNIT (ICDU) (3)
POWER SERVO ASSY (PSA)
INERTIAL MEASUREMENT UNIT (IMU)
PULSE TORQUE ASSY (PTA)
ACA
AEA
LGC POWER SUPPLY
ALIGNMENT OPTICAL TELESCOPE (AOT)
FLIGHT DISPLAYS
STAB/CONT
HEADGEAR
IMU CAGE
IMU FAIL
PTA INHIBIT
ISS TURN ON DELAY COMPLETE
ISS TURN ON DELAY REQUEST
SET GYRO CMD
RESET GYRO CMD
TORQUE ENABLE CMD
GYRO SELECT PULSES
"P" AND "N" PULSES
SWITCH PULSE
DATA PULSE
INTERRUPTS PULSE
TEMP IN LIMITS
START ABORT STAGE PROGRAM
AUTO ENGINE ON
AUTO ENGINE OFF
THRUSTER QUAD ISOLATION CMDS
STAGE VERIFY
+28 VDC SWITCHING
+1 FPS DESCENT RATE
DESCENT RATE RESET
-1 FPS DESCENT RATE
ACS INITIALIZATION (DOWNLINK DATA)
LAT VELOCITY
ALT/ALT RATE
CSU ZERO
ENGINE ARMED
GIMBAL OFF CMD
± PITCH ROLL GIMBAL TRIM CMDS
APPARENT GIMBAL FAIL
AUTO THRUST CMD
PGNS IN CONTROL OF S/C
AUTO THROTTLE CMDS
+X, Y, Z TRANSLATION CMDS
-X, Y, Z TRANSLATION CMDS
AUTO MODE
ATTITUDE HOLD MODE
OUT OF DETENT
RCS CMDS
ACA PROPORTIONAL CMDS
2-1/2° ACA CMDS
ATT ERROR
TOTAL ATT
IGA RATES
FROM IGA

LTR	PCN	DR	ENG	DATE		APPROVAL
	1	VLD	DJC	4-15-71	4-15-71	

COMMENTS:



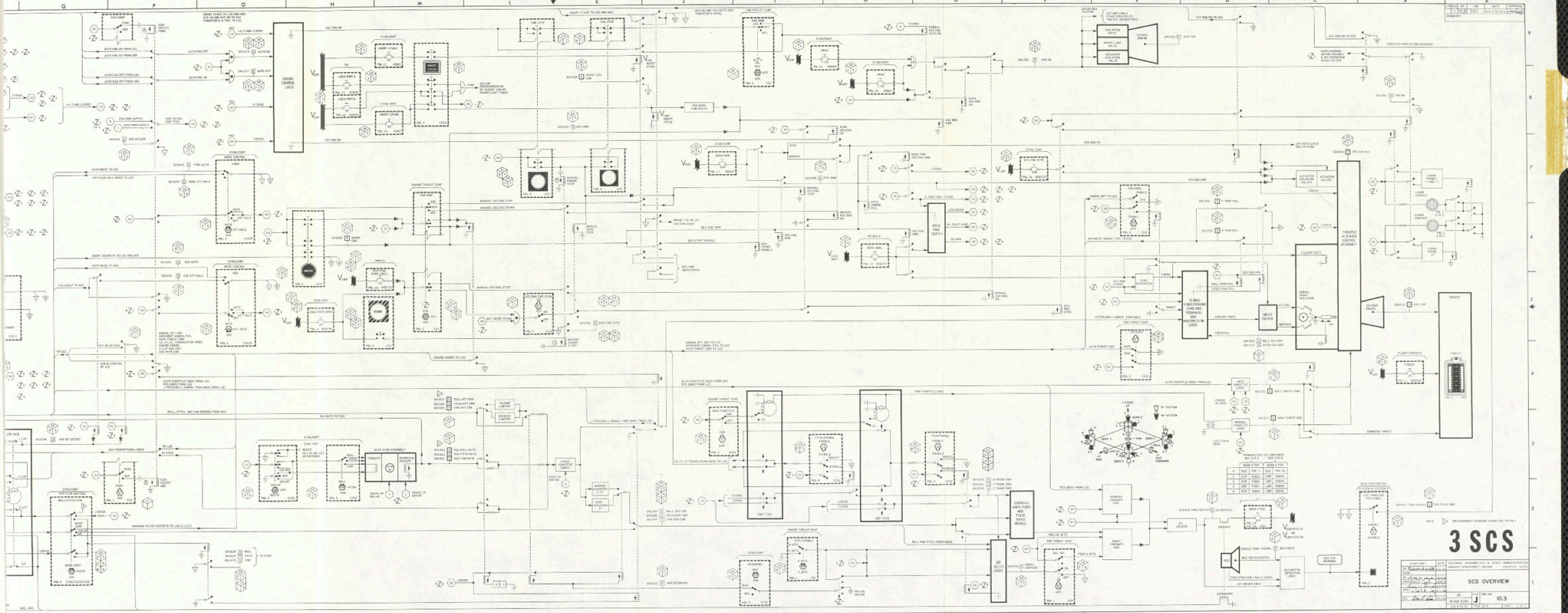
3 SCS

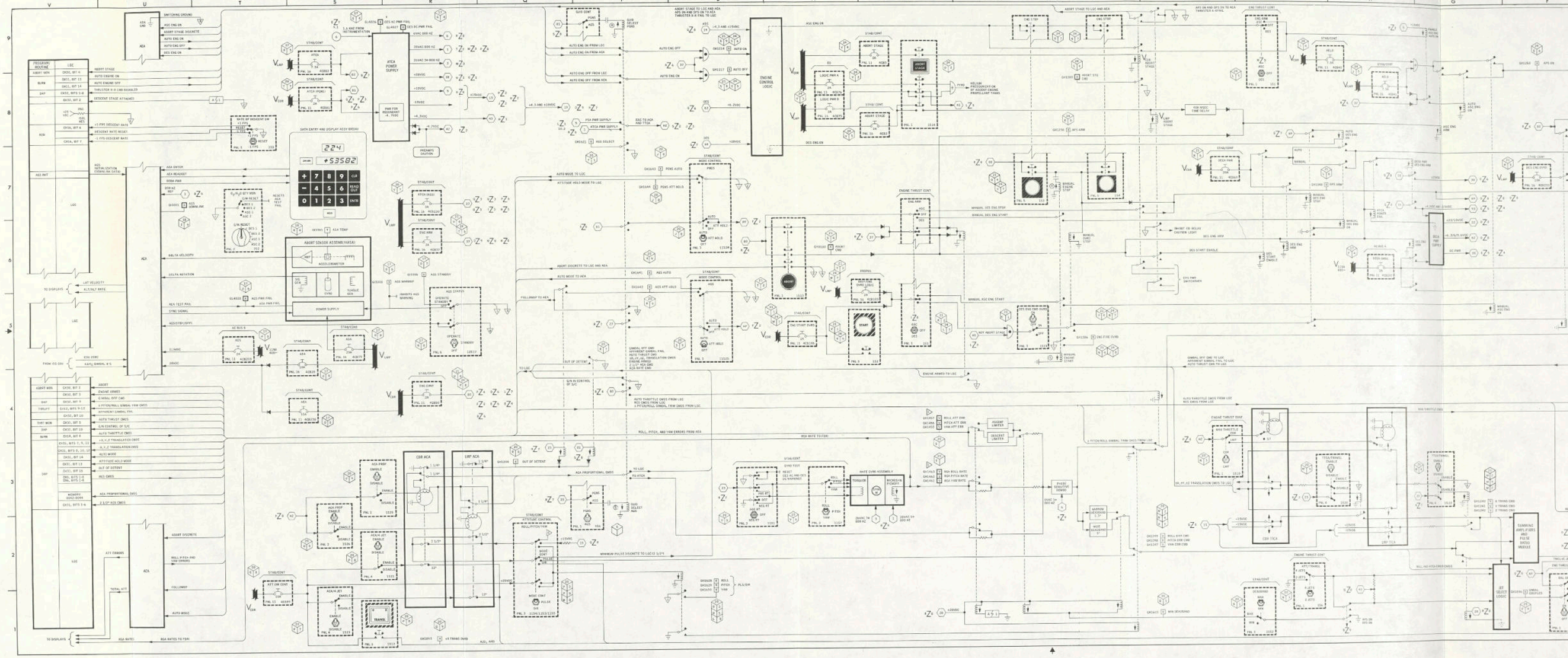
SIGNATURES	DATE
DR Malcolm H. Smith	4-16-70
DSGN	
QC	12-7-70
ENGR	11/30/70
	11/30/70
APP	
FEC	12-7-70

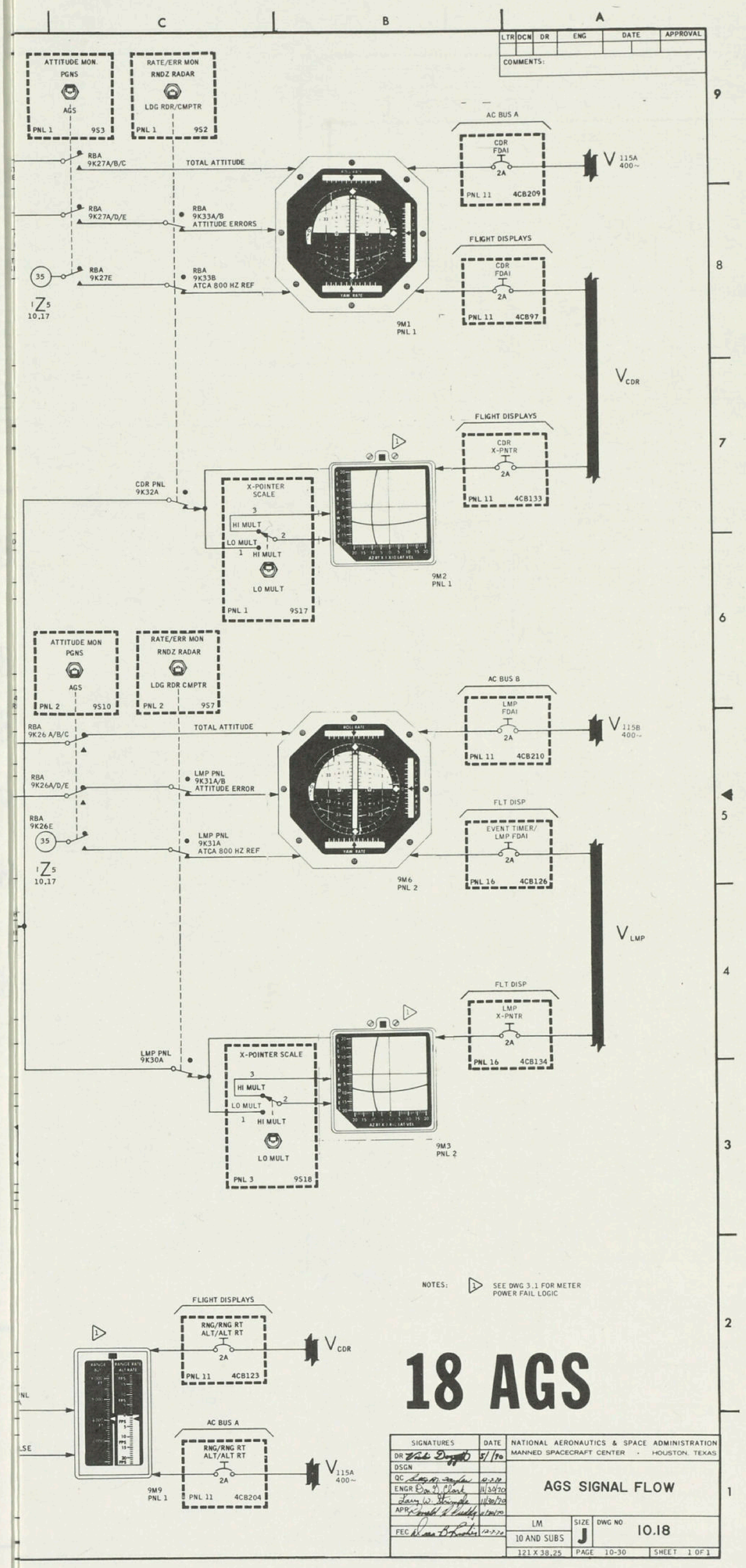
NATIONAL AERONAUTICS & SPACE ADMINISTRATION
MANNED SPACECRAFT CENTER - HOUSTON, TEXAS

SCS OVERVIEW

LM	SIZE	DWG NO
10 AND SUBS	J	10.3
121 X 38.25	PAGE 10-4	SHEET 1 OF 1


3 SCS
SCS OVERVIEW
J
10.3
ENGINE CONTROL LOGIC
ABORT STAGE
START
THROTTLE ACTUATOR CONTROL ASSEMBLY
SIGNAL CONDITIONING (CMD AND FEEDBACK) AND MULTIPLEXING LOGIC
THRUST
SUBSYSTEM INPUTS AND PULSE RATES MODULE
RCS SELECT LOGIC
PRIMARY PREAMPS (16)
ABORT PREAMPS (16)
ENGINE THRUST CONT
STAB/CONT
ATT HOLD
ATT CONTROL
MODE CONTROL
ENGINE ARMED TO LOC
ENGINE THRUST CMD
AUTO THROTTLE CMDS FROM LOC
MANUAL ASC ENG START
MANUAL SCS ENG START
MANUAL SCS ENG STOP
ASC ENG ON
SCS ENG ON
ABORT STAGE TO LOC AND ASA
AUTO ENG ON FROM LOC
AUTO ENG ON FROM ASA
AUTO ENG OFF FROM LOC
AUTO ENG OFF FROM ASA
AUTO ENG OFF
AUTO ENG ON
ASC SELECT
ASA ATT HOLD
AUTO MODE TO ASA
AUTO MODE TO LOC
ASA RATE TO PSA
ASA PROPORTIONAL CMDS
ROLL, PITCH, AND YAW ERRORS FROM ASA
ASA ROLL RATE
ASA PITCH RATE
ASA YAW RATE
ROLL RATE ASSEMBLY
ACCELEROMETER PACKAGE
ROLL, PITCH, AND YAW CMDS FROM LOC
RCS CMDS FROM LOC
ROLL AND PITCH ERROR CMDS
ROLL ERROR CMDS
PRIMARY RCS DRIVERS
ABORT DRIVERS
RCS PWR
RCS FAIL WARNING
REACTION CONTROL SYSTEM & CONTROLS
ENGINE ARMED
ENGINE ON
ENGINE OFF
ENGINE THRUST CONT
ENGINE THRUST CMD
ENGINE THRUST ENABLE
ENGINE THRUST ERROR
ENGINE THRUST ERROR DEGRADED
ENGINE THRUST ERROR DEGRADED
ENGINE THRUST ERROR
ENGINE THRUST ERROR
ENGINE THRUST ERROR


PROGRAM/ROUTINE
LGC
ABORT MON
BURN
COAST
ROM
ACS INIT
ABORT STAGE
AUTO ENGINE ON
AUTO ENGINE OFF
THROTTLE H-D CMD ENABLED
DESCENT STAGE ATTACHED
+25 FPS DESCENT RATE
DESCENT RATE RESET
-5 FPS DESCENT RATE
ACS INITIALIZATION (SIGNAL/DX DATA)
ACA
ATCA POWER SUPPLY
PWR FOR REDUNDANT -4.250C
PREMATURE CAUTION
DATA ENTRY AND DISPLAY ASSY (DSKY)
224
+53582
ABORT SENSOR ASSEMBLY(VASA)
ACCELEROMETER
POWER SUPPLY
AGS STATUS
OPERATE
STANDBY
ENGINE CONTROL LOGIC
ABORT
START
ENGINE THRUST CONT
ENG ARM
ENG STOP
ENG START OVRD
ABORT STAGE
ABORT STAGE TO LGC AND ACA
APS ON AND DPS ON TO ACA THROTTLE 0-4 FWD
ENGINE ARMED TO LGC
MANUAL ASC ENG START
MANUAL DES ENG START
MANUAL DES ENG STOP
DES START ENABLE
DES ENG ARM
ASC ENG ARM
ASC ENG ON
DES ENG ON
AUTO ENG ON
AUTO ENG OFF
AUTO MODE TO LGC
ATTITUDE HOLD MODE TO LGC
ABORT DISCRETE TO LGC AND ACA
AUTO MODE TO ACA
FOLLOWUP TO ACA
ROLL, PITCH, AND YAW ERRORS FROM ACA
ACA PROPORTIONAL EMDS
MINIMUM PULSE DISCRETE TO LGC(2 1/2°)
ATTITUDE CONTROL ROLL/PITCH/YAW
MODE CONT
PULSE
TRANS
CSM ACA
LMP ACA
ACA PREP ENABLE
ACA/H JET ENABLE
ACA/V JET ENABLE
ATT DIR CONT
ATCA
ATCA (PGNS)
ATCA (DSKY)
ATCA (AGS)
ATCA (ENG)
ATCA (ENG ARM)
ATCA (ENG START OVRD)
ATCA (ENG CONT)
ATCA (ASC)
ATCA (DES)
ATCA (DECA PWR)
ATCA (DES ENG OVRD)
ATCA (ASC ENG OVRD)
ATCA (DECA GMBL)
ATCA (DECA PWR SUPPLY)
ATCA (ASC ENG ON)
ATCA (DES ENG ON)
ATCA (ASC ENG ARM)
ATCA (DES ENG ARM)
ATCA (DES START ENABLE)
ATCA (DES PWR SWITCHOVER)
ATCA (ENGINE THRUST DISP)
ATCA (MIN THROTTLE CMD)
ATCA (TCA/TRANSL ENABLE)
ATCA (TCA/ROTNL ENABLE)
ATCA (ATT/TRANSL ENABLE)
ATCA (ATT/ROTNL ENABLE)
ATCA (ATT/TRANSL ENABLE)
ATCA (ATT/ROTNL ENABLE)
ATCA (DESCENT LIMITER)
ATCA (ASCENT LIMITER)
ATCA (DESCENT LIMITER)
ATCA (ROLL ATT ERR)
ATCA (PITCH ATT ERR)
ATCA (YAW ATT ERR)
ATCA (RGA RATE TO FDAI)
ATCA (ROLL ATT ERR)
ATCA (PITCH ATT ERR)
ATCA (YAW ATT ERR)
ATCA (RGA ROLL RATE)
ATCA (RGA PITCH RATE)
ATCA (RGA YAW RATE)
ATCA (ROLL ERR CMD)
ATCA (PITCH ERR CMD)
ATCA (YAW ERR CMD)
ATCA (MIN DEADBAND)
ATCA (ENGINE THRUST CONT)
ATCA (ATT/TRANSL ENABLE)
ATCA (ATT/ROTNL ENABLE)
ATCA (ATT DIR ON)
ATCA (ATT DIR OFF)
ATCA (ENABLE ROT/TRANS)
ATCA (ENABLE ROTNL)
ATCA (ENABLE TRANS)
ATCA (ENABLE ROT/TRANS ENABLE)
ATCA (ENABLE ROTNL ENABLE)
ATCA (ENABLE TRANS ENABLE)
ATCA (ROLL AND PITCH ERR EMDS)
ATCA (ENABLE ROT/TRANS EMDS)
ATCA (ENABLE ROTNL EMDS)
ATCA (ENABLE TRANS EMDS



18 AGS

SIGNATURES	DATE
DR	5/70
DSGN	
QC	
ENGR	11/30/70
	11/30/70
APPR	
FEC	12-7-70

NATIONAL AERONAUTICS & SPACE ADMINISTRATION
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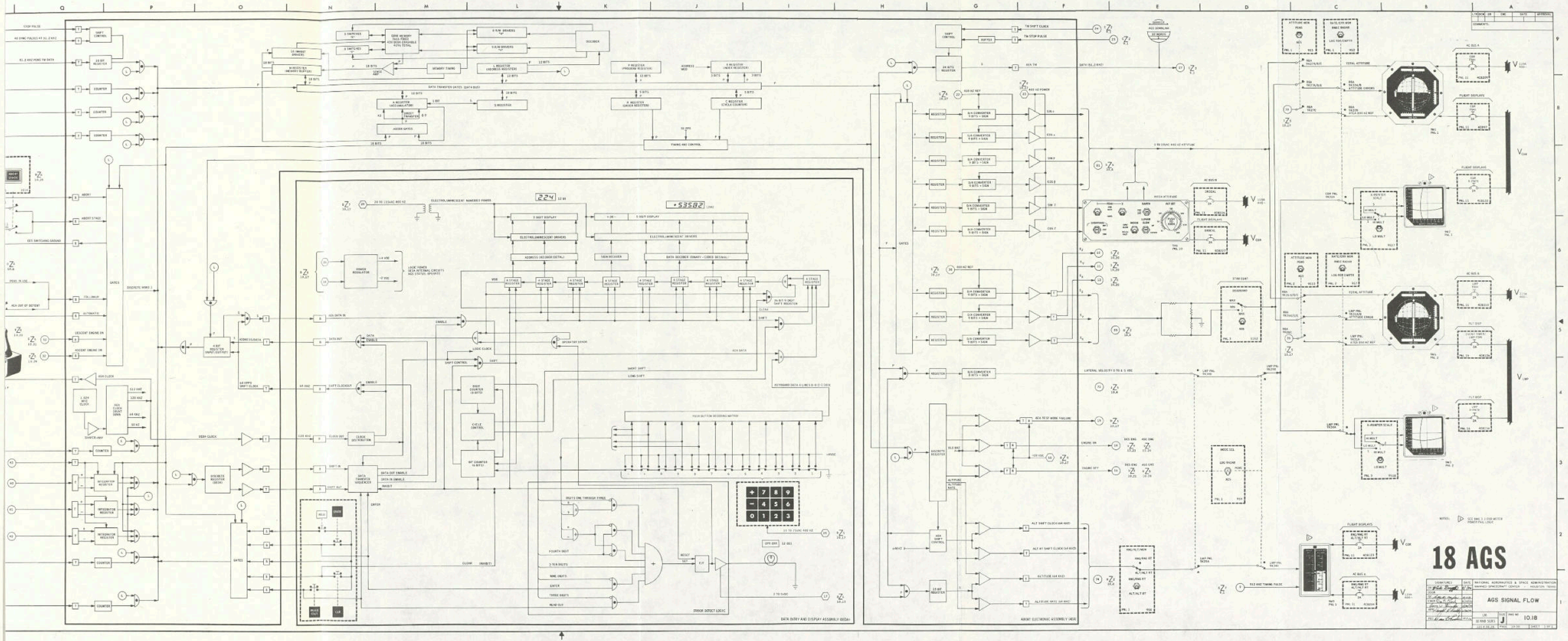
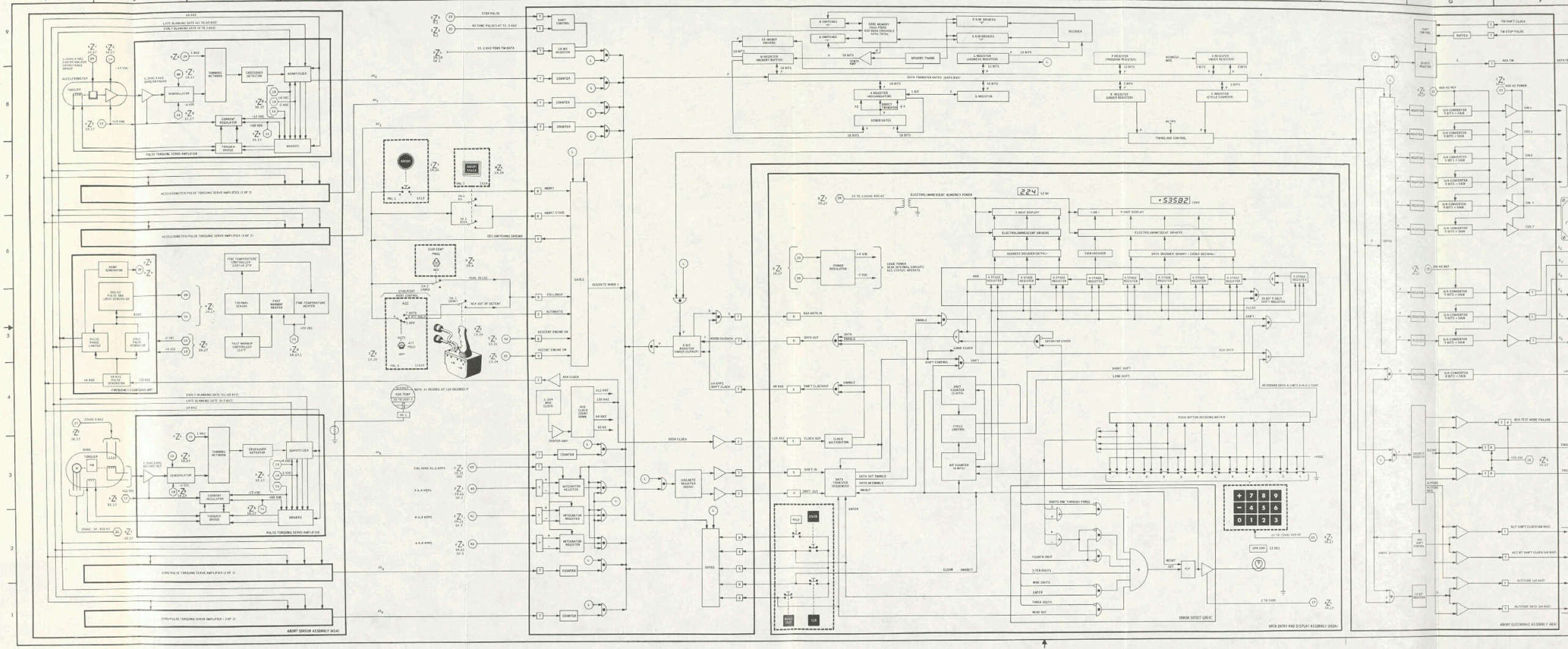
AGS SIGNAL FLOW

LM	SIZE	DWG NO
10 AND SUBS	J	10.18
121 X 38.25	PAGE 10-30	SHEET 1 OF 1

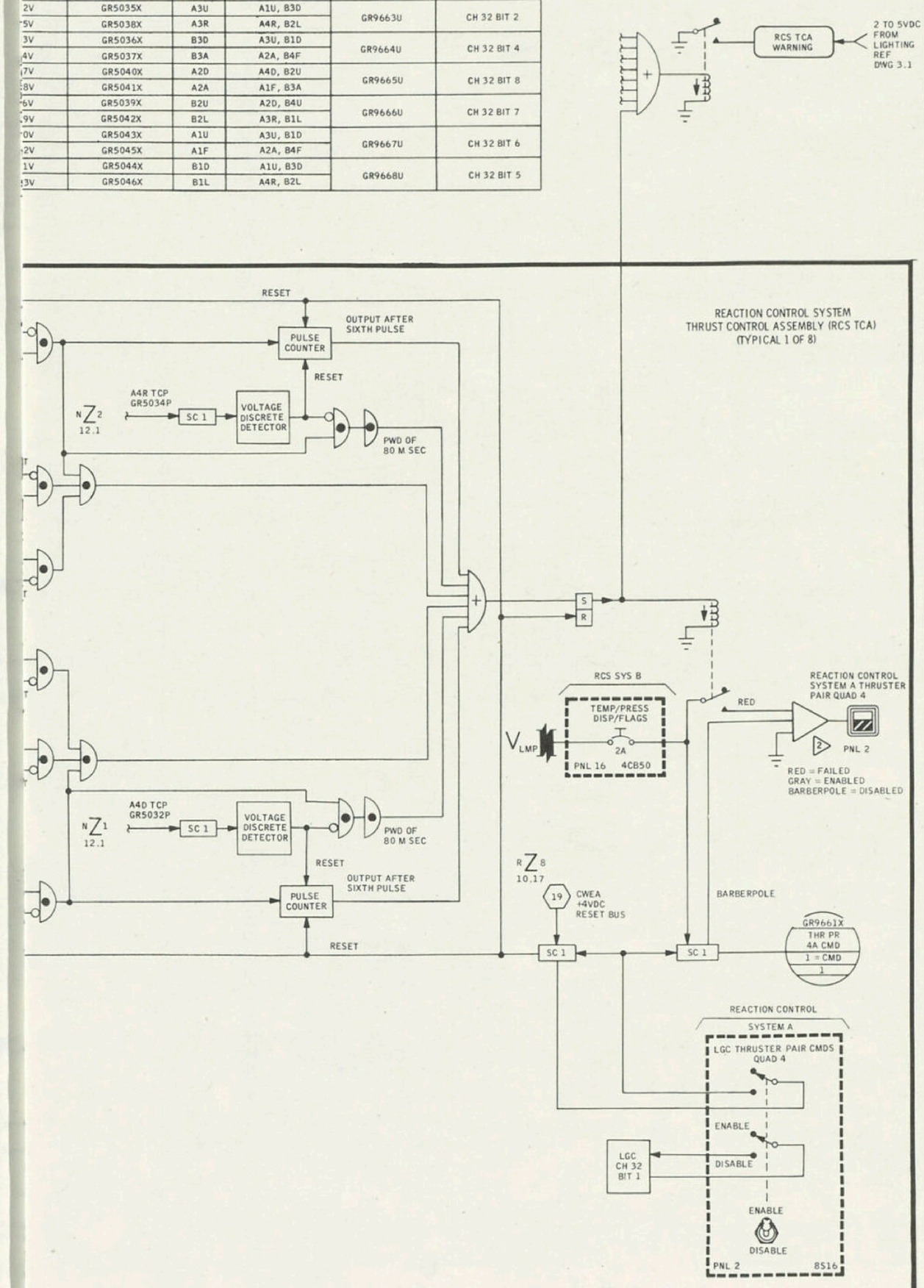

18 AGS
AGS SIGNAL FLOW
NATIONAL AERONAUTICS & SPACE ADMINISTRATION
MANNED SPACECRAFT CENTER - HOUSTON, TEXAS
10.18
DATA INPUT AND DISPLAY ASSEMBLY (DIDA)
ABORT ELECTRONIC ASSEMBLY (AEA)
SIG FLOW


ABORT SENSOR ASSEMBLY (ASA)
PULSE TORQUING SERVO AMPLIFIER
ACCELEROMETER/PULSE TORQUING SERVO AMPLIFIER (2 OF 3)
ACCELEROMETER/PULSE TORQUING SERVO AMPLIFIER (3 OF 3)
FREQUENCY COMPENSATOR UNIT
GYRO/PULSE TORQUING SERVO AMPLIFIER (2 OF 3)
GYRO/PULSE TORQUING SERVO AMPLIFIER (3 OF 3)
DATA ENTRY AND DISPLAY ASSEMBLY (DEDA)
ERROR DETECT LOGIC
ABORT ELECTRONIC ASSEMBLY (AEA)
STOP PULSE
40 SYNC PULSES AT 51.2 KHZ
51.2 KHZ PCMS TM DATA
DATA TRANSFER GATES (DATA BUS)
TIMING AND CONTROL
ELECTROLUMINESCENT NUMERICS POWER
ELECTROLUMINESCENT DRIVERS
PUSH BUTTON DECODING MATRIX
DISCRETE INPUT

LTR	PCN	DR	ENG	DATE	APPROVAL
	1	RJB	BDC	4-15-71	4-15-71

COMMENTS:

	THRUST CHAMBER PRESSURE TM (TCP)	JET	OPPOSING BALANCE COUPLE	THR PR CMD TM NO	LGC INHIBIT
	TYPICAL 16			TYPICAL 8	
9V	GR5032X	A4D	A2D, B4U	GR9661U	CH 32 BIT 1
1V	GR5034X	A4R	A3R, B1L		
8V	GR5031X	B4U	A4D, B2U	GR9662U	CH 32 BIT 3
0V	GR5033X	B4F	A1F, B3A		
2V	GR5035X	A3U	A1U, B3D	GR9663U	CH 32 BIT 2
5V	GR5038X	A3R	A4R, B2L		
3V	GR5036X	B3D	A3U, B1D	GR9664U	CH 32 BIT 4
4V	GR5037X	B3A	A2A, B4F		
7V	GR5040X	A2D	A4D, B2U	GR9665U	CH 32 BIT 8
8V	GR5041X	A2A	A1F, B3A		
6V	GR5039X	B2U	A2D, B4U	GR9666U	CH 32 BIT 7
9V	GR5042X	B2L	A3R, B1L		
0V	GR5043X	A1U	A3U, B1D	GR9667U	CH 32 BIT 6
2V	GR5045X	A1F	A2A, B4F		
1V	GR5044X	B1D	A1U, B3D	GR9668U	CH 32 BIT 5
3V	GR5046X	B1L	A4R, B2L		



20 RCS

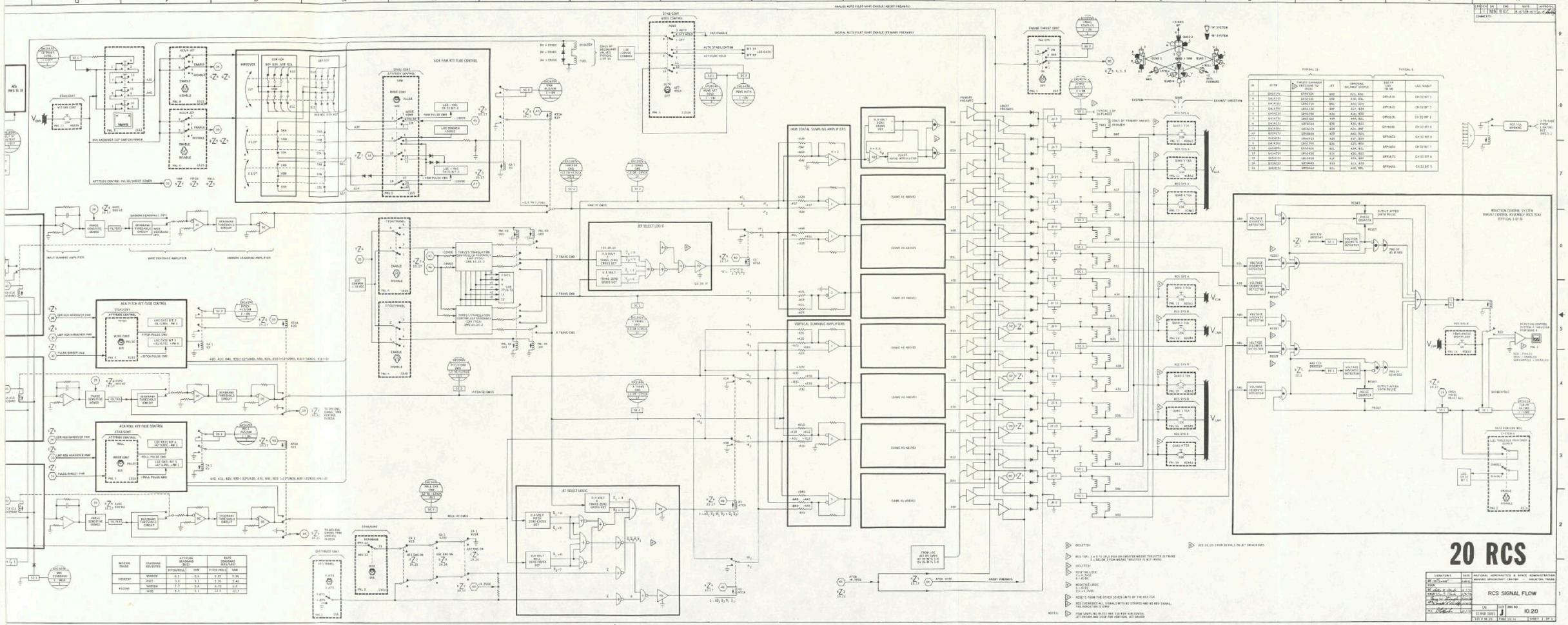
SIGNATURES	DATE
DR	6-29-70
DSGN	
QC	12-7-70
ENGR	11/30/70
	11/20/70
APP	11/20/70
FEC	12-7-70

NATIONAL AERONAUTICS & SPACE ADMINISTRATION
MANNED SPACECRAFT CENTER · HOUSTON, TEXAS

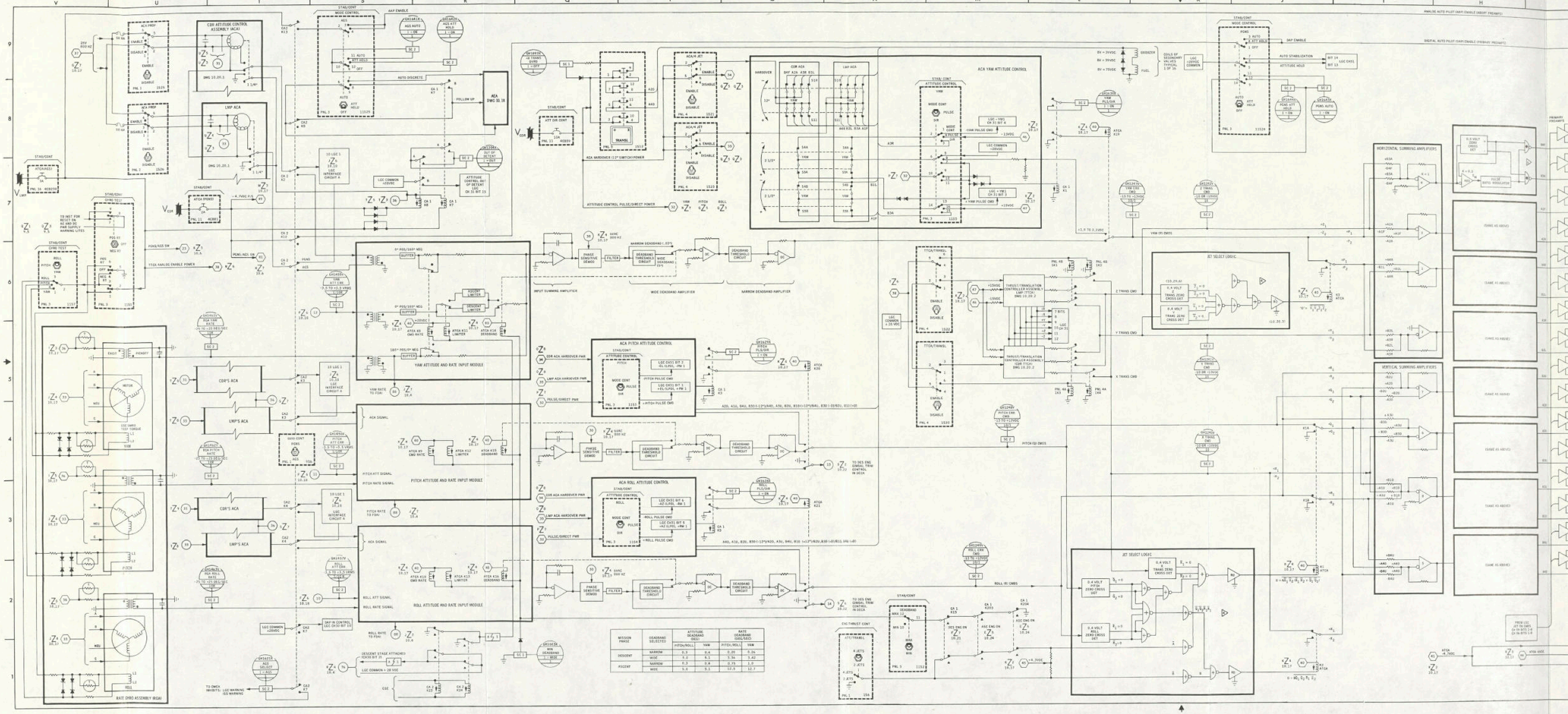
RCS SIGNAL FLOW

LM	SIZE	DWG NO
10 AND SUBS	J	10.20
121 X 38.25	PAGE 10-35	SHEET 1 OF 1

DPS MECH
SIG FLOW SL
ASC ENG
APS MECH
SIG FLOW
RCS
RCS MECH
SIG FLOW
DES ENG
SIG FLOW



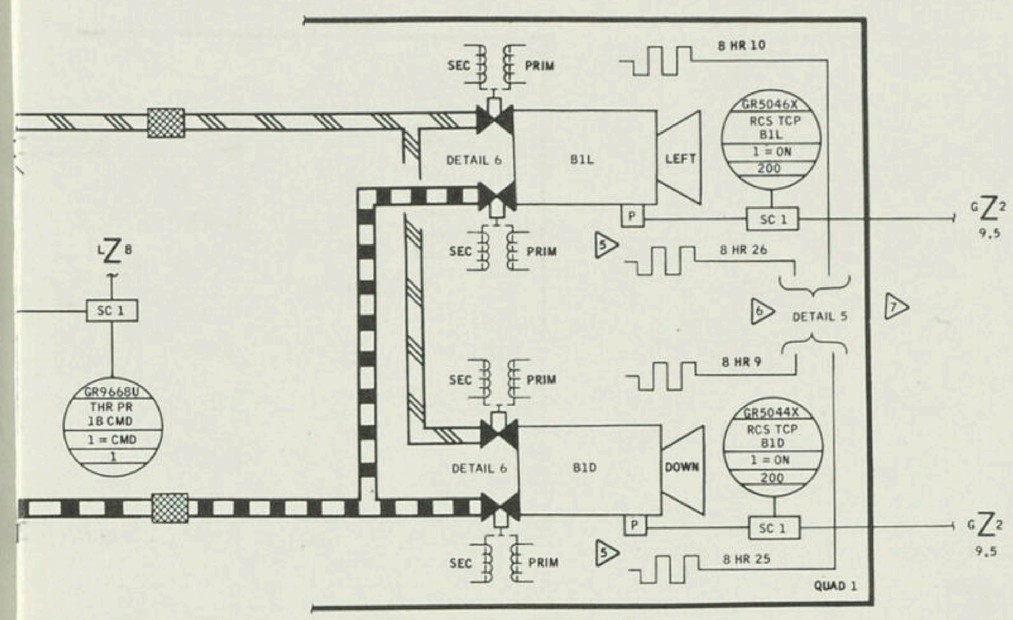
MISSION PHASE	SEGMENT SELECTED	ATTITUDE MODE DESIGNED PITCH/ROLL	YAW	RATE DEADBAND DESIGNED PITCH/ROLL	YAW
DESCENT	NARROW	0.3	0.4	0.20	0.25
	WIDE	1.0	1.1	1.25	1.42
ASCENT	NARROW	0.3	0.4	0.70	1.0
	WIDE	1.1	1.1	12.5	12.7

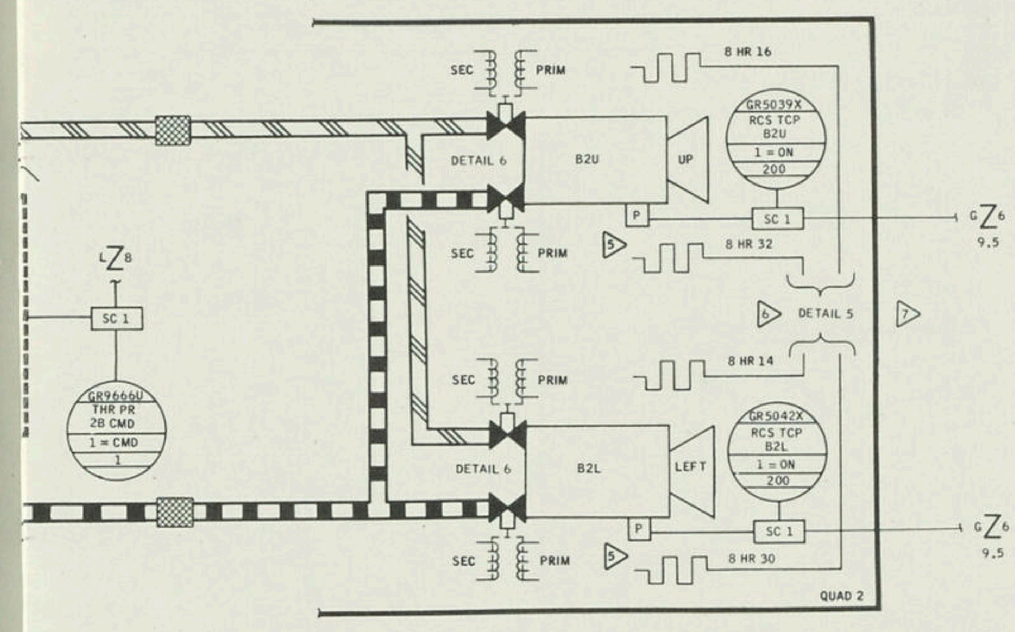


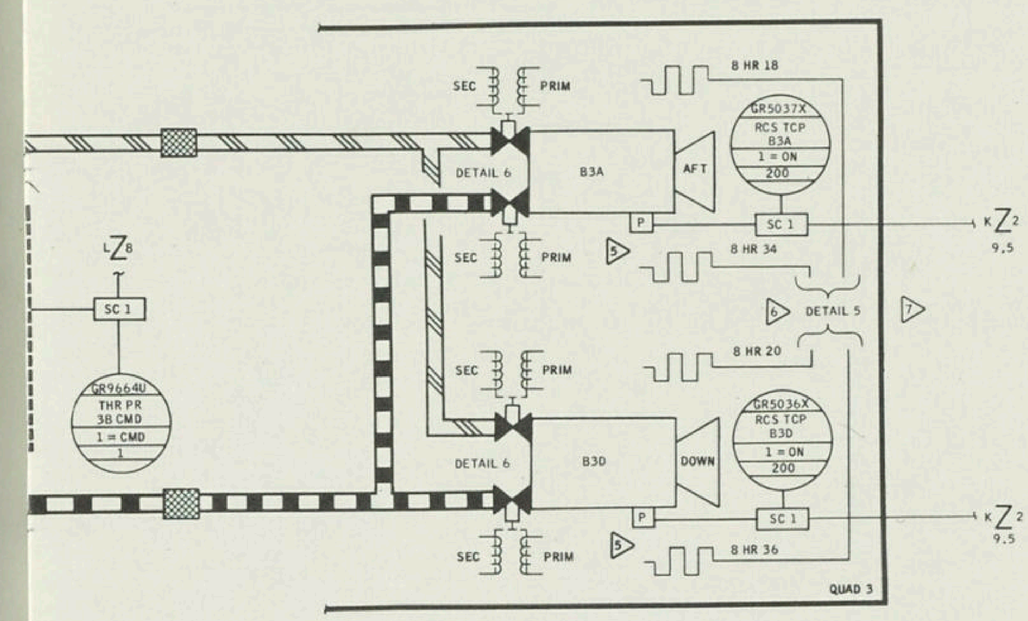
MISSION PHASE	DEADBAND SELECTED	ATTITUDE DEADBAND (DEG)		RATE DEADBAND (DEG/SEC)	
		PITCH/ROLL	YAW	PITCH/ROLL	YAW
DESCENT	NARROW	0.3	0.4	0.20	0.24
	WIDE	5.0	5.1	3.36	3.42
ASCENT	NARROW	0.3	0.4	0.75	1.0
	WIDE	5.0	5.1	17.0	12.7

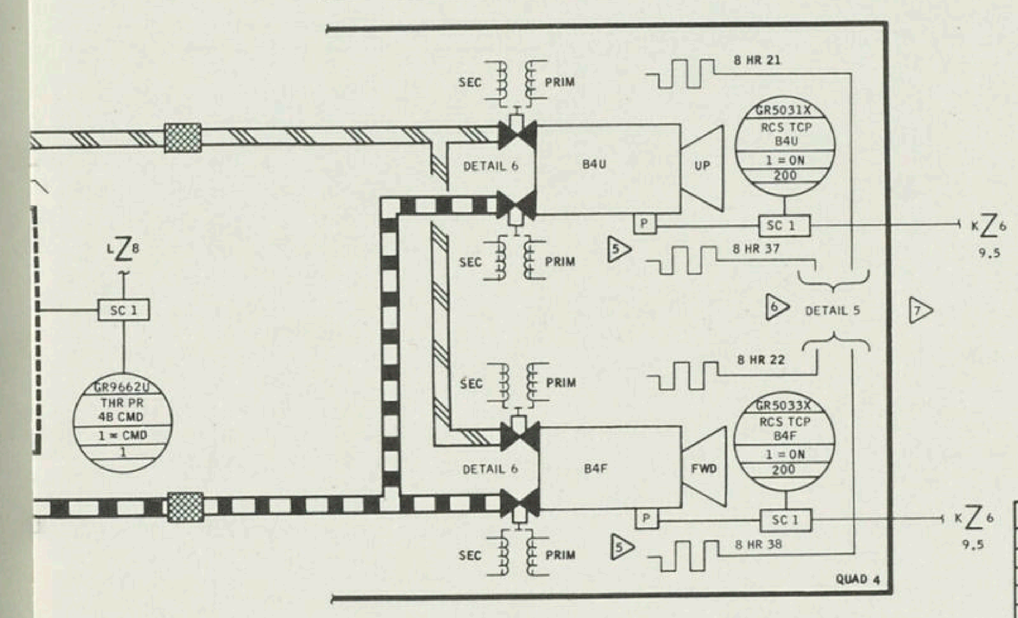
LTR	DCN	DR	ENG	DATE		APPROVAL

COMMENTS:









NOTES:

1. WARNING LIGHT INHIBITED IF MAINS OF SYSTEM ARE CLOSED
2. SEE DWG 3.1 FOR METER POWER FAIL LOGIC
3. ALL PRESSURE SENSORS ARE FUSED BY 1/4 AMP FUSES AND ARE POWERED FROM 4CB132 CIRCUIT BREAKER
4. VALUES SHOWN ARE SPECIFICATION VALUES UNLESS OTHERWISE NOTED
5. PRESSURE SWITCH CLOSURE PROVIDES DISCRETE SIGNAL
6. ± 2° DEADBAND
   a) PRIMARY THERMOSTATS SET AT 140 ± 8° F (17.5 WATTS EACH)
   b) SECONDARY THERMOSTATS SET AT 147 ± 7° F (17.5 WATTS EACH)
7. THE QUAD TEMP MEASUREMENT IS LOCATED ON THE THRUSTER MOUNT WHICH HOLDS 2 SYSTEM A AND 2 SYSTEM B THRUSTERS
8. THREE POSITION FLAG
   GRAY = ENABLE
   BARBERPOLE = DISABLE
   RED = FAILED
9. TWO POSITION FLAG
   GRAY = OPEN
   BARBERPOLE = CLOSED

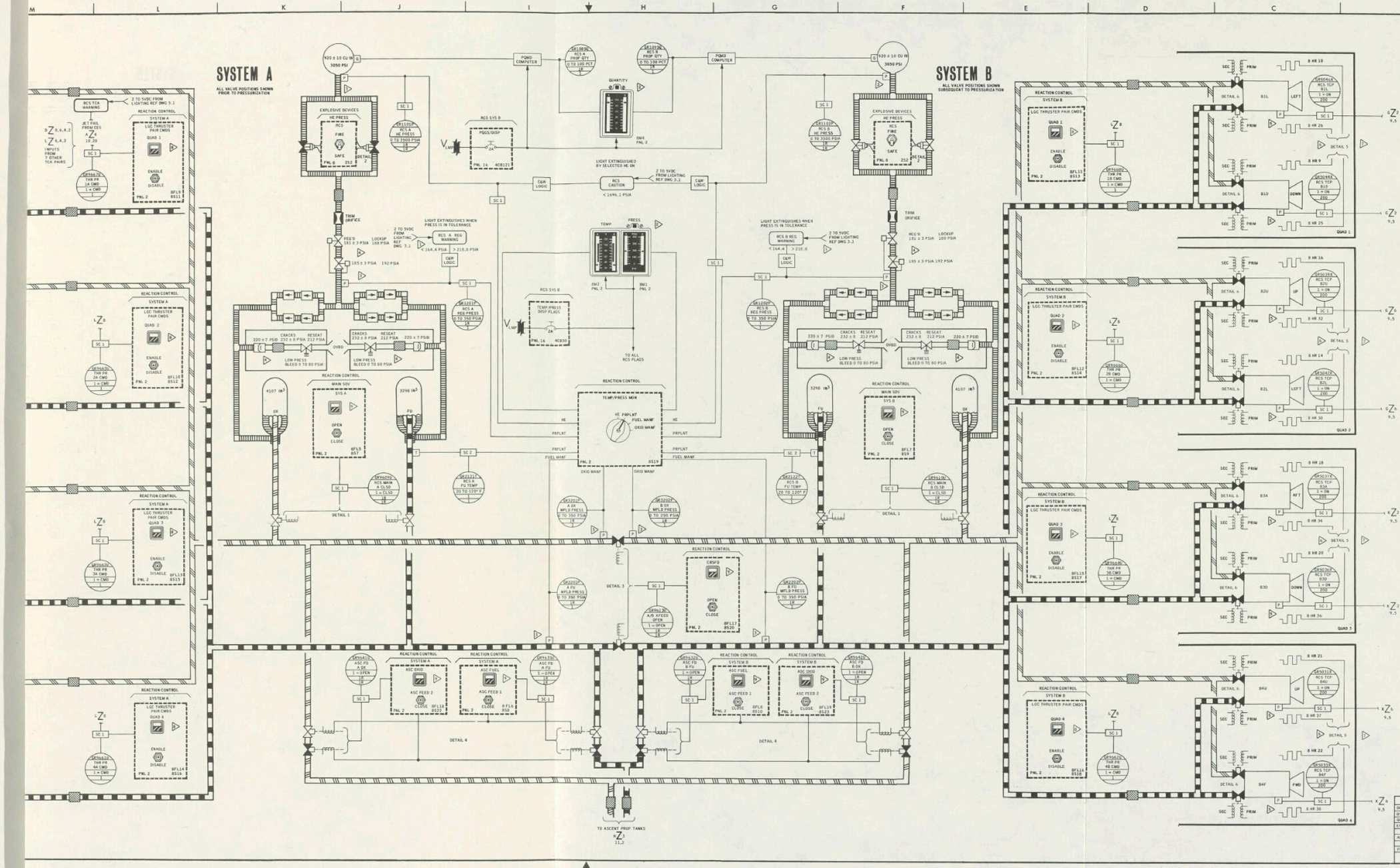
1 RCS

SIGNATURES	DATE
DR Bobby L. Osborn	4-9-70
DSGN	
QC Betty M. Taylor	12-7-70
ENGR E. J. Kessler	11-30-70
J. A. Wiggins	11-30-70
APP Donald P. Hadley	11-30-70
FEC Dan B. Reeder	12-7-70

NATIONAL AERONAUTICS & SPACE ADMINISTRATION
MANNED SPACECRAFT CENTER · HOUSTON, TEXAS

RCS MECHANICAL SCHEMATIC

LM	SIZE	DWG NO
10 AND SUBS	J	12.1
88 X 38.25	PAGE 12-4	SHEET 1 OF 1



LTR	DCN	DR	ENG	DATE	APPROVAL

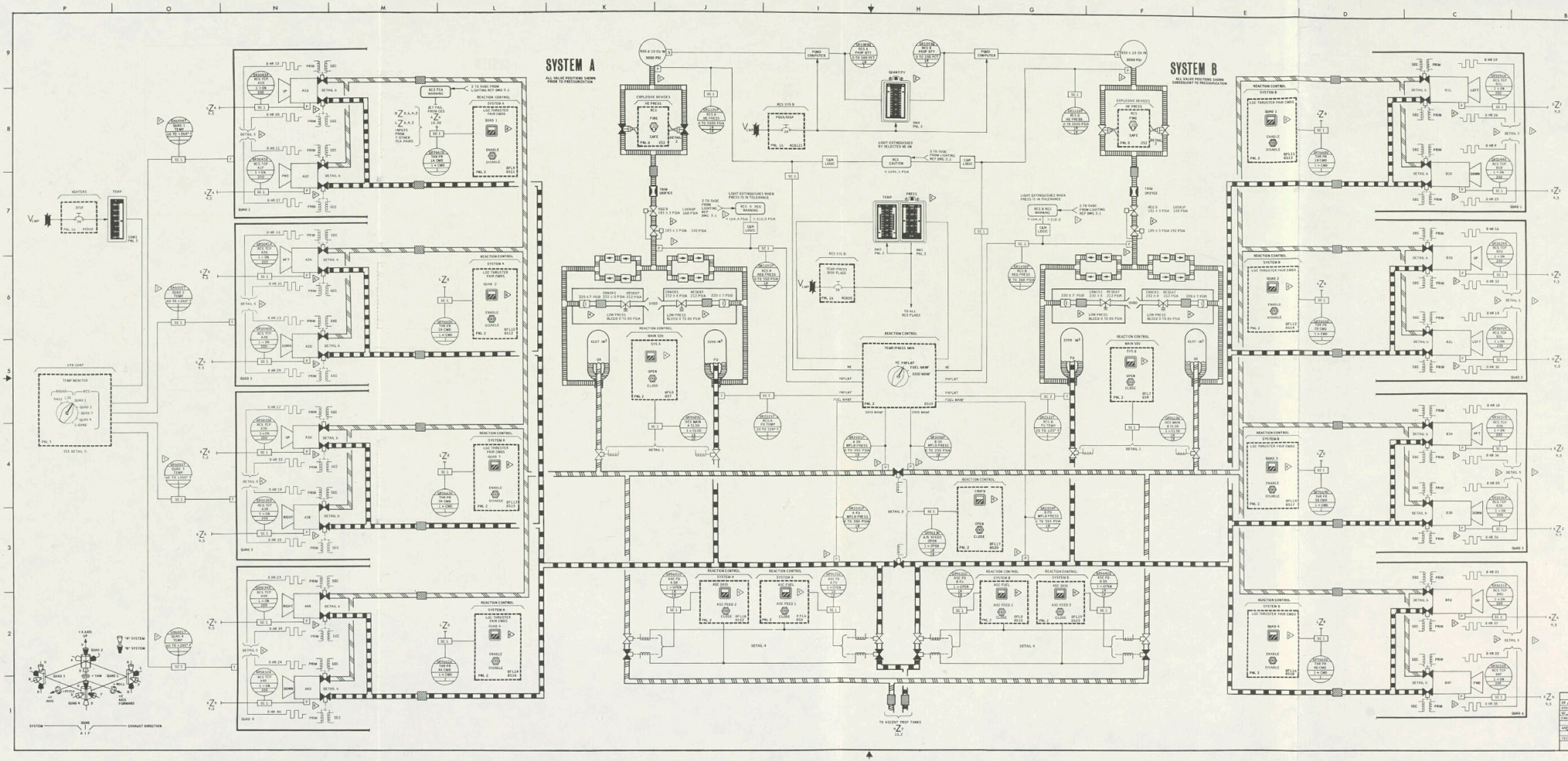
COMMENTS:

1RCS

SIGNATURES	DATE	NATIONAL AERONAUTICS & SPACE ADMINISTRATION MANNED SPACECRAFT CENTER - HOUSTON, TEXAS
DR	4-9-70	RCS MECHANICAL SCHEMATIC
SD	12-2-70	
ENGR	12-2-70	
	12-30-70	
APP	12-30-70	
REC	1-7-71	

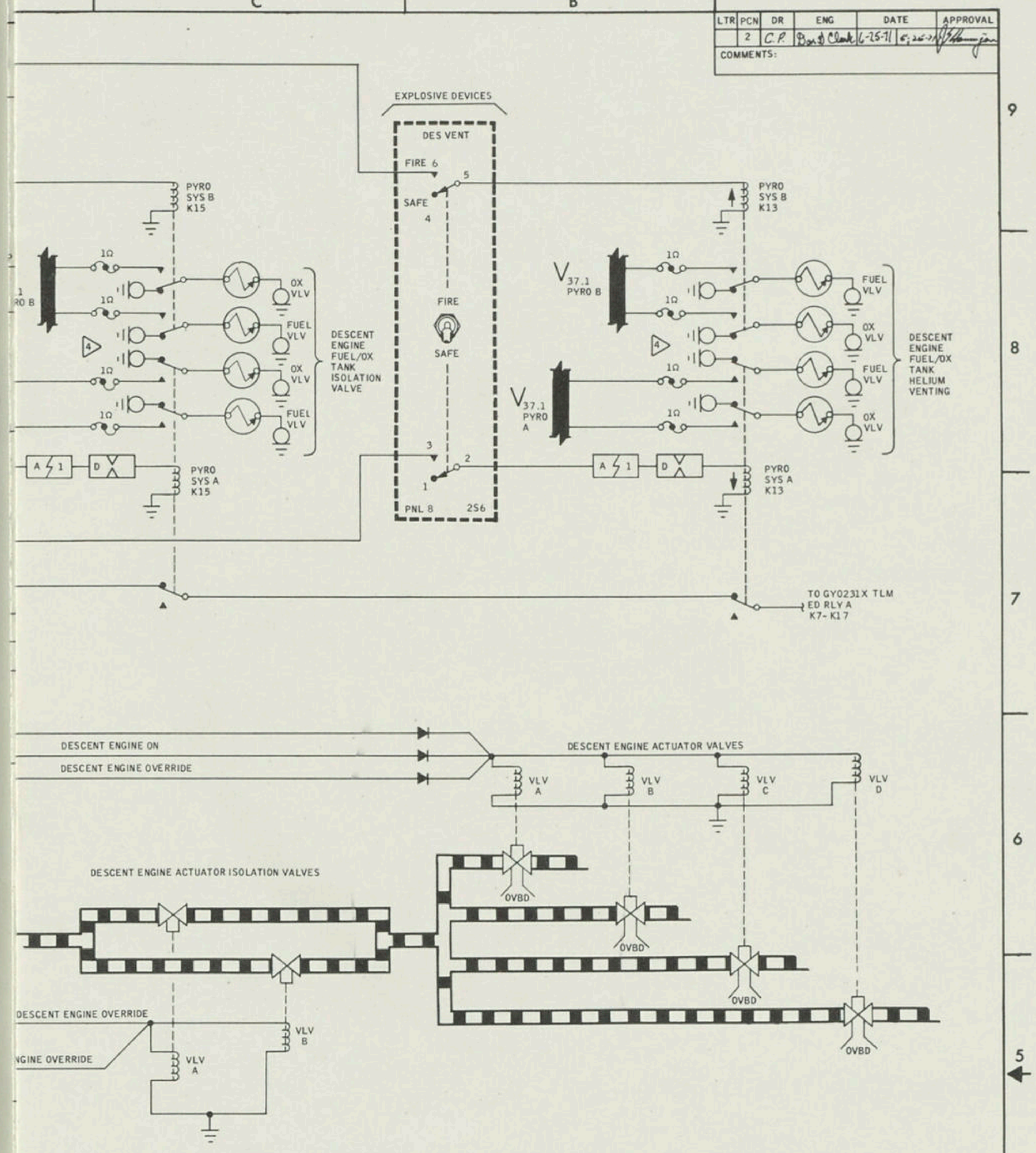
LM 10 AND SUBS | SIZE J | DWG NO 12.1 | 98 X 38.25 | PAGE 12-4 | SHEET 1 OF 1

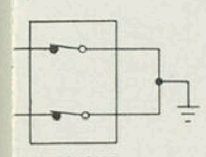
RCS MECH


SYSTEM A
ALL VALVE POSITIONS SHOWN PRIOR TO PRESSURIZATION
SYSTEM B
ALL VALVE POSITIONS SHOWN SUBSEQUENT TO PRESSURIZATION
EXPLOSIVE DEVICES
REACTION CONTROL
TO ASCENT PROP TANKS

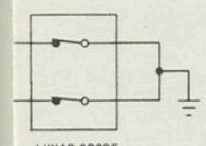
LTR	PCN	DR	ENG	DATE	APPROVAL
	2	C.P.		6-25-71	

COMMENTS:





LUNAR PROBE
-Y 1S16
GM2432X



LUNAR PROBE
+Y 1S15
GM2431X

4 ALL FLOATING GROUNDS ON THIS DRAWING ARE PYRO GROUNDS

3 LOSS OF THE 6.2VDC, 6 VDC, AND 5.6 VDC WILL INHIBIT THE DESCENT ENGINE CONTROL LOGIC FROM ISSUEING AN AUTO ON UPON RECEIVING AN AUTO DESCENT ENGINE ON

2 NEGATIVE LOGIC
1 = 0 VDC
0 = +4.3 VDC/OPEN

NOTE: 1 ONE SHOT PULSE (PULSE WIDTH = 100 MILLISECONDS)

21 DPS SIG

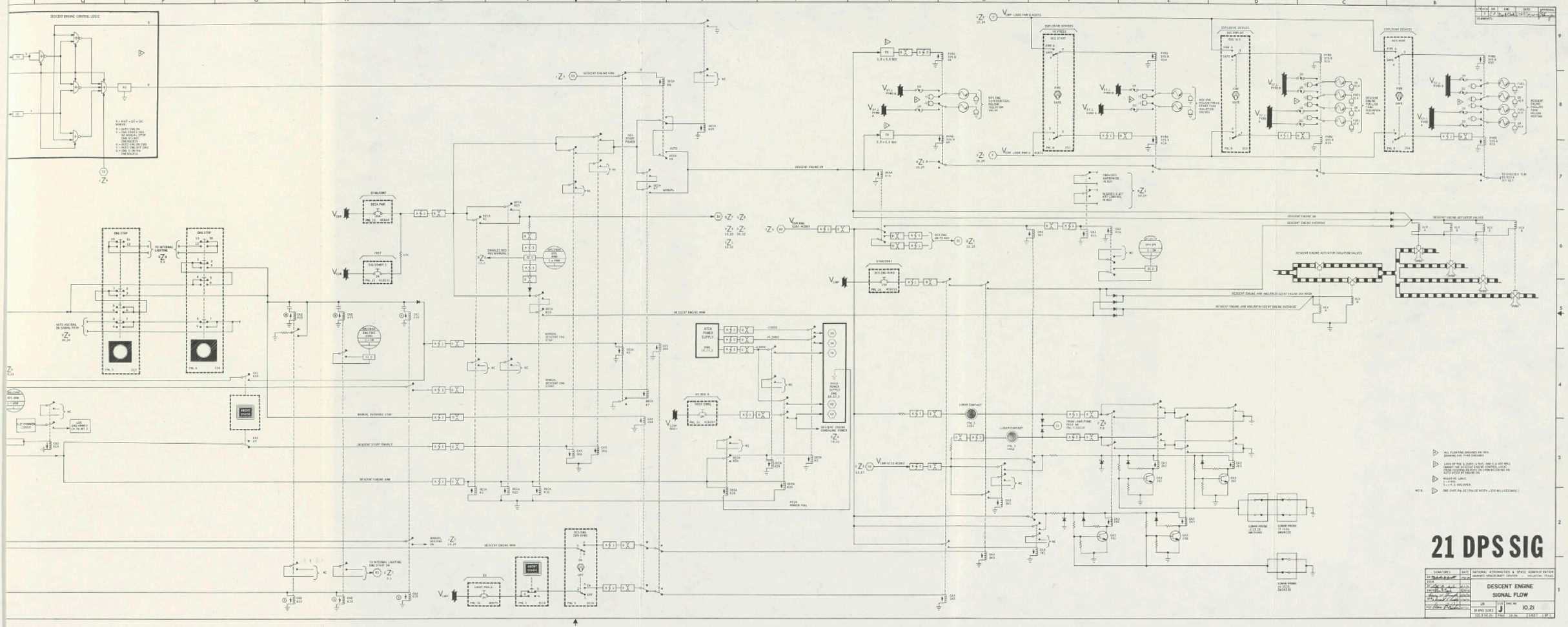
SIGNATURES	DATE
DR	1-2-70
DSGN	
QC	12-2-70
ENGR	11/30/70
	11/30/70
APR	11/30/70
FEC	12-2-70

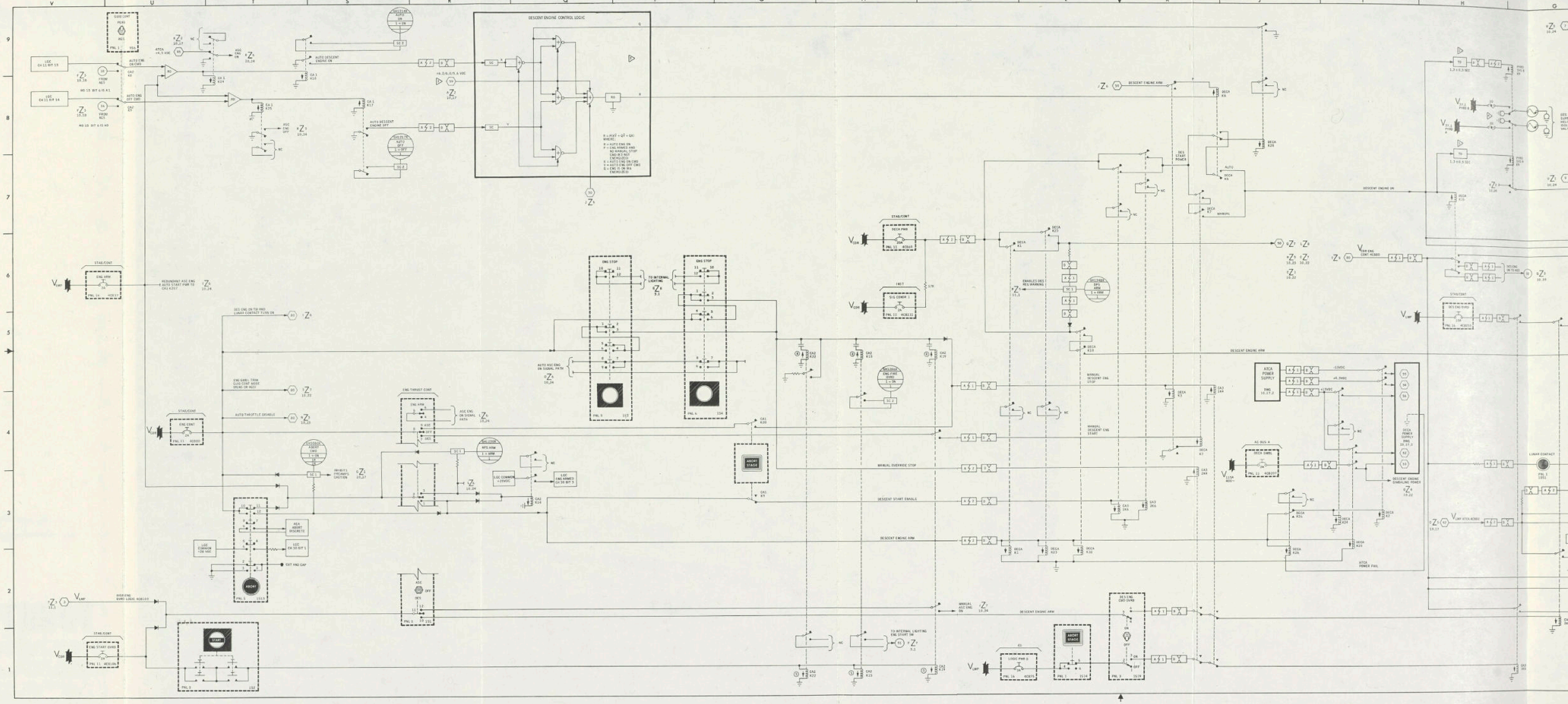
NATIONAL AERONAUTICS & SPACE ADMINISTRATION
MANNED SPACECRAFT CENTER · HOUSTON, TEXAS

DESCENT ENGINE SIGNAL FLOW

LM	SIZE	DWG NO	
10 AND SUBS	J	10.21	
121 X 38.25	PAGE 10-36		SHEET 1 OF 1

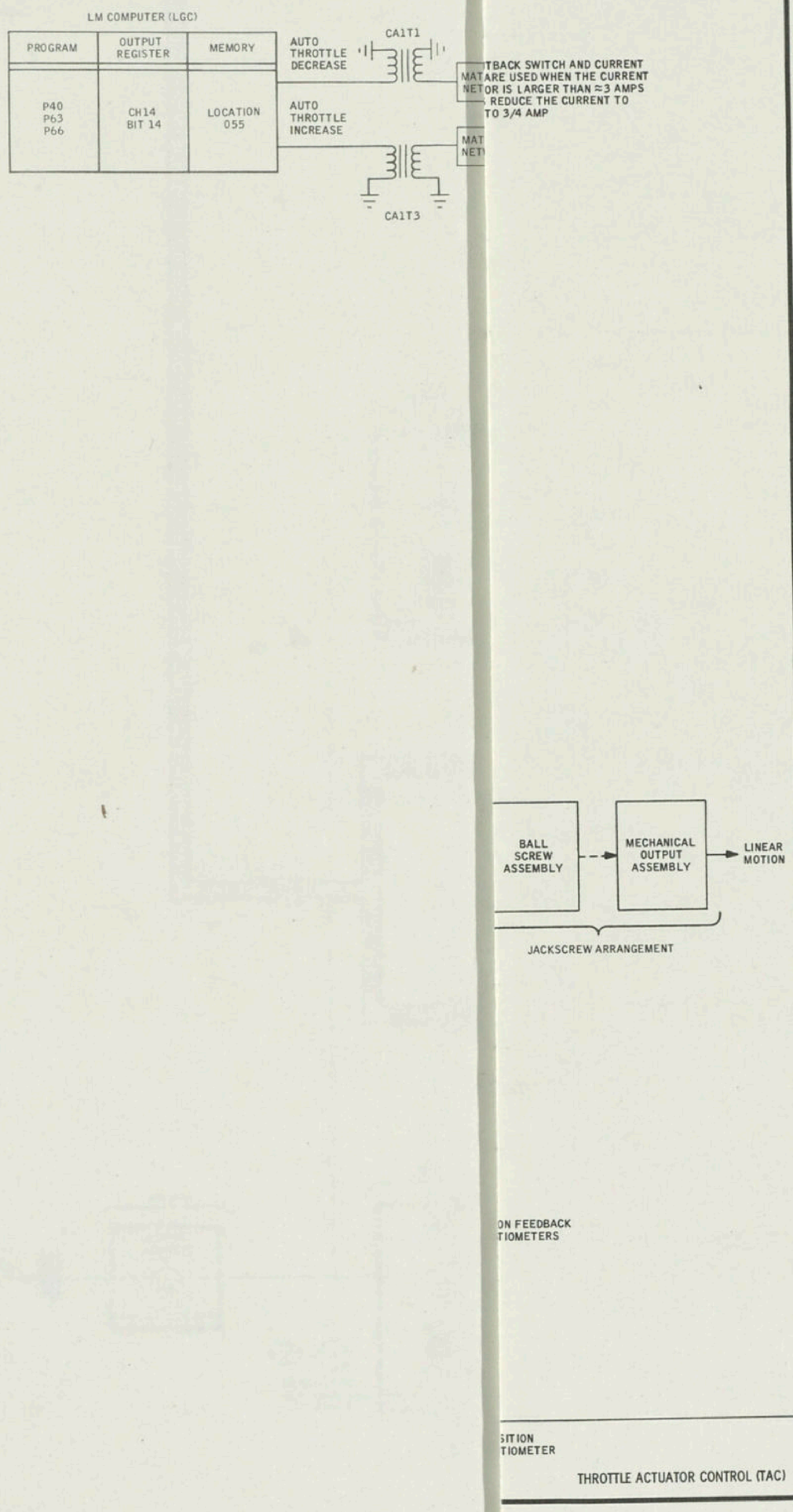
DPS MECH
SIG FLOW SI
ASC ENG
APS MECH
LRV
DRIVE CONT
SIG FLOW
DES ENG
SIG FLOW


DESCENT ENGINE CONTROL LOGIC
ENG STOP
DESCENT ENGINE ARM
DESCENT ENGINE ON
DESCENT ENGINE ACTUATOR VALVES
DESCENT ENGINE ACTUATOR ISOLATION VALVES
EXPLOSIVE DEVICES
LUNAR CONTACT
ABORT STAGE
ATCA POWER SUPPLY
DESCENT ENGINE SIGNALING POWER
ALL FLOATING GROUNDS ON THIS DRAWING ARE PINS GROUNDS
LOSS OF THE 5 VOLT, 4 MHZ, AND 5 & 400 HZ WILL INHIBIT THE DESCENT ENGINE CONTROL LOGIC FROM ACTUATING ITS LATCH BUTTERFLY VALVE DESCENT ENGINE ON.
NEGATIVE LOGIC
1 = 0 VDC
0 = +4.5 VDC/OPEN
NOTE: ONE SHOT PULSE (ONLY IF NOTE 4 LOSS WILL LOCKDOWN)
21 DPS SIG
SIGNATURES
NATIONAL AERONAUTICS & SPACE ADMINISTRATION
MANNED SPACECRAFT CENTER — HOUSTON, TEXAS
DESCENT ENGINE
SIGNAL FLOW
10.21
SIG FLOW
DES ENG


DESCENT ENGINE CONTROL LOGIC
AUTO DESCENT ENGINE ON
AUTO DESCENT ENGINE OFF
DESCENT ENGINE ARM
DESCENT ENGINE ON
ENG STOP
ENG THRUST CONT
STAB/CONT
ABORT STAGE
START
MANUAL OVERRIDE STOP
DESCENT START ENABLE
DESCENT ENGINE ARM
ATCA POWER SUPPLY
DECA POWER SUPPLY
LUNAR CONTACT

LTR	DCN	DR	ENG	DATE		APPROVAL

COMMENTS:



2 SEE DWG 3.1 FOR METER POWER FAIL LOGIC

NOTE: 1 FOR ALL CONNECTIONS TO 4CB132 SIG SENSOR SEE TABLE 9-II

23 ENG THROT

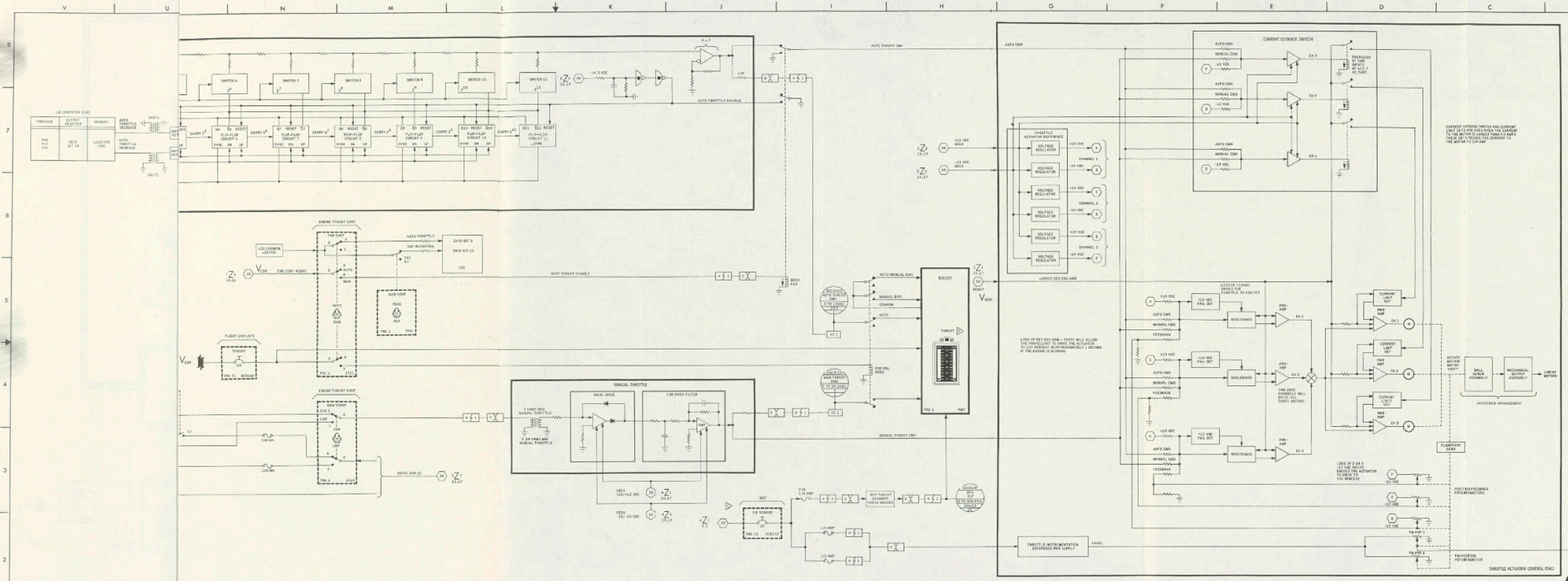
SIGNATURES	DATE
DR Vicki Doggett	6/22/70
DSGN	
QC Betty M. Taylor	12-7-70
ENGR Ron D. Clark	11/30/70
Larry W. Stimple	11/30/70
APP Donald R. Eudy	11/30/70
FEC Dean B. Rieder	12-7-70

NATIONAL AERONAUTICS & SPACE ADMINISTRATION
MANNED SPACECRAFT CENTER • HOUSTON, TEXAS

DESCENT ENGINE
THROTTLING SIGNAL FLOW

LM	SIZE	DWG NO
10 AND SUBS	J	10.23
121 X 34	PAGE 10-38	SHEET 1 OF 1

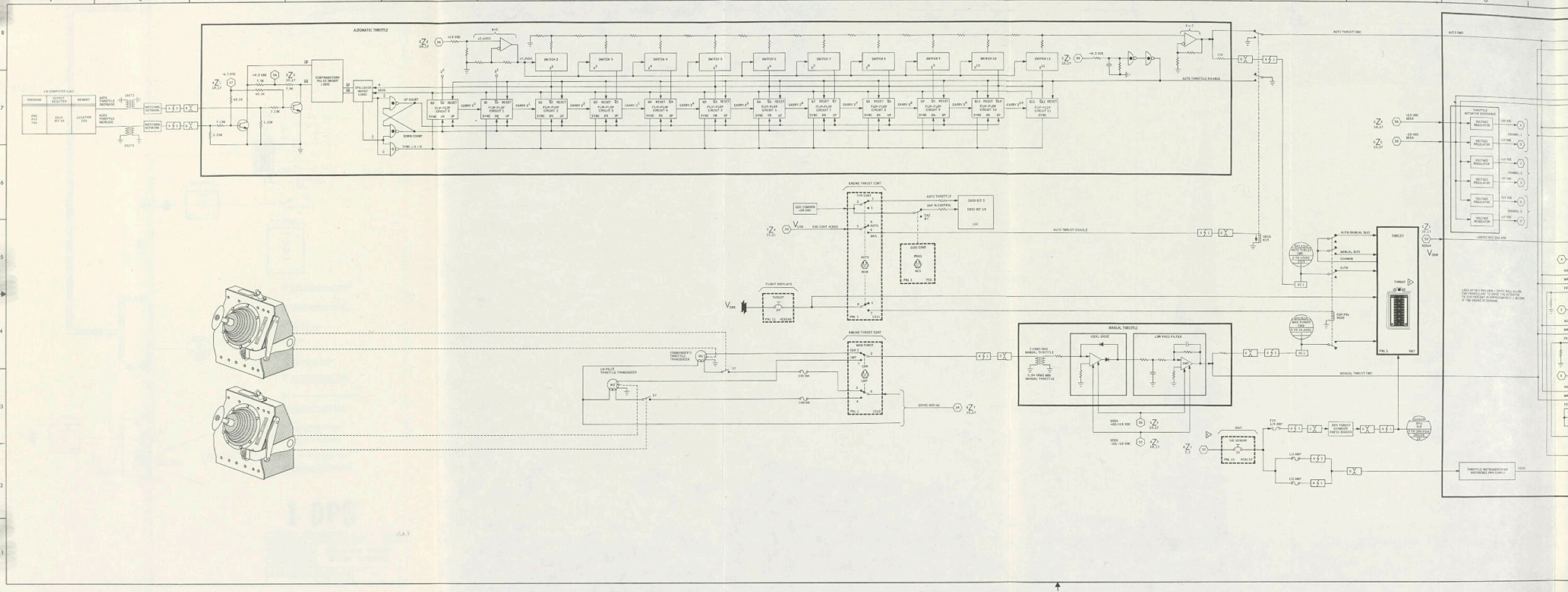
DPS MECH
SIG FLOW
ASC ENG
APS MECH
LRV
DRIVE CONT
SUSPENSION
SIG FLOW



23 ENG THROT

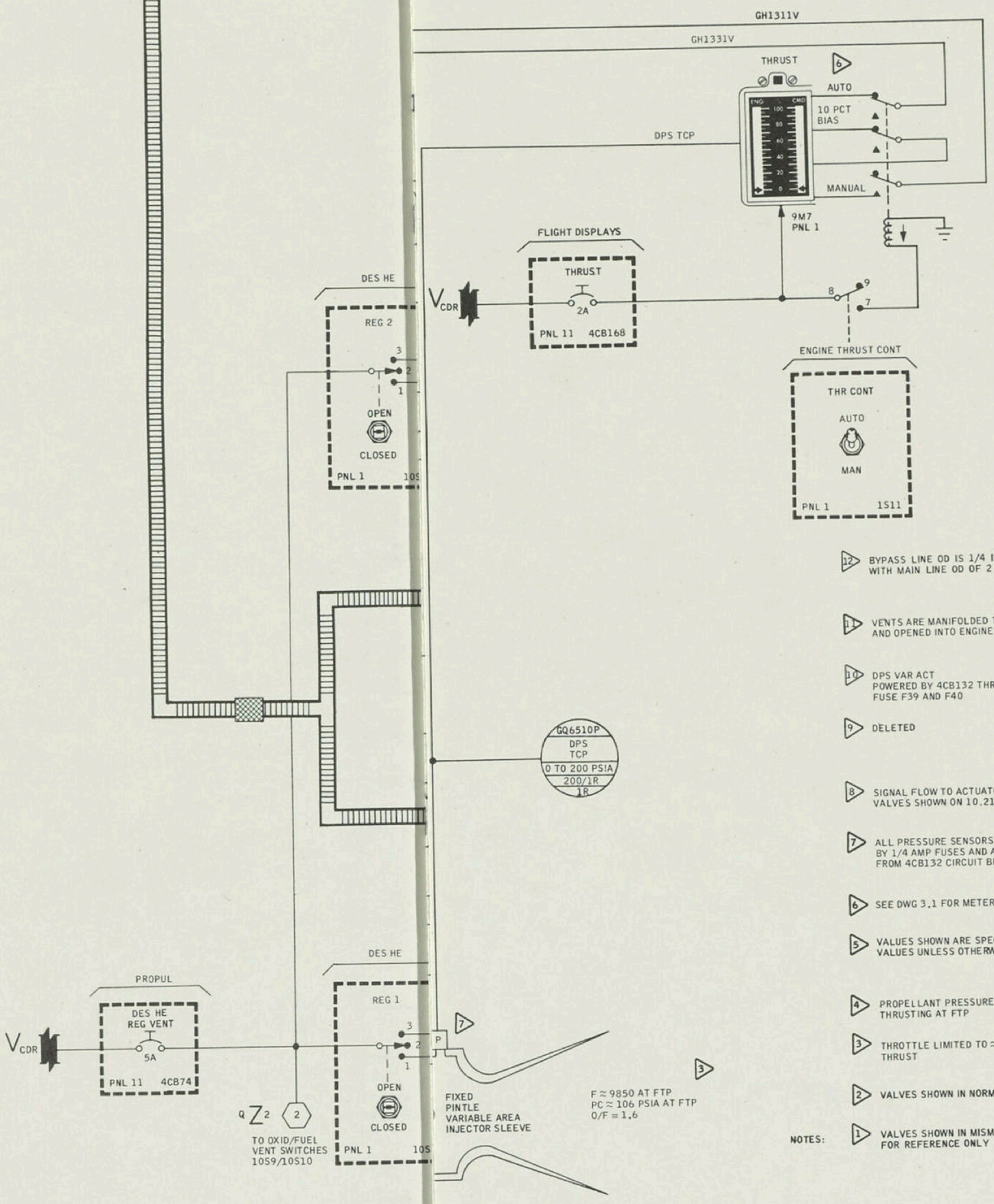
SIGNATURE	DATE	NATIONAL AERONAUTICS & SPACE ADMINISTRATION MANNED SPACECRAFT CENTER — HOUSTON, TEXAS
DR Bob Doggett	3-27-70	DESCENT ENGINE THROTTLING SIGNAL FLOW
DYSC		
CHK Bob Doggett	3-27-70	
CHK Bob Doggett	3-27-70	
ESC Leon E. Fuller	3-27-70	LM 10 AND SUBS — SIZE J — DWG NO 10.23 — 225 R 50 — PAGE 10-30 — SHEET 1 OF 1

SIG FLOW


AUTOMATIC THROTTLE
LM COMPUTER (LGC)
PROGRAM
OUTPUT REGISTER
MEMORY
AUTO THROTTLE DECREASE
AUTO THROTTLE INCREASE
WATCHING NETWORK
CONTRADICTORY PULSE INHIBIT LOGIC
SPILLOVER INHIBIT LOGIC
UP COUNT
DOWN COUNT
FLIP-FLOP CIRCUIT 1
FLIP-FLOP CIRCUIT 2
FLIP-FLOP CIRCUIT 3
FLIP-FLOP CIRCUIT 4
FLIP-FLOP CIRCUIT 5
FLIP-FLOP CIRCUIT 6
FLIP-FLOP CIRCUIT 7
FLIP-FLOP CIRCUIT 8
FLIP-FLOP CIRCUIT 9
FLIP-FLOP CIRCUIT 10
FLIP-FLOP CIRCUIT 11
SWITCH 2
SWITCH 3
SWITCH 4
SWITCH 5
SWITCH 6
SWITCH 7
SWITCH 8
SWITCH 9
SWITCH 10
SWITCH 11
AUTO THRUST CMD
AUTO THROTTLE DISABLE
ENGINE THRUST CONT
LGC COMMAND
FLIGHT DISPLAYS
THRUST
GUID CONT
PGNS
AGS
CDR THROTTLE TRANSDUCER
LM PILOT THROTTLE TRANSDUCER
MAN THROT
MANUAL THROTTLE
IDEAL DIODE
LOW PASS FILTER
AUTO THRUST DISABLE
MANUAL THRUST CMD
AUTO/MANUAL BIAS
MANUAL BIAS
COMMON
AUTO
THRUST
ENG SENSOR
THROTTLE ACTUATOR REFERENCE
VOLTAGE REGULATOR
THROTTLE INSTRUMENTATION REFERENCE PWR SUPPLY

LTR	PCN	DR	ENG	DATE	APPROVAL
	1				

COMMENTS:



NOTES:

1. VALVES SHOWN IN MISMATCH POSITION FOR REFERENCE ONLY
2. VALVES SHOWN IN NORMAL POSITION
3. THROTTLE LIMITED TO ≈92.5 PCT THRUST
4. PROPELLANT PRESSURES DURING THRUSTING AT FTP
5. VALUES SHOWN ARE SPECIFICATION VALUES UNLESS OTHERWISE NOTED
6. SEE DWG 3.1 FOR METER POWER FAIL LOGIC
7. ALL PRESSURE SENSORS ARE FUSED BY 1/4 AMP FUSES AND ARE POWERED FROM 4CB132 CIRCUIT BREAKER
8. SIGNAL FLOW TO ACTUATOR VALVES SHOWN ON 10.21
9. DELETED
10. DPS VAR ACT POWERED BY 4CB132 THRU FUSE F39 AND F40
11. VENTS ARE MANIFOLDED TOGETHER AND OPENED INTO ENGINE COMPARTMENT
12. BYPASS LINE OD IS 1/4 INCH COMPARED WITH MAIN LINE OD OF 2 INCHES

1 DPS

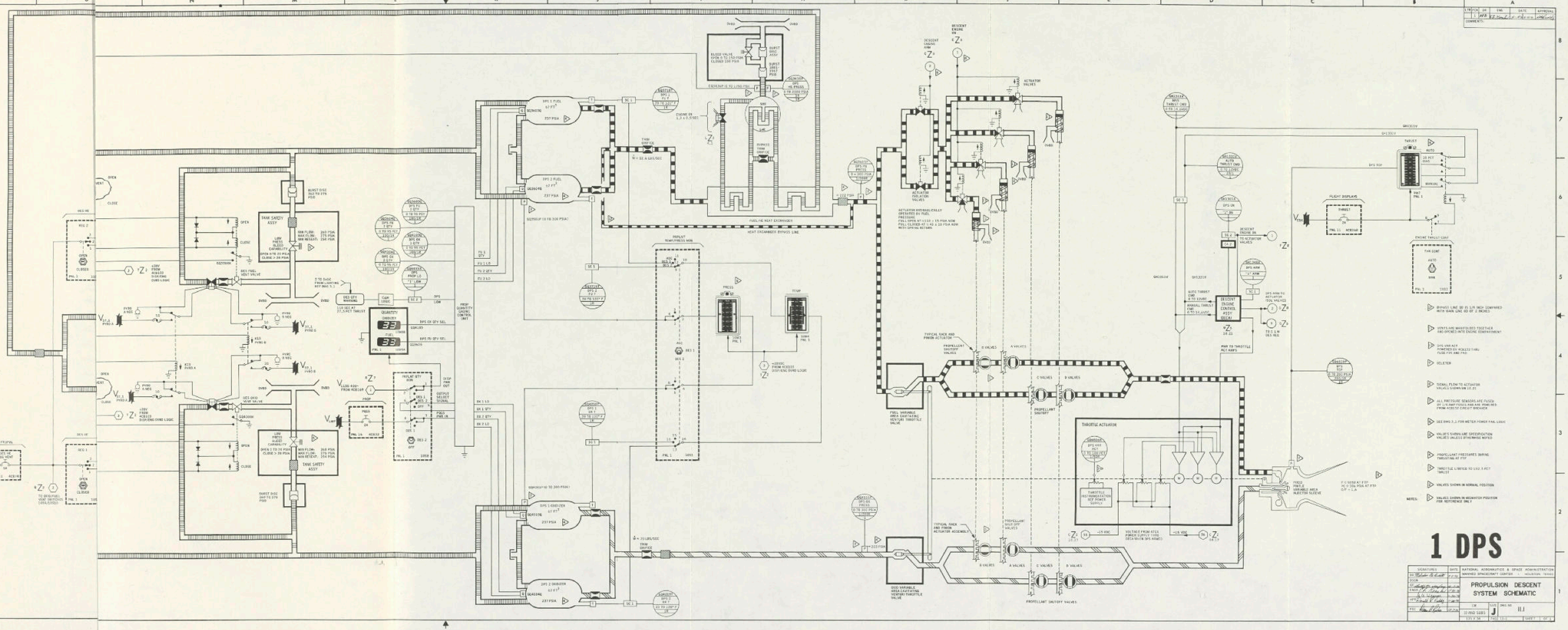
SIGNATURES	DATE
DR	4-2-70
DSGN	
QC	12-7-70
ENGR	12-30-70
	11-30-70
APR	11-30-70
FEC	12-7-70

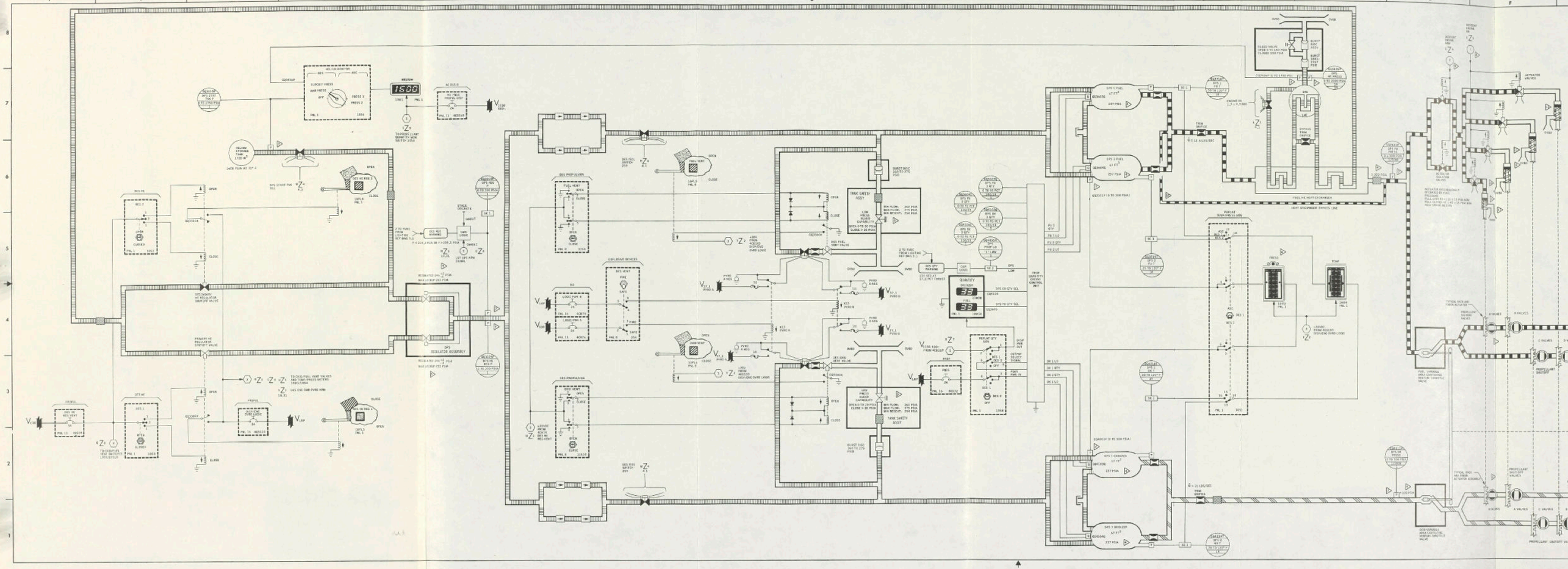
NATIONAL AERONAUTICS & SPACE ADMINISTRATION
MANNED SPACECRAFT CENTER · HOUSTON, TEXAS

PROPULSION DESCENT SYSTEM SCHEMATIC

LM	SIZE	DWG NO
10 AND SUBS	J	II.1
121 X 34	PAGE 11-1	SHEET 1 OF 1

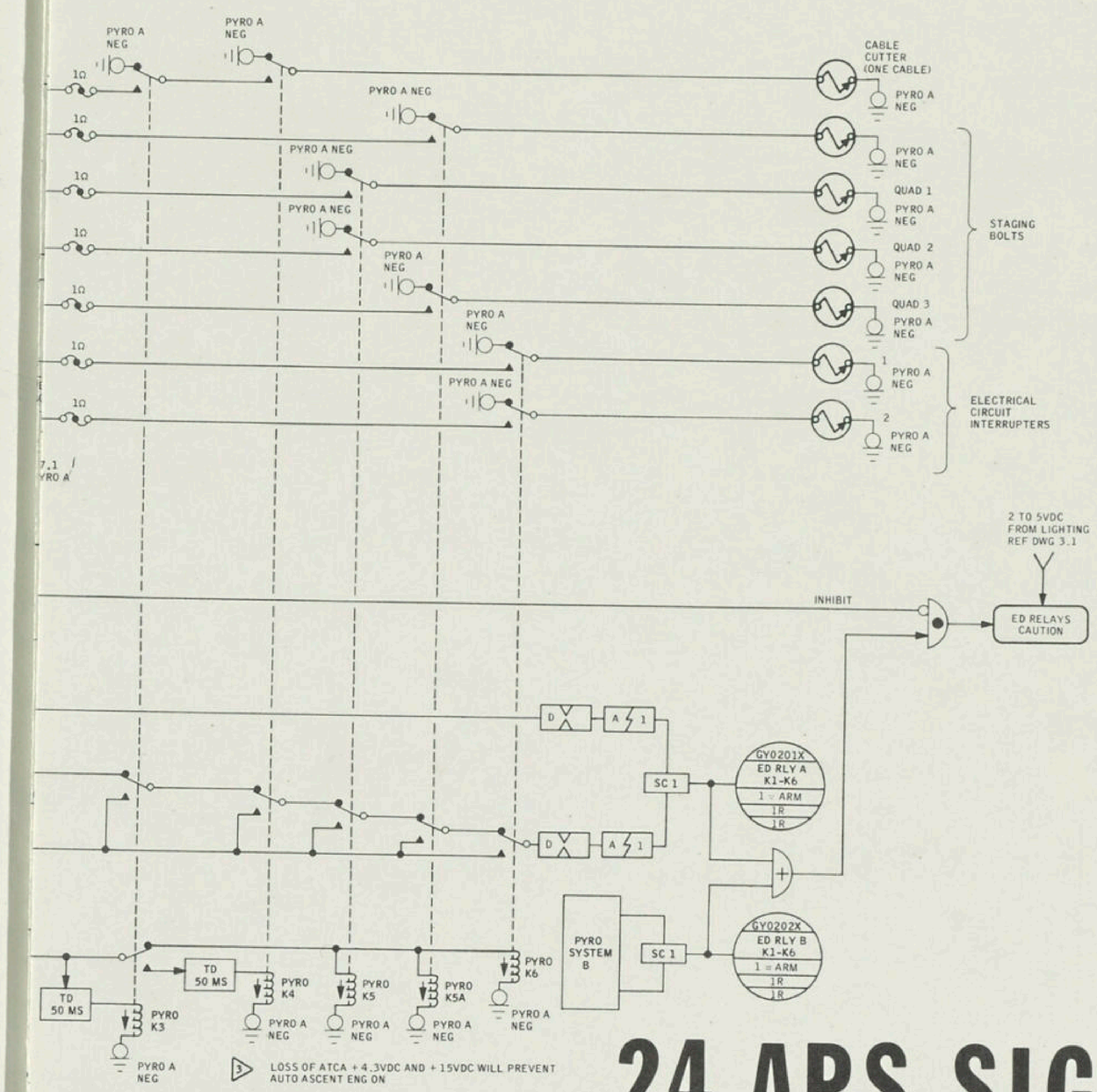
DPS MECH
SIG FLOW ENG
ASC
APS MECH
LRV
DRIVE CONT
SUSPENSION
LRV STEER MECH


1 DPS
PROPULSION DESCENT SYSTEM SCHEMATIC
NATIONAL AERONAUTICS & SPACE ADMINISTRATION
MANNED SPACECRAFT CENTER - HOUSTON, TEXAS
10 AUG 1965
II.1
TANK SAFETY ASSY
THROTTLE ACTUATOR
FUEL/HE HEAT EXCHANGER
HEAT EXCHANGER BYPASS LINE
DESCENT ENGINE CONTROL ASSY (DECA)
FLIGHT DISPLAYS
ENGINE THRUST CONT
QUANTITY GAUGING
PROP QUANTITY CONTROL UNIT
PROPELLANT SHUTOFF VALVES
FUEL VARIABLE AREA EXCITATING VENTURI THROTTLE VALVE
OXID VARIABLE AREA EXCITATING VENTURI THROTTLE VALVE
FIXED PINTLE VARIABLE AREA INJECTOR SLEEVE
DPS MECH


HELIUM
1600
HELIUM STORAGE TANK
SECONDARY HE REGULATOR SHUTOFF VALVE
PRIMARY HE REGULATOR SHUTOFF VALVE
DPS REGULATOR ASSEMBLY
DES PROPULSION
EXPLOSIVE DEVICES
TANK SAFETY ASSY
QUANTITY DIVIDER
PROP QUANTITY GAGING CONTROL UNIT
DPS 1 FUEL
DPS 2 FUEL
DPS 1 OXIDIZER
DPS 2 OXIDIZER
FUEL HE HEAT EXCHANGER
HEAT EXCHANGER BYPASS LINE
PROPELLANT TEMP/PRESS MON
ACTUATOR VALVES
PROPELLANT SHUTOFF VALVES
DES VARIABLE AREA CAVITATING VENTURI THROTTLE VALVE

LTR	PCN	DR	ENGR	DATE	APPROVAL
	2			6-25-71	6-25-71

COMMENTS:



24 APS SIG

3 LOSS OF ATCA + 4.3VDC AND + 15VDC WILL PREVENT AUTO ASCENT ENG ON

2 NEGATIVE LOGIC
1 = 0VDC
0 = 4.3VDC

NOTE: 1. THERE ARE NO CIRCUIT INTERRUPTERS (A 1) ASSOCIATED WITH PYRO SYSTEM B

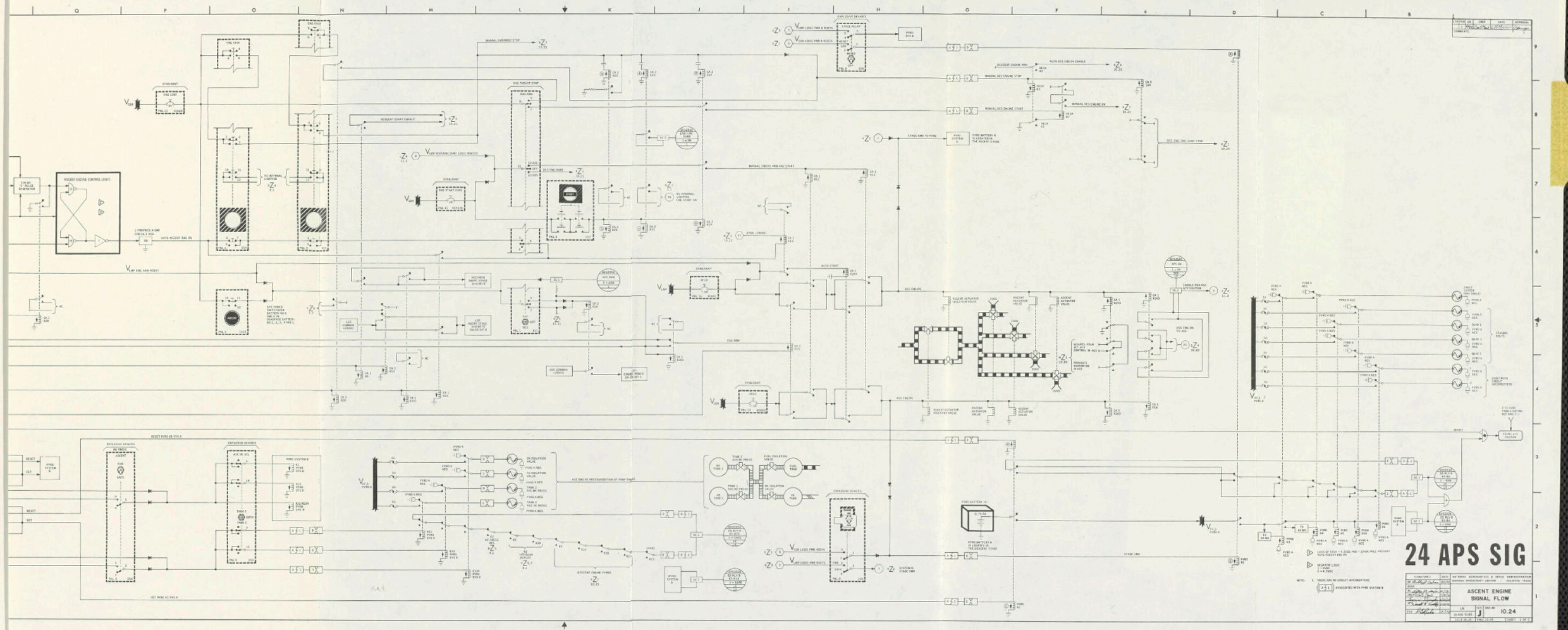
SIGNATURES	DATE
DR Bobby J. Cobern	7/21/70
DSGN	
QC	12-7-70
ENGR Don O. Clark	11/30/70
Larry W. Springer	11/30/70
APR Donald R. Kindle	11/30/70
FEC	12-7-70

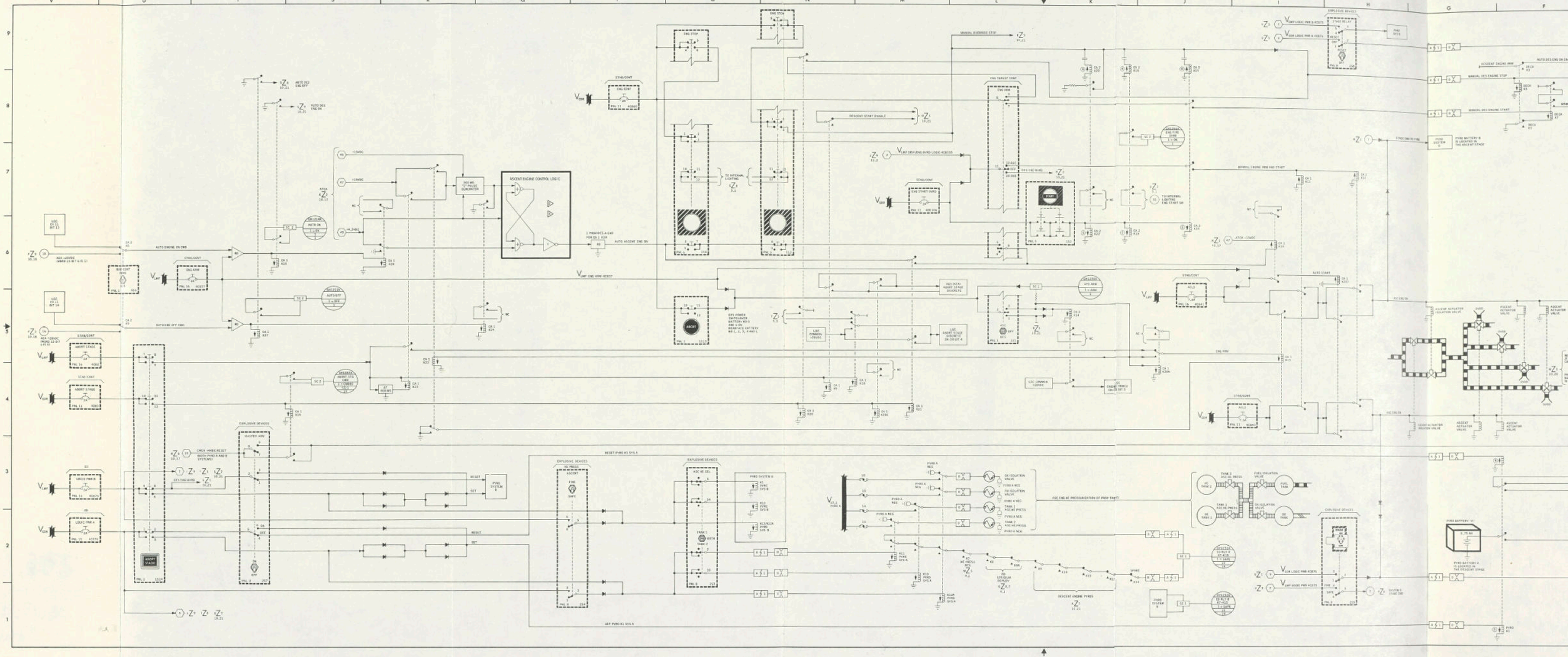
NATIONAL AERONAUTICS & SPACE ADMINISTRATION
MANNED SPACECRAFT CENTER · HOUSTON, TEXAS

ASCENT ENGINE
SIGNAL FLOW

LM	SIZE	DWG NO
10 AND SUBS	J	10.24
121 X 38.25	PAGE 10-39	SHEET 1 OF 1

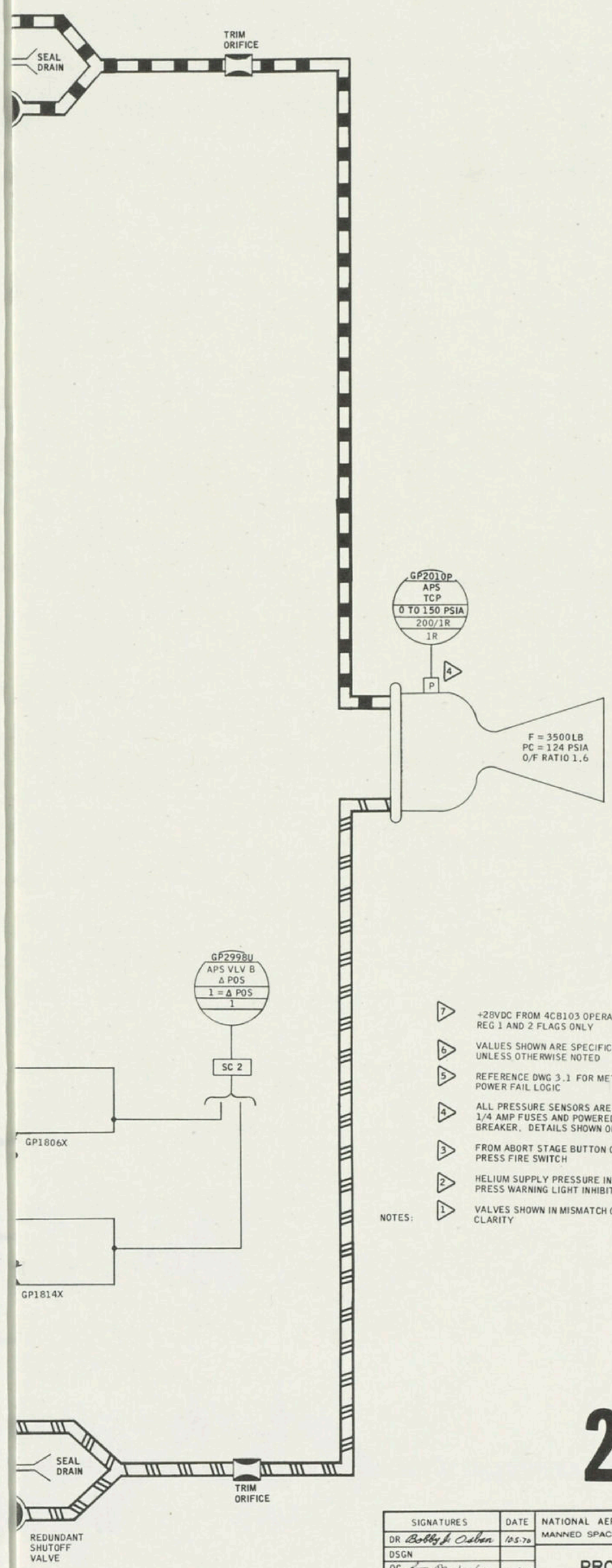
SENSORS
DISPLAYS
SIG FLOW
ASC ENG
APS MECH
LRV
DRIVE CONT
SUSPENSION
LRV
STEER MECH


24 APS SIG
ASCENT ENGINE SIGNAL FLOW
NATIONAL AERONAUTICS & SPACE ADMINISTRATION
MANNED SPACECRAFT CENTER HOUSTON, TEXAS
10.24
ASCENT ENGINE CONTROL LOGIC
MANUAL OVERRIDE STOP
RESIDENT START ENABLE
ENG THRUST CONT
ENG ARM
AUTO START
ASC ENG ON
DESCENT ENGINE ARM
AUTO DES ENG ON ENABLE
MANUAL DES ENGINE STOP
MANUAL DES ENGINE START
MANUAL DES ENGINE ON
DES ENG TRN SUPR STOP
STAGE END TO PYRO
ASCENT ACTUATOR ISOLATION VALVE
ASCENT ACTUATOR VALVE
ENABLE PYRO ASC STY CIRCUITRY
ENABLE PYRO ASC ENG ON
ASC ENG ON TO ADS
STAGING BOLTS
ELECTRICAL CIRCUIT INTERRUPTERS
PYRO SYSTEM B
EXPLOSIVE DEVICES
ASC HE SOL
PYRO SYSTEM A
PYRO SYSTEM B
RESET PYRO B1 SYS B
SET PYRO B1 SYS B
ASC ENG HE PRESSURIZATION OF PROP TANKS
TANK 2 ASC HE PRESS
TANK 1 ASC HE PRESS
FUEL ISOLATION VALVE
OX ISOLATION VALVE
FUEL TANK
OX TANK
DESCENT ENGINE PYROS
PYRO BATTERY A
PYRO BATTERY B
STAGE END
SYSTEM B STAGE END
LOSS OF ASCA + A DISC MNB + (2 PYRO FIRES) PREVENT AUTO ASCENT END-OFF
NEGATIVE LOGIC
A + B DISC
2 + A DISC
NOTES: 1. THERE ARE NO CIRCUIT INTERRUPTERS
ASSOCIATED WITH PYRO SYSTEM B
SIG FLOW ASC ENG


ASCENT ENGINE CONTROL LOGIC
ENG STOP
ENG CONT
ENG ARM
ABORT STAGE
LOGIC PWR B
LOGIC PWR A
MASTER ARM
EXPLOSIVE DEVICES
ASC NE SEG
PYRO SYSTEM B
PYRO SYSTEM A
TANK 1 ASC NE PRESS
TANK 2 ASC NE PRESS
FUEL TANK
OX TANK
FUEL ISOLATION VALVE
OX ISOLATION VALVE
ASCENT ACTUATOR VALVE
ASCENT ACTUATOR ISOLATION VALVE
PYRO BATTERY "A"
PYRO BATTERY "B"
DESCENT ENGINE PYROS
DESCENT START ENABLE
MANUAL OVERRIDE STOP
AUTO ENGINE ON CMD
AUTO ENGINE OFF CMD
AUTO ASCENT ENG ON
MANUAL ENGINE ARM AND START
AUTO START
ENG ARM
ASC ENGIN
RESET PYRO #3 SYS A
SET PYRO #3 SYS A

LTR	DCN	DR	ENG	DATE		APPROVAL

COMMENTS:



NOTES:

7. +28VDC FROM 4CB103 OPERATES ASC HE REG 1 AND 2 FLAGS ONLY
6. VALUES SHOWN ARE SPECIFICATION VALUES UNLESS OTHERWISE NOTED
5. REFERENCE DWG 3.1 FOR METER POWER FAIL LOGIC
4. ALL PRESSURE SENSORS ARE FUSED BY 1/4 AMP FUSES AND POWERED FROM 4CB132 CIRCUIT BREAKER. DETAILS SHOWN ON DRAWING 9.14
3. FROM ABORT STAGE BUTTON OR ASC HE PRESS FIRE SWITCH
2. HELIUM SUPPLY PRESSURE INPUT TO ASC PRESS WARNING LIGHT INHIBITED AT STAGING
1. VALVES SHOWN IN MISMATCH CONDITION FOR CLARITY

2 APS

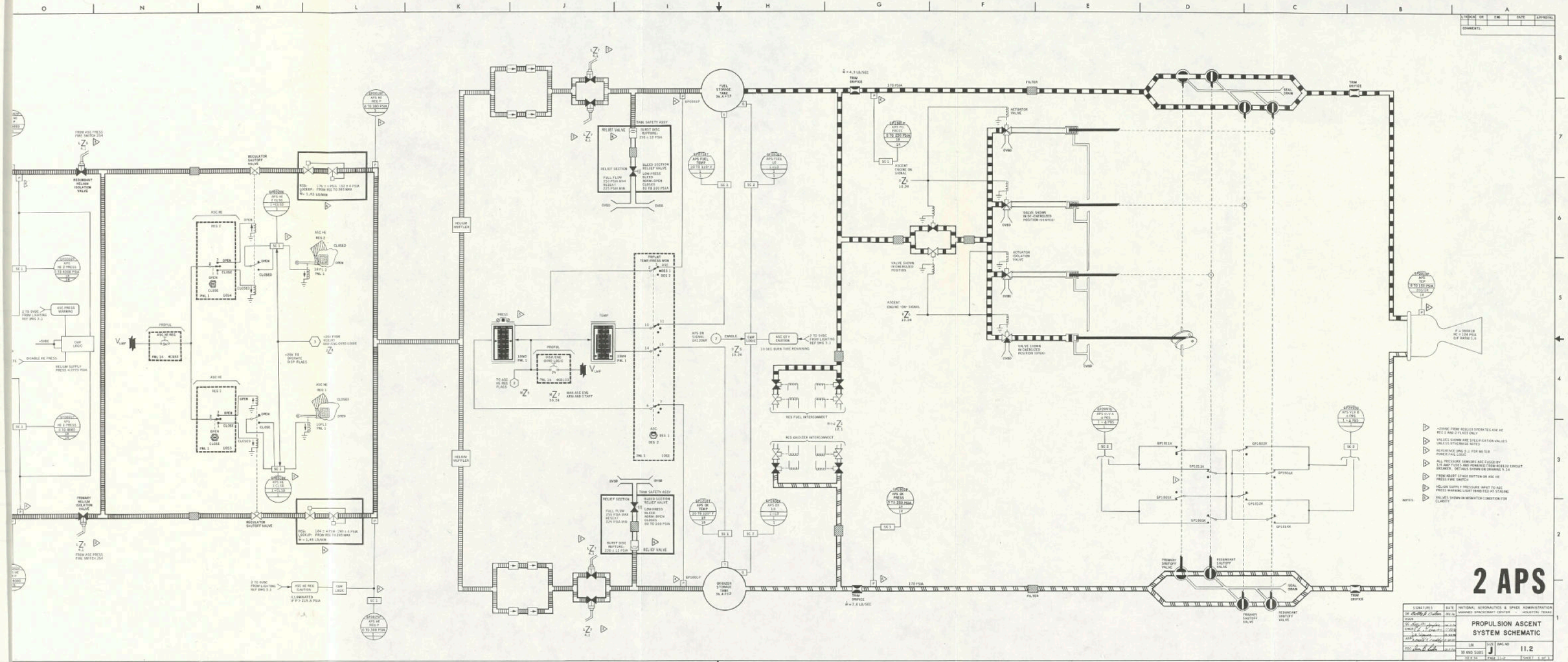
SIGNATURES	DATE
DR Bobby J. Osborn	10-5-70
DSGN	
QC	12-7-70
ENGR	11-30-70
	11-30-70
APP Ronald H. Ruddy	11-30-70
FEC	12-7-70

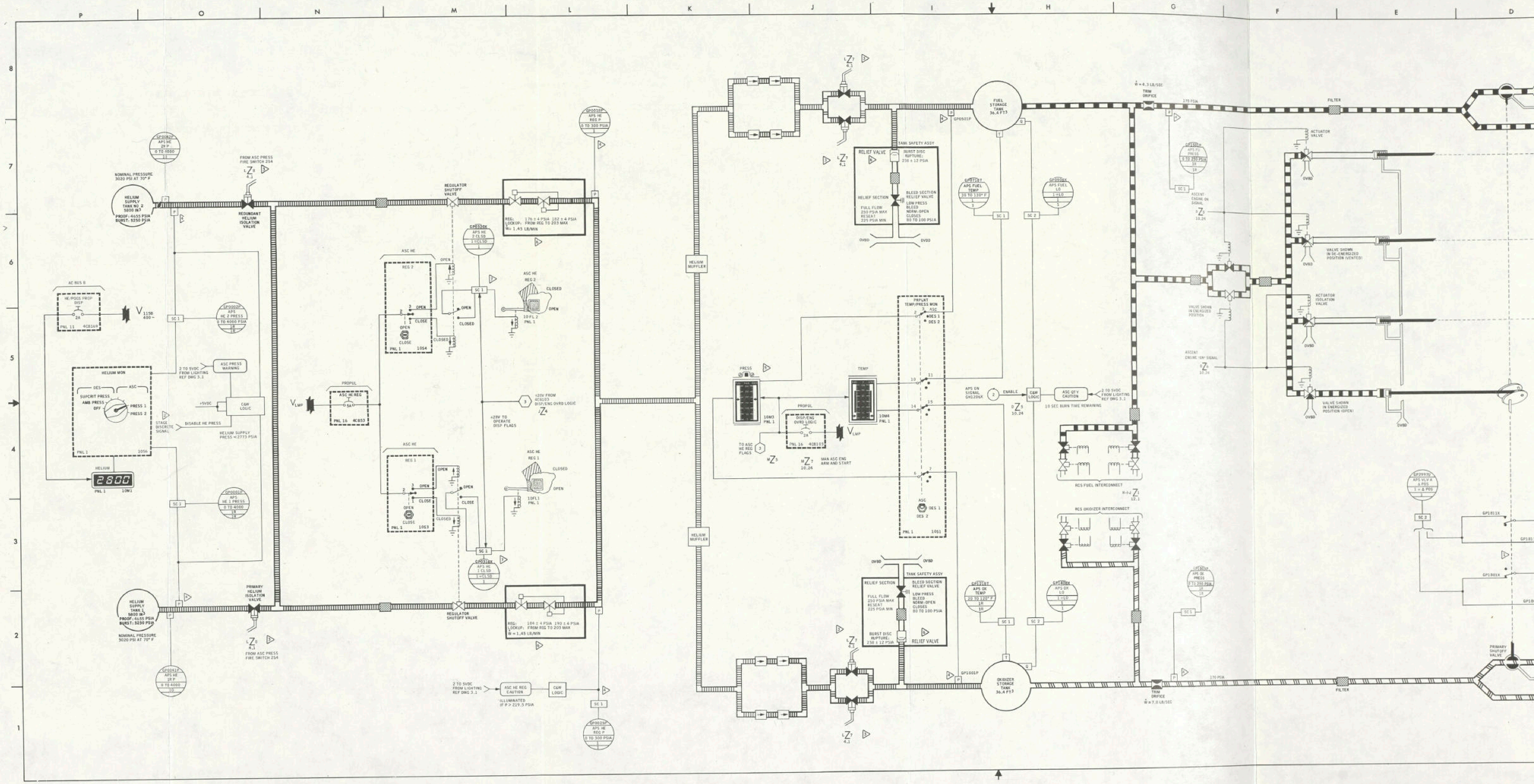
NATIONAL AERONAUTICS & SPACE ADMINISTRATION
MANNED SPACECRAFT CENTER · HOUSTON, TEXAS

PROPULSION ASCENT SYSTEM SCHEMATIC

LM	SIZE	DWG NO
10 AND SUBS	J	11.2
88 X 34	PAGE 11-2	SHEET 1 OF 1

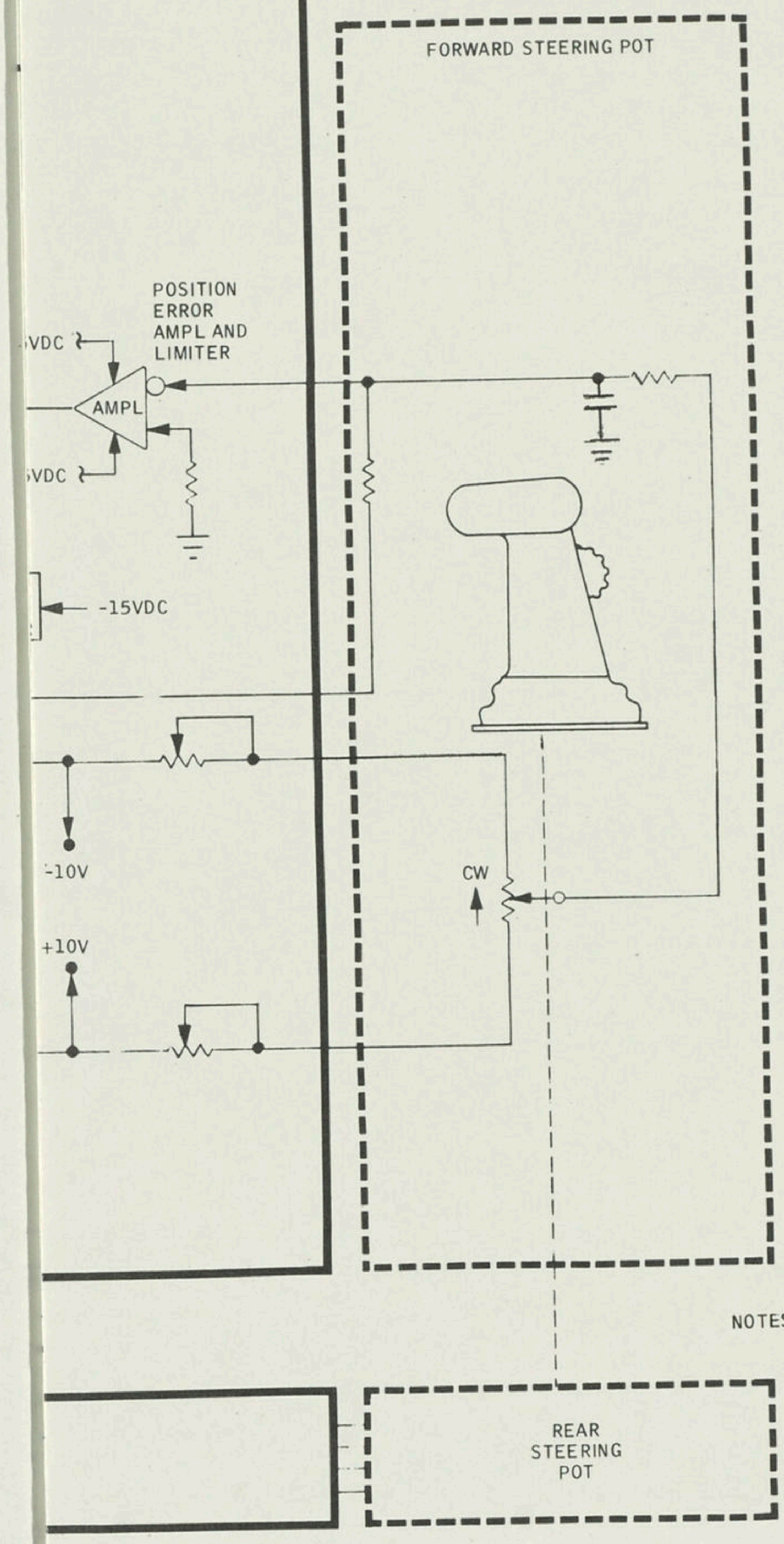
SENSORS
DISPLAYS
POWER DIST
APS MECH
LRV
DRIVE CONT
SUSPENSION
LRV
STEER MECH


2 APS
PROPULSION ASCENT SYSTEM SCHEMATIC
NATIONAL AERONAUTICS & SPACE ADMINISTRATION
MANNED SPACECRAFT CENTER HOUSTON, TEXAS
DWG NO 11.2
SCALE J
SHEET 1 OF 1
FUEL STORAGE TANK 36.4 PSIA
OXIDIZER STORAGE TANK 36.4 PSIA
HELIUM MUFFLER
REGULATOR SHUTOFF VALVE
RESIDUAL HELIUM ISOLATION VALVE
PRIMARY HELIUM ISOLATION VALVE
RELIEF VALVE
TANK SAFETY ASSY
FILTER
TRIM ORIFICE
ACTUATOR VALVE
ACTUATOR ISOLATION VALVE
VALVE SHOWN IN DE-ENERGIZED POSITION (ENTERED)
VALVE SHOWN IN ENERGIZED POSITION (OPEN)
SEAL DRAIN
PRIMARY SHUTOFF VALVE
RESIDUAL SHUTOFF VALVE
RCS FUEL INTERCONNECT
RCS OXIDIZER INTERCONNECT
ASC HE
PROPULS
PRESS
TEMP
ASC
ASC OX CAUTION
CAM LOGIC
ENABLE
APS ON SIGNAL
ASCENT ENGINE ON SIGNAL
MAN ASC ENG ARM AND START
TO ASC HE RED FLAGS
ASC HE RED CAUTION
ILLUMINATED IF P > 225.5 PSIA
ASC PRESS WARNING
HELIUM SUPPLY PRESS ≥ 2775 PSIA
DISABLE HE PRESS.
FROM ASC PRESS FIRE SWITCH 254
FROM ASC PRESS FIRE SWITCH 254
NOTES.
VALVES SHOWN ARE SPECIFICATION VALUES UNLESS OTHERWISE NOTED
REFERENCE DWG 2-2 FOR METER POWER FAIL LOGIC
ALL PRESSURE SENSORS ARE FUSED BY 1/4 AMP FUSES AND POWERED FROM 40 AMP CIRCUIT BREAKER. DETAILS SHOWN ON DRAWING 9.24
FROM ASCENT STAGE BOTTOM OR ASC HE PRESS FIRE SWITCH
HELIUM SUPPLY PRESSURE INPUT TO ASC PRESS WARNING LIGHT INHIBITED AT STAGING
VALVES SHOWN IN MISMATCH CONDITION FOR CLARITY
APS MECH


HELIUM SUPPLY TANK NO 2 5800 IN3
PROOF: 4655 PSIA BURST: 5250 PSIA
NOMINAL PRESSURE 3020 PSI AT 70° F
REDUNDANT HELIUM ISOLATION VALVE
FROM ASC PRESS FIRE SWITCH 254
REGULATOR SHUTOFF VALVE
REG: 176 ± 4 PSIA 182 ± 4 PSIA
LOCKUP: FROM REG TO 203 MAX
W = 1.45 LB/MIN
HELIUM SUPPLY TANK 1 5800 IN3
PROOF: 4655 PSIA BURST: 5250 PSIA
PRIMARY HELIUM ISOLATION VALVE
REG: 184 ± 4 PSIA 190 ± 4 PSIA
LOCKUP: FROM REG TO 203 MAX
W = 1.45 LB/MIN
HELIUM MUFFLER
FUEL STORAGE TANK 36.4 FT3
OXIDIZER STORAGE TANK 36.4 FT3
RELIEF VALVE
TANK SAFETY ASSY
BURST DISC RUPTURE: 230 ± 12 PSIA
RELIEF SECTION
FULL FLOW 250 PSIA MAX RESEAT 225 PSIA MIN
BLEED SECTION RELIEF VALVE
LOW PRESS BLEED NORM-OPEN CLOSES 80 TO 100 PSIA
TRIM ORIFICE
FILTER
ACTUATOR VALVE
ACTUATOR ISOLATION VALVE
VALVE SHOWN IN DE-ENERGIZED POSITION (VENTED)
VALVE SHOWN IN ENERGIZED POSITION (OPEN)
RCS FUEL INTERCONNECT
RCS OXIDIZER INTERCONNECT
PRIMARY SHUTOFF VALVE
HELIUM MON
ASC PRESS WARNING
C&W LOGIC
PROPUL
ASC HE REG
ASC HE REG 1
ASC HE REG 2
PRESS
TEMP
PROPUL DISP/ENG OVRD LOGIC
ASC QTY CAUTION
ASC HE REG CAUTION
ILLUMINATED IF P > 219.5 PSIA
MAN ASC ENG ARM AND START
10 SEC BURN TIME REMAINING
ASCENT ENGINE ON SIGNAL
ASCENT ENGINE-OFF SIGNAL
APS ON SIGNAL GH120XX
ENABLE
DISABLE HE PRESS
HELIUM SUPPLY PRESS <2773 PSIA
2 TO 5VDC FROM LIGHTING REF DWG 3.1
+120V FROM AC8103 DISP/ENG OVRD LOGIC
+28V TO OPERATE DISP FLAGS
TO ASC HE REG FLAGS
AC BUS B
HE/PQGS PROP DISP
PNL 11 4CB169
HELIUM
PNL 1 10M1
PNL 1 10S6
PNL 1 10S3
PNL 1 10S4
PNL 1 10M3
PNL 1 10M4
PNL 1 10S1
PNL 16 4CB53
PNL 16 4CB103
GP0032P APS HE REG P 0 TO 300 PSIA
GP0032X APS HE 2 CLSD 1 = CLSD
GP0033X APS HE 1 CLSD 1 = CLSD
GP0061P APS HE 2 P 0 TO 4000
GP0062P APS HE 2 PRESS 0 TO 4000 PSIA
GP0063P APS HE 1 PRESS 0 TO 4000
GP0064P APS HE 1 P 0 TO 4000
GP1001P
GP1011T APS OX TEMP 20 TO 120° F
GP1012T APS FUEL TEMP 20 TO 120° F
GP1013X APS OX LO 1 = LO
GP1014X APS FUEL LO 1 = LO
GP1015P APS FUEL PRESS 0 TO 250 PSIA
GP1016P APS OX PRESS 0 TO 250 PSIA
GP1801X
GP1802X
GP2997Q APS VLV 4 POS 1 = A POS

LTR	PCN	DR	ENG	DATE		APPROVAL
A		D.J.	[illegible]	[illegible]	[illegible]	[illegible]

COMMENTS:



5 CURRENT LIMITING IS HELD TO 1.8 AMPS IN EITHER FIELD WITH RESPECT TO THE OTHER

4 FLYWHEEL DIODES ALLOW MOTOR FIELDS TO COLLAPSE AFTER EACH PULSE PROVIDING ADDITIONAL POWER

3 AMPLITUDE MODULATED ERROR SIGNAL AND TRIANGLE WAVE OSCILLATOR RESULT IN PULSE WIDTH MODULATION DRIVING SIGNAL TO MOTOR TRANSISTORS

2 AMPLIFIES ERROR SIGNAL LESS OUTPUT OF CURRENT LIMITER AND APPLIES MIXED OUTPUT TO THE PULSE WIDTH MODULATORS

NOTES: 1 A PLUS VOLTAGE TURNS TRANSISTOR ON

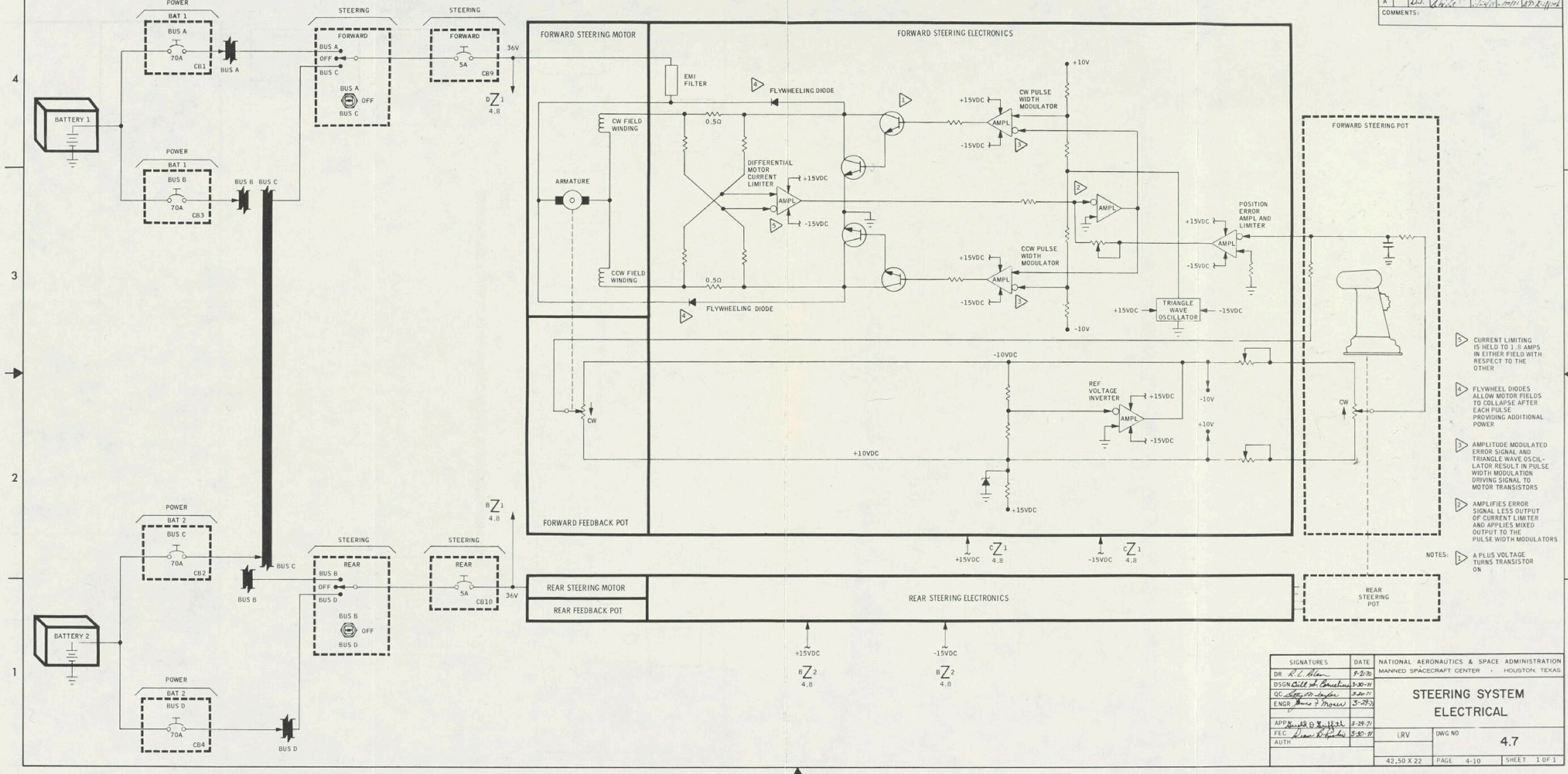
SIGNATURES	DATE
DR R. L. Rolen	9-21-70
DSGN Bill A. Cornelius	3-30-71
QC Betty M. Taylor	3-30-71
ENGR James F. Moser	3-29-71
APP Gerald D. Griffith	3-29-71
FEC Dean D. Rucker	3-30-71
AUTH	

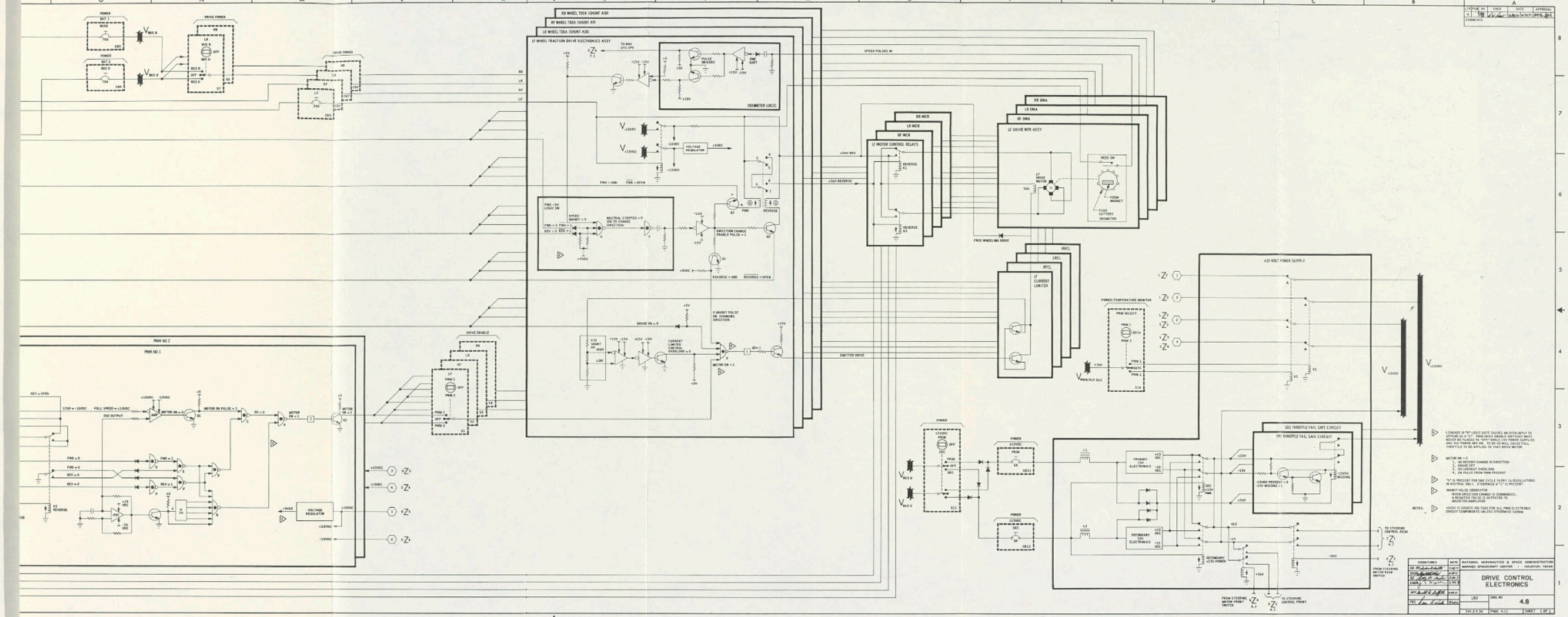
NATIONAL AERONAUTICS & SPACE ADMINISTRATION
MANNED SPACECRAFT CENTER · HOUSTON, TEXAS

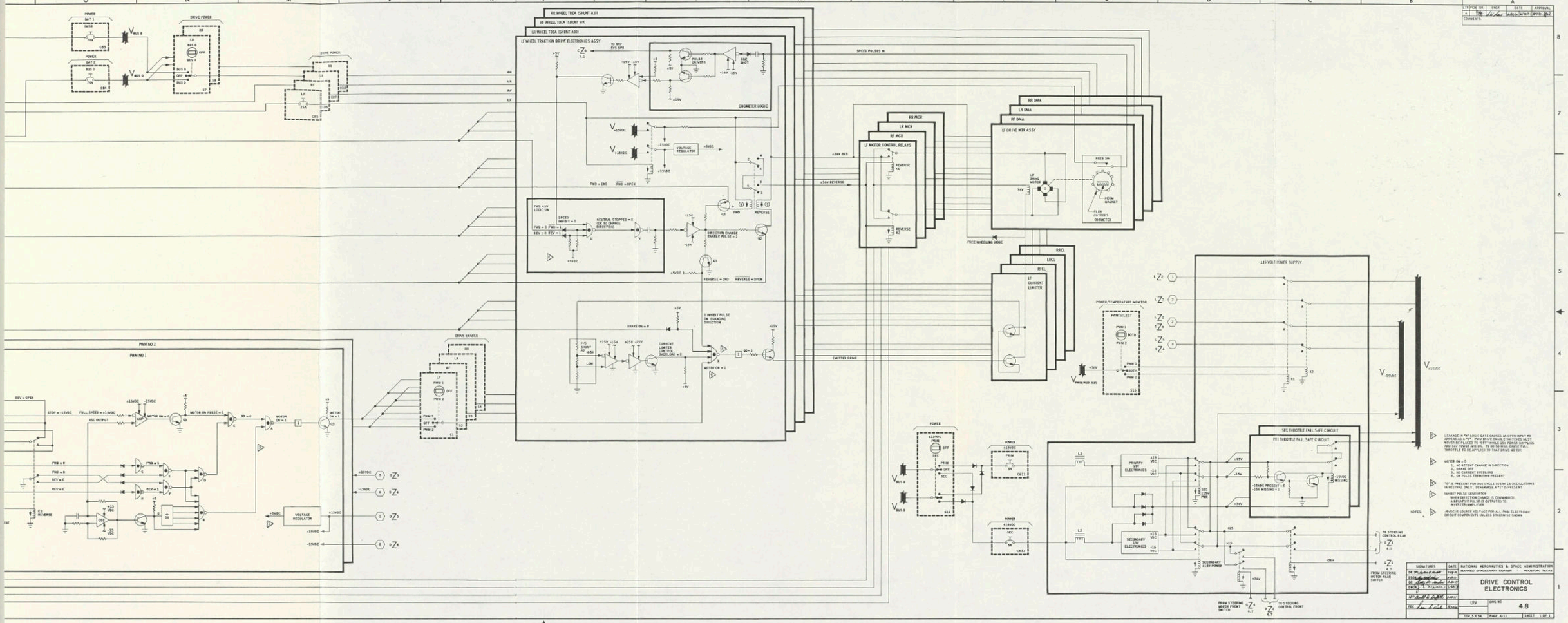
STEERING SYSTEM ELECTRICAL

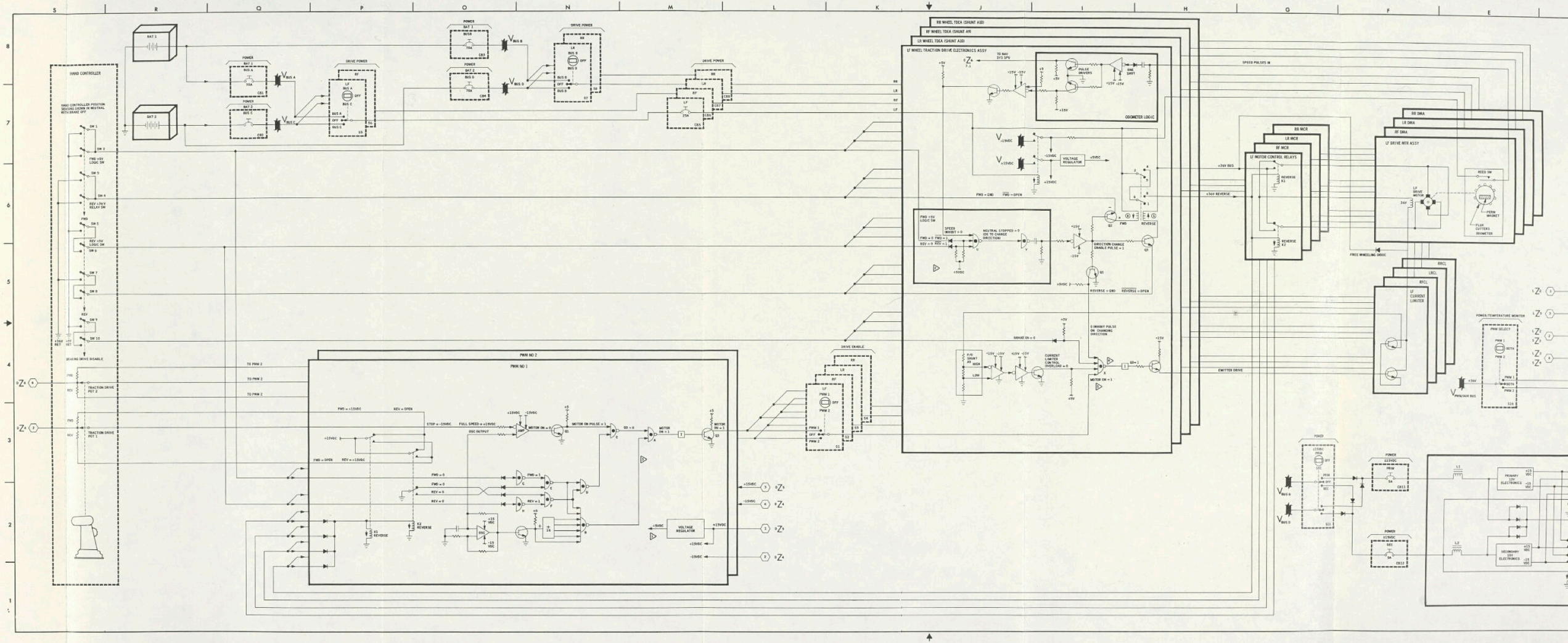
LRV	DWG NO 4.7	
42.50 X 22	PAGE 4-10	SHEET 1 OF 1

SENSORS
DISPLAYS
POWER DIST
LCRU
LRV
DRIVE CONT
SUSPENSION
LRV STEER MECH


BATTERY 1
BATTERY 2
POWER
BAT 1
BAT 2
BUS A
BUS B
BUS C
BUS D
70A
CB1
CB2
CB3
CB4
STEERING
FORWARD
REAR
OFF
5A
CB9
CB10
36V
FORWARD STEERING MOTOR
FORWARD STEERING ELECTRONICS
FORWARD STEERING POT
FORWARD FEEDBACK POT
REAR STEERING MOTOR
REAR FEEDBACK POT
REAR STEERING ELECTRONICS
REAR STEERING POT
EMI FILTER
FLYWHEELING DIODE
CW FIELD WINDING
CCW FIELD WINDING
ARMATURE
0.5Ω
DIFFERENTIAL MOTOR CURRENT LIMITER
AMPL
+15VDC
-15VDC
CW PULSE WIDTH MODULATOR
CCW PULSE WIDTH MODULATOR
POSITION ERROR AMPL AND LIMITER
TRIANGLE WAVE OSCILLATOR
REF VOLTAGE INVERTER
+10V
-10V
-10VDC
+10VDC
CW
NOTES:
1. A PLUS VOLTAGE TURNS TRANSISTOR ON
2. AMPLIFIES ERROR SIGNAL LESS OUTPUT OF CURRENT LIMITER AND APPLIES MIXED OUTPUT TO THE PULSE WIDTH MODULATORS
3. AMPLITUDE MODULATED ERROR SIGNAL AND TRIANGLE WAVE OSCILLATOR RESULT IN PULSE WIDTH MODULATION DRIVING SIGNAL TO MOTOR TRANSISTORS
4. FLYWHEEL DIODES ALLOW MOTOR FIELDS TO COLLAPSE AFTER EACH PULSE PROVIDING ADDITIONAL POWER
5. CURRENT LIMITING IS HELD TO 1.8 AMPS IN EITHER FIELD WITH RESPECT TO THE OTHER
LTR PCN DR ENG DATE APPROVAL
A
COMMENTS:
SIGNATURES DATE
DR 9-21-70
DSGN 3-30-71
QC 3-30-71
ENGR 3-29-71
APP 3-29-71
FEC 3-30-71
AUTH
NATIONAL AERONAUTICS & SPACE ADMINISTRATION
MANNED SPACECRAFT CENTER · HOUSTON, TEXAS
STEERING SYSTEM ELECTRICAL
LRV
DWG NO 4.7
42.50 X 22
PAGE 4-10
SHEET 1 OF 1

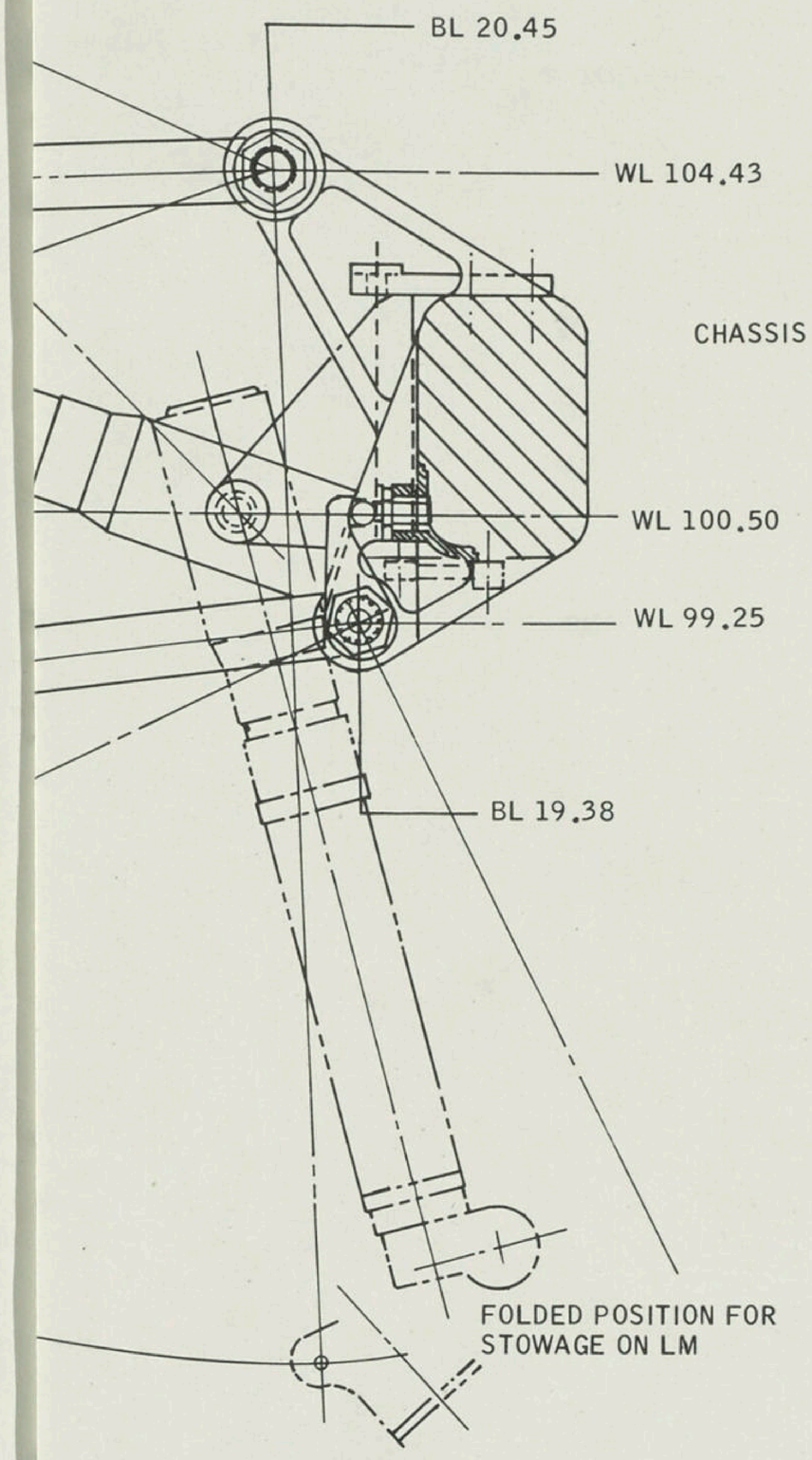

DRIVE CONTROL ELECTRONICS
NATIONAL AERONAUTICS & SPACE ADMINISTRATION
MANNED SPACECRAFT CENTER - HOUSTON, TEXAS
4.8
LF WHEEL TRACTION DRIVE ELECTRONICS ASSY
LF MOTOR CONTROL RELAYS
LF DRIVE MOTOR ASSY
LF CURRENT LIMITER
±15 VOLT POWER SUPPLY
POWER/TEMPERATURE MONITOR
PWM NO 1
PWM NO 2
DRIVE ENABLE
ODOMETER LOGIC
SPEED PULSES IN
EMITTER DRIVE
FREE WHEELING DIODE
SEC THROTTLE FAIL SAFE CIRCUIT
PRI THROTTLE FAIL SAFE CIRCUIT
TO STEERING CONTROL REAR
TO STEERING CONTROL FRONT
FROM STEERING MOTOR REAR SWITCH
FROM STEERING MOTOR FRONT SWITCH
ELECT DRIVE CONT


DRIVE CONTROL ELECTRONICS
4.8
NATIONAL AERONAUTICS & SPACE ADMINISTRATION
MANNED SPACECRAFT CENTER HOUSTON, TEXAS
LF WHEEL TRACTION DRIVE ELECTRONICS ASSY
RR WHEEL TOCA (SHUNT A33)
RF WHEEL TOCA (SHUNT AY)
LR WHEEL TOCA (SHUNT A33)
ODOMETER LOGIC
PULSE DRIVERS
DIRECTION CHANGE ENABLE PULSE = 1
REVERSE = GND
REVERSE = OPEN
CURRENT LIMITER CONTROL OVERLOAD = 0
MOTOR OR = 1
DRIVE ENABLE
PWM NO 2
PWM NO 1
VOLTAGE REGULATOR
SPEED PULSES IN
+36V RES
+36V REVERSE
EMITTER DRIVE
FREE WHEELING DIODE
RR MCR
LR MCR
RF MCR
LF MOTOR CONTROL RELAYS
RR DMA
LR DMA
RF DMA
LF DRIVE MTR ASSY
REED SW
FLOW COTTERS ODOMETER
RRCL
LRCL
RFCL
LF CURRENT LIMITER
POWER/TEMPERATURE MONITOR
PWM SELECT
±15 VOLT POWER SUPPLY
SEC THROTTLE FAIL SAFE CIRCUIT
PRI THROTTLE FAIL SAFE CIRCUIT
PRIMARY 15V ELECTRONICS
SECONDARY 15V ELECTRONICS
SECONDARY 115V POWER
TO STEERING CONTROL REAR
FROM STEERING MOTOR REAR SWITCH
FROM STEERING MOTOR FRONT SWITCH
TO STEERING CONTROL FRONT
LEAKAGE IN "M" LOGIC GATE CAUSES AN OPEN INPUT TO APPEAR AS A "1". PWM DRIVE ENABLE SWITCHES MUST BE OFF WHEN "M" IS "1" TO PREVENT DRIVE POWER SUPPLIES AND DIV POWER ARE ON. TO DO SO WILL CAUSE FULL THROTTLE TO BE APPLIED TO THAT DRIVE MOTOR.
MOTOR ON = 0
1. NO RECENT CHANGE IN DIRECTION
2. BRAKE OFF
3. NO CURRENT OVERLOAD
4. ON PULSE FROM PWM PRESENT
"0" IS PRESENT FOR ONE CYCLE EVERY 16 OSCILLATIONS IN NEUTRAL ONLY. OTHERWISE A "1" IS PRESENT.
INHIBIT PULSE GENERATOR
WHEN DIRECTION CHANGE IS COMMANDED, A NEGATIVE PULSE IS OUTPUTED TO INVERTER/AMPLIFIER
+5VDC IS SOURCE VOLTAGE FOR ALL PWM ELECTRONIC CIRCUIT COMPONENTS UNLESS OTHERWISE SHOWN
NOTES:
SIGNATURES
DATE
ELECT DRIVE CONT


HAND CONTROLLER
HAND CONTROLLER POSITION SECURE (SHOWN IN NEUTRAL WITH BRAKE OFF)
BRAKING DRIVE DISABLE
TRACTION DRIVE POT 2
TRACTION DRIVE POT 1
BAT 1
BAT 2
POWER
DRIVE POWER
PWM NO 2
PWM NO 1
TO PWM 2
FULL SPEED = ±15VDC
OSC OUTPUT
MOTOR ON = 0
MOTOR ON PULSE = 1
MOTOR ON = 1
VOLTAGE REGULATOR
DRIVE ENABLE
RR WHEEL TDEA (SHUNT A10)
RF WHEEL TDEA (SHUNT A9)
LR WHEEL TDEA (SHUNT A10)
LF WHEEL TRACTION DRIVE ELECTRONICS ASSY
TO RAV 3(+5 SPU)
PULSE DRIVERS
ONE SHOT
ODOMETER LOGIC
SPEED PULSES IN
FWD = GND
FWD = OPEN
FWD >5V LOGIC SW
SPEED INHIBIT = 0
NEUTRAL STOPPED = 0 OK TO CHANGE DIRECTION
DIRECTION CHANGE ENABLE PULSE = 1
REVERSE = GND
REVERSE = OPEN
BRAKE ON = 0
CURRENT LIMITER CONTROL OVERLOAD = 0
MOTOR ON = 1
EMITTER DRIVE
+36V BUS
+36V REVERSE
RR MCR
LR MCR
RF MCR
LF MOTOR CONTROL RELAYS
REVERSE K1
REVERSE K2
RR DMA
LR DMA
RF DMA
LF DRIVE MTR ASSY
REED SW
LF DRIVE MOTOR
PERM MAGNET
FLUX GUTTERS ODOMETER
FREE WHEELING DIODE
RRCL
LRCL
RFCL
LF CURRENT LIMITER
POWER/TEMPERATURE MONITOR
PWM SELECT
PRIMARY 15V ELECTRONICS
SECONDARY 15V ELECTRONICS

LTR	PCN	DR	ENG	DATE		APPROVAL
A		NA		6/22/71	6/22/71	
COMMENTS:						

SUSPENSION SYSTEM
NG WHEEL FOLDING AND UNFOLDING)



NOTES: 1. ALL DIMENSIONS ARE IN INCHES UNLESS OTHERWISE SPECIFIED

SIGNATURES	DATE
DR PAT SHERRILL	8-20-70
DSGN Bill A. Cornelius	3-30-71
QC Betty M. Naylor	3.30.71
ENGR John H. Cooper	3-29-71
APP Gerald D. Griffith	3.29-71
FEC Dean B. Rucker	3-30-71
AUTH	

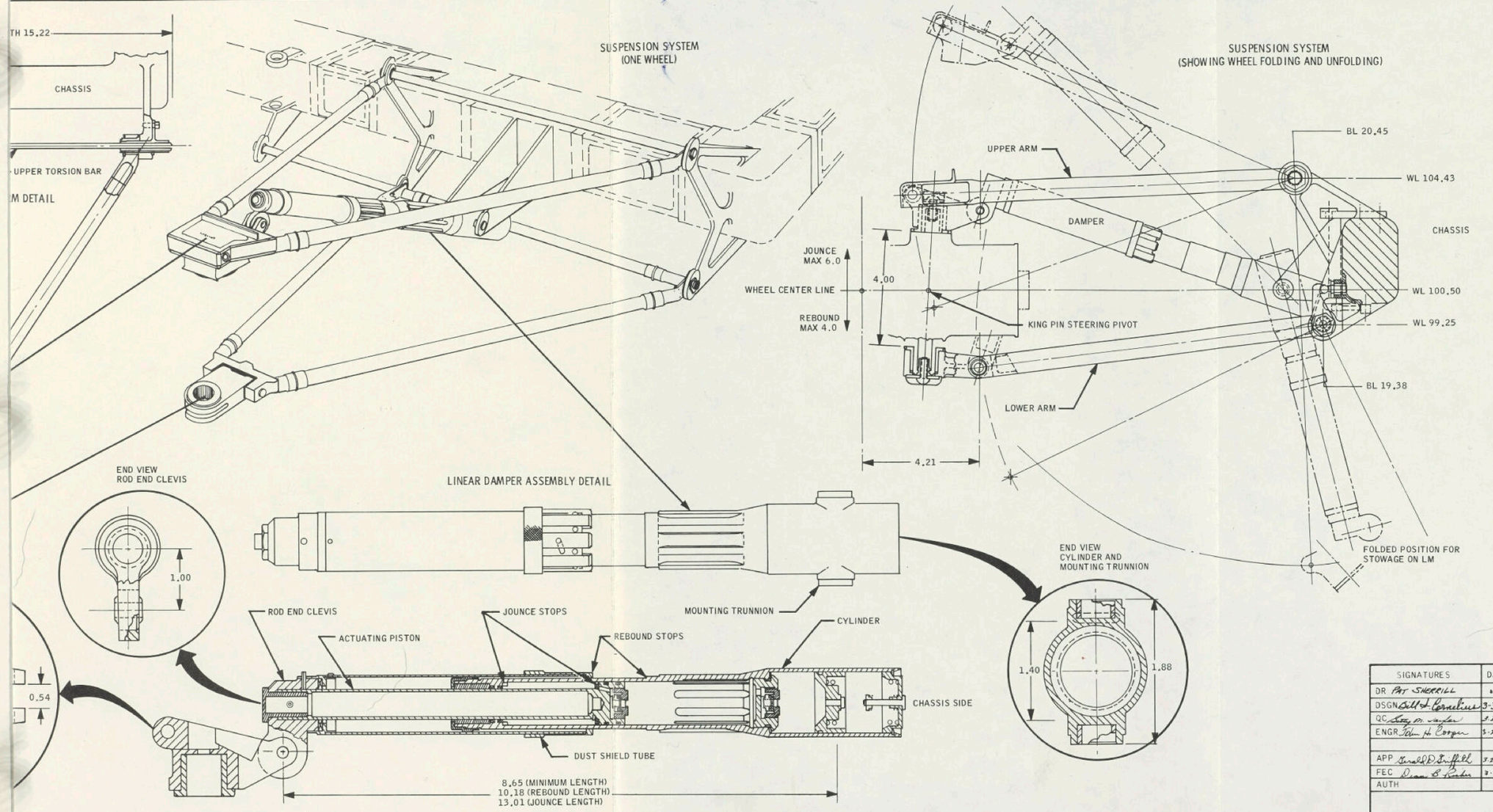
NATIONAL AERONAUTICS & SPACE ADMINISTRATION
MANNED SPACECRAFT CENTER · HOUSTON TEXAS

SUSPENSION SYSTEM

LRV	4.3
55 X 17	PAGE 4-6 SHEET 1 OF 1

LTR	PCN	DR	ENG	DATE	APPROVAL
A		NA		6/22/71	6/22/71

COMMENTS:



NOTES: 1. ALL DIMENSIONS ARE IN INCHES UNLESS OTHERWISE SPECIFIED

SIGNATURES	DATE
DR PAT SHERRILL	3-30-70
DSGN	3-30-71
QC	3-30-71
ENGR	3-29-71
APP	3-29-71
FEC	3-30-71
AUTH	

NATIONAL AERONAUTICS & SPACE ADMINISTRATION
MANNED SPACECRAFT CENTER · HOUSTON TEXAS

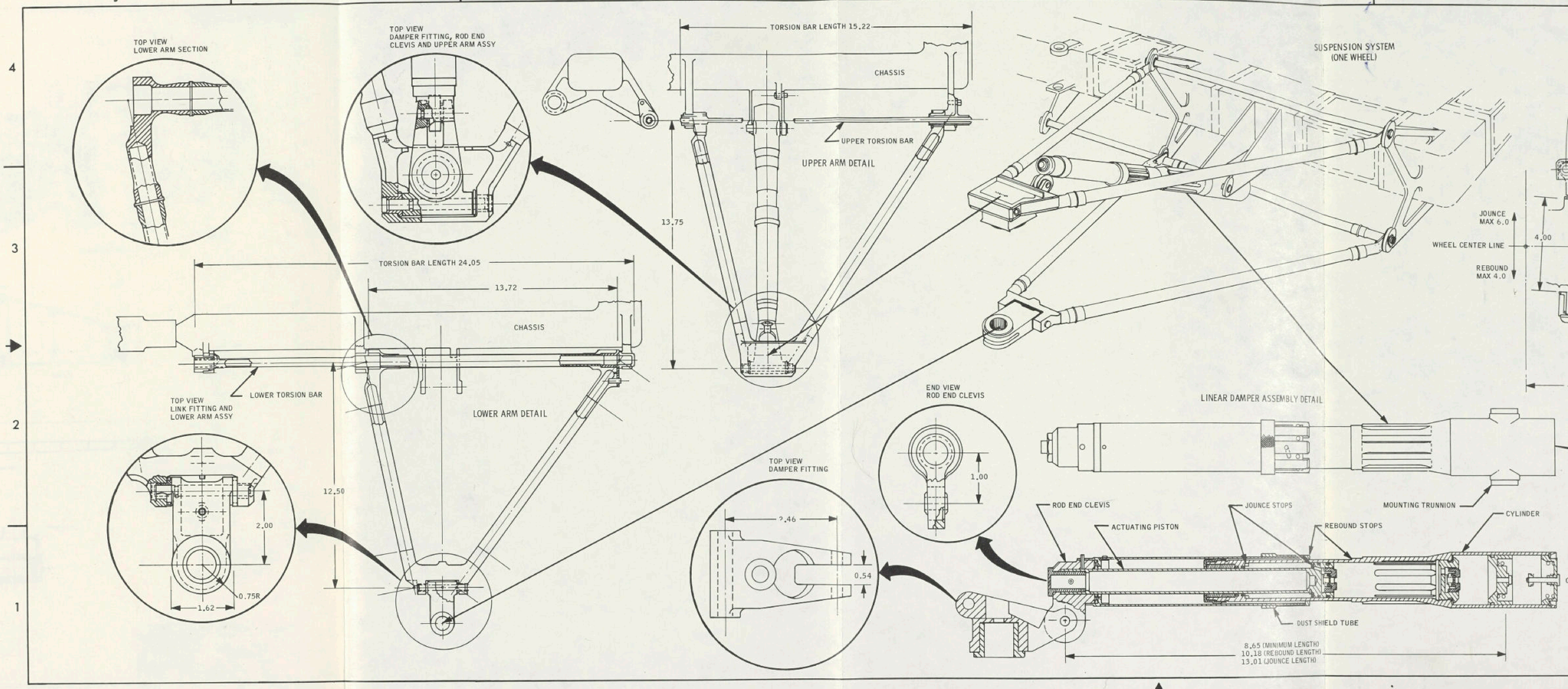
SUSPENSION SYSTEM

LRV

4.3

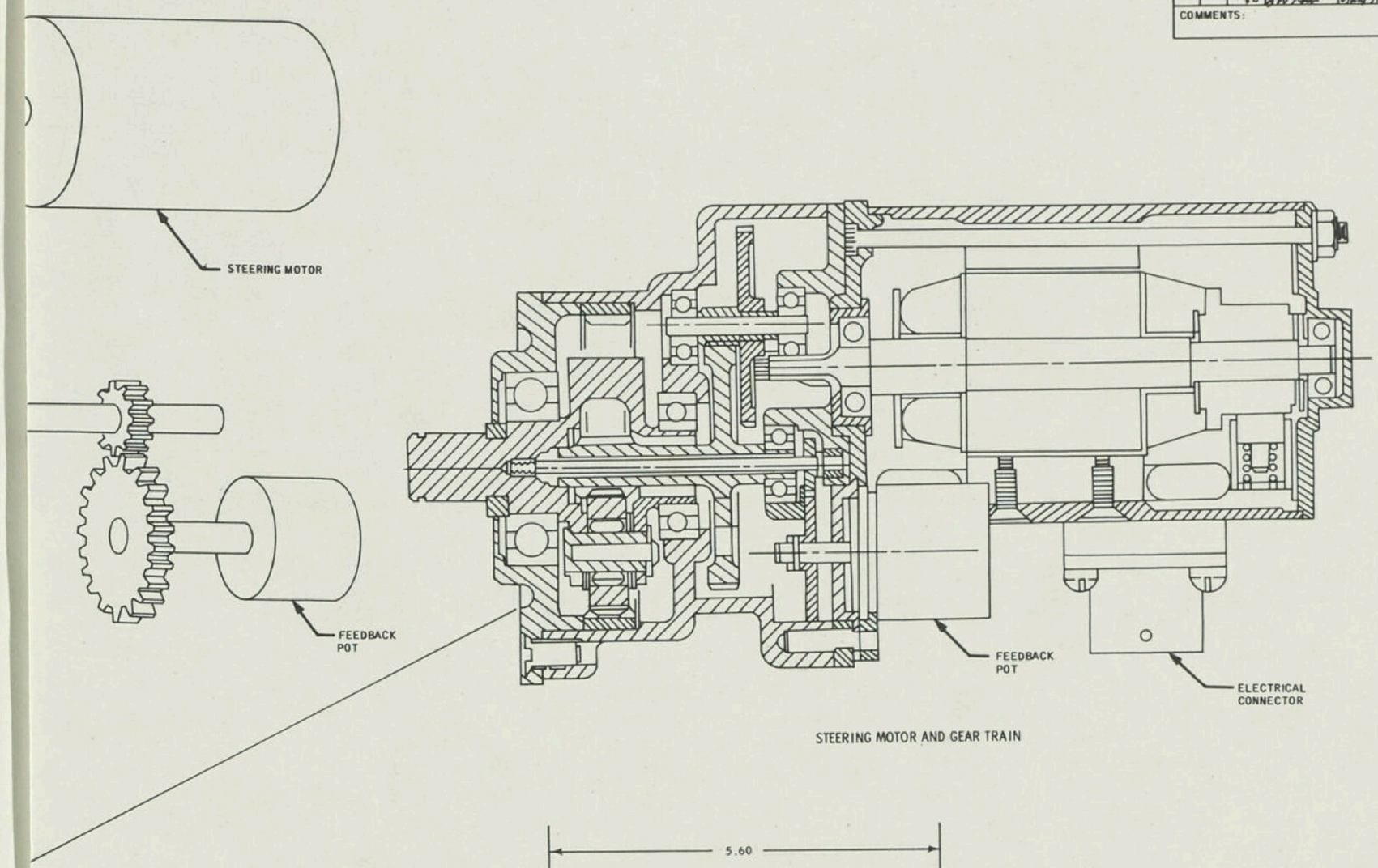
55 X 17 | PAGE 4-6 | SHEET 1 OF 1

SUSPENSION

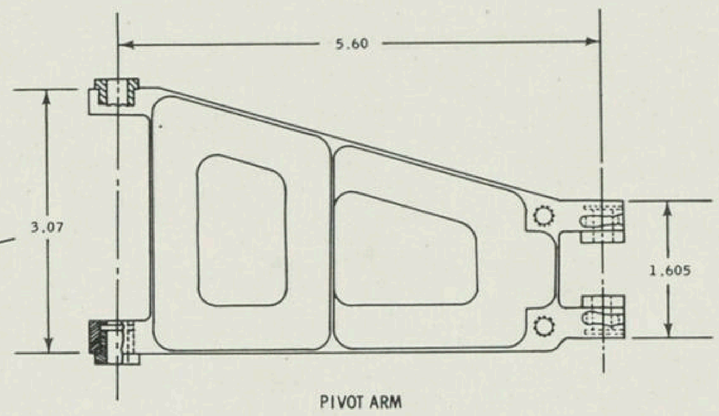

TOP VIEW
LOWER ARM SECTION
TOP VIEW
DAMPER FITTING, ROD END
CLEVIS AND UPPER ARM ASSY
TORSION BAR LENGTH 15.22
CHASSIS
UPPER TORSION BAR
UPPER ARM DETAIL
13.75
SUSPENSION SYSTEM
(ONE WHEEL)
JOUNCE
MAX 6.0
WHEEL CENTER LINE
4.00
REBOUND
MAX 4.0
TORSION BAR LENGTH 24.05
13.72
CHASSIS
LOWER TORSION BAR
TOP VIEW
LINK FITTING AND
LOWER ARM ASSY
LOWER ARM DETAIL
12.50
2.00
0.75R
1.62
END VIEW
ROD END CLEVIS
1.00
TOP VIEW
DAMPER FITTING
2.46
0.54
LINEAR DAMPER ASSEMBLY DETAIL
ROD END CLEVIS
ACTUATING PISTON
JOUNCE STOPS
REBOUND STOPS
MOUNTING TRUNNION
CYLINDER
DUST SHIELD TUBE
8.65 (MINIMUM LENGTH)
10.18 (REBOUND LENGTH)
13.01 (JOUNCE LENGTH)

LTR	PCN	DR	ENG	DATE		APPROVAL
A				6/22/71	6/22/71	

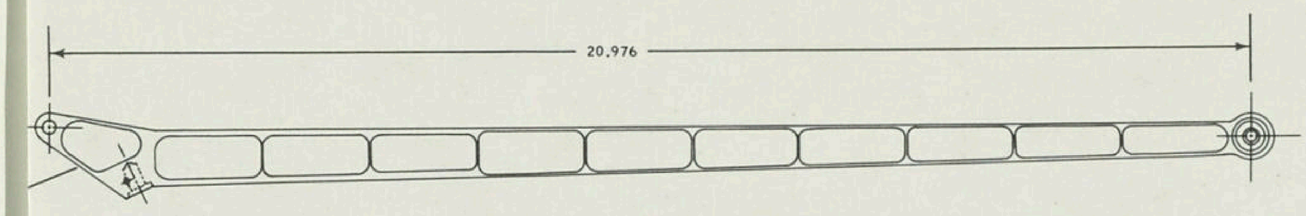
COMMENTS:



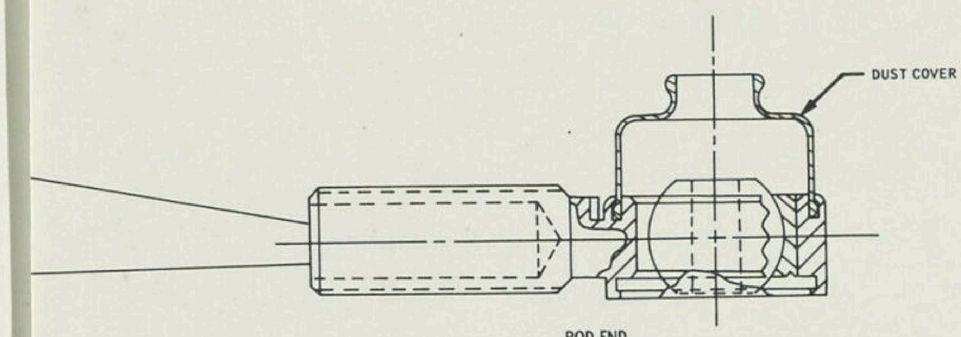
STEERING MOTOR AND GEAR TRAIN



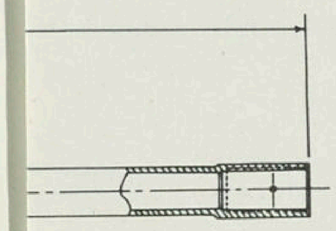
PIVOT ARM



STEERING ARM



ROD END



NOTES:
1. YELLOW PAINT SHOWS WHEN STEERING IS DECOUPLED
2. ALL DIMENSIONS ARE IN INCHES UNLESS OTHERWISE INDICATED
3. STEERING REENGAGEMENT TOOL, STOWED ON AFT CHASSIS

SIGNATURES	DATE
DR	6/22/71
DSGN	6-22-71
QC	6-22-71
ENGR	6-22-71
APP	6-22-71
FEC	6-22-71
AUTH	

NATIONAL AERONAUTICS & SPACE ADMINISTRATION
MANNED SPACECRAFT CENTER · HOUSTON, TEXAS

STEERING SYSTEM MECHANICAL

LRV | DWG NO: 4.6

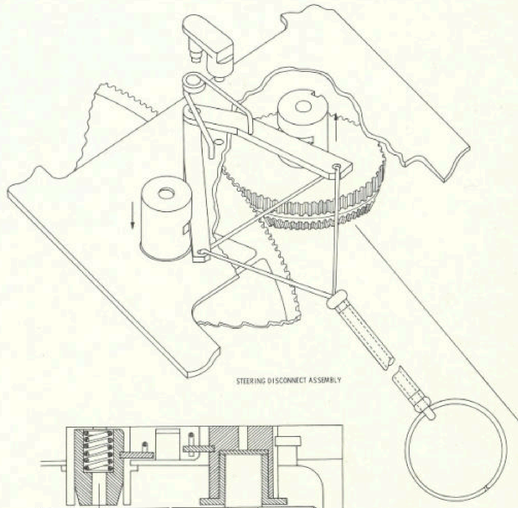
93.5 X 34 | PAGE 4-9 | SHEET 1 OF 1

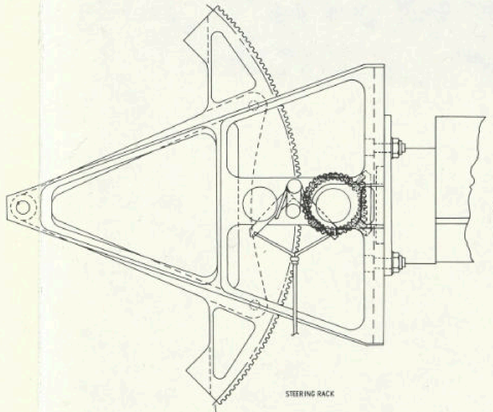
NASA — MSC

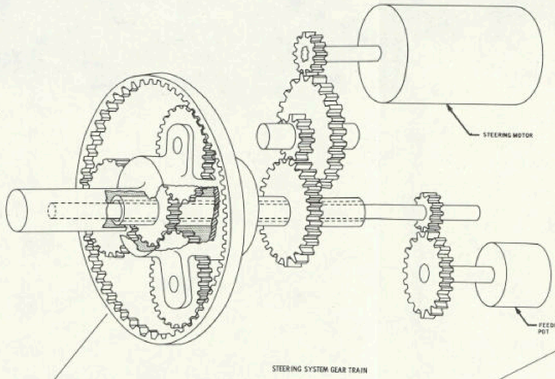
SENSORS DISPLAYS | POWER DIST | LCRU | TOTAL RCS | LM DESCENT AMP-HRS | LM DESCENT O_2 | LRV STEER MECH

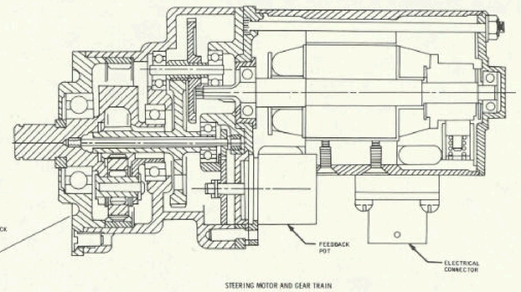
LTR	PCN	DR	ENG	DATE	APPROVAL
A					

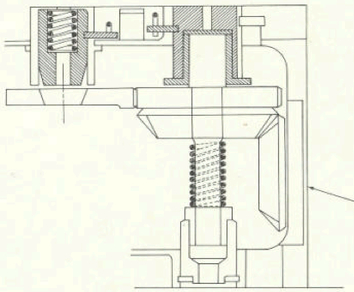
COMMENTS:

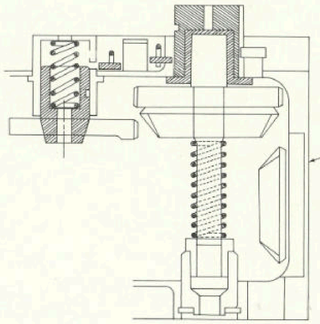


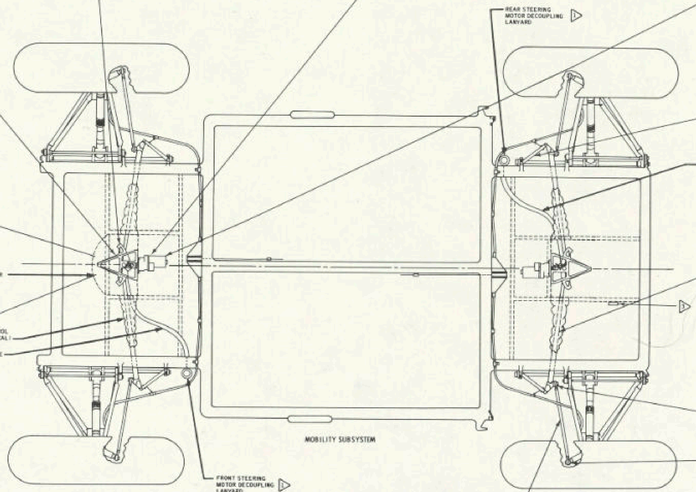


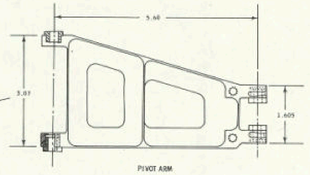


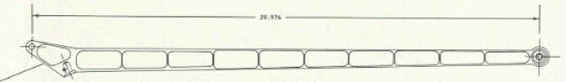


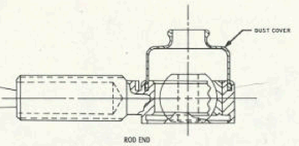


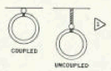


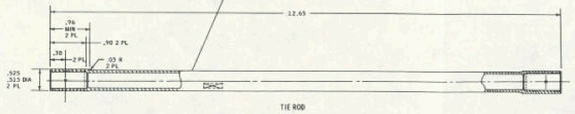












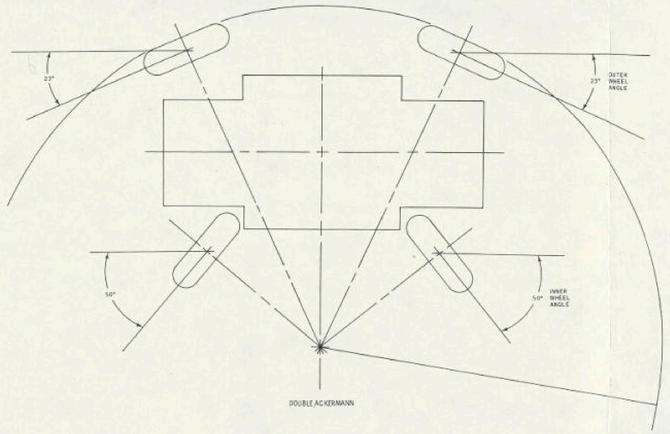
STEERING REENGAGEMENT TOOL, STOWED ON AFT CHASSIS

2. ALL DIMENSIONS ARE IN INCHES UNLESS OTHERWISE INDICATED

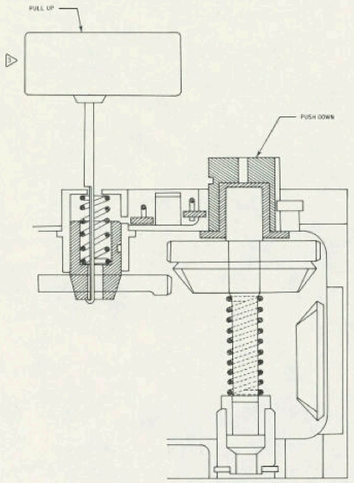
NOTES: YELLOW PAINT SHOWS WHEN STEERING IS DECOUPLED

SIGNATURES	DATE	NATIONAL AERONAUTICS & SPACE ADMINISTRATION MANNED SPACECRAFT CENTER · HOUSTON, TEXAS
DR		STEERING SYSTEM MECHANICAL
DSGN		
SE		
ENGR		
APP		LRV — DWG NO. 4.6
FEC		
AUTH		
		93.5 X 34 — PAGE 4-9 — SHEET 1 OF 1

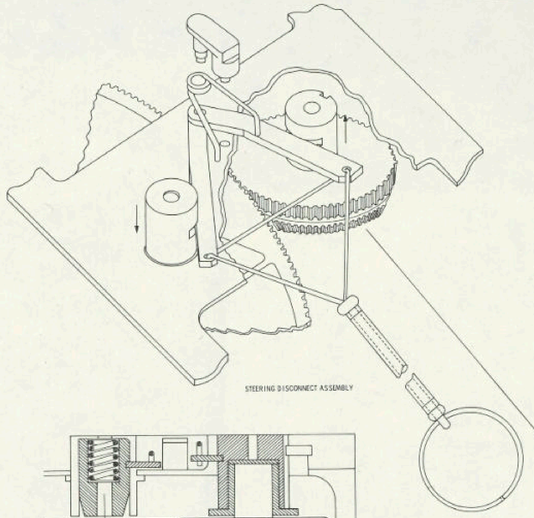
LRV STEER MECH



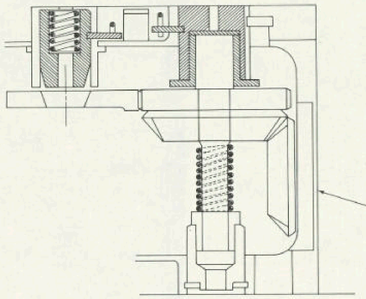
DOUBLE ACKERMANN



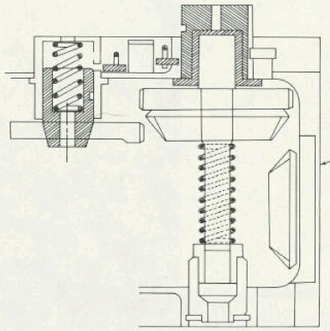
STEERING RECOUPLING
(REAR ONLY)



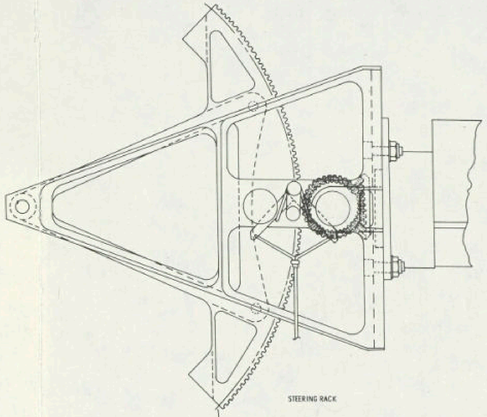
STEERING DISCONNECT ASSEMBLY



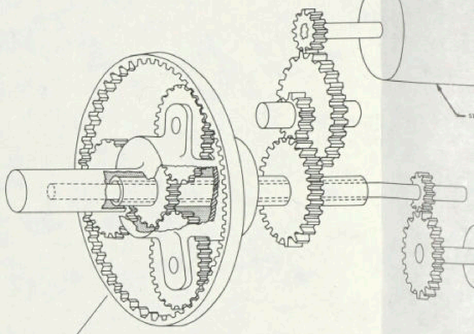
BEFORE STEERING DISCONNECT



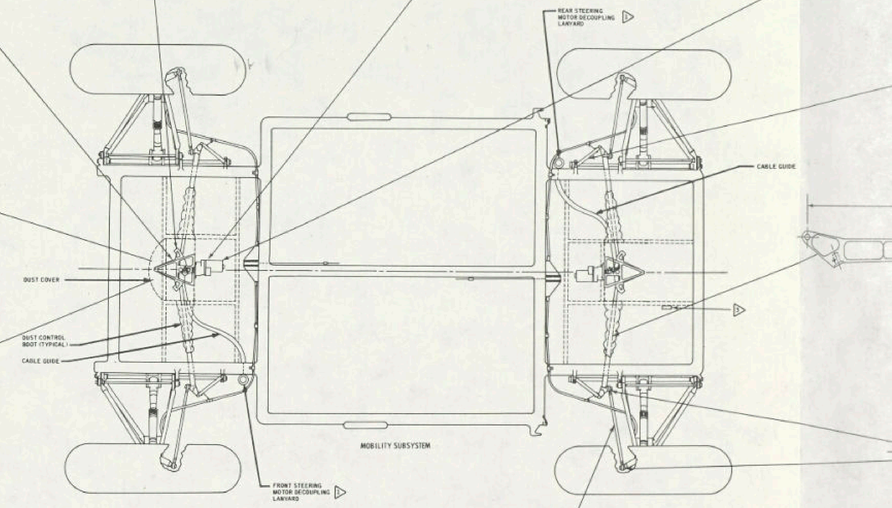
AFTER STEERING DISCONNECT



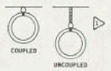
STEERING RACK

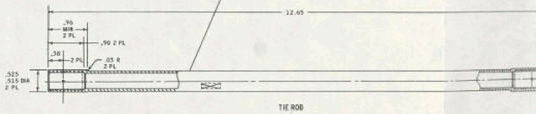


STEERING SYSTEM GEAR TRAIN



MOBILITY SUBSYSTEM

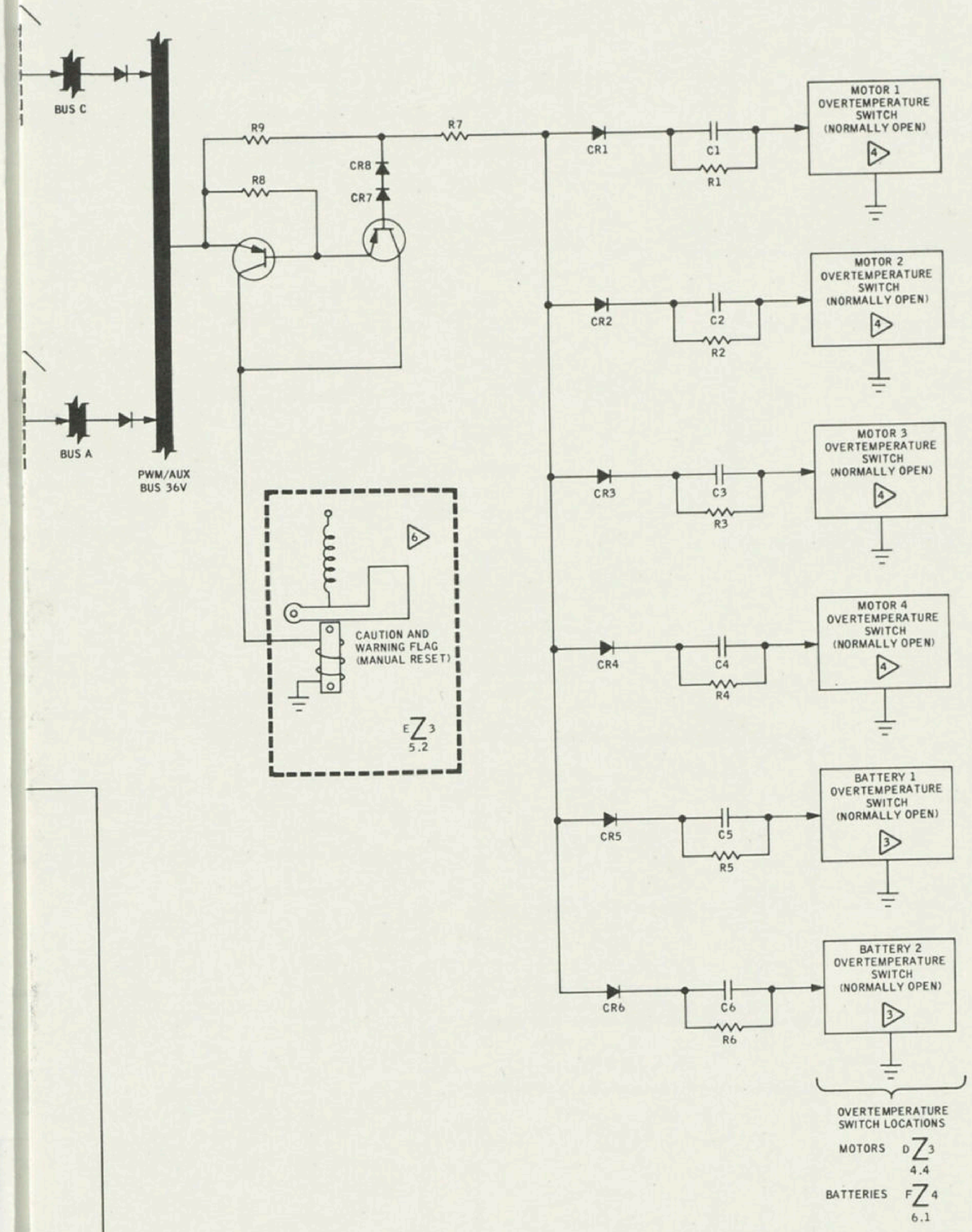




TIE ROD

LTR	PCN	DR	ENG	DATE		APPROVAL
A		D. J.				

COMMENTS:



6 FLAG IS SPRING LOADED TO RISE AND IS HELD DOWN BY A PERMANENT MAGNET. CURRENT THROUGH THE COIL (10MS, 36V PULSE) BUCKS THE PERMANENT MAGNET, ALLOWING THE FLAG TO POP UP

5 MERCURY COLUMN VARIES CAPACITANCE BETWEEN PLATES

4 MOTOR TEMPERATURE SWITCHES CLOSE AT 400° ± 12° F OPEN AT 370° ± 12° F

3 BATTERY TEMPERATURE SWITCHES CLOSE AT 125° ± 5° F OPEN AT 110° ± 5° F

2 MOTOR TRANSDUCER RANGE +150° TO +600° F

NOTES: 1 BATTERY TRANSDUCER RANGE 0° TO 180° F ±2° F FROM +20° TO 150° F

SIGNATURES	DATE
DR	11-10-70
DSGN	3-30-71
QC	3-30-71
ENGR	3-29-71
APP	3-29-71
FEC	3/29/71

NATIONAL AERONAUTICS & SPACE ADMINISTRATION
MANNED SPACECRAFT CENTER · HOUSTON, TEXAS

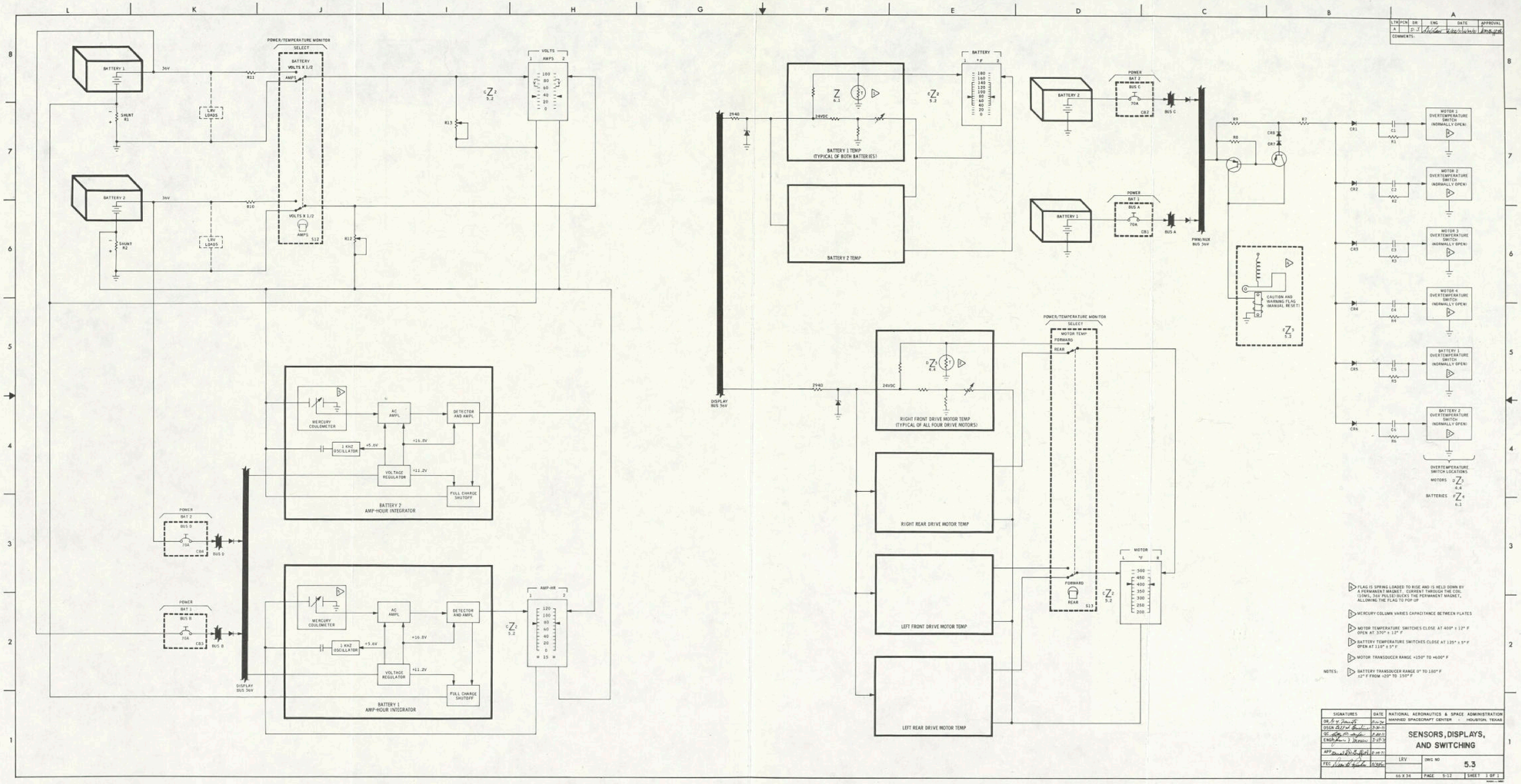
SENSORS, DISPLAYS, AND SWITCHING

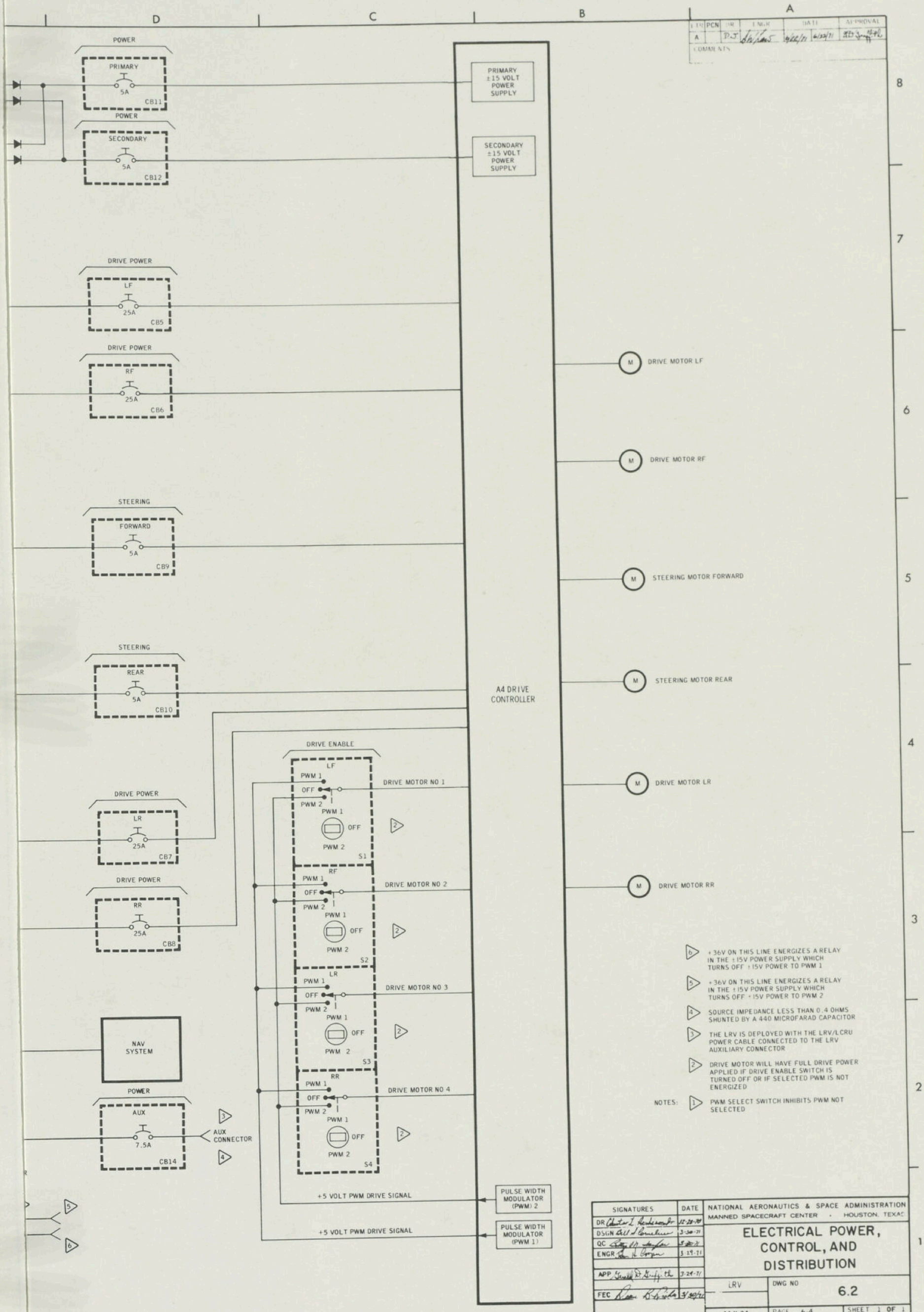
LRV | DWG NO 5.3

66 X 34 | PAGE 5-12 | SHEET 1 OF 1

NASA — MSC

SENSORS DISPLAYS
POWER DIST SL
LCRU
TOTAL RCS
LM DESCENT AMP-HRS
LM DESCENT O2
LRV AMP-HRS


BATTERY 1
BATTERY 2
36V
SHUNT R1
SHUNT R2
LRV LOADS
R11
R10
POWER/TEMPERATURE MONITOR
SELECT
BATTERY
VOLTS X 1/2
AMPS
S12
R12
R13
VOLTS
1 AMPS 2
MERCURY COULOMETER
AC AMPL
DETECTOR AND AMPL
1 KHZ OSCILLATOR
+5.6V
+16.8V
+11.2V
VOLTAGE REGULATOR
FULL CHARGE SHUTOFF
BATTERY 2 AMP-HOUR INTEGRATOR
BATTERY 1 AMP-HOUR INTEGRATOR
POWER
BAT 2
BUS D
70A
CB4
BAT 1
BUS B
CB3
DISPLAY BUS 36V
AMP-HR
2940
24VDC
BATTERY 1 TEMP (TYPICAL OF BOTH BATTERIES)
BATTERY 2 TEMP
BATTERY
BUS C
CB2
BUS A
CB1
PWM/AUX BUS 36V
R9
R8
R7
CR8
CR7
CAUTION AND WARNING FLAG (MANUAL RESET)
CR1
CR2
CR3
CR4
CR5
CR6
C1
C2
C3
C4
C5
C6
R1
R2
R3
R4
R5
R6
MOTOR 1 OVERTEMPERATURE SWITCH (NORMALLY OPEN)
MOTOR 2 OVERTEMPERATURE SWITCH (NORMALLY OPEN)
MOTOR 3 OVERTEMPERATURE SWITCH (NORMALLY OPEN)
MOTOR 4 OVERTEMPERATURE SWITCH (NORMALLY OPEN)
BATTERY 1 OVERTEMPERATURE SWITCH (NORMALLY OPEN)
BATTERY 2 OVERTEMPERATURE SWITCH (NORMALLY OPEN)
OVERTEMPERATURE SWITCH LOCATIONS
MOTORS
BATTERIES
RIGHT FRONT DRIVE MOTOR TEMP (TYPICAL OF ALL FOUR DRIVE MOTORS)
RIGHT REAR DRIVE MOTOR TEMP
LEFT FRONT DRIVE MOTOR TEMP
LEFT REAR DRIVE MOTOR TEMP
MOTOR TEMP
FORWARD
REAR
S13
MOTOR
L °F R
FLAG IS SPRING LOADED TO RISE AND IS HELD DOWN BY A PERMANENT MAGNET. CURRENT THROUGH THE COIL (10MS, 36V PULSE) BUCKS THE PERMANENT MAGNET, ALLOWING THE FLAG TO POP UP
MERCURY COLUMN VARIES CAPACITANCE BETWEEN PLATES
MOTOR TEMPERATURE SWITCHES CLOSE AT 400° ± 12° F OPEN AT 370° ± 12° F
BATTERY TEMPERATURE SWITCHES CLOSE AT 125° ± 5° F OPEN AT 110° ± 5° F
MOTOR TRANSDUCER RANGE +250° TO +600° F
NOTES:
BATTERY TRANSDUCER RANGE 0° TO 180° F ±2° F FROM +20° TO 150° F
SIGNATURES
DATE
NATIONAL AERONAUTICS & SPACE ADMINISTRATION
MANNED SPACECRAFT CENTER : HOUSTON, TEXAS
SENSORS, DISPLAYS, AND SWITCHING
LRV
DWG NO
5.3
66 X 34
PAGE 5-12
SHEET 1 OF 1
SENSORS DISPLAYS



SIM BAY SECRD/OPEN

POWER DIST

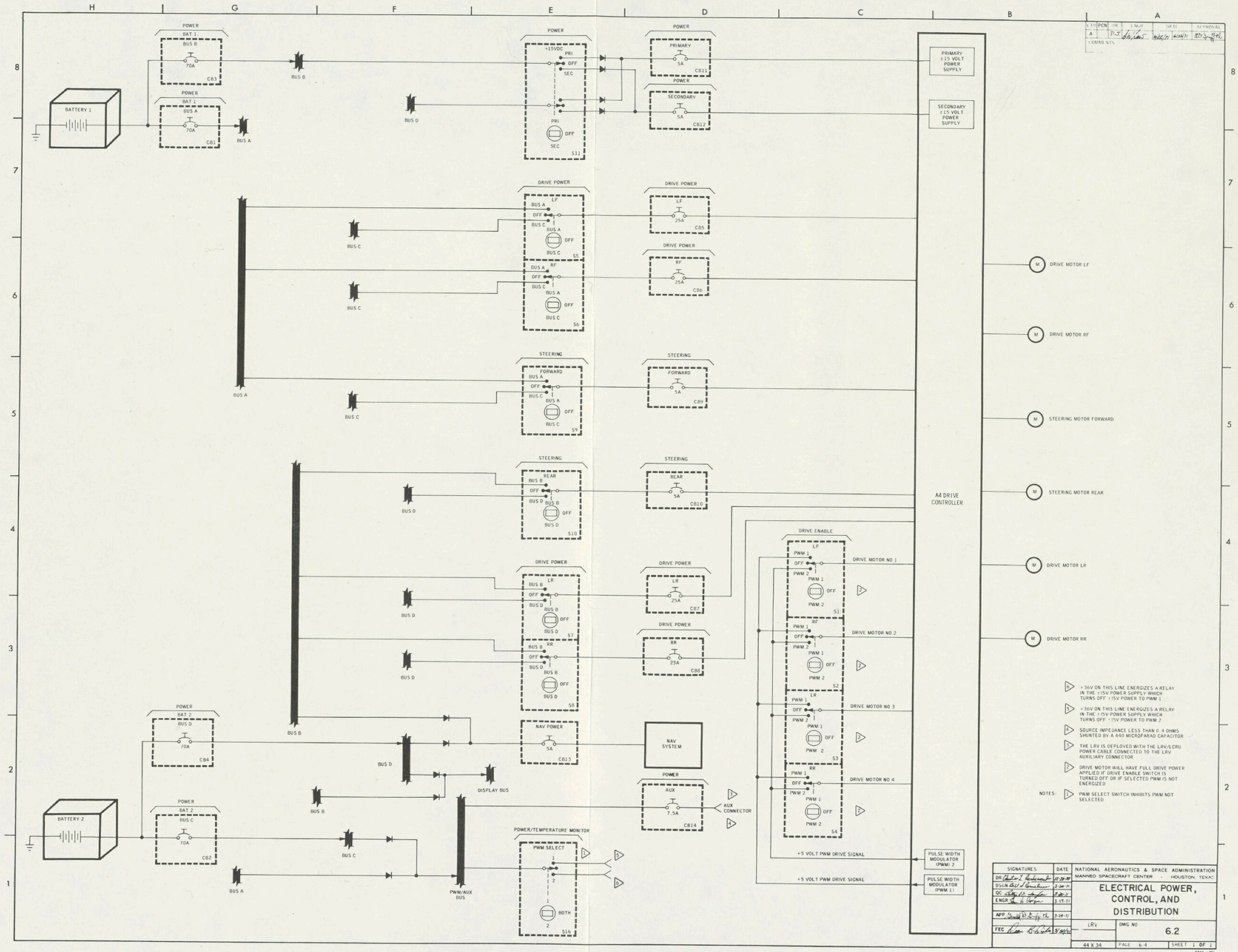
LCRU

TOTAL RCS

LM DESCENT AMP-HRS

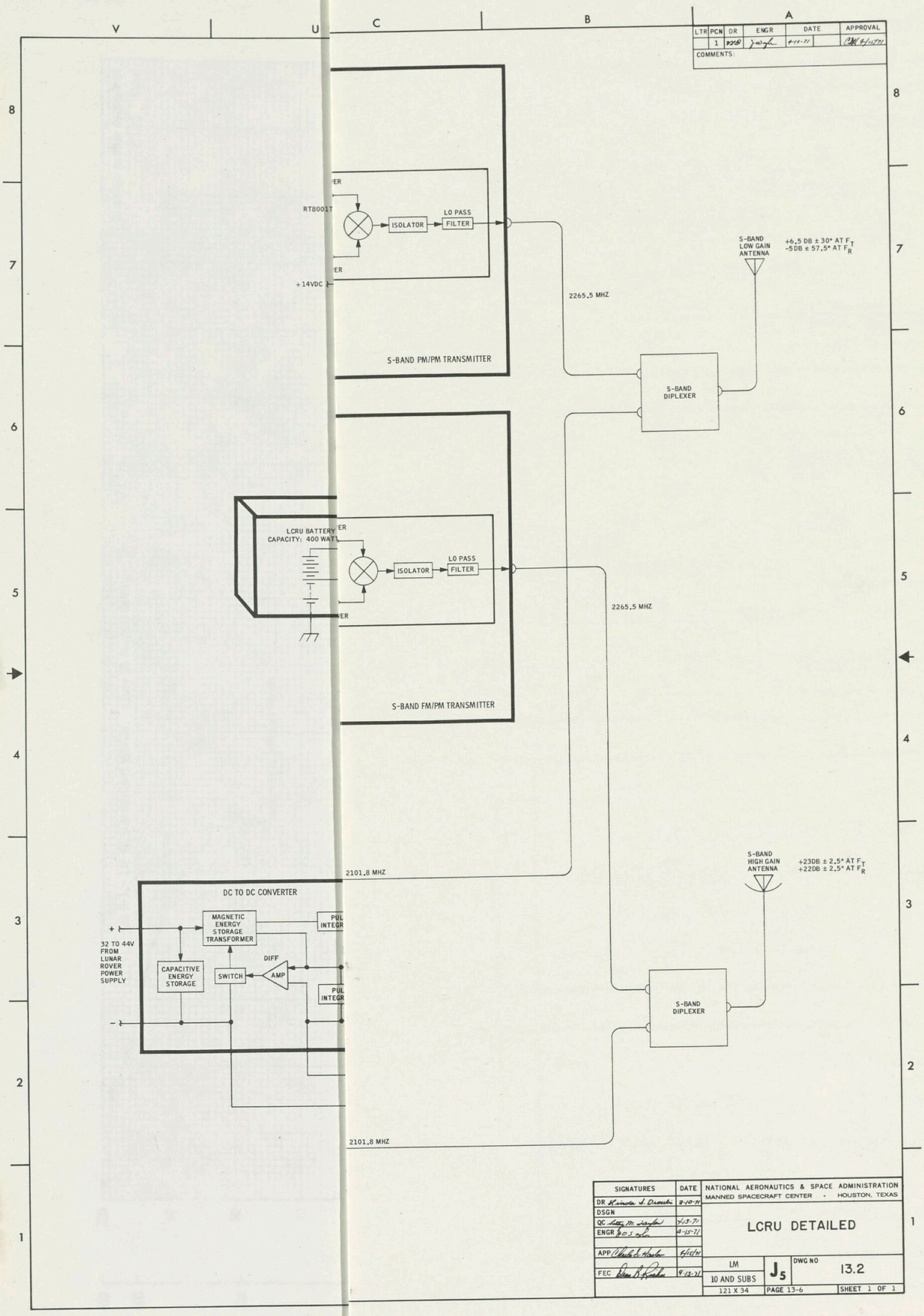
LM DESCENT O2

LRV AMP-HRS


POWER
BAT 1
BUS B
70A
CB3
BATTERY 1
BUS A
CB1
BUS B
BUS A
BUS D
+15VDC
PRI
OFF
SEC
S11
PRIMARY
5A
CB11
SECONDARY
CB12
DRIVE POWER
LF
BUS A
OFF
BUS C
S5
RF
S6
25A
CB5
CB6
STEERING
FORWARD
S9
5A
CB9
REAR
S10
CB10
LR
S7
CB7
RR
S8
CB8
BUS C
NAV POWER
NAV SYSTEM
CB13
BAT 2
CB4
CB2
BATTERY 2
DISPLAY BUS
AUX
7.5A
CB14
AUX CONNECTOR
POWER/TEMPERATURE MONITOR
PWM SELECT
BOTH
S16
PWM/AUX BUS
PRIMARY ±15 VOLT POWER SUPPLY
SECONDARY ±15 VOLT POWER SUPPLY
A4 DRIVE CONTROLLER
DRIVE ENABLE
PWM 1
PWM 2
S1
S2
S3
S4
DRIVE MOTOR NO 1
DRIVE MOTOR NO 2
DRIVE MOTOR NO 3
DRIVE MOTOR NO 4
+5 VOLT PWM DRIVE SIGNAL
PULSE WIDTH MODULATOR (PWM) 2
PULSE WIDTH MODULATOR (PWM) 1
DRIVE MOTOR LF
DRIVE MOTOR RF
STEERING MOTOR FORWARD
STEERING MOTOR REAR
DRIVE MOTOR LR
DRIVE MOTOR RR
NOTES:
+36V ON THIS LINE ENERGIZES A RELAY IN THE ±15V POWER SUPPLY WHICH TURNS OFF ±15V POWER TO PWM 1
+36V ON THIS LINE ENERGIZES A RELAY IN THE ±15V POWER SUPPLY WHICH TURNS OFF ±15V POWER TO PWM 2
SOURCE IMPEDANCE LESS THAN 0.4 OHMS SHUNTED BY A 440 MICROFARAD CAPACITOR
THE LRV IS DEPLOYED WITH THE LRV/LCRU POWER CABLE CONNECTED TO THE LRV AUXILIARY CONNECTOR
DRIVE MOTOR WILL HAVE FULL DRIVE POWER APPLIED IF DRIVE ENABLE SWITCH IS TURNED OFF OR IF SELECTED PWM IS NOT ENERGIZED
PWM SELECT SWITCH INHIBITS PWM NOT SELECTED
SIGNATURES
DATE
DR
DSGN
QC
ENGR
APP
FEC
NATIONAL AERONAUTICS & SPACE ADMINISTRATION
MANNED SPACECRAFT CENTER - HOUSTON, TEXAS
ELECTRICAL POWER, CONTROL, AND DISTRIBUTION
LRV
DWG NO
6.2
44 X 34
PAGE 6-4
SHEET 1 OF 1
POWER DIST

LTR	PCN	DR	ENGR	DATE	APPROVAL
	1			4-15-71	

COMMENTS:



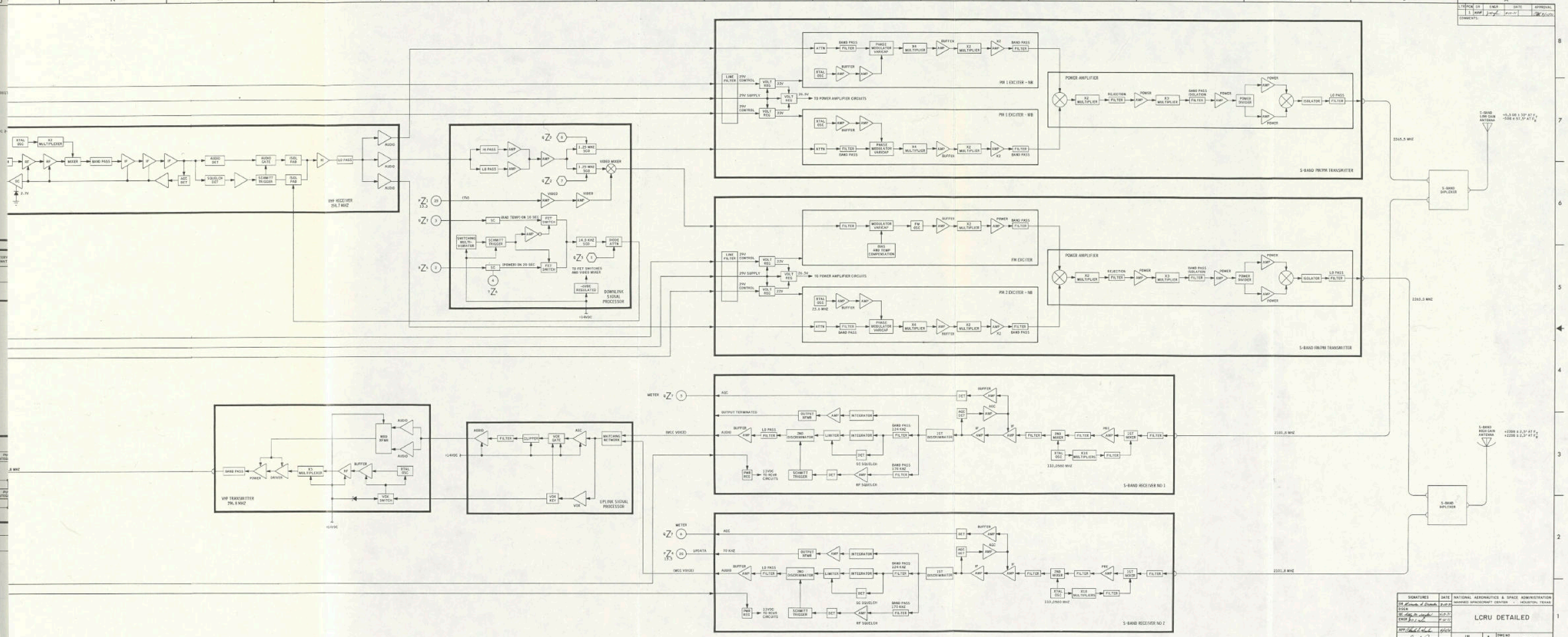
SIGNATURES	DATE
DR Kenneth J. Drouhi	7-10-71
DSGN	
QC Lee M. Jaylor	4-13-71
ENGR	4-15-71
APP Charles S. Hooton	4/15/71
FEC Dean R. Rocker	4-13-71

NATIONAL AERONAUTICS & SPACE ADMINISTRATION
MANNED SPACECRAFT CENTER · HOUSTON, TEXAS

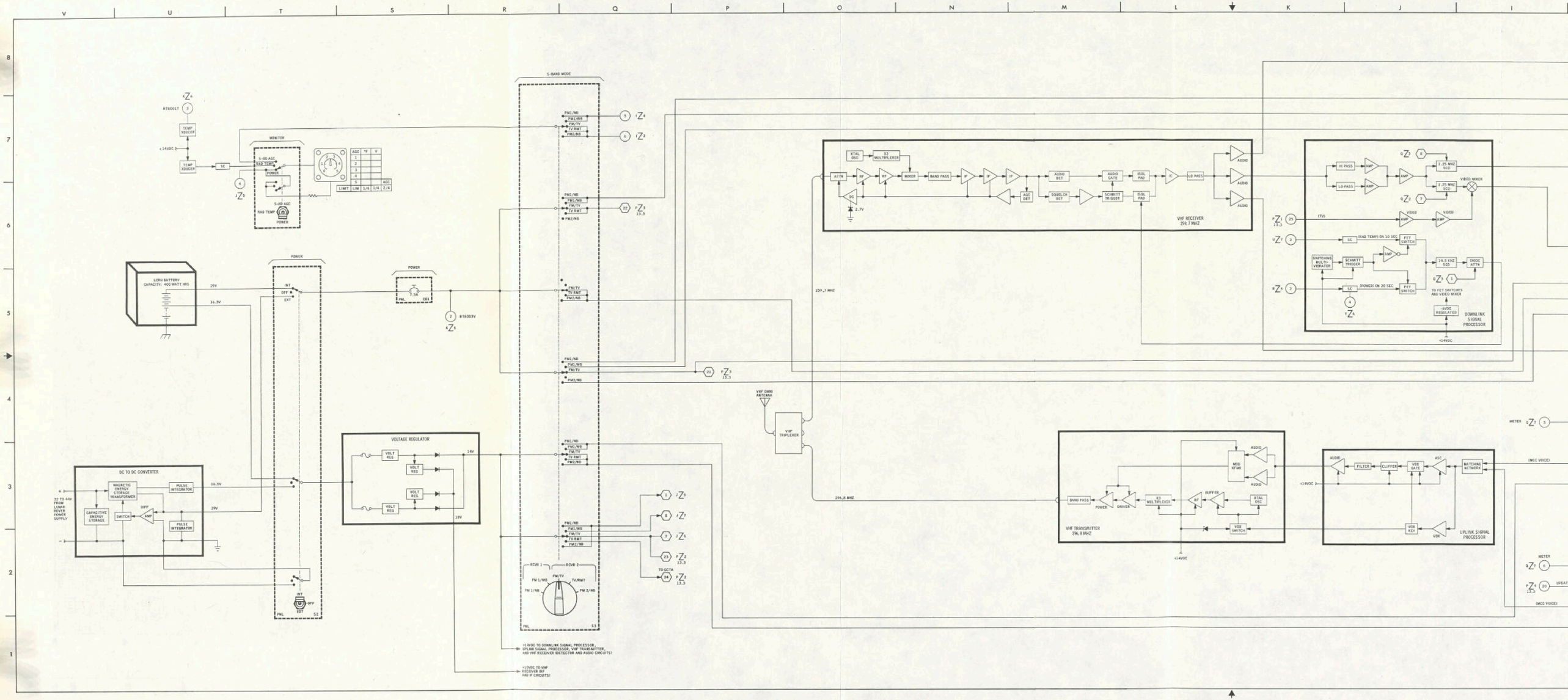
LCRU DETAILED

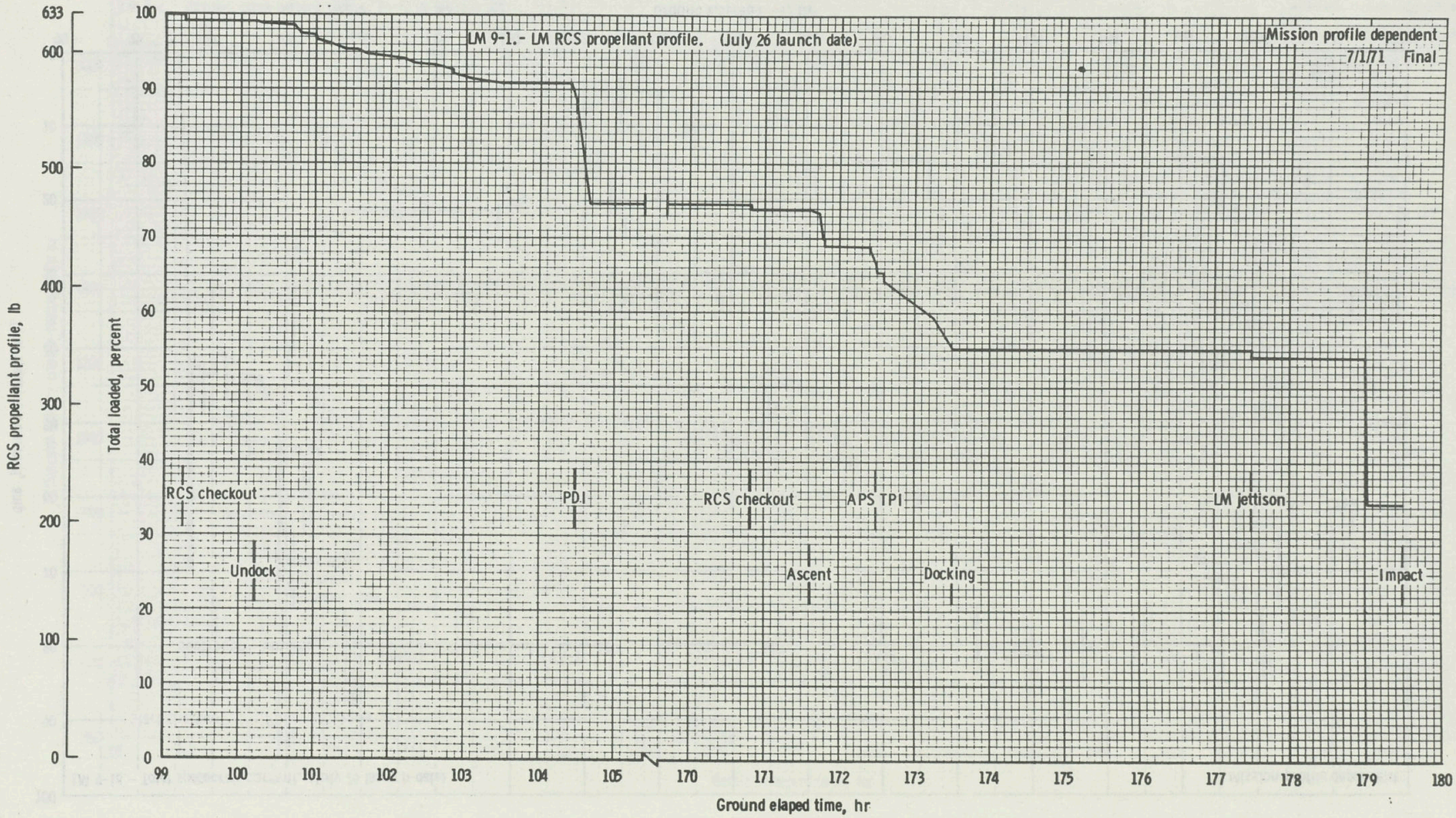
LM	J5	DWG NO 13.2
10 AND SUBS		
121 X 34	PAGE 13-6	SHEET 1 OF 1

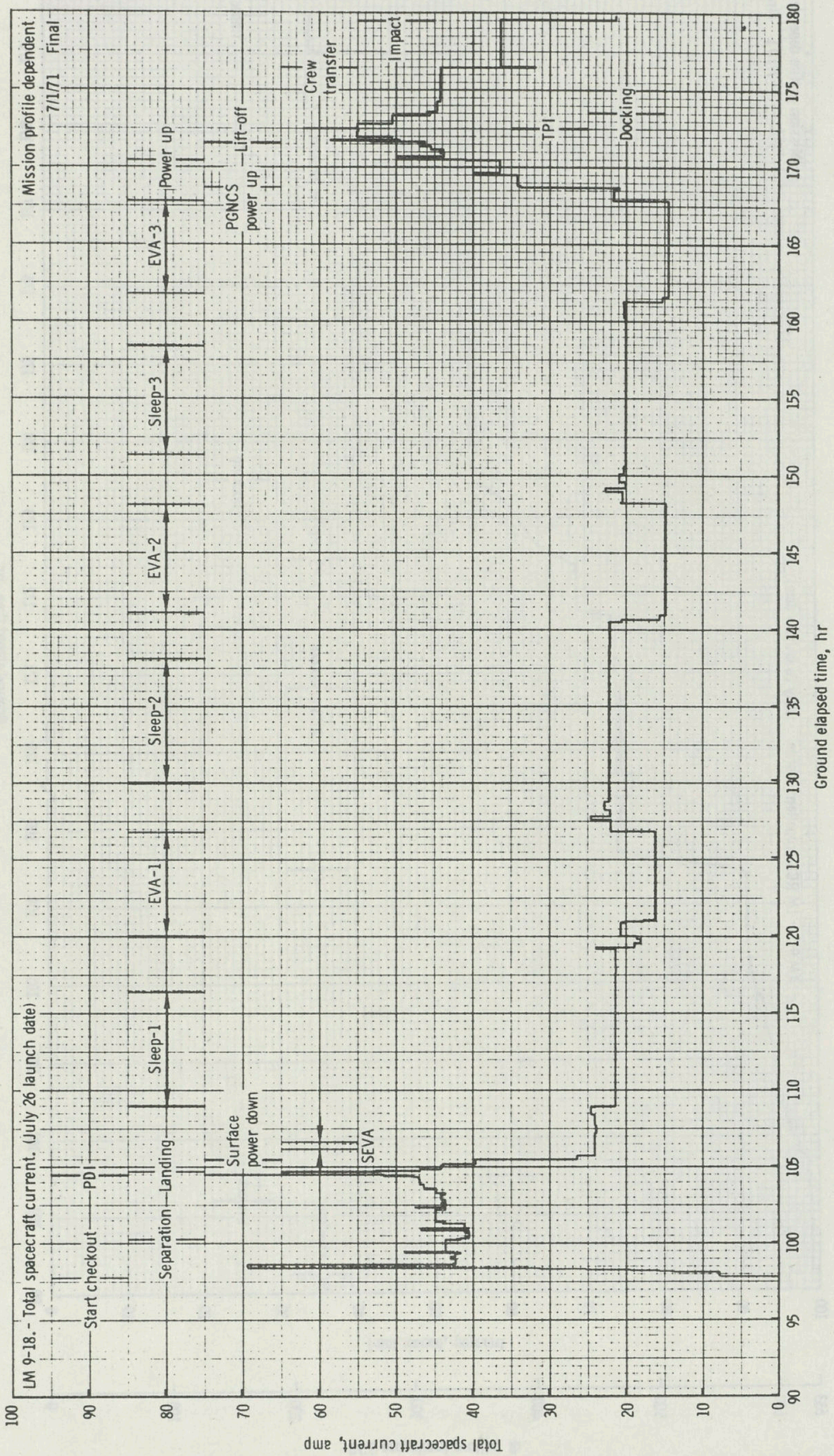
SIM BAY SECRD/OPEN
SIM BAY DOCKING
LCRU
TOTAL RCS
LM DESCENT AMP-HRS
LM DESCENT O_2
LRV AMP-HRS

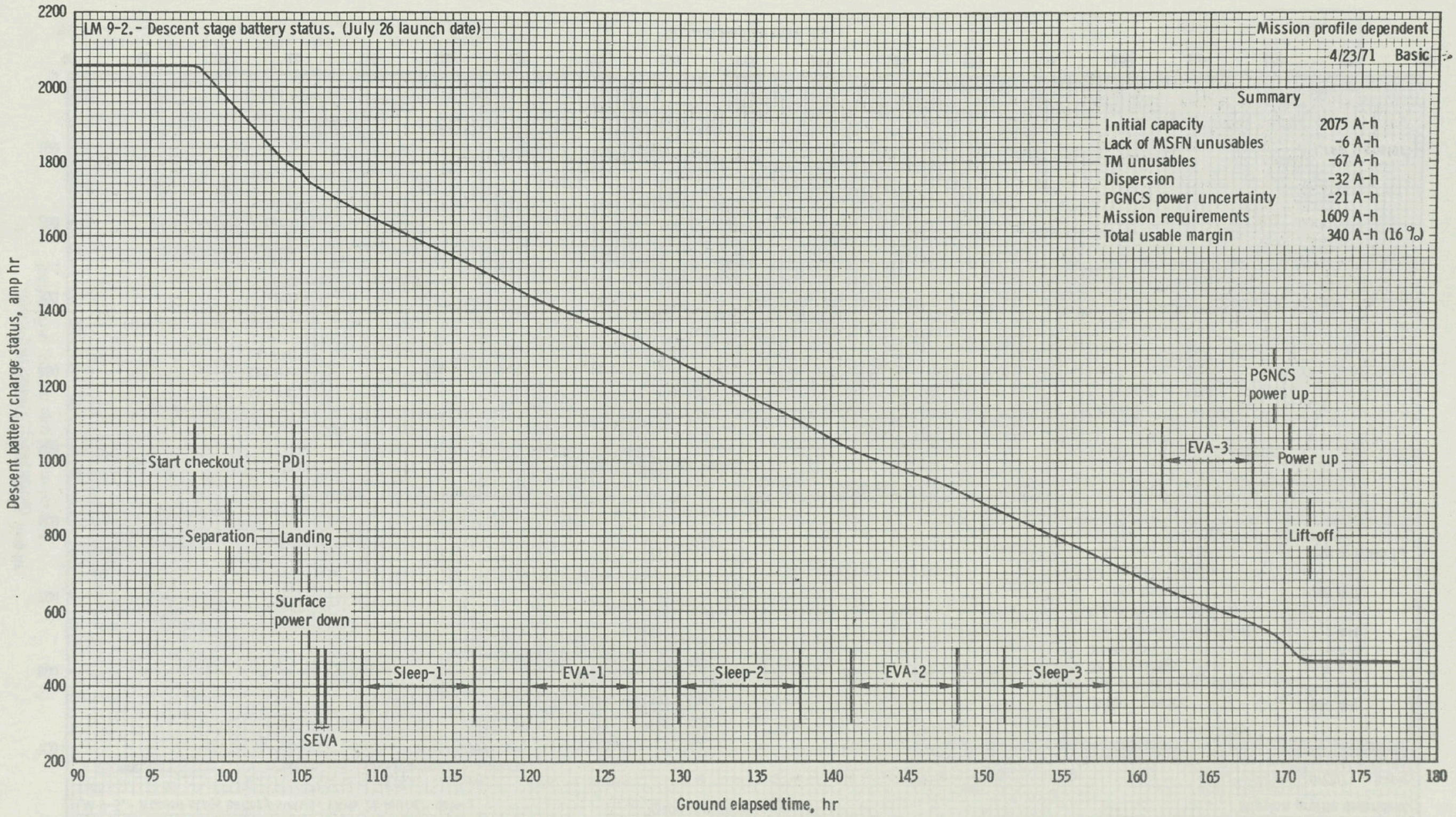


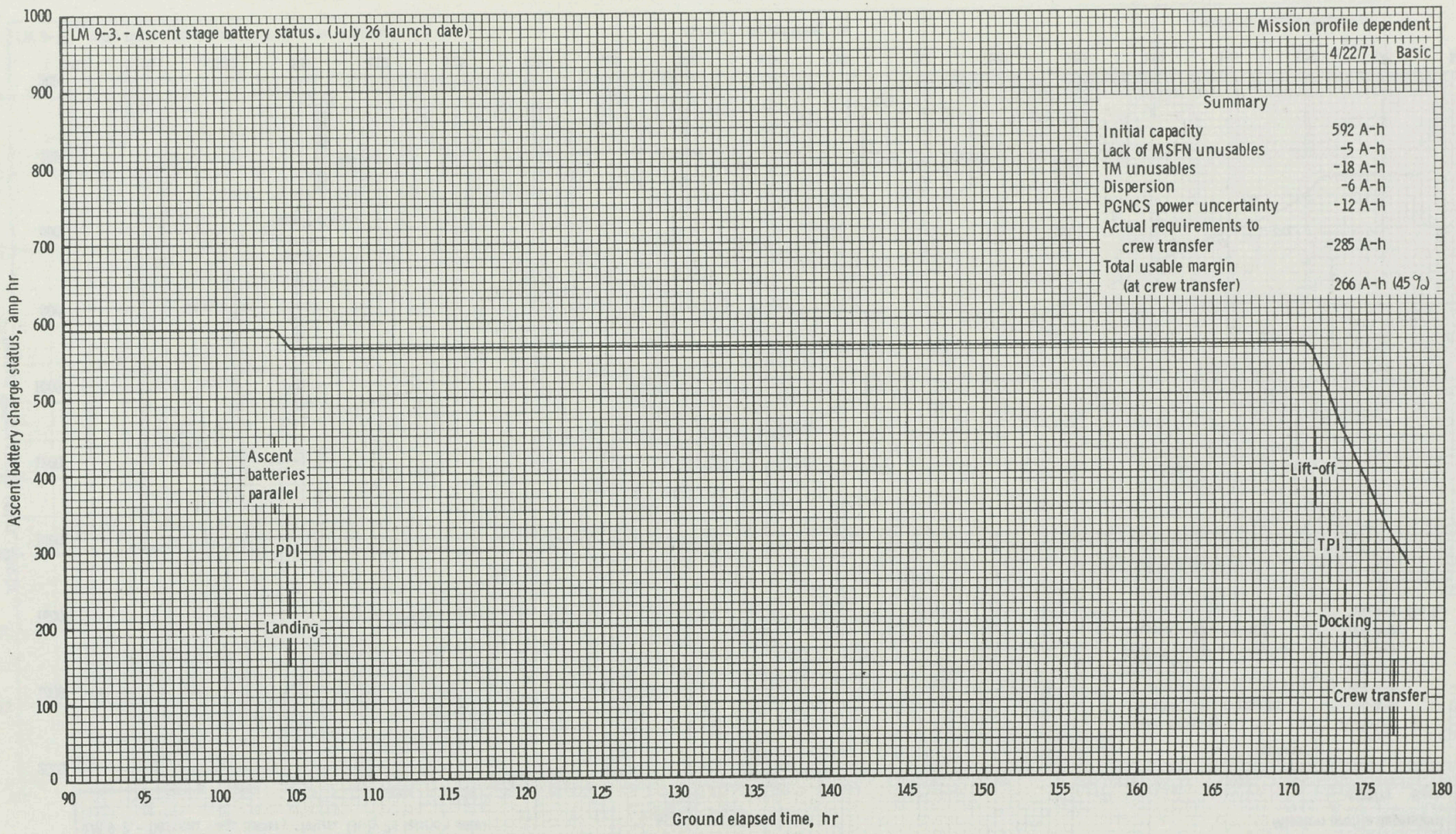
SIGNATURES	DATE	NATIONAL AERONAUTICS & SPACE ADMINISTRATION MANNED SPACECRAFT CENTER - HOUSTON, TEXAS
DR		LCRU DETAILED
DSGN		
QC		
ENGR		
APP		
FEC		LM J5 DWG NO 13.2
		10 AND SUBS
		101 & 24 PAGE 13-6 SHEET 1 OF 1

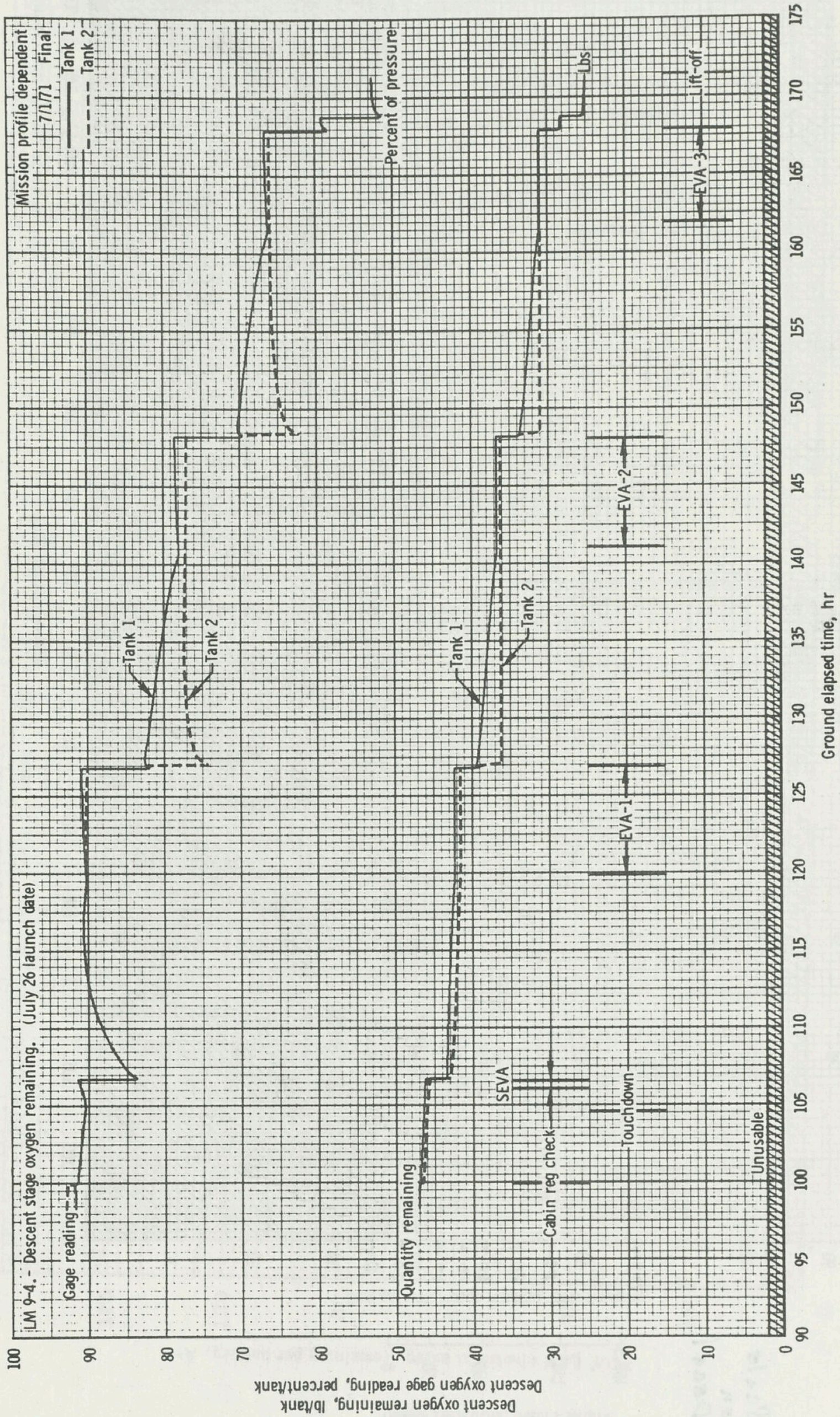

S-BAND MODE
MONITOR
POWER
VOLTAGE REGULATOR
DC TO DC CONVERTER
LORU BATTERY
CAPACITY: 400 WATT HRS
VHF RECEIVER
256.7 MHZ
VHF TRANSMITTER
296.8 MHZ
DOWNLINK SIGNAL PROCESSOR
UPLINK SIGNAL PROCESSOR
VHF OMNI ANTENNA
VHF TRIPLEXER
+14VDC
+12VDC TO DOWNLINK SIGNAL PROCESSOR, UPLINK SIGNAL PROCESSOR, VHF TRANSMITTER, AND VHF RECEIVER (DETECTOR AND AUDIO CIRCUITS)
+10VDC TO VHF RECEIVER (RF AND IF CIRCUITS)


LM 9-1.- LM RCS propellant profile. (July 26 launch date)
Mission profile dependent
7/1/71 Final
RCS propellant profile, lb
Total loaded, percent
633
600
500
400
300
200
100
0
100
90
80
70
60
50
40
30
20
10
0
RCS checkout
Undock
PDI
RCS checkout
APS TPI
Ascent
Docking
LM jettison
Impact
99
100
101
102
103
104
105
170
171
172
173
174
175
176
177
178
179
180
Ground elaped time, hr


LM 9-18.- Total spacecraft current. (July 26 launch date)
Mission profile dependent.
7/1/71 Final
Start checkout
PDI
Separation
Landing
Surface power down
SEVA
Sleep-1
EVA-1
Sleep-2
EVA-2
Sleep-3
EVA-3
Power up
PGNCS power up
Lift-off
Crew transfer
Impact
TPI
Docking
Total spacecraft current, amp
Ground elapsed time, hr
0
10
20
30
40
50
60
70
80
90
100
90
95
100
105
110
115
120
125
130
135
140
145
150
155
160
165
170
175
180


LM 9-2.- Descent stage battery status. (July 26 launch date)
Mission profile dependent
4/23/71 Basic
Summary
Initial capacity 2075 A-h
Lack of MSFN unusables -6 A-h
TM unusables -67 A-h
Dispersion -32 A-h
PGNCS power uncertainty -21 A-h
Mission requirements 1609 A-h
Total usable margin 340 A-h (16 %)
Descent battery charge status, amp hr
2200
2000
1800
1600
1400
1200
1000
800
600
400
200
Start checkout
PDI
Separation
Landing
Surface power down
SEVA
Sleep-1
EVA-1
Sleep-2
EVA-2
Sleep-3
EVA-3
PGNCS power up
Power up
Lift-off
90
95
100
105
110
115
120
125
130
135
140
145
150
155
160
165
170
175
180
Ground elapsed time, hr


LM 9-3.- Ascent stage battery status. (July 26 launch date)
Mission profile dependent
4/22/71 Basic
Summary
Initial capacity 592 A-h
Lack of MSFN unusables -5 A-h
TM unusables -18 A-h
Dispersion -6 A-h
PGNCS power uncertainty -12 A-h
Actual requirements to crew transfer -285 A-h
Total usable margin (at crew transfer) 266 A-h (45 %)
Ascent battery charge status, amp hr
1000
900
800
700
600
500
400
300
200
100
0
Ascent batteries parallel
PDI
Landing
Lift-off
TPI
Docking
Crew transfer
90
95
100
105
110
115
120
125
130
135
140
145
150
155
160
165
170
175
180
Ground elapsed time, hr



LM 9-4.- Descent stage oxygen remaining. (July 26 launch date)

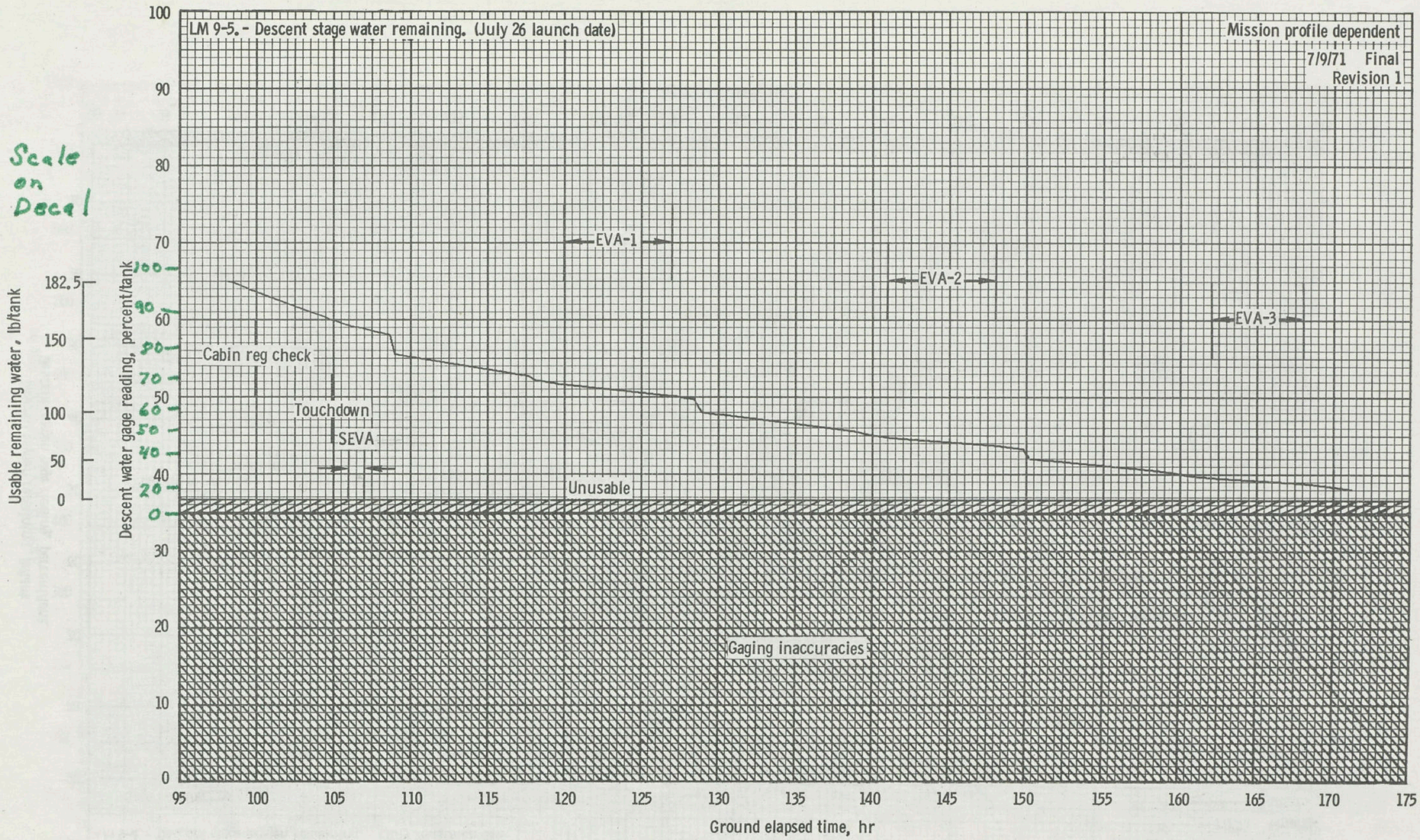
SIM BAY SECRD/OPEN

SIM BAY DOCKING

LM DESCENT O_2

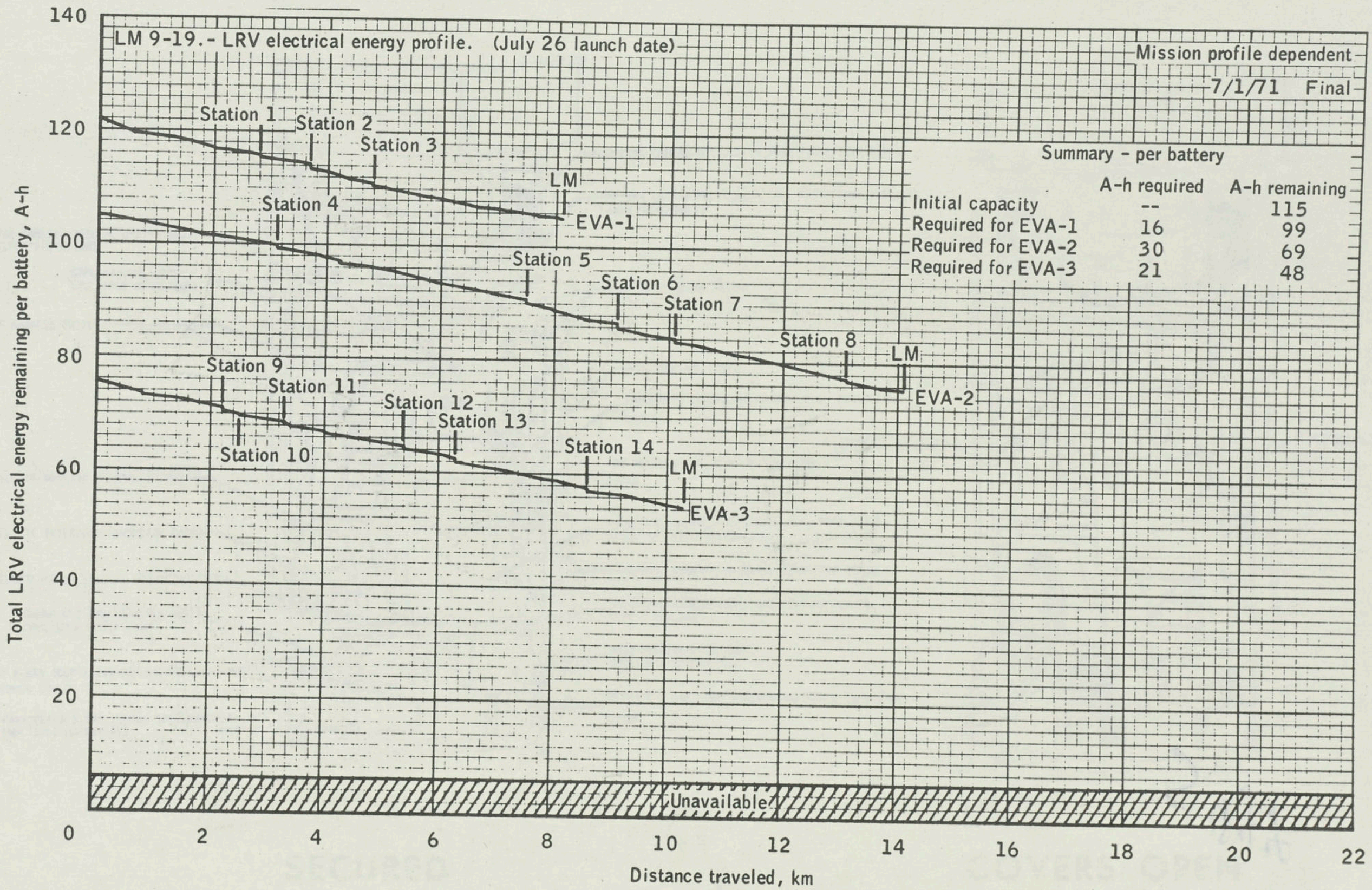
LRV AMP-HRS

LM DESCENT H_2O | LM ASCENT AMP-HRS | TOTAL CURRENT



PAGE 41

DATE 7/12/71
7/21/71



LRV AMP-HRS

SIM BAY DOCKING

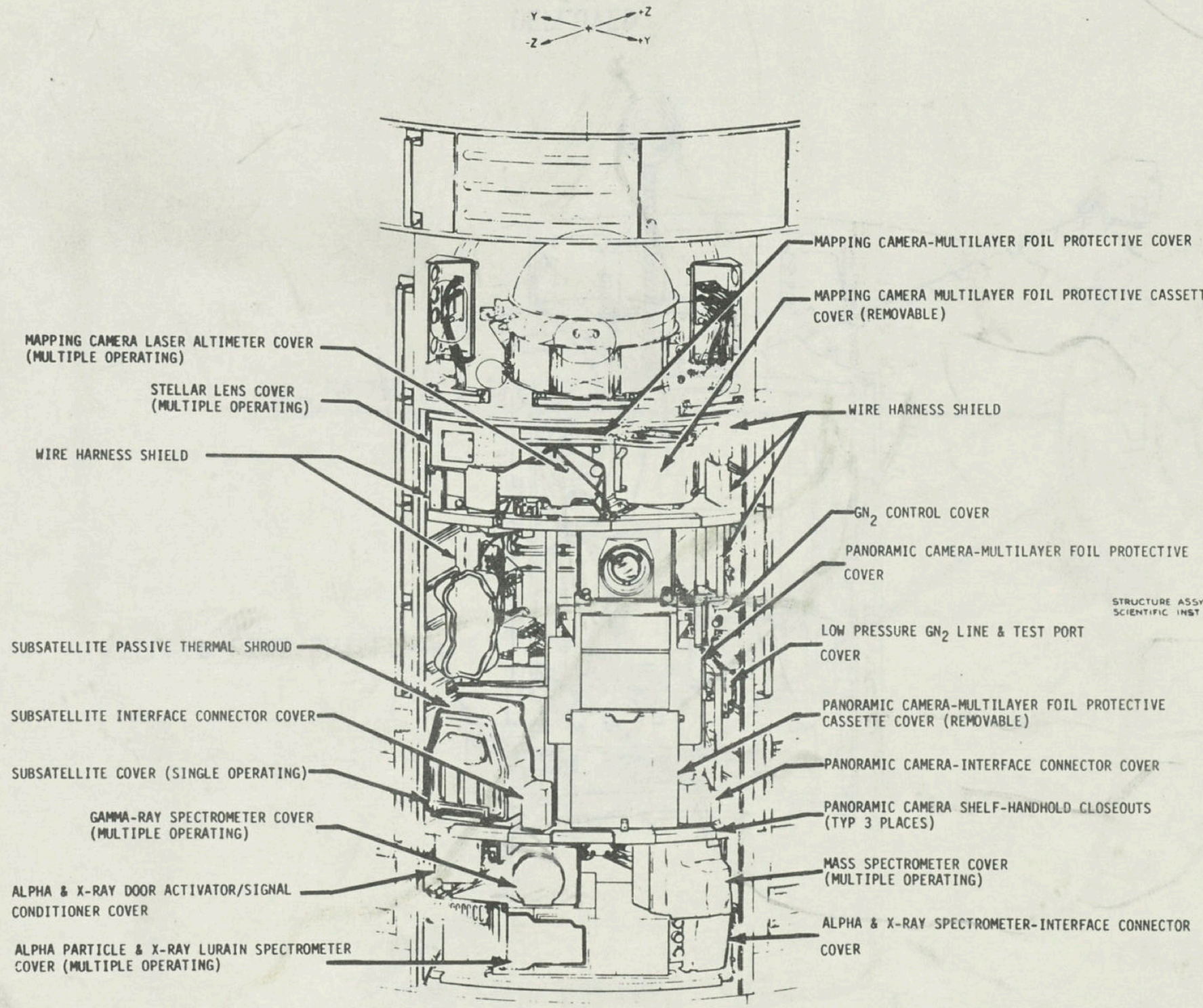
SIM BAY SECRD/OPEN

LM DESCENT H_2O

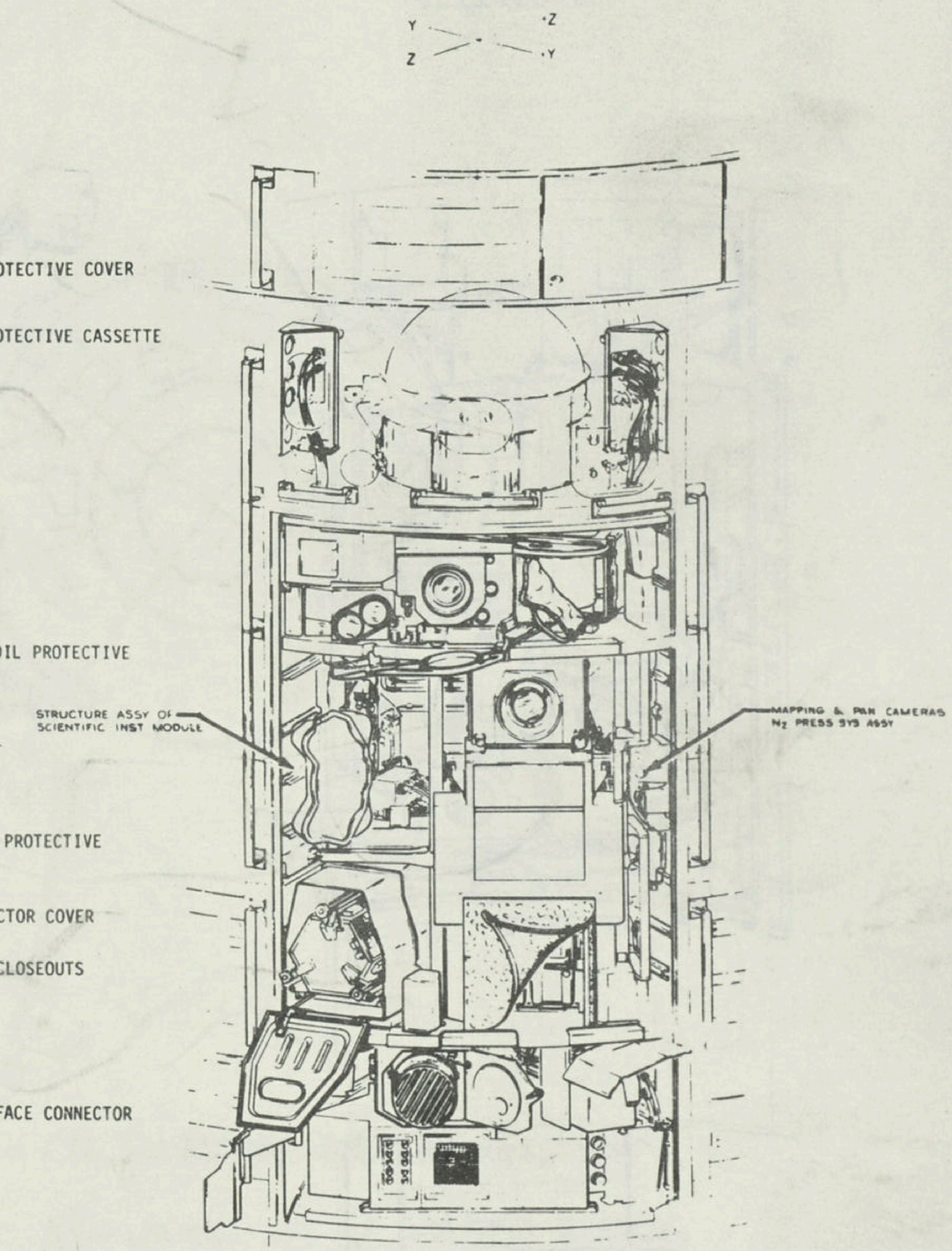
LM ASCENT AMP-HRS

TOTAL CURRENT

5444



SECURED



COVERS OPEN

SIM BAY DOCKING

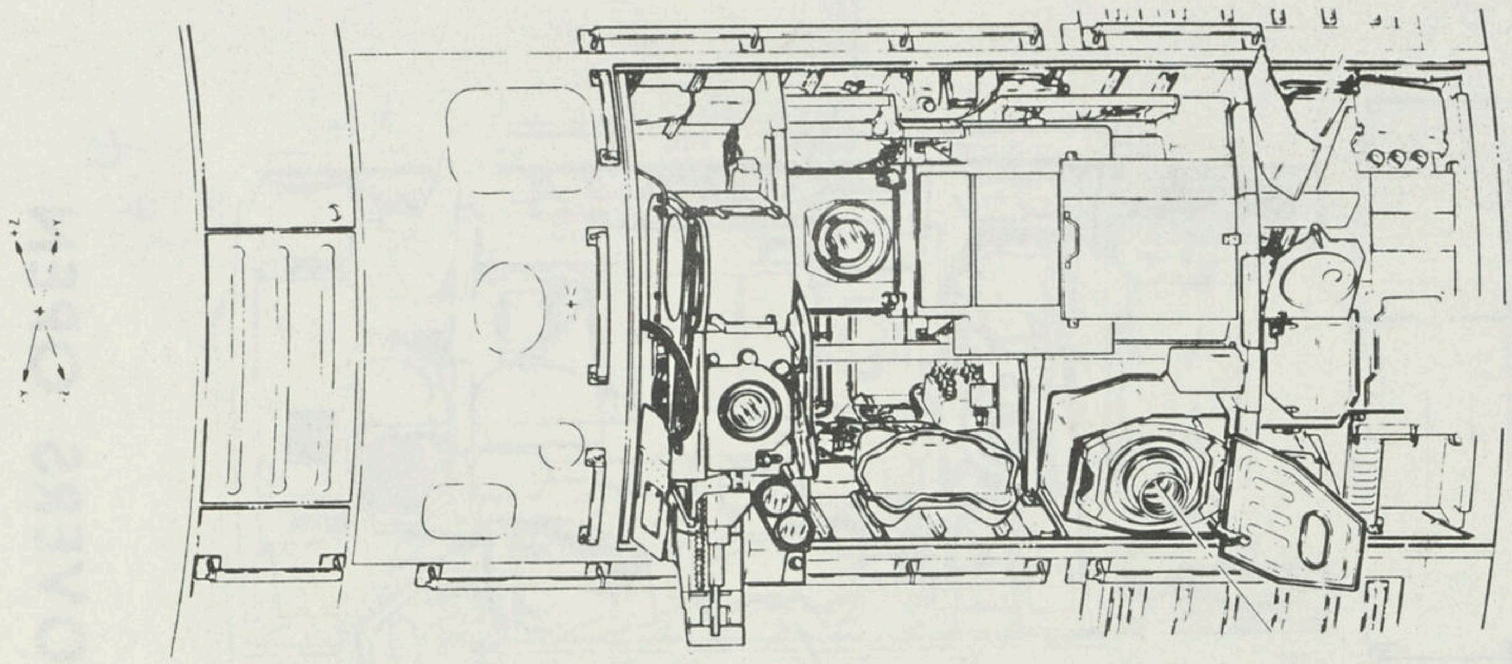
SIM BAY SECRD/OPEN

DEP & JETT SIM BAY

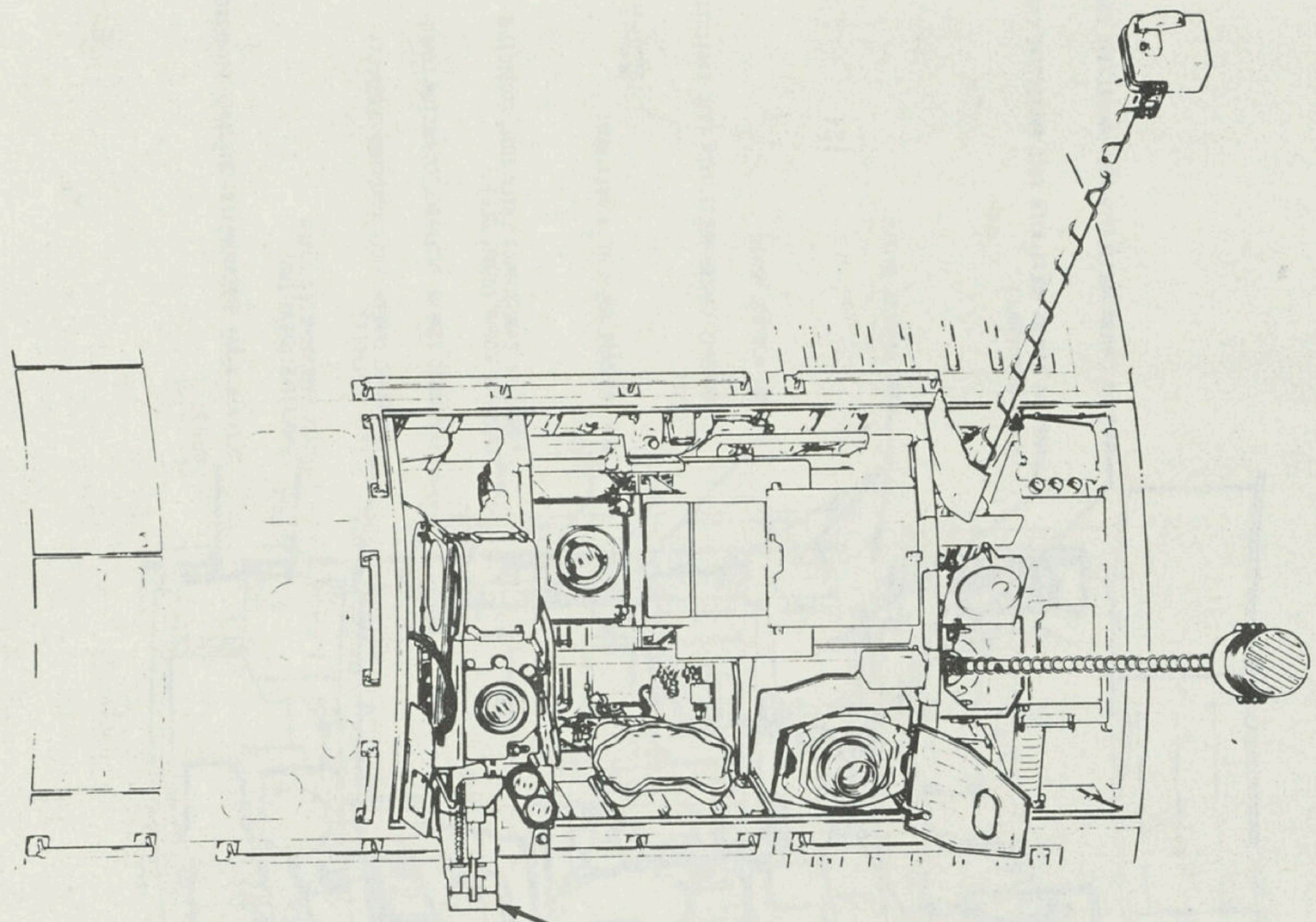
TOTAL CURRENT

LM ASCENT AMP-HRS

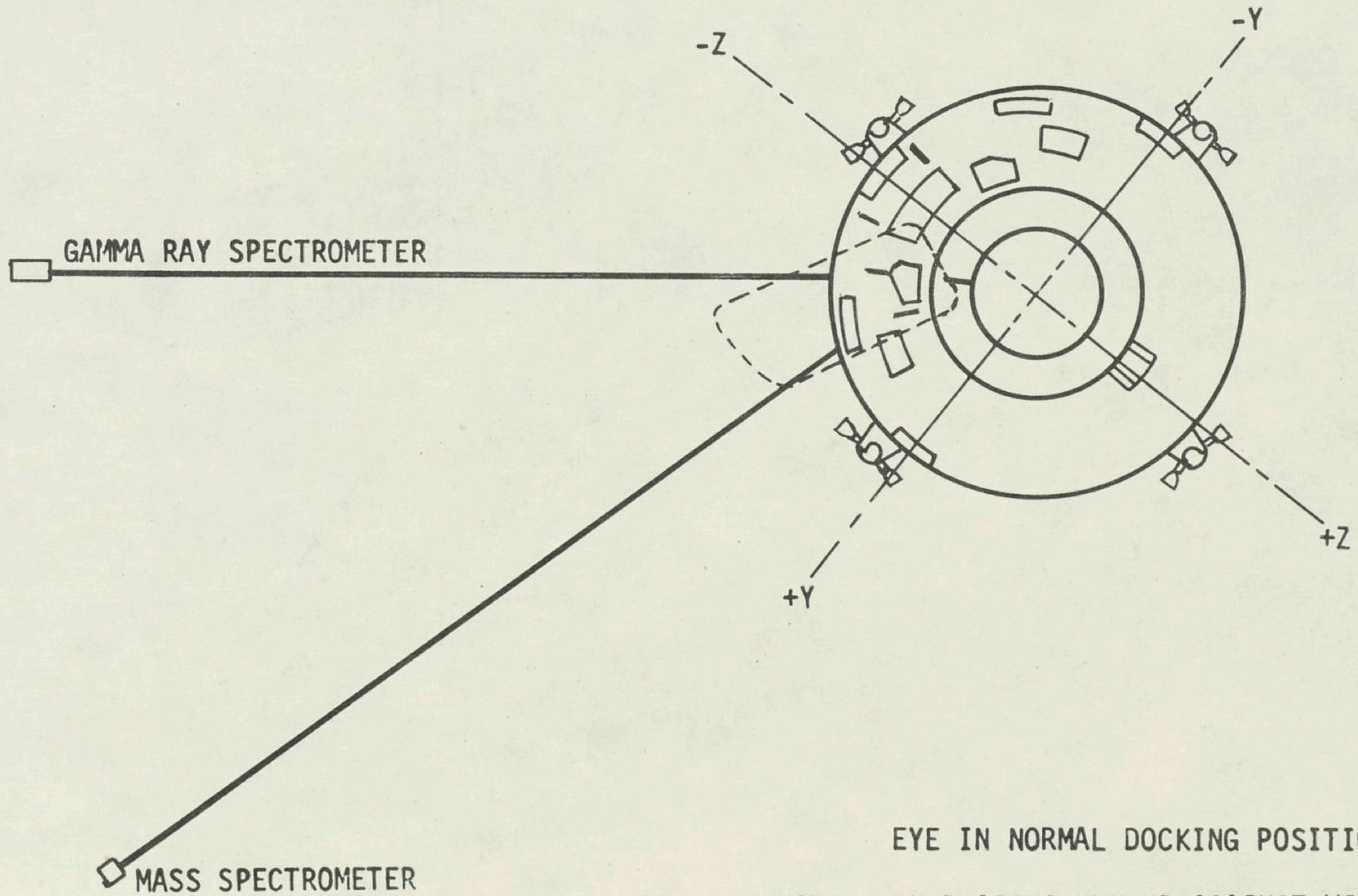
LM DESCENT H_2O



JETTISONED



DEPLOYED



EYE IN NORMAL DOCKING POSITION

NOTE: BY PLACING EYE UP AGAINST WINDOW, THE ENDS OF THE BOOMS CAN BE SEEN.

VIEW THRU DOCKING WINDOW WITH BOOMS DEPLOYED

SIM BAY DOCKING

LM DESCENT H_2O

LM ASCENT AMP-HRS

TOTAL CURRENT

DEP & JETT SIM BAY