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STS Inertial Upper Stage (IUS) Systems Handbook

Shuttle Operations Division
Payload Analysis Branch

Basic Rev G
December 1, 1988

USAF
United States Air Force

Consolidated Space Test Center
Onizuka AFB, California

NASA
National Aeronautics and
Space Administration

Lyndon B. Johnson Space Center
Houston, Texas

IUS SYSTEMS HANDBOOK

BASIC, REV. G

DECEMBER 1, 1988

PREPARED BY:

CSTC MISSION CONTROL TEAM
VEHICLE PLANS/ANALYSIS

DAVID R. PENNELL JR.
Book Manager

JAMES S. SCHNEPP, Lead
Vehicle/Plans Analysis

RAYMOND J. RYNEARSON, Supervisor
Vehicle/Plans and Orbit Analysis

DARYL J. JOSEPH, Lt. Col., USAF
Mission Director,
Shuttle and IUS Operations Division

UNITED STATES AIR FORCE
CONSOLIDATED SPACE TEST CENTER
ONIZUKA AFB, CALIFORNIA

INERTIAL UPPER STAGE SYSTEMS HANDBOOK

Revision G

PREFACE

This revision was prepared by the Lockheed Mission Control Team Vehicle/ Plans Analysis Branch, Shuttle Operations Division, Consolidated Space Test Center (CSTC), Sunnyvale, CA.

This document reflects the IUS systems and Orbiter interfaces. The material is presented in the form of functional schematics and overviews. Major emphasis is on material for use by the CSTC flight operations personnel. Further details can be found in schematics and documents provided by Boeing Aerospace Company. Comments concerning the contents of this handbook should be directed to David Pennell, Onizuka Air Force Base, (408) 752-4113. Changes in distribution should be directed to Lt. Chris Gdanski, Johnson Space Center, (713) 483-3511.

The IUS Systems Handbook is a "generic" document. To accommodate this, some drawings have been split into a TDRS configuration and a DOD configuration. This is designated in the drawing number by an 'A' or 'B,' respectively.

Mission-specific annexes to this document will be produced to include data which is unique to each mission. These annexes will be classified SECRET for all DOD missions and will have separate distribution lists.

INERTIAL UPPER STAGE SYSTEMS HANDBOOK

BASIC, REV G

December 1, 1988

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TABLE 1-I.- IUS BUS NOMENCLATURE

Symbology	Nomenclature
ORBITER	
V AUX PLA	Auxiliary payload A bus
V AUX PLA RTN	Auxiliary payload A bus return
V AUX PLB	Auxiliary payload B bus
V AUX PLB RTN	Auxiliary payload B bus return
V ESS1BC	Essential bus 1BC
V ESS2CA	Essential bus 2CA
V MNA MPC 1	Main A, mid power controller 1
V MNB MPC 2	Main B, mid power controller 2
V PCP PRI	Power control panel primary bus
V PCP PRI RTN	Power control panel primary return
V PCP ALT	Power control panel alternate return
V PCP ALT RTN	Power control panel alternate bus
V PRI PL	Primary payload bus

TABLE 1-I.- Continued

Symbology	Nomenclature
ORBITER (Concluded)	
$V_{PL\ RTN}$	Primary payload return bus
$V_{SEC\ PL}$	Secondary payload bus
$V_{MNA\ RTN}$	Main A, return bus
$V_{MNB\ DA2}$	Main B, distribution bus
$V_{MNC\ DA3}$	Main C, distribution bus
$V_{MNC\ RTN}$	Main C, return bus
$V_{CAB\ PL\ 1}$	Orbiter cabin payload bus 1
$V_{CAB\ PL\ 1\ RET}$	Orbiter cabin payload bus 1 rtn
$V_{CAB\ PL\ 2}$	Orbiter cabin payload bus 2
$V_{CAB\ PL\ 3}$	Orbiter cabin payload bus 3
$V_{CNTL\ BC1}$	Main B control bus 1
$V_{CNTR\ BC2}$	Main B control bus 2
$V_{MNC3\ FLC\ 1}$	Main C forward load controller
$V_{MNB\ FLC\ 2}$	Main B forward load controller

TABLE 1-I.- Continued

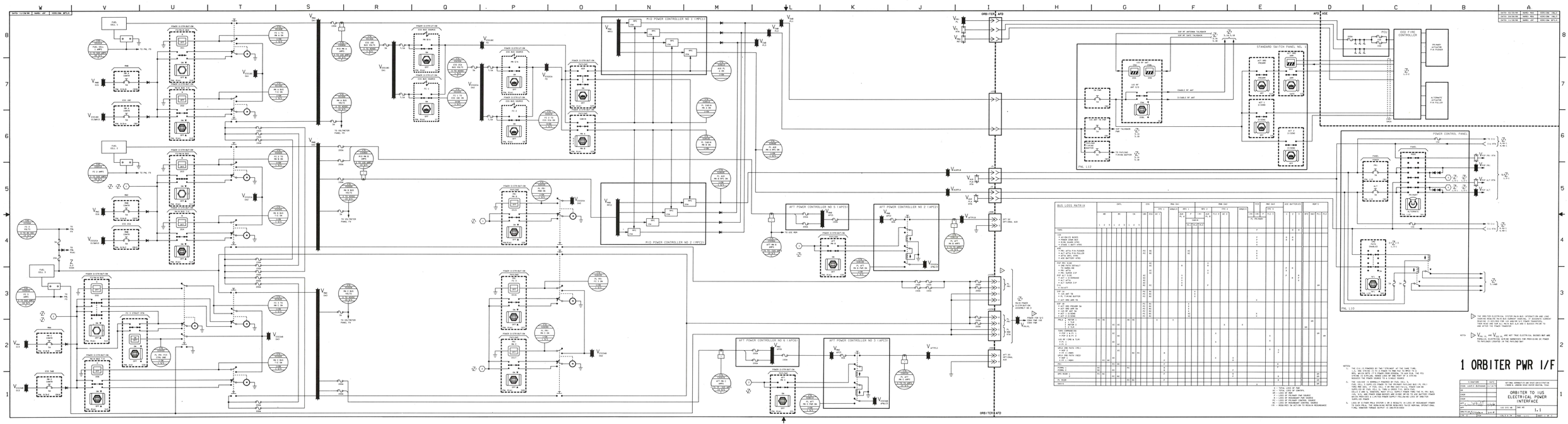
Symbology	Nomenclature
AIRBORNE SUPPORT EQUIPMENT	
V CIU	CIU bus
V CIU RTN	CIU bus return
V PCA	Power control bus A
V PCB	Power control bus B
V PPB A	Pin puller bus A
V PCP PRI	PCP primary bus
V PCP PRI RTN	PCP primary bus return
V PCP ALT	PCP alternate bus
V PCP ALT RTN	PCP alternate bus return
V PPB B	Pin puller bus B
V PPB A RTN	Pin puller A return bus
V PPB B RTN	Pin puller B return bus
V ORD A	Ordnance bus A
V ORD B	Ordnance bus B
V 20 VDC PRI ACT CNTLER	Primary actuator potentiometer power
V 20 VCD ALT ACT CNTLER	Alternate actuator potentiometer power

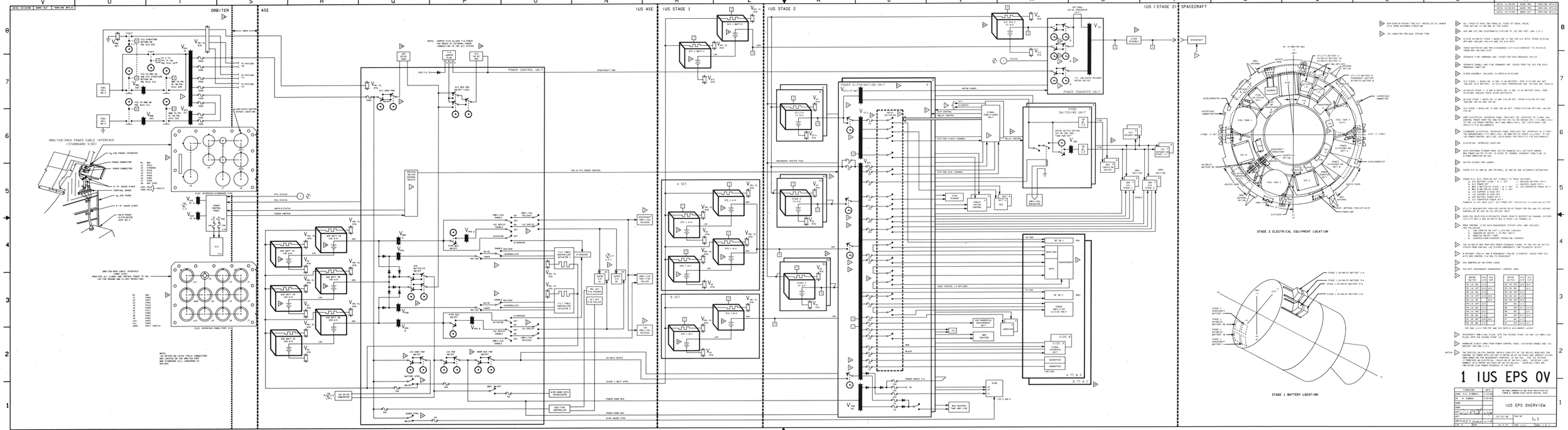
TABLE 1-I.- Continued

Symbology	Nomenclature
AIRBORNE SUPPORT EQUIPMENT (Concluded)	
V 10 VDC PRI ACT CNTLER	Primary actuator controller logic power
V 10 VDC ALT ACT CNTLER	Alternate actuator controller logic power
INERTIAL UPPER STAGE	
V AV A	Avionics bus A
V AV A RTN	Avionics bus A return
V AV B	Avionics bus B
V AV B RTN	Avionics bus B return
V UTIL A	Utility bus A
V UTIL B	Utility bus B
V UTIL BATT A	Utility battery bus A
V UTIL BATT B	Utility battery bus B
V PWR DWN A	Power down bus A
V PWR DWN B	Power down bus B
V SC	Spacecraft bus
V ORD A	Ordnance bus A

TABLE 1-I.- Concluded

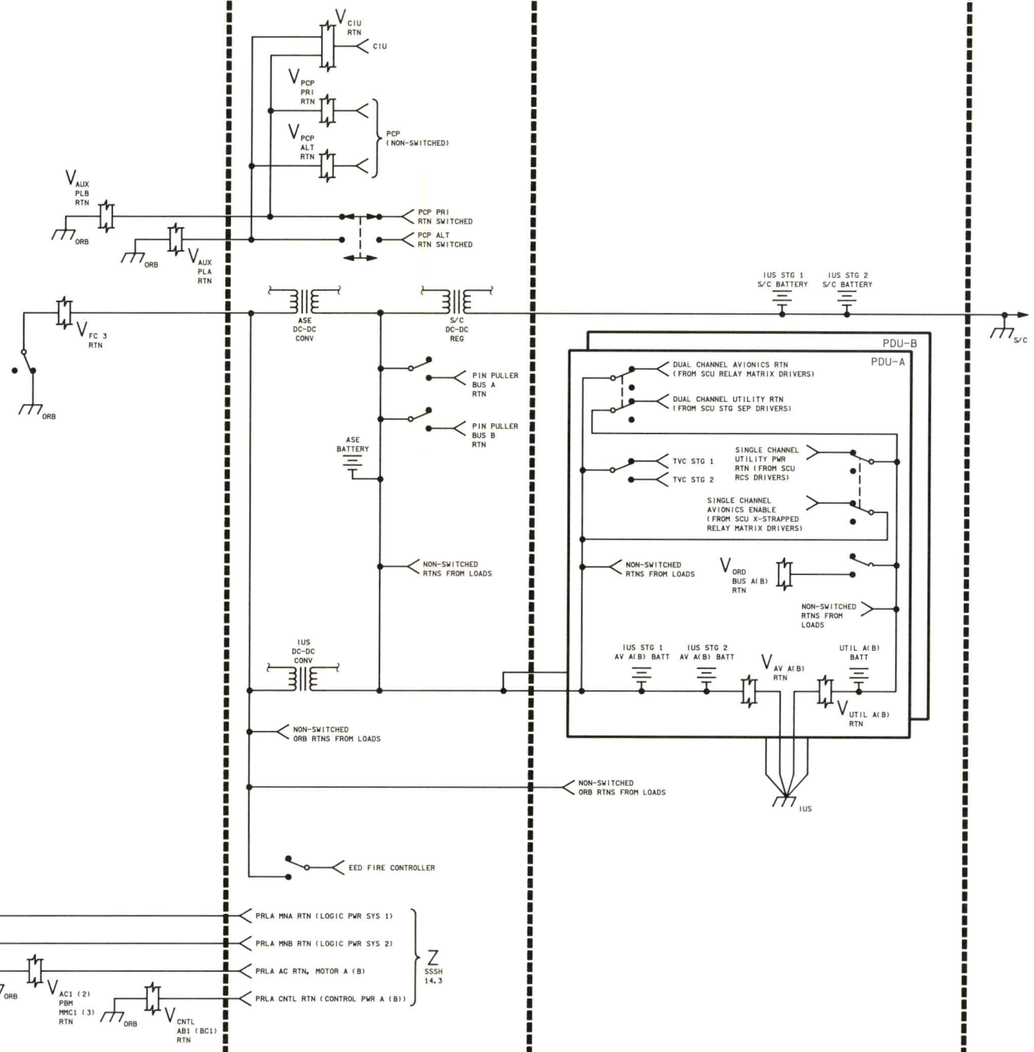
Symbology	Nomenclature
INERTIAL UPPER STAGE (Concluded)	
$V_{ORD\ B}$	Ordnance bus B
$V_{ORD\ A\ RTN}$	Ordnance return bus A
$V_{ORD\ B\ RTN}$	Ordnance return bus B


1 ORBITER PWR I/F
ORBITER ELECTRICAL POWER INTERFACE
ORBITER TO LUS
BUS LOSS MATRIX
NOTES:
1. THE CCU IS POWERED BY THE "ON-WAY" AT THE SAME TIME.
2. THE CCU IS POWERED BY THE "ON-WAY" AT THE SAME TIME.
3. THE CCU IS POWERED BY THE "ON-WAY" AT THE SAME TIME.


ORBITER
ASE
IUS STAGE 1
IUS STAGE 2
IUS STAGE 2I
SPACECRAFT
IUS ASE
POWER CONTROL UNIT
POWER DISTRIBUTION UNIT
POWER TRANSFER UNIT
SWITCHING UNIT
SIDE A
SIDE B
A SET
B SET
STAGE 2 ELECTRICAL EQUIPMENT LOCATION
STAGE 1 BATTERY LOCATION
1 IUS EPS OV
IUS EPS OVERVIEW
SIZE: D
SHT NO: 1
REV: 5.1

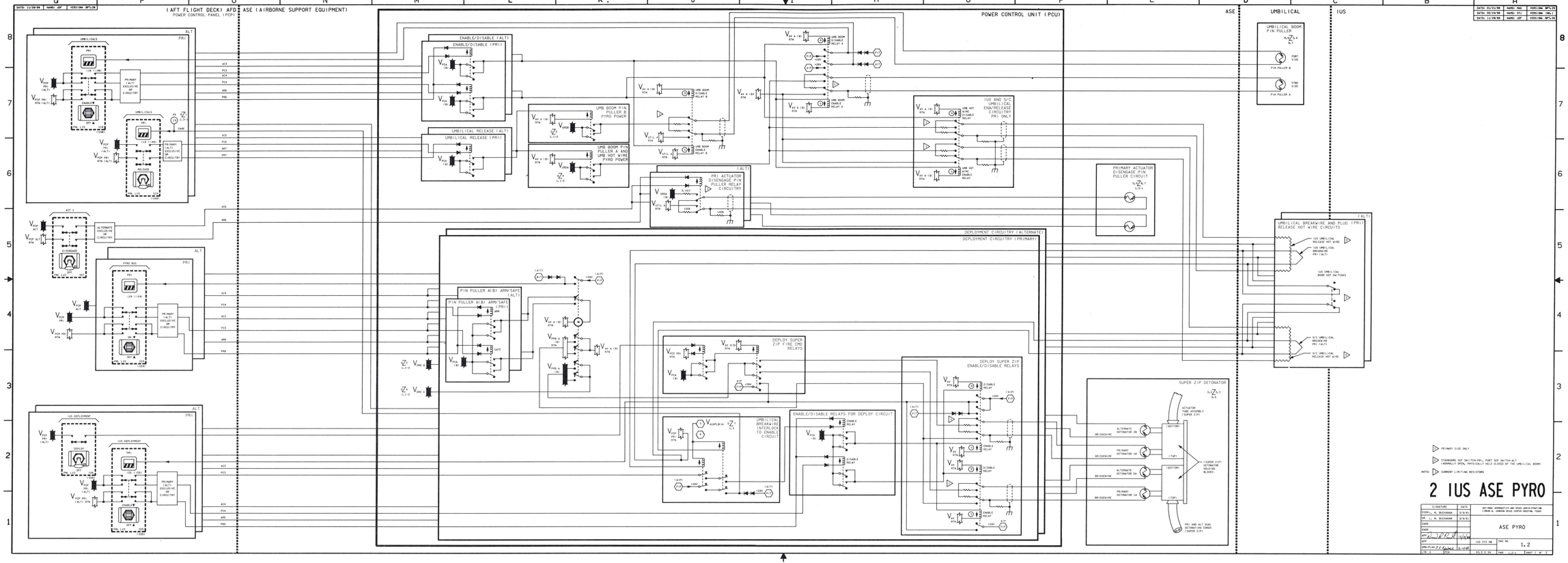
DATE: 1/15/88	NAME: BJT	VERSION: BPT 3
DATE: 2/24/88	NAME: MFB	VERSION: INK 2
DATE: 11/14/88	NAME: BCH	VERSION: BPT 4

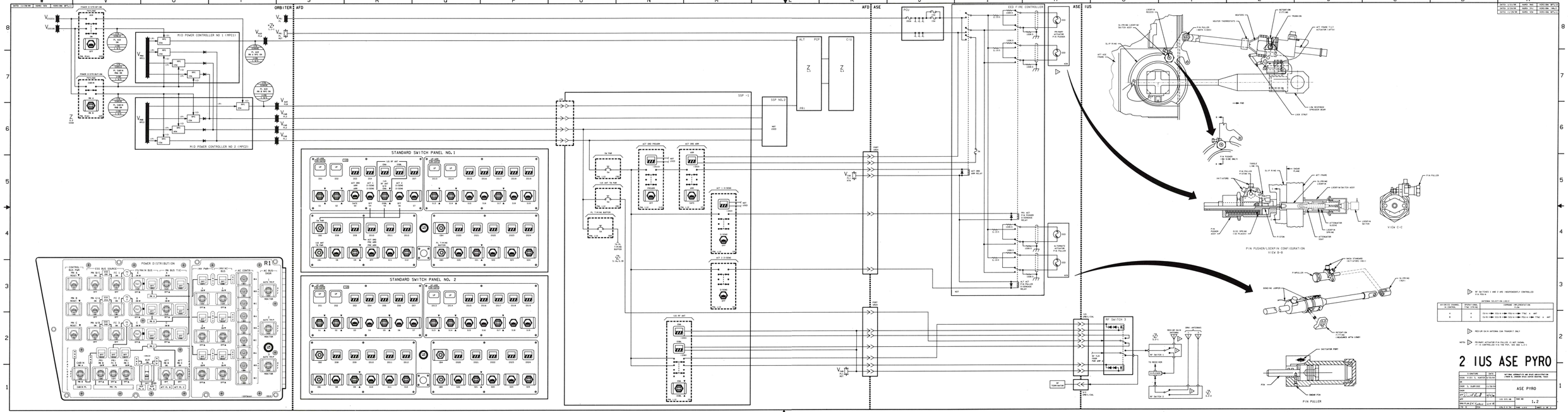
ORBITER | ASE | ASE | IUS | IUS | SPACECRAFT

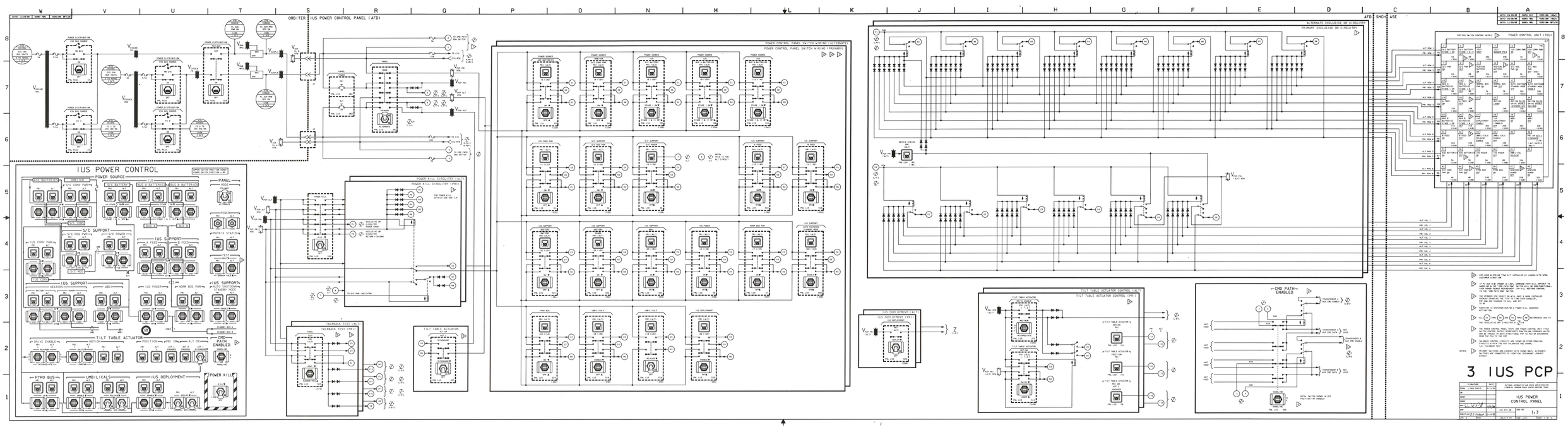


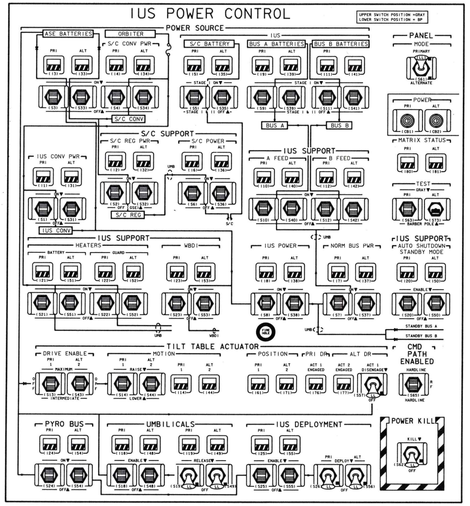
IUS RTN CIR DIAGRAM

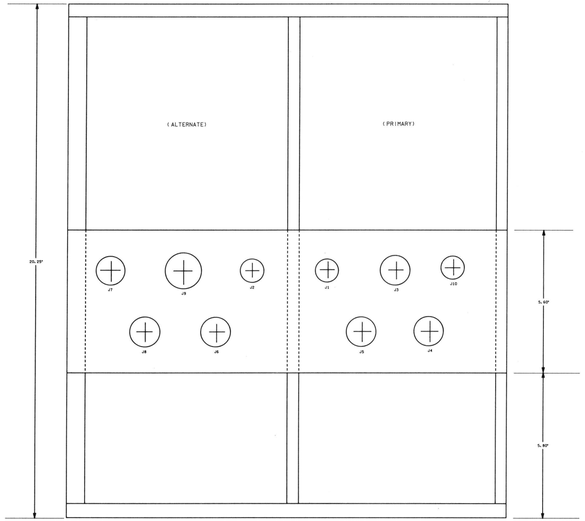
SIGNATURE	DATE	NATIONAL AERONAUTICS AND SPACE ADMINISTRATION LYNDON B. JOHNSON SPACE CENTER HOUSTON, TEXAS
DSGN JAMES BLANCHARD	10/24/86	
DR		
ENGR S. DuBridge	4/6/88	IUS RETURN CIRCUIT DIAGRAM
ENGR		
APP Scott DuBridge	4/6/88	
APP	4/12/88	IUS DWG NO 1.1
OMNIPLAN, S.C. Kaiser	4-8-88	
LTR G PCN		44 X 34 PAGE 1.1-3 SHEET 3 OF 3


(AFT FLIGHT DECK) AFD
POWER CONTROL PANEL (PCP)
ASE (AIRBORNE SUPPORT EQUIPMENT)
POWER CONTROL UNIT (PCU)
ASE
UMBILICAL
IUS
UMBILICAL BOOM PIN PULLER
ENABLE/DISABLE (ALT)
ENABLE/DISABLE (PRI)
UMBILICAL RELEASE (ALT)
UMBILICAL RELEASE (PRI)
LMB BOOM PIN PULLER B PYRO POWER
LMB BOOM PIN PULLER A AND UMB HOT WIRE PYRO POWER
PRI ACTUATOR DISENGAGE PIN PULLER RELAY CIRCUITRY
IUS AND S/C UMBILICAL ENA/RELEASE CIRCUITRY PRI ONLY
PRIMARY ACTUATOR DISENGAGE PIN PULLER CIRCUIT
UMBILICAL BREAKWIRE AND PLUG (PRI) RELEASE HOT WIRE CIRCUITS
DEPLOYMENT CIRCUITRY (ALTERNATE)
DEPLOYMENT CIRCUITRY (PRIMARY)
PIN PULLER A(B) ARM/SAFE (ALT)
PIN PULLER A(B) ARM/SAFE (PRI)
DEPLOY SUPER ZIP FIRE CMD RELAYS
DEPLOY SUPER ZIP ENABLE/DISABLE RELAYS
ENABLE/DISABLE RELAYS FOR DEPLOY CIRCUIT
UMBILICAL BREAKWIRE INTERLOCK TO ENABLE CIRCUIT
SUPER ZIP DETONATOR
ACTUATOR TUBE ASSEMBLY (SUPER ZIP)
PRI AND ALT DUAL DETONATING CORDS (SUPER ZIP)
PRIMARY SIDE ONLY
STARBOARD SEP SWITCH-PRI, PORT SEP SWITCH-ALT
NORMALLY OPEN, PHYSICALLY HELD CLOSED BY THE UMBILICAL BOOM
NOTE
CURRENT LIMITING RESISTORS
2 IUS ASE PYRO
SIGNATURE
DATE
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
LYNDON B. JOHNSON SPACE CENTER HOUSTON, TEXAS
ASE PYRO
IUS STS 5B
DWG NO
1.2
SCALE NONE
SHEET 1 OF 2

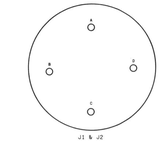

ORBITER AFD
AFD ASE
ASE IUS
MID POWER CONTROLLER NO 1 (MPC1)
MID POWER CONTROLLER NO 2 (MPC2)
POWER DISTRIBUTION
STANDARD SWITCH PANEL NO. 1
STANDARD SWITCH PANEL NO. 2
SSP NO.1
SSP NO.2
ECO FIRE CONTROLLER
RF SWITCH 3
RF SWITCH 1
RF SWITCH 2
TO RCS HDR
OMNI ANTENNAS
RCS-FUR QUAD ANTENNA
PIN PULLER
VIEW C-C
PIN PUSHER/LOCKPIN CONFIGURATION
VIEW B-B
2 IUS ASE PYRO
ASE PYRO
1.2


ORBITER IUS POWER CONTROL PANEL (AFD)
IUS POWER CONTROL
POWER SOURCE
S/C SUPPORT
IUS SUPPORT
LMBILICALS
IUS DEPLOYMENT
PYRO BUS
TILT TABLE ACTUATOR
POWER KILL
CMD PATH ENABLED
POWER CONTROL PANEL SWITCH WIRING (ALTERNATE)
POWER CONTROL PANEL SWITCH WIRING (PRIMARY)
POWER KILL CIRCUITRY (ALT)
POWER KILL CIRCUITRY (PRI)
TALKBACK TEST (ALT)
TALKBACK TEST (PRI)
TILT TABLE ACTUATOR CONTROL (ALT)
TILT TABLE ACTUATOR CONTROL (PRI)
IUS DEPLOYMENT (ALT)
IUS DEPLOYMENT (PRI)
ALTERNATE EXCLUSIVE OR CIRCUITRY
PRIMARY EXCLUSIVE OR CIRCUITRY
AFD # SMOKE ASE
3 IUS PCP
IUS POWER CONTROL PANEL
1.3

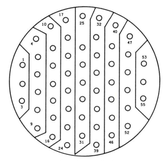




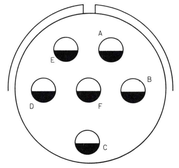
(REAR VIEW)
POWER CONTROL PANEL CONNECTOR LOCATION



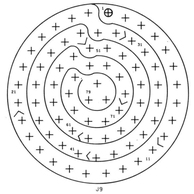
J1 & J2

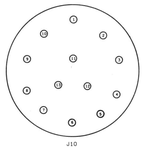


J3, J4, J7, & J8



J5 & J6





POWER CONTROL PANEL
CONNECTOR LAYOUT

POWER CONTROL PANEL CONNECTOR PIN ASSIGNMENTS

CONNECTOR	PIN NO.	FUNCTION
J1	A	28 VDC AUR BUS B (AUR PL B)
	B	RETURN
J2	A	28 VDC AUR BUS A (AUR PL A)
	B	RETURN
J3	5	PRIMARY COL 1
	6	PRIMARY COL 2
	7	PRIMARY COL 3
	8	PRIMARY COL 4
	14	PRIMARY COL 5
	21	PRIMARY ROW 1
	22	PRIMARY ROW 2
	23	PRIMARY ROW 3
	29	PRIMARY ROW 4
	30	PRIMARY ROW 5
	12	PRIMARY ROW 6
	13	PRIMARY ROW 7
	37	PRIMARY ROW 8
	38	PRIMARY ROW 9
	39	PRIMARY ROW 10
	41	S/C PWR SRC PRI PTS (IUS CONV PWR)
	42	S/C PWR SRC PRI PTS (S/C REG PWR)
	43	ASE BATT ON PTS (ASE BATTERIES)
	44	SRB PWR ON PTS (S/C CONV PWR)
J4	1	S/C STG 1 BATT ON PSN (S/C BATTERY)
	5	S/C ASE ON PSG (S/C POWER)
	32	IUS PWR UP PST (WORM BUS PWR)
	33	IUS PWR UP PSU (WORM BUS PWR)
	43	AY BUS A STG 1 BATT ON PSX (BUS A BATTERIES)
	44	AY BUS A ASE ON PSSS (A FEED)
	47	AY BUS B STG 1 BATT ON PSW (BUS B BATTERIES)
	48	AY BUS B ASE ON PSSS (B FEED)
	49	AST OPERATING PS24 (TILT TABLE ACTUATOR MOTION)
	13	UMB SEP ENABLED PS18
	14	UMB SEP RELEASED PS18
	54	OVER TEMP OVERRIDE PS20 (AUTO SHUTDOWN STANDBY MODE)
	21	BATT HEATER ON PS22
	22	WBDI ON PS23
	15	PYR PULLED BUS ARMED PS24 (PYRO BUS)
	23	IUS DEPLOY ENABLED PS25
	24	AST CMD L/M/T AST2 TILT TABLE ACTUATOR POSITION)
	52	IUS DEPLOY CMD PR1 PS26
	53	NOT USED PART #29502
	30	RETURN
	56	NO CONNECTION (POP SPRG)
	27	AST 1 LOCK PIN ENG PS28 (PRI DR, ACT 1 ENGAGED)
J5	A	28 VDC AUR BUS B (AUR PL B)
	B	RETURN
	C	RETURN
	D	28 VDC AUR BUS A (AUR PL A)
	E	28 VDC AUR BUS B (AUR PL B)
	F	28 VDC AUR BUS B (AUR PL B)
J6	A	28 VDC AUR BUS A (AUR PL A)
	C	RETURN
J7	5	ALTERNATE COL 1
	6	ALTERNATE COL 2
	7	ALTERNATE COL 3
	8	ALTERNATE COL 4
	14	ALTERNATE COL 5
	15	ALTERNATE ROW 1
	22	ALTERNATE ROW 2
	23	ALTERNATE ROW 3
	29	ALTERNATE ROW 4
	30	ALTERNATE ROW 5
	12	ALTERNATE ROW 6
	13	ALTERNATE ROW 7
	37	ALTERNATE ROW 8
	38	ALTERNATE ROW 9
	39	ALTERNATE ROW 10
	41	S/C PWR SRC ALT PTS (IUS CONV PWR)
	42	S/C PWR SRC ALT PTS (S/C REG PWR)
	43	ASE BATT ON ATS (S/C BATTERIES)
	44	SRB PWR ON ATS (S/C CONV PWR)
J8	1	S/C STG 1 BATT ON ATP (S/C BATTERY)
	5	S/C ASE ON ATG (S/C POWER)
	32	IUS PWR UP ATT (WORM BUS PWR)
	33	IUS ON ALT ATR (IUS POWER)
	43	AY BUS A STG 1 BATT ON ATX (BUS A BATTERIES)
	44	AY BUS A ASE ON ATSS (A FEED)
	47	AY BUS B STG 1 BATT ON ATU (BUS B BATTERIES)
	48	AY BUS B ASE ON ATSS (B FEED)
	49	AST OPERATING ATS4 (TILT TABLE ACTUATOR MOTION)
	13	UMB SEP ENABLED ATS8
	14	UMB SEP RELEASED ATS8
	54	OVER TEMP OVERRIDE ATS0 (AUTO SHUTDOWN STANDBY MODE)
	21	BATT HEATER ON ATS2
	22	WBDI ON ATS3
	15	PYR PULLED BUS ARMED ATS4 (PYRO BUS)
	23	IUS DEPLOY ENABLED ATS5
	24	AST CMD L/M/T AST2 TILT TABLE ACTUATOR POSITION)
	51	AST 2 LOCK PIN ENG ASTT (ALT DR, ACT 2 ENGAGED)
	52	IUS DEPLOY CMD ATS6 (TILT TABLE DRIVE ENABLE)
	53	IUS DEPLOY CMD ATS6
	30	PYR ALTERNATE +28VDC
	56	PIN
J9	55	TRANSPONDER A SIGNAL CNTL (CMD PATH ENABLED)
	56	RETURN
	58	TRANSPONDER B SIGNAL CNTL (CMD PATH ENABLED)
	59	RETURN
J10		NO FUNCTION

▷ ECP-0259 B-STRING ITAC KIT INSTALLED AT LAUNCH SITE UPON CUSTOMER DIRECTION

NOTES: ▷ NOT CONNECTED IN C1U CONNECTOR

3 IUS PCP 2

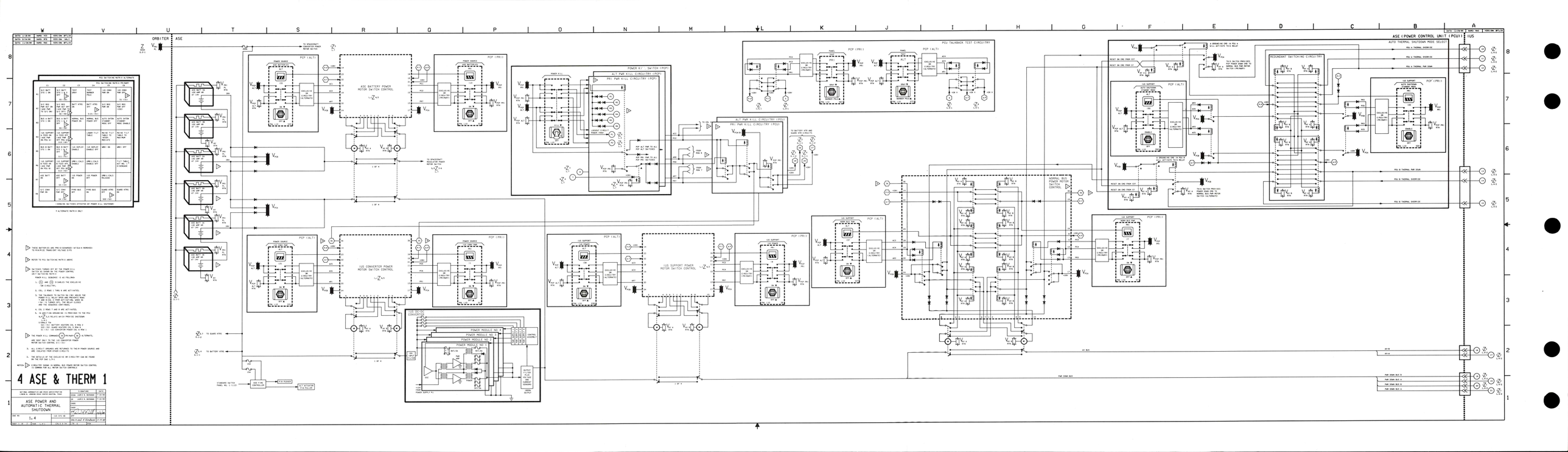
SIGNATURE		DATE
DSGN	MONTA UREGALES	5/29/88
DR	MONTA UREGALES	5/29/88
CHKR		
ENGR		
APP		
APP		
MNFL/PLNG		
T/R		
QUA		

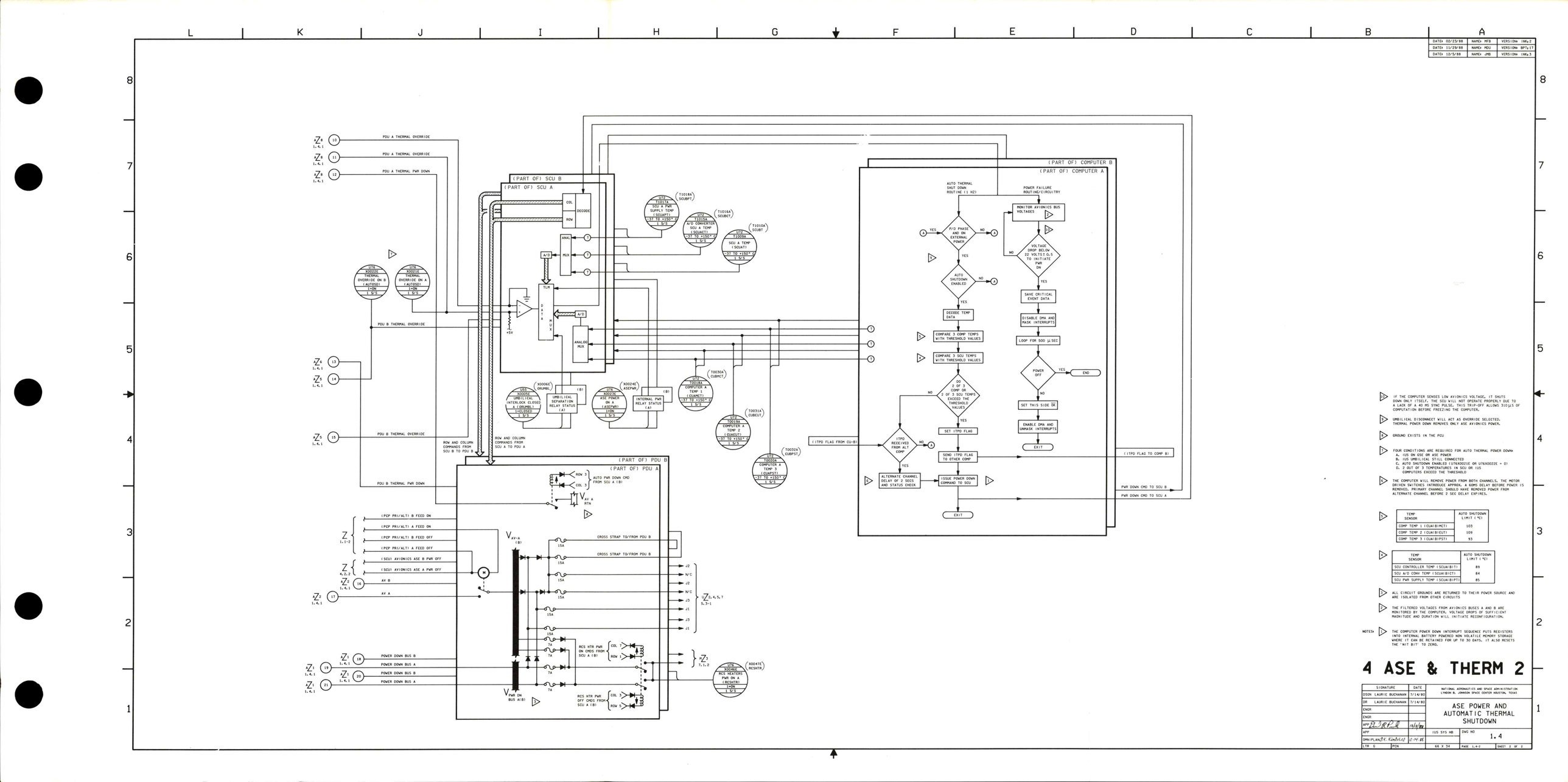
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
LYNDON B. JOHNSON SPACE CENTER HOUSTON, TEXAS

IUS POWER CONTROL PANEL

IUS SYS NO | DWG NO 1.3

35.5.2.34 | PAGE 1.3-2 | SHEET 3 OF 3


4 ASE & THERM 1
ASE POWER AND AUTOMATIC THERMAL SHUTDOWN
ASE (POWER CONTROL UNIT (PCU)) 1 IUS
AUTO THERMAL SHUTDOWN MODE SELECT
PCU SWITCHING MATRIX (ALTERNATE)
ORBITER ASE
POWER SOURCE
PCP (ALT)
PCP (PRI)
ASE BATTERY POWER MOTOR SWITCH CONTROL
IUS CONVERTER POWER MOTOR SWITCH CONTROL
IUS SUPPORT POWER MOTOR SWITCH CONTROL
NORMAL BUS POWER MOTOR SWITCH CONTROL
POWER K1 SWITCH (PCP)
ALT PWR K1LL CIRCUITRY (PCP2)
PRI PWR K1LL CIRCUITRY (PCP1)
PCU TALKBACK TEST CIRCUITRY
REDUNDANT SWITCHING CIRCUITRY
IUS SUPPORT
AUTO SHUTDOWN
MODE SELECT
EXCLUSIVE OR CIRCUITRY (AUTOMATIC)
EXCLUSIVE OR CIRCUITRY (THERMAL)
IUS CONVERTER
POWER MODULE NO. 4
POWER MODULE NO. 3
POWER MODULE NO. 2
POWER SUPPLY #2
CONTROL SIGNALS
OUTPUT TO IUS VIA "UP" UMBILICAL
UMBILICAL SIGNALS
STANDARD SWITCH PANEL NO. 3 (L33)
ASE FAN CONTROLLER
ASE FUSING
ALT AVIONICS 28 VDC BUS
TO GUARD HTRS
TO BATTERY HTRS
TO SPACECRAFT REDUNDANT POWER MOTOR SWITCHES
TO SPACECRAFT ALTERNATE POWER MOTOR SWITCHES
TO BATTERY HTR AND POWER MOTOR SWITCHES
PWR DOWN BUS
PCU A THERMAL OVERHEAT
PCU A THERMAL PWR DOWN
PCU B THERMAL PWR DOWN
PCU B THERMAL OVERHEAT
PWR DOWN BUS A
PWR DOWN BUS B
PWR DOWN BUS C
PWR DOWN BUS D
ASE BATTERY HTRS
GUARD HTRS
ASE FUSING
ALT AVIONICS 28 VDC BUS
NORMAL BUS
ALT AVIONICS
IUS SUPPORT
PCP (ALT)
PCP (PRI)
POWER SOURCE
ASE BATTERY POWER MOTOR SWITCH CONTROL
IUS CONVERTER POWER MOTOR SWITCH CONTROL
IUS SUPPORT POWER MOTOR SWITCH CONTROL
NORMAL BUS POWER MOTOR SWITCH CONTROL
POWER K1 SWITCH (PCP)
ALT PWR K1LL CIRCUITRY (PCP2)
PRI PWR K1LL CIRCUITRY (PCP1)
PCU TALKBACK TEST CIRCUITRY
REDUNDANT SWITCHING CIRCUITRY
ASE (POWER CONTROL UNIT (PCU)) 1 IUS
AUTO THERMAL SHUTDOWN MODE SELECT



DATE▷ 02/23/88	NAME▷ MFB	VERSION▷ INH₂2
DATE▷ 11/29/88	NAME▷ MDU	VERSION▷ BP7₂17
DATE▷ 12/5/88	NAME▷ JMB	VERSION▷ INH₂3

▷ IF THE COMPUTER SENSES LOW AVIONICS VOLTAGE, IT SHUTS DOWN ONLY ITSELF. THE SCU WILL NOT OPERATE PROPERLY DUE TO A LACK OF A 40 MS SYNC PULSE. THIS TRIP-OFF ALLOWS 310 μS OF COMPUTATION BEFORE FREEZING THE COMPUTER.

▷ UMBILICAL DISCONNECT WILL ACT AS OVERRIDE SELECTED. THERMAL POWER DOWN REMOVES ONLY ASE AVIONICS POWER.

▷ GROUND EXISTS IN THE PCU

▷ FOUR CONDITIONS ARE REQUIRED FOR AUTO THERMAL POWER DOWN
A. IUS ON OSE OR ASE POWER
B. IUS UMBILICAL STILL CONNECTED
C. AUTO SHUTDOWN ENABLED (U76X0021E OR U76X0022E = 0)
D. 2 OUT OF 3 TEMPERATURES IN SCU OR IUS COMPUTERS EXCEED THE THRESHOLD

▷ THE COMPUTER WILL REMOVE POWER FROM BOTH CHANNELS. THE MOTOR DRIVEN SWITCHES INTRODUCE APPROX. A 60MS DELAY BEFORE POWER IS REMOVED. PRIMARY CHANNEL SHOULD HAVE REMOVED POWER FROM ALTERNATE CHANNEL BEFORE 2 SEC DELAY EXPIRES.

▷

TEMP SENSOR	AUTO SHUTDOWN LIMIT (°C)
COMP TEMP 1 (CUA(B)MCT)	103
COMP TEMP 2 (CUA(B)EUT)	109
COMP TEMP 3 (CUA(B)PST)	93

▷

TEMP SENSOR	AUTO SHUTDOWN LIMIT (°C)
SCU CONTROLLER TEMP (SCUA(B)IT)	89
SCU A/D CONV TEMP (SCUA(B)CT)	84
SCU PWR SUPPLY TEMP (SCUA(B)PT)	85

▷ ALL CIRCUIT GROUNDS ARE RETURNED TO THEIR POWER SOURCE AND ARE ISOLATED FROM OTHER CIRCUITS

▷ THE FILTERED VOLTAGES FROM AVIONICS BUSES A AND B ARE MONITORED BY THE COMPUTER. VOLTAGE DROPS OF SUFFICIENT MAGNITUDE AND DURATION WILL INITIATE RECONFIGURATION.

NOTES▷ THE COMPUTER POWER DOWN INTERRUPT SEQUENCE PUTS REGISTERS INTO INTERNAL BATTERY POWERED NON VOLATILE MEMORY STORAGE WHERE IT CAN BE RETAINED FOR UP TO 30 DAYS. IT ALSO RESETS THE 'INIT BIT' TO ZERO.

4 ASE & THERM 2

SIGNATURE		DATE
DSGN	LAURIE BUCHANAN	7/14/80
DR	LAURIE BUCHANAN	7/14/80
ENGR		
ENGR		
APP		
APP		
OPNS PLAN		

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
LYNDON B. JOHNSON SPACE CENTER HOUSTON, TEXAS

ASE POWER AND AUTOMATIC THERMAL SHUTDOWN

IUS SYS HB

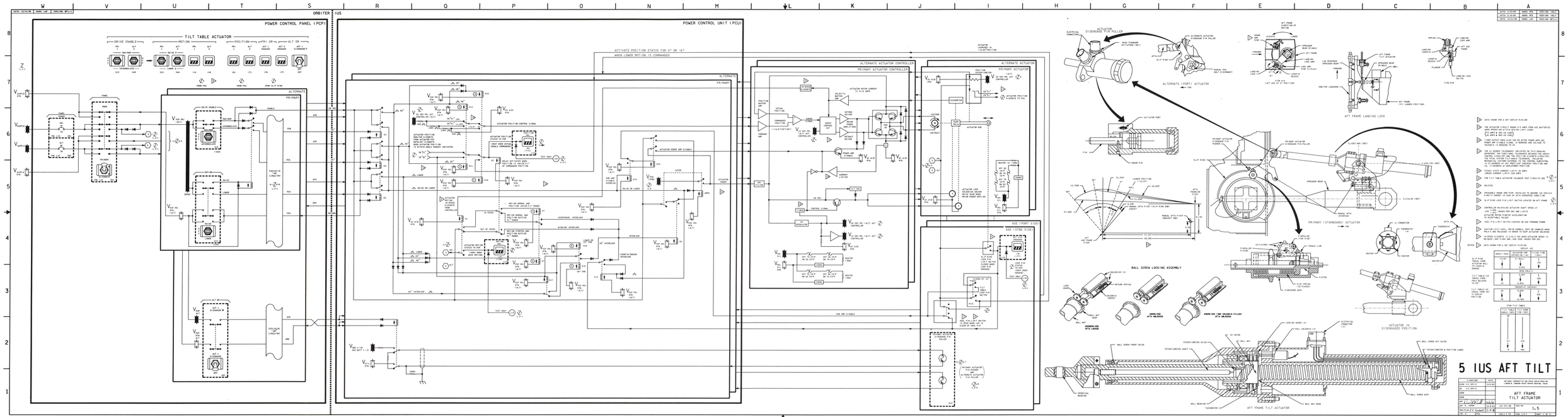
DWG NO 1.4

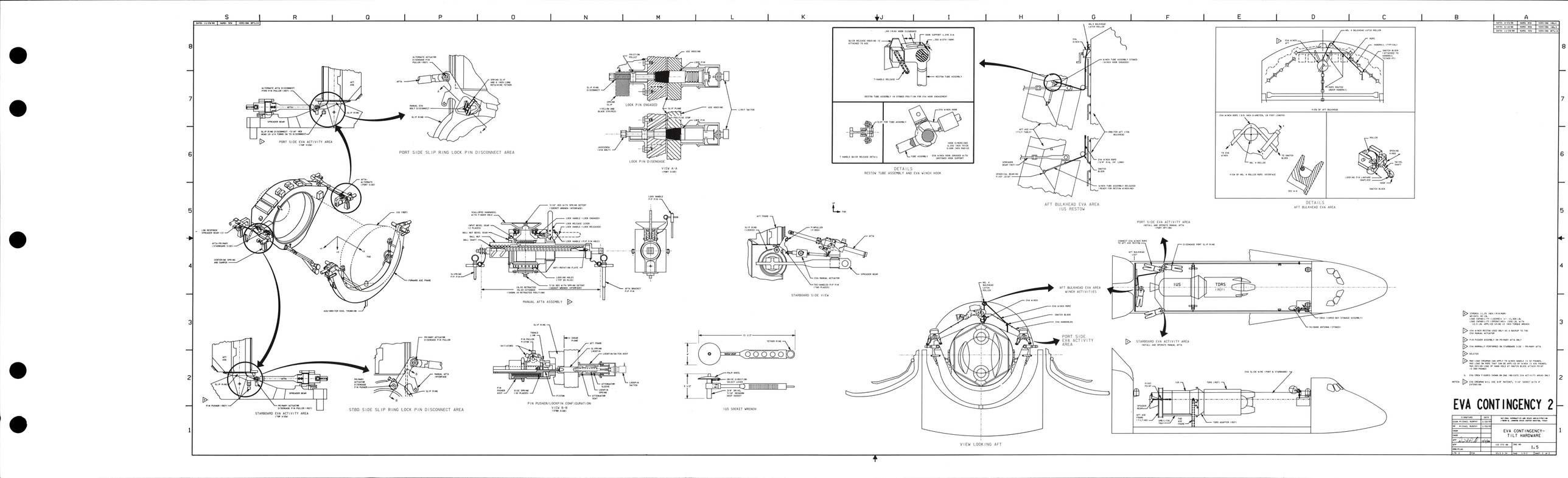
LTR G PCN

66 X 34

PAGE 1.4-2

SHEET 2 OF 2


ORBITER / IUS
POWER CONTROL PANEL (PCP)
TILT TABLE ACTUATOR
DRIVE ENABLE
MOTION
POSITION
ALT DR
RAISE
LOWER
ALT 1 ENGAGED
ALT 2 ENGAGED
ALT 1 DISENGAGE
ALT 2 DISENGAGE
ALTERNATE
PRIMARY
POWER CONTROL UNIT (PCU)
ACTIVATE POSITION STATUS FOR 0° OR -6° WHEN LOWER MOTION IS COMMANDED
ALTERNATE ACTUATOR CONTROLLER
PRIMARY ACTUATOR CONTROLLER
ALTERNATE ACTUATOR
PRIMARY ACTUATOR
AXIS SYSTEM
ACTUATOR DISENGAGE PIN PULLER
ALTERNATE (PORT) ACTUATOR
AFT FRAME LANDING LOCK
PRIMARY (STARBOARD) ACTUATOR
BALL SCREW LOCKING ASSEMBLY
AFT FRAME TILT ACTUATOR
ACTUATOR IN DISENGAGED POSITION
5 IUS AFT TILT
AFT FRAME TILT ACTUATOR
AFT FRAME TILT TABLE
ACTUATOR DISENGAGE PIN PULLER
ACTUATOR LAUNCHED IN LOCKED MODE
ACTUATOR POSITION DISAGREE TO PCU
ACTUATOR MOTOR CURRENT (3 TO 12 AMPS)
ACTUATOR POWER AMP ENABLE
ACTUATOR POSITION CONTROL SIGNAL
ACTUATOR POSITION MONITOR SIGNALS
MOTION NORMAL AND POSITION INDICATE 1 FRAME
MOTION STOPPED AND POSITION OUTSIDE LIMITS
OVERTRAVEL INTERLOCK
B-NUT/NO INTERLOCK
LOWER-IN-DRAWER INTERLOCK
ACTUATOR MOTOR STATUS TO PCP
LOWER MOTION HAS RETURNED
RELAY ACTUATOR POSITION IS VALID IF COMMANDED POSITION
ACTUATOR POSITION MONITOR SIGNALS TO PCP
LOWER MOTION HAS RETURNED
ACTUATOR POSITION IS VALID IF ACTUATOR IS AT A VALID RANGE INDICATED
ACTUATOR POWER AMP ENABLE
LATCH
ACTUATOR MOTOR CURRENT
ACTUATOR POSITION DISAGREE TO PCP
LOWER MOTION HAS RETURNED
ACTUATOR POSITION MONITOR SIGNALS
MOTION NORMAL AND POSITION INDICATE 1 FRAME
MOTION STOPPED AND POSITION OUTSIDE LIMITS
OVERTRAVEL INTERLOCK
B-NUT/NO INTERLOCK
LOWER-IN-DRAWER INTERLOCK
ACTUATOR MOTOR STATUS TO PCP
LOWER MOTION HAS RETURNED
RELAY ACTUATOR POSITION IS VALID IF COMMANDED POSITION
ACTUATOR POSITION MONITOR SIGNALS TO PCP
LOWER MOTION HAS RETURNED
ACTUATOR POSITION IS VALID IF ACTUATOR IS AT A VALID RANGE INDICATED
ACTUATOR POWER AMP ENABLE
LATCH
ACTUATOR MOTOR CURRENT
ACTUATOR POSITION DISAGREE TO PCU
ACTUATOR LAUNCHED IN LOCKED MODE
ACTUATOR LOCK RELEASE MOTOR DRIVE GEAR MOTOR POWER APPLIED
ACTUATOR ROD
ACTUATOR POSITION DISAGREE TO PCU
ACTUATOR MOTOR CURRENT (3 TO 12 AMPS)
ACTUATOR POWER AMP ENABLE
ACTUATOR POSITION CONTROL SIGNAL
ACTUATOR POSITION MONITOR SIGNALS
MOTION NORMAL AND POSITION INDICATE 1 FRAME
MOTION STOPPED AND POSITION OUTSIDE LIMITS
OVERTRAVEL INTERLOCK
B-NUT/NO INTERLOCK
LOWER-IN-DRAWER INTERLOCK
ACTUATOR MOTOR STATUS TO PCP
LOWER MOTION HAS RETURNED
RELAY ACTUATOR POSITION IS VALID IF COMMANDED POSITION
ACTUATOR POSITION MONITOR SIGNALS TO PCP
LOWER MOTION HAS RETURNED
ACTUATOR POSITION IS VALID IF ACTUATOR IS AT A VALID RANGE INDICATED
ACTUATOR POWER AMP ENABLE
LATCH
ACTUATOR MOTOR CURRENT
ACTUATOR POSITION DISAGREE TO PCU
ACTUATOR LAUNCHED IN LOCKED MODE
ACTUATOR LOCK RELEASE MOTOR DRIVE GEAR MOTOR POWER APPLIED
ACTUATOR ROD
ACTUATOR POSITION DISAGREE TO PCU
PRIMARY ACTUATOR DISENGAGE PIN PULLER
ALTERNATE ACTUATOR DISENGAGE PIN PULLER
ACTUATOR DISENGAGE PIN PULLER
ELECTRICAL CONNECTOR
MAKE STANDARD ACTUATORS ONLY
ALTERNATE ACTUATOR DISENGAGE PIN PULLER
MANUAL RTN BELT TO DISENGAGE
ALTERNATE (PORT) ACTUATOR
AFT FRAME
CRANK ARM STOP
CLEVIS
SPREADER BEAM W/ CABLE
FORWARD
LOCK ARM
LOCK ARM AT 90 PLACES
LOCK PIN
LOCKED
LANDING LOCK
LOCK ARM
LOCK PIN
LANDING LOCK
LOCK ARM
LOCK PIN
LOCKED
LOCK ARM
LOCK PIN
LOCKED
LOCK ARM
LOCK PIN
LOCKED
PLUNGER
LANDING LOCK SWITCH
AFT FRAME LANDING LOCK
AFT FRAME TILT ACTUATOR
SPREADER BEAM W/CABLE
FORWARD
SPREADER BEAM W/CABLE
AFT FRAME
AFT FRAME TILT, LOCKED POSITION
ACTUATOR PORT
PIN PULLER
SHEAR PIN
SLIP RING
PRIMARY ACTUATOR DISENGAGE PIN PULLER
ALIGNED
SPREADER BEAM
PRIMARY (STARBOARD) ACTUATOR
LAUNCH POSITION
LS, PORT
LS, STBD
AFT FRAME TILT ACTUATOR
MANUAL AFT FITTING
MANUAL AFT FITTING
MANUAL AFT FITTING
INTERFACE
P-FITTING
P-FITTING PISTON
TOGGLE CLAMP
P-FITTING ASSY
HEATER
THERMOSTAT
J-C CONNECTOR
THERMOSTAT
HEATER
HEATER
ACTUATOR IN DISENGAGED POSITION
BALL SCREW LOCKING ASSEMBLY
LOCK
BALL NUT
SOLENOID (2)
RETURN SPRING
SOLENOID COMPLY
BALL NUT
STOP
SPDM/OTD-250 SPTA LS0202
DM/MS-252 SPTA MS/0202
DM/MS-253 / DM SOLENOID FV1321 SPTA MS/0203
AFT FRAME TILT ACTUATOR
LOCK/NO GEARS (2)
BALL NUT
DC MOTOR
BALL SCREW FRONT BUSH
POTENT/IMETER SHAFT
POTENT/IMETER BUSH
POTENT/IMETER & POSITION LIMITS
ELECTRICAL CONNECTOR (2)
BALL SCREW AFT BUSH
SPHERICAL BEARING
BALL BEARING
BALL NUT GEAR
"ACTUATOR"
AFT FRAME TILT ACTUATOR
DATA SHOWN FOR A 28 V DEPLOY POSITION
THE ACTUATOR CIRCUIT BRAKE 2/5 AMPS FROM AFD BATTERIES (1) AND (2) RESPECTIVELY (1) AMPS & VDC (A CAN)
LAUNCH POSITION IS 0.05 AND 40.40 FROM APPLIED, POWER AMP ENABLE SIGNAL, 15 DEPENDS AND VOLTAGE TO SOLENOID IS REDUCED TO 4V
THE ±2 DEGREE TOLERANCE INDICATED ON THIS DRAWING REPRESENT THE FUNCTIONAL TOLERANCE BETWEEN THE DEPENDENT VARIABLES OF ACTUATOR POSITION AND MOTOR CURRENT. THE TOTAL SYSTEM TILT/ANGLE TOLERANCE, INCLUDING ALIGNMENT, IS ±0.5 DEGREES AT THE ACTUATOR INTERFACE AND IS ±1 DEGREES AT THE FIRST/LAST CHECKOUT POSITION AND ±1 DEGREES AT DEPLOYMENT POSITION
TOTAL STATE CURRENT LIMITS TO 3PS AMPS
FOR TILT TABLE ACTUATOR TELEMACH TEST CIRCUITS SEE
DELETED
CRUSHABLE CRUSH ARM STOP INSTALLED TO ARRIVE LOS VEHICLE STABILITY ENERGY IN CASE OF MTA OVERSPEED CONDITION
SLIP RING LOCK P/A LIMIT SWITCH LOCATED ON AFT FRAME
CONTROLLER MEASURES ACTUATOR SHAFT SPEED AT LOWER MOTION FOR SEC AND LIMITS ACTUATOR MOTOR STARTUP ACCELERATION
SEE P/A LIMIT SWITCH LOCATIONS ON AXE FORWARD FRAME
CAUTION-LOCK (SOL), DRIVE ENABLE, MUST BE ENABLED WHEN ONLY ONE RELEASED TO START ACTUATOR MOVEMENT
14-SPEED DISCRETE (1.2-15.2 DEG PER) MOTOR SPEED (3 BETWEEN LOWER 3,000 AND 3,500 (NOM) PER SEC)
DATA SHOWN FOR A 28V DEPLOY POSITION
DEPLOY (2)
SLIP RING TRAVEL FROM LOCKED TO LOCKED W/ ENGAGE
TILT TABLE/LCE TRAVEL FROM LOCKED TO LOCKED
TILT TABLE/LCE TRAVEL FROM 20 TO DEPLOY POSITION
ANGLE (DEG)
ACTUATOR ARM LENGTH (INCHES)
TOTAL TIME (SEC)
PRIMARY
ALTERNATE
PRIMARY
ALTERNATE
FROM TILT TABLE
ANGLE (DEG)
TOTAL TIME (SEC)
PRIMARY
ALTERNATE
5 IUS AFT TILT
SYSTEMS
DATA
ACTUATOR, HYDRAULIC OR AFT FRAME INSTALLATION
ITHACA N. LOWER RIVER CENTER RENTAL TEXAS
AFT FRAME TILT ACTUATOR
APP
DRAWN
CHK
APP
APP
APP
1.5
SIZE
SCALE
DWG NO
SHEET 1 OF 1



STRONGLY SILICON (WITH HIGH ACTIVITY) MES-2.5L
LOAD CAPABILITY = 11,500 LBS +/- 11,700 LBS
LOAD CAPABILITY (OPERATIONAL) = 2500 LBS, ULTIMATE 10,5 LBS, APPLIED 10-90 12 INCH TORQUE WRENCH

EVA WINCH ROTATION USED ONLY AS A BACKUP TO THE EVA MANUAL ACTUATOR

P-N PUSHER ASSEMBLY-IN PRIMARY AFTA ONLY

EVA NORMALLY PERFORMED ON STARBOARD SIDE - PRIMARY AFTA

SELECTED

MAX LOAD CREWMAN CAN APPLY TO WINCH HANDLE IS 50 POUNDS, MAX LOAD ON ROPE THAT CAN BE APPLIED BY WINCH IS 400 POUNDS, THE MAXIMUM LOAD OF HAND HELD AT SWITCH BLOCK ATTACH POINT IS 100 POUNDS

EVA CREWMAN FIGURES SHOWN ON DWG INDICATE EVA ACTIVITY AREAS ONLY

NOTES: EVA CREWMAN WILL USE 3/8" RATCHET, 7/16" SOCKET WITH 4" EXTENSION

EVA CONTINGENCY 2

ORIGINATOR	DATE	NATIONAL AERONAUTICS AND SPACE ADMINISTRATION	
DESIGN MICHAEL MURPHY	12/26/88	LYNDON B. JOHNSON SPACE CENTER, HOUSTON, TEXAS	
DR MICHAEL MURPHY	12/26/88		
CHECK		EVA CONTINGENCY-TILT HARDWARE	1
CHECK			
APP			
APP		IUS SYS NO	DWG NO 1.5
APP			
DRR/PLAN			
TCE R	DATE	SCALE N/A	SHEET 1 OF 2

DATE 12/26/88 NAMS MFA VERS/DRA (MFA/T)
DATE 3/14/88 NAMS MFA VERS/DRA (MFA/T)
DATE 12/26/88 NAMS MFA VERS/DRA (MFA/T)

DATE▸ 02/25/88	NAME▸ MAG	VERSION▸ INV.2
DATE▸ 04/06/88	NAME▸ MDU	VERSION▸ INV.3
DATE▸ 11/29/88	NAME▸ MAG	VERSION▸ BPT.21

IUS BUS LOSS CHART

FAILURE	LOSS	NOTES
AV BUS A	● A-SIDE AVIONICS PWR ● RIMU CHANNEL 1	UTIL AND S/C PWR NOT REMOVED RF TLM LOST, NSLN TLM REQUIRES CIU PL SELECT SW CHANGE IF UMB ATTACHED, PWR DWN BUS PWRS RIMU AND RCS TNK AND LINE HTRS RIMU CHANNEL 2 RECEIVES PWR FROM BOTH AV BUS A & B
AV BUS B	● B-SIDE AVIONICS PWR ● RIMU CHANNEL 3	UTIL AND S/C PWR NOT REMOVED IF B-TLM AT TIME OF PWR LOSS, AUTOMATIC SWITCH TO A-TLM WILL OCCUR IF UMB ATTACHED, PWR DWN BUS PWRS RIMU AND RCS TNK AND LINE HTRS RIMU CHANNEL 2 RECEIVES PWR FROM BOTH AV BUS A & B
POWERDOWN A	PWR TO RIMU CHANNEL 1 AND A-SIDE RCS TANK AND LINE HEATERS DURING AUTOTHERMAL SHUTDOWN	RIMU CHANNEL 2 RECEIVES PWR FROM BOTH POWER – DOWN A & B
POWERDOWN B	PWR TO RIMU CHANNEL 3 AND B-SIDE RCS TANK AND LINE HEATERS DURING AUTOTHERMAL SHUTDOWN	RIMU CHANNEL 2 RECEIVES PWR FROM BOTH POWER – DOWN A & B
UTIL BAT A(B)	● ORD BUS A(B) REDUNDANCY FOR SRM 1 AND SRM 2 FIRING STAGE 1/2 SEP S/C SEP ● RCS ISOVALVE FIRING REDUNDANCY ● PTU MOTOR DRIVEN SW PWR REDUNDANCY	OTHER SIDE OF PSU INITIATES THE EVENTS OTHER SIDE OF PSU FIRES THE ISOVALVES
UTIL A	● EEC THERMAL BATT-A INITIATION REDUNDANCY ● TVC-A ● RCS VALVE DRIVERS "A" ● RF SW	RELAY CONTROL (MGA CONTROL)	INITIATION THRU UTIL B VALVE DRIVERS CONTROLLED BY SIDE IN CONTROL
UTIL B	● EEC THERMAL BATT-B INITIATION ● TVC-B ● RCS VALVE DRIVERS "B"	INITIATION THRU UTIL A VALVE DRIVERS CONTROLLED BY SIDE IN CONTROL
S/C	● IUS ON EXT PWR ORB/ASE PWR TO S/C ● IUS ON INT PWR IUS PWR TO S/C	

▷ MONITORED WHENEVER TVC UTILITY POWER IS ON

▷ CROSS-STRAPPED DRIVERS (SINGLE CHANNEL CONTROL) –

▷ ROW DRIVER NORM STATE (NOT ACTIVATED) IS "1"
COL DRIVER NORM STATE (NOT ACTIVATED) IS "0"

▷ STS MISSIONS USE TIMER ENABLES. TITAN MISSIONS HAVE DRIVERS DIRECTLY ENABLED VIA CODE PLUG

▷ MONITORED RELAYS ARE CHECKED AT SPECIFIED INTERVALS AFTER INITIALIZATION. SHOULD THE RELAY CHANGE STATE FOR TWO CONSECUTIVE SAMPLES WITHOUT BEING COMMANDED, RECONFIGURATION WILL OCCUR. ONCE COMMANDED, IT IS NO LONGER MONITORED WITH THE EXCEPTION OF SPACECRAFT DISCRETES. SPACECRAFT DISCRETES ARE MONITORED FOR PROPER RESPONSE TO BOTH "ENABLE" AND "DISABLE" COMMANDS. IF THE RESPONSE DOES NOT CORRESPOND TO THE COMMANDED STATE, RECONFIGURATION WILL OCCUR

▷ CRITICAL RELAYS ARE RELAYS THAT ARE COMMANDED TO AN INITIAL POSITION DURING INITIALIZATION AND CHECKED FOR 15 SEC. AFTER POWER-UP. IF THE RELAY IS NOT IN IT'S INITIAL STATE AFTER BEING COMMANDED, RECONFIGURATION WILL OCCUR

▷ THIS MATRIX IS FOR REFERENCE ONLY. FURTHER PCP DETAIL CAN BE FOUND ON DWG 1.3

NOTE▸ ▷ THIS MATRIX IS FOR REFERENCE ONLY. FURTHER SCU DETAIL CAN BE FOUND ON DWG 4.2-2

6 IUS PWR DIST 1

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION LYNDON B. JOHNSON SPACE CENTER HOUSTON, TEXAS	SIGNATURE	DATE
	DSGN LAURIE BUCHANAN	2/1/80
POWER DISTRIBUTION UNIT	CR	
	ENGR	
	APP'D	12/6/88
DWG NO 1.6	IUS SYS HB APP	
	OMNIPLAN J. C. Childress	12-6-88
SHEET 1 OF 3 PAGE 1.6-1	44 X 34 LTR G FCN	

SIGNAL CONDITIONING UNIT COMMAND MATRIX

▷ MONITORED WHENEVER TVC UTILITY POWER IS ON

	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12	C13	C14	C15	C16	C17	C18	C19	C20	
UNPROTECTED MATRIX DRIVER (DUAL CHANNEL AVIONICS POWER)	R1	S/C STG I↓ BATT ON M111		SRM 2 SAFE ON M32 *	S/C DISCRETE 1 ENABLE M50 * **	S/C DISCRETE 7 ENABLE M56 * **	S/C DISCRETE 8 DISABLE M88 *	RCS NTRS ON M85 ↕		TVC AVIONIC PWR ON M9 XD	TT & C RNG CNTL OFF M40 ↕							STG I→II SEP FIRE * * * M16 O		R1
	R2	S/C DISCRETE 5 DISABLE M95 *	S/C ASE PWR OFF M109			S/C DISCRETE 1 DISABLE M91 *	S/C DISCRETE 7 DISABLE M97 *	S/C DISCRETE 3 ENABLE M52 * **			TVC AVIONIC PWR OFF M8 *	TT & C RNG CNTL ON M39					TITAN ANTENNA ON M88 T	TITAN SEP FIRE * * * M31 T		R2
	R3	SRM 1 SAFE ON M27 *	RECEIVER TO STDN M41 N, I	AUTO PWR DOWN M4	EXTEND EXIT CONE DISABLE M116	REM NTRS ON M77	S/C DISCRETE 2 ENABLE M51 * **	S/C DISCRETE 8 ENABLE M57 * **	TVC UTILITY PWR ON M11		STAR SCANNER ON M81	S/G STG I BATT OFF M110								R3
	R4	S/C DISCRETE 4 ENABLE ' M53 * **	XPNDR TO COHO MODE M58	S/C STG II BAT OFF M112	ORD PWR OFF M6 XS *			S/C DISCRETE 2 DISABLE M92 *	S/C DISCRETE 6 ENABLE M55 * **	TVC UTILITY PWR OFF M10 *	XMTR L,024 CARRIER ON M60 ↕	STAR SCANNER OFF M82 ↕						S/C SEP FIRE * * * M19 XS	TITAN ANTENNA OFF M89 T	R4
	R5	S/C DISCRETE 6 DISABLE M56 *	S/C DISCRETE 4 DISABLE M54 *	RCS NTRS OFF M86	AVIONICS ASE PWR OFF M104	SRM 3 SA/E ON M88 N	PYRO MSTR DISABLE * * * M14 XS *		XMTR TDRS M44 N	TVC CONTROLLER STG I M12 XD ▷	XMTR L,024 CARRIER OFF M61								EXTEND EXIT CONE DEPLOY M117	R5
	R6	XPNDR TO NON-COHO M59 ↕	S/C DISCRETE 3 DISABLE M93 *	S/C DISC 5 ENABLE M54 * **	REM HTRS OFF M78 ↕		RECEIVER TO TDRS/ STDN M42 N	XMTR TO STDN M43 N, I			TVC CONTROLLER STG II M13 XD ▷						EXTEND EXIT CONE ENABL' M115				R6
CROSS-STRAPPED INPUTS MATRIX DRIVER (AVIONICS POWER-SINGLE CHANNEL CONTROL)	R7											STS MGA ANT ON M45 S	AVIONICS STG II BATT ON M106	XG-46 ON - * M101 S, I	XMTR L,7 CARRIER ON M62						R7
	R8											AVIONICS STG I BATT OFF M105	STS MGA ANT OFF M46 S, I	XMTR ON M66	XG-46 OFF * M101 S						R8
	R9												20 WATT AMP ON M64	RF SWITCH TO ANT 1 M37	XMTR OFF M71 ↕						R9
	R10											XMTR L,7 CARRIER OFF M63 ↕		20 WATT AMP OFF M73 ↕	RF SWITCH TO ANT 2 M38 ↕						R10
10 MINUTE PROTECTED DRIVER (DUAL CHANNEL AVIONICS POWER)	R11															RCS ISOL * VLVS ENABLE * * M24 XS * *				SRM 2 ARM M34	R11
	R12																RCS ISOL VLVS FIRE * * * M25 XS		SRM 2 SAFE OFF M33 * *		R12
45 MINUTE PROTECTED DRIVER (DUAL CHANNEL AVIONICS POWER)	R13															SRM 1 SAFE OFF M28 * *		SRM 2 FIRE M35 * * *		APPLY ORD PWR M5 XS * *	R13
	R14																S/C SEP ENABLE * * * M18 XS * *	SRM 1 FIRE M30 * * *	STG I→II SEP ENABLE * * * M15 XS * *		R14
	R15															SRM 1 ARM M29		SRM 3 SAFE OFF M69 N	TITAN SEP ENABLE M20 T * * *		R15
		C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12	C13	C14	C15	C16	C17	C18	C19	C20	

COMMAND NUMBER IS GIVEN IN LOWER LEFT OF MATRIX SQUARE FOR INFORMATION ONLY

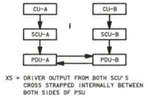
▷ * – CRITICAL RELAY

▷ ** – MONITORED RELAY

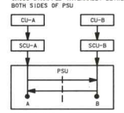
*** – RELAYS LOCATED IN PSU

■ – THIS RELAY IS LOCATED IN THE SIU

NOTE▸ XD = DRIVER OUTPUT FROM BOTH SCU'S CROSS STRAPPED BETWEEN BOTH PDU'S



XS = DRIVER OUTPUT FROM BOTH SCU'S CROSS STRAPPED INTERNALLY BETWEEN BOTH SIDES OF PSU



S = STS COMMAND ONLY

T = TITAN COMMAND ONLY

O = RELAY MATRIX CMD M16 (SIDE A) AND STG I/2 SEP FIRE DISCRETE CMD (SIDE B) ARE ISSUED SIMULTANEOUSLY AND EITHER ONE OR BOTH WILL FIRE SIDE A (STG 1 NUTS), 40 MS LATER THE SEQUENCE IS REVERSED WITH SIDE A ISSUING THE STG 1/2 SEP FIRE DISCRETE AND SIDE B ISSUING THE M16 RELAY MATRIX COMMAND TO FIRE THE SIDE B (STG 2) SEPARATION NUTS

N = NASA COMMAND ONLY (NOT APPLICABLE TO DOD IUS TWO STG VEHICLE)

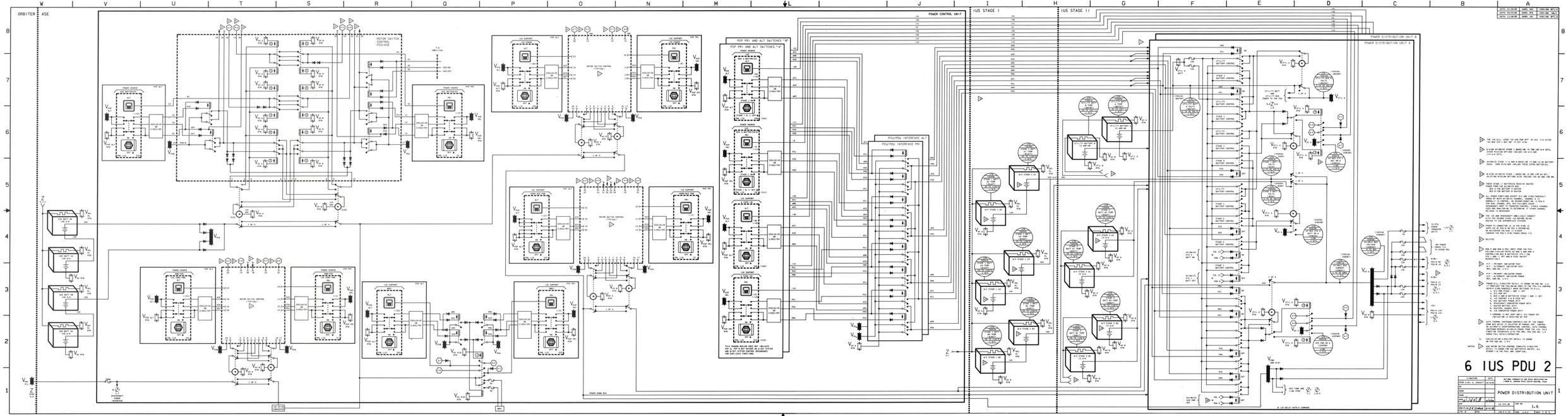
I = COMMAND SENT AT INITIALIZATION BUT NOT CHECKED

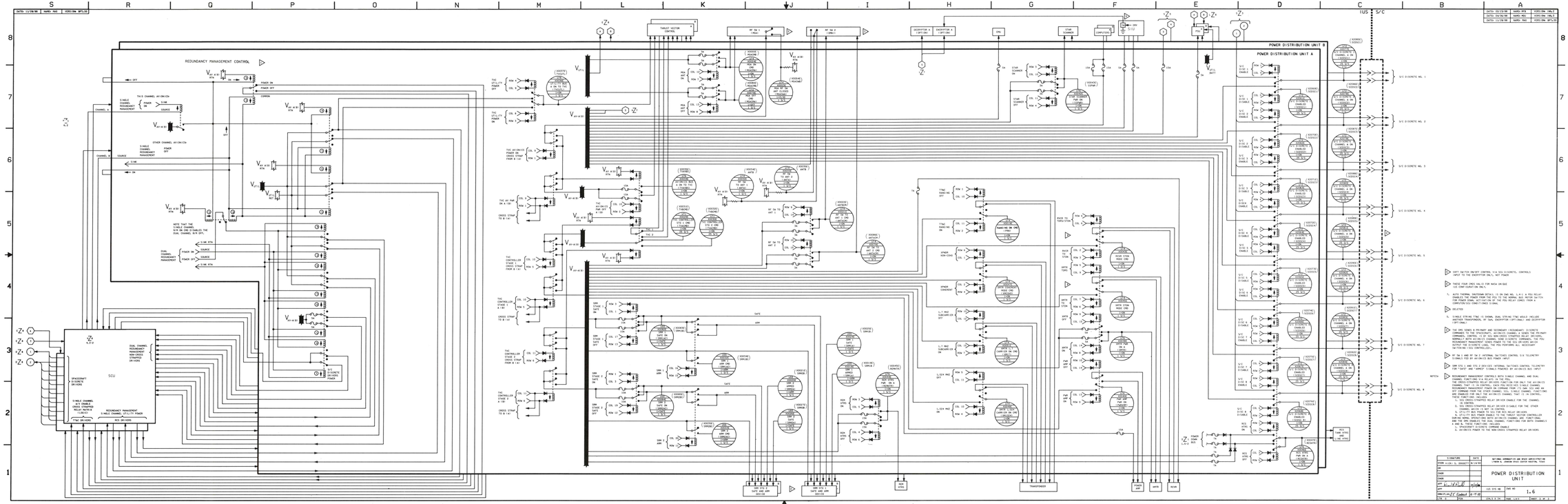
PCP/PCU MATRIX

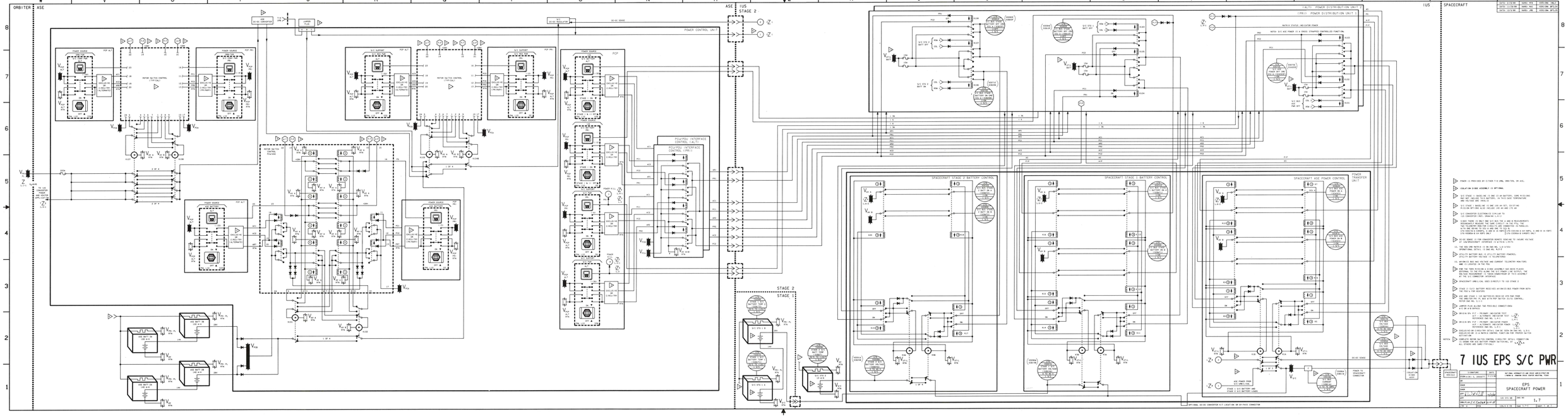
	C1	C2	C3	C4	C5	C6
R1	1 S/C BATTERY STG 1 ON 5A 35A	2 S/C BATTERY STG 1 & 2 OFF 5B 35B	3 TEST GRAY 63A 73A	4 TEST BARBER POLE 63B 73B	5 IUS CONV PWR ON 1A 31A	6 IUS CONV PWR OFF 1B 31B
R2	7 S/C PWR ON 6A 36A	8 S/C PWR OFF 6B 36B	9 BATTERY HEATER ON 21A 51A	10 BATTERY HEATER OFF 21B 51B	11 S/C REG PWR ON 2A 32A	12 S/C REG PWR OFF (OSE) 2B 32B
R3	13 BUS A BATTERY STG 1 ON 9A 39A	14 BUS A BATTERY STG 1 & 2 OFF 9B 39B	15 NORMAL BUS PWR ON 7A 37A	16 NORMAL BUS PWR OFF 7B 37B	17 AUTO SHTDN STDBY MODE OFF 20A 50A	18 AUTO SHTDN STDBY MODE ENABLE 20B 50B
R4	19 T FEED ON 10A 40A	20 T FEED OFF 10B 40B	21	22 MOTION LOWER 14B 44B	23 MOTION RAISE DRIVE ENABLE INTERMEDIATE 13B (29°) 43B	24 MOTION RAISE DRIVE ENABLE MAX (58°) 13A 43A
R5	25 BUS B BATTERY STG 1 ON 11A 41A	26 BUS B BATTERY STG 1 & 2 OFF 11B 41B	27 IUS DEPLOY ENABLE 25A 55A	28 IUS DEPLOY OFF 25B 55B	29 WDI ON 23A 53A	30 WDI OFF 23B 53B
R6	31 B FEED ON 12A 42A	32 B FEED OFF 12B 42B	33 UMBILICAL ENABLE 18A 48A	34 UMBILICAL ENABLE OFF 18B 48B	35	36 ALT DR ACT 1 DISENGAGE 57A
R7	37 ASE BATT PWR ON 3A 33A	38 ASE BATT PWR OFF 3B 33B	39 IUS PWR ON 8A 38A	40 IUS PWR OFF 8B 38B	41 UMBILICAL RELEASE 19A 49A	42
R8	43 S\C CONV PWR ON 4A 34A	44 S/C CONV PWR OFF 4B 34B	45 PYRO BUS OFF 24B 54B	46 PYRO BUS ON 24A 54A	47 GUARD HTRS OFF 22B 52B	48 GUARD HTRS ON 22A 52A

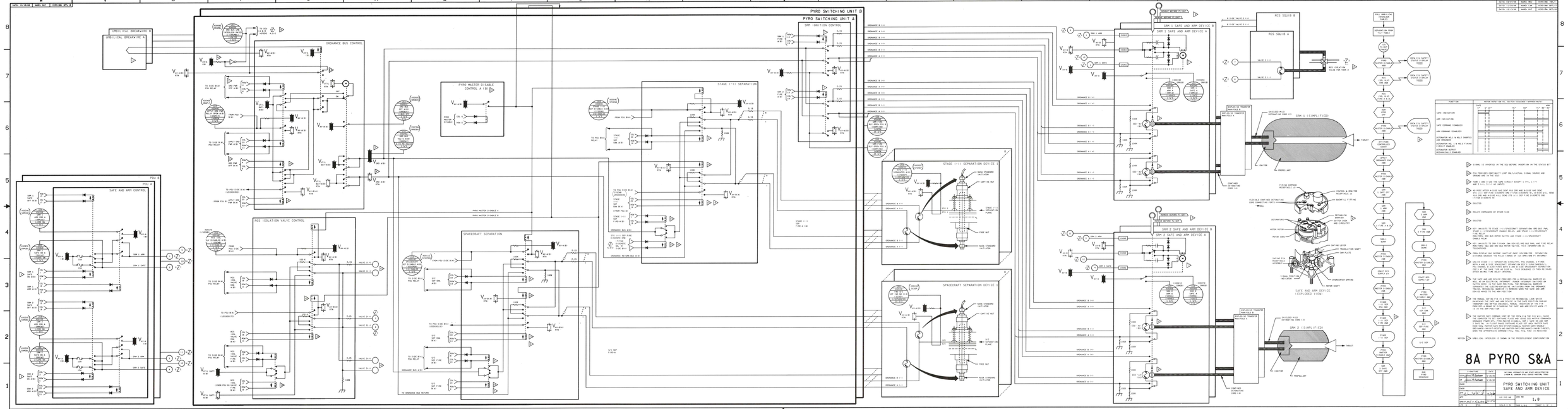
PCP SWITCH NUMBER IS GIVEN IN LOWER LEFT OF MATRIX SQUARE
(PRIMARY SWITCH IS UPPER NUMBER AND ALTERNATE SWITCH IS LOWER)
* ALTERNATE MATRIX ONLY
– SWITCH NOMENCLATURE

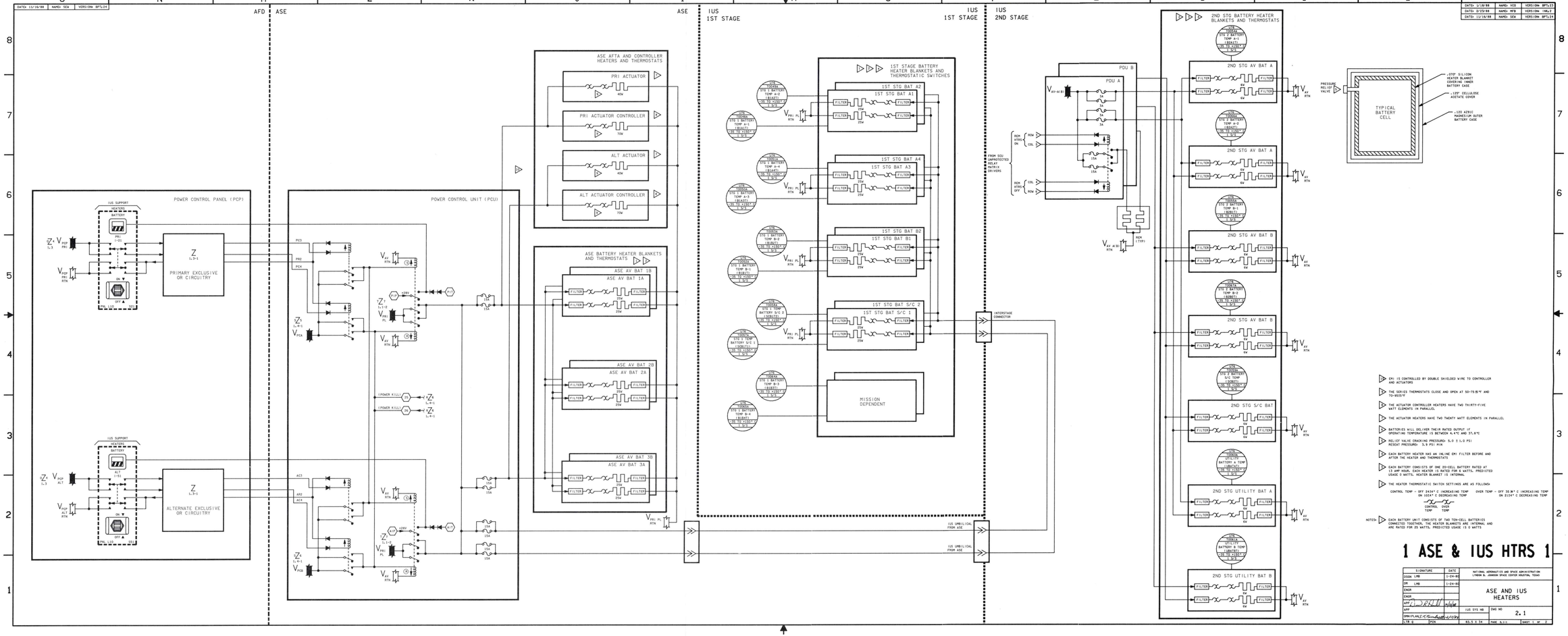
NOTE ▸ COL 1 – 2, ROW 1 – 2 ARE PTU CONTROL SWITCHING FUNCTIONS
COL 1 – 2, ROW 1 – 6 ARE PDU CONTROL SWITCHING FUNCTIONS


ORBITER
ASE
POWER CONTROL UNIT
IUS STAGE I
IUS STAGE II
POWER DISTRIBUTION UNIT B
POWER DISTRIBUTION UNIT A
MOTOR SWITCH CONTROL PCU/ASE
PCP PRI AND ALT SWITCHES "A"
PCP PRI AND ALT SWITCHES "B"
PCU/PDU INTERFACE ALT
PCU/PDU INTERFACE PRI
MOTOR SWITCH CONTROL (TYPICAL)
POWER SOURCE
PCP ALT
PCP PRI
LCC SUPPORT
ASE BATT 1A
ASE BATT 2B
ASE BATT 3A
ASE BATT 4B
SPACECRAFT INTERFACE
POWER DOWN BUS
6 IUS PDU 2
POWER DISTRIBUTION UNIT
1 of 6


POWER DISTRIBUTION UNIT B
POWER DISTRIBUTION UNIT A
REDUNDANCY MANAGEMENT CONTROL
SCU
TARGET VECTOR CONTROL
RF SW 1 (PRI)
RF SW 2 (SEC)
RF SW 3
RF SW 4
SAFE AND ARM DEVICE
TRANSDUCER
POWER AMP
GATE
VCM
S/C DISCRETE NO. 1
S/C DISCRETE NO. 2
S/C DISCRETE NO. 3
S/C DISCRETE NO. 4
S/C DISCRETE NO. 5
S/C DISCRETE NO. 6
S/C DISCRETE NO. 7
S/C DISCRETE NO. 8
SOFT SWITCH ON/OFF CONTROL V14 SCU DISCRETE, CONTROLS THRUST TO THE EXCEPTION ONLY, NOT POWER
THESE FOUR CMDS HAL/S FOR NASA ON-USE FCS CONFIGURATION ONLY.
1. AUTO TRIPOL TRIPOLING DETAILS, (5 ON 2)ND NO. 1 R-1 A POLI RELAY ENABLES THE POWER FROM THE POLI TO THE NORMAL BUS MOTOR SWITCH ENABLES THE POWER FROM THE POLI POLI RELAY COILS FROM A COMPUTER/SCU DISCRETIONED SIGNAL
DELETED
5. SINGLE STRING TTAC 11 SIGNAL DUAL STRING TTAC WOULD INCLUDE ADDITIONAL DISCRETIONS, RF SW4, EXCEPTION (1)RF1/SW4) AND EXCEPTION (1)RF1/SW4)
THE DMS SENDS 8 PR-PRIMARY AND SECONDARY (SECONDARY) DISCRETE COMMANDS TO THE (PAIR)(SWAT), 4 SINGLE SIGNALS SENDS THE PRIMARY COMMANDS, CONTROL (1) BY SCU NON-CROSS STRAPPED RELAY DRIVERS, CONTROL (1) BY SCU NON-CROSS STRAPPED RELAY DRIVERS, AND REDUNDANCY MANAGEMENT SENDS POWER TO THE SCU DRIVERS AND TO OUTPUT THE DISCRETE LOAD, THE POLI PERFORMS ALL NECESSARY
RF SW 1 AND RF SW 2 (NATIONAL SWITCHES CONTROL S/U TELEMETRY SIGNALS FOR RF ANTENNIS BUS POWER INPUT
SWA STG 1 AND STG 2 DEVICES, NATIONAL SWITCHES CONTROL TELEMETRY FOR "SAFE" AND "ARMED" SIGNALS POWERED BY AV-ONICS BUS INPUT
REDUNDANCY MANAGEMENT CONTROLS BOTH SINGLE CHANNEL AND DUAL CHANNEL OPERATIONS, AS FOLLOWS: 1. SINGLE CHANNEL: THE SINGLE-STRAPPED RELAY DRIVERS FUNCTION ONLY THE AV-ONICS CHANNEL THAT IS ON CONTROL, EACH POLI RECEIVES SINGLE CHANNEL CONTROL SIGNALS FROM THE SCU DISCRETE OUTPUTS. THE SCU SENDS AN OFF COMMAND FROM THE OTHER CHANNEL SCU. SINGLE CHANNEL FUNCTIONS ARE ENABLED FOR ONLY THE AV-ONICS CHANNEL THAT IS IN CONTROL. 2. DUAL CHANNEL: a. SCU DISCRETE STRAPPED RELAY DRIVERS ENABLE FOR THE CHANNEL IN CONTROL b. SCU DISCRETE STRAPPED RELAY DRIVERS DISABLE FOR THE OTHER CHANNEL WHICH IS NOT IN CONTROL c. (P1)/(P2) BUS POWER TO SCU FOR RCS RELAY DRIVERS d. (P1)/(P2) BUS POWER TO SCU FOR RCS RELAY DRIVERS e. SCU DISCRETE OUTPUTS FROM THE NON-CROSS STRAPPED RELAY DRIVERS CONTROL THE RCS THRUSTER VALVES. THE SCU DISCRETE OUTPUTS ARE BOTH CHANNELS A AND B, THESE FUNCTIONS INCLUDE: a. AV-ONICS POWER TO THE RCS ENABLE b. AV-ONICS POWER TO THE NON-CROSS STRAPPED RELAY DRIVERS
NOTES:
S/C DISCRETE NO. 1 (SODB01/S0D011)
S/C DISCRETE NO. 2 (SODB02/S0D021)
S/C DISCRETE NO. 3 (SODB03/S0D031)
S/C DISCRETE NO. 4 (SODB04/S0D041)
S/C DISCRETE NO. 5 (SODB05/S0D051)
S/C DISCRETE NO. 6 (SODB06/S0D061)
S/C DISCRETE NO. 7 (SODB07/S0D071)
S/C DISCRETE NO. 8 (SODB08/S0D081)
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
LYNDON B. JOHNSON SPACE CENTER HOUSTON, TEXAS
POWER DISTRIBUTION UNIT
SHEET 1 OF 2


ORBITER
ASE
IUS
SPACECRAFT
ASE IUS STAGE 2
POWER CONTROL UNIT
PCP
PCU/PDU INTERFACE CONTROL (ALT)
PCU/PDU INTERFACE CONTROL (PRI)
MOTOR SWITCH CONTROL (TYPICAL)
MOTOR SWITCH CONTROL (TYPICAL)
MOTOR SWITCH CONTROL (TYPICAL)
ASE 50-60 CONVERTER
LAUNCH CLAMP
S/C SUPPORT
S/C REGULATOR
50-60 SIGNAL
POWER SOURCE
ASE BATT 3A (22 A-H)
ASE BATT 3B (22 A-H)
ASE BATT 3C (22 A-H)
ASE BATT 3D (22 A-H)
STAGE 2 BATTERY CONTROL
STAGE 1 BATTERY CONTROL
ASE POWER CONTROL
POWER TRANSFER UNIT
+ALT POWER DISTRIBUTION UNIT
(PRI) POWER DISTRIBUTION UNIT
ISOLATION DIODE ASSEMBLY
ISOLATION DIODE
ASE POWER FROM S/C BATTERIES
STAGE 1 S/C BATTERY AND POWER TRANSFER UNIT
TO/FROM S/C
OPTIONAL 50-60 CONVERTER S/T LOCATION OR S/C CASS CONNECTOR
7 IUS EPS S/C PWR
EPS
SPACECRAFT POWER
1.7


PYRO SWITCHING UNIT B
PYRO SWITCHING UNIT A
SRM 1 IGNITION CONTROL
ORDNANCE BUS CONTROL
PYRO MASTER DISABLE CONTROL A (SI)
RCS ISOLATION VALVE CONTROL
SAFE AND ARM CONTROL
STAGE 1-2 SEPARATION
SPACECRAFT SEPARATION
STAGE 1-2 SEPARATION DEVICE
SPACECRAFT SEPARATION DEVICE
SRM 1 SAFE AND ARM DEVICE A
SRM 1 SAFE AND ARM DEVICE B
SRM 2 SAFE AND ARM DEVICE A
SRM 2 SAFE AND ARM DEVICE B
RCS SQUIB A
RCS SQUIB B
SRM 1 (SIMPLIFIED)
SRM 2 (SIMPLIFIED)
SAFE AND ARM DEVICE (EXPLODED VIEW)
8A PYRO S&A
PYROTECHNIC SHOCK AND VIBRATION CRITERIA
PYROTECHNIC SEPARATION COMPONENTS
PYROTECHNIC DEVICES
PYRO SWITCHING UNIT
SAFE AND ARM DEVICE
1.8


AFD
ASE
ASE
IUS 1ST STAGE
IUS 1ST STAGE
IUS 2ND STAGE
POWER CONTROL PANEL (PCP)
POWER CONTROL UNIT (PCU)
IUS SUPPORT HEATERS BATTERY
PRIMARY EXCLUSIVE OR CIRCUITRY
ALTERNATE EXCLUSIVE OR CIRCUITRY
ASE AFTA AND CONTROLLER HEATERS AND THERMOSTATS
PRI ACTUATOR
PRI ACTUATOR CONTROLLER
ALT ACTUATOR
ALT ACTUATOR CONTROLLER
ASE BATTERY HEATER BLANKETS AND THERMOSTATS
ASE AV BAT 1B
ASE AV BAT 1A
ASE AV BAT 2B
ASE AV BAT 2A
ASE AV BAT 3B
ASE AV BAT 3A
1ST STAGE BATTERY HEATER BLANKETS AND THERMOSTATIC SWITCHES
1ST STG BAT A2
1ST STG BAT A1
1ST STG BAT A4
1ST STG BAT A3
1ST STG BAT B2
1ST STG BAT B1
1ST STG BAT S/C 2
1ST STG BAT S/C 1
MISSION DEPENDENT
INTERSTAGE CONNECTOR
IUS UMBILICAL FROM ASE
IUS UMBILICAL FROM ASE
PDU B
PDU A
2ND STG BATTERY HEATER BLANKETS AND THERMOSTATS
2ND STG AV BAT A
2ND STG AV BAT B
2ND STG S/C BAT
2ND STG UTILITY BAT A
2ND STG UTILITY BAT B
TYPICAL BATTERY CELL
.030" SILICON HEATER BLANKET WITH POWER BATTERY CASE
.125" CELLULOSE ACETATE COVER
.120 AZBIC MAGNESIUM OUTER BATTERY CASE
PRESSURE RELIEF VALVE
FROM SDU UNPROTECTED RELAY MATRIX DRIVERS
EMI IS CONTROLLED BY DOUBLE SHIELDED WIRE TO CONTROLLER AND ACTUATORS
THE SERIES THERMOSTATS CLOSE AND OPEN AT 50-75.15 °F AND 70-93.33 °F
THE ACTUATOR CONTROLLER HEATERS HAVE TWO THIRTY-FIVE WATT ELEMENTS IN PARALLEL
THE ACTUATOR HEATERS HAVE TWO TWENTY WATT ELEMENTS IN PARALLEL
BATTERIES WILL DELIVER THEIR RATED OUTPUT IF OPERATING TEMPERATURE IS BETWEEN 4.4 °C AND 37.8 °C
RELIEF VALVE CRACKING PRESSURE: 5.0 ± 1.0 PSI
RESEAT PRESSURE: 3.9 PSI MIN
EACH BATTERY HEATER HAS AN INLINE EMI FILTER BEFORE AND AFTER THE HEATER AND THERMOSTATS
EACH BATTERY CONSISTS OF ONE 20-CELL BATTERY RATED AT 13 AMP HOUR. EACH HEATER IS RATED FOR 6 WATTS. PREDICTED USAGE 0 WATTS. HEATER BLANKET IS INTERNAL
THE HEATER THERMOSTATIC SWITCH SETTINGS ARE AS FOLLOWS:
CONTROL TEMP - OFF 24.54° C INCREASING TEMP ON 10.94° C DECREASING TEMP
CONTROL OVER TEMP - OFF 35.18 ° C INCREASING TEMP ON 21.74° C DECREASING TEMP
NOTES: EACH BATTERY UNIT CONSISTS OF TWO TEN-CELL BATTERIES CONNECTED TOGETHER. THE HEATER BLANKETS ARE INTERNAL AND ARE RATED FOR 25 WATTS. PREDICTED USAGE IS 0 WATTS
1 ASE & IUS HTRS 1
SIGNATURE
DATE
ORIGN LMB
1-24-86
DR LMB
1-24-86
ENGR
ENGR
APP
APP
DMN/PLMS/CI-6
IUS SYS NO
DWG NO
2.1
LTR
ECN
82.3.3.34
PAGE 3.1-1
SHEET 1 OF 2
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
LYNDON B. JOHNSON SPACE CENTER HOUSTON, TEXAS
ASE AND IUS HEATERS

DATE= 11/15/88	NAME= MDU	VERSION= BPTs.14

DATE= 02/23/88	NAME= JMB	VERSION= 1Rb.2
DATE= 03/18/88	NAME= MTB	VERSION= 1Rb.3
DATE= 11/15/88	NAME= MDU	VERSION= BPTs.14

AFD (AFT FLIGHT DECK)

ASE (AIRBORNE SUPPORT EQUIPMENT)

ASE | IUS

IUS UMBILICAL

POWER CONTROL PANEL (PCP)

IUS SUPPORT HEATERS GUARD PRI

$V_{PCP\ PRI}$

$V_{PCP\ PRI\ RTN}$

PRIMARY EXCLUSIVE OR CIRCUITRY

IUS SUPPORT HEATERS GUARD ALT

$V_{PCP\ ALT}$

$V_{PCP\ ALT\ RTN}$

ALTERNATE EXCLUSIVE OR CIRCUITRY

POWER CONTROL UNIT (PCU)

PCU

PCS

PRB

ACS

ARB

$V_{AV\ RTN}$

V_{PRI-PL}

$V_{PRI-PL\ RTN}$

+28V

POWER KILL

RIMU (REDUNDANT INERTIAL MEASUREMENT UNIT)

RIMU GUARD HEATERS

OFF 23 ± 5°F
ON 10 ± 5°F

RANGE

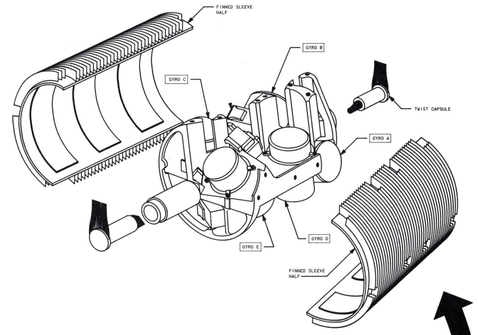
HTR GYRO A 4W

HTR GYRO B 4W

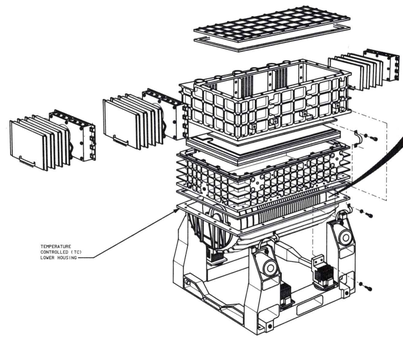
HTR GYRO E 4W

HTR GYRO D 4W

HTR GYRO C 4W



SENSOR CLUSTER ASSEMBLY (EXPLODED VIEW)



IUS RIMU

NOTES:

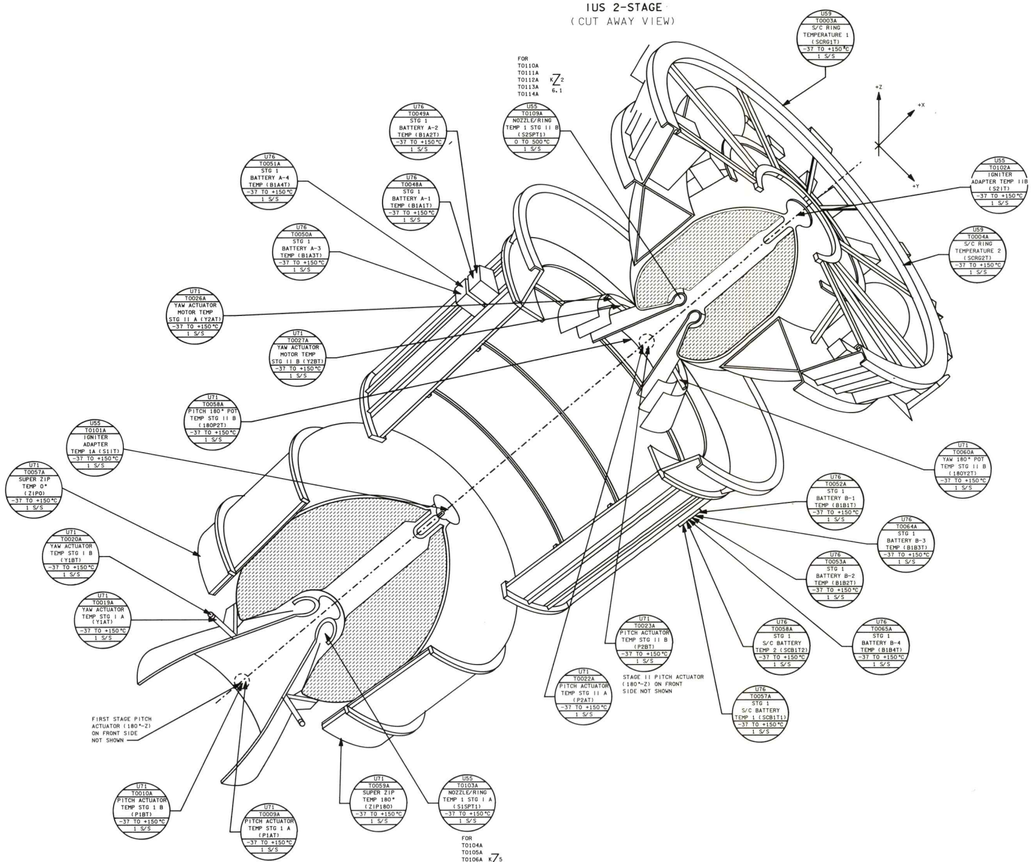
1. REFER TO DRAWING 3.3-1.2 FOR RIMU HEATERS WHICH ARE INTERNALLY CONTROLLED
2. THE 4W HEATER ELEMENTS ARE LOCATED INSIDE EACH GYRO UNIT, (i.e. A, B, C, D, & E) SEE EXPLODED VIEW "SENSOR CLUSTER ASSEMBLY".

1 IUS HTRS 2

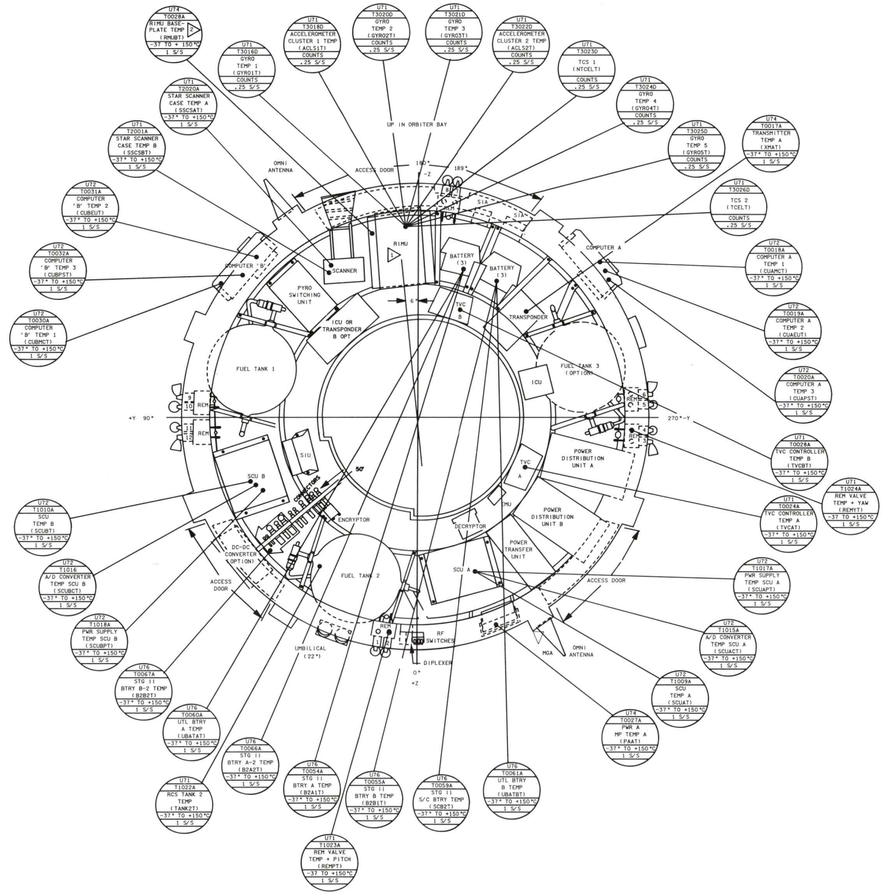
SIGNATURE	DATE	NATIONAL AERONAUTICS AND SPACE ADMINISTRATION LYNDON B. JOHNSON SPACE CENTER HOUSTON, TEXAS
DSGN HARRY J BUSH III	3/24/88	
PLN		IUS RIMU GUARD HEATERS
ENGR		
ENGR		
APP		IUS STS 1B — DWG NO 2.1
APP		
DPM/PLAN E C Goddard 12/1/88		83.5 X 34 — PAGE 3.1-2 — SHEET 2 OF 3
LTR 0	PCN	

DATE= 1/25/88	NAME= MAG	VERSION= BFTs17
DATE= 2/23/88	NAME= JMB	VERSION= INR=2
DATE= 11/15/88	NAME= LAM	VERSION= BFTs18

IUS 2-STAGE
(CUT AWAY VIEW)



EQUIPMENT SUPPORT SECTION
(AVIONICS BAY)

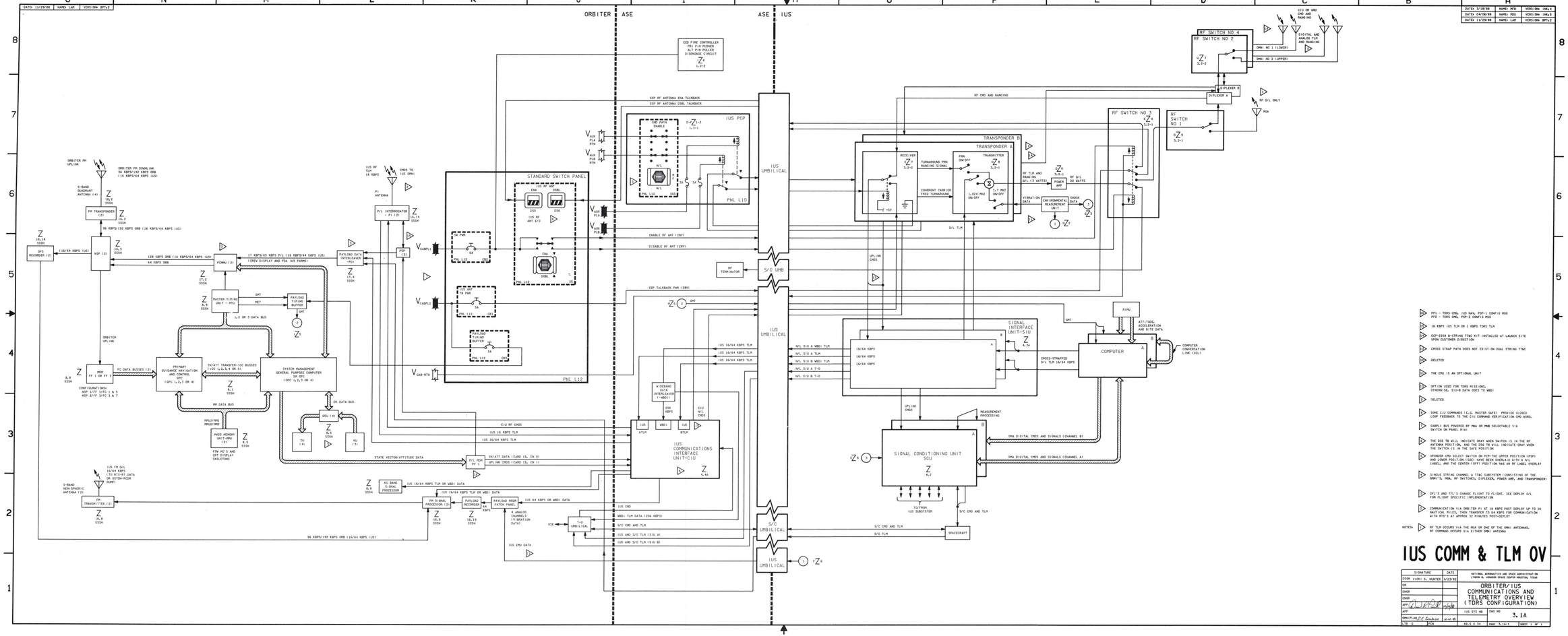


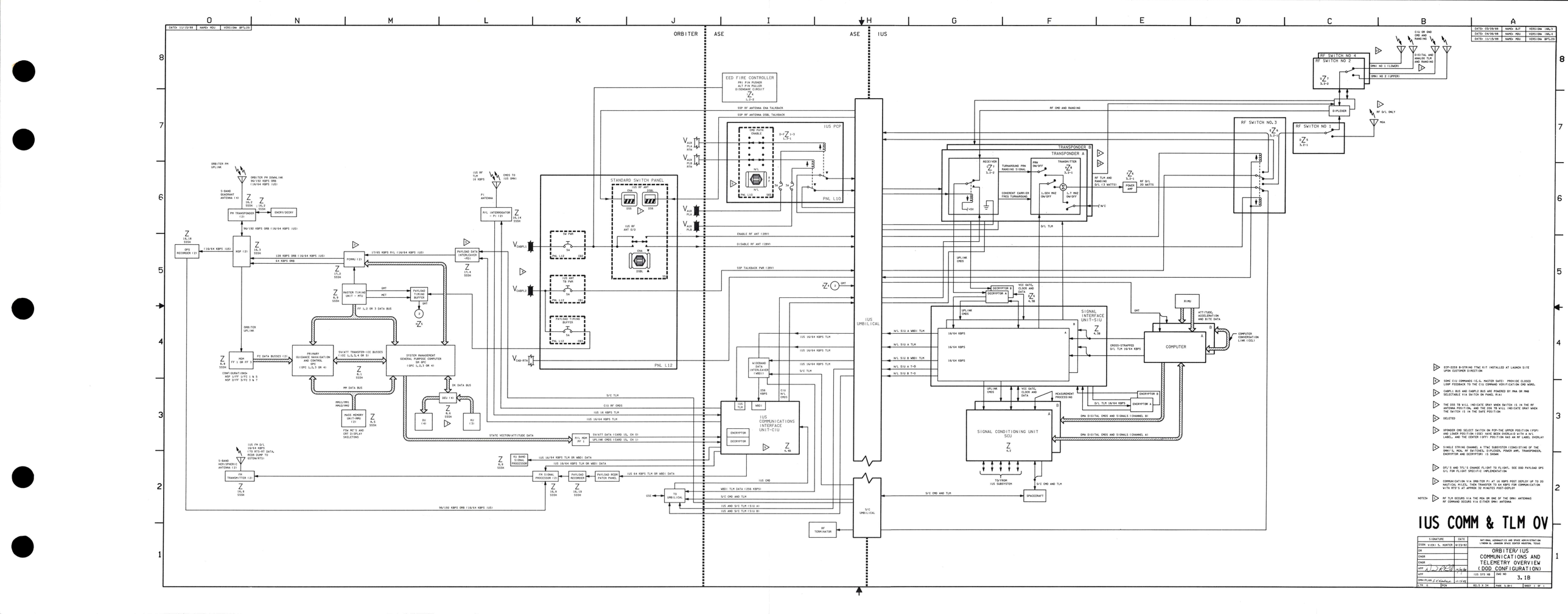
▷ MEASURES RIMU BASE-PLATE TEMPERATURE, HOWEVER, THIS MEASUREMENT IS LABELED "POWER AMP TEMP B" IN IUS MTF AND TELEMETRY DESCRIPTION HANDBOOK

NOTES ▷ CALIBRATION TO CONVERT COUNTS → °C IS A FUNCTION OF RIMU HARDWARE

2 THERM INST

SIGNATURE		DATE	NATIONAL AERONAUTICS AND SPACE ADMINISTRATION LYNDON B. JOHNSON SPACE CENTER HOUSTON, TEXAS
DSGN	VIC ORTIZ	6/30/80	
DR			THERMAL INSTRUMENTATION
CNGR			
CNGR			
APP			
APP	G. JURAN	10/16/84	IUS SYS NB
OMNIPLAN		9-14-88	DWG NO 2.2
LTR	G	PCN	66 X 34 PAGE 2.2-1 SHEET 1 OF 1


ORBITER
ASE
ASE
IUS
STANDARD SWITCH PANEL
PNL L12
IUS PCP
IUS UMBILICAL
S/C UMB
S/C UMBILICAL
IUS UMBILICAL
TRANSPONDER B
TRANSPONDER A
RF SWITCH NO 4
RF SWITCH NO 2
RF SWITCH NO 3
RF SWITCH NO 1
DIPLEXER B
DIPLEXER A
COMPUTER
SIGNAL CONDITIONING UNIT SCU
SIGNAL INTERFACE UNIT-SIU
IUS COMMUNICATIONS INTERFACE UNIT-CIU
SPACECRAFT
PM TRANSPONDER (2)
MSP (2)
PCMMU (2)
MDM FF 1 OR FF 3
PRIMARY GUIDANCE NAVIGATION AND CONTROL SYSTEM (3 GPC (GPC 1,2,3 OR 4)
SYSTEM MANAGEMENT GENERAL PURPOSE COMPUTER SM GPC (GPC 1,2,3 OR 4)
MASTER TIMING UNIT - MTU
PAYLOAD TIMING BUFFER
PAYLOAD DATA INTERLEAVER (-PDI)
PSP (2)
P/L INTERROGATOR - PI (2)
P/L ANTENNA
GPS RECEIVER (2)
S-BAND QUADRANT ANTENNA (4)
S-BAND OMNIDIRECTIONAL ANTENNA (2)
PM TRANSMITTER (2)
MASS MEMORY UNIT-MMU (3)
DEU (4)
DU (4)
KU (3)
KU BAND SIGNAL PROCESSOR
PM SIGNAL PROCESSOR (2)
PAYLOAD RECORDER
PAYLOAD MDM PATCH PANEL
P/L MDM FF 1
TLC UMBILICAL
EED FIRE CONTROLLER PRI P/R PULSER ALT P/R PULLER DISCONNECT CIRCUIT
RF TERMINATOR
RIMU
ATTITUDE, ACCELERATION AND BITE DATA
COMPUTER CONVERSATION LINK (CCL)
MEASUREMENT PROCESSING
ENVIRONMENTAL MEASUREMENT UNIT
POWER AMP
RF D/L ONLY
MEA
OMNI NO 1 (LOWER)
OMNI NO 2 (UPPER)
C/U OR OMD CMD AND RANGING
DIGITAL AND ANALOG TLM AND RANGING
RF CMD AND RANGING
RF TLM AND RANGING D/L 1.5 WATTS
RF D/L 20 WATTS
VIBRATION DATA
SHOCK DATA
TURNAROUND PRN RANGING SIGNAL
COHERENT CARRIER FREQ TURNAROUND
PRN ON-OFF
1.7 MHZ ON-OFF
1.024 MHZ ON-OFF
+5V
G/L TLM
UPLINK CMDS
CROSS-STRAPPED G/L TLM 16/64 KBPS
DMA DIGITAL CMDS AND SIGNALS (CHANNEL B)
DMA DIGITAL CMDS AND SIGNALS (CHANNEL A)
TO/FROM IUS SUBSYSTEM
S/C CMD AND TLM
IUS CMD
IUS CMD DATA
WBDI TLM DATA (256 KBPS)
IUS AND S/C TLM (SIU A)
IUS AND S/C TLM (SIU B)
ANALOG CHANNELS (VIBRATION DATA)
ENABLE RF ANT (28V)
DISABLE RF ANT (28V)
SSP TALKBACK PWR (28V)
SSP RF ANTENNA ENA TALKBACK
SSP RF ANTENNA DISBL TALKBACK
ORBITER PM UPLINK
ORBITER PM DOWNLINK 96 KBPS/192 KBPS ORB (16 KBPS/64 KBPS (US)
96 KBPS/192 KBPS ORB (16 KBPS/64 KBPS (US)
128 KBPS ORB (16 KBPS/64 KBPS (US)
64 KBPS ORB
17 KBPS/65 KBPS P/L (16 KBPS/64 KBPS (US)
(ORDV DISPLAY AND PDA (US PAYMS)
1,2 OR 3 DATA BUS
MM DATA BUS
DK DATA BUS
FC DATA BUSSES (2)
SV/ATT TRANSFER-ICC BUSSES (GPC 1,2,3,4 OR 5)
SV/ATT DATA (CARD 15, CH 3)
UPLINK CMDS (CARD 15, CH 1)
STATE VECTOR/ATTITUDE DATA
IUS 16/64 KBPS TLM
IUS 16/64 KBPS TLM OR WBDI DATA
IUS 64 KBPS OR WBDI DATA
C/U RF CMDS
C/U W/L CMDS
W/L SIU A WBDI TLM
W/L SIU A TLM
W/L SIU B WBDI TLM
W/L SIU B TLM
W/L SIU A T-0
W/L SIU B T-0
W-BAND DATA INTERLEAVER (-WBDI)
256 KBPS
IUS ATLM
IUS BTLM
WBDI
OSE
OMD PATH ENABLE
W/L
P/L
ENA
DISBL
DSS
IUS RF ANT E/O
PNL L10
PNL L11
PNL L13
PNL L14
PNL L15
PNL L16
PNL L17
PNL L18
TO PNL
5A
OMT
MET
GPC
PFS
PFT
PFT - TDRS CMD, IUS NAV, PSP-1 CONFIG MSG
PFT - TDRS CMD, PSP-2 CONFIG MSG
16 KBPS IUS TLM OR 1 KBPS TDRS TLM
ECP-3259 B-STRING TT&C KIT INSTALLED AT LAUNCH SITE UPON CUSTOMER DIRECTION
CROSS STRAP PATH DOES NOT EXIST ON DUAL STRING TT&C
DELETED
THE ENU IS AN OPT/DUAL UNIT
OPT:ION USED FOR TDRS MISSIONS, OTHERWISE, SIU-B DATA GOES TO WBDI
SKELETED
SOME C/U COMMANDS (E.G. MASTER SAFE) PROVIDE CLOSED LOOP FEEDBACK TO THE C/U COMMAND VERIFICATION CMD WORD.
CARPL1 BUS POWERED BY MNA OR MNB SELECTABLE V1A SWITCH ON PANEL R1A1
THE DSS TB WILL INDICATE GRAY WHEN SWITCH IS IN THE RF ANTENNA POSITION, AND THE DSS TB WILL INDICATE GRAY WHEN THE SWITCH IS IN THE SAFE POSITION
XPONDER ONE SELECT SWITCH ON PCP-THE UPPER POSITION (PDI) WILL BE COVERED WITH A BLACK PATCH OVERLAID WITH A BLACK LABEL, AND THE CENTER (OFF) POSITION HAS AN RF LABEL OVERLAY
SINGLE STRING CHANNEL A TT&C SUBSYSTEM (CONSISTING OF THE OMNI S, MNA, RF SWITCHES, DIPLEXER, POWER AMP, AND TRANSPONDER)
DFI/ S AND TFI/ S CHANGE FLIGHT TO FLIGHT, SEE DEPLOY G/L FOR FLIGHT SPECIFIC CONFIGURATIONS
COMMUNICATION V1A ORBITER FI AT 16 KBPS POST DEPLOY UP TO 20 NAUTICAL MILES, THEN TRANSFER TO 64 KBPS FOR COMMUNICATION WITH RTF'S AT APPROX 30 MINUTES POST-DEPLOY
NOTES:
RF TLM OCCURS V1A THE MDA OR ONE OF THE OMNI ANTENNAS. RF COMMAND OCCURS V1A EITHER OMNI ANTENNA
DATED 5/15/88 NAMO MFD VERSION# OMA/4
DATED 04/05/88 NAMO MDU VERSION# OMA/5
DATED 11/29/88 NAMO LAM VERSION# OPT/2
IUS COMM & TLM OV
SIGNATURE DATE
SSOR VICKI S. HUNTER 4/23/92
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION LYNDON B. JOHNSON SPACE CENTER HOUSTON, TEXAS
ORBITER/IUS COMMUNICATIONS AND TELEMETRY OVERVIEW (TDRS CONFIGURATION)
IUS SYS NB
DWG NO 3.1A
SIZE D
SCALE NONE
SHEET 1 OF 1

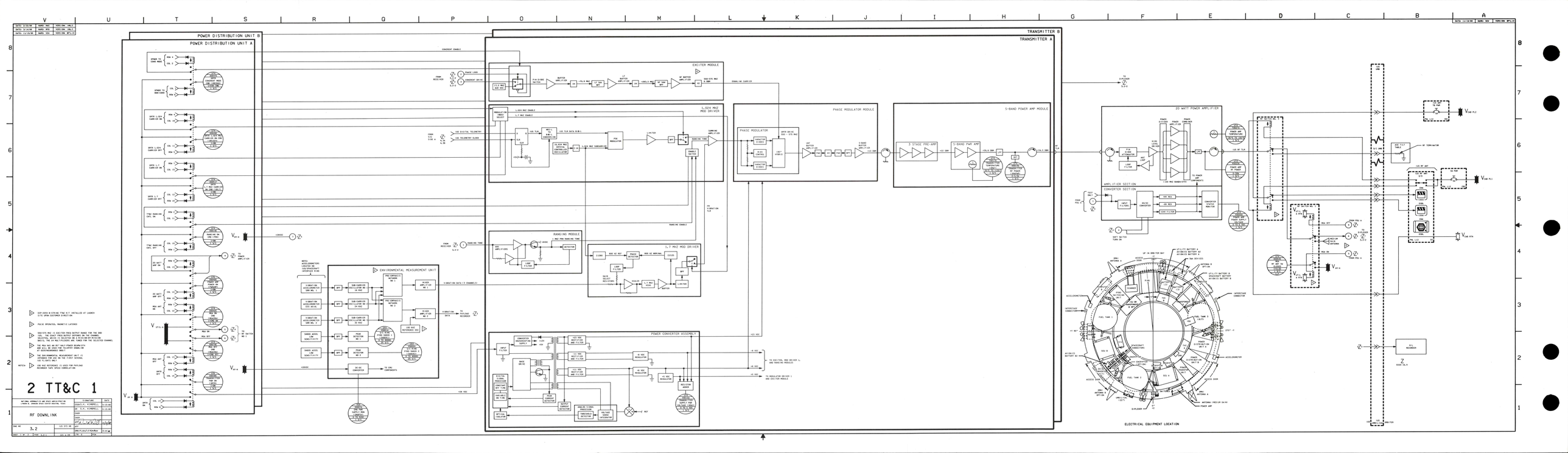


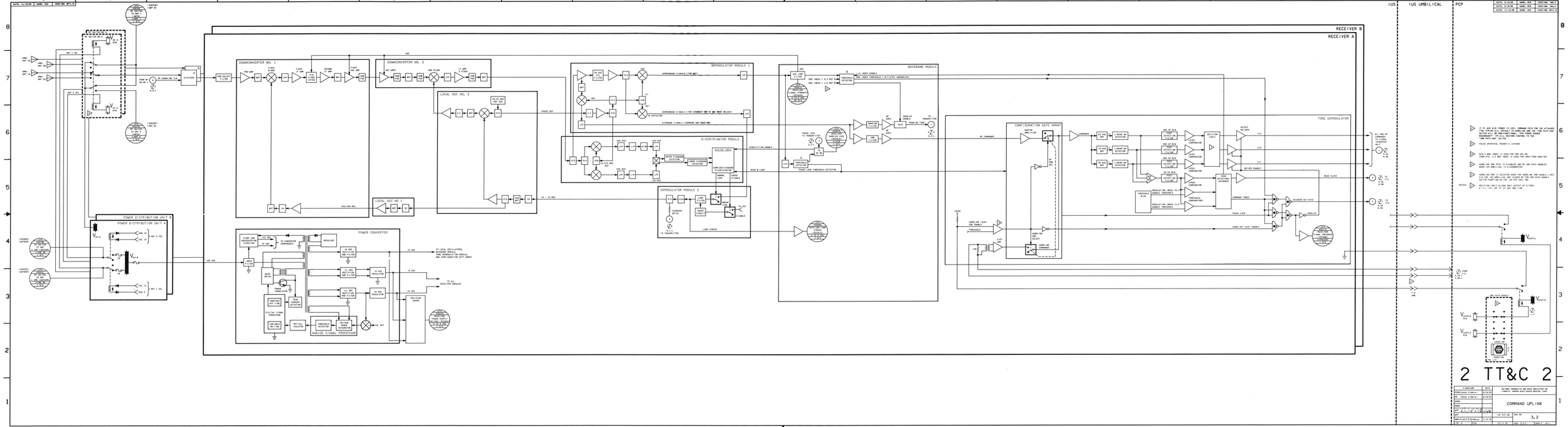
IUS COMM & TLM OV

SIGNATURE	DATE	
DRAWN VICKI S. HUNTER	4/23/93	NATIONAL AERONAUTICS AND SPACE ADMINISTRATION LYNDON B. JOHNSON SPACE CENTER HOUSTON, TEXAS
DR		ORBITER/IUS COMMUNICATIONS AND TELEMETRY OVERVIEW (DOD CONFIGURATION)
CHKR		
ENGR		
APP		IUS SYS NO 3.1B DWG NO
APP		
DRN-PLAN		

LTR	REVISIONS	DATE	APPROVED
A	DATA: 03/09/88 NAMEK: BJT VERSION: IMA/3		
B	DATA: 04/06/88 NAMEK: MDU VERSION: IMA/3		
C	DATA: 11/15/88 NAMEK: MDU VERSION: BMT4.29		

DATE: 3/29/94	NAME: MAC	VERSION: ORL3
DATE: 3/14/89	NAME: MFR	VERSION: ORL3
DATE: 12/15/88	NAME: SEK	VERSION: SPLIT




RECEIVER B
RECEIVER A
IUS
IUS UMBILICAL
PCP
DOWNCONVERTER NO. 1
DOWNCONVERTER NO. 2
LOCAL OSC NO. 1
LOCAL OSC NO. 2
DEMODULATOR MODULE 1
DEMODULATOR MODULE 2
DISCRIMINATOR MODULE
BASEBAND MODULE
CONFIGURATION GATE ARRAY
TONE DEMODULATOR
POWER DISTRIBUTION UNIT B
POWER CONVERTER
ANALOG SIGNAL PROCESSOR
DIGITAL SIGNAL PROCESSOR
2 TT&C 2
COMMAND UPLINK

DATE 12/21/87 | NAME: LAM | VERSION: BPS:9

DATE 04/07/88 | NAME: MSU | VERSION: IMU:3
DATE 7/16/88 | NAME: PAS | VERSION: BPS:6
DATE 12/01/88 | NAME: LAM | VERSION: BPS:9

COMPUTER UNIT-B
COMPUTER UNIT-A

SYSTEM SYNCHRONIZATION
IMU-1
IMU-2
IMU-3
RIMU
SCU
CMD/ECHO
SCU DMA
COMPUTER CONVERSATION LINK
COMPUTER UNIT
ORBITER-PAYLOAD DMT TIMING BUFFER (VIA GPC)

RATE	INTERFACE LEVEL	DESCRIPTION	CHECKS
25 HZ	LEVEL 9 LEVEL 13	DIFFERENTIAL DIGITAL	
1.024 MHZ		DATA-16 BITS, 17 WORDS MRZ-L, DMA CLOCK-GATED SQUARE WAVE	CHECKSUM, WORD PARITY, 4 INTERWORD GAP
1.024 MHZ	LEVEL 8	DATA-33 BITS SERIAL MRZ-L, CLOCK-GATED SQUARE WAVE	PARITY, CHECKSUM, 1 DISCRETES-PULSE DURATION 2±.5 TO 20±.5
1.024 MHZ		DATA-33 BITS SERIAL MRZ-L, CLOCK-GATED SQUARE WAVE DISCRETES-PULSE DURATION 2±.5 TO 20±.5	PARITY
1.024 MHZ	LEVEL 10 LEVEL 13	DATA 33 BITS, 33 WORDS, MRZ-L, DMA CLOCK-GATED SQUARE WAVE	PARITY, CHECKSUM, 1 INTERWORD GAP
1 KHZ	LEVEL 12		

2 OF 3 VOTER
40 MS SYNC
RIMU DMA 33 BITS
CLOCK
CMD ECHO 33 BITS
SCU DMA 33 BITS
END OF WORD
CDL DMA 33 BITS
SCU CDL RIMU DATA 33 BITS

MEMORY UNIT

MEMORY CONTROLLER
- BUS PRIORITY CONTROL-CPU/DMA CONTENTION
- ILLEGAL ADDRESS PROTECTION-INTERRUPT LEVEL 2
- RAM TIMING
- EDC INTERFACE

MEMORY
- ORGANIZED AS 39 BITS WITH 6 OF THESE BITS BEING HAMMING CODE AND 1 BIT PARITY
- THE 32 BITS CONSIST OF 2 16-BIT WORDS
- 65,536 WORDS TOTAL STORAGE (16 BITS PER WORD)

RAM MODULE 0 36 X 39 BITS
EXPANSION RAM MODULE (-) 36 X 39 BITS
39 BITS
10033A (QUAD 4 MEMORY CONTROL ELEMENT) 16 PIN DIP
10030A (SUBMIT)

ERROR DETECTION+CORRECTION UNIT
- SINGLE-ERROR DETECTION
- DOUBLE-ERROR DETECTION - INTERRUPT 4
- SELF-TEST
- FAULT ISOLATION-INTERRUPT 4

CHECKS	INTERRUPT LOGIC	DESCRIPTION	RATE
	LEVEL 6	PULSE DURATION OF 2±0.5	25 HZ
		DATA-33 BITS, MRZ-L CLOCK-GATED SQUARE WAVE DISCRETES-PULSE DURATION OF 2±0.5 TO 20±.5	1.024 MHZ
PARITY, CHECKSUM, INTERWORD GAP	LEVEL 10	DATA 33 BITS, 33 WORDS, MRZ-L, CLOCK-GATED SQUARE WAVE	1.024 MHZ
		DATA-MRZ-L, 16 BIDIRECTIONAL DATA WORDS - RG WORDS FOR 16 KHZ - 320 WORDS FOR 64 KHZ CLOCK-GATED SQUARE WAVE	16 KHZ OR 64 KHZ

40 MSEC SYNC
GU-A SCU-A SYNC
GU-B SCU-B SYNC
IMU MODE CONTROL
CMD/ECHO
PRIME SCU
ALT SCU
DATA CLOCK
DATA READY
DATA ACKNOWLEDGE
DATA VALID
OK DISCRETE
CDL DATA
CDL CLOCK
ID GROUND
COMPUTER CONVERSATION LINK
COMPUTER UNIT
TLM
CLOCK
SIU-A
SIU-B
TELEMETRY

POWER CONVERTER UNIT
PDU B $V_{DC\,B}$ 15A
PDU A $V_{DC\,A}$ 15A
28VDC
10033A (UNIT 2 FWD SUPPLY (SUPPLY) 16 PIN DIP) 1.3CA
10033A (UNIT 4 AFT SUPPLY (SUPPLY) 16 PIN DIP) 1.3CA
10033A (UNIT 4 AFT SUPPLY (+5 VOLTS) 16 PIN DIP) 1.3CA
10033A (UNIT 2 FWD SUPPLY (+5 VOLTS) 16 PIN DIP) 1.3CA
10040A CUR=5
10040A CUR=10
10040A CUR=15
10040A CUR=19
5.25V MEMORY SUPPLY

CENTRAL PROCESSING UNIT
- INITIALIZATION PROGRAM START
- SELF TEST LOGIC
- EXCESSIVE INTERRUPT PROTECTION
- PROGRAMMABLE INTERVAL TIMER INTERRUPT-LEVEL 7
10033A (UNIT 4 CPU EXECUTION 16 PIN DIP) 1.3CA
CUBOUT 10033A
CRYSTAL OSCILLATOR 20.48 MHZ

BUILT-IN-TEST-EQUIPMENT (BITE)
- INTERRUPT 0 - ILLEGAL OPERATIONS CODE
- INTERRUPT 1 - POWER OFF
- INTERRUPT 2 - ILLEGAL MEMORY ADDRESS
- INTERRUPT 3 - COMPUTER OPERATIONS TIMER
- INTERRUPT 5 - ARITHMETIC FAULT
- INTERRUPT 13 - I/O FAULT

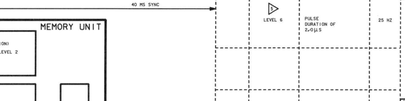
TEST POINT (J9-80)
TEST POINT (J9-109)
TEST POINT (J9-110)
TEST POINT (J9-81)
10R
160K
10
10K
BATTERIES
3VDC
CRACK PRESSURE 27 TO 41 PSIA
6.34K
15.4K
CPU GROUND
TEST POINTS (J9-78, J9-108)
TEST POINTS (J9-34, J9-52)

MEMORY RAM SUPPLY VOLTAGE NOT TELEMETERED, TESTED AS PART OF BATTERY POST INSTALLATION PROCEDURE

INTERFACES FOR COMPUTER-B ARE IDENTICAL EXCEPT AS NOTED IN

THIS INTERRUPT WILL INHIBIT THE COMPUTER OR DISCRETE AND CAUSE AVIONICS STRING RECONFIGURATION

ORBITER DMT TIMING INPUT FLOW 100 HZ PROCESSING). PROCESSING PERFORMED WHILE ON EXTERNAL POWER, WHILE ON INTERNAL POWER, THE CURRENT TIME IS MAINTAINED INTERNALLY



IUS COMPUTER EDC

EACH WORD IN MEMORY HAS A 6-BIT HAMMING CODE WHICH IS GENERATED BY LUNIC-IN THE EDC UNIT AND IS USED TO DETECT ONE OR TWO ERRORS. IF A ONE-BIT ERROR OCCURS, THE HAMMING CODE IS USED TO DETECT WHICH BIT IS IN ERROR SO THAT IT CAN BE CORRECTED. THE FOLLOWING TABLE ILLUSTRATES THE USE OF THE HAMMING CODE IN DEFINING THE TYPE OF ERROR.

ROW 1	ROW 2	F	E	D	C	B	A
0¢	00	0	0	0	0	0	0
A¢	01	0	0	0	0	0	1
B¢	02	0	0	0	0	1	0
01	03	0	0	0	0	1	1
C¢	04	0	0	0	1	0	0
02	06	0	0	0	1	1	0
03	06	0	0	0	1	1	0
04	07	0	0	0	1	1	1
D¢	08	0	0	0	1	1	1
05	09	0	0	1	0	0	1
06	10	0	0	1	0	1	0
07	11	0	0	1	0	1	1
08	12	0	0	1	1	0	0
09	13	0	0	1	1	0	1
10	14	0	0	1	1	1	0
11	15	0	0	1	1	1	1
E¢	16	0	1	0	0	0	0
12	17	0	1	0	0	0	1
13	18	0	1	0	0	1	0
14	19	0	1	0	0	1	1
15	20	0	1	0	1	0	0
16	21	0	1	0	1	0	1
17	22	0	1	0	1	1	0
18	23	0	1	0	1	1	1
19	24	0	1	1	0	0	0
20	25	0	1	1	0	0	1
21	26	0	1	1	0	1	0
22	27	0	1	1	0	1	1
23	28	0	1	1	1	0	0
24	29	0	1	1	1	0	1
25	30	0	1	1	1	1	0
26	31	0	1	1	1	1	1
F¢	32	1	0	0	0	0	0
27	33	1	0	0	0	0	1
28	34	1	0	0	0	1	0
29	35	1	0	0	0	1	1
30	36	1	0	0	1	0	0
31	37	1	0	0	1	0	1
32	38	1	0	0	1	1	0
P	39	EXCLUSIVE-OR' 39 BITS					

M BUS BITS

A = P' ⊕ 1 ⊕ 2 ⊕ 4 ⊕ 5.....
B = P' ⊕ 1 ⊕ 3 ⊕ 4 ⊕ 6.....
C = P' ⊕ 2 ⊕ 3 ⊕ 4 ⊕ 7.....
D = P' ⊕ 5 ⊕ 6 ⊕ 7 ⊕ 8.....
E = P' ⊕ 13 ⊕ 14 ⊕ 15.....
F = P' ⊕ 27 ⊕ 28 ⊕ 29 ⊕ 30.....
P = EXCLUSIVE-OR' OF ALL 39 BITS.....

WHERE A', B', C', D', E', F' ARE HAMMING CODE BITS, AND A,B,C,D,E,F ARE EDC BITS IN MEMORY

FOR EDD PARITY=
SINGLE ERROR=(A,B,C,D,E,F)'
DOUBLE ERROR= (A,B,C,D,E,F)' (P')
PARITY BIT ERROR= (A,B,C,D,E,F)' (P')

COMPLEMENT LOCATION IS THE BIT POSITION WHICH IS REPRESENTED BY DECODING BITS F,E,D,C,B,A IN THAT ORDER

THE FOLLOWING EDC TRUTH TABLE DEFINES THE USE OF HAMMING AND PARITY ERRORS TO DETERMINE THE ACTION WHICH SHOULD BE TAKEN

PE	HE	INTERPRETATION	ACTION
0	0	NO ERROR	-NO CORRECTION
0	1	UNCORRECTABLE ERROR	-SET FAULT FLAG -INTERRUPT PROCESSOR-LEVEL 4 -SET ERROR STATUS FLAG -TRAP ERROR ADDRESS
1	0	PARITY BIT IN ERROR (DATA VALID)	-NO CORRECTION -SET ERROR STATUS FLAG -TRAP ERROR ADDRESS
1	1	SINGLE BIT ERROR (DATA OR HAMMING CODE)	-CORRECT IF DATA BIT IN ERROR -SET ERROR STATUS FLAG -TRAP ERROR ADDRESS

PE = PARITY ERROR HE = HAMMING CODE ERROR

THE COMPUTER UNIT 1A OR B1 I/O VOLTAGES ARE BASED ON THE VOLTAGE OF THE BUS WITH THE HIGHEST VOLTAGE OF THE THREE MAIN BUS. THIS BUS MAY BE POWERED BY THE LEFT OR RIGHT MAIN BATTERIES OR EXTERNALLY FROM THE ORBITER'S FUEL CELL NO. 3, OR AUXBOMB EQUIPMENT (ASE) BATTERIES. IF THE VOLTAGE FROM THE PDU DROPS BELOW 22VDC, THE COMPUTER UNIT 1A OR B1 WHICH IS RECEIVING THIS VOLTAGE WILL SET ITSELF "NOT OK", OR TERMINATE PROCESSING

REDUNDANCY MANAGEMENT STATUS WORDS-
THE REDUNDANCY MANAGEMENT STATUS WORDS CONTAIN BITS THAT ARE UPDATED AT 200 XSL. THE FIRST STATUS WORD IS TELEMETERED AT 100 HZ FOR 64 KBPS AND 25 HZ FOR 16 KBPS. SINCE WORD 1 CONTAINS THE MOST IMPORTANT BITS, IT IS INCLUDED IN ODD AND EVEN 16 MILLISECOND FRAMES SO THAT IT IS SAMPLED TWICE. ALL BITS IN THE REMAINING WORDS ARE SAMPLED ONCE. USE THE NUMBERS LISTED

UT2-M-0102-0 RM-CONTROL-WORD 1 (1), ODD 10 MSEC SLOTS
BIT 1= U-90-9-4051-E EXEC-SIO-I-DIR-IN-CONTROL-FLT
U-90-9-4202-E EXEC-SIO-THIS-S-SIDE-IN-FLAG
U-9C-9-4203-E EXEC-SIO-BUS-CHANNEL-STATUS
U-90-9-4204-E EXEC-SIO-RECONFIGURATION-IN-PROCESS-FLAG
U-90-9-4205-E EXEC-STAGE-1/1-FDP-FUNCTIONING-IN-PROCESS
U-90-9-4206-E EXEC-SIO-RECONFIGURATION-STATUS
U-90-9-4207-E EXEC-SIO-MDM-VERIFY-STATUS
U-90-9-4208-E RM-I-SNGLE-BIT-MEMORY-ERROR-FLAG
U-90-9-4209-E EXEC-I-DOUBLE-BIT-MEMORY-ERROR-FLAG
U-90-9-4211-E EXEC-I-ILLEGAL-ADDRESS-FAULT-FLAG
U-90-9-4209-E EXEC-I-ILLEGAL-INSTRUCT-ON-FAULT-FLAG
U-90-9-4235-E EXEC-ARITHMETIC-FAULT-FLAG
U-90-9-4213-E EXEC-COP-INTERRUPT-DETECTED-INDICATOR
U-90-9-4214-E EXEC-COMPUTER-OPERATIONS-TIMER
U-90-9-4215-E EXEC-SIO-COMMAND-FAIL-INDICATOR
BIT 16=U-90-9-4216-E EXEC-SIO-NU-INDICATOR

UT2-M-0014-0 RM-CONTROL-WORD 11, EVEN 10 MSEC SLOTS
(SAME PARAMETERS AS UT2-M-0013-0 BUT NOT AVAILABLE IN 16 KBPS)

ALL REMAINING RM WORDS TELEMETERED AT 1 HZ

UT2-M-0026-M RM-CONTROL-WORD 13
BIT 1= U-90-9-4217-D SPARE
U-90-9-4218-E EXEC-OPT-FAULT-INDICATOR
U-90-9-4247-D RM-R1MU-CH-1-FAILURE
U-90-9-4248-D RM-R1MU-CH-2-FAILURE
U-90-9-4248-D RM-R1MU-CH-3-FAILURE
U-90-9-4222-D RM-TVC-STAGE-SELECT-FAULT
U-90-9-4223-D RM-RCS-COMMAND-FAILURE-INDICATOR
U-90-9-4224-D RM-T-TAN-COMMAND-FAILURE-INDICATOR
U-90-9-4225-D RM-T-TAN-RESPONSE-FAILURE-INDICATOR (2 BITS IN LENGTH)
U-90-9-4230-D SELF-TEST-STATUS-INDICATOR (2 BITS IN LENGTH)
U-90-9-4255-D G-F-TVC-ACTUATOR-TEST-FAILURE
U-90-9-4256-E POWER-NOT-INTERRUPTED-FLAG
U-90-9-4257-D EXEC-SIO-DMA-DATA-NOT-AVAILABLE
U-90-9-4258-D EXEC-SIO-EXTERNAL-CLOCK-DRIFT-CHECK
BIT 16=U-90-9-4259-D SPARE

UT2-M-0027-D RM-CONTROL-WORD 13
BIT 1= U-90-9-4219-E EXEC-CROSS-STRAP-INTERRUPT-INHIBIT
U-90-9-4232-E TVC-YAW-RESPONSE-FAILURE-INDICATOR
U-90-9-4231-E TVC-PITCH-RESPONSE-FAILURE-INDICATOR
U-90-9-4234-E TTAC-POWER-AMPLIFIER-FAILURE-INDICATOR
U-90-9-4235-E RM-T-TAN-SIGNAL-FAILURE-INDICATOR
U-90-9-4236-E RM-T-TAN-SYNCHRO-FAILURE
U-90-9-4233-E RM-RCS-RESPONSE-FAILURE-INDICATOR
U-90-9-4237-E EXEC-STAR-SCANNER-DATA-FAULT
U-90-9-4238-E EXEC-STAR-SCANNER-INTERRUPT-INHIBIT
U-90-9-4239-E EXEC-SIO-INTERRUPT-INHIBIT-FLAG
U-90-9-4241-E EXEC-SIO-INTERRUPT-INHIBIT-FLAG
U-90-9-4242-E EXEC-SIO-DMA-FAULT
U-90-9-4243-E EXEC-SIO-DMA-PATTERN-FAILURE
U-90-9-4250-E EXEC-CONV-L-MM-PARITY-FAILURE
U-90-9-4251-E EXEC-CONV-L-MM-PARITY-FAILURE
U-90-9-4252-E EXEC-CONV-L-MM-DATA-DROPOUT
BIT 16=U-90-9-4253-E SPARE

UT2-M-0028-D RM-CONTROL-WORD 41
BIT 1= U-90-9-4213-E EXEC-FRAME-OVERRUN-FAILURE
U-90-9-4211-E EXEC-KMSEC-RESET-FAULT
U-90-9-4212-E EXEC-SYNC-FAILURE-FLAG
U-90-9-4218-E RM-SCU-RELAY-MATRIX-FAILURE-INDICATOR
U-90-9-4227-E EXEC-RM-RECONFIGURATION-REQUEST
U-90-9-4227-E EXEC-RM-RECONFIGURATION-INDICATOR
U-90-9-4228-E RM-TVC-RECONFIGURATION-REQUEST-INDICATOR
U-90-9-4229-E EXEC-SIO-COMMAND-FAILURE-INDICATOR
U-90-9-4243-E EXEC-SIO-DMA-FAILURE-INDICATOR
U-90-9-4244-E RM-SIO-DMA-PATTERN-FAILURE
U-90-9-4244-E RM-SIO-STATUS-STATUS-RECONFIGURATION-REQUEST-INDICATOR
U-90-9-4240-E EXEC-POWER-OFF-INTERRUPT-RECEIVED
U-90-9-4246-E EXEC-SIO-T-MODE?-INDICATOR
U-90-9-4260-E SPARE
U-90-9-4261-E SPARE
BIT 16=U-90-9-4262-E SPARE

THE ALTERNATE COMPUTER UNIT TRANSFERS THE SAME INFORMATION VIA THE COMPUTER CONVERSATION LINK (CCL). THE TELEMETRY PARAMETERS FROM THE ALTERNATE COMPUTER AREA

UT2-M-0013-D CONV-L-MM-RM-CONTROL-WORD 1 (1), PREVIOUS 10 MS SLOTS
UT2-M-0051-D CONV-L-MM-RM-CONTROL-WORD 11, CURRENT 10 MS SLOTS
UT2-M-0014-D CONV-L-MM-RM-CONTROL-WORD 11
UT2-M-0034-D CONV-L-MM-RM-CONTROL-WORD 13
UT2-M-0035-D CONV-L-MM-RM-CONTROL-WORD 41

ALL OF THESE ALTERNATE SIDE MEASUREMENT ARE GENERATED AT 100 HZ BUT ARE TELEMETERED AT 1 HZ, EXCEPT WORD 1

THE END-OF-WORD PULSE ACTS AS A COUNTER OF THE 40 SCU MEASUREMENT DATA BLOCKS BEING CLOCKED INTO THE DMA FROM THE SCU EVERY 40 MILLISECONDS. EACH DATA BLOCK CONSISTS OF 1-33 BIT WORD AND 32 16-BIT WORDS FOR A TOTAL OF 545 BITS. THE SCU USES 256 X 16 BIT BUFFERS TO ACCOMPLISH THIS DATA TRANSFER. DURING A SINGLE 40 MILLISECOND CYCLE, ONE OF THE BUFFERS OUTPUTS TO THE DMA WHILE THE OTHER IS READING IN THE SCU DATA. THIS PROCESS ALTERNATES EVERY 40 MILLISECONDS

1-40 SCU-A MEASUREMENT DATA
2-40 SCU-B MEASUREMENT DATA
41-80 S/C SLOT 1 MEASUREMENT DATA
81-120 S/C SLOT 2 MEASUREMENT DATA
121-156 S/C SLOT 3 MEASUREMENT DATA (1 ICU DATA)
159-256 S/C SLOT 4 MEASUREMENT DATA (1 ICU DATA)

AFTER EACH 40 MILLISECOND DATA TRANSFER, THE COUNTER IS RESET

IF MORE THAN TWO SUCCESSIVE BLOCKS OF THE COMPUTER CONVERSATION LINK (CCL) ARE IN ERROR, THE CCL IS CONSIDERED TO HAVE FAILED. THE SOFTWARE SETS A FLAG TO BLOCK FURTHER CCL INPUTS, NO RECONFIGURATION RESULTS, BUT THE REDUNDANCY MANAGEMENT STATUS WORD 3 INDICATES THE FAILURE. TWO OR MORE SPURIOUS INTERRUPTS DURING A 10 MILLISECOND CYCLE WILL ALSO RESULT IN THE CCL BEING DECLARED FAILED. THE COMPUTER CONVERSATION LINK (CCL) OUTPUT COMMAND DATA IS SET TO ZERO AND THE ALTERNATE SCU INDICATES BUS CHANNEL STATUS TO REDUNDANCY MANAGEMENT WHEN ON INTERNAL POWER. THE CCL CONTAINS THE FOLLOWING DATA

MISSION-ELAPSED-TIME-REFERENCE	100 HZ
EXEC INTENT TO POWER DOWN (1 BIT)	100 HZ
TERMINATED INDEX NUMBER	100 HZ
MISSION ARC TIME	100 HZ
CURRENT MISSION ARC TIME	100 HZ
EXEC SPEEDING/OH MEAN TIME	100 HZ
EXEC SB FRAME NUMBER MODULO 100	100 HZ
REDUNDANCY MANAGEMENT	100 HZ
EXEC SB SYNCHRONIZATION PATTERN	100 HZ
CONFIRMED SCHEDULED TASK ID	100 HZ
UNIT CONV L/NK OPERATING	100 HZ
NEXT MISSION ARC TIME	100 HZ
PRIMARY NAVIGATION QUATERNION QR	50 HZ
PRIMARY INERTIAL VELOCITY	25 HZ
PRIMARY INERTIAL RELATIVITY	25 HZ
WEIGHT RCS CONSUMED	100 HZ
TELEMETRY SUB-FRAME COUNTER	100 HZ
CURRENT STATE VECTOR TIME TAG	100 HZ

DATA TRANSFERS BETWEEN THE COMPUTER AND THE EXTERNAL SUBSYSTEMS FALL INTO THREE EXCEEDINGLY DATA TRANSFER UNDER PROGRAM CONTROL, DIRECT MEMORY ACCESS (DMA) TRANSFER, AND INTERRUPT INITIATED DATA TRANSFER, THE ONLY I/O CHANNELS SPECIFICALLY SHOWN ON THIS DRAWING ARE OF THE DMA TYPE. THE PROGRAM CONTROLLED I/O IS NOT SHOWN ONLY IN A GENERAL MANNER, THE INTERRUPT DRIVEN TRANSFERS ARE REFERENCED WHERE APPROPRIATE AND INCLUDE THE FOLLOWING PRIORITY TABLE

INTERRUPT PRIORITY LEVEL	INTERRUPT FUNCTION	COMPUTER RECONFIGURATION
0	ILLEGAL OPERATIONS CODE (BITE)	YES
1	POWER OFF (BITE)	YES
2	ILLEGAL MEMORY ADDRESS (BITE)	YES
3	COP (BITE)	YES
4	EDC MEMORY ERROR (DOUBLE BIT)	YES
5	ARITHMETIC FAULTS (BITE)	YES
6	10-MSEC SYSTEM SYNC	NO
7	PROGRAM TIMER	NO
8	SCU DATA AVAILABLE	NO
9	IMU DATA TRANSFER COMPLETE	NO
10	CCL DMA OUTPUT COMPLETE	NO
11	CONVERSATION COMMAND-FAIL INDICATOR	YES
12	CCL DATA AVAILABLE	NO
13	I/O FAULT (CCL OR IMU) (BITE)	YES
14	EXTERNAL SPARE	YES
15	EXTERNAL SPARE	YES
16	TEST EQUIPMENT (ASE)	YES

COMMAND/ECHO INTERFACE BETWEEN THE COMPUTER AND SCU INVOLVES THE FOLLOWING

STEP 1: COMPUTER TO SCU - SERIAL COMMAND DATA WORD AND GATED SQUARE WAVE CLOCK SIGNAL
- FOLLOWED BY DATA READY PULSE

STEP 2: SCU TO COMPUTER - SERIAL ECHO DATA AND GATED SQUARE WAVE CLOCK SIGNAL
- FOLLOWED BY DATA AVAILABLE PULSE
- LEVEL 8 INTERRUPT GENERATED TO NOTIFY SOFTWARE THAT THE COMMAND ECHO IS AVAILABLE FOR COMPARISON

STEP 3: COMPUTER TO SCU - DATA ACKNOWLEDGE PULSE INDICATES THE RECEIPT OF THE DATA TRANSFER

STEP 4: COMPUTER TO SCU - DATA VALID PULSE IS ISSUED IF THE COMPUTER DETERMINES THAT THE ECHO COMPARISON IS VALID, OR IN THE RECEIPT OF THE DATA VALID DISCRETE, THE SCU EXECUTES THE COMMAND

NOTE: THE COMMAND/ECHO INTERFACE IS ALSO USED TO TRANSFER STAR SCANNER DATA AND UPLINK COMMANDS FROM THE SCU TO THE COMPUTER

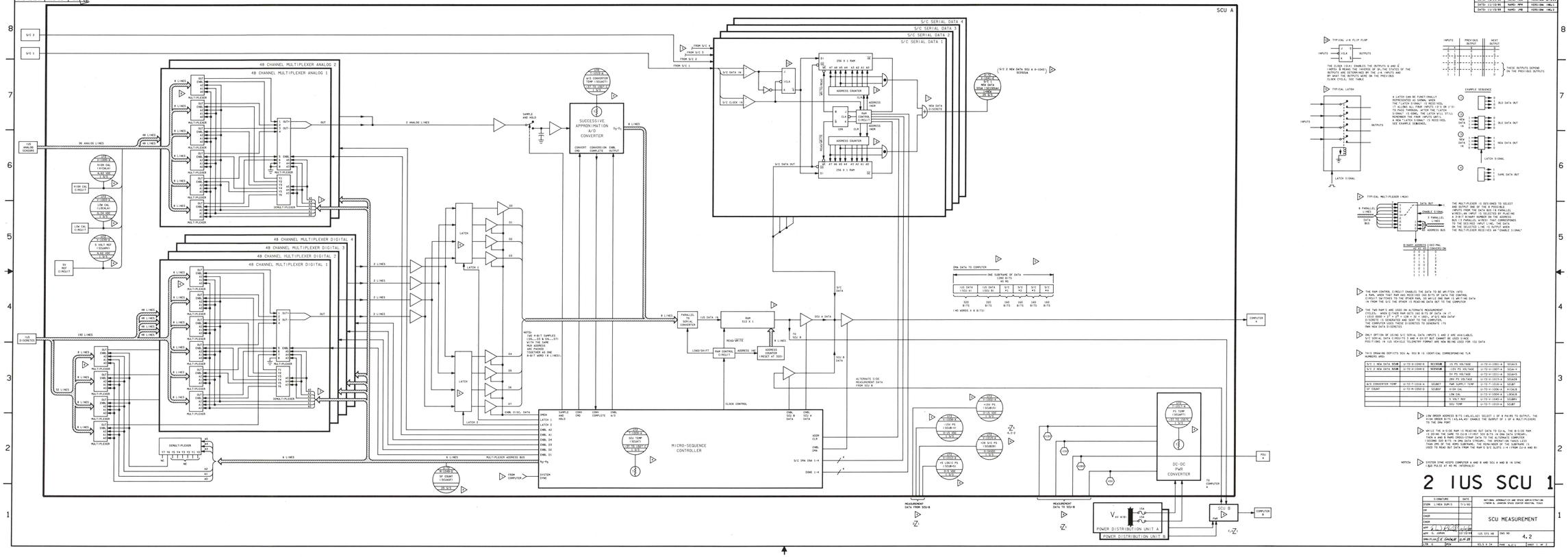
COMPUTER UNIT B'S IMU MODE CONTROL DISCRETES ARE UNUSED, ONLY THE COMPUTER UNIT A'S DISCRETES ARE USED. THE IMU MODE DISCRETES FROM SIOTERFACE, WITH THE TOGGLE BEING ADDED. THESE DISCRETES ARE USED FOR GROUND CAL IBRATIONS AND ARE LOCKED OUT BY THE POWER DISTRIBUTION UNIT (PDU) AFTER LAUNCH

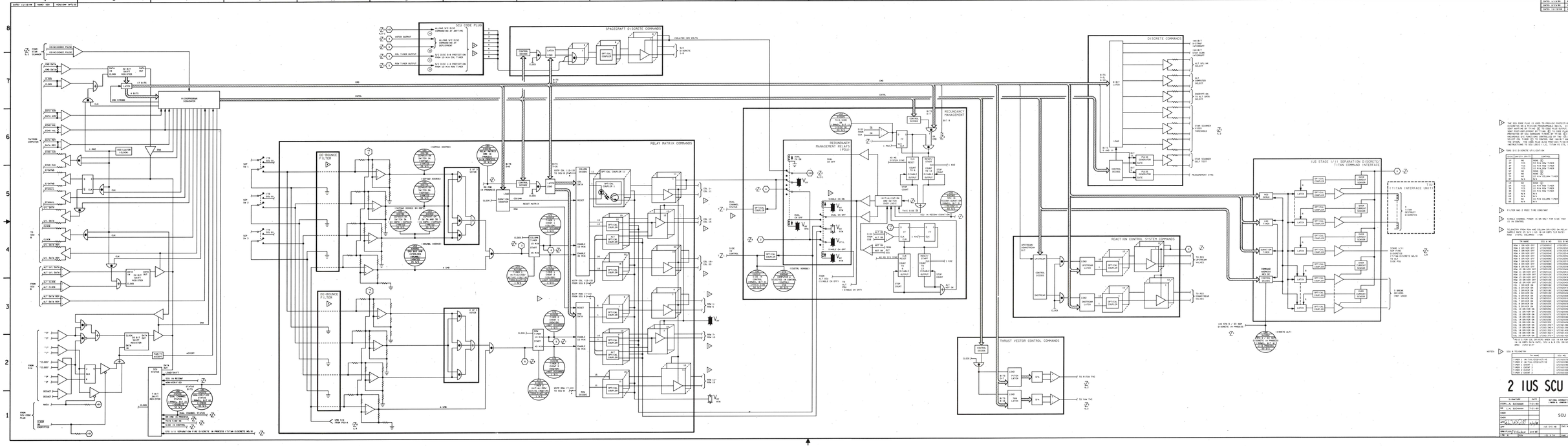
MEMORY IS A COMPLEMENTARY METAL OXIDE SEMICONDUCTOR (CMOS) MEMORY WITH REDUNDANT LITHIUM-SULFUR DIOXIDE MEMORY RETENTION BATTERIES

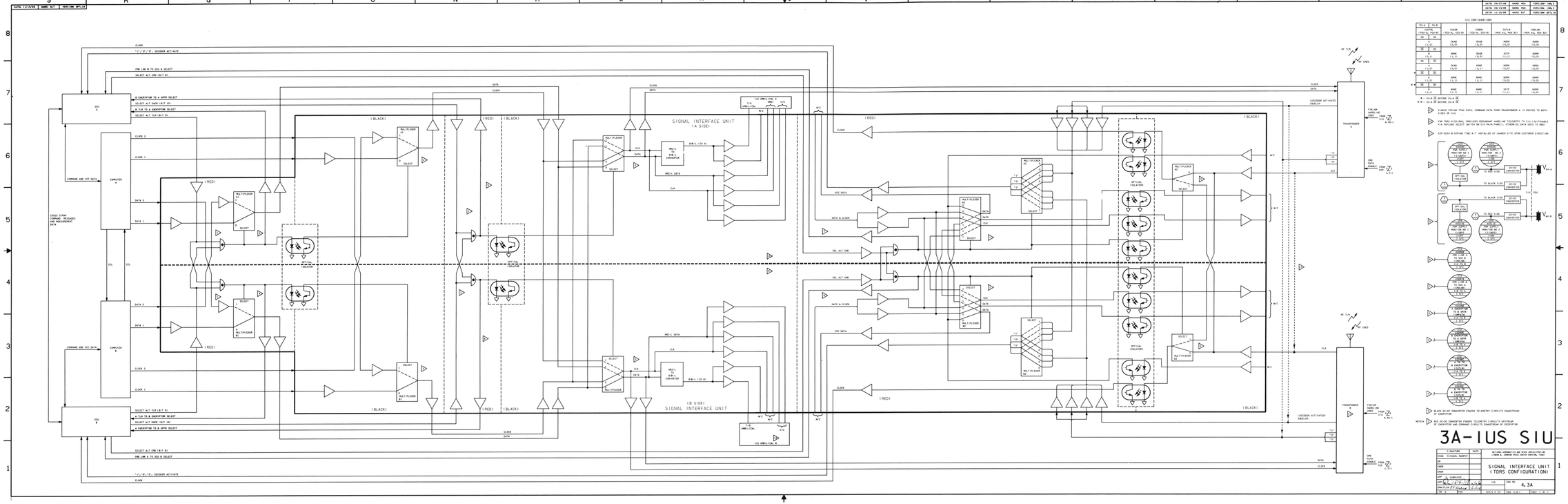
NOTES:
1. COMPUTER UNIT A IS SHOWN I/N CONTROL1 WITH UNIT B SHADOW BIRED, ALL INPUTS AND OUTPUTS ARE IDENTICAL FOR THE TWO UNITS, COMPUTER ID SELECT IS DETERMINED BY CODE PLUG

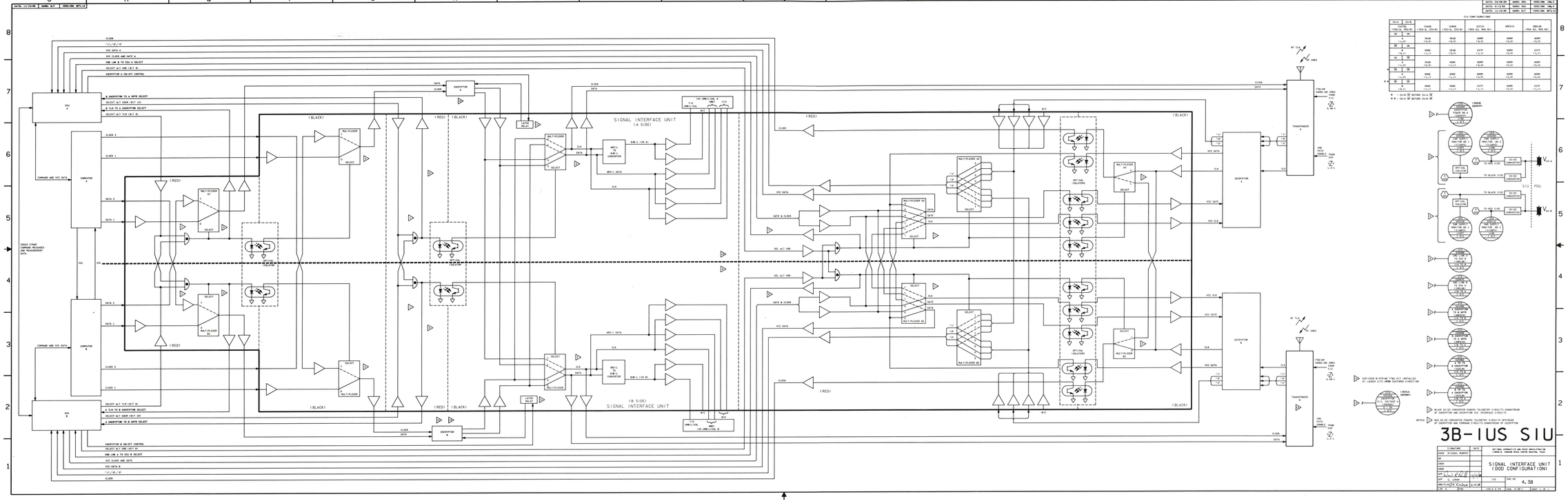
1 IUS COMP UNIT

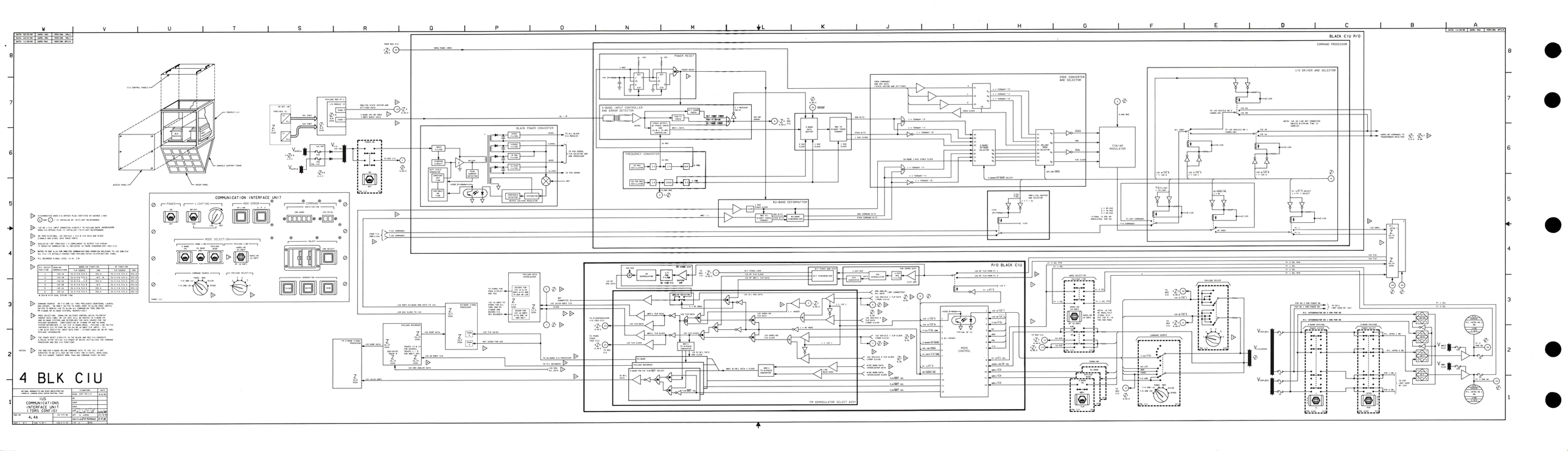
SIGNATURE	DATE	NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
DSGN VICKI S. HUNTER	8/25/83	LYNDON B. JOHNSON SPACE CENTER HOUSTON, TEXAS
DR		
ENGR		IUS COMPUTER UNIT
ENGR		
APP G. JURAN	10/4/84	
DPM/PLAN		IUS SYS HB DWG NO 4.1
CTR 0 PCN		85.5 S 34 PAGE 4.1-1 SHEET 1 OF 1

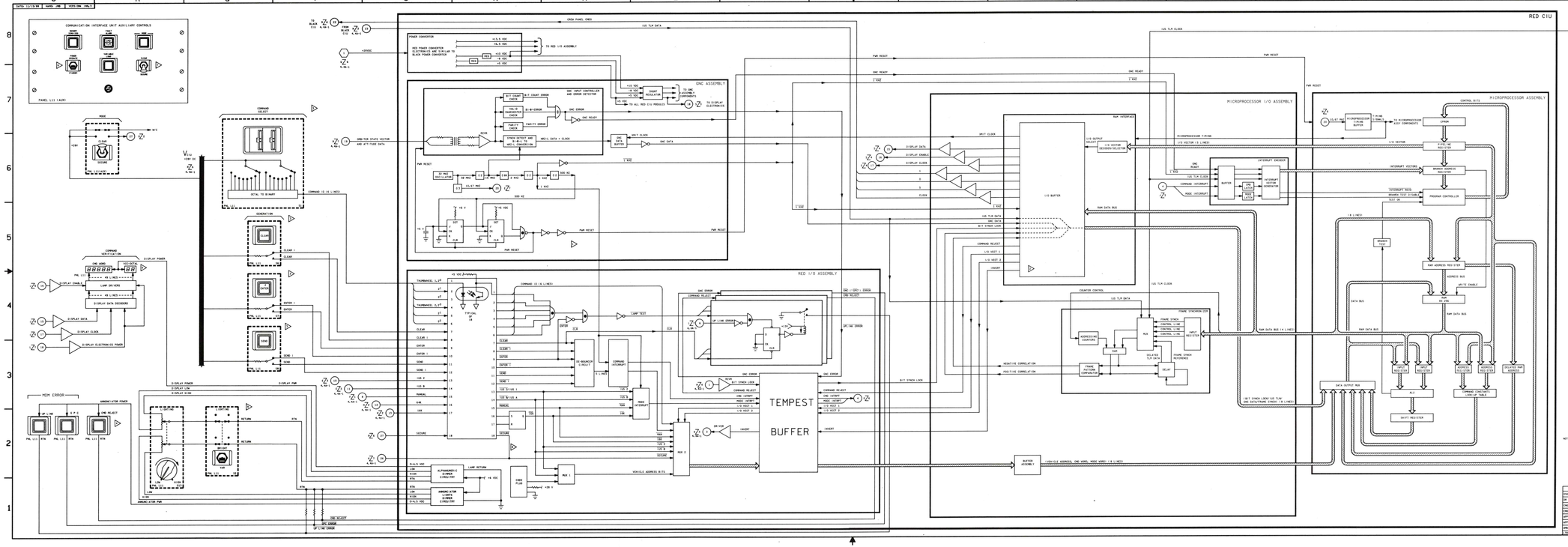

SCU A
48 CHANNEL MULTIPLEXER ANALOG 2
48 CHANNEL MULTIPLEXER ANALOG 1
48 CHANNEL MULTIPLEXER DIGITAL 4
48 CHANNEL MULTIPLEXER DIGITAL 3
48 CHANNEL MULTIPLEXER DIGITAL 2
48 CHANNEL MULTIPLEXER DIGITAL 1
SUCCESSIVE APPROXIMATION A/D CONVERTER
A/D CONVERTER TEMP (SCU44T)
MICRO-SEQUENCE CONTROLLER
SCU TEMP (SCU43T)
RF COUNT (SCU43RF)
S/C SERIAL DATA 4
S/C SERIAL DATA 3
S/C SERIAL DATA 2
S/C SERIAL DATA 1
256 X 1 RAM
ADDRESS COUNTER
RAM CONTROL CIRCUIT
512 X 1
PARALLEL TO SERIAL CONVERTER
LATCH 1
LATCH 2
DEMULTIPLEXER
MULTIPLEXER ADDRESS BUS
HIGH CAL (+10.00V)
LOW CAL (+5.00V)
5 VOLT REF (+5.00V)
+15V PS (SCU81V)
-15V PS (SCU81V)
+28 S/C PS (SCU82V)
+5 LOGIC PS (SCU81V)
DC-DC PWR CONVERTER
POWER DISTRIBUTION UNIT A
POWER DISTRIBUTION UNIT B
TO COMPUTER
FROM COMPUTER
SYSTEM SYNC
IUS ANALOG SIGNALS
IUS DIGNOSTICS
96 ANALOG LINES
192 LINES
2 ANALOG LINES
6 LINES
2 LINES
8 LINES
48 LINES
IUS DATA IN
IUS DATA OUT
SCU A DATA
SCU B DATA
ALTERNATE S/C MEASUREMENT DATA FROM SCU B
S/C DMA DATA 1-4
DONE 1-4
SAMPLE AND HOLD
CLOCK CONTROL
LOAD/SHIFT
READ/WRITE
ADDRESS COUNTER (RESET AT 3200)
S/C DATA IN
S/C CLOCK IN
S/C DATA OUT
NEW DATA COMPLETE
ADDRESS INCR
ADDRESS CLR
S/C 2 NEW DATA SCU A (I-1043) SCU B (I-1044)
DMA DATA TO COMPUTER
ONE SUBFRAME OF DATA 1280 BITS 80 WD
IUS DATA (SCU A)
IUS DATA (SCU B)
S/C 1 NEW DATA
S/C 2 NEW DATA
S/C 3 NEW DATA
S/C 4 NEW DATA
320 BITS
(40 WORDS X 8 BITS)
MEASUREMENT DATA TO SCU-B
MEASUREMENT DATA FROM SCU-B
TYPICAL J-K FLIP FLOP
THE CLOCK (CLK) ENABLES THE OUTPUTS Q AND Q̄ (NOTE: Q MEANS THE INVERSE OF Q). THE STATES OF THE OUTPUTS ARE DETERMINED BY THE J-K INPUTS AND THE OUTPUTS THAT WERE ON THE PREVIOUS CLOCK CYCLE. SEE TABLE.
INPUTS
PREVIOUS OUTPUT
NEXT OUTPUT
THESE OUTPUTS DEPEND ON THE PREVIOUS OUTPUTS
TYPICAL LATCH
A LATCH CAN BE FUNCTIONALLY DESCRIBED AS FOLLOWS: WHEN THE "LATCH SIGNAL" IS HIGH (1), IT ALLOWS ALL FOUR INPUTS (D'S ON D'S) TO PASS THROUGH TO THE OUTPUTS. WHEN THE SIGNAL IS LOW, THE LATCH WILL STILL REMEMBER THE FOUR INPUTS UNTIL A NEW "LATCH SIGNAL" IS RECEIVED. SEE EXAMPLE SEQUENCE.
EXAMPLE SEQUENCE
OLD DATA OUT
OLD DATA OUT
NEW DATA OUT
LATCH SIGNAL
SAME DATA OUT
TYPICAL MULTIPLEXER (MUX)
THE MULTIPLEXER IS DESIGNED TO SELECT ONE OF EIGHT DIGITAL OR ANALOG INPUTS FROM THE DATA BUS (3 PARALLEL WIRES). AN INPUT IS SELECTED BY PLACING A 3-BIT BINARY NUMBER ON THE ADDRESS BUS (3 PARALLEL WIRES) THAT CORRESPONDS TO THE DESIRED INPUT. THE DATA ON THE SELECTED LINE IS OUTPUT WHEN THE MULTIPLEXER RECEIVES AN "ENABLE SIGNAL"
3-BIT BINARY ADDRESS (DECIMAL EQUIVALENT) CONNECTION
THE RAM CONTROL CIRCUIT ENABLES THE DATA TO BE WRITTEN INTO A RAM, WHEN THAT RAM HAS RECEIVED 160 BITS OF DATA THE CONTROL CIRCUIT SWITCHES TO THE OTHER RAM, SO WHILE ONE RAM IS WRITING DATA IN FROM THE S/C THE OTHER IS READING OUT TO THE COMPUTER
THE TWO RAM'S ARE USED ON ALTERNATE MEASUREMENT CYCLES. WHEN ETHER RAM GETS 160 BITS OF DATA IN (T 1010 0000 = 27.5 + 128 + 32 = 160), A"S/C NEW DATA" PULSE IS SENT TO THE S/C TO INDICATE THAT THE COMPUTER USES THESE DISCRETES TO GENERATE ITS OWN NEW DATA DISCRETES.
ONLY OPTION OF USING S/C SERIAL DATA INPUTS 1 AND 2 ARE AVAILABLE. S/C SERIAL DATA CIRCUITS 3 AND 4 EXIST BUT CANNOT BE USED SINCE POSITIONS IN IUS HOUSEKEEPING TELEMETRY FORMAT ARE NOW BEING USED FOR IUS DATA
THIS DRAWING DEPICTS SCU A; SCU B IS IDENTICAL CORRESPONDING TLM NUMBERS ARE:
S/C 1 NEW DATA SCU-B U-72-V-1040-B SCU01B +15 PS VOLTAGE U-72-V-1001-A SCU41S
S/C 2 NEW DATA SCU-B U-72-V-1044-B SCU02B -15V PS VOLTAGE U-72-V-1007-A SCU4-Y
5V PS VOLTAGE U-72-V-1011-A SCU4Y5
28V PS VOLTAGE U-72-V-1013-A SCU42N
A/D CONVERTER TEMP U-72-T-1016-A SCU8T PWR SUPPLY TEMP U-72-T-1018-A SCU9T
RF COUNT U-72-M-1050-D SCU89T HIGH CAL U-72-V-1004-A LOCAL5
LOW CAL U-72-V-1004-A LOCAL5
5 VOLT REF U-72-V-1040-A SCU8R5
SCU TEMP U-72-T-1010-A SCU9T
LOW ORDER ADDRESS BITS (A0,A1,A2) SELECT 1 OF 8 PAIRS TO OUTPUT; THE HIGH ORDER BITS (A3,A4) ENABLE THE OUTPUT OF 1 OF 6 MULTIPLEXERS TO THE DMA PORT
WHILE THE 8-BIT RAM IS READING OUT DATA TO CU-A, THE 8-BIT RAM IS SENDING THE SAME TO CU-B (FIRST 320 BITS IN DMA DATA STREAM), THEN A AND B RAMS CROSS-STRAP DATA TO THE ALTERNATE COMPUTER (320ND 320 BITS IN DMA DATA STREAM). THE OPERATION TAKES 1.920 SEC. THE 1.28 SEC. DELAY IN THE SCU-B DATA IS USED BY THE COMPUTER USED TO READ OUT DATA FROM THE RAM'S S/C SLOTS 1-4 (FROM CU-A AND B)
NOTES:
1. SYSTEM SYNC KEEPS COMPUTER A AND B AND SCU A AND B IN SYNC
2 IUS SCU 1
SCU MEASUREMENT
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
LYNDON B. JOHNSON SPACE CENTER HOUSTON, TEXAS
IUS SYS MB
4.2
SHEET 1 OF 2

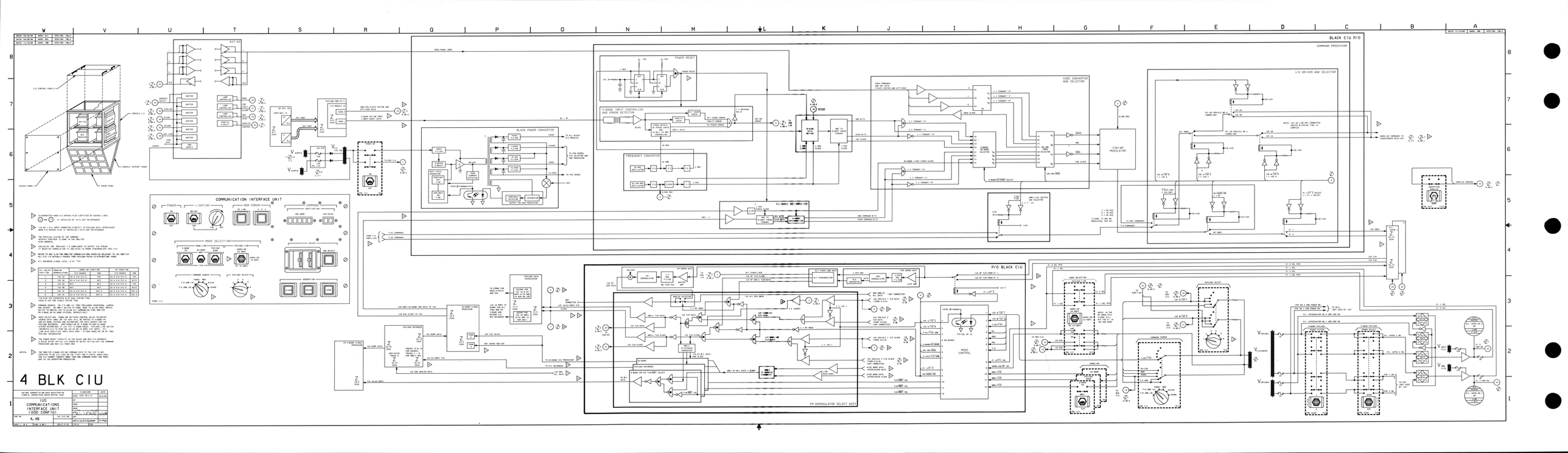

SCU CODE PLUG
SPACECRAFT DISCRETE COMMAND
RELAY MATRIX COMMANDS
REDUNDANCY MANAGEMENT RELAYS
REDUNDANCY MANAGEMENT
DISCRETE COMMANDS
REACTION CONTROL SYSTEM COMMANDS
THRUST VECTOR CONTROL COMMANDS
IUS STAGE S/V/I SEPARATION DISCRETE/ TITAN COMMAND INTERFACE
TITAN INTERFACE UNIT
MICROPROGRAM SEQUENCER
DE-BOUNCE FILTER
2 IUS SCU CMD 2
SCU COMMAND

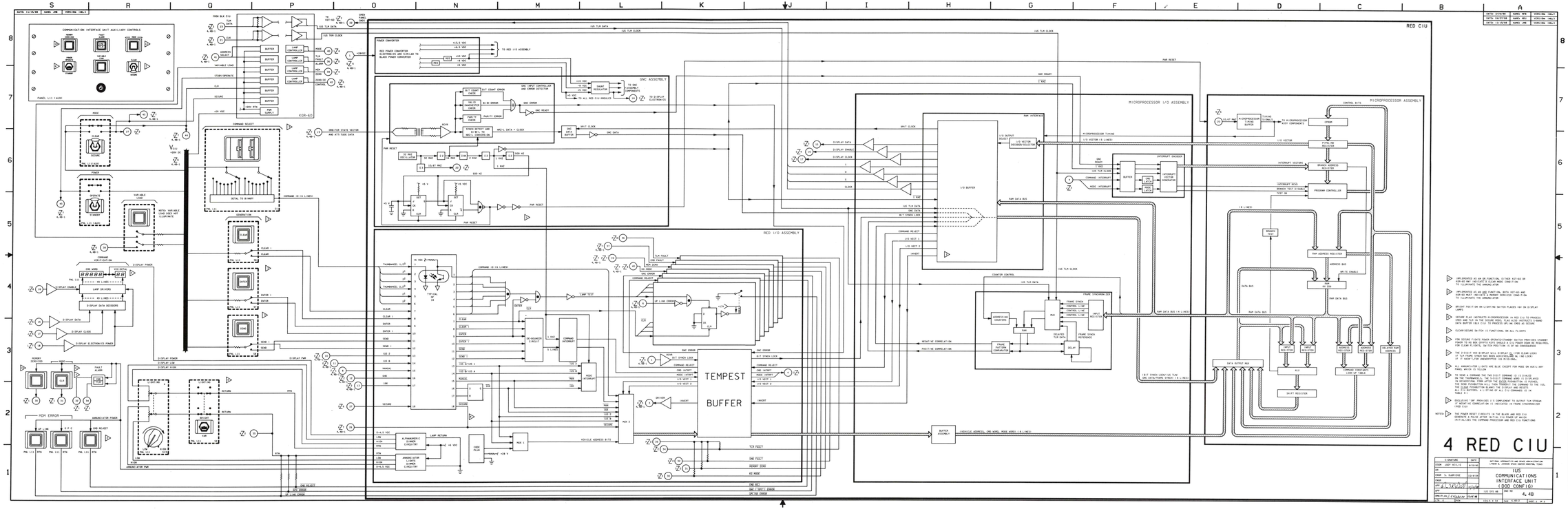

SIGNAL INTERFACE UNIT
(A SIDE)
(B SIDE)
SIGNAL INTERFACE UNIT
SIU A
SIU B
COMPUTER A
COMPUTER B
MULTIPLEXER A1
MULTIPLEXER A2
MULTIPLEXER B1
MULTIPLEXER B2
OPTICAL ISOLATORS
SINGLE STRAP COMMAND, RESEARCH AND MEASUREMENT DATA
COMMAND AND VCC DATA
CLOCK 2
CLOCK 1
DATA 2
DATA 1
VSS
SELECT ALT CMD (BIT 9)
ONE LINE A TO SIU B SELECT
"0","0","0","1" DECODER ACTIVATE
SELECT ALT TLM (BIT 9)
A TLM TO B ENCRYPTOR SELECT
SELECT ALT ENCR (BIT 10)
A ENCRYPTOR TO A XMTR SELECT
B ENCRYPTOR TO B XMTR SELECT
B TLM TO A ENCRYPTOR SELECT
ONE LINE B TO SIU A SELECT
(RED)
(BLACK)
MRD/L DATA
MRD/L CLK
B-M/L (CH A)
B-M/L (CH B)
M/C
SEL ALT CMD
HCC DATA
DATA & CLOCK
CLOCK
DATA
SELECT
CLK
SIU OPERATIONAL A
SIU OPERATIONAL B
RF TLM
RF CMD
TRANSPONDER A
TRANSPONDER B
TDRSS ACTIVATED ENABLE
CMD DATA ENABLE FROM CU
CMD DATA FROM CU
CLOCK FROM CU
DATA FROM CU
SIU CONFIGURATIONS
SINGLE STRAND TTNC PATH, COMMAND DATA FROM TRANSPONDER A IS ROUTED TO BOTH SIDES OF SIU
FOR TDRS ROUTINES, PROVIDES REDUNDANT HARDLINE TELEMETRY TO CU (ACTIVATABLE VIA PAYLOAD SELECT SWITCH ON CU VIA MAIN PANEL), STHDM-TE DATA GOES TO MDDI
ECP-2059-B STRAND TTNC KIT INSTALLED AT LAUNCH SITE UPON CUSTOMER DIRECTION
TO BLACK SIDE
TO SIU A SIDE
TO SIU B SIDE
OPTICAL ISOLATORS
DC/DC CONVERTER
$V_{OUT A}$
$V_{OUT B}$
TLM PSU
SIU A/B ENCRYPTOR POWER
BLACK DC/DC CONVERTER POWERS TELEMETRY CIRCUITS DOWNSTREAM OF ENCRYPTOR
BLACK DC/DC CONVERTER POWERS TELEMETRY CIRCUITS UPSTREAM OF ENCRYPTOR AND COMMAND CIRCUITS DOWNSTREAM OF DECRYPTOR
NOTES:
3A-IUS SIU
SIGNAL INTERFACE UNIT
(TDRS CONFIGURATION)
4.3A

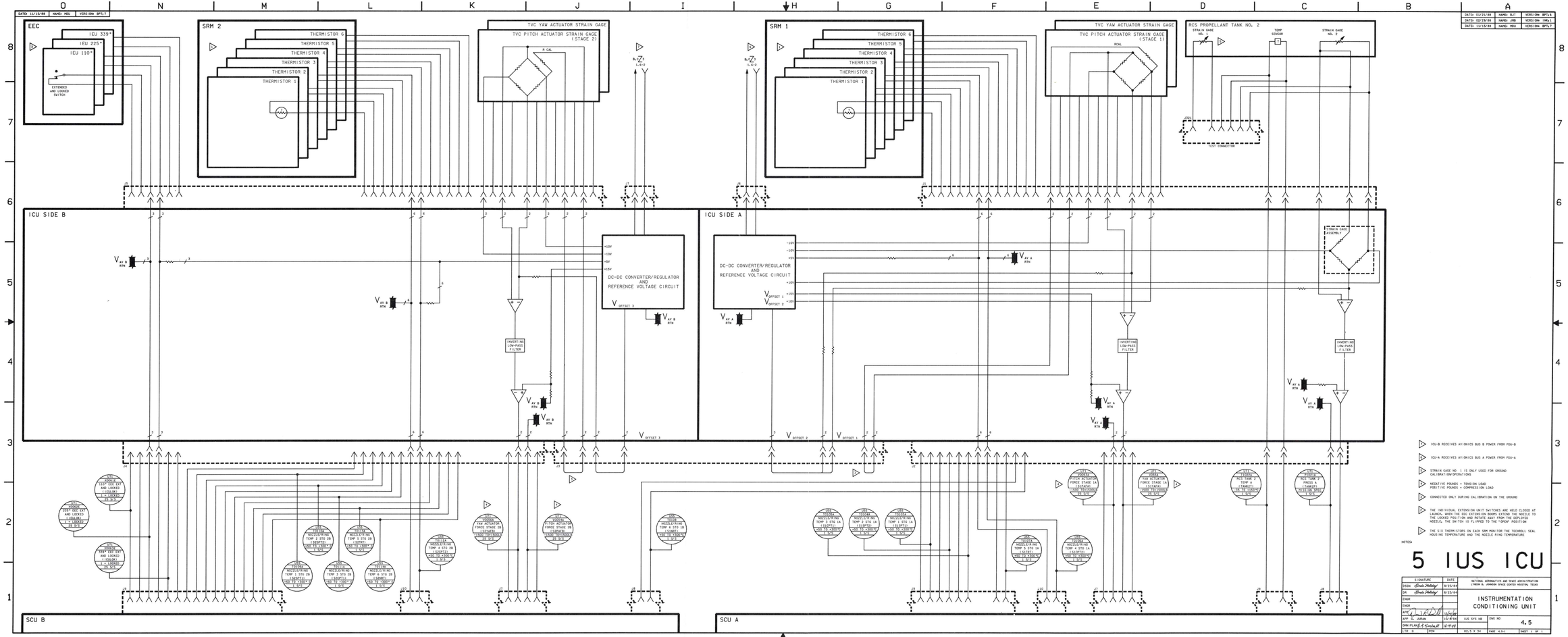

SIGNAL INTERFACE UNIT (A SIDE)
(B SIDE) SIGNAL INTERFACE UNIT
SSU A
SSU B
COMPUTER A
COMPUTER B
MULTIPLEXER A1
MULTIPLEXER A2
MULTIPLEXER B1
MULTIPLEXER B2
ENCRYPTOR A
ENCRYPTOR B
MRD-L TO D/R-L CONVERTER
LATCH DELAY
OPTICAL ISOLATORS
TRANSPONDER A
TRANSPONDER B
DECRYPTOR A
DECRYPTOR B
(RED)
(BLACK)
3B-IUS SIU
SIGNAL INTERFACE UNIT (DOD CONFIGURATION)
4.3B


4 BLK CIU
COMMUNICATION INTERFACE UNIT
BLACK C/U P/O
COMMAND PROCESSOR
POWER RESET
S-BAND INPUT CONTROLLER AND ERROR DETECTION
FREQUENCY CONVERTER
BLACK POWER CONVERTER
KU-BAND DEFORMATTER
CODE CONVERTER AND SELECTOR
I/O DRIVER AND SELECTOR
FM DEMODULATOR SELECT ASSY
P/O BLACK C/U
MODE CONTROL
PAYLOAD RECORDER
PAYLOAD DATA INTERLEAVER
PAYLOAD SELECT
COMMAND SOURCE
S-BAND PAYLOAD
KU-BAND PAYLOAD
SIGNAL MIX
SIGNAL SELECT
PAYLOAD MUX P/O PL I/F
PAYLOAD INTERFACE
PAYLOAD
ACCESS PANEL
CIU CONTROL PANELS
CONSOLE SUPPORT FRAME
CHEAP PANEL
CONSOLE L11
PANEL L11
FROM MCC CIU
TO MCC CIU
TO PAYLOAD
FROM PAYLOAD
TO/FROM PAYLOAD
TO/FROM KU-BAND EQUIPMENT
TO/FROM S-BAND EQUIPMENT
TO/FROM FM EQUIPMENT
TO/FROM MODE CONTROL
TO/FROM PAYLOAD RECORDER
TO/FROM PAYLOAD DATA INTERLEAVER
TO/FROM PAYLOAD MUX P/O PL I/F
TO/FROM PAYLOAD INTERFACE
TO/FROM PAYLOAD SELECT
TO/FROM COMMAND SOURCE
TO/FROM S-BAND PAYLOAD
TO/FROM KU-BAND PAYLOAD
TO/FROM SIGNAL MIX
TO/FROM SIGNAL SELECT


RED CIU
COMMUNICATION INTERFACE UNIT AUXILIARY CONTROLS
PANEL, LCU 1 AUX
MDC ASSEMBLY
MICROPROCESSOR I/O ASSEMBLY
MICROPROCESSOR ASSEMBLY
RED I/O ASSEMBLY
TEMPEST BUFFER
BUFFER ASSEMBLY
I/O BUFFER
RAM INTERFACE
RAM DATA BUS
I/O VECTOR DECISION/SELECTOR
INTERRUPT DECODER
PROGRAM CONTROLLER
RAM ADDRESS REGISTER
ADDRESS BUS
DATA BUS
DATA OUTPUT MUX
ALU
SHIFT MULTIPLEXER
COMMAND DISCRETE LOW-LEVEL TABLE
DELAYED RAM DATA BUS
FRAME SYNCHRONIZER
FRAME SYNCH CONTROL LINE
FRAME SYNCH REFERENCE
COUNTER CONTROL
ADDRESS/MODE COUNTERS
FRAME TIMING COMPARATOR
DELAYED TLM DATA
NEGATIVE CORRELATION
POSITIVE CORRELATION
BIT SYNCH LOCK
BIT SYNCH LOCK/LOS TLM
TO MICROPROCESSOR ASSY COMPONENTS
TO DISPLAY ELECTRONICS
TO RED I/O ASSEMBLY
TO ALL RED CIU MODULES
TO BLACK CIU
FROM BLACK CIU
TO/FROM GROUND STATION
COMMAND SELECT
GENERATION
COMMAND VERIFICATION
DISPLAY ENABLE
DISPLAY DATA
DISPLAY CLOCK
DISPLAY ELECTRONICS POWER
MDM ERROR
ANNUNCIATOR POWER
DISPLAY POWER
DISPLAY PWR
LAMP RETURN
ANNUNCIATOR PWR
SPC ERROR
UP LINK ERROR
ONE INHIBIT
VEHICLE ADDRESS BITS
+28 V
+5 VDC
+15 VDC
-15 VDC
+10 VDC
-8 VDC
+3 VDC
+2.5 VDC
+6.5 VDC
+15.5 VDC
POWER CONVERTER
RED POWER CONVERTER ELECTRONICS ARE SIMILAR TO BLACK POWER CONVERTER
+28VDC
PWR RESET
1 KHZ
SPC/MC ERROR
DMC READY
DMC ASSEMBLY
DMC INPUT CONTROLLER AND ERROR DETECTOR
BIT COUNT CHECK
DATA/ID SYNCHRONIZER CHECK
PARITY CHECK
BI-Φ-ERROR
DMC ERROR
DMC READY
PARITY ERROR
SYNCH DETECT AND BIT SYNCHRONIZER
MDC-S, DATA + CLOCK
32 MHZ OSCILLATOR
32 MHZ
÷2
÷4
÷8
÷16
÷32
500 KHZ
SHIFT CLOCK
DMC DATA
DMC BUFFER
DMC ERROR
DMC SELECT
DMC INTERRUPT
MODE INTERRUPT
I/O VECT 0
I/O VECT 1
I/O VECT 2
INVERT
COMMAND ID (6 L/MES)
THUMBWHEEL SWITCHES
CLEAR
CLEAR 1
ENTER
ENTER 1
SEND
SEND 1
LOS 2
LOS 3
MANUAL
BIT SYNCH LOCK
LOS TLM
LOS TLM CLOCK
LOS TLM DATA
DMC DATA
BIT SYNCH LOCK
COMMAND SELECT
I/O VECT 0
I/O VECT 1
I/O VECT 2
INVERT
COMMAND INTERRUPT
MODE INTERRUPT
INTERRUPT VECTORS
INTERRUPT MASK
INTERRUPT DECODER
BUFFER
I/O VECTOR DECISION/SELECTOR
I/O VECTOR
BRANCH ADDRESS REGISTER
PROGRAM CONTROLLER
INTERRUPT MASK
TEST ON
BRANCH
RAM ADDRESS REGISTER
RAM DATA BUS
RAM DATA BUS (16 L/MES)
I/O BUFFER
RAM INTERFACE
I/O VECTOR
I/O VECT 0
I/O VECT 1
I/O VECT 2
INVERT
DMC READY
PWR RESET
MICROPROCESSOR TYPE/ME
I/O VECTOR (3 L/MES)
MICROPROCESSOR I/O ASSY COMPONENTS
MICROPROCESSOR BUFFER
CLK AT MUX
TO MICROPROCESSOR ASSY COMPONENTS
CONTROL BUS
EPROM
I/O VECTOR REGISTER
BRANCH ADDRESS REGISTER
PROGRAM CONTROLLER
RAM ADDRESS REGISTER
RAM DATA BUS
ADDRESS BUS
WRITE ENABLE
RAM
DATA BUS
RAM DATA BUS
DATA OUTPUT MUX
ALU
SHIFT MULTIPLEXER
INPUT BUFFERS
ADDRESS BUFFERS
COMMAND DISCRETE LOW-LEVEL TABLE
DELAYED RAM DATA BUS
ADDRESS BUS
DATA BUS
WRITE ENABLE
RAM
RAM DATA BUS
RAM DATA BUS (16 L/MES)
I/O BUFFER
I/O VECTOR DECISION/SELECTOR
I/O VECT 0
I/O VECT 1
I/O VECT 2
INVERT
BUFFER ASSEMBLY
+VEHICLE ADDRESS, ONE WORD, MODE WORD (16 L/MES)
FRAME SYNCH CONTROL LINE
FRAME SYNCH REFERENCE
INPUT REGISTER
MUX
SELECTED TLM DATA
DELAY
ADDRESS/MODE COUNTERS
RAM
FRAME TIMING COMPARATOR
NEGATIVE CORRELATION
POSITIVE CORRELATION
BIT SYNCH LOCK/LOS TLM
TO MICROPROCESSOR ASSY COMPONENTS
TO DISPLAY ELECTRONICS
TO RED I/O ASSEMBLY
TO ALL RED CIU MODULES
FROM BLACK CIU
TO/FROM GROUND STATION
COMMAND SELECT
GENERATION
COMMAND VERIFICATION
DISPLAY ENABLE
DISPLAY DATA
DISPLAY CLOCK
DISPLAY ELECTRONICS POWER
MDM ERROR
ANNUNCIATOR POWER
DISPLAY POWER
DISPLAY PWR
LAMP RETURN
ANNUNCIATOR PWR
SPC ERROR
UP LINK ERROR
ONE INHIBIT
VEHICLE ADDRESS BITS
+28 V
+5 VDC
+15 VDC
-15 VDC
+10 VDC
-8 VDC
+3 VDC
+2.5 VDC
+6.5 VDC
+15.5 VDC
POWER CONVERTER
RED POWER CONVERTER ELECTRONICS ARE SIMILAR TO BLACK POWER CONVERTER
+28VDC
PWR RESET
1 KHZ
SPC/MC ERROR
DMC READY
DMC ASSEMBLY
DMC INPUT CONTROLLER AND ERROR DETECTOR
BIT COUNT CHECK
DATA/ID SYNCHRONIZER CHECK
PARITY CHECK
BI-Φ-ERROR
DMC ERROR
DMC READY
PARITY ERROR
SYNCH DETECT AND BIT SYNCHRONIZER
MDC-S, DATA + CLOCK
32 MHZ OSCILLATOR
32 MHZ
÷2
÷4
÷8
÷16
÷32
500 KHZ
SHIFT CLOCK
DMC DATA
DMC BUFFER
DMC ERROR
DMC SELECT
DMC INTERRUPT
MODE INTERRUPT
I/O VECT 0
I/O VECT 1
I/O VECT 2
INVERT
COMMAND ID (6 L/MES)
THUMBWHEEL SWITCHES
CLEAR
CLEAR 1
ENTER
ENTER 1
SEND
SEND 1
LOS 2
LOS 3
MANUAL
BIT SYNCH LOCK
LOS TLM
LOS TLM CLOCK
LOS TLM DATA
DMC DATA
BIT SYNCH LOCK
COMMAND SELECT
I/O VECT 0
I/O VECT 1
I/O VECT 2
INVERT
COMMAND INTERRUPT
MODE INTERRUPT
INTERRUPT VECTORS
INTERRUPT MASK
INTERRUPT DECODER
BUFFER
I/O VECTOR DECISION/SELECTOR
I/O VECTOR
BRANCH ADDRESS REGISTER
PROGRAM CONTROLLER


4 BLK CIU
COMMUNICATIONS INTERFACE UNIT (COD CONFIG)
BLACK CIU P/O
COMMAND PROCESSOR
I/O DRIVER AND SELECTOR
CODE CONVERTER AND SELECTOR
POWER RESET
S-BAND INPUT CONTROLLER AND ERROR DETECTOR
BLACK POWER CONVERTER
FREQUENCY CONVERTER
KU-BAND DEMODULATOR
FM DEMODULATOR SELECT ASSY
P/O BLACK CIU
COMMUNICATION INTERFACE UNIT
KIT-610
FXA/PM MODULATOR
MODE CONTROL
MODE SELECTION
PAYLOAD SELECT
COMMAND SOURCE
SIGNAL LVL
CIU CONTROL PANEL
CONSOLE LLL
CONSOLE SUPPORT FRAME
ACCESS PANEL
DECAL PANEL


RED CIU
COMMUNICATION INTERFACE UNIT AUX/LIGHT CONTROLS
PANEL L11 1 ACRT
RED POWER CONVERTER ELECTRONICS ARE SIMILAR TO BLACK POWER CONVERTER
GNC ASSEMBLY
RED I/O ASSEMBLY
MICROPROCESSOR I/O ASSEMBLY
MICROPROCESSOR ASSEMBLY
TEMPEST BUFFER
I/O BUFFER
PROGRAM CONTROLLER
DATA BUS
RAM DATA BUS
ADDRESS BUS
I/O VECTOR
INTERRUPT VECTOR
COMMAND SELECT
DISPLAY DATA
DISPLAY ENABLE
DISPLAY CLOCK
DISPLAY ELECTRONICS POWER
ANNUNCIATOR POWER
LAMP RETURN
PWR RESET
GNC READY
I/O CLOCK
IUS TLM DATA
IUS TLM CLOCK
IUS TRM DATA
IUS TRM CLOCK
TCR FAULT
GNC FAULT
MEMORY ERROR
RS MODE
GNC TEST ERROR
UPLINK ERROR
4 RED CIU



DATE= 11/15/88	NAME= MDU	VERSION= SPTL7

DATE= 01/21/88	NAME= BJT	VERSION= SPTL8
DATE= 02/25/88	NAME= JMB	VERSION= IMPL1
DATE= 11/15/88	NAME= MDU	VERSION= SPTL7

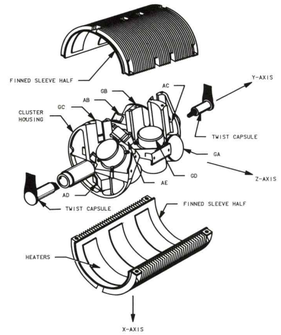
- ICU-B RECEIVES AVIONICS BUS B POWER FROM PDU-B
- ICU-A RECEIVES AVIONICS BUS A POWER FROM PDU-A
- STRAIN GAGE NO. 1 IS ONLY USED FOR GROUND CALIBRATION/OPERATIONS
- NEGATIVE POUNDS = TENSION LOAD POSITIVE POUNDS = COMPRESSION LOAD
- CONNECTED ONLY DURING CALIBRATION ON THE GROUND
- THE INDIVIDUAL EXTENSION UNIT SWITCHES ARE HELD CLOSED AT THE EXTENDED AND LOCKED POSITION BY A PIN ATTACHED TO THE NOZZLE IN THE CLOSED POSITION AND ROTATE AWAY FROM THE DEPLOYED NOZZLE. THE SWITCH IS FLIPPED TO THE "OPEN" POSITION
- THE SIX THERMISTORS ON EACH SRM MONITOR THE TECHROLL SEAL HOUSING TEMPERATURE AND THE NOZZLE RING TEMPERATURE

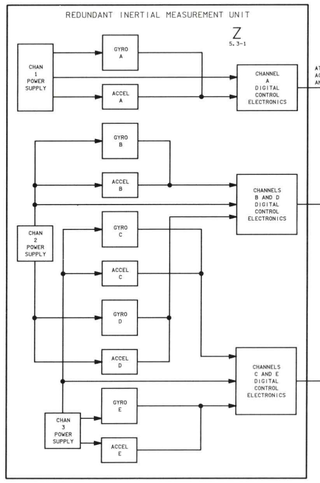
NOTES:

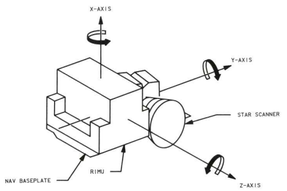
5 IUS ICU

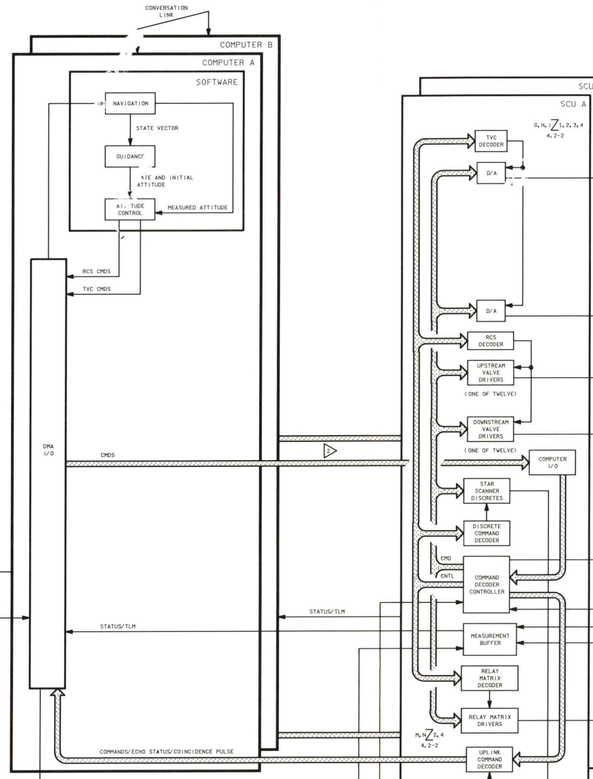
SIGNATURE	DATE	NATIONAL AERONAUTICS AND SPACE ADMINISTRATION LYNDON B. JOHNSON SPACE CENTER HOUSTON, TEXAS
DSGN Brian Talley	6/23/94	
DR Brian Talley	6/23/94	INSTRUMENTATION CONDITIONING UNIT
ENGR		
ENGR		
APP S. JORAN	12/4/94	IUS SYS HB DWG NO 4.5
APP PLANT E Kimball	12-4-94	
CTR 0 FCN		REV 3 3 74 PAGE 4.5-1 SHEET 1 OF 1

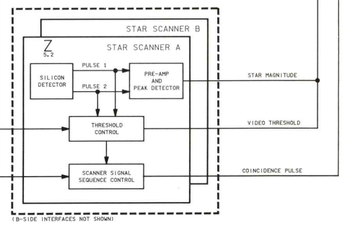
DATE▸ 2/29/88	NAME▸ JMB	VERSION▸ INAV 1
DATE▸ 11/16/88	NAME▸ MAS	VERSION▸ BPT 16
DATE▸ 12/1/88	NAME▸ BCH	VERSION▸ BPT 17

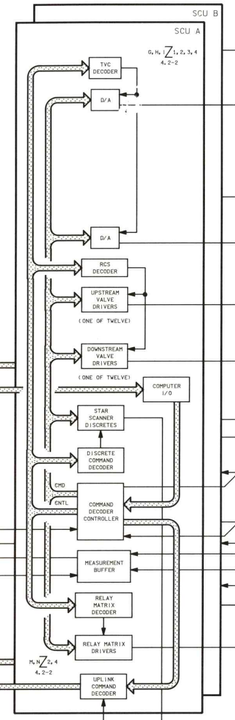


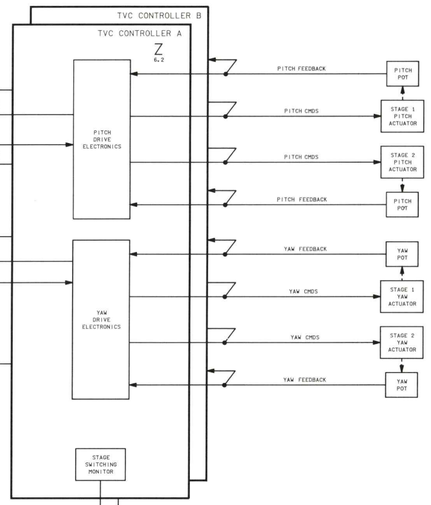


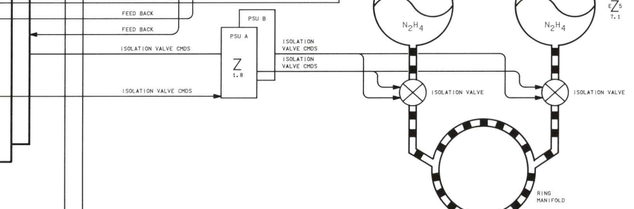


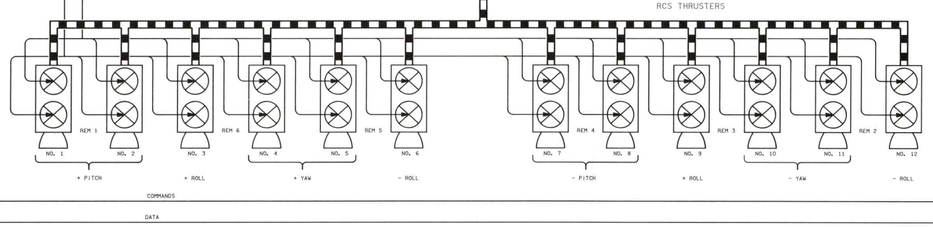


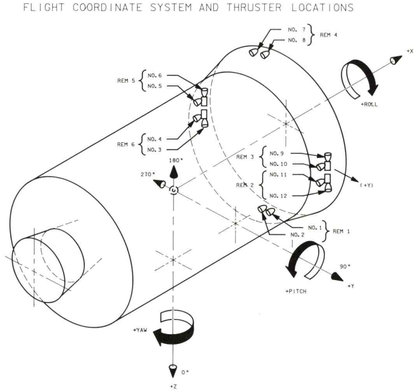


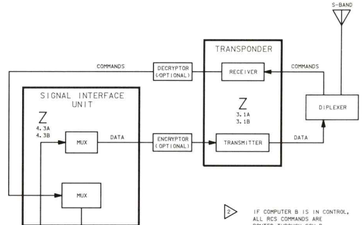










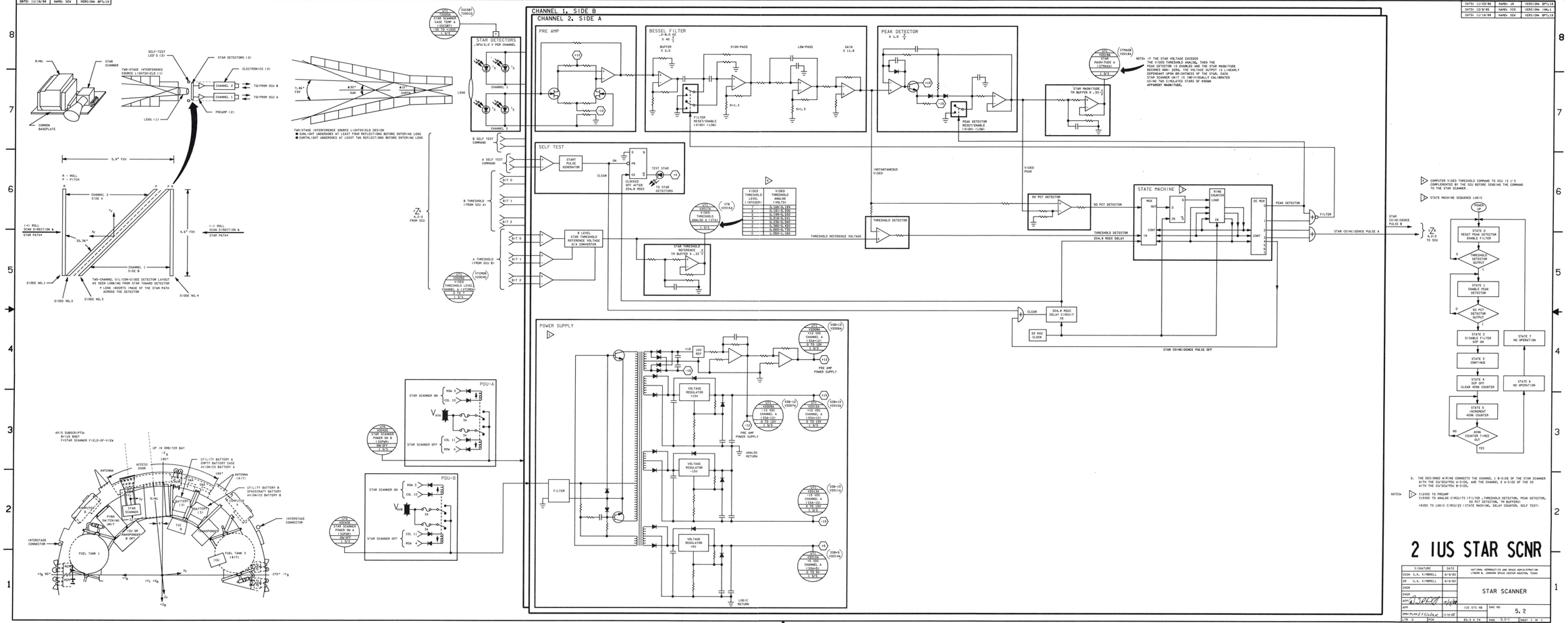


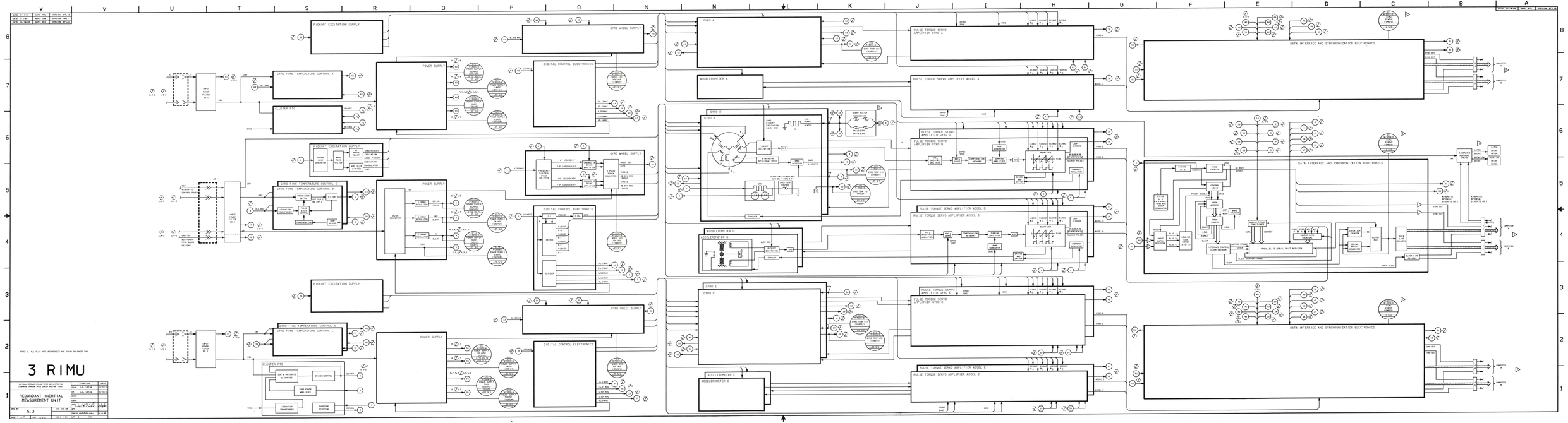
▷ IF COMPUTER B IS IN CONTROL, ALL RCS COMMANDS ARE ROUTED THROUGH SCU B ELECTRONICS

NOTES▸ ▷ IF COMPUTER B IS IN CONTROL, TVC CONTROLLER B RECEIVES ALL PITCH AND YAW COMMANDS AND ALL POTENTIOMETER FEEDBACK

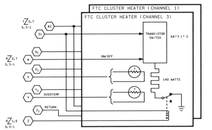
1 IUS GNC OVR

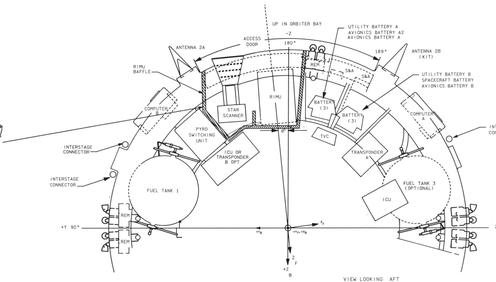
SIGNATURE	DATE	NATIONAL AERONAUTICS AND SPACE ADMINISTRATION LYNDON B. JOHNSON SPACE CENTER HOUSTON, TEXAS
DSGN T. HILL	2-21-80	
DR T. HILL	2-21-80	
ENGR		GNC CONTROL OVERVIEW
ENGR		
APP		
APP		IUS SYS NB — DWG NO 5.1
OMNIPLAN S.K. Gaskins 12-10-79		
LTR G PCN		66 X 34 — PAGE 5.1-1 — SHEET 1 OF 1

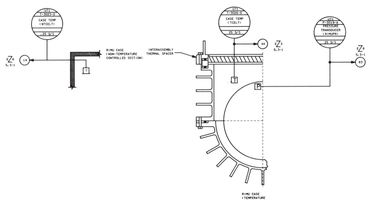

CHANNEL 1, SIDE B
CHANNEL 2, SIDE A
PRE AMP
BESSEL FILTER
BUFFER
HIGH-PASS
LOW-PASS
GAIN
PEAK DETECTOR
STAR DETECTORS
SELF TEST
START PULSE GENERATION
TEST STAR
TO STAR DETECTORS
STAR MAGNITUDE
STAR MAGNITUDE TM BUFFER
NOTE: IF THE STAR VOLTAGE EXCEEDS THE VIDEO THRESHOLD ANALOG, THEN THE PEAK DETECTOR IS ENABLED AND THE STAR MAGNITUDE TM BUFFER VOLTAGE IS PROPORTIONAL TO THE LOGARITHMICALLY DEPENDANT UPON BRIGHTNESS OF THE STARS. EACH STAR SCANNER UNIT IS INDIVIDUALLY CALIBRATED USING TWO SIMULATED STARS OF KNOWN APPARENT MAGNITUDE.
VIDEO THRESHOLD LEVEL (COMPUTER)
VIDEO THRESHOLD ANALOG
INSTANTANEOUS VIDEO
VIDEO PEAK
50 PCT DETECTOR
THRESHOLD DETECTOR
THRESHOLD REFERENCE VOLTAGE
STATE MACHINE
RING COUNTER
DEC MUX
PEAK DETECTOR
FILTER
STAR COINCIDENCE PULSE A
STAR COINCIDENCE PULSE OFF
204.8 MSEC DELAY CIRCUIT
20 KHZ CLOCK
COMPUTER VIDEO THRESHOLD COMMAND TO SOU IS 1'S COMPLEMENTED BY THE SOU BEFORE SENDING THE COMMAND TO THE STAR SCANNER
STATE MACHINE SEQUENCE LOGIC
STATE 0 RESET PEAK DETECTOR ENABLE FILTER
THRESHOLD DETECTOR OUTPUT
STATE 1 ENABLE PEAK DETECTOR
50 PCT DETECTOR OUTPUT
STATE 2 DISABLE FILTER SCP ON
STATE 3 CONTINUE
STATE 4 SCP OFF CLEAR 4096 COUNTER
STATE 5 INCREMENT 4096 COUNTER
4096 COUNTER TIMED OUT
STATE 7 NO OPERATION
STATE 6 NO OPERATION
POWER SUPPLY
FILTER
VOLTAGE REGULATOR +15V
+18 VDC CHANNEL A
+15V CHANNEL A
-15V CHANNEL A
+5V CHANNEL A
PRE AMP POWER SUPPLY
ANALOG RETURN
LOGIC RETURN
PDU-A
PDU-B
STAR SCANNER ON
STAR SCANNER OFF
ROW 3
COL 10
COL 11
ROW 4
2 IUS STAR SCNR
STAR SCANNER
SIGNATURE
DATE
DESIGN S.K. KIMBRELL
6/8/90
DR S.K. KIMBRELL
6/8/90
ENGR
CHCK
APP
APP
IUS SYS HB
DWG NO
5.2
DIMPLAN
TM 0
PCN
SIZE B
SCALE 3/4 X 34
PAGE 5-7-1
SHEET 1 OF 1

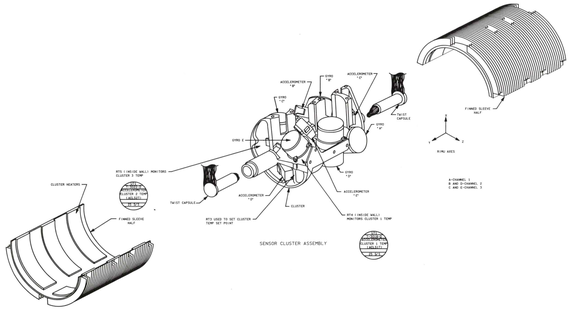

3 RIMU
REDUNDANT INERTIAL MEASUREMENT UNIT
PICKOFF EXCITATION SUPPLY
GYRO WHEEL SUPPLY
GYRO FINE TEMPERATURE CONTROL A
GYRO FINE TEMPERATURE CONTROL B
GYRO FINE TEMPERATURE CONTROL C
GYRO FINE TEMPERATURE CONTROL D
GYRO FINE TEMPERATURE CONTROL E
CLUSTER FTC
POWER SUPPLY
DIGITAL CONTROL ELECTRONICS
INPUT POWER FILTER NO. 1
INPUT POWER FILTER NO. 2
GYRO A
GYRO B
GYRO C
GYRO D
GYRO E
ACCELEROMETER A
ACCELEROMETER B
ACCELEROMETER C
ACCELEROMETER D
ACCELEROMETER E
PULSE TORQUE SERVO AMPLIFIER GYRO A
PULSE TORQUE SERVO AMPLIFIER GYRO B
PULSE TORQUE SERVO AMPLIFIER GYRO C
PULSE TORQUE SERVO AMPLIFIER GYRO D
PULSE TORQUE SERVO AMPLIFIER GYRO E
PULSE TORQUE SERVO AMPLIFIER ACCEL A
PULSE TORQUE SERVO AMPLIFIER ACCEL B
PULSE TORQUE SERVO AMPLIFIER ACCEL C
PULSE TORQUE SERVO AMPLIFIER ACCEL D
PULSE TORQUE SERVO AMPLIFIER ACCEL E
DATA INTERFACE AND SYNCHRONIZATION ELECTRONICS
COMPUTER A
COMPUTER B
COMPUTER C
NOTE 1: ALL FLAG NOTE REFERENCES ARE FOUND ON SHEET TWO

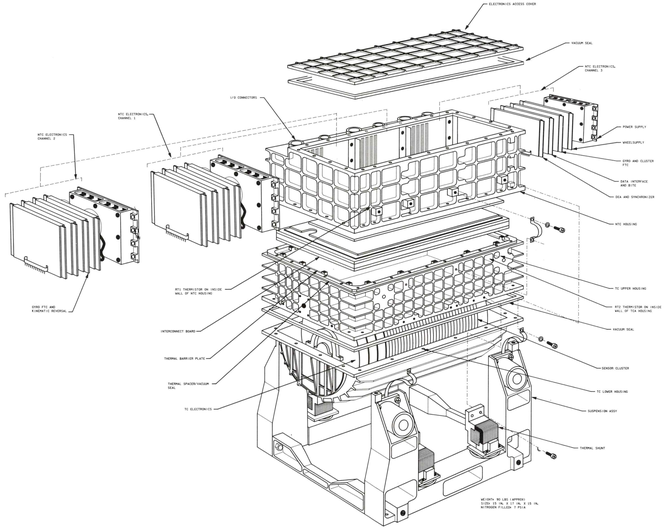
DATE: 12/28/88	NAVEX: ACP	VOCO/ENA: APOLLO
DATE: 12/28/88	NAVEX: ACP	VOCO/ENA: APOLLO
DATE: 2/2/89	NAVEX: ACP	VOCO/ENA: APOLLO

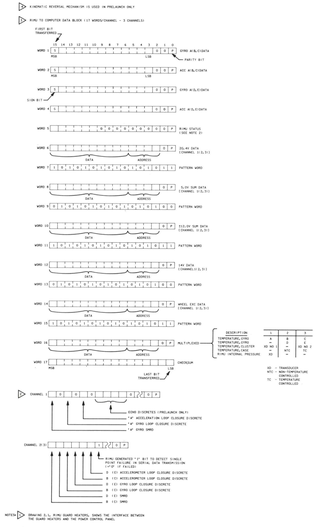












	1	2	3
1	+	+	+
2	+	+	-
3	+	-	+
4	+	-	-
5	-	+	+
6	-	+	-
7	-	-	+
8	-	-	-

(1) = TRANSducer
(2) = GYRO TEMPERATURE CONTROLLER
(3) = ACCELEROMETER CONTROLLER

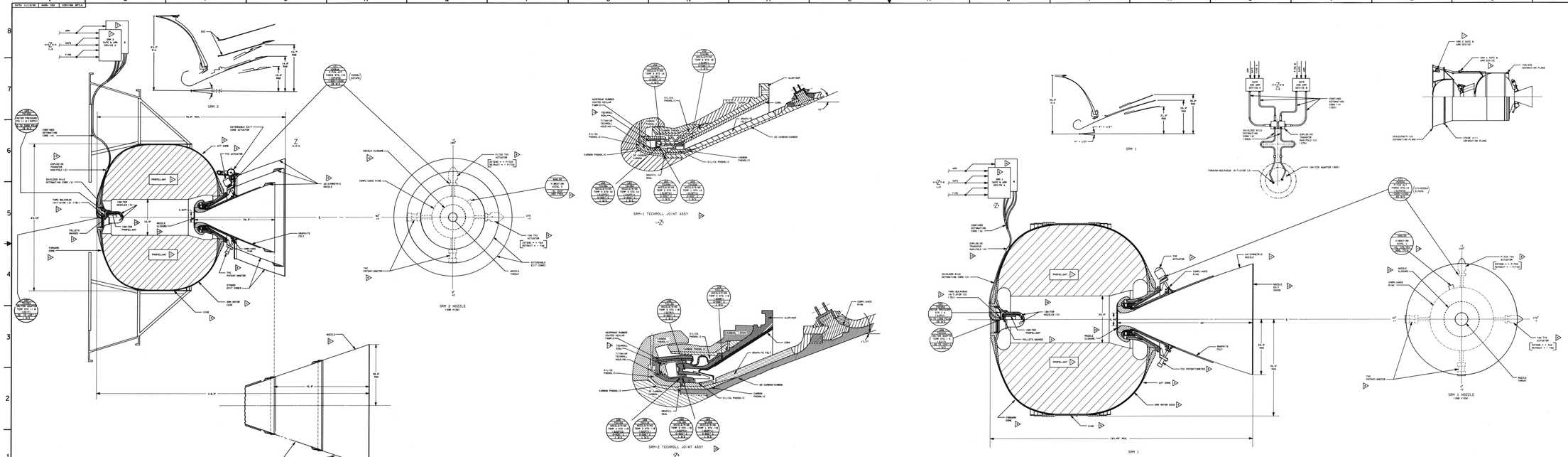
SIGNATURES	DATE
ENG. [illegible]	2/2/89
QA [illegible]	2/2/89
MFG. [illegible]	2/2/89
CHIEF ENGR. [illegible]	2/2/89
PROJ. [illegible]	2/2/89

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
GEORGE C. MARSHALL SPACE FLIGHT CENTER

REDUNDANT INERTIAL MEASUREMENT UNIT

SIZE	CODE IDENT. NO.	DWG. NO.
D	10.370.00	5.3

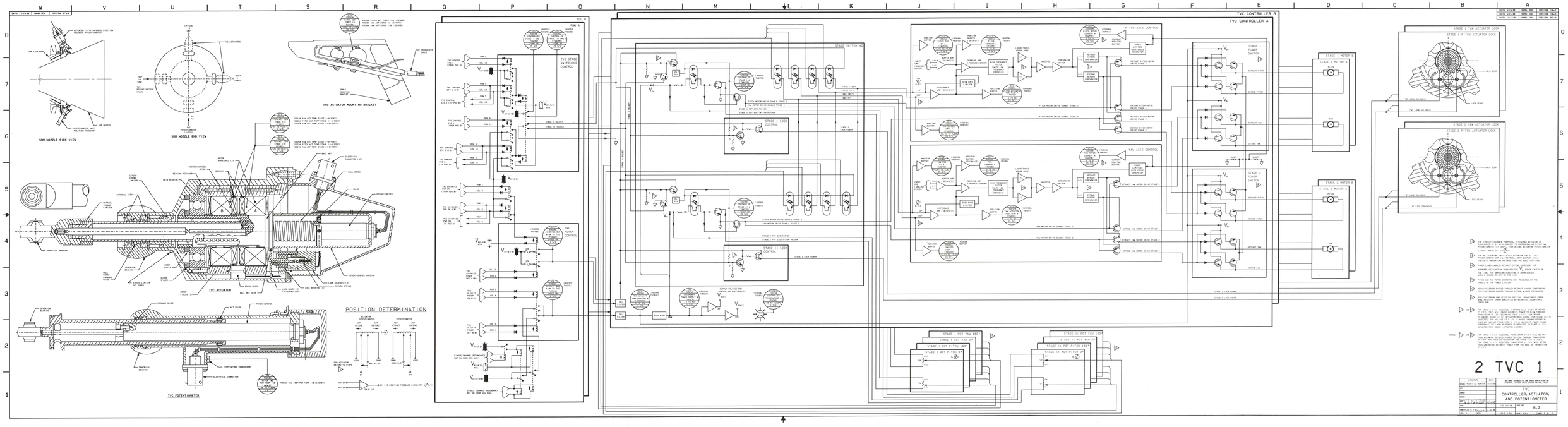
SCALE: NONE | WEIGHT: | SHEET 1 OF 1



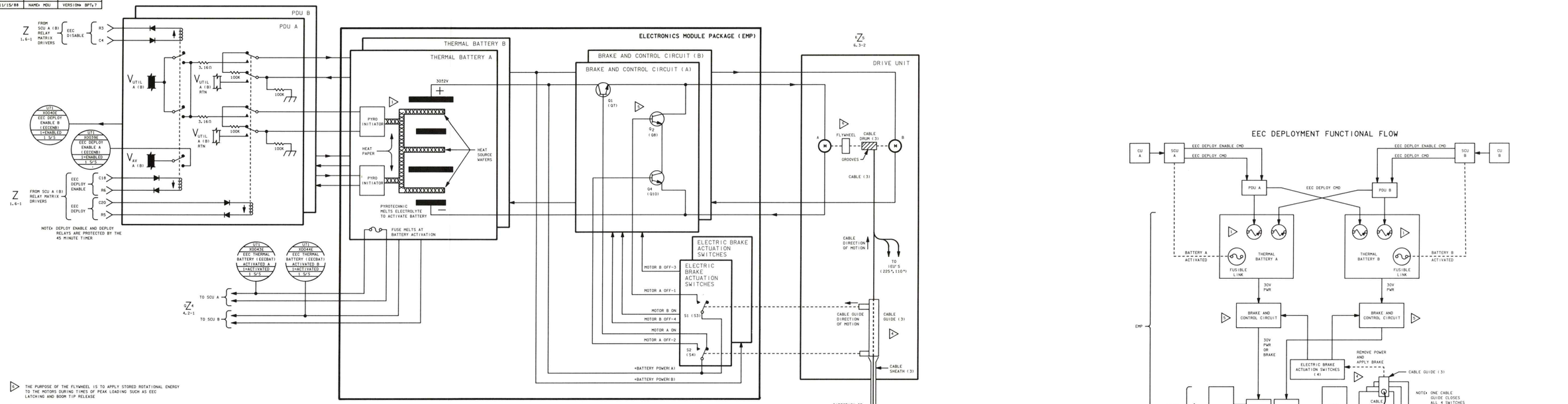
- NOMINAL FULL LOAD PROPELLANT 5,500 LBS
- NOMINAL FULL LOAD PROPELLANT 21,400 LBS
- DELETED
- DELETED
- ACTIVE WITH CMS ONLY
- TECHROLL JOINT ALLOWS NOZZLE TO PIVOT WHILE PROVIDING A POSITIVE MECHANICAL SEAL
- STR ALLOWS TRANSFER OF DETONATION IMPULSES FROM TWO (SET 1) OR THREE (SET 2) SRMS
- NOZZLE EXIT CONES CONSIST OF A CARBON/CARBON EXIT PLANE AND PHENOLIC THERMAL INSULATION (TYPE V, MLI), FULLY OPEN FOR SRM 1 & CONSTRICTED FOR SRM 2
- THERMAL CONTROL LAYER OF ALUMINIZED KAPTON TYPE V, MLI
- NOZZLE CLOSURE PROVIDES PROTECTIVE BARRIER FOR PROPELLANTS DURING SRM 1 & 2 COAST
- THERMAL CONTROL TYPE V, MLI
- THERMAL CONTROL TYPE V, MLI
- THERMAL CONTROL WHITE PAINT AND TYPE V, MLI
- THERMAL CONTROL WHITE PAINT COATING
- MATERIAL: CARBON/CARBON COMPOSITE
- MATERIAL: REFRACTORY BRICKS, INSULATED WITH EPDM RUBBER AND MULTI-LAYER INSULATION (TYPE V, MLI) BLANKET
- TVC ALLOWS TRANSMITTAL OF DETONATION WAVE IMPULSE WHILE MAINTAINING THE PRESSURE INTEGRITY OF THE BULKHEAD AND IGNITER
- BORON POTASSIUM NITRATE (BKNO3) PELLETS IGNITE MAIN IGNITER PROPELLANT CHARGE
- PROPELLANT: 1/1 FUEL: ALUMINUM - 18% MIXTURE: 1) 20/80 DIOCTYL ADIPATE/DIOCTYL SEBACATE = 10% 2) 80/20 HYDROXYL TERMINATED POLYBUTADIENE = 87% 3) OTHER = 3%

1 SRM 1 & 2 1

SIGNATURE	DATE	NATIONAL AERONAUTICS AND SPACE ADMINISTRATION LYNDON B. JOHNSON SPACE CENTER HOUSTON, TEXAS
DRAWING APPROVAL		
SRM ASSEMBLY		SRM 1 AND 2
CHECK		
DRAFTING		
APPROVED		SIZE: D — DWG NO: 10S 370-00 — REV: NC
SCALE: NONE — WEIGHT: — SHEET 1 OF 1		


SRM NOZZLE SIDE VIEW
SRM NOZZLE END VIEW
TVC ACTUATOR
TVC POTENTIOMETER
TVC ACTUATOR MOUNTING BRACKET
POSITION DETERMINATION
FQU B
FQU A
TVC CONTROLLER B
TVC CONTROLLER A
STAGE SWITCHING
PITCH AXIS CONTROL
YAW AXIS CONTROL
STAGE I POT PITCH 180°
STAGE I ACT PITCH 0°
STAGE I ACT YAW 90°
STAGE II POT PITCH 180°
STAGE II ACT PITCH 0°
STAGE II ACT YAW 90°
STAGE I MOTOR B
STAGE I MOTOR A
STAGE II MOTOR B
STAGE II MOTOR A
STAGE I YAW ACTUATOR LOCK
STAGE I PITCH ACTUATOR LOCK
STAGE II YAW ACTUATOR LOCK
STAGE II PITCH ACTUATOR LOCK
2 TVC 1
TVC CONTROLLER, ACTUATOR, AND POTENTIOMETER
6.2

DATE	NAME	VERSION
DATE= 01/21/88	NAME= VCO	VERSION= BPT.6
DATE= 02/24/88	NAME= MAG	VERSION= INK.2
DATE= 11/15/88	NAME= MDU	VERSION= BPT.7



THE PURPOSE OF THE FLYWHEEL IS TO APPLY STORED ROTATIONAL ENERGY TO THE MOTORS DURING TIMES OF PEAK LOADING SUCH AS EEC LATCHING AND BOOM TIP RELEASE

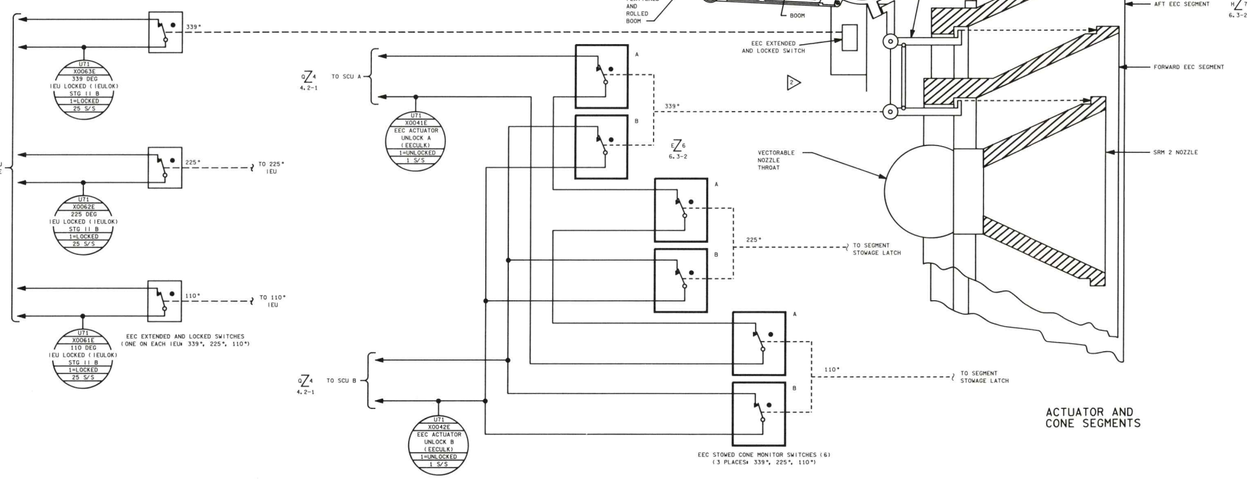
THE BRAKE AND CONTROL CIRCUIT CONNECTS BATTERY POWER TO THE MOTOR(S) THROUGH Q1 (Q7). WHEN THE BOOMS REACH FULL EXTENSION A CABLE GUIDE ACTIVATES THE 4 ELECTRIC BRAKE ACTUATION SWITCHES. S1(S3) REMOVES BATTERY POWER FROM THE MOTOR, CAUSING IT TO ACT AS A GENERATOR, BY TURNING OFF Q1 (Q7). S2(S4) ALSO TURNS ON Q4 (Q10), AND WHEN S1 (S3) CLOSES IT TURNS ON Q2 (Q8) WHICH PLACES A LOW IMPEDANCE ACROSS THE MOTOR TERMINALS. THIS DEACCELERATES AND DISSIPATES THE ROTATIONAL ENERGY OF THE FLYWHEEL

THERE ARE CABLE GUIDES MOUNTED ON THE SIDES OF THE DRIVE UNIT TO GUIDE EACH CABLE INTO GROOVES IN EACH CABLE DRUM. ONE CABLE GUIDE MECHANICALLY ACTIVATES THE 4 ELECTRIC BRAKE ACTUATION SWITCHES WHEN THE BOOMS REACH FULL EXTENSION. THESE SWITCHES REMOVE BATTERY POWER AND APPLY BRAKES TO THE MOTORS. IT TAKES LESS THAN 16 SEC TO DEPLOY THE EEC SEGMENTS AND FOR THE BOOMS TO REACH FULL EXTENSION, ROTATE AND LOCK IN THE FINAL 45° POSITION

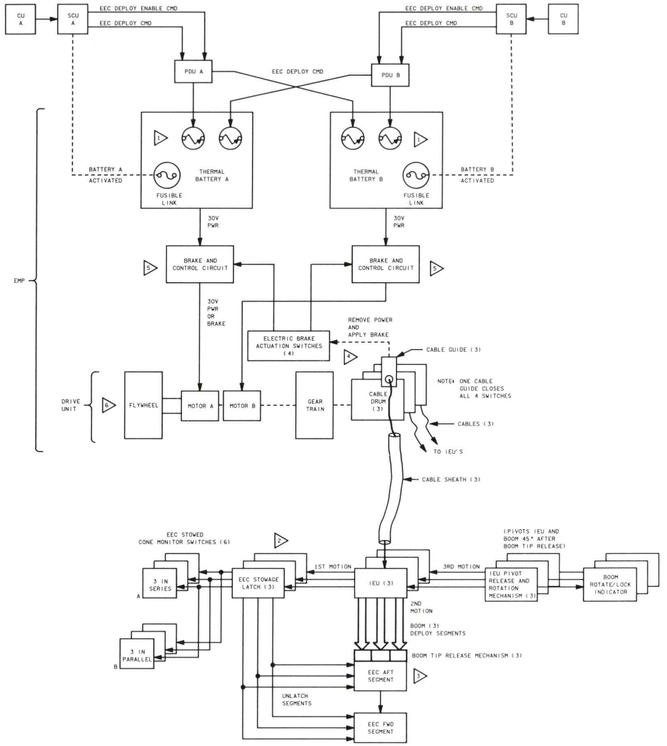
AFTER THE EEC SEGMENTS ARE UNLATCHED THE BOOMS ARE UNROLLED TO EXTEND THE EEC SEGMENTS. AFTER THE FWD SEGMENT LATCHES TO THE SRM-2 NOZZLE, THE FORCE INCREASES UNTIL LOADING ON THE BOOM TIPS EXCEEDS 85 TO 90 LBS. THE BOOM TIPS ARE THEN RELEASED FROM THE AFT SEGMENT BY THE BOOM TIP RELEASE MECHANISM. THE IEU PIVOT RELEASE AND ROTATION MECHANISMS THEN ROTATE THE BOOMS 45° AND LOCK THEM IN POSITION TO ALLOW TVC OPERATION. SWITCH CONTACTS OPEN ON EACH IEU WHEN THIS HAS OCCURRED

AFTER BATTERY ACTIVATION, THE TANDEM ELECTRIC MOTORS PULL THE 3 CABLES THROUGH THEIR SHEATHES, WIND THEM ON THE 3 DRIVE UNIT CABLE DRUMS, AND ROTATE THE 3 IEU CABLE DRUM/SPROCKETS. THE INITIAL ROTATION OF THE CABLE DRUM/SPROCKETS UNLATCHES BOTH EEC SEGMENTS. TWO SWITCHES (LOCATED NEAR THE EEC FWD SEGMENT STOWAGE LATCH) ON EACH IEU SUPPORT BRACKET REPORT ACTUATOR UNLOCK STATUS ON IUS TELEMETRY. THE A-SIDE SWITCHES ARE WIRED IN SERIES. THE B-SIDE ARE WIRED IN PARALLEL

NOTES= EACH 3012VDC THERMAL BATTERY HAS 15 LITHIUM ANODE CELLS OF 2.24V EACH. BETWEEN EACH CELL IS A 2 LAYER ELECTROLYTE-DEPOLARIZER (LiCl/KCl-FeS$_2$ WAFER AND A HEAT SOURCE (IRON POWDER-POTASSIUM PERCHLORATE) WAFER. THE EEC DEPLOY COMMAND SENDS AN ELECTRICAL IMPULSE TO THE BATTERY SQUIBS TO ACTIVATE THE BATTERY. EACH BATTERY HAS 2 SQUIBS, BOTH ARE FIRED BUT ONLY ONE IS NECESSARY TO ACTIVATE THE BATTERY. THE SQUIBS IGNITE A FAST BURNING, GASLESS PYROTECHIC MATERIAL KNOWN AS "HEAT PAPER" (ZIRONIUM POWDER, BARIUM CHROMATE, CERAMIC AND GLASS FIBERS). THIS MATERIAL TRANSMITS FLAME TO THE HEAT SOURCE WAFERS WHICH MELTS THE ELECTROLYTE TO ACTIVATE THE BATTERY. BATTERY ACTIVATION TAKES LESS THAN 1300ms FROM THE TIME OF THE DEPLOY COMMAND. FUSIBLE LINKS MELT OPEN UPON BATTERY ACTIVATION AND THEIR STATUS IS INCLUDED ON IUS TELEMETRY



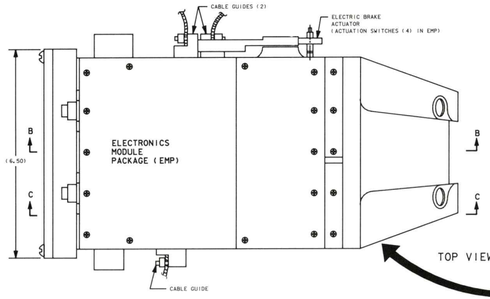
ACTUATOR AND CONE SEGMENTS



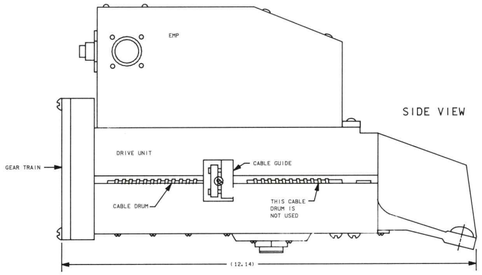
1 EEC 1

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION LYNDON B. JOHNSON SPACE CENTER HOUSTON, TEXAS	SIGNATURE	DATE
	DSGN VICKI S. HUNTER	3/18/88
	DR	
EXTENDABLE EXIT CONE	ENGR	
	ENGR	
DWG NO 6.3 / IUS SYS HB	APP	
	APP	
	OMNIPLAN	
SHEET 1 OF 2 / PAGE 6.3-1 / 66 X 34	LTR G / PCN	

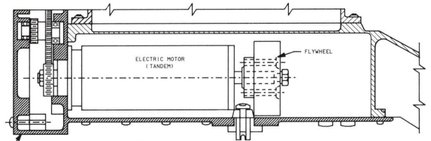
DATE: 01/21/88	NAME: SBE	VERSION: BPTs 9
DATE: 02/24/88	NAME: SKL	VERSION: INTs 2
DATE: 11/15/88	NAME: MDU	VERSION: BPTs 10



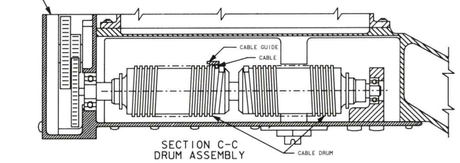
TOP VIEW



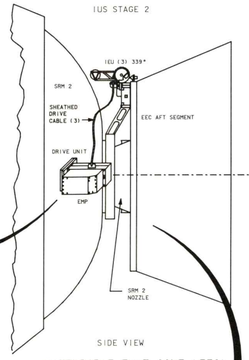
SIDE VIEW



SECTION B-B
MOTOR AND FLYWHEEL ASSEMBLY

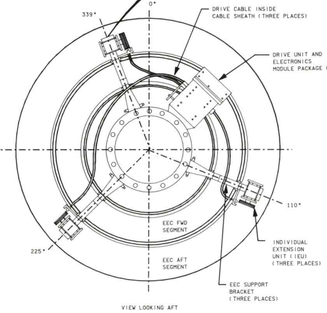


SECTION C-C
DRUM ASSEMBLY

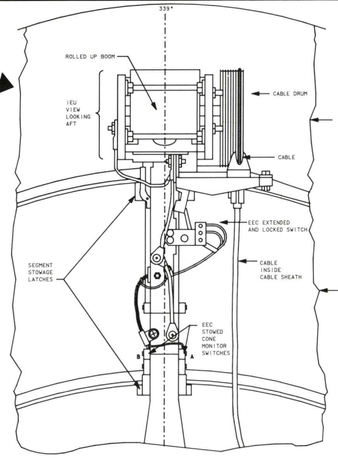


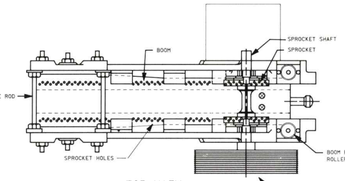
SIDE VIEW

EXTENDABLE EXIT CONE (EEC)

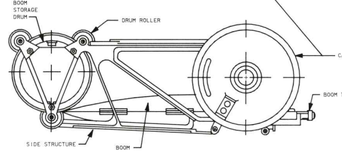


EXTENDABLE EXIT CONE (EEC)

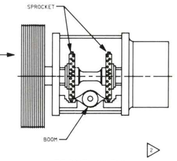




TOP VIEW

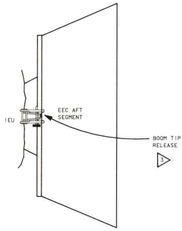


INDIVIDUAL EXTENSION UNIT (IEU)
SIDE VIEW

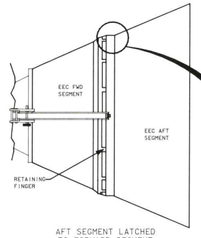


FRONT VIEW

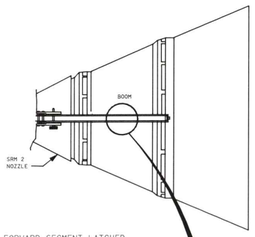
EEC DEPLOYMENT SEQUENCE



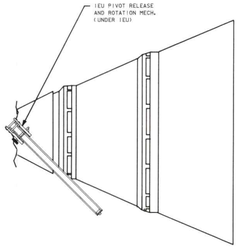
EEC STOWED POSITION



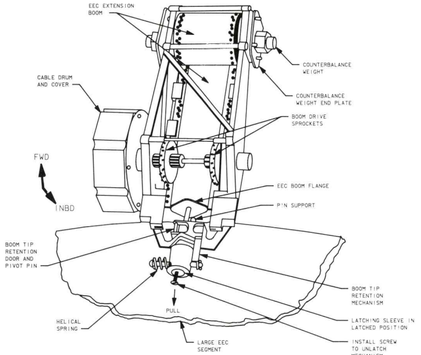
AFT SEGMENT LATCHED
TO FORWARD SEGMENT



FORWARD SEGMENT LATCHED
TO SRM 2 NOZZLE

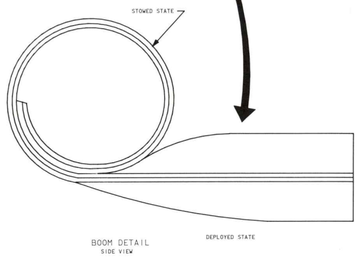


BOOM PIVOTED 45°

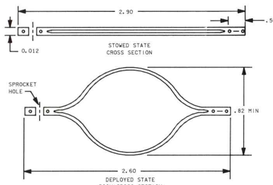


NOTE: SEQUENCE IS THE SAME FOR FWD SEGMENT LATCHING TO SRM 2 NOZZLE.

EEC LATCHING DETAIL



BOOM DETAIL
SIDE VIEW



BOOM DETAIL

▷ BOOM TIPS RELEASE AT A LOADING EXCEEDING 85-90 POUNDS.

▷ NOMINAL DEPLOY VELOCITY OF 3.5 INCHES PER SECOND.

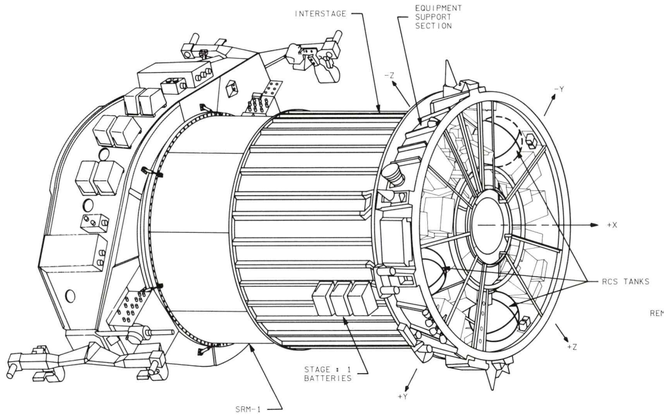
▷ AFT SEGMENT LATCHING LOADS ARE 38 TO 42 POUNDS, FORWARD SEGMENT 50 TO 55 POUNDS.

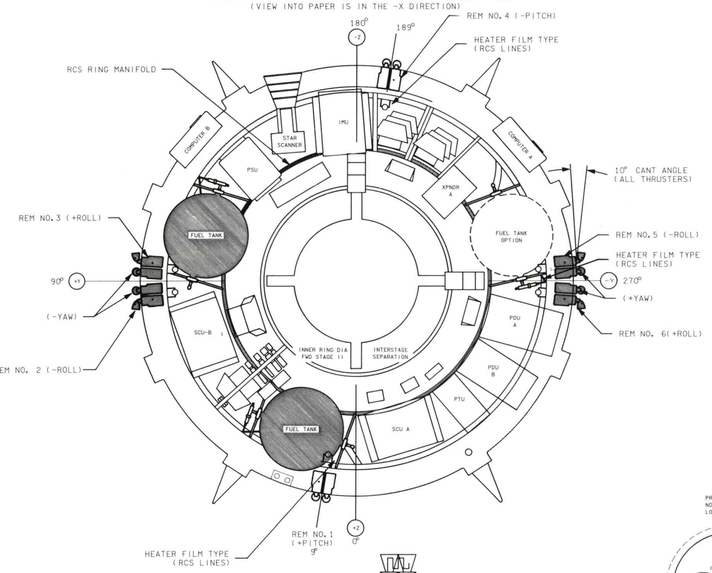
3 EEC 2

SIGNATURE		DATE	
OSSN VICKI S. HUNTER		3/18/88	NATIONAL AERONAUTICS AND SPACE ADMINISTRATION LYNDON B. JOHNSON SPACE CENTER HOUSTON, TEXAS
OR			
ENGR			
ENGR			EXTENDABLE EXIT CONE
APP			
APP			IUS SYS HB — DWG NO 6.3
OMNIPLAN			
LTR Q	PCN		66 X 34 — PAGE 6.3-2 — SHEET 2 OF 3

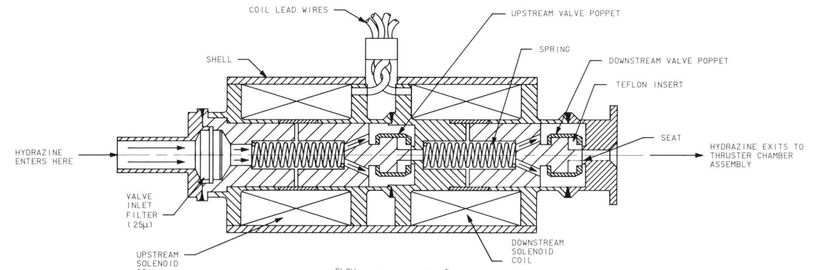
DATE▸ 3/14/88	NAME▸ MFB	VERSION▸ BPT▸10
DATE▸ 3/18/88	NAME▸ MFB	VERSION▸ INR▸3
DATE▸ 11/15/88	NAME▸ LAM	VERSION▸ BPT▸11

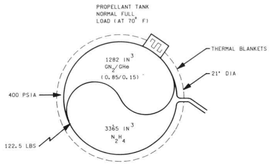
PLAN VIEW OF THE EQUIPMENT SUPPORT SECTION
(VIEW INTO PAPER IS IN THE -X DIRECTION)

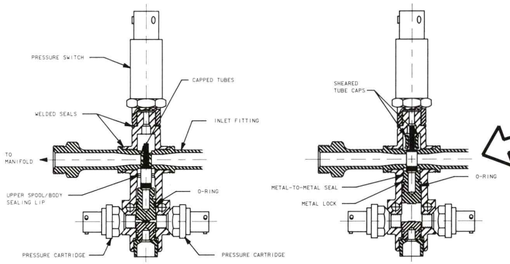




PROPELLANT VALVE



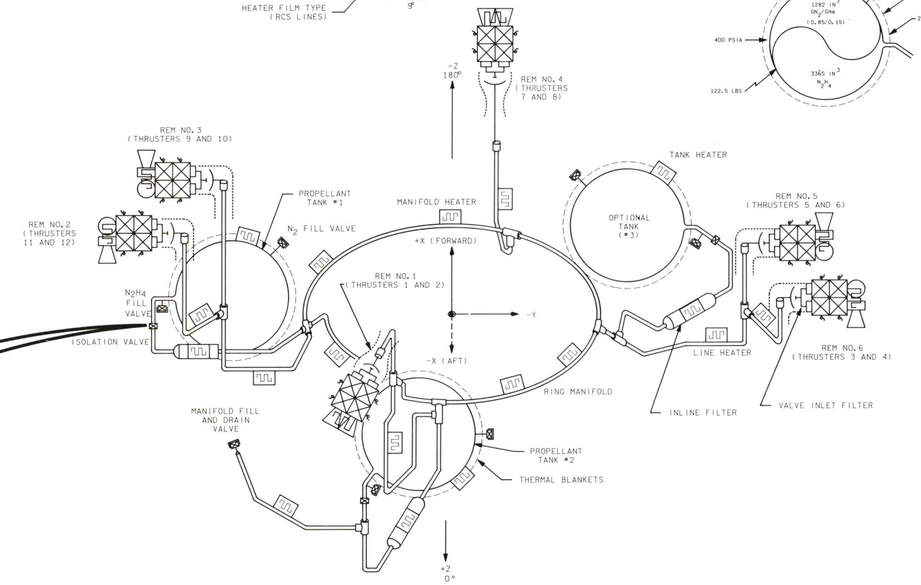


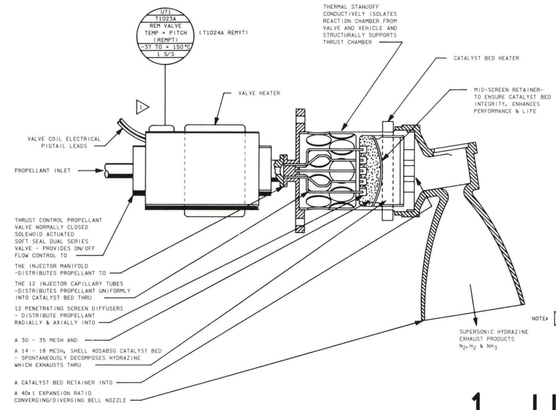


(VALVE IN NORMALLY CLOSED POSITION)

(VALVE AFTER ACTIVATION)

RCS ISOLATION VALVE

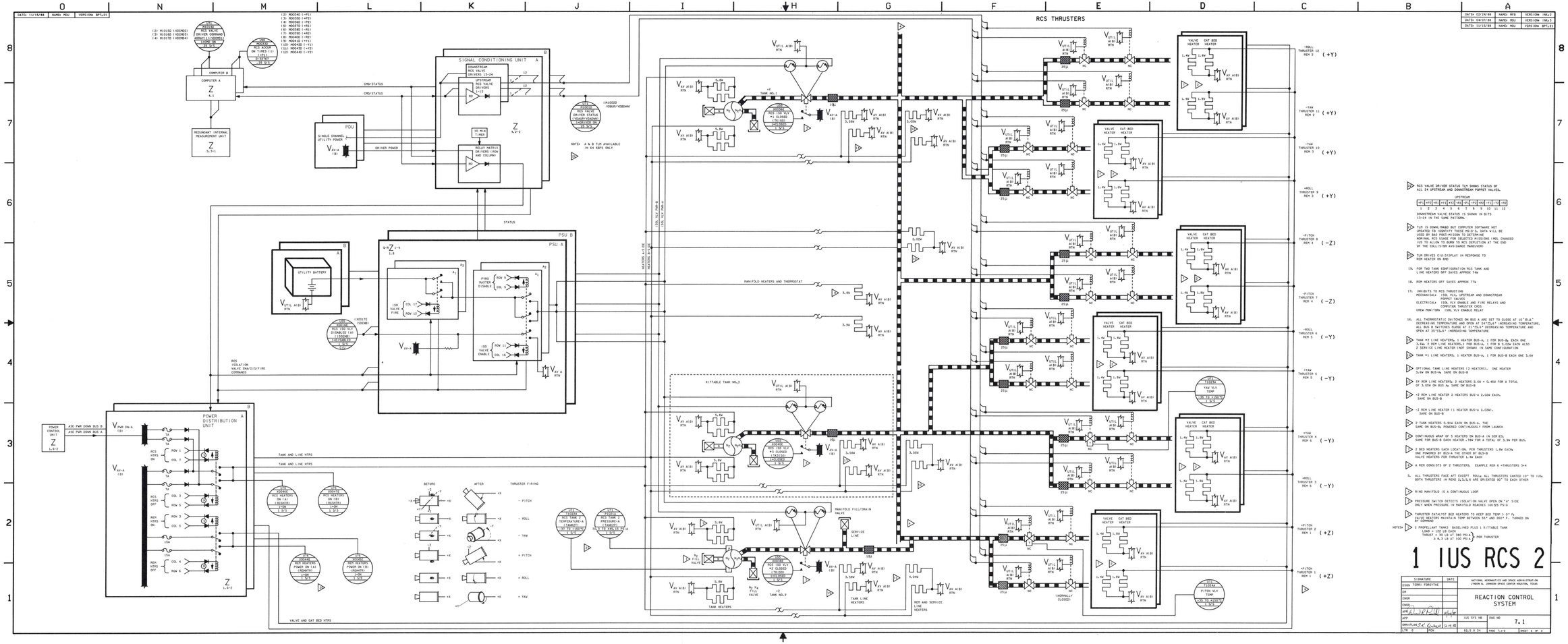


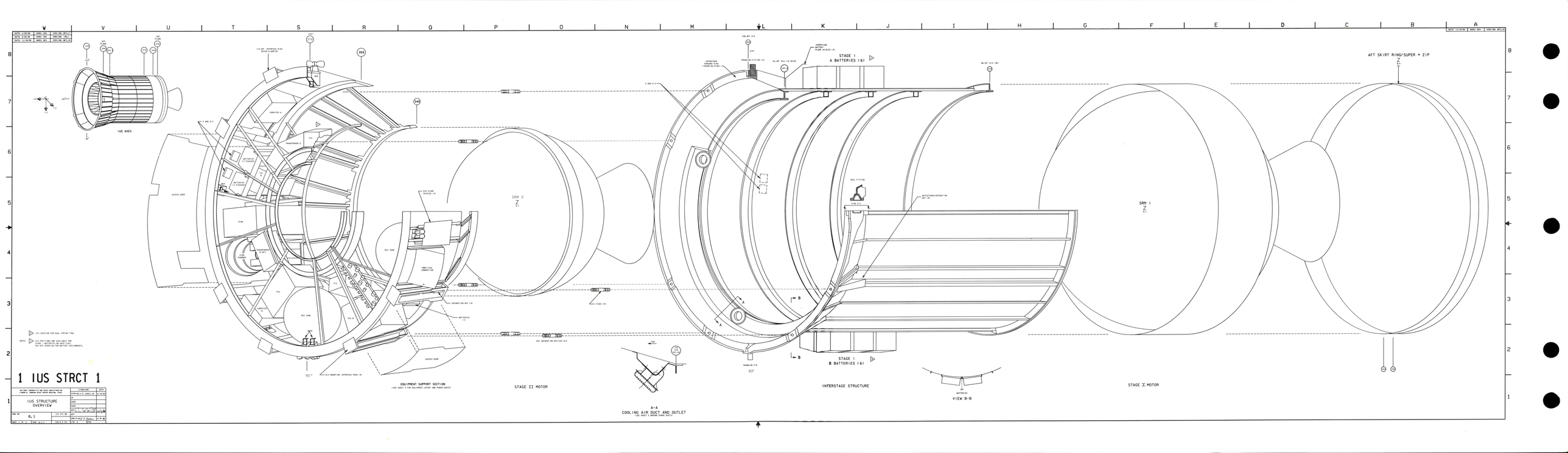


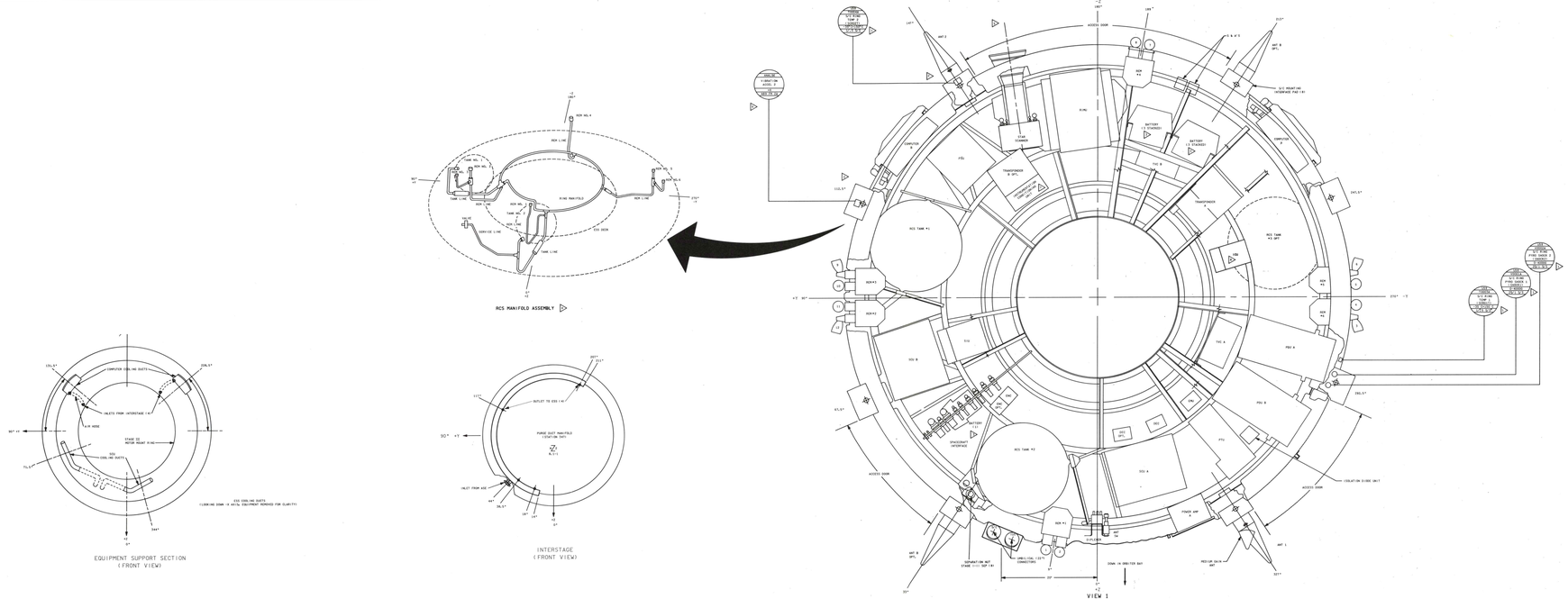
TYPICAL THRUSTER

1 IUS RCS

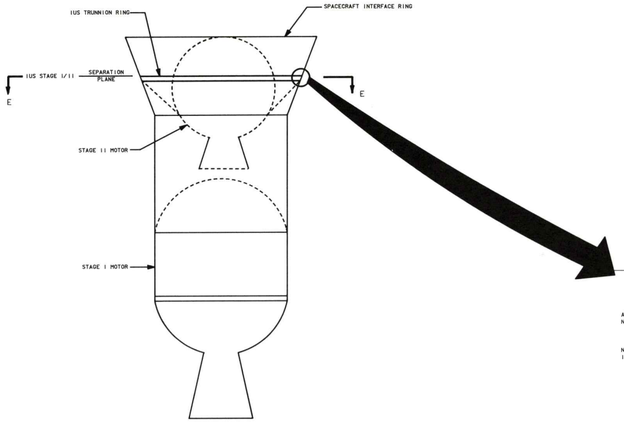
SIGNATURE		DATE	NATIONAL AERONAUTICS AND SPACE ADMINISTRATION LYNDON B. JOHNSON SPACE CENTER HOUSTON, TEXAS
DSON	THOM HILL	5-30-80	
DR	THOM HILL	5-30-80	
ENGR			IUS RCS
ENGR			
APP			IUS SYS HB — DWG NO 7.1
OMNIPLAN 5.4 Release		8-19-88	
LTR Q	PCN		66 X 34 — PAGE 7.1-1 — SHEET 1 OF 2

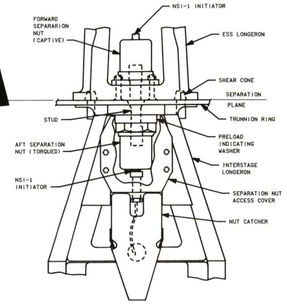

RCS THRUSTERS
SIGNAL CONDITIONING UNIT A
PSU A
PSU B
PDU
POWER DISTRIBUTION UNIT A
COMPUTER A
COMPUTER B
REDUNDANT INTERNAL MEASUREMENT UNIT
UTILITY BATTERY
MANIFOLD HEATERS AND THERMOSTAT
KITTABLE TANK NO.2
TANK NO.1
MANIFOLD FILL/DRAIN VALVE
SERVICE LINE
TANK LINE HEATERS
TANK HEATERS
RCS ISOLATION VALVE ENA/DIS/FIRE COMMANDS
VALVE AND CAT BED HTRS
TANK AND LINE HTRS
STATUS
CMD/STATUS
DRIVER POWER
-ROLL THRUSTER 12 REM 4 (+Y)
+ROLL THRUSTER 11 REM 2 (+Y)
+YAW THRUSTER 10 REM 3 (+Y)
+ROLL THRUSTER 9 REM 3 (+Y)
-PITCH THRUSTER 8 REM 4 (-Z)
-PITCH THRUSTER 7 REM 4 (-Z)
-ROLL THRUSTER 6 REM 5 (-Y)
+YAW THRUSTER 5 REM 5 (-Y)
+YAW THRUSTER 4 REM 6 (-Y)
+ROLL THRUSTER 3 REM 6 (-Y)
+PITCH THRUSTER 2 REM 1 (+Z)
+PITCH THRUSTER 1 REM 1 (+Z)
1 IUS RCS 2
7.1


IUS AXES
EQUIPMENT SUPPORT SECTION
SEE SHEET 3 FOR EQUIPMENT LAYOUT AND PANEL OUTFIT
STAGE II MOTOR
A-A
COOLING AIR DUCT AND OUTLET
SEE SHEET 3 GROUND PURGE OUTFIT
INTERSTAGE STRUCTURE
STAGE I
A BATTERIES (6)
STAGE I
B BATTERIES (6)
VIEW B-B
SRM 2
SRM 1
AFT SKIRT RING/SUPER + ZIP
STAGE II MOTOR
90°
IUS LOCATION FOR DUAL STRING TM&T
NOTES
1 IUS STRCT 1
IUS STRUCTURE OVERVIEW
8.1

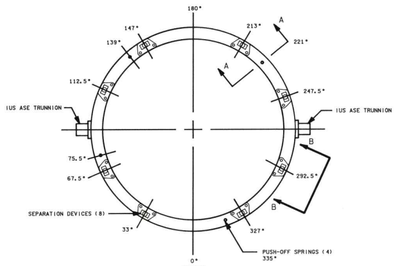

RCS MANIFOLD ASSEMBLY
EQUIPMENT SUPPORT SECTION
(FRONT VIEW)
INTERSTAGE
(FRONT VIEW)
VIEW 1
1 IUS STRCT 2
IUS STRUCTURE
(FRONT VIEW)
8.1

DATE= 1/20/88	NAME= MAG	VERSION= BPTs 2
DATE= 11/14/88	NAME= LAM	VERSION= BPTs 3
DATE= 11/28/88	NAME= LAM	VERSION= BPTs 4

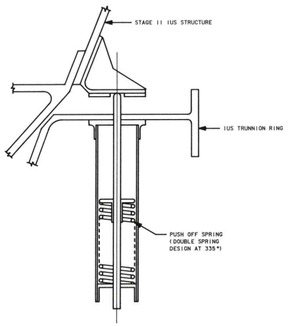




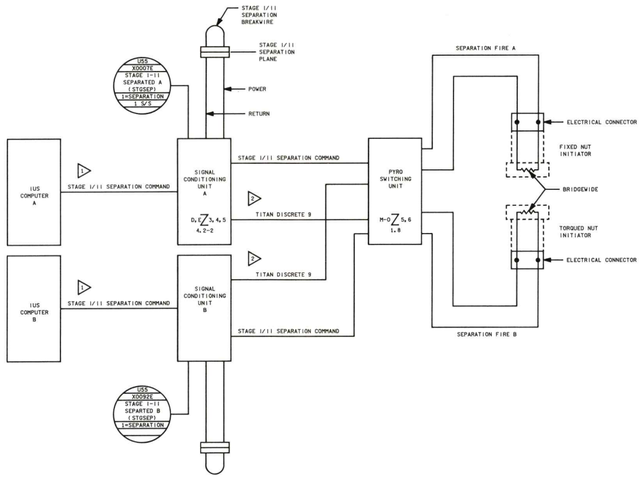
VIEW B-B
(SEE SECTION VIEWS CC AND DD FOR INTERNAL MECHANISMS)



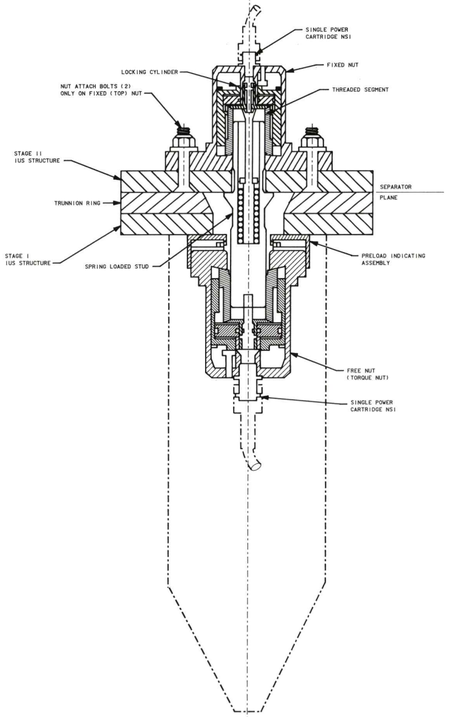
VIEW E-E
IUS TRUNNION RING FRONT VIEW



VIEW A-A

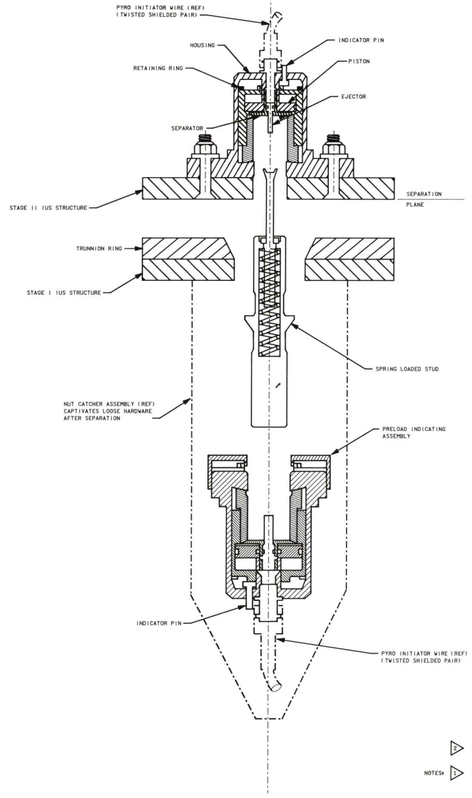


BEFORE SEPARATION



SECTION C-C

AFTER SEPARATION



SECTION D-D

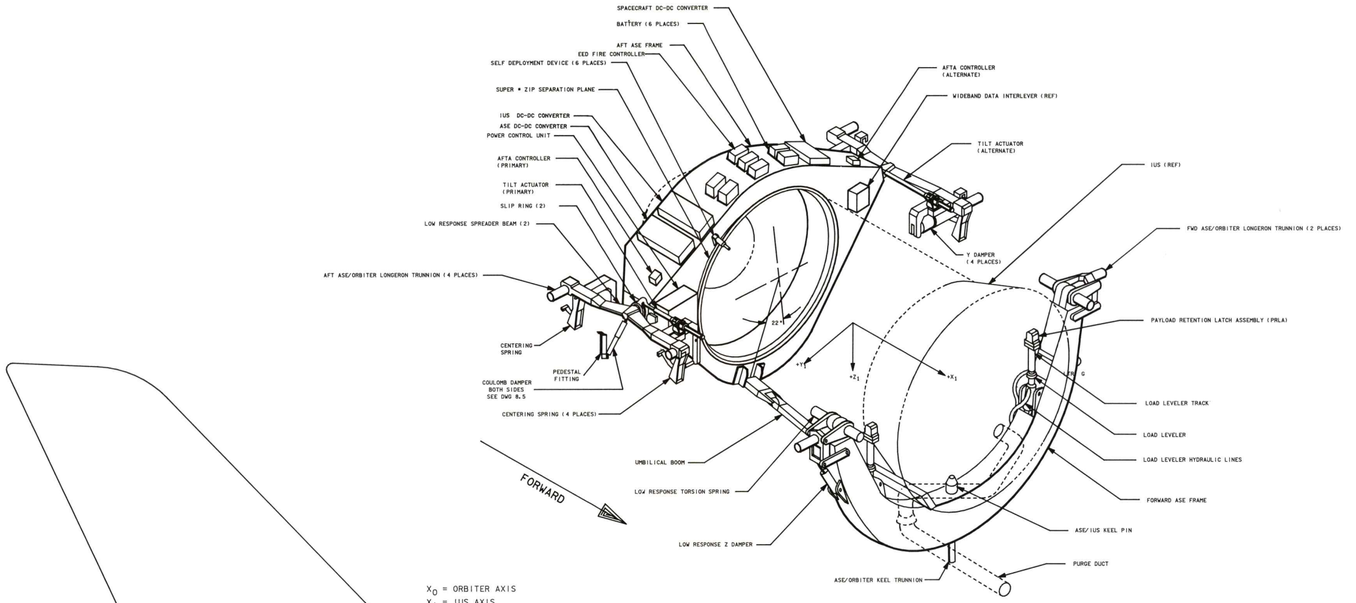
▷ TITAN DISCRETE NO. 9 PERFORMS SAME FUNCTION AS STG I/II SEP FIRE DISCRETE

NOTES: ▷ SEPARATION SEQUENCE AS FOLLOWS:
-COMPUTER A SENDS STG I/II SEP RELAY MATRIX CMD AND COMPUTER B SENDS STG I/II SEP FIRE DISCRETE CMD (TITAN DISCRETE NO. 9) TO RELEASE AND EJECT THE (8) AFT (TORQUE) NUTS. AFT NUTS EJECT AT 3 FT/SEC
-40 MS LATER COMPUTER A SENDS STG I/II SEP FIRE DISCRETE CMD (TITAN DISCRETE NO. 9) AND COMPUTER B SENDS STG I/II SEP RELAY MATRIX CMD TO RELEASE AND EJECT THE (8) STUDS FROM THE FORWARD (FIXED) NUTS AT 7 FT/SEC

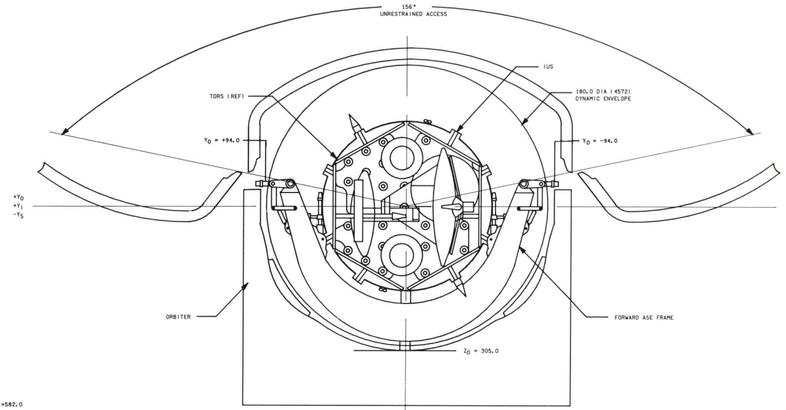
2 IUS SEP DEV

SIGNATURE		DATE	NATIONAL AERONAUTICS AND SPACE ADMINISTRATION LYNDON B. JOHNSON SPACE CENTER HOUSTON, TEXAS
DSGN	VICKI S. HUNTER	11/1/83	
DR			IUS STAGE I/II SEPARATION DEVICES
ENGR			
ENGR			
APP			
APP			IUS SYS HB DWG NO. 8.2
OMNIPLAN			
LTR	G	PCN	66 X 34 PAGE 8.2-1 SHEET 1 OF 1

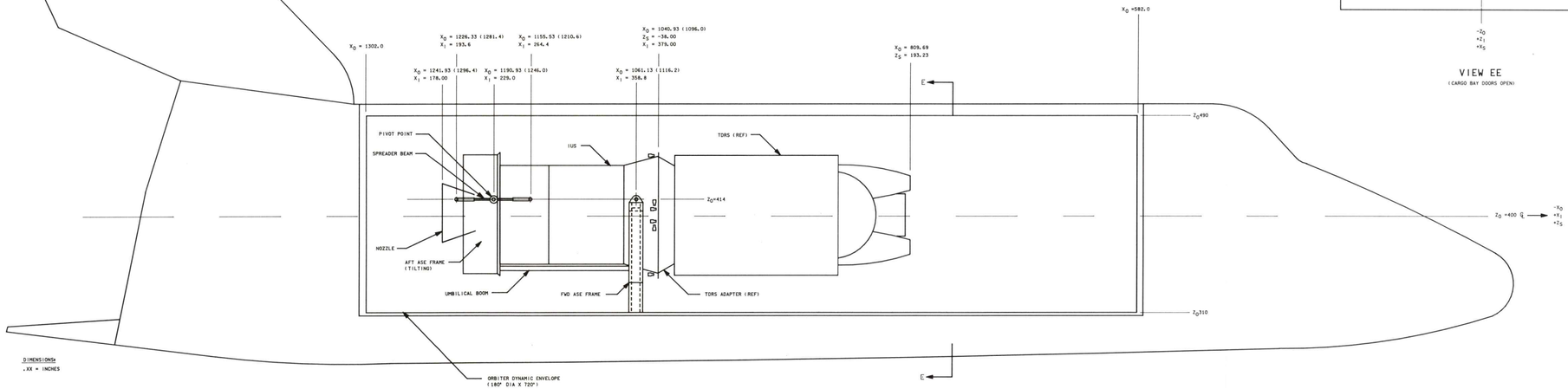
DATE: 2/25/88	NAME: MAG	VERSION: IMU 2
DATE: 11/17/88	NAME: SEW	VERSION: BPT 11
DATE: 12/2/88	NAME: SEW	VERSION: BPT 12



X_O = ORBITER AXIS
X_I = IUS AXIS
X_S = TDRS AXIS (SHOWN FOR REFERENCE)

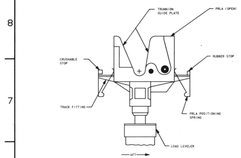


VIEW EE
(CARGO BAY DOORS OPEN)

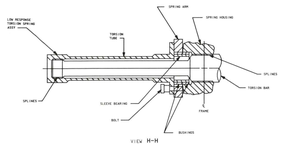


DIMENSIONS
.XX = INCHES

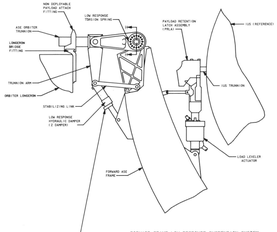
SIGNATURE	DATE	NATIONAL AERONAUTICS AND SPACE ADMINISTRATION LYNDON B. JOHNSON SPACE CENTER HOUSTON, TEXAS
DSGN Stanley V. James	6-25-80	
DR		ASE MECHANICAL OVERVIEW
ENGR		
ENGR		
APP		
APP		IUS SYS HB — DWG NO 8.3
OMNIPLAN JSC CONDEN	12-14-88	8.3-1
LTR G — PCN		66 X 34 — PAGE 8.3-1 — SHEET 1 OF 1



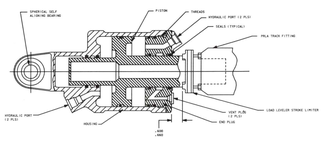
OUTBOARD VIEW OF PORT PRLA



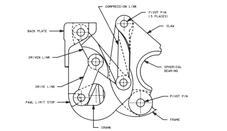
VIEW H-H

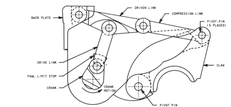


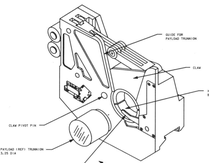
FORWARD FRAME LOW RESPONSE SUSPENSION SYSTEM



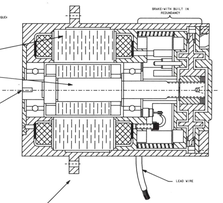
INTERNAL VIEW OF LOAD LEVELER ACTUATOR

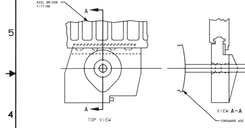




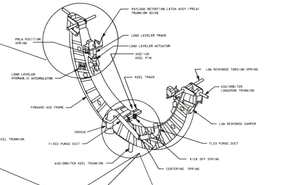


INBOARD VIEW OF PORT PRLA

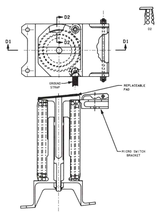


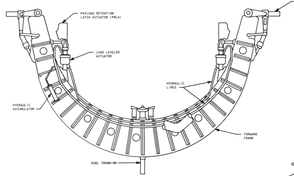


ORBITER-TO-ASE KEEL ATTACHMENT

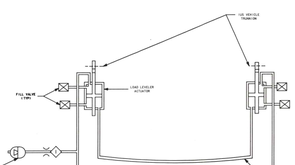


AFT VIEW



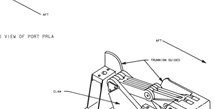


AFT VIEW

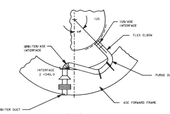


LOAD LEVELER SYSTEM SCHEMATIC
AFT VIEW

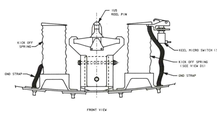
PRECHARGED TO 1080 PSIG ONLY AT 80°F
MAXIMUM OPERATING PRESSURE (3000 PSI)



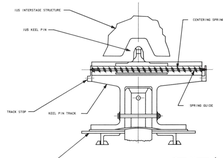
OUTBOARD VIEW OF PORT PRLA (PAYLOAD RETENTION LATCH ASSEMBLY)



PURGE DUCT DETAILS

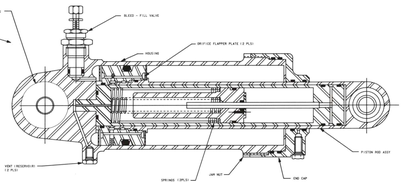


FRONT VIEW

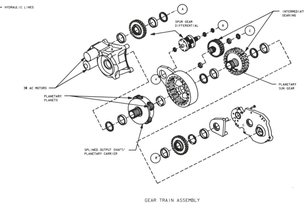


SIDE VIEW

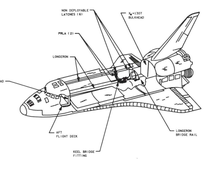
IUS-TO-ASE KEEL ATTACHMENT



INTERNAL VIEW OF LOW RESPONSE HYDRAULIC DAMPER



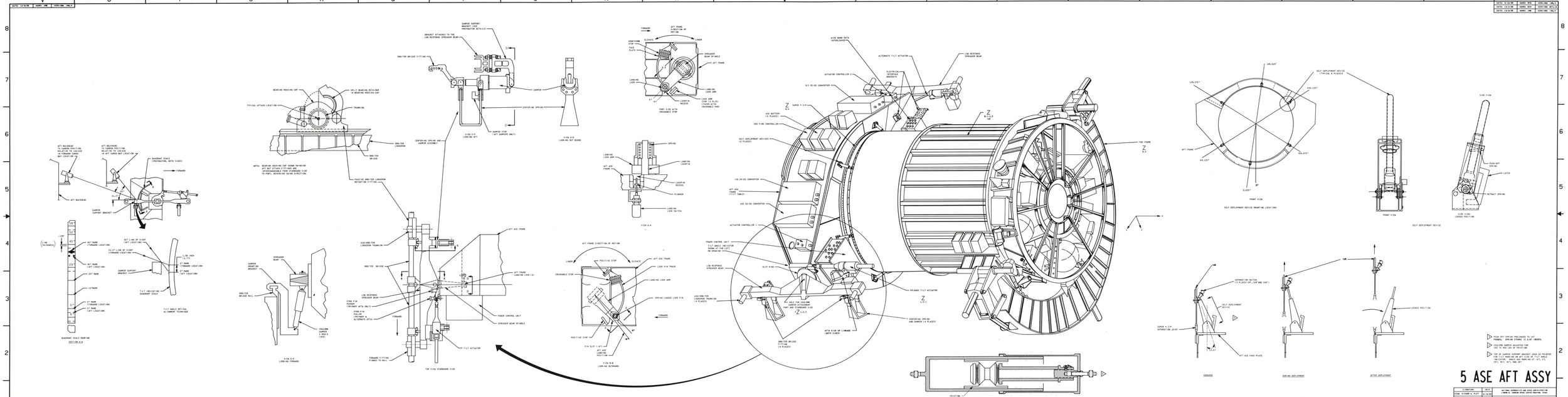
GEAR TRAIN ASSEMBLY



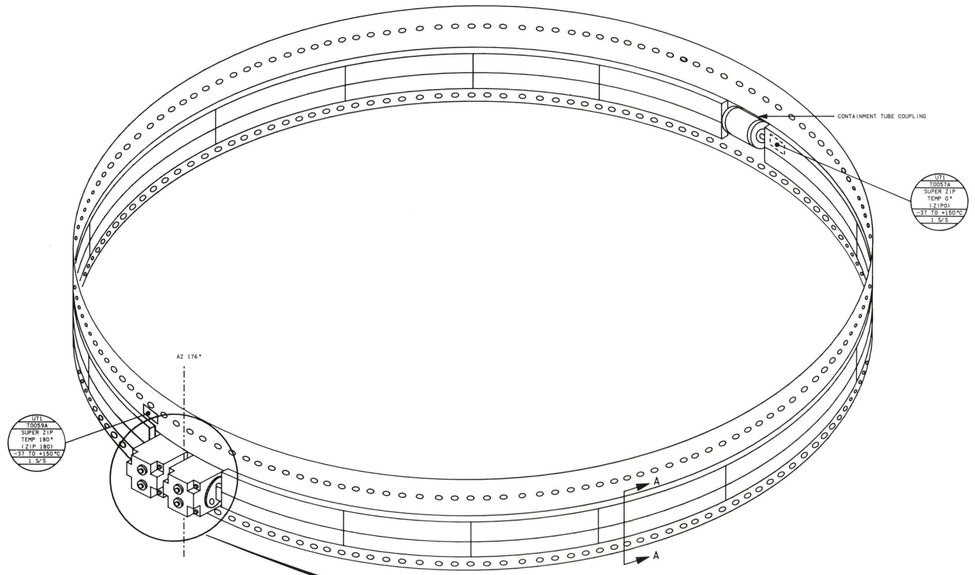
- LATCH SPEEDS TO SECONDS FOR TWO MOTORS, 60 SECONDS FOR ONE MOTOR.
- TWO (2) DAMPERS USED ON FORWARD ASE TO REDUCE LOADS IMPARTED ON THE AFT ASE AND ORBITER.
- BETWEEN KEEL PIN AND LOS (1.5.33 INCHES)

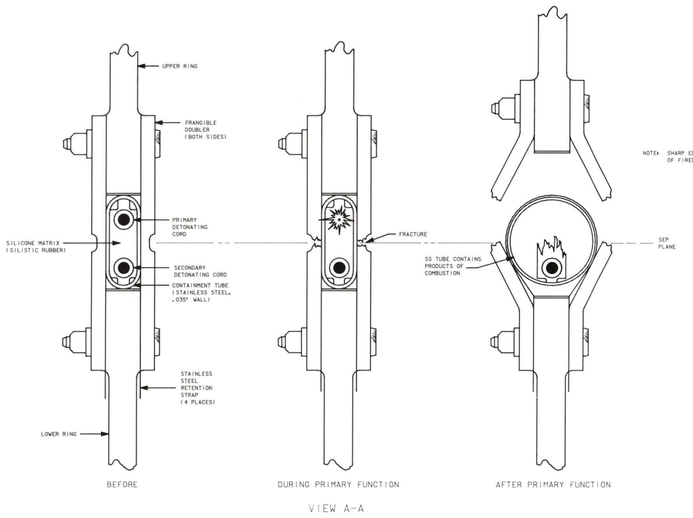
4 ASE FWD ASSY

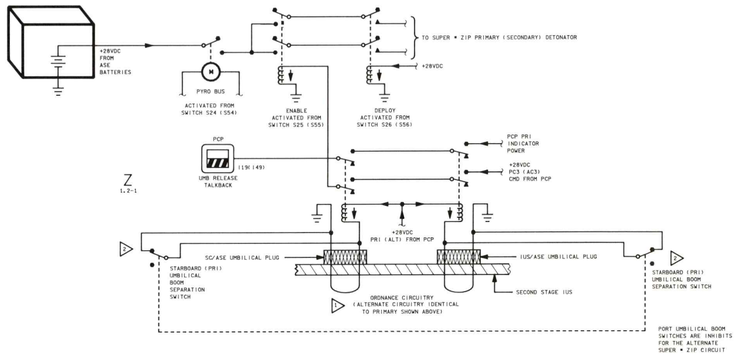
SIGNATURE	DATE	NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
DESIGN: H.O. BATLEY	10/24/83	JOHNSON SPACE CENTER HOUSTON, TEXAS
DR		
CHKR		ASE FORWARD ASSEMBLY
STRESS		
APP'D: J. A. [illegible]	10/24/83	
APP'D: [illegible]	10/24/83	LOS STS 4B DWG NO. 8.4
PROJECTS: [illegible]	10/24/83	STS
TYP. B SPEC		CALC'S NO. PAGE 8.4-1 SHEET 1 OF 1

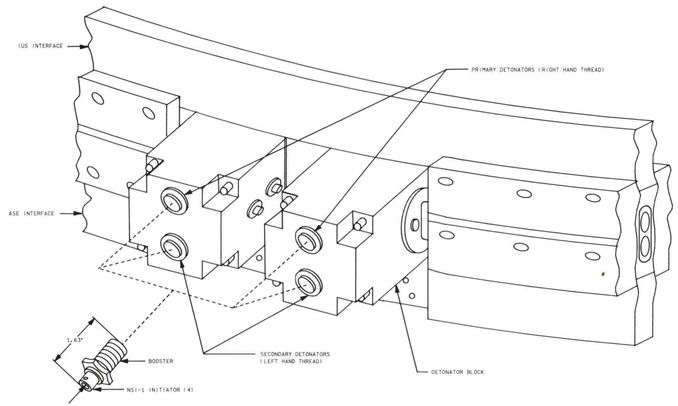

5 ASE AFT ASSY
ASE AFT ASSEMBLY
8.5
SECTION A-A
SECTION B-B
VIEW C-C
LOOKING FORWARD
VIEW D-D
LOOKING OUT BOARD
VIEW E-E
LOOKING AFT
VIEW A-A
VIEW B-B
LOOKING OUTBOARD
TOP VIEW STARBOARD SIDE
FRONT VIEW
SELF DEPLOYMENT DEVICE MOUNTING LOCATIONS
SELF DEPLOYMENT DEVICE
SELF DEPLOYMENT DEVICE OPERATION
STOWED
DURING DEPLOYMENT
AFTER DEPLOYMENT
FRONT VIEW
STOWED VIEW
LOCKED POSITION
FRONT VIEW
STOWED VIEW
LOCKED POSITION
PUSH OFF SPRING PRELOADED TO 140 POUNDS, SPRING STROKE IS 0.87 INCHES.
COLLINS DAMPER ADJUSTED FOR 200 TO 400 LBS OF PRETTION
TOP OF DAMPER SUPPORT BRACKET LEGS AT FRONTER FOR TILT MARKING ON AFT SIDE OF TILT ANGLE INDICATOR ARE AT 16°, 17°, 18°, 19°, 20°, 21°, 22°, 23°, 24°, 25°, 26°, 27°, 28°, 29°, 30°, 31°, 32°, 33°, 34°, 35°
SIGNATURE
DESIGN ENGINEER
DRAFTER
CHECKER
APPROVED
DATE
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
LYNDON B. JOHNSON SPACE CENTER HOUSTON, TEXAS
SIZE
SCALE
SHEET 1 OF 1

DATE	NAME	VERSION
DATE= 02/24/88	NAME= SVJ	VERSION= INK.2
DATE= 11/14/88	NAME= BCH	VERSION= BPT.3
DATE= 12/05/88	NAME= MDU	VERSION= BPT.4









▷ SWITCH NORMALLY OPEN-HELD CLOSED

NOTE: ▷ ORDNANCE CIRCUITRY OVERVIEW IS FOR INFORMATION ONLY. FOR DETAILS SEE ASE PYRO DRAWING NO 1.2

6 IUS SUPER * ZIP

SIGNATURE	DATE	
DSGN NONA SABBAN	6-12-80	NATIONAL AERONAUTICS AND SPACE ADMINISTRATION LYNDON B. JOHNSON SPACE CENTER HOUSTON, TEXAS
DR		
ENGR		SUPER * ZIP
ENGR		
APP		
APP		IUS SYS HB
OMNIPLAN S C Gardner 9-19-89		DWG NO 8.6
LTR G	PCN	66 X 34 PAGE 8.6-1 SHEET 1 OF 1

DATE: 12/8/88 NAME: JMB VERSION: UNLI

DATE: 2/24/89 NAME: MAS VERSION: UNLI
DATE: 11/28/89 NAME: LAT VERSION: MT/LA
DATE: 12/8/88 NAME: JMB VERSION: UNLI

MECHANICAL LINK MOVEMENT

E1 RESTOW POSITION

D1 IUS DEPLOY POSITION

C1 35° BACKUP MECHANICAL UMBILICAL RELEASE POSITION

B1 29° INTERMEDIATE POSITION / PRIOR TO UMBILICAL SEPARATION

UMBILICAL RELEASE MECHANISM

UMBILICAL BOOM END VIEW

VIEW X-X

AFT ASE

UMBILICAL CABLE BOOM

A1 LAUNCH CONFIGURATION

UMBILICAL CAPTURE ASSY

ELEVATION AND STOWAGE MOTION

E1 -6° RETRACTED POSITION FOR LANDING

D1 56° DEPLOYMENT

C1 35° BACKUP MECHANICAL UMBILICAL RELEASE SYSTEM ENGAGES

B1 29° INTERMEDIATE POSITION, UMBILICAL BOOM AND UMBILICALS RELEASED AT THIS POINT BEFORE BEING TO 56°!

A1 0° LAUNCH POSITION

AFT ASE

FORWARD ASE

UMBILICAL BOOM LATCH AND RELEASE MECHANISM

- THE TWO PINS OF THE PIN PULLERS HOLD UP A ROTATABLE TEE-FITTING ON THE UMBILICAL LATCH, ONLY ONE MUST OPERATE TO RELEASE THE LATCH
- IN LANDING POSITION THE AFT ASE TILTS FORWARD MOVING THE BOOM CATCH INTO THE JAWS OF THE TRUNK
- A PLUG IS INSTALLED IN THE UNUSED INITIATOR PORT OF EACH PIN PULLER
- **BRACKET CONNECTS TO PULL ROD TO SUPPORT IT DURING LANDING, ONCE ARM 1 IS ROTATED CLOCKWISE, THE PULL ROD IS FREE TO APPLY LOAD**
- CRANK ARM CONTACTS MECHANICAL STOP AT 211.1° TILT ANGLE DURING ASE ROTOR, THE STOP LIMITS THE AFT ROTATION OF THE CRANK ARM AND THE PULL ROD. THE STOP ALSO LIMITS THE FORWARD MOTION OF THE BOOM PAST THE LATCH, WHEN THE BOOM CONTACTS THE FORWARD ASE
- STOPS ARE PROVIDED TO MAINTAIN MECHANICAL LINK LOCK OF THREE CRANK ARM, PULL ROD AND BOOM STOPS SINCE PULL ROD IS NOT RATED. DRIVE ARM IS ALWAYS FIXED
- THE TUBE GUIDES THE CABLE BOOM DURING RESTOW AND CAPTURE
- TWO PIN PULLERS FIRE SIMULTANEOUSLY TO RELEASE FORWARD LATCH FROM 152.0° (X° T.L.) POSITION AT SAME TIME UMBILICAL CONNECTORS ARE PULLEDOFF, SEE SHT. 7.1.0.0 AND" PYRO TIMING PIN PULLERS AND UMBILICAL TO AFTA PIN PLUNGE AND PIN PULLERS
- THE BASIS OF MECHANICAL SYSTEM RELEASES UMBILICAL PLUGS AT APPROXIMATELY 29° TILT ANGLE. THE UMBILICAL CONNECTORS ARE PULLED OFF AT 35° TILT ANGLE. THE PLUGS ARE RELEASED FROM THE UMBILICALS AT 56° TILT ANGLE. THE UMBILICALS RETRACT FULLY INTO THE UMBILICAL BOOM STOWAGE AREA WHEN PULL ROD AFT TO PULL PLUGS SEQUENTIALLY AT 35° (-10) AND -6° (+1) AFT
- TWO UMBILICAL PLUGS SEPARATE BY ELECTRICAL SIGNAL FROM ASE AT APPROXIMATELY 29° TILT ANGLE. UMBILICAL BOOM LATCH IS PROVIDED AT UMBILICAL CABLE BOOM FOR MATING WITH AFT ASE ALONG THE UMBILICAL BOOM TO THE PLUGS
- ENERGY TO ELEVATE UMBILICAL BOOM PROVIDED BY TILT TABLE ACTUATORS LOCATED ON AFT FRAME SPREADER BEAMS.

7 IUS UMB REL

SIGNATURE	DATE	NATIONAL AERONAUTICS AND SPACE ADMINISTRATION GEORGE C. MARSHALL SPACE FLIGHT CENTER, HUNTSVILLE, ALABAMA
DESIGN (CLARITY S. JAMES)		
DR		
CHAR		UMBILICAL AND BOOM RELEASE
CHKR		
APP	12/12/89	
APP		SIZE: SYS NO. DWG NO. 8.7
MANAGER, P.E. DEVELOPMENT	12/12/89	
SCALE: NONE		SHEET 1 OF 1

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