GE Medical Systems

Technical Publications

Direction 2304882

Revision 2

Signa® Twin*Speed* Block Diagrams & Supplemental Schematics

Operating Documentation

DAMAGE IN TRANSPORTATION

All packages should be closely examined at time of delivery. If damage is apparent, have notation "**damage in shipment**" written on **all** copies of the freight or express bill **before** delivery is accepted or "signed for" by a General Electric representative or a hospital receiving agent. Whether noted or concealed, damage **MUST** be reported to the carrier **immediately** upon discovery, or in any event, within **14** days after receipt, and the contents and containers held for inspection by the carrier. A transportation company will not pay a claim for damage if an inspection is not requested within this **14** day period.

Call Traffic and Transportation, Milwaukee, WI (414) 785−5052/8*323−5052 **immediately** after damage is found. At this time be ready to supply name of carrier, delivery date, consignee name, freight or express bill number, item damaged and extent of damage.

Complete instructions regarding claim procedure are found in Section "S" of the Policy & Procedure Bulletins.

3/12/92

GE Medical Systems

GE Medical Systems: Telex 3797371
P.O. Box 414, Milwaukee, Wisconsin 53201 U.S.A.
(Asia, Pacific, Latin America, North America)

GE Medical Systems — Europe: Telex 261794
Shortlands, Hammersmith, London W6 8BX U.K.

WARNING

- **THIS SERVICE MANUAL IS AVAILABLE IN ENGLISH ONLY.**
- **IF A CUSTOMER'S SERVICE PROVIDER REQUIRES A LANGUAGE OTHER THAN ENGLISH, IT IS THE CUSTOMER'S RESPONSIBILITY TO PROVIDE TRANSLATION SERVICES.**
- **DO NOT ATTEMPT TO SERVICE THE EQUIPMENT UNLESS THIS SERVICE MANUAL HAS BEEN CONSULTED AND IS UNDERSTOOD.**
- **FAILURE TO HEED THIS WARNING MAY RESULT IN INJURY TO THE SERVICE PROVIDER, OPERATOR OR PATIENT FROM ELECTRIC SHOCK, MECHANICAL OR OTHER HAZARDS.**

AVERTISSEMENT

- **CE MANUEL DE MAINTENANCE N'EST DISPONIBLE QU'EN ANGLAIS.**
- **SI LE TECHNICIEN DU CLIENT A BESOIN DE CE MANUEL DANS UNE AUTRE LANGUE QUE L'ANGLAIS, C'EST AU CLIENT QU'IL INCOMBE DE LE FAIRE TRADUIRE.**
- **NE PAS TENTER D'INTERVENTION SUR LES ÉQUIPEMENTS TANT QUE LE MANUEL SERVICE N'A PAS ÉTÉ CONSULTÉ ET COMPRIS.**
- **LE NON-RESPECT DE CET AVERTISSEMENT PEUT ENTRAÎNER CHEZ LE TECHNICIEN, L'OPÉRATEUR OU LE PATIENT DES BLESSURES DUES À DES DANGERS ÉLECTRIQUES, MÉCANIQUES OU AUTRES.**

WARNUNG

- **DIESES KUNDENDIENST–HANDBUCH EXISTIERT NUR IN ENGLISCHER SPRACHE.**
- **FALLS EIN FREMDER KUNDENDIENST EINE ANDERE SPRACHE BENÖTIGT, IST ES AUFGABE DES KUNDEN FÜR EINE ENTSPRECHENDE ÜBERSETZUNG ZU SORGEN.**
- **VERSUCHEN SIE NICHT, DAS GERÄT ZU REPARIEREN, BEVOR DIESES KUNDENDIENST–HANDBUCH NICHT ZU RATE GEZOGEN UND VERSTANDEN WURDE.**
- **WIRD DIESE WARNUNG NICHT BEACHTET, SO KANN ES ZU VERLETZUNGEN DES KUNDENDIENSTTECHNIKERS, DES BEDIENERS ODER DES PATIENTEN DURCH ELEKTRISCHE SCHLÄGE, MECHANISCHE ODER SONSTIGE GEFAHREN KOMMEN.**

AVISO

- **ESTE MANUAL DE SERVICIO SÓLO EXISTE EN INGLÉS.**
- **SI ALGÚN PROVEEDOR DE SERVICIOS AJENO A GEMS SOLICITA UN IDIOMA QUE NO SEA EL INGLÉS, ES RESPONSABILIDAD DEL CLIENTE OFRECER UN SERVICIO DE TRADUCCIÓN.**
- **NO SE DEBERÁ DAR SERVICIO TÉCNICO AL EQUIPO, SIN HABER CONSULTADO Y COMPRENDIDO ESTE MANUAL DE SERVICIO.**
- **LA NO OBSERVANCIA DEL PRESENTE AVISO PUEDE DAR LUGAR A QUE EL PROVEEDOR DE SERVICIOS, EL OPERADOR O EL PACIENTE SUFRAN LESIONES PROVOCADAS POR CAUSAS ELÉCTRICAS, MECÁNICAS O DE OTRA NATURALEZA.**

ATENÇÃO

- **ESTE MANUAL DE ASSISTÊNCIA TÉCNICA SÓ SE ENCONTRA DISPONÍVEL EM INGLÊS.**
- **SE QUALQUER OUTRO SERVIÇO DE ASSISTÊNCIA TÉCNICA, QUE NÃO A GEMS, SOLICITAR ESTES MANUAIS NOUTRO IDIOMA, É DA RESPONSABILIDADE DO CLIENTE FORNECER OS SERVIÇOS DE TRADUÇÃO.**
- **NÃO TENTE REPARAR O EQUIPAMENTO SEM TER CONSULTADO E COMPREENDIDO ESTE MANUAL DE ASSISTÊNCIA TÉCNICA.**
- **O NÃO CUMPRIMENTO DESTE AVISO PODE POR EM PERIGO A SEGURANÇA DO TÉCNICO, OPERADOR OU PACIENTE DEVIDO A‘ CHOQUES ELÉTRICOS, MECÂNICOS OU OUTROS.**

AVVERTENZA

- **IL PRESENTE MANUALE DI MANUTENZIONE È DISPONIBILE SOLTANTO IN INGLESE.**
- **SE UN ADDETTO ALLA MANUTENZIONE ESTERNO ALLA GEMS RICHIEDE IL MANUALE IN UNA LINGUA DIVERSA, IL CLIENTE È TENUTO A PROVVEDERE DIRETTAMENTE ALLA TRADUZIONE.**
- **SI PROCEDA ALLA MANUTENZIONE DELL’APPARECCHIATURA SOLO DOPO AVER CONSULTATO IL PRESENTE MANUALE ED AVERNE COMPRESO IL CONTENUTO.**
- **NON TENERE CONTO DELLA PRESENTE AVVERTENZA POTREBBE FAR COMPIERE OPERAZIONI DA CUI DERIVINO LESIONI ALL’ADDETTO ALLA MANUTENZIONE, ALL’UTILIZZATORE ED AL PAZIENTE PER FOLGORAZIONE ELETTRICA, PER URTI MECCANICI OD ALTRI RISCHI.**

警告

・このサービスマニュアルには英語版しかありません。
・ＧＥＭＳ以外でサービスを担当される業者が英語以外の言語を要求される場合、翻訳作業はその業者の責任で行うものとさせていただきます。
・このサービスマニュアルを熟読し理解せずに、装置のサービスを行わないで下さい。
・この警告に従わない場合、サービスを担当される方、操作員あるいは患者さんが、感電や機械的又はその他の危険により負傷する可能性があります。

注意:

- 本维修手册仅存有英文本。
- 非 GEMS 公司的维修员要求非英文本的维修手册时，客户需自行负责翻译。
- 未详细阅读和完全了解本手册之前，不得进行维修。
- 忽略本注意事项会对维修员，操作员或病人造成触电，机械伤害或其他伤害。

REVISION HISTORY

REV	DATE	PRIMARY REASON FOR CHANGE
0	August 24, 2001	Initial release.
1	October 31, 2001	Second release: 1. SYSTEM Tab Page 1–3 and 1–4; Many circuit corrections, is redrawn. 2. GRADIENT Tab Page 1–2; Many circuit corrections, is redrawn. Corrected header mistake also.
2	March 24, 2003	Third release, various corrections to match current product, specifically: 1. SYSTEM Tab Page 1–3 and 1–4; Removed the Vacuum Sensor and connections. 2. Many changes to Tab TPS/ISE (1.5T).

LIST OF EFFECTIVE PAGES

* This revision number/letter corresponds to the indicated document's revision control system.

CONTENTS

OVERVIEW

TABLE OF CONTENTS

SECTION 1 – PURPOSE

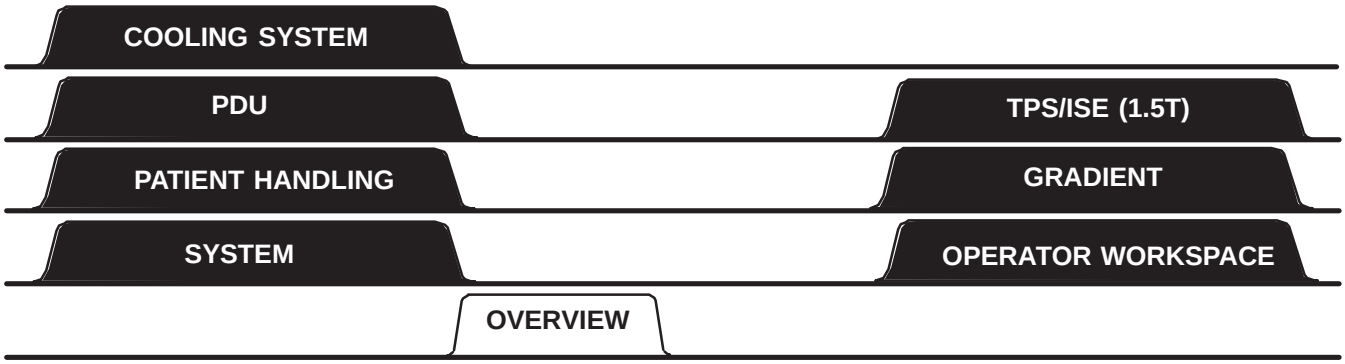
Note

This revision of Direction 2304882 is compatible with 1.5T TWIN*SPEED* hardware.

The purpose of this document is to provide an overview of the hardware which makes up the MR Signa System, and a quick means to troubleshoot major signals within the system.

It is recommended that you page through this manual to become familiar with its content and organization, beginning with System Tab, OVERALL SYSTEM. This section shows how the major subsystems are grouped by cabinet, and the main communication lines between them.

The remaining block diagrams are organized into sections which correspond to major subsystems. Some diagrams show hardware from another subsystem in order to complete an entire signal flow route. For such exceptions, the board/module title of the circuitry shown will generally help identify the applicable subsystem. See Illustration 1–1 for tab organization of this manual.



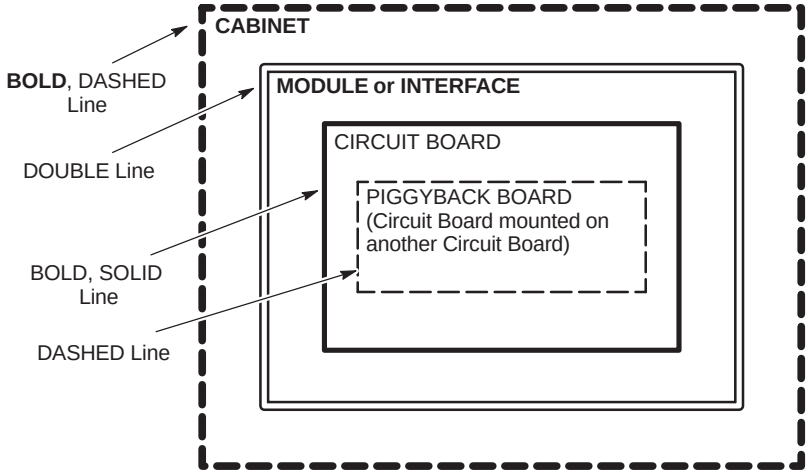
TAB ORGANIZATION FOR THIS DIRECTION
ILLUSTRATION 1

These block diagrams, along with provided diagnostics, are intended to be the primary tools for troubleshooting the MR System from a system or subsystem level on down to the specific module or board level. Since some of the RF subsystem block diagrams are presently insufficient for troubleshooting to the FRU (Field Replaceable Unit) level, schematics have been provided to supplement those block diagrams. When using the diagnostics, the block diagrams can provide a better understanding of what circuitry the diagnostics are testing, and how to further isolate a problem if required.

SECTION 2 – STANDARD CONVENTIONS

The following standard conventions are used within the block diagrams:

- The type of line used to enclose a major box on a block diagram indicates the following:



- The component designator for cabinets, modules, circuit boards, etc. is enclosed in "( )" after or below their name on the block diagram.

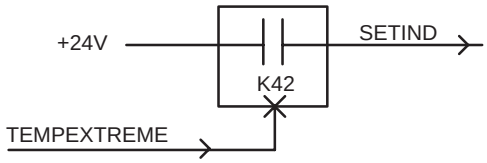
- Logic levels: A "0" indicates a logic "low" level (typ. <0.8VDC), a "1" indicates a logic "high" level (typ. > 2.0VDC).

- An "*" is used to identify an "active low" signal (e.g. "INT*" signal when at a logic "0" indicates that an interrupt is present; a logic "1" level indicates that no interrupt is present).

- A "#/" indicates the number of wires in a cable (e.g.  indactes 9 wires).

- Signal flow is generally from left to right on a block diagram. Arrows are used to identify exceptions to this rule and to aid in identifying input/output signal lines on the diagram.

- The "x" symbol (e.g. ——x) shown on boxes in a block diagram are used to indicate that the function within the box is enabled by the "active" signal on this input line.



For this example, when signal TEMPEXTREME goes active ("1"), relay K42 will close (become enabled) and the signal SETIND now becomes active to set a temperature indicator.

SECTION 3 – ABBREVIATIONS

Note

This list has been compiled from a wide variety of sources. Not all of these abbreviations will apply to your system. For an electronic copy of over 1000 acronyms, see *Direction 2124201–2.*

A

AC = Alternating Current
ACK = Acknowledge
ACQ = Acquisition
A/D = Analog–to–Digital
ADC = Analog to Digital Converter
ADD or ADDR = Address
ADJ = Adjust
ADV = Advance
AGC = Automatic Gain Control
AI = Applications Interface, Artificial Intelligence
ALGN = Align
ALU = Arithmetic Logic Unit
AM = Amplitude Modulation
AMP = ampere, amplifier
A/N = Alpha–numeric
ANSI = American National Standards Institute
AP = Array Processor
APM = Analog Power Monitor
APS = Auto Pre–Scan
APSGT = Auto Pre–Scan Gain Control
AQT = Auto QTUNE
ARCH = Archive/Remove Process
ASC = Automated Service Center
ASCII = American Standard Code for Information Interchange
ASM or ASSY = Assembly or Analog Service Module
ASM = Analog Service Module
ATTEN = Attenuator
AUTO = Automatic
AUX = Auxiliary

B

B = magnetic field
BATT = Battery
BB = Buffered Data or Broadband
BBT = BroadBand Tool
BC = Body Coil
BD = Board
BDS = Buffered Data Strobe
BLK = Black
BNC = BNC Connector
BRT = Brightness
BUF = Buffer
B/W = BandWidth

C

C = centigrade, Celsius
CAB = Cabinet
CAL = Calibration
CALC = Calculate
CATTEN = Course Attenuation
CB = Circuit Breaker
CCW = Counter Clockwise
CD–ROM = Compact Disk Read–Only Memory
CE = Chip Enable
CERD = Combined Exciter, Receiver, DAB
CF = Center Frequency
CFA = Center Frequency Adjust
CHAN or CHNL = Channel
CHK = Check
CKT = Circuit
CLR = Clear
CLI = Command Line Interpreter
CMD = Command
CMMR = Common Mode Rejection Ratio
CMOS = Complimentary Symmetry Metal Oxide Semiconductor
CMP = Compare or Compressor
CM/PM = Communications Manager / Power Monitor Board
CNT = Contrast
COAX = Coaxial
COF = Cut Off Frequency
CON or CONS = Console
CONFIG = Configuration
CONT = Continuous

CONV = Converter
CPD = Communication Pin Driver
CPU = Central Processing Unit
CRT = Cathode–Ray Tube
CT = Computed Tomography
CTL = Clock Time Control
CTRL = Control
CV = Configuration Variable
CW = Clockwise
CYL = Cylinder

D

D/A = Digital–to–Analog
DAC = Digital to Analog Converter
dB = Decibel
dBm = Decibels above or below one Milliwatt
DC = Direct Current
DCI = Digital Control Interface
DCKSTP = Dock Stop
DD = Dynamic Disable
DDS = Direct Digital Synthesizer
DDSB = Dynamic Disable Switch Box
DEC = Decimal
DECC = Digital Eddy Current Compensation
DEG = Degree(s)
DEMUX = Demultiplexer
DEV = device
DIA = Diagnostic Imaging Accessories
DIAG = Diagnostic
DIFF = Differential
DIG = Digit
Dig B0 = Digital B0 Adjustment
DIP = Dual In–line Package
DIR = Direction
DIS = Disable
DMA = Direct Memory Access
DMAC = Direct Memory Access Controller
DMM = Digital Multi–Meter
DPR or DPRAM = Dual Port Random Access Memory
DQA = Daily Quality Assurance
DRAM = Dynamic Random Access Memory
DRC = Dynamic Ram Controller
DRVR = Driver
DSP = Digital Signa Processor
DTS = Display touch Screen
DVM = Digital Volt Meter
DWG = Drawing

E

ECC = Extended Cursor Control or Error Checking and Correction
ECG = Electro–Cardiogram
EDM = Equipment Diagnostic Monitor
EEPROM = Electrically Erasable Programmable Read Only Memory
EFB = Envelop Feedback
EPI = Echo Planer Imaging
e.g. = for example
EM or EMERG = Emergency
EMI = Electro–Magnetic Interference
EN or ENA = Enable
ENV = Envelope
EOS = End Of Sequence
EOT = End Of Travel
EOW = End Of Waveform
EPO = Emergency Power Off
EPROM = Erasable Programmable Read Only Memory
ERU = Emergency Rundown Unit
EXER = Exerciser

F

f = farad
F = Fahrenheit, Fuse (designator)
FBD = Functional Block Diagram
FBK = Feedback
FC = footcandle
Fc = Center Frequency
FDBK = Feedback
FDO = Future Delivery Order
FE = Field Engineer
FET = Field–Effect Transistor
FF or FIFO = First In – First Out
FFD = Full Field Distortion
FFT = Fast Fourier Transform
FID = Free Induction Decay
FIDAT = FIFO In Data
FIFO or FF = First In – First Out
FILT = Filter
FM = Frequency Modulated
FMI = Field Modification Instruction
FOV = Field Of View
FPU = Floating Point Unit
FREQ = Frequency

FRESBECC = Frequency Shift B0 Eddy Current Compensation
FRNT = Front
FRU = Field Replaceable Unit
ft = foot
FT = Feet
FTP = File Transfer Protocol

G

G = gauss
G/A = Gradient Amplifier
GAP = Gradient Amplifier Processor
GASM = Gram Analog Service Module
G(ASM) = GASM and ASM
GEN = Generator
GEPI = Gradient Echo Planer Imaging
GIF = Gradient Interface
GIP = Gradient Interface Processor
GND = Ground
GPIB = General Purpose Interface Board
GPM = Gradient Power Module (aka 8651)
GRAD = Gradient
GRAM = Gradient Ramp Accelerator Module
GRN = Green
GRY = Grey
GP = Gradient Processor

H

H = henry
H = Hexadecimal
HC = Head Coil
HD = Head
He = Helium
He–ALARM = Helium Alarm
HEX = Hexadecimal
He–WARNING = Helium Warning
HLFC = Host Load From Cold
HORIZ or HORZ = Horizontal
HPC = Hardware and Protocol Control
HPFS = Host Platform Software
hr = hour
HSN = High Speed Network
HSS (D) = High Speed Serial Data Link
HTR = Heater
HV = High Voltage
HV PSU = High Voltage Power Supply Unit
HVAC = Heating, Ventilation, & Air Conditioning
Hz = hertz

I

I = Current or Phase or Real
IAMP = Amplifier Current (Gradient)
IC = Independent Console, Integrated Circuit
ICD = Installation Certification Document
ICL = Coil Overcurrent (Gradient)
ID = inner diameter
ID = Identity, Identifier
i.e. = that is to say
IEC = International Electrical Code
IEEE = Institute of Electrical & Electronics Engineers
I/F = Interface
IGRAD = GRAM HSSD D/A converter voltage output
in. = inch
INFO = Information
INS, INST, or INSTR = Instruction
INT or INTR = Interrupt
I/O = Input/Output
IP = Image Processor or Plate Current (RF amp) or Instruction Processor or Internet Protocol
IPA = Intermediate Power Amplifier
IPC = Interprocess Communication
IPG = Integrated Pulse Generator
IQ = Image Quality
IRQ = Interrupt Request
ISA = Interrupt Start Address
ISE = Integrated Systems Electronics
ISI = Inter–Sequence Interrupt
ISO = Isolator or Isolation
IVI = Interactive Vascular Imaging
IVME = Internal VME

J

J = Jack Connector (designator)
JP = Jumper

K

K = Kelvin (unit of temperature) or Kilo (Thousand)
KB = one thousand bytes of memory
KCal = kiloCalorie
kg = kilogram
kHz = kilohertz
KVA = kilo Volt Amperes
kW = Kilowatt

L

L or LFT = Left
LAN = Local Area Network
lb = pound
LBK = Loopback
LCA = Logic Cell Arrays
LED = Light Emitting Diode
LFC = Load From Cold
LHe =Liquid Helium
LIN = Linear
LM or LMK = Landmark
LMP = Lamp
LNK = Link
LO = Local Oscillator
LOEP = List of Effective Pages
LONG = Longitudinal
LVLE = Low Voltage, Low Energy

M

m = meter
M = mega – one million
mA = millamps
MAG = Magnet
MB = megabyte
MCD = Multi–Coil switch Driver
MDS = Multidrop Serial interface
MEM = Memory
Mfg. = Manufacturing
MFU = Multi–Format Unit
MGMNT = Management
mGRAM = mini Gradient Ramp Accelerator Module
MHz = megahertz
MIF = Master Interface
mm = millimeter
MOD = Modifier
MON = Monitor
MOSFET = Metal Oxide Semiconductor Field Effect Transistor
MOV = Metal Oxide Varistor
MPS = Manual Pre–Scan
MR = Magnetic Resonance
MSG = Message
MTR = Motor
MUX = Multiplexer
mV = millivolts
MW = megawatt
mW = milliwatt

N

N = Negative
N2 = Nitrogen
n.c. = normally closed
NEC = National Electrical Code
Ni–Cad = Nickel Cadmium
n.o. = normally open
NO. = Number
NOPROC = No Processing
NOREC = No Reconstruction
nS = Nanosecond

O

O2 = oxygen
OC = Operator's Console
OD = outside diameter
OPI = Oblique Plane Imaging
OPTO = Optical
ORG = Orange
OT = Overtemp
OV = Over voltage
OVR = Over
OVRLD or OL = Overload
oz = ounce
OW = Operator Workspace

P

P = Positive
PA = Patient or Power Amplifier
PAC = Physiological Acquisition Controller
PAL = Programmable Array Logic or Patient Alignment Lights
PAN = Primary Archive Node
PAT = Patient
PCI = Programmable Communications Interface
PCT = Pulse Controller Task
PDI = Product Delivery Instruction
PDU = Power Distribution Unit
PEN = Penetration
PIN = Positive–Intrinsic–Negative
PIO = Programmed Input/Output
PIXEL = Picture Element
PM = Phase Modulation, Periodic Maintenance
P/N = Positive/Negative
PNL = Panel
POS = Position
POT = Potentiometer
P–P = Peak to Peak
ppm = parts per million
PREAMP = Preamplifier
PROC = Process, Processor
PROG = Program, –ed, –able
PROM = Programmable Read Only Memory or Program
PS = Power Supply
PSD = Pulse Sequence Database
PSG = Pulse Sequence Generator
PSU = Power Supply Unit
PSS = Power Supply System Board
PUR = Purple
PVC = Polyvinylchloride
PW = Pulse Width
PWA = Printed Wiring Assembly
PWB = printed wiring board
PWR = Power

Q

Q = Quadrature, Quality Factor or Imaginary
Qty = Quantity
QUAD = Quadrature or Quadrant

R

R or RT = Right
RAM = Random Access Memory
RCV = Receive
RD = Read
RDY = Ready
RECON = Reconstruction
REF = Reference or Reflected
REG = Register or Regulator
RET or RTN = Return
REV = Revision or Reverse
RF = Radio Frequency
RFAMP = Radio Frequency Amplifier
RFI = Radio Frequency Interference
RF/PEN = Combined RF/Penetration Cabinet
RFSC = RF System Controller
RGB = Red Green Blue
RLA or RLY = Relay
rms = root mean square
ROI = Region of Interest
ROM = Read Only Memory
RSR = Register
RST = Reset
R/W = Read/Write
RX = Receive
RXD = Receive Data

S

S = Switch (designator)
SACK = Slave Acknowledge
SAG = Sagittal
SAR = Specific Absorption Rate
SARR = Stand–Alone Retrospective Reconstruction
S/C = Superconducting
SCA = Scan Control Assembly
SCB = Signal Collection Board
SCR = Silicon Controlled Rectifier
SCSI = Small Computer System Interface
SEC = second
SEG = Segment
SEL = Select
SEPI = Spin Echo Planer Imaging
SGI = Silicon Graphics Inc.
SIG = Signal
SII = ”S–2” (type of magnet)
SIII = ”S–3” (type of magnet)
SIMMS = Single In–line Memory Module
SIP = Single In–line Package

SL = Slice
SLE = System Level Exerciser
SMPTE = Society of Motion Picture and Television Engineers
SN = Service Note
SNR = Signal–to–Noise Ratio
SPI = Serial Peripheral Interface
SPT = System Performance Test
SPU = Signal Processing Unit
SRAM = Static Random Access Memory
SRF = Solid State RF Amplifier SGA
SRI = Scan Room Interface
SRV = Service
SSM = System Support Module
SSP = Sequence Synchronous Protocol
SST = Small Sample Test
STAB = Stability
STAT = Status
STD = Standard
STD DEV = Standard Deviation
SUB–D = Subminiature D (connector)
SW = Switch or Software
S/W = Software
SYNC = Synchronous
SYS = System
SYSID = System Identification

T

T = tesla
TBD = To Be Determined
TBL = Table
TEMP = Temperature
TFU = Thyristor Firing Unit
TG = Transmit Gain
THD = TPS Host Diagnostic
TNF = Transient Noise Filter
TP = Test Point (designator)
TPS = Transceiver Processing and Storage
TR or T/R = Transmit–Receive
TRMAP = Transmit/Receive Map
TRM = Twin Coil Resonator Module
TS = Terminal Strip
TST = Test
TTL = Transistor to Transistor Logic
TX = Transmit
TXD = Transmit Data

U

UART = Universal Asynchronous Receiver–Transmitter
uf = microfarad
UFI = Ultra Fast Imaging
UNBLK = Unblank
uP = Microprocessor
UPLMT = Up Limit
USART = Universal Synchronous/Asynchronous Receiver–Transmitter
uS or usec = microsecond
UV = Under voltage

V

VAC = Volts Alternating Current
VAR = Variable
VBUS = Bus Voltage
VCR = Video Cassette Recorder
VCNTRL = Control Voltage for 8645 Techrons
VDC = Volts Direct Current
VERT = Vertical
VFILT = GRAM Output Voltage
VIN = DAC ldi/dt to command the GRAM PWM voltage
VME = Bus Standard Veras Module Europe
VMIF = MIF Control Voltage
Vout–H/L = Power Module High/Low Voltage Output
Vp–p = Volts Peak–to–Peak
VRMS = Volts, Root Mean Square
VSA = VSB Address
VSB = VME Subsystem Bus
VTAC = Vacuum Tube Amplifier Cavity
VTR = Video Tape Recorder

W

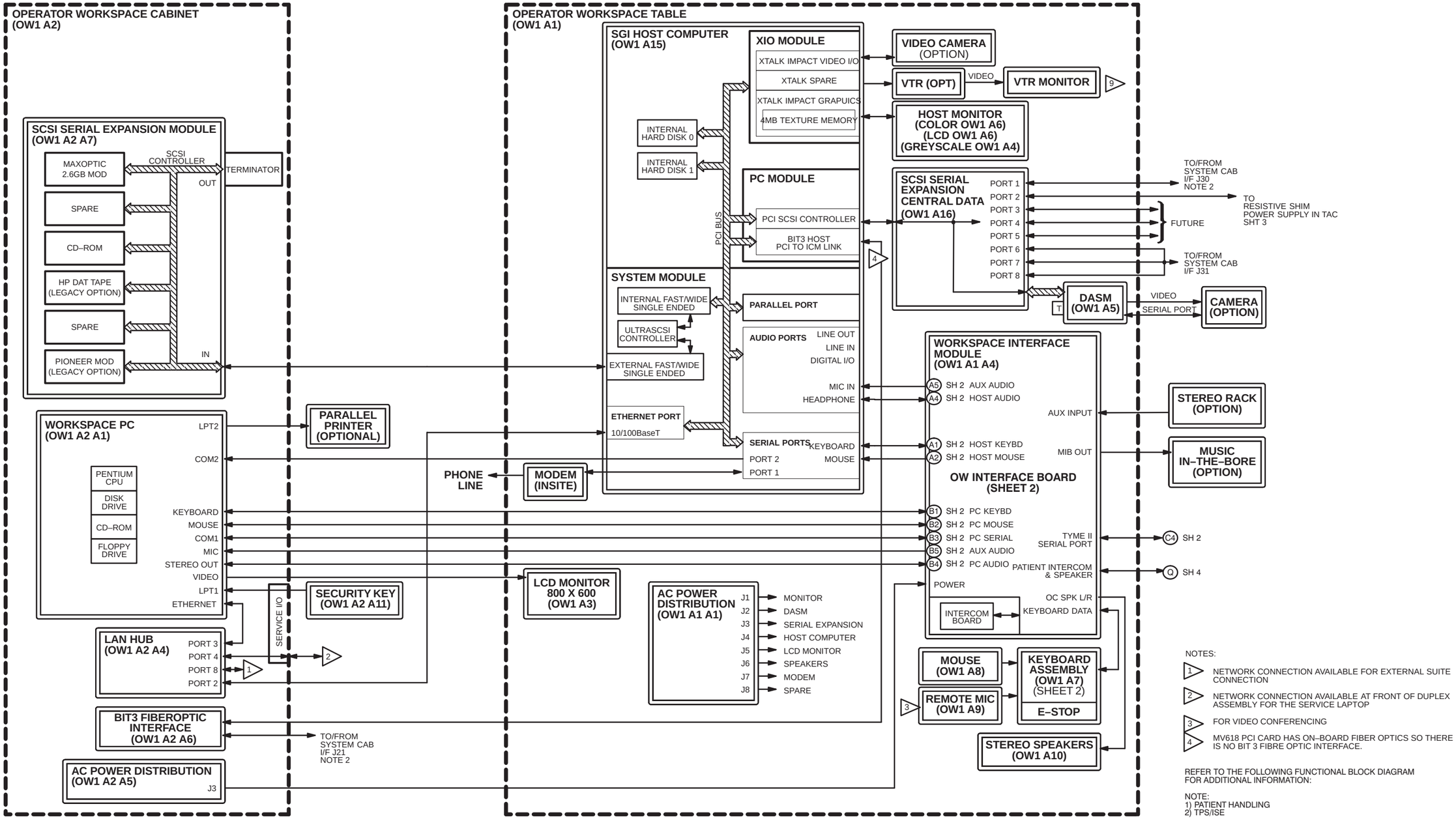
WARP = Waveform And Rotation Processor
WR = Write
WHT = White
WND = Window
WORM = Write Once Read Many
WRT = Write

X

XCVR = Transceiver
XFMR = Transformer
XMT or XMIT = Transmit

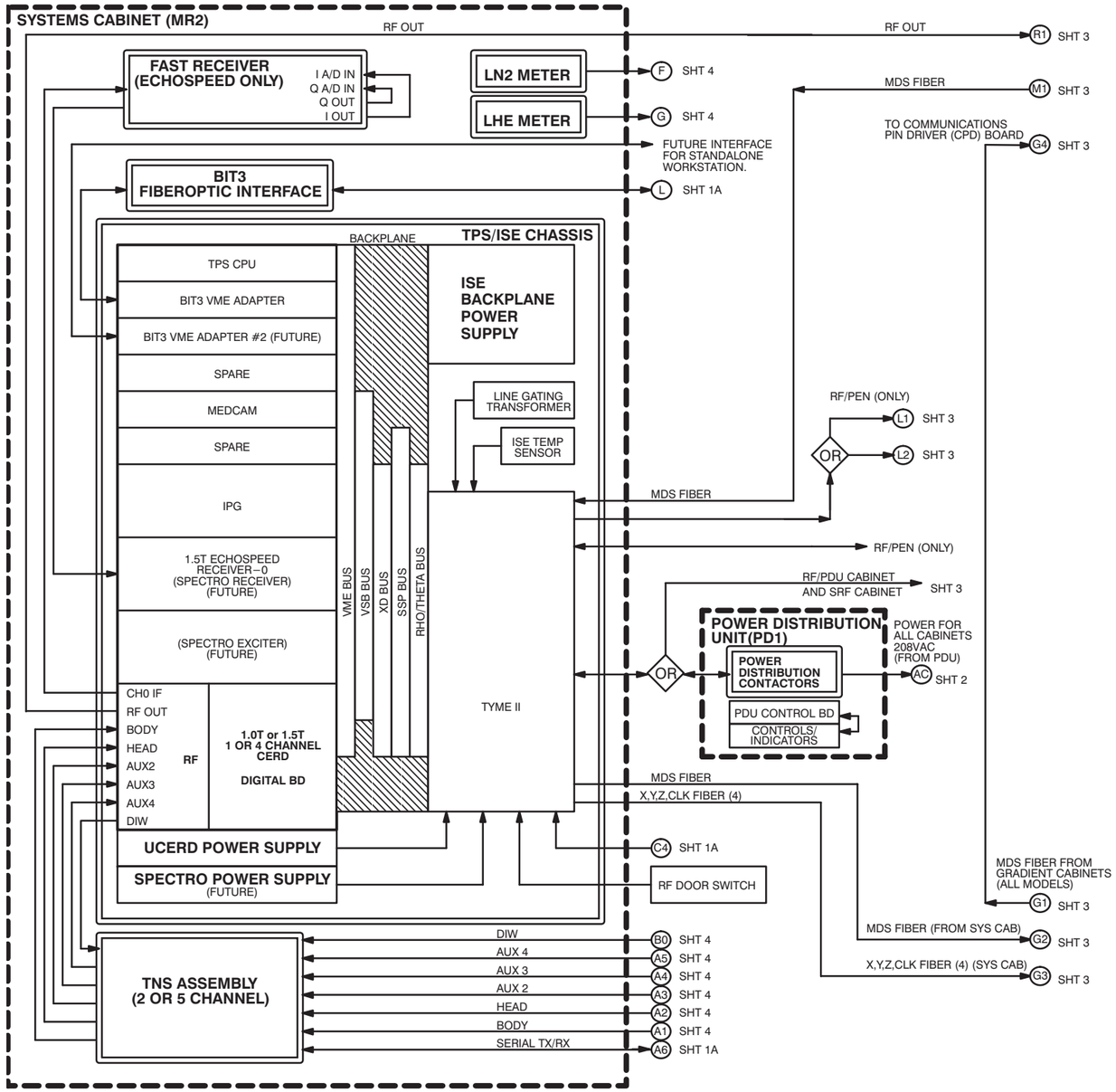
Y

YEL = Yellow
YMS = Yokogawa Medical Systems
YP = Yellow Pages (Sun Computer)

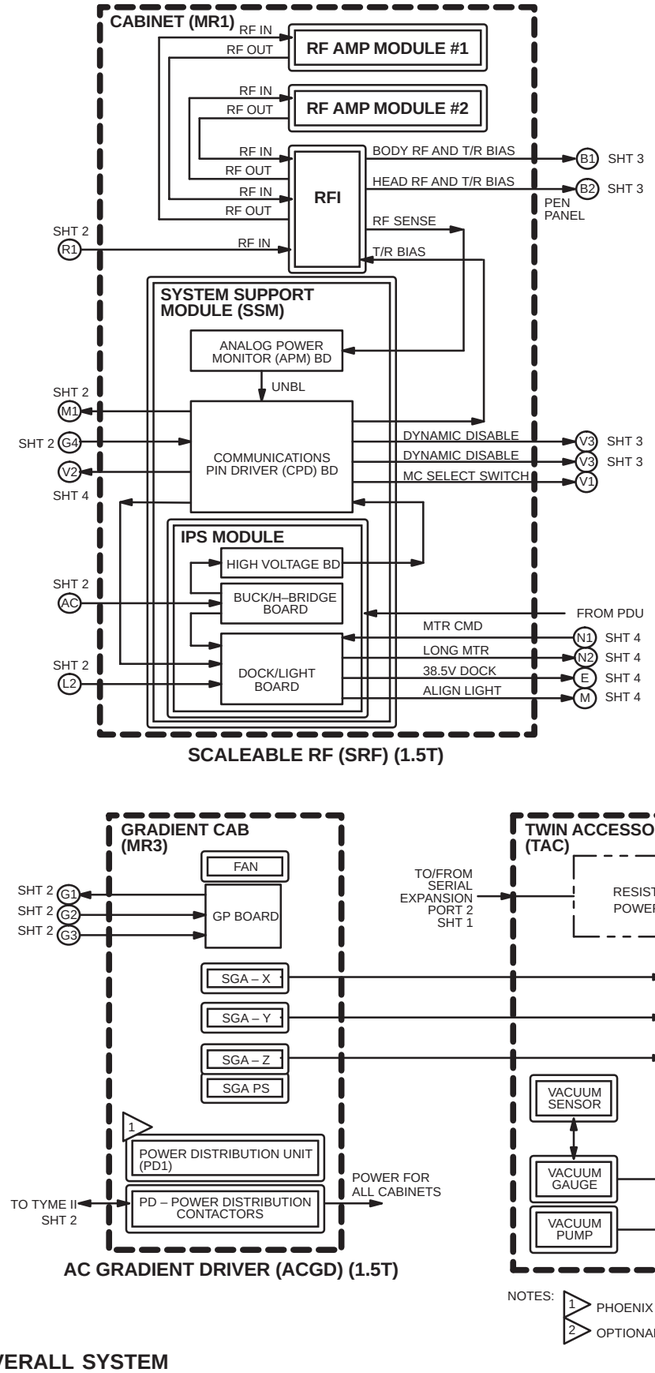


OVERALL SYSTEM – OCTANE
(OPERATOR WORKSPACE CABINET/TABLE – OCTANE)
SHEET 1 OF 4

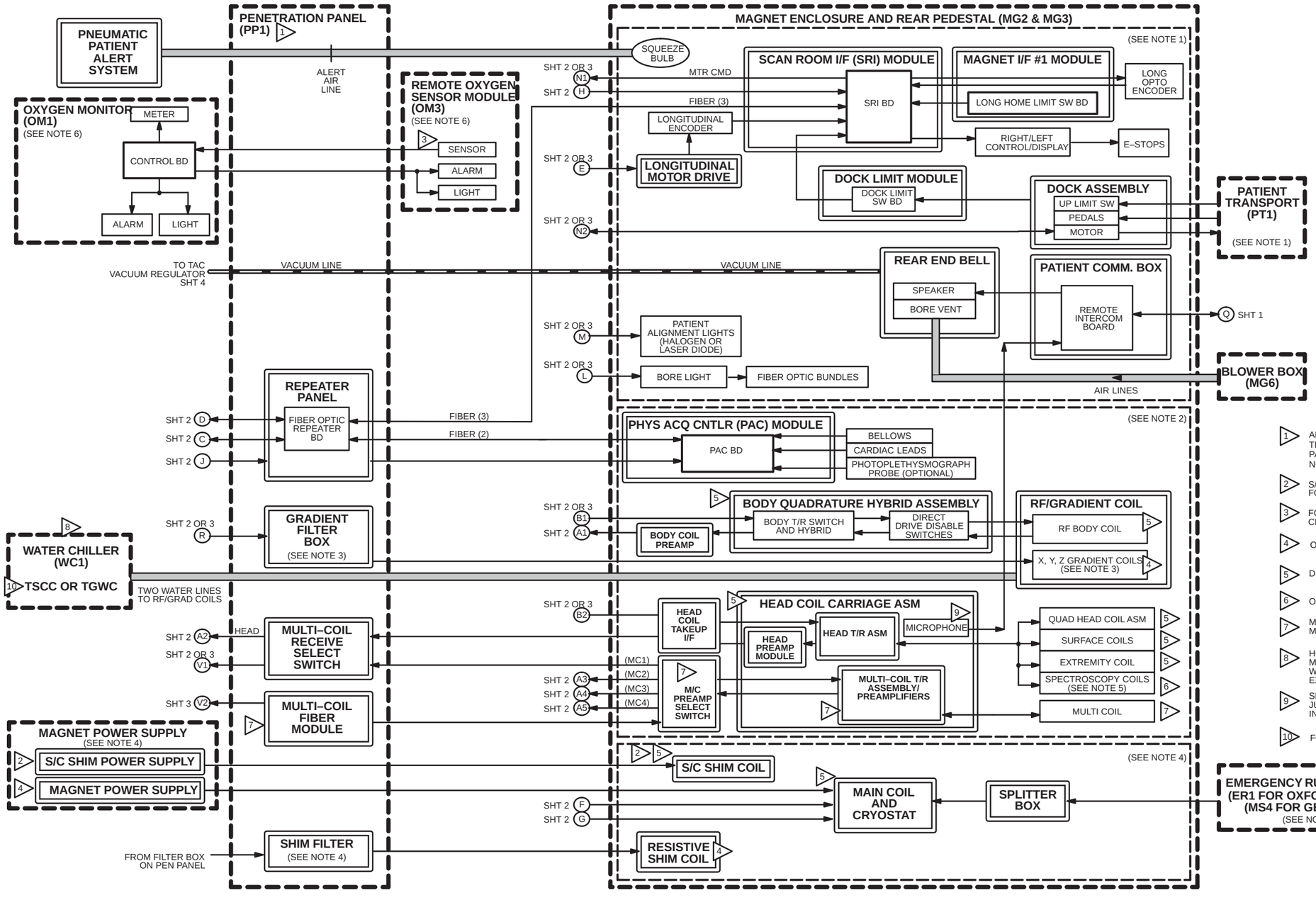
OPTIONAL CABINET COMMUNICATION LINES INDICATED ON NEXT SHEET



OVERALL SYSTEM
(ONLY MAIN COMMUNICATION LINES SHOWN)
SHEET 2 0F 4



OVERALL SYSTEM
(ONLY MAIN COMMUNICATION LINES SHOWN)
SHEET 3 0F 4



1 ALL POWER AND SIGNAL LINES ENTERING AND LEAVING THE RF ENCLOSURE PASS THROUGH THE PENETRATION PANEL. FOR EASE OF USE, ON THIS DIAGRAM, THEY ARE NOT SHOWN GOING TO THE PENETRATION PANEL.

2 S/C SHIM POWER SUPPLY AND S/C SHIM COILS FOR GE MAGNETS ONLY.

3 FOR MOBILE SYSTEMS, SENSOR IS LOCATED IN CEILING BOX.

4 OPTIONAL RESISTIVE SHIM SUPPLY AND COIL.

5 DESIGN DIFFERENCES BETWEEN 1.5T & 1.0T SYSTEMS.

6 OPTIONS AVAILABLE FOR 1.5 T SYSTEMS ONLY.

7 MULTI–COIL HARDWARE IS ONLY PRESENT WHEN MULTI–COIL COMPATIBILITY KIT HAS BEEN INSTALLED.

8 HORIZON SYSTEMS HAVE LITRON HEAT EXCHANGER MR*i* AND CV*i* FIXED SITE SYSTEMS HAVE NESLAB WATER CHILLER. MOBILES HAVE E & W HEAT EXCHANGER.

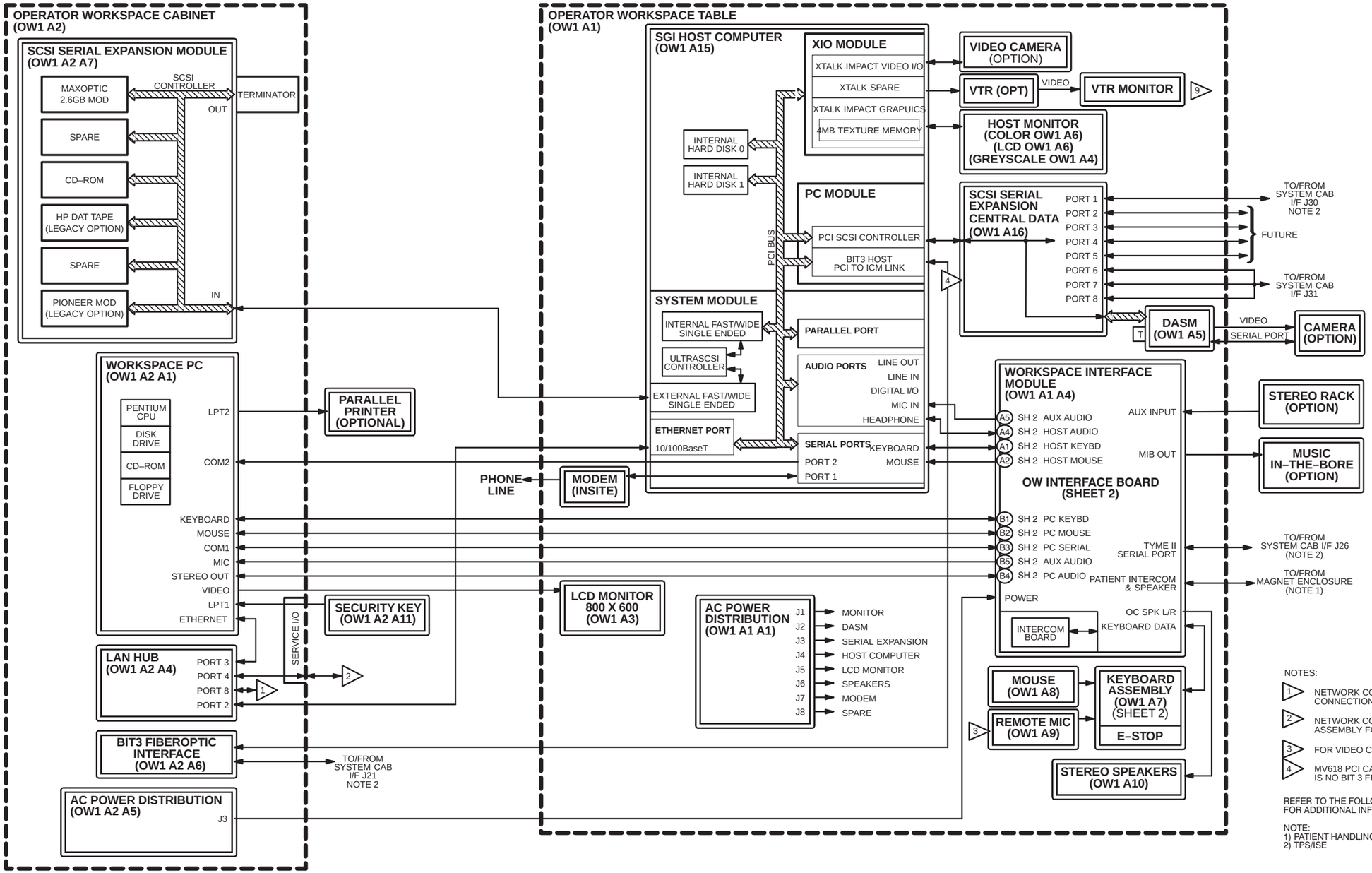
9 SIGNA MR*i* AND CV*i* SYSTEMS MANUFACTURED AFTER JUNE 15, 2000 HAVE MICROPHONE IN THE HEAD CARRIAGE INSTEAD OF THE REAR END BELL.

10 FOR TSCC AND TGWC SEE WATER CHILLER.

REFER TO THE FOLLOWING FUNCTIONAL BLOCK DIAGRAM FOR ADDITIONAL INFORMATION:

NOTE:
1) PATIENT HANDLING
2) TPS/ISE
3) GRADIENT
4) MAGNET AND CRYOGENS
5) REFER TO SPECTROSCOPY MANUALS
6) OXYGEN MONITOR SUBSYSTEM (DIR. 15336).

OVERALL SYSTEM
(ONLY MAIN COMMUNICATION LINES SHOWN)
SHEET 4 OF 4



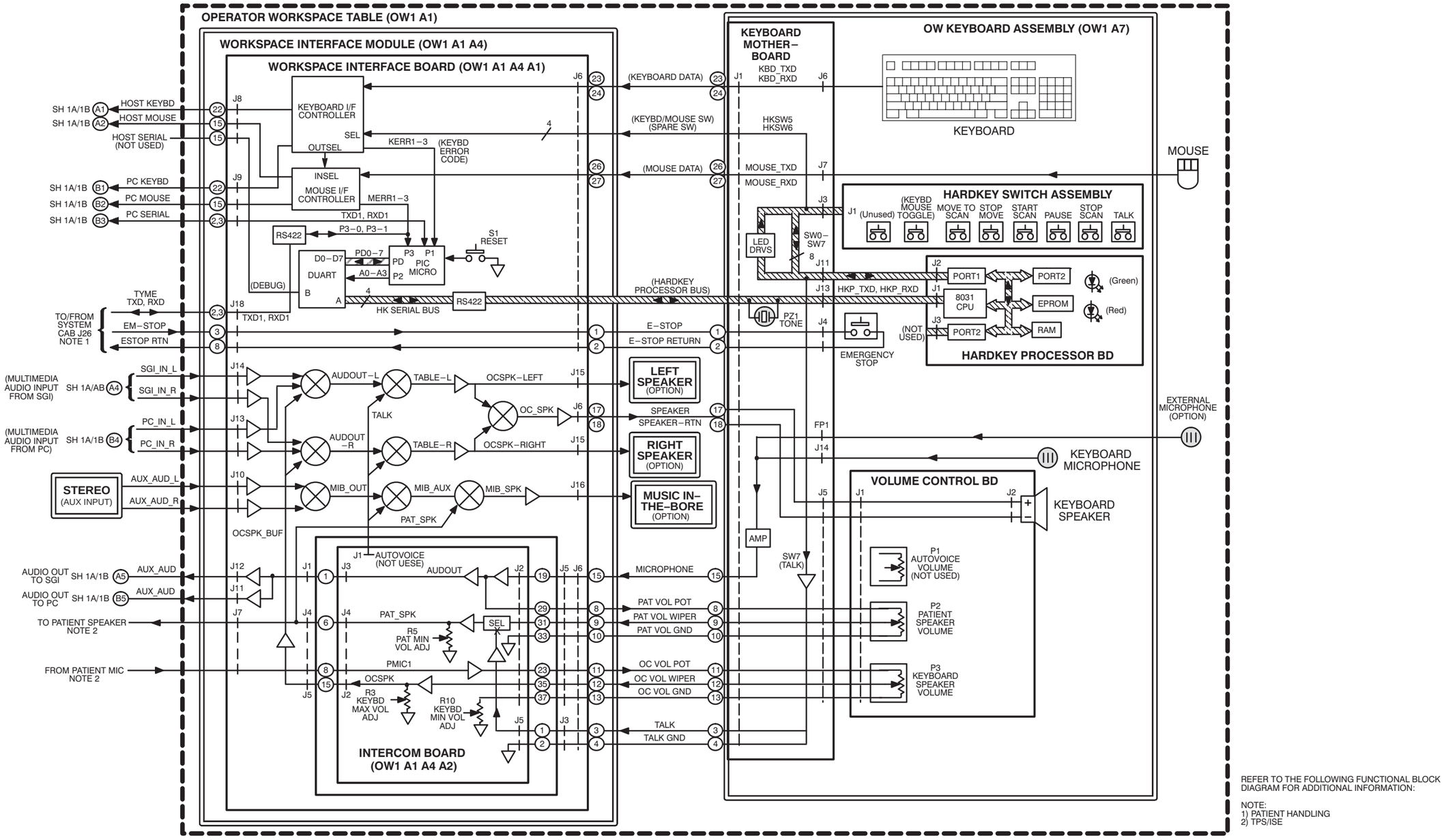
NOTES:

1. NETWORK CONNECTION AVAILABLE FOR EXTERNAL SUITE CONNECTION
2. NETWORK CONNECTION AVAILABLE AT FRONT OF DUPLEX ASSEMBLY FOR THE SERVICE LAPTOP
3. FOR VIDEO CONFERENCING
4. MV618 PCI CARD HAS ON–BOARD FIBER OPTICS SO THERE IS NO BIT 3 FIBRE OPTIC INTERFACE.

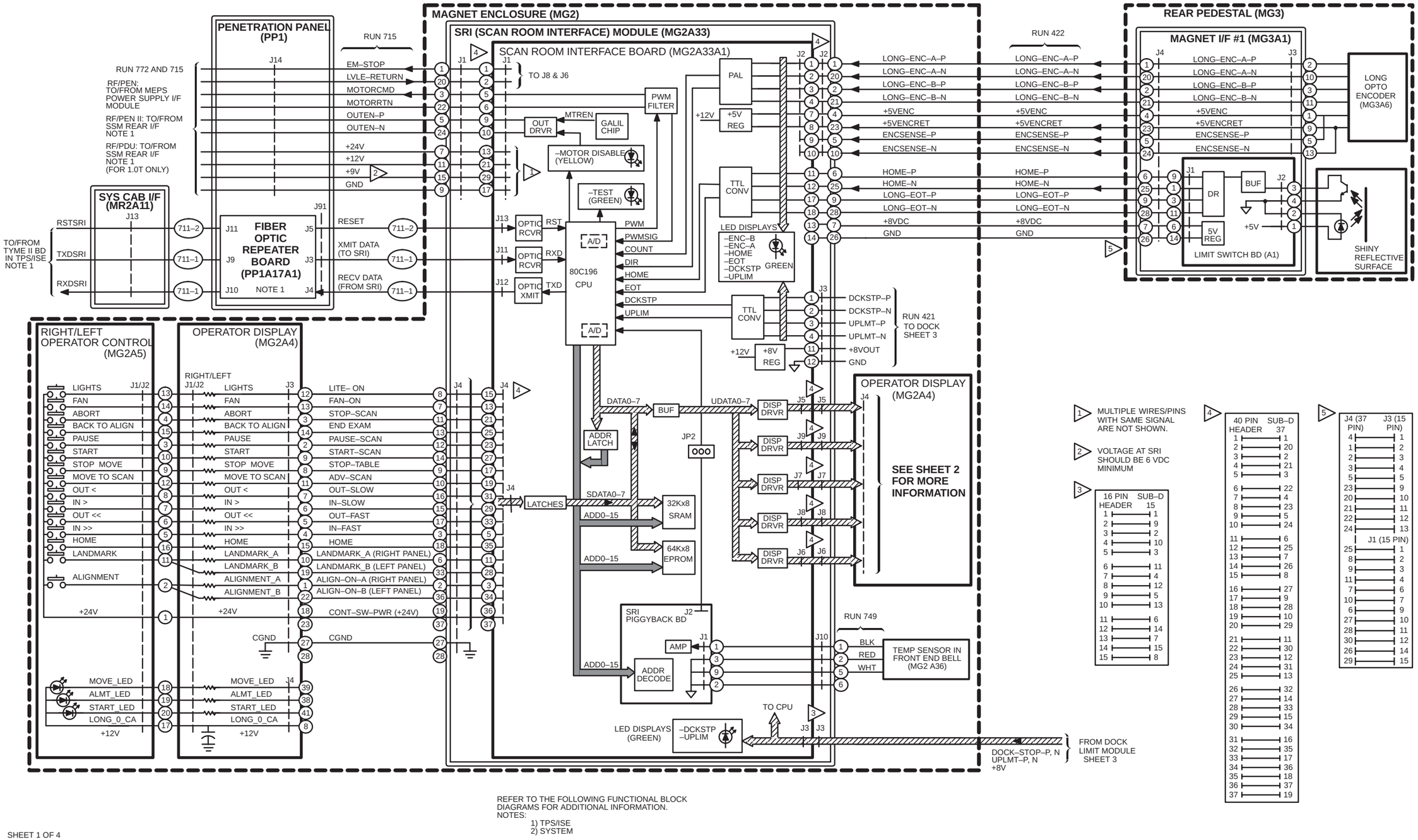
REFER TO THE FOLLOWING FUNCTIONAL BLOCK DIAGRAM FOR ADDITIONAL INFORMATION:

NOTE:
1) PATIENT HANDLING
2) TPS/ISE

OPERATOR WORKSPACE
(OPERATOR WORKSPACE CABINET/TABLE – OCTANE)
SHEET 1 OF 2

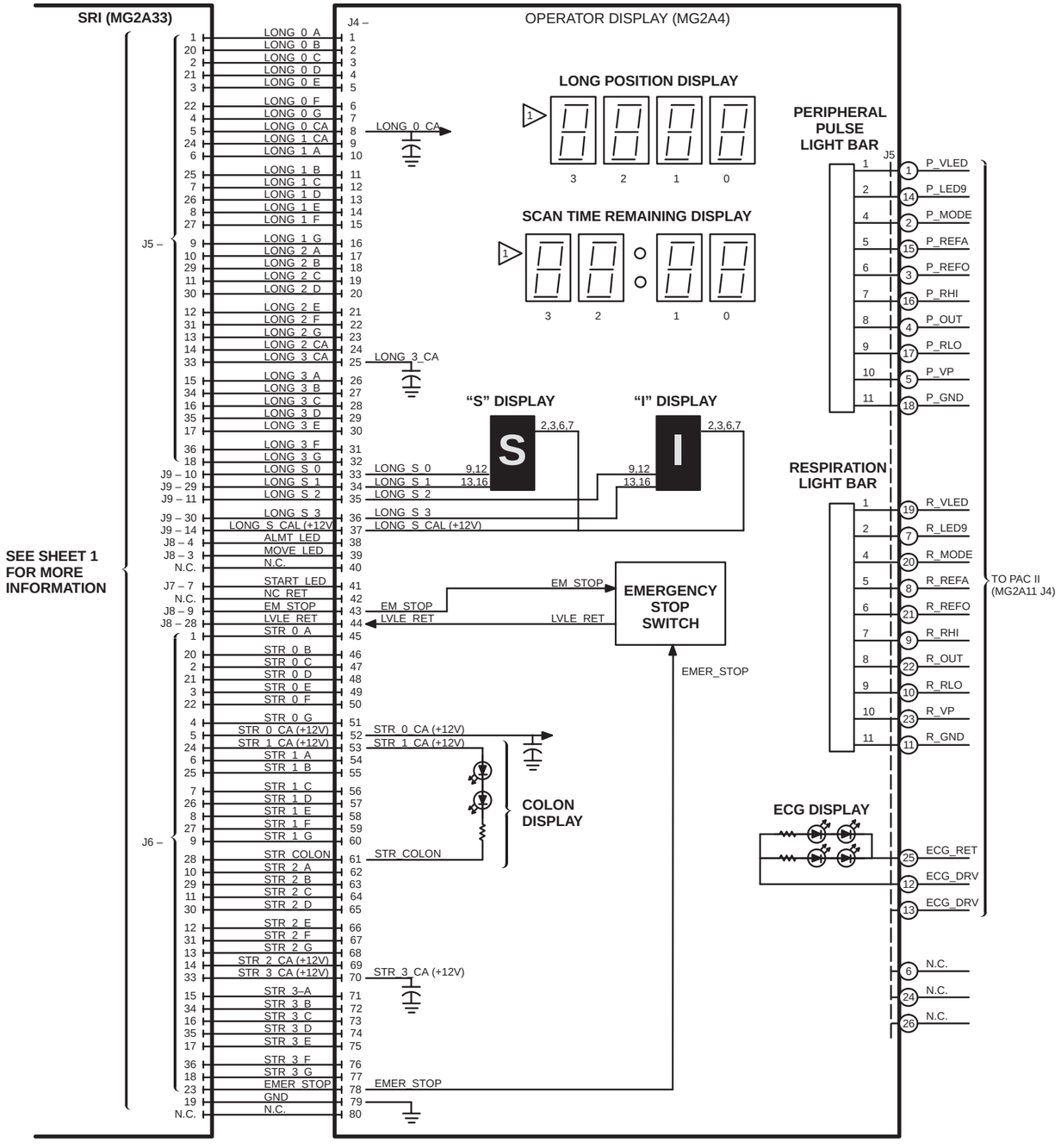


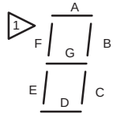
OPERATOR WORKSPACE
(OPERATOR WORKSPACE TABLE)
SHEET 2 OF 2



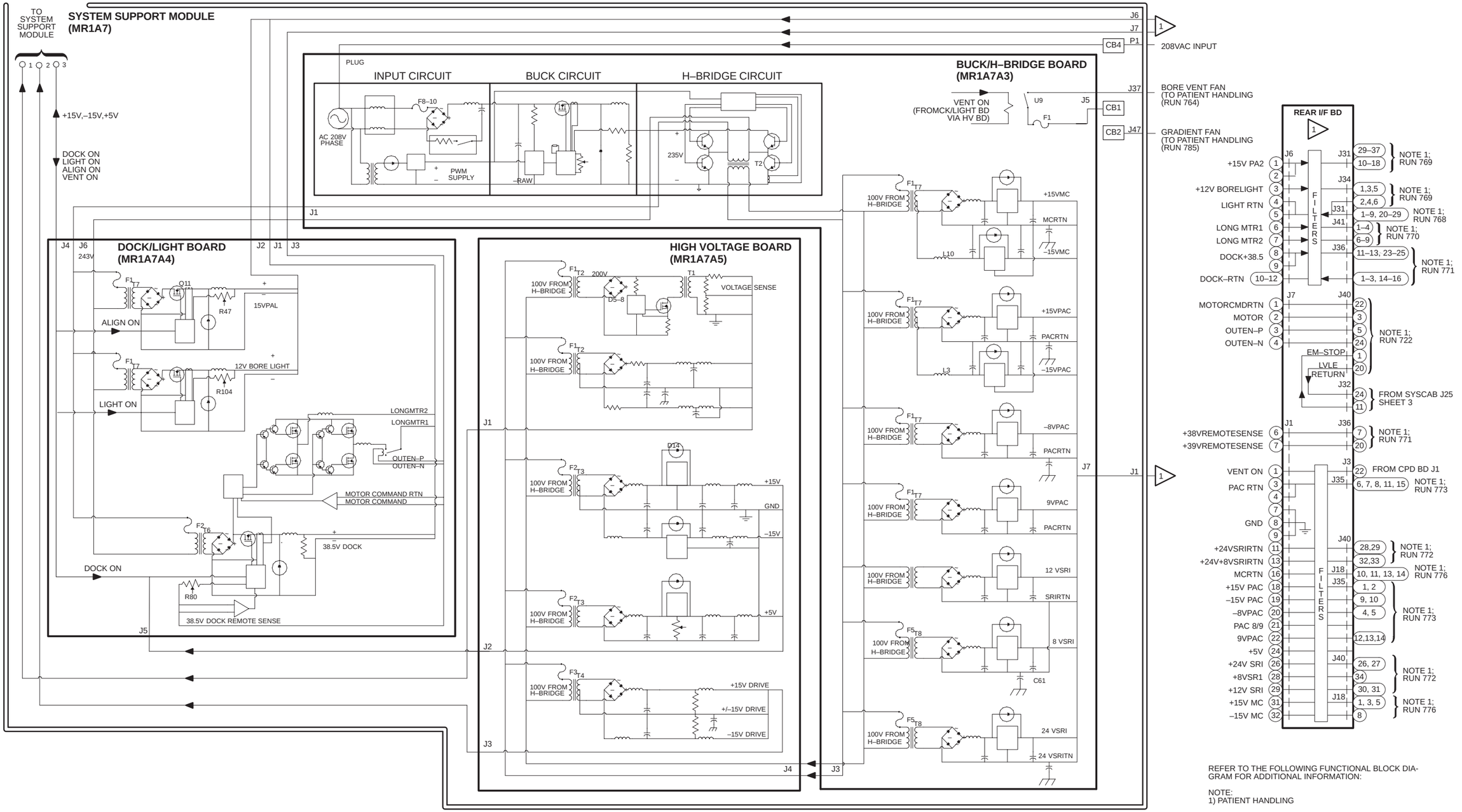
REFER TO THE FOLLOWING FUNCTIONAL BLOCK DIAGRAMS FOR ADDITIONAL INFORMATION.
NOTES:
1) TPS/ISE
2) SYSTEM

SHEET 1 OF 4


SRI (MG2A33)
OPERATOR DISPLAY (MG2A4)
SEE SHEET 1 FOR MORE INFORMATION
J4 –
J5 –
J6 –
J9 – 10
J9 – 29
J9 – 11
J9 – 30
J9 – 14
J8 – 4
J8 – 3
N.C.
J7 – 7
N.C.
J8 – 9
J8 – 28
LONG_0_A
LONG_0_B
LONG_0_C
LONG_0_D
LONG_0_E
LONG_0_F
LONG_0_G
LONG_0_CA
LONG_1_CA
LONG_1_A
LONG_1_B
LONG_1_C
LONG_1_D
LONG_1_E
LONG_1_F
LONG_1_G
LONG_2_A
LONG_2_B
LONG_2_C
LONG_2_D
LONG_2_E
LONG_2_F
LONG_2_G
LONG_2_CA
LONG_3_CA
LONG_3_A
LONG_3_B
LONG_3_C
LONG_3_D
LONG_3_E
LONG_3_F
LONG_3_G
LONG_S_0
LONG_S_1
LONG_S_2
LONG_S_3
LONG_S_CAL (+12V)
ALMT_LED
MOVE_LED
N.C.
START_LED
NC_RET
EM_STOP
LVLE_RET
STR_0_A
STR_0_B
STR_0_C
STR_0_D
STR_0_E
STR_0_F
STR_0_G
STR_0_CA (+12V)
STR_1_CA (+12V)
STR_1_A
STR_1_B
STR_1_C
STR_1_D
STR_1_E
STR_1_F
STR_1_G
STR_COLON
STR_2_A
STR_2_B
STR_2_C
STR_2_D
STR_2_E
STR_2_F
STR_2_G
STR_2_CA (+12V)
STR_3_CA (+12V)
STR_3–A
STR_3_B
STR_3_C
STR_3_D
STR_3_E
STR_3_F
STR_3_G
EMER_STOP
GND
N.C.
LONG_0_CA
LONG_3_CA
LONG POSITION DISPLAY
SCAN TIME REMAINING DISPLAY
3 2 1 0
“S” DISPLAY
“I” DISPLAY
S
I
2,3,6,7
9,12
13,16
LONG_S_0
LONG_S_1
LONG_S_2
LONG_S_3
LONG_S_CAL (+12V)
EM_STOP
LVLE_RET
EMERGENCY STOP SWITCH
EMER_STOP
STR_0_CA (+12V)
STR_1_CA (+12V)
STR_COLON
COLON DISPLAY
STR_3_CA (+12V)
EMER_STOP
PERIPHERAL PULSE LIGHT BAR
P_VLED
P_LED9
P_MODE
P_REFA
P_REFO
P_RHI
P_OUT
P_RLO
P_VP
P_GND
RESPIRATION LIGHT BAR
R_VLED
R_LED9
R_MODE
R_REFA
R_REFO
R_RHI
R_OUT
R_RLO
R_VP
R_GND
ECG DISPLAY
ECG_RET
ECG_DRV
ECG_DRV
N.C.
N.C.
N.C.
TO PAC II (MG2A11 J4)


A
F
G
B
E
D
C

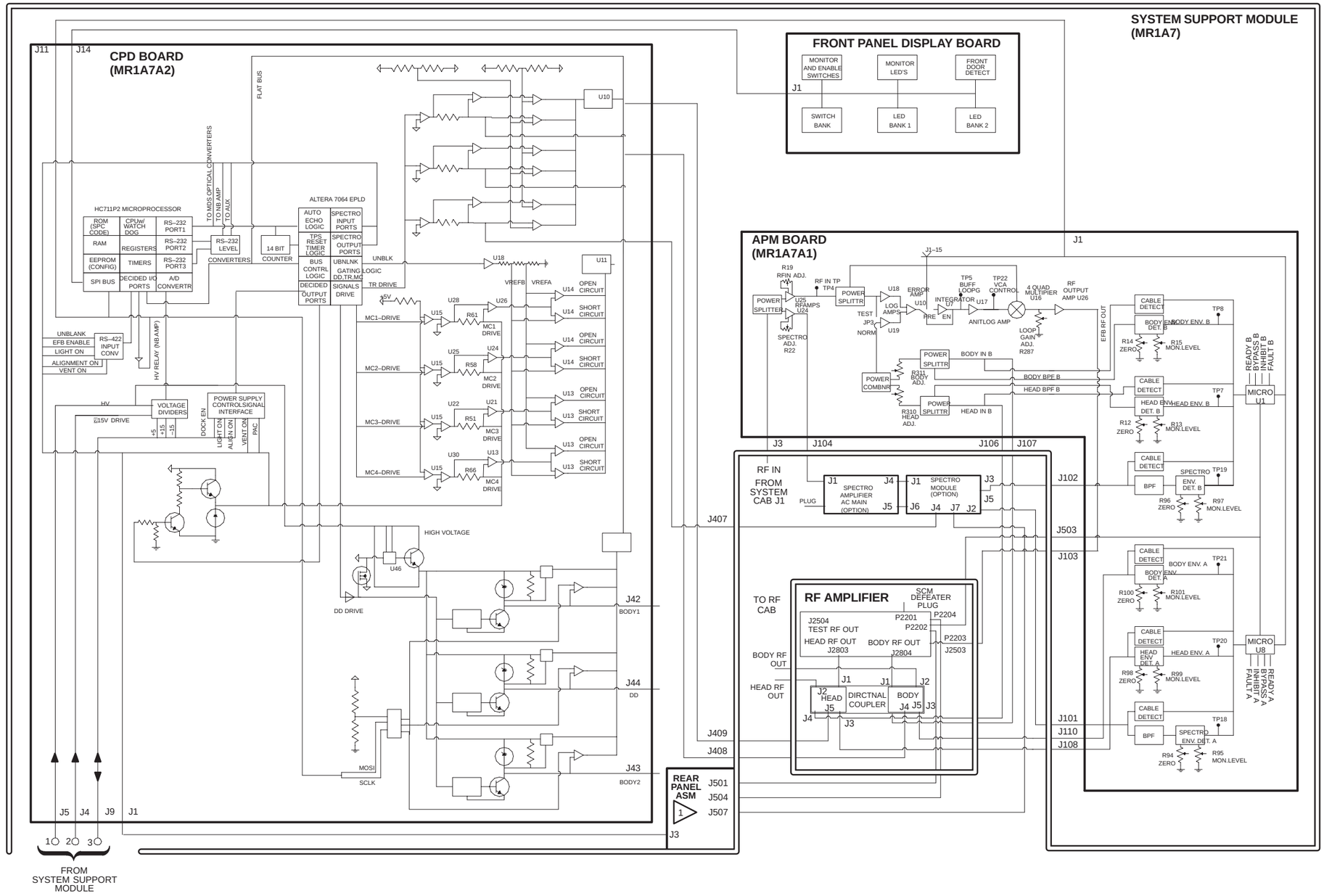
SHEET 2 OF 4



REFER TO THE FOLLOWING FUNCTIONAL BLOCK DIAGRAM FOR ADDITIONAL INFORMATION:

NOTE:
1) PATIENT HANDLING

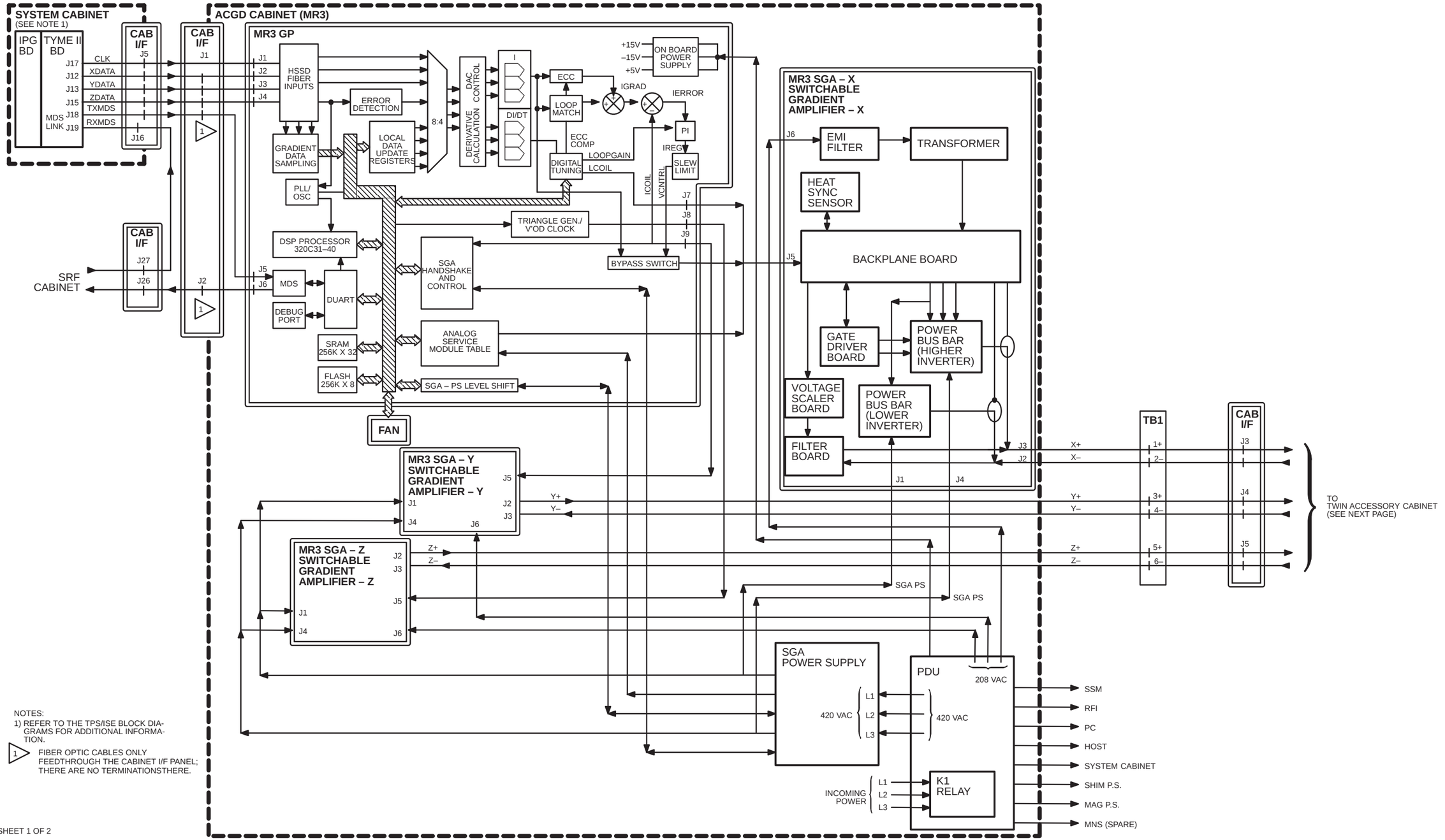
SHEET 3 OF 4



REFER TO THE FOLLOWING FUNCTIONAL BLOCK DIAGRAM FOR ADDITIONAL INFORMATION:

NOTE:
1) GRADIENT

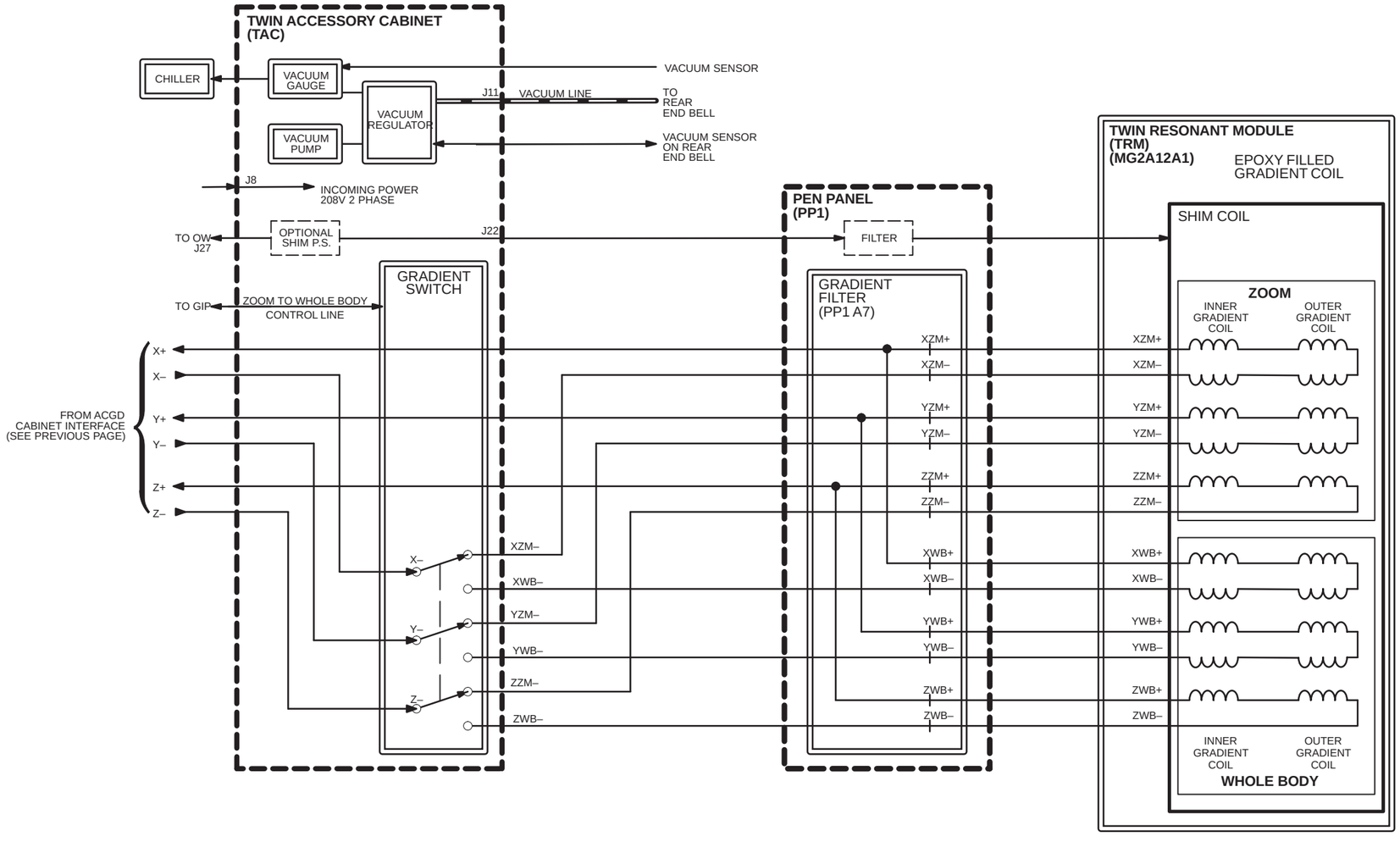
SHEET 4 OF 4



NOTES:
1) REFER TO THE TPS/ISE BLOCK DIAGRAMS FOR ADDITIONAL INFORMATION.

1 FIBER OPTIC CABLES ONLY FEEDTHROUGH THE CABINET I/F PANEL; THERE ARE NO TERMINATIONSTHERE.

SHEET 1 OF 2


TWIN ACCESSORY CABINET (TAC)
CHILLER
VACUUM GAUGE
VACUUM PUMP
VACUUM REGULATOR
VACUUM SENSOR
J11
VACUUM LINE
TO REAR END BELL
VACUUM SENSOR ON REAR END BELL
J8
INCOMING POWER 208V 2 PHASE
TO OW J27
OPTIONAL SHIM P.S.
J22
GRADIENT SWITCH
TO GIP
ZOOM TO WHOLE BODY CONTROL LINE
FROM ACGD CABINET INTERFACE (SEE PREVIOUS PAGE)
X+
X–
Y+
Y–
Z+
Z–
PEN PANEL (PP1)
FILTER
GRADIENT FILTER (PP1 A7)
XZM+
XZM–
YZM+
YZM–
ZZM+
ZZM–
XWB+
XWB–
YWB+
YWB–
ZWB+
ZWB–
TWIN RESONANT MODULE (TRM) (MG2A12A1)
EPOXY FILLED GRADIENT COIL
SHIM COIL
ZOOM
INNER GRADIENT COIL
OUTER GRADIENT COIL
WHOLE BODY

SHEET 2 OF 2

PDU

TABLE OF CONTENTS

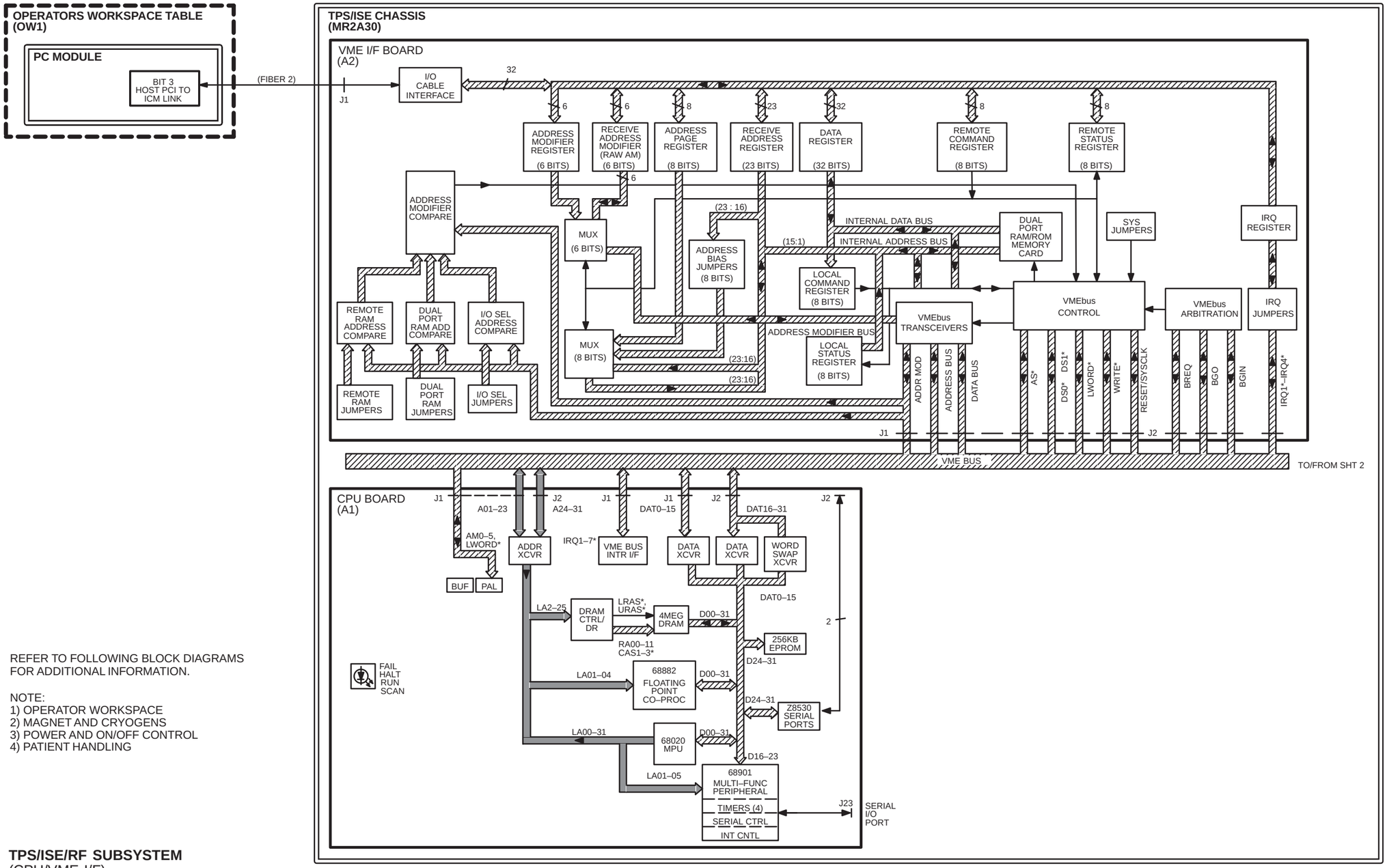
Note:

Phoenix PDU found in Vendor Manuals only. (SEE SERVICE METHODS CDROM)

TPS/ISE (1.5T)

TABLE OF CONTENTS

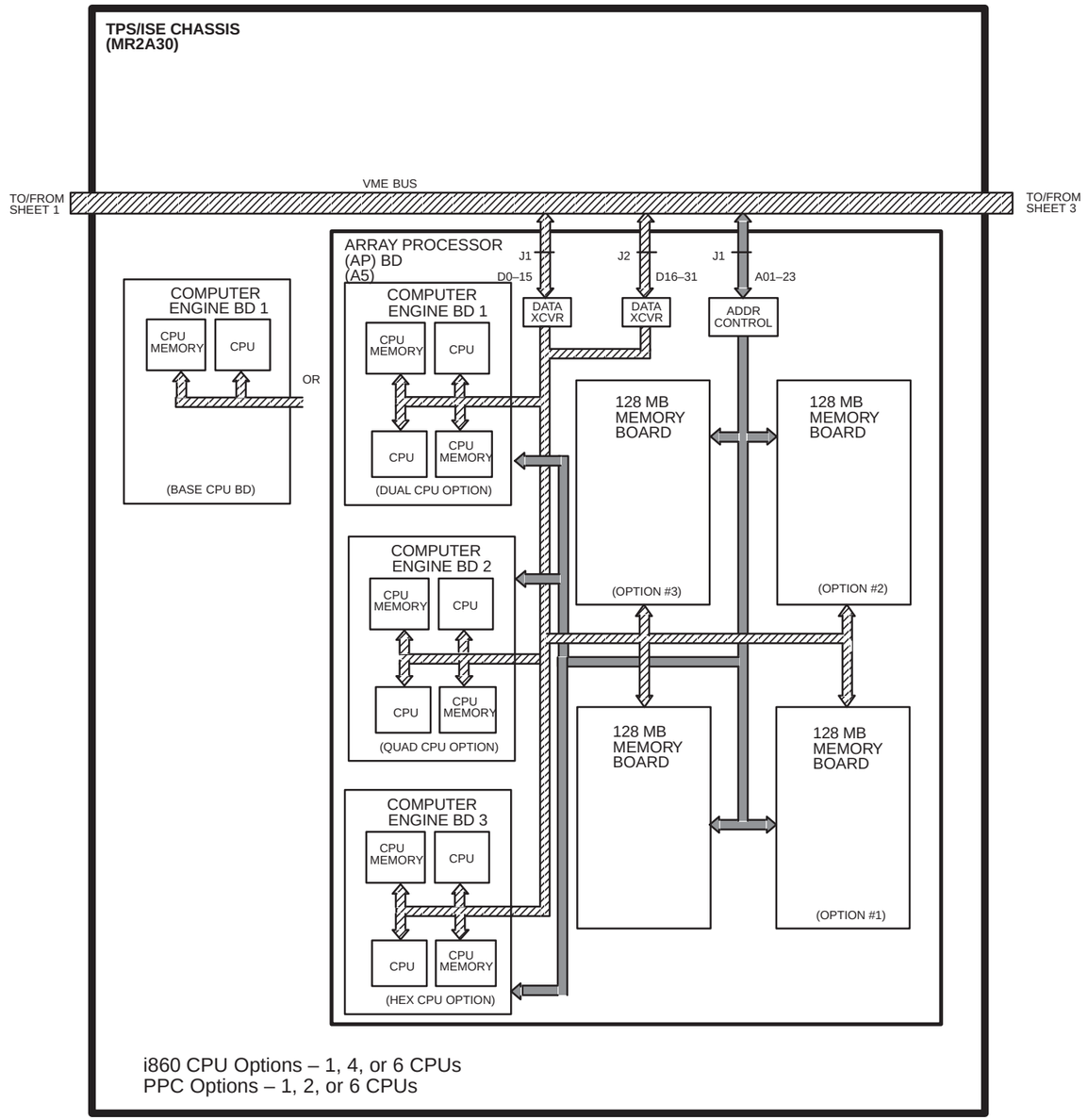
SECTION 1 – ISE/RF BLOCK DIAGRAMS (1.5T)



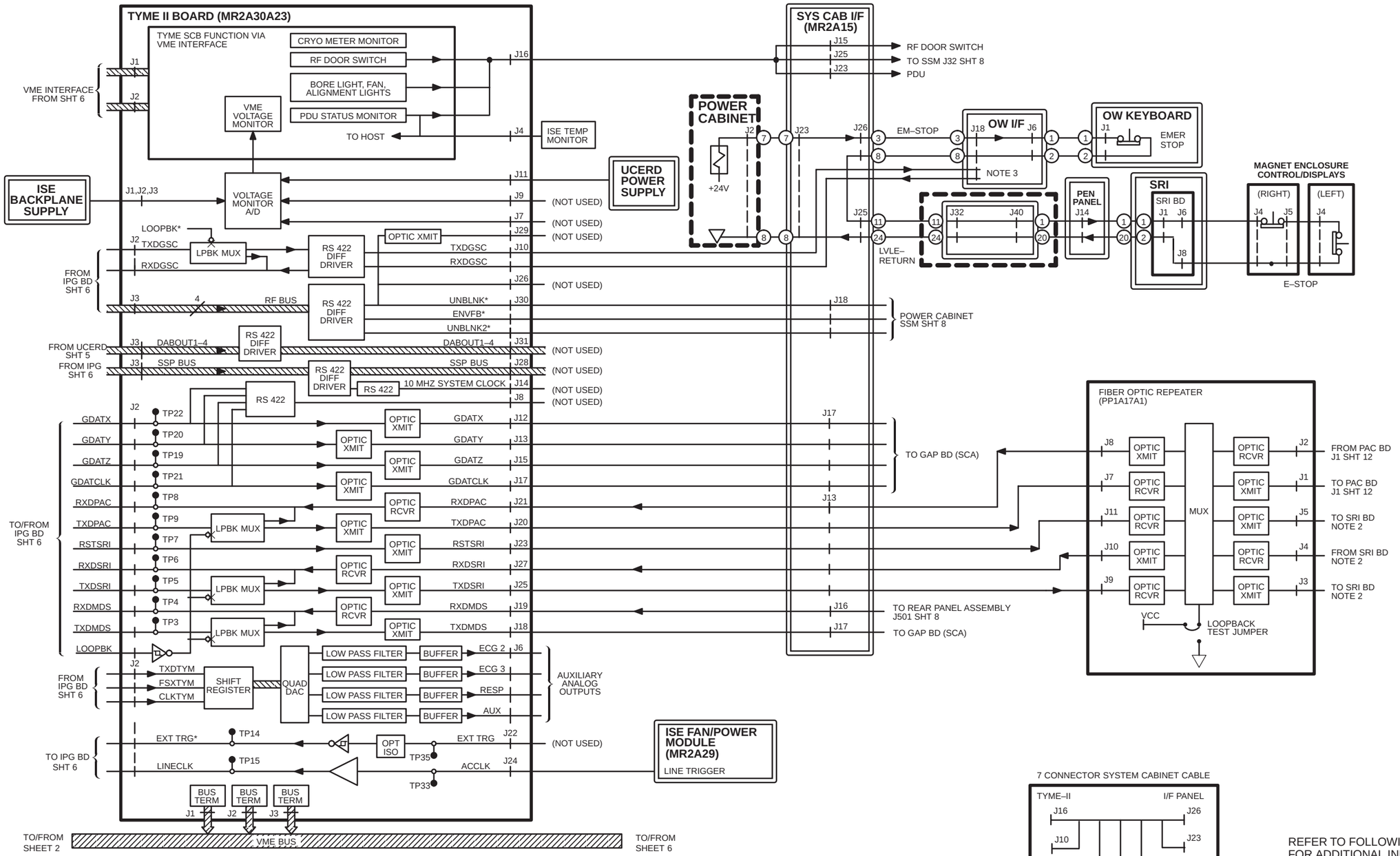
REFER TO FOLLOWING BLOCK DIAGRAMS FOR ADDITIONAL INFORMATION.

NOTE:
1) OPERATOR WORKSPACE
2) MAGNET AND CRYOGENS
3) POWER AND ON/OFF CONTROL
4) PATIENT HANDLING

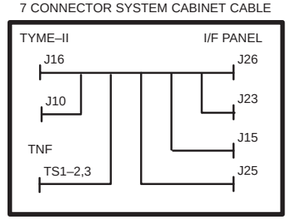
TPS/ISE/RF SUBSYSTEM
(CPU/VME I/F)
SHEET 1 OF 13



TPS/ISE/RF SUBSYSTEM
(AP)
SHEET 2 OF 13



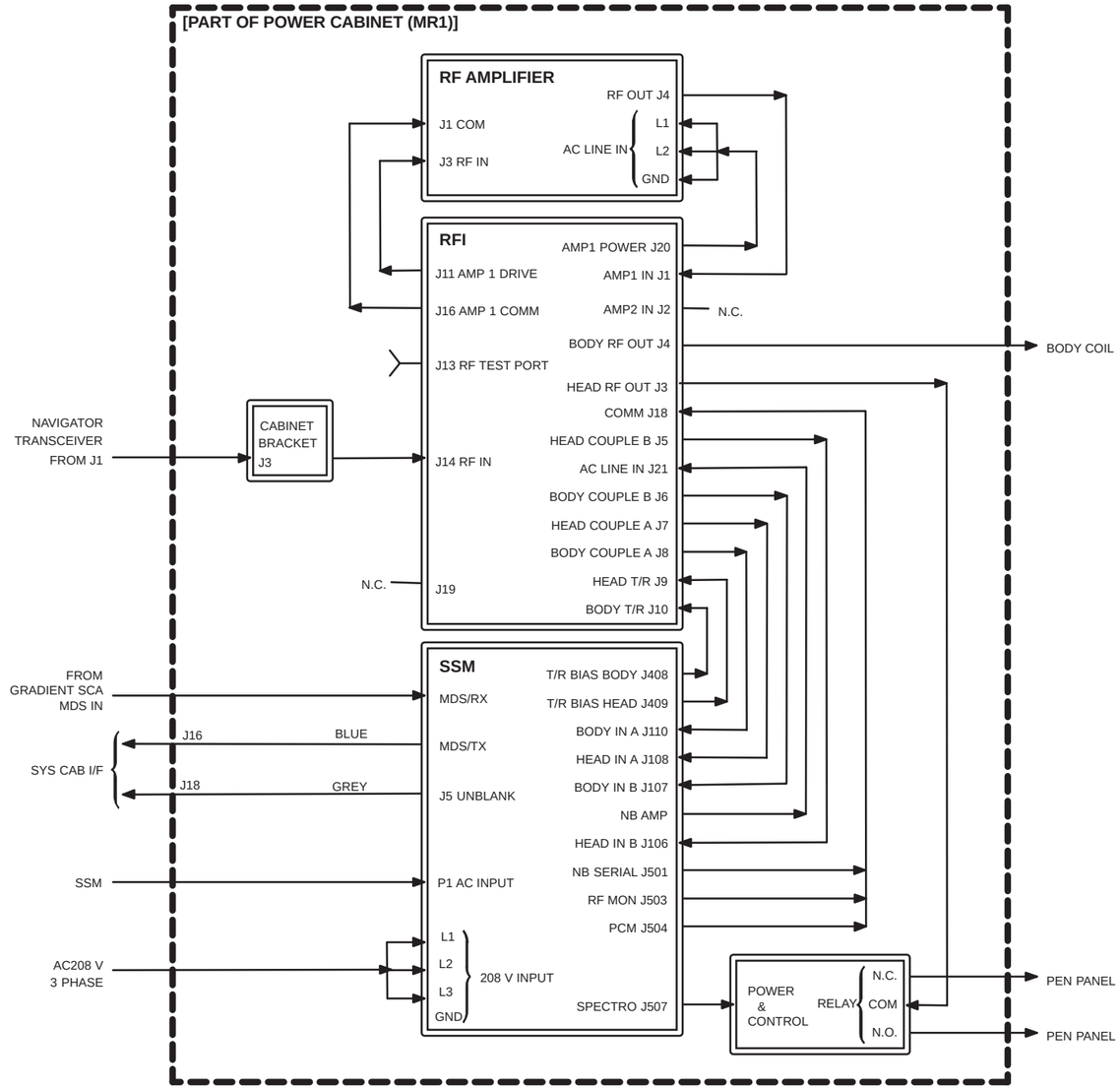
7 CONNECTOR SYSTEM CABINET CABLE



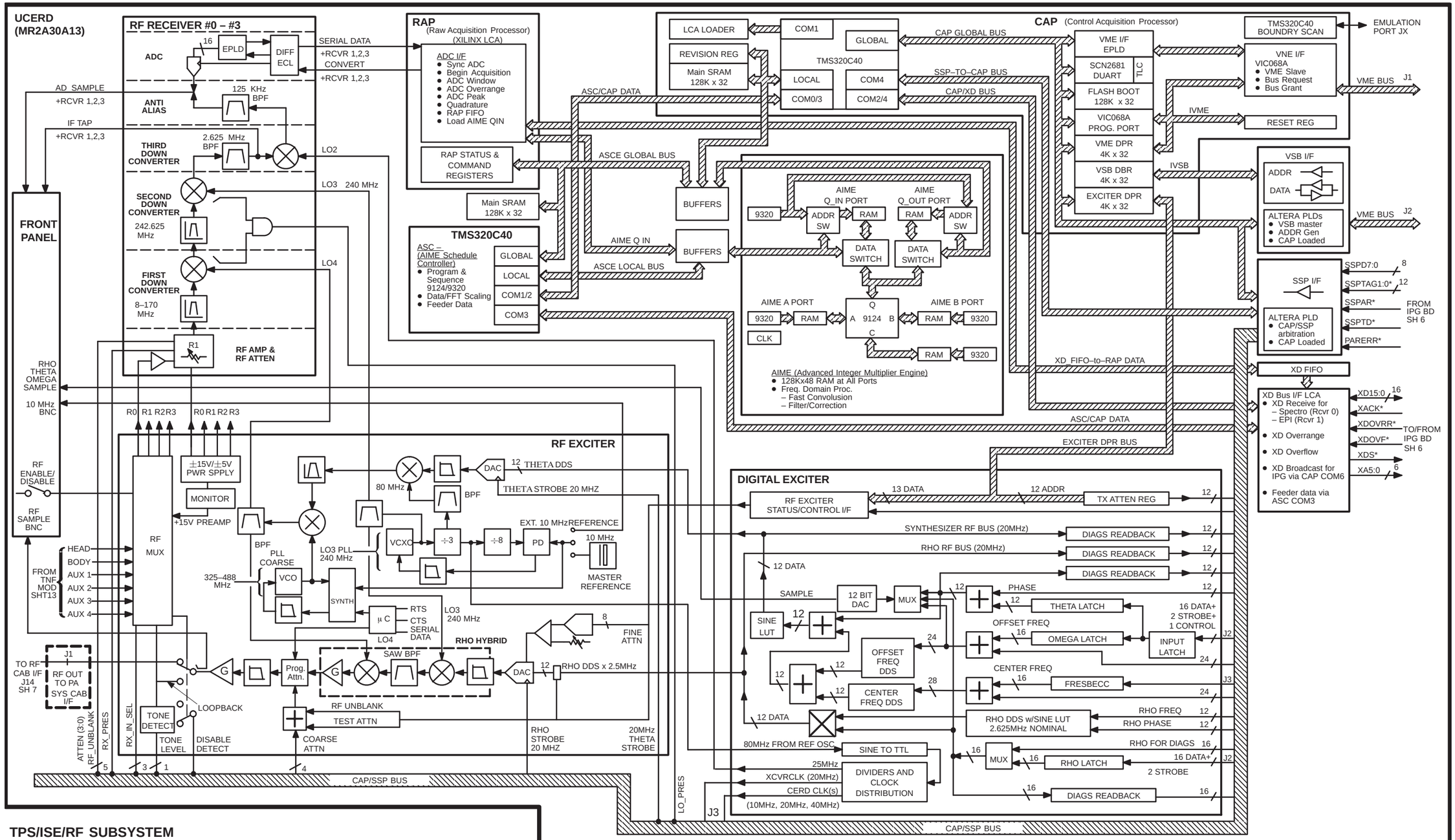
REFER TO FOLLOWING BLOCK DIAGRAMS FOR ADDITIONAL INFORMATION:

NOTE:
1) GRADIENT
2) PATIENT HANDLING
3) OPERATOR WORKSPACE

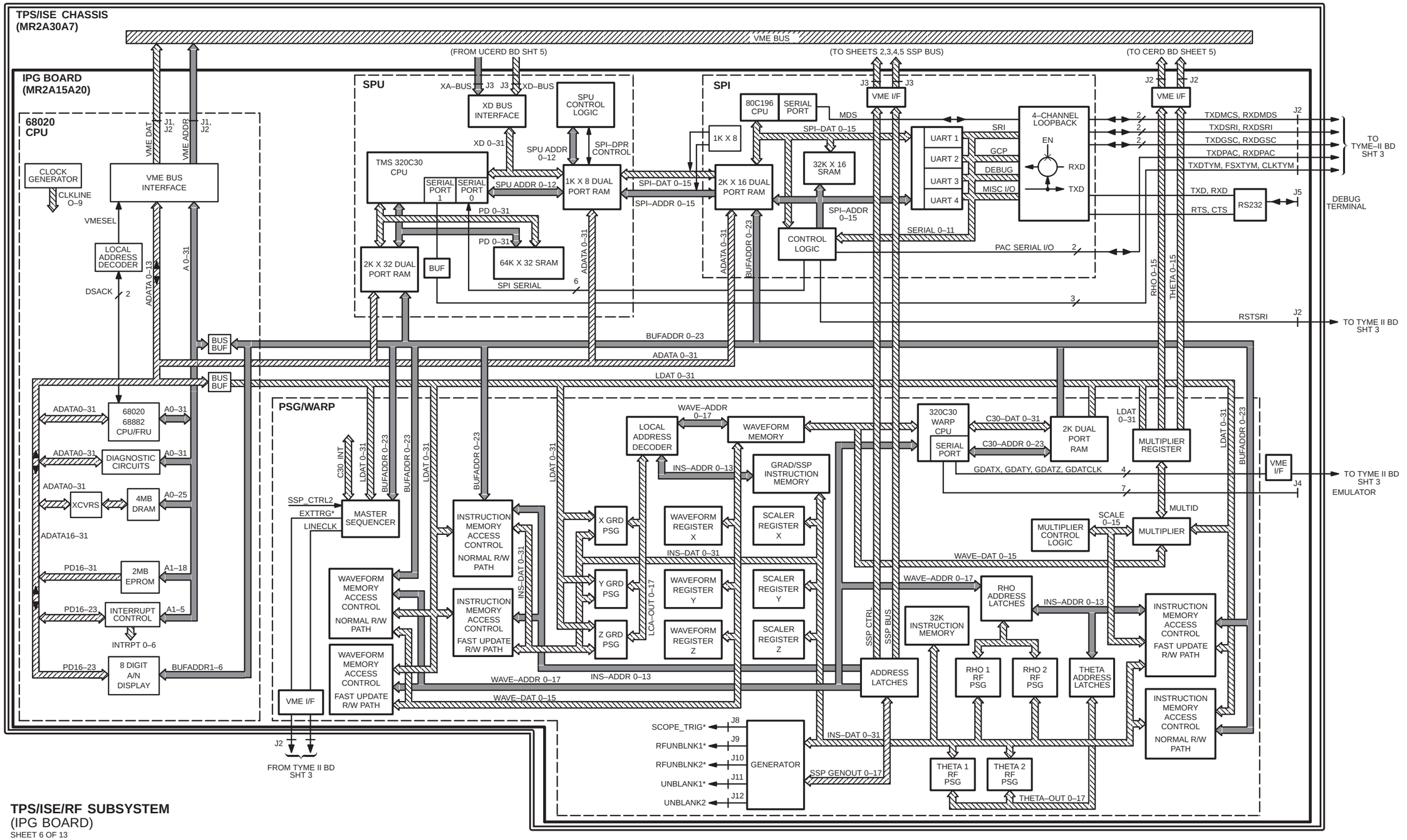
TPS/ISE/RF SUBSYSTEM
(TYME II)
SHEET 3 OF 13



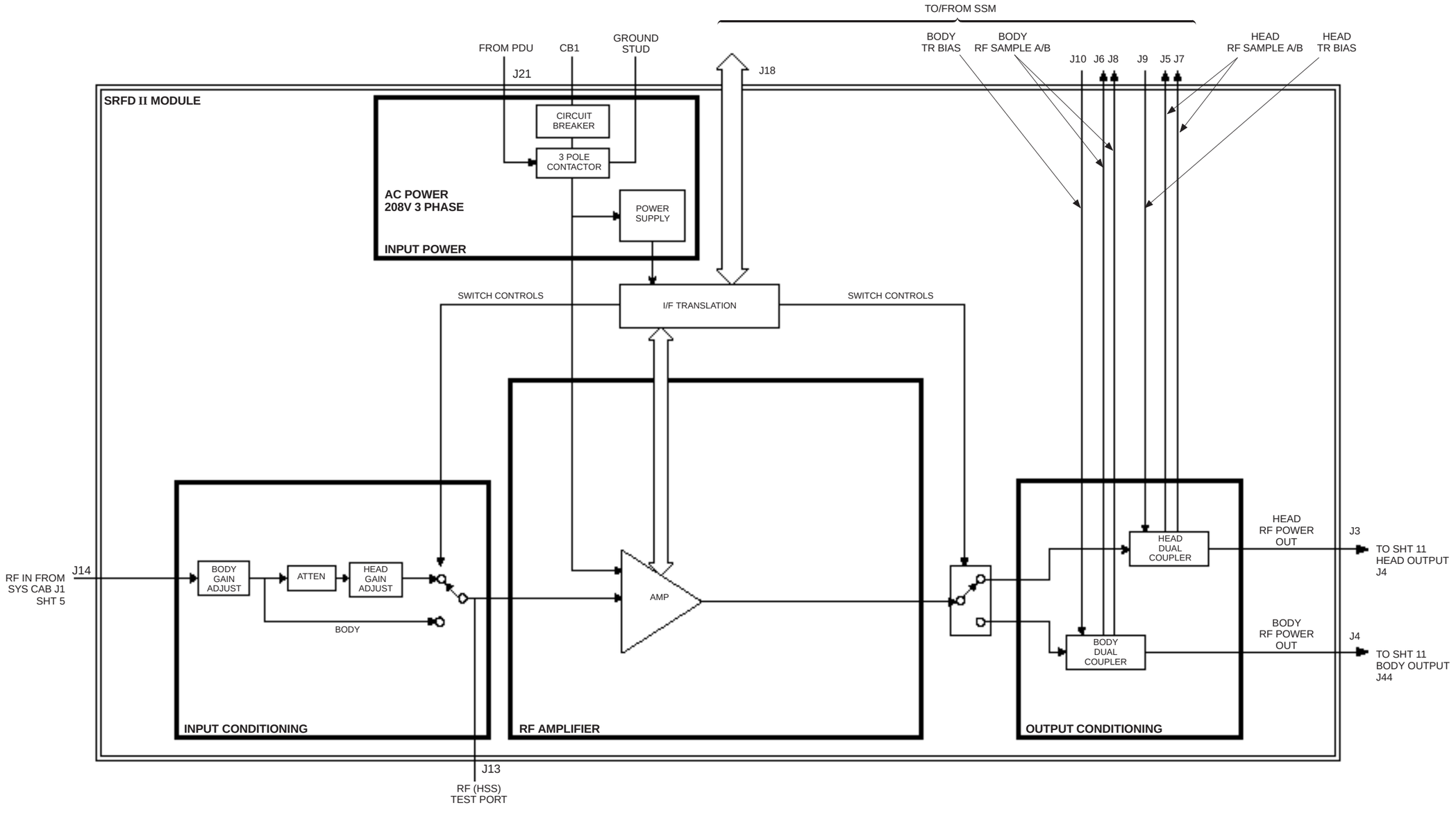
TPS/ISE/RF SUBSYSTEM
(RF SUBSYSTEM)
SHEET 4 OF 13



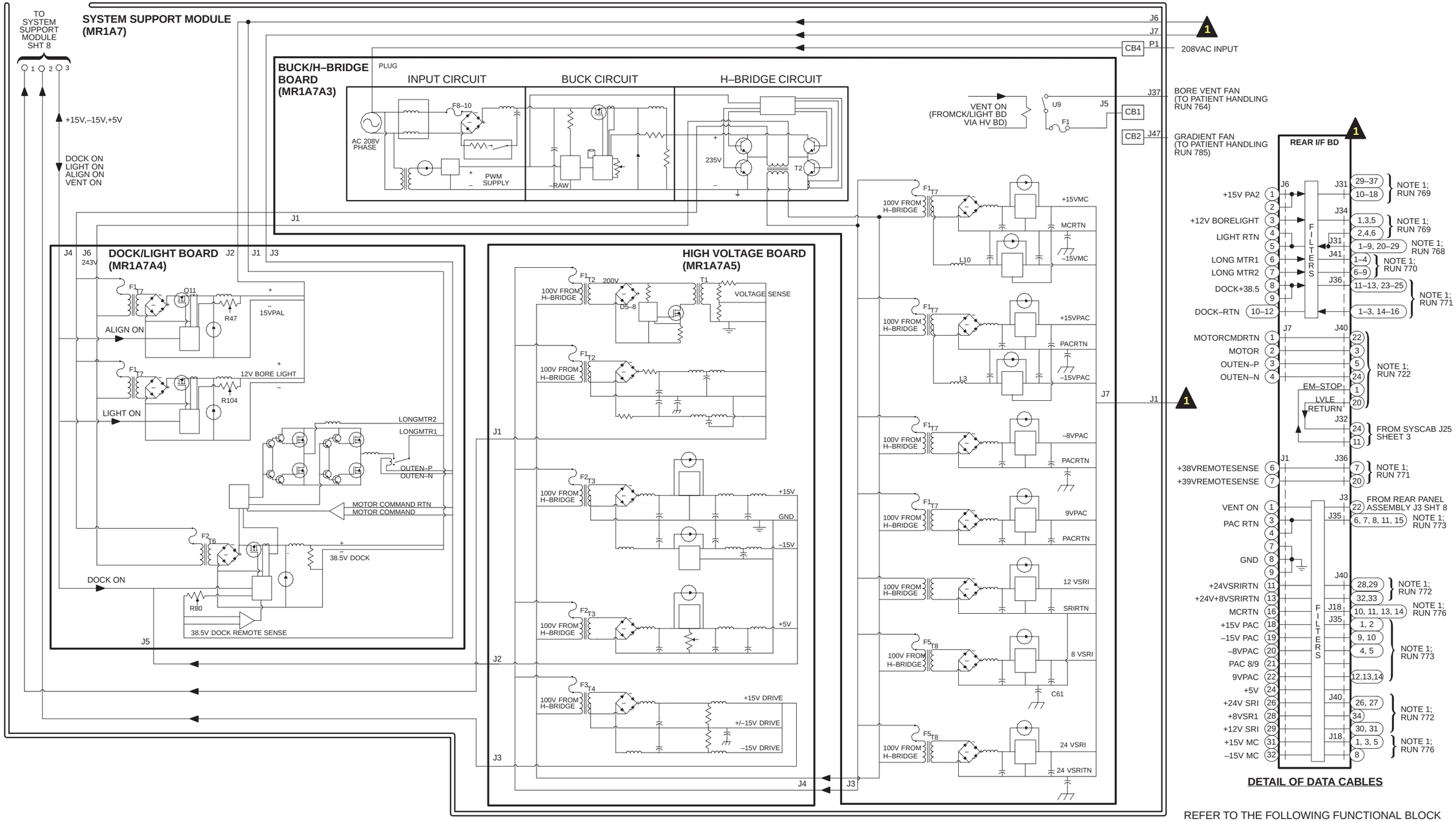
TPS/ISE/RF SUBSYSTEM
UNIVERSAL COMBINED EXCITER RECEIVER DAB (UCERD)
SHEET 5 OF 13



TPS/ISE/RF SUBSYSTEM
(IPG BOARD)
SHEET 6 OF 13



TPS/ISE/RF SUBSYSTEM
SRFD II CABINET – SRFD II RF AMPLIFIER
SHEET 7A OF 13

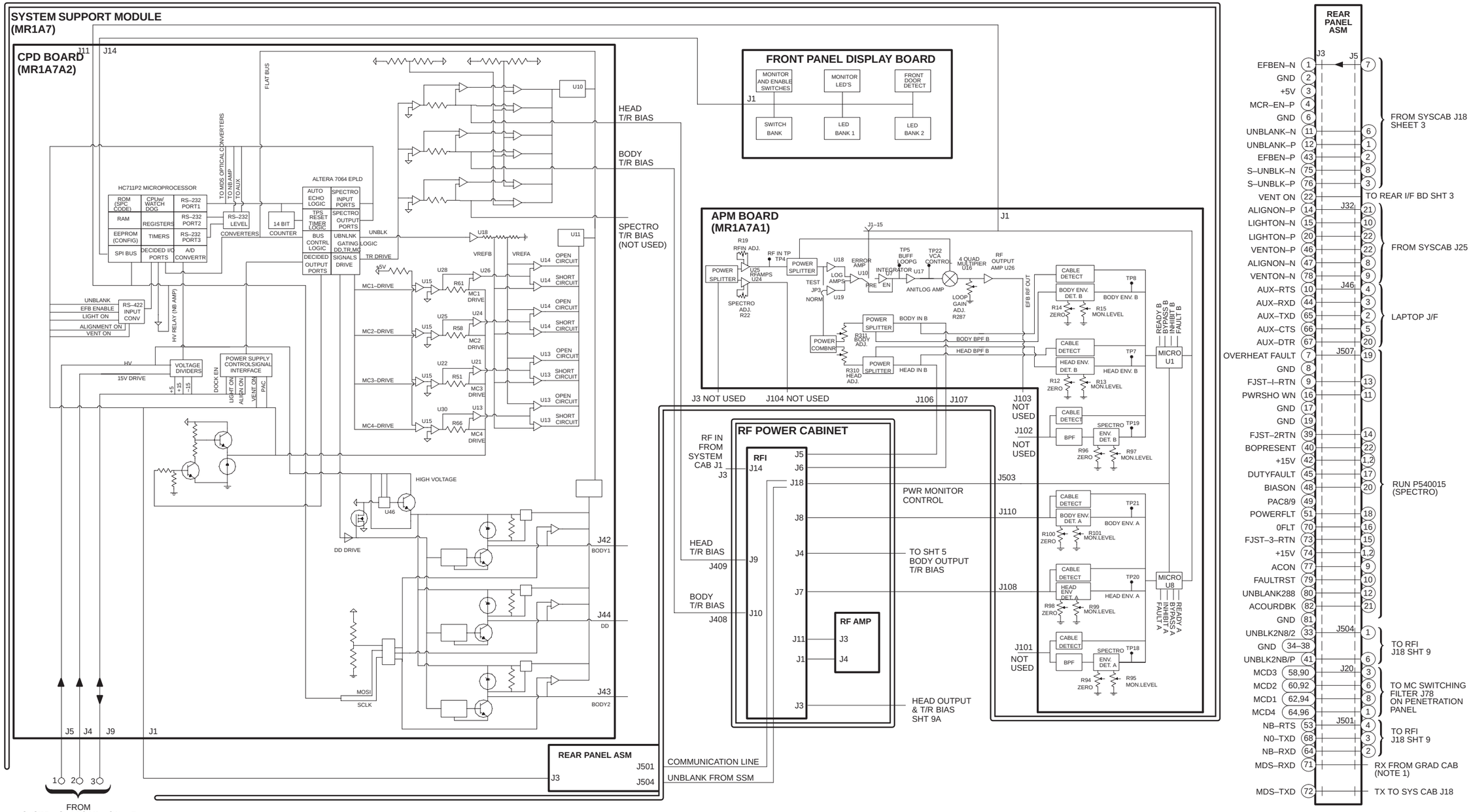


DETAIL OF DATA CABLES

TPS/ISE/RF SUBSYSTEM
(RF POWER CABINET – SYSTEM SUPPORT MODULE)
SHEET 7B OF 13

REFER TO THE FOLLOWING FUNCTIONAL BLOCK DIAGRAM FOR ADDITIONAL INFORMATION:

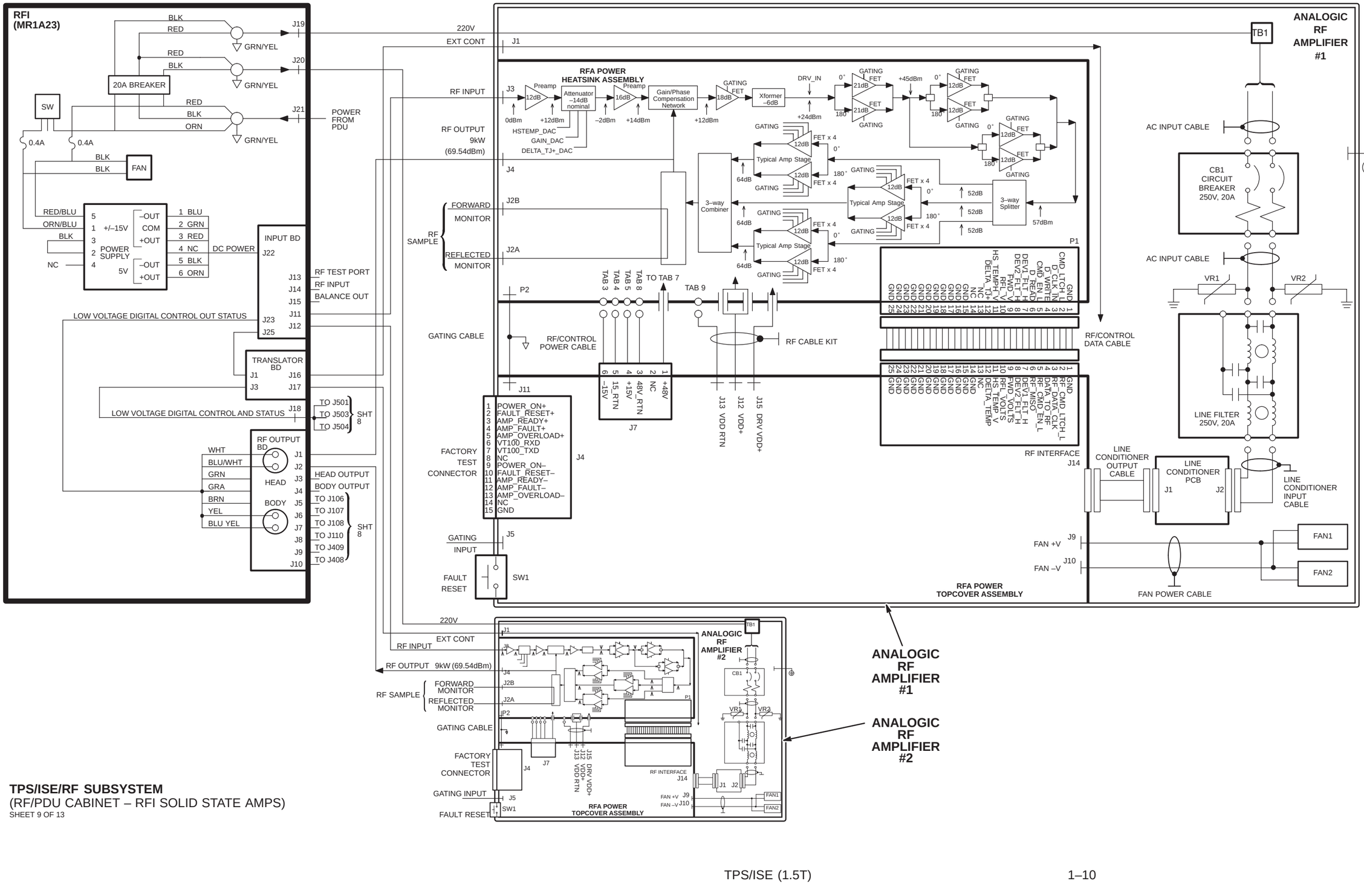
NOTE:
1) PATIENT HANDLING



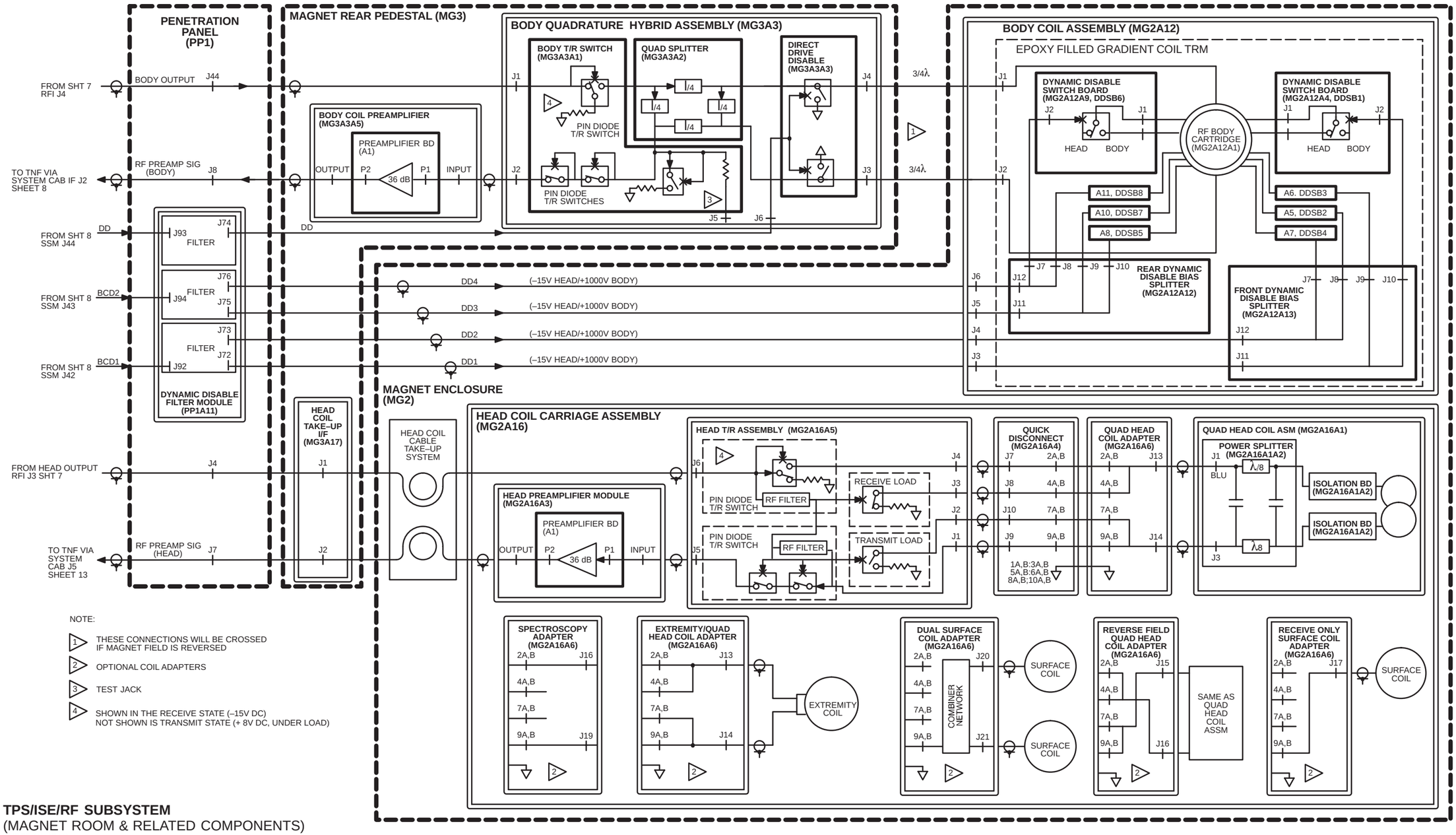
TPS/ISE/RF SUBSYSTEM
(RF POWER CABINET – SYSTEM SUPPORT MODULE)
SHEET 8 OF 13

REFER TO THE FOLLOWING FUNCTIONAL BLOCK DIAGRAM FOR ADDITIONAL INFORMATION:

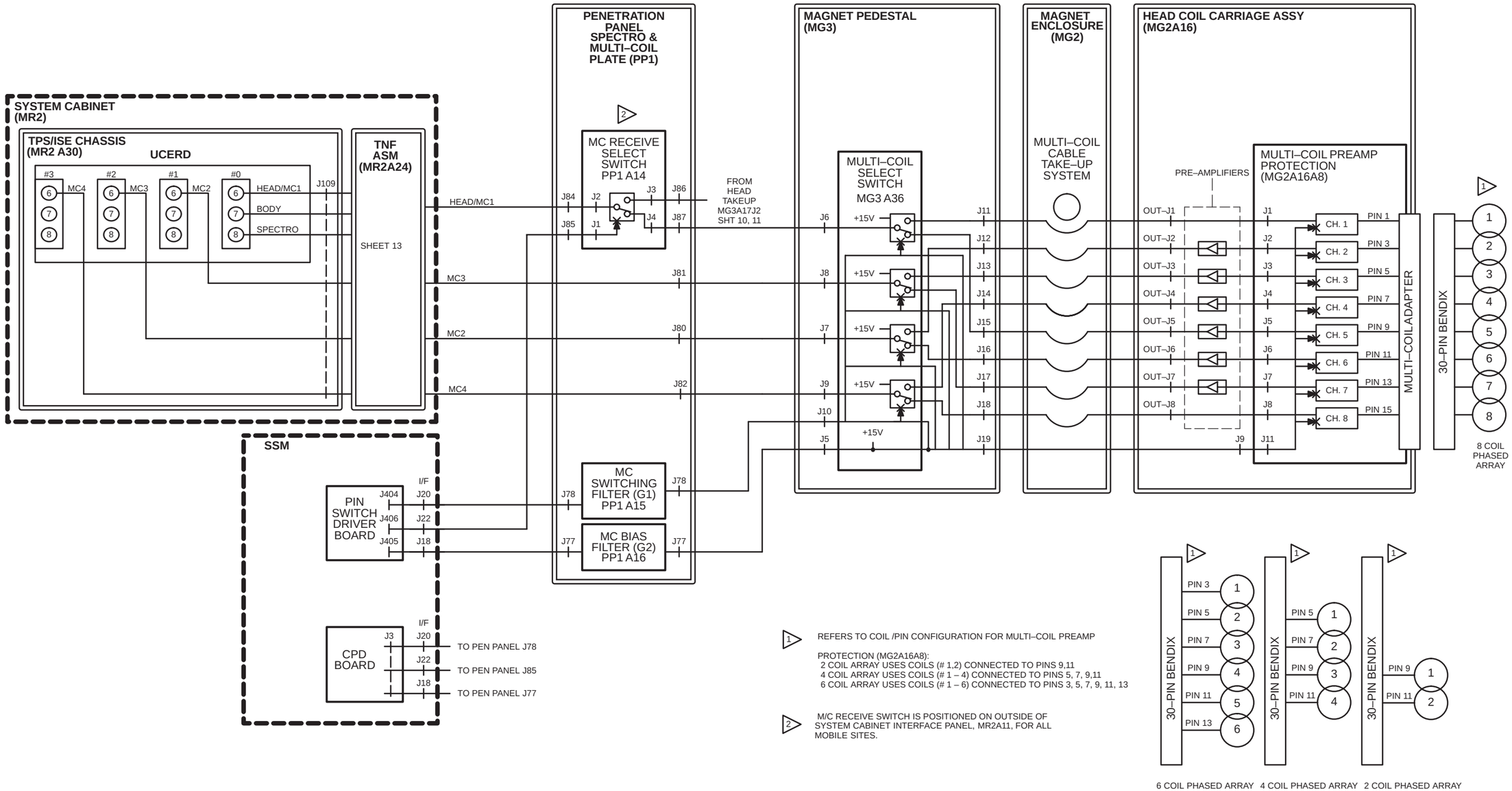
NOTE:
1) GRADIENT



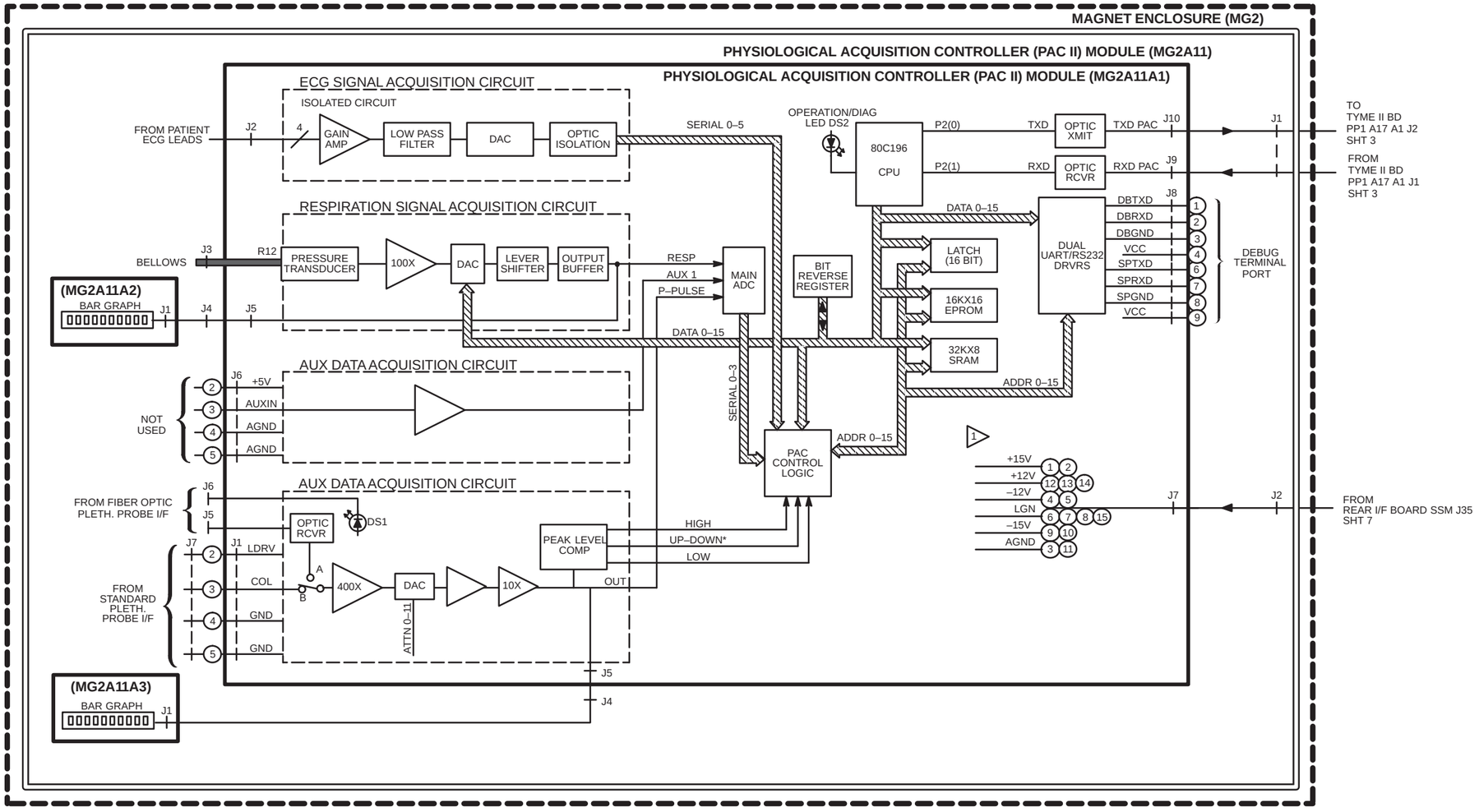
TPS/ISE/RF SUBSYSTEM
(RF/PDU CABINET – RFI SOLID STATE AMPS)
SHEET 9 OF 13



TPS/ISE/RF SUBSYSTEM
(MAGNET ROOM & RELATED COMPONENTS)
SHEET 10 OF 13

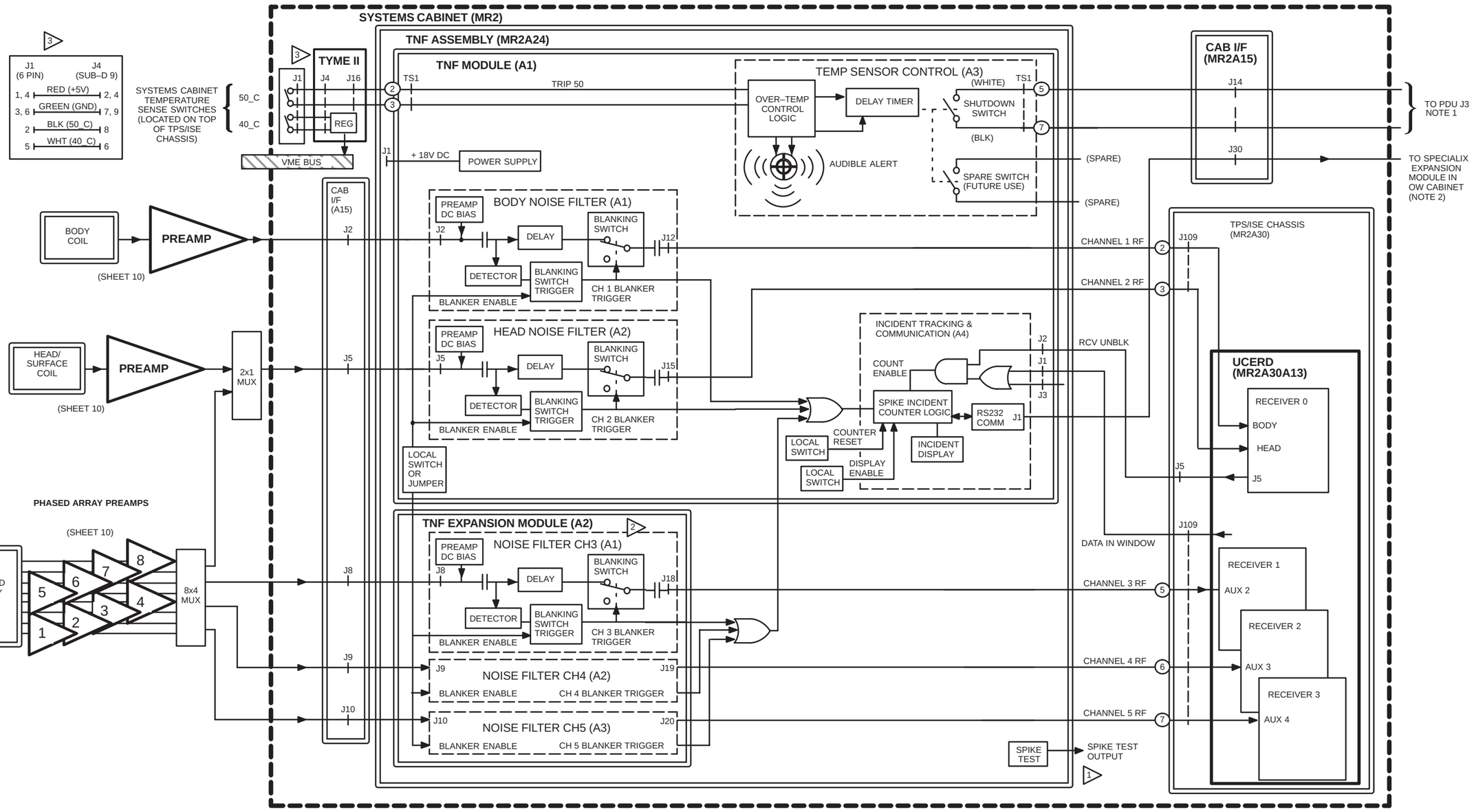


TPS/ISE/RF SUBSYSTEM
(MULTI–COIL MODULES)
SHEET 11 OF 13



TPS/ISE/RF SUBSYSTEM
(PHYSIOLOGICAL ACQUISITION CONTROLLER II)
SHEET 12 OF 13

1 MULTIPLE WIRES/PINS WITH SAME SIGNAL ARE NOT SHOWN



TPS/ISE/RF SUBSYSTEM
(TRANSIENT NOISE FILTER)
SHEET 13 of 13

REFER TO THE FOLLOWING FUNCTIONAL BLOCK DIAGRAM FOR ADDITIONAL INFORMATION.

NOTE:
1) PDU, COMPACT PDU
2) OPERATOR WORKSPACE

1 CONNECT TO ANY DESIRED CHANNEL INPUT VIA COAX FOR TEST PERIOD ONLY

2 HARDWARE PRESENT ONLY WITH PHASED ARRAY OPTION.

DRAWING NO. 46-264288-S SHT NO. 1 CONT ON SHEET 2

UNLESS OTHERWISE SPECIFIED USE THE FOLLOWING:-

APPLIED PRACTICES
46-208600

REV AH
46-264288-S
CONT ON SHEET 2 SHT NO. 1

TITLE
SCHEMATIC DIAGRAM
DUAL DIRECTIONAL COUPLER
FIRST MADE FOR MRDDAMP

46-264288-S
CONT ON SHEET 2 SHT NO 1

46-264288G1-D

MR1A6 A1

RF BODY IN — J1

C20 0.15 — C21 0.15 — C22 0.15 — C23 0.15

J3 — RF BODY OUT

L29 2.7UH

J11 — BODY T/R BIAS

C28 .01

AT30 50 10W

AT19 PA 3DB 20W

NOMINAL -61DB COUPLING

C17 390PF — R18 7.5 400MW — R16 7.5 400MW — R15 47 800MW

FBK — J10

P1 — 1 — S U14 POWER COMBINER P2 — 2,3,4,7,8 — 5 — 6

R13 47 800MW

C11 390PF — R12 7.5 400MW — R10 7.5 400MW

NOMINAL -52DB COUPLING

AT9 PA 3DB 20W

AT25 50 10W

C27 .01

J12 — HEAD T/R BIAS

L26 2.7UH

J4 — RF HEAD OUT

C5 0.15 — C6 0.15 — C7 0.15 — C8 0.15

RF HEAD IN — J2

THE REVISION NUMBER OF THIS SHEET IS THE CONTROL NUMBER OF THIS ENTIRE DOCUMENT. THIS REVISION NUMBER MUST INCREASE WHENEVER ANY SHEET IS CHANGED. THE CHANGE MUST BE RECORDED IN THE FORM BELOW.

PCN#	-------	158051	158445	171514	171706	171687	-------
DATE / SHT	-------	12MAY89	13MAR90	21FEB91	02MAY91	08MAY91	-------
2	AA	AB	AC	AD	AE	AF	-

NOTES:
1. UNLESS OTHERWISE SPECIFIED:
ALL RESISTORS ARE 0.25W, 5%
AND ARE IN OHMS.

REVISIONS				PRINTS TO	
AD	FEP 16MAY89	AG	FEP 2MAY91	740	
PCN 158051		PCN 171706			
AE	DLW 13MAR90	AH	FEP 8MAY91		
PCN 158445		PCN 171687			
AF	DPB 21FEB91	NR	DLW 30JAN89		
PCN 171514		ADDED G2			

MADE BY C.LUEBBE 4AUG87
ISSUED R.BECERRA 14OCT87
APPROVALS RCR 15OCT87
DIV OR DEPT MEDICAL SYSTEMS
LOCATION MILWAUKEE, WI.
46-264288-S
CONT ON SHEET 2 SHT NO. 1

46-264288-S

DRAWING NO. 46-264288-S CONT ON SHEET - SHT NO. 2

UNLESS OTHERWISE SPECIFIED USE THE FOLLOWING:-

APPLIED PRACTICES 46-208600

REV AF

46-264288-S

CONT ON SHEET - SHT NO. 2

TITLE

SCHEMATIC DIAGRAM
DUAL DIRECTIONAL COUPLER

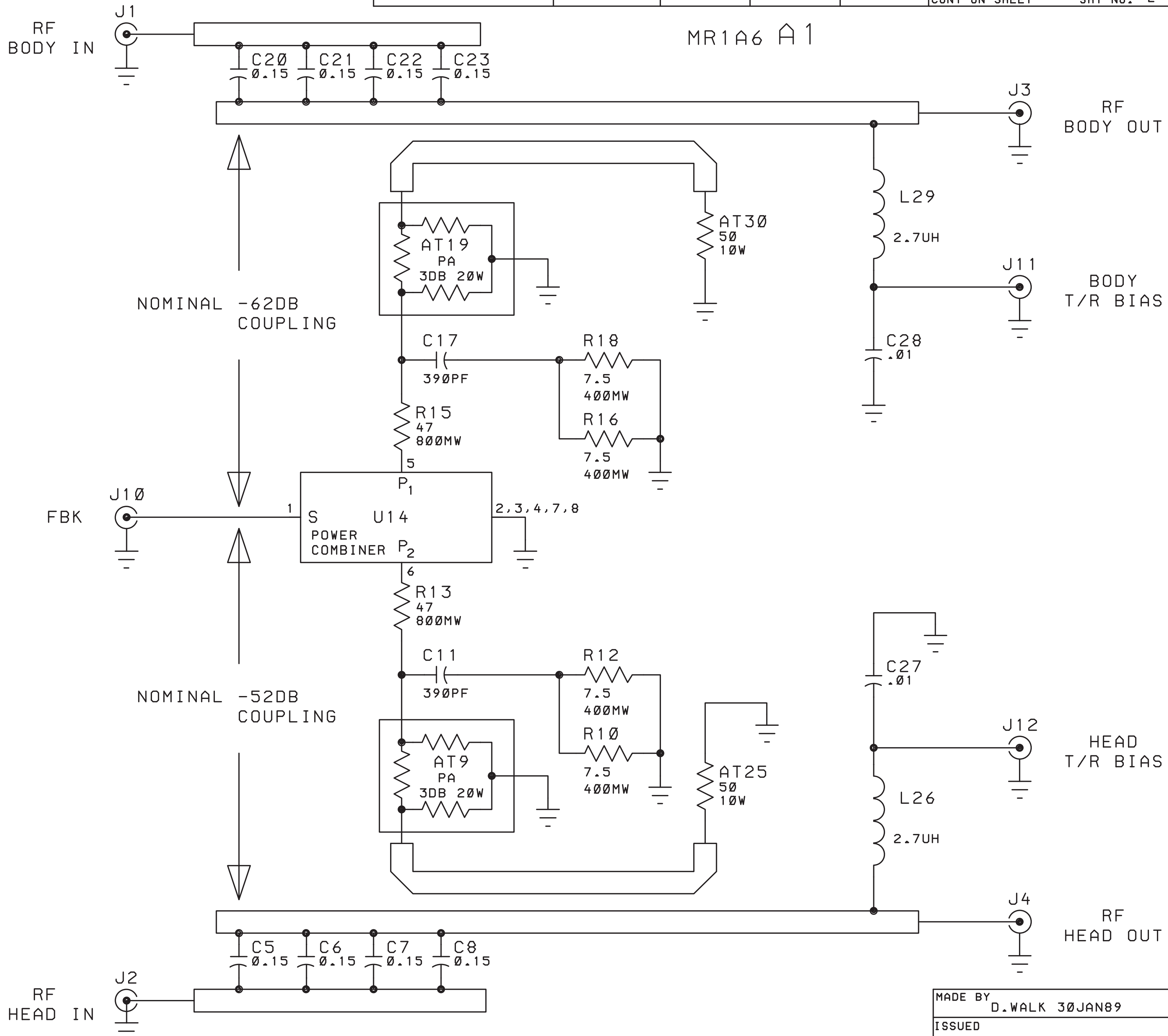
FIRST MADE FOR MRDDAMP

46-264288-S

CONT ON SHEET - SHT NO 2

MR1A6 A1

46-264288G2-B



REVISIONS				PRINTS TO	
AE	FEP 2MAY91	AB	FEP 16MAY89	740	
PCN 171706		PCN 158051			
AF	FEP 8MAY91	AC	DLW 13MAR90		
PCN 171687		PCN 158445			
		AD	DPB 21FEB91		
		PCN 171514			

MADE BY D.WALK 30JAN89

ISSUED

APPROVALS

MEDICAL SYSTEMS DIV OR DEPT

MILWAUKEE, WI. LOCATION

46-264288-S

CONT ON SHEET - SHT NO. 2

46-264288-S

DRAWING NO. 46-264442-S SHT NO. 1 CONT ON SHEET -

UNLESS OTHERWISE SPECIFIED USE THE FOLLOWING:-

APPLIED PRACTICES
46-208600

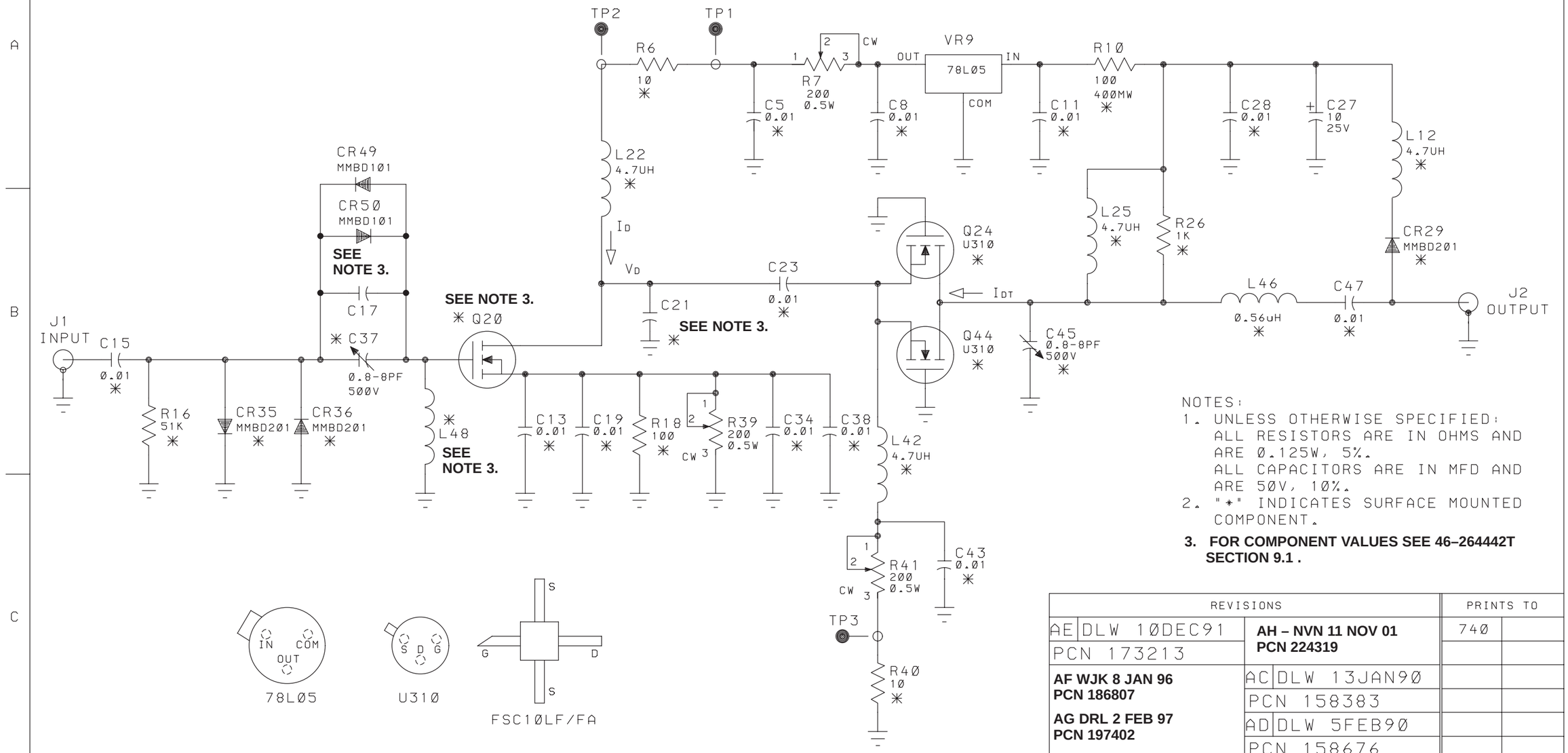
REV AE AG AH
46-264442-S
CONT ON SHEET - SHT NO. 1

TITLE
SCHEMATIC DIAGRAM
PREAMP
FIRST MADE FOR MR TPS

46-264442-S
CONT ON SHEET - SHT NO 1

MG2A16A3 A1 (HEAD)
MG3A3A5 A1 (BODY)

46-264442G2-A
46-264442G3-A



NOTES:
1. UNLESS OTHERWISE SPECIFIED:
   ALL RESISTORS ARE IN OHMS AND ARE 0.125W, 5%.
   ALL CAPACITORS ARE IN MFD AND ARE 50V, 10%.
2. "*" INDICATES SURFACE MOUNTED COMPONENT.
3. **FOR COMPONENT VALUES SEE 46–264442T SECTION 9.1 .**

REVISIONS		PRINTS TO	
AE DLW 10DEC91	**AH – NVN 11 NOV 01 PCN 224319**	740	
PCN 173213			
AF WJK 8 JAN 96 PCN 186807	AC DLW 13JAN90		
	PCN 158383		
AG DRL 2 FEB 97 PCN 197402	AD DLW 5FEB90		
	PCN 158676		

MADE BY R. LISOWSKI 14JAN88
ISSUED R. BECERRA 24JUN88
APPROVALS R.B. 20MAR89
MEDICAL SYSTEMS DIV OR DEPT
MILWAUKEE, WI. LOCATION
46-264442-S
CONT ON SHEET - SHT NO. 1

46-264442-S 1

GENERAL ELECTRIC
46–264776–S
CONT. ON SHEET NO.
TITLE SCHEMATIC DIAGRAM
DYNAMIC–DISABLE–FILTER–MODULE
FIRST MADE FOR MRSPEC4.5
P/L ISSUED
46–264776G1–B
UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
APPLIED PRACTICES 46–208600
SURFACES
TOLERANCES ON DIMENSIONS
DECIMALS (2 PLACES) ±
DECIMALS (3 PLACES) ±
ANGLES ±
REVAB
46–264776–S
CONT. ON SHEET NO.

INPUTS

J1

FROM DYNAMIC DISABLE MODULE (MR1 A9)

DYNAMIC DISABLE FILTER 1

15 BCD1 — L45 4.0 2.5A — C47 .003 1000V — L46 4.0 2.5A — C44 .003 1000V — L40 4.0 2.5A — C43 .003 1000V — L41 4.0 2.5A — C42 .003 1000V — DD1 J2

13 BCD1–RTN — C53 .022 50v

TO DYNAMIC DISABLE SWITCHES 1 AND 3

DYNAMIC DISABLE FILTER 2

6 BCD2 — L34 4.0 2.5A — C36 .003 1000V — L35 4.0 2.5A — C33 .003 1000V — L29 4.0 2.5A — C32 .003 1000V — L30 4.0 2.5A — C31 .003 1000V — DD2 J3

8 BCD2–RTN — C52 .022 50v

TO DYNAMIC DISABLE SWITCHES 2 AND 4

INDUCTIVE DRIVE FILTER

4 IDD — L27 8.0 2.5A — C28 .003 1000V — L25 8.0 2.5A — C26 .003 1000V — ID J4

12 GND — GND

TO INDUCTIVE DRIVE SWITCHES

DYNAMIC DISABLE FILTER 3

3 BCD3 — L19 4.0 2.5A — C20 .003 1000V — L18 4.0 2.5A — C17 .003 1000V — L15 4.0 2.5A — C16 .003 1000V — L14 4.0 2.5A — C13 .003 1000V — DD3 J5

1 BCD3–RTN — C51 .022 50v

TO DYNAMIC DISABLE SWITCHES 5 AND 7

DYNAMIC DISABLE FILTER 4

9 BCD4 — L11 4.0 2.5A — C12 .003 1000V — L10 4.0 2.5A — C9 .003 1000V — L7 4.0 2.5A — C8 .003 1000V — L6 4.0 2.5A — C5 .003 1000V — DD4 J6

11 BCD4–RTN — C50 .022 50v

TO DYNAMIC DISABLE SWITCHES 6 AND 8

NOTES:

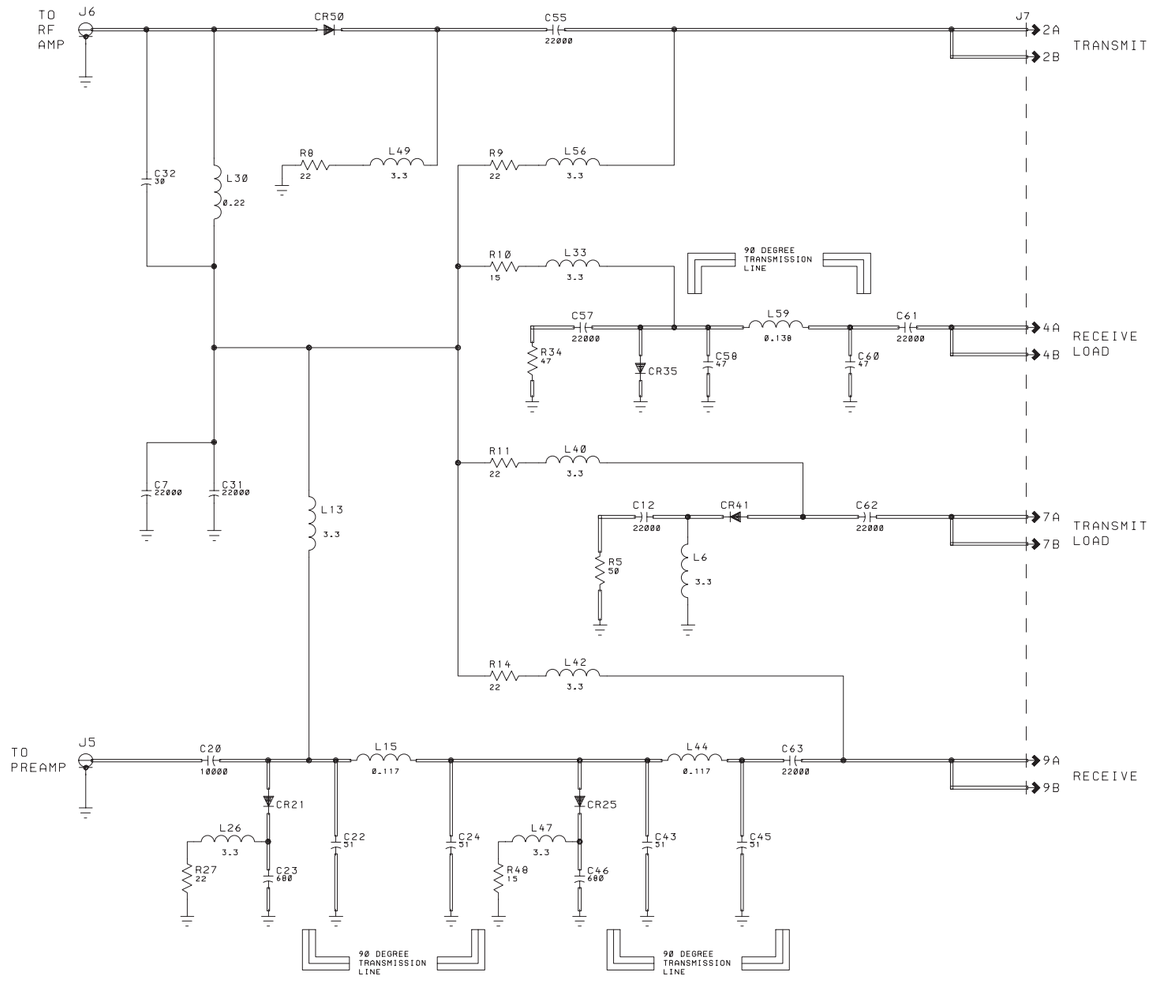
1. UNLESS OTHERWISE SPECIFIED:
   ALL CAPACITORS ARE IN MFD.
   ALL INDUCTORS ARE IN uH.

REVISIONS		PRINTS TO
B	DLW–18OCT89	740
	GEN.–CHNGS.	
C	DLW–10NOV89	
	GEN.–CHNGS.	
AB	DLW–15SEP92	
	PCN_173713	

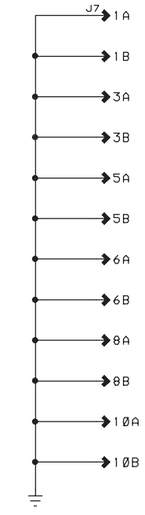
MADE BY D.WALK 25APR89
ISSUED J.BIEDLINGMAIER 15JAN90
APPROVALS MEDICAL SYSTEMS OR RCR 24JAN90
DEPT MILWAUKEE, WISCONSIN
LOCATION

UNLESS OTHERWISE SPECIFIED USE THE FOLLOWING:-	REV AD	TITLE	46-264988-S
APPLIED PRACTICES 46-208600	46-264988-S CONT ON SHEET - SHT NO. 1	SCHEMATIC DIAGRAM HEAD T/R SWITCH	CONT ON SHEET - SHT NO 1
		FIRST MADE FOR MRHC2	

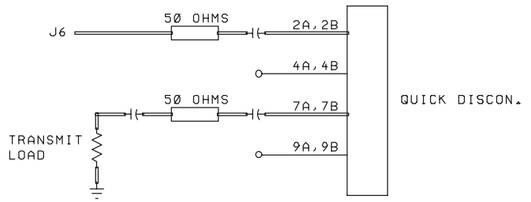
46-264988G1-B
46-264988G2-A



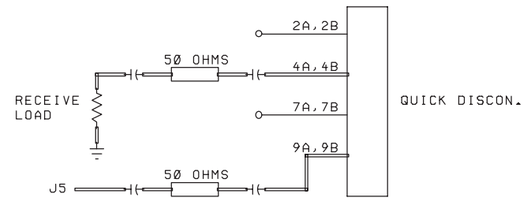
UNUSED PINS:



BIAS ON



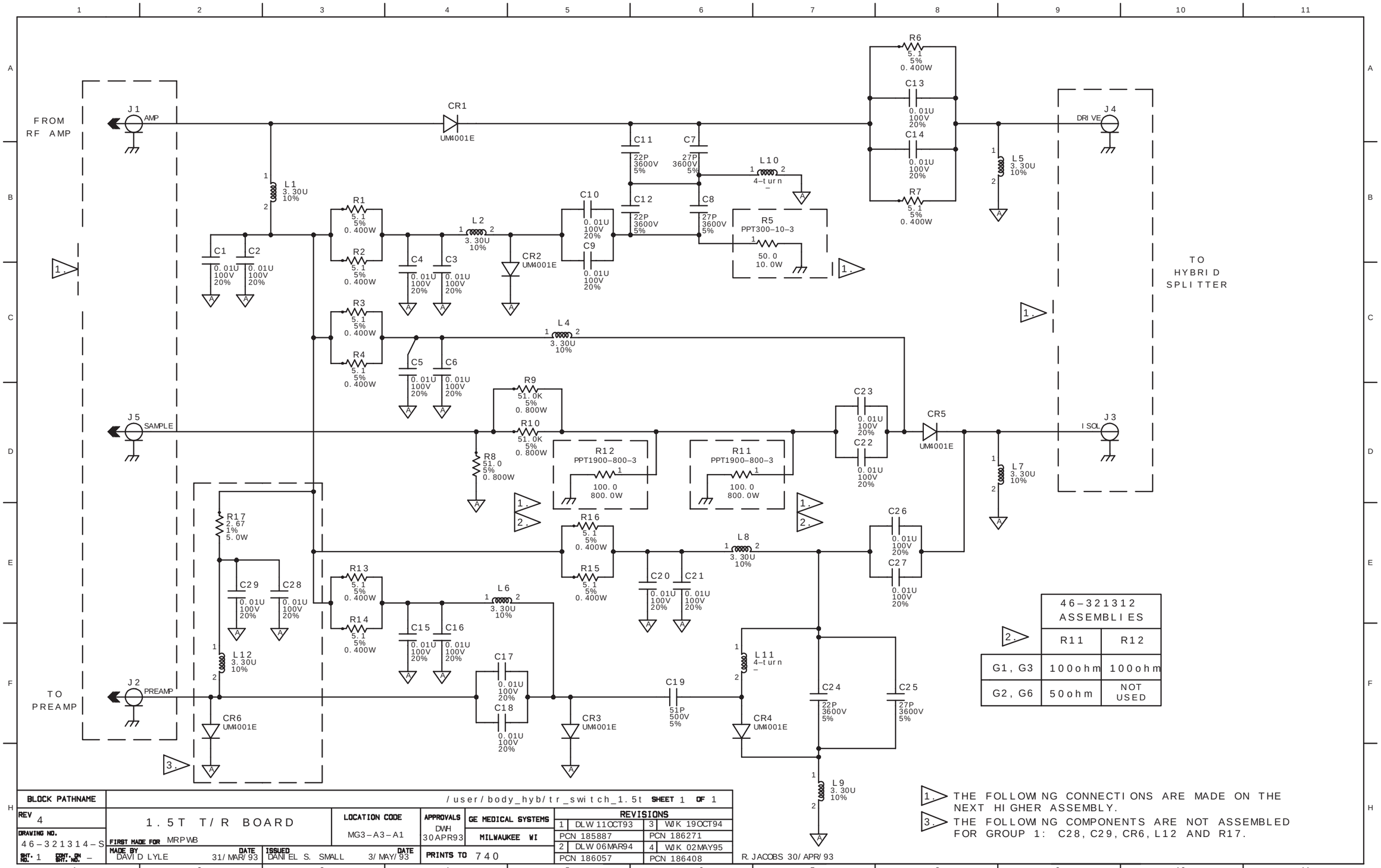
BIAS OFF



NOTES:
1. UNLESS OTHERWISE SPECIFIED:
   ALL RESISTORS ARE 3.0W, 1%
   AND ARE IN OHMS.
   ALL CAPACITORS ARE IN pF.
   ALL INDUCTORS ARE IN uH.
   ALL DIODES ARE UM9415.
2. DARKER CONNECTIONS INDICATE RF SIGNAL PATHS.

REVISIONS		PRINTS TO
AD DRL 16 JUN 98 PCN 197927	B DLW 5DEC89	740
	GEN. CHNGS.	
	AB DLW 20MAR90	
	PCN 158759	
	AC WJK 8 JUN 93 PCN 185690	

MADE BY D.WALK 27JUL89	APPROVALS RCR 12MAR90	MEDICAL SYSTEMS DIV OR DEPT	46-264988-S
ISSUED J. WALTER 23JAN90		MILWAUKEE, WI. LOCATION	CONT ON SHEET - SHT NO. 1



46-321312 ASSEMBLIES		
	R11	R12
G1, G3	100ohm	100ohm
G2, G6	50ohm	NOT USED

1. THE FOLLOWING CONNECTIONS ARE MADE ON THE NEXT HIGHER ASSEMBLY.
3. THE FOLLOWING COMPONENTS ARE NOT ASSEMBLED FOR GROUP 1: C28, C29, CR6, L12 AND R17.

BLOCK PATHNAME	/user/body_hyb/tr_switch_1.5t SHEET 1 OF 1		
REV 4	1.5T T/R BOARD	LOCATION CODE MG3-A3-A1	APPROVALS DWH 30APR93
DRAWING NO. 46-321314-S	FIRST MADE FOR MRPWB		GE MEDICAL SYSTEMS MILWAUKEE WI
SHT. NO. 1 CONT. ON SHT. NO. –	MADE BY DAVID LYLE DATE 31/MAR/93	ISSUED DANIEL S. SMALL DATE 3/MAY/93	PRINTS TO 740

REVISIONS	
1 DLW 11OCT93	3 WJK 19OCT94
PCN 185887	PCN 186271
2 DLW 06MAR94	4 WJK 02MAY95
PCN 186057	PCN 186408

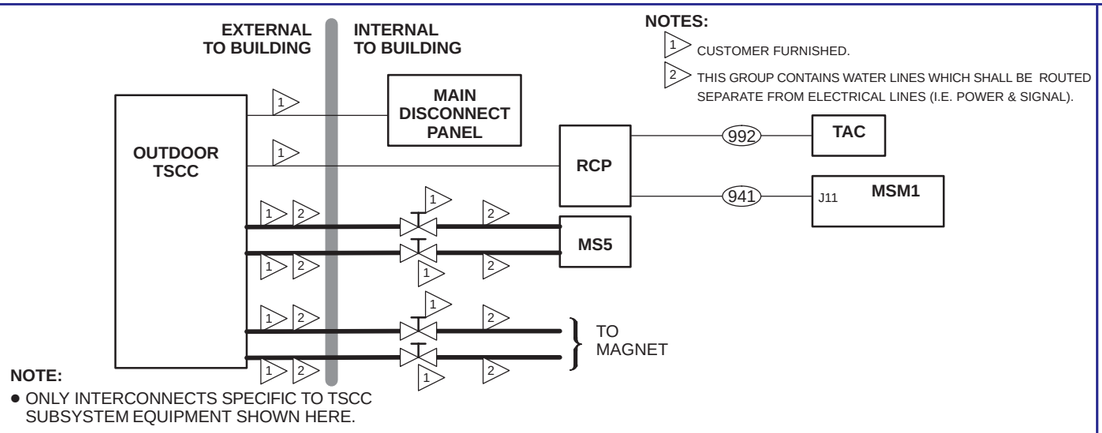
R. JACOBS 30/APR/93

COOLING SYSTEM

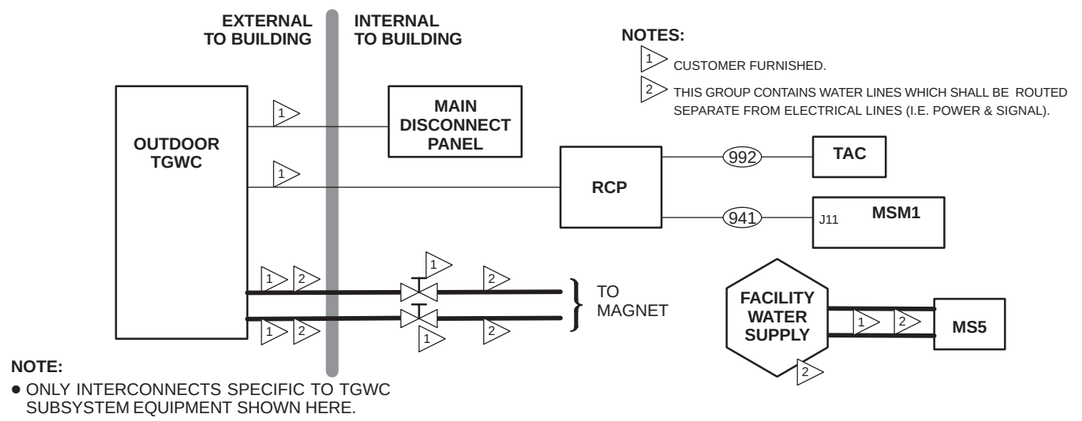
TABLE OF CONTENTS

Note:

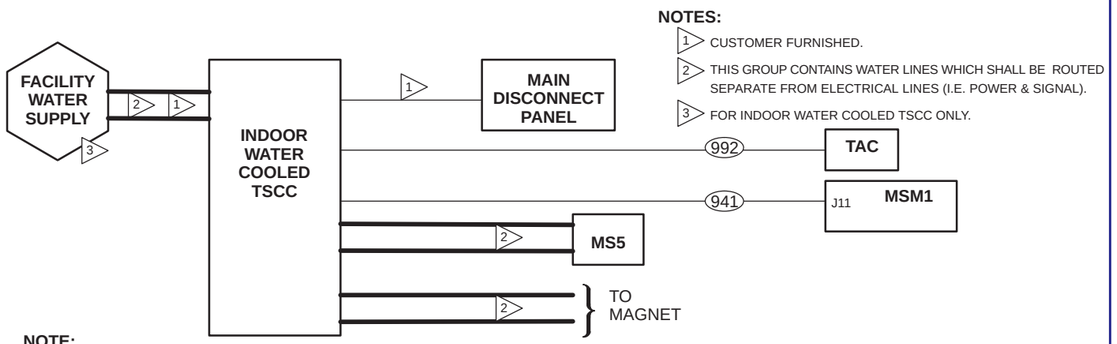
For all Chillers and Cooling System variations (SEE Vendor Manuals on MR Service Methods CDROM)



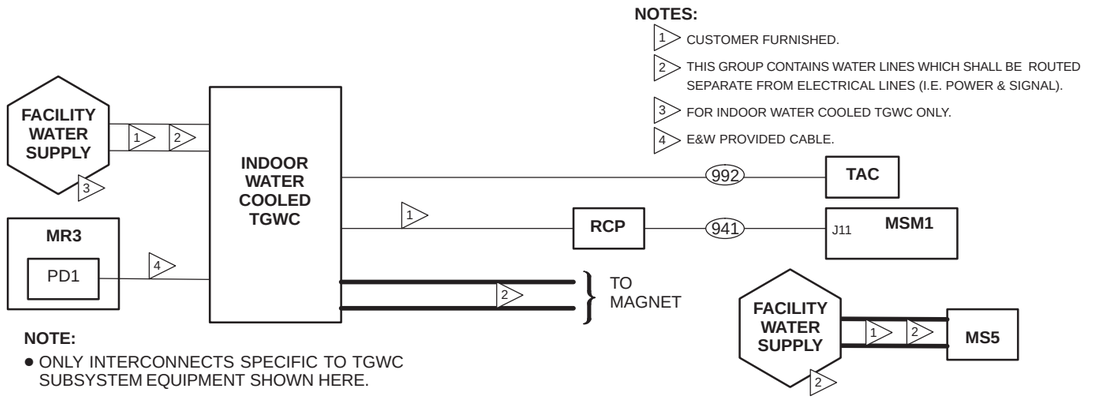
OUTDOOR TSCC & RCP SUBSYSTEM GROUP INTERCONNECT DIAGRAM



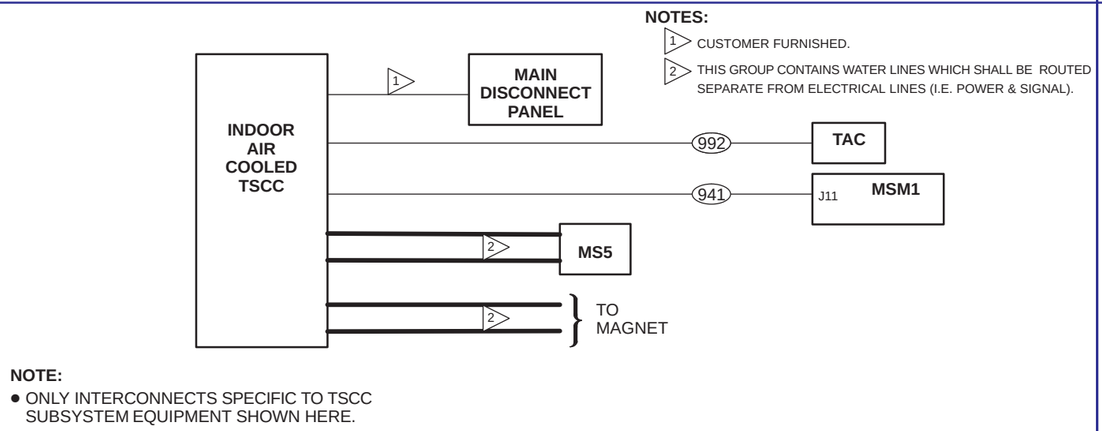
OUTDOOR TGWC & RCP SUBSYSTEM GROUP INTERCONNECT DIAGRAM



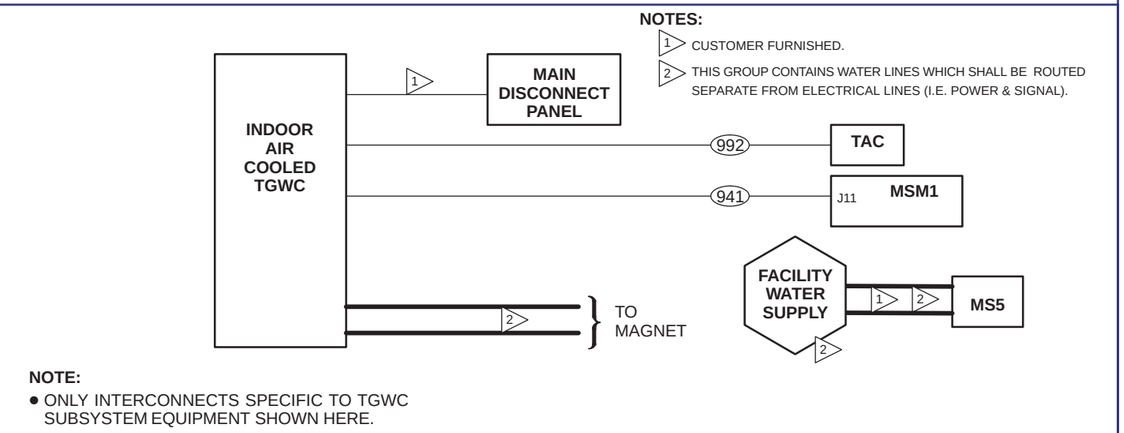
INDOOR WATER COOLED TSCC SUBSYSTEM GROUP INTERCONNECT DIAGRAM



INDOOR WATER COOLED TGWC SUBSYSTEM GROUP INTERCONNECT DIAGRAM



INDOOR AIR COOLED TSCC SUBSYSTEM GROUP INTERCONNECT DIAGRAM



INDOOR AIR COOLED TGWC SUBSYSTEM GROUP INTERCONNECT DIAGRAM