NATIONAL RADIO ASTRONOMY OBSERVATORY
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VLBA TECHNICAL REPORT NO. 3

MODEL F105, 4.8 GHZ CRYOGENIC FRONT-END

R. Norrod

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Roger D. Norrod

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MODEL F105, 4.8 GHZ CRYOGENIC FRONT-END

Section 1. SYSTEM DESCRIPTION

1.1 Brief Block Diagram Description

This report describes a dual-channel, low-noise amplifier system intended for use as a radio astronomy receiver front-end. A frequency range of 4.6 to 5.1 GHz is covered with a receiver noise temperature of less than 25K (noise figure less than 0.36 dB). The dual-channels allow both left and right circularly-polarized (LCP and RCP) signals to be received.

A block diagram of the system is shown in Figure 1.1-1 and photographs are shown in Figure 1.1-2. A 4.49 cm (1.768 inch) diameter circular waveguide, propagating both TE_{11} circularly polarized waves, provides the input to the system. A low-loss foam plug window in the waveguide supports a vacuum in a dewar which contains receiver components cooled to temperatures of 50 and 15 Kelvin by a closed-cycle, cryogenic refrigerator. The thermal barrier separating the room temperature and cryogenic portions of the input waveguide is achieved by a 0.4 mm (.016 inch) gap in the waveguide wall. A sloped-septum waveguide polarizer accepts the waveguide signal and extracts the two orthogonal circular polarizations. The two SMA coaxial-line outputs of the polarizer are connected via directional couplers and semi-rigid coaxial lines to the inputs of three-stage gallium-arsenide field-effect transistor (GASFET) amplifiers with approximately 30 dB of gain. The amplifier outputs connect to commercial vacuum tight feed-thru connectors via 2.159 mm (.085 inch) diameter coaxial cables made of low thermal conductivity alloys.

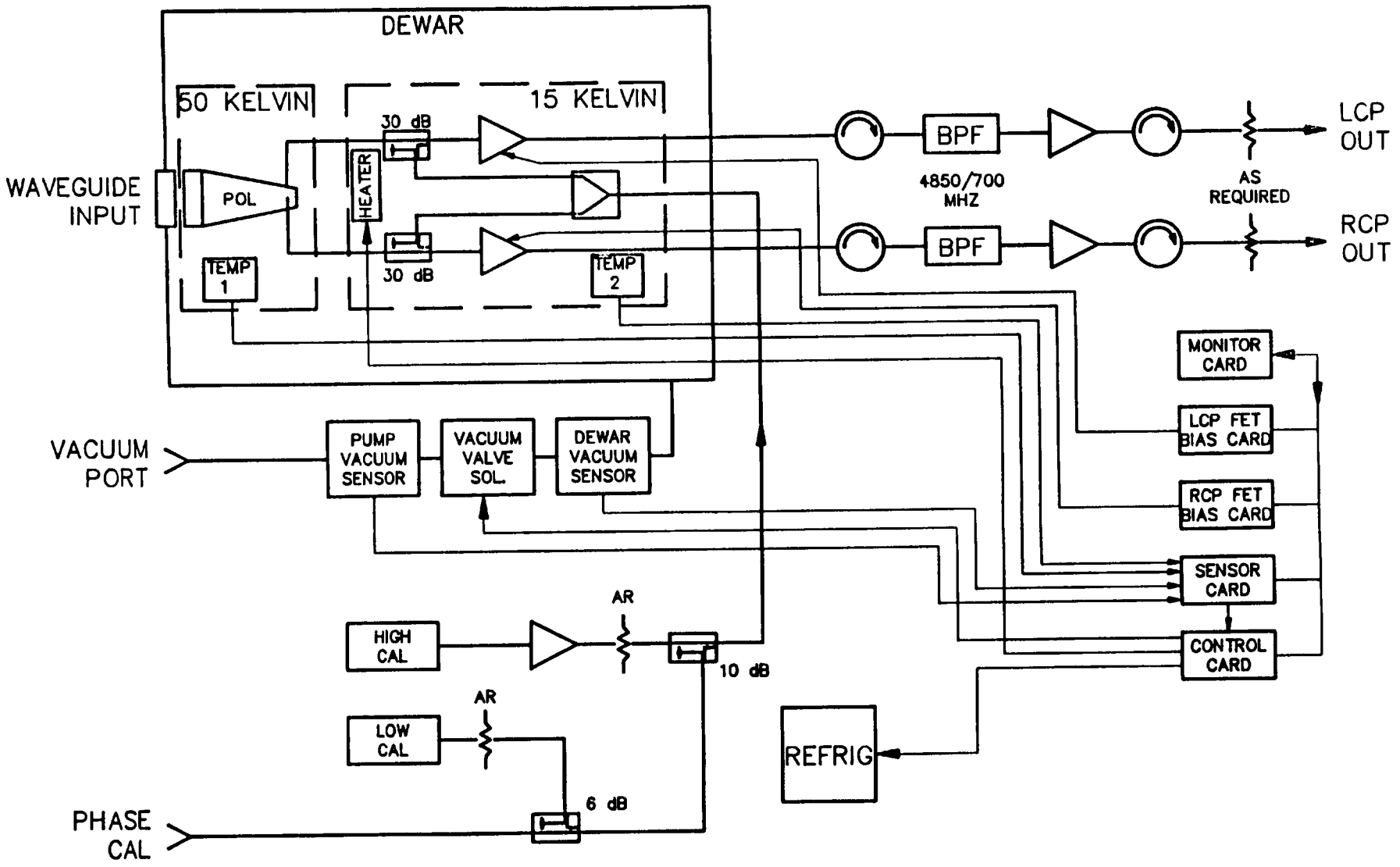
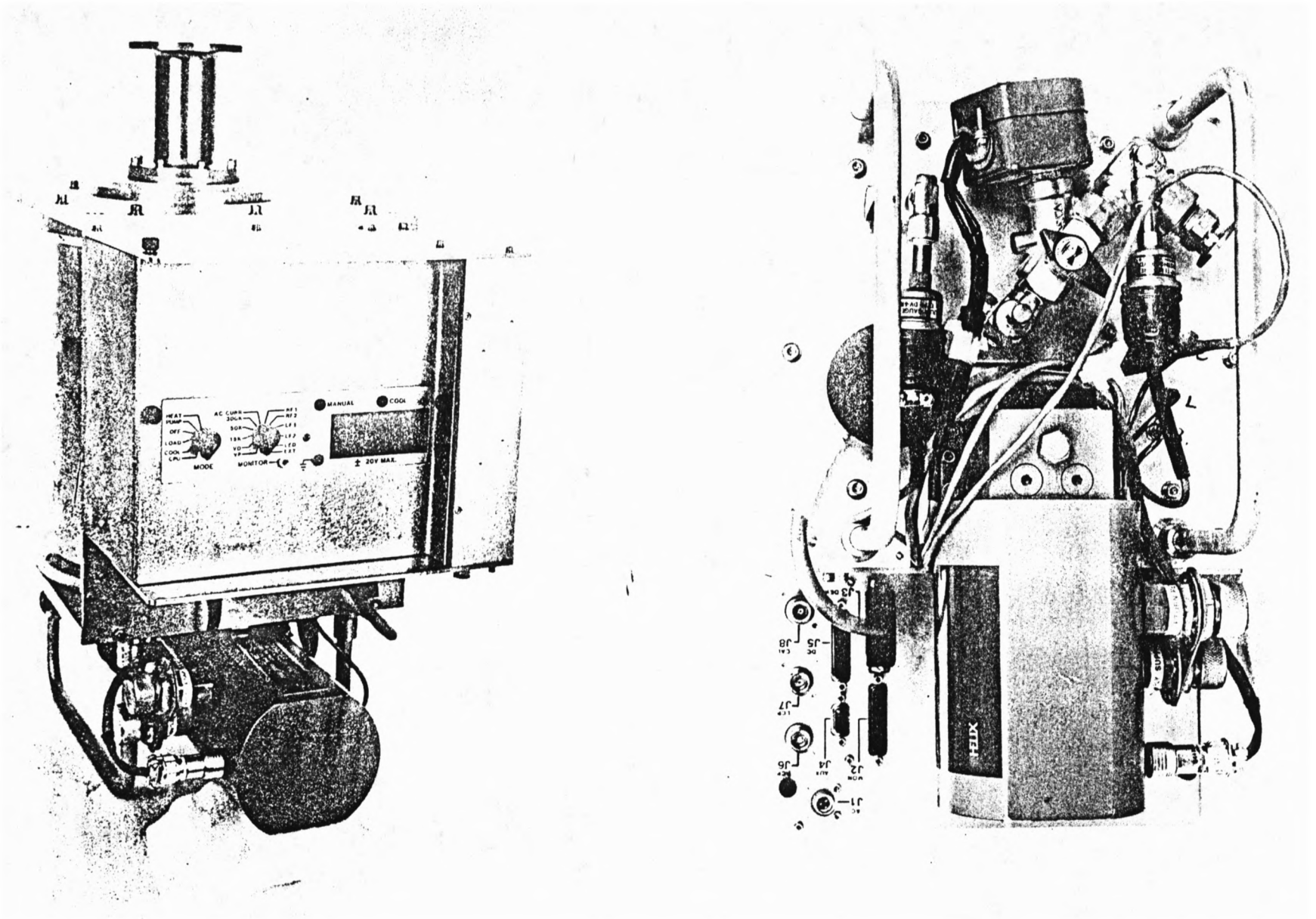


Figure 1.1-1

VLBA 4.8 GHz Front-End Block Diagram



(a) (b)

Figure 1.1-2

(a) The input waveguide is at top and local control panel is at center.

(b) Close-up showing the Bottom Plate, Inspection Cover, and refrigerator motor.

Attached to the front-end dewar is an electronics card cage containing six printed circuit boards. On one of these boards a local monitor/control panel is mounted. This small panel contains a six-position switch with positions CPU, COOL, STRESS, OFF, PUMP, and HEAT. The latter five positions place the front-end into each of its logical states; the CPU position allows the state to be determined by three control bits from the station computer. When not in the CPU position, a red indicator is illuminated and a monitor bit is set low. A twelve position monitor switch and a 4 1/2 digit DVM are available on the local panel for reading analog monitor points; a pin jack in parallel with the DVM is provided to connect a monitor point to other equipment or to meter external voltages. The dewar and pump port vacuum are monitored, along with dewar temperature, by sensors and circuitry on a sensor card in the attached card cage. The sensor outputs, AC power, and the three control bits are input to a control card which controls the vacuum solenoid, the refrigerator motor power, and a dewar heater. Two bias cards providing constant drain-current bias for the cooled GASFET amplifiers are included in the card cage. Details of the operation of the front-end card cage electronics package is provided in a separate report. Details of a preliminary version of the printed circuit cards is included in VLBA Technical Report No. 1.

The two dewar RF output signals feed room temperature bipolar transistor amplifiers having a noise figure less than 3.5 dB and 17 to 20 dB of gain. The amplifiers, bandpass filters, calibration

noise sources, and related components are mounted on a RF circuit card that is included in the front-end card cage. Three types of calibration signals are provided:

a) A low noise calibration signal, approximately 3K, for continuous pulsed gain and noise calibration of the system.

b) A high noise calibration signal, approximately 3000K, which may be useful for solar or other large signal observations.

c) An externally applied signal, coupled -44 dB to both inputs, for the purposes of phase or time-delay calibration of the system.

The cryogenic components are cooled with a Cryogenics Technology, Inc., Model 22 refrigerator which requires an external helium compressor. Vacuum service, such as provided by a two-stage mechanical pump, is also required and is connected to the dewar through a solenoid-operated valve.

1.2 Specifications

Unless otherwise stated these specifications apply to the system at its cryogenic operating temperature, and over the frequency range 4.6 to 5.1 GHz. A set of test data similar to that which will be provided for each front-end is given in Appendix I.

1.2.1 Noise Temperature

The receiver noise temperature measured at the front-end waveguide input flange shall be less than 25K at mid-band and less than 30K over the entire frequency range. The noise temperature shall be measured with a properly calibrated liquid-nitrogen noise temperature standard and at 50 MHz intervals from 4.5 to 5.2 GHz.

1.2.2 Input Return Loss

The return loss for the two orthogonal circular waves in the input circular waveguide must be greater than 15 dB.

1.2.3 Front-end Gain

The gain through either channel measured from the front-end waveguide input flange to the RF Out jacks J6 and J7 shall be 46 ± 3 dB.

1.2.4 Phase Cal Coupling

The calculated coupling from the Phase Cal input jack J8 to the cooled GASFET amplifier inputs shall be -44 ± 2 dB.

1.2.5 Phase Cal Input Return Loss

The return loss at the Phase Cal input jack J8 shall be $\geq$ 20 dB.

1.2.6 Output Return Loss

The output return loss for the RCP and LCP channels, at RF Out jacks J6 and J7, shall be $\geq$ 20 dB.

1.2.7 Calibration Noise Temperature

The noise added to the system in each channel when +28 volts is applied to the Cal control line shall be 3 ± 2K and calibrated with an accuracy of ± 0.1K.

1.2.8 High Calibration Noise Temperature

The noise added to the system in each channel when +28 volts is applied to the High Cal control line shall be 3000K ± 15% and calibrated with an accuracy of ± 30K.

1.2.9 Output Total Noise Power

With a room temperature waveguide load connected at the input waveguide flange, the noise power out of the RF Out jacks J6 and J7, measured with a broadband power meter, shall be -40 ± 3 dBm. The total noise power shall also be recorded with the following waveguide input conditions: short circuit; short circuit with Cal on; and short circuit with High Cal on.

1.2.10 Output Noise Power Stability

The receiver waveguide input shall be short-circuited and a test receiver with approximately 10 MHz I.F. bandwidth and 1 kHz postdetection bandwidth connected to the RF Output jacks. With the receiver tuned near to the front-end center frequency, and gain adjusted for 5 ± 1 VDC output from the receiver, the peak-to-peak AC (> 2 Hz) receiver output shall be less than 250 mV peak-to-peak as viewed on an oscilloscope. This test shall be passed under conditions of light tapping upon the dewar, RF components, and

coaxial cables. (The purpose of the test is to check for mechanical looseness, vibration sensitivity, 60 Hz modulation, and refrigerator induced gain modulation.)

1.2.11 Cold Station Temperatures

The temperature of the refrigerator first stage (as measured on the polarizer connected to that stage) shall be $\leq$ 70K; the second stage temperature as measured on the cold plate near the cooled amplifiers shall be $\leq$ 17K.

1.2.12 FET Bias Data

The optimum drain voltage V_D, drain current I_D, and gate voltage V_g, at room and cryogenic operating temperatures, shall be recorded for each stage of the cooled amplifiers.

1.2.13 Cool-Down Time

The time required to cool the cryogenic components from 300K to operating temperature shall be less than 12 hours.

1.2.14 Physical Weight and Size

The front-end shall weigh less than 80 pounds and shall have the outline shown in Figure 1.3-1.

1.3 Interface Description

Descriptions of the mechanical and electrical interfaces of the system follow.

1.3.1 Mechanical Interface

Locations of the input waveguide, helium supply and return ports, vacuum port, and mounting holes are shown in Figure 1.3-1.

The intended mounting concept is to align the front-end to the antenna feed using the input waveguide flange and then take up most of the front-end weight with adjustable supports bolted through the .531" diameter holes in the four corners of the 10 inches square aluminum plates. When mounted, access should be provided so that the circuit cards, RF card, or refrigerator motor and displacers can be removed without demounting the front-end assembly.

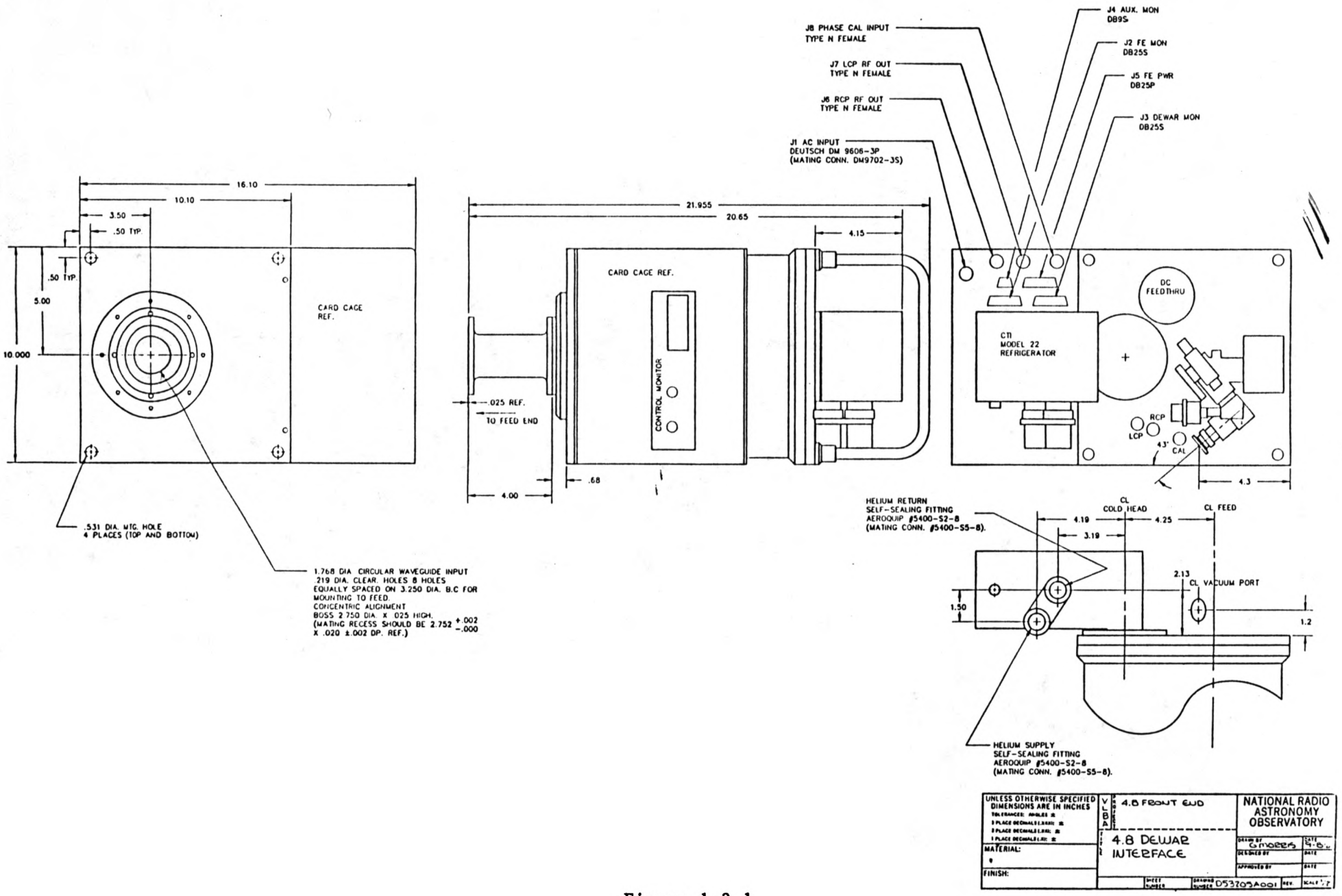


Figure 1.3-1

4.8 GHz Dewar Interface

1.3.2 Vacuum and Helium Interface

The vacuum port connection is through a Leybold-Heraeus type KF16 flange, type 18321 centering ring, and type 18346 quick disconnect clamp. A control signal on connector J2, PUMP REQUEST, is high when vacuum pumping is needed; this may be either used to turn on a pump or open a solenoid-operated valve to a pump manifold.

The helium interface is through Aeroquip 5400-S2-8 self-sealing fittings. The helium supply pressure should be 250 ± 10 psi dynamic, and the return pressure is 60 ± 15 psi.

1.3.3 RF Interface

The RF outputs J4 and J5, and Phase Cal input J6, are coaxial type N female connectors. The return loss at these connectors will be $\geq$ 20 dB from 4.6 to 5.1 GHz. The RF Outputs connect in the VLBA system to the T105 4.8 GHz Converter Module. With 43 dB of front-end gain, the system following the front-end must have a noise figure, including cable losses, of less than 18 dB to add less than 1K to the receiver noise temperature.

1.3.4 Front-end DC Interface Connectors

The Monitor connector, J2, provides various analog and digital monitor functions. The Power, Control, and ID connector, J5, supplies front-end power, refrigerator and cal source controls, and a twelve-bit ID word. The Auxiliary connector, J4, is provided to interface with equipment related to the front-end, such as the refrigerator power supply and vacuum pump control. The pin assignments for these connectors are given in Tables I, II, and

III. The front-end card cage is not designed to connect directly with the VLBA Monitor/Control bus, but a Front-end Control Module F101 is provided to do so. Details of the F101 module is given in a separate report. Descriptions of the signals on the front-end DC connectors follow.

1.3.4.1 Power, Control, and ID Connector, J5

The circuitry is designed so that if this connector is unplugged the refrigerator will continue to run; this allows maintenance of a portion of the system without causing a warm-up. Note that if the 15 volt supplies are turned off while the AC voltage is applied, power will be applied to the refrigerator motor regardless of the condition of the dewar vacuum.

TABLE I

J2-MONITOR (DB25S ON FRONT-END)		
Pin	Label	Function
1	VP	PUMP VAC
2	VD	DEWAR VAC
3	15K	TEMP MON,
4	50K	10 mV/°K
5	300K	
6	AC I	AC CURRENT
7	RF1	RCP STAGE 1
8	RF2	OTHER STAGES
9	LF1	LCP STAGE 1
10	LF2	OTHER STAGES
11	LED	LED VOLTAGE
12	-	-
13	QGND	QUALITY GND
14	SENS	TEMP SENS A
15		
16		
17		
18		
19		
20	S	SOLENOID MON
21	P	PUMP REQ
22	$\overline{M}$	MANUAL MON
23	X	CONTROL
24	C	MODE
25	$\overline{H}$	MONITOR

TABLE II

J5-PWR, CONTROL, AND ID (DB25P ON FRONT-END)		
Pin	Label	Function
1	GND	POWER GROUND
2	+15	600 mA
3	-15	100 mA
4		
5		
6	X	CONTROL BITS
7	C	
8	$\overline{H}$	
9	$\overline{PA}$	FE PARITY (EVEN)
10		
11	CAL	28.0 V, 4-10 mA
12	HI CAL	28.0 V, ~ 50 mA
13	GND	
14	FØ	LSB
15	F1	FREQUENCY
16	F2	ID
17	F3	MSB
18	SØ	LSB
19	S1	SERIAL
20	S2	NUMBER
21	S3	
22	S4	
23	S5	MSB
24	MØ	MODIFICATION
25	M1	MSB

TABLE III

J4-AUXILIARY (DB9S ON FRONT-END)		
Pin	Label	Function
1	AC+	CURR MON, 10V/AMP
2	AC-	RETURN
3	P	PUMP REQUEST
4	GND	GROUND
5		
6		
7		
8		
9		

TABLE IV

FREQUENCY ID CODE		
Code	Frequency	$\overline{PA}$
0	75	0
1	327/610	1
2	1.5	1
3	2.3	0
4	4.9	1
5	8.4	0
6	10.7	0
7	14.9	1
8	23	1
9	43	0
A	86	0
B		
C		
D		
E		
F		

TABLE V

J1-AC POWER 150 VAC 2ϕ 0.5-1.0 A (DEUTSCH DM9606-3P ON FRONT-END)			
Pin	Label	Function	MS Pin Power Supply
1	Ø1	SHIFTED PHASE	A
2	Ø2	LINE PHASE	B
3	R	RETURN	C

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The effect of the control bits on J5; C, NOT-H, and X; is shown in Table VI.

Table VI
Front-End Control States

C	$\overline{H}$	X	Mode	Comment
0	1	1	OFF	No refrigerator power, heater power, or vacuum pumping.
1	1	1	COOL	Normal cooled operation.
0	0	1	STRESS	COOL with small added heat load to sress-test cryogenics.
1	0	1	HEAT	Fast warm-up of dewar with 33 watts of heat added. PUMP REQ becomes high when dewar vacuum is greater than 10 microns.
1	0	0	PUMP	No refrigerator or heater power. PUMP REQ high; vacuum solenoid open when manifold pressure less than dewar pressure.

Note that a control data failure which forces all bits high will keep the system in COOL mode. Although all zeros are not defined, it is currently interpereted as the STRESS state. There is no memory in the dewar control circuitry and switching from one mode to another can be performed without damage; the control card will not open the vacuum valve solenoid unless the pump port vacuum is sufficiently low, and also protects the dewar from overheating by the heaters. The control bits are TTL levels with each driving one LS load.

The CAL and HI CAL control signals directly drive the calibration noise sources and in the case of HI CAL also drive a one-stage noise calibration amplifier. The CAL signals are turned on with +28 volts at 15 mA for CAL and 120 mA for the HI CAL. The coefficient of calibration power output versus supply voltage is less than 0.1 dB/% for CAL.

The twelve bit ID word provided on J5 is functionally divided into four frequency ID bits, six serial number bits, and two modification ID bits. The frequency ID codes are given in Table IV. In the VLBA system, the frequency ID bits will be used for monitor and control address assignment. Accordingly, a parity bit (NOT-PA) is provided, giving the inverted Even parity of the four frequency bits. This bit is inverted in the Front-end Control Module giving Even parity of the M/C address. Low ID bits are connected to Ground; high bits are open-circuits. Pull-up resistors are required in the Front-end Control Module F101.

1.3.4.2 Monitor Connector, J2

Six TTL digital monitor signals are provided on Monitor connector J2. The pump request signal, P, is a TTL level which is high if dewar vacuum pumping is required, and should be monitored and connected to the vacuum manifold control circuits. P is provided on both J2 and J4. The vacuum solenoid signal, S, is a TTL signal for monitor purposes; S is high when the vacuum valve is open. NOT-M, Manual Mon, is high if the manual control switch on the front-end card cage is in the CPU position. C, NOT-H, and X monitors are provided to indicate the active control state.

The analog monitor signals on J2 are provided for fault detection and isolation. The vacuum pressure as a function of the vacuum monitor voltages V_P and V_D is given in Figure 1.3-2.

Three linearized (10 mV/K) temperature monitors are provided: the refrigerator first (50K) and second (15K) stages, and an ambient (300K) temperature, sensed on the RF card in the card cage. In addition, the refrigerator second stage temperature sensor voltage, buffered by a unity-gain amplifier, is provided (SENS). This output has a non-linear relation to temperature, but gives greater sensitivity and potential accuracy at low temperatures than the linearized 10mV/K output.

RF1 and LF1 are the first stage gate voltages of the LCP and RCP cooled amplifiers, respectively. RF2 and LF2 are the voltage sum of the remaining stages' gate voltages for the two channels. A large change in any of the gate voltages usually means than one of the amplifier stages has a fault or that a problem exists in the bias card or the front-end wiring.

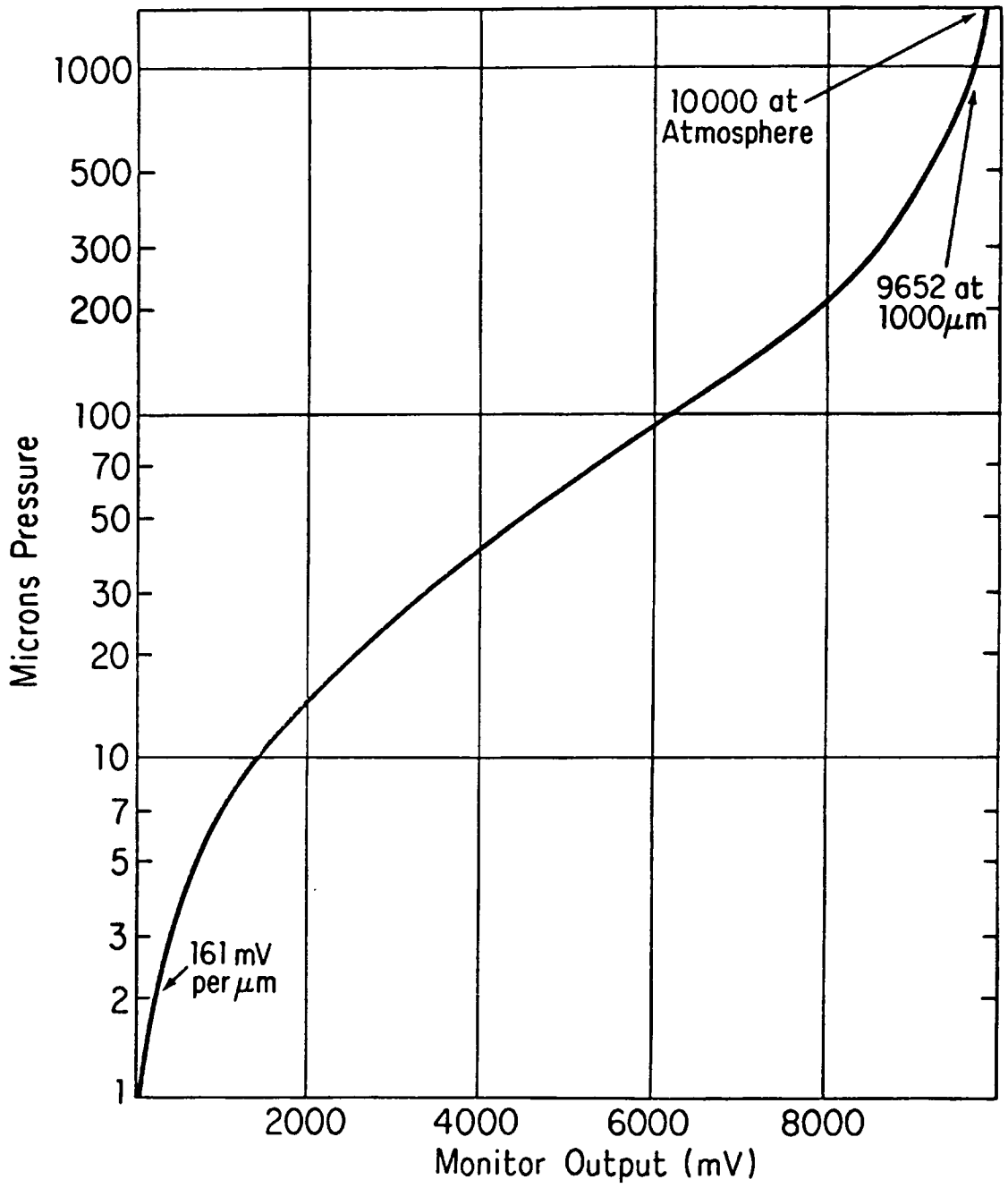


Figure 1.3-2

Vacuum Monitor Voltage vs. Pressure

The output AC I is the signal fed into the front-end card cage at Auxiliary connector pins 1 and 2. The refrigerator power supply provided with the front-end produces this voltage (10 Volts/Amp) and is provided at J2 so that the station control computer can verify that power is applied to the refrigerator motor and/or other front-end AC components. The refrigerator motor, vacuum valve solenoid, and dewar heaters currents are summed into this monitor voltage. Typical currents in the various front-end modes are: COOL - 0.7 A, STRESS - 0.73 A, and HEAT- 0.45 A. The rms current drawn by the various loads are as follows:

Refrigerator Motor	0.7 amps
Vacuum Solenoid*	0.25 amps
Heaters in HEAT Mode	0.20 amps
Heaters in STRESS Mode	0.03 amps

*If the vacuum solenoid is powered but through a fault does not actuate, it will draw 0.40 amps.

Quality Ground, QGND, is provided on J2 as a low current return path for the front-end analog monitors. It should be isolated from the system power supply grounds at the circuitry measuring those voltages.

1.3.4.3 Auxiliary Connector, J4

This connector is provided to allow miscellaneous connections to the front-end. The AC current monitor and the Pump Request signal are explained in the above section.

1.3.5 AC Power Interface, J1

The CTI Model 22 refrigerator requires two-phase, 150 volt, 60 or 50 Hz AC power which is supplied into a three-pin receptacle, Deutsch DM9606-3P, with mating plug, DM9702-3S. The pin assignments are given in Table V. A simplified AC power schematic of the entire system, and a suggested power source schematic are shown in Figure 1.3-3. The P111 Model 22 Power Supply provides the proper voltages to run the refrigerator motor and is described in Section 2.9.

Note that the AC power cable may be removed from J1 and plugged directly into the refrigerator motor to keep the system cold while removing AC power from the control circuits.

1.4 System Parameter Budgets

The system noise temperature budget is given in Table VII. The front-end gain budget is given in Table VIII, and the estimated heat loads on the refrigerator second (15K) stage is given in Table IX.

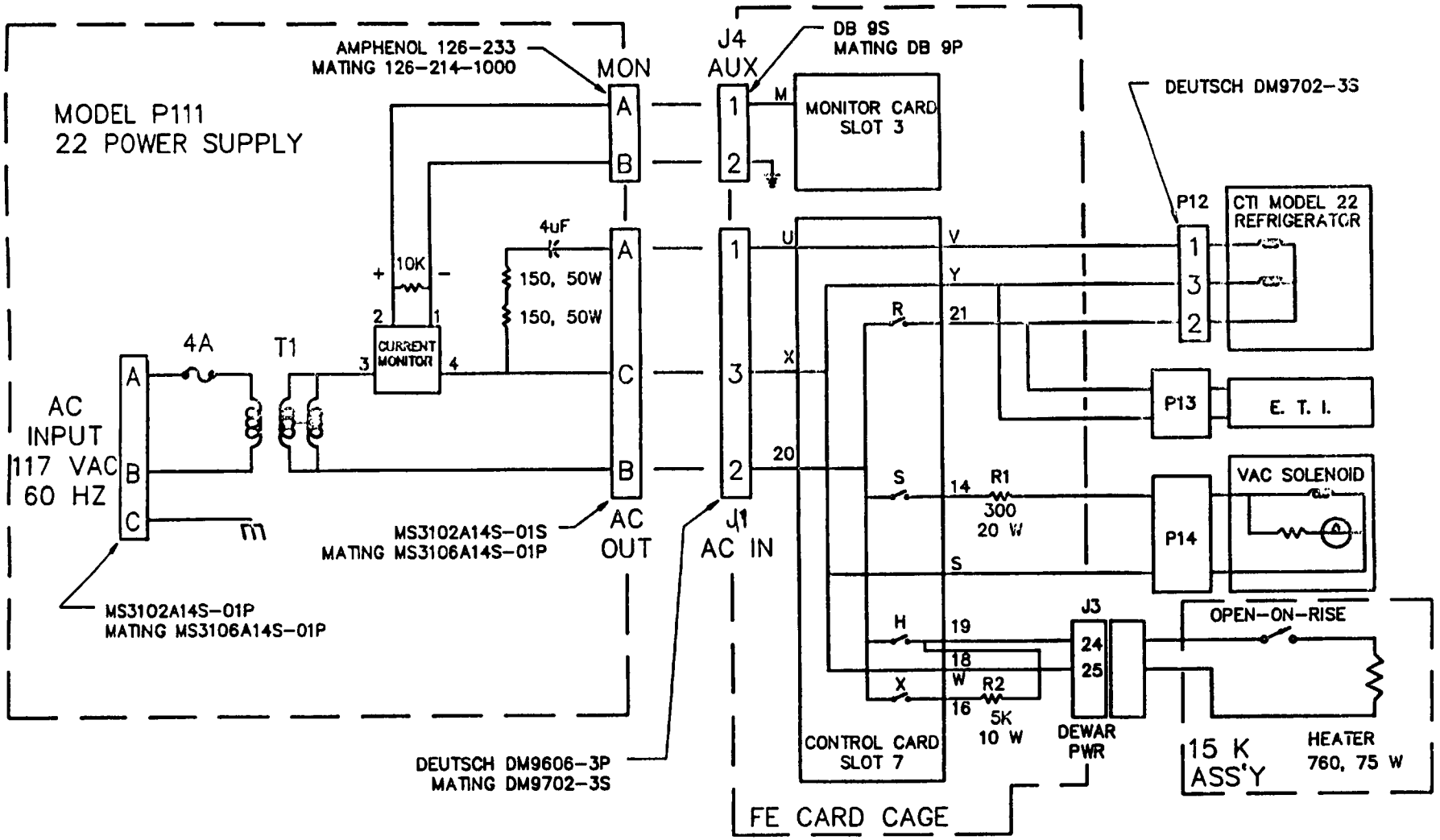


Figure 1.3-3

Front-End AC Wiring

Table VII
System Noise Budget

Component	Physical Temperature	Noise Temperature or Loss	System Contribution
FET Amplifier	16 K	15.0 K	15.0 K
Post Front-end	300 K	18,000 K	0.9 K
Second Stage	300 K	530 K	0.5 K
Cal Coupler and Coax Cable	16 K	0.15 dB	0.9 K
Polarizer	50 K	0.10 dB	1.4 K
Window	300 K	0.001 dB	0.1 K
	TOTAL RECEIVER TEMPERATURE		18.8 K

Table VIII
Front-end Gain Budget

Input Losses	- 0.2 dB
3-Stage CRYOFET	+ 32 ± 1.5 dB
9" .085" D. SS/AG Cable	- 0.6 dB
12" .141" D. CU/CU Cable	- 0.2 dB
Bandpass Filters	- 0.5 dB
3-Stage Post Amp	+ 18.5 ± 1.5 dB
Output Attenuator	- 3 dB
NET GAIN	+ 46.0 ± 3.0 dB

Table IX
Heat Load on Refrigerator Second Stage

Radiation	0.2 watts
Coaxial Lines to 300K (3)	0.13
Coaxial Lines to 50K (2)	0.66
No. 32 Brass Wire (16)	0.04
FET Amplifier DC Bias	0.4
TOTAL	1.4 watts

Section 2. COMPONENT DESCRIPTIONS AND OPERATIONAL NOTES

2.0 General

A number of key drawings are shown in Appendix II. These drawings include bill-of-materials (BOM) documents which index other drawings. Manufacturer's data sheets for commercial components used in this front-end are included in Appendix III. In Appendix IV, special test equipment needed to test or construct the front-end is described.

2.1 Vacuum Dewar

The vacuum dewar is a cylindrical vessel, formed from aluminum tubing capped with one-half inch thick aluminum endplates. The waveguide input flange is located on the Top Plate (so called because it will be nearer the sky in the VLBA cassegrainian system). The refrigerator, DC and RF feedthrus, and the Inspection Cover are mounted on the Bottom Plate. The vacuum manifold is mounted on the circular Inspection Cover that may be removed to gain access to the internal components. All joints are sealed with O-rings; no welding is used.

2.1.1 Vacuum Pumping

The dewar interior volumn is approximately 11.4 liters. The interior surfaces, the cryopumping charcoal on the 15K plate, and especially the rigid foam used in the vacuum window construction, adsorb gases and water vapor that are difficult to remove by mechanical pumping. If a dewar has been open for several days in

humid conditions, it can take a couple of hours for a 127 liter/minute roughing pump to evacuate the dewar to a pressure of 50 microns. However, if a dewar has been stored under vacuum, the same pump can achieve 50 microns in less than 30 minutes. It is recommended that, before cooling the front-end prior to installing on the telescope, it be pumped at room temperature for twenty-four hours, if possible.

2.1.2 Radiation Shields

A single level of radiation shielding is used in the dewar to reduce the radiation loading on the refrigerator cold stations. The shields are constructed of thin aluminum sheets formed into the proper shapes. A cylindrical shield is attached to the refrigerator first stage and is spaced away from the dewar outer cylinder by about 3/8 inches. Circular shields are mounted off of the endplates by nylon clips, closing the ends of the cylindrical shield. These shields surround the polarizer, the refrigerator cylinder, and the 15K components.

2.1.3 System Cooldown Procedure

When preparing the front-end for installation on the telescope, it is recommended that the dewar be pumped, using the PUMP mode, for at least 24 hours prior to cooling. For routine tests or if the dewar has been stored under vacuum, extended pumping is not necessary. In either case, the following procedure should be followed:

1) Check that the compressor is operating and that the supply pressure is 250 ± 10 psi. Connect the refrigerator helium ports to the compressor lines, return line first.

2) Connect the front-end vacuum port to a pump or vacuum manifold.

3) Connect the Monitor connector J2, the Power connector J5, the Auxiliary connector J4, and the AC connector J1 to the proper cables. Check that the AC and DC power supplies are on. Using the meter on the local control panel, check that the monitor voltages are reasonable.

4) Check that the dewar vent valve is closed and capped and that, unless manual control will be used, the control switch on the card cage is in the CPU position.

5) Place the front-end into the COOL state, using either the local control panel or the station computer. From this point, the cooldown procedure is automatic. The front-end will generate a PUMP REQUEST and when the pump vacuum becomes lower than the dewar vacuum, the vacuum valve solenoid will open. When the dewar vacuum becomes approximately 50 microns, the refrigerator motor will start. When the dewar vacuum becomes less than 5 microns, the PUMP REQUEST signal will become low.

Chart recordings of a typical cooldown and HEAT mode warm-up are shown in Figure 2.1-1. The cooldown time is approximately 12 hours to a final temperature of 12K to 15K on the second stage and 50K to 70K on the first stage. The warm-up time with 33 watts of heat applied is five hours. The ratio of these times gives an average refrigerator cool-down power of 13 watts including 0.4 watts to compensate for FET DC bias power.

2.1.4 Disassembly of Dewar

Figures 2.1-2 through 2.1-4 show the front-end in a disassembled state. The steps necessary to disassemble the dewar so that the cooled components may be worked on are:

a) With the front-end warmed to room temperature, open the manual vent valve, bringing the dewar to atmospheric pressure. On a convenient work surface, place the front-end so that the Inspection Plate is accessable.

b) If the vacuum and helium lines are still attached, disconnect them for convenience. Remove the four 8-32 screws attaching the Inspection Plate to the Dewar Bottom Plate and lift it off.

c) Through the inspection hole, remove the two 10-32 screws attaching the polarizer cold strap to the polarizer. Disconnect the semi-rigid coax from the polarizer outputs and rotate it out of the way. Unplug the wires from the temperature sensor mounted on the polarizer.

d) Remove the two 10-32 screws holding the cardcage bracket to the Dewar Top Plate. Remove the six 10-32 screws holding the Dewar Bottom Plate to the Dewar Cylinder and carefully withdraw the Bottom Plate and attached components from the Cylinder. The polarizer and gapped waveguide will remain, attached to the Top Plate.

e) Remove the three screws holding the cylindrical shield and remove the shield.

Access to any of the cooled components is now possible.

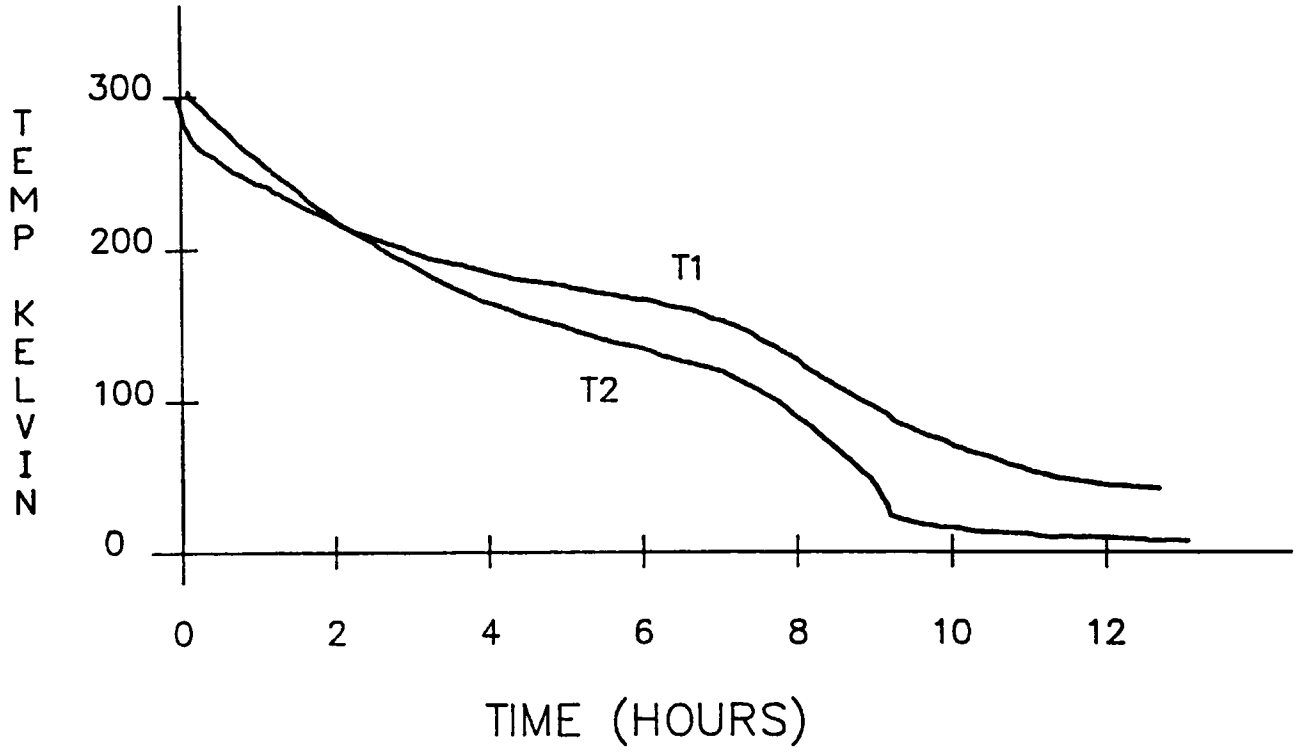


Figure 2.1-1 (a)

Front-End Cooldown Record

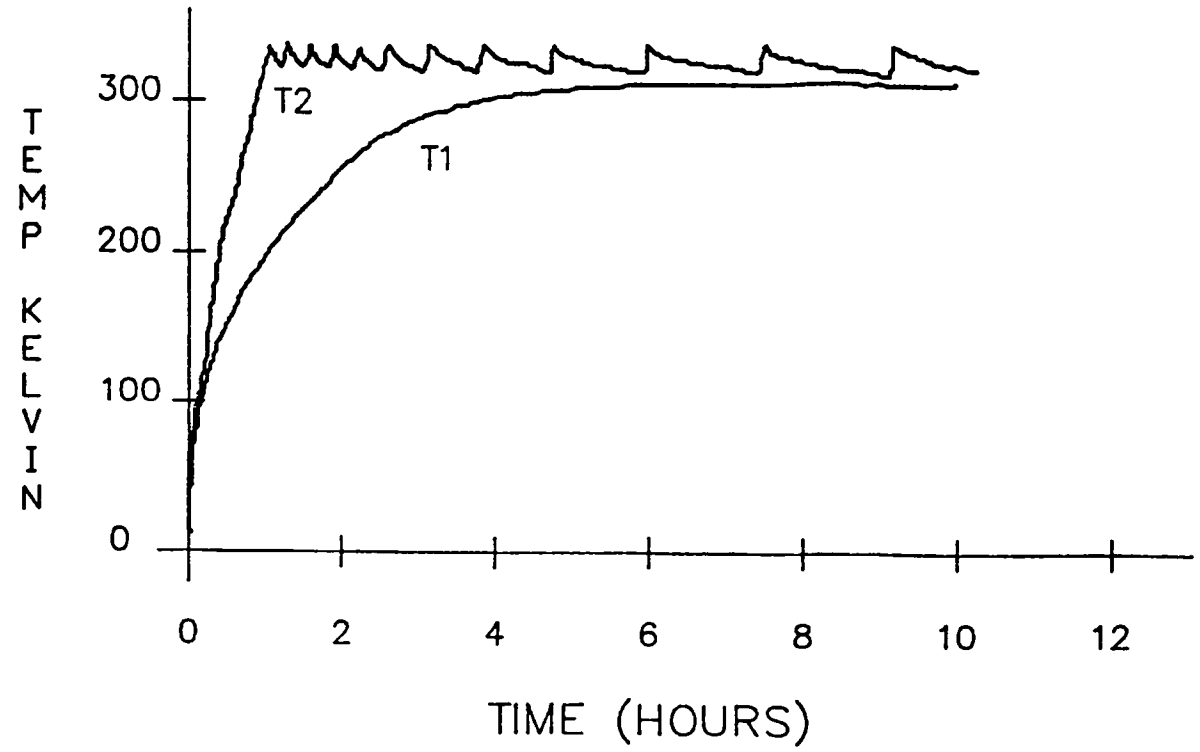


Figure 2.1-1 (b)

Front-End Warmup Record

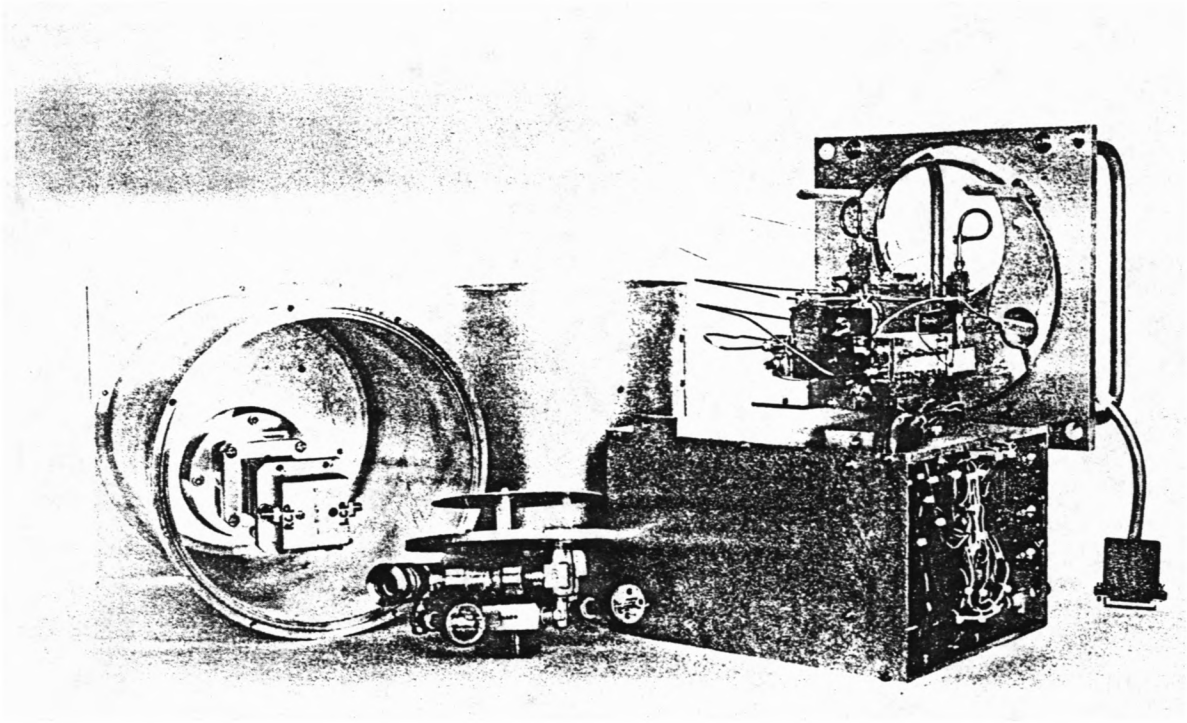


Figure 2.1-2

The Disassembled Dewar.

Clockwise from lower center: The Inspection Cover; the polarizer and Thermal Transition mounted to the dewar Top Plate and Cylinder; the Side Shield; the Bottom Plate and cooled components with the card cage.

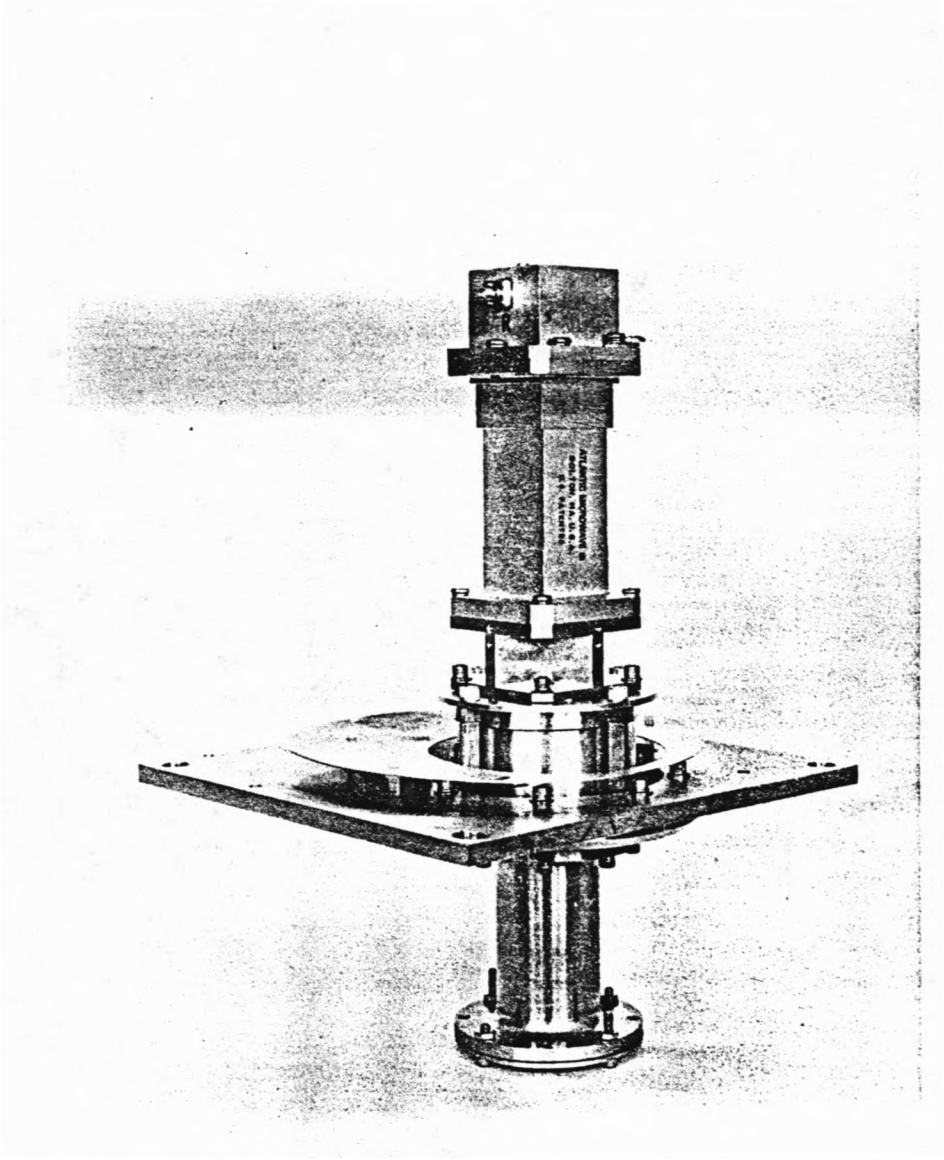


Figure 2.1-3

The Polarizer, Thermal Transition, and Input Waveguide Mounted to the Dewar Top Plate.

Note the radiation shield mounted with nylon clips.

One disadvantage of the foam is that it adsorbs moisture, slowing down the rough pumping process, and making it necessary to provide a water vapor seal on the external side of the window. This is obtained with a sheet of Saran-wrap epoxied into the Window Ring that bolts over the waveguide window. Tests have shown that the Saran-wrap contributes no measurable amount to the receiver noise temperature.

2.3 Waveguide Thermal Transition

Thermal isolation between the dewar input flange and the polarizer at 50K is provided by a 0.4mm (0.016 inch) gap in the waveguide wall. A choke groove at the gap is used. Insertion loss and return loss tests of the thermal transition assembly have shown no evidence of measurable energy radiating from the gap. The gap is supported by four tubes machined from 0.5 inch diameter, type G-10 epoxy-fiberglass rod stock. The calculated heat load through each support tube is 56 mW for 224 mW total conducted load.

The thermal transition is machined in two sections from 6061-T6 aluminum. The top section bolts to the Dewar Top Plate and contains the vacuum window material. The lower section is supported from the top section by the four support tubes, and the polarizer is bolted to its lower surface.

2.4 Polarizer

The polarizer is a sloped-septum waveguide structure provided by a commercial vendor. The stepped septum is mounted in square

waveguide and separates the two circularly polarized waves to the two SMA output connectors. A simple screw-tuned adapter to circular waveguide is provided by the polarizer vendor. The polarizer is specified in VLBA Specification A53200N001.

2.5 Noise Calibration System

The noise calibration components are shown in the block diagram, Figure 1.1-1. A 30 dB coaxial directional-coupler in each input signal line couples in a cal signal, a high cal signal, and an externally applied phase calibration signal. A coaxial power divider within the dewar splits the common calibration signal to the two receiver channels. The dewar calibration input is through a SMA hermetic feedthru; the coupling from this jack to each receiver input is approximately -34 dB (including 1 dB of cable losses).

The remainder of the calibration components are mounted on the RF card, as shown in Figure 2.8-1. The high cal originates in an avalanche diode noise source having ENR = 35 dB, is amplified by an amplifier with about 10 dB of net gain, and feeds through the main line of a 10 dB coupler to the dewar cal input. With 1 dB of other losses, the ENR referred to the receiver input is 35 + 10 - 1 - 34 = 10 dB which is 3000K excess noise temperature. The high cal is turned on by applying +28 volts to the HIGH CAL control line; this supplies the noise source (15 mA) and, through a 15 volt regulator, the 100 mA for the high cal amplifier. Note that when the high cal is not in use, the cal amplifier must also be turned off to prevent about 3 Kelvin of noise from being added to the receiver by the amplifier noise.

The normal cal signal originates in a second 35 dB ENR noise source which drives through a 3 dB pad into the -6 dB port of a second coupler and into the -10 dB port of the first coupler. Allowing 1 dB for losses, the ENR referred to the receiver input is 35 - 3 - 6 - 10 - 1 - 34 = -19 dB which is 3.7K. The CAL control line must supply +28 volts at 15 mA.

2.6 Cooled Amplifiers

The 3-stage FET amplifier is described in NRAO EDIR No. 259. The noise temperature budget for the cooled RF components is given in Table VII. The typical power dissipated by each amplifier is 0.2 watts (see heat load budget in Table IX).

2.7 Dewar Internal Wiring and Coaxial Lines

There are 16 wires between the 300K dewar RFI feedthru plate and the components at 15K and two wires to the polarizer temperature sensor. To reduce the heat load of these wires, a special brass wire is used. The wire is #32 soft brass (type 260) which gives a factor of 8 lower heat load and higher strength than copper at a sacrifice of 2.3 times greater resistance at 300K. It is coated with polyurethene insulation which can be burned off with a soldering iron and is bonded into a red/green pair with polyvinyl butral which can be dissolved with alcohol. The wire is part number B2322111-001 from MWS Precision Wire in Chatsworth, CA. Within the dewar the wires are cut to a length of about 12 inches and the total heat load for 16 wires (FET bias and 15K temperature

sensor) is 34 mW. For the 2 wires to the dewar heaters which must pass 0.21 amps, 12" of 7 x 38 AWG copper wire is used. The polarizer temperature sensor is connected with brass wires.

The heat flow and attenuation of various types of coaxial cables at cryogenic temperatures are given in NRAO EDIR No. 223. The coaxial lines from the polarizer to the amplifier plates are fabricated of approximately 3 inch lengths of .141" copper coaxial line, giving 0.01 dB loss at 15K. The .085" coaxial lines between the 15K components and 300K have approximately 0.6 dB of RF loss and conduct approximately 40 mW of heat each.

2.8 RF Card

All room temperature RF components are mounted on a printed circuit board (Figure 2.8-1) that is included in the front-end card cage. Semi-rigid coax connects the three dewar SMA feedthrus to the proper connectors on the RF Card. The noise sources and coupling networks are described in section 2.5; all of these are standard commercial components.

The room temperature post amplifier used in this front-end is described in specification A53205N001. The temperature coefficients of a Miteq amplifier SN 66815 purchased under this specification were measured as -0.02 dB/°C for gain, and -0.13 °/°C for phase.

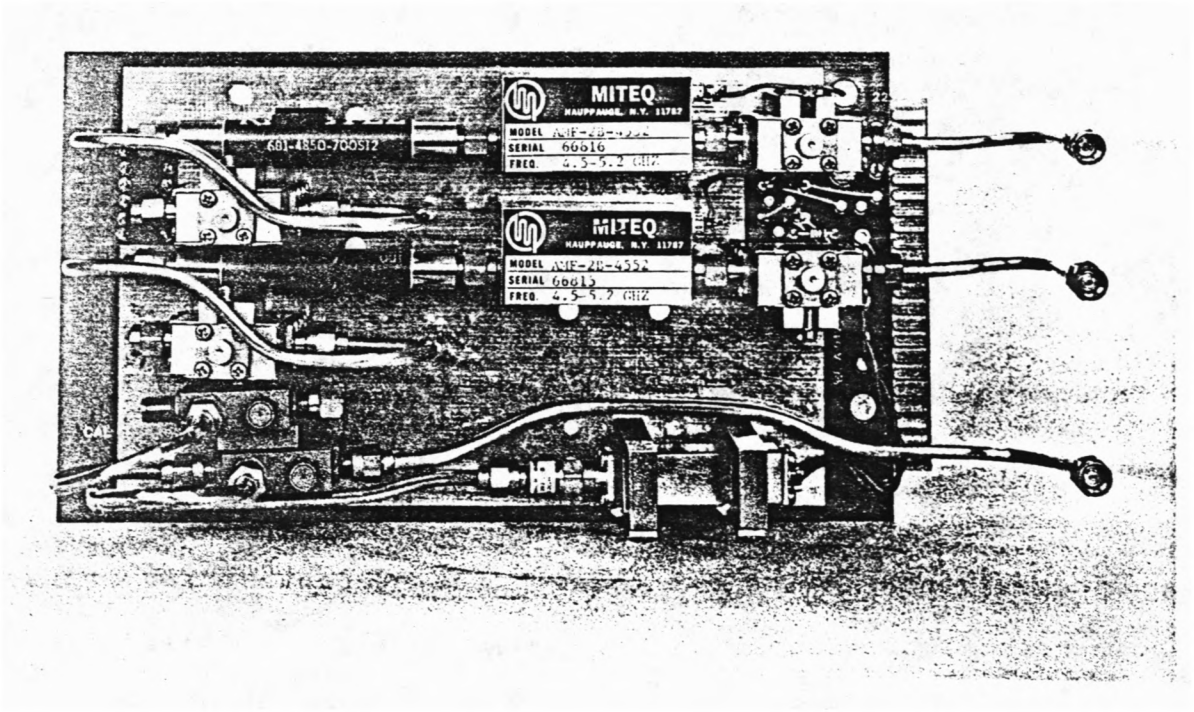


Figure 2.8-1

RF Card.

The high cal amp and noise source
are not mounted on this card.

The High Cal amplifier is a unit identical to the post amplifiers. An attenuator following the amplifier is selected such that the High Cal level is approximately 3000K. A regulator is required to reduce the 28 V cal drive voltage to the 15 volts required by the amplifier, and is mounted on the RF Card.

2.9 Refrigerator Power Supply

The refrigerator motor requires two-phase (90 degrees phase difference) AC power and will operate at 120 to 160 volts RMS at 50 to 60 Hz. The P111 Model 22 Power Supply is designed to provide the proper voltages, derived from 120 volt, 60 Hz, single-phase power; the schematic is shown in Figure 2.9-1. An isolation transformer is used in the P111 with an unloaded output voltage of 160 volts RMS. The shifted phase output is obtained with a RC network. The resistance consists of two 150 ohm, 50 watt, 1% wirewound resistors in series. Total power dissipated in the resistors is approximately 45 watts. The capacitor is a 4 μF oil-filled capacitor.

Included within the P111 is a device that senses the AC current delivered to the front-end. The current sensor produces a DC current proportional to the AC current (1 mA-DC/ 1 A-AC). A 10 K ohm resistor is provided across the DC terminals, resulting in a DC output voltage of 10 VDC/Amp when measured with a high impedance circuit. The DC sensor voltage is output on pins A and B of connector J3 on the front panel of the P111. These pins are normally wired to pins 1 and 2 of the front-end Auxiliary connector J4, so that the station computer can monitor the AC current via the Monitor/Control bus.

2.10 Front-end Card Cage

The card cage electrical interface signals are described in section 1.3 of this report. The card cage, the associated circuit cards, and test and calibration procedures are described in detail in a separate report. A preliminary version of the circuit cards are described in VLBA Technical Report No. 1.

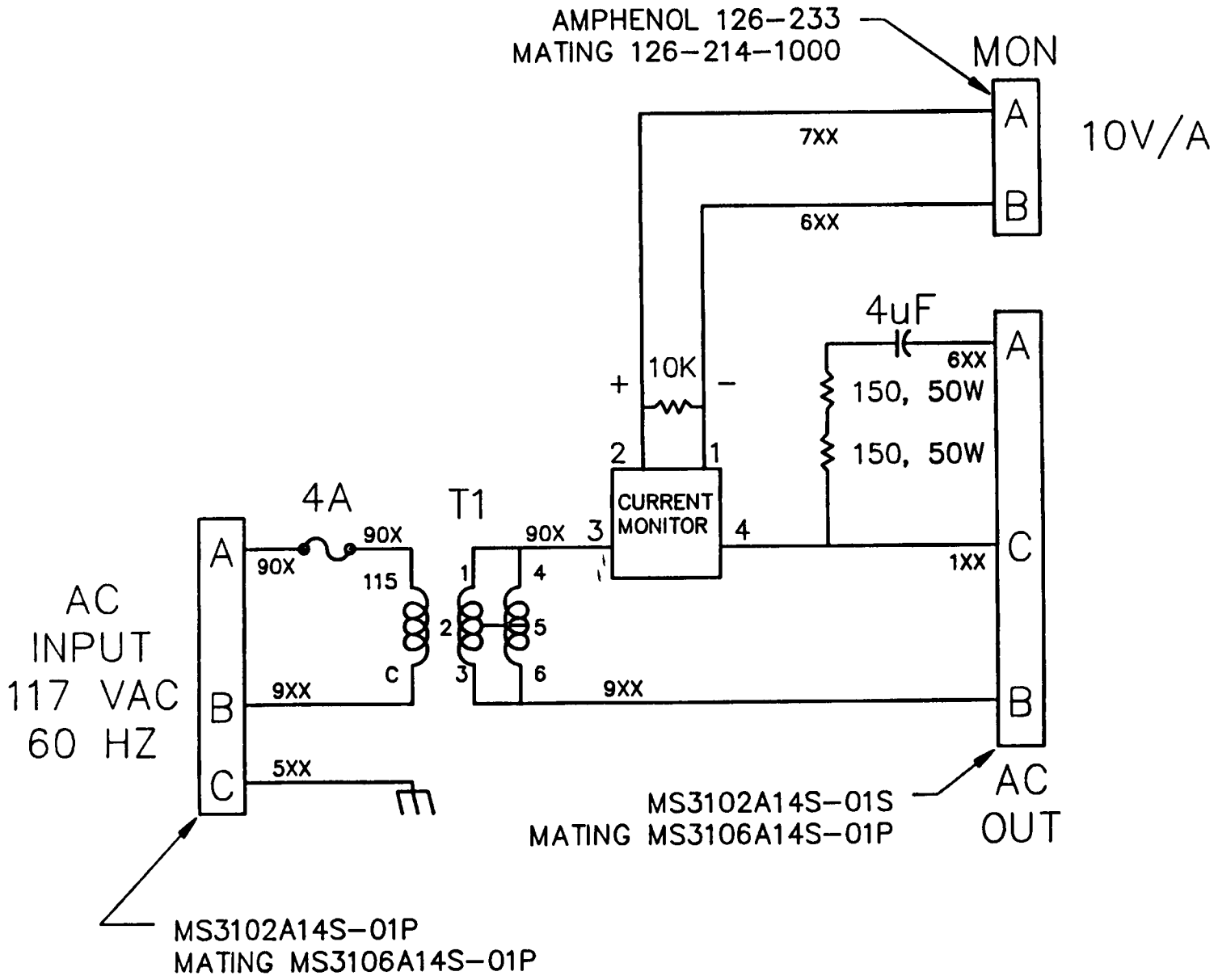


Figure 2.9-1

Schematic of Fill Refrigerator Power Supply

Section 3. TROUBLESHOOTING

3.0 Introduction

This section gives a few suggestions for locating and correcting problems that may be experienced with the system.

3.1 Low or No Gain

Check the cooled FET amplifier bias voltages. The gate voltages may be checked through the Monitor/Control bus, but if an abnormality is found, then the drain voltages and currents must be checked at test points on the bias cards. RF1 and LF1 are the amplifiers' first stage gate voltages. RF2 and LF2 is the voltage sum of the remaining stages' gate voltage. The signals RF1, RF2, LF1, and LF2 will normally range between 0 and -2 volts, and should not vary by more than ± .02 volts from the values recorded in the test data for each cooled amplifier. A value greater than zero volts (usually +14 volts) indicates insufficient drain current and less than -2 volts (usually -14 volts) indicates a drain circuit short. If a problem with a amplifier's bias conditions is noted, try replacing the applicable bias card. If that does not correct the problem, examine the Dewar Power connector, J3, and the dewar DC feedthrus for obvious problems. If all that fails, then the dewar will have to be opened to replace the amplifier.

If the cooled amplifiers' bias voltages are correct, measure the +15 V terminals on the postamps located on the RF Card in the card cage. If the +15 volts is not correct, unplug the RF Card

and measure the voltage at pin 2 of the card cage slot 1 connector. If that voltage is +15 ± 0.1 volts, then the RF Card should be replaced; otherwise, locate the problem with the 15 volt supply.

If all the DC voltages appear correct, check all the RF connections for tightness. It may be possible to isolate the problem by observing a total power indicator while tapping or shaking the cables and RF components. If not, the front-end will have to be removed for servicing.

3.2 Cooldown Failure

3.2.1 Refrigerator Motor Never Starts

The refrigerator motor will not start until the dewar vacuum becomes less than about 50 microns (4.5 volts on the V_D monitor). Check that the front-end is commanded to the COOL mode. Check that the vacuum valve solenoid is energized (indicator on the valve lit). If not, check that the pump vacuum (V_P monitor) is less than the dewar vacuum and that the PUMP REQ bit is high; if these appear reasonable, check that the AC voltage is present (an easy way is to unplug the AC cable from the card cage and plug it directly into the refrigerator motor). If the front-end vacuum valve is open, but the dewar and pump vacuums do not fall (refer to Section 2.1 for a discussion of the dewar pumping characteristics), command the front-end OFF to close the valve. The pump vacuum should then fall to near its blank-off pressure; if not, there is a problem with the pump or the vacuum manifold. If it does, there probably is a gross vacuum leak in the front-end dewar; refer to the next section.

If the dewar vacuum is less than 50 microns but the refrigerator still doesn't run, try connecting the AC power cable directly into the refrigerator motor. If it then runs, replace the control card in the card cage; if not, either the AC supply isn't working or the refrigerator will have to be serviced.

3.2.2 Refrigerator Runs, but System Doesn't Cool

In the event of a cool-down failure, it is often difficult to ascertain whether the problem is a vacuum leak which loads the refrigerator or a refrigerator problem which gives poor vacuum due to insufficient cryopumping. If initial checks of refrigerator motor current, refrigerator sound, and compressor supply and return helium pressures do not reveal the problem, it is necessary to warm up the front-end to room temperature and observe the vacuum with the refrigerator off. A leak tester may be necessary, but it is also possible to observe the rate of vacuum rise after pumping for greater than one hour at 300K. The system is then commanded to OFF (closes solenoid valve) and a vacuum rise rate greater than 10 micron/min is indicative of a leak. Petroleum ether sprayed around the dewar O-ring joints may help locate a gross leak; the mechanical vacuum pump will begin to labor when the petroleum ether enters the dewar.

Refer to Section 2.1.5 for precautions to observe when reassembling the dewar. The cause of vacuum leaks is most often a missing, dirty, or pinched O-ring, or loose bolts that cause an O-ring to be less than fully compressed.

APPENDIX I

Test Data Sample

4.8 GHz VLBA Front End
Final Test Report
Assembly 53205A001

Card Cage S/N: 501 Date: 29 MAY 1986
Dewar S/N: 501 Tested by: [illegible]

Record Components' Model/Serial Numbers:

1. Refrigerator: CTI MODEL 22 S/N 11C63428
2. Orthomode Transducer: _____
3. Monitor Card: MC-8
4. RCP Bias Card: BC-11
5. LCP Bias Card: BC-19
6. Sensor Card: SC-6
7. Control Card: CC-5
8. 15 K Temp Sensor: [illegible]
9. 50 K Temp Sensor: NOT AVAILABLE
10. RCP Cryogenic Amplifier: [illegible]
11. LCP Cryogenic Amplifier: [illegible]
12. RCP Bandpass Filter: MODEL 681-4850-400512 S/N 85-?
13. LCP Bandpass Filter: MODEL 681-4850-400512 S/N 85-7
14. RCP Post Amplifier: [illegible]
15. LCP Post Amplifier: MODEL APF-2B-4552 S/N 6681[illegible]
16. Low Cal Noise Source: MODEL NC 3205-G S/N 028
17. High Cal Noise Source: NOT INSTALLED
18. High Cal Noise Amplifier: NOT INSTALLED

Attach Strip Recording of Dewar Cool-Down.

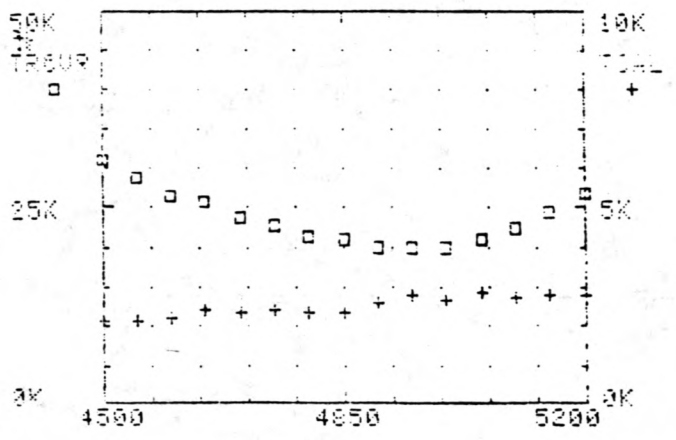
CALIBRATION RECORD OF 4.9 GHZ RECEIVER, SERIAL #1, MOD #0
RCP POLARIZATION, TESTED BY RDN
DATE 09/08/85 TIME 08:45.6
COMMENT: NONE

15K TEMP =	11.72	50K TEMP =	52.57	300K TEMP =	302.23		
AC AMPS =	0.273	DEWR VAC =	212	PUMP VAC =	10081		
HEMT LED =	14.41	+15 VOLT =	14.885	-15 VOLT =	-15.066		
CAL VOLT =	27.82	HIGH CAL =	27.63	SPARE =	-.01		
FETS: LF1=	-.571	LF2=	-.521	RF1=	-.836	RF2=	-.640

PARITY OK
CRYO MODE IS COOL (7) CONTROLLED BY CPR

08:52.8 09/08/85 THOT=294 TCOLD=77.93 TLN = 76.93

F,MHZ	TRCVR	TCAL	HI CAL	SHORT
4500	31.0	2.09	0.0	16.0
4550	28.4	2.07	0.0	16.0
4600	26.3	2.15	0.0	17.1
4650	25.5	2.34	0.0	16.7
4700	23.5	2.33	0.0	17.3
4750	22.6	2.40	0.0	17.1
4800	21.3	2.33	0.0	16.9
4850	20.7	2.29	0.0	17.2
4900	20.0	2.50	0.0	17.0
4950	19.8	2.79	0.0	17.3
5000	20.0	2.63	0.0	17.3
5050	20.8	2.84	0.0	17.5
5100	22.2	2.72	0.0	17.6
5150	24.3	2.74	0.0	17.6
5200	26.6	2.80	0.0	18.8



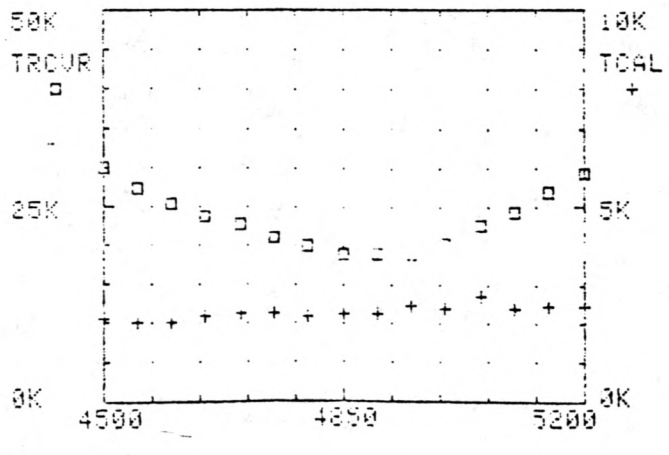
CALIBRATION RECORD OF 4.9 GHZ RECEIVER, SERIAL #1, MOD #0
LCP POLARIZATION, TESTED BY RDN
DATE 09/08/85 TIME 08:55.9
COMMENT: NONE

15K TEMP =	11.65	50K TEMP =	52.57	300K TEMP =	303.35
AC AMPS =	0.280	DEWR VAC =	213	PUMP VAC =	10078
HEMT LED =	14.41	+15 VOLT =	14.885	-15 VOLT =	-15.071
CAL VOLT =	27.82	HIGH CAL =	27.63	SPARE =	-.01
FETS: LF1=	-.572	LF2= -.522	RF1=	-.837	RF2= -.641

PARITY OK
CRYO MODE IS COOL (7) CONTROLLED BY CPR

09:02.9 09/08/85 THOT=294 TCOLD=77.93 TLN = 76.92

F,MHZ	TRCVR	TCAL	HI CAL	SHORT
4500	30.0	2.11	0.0	16.3
4550	27.3	1.97	0.0	16.4
4600	25.3	1.98	0.0	16.7
4650	23.6	2.17	0.0	16.8
4700	22.4	2.25	0.0	16.3
4750	20.9	2.25	0.0	16.5
4800	19.7	2.17	0.0	16.3
4850	19.0	2.26	0.0	16.2
4900	18.8	2.23	0.0	16.3
4950	19.0	2.43	0.0	16.2
5000	20.3	2.37	0.0	16.5
5050	22.4	2.71	0.0	16.2
5100	24.1	2.35	0.0	16.2
5150	26.9	2.43	0.0	16.1
5200	29.3	2.44	0.0	17.7

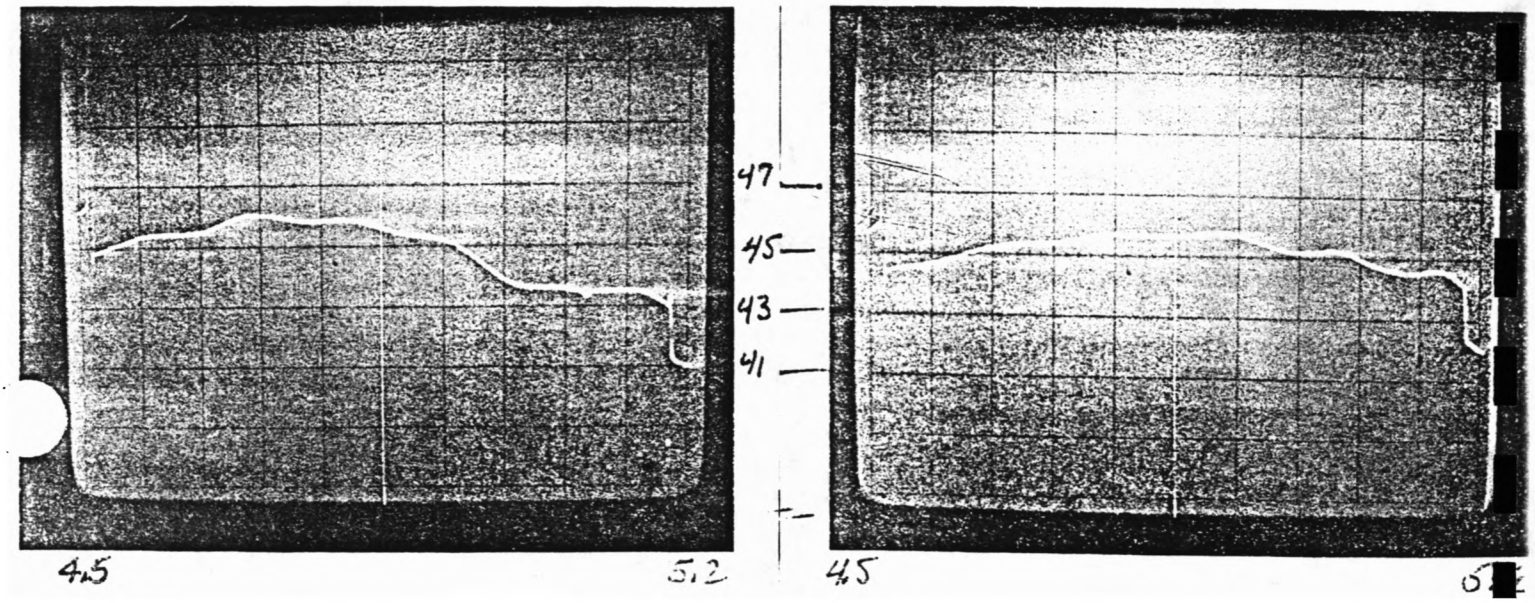


4.8 GHz VLBA Front End
Final Test Report
Assembly 53205A001

Card Cage S/N: _____ Date: 09/04/85
Dewar S/N: 501 Tested by: _____

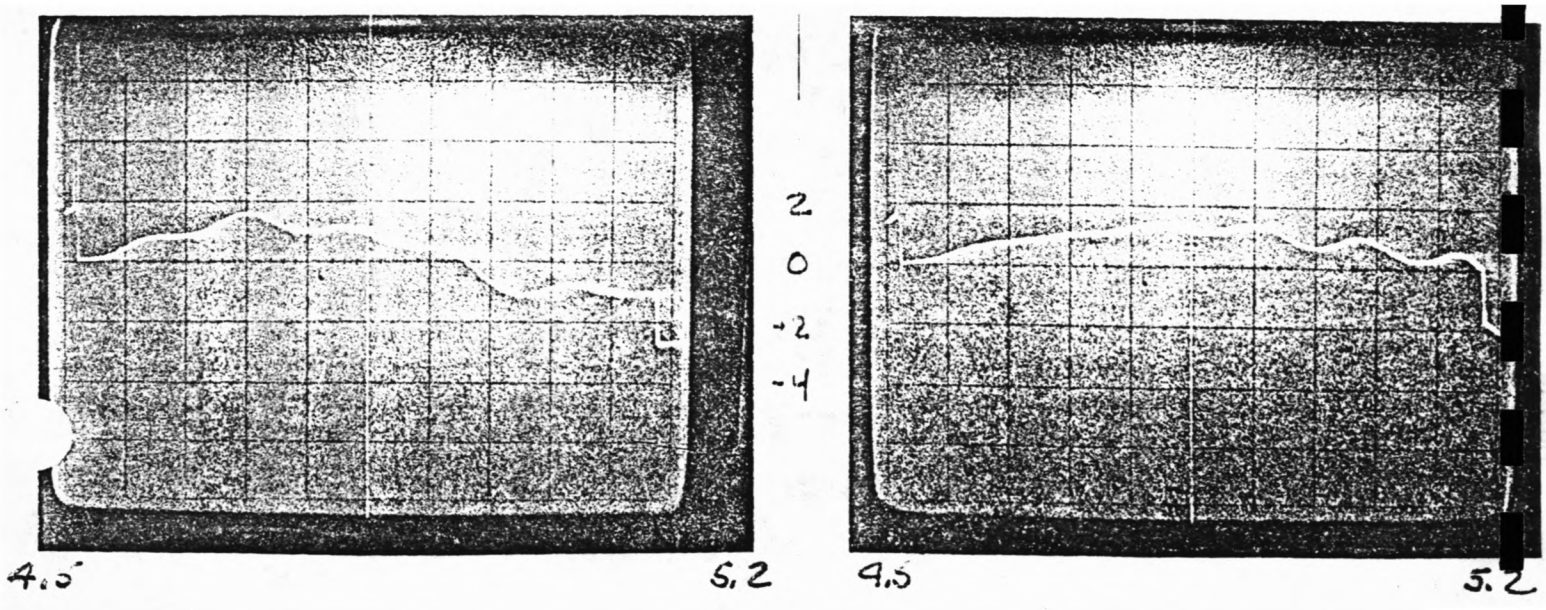
Gain-Dewar Flange to Output Connector (4.5-5.1 GHz):

L-Channel R-Channel



Gain-Phase Cal Input to Output Connector (4.5-5.1 GHz):

L-Channel R-Channel



4.8 GHz VLBA Front End
Final Test Report
Assembly 53205A001

Card Cage S/N: _____ Date: 29 JAN 1993
Dewar S/N: 501 Tested by: [illegible]

FET Bias Settings

Stage	L-Channel Amp #2,637-517				R-Channel Amp # C-004			
	V_D (V)	I_D (mA)	V_G 300 K	V_G 15 K (V)	V_D	I_D	V_G 300 K	V_G 15 K
1	5.00	.981	-.54	-.564	5.02	.995	-.73	-.829
2	5.01	1.50	-.48	-.531	5.00	1.50	-.43	-.493
3	5.01	1.50	-.45	-.495	4.01	1.51	-.71	-.798

Total RF Power Out
Measured with HP436/8484A Power Meter

Input Condition	At 15 K		At 300 K	
	L-Channel dBm	R-Channel dBm	L-Channel dBm	R-Channel dBm
302 K Load	-31.77	-31.07	-44.4	-43.3
79.7 K Load	-44.13	[illegible]	NA	NA
Short	[illegible]	[illegible]	-44.2	-43.1
Short + Cal	[illegible]	[illegible]	-44.2	-43.1
Short + HI Cal	NA	NA	NA	NA

4.8 GHz VLBA Front End -- Final Test Report -- Assembly 53205A001

Card Cage S/N: _____ Date: 9/[illegible]/8[illegible]

Dewar S/N: 501 Tested by: [illegible]

Output 1 dB Compression Point:

L-Channel			R-Channel		
4.6 GHz:	7.42	dBm	4.6 GHz:	6.60	dBm
4.85 GHz:	[illegible]	dBm	4.85 GHz:	[illegible]	dBm
5.1 GHz:	4.12	dBm	5.1 GHz:	5.07	dBm

Low Frequency Spectrum:

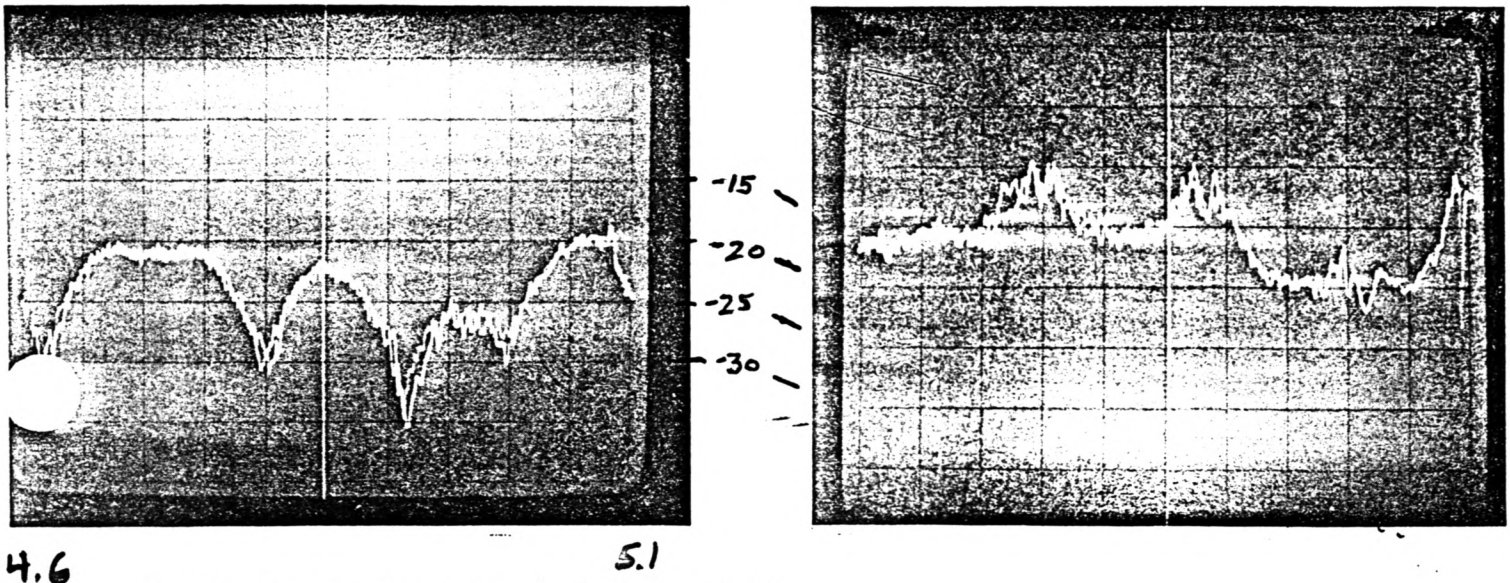
L-Channel	R-Channel
0-10 Hz	0-10 Hz
NOT AVAILABLE.	NOT AVAILABLE.
0-500 Hz	0-500 Hz
NOT AVAILABLE.	NOT AVAILABLE.

4.8 GHz VLBA Front End
Final Test Report
Assembly 53205A001

Card Cage S/N: 001 Date: 9/1/86
Dewar S/N: 501 Tested by: [illegible]

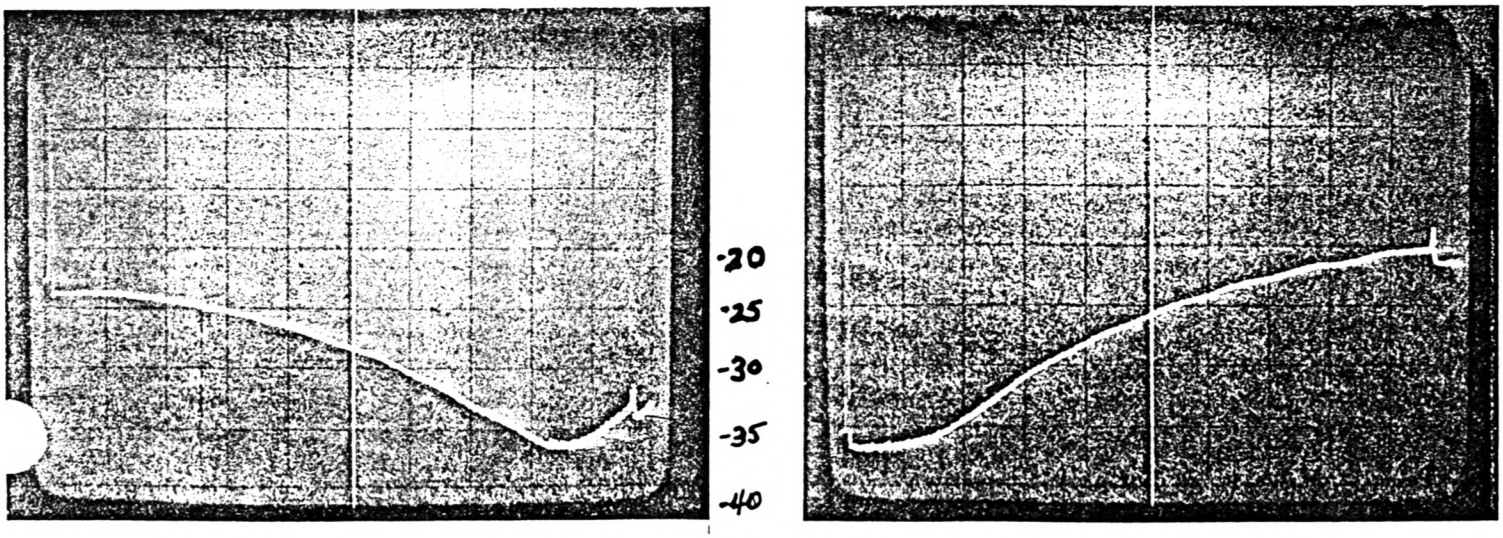
Input Return Loss (4.6-5.1 GHz):

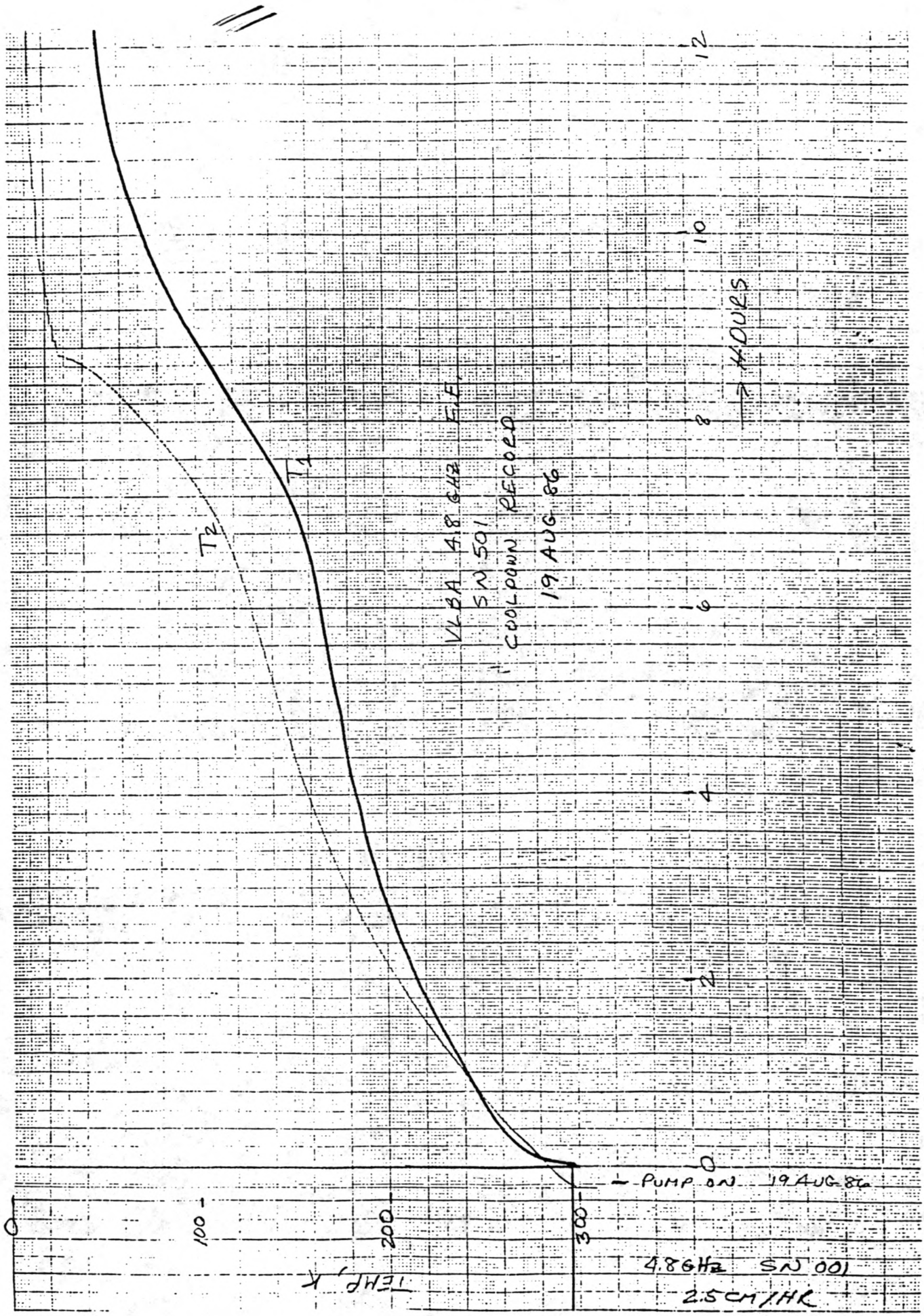
L-Channel R-Channel

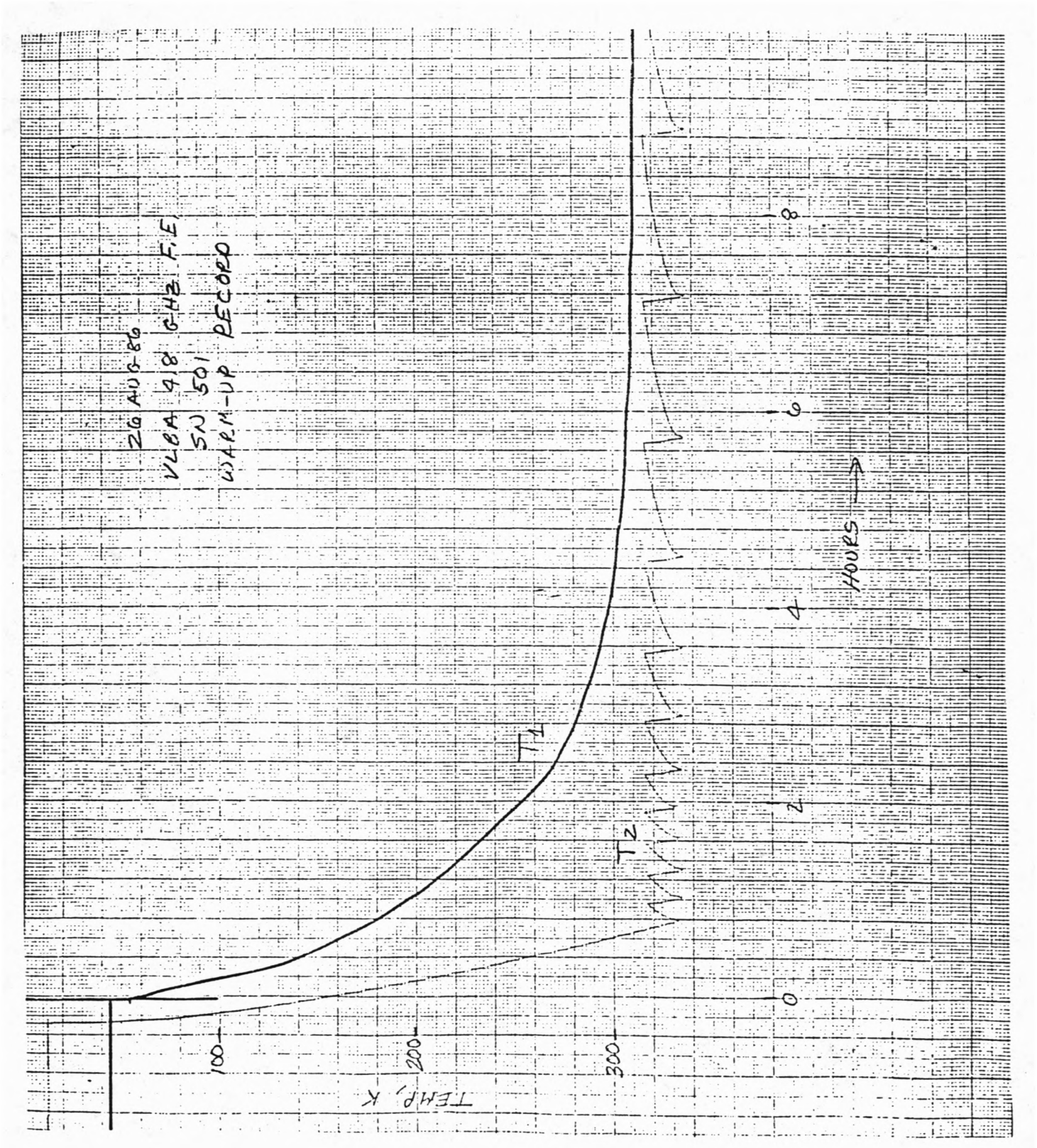


Output Return Loss (4.6-5.1 GHz):

L-Channel R-Channel




T1
T2
VLBA 4.8 GHz E-F
SN 501
COOLDOWN RECORDED
19 AUG 86
HOURS
0
2
4
6
8
10
12
PUMP ON 19 AUG 86
0
100
200
300
TEMP, K
4.8 GHz SN 001
2.5 CM/HR

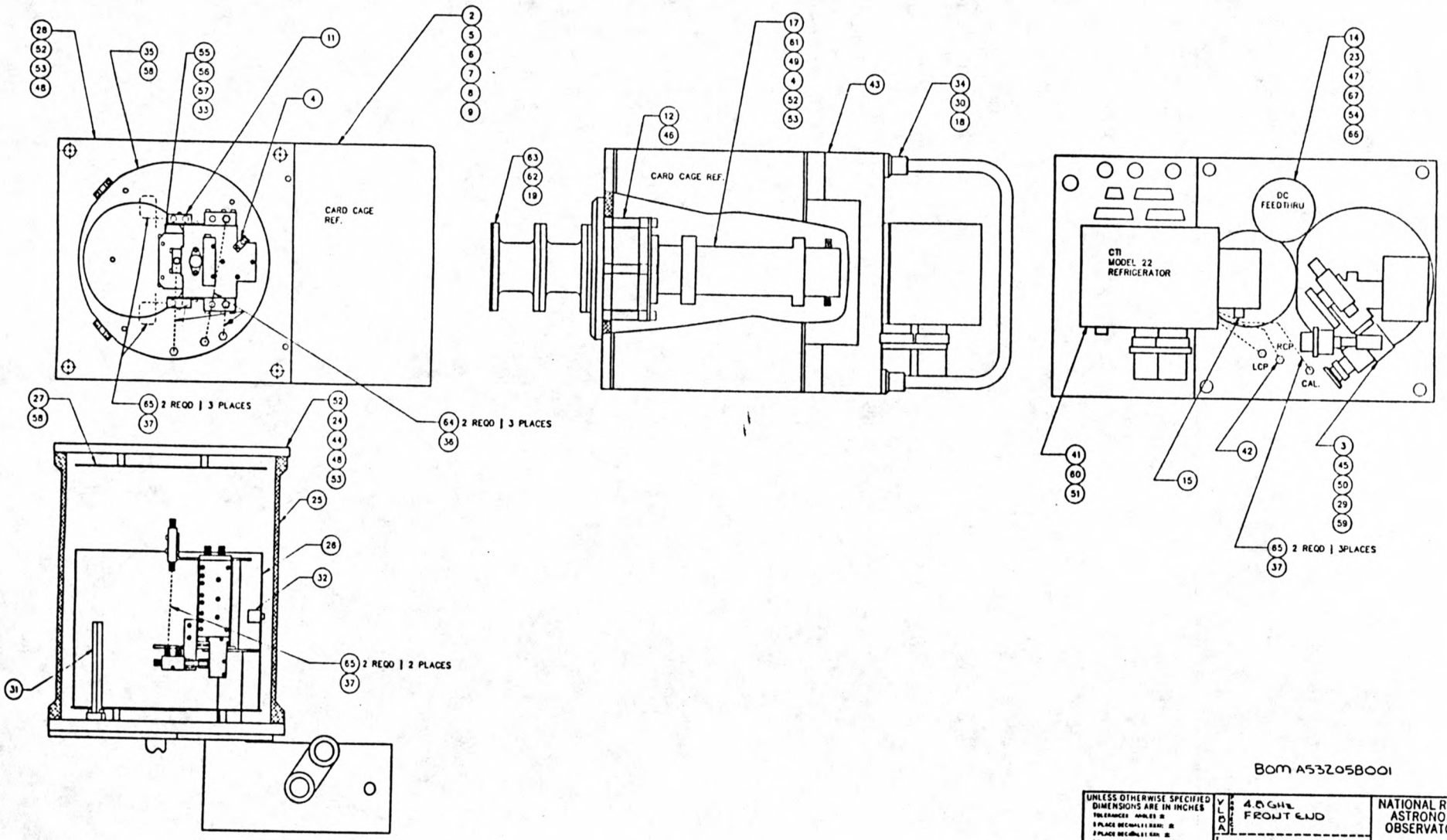

TEMP, K
100
200
300
0
2
4
6
8
HOURS
T1
T2
VLBA 4.8 GHz F.E.
SN 501
WARM-UP RECORD
2a AUG 96

APPENDIX II

Drawings and Bill of Materials

The front-end is documented in the VLBA drafting system and associated drawings are filed there. Included in this appendix are assembly drawings, wiring lists and diagrams, and bills of materials, from which all associated documentation can be determined. The following is a list of documents included here:

Drawing No.	Title
D53205A001	Assembly, 4.8 GHz Front-End
A53205B001	BOM, 4.8 GHz Front-End
D53205A002	Assembly, 15K Plate
A53205B002	BOM, 15K Plate
A53205A005	Assembly, RF Card
A53205B005	BOM, RF Card
C53205A006	Assembly, Thermal Transition
A53205B006	BOM, Thermal Transition
A53200A001	Assembly, Temperature Sensor
A53200B001	BOM, Temperature Sensor
D53206A005	Assembly, Card Cage
A53206B005	BOM, Card Cage
C53206A007	Assembly, Inspection Cover
A53206B007	BOM, Inspection Cover
B53206A008	Assembly, Solenoid
A53206B008	BOM, Solenoid
B53206A012	Assembly, Cable J1 to Dewar
A53206B012	BOM, Cable J1 to Dewar
A53206A013	Assembly, E.T.I.
A53206B013	BOM, E.T.I.
A53206W001	Wiring List, Card Cage



BOM A53205B001

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES	VLBA	4.0 GHz FRONT END	NATIONAL RADIO ASTRONOMY OBSERVATORY	
MATERIAL:		DEWAR ASSY	DRAWN BY G MORRIS	DATE 10/4
FINISH:			CHECKED BY	DATE
NEXT ASSY / USED ON			APPROVED BY	DATE
		SHEET NUMBER	DRAWING NUMBER D53205A001	REV.

BILL OF MATERIAL: A53205B001	TITLE: Dewar Assembly, 4.8 GHz F.E.	APPROVED BY/DATE:	PREPARED BY/DATE: R.Norrod 10/9/86	REV: DATE:

Item	Qty. Req.	Description	Designation	P/N	Suggested Manufacturer
1.	Ref	Assembly Dwg - Dewar		53205A001	NRAO
2.	1	Assembly -- Card Cage		D53206A005	NRAO
3.	1	Assembly -- Inspection Cover		C53206A007	NRAO
4.	1	Assembly -- Temperature Sensor		A53200A001	NRAO
5.	1	Assembly -- RF Card		A53205A005	NRAO
6.	2	Assembly -- Bias Card		D53206A002	NRAO
7.	1	Assembly -- Control Card		D53200A004	NRAO
8.	1	Assembly -- Monitor Card		D53200A006	NRAO
9.	1	Assembly -- Sensor Card		D53200A003	NRAO
10.					
11.	1	Assembly -- 15 K Plate		D53205A002	NRAO
12.	1	Assembly -- Thermal Transition		A53205A006	NRAO
13.					
14.	1	Assembly -- DC Feedthru		B53206A012	NRAO
15.	1	Assembly -- Timer		A53206A013	NRAO
16.					
17.	1	Polarizer (Spec Type B)		A53200N001	Atlantic Microwave
18.	4	1/4 - 20 X 1/2 SHCS			All Metal
19.	1	Quick-Release Waveguide Clamp		KF-50 18345	Leybold
20.					

Continued

BILL OF MATERIAL: A53205B001	TITLE: Dewar Assembly, 4.8 GHz F.E.	APPROVED BY/DATE:	PREPARED BY/DATE: R.Norrod 10/9/86	REV: DATE:

Item	Qty. Req.	Description	Designation	P/N	Suggested Manufacturer
21.					
22.					
23.	1.	DC Feedthru Cover		A53206M060	NRAO
24.	1	Dewar Top Plate		C53205M005	NRAO
25.	1	Dewar Cylinder		D53205M006	NRAO
26.	1	Dewar Side Shield		B53205M007	NRAO
27.	1	Dewar Top Shield		A53205M008	NRAO
28.	1	Dewar Bottom Plate		D53200M027	NRAO
29.	1	Dewar Inspection Shield		A53206M018	NRAO
30.	2	Dewar Handle		B53206M020	NRAO
31.	2	Dewar Shield Support		A53206M009	NRAO
32.	1	Dewar 70 K Shield Connection		A53206M010	NRAO
33.	1	Polarizer Cold Strap		A53205M009	NRAO
34.	4	Handle Collar		A53206M019	NRAO
35.	1	Bottom Shield		C53206M021	NRAO
36.	AR	.086 Diameter Stainless Steel Semi-Rigid Coax			
37.	AR	.141 Diameter Copper Semi-Rigid Coax			
38.					
39.					
40.					

Continued

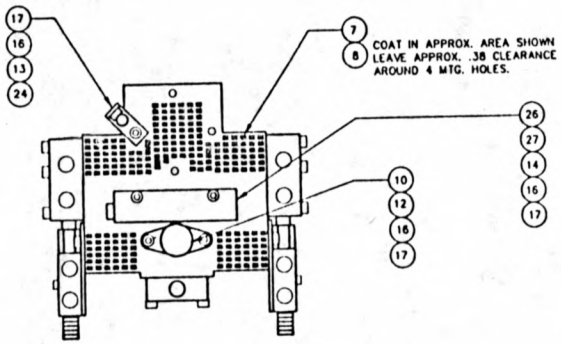
BILL OF MATERIAL: A53205B001	TITLE: Dewar Assembly, 4.8 GHz F.E.	APPROVED BY/DATE:	PREPARED BY/DATE: R.Norrod 10/9/86	REV: DATE:

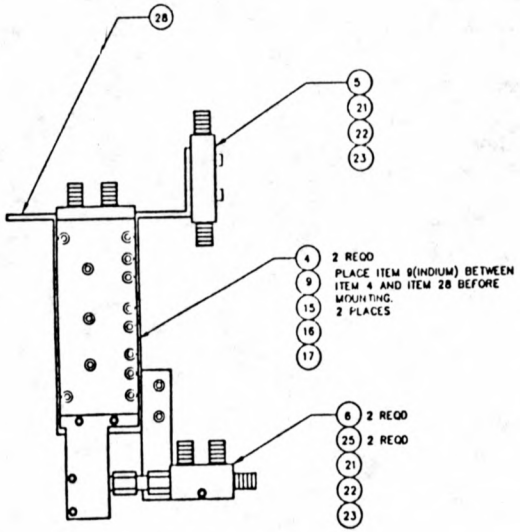
Item	Qty. Req.	Description	Designation	P/N	Suggested Manufacturer
41.	1	Cryogenic Refrigerator		Model 22	CTI
42.	3	SMA Feedthru (hermetic)		208	Omni-Spectra
43.	1	Card Cage Bracket		B53205M014	NRAO
44.	2	O-Ring (cylinder)		2-270	Parker
45.	1	O-Ring (inspection cover)		2-251	Parker
46.	1	O-Ring (thermal transition)		2-253	Parker
47.	1	O-Ring (bias feedthru)		2-130	Parker
48.	11	10-32 x 1 Socket Head Cap Screws			All Metal
49.	4	10-32 x 1/2 SHCS			All Metal
50.	6	8-32 x 3/8 SHCS			All Metal
51.	2	10-32 x 5/8 SHCS			All Metal
52.	15	#10 Flat Washers			All Metal
53.	17	#10 Lock Washers			All Metal
54.	4	#8 Lock Washers			All Metal
55.	5	6-32 x 3/8 SHCS			All Metal
56.	5	#6 Flat Washers			All Metal
57.	5	#6 Lock Washers			All Metal
58.	8	Nylon Standoffs			
59.	3	Nylon Standoffs (inspection cover)			
60.	1	O-Ring (refrigerator)		2-144	Parker

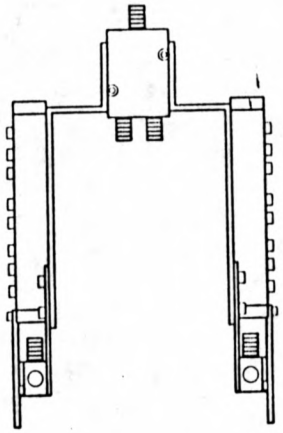
Continued --

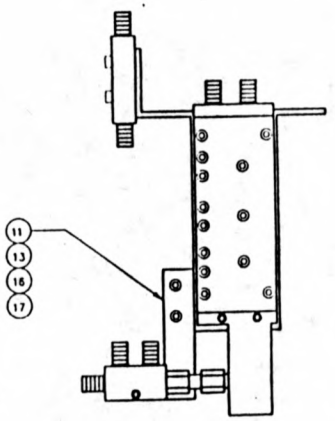
BILL OF MATERIAL: A53205B001	TITLE: Dewar Assembly, 4.8 GHz F.E.	APPROVED BY/DATE:	PREPARED BY/DATE: R.Norrod 10/9/86	REV: DATE:

Item	Qty. Req.	Description	Designation	P/N	Suggested Manufacturer
61.	REF	Polarizer Outline and Modification		B53205M018	NRAO
62.	1	Waveguide Cover		B53205M012	NRAO
63.	1	Waveguide Extension		B53205M011	NRAO
64.	6	Coax Connectors (.086)		201-2A	Omni-Spectra
65.	14	Coax Connectors (.14)		2001-7641-02	Omni-Spectra
66.	2	8-32 x 3/4 SHCS			All-Metal
67.	2	Male-Female Spacers 8-32 x 1/2		60855	Waldom









BOM A53205B002

		UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES: ANGLES ± 2 PLACE DECIMALS .XX ± 3 PLACE DECIMALS .XXX ± 4 PLACE DECIMALS .XXXX ±	VLBA	4 GHz FRONT END 15K PLATE ASSY
		MATERIAL:		
		FINISH:		
NEXT ASSY	USED ON			

NATIONAL RADIO ASTRONOMY OBSERVATORY

DRAWN BY G. Morris DATE 10-5-
DESIGNED BY DATE
APPROVED BY DATE

SHEET NUMBER | DRAWING NUMBER D53205A002 | REV | SCALE 1" = 1

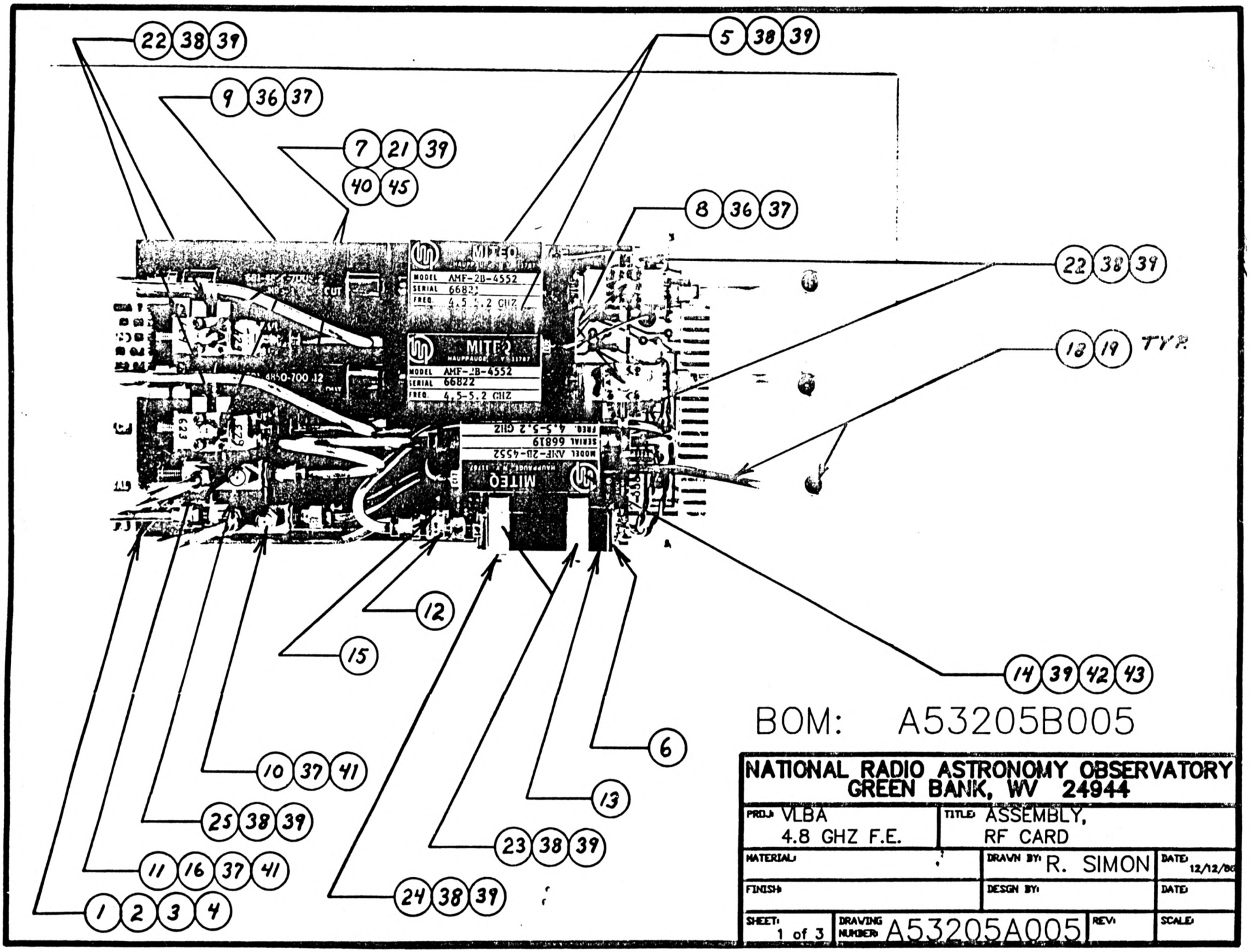
BILL OF MATERIAL: A53205B002	TITLE: 15 K Plate, 4.8 GHz F.E.	APPROVED BY/DATE:	PREPARED BY/DATE: EDN 9/3/86	REV: DATE:

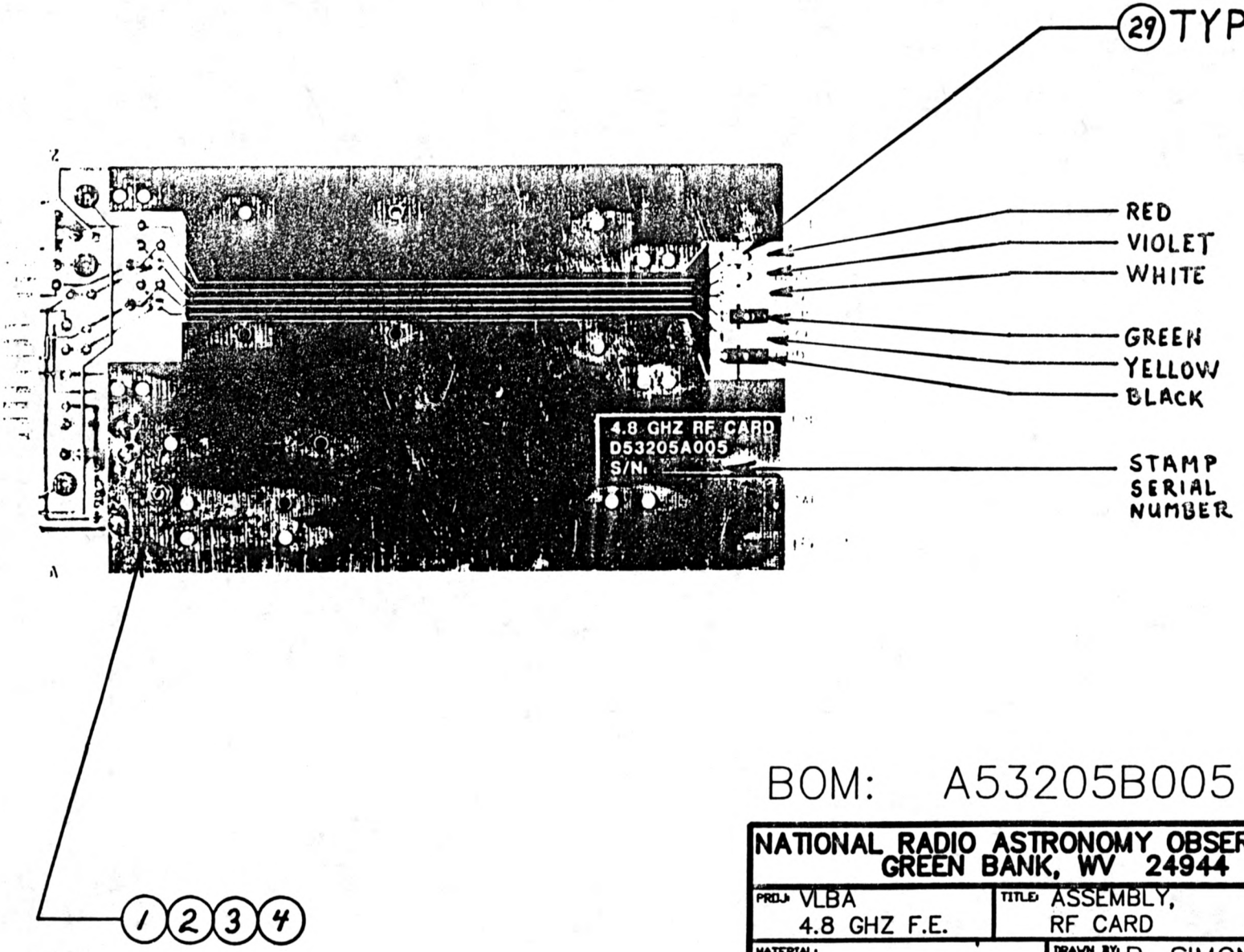
Item	Qty. Req.	Description	Designation	P/N	Suggested Manufacturer
1.	Ref	Assembly -- 15 K Plate		D53205A002	NRAO
2.					
3.					
4.	2	Cryogenic Amplifier, 4.8 GHz FET		A53205B101	NRAO
5.	1	Power Splitter		PN 2089-6203-00-FSC-16179	Omni-Spectra
6.	2	30 dB Couplers		4014C-30	Narda
7.	AR	Epoxy		A-12	Armstrong
8.	AR	Activated Carbon		Grade JXC 6X8 Mesh	Witco
9.	AR	Indium			
10.	1	Thermostat			
11.					
12.	2	4-40 x 3/8			All Metal
13.	4	4-40 x 1/2			All Metal
14.	2	4-40 x 5/8			All Metal
15.	8	4-40 x 7/8			All Metal
16.	16	#4 Flat Washers			All Metal
17.	16	#4 Lock Washers			All Metal
18.	4	6-32 X 1/2 SHCS			All Metal
19.	4	#6 Flat Washers			All Metal
20.	4	#6 Lock Washers			All Metal

Continued --

BILL OF MATERIAL:	TITLE:	APPROVED BY/DATE:	PREPARED BY/DATE:	REV: DATE:
A53205B002	15 K Plate, 4.8 GHz F.E.	RDN		

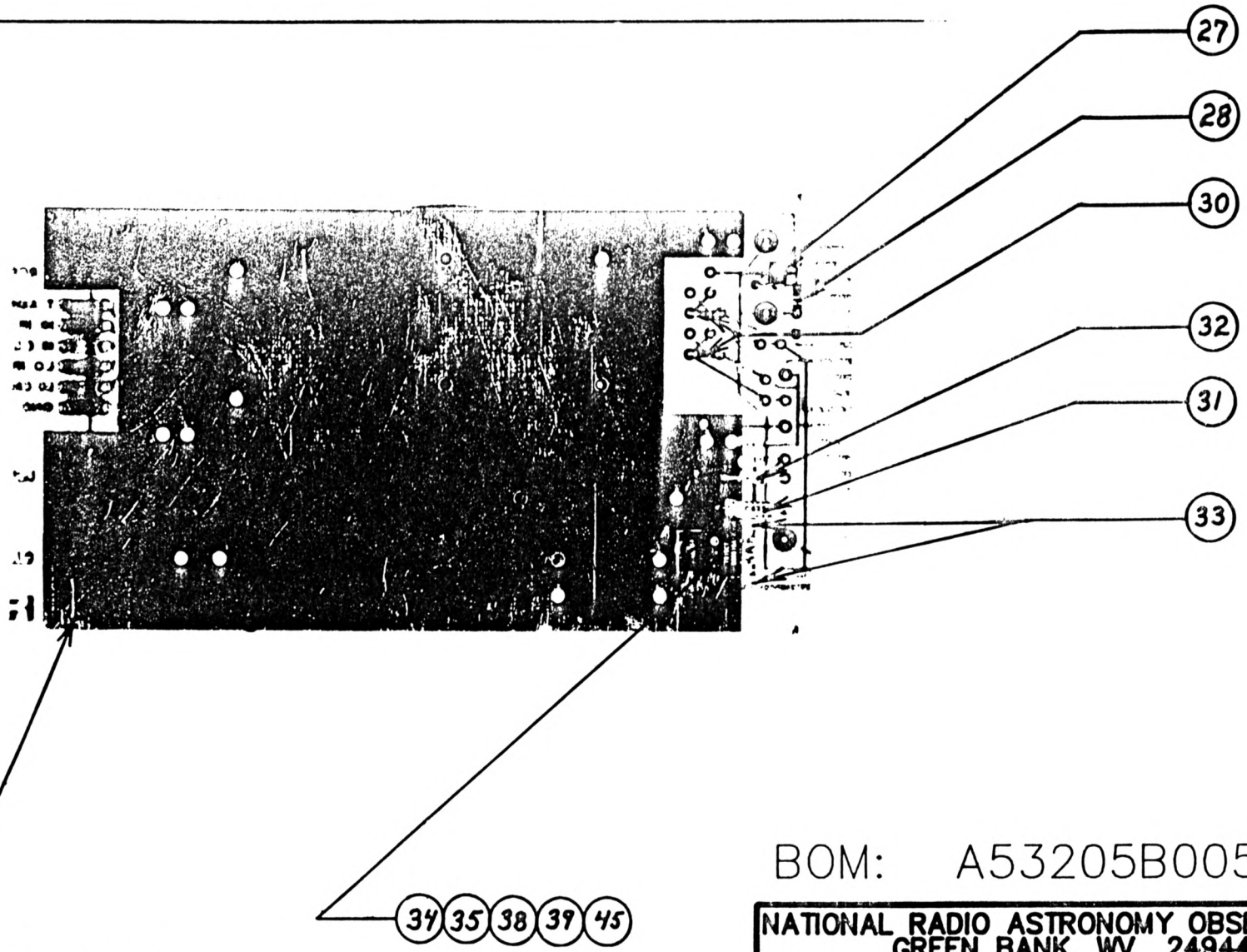
Item	Qty. Req.	Description	Designation	P/N	Suggested Manufacturer
21.	4	2-56 x 7/8			All Metal
22.	8	#2 Flat Washers			All Metal
23.	4	#2 Lock Washers			All Metal
24.	1	Assembly -- Temperature Sensor		A53200A001	NRAO
25.	2	SMA Barrels			Omni-Spectra
26.	1	Heater		SC 252.25	Hotwatt
27.	1	Heater Clamp		A53206M056 -01	NRAO
28.	1	15 K Cold Plate		C53205M016	NRAO


22 38 39
5 38 39
9 36 37
7 21 39
40 45
8 36 37
22 38 39
18 19 TYP.
MITEQ
MODEL AMF-2B-4552
SERIAL 6682
FREQ. 4.5-5.2 GHZ
MITEQ
MODEL AMF-2B-4552
SERIAL 66822
FREQ. 4.5-5.2 GHZ
12
15
14 39 42 43
BOM: A53205B005
6
10 37 41
13
25 38 39
23 38 39
11 16 37 41
24 38 39
1 2 3 4
NATIONAL RADIO ASTRONOMY OBSERVATORY
GREEN BANK, WV 24944
PROJ: VLBA
4.8 GHZ F.E.
TITLE: ASSEMBLY,
RF CARD
MATERIAL:
DRAWN BY: R. SIMON
DATE: 12/12/86
FINISH:
DESIGN BY:
DATE:
SHEET: 1 of 3
DRAWING NUMBER: A53205A005
REV:
SCALE:



BOM: A53205B005

NATIONAL RADIO ASTRONOMY OBSERVATORY GREEN BANK, WV 24944			
PROJ: VLBA 4.8 GHZ F.E.	TITLE: ASSEMBLY, RF CARD		
MATERIAL:	DRAWN BY: R. SIMON		DATE: 12/12/86
FINISH:	DESGN BY:		DATE:
SHEET: 2 of 3	DRAWING NUMBER: A53205A005	REV:	SCALE:



BOM: A53205B005

NATIONAL RADIO ASTRONOMY OBSERVATORY GREEN BANK, WV 24944			
PROJ: VLBA 4.8 GHZ F.E.	TITLE: ASSEMBLY, RF CARD		
MATERIAL:	DRAWN BY: R. SIMON		DATE: 12/12/86
FINISH:	DESGN BY:		DATE:
SHEET: 3 OF 3	DRAWING NUMBER: A53205A005	REV:	SCALE:

Sheet 1 of 3

BILL OF MATERIAL:	TITLE:	APPROVED BY/DATE:	PREPARED BY/DATE:	REV: DATE:
A53205B005	RF Card Assembly, 4.8 GHz F.E.		12/12/86	

Item	Qty. Req.	Description	Designation	P/N	Suggested Manufacturer
1.	REF	RF Card Artwork		53205Q001	NRAO
2.	REF	Assembly, RF Card		53205A005	NRAO
3.	REF	RF Card Drill Drawing		53205P001	NRAO
4.	REF	RF Card Schematic		53205S002	NRAO
5.	2	Post-Amp		A53205N001	Miteq
6.	1	Cal Noise Source w/option SMA Female Output		NC3205G	NoiseCom
7.	2	Bandpass Filter w/Mounting Clips		6B1-4850 -700S12	Reactel
8.	2	Isolator, SMA Male In/Female Out		V3I-4080-1	Virtech
9.	2	Isolator, SMA Female In/Out		V3I-4080	Virtech
10.	1	Coupler, 6 dB, 4.8 GHz		2020-6616 -06	OSM
11.	1	Coupler, 10 dB, 4.8 GHz		20200-6617 -10	OSM
12.	1	Attenuator, CAL (Select in Test)		292-XX	Midwest MW
13.	1	High Cal Noise Source w/SMA Female Out (Optional)		NC3205G	NoiseCom
14.	1	High Cal Amplifier (Optional)		A53205N001	Miteq
15.	1	Attenuator, Select in Test (if items 13-14 installed)		292-XX	Midwest MW
16.	1	Termination (use if items 13-15 not installed)		4112P	EMC
17.					
18.	AR	Semi-rigid coax cable, .141 Dia.			
19.	18	SMA Connector for .141 cable			
20.					

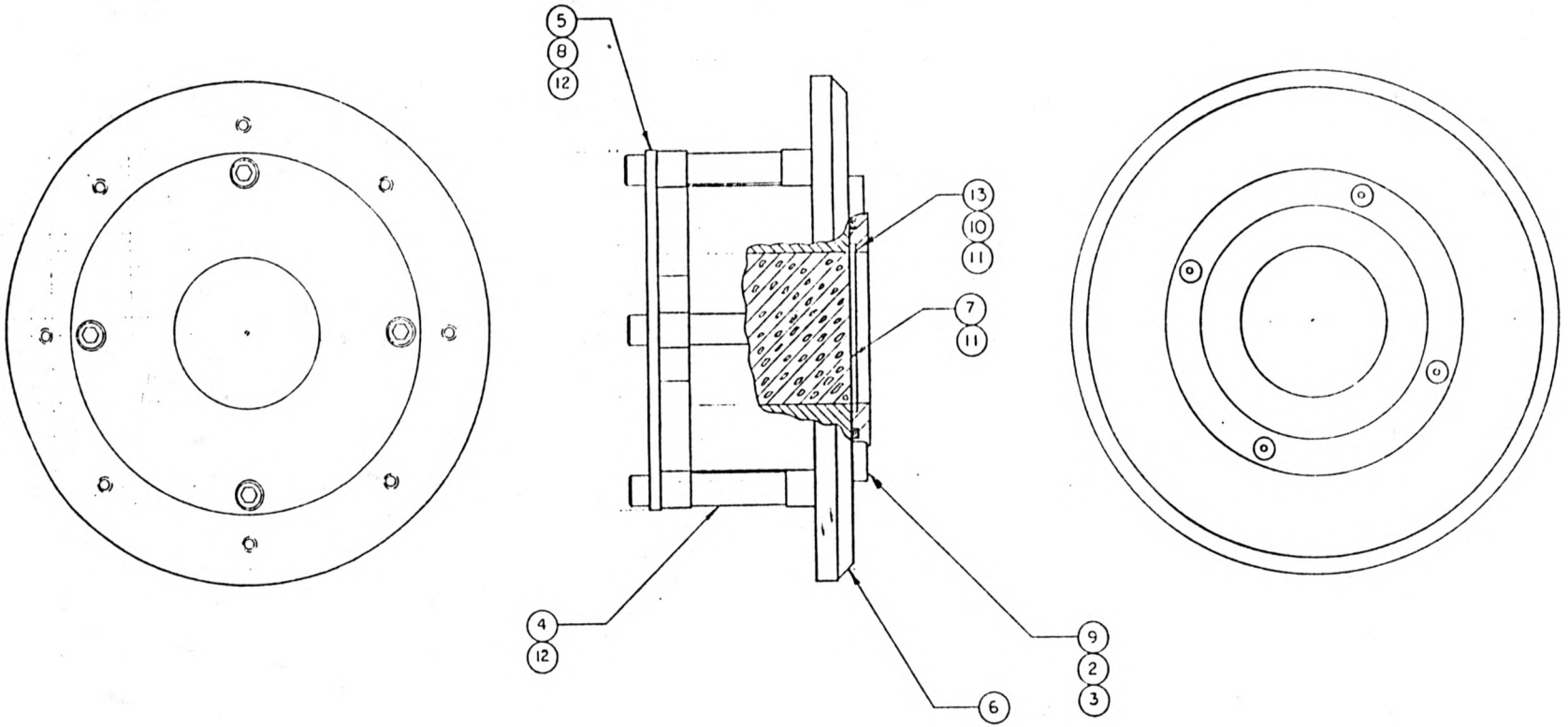
Sheet 2 of 3

BILL OF MATERIAL:	TITLE:	APPROVED BY/DATE:	PREPARED BY/DATE:	REV: DATE:
A53205B005	RF Card Assembly, 4.8 GHz F.E.		12/12/86	

Item	Qty. Req.	Description	Designation	P/N	Suggested Manufacturer
21.	2	Filter Clip Spacer		B53205M017	NRAO
22.	4	Isolator Support		B53205M019	NRAO
23.	2	Mount, Noise Source		A53206M033	NRAO
24.	2	Clamp, Noise Source		A53206M034	NRAO
25.	1	Mount, Coupler		A53206M032	NRAO
26.					
27.	1	Temperature Sensor		LM335AZ	National
28.	1	Resistor, 12K, 5%		RC079F123J	Allen-Bradley
29.	6	Test Jack (1 ea. Blk, Yel, Grn, Wht, Vio, Red)		105-07XX -001	E.F. Johnson
30.	2	Resistor, 1 ohm, 0.1%		RN55C	Dale
31.	1	Capacitor, 15 µF, 20V, Tantalum			
32.	1	Transient Suppressor, 15 V		MPTE-15	General Semiconductor
33.	2	Capacitor, 0.22 µF (when item 14 installed)			
34.	1	Voltage Regulator (when item 14 installed)		7815CT	Motorola
35.	AR	Heat Sink Compound		340	Dow
36.	4	SHCS, 2-56 X 3/8			
37.	6	FLAT WASHER, #2			
38.	25	SHCS, 4-40 X 1/4			
39.	29	FLAT WASHER, #4			
40.	2	SHCS, 4-40 X 3/8			

BILL OF MATERIAL:	TITLE:	APPROVED BY/DATE:	PREPARED BY/DATE:	REV: DATE:
A53205B005	RF Card Assembly, 4.8 GHz F.E.		12/12/86	

Item	Qty. Req.	Description	Designation	P/N	Suggested Manufacturer
41.	2	SHCS, 2-56 X 5/8			
42.	2	CLEARANCE SPACER, #4 X 3/4 LONG			
43.	2	SHCS, 4-40 X 7/8			
44.	AR	#22 STRANDED WIRE			
45.	3	HEX NUT, 4-40			

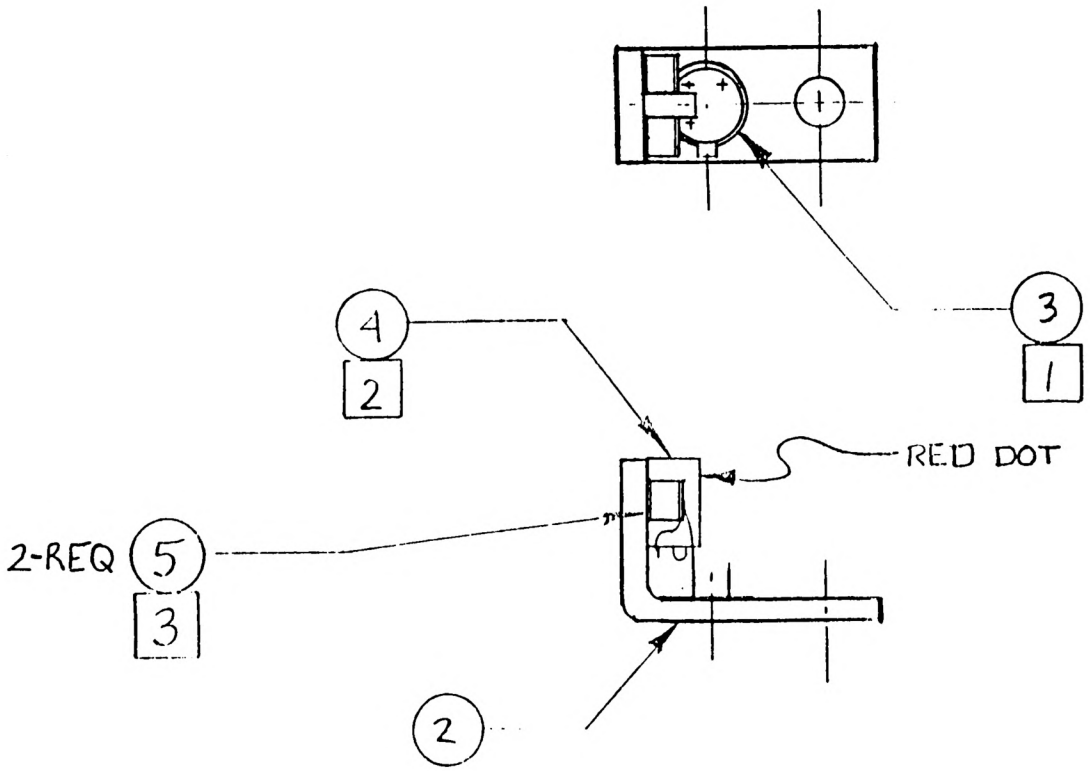


BOM A53205B006

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES: ANGLES ± 3 PLACE DECIMALS (.XXX): ± 2 PLACE DECIMALS (.XX): ± 1 PLACE DECIMALS (.X): ±	VLBA PROJECT	4.8 FRONT END	NATIONAL RADIO ASTRONOMY OBSERVATORY	
MATERIAL:	TITLE	THERMAL TRANSITION ASSY	DRAWN BY G.MORRIS	DATE 10-86
			DESIGNED BY	DATE
FINISH:			APPROVED BY	DATE
NEXT ASSY / USED ON		SHEET NUMBER / DRAWING NUMBER C53205A006	REV.	SCALE 1:1

BILL OF MATERIAL: A53205B006	TITLE: Thermal Transition, 4.8 GHz F.E.	APPROVED BY/DATE:	PREPARED BY/DATE: R. Norrod 10/9/86	REV: A DATE:

Item	Qty. Req.	Description	Designation	P/N	Suggested Manufacturer
1.	Ref	Assembly - Thermal Transition		53205A006	NRAO
2.	4	FHCS, 6-32 x 1/4 LG.			All Metal
3.	1	O-Ring (Window Ring)		2-141	Parker
4.	4	Support Tube		B53205M002	NRAO
5.	1	Polarizer Ring		B53205M001	NRAO
6.	1	Dewar Cap		C53205M004	NRAO
7.	1	Window Insert		A53205M010	NRAO
8.	4	1/4-20X3/8 Socket Head Cap Screws			All Metal
9.	1	Window Ring		B53205M003 -1	NRAO
10.	1	Window Holding Ring		B53205M003 -3	NRAO
11.	AR	Epoxy		A-12	Armstrong
12.	AR	Lock-Tite			
13.	AR	Saran-Wrap			



NOTES

[1] SOLDER W/20F2
ALIGN AS SHOWN

[2] SOLDER W/ 60/40 RC
PAINT RED DOT ON SIDE OF CONNECTER INDICATED WITH ARROW.
EPOXY CONNECTOR BTTWEEN CAPACITOR BLOCKS

[3] SOLDER CAPACITOR AND LEADS W/ SN62 SOLDER.

(1) BOM A53200B001

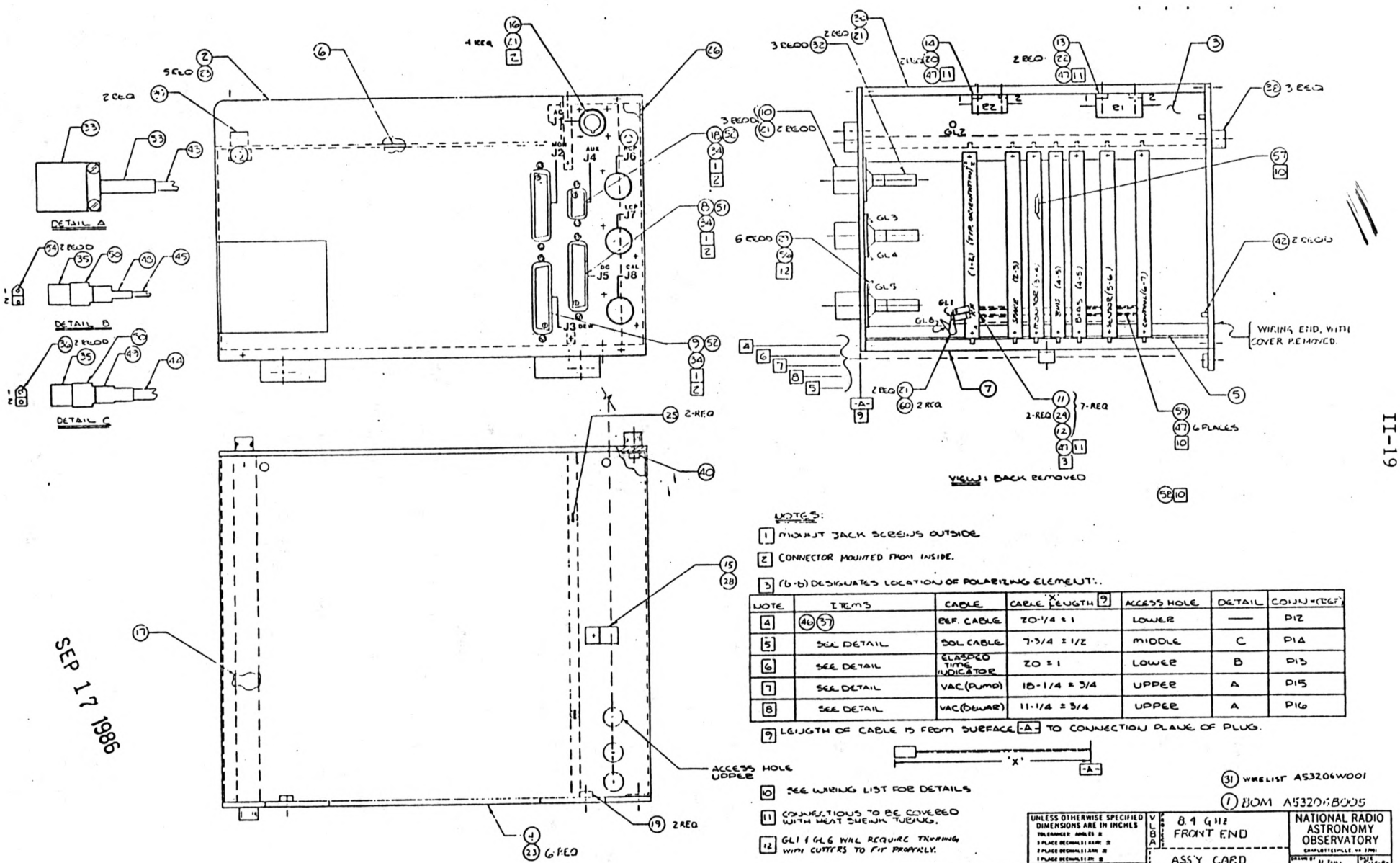
NATIONAL RADIO ASTRONOMY OBSERVATORY
VLBA

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ANGLES ± 3 PLACE DEC.(xxx) ± 2 PLACE DEC.(xx) ± 1 PLACE DEC. (x) ±	PROJ: COMMON F.E.	TITLE: ASS'Y TEMP. SENSOR	
	MATERIAL: ~	DRAWN BY: HDILL	DATE: 890530
		DESIGNED BY:	DATE:
	FINISH: ~	APPROVED BY:	DATE:
	SHEET NUMBER: 1:1	DRAWING NUMBER: A53200A001 REV.	SCALE: 2X

Page No. 1 A53200B001-BOM TEMPERATURE SENSOR
09/15/86

NRAO-BILL OF MATERIALS

ITEM	MANUFACTURER	PART NUMBER	DESCRIPTION	QUAN
0	NRAO	A53200A001	ASS'Y TEMPERATURE SENSOR	0
1	NRAO	A53200B001	BOM TEMPERATURE SENSOR	0
2	NRAO	A53200M002	TEMP SENSOR MOUNT	1
3	LAKE SHORE	DT-500-KL	M/N DT-500KL silicon diode temperature sensors	1
4	MICROTECH	GF-2	CONNECTOR, 2 SOCKET	1
5	ATC	100-B-681-M-P-50	Chip capacitor 680pf	2



NOTES:

1. MOUNT JACK SCREWS OUTSIDE
2. CONNECTOR MOUNTED FROM INSIDE.
3. (6-6) DESIGNATES LOCATION OF POLARIZING ELEMENT.

NOTE	ITEMS	CABLE	CABLE LENGTH [9]	ACCESS HOLE	DETAIL	CONN (REF)
4	(46) (37)	REF. CABLE	20-1/4 ± 1	LOWER	—	P12
5	SEE DETAIL	SOL CABLE	7-3/4 ± 1/2	MIDDLE	C	P14
6	SEE DETAIL	ELAPSED TIME INDICATOR	20 ± 1	LOWER	B	P13
7	SEE DETAIL	VAC (PUMP)	18-1/4 ± 3/4	UPPER	A	P15
8	SEE DETAIL	VAC (DEWAR)	11-1/4 ± 3/4	UPPER	A	P16

9. LENGTH OF CABLE IS FROM SURFACE [A] TO CONNECTION PLANE OF PLUG.

10. SEE WIRING LIST FOR DETAILS
11. CONNECTIONS TO BE COVERED WITH HEAT SHRINK TUBING.
12. GL1 & GL6 WILL REQUIRE TRIMMING WITH CUTTERS TO FIT PROPERLY.

(31) WIRELIST A53206W001

(1) BOM A53206B005

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES	8.4 GHz FRONT END
ASS'Y CARD CAGE	NATIONAL RADIO ASTRONOMY OBSERVATORY, CHARLOTTESVILLE, VA 22901
MATERIAL:	DRAWN BY H DULL, DATE 5-15-87
FINISH:	DESIGNED BY, DATE
DS3206A001 NEXT ASSY	APPROVED BY, DATE
USED ON	SHEET 1/1, DRAWING NUMBER DS3206A005, REV A, SCALE

SEP 17 1986

Page No. 1
09/15/86

A53206B005-BOM CARD CAGE

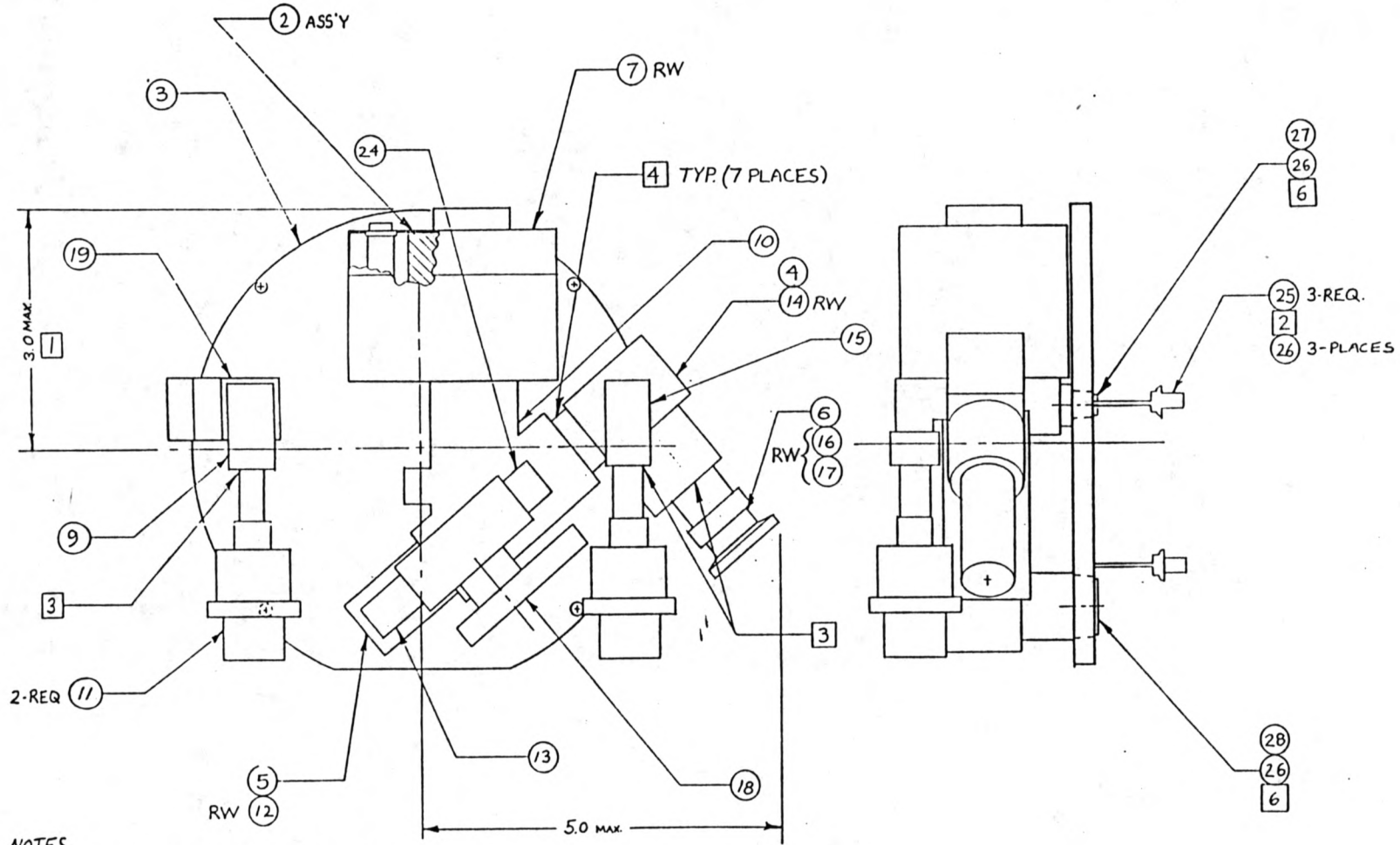
NRAO-BILL OF MATERIALS

ITEM	MANUFACTURER	PART NUMBER	DESCRIPTION	QUAN
0	NRAO	D53206A005	ASS'Y CARD CAGE	0
1	NRAO	A53206B005	BOM CARD CAGE	0
2	NRAO	C53206M068	FRONT PANEL	1
3	NRAO	B53206M063	SIDE PLATE	1
4	NRAO	C53206M067	BACK PANEL	1
5	NRAO	A53206M061	SIDE RAIL	1
6	NRAO	C53206M065	COVER(SIDE)	1
7	NRAO	D53206M069	TOP SIDE	1
8	AMP	205208-1	HD-20 Metal Shell Connector, Plug 25 position	1
9	AMP	205207-1	HD-20 Metal Shell Connector, Recept. 25 position	2
10	OMNI-SPECTRA	21011	SMA-TYPE N BULK HEAD	3
11	CINCH (TRW)	50-44A-30	EDGE CARD CONNECTOR, 44 PIN	7
12	CINCH (TRW)	50-PK-2	POLARIZING KEY	7
13	DALE	RH-25 300	RES. 300 25W 1%	1
14	DALE	RH-10	RES. 5K 10W 1%	1
15	VOLTREX	ECC-6	CABLE CLAMP	1
16	DEUTSCH	DM9606-3P	AC connector jack, 3 pin	1
17	NRAO	B53206M062	BAR	1
18	AMP	205203-1	HD-20 Metal Shell Connector, Recept 9 position	1
19	SOUTHCO	74-13-210-24	#10-32 S.S. Insert	2
20	ALLMETAL		#2-56 X 3/16 lg. S.S. socket head cap screws	2
21	ALLMETAL		#4-40 x 3/16 lg S.S. socket head cap screw	14
22	ALLMETAL		#4-40 x 1/4 lg. S.S. socket head cap screw	2
23	ALLMETAL		#4-40 x 5/16 lg. S.S. socket head cap screw	11
24	ALLMETAL		#4-40 x 3/8 lg. S.S. socket head cap screw	14
25	ALLMETAL		#4-40 x 3/8 lg. S.S. flat head slotted screw	2
26	NRAO	C53206M066	COVER	1
27				0
28	ALLMETAL		#10-32 x 3/8 lg. S.S. Socket Head Cap Screws	1
29	KEYSTONE	908	# 4 GROUND LUG	6
30	NRAO	B53206M064	END PLATE	1
31	NRAO	A53206W001	WIRE LIST CARD CAGE	1
32	OMNI-SPECTRA	216	SMA ADAPTER, PLUG/JACK	3
33	AMPHENOL	78-PF8-11	Octal Socket Plug with clamp	2
34	CINCH (TRW)	D-28418-2	CONNECTOR JACK SCREW KIT (1 PAIR)	4
35	MOLEX	03-09-1022	2 PIN CONN RECEPTACLE	2
36	MOLEX	02-09-1103	FEMALE .093 DIA PIN 20-14 AWG	2
37	DEUTSCH	DM9702-3S	display structure, 3 socket	1
38	SOUTHCO	47-10-103-10	#4-40 Captive screw ass'y 1/8" panel	3
39	SOUTHCO	47-10-101-10	#4-40 Captive screw ass'y, 1/16" panel	2
40	SOUTHCO	74013-104-24	#4-40 S.S. Insert	1
41	HELICOIL		#4-40 Heli Coil Inserts S.S. Free Running 168	4
42	ALLMETAL		3/32" Dia. 1/4" long S. S. dowels	2
43	BELDEN	8443	JACKETED 3 WIRE 22 AWG	0
44	BELDEN	9740	JACKETED 2 WIRE 18 AWG TWISTED PAIR	0
45	BELDEN	8442	JACKETED 2 WIRE 22 AWG TWISTED PAIR	0
46	MANHATTEN CABLE	M 39076	JACKETED 3 WIRE 18 AWG	0
47	ALPHA WIRE	FIT-221-1/8 CLR	HEAT SHRINK TUBING 1/8 ID CLEAR	0
48	ALPHA	FIT-221-1/4 BLK	HEAT SHRINK TUBING 1/4 ID BLACK	0
49	ALPHA	FIT-221-3/8 BLK	HEAT SHRINK TUBING 3/8 ID BLACK	0

A53206B005-BOM CARD CAGE

NRAO-BILL OF MATERIALS

ITEM	MANUFACTURER	PART NUMBER	DESCRIPTION	QUAN
50	ALPHA	FIT-221-3/4 BLK	HEAT SHRINK TUBING 3/4 ID BLACK	0
51	AMP	66506-9	HD-20 Connector Contact-Pin	25
52	AMP	66504-9	HD-20 Connector Contact-Socket	59
53	AMPHENOL	9779-513-4	Rubber Bushing Type AN3420	1
54	MOLEX	02-09-2118	MALE .093 DIA. PIN 24-18 AWG	2
55	NRAO	A53206I004	FRONT PANEL SILKSCREEN	1
56	ALPHA	1855	STRANDED 22 AWG WIRE COLORS AS REQ.	0
57	ALLEN-BRADLEY	RC20GF511J	RES. 510 1/2W 5%	1
58	ALPHA	1857	STRANDED 18 AWG HOOK WIRE	0
59	ALPHA	296	SOLID 18 AWG BUS WIRE	0
60	MOTOROLA	1N5355A	DIODE, 1N5355A (ZENAR 18V)	2



NOTES

1. VALVE ASS'Y CAN BE ROTATED CW TO CLEAR 3.0 EDGE LINE.
2. TAILS OF SPACERS TO BE CUT .1 FROM BASE. SPACER EPOXIED IN PLACE.
3. TEFLON TAPE TO SEAL PIPE JOINT.
4. EPOXY (ITEM (26)) USED TO SEAL JOINT.
5. STEM AND HANDLE OF ITEM (18) NEED TO BE DISASSEMBLED, ROTATED 90° AND REASSEMBLED.
6. EPOXY DISK OVER OPENING BY LAYING A BEAD OF EPOXY AROUND THE PERIMETER OF THE DISK.

BOM A53206B007

D53206A001	
NEXT ASSY	USED ON

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
TOLERANCES: ANGLES ±
3 PLACE DECIMALS (.XXX): ±
2 PLACE DECIMALS (.XX): ±
1 PLACE DECIMALS (.X): ±
MATERIAL:
FINISH:

PROJECT: VLBA 8.4 GHZ F.E.

TITLE: A'SSY INSPECTION COVER

NATIONAL RADIO ASTRONOMY OBSERVATORY
CHARLOTTESVILLE, VA. 22901

DRAWN BY H DILL	DATE 5-17-84	
DESIGNED BY	DATE	
APPROVED BY	DATE	

SHEET NUMBER 1:1 | DRAWING NUMBER C53206A007 | REV. | SCALE

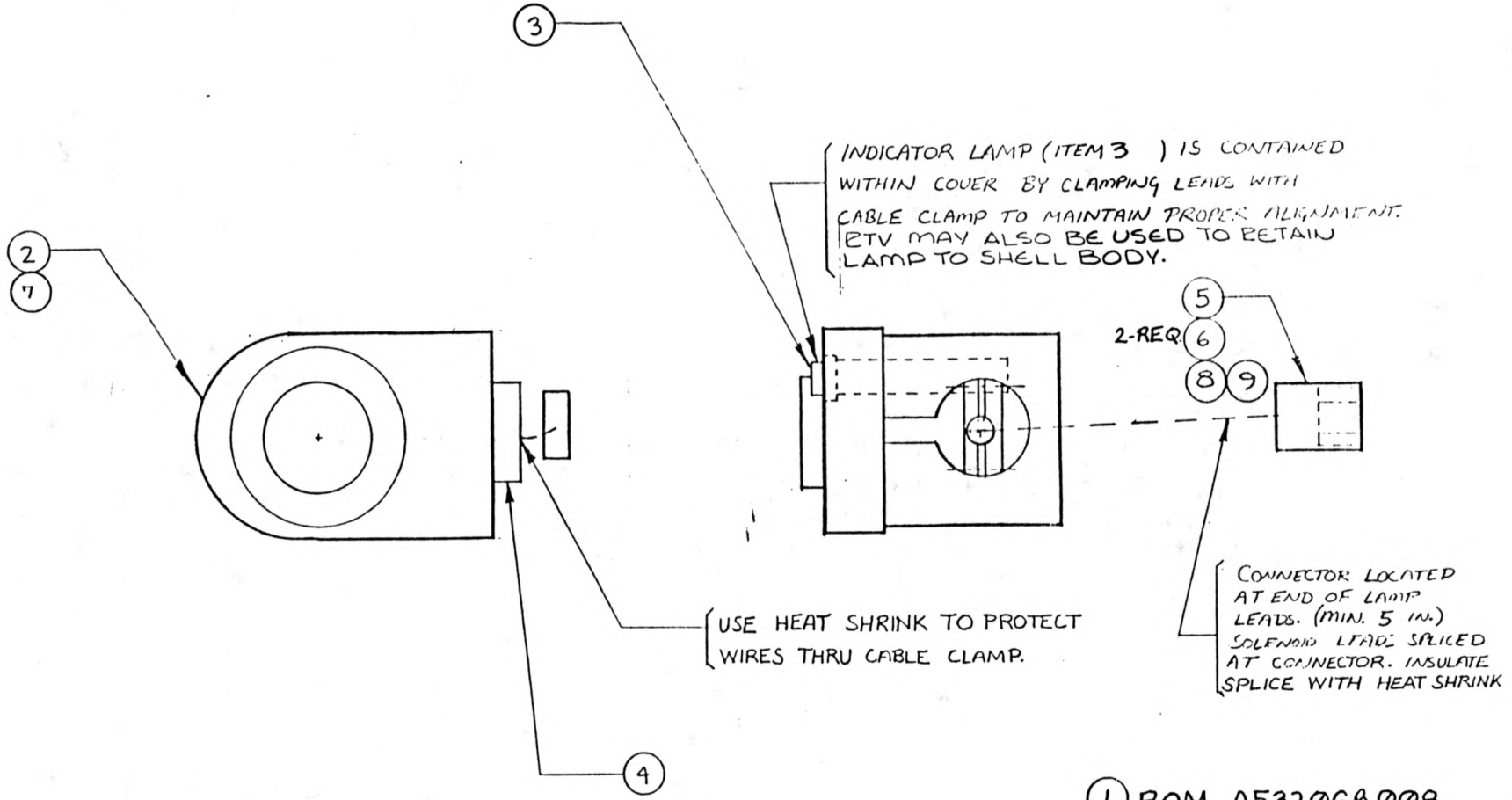
SEP 17 1986

Page No. 1
09/15/86

A53206B007-BOM INSPECTION COVER

NRAO-BILL OF MATERIALS

ITEM	MANUFACTURER	PART NUMBER	DESCRIPTION	QUAN
0	NRAO	C53206A007	ASS'Y INSPECTION COVER	0
1	NRAO	A53206B007	BOM INSPECTION COVER	0
2	NRAO	B53206A008	ASS'Y SOLENOID	1
3	NRAO	B53206M007	INSPECTION COUER	1
4	NRAO	A53206M028	SE FITTING REWORK (ITEM 14)	0
5	NRAO	A53206M029	ME FITTING REWORK (ITEM 12)	0
6	NRAO	A53206M050	VAC CONN. R.W. (ITEMS 16 & 17)	0
7				0
8				0
9	CAJON	B-2-E	1/8 NPT Brass female elbow	1
10	ASCO	8030A17VH	Vacuum valve, 120V, 60 Hz coil, 1/2" NPT	1
11	TELEDYNE-HASTING	DV-6R	Vacuum gauge (metal housing, octal plug)	2
12	CAJON	B-8-ME	1/2 NPT male elbow	1
13	CAJON	B-2-ME	1/2 NPT Brass male elbow	1
14	CAJON	B-8-SE	1/2 NPT street elbow	1
15	CAJON	B-2-SE	1/8 NPT Brass street elbow	1
16	CAJON	B-8-HN	1/2 NPT Hex nipple	1
17	L & H	910-280-119	Male flange fitting Type KF-16	1
18	NUPRO	B2P4T4	Plug valve, 1/8 NPT, female	1
19	NUPRO	B-2P4T2	Plug valve, 1/8 NPT, male	1
20				0
21				0
22				0
23			TEFLON PIPE SEALANT TAPE 1\2 WIDE	0
24	ARO		FILTER (OPTIONAL)	1
25	AMERLOCK	PCS-16	Nylon spacer, 1 LG	3
26			EPOXY 2-PART 5 MINUTE CURE	0
27	PSM	4-1, grade F-30	1/4 DIA. 1/16 BRONZE FILTER	1
28	PSM	10-1, grade F-30	5/8 DIA 1/16 TH BRONZE FILTER	1



(1) BOM A53206B008

NATIONAL RADIO ASTRONOMY OBSERVATORY VLBA			
UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ANGLES ± 3 PLACE DEC. (xxx) ± .005 2 PLACE DEC. (xx) ± .02 1 PLACE DEC. (x) ±	PROJ: 8.4 GHZ F.E.	TITLE: ASS'Y SOLENOID	
	MATERIAL:	DRAWN BY: H. DILL	DATE: 8/26/85
	FINISH:	DESIGNED BY:	DATE:
		APPROVED BY:	DATE:
	SHEET NUMBER: 1:1	DRAWING NUMBER: 853206A008 REV.	SCALE: FULL SIZE

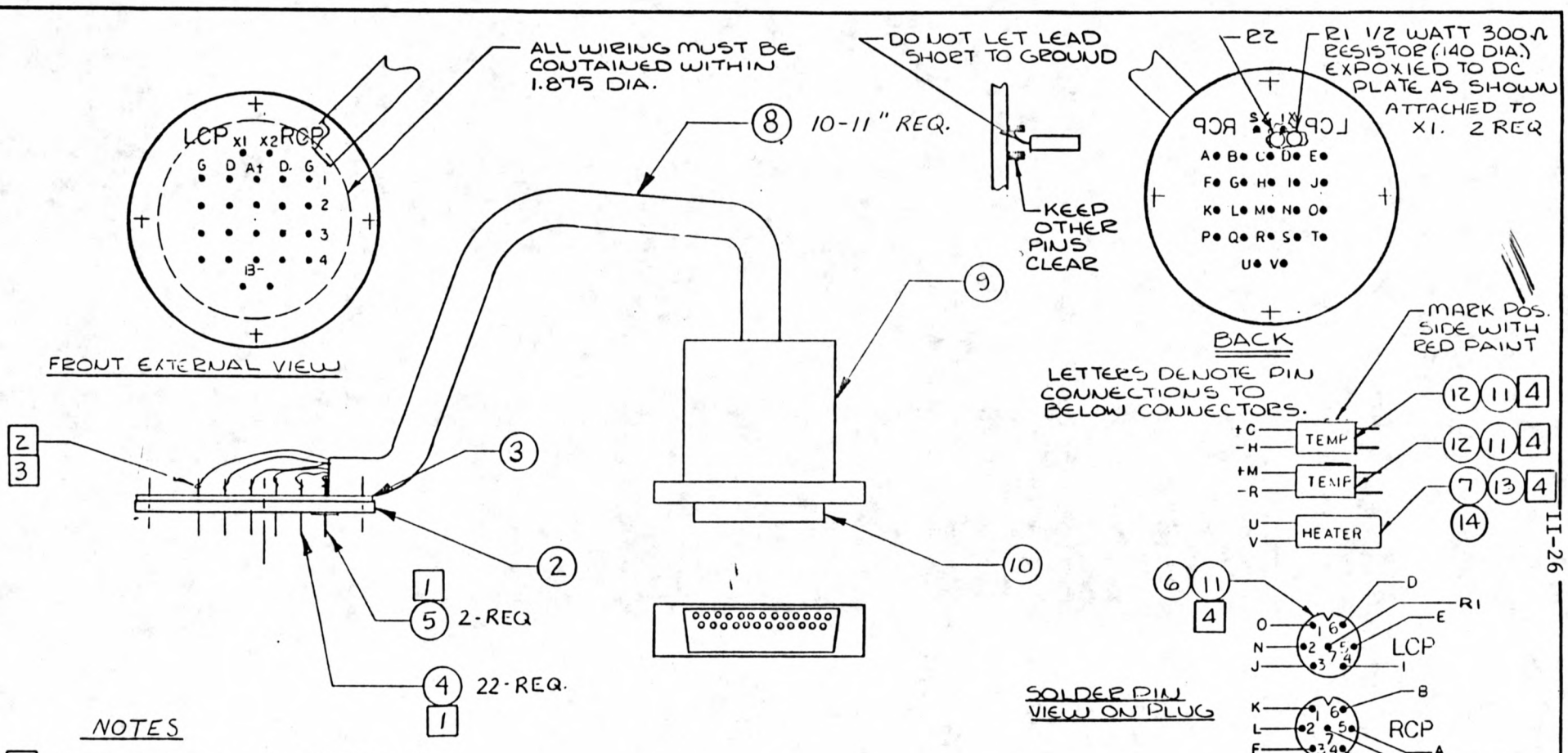
USED ON D53206A001
NEXT ASS'Y C53206A007

Page No. 1
09/15/86

A53206B008-BOM SOLENOID

NRAO-BILL OF MATERIALS

ITEM	MANUFACTURER	PART NUMBER	DESCRIPTION	QUAN
0	NRAO	B53206A008	ASS'Y SOLENOID	0
1	NRAO	A53206B008	BOM SOLENOID	0
2	ASCO	ITEM 10	BOM A53206B007 (REF)	1
3	LEECRAFT	45RN2111	INDICATOR LIGHT	1
4			ROMEX CONNECTOR (1/2" COND.), alum	1
5	MOLEX	03-09-2022	2 Pin connector plug, MOLEX	1
6	MOLEX	02-09-2103	MALE .093 DIA PIN 20-14 AWG	2
7	NRAO	A53206M070	SOLENOID COVER REWORK	1
8	ALPHA	FIT-221-3/8 BLK	HEAT SHRINK TUBING 3/8 ID BLACK	0
9	ALPHA	FIT-221-3/4 BLK	HEAT SHRINK TUBING 3/4 ID BLACK	0



NOTES

1. SOLDER CAPACITOR FEEDTHRUS WITH SN 60/40 SOLDER
2. WIRES SHOULD BE CRIMPED AROUND FEEDTHRU PIN PRIOR TO SOLDERING.
3. WIRELIST IS SHEET 2 OF A53200W002.
4. WIRE LENGTH IS 12 INCHES.

NEXT ASSY D53200A0006

(1) BOM- A53206B012

LTR	BY	DATE	REVISION
B	GM	3-6-86	CO-860306-10
A	GM	1-17-86	CO-860117-03

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
TOLERANCES
ANGLES ±
3 PLACE DEC. (.xxx) ±
2 PLACE DEC. (.xx) ± .1
1 PLACE DEC. (.x) ± .5

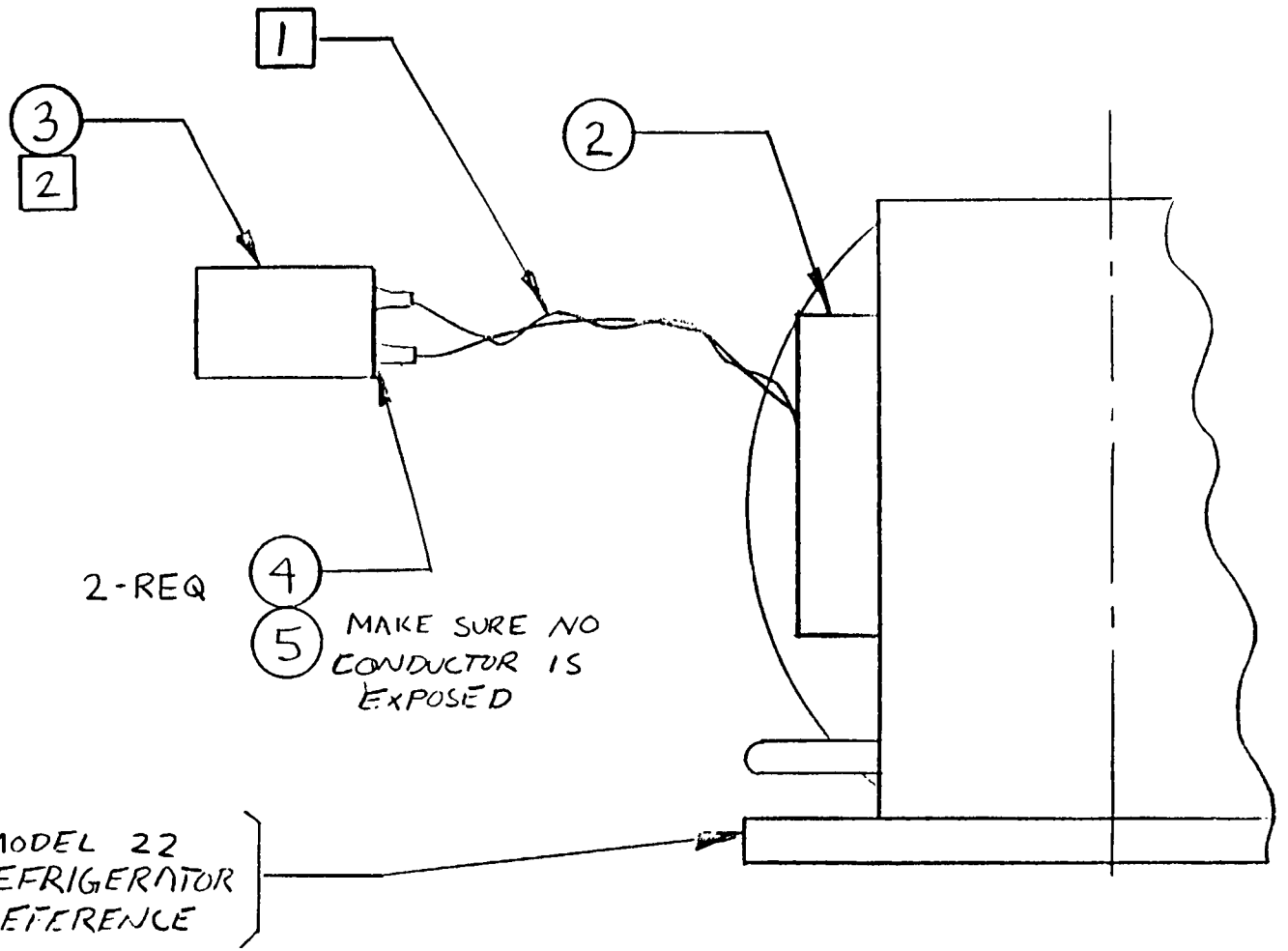
NATIONAL RADIO ASTRONOMY OBSERVATORY
VLBA

PROJ: 8.4 GHZ F.E.
TITLE: CABLE ASS'Y J1-DWR
MATERIAL:
FINISH:
DRAWN BY: H DILL DATE: 10-3-84
DESIGNED BY: H DILL DATE: 10-3-84
APPROVED BY: DATE:
SHEET NUMBER:
DRAWING NUMBER: B53206A012
REV: B
SCALE: F.S.

Page No. 1 A53206B012-BOM CABLE ASSY J1 TO DEWAR
09/15/86

NRAO-BILL OF MATERIALS

ITEM	MANUFACTURER	PART NUMBER	DESCRIPTION	QUAN
0	NRAO	B53206A012	ASS'Y CABLE J1 TO DEWAR	0
1	NRAO	A53206B012	BOM CABLE ASSY J1 TO DEWAR	0
2	NRAO	A53206M008	DC FEEDTHRU	1
3	NRAO	A53200I002	DC FEED THRU ARTWORK	1
4	VICLAN	7648-1011-102	1000pf, 200 volt feed-thru capacitor	22
5	US MICROTECK COMP.	XS1F2-332H	3300pf, 500 volt feed-thru capacitor	2
6	MICROTECH	EP-7S-1	Connector, 7 socket	2
7	MICROTECH	GF-2	2 pin connector, recept.	1
8	BELDEN	9747	22 AWG / 24 COND	0
9	AMP	205208-1	HD-20 Metal Shell Connector, Plug 25 position	1
10	CINCH (TRW)	DBM-25P	'D' CONN. 25 PINS	1
11	MWS PRECISION WIRE	B-2322111-001	#32 soft brass, type 260, bifilar wire	0
12	MICROTECH	GM-2	2 pin connector, plug	2
13	MICROTECH	MS-7	AG PLATED CU STEEL(USE SINGLE WIRE)	0
14	ALPHA WIRE	FIT-221-1/8 CLR	HEAT SHRINK TUBING 1/8 ID CLEAR	0



II-28

1. MOUNT CONNECTOR ON END OF STANDARD LEADS, MIN LENGTH 7".

2. NO SPECIFIC ARRANGEMENT OF WIRES CONNECTION TO PLUG.

NEXT ASS'Y
D53206B001

(1) BOM A53206B013

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
TOLERANCES
ANGLES ±
3 PLACE DEC.(xxx) ±
2 PLACE DEC.(xx) ±
[redacted] E DEC.

NATIONAL RADIO ASTRONOMY OBSERVATORY
VLBA

PROJ: 8.4 GHz F.E.	TITLE: ETI ASS'Y		
MATERIAL: S		DRAWN BY: H. DILL	DATE: 10 3-89
		DESIGNED BY:	DATE:
FINISH: S		APPROVED BY:	DATE:
SHEET NUMBER	DRAWING NUMBER: A53206A013	REV.	SCALE: S

Page No. 1 A53206B013-BOM ELAPSED TIME INDICATOR
09/15/86

NRAO-BILL OF MATERIALS

ITEM	MANUFACTURER	PART NUMBER	DESCRIPTION	QUAN
0	NRAO	A53206A013	ASS'Y ELAPSED TIME INDICATOR	0
1	NRAO	A53206B013	BOM ELAPSED TIME INDICATOR	0
2	CURTIS	520-CP3	ELAPSED TIME INDICATOR-WIDE RANGE	1
3	MOLEX	03-09-2022	2 Pin connector plug, MOLEX	1
4	MOLEX	02-09-1118	FEMALE .093 DIA. 24-18 AWG	2
5	ALPHA	PVC-185-12	ALL-PURPOSE TUBING 0.085 ID	0
6	ALPHA	FIT-221-1/4 BLK	HEAT SHRINK TUBING 1/4 ID BLACK	0
7	ALPHA	FIT-221-3/4 BLK	HEAT SHRINK TUBING 3/4 ID BLACK	0

VLBA 8.4 GHZ FRONT END

CARD CAGE

WIRING LIST

Note:

Unless noted all wire 22 AWG stranded, BOM Item 56. Noted types are:

Jacketed 3-wire 22 AWG cable; BOM Item 43.

Jacketed twisted pair 18 AWG cable; BOM Item 44.

Jacketed 3-wire 18 AWG; BOM Item 46.

Jacketed twisted pair 22 AWG; BOM Item 45

18 AWG Stranded Wire; BOM Item 58

18 AWG Solid Bus Wire; BOM Item 59

Ref: Bill Of Materials A53206B005
Assembly Drawing D53206A005

COLOR CODE

X-NONE	N_1 N_2 N_3
0-BLACK	
1-BROWN	N_1-PRIMARY COLOR
2-RED	N_2-1st TRACER IF SPECIFIED
3-ORANGE	N_3-2nd TRACER IF SPECIFIED
4-YELLOW	
5-GREEN	
6-BLUE	
7-VIOLET	
8-GRAY	
9-WHITE	
P-PINK	
T-TAN	

GROUND LUGS

GL1, GL2, GL3, GL4, GL5, GL6- SEE D53206A005 FOR PLACEMENT.

February 18, 1986
By: H. Dill

Dwg. No.: A53206W001
Sheet: 1 OF 14
Revision:B

CARD SLOT WIRING LIST

SYSTEM: VLBA 8.4 GHZ FRONT END
ASS'Y: CARD CAGE
SLOT: 1
CARD: RF Card

DWG. NO.: A53206W001
DATE: February 18, 1986
BY: H. DILL
SHEET: 2

PIN	FUNCTION	TO	COLOR	PIN	FUNCTION	TO	COLOR
A	GROUND	BUS S1-M	BUS 0XX	1	GROUND	GL1 BUS	0XX
B	+15 VOLTS	BUS J5-2	BUS 2XX	2	+15 VOLTS	BUS *1	2XX
C	-15 VOLTS	BUS J5-3	BUS 4XX	3	-15 VOLTS	BUS *2	4XX
D				4			
E				5			
F				6			
H				7			
J				8			
K				9			
L				10			
M	LO CAL RET.	S1-S S1-A	0XX	11			
N	LO CAL IN	J5-11	8XX	12			
P				13			
R				14			
S	HI CAL RET.	S1-M	0XX	15			
T	HI CAL IN	J5-12	8XX	16			
U				17			
V				18			
W	300K TEM MON.	S3-L	92X	19			
X				20			
Y				21			
Z	QUA. GND	J2-13 GL2	5XX	22			

SPECIAL INSTRUCTIONS:
*1 WIRE 1N5355A ZENAR DIODE BETWEEN GL1 AND PIN 2 WITH BAND TOWARD PIN 2.
*2 WIRE 1N5355A ZENAR DIODE BETWEEN GL1 AND PIN 3 WITH BAND TOWARD GL1.

'BUS' SIGNIFIES 18 AWG SOLID BUS WIRE STRAPPED THROUGH ALL SEVEN CARD SLOT CONNECTORS.

KEY BETWEEN 1&2.

CARD SLOT WIRING LIST

SYSTEM: VLBA 8.4 GHZ FRONT END
ASS'Y: CARD CAGE
SLOT: 2
CARD: SPARE

DWG. NO.: A53206W001
DATE: February 18, 1986
BY: H. DILL
SHEET: 3

PIN	FUNCTION	TO	COLOR	PIN	FUNCTION	TO	COLOR
A	GROUND	BUS	BUS	1	GROUND	BUS	BUS
B	+15 VOLTS	BUS	BUS	2	+15 VOLTS	BUS	BUS
C	-15 VOLTS	BUS	BUS	3	-15 VOLTS	BUS	BUS
D				4			
E				5			
F				6			
H				7			
J				8			
K				9			
L				10			
M				11			
N				12			
P				13			
R				14			
S				15			
T				16			
U				17			
V				18			
W				19			
X				20			
Y				21			
Z				22			

SPECIAL INSTRUCTIONS:

CARD SLOT WIRING LIST

SYSTEM: VLBA 8.4 GHZ FRONT END
ASS'Y: CARD CAGE
SLOT: 3
CARD: MONITOR CARD

DWG. NO.: A53206W001
DATE: February 18, 1986
BY: H. DILL
SHEET: 4

PIN	FUNCTION	TO	COLOR	PIN	FUNCTION	TO	COLOR
A	GROUND	BUS	BUS	1	GROUND	BUS	BUS
B	+15 VOLTS	BUS S3-X	BUS 2XX	2	+15 VOLTS	BUS	BUS
C	-15 VOLTS	BUS	BUS	3	-15 VOLTS	BUS	BUS
D				4			
E	QUALITY GROUND	GL2 S4-J	5XX	5			
F	PUMP VAC MON	J2-1 S6-14	8XX	6			
H	DEWAR VAC MON	J2-2 S6-N	6XX	7			
J	15K MON (TEMP A)	J2-3 S6-D	96X	8			
K	50K MON (TEMP B)	J2-4 S6-5	95X	9			
L	300K MON	J2-5 S1-W	92X	10			
M	AC CURRENT MON	J2-6 J4-1	PXX	11			
N	RCP GATE 1 MON	J2-7 S4-7	90X	12	X-MON	J2-23	7XX
P	RCP GATE 2,3 MON	J2-8 S4-6	904	13	C-MON	J2-24	9XX
R	LCP GATE 1 MON	J2-9 S5-7	94X	14	NOT H-MON	J2-25	3XX
S	LCP GATE 2,3 MON	J2-10 S5-6	97X	15			
T	LED MON	J2-11*1 J3-22	903	16			
U	SPARE MON	J2-12	1XX	17	X-CPU	J5-6	7XX
V	*2			18	X-OUTPUT	S7-4	7XX
W	MANUAL MON	J2-22	902	19	C-CPU	J5-7	9XX
X	LED +15 VOLTS	S3-B*1	2XX	20	C-OUTPUT	S7-M	9XX
Y				21	NOT H-CPU	J5-8	3XX
Z				22	NOT H-OUTPUT	S7-L	3XX

SPECIAL INSTRUCTIONS: *1 CONNECT R3 (510 OHM, 1/2 WATT CARBON, BOM ITEM 9) ACROSS PINS S3-T,X.
*2 RESERVED LOCATION (USED IN PLACE OF PIN X ON SOME EARLY MODELS NOT RECOMMENDED FOR NEW DESIGNS.)

KEY BETWEEN 3 & 4

CARD SLOT WIRING LIST

SYSTEM: VLBA 8.4 GHZ FRONT END
ASS'Y: CARD CAGE
SLOT: 4
CARD: RCP FET BIAS

DWG. NO.: A53206W001
DATE: February 18, 1986
BY: H. DILL
SHEET: 5

PIN	FUNCTION	TO	COLOR	PIN	FUNCTION	TO	COLOR
A	GROUND	BUS	BUS	1	GROUND	BUS	BUS
B	+15 VOLTS	BUS	BUS	2	+15 VOLTS	BUS	BUS
C	-15 VOLTS	BUS	BUS	3	-15 VOLTS	BUS	BUS
D	GATE 4	J3-19	7XX	4	GATE 4 MON	N.C.	
E	GATE 3	J3-17	98X	5	GATE 3 MON	S4-6	904
F	GATE 2	J3-15	4XX	6	GATE 2 MON	S3-P	904
H	GATE 1	J3-13	90X	7	GATE 1 MON	S3-N	90X
J	QUALITY GROUND	S3-E S5-J	5XX	8			
K	DRAIN 4	J3-20	902	9			
L	DRAIN 3	J3-18	6XX	10			
M	DRAIN 2	J3-16	3XX	11			
N	DRAIN 1	J3-14	25X	12			
P				13			
R				14			
S				15			
T				16			
U				17			
V				18			
W				19			
X				20			
Y				21			
Z	6 VOLT CONTROL	N.C.		22			

SPECIAL INSTRUCTIONS:

KEY BETWEEN 4 & 5

CARD SLOT WIRING LIST

SYSTEM: VLBA 8.4 GHZ FRONT END
ASS'Y: CARD CAGE
SLOT: 5
CARD: LCP FET BIAS

DWG. NO.: A53206W001
DATE: February 18, 1986
BY: H. DILL
SHEET: 6

PIN	FUNCTION	TO	COLOR	PIN	FUNCTION	TO	COLOR
A	GROUND	BUS	BUS	1	GROUND	BUS	BUS
B	+15 VOLTS	BUS	BUS	2	+15 VOLTS	BUS	BUS
C	-15 VOLTS	BUS	BUS	3	-15 VOLTS	BUS	BUS
D	GATE 4	J3-11	91X	4	GATE 4 MON	N.C.	
E	GATE 3	J3-9	9XX	5	GATE 3 MON	S5-6	97X
F	GATE 2	J3-7	97X	6	GATE 2 MON	S3-S	97X
H	GATE 1	J3-5	94X	7	GATE 1 MON	S3-R	94X
J	QUALITY GROUND	S4-J GL6	5XX	8			
K	DRAIN 4	J3-12	8XX	9			
L	DRAIN 3	J3-10	PXX	10			
M	DRAIN 2	J3-8	24X	11			
N	DRAIN 1	J3-6	20X	12			
P				13			
R				14			
S				15			
T				16			
U				17			
V				18			
W				19			
X				20			
Y				21			
Z	6 VOLT CONTROL	N.C.		22			

SPECIAL INSTRUCTIONS:

KEY BETWEEN 4 & 5

CARD SLOT WIRING LIST

SYSTEM: VLBA 8.4 GHZ FRONT END
ASS'Y: CARD CAGE
SLOT: 6
CARD: SENSOR CARD

DWG. NO.: A53206W001
DATE: February 18, 1986
BY: H. DILL
SHEET: 7

PIN	FUNCTION	TO	COLOR	PIN	FUNCTION	TO	COLOR
A	GROUND	BUS	BUS	1	GROUND	BUS	BUS
B	+15 VOLTS	BUS	BUS	2	+15 VOLTS	BUS	BUS
C	-15 VOLTS	BUS	BUS	3	-15 VOLTS	BUS	BUS
D	A MON OUT (15K)	S3-J S7-D	96X	4	TEMP SENSOR A	J3-2	96X
E	SENSOR A RTN	J3-1 S6-F	93X	5	B MON OUT (50K)	S3-K	95X
F	SENSOR B RTN	J3-3 S6-E	92X	6			
H	SENSOR B	J3-4	95X	7			
J	VAC TUBE DWR-1	P16-3	2XX*1	8			
K	VAC TUBE DWR-2	P16-5	0XX*1	9			
L	VAC TUBE DWR-3	P16-7	5XX*1	10			
M	VAC DWR LOCAL MON	N.C.		11			
N	VAC DWR MON	S3-H S7-E	6XX	12			
P				13			
R				14	VAC PUMP MON	S3-F S7-F	8XX
S	TEMP A NLIN	J2-14	906	15	TEMP A NLIN	NC	
T	TEMP B NLIN	NC		16	TEMP B NLIN	NC	
U				17	VAC TUBE PUMP-3	P15-7	5XX*2
V				18			
W				19			
X				20			
Y				21	VAC TUBE PUMP-1	P15-3	2XX*2
Z				22	VAC TUBE PUMP-2	P15-5	0XX*2

SPECIAL INSTRUCTIONS:
*1 AND *2 - USE THREE CONDUCTOR JACKETED CABLE; BOM ITEM 43.
TERMINATE EACH AS SPECIFIED BY D53206A005.
KEY BETWEEN 5 & 6

CARD SLOT WIRING LIST

SYSTEM: VLBA 8.4 GHZ FRONT END
ASS'Y: CARD CAGE
SLOT: 7
CARD: CONTROL CARD

DWG. NO.: A53206W001
DATE: February 18, 1986
BY: H. DILL
SHEET: 8

PIN	FUNCTION	TO	COLOR	PIN	FUNCTION	TO	COLOR
A	GROUND	BUS	BUS	1	GROUND	BUS	BUS
B	+15 VOLTS	BUS	BUS	2	+15 VOLTS	BUS	BUS
C	-15 VOLTS	BUS	BUS	3	-15 VOLTS	BUS	BUS
D	TEMP A MON IN	S6-D	96X	4	X EVAC CONTROL	S3-18	7XX
E	VAC DWR MON IN	S6-N	6XX	5			
F	VAC PUMP MON IN	S6-14	8XX	6			
H				7			
J	S-SOL MON OUT	J2-20	98X	8			
K	P-PUMP REQ OUT	J2-21 J4-3	91X	9			
L	NOT H-NO HEAT CTRL	S3-22	3XX	10			
M	C-COOL CONTROL	S3-20	9XX	11			
N				12			
P				13			
R				14	SOLENOID RTN	R1-2	9XX*1
S	SOLENOID SUPPLY	P14-1	0XX*2	15			
T				16	RESISTOR LOAD	R2-1	0XX
U	150VAC IN, PHASE 2	J1-1	2XX*1	17			
V	150VAC REFR, PHA 2	P12-1	2XX*3	18	LOAD HEATER RTN	R2-2	TXX
W	DEWAR HEATER	J3-24	1XX*5	19	DEWAR HEATER RTN	J3-25	TXX
X	150VAC IN, PHASE 1	J1-3	0XX*1	20	150VAC RTN IN	J1-2	9XX*1
Y	150VAC REFR, PHA 1	P12-3 P13-1	0XX*3 0XX*4	21	REFR RTN	P12-2 P13-2	9XX*3 9XX*4
Z				22			

SPECIAL INSTRUCTIONS: KEY BETWEEN 6 & 7.

*1 - USE 18 AWG STRANDED WIRE. TWIST S7-U,X,20.

*2 - USE TWO CONDUCTOR JACKETED CABLE; BOM ITEM 44. CONNECT RED CONDUCTOR (FREE END IN CARD CAGE) TO R1-1. OPPOSITE END TERMINATED IN P14-2.

*3 - USE THREE CONDUCTOR JACKETED CABLE; BOM ITEM 46. OPPOSITE END TERMINATED IN P12.

*4 - USE JACKETED 22 AWG TWISTED PAIR; BOM ITEM 45. OPPOSITE END TERMINATED IN P13.

*5 - TWIST S7-W,19.

25 PIN D-CONNECTOR WIRING LIST

SYSTEM: VLBA 8.4 GHZ FRONT END
ASS'Y: CARD CAGE
TYPE: BULKHEAD
SEX: FEMALE (SOCKET)
FUNC'T: FRONT END MONITOR

DWG. NO.: A53206W001
DATE: February 18, 1986
BY: H. DILL
SHEET: 9
DESIGNATION: J2

PIN	FUNCTION	TO	COLOR	PIN	FUNCTION	TO	COLOR
1	VAC PUMP MONITOR	S3-F	8XX	14	TEMP A NLIN	S6-S	906
2	VAC DEWAR MONITOR	S3-H	6XX	15			
3	15K MON (TEMP A)	S3-J	96X	16			
4	50K MON (TEMP B)	S3-K	95X	17			
5	300K MON (AMBIENT)	S3-L	92X	18			
6	AC CURRENT MONITOR	S3-M	PXX	19			
7	RCP GATE 1 MON	S3-N	90X	20	S-SOL MON	S7-J	98X
8	RCP GATE 2,3 MON	S3-P	904	21	P-PUMP REQUEST	S7-K	91X
9	LCP GATE 1 MON	S3-R	94X	22	MANUAL MON	S3-W	902
10	LCP GATE 2,3 MON	S3-S	97X	23	X-MON	S3-12	7XX
11	LED MON	S3-T	903	24	C-MON	S3-13	9XX
12	SPARE MON	S3-U	1XX	25	NOT H-MON	S3-14	3XX
13	QUALITY GROUND	GL2	5XX				

SPECIAL INSTRUCTIONS:
ORIENT CONNECTOR WITH SOCKETS 14-25 CLOSEST TO WIRING EDGE OF FRONT PANEL.
(SEE D53206A005)

25 PIN D-CONNECTOR WIRING LIST

SYSTEM: VLBA 8.4 GHZ FRONT END
ASS'Y: CARD CAGE
TYPE: BULKHEAD
SEX: FEMALE (SOCKET)
FUNC'T: DEWAR POWER/MONITOR

DWG. NO.: A53206W001
DATE: February 18, 1986
BY: H. DILL
SHEET: 10
DESIGNATION: J3

PIN	FUNCTION	TO	COLOR	PIN	FUNCTION	TO	COLOR
1	SENSOR A RTN	S6-E	93X	14	RCP DRAIN 1	S4-N	25X
2	SENSOR A (15K)	S6-4	96X	15	RCP GATE 2	S4-F	4XX
3	SENSOR B RTN	S6-F	92X	16	RCP DRAIN 2	S4-M	3XX
4	SENSOR B	S6-H	95X	17	RCP GATE 3	S4-E	98X
5	LCP GATE 1	S5-H	94X	18	RCP DRAIN 3	S4-L	6XX
6	LCP DRAIN 1	S5-N	20X	19	RCP GATE 4	S4-D	7XX
7	LCP GATE 2	S5-F	97X	20	RCP DRAIN 4	S4-K	902
8	LCP DRAIN 2	S5-M	24X	21	DEWAR GROUND	GL6	0XX
9	LCP GATE 3	S5-E	9XX	22	LED	S3-T	903
10	LCP DRAIN 3	S5-L	PXX	23			
11	LCP GATE 4	S5-D	91X	24	DEWAR HEATER	S7-W	1XX
12	LCP DRAIN 4	S5-K	8XX	25	DEWAR HEATER RTN	S7-19	TXX
13	RCP GATE 1	S4-H	90X				

SPECIAL INSTRUCTIONS:
TWIST J3-24,25.
ORIENT CONNECTOR WITH SOCKETS 1-13 CLOSEST TO WIRING EDGE OF FRONT PANEL.
(SEE D53206A005)

9 PIN D-CONNECTOR WIRING LIST

SYSTEM: VLBA 8.4 GHZ FRONT END
ASS'Y: CARD CAGE
TYPE: BULKHEAD
SEX: FEMALE (SOCKET)
FUNC'T: AUXILIARY MONITOR

DWG. NO.: A53206W001
DATE: February 18, 1986
BY: H. DILL
SHEET: 11
DESIGNATION: J4

PIN	FUNCTION	TO	COLOR	PIN	FUNCTION	TO	COLOR
1	AC CURRENT MONITOR	S3-M	PXX	6			
2	AC CUR. MON RTN	GL2	0XX	7			
3	PUMP REQUEST	S7-K	91X	8			
4	PUMP REQUEST RTN	GL2	0XX	9			
5							

SPECIAL INSTRUCTIONS:
ORIENT CONNECTOR WITH SOCKETS 6-9 CLOSEST TO THE WIRING EDGE OF RONT PANEL.
(SEE D53206A005)

25 PIN D-CONNECTOR WIRING LIST

SYSTEM: VLBA 8.4 GHZ FRONT END
ASS'Y: CARD CAGE
TYPE: BULKHEAD
SEX: MALE PINS
FUNC'T: DC POWER AND CONTROL

DWG. NO.: A53206W001
DATE: February 18, 1986
BY: H. DILL
SHEET: 12
DESIGNATION: J5

PIN	FUNCTION	TO	COLOR	PIN		FUNCTION	TO	COLOR
1	GROUND	GL6	0XX	14	ID	F0	*1	0XX
2	+15 VOLT SUPPLY	S1-B	2XX	15		F1	*1	0XX
3	-15 VOLT SUPPLY	S1-C	4XX	16		F2	*1	0XX
4				17		F3	*1	0XX
5				18	ID	SN0	*2	0XX
6	X (EVAC CONTROL)	S3-17	7XX	19		SN1	*2	0XX
7	C (COOL CONTROL)	S3-19	9XX	20		SN2	*2	0XX
8	H (NO HEAT CTRL)	S3-21	3XX	21		SN3	*2	0XX
9	NOT PARITY (EVEN)	*4	0XX	22	ID	SN4	*2	0XX
10				23		SN5	*2	0XX
11	CAL CONTROL	S1-N	8XX	24		MOD0	*3	0XX
12	HIGH CAL CONTROL	S1-T	8XX	25		MOD1	*3	0XX
13								

SPECIAL INSTRUCTIONS:
*1 - FREQUENCY CODE WILL BE WIRED BY GROUNDING APPROPRIATE BITS, F0-F3, TO GL3 TO READ THE PROPER CODES.
*2 - THE UNIT SERIAL NUMBER CODE WILL BE WIRED BY GROUNDING APPROPRIATE BITS, SN0-SN5, TO GL5 TO READ THE PROPER SERIAL NUMBER.
*3 - MODIFICATIONS WILL BE CODED BY GROUNDING APPROPRIATE BITS, MOD0-MOD1, TO GL4.
*4 - NOT PARITIY WILL BE GROUNDED TO ENSURE EVEN PARITY OF THE FREQUENCY CODE.

NOTE- THE FREQUENCY CODE, SERIAL NUMBER, MOD CODE AND PARITIY BITS WILL BE WIRED IN UPON THE FINISHED ASSEMBLY OF THE COMPLETE FRONT END. THESE WILL BE MADE UP OF GROUND LUGS WITH THE PROPER NUMBER OF WIRES AND PINS.

ORIENT CONNECTOR WITH PINS 14-25 CLOSEST TO THE WIRING EDGE OF THE FRONT PANEL. (SEE D53206A005)

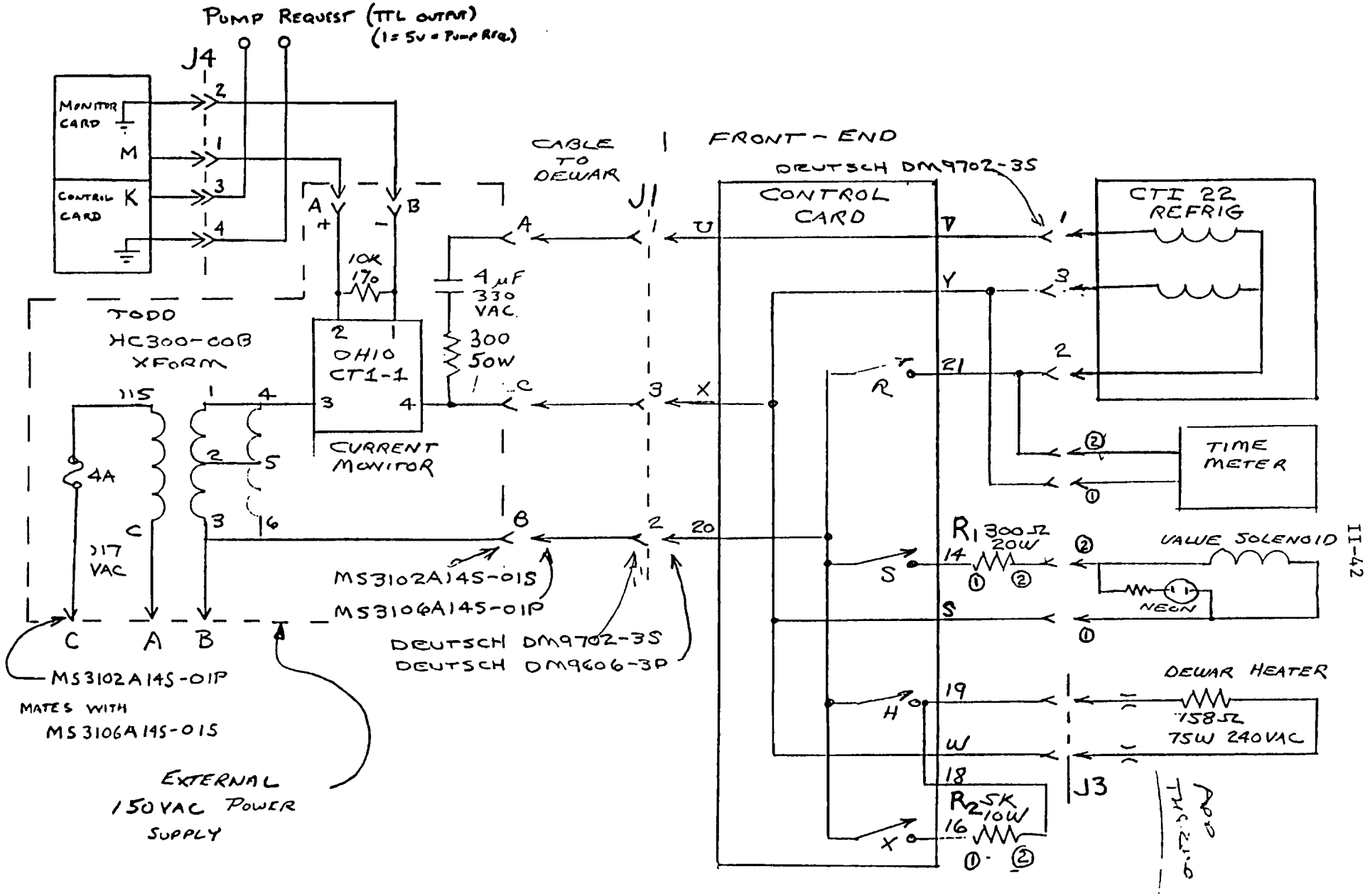
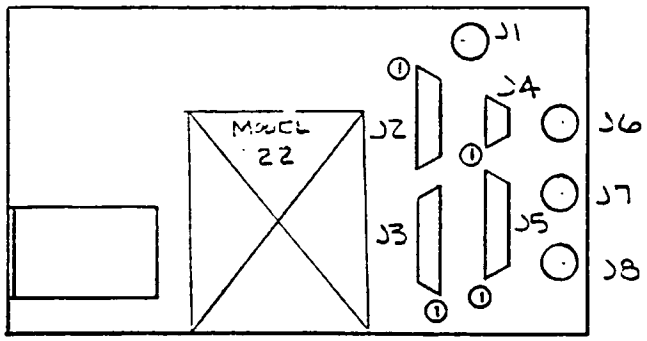


Fig. 1.3-2. Front-end AC wiring. Note that the dewar AC cable can be unplugged from J3 and plugged into the refrigerator to keep the system cold while servicing the control card.

REV.	DATE	DRAWN BY	APPRV'D BY	DESCRIPTION



FRONT OF CARD CAGE

#	DESCRIPTION	CONN.	BOM * ITEM	MATING CONN.
J1	AC POWER TO F.E.	DEUTSCH 3P	16,52	P1
J2	MONITOR FROM F.E.	25 RECEP	9,52	P2
J3	MONITOR FROM DEWAR	25 RECEP	9,52	P3
J4	AUX. MONITOR TO F.E	9 RECEP	18,52	P4
J5	DC POWER & CONTROL BITS	25 PLUG	8,51	P5
J6	RCP OUT	TYPE N	10	P6
J7	LCP OUT	TYPE N	10	P7
J8	CAL IN	TYPE N	10	P8
J9	RCP DEWAR	SMA	—	P9
J10	LCP DEWAR	SMA	—	P10
J11	CAL DEWAR	SMA	—	P11
J12	AC POWER REFR.	DEUTSCH 35	37	P12
J13	ELASPED TIME INDICATOR	MOLEX	35,54	P13
J14	SOLENOID	MOLEX	35,36	P14
J15	V PUMP	OCTAL	33	P15
J16	V DEWAR	OCTAL	33	P16

* REF: BOM A53206B005

MASTER

NATIONAL RADIO ASTRONOMY OBSERVATORY	PROJECT: FRONT ENDS	TITLE: DEWAR INPUTS	
	SHEET NUMBER 14	DRAWING NUMBER A53206W001	REV

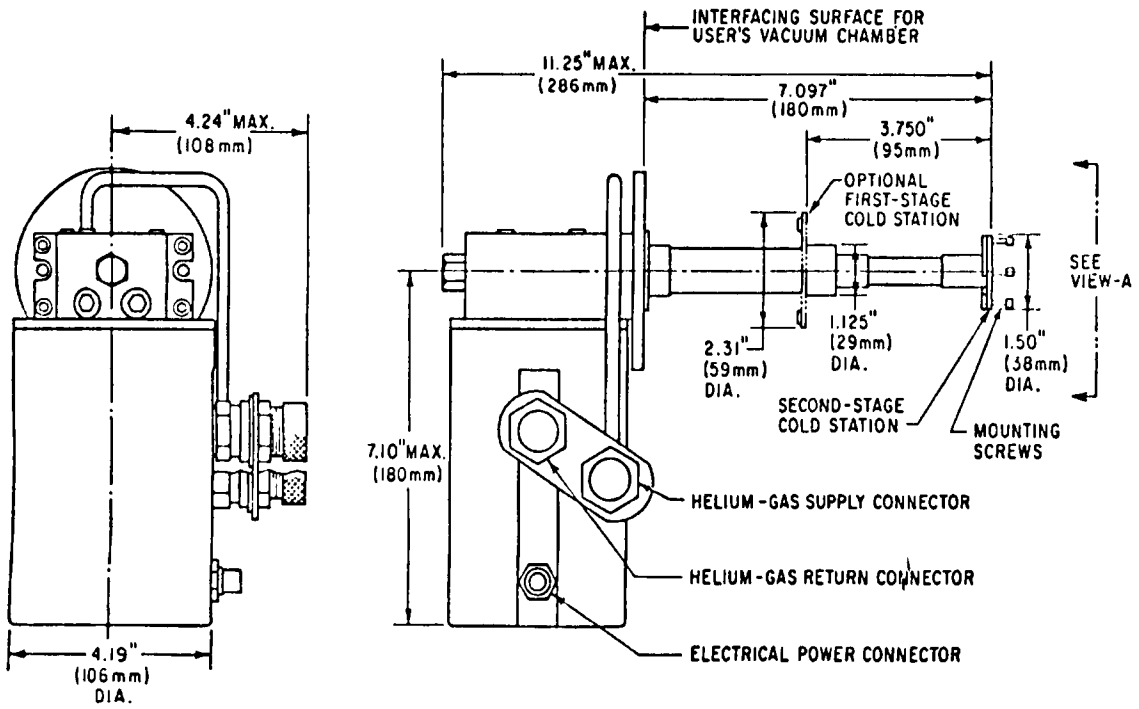
APPENDIX III

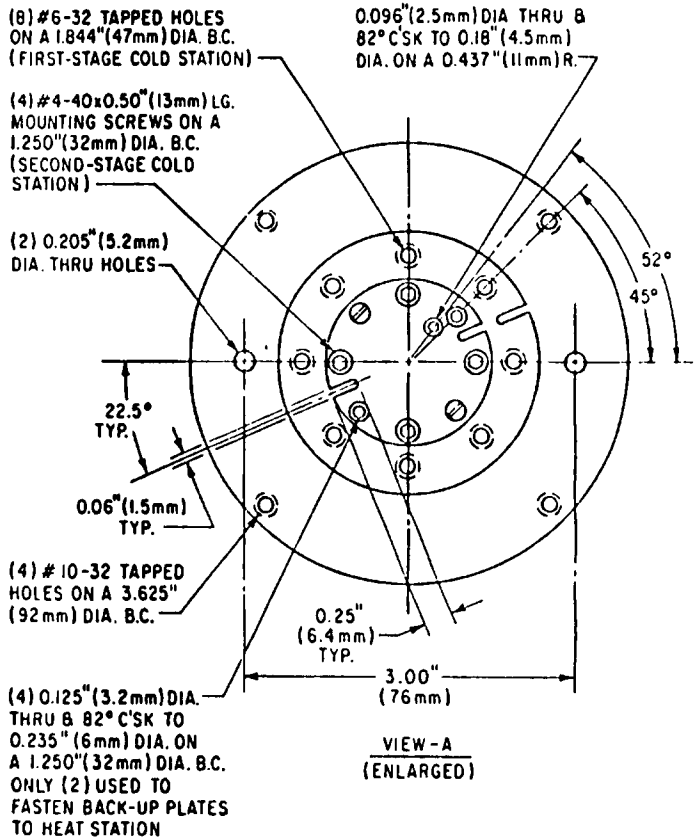
Manufacturers' Data Sheets

APPENDIX IV

Special Test Fixtures

A waveguide cold termination (Assembly 53205A007) was fabricated to test the front-end. Four quartz fins are mounted in circular waveguide which is immersed in liquid nitrogen to provide the cold termination. A gapped waveguide and vacuum window similar to that used in the front-end is incorporated. Vacuum sensors, temperature sensors, and heaters are included for control of the unit. Figure IV-1 shows photographs of the cold termination. When filled, the termination may be used in either a horizontal or vertical orientation and will remain cold for over 12 hours without refilling.





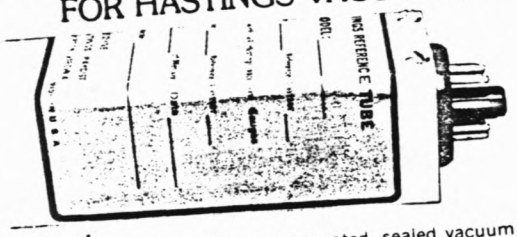
CTI CRYOGENICS
KELVIN PARK
WALTHAM, MASS 02254
(617) 890-940C

FIGURE 2-5. INSTALLATION INTERFACE OF THE MODEL 22 COLD HEAD

TELEDYNE HASTINGS - RAYDIST HAMPTON, VA (804) 723-6531

reference tube

A QUICK CALIBRATION DEVICE FOR HASTINGS VACUUM GAUGES



The Hastings Reference Tube is an evacuated, sealed vacuum gauge tube accurately calibrated and marked at its exact pressure. It is electrically equivalent to our metal and Pyrex gauge tubes. It permits quick and easy recalibration of Hastings Vacuum Gauges by merely plugging the instrument into the reference and adjusting the calibration potentiometer until the instrument reads the exact pressure noted on the reference tube.

Equivalent Gauge Tube and Range			Reference Tube Model No.
Metal	Pyrex	Range	
DV-4D	DV-16D	0-20 mm Hg	DB-16D
*DV-5M	*DV-18	0-100 Microns Hg	*DB-18
DV-6M	DV-20	0-1000 Microns Hg	DB-20
DV-8M	DV-31	.01-10 Microns Hg	DB-31
DV-23	—	0-5000 Microns Hg	DB-33
DV-24	—	0-50 Torr	DB-44
DV-100	—	0-100 Torr	Not Available
DV-77	—	10^{-4} to 10^{-2} Torr	Not available
DV-100	—	0-100 Torr	Not available
DV-800	—	0-800 Torr	Not available

*State reference letter of your Gauge Tube type for matching purposes.

ADVANTAGES OF HASTINGS VACUUM INSTRUMENTS

- **Fully compensated for both temperature and rate-of-change of temperature**
- **Designed for panel mounting or in instrument cabinets.**

Hastings instruments have many exclusive advantages. Self contained, solid-state circuitry throughout assures long life and low maintenance costs. All instruments use frictionless, taut-band pivotless meters. Instruments are electrical to provide rapid response and permit remote installations.

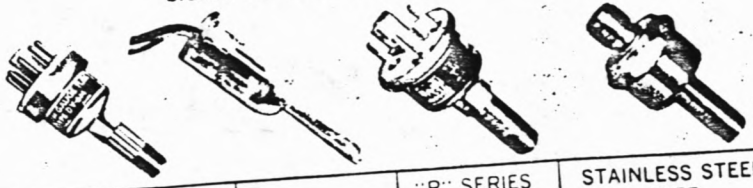
Hastings gauge tubes can withstand great g-shock and vibration, using short firmly connected thermocouples with no suspended weld to an external heater. They are corrosion resistant and non-contaminating using noble metal thermopiles which assures stable calibration held indefinitely. Gauge tubes are easily cleaned with any suitable solvent. Each gauge tube is specifically designed and checked out for the range it covers, assuring maximum sensitivity.

gauge tubes

THE ONLY GAUGE TUBES COMPENSATED FOR BOTH AMBIENT TEMPERATURE AND RATE OF TEMPERATURE CHANGE

- **METAL** Constructed of nickel plated steel with plastic bases color coded to prevent mix-up.
- **PYREX GLASS** Available for high temperature and bakeable systems.
- **"R" SERIES** Ruggedized with a gold-plated hermetic seal base with monel housing for weather resistance.
- **STAINLESS STEEL** For weather-proof, corrosive and bakable applications. Withstands high over-pressurization. May be brazed or welded to system. Plain or threaded connection.

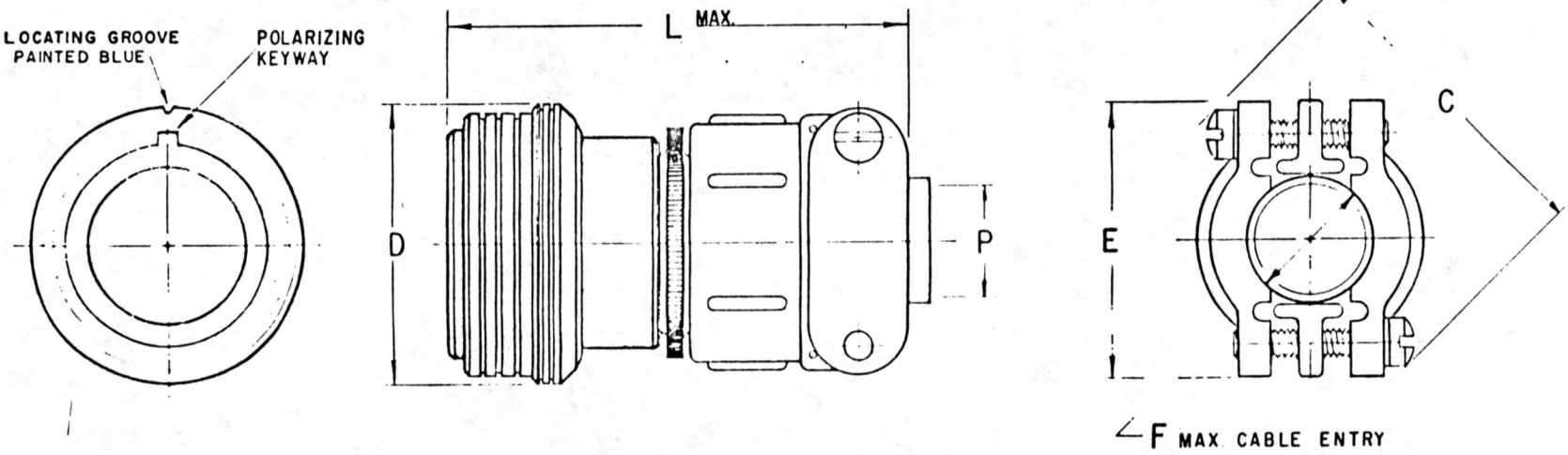
FOR PROPER ACCURACY AND PERFORMANCE, HASTINGS VACUUM GAUGES SHOULD ALWAYS BE USED WITH THE PROPER RANGE OF HASTINGS VACUUM GAUGE TUBES!



INSTRUMENT SERIES	RANGE	METAL TYPE	BASE COLOR	PYREX TYPE	"R" SERIES TYPE	STAINLESS STEEL TYPE
NV-8	10^{-5} torr 10^{-2} torr	DV-8	Green	DV-31	—	—
VT-5, CVT-15/25	0-100 μ Hg	DV-5M	Red	DV-18	—	—
VT-6, CVT-16/26, DAV-6, TV-4A, MRV-6, TV-47	0-1000 μ Hg	DV-6M	Yellow	DV-20	DV-6R	DV-36
VH-3, CVH-3/23	0-5 torr	DV-23	Orange	—	—	—
VT-4, CVT-14/24, DAV-4, TP-7A, MRV-4, TV-47	0-20 mm Hg	DV-4D	Purple	DV-16D	DV-4R	DV-34
VH-4, CVH-4/24	0-50 torr	DV-24	White	—	—	—
NV-100	0-100 torr	DV-100	Brown	—	—	—

MODEL DV-800 GAUGE TUBE is used with Wide Range Vacuum Gauges, Models NV-800 and DNNV-800. This linear voltage displacement transformer type is for the range of 0-800 torr.

MODEL DV-77 GAUGE TUBE is used with the Cold Cathode Ion Gauge, Model NV-77. Range is 10^{-4} to 10^{-2} torr. Replacement cathode-anode assemblies are available.



PART NO.	C	D	E	F	L	P	WT. IN LBS
DM 9702- 3 PS	1 1/16	23/32	13/16	1/4	2 3/32	1/8	.0506
DM 9702- 7 PS	1 1/8	29/32	7/8	5/16	2 3/32	7/32	.0582 .0758 .0806
DM 9702-12 PS	1 11/32	1 1/16	1 1/16	7/16	2 5/32	5/16	.1036 .1113
DM 9702-19 PS	1 1/2	1 3/16	1 5/32	9/16	2 7/32	7/16	.1302 .1416
DM 9702-27 PS	1 19/32	1 23/64	1 1/4	5/8	2 7/32	9/16	.1456 .1605
DM 9702-37 PS	1 7/8	1 1/2	1 15/32	3/4	2 7/32	5/8	.2093 .2303
DM 9702-61 PS	2 1/8	1 53/64	1 11/16	15/16	2 3/8	3/4	.3354 .3422

NOTE:

1. SEE "GENERAL DESCRIPTION" FOR ELECTRICAL AND MATERIAL SPECIFICATIONS
2. FOR AVAILABLE CONTACT ARRANGEMENTS AND ALTERNATE INSERT POSITIONS, SEE CATALOG PAGE # 14500, IN DM SECTION

III-3

1. DE-BURR ALL SHARP EDGES

TOLERANCES
FRACTIONS ± .015 DECIMALS ± .005 ANGLES ± ½°
UNLESS OTHERWISE SPECIFIED

MATERIAL	SPEC	
MATERIAL	SPEC	
MATERIAL	SPEC	
FORGING	SPEC	WT.

THE DEUTSCH COMPANY

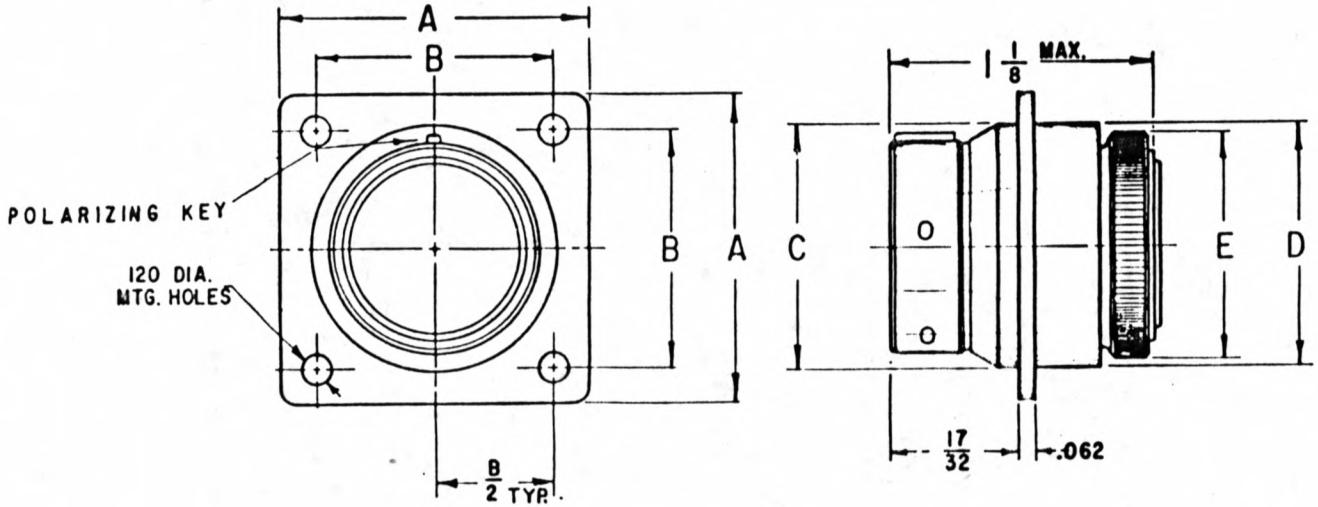
(ENVELOPE)
PLUG, WITH CABLE CLAMP
QUICK DISCONNECT - PUSH-PULL TYPE

NO	CHANGE	BY	DATE

DRAWN	C. HASTINGS
CHECKED	
APPROVED	
DATE 4-22-60	CODE 11139

DM 9702-* PS

DM 9606-✱ P S	REVISIONS			
	SYM	DESCRIPTION	DATE	APPROVAL



PART NO.	A	B	C	D	E	WEIGHT IN LBS
DM 9606-3 P S	7/8	.625	9/16	39/64	1/2	P .0208 S .0230
DM 9606-7 P S	1	.719	43/64	11/16	41/64	P .0298 S .0338
DM 9606-12 P S	1 3/32	.813	13/16	13/16	49/64	P .0418 S .0493
DM 9606-19 P S	1 3/16	.906	15/16	15/16	57/64	P .0549 S .0673
DM 9606-27 P S	1 9/32	.968	1 1/8	1 1/16	1 1/32	P .0750 S .0927
DM 9606-37 P S	1 7/16	1.187	1 1/4	1 1/4	1 13/64	P .0976 S .1162
DM 9606-61 P S	1 25/32	1.437	1 9/16	1 9/16	1 33/64	P .1540 S .1894

III-4

NOTE:

1. SEE "GENERAL DESCRIPTION" FOR ELECTRICAL AND MATERIAL SPECIFICATIONS.
2. FOR AVAILABLE CONTACT ARRANGEMENTS AND ALTERNATE INSERT POSITIONS, SEE CATALOG PAGE ✱ 14500. IN DM SECTION

NEXT ASSY	USED ON	ITEM	QTY	PART NUMBER	DESCRIPTION
APPLICATION		LIST OF MATERIAL			

TOLERANCES UNLESS OTHERWISE NOTED
FRACTIONS ±.015
DECIMALS ±.005
ANGLES 10' 30'0"

MATERIAL

FINISH

	SIGNATURE & DATE
DR	C. HASTINGS
CHK	R. Yates 5-3-61
PE	J. W. Stirling 5-3-61
APP	CED

(ENVELOPE)

RECEPTACLE,
MINIATURE SQUARE FLANGE MOUNTING TYPE
DM TYPE

SCALE | WT.

The Deutsch Company
ELECTRONIC COMPONENTS DIVISION
Municipal Airport · Banning, California

DWG SIZE B | DM 9606-✱ P S | CODE 11139 | SHEET

HOTWATT, INC.
...VERS, MA
...) 777-0070

- Stainless Steel Sheath
- Maximum Temperatures to 1250°F
- Moderate Watt Density
- U.L. Recognized & CSA Certified (¼" & up)
- Supplied with 12" SF-1 Leads

IN-STOCK HEATERS

STANDARD CARTRIDGE HEATERS

DIMENSIONS	CAT. NO.	WATTAGE	VOLTAGE	WATT DENSITY W/in²
1/8" × 1"	SC121	10W	120V	35
1/8" × 1"	SC121	15W	120V	50
1/8" × 1½"	SC1215	20W	120V	40
1/8" × 1½"	SC1215	25W	120V	50
1/8" × 2"	SC122	35W	120V	50
5/32" × 1"	SC151	10W	120V	25
5/32" × 1½"	SC1515	20W	120V	35
5/32" × 2"	SC152	35W	120V	40
3/16" × 1½"	SC1815	30W	120V	40
3/16" × 2"	SC182	35W	120V	35
3/16" × 3"	SC183	65W	120V	40
3/16" × 4"	SC184	90W	120V	40
3/16" × 4"	SC184	60W	120V	25
3/16" × 4"	SC184	100W	120V	45
¼" × 1"	SC251	20W	120V	35
¼" × 1¼"	SC251.25	20W	120V	25
¼" × 1½"	SC2515	30W	120V	30
¼" × 1½"	SC2515	30W	240V	30
¼" × 1½"	SC2515	50W	120V	50
¼" × 1½"	SC2515	50W	240V	50
¼" × 2"	SC252	50W	120V	35
¼" × 2"	SC252	50W	240V	35
¼" × 2¼"	SC252.25	75W	240V	50
¼" × 2½"	SC2525	65W	120V	35
¼" × 2½"	SC2525	65W	240V	35
¼" × 3"	SC253	100W	240V	45
¼" × 3½"	SC2535	90W	120V	35
"	SC2535	90W	240V	35
¼" × 4"	SC254	110W	120V	40
¼" × 4"	SC254	110W	240V	40
¼" × 4½"	SC2545	110W	120V	30
¼" × 4½"	SC2545	110W	240V	30
¼" × 7"	SC257	150W	120V	30
3/8" × 1"	SC371	30W	120V	40
3/8" × 1"	SC371	30W	240V	40
3/8" × 1½"	SC3715	30W	120V	20
3/8" × 1½"	SC3715	30W	240V	20
3/8" × 1½"	SC3715	50W	120V	40
3/8" × 1½"	SC3715	50W	240V	40
3/8" × 2"	SC372	70W	120V	35
3/8" × 2"	SC372	70W	240V	35
3/8" × 2"	SC372	100W	120V	50
3/8" × 2½"	SC3725	100W	120V	40
3/8" × 2½"	SC3725	100W	240V	40
3/8" × 3"	SC373	75W	120V	25
3/8" × 3"	SC373	75W	240V	25
3/8" × 3½"	SC3735	150W	120V	50
3/8" × 3½"	SC3735	150W	240V	50
3/8" × 4"	SC374	75W	240V	20
3/8" × 4"	SC374	220W	120V	50
3/8" × 4"	SC374	220W	240V	50
3/8" × 4½"	SC3745	250W	120V	50
3/8" × 4½"	SC3745	250W	240V	50
3/8" × 5"	SC375	280W	120V	50
3/8" × 5"	SC375	280W	240V	50
3/8" × 5½"	SC3755	100W	240V	15
3/8" × 6"	SC376	350W	120V	50
3/8" × 6"	SC376	350W	240V	50

DIMENSIONS	CAT. NO.	WATTAGE	VOLTAGE	WATT DENSITY W/in²
½" × 1½"	SC5015	75W	120V	50
½" × 1½"	SC5015	75W	240V	50
½" × 1½"	SC5015	90W	120V	60
½" × 2"	SC502	120W	120V	50
½" × 2"	SC502	120W	240V	50
½" × 2½"	SC5025	80W	120V	25
½" × 2½"	SC5025	150W	120V	50
½" × 2½"	SC5025	150W	240V	50
½" × 3"	SC503	200W	120V	50
½" × 3"	SC503	200W	240V	50
½" × 4"	SC504	275W	120V	50
½" × 4"	SC504	275W	240V	50
½" × 5"	SC505	350W	120V	50
½" × 5"	SC505	350W	240V	50
½" × 6"	SC506	425W	120V	50
½" × 6"	SC506	425W	240V	50
5/8" × 2½"	SC6225	75W	240V	20
5/8" × 2½"	SC6225	200W	120V	50
5/8" × 2½"	SC6225	200W	240V	50
5/8" × 3"	SC623	250W	120V	50
5/8" × 3"	SC623	250W	240V	50
5/8" × 3½"	SC6235	300W	120V	50
5/8" × 3½"	SC6235	300W	240V	50
5/8" × 3½"	SC6235	350W	120V	60
5/8" × 4"	SC624	350W	120V	50
5/8" × 4"	SC624	350W	240V	50
5/8" × 5"	SC625	450W	120V	50
5/8" × 5"	SC625	450W	240V	50
5/8" × 6"	SC626	350W	120V	30
5/8" × 6"	SC626	400W	240V	30
5/8" × 6"	SC626	540W	120V	50
5/8" × 6"	SC626	540W	240V	50
5/8" × 7"	SC627	635W	120V	50
5/8" × 7"	SC627	635W	240V	50
¾" × 2½"	SC7525	230W	120V	50
¾" × 2½"	SC7525	230W	240V	50
¾" × 3½"	SC7535	350W	120V	50
¾" × 3½"	SC7535	350W	240V	50
¾" × 5"	SC755	500W	120V	50
¾" × 5"	SC755	500W	240V	50
¾" × 6"	SC756	650W	120V	50
¾" × 6"	SC756	650W	240V	50
¾" × 7"	SC757	760W	120V	50
¾" × 7"	SC757	760W	240V	50
¾" × 8"	SC758	750W	120V	40
¾" × 8"	SC758	885W	120V	50
¾" × 8"	SC758	885W	240V	50

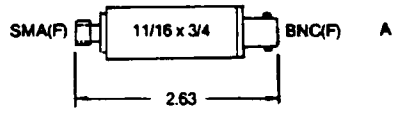
Precision Calibrated Coaxial Noise Sources - 10KHz to 18 GHz

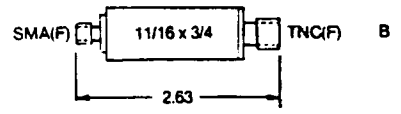
NC 3000 Series

NOISECOM, INC.
HACKENSACK, NJ
(201) 488-4144
CAT NC 985

FEATURES:

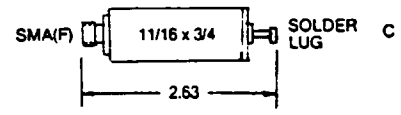
- Input power +28 volts, 25 ma. max.
- Noise output variation with temperature less than 0.01 DB/°C
- Noise output variation with voltage less than 0.1 DB/%V
- Operating temperature range -55°C to +85°C
- Calibration charts are supplied with each noise source
- Calibration points are listed on each noise source
- Noise output rise time and fall time <1 usec
- Noise diode is hermetically sealed

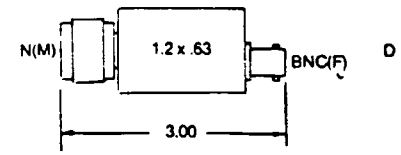




NOISE FIGURE METER COMPATIBLE TYPES:

MODEL	FREQUENCY RANGE (GHz)	NOISE OUTPUT ENR (DB)	VSWR MAX	PACKAGE CODE*	CALIBRATION FREQUENCIES
NC 3101	.01 – 8	15.5 ± .5	1.2 on/off		.01, .1, 1.0 & 1GHz steps
NC 3102	.01 – 12 4	15.5 ± 5	1.2 on/off	A	
NC 3103	1 – 12.4	15.5 ± .5	1.2 on/off	to	
NC 3104	1 – 18	15.5 ± 5	1.35 on/off	H	1GHz steps
NC 3105	12 – 18	15.5 ± 5	1.35 on/off		

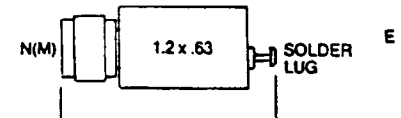


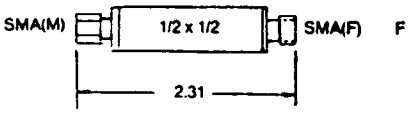


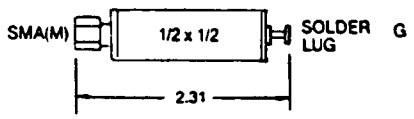
HIGH NOISE OUTPUT TYPES:

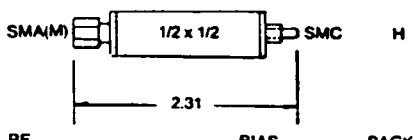
MODEL	FREQUENCY RANGE (GHz)	NOISE OUTPUT ENR (DB)	NOISE OUTPUT FLATNESS	PACKAGE CODE*	CALIBRATION FREQUENCY
NC 3201	10 KHz – 1.1GHz	30 – 35	± 1DB		0.1, .1, .5, 1.0
NC 3202	001 – 6	30 – 35	± 1DB		.01, .1, .6
NC 3203	1 – 2	30 – 35	± 1DB	A	1, 1.5, 2.0
NC 3204	2 – 4	30 – 35	± 1DB	to	
→ NC 3205	4 – 8	30 – 35	± 1DB	H	1GHz STEPS
NC 3206	8 – 12	28 – 33	± 1DB		
NC 3207	12 – 18	26 – 32	± 1DB		

*Specify package code









OPTIONS

1. Housing A-E can be supplied with threaded mounting holes.
2. SMA connectors standard as shown. Alternate sex may be specified.
3. Input voltages as low as 15 volts are available in some models - consult factory.

TUBULAR BANDPASS FILTERS

• 20 TO 5000 MHZ — 1 TO 13 SECTIONS •

SERIES - 1

SERIES - 2

SERIES - 3

SERIES - 4

Reactel, Inc,
Rockville, MD.
(301) 279-5535
CAT R80-B

PART NO. DEFINITION: 3 B 1 - 500 - 100 S 1 1

- NO. OF SECTIONS
- TUBULAR BANDPASS
- SERIES IDENTIFICATION
- CENTER FREQ. (MHZ)
- 3dB BANDWIDTH (MHZ)
- CONNECTOR DEFINITION
- INPUT CONNECTOR TYPE
- OUTPUT CONNECTOR TYPE

ELECTRICAL SPECS.	SERIES-1	SERIES-2	SERIES-3	SERIES-4
CENTER FREQ. RANGE	100-5000 MHZ	50-3000 MHZ	40-2000 MHZ	20-1000 MHZ
3dB BW (% OF Fo)	1 - 65%	1 - 85%	1 - 90%	.5 - 95%
MAX INSERTION LOSS	see fig. 7	see fig. 7	see fig. 8	see fig. 8
IMPEDANCE	50 ohms	50 ohms	50 ohms	50 ohms
MAX. VSWR @ Fo and †	1.5:1	1.5:1	1.5:1	1.5:1
ATTENUATION	see fig. 3	see fig. 4	see fig. 5	see fig. 6
DIAMETER	3/8 IN.	1/2 IN.	3/4 IN.	1 1/4 IN.
INPUT POWER **	10 WATTS	20 WATTS	50 WATTS	200 WATTS
APPROX. LENGTH	see tables	see tables	see tables	see tables
ENVIRONMENTAL SPECS.				
SHOCK	30G - 11ms	30G - 11ms	15G - 11ms	15G - 11ms
VIBRATION	10G-.02-2000 CPS	10G-.02-2000 CPS	10G-.02-2000 CPS	10G-.02-2000 CPS
HUMIDITY	up to 95%	up to 95%	up to 95%	up to 95%
TEMPERATURE	-55°C to 125°C	-55°C to 125°C	-55°C to 125°C	-55°C to 125°C
ALTITUDE	space rated	space rated	space rated	space rated

† 40% OF 3dB BANDWIDTHS UP TO 4 SECTIONS, 60% OF 3dB BANDWIDTHS UP TO 6 SECTIONS, 80% OF 3dB BANDWIDTHS UP TO 13 SECTIONS

** HIGHER POWER AVAILABLE CONSULT THE FACTORY

NOTE: SEE PAGE 7 FOR CONNECTOR DEFINITIONS AND TYPES.

ALL REACTEL, INC. STANDARD TUBULAR BANDPASS FILTERS ARE DESIGNED TO A LOW RIPPLE CHEVYSHEV CONFIGURATION. BESSEL, GAUSSIAN, BUTTERWORTH OR OTHER CONFIGURATIONS ARE AVAILABLE UPON REQUEST. PLEASE CALL THE FACTORY TO DISCUSS SPECIFIC REQUIREMENTS.

TABLES: LENGTH (L) vs FREQ.& NO. OF SECTIONS

SERIES - 1

fo (MHZ)	NO. OF SECTIONS								
	2	3	4	5	6	7	8	9	10
100-200	3	4	5	5½	6	6½	7	8½	9
201-300	2¾	3	3½	3¾	4	5	5½	6½	6¾
301-500	2½	2¾	3¾	3½	3¾	4¾	5	6¼	6½
501-700	2	2½	3	3¼	3¾	4½	5	6	6½
701-1000	1¾	2	2½	3	3½	4	4½	5	5¼
1001-2000	1½	1¾	2	2½	3	3½	3¾	4	4½
2001-3000	1¼	1½	1¾	2¼	2½	3	3½	3¾	4¼
3001-5000	1	1¼	1½	2	2¼	2½	3	3½	4

SERIES - 3

40-50	5	7	9	11½	14	17	19	21½	24
51-75	4½	6½	8	9½	11½	13	15	16	17
76-150	3	3½	4	5½	6½	8	9	10	11
151-300	2½	3	3½	4	5	5½	6½	7	8
301-700	2	2½	3	3½	4	4½	5	6	7
701-2000	1½	2	2½	3	3½	4	4½	5	6

SERIES - 2

fo (MHZ)	NO. OF SECTIONS								
	2	3	4	5	6	7	8	9	10
50-70	5½	8	10	12	14½	17	—	—	—
71-100	3½	4½	6	8	9¾	11½	13½	15½	17
101-140	3	3½	5	6½	7½	8½	9½	11	12½
141-200	2½	3	4¼	5¼	6¼	7	8	9	10
201-300	2¼	2¾	3½	4¼	5	5½	6¼	7	8
301-400	2	2½	3	3½	4¼	5	5½	6½	7½
401-700	1½	2	2½	3	3½	4½	5	6	7
701-3000	1	1½	2	2½	3	3½	4	4½	5

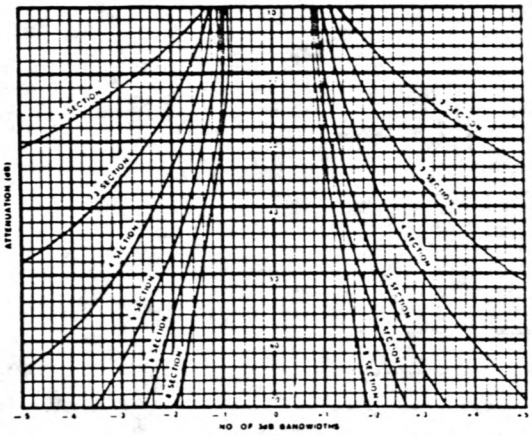
SERIES - 4

20-40	4½	6½	9	10½	13	16	19	22	25
41-60	4	5	6½	8½	10	13	15	17	19
61-80	3½	4	5½	7	8½	9½	11	13	14½
81-200	3	4	4½	6	7	8	9½	11	12
201-500	3	3½	4	5	6	7	8	*9	10
501-1000	2½	3	3½	4½	5	5½	6½	7	8

ATTENUATION CURVES

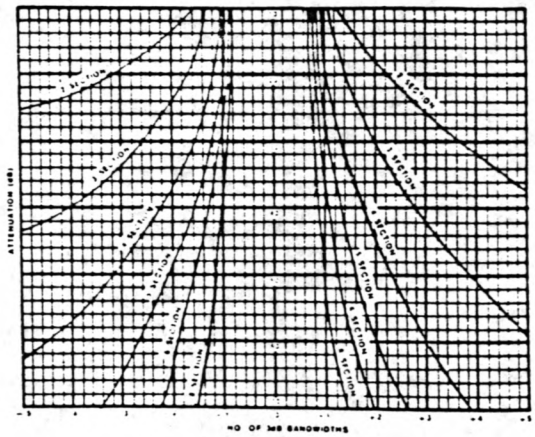
2%, 3dB BANDWIDTH

FIG. 3



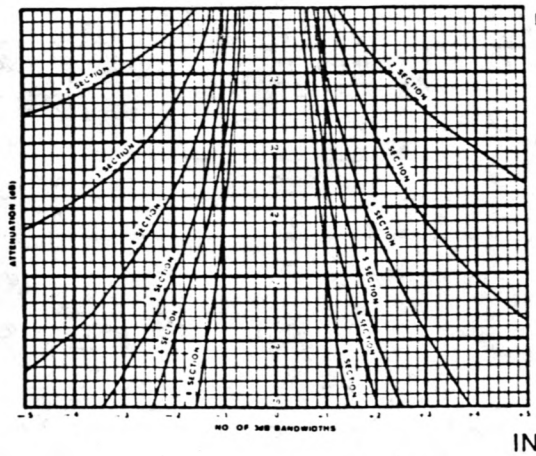
5%, 3dB BANDWIDTH

FIG. 4



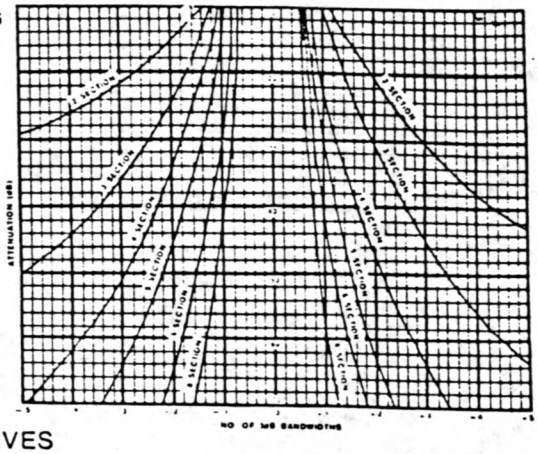
15%, 3dB BANDWIDTH

FIG. 5



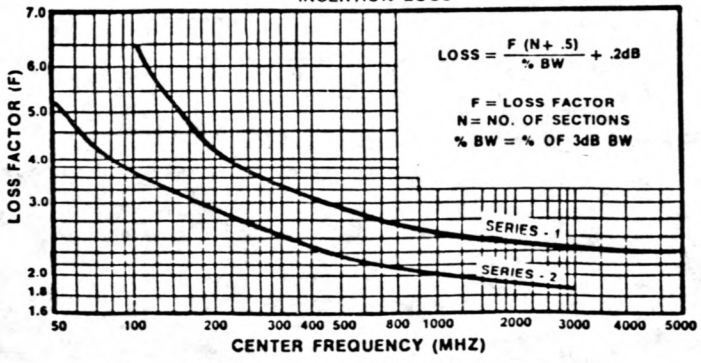
25%, 3dB BANDWIDTH

FIG. 6



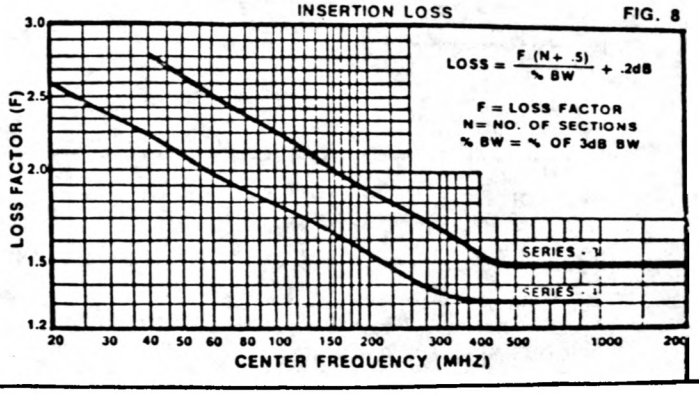
INSERTION LOSS CURVES

INSERTION LOSS



INSERTION LOSS

FIG. 8

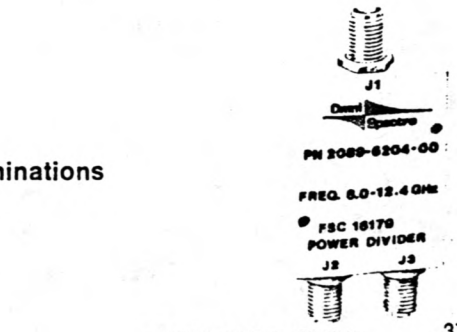


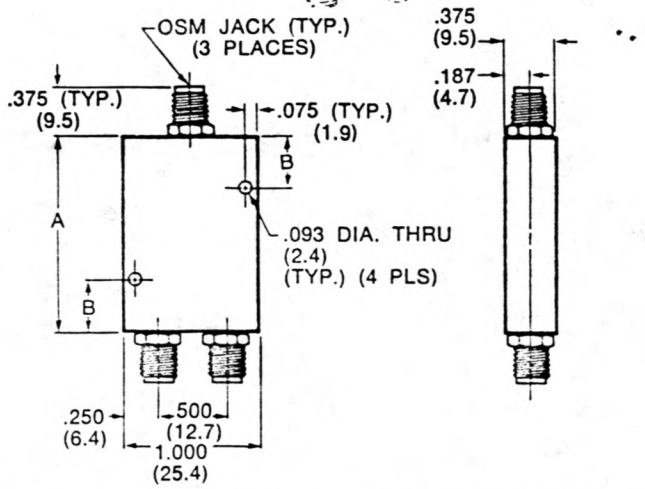
(303) 424-4111

TWO-WAY • WILKINSON • ISOLATED

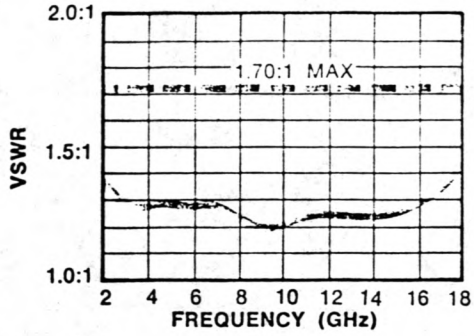
- Excellent Amplitude And Phase Balance
- High Isolation Between Output Ports
- Low VSWR, Small Size And Light Weight
- Octave and Multi-Octave Frequency Coverage.
- Power: 10 Watts Input Maximum with Matched Terminations
- Meets MIL-E-5400 and MIL-E-16400 Environments

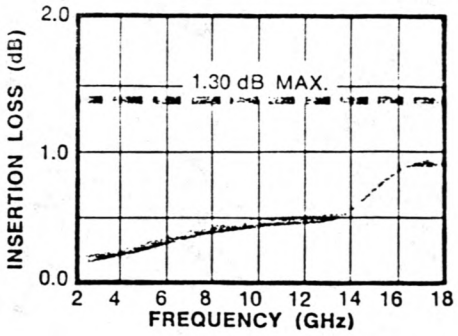
This series of two-way, in-phase stripline power dividers demonstrates excellent performance as well as small size and light weight. These octave and multi-octave power dividers have high isolation, low VSWR and excellent amplitude and phase balance. Their rugged construction meets MIL-E-5400 environmental conditions, making them ideal for high performance microwave systems.

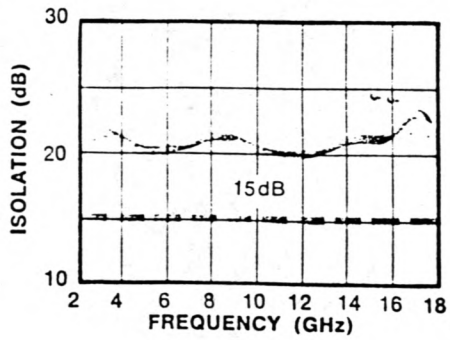




TYPICAL PERFORMANCE PART NO. 2089-6208-00







SPECIFICATIONS

2089-6201-00	1.0-2.0	1.25	20	0.4	0.2	4.0	2.0	2.0 (50.8)	0.5 (12.7)	1.5	43
2089-6202-00	2.0-4.0	1.35	20	0.4	0.2	4.0	2.0	2.0 (50.8)	0.5 (12.7)	1.5	43
→ 2089-6203-00	4.0-8.0	1.40	20	0.6	0.2	6.0	2.0	1.38 (35)	0.4 (10.2)	1.2	35
2089-6204-00	8.0-12.4	1.60	18	0.65	0.25	6.0	2.0	1.38 (35)	0.4 (10.2)	1.2	35
2089-6205-00	12.4-18.0	1.70	15	0.8	0.25	6.0	3.0	1.38 (35)	0.4 (10.2)	1.2	35
2089-6207-00	2.0-8.0	1.50	18	0.8	0.25	8.0	4.0	2.25 (57.2)	0.5 (12.7)	1.3	37
2089-6208-00	2.0-18.0	1.70	15	1.30	0.25	8.0	10.0	2.25 (57.2)	0.5 (12.7)	1.3	37
2089-6209-00	4.0-18.0	1.70	15	1.20	0.25	8.0	4.0	1.63 (41.4)	0.5 (12.7)	1.3	37
2089-6210-00	7.0-18.0	1.70	15	0.8	0.25	8.0	3.0	1.38 (35)	0.4 (10.2)	1.2	35

*Maximum input power with output loads of VSWR ≤ 2.0:1.
Derate to 10% of listed value when arbitrarily terminated.

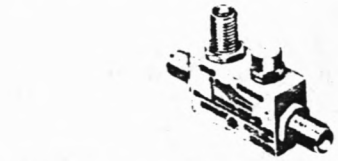
SMALL SPECTRA
MICROWAVE, INC.
(603) 424-4111

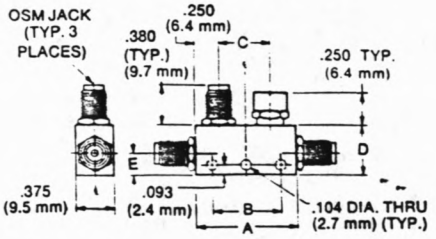
DIRECTIONAL COUPLERS

MINI COUPLERS • OCTAVE BANDWITH

- **Smallest and Lightest Couplers Available**
- **.5 Through 18 GHz Including Wideband Units**
- **High Directivity — Low VSWR**
- **Meets MIL-E-5400 and MIL-E-16400 Environments**

This complete line of mini-series coaxial stripline couplers features the smallest and lightest units available anywhere, typically measuring 1 inch by ½ inch by ⅜ inch thick and weighing only about ½ ounce. These units are the ultimate in performance and will consistently outperform their conservative specifications. All of the units use OSM female stainless steel precision connectors.





SPECIFICATIONS

Part No.	Case Style	Frequency Range (GHz)	Coupling (Including Frequency Sensitivity) (dB)	Frequency Sensitivity (dB)	Insertion Loss (dB)	Directivity (dB)	VSWR Prim. Line	VSWR Sec. Line	Power (Input) Ave. Inp. (W)	Power (Input) Ave. Refl. (W)	Power (Input) Pk. (kW)
2020-6600-06	7	0.5-1.0	6 ±1.0	±0.60	0.15	25	1.10	1.10	50	4	4
2020-6601-10	7		10 ±1.0	±0.75	0.15	25	1.10	1.10	50	10	4
2020-6602-20	7		20 ±1.0	±0.75	0.15	25	1.10	1.10	50	50	4
2020-6603-30	7		30 ±1.0	±0.75	0.15	25	1.10	1.10	50	50	4
2020-6604-06	5	1.0-2.0	6 ±1.0	±0.60	0.20	25	1.15	1.15	50	4	4
2020-6605-10	5		10 ±1.0	±0.75	0.20	25	1.15	1.15	50	10	4
2020-6606-20	5		20± 1.0	±0.75	0.20	25	1.15	1.15	50	50	4
2020-6607-30	6		30 ±1.0	±0.75	0.20	25	1.15	1.15	50	50	4
2020-6608-06	3	2.0-4.0	6 ±1.0	±0.60	0.20	22	1.15	1.15	50	4	4
2020-6609-10	3		10 ±1.0	±0.75	0.20	22	1.15	1.15	50	10	4
2020-6610-20	3		20 ±1.0	±0.75	0.20	22	1.15	1.15	50	50	4
2020-6611-30	4		30 ±1.0	±0.75	0.20	22	1.15	1.15	50	50	4
2020-6612-06	2	2.6-5.2	6 ±1.0	±0.60	0.25	20	1.25	1.25	50	4	4
2020-6613-10	2		10 ±1.0	±0.75	0.25	20	1.25	1.25	50	10	4
2020-6614-20	2		20 ±1.0	±0.75	0.25	20	1.25	1.25	50	50	4
2020-6615-30	1		30 ±1.0	±0.75	0.25	20	1.25	1.25	50	50	4
2020-6616-06	2	4.0-8.0	6 ±.75	±0.50	0.25	18	1.25	1.25	50	4	4
2020-6617-10	2		10 ±.75	±0.50	0.25	20	1.25	1.25	50	10	4
2020-6618-20	2		20 ±.75	±0.50	0.25	20	1.25	1.25	50	50	4
2020-6619-30	1		30 ±.75	±0.50	0.25	20	1.25	1.25	50	50	4
2020-6620-06	2	7.0-12.4	6 ±1.0	±0.40	0.40	15	1.35	1.35	50	4	4
2020-6621-10			10 ±1.0	±0.50	0.40	17	1.35	1.35	50	10	4
2020-6622-20	1		20 ±1.0	±0.50	0.30	17	1.35	1.35	50	50	4
2020-6623-30	1		30 ±1.0	±0.50	0.30	17	1.35	1.35	50	50	4
2020-6624-06	2	7.0-18.0	6 ±1.0	±0.50	0.50	15	1.35	1.35	50	4	3
2020-6625-10			10 ±1.0	±0.75	0.50	12	1.45	1.45	50	10	3
2020-6626-20	1		20 ±1.0	±0.75	0.50	15**	1.45	1.45	50	50	3
2020-6627-30	8		30 ±1.0	±0.75	0.50	15**	1.45	1.45	50	50	3
2020-6628-06	2	12.4-18.0	6 ±1.0	±0.40	0.50	15	1.35	1.35	50	4	2
2020-6629-10			10 ±1.0	±0.50	0.50	12	1.45	1.45	50	10	2
2020-6630-20	1		20 ±1.0	±0.50	0.50	12	1.45	1.45	50	50	2
2020-6631-30	8		30 ±1.0	±0.50	0.50	12	1.45	1.45	50	50	2

MECHANICAL SPECIFICATIONS

Case Style							
1	1.000 (25.4 mm)	N/A	.500 (12.7 mm)	.546 (13.9 mm)	.219 (5.6 mm)	0.62	17.6
2				.500 (12.7 mm)		0.60	17.0
3	1.156 (29.4 mm)	.343 (8.7 mm)	.656 (16.7 mm)	.500 (12.7 mm)		0.64	18.2
4				.546 (13.9 mm)		0.67	19.0
5	1.781 (45.2 mm)	.937 (23.8 mm)	1.281 (32.5 mm)	.500 (12.7 mm)		0.82	23.2
6				.546 (13.9 mm)		0.87	23.3
*7	3.000 (76.2 mm)	1.000 (25.4 mm)	2.500 (63.5 mm)	.750 (19.1 mm)	.310 (7.9 mm)	1.50	43.0
8	1.000 (25.4 mm)	N/A	.500 (12.7 mm)	.625 (15.9 mm)	.219 (5.6 mm)	0.67	19.0

*NOTE Case style seven has four mounting holes located symmetrically to the two shown dotted in figure.

**12dB from 12.4 to 18.0 GHz.

2.6-5.2 GHz

Model	Frequency Range (GHz)	Coupling Nominal (dB)	Frequency * Sensitivity (dB)	Insertion Loss Excluding Coupled Power	Insertion Loss True	Directivity (dB Min)	VSWR Primary Line	VSWR Secondary Line	Power Average Incident (Watts)	Power Average Reflected (Watts)	Power Peak (kW)	Weight Oz
4053-6	2.6-5.2	6±1.00	±0.60	0.25	1.80	18	1.25	1.25	50	2	3	0.43
4053-10	2.6-5.2	10±1.25	±0.75	0.25	0.80	20	1.25	1.25	50	5	3	0.43
4053-20	2.6-5.2	20±1.25	±0.75	0.25	0.25	20	1.25	1.25	50	50	3	0.43
4053-30	2.6-5.2	30±1.25	±0.75	0.25	0.20	20	1.25	1.25	50	50	3	0.46

4-8 GHz

Model	Frequency Range (GHz)	Coupling Nominal (dB)	Frequency * Sensitivity (dB)	Insertion Loss Excluding Coupled Power	Insertion Loss True	Directivity (dB Min)	VSWR Primary Line	VSWR Secondary Line	Power Average Incident (Watts)	Power Average Reflected (Watts)	Power *Peak (kW)	Weight Oz	Weight Grams
4014C-6	4-8	6±1.00	±0.60	0.25	2.00	18	1.25	1.25	50	2	3	.56	16
4014C-10	4-8	10±1.25	±0.75	0.25	1.00	20	1.25	1.25	50	5	3	.56	16
4014C-20	4-8	20±1.25	±0.75	0.25	0.30	20	1.25	1.25	50	50	3	.56	16
→ 4014C-30	4-8	30±1.25	±0.75	0.25	0.25	20	1.25	1.25	50	50	3	.60	17

7-12.4 GHz

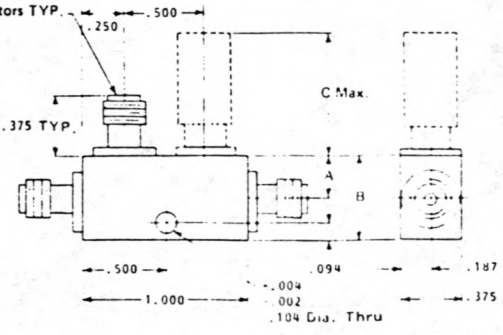
Model	Frequency Range (GHz)	Coupling Nominal (dB)	Frequency * Sensitivity (dB)	Insertion Loss Excluding Coupled Power	Insertion Loss True	Directivity (dB Min)	VSWR Primary Line	VSWR Secondary Line	Power Average Incident (Watts)	Power Average Reflected (Watts)	Power Peak (kW)	Weight Oz	Weight Grams
4015C-6	7-12.4	6±1.00	±0.50	0.40	2.00	15	1.30	1.30	50	2	3	.63	18
4015C-10	7-12.4	10±1.25	±0.50	0.40	1.00	17	1.30	1.30	50	5	3	.64	18
4015C-20	7-12.4	20±1.00	±0.50	0.30	0.35	17	1.25	1.25	50	50	3	.63	18
4015C-30	7-12.4	30±1.00	±0.50	0.30	0.30	17	1.25	1.25	50	50	3	.71	20

7.5-16 GHz

Model	Frequency Range (GHz)	Coupling Nominal (dB)	Frequency * Sensitivity (dB)	Insertion Loss Excluding Coupled Power	Insertion Loss True	Directivity (dB Min)	VSWR Primary Line	VSWR Secondary Line	Power Average Incident (Watts)	Power Average Reflected (Watts)	Power Peak (kW)	Weight Oz	Weight Grams
4055-6	7.5-16	6±1.10	±0.60	0.60	2.00	12	1.35	1.40	50	2	2	.63	18
4055-10	7.5-16	10±1.50	±0.75	0.60	1.00	12	1.35	1.40	50	5	2	.63	18
4055-20	7.5-16	20±1.25	±0.75	0.50	0.50	15	1.35	1.40	50	50	2	.63	18
4055-30	7.5-16	30±1.25	±0.75	0.50	0.50	15	1.35	1.40	50	50	2	.70	20

*Frequency sensitivity is included in coupling.

Type SMA
Stainless Steel Female
Connectors TYP.



Model No.	A	B	C
*4014C-6, -10, -20	.281	.507	.47
4014C-30	.320	.541	.47
*4015C-6, -10, -20	.281	.507	.81
*4015C-30	.404	.625	.81
*4016C-20, -30	.404	.625	.81
4053-6, -10, -20	.281	.507	.47
4053-30	.320	.541	.47
*4055-6, -10	.281	.507	.81
*4055-20, -30	.404	.625	.81

tol.: ±.015

NOTE: Add .040 max to the length, width, and height to allow for exterior finish.

NARDA MICROWAVE
HAUPPAUGE, NY
(516) 231-1700

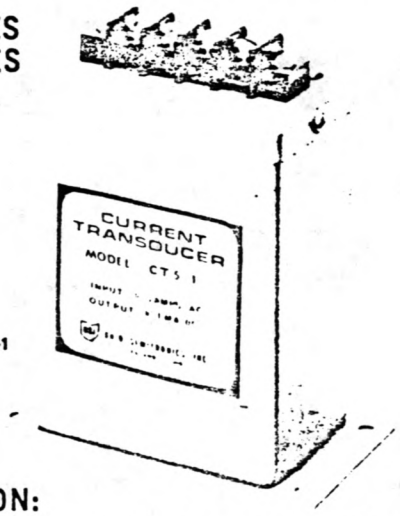
CAT LIN55K82

narda

OSI SPECIALISTS IN MEASUREMENT MONITORING, AND CONTROL OF CURRENT, POWER AND ENERGY

AC VOLTAGE AND CURRENT TRANSDUCERS

VT SERIES
CT SERIES



MODEL CT5-1

DESCRIPTION:

The VT (Voltage Transducers) and CT (Current Transducers) provide a 0 to 1 mA DC output related to the AC input signal to the transducer. Transducer output is derived from the average absolute value of the input and is calibrated in terms of the rms value for sine wave input.

Voltage transducers are available for 120, 240, 480 volt inputs at 50 to 500 Hz.

Current transducers are available with full-scale current input ranges from 1 to 1000 Amperes rms.

4-20 mA output available upon request.

MODEL	VOLTAGE (VAC) RANGE	OUTPUT CAL
VT120	0 to 150	1 mA @ 150V
VT240	0 to 300	1 mA @ 300V
VT480*	0 to 575	1 mA @ 575V

MODEL	CURRENT (AMPS AC) RANGE	OUTPUT CAL	CURRENT SENSOR DRAWING
CT1-1	0 to 1	1 mA @ 1A	Internal
CT5-1	0 to 5	1 mA @ 5A	Internal
CT10-1	0 to 10	1 mA @ 10A	Internal
CT20-1	0 to 20	1 mA @ 20A	Internal
CT5-100	0 to 100	1 mA @ 100A	W
CT5-200	0 to 200	1 mA @ 200A	W
CT5-300	0 to 300	1 mA @ 300A	W
CT5-400	0 to 400	1 mA @ 400A	X
CT5-600	0 to 600	1 mA @ 600A	X
CT5-1000	0 to 1000	1 mA @ 1000A	Y

* Includes OSI 226-145 Potential Transformer.

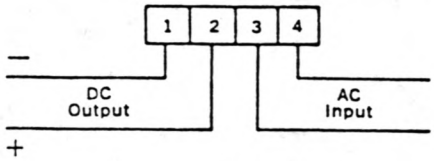
SPECIFICATIONS (Common to All Models):

ACCURACY (Calibration, linearity @ 25°C)	±0.5% FS
FREQUENCY RANGE	50 to 500Hz
RESPONSE TIME	400ms
TEMPERATURE EFFECT (from calibrated value) −20°C to +60°C	±1% of Reading
RIPPLE	<1% FS
FULL SCALE OUTPUT	1 mA DC
OUTPUT LOADING	0-10K ohms
OVERLOAD (Continuous)	
Voltage	Full Scale Rating
Current	2 X Rating
Except CT10-1 & CT20-1	1.25 Rating
1 Second Transients	50 X Rated Input
BURDEN	
Voltage	2.8VA FS
Current	1VA FS
OPERATING RANGE (Extended)	
Voltage	Full Scale
Current	1.2 X Rating
DIELECTRIC TEST: (Input/Output/Case)	
VT and CT	1500VAC

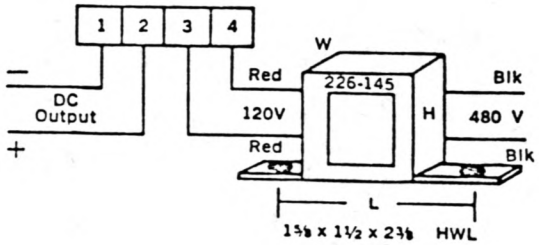
CASE SIZE DRAWING B, See Attached Drawing
CURRENT SENSOR DIMENSIONS, See Attached Drawing

VOLTAGE AND CURRENT TRANSDUCER CONNECTIONS

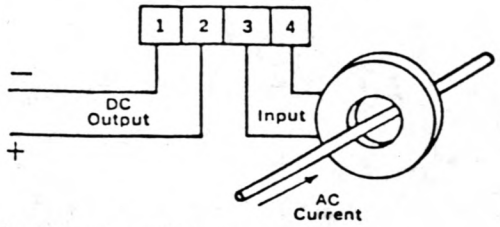
MODELS CT5-1 THRU CT20-1 VT120 AND VT240



MODEL VT480



MODELS CT5-100 THRU CT5-1000



Current Transformer Phasing is not required

Curtis Instruments, Inc.
200 KISCO AVENUE
MOUNT KISCO, N.Y. 10549
TEL: (914) 666-2971
TWX 710 571-2163

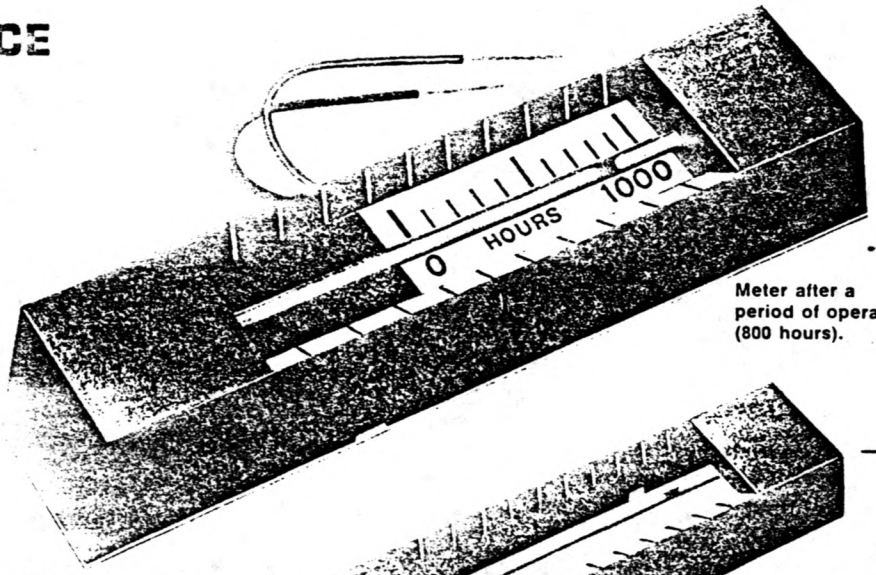
12-74

DATA SUMMARY

CP3-Series
Curtis Indachron
Elapsed Time Meter/Counter

FOR MAINTENANCE MONITORING

- Measures operating time
- Counts to Megahertz rates

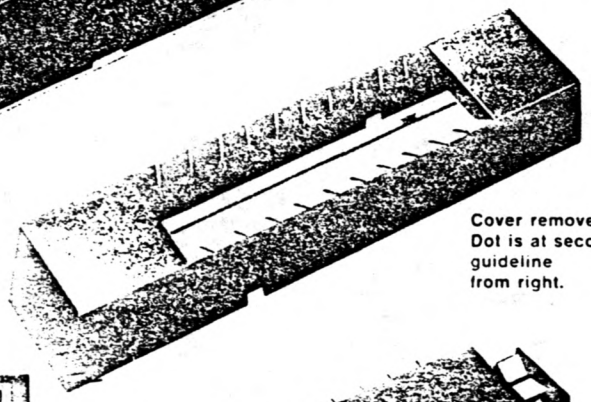


Meter after a period of operation (800 hours).

THE NEW CP3 SERIES CURTIS INDACHRON ELAPSED TIME METER/COUNTER

was developed as a low cost monitor for preventive maintenance scheduling, and other applications requiring a convenient, simple means of reset to zero in the field. It simplifies preventive maintenance scheduling and field service records reducing field service costs. Additionally, the actual hours of use or total cycles data has many areas of application.

Cost of the CP3 Series is under $4.00 in moderate production quantities. Typical applications are P/M scheduling for office machines, test instruments, appliances, computer elements, machine tools, etc.

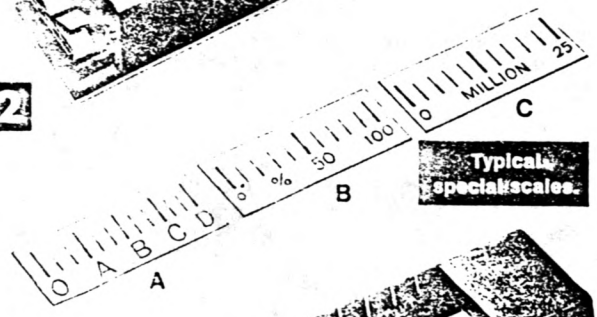


Cover removed. Dot is at second guideline from right.

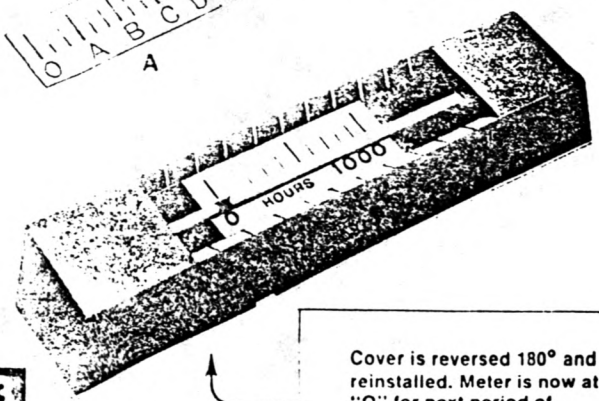
1

Scale "O" is set to second guideline from left.

2



Typical special scales.



3

Cover is reversed 180° and reinstalled. Meter is now at "O" for next period of operation.

FEATURES:

- Instant Field Reset to Zero
- Easy Readability
- Overrun Safety
- Infinite cycles
- Scales for any type of scheduling programs
- Models operate from any AC or DC Voltage
- Compact Size
- Counts Operation Cycles—from Pulsed Inputs

GENERAL DESCRIPTION

The heart of the Model 520 CP3 is the patented* Curtis mercury coulometer, in which the indicating dot travels longitudinally along a mercury filled capillary tube at a rate proportional to the flow of electric current through the instrument.

In the CP3 Series, the capillary tube is mounted on a window-cover assembly 1. This plugs into

continued . . .

*U.S. Pat. 3,665,308, others pending

. . . continued

the bed which has a grooved channel in which the adjustable scale is mounted 2. The scale can be set anywhere along the length of the meter and is ½ the length of the channel, providing for overrun safety should the meter run beyond the full scale time period.

To reset the instrument, the equipment maintenance man merely removes the cover from the bed and reverses it 180°. This places the dot downscale where it can start travel upscale again (the dot always moves from negative [−] to positive [+]). Inasmuch as the scale can be moved in its channel, it is positioned so that "zero" or any other marking can align with the new downscale position of the dot 3.

To facilitate the rezeroing operation, the cover assembly has ten molded reference marks on the cover. These marks are matched by identical marks on the bed. To determine where to set the scale when rezeroing, note is made of the position of the indicating dot relative to the cover reference marks and the zero indice of the scale is simply moved to the corresponding mark on the bed.

Any type of scale markings can be used — in hours or in symbols that refer to various maintenance schedules or other procedures. Moreover, simple records can indicate how many times full or part scale has been "reversed" so that an infinite number of hours or readings can be made from a basically short-period scale. It never "runs out of time". A lens is molded into the window of the cover, doubling the readability of the indicating dot.

TECHNICAL DESCRIPTION

Operational Temperature: 0° to +50°C
Shock: 50 g 11 millisec
Vibration: 20 g 50-500 Hz
Attitude: Attitude insensitive

Storage Temperature: — 35° C to + 70° C

Materials: Body — ABS Flame Retardant High Modulus; Window — Acrylic ASTM D — 788, Grade 8

Terminations: 8" wire leads, #26 ga. AWG, vinyl insulated

Standard Mounting: Adhesive backing with 3M #4032 polyurethene tape

Optional Mountings:
Code A: Threaded studs, no adhesive backing.
Code B: Frangible seal.
Code C: Non-threaded studs with adhesive backing.
Code D: Rear exit leads.
Code E: High current cover (11087-11437).
2 Milliampere Max. Current.
3.2 Milliampere-hours full scale.
Minimum hour range = 2.0 hours.
Code F: High current cover (11087-11686).
3.5 Milliampere Max. Current.
1.6 Milliampere-hours full scale.
Minimum hour range = 0.5 hours.

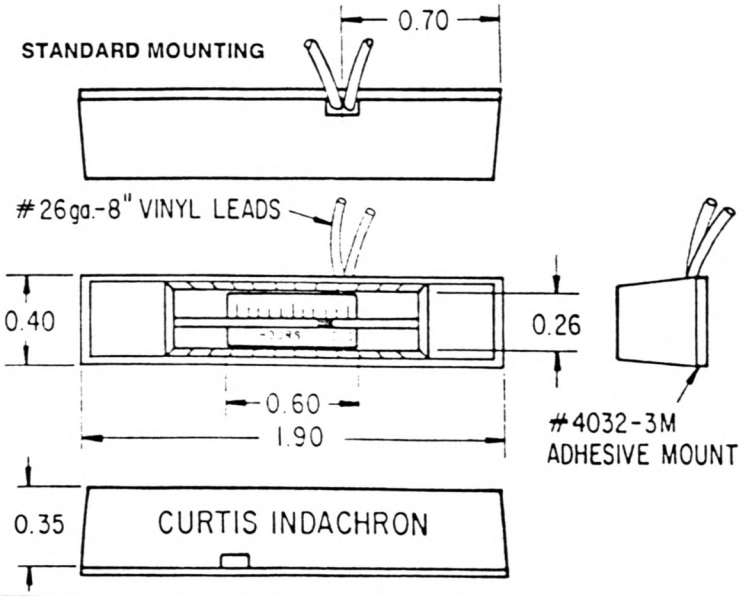
MODELS

MODEL 520 CP3: Operates from 115 VAC; incorporates a zener diode and resistor power supply rated to obtain proper current from 115 VAC input according to the desired time scale. Internally regulated for line voltage variations.

MODEL 420 CP3: Operates from any DC Voltage; incorporates resistors rated to obtain proper current for desired time interval from the specified DC voltage input.

MODEL 120 CP3: Operates from DC Current; is the lowest cost unit. It operates directly from current or pulse train established in the parent equipment to provide the desired time constant, i.e.: 1000 hours = 3.2 microamperes.

Scales: (See other side) Standard scale is ½". 0-1000 hours. Other scales can be furnished as required. Any type scale marking can be used — in hours or in symbols that refer to various maintenance schedules or other procedures. **A**, **B** and **C** are typical customer applications.



Curtis Instruments, Inc.
200 KISCO AVENUE, MOUNT KISCO, N.Y. 10549 TEL: (914) 666-2971 TWX: 710-571-2163

INSTALLATION AND MAINTENANCE INSTRUCTIONS

2-WAY DIRECT ACTING SOLENOID VALVES
NORMALLY CLOSED OPERATION – 3/8 AND 1/2 NPT

BULLETINS
8030
8031

ASCO

Form No. V-5304R2

DESCRIPTION

Bulletin 8030's are 2-way normally closed direct acting solenoid valves. Valves are constructed with forged brass or stainless steel bodies and soft seating for tight seating on low pressure service. Standard valves have a General Purpose NEMA Type I Solenoid Enclosure.

Bulletin 8031's are the same as Bulletin 8030's except the solenoids are equipped with an enclosure which is designed to meet NEMA Type 4 - Watertight, NEMA Type 7 (C or D) Hazardous Locations - Class I, Group C or D and NEMA Type 9 (E, F or G) Hazardous Locations - Class II, Groups E, F or G and are shown on separate sheets of Installation and Maintenance Instructions, Form Nos. V-5380 and V-5381.

OPERATION

Normally Closed: Valve is closed when solenoid is de-energized. Valve opens when solenoid is energized.

IMPORTANT: No minimum operating pressure required.

INSTALLATION

Check nameplate for correct catalog number, pressure, voltage and service.

TEMPERATURE LIMITATIONS

For maximum valve ambient and fluid temperatures, refer to chart below. The temperature limitations listed are for UL applications. For non UL applications, higher ambient and fluid temperature limitations are available. Consult factory. Check catalog number and wattage on nameplate to determine maximum temperatures.

CONSTRUCTION	COIL CLASS / WATT RATING	Catalog Number Prefix	Maximum Ambient Temp. °F	Maximum Fluid Temp. °F
A-C Construction (Alternating Current)	A / 10.5	None	77	180
	A / 15.4	None	77	200
	F / 10.5 or 15.4	FT	122	200
	H / 10.5 or 15.4	HT	140	200
D-C Construction (Direct Current)	A, F or H / 11.2	None, FT or HT	77	150
	A, F or H / 16.8	None, FT or HT	77	180

POSITIONING/MOUNTING

This valve is designed to perform properly when mounted in any position. However, for optimum life and performance, the solenoid should be mounted vertical and upright so as to reduce the possibility of foreign matter accumulating in the core tube area. For mounting bracket (optional feature) dimensions, refer to Figure 1.

PIPING

Connect piping to the valve according to marking on valve body. Apply pipe compound sparingly to male pipe threads only; if applied to valve threads, it may enter the valve and cause operational difficulty. Pipe strain should be avoided by proper support and alignment of piping. When tightening the pipe, do not use valve as a lever. Wrenches applied to valve body or piping are to be located as close as possible to connection point.

IMPORTANT: For the protection of the solenoid valve, install a strainer or filter suitable for the service involved in the inlet side as close to the valve as possible. Periodic cleaning is required depending on service conditions. See Bulletins 8600, 8601 and 8602 for strainers.

WIRING

Wiring must comply with Local and National Electrical Codes. Solenoid housings are provided with a 7/8 diameter hole, for 1/2 inch conduit. The general purpose solenoid enclosure may be rotated to facilitate wiring by removing the retaining cap or clip. CAUTION: When metal retaining clip disengages, it will spring upwards. Rotate enclosure to desired position. Replace retaining cap or clip before operating.

NOTE: Alternating Current (A-C) and Direct Current (D-C) solenoids are built differently. To convert from one to the other, it is necessary to change the complete solenoid including the complete solenoid base sub-assembly and core assembly.

SOLENOID TEMPERATURE

Standard catalog valves are supplied with coils designed for continuous duty service. When the solenoid is energized for a long period, the solenoid enclosure becomes hot and can be touched with the hand only for an instant. This is a safe operating temperature. Any excessive heating will be indicated by the smoke and odor of burning coil insulation.

MAINTENANCE

WARNING: Turn off electrical power supply and depressurize valve before making repairs. It is not necessary to remove the valve from the pipe line for repairs.

CLEANING

A periodic cleaning of all solenoid valves is desirable. The time between cleanings will vary, depending upon media and service conditions. In general, if the voltage to the coil is correct, sluggish valve operation, excessive leakage or noise will indicate that cleaning is required. Be sure to clean valve strainer or filter when cleaning solenoid valve.

PREVENTIVE MAINTENANCE

1. Keep the medium flowing through the valve as free from dirt and foreign material as possible.
2. While in service, operate the valve at least once a month to insure proper opening and closing.
3. Periodic inspection (depending on media and service conditions) of internal valve parts for damage or excessive wear is recommended. Thoroughly clean all parts. Replace any parts that are worn or damaged.

Form No. V-5304R2 PRINTED IN U.S.A. 1976 Automatic Switch Co.

ASCO Valves

FLORHAM PARK, NEW JERSEY 07932

IMPROPER OPERATION

1. **Faulty Control Circuit:** Check the electrical system by energizing the solenoid. A metallic click signifies the solenoid is operating. Absence of the click indicates loss of power supply. Check for loose or blown-out fuses, open circuited or grounded coil, broken lead wires or splice connections.
2. **Burned-Out Coil:** Check for open circuited coil. Replace coil, if necessary.
3. **Low Voltage:** Check the voltage across the coil leads. Voltage must be at least 85% of nameplate rating.
4. **Incorrect Pressure:** Check valve pressure. Pressure to valve must be within range specified on nameplate.
5. **Excessive Leakage:** Disassemble valve and clean all parts. Replace worn or damaged parts with a complete Spare Parts Kit for best results.

COIL REPLACEMENT

Turn off electrical power supply and disconnect coil lead wires. Determine valve size (NPT) and proceed in the following manner:

3/8 NPT CONSTRUCTION - Refer to Figure 2.

1. Remove retaining cap or clip, nameplate and housing. CAUTION: When metal retaining clip disengages, it will spring upwards.
2. Remove spring washer, insulating washer and coil. Insulating washers are omitted when a molded coil is used.
3. Reassemble in reverse order of disassembly paying careful attention to exploded view provided for identification and placement of parts.

1/2 NPT CONSTRUCTION - Refer to Figure 3.

1. Remove retaining cap or clip, nameplate and cover. CAUTION: When metal retaining clip disengages, it will spring upwards.
2. Slip yoke containing coil, sleeves and insulating washers off the solenoid base sub-assembly. Insulating washers are omitted when a molded coil is used. Slip coil, sleeves and insulating washers from yoke. For D-C Construction, a single fluxplate over the coil replaces yoke, sleeves and insulating washers.
3. Reassemble in reverse order of disassembly paying careful attention to exploded views provided for identification and placement of parts.

CAUTION: Solenoid must be fully reassembled as the housing and internal parts are part of and complete the magnetic circuit. Place insulating washers at each end of coil, if required.

VALVE DISASSEMBLY AND REASSEMBLY (Refer to Figures 2 and 3)

Depressurize valve and turn off electrical power supply. Proceed in the following manner:

1. Remove the retaining cap or clip and slip the entire solenoid enclosure off the solenoid base sub-assembly. CAUTION: When metal retaining clip disengages, it will spring upwards.
2. Unscrew solenoid base sub-assembly and remove body gasket, core assembly and core spring.
3. For normal maintenance, it is not necessary to disassemble the manual operator unless external leakage is evident. If disassembly is required, remove stem pin, stem and stem gasket.
4. All parts are now accessible for cleaning or replacement. Replace worn or damaged parts with a complete Spare Parts Kit for best results.
5. Reassemble in reverse order of disassembly paying careful attention to exploded views provided for identification and placement of parts.
6. Replace body gasket, core assembly and core spring. For 1/2 NPT Construction, be sure wide end of core spring goes into core first and closed end protrudes from the top of the core. Replace solenoid base sub-assembly and torque to 175 ± 25 inch pounds. Replace solenoid enclosure and retaining cap or clip.
7. After maintenance, operate the valve a few times to be sure of proper opening and closing.

SPARE PARTS KITS

Spare Parts Kits and Coils are available for ASCO valves. Parts marked with an asterisk (*) are supplied in Spare Parts Kits.

ORDERING INFORMATION FOR SPARE PARTS KITS

When Ordering Spare Parts or Coils Specify Valve Catalog Number, Serial Number and Voltage.

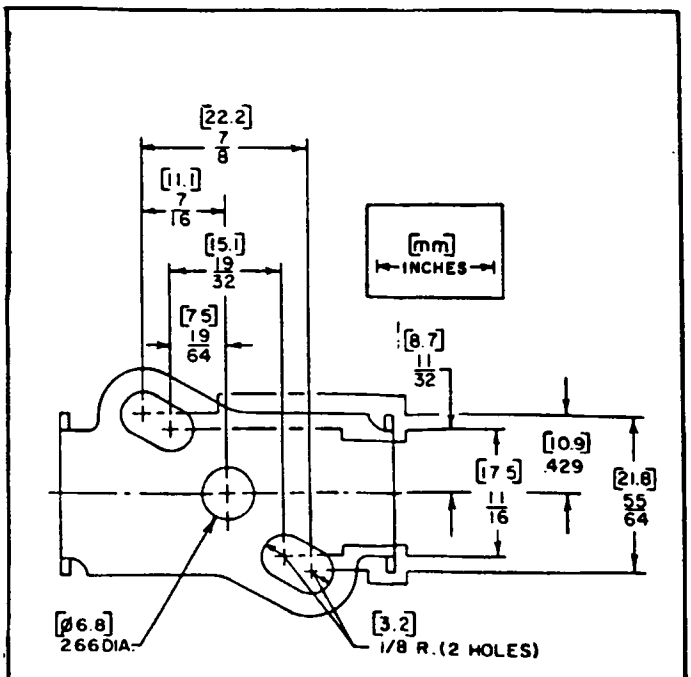
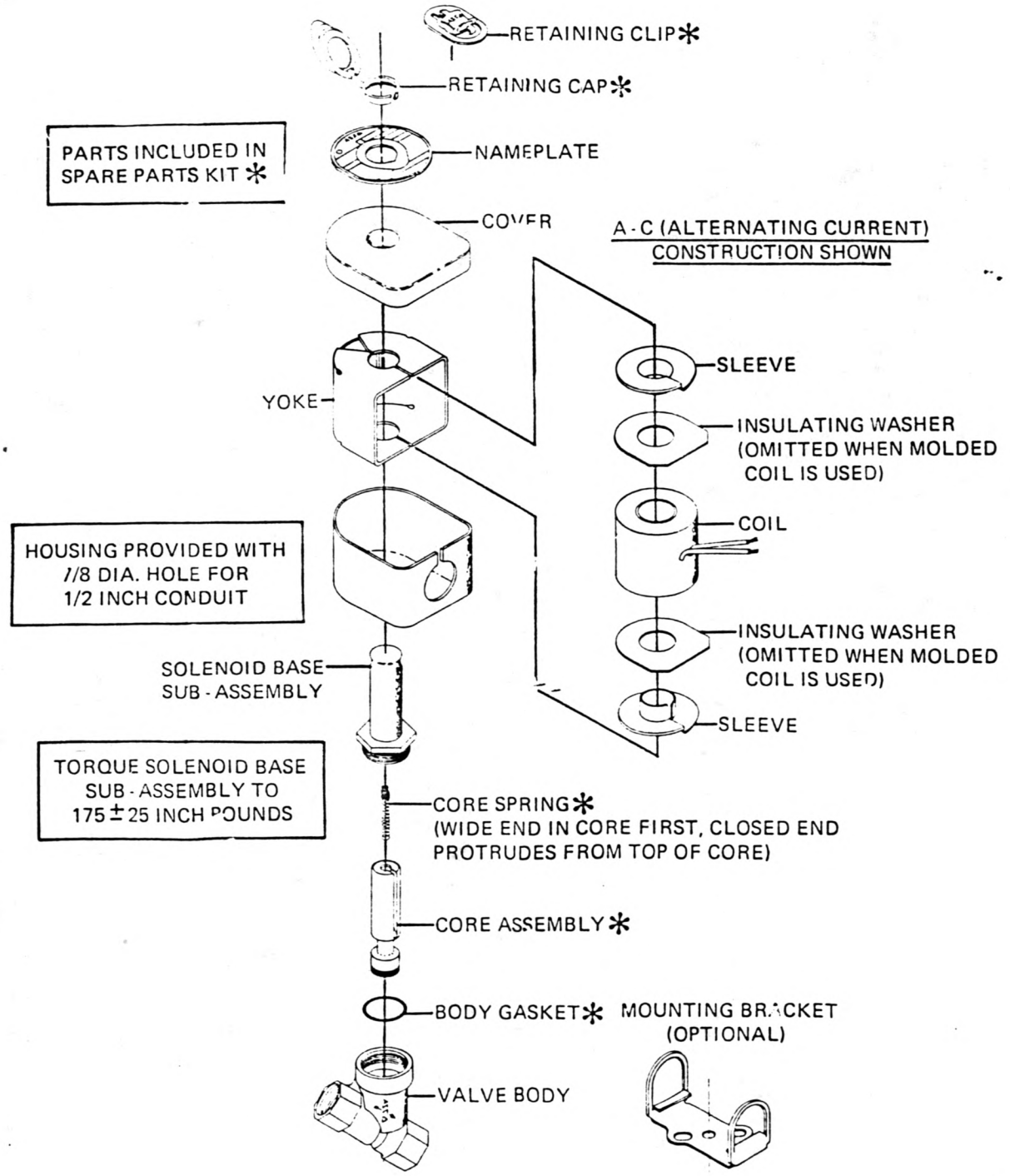


Figure 1. Dimensions for Mounting Bracket (Optional Feature)



Bulletin 8030 - 1/2 NPT
General Purpose Solenoid Enclosure Shown.
For Explosion-proof/Watertight Solenoid Enclosure used on Bulletin 8031, See Form No. V-5381.

Figure 3.

ASCO Valves
Automatic Switch Co. FLORHAM PARK, NEW JERSEY 07932 Form No. V-5304R2 PRINTED IN U.S.A. 1976

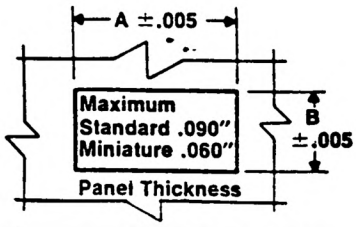
.093″ Diameter Terminals • .198″ Centers (Grid Pattern)

(SEE PAGES 10 AND 11 FOR DESCRIPTION)

STYLE		ELECTRICAL		RECEPTACLE ORDER NUMBERS				PLUG ORDER NUMBERS	
Circuits (a)	Model No.	Max. Amps	Max. Volts	With Mtg. Ears Only	With Holding Tabs Only	With Ears And Tabs	Without Ears Or Tabs	With Mtg. Ears	Without Mtg. Ears
1 (a)	1951	12	5,000	N/A	03-09-1014	N/A	N/A	N/A	03-09-2014
1	1619	12	250	N/A	03-09-1011	N/A	N/A	N/A	03-09-2011
2 (b)	1545	12	250	N/A	03-09-1022	03-09-1021	03-09-1023	03-09-2021	03-09-2022
2 (b)	1816	12	600	N/A	03-09-1028	N/A	N/A	N/A	03-09-2028
3	1396	12	250	N/A	03-09-1032	03-09-1031	03-09-1033	03-09-2031	03-09-2032
3 (b)	1816	9	600	N/A	03-09-1038	N/A	N/A	N/A	03-09-2038
4	1490	9	250	N/A	03-09-1042	03-09-1041	N/A	03-09-2041	03-09-2042
4 (c)	2163	9	250	N/A	03-09-1049	03-09-1040	N/A	03-09-2040	03-09-2049
4 (b)	1816	9	600	N/A	03-09-1047	N/A	N/A	N/A	03-09-2048
5	1653	9	250	N/A	03-09-1052	N/A	N/A	N/A	03-09-2052
5 (d)	2629	9	250	N/A	03-09-1057	N/A	N/A	N/A	03-09-2057 (d)
6	1261	9	250	03-09-1062	03-09-1064	03-09-1061	03-09-1063	03-09-2061	03-09-2062
9	1292	9	250	03-09-1092	03-09-1094	03-09-1091	03-09-1093	03-09-2091	03-09-2092
12	1360	7.5	250	03-09-1121	03-09-1126	03-09-1125	03-09-1122	03-09-2122	03-09-2121
15 (e, f)	1375	7.5	250	03-09-1151	N/A	03-09-1154 (e)	03-09-1152	03-09-2152	03-09-2153 (f)

N/A — Not available.

- Housings are molded nylon 6/6 Zytel 101 or equivalent.
- Housings are standard white, or at an additional cost may be dyed any of the following colors: Black, Blue, Brown, Green, Gray, Orange, Amber, Red, or Yellow.
- Integrally molded mounting ears snap-lock either the plug or receptacle into a panel without hardware. See Mounting Ear Detail.
- Tabs on the side of receptacles provide friction locking of connector housings.



(a) Electrical ratings are per circuit; UL and CSA recognized; except for Model 1951. Molex UL file card No. E29179; CSA file card No. 19980.

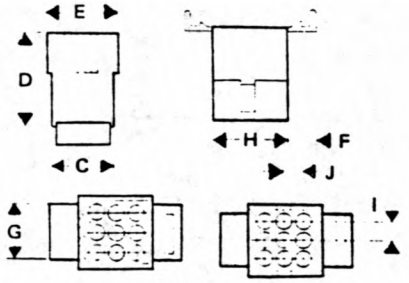
(b) Center spacing .248". Will accommodate: 14, 16 and 18 AWG with 1/32" insulation – 16 with 18 AWG (double crimp), each with 1/32" insulation. Model 1816 housings have positive lock rather than holding tabs.

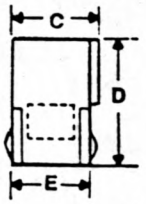
(c) 4 circuits in square grid pattern.

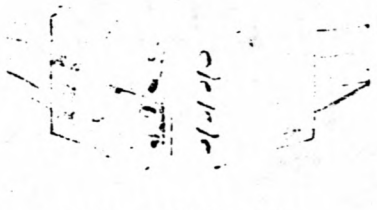
(d) Has positive lock rather than holding tabs; plug 03-09-2057 will mate also with 5-circuit receptacle Model 1653, part 03-09-1051, and 4-circuit receptacle Model 1490, part 03-09-1042.

(e) To order mating plug for receptacle part 03-09-1154 (with ears and locking tabs) specify only plug part 03-09-2154 (has pull tabs, no mounting ears).

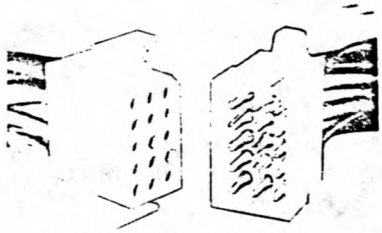
(f) Plug also is available with pull tabs and without mounting ears. Order part 03-09-2151.





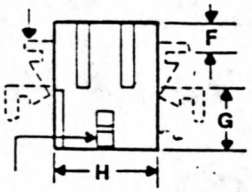


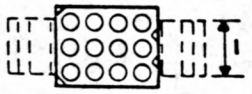
4-Circuit with Positive Lock



15-Circuit Plug with Pull Tabs

4 Circuits in Square Grid Pattern





STYLE		RECEPTACLE									PLUG									
Circuits	Model No.	A	B	C	D	E	F	G	H	I	A	B	C	D	E	F	G	H	I	J
1	1951	N/A	N/A	N/A	1.859	.312 Dia.	N/A	N/A	N/A	N/A	N/A	N/A	.312 Dia.	2.25	.437 Dia.	N/A	N/A	N/A	N/A	N/A
1	1619	N/A	N/A	N/A	1.00	.234 Dia.	N/A	N/A	N/A	N/A	N/A	N/A	.241 Dia.	.968	.358 Dia.	N/A	N/A	N/A	N/A	N/A
2	1545	.725	.312	N/A	1.00	.250	N/A	.442	.536	.250	.800	.375	.257	.968	.352	N/A	.421	.639	.250	.532
2	1816	N/A	N/A	N/A	1.063	.265	N/A	N/A	.531	N/A	N/A	N/A	.265	1.031	.359	N/A	N/A	.656	N/A	.625
3	1396	.840	.312	.236	1.015	.236	.37	.44	.670	.24	.933	.375	.240	.97	.34	.37	.421	.77	.250	.666
3	1816	N/A	N/A	N/A	1.063	.265	N/A	N/A	.784	N/A	N/A	N/A	.254	1.031	.368	N/A	N/A	.921	N/A	.840
4	1490	1.038	.312	N/A	1.000	.236	.37	.437	.868	.236	1.131	.375	.24	.969	.338	.37	.421	.971	.24	.843
4	2163	.500	.600	N/A	1.000	.434	N/A	.442	.434	.312	.555	.695	.450	.969	.538	N/A	.421	.538	.312	.450
4	1816	N/A	N/A	N/A	1.063	.265	N/A	N/A	1.032	N/A	N/A	N/A	.265	1.031	.359	N/A	N/A	1.156	N/A	1.125
5	1653	1.238	.312	N/A	1.000	.243	N/A	.437	1.066	.243	1.331	375	.252	.969	.338	N/A	.421	1.075	.252	1.066
5	2629	N/A	N/A	N/A	1.000	.24	N/A	N/A	1.07	.24	N/A	N/A	.25	.969	.35	N/A	N/A	1.17	N/A	1.07
6	1261	.718	.600	N/A	1.015	.632	N/A	.442	.434	.563	.750	.695	.633	.969	.733	N/A	.421	.536	.563	.536
9	1292	.828	.725	N/A	1.015	.627	.37	.442	.666	.563	.937	.660	.630	.970	.730	.28	.56	.770	.198	.198
12 (a)(b)	1360	1.050	.655	N/A	1.015	.633	N/A	.442	.871	.563	1.155	.760	.633	.969	.737	N/A	.421	.975	.563	.975 (a)
15 (c)	1375	1.240	.655	N/A	1.015	.632	.37	.442	1.066	.563	1.343	.760	.629	.969	.734	.37	.421	1.169	.563	1.169

N/A — Not applicable. • Dimensions subject to nominal variation — .005".

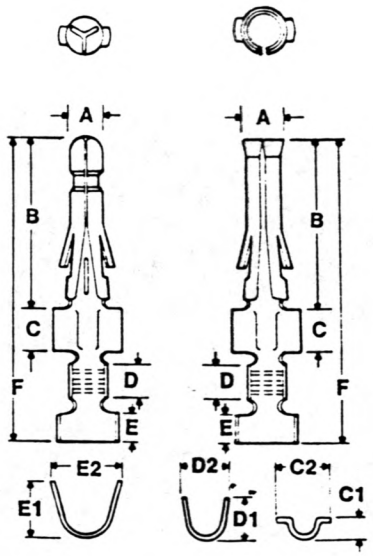
(a) 12-circuit plug, Model 1360, has alternate design of .844" Dim. J.

(b) 12-circuit receptacle with mounting ears and locking tabs 03-09-1125 mounting hole "B" dimension is .725 min.

(c) 15-circuit receptacle with mounting ears and locking tabs 03-09-1154 mounting hole "B" dimension is .725 min.

MODEL No.	A	B	C	D	E	F	G	H	C1	C2	D1	D2	E1	E2	H1	H2
1189 Female	.120	—	—	.120	.09	.865	—	—	.055	.150 Max.	.125	.140/.100	.190	.260/.180	—	—
1190 Male	.093	—	—	.120	.09	.865	—	—	.055	.150 Max.	.125	.140/.100	.190	.260/.180	—	—
1377 Female	.120	—	—	—	—	—	1.125	—	.055	.150 Max.	—	—	—	—	.050	.023
1376 Male	.093	—	—	—	—	—	1.125	—	.055	.150 Max.	—	—	—	—	.050	.023
1381 Female	.120	—	—	.120	.09	.865	—	—	.055	.150 Max.	.125	.140/.100	.140	.160/.100	—	—
1380 Male	.093	—	—	.120	.09	.865	—	—	.055	.150 Max.	.125	.140/.100	.140	.160/.100	—	—
1433 Female	.120	—	—	.120	.09	.865	—	—	.055	.150 Max.	.075	.095/.080	.075	.095/.080	—	—
1434 Male	.093	—	—	.120	.09	.865	—	—	.055	.150 Max.	.075	.095/.080	.075	.095/.080	—	—
1451 Female	.120	—	—	.120	.09	.865	—	—	.055	.150 Max.	.125	.120	.190	.210	—	—
1450 Male	.093	—	—	.120	.09	.865	—	—	.055	.150 Max.	.125	.120	.190	.210	—	—
2151 Female	.120	—	—	.120	.09	.865	—	—	.055	.150 Max.	.125	.120	.140	.130	—	—
2152 Male	.093	—	—	.120	.09	.865	—	—	.055	.150 Max.	.125	.120	.140	.130	—	—
2871 Female	.120	—	—	.120	.070	.865	—	—	.055	.150 Max.	.079	.107	.089	.109	—	—
2870 Male	.093	—	—	.120	.070	.865	—	—	.055	.150 Max.	.079	.107	.089	.109	—	—

Dimensions subject to nominal variation ±.005".



Molex makes terminals of various metals with optional plating finishes to satisfy specific operational requirements.

Brass, Tin Plated Terminals

Most applications are met by the standard Molex brass, tin plated terminal. Tin plating is applied prior to forming of the 30 per cent zinc, 70 per cent copper alloy material.

Suggested application is for more than 50 millivolt at 1 milliamp current usage.

Brass, Gold Plated Terminals

Gold plated brass terminals are best suited for low current use and where excessive corrosion is a factor, or when storage of two years or more for use is expected. Plating is applied after forming, except for selective area plating.

Suggested application is for use with less than 50 millivolt at 1 milliamp current.

Phosphor Bronze, Tin Plated Terminals

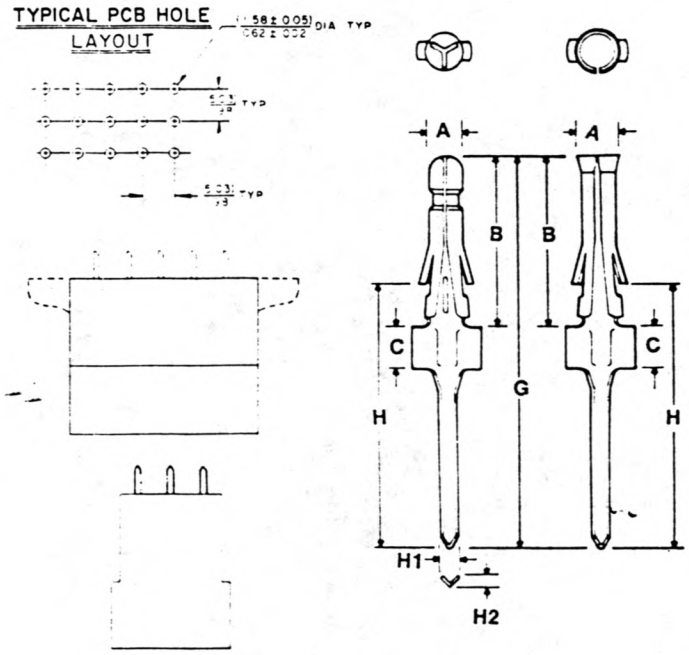
Improved mechanical characteristics, but reduced electrical characteristics are typical of tin plated phosphor bronze terminals. Conductivity is 15 per cent, compared with 28 per cent for tin-plated brass terminals.

Suggested application is for use where a high number of insertion and withdrawal cycles is required.

Modified Copper, Tin Plated Terminals

Where higher current is employed, and insertion and withdrawal cycles are low, tin plated modified copper terminals are suggested.

These terminals have a conductivity of 65 per cent, compared with 28 per cent for tin plated brass and 15 per cent for tin plated phosphor bronze.



Electrical

Resistance

M/V voltage drop per amp, ±10%:

1st engagement 3.0 10th engagement 3.1

Probe about 1 inch from crimp barrel on 18 AWG stranded wire. Voltage drop includes mated terminals and both crimps. Tin material and plating.

High Voltage Test

Withstands 1500 volts RMS applied between adjacent terminals for 60 seconds, mounted in all housings.

Temperature Rise / Operating Range

30° maximum for all connectors at maximum rated current. Temperature range —40 C to 105° C.

Current Rating

Amperage rating UL listed.

Mechanical

Terminal Crimp Strength

Minimum pull-out force in pounds for AWG wire sizes:

14 — 35 lbs.	24 — 8 lbs.
16 — 30 lbs.	26 — 5 lbs.
18 — 25 lbs.	28 — 3 lbs.
20 — 15 lbs.	30 — 2 lbs.
22 — 10 lbs.	

Engage / Disengage Forces

Standard terminal of .010 stock 70/30 brass — average engage/disengage forces in plug/receptacle connector with ±30% tolerance, in pounds per circuit:

1-circuit 2.9/1.2	6-circuit 17.4/ 7.2
2-circuit 5.8/2.4	9-circuit 25.1/10.8
3-circuit 8.7/3.6	12-circuit 34.8/14.4
4-circuit 11.6/4.8	15-circuit 43.5/18.0
5-circuit 14.5/6.0	

Average insertion force ±30% male and female terminal in connector housing is 2.7 lbs.; retention, 20 lbs. minimum.

(See Page 2)

Terminal Model No.	HAND TOOLS			CRIMPING MACHINE	
	Crimping	Insertion	Extractor	Bench	Automatic
1189-1190	11-01-0002	Not Required	11-03-0006 (a) 11-03-0015	11-04-0006	Artos
1380-1381	11-01-0002	Not Required	11-03-0006 (a) 11-03-0015	11-04-0006	Artos
1433-1434	11-01-0006	11-02-0003	11-03-0006 (a) 11-03-0015	11-04-0006	Artos
1450-1451	11-01-0002	Not Required	11-03-0006 (a) 11-03-0015	11-04-0006	Artos
2151-2152	11-01-0002	Not Required	11-03-0006 (a) 11-03-0015	11-04-0006	Artos
2870-2871	11-01-0026	Not Required	11-03-0006 (a) 11-03-0015	11-04-0006	Artos

(a) Spring-loaded for automatic terminal ejection.

ORDERING DATA

TERMINALS			ORDER NUMBERS							
Crimp Wire Size	Insulation Diameter	Model Nos.	Chain Form (a)				Loose Form			
			Male		Female		Male		Female	
			With Detent	W/O Detent	With Dimple	W/O Dimple	With Detent	W/O Detent	With Dimple	W/O Dimple
14-20	.065-.160	1189 F 1190 M	02-09-2101	—	02-09-1101	02-09-1102	02-09-2103	—	02-09-1103	02-09-1104
18-22	.060-.120	1380 M 1381 F	02-09-2116	—	02-09-1116	02-09-1117	02-09-2118	—	02-09-1118	02-09-1119
18-24 (b)	.070 Max.	2870 M 2871 F	02-09-2136	—	02-09-1136	02-09-1138	02-09-2137	—	02-09-1137	02-09-1139
24-30	.030-.060	1433 F 1434 M	02-09-2141	—	02-09-1141	02-09-1142	02-09-2143	—	02-09-1143	02-09-1144
PC Tail	Hole Size: .060	1376 M 1377 F	—	—	—	—	02-09-2133	02-09-2134	02-09-1133	02-09-1134

(a) 8,000 terminals per reel—All chain form orders are rounded to the nearest full reel.
Chain form reels for Models:
1433 and 1434 contain 6,000 terminals.
2870 and 2871 contain 4,000 terminals.

(b) For fire-retardant insulated wire.

F = Female M = Male

TERMINALS			ORDER NUMBERS							
Crimp Wire Size	Insulation Diameter	Model Nos.	Chain Form (a)				Loose Form			
			Male		Female		Male		Female	
			With Detent	W/O Detent	With Dimple	W/O Dimple	With Detent	W/O Detent	With Dimple	W/O Dimple
14-20 (b)	.065-.160	1189 F 1190 M	02-09-6101	—	02-09-5101	02-09-5102	02-09-6110	—	02-09-5110	02-09-5111
14-20 (c)	.065-.160	1189 F 1190 M	02-09-6100	—	02-09-5100	02-09-5103	02-09-6106	—	02-09-5106	02-09-5109
14-20 (d)	.065-.160	1189 F 1190 M	02-09-6107	—	—	02-09-5107	02-09-6109	—	—	02-09-5108
18-22 (d)	.060-.120	1380 M 1381 F	02-09-6121	—	02-09-5119	—	02-09-6124	—	02-09-5124	—
18-22 (e)	.060-.120	1380 M 1381 F	02-09-6117	—	02-09-5120	—	02-09-6118	—	02-09-5121	—
18-22 (c)	.060-.120	1380 M 1381 F	02-09-6122	—	02-09-5122	—	02-09-6123	—	02-09-5123	—
24-30 (c)	.030-.060	1433 F 1434 M	02-09-6144	—	02-09-5144	02-09-5146	02-09-6145	—	02-09-5145	02-09-5147
PC Tail (d)	Hole Size: .060	1376 M 1377 F	—	—	—	—	02-09-6132	02-09-6134	02-09-5131	02-09-5132

(a) 8,000 terminals per reel—All chain form orders are rounded to the nearest full reel.
Chain form reels for Models 1433 and 1434 contain 6,000 terminals.
(b) 0.00005 min. gold over 0.00010 min. copper plate.
(c) 0.00002 min. gold over 0.00003 min. nickel plate.
(d) 0.00003 min. gold over 0.00003 min. nickel plate.
(e) 0.00005 min. gold over 0.00010 min. nickel plate.
TERMINALS OVERALL GOLD PLATED AFTER FORMING.
SPECIAL PLATINGS AVAILABLE UPON REQUEST

F = Female
M = Male

TERMINALS			ORDER NUMBERS							
Crimp Wire Size	Insulation Diameter	Model Nos.	Chain Form (a)				Loose Form			
			Male		Female		Male		Female	
			With Detent	W/O Detent	With Dimple	W/O Dimple	With Detent	W/O Detent	With Dimple	W/O Dimple
18-22	.060-.120	2151 F 2152 M	02-09-2201	—	02-09-1201	02-09-1203	02-09-2202	—	02-09-1202	02-09-1204
18-22 (b)	.060-.120	2151 F 2152 M	—	—	—	—	02-09-6202	—	02-09-5202	—

(a) 8,000 terminals per reel—All chain form orders are rounded to the nearest full reel.

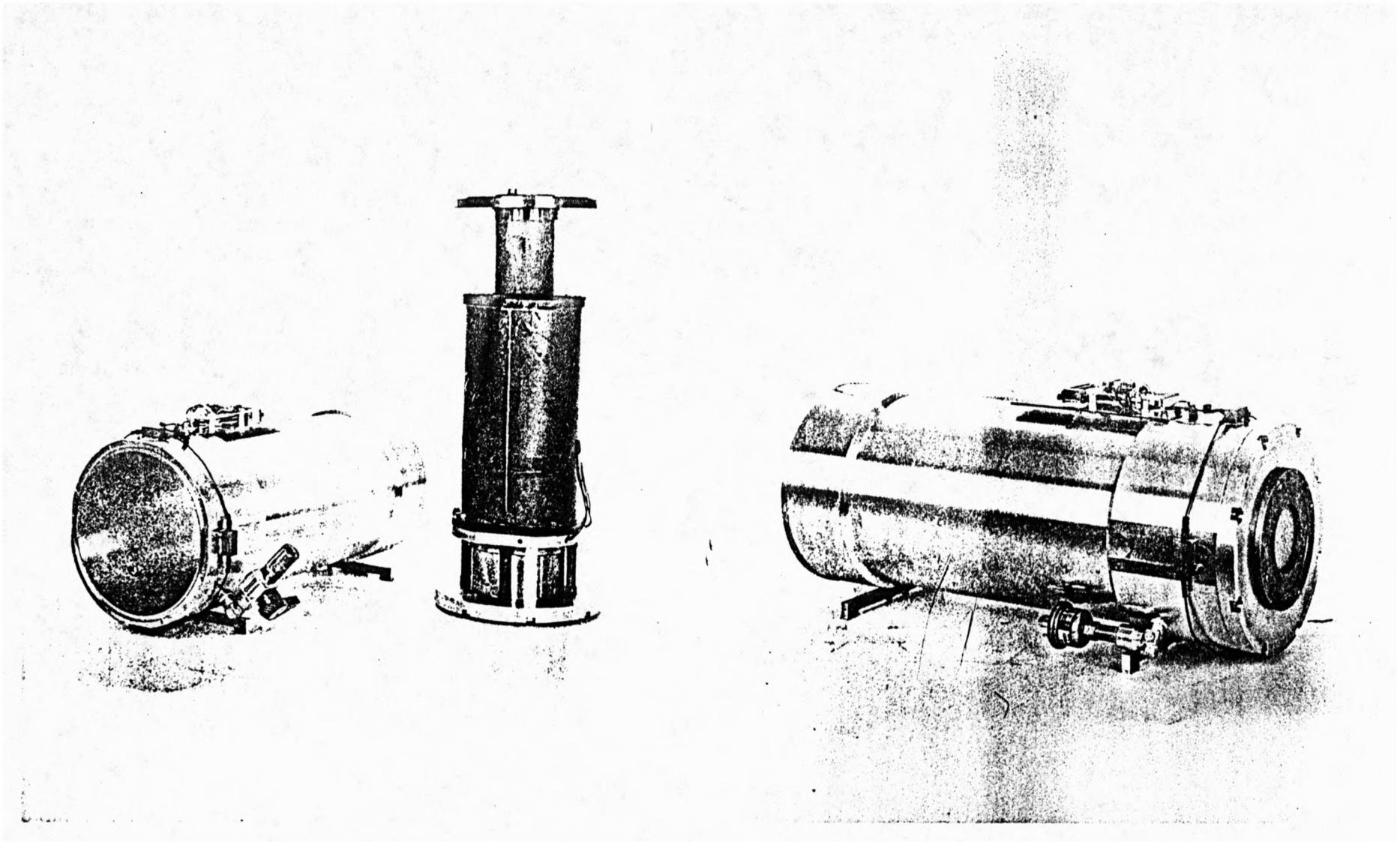
(b) 0.00002 min. gold over 0.00003 min. nickel plate.
TERMINALS OVERALL GOLD PLATED AFTER FORMING.
SPECIAL PLATINGS AVAILABLE UPON REQUEST

F = Female
M = Male

TERMINALS										
Crimp Wire Size	Insulation Diameter	Model Nos.	Chain Form (a)				Loose Form			
			Male		Female		Male		Female	
			With Detent	W/O Detent	With Dimple	W/O Dimple	With Detent	W/O Detent	With Dimple	W/O Dimple
14-20	.060-.160	1450 F 1451 M	02-09-2301	02-09-2302	02-09-1301	02-09-1302	02-09-2303	—	02-09-1303	02-09-1304

(a) 6,000 terminals per reel—All chain form orders are rounded to the nearest full reel.

F = Female
M = Male



(a)
Disassembled. The quartz fins and liquid nitrogen are within the cylinder sitting atop the gapped waveguide.

(b)
At right is the waveguide input flange.

Figure IV-1

Cold Termination.