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VLBA TECHNICAL REPORT NO. 2

MODEL F103, 1.5 GHZ CRYOGENIC FRONT-END

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MODEL F103, 1.5 GHz CRYOGENIC FRONT-END

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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 1.35 to 1.75 GHz is covered with a receiver noise temperature of less than 15K (noise figure less than 0.22 dB). With the addition of a waveguide quarter-wave plate in front of the receiver input flange, 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 a photograph is shown in Figure 1.1-2. A 16.34 cm (6.431 inch) diameter circular waveguide, propagating both TE_{11} linearly 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 quad-ridged ortho-mode transducer (OMT) accepts the waveguide signal and extracts orthogonal

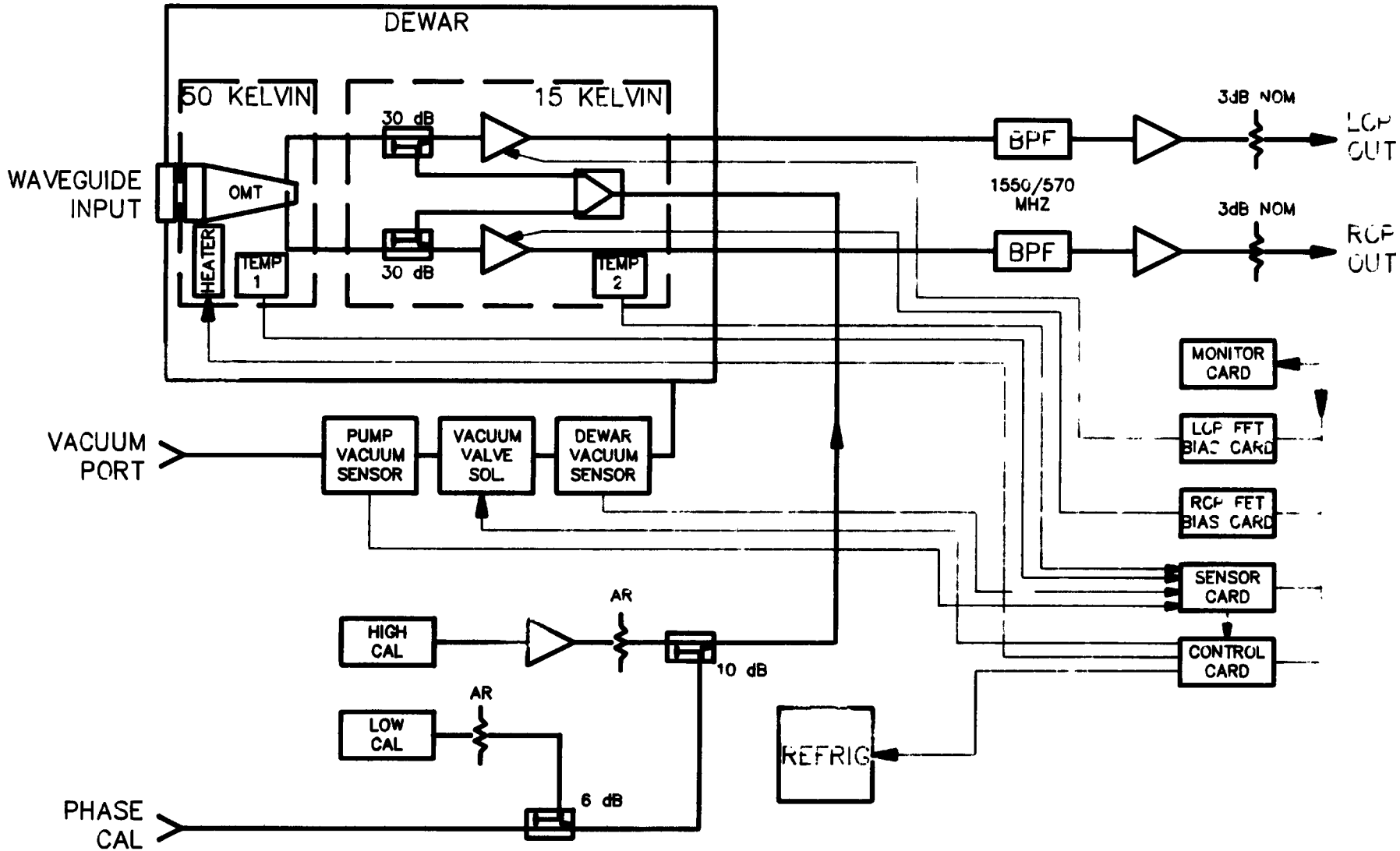


Figure 1.1-1

System Block Diagram

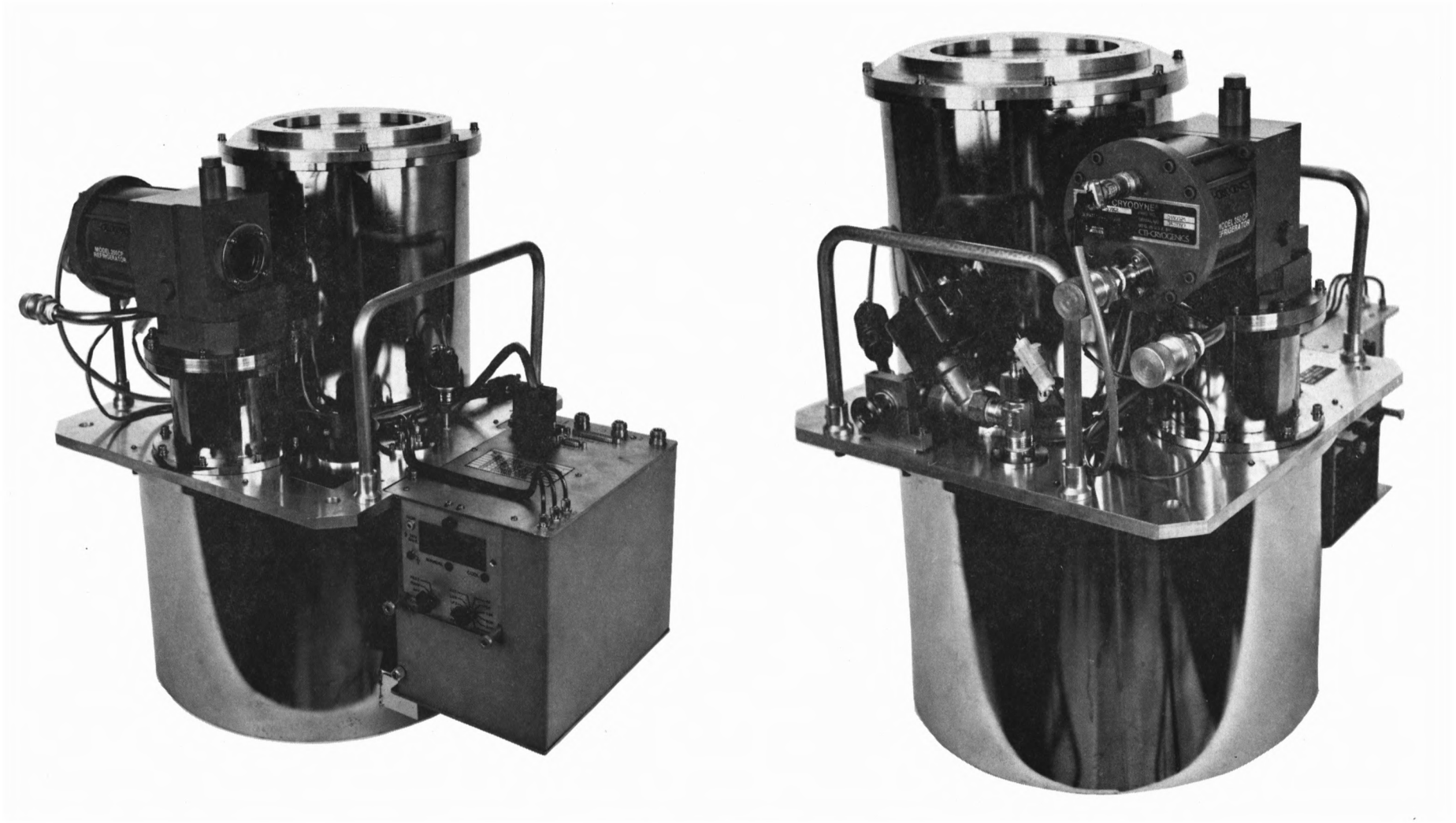


Figure 1.1-2

The VLBA 1.5 GHz Front-End.

(a)
The waveguide input flange is at the top and the card cage is at the lower right.

(b)
Showing the vacuum and helium ports.

linear polarizations. The two SMA coaxial-line outputs of the OMT 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.

Attached to the front-end dewar is an electronics card cage containing five 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 dewar heaters. 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 plate that attaches to 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 7000K, which may be useful for solar or other large signal observations. The components required to generate this signal are mounted only on the S/N 001 front-end, but may be added to later units as the need arises.

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 350 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 1.35 to 1.75 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 15K. The noise temperature shall be measured with a properly calibrated liquid-nitrogen noise temperature standard and at 50 MHz intervals from 1.3 to 1.8 GHz.

1.2.2 Input Return Loss

The return loss for the two orthogonal linear TE_{11} modes in the input circular waveguide must be greater than 15 dB. This measurement may be performed with a coaxial reflectometer, a WR650 rectangular waveguide-to-coax adapter, and a well-matched WR650 to circular waveguide transition.

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 7000K ± 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 OMT 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 $\leq$ 12 hours.

1.2.14 Physical Weight and Size

The front-end shall weigh less than 115 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 large 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 16.25 inches square aluminum plate. When mounted, access should be provided so that the circuit cards, RF plate, or refrigerator motor and displacers can be removed without demounting the front-end assembly.

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-dis-

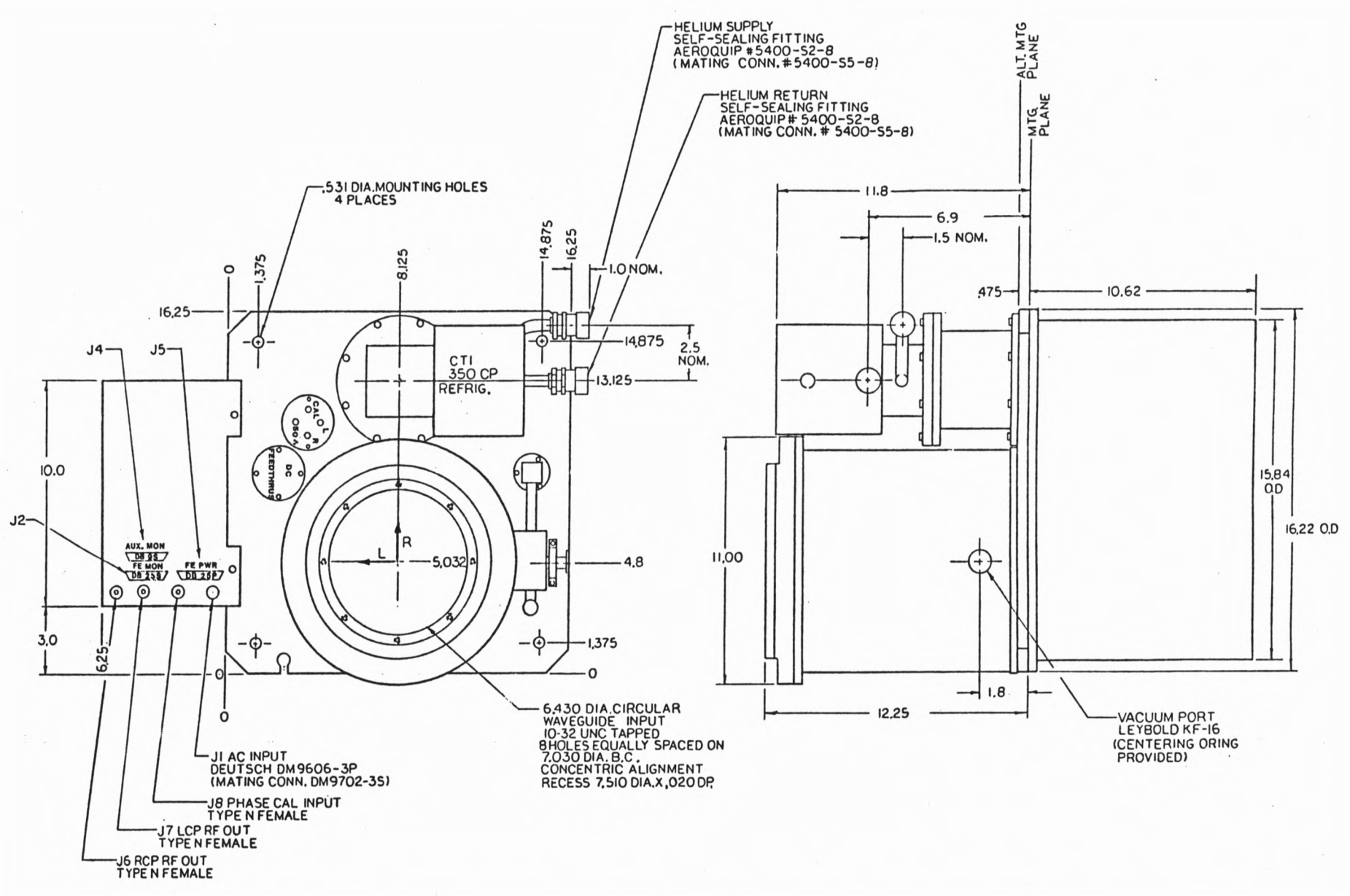


Figure 1.3-1

Front-End Outline and Interface Drawing.

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

connect 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 270 ± 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 1.35 to 1.75 GHz. The RF Outputs connect in the VLBA system to the T103 1.5 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 Interface Module F117 is provided to do so. Details of the F117 module is

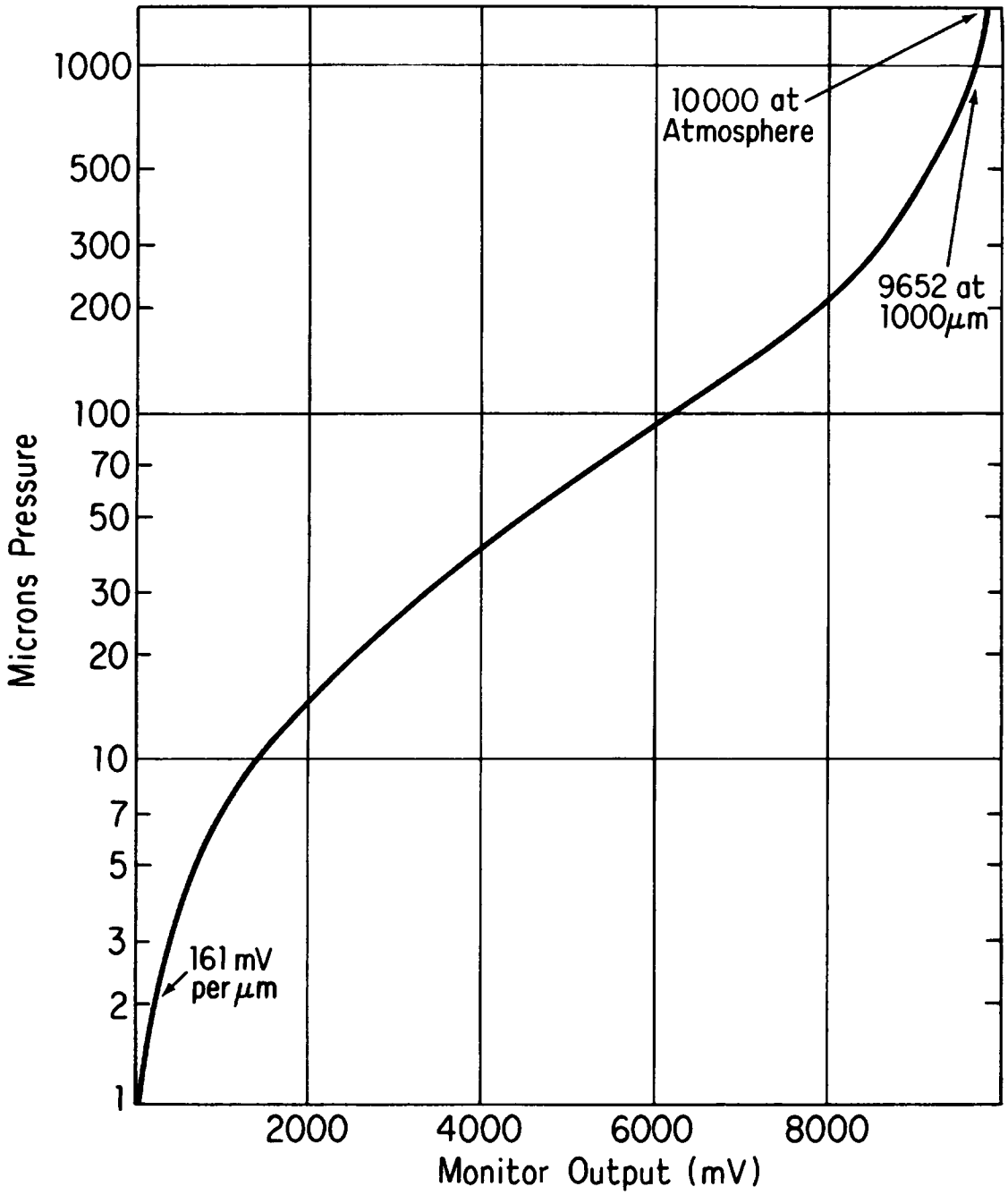


Figure 1.3-2

Vacuum pressure as a function of monitor output voltage.

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.

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 65 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 4 to 10 mA for CAL and 34 to 40 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 Interface 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 Interface Module F117.

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 Plate 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.

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 - 0.76 A, STRESS - 0.79 A, and HEAT- 0.40 A. The rms current drawn by the various loads are as follows:

Refrigerator Motor	0.76 amps
Vacuum Solenoid*	0.25 amps
Heaters in HEAT Mode	0.40 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 350 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 P112 Model 350 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.

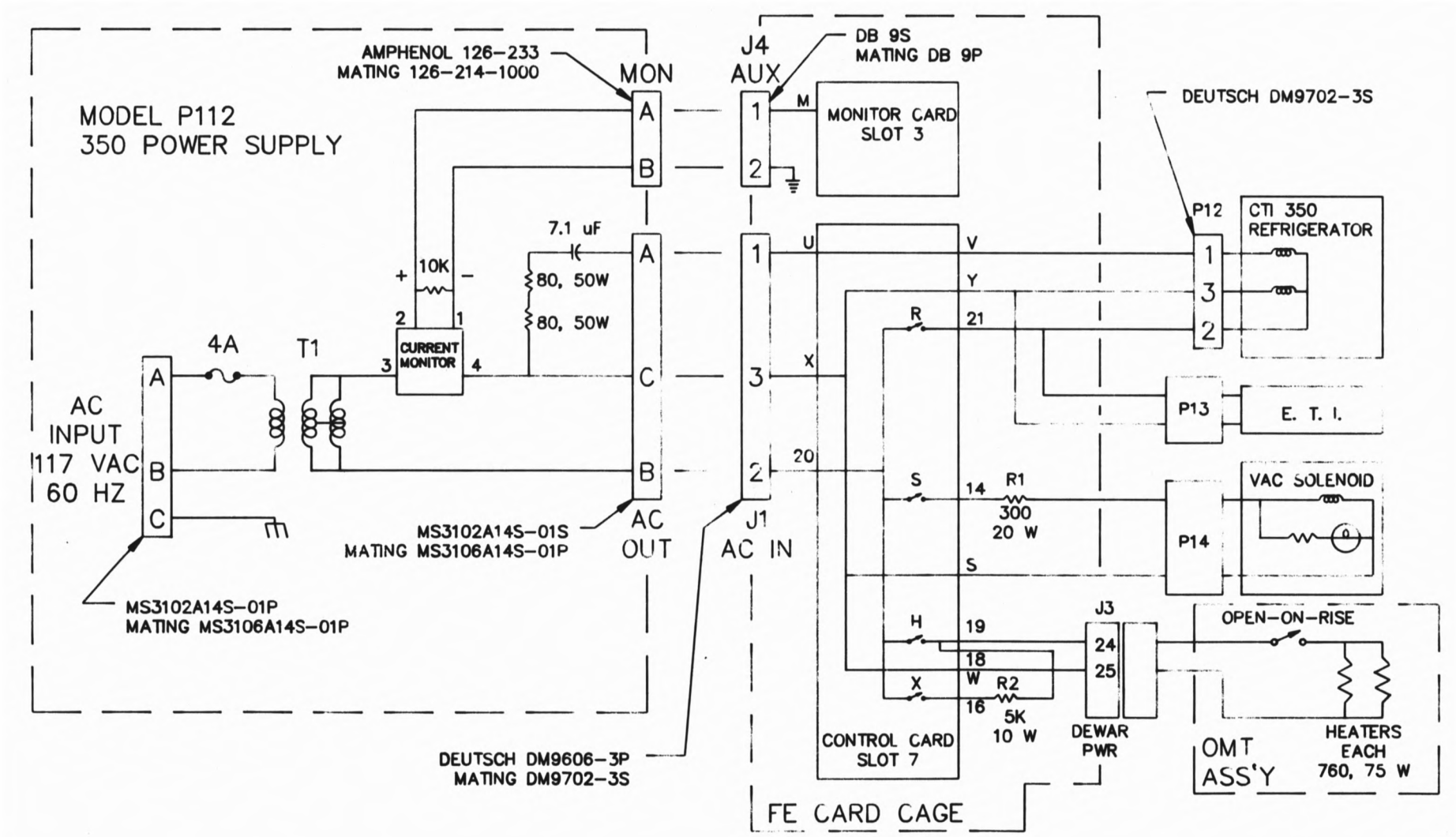


Figure 1.3-3

Front-end AC wiring and AC power supply schematic.

Table VII
System Noise Budget

Component	Physical Temperature	Noise Temperature or Loss	System Contribution
FET Amplifier	16 K	9.0 K	9.0 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
OMT	50 K	0.10 dB	1.4 K
Window	300 K	0.001 dB	0.1 K
	TOTAL RECEIVER TEMPERATURE		12.8 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 (4)	0.17
Coaxial Lines to 50K (2)	0.66
No. 32 Brass Wire (16)	0.04
FET Amplifier DC Bias	0.4
TOTAL	1.5 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 formed of two cylindrical vessels, a third, smaller cylinder, and a one-half inch thick aluminum plate. The Top Vessel (called top because it will be nearer the sky in the VLBA cassegrainian system) supports the thermal transition and the OMT. The refrigerator is supported at the correct position relative to the OMT by the small cylinder. The Lower Vessel supports no components, and so can be easily removed allowing access to the dewar internal components. All three of the cylinders bolt to the Dewar Mounting Plate, machined out of one-half inch thick aluminum. The cylinders are formed by rolling thin stainless-steel sheets, welding the seam, and welding flanges to the resulting cylinder. Many reliable dewars have been fabricated in this manner at NRAO.

2.1.1 Vacuum Pumping

The dewar interior volumn is approximately 48 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 more than four 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

Two levels of radiation shields are 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. The first level of shielding is provided by a "floating" shield, one that is not thermally connected to the refrigerator. This shield consists of a Upper Vessel Shield, surrounding the thermal transition and OMT in the Upper Dewar Vessel, and a Lower Vessel Shield and Plate that surround the components in the Lower Dewar Vessel. These shields are supported from the Dewar Mounting Plate by brackets machined from epoxy-fiberglas type G-10.

The second level of shielding is provided by the 50K Shield which is mounted on the 50K Plate, and surrounds the 15K Plate, and by aluminized mylar wrapped around the OMT. The OMT is first wrapped with a plastic netting which prevents direct contact

between the OMT surface and the mylar wrap. Then the aluminized mylar is wrapped over the netting and held in place with unwaxed lacing cord. Tests showed that use of the netting and aluminized mylar wraps reduced the loading on the refrigerator first stage by approximately two watts.

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, that 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 270 ± 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.

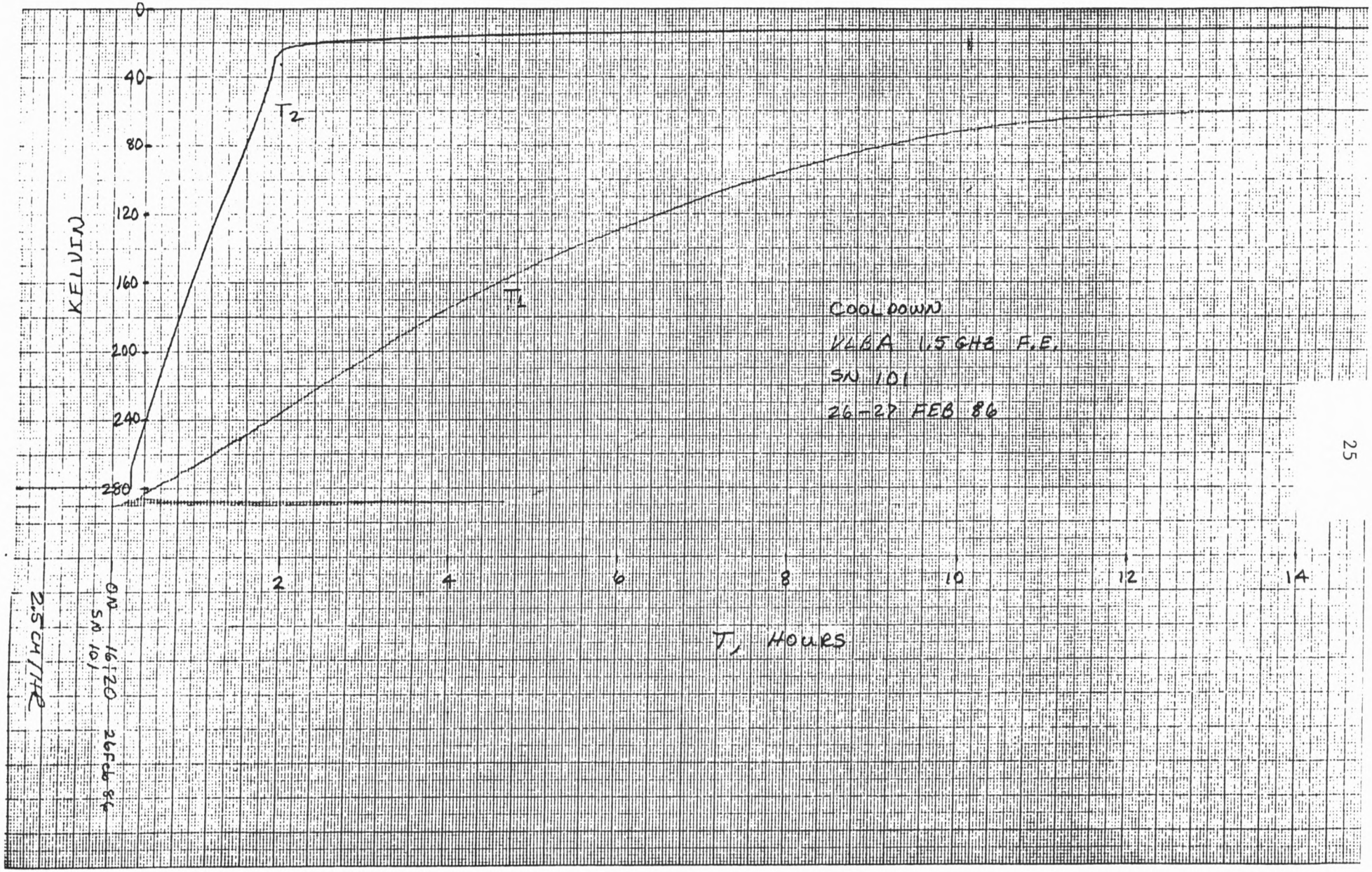


Figure 2.1-1

(a) Dewar cool-down record.

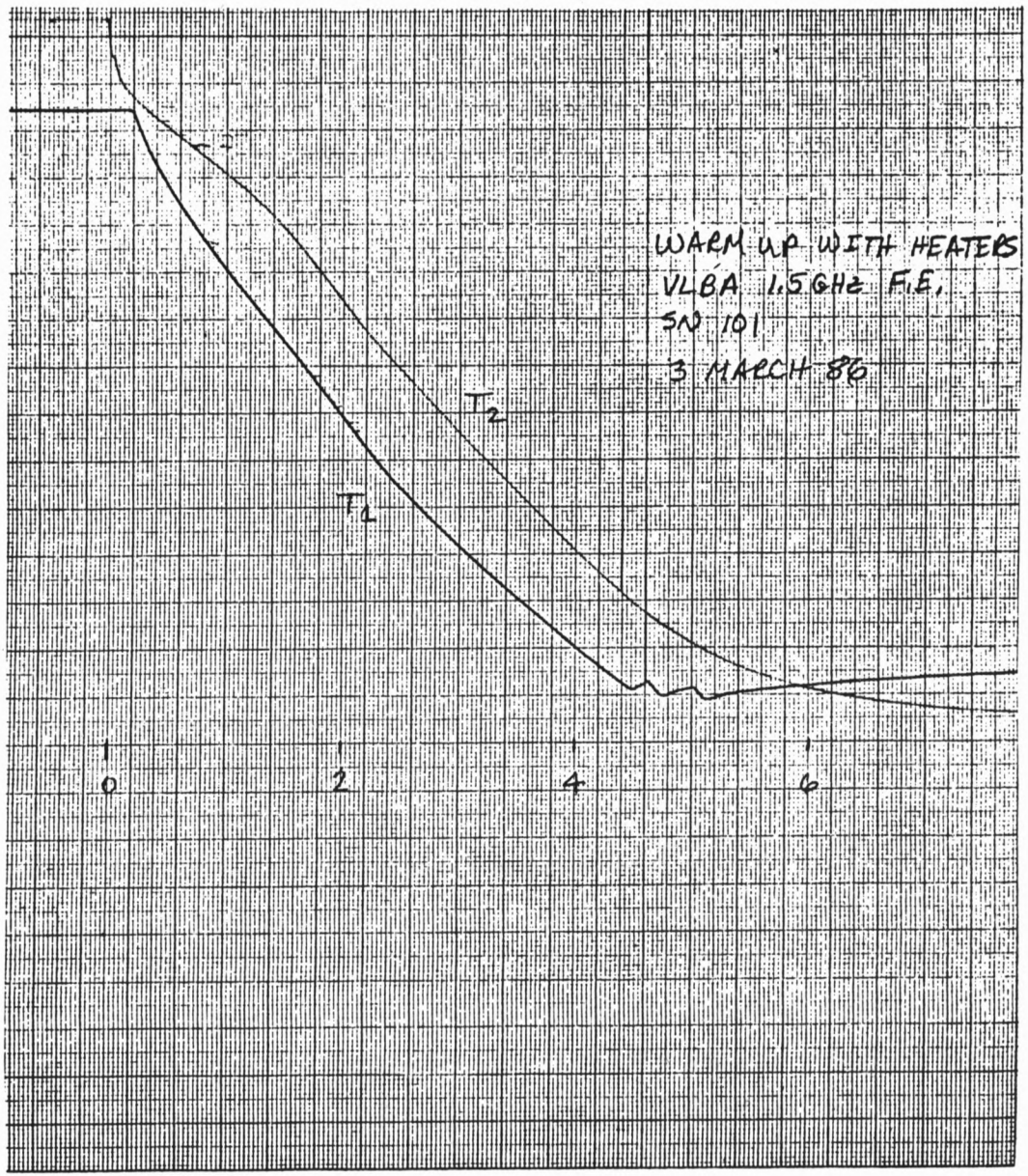


Figure 2.1-1

(b) Dewar warm-up record.

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 10K to 13K on the second stage and 50K to 55K on the first stage. The second stage and cooled amplifiers reach operational temperature in less than five hours; the additional time is required to cool the OMT mass. The warm-up time with 65 watts of heat applied is five hours. The ratio of these times gives an average refrigerator cool-down power of 27.5 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 shows the steps necessary to disassemble the dewar so that the cooled components may be worked on. The steps 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, invert the front-end so that the Lower Vessel is up.

b) Remove the two 10-32 screws attaching the card cage to the Lower Vessel, and the eight screws attaching the Lower Vessel to the Dewar Mounting Plate. Lift off the Lower Vessel. It will be necessary to loosen the screws attaching the card cage to the Dewar Mounting Plate and to then tilt the card cage out of the way so that the vessel flange will clear the card cage mounting tabs.

c) Remove the four 6-32 binder head screws attaching the Upper Vessel Shield to its supports, and remove the shield.

d) Remove the four 6-32 binder head screws attaching the Access Cover to the 50K Heat Shield, and remove the cover. Remove the six 6-32 binder head screws attaching the 50K Shield to the 50K Plate, and remove the shield.

Access to any of the cooled components is now possible. Note that, to this point, no RF connections need be broken. If

it should become necessary to remove the OMT, then additional steps are required:

e) Loosen and remove the .141 coax connecting the OMT to the cal couplers. Disconnect the connector on the OMT temperature sensor. Unsolder the wires connecting the DC feedthrus and the heaters. Remove the three 4-40 screws attaching the OMT heat strap to the 50K Plate.

f) Rotate the dewar assembly on the work surface, and remove the eight 10-32 screws attaching the Thermal Transition Dewar Cap to the Top Vessel. While supporting the small end of the OMT, carefully withdraw the Thermal Transition Assembly and OMT from the Top Vessel.

2.1.5 Reassembly of Dewar

When assembling or re-assembling the dewar, the following precautions should be observed:

a) Note the surfaces which must seal against an O-ring and be careful not to scratch these surfaces. When closing the dewar, check that there is no dirt or foreign objects on O-ring surfaces. Lubricate the O-rings with a small amount of vacuum grease and check during assembly that the O-rings are seated properly.

b) The emissivity of surfaces is greatly increased by the presence of a film on the surface. (A doubling of the emissivity was noted for an aluminum surface cleaned with acetone compared to cleaning with Freon.) This is important for the interior of the dewar walls and exterior of the radiation shields. These surfaces should be initially cleaned with Freon and then not touched. The 15K components should be kept reasonably clean but can be handled for maintenance without cleaning.

c) When closing the dewar, make sure all connections are made and are tight.

Figure 2.1-2

Dewar Lower Vessel removed. The front-end is shown inverted and the Lower Vessel Shield can be seen.

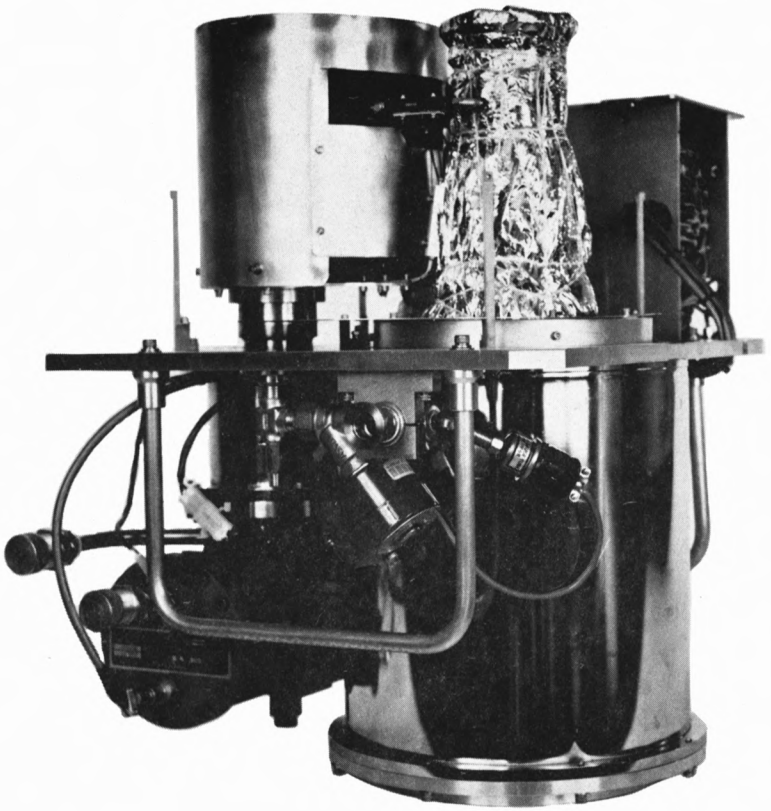


Figure 2.1-3

Lower Vessel Shield removed. The 50K Shield, the OMT, and one of the cal couplers can be seen.

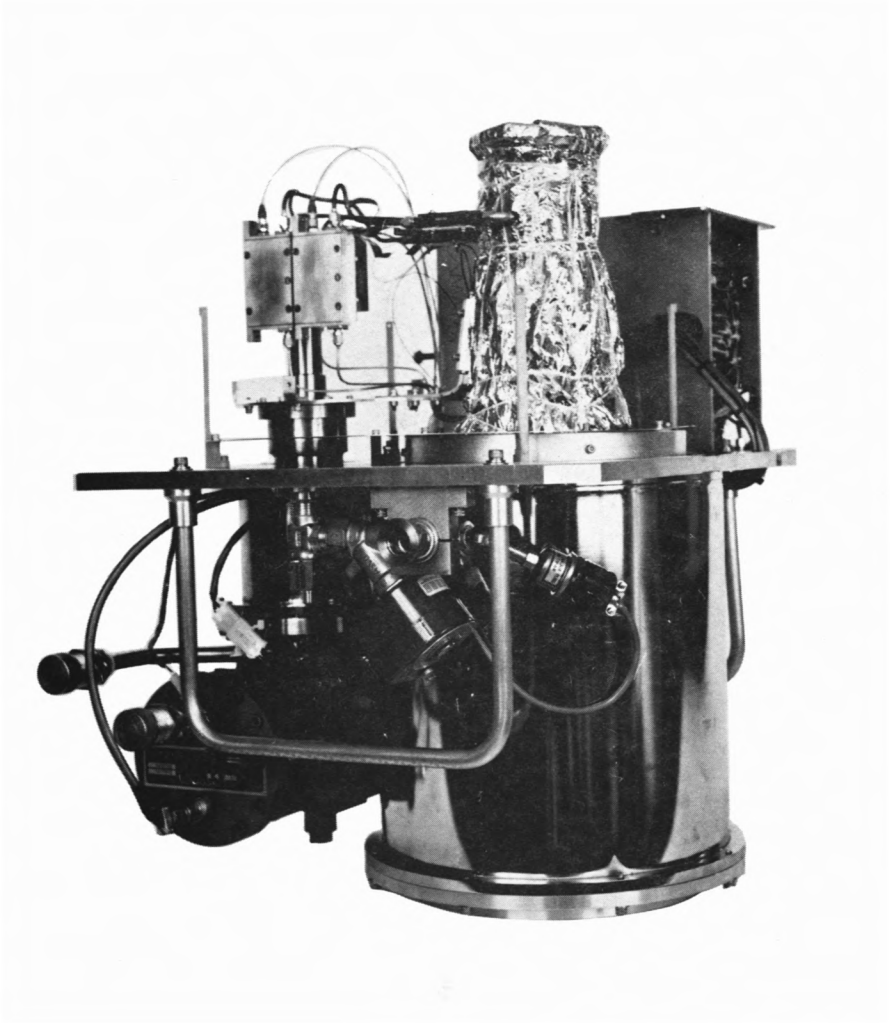


Figure 2.1-4

50K Shield removed. The 15K plate is visible with the two cooled amplifiers mounted.

2.2 Waveguide Vacuum Window

A circular waveguide window is necessary to preserve vacuum within the cryogenics dewar. The window used in this system is formed by epoxying a 2.5 inch thickness of a rigid, closed-cell foam with 1.04 dielectric constant into a machined aluminum section of the 16.34 cm diameter circular waveguide. The low dielectric constant, strength, and low loss of this material allows the construction of a vacuum window with excellent microwave properties. Tests have shown that the window contributes a negligable amount to the input VSWR, and similar designs have given reliable service while under vacuum for years. Leak tests of samples of this foam and other potential window materials such as mylar or polyethelene have shown that the foam has excellent gas diffusion properties (NRAO EDTN No. 118 and 125).

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. The original design used a thin film of polyethelene or mylar, and used a O-ring to seal the junction between the film and the foam. However, problems were encountered with lossy microwave resonances in the O-ring groove. The solution chosen was to coat the external surface of the foam window material with an epoxy recommended by the foam manufacturer. Tests have shown that the epoxy has no measurable effect on the front-end noise temperature.

2.3 Waveguide Thermal Transition

Thermal isolation between the dewar input flange and the OMT at 50K is provided by a 0.4mm (0.016 inch) gap in the waveguide wall. No choke groove 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 six 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 336 mW total conducted load.

The thermal transition is machined in two sections from 6061-T6 aluminum. The top section forms the top cover of the Top Vessel and contains the vacuum window material. The lower section is supported from the top section by the six support tubes, and the OMT is bolted to its lower surface.

2.4 Ortho-Mode Transducer

The OMT is a quad-ridged, tapered structure with 16.34 cm diameter input waveguide and two SMA output ports for the orthogonal linear polarizations. The fundamental TE11 mode propagates in the device. The OMT is identical to that described in NRAO EDIR No. 245, and design details will not be repeated here. The OMT is constructed by machining the ridges from flat copper plates, mounting them in a mandrel with the proper profile, electroforming the outer shell, and removing the mandrel. The primary concern during construction is that the proper gap and alignment of the ridges must be maintained.

The OMT achieves greater than 35 dB of polarization isolation and 15 to 20 dB return loss over the 1.3 to 1.8 GHz frequency range. At room temperature, it has approximately 0.20 dB of loss; at 60K this loss is estimated to be 0.1 dB. The unit weighs 17 pounds.

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 plate which mounts on the side of the card cage, as shown in Figure 2.5-1. The high cal originates in an avalanche diode noise source having ENR = 35 dB, is amplified by an amplifier with about 14 dB of 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 + 14 - 1 - 34 = 14 dB which is about 7500K excess noise temperature. The high cal is turned on by appling +28 volts to the HIGH CAL control line; this supplies the noise source (4 to 10 mA) and, through a 15 volt zener regulator, the 12 to 15 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 6K 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 4 to 10 mA.

2.6 Cooled Amplifiers

The 3-stage FET amplifier is described in NRAO EDIR No. 220. 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 OMT 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 0.42 amps, 12" of 7 x 38 AWG copper wire is used. The OMT 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 ..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 Plate

All room temperature RF components are mounted on a 1/4 inch aluminum plate that attaches to the side of the front-end card cage. Semi-rigid coax connects the three dewar SMA feedthrus to corresponding feedthrus on the card cage, and hence to the RF plate. Power is supplied to the RF plate through a 9-pin type "D" connector. 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 A53203N001. 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.

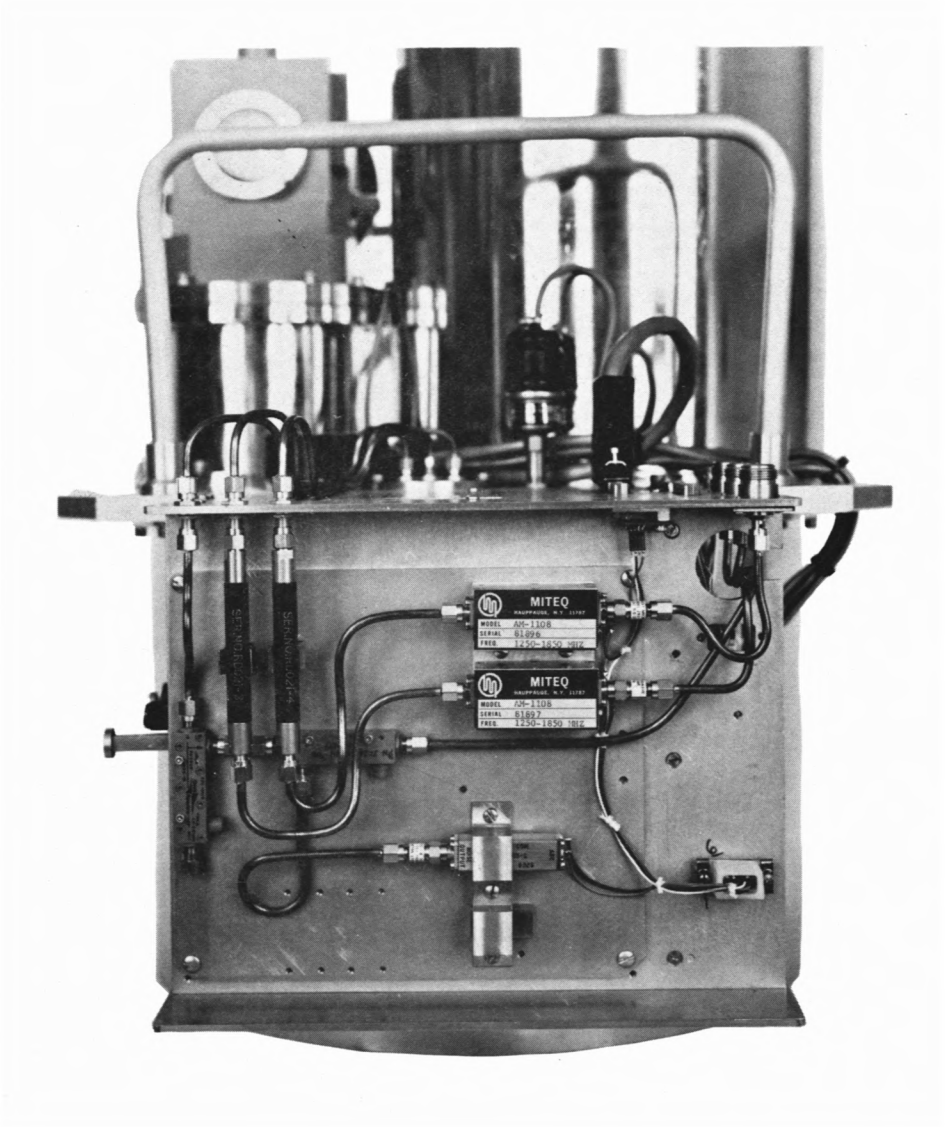


Figure 2.5-1

The RF Plate. The plate is shown mounted to the card cage. The bandpass filters are at the top left, the postamps at top right, and the noise source is at bottom center. The high cal components are not mounted on this unit.

The High Cal Amplifier used is constructed by NRAO using two TO-8 modular amplifiers and a circuit card and enclosure supplied by the amplifier manufacturer. A regulator is included to reduce the 28 V cal drive voltage to the 15 volts required by the amplifiers.

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 P112 Model 350 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 P112 with an unloaded output voltage of 160 volts RMS. The shifted phase output is obtained with a RC network. The resistance consists of two 80 ohm, 50 watt, 1% wirewound resistors in series. Total power dissapated in the resistors is approximately 45 watts. The capacitor is formed from a 7 μF oil-filled capacitor and ceramic trimming capacitors in parallel to achieve the 7.1 μF nominal desired value. Experiments have shown that the capacitance value can vary by ± 0.2 uF without audible effect on the motor.

Included within the P112 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 P112. 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.

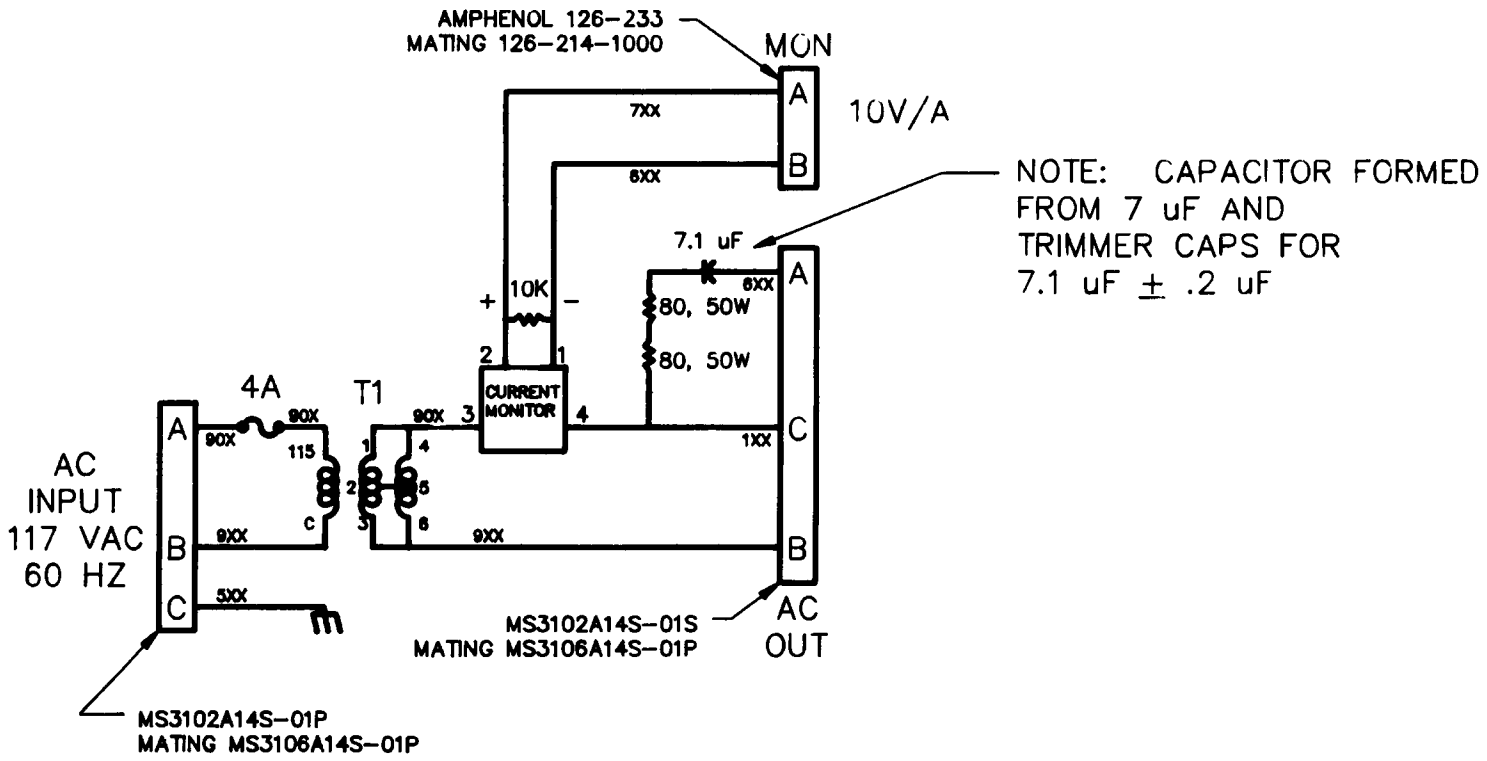


Figure 2.9-1

Schematic of the P112 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 Plate in the card cage. If the +15 volts is not correct, disconnect the

RF Plate power connector and measure the voltage at pin 2. If that voltage is +15 ± 0.1 volts, then the RF Plate 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

Sample Test Data

1.5 GHz VLBA Front End
Final Test Report
Assembly 53203A001

Card Cage S/N: 01 Date: MARCH 1986
Dewar S/N: 101 Tested by: NORRIS/SIMON

Record Components' Model/Serial Numbers:

1. Refrigerator: MODEL 350 D3695576 S/N 8501
2. Orthomode Transducer: 101
3. Monitor Card: MC 3
4. RCP Bias Card: BC5
5. LCP Bias Card: BC7
6. Sensor Card: SC 4
7. Control Card: CC4
8. 15 K Temp Sensor: —
9. 50 K Temp Sensor: —
10. RCP Cryogenic Amplifier: 291
11. LCP Cryogenic Amplifier: 282
12. RCP Bandpass Filter: PB 469-2
13. LCP Bandpass Filter: PB 469-1
14. RCP Post Amplifier: AM-1108 - 81894
15. LCP Post Amplifier: AM-1108 - 81895
16. Low Cal Noise Source: MSC 412
17. High Cal Noise Source: MSC 419
18. High Cal Noise Amplifier: 53203 A008

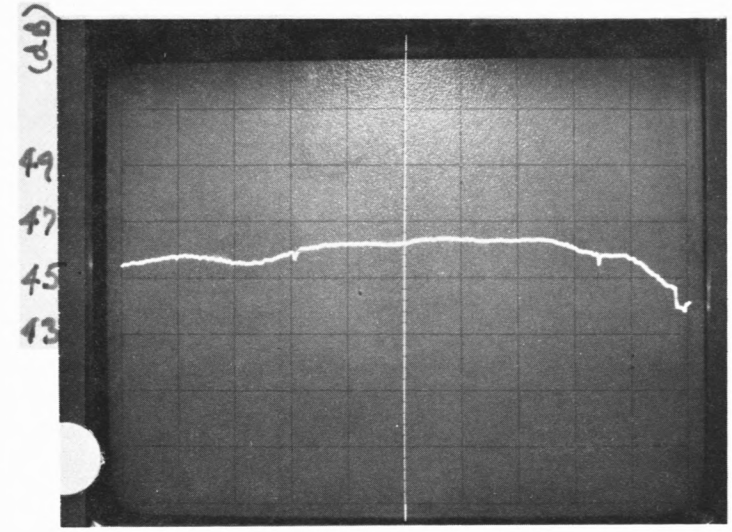
Attach Strip Recording of Dewar Cool-Down.

1.5 GHz VLBA Front End
Final Test Report
Assembly 53203A001

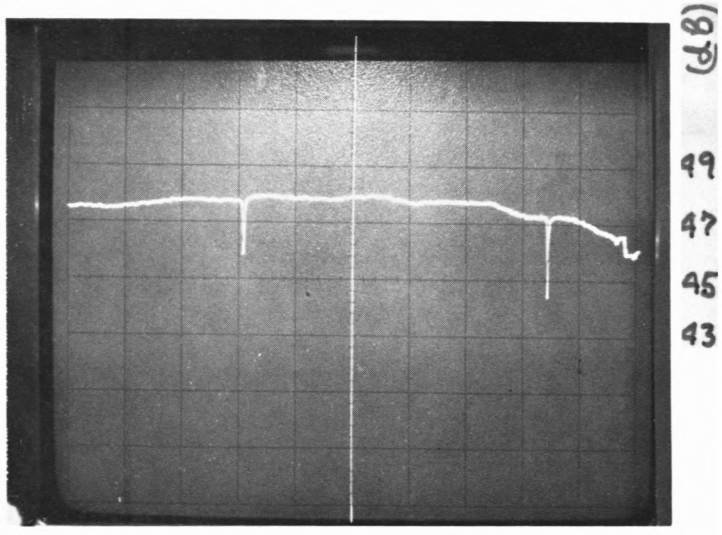
Card Cage S/N: 01 Date: 3 Mar 86
Dewar S/N: 101 Tested by: RDN

Gain-Dewar Flange to Output Connector (1.3-1.8 GHz):

L-Channel

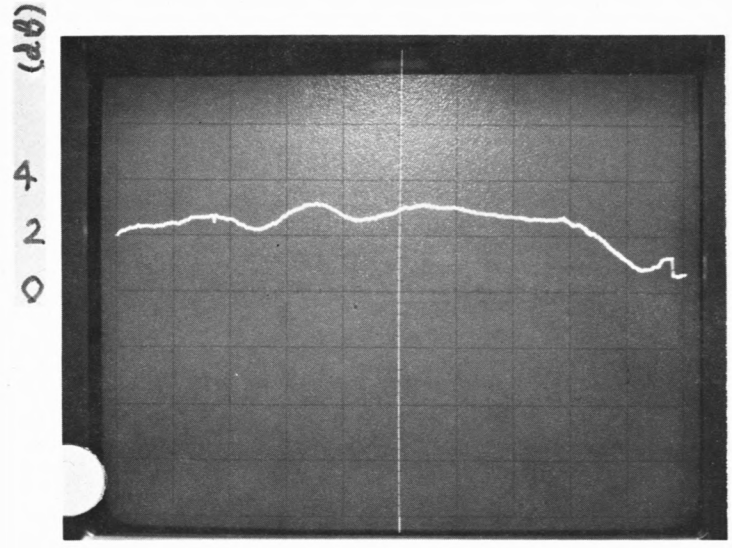


R-Channel

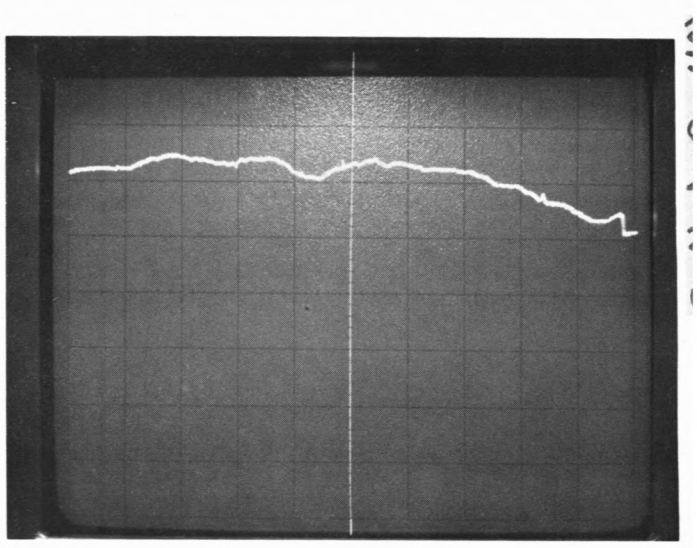


Gain-Phase Cal Input to Output Connector (1.3-1.8 GHz):

L-Channel



R-Channel

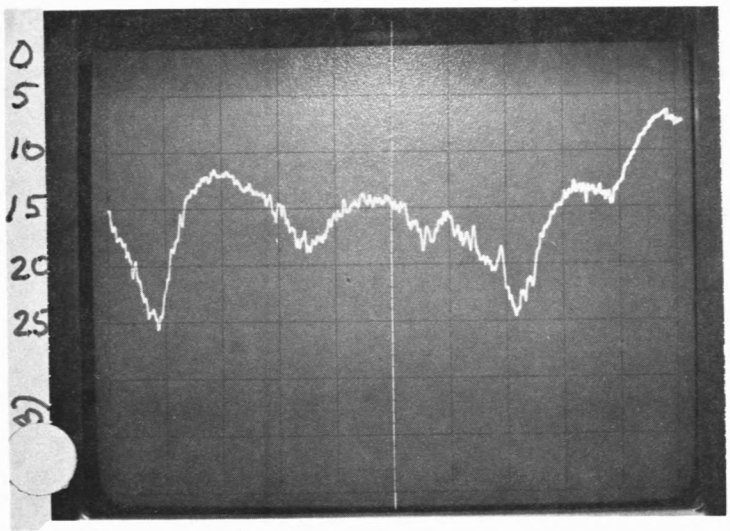


1.5 GHz VLBA Front End
Final Test Report
Assembly 53203A001

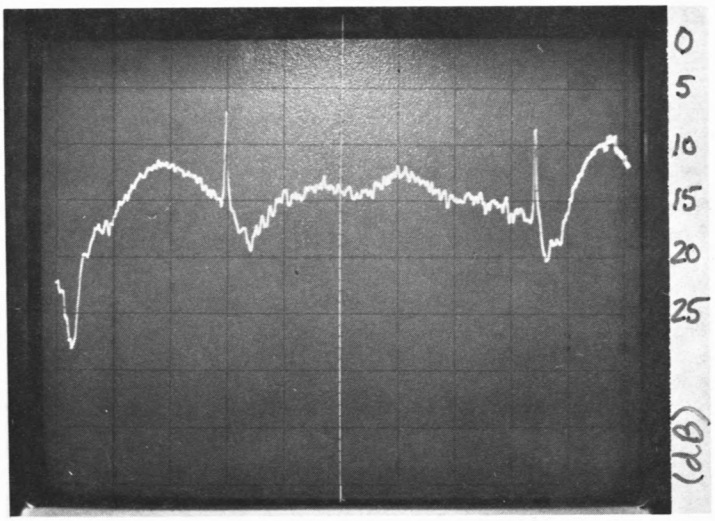
Card Cage S/N: 01 Date: 5 March 1986
Dewar S/N: 101 Tested by: RDN

Input Return Loss (1.3-1.8 GHz):

L-Channel

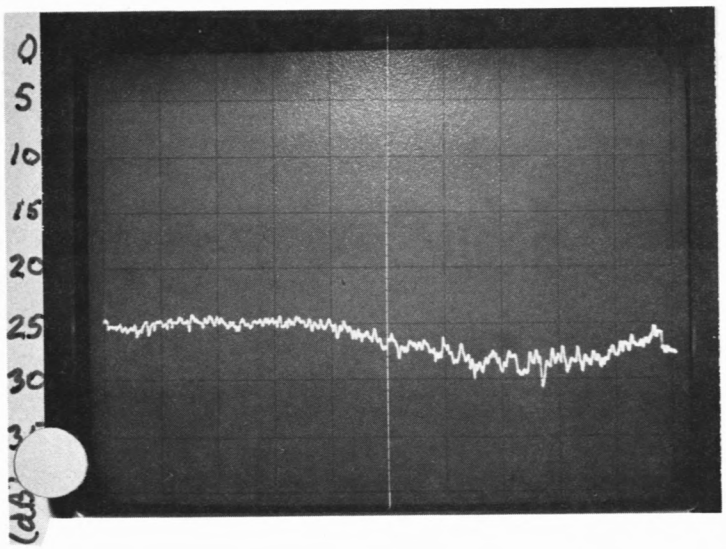


R-Channel

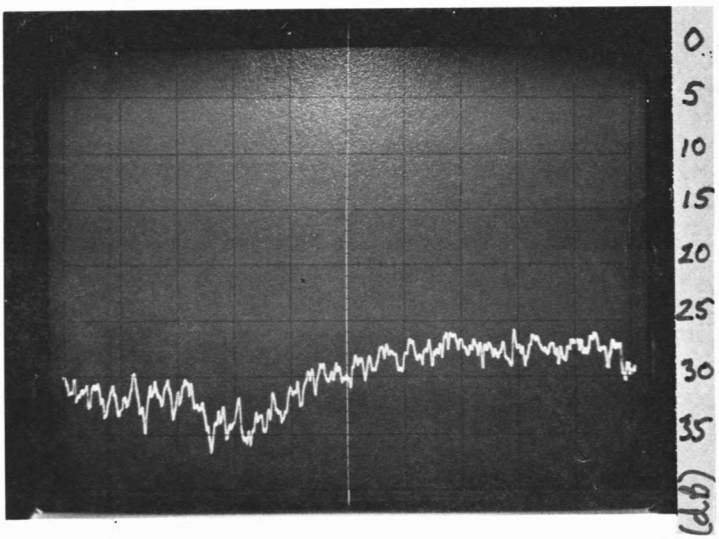


Output Return Loss (1.3-1.8 GHz):

L-Channel



R-Channel



1.5 GHz VLBA Front End
Final Test Report
Assembly 53203A001

Card Cage S/N: 01
Dewar S/N: 101

Date: 5 March 1986
Tested by: RDN

FET Bias Settings

Stage	L-Channel Amp # 282				R-Channel Amp # 291			
	V_D	I_D	V_G 300 K	V_G 15 K	V_D	I_D	V_G 300 K	V_G 15 K
1	5.00	13.8	-0.58	-0.77	5.00	19.6	-0.45	-0.62
2	5.00	6.0	-1.32	-1.37	5.00	14.8	-1.27	-1.35
3	4.00	9.8	-0.98	-1.24	4.00	9.8	-0.71	-0.88

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	-39.2	-37.6	-43.3	-42.1
79.7 K Load	-44.2	-42.8	———	———
Short	-52.9	-52.0	-48.6	-47.3
Short + Cal	-56.4	-51.5	N.C.	-47.1
Short + HI Cal	-25.4	-23.8	-29.8	-28.8

1.5 GHz VLBA Front End -- Final Test Report -- Assembly 53203A001

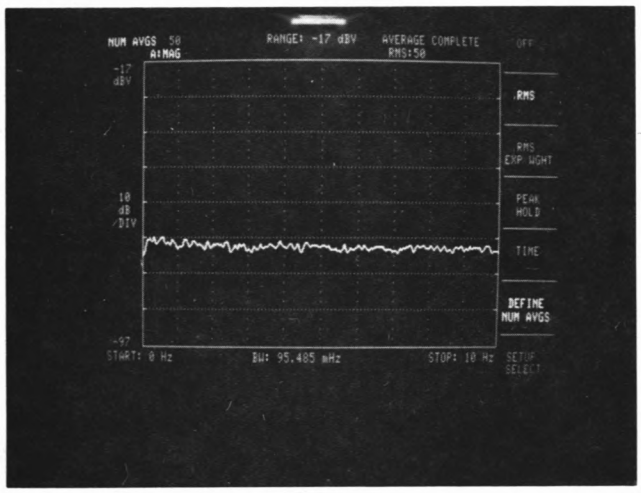
Card Cage S/N: 01 Date: 5 Mar 86
Dewar S/N: 101 Tested by: RCN

Output 1 dB Compression Point:

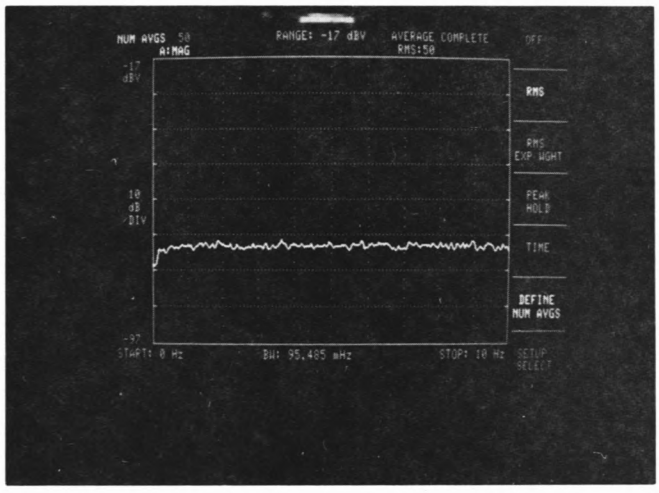
L-Channel			R-Channel		
1.35 GHz:	+5.5	dBm	1.35 GHz:	+3.0	dBm
1.55 GHz:	+6.1	dBm	1.55 GHz:	+3.7	dBm
1.75 GHz:	+7.1	dBm	1.75 GHz:	+4.5	dBm

Low Frequency Spectrum:

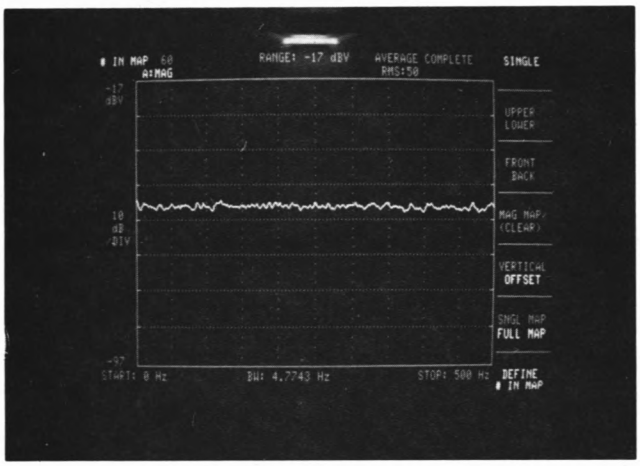
L-Channel
0-10 Hz

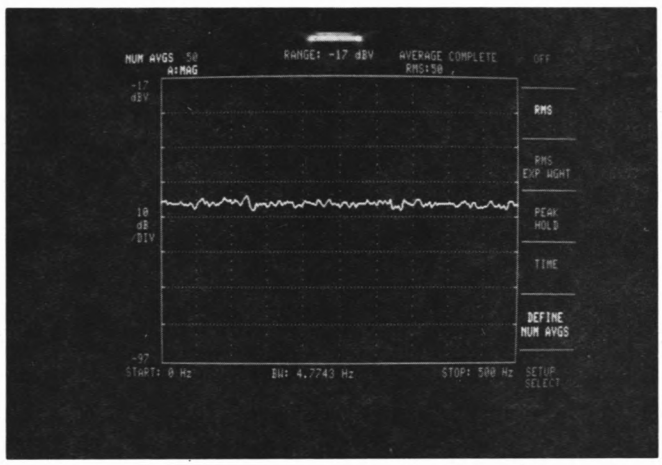


R-Channel
0-10 Hz



All measured with 300K input termination,
10/5 MHz IF, and 1.5 V DC backoff
of detected voltage.



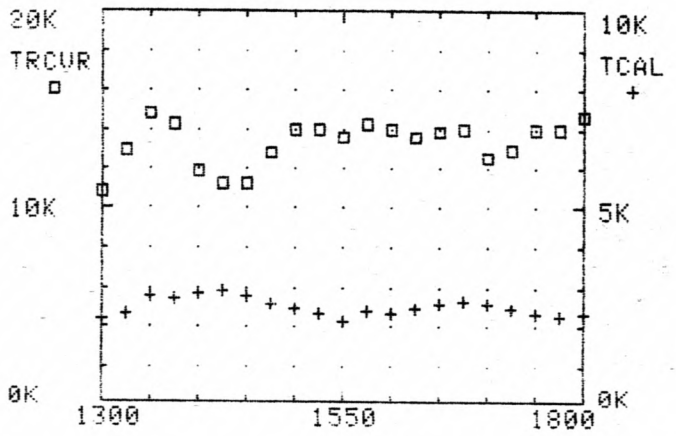


CALIBRATION RECORD OF 1.5 GHZ RECEIVER, SERIAL #1, MOD #3
RCP POLARIZATION, TESTED BY RDN
DATE 03/06/85 TIME 09:25.1
COMMENT: NONE

15K TEMP = 10.10 50K TEMP = 53.11 300K TEMP = 299.74
AC AMPS = 0.764 LSWP VAC =   -80 PUMP VAC = 10069
HEMT LED = 14.40 +15 VOLT = 14.852 -15 VOLT =-15.132
CAL VOLT = 27.71 HIGH CAL = 27.45 SPARE   =   -.01
FETS: LF1= -.786 LF2= -1.323 RF1= -.630 RF2= -1.143
PARITY OK
CRYO MODE IS COOL (7) CONTROLLED BY CPR

09:33.5 03/06/85 THOT=307 TCOLD=82 TEST3

F.MHZ	TRCVR	TCAL	HI CAL	SHORT
1300	10.8	2.19	5892.6	0.0
1325	12.9	2.32	6614.3	0.0
1350	14.8	2.78	7153.7	0.0
1375	14.2	2.72	7564.1	0.0
1400	11.8	2.85	7964.7	0.0
1425	11.1	2.87	8343.0	0.0
1450	11.1	2.80	8577.2	0.0
1475	12.8	2.58	8525.3	0.0
1500	14.0	2.44	8785.0	0.0
1525	13.9	2.32	8432.1	0.0
1550	13.5	2.10	8038.7	0.0
1575	14.2	2.40	7880.3	0.0
1600	13.9	2.33	7698.5	0.0
1625	13.6	2.46	7364.3	0.0
1650	13.8	2.58	7025.8	0.0
1675	14.0	2.66	6746.0	0.0
1700	12.5	2.57	6459.6	0.0
1725	12.9	2.45	6240.0	0.0
1750	13.9	2.32	6073.5	0.0
1775	13.9	2.22	5977.1	0.0
1800	14.6	2.33	6183.0	0.0



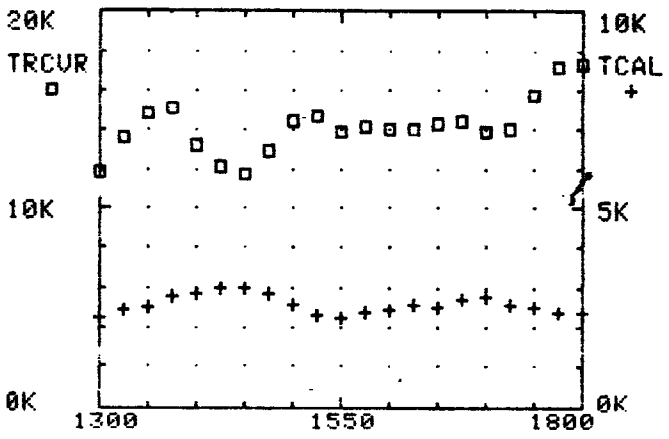
CALIBRATION RECORD OF 1.5 GHZ RECEIVER, SERIAL #1, MOD #0
LCP POLARIZATION, TESTED BY RDN
DATE 03/06/85 TIME 10:00.6
COMMENT: NONE

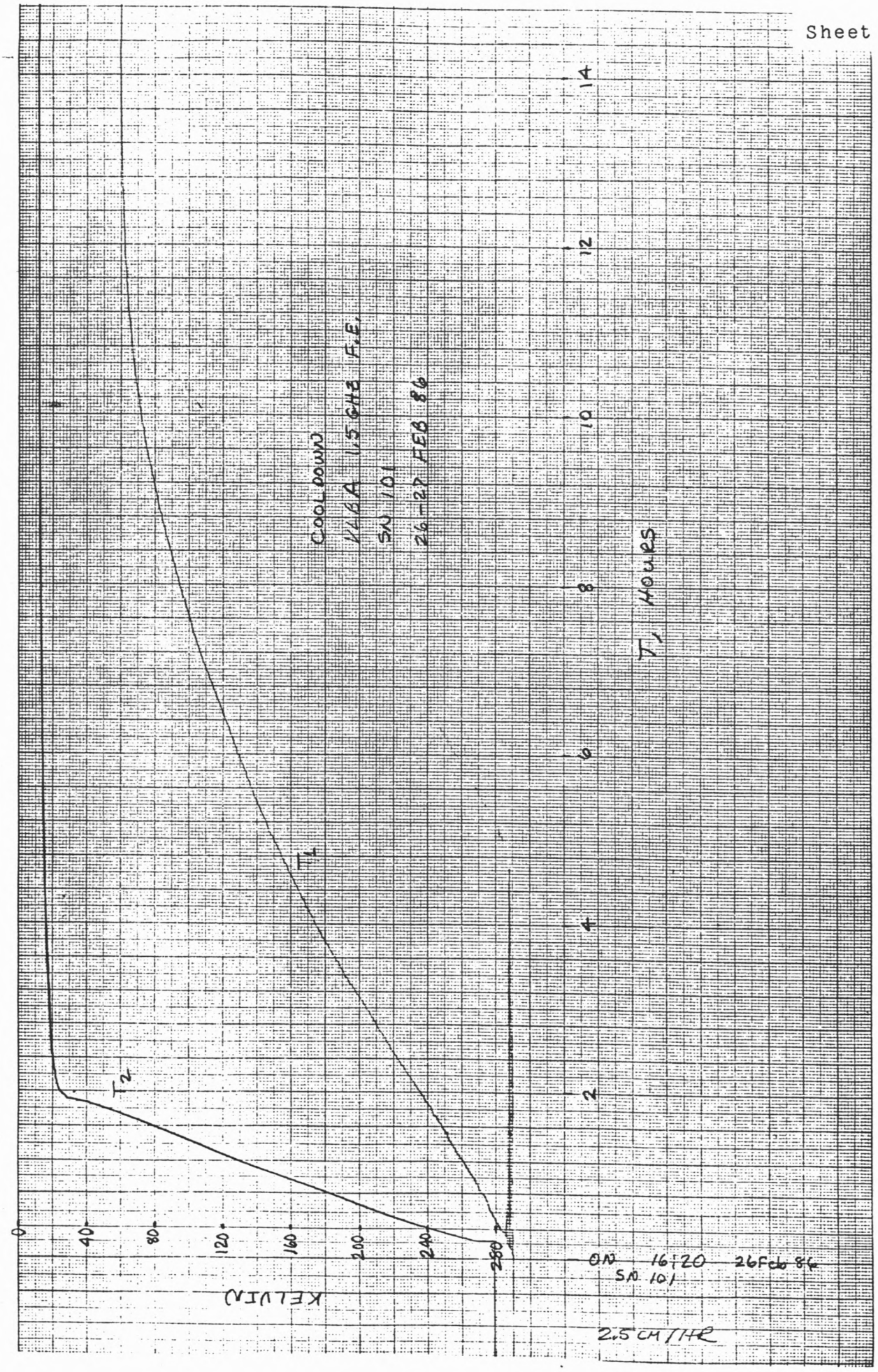
15K TEMP =	9.85	50K TEMP =	52.98	300K TEMP =	299.70		
AC AMPS =	0.768	DEWR VAC =	-79	PUMP VAC =	10065		
HEMT LED =	14.39	+15 VOLT =	14.847	-15 VOLT =	-15.133		
CAL VOLT =	27.70	HIGH CAL =	27.44	SPARE =	-.01		
FETS: LF1=	-.787	LF2=	-1.325	RF1=	-.632	RF2=	-1.144

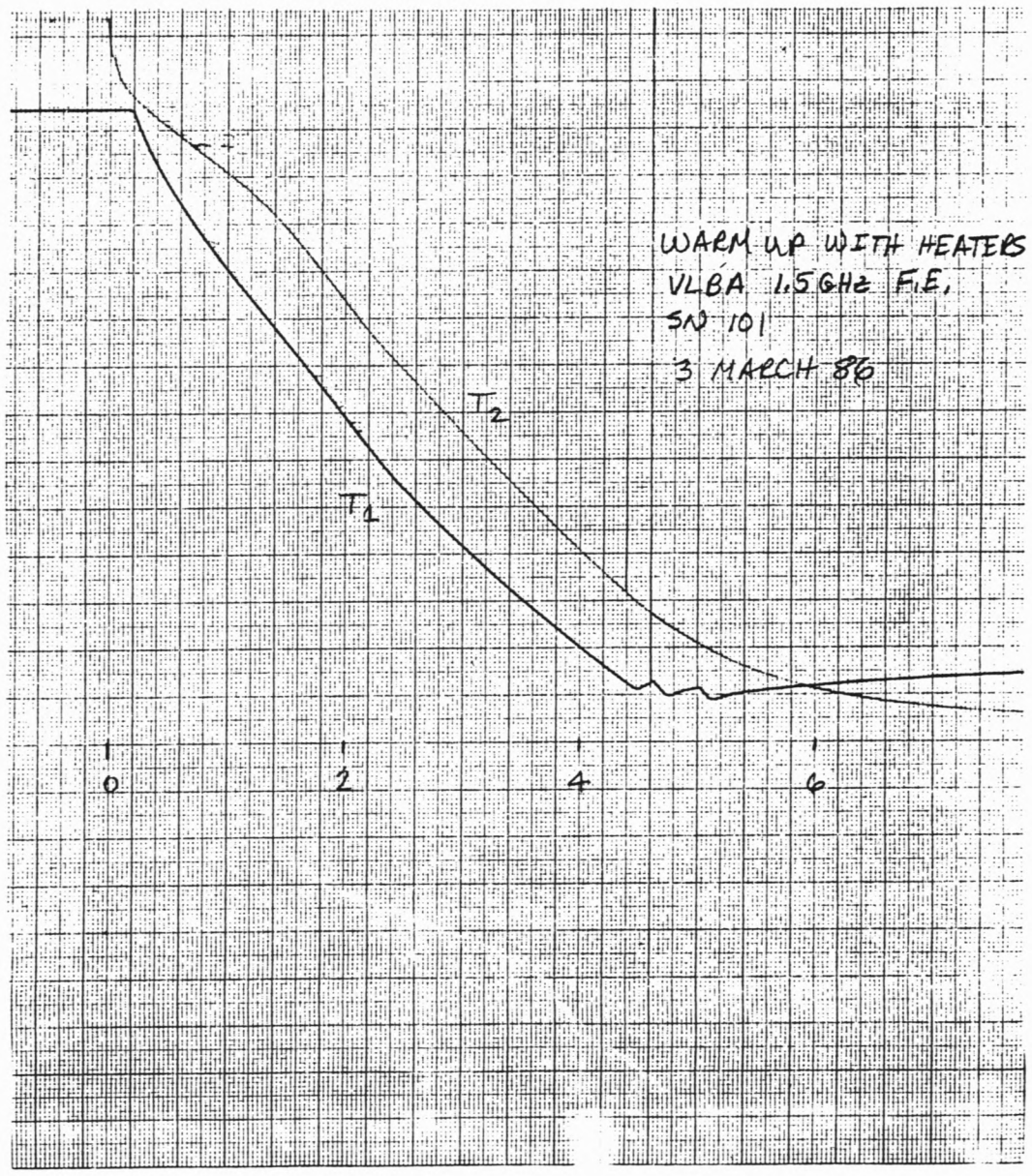
PARITY OK
CRYO MODE IS COOL (7) CONTROLLED BY CPR

10:11.1 03/06/85 THOT=307 TCOLD=82 TEST1

F.MHZ	TRCVR	TCAL	HI CAL	SHORT
1300	11.8	2.21	6052.3	0.0
1325	13.6	2.44	6645.2	0.0
1350	14.8	2.53	7117.2	0.0
1375	15.0	2.80	7604.2	0.0
1400	13.1	2.84	8129.3	0.0
1425	12.1	2.94	8490.9	0.0
1450	11.7	2.99	8728.2	0.0
1475	12.9	2.82	8828.3	0.0
1500	14.3	2.54	8924.5	0.0
1525	14.6	2.31	8685.6	0.0
1550	13.8	2.24	8149.5	0.0
1575	14.1	2.37	7914.2	0.0
1600	14.0	2.41	7741.5	0.0
1625	13.9	2.54	7400.3	0.0
1650	14.2	2.49	7058.4	0.0
1675	14.4	2.73	6795.2	0.0
1700	13.8	2.79	6552.5	0.0
1725	13.9	2.59	6286.3	0.0
1750	15.7	2.47	6174.7	0.0
1775	17.2	2.39	6145.2	0.0
1800	17.3	2.38	6258.5	0.0




COOLDOWN
1146A 1.5 GHz F.E.
SN 101
26-27 FEB 86
T1, HOURS
KELVIN
T2
T1
0
40
80
120
160
200
240
280
2
4
6
8
10
12
14
ON 16:20 26Feb 86
SN 101
2.5 CM/HR

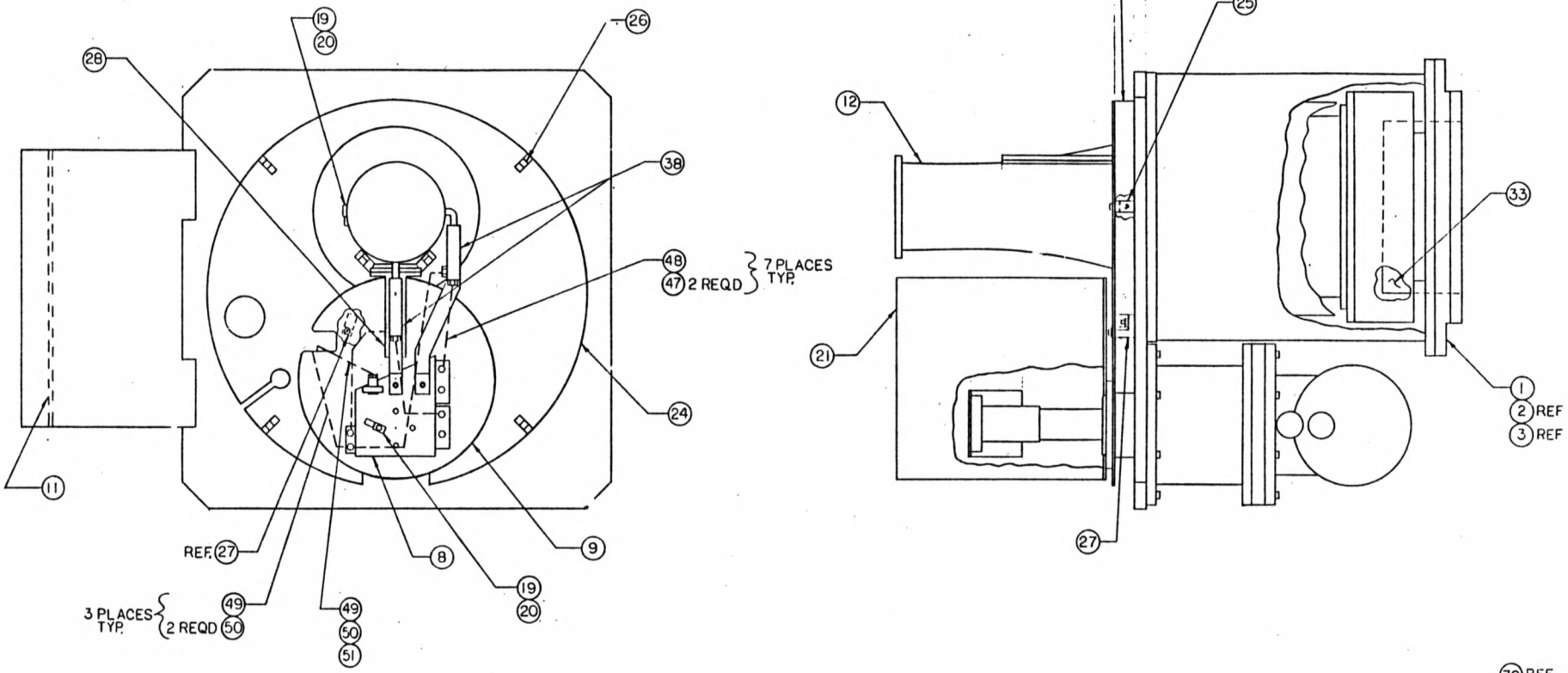

WARM UP WITH HEATERS
VLBA 1.5 GHz F.E.
SN 101
3 MARCH 86
T_2
T_1
0
2
4
6

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 bill of materials, from which all associated documentation can be determined. The following is a list of documents included here:

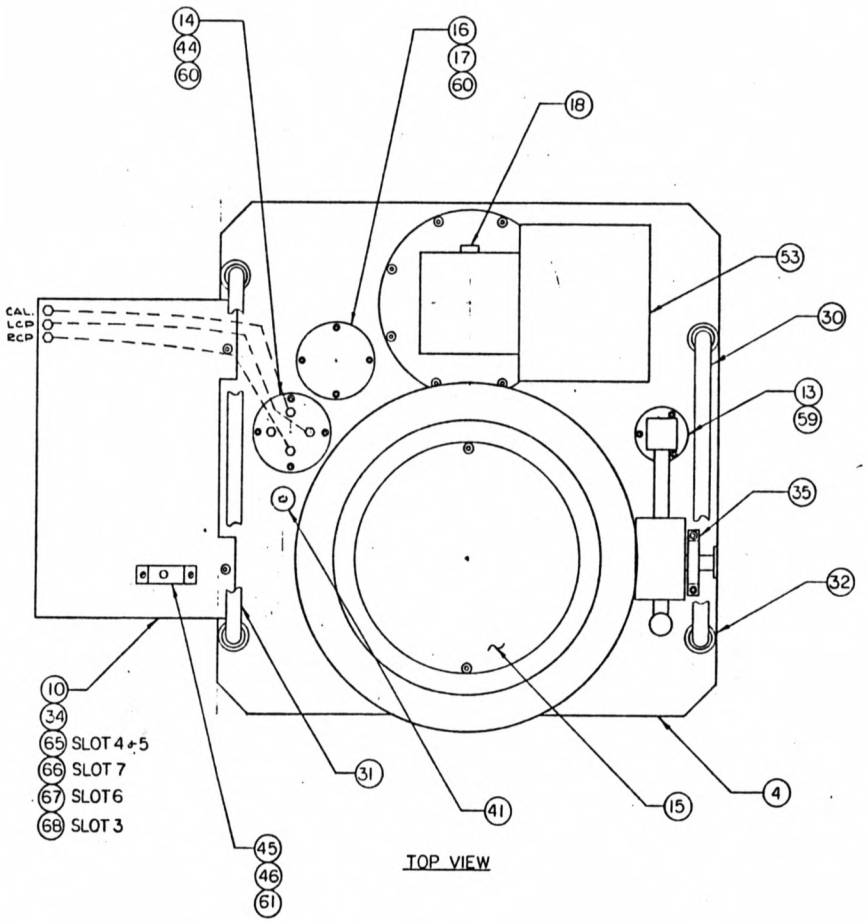
Drawing No.	Title
D53203A001	Assembly, 1.5 GHz Front End
A53203B001	BOM, 1.5 GHz Front End
C53203A002	Assembly, 15K Plate
A53203B002	BOM, 15K Plate Assembly
C53203A003	Assembly, 50K Plate
A53203B003	BOM, 50K Plate Assembly
D53203A004	Assembly, 1.5 GHz F.E. Card Cage
A53203B004	BOM, 1.5 GHz F.E. Card Cage
C53203A005	RF Plate Assembly
A53203B005	BOM, RF Plate Assembly
D53203A006	Assembly, OMT
A53203B006	BOM, OMT Assembly
C53203A007	Assembly, Vacuum
A53203B007	BOM, Vacuum Assembly
A53203B008	BOM, Solar Cal Amp Assembly
A53203N001	Spec, 1.5 GHz F.E. Postamp
A53203W001	1.5 GHz F.E. Card Cage Wiring List
B53203W002	1.5 GHz F.E. Card Cage Wiring Diagram
A53200B007-2	BOM, Model 350 Refrigerator Power Supply



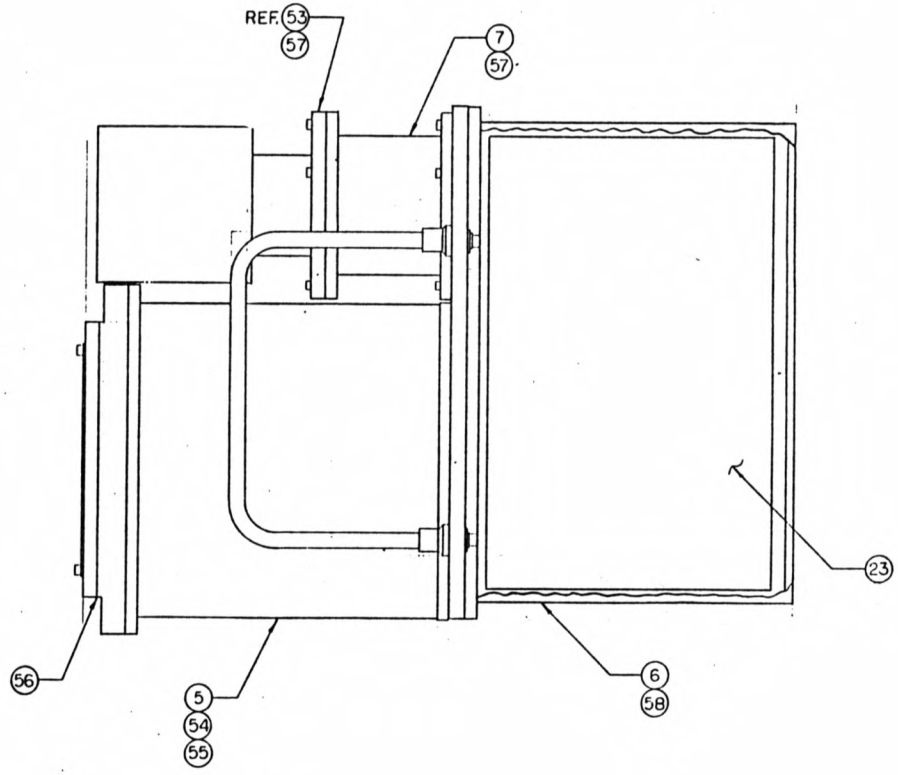
BOTTOM VIEW

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES: ANGLES ± 3 PLACE DECIMALS (.XXX): ± 2 PLACE DECIMALS (.XX): ± 1 PLACE DECIMALS (.X): ± MATERIAL: FINISH:	VLBA SUBSYSTEM: 1.5 GHz FRONT END TITLE: FRONT END ASSY SHEET NUMBER 1:2 DRAWING NUMBER 053203A001 REV.	NATIONAL RADIO ASTRONOMY OBSERVATORY DRAWN BY G. MORRIS DATE 4-15-85 DESIGNED BY DATE APPROVED BY DATE SCALE 1/2

BOM A53203B001



TOP VIEW



UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES: ANGLES ± 3 PLACE DECIMALS (.XXX): ± 2 PLACE DECIMALS (.XX): ± 1 PLACE DECIMALS (.X): ±	VLBA 1.5 GHz FRONT END	NATIONAL RADIO ASTRONOMY OBSERVATORY
MATERIAL: ~	FRONT END ASSY	DRAWN BY: G. MORRIS DATE: 7-18-85 DESIGNED BY DATE APPROVED BY DATE
FINISH: ~	SHEET NUMBER 2-2 DRAWING NUMBER D53203A001 REV. SCALE 1/2	

Sheet 1 of 4

BILL OF MATERIAL:	TITLE:	APPROVED BY/DATE:	PREPARED BY/DATE:	REV: DATE:
A53203B001	**1.5 GHz Front End**	6/13/85	R. Norrod	A 7/3/85

Item	Qty. Req.	Description	Designation	P/N	Suggested Manufacturer
1.	1	Assembly, Thermal Transition		D53203M003	NRAO
2.	REF	Detail, Thermal Transition		D53203M004	NRAO
3.	REF	Dewar Cap, Thermal Transition		D53203M005	NRAO
4.	1	Dewar Mounting Plate		D53203M010	NRAO
5.	1	Dewar Upper Vessel		D53203M011	NRAO
6.	1	Dewar Lower Vessel		D53203M012	NRAO
7.	1	Refrigerator Mounting Assembly		D53203M032 -01	NRAO
8.	1	Assembly, Dewar 15K Plate		53203A002	NRAO
9.	1	Assembly, Dewar 50K Plate		53203A003	NRAO
10.	1	Assembly, Card Cage		53203A004	NRAO
11.	1	Assembly, RF Plate		53203A005	NRAO
12.	1	Assembly, OMT		53203A006	NRAO
13.	1	Assembly, Vacuum		53203A007	NRAO
14.	1	SMA Feedthru Plate		A53203M006	NRAO
15.	1	Dewar Window Cover Plate		A53203M024	NRAO
16.	1	Dewar Feedthru Cover		A53203M028	NRAO
17.	1	Assembly, DC Feedthru		B53206A012	NRAO
18.	1	Assembly, Timer		A53206A013	NRAO
19.	2	Assembly, Temperature Sensor		A53200A001	NRAO
20.	2	Connector, Temperature Sensor		GF-2	Microtech

Sheet 2 of 4

BILL OF MATERIAL: A53203B001	TITLE: 1.5 GHz Front End	APPROVED BY/DATE: 6/13/85	PREPARED BY/DATE: R. Norrod	REV: DATE: A 7/3/85

Item	Qty. Req.	Description	Designation	P/N	Suggested Manufacturer
21.	1	Dewar 50K Radiation Shield		C53203M015	NRAO
22.	1	Dewar Upper Vessel Shield		B53203M016	NRAO
23.	1	Dewar Lower Vessel Shield		B53203M017	NRAO
24.	1	Dewar Radiation Shield Plate		D53203M018	NRAO
25.	4	Dewar L-Bracket		A53203M025	NRAO
26.	4	Dewar Lower Vessel Shield Support		A53203M026	NRAO
27.	2	Dewar Shield Plate Support		A53203M027	NRAO
28.	1	Dewar OMT Cold Strap		A53203M029	NRAO
29.					
30.	1	Handle		B53203M037 -01	NRAO
31.	1	Handle		B53203M037 -02	NRAO
32.	4	Handle Collar		A53206M019	NRAO
33.	1	Thermal Transition Insert		B53203M034	NRAO
34.	1	Card Frame Bracket		53203M035	NRAO
35.	1	Vacuum Port Clamp		A53203M036	NRAO
36.					
37.					
38.	2	Directional Coupler, 30 dB		4012C-30	Narda
39.					
40.					

Sheet 3 of 4

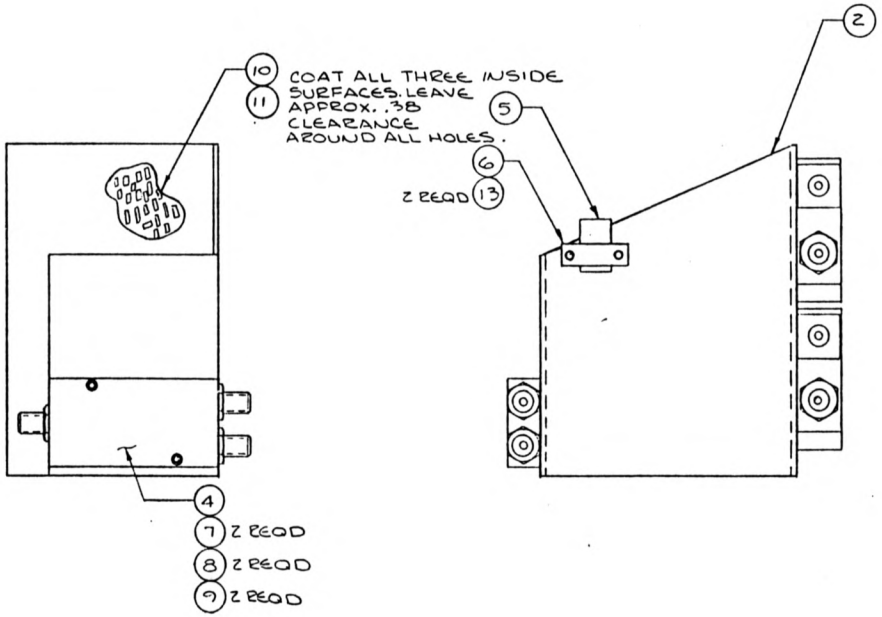
BILL OF MATERIAL:	TITLE:	APPROVED BY/DATE:	PREPARED BY/DATE:	REV: DATE:
A53203B001	1.5 GHz Front End	6/13/85	R. Norrod	A 7/3/85

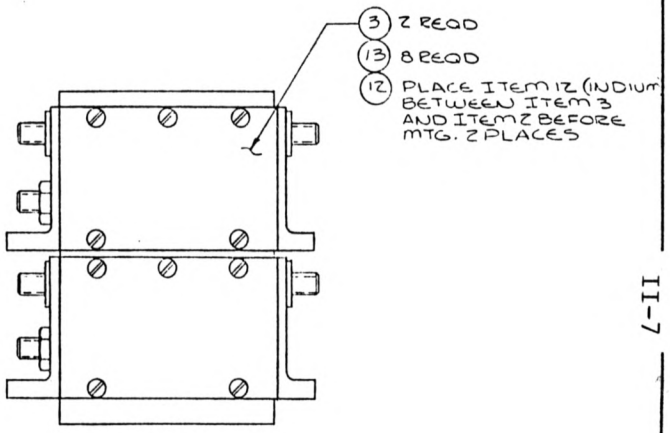
Item	Qty. Req.	Description	Designation	P/N	Suggested Manufacturer
41.	1	Vacuum Gauge Tube		DV-6M	Teledyne-Hastings
42.					
43.					
44.	4	SMA Hermetic Feedthru		208A	Omni Spectra
45.	1	Connector, Dewar Power		DB25P	TRW Cinch
46.	1	DB25 Backshell, Straight, with Locking Backshell			
47.	14	SMA-141 Connector		201-1A	Omni Spectra
48.	AR	141 Semi-Rigid Coax			
49.	AR	085 Semi-Rigid SS Coax		UT-85SS	Uniform Tube
50.	7	SMA-085 Connector		201-2A	Omni Spectra
51.	1	SMA Female-085 Connector		202-2	Omni Spectra
52.					
53.	1	Refrigerator, Cryogenic, Model 350CP		D3695576	CTI
54.	1	O-Ring, N674-70 Compound, Upper Vessel-1		2-271	Parker
55.	1	O-Ring, N674-70 Compound, Upper Vessel-2		2-274	Parker
56.	1	O-Ring, N674-70 Compound, WG Window		2-262	Parker
57.	2	O-Ring, N674-70 Compound, REF Mounting		2-157	Parker
58.	1	O-Ring, N674-70 Compound, Lower Vessel		2-281	Parker
59.	1	O-Ring, N674-70 Compound, Vacuum Assembly		2-118	Parker

Sheet 4 of 4

BILL OF MATERIAL: A53203B001	TITLE: 1.5 GHz Front End	APPROVED BY/DATE: 6/13/85	PREPARED BY/DATE: R. Norrod	REV: DATE: A 7/3/85

Item	Qty. Req.	Description	Designation	P/N	Suggested Manufacturer
60.	2	O-Ring, N674-70 Compound, Feedthrus		2-130	Parker
61.	2	"D" Connector Locking Screws		D-20419-16	TRW Cinch
62.					
63.					
64.					
65.	2	FET Bias Card		D53200A002	NRAO
66.	1	Control Card		D53200A004	NRAO
67.	1	Sensor Card		D53200A003	NRAO
68.	1	Monitor Card		D53200A006 -02	NRAO
69.					
70.	REF	System Block Diagram		B53203K001	NRAO
71.	REF	Front End AC Wiring		B53203W004	NRAO
72.	REF	1.5 GHz Dewar Interface		C53203A009	NRAO
73.					
74.					
75.					
76.					
78.					
79.					
80.					





1 BOM A53203B002

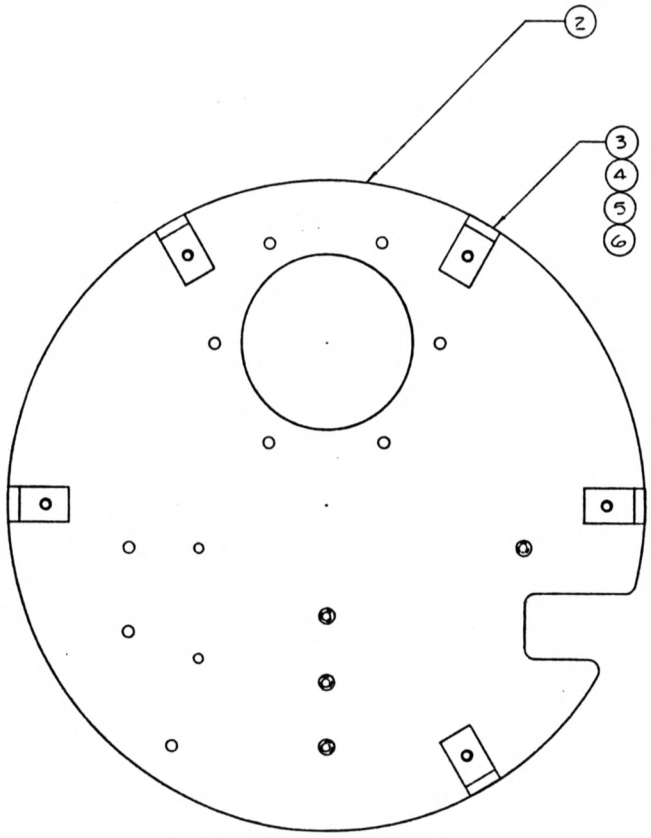
REV	DATE	DRAWN BY	APPRV'D BY	DESCRIPTION

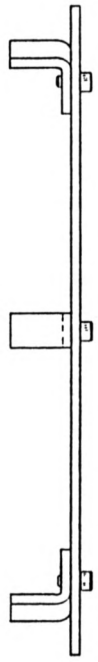
VLBA PROJECT	1.5 GHz FRONT END	NATIONAL RADIO ASTRONOMY OBSERVATORY, CHARLOTTESVILLE, VA 22901
TITLE	DEWAR 15K PLATE ASSY	DRAWN BY G. MORRIS — DATE 9.12.85
		DESIGNED BY — DATE
		APPROVED BY — DATE
SHEET NUMBER	DRAWING NUMBER C53203A002	REV — SCALE 1:1

Page No. 1 A53203B002-BOM DEWAR 15K PLATE ASSY
11/05/85

BILL OF MATERIALS
National Radio Astromomy Observatory
VLBA

ITEM NUM.	REF. DES.	MANUFACTURER	MANUFACTURER'S PART NUMBER	DESCRIPTION	QUAN. REQ.
1		NRAO	A53203B002	BOM 15K ASSY PLATE	0
2		NRAO	C53203M014	DEWAR 15K PLATE	1
3		NRAO		AMPLIFIER 1.5 GhZ COOLED FET	2
4		OMNI-SPECTRA	2089-6201-00	POWER DIVIDER	1
5		EMC	4112 P	SMA TERMINATION	1
6		NRAO	A53203M033	TERMINATION CLAMP	1
7			#4-40 X 3/4 LG	S.S. SHCS	2
8			#4-40	NUT	2
9			#4	LOCK WASHER	2
10		WILCO CHEMICAL	AC-4051	CHARCOAL PELLETS	AR
11		ARMSTRONG	A-12	EPOXY	AR
12				INDIUM	AR
13			#4-40 X 1/2 LG	S.S. SHCS	10





(1) BOM A53203B003

REV	DATE	DRAWN BY	APPRVD BY	DESCRIPTION

VLBA DESIGNATION: 1.5 GHz FRONT END

TITLE: DEWAR 50K PLATE ASSY

NATIONAL RADIO ASTRONOMY OBSERVATORY
CHARLOTTESVILLE, VA. 22901

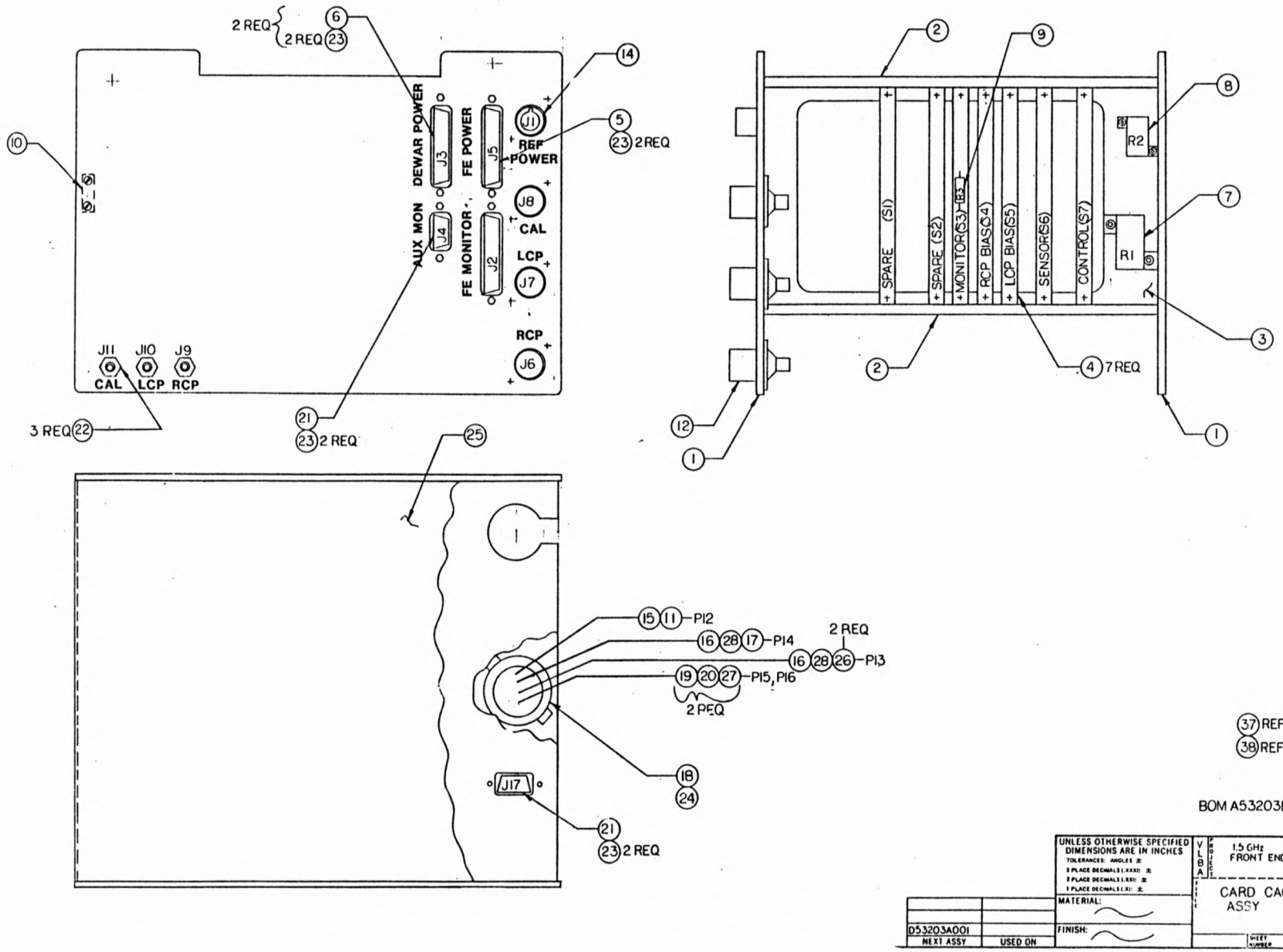
DRAWN BY	G MORRIS	DATE 3-11-85
DESIGNED BY		DATE
APPROVED BY		DATE

SHEET NUMBER | DRAWING NUMBER C53203A003 | REV | SCALE 1:1

Page No. 1 A53203B003-BOM DEWAR 50K PLATE ASSY
11/05/85

BILL OF MATERIALS
National Radio Astromomy Observatory
VLBA

ITEM NUM.	REF. DES.	MANUFACTURER	MANUFACTURER'S PART NUMBER	DESCRIPTION	QUAN. REQ.
1		NRAO	A53203B003	BOM 50K PLATE ASSY	0
2		NRAO	B53203M013	DEWAR 50K PLATE	5
3		NRAO	A53203M025	DEWAR L-BRACKET	5



BOM A53203B004

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES: ANGLES ± 3 PLACE DECIMALS (.XXX) ± 2 PLACE DECIMALS (.XX) ± 1 PLACE DECIMALS (.X) ±		PROJECT: VLBA	1.5 GHz FRONT END	NATIONAL RADIO ASTRONOMY OBSERVATORY
MATERIAL:		TITLE:	CARD CAGE ASSY	DRAWN BY: G MORRIS DESIGNED BY APPROVED BY
FINISH:				
D53203A001		SHEET NUMBER	DRAWING NUMBER D53203A004	REV
NEXT ASSY	USED ON			

Sheet 1 of 2

BILL OF MATERIAL:	TITLE:	APPROVED BY/DATE:	PREPARED BY/DATE:	REV: DATE:
A53203B004	Card Cage/1.5 GHz F.E.		6/13/85	

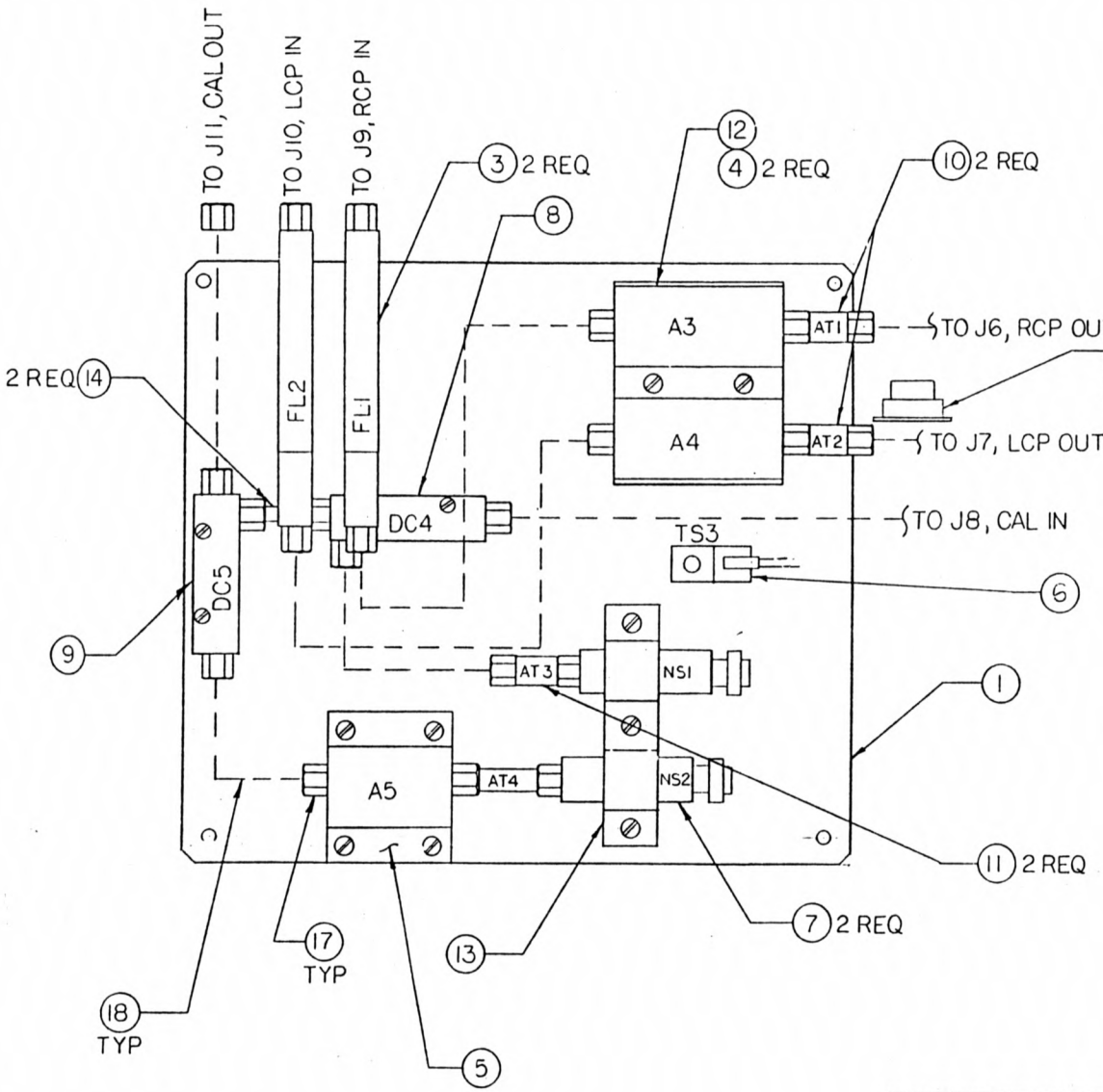
Item	Qty. Req.	Description	Designation	P/N	Suggested Manufacturer
1.	1	Card Frame Top, Bottom Plate		D53203M019	NRAO
2.	1	Card Frame Sides		D53203M020	NRAO
3.	1	Mother Board Plate		C53206M025	NRAO
4.	7	44 Pin Edge Card Connector	S1-S7	50-44A-30	TRW Cinch
5.	1	Connector, 25 Pin	J5	DBM-25P	TRW Cinch
6.	2	Connector, 25 Socket	J2, J3	DBM-25S	TRW Cinch
7.	1	Resistor, 300Ω 25W 1%	R1	RH-25	Dale
8.	1	Resistor, 5KΩ 10W 1%	R2	RH-10	Dale
9.	1	Resistor, 510Ω 1/2W 5% Carbon	R3	-	-
10.	1	Card Cage Bracket		A53203M038	NRAO
11.	AR	18 Gauge 3 Conductor Cable		M39076	Manhattan Cable
12.	3	SMA Type N Bulkhead	J6-J8	21011	Omni Spectra
13.	1	0-10,000 Hour Timer		CP-3	Curtis
14.	1	3 Conductor AC Input Connector	J1	DM9606-3P	Deutsch
15.	1	3 Conductor REF Power Connector	P12	DM9702-3S	Deutsch
16.	2	Molex Connector Receptacle	P13, P14	03-09-1022	Molex
17.	2	Molex Pin--Female (for P14)		02-09-1118	Molex
18.	1	Card Cage Clamp		AN3057-10	Amphenol
19.	2	8 Pin Vacuum Gauge Connector	P15, P16	78-S8	Amphenol
20.	2	8 Pin Vacuum Gauge Connector Backshell with Clamp		86-3-24	Amphenol

Continued

Sheet 2 of 2

BILL OF MATERIAL:	TITLE:	APPROVED BY/DATE:	PREPARED BY/DATE:	REV: DATE:
A53203B004	Card Cage/1.5 GHz F.E.		6/13/85	

Item	Qty. Req.	Description	Designation	P/N	Suggested Manufacturer
21.	2	Connector, 9 Socket	J4, J17	DE-9S	TRW
22.	3	SMA Feedthru's	J9-J11	209A	Omni Spectra
23.	10	Type "D" Connector Screw Post		D-20418-2	TRW
24.	1	Card Cage Clamp Coupling Ring		MS3106A18	Amphenol
25.	1	Card Cage Cover		B53203M039	NRAO
26.	2	Molex Pin--Male (for P13)		02-09-2118	Molex
27.	AR	Jacketed 3-Wire 22 AWG Cable		8443	Belden
28.	AR	Jacketed 1 Twisted Pair 18 AWG		9740	Belden
29.	AR	Jacketed 25-Wire 22 AWG Cable		1181/25	Alpha
30.					
31.					
32.					
33.					
34.					
35.					
36.					
37.	REF	Card Cage Wiring List		A53203W001	NRAO
38.	REF	Card Cage Wiring Diagram		B53203W002	NRAO
39.					
40.					



PIN	FN	CONNECT TO
1	GND	A3, A4 (−)
2	15	A3, A4(+), TS3(4)
3	15	N.C.
4	GND	A5(−), TS3(2)
5	LO CAL	NS1(+)
6	HI CAL	NS2(+), A5(+)
7	GND	NS1 NS2(−)
8	TEMP MON	TS3(1)
9	SPARE	N.C.

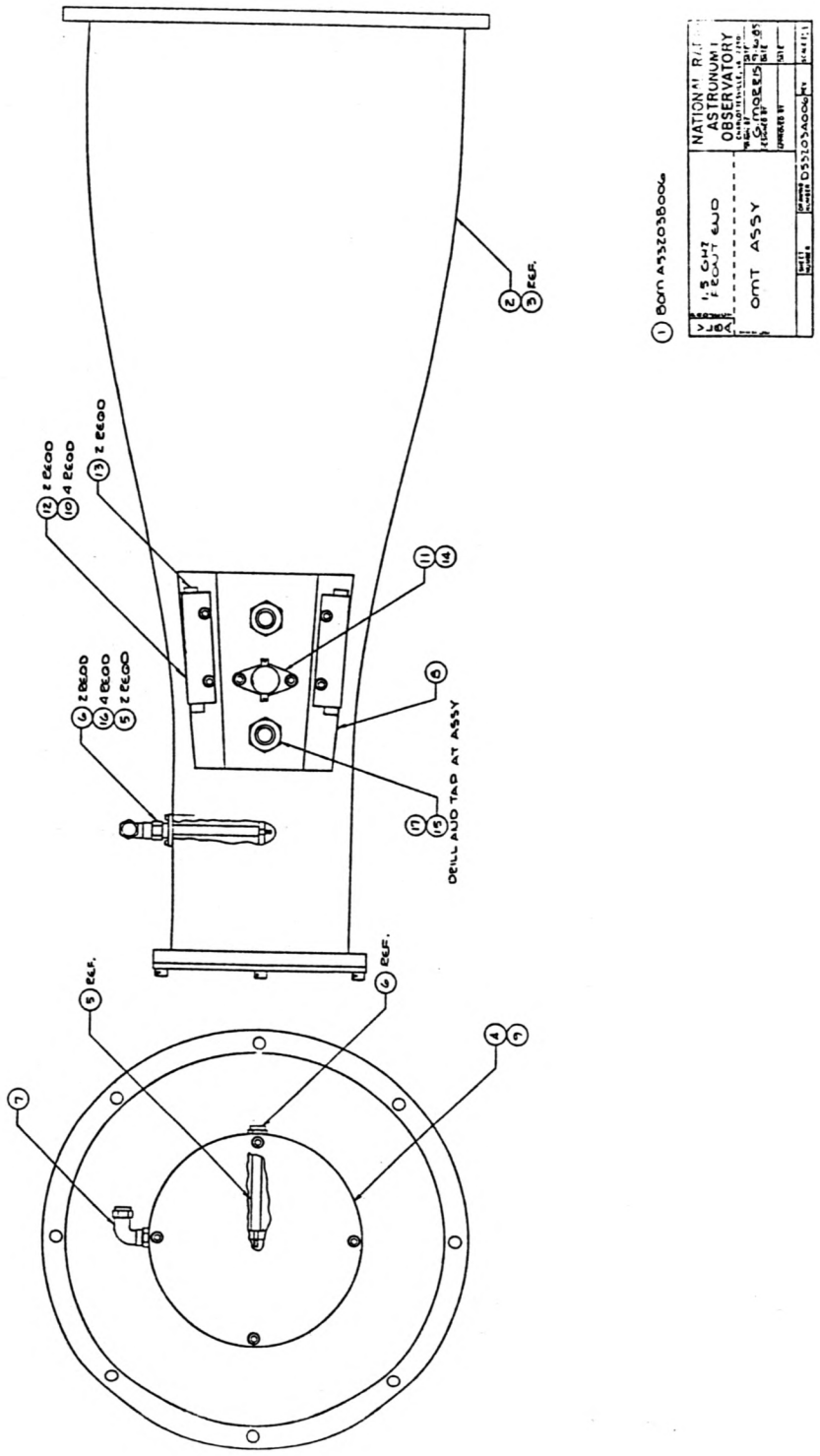
19 REF
BOM A53203B005

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES: ANGLES ± 3 PLACE DECIMALS (.XXX): ± 2 PLACE DECIMALS (.XX): ± 1 PLACE DECIMALS (.X): ±	VLBA PROJECT	1.5 GHz FRONT END	NATIONAL RADIO ASTRONOMY OBSERVATORY
MATERIAL:	TITLE	RF PLATE ASSY	DRAWN BY G MORRIS DATE 9-3-86
FINISH:			DESIGNED BY DATE
NEXT ASSY / USED ON			APPROVED BY DATE
	SHEET NUMBER	DRAWING NUMBER C53203A005 REV.	SCALE 1:1

Sheet 1 of 1

BILL OF MATERIAL: A53203B005	TITLE: RF Plate Assembly/1.5 GHz FE	APPROVED BY/DATE:	PREPARED BY/DATE: R. Norrod 6/13/85	REV: DATE: B 9/9/86

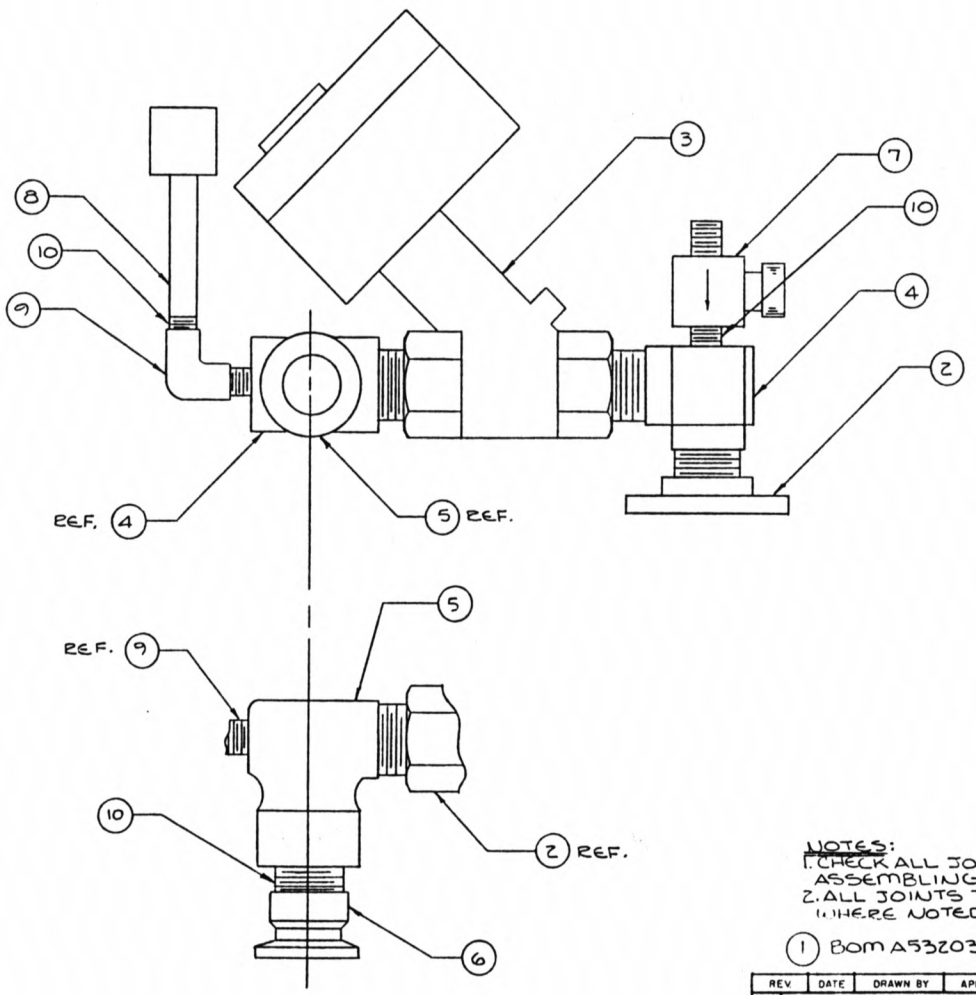
Item	Qty. Req.	Description	Designation	P/N	Suggested Manufacturer
1.	1	RF Plate		B53203M021	NRAO
2.					
3.	2	Bandpass Filter	FL1, FL2	6B380-1550 /570-OP/0	K&L Microwave
4.	2	RF Amplifier	A3, A4	A53203N001	
5.	1	Cal Amplifier	A5	53203A008	NRAO
6.	1	Ambient Temp Sensor	TS1	C53203A010	NRAO
7.	2	Noise Source: Option SMA-F Output	NS1, NS2	NC3203G	NoiseCom
8.	1	Directional Coupler, 6 dB	DC4	2020-6604 -06	Omni Spectra
9.	1	Directional Coupler, 10 dB	DC5	2020-6605 -10	Omni Spectra
10.	2	Attenuator, 3 dB	AT1, AT2	292-3	Midwest MW
11.	2	Attenuator, Select in Test	AT3, AT4	292-X	Midwest MW
12.	1	Mounting Plate, Amplifier		A53203M022	NRAO
13.	1	Mounting Bracket, Noise Source		A53203M023	NRAO
14.	2	SMA Male-Male Adapter		218	Omni Spectra
15.	1	Connector, Power		DE-9P	Cinch
16.	1	Connector, Backshell		DE50904-1	Cannon
17.	16	Connector, SMA-141 Cable		201-1A	Omni Spectra
18.	AR	141 Semi-Rigid Coax			
19.	REF	Dewar System Block Diagram		B53203K001	NRAO
20.	REF	Assembly Drawing, RF Plate		53203A005	


(1) BOM A5320380004
NATIONAL RADIO ASTRONOMY OBSERVATORY
1.5 GHz FEED/FUD
OMT ASSY
(2) (3) REF.
(12) 2 REQD
(10) 4 REQD
(13) 2 REQD
(4) 2 REQD
(14) 4 REQD
(5) 2 REQD
(11) (14)
(6)
(17) (15) DRILL AND TAP AT ASSY
(8) REF.
(6) REF.
(7)
(4) (1)

Page No. 1 A53203B006-OMT ASSY
11/05/85

BILL OF MATERIALS
National Radio Astromomy Observatory
VLBA

ITEM NUM.	REF. DES.	MANUFACTURER	MANUFACTURER'S PART NUMBER	DESCRIPTION	QUAN. REQ.
1		NRAO	A53203B006	BOM OMT ASSY	0
2		A.J. TUCK	E53203M001	OMT L-BAND	1
3		A.J. TUCK	D53203M002	OMT RIDGE DETAIL	REF.
4		NRAO	A53203M007	OMT COVER PLATE	1
5		NRAO	A53203M008	OMT PROBE AND SUPPORT	2
6		EMC	6620	SMA MALE CONNECTOR	2
7		SOLITRON MICROWAVE	2994-6002	SMA SWEPT RIGHT ANGLE	1
8		NRAO	B53203M030	OMT STRAP BRACKET	1
9			#6-32 X 3/8 LG	S.S. SHCS	4
10			#6-32 X 1/2 LG	S.S. SHCS	4
11		ELMWOOD SENSORS	2450-B201A-T107	SAFETY THERMOSTAT	1
12		NRAO	A53206M056	HEATER CLAMP	2
13		HOTWATT	SC252.25	HEATER UNIT	2
14			#6-32 X 1/4 LG	S.S. SHCS	2
15			3/8-24 X 3/8 LG	S.S. HEX HEAD SCREW	2
16			#2-56 X 1/8 LG	S.S. SHCS	4



NOTES:
1. CHECK ALL JOINTS FOR LEAKS AFTER ASSEMBLING.
2. ALL JOINTS TO BE EPOXIED EXCEPT WHERE NOTED BY ITEM 10.

(1) BOM A53203B002

REV.	DATE	DRAWN BY	APPRV'D BY	DESCRIPTION

VLBA PROJECT	1.5 GHz FRONT END	NATIONAL RADIO ASTRONOMY OBSERVATORY, CHARLOTTESVILLE, VA. 22901
TITLE	VACUUM ASSY	DRAWN BY G. MORRIS — DATE 9-13-85
		DESIGNED BY — DATE
		APPROVED BY — DATE
SHEET NUMBER	DRAWING NUMBER C53203A007	REV — SCALE ~

Page No. 1 A53203B007-VACUUM ASSY
11/05/85

BILL OF MATERIALS
National Radio Astromomy Observatory
VLBA

ITEM NUM.	REF. DES.	MANUFACTURER	MANUFACTURER'S PART NUMBER	DESCRIPTION	QUAN. REQ.
1		NRAO	A53203B007	BOM VACUUM ASSY	0
2		NRAO	A53203M009	VACUUM FEEDTHRU	1
3		NRAO	B53206A008	SOLENOID ASSY	1
4		NRAO	A53206M029	ME FITTING REWORK	1
5		NRAO	A53203M031	SE FITTING REWORK	1
6		NRAO	A53206M050	VACUUM PORT FITTING	1
7		NUPRO	B-2P4T2	VENTING VALVE	1
8		TELEDYNE HASTINGS	DV-6R	VACUUM GAUGE TUBE	1
9		CAJON	B-2-SE	1/8 NPT STREET ELBOW	1
10				TEFLON TAPE	AR
11				EPOXY	AR

Sheet 1 of 1

BILL OF MATERIAL: A53203B008	TITLE: Solar Cal Amplifier/1.5 FE	APPROVED BY/DATE:	PREPARED BY/DATE: R.Norrod 6/13/85	REV: DATE:

Item	Qty. Req.	Description	Designation	P/N	Suggested Manufacturer
1.	2	Amplifier Module		UTO-2001	Avantek
2.	1	Circuit Board		TB-2	Avantek
3.	1	Case, SMA Female Connectors		TC-2	Avantek
4.	1	Voltage Regulator		78M15C	
5.					
6.					
7.					
8.					
9.					
10.					
11.					
12.					
13.					
14.					
15.					
16.					
17.					
18.					
19.					
20.	REF	Assembly, Solar Cal Amplifier		53203A008	NRAO

SPECIFICATION: A53203N001 Date: 7 June 1985

TITLE: **1.5 GHz FRONT END POST AMP** Rev. B: 1 Aug 1985

PROJECT: VLBA Page 1 of 2

PREPARED BY: Roger D. Norrod Approved by: _____

1.0 General

This specification sets forth the requirements for a microwave transistor amplifier. The amplifier will be used in a radio astronomy receiver system.

2.0 Electrical Specifications (18°C-28°C)

Frequency Range	1.25-1.85 GHz
Average Gain	17-20 dB
Gain Ripple	± 0.5 dB max
Noise Figure (23°C)	3.5 dB max
Input/Output VSWR (50 ohm)	1.5:1 max
Output 1 dB Compression	+5 dBm min

2.1 Stability

The unit shall be unconditionally stable. It shall exhibit no spurious output signals when a short circuit is connected to the input or output port and the short position varied over a six inch distance.

The unit shall exhibit no out-of-band (DC to 6 GHz) gain responses more than 6 dB above the average in-band gain.

Variation of the average gain with temperature over the range 18°C to 28°C shall be less than 0.03 dB/°C.

Variation of gain with bias voltages shall be less than 0.01 dB/100 mV.

2.2 Power Requirements

The voltage available to operate the unit is +15 V ± 0.5 V. The unit shall meet the gain-bias stability requirement in 2.1 over this voltage range.

3.0 Environmental Specifications

Unless otherwise stated above, the unit shall meet the performance specifications under the following conditions:

Temperature	0-50°C
Humidity	0-95%

SPECIFICATION: A53203N001 Date: 7 June 1985

TITLE: **1.5 GHz FRONT END POST AMP** Rev. B: 1 Aug 1985

PROJECT: VLBA Page 2 of 2

PREPARED BY: Roger D. Norrod Approved by: _____

3.0 Continued:

The unit performance shall not be degraded after being subjected to storage temperatures of -40°C to 60°C and shocks of 30 G, 11 msec.

4.0 Mechanical Specifications

The amplifier package dimensions, exclusive of connectors, shall be 2.0" x 1.0" x 1.0" maximum. Mounting holes shall be provided on one amplifier face.

The input and output connectors shall be SMA jacks.

Solder terminals shall be provided for the DC voltage and ground.

5.0 Testing

The vendor shall certify that the unit meets or exceeds all performance requirements set forth in this specification. The unit will be tested upon receipt at NRAO, prior to acceptance.

VLBA 1.5 GHZ FRONT END

CARD CAGE

WIRING LIST

Note:

Unless noted all wire 22 AWG stranded. Noted types are:

Jacketed 3-wire 22 AWG cable; BOM Item 27.

Jacketed twisted pair 18 AWG cable; BOM Item 28.

Jacketed 3-wire 18 AWG; BOM Item 11.

Jacketed 25-wire 22 AWG; BOM Item 29. Strip the jacket off and use for wires going to J3.

18 AWG Stranded Wire.

18 AWG Solid Bus Wire

Ref: Bill Of Materials A53203B004
Wiring Diagram B53203W002

CARD SLOT WIRING LIST

SYSTEM: VLBA 1.5 GHZ FRONT END DWG. NO.: A53203W001
ASS'Y: CARD CAGE DATE: October 23, 1985
SLOT: 1 BY: R. D. NORROD
CARD: SPARE SHEET: 2

PIN	FUNCTION	TO	COLOR	PIN	FUNCTION	TO	COLOR
A	GROUND	BUS	BUS	1	GROUND	J5-1 BUS	0XX
B	+15 VOLTS	BUS	BUS	2	+15 VOLTS	J5-2 BUS	2XX
C	-15 VOLTS	BUS	BUS	3	-15 VOLTS	J5-3 BUS	4XX
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: 'BUS' SIGNIFIES 18 AWG SOLID BUS WIRE STRAPPED THROUGH ALL SEVEN CARD SLOT CONNECTORS.

CARD SLOT WIRING LIST

SYSTEM: VLBA 1.5 GHZ FRONT END
ASS'Y: CARD CAGE
SLOT: 2
CARD: SPARE

DWG. NO.: A53203W001
DATE: October 23, 1985
BY: R. D. NORROD
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 1.5 GHZ FRONT END
ASS'Y: CARD CAGE
SLOT: 3
CARD: MONITOR CARD

DWG. NO.: A53203W001
DATE: September 3, 1986
BY: R. D. NORROD
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	J2-13 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 J17-8	92X	10			
M	AC CURRENT MON	J2-6 J4-1	1XX	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* J3-22	5XX	16			
U	SPARE MON	J2-12	1XX	17	X-CPU	J5-6	7XX
V				18	X-OUTPUT	S7-4	7XX
W	MANUAL MON	J2-22	902	19	C-CPU	J5-7	9XX
X	LED +15 VOLTS	S3-B*	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: CONNECT R3 (510 OHM, 1/2 WATT CARBON, BOM ITEM 9) ACROSS PINS S3-T,X.
KEY BETWEEN PINS 3 AND 4.

CARD SLOT WIRING LIST

SYSTEM: VLBA 1.5 GHZ FRONT END
ASS'Y: CARD CAGE
SLOT: 4
CARD: RCP FET BIAS

DWG. NO.: A53203W001
DATE: January 17, 1986
BY: R. D. NORROD
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 S4-5	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: SEE NOTE ON SHEET 1 PERTAINING TO CONNECTIONS TO J3. KEY BETWEEN PINS 4 AND 5.

CARD SLOT WIRING LIST

SYSTEM: VLBA 1.5 GHZ FRONT END
ASS'Y: CARD CAGE
SLOT: 5
CARD: LCP FET BIAS

DWG. NO.: A53203W001
DATE: January 17, 1986
BY: R. D. NORROD
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	S5-5 S3-R	94X
J	QUALITY GROUND	S4-J CHS GND	5XX	8			
K	DRAIN 4	J3-12	8XX	9			
L	DRAIN 3	J3-10	1XX	10			
M	DRAIN 2	J3-8	23X	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: SEE NOTE ON SHEET 1 PERTAINING TO CONNECTIONS TO J3. KEY BETWEEN PINS 4 AND 5.

CARD SLOT WIRING LIST

SYSTEM: VLBA 1.5 GHZ FRONT END
ASS'Y: CARD CAGE
SLOT: 6
CARD: SENSOR CARD

DWG. NO.: A53203W001
DATE: January 17, 1986
BY: R. D. NORROD
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 SENS A	J2-14	93X	15			
T	TEMP SENS B	N.C.		16			
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 27.
TERMINATE EACH IN ONE OF BOM ITEM 19; P15 AND P16. CABLE LENGTH TO BE DETERMINED IN ASSEMBLY.
SEE NOTE ON SHEET 1 PERTAINING TO CONNECTIONS TO J3.
KEY BETWEEN PINS 5 AND 6.

CARD SLOT WIRING LIST

SYSTEM: VLBA 1.5 GHZ FRONT END
ASS'Y: CARD CAGE
SLOT: 7
CARD: CONTROL CARD

DWG. NO.: A53203W001
DATE: September 3, 1986
BY: R. D. NORROD
SHEET: 8

PIN	FUNCTION	TO	COLOR	PIN	FUNCTION	TO	COLOR
A	GROUND	BUS CHS GND	BUS 0XX*1	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	2XX*1
S	SOLENOID SUPPLY	P14-S	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	TAN
W	DEWAR HEATER	J3-24	1XX	19	DEWAR HEATER RTN	J3-25	TAN
X	150VAC IN, PHASE 1	J1-3	0XX*1	20	150VAC RTN IN	J1-2	9XX*1
Y	150VAC REFR, PHA 1	P12-3	0XX*3	21	REFR RTN	P12-2	9XX*3
	TIMER	P13-1	0XX*4		TIMER RTN	P13-2	2XX*4
Z				22			

*1 - USE 18 AWG STRANDED WIRE. TWIST S7-U,X,20.
*2 - USE TWO CONDUCTOR JACKETED CABLE; BOM ITEM 28. CONNECT RED CONDUCTOR TO R1-1. OPPOSITE END TERMINATED IN P14; BOM ITEM 16.
*3 - USE THREE CONDUCTOR JACKETED CABLE; BOM ITEM 11. OPPOSITE END TERMINATED IN P12; BOM ITEM 15.
*4 - USE TWO CONDUCTOR JACKETED CABLE; BOM ITEM 28. OPPOSITE END TERMINATED IN P13; BOM ITEM 16.
LENGTHS OF CABLES TO BE DETERMINED IN ASSEMBLY. KEY BETWEEN PINS 6 AND 7.
SEE NOTE ON SHEET 1 PERTAINING TO CONNECTIONS TO J3. TWIST S7-W,19.

25 PIN D-CONNECTOR WIRING LIST

SYSTEM: VLBA 1.5 GHZ FRONT END
ASS'Y: CARD CAGE
TYPE: BULKHEAD (BOM ITEM 6)
SEX: FEMALE (SOCKET)
FUNC'T: FRONT END MONITOR

DWG. NO.: A53203W001
DATE: September 3, 1986
BY: R. D. NORROD
SHEET: 9
DESIGNATION: J2

PIN	FUNCTION	TO	COLOR	PIN	FUNCTION	TO	COLOR
1	VAC PUMP MONITOR	S3-F	8XX	14	TEMP SENS A	S6-S	93X
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	1XX	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	5XX	24	C-MON	S3-13	9XX
12	SPARE MON	S3-U	1XX	25	NOT H-MON	S3-14	3XX
13	QUALITY GROUND	S3-E	5XX				

SPECIAL INSTRUCTIONS:

25 PIN D-CONNECTOR WIRING LIST

SYSTEM: VLBA 1.5 GHZ FRONT END
ASS'Y: CARD CAGE
TYPE: BULKHEAD
SEX: FEMALE (SOCKET)
FUNC'T: DEWAR POWER/MONITOR

DWG. NO.: A53203W001
DATE: September 3, 1986
BY: R. D. NORROD
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	23X	21	DEWAR GROUND	GND BUS	0XX
9	LCP GATE 3	S5-E	9XX	22	LED	S3-T	5XX
10	LCP DRAIN 3	S5-L	1XX	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	TAN
13	RCP GATE 1	S4-H	90X				

SPECIAL INSTRUCTIONS:
SEE NOTE ON SHEET 1 PERTAINING TO CONNECTIONS TO J3.
TWIST J3-24,25.

9 PIN D-CONNECTOR WIRING LIST

SYSTEM: VLBA 1.5 GHZ FRONT END
ASS'Y: CARD CAGE
TYPE: BULKHEAD
SEX: FEMALE (SOCKET)
FUNC'T: AUXILIARY MONITOR

DWG. NO.: A53203W001
DATE: October 25, 1985
BY: R. D. NORROD
SHEET: 11
DESIGNATION: J4

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

SPECIAL INSTRUCTIONS:

25 PIN D-CONNECTOR WIRING LIST

SYSTEM: VLBA 1.5 GHZ FRONT END
ASS'Y: CARD CAGE
TYPE: BULKHEAD
SEX: MALE PINS
FUNC'T: DC POWER AND CONTROL

DWG. NO.: A53203W001
DATE: September 3, 1986
BY: R. D. NORROD
SHEET: 12
DESIGNATION: J5

PIN	FUNCTION	TO	COLOR	PIN		FUNCTION	TO	COLOR
1	GROUND	S1-1	0XX	14	ID	F0	GND BUS	0XX
2	+15 VOLT SUPPLY	S1-2	2XX	15		F1	N.C.	
3	-15 VOLT SUPPLY	S1-3	4XX	16		F2	GND BUS	0XX
4				17		F3	GND BUS	0XX
5	NOT-PA (PARITY)	N.C.		18	ID	SN0	*1	
6	X (EVAC CONTROL)	S3-17	7XX	19		SN1	*1	
7	C (COOL CONTROL)	S3-19	9XX	20		SN2	*1	
8	H (NO HEAT CTRL)	S3-21	3XX	21		SN3	*1	
9				22		SN4	*1	
10				23		SN5	*1	
11	CAL CONTROL	J17-5	8XX	24	ID	MOD0	*2	
12	HIGH CAL CONTROL	J17-6	8XX	25		MOD1	*2	
13								

SPECIAL INSTRUCTIONS:
*1 - SERIALIZE CARD CAGE ASSEMBLY BY GROUNDING APPROPRIATE BITS, SN0-SN5.
*2 - INDICATE CURRENT MODIFICATION BY GROUNDING APPROPRIATE BITS, MOD0-MOD1.

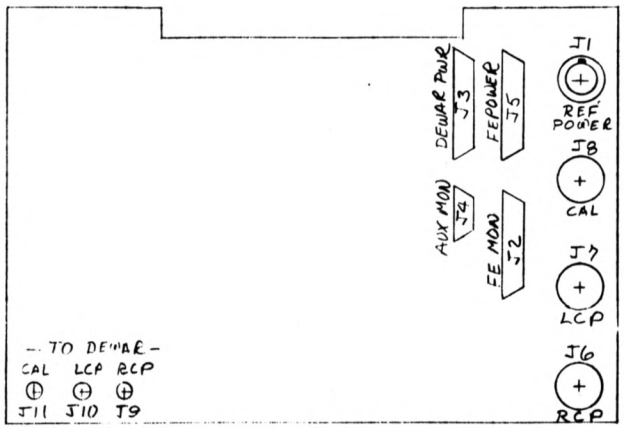
9 PIN D-CONNECTOR WIRING LIST

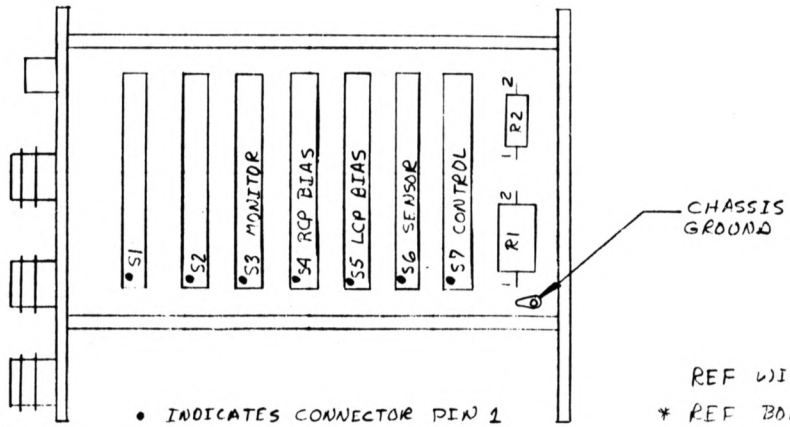
SYSTEM: VLBA 1.5 GHZ FRONT END
ASS'Y: CARD CAGE
TYPE: BULKHEAD
SEX: FEMALE (SOCKET)
FUNC'T: RF PLATE CONTROL

DWG. NO.: A53203W001
DATE: October 25, 1985
BY: R. D. NORROD
SHEET: 13
DESIGNATION: J17

PIN	FUNCTION	TO	COLOR	PIN	FUNCTION	TO	COLOR
1	GROUND	GND BUS	0XX	6	HIGH CAL CONTROL	J5-12	8XX
2	+15 VOLTS	+15 BUS	2XX	7	CAL RTN	GND BUS	0XX
3	-15 VOLTS	-15 BUS	4XX	8	300K TEMP MON	S3-L	92X
4	GROUND	GND BUS	0XX	9			
5	LOW CAL CONTROL	J5-11	8XX				

SPECIAL INSTRUCTIONS:



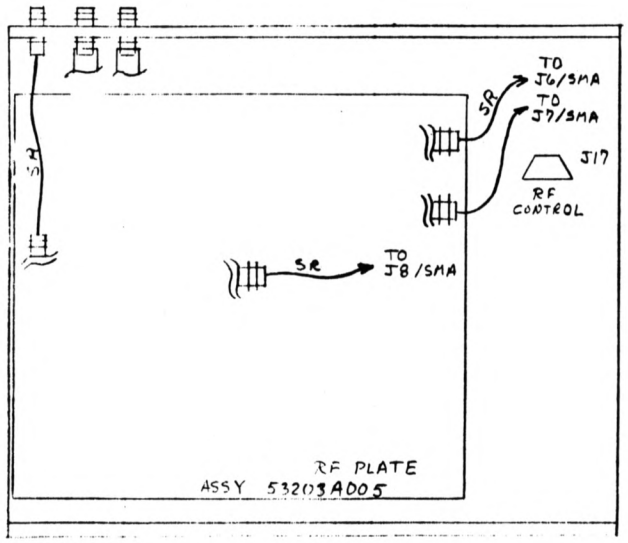


• INDICATES CONNECTOR PIN 1

SR INDICATES .141 SEMI-RIGID COAX WITH APPROPRIATE CONNECTORS

REF WIRING LIST A53203W001

* REF BOM A53203B004



DESG	FUNCTION	TYPE	30M * ITEM
J1	REFRIGERATOR POWER INPUT	DM19606-3P	14
J2	FRONT END MONITOR	DBM-25S	6
J3	DEWAR POWER/MONITOR	DBM-25S	6
J4	AUXILIARY MONITOR	DE-9S	21
J5	FRONT END POWER	DBM-25P	5
J6	RCP RF OUT	N/SMA ADP	12
J7	LCP RF OUT	N/SMA ADP	12
J8	PHASE CAL IN	N/SMA ADP	12
J9	RCP RF IN	SMA/SMA	22
J10	LCP RF IN	SMA/SMA	22
J11	CAL OUT	SMA/SMA	22
P12	REFRIGERATOR POWER OUT	DM3702-3S	15
P13	ETI POWER	MOLEX	16
P14	VACUUM SOLENOID POWER	MOLEX	16
P15	PUMP VACUUM SENSOR	OCTAL	19
P16	DEWAR VACUUM SENSOR	OCTAL	19
J17	RF PLATE CONTROL	DE-9S	21

H. T. HALL 4-

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

NATIONAL RADIO ASTRONOMY OBSERVATORY
GREEN BANK, W. VA. 24944

PROJ: VLBA 1.5 GHZ FE
TITLE: CARD CAGE WIRING DIAGRAM
MATERIAL:
FINISH:
DRAWN BY: RON DATE: 10/7/
DESIGNED BY: RON DATE:
APPROVED BY: DATE:
SHEET NUMBER: 1/1
DRAWING NUMBER: B53203W002
REV.
SCALE:

Sheet 1 of 2

BILL OF MATERIAL:	TITLE:	APPROVED BY/DATE:	PREPARED BY/DATE:	REV: DATE:
A53200B007-2	Model 350 Ref. Power Supply		RDN 08/12/86	

Item	Qty. Req.	Description	Designation	P/N	Suggested Manufacturer
1.	1	150 VAC Power Supply Case		D53200M003	NRAO
2.	1	Cover - Power Supply		B53200M004	NRAO
3.	1	Heat Sink		B53200M035	NRAO
4.	AR	18 AWG Wire			Alpha
5.	AR	22 AWG Wire			Alpha
6.	AR	Wire Ties		CT-3B	Caltronics
7.	1	Fuse Molder		341001	Little Fuse
8.	1	Fuse 4A		MTH-4	Buss
9.	1	Bulkhead - AC Connector Male	AC In	MS3102A14S -01P	Amphenol
10.	1	Bulkhead - AC Connector Female	AC Out	MS3102A14S -01S	Amphenol
11.	1	Mating Connector		MS3106A14S -01P	Amphenol
12.	1	Mating Connector		MS3106A14S -01S	Amphenol
13.	2	Back Shell		97-3057-6	Amphenol
14.	1	Bulkhead-4 Pin Female	Mon Out	126-233	Amphenol
15.	1	Mating Connector- 4 Pin Male		126-214- 1000	Amphenol
16.	1	Back Shell Assembly		126-215	Amphenol
17.	14	Crimp-On Spade Terminal		T-2084	Waldon
18.	4	Slide-On Crimp Terminals		ST-2188	Waldon
19.	2	#8 Solder Lugs			Waldon
20.	AR	Heat Sink Compound		340	Dow Corning

BILL OF MATERIAL:	TITLE:	APPROVED BY/DATE:	PREPARED BY/DATE:	REV: DATE:
A53200B007-2	Model 350 Ref. Power Supply		RDN 08/12/86	

Item	Qty. Req.	Description	Designation	P/N	Suggested Manufacturer
21.	2	Resistor 80Ω 50W		RH-50	Dale
22.	1	Transformer		300-00	Todd/Systems
23.	1	Current Transducer		CTI-1	Ohio-Electronics
24.	1	Capacitor 7μF 330 VAC		RPN3307Z	Mallory
25.	1	Trimmer Capacitor		Selected in Test	Sprague
26.	1	Resistor 10K 1%		RN55C-1002	Dale
27.					
28.	1	10-32x1/2 Binder Head Screws			All-Metal
29.	12	4-40x3/8 Binder Head Screws			All-Metal
30.	8	4-40 Nuts			All-Metal
31.	12	#4 Flat Washers			All-Metal
32.	12	#4 Lock Washers			All-Metal
33.	4	4-40x1/2 Binder Head Screws			All-Metal
34.	11	8-32 Nuts			All-Metal
35.	11	#8 Lock Washers			All-Metal
36.	11	#8 Flat Washers			All-Metal
37.	1	#10 Lock Washers			All-Metal
38.	1	#10 Flat Washers			All-Metal
39.	1	Power Supply Label Artwork		A53200I012	NRAO
40.	REF	Schematic, 350 Power Supply		B53203W004	NRAO

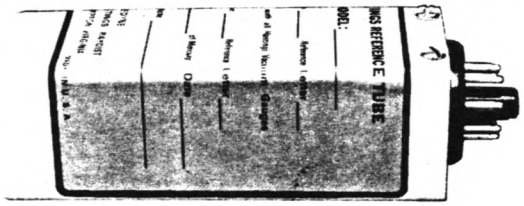
APPENDIX III

Manufacturers' Data Sheets

TELEDYNE HASTINGS-RAYDIST HAMPTON, VA (804) 723-6531 JUNE 85

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^{-6} 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!

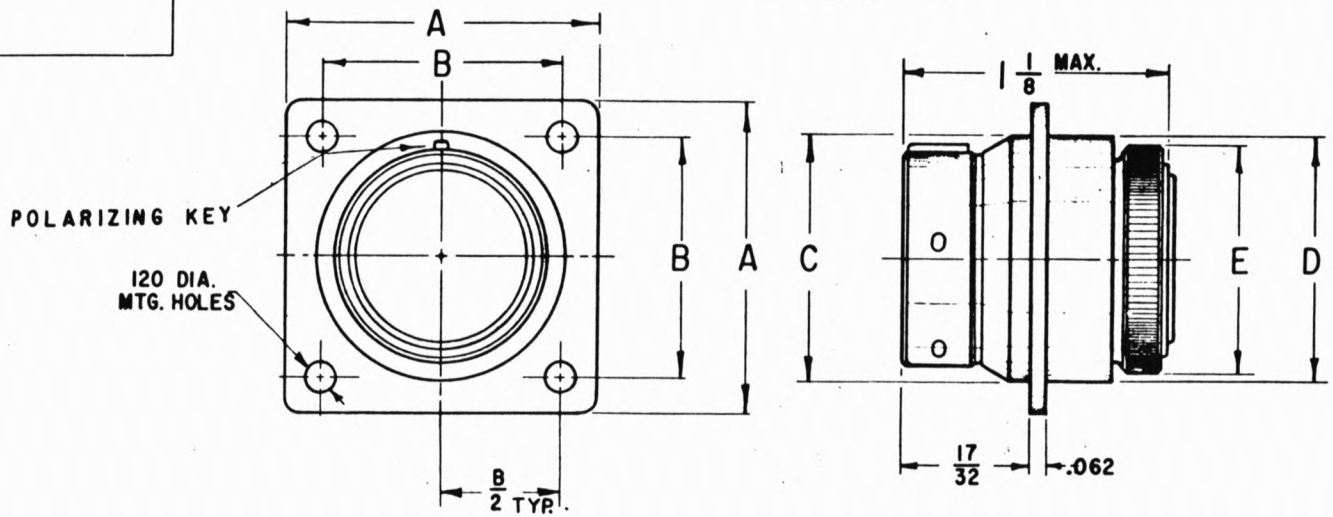
INSTRUMENT SERIES	RANGE	METAL TYPE	BASE COLOR	PYREX TYPE	"R" SERIES TYPE	STAINLESS STEEL TYPE
NV-8	10^{-5} torr 10^{-2} torr	DV-8	Green	DV-31	—	—
VT-5, CVT-15/25	0-100 μ Hg	DV-5M	Red	DV-18	—	—
VT-6, CVT-16/26, DAV-6, TV-4A, MRV-6, TV-47	0-1000 μ Hg	DV-6M	Yellow	DV-20	DV-6R	DV-36
VH-3, CVH-3/23	0-5 torr	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^{-6} to 10^{-2} torr. Replacement cathode-anode assemblies are available.

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

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 ±0° 30'0"

MATERIAL

FINISH

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

(ENVELOPE)

RECEPTACLE,
MINIATURE SQUARE
FLANGE MOUNTING TYPE
DM TYPE

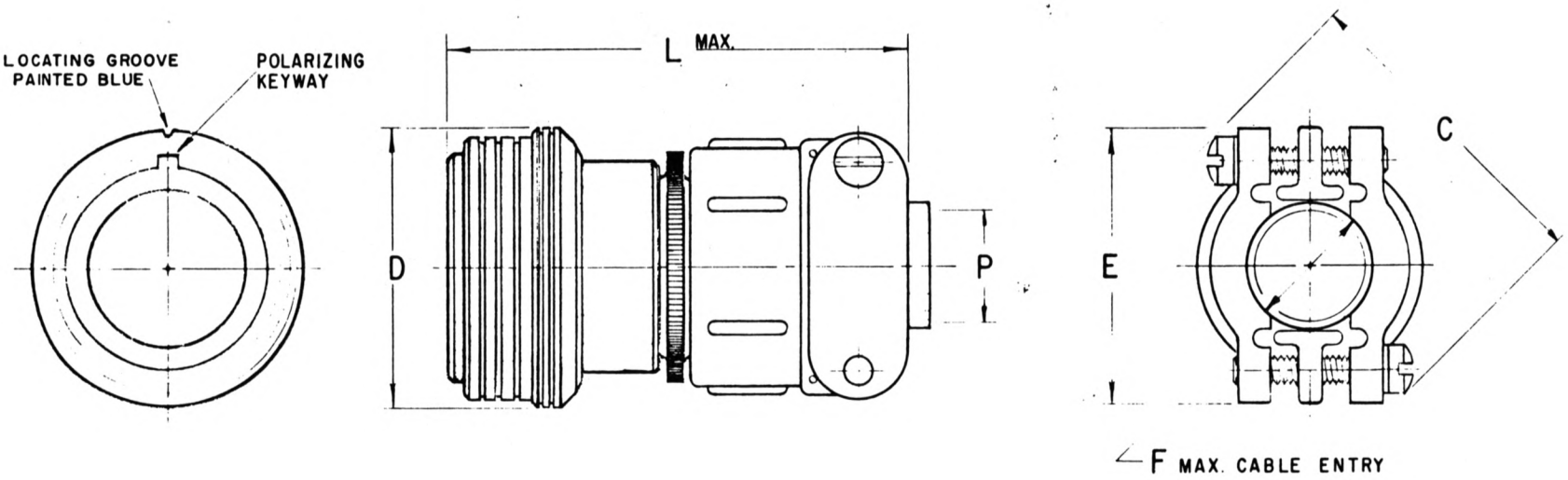
SCALE | WT

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

(c) 1962, THE DEUTSCH COMPANY

B DM 9606-* P S

DWG SIZE | CODE 11139 | SHEET



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
DM 9702-12 PS	1 11/32	1 1/16	1 1/16	7/16	2 5/32	5/16	.0758
DM 9702-19 PS	1 1/2	1 3/16	1 5/32	9/16	2 7/32	7/16	.0806
DM 9702-27 PS	1 19/32	1 23/64	1 1/4	5/8	2 7/32	9/16	.1036
DM 9702-37 PS	1 7/8	1 1/2	1 15/32	3/4	2 7/32	5/8	.1113
DM 9702-61 PS	2 1/8	1 53/64	1 11/16	15/16	2 3/8	3/4	.1302 .1416 .1456 .1605 .2093 .2303 .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

NO.	CHANGE	BY	DATE

1. DE-BURR ALLSHARP 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

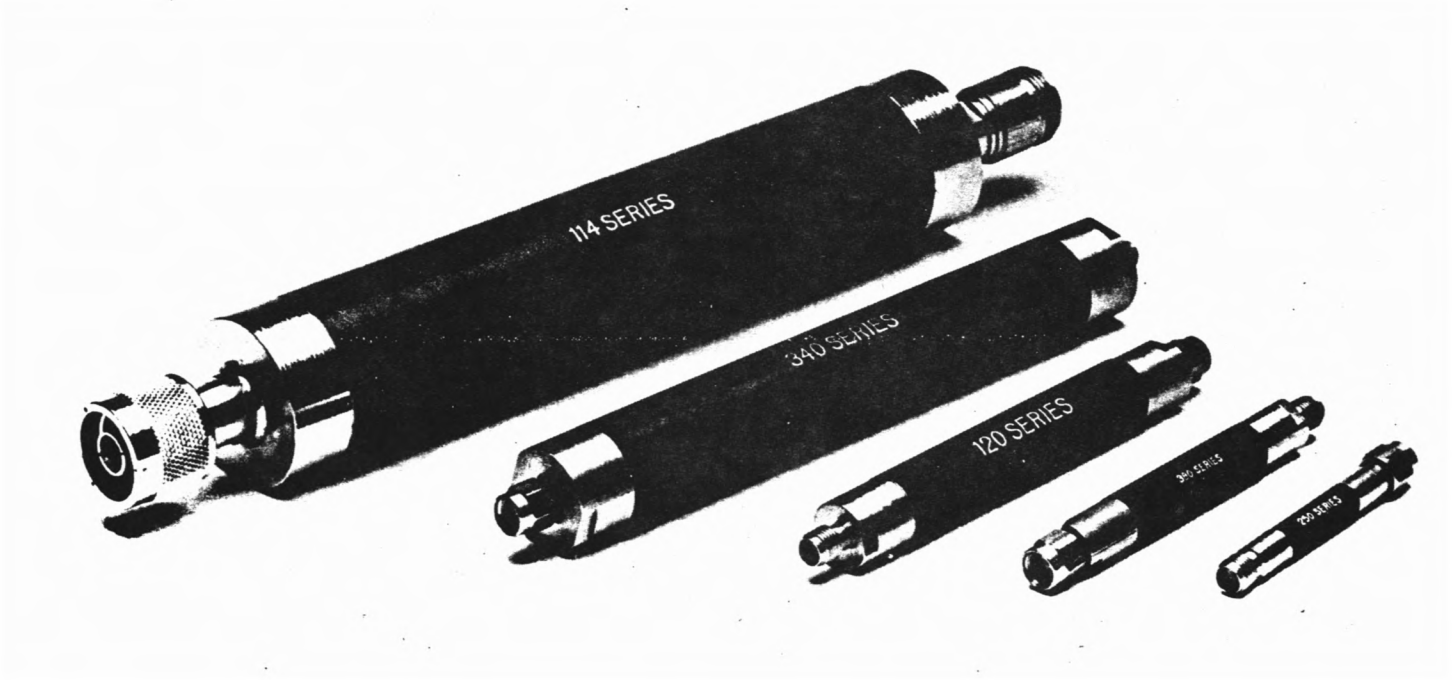
DRAWN	C. HASTINGS
CHECKED	
APPROVED	
DATE 4-22-60	CODE 11139

DM 9702-* PS

FORM 1695 F

JUNE 85

Tubular Filters Bandpass



Features

K&L tubular bandpass filters are available in five different series ranging in size from 1/4 inch diameter to 1-1/4 inch diameter to cover the frequency range of 15 MHz to 12.4 GHz. K&L uses a .05 Chebyshev design to yield low insertion loss in the passband and high attenuation levels in the stopband. The tubular filter design is made up of small resonating sections. These sections are capacitively coupled to provide the specified passband response and selectivity required. This coupling structure provides a DC block which is a major contributor in eliminating spurious response.

In choosing the best tubular filter to meet the user's needs, K&L recommends the use of the 1/2 inch diameter; model B120. This series has convenient size, broad frequency range, versatility of design, and is the most economical.

The two larger series, 3/4 inch diameter and 1-1/4 inch diameter, offer the user lower insertion loss, lower frequency operation, and higher power capabilities. The two smaller diameter filter series, 3/8 inch diameter and 1/4 inch diameter, offer the user miniature size and volume, higher frequency operation and less weight.

To Order

5	B120	-	300	/	30	-	0	/	OP
1	2		3		4		5		6

1. Number of sections
2. Model
3. Center frequency (MHz)
4. 3dB Bandwidth (MHz)
5. Input connector
6. Output connector

Mechanical

For sizes and connectors see page 18.

CAT 82-15M

Phone 301-749-2424 • TWX 710-864-9683

K&L MICROWAVE INCORPORATED

Bandpass Tubular Filters

Specification

Model	Diameter Inches	Frequency Range (MHz)	3dB BW (% of Center Freq.)	VSWR	No. of Sections	Impedance (Ohms (2))	Avg. Power (Watts)	Shock	Vibration	Humidity	Temp. Range
B250	1/4	160-12,400	3-70%(1)	1.5:1 or Less	2-8	50 75 100	2	30G, 11ms	10 G 5-2,000 Hz	0-95%	–55°C +85°C
B380	3/8	100-4,000	3-70%(1)	1.5:1 or Less	2-8	50 75 100	5	30G, 11ms	10 G 5-2,000 Hz	0-95%	–55°C to +85°C
B120*	1/2	50-3,900	1-70%	1.5:1 or Less	2-12	50 75 100	18	30G, 11ms	10 G 5-2,000 Hz	0-95%	–55°C to +85°C
B340	3/4	25-1,700	1-80%	1.5:1 or Less	2-12	50 75 100	40	30G, 11ms	10 G 5-2,000 Hz	0-95%	–55°C to +85°C
B114	1-1/4	15-1,000	1-80%	1.5:1 or Less	2-12	50 75 100	200	30G, 11ms	10 G 5-2,000 Hz	0-95%	–55°C to +85°C

*** Most versatile • Fits most applications • Immediate delivery**

(1) For frequency below 400 MHz, % 3 dB Bandwidth range from 3% to 40%
(2) 50 Ohms standard

LOSS CONSTANT VS. FREQUENCY VS. MODEL

	Center Frequency (MHz)										
Model	15 25	26 40	41 50	51 65	66 100	101 200	201 400	401 1,000	1,001 2,000	2,001 4,000	4,001 10,000
B250						5.0	5.0	4.0	3.5	3.0	2.5
B380						4.0	3.0	2.5	2.0	1.8	
B120				4.0	3.5	3.0	2.5	2.0	1.8	1.6	
B340		3.5	3.0	2.5	2.2	2.0	1.6	1.4	1.2		
B114	2.6	2.5	2.4	2.2	1.8	1.6	1.3	1.2			

Insertion Loss

To determine the maximum insertion loss of the tubular filter at center frequency the following formula is used.

Insertion loss at Center frequency =

$$\frac{(\text{Loss constant})\ (\text{No. of sections} + 1/2)}{\%\ 3\text{dB BW}} + 0.2$$

EXAMPLE:

Center frequency = 500 MHz
3dB Bandwidth = 80 MHz
Number of sections = 5
Filter model: B120
Find the insertion loss at Center frequency
From the table the Loss constant is shown to be 2.0
Number of sections = 5
The percent 3dB bandwidth is:

$$\frac{3\text{dB BW}\ (100)}{\text{Center freq.}} = \frac{(80)(100)}{500} = 16\%$$

By substituting in the formula we find the Insertion loss =

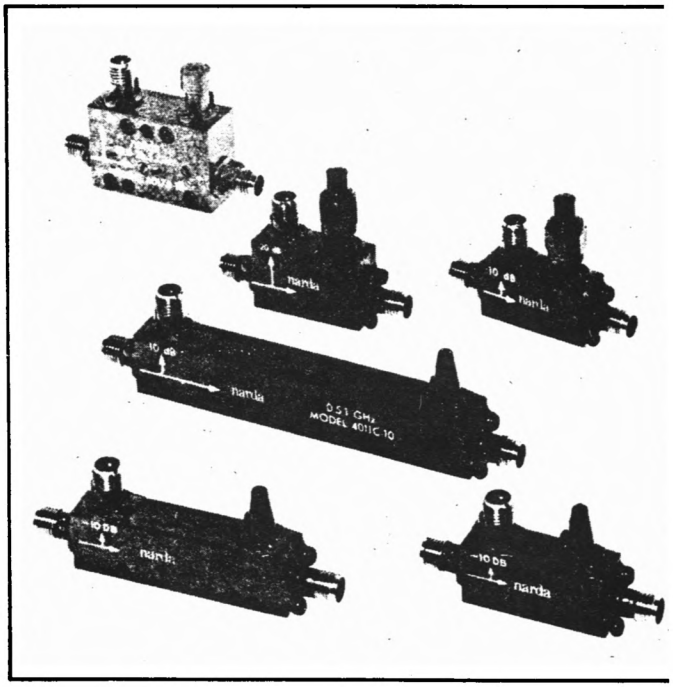
$$\frac{(2)\ (5 + 1/2)}{16} + 0.2 = 0.88\text{dB}$$

K&L MICROWAVE INCORPORATED
Phone 301-749-2424 • TWX 710-864-9683

NARDA MICROWAVE CO.
HAUPPAUGE, NY
(516) 231-1700
CAT! LIN 55K82

JUNE 85

MINIATURE STRIPLINE COAXIAL COUPLERS



DESCRIPTION

Narda's Model 4000 Series Miniature Coaxial Couplers represent a substantial reduction in size and weight compared to previous models. All units are of miniature stripline design with the exception of Model 4017B which is an airline coupler.

All units are rated conservatively and typically perform well above specifications. For instance, typical performance of the L-band unit, Model 4012C, is 35 dB (minimum) directivity; the X band unit, Model 4015C, has a directivity in excess of 23 dB. On a special order basis, units can be supplied with superior specifications in given models at extra cost.

Connectors are Narda SMA female stainless steel precision miniatures and mate with standard connectors in use for 0.141 inch coax line.

Refer to previous page for Narda's Model 4240 series of maximally flat miniature stripline coaxial couplers with multi-octave bandwidth coverage.

FEATURES

- **Smallest, Lightest Units Available from 0.5 to 26.5 GHz**
- **Highest Directivity, Lowest VSWR**
- **Sweep Frequency Tested**
- **Operational to 105°C Without Degradation (125°C Storage)**
- **Complies with MIL-C-15370**

SPECIFICATIONS

0.5-1 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
4011C-10	0.5-1	10±1.25	±0.75	0.20	0.80	25	1.15	1.15	50	5	3	1.16
4011C-20	0.5-1	20±1.25	±0.75	0.20	0.20	25	1.15	1.15	50	50	3	1.2

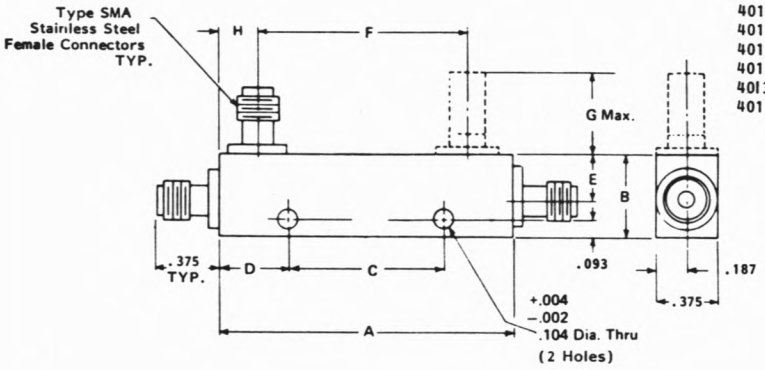
1-2 GHz

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	Weight Grams
4012C-6	1-2	6±1.00	±0.60	0.20	1.80	25	1.15	1.15	50	2	3	0.78	22
4012C-10	1-2	10±1.25	±0.75	0.20	0.90	25	1.10	1.10	50	5	3	0.78	22
4012C-20	1-2	20±1.25	±0.75	0.20	0.20	27	1.10	1.10	50	50	3	0.78	22
4012C-30	1-2	30±1.25	±0.75	0.20	0.20	27	1.10	1.10	50	50	3	0.81	23

2-4 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
4013C-6	2-4	6±1.00	±0.60	0.20	1.60	22	1.15	1.15	50	2	3	0.60	17
4013C-10	2-4	10±1.25	±0.75	0.20	0.70	22	1.15	1.15	50	5	3	0.60	17
4013C-20	2-4	20±1.25	±0.75	0.20	0.20	22	1.15	1.15	50	50	3	0.60	17
4013C-30	2-4	30±1.25	±0.75	0.20	0.20	22	1.15	1.15	50	50	3	0.60	17

*Frequency sensitivity is included in coupling.



Model No.	A	B	C	D	E	F	G	H
4011C-10	3.020	.541	1.500	.760	.320	2.520	.47	.250
4011C-20	3.004	.507	1.750	.627	.281	2.505	.75	.250
4012C-6,-10,-20	1.774	.507	.938	.418	.281	1.274	.47	.250
4012C-30	1.774	.541	.938	.418	.320	1.274	.47	.250
4013C-6,-10,-20	1.162	.507	.343	.406	.320	.662	.47	.250
4013C-30	1.162	.541	.344	.409	.320	.662	.47	.250

tol.: ±.015

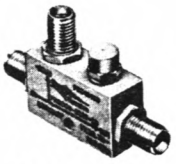
NOTE: Add .040 max to the length, width and height to allow for exterior finish.

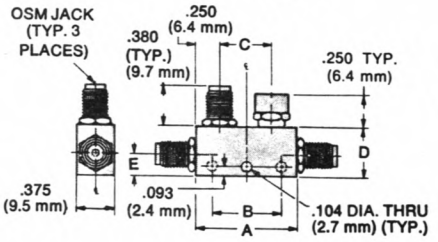
DIRECTIONAL COUPLERS

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 (INCLUDES FREQUENCY SENSITIVITY) (dB)	FREQUENCY SENSITIVITY (dB)	INSERTION LOSS max (dB)	DIRECTIVITY min (dB)	VSWR (max.) PRI LINE	VSWR (max.) SEC LINE	POWER (INPUT) AVG IN (W)	POWER (INPUT) AVG 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

						WEIGHT	
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.

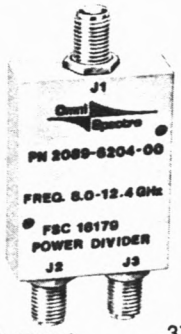
OMNI SPECTRA, INC.
MERRIMACK, NH
(603) 424-4111

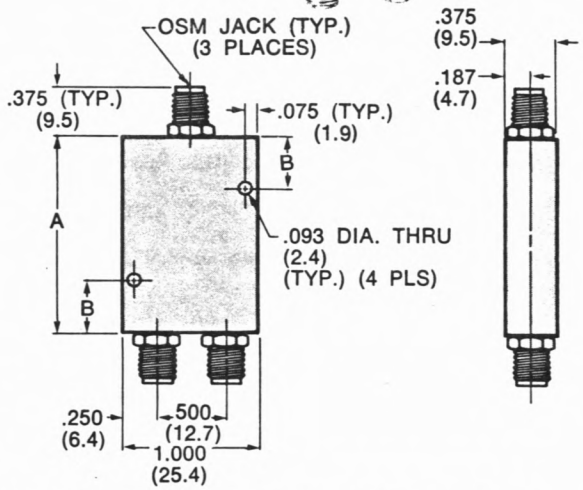
JUNE 85

POWER DIVIDERS
TWO-WAY • WILKINSON • ISOLATED

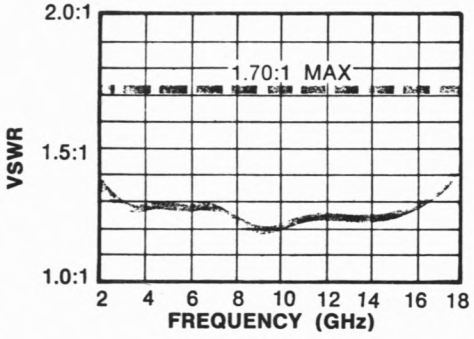
- **Excellent Amplitude And Phase Balance**
- **High Isolation Between Output Ports**
- **Low VSWR, Small Size And Light Weight**
- **Octave and Multi-Octave Frequency Coverage.**
- **Power: 10 Watts Input Maximum with Matched Terminations**
- **Meets MIL-E-5400 and MIL-E-16400 Environments**

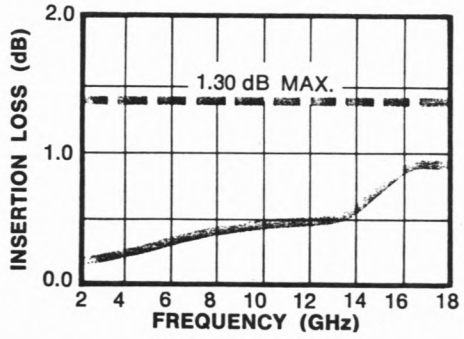
This series of two-way, in-phase stripline power dividers demonstrates excellent performance as well as small size and light weight. These octave and multi-octave power dividers have high isolation, low VSWR and excellent amplitude and phase balance. Their rugged construction meets MIL-E-5400 environmental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

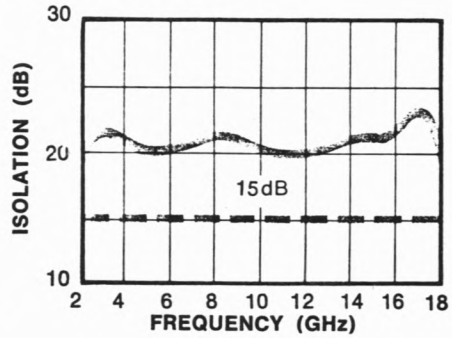




TYPICAL PERFORMANCE PART NO. 2089-6208-00







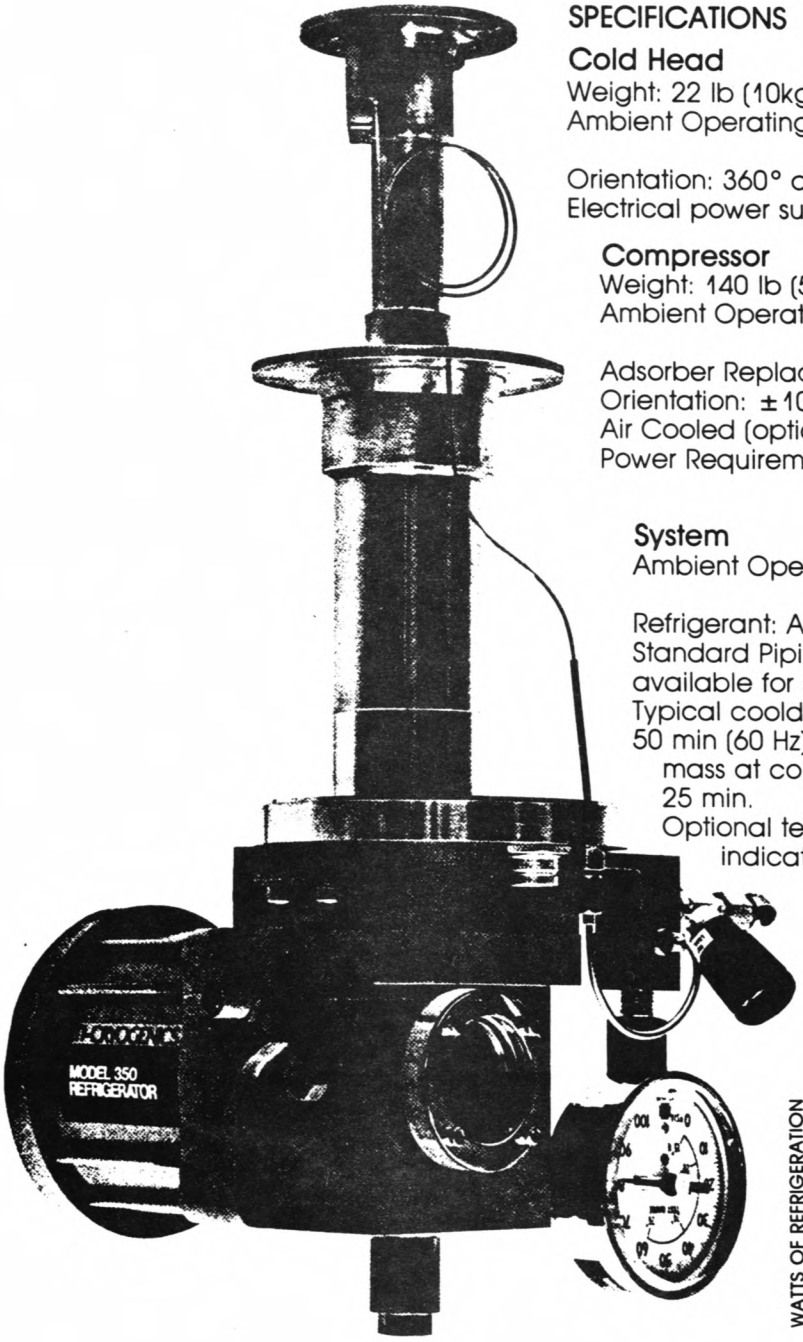
SPECIFICATIONS

PART NO.	FREQUENCY RANGE (GHz)	VSWR (max.)	ISOLATION dB (min.)	INSERTION LOSS dB (max.)	OUTPUT UNBALANCE: AMP. (dB)	OUTPUT UNBALANCE: PHASE (deg.)	MAXIMUM INPUT POWER (watts)*	SIZE INCHES (mm): A	SIZE INCHES (mm): B	WEIGHT: oz.	WEIGHT: g
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.

OCT 84

CRYODYNE® MODEL 350 SC CRYOGENIC REFRIGERATION SYSTEM



SPECIFICATIONS

Cold Head

Weight: 22 lb (10kg)
Ambient Operating Range: −25°F to 125°F
(−32°C to 52°C)
Orientation: 360° any plane
Electrical power supplied through compressor

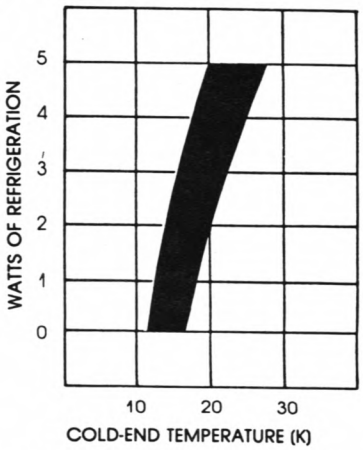
Compressor

Weight: 140 lb (59kg) approx.
Ambient Operating Range: 60°F to 100°F
(16°C to 38°C)
Adsorber Replacement: 10,000 hours
Orientation: ±10° from horizontal
Air Cooled (optional water cooled available)
Power Requirements: 1.5kW 208/230 vac, 1ø,
50/60 Hz

System

Ambient Operating Range: 60°F to 100°F
(16°C to 38°C)
Refrigerant: Ambient temperature helium gas
Standard Piping: 10 feet. Optional piping available for separation distances up to 500 feet.
Typical cooldown time to 20K with no load:
50 min (60 Hz), 65 min (50 Hz). Each lb (.45kg) mass at cold end increases cooldown time 25 min.
Optional temperature sensors and indicators are available.

Cooling Capacity*



*Cold head performance will be within limits given here

CTI-CRYOGENICS
The pure performance company

CTI-CRYOGENICS

CRYODYNE(R) MODEL 350CP CRYOGENIC SYSTEM

DOMESTIC LIST

CATALOGUE NO.	SYSTEM	PRICE - F.O.B. WALTHAM, MASS.
50/60Hz		
3695600 G1	CRYODYNE Model 350CP Cryogenic system consisting of refrigerator unit (concentric configuration), SC air-cooled compressor unit (208V), standard 10' flexlines, installation tools, and manual.	$8,650.00
3695600 G2	CRYODYNE Model 350CP Cryogenic system consisting of refrigerator unit (concentric configuration), SC water-cooled compressor unit (280V), standard 10' flexlines, installation tools, and manual.	8,650.00

MAJOR COMPONENTS

D3695576	Model 350CP Refrigerator unit	6,090.00
8032551 G2	SC Compressor unit (208V, 50Hz or 60HZ) Air-cooled	3,500.00
8032550 G2	SC Compressor unit (208V, 50Hz or 60Hz) Water-cooled	3,500.00

Shipping Weight: Approx. 240 lbs.

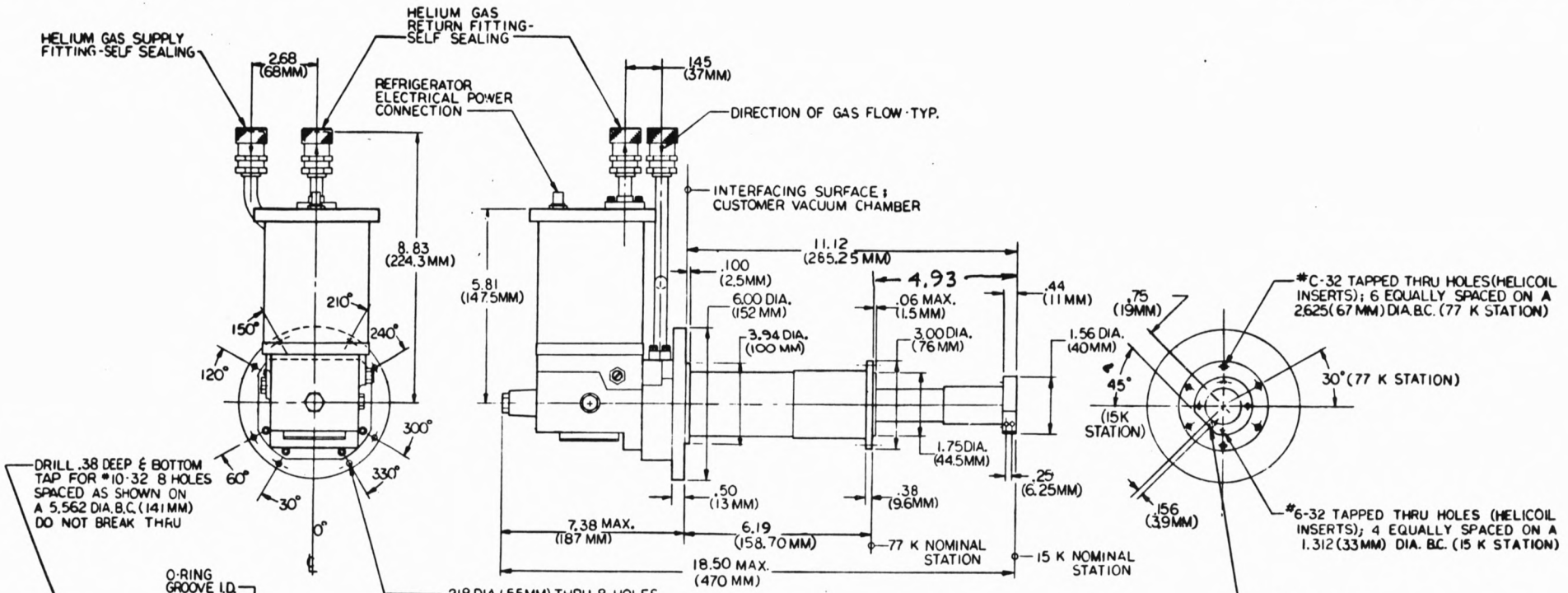
Effective January 1, 1984

Printed in U. S. A.

PRICES ARE SUBJECT TO CHANGE WITHOUT NOTICE

CTI-CRYOGENICS

REVISIONS				
LTR	DESCRIPTION	DATE	APPD
A	PER DCO # 5756	4-30-80	GSC
B	REV. PER DCO # 6110	10-3-80	
C	REV PER DCO 6577	3-24-81	



ITEM NO	QTY REQ	D3695577G1 ASS'Y-MOD. 350CP REFRIG.
1		

PARTS LIST

PROPRIETARY AND CONFIDENTIAL

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UNLESS OTHERWISE SPECIFIED:

	BY	DATE
DRAWN	S. HU	1/21/80
CHECKED		
ENG. APPR.		
MFG. APPR.		
CUSTOMER APPR.		
PRE-PRODUCTION		
PRODUCTION		

EFF. SERIAL NO.	SPECIAL (CUSTOMER)
P/L 3695551	350 CP
NEXT ASSY	USED ON

APPLICATION

CTI-CRYOGENICS

INSTALLATION/INTERFACE MODEL 350 CP REFRIGERATOR

SIZE	CODE IDENT NO.		REVISION
D	31949	3695576	C

SCALE NONE SHEET

5513

III-12

JUNE 85

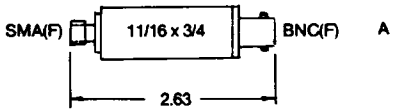
Precision Calibrated Coaxial Noise Sources - 10KHz to 18 GHz

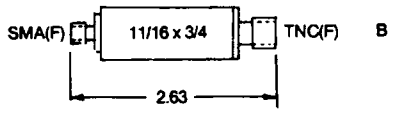
NC 3000 Series

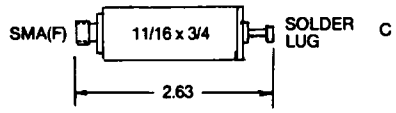
NOISE COM, INC.
HACKENSACK, NJ
(201) 488-4144
CAT NC 985

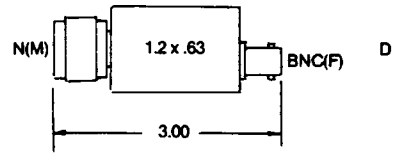
FEATURES:

- 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









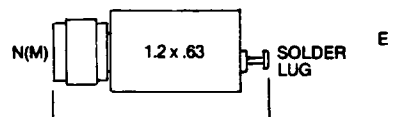
NOISE FIGURE METER COMPATIBLE TYPES:

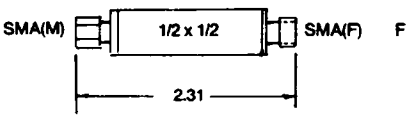
MODEL	FREQUENCY RANGE (GHz)	NOISE OUTPUT ENR (DB)	VSWR MAX	PACKAGE CODE*	CALIBRATION FREQUENCIES
NC 3101	.01 – 8	15.5 ± .5	1.2 on/off	A to H	.01, .1, 1.0 & 1GHz steps
NC 3102	.01 – 12.4	15.5 ± .5	1.2 on/off		
NC 3103	1 – 12.4	15.5 ± .5	1.2 on/off		1GHz steps
NC 3104	1 – 18	15.5 ± .5	1.35 on/off		
NC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

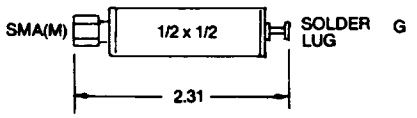
HIGH NOISE OUTPUT TYPES:

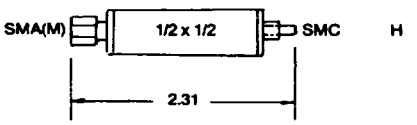
MODEL	FREQUENCY RANGE (GHz)	NOISE OUTPUT		PACKAGE CODE*	CALIBRATION FREQUENCY
		ENR (DB)	FLATNESS		
NC 3201	10 KHz – 1.1GHz	30 – 35	±1DB	A to H	0.1, .1, .5, 1.0
NC 3202	.001 – .6	30 – 35	±1DB		.01, .1, .6
NC 3203	1 – 2	30 – 35	±1DB		1, 1.5, 2.0
NC 3204	2 – 4	30 – 35	±1DB		1GHz STEPS
NC 3205	4 – 8	30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

*Specify package code









RF CONNECTOR | BIAS CONNECTOR | 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.

AVANTEK, INC
SANTA CLARA, CA

(408) 496-6710

A122/R4-84 CAT

JUNE 85

HIGH PERFORMANCE THIN-FILM AMPLIFIER MODULES, TO-8 PACKAGE, Continued

Guaranteed Specifications: 0° to 50°C (A), −54° to 85°C (B), Case Temperature, other specifications at 25°C.

Model	Frequency Response (MHz) Minimum	Gain (dB) Minimum A	Gain (dB) Minimum B	Noise Figure (dB) Maximum A	Noise Figure (dB) Maximum B	Power Output at 1dB Gain Compression (dBm) Minimum A	Power Output at 1dB Gain Compression (dBm) Minimum B	Gain Flatness (±dB) Maximum A	Gain Flatness (±dB) Maximum B	Typical 3rd Order Intercept Point (dBm)	Typical 2nd Order Intercept Point (dBm)	VSWR (50 ohms) Maximum In	VSWR (50 ohms) Maximum Out	Input Power (±1% Reg.) Volts (VDC)	Input Power (±1% Reg.) Current (mA) Typ	"R" Series Burn-In Case Temperature (°C)	Case Drawing
2 to 1000 MHz (Listed in Order of Increasing Noise Figure, Increasing Power Output)																	
UTO-1011	2-1000	14	13.5	3.5	4.0	−5	−6	0.7	1.0	+10	–	2.0	2.2	+15	8	125	TO-8U
UTO-1012	5-1000	15	14	4.0	4.5	+4	+3	1.0	1.0	+17	–	2.0	2.0	+15	18	125	TO-8U
UTO-1043[1]	10-1000	10	9	4.0	4.5	+6	+6	1.0	1.0	+22	–	2.0	2.0	+15	25	125	TO-8T
UTO-1013	5-1000	15	14	4.5	5.0	+9	+8	1.0	1.0	+20	–	2.0	2.0	+15	29	125	TO-8U
UTO-1044[1]	10-1000	10	9	4.5	5.0	+12	+12	1.0	1.0	+28	+40	2.0	2.0	+15	35	125	TO-8T
UTO-1021	5-1000	22	21	4.5	5.0	+12	+11	1.0	1.0	+27	+50	2.0	2.0	+15	85	100	TO-8U
UTO-1051	5-1000	10	9	5.0	5.7	−5	−6	1.0	1.0	+10	–	2.0	2.0	+5	7	125	TO-8U
UTO-1001	5-1000	14	13.5	5.0	5.5	−2	−3	1.0	1.0	+11	–	2.0	2.0	+15	10	125	TO-8U
UTO-1007	5-1000	12.5	11.5	5.0	5.5	+11	+10	0.7	1.0	+21	–	2.0	2.0	+5	33	125	TO-8T
UTO-1006	5-1000	11	10.5	6.0	6.5	+17	+16	1.0	1.0	+30	+37	2.0	2.0	+15	70	100	TO-8T
UTO-1005	5-1000	11	10.5	6.0	6.5	+20	+19	1.0	1.0	+33	+40	2.0	2.0	+15	90	100	TO-8T
UTO-1002	5-1000	14	13.5	6.5	7.0	+7	+7	1.0	1.0	+21	–	2.0	2.0	+15	23	125	TO-8U
UTM-1056[P]	10-1000	25.6	25.0	6.5	7.0	+12.0	+10.5	0.7	1.0	+26	+35	1.7	1.7	+15	135	100	TO-8T
UTM-1057[P]	10-1000	26.0	25.5	6.5	7.0	+14.0	+12.5	0.7	1.0	+29	+42	1.7	1.7	+15	170	100	TO-8T
UTM-1055[P]	10-1000	15.5	15.0	7.5	8.0	+15.0	+13.5	0.7	0.7	+29	+45	1.7	1.7	+15	135	100	TO-8T
UTO-1003	5-1000	9	8.5	8.0	8.5	+13	+13	1.0	1.0	+25	+32	2.0	2.0	+24	50	100	TO-8U
UTO-1033	5-1000	10	9	8.0	8.5	+14	+13	1.0	1.0	+28	+40	2.0	2.0	+15	48	100	TO-8T
UTM-1053	5-1000	27	25	9.0	9.0	+5	+4	2.0	2.0	+21	+30	2.0	2.0	+15	90	71	TO-8T
UTO-1004	10-1000	6	5.5	12.0	12.5	+20	+19	0.7	1.0	+40	+50	2.0	2.0	+15	110	71	TO-8T
1 to 1500 MHz (Listed in Order of Increasing Noise Figure, Increasing Power Output)																	
UTO-1524	10-1500	21	20	4.5	5.0	+7	+6	1.5	1.5	+19	–	2.0	2.0	+15	60	100	TO-8U
UTO-1511	5-1500	10	10	4.5	5.0	−9	−10	0.5	1.0	+1	–	2.0	2.0	+15	7	125	TO-8U
UTO-1522	5-1500	18	17	5.5	6.0	+11	+10	1.5	1.5	+23	–	2.0	2.0	+15	85	100	TO-8U
UTO-1501	5-1500	9	8.5	5.5	6.0	−3	−4	0.5	1.0	+10	–	2.0	2.0	+15	10	125	TO-8U
UTO-1502	5-1500	9	8.5	7.5	7.5	+6	+6	0.5	1.0	+19	–	2.0	2.0	+15	23	125	TO-8U
UTO-1504	2-1500	9	8.5	8.0	8.5	+12	+12	1.0	1.0	+29	+38	2.0	2.0	+24	60	100	TO-8U
UTO-1521	1-1500	28	26	8.0	8.5	+13	+12	2.0	3.0	+30	+44	A=2.2 B=2.5	2.2 2.5	+24	135	100	TO-3
UTO-1503	5-1500	6	5.5	9.0	9.0	+12	+12	0.5	1.0	+30	+40	2.0	2.0	+24	50	100	TO-8U
1 to 2000 MHz (Listed in Order of Increasing Noise Figure, Increasing Power Output)																	
UTO-2031	1-2000	9	8.5	5.5	5.5	+2	+2	1.0	1.0	+14	–	2.0	2.0	+15	16	125	TO-8U
UTO-2032	1-2000	9	8.5	6.0	6.0	+7	+6.5	1.0	1.0	+17	–	2.0	2.0	+15	25	125	TO-8U
UTO-2033	1-2000	8	7.5	8.5	9.5	+14	+14	1.0	1.0	+30	+41	2.0	2.0	+15	50	71	TO-8T
10 to 2000 MHz (Listed in Order of Increasing Noise Figure, Increasing Power Output)																	
UTO-2012 FET	500-2000	9	8.5	4.0	4.5	+12	+11	1.0	1.0	+23	+33	2.0	2.0	+15	50	71	TO-8U
UTO-2013 FET	500-2000	9	8.5	5.5	6.0	+19	+18	1.0	1.0	+33	+37	2.0	2.0	+15	100	71	TO-8U
UTO-2011	1000-2000	7.5	7.5	5.0	5.5	−3	−4	0.5	1.0	+10	–	2.0	2.0	+15	12.5	125	TO-8U
UTO-2021	10-2000	9	8.5	5.5	5.5	+2	+2	1.0	1.0	+14	–	2.0	2.0	+15	16	125	TO-8U
UTO-2024	5-2000	15	14	5.5	6.0	+5	+4	1.0	1.0	+18	+45	2.0	2.0	+15	38	125	TO-8T
UTO-2022	10-2000	9	8.5	6.0	6.0	+7	+6.5	1.0	1.0	+17	–	2.0	2.0	+15	25	125	TO-8U
✓ UTO-2001	1000-2000	7.5	6.5	6.0	6.5	−3	−4	0.5	1.0	+10	–	2.0	2.0	+15	12.5	125	TO-8U
UTO-2002	1000-2000	8	7.5	7.0	7.5	+3	+3	0.5	1.0	+16	–	2.0	2.0	+15	20	125	TO-8U
UTO-2003	1000-2000	8	7.5	8.0	8.5	+7	+7	1.0	1.0	+20	–	2.0	2.0	+15	30	125	TO-8U
UTO-2023	10-2000	8	7.5	8.5	9.5	+14	+14	1.0	1.0	+29	+40	2.2	2.2	+15	50	71	TO-8T
1700 to 2300 MHz (Listed in Order of Increasing Noise Figure, Increasing Power Output)																	
UTO-2311	1700-2300	8	8	5.0	5.5	−3	−4	0.5	1.0	+10	–	2.0	2.0	+15	15	125	TO-8U
UTO-2302	1700-2300	8	8	6.5	7.0	+3	+2	0.5	1.0	+13	–	2.0	2.0	+15	18	125	TO-8U
UTO-2303	1700-2300	8	8	8.0	8.5	+10	+9	0.5	1.0	+20	–	2.0	2.0	+15	30	100	TO-8U
UTO-2321	1700-2300	14	13	8.0	8.5	+10	+9	1.0	1.0	+23	–	2.0	2.0	+15	70	100	TO-8U

Notes:

For units with 71°C burn-in temperature, B column is −54°C to +71°C.

The factory can guarantee operation of most GPD, GPM, UTM and UTO Series amplifier modules over −54°C to +105°C if required.

(P) Preliminary

1. Both RF input and RF output pins are at DC ground – no blocking capacitor.
2. RF input pin is at DC ground – no input blocking capacitor.
3. A portion of any DC voltage applied to the RF input pin will appear at the RF output pin (i.e., a resistive DC path exists between pins). There is no input or output blocking capacitor.
4. 2.2:1 from 350-400 MHz.
5. 20-100 MHz
6. 100-200 MHz

CASCADABLE MODULAR AMPLIFIERS UTO SERIES, TO-8 PACKAGED, continued

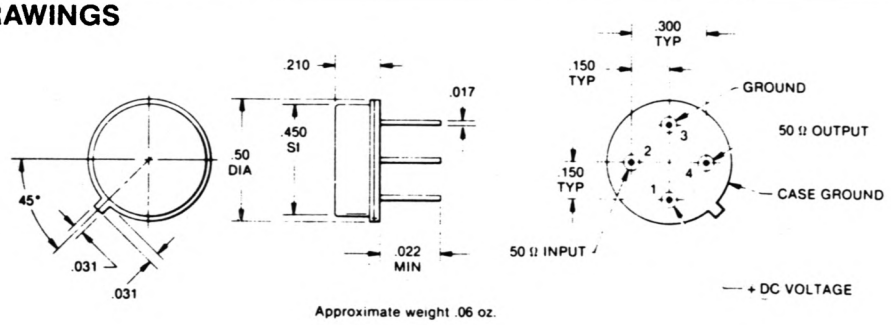
Guaranteed Specifications: 0° to 50°C (A), −54° to +85°C (B)

Model	Frequency Response (MHz) Minimum	Gain (dB) Minimum A	Gain (dB) Minimum B	Noise Figure (dB) Maximum A	Noise Figure (dB) Maximum B	Power Output at 1 dB Gain Compression (dB) Minimum A	Power Output at 1 dB Gain Compression (dB) Minimum B	Gain Flatness (±dB) Maximum A	Gain Flatness (±dB) Maximum B	Typical Intercept Point for IM Products (dBm)	VSWR (50 ohms) Maximum In	VSWR (50 ohms) Maximum Out	Input Power (±1% Reg.) Volts DC	Input Power (±1% Reg.) Current mA Typ.	"R" Series Burn-in Case Temperature (°C)	Case Drawing
1700 to 2300 MHz (Listed in Order of Increasing Noise Figure, Decreasing Gain)																
UTO-2311	1700–2300	8	8	5.0	5.5	−3	−4	0.5	1.0	+10	2.0	2.0	+15	15	125	TO-8U
UTO-2302	1700–2300	8	8	6.5	7.0	+3	+2	0.5	1.0	+13	2.0	2.0	+15	18	125	TO-8U
UTO-2321	1700–2300	14	13	8.0	8.5	+14	+13.5	1.0	1.0	+26	2.0	2.0	+15	70	100	TO-8U
UTO-2303	1700–2300	8	8	8.0	8.5	+10	+9	0.5	1.0	+20	2.0	2.0	+15	30	100	TO-8U

Boldface Listings *are new products not listed in* Designing with modular amplifiers, third edition.
For units with 71°C burn-in temperature, B column is –54° to +71°C.
Δ Preliminary, contact factory.
Note 1: Third order intercept point.
Note 2: Second order intercept point.
Note 3: RF input pin is at DC ground.
Note 4: Both RF input and RF output pins are at DC ground.
Note 5: A portion of any DC voltage applied at the RF input pin will appear on the RF output pin (i.e., a resistive DC path exists between pins).
The factory can also provide information on operating specific MICamp modules at temperatures above +85°C or below –54°C. It is recommended that precautions be taken to assure that the CW power applied to the input of any UTO MICamp module never exceed +13 dBm or possible permanent noise figure degradation may result. Under certain conditions, high CW or pulse power levels may be applied to specific modules with difficulty—contact the factory for recommendations.
Most UTO Series MICamp thin-film modules are available with high reliability screening under the Avantek "R" Series program. The "R" Series devices are conditioned with a full complement of Method 5004.2 screening procedures which provide Class B level reliability assurance. These test procedures, selected from MIL-STD-883, are sufficient to provide this assurance.

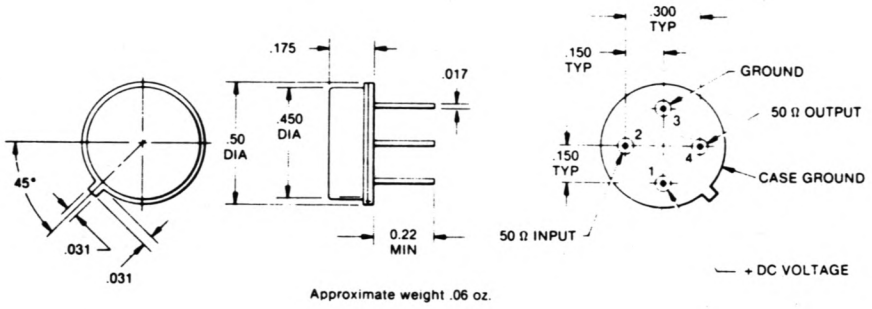
OUTLINE DRAWINGS

TO-8T



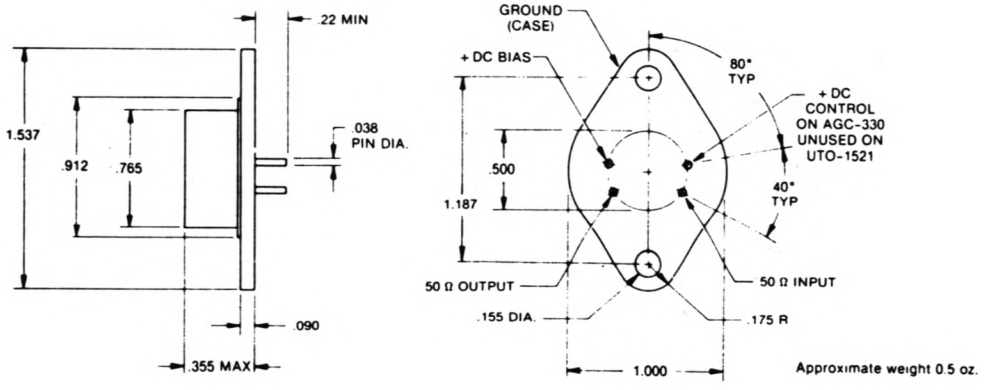
Approximate weight .06 oz.

TO-8U



Approximate weight .06 oz.

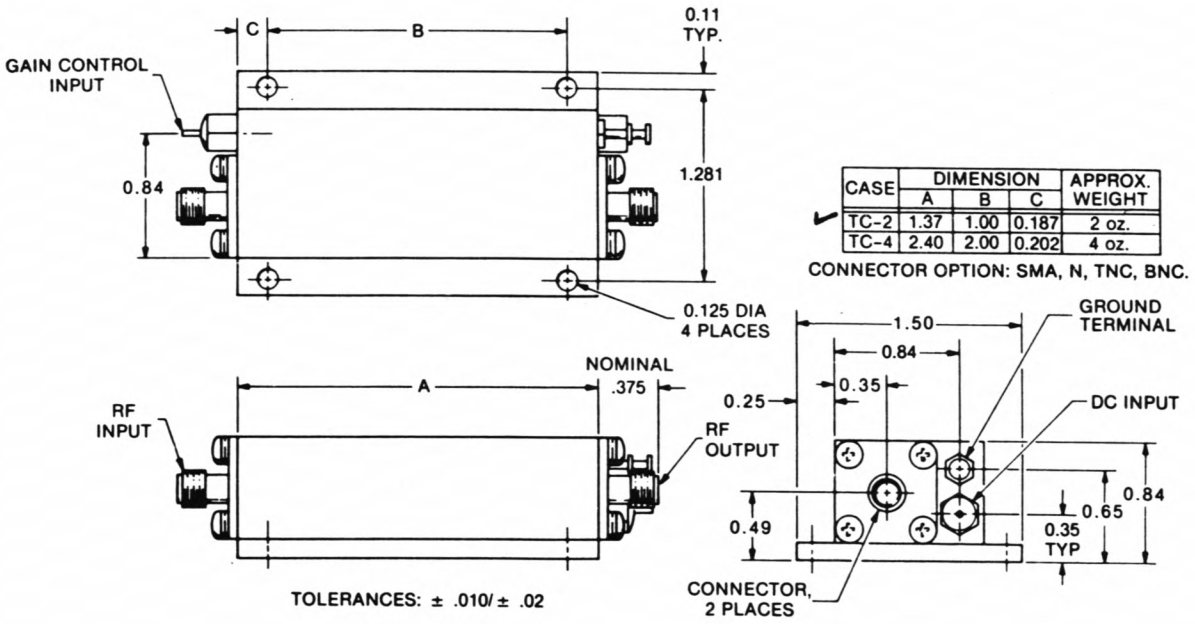
TO-3



Approximate weight 0.5 oz.

OUTLINE DRAWINGS, CONTINUED

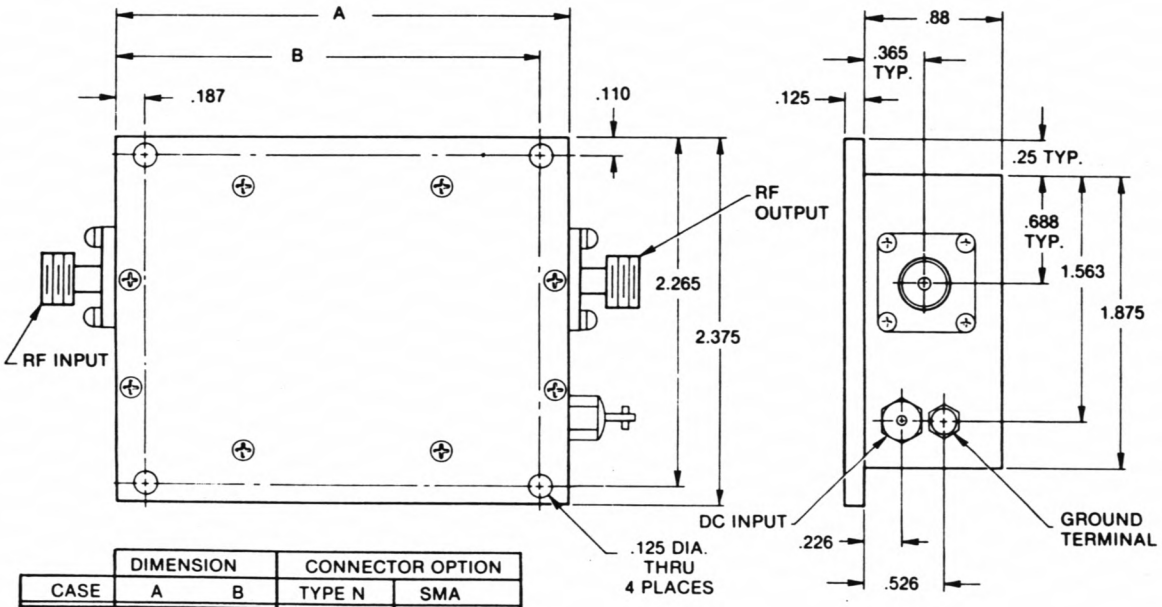
TC CASE



CASE	DIMENSION A	B	C	APPROX. WEIGHT
TC-2	1.37	1.00	0.187	2 oz.
TC-4	2.40	2.00	0.202	4 oz.

CONNECTOR OPTION: SMA, N, TNC, BNC.

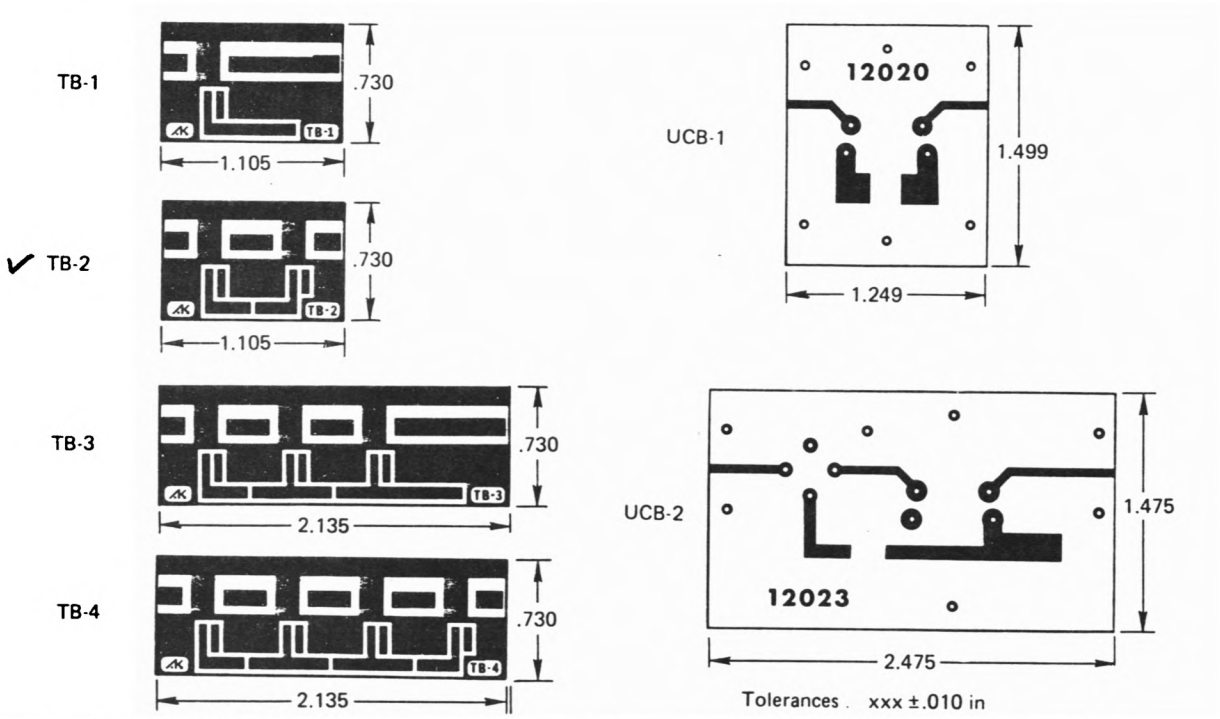
UCS CASE



CASE	DIMENSION A	B	CONNECTOR OPTION TYPE N	SMA
UCS-1	1.625	1.437	– 001	– 002
UCS-2	2.875	2.668	– 001	– 002

CIRCUIT BOARDS

(Shown actual size)



REVISIONS TO DESIGNING WITH MODULAR AMPLIFIERS, THIRD EDITION.

The following data is a supplement to the third edition and contains all new and revised information concerning the products listed in that publication. The specifications for new UTO Series amplifier modules introduced since the third edition was published are listed in bold face on pages 2 and 3 of this data sheet.

The next supplement to Designing with modular amplifiers, third edition will be issued in February 1980.

To receive a copy of ***Designing with modular amplifiers*** which is a complete handbook detailing the Avantek UTO Series of modular amplifiers, the UTF Series voltage-controlled attentuator, UTL Series thin-film limiters and limiting amplifiers and the AGC-330 Voltage controlled amplifiers; or to have your name placed on the mailing list to receive future supplements, write or call:

Avantek, Inc.
Attn. Corporate Communications
3175 Bowers Avenue
Santa Clara, CA 95051

CORRECTIONS:

(Page 75, Designing with Modular Amplifiers, Third Edition.)

UTF-025 Typical Performance Curve (@ 25°C)

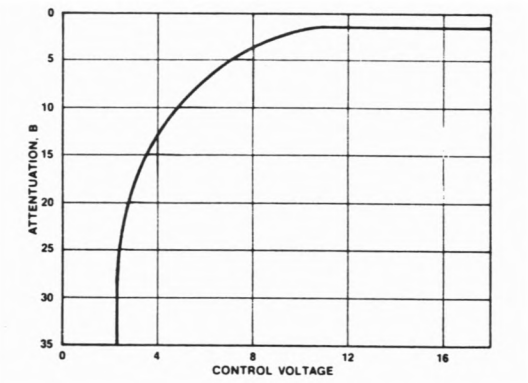


Figure 3-18a UTF-025 Attenuation vs. Control Voltage

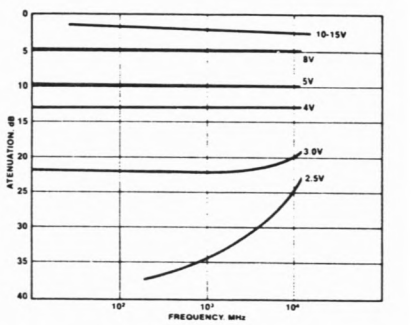
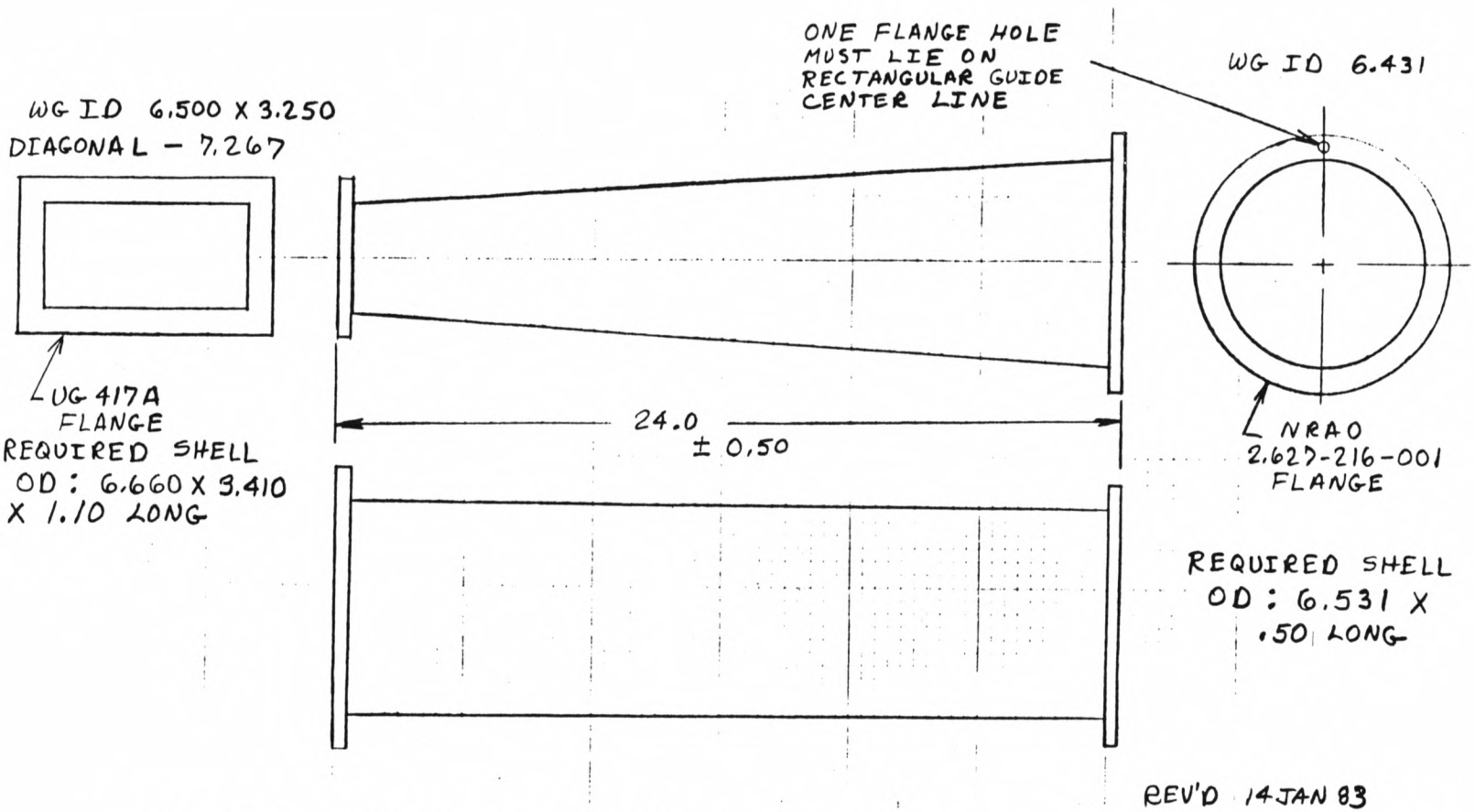


Figure 3-18b. UTF-025 Attenuation vs. Frequency With Various Control Voltages

APPENDIX IV

Special Test Fixtures

One special item was fabricated for work with this receiver: a circular to rectangular waveguide adapter. Attached are drawings 2.627-217-001 and 2.627-216-001 which were used to fabricate the adapter.

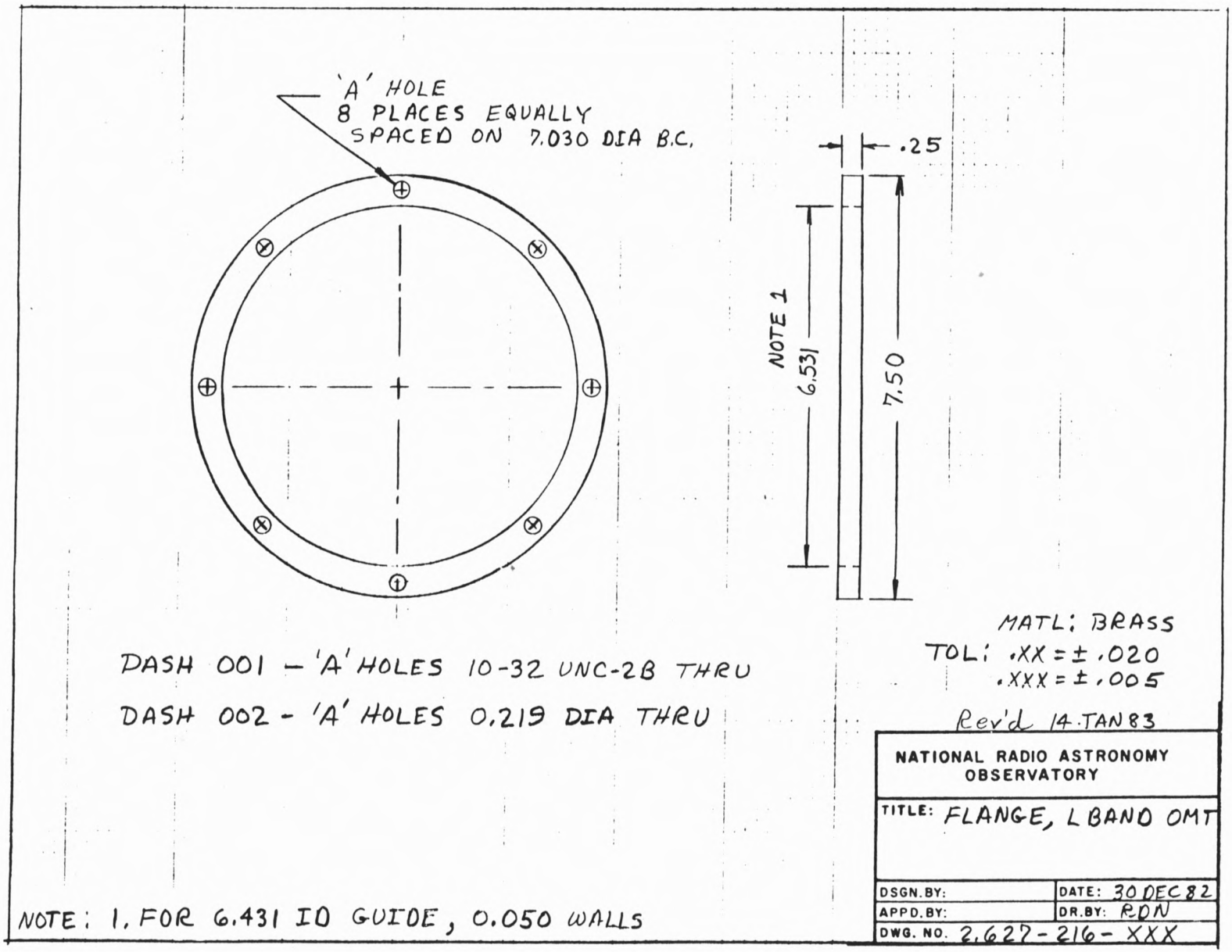


REV'D 14JAN 83

TOL = .XXX = ±.005

ELECTROFORM COPPER WALL THICKNESS – 0.080 MIN
MANDREL MATERIAL – AL 6061 – T6
MANDREL SHALL HAVE 60° CENTER ON RECTANGULAR END, AND CHUCKING BOSS ON CIRCULAR END WITH REFERENCE FLAT PARALLEL TO RECTANGULAR SURFACES. CIRCULAR END SHALL ALSO HAVE A 3/4-10 TAPPED HOLE ON CENTER.

NATIONAL RADIO ASTRONOMY OBSERVATORY	
TITLE: CIRCULAR - RECTANGULAR TRANSITION, L-BAND OMT	
DSGN. BY:	DATE: 3 JAN 83
APPD. BY:	DR. BY: RON
DWG. NO. 2.627-217-001	


'A' HOLE
8 PLACES EQUALLY
SPACED ON 7.030 DIA B.C.
.25
NOTE 1
6.531
7.50
DASH 001 – 'A' HOLES 10-32 UNC-2B THRU
DASH 002 - 'A' HOLES 0.219 DIA THRU
MATL: BRASS
TOL: .XX = ± .020
.XXX = ± .005
Rev'd 14-JAN 83
NATIONAL RADIO ASTRONOMY OBSERVATORY
TITLE: FLANGE, L BAND OMT
DSGN. BY:
DATE: 30 DEC 82
APPD. BY:
DR. BY: RDN
DWG. NO. 2.627-216-XXX
NOTE: 1. FOR 6.431 ID GUIDE, 0.050 WALLS