NATIONAL RADIO ASTRONOMY OBSERVATORY
Green Bank, West Virginia

ELECTRONICS DIVISION INTERNAL REPORT
NO. 299

20 METER S/X RECEIVER

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April 1995

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1.0 General

This report documents the receiver system of the Green Bank USNO 20 meter telescope. The antenna, for which this receiver is designed, is a copy of the 20 meter telescope located at Kokee Park Kauaii, Hawaii. The feed is exactly the same as the Kokee Park receiver, and the dewar is the same, with the exception of changes in the DC feed throughs to improve vacuum losses. Electronics Division Internal Report 294[1] documents the Kokee Park receiver, and a paper[2] submitted to JPL gives a detailed description of the components of the receiver. At the time of the design of the 20 meter receiver system, advancement in fiber optic technology facilitated a change in the topology of the receiver to improve the phase calibrator response and reduce the number of components in the front end box. This receiver also allows observing of both polarizations simultaneously.

The corruption of the phase calibrator signals by the receiver system of 85-3 was attributed to a combination of design problems. The upper portion of the X pass-band corruption was due to low image rejection and isolation from the lower X band IF. The S band corruption was due to low isolation from the X band IF and a high level of 2 X 1 products from the second mixer. The design of the 20 meter receiver eliminated the isolation problems and eliminated a need for a second conversion of the S and upper X pass-bands. Specifically, the RF energy at X and S band for the right polarization is combined then modulated directly on to a singlemode fiber via a 10 GHz bandwidth fiber optic transmitter and receiver pair. The left polarization is combined and modulated onto an identical fiber optic transmitter/receiver pair. A 500 MHz reference generated from the 100 MHz maser reference is transmitted to the front end box for the phase calibrator and round trip phase measurements.

2.0 S and X Receiver A17707B001

The receiver is mounted in a standard NRAO Green Bank front end box 60" x 28" x 28", supported in the focus and polarization mount by a 45" diameter circular flange. The receiver box is kept at a temperature of 25 C + or - 3 C, with thermoelectric heat pumps and a proportional controller. As shown on the block diagram A17707K001, both the right and left-hand circularly polarized signals are received. The two polarizations at each frequency are designated X-R, X-L and S-R, S-L. The signal flow is from the feed through the HEMT amplifiers which are cryogenically cooled in the dewar.

The four channel output of the dewar is then input to a temperature controlled RF amplifier box where the S and X bands for each polarization are combined. The RF box houses all the room temperature RF amplifiers, isolators, filters, and power combiners. The 500 MHz reference is input to the RF box from the phase calibrator box. The reference signal is then combined with the right polarized X and S bands through a 10 dB coupler and returned to the control room. The left polarization also has a wideband 10 dB coupler, but a reference is not returned in the normal operations. Each of the polarizations are input to microwave fiber optic links.

A temperature-controlled box houses the phase cal generator and the noise diodes for both X and S bands. The phase cal signals and the output of the noise diodes are combined for each channel and input to the HEMT amplifiers. This box also contains a fiber optic receiver which demodulates the optic signal intensity modulated with the 500 MHz reference.

A digital interface rack (DAR), located in the control room, contains a S/X receiver digital interface drawer, two (DAR) interfaces and power supplies. The digital interface drawer contains a digital module which is identical to the module in the front end. The digital module monitors the LO lock levels and detected power levels from the two DAR interfaces. The serial data from the front end arrives via a single mode fiber and a RS422 transmitter/receiver pair. The serial data from the font end and DAR drawers are combined and input to the field system computer where the information is logged and displayed.

Each DAR interface contains a fiber optic receiver which demodulates the optical signal intensity modulated with the S band, X band, and the 500 MHz reference. The S and X bands are filtered, downconverted to an IF frequency band from 500 MHz to 1000 MHz, and input to the DAR. The 500 MHz is filtered and input to the Vector Voltmeter.

2.1 S and X Feed
A17222B010

A dual-frequency dual-polarized feed was designed for this receiver. It illuminates the reflector antenna with an f/d of .43, with minimum spillover. From feed patterns obtained on the test range, the computed aperture efficiency was 65% at S Band, and the spillover and scattered noise was less than 3.5° Kelvin. At X-band, feed patterns predicted 64% aperture efficiency and less than 1.0° Kelvin spillover. The worst case axial ratio measurements and the feed performance is given in Table 1 and 2, respectively. The positive angles are taken counterclockwise from the on axis measurement with respect to the feed. An outline drawing of the feed and the parts list is given in documents D17222M005 and A17222B010, respectively.[2]

2.2 Dewar Assembly

A17707B005

The receiver uses low noise HEMT amplifiers cooled to 15° Kelvin with a closed-cycle helium refrigerator system. The S band inputs to the dewar are through rectangular waveguide. The X band input is a circular waveguide with the polarizer inside the dewar. The noise temperatures for the S-band channels measured at the flange of the dewar are given in Table 3. The X band noise temperatures at the dewar flange are also given in Table 3. These measurements were taken with a 70° cryogenic load as the cold load, and a room temperature load for the hot load. The noise temperatures were measured in a 20 MHz bandwidth at different frequencies across the band. A power meter was used to determine the Y factor. The noise measurements were made with and without the fiber optic link to determine if the fiber optic link added noise. The noise measurements were the same.

2.3 Phase Calibrator Generator Box

A17707B011

The phase calibrator generator module, the S and X noise diodes, and the fiber optic receiver are contained in a temperature-controlled box. The phase cal generator is a modified version of the one designed by Alan Rodgers of Haystack Observatory and used by the VLBA receiver systems. The GigaBit high-speed dividers were no longer available; therefore, two Plessey 5 GHz divided by 10 were used to generate the 5 MHz signal from the 500 MHz reference. A Motorola ECL PS Lite logic differential reciever at the input extended the input range of the phase cal generator from -7 dBm to greater than +10 dBm. The temperature coefficient of the Plessy chip was not as good as expected — 5ps/C; however, a tightly-controlled temperature of the module should compensate for the higher temperature coefficient. A graph of the temperature coefficient measured at 500 MHz is shown in Figure 1. The ON/OFF input was also changed, because the level from the digital module was not high enough to completely cut off the PIN diode switch. The circuit board was modified so the ON/OFF input inhibited the CMOS divider. The CMOS divider generates a pulse every 1 microsecond which turns on the PIN diode switch. The PIN diode switch is a newer version of the switch used in the VLBA phase cal generators.

The phase calibrator box also contains the S and X noise diodes along with the power splitters and couplers for combining the calibration noise power with the phase cal signals for each of the four channels. A 20 dB pad reduces the level of the S band phase cals to acceptable levels. A card mounted on top of the box provides the digital interface and supplies a regulated voltage to

the noise diodes. Coaxial attenuators were added to obtain the noise cal values measured and shown in Table 4.

2.4 RF Amplifier Module A17707B006

The S and X band room temperature amplifiers, the power combiners and a wideband coupler are contain in a temperature-controlled box. The X band channel contains two amplifiers which are adjusted with coaxial attenuators to provide approximately 60 dB of gain for each of the polarizations. The S band channel also contains two amplifiers which are adjusted to provide 60 dB of gain. The X band channel has an isolator at the input, followed by a 1000 MHz bandpass filter. Two filters were needed in the X band channel; the first filter limits the input power to the amplifiers, and the second limits the input power to the fiber optic transmitter. The S band needed only one filter to limit the power input to the fiber optic transmitter. The X and S bands are combined via a power combiner and input to a wideband coupler. The 500 MHz reference is input to the coupled port.

2.5 DAR Interface Rack A17707B003

A digital interface rack (DAR) contains a DAR interface for each polarization, which demodulates the optical signal and separates the S band, X band, and 500 MHz reference. The S band is filtered and mixed with a 1500 MHz LO to produce a 500 to 1000 MHz IF. The X band is divided into a 8100 to 8600 MHz, and a 8600 to 9100 MHz band, which are mixed with a 7600 and 8100 MHz LO, respectively, to produce a 500 to 1000 MHz IF. Each IF passband is amplified after the mixer, and part of the power is coupled and detected. A BD-4 tunnel diode circuit produces a voltage porportional to the power. Figure 2 displays a typical power detector response curve. The output of each channel is a 500 to 1000 MHz IF passband at -28 dBm power level.

The two DAR interfaces are not identical; therefore, coaxial interconnections are required. DAR #1 contains all the PLO's which are split and output to DAR #2. DAR #2 contains a power amplifier which amplifies the 100 MHz reference signal from the maser to +28 dBm. The signal is input to a comb generator where the output is filtered to produce the 500 MHz reference signal. The 500 MHz reference signal is split and input to the fiber optic transmitter and output to the

Vector-Voltmeter. The 100 MHz reference is also divided in a three-way splitter and input to the PLO's.

2.6 Receiver Control and Monitor A17707B008

A front end electronics monitor assembly is located in the front end box. One chassis contains the bias cards for the HEMT amplifiers and also the electronics for monitoring vacuum, current and temperature of the dewar. The other chassis contains the digital electronics for mulitiplexing all the information from the dewar, the voltage levels from the power supplies, the temperatures of the RF box, FE box, and the phase cal box. The monitor functions are then input to a standard interface, where the serial data is modulated onto a single mode fiber optic transmitter.

The DAR interface rack located in the control room contains the S/X receiver digital interface drawer. The digital interface drawer contains the same digital module as the front end. The digital module monitors the LO lock levels and detected power levels from the two DAR interfaces. The monitor functions are input to a Standard Interface where the serial data is combined onto a MCB bus with the serial data from the font end. The serial data is input to the field system computer where the information is logged and displayed.

The output from the computer is through the serial port which is operated at 56 kilobaud. The computer program provides a real time display of receiver system status as shown in Figure 3. The lock voltage of the 1500 MHz, 7600 MHz and 8100 MHz PLO's are displayed. The ON/OFF state of the noise source, phase calibrator and the type of polarization are displayed along with the HEMT LED voltage. The refrigerator 50° temperature, 15° temperature, the receiver box temperature, the phase calibrator box temperature and the RF box temperature are shown along with the cryogenic compressor supply and return pressures. A total power reading from the square low detectors for each channel is displayed as a voltage. The MCB status registers are also displayed. The amplitude and phase readings from the Vector-Voltmeter are displayed for the 500 MHz reference and return.

2.7 System Noise Temperatures

The system noise temperatures were measured in the receiver test building. A microwave absorber at ambient temperature, placed just in front of the feed, was used as the hot load, and the cold sky was used as the cold load. The system temperature was measured in a 20 MHz bandpass

at different center frequencies across the band, with the power meter used to determine the Y factor. In addition, the noise cals were fired and the cal values were determined form the system temperatures. The results are given in Table 4.

The system noise temperatures were also measured with the receiver mounted on the 20 meter telescope. The system temperatures for the right polarization were determined at different elevations by firing the noise calibrators. For elevations greater than 30°, the X band noise temperature is 46°, and the S band noise temperature is 31°. A listing of the individual noise contributors is given in Table 5.

3.0 Acknowledgement

Funding for the construction of the receiver was provided by the U.S. Naval Observatory for operation with the 20 meter telescope located in Green Bank, West Virginia.

A number of NRAO employees contributed to the construction of the receiver, which was accomplished in a timely and professional manner. J. Oliver constructed and assembled most of the receiver, while B. Shank constructed the dewar and assisted with system testing. G. Behrens designed and tested the S/X feed, which was fabricated by the Green Bank Machine Shop. R. Norrod designed the dewar assembly. F. Ghigo wrote the software for monitoring the receiver and provided scientific input. R. Lacasse modified and is responsible for the digital interface.

4.0 References

1. EDIR NO. 294, *Hawaii S and X Receiver System,* S. D. White (April 1993)

2. NRAO paper submitted to JPL, *Design and Implementation of a Low-noise Prime Focus S/X Receiver System for Radio Astronomy,* R.D. Norrod, G.H. Behrens, F.D. Ghigo, and B.J. Levin (December 11, 1992)

3. EDIR NO. 283, *A S/X Four Channel, Cryogenic Dewar Package,* R.D. Norrod (April 1989)

TABLE 1
Worst Case Axial Ratio Measurements

Radiation Angle From Borsight	S-Band Maximum Axial Ratio Max	S-Band Maximum Axial Ratio Min	X-Band Max	X-Band Min
0	2.25	2.25	1.25	1.75
0	2.15	2.15	1.90	1.90
+20	2.40	2.60	3.25	2.80
-20	2.05	2.40	3.60	3.40
+40	2.60	3.10	4.20	4.45
-40	2.30	3.10	5.25	5.60
+60	4.90	3.70	36.0	39.3
-60	2.80	3.60	26.0	39.8

TABLE 2
Feed Performance

	Avg Edge Taper E-Plane	Avg Edge Taper H-Plane	Calculated Efficiency	Calculated Spillover
S-Band 2.26 GHz	16.87 dB	18.35 dB	0.65	3.4 K
X-Band 8.6 GHz	15.42	35.50	0.64	1.06 K

TABLE 3
Noise Temperature Measured at Dewar Flange

Frequency [GHz]	Right [K]	Left [K]
2.20	13.99	15.74
2.30	15.42	14.78
2.40	15.79	16.91
Average	*15.07*	*15.81*
8.20	17.33	17.48
8.30	18.00	18.13
8.40	18.90	18.82
8.50	18.80	18.94
8.70	19.50	17.23
8.80	19.30	18.90
8.90	20.00	19.81
9.00	20.30	21.40
Average	*19.15*	*18.84*

TABLE 4
System Temperatures and Noise Cals

Freq [GHz]	Right		Left	
	Noise [K]	Cal [K]	Noise [K]	Cal[K]
2.20	15.57	5.79	13.47	5.70
2.25	15.37	4.71	12.86	5.92
2.30	15.61	5.36	13.51	5.92
2.40*	30.07	6.66	29.10	7.31
Average	*15.52*	*5.29*	*13.28*	*5.85*
*not included in average				
8.20	27.93	7.16	29.95	7.47
8.30	28.70	7.96	30.77	8.27
8.40	28.12	7.80	31.02	8.51
8.50	29.38	8.09	31.77	9.06
8.70	narrow filter	29.69	9.86	
8.80	"		30.16	10.26
8.90	"		31.54	10.63
9.00	"		33.86	10.58
Average	*28.645*	*7.75*	*31.094*	*9.33*

TABLE 5
System Noise Temperature Contributions

Channel	X-R	X-L	S-R	S-L
Receiver Temp at Dewar Flange	19.15	18.84	15.52	13.28
Feed & Waveguide Losses	9.50	12.25	0	0
Feed and Spillover	11.35	12.25	11.24	7.75
Sky noise(esitmate)	6	6	5	5
Total	46.52	46.90	31.32	26.03

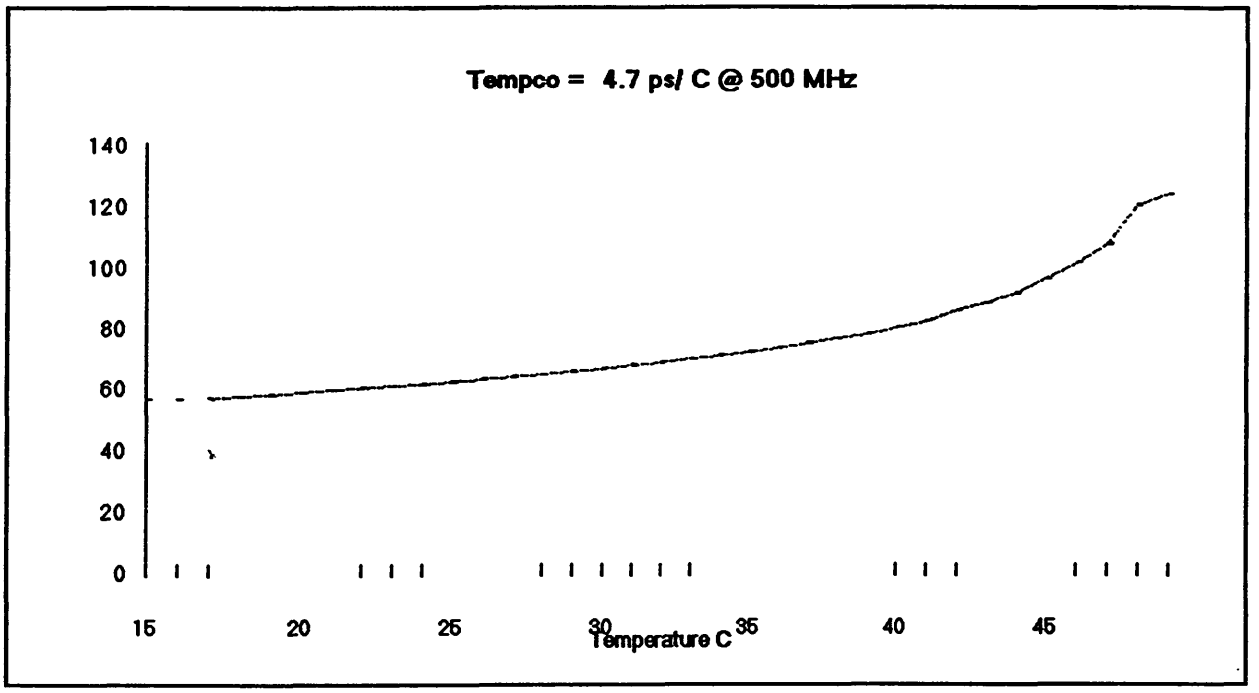


FIGURE 1. Temperature Coefficient of Phase Calibrator

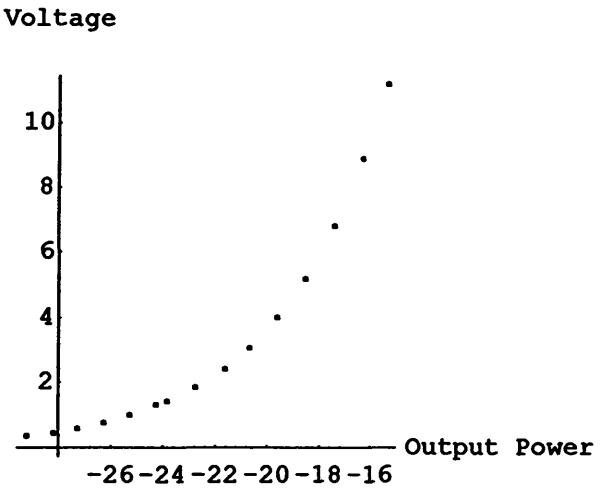
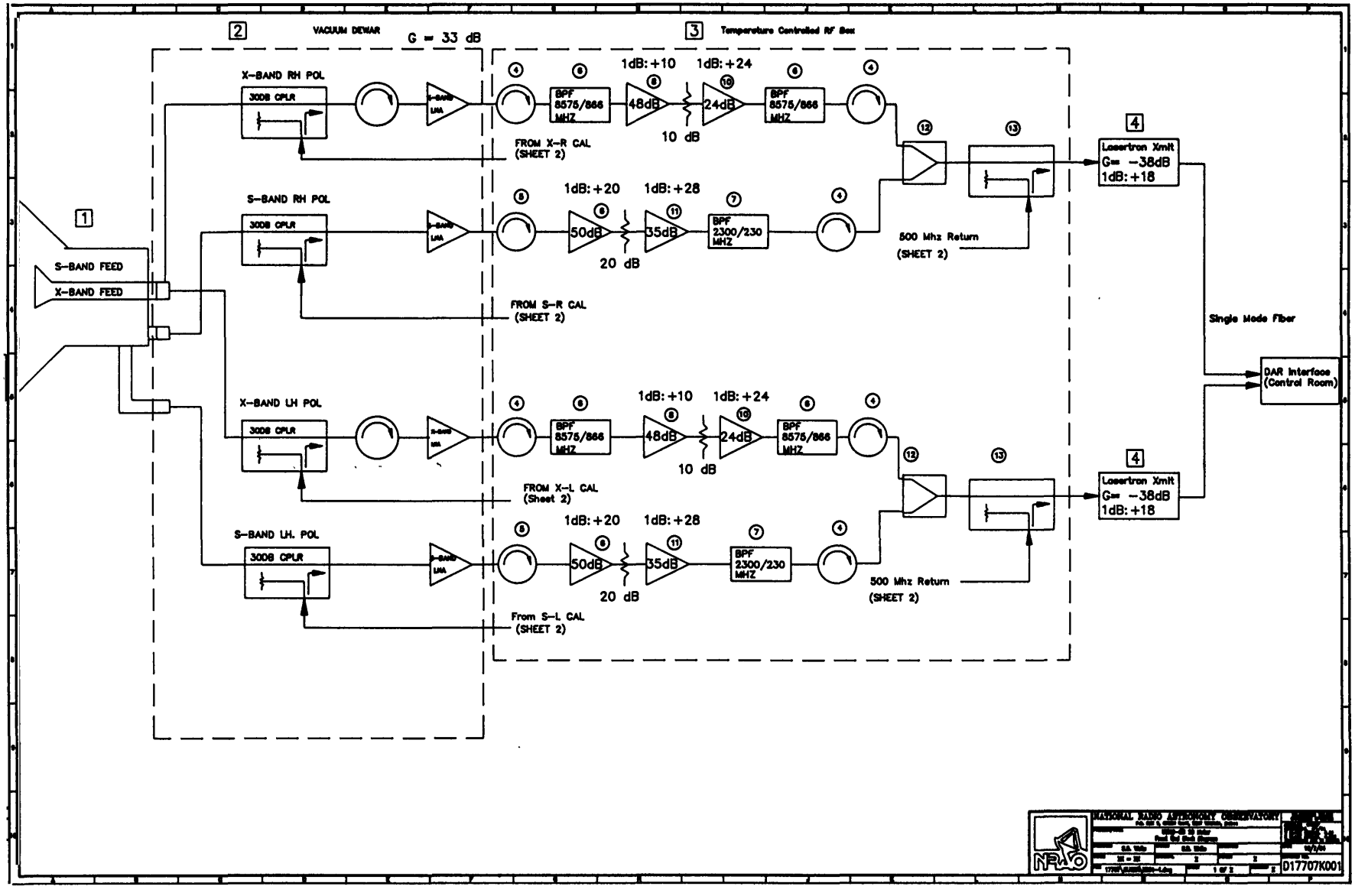


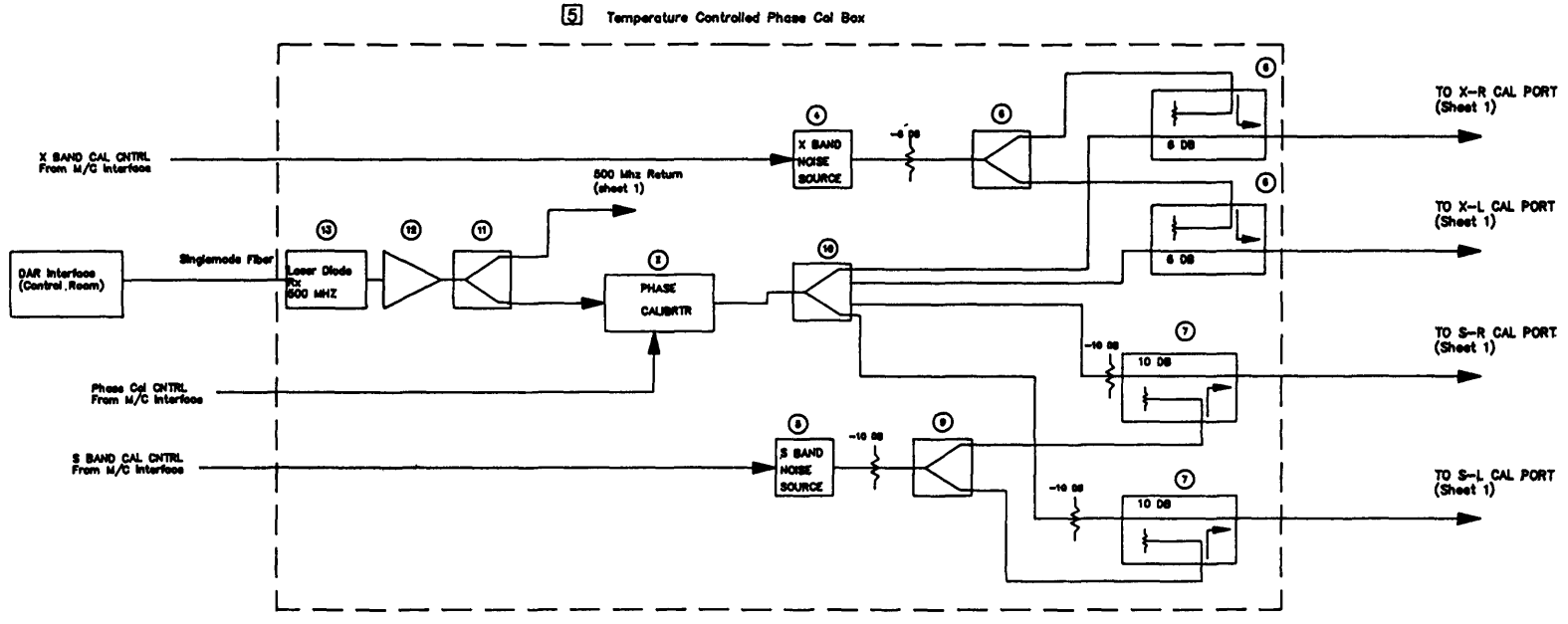
FIGURE 2. Power Detector Response Curve

Drawing Number: A17707B001 Date: 1/30/95
Title: Receiver System Rev: A

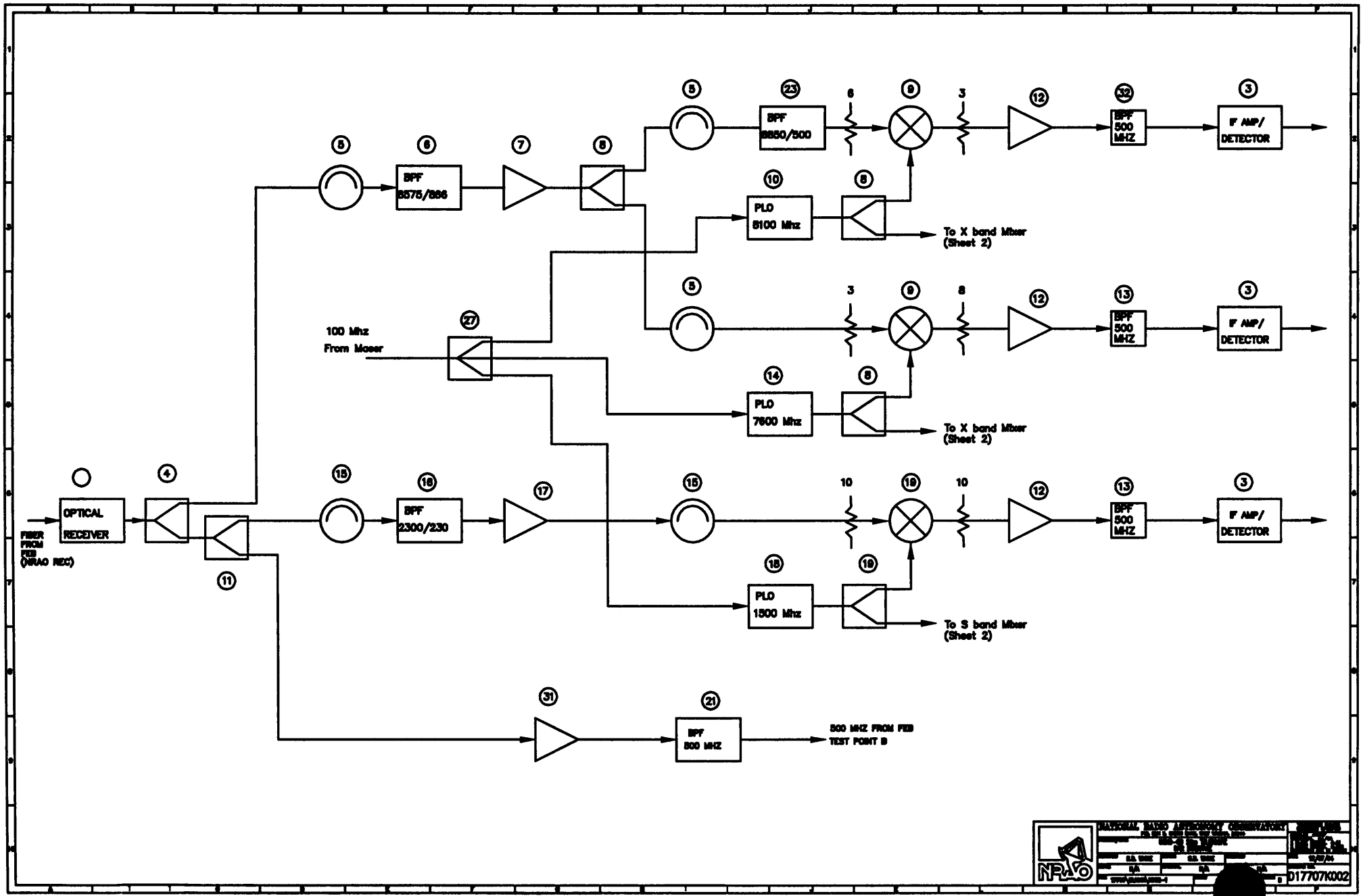
ITM	QTY	DESCRIPTION	PART NUMBER	MANUFACTURE
1	1	FE Block Diagram	B17707K001	NRAO
2	1	DAR Interface BLK DIA	B17707K002	NRAO
3	1	Front End Box	A17707B002	NRAO
4	1	DAR Interface	A17707B003	NRAO
5	1	Cryogenic System	A17707B004	NRAO
6	1	HP Vector Voltmeter	HP 8508A	Hewlett Packard

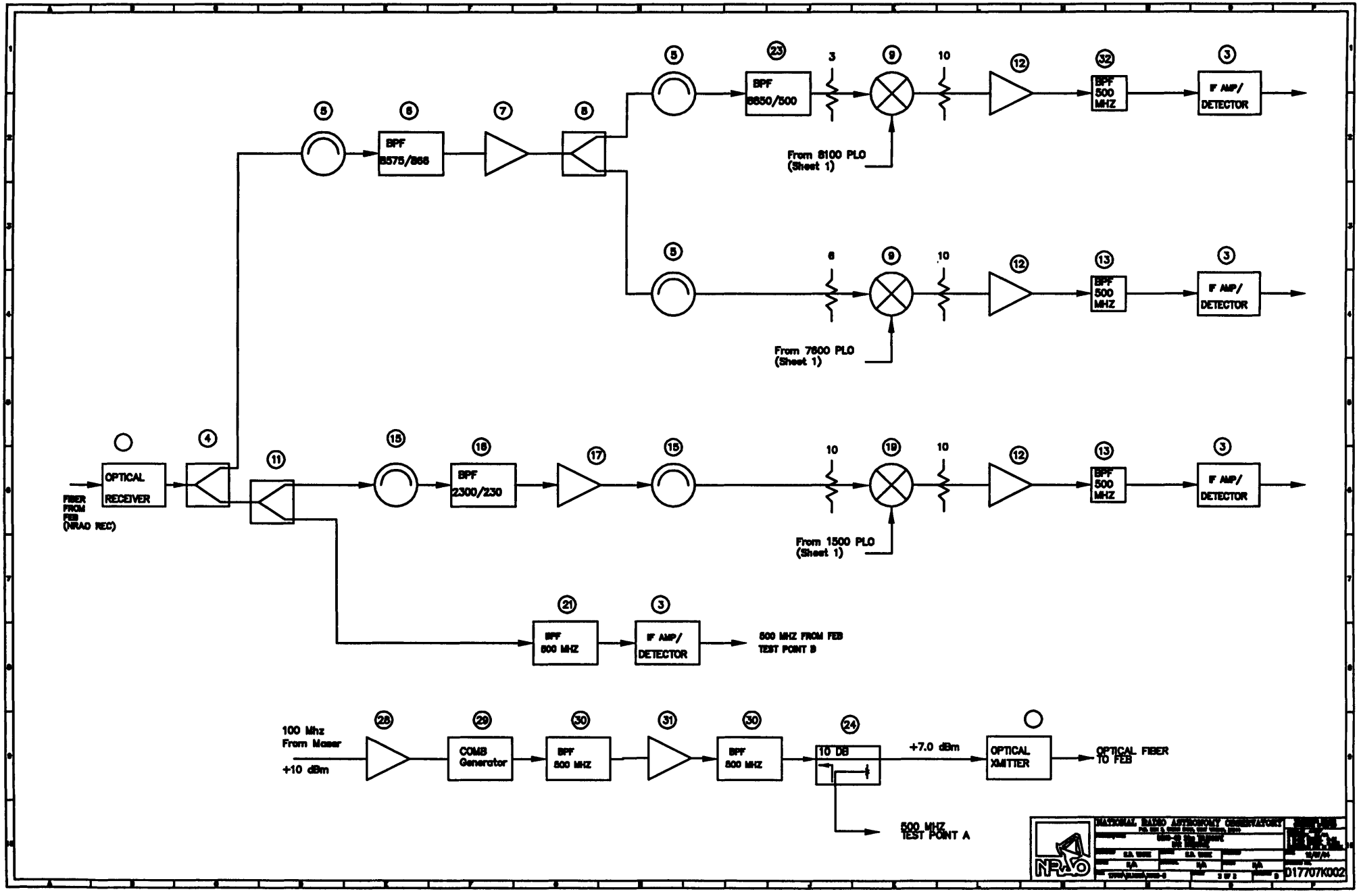

2
VACUUM DEWAR
G = 33 dB
3
Temperature Controlled RF Box
X-BAND RH POL
30DB CPLR
S-BAND RH POL
30DB CPLR
X-BAND LH POL
30DB CPLR
S-BAND LH. POL
30DB CPLR
1
S-BAND FEED
X-BAND FEED
BPF 8575/866 MHZ
1dB:+10
48dB
1dB:+24
24dB
10 dB
1dB:+20
50dB
1dB:+28
35dB
20 dB
BPF 2300/230 MHZ
FROM X-R CAL (SHEET 2)
FROM S-R CAL (SHEET 2)
FROM X-L CAL (Sheet 2)
From S-L CAL (SHEET 2)
500 Mhz Return (SHEET 2)
4
Lasertron Xmit
G= -38dB
1dB:+18
Single Mode Fiber
DAR Interface (Control Room)
D17707K001

A2


5 Temperature Controlled Phase Cal Box
X BAND CAL CNTRL
From M/C Interface
500 Mhz Return
(sheet 1)
X BAND
NOISE
SOURCE
-6 DB
6 DB
TO X-R CAL PORT
(Sheet 1)
6 DB
TO X-L CAL PORT
(Sheet 1)
OAR Interface
(Control Room)
Singlemode Fiber
Laser Diode
Rx
500 MHZ
PHASE
CALIBRTR
-10 DB
10 DB
TO S-R CAL PORT
(Sheet 1)
Phase Cal CNTRL
From M/C Interface
S BAND CAL CNTRL
From M/C Interface
S BAND
NOISE
SOURCE
-10 DB
-10 DB
10 DB
TO S-L CAL PORT
(Sheet 1)
NATIONAL RADIO ASTRONOMY OBSERVATORY
10/7/99
D17707K001

A3


OPTICAL RECEIVER
FIBER FROM FEB (NRAO REC)
BPF 8575/866
BPF 8850/500
BPF 2300/230
BPF 800 MHZ
PLO 8100 Mhz
PLO 7600 Mhz
PLO 1500 Mhz
100 Mhz From Moser
To X band Mixer (Sheet 2)
To X band Mixer (Sheet 2)
To S band Mixer (Sheet 2)
BPF 500 MHZ
IF AMP/ DETECTOR
800 MHZ FROM FEB TEST POINT B
D17707K002


BPF 8650/500
BPF 8575/868
From 8100 PLO (Sheet 1)
From 7600 PLO (Sheet 1)
From 1500 PLO (Sheet 1)
IF AMP/ DETECTOR
BPF 500 MHZ
OPTICAL RECEIVER
FIBER FROM FEB (NRAO REC)
BPF 2300/230
500 MHZ FROM FEB TEST POINT B
100 Mhz From Maser
+10 dBm
COMB Generator
10 DB
+7.0 dBm
OPTICAL XMITTER
OPTICAL FIBER TO FEB
500 MHZ TEST POINT A
D17707K002

Drawing Number: A17707B002 Date: 1/30/95
Title: Front End Box Rev: A

ITM	QTY	DESCRIPTION	PART NUMBER	MANUFACTURE
1	1	S/X Feed Assembly	A17222B010	NRAO
2	1	Cryogenic Assembly	A17707B004	NRAO
3	1	S/X Dewar	A17707B005	NRAO
4	1	RF Electronics	A17707B006	NRAO
5	2	Fiber Optic Transceiver	Qlink2-101	Lasertron
6	1	Phase Calibrator Box	A17707B011	NRAO
7	1	M/C Box	A17707B008	NRAO
8	12	AC Fans	A47-B15A-15T3-000	Globe Motors
9	2	+5 V Supply	LNS-Z-5-0V	Lambda
10	1	+/- 15 V Supply	LND-X-152	Lambda
11	1	+24 V Supply	LRS-52-24	Lambda
12	1	+32 V Supply	B32GT50	Acopian
13	2	+15 V Supply	LZS-150-2	Lambda
14	1	Connector Plate	D17707M013	NRAO
15	10	Heater Cooler Modules	TPC-6-30F	SCI
16	4	FC/APC Pigtails	APC-1P-003	Seiko Inst
17	1	FC Jumper	SPC-1J-003	Seiko Inst
18	1	Splice Tray	M67-048	Siecor
19	24	1 Ft Semirigid	HC90000-1	Precision Tube
20	22	Coax Conn 201-1A	2001-5031-00	Omni-Spectra
21	1	DC Box Mount Recep	QWL 10-107224-79I	Bendix
22	1	AC Box Mount Recep	QWL 10-107224-79P	Bendix
23	1	4 Pr Box Mount Recep	QWL 10-107220-33P	Bendix
24	1	Rerig Drive Recep	QWL-10-10724-2P	Bendix
25	2	Helium Line Connector	5400-S2-8	Aeroquip
26	6	Receptical Cover	10-101063-20	Bendix

Drawing Number: A17707B010 Date: 3/29/93
Title: S/X Feed Rev: A

ITM	QTY	DESCRIPTION	PART NUMBER	MANUFACTURE
0	1	S/X Feed Assembly	D17222M005	NRAO
1	1	Large Feed Section	D17222M009	NRAO
2	1	Small Feed Section	D17222M010	NRAO
3	1	Tuning Section	D17222M011	NRAO
4	1	Polarizer	D17222M012	NRAO
4A	1	Dielectric Polarizer	D17222M013	NRAO
5	1	Orthomode Transducer	D17222M014	NRAO
6	1	Orthomode Transducer	D17222M014	NRAO
7	1	Back Short	D17222M015	NRAO
8	1	Iris(no drawing)	D17222M016	NRAO
9	1	Waveguide Shim	D17222M017	NRAO
10	1	W-Band WG Flange	D17222M018	NRAO
11	1	X-Band Cicular WG	D17222M019	NRAO
12	1	Dielectric Tuning Plug	D17222M020	NRAO
13	1	Dielectric Feed Cone	D17222M021	NRAO
14	1	Septum	D17222M022	NRAO
15	1	Front End Cabling Diagram	D17222M008	NRAO

Drawing Number: A17707B004 Date: 2/13/95
Title: Cryogenic Assembly Rev: A

ITM	QTY	DESCRIPTION	PART NUMBER	MANUFACTURE
1	1	Compressor Motor	38EV668500	Hitachi
2	1	Fan Motor	Grainger #3K747	GE
3	1	Fan Blade	Grainger #4C136	GE
4	1	By-Pass Regulator	ADRS2-0/80-1/2"ODF	Sporlan
5	2	Oil Coolers	#5458 & #5460	Valley Ind
6	1	Oil Seperator #1	#501	Temprite
7	3	Oil Seperator #2,3,4	#915A(+element)	Balston
8	1	Oil FIlter(Bulk)	#50221	Purolator
9	3	Oil Filter (Line)	B-2TF2-60	Nupro
10	1	Charging Valve	SS-4JBA	Nupro
11	1	Relief Valve	B-4CPA2-DR-150	Nupro
12	1	Check Valve	SS-CHS8-1/3	Nupro
13	1	Misc Fittings		Swagelor & Cayon
14	4	Signt Glasses	F151	Lube Devices
15	1	Pressure Gauges	G10128,G10129	Marshall town
16	2	Self Sealings FTGS	#5400-S2-8	Aeroquip
17	10	Tubing	1/2"	Williams Co
18	10	Tubing	3/8"	Williams Co
19	10	Tubing	1/4"	Williams Co
20	4	Casters	#995OT12	McMaster-Carr
21	1	Electronics Box	# 02254016	Rose Enclosures
22	1	Motor Starter	#A200-Micac	Aeroquip
23	1	Power Monitor	#258B	Time Mark
24	1	Time Delay Relay	New #56F959	Magna Craft
25	1	Lights,Swit,Relay,Conn		
26	1	Time Meter	Newark #35F3805	Cramer

Drawing Number: A17707B005 Date: 1/30/95
Title: Dewar Assembly Rev: A

ITM	QTY	DESCRIPTION	PART NUMBER	MANUFACTURE
1	1	Dewar Card Cage	A17211A002	NRAO
2	2	DC Feedthru Plate	A532006M008	NRAO
3	1	Dewar Body	D17211M011	NRAO
4	1	Dewar Cover Plate	D17211M012	NRAO
5	1	Dewar Feed Plate	D17211M010	NRAO
6	1	Elco-38 Bracket	B17211M028	NRAO
7	2	Heater Clamp	A53206M056	NRAO
8	1	Iris, X band Window Plate	A53206M055-01	NRAO
9	4	PCB, FET Bias	D53200A002	NRAO
10	1	PCB, Monitor	B17211A003	NRAO
11	1	PCB, Sensor	D53200A003	NRAO
12	1	Refrigerator Cylinder	D17211M025	NRAO
13	4	S band Transfer Plate	B17211M008	NRAO
14	2	S band Transition Plate	D17211M006	NRAO
15	12	S band Transition Support 1	B17211M009-01	NRAO
16	12	S band Transition Support 2	B17211M009-02	NRAO
17	2	S band Waveguide Assembly	C17211M005	NRAO
18	1	Shield 1	D17211M021	NRAO
19	1	Shield 2	D17211M022	NRAO
20	1	Shield 3	D17211M023	NRAO
21	1	Shield 4	C17211M024	NRAO
22	1	Strap, 70K	B17211M013	NRAO
23	1	Vacuum Feedthru	B17211M013	NRAO
24	1	X band Cylinder	D17211M015	NRAO
25	2	X band Polarizer Mount	D17211M014	NRAO
26	4	X band Transition Support	B17211M009-03	NRAO
27	1	X band Waveguide	B17211M017	NRAO
28	1	X band Window	A53206M054-01	NRAO
29	1	X band Window Plate	D17211M016	NRAO
30	2	X band Amplifier		NRAO
31	2	S band Amplifier	S-2.3-30H	Berkshire
32	1	DC FeedThru Conn	DTIH16-23PN	Detoronics
33	1	DC FeedThru Conn	MS3116F16-235	Detoronics
34	110	Brass Wire, 32 AWG insulated		MWS Wire
35	20	Coax, 0.085 SS	JS-50085	Pres. Tube
36	4	Connector, FET Bias	EP-7S-1	Mircotech
37	2	Coupler, X band 30 dB	C3206-30	Mac Tech
38	2	Cryogenic Temp Sensor	DT-471-DI	Lake Shore
39	0	Epoxy	A-12	Armstrong
40	2	Heater Unit 50W 120V	SC252	Hotwatt
41	0	Heater Wire (Individual Wires)	MS-7	Mircotech
42	2	Isolator X band	ASI7011-3	ST MW
43	2	O-Ring 350 Refrig Cylinder	2-246	Parker
44	4	O-Ring, DC Feedthru	2-130	Parker
45	2	O-Ring Dewar Covers	2-283	Parker
46	2	O-Ring S band Waveguide	2-244	Parker
47	1	O-Ring Vacuum Feedthru	2-118	Parker
48	2	O-Ring X band Cylinder	2-250	Parker
49	1	Polarizer X band	AMC0881	ATL MW
50	1	Quick Release Clamp KF-50	18345	Leybold
51	1	Refrigerator	Model 350	CTI
52	2	S band Waveguide Assembly	LA40-3A	MRC
53	16	SMA Conn 085 Crimp-On	2001-7685-02	Omni-Spec
54	8	SMA Conn 141 Crimp-On	2001-7641-02	Omni-Spec
55	8	SMA Feedthru Hermetic	208A	Omni-Spec
56	2	Termination Cal Coupler	SM8018-6005	Solitron
57	2	Thermostat	2450-B201A-T107	Elmwood
58	1	Vacuum Sensor	DV-6R	Tel-Hast
59	1	Vacuum Valve	FD-ILS-62	Vacoa
60	3	1 Ft Copper 0.141	HC90000-1	Presicion Tube

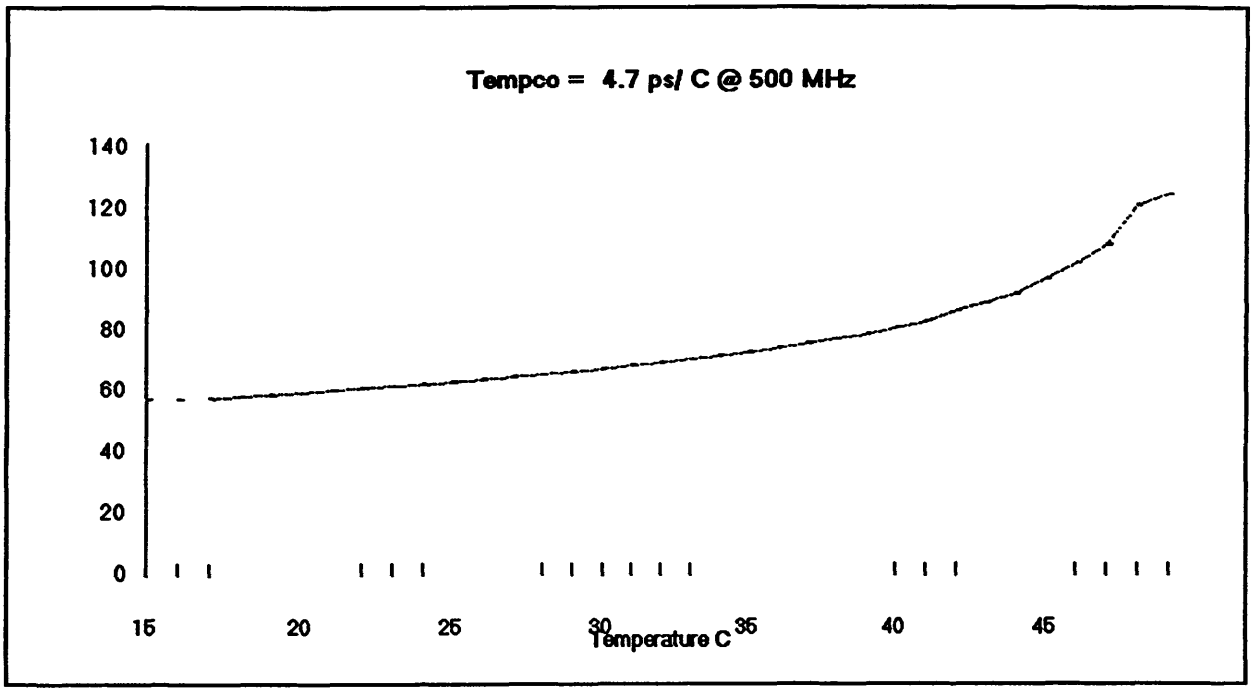


FIGURE 1. Temperature Coefficient of Phase Calibrator

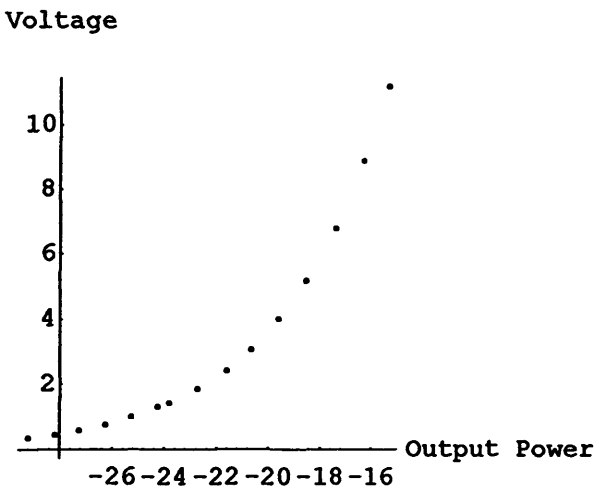
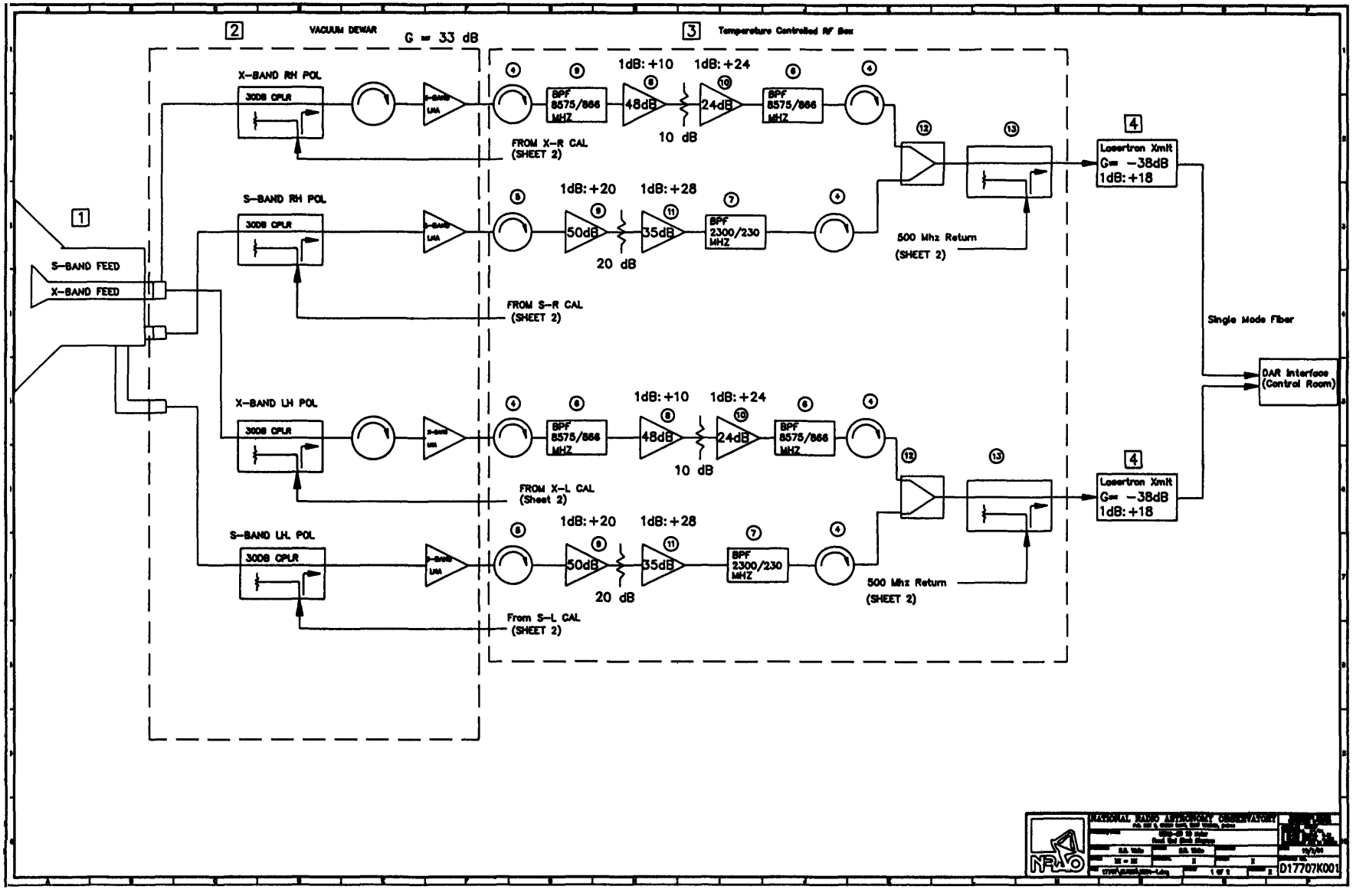


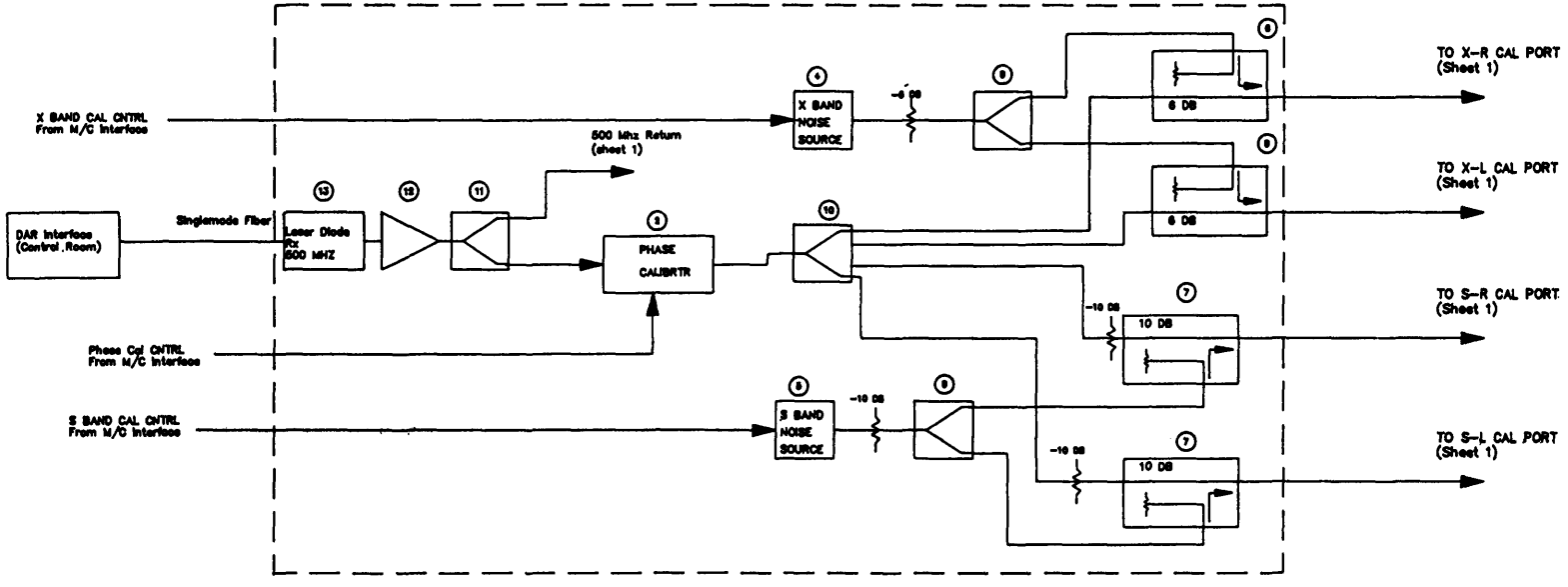
FIGURE 2. Power Detector Response Curve

Drawing Number: A17707B001 Date: 1/30/95
Title: Receiver System Rev: A

ITM	QTY	DESCRIPTION	PART NUMBER	MANUFACTURE
1	1	FE Block Diagram	B17707K001	NRAO
2	1	DAR Interface BLK DIA	B17707K002	NRAO
3	1	Front End Box	A17707B002	NRAO
4	1	DAR Interface	A17707B003	NRAO
5	1	Cryogenic System	A17707B004	NRAO
6	1	HP Vector Voltmeter	HP 8508A	Hewlett Packard


2
VACUUM DEWAR
G = 33 dB
3
Temperature Controlled RF Box
X-BAND RH POL
30DB CPLR
FROM X-R CAL
(SHEET 2)
S-BAND RH POL
30DB CPLR
FROM S-R CAL
(SHEET 2)
X-BAND LH POL
30DB CPLR
FROM X-L CAL
(Sheet 2)
S-BAND LH POL
30DB CPLR
From S-L CAL
(SHEET 2)
1
S-BAND FEED
X-BAND FEED
BPF
8575/866
MHZ
1dB: +10
48dB
1dB: +24
24dB
10 dB
1dB: +20
50dB
1dB: +28
35dB
20 dB
BPF
2300/230
MHZ
500 Mhz Return
(SHEET 2)
4
Lasertron Xmit
G= -38dB
1dB: +18
Single Mode Fiber
DAR Interface
(Control Room)
A2
NRAO
D17707K001

5 Temperature Controlled Phase Cal Box

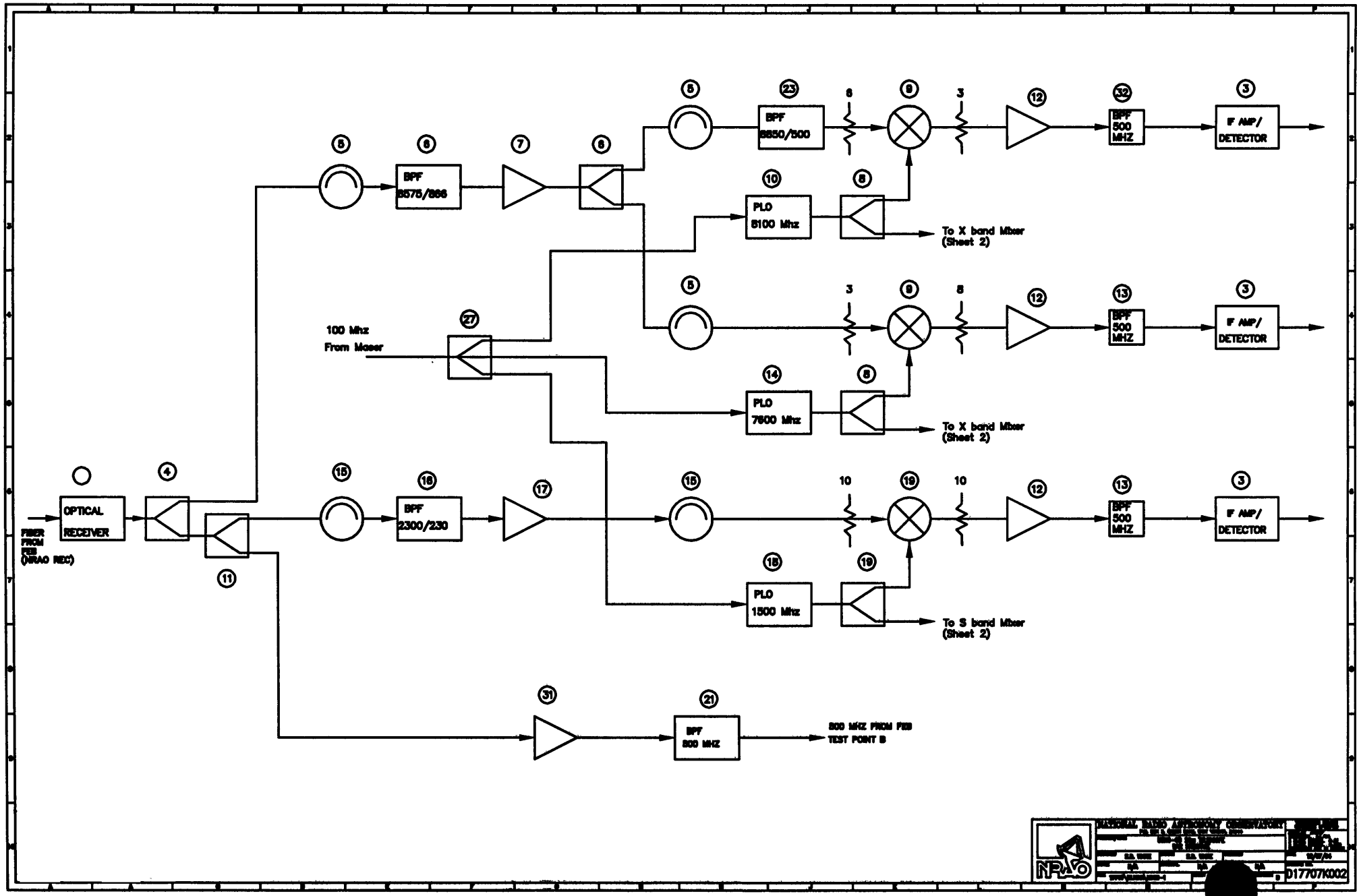


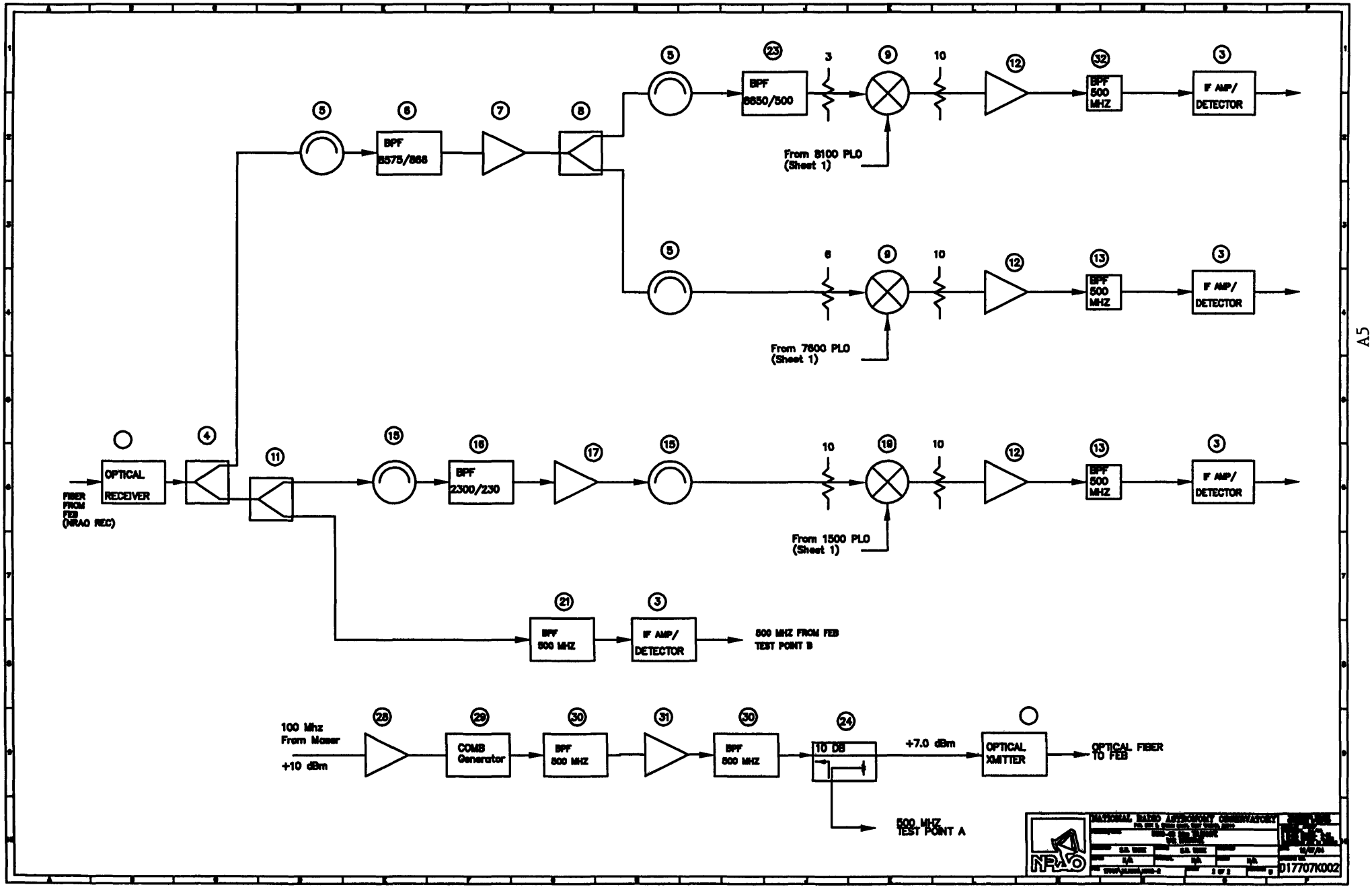
NATIONAL RADIO ASTRONOMY OBSERVATORY

11/1/94

D17707K001

A3


OPTICAL RECEIVER
FIBER FROM FEB (NRAO REC)
BPF 8575/866
BPF 8850/500
PLO 8100 Mhz
To X band Mixer (Sheet 2)
100 Mhz From Maser
PLO 7600 Mhz
To X band Mixer (Sheet 2)
BPF 2300/230
PLO 1500 Mhz
To S band Mixer (Sheet 2)
BPF 500 MHZ
IF AMP/ DETECTOR
BPF 800 MHZ
800 MHZ FROM FEB TEST POINT B
D17707K002


OPTICAL RECEIVER
FIBER FROM FEB (NRAO REC)
BPF 8575/868
BPF 8650/500
From 8100 PLO (Sheet 1)
BPF 500 MHZ
IF AMP/ DETECTOR
From 7600 PLO (Sheet 1)
BPF 2300/230
From 1500 PLO (Sheet 1)
BPF 500 MHZ
IF AMP/ DETECTOR
500 MHZ FROM FEB TEST POINT B
100 Mhz From Maser
+10 dBm
COMB Generator
BPF 500 MHZ
BPF 500 MHZ
10 DB
+7.0 dBm
OPTICAL XMITTER
OPTICAL FIBER TO FEB
500 MHZ TEST POINT A
017707K002

A5

Drawing Number: A17707B002 Date: 1/30/95
Title: Front End Box Rev: A

ITM	QTY	DESCRIPTION	PART NUMBER	MANUFACTURE
1	1	S/X Feed Assembly	A17222B010	NRAO
2	1	Cryogenic Assembly	A17707B004	NRAO
3	1	S/X Dewar	A17707B005	NRAO
4	1	RF Electronics	A17707B006	NRAO
5	2	Fiber Optic Transceiver	Qlink2-101	Lasertron
6	1	Phase Calibrator Box	A17707B011	NRAO
7	1	M/C Box	A17707B008	NRAO
8	12	AC Fans	A47-B15A-15T3-000	Globe Motors
9	2	+5 V Supply	LNS-Z-5-0V	Lambda
10	1	+/- 15 V Supply	LND-X-152	Lambda
11	1	+24 V Supply	LRS-52-24	Lambda
12	1	+32 V Supply	B32GT50	Acopian
13	2	+15 V Supply	LZS-150-2	Lambda
14	1	Connector Plate	D17707M013	NRAO
15	10	Heater Cooler Modules	TPC-6-30F	SCI
16	4	FC/APC Pigtails	APC-1P-003	Seiko Inst
17	1	FC Jumper	SPC-1J-003	Seiko Inst
18	1	Splice Tray	M67-048	Siecor
19	24	1 Ft Semirigid	HC90000-1	Precision Tube
20	22	Coax Conn 201-1A	2001-5031-00	Omni-Spectra
21	1	DC Box Mount Recep	QWL 10-107224-79I	Bendix
22	1	AC Box Mount Recep	QWL 10-107224-79P	Bendix
23	1	4 Pr Box Mount Recep	QWL 10-107220-33P	Bendix
24	1	Rerig Drive Recep	QWL-10-10724-2P	Bendix
25	2	Helium Line Connector	5400-S2-8	Aeroquip
26	6	Receptical Cover	10-101063-20	Bendix

Drawing Number: A17707B010 Date: 3/29/93
Title: S/X Feed Rev: A

ITM	QTY	DESCRIPTION	PART NUMBER	MANUFACTURE
0	1	S/X Feed Assembly	D17222M005	NRAO
1	1	Large Feed Section	D17222M009	NRAO
2	1	Small Feed Section	D17222M010	NRAO
3	1	Tuning Section	D17222M011	NRAO
4	1	Polarizer	D17222M012	NRAO
4A	1	Dielectric Polarizer	D17222M013	NRAO
5	1	Orthomode Transducer	D17222M014	NRAO
6	1	Orthomode Transducer	D17222M014	NRAO
7	1	Back Short	D17222M015	NRAO
8	1	Iris(no drawing)	D17222M016	NRAO
9	1	Waveguide Shim	D17222M017	NRAO
10	1	W-Band WG Flange	D17222M018	NRAO
11	1	X-Band Cicular WG	D17222M019	NRAO
12	1	Dielectric Tuning Plug	D17222M020	NRAO
13	1	Dielectric Feed Cone	D17222M021	NRAO
14	1	Septum	D17222M022	NRAO
15	1	Front End Cabling Diagram	D17222M008	NRAO

Drawing Number: A17707B004 Date: 2/13/95
Title: Cryogenic Assembly Rev: A

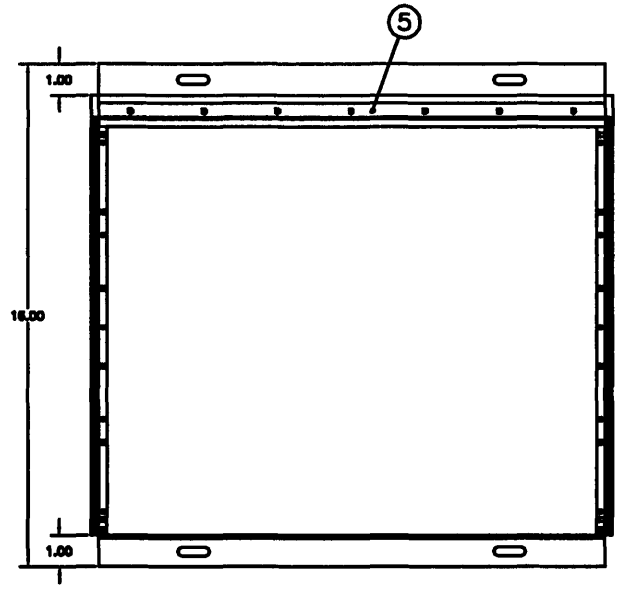
ITM	QTY	DESCRIPTION	PART NUMBER	MANUFACTURE
1	1	Compressor Motor	38EV668500	Hitachi
2	1	Fan Motor	Grainger #3K747	GE
3	1	Fan Blade	Grainger #4C136	GE
4	1	By-Pass Regulator	ADRS2-0/80-1/2"ODF	Sporlan
5	2	Oil Coolers	#5458 & #5460	Valley Ind
6	1	Oil Seperator #1	#501	Temprite
7	3	Oil Seperator #2,3,4	#915A(+element)	Balston
8	1	Oil FIlter(Bulk)	#50221	Purolator
9	3	Oil Filter (Line)	B-2TF2-60	Nupro
10	1	Charging Valve	SS-4JBA	Nupro
11	1	Relief Valve	B-4CPA2-DR-150	Nupro
12	1	Check Valve	SS-CHS8-1/3	Nupro
13	1	Misc Fittings		Swagelor & Cayon
14	4	Signt Glasses	F151	Lube Devices
15	1	Pressure Gauges	G10128,G10129	Marshall town
16	2	Self Sealings FTGS	#5400-S2-8	Aeroquip
17	10	Tubing	1/2"	Williams Co
18	10	Tubing	3/8"	Williams Co
19	10	Tubing	1/4"	Williams Co
20	4	Casters	#995OT12	McMaster-Carr
21	1	Electronics Box	# 02254016	Rose Enclosures
22	1	Motor Starter	#A200-Micac	Aeroquip
23	1	Power Monitor	#258B	Time Mark
24	1	Time Delay Relay	New #56F959	Magna Craft
25	1	Lights,Swit,Relay,Conn		
26	1	Time Meter	Newark #35F3805	Cramer

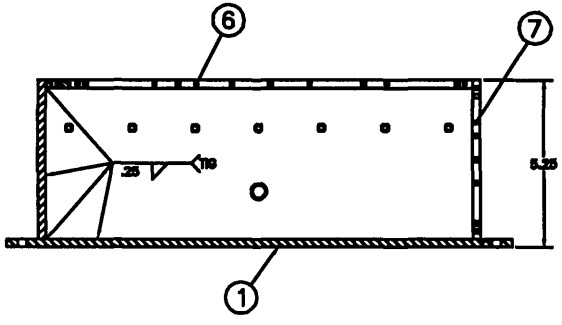
Drawing Number: A17707B005 Date: 1/30/95
Title: Dewar Assembly Rev: A

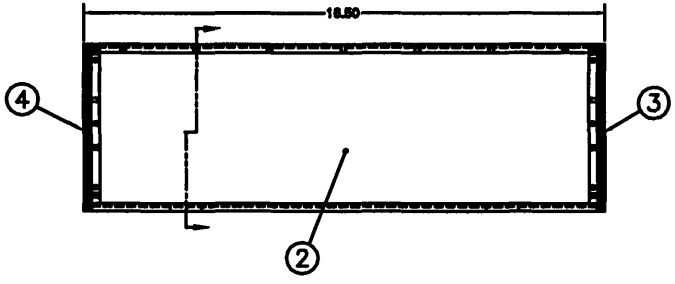
ITM	QTY	DESCRIPTION	PART NUMBER	MANUFACTURE
1	1	Dewar Card Cage	A17211A002	NRAO
2	2	DC Feedthru Plate	A532006M008	NRAO
3	1	Dewar Body	D17211M011	NRAO
4	1	Dewar Cover Plate	D17211M012	NRAO
5	1	Dewar Feed Plate	D17211M010	NRAO
6	1	Elco-38 Bracket	B17211M028	NRAO
7	2	Heater Clamp	A53206M056	NRAO
8	1	Iris, X band Window Plate	A53206M055-01	NRAO
9	4	PCB, FET Bias	D53200A002	NRAO
10	1	PCB, Monitor	B17211A003	NRAO
11	1	PCB, Sensor	D53200A003	NRAO
12	1	Refrigerator Cylinder	D17211M025	NRAO
13	4	S band Transfer Plate	B17211M008	NRAO
14	2	S band Transition Plate	D17211M006	NRAO
15	12	S band Transition Support 1	B17211M009-01	NRAO
16	12	S band Transition Support 2	B17211M009-02	NRAO
17	2	S band Waveguide Assembly	C17211M005	NRAO
18	1	Shield 1	D17211M021	NRAO
19	1	Shield 2	D17211M022	NRAO
20	1	Shield 3	D17211M023	NRAO
21	1	Shield 4	C17211M024	NRAO
22	1	Strap, 70K	B17211M013	NRAO
23	1	Vacuum Feedthru	B17211M013	NRAO
24	1	X band Cylinder	D17211M015	NRAO
25	2	X band Polarizer Mount	D17211M014	NRAO
26	4	X band Transition Support	B17211M009-03	NRAO
27	1	X band Waveguide	B17211M017	NRAO
28	1	X band Window	A53206M054-01	NRAO
29	1	X band Window Plate	D17211M016	NRAO
30	2	X band Amplifier		NRAO
31	2	S band Amplifier	S-2.3-30H	Berkshire
32	1	DC FeedThru Conn	DTIH16-23PN	Detoronics
33	1	DC FeedThru Conn	MS3116F16-235	Detoronics
34	110	Brass Wire, 32 AWG insulated		MWS Wire
35	20	Coax, 0.085 SS	JS-50085	Pres. Tube
36	4	Connector, FET Bias	EP-7S-1	Mircotech
37	2	Coupler, X band 30 dB	C3206-30	Mac Tech
38	2	Cryogenic Temp Sensor	DT-471-DI	Lake Shore
39	0	Epoxy	A-12	Armstrong
40	2	Heater Unit 50W 120V	SC252	Hotwatt
41	0	Heater Wire (Individual Wires)	MS-7	Mircotech
42	2	Isolator X band	ASI7011-3	ST MW
43	2	O-Ring 350 Refrig Cylinder	2-246	Parker
44	4	O-Ring, DC Feedthru	2-130	Parker
45	2	O-Ring Dewar Covers	2-283	Parker
46	2	O-Ring S band Waveguide	2-244	Parker
47	1	O-Ring Vacuum Feedthru	2-118	Parker
48	2	O-Ring X band Cylinder	2-250	Parker
49	1	Polarizer X band	AMC0881	ATL MW
50	1	Quick Release Clamp KF-50	18345	Leybold
51	1	Refrigerator	Model 350	CTI
52	2	S band Waveguide Assembly	LA40-3A	MRC
53	16	SMA Conn 085 Crimp-On	2001-7685-02	Omni-Spec
54	8	SMA Conn 141 Crimp-On	2001-7641-02	Omni-Spec
55	8	SMA Feedthru Hermetic	208A	Omni-Spec
56	2	Termination Cal Coupler	SM8018-6005	Solitron
57	2	Thermostat	2450-B201A-T107	Elmwood
58	1	Vacuum Sensor	DV-6R	Tel-Hast
59	1	Vacuum Valve	FD-ILS-62	Vacoa
60	3	1 Ft Copper 0.141	HC90000-1	Presicion Tube

Drawing Number: A17707B006 Date: 1/30/95
Title: RF Electronic Box Rev: A

ITM	QTY	DESCRIPTION	PART NUMBER	MANUFACTURE
1	1	RF Enclosure	D17707M005	NRAO
2	1	Block Diagram	D17707K001	NRAO
3	1	Temperature Control	A17707B009	NRAO
4	4	X Band Isolator	9-8012-11	Applied Eng
5	4	S Band Isolator	9-2040-11	Applied Eng
6	4	8575 Mhz BPF	3C2-8575-1000-S11	Reactel
7	2	2300 Mhz BPF	5B2-2300-230-S11	Reactel
8	2	X Amplifier Hi Gain	JCA812-600N	JCA
9	2	S Amplifier Hi Gain	S934061	MilliWave
10	2	X Amplifier Hi Power	JCA812-305	JCA
11	2	S Amplifier Hi Power	A2P2520	Cougar
12	2	Wideband Splitter	4456-2	Narda
13	2	Wideband Coupler	42610	Narda
14	5	Coaxial FeedThru	2084-0000-02	Omni-Specra
15	9	1 ft 0.141 Semi-rigid	HC90000-1	Precision Tube
16	56	OSM 201-1A Conn	2001-5031-00	Omni-Spectra
17	1	7 Pin Connector		Amphenol
18	4	20 dB Coaxial Atten	263-20	Midwest







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PARTS LIST

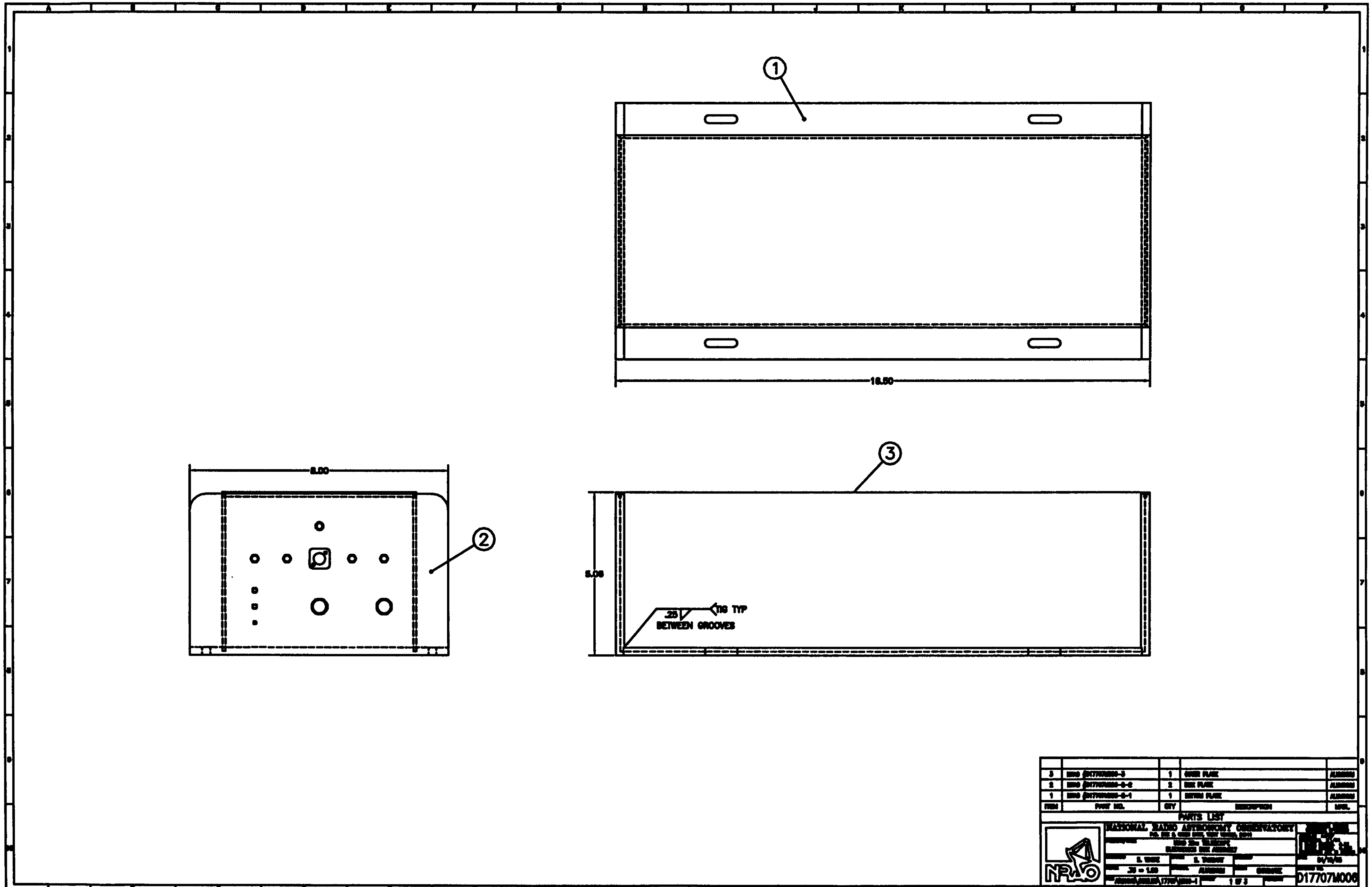
NATIONAL RADIO ASTRONOMY OBSERVATORY

D17707M005

A11

Drawing Number: A17707B011 Date:1/24/95
Title: Phase Calibrator Box Rev: A

ITM	QTY	DESCRIPTION	PART NUMBER	MANUFACTURE
1	1	Block Diagram	D17707K001	NRAO
2	1	Temp Controlled Box	B17707M006	NRAO
3	1	Phase Cal Module	B17707B012	NRAO
4	1	Temp Control	B17707B009	NRAO
5	1	X Band Noise Source	NC3206F	Noise/Com
6	1	S Band Noise Source	NC3204F	Noise/Com
7	2	6 dB Coupler (X Band)	4015C-6	Narda
8	2	10 dB Coupler (S Band)	4013C-10	Narda
9	2	X Band Splitter	4314-2	Narda
10	2	S Band Splitter	4324-2	Narda
11	1	Wideband Splitter -4	4426-4	Narda
12	1	500 Mhz Splitter	4321-2	Narda
13	1	500 Mhz Amplifier	QBH-9-812	Q-Bit
14	1	General Optics Receiver	AS/ALS	General Optics
15	1	Optical APC Feedthru	944-120-6000	Amphenol
16	1	7 Pin Connector		
17	5	Coaxial Feedthru	2084-0000-02	Omni-Spectra
18	32	OSM 201-1A Conn	2001-5031-00	Omni-Spectra
19	1	5 Pin Connector		
20	1	20 dB coaxial atten	263-20	MidWest
21	1	10 dB coaxial atten	263-10	MidWest
22	1	6 dB coaxial atten	263-6	MidWest
23	9	1 ft 0.141 semi-rigid	HC90000-1	Precision Tube



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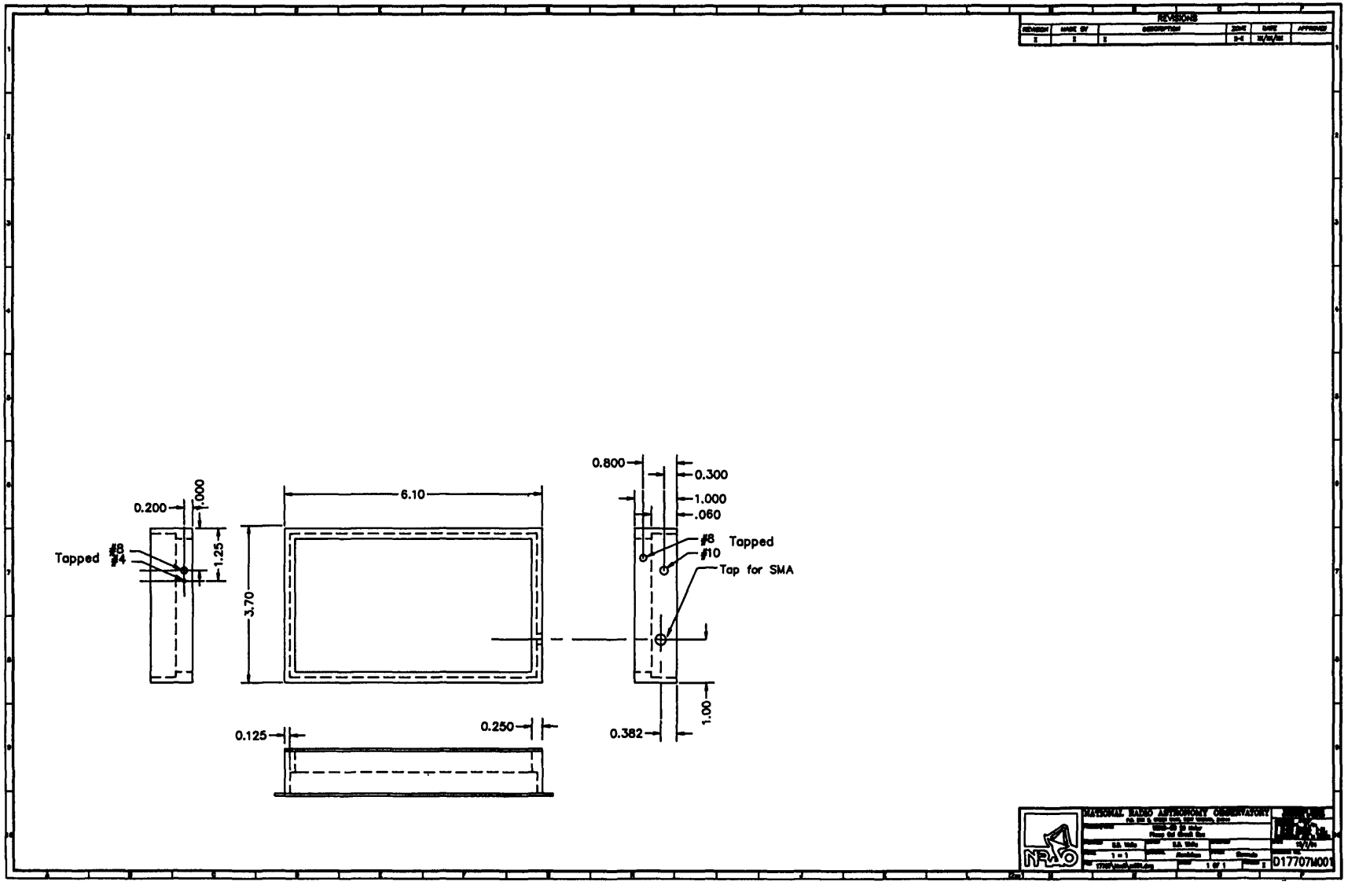
Drawing Number: A17707B012 Date:1/24/95
Title: Phase Calibrator Module Rev: A

ITM	QTY	DESCRIPTION	PART NUMBER	MANUFACTURE
1	1	Schematic	B17707S001	NRAO
2	1	PC Art Work	B17707Q011	NRAO
3	1	PC Board Box	B17707M001	NRAO
4	1	Tunnel Diode	SMTD 1017	Germanium Devices
5	1	Connector Block	131-0741-00	Tektronix
6	1	SMA Feed Thru	131-0631-01	Tektronix
7	1	SMA Thread Nut	220-0531-02	Tektronix
8	1	Thumb Screw	213-0194-00	Tektronix
9	1	Spring	214-1073-01	Tektronix
10	1	Barrell Diode	131-1073-02	Tektronix
11	1	Pin Diode Switch	SS213DHS	Narda
12	1	Binary Counter	74HCT390	Motorola
13	1	CMOS NAND	74HCT00N	Motorola
14	1	Line Receiver	75140P	TI
15	1	Differential Receiver	MC10EL16D	Motorola
16	2	High Speed Dividers	8910	GEC Plessey
17	1	Darlington Transistor	2N6426	Motorola
18	1	Voltage Regulator	MC7805CT	Motorola
19	15	Chip Capacitor	C1210C392J5GAC	Sprague
20	15	Chip Capacitor	C1206C102J5GAC	Sprague
21	1	Amplifier	UTO-1005	Avantek
22	2	DC Cap Feed Through	1250-054	Murati Erie
23	1	DC Feed Through		Murati Erie
24	1	Coaxial Feed Through PO	51-475-0000-220	Sealectro
25	1	Coaxial Feed Through	901-9204	Amphenol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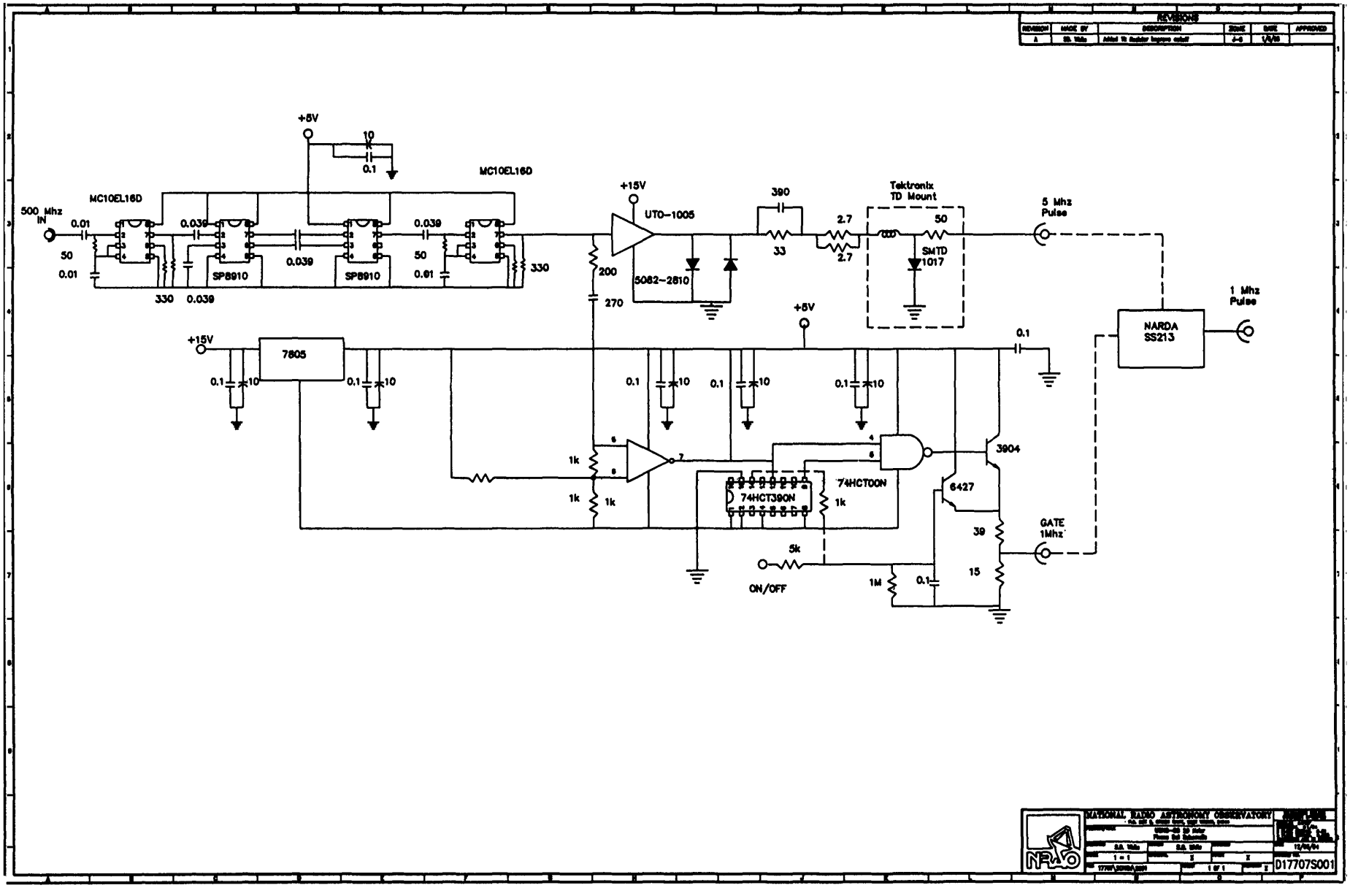
D17707M001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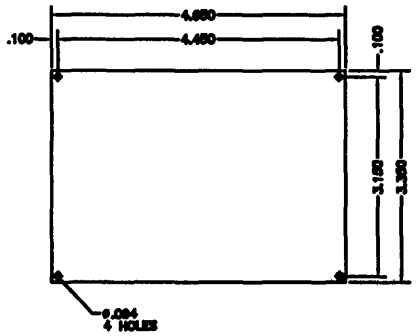
SP8910
0.039
50
0.01
330
330
0.039
+15V
UTO-1005
200
270
5082-2810
390
33
2.7
2.7
Tektronix TD Mount
50
SMTD 1017
5 Mhz Pulse
1 Mhz Pulse
NARDA SS213
+5V
+15V
7805
0.1
10
0.1
10
0.1
10
0.1
10
0.1
10
0.1
1k
1k
1k
74HCT00N
74HCT390N
1k
3904
6427
39
15
GATE 1Mhz
5k
ON/OFF
1M
0.1
NATIONAL RADIO ASTRONOMY OBSERVATORY
D17707S001

A16

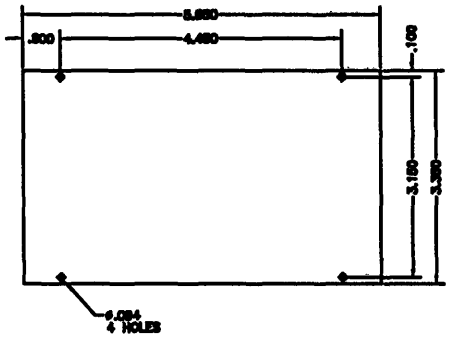
Drawing Number: A17707B009 Date: 1/30/95
Title: Component Box Temp Control Rev: A

ITM	QTY	DESCRIPTION	PART NUMBER	MANUFACTURE
1	1	Temp Cont Schematic	C17707S002	NRAO
2	1	Temp Cont PC Box	B17707M004	NRAO
3	1	PC Board Artwork	B17707Q002	NRAO
4	1	10 Volt Reference	REF01EZ	Analog Devices
5	1	10 K Pot	3299-103	Bourns
6	1	Thermistor 100K	140-104GAC	Fenwall
7	1	Op Amp	OP-27GN	Analog Devices
8	1	Dual Op Amp	LF442	National Semi
9	1	PNP Transistor	TIP147	Motorola
10	1	NPN Transistor	TIP 141	Motorola
11	4	Peltier Unit	CP1.4-127-06L	Melcor
12	1	1/4W 1% Resistor	RN55D-182K	Dale
13	4	1/4W 1% Resistor	RN55D-100K	Dale
14	2	1/4W 1% Resistor	RN55D-10K	Dale
15	1	1/4W 1% Resistor	RN55D-9.608K	Dale
16	1	1/4W 1% Resistor	RN55D-9.60K	Dale
17	2	1/4W 1% Resistor	RN55D-1.0K	Dale
18	2	1/4W 1% Resistor	3.0M	Dale
19	5	0.1 Cermanic Chip	1206Z104M500NT	Mallory
20	5	10 uF Tantalum	10.0 uF	595D686X0025R2T
21	3	DC Cap Feed Thru	1250-054	Murati Erie
22	1	Ground Lug		
23	3	8 Pin IC Socket	2-640463-3	



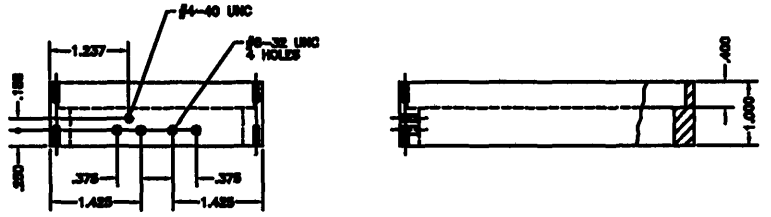
PART NO. -1 COVER PLATE

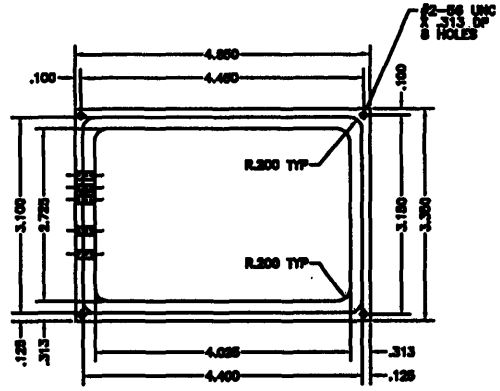
SCALE: FULL
MATERIAL: .062 THK ALUMINUM
FINISH: CHROMATE
REMOVE ALL BURRS & SHARP EDGES



PART NO. -2 BASE PLATE

SCALE: FULL
MATERIAL: .062 THK ALUMINUM
FINISH: CHROMATE
REMOVE ALL BURRS & SHARP EDGES





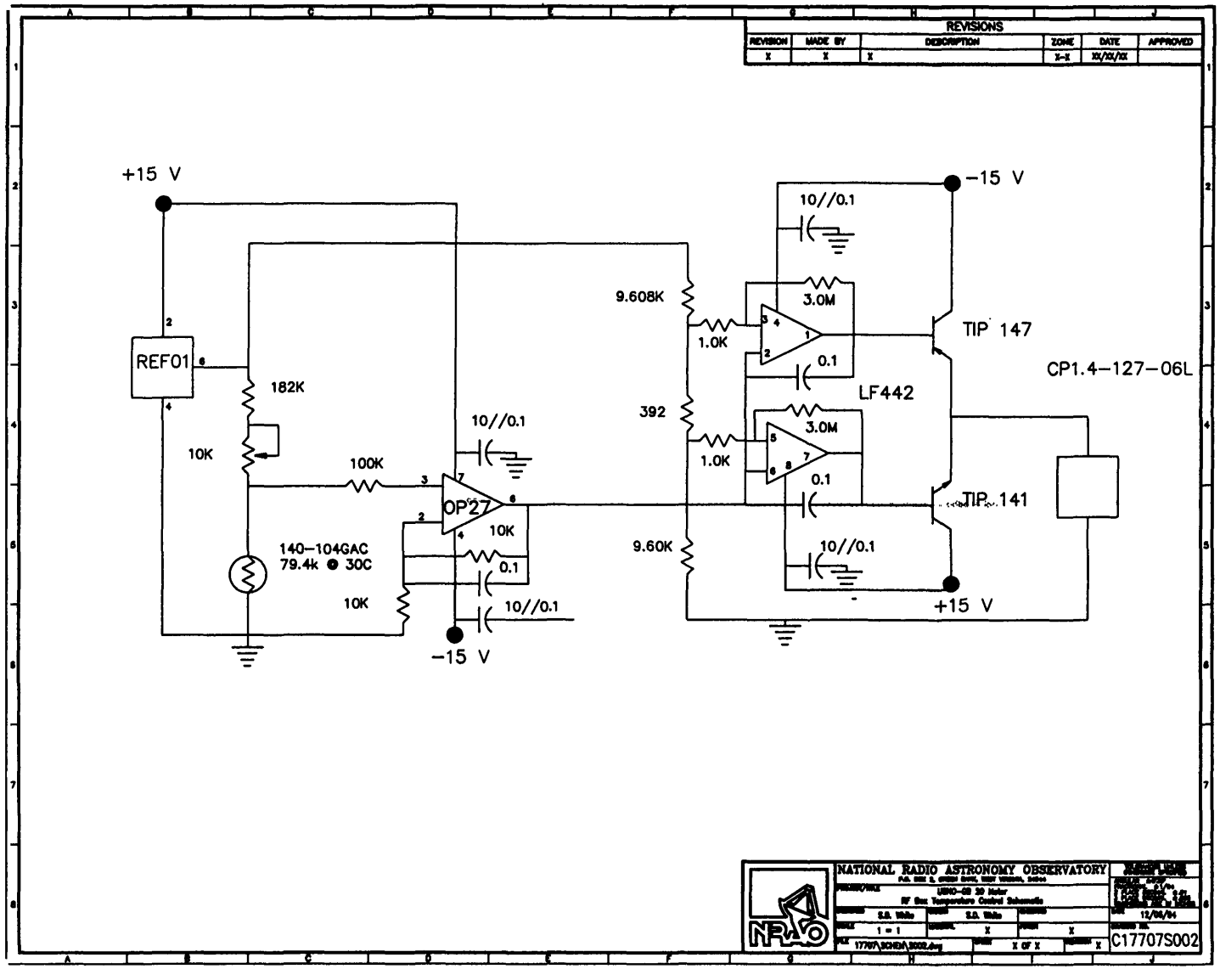
PART NO. -3 BOX BODY

SCALE: FULL
MATERIAL: ALUMINUM
FINISH: CHROMATE
REMOVE ALL BURRS & SHARP EDGES

NRAO

D17707M004

A18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APPROVED
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REF01
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10K
140-104GAC
79.4k @ 30C
100K
OP27
10//0.1
10K
0.1
10K
10//0.1
-15 V
9.608K
1.0K
3.0M
0.1
LF442
392
1.0K
3.0M
0.1
9.60K
10//0.1
-15 V
TIP 147
TIP 141
CP1.4-127-06L
+15 V
NATIONAL RADIO ASTRONOMY OBSERVATORY
C17707S002

Drawing Number: A17707B003 Date: 7/19/94
Title:DAR Interface Rack Rev: A

ITM	QTY	DESCRIPTION	PART NUMBER	MANUFACTURE
1	1	M\C Box	B17707B008	NRAO
2	2	DAR Interface	B17707B014	NRAO
3	1	Power Supply Drawer	B17707B016	NRAO

Drawing Number: A17707B008 Date: 1/30/95
Title: MCB Box Rev: A

ITM	QTY	DESCRIPTION	PART NUMBER	MANUFACTURE
1	1	Mechanical Box	B17222M024	NRAO
2	1	Analog Multiplex Card	B17222A009	NRAO
3	1	Receiver Control Card	A17222A008	NRAO
4	2	Fiber Optic Interface	XR-200A	Math Associates
5	1	Standard Interface Board	A55001B004	NRAO

Drawing Number: A17707B007 Date: 1/30/95
Title: Analog Multiplex Card Rev: A

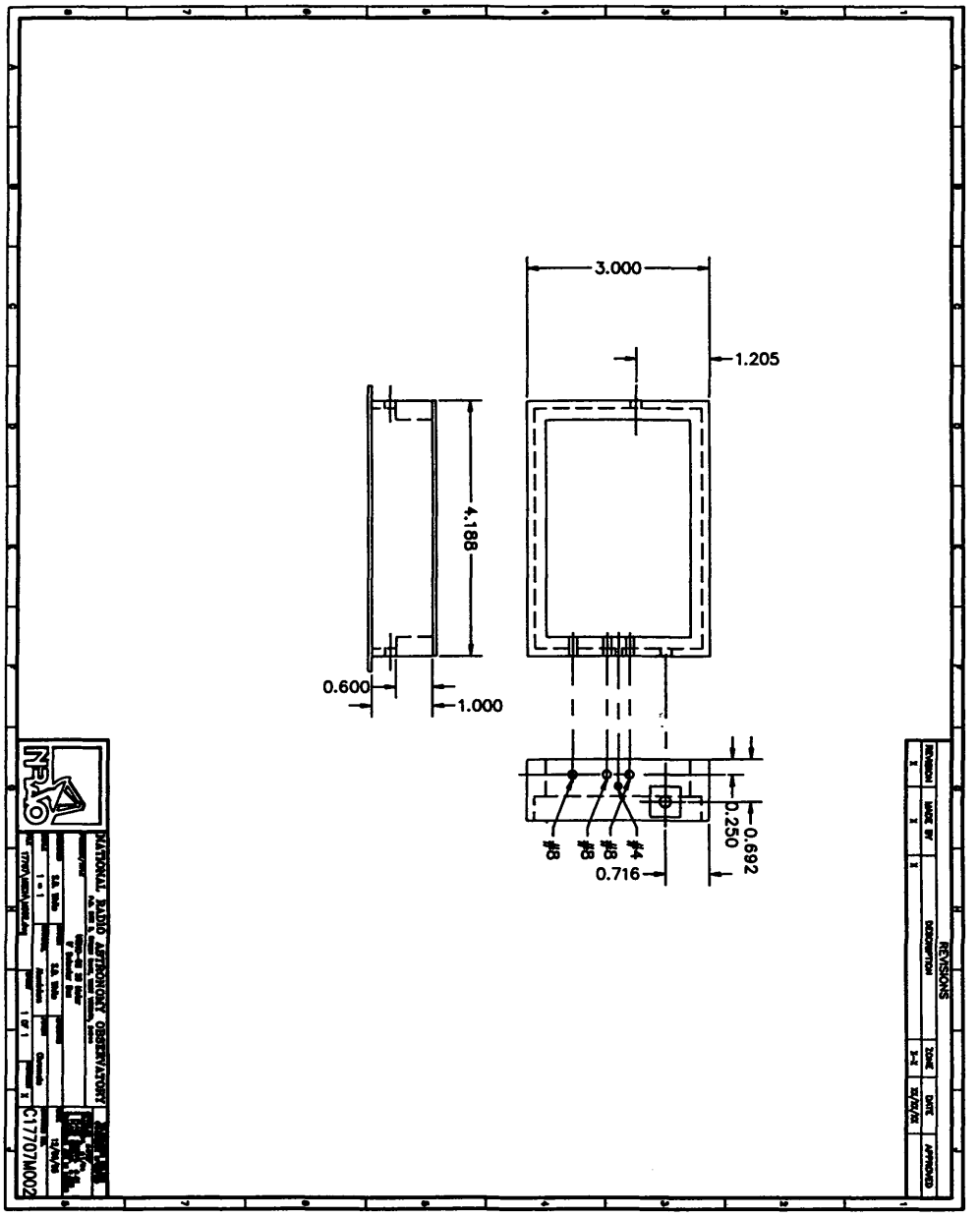
ITM	QTY	DESCRIPTION	PART NUMBER	MANUFACTURE
1	1	Schematic	A17222S008	NRAO
2	64	Silicon Diodes	1N914	Motorola
3	1	Zener Diode Z1	1N4740	Motorola
4	1	Zener Diode Z2	1N4720	Motorola
5	28	1/4 W 1% Film Res	511	Dale
6	28	1/4 W 1% Film Res	1M	Dale
7	2	1/4 W 1% Film Res	10K	Dale
8	4	1/4 W 1% Film Res	4.99K	Dale
9	1	1/4 W 1% Film Res	19.1K	Dale
10	2	1/4 W 1% Film Res	26.7K	Dale
11	2	22uF Tantalum Capacitor	TDC-226M025NFS	Mallory
12	8	Analog Multiplexer	MUX 08FS	Analog Devices

Drawing Number: A17707B013 Date: 1/30/95
Title: Receiver Control Card Rev: A

ITM	QTY	DESCRIPTION	PART NUMBER	MANUFACTURE
1	1	Schematic	A17222S007	NRAO
2	1	DIP Switch	SW DIP-8	
3	1	DIP Resistor Pack	R899-1-2K	Beckman
4	4	TTL Buffer	74LS244	TI
5	3	Decoder 3-8	74LS138	TI
6	1	4 input Nand	74LS20	TI
7	1	2 input Nand	74LS00	TI
8	1	Hex Inverter	74LS04	TI
9	1	D Flip-Flop	74LS374	TI
10	1	Diff Line Driver	DM8830	Signetics
11	1	Diff Line Receiver	UA9637	Signetics
12	1	Silicon Diode	1N914	Motorola
13	3	1/4 W 5% Carbon Res	10K	Dale
14	1	1/4 W 5% Carbon Res	470	Dale
15	1	22 uF Tantalum Cap	TDC-226M025NFS	Mallory

Drawing Number: A17707B010 Date: 1/30/95
Title: IF Amp Detector Rev: A

ITM	QTY	DESCRIPTION	PART NUMBER	MANUFACTURE
1	1	IF Amp Schematic	C17707S003	NRAO
2	1	IF Amp Box	C17707M002	NRAO
3	1	IF Amp	QBH-827	Qbit
4	1	10 dB Coupler	PDC-10-5	MiniCircuits
5	2	Op Amp	OP27GP	Analog Devices
6	1	Tunnel Diode	BD-4	GE
7	2	10 K Pot	3299-103	Bourns
8	1	1/4W 1% Resistor	RN55D-47	Dale
9	1	1/4W 1% Resistor	RN55D-2K	Dale
10	1	1/4W 1% Resistor	RN55D-475	Dale
11	1	1/4W 1% Resistor	RN55D-237K	Dale
12	1	1/4W 1% Resistor	RN55D-442K	Dale
13	7	0.1 Chip Cap	1206Z104M500NT	Mallory
14	4	10 uF Tantalum	595D686X0025R2T	Spargue
15	1	0.022 Chip Cap	0805B223K500NT	Mallory
16	1	1000 pF Chip Cap	0805B102K500NT	Mallory
17	1	0.47 Tantalum Cap	293D474X9025A2T	Mallory
18	2	Coaxial Feed Through	901-9204	Amphenol
19	3	DC Cap Feed Through	1250-054	Murati Erie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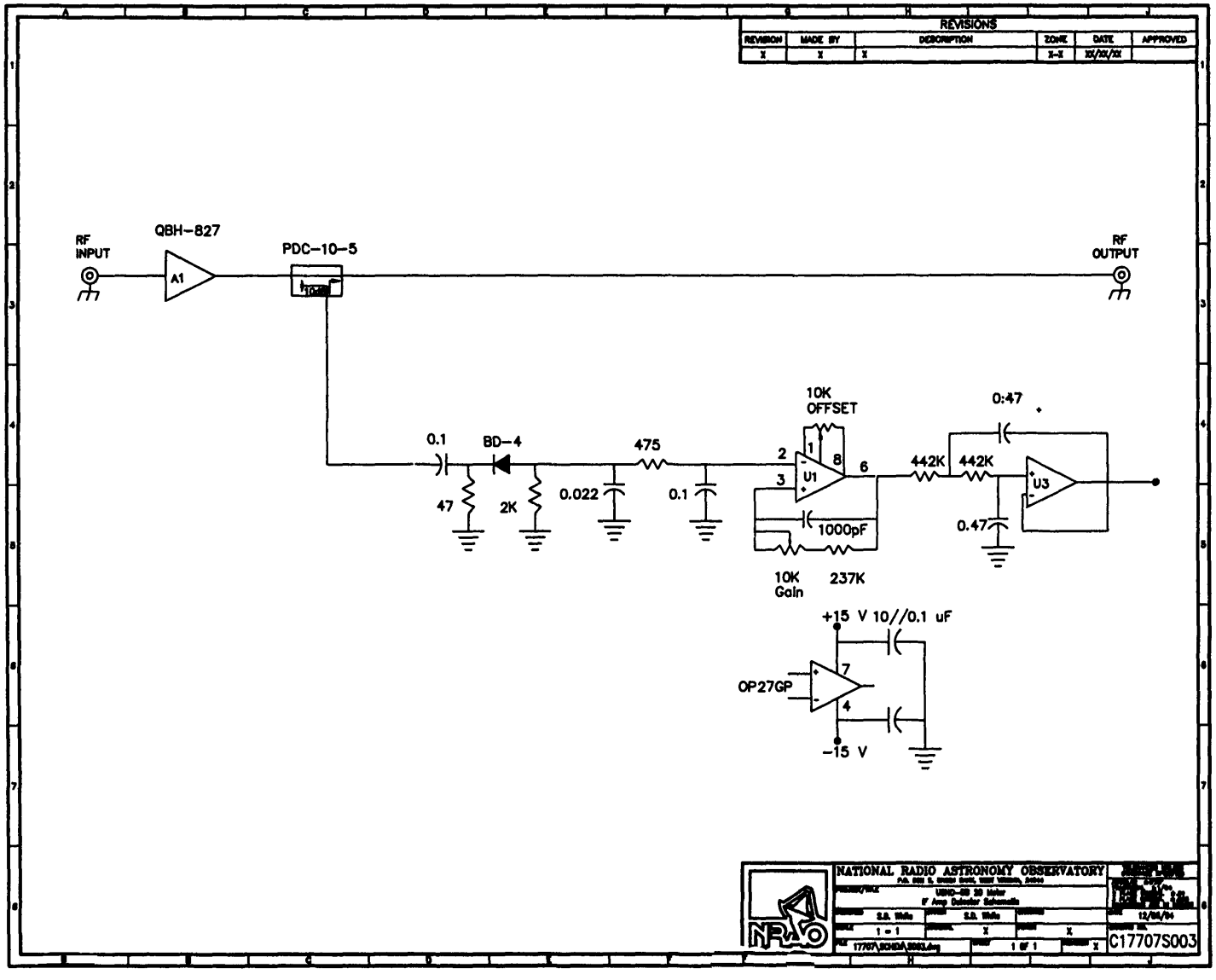
NRAO
NATIONAL RADIO ASTRONOMY OBSERVATORY
C17707M002
REVISIONS
DESCRIPTION
DATE
APPROVED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REVISION
MADE BY
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ZONE
DATE
APPROVED
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PDC-10-5
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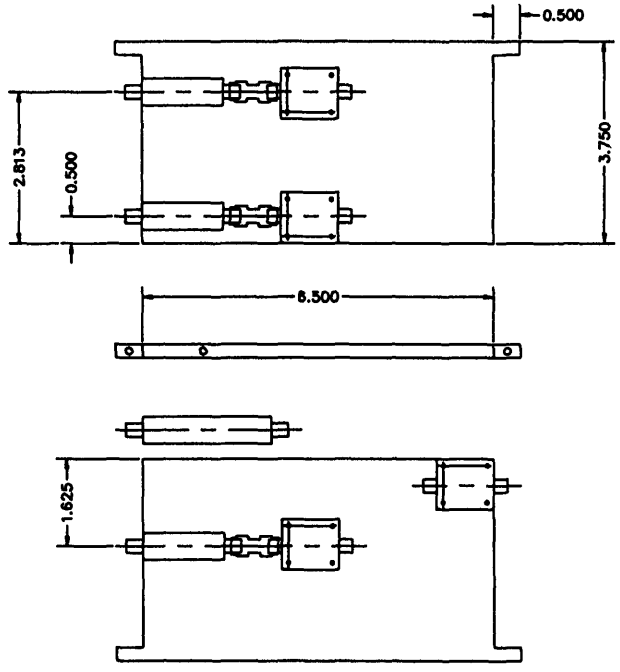
BD-4
47
2K
0.022
475
0.1
10K OFFSET
U1
1000pF
10K Gain
237K
442K
442K
0.47
0.47
U3
+15 V 10//0.1 uF
OP27GP
-15 V
NATIONAL RADIO ASTRONOMY OBSERVATORY
C17707S003

Drawing Number: A17707B014 Date: 7/19/94
Title:DAR Interface Rev: A

ITM	QTY	DESCRIPTION	PART NUMBER	MANUFACTURE
1	1	Block Diagram	D17707K002	NRAO
2	3	DAR Chassis Bracket	D17707M003	NRAO
3	6	IF Amp/Detector	B17707B010	NRAO
4	2	Wideband Splitter	4426-2	Narda
5	6	X Band Isolator	9-8012-11	Applied Eng
6	2	8575 Mhz BPF	3C2-8575-1000-S11	Reactel
7	2	X Band Amplifier	JCA812-600N	JCA
8	2	X band Splitter	4315-2	Narda
9	4	X band Mixer	M76HC	Watkins-Johnson
10	1	8100 PLO	PLM-8100-A-0-15P	Miteq
11	1	S band Splitter	4322-2	Narda
12	6	IF Amplifier	QBH-817	Q-Bit
13	6	500 Mhz BPF	6IB40-750/T400-0/0	K&L
14	1	7600 PLO	PLM-7600-A-0-15P	Miteq
15	4	S Band Isolator	9-2040-11	Applied Eng
16	2	2300 Mhz BPF	5B2-2300-230-S11	Reactel
17	2	S Band Amplifier	AMF-2B-2224-35	Miteq
18	1	1500 PLO	PLC-1500-A-0-15P	Miteq
19	2	S band Mixer	WJM8THC	Watkins-Johnson
20	1	General Optics Xmitter	ALS/AS	General Optics
21	1	500 Mhz BPF	3B120-500/U50-0/0	K&L
22	1	500 Mhz Amp	QB-817	Qbit
23	1	X Band Filter	5FV10-8850/E500-0/0	K&L
24	1	10 dB Coupler	ZFDC-10-2	Mini-Circuits
25	6	Step Attenuator	RA-50	Trilithic
26	1	Computer Interface		NRAO
27	1	100 Mhz Splitter	ZFSC-3-3	Mini Circuits
28	1	Power Amp	ZHL-2W-1	Mini Circuits
29	1	Comb Generator	33002A	HP
30	1	500 Mhz Filter	5B121-500/T50-0/0	K&L
31	2	500 Mhz Amp	QBH-9-812	QBit
32	2	500 Mhz BPF	6IB40-780/T400-0/0	K&L



D17707M003

Drawing Number: A17707B016 Date: 4/11/95
Title:Power Supply Drawer Rev: A

ITM	QTY	DESCRIPTION	PART NUMBER	MANUFACTURE
1	1	Power Supply Drawer	D17707M007	NRAO
2	1	-5 .2 V Supply	LNS-Z-5-0V	Lambda
3	1	+ 15 V Supply	LNS-P-15	Lambda
4	1	+24 V Supply	LRS-52-24	Lambda
5	1	-15 V Supply	LNS-Z-15	Lambda