

**NATIONAL RADIO ASTRONOMY OBSERVATORY
Green Bank, West Virginia**

**ELECTRONICS DIVISION INTERNAL REPORT
NO. 294**

HAWAII S AND X RECEIVER SYSTEM

S. D. WHITE

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1.0 General

This report documents the receiver system of the USNO 20 meter antenna located in Hawaii. The design is the same as the receiver systems used on the 85 foot antennas of the interferometer, with an increased bandwidth and other improvements. An electronics division internal report 287¹ documents the 85 foot receivers, and a paper² submitted to JPL gives a detail description of the components of the receiver.

The S/X band system receives the 2210 to 2345 and 8210 to 8932 MHz frequency bands and downconverts them to baseband. The receiver consists of a dual-band feed, which is a single corrugated horn with two circular waveguide concentric openings at the throat; a S/X four channel cryogenic dewar package³; front-end amplifiers, mixers and filters; an IF amplifier and detector module; a phase locked oscillator module, which generates all the front-end LO's; an analog optic module, which receives the 500 MHz reference and modulates the IF, along with the returned 500 MHz reference signal on to an optic fiber. The IF system is designed to accommodate a Mark III VLBI recorder, a VLBA DAR recorder, or the existing CDP receiver with either of the recorders. A list of drawing numbers is given in document A17222D001.

2.0 S and X Receiver Package

The receiver is mounted in a standard NRAO Green Bank front end box, 60" by 28" by 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. The block diagram and parts list of the receiver are given in documents B17222K001 and A17222B001, respectively. As shown on the block diagram, 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 low noise amplifier. After amplification in the low noise amplifier, the signals are limited in frequency by the band pass filters. The RF amplifiers increase the signal level ahead of the mixer to minimize the mixer contribution to the overall noise temperature. The Intermediate Frequency signals from the mixer are amplified and detected to get the total power for monitoring receiver performance. The X-R and S-R IF signals, along with the 500 MHz Local Oscillator reference signal, are combined in the IF triplexer.

2.1 S and X Feed

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 degree Kelvin. At X-band feed patterns predicted 60% aperture efficiency and less than 0.9 degree Kelvin spillover. The worst case axial ratio measurements and the feed performance is given in Table 1 and 2, respectively. An outline drawing of the feed and the parts list is given in documents D17222M005 and A17222B010, respectively.²

2.2 Dewar Assembly

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. Typical gain and noise temperatures for the S-band channels are 33 dB and 12 Kelvin. The X-band noise temperatures at the dewar flange are 14 Kelvin, with a gain of 35 dB.³

2.3 Phase Locked Oscillator Box

The local oscillator system generates the X-band and S-band LO signals by phase locking a 7600 MHz and 2000 MHz oscillator to a 100 MHz VCO. The fifth harmonic of the 100 MHz VCO, which is derived from a step recovery diode comb generator, is compared to a 500 MHz reference from the hydrogen maser, and the error signal is used to lock the VCO.

The local oscillators can be switched on and off from the control computer. This allows one to determine if offsets exist in the total power monitors used for system temperature measurements.

2.3.1 Phase Detector Module

A phase detector, loop amplifier and lock indicator module are used in the phase lock loop in the receiver front end. The schematic and parts list are given in B17222S002 and A17222B009, respectively. Signal and reference input levels are 0 dBm. The mixers M1 and M2 perform as phase detectors. The signal input to the lock detector mixer M2 is shifted 90 degrees by the lumped constant quarter wave transmission line so it's output is maximum when the oscillator and reference are locked. If the lock indicator level drops below -.5 volt level set by pot K1, power is applied to the 555 timer to generate a square wave. This signal is injected into the loop amplifier to sweep the oscillator frequency to aid in attaining lock. The phase lock loop natural frequency and damping are set by R14, C15 and R13.

2.4 Analog Optical Fiber Optic Link

The fiber optic link consists of the analog optic box located in the front-end box, the fiber optic cable connecting the front-end box with the control room electronic, and the optical receiver located in the VLBA interface. The analog optical box (A17222B005) houses the optical transmitter, an IF triplexer, two RF switches, and the optical receiver. One RF switch selects either the X-R or the X-L for input to the triplexer. The other RF switch selects either the S-R or the S-L input to the triplexer. The triplexer combines the selected X-band IF and the selected S-band IF with the returned 500 MHz reference. The transmitter and receiver operate at optical wavelength of 1300 nanometer. The laser diode transmitter is amplitude modulated by the radio frequency signals with a maximum frequency range of 10 to 1500 MHz. Single mode fibers are used to carry these broadband signals. To minimize the noise from the optical transmitters, the reflections in the fiber must be low. Low reflection optical connectors were installed on the transmitters and receivers. Fusion splices are used to interconnect all optical fibers. The fiber optic cable contains four single mode fibers for use with the analog links and four multimode fibers for digital links.

The rf transmission loss with the transmitter connected directly to the receiver is about 15 dB. The maximum input power level is +10 dBm, and with narrow band signals the S/N at the receiver is 120 dB/Hz. When broadband signals are transmitted through the link, the noise level increases due to intermodulation. With the 230 MHz wide S-Band IF and the 866 MHz X-Band IF signals transmitted on the same link, the S/N at the control room is calculated to be 24 dB.

2.5 Phase Calibration

The phase calibration system uses the Mark III VLBI Phase and Group delay calibrator to generate the 1 MHz comb of frequencies. These signals are combined with the noise calibration signals through a 6 dB directional coupler, as shown in document B17222K001, and injected into the cal port on the dewar for each of the four channels. The input 5 MHz to the delay calibrator antenna unit is produced by dividing the 500 MHz local oscillator reference signal by 100.

2.6 Receiver Control and Monitor

The receiver has six power supply voltages and other analog signals which are monitored and displayed at the Control Building. There are also separate on/off controls for each of the local oscillators and the noise calibration signals. The control and monitor is implemented using a VLBA standard interface board mounted in an RFI tight enclosure in the receiver box. This board contains a microprocessor, an A-D Converter and multiplexer, as well as digital I/O. The MCB Interface Box contains the standard interface card, the receiver control card (A17222S007), the analog multiplexer card (A17222S008), and the fiber optic interface board (A17222S009). The analog multiplexer card scales all the detected signals by a resistive divider and multiplexes them to the four A-D converters. The relative address RA3 through RA7 enables the four analog multiplexers via logic located on the receiver control card, while RA0 through RA2 determines which signals are output. The receiver control card multiplexes the digital command and monitor signals onto the sixteen I/O bits of the standard interface card. All functions are read once every two seconds. Once the data is converted to a serial data stream, the data is modulated onto the multimode fiber on the fiber interface board. A receiver on the board converts the optical signal to a serial data stream input to the standard interface card.

The output from the computer is through the serial port, which is operated at 56 kilobaud. The computer interface box (A17222S010) receives and transmits the serial data from the computer. The computer program provides a real time display receiver status as shown in Figure 1. The lock status of the S-Band, X-Band and 100 MHz VCO are displayed. The on/off state of the noise source, LO, and the type of polarization are displayed along with the LO level and HEMT LED voltage. The refrigerator second stage temperature and the receiver box temperature are shown along with the cryogenic compressor supply and return pressures. A total power reading from a square law detector for each channel is displayed as a voltage, along with a more precise reading used for pointing measurements. The transmitter and receiver status are shown, as well as the MCB status registers.

2.7 System Noise Temperatures

The system noise temperatures were measured in the receiver test building. For these measurements, the hot load was a microwave absorber at ambient temperature placed just in front of the feed. The cold load was the sky, assumed to have a temperature of 5K. Measurements were wide band, using the total power detector monitors located in the front-end box. System temperature for the S/X band and right and left hand polarization were determined using the hot and cold loads. In addition, the noise cals were fired and the cal values were determined from the system temperatures⁴. The results are given in Table 3.

3.0 VLBA Interface

The function of this equipment is to receive the S-Band, X-Band, and returned 500 MHz from the optical fiber, and convert the IF to the frequencies needed by the backends. The VLBA interface also contains a 500 MHz VCO which is locked to the 5 MHz reference from the Hydrogen Maser. The 500 MHz signal is used as an LO for all downconversion, transmitted to the frontend over the fiber optic link and used as a reference for all LO's. The 500 MHz is also the reference signal for the round trip phase measurement system. A listing of the S-Band and X-Band IF converter frequencies for VLBI and VLBA are tabulated in Table 4 and Table 5, respectively. The composite bandpass, which includes the S-Band IF, the X-Band IF, and the 500 MHz reference frequency, is separated by the triplexer. The X and S bands are then filtered and downconverted to baseband. The IF amplifier/detector module provides a total power monitor, which are displayed on the front panel, of the X and S bands.

The interface is designed to accommodate a Mark III backend, a VLBA DAR backend, or the existing CDP receiver with either of the backends. In order to use the CDP receiver, the CDP X input must be connected to item 8, and the CDP S input to item 20 as shown in the block diagram. Items 10 and 13 should be interchanged in the CDP X-A DAR signal path. A block diagram and parts list are given in documents A17222K002 and A17222B002, respectively.

4.0 Acknowledgements

Funding for the construction of the receiver was provided by the U.S. Naval Observatory for operation with the 20 meter Kokee Park antenna located in Hawaii.

The receiver was constructed from the design of the late J.R. Coe, under the direction of B.J. Levin. B. Shank and J. Oliver did the majority of the construction and testing of the receiver system.

G. Behrens designed 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.

5.0 References

1. EDIR NO. 287, "85-3 S and X Receiver System," J. R. Coe (April 1990)
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)
4. Memo "System Temperature of USNO/KPGO Receiver," B.J. Levin

TABLE 1
Worst Case Axial Ratio Measurements

<u>Radiation Angle From Borsight</u>	<u>S-Band Maximum Axial Ratio</u>	<u>X-Band Maximum Axial Ratio</u>
0	1.1 dB	3.0 dB
20	1.6 dB	4.0 dB
40	1.9 dB	6.0 dB
60	2.6 dB	32.0 dB

TABLE 2
Feed Performance

	<u>Avg Edge Taper E-Plane</u>	<u>H-Plane</u>	<u>Calculated Efficiency</u>	<u>Calculated Spillover</u>
S-Band 2.35 GHz	16.94 dB	19.14 dB	0.65	3.0 K
X-Band 8.6 GHz	17.05	27.88	0.62	0.88 K

TABLE 3
System Noise Temperature

<u>Band</u>	<u>Tsys [K]</u>	<u>Tcal[K]</u>
X-R	29.6	5.5
X-L	32.6	6.5
S-R	27.0	7.2
S-L	24.7	6.8

TABLE 4
NAVNET VLBI

<u>Sky Frequencies [MHz]</u>		<u>BBC Frequency [MHz]</u>
1	8210.99	610.99
2	8220.99	620.00
3	8250.99	650.99
4	8310.99	710.99
5	8420.99	820.99
6	8500.99	900.99
7	8550.99	950.99
8	8570.99	970.99
9	2217.99	717.99
10	2222.99	722.99
11	2237.99	737.99
12	2267.99	767.99
13	2292.99	792.99
14	2302.99	802.99

TABLE 5
USNO VLBA

<u>Sky Frequencies [MHz]</u>		<u>BBC Frequency [MHz]</u>
1	8212.99	612.99
2	8252.99	652.99
3	8352.99	752.99
4	8512.99	952.99
5	8732.99	632.99
6	8852.99	752.99
7	8912.99	812.99
8	8932.99	832.99
9	2220.99	720.99
10	2230.99	730.99
11	2250.99	750.99
12	2305.99	805.99
13	2340.99	840.99
14	2345.99	845.99

Receiver Status 1992-276 18:27:05 UT

Lock	CAL	LO	LOlevel	HENT_LED	Pol:	RCP
Sband :locked	off	on	3.66	4.69	BoxTemp	25.97 C
Xband :locked	off	on	4.53	7.03	Pcal T:	48.45 C
100MHz:locked						

	Power	Exten.Pwr	Gate_Mon	Dewar	Compressor
SR:	0.46	-10.00	-0.54	15K 302.88	Supply(psi): 6.35
SL:	0.47	-10.00	-0.78	50K 297.51	Return(psi): 1.46
XR:	2.25	10.00	-0.29	Vac 10.00	Ref.Dr(amp): 0.01
XL:	2.12	10.00	-0.34		

Power Supplies		Fiber XCVR	MCB Status Registers	
32V: 31.84	15V: 14.98	laser:norm	adr_pe:0	bad SYN: 0
24V: 23.82	-15V: -14.90	recvr:low	blk_pe:65413	good ctl:4243
12V: 12.05	+5V: 4.97		ctl_pe:0	good dat:896
	-5V: -5.01			

CONTROL ROOM DISPLAY

FIGURE 1

Drawing List: A17222D001		Date: 4/26/1993			
Drawing Title	Drawing Number	Date	Format	Pages	
Receiver Control Assembly	A17222A008	4/23/93	ACAD	1	
Analog Multiplex Assembly	A17222A009	4/23/93	ACAD	1	
Hawii RCVR Front End Box	A17222B001	3/16/93	QPRO	1	
VLBA Interface Drawer	A17222B002	3/16/93	QPRO	1	
500 Mhz Divider	A17222B003	3/16/93	QPRO	1	
IF Amplifier Detector	A17222B004	3/16/93	QPRO	1	
Analog Optic Box	A17222B005	3/16/93	QPRO	1	
IF Triplexer	A17222B006	3/18/93	QPRO	1	
Phase Locked Oscillator Box	A17222B007	3/16/93	QPRO	1	
S/X Dewar	A17222B008		QPRO	1	
500 Mhz Phase Detector	A17222B009	3/17/93	QPRO	1	
S/X Feed	A17222B010	3/29/93	QPRO	1	
Receiver Card Box	A17222B011	4/26/93	QPRO	1	
MCB Box	A17222B012	4/28/93	QPRO	1	
Hawaii Receiver Blk Dia	B17222K001	3/7/93	ACAD	2	
VLBA Interface Drawer	B17222K002	3/4/93	ACAD	1	
Analog Optic Box	B17222K003	3/9/93	ACAD	1	
Phase Locked Oscillator Box	B17222K004	3/9/93	ACAD	1	
Hawii Composite Blk Dia	B17222K005	3/2/93	ACAD	1	
500 Mhz Divider Box	A12222M001		ACAD	1	
Phase Locked Oscillator Box	B17222M002		ACAD	1	
IF Amplifier Detector	B17222M003		ACAD	1	
500 Mhz Phase Detector	B17222M004		ACAD	1	
S/X Feed Assembly	D17222M005	3/26/93	ACAD	2	
IF Triplexer Box	B17222M006		ACAD	1	
Analog Optic Box	B17222M007		ACAD	1	
Front End Cabling Dia	D17222M008	8/28/91	ACAD	1	
S/X Feed Large Section	D17222M009	3/29/93	ACAD	1	
S/X Feed Small Section	D17222M010	3/29/93	ACAD	1	
S/X Feed Tuning Section	D17222M011	3/29/93	ACAD	1	
S/X Feed Polarizer	D17222M012	3/29/93	ACAD	1	
S/X Feed Dielectric Polarizer	D17222M013	3/29/93	ACAD	1	
S/X Orthromode Transducer	D17222M014	7/29/91	ACAD	1	
S/X Back Short	D17222M015	2/28/90	ACAD	1	
S/X Feed Iris	D17222M016	3/29/93	ACAD	1	
S/X Waveguide Shim	D17222M017	3/29/93	ACAD	1	
X Band Waveguide Disconnect	D17222M018		ACAD	1	
X Band Circular Waveguide	D17222M019		ACAD	1	
S/X Dielectric Tuning Plug	D17222M020		ACAD	1	
X Band Dielectric Feed Cone	D17222M021		ACAD	1	
S/X Feed Septum	D17222M022		ACAD	1	
Receiver Card Box	D17222M023	4/26/93	ACAD	1	
500 Mhz Divider PC	A17222P001	3/29/93	ACAD	1	
IF Amplifier Detector PC	A17222P002		ACAD	1	
500 Mhz Phase Detector PC	A17222P003		ACAD	1	
IF Triplexer	A17222P004		ACAD	1	

500 Mhz Divider PC	A17222Q001		ACAD	1
IF Amplifier Detector PC	A17222Q002		ACAD	1
500 Mhz Phase Detector PC	A17222Q003		ACAD	1
IF Triplexer	A17222Q004		ACAD	1
IF Amplifier Detector	A17222S001	3/3/93	ACAD	1
500 Mhz Phase Detector	A17222S002	3/26/93	ACAD	1
500 Mhz Divider	A17222S003	3/9/93	ACAD	1
Control Interface Card	A17222S004	3/6/93	ACAD	2
Monitor Interface Card	A17222S005	4/1/93	ACAD	1
IF Triplexer	A17222S006	3/17/93	ACAD	1
Receiver Control	A17222S007	3/21/93	ORCAD	2
Analog Multiplex	A17222S008	4/22/93	ORCAD	2
Fiber Interface	A17222S009	4/22/93	ORCAD	1
Computer Interface	A17222S010	4/23/93	ORCAD	1
PLO Box Wiring List	A17222W001	3/30/93	QPRO	2
Analog Optic Box Wiring List	A17222W002	3/30/93	QPRO	1
IF Amp Det Wiring List	A17222W003	3/30/93	QPRO	1
Rec Card Box S3	A17222W004	3/30/93	QPRO	2
Receiver Card Box	A17222W005	3/30/93	QPRO	3
VLBA Interface Drawer	A17222W006	3/30/93	QPRO	1
VLBA Interface Power	A17222W007	3/30/93	QPRO	1
MCB Interface Box	A17222W008	3/30/93	QPRO	1

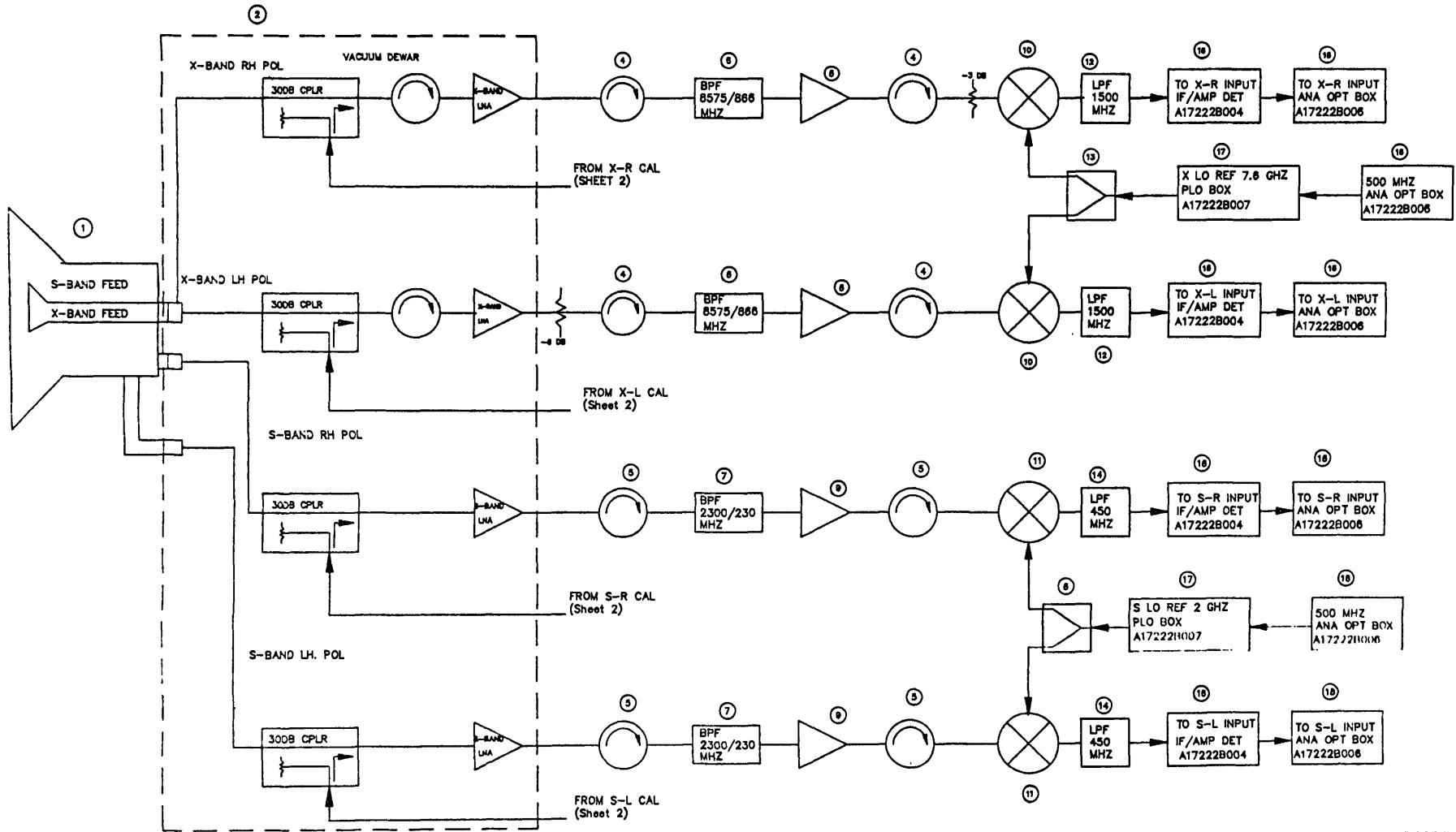
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Date: 3/16/93

Title: Hawaii Receiver

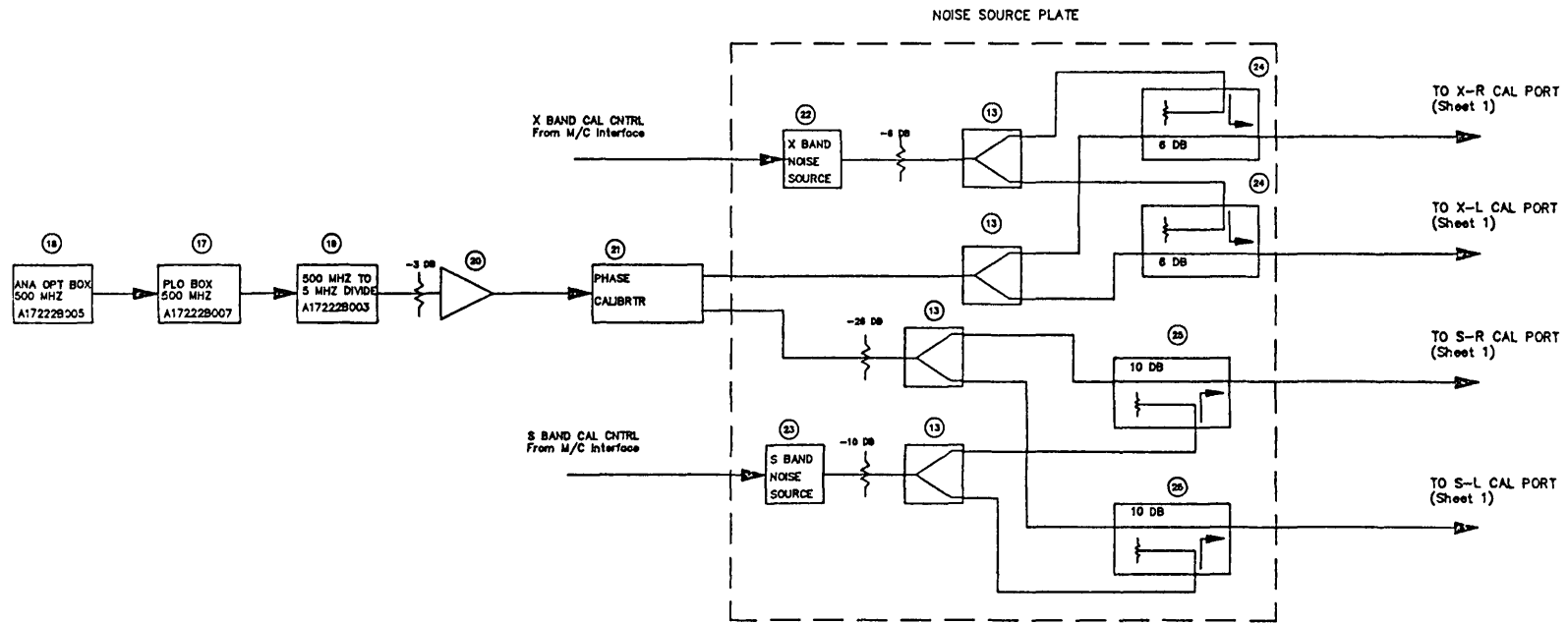
Rev: A

ITEM	QTY	DESCRIPTION	PART NUMBER	MANUFACTURE
1	1	S/X Feed Assembly	A17222B010	NRAO
2	1	S/X Dewar	A17222B008	NRAO
3	1	Receiver Block Diagram	B17222K001	NRAO
4	4	X Band Isolator	9-8012-11	Applied Eng
5	4	S Band Isolator	9-2040-11	Applied Eng
6	2	8575 Mhz BPF	3C2-8575-1000-S11	Reactel
7	2	2300 Mhz BPF	5B2-2300-230-S11	Reactel
8	2	X Band Amplifier	AMF-2B-8286-45	Miteq
9	2	S Band Amplifier	AMF-2B-2224-35	Miteq
10	2	X Band Mixer	FP50 MC2	Triangle Microwave
11	2	S Band Mixer	DM2-4A	RHG
12	2	1500 Mhz LPF	4L121-1500/U7400-0/0	K&L
13	3	X Band Splitter	2035-6365-0	Omni-Spectra
14	2	450 Mhz LPF	4L2-450-S11	Reactel
15	3	S Band Splitter	2035-6365-0	Omni-Spectra
16	1	IF Amp Detector	A17222B004	NRAO
17	1	PLO Box	A17222B007	NRAO
18	1	Analog Optic Box	A17222B006	NRAO
19	1	500 Mhz Divider	A17222B003	NRAO
20	2	100 Mhz Amplifier	QBH-9-160	Q-Bit
21	1	Phase Calibrator		Haystack Obs
22	1	X Band Noise Source	NC3206F	Noise/Com
23	1	S Band Noise Source	NC3204F	Noise/Com
24	2	6 Db Coupler(X band)	4015C-6	Narda
25	2	10 Db Coupler(S Band)	4013C-10	Narda

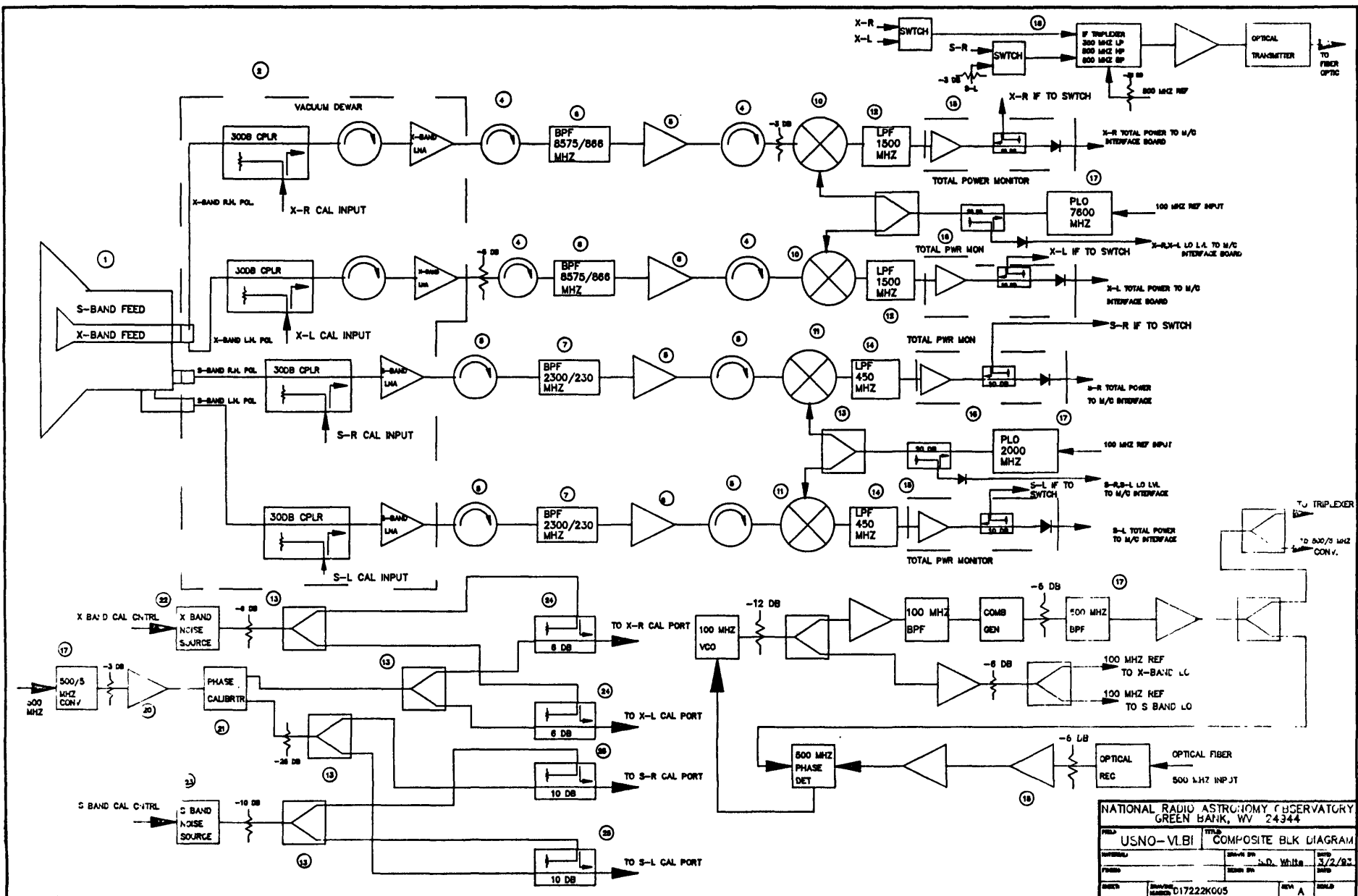


Note: A17222B001 Parts List
 D17222M005 Feed Assembly
 A17222B008 S/X Dewar

NATIONAL RADIO ASTRONOMY OBSERVATORY GREEN BANK, W. 24344			
PROJECT: USNO-VLBI	TITLE: HAWAII RECEIVER BLOCK DIAGRAM	DATE: 3/7/83	BY: S.D. WHITE
DESIGNED BY:	APPROVED BY:	DATE:	BY:
OF 2	REVISED:	DATE:	BY:



NATIONAL RADIO ASTRONOMY OBSERVATORY GREEN BANK, WV 24944			
FORM	TITLE	USNO-VLBI HAWAII RCVR BLK DIA	
INTERNAL	DESIGN BY	S.C. WHITE	DATE
FIGURE	REVISION		DATE
OF 2	REVISION NUMBER	B17222K001	REV. A



NATIONAL RADIO ASTRONOMY OBSERVATORY
 GREEN BANK, WV 24344

FILED	USNO-VLBI	TITLE	COMPOSITE BLK DIAGRAM
DATE		DESIGNED BY	J.D. White
DESIGNED BY		DATE	3/2/82
REVISION		REV	A
REVISION NUMBER	D1722K005		

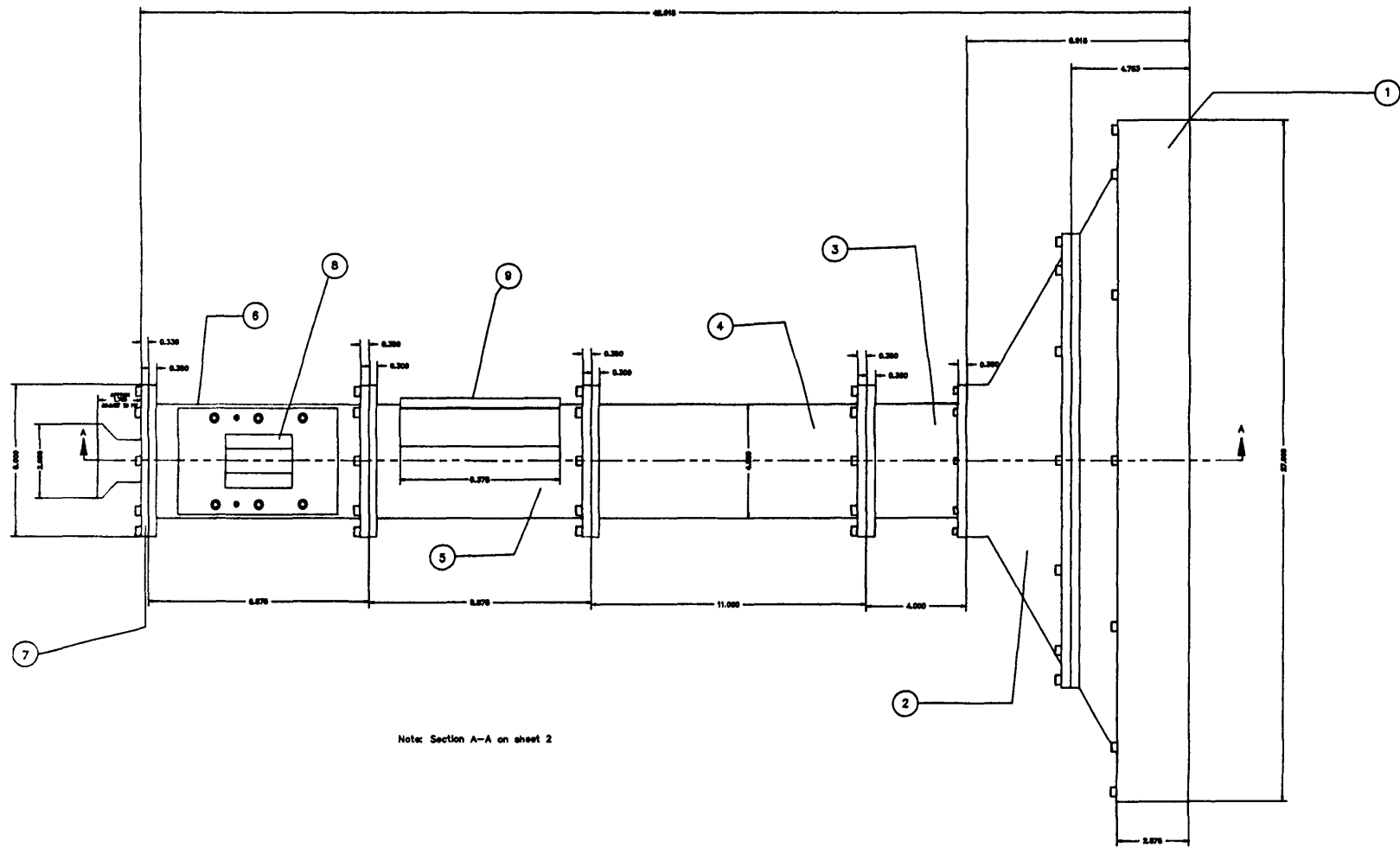
APPENDIX A

**S/X FEED
A17222B010**

Drawing Number: A17222B010
Title: S/X Feed

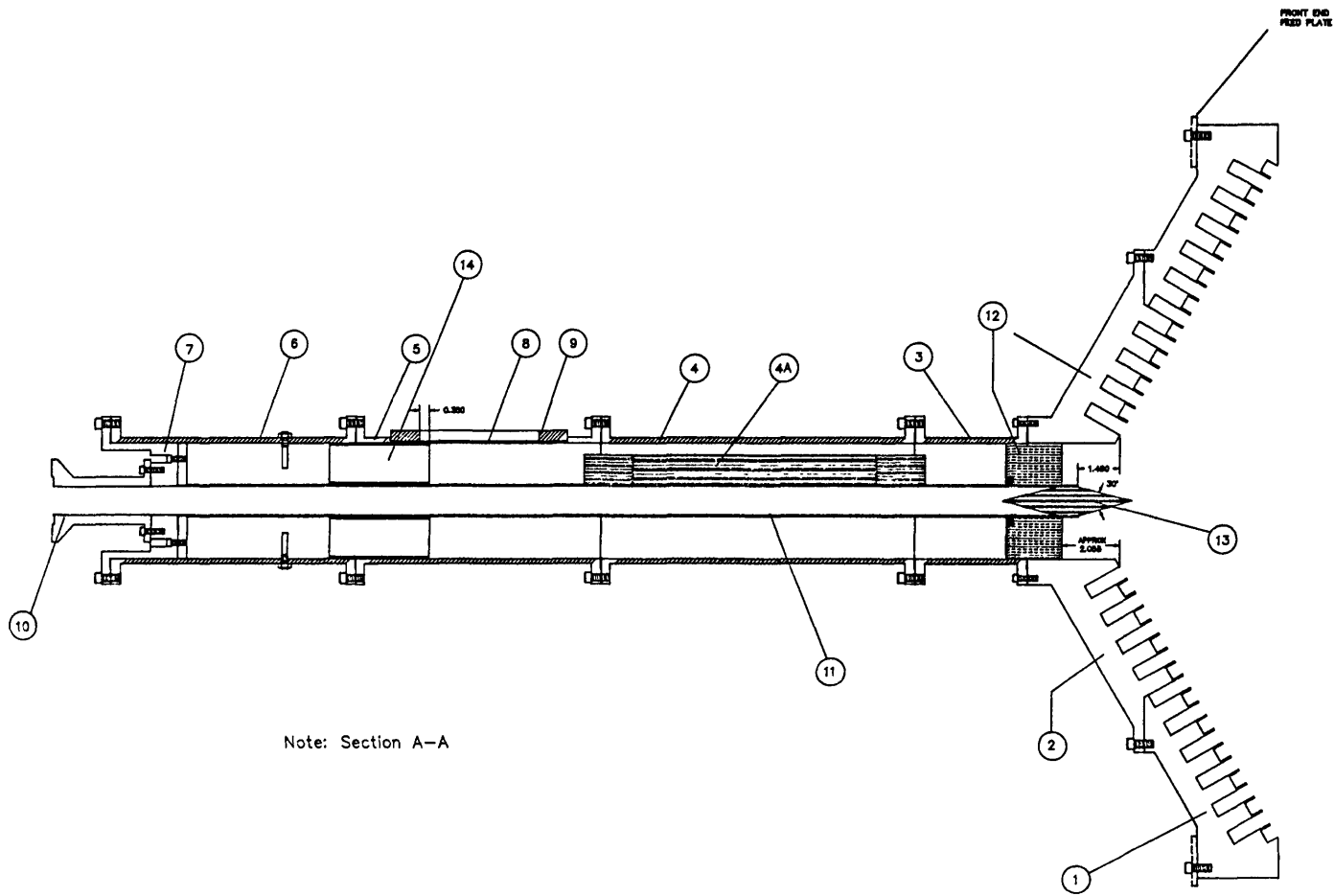
Date: 3/29/93
Rev: A

ITEM	QT	DESCRIPTION	PART NUMBER	MANUFACTURE
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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	X-band WG Flange	D17222M018	NRAO
11	1	X-band Circular WG	D17222M019	NRAO
12	1	Dielectric Tuning Plug	D17222M020	NRAO
13	1	Dielectric Feed Cone	D17222M021	NRAO
14	1	Septum	B17222M022	NRAO
15	1	Front End Cabling Diagram	D17222M008	NRAO



Note: Section A-A on sheet 2

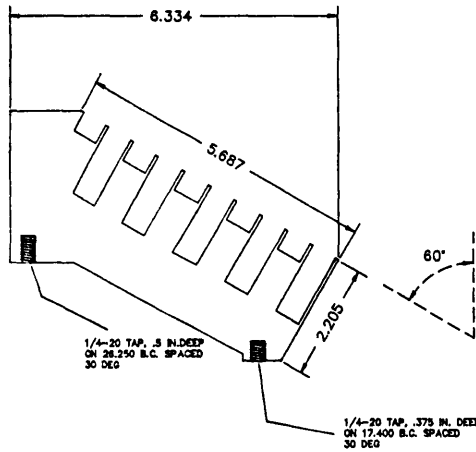
NATIONAL RADIO ASTRONOMY OBSERVATORY GREEN BANK, WV 24844			
PROJECT	USNO-VLBI	ITEM	S/X Feed
MATERIAL	ALUMINUM	DESIGNER	S.D. White
FINISH	CHROME	DESIGN NO.	C. 80-1028
SHEET	1 OF 2	DRAWING NUMBER	D17222M005
		SCALE	2:1



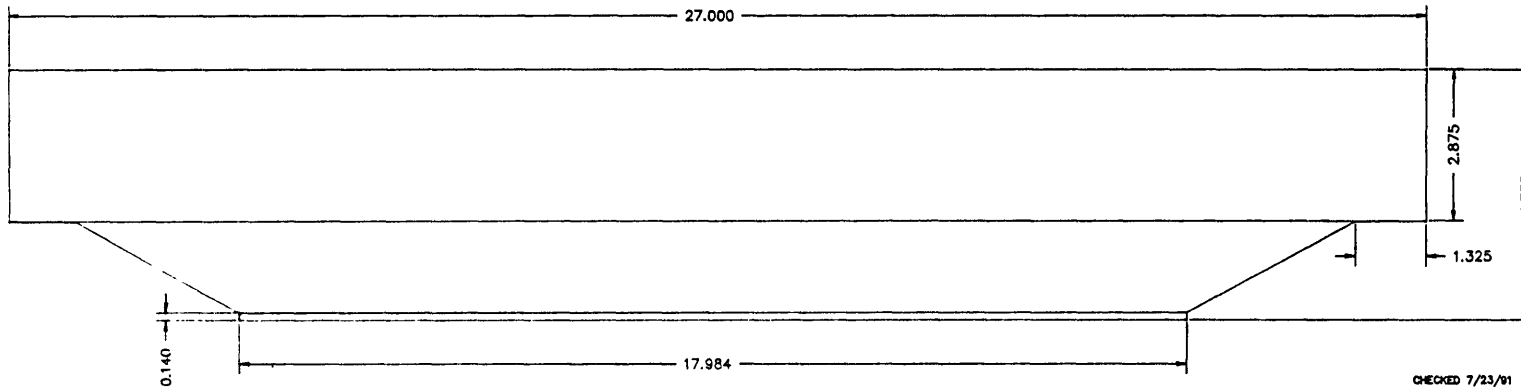
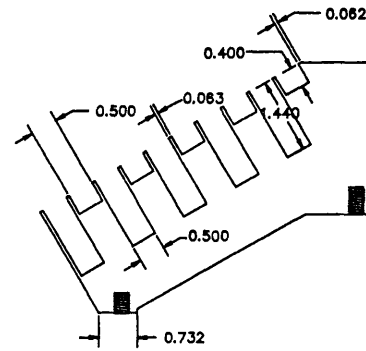
Note: Section A-A

CHECKED 7/22/71
ACAD FILENAME: SXPFS.DWG

NATIONAL RADIO ASTRONOMY OBSERVATORY GREEN BANK, WV 24944			
PART USNO-VLBI		TITLE S/X FEED	
MATERIAL ALUMINUM	DRAWN BY S.D. WHITE	DATE 3/29/83	
FINISH CHROMATE	SEEN BY C. CHESTNUT G. BEYRENS	DATE	
SIZE 2 OF 2	DRAWING NUMBER D17224005	REV	SCALE 2:1



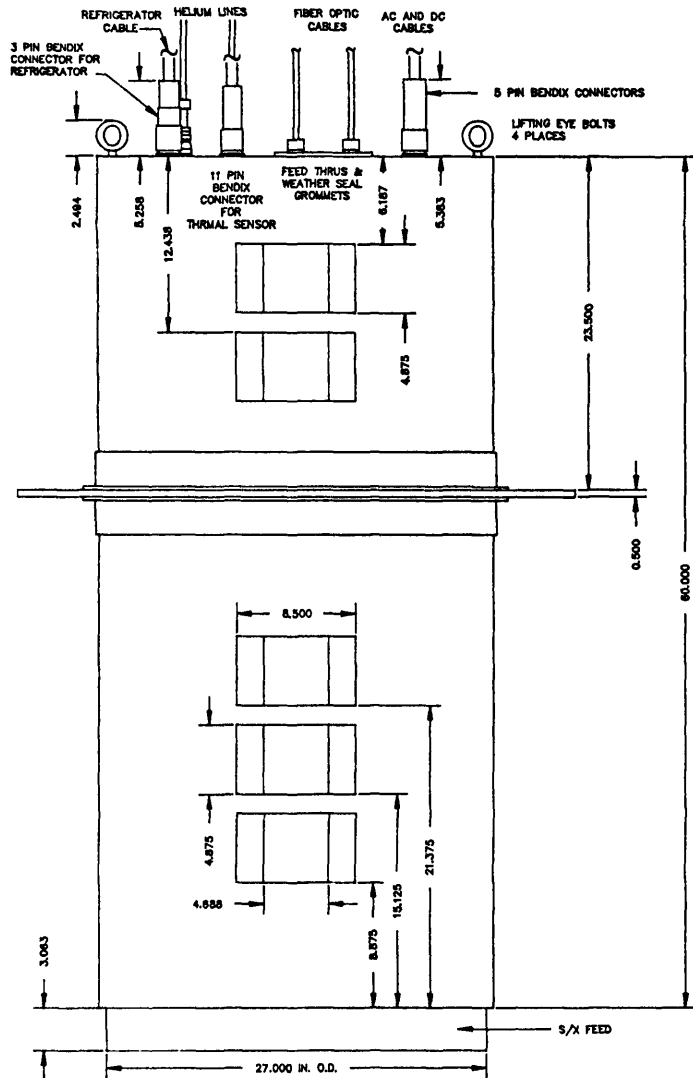
CROSS SECTION



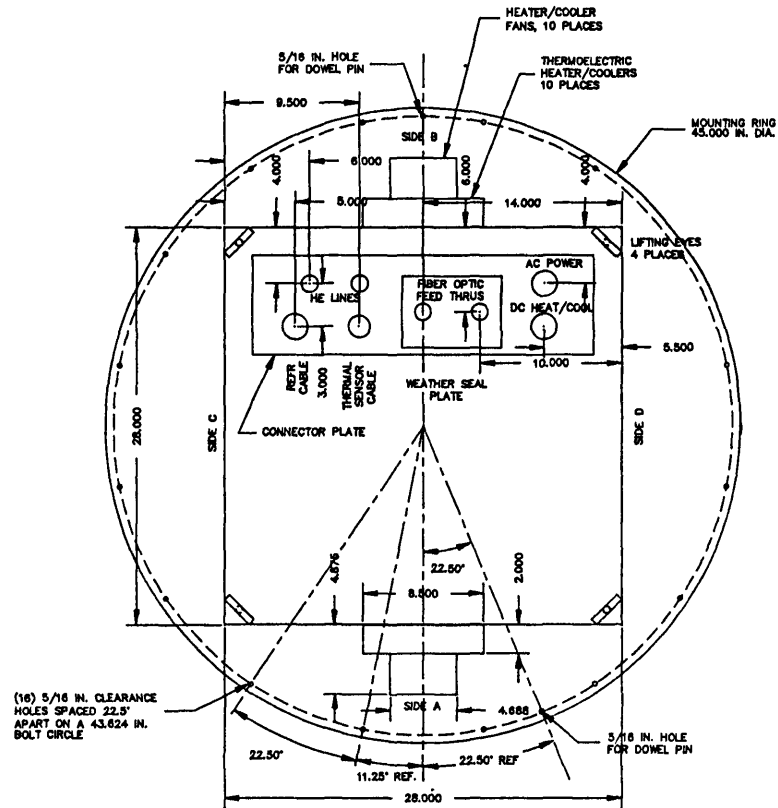
SIDE VIEW

CHECKED 7/23/91
ACAD FILENAME: SXLFD.DWG

NATIONAL RADIO ASTRONOMY OBSERVATORY GREEN BANK, WV 24944			
PROJECT	USNO-VLBI	TITLE	Feed, Large Section
MATERIAL	ALUMINUM	DESIGN BY	S.D. WING 3/29/93
FINISH	CHROMATE	DESIGN BY	C. SCHREIBER
SHEET	1 OF 1	DESIGN	CHKD BY C. SCHREIBER
DATE		SCALE	1:1



SIDE A VIEW

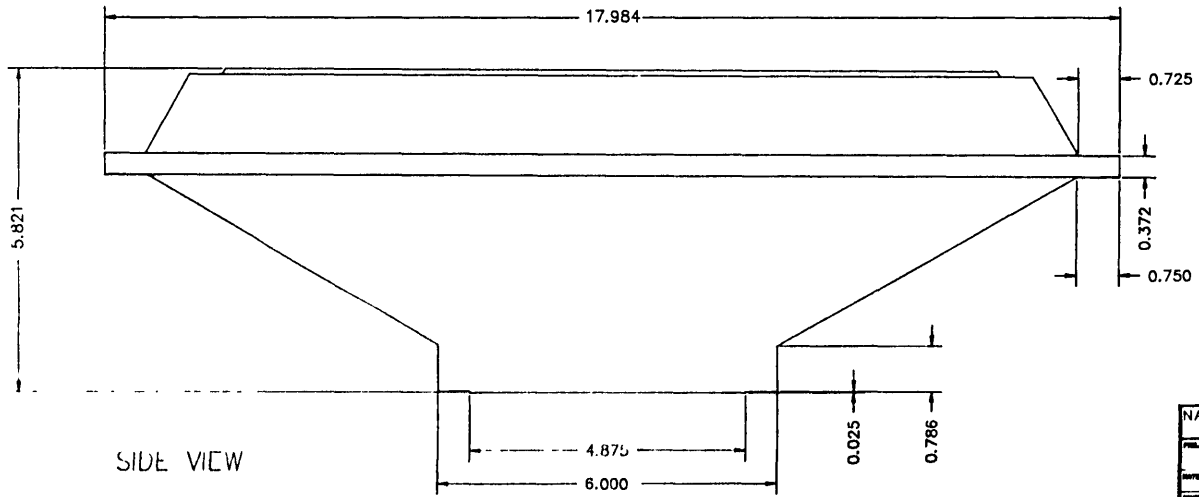
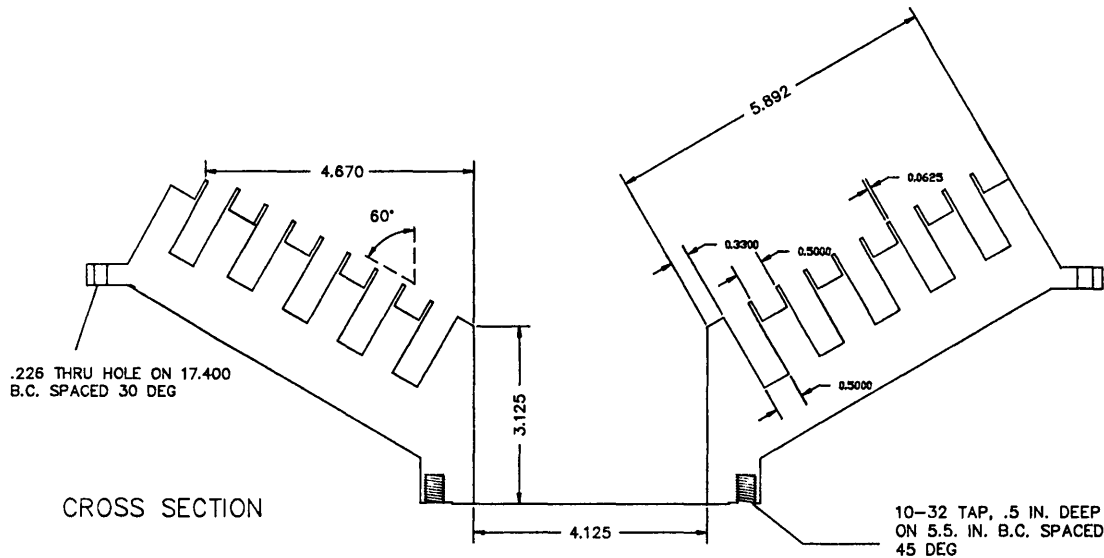


TOP VIEW

(16) 5/16 IN. CLEARANCE HOLES SPACED 22.5° APART ON A 43.024 IN. BOLT CIRCLE

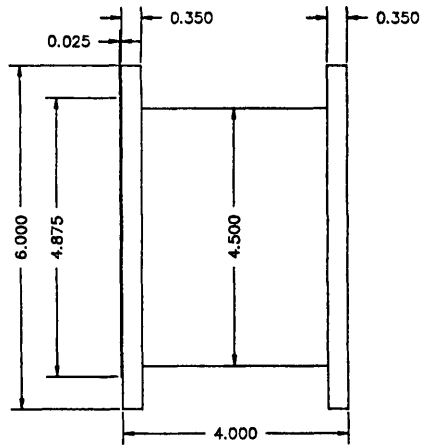
REV A : 2/3/82
 1) ADDED DWG. NO.
 2) ADDED MTG. RING BOLT HOLE DETAILS

NATIONAL RADIO ASTRONOMY OBSERVATORY GREEN BANK, WV 24944			
PROJ	HAWAII TELESCOPE	TITLE	FRONT END BOX MTO. & CABLING DETAILS
DESIGNER	G. BEHRENS	DATE	8/28/81
DATE	8/28/81	SCALE	1/4"
DRAWN	017222M008	REV. A	3/9/82

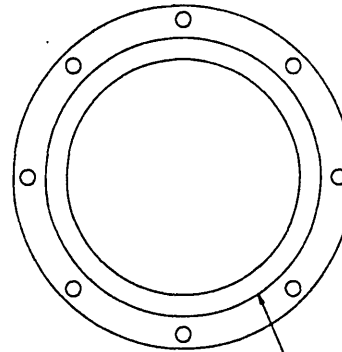


CHECKED 7/23/91

NATIONAL RADIO ASTRONOMY OBSERVATORY GREEN BANK, WV 24944			
PROJECT	USNO-VI BI	TITLE	S/X, Small Section
MATERIAL	ALUMINUM	DESIGNER	S.D. WHITE
FINISH	CHROMATE	DATE	3/29/93
DATE	11/22/91	DR	G. BEJREK
REV	1	APP	

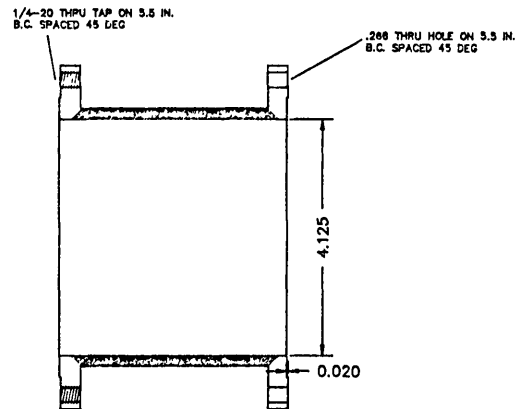


SIDE VIEW



FRONT VIEW

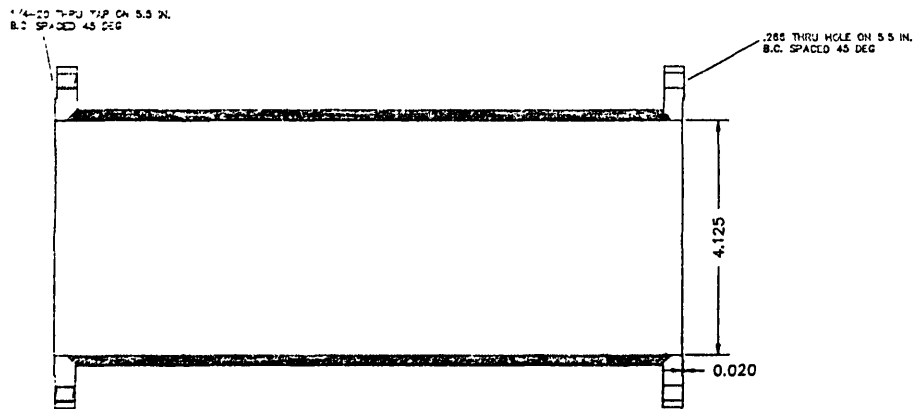
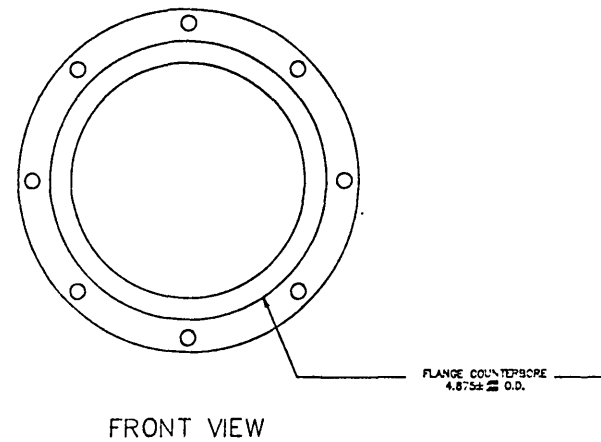
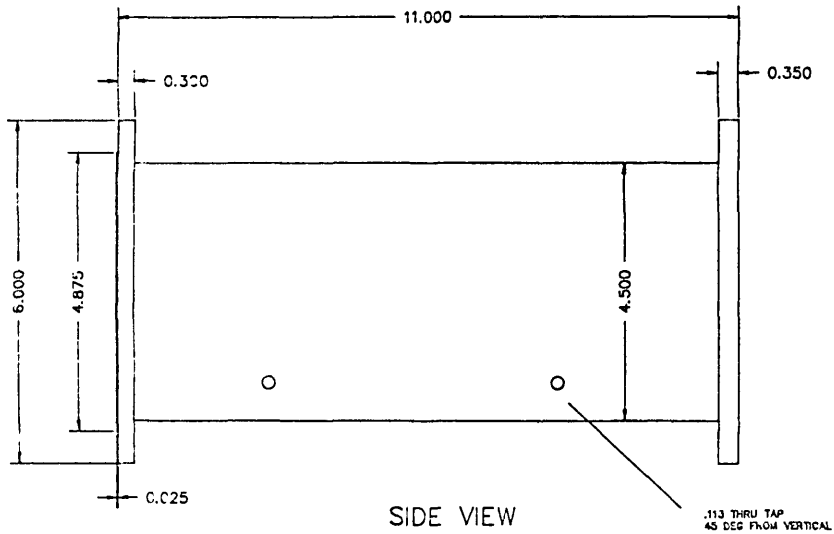
FLANGE COUNTERSCORE
4.875±0.005 O.D.



CROSS SECTION

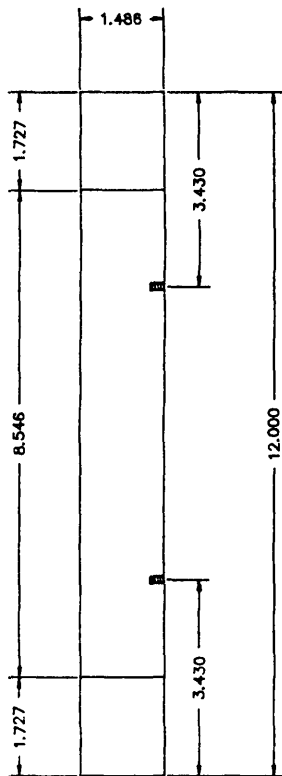
CHECKED 7/23/91
Same As D172124005

NATIONAL RADIO ASTRONOMY OBSERVATORY GREEN BANK, WV 24944			
PROJ	USNO-VLBI	TRND	S-BAND TUNING SECTION
MATERIAL	ALUMINUM	DRWG BY	S.C. White
DATE	09/04/84	CHKD BY	A. BOHENS
REV	1 OF 1	REVISED	D17224-011
		NET	SCALE FULL

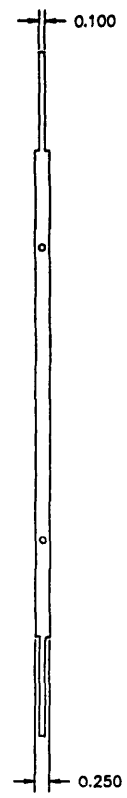


CHECKED 7/23/91
Same As D17224008

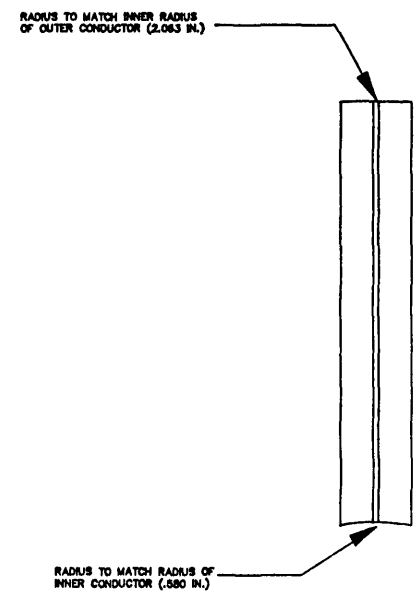
NATIONAL RADIO ASTRONOMY OBSERVATORY GREEN BANK, WV 24944	
PROJ USNO-VLB	TITLE POLARIZER
DESIGNED BY ALLAN W.	DATE 3/79/93
DRAWN BY G. SCHREIBER	REV 0
QTY OF 1	SCALE FULL



FRONT VIEW



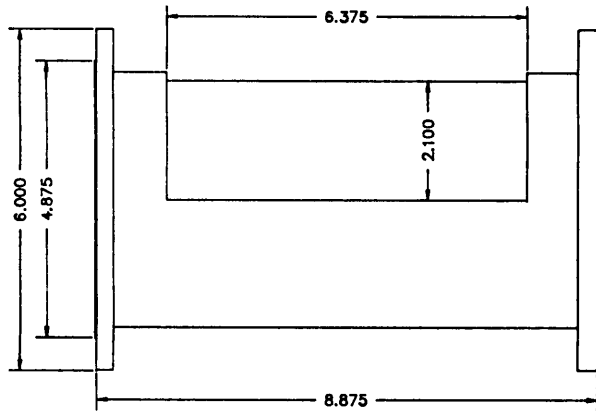
SIDE VIEW



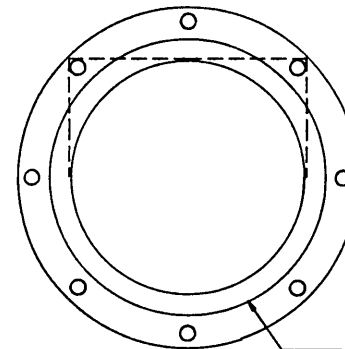
END VIEW (x5 SCALE)

Same As D17212M007

NATIONAL RADIO ASTRONOMY OBSERVATORY GREEN BANK, WV 24944			
FIELD	USNO-VLBI	FIELD	DIELECTRIC POLARIZER
MATERIAL	ALUMINUM	DRAWN BY	S.D. White
FINISH	CHROMATE	DESIGN BY	G. BEHRENS
DATE	1/1	PROJECT	D17222M013
		REV	FIELD

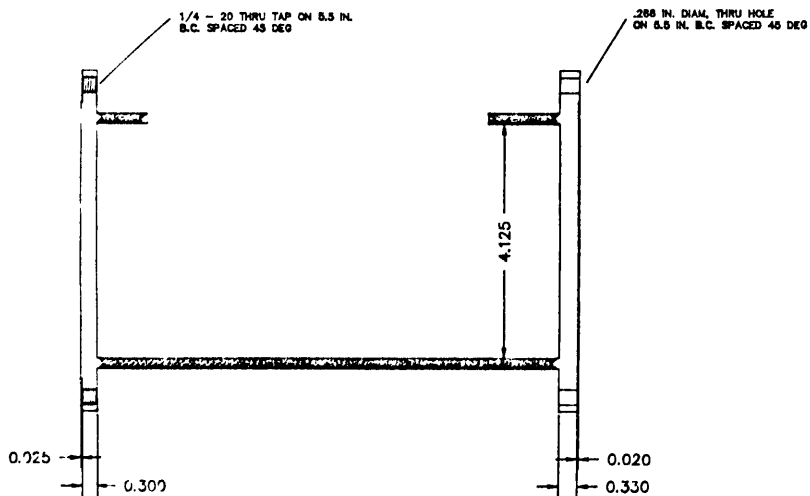


SIDE VIEW

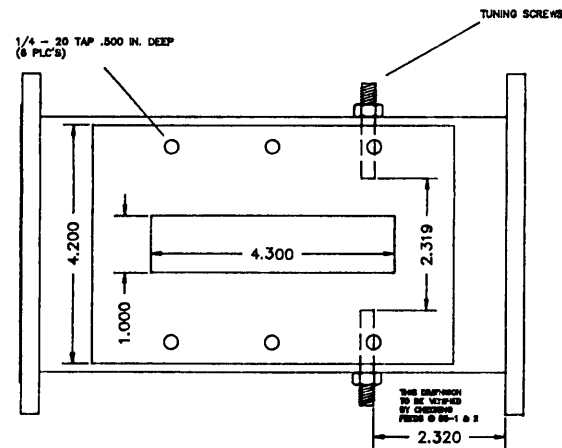


FLANGE COUNTERBORE
4.875 ± .005 O.D.

FRONT VIEW



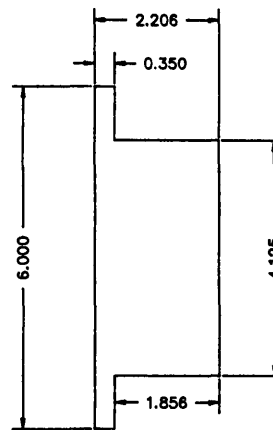
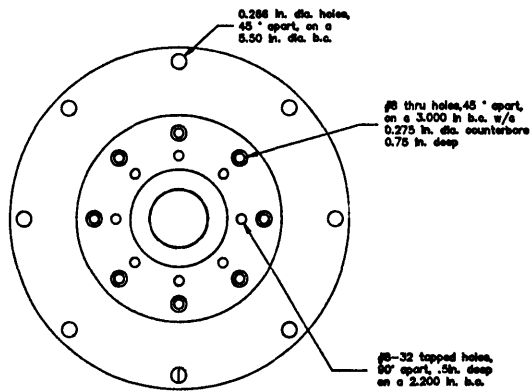
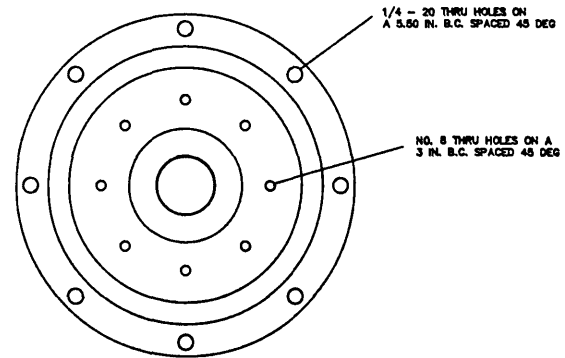
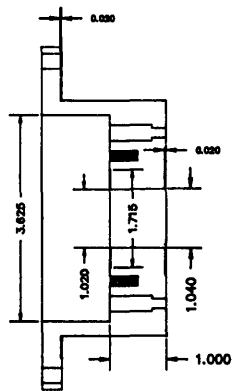
CROSS SECTION



TOP VIEW

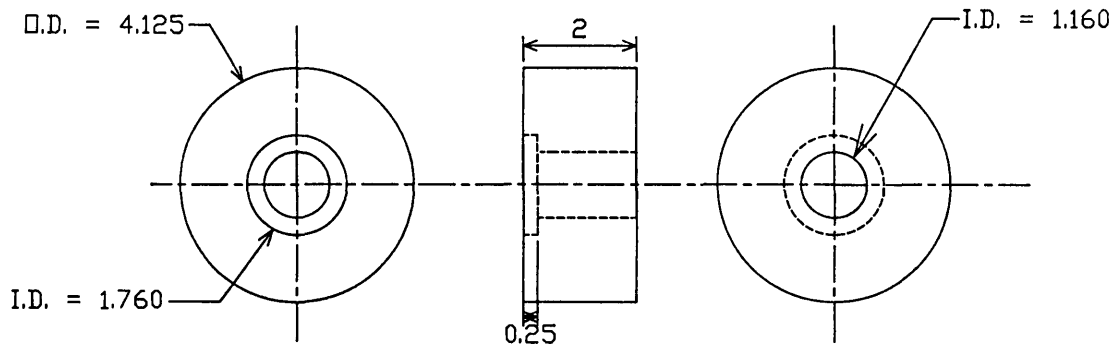
CHECKED 7/23/91
Some As D172124008

NATIONAL RADIO ASTRONOMY OBSERVATORY GREEN BANK, WV 24944			
PROJ	USNO-VLBI	TRAC	ORTHOMODE TRANSDUCER, REAR PORT
MATERIAL	ALUMINUM	DESIGNER	E.D. WHITE
FINISH	CHROMATE	ENGINEER	BEHRENS
REV	T OF 1	ISSUED	D172224014
DATE		REV	7/29/91
		SCALE	1:1



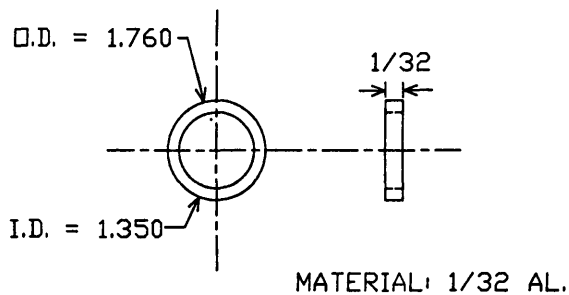
CHECKED 7/22/91
 Same As-D17212M010

NATIONAL RADIO ASTRONOMY OBSERVATORY GREEN BANK, WV 24944			
PROJ.	USNO-VLBI	TITLE	S/X Feed BACKSHORT
MATERIAL	ALUMINUM	DESIGN BY	S. D. WILSON
DATE	CHROMATE	DATE	3/29/79
QTY	DF 1	REV	D17212M015
		APP'D	C. BEHRENS
		DATE	3/29/79
		STATUS	FULL



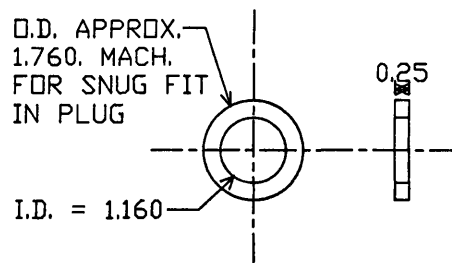
MATERIAL = ECCDFDAM PS 1.04

DIELECTRIC PLUG



MATERIAL: 1/32 AL.

TUNING RING

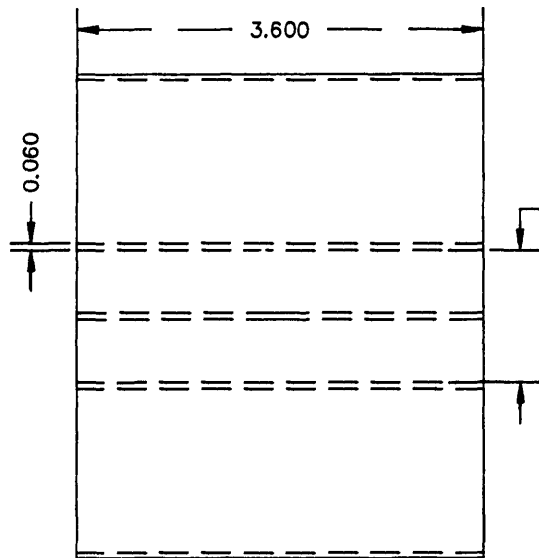


MATERIAL: ECCDFDAM PS 1.04

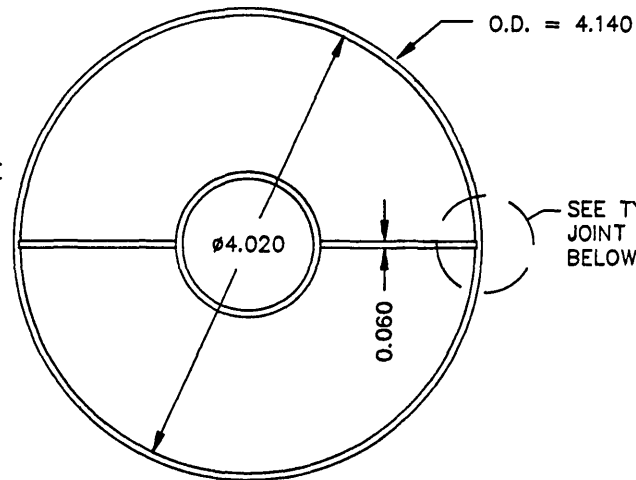
RETAINING RING

Checked 7/22/91
Same As D17212M015

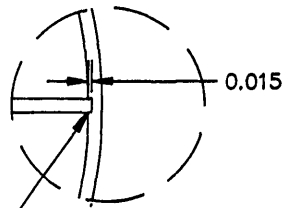
NATIONAL RADIO ASTRONOMY OBSERVATORY GREEN BANK, WV 24944		
USNO-VLBI	S-Feed Tuning Plug	
By: S. R. White	DATE: 7/22/91	
By: G. Behrens		
17212	D1722M020	



I.D. = 1.160
 MACHINE TO GIVE
 SLIDING FIT ON
 COPPER W/G



SEE TYPICAL
 JOINT DETAIL
 BELOW



SOLDER ALL
 JOINTS

SCALE : X2

TYPICAL JOINT DETAIL

CHECKED 7/22/91

Same As B17212M017

NATIONAL RADIO ASTRONOMY OBSERVATORY GREEN BANK, WV 24944			
FIELD	TITLE		
USNO-VLBI	SEPTUM		
MATERIAL	BRASS, GOLD PLATE	DRAWN BY	S.D. White
DATE		DATE	2/29/93
FINISH	GOLD PLATE	DESIGN BY	G. BEHRENS
DATE		DATE	1/31/89
SHEET	1 OF 1	DRAWING NUMBER	B17222M022
REV		SCALE	FULL

APPENDIX B

**IF Amplifier Detector
A17222B004**

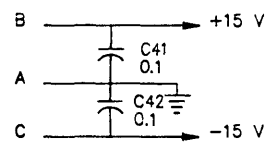
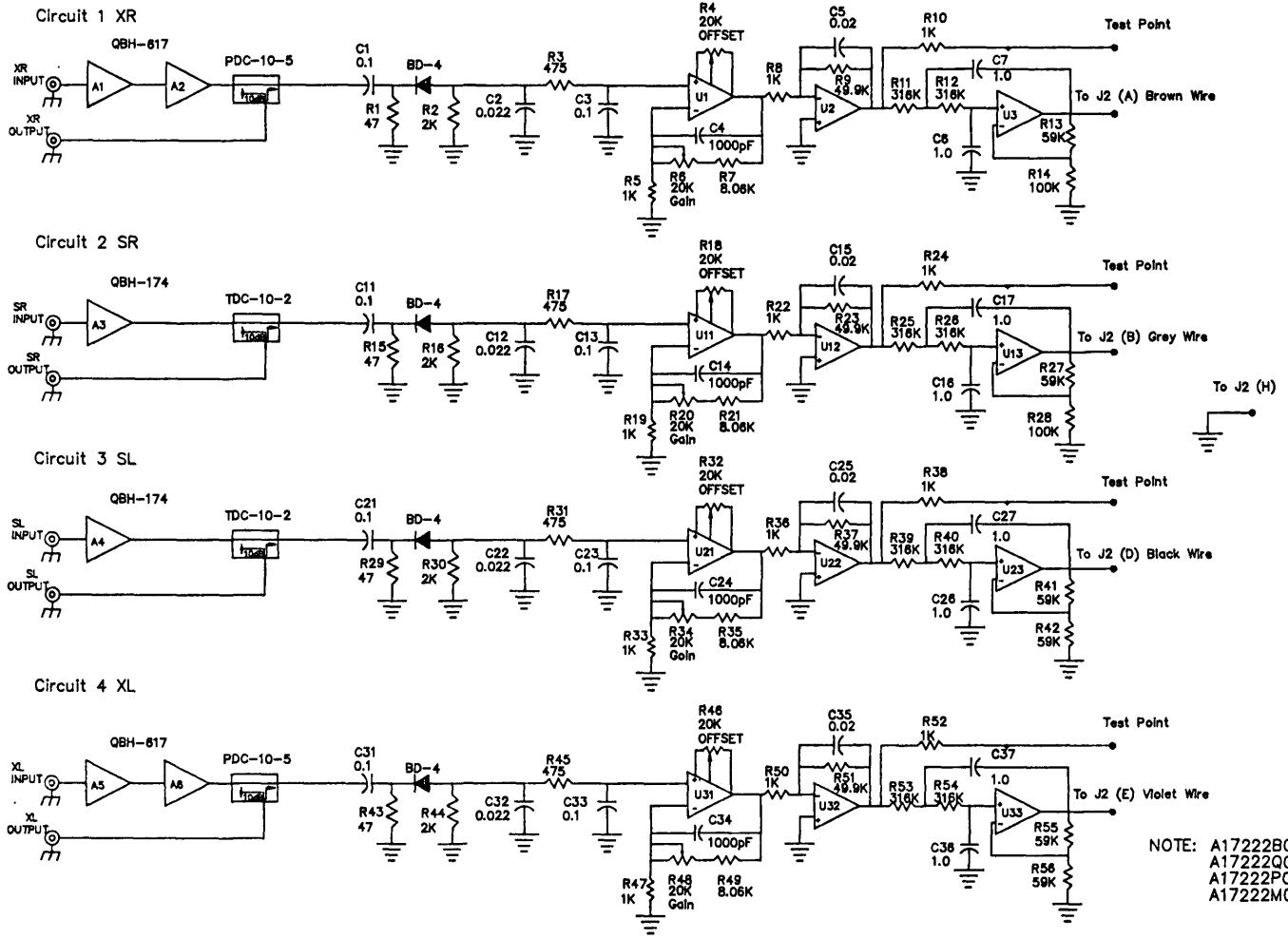
Drawing Number: A17222B004
 Title: IF AMP-Detector

Date: 3/16/93
 Rev: A

ITM	QTY	DESIGNATION	DESCRIPTION	PART NUMBER	MANUFACTURE
1	1		Assembly	A17222A002	NRAO
2	1		Mechanical Box	A17222M003	NRAO
3	1		PC Board	A17222P002	NRAO
4	1		PC Artwork	A17222Q002	NRAO
5	1		Schematic	A17222S001	NRAO
6	4	A1,A2,A5,A6	IF Amplifier	QBH-817	Q-Bit
7	2	A3,A4	IF Amplifier	QBH-174	Q-Bit
8	2		10 dB Coupler	PDC-10-5	Mini-Circuits
9	2		10 dB Coupler	TDC-10-2	Mini-Circuits
10	4	R1,R15,R29,R43	Res 5% 1/4w 47 Ohm		
11	4	R2,R16,R30,R44	Res 5% 1/4w 2K Ohm		
12	4	R3,R17,R31,R45	Res 5% 1/4w 475 Ohm		
13	12	R5,R8,R10,R19,R22,R24,R33,R36,R38,R47,R50,R52	Res 5% 1/4w 1K Ohm		
14	8	R4,R6,R18,R20,R32,R34,R46,R48	Pot 10T 1/4w 20K Ohm		
15	4	R7,R21,R35,R49	Res 1% 1/4w 8.06K Ohm		
16	8	R9,R23,R37,R51,R11,R12,R25,R26	Res 1% 1/4w 49.9K Ohm		
17	4	R39,R40,R53,R54	Res 5% 1/4w 314K Ohm		
18	4	R13,R27,R41,R55	Res 5% 1/4w 59K Ohm		
19	4	R14,R28,R42,R56	Res 5% 1/4w 100K Ohm		
20	10	C1,C3,C11,C13,C21,C23,C31,C33,C41,C42	Cap 0.1 uF ceramic		
21	4	C2,C12,C22,C32	Cap 0.022 uF ceramic		
22	4	C4,C14,C24,C34	Cap 1000pF ceramic		
23	4	C7,C17,C27,C37	Cap 1.0 uF ceramic		
24	4	D1 thru D4	Back Diodes	BD-4	HP
25	8	U1,U2,U11,U12,U21,U22,U31,U33	Op Amps	OP-27GN	
26	4	U3,U13,U23,U33	Op Amps	OP-07CN	

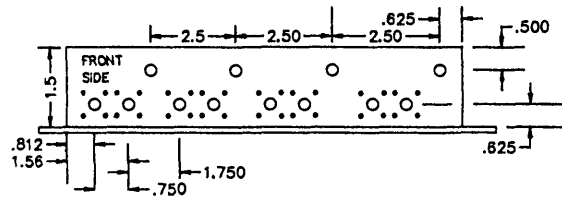
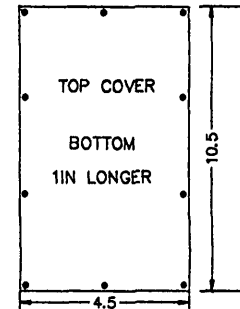
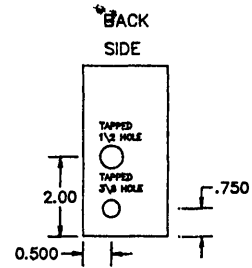
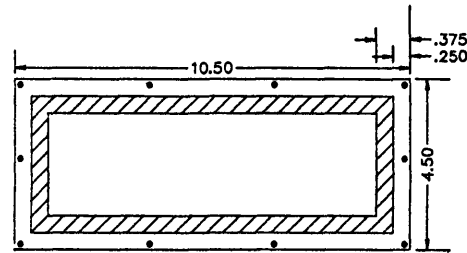
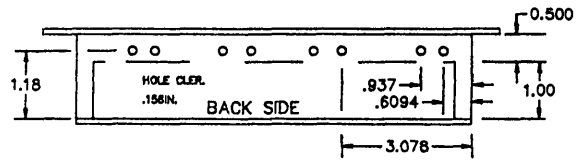


U1,U2,U11,U12,U21,U22,U31,U32 OP27GN
U3,U13,U23,U33 OP07CN



NOTE: A17222B004 PARTS LIST
A17222Q002 ART WORK
A17222P002 PC BOARD
A17222M003 MECHANICAL

NATIONAL RADIO ASTRONOMY OBSERVATORY GREEN BANK, WV 24944	
PROJECT: USNO-VLBI	TITLE: F AMP-DETECTOR
DESIGNED BY: S.D. White	DATE: 11/83
DRAWN BY: S.D. White	DATE: 11/83
REV: 1	REV: A17222S001



NOTE:
ON FRONT SIDE TOP HOLES 12-32 TAPPED
BOTTOM HOLES .156IN. CLER.

NOTE: A17222B004 ASSEMBLY

NATIONAL RADIO ASTRONOMY OBSERVATORY GREEN BANK, WV 24944			
PROJECT	USNO-VLBI	TITLE	IF AMP. DET.
INTERVAL		DESIGNER	J. OLIVER
PERIOD		DATE	1/20/83
DRAWN	BY/REV	REVISION	B17222M003

System: Hawaii S/X Receiver
Ass'Y: IF Amp/Det Box
Type:
Func: Interconnecting
Dwg: A17222W003

Date: 3/30/93
By: S.D. White
Sheet: 1 OF 1
Designation: J1,J2

Pin#	Function	To
J1-A	Return	Term Board
J1-B	+15V	Term Board
J1-C	-15V	Term Board
J1-D		
J2-A	X-R Total Power	J2-M (Rec Card)
J2-B	S-R Total Power	J2-N (Rec Card)
J2-D	S-L Total Power	J2-P (Rec Card)
J2-E	X-L Total Power	J2-R (Rec Card)
J2-H	Total Power Return	J2-S (Rec Card)

**Phase Locked Oscillator
A17222B007**

Drawing Number: A17222B007

Date: 3/16/93

Title: PLO Box

Rev: A

ITEM	QT	DESCRIPTION	PART NUMBER	MANUFACTURE
1	1	PLO Assembly	A17222A003	NRAO
2	1	Mechanical Box	B17222M002	NRAO
3	1	PLO Block Diagram	B17222K004	NRAO
4	1	100 Mhz VCO	CO233-9516	Vectron
5	4	5-500 Mhz Splitter	ZFSC-2-1	Mini-Circuits
6	2	100 Mhz Amplifier	QBH-9-176	Q-Bit
7	1	7600 Mhz PLO	PLM-074-076-A-0-20P	Miteq
8	1	20 Db Coupler(S Band)	10616-20	Anaren
9	1	2000 Mhz PLO	PLC-019-021-A-0-20P	Miteq
10	1	Power Amplifier	ZHL-1-2W	Mini-Circuits
11	1	100 Mhz BPF	6B2-100-18S11	Reatel
12	1	Comb Generator	33002A	HP
13	1	500 Mhz BPF	3B120-500-U50/0/0	K&L
14	1	500 Mhz Amplifier	UTO-1003	Avantek
15	1	500 Mhz Amp(30 dB)	ZFL-2000	Mini-Circuits
16	1	500 Mhz Phase Detector	A17222B009	NRAO
17	2	6 Db Coupler(X band)	4015C-6	Narda

Drawing Number: A17222B009
 Title: 500 Mhz Phase Detector

Date: 3/17/93
 Rev: A

ITM	QTY	DESIGNATION	DESCRIPTION	PART NUMBER	MANUFACTURE
1	1		Assembly	A17222A004	NRAO
2	1		Mechanical Box	A17222M004	NRAO
3	1		PC Board	A17222P003	NRAO
4	1		PC Artwork	A17222Q003	NRAO
5	1		Schematic	A17222S002	NRAO
6	4	A1,A2,A3,A4	RF Amplifier	MSA-304	Avantek
7	3	OA1,OA2,OA3	Op Amp	OP-07	Analog Devices
8	1	MV1	Timer	SN555	Signetics
9	2	M1,M2	Phase Det Mixer	MPD-2	Mini-Circuits
10	2	R1,R2,R3,R4	Res 5% 1/2w 300 Ohm		
11	6	R5 thru R10	Res Chip 5% 20 Ohm	CRCW1206	Dale
12	2	R11,R12	Res Chip 5% 51 Ohm	CRCW1206	Dale
13	1	R13	Res 1% 1/4W 1K Ohm		
14	1	R14	Res 1% 1/4W 9.76K Ohm		
15	1	R15	Res 5% 1/2W 1K		
16	1	R16	Res 1% 1/4W 511 Ohm		
17	8	R17,R18,R22,R23,R24,R25,R27,R29	Res 1% 1/4W 10K Ohm		
18	1	R19	Res 1% 1/4W 511K Ohm		
19	1	R20	Res 1% 1/4W 49.9K Ohm		
20	1	R21	Res 1% 1/4W 470 Ohm		
21	1	R26	Res 1% 1/4W 100K Ohm		
22	1	R28	Res 1% 1/4W 20K Ohm		
23	1	R30	Res 1% 1/4W 2.5M Ohm		
24	10	C1,C12,C14,C18,C19,C21,C22,C23,C24,C20	Cap Chip 0.1uF		
25	1	C13	Cap Chip 1000pF		
26	1	C15	Cap 0.047 uF		
27	1	C16	Cap 0.47 uF		
28	1	C17	Cap 1uF		
29	1	C25	Cap Chip 6.2pF		
30	1	K1	Pot Trim 1T 1K Ohm	3329H	Bourne Cermet
31	1	K2	Pot Trim 1T 20K Ohm	3329H	Bourne Cermet
32	4	L1,L2,L3,L4	Ind 4.7uH		
33	2	L5,L6	Ind 1.5uH		
34	2	L7,L8	Ind 16nH (3T 0.064" D)		
35	2	Q1,Q2	Transistor	2N3904	
36	1	Q3	Transistor	2N2219	
38	2	D1,D3,D4	Diode Silicon	1N456	
39	1	D2	Diode Zener 5V		

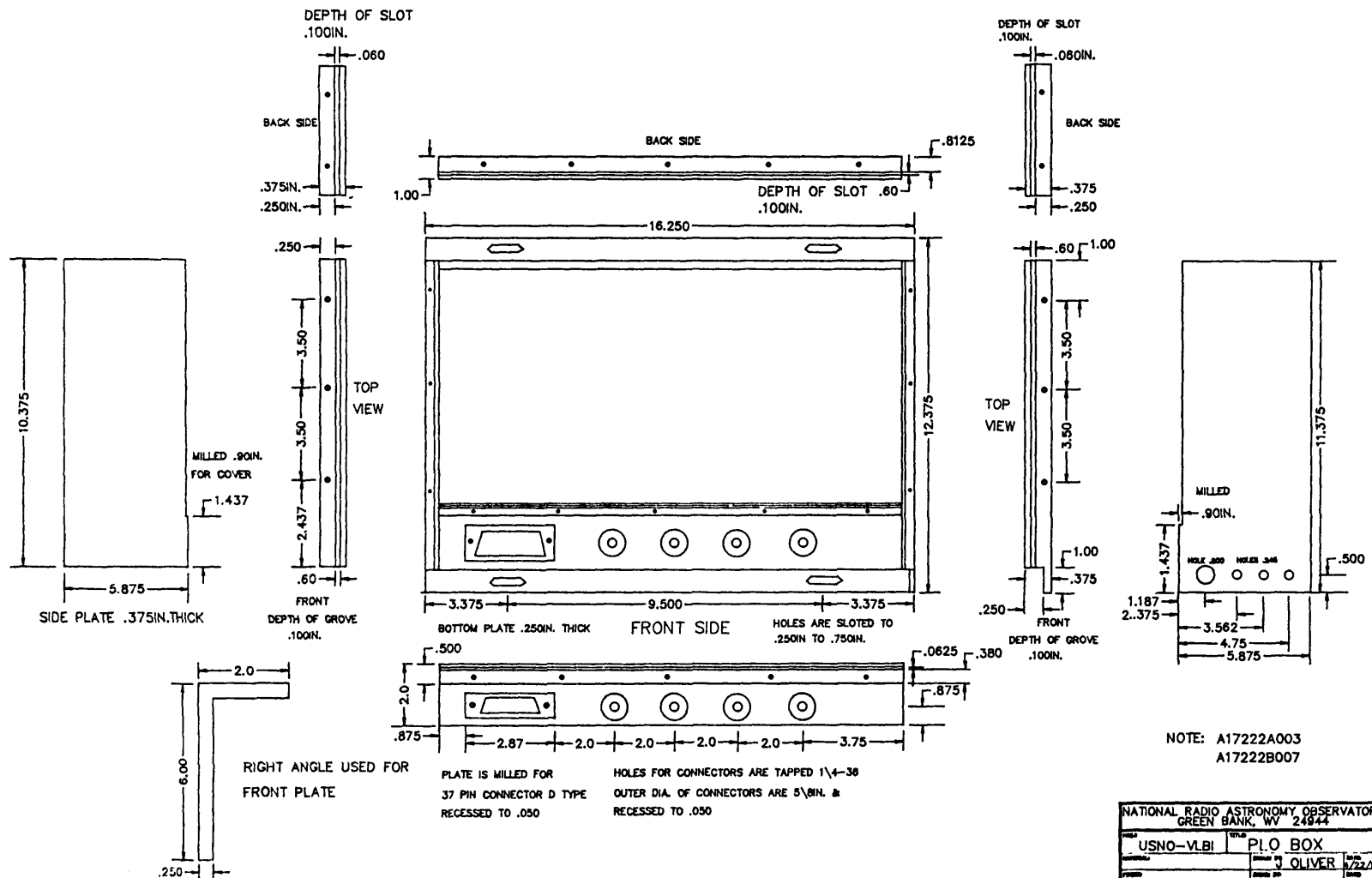
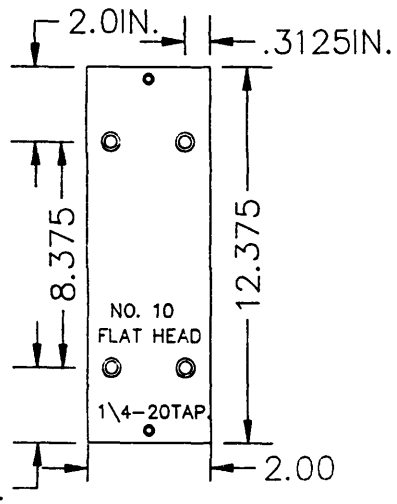


PLATE IS MILLED FOR 37 PIN CONNECTOR D TYPE RECESSED TO .050

Holes for connectors are tapped 1/4-36 OUTER DIA. OF CONNECTORS ARE 5/16IN. & RECESSED TO .050

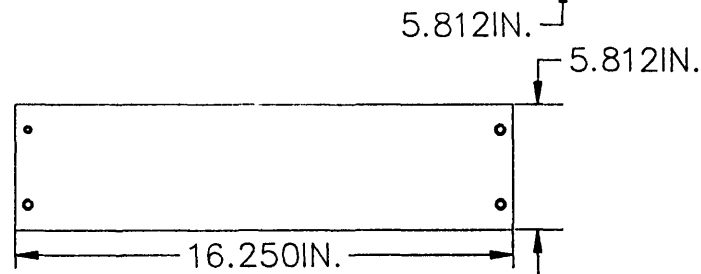
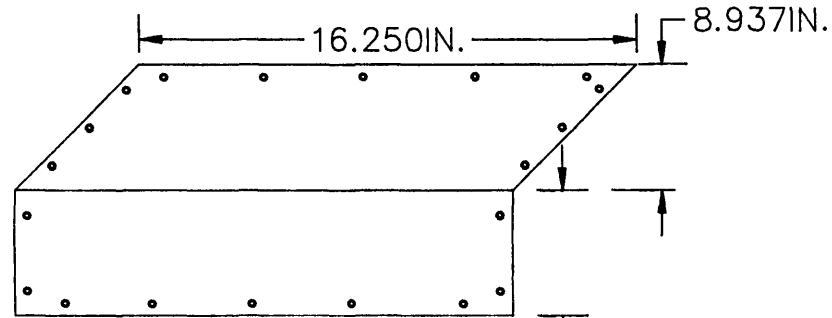
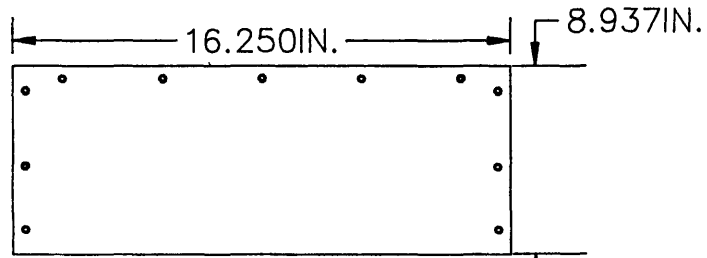
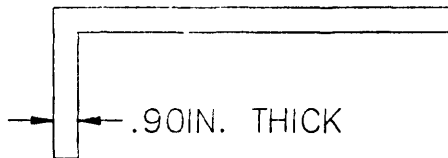
NATIONAL RADIO ASTRONOMY OBSERVATORY GREEN BANK, WV 24844			
PROJECT	USNO-VLBI	PILOT BOX	DATE
DESIGNED BY	J. OLIVER		DATE
DATE	7/22/83		
REVISED BY			
DATE			
PROJECT	817222M002		TOP

.250IN THICK



TWO EACH
MOUNTING PLATE FOR PLO BOX

BEND TO 90 DEG.

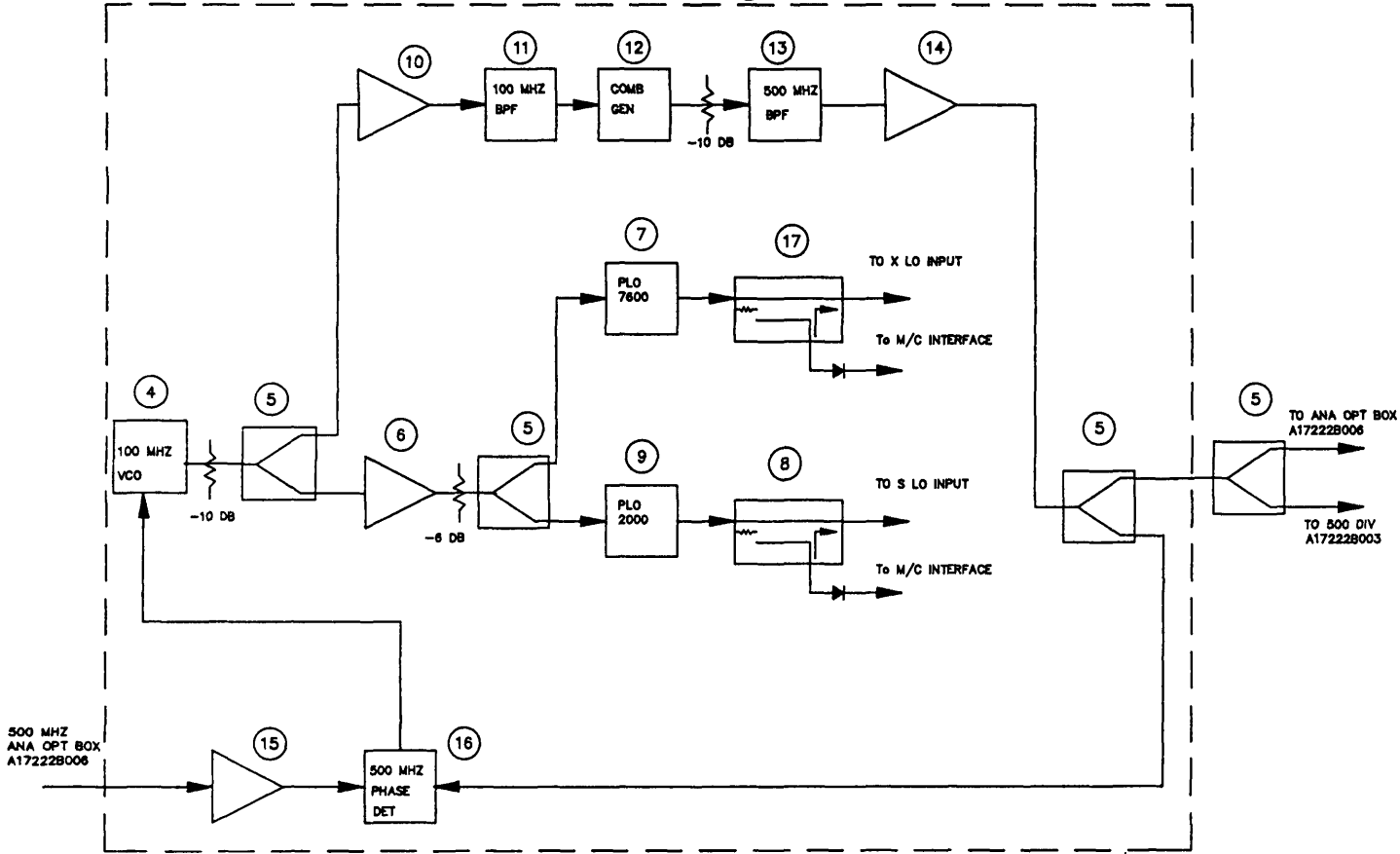


NOTE: A17222A003
A17222B007

CLEARANCE HOLES IN COVER FOR 4-40

NATIONAL RADIO ASTRONOMY OBSERVATORY GREEN BANK, WV 24944			
PROJ.	TITLE		
USNO-VLBI	PLO BOX COVER		
MATERIAL	DRAWN BY	DATE	
	OLIVER	4/23/93	
FINISH	DESIGN BY	DATE	
SHEET	DRAWING NUMBER	20F2	SCALE
	B17222M002		

PLO BOX (2)

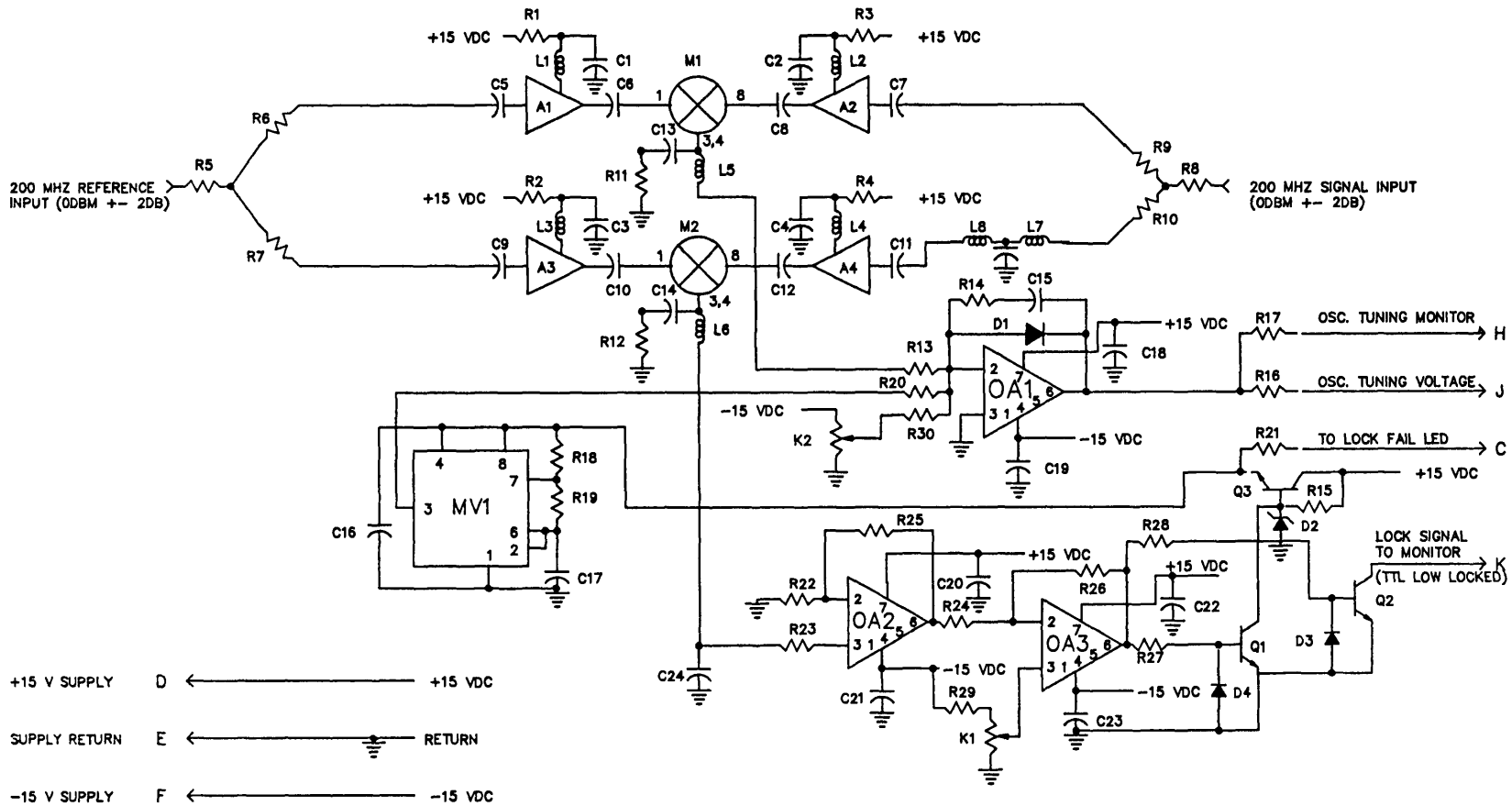


500 MHz
ANA OPT BOX
A17222B006

TO ANA OPT BOX
A17222B006
TO 500 DIV
A17222B003

Note: A17222A003 Assembly
A17222B007 Parts List
A17222M002 Mechanical

NATIONAL RADIO ASTRONOMY OBSERVATORY GREEN BANK, WV 24944			
FIELD	TITLE		
	USNO-VLBI PHASE LOCK OSC		
MATERIAL	DESIGNED BY	DATE	
	S.D. WHITE	3/9/93	
FIGURE	REVISIONS	DATE	
SHEET 1 OF 1	DRAWING NUMBER	REV	SCALE
	B17222K004		



Note: A17222A004 Assembly
 A17222B009 Parts List
 A17222M004 Mechanical
 A17222P003 PC Board
 A17222Q003 Artwork

NATIONAL RADIO ASTRONOMY OBSERVATORY GREEN BANK, WV 24944			
PROJ USNO-VLBI	TITLE PHASE DETECTOR SCHEMATIC	DATE 3/26/93	DESIGN BY S.D. White
MATERIAL	DESIGN BY J.R. COE	DATE 8/18/88	REV
SHEET 1 OF 1	DRAWING NUMBER B17222S002	DATE	REV

System: Hawaii S/X Receiver
Ass'Y: LO Box
Type: 37 Pin D (P)
Func: LO Internal Wiring
Dwg: A17222W001

Date: 3/30/93
By: S.D. White
Sheet: 1 of 2
Designation: J1

Pin#	Function	Color
1	24 V (ZHL-1-2W)	WH/BK
2	100 MHZ OSC Tuning Voltage	Y
3	2 GHZ OSC Tuning Volt Monitor	WH/BK/BK/R
4	7.6 GHZ OSC Tuning Volt Monitor	WH/BK/BK/Y
5	Signal Return	BH/BK/BK/GN
6	20 V Return (OSC Power)	WH/BN
7	+/- 15V Return(Phase Det)	BK
8	+15V (Phase Det)	R
9	24V Return (ZHL-1-2W)	WH/R
10	100 MHZ OSC Lock	W
11	7.6 GHZ OSC Lock	WH/Dark BN
12	2 GHZ OSC Lock	WH/LT BN
13	+20V (2 GHZ OSC)	WH/OR
14	+20V (7.6 GHZ OSC)	WH/Y
15	-15V (Phase Det)	OR
16	+15V (Out-Of-Lock CKT)	R
17	+15V (QBH-9-176)	WH/BL
18	+15V (100 MHZ OSC)	WH/V
19	+15V (UTO 1003)	WH/GY
20	7.6 GHZ OSC LVL DET SIG	Coax
21	7.6 GHZ OSC LVL DET Return	Coax Shield
22	2 GHZ OSC LVL DET SIG	Coax
23	2 GHZ OSC LVL DET Return	Coax Shield
24	+15V (ZFL-2000)	WH/BK/R
25	+15V Return (ZFL-2000)	WH/BK/OR
26	+15V Return (UTO-1003)	WH/BK/Y
27	+15V Retrun (100 MHZ OSC)	WH/BK/BL
28	7.6 GHZ OSC Lock	WH/BK/V
29	2 GHZ OSC Lock	WH/BK/GY
30	100 MZH OSC Lock	BN
31	Out-Of-Lock Return	WH/BK/BN
32	+15V Return (QBH-9-176)	BK
33	+15V Return (Out-of-Lock Ckt)	BK
34	Spare	
35	Spare	
36	Spare	
37	Spare	

System: Hawaii S/X Receiver
Ass'Y: LO Box Cable
Type: 37 Pin D (S)
Func: LO Box Interconnect
Dwg: A17222W001

Date: 3/30/93
By: S.D. White
Sheet: 2 of 2
Designation: J1

Pin#	Function	To
1	24 V (ZHL-1-2W)	Term Board
2	100 MHZ OSC Tuning Voltage	J2-CC (Rec Card)
3	2 GHZ OSC Tuning Volt Monitor	J2-DD (Rec Card)
4	7.6 GHZ OSC Tuning Volt Monitor	J2-EE (Rec Card)
5	Signal Return	J2-FF (Rec Card)
6	20 V Return (OSC Power)	J2-HH (Rec Card)
7	+/- 15V Return(Phase Det)	Term Board
8	+15V (Phase Det)	Term Board
9	24V Return (ZHL-1-2W)	Term Board
10	100 MHZ OSC Lock	J2-MM (Rec Card)
11	7.6 GHZ OSC Lock	J2-NN (Rec Card)
12	2 GHZ OSC Lock	J2-PP (Rec Card)
13	+20V (2 GHZ OSC)	J2-RR (Rec Card)
14	+20V (7.6 GHZ OSC)	J2-SS (Rec Card)
15	-15V (Phase Det)	Term Board
16	+15V (Out-Of-Lock CKT)	Term Board
17	+15V (QBH-9-176)	Term Board
18	+15V (100 MHZ OSC)	Term Board
19	+15V (UTO 1003)	Term Board
20	7.6 GHZ OSC LVL DET SIG	J2-C (Rec Card)
21	7.6 GHZ OSC LVL DET Return	
22	2 GHZ OSC LVL DET SIG	J2-E (Rec Card)
23	2 GHZ OSC LVL DET Return	
24	+15V (ZFL-2000)	Term Board
25	+15V Return (ZFL-2000)	Term Board
26	+15V Return (UTO-1003)	Term Board
27	+15V Retrun (100 MHZ OSC)	Term Board
28	7.6 GHZ OSC Lock	Light On LO Box
29	2 GHZ OSC Lock	Light On LO Box
30	100 MZH OSC Lock	Light On LO Box
31	Out-Of-Lock Return	
32	+15V Return (QBH-9-176)	Term Board
33	+15V Return (Out-of-Lock Ckt)	Term Board
34	Spare	
35	Spare	
36	Spare	
37	Spare	

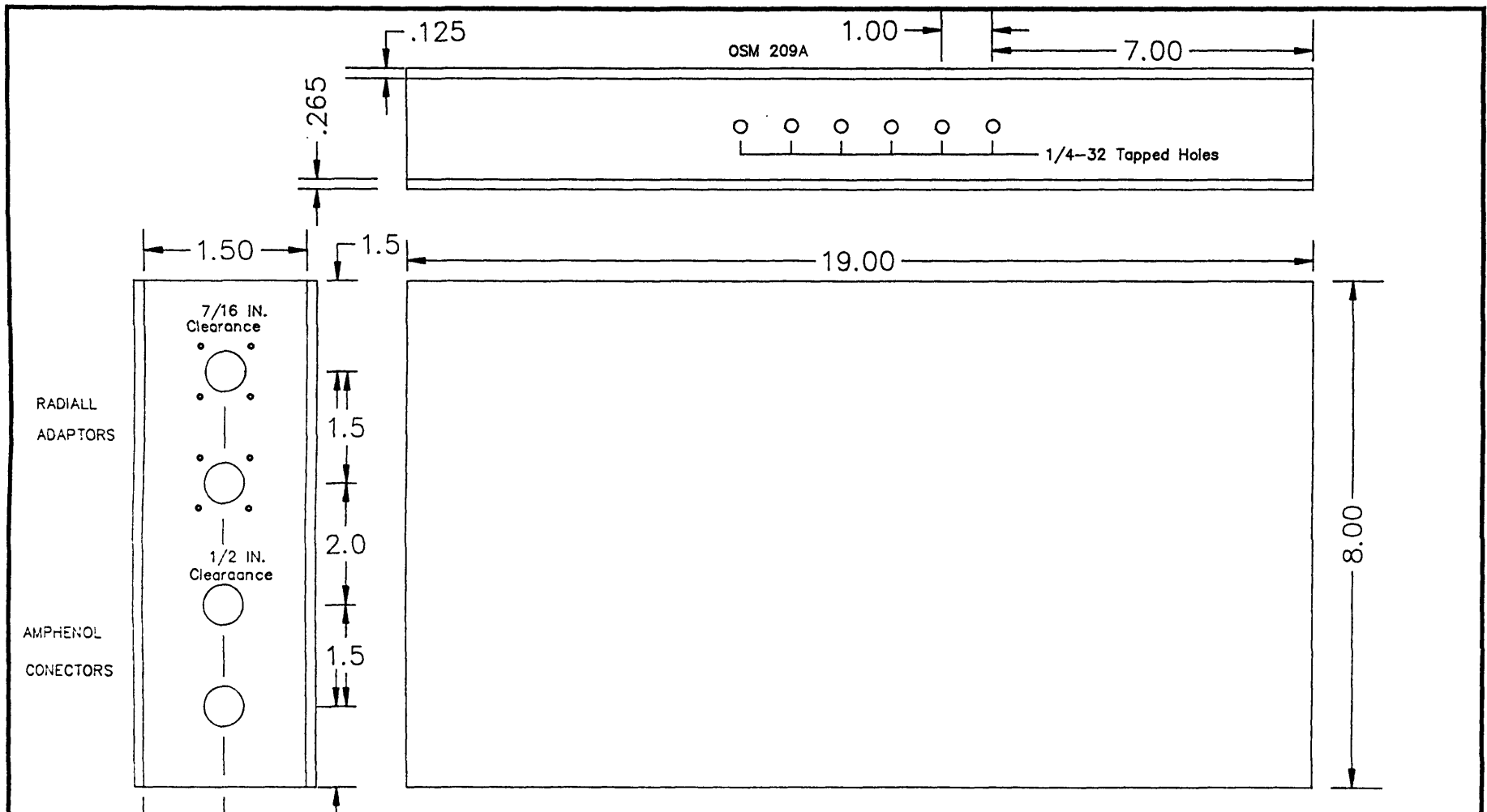
APPENDIX D

**Analog Optic Box
A17222B005**

Drawing Number: A17222B005
Title: Analog Optic Box

Date: 3/16/93
Rev: A

ITM	QTY	DESCRIPTION	PART NUMBER	MANUFACTURE
1	1	Assembly	A17222A003	NRAO
2	1	Schematic	A17222K003	NRAO
3	1	Mechanical Box	B17222M007	NRAO
4	1	Optical Transmitter	LDAT-2200	Laser Diode
5	1	Optical Receiver	LDAR-2200	Laser Diode
6	1	IF Triplexer	A17222B006	NRAO
7	2	IF SPDT Switch/Driver	ZSDR-230	Mini-Circuits
8	1	500 MHZ Amplifier	QBH-9-160	Q-Bit
9	1	Wideband Amplifier	QB-9-175	Q-Bit



NOTE: END PLATES AND SIDE PLATES 1/4 IN THICK

NOTE: A17222A003 ASSEMBLY
 A17222B005 PARTS LIST
 A17222K005 BLOCK DIAGRAM

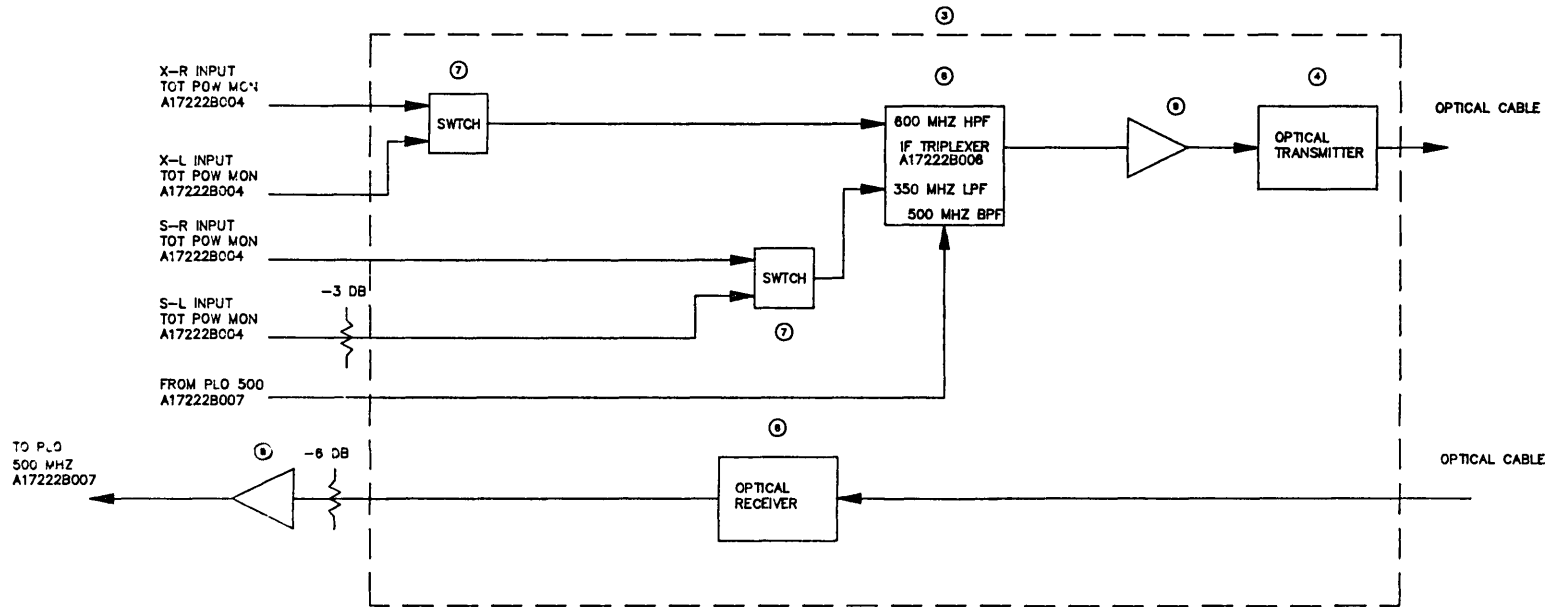
PROJ: S&X BAND RCVR		TITLE: ANALOG OPTICAL LINK BOX	
MATERIAL:		DRWN BY: J OLIVER	DATE: 4/5/93
FINISH:		DESIGN BY:	DATE:
SHEET:	DRAWING NUMBER: B17222M007	REV: A	SCALE:

Drawing Number: A17222B006 Date: 3/18/93

Title: Triplexer

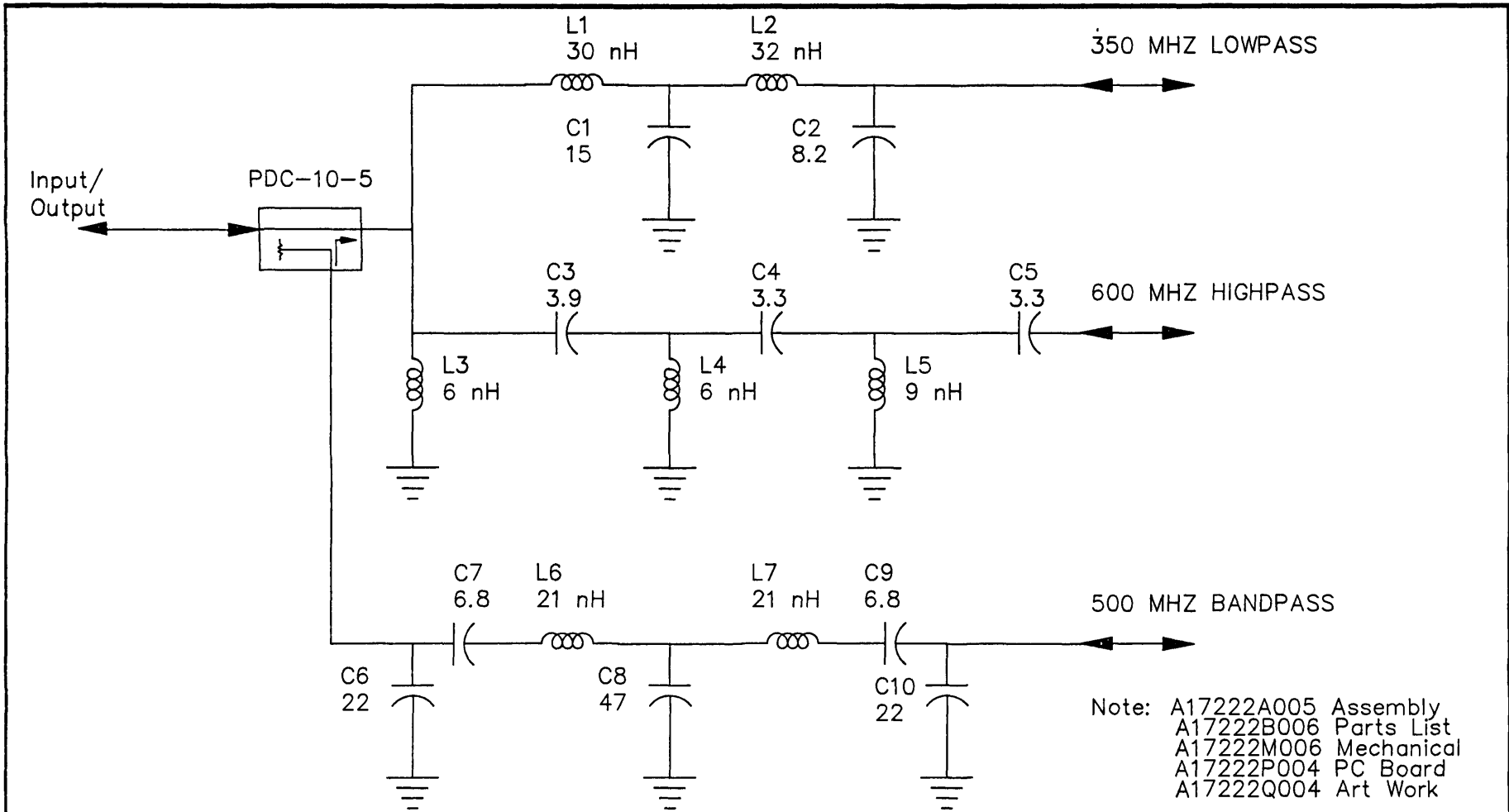
ITM	QTY	DESIGNATION	DESCRIPTION	PART NUMBER	MANUFACTURE
1	1		Assembly	A17222A005	NRAO
2	1		Mechanical Box	A17222M006	NRAO
3	1		PC Board	A17222P004	NRAO
4	1		PC Artwork	A17222Q004	NRAO
5	1		Schematic	A17222S006	NRAO
6	1		10 dB Coupler	PDC-10-5	Mini-Circuits
7	1	L1	Ind 30 nH (5T 0.082"D)		
8	1	L2	Ind 32 nH (4T 0.111" D)		
9	2	L3,L4	Ind 6 nH (2T 0.064"D)		
10	1	L5	Ind 9 nH (2T 0.082"D)		
11	2	L6,L7	Ind 21 nH (3T 0.082"D)		
12	1	C1	Cap 15 pF ceramic		
13	1	C2	Cap 8.2 pF ceramic		
14	1	C3	Cap 3.9 pF ceramic		
15	1	C4,C5	Cap 3.3 pF ceramic		
16	1	C6,C10	Cap 22 pF ceramic		
17	1	C7,C9	Cap 6.8 pF ceramic		
18	1	C8	Cap 47 pF ceramic		

ANALOG OPTICAL BOX



Note: A17222A006 Assembly
 A17222B005 Parts List
 B17222M007 Mechanical

NATIONAL RADIO ASTRONOMY OBSERVATORY GREEN BANK, WV 24944			
PROJ	USNO-VLBI	TRNG	ANALOG OPTICAL BLK DIA
UNIVERSITY		DESIGNER	S.D. WALKER / 93
DATE		SCALE	
SHEET	1 OF 1	ISSUED	REVISED
		DATE	A

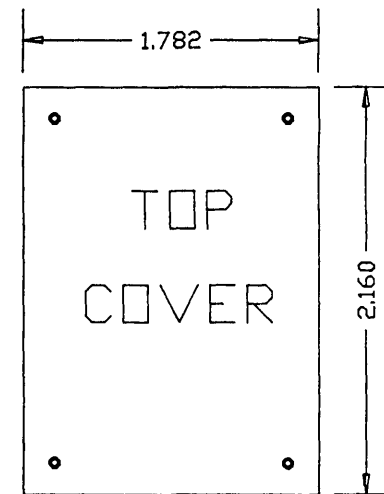
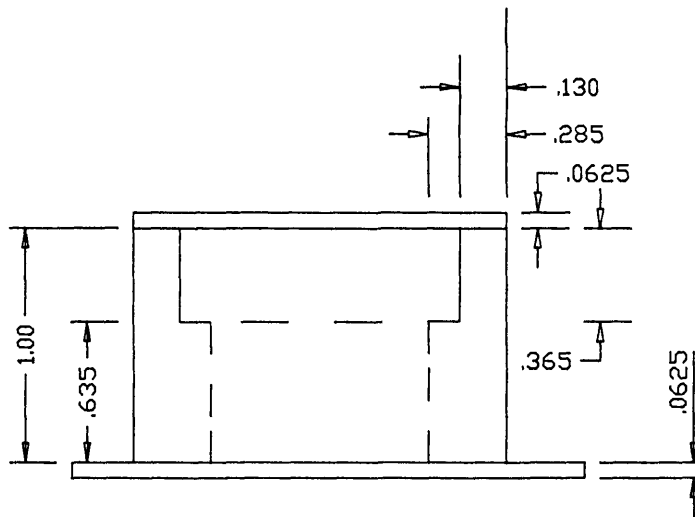
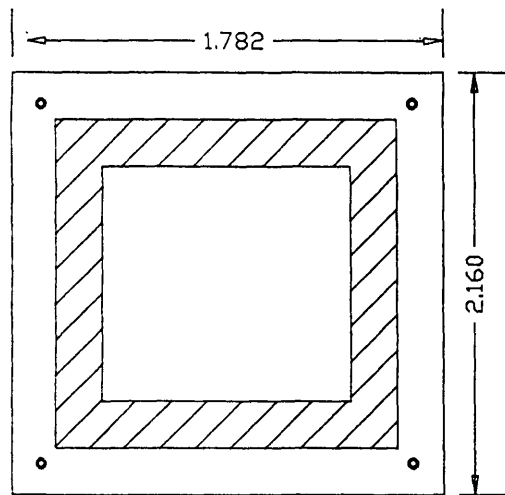


NATIONAL RADIO ASTRONOMY OBSERVATORY GREEN BANK, WV 24944			
PROJ	TITLE		
USNO-VLBI		IF TRIPLEXER	
MATERIALS	DRAWN BY	S.D. WHITE	DATE
FINISH	DESIGN BY	J.R. COE	DATE
SHEET	DRAWING NUMBER	REV.	SCALE
1 OF 1	A17222S006	A	

System:	Hawaii S/X Receiver	Date:	3/30/93
Ass'Y:	Analog Optic Box	By:	S.D. White
Type:	Amp 9 Pin, Amp 5 Pin, SMA	Sheet:	1 OF 1
Func:	Interconnecting	Designation:	J1-J8
Dwg:	A17222W002		

Pin#	Function	To	Color
J1-A	+15V	Term Board	
J1-B	Return	Term Board	
J1-C	-15V	Term Board	
J1-D	+5V	Term Board	
J1-E	Return	Term Board	
J1-F	-5V	Term Board	
J1-H	OPT Tx Alarm	J2-H (Rec Card) Box	
J1-J	OPT Rx Alarm	J2-J (Rec Card) Box	
J2-A	TTL/IF Switch	J2-X (Rec Card) Box X-R or X-L	
J2-B	TTL/IF Switch	J2-Y (Rec Card) Box S-R or S-I	
J2-D	+5V	Term Board	
J2-E	Return	Term Board	
J2-H	TTL Return	Term Board	
J3	X-R IF Input	SMA/LO box	
J4	S-R IF Input	SMA/LO Box	
J5	X-L IF Input	SMA/LO Box	
J6	S-L IF Input	SMA/LO Box	
J7	500 MHZ Input	SMA/LO Box	
J8	500 MHZ Output	SMA/LO Box	

Note: IF Switches: RF-1 = S+R - X-R | RF-2 = S-L - X-L



BOTTOM COVER
 HALF INCH LONGER

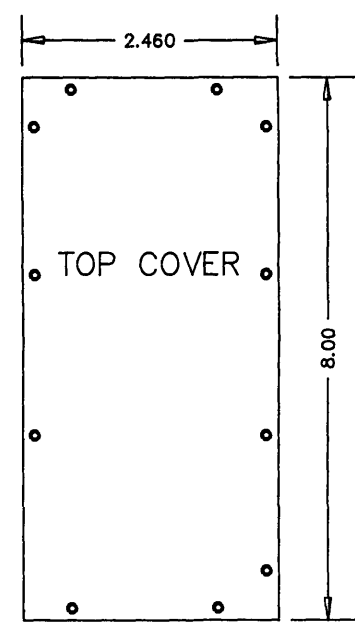
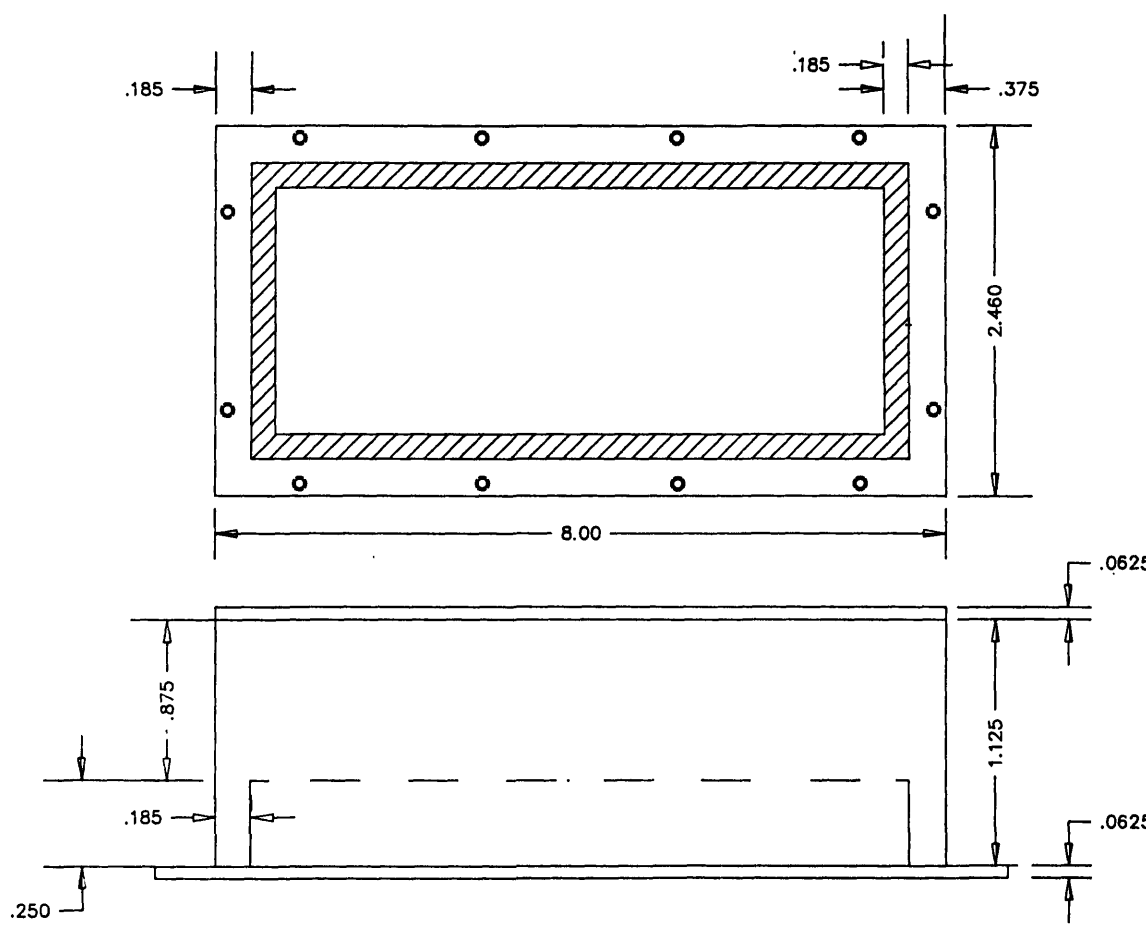
NOTE: A17222A005 ASSEMBLY

NATIONAL RADIO ASTRONOMY OBSERVATORY
 GREEN BANK, WV 24944

PROJ: USNO-VLBI		TITLE: TRIPLEXER	
MATERIAL:	DESIGN BY: J. OLIVER	DATE: 4/12/93	DATE:
FINISH:	DESIGN BY:	DATE:	DATE:
SHEET:	DRAWING NUMBER: B17222M006	REV:	SCALE:

APPENDIX E

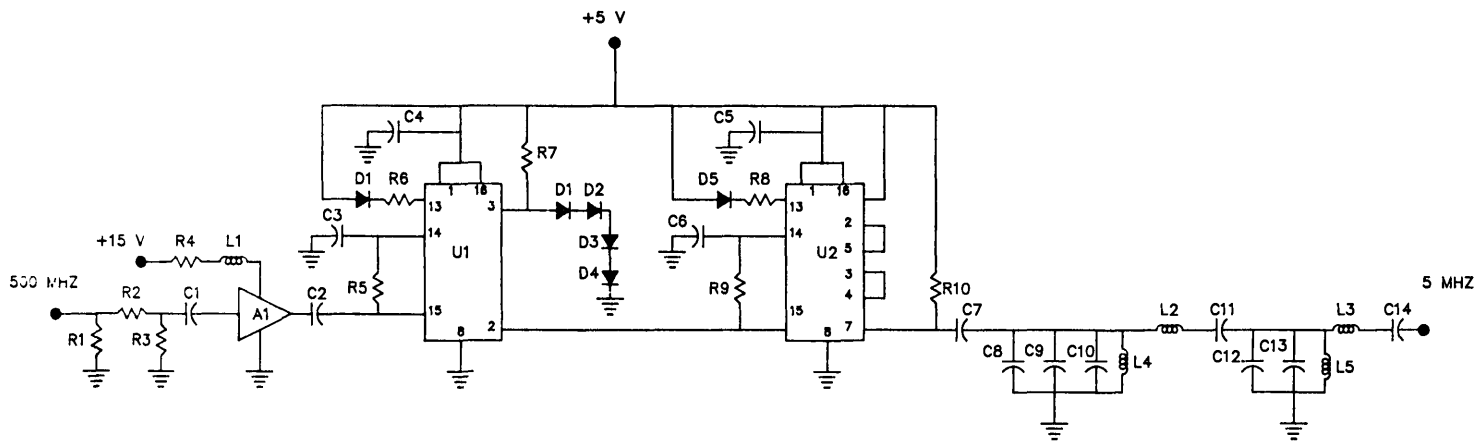
**500 MHz Divider
A17222B003**



BOTTOM COVER
HALF INCH LONGER

NOTE: A17222A004 ASSEMBLY
A17222B003 BILL OF MATE.

NATIONAL RADIO ASTRONOMY OBSERVATORY GREEN BANK, WV 24944			
PROJ.	TITLE USNO-VLBI 500 DIVIDE BOX		
MATERIAL	DRAWN BY J OLIVER	DATE 3/11/93	
FINISH	DESIGN BY	DATE	
SHEET	DRAWING NUMBER B17222M001	REV.	SCALE



Note: A17222B003 Parts List
 A17222A001 Assembly
 A17222M001 Mechanical
 A17222P001 PC Board

NATIONAL RADIO ASTRONOMY OBSERVATORY GREEN BANK, WV 24944			
PROJECT	USNO-VLBI	GROUP	500 MHZ DIVIDER
DESIGNED BY	S.D. WHITE	DATE	5/8/93
DESIGNED BY	S.D. WHITE	DATE	2/8/90
GROUP	PROJECT NUMBER	REV	SCALE
	A17222S003	A	

APPENDIX F

MCB INTERFACE

Drawing Number: A17222B003

Date: 3/16/93

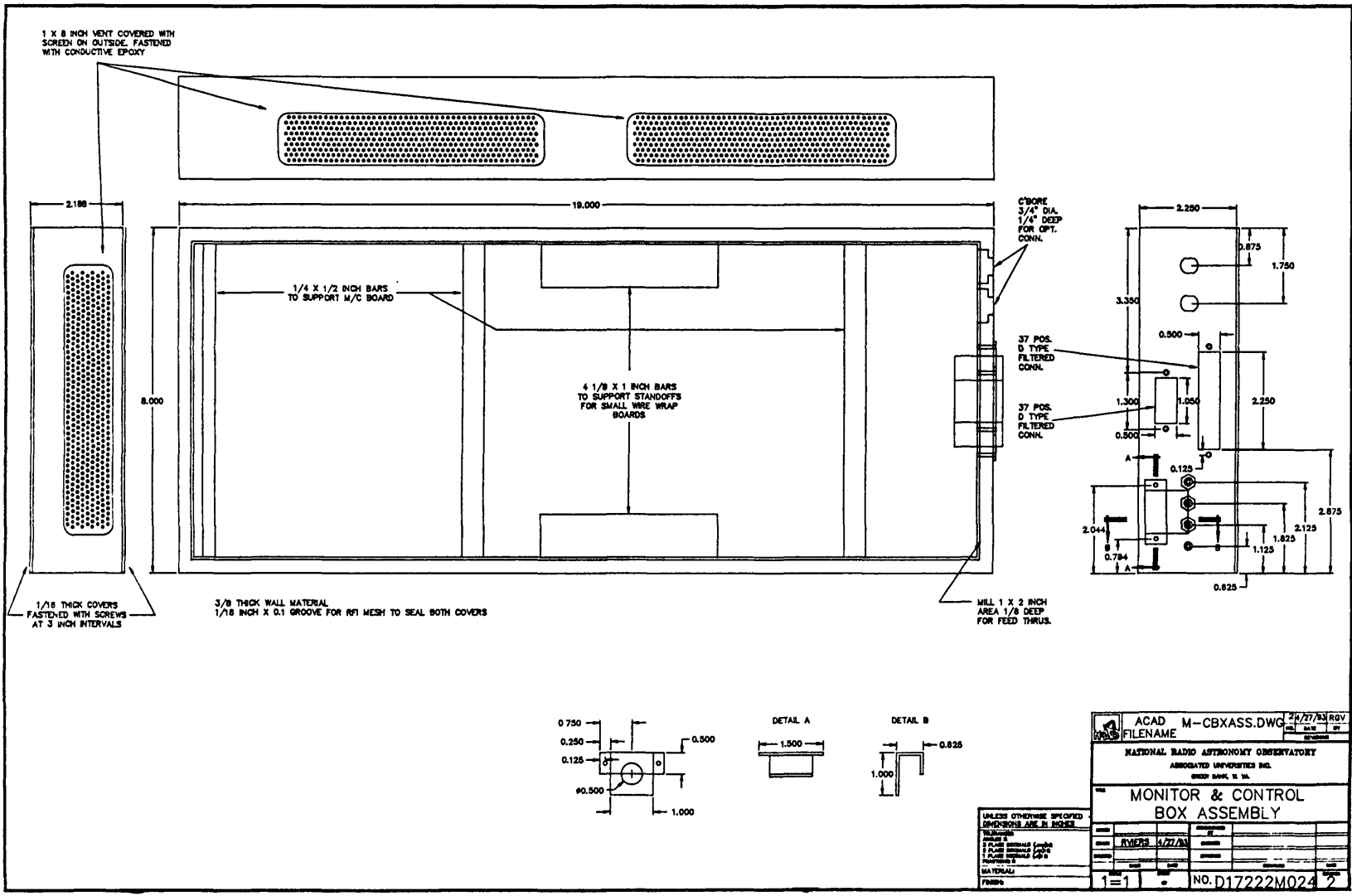
Title: 500 Mhz Divider

ITM	QTY	DESIGNATION	DESCRIPTION	PART NUMBER	MANUFACTURE
1	1		Assembly	A17222A001	NRAO
2	1		Mechanical Box	A17222M001	NRAO
3	1		PC Board	A17222P001	NRAO
4	1		PC Artwork	A17222Q001	NRAO
5	1		Schematic	A17222S003	NRAO
6	2	R1,R3	Res 5% 1/4W 110 Ohm		
7	1	R2	Res 5% 1/4W 36 Ohm		
8	1	R4	Res 5% 1/2w 267 Ohm		
9	4	R5,R7,R9,R10	Res 5% 1/4w 1K Ohm		
10	2	R6,R8	Res 5% 1/4w 100 Ohm		
11	7	C1 thru C7	Cap 0.1 UF chip 50V	AVX 1205C104MAT050M	AVX
12	1	C8	Cap 3300 pF ceramic		
13	2	C9,C13	Cap 100 pF ceramic		
14	1	C10	Cap 120 pF ceramic		
15	1	C11	Cap 220 pF ceramic		
16	1	C12	Cap 4700 pF ceramic		
17	1	C14	Cap 300 pF ceramic		
18	1	L1	Ind 2.2 uH		
19	1	L2	Ind 4.4 uH		
20	1	L3	Ind 3.3 uH		
21	1	L4	Ind 0.3 uH		
22	1	L5	Ind 0.22 uH		
23	1	A1	Amp RF	MSA 0304	Avantek
24	2	U1,U2	Two Modulus Prescaler	MC12013L	Motorola
25	5	D1 thru D5	Diodes, Silicon	HP 5082-2835	HP

Drawing Number: A17222B012
Title: MCB Box

Date: 4/28/93
Rev: A

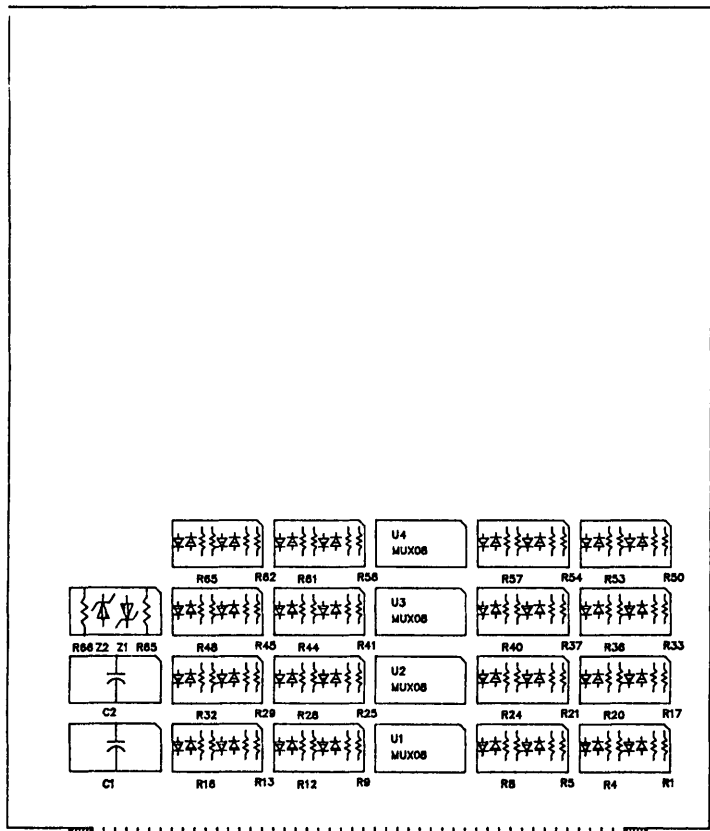
ITM	QTY	DESCRIPTION	PART NUMBER	MANUFACTURE
1	1	Mechanical Box	D17222M024	NRAO
2	1	Analog Multiplex Card	A17222A009	NRAO
3	1	Receiver Control Card	A17222A008	NRAO
4	1	Fiber Interface Board	A17222S009	NRAO
5	1	Interconnecting Wire List	A17222W008	NRAO



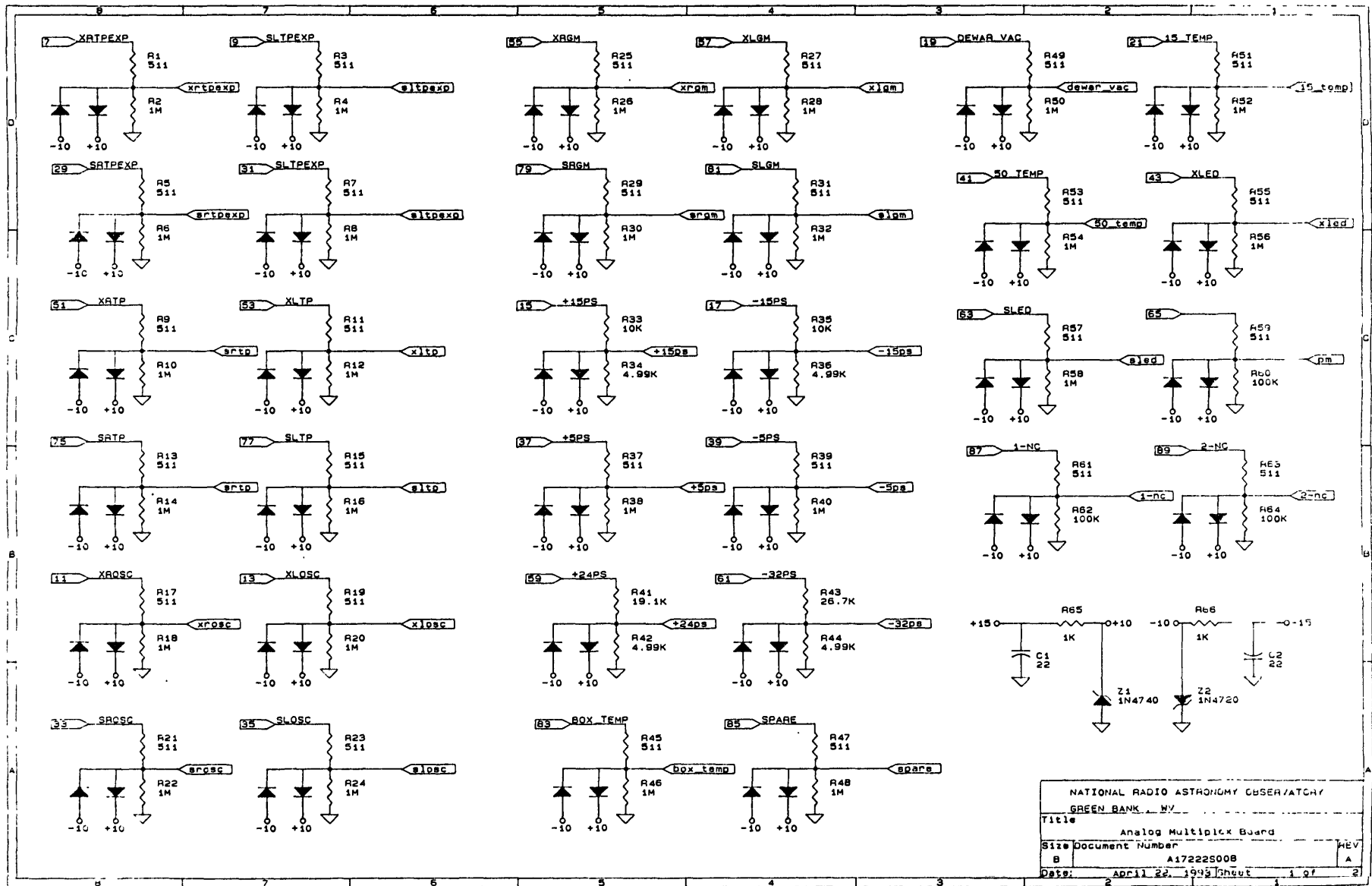
ACAD M-CBXASS.DWG		2/27/83	REV
FILENAME			
NATIONAL RADIO ASTRONOMY OBSERVATORY			
ASSOCIATED UNIVERSITIES INC.			
GREEN BANK, W. VA.			
MONITOR & CONTROL BOX ASSEMBLY			
DESIGNED BY	DATE	APPROVED BY	DATE
DRAWN BY	DATE	CHECKED BY	DATE
CHECKED BY	DATE	APPROVED BY	DATE
MATERIALS	DATE	APPROVED BY	DATE
FORMER	DATE	APPROVED BY	DATE

ANAMUX.XLS

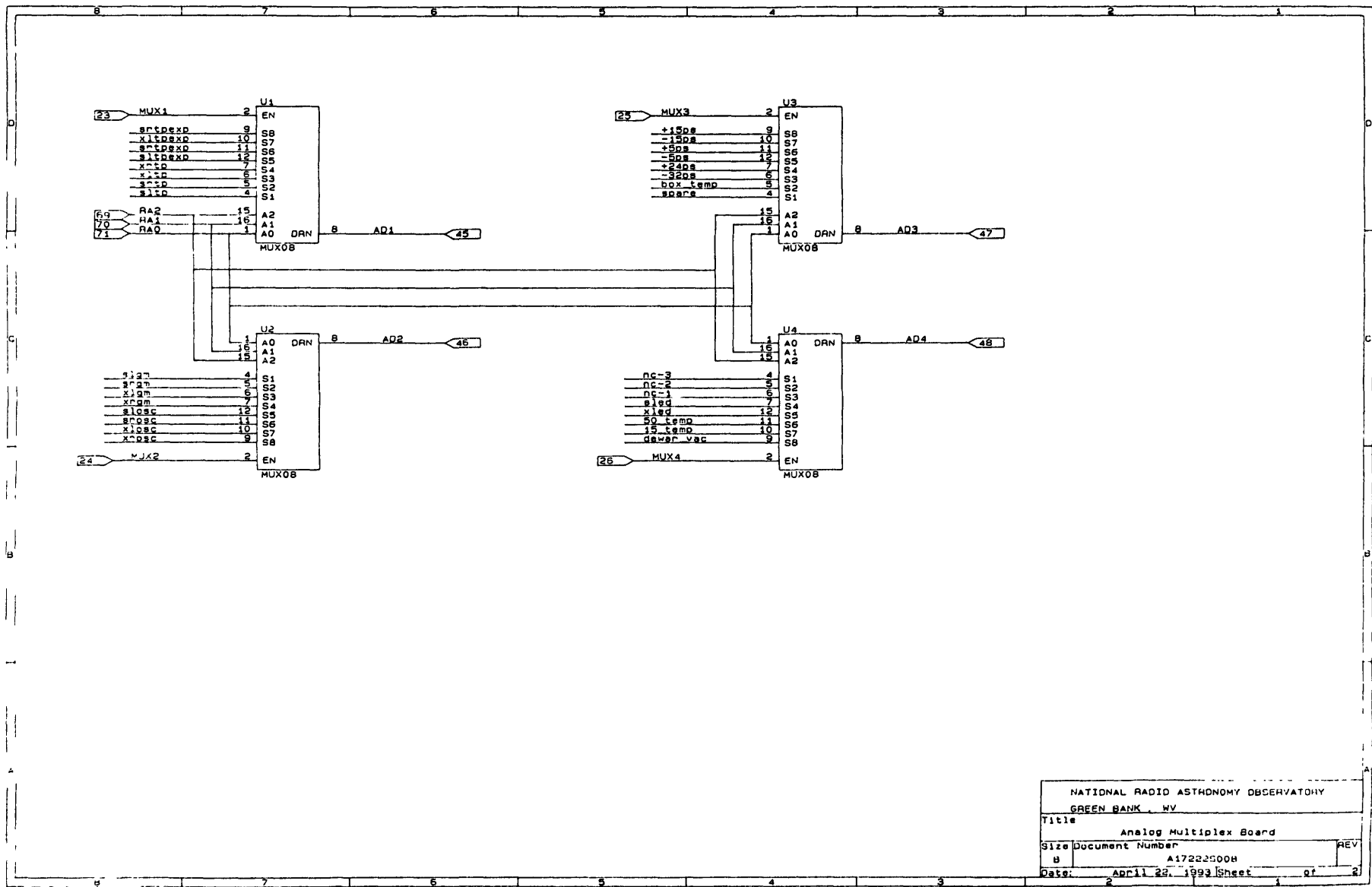
Name:	Analog Multiplex		Slot:		Date:	4/22/93	
Signal Name	Back#	To	From	Signal Name	Back#	To	From
+ 15V	1		J5-15		2		
Ground	3		J5-14		4		
	5				6		
XRTPEXP	7		J6-1		8		
XLTPEXP	9		J6-2		10		
XR OSC	11		J6-9		12		
XL OSC	13		J6-10		14		
+ 15 PS	15		+ 15 Feed		16		
-15 PS	17		-15 Feed		18		
DEWAR VAC	19		J5-5		20		
15 deg Temp	21		J5-6		22		
MUX1	23		J3-66	MUX2	24		J3-65
MUX3	25		J3-64	MUX4	26		J3-63
Ground	27				28		
SRTPEXP	29		J6-3		30		
SLTPEXP	31		J6-4		32		
SR OSC	33		J6-11		34		
SL OSC	35		J6-12		36		
+ 5 PS	37		+ 5 Feed		38		
-5 PS	39		J6-13		40		
50 deg Temp	41		J5-7		42		
X LED	43		J5-8		44		
AD1	45	J1-2		AD2	46	J1-3	
AD3	47	J1-4		AD4	48	J1-5	
Ground	49				50		
X RTP	51		J6-5		52		
XLTP	53		J6-6		54		
X RGM	55		J5-1		56		
XLGM	57		J5-2		58		
+ 24 PS	59		J6-14		60		
-32 PS	61		J6-15		62		
S LED	63		J5-9		64		
NC-3	65		J5-12		66		
	67				68		
RA0	69		J3-58	RA1	70		J3-57
RA2	71		J3-56		72		
Ground	73				74		
S RTP	75		J6-7		76		
SLTP	77		J6-8		78		
S RGM	79		J5-3		80		
SLGM	81		J5-4		82		
Box Temp	83		J6-16		84		
Spare	85		J6-17		86		
NC-1	87		J5-10		88		
NC-2	89		J5-11		90		
+ 15V	91		+ 15 Feed	+ 15V	92		+ 15 Feed
-15V	93		-15 Feed	-15V	94		-15 Feed
	95				96		
+ 15 V	97	J1-18	J5-15		98		
Ground	99	J1-22	J5-14		100		



NATIONAL RADIO ASTRONOMY OBSERVATORY GREEN BANK, WV			
VME			
Analog Multiplex Card			
USNO-VLB			
FORM		REV	
DATE		FILE	
SCALE	1 of 1	DWG. NO.	A17222A009

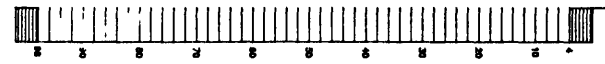
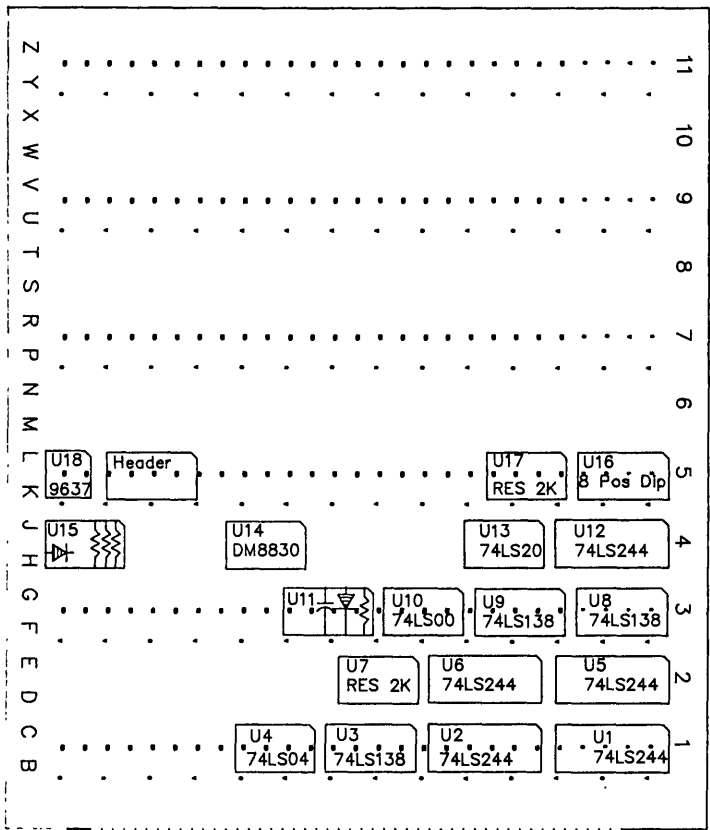


NATIONAL RADIO ASTRONOMY OBSERVATORY
 GREEN BANK, WV
 Title Analog Multiplex Board
 Size Document Number A172225008
 B A
 Date: April 22, 1993 sheet 1 of 2

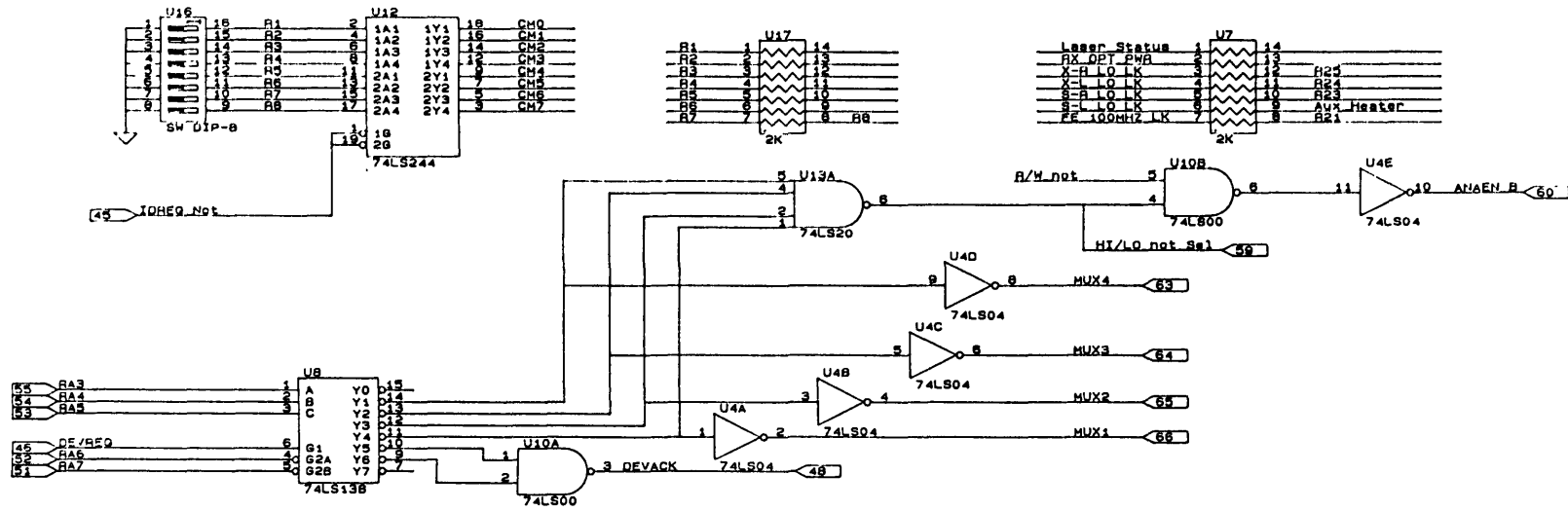


REC_CON.XLS

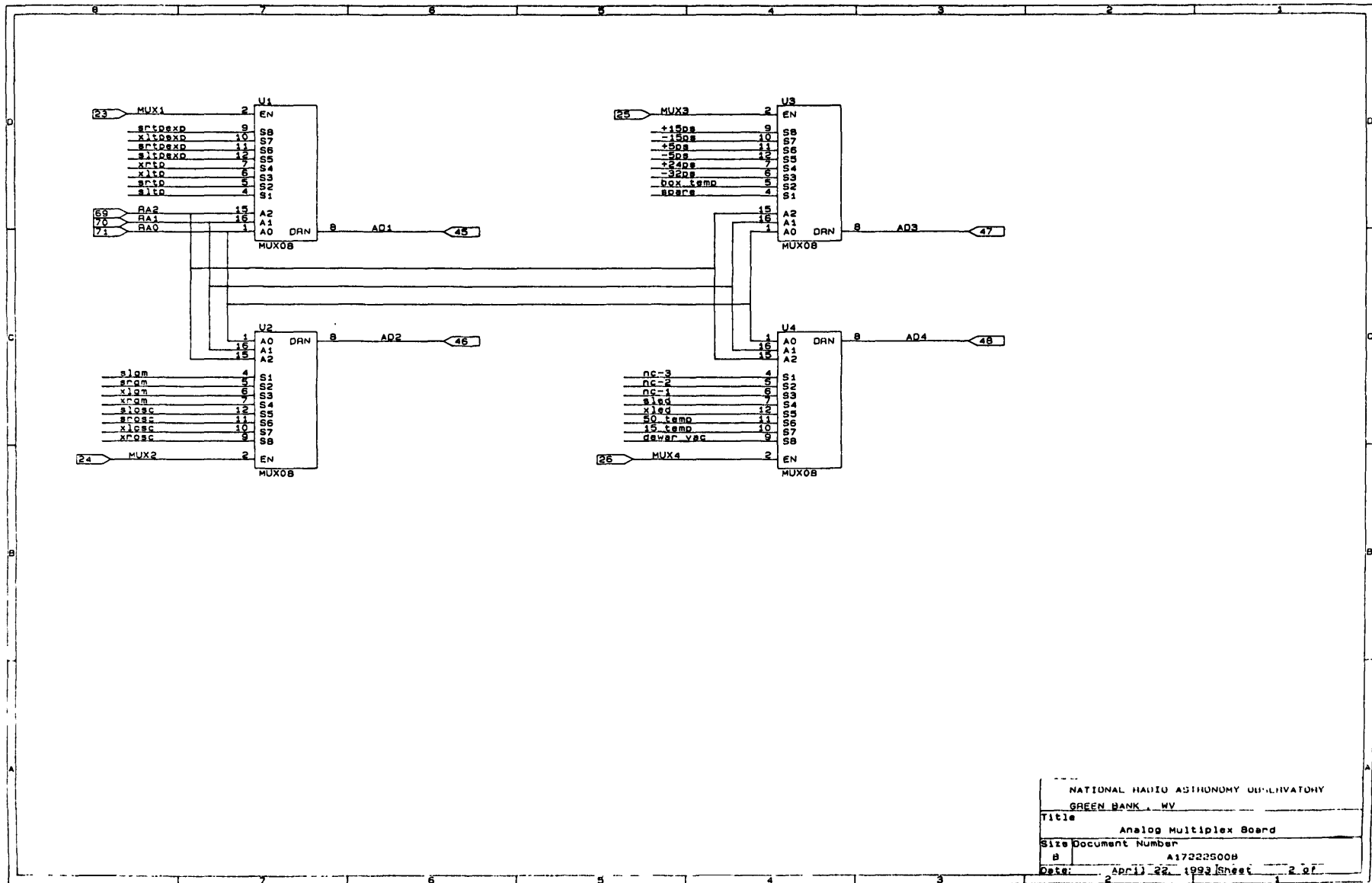
Name:	Receiver Control		Slot:		Date:	4/22/93	
Signal Name	Back#	To	From	Signal Name	Back#	To	From
Ground	1			+5	2		
Ground	3			+5	4		
Spare	5			S-Band Cal	6		
X-Band Cal	7			Noise Mod	8		
X-L OSC	9			X-R OSC	10		
S-L OSC	11			S-R OSC	12		
	13				14		
Spare	15			Spare	16		
Spare	17			Aux Heater	18		
	19			FE 100MHZ	20		
S-L LO Lock	21			S-R LO Lock	22		
X-L Lo Lock	23			X-R LO Lock	24		
Rx Opt Power	25			Laser Status	26		
Ground	27				28		
CM15	29			CM14	30		
CM13	31			CM12	32		
CM11	33			CM10	34		
CM9	35			CM8	36		
CM7	37			CM6	38		
CM5	39			CM4	40		
CM3	41			CM2	42		
CM1	43			CM0	44		
ID Req-	45			DEV_REQ	46		
R/W_not	47			DEV_ACK	48		
Ground	49				50		
RA7	51			RA6	52		
RA5	53			RA4	54		
RA3	55			RA2	56		
RA1	57			RA0	58		
HI/LO_not Sel	59			ANAENB	60		
	61				62		
MUX4	63			MUX3	64		
MUX2	65			MUX1	66		
	67				68		
	69				70		
	71				72		
Ground	73				74		
	75				76		
	77				78		
	79				80		
	81				82		
	83				84		
	85				86		
	87				88		
RCV+	89			RCV-	90		
	91				92		
XMT+	93			XMT-	94		
	95				96		
Ground	97				98		
Ground	99				100		



NATIONAL RADIO ASTRONOMY OBSERVATORY GREEN BANK, WV			
TITLE Receiver Control Card			
PROJECT USNO-VLBI			
DESIGN		REVISION	
DRAWN		DATE	
SHEET	1 of 1	FORM	
SCALE		DWG. NO.	A17222A008



NATIONAL RADIO ASTRONOMY OBSERVATORY	
GREEN BANK, WV	
Title Receiver Control	
Size	Document Number
B	A172225007
Date:	Apr 11 23, 1993 Sheet 1 of 2
REV	A

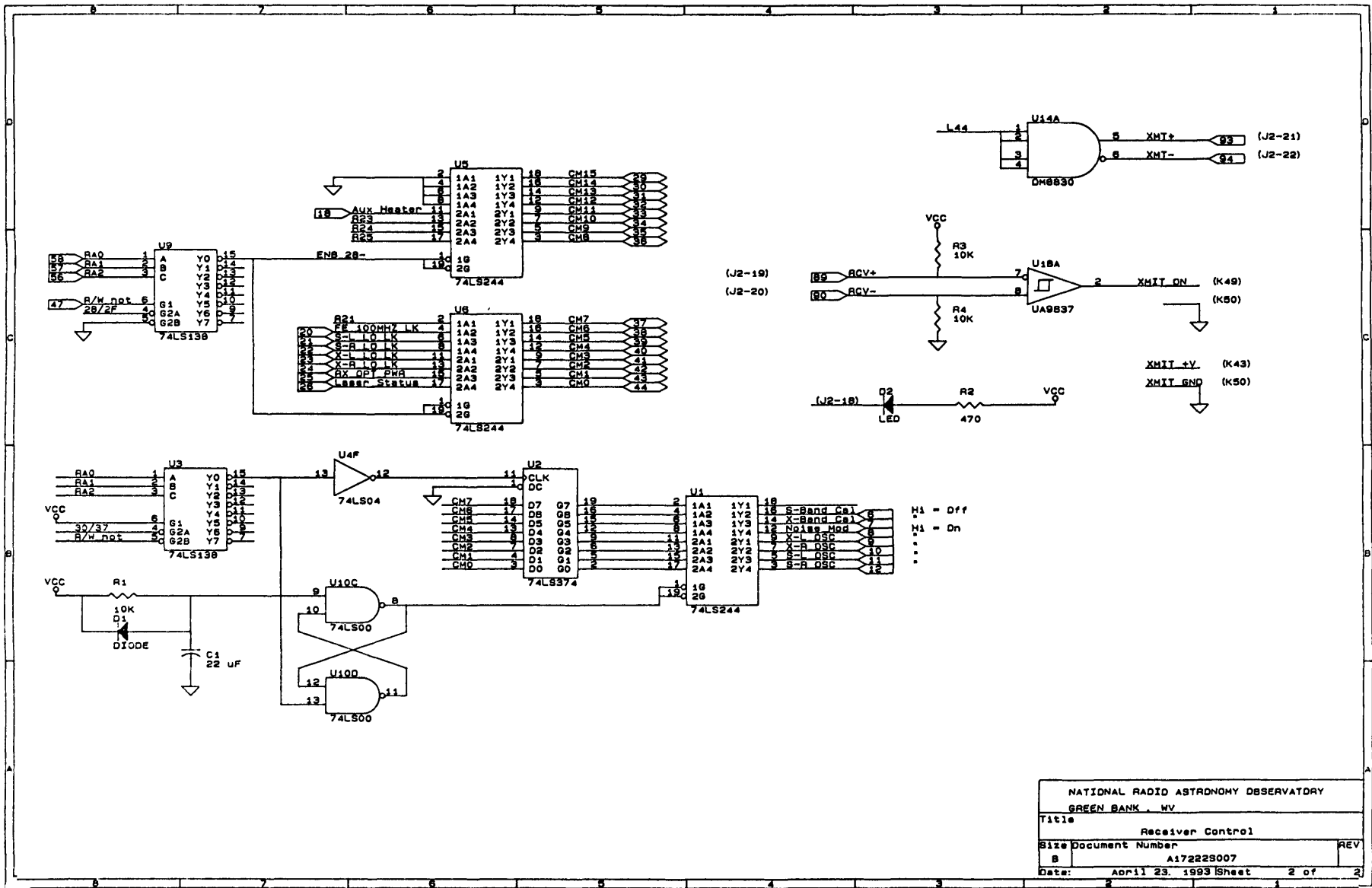


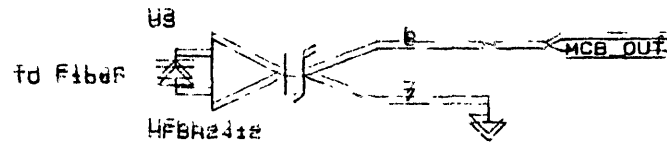
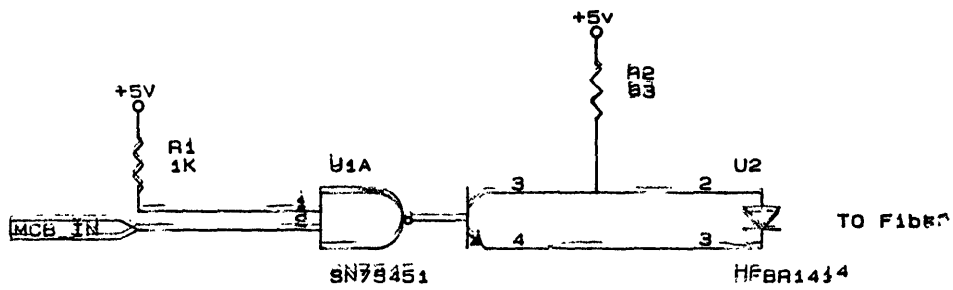
NATIONAL RADIO ASTRONOMY OBSERVATORY
 GREEN BANK, WV

Title: Analog Multiplex Board

Size Document Number: B A17222500B

Date: April 22, 1993 Sheet 1 of 2





NATIONAL RADIO ASTRONOMY OBSERVATORY		
GREEN BANK, WV		
Title		
Fiber Interface Board		
Size	Document Number	REV
A	A17222S009	
Date:	April 22, 1993	Sheet 1 of 2

System: Hawaii S/X Receiver
 Ass'Y: MCB Interface Box
 Type: 37 Pin D (P)
 Func: Monitor Inputs
 Dwg: A17222W008

Date: 3/30/93
 By: S.D. White
 Sheet: 1 OF 4
 Designation: J6

Pin#	Function	To	Color
1	XR Total PWR Expanded	J4-7	
2	XL Total PWR Expanded	J4-9	
3	SR Total PWR Expanded	J4-29	
4	SL Total PWR Expanded	J4-31	
5	SR Total PWR	J4-51	
6	XL Total PWR	J4-53	
7	XR Total PWR	J4-75	
8	SL Total PWR	J4-77	
9	7.6 GHZ OSC Level	J4-11	
10	Phase Cal Box Temp	J4-13	
11	2.0 GHZ OSC Level	J4-33	
12	Phase Cal Box 12V Monitor	J4-35	
13	-5V PWR Supply	J4-39	
14	+24V PWR Supply	J4-59	
15	+32V PWR Supply	J4-61	
16	FE Box Temp	J4-83	
17	NC 2 (Spare Analog Input)	J4-85	
18	Spare (DI-11)	J3-15	
19	Spare (DI-10)	J3-16	
20	Spare (DI-9)	J3-17	
21	Aux HTR (DI-8)	J3-18	
22	Spare (DI-7)	J3-19	
23	FE 100 MHZ Lock (DI-6)	J3-20	Short = Lock
24	Spare (DI-5)	J3-21	
25	SR LO Lock (DI-4)	J3-22	Short = Lock
26	Spare (DI-3)	J3-23	
27	SR LO Lock (DI-2)	J3-24	Short = Lock
28	RCV Optical PWR (DI-1)	J3-25	Short = Low
29	Laser Status (DI-0)	J3-26	Short = High
30	Spare (DO-7)	J3-5	
31	S Band Cal (DO-6)	J3-6	OFF (4V) ON (0.1V)
32	X Band Cal (DO-5)	J3-7	OFF (4V) ON (0.1V)
33	Noise Mod (DO-4)	J3-8	ON (4V) OFF (0.1V)
34	Spare (DO-3)	J3-9	
35	XR OSC (On) (DO-2)	J3-10	ON (4V) OFF (0.1V)
36	Spare (DO-1)	J3-11	
37	SR OSC (On) (DO-0)	J3-12	ON (4V) OFF (0.1V)

System:	Hawaii S/X Receiver	Date:	3/30/93
Ass'Y:	MCB Cable	By:	S.D. White
Type:	37 Pin D (P),38 Elco (E)	Sheet:	2 OF 4
Func:	Interconnecting	Designation:	J6,J3
Dwg:	A17222W008		

Pin#	Function	To	Color
J6-		J3-	
1	XR Total PWR Expanded	A	Y
2	XL Total PWR Expanded	B	R
3	SR Total PWR Expanded	C	BN
4	SL Total PWR Expanded	D	R
5	SR Total PWR	E	BL
6	XL Total PWR	F	R
7	XR Total PWR	G	BN
8	SL Total PWR	H	BK
9	7.6 GHZ OSC Level	J	WH
10	Phase Cal Box Temp	K	R
11	2.0 GHZ OSC Level	L	Y
12	Phase Cal Box 12V Monitor	M	BK
13	-5V PWR Supply	N	BL
14	+24V PWR Supply	P	BK
15	+32V PWR Supply	R	GN
16	FE Box Temp	S	BK
17	NC 2 (Spare Analog Input)	T	OR
18	Spare (DI-11)	U	BK
19	Spare (DI-10)	V	OR
20	Spare (DI-9)	W	R
21	Aux HTR (DI-8)	X	WH
22	Spare (DI-7)	Y	BK
23	FE 100 MHZ Lock (DI-6)	Z	R
24	Spare (DI-5)	AA	BK
25	SR LO Lock (DI-4)	BB	BL
26	Spare (DI-3)	CC	GN
27	SR LO Lock (DI-2)	DD	BN
28	RCV Optical PWR (DI-1)	EE	GN
29	Laser Status (DI-0)	FF	Y
30	Spare (DO-7)	HH	GN
31	S Band Cal (DO-6)	JJ	BL
32	X Band Cal (DO-5)	KK	WH
33	Noise Mod (DO-4)	LL	WH
34	Spare (DO-3)	MM	R
35	XR OSC (On) (DO-2)	NN	GN
36	Spare (DO-1)	PP	OR
37	SR OSC (On) (DO-0)	RR	GN

System: Hawaii S/X Receiver
Ass'Y: MCB Interface Box
Type: 15 Pin D Conn,Amp 7 Pin
Func: Monitor Inputs
Dwg: A17222W008

Date: 3/30/93
By: S.D. White
Sheet: 3 OF 4
Designation: J5,J7

Pin#	Function	To	Color
J5-			
1	XR Gate Monitor	J4-55	
2	XL Gate Monitor	J4-57	
3	SR Gate Monitor	J4-79	
4	SL Gate Monitor	J4-81	
5	Dewar VAC Monitor	J4-19	
6	15 Deg Station Monitor	J4-21	
7	50 Deg Station Monitor	J4-41	
8	X LED Monitor	J4-43	
9	S LED Monitor	J4-63	
10	NC3	J4-87	
11	NC4	J4-89	
12	NC1	J4-65	
13			
14	15 V Gnd	J4-3,99+J2-17	
15	15 V Gnd	J4-1,97+J1-38	
J7-			
A	+15 V	Terminal Board	
B	+/- 15 Return	Terminal Board	
C	-15 V	Terminal Board	
D	+5 V	Terminal Board	
E	+5 V Return	Terminal Board	
F	-5 V	Terminal Board	
H	+5 V	Terminal Board	

System: Hawaii S/X Receiver
Ass'Y: MCB Cable
Type: 15 Pin D,20 Elco(R)
Func: Interconnecting
Dwg: A17222W008

Date: 3/30/93
By: S.D. White
Sheet: 4 OF 4
Designation: J5,J2

Pin#	Function	To Dewar Card Cage
J5-		J2-
1	XR Gate Monitor	M
2	XL Gate Monitor	L
3	SR Gate Monitor	K
4	SL Gate Monitor	J
5	Dewar VAC Monitor	E
6	15 Deg Station Monitor	F
7	50 Deg Station Monitor	H
8	X LED Monitor	P
9	S LED Monitor	N
10	NC3	
11	NC4	
12	NC1	
13		
14	15 V Gnd	A
15	15 V Gnd	A

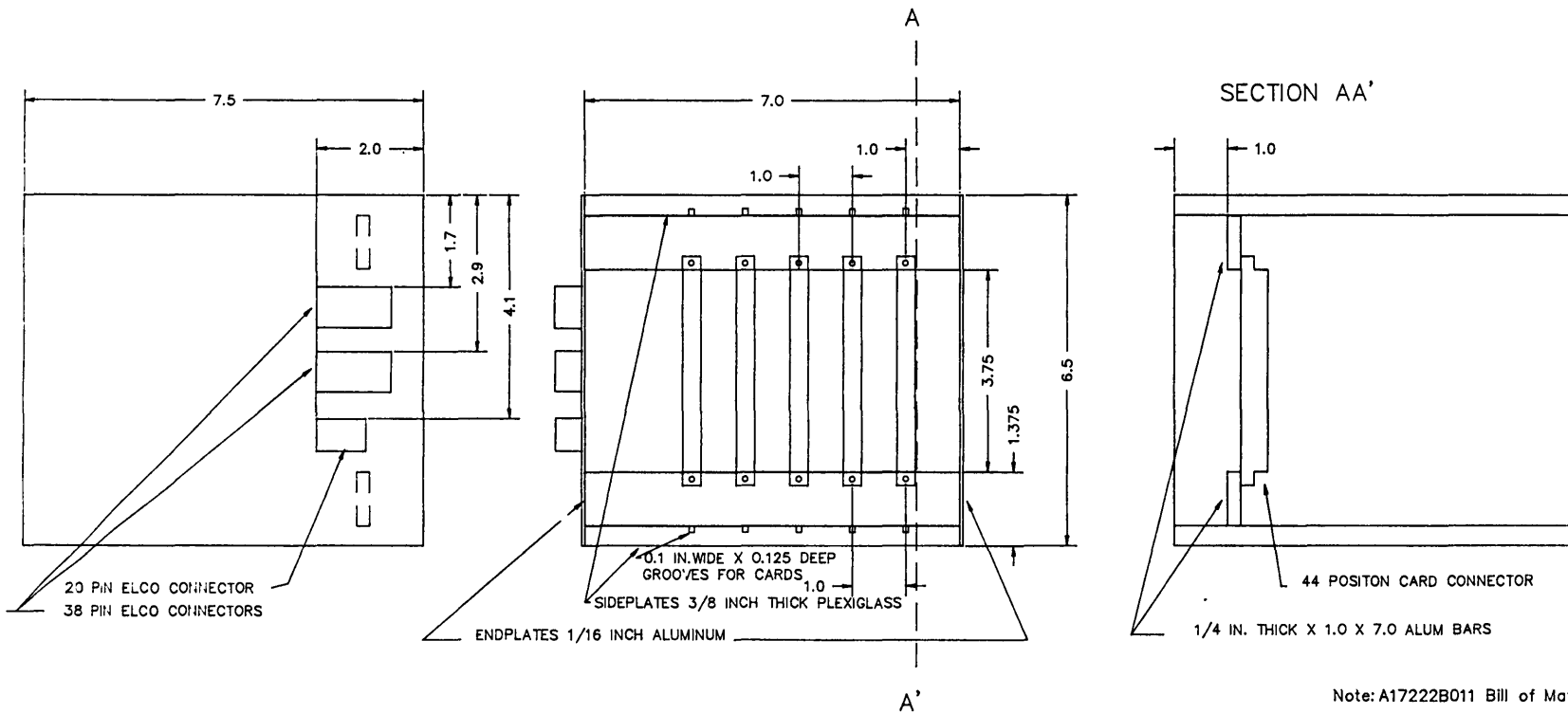
APPENDIX G

RECEIVER CARD BOX

Drawing Number: A17222B011
Title: Receiver Card Box

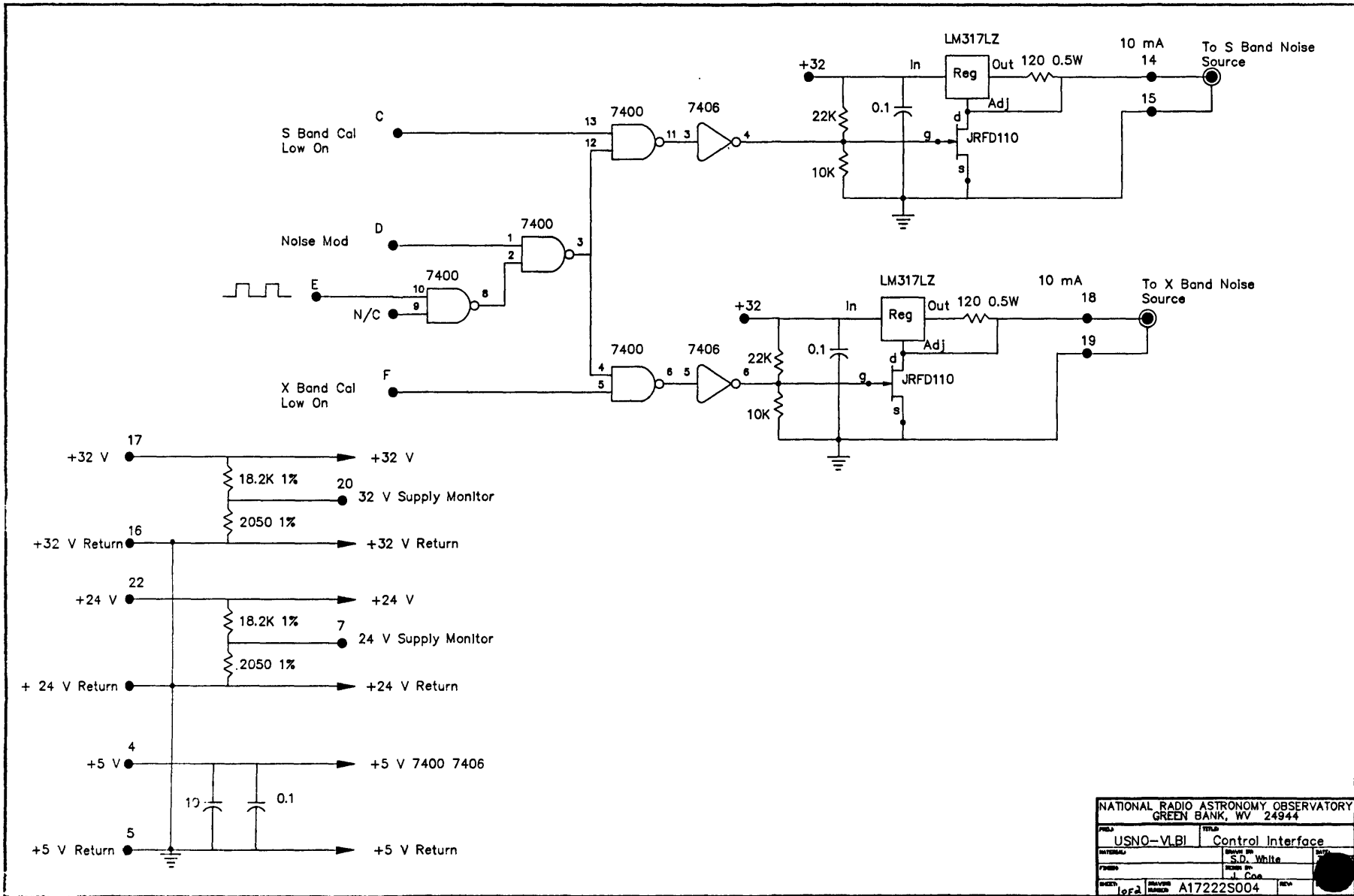
Date: 4/26/93
Rev: A

ITM	QTY	DESCRIPTION	PART NUMBER	MANUFACTURE
1	1	Mechanical Box	D17222M023	NRAO
2	1	Control Interface	A17222S004	NRAO
3	1	Monitor Interface	A17222S005	NRAO
4	1	Test Card Wire List	A17222W004	NRAO
5	1	Interconnecting Wire List	A17222W005	NRAO

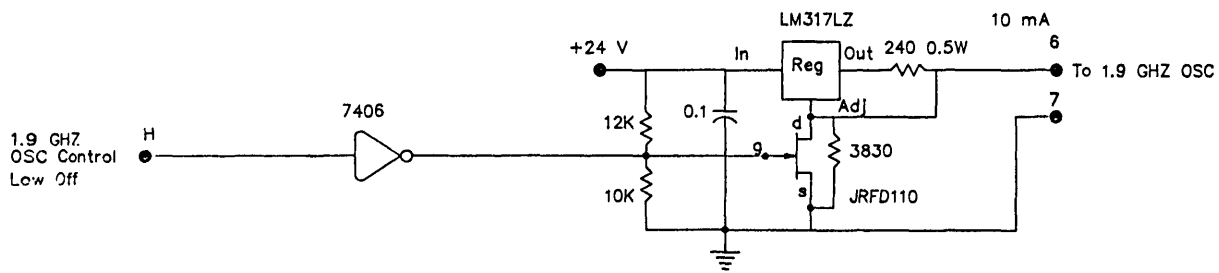
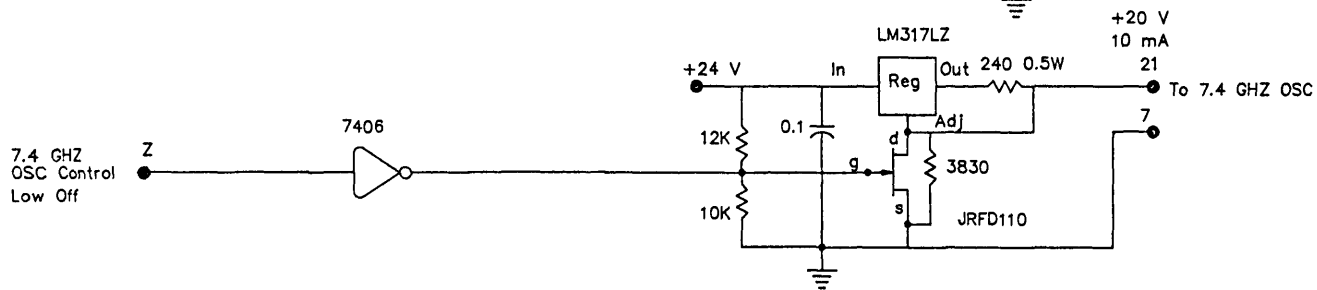
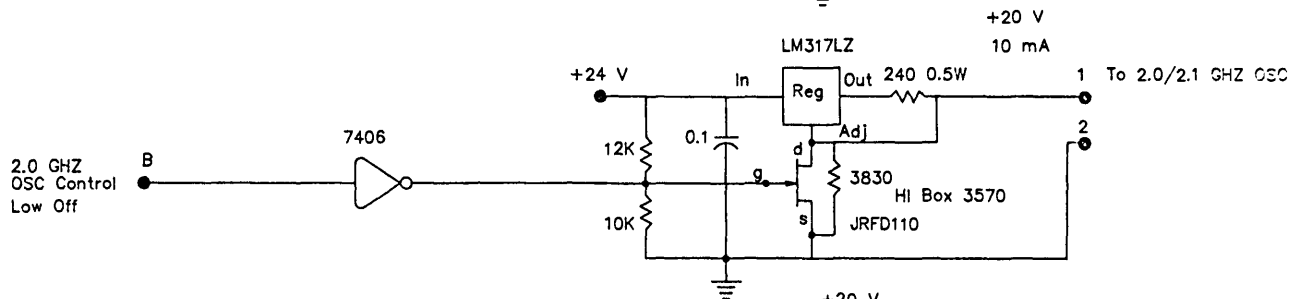
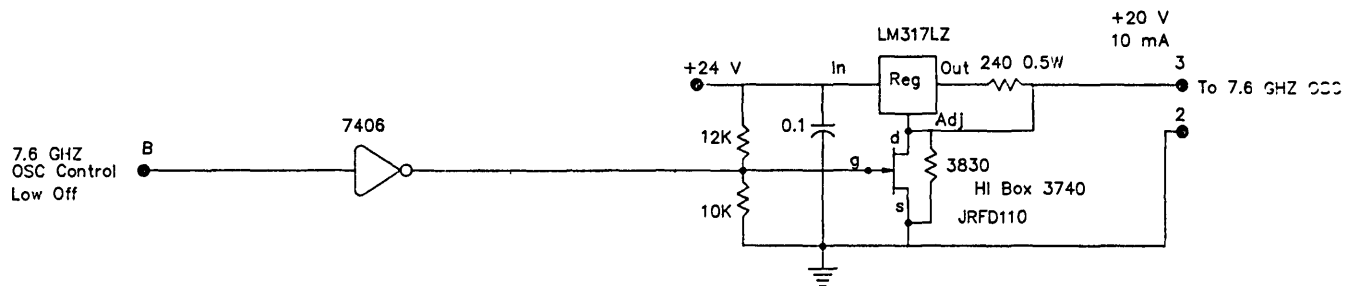


Note: A17222B011 Bill of Materials

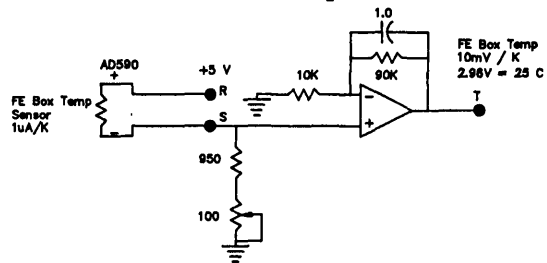
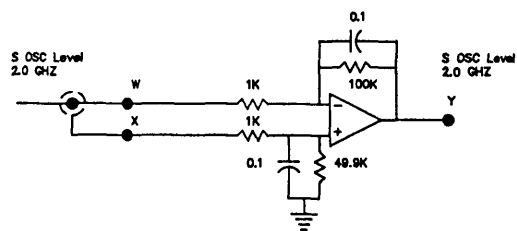
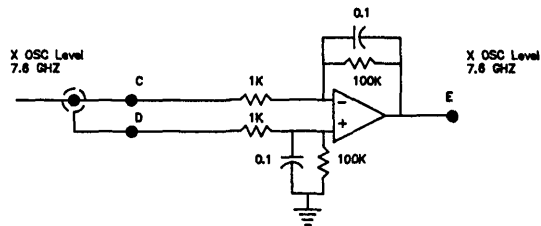
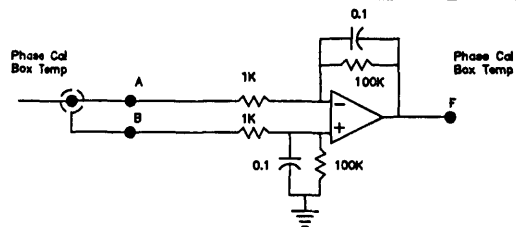
NATIONAL RADIO ASTRONOMY OBSERVATORY GREEN BANK, WV 24944			
PROJ	S & X BAND RECEIVER	TITLE	RECEIVER CARD BOX ASSEMBLY
DESIGNED BY	J.R. COE	DRAWN BY	S.D. White
CHECKED BY	J.R. COE	DATE	4/26/63
REV	017222M.023	SCALE	1:1



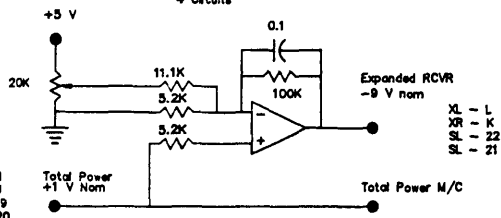
NATIONAL RADIO ASTRONOMY OBSERVATORY GREEN BANK, WV 24944			
FILE#	TITLE	DATE	REV#
USNO-VLBI	Control Interface		
DRAWN BY	INSTR BY	DATE	
	S.D. White		
DESIGNED BY	REVIEW BY	DATE	
	J. Coe		
SHEET	ISSUE NO.	REV#	
1 of 2	REVISED	A17222S004	



NATIONAL RADIO ASTRONOMY OBSERVATORY GREEN BANK, WV 24944			
REV	DATE	BY	APP
USNO-VLBI		Control Interface	
INITIAL	DATE	BY	APP
	3/28/93	S.O. White	
DESIGN	DATE	BY	APP
	3/19/93	J. Coe	
FIG#	REV#	DATE	BY
2 OF 2		A17222S004	

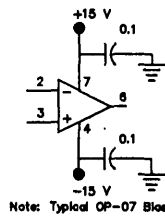
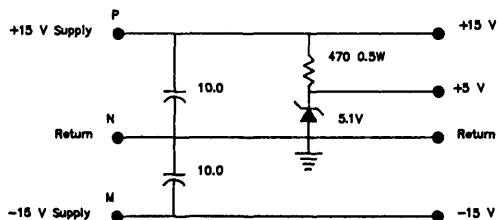
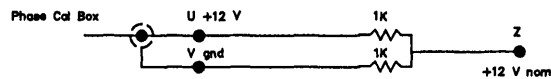


4 Circuits



XL - H
XR - J
SL - 19
SR - 20

XL - L
XR - K
SL - 22
SL - 21



NATIONAL RADIO ASTRONOMY OBSERVATORY GREEN BANK, WV 24944			
PROJECT	USNO-VLBI	MONITOR INTERFACE CARD	
DESIGNED BY	S.D. White	DATE	4/2/83
DRAWN BY	J. Coe	REV	5/19/85
DATE		SCALE	
PART NUMBER: A17222S005			

System: Hawaii S/X Receiver
Ass'Y: Receiver Card Box
Type:
Func: Test Card
Dwg: A17222W004

Date: 3/30/93
By: S.D. White
Sheet: 1 OF 2
Designation: S3

Pin#	Function	Signal Level
1	100 MHZ OSC Tuning Volt Monitor	+1.7 V
2	2 GHZ OSC tuning Volt Monitor	+4.8 V
3	7.6 GHZ OSC Tuning Volt Monitor	+4.6 V
4	Signal Return	
5	X Band Noise Source Supply	+29.4 V
6	S Band Noise Source Supply	+29.4 V
7		
8	-5 V Supply	-5.08 V
9	+5 V Supply	+4.99 V
10	+5 V Return	-14.9 V
11	-15 V Supply	
12	+/-15 V Return	+15.08 V
13	+15 V Supply	+32.06 V
14	+32 V Supply	
15	+32 V Return	+23.9 V
16	+24 V Supply	
17	+24 V Return	
18	100 MHZ OSC Lock	
19	7.6 GHZ OSC Lock	
20	2.0 GHZ OSC Lock	
21	+20 V OSC Supply	+20.2 V
22	+20 V 7.6 GHZ OSC Supply	+20.1 V

System: Hawaii S/X Receiver
Ass'Y: Receiver Card Box
Type:
Func: Test Card
Dwg: A17222W004

Date: 3/30/93
By: S.D. White
Sheet: 2 OF 2
Designation: S3

Pin#	Function	Signal Level
A	XR Total PWR Expanded	
B	XL Total PWR Expanded	
C	SR Total PWR Expanded	
D	SL Total PWR Expanded	
E	XR Total PWR	5.4V
F	XL Total PWR	6.5V
H	SR Total PWR	3.5V
J	SL Total PWR	+5V
K	7.6 GHZ OSC Level	-2.1 V
L	Phase Cal Box Temp	
M	2.0 GHZ OSC Level	0.56 V
N	FE Box Temp	
P		
R	Rec OPT Power Normal	
S	Laser Status Normal	
T	X Band Cal Off	
U	S Band Cal Off	
V	Noise Mod On	
W	Noise Mod Square Wave	
X	7.6 GHZ OSC On	
Y	Phase Cal Box 12 V Mon	
Z	2.0 GHZ OSC On	

System: Hawaii S/X Receiver
Ass'Y: Receiver Card Box
Type: Elco 20
Func: Interconnecting
Dwg: A17222W005

Date: 3/30/93
By: S.D. White
Sheet: 1 OF 3
Designation: J1

Pin#	Function	To
A	+/- 15 V	S2-N,S3-12,J2-S,J2-JJ,J2-FF
B	+15 V	S2-P,S3-13,J2-KK
C	-15 V	S2-M,S3-11,J2-TT
D		
E	+/- 5 V	S1-5,S3-10
F	+5 V	S1-4,S3-9
H	-5 V	S3-8,J3-P
J		
K	+32 V	S1-17,S3-14,J3-S
L	+32 V Return	S1-16,S3-15
M		
N	+24 V	S1-22,S3-16,J3-R,J2-BB

System: Hawaii S/X Receiver
 Ass'Y: Receiver Card Box
 Type: Elco 38
 Func: Interconnecting
 Dwg: A17222W005

Date: 3/30/93
 By: S.D. White
 Sheet: 2 OF 3
 Designation: J2

Pin#	Function	To	Color
A	AD590 Box Temp Sensor +	S2-R	GY
B	AD590 Box Temp Sensor -	S2-S	WH
C	7.6 GHZ OSC LVL Det Signal	S2-C	
D	7.6 GHZ OSC LVL Det Return	S2-D	
E	2.0 GHZ OSC LVL Det Signal	S2-W	
F	2.0 GHZ OSC LVL Det Return	S2-X	
H	Laser Tx Status Normal	S3-S,J3-HH	WH
J	Receiver Optical PWR Normal	S3-R,J3-FF	GY
K	Phase Cal Box Temp+	S2-A	
L	Phase Cal Box Temp-	S2-B	
M	X-R Total PWR	S2-J,S3-E,J3-E	GY
N	S-R Total PWR	S2-20,S3-H,J3-H	WH
P	S_L Total PWR	S2-19,S3-J,J3-J	BN
R	X-L Total PWR	S2-H,S3-F,J3-F	BL
S	Total PWR Return	S3-12	BK
T	X Bnad Noise Source	S1-18,S3-5	
U	Return	S1-19	
V	Phase Cal Box 12V Mon	S2-U	
W	Phase Cal Box 12V Return	S2-V	
X	Spare		
Y	Spare		
ZZ	S-Band Noise Source	S1-14,S3-6	
AA	Return	S1-15	
BB	+24V Supply	S1-22	Y
CC	100 MHZ OSC Tuning Volt Mon	S3-1	BN
DD	2 GHZ OSC Tuning Volt Mon	S3-2	GY
EE	7.6 GHZ OSC Tuning Volt Mon	S3-3	BL
FF	Signal Return	S3-4	BK
HH	OSC PWR Return	S1-2	BK
JJ	+/- 15V Return	S3-4	BK
KK	+ 15V Supply	S3-13	R
LL	+ 24V Return	S3-17	BK
MM	100 MHZ OSC Lock	S3-18,J3-AA	WH
NN	7.6 GHZ OSC Lock	S3-19,J3-EE	WH/BL
PP	2.0 GHZ OSC Lock	S3-20,J3-CC	WH/BN
RR	+ 20V 2 GHZ OSC Supply	S1-1,S3-21	WH/Y
SS	+ 20V 7.6 GHZ OSC Supply	S1-3,S3-22	WH/Y/BK
TT	- 15V Supply	S3-11	OR

System: Hawaii S/X Receiver
Ass'Y: Receiver Card Box
Type: Elco 38 (Green)
Func: To MCB Monitor In
Dwg: A17222W005

Date: 3/30/93
By: S.D. White
Sheet: 3 OF 3
Designation: J3

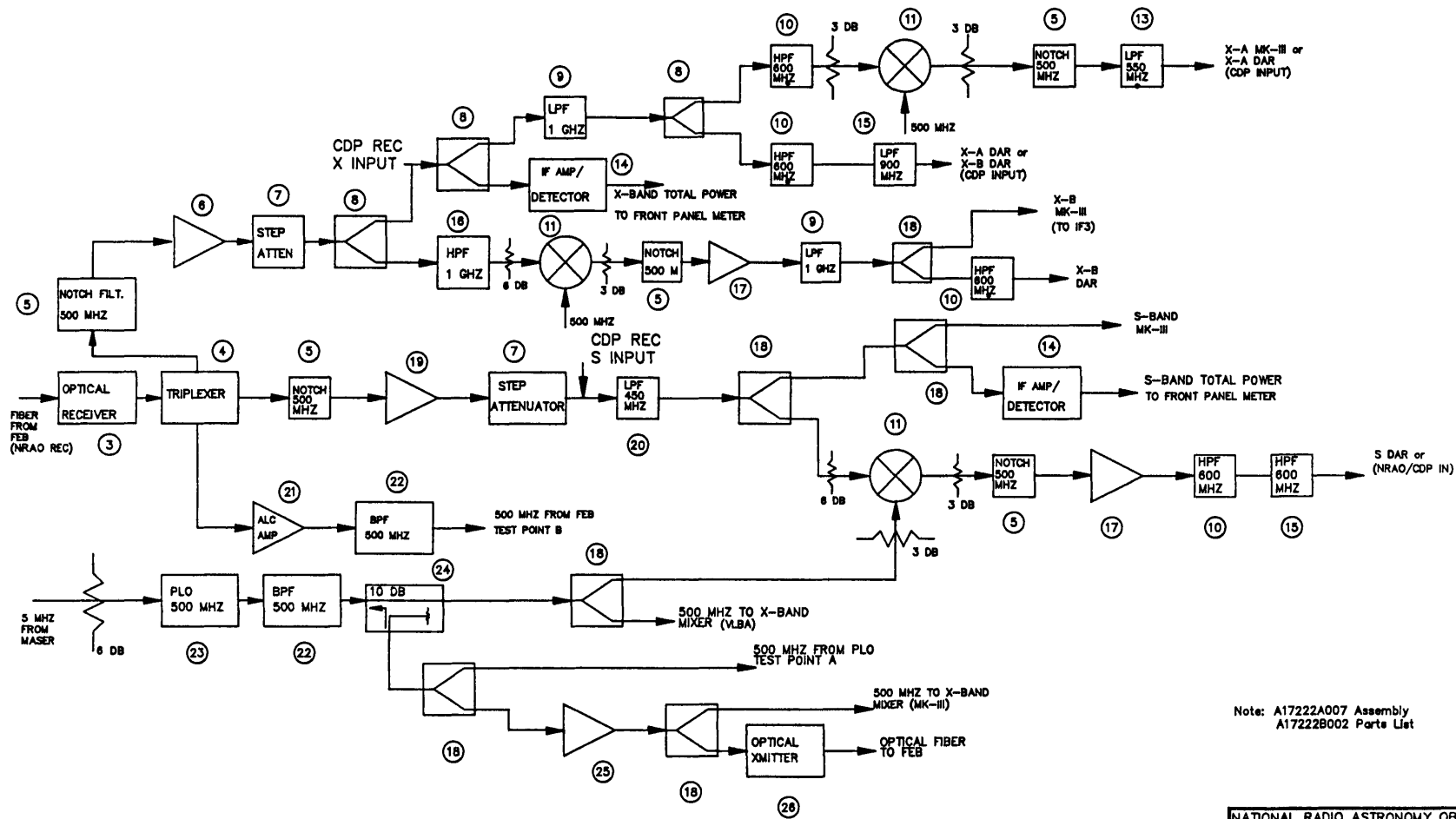
Pin#	Function	To
A	XR Total PWR Expanded	S2-K,S3-A
B	XL Total PWR Expanded	S2-L,S3-B
C	SR Total PWR Expanded	S2-21,S3-C
D	SL Total PWR Expanded	S2-22,S3-D
E	SR Total PWR	S3-E,..
F	XL Total PWR	S3-F,..
H	XR Total PWR	S3-H,..
J	SL Total PWR	S3-J,..
K	7.6 GHZ OSC Level	S2-E,S3-K
L	Phase Cal Box Temp	S2-F,S3-L
M	2.0 GHZ OSC Level	S2-Y,S3-M
N	Phase Cal Box 12V Monitor	S2-Z,S3-Y
P	-5V PWR Supply	S3-8,..
R	+24V PWR Supply	S3-16,..
S	+32V PWR Supply	S3-14,..
T	FE Box Temp	
U	NC 2 (Spare Analog Input)	
V	Spare (DI-11)	
W	Spare (DI-10)	
X	Spare (DI-9)	
Y	Aux HTR (DI-8)	
ZZ	Spare (DI-7)	
AA	FE 100 MHZ Lock (DI-6)	S3-18,..
BB	Spare (DI-5)	
CC	2 GHZ Lock Fail (DI-4)	S3-20,..
DD	Spare (DI-3)	
EE	7.6 GHZ Lock Fail (DI-2)	S3-19,..
FF	RCV Optical PWR (DI-1)	S3-R,J2-J
HH	Laser Status (DI-0)	S3-S,J2-H
JJ	Spare (DO-7)	J2-X,J2-Y
KK	S Band Cal (DO-6)	S1-F,S3-T
LL	X Band Cal (DO-5)	S1-C,S3-U
MM	Noise Mod (DO-4)	S1-D,S3-V
NN	Spare (DO-3)	
PP	XR OSC (On) (DO-2)	S1-B,S3-X
RR	Spare (DO-1)	
SS	SR OSC (On) (DO-0)	S1-A,S3-Z
TT		

**VLBA Interface
A17222B002**

Drawing Number: A17222B002
Title: VLBA Interface

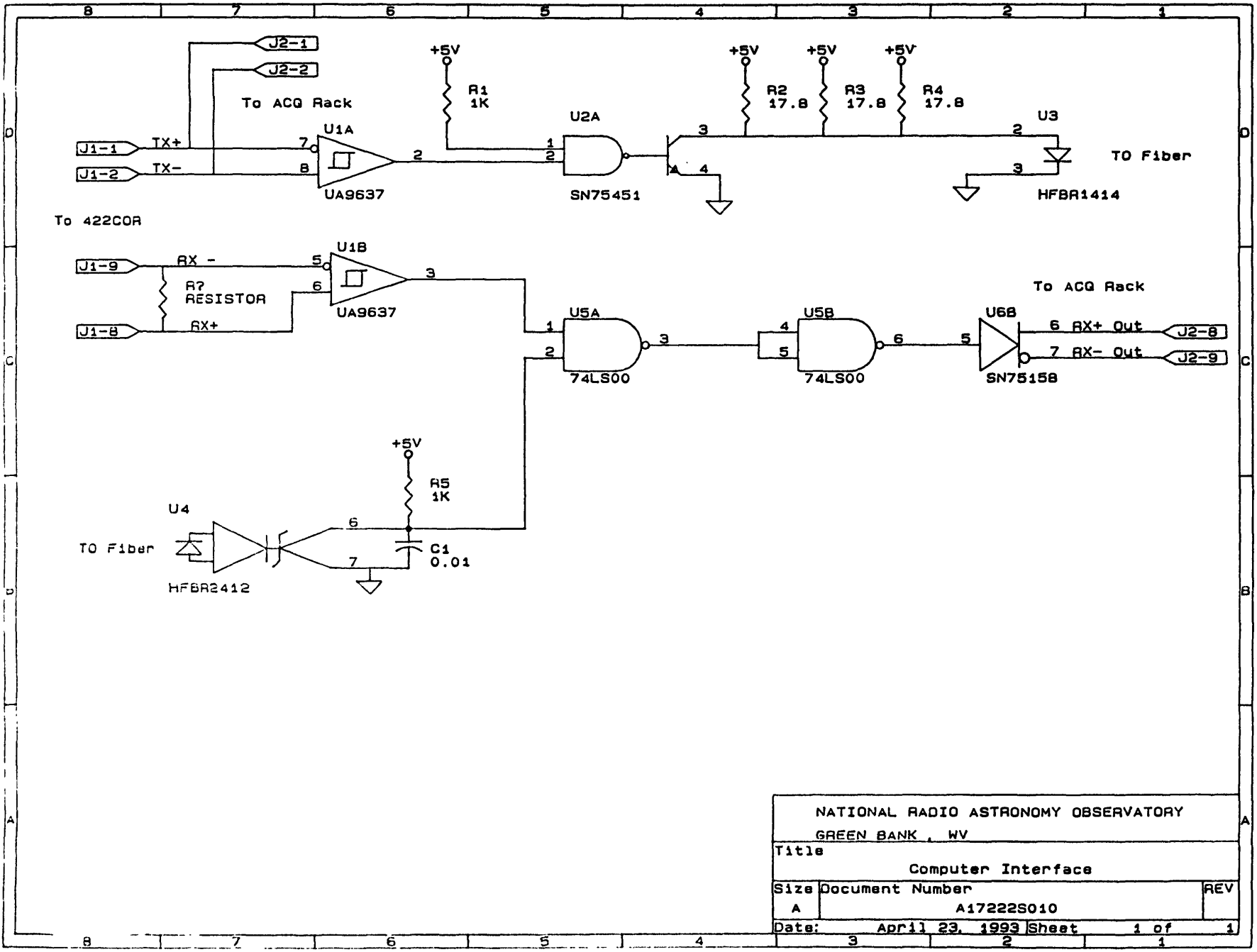
Date: 3/16/93
Rev: A

ITM	QTY	DESCRIPTION	PART NUMBER	MANUFACTURE
1	1	Assembly	A17222A007	NRAO
2	1	Block Diagram	A17222K002	NRAO
3	1	Optical Receiver	LDAR-2200	Laser Diode
4	1	Triplexer	A17222B006	NRAO
5	5	500 Mhz Notch Filter	4IN41-500/T180-0/0	
6	1	IF Amplifier	QBH-817	Q-Bit
7	2	Step Attenuator	TA-50	Trilithic
8	2	Power Splitter	ZFSC-2-5	Mini- Circuits
9	2	1 GHZ LPF	SLP-1000	Mini-Circuits
10	2	600 MHZ HPF	SHP-600	Mini-Circuits
11	3	IF Mixer	ZFM-150	Mini-Circuits
12	1	850 MHZ LPF	8L121-900/T1000-O/O	K&L
13	1	550 MHZ LPF	SLP-550	Mini-Circuits
14	2	IF AMP/Detector	A17222B004	NRAO
15	1	900 MHZ LPF	6L121-900/T1000-O/O	K&L
16	1	1 GHZ HPF	SHP-1000	Mini-Circuits
17	2	IF Amplifier	QBH-9-176	Q-Bit
18	6	Power Splitter	ZFSC-2-2	Mini-Circuits
19	1	IF Amplifier	ZFL-1000	Mini-Circuits
20	1	450 MHZ LPF	SLP-450	Mini-Circuits
21	1	ALC Amplifier	ALC-500M	Avantek
22	2	500 MHZ BPF	3B120-500/U50-O/O	K&L
23	1	500 MHZ PLO	DPLO-5-500-0-15P	Miteq
24	1	10 Db Coupler	ZFDC-10-2	Mini-Circuits
25	1	500 MHZ Amplifier	QBH-9-160	Q-Bit
26	1	Optical Transmitter	LDAT-2200	Laser Diode



Note: A1722A007 Assembly
A1722B002 Parts List

NATIONAL RADIO ASTRONOMY OBSERVATORY GREEN BANK, WV 24944			
FILED	TITLE	USNO-VLBI VLBA Interface	
INTERNAL	DESIGNED BY	S.D. White	5/4/93
FIGURE	REVISION		
1 of 1	ISSUED	A1722K002	REV A



NATIONAL RADIO ASTRONOMY OBSERVATORY		
GREEN BANK, WV		
Title		
Computer Interface		
Size	Document Number	REV
A	A17222S010	
Date:	April 23, 1993	Sheet 1 of 1

System:	Hawaii S/X Receiver	Date:	3/30/93
Ass'Y:	VLBA Interface Drawer	By:	S.D. White
Type:	Bendix 14 P	Sheet:	1 OF 1
Func:	Power Connector	Designation:	J1
Dwg:	A17222W005		

Pin#	Function	To	Color
A			
B	+15 V	QBH-9-176,ZFL-1000,QBH-60	BK
C	+15 V	Optical Receiver, OSC	BN
D	+15 V	ALC-500M,IF Amp/Det	R
E	-5 V	Optical Transmitter	Y
F	-5 V Return	Optical Transmitter	GN
G	+/- 15 V Return	Optical Recr,ALC-500M,Amp/Det	BL
H	+5 V	OSC	V
I			
J			
K	+15 Return	QBH-9-176,ZFL-1000,QBH-60	GY
L	+15 Return	Optical Receiver, OSC	WH

System:	Hawaii S/X Receiver	Date:	3/30/93
Ass'Y:	VLBA Interface Drawer	By:	S.D. White
Type:	Bendix 14 P	Sheet:	1 OF 1
Func:	Power Connector	Designation:	J1
Dwg:	A17222W006		

Pin#	Function	To	Color
A			
B	+15 V	QBH-9-176,ZFL-1000,QBH-160	BK
C	+15 V	Optical Receiver, OSC	BN
D	+15 V	ALC-500M,IF Amp/Det	R
E	- 5 V	Optical Transmitter	Y
F	-5 V Return	Optical Transmitter	GN
G	+/- 15 V Return	Optical Recr,ALC-500M,Amp/Det	BL
H	+ 5 V	OSC	V
I			
J			
K	+15 Return	QBH-9-176,ZFL-1000,QBH-160	GY
L	+15 Return	Optical Receiver, OSC	WH

System: Hawaii S/X Receiver
Ass'Y: VLBA Power Drawer
Type: Bendix 14P,14P,3P,3P
Func: Power Connector
Dwg: A17222W007

Date: 3/30/93
By: S.D. White
Sheet: 1 OF 1
Designation: none

Pin#	Function	To	Color	To
DC Power 1				
A	+5 V	TB 16	WH/R	J1-H
B	+5 V Return	TB 17		J1-N
G	+15 V	TB 12-13	R	J1-D
J	-15 V	TB 9	OR	J1-M
H	+15 V	TB 10-11	BK	J1-G
C	- 5 V	TB 14	WH/OR	J1-E
E	-5 V Return	TB 15	WH/BK	J1-F

DC Power 2				
G	+15 V	TB 8		J1-C
H	+15 V Return	TB 7		J1-L

AC Power

A AC+
 B AC-
 C Neutral

AC Power

A AC+
 B AC-
 C Neutral

