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4-FEED, 21-CM RECEIVER

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Introduction

The original 4-feed, 21-cm receiver built in the late sixties is now replaced with a new receiver covering the 1.3-1.5 GHz range. Used mainly as a survey instrument, significant improvements in sensitivity, stability, bandwidth and reliability have been achieved with the new receiver. These improvements are mainly the result of (1) replacing inherently unstable paramps with gain stable GaAsFET amplifiers, (2) improving the temperature stability of other front-end components, (3) replacing the old internal LO with the more stable ULO system, and (4) rebuilding the original feeds which had mechanically unstable feed probe assemblies.

In October 1982 the new receiver was installed on the 300-ft telescope for its first observing run. Except for intermittent instabilities, due to the unstable feed probes (now corrected), the new receiver performed very well. The "on telescope" system noise temperature for all channels was measured at or less than 98^{o}K as compared to the old receiver noise temperature of 150^{o}K. Also, the measured peak-to-peak noise fluctuations are very close or equal to theoretical values for time constants less than 1 second. Because of interference considerations, an RF filtering feature has been added to allow the user to remotely narrow the front-end RF bandwidth to minimize interference effects. The user has a choice of four different filter bandwidths for

each channel. The noise cal system is arranged to allow the receiver to function as either a total power or as a noise adding radiometer.

General Description

The front-end portion of the receiver (Figure 1) is housed in a standard NRAO temperature-controlled front-end box and can be installed at either the 300-ft or 140-ft telescope. Control and monitoring of the front end is accomplished from the control rack (Figure 2). The relationship of the receiver with other components of the telescope system is shown in the block diagram of Figure 3. The RF block diagram and the monitor and control block diagram of the receiver are shown in Figures 4 and 5, respectively.

Front-End Description

The front-end can be divided into five subsystems: (1) the feed assembly, (2) the low-noise amplifier housing, (3) the noise source and RF sweeper system, (4) the bandpass filter assembly, and (5) the mixer and IF system.

1) Feed Assembly

The four standard pyramidal feed horns (Figure 6) used in the receiver are the same ones used in the old 4-feed receiver. The dimensional relationship between the horns, shown in Figure 7, is also identical to the old receiver. However, the feeds are now designated alphabetically rather than numerically as in the old receiver. The geometrical relationship of the radiation beams of the four feeds is shown in Figure 8.

During the initial observing run two of the receiver channels were intermittently unstable. This instability was traced to poor mechanically supported feed probes. The probe assemblies were rebuilt, the feeds were cleaned, electroplated with copper and passivated with Metcote 7P to prevent corrosion. After reassembly the feeds were tuned for best match. Measured values of return loss are shown in Figures 9A and 9B.

2) Low Noise Amplifier Housing

To insure maximum temperature stability of the low-noise RF amplifiers and noise cal coupers, they are heat sunk to heavy copper plates and then enclosed in a thermally insulated aluminum chassis.

a) Low noise GaAsFET amplifiers

The 3-stage GaAsFET amplifiers, designed and built at NRAO/Charlottesville, are identical to those described in EDIR #220 ("Ultra Low Noise 1.2-1.7 GHz Cooled GaAsFET Amplifiers") except that the amplifiers have been optimized to operate at room temperature rather than 15 K. Measured test data of the amplifiers used with the 4-feed, 21-cm receiver are shown in Figures 10A and 10B. Each amplifier is biased by its own constant current supply shown in Figure 11. Measured operating values of bias voltages and currents for the various channels and stages are given in Table 1.

TABLE 1

Operating Bias Voltages and Currents of FET Amplifiers measured at Constant Current Power Supplies. 1/

Channel	Stage	Drain Voltage (Volts)	Drain Current (mA)	Gate Voltage 2/ (Volts)
A	1	5.50	20.0	-0.426
	2	5.50	20.0	-0.708
	3	4.00	10.0	-1.358
B	1	5.5	17.5	-1.057
	2	5.5	17.5	-0.691
	3	4.0	10.0	-1.168
C	1	5.5	17.15	-0.508
	2	5.5	13.75	-0.834
	3	4.0	10.0	-1.230
D	1	5.50	20.0	-0.483
	2	5.50	17.5	-1.020
	3	4.0	10.0	-1.609

Notes: 1/ Values measured 13 December 1983.

2/ Gate voltage read at DPM in control room is same as measured at power supplies.

b) Bipolar transistor amplifiers

An additional 31 dB of RF gain to overcome the noise contribution of the mixer, RF filters, and power dividers is provided by Trontec, Inc., bipolar transistor amplifiers, model P2GC4.

3) Noise Add, Noise Cal and RF Sweeper System

As shown in the block diagram of Figure 12, there are two noise sources, NS-1 and NS-2. Both noise sources are Microwave Semiconductor Corporation solid state noise sources models MSC-1000, with NS-1 being used as the calibration noise source and NS-2 used during the noise adding radiometer mode.

Since the stability of solid state noise sources are dependent on both drive current stability and temperature stability, steps were taken to insure stability of these two parameters. The circuit shown in Figure 13 is used to provide constant current for the noise sources. The current stability of the circuit was tested by varying ambient temperature and supply voltage. Results of these tests indicate:

Temperature coefficient = 1.03 uA/^{o}C

Supply voltage effects = 3.0 uA/volt

To minimize the effects of thermal drift, the noise sources and constant current circuit components were thermally bonded to a heavy copper block which was then mounted in the noise source assembly chassis (a thermally insulated aluminum chassis

which also houses the pin modulators, circulators, and hybrids associated with the cal system).

4) Bandpass Filter Assembly

Because recent EMI surveys in the 1.0-2.0 GHz range show considerable time varying interference in the passband of the GaAsFET amplifiers (1.2-1.7 GHz), it was decided that remotely switched RF bandpass filters were needed in the front end to allow the user to pick the optimum band depending upon existing interference conditions. This function is achieved through the use of the bandpass filter assembly shown in the block diagram (Figure 14) and schematically in Figures 15A and 15B. The table below shows what filter choices are available.

Switch Position	Filter Passband (MHz)	Filter Bandwidth (MHz)
1	1350-1427	77
2	1295-1427	132
3	1295-1500	205
4	No filter.	-

If experience shows other passbands are more desirable, it will be a simple matter to replace the existing filters with new filters.

5) Mixer and IF System

Mini-Circuits Model ZLW-11 double balanced mixers are used to provide RF to IF conversion. The mixers are driven at an LO level of +7 dBm (5 milliwatts) from the Universal LO system

(ULO) in the control room. Remote leveling of the LO is obtained from the ULO ALC circuit. The 5 volt input signal necessary to drive the ALC circuit at the ULO is derived from sampled LO at mixer A. The LO signal is sampled with a crystal detector, amplified in the front end by circuit CF-5 (Figure 16), buffered and level-adjusted in the control rack by CR-5 (Figure 17) and then sent to the ULO to drive the ALC circuit.

A Trontec Model W500F-4 amplifier (5-500 MHz) provides 44 dB of IF gain for each channel. The amplifiers have a 1 dB gain compression point at greater than +26 dBm. The four amplifiers are mounted to a heavy heat exchanger to minimize thermal effects on gain stability.

6) Monitor and Control Circuits

Several plug-in circuit cards are located in both the front-end box and the control rack. These circuits allow remote monitoring and control of various front-end functions from the control rack. The circuit cards for the front-end box and the control rack are located in card cages CC-F and CC-R, respectively. The function, location, and figure number of the various circuits are shown in Table 1.

TABLE 2

Plug-In Circuit Cards located in the Front-End and Control Rack

Circuit	Function	Fig.
CF-1	Gate voltage monitor driver/Channel A	18
CF-2	Gate voltage monitor driver/Channel B	18
CF-3	Gate voltage monitor driver/Channel C	18
CF-4	Gate voltage monitor driver/Channel D	18
CF-5	LO ALC and level monitor driver	16
CF-6	Sweeper ALC level monitor driver	20
CF-7	Bandpass monitor driver	22
CF-8	Noise cal and noise add PIN modulator driver	24
CF-9,10	Spare	
	Control Rack	
CR-1	Gate voltage monitor driver/Channel A	19
CR-2	Gate voltage monitor driver/Channel B	19
CR-3	Gate voltage monitor driver/Channel C	19
CR-4	Gate voltage monitor driver/Channel D	19
CR-5	LO ALC and level monitor receiver	17
CR-6	Sweeper ALC level monitor receiver	21
CR-7	Bandpass monitor receiver	23
CR-8	Temperature monitor	25

7) Temperature Monitor and Control System

The temperature of the front-end box is stabilized in the usual fashion, i.e., a 4 K thermistor located at the output of the heating-cooling duct acts as the control sensor for the temperature control system in the control room.

The temperature of the front-end box or of the noise source assembly can be observed at a DPM on the monitor panel in the control rack. A selector switch at the DPM determines which temperature is monitored. The temperature monitor circuit is shown in Figure 25. The monitor sensor for the front-end box is located at the output of the heating-cooling duct. The sensor for monitoring the temperature of the noise source assembly is mounted on the copper block which houses the temperature sensitive components of that system.

8) Bias Controller

Remote on/off control of the FET and the RF transistor amplifiers is achieved through the use of the Bias Controller. The block diagram and schematic of the bias controller are shown in Figures 26 and 27, respectively.

9) Front-End DC Power Distribution

To minimize system instabilities due to ground loops, noise and hum picked up by long telescope cables, all DC voltages required for driving critical front-end components are derived from power supplies located in the front-end box. These power supplies are installed on the power supply chassis PSC-F. DC voltages for uncritical functions, e.g., lights and relays,

are obtained from the control rack via telescope cables. Distribution of the DC voltages is shown in Figure 28.

10) Front-End AC Power Distribution

The 115 V, 60 Hz, AC supply voltage for the front-end box is obtained from the control rack via a 4/C - #8 cable. The AC supply voltage enters the front-end box via connector JF-AC and is distributed to the various AC outlets in the front-end as shown in the wiring diagram of Figure 29.

11) Interconnecting Cables

Information regarding the various interconnecting cables between the front-end box and the equipment in the control room is shown in the following Table 3.

(Table 3 follows.)

TABLE 3

Telescope Interconnecting Cable and Connector Information

Cable Information

Cable	Function	Front End		Control Room Equipment		
		Connector	Terminal Board	Equipment	Terminal Board	Connector
15 Pair - #18	CH A & C Monitor & Control	JF-A	TBF-A	Control Rack	TB-A	JC-A
15 Pair - #18	CH B & D Monitor & Control	JF-B	TBF-B	Control Rack	TB-B	JC-B
15 Pair - #18	Common Functions Monitor & Control	JF-C	TBF-C	Control Rack	TB-C	JC-C
30/C - #16	Control	JD-D	TBF-D	Control Rack	TB-D	JC-D
30/C - #16	Control	JF-E	TBF-E	Control Rack	TB-E	JC-E
4/C - #8	115 V AC for F.E.	JF-AC	F.E. AC Dist. Box	Control Rack	Monitor Chassis Outlet	JC-AC
4/C - #8	D.C. for F.E. Heat/Cool	JF-DC	TBF-DC	Temp. Control Rack	-	-
7/8 Spiroline	LO	LO	-	ULO	-	ULO Output
Coax 7/8 or RG-9	IF CH A	IF-A	-	Digital Receiver	-	IF Input CH 0
Coax 7/8 or RG-9	IF CH B	IF-B	-	Digital Receiver	-	IF Input CH 1
Coax 7/8 or RG-9	IF CH C	IF-C	-	Digital Receiver	-	IF Input CH 2
Coax 7/8	IF CH D	IF-D	-	Digital Receiver	-	IF Input CH 3
Coax 7/8	RF Sweep	Sweep	-	Control Rack	-	Sweeper to F.E.

TABLE 3 (continued):

15 TWISTED PAIR — 18 GA: CONNECTOR JF-A/JC-A 7-21-82

LOCATION FRONT END BOX/CONTROL RACK
TBF-A/TB-A

Tracer Color	Wire Color	Pin Letter	Term. No.	Function
	Red	A	1	VG1 Monitor, CH A
Blue	Yellow	B	2	Return
	Shield	E		Shield
	Red	C	3	VG2 Monitor, CH A
Purple	Yellow	D	4	Return
	Shield	J		Shield
	Red	O	5	VG3 Monitor, CH A
Gray	Yellow	P	6	Return
	Shield	H		Shield
	Red	F	7	LO Monitor, CH A
Green	Yellow	G	8	Return
	Shield	M		Shield
	Red	T	9	Bandpass, CH A
Yellow	Yellow	U	10	Return
	Shield	N		Shield
	Gray	K	11	FET Amp ON-OFF Switch, CH A (+28 V = Off, 0 V = On)
White	Yellow	L	12	FET Amp "ON" Indicator, CH A (28 V = On, 0 V = Off)
	Shield	R		
	Blue	X	13	Transistor Amp ON-OFF Switch, CH A (28 V = Off, 0 V = On)
White	Yellow	Y	14	Transistor Amp "ON" indicator CH A (28 V = On, 0 V = Off)
	Shield	Q		
	Gray	Z	15	VG1 Monitor, CH C
White	Red	a	16	Return
	Shield	S		
	Red	V	17	VG2 Monitor, CH C
White	Yellow	W	18	Return
	Shield	d		
	Red	m	19	VG3 Monitor, CH C
Black	Yellow	n	20	Return
	Shield	e		
	Red	b	21	LO Monitor, CH C
Orange	Yellow	c	22	Return
	Shield	k		
	Red	r	23	Bandpass, CH C
Red	Yellow	s	24	Return
	Shield	x		
	Red	t	25	FET Amp ON-OFF Switch, CH C (+28 V = Off, 0 V = On)
Brown	Yellow	u	26	FET Amp "ON" Indicator CH C (+28 V = On, 0 V = Off)
	Shield	y		
	Blue	f	27	Transistor Amp On-OFF Switch, CH C (28 V = Off, 0 V = On)
White	Gray	g	28	Transistor Amp "ON" Indicator CH C (+28 V = On, 0 V = Off)
	Shield	p		
	Red	h	29	Spare
White	Blue	j	30	Spare
	Shield	q		

C = 57.6 pF/ft wire-to-wire. C = 97.4 pF/ft wire-to-shield.

TABLE 3 (continued):

15 TWISTED PAIR — 18 GA: CONNECTOR JF-B/JC-B

LOCATION FRONT END BOX/CONTROL RACK

TBF-B/TB-B

Tracer Color	Wire Color	Pin Letter	Term. No.	Function
	Red	A	1	VG1 Monitor, CH B
Blue	Yellow	B	2	Return
	Shield	E		
	Red	C	3	VG2 Monitor, CH B
Purple	Yellow	D	4	Return
	Shield	J		
	Red	O	5	VG3 Monitor, CH B
Gray	Yellow	P	6	Return
	Shield	H		
	Red	F	7	LO Monitor, CH B
Green	Yellow	G	8	Return
	Shield	M		
	Red	T	9	Bandpass, CH B
Yellow	Yellow	U	10	Return
	Shield	N		
	Gray	K	11	FET Amp ON-OFF Switch, CH B (+28 V = Off, 0 V = On)
White	Yellow	L	12	FET Amp "ON" Indicator, CH B (28 V = On, 0 V = Off)
	Shield	R		
	Blue	X	13	Transistor Amp On-OFF Switch, CH B (28 V = Off, 0 V = On)
White	Yellow	Y	14	Transistor Amp "ON" Indicator CH B (+28 V = On, 0 V = Off)
	Shield	Q		
	Gray	Z	15	VG1 Monitor, CH D
White	Red	a	16	Return
	Shield	S		
	Red	V	17	VG2 Monitor, CH D
White	Yellow	W	18	Return
	Shield	d		
	Red	m	19	VG3 Monitor, CH D
Black	Yellow	n	20	Return
	Shield	e		
	Red	b	21	LO Monitor, CH D
Orange	Yellow	c	22	Return
	Shield	k		
	Red	r	23	Bandpass, CH D
Red	Yellow	s	24	Return
	Shield	x		
	Red	t	25	FET Amp ON-OFF Switch, CH D (+28 V = Off, 0 V = On)
Brown	Yellow	u	26	FET Amp "ON" Indicator CH D (+28 V = On, 0 V = Off)
	Shield	y		
	Blue	f	27	Transistor Amp ON-OFF Switch, CH D (28 V = Off, 0 V = On)
White	Gray	g	28	Transistor Amp "ON" indicator CH D (28 V = On, 0 V = Off)
	Shield	p		
	Red	h	29	
White	Blue	j	30	
	Shield	q		

C = 57.6 pF/ft wire-to-wire. C = 97.4 pF/ft wire-to-shield.

TABLE 3 (continued):

15 TWISTED PAIR — 18 GA: CONNECTOR JF-C/JC-C

LOCATION FRONT END BOX/CONTROL RACK TBF-C/TB-C

Tracer Color	Wire Color	Pin Letter	Term. No.	Function
	Red	A	1	Sweeper ALC
Blue	Yellow	B	2	Return
	Shield	E		
	Red	C	3	Noise cal; 0 V = On, +5 V = Off
Purple	Yellow	D	4	Return
	Shield	J		
	Red	O	5	Noise add; 0 V = On, +5 V = Off
Gray	Yellow	P	6	Return
	Shield	H		
	Red	F	7	Noise cal indicator; 0 V = cal on, +5 V = cal off
Green	Yellow	G	8	Return
	Shield	M		
	Red	T	9	Noise add indicator; 0 V = noise on, +5 V = noise off
Yellow	Yellow	U	10	Return
	Shield	N		
	Gray	K	11	Spare
White	Yellow	L	12	Spare
	Shield	R		
	Blue	X	13	Spare
White	Yellow	Y	14	Spare
	Shield	Q		
	Gray	Z	15	F.E. Box Temperature Monitor
White	Red	a	16	Return
	Shield	S		
	Red	V	17	Noise Add Temperature Monitor
White	Yellow	W	18	Return
	Shield	d		
	Red	m	19	F.E. Temperature Control } to BNC at
Black	Yellow	n	20	Return } top of rack.
	Shield	e		
	Red	b	21	F.E. Temperature Monitor } to BNC at
Orange	Yellow	c	22	Return } top of rack
	Shield	k		
	Red	r		
Red	Yellow	s		
	Shield	x		
	Red	t		
Brown	Yellow	u		
	Shield	y		
	Blue	f		
White	Gray	g		
	Shield	p		
	Red	h		
White	Blue	j		
	Shield	q		

C = 57.6 pF/ft wire-to-wire. C = 97.4 pF/ft wire-to-shield.

TABLE 3 (continued):

30 CONDUCTOR – 16 GA: CONNECTOR JF-E/JC-E

LOCATION FRONT END BOX/CONTROL RACK

TBF-E/TB-E

Wire Color	Pin Letter	Term. No.	Function
Orange Purple	A	1	BP Filter Sw., CH B, Pos. 1, Coil, +28 V
Orange Blue	B	2	" " " " " " 2 " "
Yellow White	C	3	" " " " " " 3 " "
Yellow	D	4	" " " " " " 4 " "
Red Purple	E	5	" " " " " " 1 Indicator, Return
Red Blue	F	6	" " " " " " 1 " +5 V
Orange Green	G	7	" " " " " " 2 " Return
Yellow Black	H	8	" " " " " " 2 " +5 V
Yellow Brown	J	9	" " " " " " 3 " Return
Black	K	10	" " " " " " 3 " +5 V
White Yellow	L	11	" " " " " " 4 " Return
Red Green	M	12	" " " " " " 4 " +5 V
Orange Yellow	N	13	" " " CH D " 1 Coil, +28 V
Orange	P	14	" " " " " " 2 " "
Brown	R	15	" " " " " " 3 " "
Red	S	16	" " " " " " 4 " "
Red Black	T	17	" " " " " " 1 Indicator, Return
Red Yellow	U	18	" " " " " " 1 " +5 V
Red Brown	V	19	" " " " " " 2 " Return
Orange Brown	W	20	" " " " " " 2 " +5 V
Green	X	21	" " " " " " 3 " Return
Orange White	Y	22	" " " " " " 3 " +5 V
Orange Black	Z	23	" " " " " " 4 " Return
Blue	a	24	" " " " " " 4 " +5 V
Purple	b	25	+5 V for F.E. Box
Purple White	c	26	+5 V Return for F.E. Box
Green White	d		
Green Black	e		
Green Brown	f		
Red White	g		
Shield	l	Shield	

TABLE 3 (continued):

30 CONDUCTOR – 16 GA: CONNECTOR JF-D/JC-D 7/20/82

Rev. A 7/23/82

LOCATION FRONT END BOX/CONTROL RACK

TBF-D/TB-D

Wire Color	Pin Letter	Term. No.	Function
Orange Purple	A	1	BP Filter Sw., CH A, Pos. 1, Coil, +28 V
Orange Blue	B	2	" " " " " " 2 " "
Yellow White	C	3	" " " " " " 3 " "
Yellow	D	4	" " " " " " 4 " "
Red Purple	E	5	" " " " " " 1 Indicator Return
Red Blue	F	6	" " " " " " 1 " +5 V
Orange Green	G	7	" " " " " " 2 " Return
Yellow Black	H	8	" " " " " " 2 " +5 V
Yellow Brown	J	9	" " " " " " 3 " Return
Black	K	10	" " " " " " 3 " +5 V
White Yellow	L	11	" " " " " " 4 " Return
Red Green	M	12	" " " " " " 4 " +5 V
Orange Yellow	N	13	" " " CH C " 1 Coil, +28 V
Orange	P	14	" " " " " " 2 " "
Brown	R	15	" " " " " " 3 " "
Red	S	16	" " " " " " 4 " "
Red Black	T	17	" " " " " " 1 Indicator Return
Red Yellow	U	18	" " " " " " 1 " +5 V
Red Brown	V	19	" " " " " " 2 " Return
Orange Brown	W	20	" " " " " " 2 " +5 V
Green	X	21	" " " " " " 3 " Return
Orange White	Y	22	" " " " " " 3 " +5 V
Orange Black	Z	23	" " " " " " 4 " Return
Blue	a	24	" " " " " " 4 " +5 V
Purple	b	25	+28 V for F.E. Box
Purple White	c	26	+28 V Return for F.E. Box
Green White	d	27	+15 V for F.E. Box
Green Black	e	28	-15 V for F.E. Box
Green Brown	f	29	$\pm$ 15 Return
Red White	g	30	F.E. AC on Indicator, +28 V from Relay
Shield	l	Shield	

TABLE 3 (continued):

4-CONDUCTOR — 8 GA: CONNECTOR JF-AC/JC-AC and JF-DC

LOCATION FRONT END BOX/CONTROL RACK

Wire Color	Pin Letter	Term. No.	Function
AC STANDARD*			
Black	A		(Tied together in AC Distribution Box) Hot for F.E. AC Outlets
Red	B		
Shield	C		Gnd
White	D		(Tied together in AC Distribution Box) Neutral for F.E. AC outlets
Green	E		
DC STANDARD*		JF-DC	
Black	A	1	+DC Source to Heat Pumps
Red	B	2	-DC Source to Heat Pumps
Shield	C	3	Shield
White	D	4	+DC Source to Heat Pumps
Green	E	5	-DC Source to Heat Pumps
NON-STANDARD			
Black	A	___	_____
Red	B	___	_____
Shield	C	___	_____
White	D	___	_____
Green	E	___	_____

* Note: +DC pins A and D are tied together in rack and front-end box (as are -DC pins B and E) in order to protect heat pumps by blowing the AC breaker if DC cable is accidentally connected to the AC source.

Control Rack Description

The control rack (Figure 2) consists of four subassemblies: (1) the monitor chassis, (2) the control panel, (3) the RF bandpass test assembly, and (4) the power supply chassis.

1) Monitor Chassis

On the front panel of the monitor chassis are five DPMS used for monitoring the following front-end functions: (1) the gate voltage of each FET amplifier stage, (2) the LO input to each of the four mixers, and (3) the ambient temperatures of the front-end box and the noise source assembly. Adjacent to the selector switch of each DPM is a BNC jack which can be used for driving a chart recorder for stability tests. Also on the front panel are breaker switches, and associated indicators, for controlling the AC supply voltage to the control rack and the front-end box.

Inside the monitor chassis is mounted the card cage CC-C which contains the circuit cards for various monitor and control functions mentioned above. Also contained within the unit are two +5 V DC modular power supplies used for powering the DPMS.

2) Control Panel

Mounted on the front of the control panels are several switches which enable the user to do the following:

1) Choose one of four possible bandwidths for each channel.
2) Select either manual or computer operation of the noise cal and noise add systems.
3) Turn the FET amplifiers and bipolar transistor amplifiers on and off from the control room as required for certain maintenance and troubleshooting procedures.

Also on the panel are several LED indicators indicating the status of the front-end equipment with regard to the three statements listed above.

3) RF bandpass Test Assembly

This assembly consists of the RF bandpass panel and an oscilloscope (HP 130C) and is used to check the RF bandpass of the front-end including the RF filter assembly.

An external sweeper is connected to the RF input connector of the panel. With the sweeper set in the external ALC mode, and the ALC input of the sweeper connected to the ALC connector on the panel, the RF level is adjusted to cause the sweep level meter to read mid-scale. At this RF sweep level, the response of each channel can be observed on the oscilloscope and should be approximately 0.5-1.0 volts.

4) Power Supply Chassis

The power supply chassis contains several regulated power supplies and is mounted at the bottom of the control rack. The table below gives information regarding this subassembly.

TABLE 4

Power Supply Data for Control Rack

Power	Manufacturer		
PSC-1	AD922	+5 V	PIN modulator driver for noise add and noise cal system. LEDs on monitor panel. CKT CR-8.
PSC-2A	Lambda LM C15	+15 V	Circuits CR-1 thru CR-8.
PSC-2B	Lambda LM C15	-15 V	Circuits CR-1 thru CR-7.
PSC-3	Lambda LM D28	28 V	BPF assembly coax switches. F.E. "AC on" indicator.

TABLE 5

Microwave Component List

Code	Device	Specifications	Manufacturer and Model No.
A1 thru A4	Room temperature, low noise, GaAsFET amplifiers	1.3-1.5 GHz N.F. = 60°K maximum Gain = 24 dB minimum	NRAO
A5 thru A8	RF bipolar transistor amplifiers	1.2-1.6 GHz N.F. = 3 dB maximum Nominal gain = 31 dB	Trontec, Inc. Model P2GC-4
A9	RF amplifier	1-2 GHz N.F. = 3.7 dB maximum Gain = 30 dB	Trontec, Inc. Model W2GA-3
AI-1 thru AI-4	IF amplifier	5-500 MHz N.F. = 2.5 dB maximum Gain = 46 dB minimum	Trontec, Inc. Model W500F-4
C1 thru C14	Ferrite circulator	1-2 GHz I.L. = 0.5 dB maximum 150 L. = 20 dB minimum VSWR = 1.25 maximum	UTE Microwave Model CT-2102-OT
CS1 thru CS8	Coaxial switch	DC-18 GHz 1 pole - 4 throw	DB Products 4S0211
D1 thru D4	Directional coupler	1-2 GHz Coupling = -30 dB Flatness = $\pm$ 0.75 dB I.L. = 0.1 dB maximum VSWR = 1.10 maximum	MAC Technology Model 3203-30
DT1 thru DT4 & DT9	Point contact detector	0.01-12.4 GHz T_{SS} = -43 dBm K = 300 mV/mW (0.C.) Polarity - Negative	Omni-Spectra Model 20090
DT5 thru DT8	Schottky detector	1.0-2,0 GHz T_{SS} = -54 dBm K = 2500 mV/mW typical	Aertec, Inc. Model DOM102BR
F1 thru F4	Feed horn	Pyramidal horn Linear polarized Optimized tuning at 1.4 GHz Return loss = -20 dB maximum IN 1.35-1.45 GHz range	NRAO
FL1 thru FL4	RF bandpass filter	1 dB B.W. = 1350-1427 MHz I.L. = 0.7 dB maximum at f_o VSWR = 1.5 maximum in P.B. Rejection: 5 pole response	Reactel Model 5B2-1388-85S11

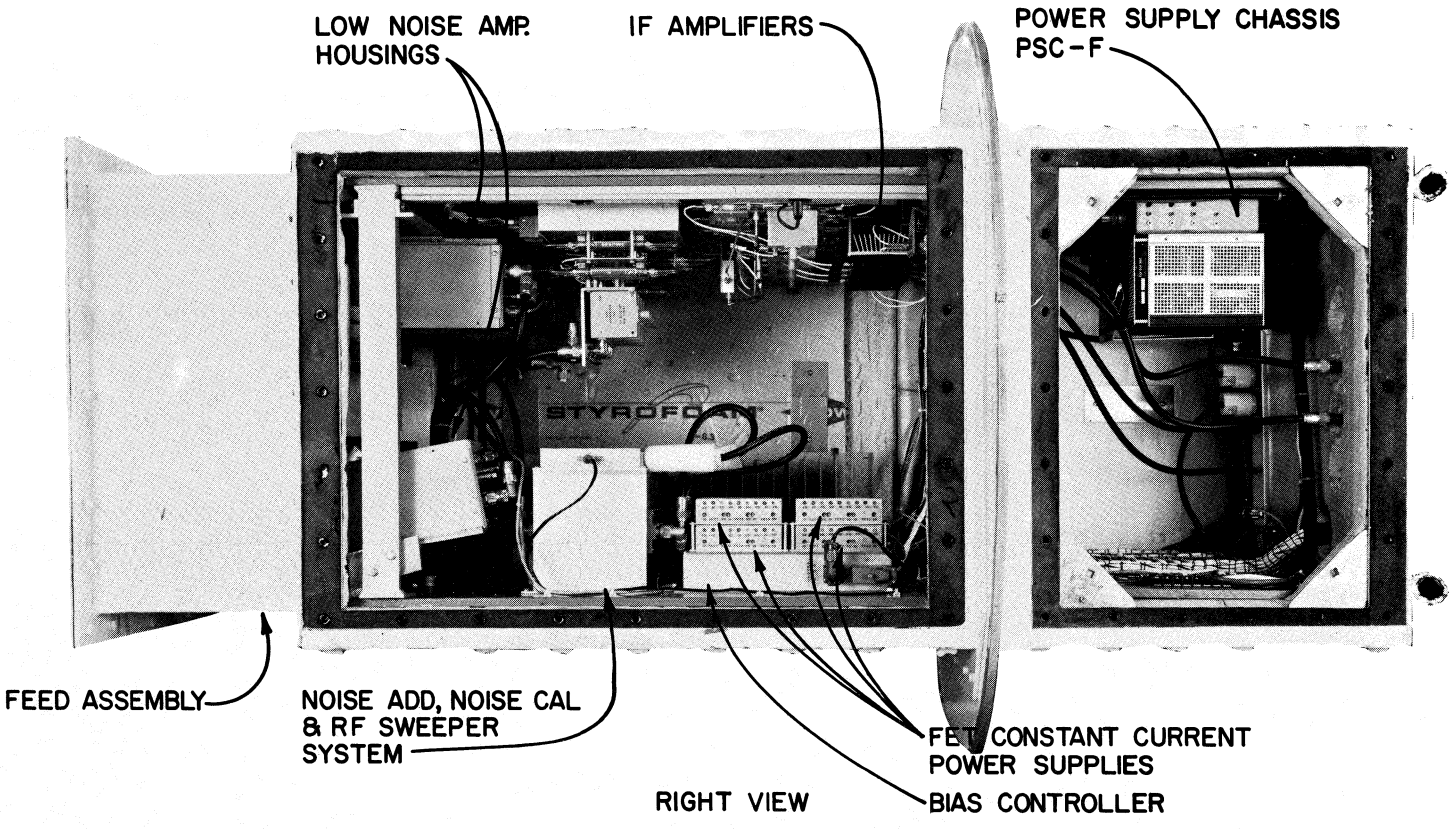
TABLE 5 (continued):

Microwave Component List

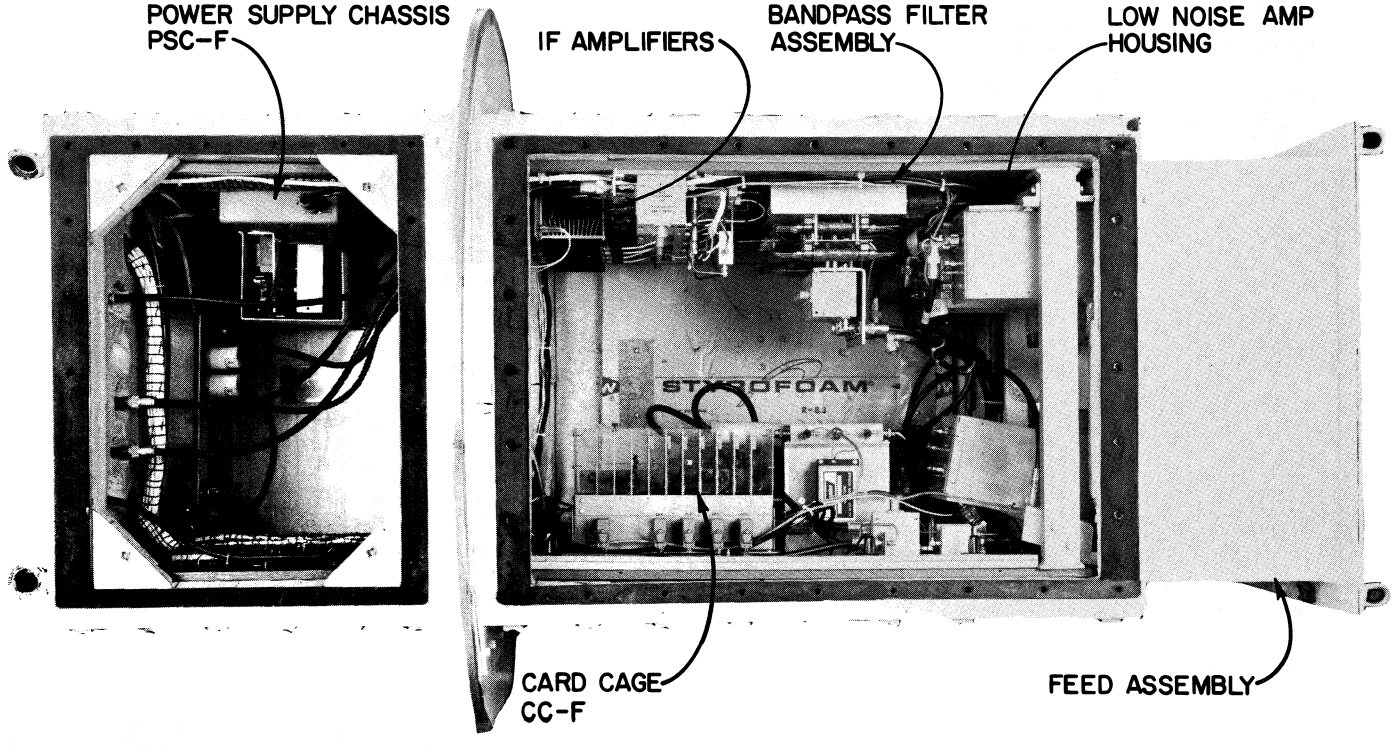
Code	Device	Specifications	Manufacturer and Model No.
FL5 thru FL8	RF bandpass filter	1 dB B.W. = 1295-1427 MHz I.L. = 0.7 dB maximum at f_o VSWR = 1.5 maximum in P.B. Rejection = 5 pole response	Reactel Model 5B2-1361-137S11
FL9 thru FL12	RF bandpass filter	1 dB B.W. = 1295-1500 MHz I.L. = 0.4 dB maximum at f_o VSWR = 1.5 maximum in P.B. Rejection = 5 pole response	Reactel Model 5B2-1397-210S11
FL13 thru FL16	IF low pass filter	3 dB B.W. = 0-500 MHz I.L. = 0.5 dB maximum at $f_o/2$ VSWR = 1.5 maximum in P.B. Rejection = 5 section response	Reactel Model 5L2-500-S11
H1 thru H3	3 dB 90° hybrid	1-2 GHz	Norsal Model 4501-3
MX1 thru MX4	Frequency mixer	RF response = 5-2000 MHz IF response = 10-600 MHz Conversion loss = 6.5 dB typical LO-IF isolation = 30 dB typical	Mini-Circuits, Inc. Model ZLW-11
NS1	Solid State Noise Source	ENR = 35 dB I = 7.35 mA	Microwave Semiconductor Corporation Model MSC-1000
NS2		ENR = 35 dB I = 4.7 mA	
PD1 thru PD10	2-Way power divider	1-2 GHz Phase difference = 2° typical VSWR = 1.2 typical I.L. = 0.25 dB typical Isolation = 25 dB typical	Mini-Circuits, Inc. Model ZAPD-2
PD11	4-Way power divider	1-2 GHz Phase difference = 6° typical I.L. = 0.3 dB typical Isolation = 25 dB	Mini-Circuits, Inc. Model ZA4PD-2
PM1 and PM2	Pin modulator	I.L. = 1.0 dB maximum Isolation = 35 dB minimum VSWR = 1.7 maximum I = -100 mA for maximum isolation	Hewlett-Packard Model HP33102A

LIST OF FIGURES

TABLES



RIGHT VIEW

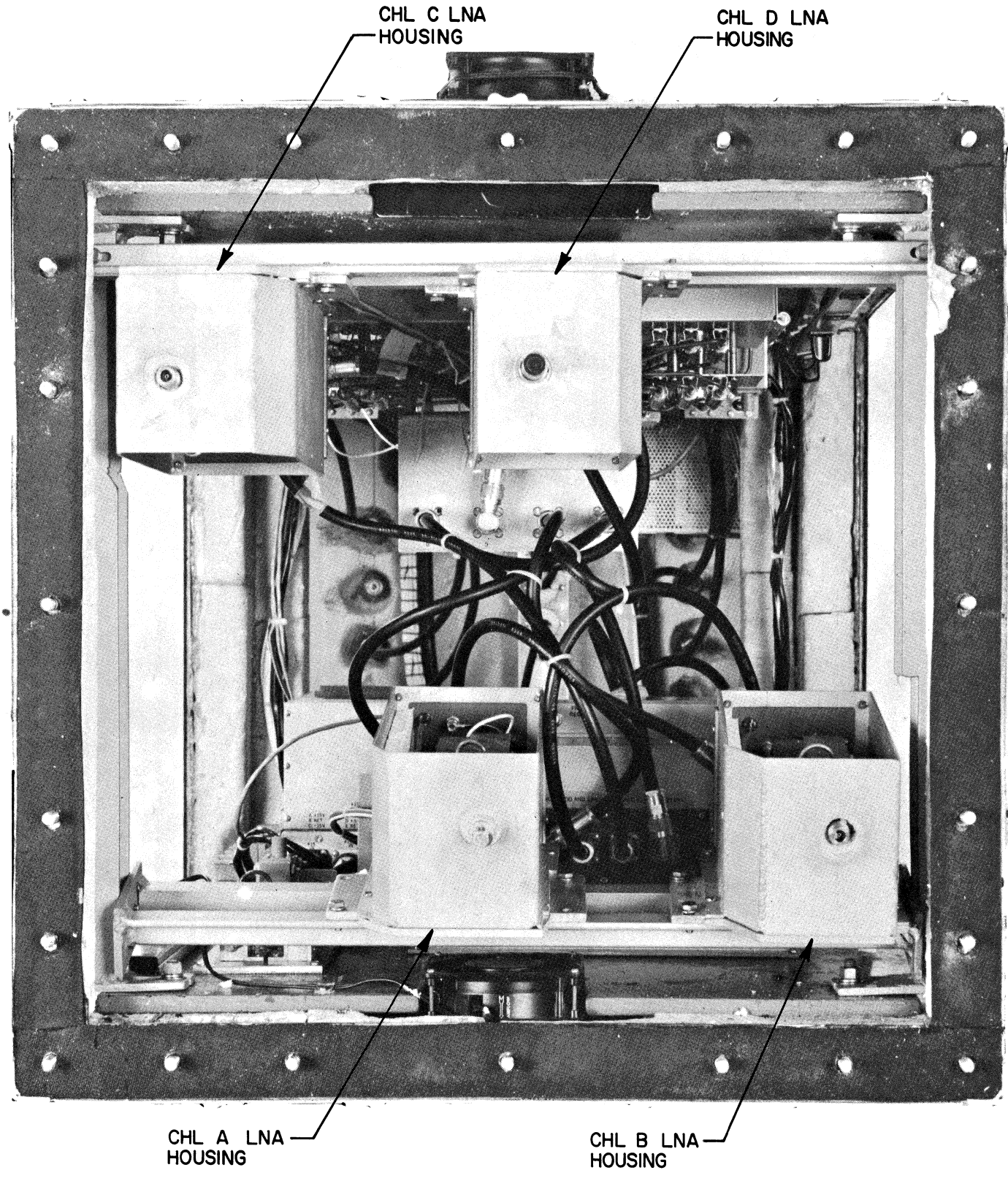


LEFT VIEW

FRONT END BOX, 4-FEED, 21-CM RECEIVER

FIG. 1

(OVER)



FRONT VIEW WITH FEED ASSEMBLY REMOVED

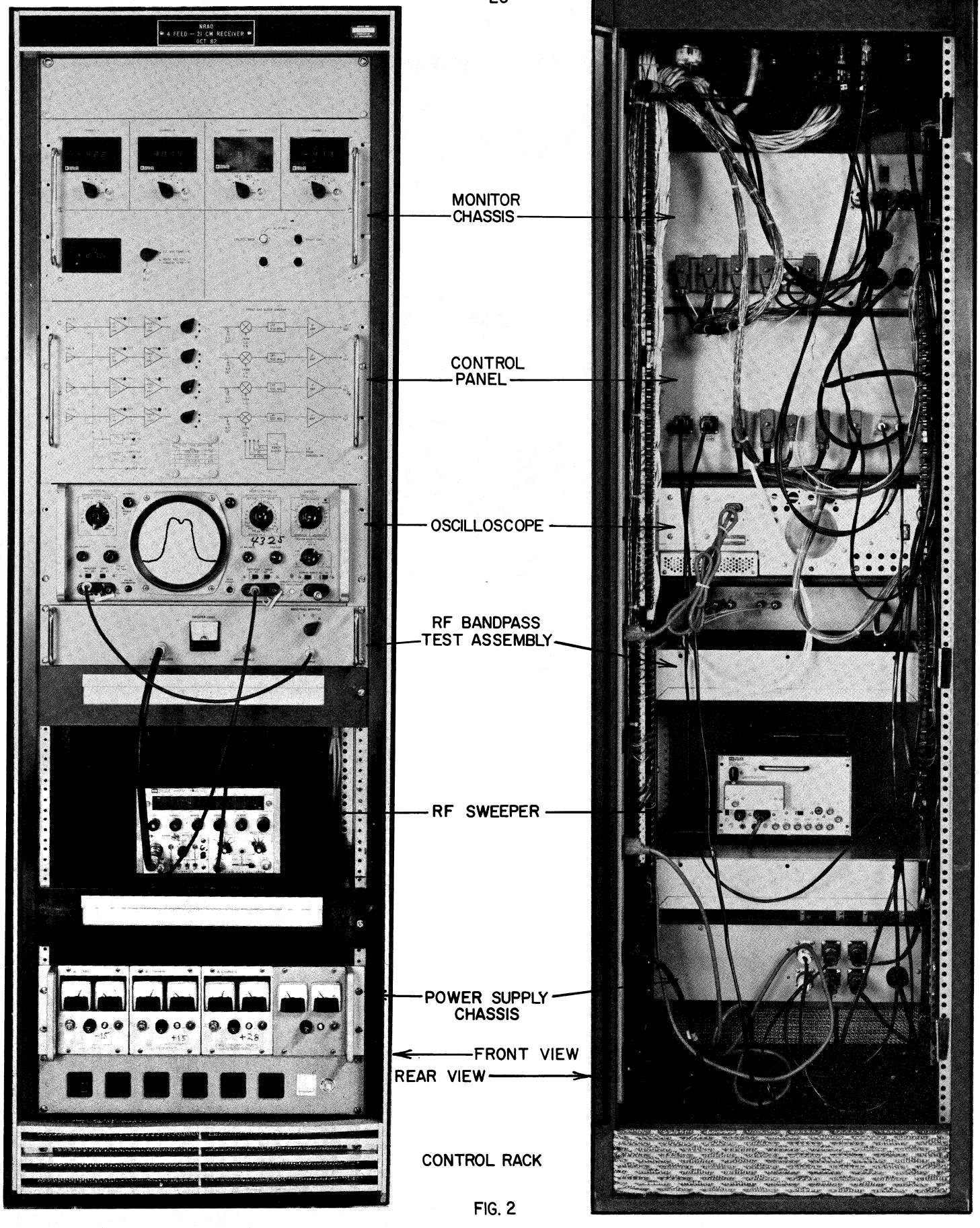
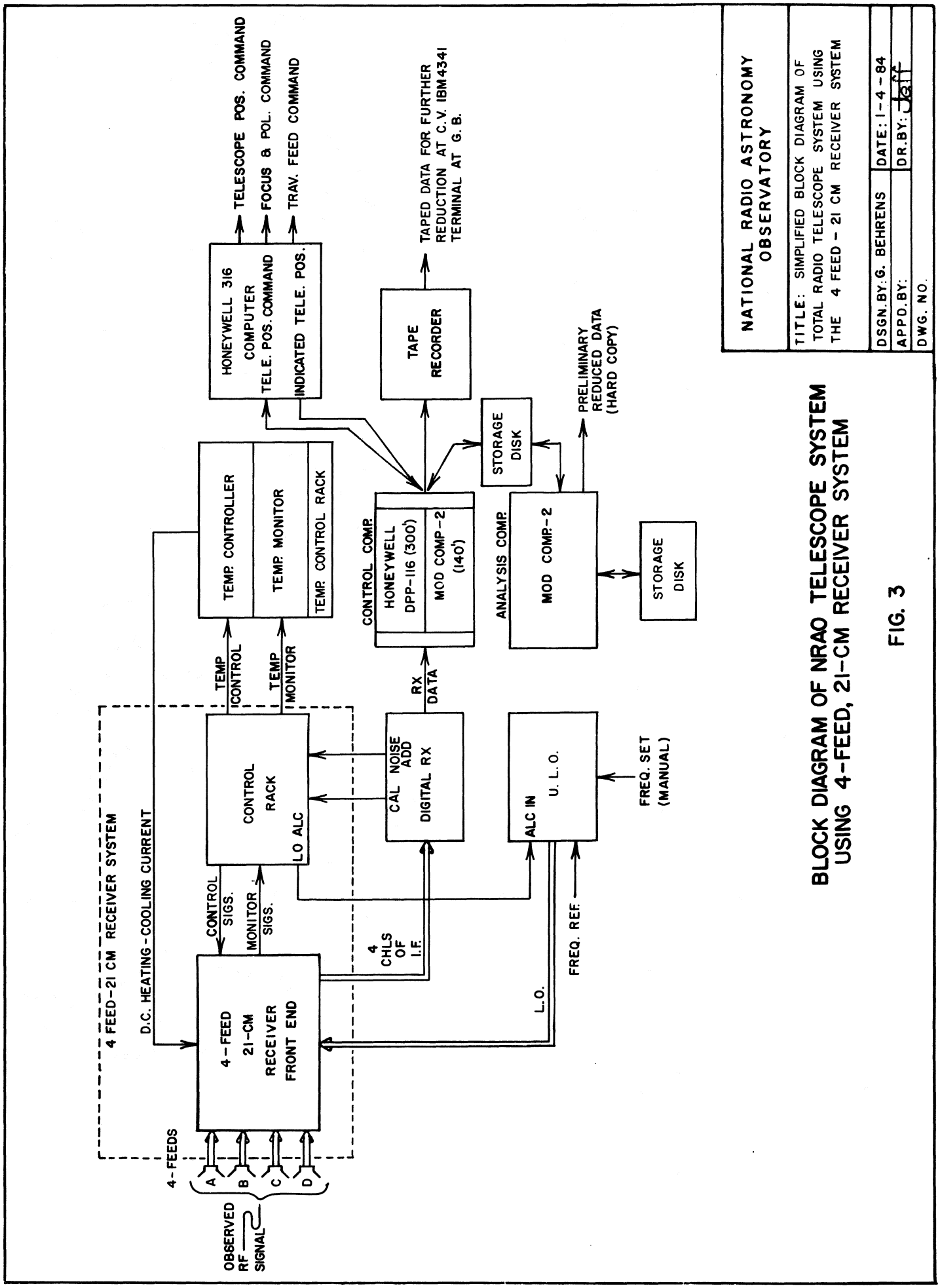
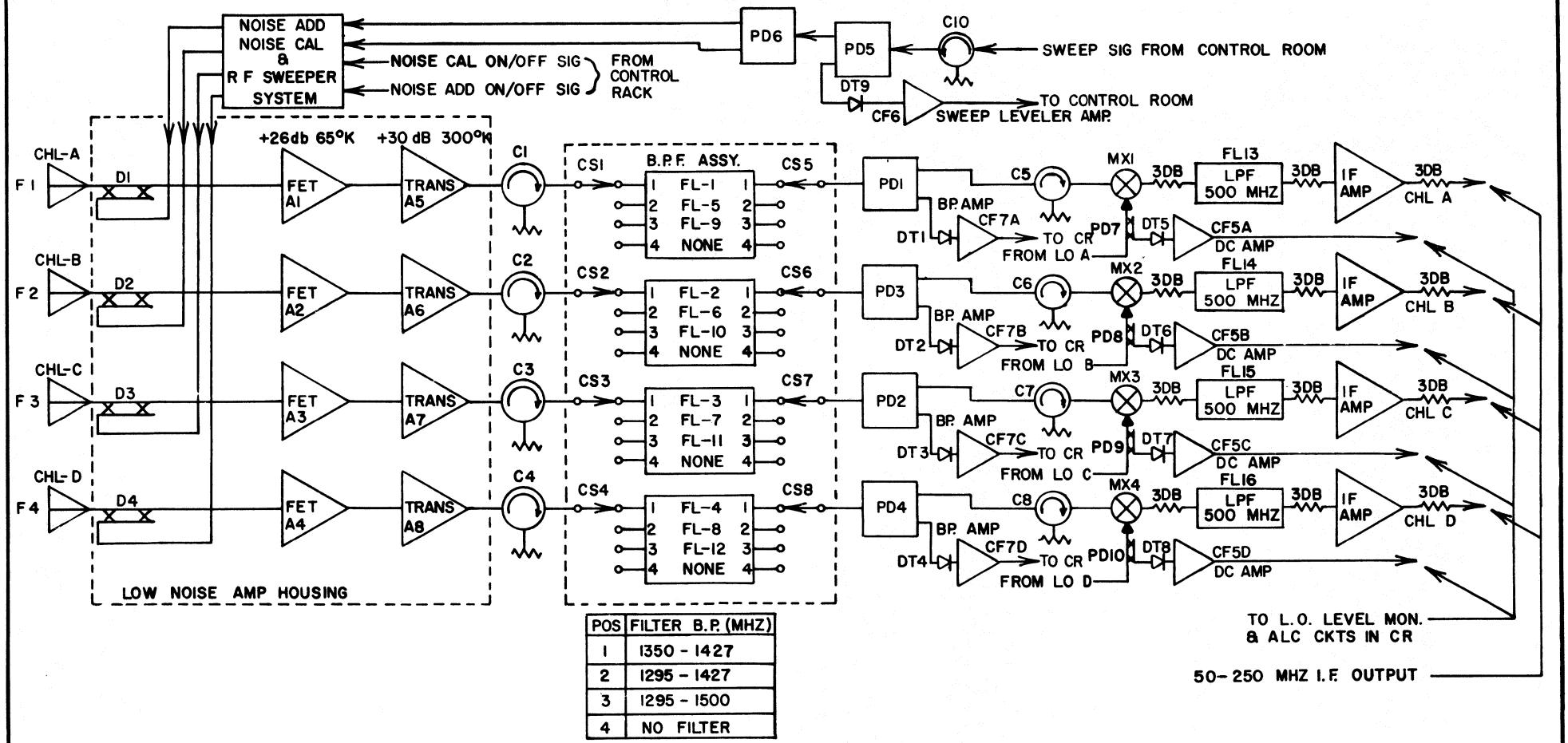

NRAO
4 FEED — 21 CM RECEIVER
OCT. 82
MONITOR CHASSIS
CONTROL PANEL
OSCILLOSCOPE
RF BANDPASS TEST ASSEMBLY
RF SWEEPER
POWER SUPPLY CHASSIS
FRONT VIEW
REAR VIEW
CONTROL RACK

FIG. 2

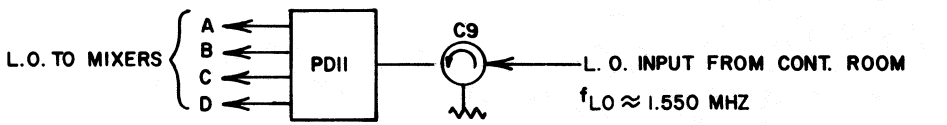


BLOCK DIAGRAM OF NRAO TELESCOPE SYSTEM USING 4-FEED, 21-CM RECEIVER SYSTEM

FIG. 3



POS	FILTER B.P. (MHZ)
1	1350 - 1427
2	1295 - 1427
3	1295 - 1500
4	NO FILTER

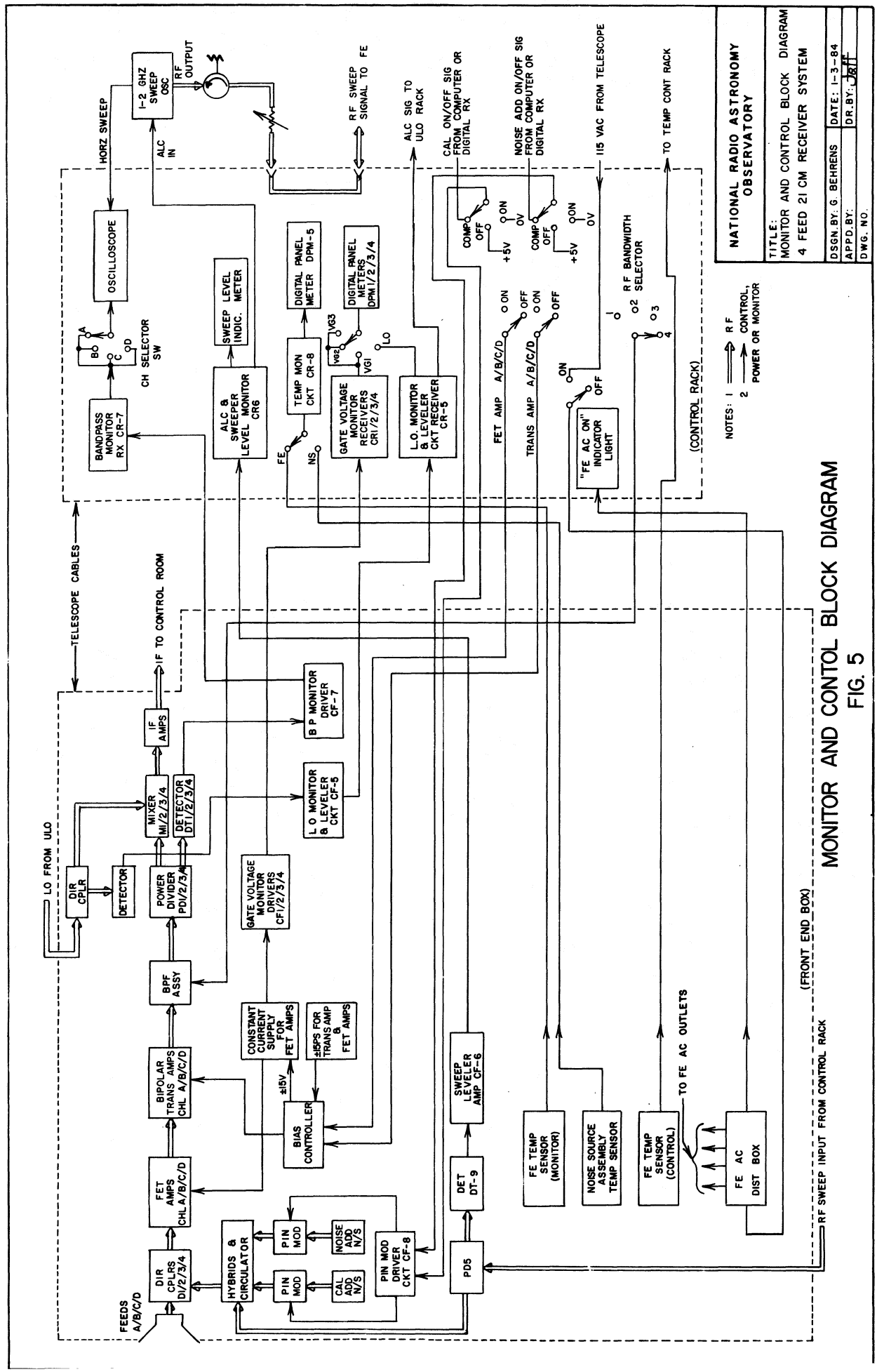


RF BLOCK DIAGRAM

FIG. 4

REV E 2-2-84
REV A 2-22-82
REV B 3-3-82
REV C 3-15-82
REV D 10-19-82

NATIONAL RADIO ASTRONOMY OBSERVATORY	
TITLE: 4 FEED 21 CM RECEIVER RF BLOCK DIAGRAM	
DSGN. BY: G. BEHRENS	DATE: 10-19-82
APPD. BY:	DR. BY: Jeff
DWG. NO.	


NATIONAL RADIO ASTRONOMY OBSERVATORY
TITLE: MONITOR AND CONTROL BLOCK DIAGRAM 4 FEED 21 CM RECEIVER SYSTEM
DSGN. BY: G. BEHRENS
DATE: 1-3-84
APPD. BY:
DR. BY:
DWG. NO.
MONITOR AND CONTOL BLOCK DIAGRAM
FIG. 5
(FRONT END BOX)
(CONTROL RACK)
TELESCOPE CABLES
IF TO CONTROL ROOM
RF SWEEP INPUT FROM CONTROL RACK
LO FROM ULO
FEEDS A/B/C/D
DIR CPLRS D1/2/3/4
HYBRIDS & CIRCULATOR
PIN MOD
NOISE ADD N/S
CAL ADD N/S
PIN MOD DRIVER CKT CF-8
FET AMPS CHL A/B/C/D
BIPOLAR TRANS AMPS CHL A/B/C/D
BPF ASSY
DIR CPLR
DETECTOR
POWER DIVIDER PD1/2/3/4
MIXER MI/2/3/4
DETECTOR DT1/2/3/4
IF AMPS
GATE VOLTAGE MONITOR DRIVERS CF1/2/3/4
CONSTANT CURRENT SUPPLY FOR FET AMPS
±15V
±8PS FOR TRANSAMP & FET AMPS
BIAS CONTROLLER
L O MONITOR & LEVELER CKT CF-5
B P MONITOR DRIVER CF-7
SWEEP LEVELER AMP CF-6
DET DT-9
PD5
FE TEMP SENSOR (MONITOR)
NOISE SOURCE ASSEMBLY TEMP SENSOR
FE TEMP SENSOR (CONTROL)
TO FE AC OUTLETS
FE AC DIST BOX
HORZ SWEEP
OSCILLOSCOPE
CH SELECTOR SW
A
B
C
D
BANDPASS MONITOR RX CR-7
ALC & SWEEPER LEVEL MONITOR CR6
SWEEP LEVEL INDIC. METER
TEMP MON CKT CR-8
FE
NS
GATE VOLTAGE MONITOR RECEIVERS CR1/2/3/4
L.O. MONITOR & LEVELER CKT RECEIVER CR-5
VG3
VG2
VG1
LO
DIGITAL PANEL METER DPM-5
DIGITAL PANEL METERS DPM1/2/3/4
1-2 GHZ SWEEP OSC
RF OUTPUT
ALC IN
RF SWEEP SIGNAL TO FE
ALC SIG TO ULO RACK
CAL ON/OFF SIG FROM COMPUTER OR DIGITAL RX
NOISE ADD ON/OFF SIG FROM COMPUTER OR DIGITAL RX
115 VAC FROM TELESCOPE
TO TEMP CONT RACK
COMP
OFF
ON
+5V
0V
FET AMP A/B/C/D
TRANS AMP A/B/C/D
"FE AC ON" INDICATOR LIGHT
R F BANDWIDTH SELECTOR
1
2
3
4
NOTES: 1 ⟹ R F
2 ⟹ CONTROL, POWER OR MONITOR

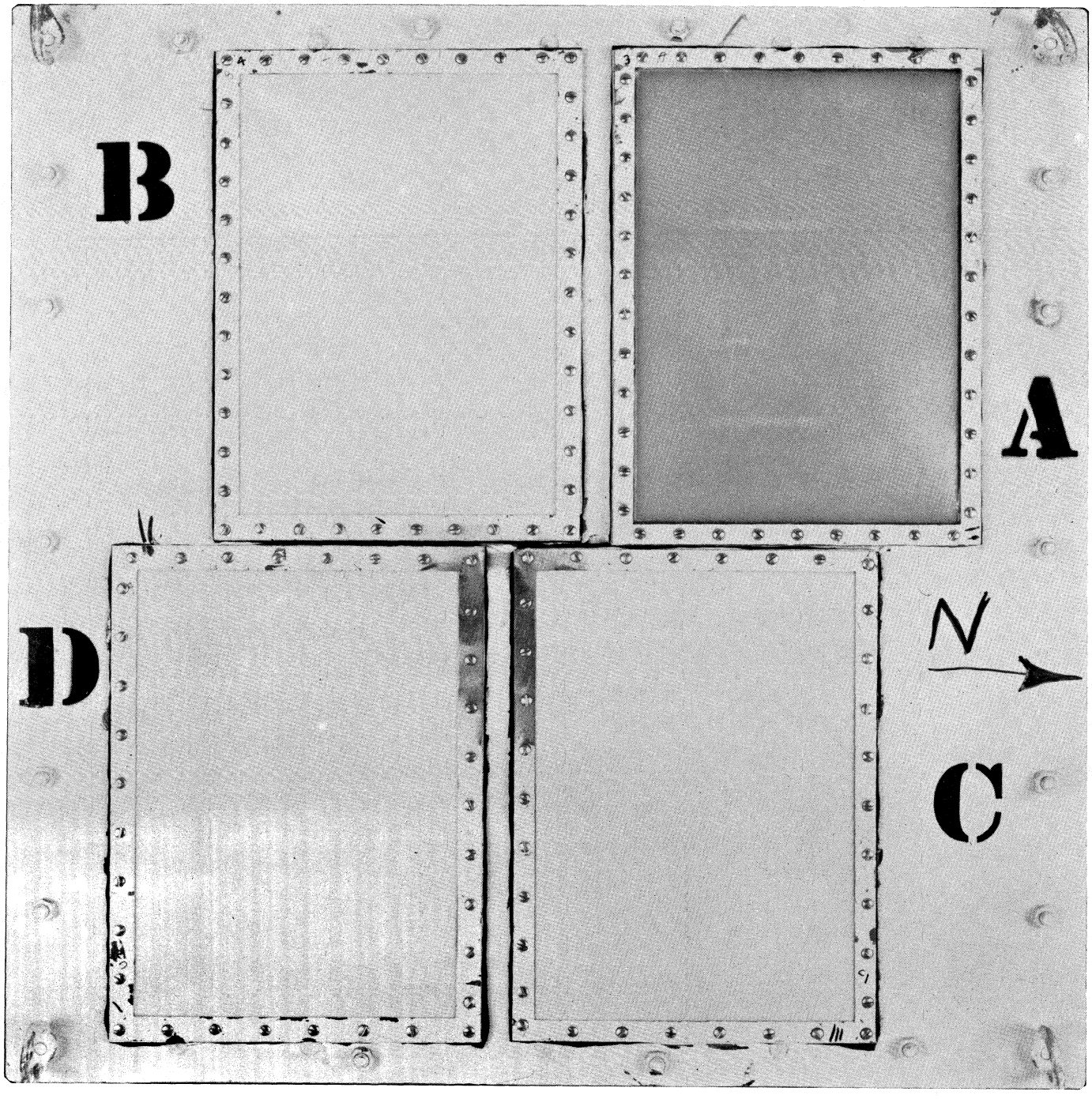
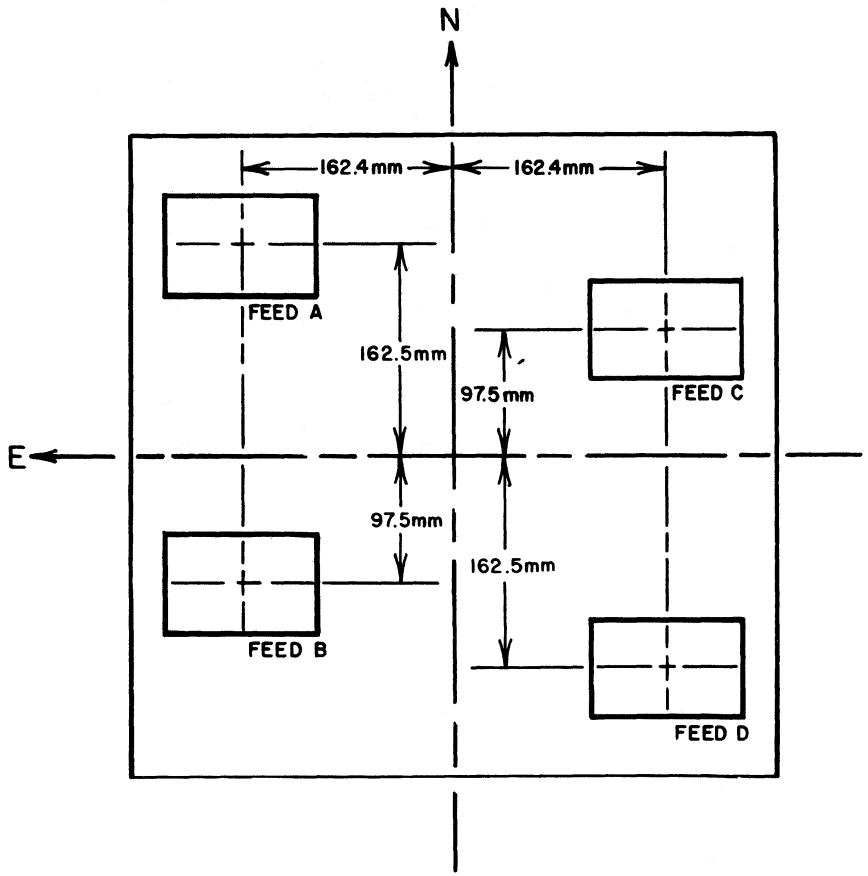


FIG. 6



FEED GEOMETRY AS VIEWED LOOKING INTO FEEDS FROM DISH SURFACE. POLARIZATION CONTROL SET TO 0.00

FEED ASSEMBLY DIMENSIONS

FIG. 7

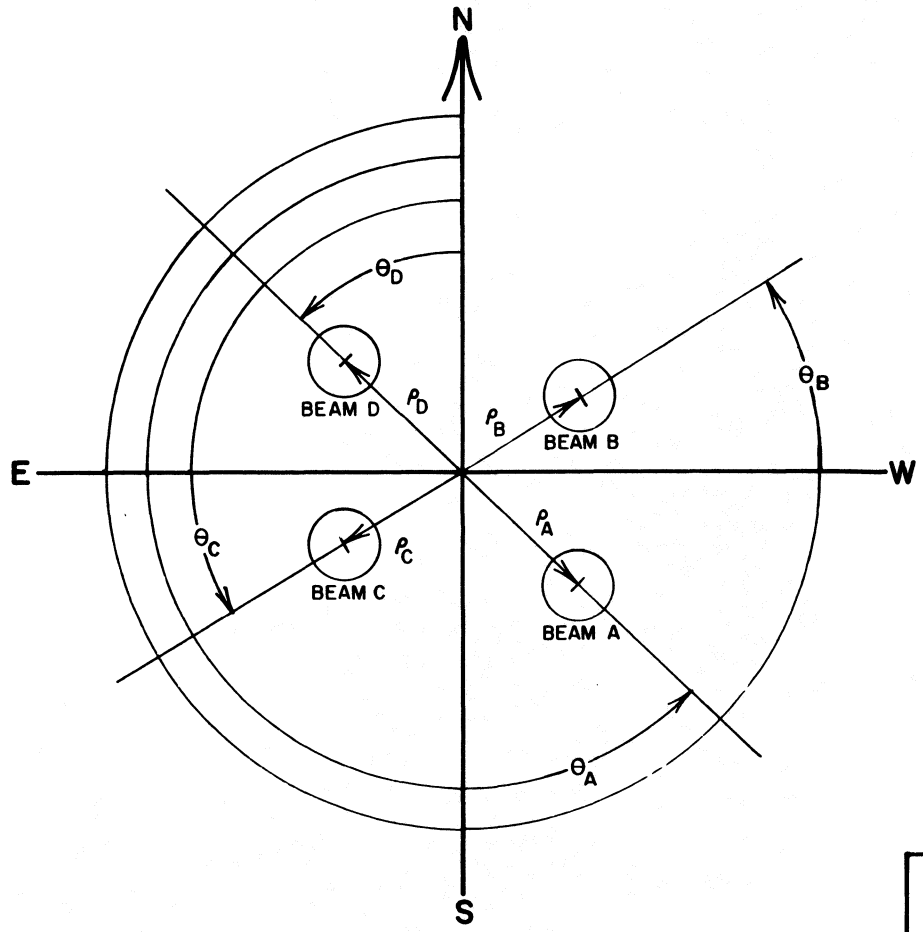
NOTE: FEED CONFIGURATION IS SAME AS OLD 4-FEED, 21-CM RX AS INSTALLED 8-11-80. HOWEVER, THE FEEDS HAVE BEEN REDESIGNATED AS PER CHART AT RIGHT.

NEW RX	OLD RX
CHL A =	CHL 2
CHL B =	CHL 3
CHL C =	CHL 1
CHL D =	CHL 4

NATIONAL RADIO ASTRONOMY OBSERVATORY

TITLE:
FEED GEOMETRY, 4 FEED 21 CM RECEIVER

DSGN. BY: G. BEHRENS	DATE: 10-4-83
APPD. BY:	DR. BY: Jaff
DWG. NO.	



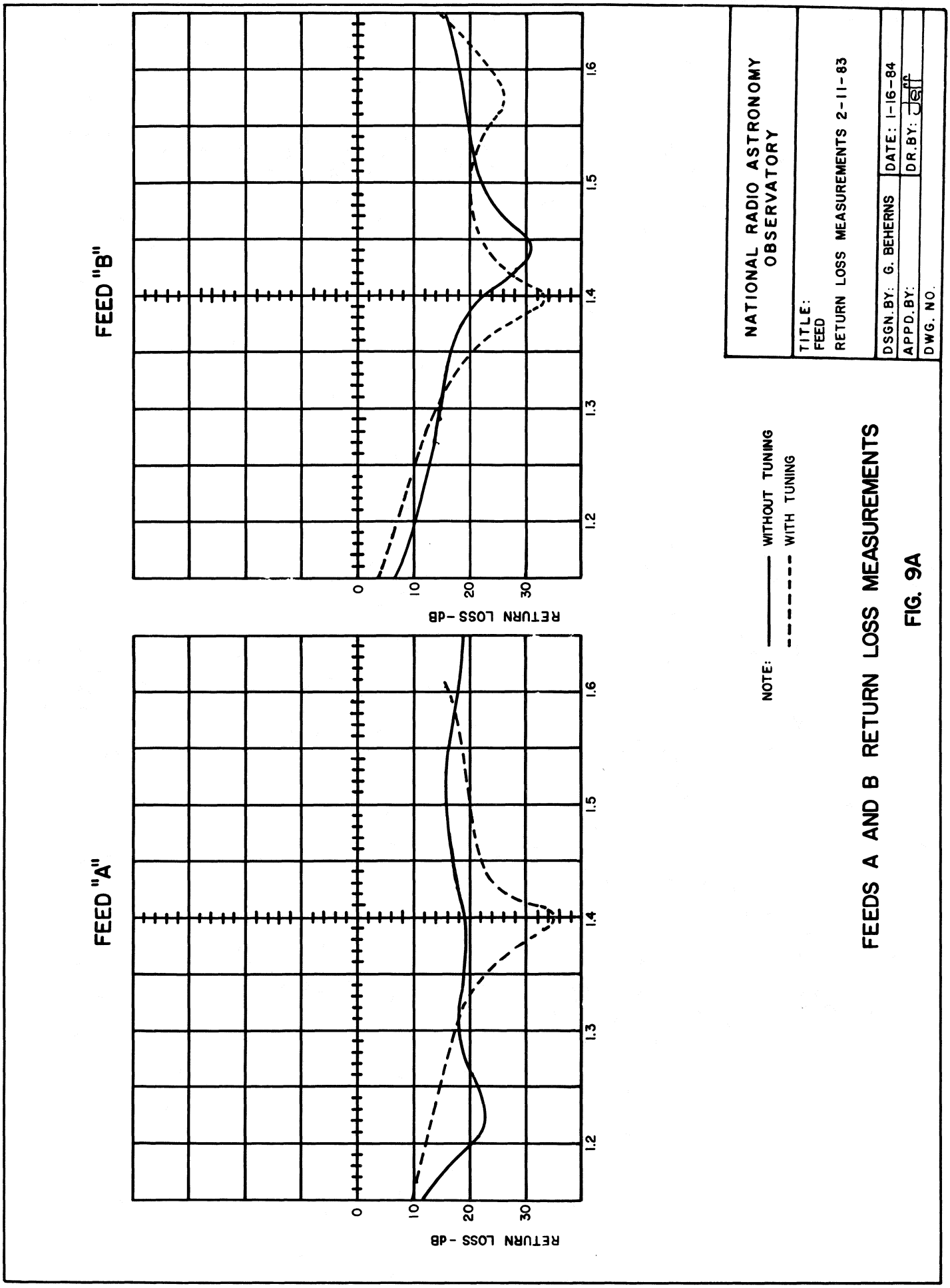
BEAM	θ°	ρ
A	226.4	.2863
B	302.2	.2440
C	121.1	.2389
D	46.3	.2856

NOTE: VALUES OF θ AND ρ WERE OBTAINED FROM INSTALLATION SHEET OF 8-11-80. ACCURACY OF VALUES ARE UNCERTAIN & SHOULD BE REMEASURED IF ABSOLUTE ACCURACY IS REQUIRED.

FEED ASSEMBLY BEAM GEOMETRY

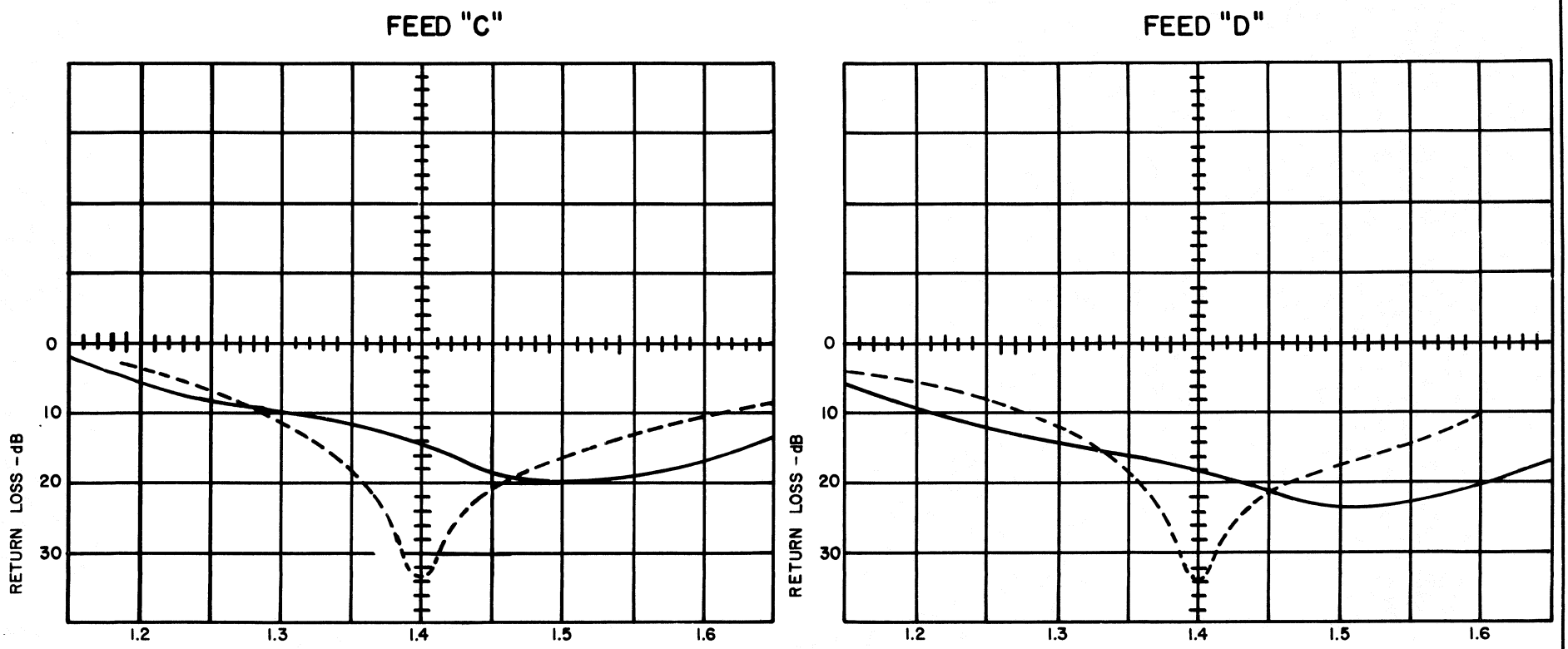
FIG. 8

NATIONAL RADIO ASTRONOMY OBSERVATORY	
TITLE: BEAM GEOMETRY AS PROJECTED ON THE SKY POLARIZATION CONTROL SET TO 0.00	
DSGN. BY: G. BEHRENS	DATE: 1-17-84
APPD. BY:	DR. BY: Jeff
DWG. NO.	



FEEDS A AND B RETURN LOSS MEASUREMENTS

FIG. 9A



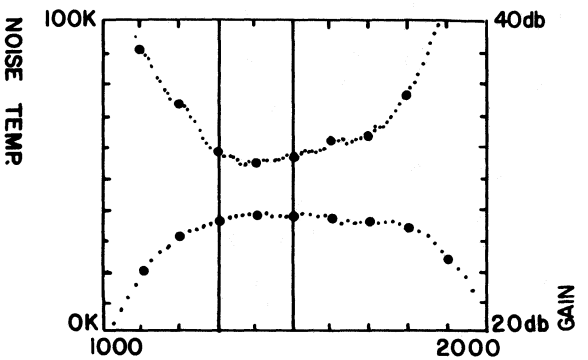
NOTE: ——— WITHOUT TUNING
- - - - - - - WITH TUNING

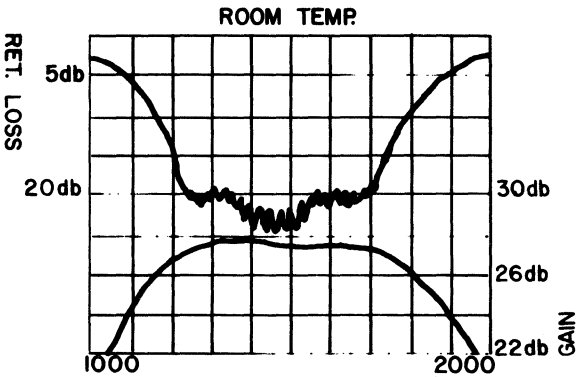
FEEDS C AND D RETURN LOSS MEASUREMENTS

FIG. 9B

NATIONAL RADIO ASTRONOMY OBSERVATORY	
TITLE: FEED RETURN LOSS MEASUREMENTS 2-11-83	
DSGN.BY: G. BEHERNS	DATE: 1-16-84
APPD.BY:	DR.BY: Jeff
DWG. NO.	

CHL. A

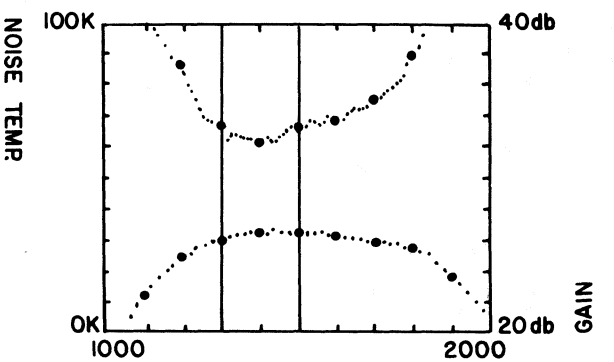


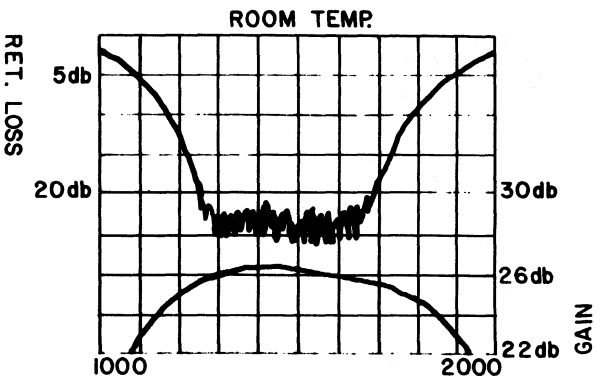


S/N 100 3-STAGE FET P.S. - WITH THIRD STAGE GATE CONTROL

	FET 1	FET2	FET3
V_D	5.5	5.5	4.0
I_D (.1V/Ma)	20.0	20.0	10.0
V_G	-.403	-.692	-1.364

CHL. B





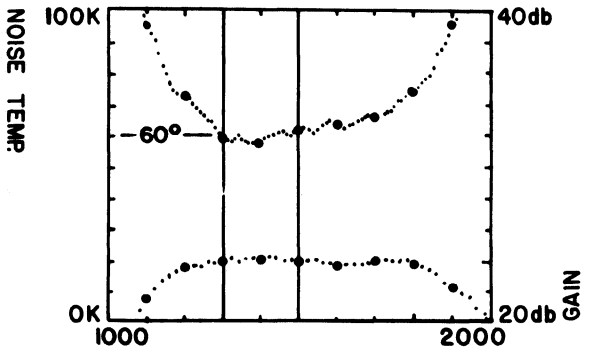
S/N 95 3-STAGE FET P.S. - WITH THIRD STAGE GATE CONTROL

	FET 1	FET2	FET 3
V_D	5.5	5.5	4.0
I_D (.1V/Ma)	17.50	17.50	10.0
V_G	-1.059	-.679	-1.170

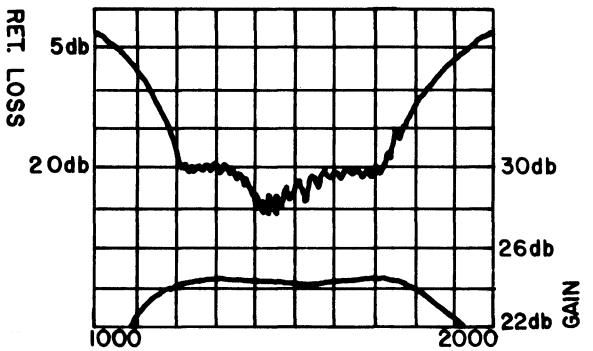
GAIN AND NOISE TEMPERATURE MEASUREMENTS OF CHANNELS A & B FET AMPLIFIERS

FIG. 10A

CHL. C



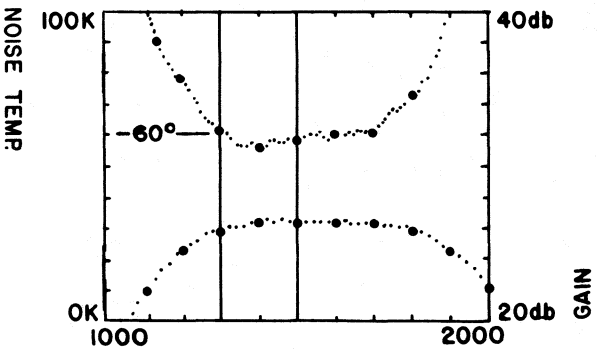
ROOM TEMP.



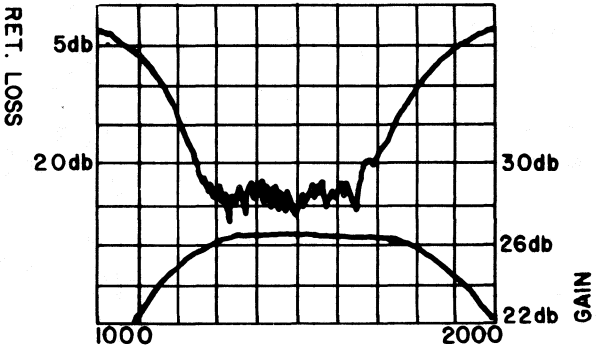
S/N 102 3-STAGE FET P.S. - WITH THIRD STAGE GATE CONTROL

	FET 1	FET2	FET3
V_D	5.5	5.5	4.0
I_D(.IV/Ma)	17.15	13.75	10.00
V_G	-.486	-.811	-1.240

CHL. D



ROOM TEMP.



S/N 101 3-STAGE FET P.S. - WITH THIRD STAGE GATE CONTROL

	FET 1	FET2	FET3
V_D	5.5	5.5	4.0
I_D(.IV/Ma)	20.0	17.5	10.0
V_G	-459	-1.023	-1.628

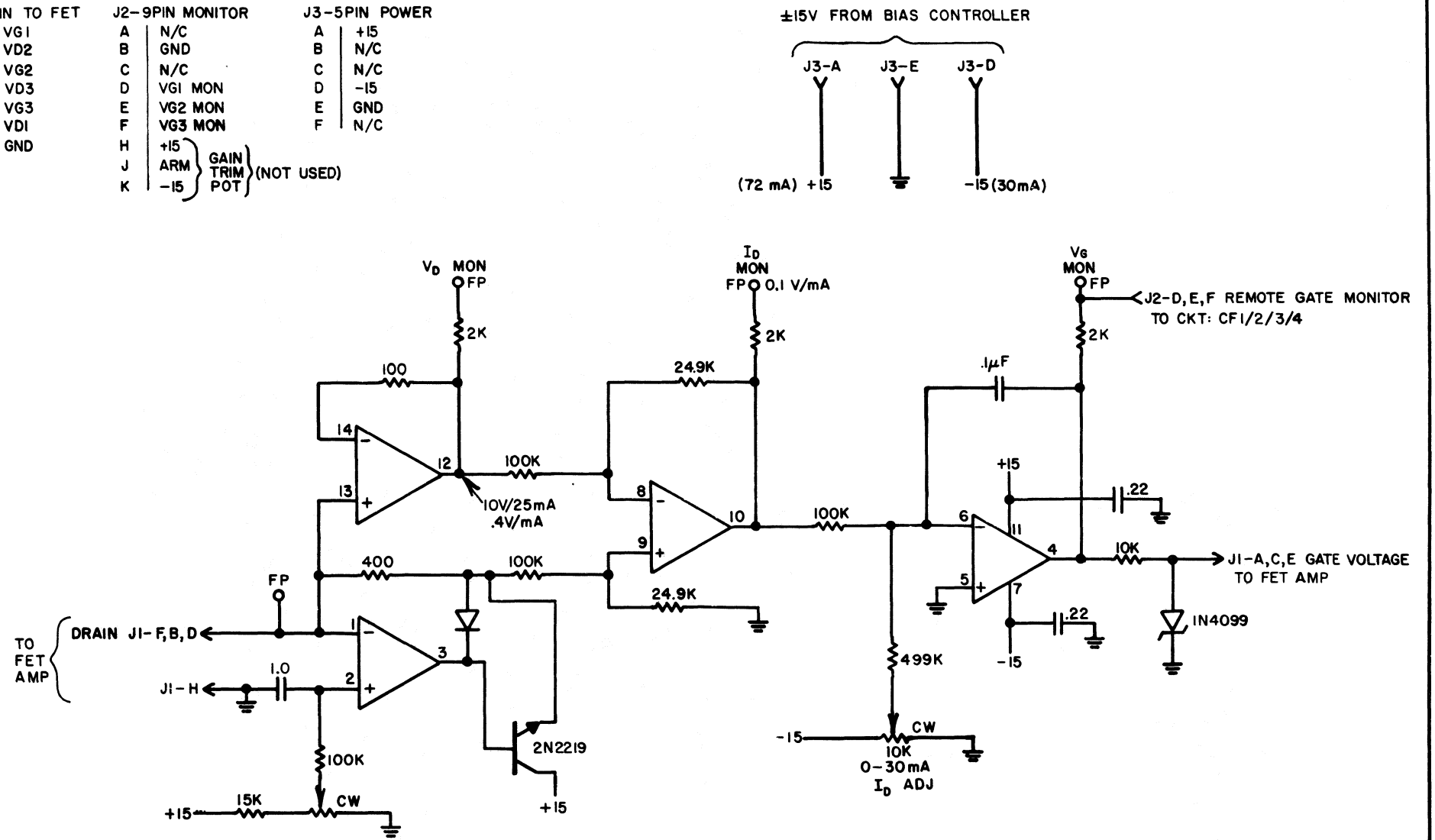
GAIN AND NOISE TEMPERATURE MEASUREMENTS OF CHANNELS C & D FET AMPLIFIERS

FIG. 10B

J1-7PIN TO FET	
A	VG1
B	VD2
C	VG2
D	VD3
E	VG3
F	VD1
H	GND

J2-9PIN MONITOR		
A	N/C	
B	GND	
C	N/C	
D	VG1 MON	
E	VG2 MON	
F	VG3 MON	
H	+15	
J	ARM	GAIN TRIM POT (NOT USED)
K	-15	

J3-5PIN POWER	
A	+15
B	N/C
C	N/C
D	-15
E	GND
F	N/C



NOTES:
1. SAME CIRCUIT AS DESIGNED BY S. WEINREB 6-3-81 EXCEPT J3 ADDED TO SEPARATE ±15V INPUT FROM MONITOR CONNECTOR J2
2. MEASURED POWER REQUIREMENT +15V AT 72 ma AND -15V AT 30 ma
3. ALL OP AMPS 1/4 TL075BCN

CONSTANT CURRENT SUPPLY FOR FET AMPLIFIERS

FIG. 11

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

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

PROJ.: 4 FEED 21 CM RX	TITLE: CONSTANT CURRENT FET SUPPLY		
MATERIAL: N/A		DRAWN BY: Jeff	DATE: 1/23/84
		DESIGNED BY: G. BEHRENS	DATE: 6-21-82
FINISH: N/A		APPROVED BY:	DATE:
SHEET NUMBER:	DRAWING NUMBER:	REV.	SCALE: N/A

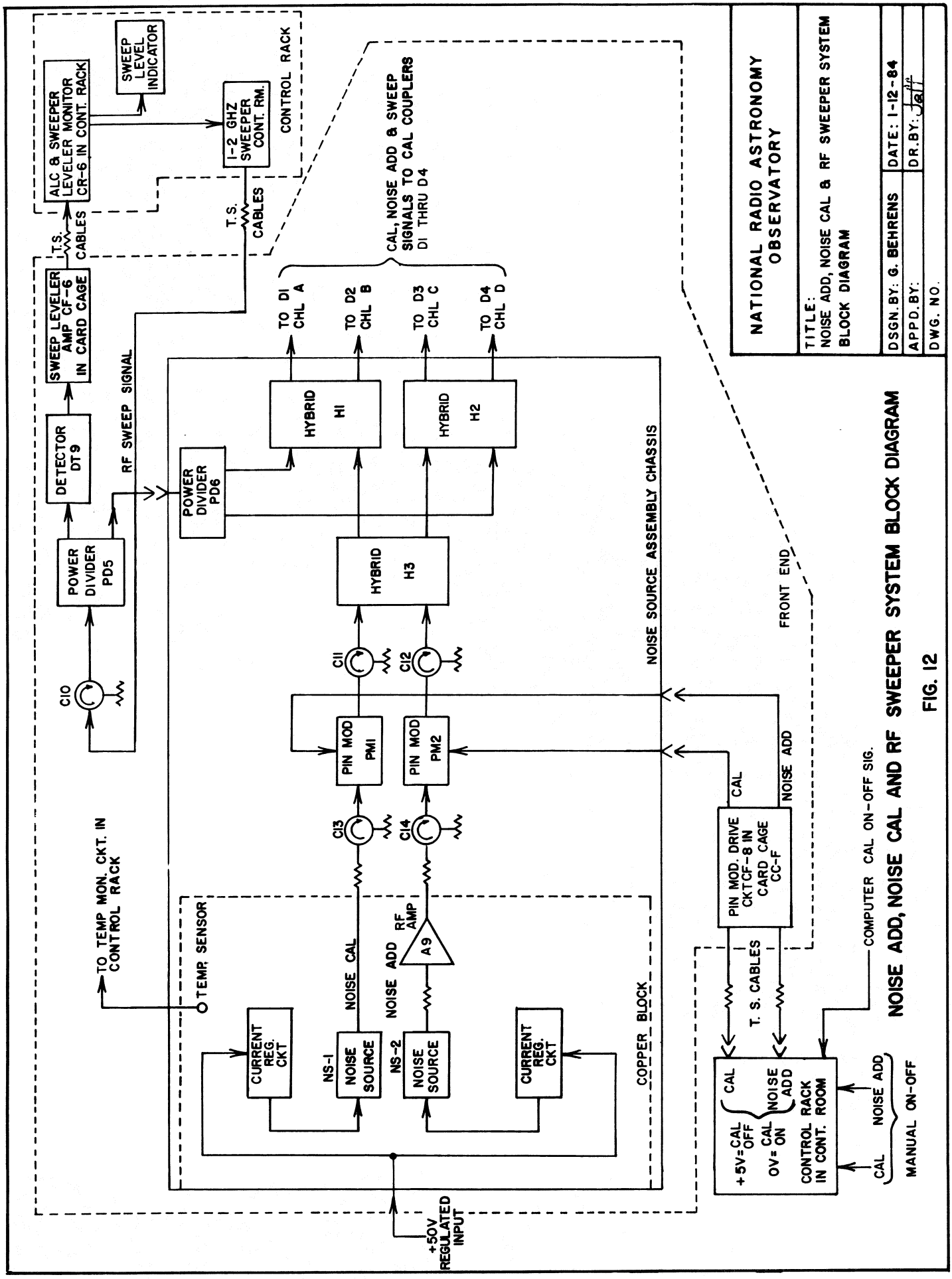

NATIONAL RADIO ASTRONOMY OBSERVATORY
TITLE: NOISE ADD, NOISE CAL & RF SWEEPER SYSTEM BLOCK DIAGRAM
DSGN. BY: G. BEHRENS
DATE: 1-12-84
APPD. BY:
DR. BY: Jeff
DWG. NO.
NOISE ADD, NOISE CAL AND RF SWEEPER SYSTEM BLOCK DIAGRAM
CONTROL RACK
ALC & SWEEPER LEVELER MONITOR CR-6 IN CONT. RACK
SWEEP LEVEL INDICATOR
1-2 GHZ SWEEPER CONT. RM.
T.S. CABLES
SWEEP LEVELER AMP CF-6 IN CARD CAGE
DETECTOR DT9
POWER DIVIDER PD5
POWER DIVIDER PD6
RF SWEEP SIGNAL
CAL, NOISE ADD & SWEEP SIGNALS TO CAL COUPLERS D1 THRU D4
TO D1 CHL A
TO D2 CHL B
TO D3 CHL C
TO D4 CHL D
HYBRID H1
HYBRID H2
HYBRID H3
C10
C11
C12
C13
C14
PIN MOD PM1
PIN MOD PM2
NOISE SOURCE ASSEMBLY CHASSIS
FRONT END
TO TEMP MON. CKT. IN CONTROL RACK
TEMP. SENSOR
CURRENT REG. CKT
NS-1 NOISE SOURCE
NOISE CAL
NOISE ADD
RF AMP A9
NS-2 NOISE SOURCE
CURRENT REG. CKT
COPPER BLOCK
PIN MOD. DRIVE CKT CF-8 IN CARD CAGE CC-F
CAL
NOISE ADD
T. S. CABLES
COMPUTER CAL ON-OFF SIG.
+5V=CAL OFF
0V= CAL ON
CAL
NOISE ADD
CONTROL RACK IN CONT. ROOM
CAL
NOISE ADD
MANUAL ON-OFF
+50V REGULATED INPUT

FIG. 12

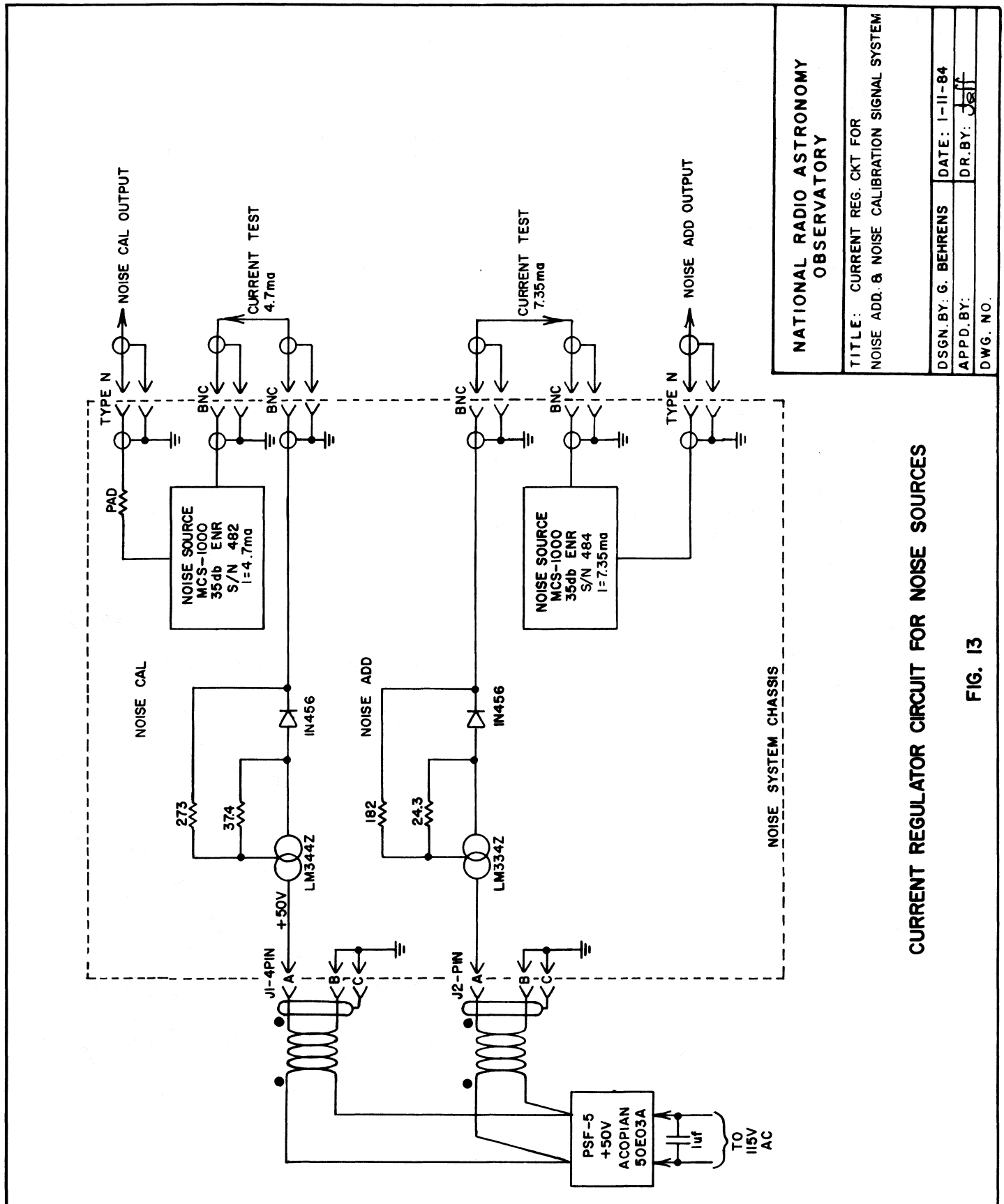
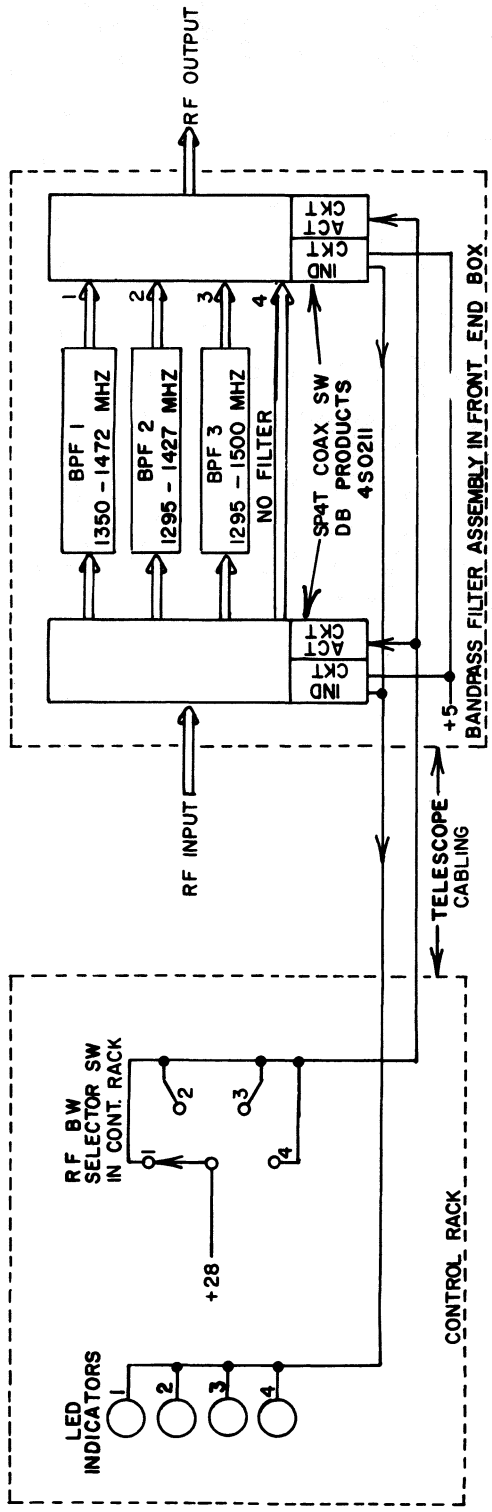

NOISE CAL OUTPUT
CURRENT TEST 4.7ma
CURRENT TEST 7.35ma
NOISE ADD OUTPUT
TYPE N
BNC
PAD
NOISE SOURCE MCS-1000 35db ENR S/N 482 I=4.7ma
NOISE SOURCE MCS-1000 35db ENR S/N 484 I=7.35ma
NOISE CAL
NOISE ADD
IN456
273
374
182
24.3
LM334Z
+50V
J1-4PIN
J2-PIN
A
B
C
NOISE SYSTEM CHASSIS
PSF-5 +50V ACOPIAN 50E03A
1uf
TO 115V AC
NATIONAL RADIO ASTRONOMY OBSERVATORY
TITLE: CURRENT REG. CKT FOR NOISE ADD. & NOISE CALIBRATION SIGNAL SYSTEM
DSGN. BY: G. BEHRENS
DATE: 1-11-84
APPD. BY:
DR. BY: Jeff
DWG. NO.

FIG. 13

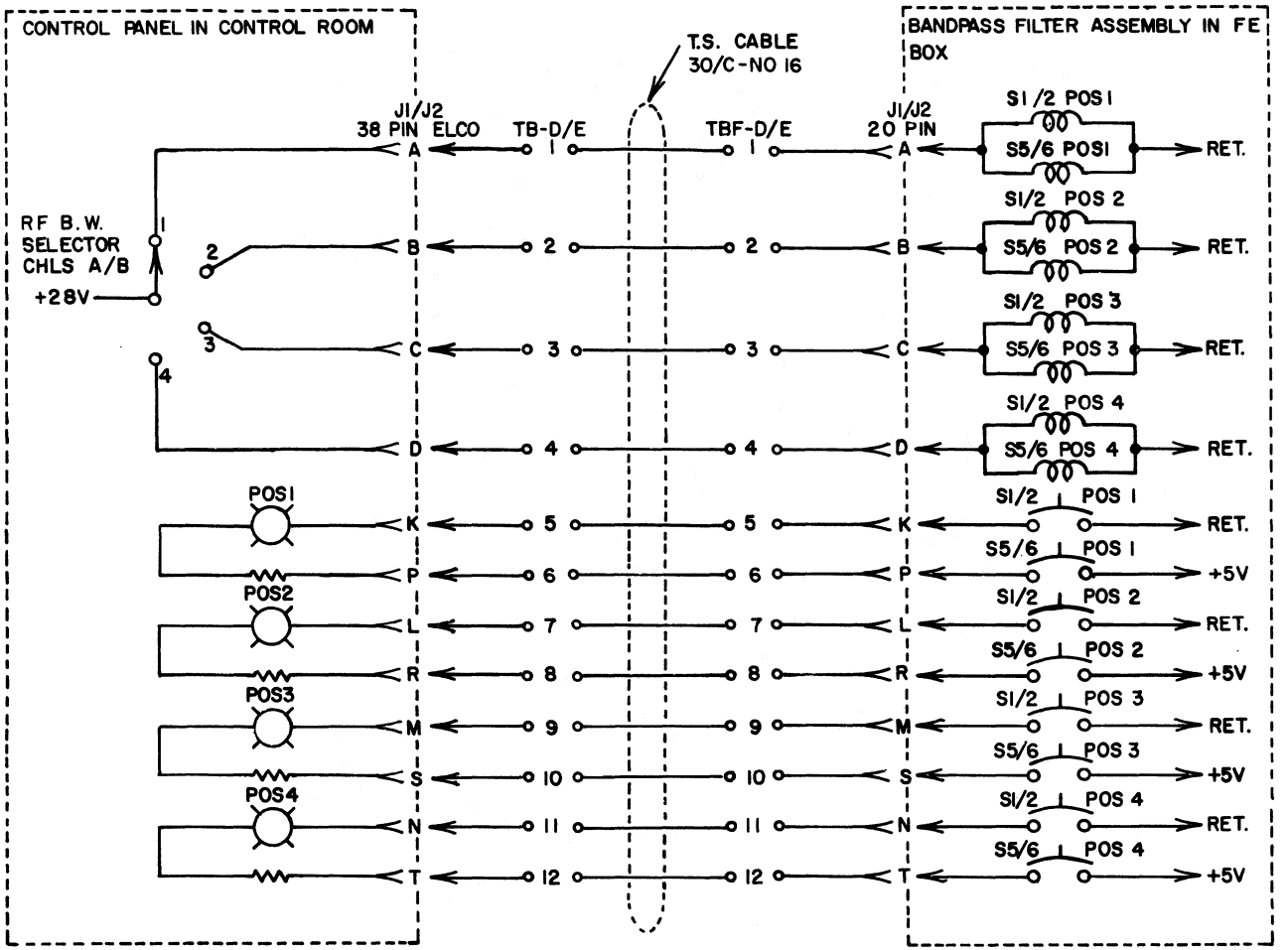


NOTE: ONE EACH PER CHANNEL

NATIONAL RADIO ASTRONOMY OBSERVATORY	
TITLE: BLOCK DIAGRAM OF BANDPASS FILTER ASSEMBLY	
DSGN.BY: G. BEHRENS	DATE: 1-5-84
APPD.BY:	DR.BY: Jeff
DWG. NO.	

BANDPASS FILTER ASSEMBLY BLOCK DIAGRAM

FIG. 14

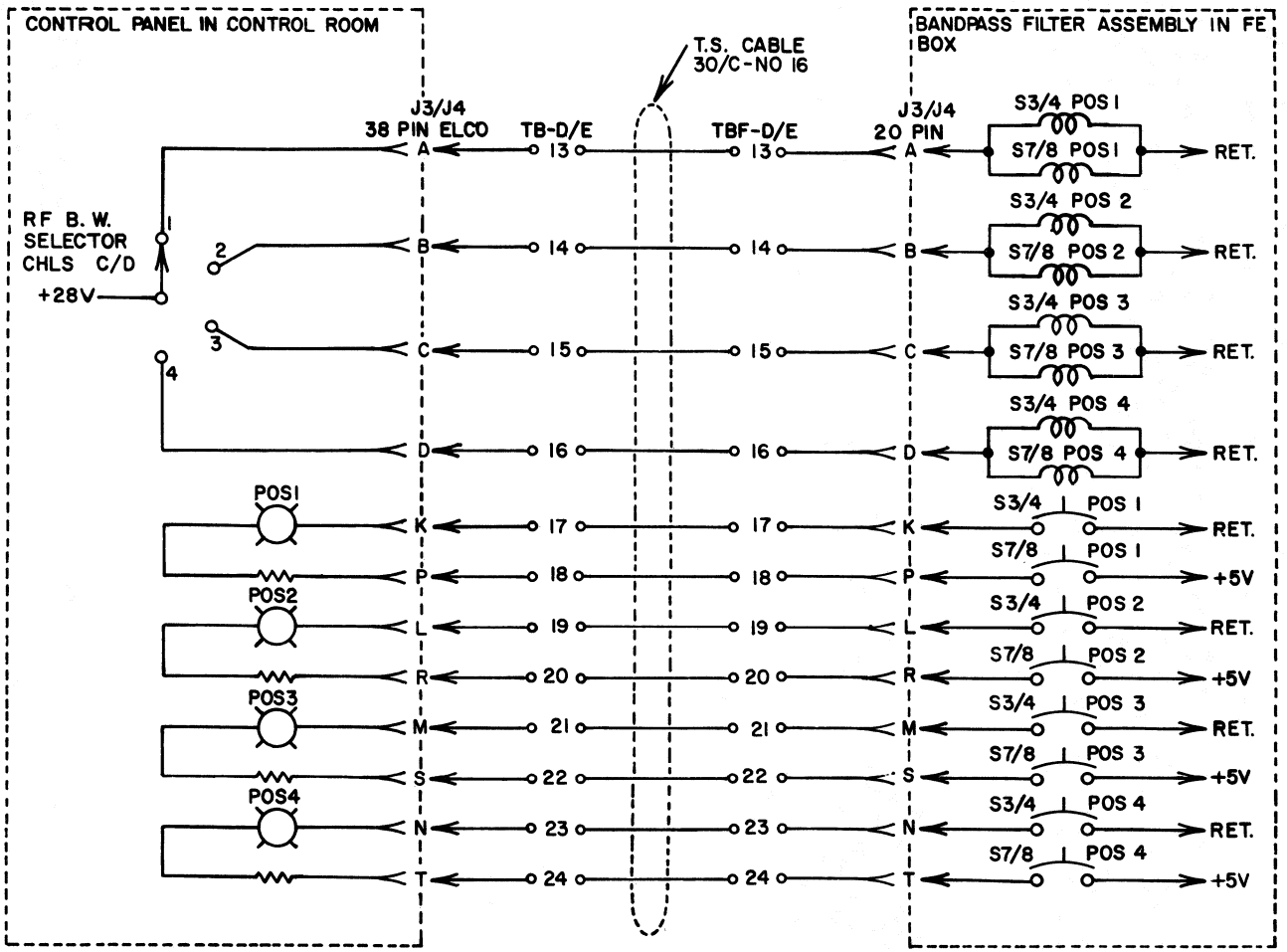


BANDPASS FILTER ASSEMBLY ACTUATOR AND INDICATOR CIRCUIT, CHANNELS A AND B

FIG. 15A

REV A 7-22-82 SHEET 2 OF 2

NATIONAL RADIO ASTRONOMY OBSERVATORY	
TITLE: CHANNELS A/B BANDPASS FILTER ASSEMBLY ACTUATOR AND INDICATOR CIRCUIT	
DSGN.BY: G. BEHRENS	DATE: 7-20-82
APPD.BY:	DR.BY: Jeff
DWG. NO.	

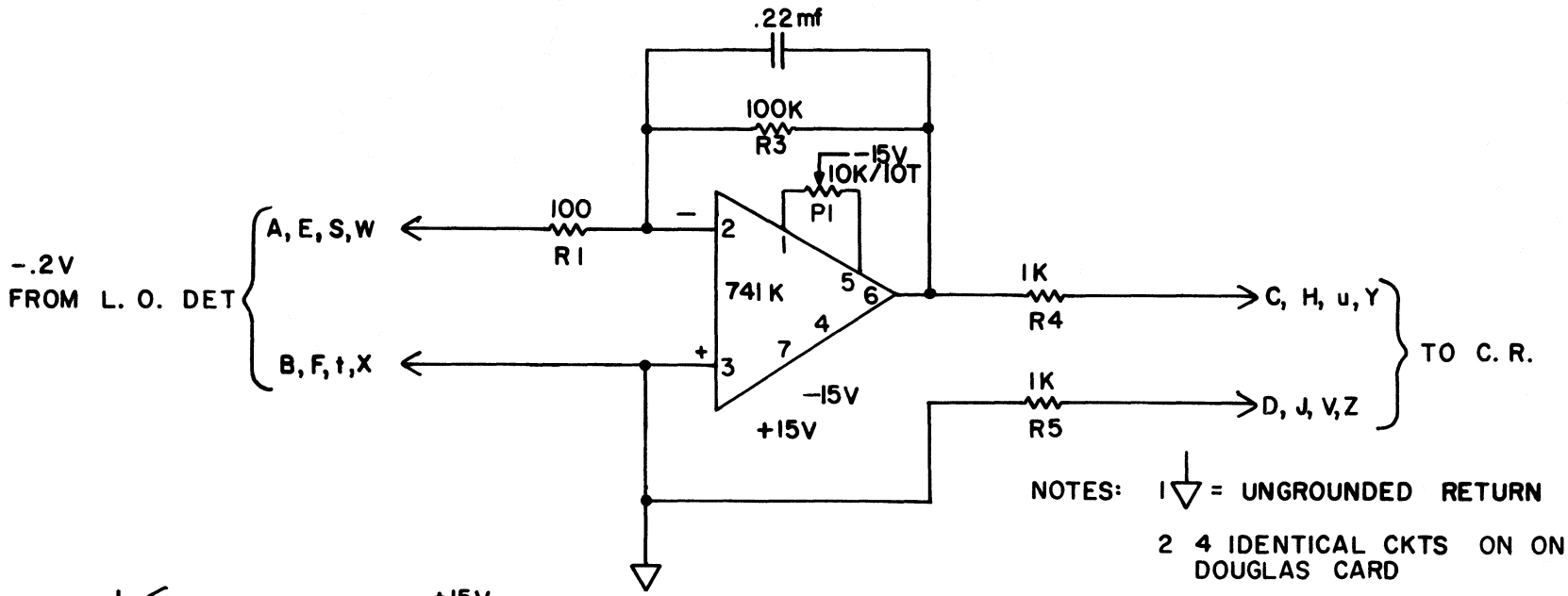


BANDPASS FILTER ASSEMBLY ACTUATOR AND INDICATOR CIRCUIT, CHANNELS C AND D

FIG. 15B

REV A 7-22-82 SHEET 1 OF 2

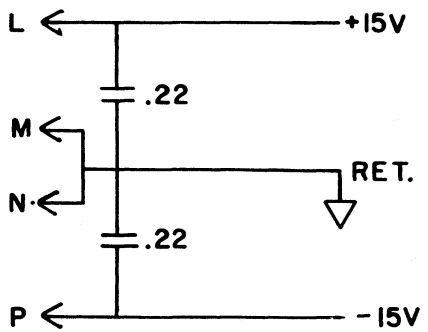
NATIONAL RADIO ASTRONOMY OBSERVATORY	
TITLE: CHANNELS C/D BANDPASS FILTER ASSEMBLY ACTUATOR AND INDICATOR CIRCUIT	
DSGN. BY: G. BEHRENS	DATE: 7-20-82
APPD. BY:	DR. BY: Jaff
DWG. NO.	



NOTES: 1 ▽ = UNGROUNDED RETURN

2 4 IDENTICAL CKTS ON ONE DOUGLAS CARD

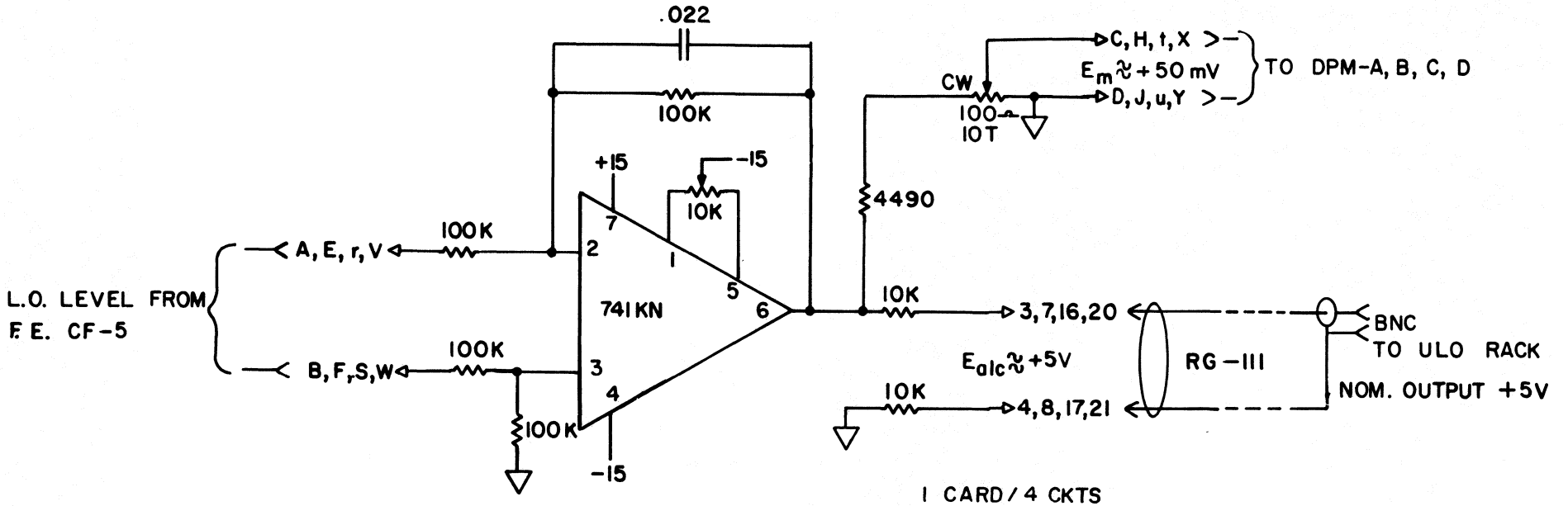
3 LABLE POTS ZERO A, B, C, & D

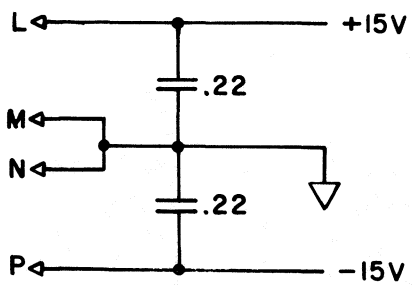


LO ALC AND LEVEL MONITOR DRIVER
CIRCUIT: CF-5

FIG. 16

NATIONAL RADIO ASTRONOMY OBSERVATORY	
TITLE: L.O. MONITOR & LEVEL CKT AT F. E. BOX 4 CHLS. CKT: CF-5	
DSGN. BY: G. BEHRENS	DATE: 1/7/82
APPD. BY:	DR. BY: Jeff
DWG. NO. CF-5	

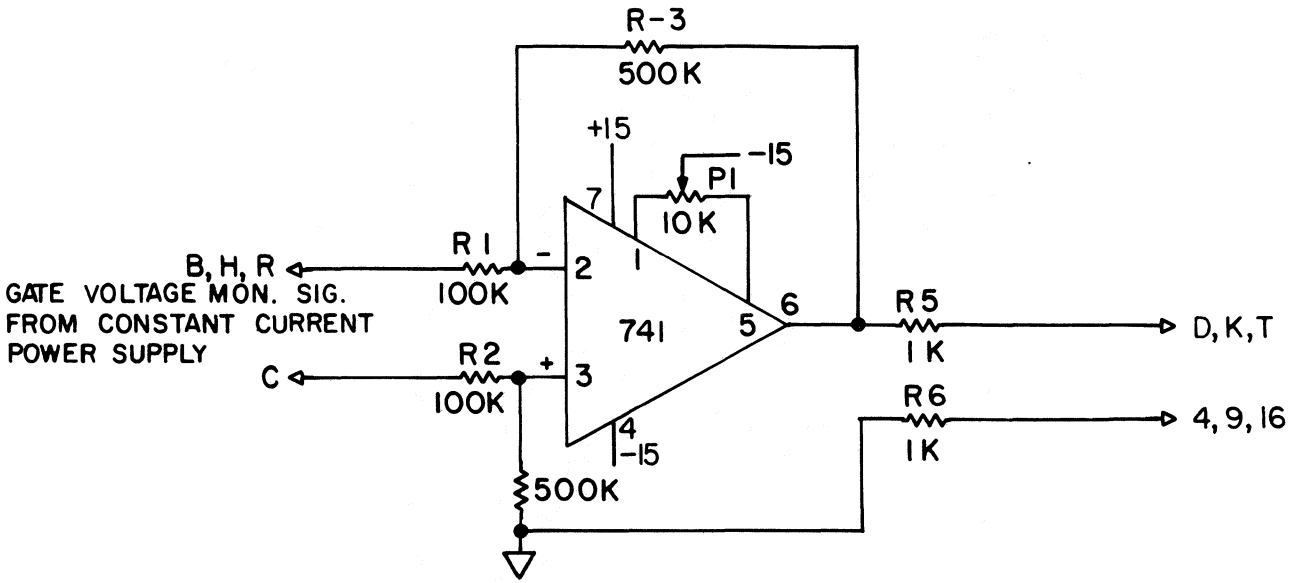


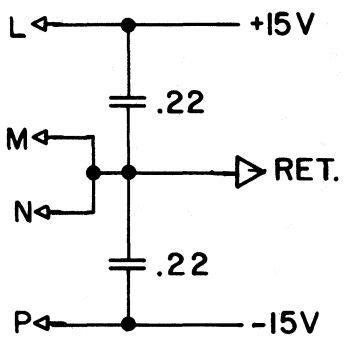


LO ALC AND LEVEL MONITOR RECEIVER
CIRCUIT: CR-5

FIG. 17

NATIONAL RADIO ASTRONOMY OBSERVATORY	
TITLE: 4 FEED 21 CM RX L.O. LEVEL MONITOR & ALC RX CKT: CR-5	
DSGN. BY: G. BEHRENS	DATE: 9/28/82
APPD. BY:	DR. BY: Jeff
DWG. NO. CR-5	





3 CKTS/CARD
4 CARDS
1 STAGE B, D, 4
2 ND STAGE H, K, 9
3 RD STAGE R, T, 16

GATE VOLTAGE MONITOR DRIVER CIRCUIT:
CF-1, 2, 3, 4

FIG. 18

NATIONAL RADIO ASTRONOMY OBSERVATORY	
TITLE: 4 FEED 21 CM RX CK: CF-1, CF-2, CF-3, CF-4 FET GATE VOLTAGE MON. CKT. (DRIVER)	
DSGN. BY: G. BEHRENS	DATE: 1/22/82
APPD. BY:	DR. BY: Jeff
DWG. NO.	

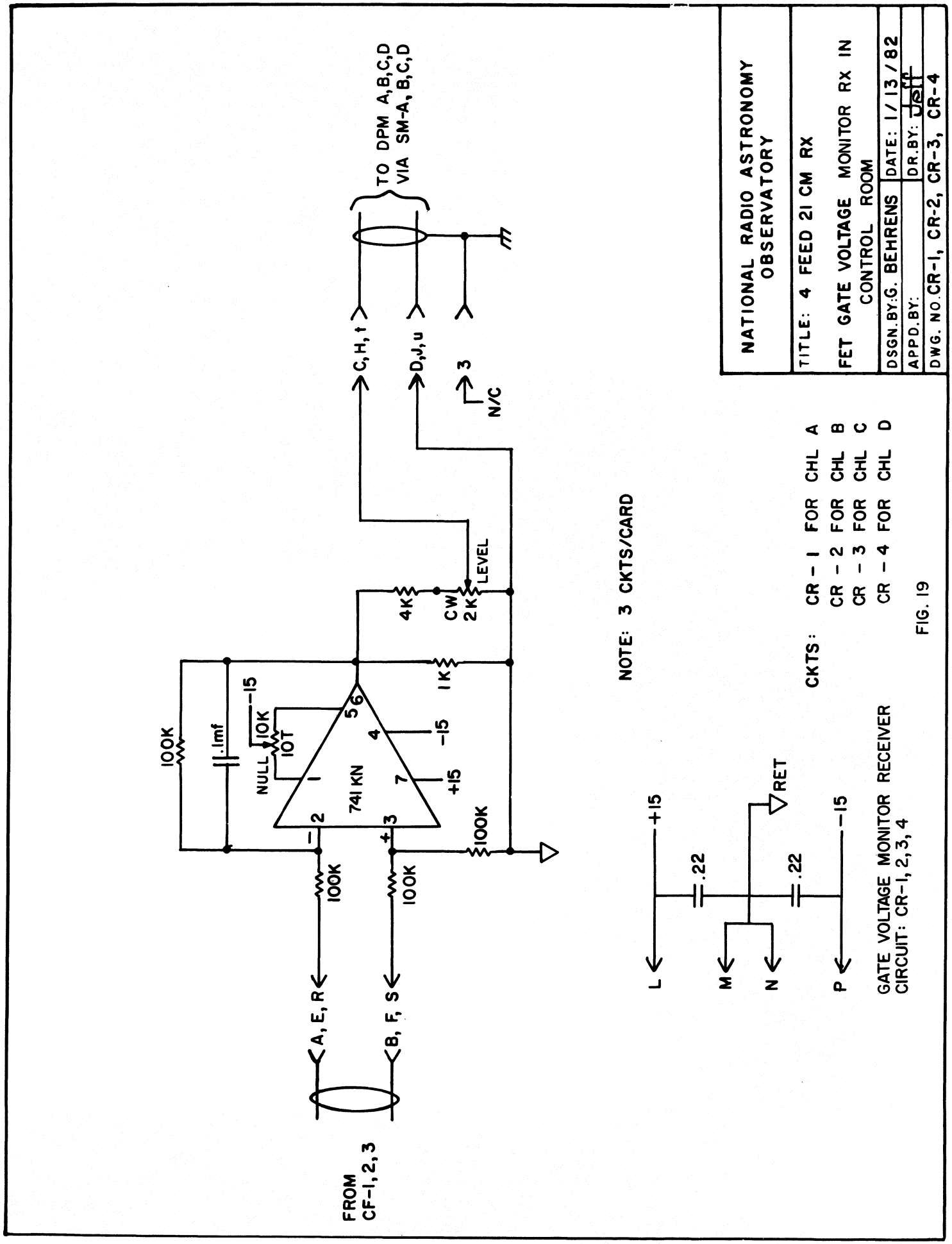

NATIONAL RADIO ASTRONOMY OBSERVATORY
TITLE: 4 FEED 21 CM RX
FET GATE VOLTAGE MONITOR RX IN CONTROL ROOM
DSGN.BY:G. BEHRENS
DATE: 1/13/82
APPD.BY:
DR.BY:
DWG. NO.CR-1, CR-2, CR-3, CR-4
TO DPM A,B,C,D VIA SM-A, B,C,D
C,H,t
D,J,u
3
N/C
4K
CW 2K LEVEL
1K
100K
1.1mf
10K
10T
NULL
-15
741 KN
+15
100K
100K
100K
A, E, R
B, F, S
FROM CF-1, 2, 3
NOTE: 3 CKTS/CARD
CKTS: CR - 1 FOR CHL A
CR - 2 FOR CHL B
CR - 3 FOR CHL C
CR - 4 FOR CHL D
+15
.22
RET
.22
-15
L
M
N
P
GATE VOLTAGE MONITOR RECEIVER
CIRCUIT: CR-1, 2, 3, 4

FIG. 19

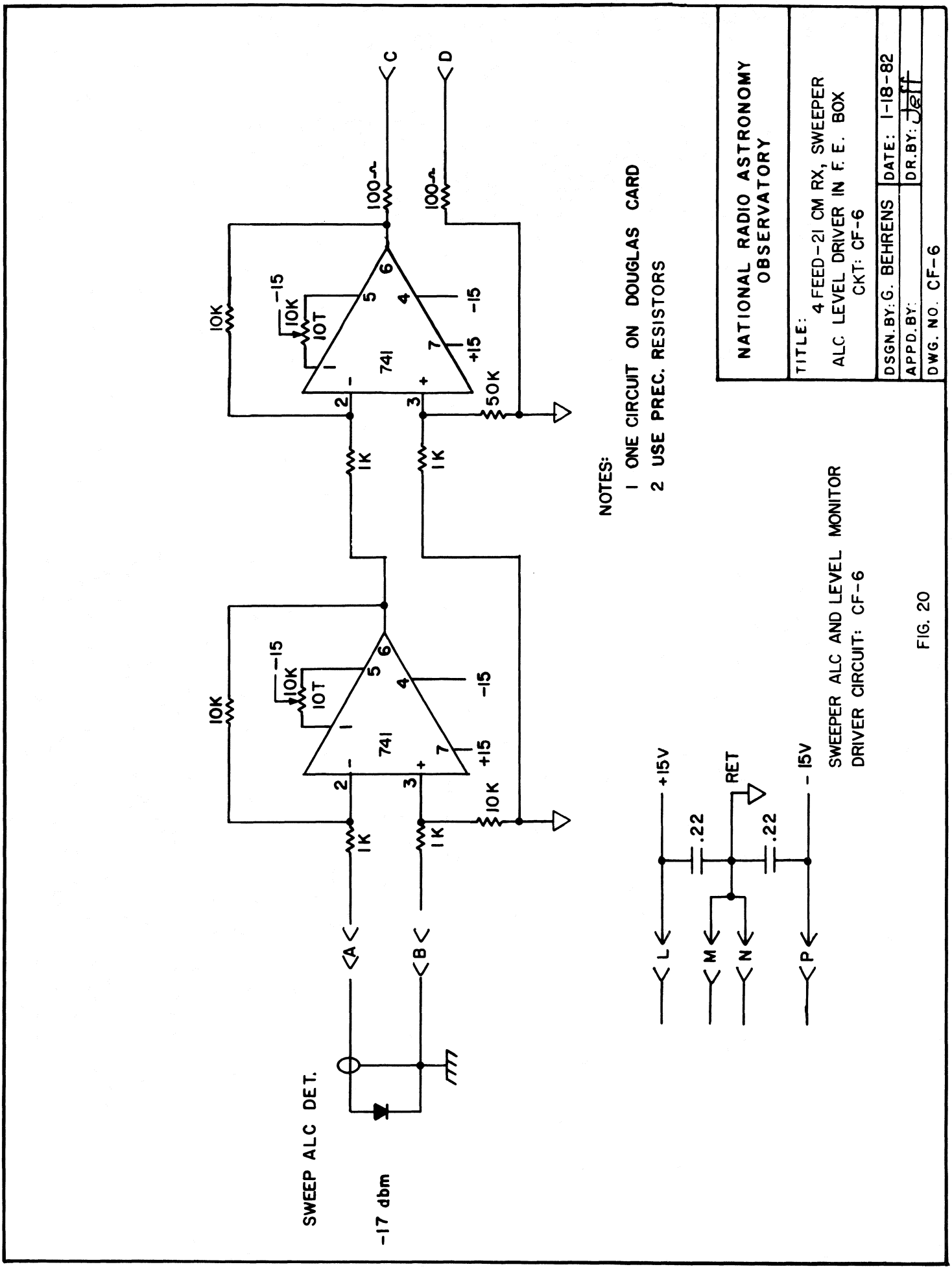
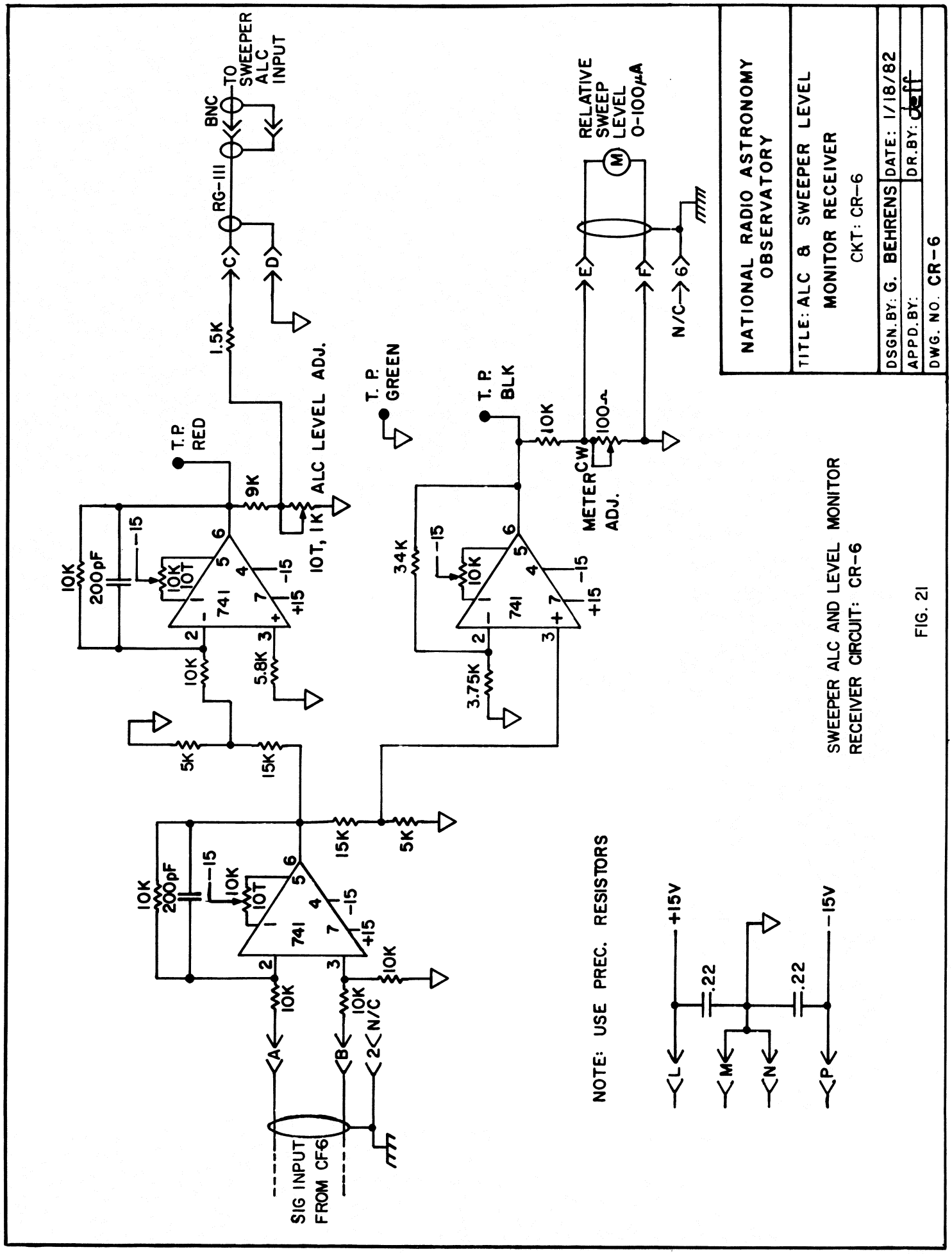

SWEEP ALC DET.
-17 dbm
A
B
C
D
100Ω
10K
10K
10T
-15
741
+15
-15
50K
1K
10K
L
M
N
P
+15V
RET
-15V
.22
.22
NOTES:
1 ONE CIRCUIT ON DOUGLAS CARD
2 USE PREC. RESISTORS
SWEEPER ALC AND LEVEL MONITOR
DRIVER CIRCUIT: CF-6
NATIONAL RADIO ASTRONOMY OBSERVATORY
TITLE:
4 FEED-21 CM RX, SWEEPER
ALC LEVEL DRIVER IN F.E. BOX
CKT: CF-6
DSGN.BY: G. BEHRENS
DATE: 1-18-82
APPD.BY:
DR.BY: Jeff
DWG. NO. CF-6

FIG. 20



SWEEPER ALC AND LEVEL MONITOR RECEIVER CIRCUIT: CR-6

FIG. 21

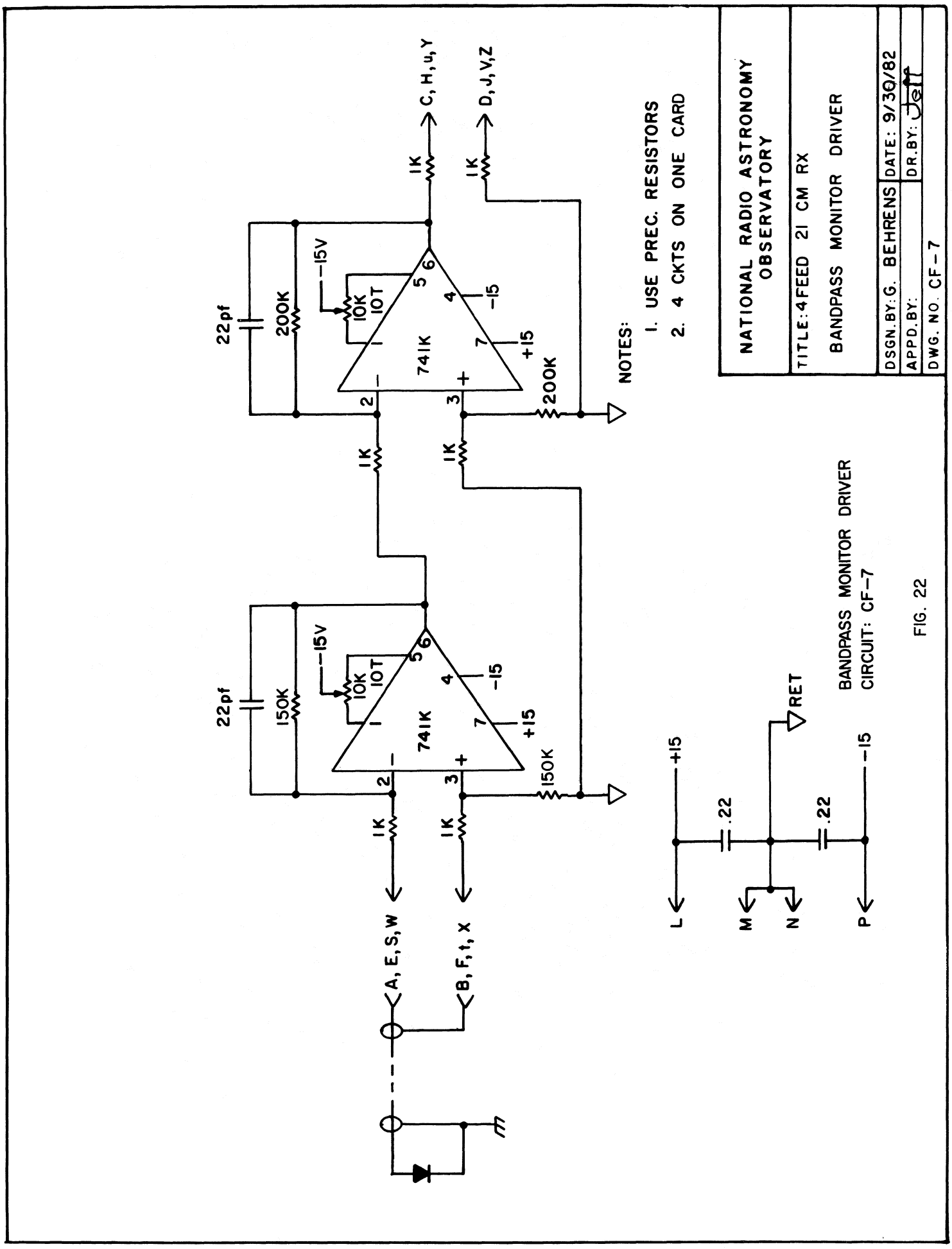

NATIONAL RADIO ASTRONOMY OBSERVATORY
TITLE: 4FEED 21 CM RX
BANDPASS MONITOR DRIVER
DSGN. BY: G. BEHRENS
DATE: 9/30/82
APPD. BY:
DR. BY: Jeff
DWG. NO. CF-7
NOTES:
1. USE PREC. RESISTORS
2. 4 CKTS ON ONE CARD
22pf
200K
150K
-15V
10K
10T
741K
+15
-15
1K
C, H, u, Y
D, J, V, Z
A, E, S, W
B, F, t, x
RET
L
M
N
P
.22
BANDPASS MONITOR DRIVER
CIRCUIT: CF-7

FIG. 22

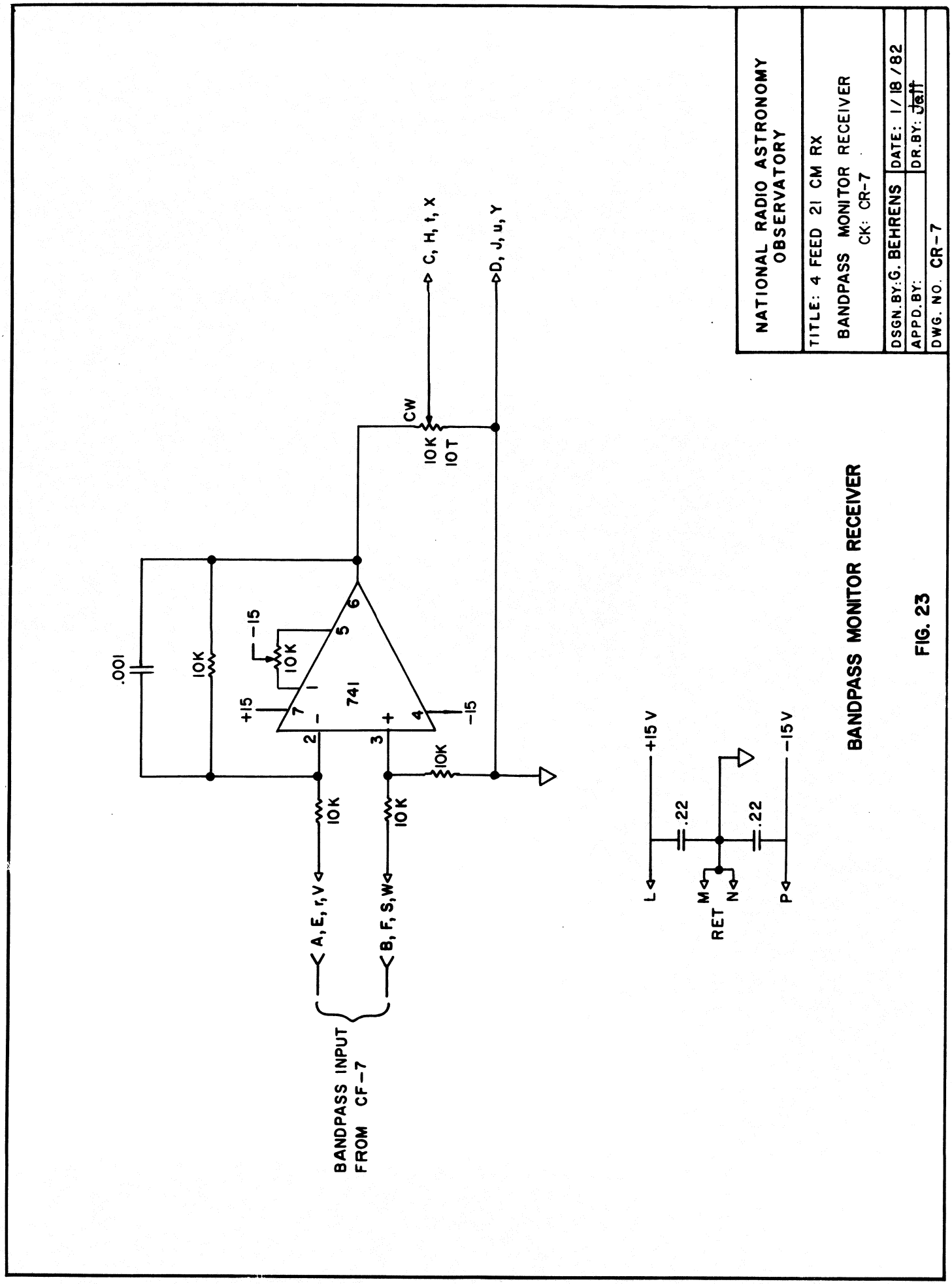
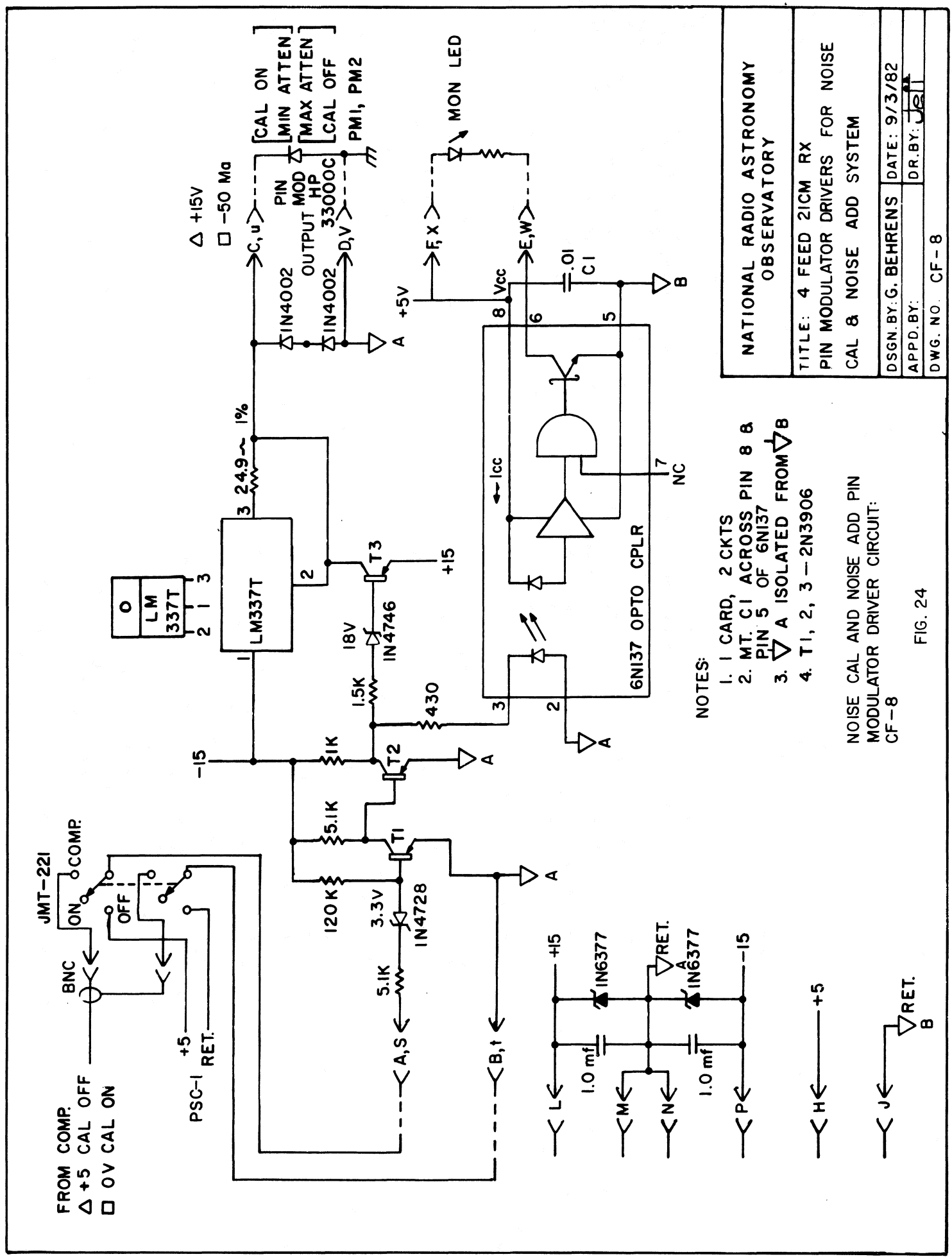
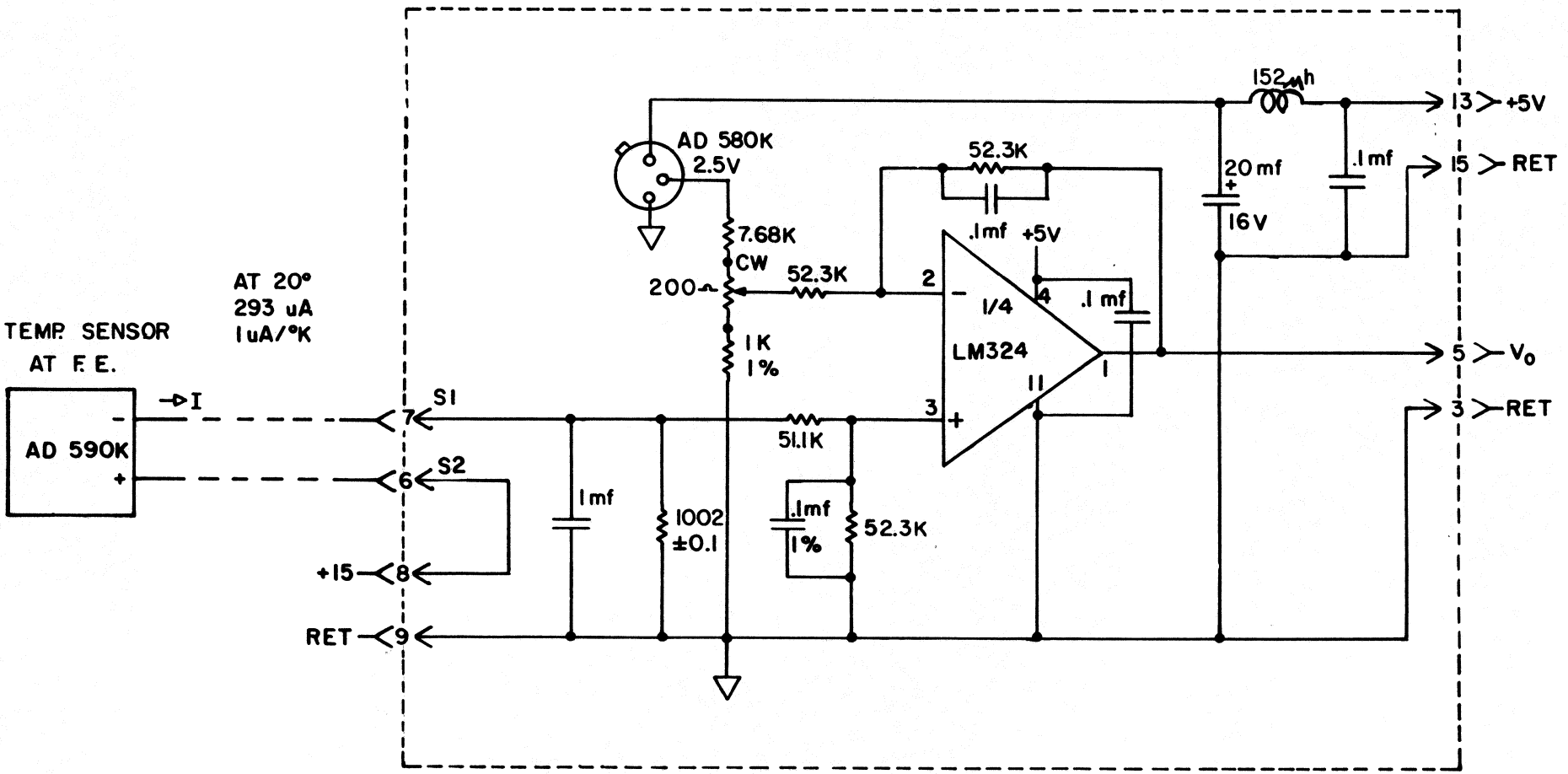

NATIONAL RADIO ASTRONOMY OBSERVATORY
TITLE: 4 FEED 21 CM RX
BANDPASS MONITOR RECEIVER
CK: CR-7
DSGN.BY: G. BEHRENS
DATE: 1/18/82
APPD.BY:
DR.BY: jeff
DWG. NO. CR-7
BANDPASS MONITOR RECEIVER
C, H, t, X
D, J, u, Y
CW
10K
10T
.001
10K
-15
10K
+15
741
1
5
6
7
2
3
4
-15
10K
10K
10K
A, E, r, V
B, F, S, W
BANDPASS INPUT
FROM CF-7
+15 V
.22
.22
-15 V
L
M
RET
N
P

FIG. 23

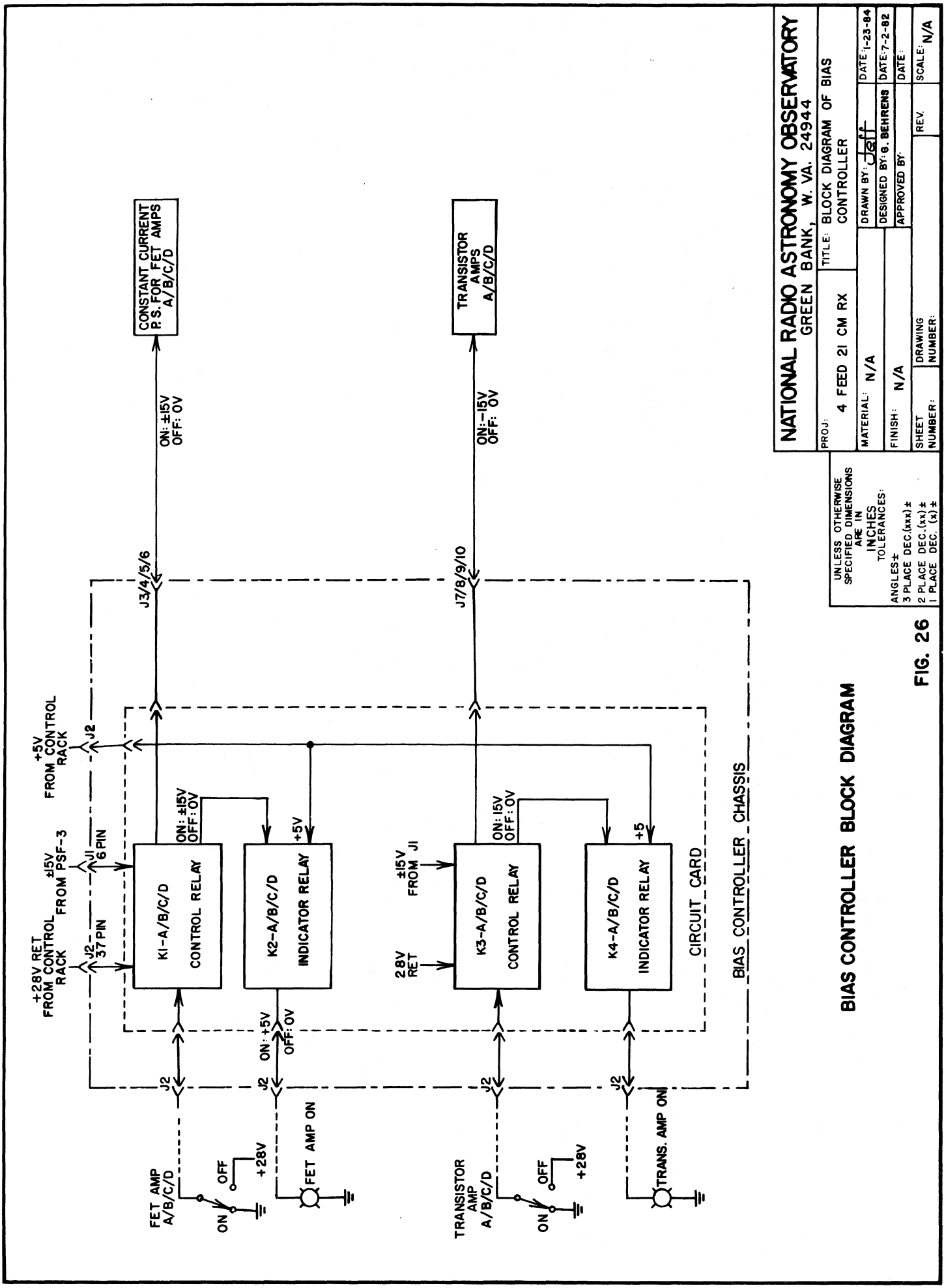

NATIONAL RADIO ASTRONOMY OBSERVATORY
TITLE: 4 FEED 21CM RX
PIN MODULATOR DRIVERS FOR NOISE CAL & NOISE ADD SYSTEM
DSGN.BY: G. BEHRENS
DATE: 9/3/82
APPD.BY:
DR.BY:
DWG. NO. CF-8
NOTES:
1. 1 CARD, 2 CKTS
2. MT. C1 ACROSS PIN 8 & PIN 5 OF 6N137
3. ▽A ISOLATED FROM ▽B
4. T1, 2, 3 — 2N3906
NOISE CAL AND NOISE ADD PIN MODULATOR DRIVER CIRCUIT: CF-8
FIG. 24
FROM COMP.
△ +5 CAL OFF
□ 0V CAL ON
JMT-221
COMP.
ON
OFF
BNC
PSC-1
+5
RET.
A,S
B,t
120K
3.3V
IN4728
5.1K
5.1K
1K
-15
T1
T2
T3
+15
LM337T
LM 337T
1.5K
18V
IN4746
430
3 24.9Ω 1%
△ +15V
□ -50 Ma
C,u
D,V
IN4002
IN4002
OUTPUT
PIN MOD HP 33000C
CAL ON
MIN ATTEN
MAX ATTEN
CAL OFF
PM1, PM2
F,X
E,W
MON LED
+5V
Vcc
Icc
.01
C1
6N137 OPTO CPLR
NC
L
M
N
P
H
J
1.0 mf
1.0 mf
IN6377
IN6377
RET.
RET.
+15
-15
+5
A
B



TEMPERATURE MONITOR CIRCUIT: CR-8

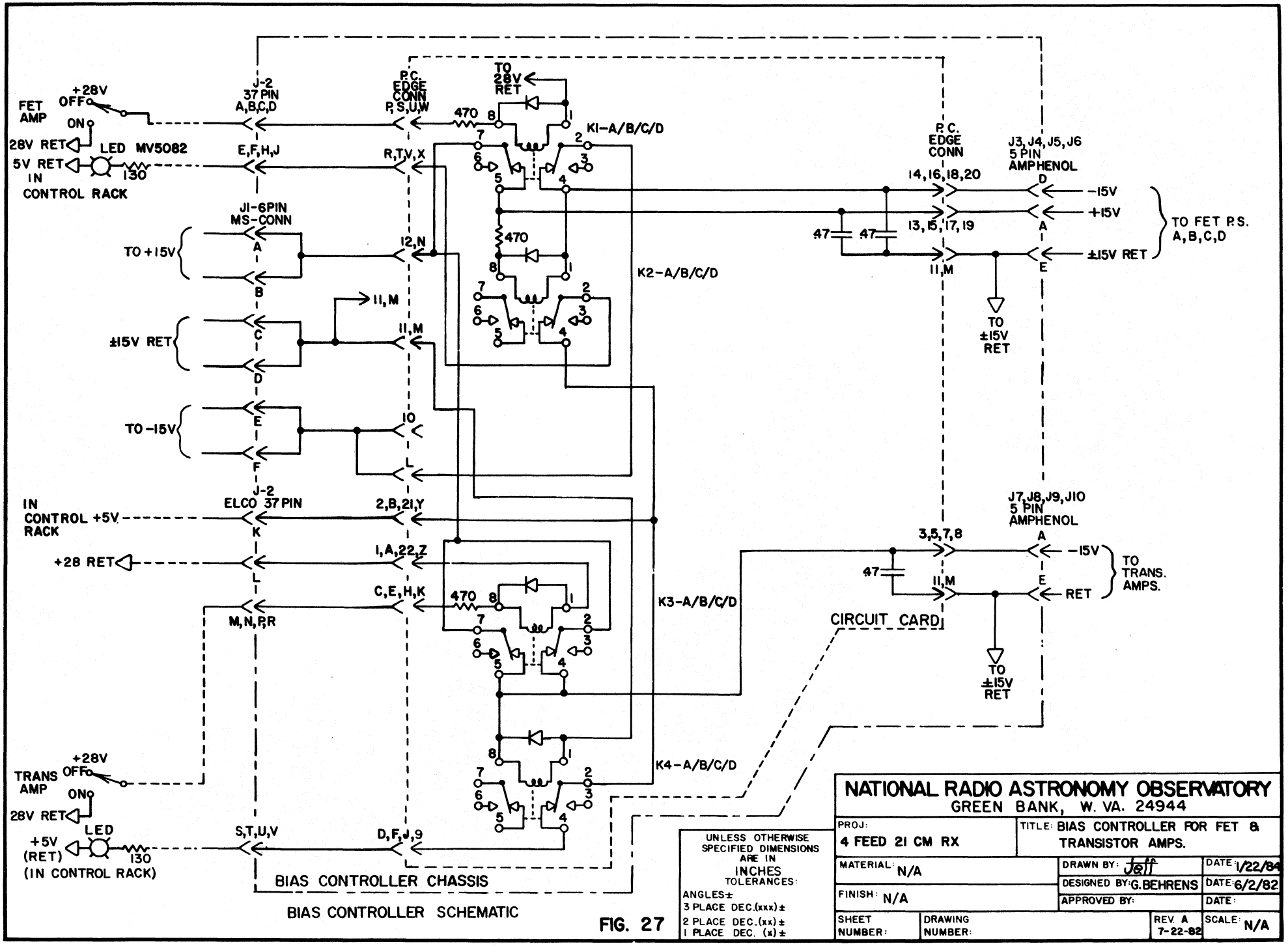
FIG. 25

NATIONAL RADIO ASTRONOMY OBSERVATORY	
TITLE: TEMP MONITOR	
DSGN.BY: G BEHRENS	DATE: 9/29/82
APPD.BY:	DR.BY: Jaff
DWG. NO. CR-8	



BIAS CONTROLLER BLOCK DIAGRAM

FIG. 26



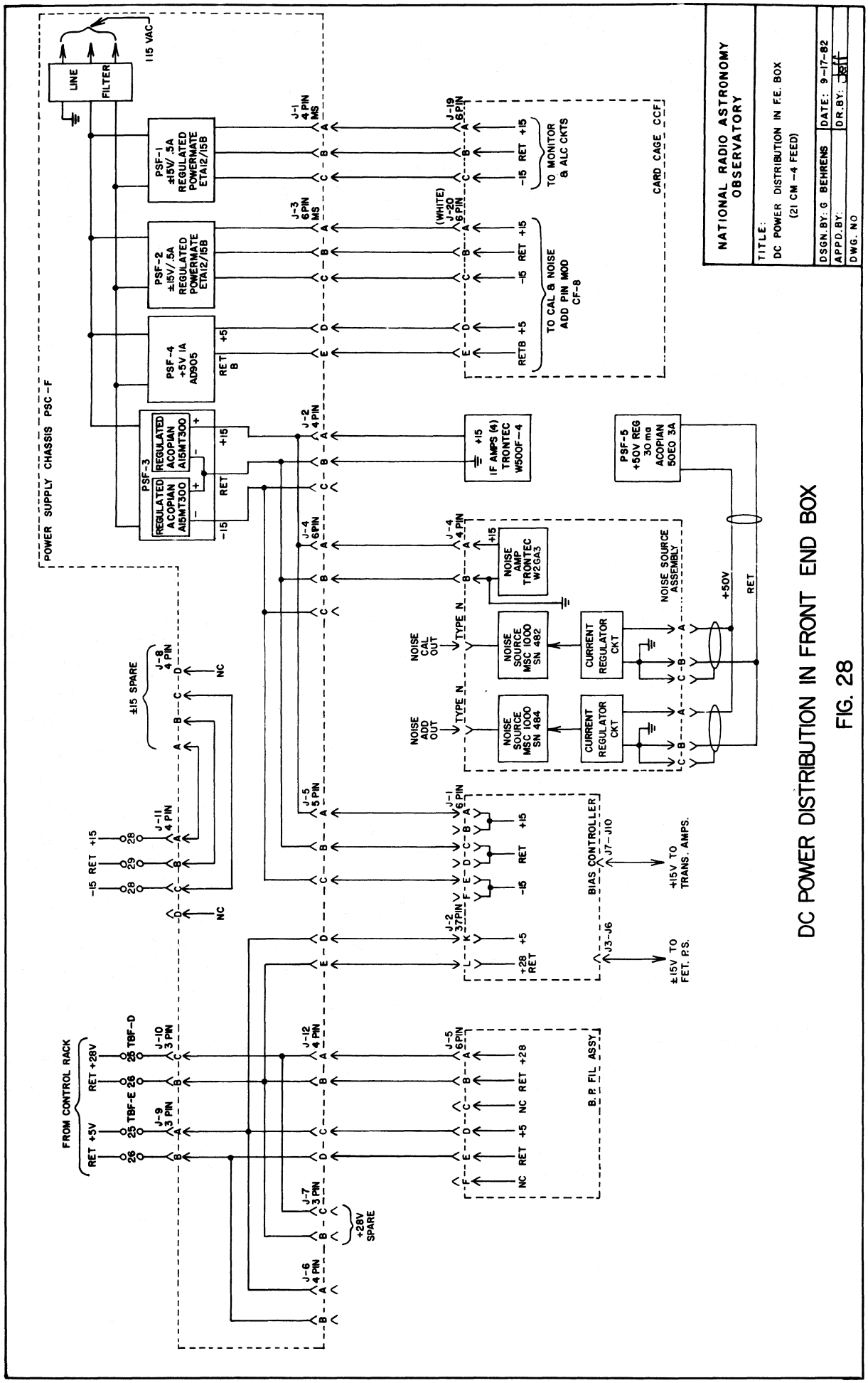
BIAS CONTROLLER SCHEMATIC

FIG. 27

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

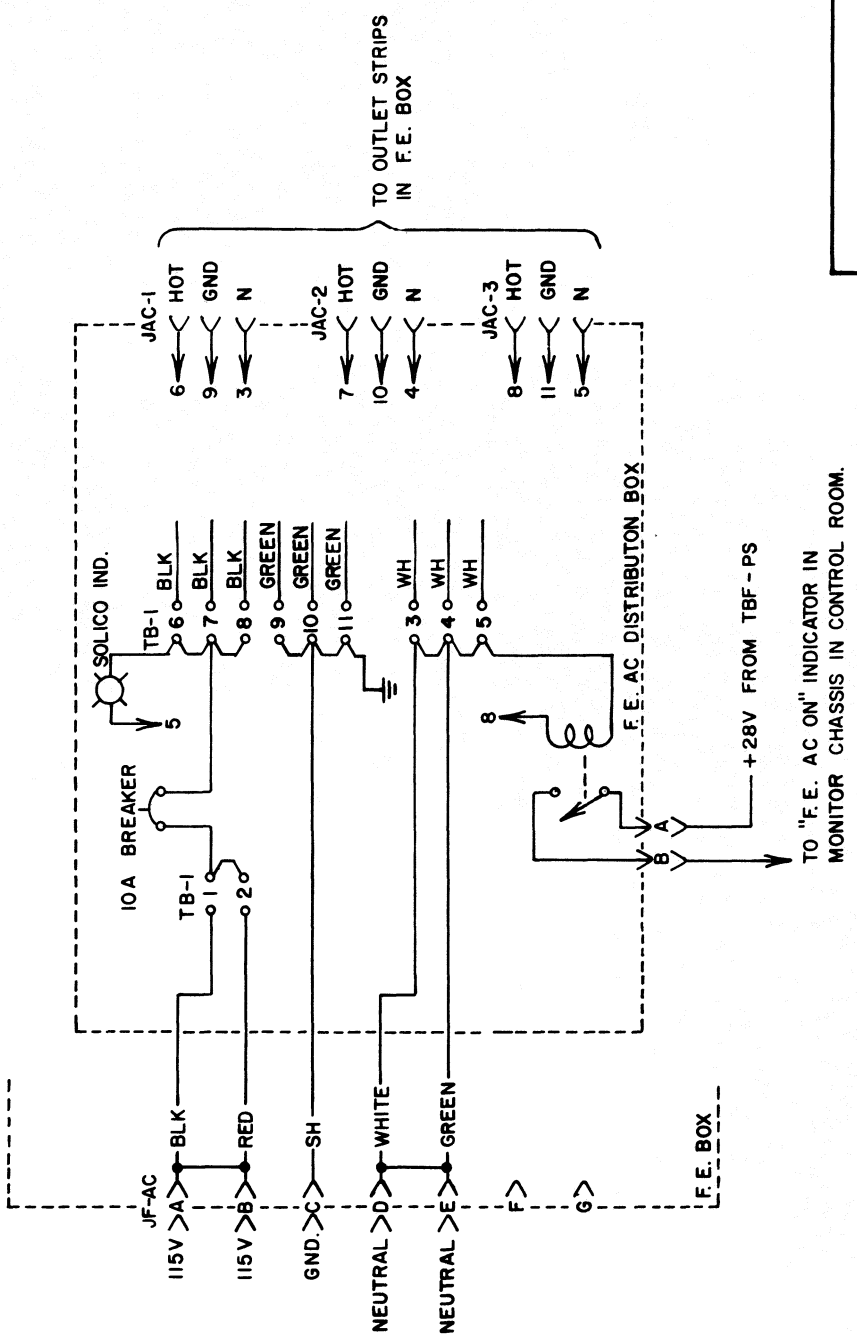
NATIONAL RADIO ASTRONOMY OBSERVATORY
GREEN BANK, W. VA. 24944

PROJ: 4 FEED 21 CM RX	TITLE: BIAS CONTROLLER FOR FET & TRANSISTOR AMPS.		
MATERIAL: N/A		DRAWN BY: Jeff	DATE: 1/22/84
		DESIGNED BY: G. BEHRENS	DATE: 6/2/82
FINISH: N/A		APPROVED BY:	DATE:
SHEET NUMBER:	DRAWING NUMBER:	REV. A 7-22-82	SCALE: N/A



DC POWER DISTRIBUTION IN FRONT END BOX

FIG. 28



AC POWER DISTRIBUTION IN FRONT END BOX

FIG. 29

NATIONAL RADIO ASTRONOMY OBSERVATORY	
TITLE: 4 FEED 21CM F.E. AC DISTRIBUTION BOX	
DSGN. BY: G. BEHRENS	DATE: 4-15-82
APPD. BY:	DR. BY: J&ff
DWG. NO.	