VLBA Electronics Memo No. 60

NATIONAL RADIO ASTRONOMY OBSERVATORY
Charlottesville, Virginia

February 11, 1986

MEMORANDUM:

TO: VLBA Electronics Group

FROM: S. Weinreb

SUBJECT: Front-End Changes

This memo supplements VLBA Electronics Memo #56 by describing further changes and drawing corrections as follows:

I. Drawing Corrections

Some obsolete drawings were included in Memo #56. Corrected versions which also include the changes described below are attached.

II. Frequency ID Parity Bit

Since the frequency ID will be used for monitor and control address assignment, it must include a parity bit in accordance with VLBA M/C Specification A55001N002-A. There are several possible ways of arranging the wiring of this byte since some of the wiring is in the FE assembly and some can be in the FE M/C module. The adopted method is shown in the attached Figure 1. An even parity bit, $\overline{PA}$, protects the four frequency ID bits and is inverted in the front-end M/C module to form the ID byte parity bit, PA.

III. Temperature Sensor Direct Output

The sensor card will be modified to include the temperature sensor voltage buffered by a unity-gain op amp outputted on card pin S for circuit A (usually 15K) and pin T for circuit B (usually 50K). The circuit A sensor voltage will be wired to FE connector J2, pin 14, for use by the M/C system if desired. The sensor voltage has a non-linear relation to temperature but gives greater sensitivity and potential accuracy at low temperatures where the linearized sensor output sensitivity of 10 mV/°K may be inadequate. This change makes the sensor card more useful for front-ends which may be cooled to 4K and provides the potential of more precise monitoring of 15K, cryofet front-ends if it becomes necessary.

IV. 8.4 GHZ Gain Range

The gain of all front-ends will be set reasonably close to values suggested in VLBA Electronics Memo #39; some latitude is needed to accommodate the quantization of gain in number of transistor stages. For the 8.4 GHz front-end the following gain values will be adopted where the limits include frequency variation of 8.0 to 8.8 GHz:

Three-stage CRYOFET	32 ± 2 dB
Two-stage post-amp	17.5 ± 1 dB
Total losses	3.5 db
Total Gain	46 ± 3 dB

With a frequency-converter noise figure at the front-end output connector of 20 dB, the added noise is 0.75K at 46 dB and 1.5K at 43 dB. The phase-cal coupling is -45 dB; thus the gain from phase-cal input to front-end output should be between -2 and +4 dB.

V. 8.4 GHz Cal Values

The 8.4 GHz front-ends will utilize calibration circuitry per Memo #56, Figure 1, with α_1 = 3 dB, α_2 = 8 dB, $C_1 = C_2$ = 10 dB, and C_3 = 30 dB. The CAL value will be 4.0 ± 0.5K and HI CAL will be 900 ± 300K. Exact (± 1%) values will be supplied as a function of frequency with each front-end.

VI. Front-End Test Data

Three copies of the production test data for each front-end will be prepared. One copy will go to the central drawing file, one copy will stay in the front-end construction group, and one copy will be shipped with the front-end.

A sample of production test data for a front-end is attached.

VII. Monitor-Bit Clarifications

The pump request bit, P, is a 1 if dewar vacuum pumping is required. However, the vacuum solenoid to the dewar will not open unless the vacuum on the pump line is low enough. When the solenoid valve opens, the monitor bit, S, becomes 1, indicating connection to the vacuum pump.

Control bit logic equations have been added to the control card schematic.

VIII. Serial and Mod Numbers

To allow for larger numbers of front-ends (including VLA), the Serial Number bits have been increased from 4 to 6, and Mod bits have been reduced from 4 to 2. All 8.4 GHz receivers will have the same Frequency ID bits, rather than the scheme shown in Table IV of Memo #56. Up-to-date tables of pin assignments are attached.

Fig. 1. Monitor and control ID byte for front-ends.

TABLE [redacted]

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

TA[redacted] II[redacted]

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

TA[redacted] III[redacted]

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

TABLE IV

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

TABLE V

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

February 11, 1986

CALIBRATION RECORD OF 8.4 GHZ RECEIVER, SERIAL #1, MOD #Ø
LCP POLARIZATION, TESTED BY CRADY/WEINREB, DATE Ø2/Ø3/85
TIME 16:2Ø.5
COMMENT: CAL BY LN8, ADDING Ø.72K FOR LOSS

15K TEMP =	14.32	5ØK TEMP =	52.72	3ØØK TEMP =	3Ø3.Ø7
AC AMPS =	Ø.447	DEWR VAC =	161	PUMP VAC =	1ØØ69
HEMT LED =	1Ø.11	+15 VOLT =	15.1Ø3	TA SENS V=	-1.894
CAL VOLT =	28.Ø2	HIGH CAL =	28.Ø1	SPARE =	Ø.Ø1
FETS: LF1=	-.812	LF2=	-.864	RF1= -.812	RF2= -.877

CRYØ MODE IS COOL (7) CONTROLLED BY MANUAL. PARITY IS CORRECT

16:29.9 Ø2/Ø3/85 THOT=299.7 TCOLD=79.88 IF 48DB ATTEN, 3ØMHZ BW

F,MHZ	TRCVR	TCAL	HI CAL	SHORT
74ØØ	391.4	1.96	638.Ø	15.7
75ØØ	251.8	3.52	627.3	18.3
76ØØ	172.5	3.23	67Ø.8	18.5
77ØØ	12Ø.6	3.87	84Ø.Ø	19.1
78ØØ	91.8	4.17	948.4	21.5
79ØØ	74.4	4.Ø8	9Ø2.4	21.2
8ØØØ	62.6	3.99	852.6	17.3
81ØØ	51.9	3.98	816.5	16.9
82ØØ	42.6	4.12	795.7	17.9
83ØØ	36.6	4.Ø7	859.2	18.9
84ØØ	33.8	3.99	983.1	19.1
85ØØ	33.8	3.99	1Ø64.2	18.4
86ØØ	33.3	4.1Ø	93Ø.8	17.4
87ØØ	33.6	4.11	814.4	17.Ø
88ØØ	37.8	4.13	772.4	16.5
89ØØ	48.6	3.95	88Ø.1	17.7
9ØØØ	69.2	3.84	1Ø45.6	17.6
91ØØ	1Ø8.8	3.46	1Ø36.3	2Ø.7
92ØØ	291.2	6.55	1529.2	16.4
93ØØ	29Ø.5	5.13	91Ø.7	19.Ø
94ØØ	375.8	6.4Ø	892.1	11.6

CALIBRATION RECORD OF 8.4 GHZ RECEIVER, SERIAL #1, MOD #Ø
RCP POLARIZATION, TESTED BY CRADY/WEINREB, DATE Ø2/Ø3/85
TIME 16:34.Ø
COMMENT: LN8 LN2 CAL SOURCE, ADDED Ø.72K TO PHYSICAL TEMP

15K TEMP = 14.33 5ØK TEMP = 52.69 3ØØK TEMP = 3Ø3.79
AC AMPS = Ø.448 DEWR VAC = 161 PUMP VAC = 1ØØ72
HEMT LED = 1Ø.12 +15 VOLT = 15.1Ø4 TA SENS V= -1.894
CAL VOLT = 28.Ø1 HIGH CAL = 28.Ø1 SPARE = Ø.Ø1
FETS: LF1= -.813 LF2= -.864 RF1= -.812 RF2= -.879
CRYØ MODE IS COOL (7) CONTROLLED BY MANUAL. PARITY IS CORRECT

17:Ø7.5 Ø2/Ø3/85 THOT=299.7 TCOLD=79.88 45DB IF ATTENUATION
, 3ØMHZ BW

F,MHZ	TRCVR	TCAL	HI CAL	SHORT
74ØØ	513.1	1.51	589.2	17.2
75ØØ	355.3	3.76	6Ø2.Ø	19.7
76ØØ	222.6	2.85	656.Ø	2Ø.5
77ØØ	138.8	3.96	828.9	21.5
78ØØ	93.2	4.Ø3	938.5	2Ø.1
79ØØ	7Ø.8	4.1Ø	9Ø3.9	18.8
8ØØØ	55.Ø	4.2Ø	837.6	17.2
81ØØ	44.9	4.Ø9	8Ø6.2	17.4
82ØØ	37.3	4.21	8Ø5.9	18.2
83ØØ	33.Ø	4.17	873.1	19.1
84ØØ	31.8	4.Ø7	995.9	19.1
85ØØ	32.1	4.Ø4	1Ø56.6	18.5
86ØØ	33.5	3.96	916.Ø	18.Ø
87ØØ	36.2	4.Ø3	799.8	17.3
88ØØ	41.7	4.Ø5	777.Ø	16.9
89ØØ	5Ø.4	4.1Ø	894.3	18.3
9ØØØ	62.4	3.88	1Ø73.1	17.8
91ØØ	88.Ø	3.88	1Ø68.Ø	21.1
92ØØ	181.Ø	6.63	1498.Ø	18.5
93ØØ	166.1	4.75	956.4	19.9
94ØØ	188.3	3.88	875.2	17.7

84 GHz FRONT-END, S/N 1 Date: 3-10-86

FET BIAS SETTINGS

Stage	LCP AMP # 311				RCP AMP # 310			
	V_D	I_D	V_G 300K	V_G 15K	V_D	I_D	V_G 300K	V_G 15K
1	3.50	12.5	-.746	-.825	3.00	14.0	-.801	-.829
2	3.00	14.5	-.794	-.774	4.00	14.8	-1.029	-1.195
3	4.00	9.7	-.726	-.978	4.50	14.5	-.364	-.584

TOTAL RF POWER OUT INTO 1.4 GHz BANDWIDTH AS MEASURED WITH HP436/8484A POWER METER

Input Condition	15K LCP dBm	15K RCP dBm	300K LCP dBm	300K RCP dBm
302K Load	-38.04	-39.64	-41.89	-42.80
79.7K Load	—	—	—	—
Short	-45.24	-46.98	-41.88	-42.79
Short + Cal	-44.98	-46.70	-41.86	-42.76
Short + HI Cal	-33.71	-35.31	-38.56	-39.49

8.4 GHZ RECEIVER TEST DATA

Front-End S/N: 1

Date: 2/6/86

By: S. WEINREB

Remarks: RCP GAIN NOT IN SPEC
ACCEPTABLE

RECEIVER FLUCTUATION SPECTRA

Measured with shorting plate on input, 30 MHz I.F. bandwidth, and 1.55 volts DC back-off voltage into HP3561A analyzer.

Receiver 8.4-1 Date 2/11/86

8.4-1 RCP 10HZ 2/10/86

8.4-1 RCP 500HZ 2/7/86

8.4-1 LCP 10HZ 2/9/86

8.4-1 LCP 500HZ 2/8/86

NOTES.

1. U1-4 TL084BCN
2. U5-6 AD581JH
3. ALL CAPS. ARE 50V UNLESS OTHERWISE MARKED.
4. ALL RES. AS FOLLOWS:
   5% 1/4 WATT
   1% 1/8 WATT
5. SEE CR3 FOR FOR INTERNAL SCHEMATIC.
6. K1-MAGNECRAFT W171DIP-14

REV	DATE	DRAWN BY	APPRV'D BY	DESCRIPTION
B	8/25/86	G. MORRIS		
A	8/21	H. DILL		CO-890816-21

VLBA RECEIVER

FRONT ENDS

FET BIAS CARD
4-STAGE

NATIONAL RADIO ASTRONOMY OBSERVATORY
CHARLOTTESVILLE, VA 22901

DRAWN BY H. DILL DATE 8/07/86
DESIGNED BY S. WEWERKA DATE 8/08/83
APPROVED BY DATE

SHEET NUMBER OF DRAWING NUMBER 0532005001 REV B SCALE

NOTES

1. U1,U2,U8-TL084BCN
2. U3-LM393AN
3. U4-AD7512DIKN
4. U5-U6-OP10GY
5. U7-AD581JH
6. ALL CAPS. ARE 50V UNLESS NOTED OTHERWISE.
7. ALL RES. AS FOLLOWS UNLESS NOTED OTHERWISE.
   1% 1/8 WATT
   5% 1/4 WATT

REV	DATE	DRAWN BY	APPR'D BY	DESCRIPTION
C	1-86	G. MORRIS		CO860130-07
B	11-85	G. MORRIS		
A	8/84	H. DILL		60-840817-20

VBA FRONT ENDS

SENSOR CARD

NATIONAL RADIO ASTRONOMY OBSERVATORY
CHARLOTTESVILLE, VA 22901

DRAWN BY H. DILL DATE 840718
DESIGNED BY S. WEINREB DATE 840522
CHECKED BY
APPROVED BY

SHEET NUMBER 1 of 1 DRAWING NUMBER 0532005002 REV C SCALE

NOTES

1. U1-U2 - LM339N
2. U3-74LS04
3. U4-74LS11
4. U5-74LS32
5. U6-74LS08
6. U7-U8-75452
7. U9-7805CT
8. U10-AD581JH
9. ALL CAPS. ARE 50V UNLESS OTHERWISE MARKED.
10. ALL RES. AS FOLLOWS:
    1% 1/8WATT
    5% 1/4WATT
11. K1-K4 P&B T71U50164
12. U11-74LS02

CONTROL STATES*

STATE	CONTROL BIT X	C	H	OCTAL VALUE	SYSTEM MODE
COOL	1	1	1	7	NORMAL
LOAD	1	0	0	4	1/2 W LOAD
OFF	1	0	1	5	NO COOL, HEAT OR PUMP
PUMP	0	1	0	2	PUMP ONLY
HEAT	1	1	0	6	PUMP AND HEAT (30W)
UNUSED	0	0	0	0	LOAD
UNUSED	0	0	1	1	OFF
UNUSED	0	1	1	3	COOL

*TTL LOGIC 1=ON =HI LEVEL
0=OFF=LO LEVEL

CONTROL LOGIC*

L=1/2 W Load $=\bar{C}\bullet H\bullet(TA<360K)$

P=Pump Request $=(C+\bar{C}\bullet H)\bullet(VD>3\mu)$

Q=Heater 30 W $=(\bar{X}+\bar{C})\bullet H\bullet(TA<360K)$

R=Refrigerator PWR $=(C\bullet\bar{H}+\bar{C}\bullet H)\bullet(VD<50\mu)$

S=Valve Open (Sol. On) $=(C+\bar{C}\bullet H)\bullet(VD>5\mu)\bullet(VP<VD)\bullet(TA>30K)+(VD>50\mu)\bullet(TA>280K)$

REV	DATE	DRAWN BY	APPRV'D BY	DESCRIPTION
C	1-86	G MORRIS		CO-860130-06
B	6/85	G MORRIS		
A	8/84	H.D.W.		CO-840817-20

VLBA FRONT ENDS

NATIONAL RADIO ASTRONOMY OBSERVATORY
CHARLOTTESVILLE, VA

CONTROL CARD

DRAWN BY H DILL DATE 840710
DESIGNED BY E. WEINREB DATE 840622
APPROVED BY DATE

SHEET NUMBER 1 of 1 DRAWING NUMBER 0532008003 REV C SCALE

REV.	DATE	DRAWN BY	APPRV'D BY	DESCRI[redacted]
A	11-86	G. MORRIS		
B	1-17-86	G. MORRIS		C0816 0117-02

NOTES:

1. U1 - 74LS148
2. U2 - 74LS157
3. U3 - 74LS32
4. U4 - 74LS12
5. U5 - 7805CT
6. ALL CAPS ARE 50V UNLESS NOTED OTHERWISE.

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES: ANGLES ± 3 PLACE DECIMALS (.XXX): ± 2 PLACE DECIMALS (.XX): ± 1 PLACE DECIMALS (.X): ±	PROJECT: FRONT END	NATIONAL RADIO ASTRONOMY OBSERVATORY	
MATERIAL:	TITLE: MONITOR BOARD	DRAWN BY G. MORRIS	DATE 8-30-85
		DESIGNED BY S WEINREIB	DATE 7-15-85
FINISH:		APPROVED BY	DATE
NEXT ASSY / USED ON	SHEET NUMBER	DRAWING NUMBER C532005005	REV. B / SCALE